1991

CHEVROLET

CAMARO
SERVICE
MANUAL

ST 368-91

CAUTION

To reduce the chance of personal injury and/or property damage, the following instructions must be carefully observed:

Proper service and repair are important to the safety of the service technician and the safe, reliable operation of all motor vehicles. If part replacement is necessary, the part must be replaced with one of the same part number or with an equivalent part. Do not use a replacement part of lesser quality.

The service procedures recommended and described in this service manual are effective methods of performing service and repair. Some of these procedures require the use of tools specifically designed for the purpose.

Accordingly, anyone who intends to use a replacement part, service procedure or tool, which is not recommended by the vehicle manufacturer, must first determine that neither his safety nor the safe operation of the vehicle will be jeopardized by the replacement part, service procedure or tool selected.

It is important to note that this manual contains various 'Cautions' and 'Notices' that must be carefully observed in order to reduce the risk of personal injury during service or repair, or the possibility that improper service or repair may damage the vehicle or render it unsafe. It is also important to understand that these 'Cautions' and 'Notices' are not exhaustive, because it is impossible to warn of all the possible hazardous consequences that might result from failure to follow these instructions.

991 CAMARO SERVICE MANUAL

FOREWORD

This manual provides information on diagnosis, service procedures, adjustments and specifications for the 1991 Camaro.

An understanding of the material contained in this manual and in the appropriate Dealer Service Bulletins will help technicians to better serve vehicle owners.

When reference is made in this manual to a brand name, number, or specific tool, an equivalent product may be used in place of the recommended item.

All information, illustrations and specifications contained in this literature are based on the latest product information available at the time of publication approval. The right is reserved to make changes at any time without notice.

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CHEVROLET-PONTIAC-CANADA GROUP
General Motors Corporation
WARREN, MICHIGAN

1991 SERVICE MANUAL COMMENT FORM

Use this form to advise us of any errors you might find in this manual. We also welcome suggestions for improving the Chevrolet Service Manual.

Service Manual(s) that have the error ______________________

Page number(s) that have the error ______________________

Figure number(s) that have the error ______________________

VIN (if available) or model and applicable options ______________________

Describe in detail, the error found or the suggestion(s). Attach additional pages if necessary.

From: Dealer Firm Name ______________________ Dealer Code ____________
City/Town ______________________ State ____________
Name of Person Submitting This Comment Form ______________________
Signature ______________________ Date ____________

Mail To: Customer Satisfaction
G-30-5
Chevrolet C.O. Building
30007 Van Dyke Ave.
Warren, MI. 48090

SECTION 0A

GENERAL INFORMATION

CAUTION: On vehicles equipped with Supplemental Inflatable Restraints (SIR), refer to CAUTIONS in Section 9J-B under On-Vehicle Service before performing service on or around SIR components or SIR wiring. Failure to follow cautions could result in possible air bag deployment, personal injury or unneeded SIR system repairs.

CONTENTS

HANDLING ELECTROSTATIC DISCHARGE (ESD) SENSITIVE PARTS

Figure 1

NOTICE: When handling an electronic part that has an ESD sensitive sticker, (Figure 1) or is identified as ESD sensitive in the list that follows, the service technician should follow these guidelines to reduce any possible electrostatic charge buildup on the service technician's body and the electronic part in the dealership:

1. Do not open the package until it is time to install the part.
2. Avoid touching electrical terminals of the part.
3. Before removing the part from its package, ground the package to a known good ground on the vehicle.
4. Always touch a known good ground before handling the part. This should be repeated while handling the part and more frequently after sliding across the seat, sitting down from a standing position or walking a distance.

Not all parts that can be damaged by ESD have an ESD label. Components that can be damaged by ESD are:

Chime module

Cruise control module

Driver information module

Power door lock module

ECM (Electronic Control Module)

Theft deterrent module

Radio/radio control

Supplemental inflatable restraint control module

Electronic spark timing module

Steering wheel switch

PROM (Programming Read Only Memory) calibrator

MEM-CAL (Memory and Calibration unit)

CalPak

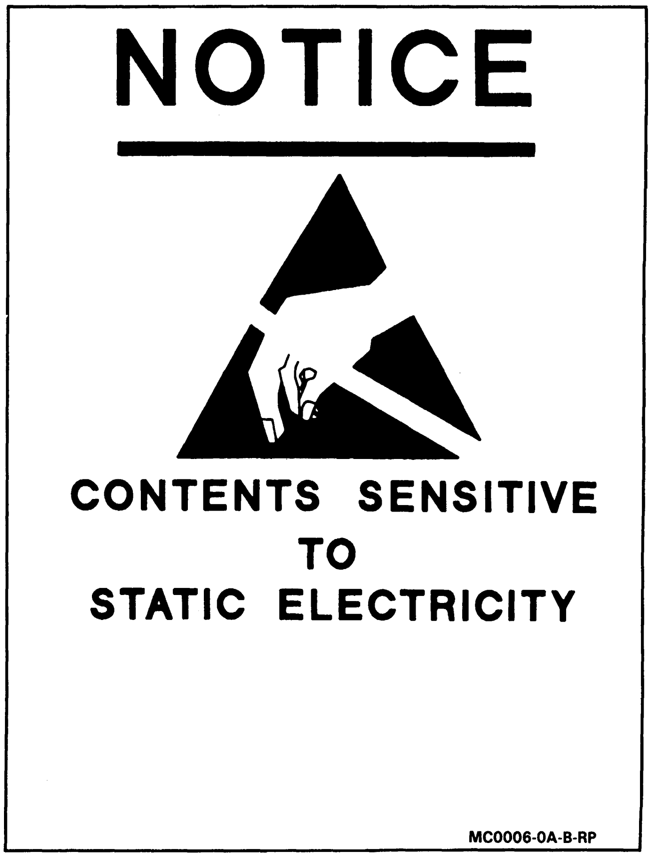


Figure 1 - ESD Sensitive Parts Label

BODY IDENTIFICATION

A body identification tag is attached to the vehicle on the center of the radiator tie. The tag gives a schedule number and the last four digits of the Vehicle Identification Number (VIN) sequence number. Refer to "Vehicle Identification Number" in this section. Paint codes, trim numbers, seat option codes and other body information is included on the Service Parts Identification Label. Refer to "Service Parts Identification Label" in this section.

FEDERAL VEHICLE THEFT PREVENTION STANDARD

Federal law requires General Motors to place a VIN label on certain parts on selected vehicles. The purpose of the standard is to reduce motor vehicle thefts by making parts removed from stolen vehicles easier to trace and recover.

The label is permanently attached to an interior surface of the part and will contain the complete VIN. The label on replacement parts will contain the letter "R," the manufacturer's logo and the symbol "DOT." The labels must not be defaced, removed or covered.

> **NOTICE:** The theft deterrent label found on some major sheet metal, engines and transmissions must be masked prior to painting, rustproofing, undercoating, etc. The mask must be removed following these operations. Failure to keep the label clean and readable may result in liability for violation of Federal Vehicle Theft Prevention Standard, and subject the vehicle owner to possible suspicion that the part was stolen.

The theft deterrent labels are located on the doors, front and rear fenders, hood, compartment lift window panel, front and rear impact bars and the door windows.

VEHICLE IDENTIFICATION NUMBER

Figures 2 thru 4

The Vehicle Identification Number (VIN) legally identifies the vehicle. A VIN plate is attached to the upper left of the instrument panel and can be seen from outside the vehicle. Each sequential unit number is prefixed by letters and numbers that are explained in Figure 3. The VIN also appears on the Vehicle Certificate of Title and Registration.

A derivative of the VIN appears on the engine and transmission. The code gives the division, model year, plant of manufacture and a sequence number.

A bar code VIN is also on the vehicle identification plate.

ENGINE IDENTIFICATION

Figures 5 and 6

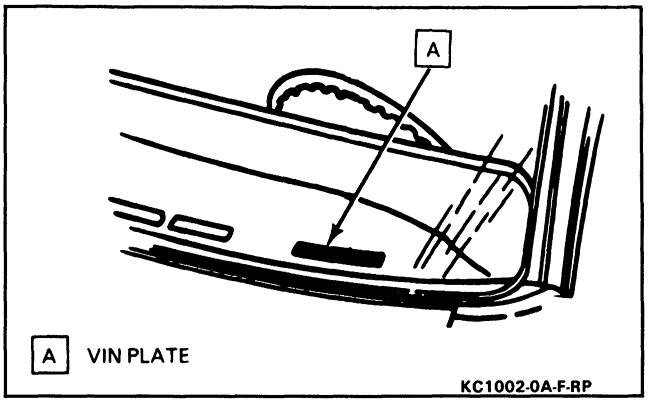


Figure 2 - VIN Plate Location

The engine has three identifying labels: the engine identification number, the engine verification label and the VIN derivative. The engine identification number gives a source code, month and date of build and a broadcast code. The engine verification label contains a bar code and other information used in-plant. The VIN derivative is created from the complete VIN. Refer to "Vehicle Identification Number" in this section.

If the engine in the vehicle is the original engine, information can be derived from the eighth VIN position letter number (Figure 3). To determine if the engine is original, compare the VIN and the VIN derivative. The VIN derivative should be the same as positions 3 and 10 through 17 of the VIN.

TRANSMISSION USAGE

Figure 7

Transmission usage affects axle usage. The transmission usage chart lists each engine with the axles and transmissions used for each.

TRANSMISSION IDENTIFICATION

Figures 8 and 9

The transmission has two identifying labels: the transmission ientification label and the VIN derivative. The transmission identification number gives the model and when it was made. On the automatic transmission, the transmission identification number is located on a plate on the automatic transmission case. On the manual transmission, the transmission identification number is located either on the transmission case, or the bell housing. The VIN derivative is created from the complete VIN. Refer to "Vehicle Identification Number" in this section.

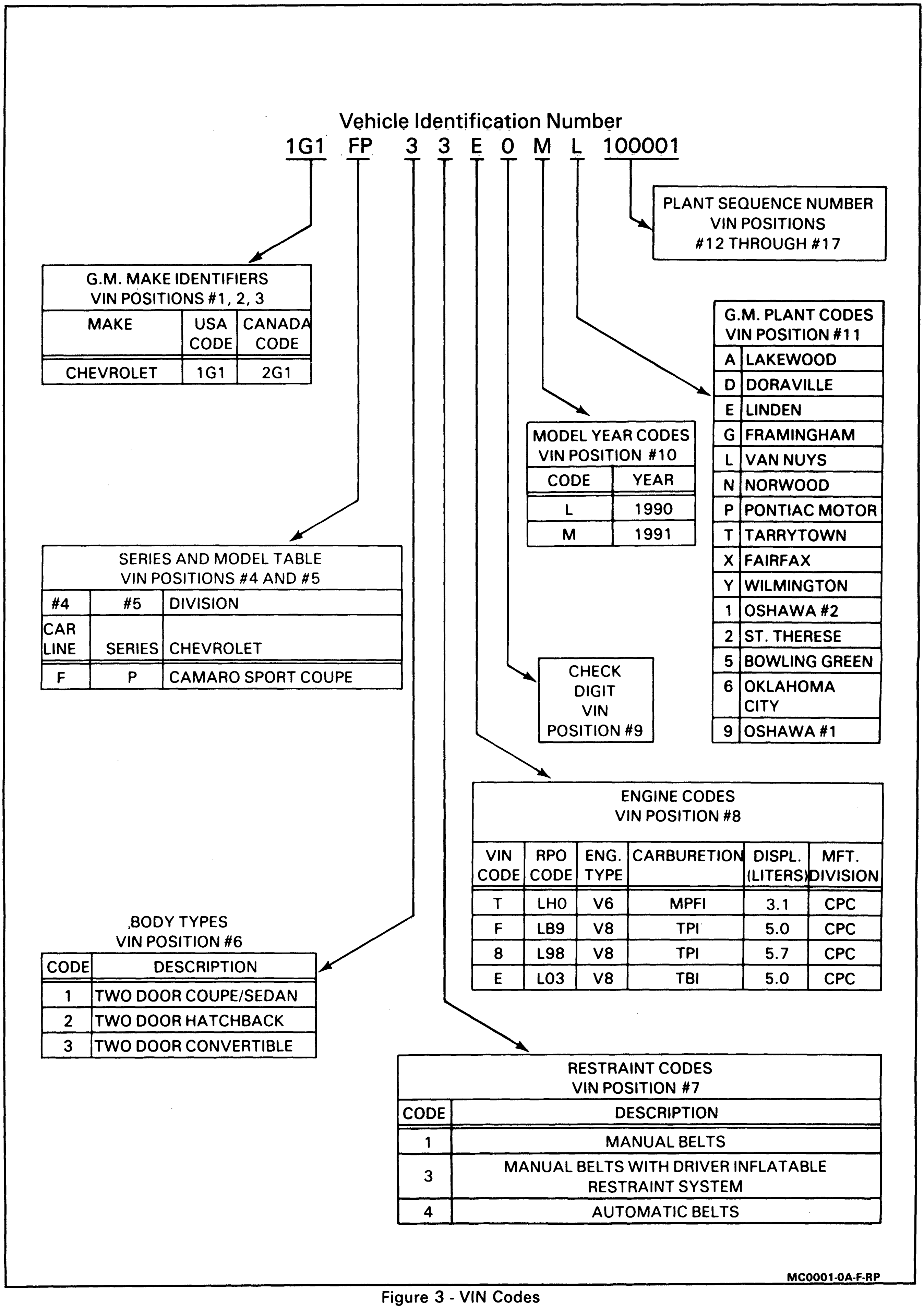
DIFFERENTIAL RATIOS AND TIRE INFORMATION

For differential ratios and tire information, refer to REAR AXLE (SEC. 4B) or TIRES AND WHEELS (SEC. 3E).

GENERAL VEHICLE LIFTING AND JACKING

Figure 10

> **CAUTION: To help avoid personal injury when a vehicle is on a hoist, provide additional support for the vehicle at the opposite end from which components are being removed. The additional support will reduce the possibility of the vehicle's**



Vehicle Identification Number

1G1 FP 3 3 E 0 M L 100001

PLANT SEQUENCE NUMBER
VIN POSITIONS
#12 THROUGH #17

G.M. MAKE IDENTIFIERS
VIN POSITIONS #1, 2, 3

MAKE	USA CODE	CANADA CODE
CHEVROLET	1G1	2G1

G.M. PLANT CODES
VIN POSITION #11

A	LAKEWOOD
D	DORAVILLE
E	LINDEN
G	FRAMINGHAM
L	VAN NUYS
N	NORWOOD
P	PONTIAC MOTOR
T	TARRYTOWN
X	FAIRFAX
Y	WILMINGTON
1	OSHAWA #2
2	ST. THERESE
5	BOWLING GREEN
6	OKLAHOMA CITY
9	OSHAWA #1

MODEL YEAR CODES
VIN POSITION #10

CODE	YEAR
L	1990
M	1991

SERIES AND MODEL TABLE
VIN POSITIONS #4 AND #5

#4	#5	DIVISION
CAR LINE	SERIES	CHEVROLET
F	P	CAMARO SPORT COUPE

CHECK
DIGIT
VIN
POSITION #9

ENGINE CODES
VIN POSITION #8

VIN CODE	RPO CODE	ENG. TYPE	CARBURETION	DISPL. (LITERS)	MFT. DIVISION
T	LH0	V6	MPFI	3.1	CPC
F	LB9	V8	TPI	5.0	CPC
8	L98	V8	TPI	5.7	CPC
E	L03	V8	TBI	5.0	CPC

BODY TYPES
VIN POSITION #6

CODE	DESCRIPTION
1	TWO DOOR COUPE/SEDAN
2	TWO DOOR HATCHBACK
3	TWO DOOR CONVERTIBLE

RESTRAINT CODES
VIN POSITION #7

CODE	DESCRIPTION
1	MANUAL BELTS
3	MANUAL BELTS WITH DRIVER INFLATABLE RESTRAINT SYSTEM
4	AUTOMATIC BELTS

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Figure 3 - VIN Codes

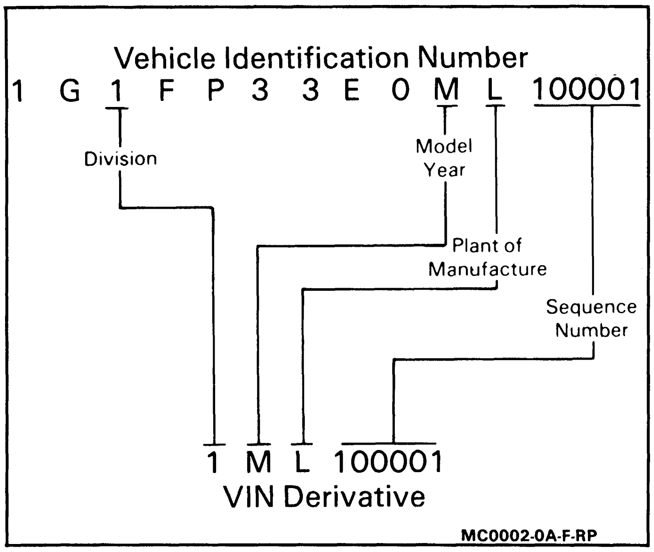

Figure 4 - VIN Derivative

falling off the hoist. When removing major components of the vehicle while the vehicle is on a hoist, the vehicle frame should be chained to the hoist pads at the same end as the removed components to prevent tip-off. Failure to follow these precautionary measures could result in vehicle damage, serious personal injury or death.

NOTICE: When jacking or lifting the vehicle from the frame side rails, be certain the lift pads do not contact the catalytic converter or damage could result.

When a vehicle is lifted with a vehicle jack or floor jack, the wheels at the opposite end should be blocked. Jackstands should be used to provide additional support. Jackstands should be placed under the frame, front suspension crossmember or the axle.

The vehicle should be on a clean, hard, level surface before any lifting procedure begins. All lifting equipment must meet weight standards and be in good working order. Make sure all vehicle loads are equally distributed and secure. If the only support for the vehicle is at the frame side rails, make sure the lifting equipment does not put too much stress on or weaken the frame side rails.

Recommended vehicle lifting points are shown in Figure 10. If any other hoist methods are used, take special care not to damage the fuel tank, filler neck, exhaust system or underbody.

METRIC FASTENERS

Many fasteners are metric. Metric fasteners may be close in dimension to well-known customary fasteners in the inch system. Replacement fasteners must be the correct nominal diameter, thread pitch and strength.

Original equipment metric fasteners, except for exposed bumper bolts and other beauty bolts and cross-recess head screws, have numbers on their heads identifying them as metric. Cross-recess head screws can be identified by a Posidriv or a Type 1A cross-recess. Either type of cross-recess screwdriver can be used to remove Posidriv recess head screws, but Type 1A will perform better.

NOTICE: Most metric fasteners have a blue color coating. This coating should not be used to positively identify fasteners because not all metric fasteners are color-coated. Damage to the fastener or part could result if a customary fastener is incorrectly used to replace a metric fastener.

General Motors Engineering Standards, along with other North American industries, have adopted a portion of the standard metric fastener sizes defined by the International Standards Organization (ISO). This standard was adopted to reduce the number of fasteners used while keeping the best strength qualities of each thread size. For example, the customary 1/4-20 and 1/4-28 screws were replaced by the metric M6.0x1 screw, which has almost the same diameter and 25.4 threads per inch. The thread pitch is between the customary coarse and fine thread pitches.

Metric and customary thread notations differ slightly. The thread major diameter of a 1/4-20 bolt is 1/4 inch, and the bolt has 20 threads per inch. The thread major diameter of an M6.0x1 bolt is 6.0mm, and the bolt has 1mm between threads.

FASTENER STRENGTH IDENTIFICATION

Figure 11

Most commonly used metric fastener strength property classes are 9.8 and 10.9. The class identification is embossed on the head of each bolt. Customary fastener strength property classes range from grade 2 to 8. Radial lines are embossed on the head of each bolt to identify the strength class. Some metric nuts are marked with strength identification numbers on the nut face.

When replacing fasteners, be careful to use bolts and nuts of the same strength class as, or higher than, the original fasteners. Many metric fasteners available in the aftermarket parts channels were designed to metric standards of countries other than the United States. The fasteners may have different strength or thread pitch and may not have the numbered head marking system. The metric fasteners used on GM products are designed to new international standards that may not be used by some nondomestic bolt and nut suppliers.

PREVAILING TORQUE FASTENERS

Figures 12 and 13

A prevailing torque nut is designed to develop an interference between the nut and bolt threads. This interference is usually created by distortion of the top of an all-metal nut or by a nylon patch on the threads in the middle of a hex flat. A nylon insert may also be used.

A prevailing torque bolt is designed to develop an interference between the bolt and nut threads or between the bolt and tapped hole threads. This interference is created by distorting some of the threads or by using a nylon patch or adhesive.

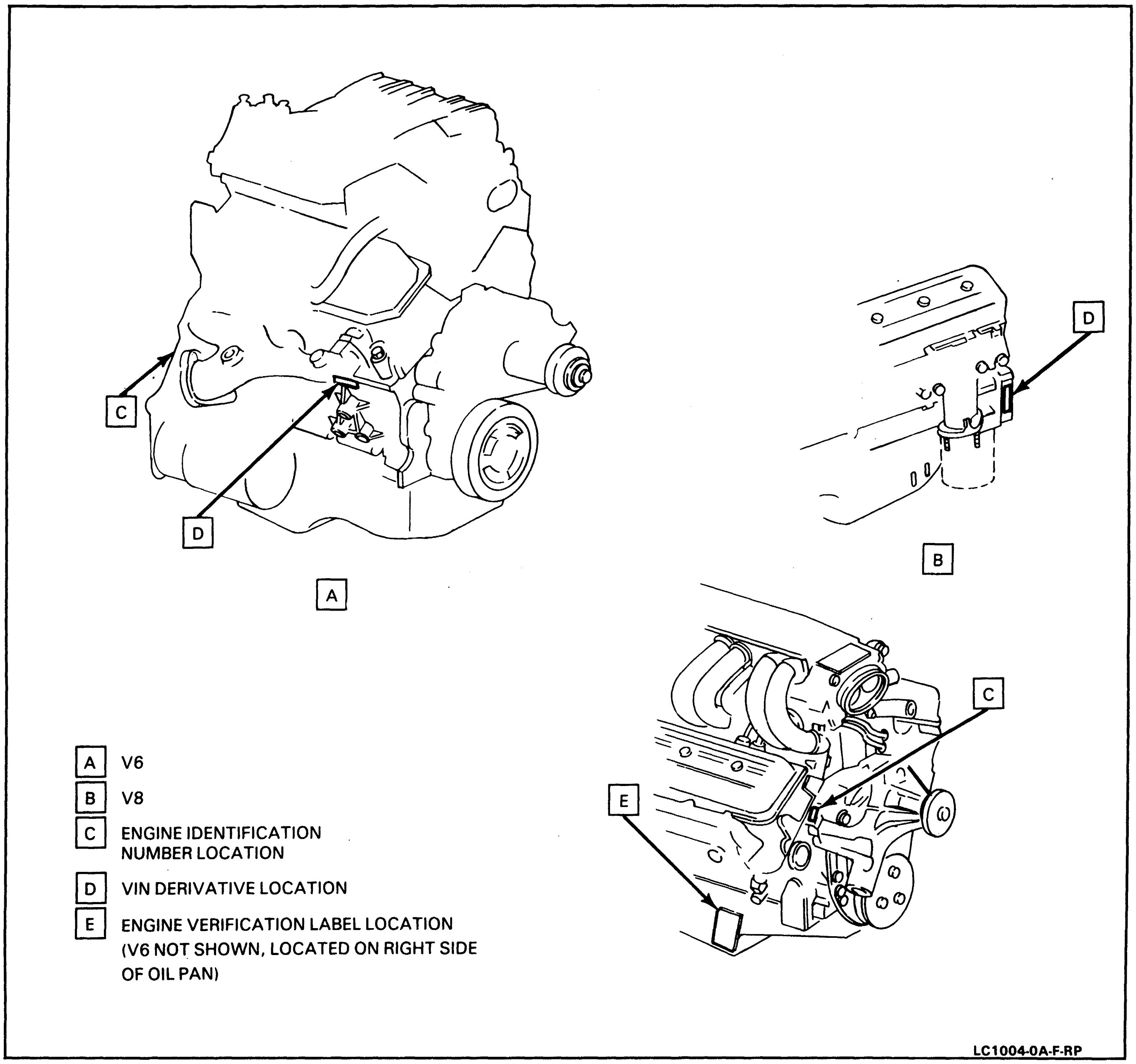

Figure 5 - Engine Label Locations

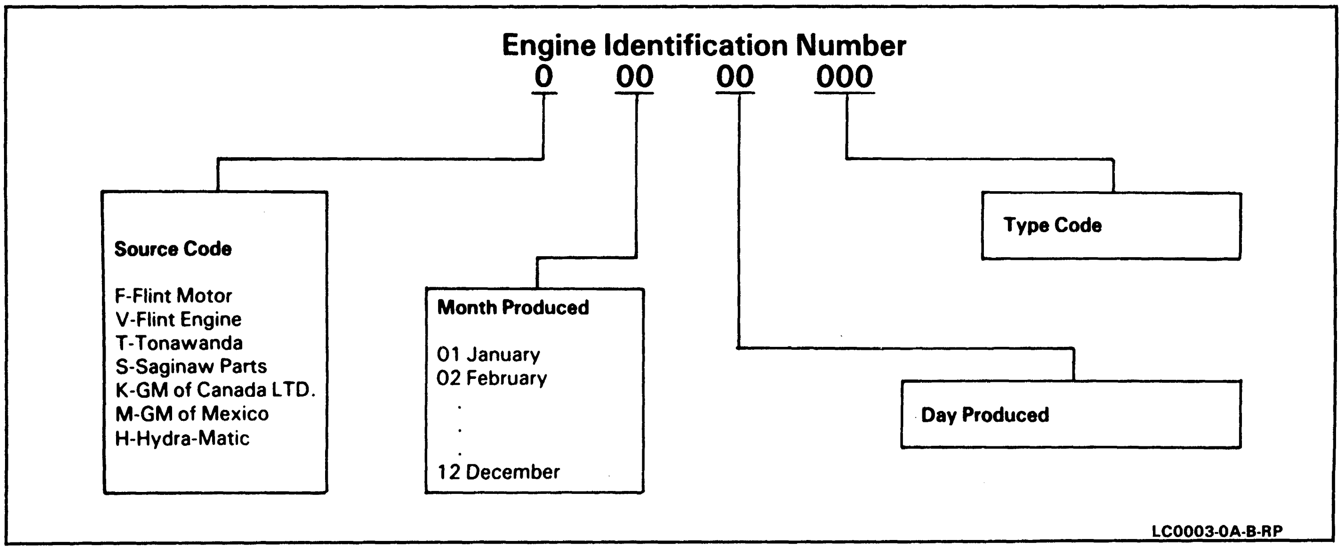

Figure 6 - Engine Identification Number

TRANSMISSION USAGE

Engine	Axle (RPO-Ratio)	Transmission
3.1L, V6 (VIN T)	GU6-3.42	MBI-Manual
	GU5-3.23	MD8-Hydra-Matic 4L60
5.0L, V8 (VIN F)	GU4-3.08	M39-Manual
	GU6-3.42	MK6-Manual
	GU2-2.73	MD8-Hydra-Matic 4L60
5.0L, V8 (VIN E)	GU4-3.08	M39-Manual
	GU2-2.73	MD8-Hydra-Matic 4L60
5.7L, V8 (VIN 8)	GU5-3.23	MD8-Hydra-Matic 4L60

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Figure 7 - Transmission Usage Chart

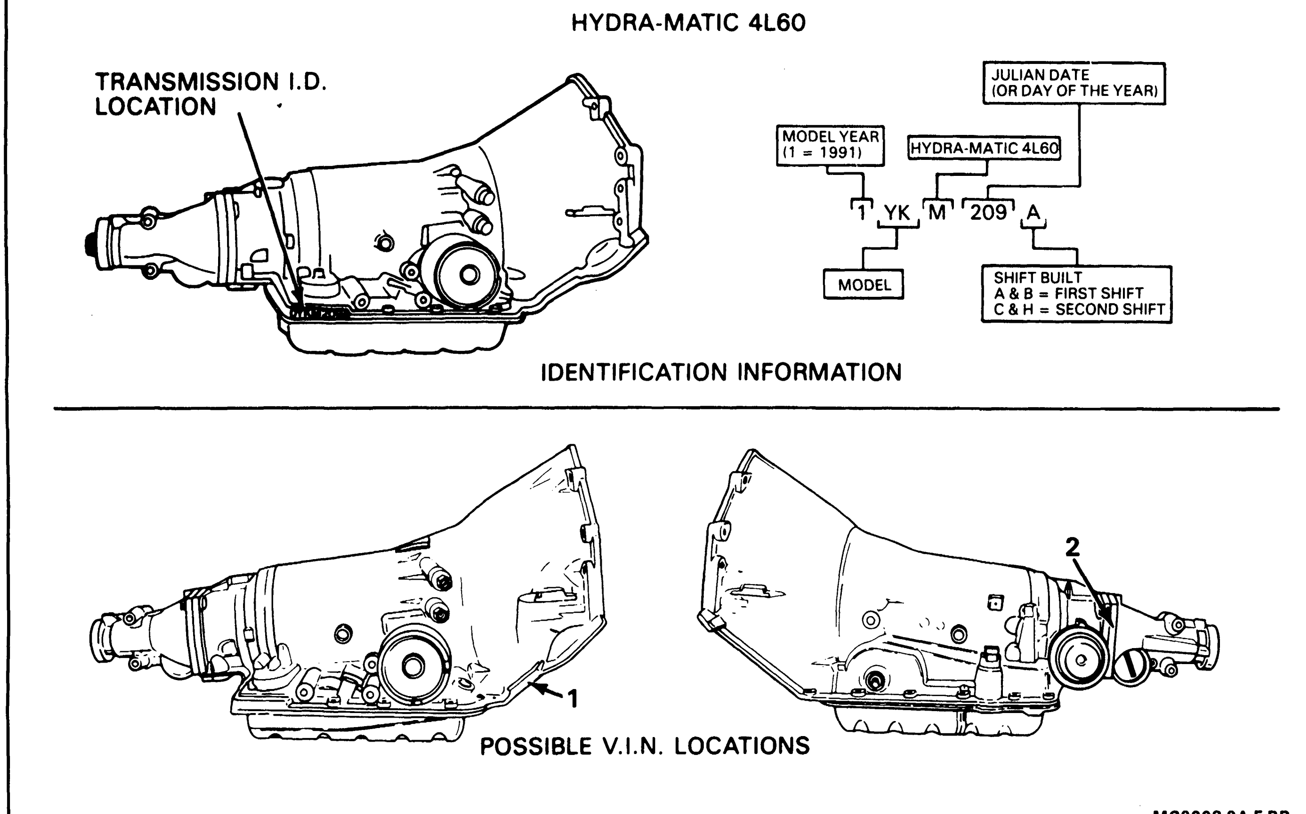


Figure 8 - Automatic Transmission Label Locations

Rusty or damaged bolts and nuts should be replaced with new parts of the same strength class or higher. Clean, unrusted bolts and nuts can be reused. Be sure to use the following recommendations.

1. Clean dirt and other foreign material from the nut or bolt.
2. Inspect the nut or bolt for cracks, elongation or other signs of abuse or overtightening.
   - If the nut or bolt is worn in any way, replace with a nut or bolt of the same strength class or higher.
3. Assemble the parts and hand-start the nut or bolt.
4. Check that the nut or bolt develops torque according to Figure 13 before it seats.
   - If the nut or bolt fails to develop torque correctly, replace with a nut or bolt of the same strength class or higher.
5. Tighten the fasteners to the torque specified in the appropriate installation procedure in this manual.

ENGLISH-METRIC CONVERSIONS

Figure 14

To convert customary units to metric units, refer to Figure 14. To convert metric units to customary units, divide the metric units by the conversion factor shown in Figure 14.

DECIMAL AND METRIC EQUIVALENTS

Figure 15

Inch-to-millimeter decimal equivalents are shown in Figure 15.

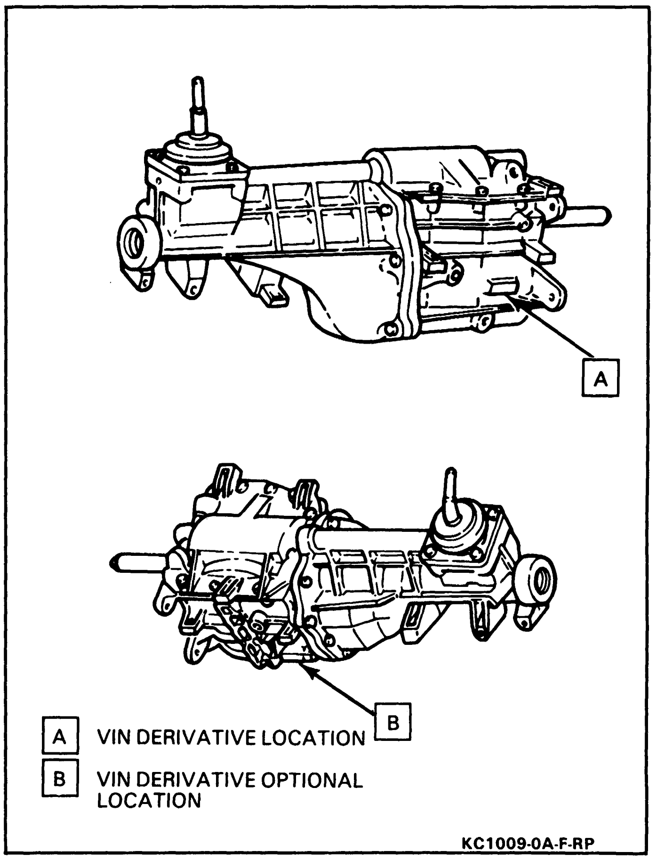
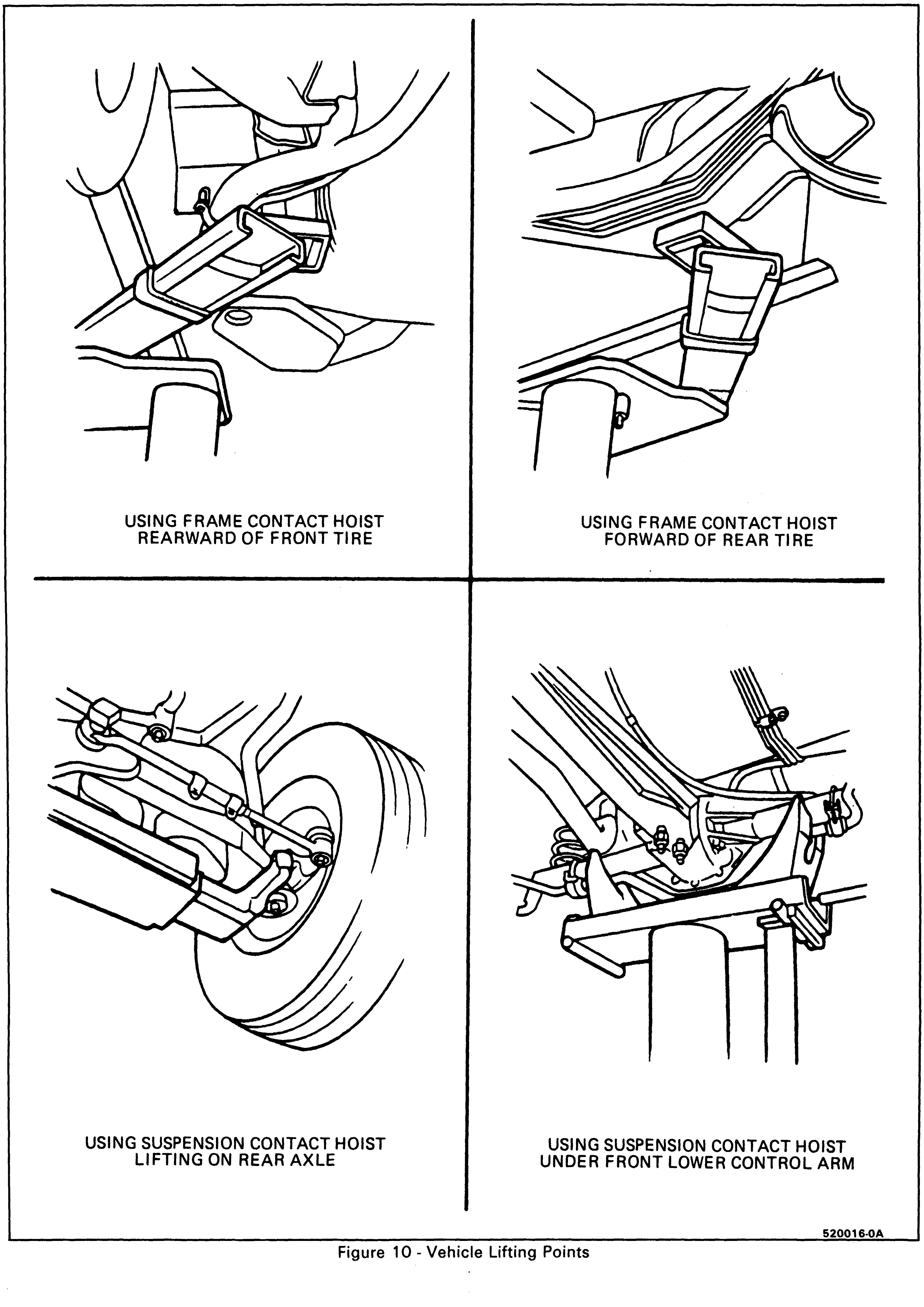


Figure 9 - Manual Transmission Label Location



USING FRAME CONTACT HOIST
REARWARD OF FRONT TIRE

USING FRAME CONTACT HOIST
FORWARD OF REAR TIRE

USING SUSPENSION CONTACT HOIST
LIFTING ON REAR AXLE

USING SUSPENSION CONTACT HOIST
UNDER FRONT LOWER CONTROL ARM

Figure 10 - Vehicle Lifting Points

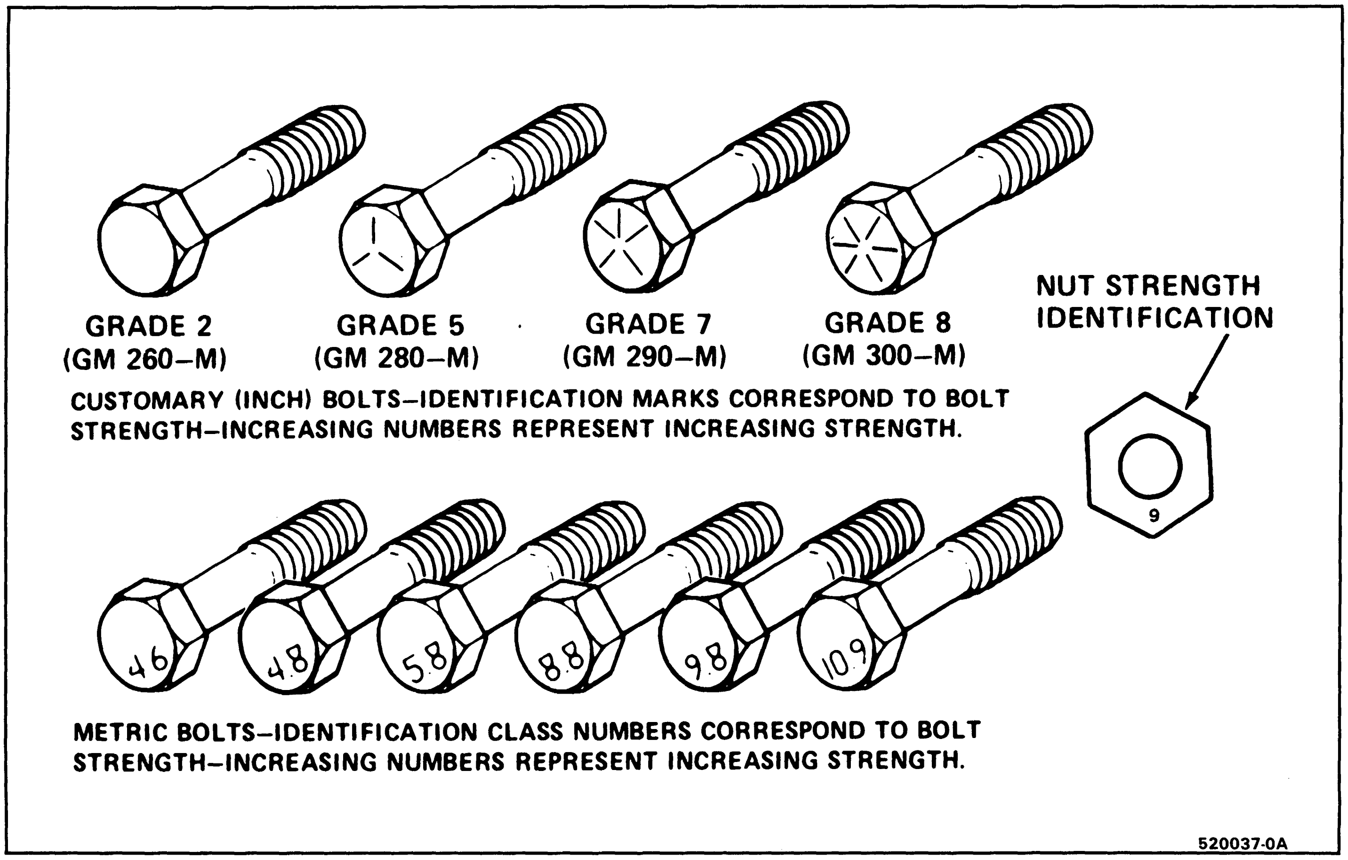


Figure 11 - Fastener Strength Marks

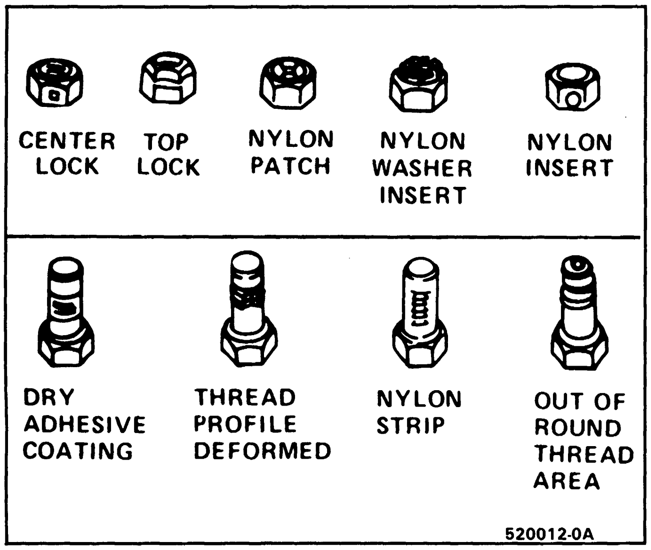


Figure 12 - Prevailing Torque Fasteners

FASTENER TYPE	TORQUE UNITS	METRIC-SIZE FASTENERS							
		6	6.3	8	10	12	14	16	20
Nuts and All Metal Bolts	N.m	0.4	0.4	0.8	1.4	2.2	3.0	4.2	7.0
	Lb. In.	4	4	7	12	19	27	37	62
Adhesive or Nylon Coated Bolts	N.m	0.4	0.4	0.6	1.2	1.6	2.4	3.4	5.6
	Lb. In.	4	4	5	11	14	21	30	50

FASTENER TYPE	TORQUE UNITS	INCH-SIZE FASTENERS							
		.250	.312	.375	.437	.500	.562	.625	.750
Nuts and All Metal Bolts	N.m	0.4	0.6	1.4	1.8	2.4	3.2	4.2	6.2
	Lb. In.	4	5	12	16	21	28	37	55
Adhesive Nylon Coated Bolts	N.m	0.4	0.6	1.0	1.4	1.8	2.6	3.4	5.2
	Lb. In.	4	5	9	12	16	23	30	49

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Figure 13 - Prevailing Torque Fastener Specifications

Multiply	by	to get equivalent number of:
	LENGTH	
Inch	25.4	millimeters (mm)
Foot	0.304 8	meters (m)
Yard	0.914 4	meters
Mile	1.609	kilometers (km)
	AREA	
Inch^2	645.2	millimeters^2 (mm^2)
	6.45	centimeters^2 (cm^2)
Foot^2	0.092 9	meters^2 (m^2)
Yard^2	0.836 1	meters^2
	VOLUME	
Inch^3	16387.	mm^3
	16.387	cm^3
	0.016 4	liters (l)
Quart	0.946 4	liters
Gallon	3.785 4	liters
Yard^3	0.764 6	meters^3 (m^3)
	MASS	
Pound	0.453 6	kilograms (kg)
Ton	907.18	kilograms (kg)
Ton	0.907	tonne (t)
	FORCE	
Kilogram	9.807	newtons (N)
Ounce	0.278 0	newtons
Pound	4.448	newtons

Multiply	by	to get equivalent number of:
	ACCELERATION	
Foot/sec^2	0.304 8	meter/sec^2 (m/s^2)
Inch/sec^2	0.025 4	meter/sec^2
	TORQUE	
Pound-inch	0.112 98	newton-meters (N.m)
Pound-foot	1.355 8	newton-meters
	POWER	
Horsepower	0.746	kilowatts (kW)
	PRESSURE OR STRESS	
Inches of water	0.249 1	kilopascals (kPa)
Pounds/sq. in.	6.895	kilopascals
	ENERGY OR WORK	
BTU	1 055.	joules (J)
Pound-foot	1.355 8	joules
Kilowatt-hour	3 600 000. or 3.6 x 10^6	joules (J = one W·s)
	LIGHT	
Foot candle	10.764	lumens/meter^2 (lm/m^2)
	FUEL PERFORMANCE	
Miles/gal	0.425 1	kilometers/liter (km/l)
Gal/mile	2.352 7	liter/kilometer (l/km)
	VELOCITY	
Miles/hour	1.609 3	kilometers/hr. (km/h)

TEMPERATURE

To convert Fahrenheit temperature to Celsius temperature, use formula:
$C = {}^5/_9\,(F-32)$

To convert Celsius temperature to Fahrenheit temperature, use formula:
$F = {}^9/_5\,C + 32$

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Figure 14 - English-Metric Conversion Chart

DECIMAL AND METRIC EQUIVALENTS

Fractions	Decimal In.	Metric MM.	Fractions	Decimal In.	Metric MM.
1/64	.015625	.39688	33/64	.515625	13.09687
1/32	.03125	.79375	17/32	.53125	13.49375
3/64	.046875	1.19062	35/64	.546875	13.89062
1/16	.0625	1.58750	9/16	.5625	14.28750
5/64	.078125	1.98437	37/64	.578125	14.68437
3/32	.09375	2.38125	19/32	.59375	15.08125
7/64	.109375	2.77812	39/64	.609375	15.47812
1/8	.125	3.1750	5/8	.625	15.87500
9/64	.140625	3.57187	41/64	.640625	16.27187
5/32	.15625	3.96875	21/32	.65625	16.66875
11/64	.171875	4.36562	43/64	.671875	17.06562
3/16	.1875	4.76250	11/16	.6875	17.46250
13/64	.203125	5.15937	45/64	.703125	17.85937
7/32	.21875	5.55625	23/32	.71875	18.25625
15/64	.234375	5.95312	47/64	.734375	18.65312
1/4	.250	6.35000	3/4	.750	19.05000
17/64	.265625	6.74687	49/64	.765625	19.44687
9/32	.28125	7.14375	25/32	.78125	19.84375
19/64	.296875	7.54062	51/64	.796875	20.24062
5/16	.3125	7.93750	13/16	.8125	20.63750
21/64	.328125	8.33437	53/64	.828125	21.03437
11/32	.34375	8.73125	27/32	.84375	21.43125
23/64	.359375	9.12812	55/64	.859375	21.82812
3/8	.375	9.52500	7/8	.875	22.22500
25/64	.390625	9.92187	57/64	.890625	22.62187
13/32	.40625	10.31875	29/32	.90625	23.01875
27/64	.421875	10.71562	59/64	.921875	23.41562
7/16	.4375	11.11250	15/16	.9375	23.81250
29/64	.453125	11.50937	61/64	.953125	24.20937
15/32	.46875	11.90625	31/32	.96875	24.60625
31/64	.484375	12.30312	63/64	.984375	25.00312
1/2	.500	12.70000	1	1.00	25.40000

520014-0A

Figure 15 - Inch-to-Millimeter Decimal Equivalents

ABBREVIATIONS

The following abbreviations may appear in this manual.

A

A-6	Axial 6 Cylinder A/C Compressor
A/C	Air Conditioning
A/F	Air/Fuel (A/F Ratio)
ABDC	After Bottom Dead Center
ABS	(Body) Acrylonitrile-Butadiene-Styrene
ABS	(Brake) Antilock Brake System
AC	Alternating Current (Also a GM Division)
ACC	Automatic Climate Conrol
ADF	Air Deflector Valve
AIR	Air Injection Reaction
AL	aluminum
ALC	Automatic Level Control
ALCL	Assembly Line Communication Link
ALDL	Assembly Line Diagnostic Link
AM/FM	Amplitude Modulation/Frequency Modulation
amp	amperes
API-GL	American Petroleum Institute-Gear Lubricant
APS	Absolute Pressure Sensor
APT	Adjustable Part Throttle
ARS	Automatic Restraint System
ATC	Automatic Temperature Control
ATDC	After Top Dead Center
ATS	Air Temperature Sensor
avg	average
AWD	All-Wheel Drive
AWG	American Wire Gage

B

BARO	Barometric Absolute Pressure Sensor
BBDC	Before Bottom Dead Center
BCM	Body Computer Module
BHP	Brake Horsepower
BP	Back Pressure
BTDC	Before Top Dead Center
Btu	British thermal units

C

C	Celsius
C LOOP	Closed Loop
C-4	Computer Controlled Catalytic Converter
C3I, 3CI	Computer Controlled Coil Ignition
CAD	Computer Aided Design
CAM	Computer Aided Manufacturing
CCC, 3-C	Computer Command Control
CCOT	Cycling Clutch Orifice Tube
CCP	Controlled Canister Purge
Cd	cadmium
CDRV	Crankcase Depression Regulator Valve
CEAB	Cold Engine Airbleed
CEMF	Counter Electromotive Force
cfm	cubic feet per minute
cg	center of gravity
CHA	Carburetor Hot Air
CID	Cubic Inch Displacement
CLCC	Closed Loop Carburetor Control
CLTBI	Closed Loop Throttle Body Injection
cm^3	cubic centimeter
CO	carbon monoxide
COA	Carburetor Outside Air
CP	Canister Purge
CPA	Connector Position Assurance
CPS	Central Power Supply
CPU	Central Processing Unit
CTS	Coolant Temperature Sensor, Coolant Temperature Switch, Cold Trapped Spark
cu ft or ft^3	cubic foot or cubic feet
cu in or in^3	cubic inch or cubic inches
CV	constant velocity

D

dB	decibels
dBA	decibels on A-weighted scale
DBB	Dual Bed Bead
DBM	Dual Bed Monolith
DC	Direct Current
DEC	Digital Electronic Controller
DEFI	Digital Electronic Fuel Injection
DFI	Digital Fuel Injection
dia	diameter
DIS	Direct Ignition System
DRL	Daytime Running Lamps
DVM	Digital Voltmeter

E

EAC	Electric Air Control
EAS	Electric Air Switching
EBCM	Electronic Brake Control Module
ECI	Extended Compressor at Idle
ECM	Electronic (Engine) Control Module
ECS	Emission Control System
ECU	Engine Calibration Unit
EDES	Electric Divert/Electric Air Switching Valve
EEC	Evaporative Emission Control
EECS	Evaporative Emissions Control System
EES	Evaporative Emission System
EFE	Early Fuel Evaporation
EFI	Electronic Fuel Injection
EGR	Exhaust Gas Recirculation
ELC	Electronic Level Control
EMF	Electromotive Force
EOS	Exhaust Oxygen Sensor
EPR	Exhaust Pressure Regulator

EPROM	Erasable Programmable Read-Only Memory
ESC	Electronic Spark Control
ESD	Electrostatic Discharge
EST	Electronic Spark Timing
ETC	Electronic Temperature Control
ETR	Electronically Tuned Receiver
EVRV	Electronic Vacuum Regulator Valve

F

F	Fahrenheit
FDC	Fuel Data Center
FEC	Fuel Evaporator Control
FED	Federal
FI	Fuel Injection
FICD	Fast Idle Control Diaphragm
ft	foot, feet

G

g	gravitational acceleration
GA	gage
gal	gallon
GM	General Motors
gas	gasoline

H

H_2O	water
H/CMPR	High Compression
HC	hydrocarbons
HD	Heavy Duty
HDC	Heavy Duty Cooling
HEI	High Energy Ignition
hex	hexagon
Hg	mercury
HI ALT	High Altitude
HIC	High Idle Compensator
hp	horsepower
HPCA	Housing Pressure Cold Advance
HPL	High Pressure Liquid
HPV	High Pressure Vapor
HVAC	Heater-Vent-Air Conditioning
Hz	hertz

I

IAC	Idle Air Control
IC	Integrated Circuit
ID	Inside Diameter, identification
ILC	Idle Load Compensator
IP	Instrument Panel
ISC	Idle Speed Control

J

K

kg	kilogram
kHz	kilohertz
km/h	kilometers per hour
km/l	kilometers per liter
kPa	kilopascals
kV	kilovolts

L

L	liter
lb. ft.	pound-feet (torque)
lb. in.	pound-inch (torque)
LCD	Liquid Crystal Display
LF	Left Front
LH	Left-Hand
LR	Left Rear

M

M/C	Mixture Control
MAF	Mass Air Flow
MAP	Manifold Absolute Pressure
MAT	Manifold Air Temperature
MDP	Manifold Differential Pressure
MEM-CAL	Memory and Calibration Unit
MFI	Multi-port Fuel Injection
mi	miles
mm	millimeters
mpg	miles per gallon
mph	miles per hour
ms	millisecond
M/T	Manual Transmission, Manual Transaxle
MV	megavolt
mV	millivolt
MVS	Metering Valve Sensor

N

N·m	Newton-meters (torque)
NC	Normally Closed
NEU	neutral
Ni	nickel
NLGI	National Lubricating Grease Institute
NO	Normally Opened
No	oxides of nitrogen
NPTC	National Pipe Thread, Course
NPTF	National Pipe Thread, Fine

O

O_2	oxygen
OC	Oxidizing Converter
OD	Outside Diameter
OEM	Original Equipment Manufacturer
ORC	Oxidizing Reducer Converter
oz	ounce(s)

P

P/N	Park/Neutral
PAIR	Pulse Air Injection Reaction
PCV	Positive Crankcase Ventilation

PECV	Power Enrichment Control Valve
PEDESV	Pressure Operated Electric Divert/Electric Switching Valve
PFI	Port Fuel Injection
POA	Pilot Operated Absolute Valve
POLYE	polyethylene
POLYF	polyfoam
POLYP	polypropylene
POLYU	polyurethane
ppm	parts per million
PROM	Programmable Read-Only Memory
PS	Power Steering
psi	pounds per square inch
psia	pounds per square inch, absolute
psig	pounds per square inch, gage
pt	pint
PWM	Pulse Width Modulated

Q

qt	quart(s)

R

R-4	Radial Four-Cylinder Air Conditioning Compressor
R-12	Refrigerant-12
RAM	Random Access Memory
RAP	Retained Accessory Power
RF	Right Front
RFI	Radio Frequency Interference
RH	Right-Hand
RIM	Reaction Injection Molded (Urethane)
RPM	Revolutions Per Minute
RPO	Regular Production Option
RR	Right Rear
RRIM	Reinforced Reaction Injection Molded Urethane
RT	right
RTV	Room Temperature Vulcanizing (Sealer)
RVR	Response Vacuum Reducer
RWD	Rear-Wheel Drive

S

SAE	Society of Automotive Engineers
sec	second(s)
SEO	Special Equipment Option
SES	Service Engine Soon
SI	System International
Si	silicon
SIR	Supplemental Inflatable Restraint
SMC	Sheet Molded Compound
SO$_2$	sulfur dioxide
sq ft., ft^2	square foot (feet)
sq in., in^2	square inch(es)

T

TAC	Thermostatic Air Cleaner
TBI	Throttle Body Injection
TCC	Torque Converter Clutch, Transmission Converter Clutch
TCCTVMV	Torque Converter Clutch Trim Vacuum Modulator Valve
TDC	Top Dead Center
TH	Turbo-Hydramatic
THERMAC	Thermostatic Air Cleaner
TPE	Thermoplastic Olefin
TPI	Tuned Port Injection
TPO	Thermo Plastic Olefin
TPS	Throttle Position Sensor, Throttle Position Switch
TRC	Throttle Return Control
TV	Throttle Valve
TVBV	Turbocharger Vacuum Bleed Valve
TVRS	Television and Radio Supression
TVS	Thermal Vacuum Switch

U

U-joint	universal joint

V

V	volt(s), voltage
V6	Six Cylinder Engine
V8	Eight Cylinder Engine
VAC	vacuum
VATS	Vehicle Anti-Theft System
VDV	Vacuum Delay Valve
vel	velocity
VF	Vacuum Fluorescent
VIN	Vehicle Identification Number
VLV	Vacuum Limiting Valve
VLVMV	Vacuum Limiting Vacuum Modulator Valve
VMV	Vacuum Modulator Valve
VRV	Vacuum Reducer Valve
VSS	Vehicle Speed Sensor

W

W/S	windshield
WOT	Wide Open Throttle

X

X-valve	expansion valve

Y

yd	yard

Z

Zn	zinc

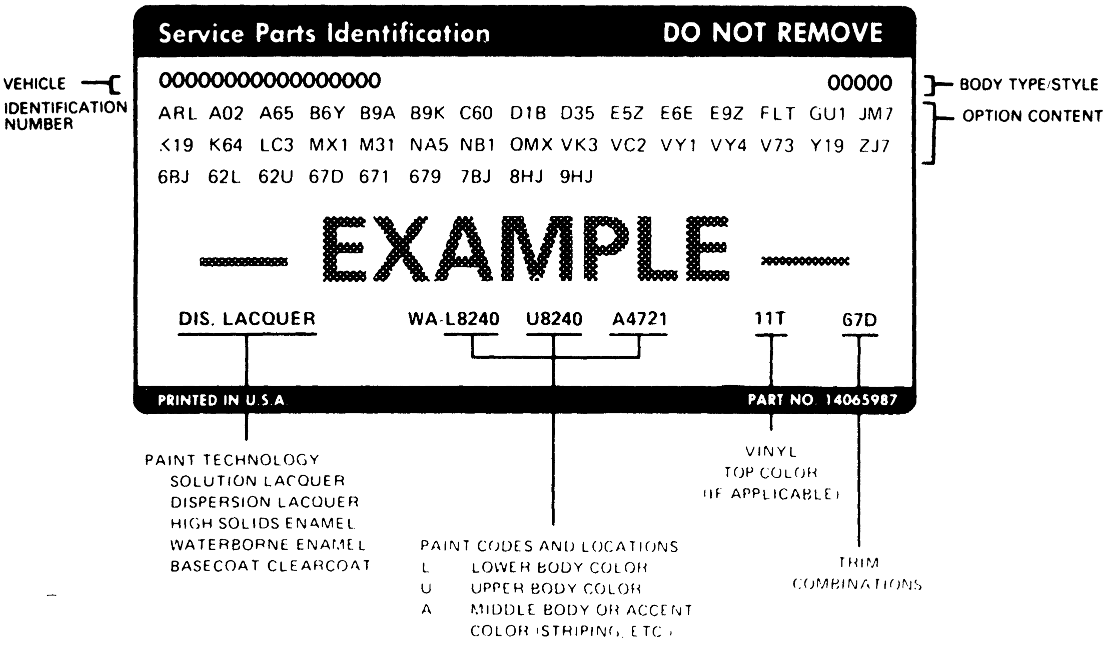
SERVICE PARTS IDENTIFICATION LABEL

Figure 16

The Service Parts Identification Label has been developed and placed on the vehicle to help service and parts personnel identify parts and options originally installed on the vehicle. Regular production options (RPOs), standard and mandatory options are listed. The label is attached to the inside of the console door.

OPTION CODES

Vehicle options are identified on the Service Parts Identification Label by an option code. The option codes are three digit combinations of letters and numbers. They identify equipment installed on the vehicle and trim and paint colors. Refer to the "Option and Process Codes" list in this section.



KC1017-0A-F-RP

Figure 16 - Service Parts Identification Label

OPTION AND PROCESS CODES

AAC	Shipped Loose Parts
AC3	Adjuster, 6-way Power Bucket, Driver Seat
AG9	Adjuster, 6-way Power Seat
AJ3	Restraint System - Front Seat, Inflatable
AM9	Seat Asm, Rear Split Back Fold Down
AN4	Restraint Provision, Child (Canadian)
AR9	Seat Asm, Front Bucket Recline (European Style)
AU3	Lock, Side Door Electric
A31	Window, Electric Control
A4G	Override Canadian Requirements
A90	Lock, Rear Compartment Lid, Remote Control, Electric Release
BF9	Delete Floor Mat
B18	Ornamentation, Interior Deluxe
B2L	Engine Package - V8 5.7L, PFI
B3E	Noise Control
B34	Mats, Front Floor (Carpet Insert)
B35	Mats, Rear Floor (Carpet Insert)
B84	Molding, Exterior, Body Side
CC1	Hatch Roof, Removable Panels
C41	Heater, With Defroster, Outside Air
C49	Defogger, Rear Window Electric
C60	Air Conditioner, Manual Control
DC4	Mirror, Instrument Panel Rear View Tilt, Dual Reading Lamp
DD9	Mirror, Outside Rear View Electric Remote
DE1	Sunshade - Back Window
DG7	Mirror, Outside, Dual, Remote Control, Painted
D3V	Speedometer Driven Gear
D3W	Speedometer Driven Gear
D34	Mirror, Visor Vanity
D35	Mirror, Outside Rear View

D42	Cover, Rear Compartment Security
D5S	Speedometer Driven Gear
D5V	Speedometer Driven Gear
D5X	Speedometer Driven Gear
D60	Color Override, Trim and Paint Compatibility
D7C	Speedometer Driven Gear
D8E	Vehicle Speed Sensor
D8F	Vehicle Speed Sensor
D8G	Vehicle Speed Sensor
D80	Spoiler, Deck Lid Rear
D81	Spoiler, Rear, Aero Wing
E5Z	Speedometer Adapter (Delete)
E9Z	Speedometer Key (Delete)
FE1	Suspension System, Soft Ride
FE2	Suspension System, Touring Ride and Handling
F41	Suspension, Special Heavy Duty Front and Rear
GU2	Axle, Rear 2.73 Ratio
GU4	Axle, Rear 3.08 Ratio
GU5	Axle, Rear 3.23 Ratio
GU6	Axle, Rear 3.42 Ratio
G80	Axle, Rear Locking Type (Limited Slip)
G92	Axle, Performance Ratio
IPB	Trim-Interior Design
IPC	Trim-Interior Design
IP2	Trim-Interior Design
JG1	Shaft, Prop (Aluminum)
J41	Brake System, Power, Disc/Drum (Cast Iron)
J42	Brake System, Power, Disc/Drum (Aluminum)
J65	Brake System, Power, Front and Rear Disc
KC4	Cooler, Engine Oil
KO5	Heater, Engine Block
K34	Control, Speed and Cruise (Integrated Computer)
K60	Generator, 100 Amp
K68	Generator, 105 Amp
LB9	Engine, 5.0L V8
LH0	Engine, 3.1L V6
L03	Engine, 5.0L V8 (TBI)
L98	Engine, 5.7L V8
MB1	Transmission, 5-Speed Manual (Borg-Warner)
MD8	Transmission, 4-Speed Automatic (Hydra-matic 4L60)
MK6	Transmission, 5-Speed Manual (Borg-Warner)
MM5	Transmission, 5-Speed Manual (Merchandising Option)
MX0	Transmission, Automatic (Merchandising Option)
M39	Transmission, 5-Speed Manual (Borg-Warner)
NA5	Emission System, Federal Requirements
NB2	Emission System, California Requirements
NK3	Sport Steering, Simulated Leather
NN5	Emission System, California Override
NP5	Wheel, Steering (Leather Wrapped)
N10	Exhaust System, Dual
N64	Wheel and Tire, Spare, Aluminum Space Saver
N65	Wheel and Tire, Stowaway Spare
N90	Wheel, 15x7 (Cast Aluminum)
N96	Wheel, 16x8 (Cast Aluminum)
P43	Inflator, Spare Tire (Delete)
QLC	Tire, P245/50ZR16
QMT	Tire, P235/55R16
QPH	Tire, P215/65R15
T61	Daytime Running Lamps (Canadian)
T93	Lamp, Tail and Stop (Smoked Lens)
T96	Lamps, Front Fog
UB3	Cluster, Instrument (Oil, Temperature, Volts, Trip Odometer, Tachometer
UK1	Radio, Japanese Frequency
UL5	Radio (Delete)
UM7	Radio, AM/FM Stereo, Clock, ETR
UN6	Radio, AM/FM Stereo Cassette, Clock, ETR
UQ1	Radio, Stereo Installation Provisions
UQ4	Speaker System, Bose 4-Speaker With Amplifier
UQ9	Speaker System (Delete)
UU8	Radio, AM/FM Stereo Cassette, Clock, ETR, Delco/Bose
UX1	Radio, AM and FM Stereo Cassette, Equalizer, ETR, Clock
UX6	Dual Front Speaker System
U1C	Radio, AM/FM Stereo, Compact Disc, ETR, Clock
U18	Speedometer, Instrument Panel (kilometer)
U19	Speedometer, Instrument Panel (Canadian)
U79	Speaker, 4 Dual Front Coax, Dual Extended Rear
VK3	Mounting, Front License Plate
YK6	SEO Identification
Y86	Camaro RS
Z28	Special Performance Option
Z49	Mandatory Canadian Base Equipment Modifications

1LE	Performance Package Components
1SA	Option Package 01
1SB	Option Package 02
1SC	Option Package 03
1SD	Option Package 04
1SE	Option Package 05
10Q	Molding Color (Arctic White)
10U	Exterior Color, Primary (Arctic White)
11P	Wheel Color - White
17P	Wheel Color (Silver)
19B	Trim Combination, Cloth (Black)
19C	Trim Combination, Cloth (Black)
191	Interior Trim (Black)
19Q	Molding Color (Black)
199	Safety Belts (Black)
23Q	Molding Color (Medium Maui Metallic)
23U	Exterior Color (Medium Maui Blue Metallic)
24Q	Molding Color (Bright Blue Metallic)
37P	Wheel Color (Dark Bright Teal Metallic)
37Q	Molding Color (Dark Bright Teal Metallic)
37U	Exterior Color, Primary (Dark Bright Teal Metallic)
41U	Exterior Color, Primary (Black)
6AC	Spring, Computer Selected, Front, Left Hand
6DB	Spring, Computer Selected, Front, Left Hand
6KR	Spring, Computer Selected, Front, Left Hand
6XM	Spring, Computer Selected, Front, Left Hand
6XN	Spring, Computer Selected, Front, Left Hand
6XR	Spring, Computer Selected, Front, Left Hand
6XS	Spring, Computer Selected, Front, Left Hand
6XT	Spring, Computer Selected, Front, Left Hand
6XU	Spring, Computer Selected, Front, Left Hand
6XW	Spring, Computer Selected, Front, Left Hand
6XX	Spring, Computer Selected, Front, Left Hand
6XY	Spring, Computer Selected, Front, Left Hand
6ZW	Spring, Computer Selected, Front, Left Hand
6ZX	Spring, Computer Selected, Front, Left Hand
6ZY	Spring, Computer Selected, Front, Left Hand
66B	Trim Combination, Cloth (Beechwood)
66C	Trim Combination, Cloth (Beechwood)
661	Interior Trim (Beechwood)
662	Trim Combination, Leather (Beechwood)
669	Safety Belts (Beechwood)
7AC	Spring, Computer Selected, Front, Right Hand
7DB	Spring, Computer Selected, Front, Right Hand
7KR	Spring, Computer Selected, Front, Right Hand
7XM	Spring, Computer Selected, Front, Right Hand
7XN	Spring, Computer Selected, Front, Right Hand
7XR	Spring, Computer Selected, Front, Right Hand
7XS	Spring, Computer Selected, Front, Right Hand
7XT	Spring, Computer Selected, Front, Right Hand
7XU	Spring, Computer Selected, Front, Right Hand
7XW	Spring, Computer Selected, Front, Right Hand
7XX	Spring, Computer Selected, Front, Right Hand
7XY	Spring, Computer Selected, Front, Right Hand
7ZW	Spring, Computer Selected, Front, Right Hand
7ZX	Spring, Computer Selected, Front, Right Hand
7ZY	Spring, Computer Selected, Front, Right Hand
73B	Trim Combination, Cloth (Flame Red)
73C	Trim Combination, Cloth (Flame Red)
731	Interior Trim (Flame Red)
732	Trim Combination, Leather (Flame Red)
739	Safety Belts (Flame Red)
75Q	Molding Color (Brilliant Red Metallic)
75U	Exterior Primary Color (Brillant Red Metallic)
8NB	Spring, Computer Selected, Rear, Left Hand
8NL	Spring, Computer Selected, Rear, Left Hand
8NM	Spring, Computer Selected, Rear, Left Hand
8NN	Spring, Computer Selected, Rear, Left Hand
8UX	Spring, Computer Selected, Rear, Left Hand
8UY	Spring, Computer Selected, Rear, Left Hand
8UZ	Spring, Computer Selected, Rear, Left Hand
8WA	Spring, Computer Selected, Rear, Left Hand
8YA	Spring, Computer Selected, Rear, Left Hand
8YB	Spring, Computer Selected, Rear, Left Hand
81P	Wheel Color (Bright Red)
81Q	Molding Color (Bright Red)
81U	Exterior Color, Primary (Bright Red Metallic)
82B	Trim Combination, Cloth (Dark Medium Gray)
82C	Trim Combination, Cloth (Dark Medium Gray)
821	Interior Trim (Dark Medium Gray)
822	Trim Combination, Leather (Dark Medium Gray)
829	Safety Belts (Gray)
87Q	Molding Color (Gunmetal Metallic)
87U	Exterior Color, Primary (Gunmetal Metallic)
9NB	Spring, Computer Selected, Rear, Right Hand
9NL	Spring, Computer Selected, Rear, Right Hand
9NM	Spring, Computer Selected, Rear, Right Hand
9NN	Spring, Computer Selected, Rear, Right Hand
9UX	Spring, Computer Selected, Rear, Right Hand
9UY	Spring, Computer Selected, Rear, Right Hand
9UZ	Spring, Computer Selected, Rear, Right Hand
9WA	Spring, Computer Selected, Rear, Right Hand
9YA	Spring, Computer Selected, Rear, Right Hand
9YB	Spring, Computer Selected, Rear, Right Hand
98U	Exterior Color, Primary (Ultra Blue Metallic)

LUBRICATION POINTS AND FLUID CAPACITIES

For information on lubrication points and fluid capacities, refer to MAINTENANCE AND LUBRICATION (SEC. 0B).

SECTION 0B

MAINTENANCE AND LUBRICATION

CONTENTS

SCHEDULED MAINTENANCE SERVICE

NORMAL VEHICLE USE

The maintenance instructions contained in the Maintenance Schedule are based on the assumption that the vehicle will be used as designed:

- To carry passengers and cargo within the limitation indicated on the Tire Placard located on the edge of the driver's door.
- On reasonable road surfaces within legal operating limits.
- On unleaded gasoline.

SCHEDULE I

Figure 1

Follow Schedule I if the vehicle is operated under one or more of the following conditions:

- When most trips are less than 6 km (4 miles).
- Operating when outside temperatures remain below freezing and when most trips are less than 16 km (10 miles).
- When most trips include extended idling and/or frequent low-speed operation as in stop-and-go traffic.
- Towing a trailer. Trailering is not recommended for some models. See the Owner's Manual for details.
- Operating in dusty areas.

Schedule I should also be followed if the vehicle is used in delivery service, police, taxi or other commercial applications.

SCHEDULE II

Figure 2

Follow Schedule II ONLY if none of the driving conditions specified in Schedule I apply.

EXPLANATION OF SCHEDULED MAINTENANCE SERVICES

Refer to Figures 1 and 2 for the schedules of time and/or mileage intervals. The following text and illustrations (Figures 3, 4 and 5) give details of the required maintenance services.

Engine Oil and Oil Filter Change

ALWAYS USE SG QUALITY ENERGY CONSERVING II OILS OF PROPER VISCOSITY. Oils designated "SG" will protect better than SF/CC or SF/CD oils. The "SG" designation may be shown alone or in combination with other designations such as SG/CC, SG/CD, etc.

Engine oil viscosity (thickness) has an effect on fuel economy and cold-weather operation (starting and oil flow). Lower viscosity engine oils can provide better fuel economy and cold-weather performance; however, higher temperature weather conditions require higher viscosity engine oils for satisfactory lubrication. **Using oils of any viscosity other than those viscosities recommended could result in engine damage.**

When choosing an oil, consider the range of temperatures the vehicle will be operated in before the next oil change. Then, select the recommended oil viscosity from the chart (Figure 3).

SCHEDULED MAINTENANCE SERVICES

SCHEDULE I

Follow Schedule I if your vehicle is MAINLY driven under one or more of the following conditions:

- When most trips are less than 6 kilometers (4 miles).
- When most trips are less than 16 kilometers (10 miles) and outside temperatures remain below freezing.
- When most trips include extended idling and/or frequent low-speed operation as in stop-and-go traffic.†
- Towing a trailer.**
- Operating in dusty areas.

WHEN TO PERFORM Kilometers (Miles) or Months, Whichever Occurs First

The services shown in this schedule up to 80 000 km (48,000 miles) are to be performed after 80 000 km (48,000 miles) at the same intervals.

ITEM NO.	TO BE SERVICED	KILOMETERS (000)	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
		MILES (000)	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48
1.	Engine Oil & Oil Filter Change*	Every 5 000 km (3,000 mi.) or 3 mos.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
2.	Chassis Lubrication	Every other oil change		●		●		●		●		●		●		●		●
3.	Throttle Body Mounting Bolt Torque (some models)*	At 10 000 km (6,000 mi.) only		●														
4.	Engine Idle Speed Adjustments (some models)*			●														
5.	Tire & Wheel Inspection & Rotation	At 10 000 km (6,000 mi.) and then every 25 000 km (15,000 mi.)		●					●					●				
6.	Cooling System Service*	Every 50 000 km (30,000 mi.) or 24 mos.										●						
7.	Front Wheel Bearing Repack (Rear-Wheel-Drive Cars Only)	See explanation for service interval.																
8.	Transmission/Transaxle Service																	
9.	Spark Plug Replacement*	Every 50 000 km (30,000 mi.)										●						
10.	Spark Plug Wire Inspection (some models)*‡											●						
11.	PCV Valve Inspection (some models)*‡											●						
12.	EGR System Inspection (some models)*‡	Every 50 000 km (30,000 mi.) or 36 mos.										●						
13.	Air Cleaner & PCV Filter Replacement*											●						
14.	Engine Timing Check (some models)*	Every 50 000 km (30,000 mi.)										●						
15.	Fuel Tank, Cap & Lines Inspection*‡											●						
16.	Thermostatically Controlled Air Cleaner Inspection (some models)*											●						

† Note: Schedule I should also be followed if the vehicle is used for delivery service, police, taxi or other commercial applications.

‡ The U.S. Environmental Protection Agency has determined that the failure to perform this maintenance item will not nullify the emission warranty or limit recall liability prior to the completion of vehicle useful life. General Motors, however, urges that all recommended maintenance services be performed at the indicated intervals and the maintenance be recorded in section C of the owner's maintenance schedule.

*** An Emission Control Service**

**** Trailering is not recommended for some models. See your Owner's Manual for details.**

MC0001-0B-F-RP

Figure 1 - Maintenance Schedule I

SCHEDULED MAINTENANCE SERVICES

SCHEDULE II

Follow Schedule II ONLY if none of the driving conditions specified in Schedule I apply.

ITEM NO.	TO BE SERVICED	WHEN TO PERFORM Kilometers (Miles) or Months, Whichever Occurs First	The services shown in this schedule up to 75 000 km (45,000 miles) are to be performed after 75 000 km (45,000 miles) at the same intervals.					
		KILOMETERS (000)	12.5	25	37.5	50	62.5	75
		MILES (000)	7.5	15	22.5	30	37.5	45
1.	Engine Oil Change	Every 12 500 km (7,500 mi.) or 12 mos.	●	●	●	●	●	●
	Oil Filter Change *	At first and then every other oil change or 12 months	●		●		●	
2.	Chassis Lubrication	Every 12 500 km (7,500 mi.) or 12 mos.	●	●	●	●	●	●
3.	Throttle Body Mounting Bolt Torque (some models)*	At 12 500 km (7,500 mi.) only	●					
4.	Engine Idle Speed Adjustments (some models)*		●					
5.	Tire & Wheel Inspection & Rotation	At 12 500 km (7,500 mi.) and then every 25 000 km (15,000 mi.)	●		●		●	
6.	Cooling System Service*	Every 50 000 km (30,000 mi.) or 24 mos.				●		
7.	Front Wheel Bearing Repack (Rear-Wheel-Drive Cars Only)	Every 50 000 km (30,000 mi.)				●		
8.	Transmission/Transaxle Service	See explanation for service interval.						
9.	Spark Plug Replacement*	Every 50 000 km (30,000 mi.)				●		
10.	Spark Plug Wire Inspection (some models)*‡					●		
11.	PCV Valve Inspection (some models)*‡					●		
12.	EGR System Inspection (some models)*‡	Every 50 000 km (30,000 mi.) or 36 mos.				●		
13.	Air Cleaner & PCV Filter Replacement*					●		
14.	Engine Timing Check (some models)*	Every 50 000 km (30,000 mi.)				●		
15.	Fuel Tank, Cap & Lines Inspection*‡					●		
16.	Thermostatically Controlled Air Cleaner Inspection (some models)*					●		

‡ The U.S. Environmental Protection Agency has determined that the failure to perform this maintenance item will not nullify the emission warranty or limit recall liability prior to the completion of vehicle useful life. General Motors, however, urges that all recommended maintenance services be performed at the indicated intervals and the maintenance be recorded in section C of the owner's maintenance schedule.

*** An Emission Control Service**

MC0002-0B-F-RP

Figure 2 - Maintenance Schedule II

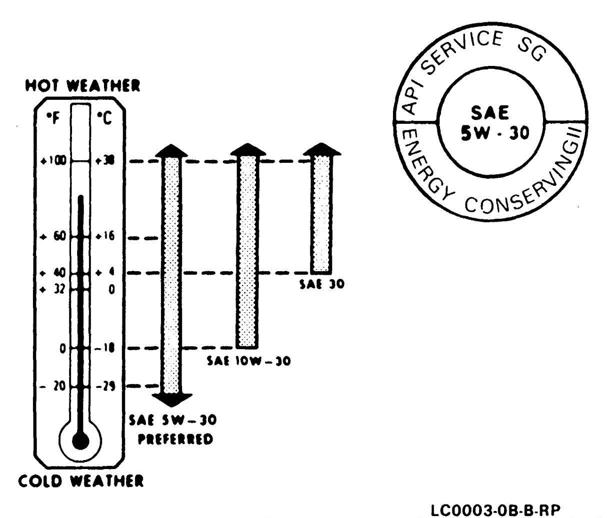


Figure 3 - Engine Oil Viscosity Recommendation

Chassis Lubrication

Lubricate transmission shift linkage.

Manual transmission - lubricate clutch cross shaft every 50 000 km (30,000 miles).

Lubricate all grease fittings in the suspension and steering linkage as described by the following:

Lubricating Joints that Have Grease Fittings

Figure 5

NOTICE: Wipe off all dirt from the grease fitting before lubricating the joint. Ball joints should not be lubricated unless their temperature is -12°C (10°F) or higher. During cold weather, the ball joint should be allowed to warm up as necessary before being lubricated. Use a low-pressure grease gun on all joints to prevent seal damage.

STEERING TIE RODS -

Apply grease until grease flows out between seal and tie rod end housing.

RELAY ROD -

Apply grease until grease flows around seal.

IDLER ARM -

Apply grease while pushing up and pulling down on the idler arm. (This will prevent "grease lock.") Apply grease until grease is seen at the seal.

BALL JOINTS -

Apply grease slowly while watching grease seal. Apply grease until grease is seen bleeding from the seal. If the seal expands but no grease is seen, do not apply any more grease and allow time for the grease to bleed from the seal.

ALL JOINTS -

Wipe off all excess grease.

Throttle Body Mounting Torque

Check torque of mounting bolts and/or nuts. Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (TBI) (SEC. 6E2-C2) OR DRIVEABILITY AND EMISSIONS - FUEL INJECTION (PORT) (SEC. 6E3-C2).

Engine Idle Speed Adjustment

Engines without Idle Speed Control or Idle Air Control System - Adjust to specifications shown on the underhood label. If no specifications are shown, no adjustment is necessary. Calibrated test equipment must be used.

Tire and Wheel Inspection and Rotation

Check tires for abnormal wear or damage. To equalize wear and obtain maximum tire life, rotate as shown in Figure 4.

If the vehicle is equipped with P245/50ZR16 size tires, the tires must be dismounted from the wheels before they can be rotated. This is because the front and rear wheels have different offsets, and the tires are directional. Directional tires have an arrow on both sides of the sidewall pointing in the direction the tires must roll for correct performance. Follow these steps:

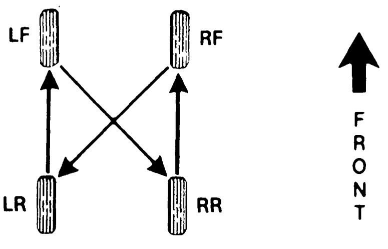
- Dismount tires from the wheels.
- Rotate the tires (not the wheels) in the rotation pattern shown. Make sure the tires rotate in the direction of the arrows as they are remounted on the wheels.
- Rebalance the tires.
- Replace wheels in their original position.

After rotation, adjust the front and rear tire pressures and be sure to check wheel nut tightness. Tighten to 140 N·m (100 lb. ft.).

If irregular or premature wear exists, check wheel alignment. Also, check for damaged wheels.

While the tires and wheels are removed, perform the brake systems inspection specified. Refer to "Each Time Oil Is Changed" in this section.

RECOMMENDED ROTATION PATTERN



NOTE: READ "INSPECTION AND ROTATION" TEXT FOR ADDITIONAL INFORMATION BEFORE ROTATING. SOME TIRE SIZES REQUIRE FURTHER STEPS.

NOTE: DO NOT INCLUDE "TEMPORARY USE ONLY" SPARE TIRE IN ROTATION.

LC0002-0B-F-RP

Figure 4 - Recommended Tire Rotation Pattern

Cooling System Service

Drain, flush and refill system with new coolant. Refer to "Recommended Fluids and Lubricants" in this section, or COOLING AND RADIATOR (SEC. 6B).

Wheel Bearing Repack

Clean and repack front wheel bearings at each brake relining or 25 000 km (15,000 miles), whichever comes first when vehicle is used in such service as police, taxi or door-to-door delivery. If the vehicle is not used in such service, clean and repack bearings at each brake relining or 50 000 km (30,000 miles), whichever comes first.

Transmission Service

For manual transmission, fluid does not require changing.

For automatic transmission, change both the fluid and filter every 25 000 km (15,000 miles) if the vehicle is mainly driven under one or more of these conditions.

- In heavy city traffic where the outside temperature regularly reaches 32°C (90°F) or higher.
- On hilly or mountainous terrain.
- Frequent trailer pulling. Trailering is not recommended for some models. See the Owner's Manual for details.
- Uses such as found in taxi, police vehicle or delivery service.

If the vehicle is not used under any of these conditions, change both the fluid and filter (or service the screen) every 160 000 km (100,000 miles). Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A) for more information.

Spark Plug Replacement

Replace spark plugs with type listed. Refer to "Maintenance Items" in this section.

Spark Plug Wire Inspection

Clean wires and inspect for burns, cracks or other damage. Check the wire boot fit at the distributor and/or coil, and at the spark plugs. Replace the wires as needed.

Positive Crankcase Ventilation (PCV) Inspection

Inspect valve for proper function. Replace valve if necessary. Also, replace any worn, plugged or collapsed hoses.

EGR System Service

5.0L (VIN E) - Perform EGR system check -Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (TBI) (SEC. 6E2, Chart C-7).

3.1L (VIN T), 5.0L (VIN F), 5.7L (VIN 8) - No service required.

Air Cleaner and PCV Filter Replacement

Replace the air cleaner filter every 50 000 km (30,000 miles). Replace more often under dusty conditions.

Replace the crankcase vent filter if so equipped.

Exhaust Pipes System Inspection

Visually inspect the exhaust pipes, muffler, and hangers for cracks, deterioration, or damage. Check the heat shields. Make sure they are secure. Start the engine and listen carefully for any exhaust gas leakage. Tighten connections or replace parts as necessary.

Engine Timing Check

Engines with distributors only.

Adjust timing to underhood label specifications.

Fuel Tank, Cap and Lines Inspection

Inspect fuel tank, cap and lines for damage or leaks. Inspect fuel rails and injection assemblies, if so equipped. Inspect fuel cap gasket for an even filler neck imprint or any damage. Replace parts as needed.

Thermostatically Controlled Air Cleaner

If equipped

Inspect all hoses and ducts for proper hookup. Make sure valve works properly.

OWNER INSPECTION AND SERVICES

Listed below are vehicle inspections and services that should be made at the frequencies indicated by either the owner or a qualified technician to help ensure proper safety, emission performance and dependability of the vehicle. Whenever repairs are necessary, have them completed at once.

Any safety related or emissions related components that could have been damaged in an accident should be inspected and all needed repairs should be performed before operating the vehicle.

WHILE OPERATING THE VEHICLE

Automatic transmission shift indicator operation - Make sure the indicator points to the gear chosen.

Horn Operation - Blow the horn occasionally to make sure it works. Check all button locations.

Brake system operation - Be alert to abnormal sounds, increased brake pedal travel or repeated pulling to one side when braking. Also, if the brake warning lamp goes on, or flashes, something may be wrong with part of the brake system.

Exhaust system operation - Be alert to any changes in the sound of the system or any smell of fumes. These are signs the system may be leaking or overheating. Have it inspected and repaired at once.

Tires, wheels and alignment operation - Be alert to a vibration of the steering wheel or seat at normal highway speeds. This may mean a wheel balance is needed. Also, a pull right or left on a straight and level road may show the need for a tire pressure adjustment or a wheel alignment.

Steering system operation - Be alert to changes in steering action. An inspection is needed when the steering wheel is harder to turn, or has too much free play, or if unusual sounds are noted when turning or parking.

Headlamp aim - Take note of light pattern occasionally. If beams seem improperly aimed, headlamps should be adjusted.

AT EACH FUEL FILL

A fluid loss in any system (except windshield washer) may indicate a problem. Have it inspected and repaired at once.

Engine oil level -Check engine oil level and add if necessary. The best time to check the engine oil level is when the oil is warm. After stopping the engine, wait a few minutes for the oil to drain back to the oil pan. Pull out the oil level indicator (dipstick). Wipe it clean, and push the oil level indicator back down all the way. Pull out the oil level indicator and look at the oil level on it.

Add oil, if needed, to keep the oil level above the "ADD" line and within the area labelled "Operating Range." Avoid overfilling the engine since this may cause engine damage. Push the oil level indicator back down all the way after taking the reading.

If you check the oil level when the oil is cold, do not run the engine first. The cold oil will not drain back to the pan fast enough to give a true oil level.

Engine coolant level and condition - Check engine coolant level in coolant reservoir tank and add if necessary. Inspect coolant and replace if dirty or rusty.

Windshield washer fluid level - Check washer fluid level in reservoir and add if necessary.

Hood latch operation -When opening the hood, note the operation of the secondary latch. It should keep the hood from opening all the way when the primary latch is released. Make sure that the hood closes firmly.

AT LEAST MONTHLY

Tire and wheel inspection and pressure check - Check tires for abnormal wear or damage. Also check for damaged wheels. Pressure should be checked when tires are "cold" (include spare unless it is a stowaway). Maintain pressures as shown in "Tire Pressure Specifications" in this section, or the Tire Placard on the driver door.

Lamp operation - Check operation of license plate lamp, sidemarker lamps, headlamps, including high beams and foglamps, parking lamps, taillamps, brake lamps (including the center high mounted stoplamp), turn signals, backup lamps, hazard warning flasher and interior lamps.

Fluid leak check - Periodically, after the vehicle has been parked for a while, inspect the surface beneath the vehicle for water, oil, fuel or other fluids. Water dripping from the air conditioning system after use is normal. If you notice fuel leaks or fumes, the cause should be found and corrected at once.

AT LEAST TWICE A YEAR

Power steering system reservoir level - Check and keep at proper level. Refer to POWER STEERING GEAR AND PUMP (SEC. 3B1).

Brake master cylinder reservoir level - Check fluid. Refer to GENERAL BRAKES (SEC. 5). Keep fluid at proper level. A low fluid level can indicate worn disc brake pads which may need to be serviced.

Hydraulic clutch system - Check fluid level in the reservoir. Refer to CLUTCH (SEC. 7C). Add fluid as required.

Weatherstrip lubrication -Clean surface and then apply a thin film of silicone grease, GM part no. 1052863 or equivalent, using a clean cloth.

AT LEAST ANNUALLY

Parking brake and transmission park mechanism operation -

CAUTION: Before checking the holding ability of the parking brake and automatic transmission park mechanism, park on a fairly steep hill with enough room for movement in the downhill direction. To reduce the risk of personal injury or property damage, be prepared to apply the regular brakes promptly if the vehicle begins to move.

To check the parking brake, with the engine running and transmission in "NEUTRAL," slowly remove foot pressure from the regular brake pedal (until the vehicle is held by only the parking brake).

To check the automatic transmission park mechanism holding ability, release all brakes after shifting the transmission to "PARK."

Transmission neutral start switch operation -

CAUTION: Before performing the following transmission neutral start switch check, be sure to have enough room around the vehicle. Then, firmly apply both the parking brake and the regular brakes. Do not use the accelerator pedal. If the engine starts, be ready to turn off the ignition promptly. Take these precautions because the vehicle could move without warning and possibly cause personal injury or property damage.

On automatic transmission vehicles, try to start the engine in each gear. The starter should crank only in "PARK" or "NEUTRAL."

On manual transmission vehicles, place the shift lever in "NEUTRAL," push the clutch pedal halfway and try to start. The starter should crank only when the clutch pedal is fully depressed.

Steering column lock operation - While parked, try to turn the key to "LOCK" in each gear range. On vehicles with automatic transmissions, the key should turn to "LOCK" only when the gear selector is in "PARK." On vehicles with key release lever, try to turn to "LOCK" without depressing the lever. The key should turn to "LOCK" only with the key lever depressed.

On all vehicles, the key should come out only in "LOCK."

Seatback latch operation - Be sure seatbacks latch on those vehicles with folding seats using mechanical latches.

Lap and shoulder belts condition and operation - Inspect belt system, including: webbing, buckles, latch plates, retractor, guide loops and anchors.

Movable head restraint operation - On vehicles with movable restraints, make sure restraints stay in the desired position.

Seatback recliner operation (if equipped) - Make sure the recliner is holding by pushing on the top of the seatback while it is reclined. The seatback should not go down any lower.

Spare tire and jack storage - Be alert to rattles in rear of the vehicle. Make sure the spare tire, all jacking equipment, any tire inflator and any covers or doors are securely stowed at all times. Oil the jack ratchet or screw mechanism after each use.

Key lock service -Lubricate the key lock cylinder.

Body lubrication service -Lubricate all body door hinges, including the hood, fuel door and rear compartment hinges and latches, the glove and console doors, and any folding seat hardware.

Lubricate the tailgate or hatchback lid hinges.

Lubricate all pivot points in the headlamp door assembly if equipped, including the spring links for each door.

Underbody flushing -At least every spring, flush from the underbody with plain water, any corrosive materials used for ice and snow removal and dust control. Take care to thoroughly clean any areas where mud or other debris can collect. Sediment packed in closed areas of the vehicle should be loosened before being flushed.

Engine cooling system -Inspect coolant and freeze protection. If dirty or rusty, drain, flush and refill with new coolant. Keep coolant at the proper mixture for proper freeze protection, corrosion inhibitor level and best engine operating temperature. Inspect hoses and replace if cracked, swollen or deteriorated. Clean outside of radiator and air conditioning condenser. Wash filler cap and neck. To help ensure proper operation, a pressure test of both the cooling system and cap is also recommended.

EACH TIME OIL IS CHANGED

Automatic transmission fluid level - Maintain level within operating range on the oil level indicator. Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A).

Manual transmission - Check fluid level and add as required. Refer to MANUAL TRANSMISSION (SEC. 7B).

Brake systems inspection - For convenience, the following should be done when wheels are removed for rotation: Inspect lines and hoses for proper hookup, binding, leaks, cracks, chafing, etc. Inspect disc brake pads for wear and rotors for surface condition. Also inspect drum brake linings for wear and cracks. Inspect other brake parts, including drums, wheel cylinders, parking brake, etc., at the same time.

The parking brake is self-adjusting. While driving there should not be any drag. The parking brake release handle should feel firm. On vehicles with disc brakes, check if the rear caliper returns to its stop when the parking brake is released.

Inspect brakes more often if habit or conditions result in frequent braking.

Steering and suspension inspection -Inspect front and rear suspension and steering system for damaged, loose or missing parts, signs of wear or lack of lubrication. Inspect power steering lines and hoses for proper hookup, binding, leaks, cracks, chafing, etc.

Exhaust system inspection -Inspect complete system including catalytic converter. Inspect body near the exhaust system. Look for broken, damaged, missing or out-of-position parts as well as open seams, holes, loose connections or other conditions which could cause a heat buildup in the floor pan or could let exhaust fumes seep into the trunk or passenger compartment.

Throttle linkage inspection - Inspect for interference, binding, damaged or missing parts.

Engine drive belt - Inspect belt for cracks, fraying, wear and proper tension. Serpentine belts cannot be adjusted. Replace tensioner or belt as needed. Refer to COOLING AND RADIATOR (SEC. 6B).

Rear Axle - Check fluid level and add if needed.

To check or add fluid, hoist vehicle at suspension contact points. Refer to GENERAL INFORMATION (SEC. 0A). Keep vehicle level. Clean dirt or foreign material from around filler plug opening before removing the filler plug. Maintain fluid level from flush with bottom of opening to no lower than 6 mm (1/4 inch) below opening. Always replace filler plug. Tighten to 41 N•m (30 lb. ft.).

Limited slip differentials should have fluid drained and refilled at the first 12 500 km (7,500 miles). Be sure to add limited slip additive.

If the vehicle is used to pull a trailer, change lubricant every 12 500 km (7,500 miles) in either type differential.

Power antenna service, three section type - Clean and then lubricate the power antenna. Refer to AUDIO SYSTEMS (SEC. 9A).

RECOMMENDED FLUIDS AND LUBRICANTS

Engine oil - GM Goodwrench motor oil or equivalent for API service SG of recommended viscosity.

Engine coolant - Mixture of water and good quality ethylene glycol base antifreeze conforming to GM Specification 1825M (GM part no. 1052753).

Hydraulic brake system - Delco Supreme 11 brake fluid (GM part no. 1052535) or equivalent DOT-3 brake fluid.

Hydraulic clutch system - Hydraulic clutch fluid (GM part no. 12345347) or equivalent DOT-3 fluid.

Power steering system - Power steering fluid meeting requirements of GM 9985010 (GM part no. 1050017, 1052884).

Automatic transmission and manual 5 speed transmissions - DEXRON® II automatic transmission fluid (GM part no. 1051855, 12345006).

Manual transmission shift linkage - Chassis grease meeting requirements of GM 6031M (GM part no. 1052497).

Key lock cylinders - Lubricate with Multi-Purpose Lubricant (GM part no. 12345120) or synthetic SAE 5W30 engine oil. (Do not use aerosols.)

Automatic transmission shift linkage - Engine oil. **Clutch linkage pivot points** - Engine oil.

Weatherstrips - Silicone grease (GM part no. 1052863 or equivalent).

Power antenna, three section type only - Light machine oil.

Chassis lubrication - Chassis grease meeting requirement of GM specification 6031M (GM part no. 1052356 or 1052497).

Standard differential rear axle - SAE 80W-90 GL-5 gear lubricant or axle lubricant (GM part no. 1052271 or 1052272).

Limited slip differential rear axle - All models require 118 ml (4 oz.) of limited slip differential additive lubricant (GM part no. 1052358) and axle lubricant (GM part no. 1052271 or 1052272).

Windshield washer solvent - GM Optikleen Washer Solvent (GM part no. 1051515 or equivalent).

Hood latch assembly, pivots and spring anchor - Engine oil.

Hood latch assembly, release pawl - Chassis grease meeting requirements of GM Specification 6031M (GM part no. 1052497).

Front wheel bearings - Lubricant (GM part no. 1051344 or equivalent).

Hood and door hinges, hatchback lid hinge and linkage. Headlamp door assemblies, if equipped. Rear folding seat. Fuel door hinge. Rear compartment lid hinges - Engine oil.

MAINTENANCE ITEMS

Air Cleaner Filter	
3.1L (VIN T)	AC Type A918
5.0L (VIN E)	AC Type A329C
5.0L (VIN F) and 5.7L (VIN 8)	AC Type A918C
Engine Oil Filter	
3.1L (VIN T)	AC Type PF51
5.0L (VIN E and F) and 5.7L (VIN 8)	AC Type PF25
Fuel Filter	
All VIN	AC Type GF481
PCV Valve	
3.1L (VIN T)	AC Type CV892C
5.0L (VIN E and F) and 5.7L (VIN 8)	AC Type CV789C
PCV Air Filter	
5.0L (VIN E)	AC Type FB59
Spark Plugs and Gap	
3.1L (VIN T)	AC Type ●R43TSK 1.14 mm (0.045")
5.0L (VIN E and F) and 5.7L (VIN 8)	AC Type ●R45TS 0.89 mm (0.035")

APPROXIMATE FLUID CAPACITIES

Air Conditioning	
R-12	1.02 kg (2.25 lb.)
Engine Crankcase	
Without Filter Change (All VIN)	3.8 liters (4.0 qt.)
With Filter Change	
3.1L (VIN T)	3.8 liters (4.0 qt.)

5.0L (VIN E and F) and 5.7L (VIN 8)	4.7 liters (5.0 qt.)
Fuel Tank	58.7 liters (15.5 gal.)
Transmission	
Manual - Drain and Refill and Overhaul	2.8 liters (5.9 pt.)
Automatic (Hydra-Matic 4L60)	
3.1L (VIN T) Drain and Refill	4.7 liters (10 pt.)
3.1L (VIN T) Overhaul	7.9 liters (16.7 pt.)
5.0L (VIN E and F) and 5.7L (VIN 8) Drain and Refill	4.7 liters (10 pt.)
5.0L (VIN E and F) and 5.7L (VIN 8) Overhaul	10.6 liters (22.4 pt.)
Cooling System	
3.1L (VIN T)	
Without Air Conditioning	13.9 liters (14.7 qt.)
With Air Conditioning	14.0 liters (14.8 qt.)
5.0L (VIN E)	
Without Air Conditioning	16.4 liters (17.4 qt.)
With Air Conditioning	17.0 liters (18.0 qt.)
5.0L (VIN F)	
Without Air Conditioning	16.9 liters (17.9 qt.)
With Air Conditioning	17.0 liters (18.0 qt.)
5.7L (VIN 8)	
Without Air Conditioning	15.7 liters (16.6 qt.)
With Air Conditioning	15.8 liters (16.7 qt.)

The capacities shown are approximate. Add fluid as necessary to bring to appropriate level. Engine oil filter replacement will require additional engine oil during refill.

BELT TENSION SPECIFICATIONS

Engines equipped with serpentine belts have an automatic tensioner. No adjustment of this belt is necessary.

WHEEL NUT TORQUE

All	140 N·m (100 lb. ft.)

TIRE PRESSURE SPECIFICATIONS

Compact Spare	415 kPa (60 psi)
Front and Rear - All	205 kPa (30 psi)

LUBRICATION FITTING LOCATIONS

9 FITTINGS

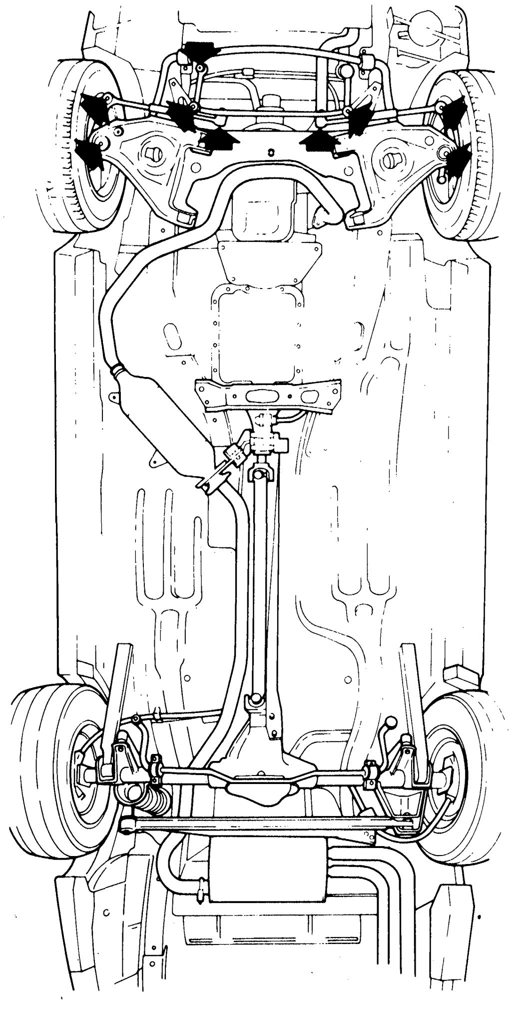


Figure 5 - Lubrication Fitting Locations

SECTION 1A

HEATER SYSTEM

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 1A-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

BASE HEATER SYSTEM

Figures 1 through 4

The base heater system provides heating, power ventilation, side window defogging and windshield defrosting. Outside air is drawn from the plenum at the base of the windshield into the heater module (1) by the blower fan (14).

Within the heater module (1), the air is heated as required and then routed through ducts to the proper outlets for discharge into the passenger compartment. A control assembly (2) in the console allows the operator to control blower speed, mode of operation and the temperature of the air coming from the heater system.

The heater module (1) contains components that heat the air flowing through it and direct the air to the proper ducts and outlets. The heater module (1) consists of two major assemblies: the heater assembly (10) and the blower assembly (8). The heater assembly (10) is mounted to the rear surface of the dash panel beneath the instrument panel, and the blower assembly (8) is mounted to the front surface of the dash panel in the engine compartment.

Hot coolant from the engine's cooling system is directed through the heater core (9) and returned to the cooling system when the engine is running. The heater core (9) transfers heat from the coolant to the air passing through the core fins. There is no hot water valve in the heater system to prevent the flow of coolant through the heater core (9).

CONTROLS

Figures 1 through 4

The control assembly (2) in the console contains three controls: a switch to control blower speed, one lever to permit selection of the desired operating mode and a second lever to provide control of heater air temperature. The blower switch is operated by the blower switch knob (13). The mode lever is operated

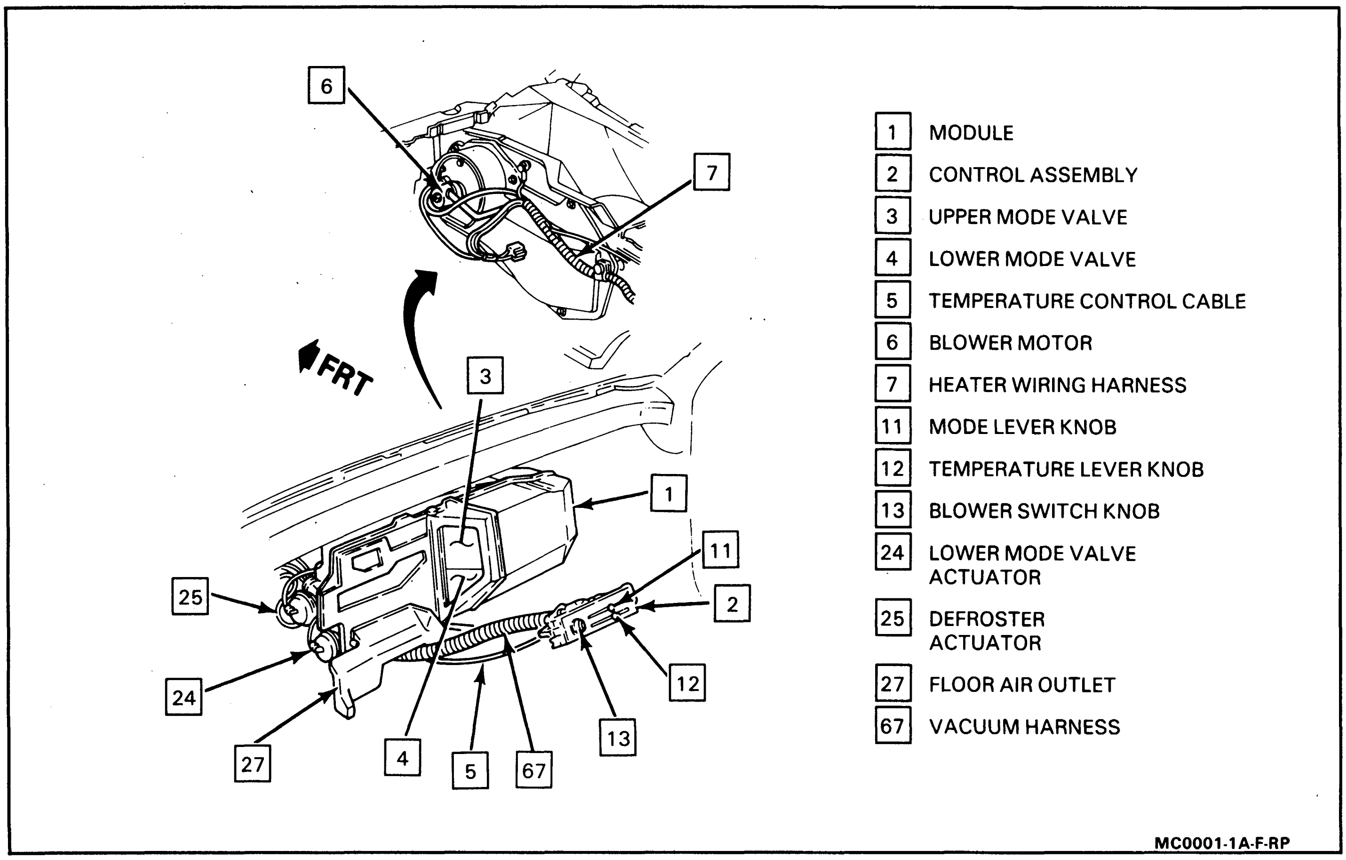


Figure 1 - Heater Module and Controls

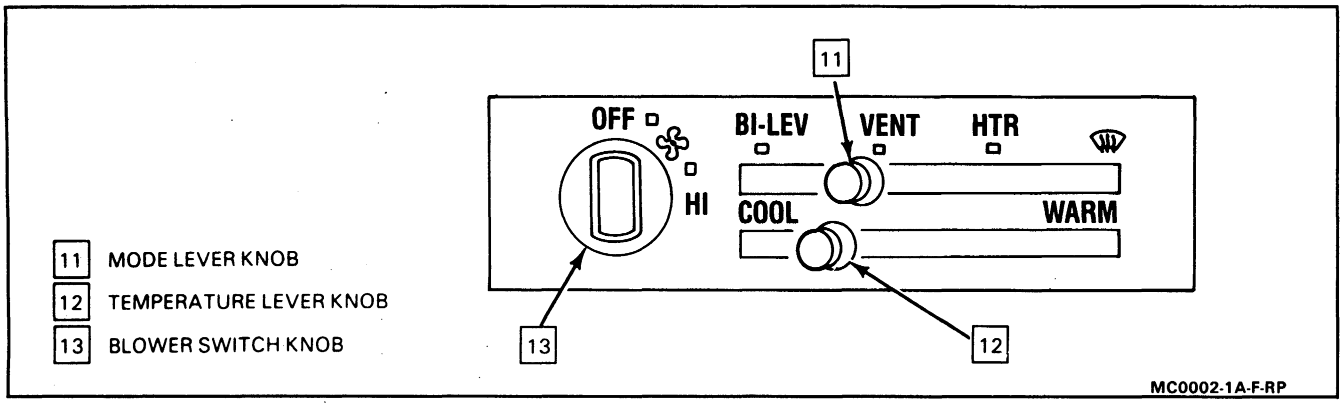


Figure 2 - Control Assembly Dial - Typical

by the mode lever knob (11). The temperature lever is operated by the temperature lever knob (12).

The controls are lit when the headlamps are on. Electrical power is provided by the instrument panel lighting circuit. The control assembly lamp is in parallel with the instrument cluster bulbs, the radio dial bulb and certain other interior illumination bulbs. Brightness of the dial illumination is controlled by the dimmer control of the headlamp switch. For electrical circuit diagrams and more information, refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

Temperature Lever

The temperature lever operates the temperature control cable (5) that goes to the heater module (1). When the temperature lever knob (12) is at "COOL" to the extreme left of the slot in the dial of the control assembly (2), all of the air delivered by the heater system is unheated. When the temperature lever knob (12) is at "WARM" to the extreme right of the slot in the dial, all the air passing through the heater module (1) is heated before it is discharged. Intermediate positions of the temperature lever knob (12) result in a mixture of heated and unheated air to provide more moderate air temperatures.

The temperature control cable (5) is attached to a crank lever on the temperature valve shaft. The temperature valve (21) is a door-like hinged deflector (or air valve) within the heater module. It controls the temperature of the air discharged from the heater system outlets by regulating the relative amount of the total airflow through the module (1) that is allowed to pass through the heater core (9). The heated air is mixed with unheated air beyond the heater core (9) to form a blend that has the desired temperature.

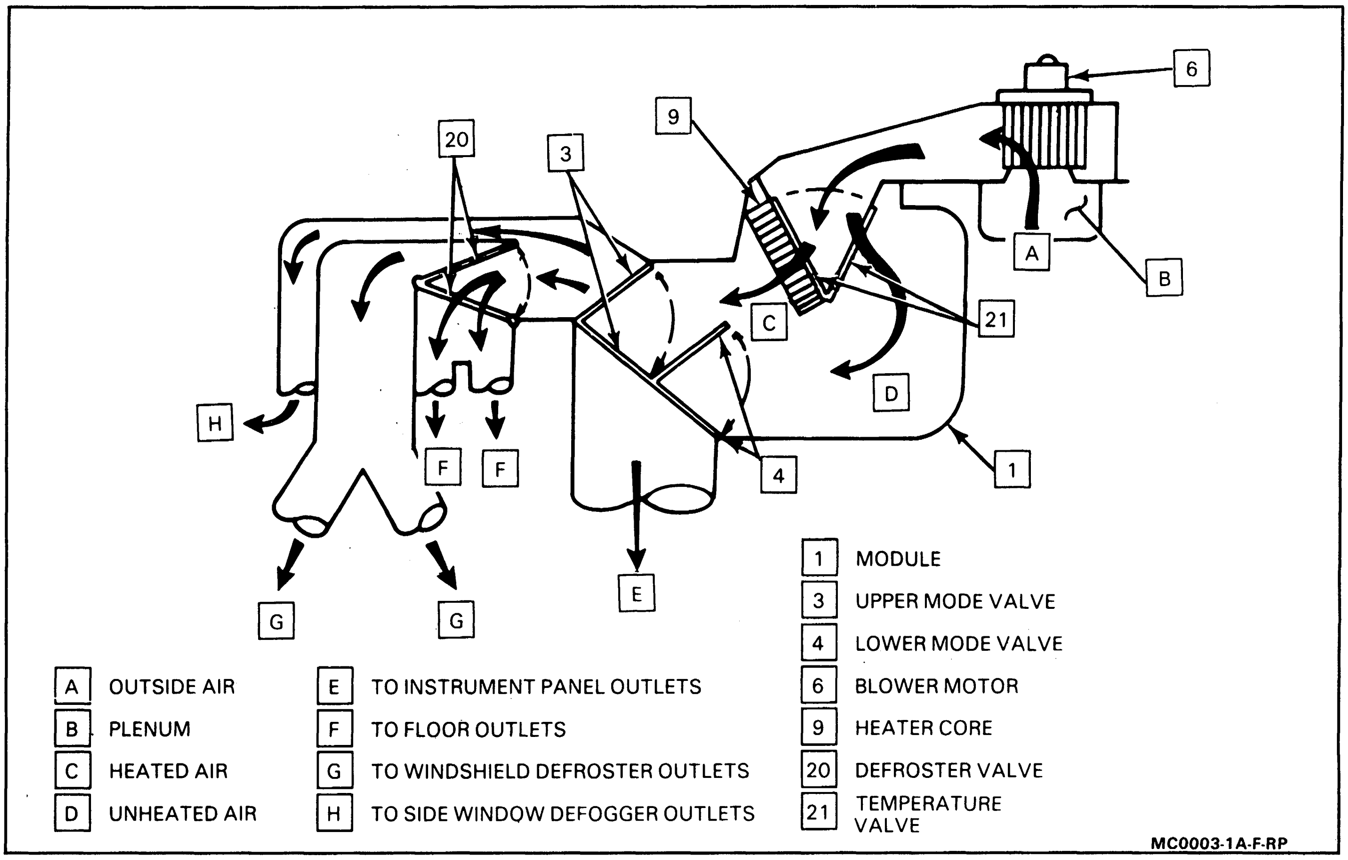


Figure 3 - Heater Module Schematic

When the temperature lever knob (12) is in the full "COOL" position, the temperature valve (21) is held snugly against the air entrance to the heater core (9). This causes all of the airflow to bypass the heater core (9) and there is no noticeable change in the air temperature.

As the temperature lever knob (12) is moved away from the "COOL" position, the temperature valve (21) moves away from the heater core (9) to allow some air to flow through the heater core (9). The farther the temperature lever knob (12) is moved to the right, the more the temperature valve (21) is turned away from the entrance to the heater core (9) and the greater the airflow through the heater core (9). Heating a greater portion of the total airflow in this manner results in a warmer discharge of air from the outlets.

When the temperature lever knob (12) is in the full "WARM" position, the temperature valve (21) blocks off the passage that allows air to bypass the heater core (9) and causes all of the airflow to go through the heater core (9) for maximum heating. This method of temperature control provides a very rapid response to any change in temperature selection throughout the entire range when the engine is warmed up.

Mode Lever

The mode lever knob (11) controls the mode lever. This lever operates a rotary vacuum switch that routes engine vacuum to specific hoses in the vacuum harness (67). The hoses control three vacuum actuators on the heater module (1). Each actuator operates an air valve (a door-like hinged deflector) that routes airflow to the various outlets of the heater system.

Mode lever knob positions are "BI-LEVEL," "VENT," "HEATER" and "DEFROST." The "BI-LEVEL," "VENT" and "HEATER" positions are indicated by "BI-LEV," "VENT" and "HTR" printed on the dial of the control assembly (2), and the "DEFROST" position is indicated by the defrost symbol.

"BI-LEVEL" Mode

With the mode lever knob (11) in the "BI-LEVEL" position, the airflow is split between the instrument panel outlets and the floor air outlets, with a small amount going to the defroster outlets and the side window defogger outlets.

"VENT" Mode

With the mode lever knob (11) in the "VENT" position, outside air is delivered through the instrument panel outlets to ventilate the passenger compartment.

"HEATER" Mode

With the mode lever knob (11) in the "HEATER" position, most of the airflow is directed to the floor air outlet (27) with the small amount remaining being routed to the windshield defroster and the side window defogger outlets. The "HEATER" mode is the normal selection for cold weather operation unless the windshield must be cleared of heavy frost.

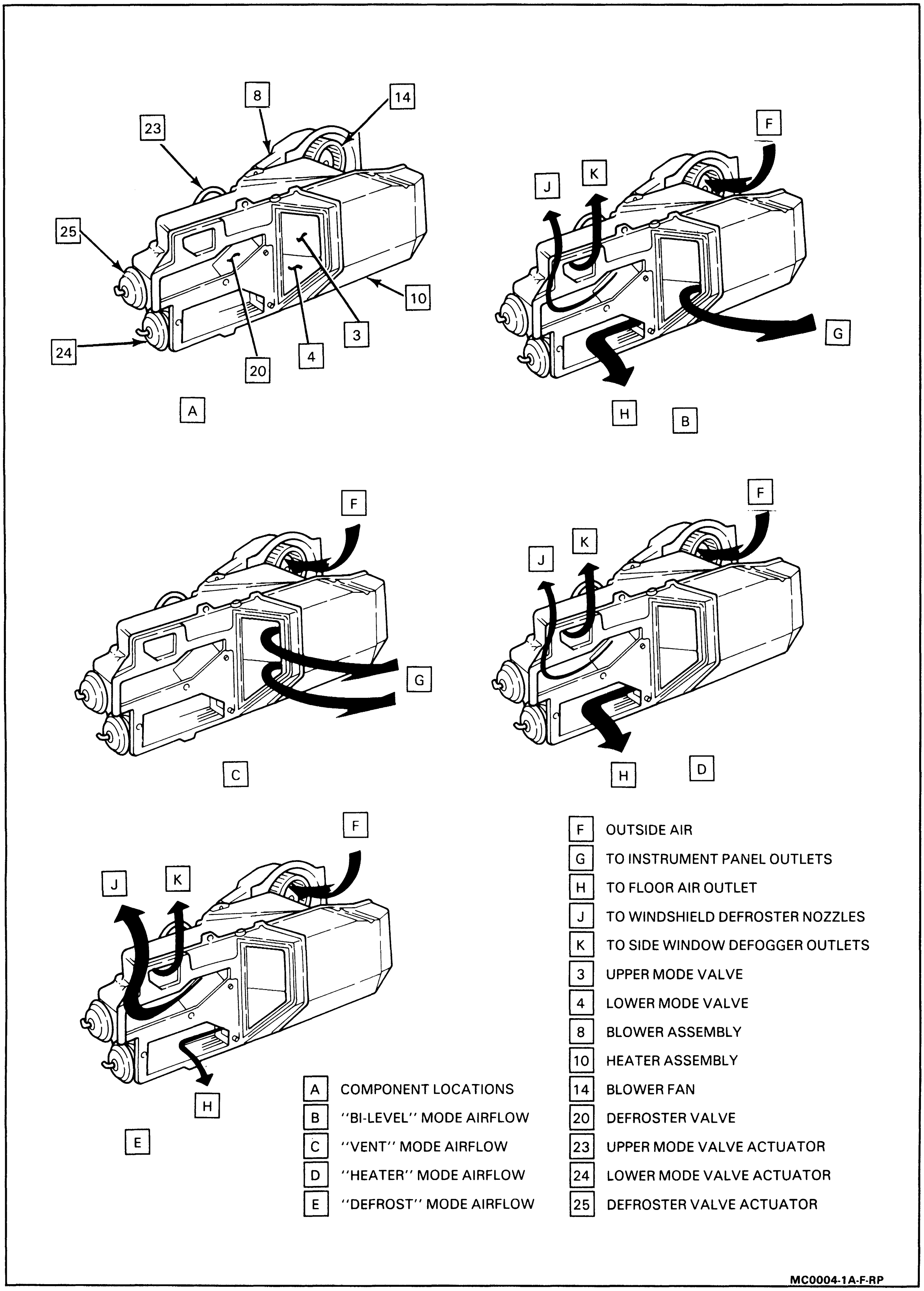


Figure 4 - Operating Mode Airflow Distribution

"DEFROST" Mode

With the mode lever knob (11) in the "DEFROST" position, most of the airflow is directed to the windshield defroster outlets, with a much smaller amount going to the floor air outlet (27). The side window defogger outlets receive the same air supply as in the "HEATER" mode.

Blower Speed Control

The blower switch is a four-position rotary switch that provides a choice of three blower speeds plus an "OFF" position. The blower switch receives power from a 25 ampere fuse in the fuse block when the ignition is "ON." With the blower switch knob (13) in the low-speed position, the circuit continues through the heater wiring harness (7) to two resistors in the resistor assembly near the blower motor (6).

When the blower switch knob (13) is in the medium-speed position, the circuit continues through the heater wiring harness (7) to the resistor assembly, but it bypasses one of the two resistors.

When the blower switch knob (13) is in the "HI" position, the circuit continues through the heater wiring harness (7) to the resistor assembly, but it bypasses both resistors to provide full power to the blower motor (6).

From the resistor assembly, the circuit goes to the blower motor terminal to operate the blower motor (6). The blower motor circuit is completed to ground by a wire in the heater wiring harness (7) that goes from the blower motor terminal to a terminal at the dash panel sheet metal near the blower assembly (8) in the engine compartment.

AIR DISTRIBUTION SYSTEM

Figure 3

Within the heater module (1) are four air valves: the temperature valve (21), the upper mode valve (3), the lower mode valve (4). and the defroster valve (20). These air valves are hinged parts that act like doors to direct the airflow through various sections of the heater module (1) to provide the proper airflow distribution for the selected temperature and operating mode.

Vacuum System

Figures 4 and 5

All air valves except the temperature valve (21) are controlled by engine vacuum stored in the vacuum tank (26) in the engine compartment. The vacuum is routed by a vacuum switch in the control assembly (2) to any of three spring-loaded two-position vacuum actuators. One vacuum actuator is linked to each air valve.

The vacuum switch in the control assembly (2) is controlled by the mode lever. For each mode lever position, the vacuum switch will direct engine vacuum to specific hoses and vent to normal air pressure the remaining hoses. When a hose is vented to normal air pressure, the vacuum actuator's internal spring will expand and hold the associated air valve in one position. When vacuum is routed to the hose, the force of the vacuum overcomes the internal spring pressure and moves the air valve to the opposite extreme of its travel. In this way, the mode lever positions the air valves for the selected operating mode.

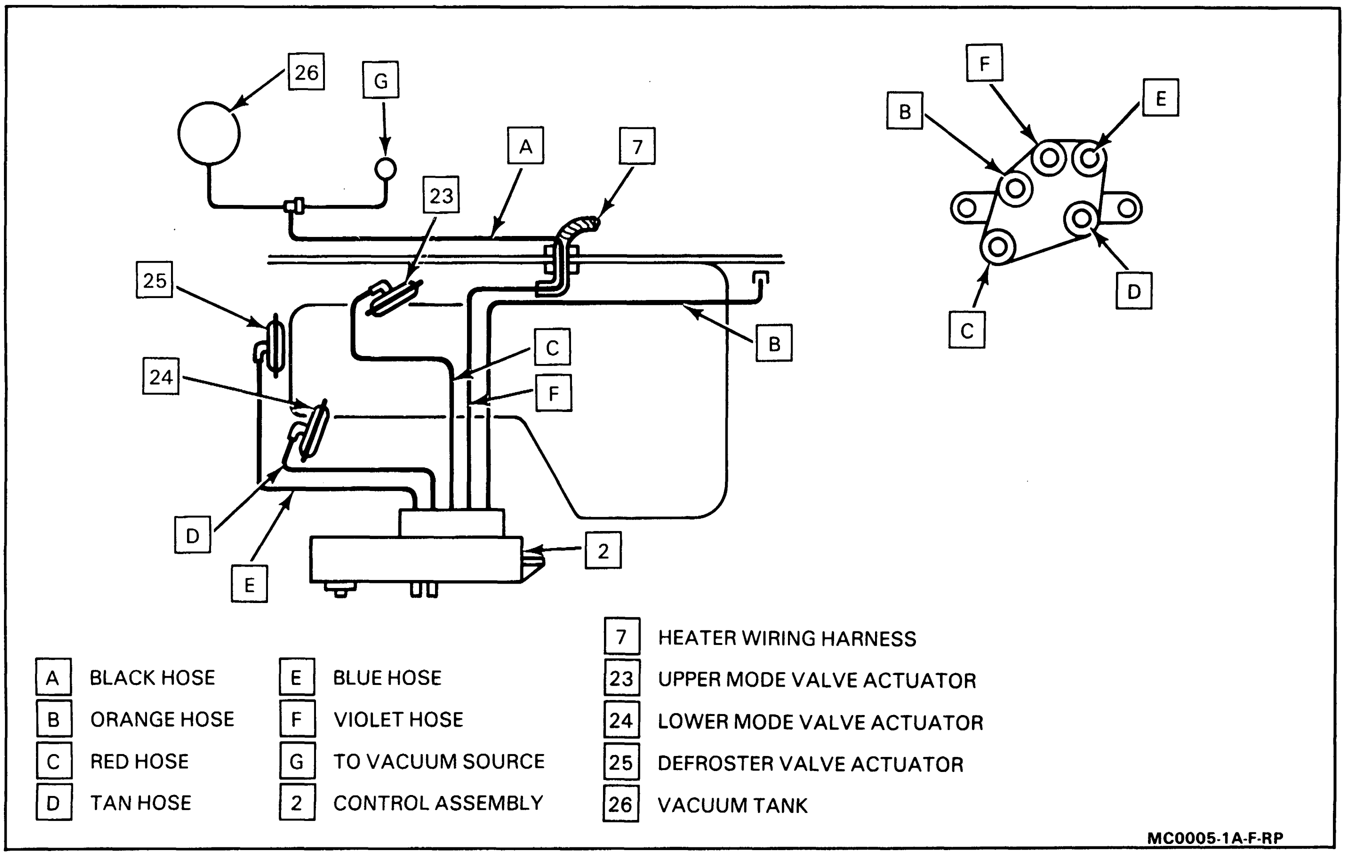


Figure 5 - Vacuum Circuit

Temperature Valve and Heater Core

Figure 3

The temperature of the air discharged from the heater system is regulated by controlling the relative amounts of warm and cool air that are mixed together downstream from the heater core area. The part of the total airflow that is allowed to pass through the heater core (9) is governed by the position of the temperature valve (21).

Hot coolant from the engine's cooling system is directed through the heater core (9). The heater core (9) transfers heat from the coolant to the air passing through the core fins.

Mode Valves

Figures 3 and 4

After the heated and unheated airflows are mixed beyond the heater core (9), the combined airflow comes to the upper mode valve (3) and lower mode valve (4). These two air valves work in combination to control airflow through the passage that feeds the instrument panel outlets. For the "VENT" mode, vacuum is directed to both vacuum actuators and both the upper mode valve (3) and the lower mode valve (4) open to allow air to flow to the instrument panel outlets. In the "HEATER" and "DEFROST" modes, both vacuum actuators are vented and both the upper mode valve (3) and the lower mode valve (4) close to prevent airflow to the instrument panel outlets.

When the "BI-LEVEL" air conditioning mode is selected, only the lower mode valve (4) is opened. This divides the airflow so the instrument panel outlets, the floor air outlet (27), the defroster nozzles and the side window defogger outlets all receive a share of the air.

The last vacuum-controlled mode valve in the air distribution system is the defroster valve (20). In the "HEATER" and "BI-LEVEL" modes, vacuum is applied to the defroster valve actuator (25). This moves the defroster valve (20) to divert almost all of the airflow to the floor air outlet (27) to heat the passenger compartment. Only a slight amount passes through an opening in the defroster valve (20) and goes to the windshield defroster nozzles.

In the "DEFROST" mode, the defroster valve actuator (25) is vented to normal air pressure and the spring in the actuator holds the defroster valve (20) in a position to route most of the airflow to the windshield defroster passage in the air distributor (32). In the "VENT" mode, the defroster valve also is held in this position. Only a slight amount of the total airflow passes through the opening in the defroster valve (20) and goes to the floor air outlet (27).

Ducts and Outlets

Figures 1 and 6

Air valves in the heater module (1) direct the airflow to the correct openings for the selected operating mode. The large air distributor (32) mounted to the rear face of the air conditioning module contains three air passages. A large passage leads from the defroster opening in the heater module (1) to the two defroster outlets at the base of the windshield. A smaller passage feeds the two ducts (38 and 39) to the side window defogger outlets in both ends of the instrument panel pad. The third passage in the air distributor (32) connects the vent opening in the heater module (1) to the system duct (35) that feeds the instrument panel center outlets.

Also mounted to the rear face of the heater module (1) is the floor air outlet (27), an inverted Y-shaped duct that connects the heater opening in the heater module (1) to the two outlets in the sides of the console. The four air outlets in the instrument panel have adjustable deflectors that permit vehicle occupants to direct the high level airflow in a desired direction. The floor air outlet (27) and the two side window defogger outlets distribute the airflow in a set pattern.

Ventilation

Figure 7

The air distribution system provides fresh air ventilation for the passenger compartment in all operating modes. After being warmed to the desired temperature, the air is discharged from the outlets appropriate to the selected operating mode. When all windows are closed, the addition of outside air builds a slight positive pressure within the passenger compartment. The pressure forces stale air to leave the vehicle through a pressure relief valve (45) near the base of the body door lock pillars after it has circulated through the passenger compartment.

DIAGNOSIS

FUNCTIONAL TEST

Before beginning the functional test of the heater system, the vehicle engine should be idling with the coolant hot and the thermostat open. Coolant temperature should be close to 90°C (194°F). During the functional test, the operating efforts of the mode lever and the temperature lever should be evaluated. Even if a problem is found during any intermediate step of the functional test, the test should be completed before repair is begun.

1. Cycle the temperature lever lever to the extreme ends of travel in the slot in the control assembly dial to assure that the self-adjusting cable is properly adjusted.
2. Set the mode lever to "BI-LEVEL," the temperature lever to full "COOL" and the blower switch to "HI."
   - Air at nearly the same temperature as outside air should come from all outlets.
3. Set the mode lever to "VENT."
   - Air at nearly the same temperature as outside air should come from the instrument panel outlets.
   - Air should not come from the floor outlets, the defroster nozzles or the side window defogger outlets.
4. Move the mode lever to the "HEATER" position.

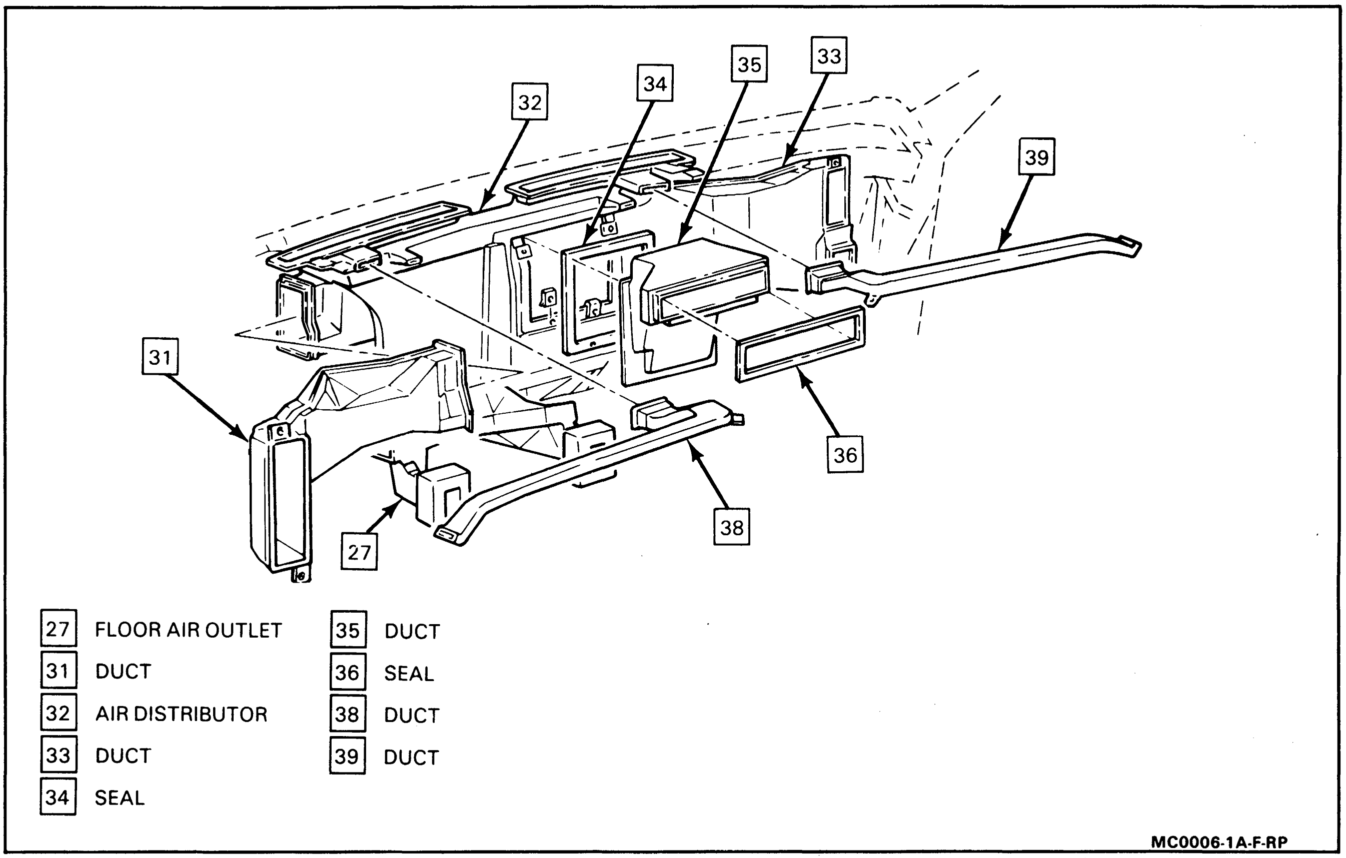


Figure 6 - Air Ducts

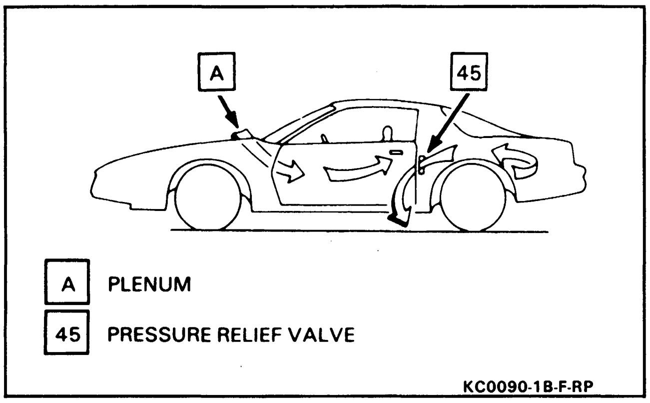


Figure 7 - Ventilation Airflow Schematic

- Most of the air should come from the floor outlets with the remainder coming out of the defroster nozzles and defogger outlets.
- Air should not come from the instrument panel outlets in the "HEATER" position.
- All air from the heater system should be at nearly the same temperature as outside air.

5. Move the mode lever from the "HEATER" position to the "DEFROST" position.

- Most of the air should be discharged onto the windshield from the defroster nozzles.
- A small amount of air also should be discharged from the floor outlets.

6. Move the mode lever back to the "BI-LEVEL" position and move the temperature lever to the full "WARM" position.
   - Air should come from the instrument panel outlets, and its temperature should climb rapidly to approximately 55°C (131°F) or higher, depending upon the outside air temperature. For a more precise heater output temperature check, refer to "Heater Output Temperature Check" in this section.
   - Defroster nozzle airflow should diminish and the airflow from the floor outlets may increase slightly.
7. Move the temperature lever back to the full "COOL" position and check to be sure the air temperature drops back to nearly the temperature of the outside air once again.
8. Slowly turn the blower switch toward "OFF," stopping briefly at each intermediate blower speed position to notice the force of the airflow coming from the instrument panel center outlets and the sound of the blower.
   - Both the airflow and the blower noise should reduce noticeably at each intermediate step.

HEATER OUTPUT TEMPERATURE CHECK

Figure 8

The heat output of the heater system can be checked with the following procedure.

Preparation

With the engine sufficiently cool, the radiator cap should be removed and the engine started and allowed to idle. Heater controls should be set to "HEATER" mode, full "WARM" temperature and "HI" blower speed. When coolant flow in the radiator is visible through the filler neck, the radiator cap should be installed.

Temperature Check

When the engine is warmed up (after approximately 20 minutes of operation), the vehicle should be driven. An accurate thermometer should be used to determine the temperature of the outside air and the temperature of the air discharged at the floor outlets with the vehicle being driven at 48 km/h (30 mph). Minimum acceptable heater output temperatures at four different outside air temperatures are shown in Figure 8.

Minimum acceptable heater output temperatures for outside air temperatures other than those shown in Figure 8 can be approximated by using the Fahrenheit scale and rounding off the outside air temperature to the nearest 5°. For every additional 5° of outside temperature, an additional 1.8° of heater output temperature should be allowed when the outside temperature is below 50°F. An additional 1.6° of heater output temperature should be allowed for every 5° of outside temperature when the outside temperature is above 50°F.

OUTSIDE AIR TEMPERATURE	-18°C (0°F)	-4°C (25°F)	10°C (50°F)	24°C (75°F)
HEATER AIR TEMPERATURE*	54°C (130°F)	59°C (139°F)	64°C (147°F)	68°C (155°F)

*Temperature at floor-level heater outlet, controls at "HI" blower, "HEATER" mode and full "WARM," engine at operating temperature and vehicle speed of 48 km/h (30 mph).

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Figure 8 - Heater Output Temperature Chart

INSUFFICIENT HEATING OR DEFROSTING

Figures 9 and 10

The most likely causes of insufficient heating outside the heater system include a low coolant level, a faulty thermostat, a partially or fully clogged heater core or hose, an obstruction to air circulation (often under the front seat) or an air leak past a faulty seal into the passenger compartment. For an organized diagnosis procedure, refer to Figures 9 and 10.

HIGH OR LOW TEMPERATURE CONTROL EFFORT

Figure 11

A kinked control cable, a binding valve or a faulty control assembly are possible causes of excessive temperature control lever effort. For an organized diagnosis procedure and an effective "fix" for too little temperature control effort, refer to Figure 11.

BLOWER NOISE

Figures 12 and 13

A constant air rush noise is typical of all heater systems when operating on "HI" blower. Some systems and modes may be worse than others. If possible, check a similar vehicle to determine whether the noise is typical or excessive. For diagnosis of excessive blower noise, refer to Figures 12 and 13.

EXCESSIVE HEAT

The most likely cause of excessive heat from the heater system is an out-of-adjustment temperature control cable. Refer to "Temperature Control Cable Adjustment" in this section. Other related causes of excessive heat include a slipping self-adjusting clip at the temperature control cable end, a loose control cable sheath retainer or bracket at the bottom of the heater assembly, or a binding or obstructed temperature air valve. A hot air leak from the engine compartment to the blower inlet is also a remote possibility.

ON-VEHICLE SERVICE

ADJUSTMENTS AND REPAIRS

Temperature Control Cable Adjustment

The temperature control cable has a self-adjusting sliding clip at the heater module end. To operate the self-adjusting feature, the temperature lever in the control assembly should be moved briskly back and forth from full "COOL" to full "WARM." If the clip requires adjustment, added effort may be required to move the temperature lever through the final part of its travel. When the temperature control cable adjustment is correct, the temperature valve will be heard hitting the stops at both extremes of lever travel.

REPLACEMENT PROCEDURES

Control Assembly and Vacuum Selector Valve and/or Blower Switch

Figure 14

↔ Remove or Disconnect

1. Radio and heater control console trim plate retaining screws (71).
2. Radio and heater control console trim plate (72).
3. Control assembly retaining screws (70).
4. Control assembly (2).
   - Pull the control assembly (2) out far enough to reach the vacuum, electrical and temperature control cable connections.
5. Blower switch connector.
6. Control assembly dial lamp wire connector.
7. Vacuum harness connector at the vacuum selector valve.
8. Temperature control cable from the control assembly (2).

INSUFFICIENT HEATING OR DEFROSTING

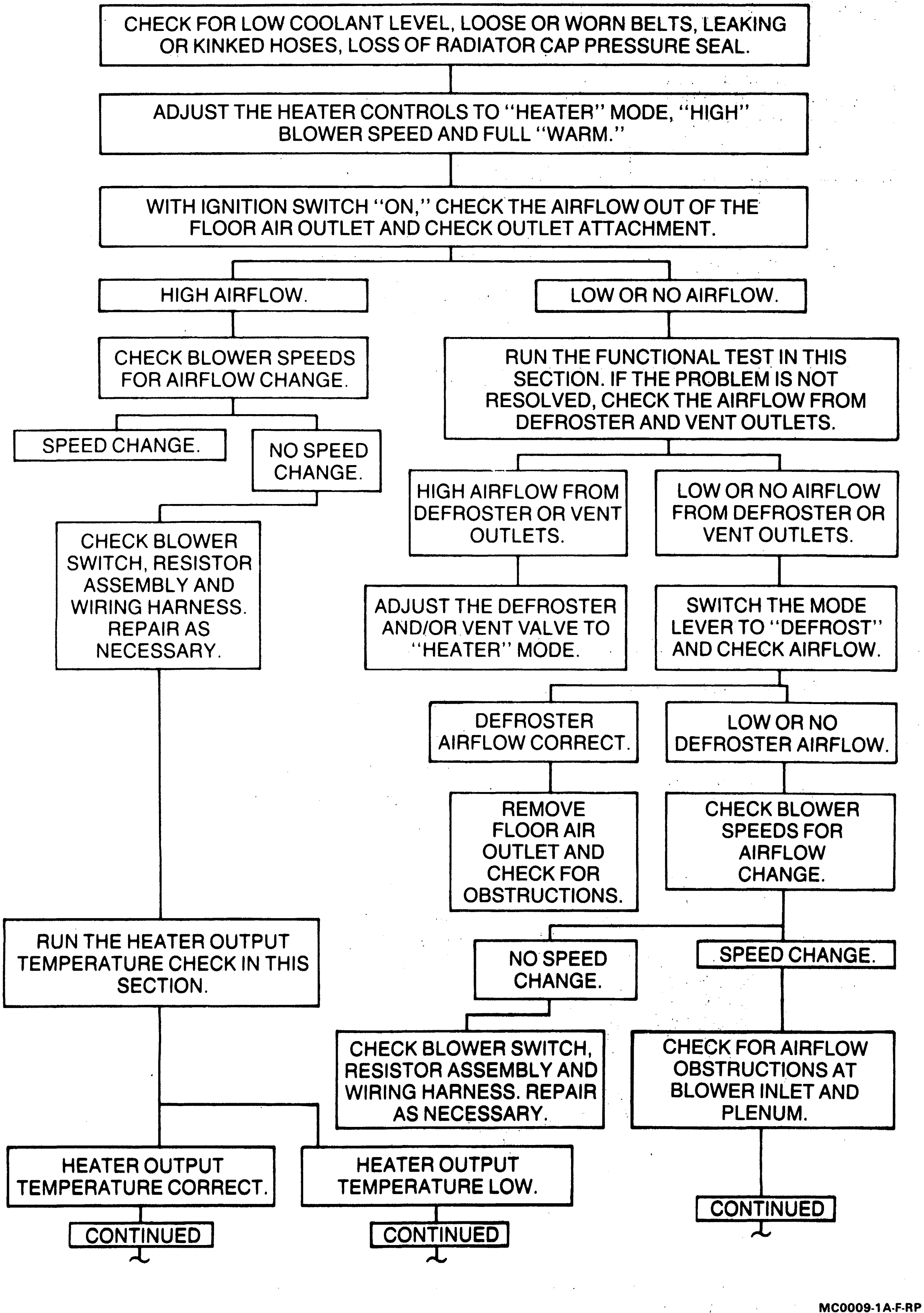

Figure 9 - Insufficient Heating or Defrosting Diagnostic Procedure (1 of 2)

INSUFFICIENT HEATING OR DEFROSTING (Continued)

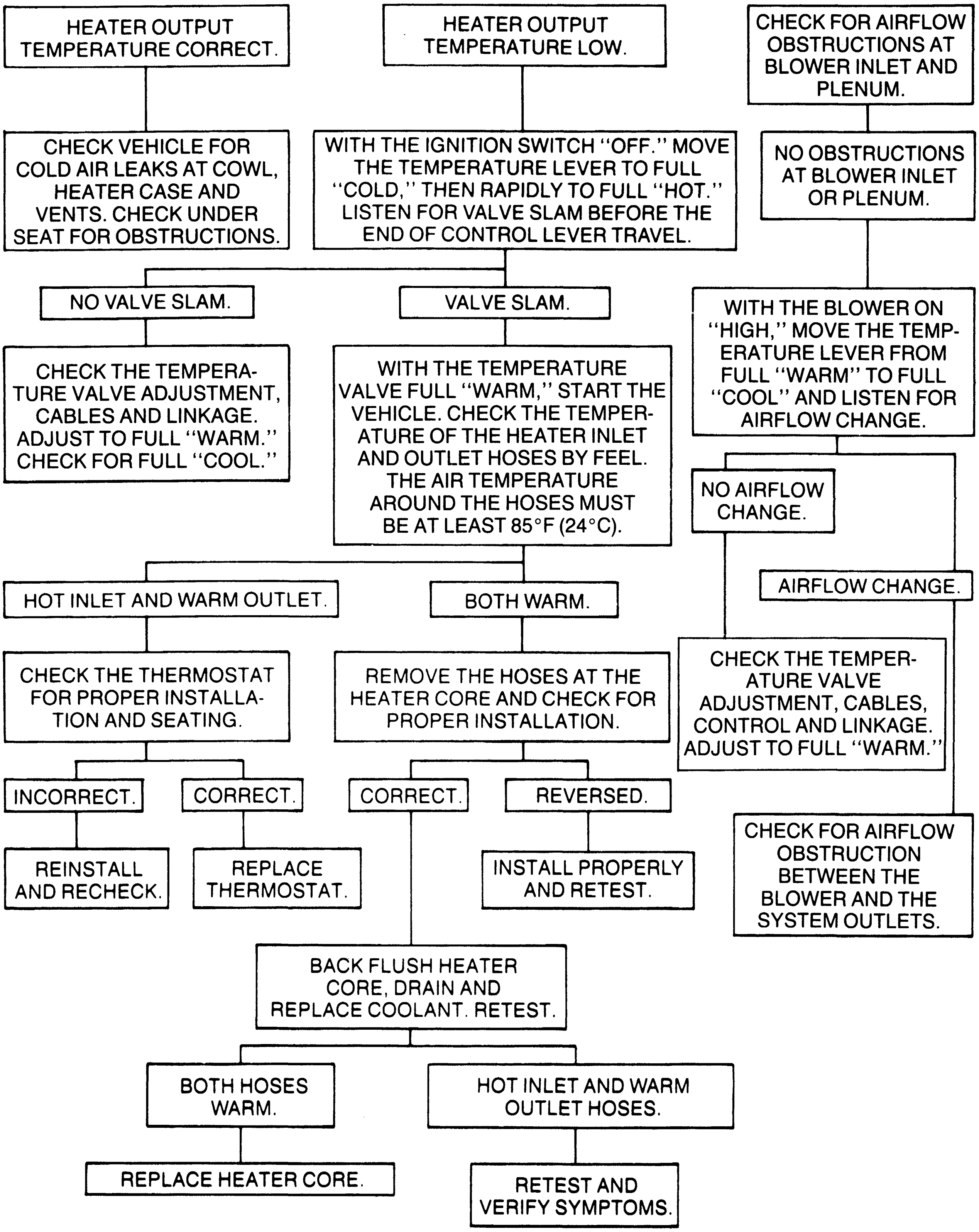

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Figure 10 - Insufficient Heating or Defrosting Diagnostic Procedure (2 of 2)
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TEMPERATURE CONTROL EFFORT

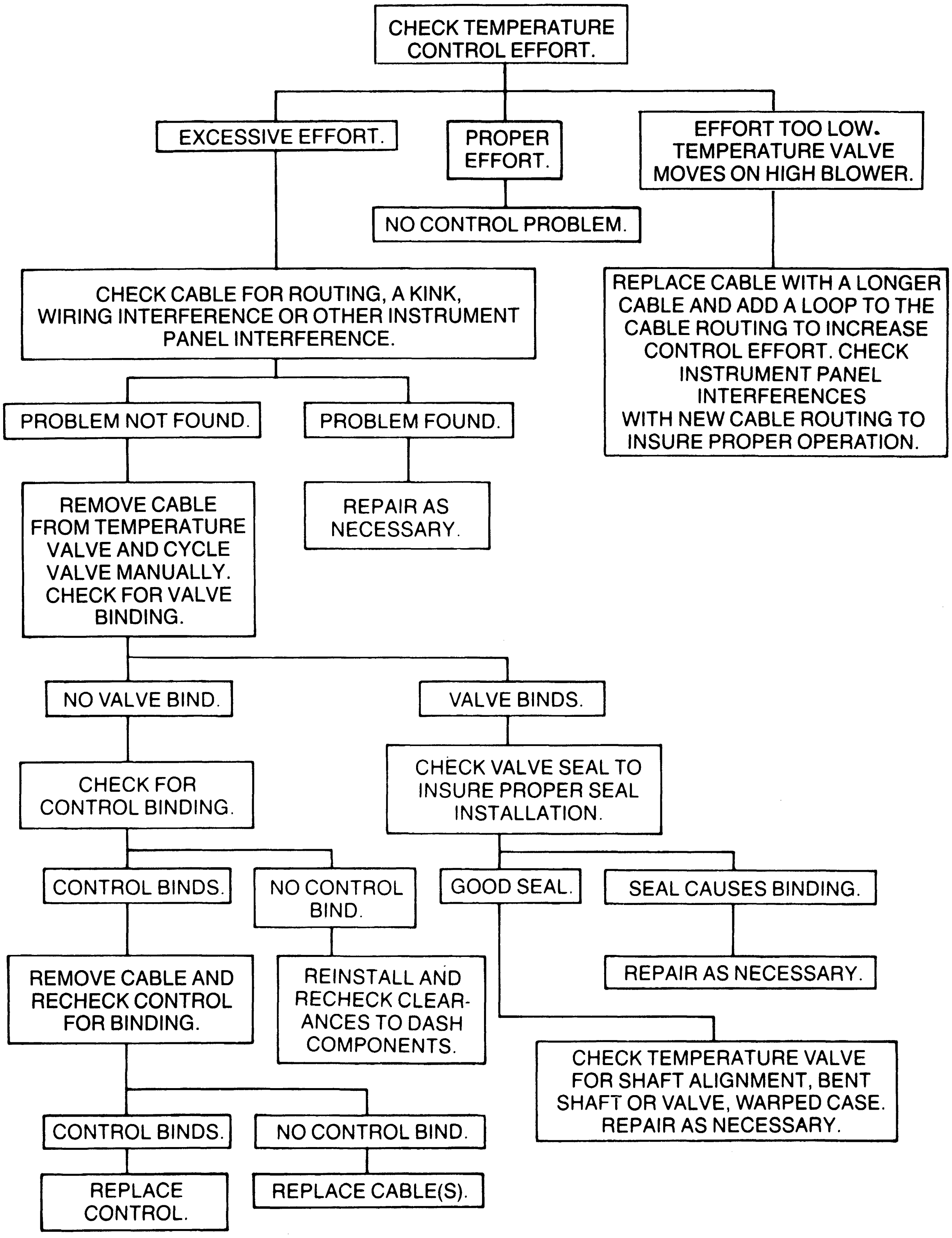

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Figure 11 - Temperature Control Effort Diagnostic Procedure

BLOWER NOISE

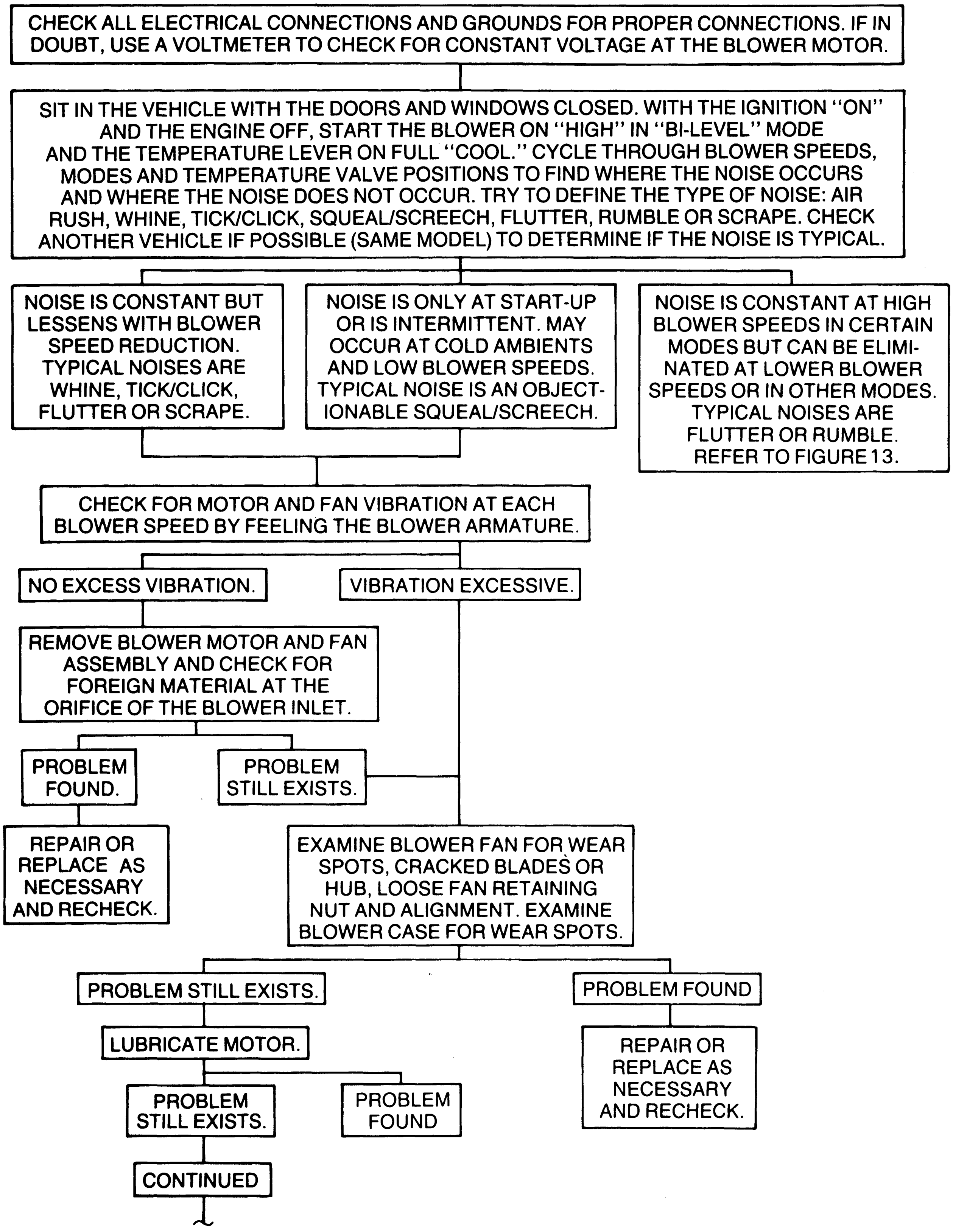

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Figure 12 - Blower Noise Diagnostic Procedure (1 of 2)

BLOWER NOISE (Continued)

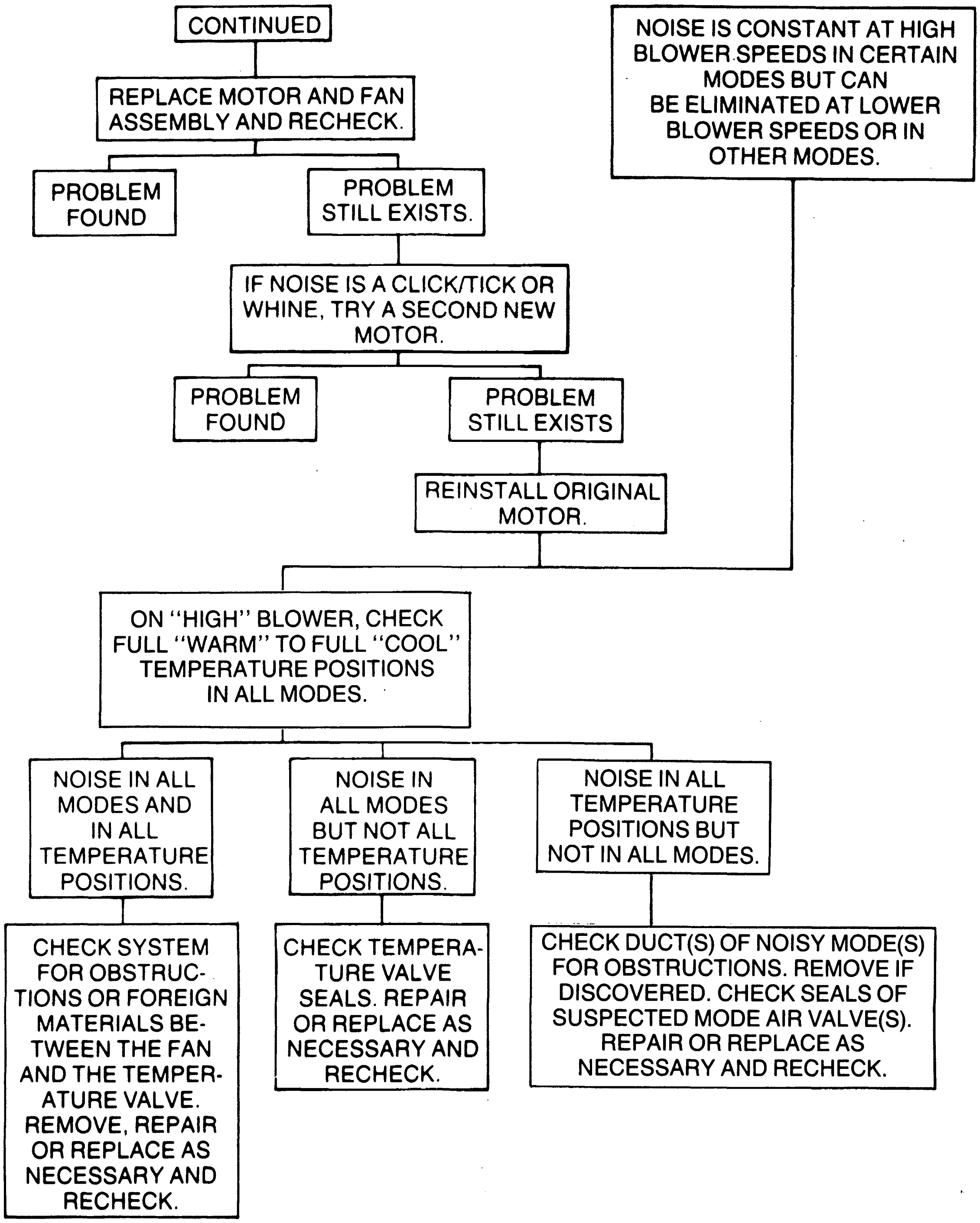

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Figure 13 - Blower Noise Diagnostic Procedure (2 of 2)

- Pull the temperature control cable clip from the control assembly (2).
- Slip the temperature control cable loop off the lever.

9. Vacuum selector valve, if necessary.
   - Remove two retaining screws and remove the vacuum selector valve.
10. Blower switch, if necessary.
    - Remove the blower switch knob and the retaining clip from the shaft of the blower switch.
    - Remove the blower switch.

Inspect

- Electrical terminals for corrosion. Remove the corrosion or replace the component as necessary.
- Temperature and mode levers for freedom of movement. Lubricate, repair or replace as necessary.
- Temperature control cable for kinks, binding and other damage. Adjust, repair or replace as necessary.

Install or Connect

NOTICE: See "Notice" on page 1A-1 of this section.

1. Blower switch, if removed.
   - Hold the blower switch in position and install the retaining clip.
   - Install the blower switch knob.
2. Vacuum selector valve and retaining screws, if removed.
3. Temperature control cable.
   - Slip the temperature control cable loop into position on the lever arm.
   - Press the temperature control clip into the slot in the control assembly (2).
4. Vacuum harness connector to the vacuum selector valve.
5. Control assembly dial lamp wire connector cable clip to the instrument panel wiring harness.
6. Blower switch connector.
7. Control assembly (2).
8. Control assembly retaining screws (70).
   - Install the lower right screw (70) first to align the control assembly (2) properly.

Tighten

- Screws (70) to 1.4 N·m (12 lb. in.).

9. Radio and heater control console trim plate (72).
10. Radio and heater control console trim plate retaining screws (71).

Tighten

- Screws (71) to 1.4 N·m (12 lb. in.).
- Test the operation of the temperature lever, the mode lever and the blower switch.

Control Assembly Lamp Bulb

Figure 14

Remove or Disconnect

1. Radio and heater control console trim plate retaining screws (71).
2. Radio and heater control console trim plate (72).
3. Control assembly retaining screws (70).
4. Control assembly (2).
   - Pull the control assembly (2) out far enough to reach the control assembly lamp bulb socket.
5. Lamp bulb and socket.
6. Bulb from socket.
   - Pull the bulb straight out from the socket.

Inspect

- Control assembly lamp bulb socket for corrosion and damage. Clean or replace as necessary.

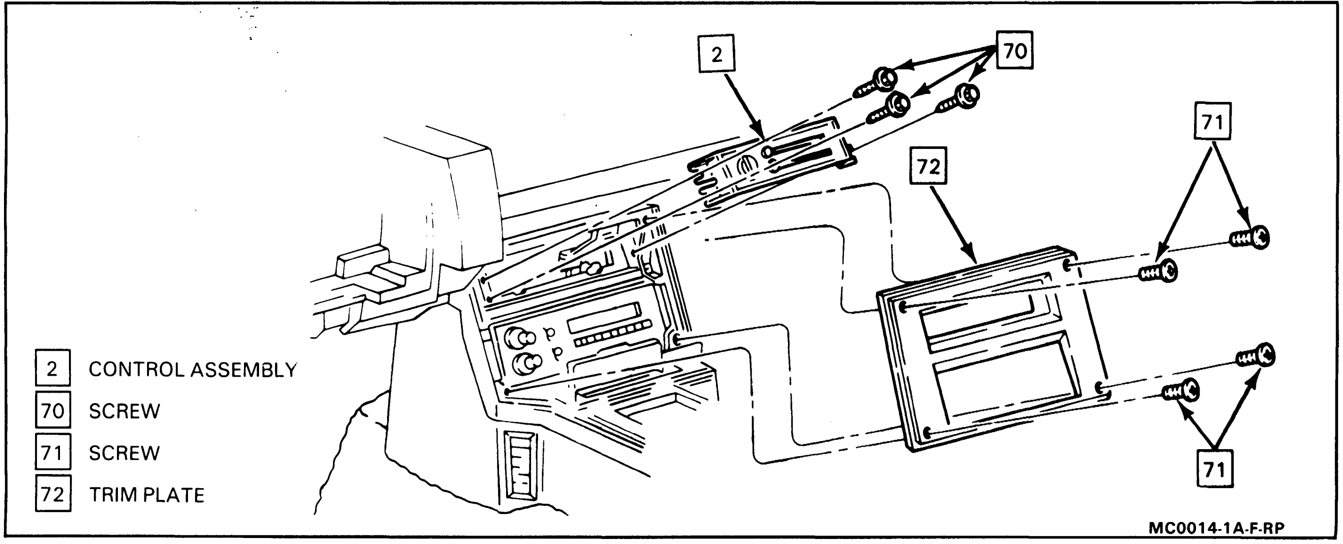


Figure 14 - Control Assembly Removed

- Wires for damage and secure connection to the bulb socket. Repair or replace as necessary.

Install or Connect

NOTICE: See "Notice" on page 1A-1 of this section.

1. New bulb.
   - Push the bulb straight into the socket.
2. Bulb and socket.
3. Control assembly (2).
4. Control assembly retaining screws (70).
   - Install the lower right screw (70) first to align the control assembly (2) properly.

Tighten

   - Screws (70) to 1.4 N·m (12 lb. in.).
5. Radio and heater control console trim plate (72).
6. Radio and heater control console trim plate retaining screws (71).

Tighten

   - Screws (71) to 1.4 N·m (12 lb. in.).

- Test the operation of the control assembly lamp bulb.

Temperature Control Cable

Figures 14 and 15

Remove or Disconnect

1. Right sound insulator. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
2. Temperature control cable (5) at the heater module (1).
   - Remove the push nut retainer (16) holding the cable adjusting clip to the temperature valve lever pin.
   - Disengage the cable clip from the slot in the heater module (1).
3. Radio and heater control console trim plate retaining screws (71).
4. Radio and heater control trim plate (72).
5. Control assembly retaining screws (70).
6. Control assembly (2).
   - Pull the control assembly (2) out far enough to reach the temperature control cable connection.
7. Temperature control cable push nut retainer (16).
8. Temperature control cable (5).
   - Pull the temperature control cable clip from the control assembly (2).
   - Slip the temperature control cable loop off the lever arm.

Install or Connect

NOTICE: See "Notice" on page 1A-1 of this section.

1. Temperature control cable (5) to the control assembly (2).
   - Slip the temperature control cable loop into position over the lever arm.
   - Press the temperature control cable clip into the slot in the control assembly (2).
2. Temperature control cable push nut retainer (16).
3. Control assembly (2).
4. Control assembly retaining screws (70).
   - Install the lower right screw (70) first to align the control assembly (2) properly.

Tighten

   - Screws (70) to 1.4 N·m (12 lb. in.).
5. Radio and heater console control trim plate (72).
6. Radio and heater console control trim plate retaining screws (71).

Tighten

   - Screws (71) to 1.4 N·m (12 lb. in.).
7. Temperature control cable (5) at the heater module (1).
   - Fit the cable self-adjusting clip onto the temperature valve lever pin.
   - Snap the cable clamp into the slot in the heater module (1).
   - Install the push nut retainer (16) to the temperature valve lever pin.
8. Right sound insulator. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).

Adjust

- Temperature control cable. Refer to "Temperature Control Cable Adjustment" in this section.

Blower Motor Resistor Assembly

Figure 16

Remove or Disconnect

- Remove the key from the ignition to assure that the switch will remain "OFF."

1. Air conditioning wiring harness connector at the blower motor resistor assembly (22).
2. Resistor assembly retaining screws (19).
3. Blower motor resistor assembly (22).

Install or Connect

NOTICE: See "Notice" on page 1A-1 of this section.

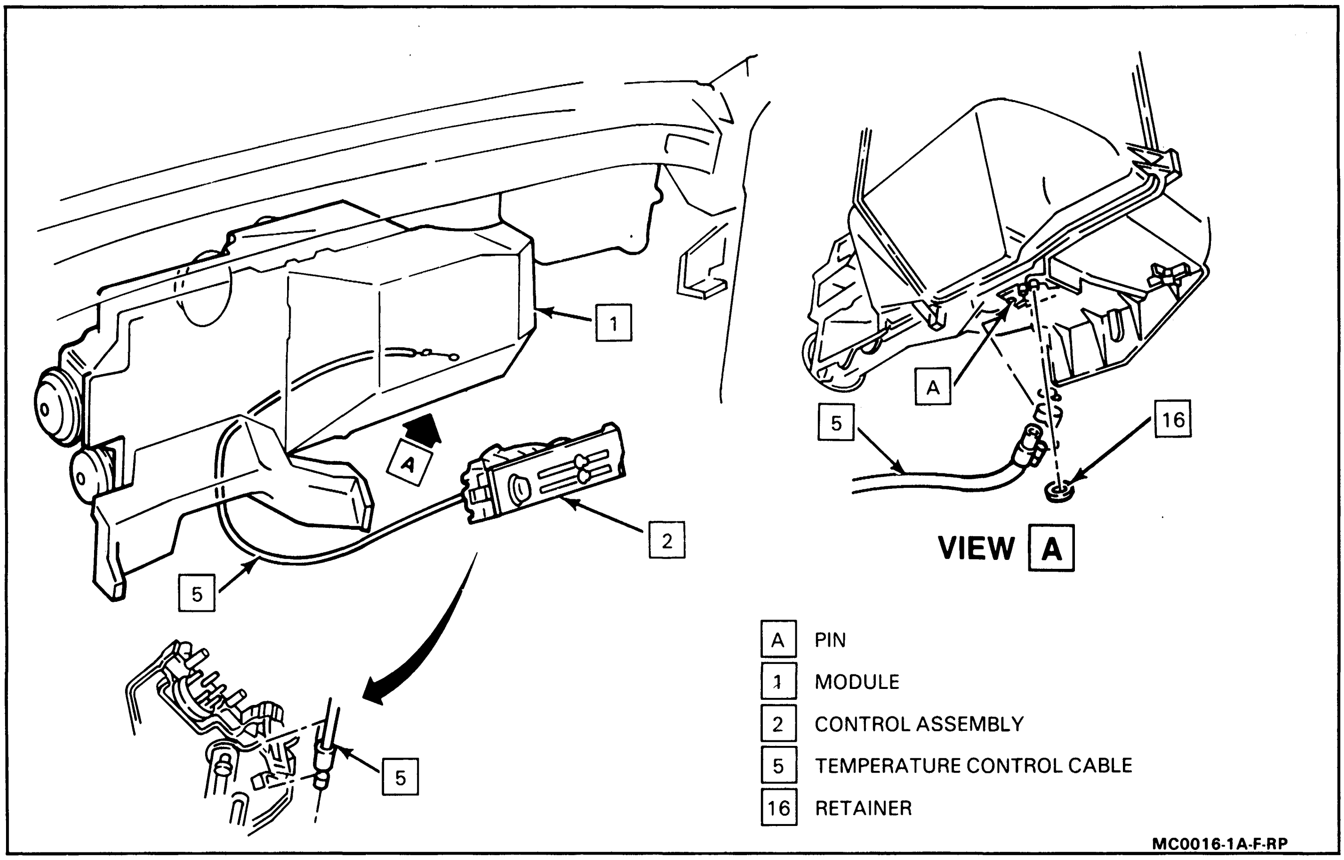


Figure 15 - Temperature Control Cable

1. Blower motor resistor assembly (22) and retaining screws (19).

Tighten

- Screws (19) to 2.0 N·m (18 lb. in.).

2. Air conditioning wiring harness connector.

- Test blower motor operation at all four speeds.

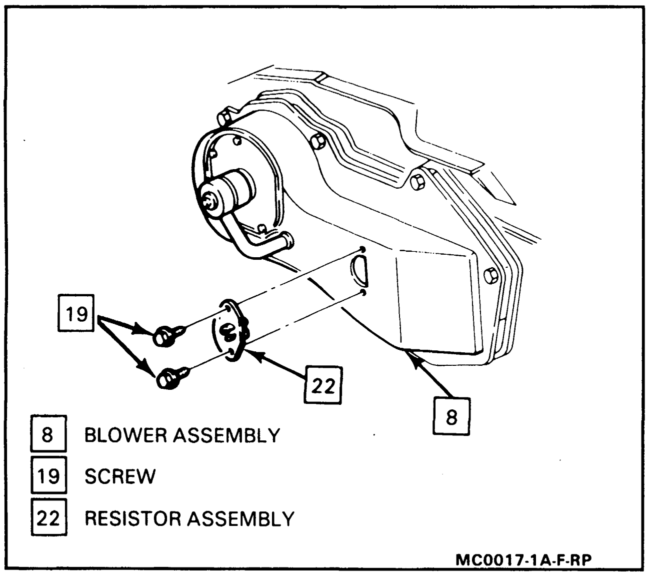


Figure 16 - Resistor Assembly Removed

Blower Motor and Fan

Figure 17

Remove or Disconnect

- Remove the key from the ignition switch to assure that the switch will remain "OFF."

1. Diagonal fender brace at the right rear corner of the engine compartment, if necessary.
   - Remove the two bolts and remove the brace.
2. Air conditioning wiring harness connectors at the blower motor power and ground terminals.
3. Blower motor cooling tube (51).
4. Blower motor attaching screws (50).
5. Blower motor (6).
   - Pull the blower motor (6) forward carefully to avoid distorting the blower fan (14).
   - Work the blower motor fan (14) up and out of the engine compartment.
6. Blower fan (14), if necessary.
   - Remove the nut from the blower motor shaft.
   - Remove the blower fan (14) and washer.

Inspect

- Blower motor terminals for corrosion. Clean corrosion from the terminals or replace the blower motor (6) as necessary.
- Flange of the blower motor (6) for damage or distortion that could cause an air leak. Repair as necessary.

- Blower fan (14) for damage and distortion. Repair or replace as necessary.

Install or Connect

1. Blower fan (14) to blower motor shaft, if removed.
   - Install the washer and the blower fan (14) to the blower motor shaft.
   - Install the nut retaining the fan to the blower motor shaft.
2. Blower motor (6).
   - Guide the blower motor (6) and blower fan (14) into position, being careful not to catch the blower fan (14) on protruding parts.
3. Blower motor attaching screws (50).
4. Blower motor cooling tube (51).
5. Air conditioning wiring harness connectors at the blower motor power and ground terminals.
6. Diagonal fender brace and bolts, if removed.

- Check blower operation.

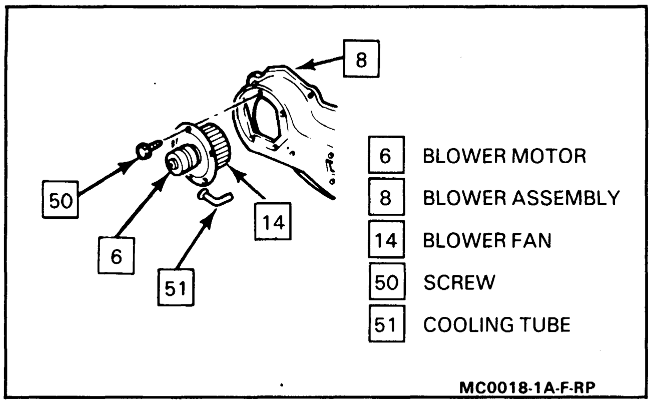


Figure 17 - Blower Motor and Fan Removed

Heater Wiring Harness

Figures 14 and 18

Remove or Disconnect

1. Battery ground cable.
2. Heater wiring harness connectors at the blower motor resistor assembly (22), blower motor power terminal and blower motor ground terminal.
3. Screw (48), washer (47) and wiring harness ground wire at the dash panel.
4. Nut (49) and wiring harness retaining clip.
5. Radio and heater control trim plate (72).
   - Remove the 4 radio and heater control trim plate screws (71).
   - Remove the trim plate (72).
6. Control assembly retaining screws (70).
7. Control assembly (2).
   - Pull the control assembly (2) out far enough to reach the blower switch connector.
8. Blower switch connector.
   - Tie a pull cord to the blower switch connector of the heater wiring harness (7) to aid installation.
   - Tie a pull cord to the instrument panel wiring harness power feed connector to aid installation.
9. Instrument panel wiring harness power feed connector.
10. Heater wiring harness (7).
    - From the engine compartment, carefully work the heater wiring harness grommet free from the dash panel.
    - Carefully pull the heater wiring harness (7) through the dash panel into the engine compartment.
    - Untie the pull cord from the blower switch connector and remove the heater wiring harness.

Clean

- Original sealer from the heater wiring harness grommet and the hole in the dash panel.

Inspect

- Connectors for corrosion, loose terminals and other damage. Clean, repair or replace as necessary.
- Exposed wires for cracked insulation, broken strands and other damage. Repair or replace as necessary.
- Wiring harness loom for breaks and other signs of major damage. Replace if necessary.

Install or Connect

NOTICE: See "Notice" on page 1A-1 of this section.

- From the engine compartment, tie the pull cord to the blower switch connector of the new or repaired heater wiring harness (7).
- Work the pull cord, blower switch connector and rear portion of the wiring harness (7) through the dash panel and into the passenger compartment.

1. Wiring harness grommet.
   - Apply fresh approved sealer to the grommet.
   - Press the grommet firmly in place in the dash panel.
2. Heater wiring harness connectors at the blower motor resistor assembly (22), blower motor power terminal and blower motor ground terminal.
3. Washer (47), wiring harness ground wire connector and screw (48) at the dash panel.

Tighten

- Screw (48) to 4.5 N·m (40 lb. in.).

4. Wiring harness retaining clip and nut (49)

Tighten

- Nut (49) to 2.0 N·m (18 lb. in.).

5. Instrument panel wiring harness power feed connector.
   - Pull the power feed connector to an accessible position with the pull cord.
   - Pull the heater wiring harness blower switch connector to an accessible position with the pull cord.
   - Connect the instrument panel wiring harness power feed connector to the heater wiring harness connector.
   - Untie and discard both pull cords.
6. Blower switch connector.
7. Control assembly (2).
8. Control assembly retaining screws (70).
   - Install the lower right screw (70) first to align the control assembly (2) properly.

   Tighten

   - Screws (70) to 1.4 N·m (12 lb. in.).
9. Radio and heater control trim plate (72).
   - Hold the trim plate (72) in position and install the four trim plate screws (71).

     Tighten

     - Screws (71) to 1.4 N·m (12 lb. in.).
10. Battery ground cable.

- Test blower motor operation at all three speeds.

Air Distributor and Instrument Panel Air Outlet Ducts

Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).

Floor Air Outlet Duct

Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).

Side Window Defogger Ducts

Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).

Air Deflectors

A heater system air deflector can be removed by prying on one side of the deflector with a small thin-blade screwdriver to pop it out. The deflector can be installed by pressing it into place.

Vacuum Hose Harness

Figure 19

Remove or Disconnect

1. Left and right sound insulators. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
2. Control assembly (2). Refer to "Control Assembly and Vacuum Selector Valve and/or Blower Switch" in this section.
3. Vacuum hose connectors at the vacuum actuators.
   - Trace each vacuum hose to its actuator on the heater module (1), noting its routing for reference during installation.
   - Disconnect the connector at each actuator by sliding the tab of the plastic retainer past the L-shaped bend in the actuator vacuum tube. Then slide the hose connector off the tube while continuing to hold the tab back against the body of the connector.
   - Disconnect the hose connector at the air inlet opening cover for the plenum in the cowl panel.
4. Main harness segment connector from the engine compartment harness segment connector.
5. Main harness segment from the retaining clip. (66).
6. Main harness segment.
7. Engine compartment harness segment, if necessary.
   - Disconnect the vacuum hose at the vacuum line T-fitting.
   - Work the vacuum hose through the heater wiring harness loom.
   - Carefully push the vacuum harness grommet through the wiring harness grommet in the dash panel until it is free.
   - Work the engine compartment harness through the hole in the wiring harness grommet until the vacuum hose is completely inside the passenger compartment.
   - Remove the engine compartment harness segment from the passenger compartment side of the dash panel.

Inspect

- Vacuum hoses for leaks by attempting to blow through the hose while covering the opposite end with a fingertip. Replace any hose that leaks.
- Vacuum switches and connecting hose at the control assembly for leaks and proper function. Replace faulty components.

Install or Connect

1. Engine compartment harness segment, if removed.
   - Guide the vacuum supply hose through the wiring harness grommet.
     - Work the hose through the wiring harness grommet until the vacuum harness grommet enters the hole in the wiring harness grommet.
     - Continue pressing the vacuum harness grommet in until its flange touches the wiring harness.

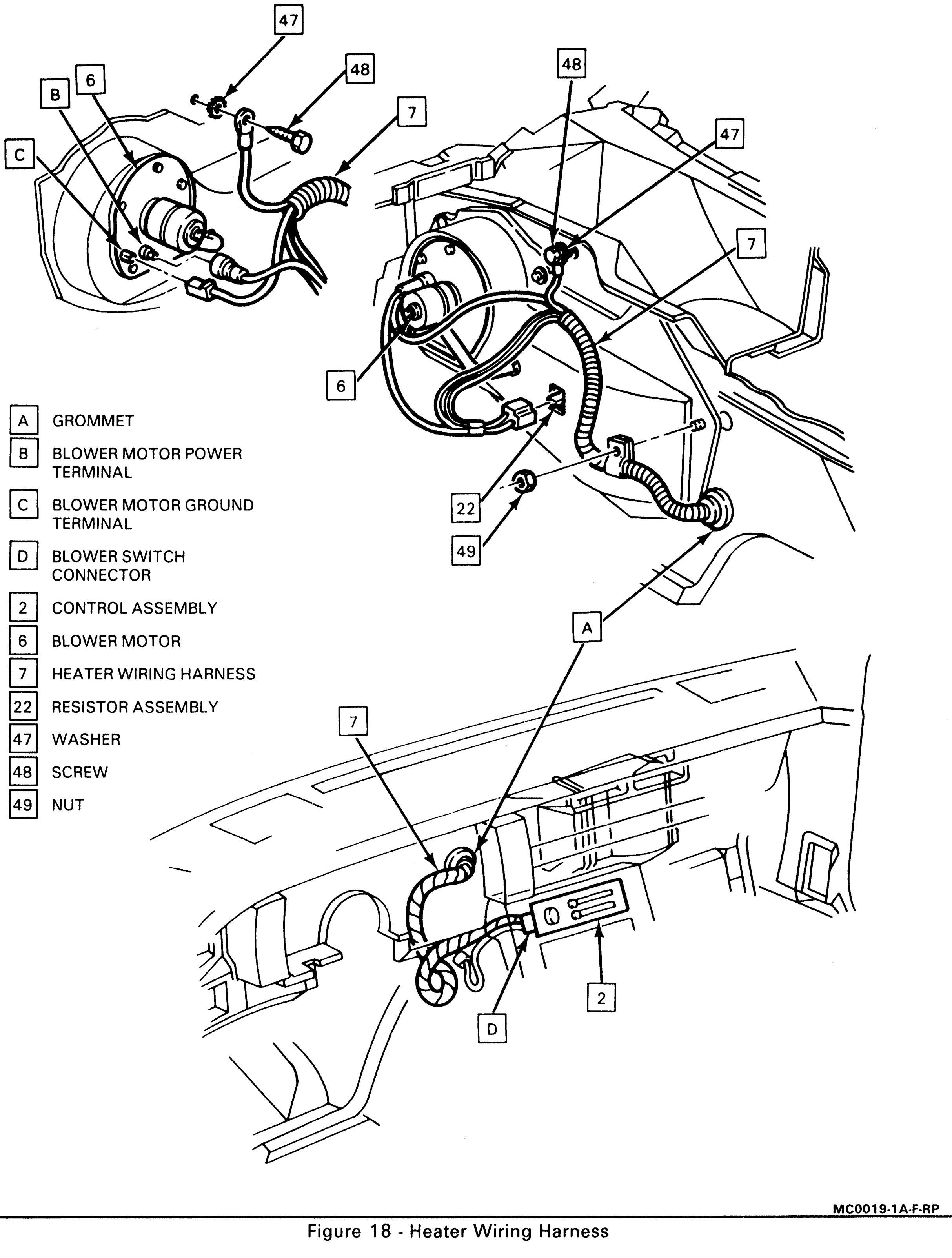


Figure 18 - Heater Wiring Harness

- Connect the vacuum supply hose to the vacuum source.

2. Main harness segment to the engine compartment harness segment.
3. Vacuum harness (67) to the clip (66) at the top of the air conditioning module.
4. Vacuum hose connectors to the vacuum actuators and air inlet opening cover.
   - To install a vacuum hose connector, bend the retaining tab of the plastic connector back flush against the end of the connector and hold it there while slipping the tab connector onto the vacuum actuator tube. When the connector is fully seated, pull the retaining tab over the L-shaped bend in the tube to hold the hose connector in place.
5. Control assembly (2). Refer to "Control Assembly and Vacuum Selector Valve and/or Blower Switch" in this section.
6. Left and right sound insulators. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).

Vacuum Tank

The vacuum tank that supplies the heater vacuum system is a ball-shaped tank under the canister tray by the left front fender.

Remove or Disconnect

- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Left lower fender brace.
2. Vacuum lines.
3. Two mounting screws from the top of the canister tray.
4. Vacuum tank.
   - Do not lose the two spring nuts on the mounting bracket.

Install or Connect

NOTICE: See "Notice" on page 1A-1 of this section.

1. Vacuum tank and mounting screws.

Tighten

- Screws to 5.0 N·m (44 lb. in.).

2. Vacuum lines.
3. Left lower fender brace.

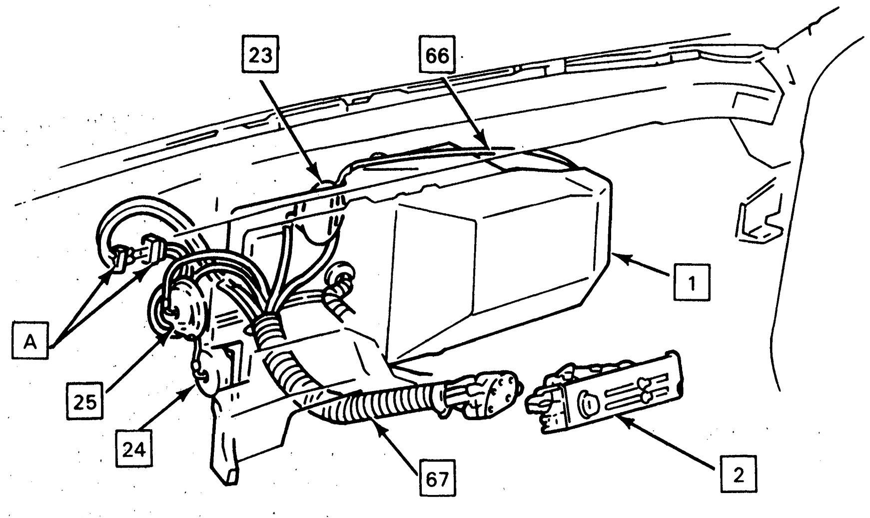
- Lower the vehicle.

Defroster Valve and/or Lower Mode Valve Vacuum Actuators

Figure 19

Remove or Disconnect

1. Left sound insulator. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
2. Vacuum hose connector at the defroster valve actuator (25) and/or the lower mode valve actuator (24).



A	VACUUM HARNESS CONNECTORS, MAIN HARNESS TO ENGINE COMPARTMENT HARNESS
1	MODULE
2	CONTROL ASSEMBLY
23	UPPER MODE VALVE ACTUATOR
24	LOWER MODE VALVE ACTUATOR
25	DEFROSTER VALVE ACTUATOR
66	CLIP
67	VACUUM HARNESS

MC0020-1A-F-RP

Figure 19 - Vacuum Harness

   - Disconnect the vacuum hose connector by sliding the tab of the connector past the L-shaped bend in the actuator vacuum tube. Then slide the hose connector off the tube while continuing to hold the tab back against the connector end.
3. Defroster valve actuator (25) and/or lower mode valve actuator (24).
   - Remove two nuts.
   - Disconnect the linkage from the actuator.

→← Install or Connect

1. Defroster valve actuator (25) and/or lower mode valve actuator (24), if removed.
   - Connect the linkage to the actuator.
   - Install the two mounting nuts.
2. Vacuum hose(s).
   - Install the blue hose to the defroster valve actuator (25) and/or the tan hose to the lower mode valve actuator (24).
   - Connect the vacuum hose connector by bending the tab of the connector back flush against the end of the connector and holding it there while slipping the tab and the connector onto the vacuum actuator tube. When the connector is fully seated, pull the tab over the L-shaped bend in the tube to hold the connector in place.
3. Left sound insulator. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).

Upper Mode Valve Vacuum Actuator

Figure 19

1. Instrument panel. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
2. Vacuum hose connector at the upper mode actuator (23).
   - Disconnect the vacuum hose connector by sliding the tab of the connector past the L-shaped bend in the actuator vacuum tube. Then slide the hose connector off the tube while continuing to hold the tab back against the connector end.
3. Upper mode actuator (23).
   - Remove two nuts.
   - Disconnect the linkage from the actuator.

→← Install or Connect

1. Upper mode actuator (23).
   - Connect the linkage to the actuator.
   - Install the two nuts.
2. Vacuum hose.
   - Install the red hose to the upper mode actuator (23).
   - Connect the vacuum hose connector by bending the tab of the connector back flush against the end of the connector and holding it there while slipping the tab and the connector onto the vacuum actuator tube. When the connector is fully seated, pull the tab over the L-shaped bend in the tube to hold the connector in place.
3. Instrument panel. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).

Heater Hoses and Pipes

Figures 20 and 21

The heater core inlet tube (60) and outlet tube (61) extend forward from the dash panel next to the heater module. The heater core inlet tube (60) is toward the right side of the vehicle from the heater core outlet tube (61).

On the 3.1L V6 engine, the heated coolant supply for the heater comes from a fitting at the front of the lower inlet manifold, just below the throttle body air inlet. A pipe (65) from the fitting extends across the front of the engine and connects to a heater inlet hose (62) that leads to a pipe (64) mounted on the right side rail in the engine compartment. The rear end of the pipe (64) is connected to a short inlet hose (62) that leads to the heater core inlet tube (60). The fitting on the pipe (65) across the front of the engine has two hose nipples that connect to short inlet and outlet hoses which heat the fuel injection system throttle body air inlet.

On V8 engines, the heated coolant supply for the heater comes from a fitting at the rear of the intake manifold of the L03 engine with throttle body fuel injection, or from the right side of the throttle body air inlet of the LB9 and L98 engines. The LB9 and L98 engines have a long heater inlet hose (62) from the heater core inlet tube (60) to a short L-shaped pipe (58) and a short hose that connects to the throttle body fitting. The L03 engine has a short inlet hose (62) that connects the intake manifold fitting directly to the heater core inlet tube (60).

On all engines, the heater core outlet tube (61) discharges coolant to a short heater outlet hose (63) that is connected to a pipe (56 or 64) mounted on the right side rail in the engine compartment. On the V6 engine, the forward end of the pipe (64) is connected to an outlet hose (63) that crosses in front of the engine and feeds the coolant into the engine coolant pump. On V8 engines, the forward end of the pipe (56) on the side rail is connected to an outlet hose (63) that feeds the coolant into the right tank of the radiator (57). On V8 engines that have an external oil cooler (78), the outlet hose (63) is connected to the oil cooler inlet pipe. After passing through the oil cooler (78), the coolant goes through the oil cooler outlet pipe and an outlet hose (63) to the right tank of the radiator (57).

The hoses are attached at each end with a spring tension clamp (59).

←→ Remove or Disconnect

1. Engine coolant.

- Drain enough coolant into a clean container to lower the coolant level below the level of the lowest heater hose fitting.

NOTICE: The heater core can be damaged if excessive force is applied on the core tubes during hose removal.

2. Inlet hose (62) and outlet hose (63).
   - Squeeze the clamp ends and slide the clamps (59) away from the fittings and beyond the end of the fitting, pipe (56, 58, 64, 65) or tube.
   - Remove the inlet hose (62) or outlet hose (63) by twisting and pulling. If the hose will not come off the heater core inlet tube (60) or outlet tube (61) easily with this method, cut off the hose forward of the heater core tube. Then cut the hose remaining on the core tube lengthwise to remove it.
   - Remove and discard the hose clamps (59) if the hose (62 or 63) is to be reused.
3. Pipe(s) (56 or 64) from side rail, if necessary.
   - Remove the retaining screw (68) from the pipe retainer and remove the pipe (56 or 64) and retainer as an assembly.
4. Front pipe (65) (V6 engine), if necessary.
   - Disconnect the two throttle body heater hoses at the front pipe connector.
   - Remove and discard the hose clamps (59) if the hoses are to be reused.
   - Disconnect the front pipe connector and discard the O-ring (55).
   - Remove the pipe attaching screw at the rear of the generator bracket and remove the pipe (65).

Install or Connect

NOTICE: See "Notice" on page 1A-1 of this section.

1. Front pipe (65) to the V6 engine, if removed.
   - Loosely install the pipe attaching screw holding the pipe to the rear of the generator bracket.
   - Using a new O-ring (55), loosely install the pipe connector to the fitting in the lower inlet manifold.

   Tighten

     - Pipe connector nut to 23 N·m (17 lb. ft.) while holding the fitting with a second wrench.
     - Pipe attaching screw to 10 N·m (89 lb. in.).

- Connect the two throttle body heater hoses to the nipples on the pipe connector.

2. Pipe(s) (56 or 64) to the side rail, if removed.
   - Loosely install the pipe(s) (56 or 64) with the retaining screws (68).

   Tighten

   - Screws (68) to 1.4 N·m (12 lb. in.).
3. Heater hose(s).
   - Cut the replacement hose(s) to the same length as the original hose(s), if necessary.
   - Apply rubber lubricant to the inside diameter of the hose(s), if desired.
   - Squeeze the clamp ends and slip a new hose clamp (59) over one end of the heater hose. Push the hose onto the pipe (56, 58, 64 or 65) or fitting with a twisting motion. The hose end should be 1.0 mm (0.04 inch) away from touching the nearest surface (dash panel, fitting hex head, etc.).
   - Install the clamp (59) beyond any bead around the pipe (56, 58, 64 or 65) or fitting, but not closer than 3.0 mm (0.12 inch) to the nearest surface (dash panel, fitting hex head, etc.).
   - Repeat the hose and clamp installation procedure at the other end of the hose.
4. Engine coolant.
   - Use the coolant drained earlier only if it is uncontaminated. Discard contaminated coolant and add fresh 50/50 coolant and water mixture.

Inspect

- Be sure the installed hose does not sag or rub against other components. Adjust or support the hose as necessary to correct the hose position.
- Operate the engine and check the hose installation for leaks.
- Check the coolant level after the engine has been warmed up. Add coolant as necessary.

Heater Core

Figures 20 through 22

Remove or Disconnect

1. Engine coolant.
   - Drain engine coolant into a clean container to lower the coolant level below the level of the lowest heater hose connection at the engine.

NOTICE: The heater core can be damaged if too much force is applied to the heater core pipes during hose removal.

2. Heater inlet hose (62) and outlet hose (63) at the heater core tubes.
   - Squeeze the clamp ends and slide the clamps (59) beyond the end of the heater core tubes.
   - Remove the hoses by twisting and pulling. If a hose will not come off the heater core tube easily with this method, and if it is possible that the heater core may be repairable, cut off the hose forward of the heater core tube. Then cut the hose

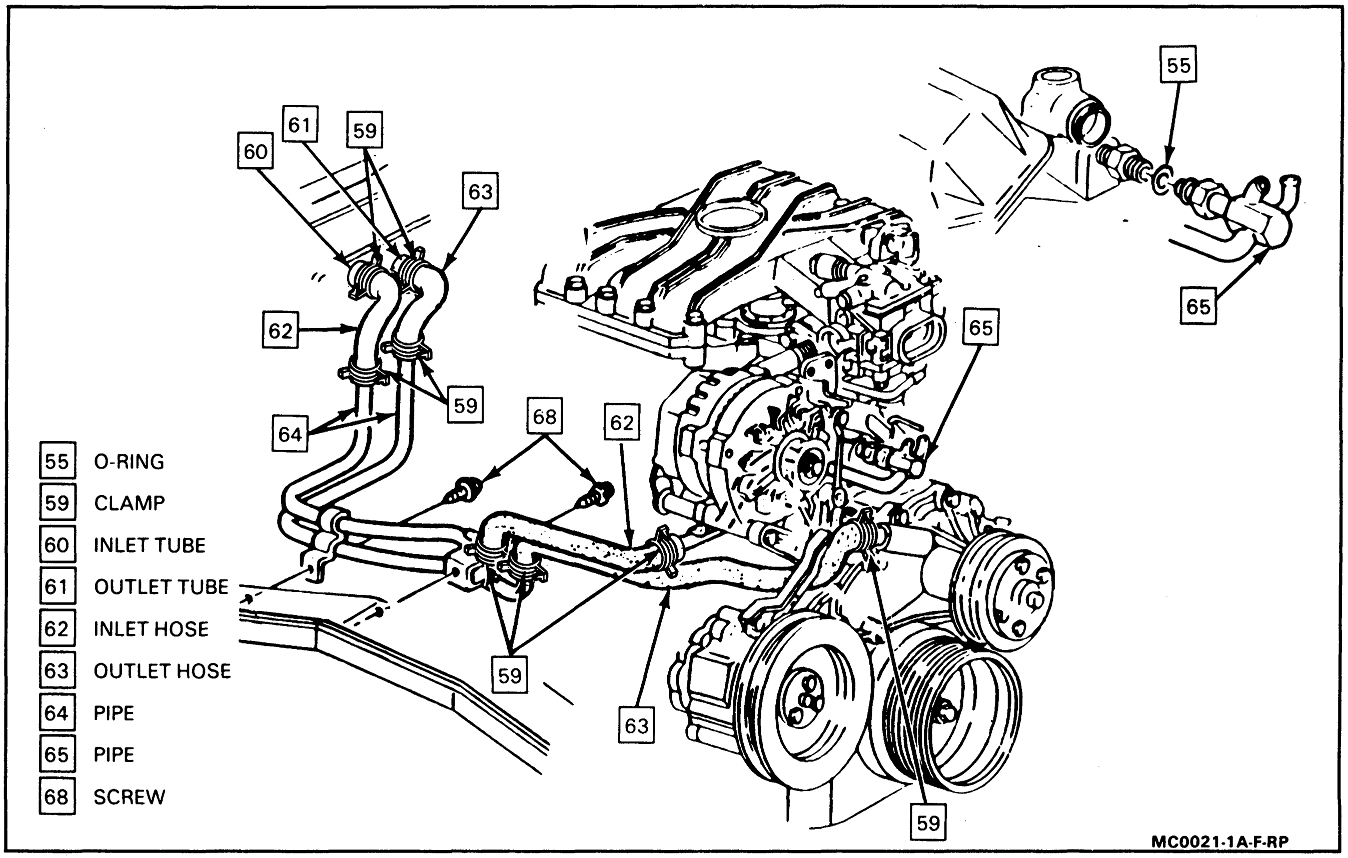


Figure 20 - Heater Hoses and Pipes (V6 Engine)

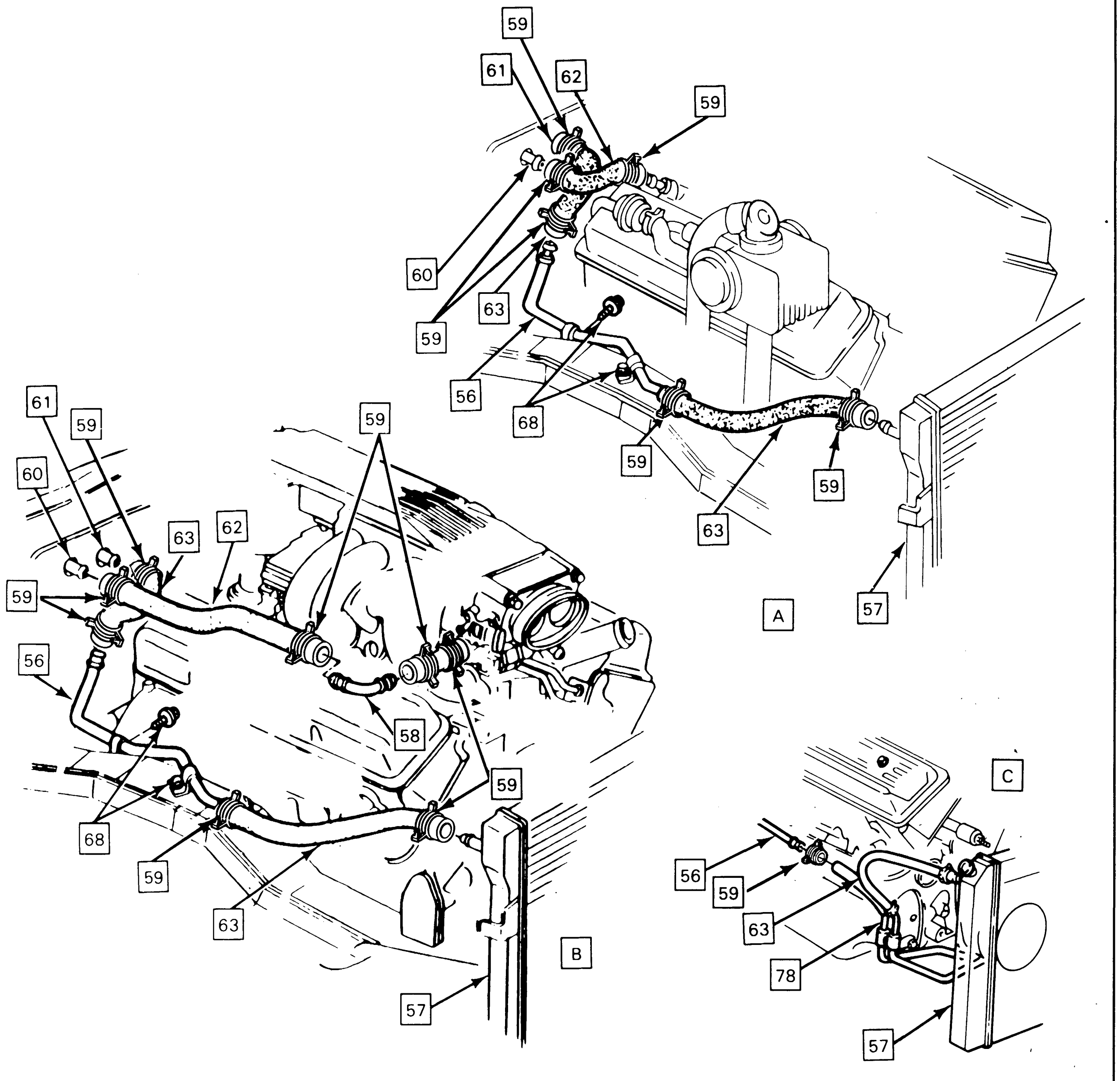
remaining on the core tube lengthwise to remove it.

- Remove and discard the hose clamps (59) if the hose is to be reused.

3. Instrument panel. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
4. Console. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
5. Screws (42) from the top, bottom and right side flanges of the rear case (77).
6. Rear case (77) from the heater module (1).
7. Core shroud screws (41) and clamp (73).
8. Core shroud (76), heater core (9) and heater core mounting strap (74) as an assembly.
9. Heater core mounting strap (74).
10. Heater core (9) from the core shroud (76).
11. Shroud seal (37) from the shroud (76).
12. Heater core seal (75), if necessary.

→← Install or Connect

1. Heater core seal (75), if removed.
2. Heater core (9) and heater mounting strap (74) to the core shroud (76).
3. Shroud seal (37) to the shroud (76).
4. Heater core (9), heater mounting strap (74) and core shroud (76) as an assembly to the interior of the heater module (1).
   - Carefully guide both heater core tubes into position at the holes in the dash panel.
5. Clamp (73) and core shroud screws (41).
6. Rear case (77) to the heater module (1).
   - Replace the original rear case flange sealer with fresh sealer.
7. Rear case flange mounting screws (42).
8. Console. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
9. Instrument panel. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
10. Heater inlet hose (62) and outlet hose (63) to the heater core tubes.
    - Apply rubber lubricant to the inside of the hoses, if desired.
    - Squeeze the clamp ends and slip a new hose clamp (59) over the end of each hose and push the hose onto the heater core tube with a twisting motion. The hose end should be 1.0 mm (0.04 inch) away from the surface of the dash panel.
    - Install the clamp (59) beyond the bead on the end of the heater core tube, but not closer than 3.0 mm (0.12 inch) to the surface of the dash panel.
11. Engine coolant.
    - Use the coolant drained earlier only if it is uncontaminated. Discard contaminated coolant and add fresh 50/50 coolant and water mixture.
    - Operate the engine and check for leaks at the heater core tubes. Tighten the hose



A	L03 V8 ENGINE
B	LB9 AND L98 V8 ENGINES
C	V8 ENGINE WITH ENGINE OIL COOLER
56	PIPE
57	RADIATOR
58	PIPE
59	CLAMP
60	INLET TUBE
61	OUTLET TUBE
62	INLET HOSE
63	OUTLET HOSE
68	SCREW
78	OIL COOLER

MC0022-1A-F-RP

Figure 21 - Heater Hoses and Pipes (V8 Engines)

clamp screw a bit at a time as necessary to stop a leak.

- Check the coolant level after the engine has been warmed up. Add coolant as necessary.

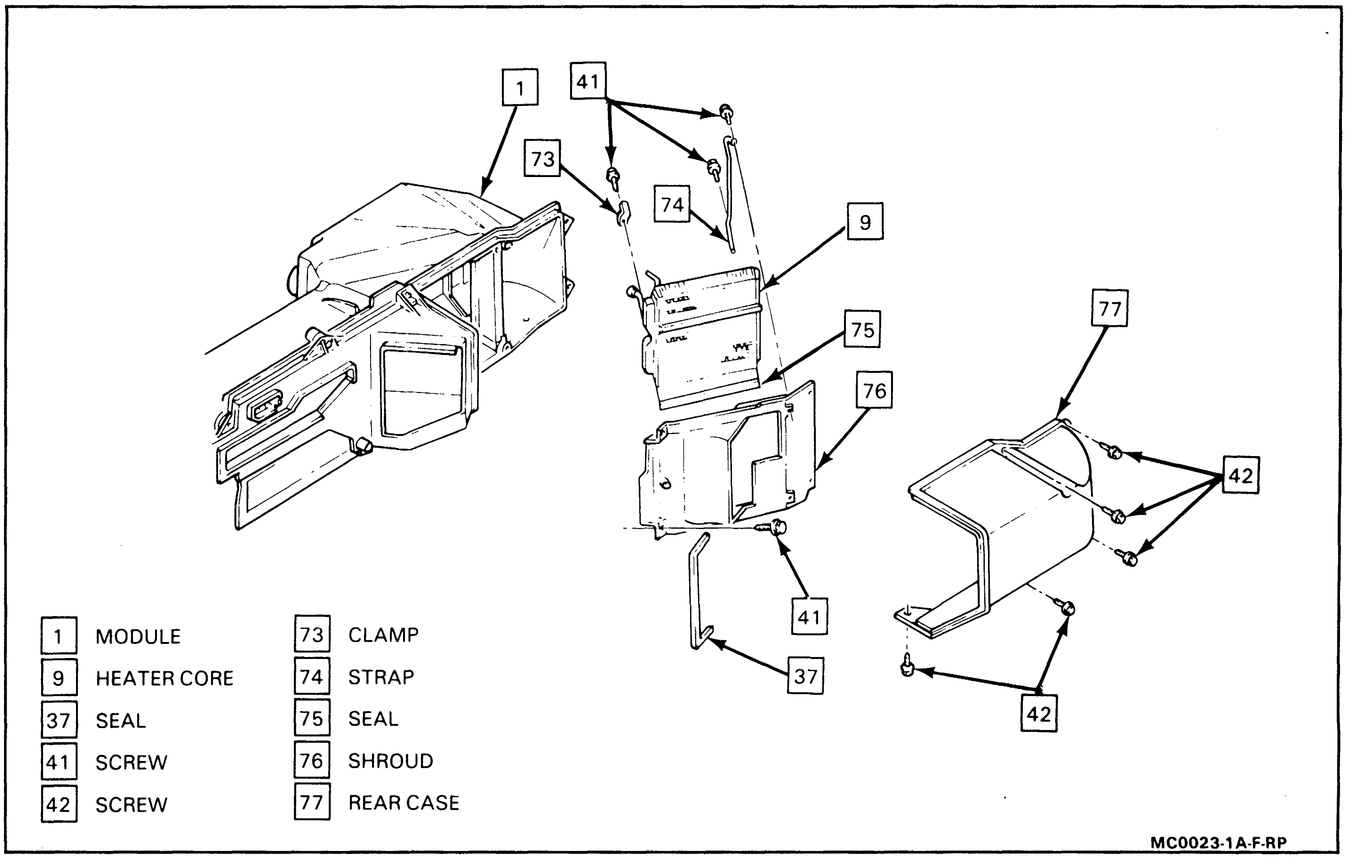


Figure 22 - Heater Core Removed

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Control Assembly Retaining Screw	1.4 N·m (12 lb. in.)
Radio and Heater Control Console Trim Plate Retaining Screw	1.4 N·m (12 lb. in.)
Blower Motor Resistor Assembly Retaining Screw	2.0 N·m (18 lb. in.)
Heater Wiring Harness Ground Wire Connector Screw	4.5 N·m (40 lb. in.)
Heater Wiring Harness Retaining Clip Nut	2.0 N·m (18 lb. in.)
Vacuum Tank Mounting Screw	5.0 N·m (44 lb. in.)
Front Heater Pipe Connector Nut (LH0 V6 Engine)	23 N·m (17 lb. ft.)
Front Heater Pipe Attaching Screw (at Generator Bracket, LH0 V6 Engine)	10 N·m (89 lb. in.)
Heater Pipe Retaining Screw (at Right Side Rail)	1.4 N·m (12 lb. in.)

ELECTRICAL

Fuse (In Fuse Block)	
Blower Motor (Labeled "HTR-A/C")	25 Amp. (White)
Control Assembly Dial (Labeled "INST LPS")	5 Amp. (Tan)
Control Assembly Dial Lamp Bulb Number	194

SECTION 1B

MANUALLY CONTROLLED AIR CONDITIONING

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 1B-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

OVERVIEW

Figures 1 through 3

The optional manually controlled air conditioning system delivers air that has been heated or cooled and dehumidified for occupant comfort. It also provides ram air ventilation, power ventilation, windshield defrosting and side window defogging.

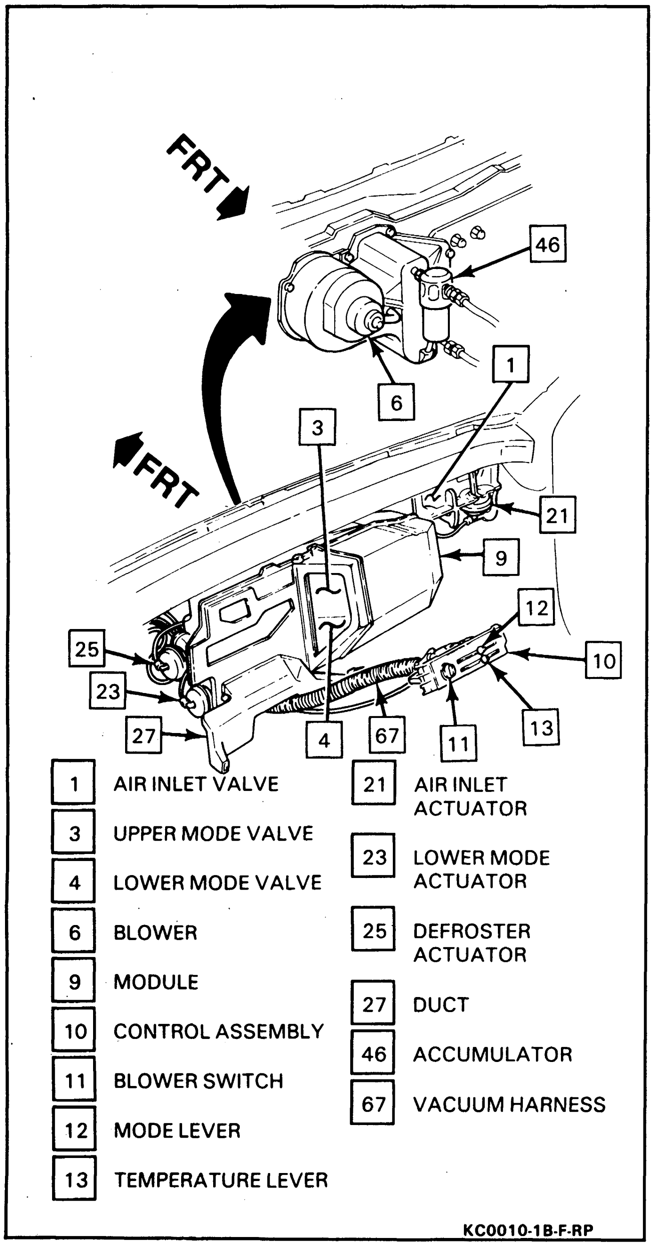


Figure 1 - Air Conditioning Module and Air Inlet

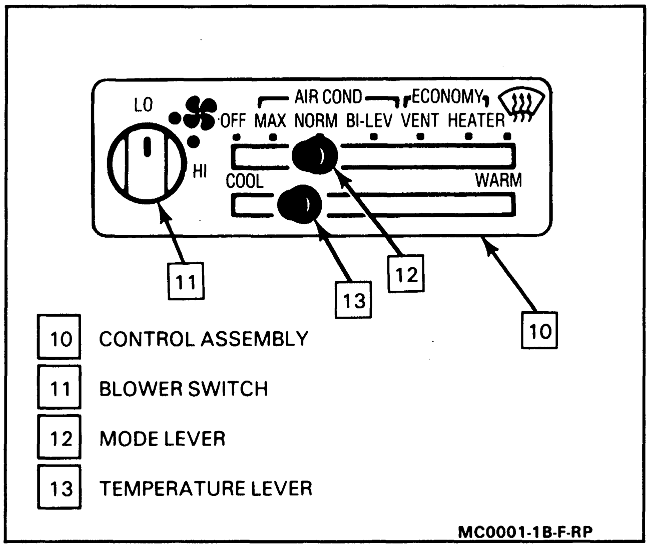


Figure 2 - Air Conditioning Control Assembly Dial

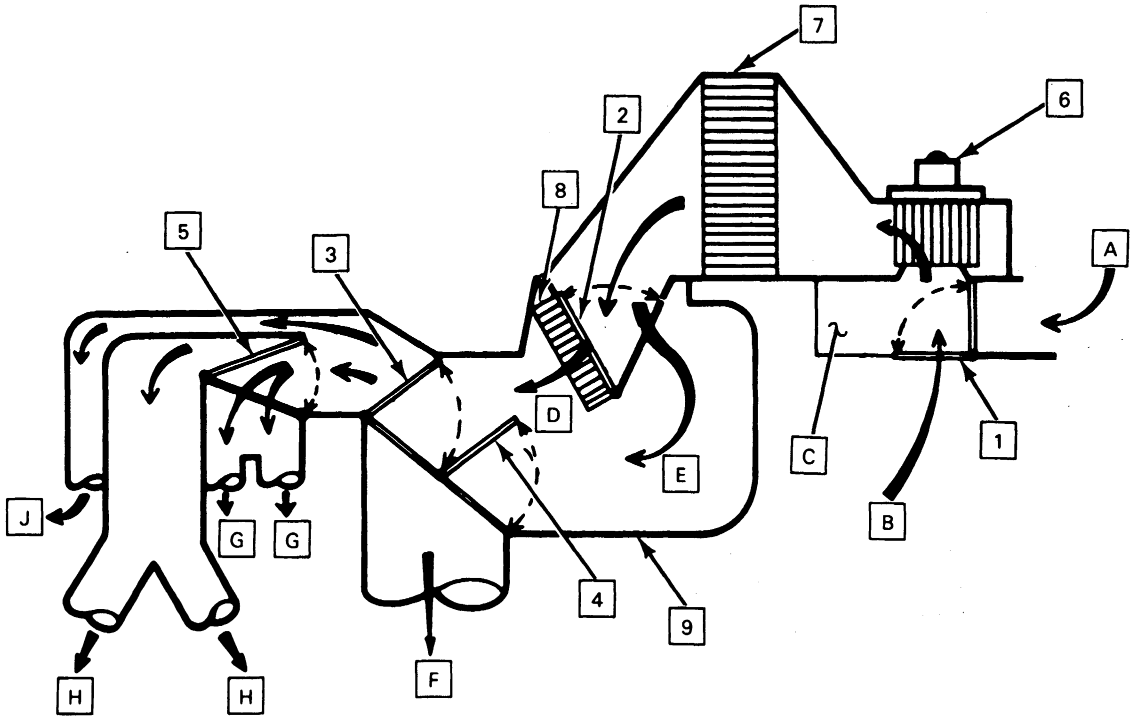
During most operating conditions, fresh outside air is drawn into the air conditioning module (9) by the blower (6). Additional outside air, called ram air, also may be forced into the air conditioning module (9) by the forward movement of the vehicle.

Within the air conditioning module (9), the air is pushed by the blower (6) through the evaporator (7). For air conditioning or defroster operating modes, the evaporator (7) is chilled almost to freezing by the engine-driven air conditioning refrigeration system. As a result, the evaporator (7) cools all of the air going through the air conditioning module (9). The cooling effect causes most of the moisture in the air to condense on the evaporator core fins and drain away, dehumidifying the air.

From the evaporator (7), some or all of the air may pass through the heater (8) which is warmed by a flow of hot engine coolant. Any of the air which is not to be heated will bypass the heater (8) and be mixed with the heated air before being guided to the proper air duct(s) for the selected operating mode.

When the maximum air conditioning mode is selected, the flow of engine coolant through the heater (8) is shut off to prevent any heating of the airflow before it is discharged. Most of the air entering the blower (6) during this mode is taken from inside the passenger compartment where the air is likely to be much cooler than outside air in very hot weather. Only outside air is used in all other operating modes.

For heater-only or ventilation modes, the refrigeration system is shut off so cooling is not provided. The amount of heating is governed by the proportions of the air directed through or around the core of the heater (8) in the same manner as with air conditioning.



A	OUTSIDE AIR	G	TO FLOOR OUTLETS	4	LOWER MODE VALVE
B	INSIDE AIR (TO BE RECIRCULATED)	H	TO WINDSHIELD DEFROSTER OUTLETS	5	DEFROSTER VALVE
C	PLENUM	J	TO SIDE WINDOW DEFOGGER OUTLETS	6	BLOWER
D	HEATED AIR	1	AIR INLET VALVE	7	EVAPORATOR
E	UNHEATED AIR	2	TEMPERATURE VALVE	8	HEATER
F	TO INSTRUMENT PANEL OUTLETS	3	UPPER MODE VALVE	9	MODULE

KC0030-1B-F-RP

Figure 3 - Air Conditioning Module Schematic

The air conditioning control assembly (10) in the console gives the operator a way to select the desired operating mode, air temperature and blower speed when the vehicle's ignition is on and the engine is running.

IDENTIFICATION OF CYCLING CLUTCH ORIFICE TUBE (CCOT) TYPE SYSTEM

The Camaro manually controlled air conditioning system is designated as a CCOT (cycling clutch orifice tube) system. This designation refers to two components of the refrigeration system. In this system, the compressor clutch is cycled on and off to control compressor operation and cause the evaporator to remain just above freezing temperature for most efficient cooling without icing.

An orifice, or restriction, within the expansion tube is used to cause the refrigerant flowing through it to expand and vaporize inside the evaporator. When it vaporizes, the refrigerant absorbs heat and cools the air flowing past the evaporator core fins. The functions of the compressor clutch, the expansion tube and other refrigeration system components are explained in more detail under "Refrigeration System" in this section.

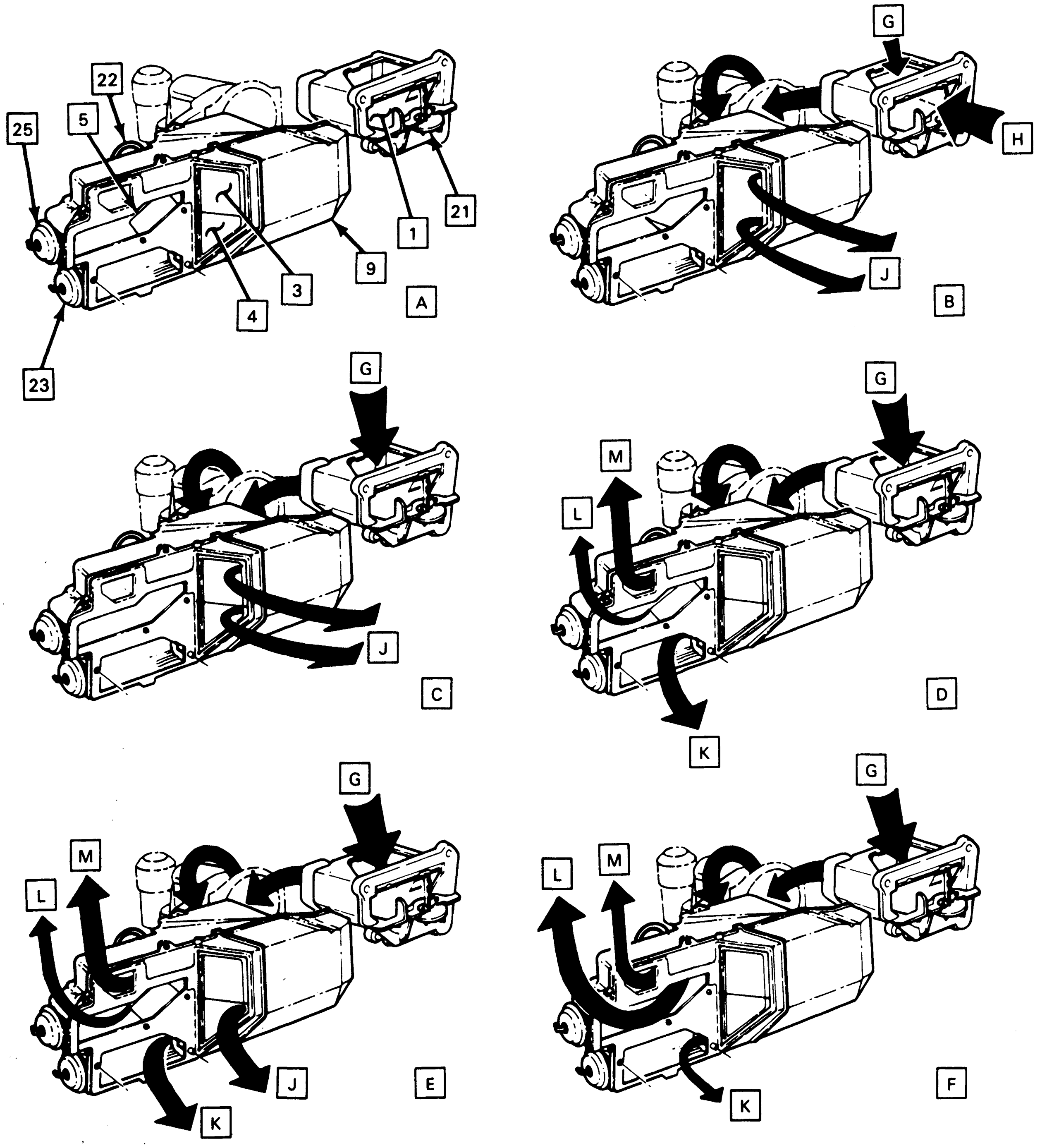
CONTROLS

Figures 1 through 6

Three controls in the control assembly (10) allow a front seat occupant to operate the manually controlled air conditioning system. The control assembly (10) is in the console, just above the radio.

Temperature Lever

The temperature lever (13) is the lower horizontal slide lever in the air conditioning control assembly (10). The temperature lever regulates the temperature of the air being discharged into the passenger compartment from the air conditioning system. The temperature lever (13) controls the position of an air valve "door" called the temperature valve (2) in the air conditioning module (9). The temperature valve (2) governs the relative amounts of heated and unheated or cooled air mixed and then discharged from the air conditioning system. Full "WARM," full "COOL" or any intermediate temperature mixture can be selected.



A	COMPONENTS
B	"MAX" AIR CONDITIONING MODE
C	"NORM" AIR CONDITIONING AND "VENT" ECONOMY MODES
D	"HEATER" ECONOMY MODE AND "OFF"
E	"BI-LEVEL" AIR CONDITIONING MODE
F	"DEFROST" MODE
G	OUTSIDE AIR
H	INSIDE AIR
J	TO INSTRUMENT PANEL OUTLETS
K	TO FLOOR AIR OUTLETS
L	TO WINDSHIELD DEFROSTER OUTLETS
M	TO SIDE WINDOW DEFOGGER OUTLETS
1	AIR INLET VALVE
3	UPPER MODE VALVE
4	LOWER MODE VALVE
5	DEFROSTER VALVE
9	MODULE
21	AIR INLET ACTUATOR
22	UPPER MODE ACTUATOR
23	LOWER MODE ACTUATOR
25	DEFROSTER ACTUATOR

KC0040-1B-F-RP

Figure 4 - Operating Mode Airflow Distribution

Mode Lever

The upper slide lever, called the mode lever (12), regulates airflow from the outlets by controlling a vacuum switch that routes engine vacuum to four vacuum actuators at the air conditioning module (9). The mode lever (12) also controls an electrical switch that supplies power to operate the refrigeration system and the blower (6) for specific mode selections.

A choice of seven operating modes can be selected by sliding the mode lever (12) in its horizontal slot in the control assembly (10). From left to right, the seven modes are "OFF," "MAX," "NORM," "BI-LEVEL," "VENT," "HEATER" and "DEFROST."

"OFF" Mode

When the mode lever (12) is in the "OFF" position, electrical power is not supplied to the refrigeration system or to the blower (6). A limited flow of ram air, caused by forward movement of the vehicle, may come from the defroster outlets, side window defogger outlets, and floor air outlets. This is the only mode in which the blower (6) does not operate.

"MAX" Mode

The "MAX" position of the mode lever (12) provides maximum air conditioning. Electrical power is supplied to the blower (6) and the refrigeration system. Air from the passenger compartment is mixed with a small amount of outside air as it enters the blower (6). After being cooled by the evaporator (7), the air is distributed through the center and outboard instrument panel outlets.

In "MAX," the system provides maximum cooling and variable blower speed. This is the only mode in which some air from the passenger compartment is recirculated through the air conditioning system. "MAX" operation is useful in conditions of very high temperature and humidity, or in areas where the outside air may have an objectionable odor.

"NORM" Mode

The "NORM" position of the mode lever (12) provides the normal air conditioning operating mode for most conditions. Electrical power is supplied to the blower (6) and the refrigeration system. Outside air is drawn in and conditioned before being directed through the center and outboard instrument panel outlets. Blower speed may be varied.

"BI-LEVEL" Mode

With the mode lever (12) in the "BI-LEVEL" position, electrical power is supplied to the blower (6) and the refrigeration system. Outside air is drawn in and conditioned. Then the airflow is split between the instrument panel outlets and the floor air outlets, with a small amount going to the defroster outlets and the side window defogger outlets. Blower speed may be varied.

This air conditioning mode is useful if windows fog up on the inside during warm weather.

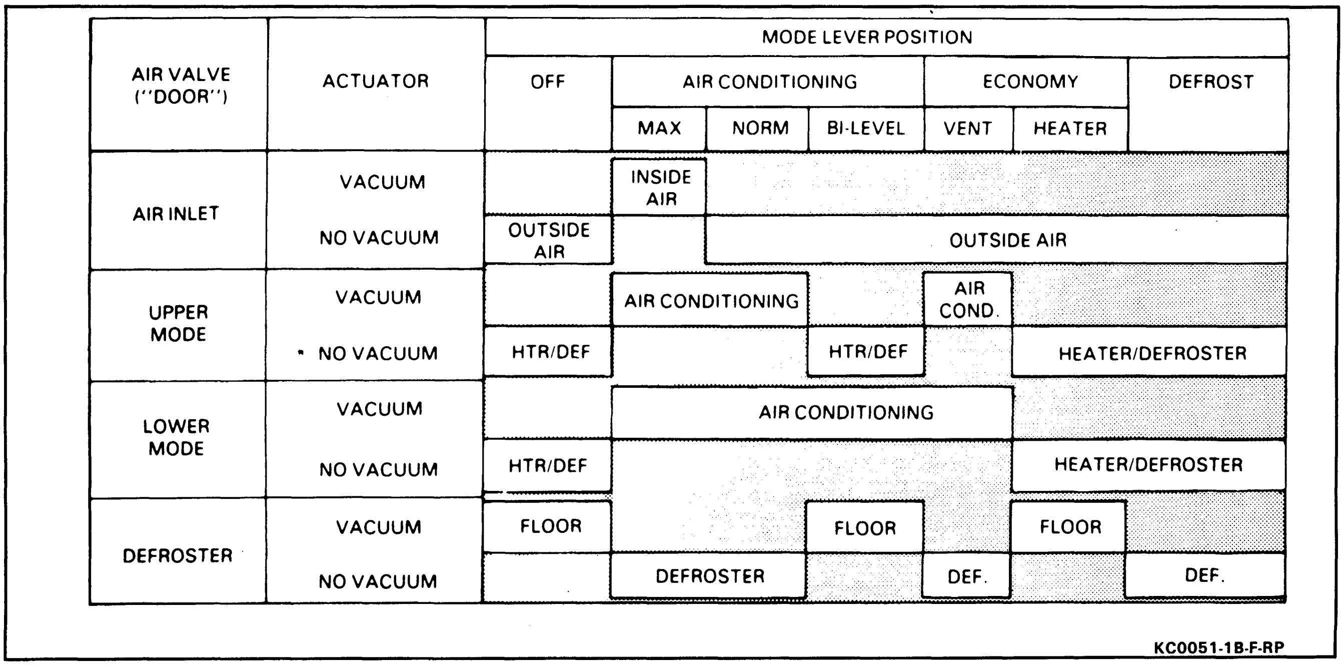
"VENT" Mode

With the mode lever (12) in the "VENT" position, electrical power to the refrigeration system is cut off but the blower (6) will run as in the other operating modes. Outside air is delivered through the instrument panel outlets to ventilate the passenger compartment. If preferred, the air may be warmed by setting the temperature lever (13) to the desired temperature.

This is one of two "ECONOMY" modes, with the refrigeration system shut off to conserve fuel.

"HEATER" Mode

With the mode lever (12) in the "HEATER" position, the other "ECONOMY" mode, electrical power to the refrigeration system is cut off but the blower (6) will run. Most of the airflow is directed to the floor outlets with the small amount remaining



AIR VALVE ("DOOR")	ACTUATOR	MODE LEVER POSITION						
		OFF	AIR CONDITIONING			ECONOMY		DEFROST
			MAX	NORM	BI-LEVEL	VENT	HEATER	
AIR INLET	VACUUM		INSIDE AIR					
	NO VACUUM	OUTSIDE AIR		OUTSIDE AIR				
UPPER MODE	VACUUM		AIR CONDITIONING			AIR COND.		
	NO VACUUM	HTR/DEF			HTR/DEF		HEATER/DEFROSTER	
LOWER MODE	VACUUM		AIR CONDITIONING					
	NO VACUUM	HTR/DEF					HEATER/DEFROSTER	
DEFROSTER	VACUUM	FLOOR			FLOOR		FLOOR	
	NO VACUUM		DEFROSTER			DEF.		DEF.

Figure 5 - Vacuum-Actuated Component Operation

being routed to the windshield defroster and the side window defogger outlets. Blower speed may be varied as in other operating modes.

The "HEATER" mode is the normal selection for cold weather operation unless the windshield must be cleared of heavy frost.

"DEFROST" Mode

With the mode lever (12) in the "DEFROST" position, electrical power is sent to the blower (6) and the refrigeration system. When the outside temperature is above approximately 4°C (40°F), the refrigeration system will operate. This provides air that has been dehumidified before it is warmed to the desired temperature while passing through the heater (8). The dryer air absorbs moisture that might condense on the windshield more effectively than humid air. At lower temperatures, the air can be warmed but it will not be dehumidified. Because colder air cannot hold as much moisture, the added moisture removal is not necessary to assure efficient defrosting at colder outside temperatures.

Most of the airflow is directed to the windshield defroster outlets, with a much smaller amount going to the floor outlets. The side window defogger outlets receive the same air supply as in the "HEATER" mode. Blower speed may be varied.

Blower Speed Control

With the ignition switch "ON," the air conditioning blower (6) runs in all mode lever positions except "OFF." Blower speed is controlled by a four-position blower switch (11) at the left side of the air conditioning control assembly (10). The blower switch (11) provides a choice of a low blower speed, two medium blower speeds and a high blower speed.

Electrical power is routed from the air conditioning fuse (14) in the fuse block (15) to the mode lever switch. The mode lever switch breaks the circuit when the mode lever (12) is in the "OFF" position, and closes the circuit to the blower switch (11) in all other mode lever positions.

When the blower switch (11) is in "LO," it closes a circuit to the blower resistor assembly (17) that routes the current through all three resistors. The resistance causes the blower (6) to run at a low speed.

When the blower switch (11) is in either medium speed position, it closes one of two circuits that bypass either one or two of the three resistors in the blower resistor assembly (17). As a result, the total resistance in the circuit is reduced and the blower (6) runs at faster speeds.

When the blower switch (11) is in "HI," it routes current to the coil of the blower relay (18). This energizes the relay (18), closing its contacts to send full battery voltage to the blower (6). The full battery voltage is supplied through a separate circuit that is protected by a fusible link (16). This separate power circuit is "hot" at all times and has the capacity to handle the current demands of the blower (6) at high speed.

The blower circuit is completed to ground through the air conditioning harness and the engine harness to a terminal at the rear of the left cylinder head on all engines. Refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

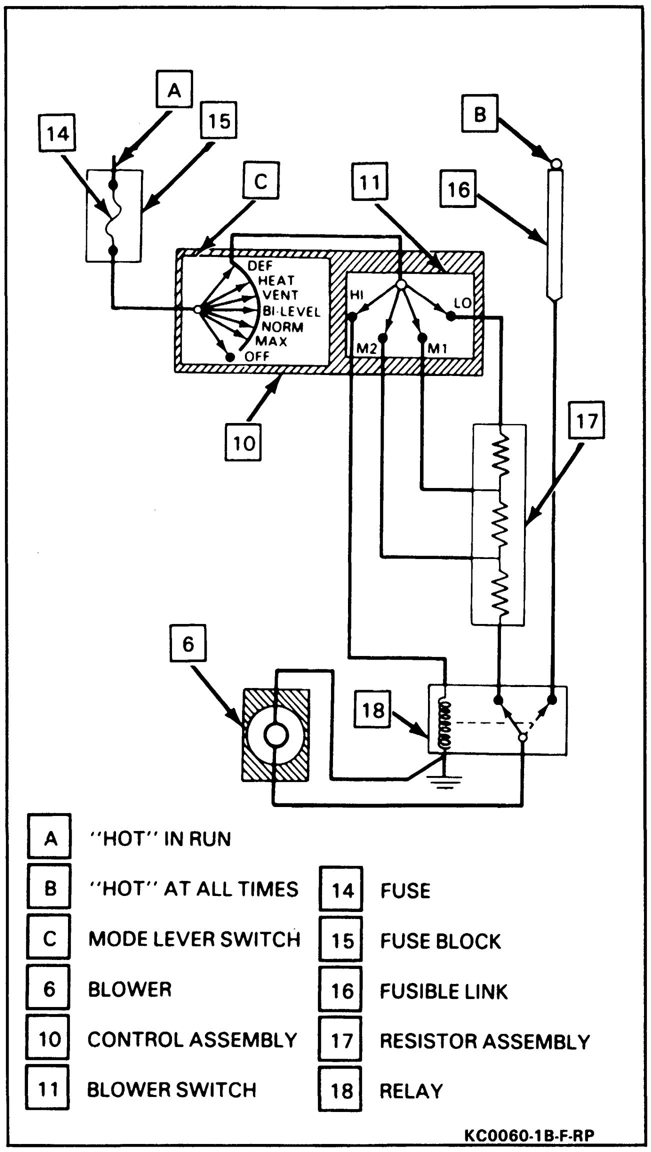


Figure 6 - Blower Circuit

AIR DISTRIBUTION SYSTEM

Figures 2 through 4, 7 and 8

Air enters the air conditioning module (9) where it may be cooled (for all air conditioning modes and the "DEFROST" mode) and then heated as necessary before being sent to the proper outlets for discharge into the passenger compartment. Within the air conditioning module (9), air valves (or "doors") guide the airflow in response to the positions of the temperature lever (13) and the mode lever (12) in the control assembly (10).

Vacuum System

All air valves except the temperature valve (2) are controlled by engine vacuum stored in the vacuum tank (26) in the engine compartment. The vacuum is routed by a vacuum switch in the control assembly to any of four spring-loaded two-position vacuum actuators. One vacuum actuator is linked to each air valve.

The vacuum switch in the control assembly (10) is controlled by the mode lever (12). For each mode lever position, the vacuum switch will direct engine vacuum to specific hoses and vent to normal air pressure the remaining hoses. When a hose is vented to normal air pressure, the vacuum actuator's internal spring will expand and hold the associated air valve in one position. When vacuum is routed to the hose, the force of the vacuum overcomes the internal spring pressure and moves the air valve to the opposite extreme of its travel. In this way, the mode lever (12) positions the air valves for the selected operating mode.

Other Components

Other components of the air distribution system include the air inlet which supplies air to the system; the blower (6) which propels the air; the evaporator (7) which cools the air when necessary; and the heater (8) which warms the air as necessary. The air inlet includes a two-position air inlet valve (1) which opens to the passenger compartment and allows some inside air to be recirculated through the air conditioning module in the "MAX" mode. For all other modes, the air inlet valve (1) remains closed so only outside air from the plenum just forward of the base of the windshield will be used by the air conditioning system.

The blower (6) draws air from the air inlet into the air conditioning module (9) and pushes it through the air distribution system to the outlets. The evaporator (7), a part of the refrigeration system, cools the air from the blower (6) when operating in an air conditioning or defrosting mode. The heater (8) provides a way to warm the air downstream from the evaporator (7).

The air distribution system also includes a large air distributor (32) and a floor air outlet duct (27). The air distributor (32) provides windshield defrosting and feeds ducts (31, 33, 38 and 39) that supply the center and outboard instrument panel outlets and the side window defogger outlets. The floor air outlet duct (27) supplies air to the two outlets in the side of the console. Air moves through the air distribution system in the following way.

Air Inlet Valve

The first air valve in the air distribution system is the air inlet valve (1). The air inlet valve (1) is operated by the air inlet actuator (21). When closed, the air inlet valve (1) covers an opening in the air inlet, a short vertical duct that connects the plenum at the base of the windshield to the blower intake. When the air inlet valve (1) is open, it allows inside air from the passenger compartment to be drawn in by the blower (6) and partially blocks the flow of outside air so only a slight amount (about 20 percent of the total airflow) can enter. Recirculating the cooled air inside the passenger compartment when outside temperature is very high gives a faster cooldown to a more comfortable temperature.

The air inlet valve (1) opens to recirculate inside air only during "MAX" air conditioning operation. When any other operating mode (including "OFF") is selected, the air inlet valve (1) completely closes off the opening in the air inlet so only fresh outside air is used.

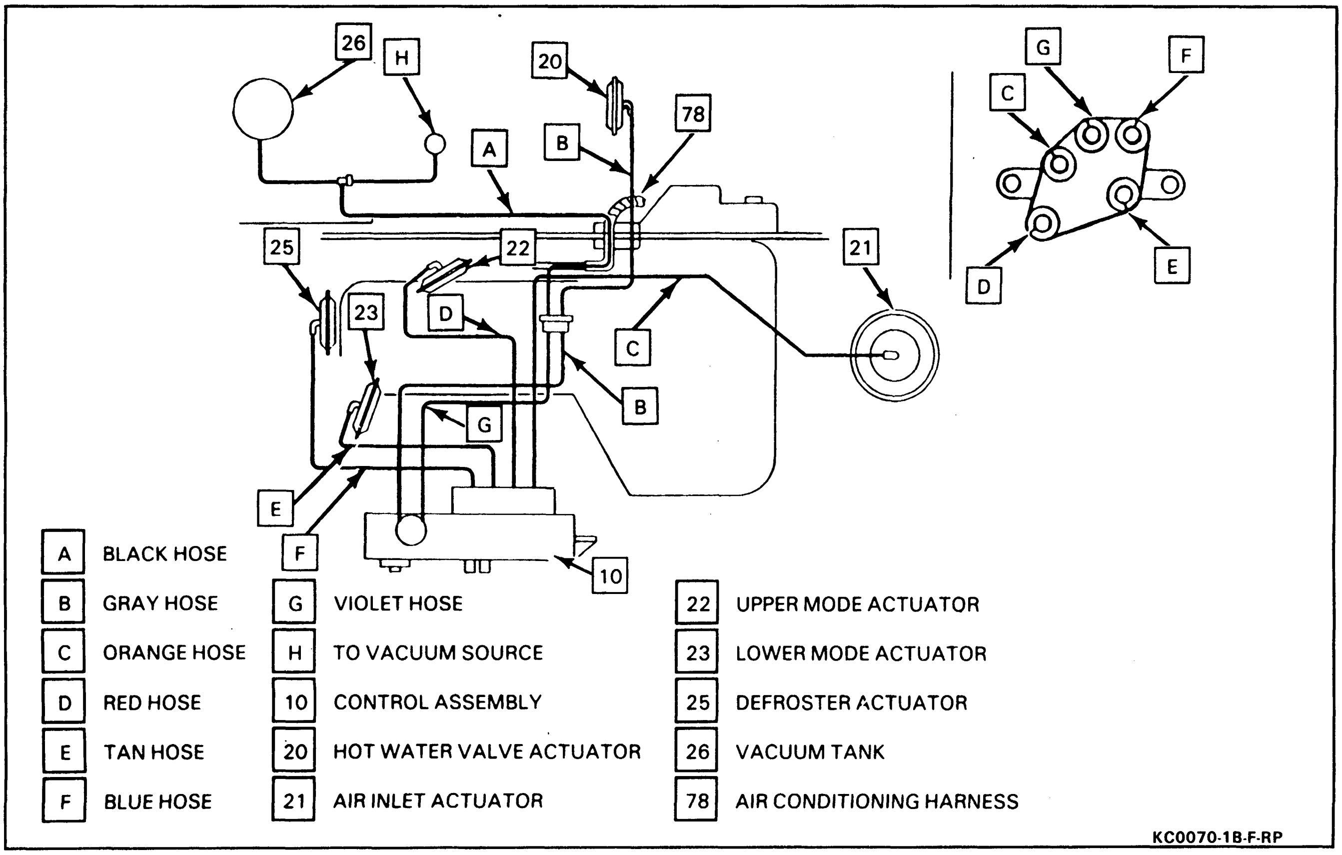


Figure 7 - Vacuum Circuit

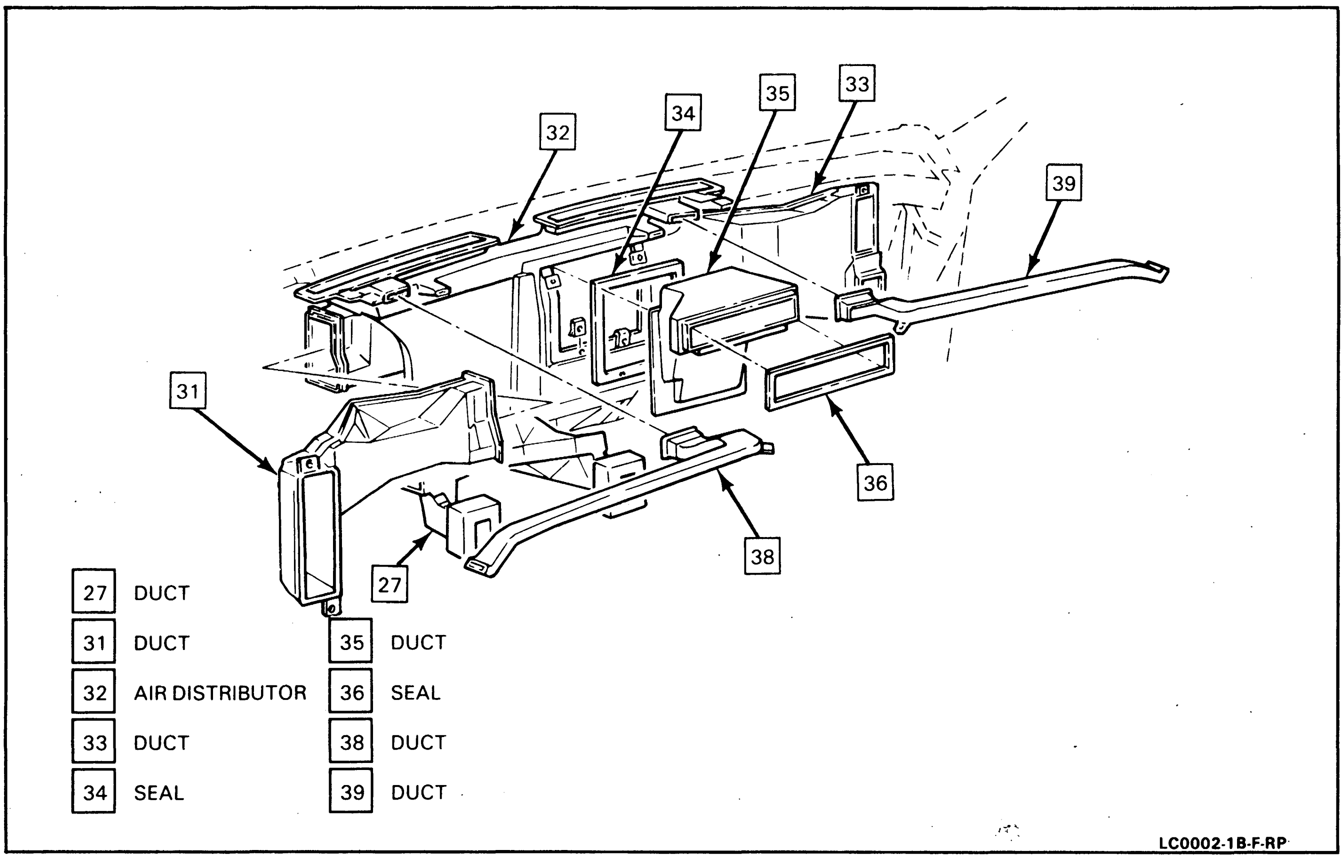


Figure 8 - Air Ducts

Blower and Evaporator

In any operating mode except "OFF," the blower (6) draws in air from the air inlet and pushes it through the evaporator (7). When "DEFROST" or any air conditioning mode is selected, the air conditioning refrigeration system chills the core of the evaporator (7) to slightly above freezing temperature. This cools the airflow and causes excess humidity to condense on the fins of the evaporator (7). The condensed moisture drips to the bottom of the case and drains out through a short hose that lets the water fall to the road below the vehicle. From the evaporator (7), the air flows toward the temperature valve (2) and the heater (8).

Temperature Air Valve and Heater

The temperature lever (13) in the air conditioning control assembly (10) is linked to the temperature valve (2) by a flexible control cable attached to a crank lever on the temperature valve shaft. The temperature valve (2) controls the temperature of the air discharged from the air conditioning system outlets by regulating the relative amount of the total airflow from the evaporator (7) that is allowed to pass through the heater (8). The heated air is mixed with unheated air beyond the heater (8) to form a blend that has the desired temperature.

When the temperature lever (13) is in the full "COOL" position, the temperature valve (2) is held snugly against the air entrance to the heater (8). This causes all of the airflow from the evaporator (7) to bypass the heater (8) and there is no noticeable change in the air temperature.

As the temperature lever (13) is moved away from the "COOL" position, the temperature valve (2) moves away from the core of the heater (8) to allow some air to flow through the core. The farther the temperature lever (13) is moved to the right in its slot, the more the temperature valve (2) is turned away from the entrance to the heater (8) and the greater the airflow through the core. Heating a greater portion of the total airflow in this manner results in a warmer discharge of air from the air conditioning system outlets.

When the temperature lever (13) is in the full "WARM" position at the right end of the slot in the dial of the control assembly (10), the temperature valve (2) blocks off the passage that allows air to bypass the heater (8) and causes all of the airflow to go through the heater (8) for maximum heating.

To prevent any slight heating of the airflow through the air distribution system when the temperature lever (13) is in the full "COOL" position, a hot water valve in the heater inlet hose diverts the flow of warm coolant directly to the heater outlet hose, bypassing the heater (8). This allows the heater (8) to cool. The hot water valve is controlled by the hot water valve actuator (20). When the temperature lever (13) is in any position other than full "COOL," the hot water valve allows coolant to flow to the heater (8) for normal heating.

Mode Air Valves

After the heated and unheated airflows are mixed beyond the heater (8), the combined airflow comes to the upper mode valve (3) and lower mode valve (4).

These two air valves work in combination to control airflow through the passage that feeds the instrument panel outlets. For maximum ("MAX") or normal ("NORM") air conditioning modes and the "VENT" mode, vacuum is directed to both vacuum actuators and both the upper mode valve (3) and the lower mode valve (4) open to allow air to flow to the instrument panel outlets. In the "OFF," "HEATER" and "DEFROST" modes, both vacuum actuators are vented and both the upper mode valve (3) and the lower mode valve (4) close to prevent airflow to the instrument panel outlets.

When the "BI-LEVEL" air conditioning mode is selected, only the lower mode valve (4) is opened. This divides the airflow so the instrument panel outlets, the floor air outlets, the defroster outlets and the side window defogger outlets all receive a share of the air.

Defroster Valve

The last vacuum-controlled air valve in the air distribution system is the defroster valve (5). In the "HEATER" and "BI-LEVEL" modes, and when the mode lever (12) is placed in the "OFF" position, vacuum is applied to the defroster actuator (25). This moves the defroster valve (5) to divert almost all of the airflow to the floor air outlet duct (27) to heat the passenger compartment. Only a slight amount passes through an opening in the defroster valve (5) and goes to the windshield defroster.

In the "DEFROST" mode, the defroster actuator (25) is vented to normal air pressure and the spring in the actuator holds the defroster valve (5) in a position to route most of the airflow to the windshield defroster passage in the air distributor (32). In the "VENT" mode and in Normal ("NORM") and Maximum ("MAX") air conditioning modes, the defroster valve also is held in this position. Only a slight amount of the total airflow passes through the opening in the defroster valve (5) and goes to the floor air outlet duct (27).

Ducts and Outlets

Air valves in the air conditioning module direct the airflow to the correct openings for the selected operating mode. The large air distributor (32) mounted to the rear face of the air conditioning module contains three air passages. A large passage leads from the defroster opening in the air conditioning module (9) to the two defroster outlets at the base of the windshield. A smaller passage feeds the two ducts (38 and 39) to the side window defogger outlets in both ends of the instrument panel pad. The third passage in the air distributor (32) connects the vent opening in the air conditioning module (9) to the system duct (35) that feeds the instrument panel center and outboard outlets.

Also mounted to the rear face of the air conditioning module is the floor air outlet duct (27), an inverted Y-shaped duct that connects the heater opening in the air conditioning module (9) to the two outlets in the sides of the console. The four air outlets in the instrument panel have adjustable deflectors that permit vehicle occupants to direct the high level air conditioning airflow in a desired direction. The two floor outlets and the two side window defogger outlets have fixed vanes that distribute the airflow in a set pattern.

Ventilation

Figure 9

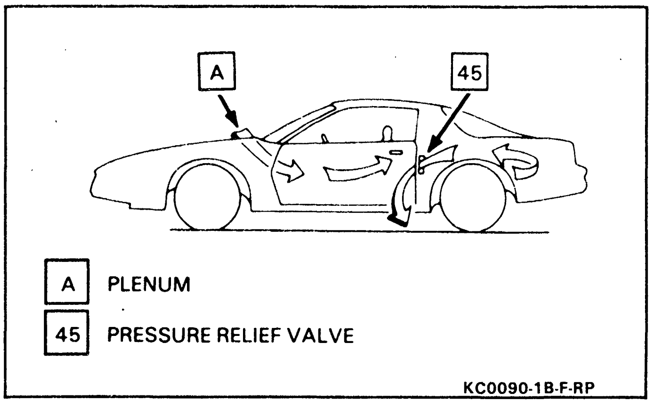


Figure 9 - Ventilation Airflow Schematic

The air distribution system provides fresh air ventilation for the passenger compartment in all operating modes. About 20 percent of the air circulated within the passenger compartment in the "MAX" air conditioning mode is taken from outside the vehicle, and all of the air circulated in the other modes also is from outside. Even in the "OFF" mode, fresh outside ram air is forced into the air distribution system by the forward movement of the vehicle.

After being warmed or cooled to the desired temperature, the air is discharged from the outlets appropriate to the selected operating mode. When all windows are closed, the addition of outside air builds a slight positive pressure within the passenger compartment. The pressure forces stale air to leave the vehicle through a pressure relief valve (45) near the base of the body door lock pillars after it has circulated through the passenger compartment.

REFRIGERATION SYSTEM

Figures 10 through 14

The refrigeration system cools the air flowing through the air distribution system during air conditioning operation. It also operates under certain conditions when the "DEFROST" mode is selected, dehumidifying the air to aid moisture removal from the windshield. Refrigeration system components and their functions are as follows:

- Refrigerant circulates throughout the refrigeration system to absorb heat from the air being cooled, and to give off heat to the air outside the vehicle. The refrigerant also carries a lubricant throughout the system, primarily to lubricate parts of the compressor.
- An engine-driven compressor (48) pumps the refrigerant through the refrigeration system.
- A condenser (51) cools the refrigerant in the same way that the engine cooling system radiator cools the engine coolant.
- An expansion tube (52) (also called an orifice tube) lowers the pressure of the liquid refrigerant

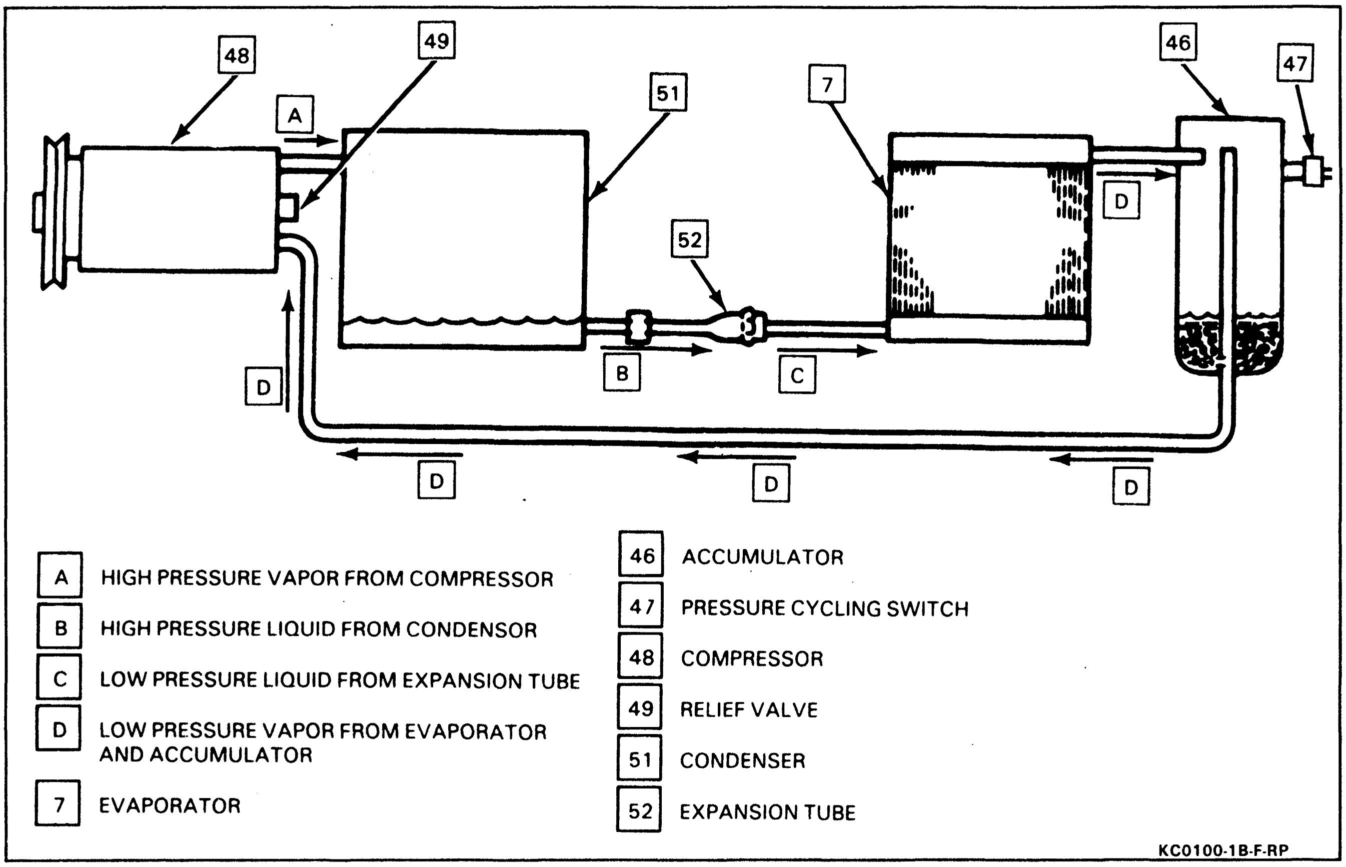


Figure 10 - Refrigeration System Schematic

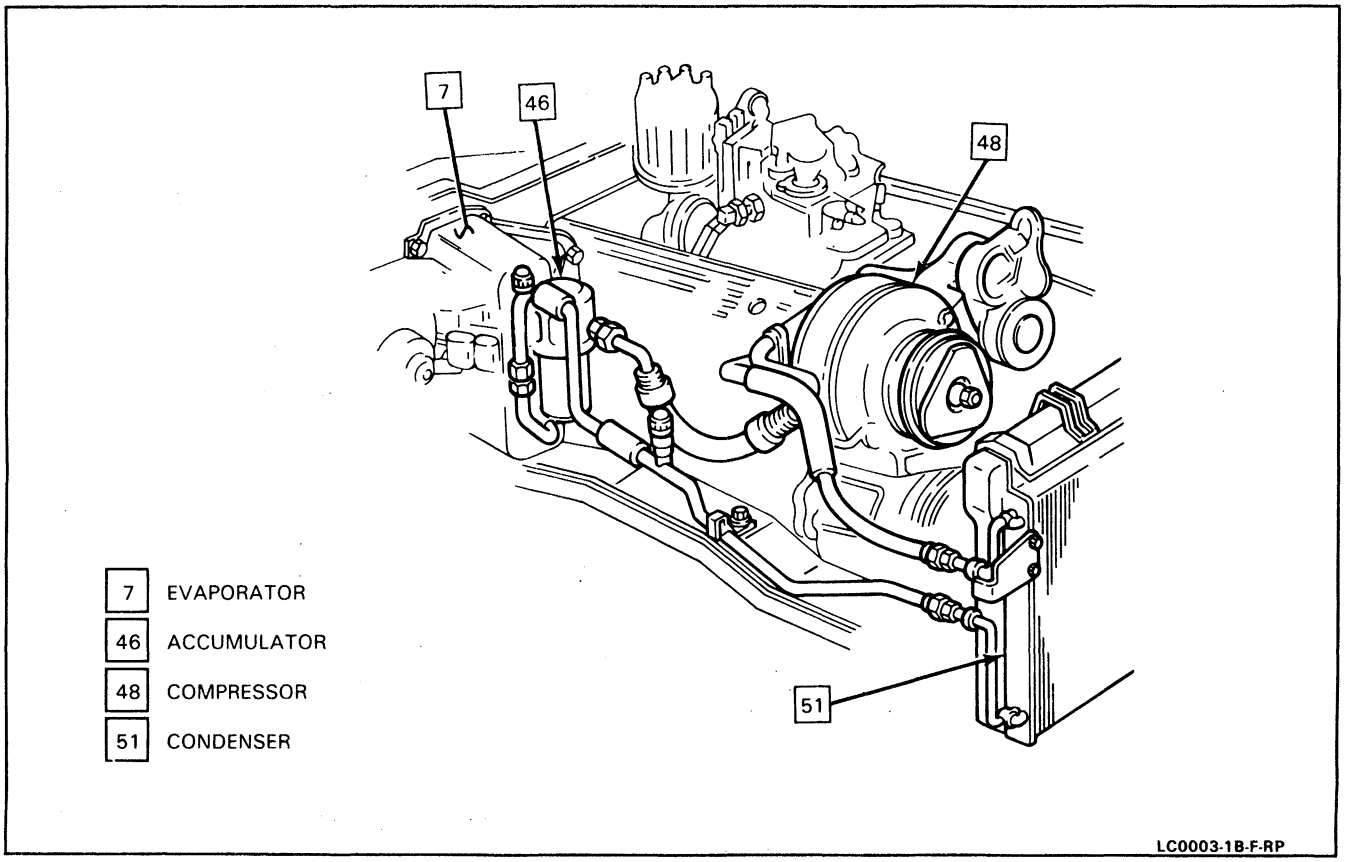


Figure 11 - Refrigeration System Underhood Components - Typical

from the condenser (51) by restricting the flow of the fluid. This prepares the refrigerant to pick up heat.

- An evaporator (7) in the path of the airflow through the air distribution system absorbs heat from the moving air and passes it on to the refrigerant inside the core of the evaporator (7). This causes the refrigerant to boil and leave the evaporator (7) as a vapor.
- An accumulator (46) dries and filters the refrigerant and stores it until the compressor (48) again circulates the refrigerant through the refrigeration system.
- Lines (metal tubes and hoses) and leak-resistant connectors join the compressor (48), condenser (51), expansion tube (52), evaporator (7), accumulator (46) and other components to provide a closed-loop circuit for the refrigerant.
- A pressure cycling switch (47) senses refrigerant pressure in the line just downstream from the evaporator (7) and turns the compressor (48) on and off to keep the temperature of the evaporator (7) just above freezing. The pressure of the refrigerant vapor is directly related to its temperature so in effect, the pressure cycling switch (47) is sensing the temperature of the evaporator (7).
- An air conditioning cutout relay temporarily turns the compressor off to reduce the load on the engine when commanded to do so by the electronic control module.
- An aftermarket liquid line filter is available to protect refrigeration systems that have been contaminated, eliminating the need for system flushing. Refer to "Liquid Line Filter Installation" in this section.

Refrigerant-12

Like the coolant in an engine cooling system, the refrigerant is the substance in the air conditioning system that absorbs, carries and then releases heat. Although various substances are used as refrigerants in other types of refrigeration systems, automotive air conditioning systems use a type called Refrigerant-12. This compound is not explosive, not flammable, not corrosive except when in contact with water, and not poisonous except when in contact with an open flame or hot metal. It is soluble in oil.

In automotive air conditioning systems, Refrigerant-12 is kept under a pressure of about 195 kPa (28 psi). At this pressure, Refrigerant-12 boils (changes from a liquid to a vapor) at approximately -1°C (30°F), which is ideal for air conditioning systems. At normal sea level pressure, Refrigerant-12 boils at about -30°C (-22°F), which is cold enough to cause severe frostbite to unprotected skin.

Refrigerant-12 carries a charge of a special lubricating oil, normally 525 viscosity refrigerant oil. Since the refrigerant has an affinity for oil, the two compounds mix easily and completely. Even the refrigerant vapor carries small particles of oil. As the liquid or vapor moves through the system, it keeps the moving parts of the compressor lubricated.

Refrigerant-12 is one member of a chemical family called chlorofluorocarbons (CFC). The use of CFC has become a worldwide environmental concern since it was determined that it is likely to be responsible for destroying ozone in the earth's upper atmosphere. This fragile ozone layer acts as a shield against harmful ultraviolet radiation from the sun. In this country, Refrigerant-12 from automotive air conditioning systems accounts for an estimated 25 percent of the CFC discharged into the air.

The Environmental Protection Agency (EPA) has taken steps to reduce production of CFC by half by the end of the decade. As production of Refrigerant-12 decreases, it will be increasingly practical to capture, recycle and reuse the refrigerant that was formerly exhausted into the atmosphere. GM and recycling equipment manufacturers, working with the EPA and an industry committee, have developed an easy method and automatic equipment for recovering and recycling used refrigerant. Refer to "Refrigeration System Services" in this section.

Compressor

The R-4 air conditioning compressor (48) for the CCOT refrigeration system is a lightweight fixed displacement refrigerant pump having four cylinders arranged radially (extending straight out from the center of the compressor) inside the compressor outer shell (54). When the refrigeration system is operating, refrigerant vapor from the accumulator (46) is drawn into the compressor crankcase through the connector block at the rear of the compressor (48). The vapor is drawn into the four cylinders through the reed-type suction valves in the top of the pistons during suction strokes.

On the following compression strokes, the vapor is forced past the plate of the relief valve (149) at the top of each cylinder into a cavity that circles the compressor body just inside the outer shell (54). This cavity guides the vapor into the connector block at the rear of the compressor (48). A pressure relief valve in the rear of the compressor is designed to open and vent refrigerant vapor if compressor discharge pressure exceeds 3036 kPa (440 psi), which is greater than the designed operating pressure of the system.

The compressor (48) is belt-driven from the engine crankshaft through the compressor clutch pulley rotor (126). The compressor clutch pulley rotor (126) rotates without driving the compressor shaft until the pressure cycling switch (47) energizes a six-pole electromagnetic coil in the clutch and pulley rotor (126). Magnetic attraction, working against the force of an internal spring in the assembly, pulls the clutch plate and hub assembly rearward, locking it to the pulley rotor (126) to drive the compressor shaft. When current to the electromagnetic coil is turned off, the internal spring forces the clutch away from the pulley rotor (126) and the pulley rotor (126) freewheels without driving the compressor shaft. For compressor overhaul procedures, refer to R-4 AIR CONDITIONING COMPRESSOR OVERHAUL (SEC. 1D1).

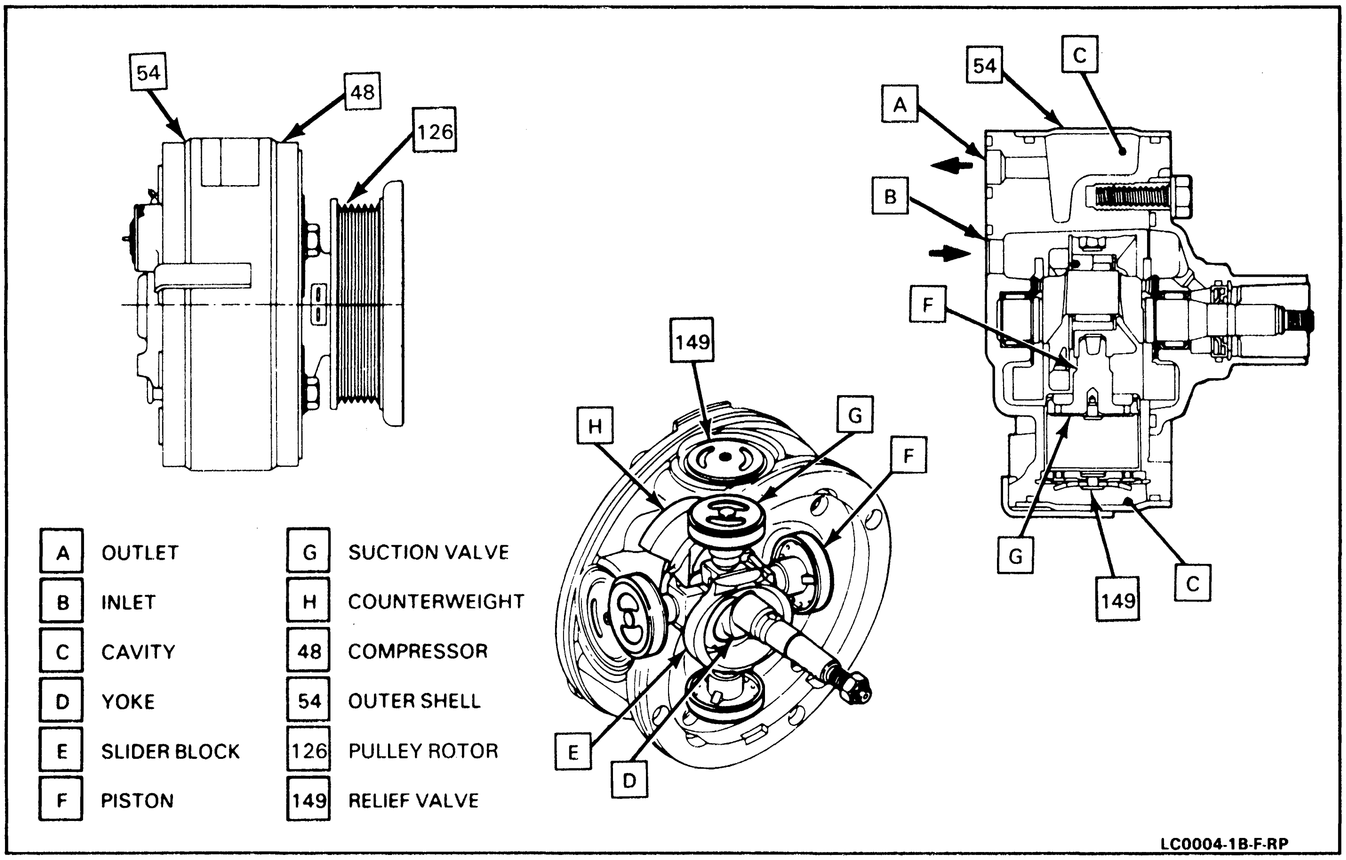


Figure 12 - Compressor Components

Condenser

The condenser (51) in front of the engine cooling system radiator is made up of coils which carry the refrigerant vapor from the compressor (48). Thin cooling fins on the coils transfer heat to the air passing through the condenser (51). This cools the high pressure refrigerant vapor and causes it to condense into a high pressure liquid.

Expansion Tube and Orifice

The plastic expansion tube (52), also called the orifice tube, is in the enlarged portion of the inlet pipe to the evaporator (7). Inside the expansion tube (52) is a small, precisely sized passage called an orifice that restricts the flow of high pressure liquid refrigerant from the condenser (51) on its way to the evaporator (7). As a result of this restriction, the refrigerant leaves the expansion tube (52) as a low pressure liquid.

The expansion tube (52) and orifice are protected from contamination by filter screens on both the inlet and outlet sides of the tube.

Evaporator

Air passing through the evaporator (7) gives off some of its heat to the evaporator core fins when the refrigeration system is operating. Refer to "Air Distribution System" in this section. The heat is conducted through the thin metal walls of the evaporator core to the low pressure liquid refrigerant flowing through the evaporator core tubes, causing the refrigerant to boil and vaporize. The refrigerant leaves the evaporator (7) as a low pressure vapor, carrying off the heat it absorbed from the evaporator surfaces.

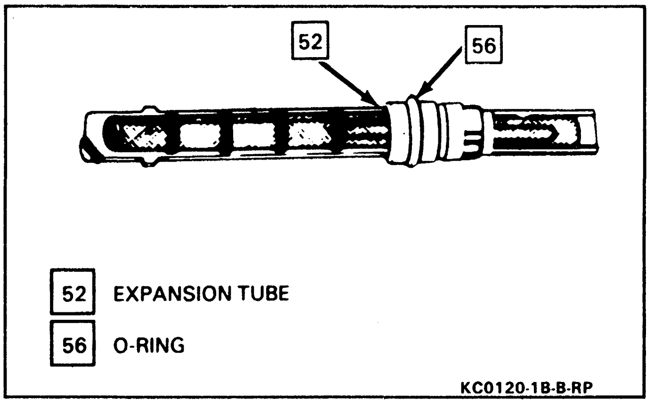


Figure 13 - Expansion Tube

Accumulator

The accumulator (46) is a sealed container connected to the evaporator outlet pipe. It serves as a refrigerant storage container and also separates any traces of liquid refrigerant that may be trapped in the vapor coming from the evaporator (7). The accumulator (46) allows no more than a slight trickle of this liquid refrigerant to go to the compressor (48) since any larger amount of liquid entering the compressor (48) at one time could damage the compressor (48).

A small oil bleed hole in the outlet tube inside the lower end of the accumulator (46) prevents trapping of refrigerant oil by feeding it into the flow of refrigerant going to the compressor (48). This helps prevent oil starvation that could cause lubrication problems in the compressor (48).

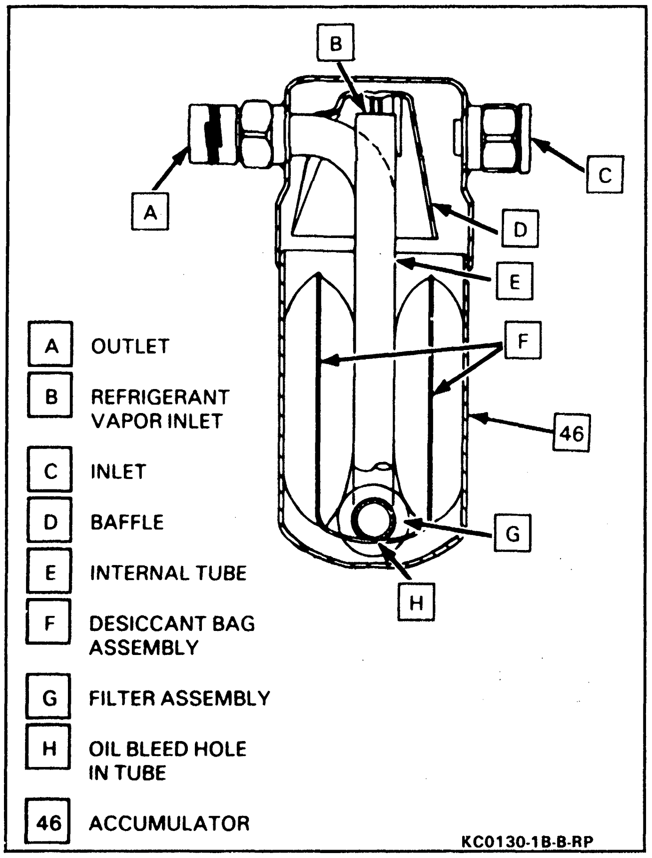


Figure 14 - Accumulator Components

A bag of desiccant (a moisture absorbing material) in the base of the accumulator (46) collects and holds any traces of moisture in the refrigerant that could otherwise create problems such as corrosion or freezing in the refrigeration system.

Recent improvement in refrigerant hose materials and the increased use of metal lines have reduced the chances for entry of moisture into the refrigerant, and an improvement in desiccant has increased its moisture-holding capacity. As a result, an accumulator should be replaced only if leaking as a result of perforation, a damaged O-ring seat or damaged threads, or if the system has been opened to outside air for an extended period.

Pressure Cycling Switch

The pressure cycling switch (47) senses low-side refrigerant pressure on the suction side of the refrigeration system and controls the power circuit to the clutch coil to electrically engage and disengage the compressor clutch. It protects the core of the evaporator (7) from freezing by shutting off the compressor (48) before the evaporator (7) can get cold enough to "ice up." Average evaporator discharge air temperature is kept about 1°C (33°F) during air conditioning system operation.

When the air conditioning system is not running, the pressures within the entire refrigeration system are equal because the compressor (48) is not forcing refrigerant through the expansion tube (52). As a result, the pressure cycling switch (47) reads the relatively high pressure in the evaporator (7) as a temperature well above freezing. This closes the contacts within the switch.

When an air conditioning mode or "DEFROST" is selected, voltage is sent through the compressor clutch coil to the closed switch contacts and then to ground. Completing the circuit in this manner engages the compressor clutch to set the refrigeration system in operation.

As cooling takes place, the compressor (48) reduces the refrigerant vapor pressure within the evaporator to approximately 175 kPa (25 psi), a pressure that corresponds to a temperature slightly above freezing. When this occurs, the pressure cycling switch contacts open to break the circuit that energizes the compressor clutch coil. The compressor (48) stops operating.

When the heat from the air passing through the evaporator (7) raises the vapor pressure of the refrigerant to approximately 315 kPa (46 psi), contacts in the pressure cycling switch (47) again close to energize the compressor clutch coil and engage the clutch. This on-and-off cycle continues as necessary to keep the evaporator temperature just above freezing.

Other Switches, Relays and Devices

Air Conditioning Cutout Relay

The air conditioning cutout relay acts as an on-off switch in series in the circuit to the compressor clutch coil. When the engine's electronic control module (ECM) receives a signal indicating one or more specific operating conditions such as wide-open throttle or excessive engine heat, the ECM grounds the relay coil to open the relay contacts and break the compressor clutch circuit. This gives the ECM the ability to interrupt the operation of the air conditioning refrigeration system when necessary.

High-Pressure Compressor Cut-Off Switch

The high-pressure cut-off switch in the head of the compressor is a protective device intended to prevent excessive compressor head pressures and reduce the chance of refrigerant escape through a safety relief valve. Normally closed, this switch will open the circuit at a high-side pressure of approximately 2965 kPa (430 psi) and reclose the circuit at approximately 1379 kPa (200 psi).

Cooling Fan Pressure Switch

A pressure switch wired to the engine cooling fan relay circuit is used with all V8 engines with air conditioning. Normally open, this switch will close the relay circuit to ground and cause the engine cooling fan to run in the "DEFROST" mode when air conditioning compressor head pressure rises excessively. The cooling fan pressure switch is installed at the Schrader valve on the liquid line from the compressor.

Liquid Line Filter

A liquid line filter is available for aftermarket installation on air conditioning refrigeration systems that have been contaminated. Installation of this filter in the high pressure liquid line before the expansion tube (52) replaces the former practice of system flushing and/or accumulator replacement.

DIAGNOSIS

GENERAL INFORMATION

Some conditions which are normal to proper air conditioning system operation may lead an owner to wrongly suspect a problem.

Under conditions of high humidity, the air discharged from the air conditioning system may not feel as cold as expected. This is because the vaporized moisture in humid air holds heat more effectively than dry air, making the humid air harder to cool. In terms of overall comfort, however, the drier dehumidified air coming from the air conditioning system in hot, humid weather will evaporate more moisture on a person's skin and provide more of a cooling effect than might be felt from cooler but more humid air. This fact should be explained to a customer if no mechanical cause can be found for persistent comments of insufficient cooling.

The cycling clutch method of controlling evaporator temperature can cause some slight increases and decreases of engine speed and power which may be noticeable under certain conditions. This condition is normal and indicates that the air conditioning system is cycling to maintain full cooling capacity while avoiding icing of the evaporator.

If the engine is turned off with the air conditioning system operating, the refrigerant will flow from the high pressure side of the expansion tube through the orifice to the low pressure side until the pressure is equalized within the refrigeration system. The refrigerant flow may be heard as a hissing sound for as long as a minute after the engine stops. This is a normal condition.

Wiring diagrams and diagnosis information for the air conditioning electrical system are in ELECTRICAL DIAGNOSIS (SEC. 8A) which also includes additional diagnostic information on the air distribution system and its vacuum control system.

REFRIGERATION SYSTEM CHECKS

If a faulty air conditioning refrigeration system is suspected because of abnormal refrigeration system pressures, the following items should be checked.

- Clogged fins in the radiator core or condenser core blocking airflow. Check between the condenser and the radiator as well as the outer surfaces of these two components.
- Restrictions or kinks in the evaporator core, condenser core, hoses, tubes and other refrigerant passages.
- Refrigerant leaks.
- Air leaks or restrictions in air ducts. A low airflow rate may indicate a restricted evaporator core.
- Compressor clutch slippage.
- Improper drive belt tension.
- A plugged accumulator or expansion tube.
- Excessive moisture in the refrigeration system.

FUNCTIONAL TEST

The following operational test sequence will aid in determining whether the air conditioning electrical, air, vacuum and refrigeration systems are working properly.

Preparation

1. The air conditioning temperature lever must be set to full "COOL." The temperature lever must be left in this position until step 7 of the test procedure.
2. The engine should be started and allowed to idle for about 20 minutes or until the engine cooling system thermostat is open.

Test

1. The mode lever should be set to "OFF" and the blower switch should be set to "HI."
    - The blower and the compressor should not run.
2. The mode lever should be moved to the "NORM" air conditioning position.
    - The blower should run at high speed and air should be discharged from the instrument panel and intermediate-level "lap cooler" outlets.
    - Air temperature at the outlets should drop to about 7°C (45°F) within a short time.
    - The compressor will come on and may cycle on and off.
3. The blower switch should be moved to the "HI" position, pausing at both of the intermediate blower speed stops.
    - The force of the airflow from the instrument panel outlets and the sound of the blower should be noted at all four blower speed positions.
    - Blower speed should increase at each blower speed stop, as indicated by an increase in the force of the airflow from the outlets and the sound of the blower.
    - The compressor may cycle on and off.
4. The mode lever should be moved to the "NORM" air conditioning position.
    - Air noises from under the right side of the instrument panel should be reduced as the air inlet valve closes to shut off the recirculation of inside air.
    - The compressor may cycle on and off.
5. The mode lever should be moved to the "BI-LEVEL" air conditioning position.
    - The blower should continue to run at high speed, the compressor may cycle on and off and some air will be discharged from the floor outlets as the force of the airflow from the instrument panel outlets is reduced slightly.
6. The mode lever should be moved to the "VENT" economy position.

- Compressor operation should stop.
- Air should flow only from the instrument panel outlets, and air temperature at the outlets should gradually increase until it is equal to outside air temperature.
- The blower should continue to run at high speed.

7. The mode lever should be moved to the "HEATER" economy position and the temperature lever should be moved to the full "WARM" position.
    - Air should flow from the floor outlets with a small amount also coming from the windshield defroster outlets and the side window defogger outlets.
    - The temperature of the air from the outlets should rise to about 60°C (140°F).
8. The mode lever should be moved to the "DEFROST" position.
    - Most of the airflow should come out of the windshield defroster outlets, with only a slight amount coming from the floor outlets.
    - Airflow from the side window defogger outlets should not show any noticeable change.
    - The compressor should run and may cycle on and off, but the discharge air temperature should remain warm.

Conclusions

Operation of the compressor and blower as described indicates that the electrical circuits are functioning properly. The discharge of air from the outlets as described indicates that the vacuum system and air distribution system are functioning properly. Delivery of air at the temperatures described indicates that the temperature lever and refrigeration system are functioning properly.

Compressor overhaul is covered in R-4 AIR CONDITIONING COMPRESSOR OVERHAUL (SEC. 1D1). Electrical system and vacuum system information is provided in ELECTRICAL DIAGNOSIS (SEC. 8A). Diagnosis of insufficient cooling and insufficient heat problems is included in this section, as are procedures and suggestions for servicing air conditioning system components.

INSUFFICIENT COOLING CHECK

If outside air temperature is above 21°C (70°F), the following procedure can be used to quickly determine whether the air conditioning refrigeration system has the proper charge of Refrigerant-12. This check can be made in a few minutes, simplifying system diagnosis by localizing the problem to a low refrigerant charge or eliminating that possibility.

The engine must be at normal operating temperature and running at normal idle speed. The hood and all body doors must be open. The air conditioning controls must be set for "NORM" air conditioning, "HI" blower speed and full "COOL" temperature.

When the compressor is operating, use a hand to feel the temperature of the evaporator inlet tube "downstream" from the expansion tube. Then feel the surface of the accumulator.

Compare and evaluate the temperatures of the two components. Proper operation with an adequate refrigerant charge is indicated if both the evaporator inlet tube and the accumulator feel cooler than the outside air and both seem to be at the same temperature.

If the evaporator inlet tube is cooler than the accumulator, or if the inlet has a coating of frost, a low refrigerant charge is indicated. Add 0.11 kg (0.250 pound) of Refrigerant-12 and allow the system to stabilize. Refer to "Refrigerant-12 Handling Instructions" in this section. This should be repeated as necessary until the evaporator inlet tube and the accumulator both feel the same temperature. Then another 0.40 kg (0.880 pound) of Refrigerant-12 should be added to the refrigeration system.

CYCLING CLUTCH ORIFICE TUBE (CCOT) AIR CONDITIONING DIAGNOSTIC PROCEDURE CHARTS

Figures 15 through 18

An organized procedure for diagnosing insufficient cooling is presented in Figures 15 through 18.

TESTING AIR CONDITIONING PERFORMANCE

Figure 19

Tools Required:

J 23575-01 Manifold and Gage Set

J 6742-03 Precision Thermometer

Performance testing provides a measure of air conditioning system operating efficiency by measuring and comparing pressures at the high-pressure and low-pressure sides of the refrigeration system and the temperature of the air being discharged into the passenger compartment.

Before making the air conditioning performance test, a functional test should be made to assure that the air distribution system air valves are functioning properly to route all the air passing through the evaporator to the outlets. Refer to "Functional Test" in this section.

Connect the high-pressure gage of J 23575-01 to the high-pressure side service fitting. Connect the low-pressure gage of J 23575-01 to the low-pressure side service fitting. Both gage valves must be closed while making the connections. The center hose fitting of J 23575-01 also must be closed, and must remain closed during the performance test.

The hood must be open and all doors and windows must be closed during the test. The air conditioning controls must be set for "MAX" air conditioning, "HI" blower speed and full "COOL" temperature.

Place a high volume fan in front of the radiator grille to insure an adequate supply of airflow across the

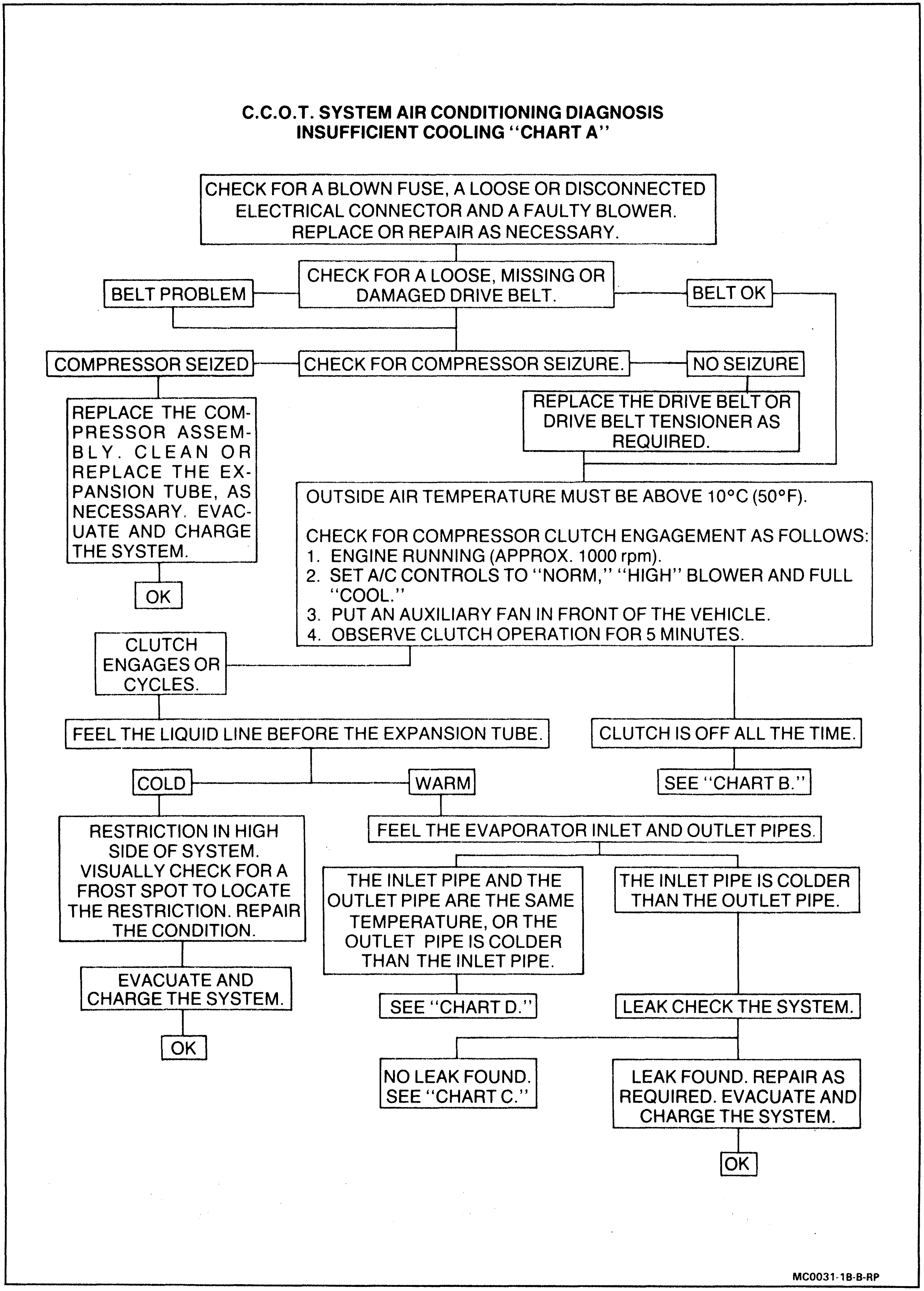
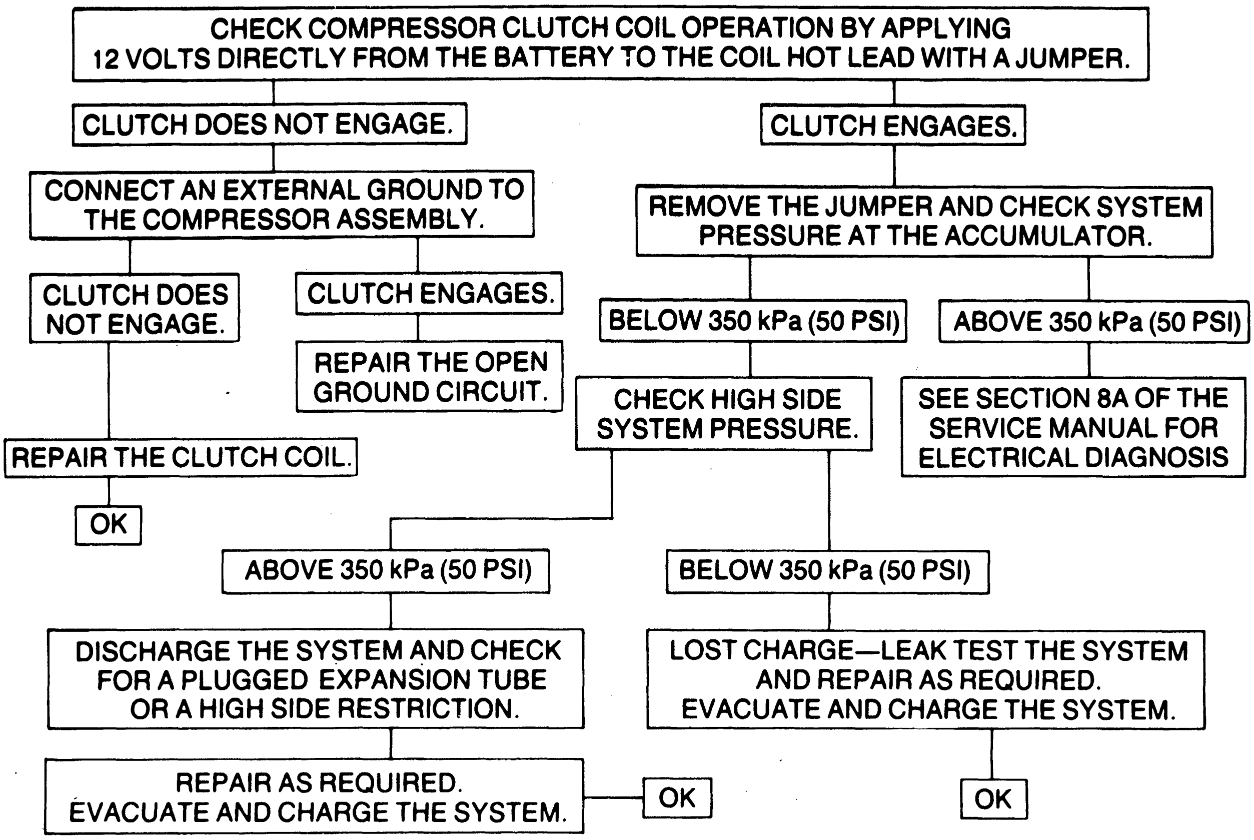


Figure 15 - Insufficient Cooling Diagnostic Procedure (1 of 4)

C.C.O.T. SYSTEM AIR CONDITIONING DIAGNOSIS
INSUFFICIENT COOLING "CHART B"



C.C.O.T. SYSTEM AIR CONDITIONING DIAGNOSIS
INSUFFICIENT COOLING "CHART C"

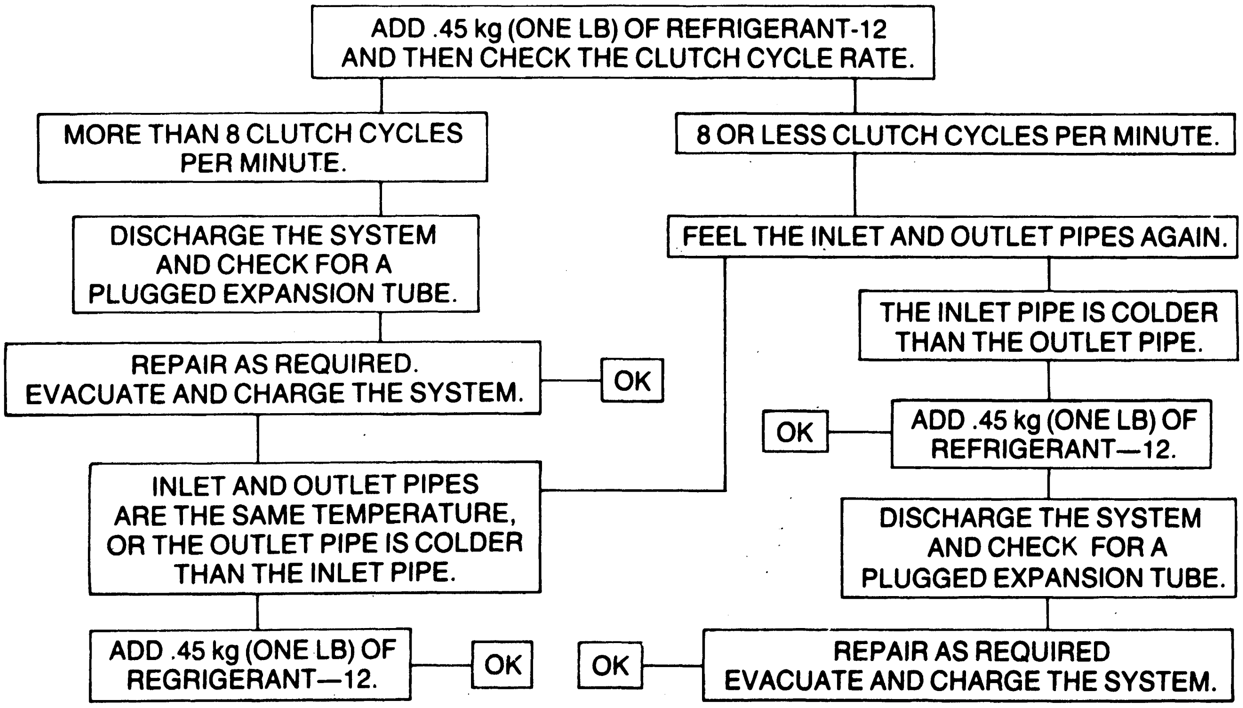


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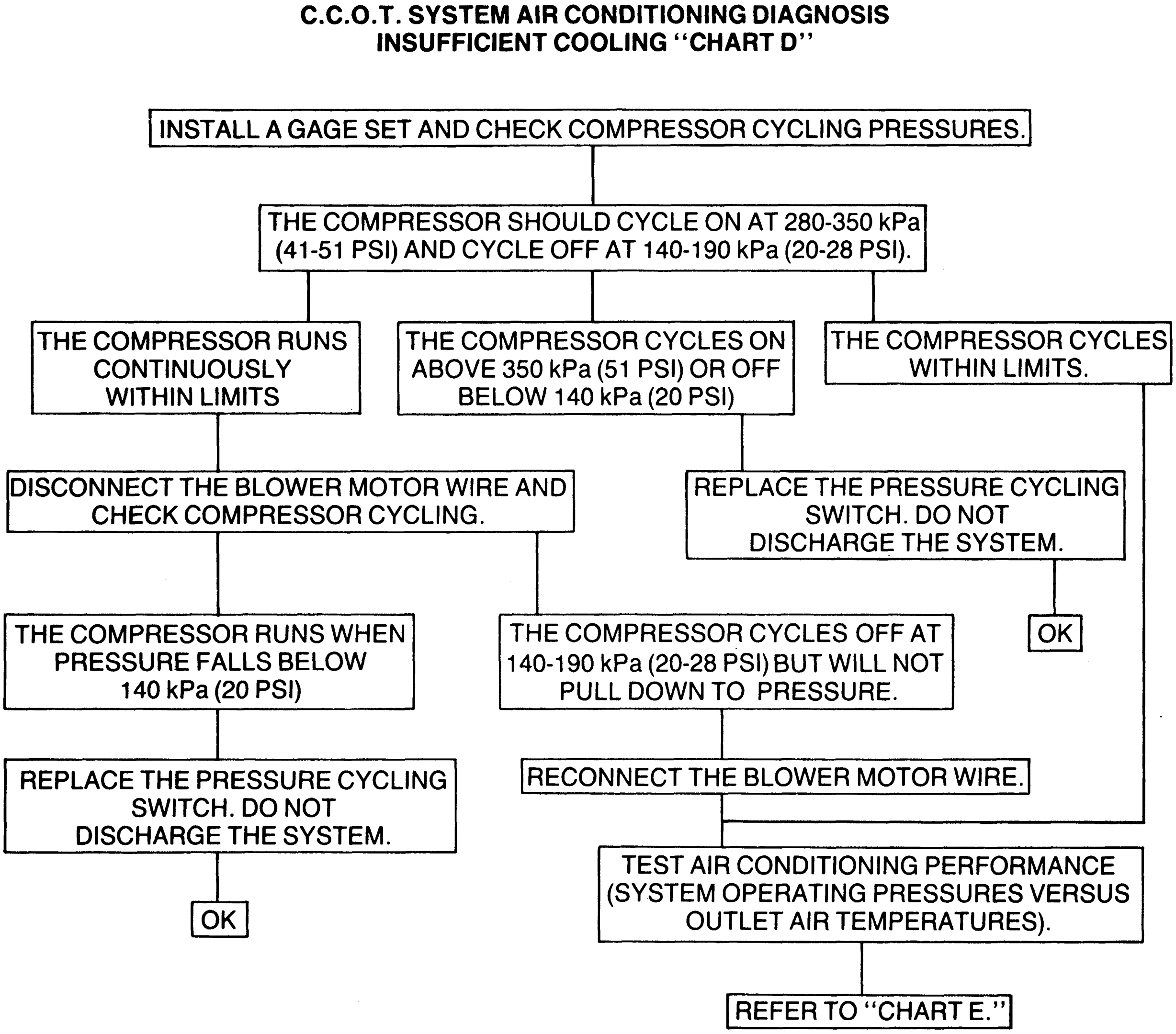
Figure 16 - Insufficient Cooling Diagnostic Procedure (2 of 4)



C.C.O.T. SYSTEM AIR CONDITIONING DIAGNOSIS
INSUFFICIENT COOLING "CHART D"

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Figure 17 - Insufficient Cooling Diagnostic Procedure (3 of 4)

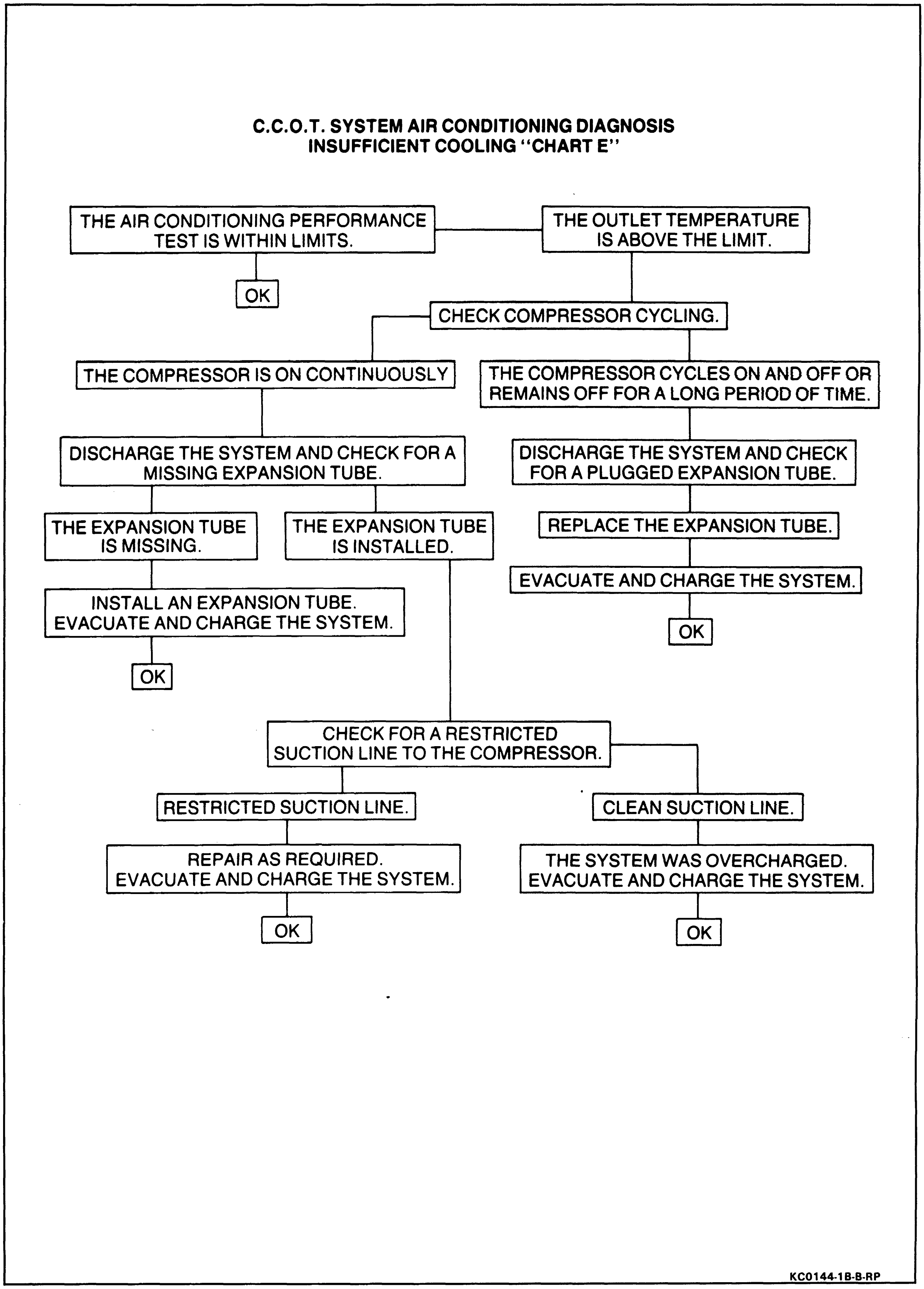

Figure 18 - Insufficient Cooling Diagnostic Procedure (4 of 4)

condenser. After idling the engine for ten minutes, increase engine speed to 2000 rpm for the test.

Just before making the performance test, determine the temperature and relative humidity of the ambient air (the air being blown against the condenser). Then measure the temperature of the air being discharged from a center instrument panel outlet with J 6742-03. Read the low-pressure gage and high-pressure gage of J 23575-01. Record and compare the readings to the data listed in Figure 19.

If operating pressures are within the normal range, the refrigeration system can be considered to be operating properly. This can be further confirmed by the outlet air temperature reading. Slight variations from the published readings can be considered acceptable if experience has shown that such minor deviations do not indicate a problem.

LEAK TESTING

When a refrigerant leak is suspected or a service operation is performed which requires loosening or tightening lines or connections, test the refrigeration system for leaks.

Access Fitting Caps

Schrader valve access fittings are provided for servicing the air conditioning refrigeration system. The high pressure side access fitting is in the liquid line near the top of the accumulator. The low pressure side access fitting is installed in the accumulator, near the top.

Each access fitting has a black plastic cap and a seal which form the primary refrigerant seal for the fitting. If the cap is missing or loose, a significant amount of refrigerant may leak past the valve core, causing poor cooling or system failure.

If a refrigerant leak is suspected, make sure the seal is in place inside the cap and that the cap is tightened. To tighten the cap properly, it should be turned down until contact is made with the O-ring above the valve core. Then the cap should be turned down another quarter-turn to half-turn.

Liquid Leak Detector

At a number of locations in the refrigeration system, such as fittings and valves, a liquid leak detector solution may be used to find refrigerant leaks. By applying the liquid leak detector solution to the area in question with the swab that is attached to the bottle cap, bubbles will form within seconds if there is a leak.

Red Dye Leak Detector

A red dye leak detector is available to aid diagnosis of air conditioning refrigeration system problems. The dye is mixable both in the liquid refrigerant and in the compressor oil. The dye leaves the compressor in the oil which is carried along with the hot refrigerant gas. In the condenser, the dye and the oil are dissolved in the liquid refrigerant. In the evaporator, the dye remains in the oil when the refrigerant boils into a vapor. It is then returned with the oil to the compressor by the suction line.

Leaks show up in a matter of minutes on the suction side as easy-to-see red stains. Leak detection in the condenser and liquid line may be slower and can appear as a faint pink color because of the low amount of red dye in the oil.

RELATIVE HUMIDITY (%)	AMBIENT AIR TEMP		LOW SIDE		ENGINE SPEED (rpm)	CENTER DUCT AIR TEMPERATURE		HIGH SIDE	
	°F	°C	kPa	PSIG		°F	°C	kPa	PSIG
20	70	21	200	29	2000	40	4	1034	150
	80	27	200	29		44	7	1310	190
	90	32	207	30		48	9	1689	245
	100	38	214	31		57	14	2103	305
30	70	21	200	29	2000	42	6	1034	150
	80	27	207	30		47	8	1413	205
	90	32	214	31		51	11	1827	265
	100	38	221	32		61	16	2241	325
40	70	21	200	29	2000	45	7	1138	165
	80	27	207	30		49	9	1482	215
	90	32	221	32		55	13	1931	280
	100	38	269	39		65	18	2379	345
50	70	21	207	30	2000	47	8	1241	180
	80	27	221	32		53	12	1620	235
	90	32	234	34		59	15	2034	295
	100	38	276	40		69	21	2413	350
60	70	21	207	30	2000	48	9	1241	180
	80	27	228	33		56	13	1655	240
	90	32	249	36		63	17	2069	300
	100	38	296	43		73	23	2482	360
70	70	21	207	30	2000	50	10	1276	185
	80	27	234	34		58	14	1689	245
	90	32	262	38		65	18	2103	305
	100	38	303	44		75	24	2517	365
80	70	21	207	30	2000	50	10	1310	190
	80	27	234	34		59	15	1724	250
	90	32	269	39		67	19	2137	310
90	70	21	207	30	2000	50	10	1379	200
	80	27	249	36		62	17	1827	265
	90	32	290	42		71	22	2275	330

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Figure 19 - Performance Test

In most cases, a bright red color (usually oil) will appear at the point of leakage. Most leaks show up in a short period of time but some may take up to 24 hours to have enough color to see. If leaks develop in parts of the system which are difficult to see, or if dirt and oil have gathered around connections, the area can be wiped with a white cloth or paper towel to pick up any traces of the red dye. The red dye should be wiped up after repairing a leak so the next technician does not look for a leak in that same location.

If new dye is to be added with Refrigerant-12, it must be charged as a liquid. If charged as a vapor, the dye will be left behind as a liquid in the container. Only GM-approved dye should be used. Other dyes may alter the chemical stability of the refrigerant or may curdle and clog the filter screen of the expansion tube.

Red dye leak detector can stain some materials. It may be necessary to clean the dye from floors, hands and clothing. Here are some suggestions for preventing red dye stains.

- A cloth or paper towel should be wrapped around couplings and fittings before charging hoses containing red dye leak detector are disconnected.
- Valve or hose outlets should be surrounded with several layers of cloth before they are vented.
- Valves should be opened slowly. This will keep liquid refrigerant and oil from blowing out of the refrigeration system.
- Gloves and eye protection should be worn.
- Surfaces should be wiped quickly with a clean cloth.

Solvents that will help in removing the red dye include lacquer thinner, Virginia No. 10 solvent, Stoddard solvent and other similar solvents. The solvents are most effective if used right away. Most of the dye can be removed from clothing by washing or dry cleaning.

Electronic Leak Detectors

Figure 20

Tools Required:

J 26934 Leak Detector or
J 29547 Leak Detector

An electronic leak tester can accurately determine leaks in hard-to-see or hard-to-reach areas that are difficult to test with liquid leak detector solution. J 26934 is powered by 110-volt alternating current and J 29547 is a portable battery-operated model. Both models provide visual and audible signals to indicate a leak.

The successful use of electronic leak detectors depends upon following the manufacturer's instructions for calibration, operation and maintenance very carefully. Battery condition is important to the accuracy of the portable battery-powered J 29547.

INSUFFICIENT HEAT CHECKS

Air ducts should be checked for proper installation and blower operation also should be checked. The temperature lever and cable should be inspected for proper installation and operation.

The hot water valve should be checked as follows:

1. The engine should be started and allowed to warm up.
2. The temperature lever should be set to the full "COOL" position.
3. Feel the heater inlet hose from the hot water valve to the heater core.
   - The hose should not be hot. A cool hose indicates that the hot water valve is diverting the flow of heated coolant directly to the heater outlet hose, bypassing the heater core.
   - If the heater inlet hose is hot, determine whether the vacuum is being supplied to the hot water valve vacuum actuator when the temperature lever is in the full "COOL" position.
     - Lack of vacuum indicates a faulty vacuum system.
     - The presence of vacuum indicates a faulty hot water valve or actuator.
4. The temperature lever should be moved to the full "WARM" position.
   - After a half-minute, the heater inlet hose should be checked as in step 3. If the heater inlet hose is not hot, the vacuum hose to the hot water valve should be disconnected and the heater hose should be checked again.
     - If the hose becomes hot, a faulty indicator vacuum switch is indicated.

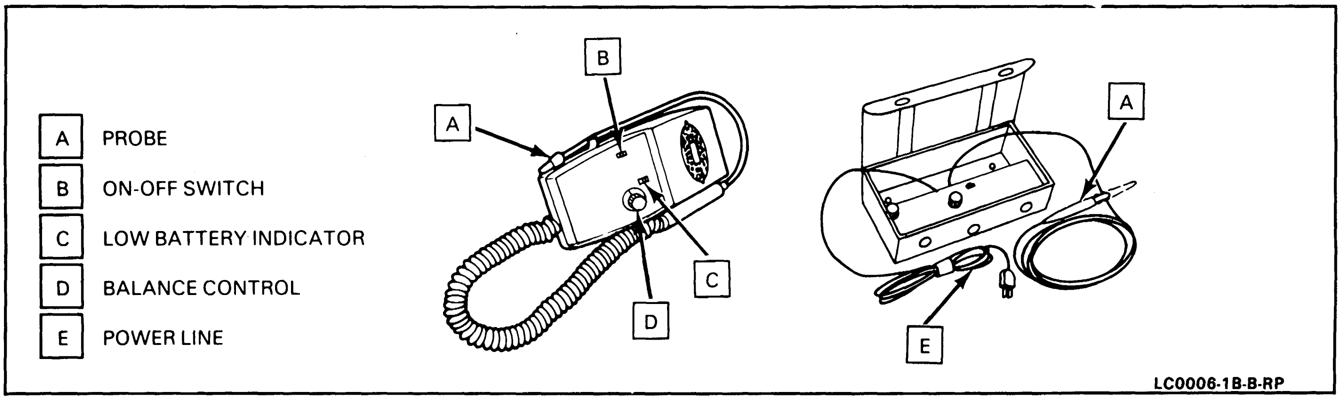


Figure 20 - Electronic Leak Detectors

- If the hose remains cool, a faulty hot water valve is indicated.

BLOWER NOISE

A constant air rush noise is typical of high speed blower operation. Some systems and modes may be more noisy than others. If possible, check another similar vehicle to determine whether the noise is typical or excessive. For diagnosis of excessive blower noise, refer to HEATER SYSTEM (SEC. 1A).

DIAGNOSIS OF AIR CONDITIONING HEATER

PROBLEM	POSSIBLE CAUSE	CORRECTION
Insufficient Heating of Passenger Compartment	1. Incorrect operation of controls.	1. The driver should be advised of proper operation of controls.
	2. Low engine coolant level.	2. Coolant should be added as needed. A check should be made for coolant leaks. The engine should be run to clear any air locks.
	3. Faulty engine thermostat.	3. The thermostat should be checked and replaced if necessary.
	4. Kinked heater hose.	4. Hoses should be checked and kinks should be straightened or hoses replaced as necessary.
	5. Obstructed heater core tubes.	5. An obstruction usually causes a squishing noise in the core. Any foreign material should be removed from the core or the core should be replaced.
	6. Faulty temperature cable.	6. The temperature lever should be moved back and forth rapidly from one end of the slot to the other while listening for the temperature valve to hit the stops at both extremes of travel. The cable should be adjusted or replaced as necessary.

PROBLEM	POSSIBLE CAUSE	CORRECTION
	7. Faulty blower motor or blower circuit.	7. Faulty wires or connections must be repaired or replaced. A faulty blower motor must be replaced.
Insufficient Heating of Rear Seat Area	1. Incorrect operation of controls.	1. The driver should be advised to use higher blower speed to force air to the rear of the passenger compartment.
	2. Obstruction on the floor.	2. A check should be made for bulky objects or torn insulation under the front seat.
Cold Drafts on Floor	1. Partially open air inlet valve.	1. The air inlet valve should close properly in all modes except "MAX" air conditioning mode. Repairs should be made as necessary.
	2. Side door seals damaged or missing.	2. All door seals should be inspected. Faulty seals should be repaired or replaced as necessary.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Inadequate Defrosting	1. Obstruction in defroster nozzle.	1. Both defroster nozzle outlets should be inspected. Any foreign objects should be removed. Any loose instrument panel pad that blocks an outlet should be repaired.
	2. Damaged defroster nozzle outlet.	2. The outlet flange should be carefully reshaped with pliers so the outlet opening is uniform. If the outlet flange cannot be reshaped, the air distributor should be replaced.
	3. Faulty defroster air valve vacuum actuator or hose.	3. Defroster air valve operation should be checked. A faulty vacuum actuator or hose should be replaced.
	4. Insufficient heat.	4. Refer to "Insufficient Heating of Passenger Compartment" in this chart.
Inoperative Blower	1. Blown fuse.	1. The fuse should be replaced.
	2. Open circuit.	2. Check the circuit between the ignition switch and the blower motor, and the blower motor ground circuit. Repair as necessary.
	3. Faulty blower switch.	3. A faulty blower switch should be replaced.

ON-VEHICLE SERVICE

CAUTION: For personal protection, goggles should be worn and a clean cloth wrapped around fittings, valves and connections when doing work that includes opening the refrigeration system. If Refrigerant-12 comes in contact with any part of the body, severe frostbite and personal injury can result. The exposed area should be flushed immediately with cold water and prompt medical help should be obtained.

NOTICE: It is essential to tighten all tubing connections to the specified torque for the type and size of tube fitting. When tightening steel-to-aluminum connections, the torque specified for aluminum tubing must be used. Insufficient or excessive torque when tightening can result in loose joints or deformed joint parts. Either condition can result in refrigerant leakage and an inoperative air conditioning system. Refer to "Specifications" in this section.

SERVICE INFORMATION

O-Ring Replacement

Install new GM-approved service replacement air conditioning O-rings when a joint or a fitting is installed, except when the O-rings are provided on new replacement components. Unless service replacement O-rings of the specified part numbers are used, excessive leakage of Refrigerant-12 may occur. Refer to the part number for identification, not to the former color-coating method of identification, because some formerly color-coated service replacement O-rings may be black.

Air conditioning O-rings should be coated with 525 viscosity refrigerant oil just before installation and should be slipped onto the flange tube to assure proper locating and sealing. To prevent the possibility of swelling and a reduction in sealing effectiveness, O-rings should not be soaked in refrigerant oil. Before installation, the O-rings and the fittings should be examined to insure that they have not been nicked or deformed. Nicked or deformed parts must be replaced or excessive refrigerant leakage may result.

Refrigerant-12 Handling Instructions

Before attempting any service which requires opening refrigeration system lines or components, refer to "Handling Refrigerant Lines and Fittings" and "Chemical Stability Maintenance" in this section. Carefully follow the instructions for discharging, adding oil, evacuating and charging the refrigeration system in this section.

All Refrigerant-12 drums are shipped with a heavy metal screw cap to protect the valve and safety plug of the drum from damage. It is good practice to replace the cap after each use of the drum to continue the protection.

If it is necessary to carry a container of Refrigerant-12 in a vehicle, it should not be carried in the passenger compartment.

When filling a small Refrigerant-12 drum from a larger one, the smaller drum never should be completely filled. Space always should be left above the liquid for expansion.

Handling Refrigerant Lines and Fittings

When opening the refrigeration system, the work area should be well ventilated. Welding or steam cleaning operations should not be done on or near refrigeration system lines or other air conditioning parts on the vehicle.

All metal tubing lines should be free from dents and kinks to prevent any loss of system capacity because of line restriction. Flexible refrigerant hose lines never should be bent to a radius of less than four times the diameter of the hose. Flexible hoses never should come closer than 63.5 mm (2.5 inches) from the exhaust manifold. Refrigerant hoses should be inspected regularly for leaks and brittleness and replaced with new hoses if deterioration or leaking is found.

Before disconnecting any fitting in the refrigeration system, the system first must be discharged of all Refrigerant-12. The technician should proceed cautiously, regardless of gage readings. The connections should be opened very slowly, keeping face and hands away so no injury can occur if there is liquid Refrigerant-12 in the line. If pressure is noticed when the fitting is loosened, the pressure must be allowed to bleed off. Refer to "Discharging, Adding Oil, Evacuating and Charging CCOT Systems" in this section.

NOTICE: Alcohol never should be used in the refrigeration system in an attempt to remove moisture. Damage to system components could occur.

If a refrigerant line is opened to the atmosphere, it should be capped or taped to close the opening immediately and prevent entry of moisture and dirt. These contaminants can cause internal compressor wear and plugged lines in the condenser and evaporator cores, the expansion tube and the compressor inlet screen.

Sealing caps should be removed from subassemblies just before making connections for final assembly. A small amount of clean 525 viscosity refrigerant oil should be used on all tube and hose joints. New O-rings dipped in clean 525 viscosity refrigerant oil should be used when assembling joints. The oil will aid in assembly and help to provide a leakproof joint. O-rings and seats must be in perfect condition because a burr or a piece of dirt can cause a refrigerant leak.

It is important to use the proper wrenches when connecting O-ring fittings. When tightening the joint, a second wrench should be used to hold the stationary part of the connection to prevent distortion of connecting lines or components. When connecting a flexible hose connection, three wrenches should be used to hold the swaged fitting, the flare nut and the coupling to which it is attached. This will prevent turning the fitting and damaging the ground seat. A solid feel when tightening a connection indicates a proper assembly.

For refrigerant line connection torque specifications for steel, aluminum or copper tubing, refer to "Specifications" in this section.

Chemical Stability Maintenance

The efficient operation and life of the air conditioning system is dependent upon the chemical stability of the refrigeration system. If foreign materials such as dirt, air or moisture contaminate the refrigeration system, they will change the stability of Refrigerant-12 and 525 viscosity refrigerant oil. They also will affect the pressure-temperature relationship of the refrigerant, reduce efficient operation and possibly cause internal corrosion and abnormal wear of moving parts. The following precautions are recommended to insure chemical stability in the system.

Before disconnecting a refrigerant line connection, any dirt or oil at or near the connection should be wiped away to reduce the possibility of foreign matter entering the system. Both sides of the opened connection should be capped, plugged or taped as soon as possible to prevent the entry of contaminants.

The manifold gage set, tools and replacement parts must be kept clean and dry. When preparing to open the refrigeration system, everything needed should be ready and handy so as little time as possible will be required to perform the operation. The refrigeration system should not be left open any longer than necessary.

Refrigeration system service parts are dehydrated and sealed before shipping. They should remain sealed until just before making connections. All parts should be at room temperature before they are uncapped to prevent condensation of moisture from the air that has entered the system. If caps are removed but the connections are not made for any reason, the parts should be resealed as soon as possible.

When adding 525 viscosity refrigerant oil, the transfer device and container should be clean and dry to assure that the refrigerant oil remains as moisture-free as possible. Also refer to "Discharging, Adding Oil, Evacuating and Charging CCOT Systems" in this section.

Any refrigerant system that has been opened should be properly evacuated before recharging with Refrigerant-12. Refer to "Discharging, Adding Oil, Evacuating and Charging CCOT Systems" in this section.

REFRIGERATION SYSTEM SERVICES

Air Conditioning Refrigerant Recovery and Recycling (ACR³) Station Setup and Refrigerant Recovery

Figures 21 through 24

The Air Conditioning Refrigerant Recovery and Recycling Station (ACR³) (J 38100-B) is designed to be compatible with charging station J 23500-01 or its equivalent. The recovery and recycling operations are performed separately with the capability to recycle 136 kg (30 pounds) in one operation. Two 136 kg (30 pound) capacity reusable tanks are included with the station.

CAUTION: Always wear goggles and wrap a clean cloth around fittings and connections when doing work that involves opening the refrigeration system. If liquid refrigerant comes into contact with the skin or eyes, injury may result.

CAUTION: Never remove a gage line from its adapter when the line is connected to the refrigeration system. Always remove the line adapter from the service fitting to disconnect a line. Do not remove the charging hose at the gage set while attached to service low-side fitting. This will result in complete discharge of system due the depressed Schrader-type valve in service low-side fitting and may cause personal injury due to escaping refrigerant.

NOTICE: The Air Conditioning Refrigerant Recovery and Recycling Station meets UL® standards for moisture and contamination removal. Recovery systems which cannot meet these standards are not approved for warranty repairs. Use of moisture or particulate contaminated refrigerant will result in premature compressor and other component failure.

- Before removing and replacing any of the air conditioning refrigeration lines or components, the refrigerant must be completely recovered.
- Always use service valve and pressure gage sets during evacuation and charging procedures.
- Do not charge while compressor system is hot.
- Always check the refrigeration system for pressure with a manifold gage set to determine if refrigerant is present in the system. Performing recovery on a refrigeration system which is open to the atmosphere as a result of a leak would allow the recovery station to pull only air into the tank.

Station (ACR³) Setup and Maintenance

Filter Drier Installation

Figure 21

NOTICE: USE ONLY AUTHORIZED FILTER DRIER CORES. Use of any other cores will give unsatisfactory results and will void the warranty.

1. Remove the screws holding the filter cap to the shell. Inside you will find a filter drier core bracket (attached to the cap), and a piece of cardboard separating the bracket and the filter cap.
2. Clean all internal parts with a lint free towel.
3. Discard the cardboard separator.
4. Remove the filter drier core from the sealed can. Do not remove the filter from the can until you are ready to install it in the system.
5. If the filter cap gasket is damaged, replace it. Replacement gaskets are included with each filter drier core.
6. Center the spring on the filter cap and place the upper bracket on the spring with the center boss of the bracket fitting into the coil and the edges of the plate facing up.

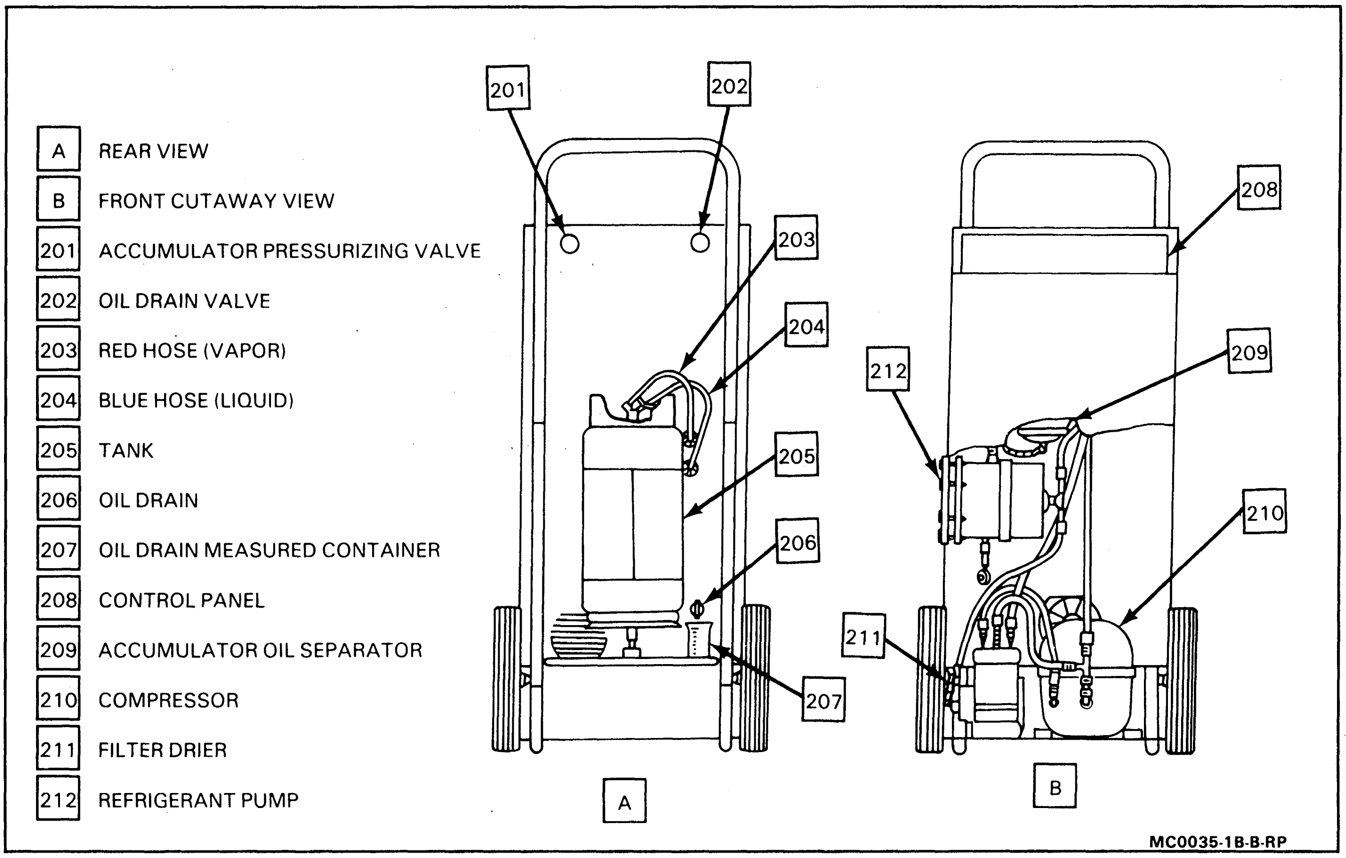


Figure 21 - ACR^3 Component Locations

7. Position the filter drier core on the upper bracket. Position the screened lower bracket on the filter drier core and install the tie rods. Tighten the tie rods until they stop.
8. Install the filter drier core assembly into the filter drier shell. Replace the screws and tighten in a star pattern to 20 N·m (15 lb. ft.).
9. When the core has been installed and the filter drier reassembled, attach the blue hose to the vacuum pump and start the vacuum pump. Run the pump for approximately 10 minutes to remove all air.
10. Turn off the vacuum pump and disconnect the hose.

Recovery Tank Installation

Perform this procedure only when putting new tanks into service.

CAUTION: Use authorized refillable refrigerant tanks only. Use of non-refillable tanks could cause personal injury and will void the warranty. Non-refillable tanks will affect weight platform calibration and will result in overfilled tanks. Overfilling could cause the safety valve to "pop-off" releasing a large quantity of refrigerant. If liquid refrigerant comes into contact with the skin or eyes, personal injury may result.

1. The recovery tank is supplied with 69 to 103 kPa (10 to 15 psi) of dry nitrogen to keep it clean and dry during shipment. Bleed this pressure from the tank before attaching the tank to the station by removing sealing cap and opening either valve. A new tank without the precharge of dry nitrogen indicates a leak and should be immediately returned for replacement. See instruction manual.
2. Place the tank on the scale platform at the rear of the station. Place the bottom lip of the tank around the outside diameter of the stand-off welded to the platform. This will center the tank automatically. Loosely fasten the strap around the tank in order to prevent the tank from tipping over.
3. Attach the red hose from the back of the station to a vacuum pump. Attach the blue hose from the back of the station to the "LIQUID" port of the tank.
4. Open the "LIQUID" valve on the tank. Turn on the vacuum pump. Pull a vacuum on the tank and station for approximately 10 minutes to remove all unwanted air from the tank and from the station.
5. After a vacuum has been pulled, turn off the vacuum pump and disconnect the hose from the vacuum pump. Attach the red hose to the "VAPOR" port on the tank and open the "VAPOR" valve.

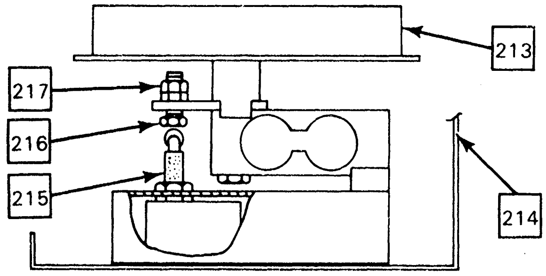
Weight Platform Calibration

Figure 22

The weight platform should be checked for accuracy at least once a month. This calibration will assure that the compressor will shut off when the tank is full.

CAUTION: Use of non-refillable tanks will affect platform calibration and will result in overfilling of non-refillable tanks. Overfilling could cause the safety valve to "pop-off" releasing a large quantity of refrigerant. If liquid refrigerant comes into contact with the skin or eyes, personal injury may result.

1. Place a known 45 pound weight centered on the platform. The switch should just trip or be very close to tripping with this amount of weight.
2. If the switch is tripped, the mechanism is in calibration. If the switch does not trip, place a 2 pound weight on top of the 45 pound weight. This weight should definitely trip the switch. If the switch is tripped, the mechanism is in calibration. If the switch did not trip, the mechanism must be recalibrated.
3. To recalibrate, remove the 2 pound weight and loosen the lock nut of the trip screw. Turn the trip screw until the switch just trips. Remove the 45 pound weight.
4. To check, replace the 45 pound weight on the platform and repeat step 2. Repeat step 3 as required. Tighten lock nut of the trip screw when recalibration is complete.



213	PLATFORM ASSEMBLY	216	ADJUSTING SCREW
214	STATION BACK PANEL	217	LOCKNUT
215	TRIP SWITCH		

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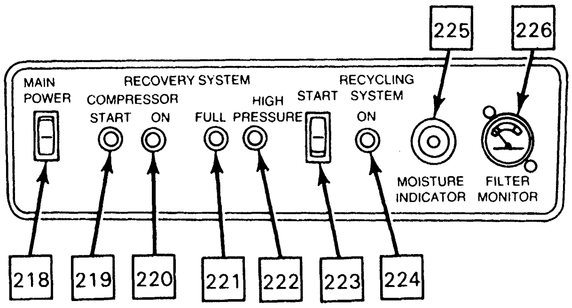
Figure 22 - Weight Platform Calibration

Control Panel

Figure 23

The control panel contains the switches and monitors as follows:

- Main Power Switch - supplies electrical power to the control panel.
- Compressor Start Switch - energizes compressor.
- Compressor On Light - lights when compressor is energized.
- High Pressure Light - lights when there is pressure above 1827 kPa (265 psi) in system.
- Recovery Tank Light - lights when recovery tank is full.
- Recycling System Start Switch - energizes recycling pump.
- Recycling Pump On Light - lights when recycling pump is energized.
- Moisture Indicator - tells if refrigerant is wet or filter core needs to be replaced if no color change occurs in two hours of recycling.
- Filter Monitor - tells when filter is plugged.



218	MAIN POWER SWITCH
219	COMPRESSOR "START" BUTTON
220	COMPRESSOR "ON" INDICATOR LAMP
221	RECOVERY TANK "FULL" INDICATOR LAMP
222	HIGH VEHICLE SYSTEM PRESSURE INDICATOR LAMP
223	RECYCLING SYSTEM "START" SWITCH
224	RECYCLING INDICATOR LAMP
225	MOISTURE INDICATOR
226	FILTER MONITOR

MC0033-1B-B-RP

Figure 23 - Control Panel

Filter Drier Core Replacement

Figure 24

NOTICE: Use only authorized filter drier cores. Use of any other cores will give unsatisfactory results and will void the warranty.

Guidelines for replacing the filter drier core:

- For proper contaminant removal, replace the filter drier core after recycling a maximum of 136 kg (300 pounds) of refrigerant.
- If the moisture indicator does not change to green after two hours of filtering time, the filter drier core is saturated with moisture and should be changed.
- If the filter drier core becomes clogged with particulates, the filter monitor needle will register in the red zone; this also means the filter core should be changed.

1. Close the "LIQUID" valve on the tank.

CAUTION: Steps 2 and 3 are critical to avoid possible hazardous release of refrigerant. If liquid refrigerant comes into contact with the skin or eyes, injury may result.

2. Attach the blue hose to recovery inlet of the station.
3. Start the compressor and recover all refrigerant remaining in the station into the storage tank. The compressor will automatically shut off when recovery is complete.
4. Remove the screws holding the filter cap to the shell. The filter drier core and bracket are attached to the filter cap.
5. Remove the tie rods from the filter cap and remove the filter drier from the bracket.
6. Clean all internal parts.
7. Remove the filter drier core from the sealed can. Do not remove the filter from the can until you are ready to install it in the system.
8. If the filter cap gasket is damaged, replace it. Replacement gaskets are included with each filter drier core.
9. Center the spring on the filter cap and place the upper bracket on the spring with the center boss of the bracket fitting into the coil and the edges of the plate facing up.
10. Position the filter drier core on the upper bracket. Position the screened lower bracket on the filter drier core and install the tie rods. Tighten the tie rods until they stop.
11. Install the filter drier core assembly into the filter drier shell. Replace the screws and tighten evenly in a star pattern to 20 N·m (15 lb. ft.).
12. When the core has been replaced and the filter drier reassembled, attach the blue hose to the vacuum pump and start the vacuum pump. Run the pump for approximately 10 minutes to remove all air.
13. Turn off the vacuum pump and disconnect the hose.
14. Reattach the blue hose to the "LIQUID" port of the tank and open the "LIQUID" valve on the tank. You are now ready to continue recycling with your station.

Refrigerant Recovery

Figure 24

The refrigerant system must be discharged using an Air Conditioning Refrigerant Recovery and Recycling System J 38100-B. After repairing the malfunction, the refrigerant system can then be evacuated and charged using air conditioning service charging station J 23500-A or equivalent, or the manifold and gage set J 23575-01 and refrigerant.

Evacuation lines from the recovery system and the charging lines from the charging station or manifold and gage set require the use of adapters to connect to the refrigeration system low-side service fitting. A straight adapter J 5420 and a 90 degree angle adapter J 9459 are available.

NOTICE: Failure to check for residual oil from the previous recovery can result in adding extra oil to the vehicle currently being serviced. This will result in reduced performance and possible compressor damage. See "Refrigerant Oil Distribution" under "Discharging, Adding Oil, Evacuating and Charging CCOT Systems" in this section.

1. Start vehicle and run with the A/C on for two minutes. Then attach a manifold gage set to the refrigeration system and attach the recovery station inlet hose to the center fitting of the manifold gage set.
2. Open both valves of the manifold gage set. Make certain the refrigerant tank "VAPOR" valve and the "LIQUID" valve are open.
3. Plug the station into a suitable electric power outlet and turn on the "MAIN POWER" switch.
4. Depress the "COMPRESSOR START" switch. The amber "COMPRESSOR ON" light will come on and the compressor will start. The compressor will shut off automatically when recovery is complete. Wait two minutes and check for pressure rise. If pressure rise occurs, depress "COMPRESSOR START" switch and allow equipment to repeat the recovery.
5. To drain the accumulator of refrigerant oil, open the "ACCUMULATOR PRESSURIZING" valve long enough to allow some compressor discharge pressure back into the accumulator. Open the oil drain valve slowly and drain the accumulator. When the oil stops draining, close the oil drain valve. Do not allow the accumulator to completely depressurize.
6. Although refrigerant can be filtered and recycled at any time, it is recommended to recycle when the tank is full for greatest efficiency. Two tanks are provided so you can fill one, recycle it, and use it for charging systems while filling the second tank.

When the recovery tank is full, the trip switch at the bottom of the weight platform will de-energize the compressor and the "TANK FULL" light will come on. Close both tank valves, remove the tank from the platform, and replace with another refillable tank or recycle the first tank. If the first tank isn't immediately recycled, take precautions to prevent its use in a refrigeration system before it is recycled. Additional tanks are available. See the "Replacement Parts" section of the instruction manual.

Refrigerant Recycling

If any of the recovered refrigerant being recycled is from a system with a hermetic motor burnout, run the recycling system for a minimum of 24 hours. Check the refrigeration oil drained from the accumulator with an acid test kit to determine the acid quantity of the oil.

1. Plug the station into a suitable electric power outlet and turn on the main power switch.
2. Open both valves on the recovery tank.
   - For efficiency recycle full tanks of refrigerant.

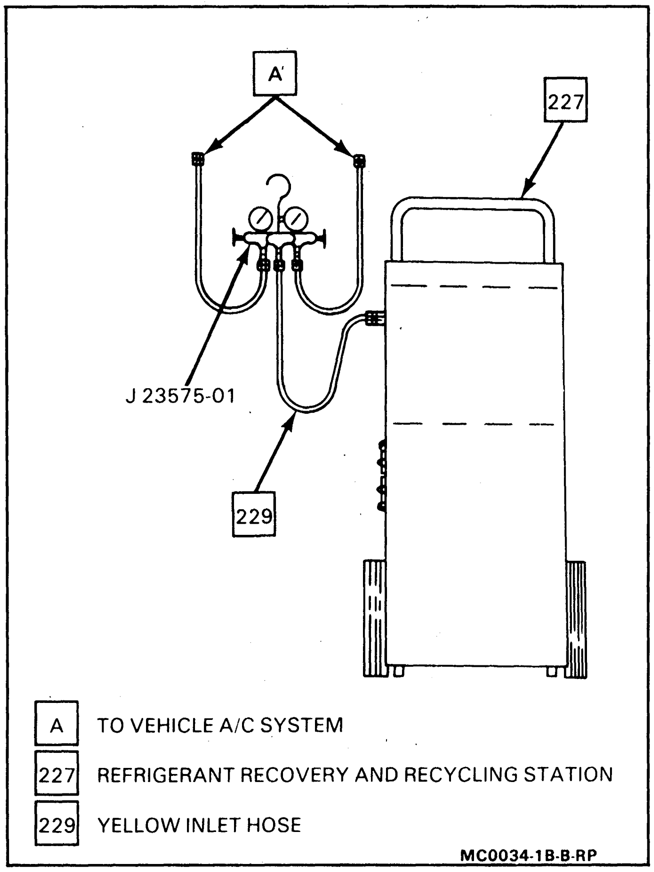


Figure 24 - ACR^3 Hook Up

3. Turn the "RECYCLE START" switch "ON." The amber "RECYCLE ON" light will come on and the refrigerant pump will start.
4. Refrigerant will be seen going through the "MOISTURE INDICATOR" at start up. If there is a sufficient supply of refrigerant, the bubbles will clear after a few seconds. When the bubbles clear from the "MOISTURE INDICATOR," the refrigerant pump is operating at maximum efficiency.
5. Allow the station to operate until the dot in the center of the "MOISTURE INDICATOR" turns green. Always run the recycling system a minimum of 30 minutes. If the "MOISTURE INDICATOR" starts out yellow, it could take as long as two hours to turn green, depending on the moisture content of the refrigerant.
6. Shut off the station when recycling is complete. This is not an automatic function.

Guidelines for replacing the filter drier core:

- For proper contaminant removal, replace the filter drier core after recycling a maximum of 136 kg (300 pounds) of refrigerant.
- If the moisture indicator does not change to green after two hours of filtering time, the filter drier core is saturated with moisture and should be changed.
- If the filter drier core becomes clogged with particulates, the filter monitor needle will register in the red zone; this also means the filter core should be changed.

Operating Hints

1. When using the recovery station in conjunction with a charging station, attach the center port hose of the manifold gage set to the inlet port of the ACR^3 station. Then follow the normal operating procedures for the recovery/recycling station.
2. When using the ACR^3 station in conjunction with an automatic charging station, attach the exhaust hose to the inlet of the ACR^3 station. On automatic A/C service stations, a hole has been added at the rear of the cabinet for convenient access to the exhaust hose. On older style stations, you must open the front doors of the cabinet to reach the exhaust hose. After attaching the exhaust hose to the ACR^3 station, depress the "MAIN POWER" switch on the automatic charging station. Then depress the "EXHAUST" switch. Then follow the normal operating procedures for the ACR^3 station.
3. Air is automatically vented from the recovery tank during recycling. This feature eliminates the need to "purge" hoses before recovering the refrigerant.
4. Operating the engine with the A/C off during recovery may reduce the recovery time by increasing the temperature in the accumulator area.
5. To help prevent the escape of refrigerant to the atmosphere, the ACR^3 can be attached to a "Dial-A-Charge" cylinder top vent port when filling the cylinder.
6. Always check the ACR^3 station for residual oil from the previous recovery. See step 5 of "Refrigerant Recovery," above.

ACR^3 Troubleshooting Guide

Refer to the following diagnosis chart if a problem is encountered with the ACR^3 station.

DIAGNOSIS OF ACR^3 STATION

PROBLEM	POSSIBLE CAUSE	CORRECTION
High Pressure Light Comes "ON" and Compressor Stops	1. Valve at tank is closed.	1. Open valve.
	2. Tank is competely full of refrigerant.	2. Remove and replace tank.
	3. Inaccurate weight	3. Check and adjust weight

PROBLEM	POSSIBLE CAUSE	CORRECTION
	platform calibration.	platform calibration or consult factory.
Compressor Continues Operation after 17 in. Vacuum Has Been Reached	Faulty vacuum switch.	Replace switch.
Compressor Starts But Does Not Run	1. High compressor temperature.	1. Allow compressor to cool down.
	2. Faulty thermal overload.	2. Consult factory.
	3. Faulty compressor.	3. Remove and replace compressor.
	4. Compressor oil quantity low.	4. Fill compressor with fresh oil.
Dot in Center of Moisture Indicator Does Not Change Color	1. Wet filter drier core.	1. Remove and replace filter drier core.
	2. Faulty moisture indicator.	2. Remove and replace moisture indicator.
Compressor Does Not Pull System to the 17 in. Vacuum Level	1. Compressor oil quantity low.	1. Fill compressor with fresh refrigeration oil.
	2. Leak in system.	2. Repair leak.
	3. Faulty compressor.	3. Remove and replace compressor.
Refrigerant Does Not Circulate	1. Liquid valve on tank closed.	1. Open valve.
	2. Vapor valve on tank closed.	2. Open valve.
	3. Pump decoupled.	3. Turn pump off, then restart.
	4. Faulty refrigerant pump.	4. Remove and replace pump.

Discharging, Adding Oil Evacuating and Charging CCOT Systems

Figure 25

Tools required:

- J 38100-B Air Conditioning Refrigerant Recovery and Recycling System
- J 34000-A, J23500-01, J23900-C or
- J 24410-B Charging Station, or J 23575-01 Manifold and Gage Set
- J 26695-B, J 24364-B or J 34119 Vacuum Pump
- J 23390 Control Valve
- J 25498-A Straight Gage Adapter
- J 25499-A 90-degree Angle Gage Adapter
- J 34122-A Flexible Gage Adapter
- J 26934 or J 29547 Leak Detector

CAUTION: A gage line never should be removed from its adapter when the line is connected to the refrigeration system. The line adapter always should be removed from the service fitting to disconnect a line. The charging hose should not be removed from the gage set while attached to the low-pressure side service fitting. This will result in complete discharge of the refrigeration system because of the depressed Schrader valve in the service fitting. The accidental complete discharge may cause personal injury from the escaping Refrigerant-12.

The air conditioning refrigeration system must be discharged by using J 38100-B Air Conditioning Refrigerant Recovery and Recycling System. Refer to "Air Conditioning Refrigerant Recovery and Recycling (ACR^3) Station Setup and Refrigerant Recovery" in this section.

The air conditioning refrigeration system may be evacuated and charged by using an air conditioning service charging station such as J 34000-A, J 23500-01,

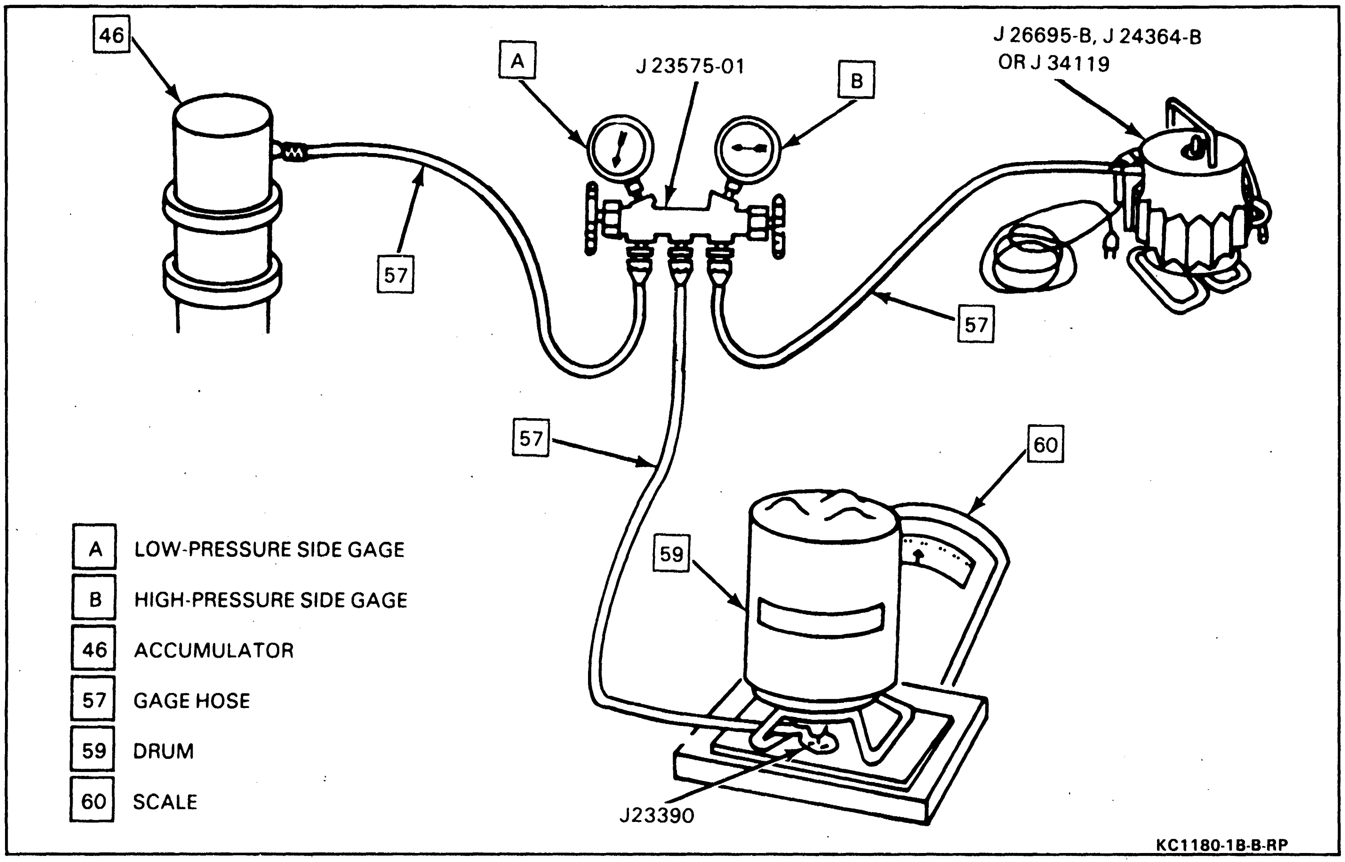


Figure 25 - Charging the System from Refrigerant Drum

J 23900-C or J 24410-B. As an alternative, the manifold and gage set J 23575-01 may be used with a vacuum pump such as J 26695-B, J 24364-B or J 34119, and a reliable scale (60) to charge from either a 13.6-kg (30-pound) drum (59) of refrigerant or a 5.4-kg (12-pound) drum (59) of refrigerant. With the 5.4-kg (12-pound) drum (59), J 23390 is needed to open the drum (59) and control the flow of refrigerant.

Charging lines from the charging station or gage hoses (57) from J 23575-01 require the use of gage adapters to connect to the refrigeration system service fitting. J 25498-A, J 25499-A and J 34122-A are available.

Before removing and replacing any of the air conditioning refrigeration system lines or components, the system must be completely discharged. Refer to "Air Conditioning Refrigerant Recovery and Recycling (ACR^3) Station Setup and Refrigerant Recovery" in this section. The system service valve and J 23575-01 must be used for evacuating and charging the system.

The system should be discharged and the entire evacuating and charging procedure should be done through the low-pressure side service fitting. The high pressure gage hose (57) or any other service line should never be connected to the high-pressure side service fitting during discharging and charging procedures. The system should not be charged while it is hot.

Gage Calibration

Before evacuating or charging the system, the low pressure gage should be checked for proper calibration. With the gage disconnected from the refrigeration system, the pointer should indicate to the center of the zero mark ("0"). The gage should be tapped gently a few times to assure that the pointer is not sticking.

If it is necessary to calibrate the low-pressure gage, the cover should be removed for access to the pointer. With the pointer adjusting screw held still, the pointer should be carefully forced to indicate zero ("0"). After the gage is gently tapped a few times to assure that the pointer is not sticking, the gage cover should be installed.

Vacuum System Check

Before connecting the vacuum pump to the refrigeration system, the low-pressure gage should be connected to the pump and the pump should be run to determine the vacuum capability of the pump. If the pump is unable to produce a vacuum of at least 94.6 kPa (28 inches of Hg), the vacuum system should be checked for leaks. If no leaks are found, the vacuum pump may require repair.

Discharging the Refrigeration System and Recovering Refrigerant

When any refrigeration system component except the pressure cycling switch is replaced, all of the Refrigerant-12 in the refrigeration system must be completely discharged and recovered by using an approved air conditioning refrigerant recovery system. (The pressure cycling switch is mounted on a Schrader valve and may be replaced without discharging the refrigeration system.) The system always must be discharged at the low-pressure side service fitting to control the loss of refrigerant oil. Oil loss will occur if the high-pressure side service fitting is used.

1. With the ignition off, the protective cap should be removed from the low-pressure side service fitting at the accumulator (46).
2. The refrigerant recovery system should be connected, following the equipment manufacturer instructions.
3. With the low-pressure side of the refrigeration system fully discharged, the high-pressure side service fitting in the liquid line near the condenser should be checked for remaining pressure.
4. If refrigerant under pressure remains in the high-pressure side of the system, an attempt should be made to discharge the high-pressure side of the system by using the same procedure as used for the low-pressure side service fitting.
   - This condition indicates a restriction in the high-pressure side of the system.
   - The cause must be diagnosed and corrected before evacuating and charging the system.
5. When the system is completely discharged and the refrigerant stored in the recovery tank, measure, record the amount and discard the refrigerant oil that was collected in the recovery system accumulator.
6. If the measured quantity of oil is 15 ml (0.5 fluid ounces) or more, the same amount of new 525 viscosity refrigerant oil must be added to the system, plus any quantity in the removed parts.
   - This must be done before evacuating the system and charging it with Refrigerant-12.
   - For the specific quantity of oil normally retained in the removed parts, refer to "Refrigerant Oil Distribution" in this section.

Adding Oil

Refrigerant oil must be added after the refrigeration system has been discharged and before it is evacuated. To add oil, the refrigeration system suction hose should be disconnected at the accumulator outlet pipe connection. The correct quantity should be poured into the hose. The hose should then be connected to the pipe. For specific quantity instructions, refer to "Discharging the Refrigeration System and Recovering Refrigerant" and "Refrigerant Oil Distribution" in this section.

Refrigerant Oil Distribution

The refrigeration system requires a total of 180 ml (6 fluid ounces) of 525 viscosity refrigerant oil. New oil quantities must be added to the system during component replacement.

With no signs of excessive oil leakage, oil should be added as follows:

- If the compressor is removed, drain the oil from both the defective compressor and the new replacement compressor. Measure the amount removed from the defective compressor. If the measured amount is less than 30 ml (1 fluid ounce), add 60 ml (2 fluid ounces) to the new replacement compressor. If more than 30 ml (1 fluid ounce) is drained from the defective compressor, add the same amount to the new compressor.
- If the evaporator is removed, 90 ml (3 fluid ounces) of new oil must be added.
- If the condenser is removed, 30 ml (1 fluid ounce) of new oil must be added.
- If the accumulator (46) is to be replaced, 105 ml (3.5 fluid ounces) of oil must be added to replace the oil trapped in the desiccant of the original accumulator (46).

With signs of excessive oil leakage, only the accumulator (46) should be removed. The oil in the accumulator (46) should be drained, measured and recorded. It is not necessary to remove and drain the R-4 compressor because it retains only a minimum quantity of oil. Oil should be added as follows:

- If less than 90 ml (3 fluid ounces) of oil was retained in the accumulator (46), 90 ml (3 fluid ounces) of new oil should be added to the system.
- If more than 90 ml (3 fluid ounces) of oil was retained, an equal amount of new oil should be added.

Refrigerant Oil Loss from an Abrupt Leak

If the refrigerant charge is abruptly lost due to a large refrigerant leak, approximately 90 ml (3 fluid ounces) of refrigerant oil will be suspended in the refrigerant and carried out of the system. Any failure that causes an abrupt refrigerant discharge will result in this oil loss. Failures that allow the refrigerant to seep or bleed off over time do not cause this oil loss.

Upon replacement of a component which caused a large refrigerant leak, add 90 ml (3 fluid ounces) of new 525 viscosity refrigerant oil plus the required amount of oil for the particular component.

Add the oil directly to the replaced component if possible. If the oil cannot easily be added to the replaced part, add the oil to the accumulator (46).

Evacuating and Charging the Refrigeration System

If the refrigeration system has been opened or the Refrigerant-12 charge has been lost, the system must be evacuated before charging. Among the approved methods of evacuating and charging the refrigeration system are the charging station method and the refrigerant drum method. Both methods are covered here. Properly recycled Refrigerant-12 can be used to charge the system.

Charging Station Method

The charging instructions provided with the charging station should be followed with the following exceptions.

- The high-pressure line should not be connected to the refrigeration system.
- The high-pressure valve on the charging station should remain closed at all times.
- The entire evacuating and charging procedure should be done through the accumulator low-pressure side service fitting.

Following these procedures will prevent high-pressure side system pressure from getting to the charging station if an error is made in valve sequence during compressor operation to pull in the Refrigerant-12 charge.

Refrigerant Drum Method

The Refrigerant-12 drum (59) should be placed on a scale (60) and the total weight noted before charging (Figure 25). During charging, the scale (60) should be watched to determine the amount of refrigerant used.

The low-pressure gage of J 23575-01 should be connected to the low-pressure side service fitting at the accumulator. The high-pressure gage should be connected to the vacuum pump. The J 23575-01 center gage hose (57) should be connected to the Refrigerant-12 drum (59). J 23390 must be used to control the flow of refrigerant from the 5.4-kg (12-pound) drum (59). The 13.6-kg (30-pound) drum (59) has its own valve.

To begin evacuating the refrigeration system, the high-pressure side and low-pressure side gage valves should be opened slowly and the vacuum pump should be started. The system should be pumped until the low-pressure side gage reaches a vacuum reading of 94.6-97.9 kPa (28-29 inches of Hg) at sea level. For each 305 m (1,000 feet) above sea level, this specification should be lowered by 3.38 kPa (1 inch of Hg). At 1,525 m (5,000 feet) elevation, a vacuum reading of only 77.7-81.1 kPa (23-24 inches of Hg) is required.

If the specified vacuum cannot be reached, the vacuum control valve should be closed and the pump should be shut off. Then the pump and connections should be checked for a leak.

When the low-pressure side gage reaches the specified vacuum reading, the system is fully evacuated. The high-pressure side gage valve should be closed and the vacuum pump should be shut off.

The low-pressure side gage should be watched to be sure the vacuum holds for five minutes. If vacuum is held for five minutes, the vacuum hose should be disconnected at the high-pressure side gage and charging should begin. If vacuum does not hold for five minutes, the system should be charged with 0.23 kg (0.5 pound) of Refrigerant-12 and a check made for refrigerant leaks. The system should be discharged and the refrigerant recovered before repairing the leak(s). Then the evacuation procedure should be repeated.

Charging

To prepare for charging the refrigeration system, the engine should be started and run until it reaches operating temperature. The air conditioning mode lever should be set to "OFF."

With the engine at operating temperature and the Refrigerant-12 drum (59) inverted, the refrigerant source valve should be opened to allow 0.23 kg (0.5 pound) of liquid Refrigerant-12 to flow into the system through the low-pressure side service fitting.

As soon as this quantity of refrigerant enters the refrigeration system, the compressor should be engaged by setting the air conditioning mode lever to "NORM" and setting the blower speed switch to "HI." This will draw in the remainder of the total refrigerant charge. The total charge is 1.02 kg (2.25 pounds).

Charging can be speeded up by placing a large volume fan in front of the vehicle to pass more air over the condenser. If condenser temperature is maintained below the temperature of the charging drum, Refrigerant-12 will enter the system more rapidly.

When the full charge is added, the Refrigerant-12 source valve should be turned off and the engine allowed to run for 30 seconds to clear the lines and gages.

CAUTION: A gage line never should be removed from its adapter when the line is connected to the refrigeration system. The line adapter from the service fitting always should be removed to disconnect a line. The charging hose at the gage set should not be removed while the hose is attached to the accumulator. Removing the hose will result in complete discharge of the system because of the depressed Schrader valve in the low-side service fitting, and personal injury may result from the escaping Refrigerant-12.

With the engine running, the low-pressure side charging hose adapter should be removed from the accumulator service fitting. It must be unscrewed rapidly to avoid releasing excessive refrigerant from the system.

NOTICE: High-pressure side and low-pressure side service fittings have a black plastic cap and seal that provides the primary refrigerant seal for the fitting. When servicing an air conditioning system, be sure all access fitting caps are installed and tight. If a cap and seal assembly is loose or missing, a significant amount of refrigerant can leak past the valve core. This can cause poor air conditioning performance or failure. To ensure proper sealing, the access fitting cap should be threaded on until contact is made with the O-ring sea, and then tightened another quarter-turn to half-turn.

After replacing the protective cap on the accumulator fitting and turning off the engine, a leak test should be conducted with J 26934 or J 29547. With the refrigeration system fully charged and leak-tested, the air conditioning system functional test should be conducted. Refer to "Functional Test" in this section.

Liquid Line Filter Installation

Figures 26 and 27

An aftermarket liquid line filter (61) is available for air conditioning refrigeration systems that have been contaminated. The liquid line filter (61) eliminates the need for Refrigerant-11 flushing. The filter (61) should be installed after repeated expansion tube plugging or when replacing a seized compressor. The filter installation is intended to replace the former practice of system flushing and/or replacement of the accumulator.

The liquid line filter (61) contains a screen and a filter pad. The screen catches larger particles and retains the filter pad. The filter pad catches the smaller particles and filters the refrigerant oil.

The filter (61) must be installed in the high pressure liquid line (65) between the condenser and evaporator. Two types of filter are available - a filter (61) without an orifice (expansion tube) and a filter with an orifice (expansion tube). The filter (61) without an orifice (expansion tube) is preferred. (The filter with an orifice is used when the filter must be installed in the low-pressure side beyond the original expansion tube in certain other vehicles. It requires removal of the original expansion tube).

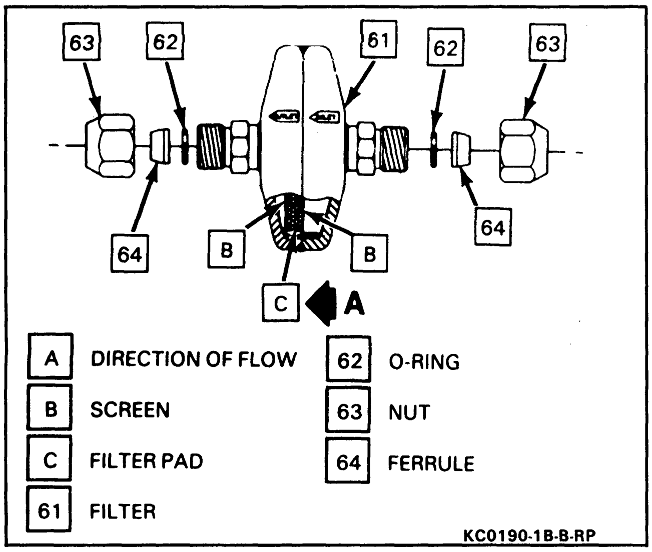


Figure 26 - Liquid Line Filter Without Orifice

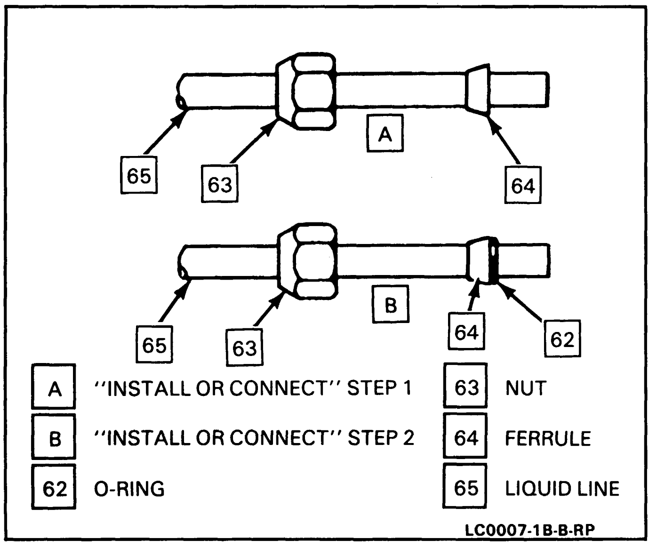


Figure 27 - Filter Ferrule and O-Ring Installed

Remove or Disconnect

1. Refrigerant.
   - Discharge the system and recover the refrigerant. Refer to "Discharging, Adding Oil, Evacuating and Charging CCOT Systems" in this section.
- Select and mark the most convenient location for the filter (61) on the high-pressure liquid line (65) between the condenser and the expansion tube.
2. High pressure liquid line (65).
   - Cap or tape fittings at the evaporator inlet and the condenser.
3. Tubing segment for filter installation.
   - Remove 50.8 mm (2 inches) of tubing at the point selected for filter installation.
     - Cut the end of the tube square with a sharp tubing cutter.
     - Cut out the internal burr, being sure no shavings remain in the two parts of the tube that will be reused.

Install or Connect

NOTICE: See "Notice" on page 1B-1 of this section.

1. Nuts (63) and ferrules (64).
   - Slip the compression nut (63) onto the liquid line (65) at the cut ends of the tube segments.
   - Slip a ferrule (64) onto each cut end of the tube, tapered end toward the nut (63).

     Important

     - Do not install O-rings at this time.
   - Push one tube end into the filter fitting, bottoming it out while tightening the nut (63) to set the ferrule (64). Repeat the procedure with the other tube end.

     Tighten

     - Nuts (63) to 15 N•m (11 lb. ft.).
- Disassemble both joints.
2. O-rings (62).
   - Coat both O-rings (62) with clean 525 viscosity refrigerant oil and slip one O-ring (62) on each tube end until it contacts the ferrule (64).
3. Liquid line tube segments to the filter (61).

   Tighten

   - Nuts (63) to 15 N•m (11 lb. ft.)
4. Liquid line (65) and filter (61).
   - Remove caps or tape from fittings at the condenser and the evaporator inlet.
   - Coat new O-rings with clean 525 viscosity refrigerant oil and install them.
   - Tighten the nuts, holding the fittings stationary with a second wrench.

   Tighten

   - Nut at the condenser fitting to 16 N•m (12 lb. ft.).
   - Nut at the evaporator inlet to 23 N•m (17 lb. ft.).
5. Refrigerant.
   - Evacuate and charge the refrigeration system. Refer to "Discharging, Adding Oil,

Evacuating and Charging CCOT Systems" in this section.

- Leak test the refrigeration system. Refer to "Leak Testing" in this section.

TEMPERATURE CONTROL CABLE ADJUSTMENT

The air conditioning temperature control cable has a self-adjusting sliding clip at the air conditioning module end. To operate the self-adjusting feature, the temperature lever in the control assembly should be moved briskly back and forth from full "COOL" to full "WARM." If the clip requires adjustment, added effort may be required to move the temperature lever through the final part of its travel. When the temperature control cable adjustment is correct, the temperature valve will be heard hitting the stops at both extremes of lever travel.

DRIVE BELT ADJUSTMENT INSPECTION

For drive belt inspection, refer to COOLING AND RADIATOR (SEC. 6B).

REPLACEMENT PROCEDURES

Control Assembly and Vacuum Selector Valve, Blower Switch, Rotary Selector Switch and/or Hot Water Valve, Vacuum Control Valve

Figures 28 and 29

Remove or Disconnect

1. Radio and air conditioning control console trim plate retaining screws (71).
2. Radio and air conditioning control console trim plate (72).
3. Control assembly retaining screws (70).
4. Control assembly (10).
    - Pull the control assembly (10) out far enough to reach the vacuum, electrical and temperature control cable connections.
5. Blower switch connector.
6. Rotary selector switch connector.
7. Control assembly dial lamp wire connector.
8. Vacuum harness connector at the vacuum selector valve (69).
9. Temperature selector control cable.
    - Pull the temperature control cable clip from the control assembly (10).
    - Slip the temperature control cable loop off the lever.
10. Vacuum selector valve (69), if necessary.
    - Remove two retaining screws and remove the vacuum selector valve (69).
11. Blower switch (11), if necessary.
    - Remove the blower switch knob and the retaining clip from the shaft of the blower switch (11).
    - Remove the blower switch (11).
12. Rotary selector switch (68), if necessary.
    - Remove two retaining screws and remove the rotary selector switch (68).
13. Hot water valve vacuum control valve, if necessary.
    - Remove the push nut holding the vacuum control valve to the control assembly (10), then lift the valve off.

Inspect

- Electrical terminal for corrosion. Remove the corrosion or replace the component as necessary.
- Temperature and mode levers for freedom of movement. Lubricate, repair or replace as necessary.
- Temperature control cable for kinks, binding and other damage. Adjust, repair or replace as necessary.

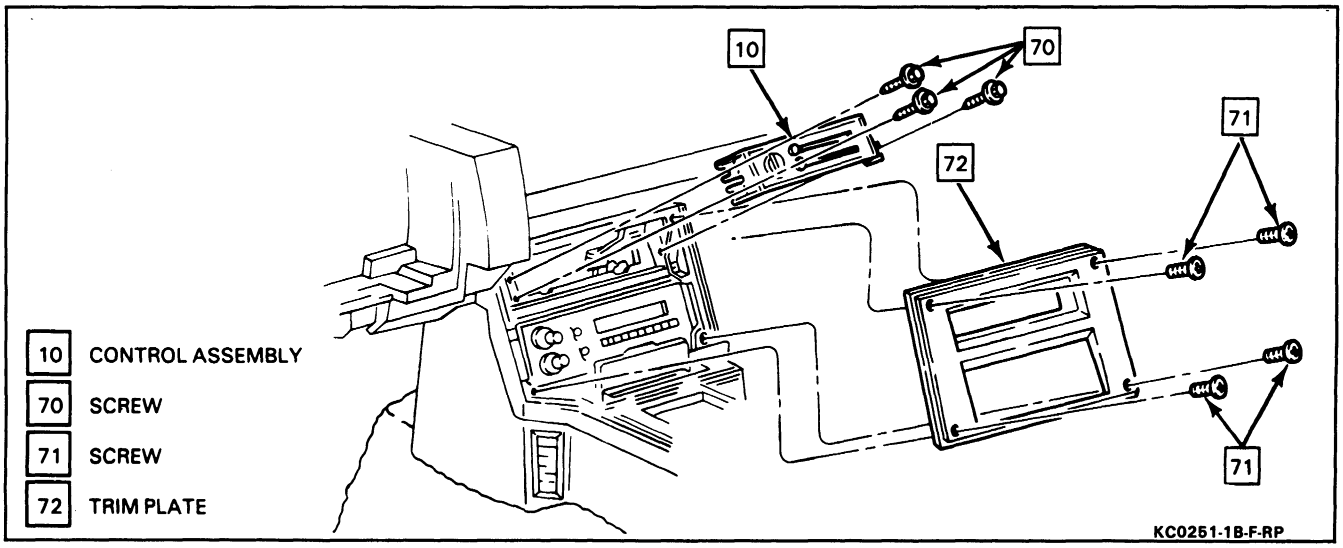


Figure 28 - Control Assembly Removed

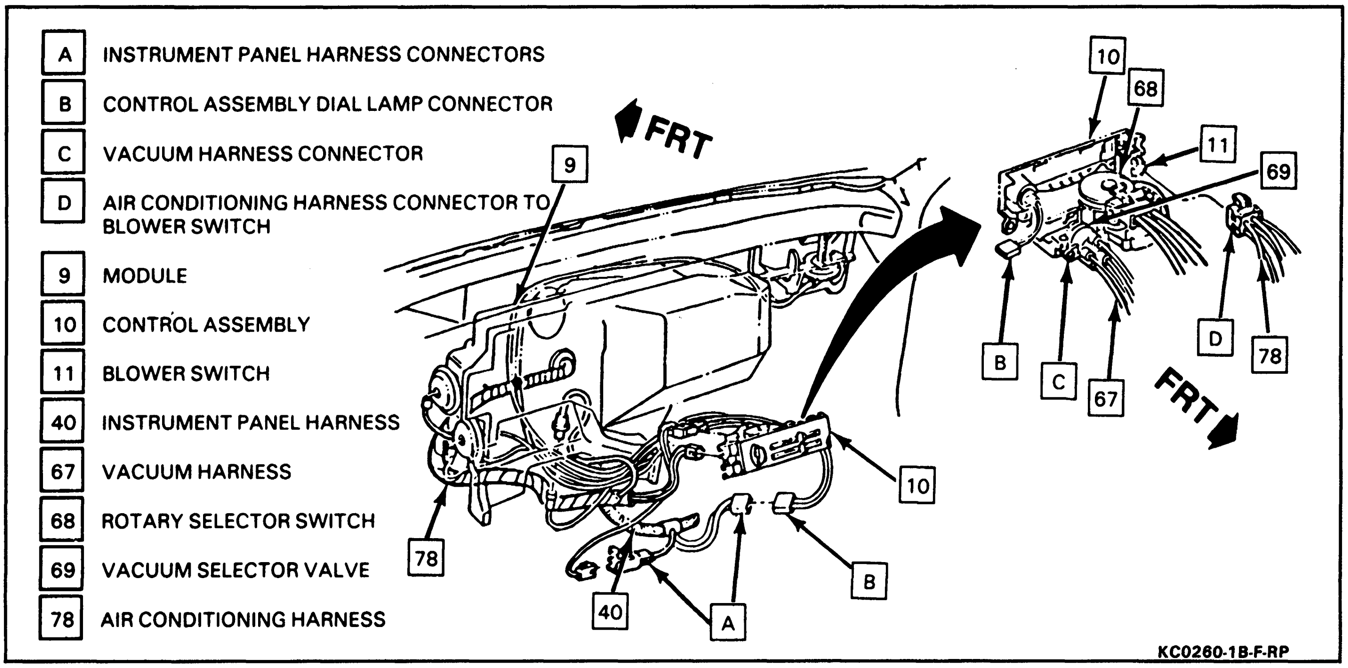


Figure 29 - Control Assembly Components and Connections

Install or Connect

1. Hot water valve vacuum control valve and push nut, if removed.
2. Rotary selector switch (68), shaft retaining clip and blower switch knob, if removed.
3. Vacuum selector valve (69) and retaining screws, if removed.
4. Temperature control cable.
    - Slip the temperature control cable loop into position on the lever arm.
    - Press the temperature control clip into the slot in the control assembly (10).
5. Vacuum harness connector to the vacuum selector valve (69).
6. Control assembly dial lamp wire connector cable clip to the instrument panel harness (40).
7. Rotary selector switch connector.
8. Blower switch connector.
9. Control assembly (10).

NOTICE: See "Notice" on page 1B-1 of this section.

10. Control assembly retaining screws (70).
    - Install the lower right screw (70) first to align the control assembly (10) properly.

Tighten

- Screws (70) to 1.4 N·m (12 lb. in.).

11. Radio and air conditioning control console trim plate (72).

NOTICE: See "Notice" on page 1B-1 of this section.

12. Radio and air conditioning control console trim plate retaining screws (71).

Tighten

- Screws (71) to 1.4 N·m (12 lb. in.).
- Test operation of the temperature lever, the mode lever and the blower switch (11).

Temperature Control Cable

Figures 28 and 30

Remove or Disconnect

1. Right sound insulator. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
2. Temperature control cable (19) at the air conditioning module (9).
    - Remove the push nut retainer (24) holding the cable adjusting clip to the temperature valve lever pin.
    - Disengage the cable clip from the slot in the air conditioning module (9).
3. Radio and air conditioning control console trim plate retaining screws (71).
4. Radio and air conditioning control trim plate (72).
5. Control assembly retaining screws (70).
6. Control assembly (10).
    - Pull the control assembly (10) out far enough to reach the temperature control cable connection.
7. Temperature control cable push nut retainer (24).
8. Temperature control cable (19).
    - Pull the temperature control cable clip from the control assembly (10).
    - Slip the temperature control cable loop off the lever arm.

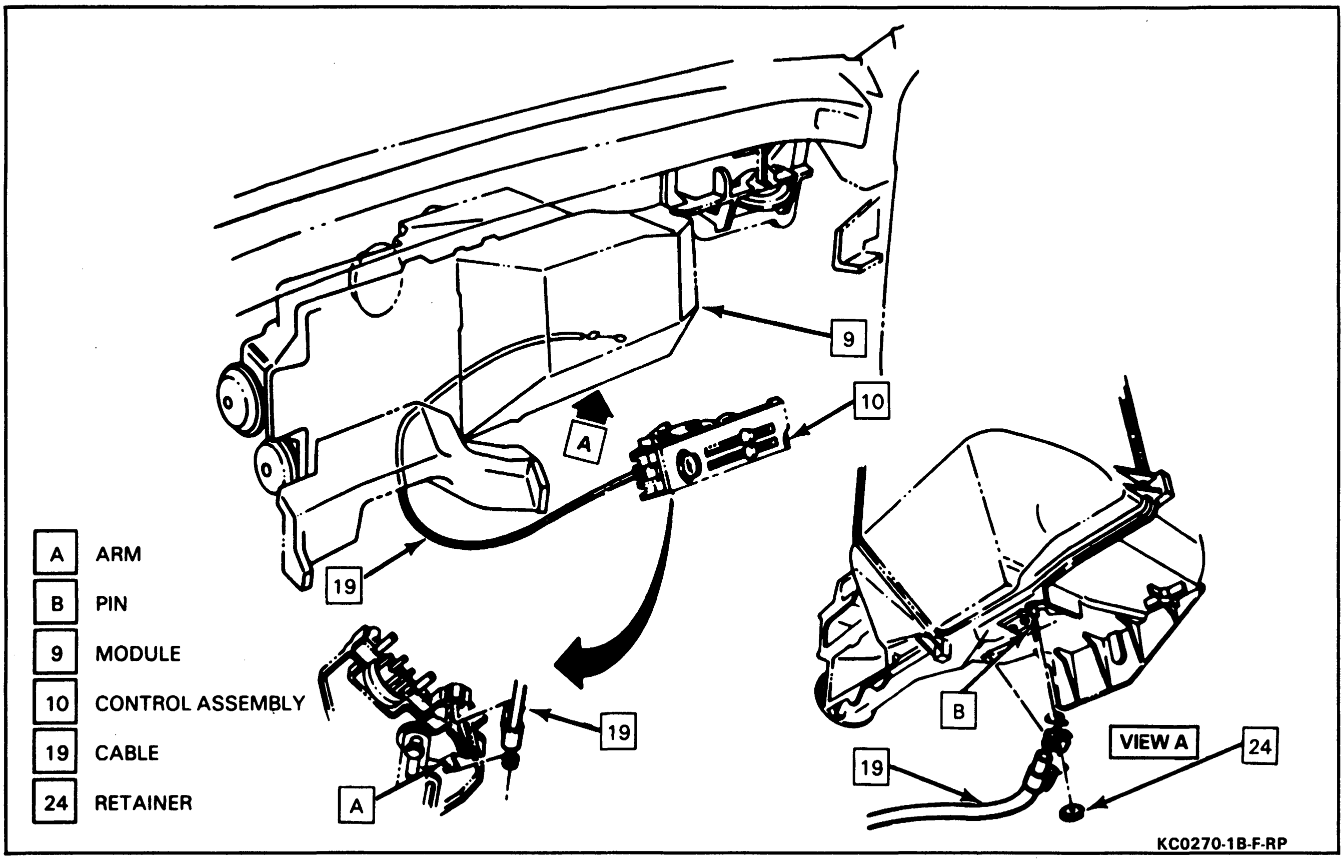


Figure 30 - Temperature Control Cable

Install or Connect

1. Temperature control cable (19) to the control assembly (10).
   - Slip the temperature control cable loop into position over the lever arm.
   - Press the temperature control cable clip into the slot in the control assembly (10).
2. Temperature control cable push nut retainer (24).
3. Control assembly (10).

NOTICE: See "Notice" on page 1B-1 of this section.

4. Control assembly retaining screws (70).
   - Install the lower right screw (70) first to align the control assembly (10) properly.

Tighten

   - Screws (70) to 1.4 N·m (12 lb. in.).
5. Radio and air conditioning console control trim plate (72).
6. Radio and air conditioning console control trim plate retaining screws (71).

Tighten

- Screws (71) to 1.4 N·m (12 lb. in.).
7. Temperature control cable (19) at the air conditioning module (9).
   - Fit the cable self-adjusting clip onto the temperature valve lever pin.
   - Snap the cable clamp into the slot in the air conditioning module (9).
   - Install the push nut retainer (24) to the temperature valve lever pin.
8. Right sound insulator. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).

Adjust

- Temperature control cable. Refer to "Temperature Control Cable Adjustment" in this section.

Blower Motor Resistor Assembly

Figure 31

Remove or Disconnect

- Remove the key from the ignition to assure that the switch will remain "OFF."

1. Air conditioning wiring harness connector at the blower motor resistor assembly (17).
2. Resistor assembly retaining screws (28).
3. Blower motor resistor assembly (17).

Install or Connect

NOTICE: See "Notice" on page 1B-1 of this section.

1. Blower motor resistor assembly (17) and retaining screws (28)

Tighten

- Screws (28) to 1.5 N·m (13 lb. in.).

2. Air conditioning wiring harness connector.

- Test blower motor operation at all four speeds.

Blower Relay

Figure 31

Remove or Disconnect

1. Negative (-) battery cable.
2. Electrical connector at the blower relay (29).
3. Blower relay (29).

- Pull the blower relay (29) off the clip of the mounting bracket.

Install or Connect

1. Blower relay (29).
    - Press the blower relay (29) onto the clip on the mounting bracket.
2. Electrical connector to the blower relay (29).
3. Negative (-) battery cable.

Air Conditioning Cutout Relay

Figure 32

Remove or Disconnect

1. Negative (-) battery cable.
2. Electrical connector at the air conditioning cutout relay (79).
3. Mounting screws (80).
4. Cutout relay (79).

Install or Connect

NOTICE: See "Notice" on page 1B-1 of this section.

1. Air conditioning cutout relay (79) and mounting screws (80).

Tighten

- Screws (80) to 6.8 N·m (60 lb. in.).

2. Electrical connector.
3. Negative (-) battery cable.

Pressure Cycling Switch

Figure 31

Remove or Disconnect

1. Negative (-) battery cable.
2. Electrical connector at the pressure cycling switch (47).
3. Pressure cycling switch (47) and O-ring.
    - The pressure cycling switch (47) is mounted on a Schrader-type valve so it is not necessary to discharge the refrigeration system.
    - Discard the O-ring.

Install or Connect

1. New O-ring to the pressure cycling switch (47).
    - Coat the O-ring with refrigerant oil.

NOTICE: See "Notice" on page 1B-1 of this section.

2. Pressure cycling switch (47).

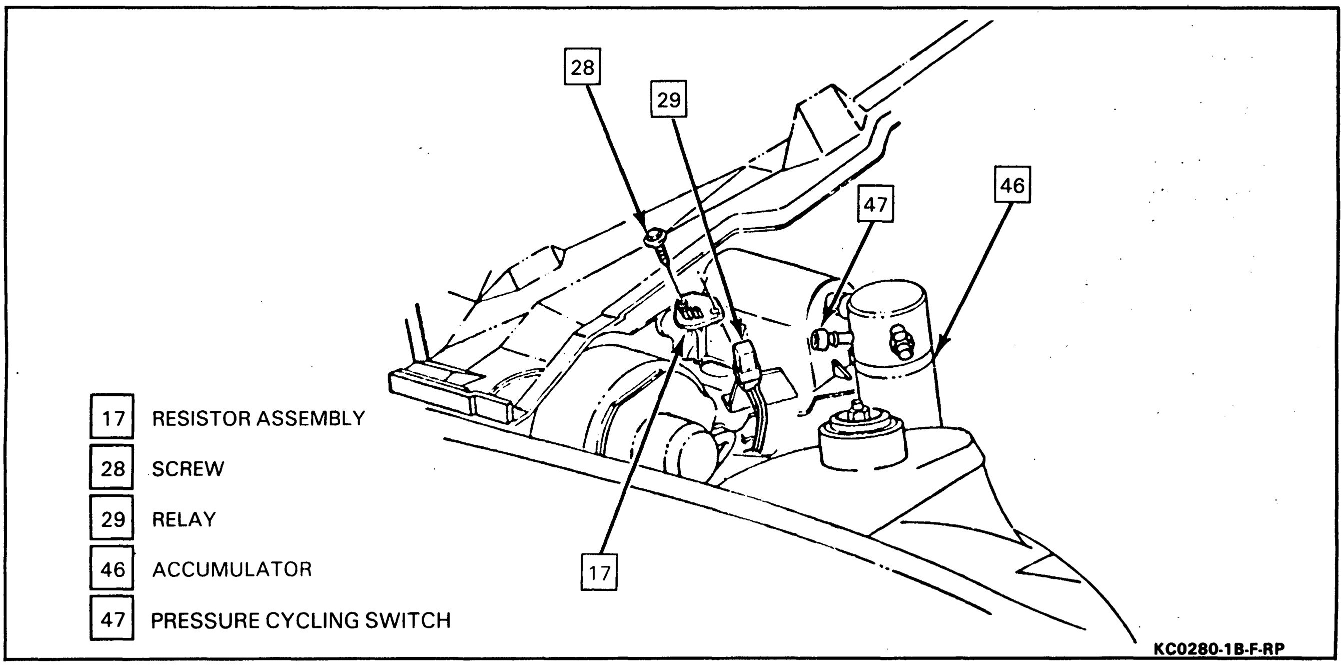


Figure 31 - Air Conditioning Electrical Components

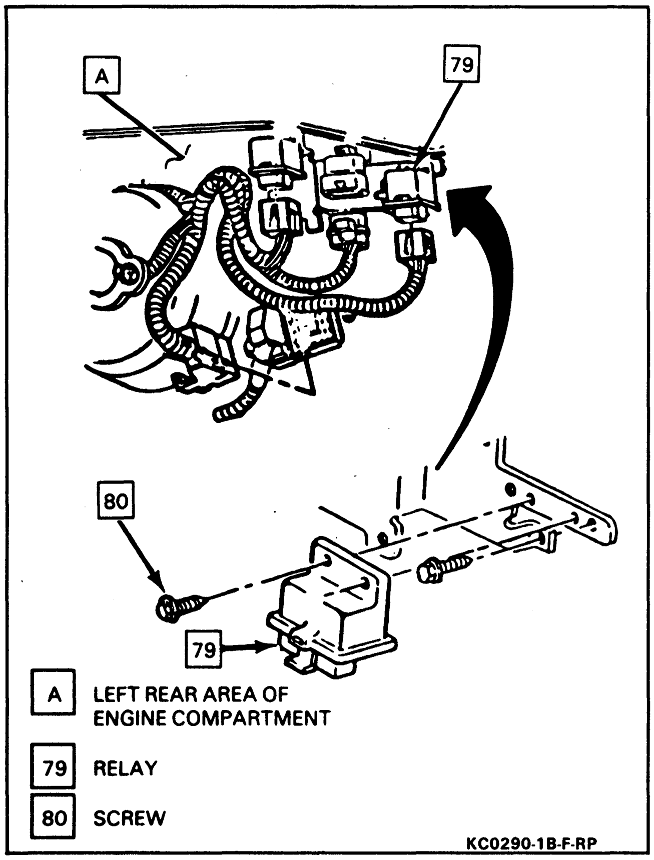


Figure 32 - Air Conditioning Cutout Relay

Tighten

- Pressure cycling switch (47) to 5 N·m (44 lb. in.).

3. Electrical connector to the pressure cycling switch (47).
4. Negative (-) battery cable.

Blower Motor and Fan

Figure 31

Remove or Disconnect

- Remove the key from the ignition switch to assure that the switch will remain "OFF."

1. Diagonal fender brace at the right rear corner of the engine compartment, if necessary.
   - Remove the two bolts and remove the brace.
2. Blower relay (29) and bracket.
   - Remove two screws from the blower bracket and remove the relay (29) and bracket as an assembly.
   - Swing the relay (29) and bracket up and out of the way.
3. Air conditioning wiring harness connectors at the blower motor power and ground terminals.
4. Blower motor cooling tube.
5. Blower motor attaching screws.
6. Blower motor.
   - Pull the blower motor forward carefully to avoid distorting the blower fan.
   - Work the blower motor fan up and out of the engine compartment.
7. Fan, if necessary.

Inspect

- Blower motor terminals for corrosion. Clean corrosion from the terminals or replace the blower motor as necessary.
- Flange of the blower motor for damage or distortion that could cause an air leak. Repair as necessary.
- Blower fan for damage and distortion. Repair or replace as necessary.

Install or Connect

1. Fan to blower motor shaft, if removed.
2. Blower motor.
   - Guide the blower motor and fan into position, being careful not to catch the fan on protruding parts.
3. Blower motor attaching screws.
4. Blower motor cooling tube.
5. Air conditioning wiring harness connectors at the blower motor power and ground terminals.

NOTICE: See "Notice" on page 1B-1 of this section.

6. Blower relay (29) and bracket assembly, and two bracket retaining screws.

Tighten

- Bracket retaining screws to 1.5 N·m (13 lb. in.).

7. Diagonal fender brace and bolts if necessary.

- Check blower operation.

Air Distributor and Instrument Panel Air Outlet Ducts

Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).

Floor Air Outlet Duct

Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).

Side Window Defogger Ducts

Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).

Air Deflectors

An air conditioning system air deflector can be removed by prying on one side of the deflector with a small thin-blade screwdriver to pop it out. The deflector can be installed by pressing it into place.

Vacuum Hose Harness

Figures 7, 29 and 33

Remove or Disconnect

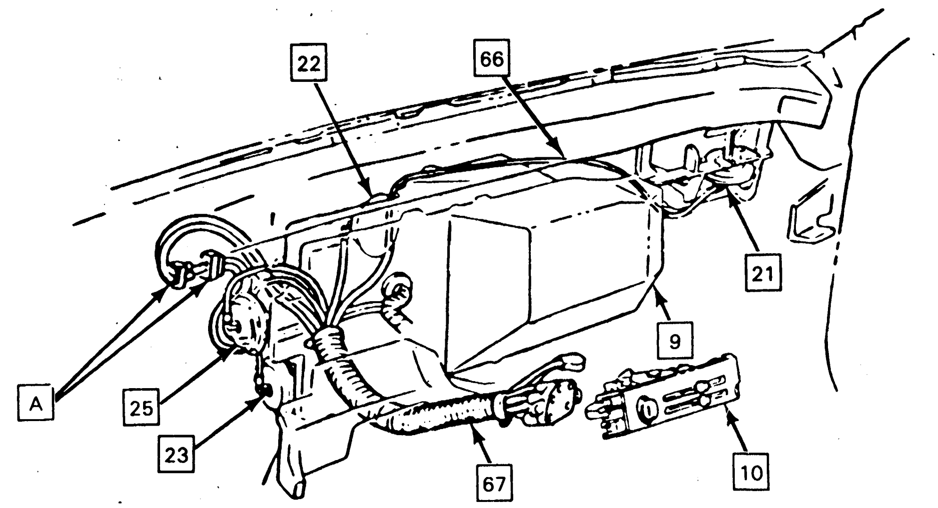
1. Left and right sound insulators. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
2. Control assembly (10). Refer to "Control Assembly and Vacuum Selector Valve, Blower Switch, Rotary Selector Switch and/or Hot Water Valve, Vacuum Control Valve" in this section.
3. Vacuum hose connectors at the vacuum actuators.
    - Trace each vacuum hose to its actuator on the air conditioning module (9), noting its routing for reference during installation.
    - Disconnect the connector at each actuator by sliding the tab of the plastic retainer past the L-shaped bend in the actuator vacuum tube. Then slide the hose connector off the tube while continuing to hold the tab back against the body of the connector.
4. Main harness segment connector from the engine compartment harness segment connector.
5. Main harness segment from the retaining clip (66).
6. Main harness segment.
7. Engine compartment harness segment, if necessary.
    - Disconnect the vacuum hose at the vacuum source.
    - Disconnect the vacuum hose connector at the hot water valve vacuum actuator.
    - Carefully push the vacuum harness grommet through the wiring harness grommet in the dash panel until it is free.
    - Work the engine compartment harness through the hole in the wiring harness grommet until both vacuum hoses are completely inside the passenger compartment.
    - Remove the engine compartment harness segment from the passenger compartment side of the dash panel.

Inspect

- Vacuum hoses for leaks by attempting to blow through the hose while covering the opposite end with a fingertip. Replace any hose that leaks.
- Vacuum switches and connecting hose at the control assembly for leaks and proper function. Replace faulty components.

Install or Connect

1. Engine compartment harness segment, if removed.
    - Guide the hot water valve actuator vacuum hose (gray) and the vacuum supply hose (violet) through the wiring harness grommet.



A	VACUUM HARNESS CONNECTORS, MAIN HARNESS TO ENGINE COMPARTMENT HARNESS
9	MODULE
10	CONTROL ASSEMBLY
21	AIR INLET ACTUATOR
22	UPPER MODE ACTUATOR
23	LOWER MODE ACTUATOR
25	DEFROSTER ACTUATOR
66	CLIP
67	VACUUM HARNESS

KC0300-1B-F-RP

Figure 33 - Vacuum Harness

    - Work both hoses through the wiring harness grommet until the vacuum harness grommet enters the hole in the wiring harness grommet.
    - Continue pressing the vacuum harness grommet in until its flange touches the wiring harness.
  - Connect the gray hose to the hot water valve vacuum actuator.
  - Connect the violet hose to the vacuum source.
2. Main harness segment to the engine compartment harness segment.
3. Vacuum harness (67) to the clip (66) at the top of the air conditioning module.
4. Vacuum hose connectors to the vacuum actuators.
   - To install a vacuum hose connector, bend the retaining tab of the plastic connector back flush against the end of the connector and hold it there while slipping the tab connector onto the vacuum actuator tube. When the connector is fully seated, pull the retaining tab over the L-shaped bend in the tube to hold the hose connector in place.
5. Control assembly (10). Refer to "Control Assembly and Vacuum Selector Valve, Blower Switch, Rotary Selector Switch and/or Hot Water Valve Vacuum Control Valve" in this section.
6. Left and right sound insulators. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).

Vacuum Tank

The vacuum tank that supplies the air conditioning vacuum system is a ball-shaped tank under the evaporator tray by the left front fender.

Remove or Disconnect

- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Left lower fender brace.
2. Vacuum lines.
3. Two mounting screws.
4. Vacuum tank.
   - Do not lose the two spring nuts on the mounting bracket.

Install or Connect

NOTICE: See "Notice" on page 1B-1 of this section.

1. Vacuum tank and mounting screws.

   ### Tighten

   - Screws to 5 N·m (44 lb. in.).
2. Vacuum lines.
3. Left lower fender brace.

- Lower the vehicle.

Defroster Valve and/or Lower Mode Valve Vacuum Actuators

Figure 33

Remove or Disconnect

1. Left sound insulator. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
2. Vacuum hose connector at the defroster actuator (25) and/or the lower mode actuator (23).
   - Disconnect the vacuum hose connector by sliding the tab of the connector past the L-shaped bend in the actuator vacuum tube. Then slide the hose connector off the tube while continuing to hold the tab back against the connector end.
3. Defroster actuator (25) and/or lower mode actuator (23).
   - Remove two nuts.
   - Disconnect the linkage from the actuator.

Install or Connect

1. Defroster actuator (25) and/or lower mode actuator (23), if removed.
   - Connect the linkage to the actuator.
   - Install the two mounting nuts.
2. Vacuum hose(s).
   - Install the blue hose to the defroster actuator (25) and/or the tan hose to the lower mode actuator (23).
   - Connect the vacuum hose connector by bending the tab of the connector back flush against the end of the connector and holding it there while slipping the tab and the connector onto the vacuum actuator tube. When the connector is fully seated, pull the tab over the L-shaped bend in the tube to hold the connector in place.
3. Left sound insulator. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).

Air Inlet Valve Vacuum Actuator

Figure 33

Remove or Disconnect

1. Right sound insulator. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
2. Vacuum hose connector at the air inlet actuator (21).
   - Disconnect the vacuum hose connector by sliding tab of the connector past the L-shaped bend in the actuator vacuum tube. Then slide the hose connector off the tube while continuing to hold the tab back against the connector end.

3. Air inlet actuator (21).
    - Remove two nuts and slide the actuator body from its installed position.
    - Disconnect the linkage from the actuator.

→← Install or Connect

1. Air inlet actuator (21).
    - Connect the linkage to the actuator.
    - Slip the air inlet actuator (21) into position and install the two mounting nuts.
2. Vacuum hose.
    - Install the orange hose to the air inlet actuator (21).
    - Connect the vacuum hose connector by bending the tab of the connector back flush against the end of the connector and holding it there while slipping the tab and connector onto the vacuum actuator tube. When the connector is fully seated, pull the tab over the L-shaped bend in the tube to hold the connector in place.
3. Right sound insulator. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).

Upper Mode Valve Vacuum Actuator

Figure 33

1. Instrument panel. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
2. Vacuum hose connector at the upper mode actuator (22).
    - Disconnect the vacuum hose connector by sliding the tab of the connector past the L-shaped bend in the actuator vacuum tube. Then slide the hose connector off the tube while continuing to hold the tab back against the connector end.
3. Upper mode actuator (22).
    - Remove two nuts.
    - Disconnect the linkage from the actuator.

→← Install or Connect

1. Upper mode actuator (22).
    - Connect the linkage to the actuator.
    - Install the two nuts.
2. Vacuum hose.
    - Install the red hose to the upper mode actuator (22).
    - Connect the vacuum hose connector by bending the tab of the connector back flush against the end of the connector and holding it there while slipping the tab and the connector onto the vacuum actuator tube. When the connector is fully seated, pull the tab over the L-shaped bend in the tube to hold the connector in place.
3. Instrument panel. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).

Hot Water Valve

Figure 34

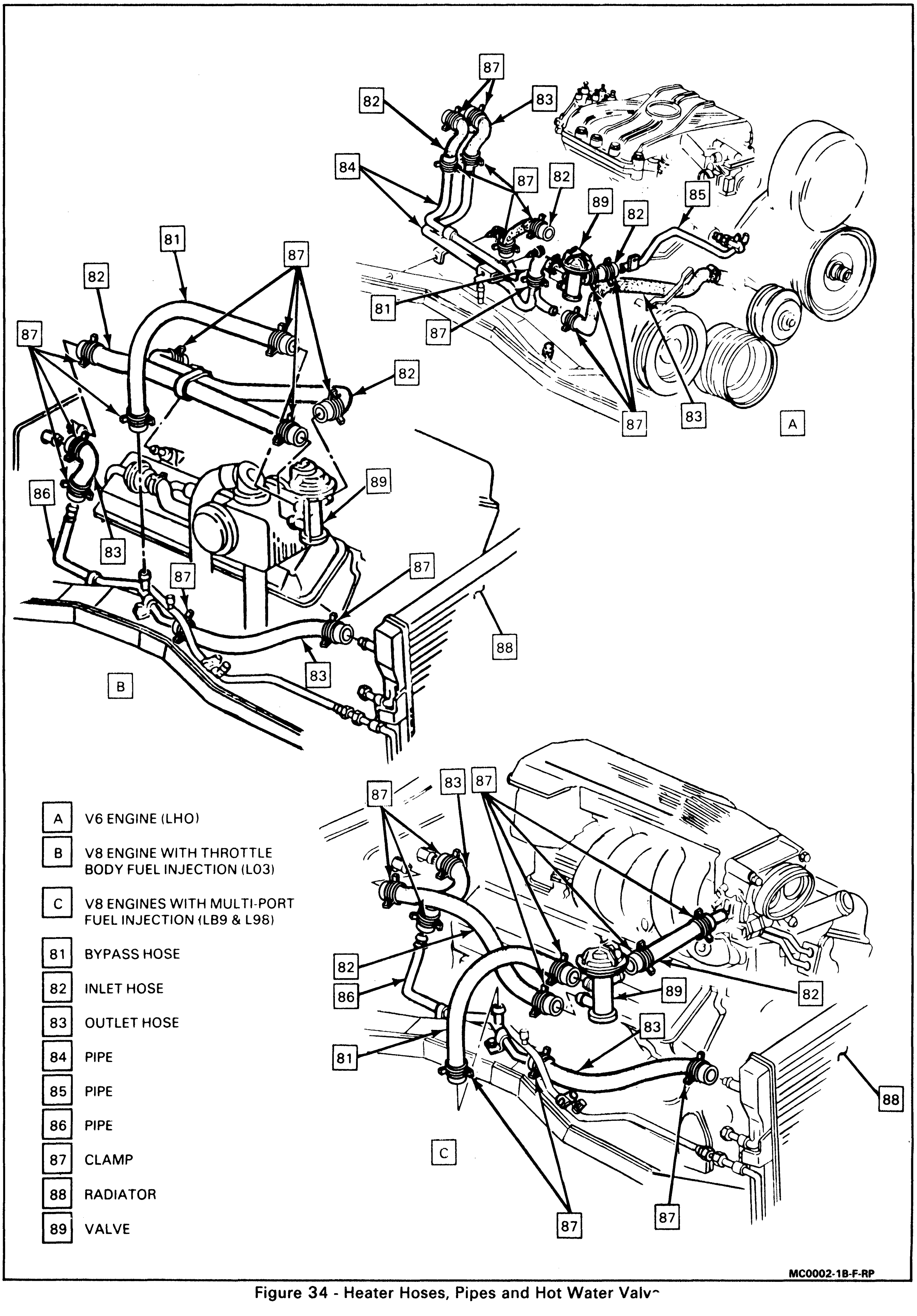
The hot water valve (89) is a bypass valve in the heater inlet hose (82) that directs hot coolant to the heater core when heating is needed or diverts the coolant flow directly to the outlet hose (83), bypassing the heater core when the temperature lever is in the full "COOL" position. The hot water valve is controlled by a vacuum actuator. The vacuum hose is gray.

←→ Remove or Disconnect

1. Coolant.
    - Drain engine coolant into a clean container for reuse.
2. Vacuum hose at the vacuum actuator of the hot water valve (89).
    - Disconnect the vacuum hose connector by sliding the tab of the connector past the L-shaped bend in the actuator vacuum tube. Then slide the hose connector off the tube while continuing to hold the tab back against the connector end.
3. Inlet hose (82), bypass hose (81) and clamps (87) at the hot water valve (89).
4. Hot water valve (89).

→← Install or Connect

1. Inlet hoses (82), bypass hose (81) and clamps (87) to the hot water valve (89).
    - The hot water valve (89) should be installed with the vacuum actuator up. The heater hoses will hold the hot water valve (89) in position.
    - The bypass hose (81) should be connected to the upper fitting, above the fitting for the inlet hose (82) to the heater core.
2. Vacuum hose to the actuator of the hot water valve (89).
    - Bend the hose connector tab back flush against the end of the connector onto the vacuum actuator tube. When the connector is fully seated, pull the tab over the L-shaped bend in the tube to hold the connector in place.
3. Coolant.
    - Reuse the drained coolant if it is clean and in good condition. If not, add fresh 50-50 mixture of coolant and water



A	V6 ENGINE (LHO)
B	V8 ENGINE WITH THROTTLE BODY FUEL INJECTION (L03)
C	V8 ENGINES WITH MULTI-PORT FUEL INJECTION (LB9 & L98)
81	BYPASS HOSE
82	INLET HOSE
83	OUTLET HOSE
84	PIPE
85	PIPE
86	PIPE
87	CLAMP
88	RADIATOR
89	VALVE

Figure 34 - Heater Hoses, Pipes and Hot Water Valv

- Run the engine long enough to purge any trapped air from the system, then add more coolant to the cooling system as necessary.

Heater Hoses and Pipes

Figure 34

The heater core inlet and outlet tubes extend forward from the dash panel next to the air conditioning module. The inlet tube is toward the right side of the vehicle from the outlet tube.

On the 3.1L V6 engine, the heated coolant supply for the heater comes from a fitting just below the thermostat housing. A pipe (85) from the fitting extends across the front of the engine and connects to a very short inlet hose (82) that connects to the hot water valve (89). From the lower inlet fitting of the hot water valve (89), another short inlet hose (82) leads to a pipe (84) mounted on the right side rail in the engine compartment. The rear end of the pipe (84) is connected to another inlet hose (82) that leads to the heater core inlet tube. The fitting on the pipe (85) across the front of the engine has two hose nipples that connect to short inlet and outlet hoses which heat the fuel injection system throttle body air inlet.

On V8 engines, the heated coolant supply for the heater core comes from a fitting at the rear of the intake manifold of the LO3 engine with throttle body fuel injection, or from the right side of the throttle body air inlet of the LB9 and L98 engines. The coolant goes through a heater inlet hose (82) to the hot water valve (89). From the lower outlet fitting of the hot water valve (89), a second heater inlet hose (82) goes to the heater inlet tube.

On all engines, the heater core outlet tube discharges coolant to a short heater outlet hose (83) that is connected to a pipe (84 or 86) mounted on the right side rail in the engine compartment. On the V6 engine, the forward end of the pipe (84) is connected to an outlet hose (83) that crosses in front of the engine and feeds coolant into the engine coolant pump. On V8 engines, the forward end of the pipe (86) on the side rail is connected to an outlet hose (83) that feeds the coolant into the right tank of the radiator (88).

A short bypass hose (81) goes from the upper outlet fitting of the hot water valve (89) to a T-connection in the pipe (84 or 86) on the side rail. All hoses are attached at both ends with a spring tension-type clamp (87).

Remove or Disconnect

1. Engine coolant.
   - Drain enough engine coolant into a clean container to lower the coolant level below the level of the lowest heater hose fitting.

   NOTICE: The heater core can be damaged if excessive force is applied to the heater core pipes during hose removal.

2. Inlet hose (82) or outlet hose (83).
   - Squeeze the clamp ends and slide the clamps (87) away from the fittings and beyond the end of the fitting, pipe (84, 85 or 86) or tube.
   - Remove the hose end by twisting and pulling. If the inlet hose (82) or the outlet hose (83) will not come off of the heater core inlet tube or outlet tube easily with this method, cut off the hose forward of the heater core tube. Then cut the inlet hose (82) or outlet hose (83) remaining on the core tube lengthwise and remove it.
   - Remove and discard the hose clamps (87) if the inlet hose (82) or outlet hose (83) are to be reused.
3. Pipe (84 or 86) from side rail, if necessary.
   - Remove the retaining screws from the pipe retainer and remove the pipe (84 or 86) and retainer as an assembly.
4. Front pipe (85) (V6 engine), if necessary.
   - Disconnect the two throttle body heater hoses at the front pipe connector.
   - Disconnect the front pipe connector and discard the O-ring.
   - Remove the pipe attaching screw at the rear of the generator bracket and remove the pipe (85).

Install or Connect

NOTICE: See "Notice" on page 1B-1 of this section.

1. Front pipe (85) to the V6 engine, if removed.
   - Loosely install the pipe attaching screw holding the pipe to the rear of the generator bracket.
   - Using a new O-ring, loosely install the pipe connector to the fitting in the lower inlet manifold.

   #### Tighten

     - Pipe connector nut to 23 N·m (17 lb. ft.) while holding the fitting with a second wrench.
     - Pipe attaching screw to 10 N·m (89 lb. in).
   - Connect the two throttle body heater hoses to the nipples on the pipe connector.
2. Pipe (84 or 86) to the side rail, if removed.
   - Loosely install the pipe (84 or 86) with the retaining screws.
     - Screws to 1.4 N·m (12 lb. in.).
3. Heater hose.
   - Cut the replacement hose to the same length as the original hose, if necessary.
   - Apply rubber lubricant to the inside diameter of the hose, if desired.
   - Squeeze the clamp ends and slip a new hose clamp over one end of the heater hose. Push the hose onto the pipe (84, 85 or 86) or fitting with a twisting motion. The hose end should be 1.0 mm (0.04 inch) away from touching the nearest surface (dash panel, fitting hex head, etc.).

- Squeeze the clamp ends and install the clamp (87) beyond any bead around the pipe (84, 85, or 86) or fitting, but not closer than 3.0 mm (0.12 inch) to the nearest surface (dash panel, fitting head, etc.).
- Repeat the hose and clamp installation procedure at the other end of the hose.

4. Engine coolant.
   - Use the coolant drained earlier only if it is uncontaminated. Discard contaminated coolant and add fresh 50/50 coolant and water mixture.

Inspect

- Be sure the installed hose does not sag or rub against other components. Adjust or support the hose as necessary to correct the hose position.
- Operate the engine and check the hose installation for leaks. Tighten the hose clamp screw a bit at a time if necessary to stop a leak.
- Check the coolant level after the engine has been warmed up and cooled. Add coolant as necessary.

Heater Core

Figures 34 and 35

Remove or Disconnect

1. Engine coolant.
   - Drain engine coolant into a clean container to lower the coolant level below the level of the lowest heater hose connection at the engine.

NOTICE: The heater core can be damaged if too much force is applied to the heater core pipes during hose removal.

2. Heater inlet hose (82) and outlet hose (83) at the heater core tubes.
   - Squeeze the clamp ends and slide the clamps (87) beyond the end of the heater core tubes.
   - Remove the hoses by twisting and pulling. If a hose will not come off the heater core tube easily with this method, and if it is possible that the heater core may be repairable, cut off the hose forward of the heater core tube. Then cut the hose remaining on the core tube lengthwise to remove it.
   - Remove and discard the hose clamps (87) if the inlet hose (82) or outlet hose (83) are to be reused.
3. Instrument panel. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
4. Console. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
5. Screws (42) from the top, bottom and right side flanges of the rear case (77).
6. Rear case (77) from the air conditioning module (9).
7. Core shroud screws (41).
8. Core shroud (76), heater (8) and heater mounting strap (74) as an assembly.
9. Heater mounting strap (74).

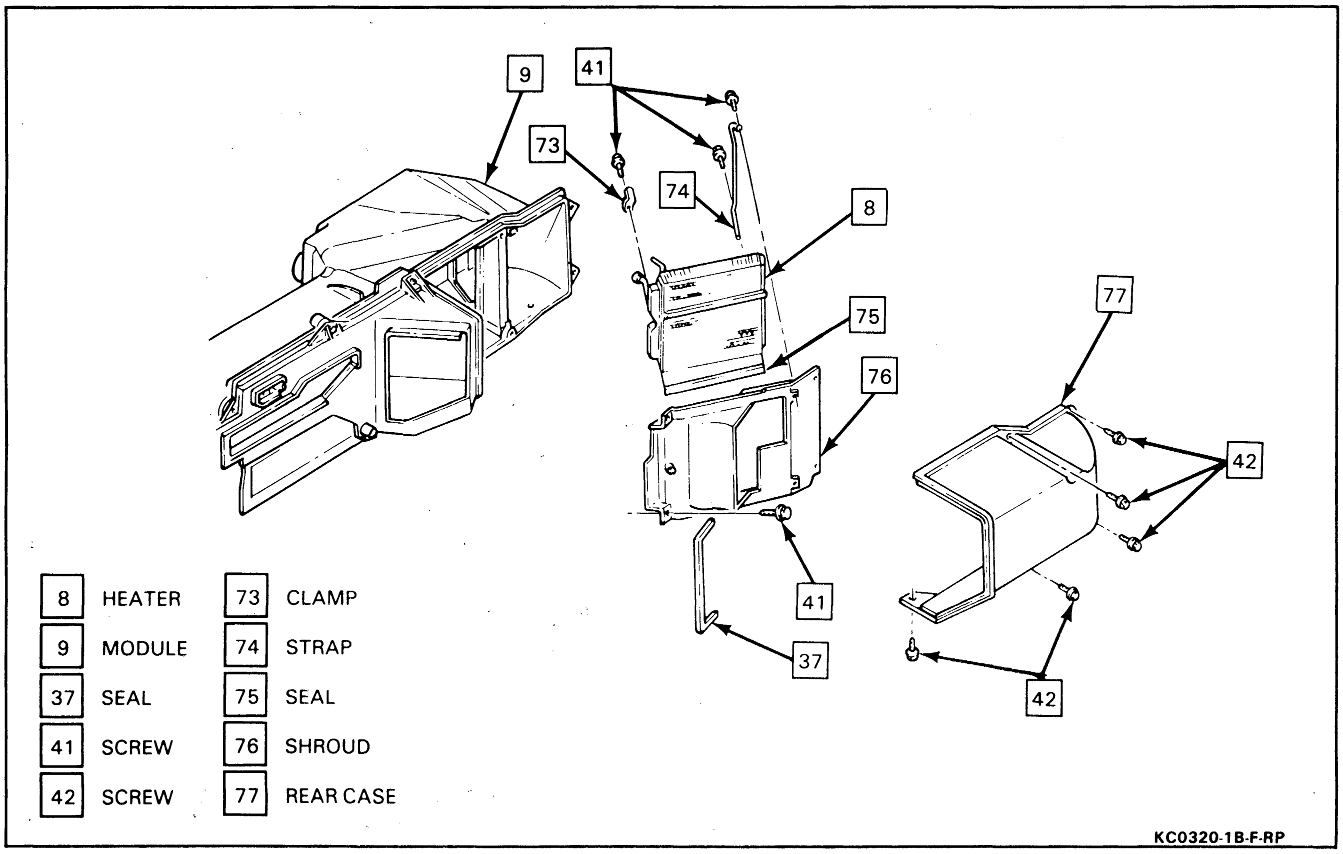


Figure 35 - Heater Core Removed

10. Heater (8) from the core shroud (76).
11. Shroud seal (37) from the shroud (76).

Install or Connect

1. Heater (8) and heater mounting strap (74) to the core shroud (76).
2. Shroud seal (37) to the shroud (76).
3. Heater (8), heater mounting strap (74) and core shroud (76) as an assembly to the interior of the air conditioning module (9).
   - Carefully guide both heater core tubes into position at the holes in the dash panel.
4. Core shroud screws (41).
5. Rear case (77) to the air conditioning module (9).
   - Replace the original rear case flange sealer with fresh sealer.
6. Rear case flange mounting screws (42).
7. Console. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
8. Instrument panel. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
9. Heater inlet hose (82) and outlet hose (83) to the heater core tubes.
   - Apply rubber lubricant to the inside of the hoses, if desired.
   - Squeeze the clamp ends and slip a new hose clamp (87) over the end of each hose. Push the hose onto the heater core tube with a twisting motion. The hose end should be 1.0 mm (0.04 inch) away from the surface of the dash panel.
   - Squeeze the clamp ends and install the clamp (87) beyond the bead on the end of the heater core tube, but not closer than 3.0 mm (0.12 inch) to the surface of the dash panel.
10. Engine coolant.
    - Use the coolant drained earlier only if it is uncontaminated. Discard contaminated coolant and add fresh 50/50 coolant and water mixture.
    - Operate the engine and check for leaks at the heater core tubes. Tighten the hose clamp screw a bit at a time as necessary to stop a leak.
    - Check the coolant level after the engine has been warmed up. Add coolant as necessary.

Schrader Valve Core

Remove or Disconnect

Tool Required:

J 22132-02 Access Valve Core Remover and Installer

1. Refrigerant.
   - Discharge the system and recover the refrigerant. Refer to "Discharging, Adding Oil, Evacuating and Charging CCOT Systems" in this section.
2. Pressure cycling switch or valve cap, if equipped.
3. Valve core.
   - J 22132-02 may be used to remove the valve core.
   - Discard the valve core.

Install or Connect

1. New valve core.
   - J 22132-02 may be used to install the valve core.
   - Do not overtighten the valve core.

NOTICE: See "Notice" on page 1B-1 of this section.

2. Pressure cycling switch or valve cap, if removed.
   - Coat a new O-ring with refrigerant oil and install it to the pressure cycling switch.

   Tighten

   - Pressure cycling switch to 5 N·m (44 lb. in.).
3. Refrigerant.
   - Evacuate and charge the system. Refer to "Discharging, Adding Oil, Evacuating and Charging CCOT Systems" in this section.

Refrigerant Hose

Remove or Disconnect

1. Refrigerant.
   - Discharge the system and recover the refrigerant. Refer to "Discharging, Adding Oil, Evacuating and Charging CCOT Systems" in this section.
2. Refrigerant hose.
   - Seal all system openings with tape or approved plastic caps to prevent dirt and moisture contamination.
   - Discard fitting O-rings.

Install or Connect

1. New O-rings.
   - Coat the O-rings with refrigerant oil just before installation.

NOTICE: See "Notice" on page 1B-1 of this section.

2. Refrigerant hose.

   Tighten

   - Fittings to specifications. Refer to "Specifications" at the end of this section.
3. Refrigerant.

- Partially charge the system and perform a leak test. Refer to "Leak Testing" in this section.
- Recover the refrigerant, and evacuate and charge the system. Refer to "Discharging, Adding Oil, Evacuating and Charging CCOT Systems" in this section.

Condenser

Figure 36

Remove or Disconnect

1. Refrigerant.
   - Discharge the system and recover the refrigerant. Refer to "Discharging, Adding Oil, Evacuating and Charging CCOT Systems" in this section.
2. Radiator shroud.
   - Remove the air cleaner and/or air intake duct work as necessary.
   - Remove the radiator shroud retaining screws, disconnect the fan electrical connections and lift off the shroud and fan assembly.
3. Refrigerant lines at the condenser (51).
   - Seal all refrigeration system openings, including the connectors on the condenser (51), with tape or approved plastic caps to prevent dirt or moisture contamination.
4. Screws (136) at the retainers (137) near both ends of the top of the condenser.
5. Condenser (51).
   - Move the radiator rearward.
   - Tilt the condenser (51) rearward, then lift it up and out of the radiator support (134).
6. Insulators (133 and 139), if necessary.

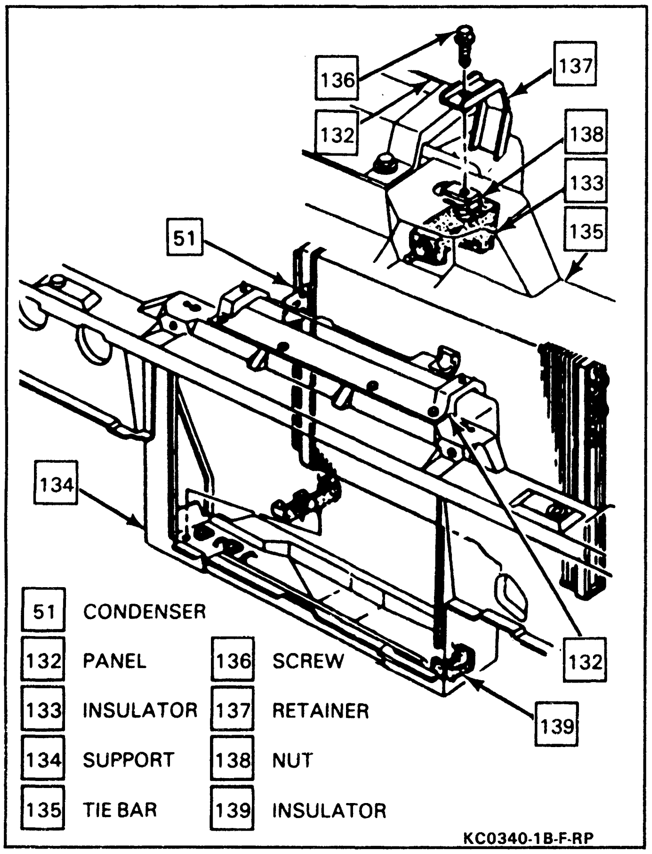


Figure 36 - Condenser Removed

Inspect

- Condenser (51) for leaks, damaged fins, faulty connections and other damage. Repair or replace as necessary.

Assemble

- Transfer brackets and mounting parts to the new condenser if replacement is necessary.

Install or Connect

NOTICE: See "Notice" on page 1B-1 of this section.

1. Refrigerant oil, if necessary.
   - If the condenser (51) is drained, add 30 ml (1 fluid ounce) of fresh 525 viscosity refrigerant oil to the condenser (51).
2. Insulators (133 and 139), if removed.
3. Condenser (51).
   - Fit the lower edge of the condenser (51) into the insulators (139) at the bottom of the radiator support (134).
4. Condenser retaining screws (136), retainers (137) and nuts (138).

Tighten

- Screws (136) to 10 N·m (89 lb. in.).

5. Refrigerant lines at the condenser (51).
   - Use new O-rings at both connections. Coat the O-rings with fresh refrigerant oil before installation.

Tighten

- Fittings to specifications. Refer to "Specifications" at the end of this section.

6. Radiator shroud and fan assembly.
   - Install the retaining screws to the shroud.
   - Connect the fan electrical connections.
   - Install the air cleaner and/or air inlet duct work, if removed.
7. Refrigerant.
   - Partially charge the system and perform a leak test. Refer to "Leak Testing" in this section.
   - Recover the refrigerant, and evacuate and charge the system. Refer to "Discharging, Adding Oil, Evacuating and Charging CCOT Systems" in this section.

Expansion Tube

Figures 13 and 37

Remove or Disconnect

Tool Required:

J 26549-D Expansion Tube Remover

1. Refrigerant.
   - Discharge the system and recover the refrigerant. Refer to "Discharging, Adding Oil, Evacuating and Charging CCOT Systems" in this section.
2. Connector at the liquid line (65) to the evaporator inlet pipe.
   - Seal the open end of the liquid line (65) with tape or an approved plastic cap to prevent dirt or moisture contamination.
   - Discard the O-ring (53).
3. Expansion tube (52) with J 26549-D.
   - If the expansion tube (52) is restricted or plugged so it is difficult to remove, the following procedure is recommended.
     - Remove as much of the residue as possible.
     - Carefully apply heat with a heat gun such as a hair dryer or an epoxy dryer, approximately 6 mm (0.25-inch) from the dimples on the evaporator inlet pipe. Do not overheat the pipe.
     - While applying heat, grip the expansion tube (52) with J 26549-D and use a twisting push-pull motion to loosen the impacted expansion tube (52) and remove it.

- Seal the open end of the evaporator inlet pipe with tape or an approved plastic cap to prevent dirt or moisture contamination.

Clean

- Evaporator inlet pipe interior.
- Expansion tube (52).
  - Blow off any metal particles and other contaminants with an air hose.
  - Clean the expansion tube (52) in solvent and dry it.

Inspect

- Expansion tube (52).
  - Discard if the plastic frame is broken.
  - Discard if the filter screen is torn, damaged or plugged with fine gritty material.
  - Discard if the brass orifice tube is damaged or plugged.

Install or Connect

1. Expansion tube (52) and O-ring (53).
   - Coat a new O-ring (56) with refrigerant oil and fit it onto the expansion tube (52) until it stops, indicating proper O-ring seating.
   - Insert the expansion tube (52) into the evaporator inlet pipe with the smaller screen end first. Install the expansion tube (52) until it stops, indicating proper O-ring seating.

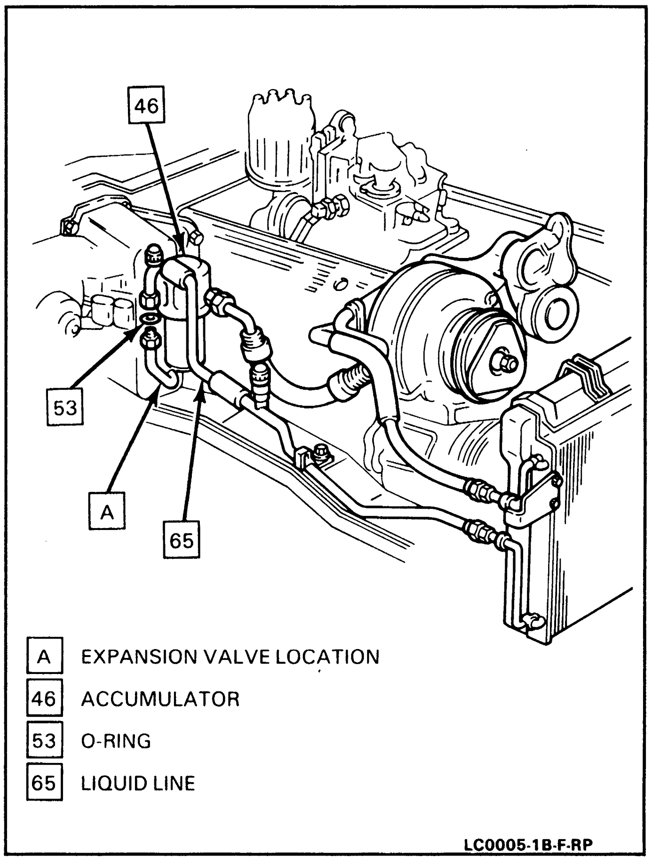


Figure 37 - Accumulator and Expansion Valve

NOTICE: See "Notice" on page 1B-1 of this section.

2. Liquid line (65) and O-ring (53) to the evaporator inlet pipe.
   - Coat the new O-ring (53) with refrigerant oil to aid installation.

Tighten

- Connector to specifications. Refer to "Specifications" at the end of this section.

3. Refrigerant.
   - Evacuate and charge the system. Refer to "Discharging, Adding Oil, Evacuating and Charging CCOT Systems" in this section.

- Test system performance. Refer to "Testing Air Conditioning Performance" in this section.

Accumulator

Figure 37

The accumulator (46) should be replaced only if it is leaking from a perforation, damaged O-ring seat or damaged threads. It is not necessary to replace the accumulator (46) if the vehicle has been involved in a collision but no perforation of the outer shell is discovered, even if the outer shell is dented. The accumulator (46) should be replaced only when it is punctured and leaking, or if the refrigeration system has been left open to the outside air for an extended period of time, saturating the desiccant. Desiccant cannot be replaced separately; the complete accumulator (46) must be replaced if the original desiccant becomes saturated.

The service replacement accumulator package includes two new O-rings (53) for the inlet and outlet connections.

Remove or Disconnect

1. Refrigerant.
   - Discharge the system and recover the refrigerant. Refer to "Discharging, Adding Oil, Evacuating and Charging CCOT Systems" in this section.
2. Pressure cycling switch. Refer to "Pressure Cycling Switch" in this section.
3. Accumulator (46).
   - Disconnect the connections at the accumulator inlet and outlet pipes, and seal the open connections in the system with tape or approved plastic caps to prevent system contamination.
   - Loosen the accumulator clamp and remove the accumulator (46).

Install or Connect

1. Refrigerant oil.
   - Drain, measure and record the amount of oil remaining in the original accumulator (46). Add the same amount of fresh 525 viscosity refrigerant oil to the replacement accumulator (46) plus an additional 60 ml (2 fluid ounces) to replace that lost with the desiccant in the original accumulator (46). Refer to "Discharging, Adding Oil, Evacuating and Charging CCOT Systems" in this section.
2. Accumulator (46).
   - Coat with clean refrigerant oil the two new O-rings (53) provided with the service replacement accumulator (46).
   - Position the accumulator (46) in the accumulator clamp and tighten the clamp.
   - Fit the O-rings (53) on the male fittings and install the connectors at the accumulator inlet and outlet pipes.

   #### Tighten

   - Fittings to specifications. Refer to "Specifications" at the end of this section.
3. Pressure cycling switch. Refer to "Pressure Cycling Switch" in this section.
4. Refrigerant.

- Evacuate and charge the system. Refer to "Discharging, Adding Oil, Evacuating and Charging CCOT System" in this section.

Evaporator Core

Figure 38

Remove or Disconnect

1. Accumulator. Refer to "Accumulator" in this section.
2. Blower motor resistor assembly. Refer to "Blower Motor Resistor Assembly" in this section.
3. Blower relay and bracket.
   - Remove two screws from the blower relay bracket and remove the relay and bracket as an assembly.
   - Swing the relay and bracket up and out of the way.
4. Upper evaporator case screws (90).
5. Upper evaporator case (91) and seal (92).
6. Refrigerant line from the lower fitting of the evaporator (7).
   - Seal the open end of the refrigerant line with tape or an approved plastic cap to prevent system damage.
7. Evaporator (7) and seal (93).
8. Expansion tube and O-ring from the lower fitting of the evaporator, if necessary.

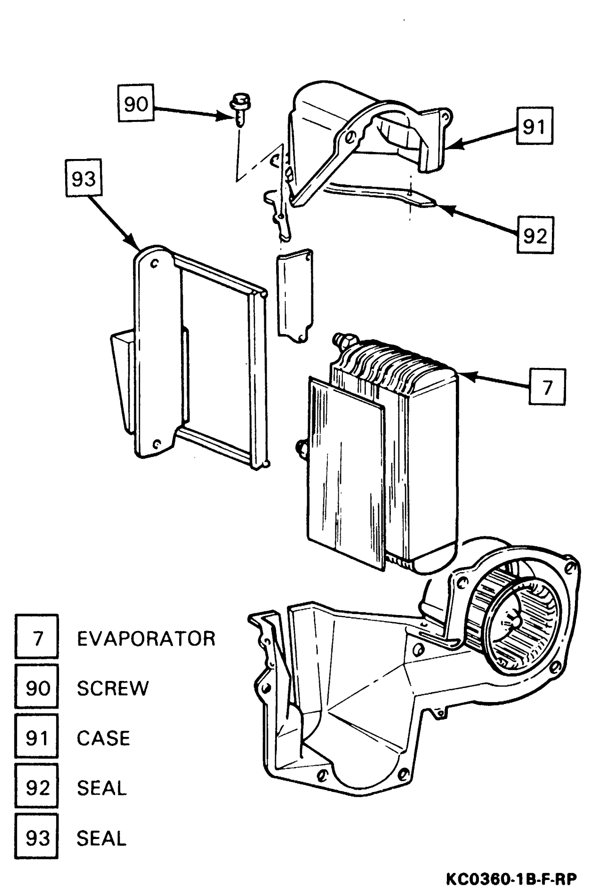


Figure 38 - Evaporator Removed

Install or Connect

NOTICE: See "Notice" on page 1B-1 of this section.

1. Evaporator (7) and seal (93).
2. Expansion tube and new O-ring, if removed.
    - Coat the O-ring with clean refrigerant oil before installation.
3. Refrigerant line to the lower fitting of the evaporator (7).

Tighten

- Refrigerant line connector to specifications. Refer to "Specifications" at the end of this section.

4. Upper evaporator case (91) and seal (92).
5. Upper evaporator case screws (90).
6. Blower relay and bracket assembly and two bracket retaining screws.

Tighten

- Bracket retaining screws to 1.5 N·m (13 lb. in.).

7. Blower motor resistor assembly. Refer to "Blower Motor Resistor Assembly" in this section.
8. Accumulator. Refer to "Accumulator" in this section.

- Test system performance. Refer to "Testing Air Conditioning Performance" in this section.

Compressor Pulley Plate and Hub

Figures 39 through 43

Tools Required:

J 33027 Compressor Clutch Hub Holding Tool

J 9399 Thin Wall Socket

J 33013-B Clutch Plate and Hub Remover

J 9480-B Clutch Plate and Hub Installer

Remove or Disconnect

- Radiator upper fan shroud, if necessary.
- Loosen the tensioner and disconnect the drive belt.

1. Compressor shaft nut (122).
    - Hold the compressor clutch drive (124) steady with J 33027 and remove and discard the shaft nut (122) with J 9399 (Figure 40).
2. Clutch drive (124).
    - Thread J 33013-B into the hub of the clutch drive (124).
    - Holding the body of J 33013-B with a wrench, turn the center screw into the tool body to remove the clutch drive (124) (Figure 41).
3. Shaft key (123) from the clutch drive (124).

Clean

- Frictional surfaces of the clutch drive (124) and pulley rotor (126).

Install or Connect

1. Shaft key (123).
    - The shaft key (123) should project approximately 4.8 mm (0.19 inch) out of the keyway.

NOTICE: To avoid internal damage to the compressor, do not drive or pound on the clutch drive or shaft.

2. Clutch drive (124).
    - Align the shaft key (123) with the shaft keyway and place the clutch drive (124) onto the compressor shaft (Figure 42).
    - Install J 9480-B. Hold the hex portion of the tool with a wrench and tighten the center screw to press the hub of the clutch drive (124) onto the shaft until there is an air gap of 0.5-1.0 mm (0.02-0.04 inch) between the

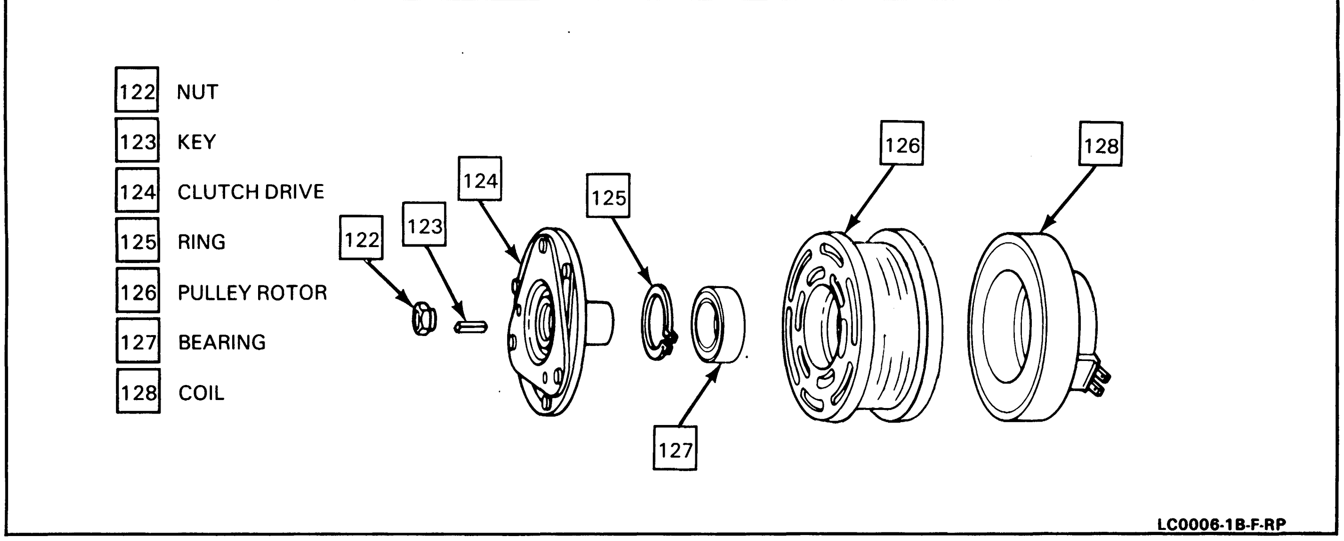


Figure 39 - Compressor Pulley Rotor and Clutch Componen

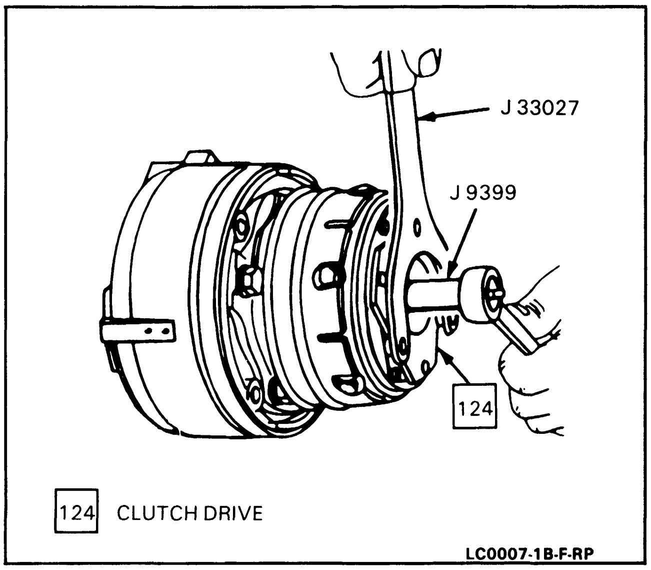


Figure 40 - Removing Shaft Nut - Typical

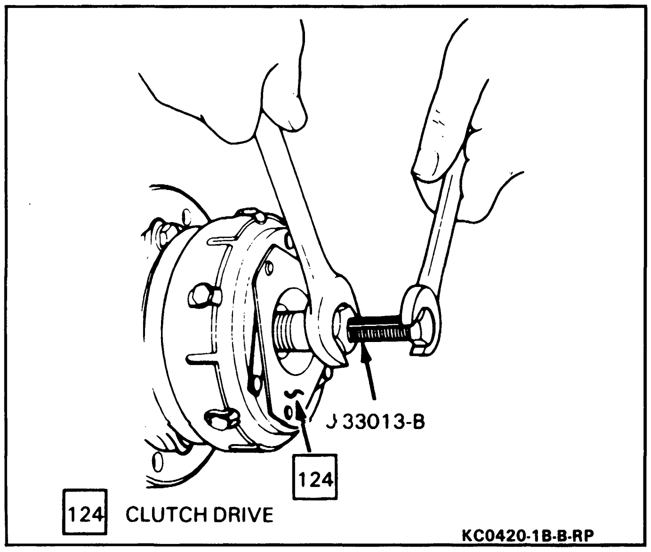


Figure 41 - Removing Clutch Drive - Typical

frictional surfaces of the clutch drive (124) and the pulley rotor (126) (Figure 43).

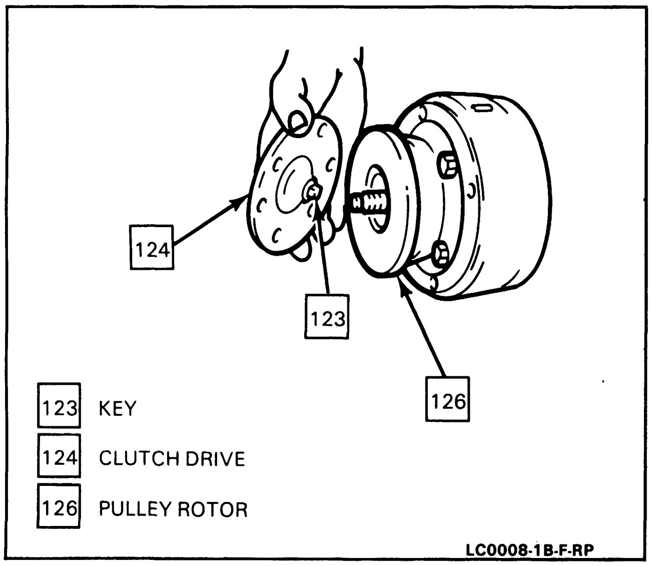


Figure 42 - Installing Shaft Key

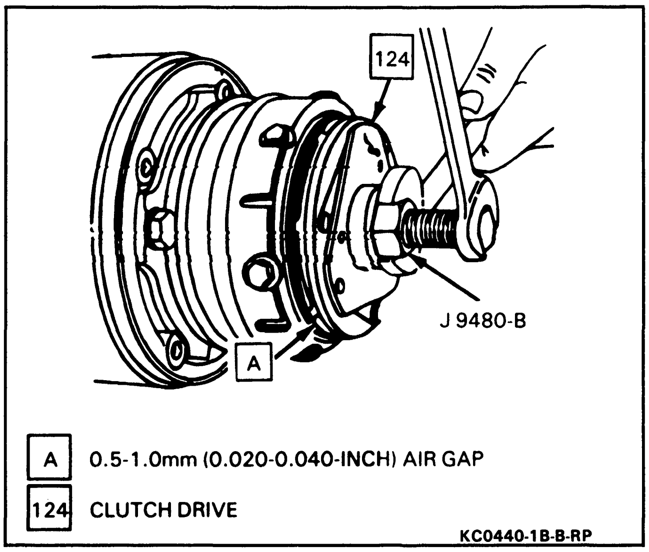


Figure 43 - Installing Clutch Drive - Typical

NOTICE: See "Notice" on page 1B-1 of this section.

3. Shaft nut (122).
   - Use J 9399 to install a new shaft nut (122) with the small diameter boss of the nut (122) against the shaft shoulder. Hold the clutch drive (124) with J 25030 while tightening the shaft nut (122).

   Tighten

   - Shaft nut (122) to 14 N·m (124 lb. in.).

- Install the drive belt.

Inspect

- Drive belt tension. Refer to COOLING AND RADIATOR (SEC. 6B).

Compressor Pulley Rotor and Bearing

Figures 39 and 44 through 50

Tools Required:

J 6083 Snap Ring Pliers
J 25031 Rotor and Bearing Puller
J 33020 Pulley Puller
J 9398-A Pulley Bearing Remover
J 21352-A Support Block
J 9481-A Pulley and Bearing Installer
J 29886 Handle
J 26271-A Rotor and Bearing Installer
J 33019 Bearing Staking Tool

Remove or Disconnect

1. Compressor clutch drive. Refer to "Compressor Pulley Plate and Hub" in this section.
2. Bearing retaining ring (125).
   - Remove the retaining ring (125) using J 6083 (Figure 44).
   - Mark the location of the clutch coil terminals for reference during assembly.
3. Pulley rotor (12

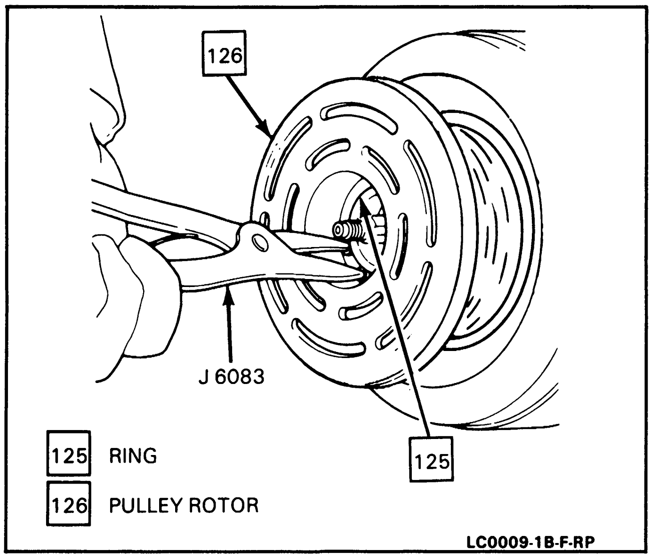


Figure 44 - Removing Rotor Retainer Ring

- Install the guide of J 25031 around the compressor shaft and install J 33020 to the inner circle of slots in the pulley rotor (126). Turn J 33020 clockwise to engage the puller tangs with the segments between the slots (Figure 45).
- Holding J 33020 in place, tighten the puller screw to remove the pulley rotor (126) and bearing (127).

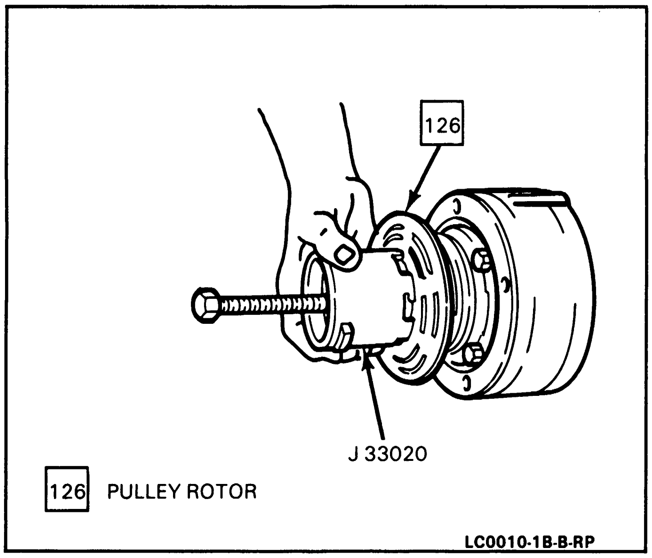


Figure 45 - Engaging Puller Tangs to Pulley Rotor

4. Bearing (127).
   - Remove the puller screw from J 33020 and invert the pulley rotor (126) with J 33020 attached onto a solid flat surface or blocks (Figure 46). The pulley rotor hub must be properly supported to prevent damage to the pulley rotor (126).
   - Remove the bearing (127) from the pulley rotor (126) using J 9398-A and J 29886 (Figure 46). It is not necessary to remove the staking at the rear of the pulley rotor hub to remove the bearing (127).

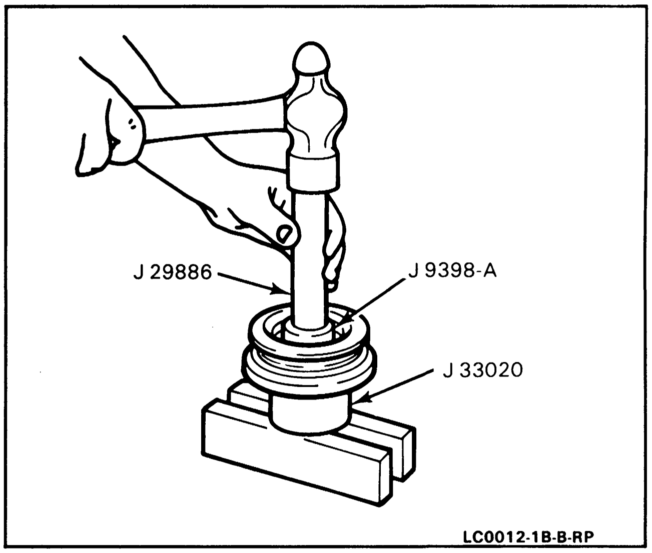


Figure 46 - Removing Pulley Rotor Bearing

Install or Connect

1. New bearing (127).
   - File away the stake metal within the pulley rotor bore for proper clearance for the new bearing (127) to prevent bearing damage.
   - With the pulley rotor (126) supported on J 21352-A, align the new bearing (127) squarely with the hub bore. Drive the bearing (127) fully into the hub, using J 9481-A with J 29886 (Figure 47).

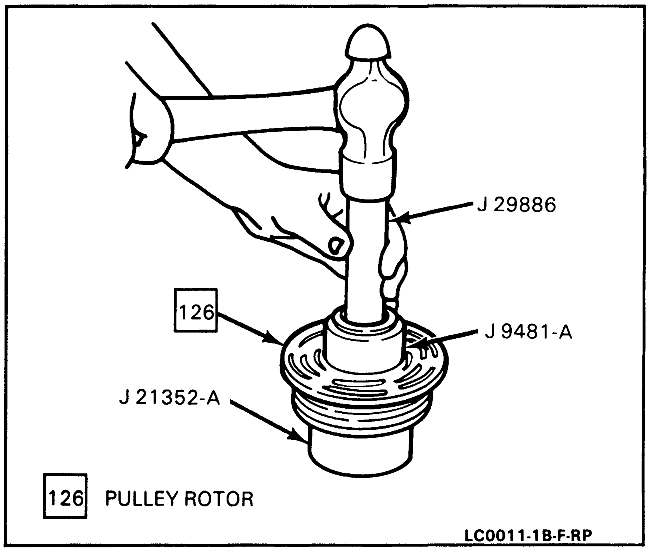


Figure 47 - Installing Pulley Rotor Bearing

NOTICE: Do not stake the hub too deeply and avoid contacting the bearing with the stake indentations to prevent distorting the outer race of the bearing.

- Stake the bearing (127) in place at three points 120 degrees apart around the pulley rotor hub, using J 33019 (Figure 48). Shift the pulley rotor (126) on J 21352 to give full support to the hub under the staking pin of J33019. A rubber band can be used to hold the staking pin in the guide of J 33019. The stakes should be 1.1 to 1.4 mm (0.04 to 0.05-inch) deep (Figure 49).

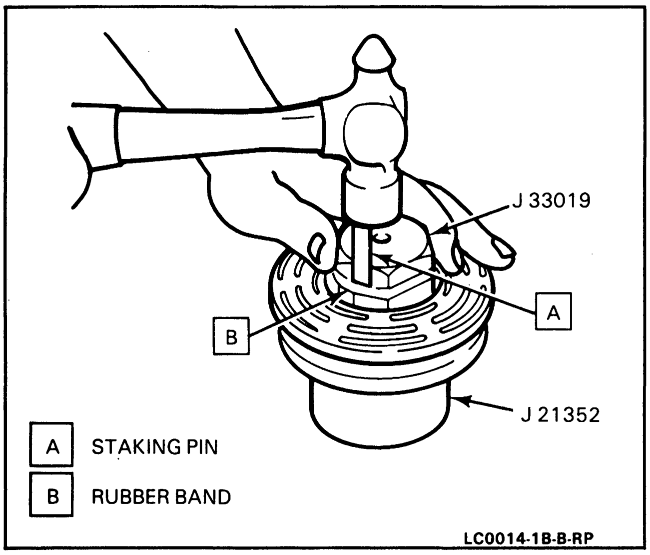


Figure 48 - Staking Pulley Rotor Bearing

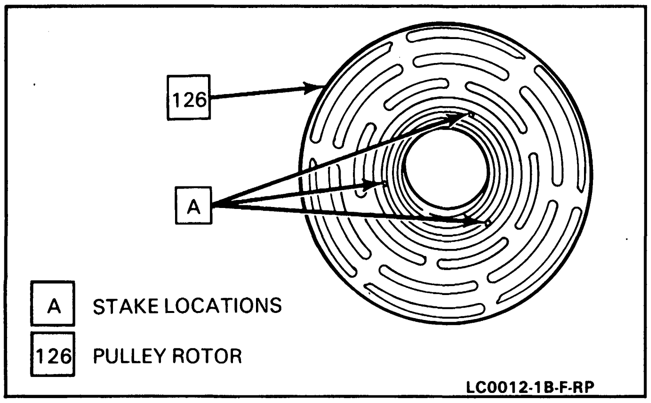


Figure 49 - Pulley Rotor Bearing Stake Locations

2. Pulley rotor (126) and bearing (127).
   - Place the pulley rotor (126) and bearing (127) in position on the compressor front head.
   - Drive the pulley rotor (126) and bearing (127) part way onto the head, using J 26271-A and a J 29886 with a small hammer while holding the pulley rotor (126) and bearing (127) aligned with the front head (Figure 50).
   - Plug the clutch coil connector onto the clutch coil (128).
   - Align the clutch coil locating tabs with the holes in the compressor front head and continue to drive the pulley rotor (126) and bearing (127) onto the front head (Figure 50).
3. Rotor and bearing retaining ring (125) using J 6083.
4. Clutch drive. Refer to "Compressor Pulley Plate and Hub" in this section.
5. Shaft nut. Refer to "Compressor Pulley Plate and Hub" in this section.
6. Drive belt.

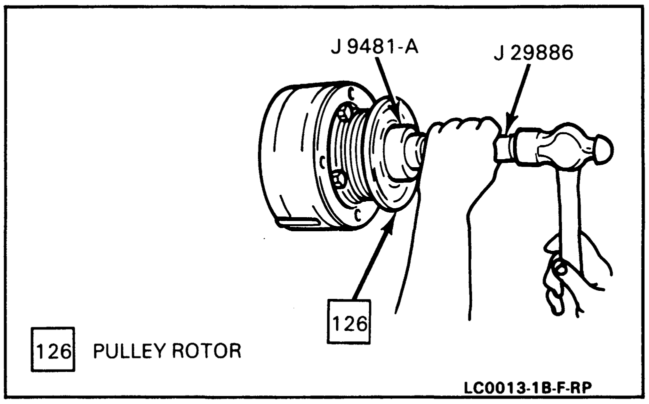


Figure 50 - Installing Pulley Rotor

Inspect

- Drive belt tension. Refer to COOLING AND RADIATOR (SEC. 6B).

Compressor Clutch Coil and Pulley Rotor

Figures 39 and 44 through 51

Remove or Disconnect

Tools Required:

J 6083 Snap Ring Pliers
J 25031 Rotor and Bearing Puller
J 33020 Pulley Puller
J 25287 Clutch Coil Puller
J 26271-A Rotor and Bearing Installer
J 29886 Handle

1. Compressor clutch drive (124). Refer to "Compressor Pulley Plate and Hub" in this section.
2. Bearing retaining ring (125).
   - Remove the bearing retaining ring (125) using J 6083 (Figure 44).
   - Mark the location of the clutch coil terminals for reference during assembly.
3. Pulley rotor (126) and bearing (127).
   - Install the guide of J 25031 around the compressor shaft and install J 33020 to the inner circle of slots in the pulley rotor (126). Turn J 33020 clockwise to engage the puller tangs with the segments between the slots (Figure 45).
   - Holding J 33020 in place, tighten the puller screw to remove the pulley rotor (126) and bearing (127).
4. Clutch coil (128).
   - Install the guide of J 25031 around the compressor shaft and install J 25287. Holding J 25287 in place, tighten the puller screw to remove the coil (128) (Figure 51).

Install or Connect

1. Clutch coil (128), pulley rotor (126) and bearing (127).

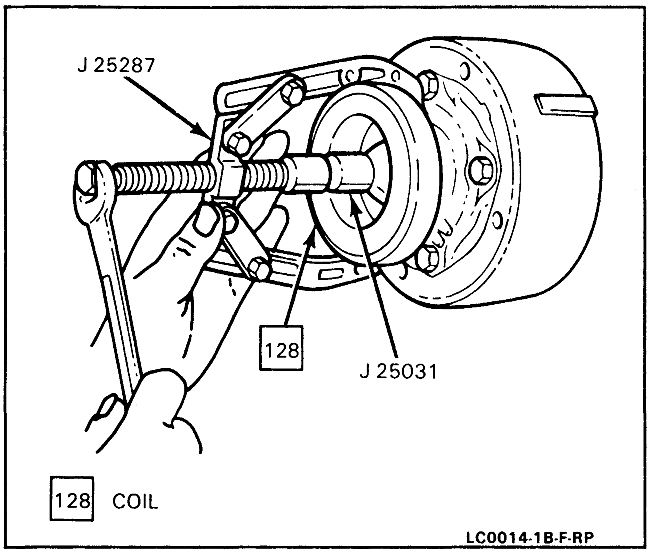


Figure 51 - Removing Clutch Coil

- Assemble the clutch coil (128) to the pulley rotor (126) and bearing (127).
- Place the assembly on the neck of the compressor front head and seat the pulley rotor (126) to driving the assembly into place using J 26271-A and J 29886 with a small hammer (Figure 50). Keep the clutch coil locating tabs aligned with the holes in the compressor front head while seating the pulley rotor (126) and bearing (127).

2. Rotor and bearing retaining ring (125) using J 6083 (Figure 44).
3. Clutch drive. Refer to "Compressor Pulley Plate and Hub" in this section.
4. Shaft nut. Refer to "Compressor Pulley Plate and Hub" in this section.

- Rotate the pulley rotor (126) to be sure the rim rotates in alignment. If the rim is distorted, adjust or replace the pulley rotor (126).

5. Drive belt. Refer to COOLING AND RADIATOR (SEC. 6B).

Inspect

- Drive belt tension. Refer to COOLING AND RADIATOR (SEC. 6B).

Compressor

Figures 52 through 54

Remove or Disconnect

1. Refrigerant.
   - Discharge the system and recover the refrigerant. Refer to "Discharging, Adding Oil, Evacuating and Charging CCOT Systems" in this section.
2. Drive belt from compressor pulley. Refer to COOLING AND RADIATOR (SEC. 6B).
3. Electrical connectors at the compressor (48).
4. Refrigerant lines.
   - Remove the screw (116) and O-ring (117) from the refrigerant line connector block (118) at rear of the compressor (48).
   - Remove the connector block (118) and discard the O-rings (110).
   - Seal both open ports in the connector block (118) with tape to prevent dirt or moisture contamination in the system.
5. Compressor brace nuts (143) from brace (142).
6. Compressor mounting bolts (101 and 119) and nut (120).
7. Compressor (48).
8. Fuel feed shield (141) and attaching screws.

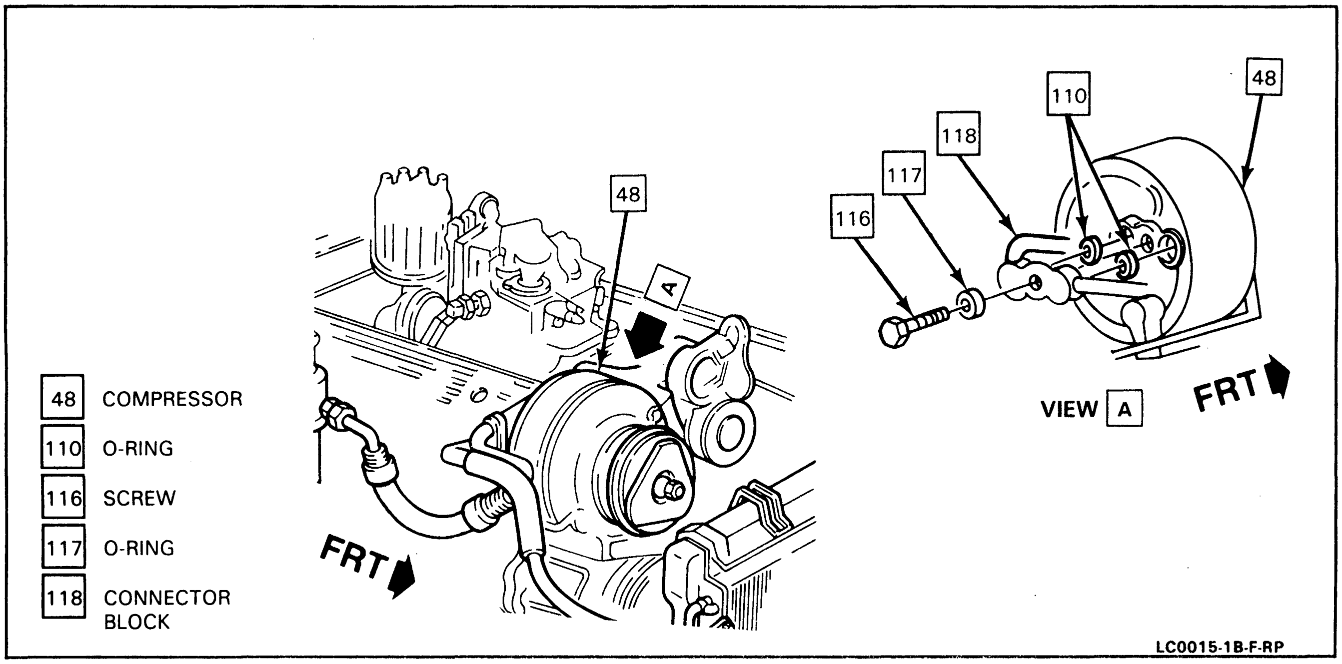


Figure 52 - Compressor Refrigerant Line Connection - Typical (V8 Engine Shown)

Install or Connect

NOTICE: See "Notice" on page 1B-1 of this section for steps 3, 4 and 5.

1. Refrigerant oil. Refer to "Discharging, Adding Oil, Evacuating and Charging CCOT Systems" in this section.
2. Fuel feed shield (141) and attaching screws.
3. Compressor (48), bolts (101 and 119) and nut (120) to the mounting bracket.

Tighten

   - Bolts (101 and 119) to 50 N·m (37 lb. ft.).

4. Compressor brace nuts (143) to brace (142).

Tighten

   - Nuts (143) to 50 N·m (37 lb. ft.).

5. Refrigerant lines.
   - Oval cross-section O-rings (110) have been released to provide more effective sealing of the refrigerant line connections at the compressor rear head. New oval cross-section O-rings (110) should be used when installing the refrigerant hose connector block to the compressor. The cavities for the O-rings (110) should be lubricated with clean refrigerant oil and the O-rings (110) should be pressed into place with a tool that will not damage the O-ring (110). A thin, smooth plastic rod with no sharp edges or points is an ideal tool for this purpose.
   - Coat new O-rings (110) with refrigerant oil.
   - Install O-rings (110) and the refrigerant line connector block (118) to the back of the compressor (48) with the screw (116) and O-ring (117).

Tighten

   - Screw (116) to 34 N·m (25 lb. ft.).

6. Electrical connectors to the compressor (48).
7. Drive belt to the compressor pulley.

Adjust

   - Drive belt tension. Refer to COOLING AND RADIATOR (SEC. 6B).

8. Refrigerant.
   - Evacuate and charge the system. Refer to "Discharging, Adding Oil, Evacuating and Charging CCOT Systems" in this section.
   - Test system performance if the compressor was serviced. Refer to "Testing Air Conditioning Performance" in this section.

Compressor Mounting Bracket

Figures 53 and 54

Remove or Disconnect

1. Compressor (48). Refer to "Compressor" in this section.
2. AIR pump. Refer to DRIVEABILITY AND EMISSIONS - GENERAL INFORMATION (SEC. 6E).

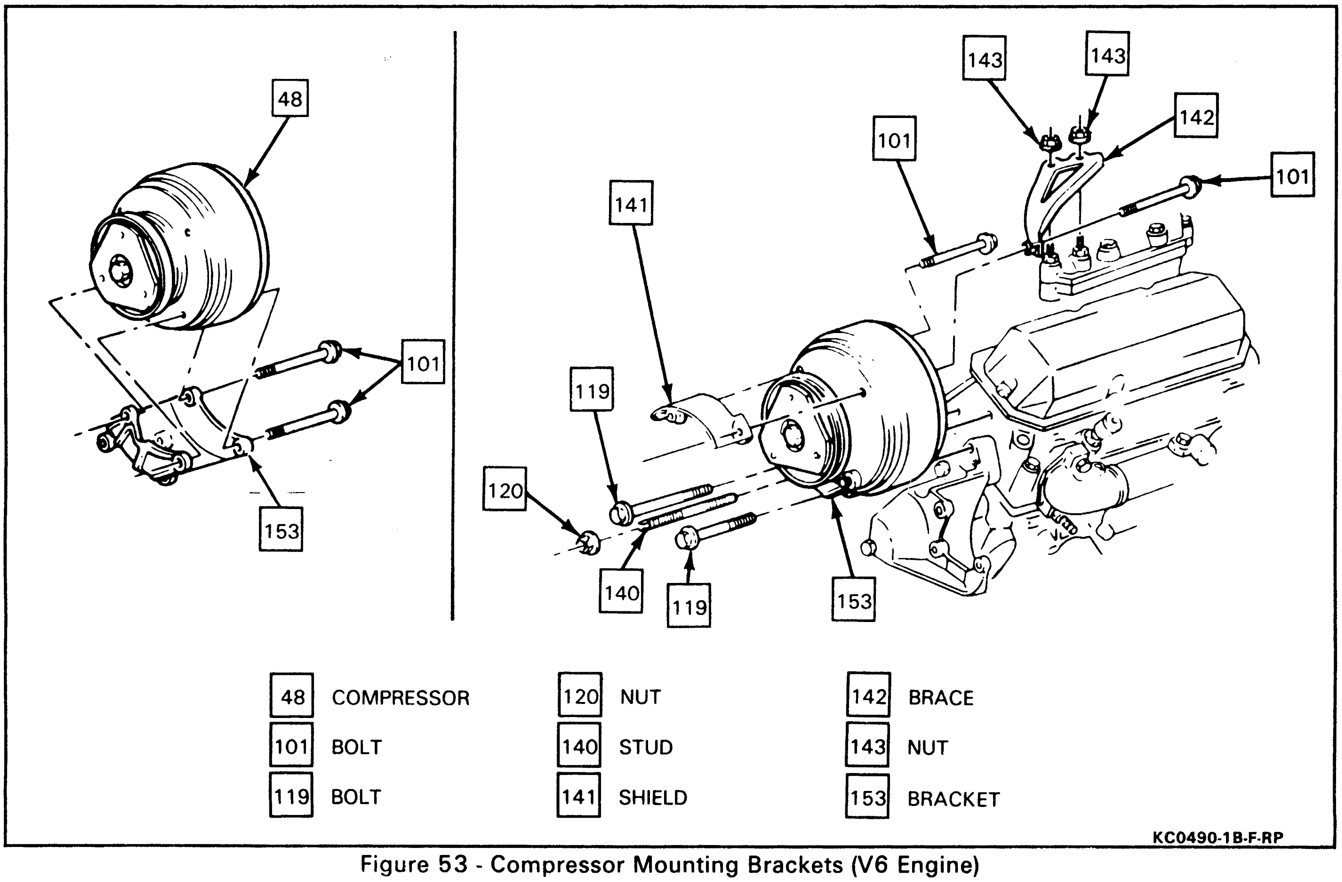


Figure 53 - Compressor Mounting Brackets (V6 Engine)

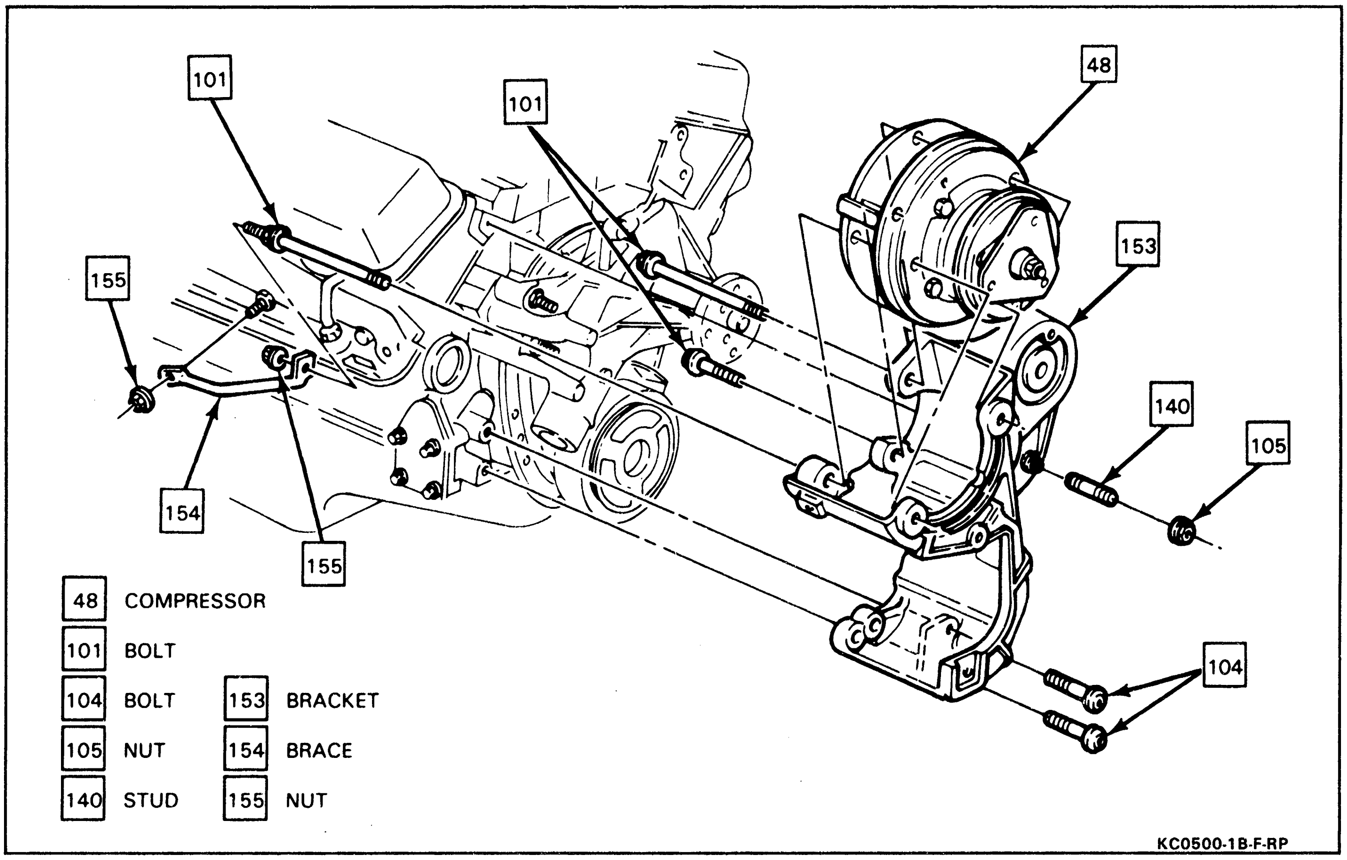


Figure 54 - Compressor Mounting Bracket (V8 Engine)

3. Belt tensioner. Refer to COOLING AND RADIATOR (SEC. 6B).
4. Brace mounting nuts (155).
5. Brace (154).
6. Mounting bracket attaching bolts (104 or 119).
7. Mounting bracket attaching nuts (105 or 120).
8. Mounting bracket (153).

Install or Connect

NOTICE: The proper compressor mounting bracket assembly sequence must be followed to prevent possible distortion of the bracket.

NOTICE: See "Notice" on page 1B-1 of this section for steps 3, 4 and 6.

1. Compressor mounting bracket (153).
2. Mounting bracket attaching nuts (105 or 120) to studs, finger tight.
3. Mounting bracket attaching bolts (104 or 119).

Tighten

- Bolts (104) to 30 N·m (22 lb. ft.).
- Bolts (119) to 50 N·m (37 lb. ft.).

4. Mounting bracket attaching nuts (105 or 120).

Tighten

- Nuts (105) to 30 N·m (22 lb. ft.).
- Nuts (120) to 25 N·m (18 lb. ft.).

5. Brace (154).
6. Brace mounting nuts (155).

Tighten

- Nuts (155) to 25 N·m (18 lb. ft.).

7. AIR pump. Refer to DRIVEABILITY AND EMISSIONS - GENERAL INFORMATION (SEC. 6E).
8. Belt tensioner. Refer to COOLING AND RADIATOR (SEC. 6B).
9. Compressor. Refer to "Compressor" in this section.

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Liquid Line Filter Compression Nut	15 N·m (11 lb. ft.)
Condenser-to-Liquid Line Fitting Nut	16 N·m (12 lb. ft.)
Evaporator Inlet-to-Liquid Line Fitting Nut	23 N·m (17 lb. ft.)
Control Assembly Retaining Screw	1.4 N·m (12 lb. in.)
Resistor Assembly Mounting Screw	1.5 N·m (13 lb. in.)
Radio and Air Conditioning Control Console Trim Plate Retaining Screw	1.4 N·m (12 lb. in.)
Air Conditioning Cutout Relay Mounting Screw	6.8 N·m (60 lb. in.)
Pressure Cycling Switch	5 N·m (44 lb. in.)
Blower Relay Bracket Retaining Screw	1.5 N·m (13 lb. in.)
Vacuum Tank Mounting Screw	5 N·m (44 lb. in.)
Heater Pipe Connector Nut (V6 Engine)	23 N·m (17 lb. ft.)
Heater Pipe-to-Generator Bracket Screw (V6 Engine)	10 N·m (89 lb. in.)
Heater Pipe-to-Side Rail Screw	1.4 N·m (12 lb. in.)
Condenser Retaining Screw	10 N·m (89 lb. in.)
Compressor Shaft Nut	14 N·m (124 lb. in.)
Compressor Pulley Rim Mounting Screw	11 N·m (97 lb. in.)
Compressor Mounting Bolt	50 N·m (37 lb. ft.)
Compressor Brace Nut	50 N·m (37 lb. ft.)
Refrigerant Line Connector Block Bolt	34 N·m (25 lb. ft.)
Compressor Mounting Bolt:	
V6 Engine	50 N·m (37 lb. ft.)
V8 Engines	30 N·m (22 lb. ft.)
Compressor Mounting Bracket Nut:	
V6 Engine	25 N·m (18 lb. ft.)
V8 Engines	30 N·m (22 lb. ft.)
Compressor Bracket Brace Mounting Nut	25 N·m (18 lb. ft.)

REFRIGERANT LINE CONNECTION TORQUE SPECIFICATIONS

Metal Tube Outside Diameter	Thread and Fitting Size	Steel Tubing Torque		Aluminum or Copper Tubing Torque		Nominal Torque Wrench Span
		N·m	Lb. Ft.	N·m	Lb. Ft.	
1/4"	7/16"	17	13	8	71 lb. in.	5/8"
3/8"	5/8"	44	32	16	12	3/4"
1/2"	3/4"	44	32	23	17	7/8"
5/8"	7/8"	44	32	33	24	1 1/16"
3/4"	1 1/16"	44	32	41	30	1 1/4"

NOTE: Use "Steel Tubing Torque" when tube is mated steel-to-steel. If steel connection is made to aluminum or copper tube fittings, use appropriate "Aluminum or Copper Tubing Torque" specifications.

KC0525-1B-B-RP

SPECIAL TOOLS

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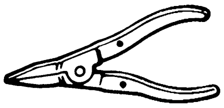
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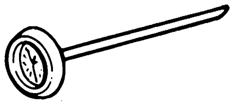
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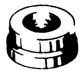
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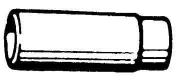
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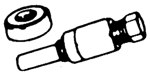
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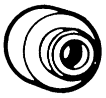
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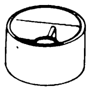
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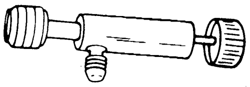
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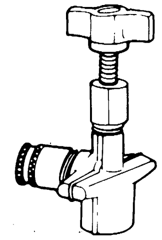
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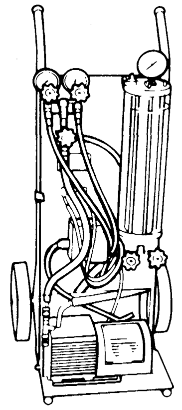
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J 23900-C
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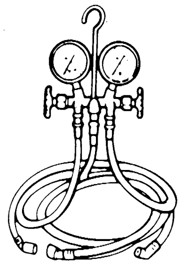
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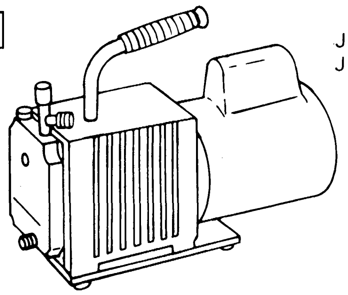
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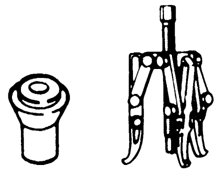
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1	SNAP RING PLIERS
2	PRECISION THERMOMETER
3	PULLEY BEARING REMOVER
4	THIN WALL SOCKET
5	CLUTCH PLATE AND HUB INSTALLER
6	PULLEY AND BEARING INSTALLER
7	SUPPORT BLOCK
8	ACCESS VALVE CORE REMOVER AND INSTALLER
9	CONTROL VALVE
10	CHARGING STATION
11	MANIFOLD AND GAGE SET
12	VACUUM PUMP
13	ROTOR AND BEARING PULLER

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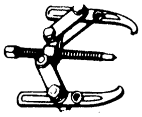
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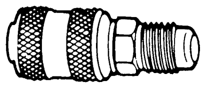
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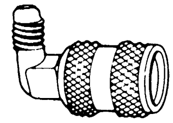
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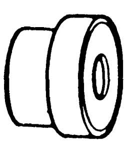
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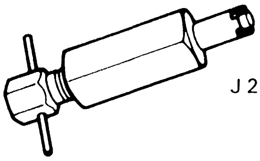
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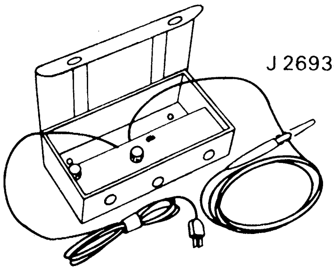
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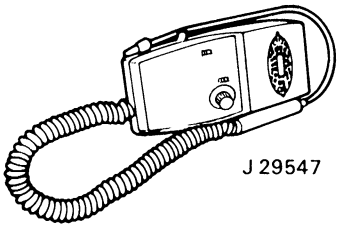
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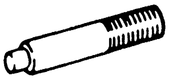
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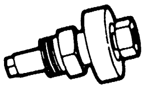
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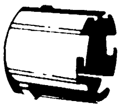
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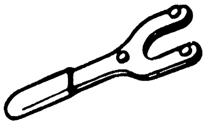
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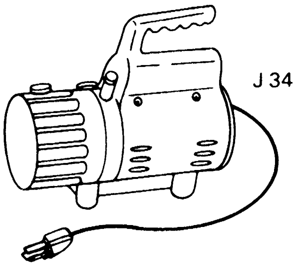
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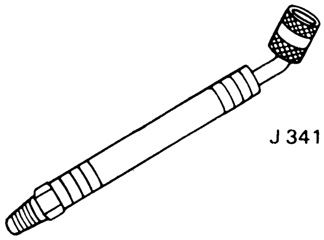
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14	CLUTCH COIL PULLER
15	STRAIGHT GAGE ADAPTER
16	90-DEGREE ANGLE GAGE ADAPTER
17	ROTOR AND BEARING INSTALLER
18	EXPANSION TUBE REMOVER
19	LEAK DETECTOR
20	LEAK DETECTOR
21	HANDLE
22	CLUTCH PLATE AND HUB REMOVER
23	BEARING STAKING TOOL
24	PULLEY PULLER
25	COMPRESSOR CLUTCH HUB HOLDING TOOL
26	VACUUM PUMP
27	FLEXIBLE GAGE ADAPTER

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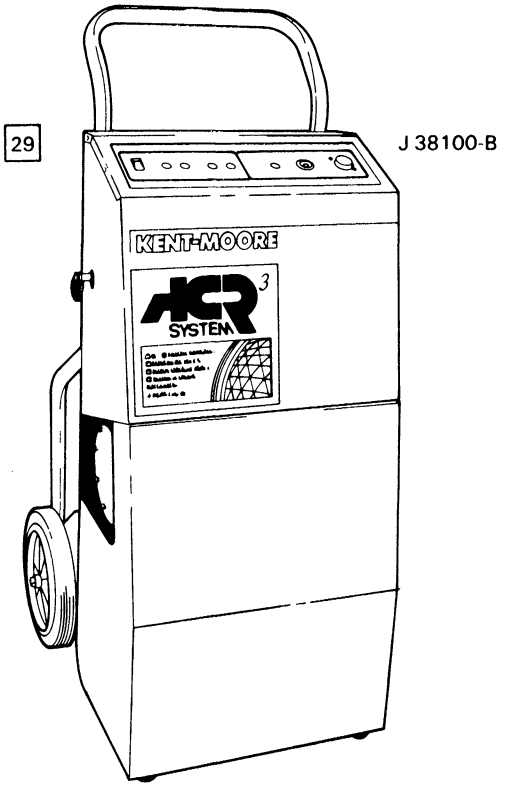

29 AIR CONDITIONING REFRIGERANT RECOVERY AND RECYCLING SYSTEM

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SECTION 1D1

R-4 AIR CONDITIONING COMPRESSOR OVERHAUL

For compressor removal and installation, refer to MANUALLY CONTROLLED AIR CONDITIONING (SEC. 1B). For discharging, adding oil, evacuating and charging procedures for A/C systems, refer to MANUALLY CONTROLLED AIR CONDITIONING (SEC. 1B).

CONTENTS

GENERAL DESCRIPTION

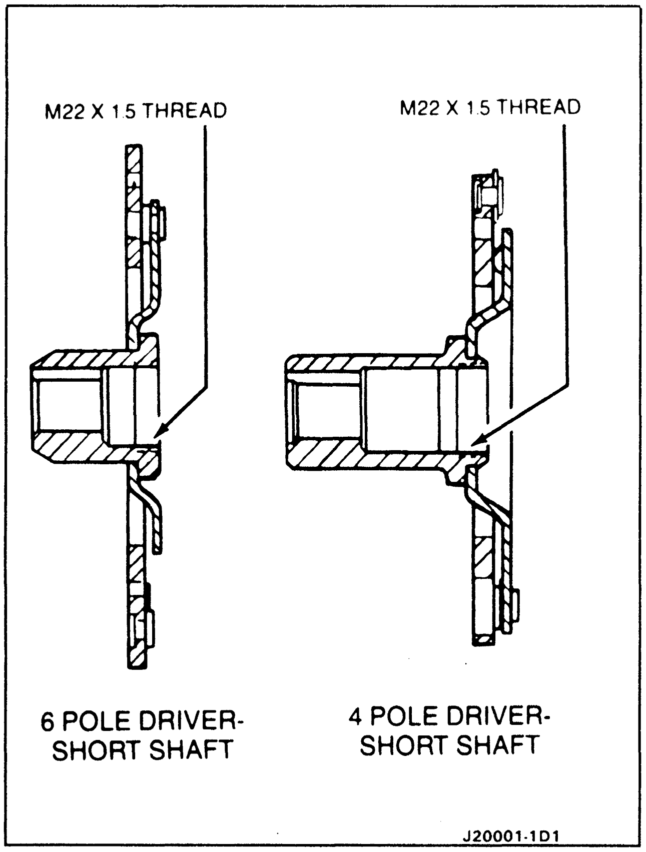
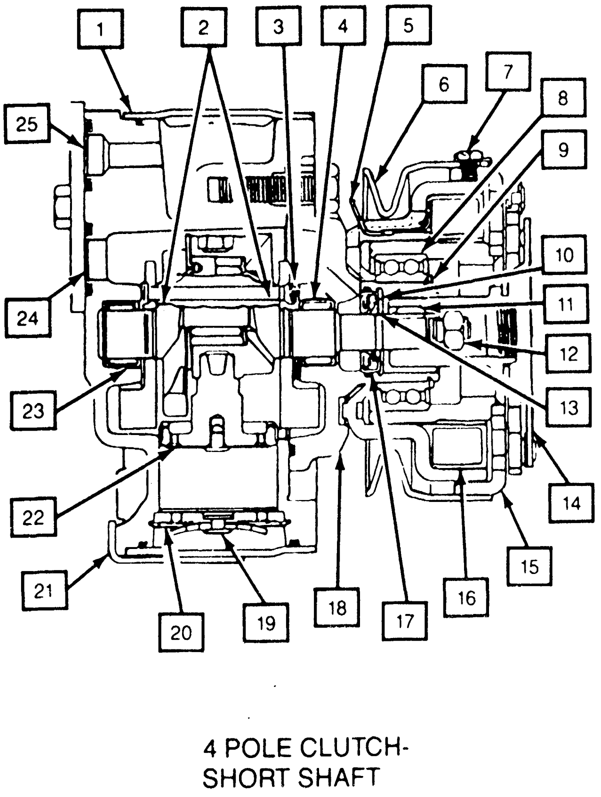


Figure 1-R-4 Compressor Clutch Drives - Short Shaft Design

Two clutch drivers are used on the R-4 air conditioning compressor that incorporate a short shaft design. They are a four-pole driver and a six-pole driver, both of which have M22 X 1.5 threads (past models had 7/8-14 UNF threads). Figure 2 shows a cross section of the short shaft design. The type of clutch driver should be identified prior to starting overhaul procedures.

When servicing the compressor, it is essential that steps be taken to prevent dirt or foreign material from getting on or into the compressor parts and system during disassembly or reassembly. Clean tools and clean work area are very important for proper service. The compressor connection areas and the exterior of the compressor should be cleaned off as much as possible prior to any "on-vehicle" repairs or removal of the compressor for workbench service. The parts must be kept clean at all times and any parts to be reassembled should be cleaned with trichloroethane, naphtha, stoddard solvent, kerosene or equivalent solvent and blown dry with dry air. When necessary to use a cloth on any part, it should be of a nonlint producing type.

Although certain service operations can be performed without completely removing the compressor from the vehicle, the operations described are based on bench over-haul with the compressor removed from the vehicle. They have been prepared in order of accessibility of the components. If compressor is removed from brackets but not disconnected from lines and hoses, the system is not discharged. Pad fender skirt and secure compressor near top of fender



1. COMPRESSOR SHELL
2. ROLL PINS
3. THRUST AND BELLEVILLE WASHER
4. MAIN BEARING-FRONT
5. CLUTCH COIL TERMINALS
6. PULLEY RIM
7. PULLEY RIM MOUNTING SCREW AND LOCKWASHER
8. ROTOR BEARING
9. ROTOR BEARING RETAINER
10. SEAL SEAT RETAINER
11. SHAFT KEY
12. SHAFT NUT
13. SHAFT SEAL
14. CLUTCH DRIVE ASSEMBLY
15. ROTOR AND HUB ASSEMBLY
16. CLUTCH COIL AND HOUSING ASSEMBLY
17. SEAL SEAT O-RING
18. FRONT HEAD
19. VALVE PLATE ASEMBLY
20. VALVE PLATE RETAINING RING
21. SHELL RETAINER
22. PISTON ASSEMBLY
23. MAIN BEARING - REAR
24. SUCTION PORT
25. DISCHARGE PORT

Figure 2-R-4 Compressor Cross Section Shaft Design

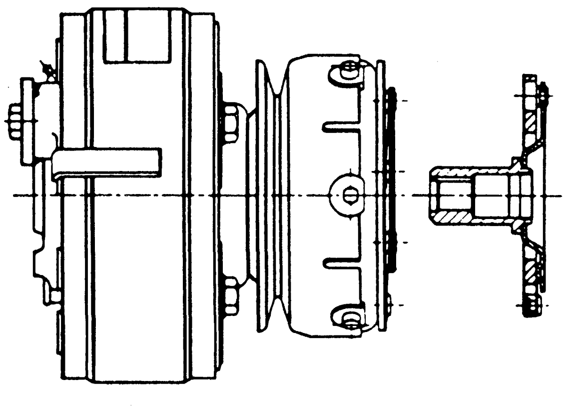


Figure 3-R-4 Compressor With Four-Pole Clutch

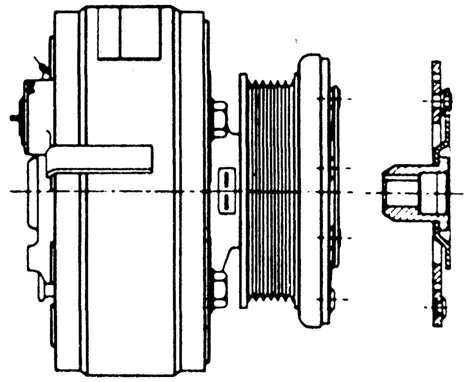


Figure 4-R-4 Compressor With Six-Pole Clutch

skirt with wire, rope, etc. when performing on-car service.

When the R-4 compressor is removed from the vehicle for servicing, the amount of oil remaining in the compressor should be drained, measured and recorded. This oil should then be discarded and the same amount of new 525 viscosity refrigerant oil added to the compressor (See "Refrigerant Oil Distribution" in the Air Conditioning Section 1B).

1–RETAINER RING
2–SHAFT SEAL
4–O-RING, SEAL SEAT
5–SHAFT SEAL KIT
6–SCREW AND WASHER ASSEMBLY FRONT HEAD MOUNTING
7–FRONT HEAD
8–MAIN BEARING
9–RING SEAL, FRONT HEAD TO CYLINDER
10–SHELL
11–O-RING, CYLINDER TO SHELL
12–THRUST WASHER
13–BELLEVILLE WASHER
14–THRUST WASHER KIT
15–CYLINDER AND SHAFT ASSEMBLY
16–RETAINER RING
17–VALVE PLATE
18–SHIPPING PLATE
19–SCREW
20–O-RING SUCTION-DISCHARGE PORTS
21–PRESSURE RELIEF VALVE
22–O-RING, PRESSURE RELIEF VALVE
23–SHAFT NUT
24–CLUTCH HUB KEY
25–CLUTCH DRIVE ASSEMBLY
26–RETAINER RING
27–ROTOR
28–ROTOR BEARING
29–ROTOR AND BEARING ASSEMBLY
30–COIL AND HOUSING ASSEMBLY
31–PULLEY RIM MOUNTING SCREW
32–PULLEY RIM

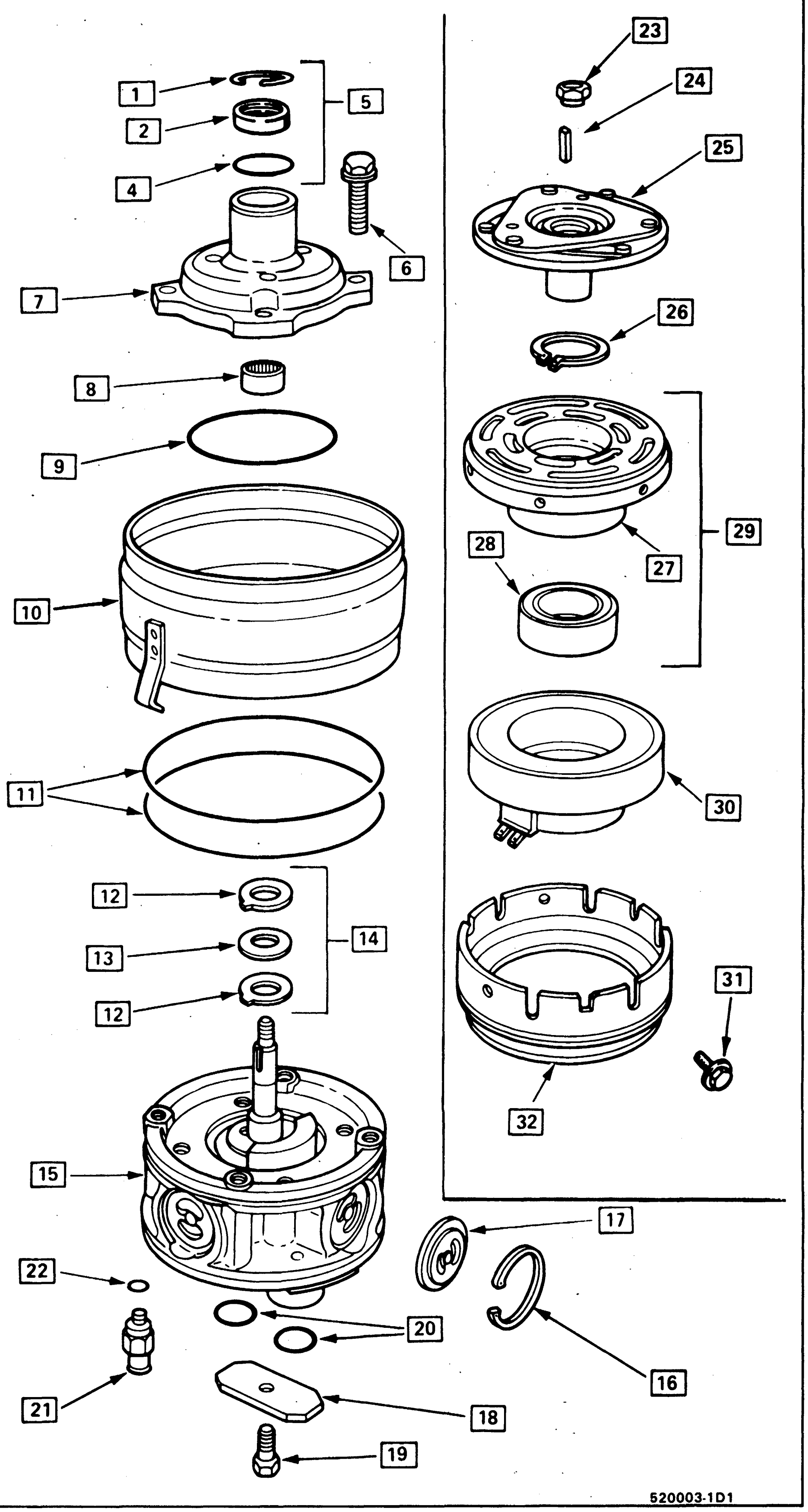


Figure 5-R-4 Compressor Disassembled View

SERVICE PROCEDURES

MINOR REPAIR PROCEDURES

THE FOLLOWING OPERATIONS TO THE R-4 COMPRESSOR CLUTCH PLATE AND HUB, ROTOR AND BEARING, AND COIL & PULLEY RIM ARE COVERED AS "MINOR" BECAUSE THEY MAY BE PERFORMED WITHOUT FIRST DISCHARGING THE SYSTEM OR REMOVING THE COMPRESSOR FROM THE VEHICLE.

The two types of drive systems used on the R-4 Compressor (V-groove type and poly-groove type) affect only minor repair procedures and are so noted where required. Major repair procedures are not affected by the type of drive system.

The Compressor Shaft Seal assembly, and Pressure Relief Valve may also be serviced WITHOUT REMOVING THE COMPRESSOR from the vehicle but these operations are covered later in this section as MAJOR REPAIR PROCEDURES because the system must be discharged, evacuated and recharged to complete service.

Illustrations used in describing these operations show the compressor removed from the vehicle only to more clearly illustrate the various operations.

When servicing the compressor, remove only the necessary components that preliminary diagnosis indicates are in need of service. Refer to the AIR CONDITIONING section and Figures 4 and 5 for information relative to parts nomenclature and location.

Removal and installation of external compressor components and disassembly and assembly of internal components must be performed on a clean workbench. The work area, tools and parts must be kept clean at all times.

CLUTCH PLATE AND HUB ASSEMBLY

Figures 6 through 10

CLUTCH PLATE AND HUB ASSEMBLY INSTALLATION AND REMOVAL PROCEDURES FOR THE SIX-POLE CLUTCH ARE THE SAME AS THE FOUR-POLE CLUTCH WITH THE EXCEPTION OF THE CLUTCH HUB HOLDING TOOL. USE J-33027 FOR BOTH CLUTCHES.

↔ **Remove or Disconnect**

1. If compressor is on the vehicle, disconnect the compressor drive belt and reposition the compressor for access, if necessary. Refer to COOLING AND RADIATOR (SEC. 6B). If compressor has been removed from the vehicle, attach the compressor to Holding Fixture J-25008-A and clamp the Holding Fixture in a vise.
   - Compressor mounting holes are metric. Use proper metric bolts with holding fixture J-25008-A.

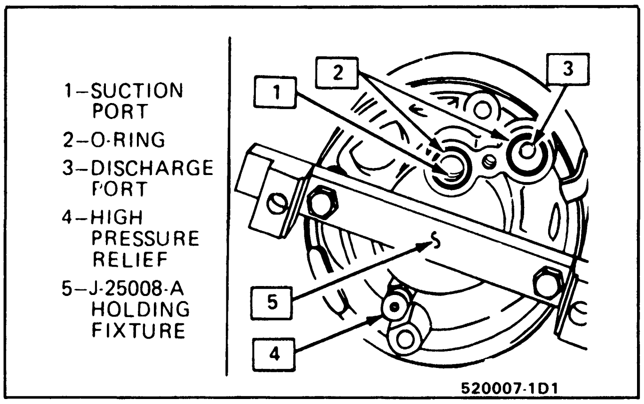


Figure 6-Compressor In Holding Fixture

2. Keep the clutch hub from turning with the Clutch Hub Holding Tool J-33027 remove, and discard the shaft nut, using Thin Wall Socket J-9399.

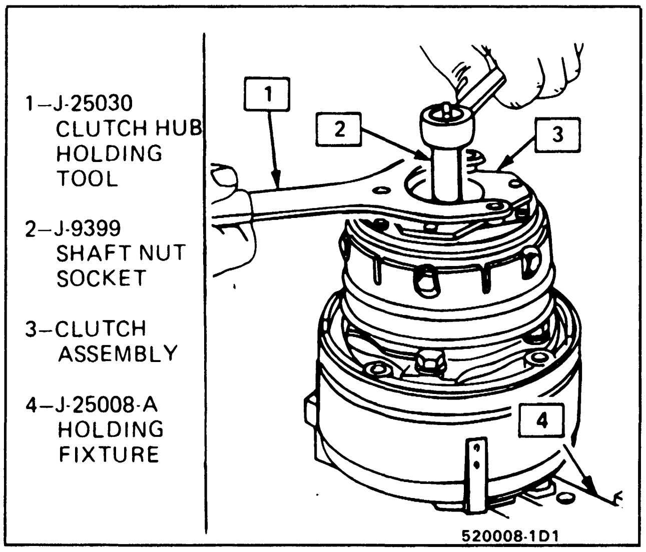


Figure 7-Removing Shaft Nut

3. Thread the Clutch Plate and Hub Assembly Remover J-33013-B into the hub. Hold the body of the Remover with a wrench and turn the center screw into the Remover body to remove the Clutch Plate and Hub assembly.
4. Shaft key.

→← **Install or Connect**

1. Shaft key in hub key groove. Allow the key to project approximately 4.8mm (3/16") out of keyway.

   The shaft key is curved slightly to provide an interference fit in the shaft key groove of the hub.
2. Be sure the frictional surface of the clutch plate and the clutch rotor are clean before installing the Clutch Plate and Hub assembly.
3. Align the shaft key with the shaft keyway and place the Clutch Plate and Hub assembly onto the compressor shaft.

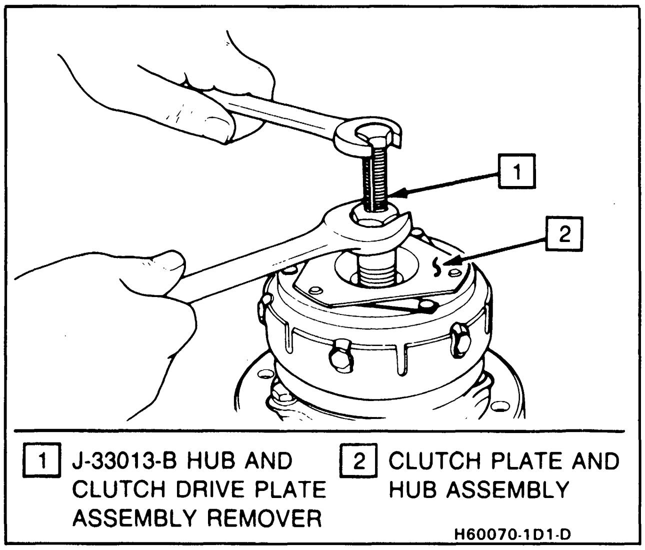


Figure 8-Clutch Plate And Hub Assembly Removal

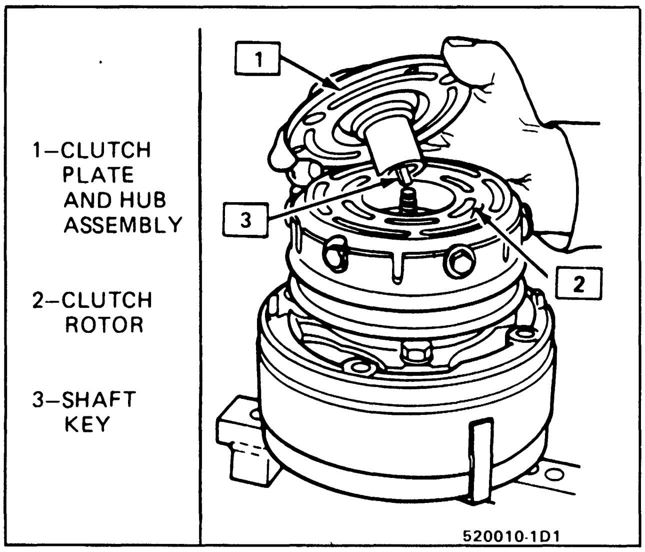


Figure 9-Installing Shaft Key

NOTICE: To avoid internal damage to the compressor, do not drive or pound on the clutch hub or shaft.

4. Install the Clutch Plate and Hub Installer J-9401-B.
5. Hold the hex portion of the Installer Body J-9401-B with a wrench and tighten the center screw to press the hub onto the shaft until there is a 0.5mm - 1.0mm (0.020-0.040 inch) air gap between the frictional surfaces of the clutch plate and clutch rotor.
6. Install a new shaft nut with the small diameter boss of the nut against the crankshaft shoulder, using Thin Wall Socket J-9399. Hold the Clutch Plate and Hub assembly with Clutch Hub Holding Tool J-33027 and tighten to 14 N·m (10 lb. ft.) torque, using a 0-60 N·m (0-25 lb.ft.) torque wrench.
7. If operation is performed with compressor on vehicle, connect drive belt and adjust belt tension. Refer to COOLING AND RADIATOR (SEC. 6B).

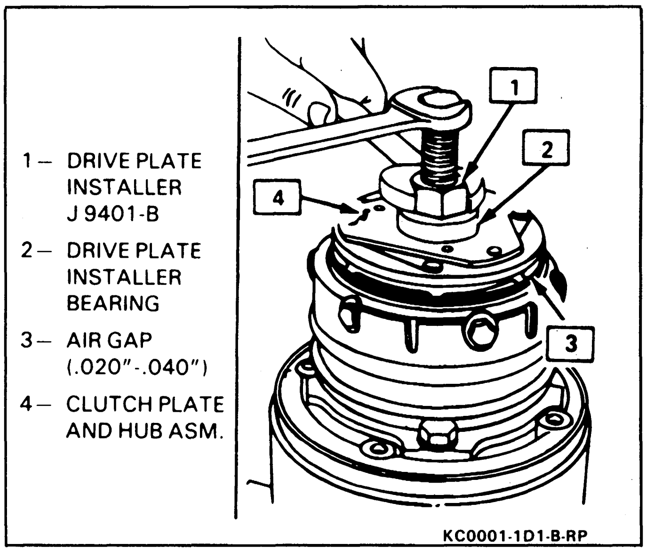


Figure 10 - Installing Clutch Plate and Hub Assembly

CLUTCH ROTOR AND BEARING: FOUR POLE CLUTCH

Figure 11 through 20

↔ Remove or Disconnect

1. Clutch Plate and Hub assembly
2. Rotor and Bearing assembly retaining ring, using Snap Ring Pliers J-6083. Mark the location of the clutch coil terminals.

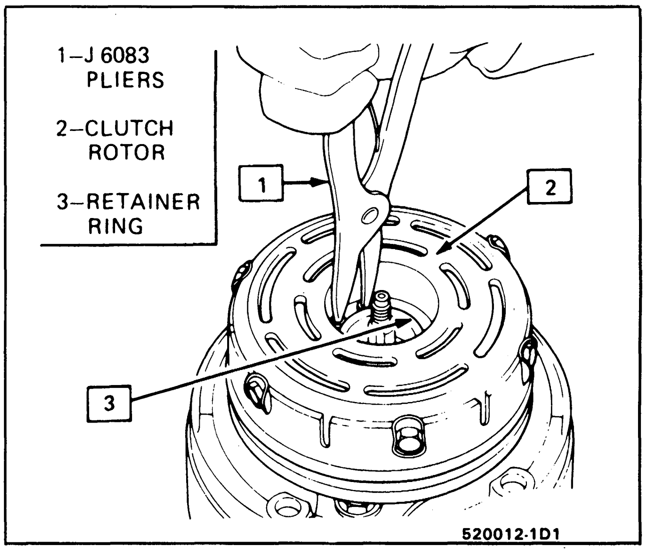


Figure 11-Removing Rotor and Bearing Assembly Retainer Ring

If only the Clutch Rotor and/or Rotor Bearing are to be replaced, bend the lockwashers away from the pulley rim mounting screws, and remove the six mounting screws and special lock washers before proceeding with Step 3. Discard the lock washers.

3. Install Rotor and Bearing Puller J-25031 down into the rotor until the Puller arms engage the recessed edge of the rotor hub. Hold the Puller and arms in place and tighten the Puller screw against the Puller Guide to remove the Clutch

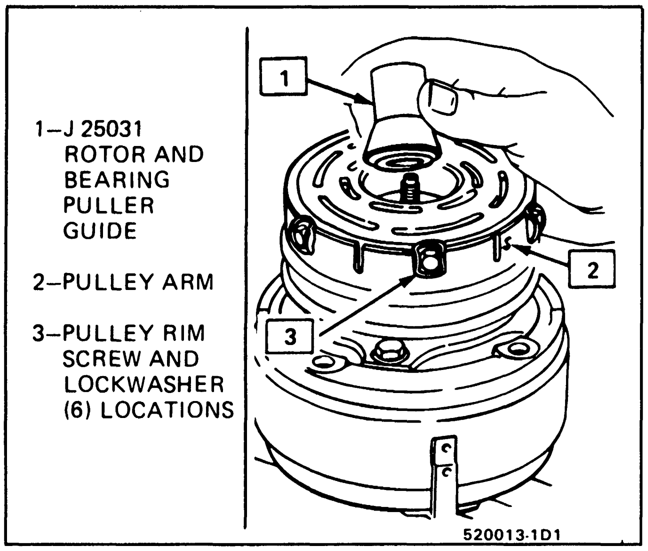


Figure 12-Installing Rotor and Bearing Puller Guide

Rotor and Bearing assembly, being careful not to drop the Puller Guide.

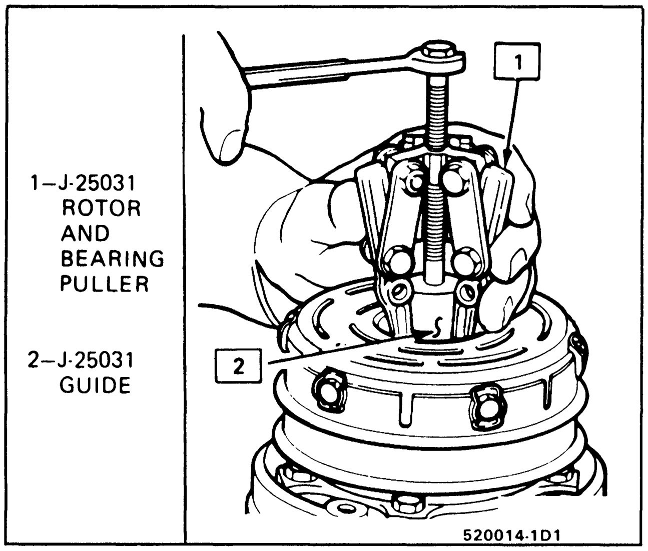


Figure 13-Removing Clutch Rotor Assembly

4. If the pulley rim mounting screws and washers were removed in Step 2, only the Clutch Rotor and Bearing assembly will be removed for replacement. The Clutch Coil and Housing assembly is pressed onto the Front Head of the compressor and will not be removed unless the pulley rim mounting screws are left securely in place and the pulley rim pulls the Coil and Housing assembly off with the total Clutch Rotor and Pulley Rim Assembly.

5. Place the Rotor and Bearing assembly on blocks. Drive the bearing out of the rotor hub with Rotor Bearing Remover J-9398-A.

It is not necessary to remove the staking at the rear of the rotor hub to remove the bearing. However, it will be necessary to file away the old stake metal for proper clearance for the new bearing to be installed into the rotor bore, or the bearing may be damaged.

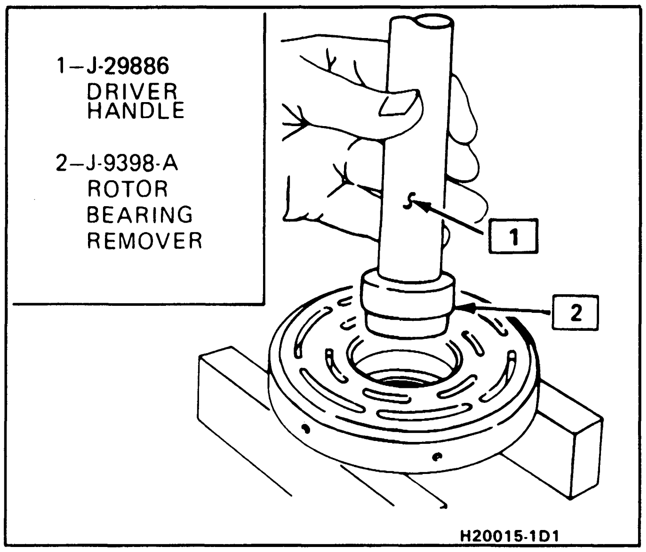


Figure 14-Clutch Rotor Bearing Removal

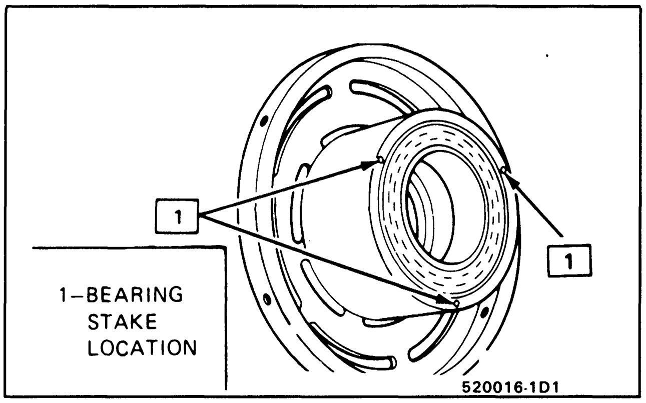


Figure 15-Rotor and Bearing Assembly

→← Install or Connect

1. Place the Rotor and Hub assembly face down on a clean, flat and firm surface.
2. Align the new bearing squarely with the hub bore and using Pulley and Bearing Installer J-9481-A with Universal Handle J-29886, drive the bearing fully into the hub. The Installer will apply force to the outer race of the bearing if used as shown.
3. Using a center punch with a 45° angle point, stake 1.1 - 1.4mm (0.045-0.055 inches) deep the bearing in three places 120° apart, but do not stake too deeply to avoid distorting the outer race of the bearing.
4. Replace rotor and bearing assembly.

On-Vehicle

A. Position the Rotor and Bearing assembly on the front head.
B. With Rotor & Bearing Installer J-26271-A (without driver handle) in position and Rotor and Bearing assembly aligned with the Front Head, drive the assembly part way onto the head.
C. Plug clutch coil connector onto Clutch Coil.
D. Position the Clutch Coil so the three locating tabs will align with the holes in the head and continue to drive the Rotor and Bearing assembly onto the front head.

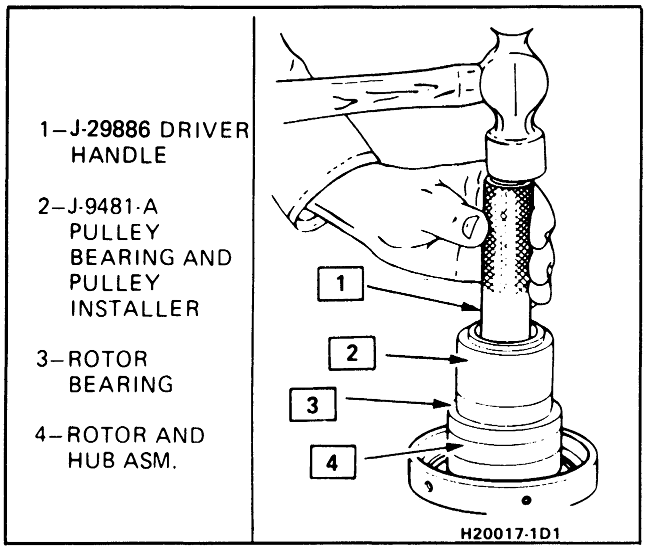


Figure 16-Installing Clutch Rotor Bearing

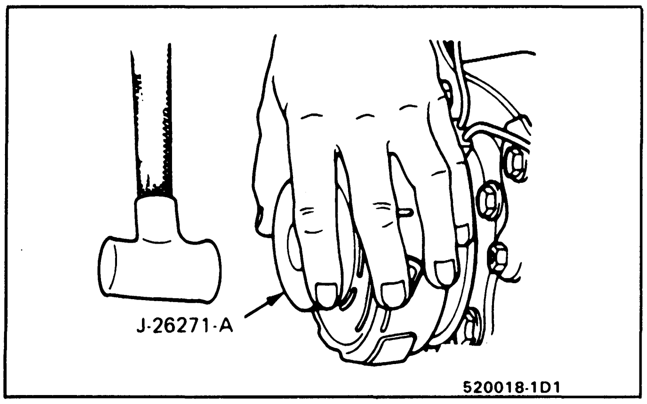


Figure 17-Installing Rotor and Bearing Assembly (On-Vehicle)

E. Install the retainer ring.

F. Reassemble the Clutch Plate and Hub with the shaft key onto the shaft with Installer J-9401-B until 0.5 to 1.0mm (0.020 to 0.040 inches) air gap is obtained.

G. Install shaft lock nut. Torque to 14 N·m (10 lb. ft.).

On Bench

Reassemble the Rotor and Bearing assembly to the front head of the compressor using Rotor & Bearing Installer J-26271-A. With Installer assembled to the Universal Handle, J-29886, force will be applied to the inner race of the bearing and the face of the rotor when installing the assembly onto the front head of the compressor.

5. Install rotor and bearing assembly retainer ring, using Snap Ring Pliers J-6083.
6. Apply sealer (Loctite RC-75, Loctite 601 or equivalent) to threads of pulley rim mounting screws. Install screws and new special lock washers but do not torque the screws.
7. Rotate the pulley rim and rotor to insure that pulley rim is rotating "in-line." If pulley rim is distorted (does not rotate in-line), adjust or replace pulley rim.

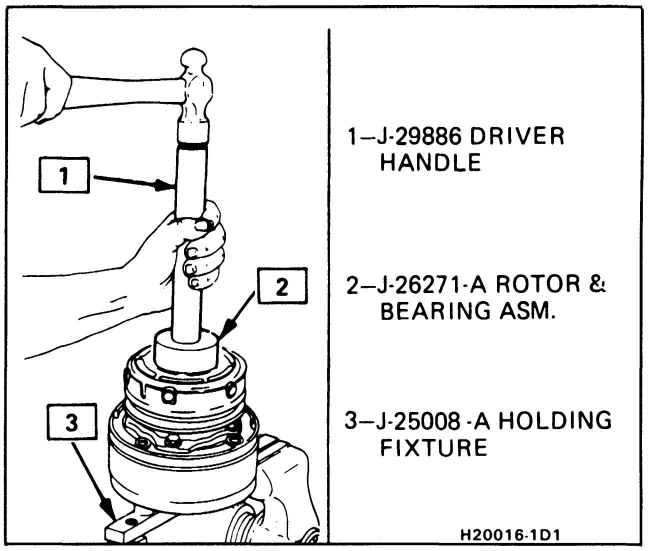


Figure 18-Installing Rotor and Bearing Assembly V-Groove Type

8. Tighten pulley rim mounting screws to 11 N·m (100 lb. in.) torque and lock screw heads in place by bending special lock washers, similar to original crimp and lock bends on washers.
9. Reinstall Clutch Plate and Hub assembly as described in "Clutch Plate and Hub" Replacement procedures.

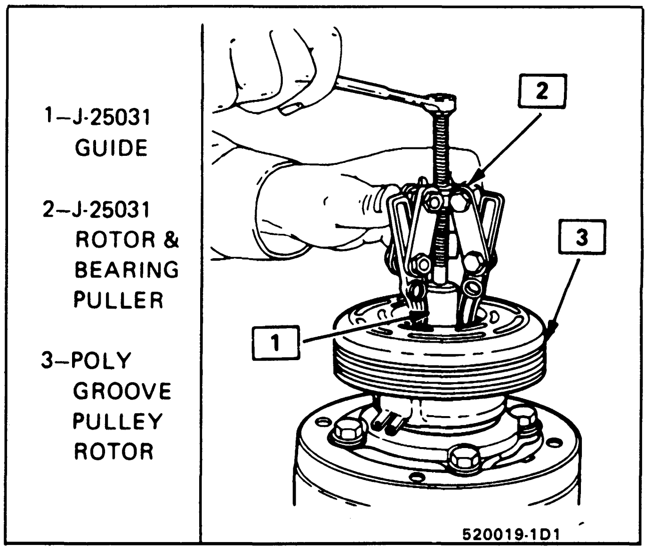


Figure 19-Removing Clutch Rotor Assembly - Poly-Groove Drive

CLUTCH ROTOR AND BEARING: SIX POLE CLUTCH

Figures 21 through 28

↔ Remove or Disconnect

1. Clutch plate hub assembly
2. Rotor and bearing assembly retaining ring using Snap Ring Pliers J-6083
3. Install Pulley Rotor and Puller Guide J-25031 to the front head and install J-33020 Pulley Rotor and Bearing Puller down into the inner circle of slots in the rotor. Turn the J-33020 puller clockwise in the slots to engage the puller tangs with the segments between the slots in the rotor.

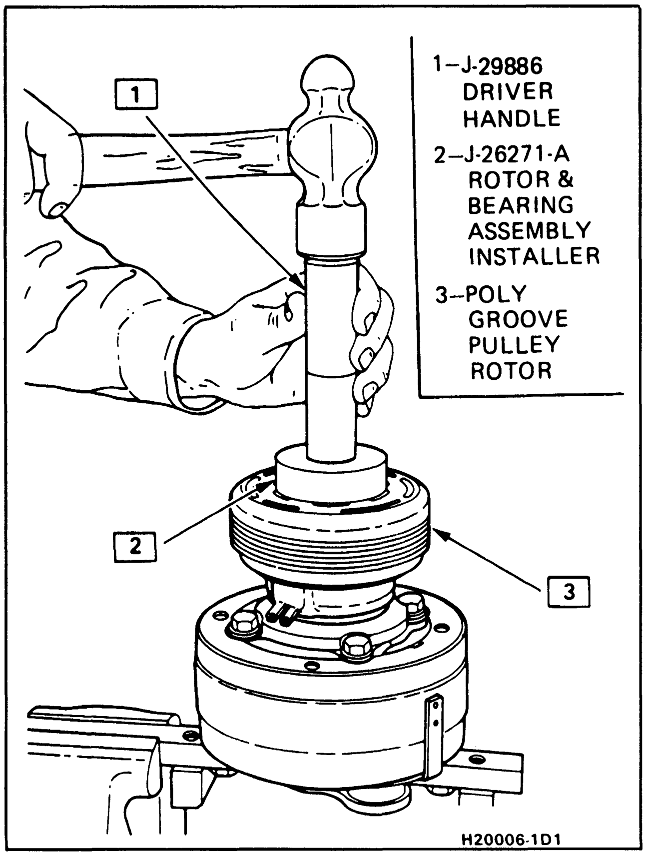


Figure 20-Installing Rotor and Bearing Assembly, Poly-Groove Type (On Bench)

4. Hold the J-33020 Puller in place and tighten the puller screw against the Puller Guide to remove the pulley rotor and bearing assembly.

5. To prevent damage to the pulley rotor during bearing removal, the rotor hub must be properly supported.

   Remove the forcing screw from J-33020 Puller and with the puller tangs still engaged in the rotor slots, invert the assembly onto a solid flat surface or blocks.

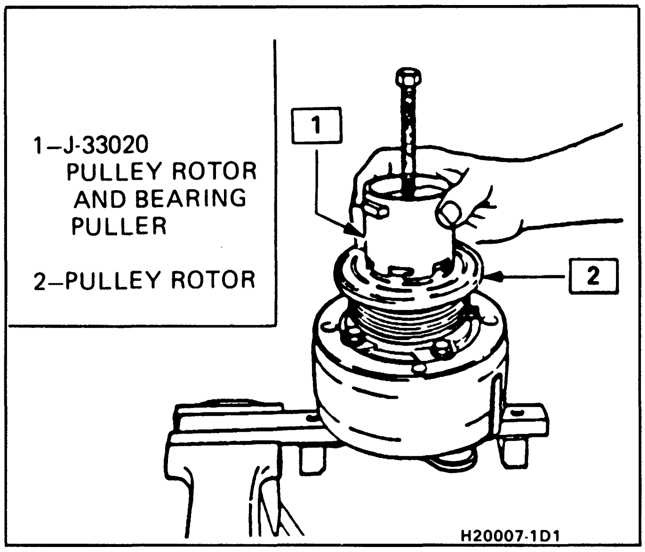


Figure 22-Pulley Rotor and Bearing Puller Installation

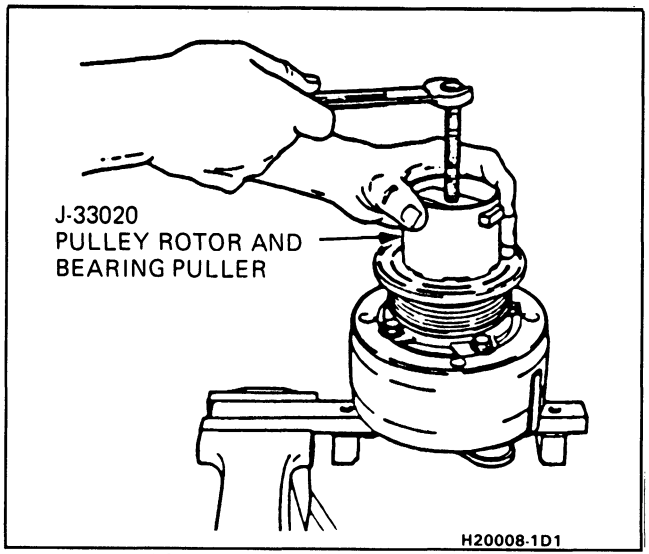


Figure 23-Pulley Rotor and Bearing Removal

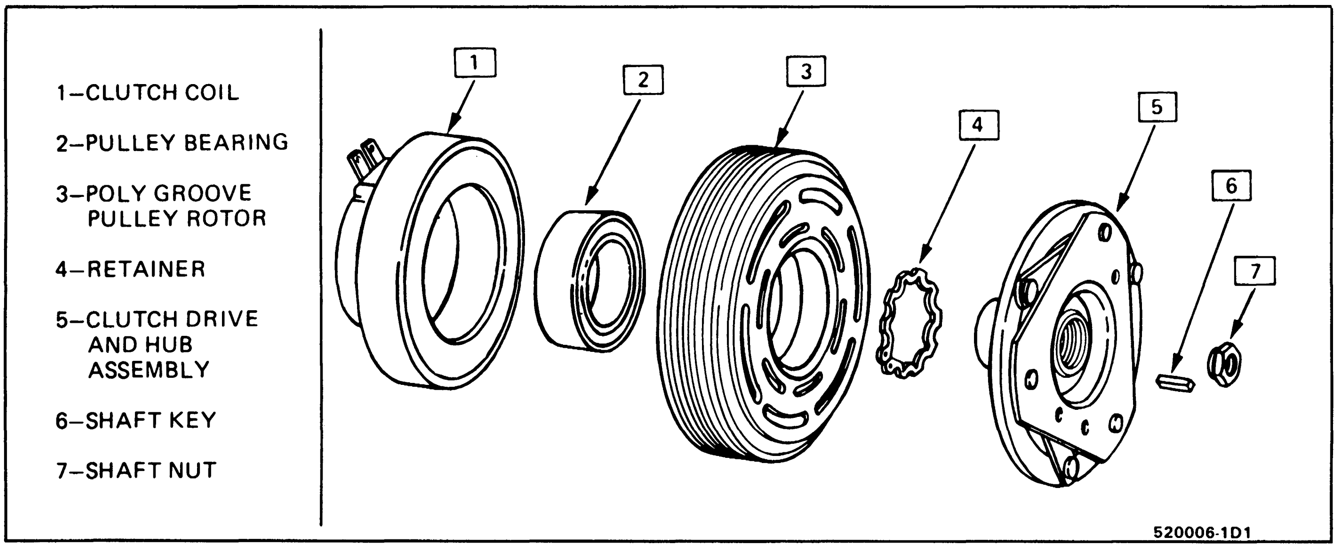


Figure 21-Disassembled View of Poly Groove Pulley Drive

6. Drive the bearing out of the rotor hub with Rotor Bearing Remover J-9398-A and J-29886 Universal Handle.
   It is not necessary to remove the staking in front of the bearing. However, it will be necessary to file away the old stake metal for proper clearance for the new bearing to be installed into the rotor bore or the bearing may be damaged.

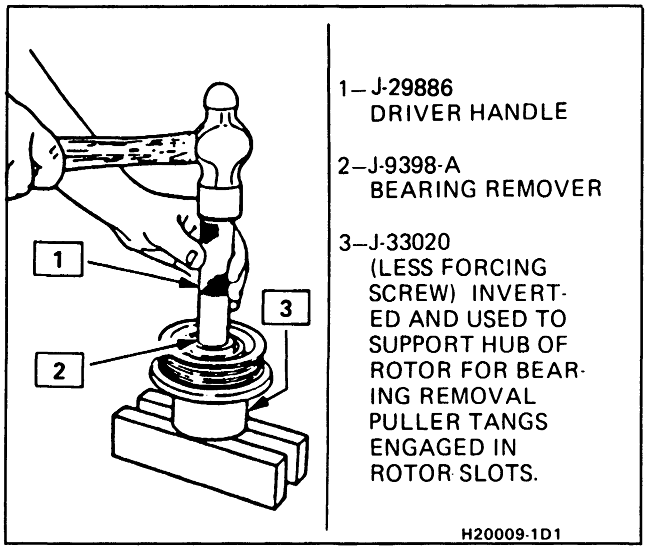


Figure 24-Bearing Removal

Install or Connect

1. Place the Pulley Rotor on the J-21352-A Support Block to fully support the rotor hub during bearing installation. **Do not** support the rotor by resting the pulley rim on a flat surface during the bearing installation or the rotor face will be bent.
2. Align the new bearing squarely with the hub bore and using Puller and Bearing Installer J-9481-A with with Universal Handle J-29886, drive the bearing fully into the hub. The Installer will apply force to the outer race of the bearing if used as shown.

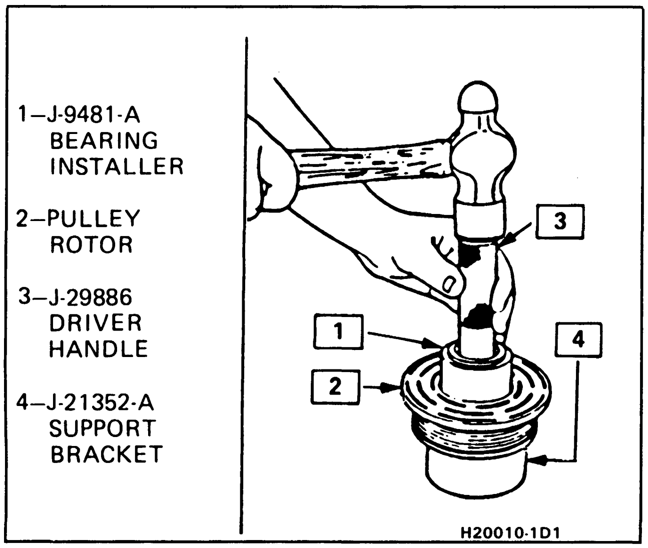


Figure 25-Bearing Installation

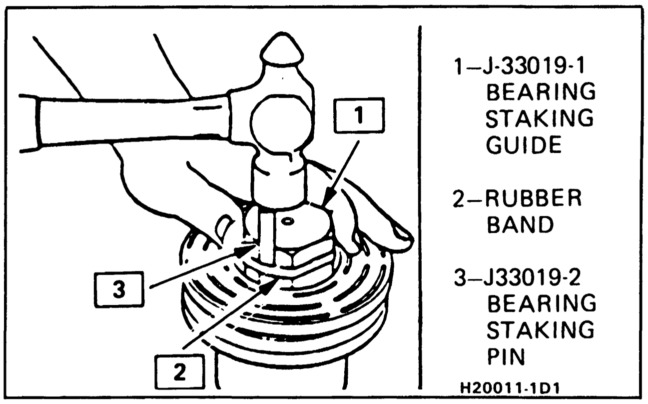


Figure 26-Bearing Staking

3. Place Bearing Staking Guide J-33019-1 and Bearing Staking Pin J-33019-2 in the hub bore. Shift the rotor and bearing assembly on the J-21352-A Support Block to give full support of the hub under the staking pin location. A heavy duty rubber band may be used to hold the stake pin in the guide, and the stake pin should be properly positioned in the guide after each impact on the pin.

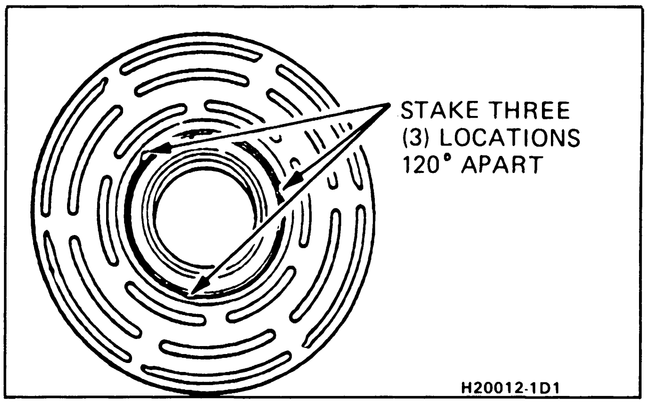


Figure 27-Staking Location

4. Using care to prevent personal injury, strike the staking pin with a hammer until a metal stake, similar to the original, is formed down to, but not touching, the bearing. Stake three places 120 degrees apart.

NOTICE: The stake metal should not contact the outer race of the bearing to prevent the possibility of distorting the outer race.

5. With the compressor mounted to the J-25008-A Holding Fixture, position the Rotor and Bearing Assembly on the front head. Using Rotor and Bearing Installer J-9481-A and Universal Handle J-29886 drive the rotor and bearing assembly onto the front head. With the Installer assembled to the Handle, force will be applied to the inner race of the bearing when installing the assembly onto the front head of the compressor.
6. Install rotor and bearing assembly retainer ring, using Snap Ring Pliers J-6083.
7. Reinstall clutch plate and hub assembly as described previously.

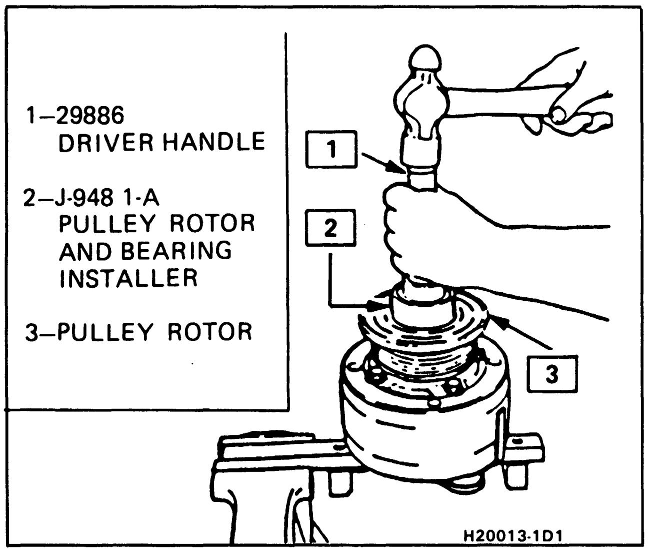


Figure 28-Pulley Rotor and Bearing Installation

CLUTCH COIL AND PULLEY RIM

Figures 29 through 34

Clutch coil and pulley rim installation and removal procedures for the six-pole clutch are the same as the four-pole clutch with the exception of Steps 1 through 4 of the clutch rotor and/or bearing - Six-Pole Clutch, removal or disconnect must be used.

V-Groove Drive

Remove or Disconnect

1. Perform Steps 1 through 4 of CLUTCH ROTOR AND BEARING removal procedure but do not loosen or remove the pulley rim mounting screws until the Clutch Rotor, Coil and Pulley Rim assembly have been removed from the Front Head. Be careful not to drop the Puller Guide J-25031 when removing the assembly.
2. Remove the pulley rim mounting screws and special lock washers. Discard the lock washers and screws.
3. Slide the pulley rim off the Rotor and Hub assembly. The Pulley Rim and the Clutch Coil are replaceable at this point.

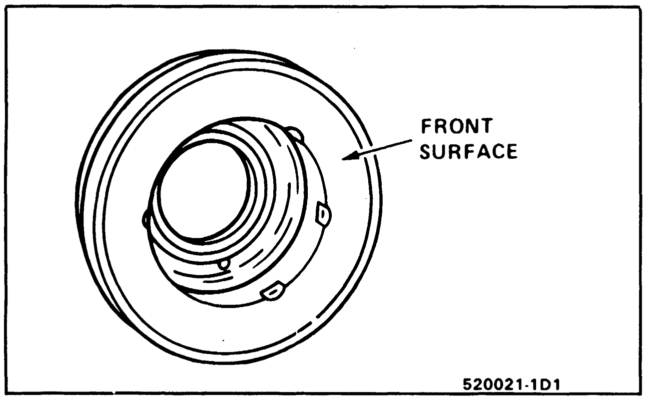


Figure 29-Clutch Coil Asembly

Poly-Groove Drive

Remove or Disconnect

1. Clutch plate and hub assembly
2. Pulley rotor and bearing assembly. Mark the location of the clutch coil terminals on the compressor.
3. Install Rotor and Bearing Puller Guide J-25031 to the front head and install Puller J-8433 with Poly-V-Belt Puller Leg Set J-24092 and remove the clutch coil from the front head. Clutch coil may also be removed by using rotor and Bearing Puller Guide J-25031 with Puller Tool J-25287.

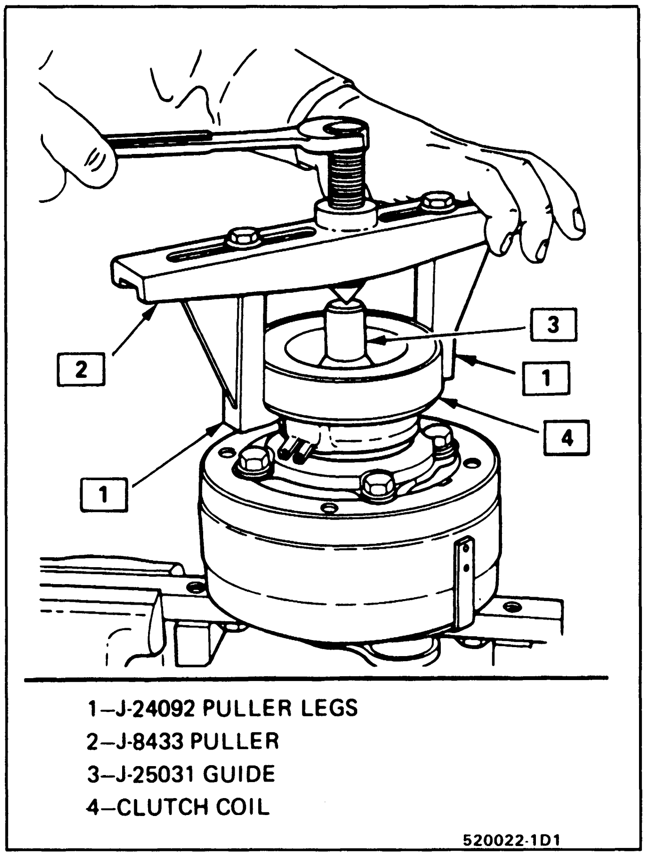


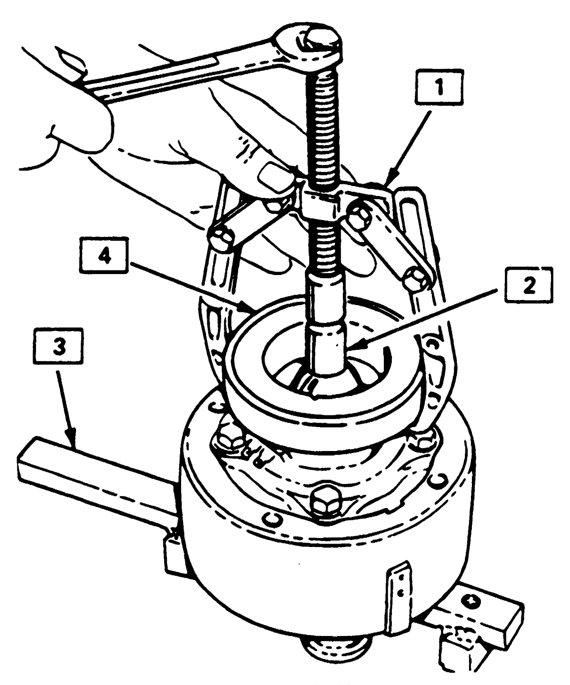
Figure 30-Removing Poly-Groove Clutch Coil

V-Groove Drive

Install or Connect

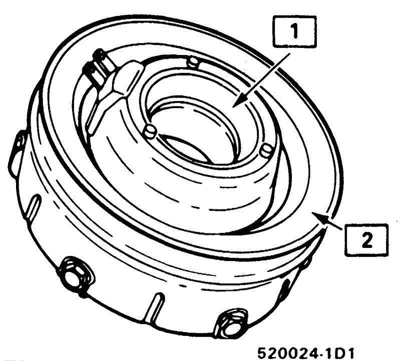
1. Assemble the Clutch Coil, Pulley Rim and the Clutch Rotor and Bearing assembly. Use new screws and special lock washers and apply sealer (Loctite RC-75, Loctite 601, or equivalent) to screw threads but do not lock the screws in place.
2. Place the assembly on the neck of the Front Head and seat into place using Rotor & Bearing Installer J-26271-A.

   Before fully seating the assembly on the Front Head, be sure the clutch coil terminals are in the proper location in relation to the compressor and that the three protrusions on the rear of the clutch coil align with the locator holes in the Front Head.



1–J-25287 CLUTCH COIL PULLER
2–J-25031 GUIDE
3–J-25008-A HOLDING FIXTURE
4–CLUTCH COIL

Figure 31-Removing Poly-Groove Clutch Coil (Optional Method)



1–CLUTCH COIL AND HOUSING ASM.

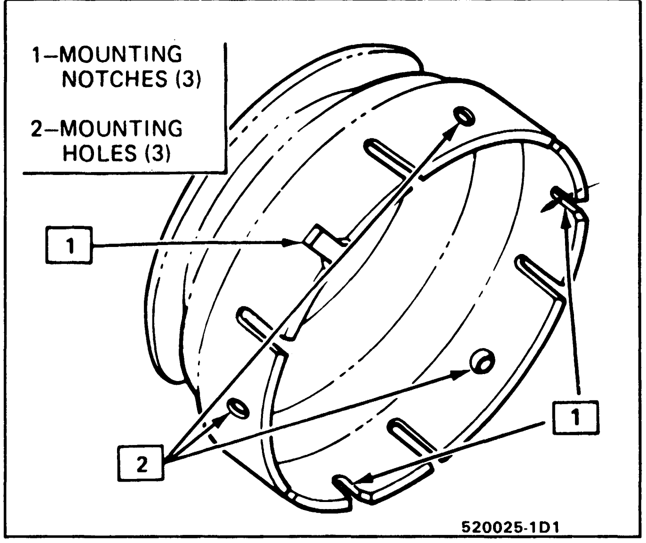
2–PULLEY RIM

Figure 32-Assembling Clutch Coil, Pulley Rim, Rotor and Bearing

3. Install the rotor and bearing assembly retaining ring and reassemble the Clutch Plate and Hub assembly as described in "Clutch Plate and Hub Assembly" Replacement procedure. Check to see that the clutch plate to clutch rotor air gap is 0.5 to 1.0mm (0.020 to 0.040 inches).

   Rotate the Pulley Rim and Rotor to be sure the Pulley Rim is rotating "in-line" and adjust or replace as required.

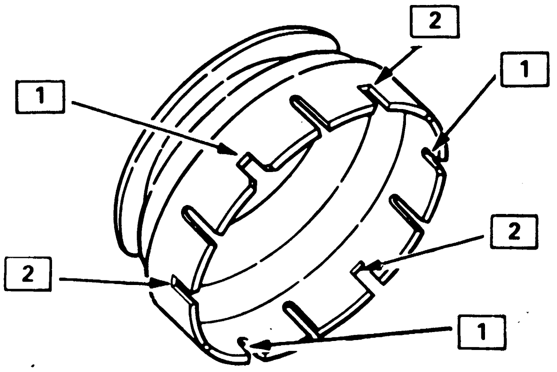
4. Tighten the pulley rim mounting screws to 11 N·m (100 lb. in.) torque and lock the screw heads in place by bending lock washers similar to original crimp and lock bends on washers.



1–MOUNTING NOTCHES (3)

2–MOUNTING HOLES (3)

Figure 33-Pulley Rim Mounting Location Detail



1– MOUNTING NOTCHES
2– MOUNTING SLOTS

Figure 34-Pulley Rim Mounting Location Detail - Optional Design

Poly-Groove Drive

Install or Connect

1. Place the clutch coil assembly on the neck of the front head with clutch coil terminals in line with mark scribed in Step 2 of the removal procedure.
2. Place the pulley rotor and bearing assembly on the neck of the front head and seat the clutch coil and pulley rotor in place using Rotor and Bearing Installer J-26271-A.

   Before fully seating the assembly on the front head, be sure the clutch coil terminals are in proper location in relation to the compressor and that the three protrusions on the rear of the clutch coil housing align with the locator holes in the front head.
3. Install the pulley rotor and bearing assembly retaining ring and reassemble the clutch plate and hub assembly as described in "Clutch Plate and Hub Assembly."
4. Check to see that the clutch plate to clutch rotor air gap is 0.5 - 1.0mm (0.020 - 0.040 inches).

MAJOR REPAIR PROCEDURES

Service repair procedures to the Compressor Shaft Seal, Pressure Relief Valve or disassembly of the Internal Compressor Cylinder and Shaft Assembly are considered "MAJOR" SINCE THE REFRIGERATION SYSTEM MUST BE DISCHARGED, EVACUATED AND RECHARGED to complete service and/or because major internal operating and sealing components of the compressor are being disassembled and serviced.

When replacing the shaft seal assembly or pressure relief valve, even if the compressor remains on the vehicle during the operation, it will be necessary to discharge the system of refrigerant (see Section 1B). Other than clutch repair procedures, the same holds true for any disassembly of the compressor.

If the compressor shell, front head or cylinder and shaft assembly are to be serviced or replaced, the oil in the compressor must be drained, measured and replaced (see Section 1B) to determine addition of proper oil quantity to new assembly.

A clean workbench, preferably covered with a sheet of clean paper, orderliness in the work area and a place for all parts being removed and replaced is of great importance, as is the use of the proper, clean service tools.

> **NOTICE:** Any attempt to use make-shift or inadequate equipment may result in damage and/or improper compressor operation.

All parts required for servicing the internal compressor are protected by a preservation process and packaged in a manner which will eliminate the necessity of cleaning, washing or flushing of the parts. The parts can be used in the internal assembly just as they are removed from the service package. *Seals and protective packaging should be left intact until just prior to installation.*

SHAFT SEAL

Figures 35 through 40

Shaft Seal Design

The shaft seal is a one piece design.

Seal Leak Detection

A shaft seal should not be changed because of an oil-line on the hood insulator. The Seal is designed to seep some oil for lubrication purposes. Only change a Shaft Seal when a leak is detected by evidence of oil sprayed in large amounts and then only after actual refrigerant leakage is found by using an approved leak Detector such as J-29547 or equivalent.

Should an R-4 compressor shaft seal ever have to be replaced, the accumulator in this R-4 system must also be removed from the vehicle. The oil in the accumulator then must be drained, measured and replaced according to the directions in Section 1B to determine oil loss.

Replacement (On-Vehicle)

Remove or Disconnect

1. Discharge A/C system. Refer to Section 1B.
2. Clutch Plate and Hub assembly. Refer to "Clutch Plate and Hub Assembly" in this section.
3. Shaft seal seat retainer ring, using Snap Ring Pliers J-5403-A.
4. Thoroughly clean inside of compressor neck area and O-ring groove surrounding the shaft, the exposed portion of the seal seat and the shaft itself. Any dirt or foreign material getting into compressor may cause damage.
5. Remove Lip Seal:
   - Fully engage the knurled tangs of Seal Remover-Installer J-23128-A into the recessed portion of the Seal by turning the handle clockwise. Remove the Seal from the compressor with a rotary-pulling motion. Discard the Seal. The handle must be hand-tightened securely. Do not use a wrench or pliers.
6. Discard the seal seat O-ring from the compressor neck using O-Ring Remover J-9553-01.
7. Recheck the shaft and inside of the compressor neck and O-ring groove for dirt or foreign material and be sure these areas are perfectly clean before installing new parts.

Inspection

Seals should not be reused. Always use a new specification service seal kit on rebuild. Care should be taken to prevent damage to the lip of the one piece seal. Make sure that the Seal Seat and Seal Lip are free of lint and dirt that could damage the seal surface or prevent sealing.

Install or Connect

1. Dip the new seal O-ring in clean 525 viscosity refrigerant oil and assemble onto O-Ring Installer J-33011.
2. Insert the O-Ring Installer J-33011 completely down into the compressor neck until the Installer "bottoms." Lower the moveable slide of the O-ring Installer to release the O-ring into the seal seat O-ring lower groove. (The compressor neck top groove is for the shaft seal retainer ring.) Rotate the Installer to seat the O-ring and remove the Installer.
3. Prepare Lip Seal:
   - Assemble seal to Seal Installer J-23128-A, by turning handle clockwise, and then push Seal Protector J-34614, into seal lip. The stamped steel case side of the lip seal must be engaged with knurled tangs of installer so that flared-out side of lip seal is facing and installed towards the compressor.
4. Install Lip Seal:
   - Place seal protector J-34614 over end of compressor shaft and slide new seal onto the

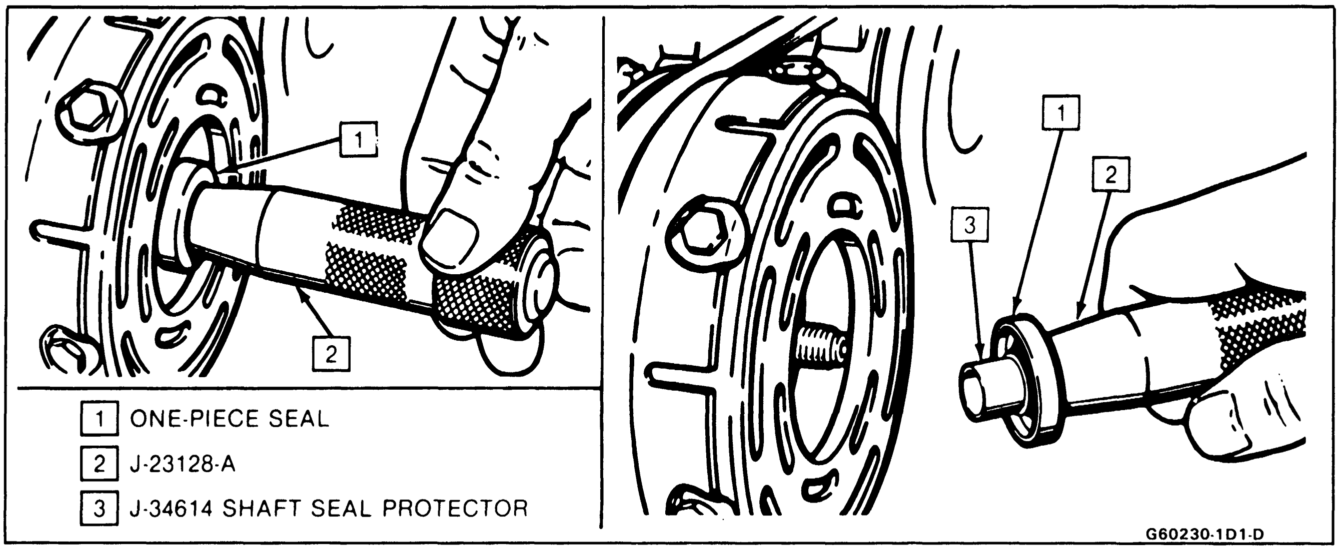


Figure 35-Removing and Installing Seal

shaft until it stops. Disengage installer from seal and remove seal protector from compressor shaft.

NOTICE: HANDLING AND CARE OF SEAL PROTECTOR IS IMPORTANT. IF SEAL PROTECTOR IS NICKED OR THE BOTTOM FLARED, THE NEW SEAL MAY BE DAMAGED DURING INSTALLATION.

5. Install the new seal seat retainer ring with its flat side against the Seal Seat, using Snap-Ring Pliers J-5403. Use the sleeve from O-Ring Installer J-33011 to press in on the seal seat retainer ring so that it snaps into its groove.
6. For Leak Test, pressurize suction side (low-pressure side) of compressor on vehicle with Refrigerant-12 vapor to equalize pressure to the drum pressure. Temporarily install the shaft nut and, with compressor in horizontal position, rotate the compressor shaft in normal direction of rotation several times by hand. Leak test the Seal and correct any leak found. Remove, discard and later replace the shaft nut.
7. Remove any excess oil, resulting from installing the new seal parts, from the shaft and inside the compressor neck.
8. Install the Clutch Plate and Hub assembly as described in "Clutch Plate and Hub Assembly" in this section.
9. Evacuate and Charge the Refrigerant System according to directions in Section 1B.

Replacement (Off-Vehicle)

Install or Connect

1. Follow applicable on-vehicle procedures.
2. To Leak Test, install leak Test Fixture J-9625 on rear head of compressor and connect gage charging lines, or pressurize suction side (low pressure side) of compressor on vehicle with Refrigerant-12 vapor to equalize pressure to the drum pressure. Temporarily install the shaft nut and, with compressor in horizontal position and using a wrench, rotate the compressor shaft in normal direction of rotation several times by hand. Leak test the seal and correct any leak found. Remove, discard and later replace with a new shaft nut.

PRESSURE RELIEF VALVE

Figure 41

The Pressure Relief Valve, located in the compressor rear head casting, should only be replaced after purging the system of refrigerant. A new valve and O-ring coated with 525 viscosity refrigerant oil should be installed.

HIGH PRESSURE CUT-OFF SWITCH

Figure 42

Remove or Disconnect

1. Discharge A/C system. Refer to Section 1B.
2. Electrical connector at switch
3. Switch retaining ring using J-5403-A Internal Snap Ring Pliers.
4. Switch from compressor by pulling on terminal housing.
5. Old O-ring seal from switch cavity using J-9553-01 O-ring removal tool or equivalent.

If high pressure cut-off switch will be reinstalled in compressor, a new O-ring seal must be used and preferably a new retainer ring should also be used. A new switch kit has the O-ring and retainer ring included.

Install or Connect

1. Check switch cavity and O-ring groove in the rear head for dirt or foreign material and clean as necessary. Install new O-ring coated with clean 525 viscosity refrigerant oil into groove in switch cavity.
2. Lubricate the high pressure cut-off switch housing with clean 525 viscosity refrigerant oil

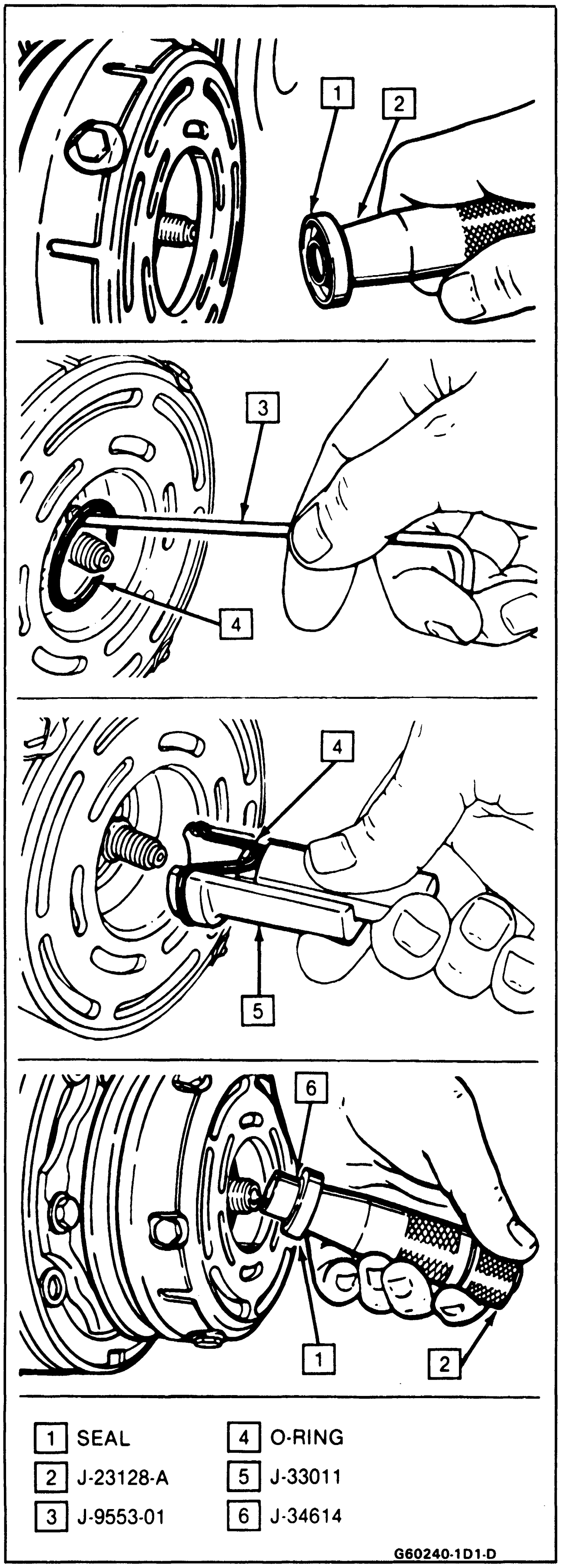


Figure 36-Removing and Installing Seal and O-Ring

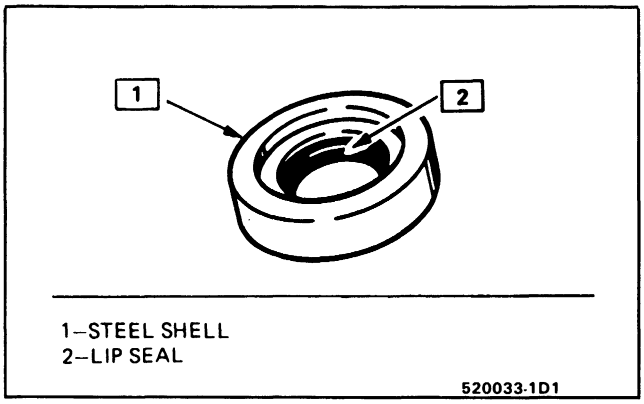


Figure 37-One Piece Shaft Seal

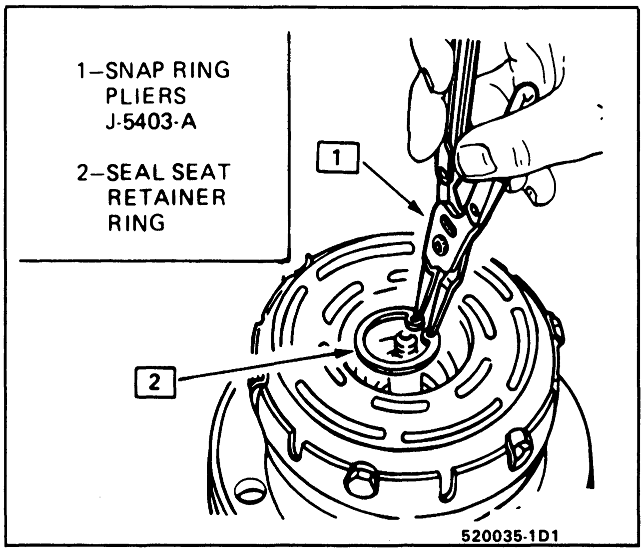


Figure 38-Removing and Installing Shaft Seal Seat Retaining Ring

and carefully insert switch into switch cavity until switch bottoms in cavity.

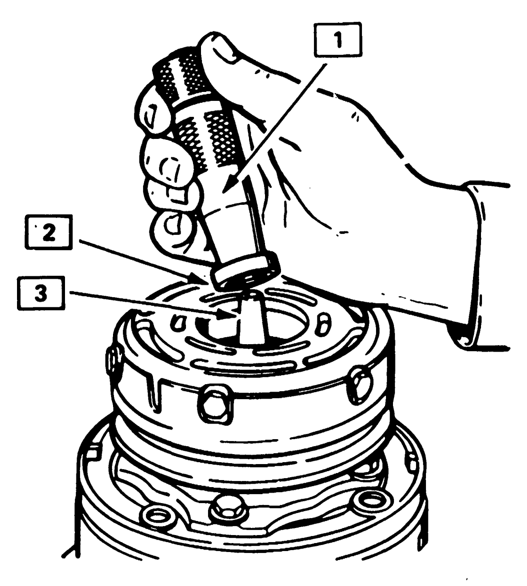
3. Using J-5403-A snap ring pliers, install switch retaining ring with high point of curved sides adjacent to the switch housing. Be sure retaining ring is properly seated in the switch cavity retainer ring groove.
4. Evacuate and charge the refrigerant system according to the directions in Section 1B.

FRONT HEAD AND O-RING

Figures 43 and 44

↔ Remove or Disconnect

1. Discharge the Refrigerant System according to the directions in Section 1B.
2. Perform steps 1 through 4 of CLUTCH ROTOR AND BEARING removal procedure, but do not loosen or remove the pulley rim mounting screws so as to remove the Clutch Rotor and Bearing, Clutch Coil and Pulley Rim as a total assembly. Be careful not to drop the Puller Guide J-25031 when removing the assembly.
3. Remove and discard the Shaft Seal parts as described in SHAFT SEAL removal procedure
4. Before removing front head, mark the cylinder next to the narrow front head leg position.



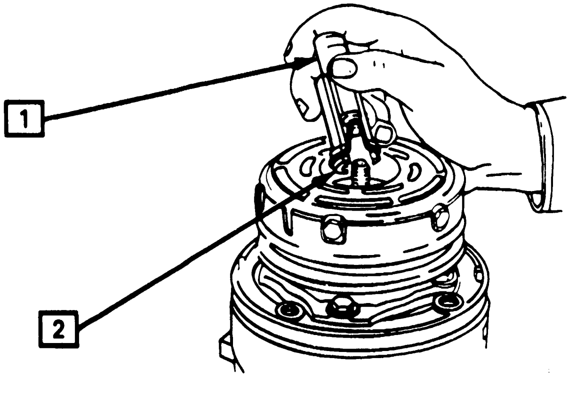
1–J-23128-A

2–ONE-PIECE SEAL

3–J-34614 - SHAFT SEAL PROTECTOR

520036-1D1

Figure 39-Removing and Installing One Piece Seal (Off-Vehicle)



1 J-33011 O-RING INSTALLER

2 SEAL SEAT O-RING

G60280-1D1-D

Figure 40-Installing Seal Seat O-Ring (Off-Vehicle)

5. Remove the four front head mounting screws and remove the Front Head assembly.

6. Remove and discard the front head O-ring.

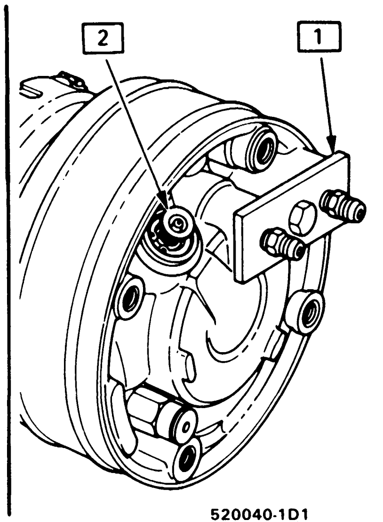
Install or Connect

1. Check the Front Head and compressor cylinder area for any dirt, lint, etc. and clean if necessary. Install a new Service thrust washer kit, if required, as described in THRUST AND BELLEVILLE WASHERS REMOVAL AND REPLACEMENT procedures.

1–LEAK TEST ADAPTER J 9625

2–HIGH PRESSURE CUT-OFF SWITCH

NOTICE: HIGH PRESSURE CUT-OFF SWITCH INSULATORS ARE COLORED RED



520040-1D1

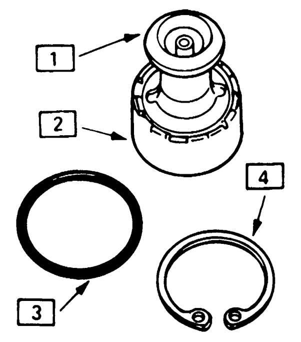
Figure 41-Compressor Leak Testing Fixture

1–RED INSULATOR

2–HIGH PRESSURE CUT-OFF SWITCH

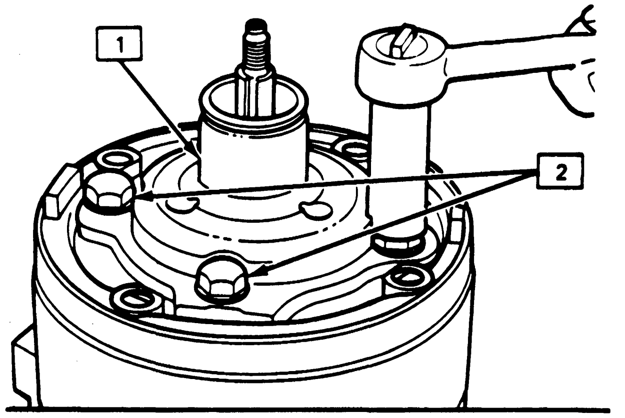
3–"O" RING

4–SWITCH RETAINING RING



520041-1D1

Figure 42-High Pressure Cut-Off Switch and Retainer



1–FRONT HEAD

2–MOUNTING SCREWS (4)

520042-1D1

Figure 43-Removing Front Head Mounting Screws

2. Dip the new front head O-ring in clean 525 viscosity refrigerant oil and install in the seal groove on the front head.

3. Position the Front Head narrow leg, to the marking previously made on cylinder, and tighten the front head mounting screws to 27 N·m (20 lb. ft.) torque.

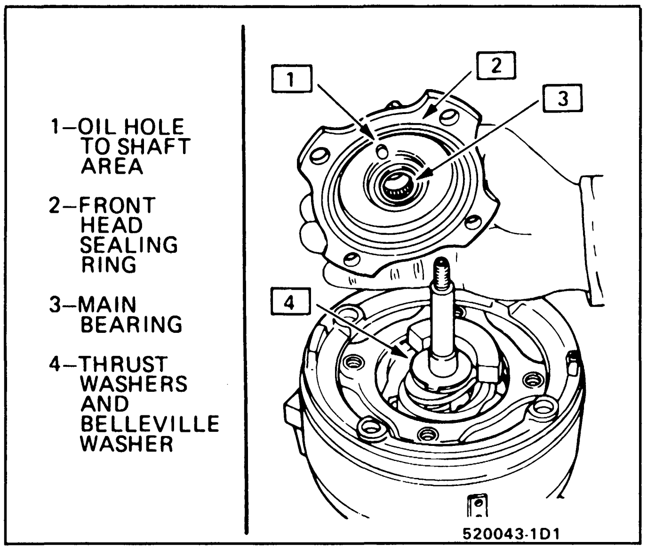


Figure 44-Removing Front Head Assembly

4. Install new specification Service Shaft Seal kit as described in SHAFT SEAL REPLACEMENT PROCEDURE.
5. Install the Clutch Rotor and Bearing assembly, Clutch Coil and Pulley Rim assembly to the Front Head, using Rotor and Bearing Installer J-26271-A.

   Before fully seating the assembly onto the Front Head, be sure the clutch coil terminals are in the proper location in relation to the compressor and that the three protrusions on the rear of the clutch coil align with the locator holes in the Front Head.
6. Install the rotor and bearing assembly retainer ring and reassemble the Clutch Plate and Hub assembly as described in CLUTCH PLATE AND HUB" replacement procedure. Check to see that the clutch plate to clutch rotor gap is 0.5 - 1.0mm (0.020 - 0.040 inches).
7. Evacuate and charge the refrigerant system according to the directions in Section 1B.

THRUST AND BELLEVILLE WASHERS

Figure 45

←→ Remove or Disconnect

1. Discharge the refrigerant system according to the directions in Section 1B.
2. Remove the Front Head assembly as described in "Front Head and O-Ring" removal procedure. Remove and discard the front head O-ring seal.
3. Remove the two thrust washers and one belleville washer from the compressor shaft. Note the assembled position of the washers.

→← Install or Connect

1. Install a new thrust washer on the compressor shaft with the thrust washer tang pointing "UP"
2. Install the new belleville washer on the shaft with the high center of the washer "UP."

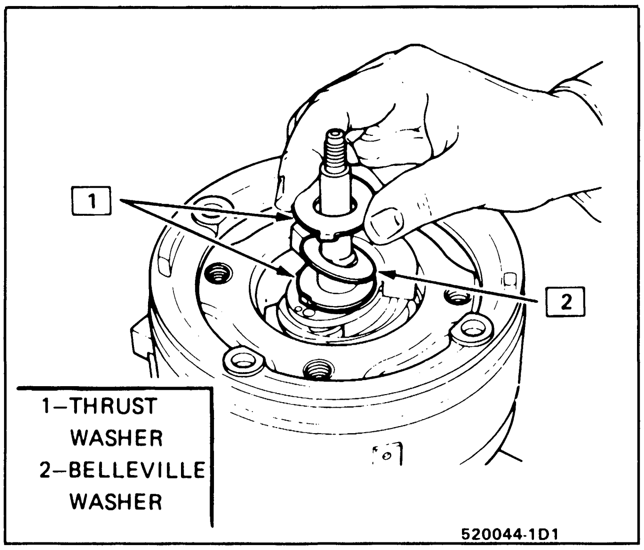


Figure 45-Replacing Thrust and Belleville Washers

3. Install the remaining thrust washer on the shaft with the tang pointing "DOWN".
4. Lubricate the three washers with clean 525 viscosity refrigerant oil and assemble the Front Head and new O-ring onto the compressor as described in "Front Head and O-Ring" replacement procedure.

MAIN BEARING

Figures 46 and 47

←→ Remove or Disconnect

1. Discharge the refrigerant system according to the direction in Section 1B.
2. Remove the Front Head assembly as described in "Front Head and O-Ring" removal procedure. Discard front head O-ring.
3. Place the Front Head assembly on two blocks, as shown in Figure 46, and use Main Bearing Remover J-24896 to drive the Main Bearing out of the Front Head.

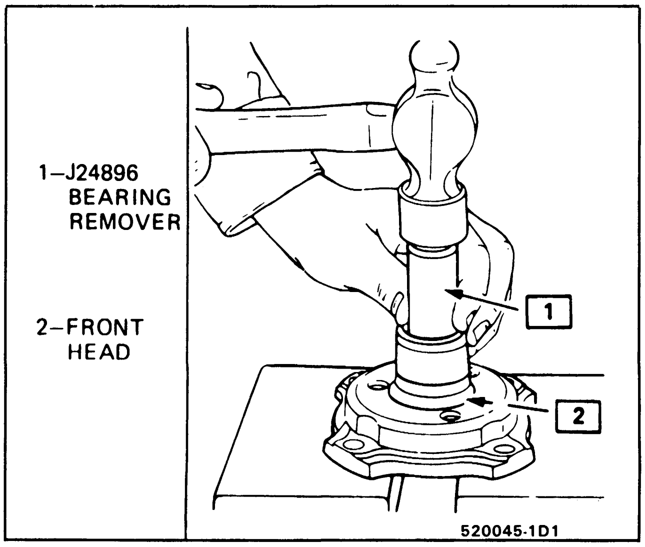


Figure 46-Removing Main Bearing

Install or Connect

1. Place the Front Head "with neck-end down" on a flat, solid surface.

Important

- The numbered letter side of the bearing must be placed against Bearing Installer J-24895.

2. Align the new Main Bearing and the Bearing Installer J-24895 squarely with the bearing bore of the Front Head and drive the bearing into the Front Head. The Installer J-24895 must seat against the Front Head to insert the bearing to the proper clearance depth.

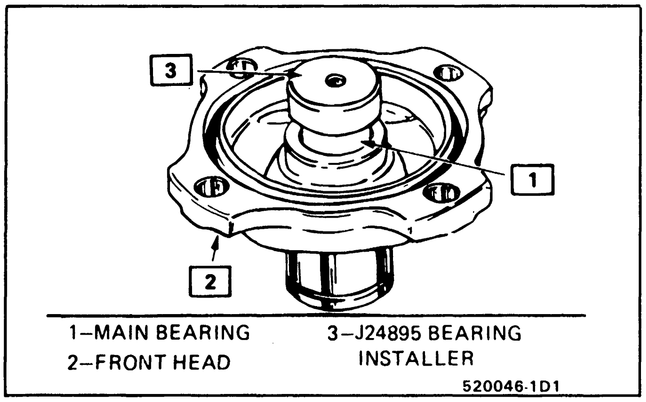


Figure 47-Installing Main Bearing

3. Assemble the Front Head to the cylinder, using a new O-ring as described in "Front Head and O-Ring" replacement procedure.
4. Evacuate and charge the refrigerant system according to the directions in Section 1B.

SHELL AND O-RINGS

Figures 48 through 50

Remove or Disconnect

1. Discharge the refrigerant system according to the directions in Section 1B.
2. Thoroughly clean exterior of compressor to prevent dirt from getting into compressor during shell removal.
3. Remove the Clutch Plate and Hub assembly as described in CLUTCH PLATE AND HUB removal procedures.
4. Perform Steps 1 through 4 of CLUTCH ROTOR AND BEARING removal procedure but do not loosen or remove the pulley rim mounting screws so as to remove the Clutch Rotor and Bearing, Clutch Coil and Pulley Rim as a total assembly. Be careful not to drop the Puller Guide J-25031 when removing the assembly.
5. Pry the shell retaining strap away from the cylinder and position the strap high enough to clear the cylinder as the Shell is removed.
6. Remove Compressor Holding Fixture J-25008-A, and reverse Holding Fixture with step block protrusions engaging the compressor Shell.

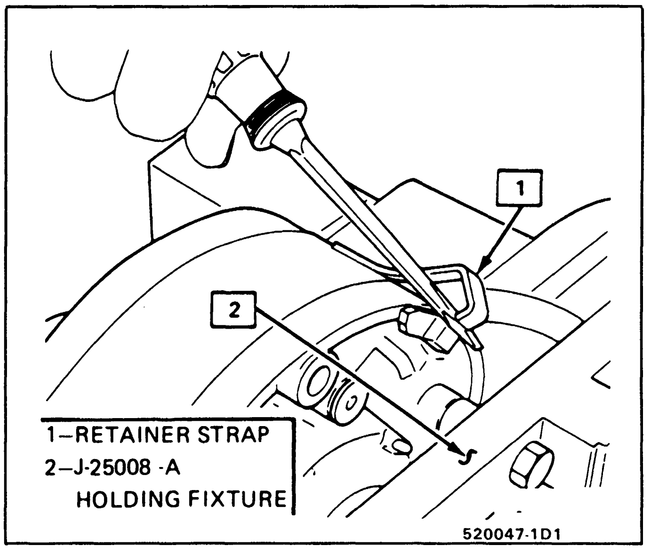


Figure 48-Releasing Shell Retaining Strap

Install the medium-length metric thread mounting bolts through the Holding Fixture and thread them finger-tight on both sides into the compressor cylinder until the step of the fixture protrusions contact the compressor Shell. Check to be sure the step protrusions do not overlap the cylinder but will pass both sides. Allow compressor to cool to room temperature before removing compressor shell.

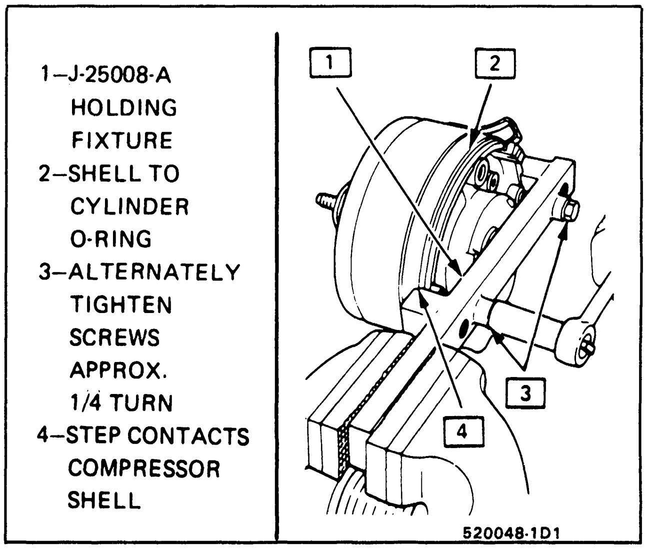


Figure 49-Removing Shell

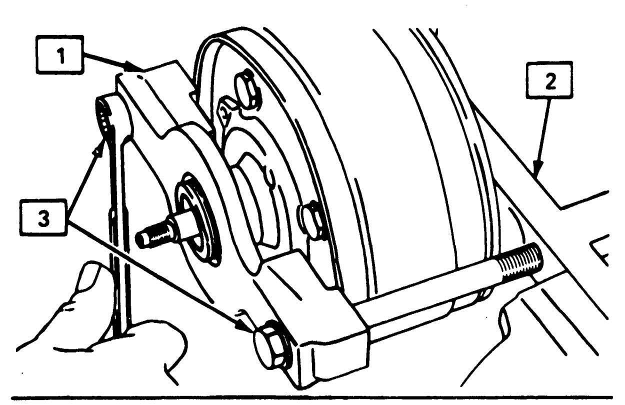
7. Alternately tighten each bolt approximately 1/4 turn to push the Shell free of the O-rings on the cylinder.

   If one screw appears to require more force to turn than the other, immediately turn the other screw to bring the screw threading sequence in-step or the Shell will be cocked and made more difficult to remove. Normal removal does not require much force on the wrench if the screws are kept in-step while turning. The Shell can be removed by hand as soon as the Shell is free of the shell to cylinder O-rings. Do not turn the screws any further than necessary to release the Shell.

8. Remove the compressor Shell and remove the Holding Fixture J-25008-A from the compressor. Reverse the Holding Fixture to again hold the compressor by the opposite side, using the short-length screws with metric threads.
9. Remove and discard both cylinder to Shell O-rings.

→← Install or Connect

1. Check the compressor cylinder assembly and interior of the compressor Shell to be sure they are free of lint, dirt, etc.
2. Dip a new cylinder-to-shell O-ring in clean 525 viscosity refrigerant oil and install in the rear O-ring groove of the cylinder. Be careful in moving the O-ring across the cylinder surface to prevent damaging the O-ring.
3. Dip the remaining cylinder-to-shell O-ring in the 525 oil and install it in the front O-ring groove of the cylinder.
4. Also coat inner O-ring surface of compressor Shell with oil. Place the compressor Shell on the cylinder and rotate the retaining strap to its original location.
5. Attach the Shell Installing Fixture J-25008-A to the Holding Fixture J-25008-A, using the long-bolts and plate washers of the set. Align the step projections of the Installing Fixture J-25008-A, to contact the compressor Shell evenly on both sides.
6. Push the compressor shell as close to the O-ring as possible by hand and check for equal alignment of the shell around the cylinder. Tighten the Fixture screws finger tight.



1–J-25008-A COMPRESSOR SHELL INSTALLER 2–J-25008-A HOLDING FIXTURE 3–ALT. TIGHTEN SCREWS APPROX. 1/4 TURN

520049-1D1

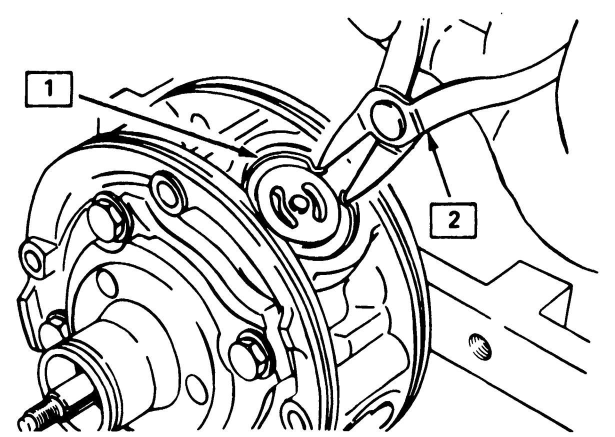
Figure 50-Installing Shell

7. Alternately tighten each bolt approximately 1/4 turn to push the compressor Shell over the O-rings and back against the shell stop flange at the rear of the compressor cylinder.

   If one screw appears to require more force to turn than the other, immediately turn the other screw to bring the screw threading sequence in-step or the shell will be cocked and made more difficult to install. Normal installation does not require much force on the wrench if the screws are kept in-step while turning.
8. When the shell is seated against the stops, bend the shell retaining strap down into place by tapping gently with a hammer. Remove the Shell Installing Fixture J-25008-A.
9. Reinstall Clutch Rotor and Bearing Asm., Clutch Coil and Pulley Rim as an assembly with Installer J-26271-A, and the Clutch Plate and Hub Assembly with Installer J-9401-B.
10. "Evacuate and Charge the Refrigerant System" according to the directions in Section 1B.

DISCHARGE VALVE PLATE AND RETAINER

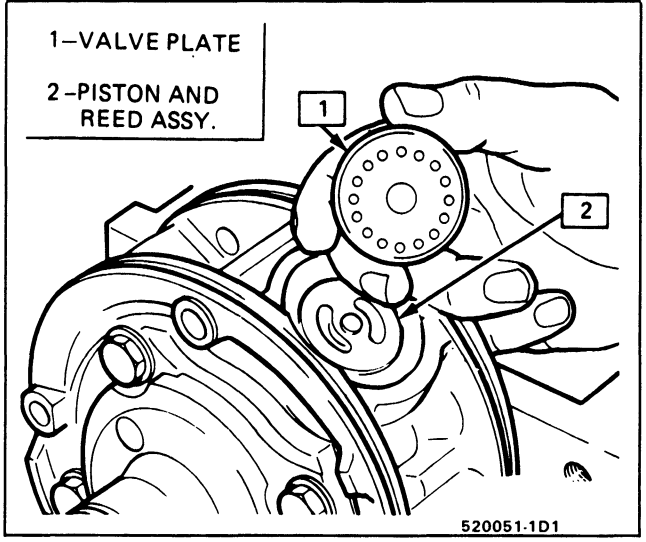
Figures 51 and 52



1–VALVE PLATE RETAINER RING 2–J 4245 PLIERS

520050-1D1

Figure 51-Replacing Valve Plate Retainer



1–VALVE PLATE
2–PISTON AND REED ASSY.

520051-1D1

Figure 52-Replacing Discharge Valve Plate

←→ Remove or Disconnect

1. Discharge the refrigerant system according to the directions in Section 1B.

2. Perform Steps 1 through 9 of SHELL AND O-RINGS removal procedure.
3. Remove valve plate retainer ring, using Internal Snap Ring Pliers J-4245. Remove Compressor Discharge Valve Plate for valve plate replacement and/or piston inspection.

   Repeat this operation for additional valve plates and retainer rings. If all four valve plates and retainers are to be removed, remove two sets and then rotate compressor and Holding Fixture J-25008-A in vise for access to the remaining two valve plates and retainers.

→← **Install or Connect**

1. Install Discharge Valve Plates and/or Retainers. Reposition compressor and Holding Fixture in vise as necessary for access. **Valve plates must be tight following retainer assembly.**
2. Reinstall compressor Shell as described in SHELL AND O-RINGS replacement procedures.
3. Evacuate and charge the refrigerant system according to the directions in Section 1B.

CYLINDER AND SHAFT ASSSEMBLY

←→ **Remove or Disconnect**

1. Discharge the refrigerant system according to the directions in Section 1B.
2. Remove the Clutch Plate and Hub assembly as described in CLUTCH PLATE AND HUB removal procedure.
3. Perform Steps 1 through 4 of CLUTCH ROTOR AND BEARING removal procedure but do not loosen or remove the pulley rim mounting screws. Remove the Clutch Rotor and Bearing, Clutch Coil and Pulley Rim as an assembly. Be careful not to drop the Puller Guide J-25031, when removing the assembly.
4. Remove the shaft seal as described in SHAFT SEAL removal procedure.
5. Remove the front head as described in "Front Head and O-Ring" removal procedure.
6. Remove the thrust and belleville washers as described in THRUST AND BELLEVILLE WASHERS removal procedures.
7. Remove the compressor shell as described in "Shell and O-Ring" removal procedure.
8. Remove the discharge valve plate and retainer as described in DISCHARGE VALVE PLATE AND RETAINER removal procedure.
9. Remove the high pressure relief valve as described in "High Pressure Cut-Off Switch."

→← **Install or Connect**

1. Replace above parts in opposite order.
2. Evacuate and charge the refrigerant system according to the directions in Section 1B.

LEAK TESTING (EXTERNAL AND INTERNAL)

Bench-Check Procedure

1. Install Test Plate J-9625-A on Rear Head of compressor.
2. Attach center hose of Manifold Gage Set on Charging Station to a refrigerant drum standing in an upright position and open valve on drum.
3. Connect Charging Station high and low pressure lines to corresponding fittings on Test Plate J-9625-A, using J-5420 Gage Adapters if hoses are not equipped with valve depressors.
   - Suction port (low-side) of compressor has large internal opening. Discharge port (hi-side) has smaller internal opening into compressor.
4. Open low-pressure control, high-pressure control and refrigerant control on Charging Station to allow refrigerant vapor to flow into compressor.
5. Using a Leak Detector, check for leaks at Pressure Relief Valve, compressor shell to cylinder, compressor front head seal, and compressor Shaft Seal. After checking, shut off low pressure control and high pressure control on Charging Station.
6. If an external leak is present, perform the necessary corrective measures and recheck for leaks to make certain the leak has been corrected.
7. Loosen the Manifold Gage hose connections to the Gage Adapters J-5420 connected to the low and high sides and allow the vapor pressure to release from the compressor.
8. Disconnect both Gage Adapters J-5420 from the Test Plate J-9625-A.
9. Rotate the complete compressor assembly (not the crankshaft or drive plate hub) slowly several turns to distribute oil to all cylinder and piston areas.
10. Install a shaft nut on the compressor crankshaft if the drive plate and clutch assembly are not installed.
11. Using a box-end wrench or socket and handle, rotate the compressor crankshaft or clutch drive plate on the crankshaft several turns to ensure piston assembly to cylinder wall lubrication.
12. Connect the Charging Station high pressure line or a high pressure gage and Gage Adapter J-5420 to the Test Plate J-9625-A high side connector.
13. Attach an Adapter J-5420 to the suction or low pressure port of the Test Plate J-9625-A to open the Schrader-type valve.

    Oil will drain out of the compressor suction port adapter if the compressor is positioned with the suction port downward.
14. Attach the compressor to the Holding Fixture J-25008-A using metric mounting screws. Clamp the compressor Holding Fixture in a vise so that the compressor can be manually turned with a wrench.
15. Using a wrench, rotate the compressor crankshaft or drive plate hub ten complete revolutions at a speed of approximately one-revolution per second.

Turning the compressor at less than one-revolution per second can result in a lower pump-up pressure and disqualify a good pumping compressor.

16. Observe the reading on HIGH pressure gage at the completion of the tenth revolution of the compressor. The pressure reading for a good pumping compressor should be 344.75 kPa (50 p.s.i.) or above. A pressure reading of less than 310. 275 kPa (45 p.s.i.) would indicate one or more suction and/or discharge valves leaking, an internal leak or an inoperative valve, and the compressor should be disassembled and checked for cause of leak. Repair as needed, reassemble and repeat the pump-up test. Externally leak test.
17. When the pressure pump-up test is completed, release the air pressure from the HIGH side and remove the Gage Adapters J-5420 and Test Plate J-9625-A.
18. On the R-4 compressor, tilt the compressor so that the compressor suction and discharge ports are down. Drain the oil from the compressor.
19. Allow the compressor to drain for 10 minutes, then charge with the proper amount of oil. The oil may be poured into the suction port.

If further assembly or processing is required, a shipping plate or Test Plate J-9625-A should be installed to keep out air, dirt and moisture until the compressor is installed.

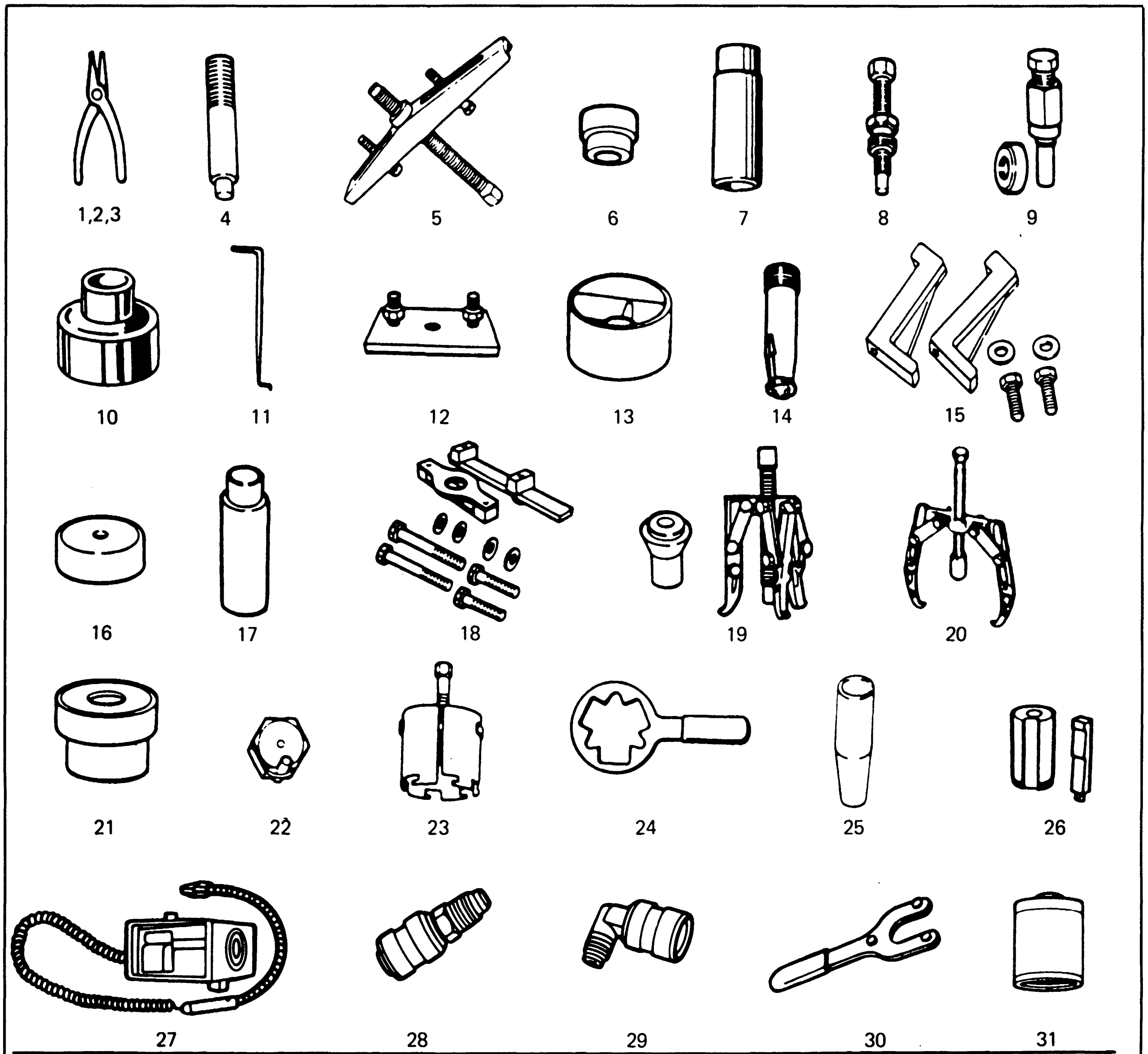
SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Clutch Plate Shaft Nut	14 N·m (10 lb. ft.)
Pulley Rim Mounting Screw	11 N·m (100 lb. in.)
Front Head Mounting Screw	27 N·m (20 lb. ft.)

COMPRESSOR SPECIFICATIONS

Clutch Plate to Clutch Rotor Gap	0.5 mm to 1.0 mm (0.020 to 0.040 inch)
Minimum Compressor Pressure	344.75 kPa (50 psi)
Lubricant	525 viscosity oil



1-J-4245	SNAP RING PLIERS (#23 INTERNAL)
2-J-5403	SNAP RING PLIERS (#21 INTERNAL)
3-J-6083	SNAP RING PLIERS (#24 INTERNAL)
4-J-29886	DRIVER HANDLE
5-J-8433	COMPRESSOR PULLEY PULLER
6-J-9398-A	ROTOR BEARING REMOVER
7-J-9399	9/16" THIN WALL SOCKET
8-J-33013-B	HUB AND DRIVE PLATE ASSEMBLY REMOVER
9-J-9480-B	HUB AND DRIVE PLATE ASSEMBLY INSTALLER
10-J-9481-A	PULLEY BEARING AND PULLEY INSTALLER
11-J-9553-01	O-RING REMOVER
12-J-9625-A	PRESSURE TEST CONNECTOR
13-J-21352-A	COMPRESSOR SUPPORT BLOCK
14-J-23128-A	SEAL REMOVER AND INSTALLER
15-J-24092	PULLEY HUB ADAPTER SET (USED WITH J-8433)
16-J-24895	BEARING INSTALLER (FRONT END)
17-J-24896	BEARING REMOVER (FRONT HEAD)
18-J-25008-A	COMPRESSOR HOLDING FIXTURE
19-J-25031	ROTOR AND BEARING PULLER WITH GUIDE
20-J-25287	CLUTCH COIL PULLER
21-J-26271-A	ROTOR AND BEARING INSTALLER (WITHOUT HANDLE)
22-J-33019	BEARING STAKING TOOL
23-J-33020	PULLEY PULLER
24-J-33027	CLUTCH HUB HOLDING TOOL
25-J-34614	SHAFT SEAL PROTECTOR
26-J-33011	SEAL SEAT O-RING INSTALLER
27-J-29547	ELECTRONIC LEAK DETECTOR
28-J-5420	7/16"-20 STRAIGHT ADAPTER
28-J-25498	7/16"-20 x 3/8"-24 STRAIGHT ADAPTER
29-J-9459	7/16"-20 90° ELBOW ADAPTER
29-J-25499	7/16"-20 x 3/8"-24 90° ELBOW ADAPTER
30-J-25030	CLUTCH HUB HOLDING TOOL
31-J-33024	CLUTCH COIL INSTALLER ADAPTER

MC0001-1D1-B-RP

Figure 53-Special Tools

SECTION 2B

BUMPERS

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 2B-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

NOTICE: The anti-theft label on some major sheet metal, engines, and transmissions must be masked prior to painting, rustproofing, undercoating, etc. The mask must be removed following the above operations. Failure to keep the label clean and readable may result in liability for violation of Federal Vehicle Theft Prevention Standard, and subject the vehicle owner to possible suspicion that the part was stolen.

CONTENTS

GENERAL DESCRIPTION

The front bumper design is a full width honeycomb energy absorber of guide flex (or equivalent) material backed up by a rigidly mounted impact bar of high strength steel. The bumper cover (fascia) is urethane painted body color. The rear bumper is of a similar design.

The bumpers are designed so that the vehicle can withstand a collision into a fixed barrier at 8 km/h (5 mph). After absorbing the energy of a collision, the bumpers restore themselves to their original position.

ON-VEHICLE SERVICE

REFINISHING BUMPERS

Urethane material will withstand minor impact and the resultant damage, such as occurs in parking lots, by recovering its original shape. Its Endura paint film responds to impact in a similar manner without cracking or splitting. If however, an area of damage in the urethane bumper or panel does not recover its shape or the surface is punctured, gouged or torn, a repair system has been developed to restore the original shape and appearance of the urethane-based material. Refer to GENERAL BODY SERVICE PROCEDURES (SEC. 10-1).

LICENSE POCKET TRIM REPAIR

1. If an old fascia is being repaired, pull off any remaining pieces of trim. Remove any metal clips that were used for assembly (these are not required for repair). Scrape off any remaining adhesive so that the fascia presents a clean surface. Avoid excessive scraping of the paint (adhesive bonds better to the urethane paint than to the raw fascia).
2. If a new fascia is being installed, paint body color and dry the paint thoroughly (do not mask the area where the trim will be attached). Refer to GENERAL BODY SERVICE PROCEDURES (SEC. 10-1).
3. Clean the rib where the trim is to be mounted by wiping with general purpose adhesive cleaner. Wait 30 minutes (allowing cleaner to flash off).
4. Apply a 5 mm (3/16 inch) diameter bead of silicone RTV adhesive to the base of the "U" channel of the trim molding.
5. Gently press molding onto fascia and align.
6. Firmly press molding flush to fascia. Allow adhesive to cure a minimum of 24 hours.

FRONT LICENSE PLATE BRACKET

↔ Remove or Disconnect

1. Bolts attaching front license plate bracket to front bumper fascia.
2. License plate bracket from front bumper fascia

Install or Connect

NOTICE: See "Notice" on page 2B-1 of this section.

- Align holes in license plate bracket with holes in front bumper fascia.
- Bolts attaching license plate bracket to front bumper fascia.

Tighten

- Bolts to 6 N·m (53 lb. in.).

FRONT BUMPER FASCIA REPLACEMENT

Figures 1 through 3

Remove or Disconnect

1. Negative battery cable.
2. Air cleaner and electrical connectors, if necessary.
3. Push-on retainers (41) and bolts (50) from bumper filler (42).
4. Bumper filler (42).
5. Nuts (23) attaching the fascia center bracket (21) to the front end panel reinforcement (19).
6. Headlamp electrical connectors.

- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

7. Fog lamp electrical connectors, if equipped.
8. Clips (53) and retainers (39) attaching the front bumper fascia extension (5) to the front fender (33).
9. Nuts (51) and bolts (24) attaching the bumper fascia (1) to the front fender (33).
10. Turn signal bulbs and sockets.
11. Bolts (36) from the bumper impact bar (3) and radiator lower air baffle (18), if equipped.
12. Radiator lower air baffle (18), if equipped.
13. Push-on retainers (27) attaching bumper fascia (1) to the bumper impact bar (3).

- Lower vehicle.

14. Bolts (47) attaching the outer brackets (25) to the front end inner structure.
15. Bumper fascia (1) with the aid of a helper.

Install or Connect

NOTICE: See "Notice" on page 2B-1 of this section.

1. Bumper fascia (1) with the aid of a helper.
2. Bolts (47) to the outer bracket (25) and front inner structure.

Tighten

- Bolts (47) to 9.5 N·m (84 lb. in.).

- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

3. Push-on retainers (27) to the bumper fascia (1) and bumper impact bar (3).
4. Radiator lower air baffle (18), if equipped.
5. Bolts (36) to the radiator lower air baffle (18) and the bumper impact bar (3).

Tighten

- Bolts (36) to 1.9 N·m (17 lb. in.).

6. Turn signal bulbs and sockets.
7. Nuts (51) and bolts (24) to the bumper fascia (1) and front fender (33).

Tighten

- Nuts (51) to 4.3 N·m (38 lb. in.).
- Bolts (24) to 1.9 N·m (17 lb. in.).

8. Clips (53) and retainers (39) to the front bumper fascia extension (5) and front fender (33).
9. Fog lamp electrical connectors, if equipped.

- Lower the vehicle.

10. Headlamp electrical connectors.
11. Nuts (23) to the fascia center bracket (21) and the front end panel reinforcement (19).

Tighten

- Nuts (23) to 4.2 N·m (37 lb. in.).

12. Bumper filler (42).
13. Push-on retainers (41) and bolts (50) to the bumper filler (42).
14. Air cleaner and electrical connectors, if necessary.
15. Negative battery cable.

FRONT BUMPER FASCIA EXTENSION REPLACEMENT

Figures 1 and 3

Remove or Disconnect

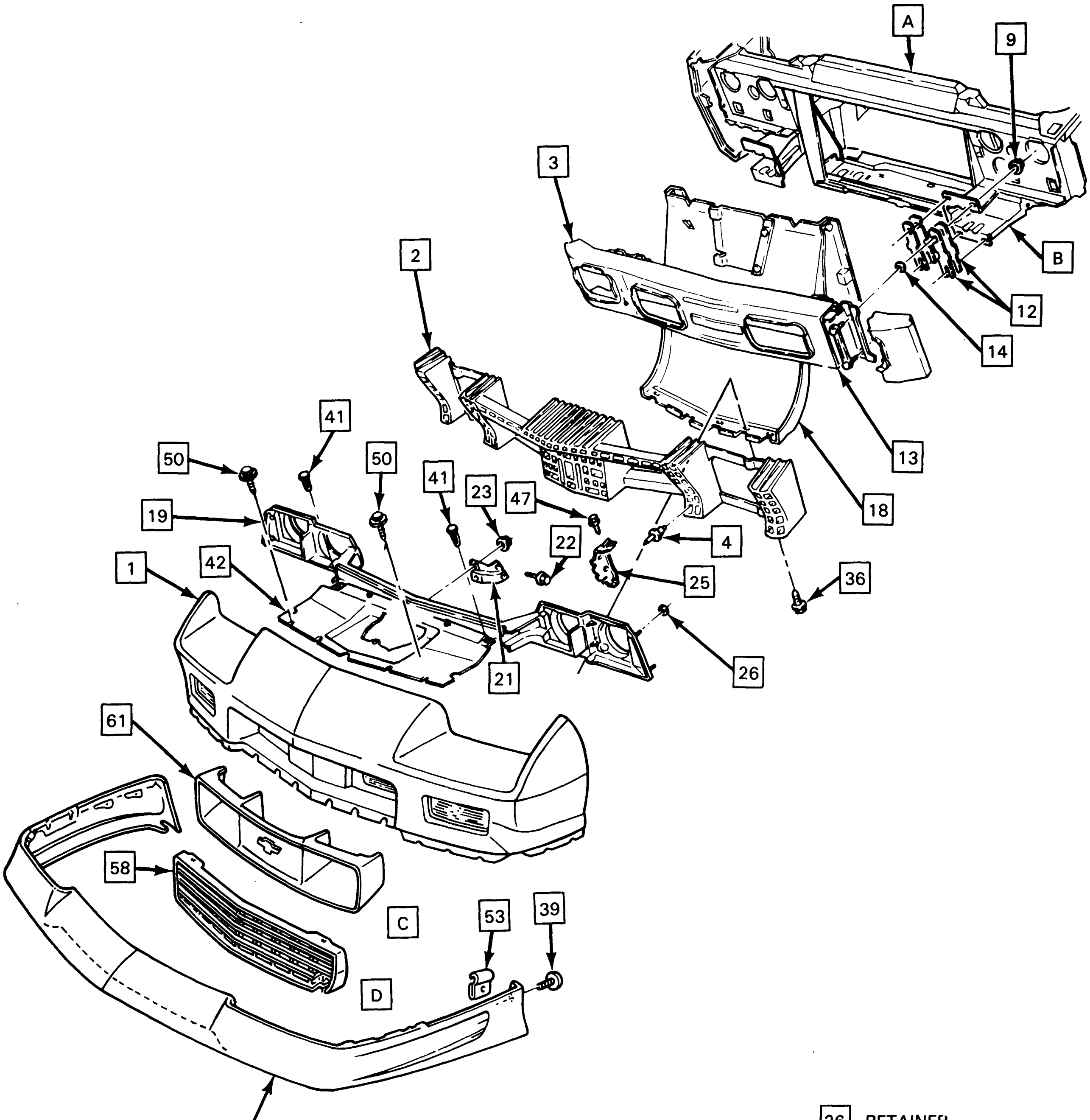
- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. OA).

1. Bolts (36) from radiator lower air baffle (18).
2. Radiator lower air baffle (18).
3. Retainers (39).
4. Clips (53).
5. Bolts (54).
6. Front bumper fascia extension (5).

Install or Connect

NOTICE: See "Notice" on page 2B-1 of this section.

1. Front bumper fascia extension (5).
   - Fit tabs into slots.
2. Bolts (54).
   - Put bolts in hand-tight. Tighten from the center of the front bumper fascia extension (5) going outward



A	FRONT INNER STRUCTURE
B	ENGINE COMPARTMENT RAIL
C	Z28 MODEL
D	RS MODEL
1	BUMPER FASCIA
2	ENERGY ABSORBER
3	BUMPER IMPACT BAR
4	RIVET
5	FRONT BUMPER FASCIA EXTENSION
9	NUT
12	SHIM
13	STUD PLATE
14	PUSH-ON NUT
18	RADIATOR LOWER AIR BAFFLE
19	FRONT END PANEL REINFORCEMENT
21	CENTER BRACKET
22	BOLT
23	NUT
25	OUTER BRACKET
26	RETAINER
36	BOLT
39	RETAINER
41	RETAINER
42	BUMPER FILLER
47	BOLT
50	BOLT
53	CLIP
58	RADIATOR GRILLE
61	RADIATOR GRILLE

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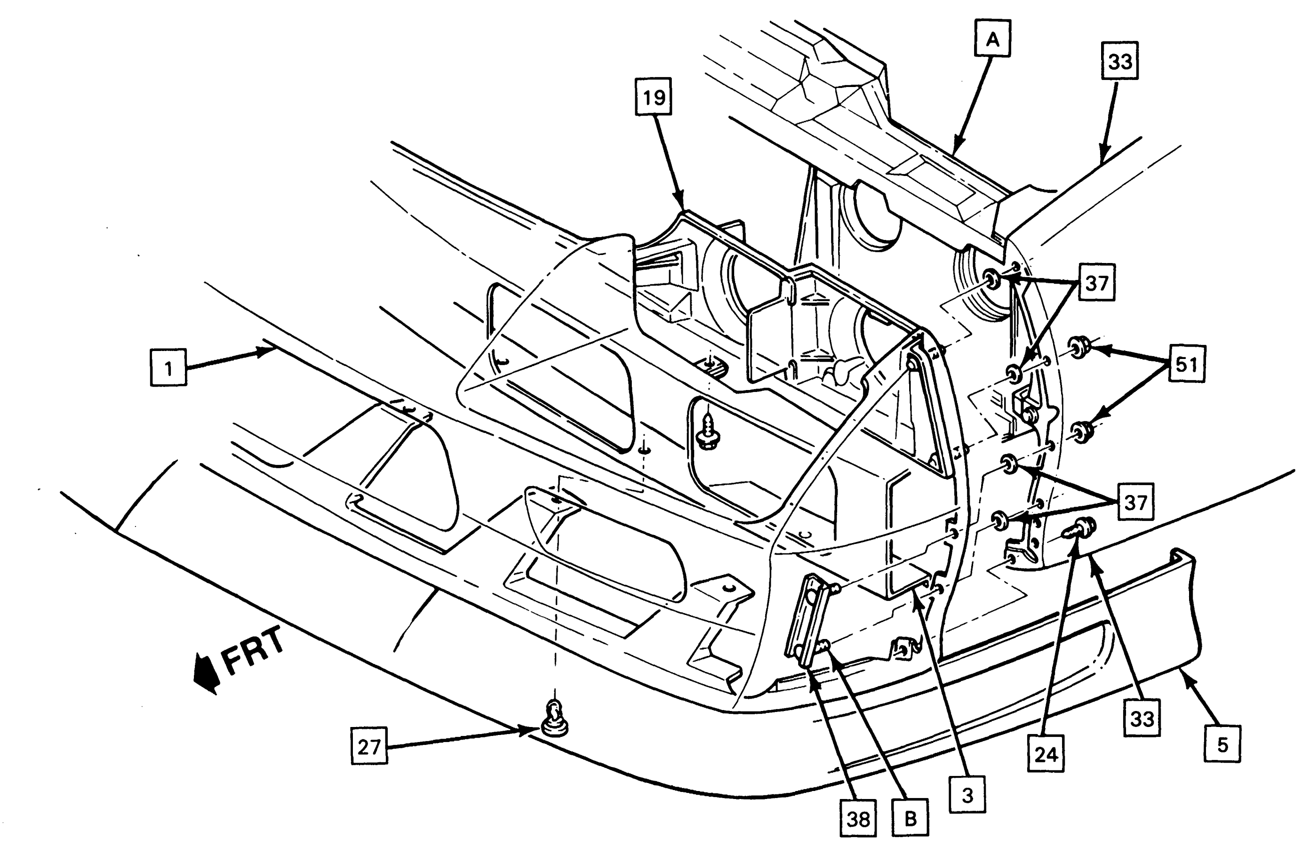
Figure 1 - Front Bumper Assembly



A	FRONT INNER STRUCTURE	24	BOLT
B	STUD	27	PUSH-ON RETAINER
1	BUMPER FASCIA	33	FRONT FENDER
3	BUMPER IMPACT BAR	37	PUSH-ON NUT
5	FRONT BUMPER FASCIA EXTENSION	38	RETAINER
19	FRONT END PANEL REINFORCEMENT	51	NUT

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Figure 2 - Front Bumper Fascia

Tighten

- Bolts (54) to 10 N·m (89 lb. in.).

3. Clips (53).
4. Retainers (39).
5. Radiator lower air baffle (18).
6. Bolts (36).

Tighten

- Bolts (36) to 1.9 N·m (17 lb. in.).

- Lower vehicle.

Radiator Grille Replacement

RS Model

Figure 4

Remove or Disconnect

1. Screws (56).
2. Screws (57).
3. Radiator grille (58).

Install or Connect

NOTICE: See "Notice" on page 2B-1 of this section.

1. Radiator grille (58).
2. Screws (57).

Tighten

- Screws (57) to 0.7 N·m (6 lb. in.).

3. Screws (56).

Tighten

- Screws (56) to 2 N·m (18 lb. in.).

Z28 Model

Figure 5

Remove or Disconnect

1. Screws (59).
2. Screws (60).

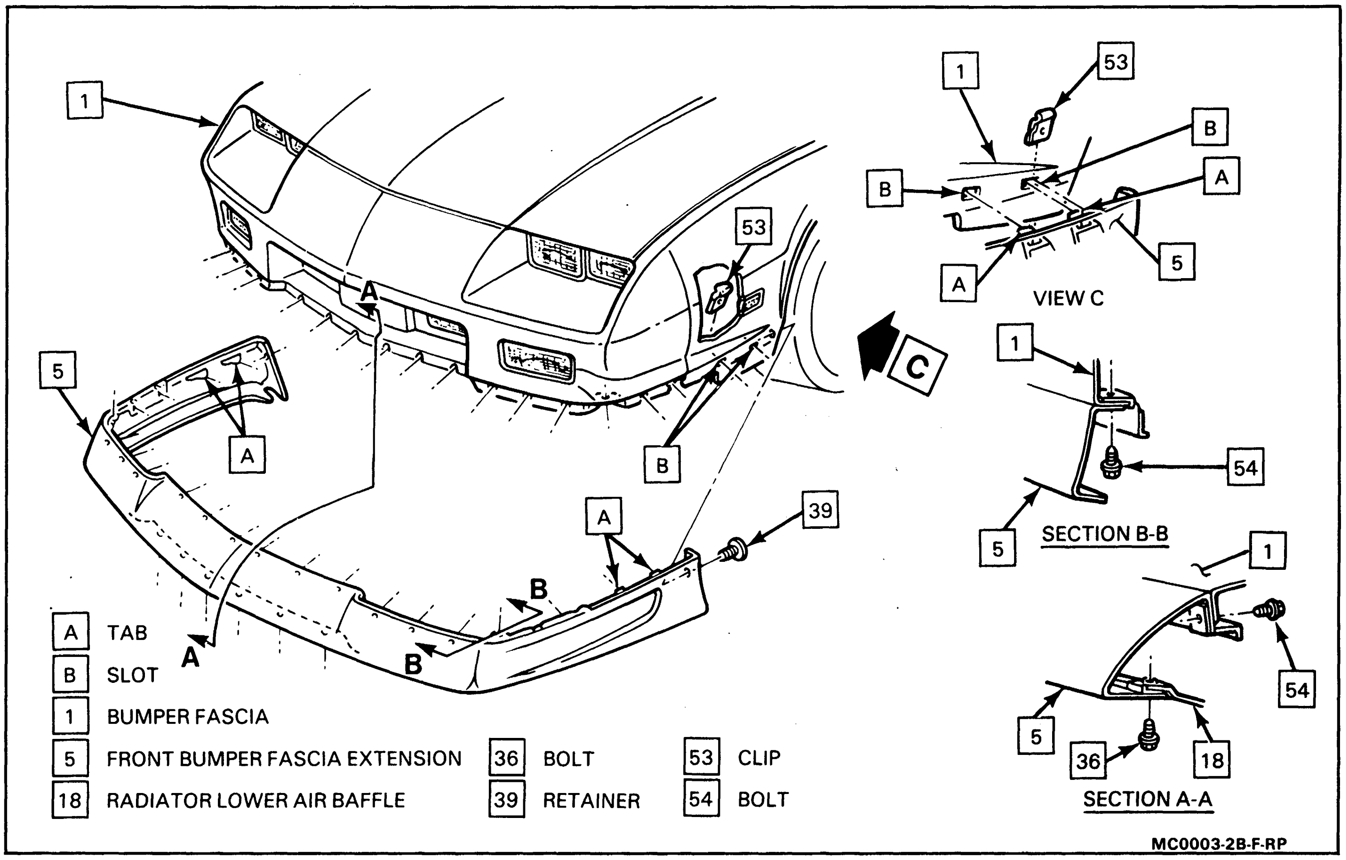


Figure 3 - Front Bumper Fascia Extension

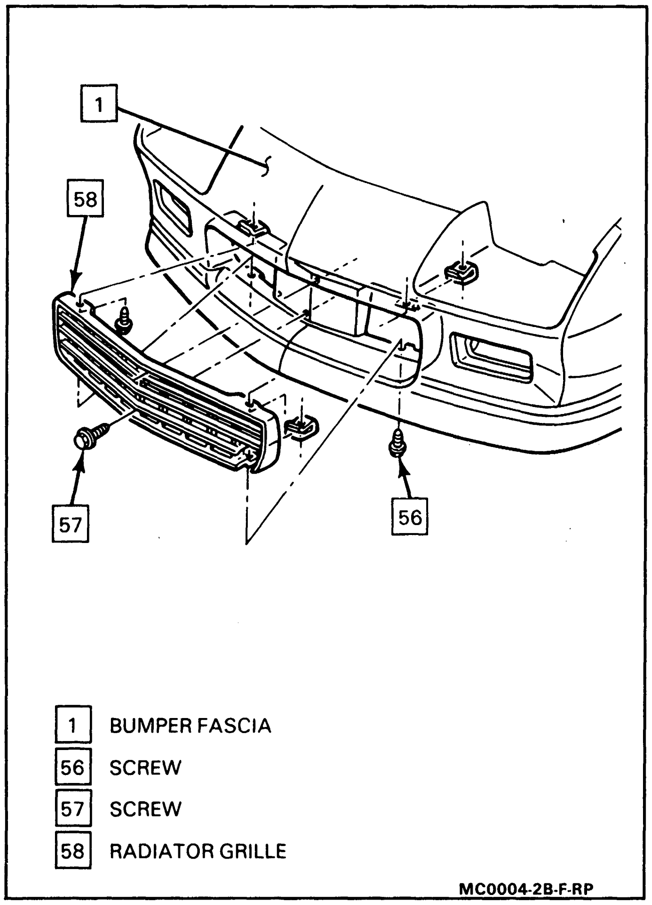


Figure 4 - Radiator Grille (RS Model)

3. Radiator grille (61).

→← Install or Connect

NOTICE: See "Notice" on page 2B-1 of this section.

1. Radiator grille (61).
2. Screws (60).

Tighten

- Screws (60) to 1.6 N·m (14 lb. in.).

3. Screws (59).

Tighten

- Screws (59) to 2 N·m (18 lb. in.).

REAR LICENSE PLATE BRACKET

←→ Remove or Disconnect

- Pull down license plate bracket to gain access to bolts.

1. Bolts attaching license plate bracket to rear bumper fascia.
2. License plate bracket from rear bumper fascia.

→← Install or Connect

NOTICE: See "Notice" on page 2B-1 of this section.

- Position license plate bracket to rear bumper fascia by aligning holes on license plate bracket hinges with holes on rear bumper fascia.
- Bolts attaching license plate bracket to rear bumper fascia.

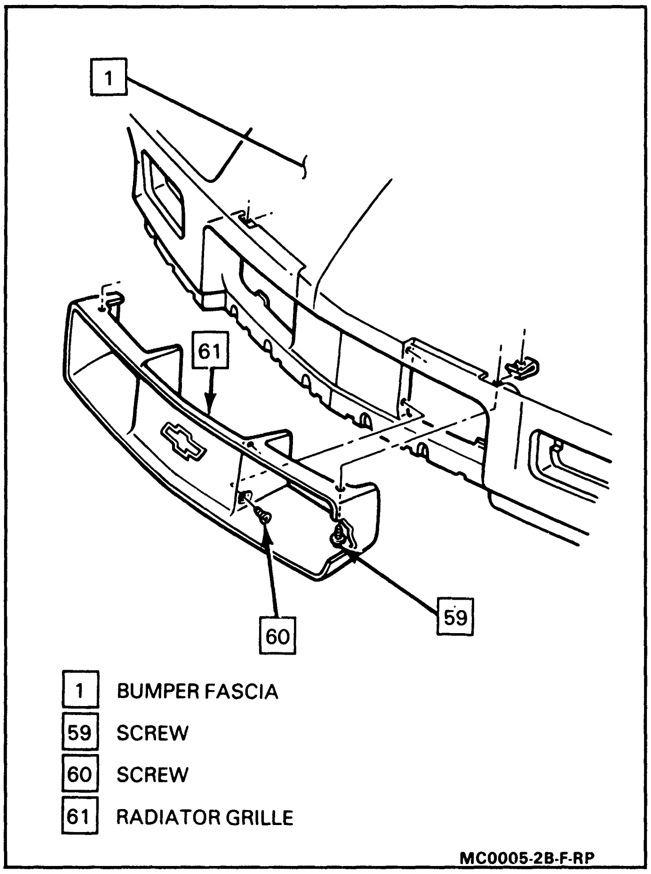


Figure 5 - Radiator Grille (Z28 Model)

Tighten

- Bolts to 6 N·m (53 lb. in.).

REAR BUMPER FASCIA REPLACEMENT

Figure 6

Remove or Disconnect

- Open rear compartment lift window.

1. Rear center trim panel. Refer to BODY REAR END (SEC. 10-7).
2. Left and right rear quarter trim panels. Refer to REAR QUARTERS (SEC. 10-6).
3. Spare tire assembly.
4. Right and left side taillamps. Refer to BODY REAR END (SEC. 10-7).
5. License plate bolts and bracket.
6. Right and left side fascia nuts (32).
7. Push-on retainers (27).
8. Lower screws (29).
9. Bumper fascia (8).

Install or Connect

NOTICE: See "Notice" on page 2B-1 of this section for steps 2, 4, and 5.

1. Bumper fascia (8).
2. Lower screws (29).

Tighten

- Screws (29) to 1.9 N·m (17 lb. in.).

3. Push-on retainers (27).
4. Right and left side fascia nuts (32).

Tighten

- Nuts (32) to 6 N·m (53 lb. in.).

5. License plate bracket and bolts.

Tighten

- Bolts to 6 N·m (53 lb. in.).

6. Right and left side taillamps. Refer to BODY REAR END (SEC. 10-7).
7. Right and left rear quarter trim panels. Refer to REAR QUARTERS (SEC. 10-6).
8. Spare tire assembly.
9. Rear center trim panel. Refer to BODY REAR END (SEC. 10-7).

FRONT ENERGY ABSORBER REPLACEMENT

Figure 1

Remove or Disconnect

1. Bumper fascia (1). Refer to "Front Bumper Fascia Replacement" in this section.
2. Rivets (4).
   - Drill out rivets (4).
3. Energy absorber (2).

Install or Connect

1. Energy absorber (2).
2. Rivets (4).
3. Bumper fascia (1). Refer to "Front Bumper Fascia Replacement" in this section.

REAR ENERGY ABSORBER REPLACEMENT

Figure 6

Remove or Disconnect

1. Bumper fascia (8). Refer to "Rear Bumper Fascia Replacement" in this section.
2. Rivets (4).
   - Drill out rivets (4).
3. Energy absorber (7).

Install or Connect

1. Energy absorber (7).
2. Rivets (4).
3. Bumper fascia (8). Refer to "Rear Bumper Fascia Replacement" in this section.

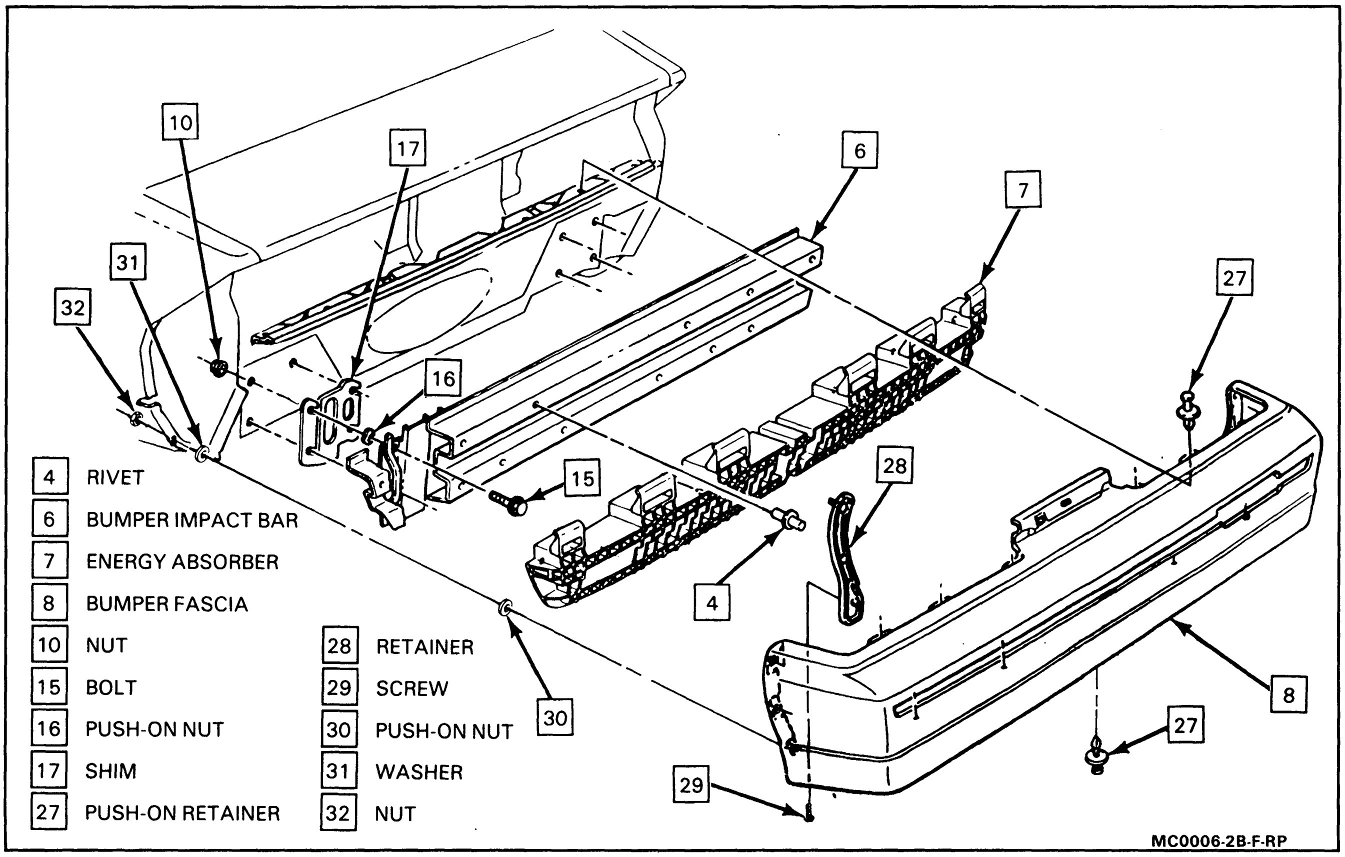


Figure 6 - Rear Bumper Assembly

FRONT BUMPER IMPACT BAR REPLACEMENT

Figure 1

Remove or Disconnect

1. Energy absorber. Refer to "Front Energy Absorber Replacement" in this section.
   - Scribe a matchmark on the bumper impact bar (3) and the engine compartment rail for alignment during assembly.
2. Nuts (9).
3. Bumper impact bar (3) and shims (12).
   - Note the number and placement of shims (12).

Install or Connect

1. Bumper impact bar (3) and shims (12).
   - Place shims (12) in the location from which they were removed.

NOTICE: See "Notice" on page 2B-1 of this section.

2. Nuts (9).
   - Align matchmarks on bumper impact bar (3) and engine compartment rail.
   - If installing a new bumper impact bar (3), refer to "Bumper Assembly Alignment" in this section for alignment specifications.

Tighten

- Nuts (9) to 27 N·m (20 lb. ft.).

3. Energy absorber. Refer to "Front Energy Absorber Replacement" in this section.

REAR BUMPER IMPACT BAR REPLACEMENT

Figure 6

Remove or Disconnect

1. Energy absorber. Refer to "Rear Energy Absorber Replacement" in this section.
   - Scribe a matchmark on the bumper impact bar (6) and the rear end body panel.
2. Nuts (10).
3. Bumper impact bar (6) and shims (17).
   - Note the number and placement of shims (17).

Install or Connect

1. Bumper impact bar (6) and shims (17).
   - Place shims (17) in the location from which they were removed.

NOTICE: See "Notice" on page 2B-1 of this section.

2. Nuts (10).
   - Align matchmarks on bumper impact bar (6) and rear end body panel.

- If installing a new bumper impact bar, refer to "Bumper Assembly Alignment" in this section for alignment specifications.

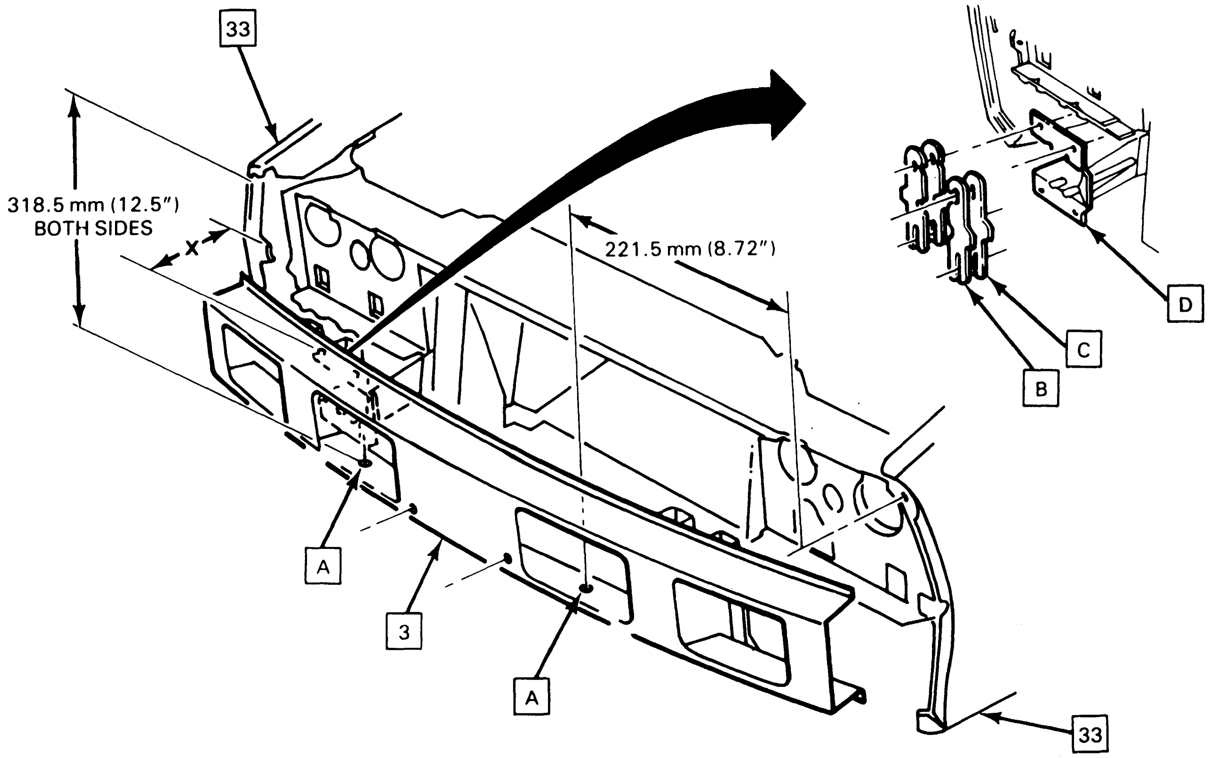
Tighten

- Nuts (10) to 27 N·m (20 lb. ft.).

3. Energy absorber. Refer to "Rear Energy Absorber Replacement" in this section.

BUMPER ASSEMBLY ALIGNMENT

For bumper assembly alignment information, refer to Figures 7 through 9.



A	GAGE HOLE
B	SHIM POSITION #1
C	SHIM POSITION #2
D	ENGINE COMPARTMENT RAIL
3	BUMPER IMPACT BAR
33	FRONT FENDER

SHIM DIM. X	TOTAL EACH LOCATION	SHIM POS #1	SHIM POS #2
63.0-66.0 mm (2.5-2.6")	4	3	1
66.1-69.0 mm (2.6-2.72")	3	2	1
69.1-72.0 mm (2.72-2.83")	2	1	1
72.1-75.0 mm (2.83-2.95")	1	0	1
75.1-HIGHER (2.95-HIGHER")	0	0	0

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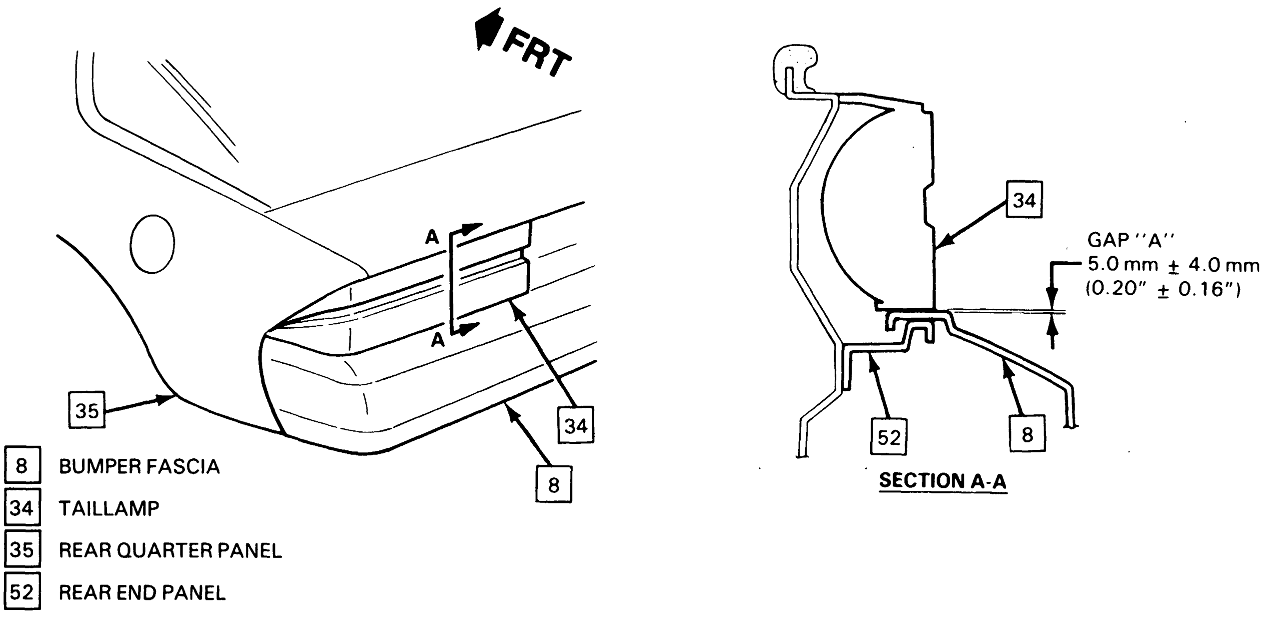
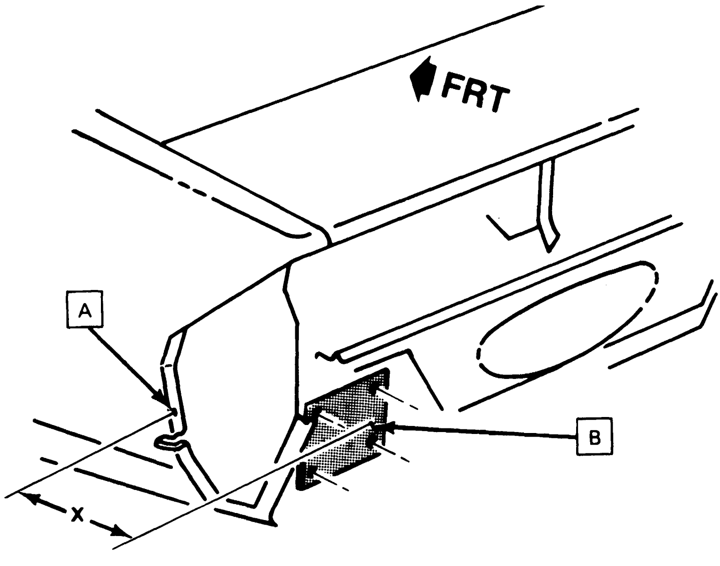
Figure 7 - Front Bumper Impact Bar Alignment and Shim Dimensions



8 BUMPER FASCIA
34 TAILLAMP
35 REAR QUARTER PANEL
52 REAR END PANEL

Figure 8 - Rear Bumper Alignment



SHIM DIM. X	REQ'D. SHIMS
111.0 mm-114.0 mm (4.4"-4.5")	2
114.1 mm-117.0 mm (4.5"-4.6")	1
117.1 mm-HIGHER (4.6"-HIGHER)	0

A QUARTER PANEL SURFACE FASCIA JOINT
B HIGH SPOT ON BUMPER MOUNT SURFACE

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Figure 9 - Rear Bumper Shim Dimensions

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Front Inner Structure-to-Outer Bracket Bolt	9.5 N·m (84 lb. in.)
Radiator Lower Air Baffle Bolt	1.9 N·m (17 lb. in.)
Fascia-to-Front Fender Nut	4.3 N·m (38 lb. in.)
Fascia-to-Front Fender Bolt	1.9 N·m (17 lb. in.)
Front End Panel Reinforcement-to-Fascia Center Bracket Nut	4.2 N·m (37 lb. in.)
Front Bumper Fascia Extension Bolt	10 N·m (89 lb. in.)
Radiator Grille Replacement (RS model) Center Grille Screw	0.7 N·m (6 lb. in.)
Radiator Grille Replacement (RS model) Side Grille Screw	2 N·m (18 lb. in.)
Radiator Grille Replacement (Z28 model) Center Grille Screw	1.6 N·m (14 lb. in.)
Radiator Grille Replacement (Z28 model) Side Grille Screw	2 N·m (18 lb. in.)
Rear Bumper Lower Screw	1.9 N·m (17 lb. in.)
Rear Bumper Fascia Nut	6 N·m (53 lb. in.)
Bumper Impact Bar Nut	27 N·m (20 lb. ft.)
Front License Plate Bracket-to-Front Bumper Fascia Bolt	6 N·m (53 lb. in.)
Rear License Plate Bracket-to-Rear Bumper Fascia Bolt	6 N·m (53 lb. in.)

SECTION 2C

FRONT END BODY PANELS

CAUTION: On vehicles equipped with Supplemental Inflatable Restraints (SIR), refer to CAUTIONS in section 9J-B under On-Vehicle Service before performing service on or around SIR components or SIR wiring. Failure to follow cautions could result in possible air bag deployment, personal injury or unneeded SIR system repairs.

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 2C-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

NOTICE: The anti-theft label found on some major sheet metal, engines, and transmissions must be masked prior to painting, rustproofing, undercoating, etc. The mask MUST be removed following the above operations. Failure to keep the label clean and readable may result in liability for violation of Federal Vehicle Theft Prevention Standard, and subject the vehicle owner to possible suspicion that the part was stolen.

CONTENTS

GENERAL DESCRIPTION

FASTENERS

Many aluminum components are used in the current models. Aluminum in contact with steel may corrode rapidly if not protected by special finishes or isolators.

Many of the fasteners used in the front sheet metal area have the GM 6174M finish which will provide adequate protection. In some places, however, special fasteners are used in conjunction with aluminum components. These special fasteners are argent silver in color to distinguish them from the standard metric fasteners, which are medium blue in color.

When replacing fasteners in the front sheet metal area, avoid substitution of otherwise similar fasteners in locations that should use GM 6174M type fasteners or special fasteners for aluminum components.

NOTICE: Failure to follow this precaution may result in premature corrosion of the sheet metal in the areas mentioned above.

ANTI-CORROSION MATERIALS

Anti-corrosion materials have been applied to the interior surfaces of some metal panels to provide rust resistance. When servicing these panels, areas where these materials have been disturbed should be properly recoated with service-type anti-corrosion material.

ON-VEHICLE SERVICE

HOOD ASSEMBLY

Figure 1

NOTICE: Place protective coverings on fender areas to prevent damage to paint during hood removal or installation.

Remove or Disconnect

1. Underhood lamp wires and wiring harness clips, if vehicle is equipped with underhood lamp.
- Scribe a line on the hood inner panel to indicate the original hinge position.
2. Hinge-to-hood screws (7), with the aid of a helper.
3. Hood (1) from hood hinges (8), with the aid of a helper.

Install or Connect

1. Hood (1) to hood hinges (8), with the aid of a helper.

NOTICE: See "Notice" on page 2C-1 of this section.

2. Hinge-to-hood screws (7), with the aid of a helper.
   - Align the hood hinges (8) with the alignment marks on the hood (1).

Tighten

- Screws (7) to 9.5 N·m (84 lb. in.).

3. Underhood lamp wires and harness clips.

Adjust

- Hood (1), if needed. Refer to "Hood Assembly Adjustment" in this section.

HOOD HINGE

Figure 1

Hood hinges (8) are fastened to the fenders (6). Two gas strut hood open assist rods (5) are used, one at each hood hinge (8). Both ends of the hood open assist rods (5) are fastened to the front portion of the hood hinges (8). This construction provides hold-open power. Make certain both hood open assist rods (5) have the same color coding if the struts are to be replaced.

NOTICE: Install protective coverings over fenders (6) to prevent damage when removing or installing hood hinges (8).

Remove or Disconnect

- Scribe line on hood (1) and fender (6) to show original position of hood hinge (8).
- Support hood (1) on side where hood hinge (8) is to be removed.

1. Hinge-to-hood screws (7).
2. Hinge-to-fender bolts (4).
3. Bumper (2).
4. Screw (3).
5. Hood hinge (8).

Install or Connect

NOTICE: See "Notice" on page 2C-1 of this section.

1. Hood hinge (8), so that it lines up with position marked on hood (1) and fender (6).
2. Hinge-to-fender bolts (4).

Tighten

- Bolts (4) to 9.5 N·m (84 lb. in.).

3. Hinge-to-hood screws (7).

Tighten

- Screws (7) to 9.5 N·m (84 lb. in.).

4. Screw (3).
5. Bumper (2).

Adjust

- Hood (1) as needed. Refer to "Hood Assembly Adjustment" in this section.

HOOD OPEN ASSIST ROD

Figure 1

NOTICE: Install protective coverings over fender areas when removing or installing hood open assist rods (5) to prevent damage.

Remove or Disconnect

- Support hood (1) in the open position.

1. Retainers (9 and 10) from the bottom and top of the hood open assist rod (5).
2. Hood open assist rod (5).

Install or Connect

1. Hood open assist rod (5).
   - One of several hood open assist rods (5) will be used, depending on hood material and configuration. Make certain that both hood open assist rods (5) have the same color coding if they are to be replaced.
2. Retainers (9 and 10) at the top and bottom of the hood open assist rod (5).

Inspect

- Hood (1) for proper operation.

PRIMARY HOOD LATCH

Figure 2

The primary hood latch (12) is a cable released, positive locking hood latch assembly located in the radiator support and baffle assembly, and locks with the hood-mounted striker. The inside hood release handle (15) is at the left shroud side trim panel. After the inside hood release handle (15) has been pulled, the hood can be fully opened by releasing the secondary hood latch hand catch on the hood underside.

After proper positioning of the hood bumpers, hood height is automatically controlled by the vertically self-adjusting primary hood latch (12). Proper hood alignment is essential for ease of latch

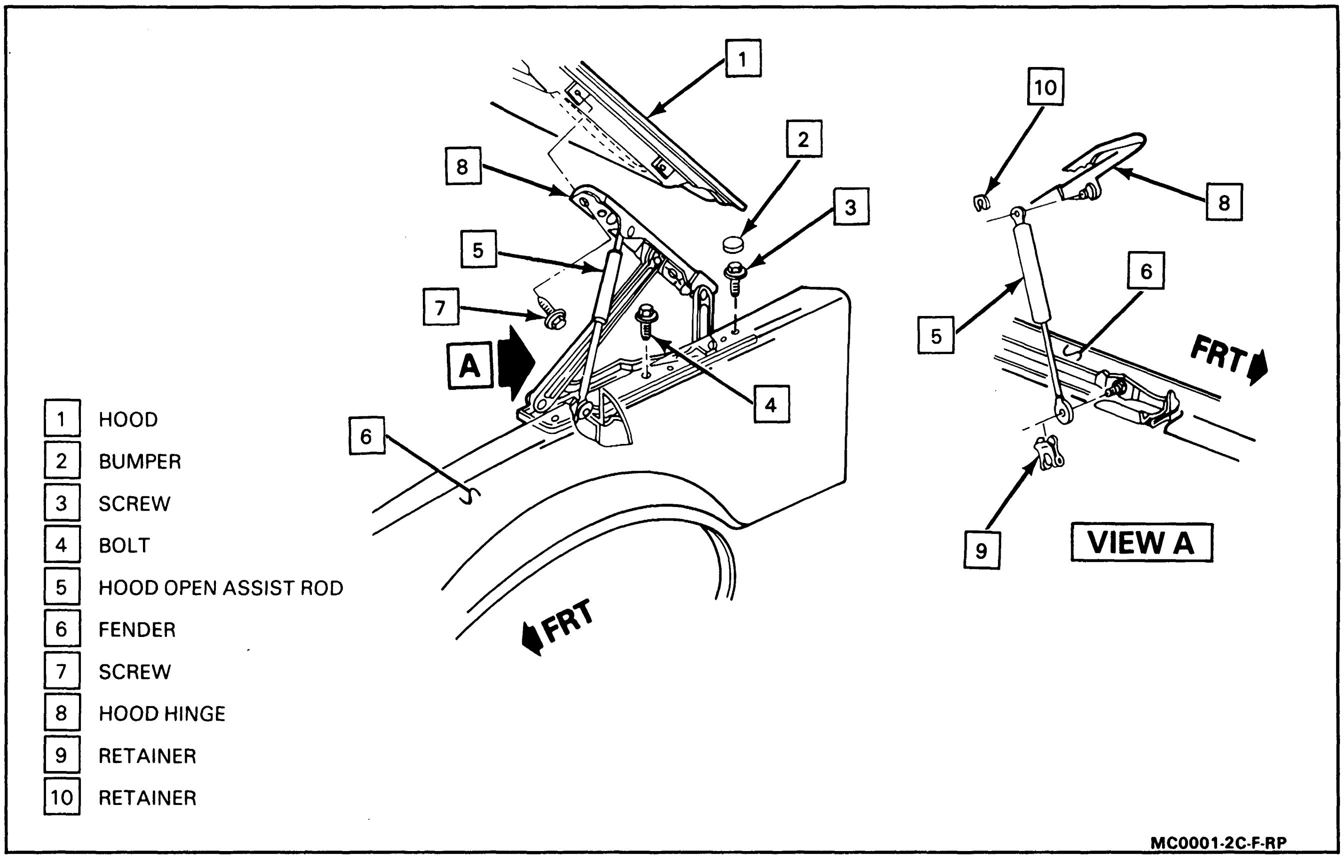


Figure 1 - Hood and Hinge

operation. Refer to "Hood Assembly Adjustment" in this section.

Remove or Disconnect

1. Primary latch release cable (13) from the cable retainer of the primary hood latch (12).
2. Bolts (11) from primary hood latch (12).
3. Primary hood latch (12).

Install or Connect

NOTICE: See "Notice" on page 2C-1 of this section.

1. Primary hood latch (12).
2. Bolts (11) to the primary hood latch (12).
   - With the primary hood latch (12) at the low end of its adjustment range, hand-tighten the bolts (11) snugly but not enough to keep the primary hood latch (12) from moving.
3. Primary hood latch release cable (13) to the cable retainer of the primary hood latch (12).

Adjust

- Primary hood latch (12).
  - While a helper pulls the inside hood release handle (15) and holds it back, close the hood.
  - Hold the hood closed against the hood bumpers while the helper momentarily releases the inside hood release handle (15) and then pulls it back again to release the primary hood latch (12).
  - Allow the hood to open after the helper releases the inside hood release handle (15).

Tighten

- Bolts (11) to 27 N·m (20 lb. ft.).

Inspect

- Hood for proper operation.

SECONDARY HOOD LATCH

Figure 3

Remove or Disconnect

1. Bolts (19).
2. Secondary hood latch (18).

Install or Connect

1. Secondary hood latch (18).

NOTICE: See "Notice" on page 2C-1 of this section.

2. Bolts (19).

Tighten

- Bolt (19) to 9.5 N·m (84 lb. in.).

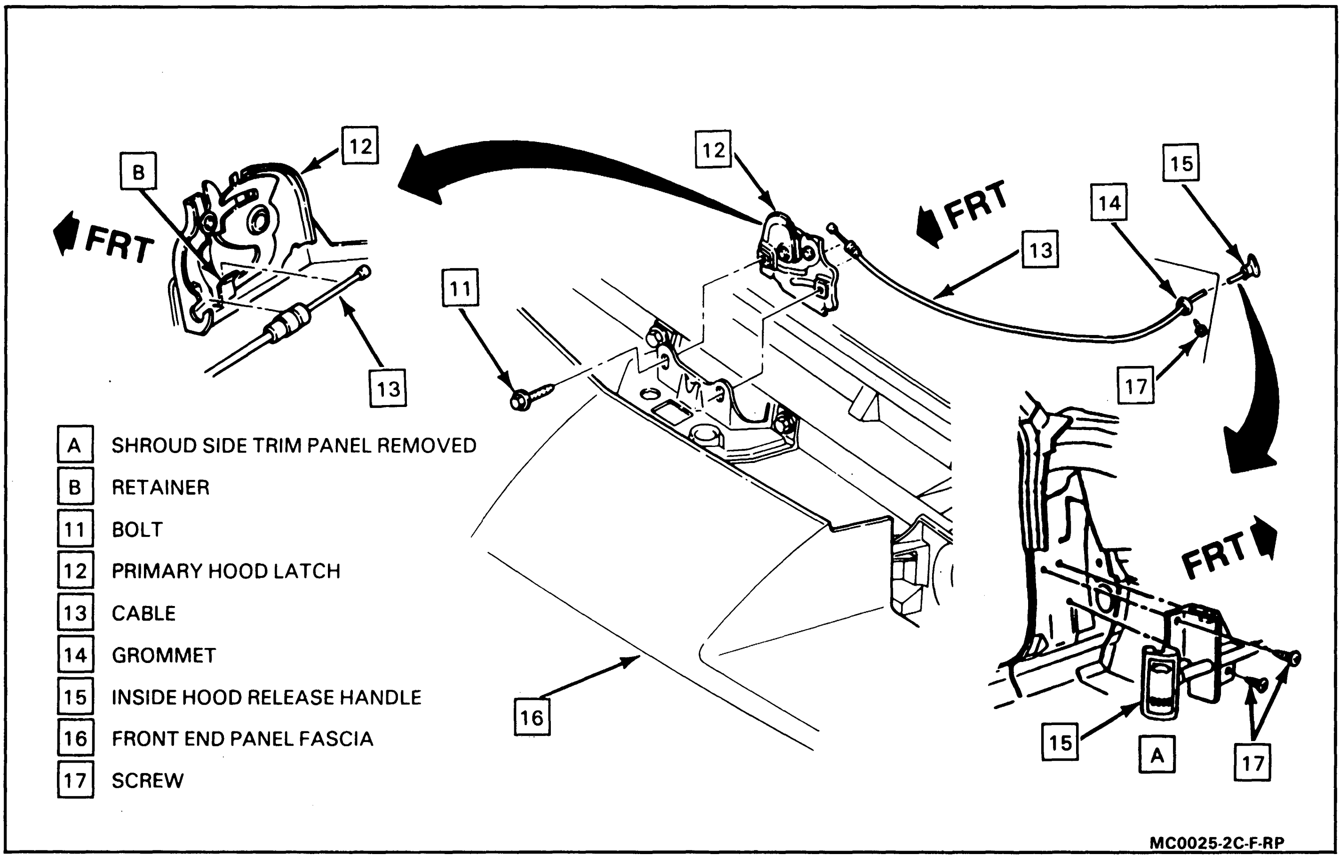


Figure 2 - Primary Hood Latch and Cable

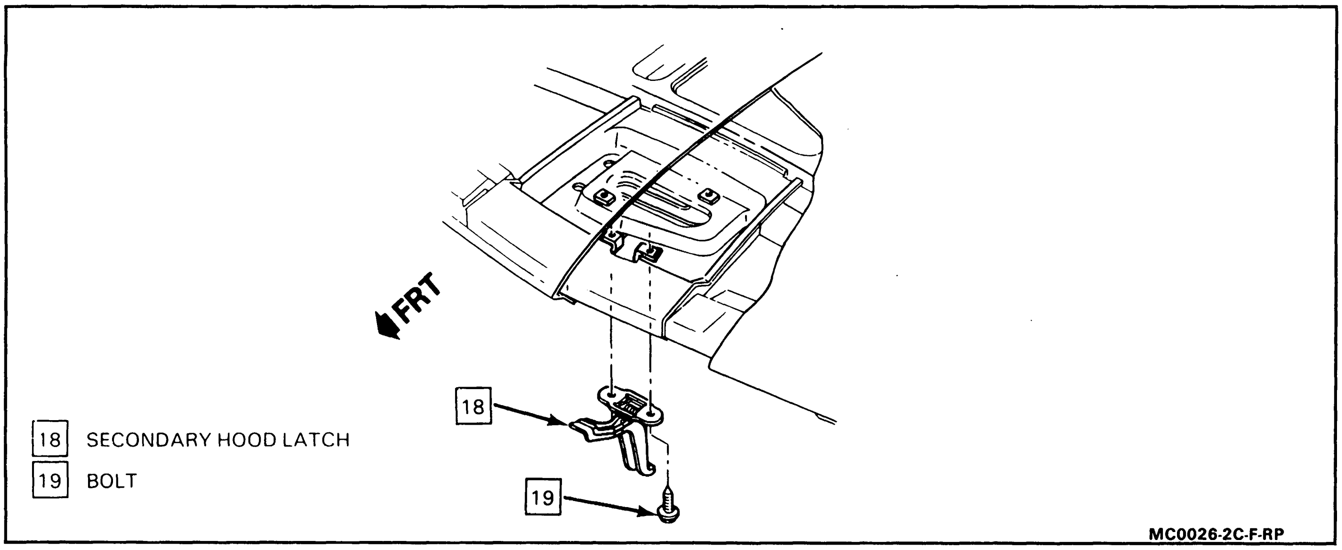


Figure 3 - Secondary Hood Latch

PRIMARY HOOD LATCH RELEASE CABLE

Figure 2

↔ Remove or Disconnect

1. Left shroud side trim finishing panel. Refer to BODY FRONT END (SEC. 10-4).
2. Cable (13) from primary hood latch (12).
   - Remove cable (13) from plastic fasteners on fenders.
   - Carefully pry cable (13) from retainer at the primary hood latch (12).
   - Pry grommet (14) through the dash panel with a screwdriver.
3. Screw (17) retaining inside hood release handle (15).
4. Cable (13) by pulling through from inside of vehicle.

→← Install or Connect

1. Cable (13) by pushing through dash panel hole from inside of vehicle.
2. Screw (17) retaining inside hood release handle (15).

- Position grommet (14) on dash panel.

3. Cable (13) to primary hood latch (12).
    - Position cable (13) on plastic fasteners on fenders.
    - Snap cable (13) to the latch retainer at the primary hood latch (12).

Left shroud side trim finishing panel. Refer to BODY FRONT END (SEC. 10-4).

Inspect

- Cable (13), inside hood release handle (15) and primary hood latch (12) for proper operation.

RADIATOR AIR LOWER BAFFLE

Figure 4

Remove or Disconnect

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Lower fascia screws (22).
2. Bolts (27) from the radiator air upper baffle (25).
3. Radiator air lower baffle (26).

Install or Connect

1. Radiator air lower baffle (26).

NOTICE: See "Notice" on page 2C-1 of this section.

2. Bolts (27) to the radiator air upper baffle (25).

Tighten

- Bolts (27) to 25 N·m (18 lb. ft.).

3. Lower fascia screws (22).

- Lower the vehicle.

FRONT END SHEET METAL SUPPORT

Figure 5

Remove or Disconnect

CAUTION: A forward crash discriminating sensor of the supplemental inflatable restraint system is mounted to the radiator support crossmember of the front end structure, just ahead of the upper edge of the radiator. When working near this sensor, be careful not to damage it or the sensor wiring circuit that comes from the forward lamp harness. Damage to the sensor or its wiring could critically reduce the effectiveness of the supplemental inflatable restraint system and increase the possibility of bodily injury in the event of an accident impact.

1. Primary hood latch. Refer to "Primary Hood Latch" in this section.
2. Retainer from front end bumper fasica filler, if equipped.

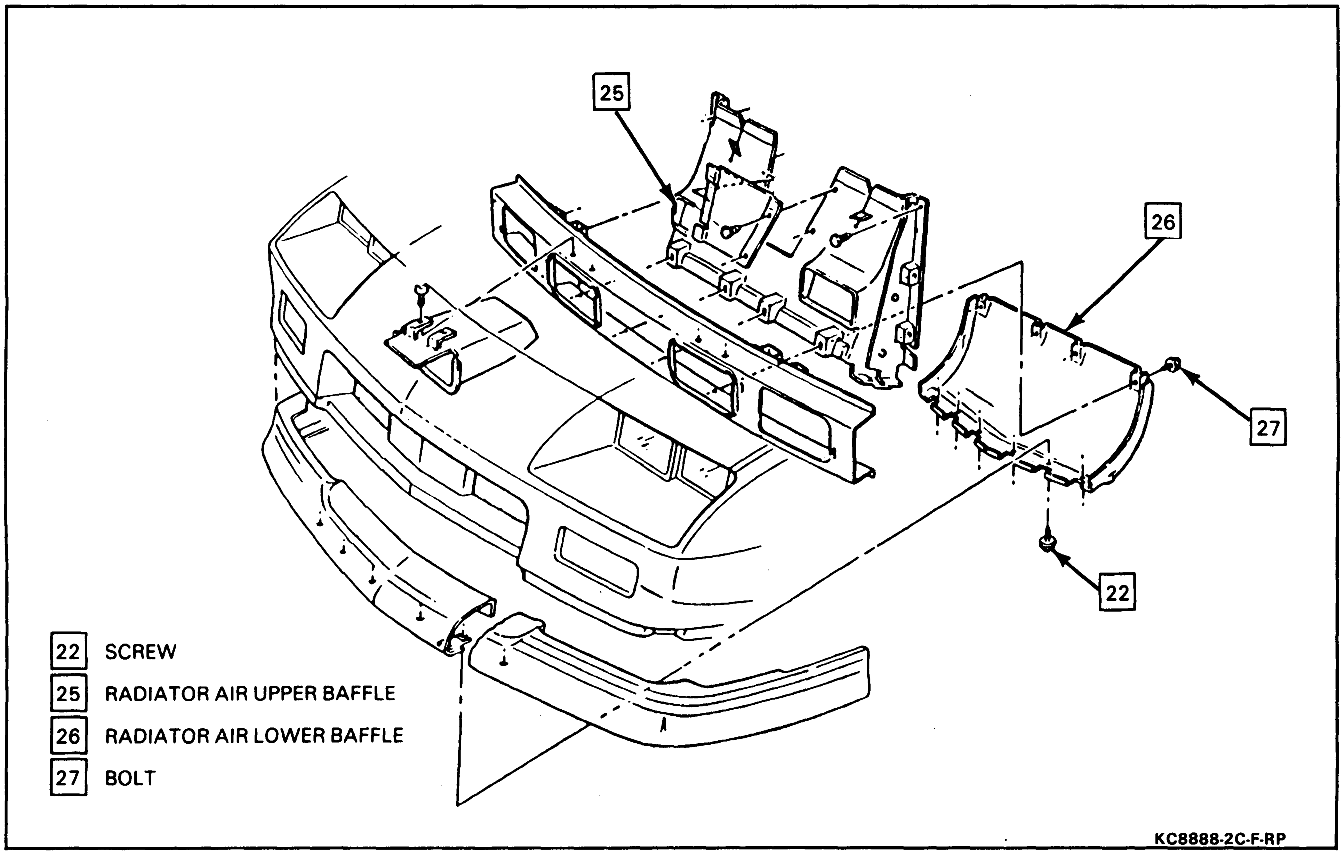


Figure 4 - Radiator Air Lower Baffle

3. Bolts (30) from the front end sheet metal support (31).
   - Raise and suitably support the vehicle to gain access to the lower bolt (30), if necessary. Refer to GENERAL INFORMATION (SEC. 0A).
4. Front end sheet metal support (31).

Install or Connect

NOTICE: See "Notice" on page 2C-1 of this section.

1. Front end sheet metal support (31).
2. Retainer to front end bumper fascia filler, if equipped.
3. Bolts (30) to the front end sheet metal support (31).

   Tighten

   - Bolts (30) to 9.5 N·m (84 lb. in.).

- Lower the vehicle, if raised.

4. Primary hood latch. Refer to "Primary Hood Latch" in this section.

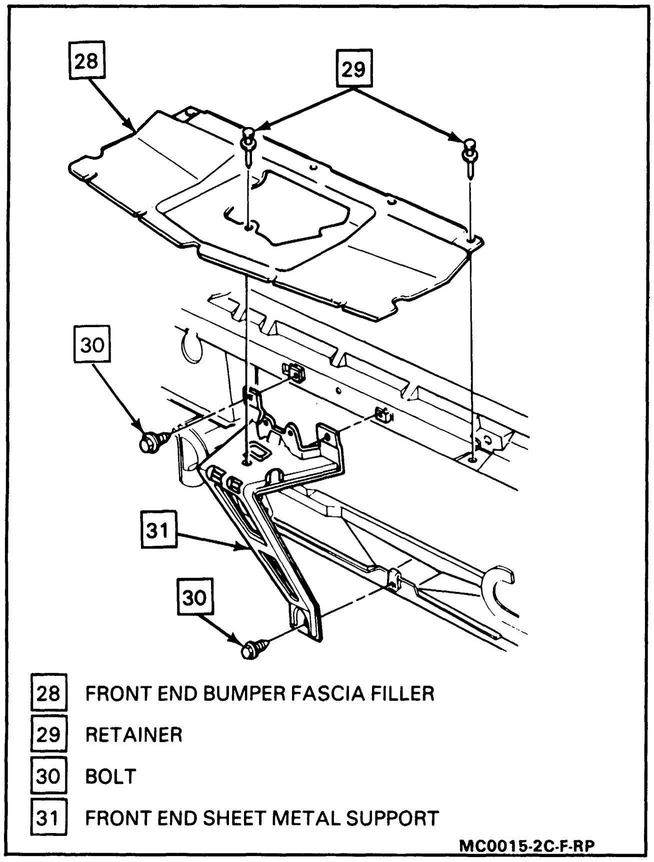


Figure 5 - Front End Sheet Metal Support

SPORT COUPE GRILLE

Figure 6

Remove or Disconnect

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Radiator air lower baffle. Refer to "Radiator Air Lower Baffle" in this section.
2. Screws (32).
3. Screws (33).
4. Grille (34).

Install or Connect

NOTICE: See "Notice" on page 2C-1 of this section.

1. Grille (34).
   - Hold grille tight against a 3 mm (0.12 inch) spacer.
2. Screws (33).

   Tighten

   - Screws (33) to 0.8 N·m (7 lb. in.).
3. Screws (32).

   Tighten

   - Screws (32) to 1.9 N·m (17 lb. in.).
4. Radiator air lower baffle. Refer to "Radiator Air Lower Baffle" in this section.

- Lower vehicle.

Z28 GRILLE

Figure 7

Remove or Disconnect

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Radiator air lower baffle. Refer to "Radiator Air Lower Baffle" in this section.
2. Screws (35).
3. Screws (36).
4. Grille (56).

Install or Connect

NOTICE: See "Notice" on page 2C-1 of this section.

1. Grille (56).
   - Hold grille (56) firmly against front end panel fascia (16) with hand centered on "Bowtie" image and pressure applied rearward.
   - Use existing holes in grille (56) as a pilot to install screws (35 and 36).
2. Screws (36).

   Tighten

   - Screws (36) to 1.5 N·m (13 lb. in.).
3. Screws (35).

   Tighten

   - Screws (35) to 1.9 N·m (17 lb. in.).

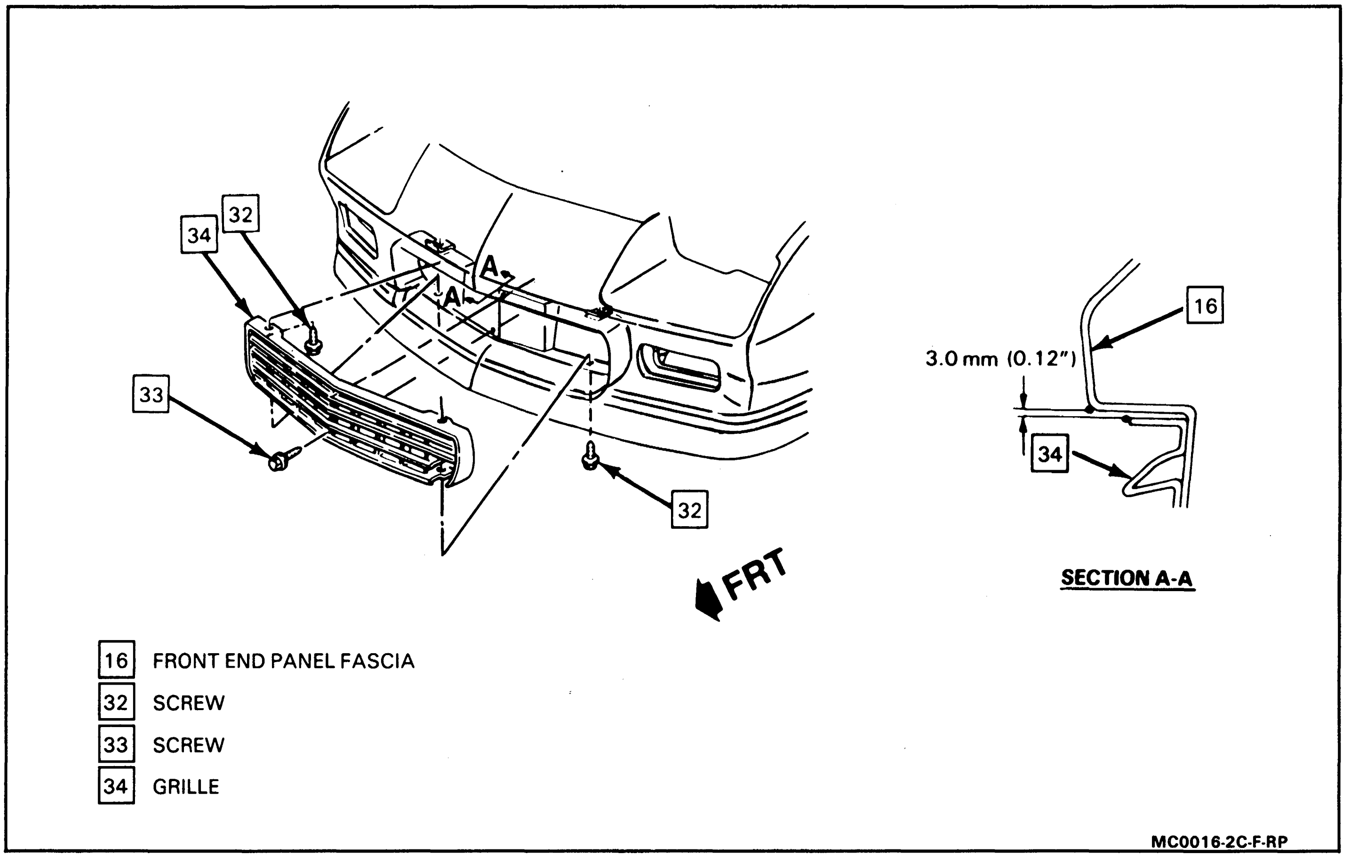


Figure 6 - Sport Coupe Grille

4. Radiator air lower baffle. Refer to "Radiator Air Lower Baffle" in this section.
- Lower vehicle.

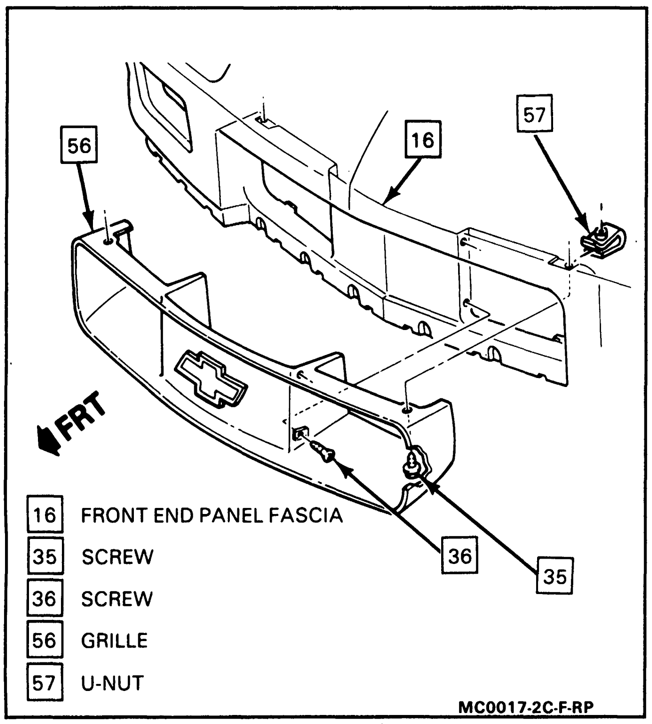


Figure 7 - Z28 Grille

FENDER

Figure 8

↔ Remove or Disconnect

NOTICE: Tape door edge with body tape to prevent damage.

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Hood. Refer to "Hood Assembly" in this section.
2. Wheelhouse panel. Refer to "Wheelhouse Panel" in this section.
3. Lower fender bolts (38).
4. Rocker panel molding. Refer to "Rocker Panel Molding" in this section.
5. Lower front end panel deflector-to-fender bolts (79).
6. Upper fender bolts (37).
7. Bolt (40) from support brace (39).
8. Front end bumper fascia-to-fender nuts (80).
9. Front end bumper fascia-to-fender screw (81).
10. Hood hinge-to-fender bolts (4).
11. Side marker lamp electrical connections by unplugging connector from lamp socket.
12. Horn, if needed. Refer to LIGHTING SYSTEMS AND HORNS (SEC. 8B).
13. Fender (6), by sliding rearward and outward, at rear, with the aid of a helper.

Install or Connect

NOTICE: See "Notice" on page 2C-1 of this section.

NOTICE: The metal outer fender panel is used with a plastic inner panel. Care should be taken in handling uninstalled fenders due to the lack of fender rigidity prior to installation.

1. Fender (6) by sliding forward and inward at front with the aid of a helper.
2. Horn, if needed. Refer to LIGHTING SYSTEMS AND HORNS (SEC. 8B).
3. Side marker lamp electrical connections by plugging connector into lamp socket.
4. Hood hinge-to-fender bolts (4).

   Tighten

   - Bolts (4) to 9.5 N·m (84 lb. in.).
5. Front end bumper fascia-to-fender screw (81).

   Tighten

   - Screw (81) to 10 N·m (89 lb. in.)
6. Front end bumper fascia-to-fender nuts (80).

   Tighten

   - Nuts (80) to 10 N·m (89 lb. in.).
7. Bolt (40) to support brace (39).
8. Upper fender bolts (37).

   Tighten

   - Bolts (37) to 10 N·m (89 lb. in.).

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

9. Lower front end panel deflector-to-fender bolts (79).

   Tighten

   - Bolts (79) to 4 N·m (35 lb. in.).
10. Rocker panel molding. Refer to "Rocker Panel Molding" in this section.
11. Lower fender bolts (38).

    Tighten

    - Bolt (38) to 10 N·m (89 lb. in.).
12. Wheelhouse panel. Refer to "Wheelhouse Panel" in this section.

- Lower vehicle.

13. Hood. Refer to "Hood Assembly" in this section.

    Adjust

    - Fender (6) as needed. Refer to "Body Panel Adjustment and Alignment" in this section.

RADIATOR UPPER MOUNTING PANEL

Figure 9

Remove or Disconnect

1. Air cleaner assembly.
2. Upper mounting bolts (82) from electric cooling fan(s) (83).
   - If equipped with air conditioning, carefully push lines and bracket (84) out of the way for easier access.
3. Upper mounting bolts (42).
4. Radiator upper mounting panel (41).
   - Unclip coolant recovery hose by gently prying from clips on upper mounting panel (41).
5. Insulators (43) from upper mounting panel (41).

Install or Connect

1. Insulators (43) to upper mounting panel (41).
2. Radiator upper mounting panel (41).
   - Attach coolant recovery hose onto clips on upper mounting panel (41).

   NOTICE: See "Notice" on page 2C-1 of this section.
3. Upper mounting bolts (42).

   Tighten

   - Bolts (42) to 5.8 N·m (51 lb. in.).
4. Upper mounting bolts (82) to electric cooling fan(s) (83).
   - Attach bracket (84) and air conditioning lines, if needed.
5. Air cleaner, if needed.

WHEELHOUSE PANEL

Figure 10

Remove or Disconnect

1. Caps (44) over wheelhouse panel screws (46).
2. Wheelhouse panel screws (46).
3. Wheelhouse panel-to-fender retainers (47).
4. Wheelhouse panel (45).

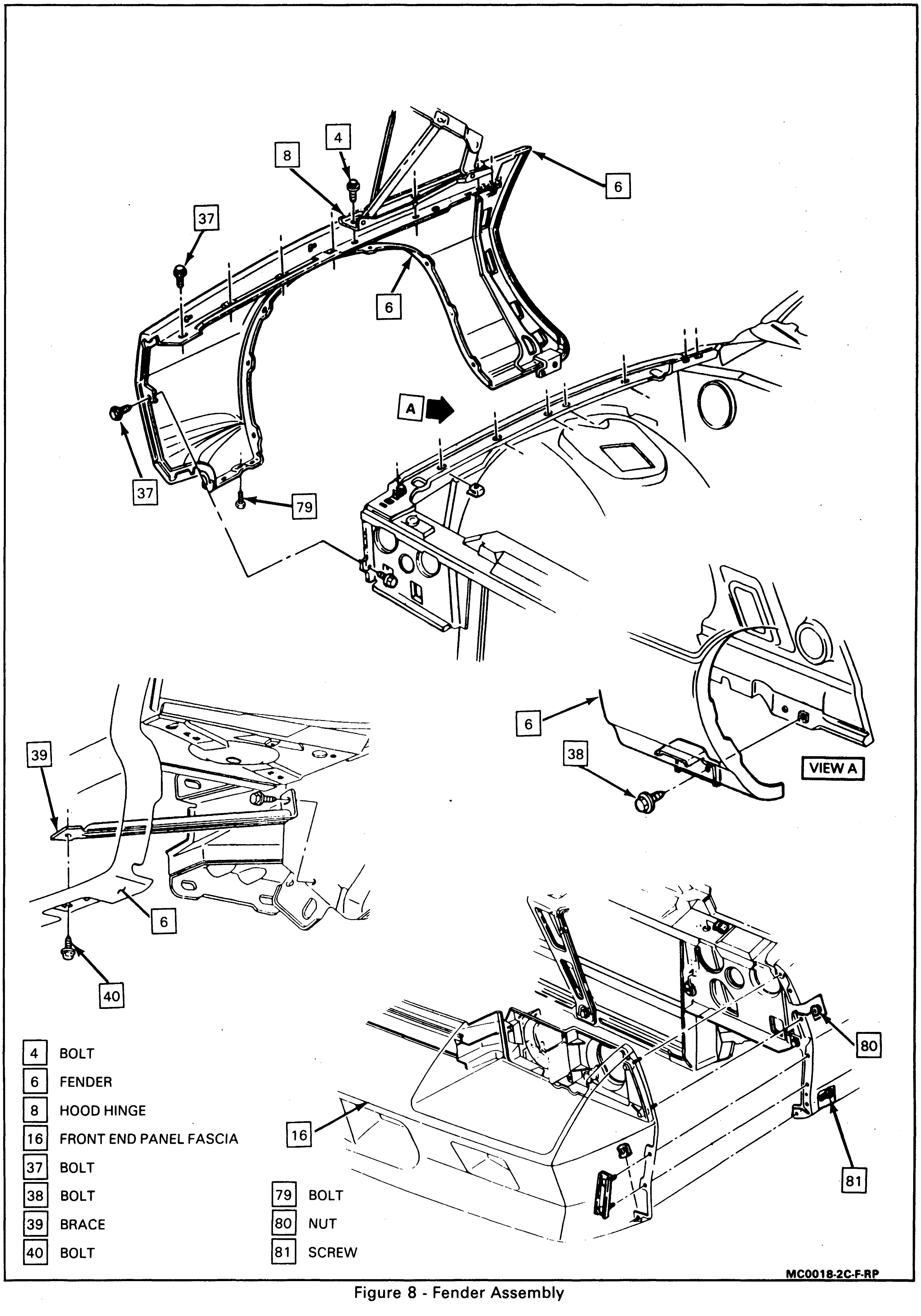
Install or Connect

1. Wheelhouse panel (45).
2. Wheelhouse panel-to-fender retainers (47).

   NOTICE: See "Notice" on page 2C-1 of this section.
3. Wheelhouse panel screws (46).

   Tighten

   - Screws (46) to 1.4 N·m (12 lb. in.).
4. Caps (44) over wheelhouse panel screws (46).



4	BOLT
6	FENDER
8	HOOD HINGE
16	FRONT END PANEL FASCIA
37	BOLT
38	BOLT
39	BRACE
40	BOLT
79	BOLT
80	NUT
81	SCREW

MC0018-2C-F-RP

Figure 8 - Fender Assembly

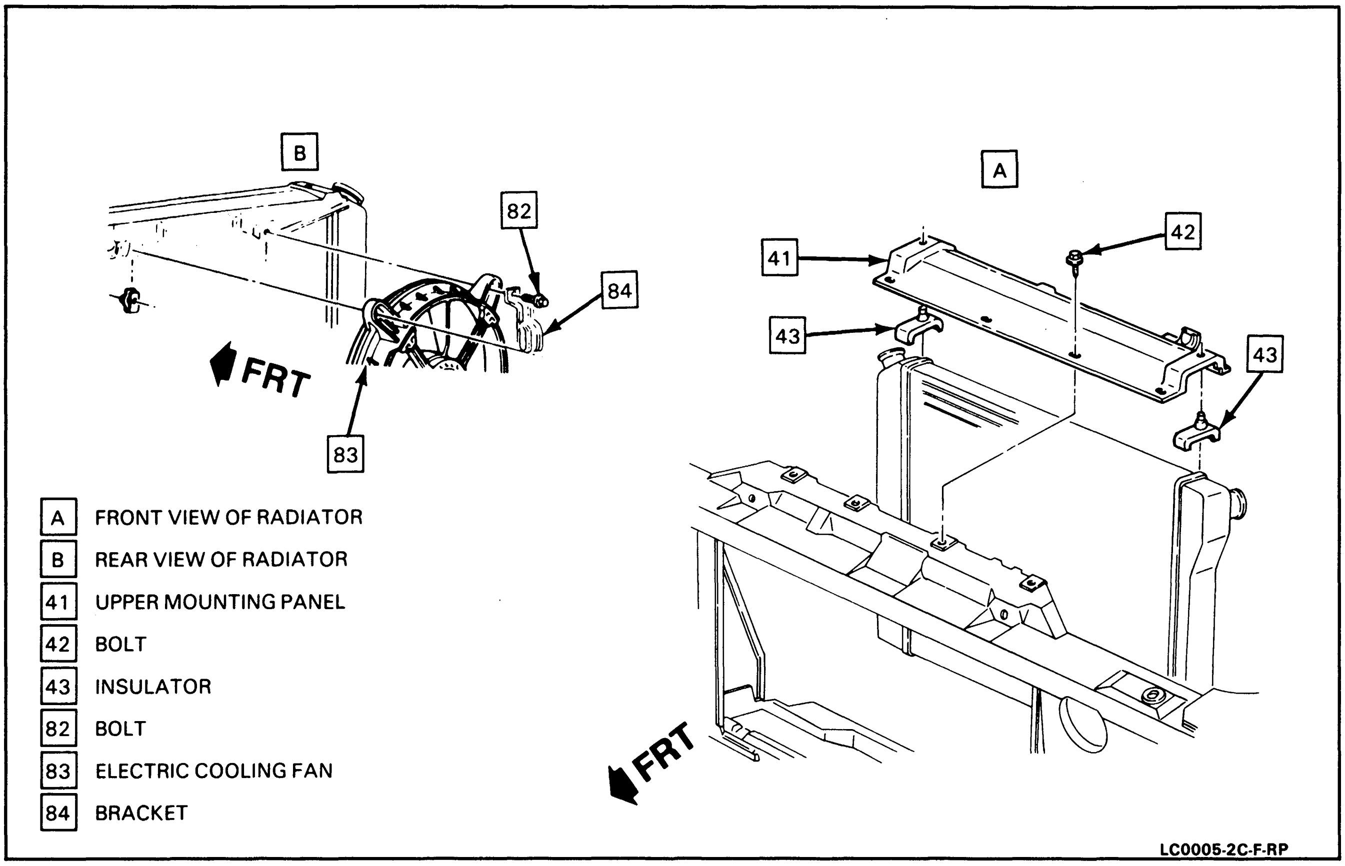


Figure 9 - Radiator Upper Mounting Panel

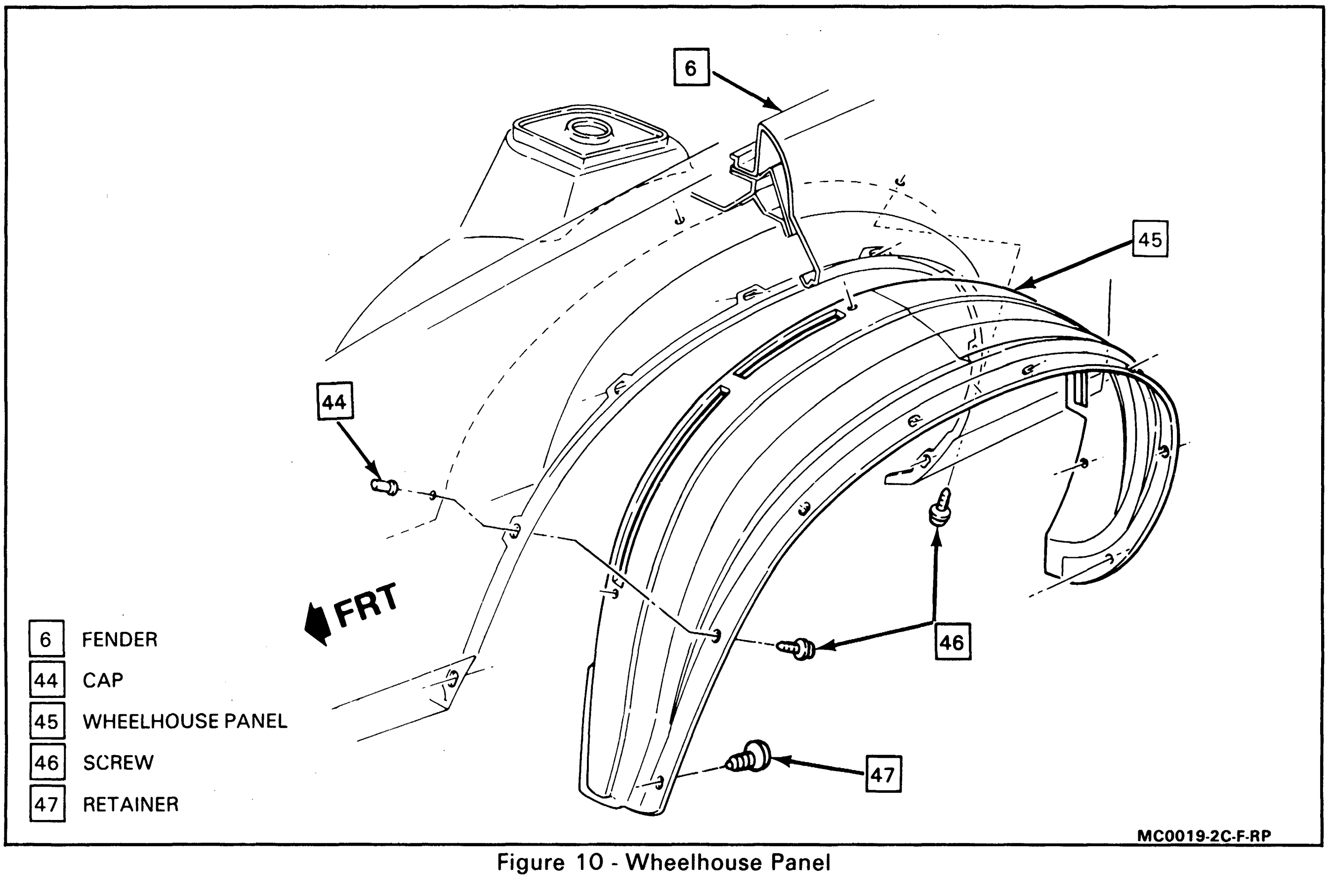


Figure 10 - Wheelhouse Panel

BODY PANEL ADJUSTMENT AND ALIGNMENT

Figure 11

Adjust

- Front fender (6).
  - Loosen bolts at location where adjustment is to be made.

NOTICE: Use care when prying on body panels to avoid damage.

  - Use pry bar to shift panels to obtain the proper clearance.

NOTICE: See "Notice" on page 2C-1 of this section.

Tighten

  - All loosened bolts to proper torque. Refer to "Specifications" in this section.
- Compare alignment to specifications in Figure 11.
  - Repeat above steps until panels are aligned.

HOOD ASSEMBLY ADJUSTMENT

Figures 1 and 11

Slotted holes are provided at all hood hinge attaching points for proper adjustment - both vertically and fore-and-aft. Vertical adjustment at the front may be made by adjusting rubber bumpers up and down. For best results, make one adjustment at a time.

Raising or Lowering Corners of Hood

Adjust

- Hood bumpers.
  - Close hood (1) firmly.
  - Determine amount of adjustment needed. Refer to Figure 11 for hood alignment specifications.
  - Open hood (1).
  - Change height by loosening the lock nuts, turning the hood bumpers up or down and tightening the lock nuts.
  - Repeat above steps until hood (1) is properly aligned.

Fore and Aft Adjustment

Adjust

- Hood (1).
  - Loosen the hinge-to-hood screws (7).
  - Move hood (1) forward or rearward. Refer to Figure 11 for hood alignment specifications.

NOTICE: See "Notice" on page 2C-1 of this section.

Tighten

  - Hinge-to-hood screws (7) to 9.5 N·m (84 lb. in.).
- Repeat above steps for the opposite side of the hood (1), if needed.

Z28 HOOD ORNAMENT

Figure 12

Remove or Disconnect

NOTICE: Place protective coverings on fenders to prevent damage.

1. Hood insulator retainers (50).
2. Hood insulator (49).
3. Nuts (51).
4. Ornament (48).

Install or Connect

1. Ornament (48).

NOTICE: See "Notice" on page 2C-1 of this section.

2. Nuts (51).

Tighten

- Nuts (51) to 5 N·m (44 lb. in.).

3. Hood insulator (49).
4. Hood insulator retainers (50).

ADHESIVE MOLDING

For adhesive molding installation, replacement or adhering of loose ends, refer to GENERAL BODY SERVICE PROCEDURES (SEC. 10-1).

REAR BUMPER FASCIA EXTENSION

Figure 13

Remove or Disconnect

1. Rear end trim panel. Refer to BODY REAR END (SEC. 10-7).
2. Left side upper quarter trim panel, if removing left fascia extension (55). Refer to REAR QUARTERS (SEC. 10-6).
3. Spare tire cover from right upper quarter trim panel, if removing right fascia extension (55). Refer to REAR QUARTERS (SEC. 10-6).
4. Spare tire, if necessary.
5. Nuts (53) from the fascia extension studs (54).
6. Fascia extension bottom screws (52).
7. Fascia extension side screws (52).
8. Rear bumper fascia extension (55).
   - Carefully pull fascia extension (55) away from bumper fascia

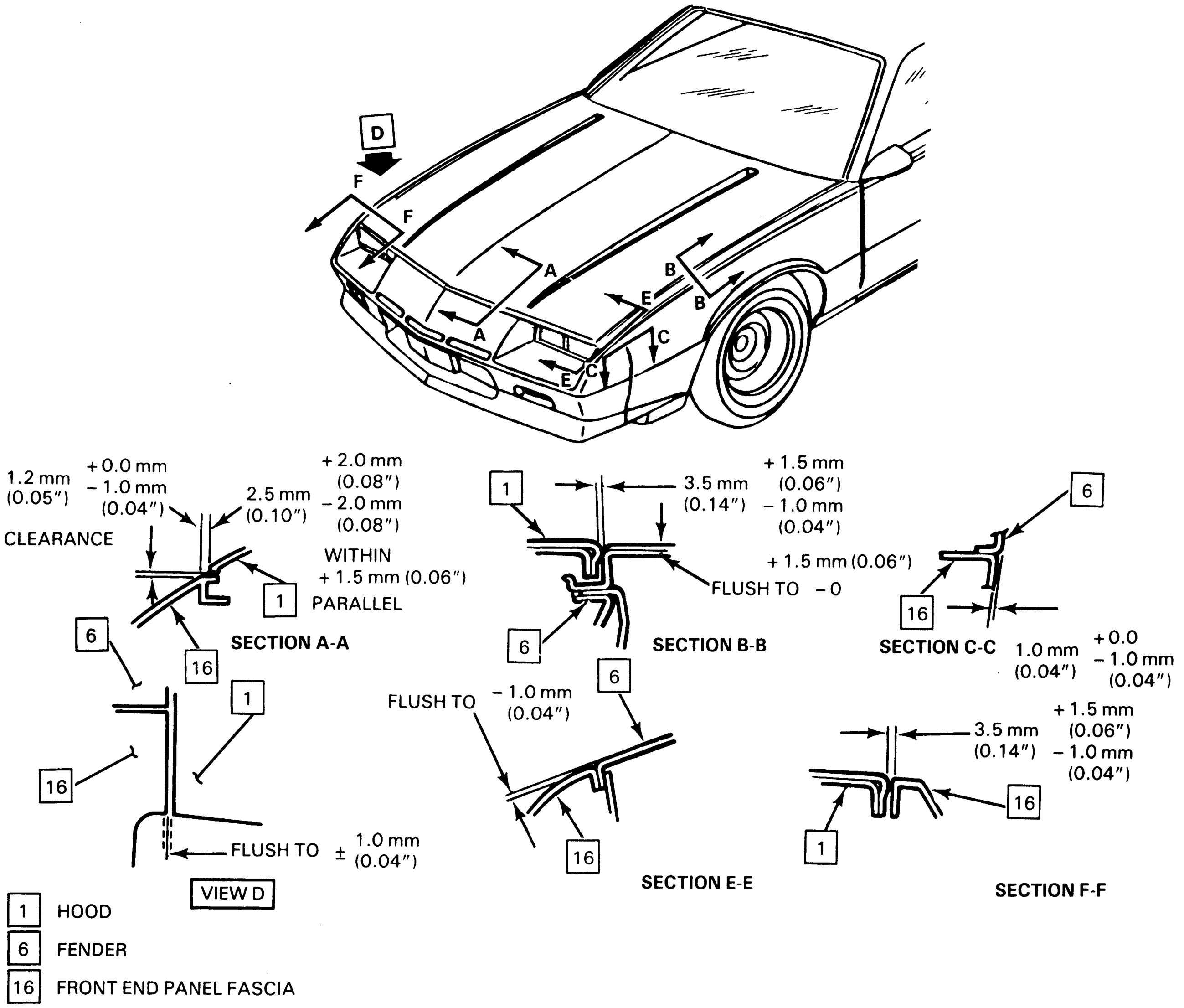


Figure 11 - Body Panel Adjustment and Alignment

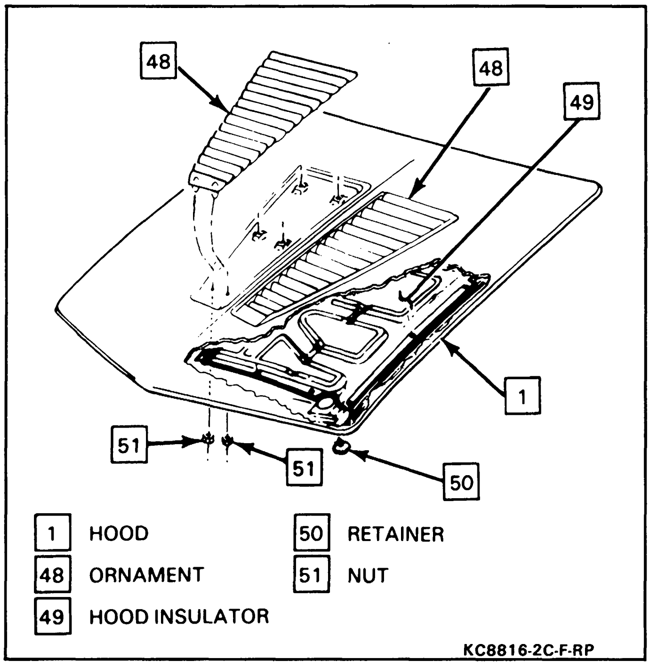


Figure 12 - Z28 Hood Ornament

Install or Connect

NOTICE: See "Notice" on page 2C-1 of this section.

1. Rear bumper fascia extension (55).
2. Fascia extension side screws (52).

   Tighten

   - Screws (52) to 1.5 N·m (13 lb. in.).
3. Fascia extension bottom screws (52).

   Tighten

   - Screws (52) to 1.5 N·m (13 lb. in.).
4. Nuts (53) to the fascia extension retainer (54).

   Tighten

   - Nuts (53) to 3.4 N·m (30 lb. in.).
5. Spare tire, if removed.
6. Spare tire cover to right upper quarter trim panel, if installing right side fascia extension (55). Refer to REAR QUARTERS (SEC. 10-6).
7. Left side upper quarter trim panel, if installing left fascia extension (55). Refer to REAR QUARTERS (SEC. 10-6).
8. Rear end trim panel. Refer to BODY REAR END (SEC. 10-7).

EMBLEM

Figure 14

Remove or Disconnect

1. Retainers from front end bumper fascia filler.
2. Bolts from front end bumper fascia filler.
3. Front end bumper fascia filler.

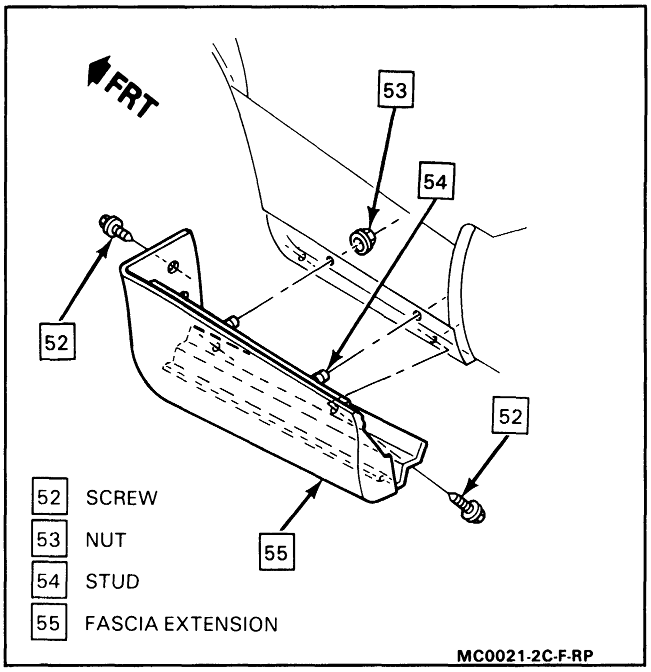


Figure 13 - Rear Bumper Fascia Extension

4. Nuts (65).
5. Emblem (63).

Install or Connect

1. Emblem (63).

   NOTICE: See "Notice" on page 2C-1 of this section.
2. Nuts (65).

   Tighten

   - Nuts (65) to 2.3 N·m (20 lb. in.).
3. Front end bumper fascia filler.
4. Bolts to front end bumper fascia filler.

   Tighten

   - Bolts to 1.9 N·m (17 lb. in.).
5. Retainers to front end bumper fascia filler.

NAMEPLATE

Figure 14

Remove or Disconnect

- Nameplate (64 or 67).
  - Using a flexible, flat bladed tool, carefully pry nameplate (64 or 67) away from rocker panel molding.
  - Use care to avoid damaging surrounding nameplate (64 or 67).

Clean

- Adhesive from nameplate (64 or 67) and rocker panel molding, using soap and water and then dry both parts.

Install or Connect

- Nameplate (64 or 67).
  - Apply a strip of foam tape to the nameplate (64 or 67).
  - Remove backing from tape.
  - Apply pressure to stick nameplate (64 or 67) securely to cutout on rocker panel molding.

DOOR LOWER AIR DEFLECTOR

Refer to DOORS (SEC. 10-5).

ROCKER PANEL MOLDING

Figure 15

Remove or Disconnect

1. Screws (69) retaining the rocker panel molding (70) to rocker panel.
2. Bolts (72).
3. Nuts (76) from rocker panel studs (71).
4. Retainer (73).
5. Rocker panel molding (70).

Install or Connect

NOTICE: See "Notice" on page 2C-1 of this section.

1. Rocker panel molding (70).
2. Retainer (73).
3. Nuts (76) to rocker panel studs (71).

Tighten

- Nuts (76) to 3.4 N·m (30 lb. in.).

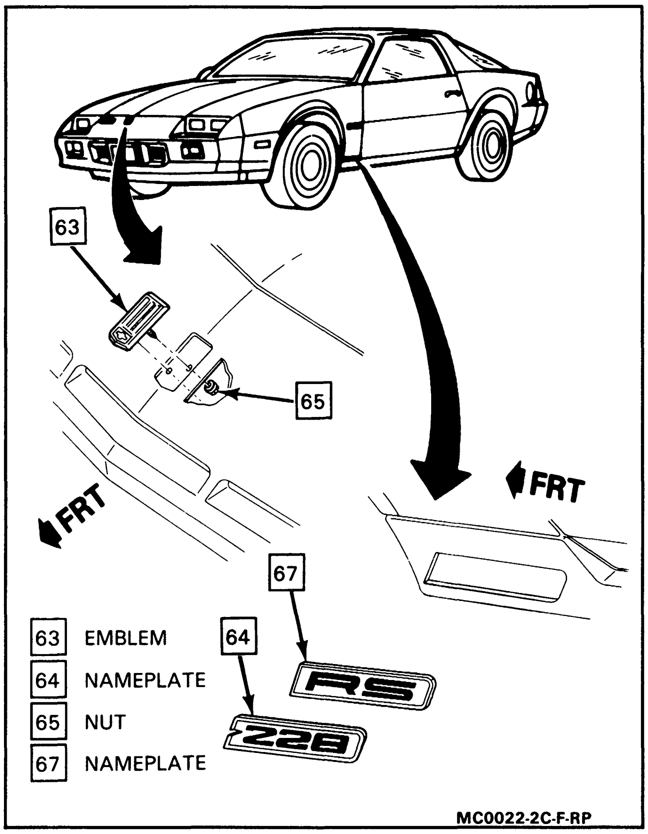


Figure 14 - Emblem and Nameplates

4. Bolts (72).

Tighten

- Bolts (72) to 1.5 N·m (13 lb. in.).

5. Screws (69).

Tighten

- Screws (69) to 1.5 N·m (13 lb. in.).

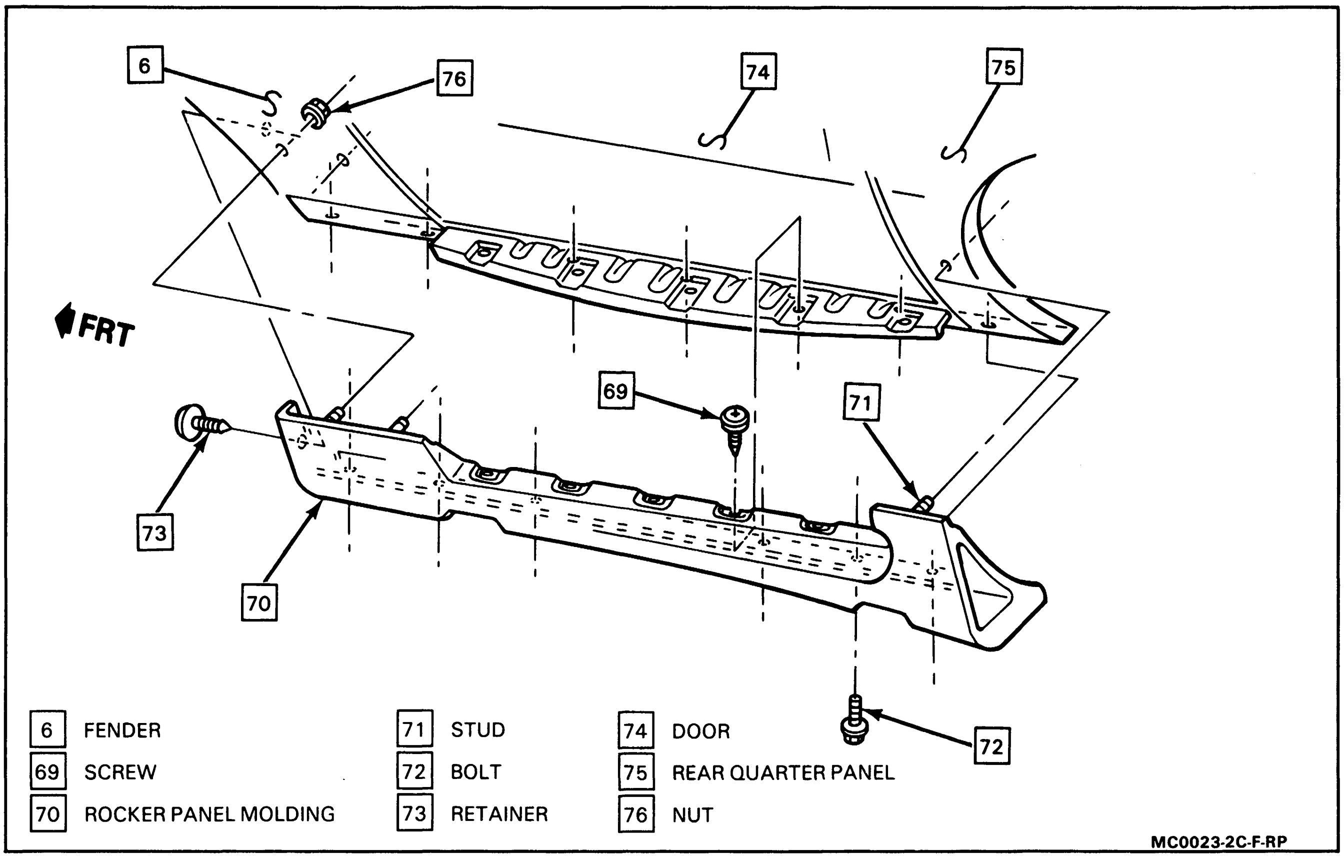


Figure 15 - Rocker Panel Molding

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Hinge-to-Fender Bolt	9.5 N·m (84 lb. in.)
Hinge-to-Hood Screw	9.5 N·m (84 lb. in.)
Primary Hood Latch Bolt	27 N·m (20 lb. ft.)
Secondary Hood Latch Bolt	9.5 N·m (84 lb. in.)
Radiator Air Upper Baffle Bolt	25 N·m (18 lb. ft.)
Front End Sheet Metal Support Bolt	9.5 N·m (84 lb. in.)
Lower Sport Coupe Grille Screw	1.9 N·m (17 lb. in.)
Front Sport Coupe Grille Screw	0.8 N·m (7 lb. in.)
Side Z28 Grille Screw	1.5 N·m (13 lb. in.)
Upper Z28 Grille Screw	1.9 N·m (17 lb. in.)
Front End Bumper Fascia-to-Fender Screw	10 N·m (89 lb. in.)
Front End Bumper Fascia-to-Fender Nut	10 N·m (89 lb. in.)
Upper Fender-to-Body Bolt	10 N·m (89 lb. in.)
Lower Front End Panel Deflector-to-Fender Bolt	4 N·m (35 lb. in.)
Lower Fender-to-Body Bolt	10 N·m (89 lb. in.)
Radiator Upper Mounting Bracket Bolt	5.8 N·m (51 lb. in.)
Z28 Hood Ornament Nut	5 N·m (44 lb. in.)
Wheelhouse Panel-to-Fender Screw	1.4 N·m (12 lb. in.)
Fascia Extension Side Screw	1.5 N·m (13 lb. in.)
Fascia Extension Bottom Screw	1.5 N·m (13 lb. in.)
Fascia Extension Retainer Nut	3.4 N·m (30 lb. in.)
Front End Panel Fascia Emblem Nut	2.3 N·m (20 lb. in.)
Rocker Panel Molding-to-Body Screw	1.5 N·m (13 lb. in.)
Rocker Panel Molding-to-Body Bolt	1.5 N·m (13 lb. in.)
Rocker Panel Molding-to-Body Nut	3.4 N·m (30 lb. in.)
Front End Bumper Fascia Filler-to-Front End Bumper Fascia	1.9 N·m (17 lb. in.)

SECTION 3

STEERING, SUSPENSION, TIRES AND WHEELS

CONTENTS

SECTION 3

STEERING, SUSPENSION, TIRES AND WHEELS DIAGNOSIS

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 3-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL INFORMATION AND DIAGNOSIS

The problems in steering, suspension, tires and wheels involve several systems. All systems must be considered when diagnosing a complaint. To avoid using the wrong symptom, always road test the vehicle first. Proceed with the following preliminary checks and correct any substandard conditions which are found.

Inspect

- Tires for wrong pressure and uneven wear.
- Joints from the column to the steering gear for loose connectors or wear.
- Front and rear suspension, steering gear or linkage for loose or damaged parts.
- Out-of-round or out-of-balance tires, bent wheels, and loose and/or rough wheel bearings.
- Power steering system for leaks. Also check the power steering fluid level and the pump drive belt tension. Refer to "Power Steering Pump Diagnosis" in this section.

Vehicle Pulls or Leads

Inspect

- Mismatched or uneven tires.
- Broken or sagging springs.
- Radial tire lateral force.
- Misaligned front wheels.
- Unbalanced steering gear valve.
- Dragging front brakes.

Abnormal or Excessive Tire Wear

Inspect

- Misaligned front or rear wheel.
- Excessive toe.
- Sagging or broken springs.
- Out of balance tire.
- Worn strut dampener or shock absorber.
- Hard driving.
- Overloaded vehicle.
- Tires not rotated.
- Low inflation pressure.

Scuffed Tires

Inspect

- Incorrect toe.
- Excessive speed on turns.
- Bent or twisted suspension arm.

Wheel Tramp

Inspect

- Out of balance tire or wheel.
- Improper strut dampener or shock absorber action.

Shimmy, Shake or Vibration

Inspect

- Out of balance tire or wheel.
- Excessive wheel stud runout.
- Excessive brake drum or rotor imbalance.
- Worn tie rod ends.
- Wheel trim imbalance.
- Worn lower ball joints.
- Excessive wheel runout.
- Excessive loaded radial runout of tire and wheel assembly.

Hard Steering

Inspect

- Hydraulic system - Perform test as outlined in "Power Steering System Test Procedure" in this section.
- Misadjusted steering gear.
- Bind or catch in steering gear.
- Loose steering gear mounting.
- Faulty steering gear pressure port check valve.

Too Much Play in Steering

Inspect

- Worn wheel bearings.
- Loose steering gear mounting.
- Loose or worn joints from column to steering gear.
- Misadjusted steering gear.

Poor Returnability

Inspect

- Lack of lubrication at ball joints and tie rod ends.
- Bind in ball joints.
- Bind in steering column.
- Misaligned front wheel.
- Misadjusted steering gear.
- Sticking valve.
- Lower coupling binding on steering gear.

Abnormal Noise at Front End

Inspect

- Lack of lubrication at ball joints and tie rod ends.
- Damaged suspension components.
- Worn control arm bushings or tie rod ends.
- Loose stabilizer shaft.
- Loose wheel nuts.
- Loose suspension bolts.
- Loose wheel covers.
- Misadjusted steering gear.

- Worn strut dampeners or mountings.
- Improperly positioned spring.

Wander or Poor Steering Stability

Inspect

- Mismatched or uneven tires.
- Lack of lubrication at ball joints and tie rod ends.
- Worn strut dampeners.
- Loose stabilizer shaft.
- Broken or sagging springs.
- Misadjusted steering gear.
- Misaligned front or rear wheel.

Erratic Steering When Braking

Inspect

- Worn wheel bearings.
- Broken or sagging springs.
- Leaking wheel cylinder or caliper.
- Warped rotors.
- Incorrect or uneven caster.

Low or Uneven Trim Height

Inspect

- Broken or sagging springs.
- Overloaded vehicle.
- Incorrect or weak springs.

Ride Too Soft

Inspect

- Worn strut dampeners or shock absorbers.
- Incorrect or sagging springs.

Ride Too Harsh

Inspect

- Incorrect strut dampeners or shock absorbers.
- Incorrect springs.

Body Leans or Sways in Corners

Inspect

- Loose stabilizer shaft.
- Worn strut dampeners, shock absorbers or mounting.
- Broken or sagging springs.
- Overloaded vehicle.

Suspension Bottoms

Inspect

- Overloaded vehicle.
- Worn strut dampeners or shock absorbers.
- Incorrect, broken or sagging spring.

"Dog" Tracking

Inspect

- Damaged rear suspension arm or worn bushings.
- Bent rear axle.
- Incorrect frame or underbody alignment.

Steering Wheel Kickback

Inspect

- Air in system.
- Loose steering gear mounting.
- Loose or worn joints from column to steering gear.
- Loose tie rod ends.
- Worn or missing check valve.
- Worn wheel bearings.
- See "Too Much Play in Steering" in this section, for other possible causes.

Steering Wheel Surges or Jerks

Inspect

- Incorrect hydraulic system pressure.
  - Perform pressure test with gage J 5176-D or J 25323-A as outlined in "Power Steering System Test Procedure" in this section.
- Sluggish steering gear valve.

Cupped Tires

Inspect

- Misaligned front or rear wheel.
- Weak strut dampeners or shock absorbers.
- Worn wheel bearing.
- Excessive tire or wheel runout.
- Worn ball joint.
- Loose steering gear adjustment.

POWER RECIRCULATING BALL STEERING GEAR DIAGNOSIS

Hissing Noise

There is some noise in all power steering systems. One of the most common is a hissing sound when the steering wheel is turned and the car is not moving. This noise will be most evident when turning the wheel while the brakes are applied. There is no relationship between this noise and steering performance. Do not replace the valve unless the hissing noise is extremely objectionable. A replacement valve will also have a slight noise, and is not always a cure for the condition. Check that the intermediate shaft joints are not loose.

Rattle or Chucking Noise

Inspect

- Pressure hose grounding out.
- Loose tie rod ends.
- Loose steering gear attachment.

- Loose pitman shaft.

A slight rattle may occur on turns because of increased clearance off the "high point." This is normal and clearance must not be reduced below specified limits to eliminate this slight rattle.

Poor Return of Steering Wheel to Center

Inspect

- Misaligned front wheel.
- Worn wheel bearing.
- Binding tie rod end.
- Binding ball joint.
- Steering wheel rubbing against turn signal housing.
- Misadjusted steering gear.
- Tight or frozen intermediate steering shaft.
- Sticky or plugged spool valve.

Momentary Increase in Effort When Turning Wheel Fast to Right or Left

Inspect

- High internal leakage.

Steering Wheel Surges or Jerks When Turning with Engine Running, Especially During Parking

Inspect

- Insufficient pump pressure.
- Sticky flow control valve.

Excessive Wheel Kickback or Loose Steering

Inspect

- Air in system.
- Loose steering gear adjustment.
- Loose tie rod ends.
- Worn wheel bearings.
- Steering gear flexible coupling loose on shaft.
- Loose rubber disc mounting nuts.
- Loose thrust bearing preload adjustment.
- Excessive "over-center" lash.
- Worn pressure port check valve.

Hard Steering or Lack of Assist, Especially During Parking

Inspect

- Brakes applied while turning steering wheel.
- Damaged or worn intermediate shaft.
- Sticky flow control valve.
- Insufficient pump pressure.
- Excessive internal pump leakage.
- Excessive internal steering gear leakage.

STEERING LINKAGE DIAGNOSIS

Excessive Play or Looseness in Steering System

Inspect

- Worn upper ball joints.
- Loosely adjusted steering gear worm bearings.
- Excessive pitman shaft to ball nut lash in steering gear.
- Worn relay rod or tie rod sockets.

Excessive Looseness in Tie Rod or Relay Rod Pivots, or Excessive Vertical Lash in Idler Support

Inspect

- Damaged and leaking seal resulting in loss of lubricant, corrosion and excessive wear.

Hard Steering

Inspect

- Tight or frozen relay rod, tie rod or idler socket.
- Steering gear adjusted too tight.

POWER STEERING PUMP DIAGNOSIS

Foaming, Milky Power Steering Fluid, Low Fluid Level, and Possible Low Pressure

This can be caused by air in the fluid, and loss of fluid due to internal pump leakage causing overflow. Check for leak and correct. Bleed the system. Extremely cold temperatures will cause air bubbles in the system if the fluid level is low. If the fluid level is correct and pump still foams, remove pump from the vehicle and separate reservoir from housing. Check soft plug and housing for cracks. If housing is cracked, replace housing.

Low Pressure Due to Steering Pump

Inspect

- Stuck or inoperative flow control valve.
- Pressure plate not flat against cam ring.
- Extremely worn cam ring.
- Scored pressure plate, thrust plate or rotor.
- Vanes sticking in rotor slots.
- Cracked or broken thrust or pressure plate.
- High internal leakage.

Low Pressure Due to Steering Gear

Inspect

- Scored housing bore.
- Leakage at valve rings or seals.

Growling Noise in Steering Pump

Inspect

- Restricted hoses or steering gear, causing excessive back pressure.
- Scored pressure plates, thrust plate or rotor.

- Worn cam ring.

Groaning Noise in Steering Pump

Inspect

- Air in the fluid.
- Low fluid level.
- Loose pump mounting.

Rattling Noise in Steering Pump

Inspect

- Vanes sticking in rotor slots.
- Improperly installed vane.
- Damaged ball bearing.

Swishing Noise in Steering Pump

Inspect

- Damaged flow control valve.

Whining Noise in Steering Pump

Inspect

- Scored pump shaft bearing.
- Scored pressure plates and vanes.

STEERING COLUMN DIAGNOSIS

LOCK SYSTEM

Will Not Unlock

Inspect

- Collapsed shear flange on sector shaft.
- Damaged lock bolt.
- Damaged lock cylinder.
- Damaged housing.
- Damaged sector.
- Damaged rack.
- Damaged park lock cable.

Will Not Lock

Inspect

- Broken or worn lock bolt spring.
- Damaged sector.
- Damaged lock cylinder.
- Burr on lock bolt.
- Damaged housing.
- Improper shift linkage adjustment.
- Damaged rack.
- Interference between bowl and rack coupling.
- Stuck ignition switch.
- Restricted actuator rod.
- Incorrectly installed sector.
- Damaged park lock cable.

High Lock Effort

Inspect

- Damaged lock cylinder.
- Damaged ignition switch.
- Broken or deformed rack preload spring.
- Burrs on sector, rack, housing, support or actuator rod coupling.
- Bent sector shaft.
- Damaged rack.
- Extreme misalignment of housing to cover.
- Distorted coupling slot in rack.
- Bent actuator rod.
- Bent ignition switch mounting bracket.
- Restricted actuator rod.
- Improper shift linkage adjustment.

Will Stick in "Start"

Inspect

- Deformed actuator rod.
- Check items under "High Lock Effort" in this section.

Key Cannot Be Removed in "OFF-LOCK"

Inspect

- Incorrectly set ignition switch.
- Damaged lock cylinder.
- Misadjusted linkage.

Lock Cylinder Can Be Removed

Inspect

- Missing lock cylinder retaining screw.

High Effort in Lock Cylinder Between "OFF" and "OFF-LOCK"

Inspect

- Distorted rack.

Lock Bolt Hits Shaft Lock in "OFF" and "PARK"

Inspect

- Incorrectly set ignition switch.

COLUMN

Noise in Column

Inspect

- Loose joints from the column to the steering gear.
- Incorrectly aligned column.
- Unlubricated horn contact ring.
- Lack of grease on bearings.
- Loose sight shields.
- Worn or broken lower or upper steering shaft bearing.

- Unseated shaft lock snap ring.
- Unlubricated spherical joint.

High Steering Shaft Effort

Inspect

- Misaligned column assembly.
- Improperly installed or deformed dust seal.
- Damaged upper or lower bearing.
- Flash on inside diameter of shift tube.
- Tight intermediate steering shaft universal joint.

Lash in Steering Column

Inspect

- Loose instrument panel-to-column upper and lower bracket mounting bolts.
- Broken weld nuts on jacket.
- Sheared instrument panel upper bracket capsule.
- Loose shoes in housing.
- Loose tilt head pivot pins.
- Loose shoe lock pin in support.
- Loose support screws.
- Loose column upper and lower bracket-to-jacket bolts.
- Loose lower bracket-to-adapter and bearing assembly mounting screws.
- Loose instrument panel-to-jacket mounting bolts.

Housing Scraping on Bowl

Inspect

- Bent bowl or bowl not concentric with hub.
- Improperly installed cover and housing end cap.

Loose Steering Wheel

Inspect

- Excessive clearance between holes in support or housing and pivot pin diameters.
- Damaged or missing anti-lash spring in spheres.
- Upper bearing not seated in housing.
- Missing upper bearing inner race seal.
- Loose support screws.
- Missing or broken bearing preload spring.

Loose Steering Wheel (Every Other Tilt Position)

Inspect

- Loose fit between shoe and shoe pivot pin.
- Shoe not free in slot.

Steering Column Not Locking in Any Tilt Position

Inspect

- Shoe seized on pivot pin.
- Burrs or dirt on shoe grooves.
- Weak or broken shoe lock spring.

Steering Wheel Fails to Return to Top Tilt Position

Inspect

- Bound-up pivot pins.
- Broken or weak wheel tilt spring.
- Tight turn signal switch wires.

Noise When Tilting Column

Inspect

- Worn upper tilt bumpers.
- Tilt spring rubbing in housing.

TURN SIGNAL SWITCH

This diagnosis covers mechanical problems only. Refer to ELECTRICAL DIAGNOSIS (SEC. 8A) for turn signal switch electrical diagnosis.

Turn Signal Will Not Stay in Turn Position

Inspect

- Foreign material or loose parts impeding movement of yoke.
- Broken or missing detent or cancelling spring.
- None of the above. Replace switch.

Turn Signal Will Not Cancel

Inspect

- Loose switch mounting screws.
- Broken switch or anchor bosses.
- Broken, missing or out of position detent, return or cancelling spring.
- Worn cancelling cam.

Turn Signal Difficult to Operate

Inspect

- Loose turn signal switch arm.
- Broken or distorted yoke, replace switch.
- Loose or misplaced springs.
- Foreign parts and/or material.
- Loose turn signal switch mounting screws.

Turn Signal Will Not Indicate Lane Change

Inspect

- Broken lane change pressure pad or spring hanger.
- Broken, missing or misplaced lane change spring.
- Jammed base or wires.

Hazard Switch Cannot Be Turned "OFF"

Inspect

- Foreign material between hazard support cancelling leg and yoke.
- If no foreign material is found, replace turn signal switch.

Hazard Switch Will Not Stay "ON" or Difficult to Turn "OFF"

Inspect

- Loose turn signal switch.
- Interference with other components.
- Foreign material interference.
- None of the above. Replace turn signal switch.

No Turn Signal Lamps

Inspect

- Electrical failure in chassis harness.
- Inoperative turn signal flasher.
- Loose chassis-to-column connector. Disconnect chassis-to-column connector and connect new turn signal switch to chassis and operate switch by hand.
  - If vehicle lamps now operate normally, turn signal switch is inoperative.
  - If vehicle lamps do not operate, refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

Turn Indicator Lamps "ON," But Not Flashing

Inspect

- Inoperative turn signal flasher.
- Loose chassis-to-column connection.
- Inoperative turn signal switch.
- To determine if turn signal switch is inoperative, substitute new turn signal switch into circuit and operate switch by hand. If the vehicle lamps operate normally, turn signal switch is inoperative.

Front or Rear Turn Signal Lamps Not Flashing

Inspect

- Burned-out or damaged turn signal bulb.
- High resistance connection to ground at bulb socket.
- Loose chassis-to-column connector. Disconnect chassis-to-column connector and connect new turn signal switch into system and operate switch by hand.
  - If turn signal lamps are now "ON" and flashing, turn signal switch is inoperative.
  - If vehicle lamps do not operate, refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

No Turn Indicator Panel Lamps

Inspect

- Burned out bulbs or opens, grounds in the wiring harness from the front turn signal bulb socket to the indicator lamps. Refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

Stoplamp Not "ON" When Turn Indicated

Inspect

- Loose chassis-to-column connection.
- Disconnect the chassis-to-column connector and connect the new turn signal switch into the system and operate the switch by hand.
  - If the brake lamps work when the switch is in the turn position, the turn signal switch is inoperative.
  - If the brake lamps do not work, refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

Turn Signal Lamps Flash Very Slowly

Inspect

- Loose chassis-to-column connection.
- Disconnect the chassis-to-column connector and connect a new turn signal switch into the system and operate the switch by hand.
  - If the lamps flash at a normal rate, the turn signal switch is inoperative.
  - If the lamps still flash very slowly, refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

Hazard Signal Lamps Will Not Flash - Turn Signal Functions Normally

Inspect

- Blown fuse.
- Inoperative hazard warning flasher.
- Loose chassis-to-column connection.
- Disconnect the column-to-chassis connector and connect a new turn signal switch into the system, then press in the hazard warning button and watch the hazard warning lights.
  - If the lamps now work normally, the turn signal switch is inoperative.
  - If the lamps do not flash, check the wiring harness. Refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

IGNITION SWITCH

Electrical System Will Not Function

Inspect

- Damaged ignition switch.
- Improperly adjusted ignition switch.
- Loose connector at the ignition switch.

Switch Will Not Turn

Inspect

- Damaged ignition switch.

Switch Cannot Be Set Correctly

Inspect

- Deformed switch actuator rod.
- Sector to rack engaged in wrong tooth.

KEY REMINDER

Figures 1 through 10

Reminder Continues to Operate with Key Out, but Stops When Driver's Door is Closed

Inspect

- Chips, foreign material in lock cylinder bore.
- Sticky lock cylinder actuator tip.
- Damaged or broken reminder switch (3).

Reminder Does Not Sound with Key Fully Inserted in Lock Cylinder and the Driver's Door Open

Inspect

NOTICE: If you are using a multimeter to check continuity with voltage present in circuits, be sure to use a voltage setting. A multimeter set on a resistance scale will be damaged by the voltage from live circuits.

1. Reminder to see if power is available. Refer to ELECTRICAL DIAGNOSIS (SEC. 8A).
2. Chassis wiring for open circuit.
   - Separate chassis connector (1) from column connector (2).
   - Connect the female contacts of terminals "E" and "F" on the chassis connector (1). A bent paperclip will work as a jumper.
     - If the reminder sounds, repair the chassis wiring.
     - If the reminder does not sound, go to step 3.
3. Continuity between the male "E" and "F" column connector contacts with a multimeter (or test light).
   - Push the key all the way into the lock cylinder (4).
     - If there is continuity when the key is in, and off when the key is out, the function is normal.
     - If there is no continuity, the fault is in the column. Go to step 4.
4. Probes of the reminder switch (3) to ensure good contact with the pads on the signal switch.
   - Disassemble the upper end of the column until the turn signal switch mounting screws have been removed.
   - Lift the turn signal switch to gain access to the probes.
   - Bend the probes, if needed. Then replace the turn signal switch and tighten the three screws.
   - Check the function as in step 3.
5. Turn signal switch wiring for short or fault.
   - Connect the male contacts of terminals "E" and "F" of the column connector (2) with a jumper.
   - Check key reminder switch pads on turn signal switch with multimeter.
     - If there is continuity, the function is normal.
     - If there is no continuity, replace the turn signal switch.
6. Continuity of check key reminder switch probes, if the problem has not been found.
   - Connect a multimeter to the probes on the reminder switch (3).
   - Fully insert and remove the key from the lock cylinder (4).
     - If there is continuity when the key is in the lock cylinder (4) and no continuity when the key is out, the function is normal. Retrace the diagnostic steps starting at step 3.
     - If there is no continuity, the fault is in the lock cylinder (4) or reminder switch (3).
7. Lock cylinder (4) for chips, burrs or foreign material that may prevent actuator tip function.
   - The key must be removed, or the lock cylinder (4) must be in the "RUN" position, before the lock cylinder can be removed.
   - Remove chips, burrs or foreign material.
   - Reassemble and recheck (step 6).
8. Lock cylinder (4) for damage.
   - With the lock cylinder (4) removed, push the key all the way in. Turn to the "RUN" position and then remove the key.
     - The lock cylinder actuator tip should extend and retract smoothly. The total extension of the tip should be 1.27 mm (0.050 inch).
     - If not, replace the lock cylinder (4). Reassemble and recheck per step 4.
9. Reminder switch (3) if it appears good but will not operate.
   - Connect multimeter leads to the reminder switch probes on the reminder switch (3).
   - Press on the actuator pad until the switch points touch.
   - If there is no continuity, replace the reminder switch (3).
10. Reminder switch contact gap.
    - Connect multimeter leads to the reminder switch probes on the reminder switch (3).
    - Press a 0.76 mm (0.030-inch) wire type plug gage with a flat piece of stock onto the actuator pad.
      - If contact is not made (no continuity), decrease the switch contact gap until positive contact is made.
11. Reminder switch contact gap, with positive contact gap set at 0.76 mm (0.030 inch) as outlined above.
    - Use a 0.63 mm (0.025-inch) plug gap wire beneath the flat stock.
      - If contact is made (continuity), increase the switch contact gap.

- The reminder switch (3) is set properly when the switch contact will touch the 0.76 mm (0.030 inch) wire but not the 0.63 mm (0.025 inch) wire.

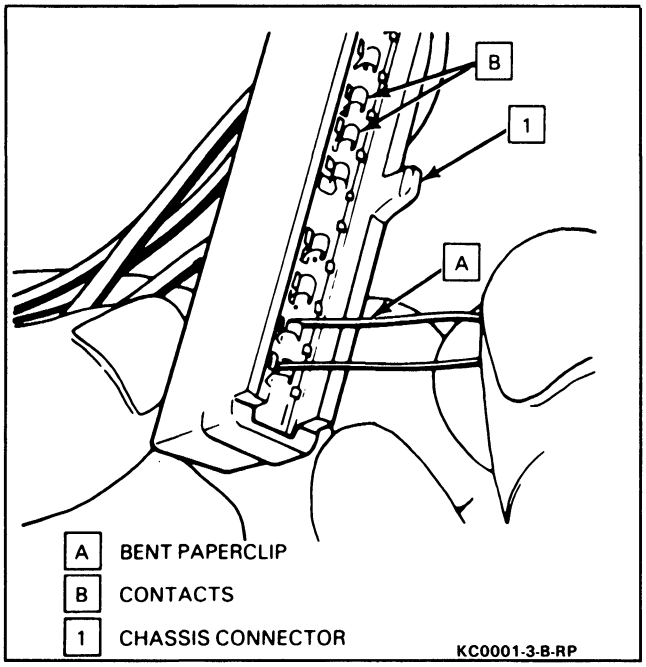


Figure 1 - Checking Reminder at Chassis Connector

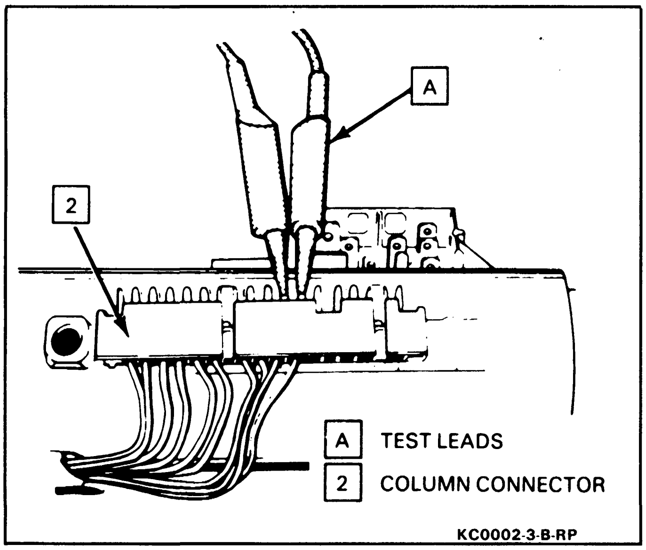


Figure 2 - Checking Reminder at Column Connector

Reminder Key Keeps Operating with Key in Lock Cylinder, Driver's Door Open or Closed; Ceases When Key is Removed

Inspect

- Misadjusted or inoperative door jamb switch on driver's side.
- Shorted wire from signal switch to door jamb switch.
    - This condition indicates the lock cylinder (4) or the reminder switch (3) is at fault. To verify, check for continuity at the "E" and "F" male column connector contacts, with the key removed from the lock cylinder (4).
        - If continuity exists, the fault is in the column.

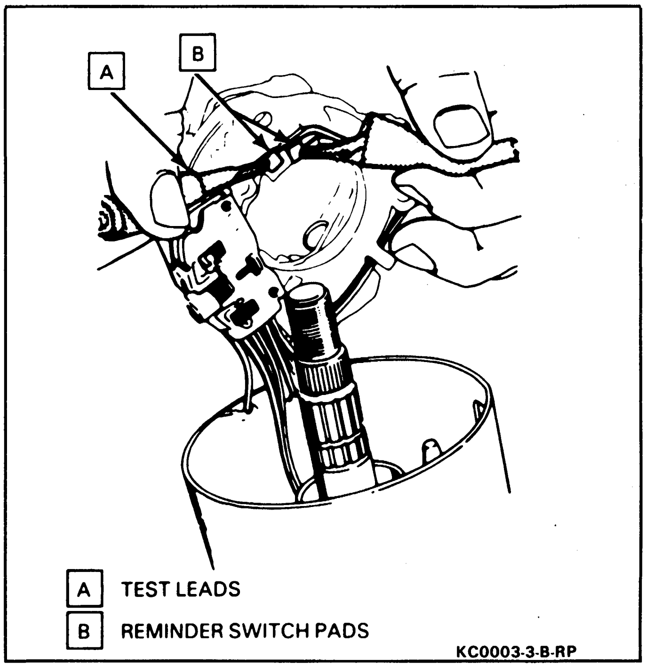


Figure 3 - Checking Reminder Switch Pads

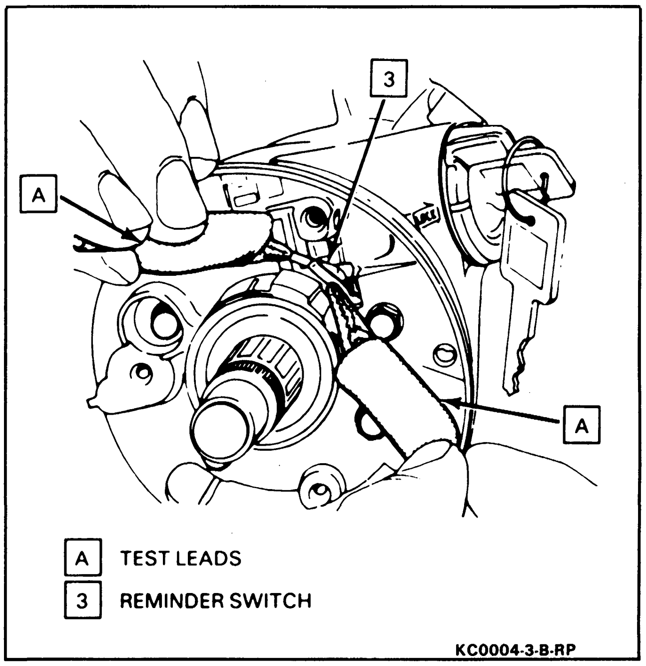


Figure 4 - Checking Reminder Switch

- Insert the key into the lock, then turn the lock toward the "START" position.
    - If the reminder stops when the key is in the "RUN" position or when it is turned past "RUN" toward "START," the problem is a sticky lock cylinder actuator.

COLUMN-MOUNTED DIMMER SWITCH

No "LOW" or "HIGH" Beam

Inspect

- Loose connector at dimmer switch.

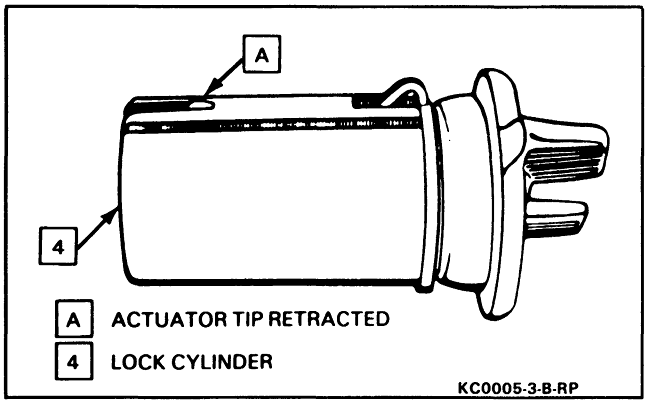


Figure 5 - Lock Cylinder Actuator - Key Removed

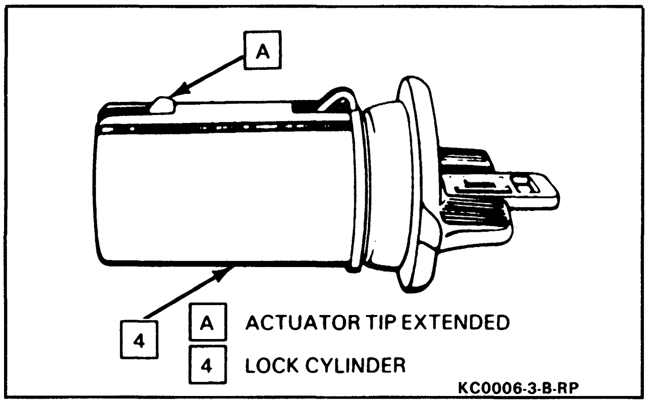


Figure 6 - Lock Cylinder Actuator - Key in Place

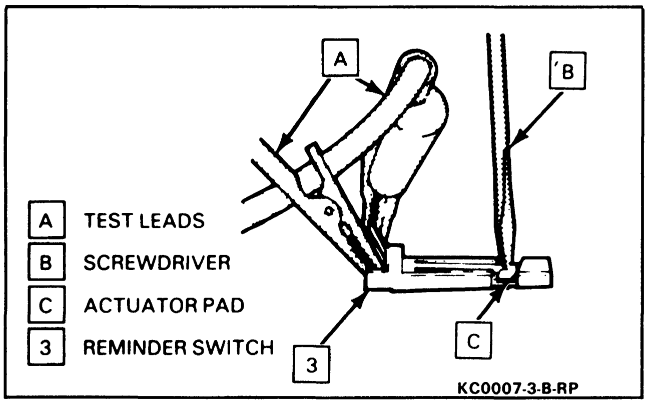


Figure 7 - Checking Key Reminder Switch Continuity

- Improper adjustment.
- Internally damaged or worn switch.
    - Check the continuity on the switch at the light green and at the tan switch terminals by pushing in the plunger all the way. A click should be heard.
        - If there is no continuity, replace the dimmer switch.
        - If there is continuity, refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

PIVOT AND SWITCH ASSEMBLY

Switch Inoperative: No "LOW," "HIGH" and/or "WASH"

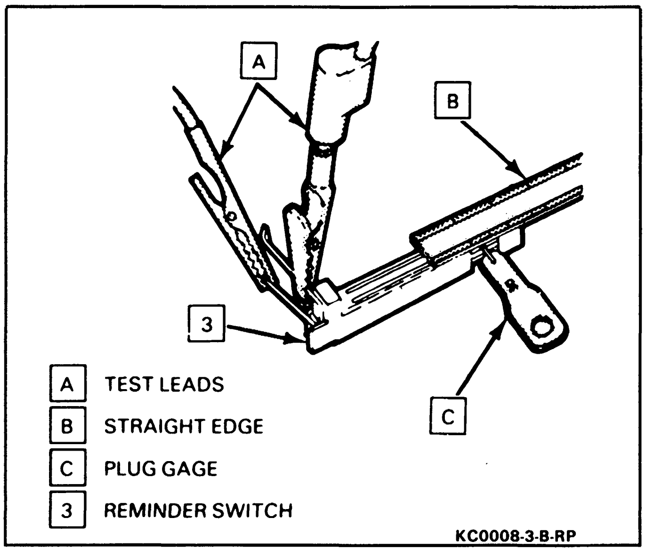


Figure 8 - Checking Contact Gap

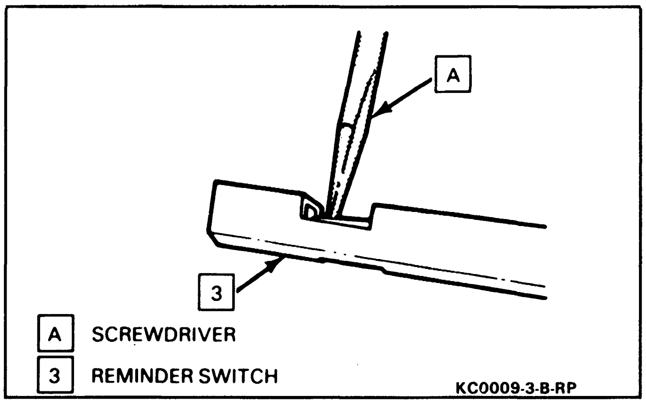


Figure 9 - Decreasing Switch Contact Gap

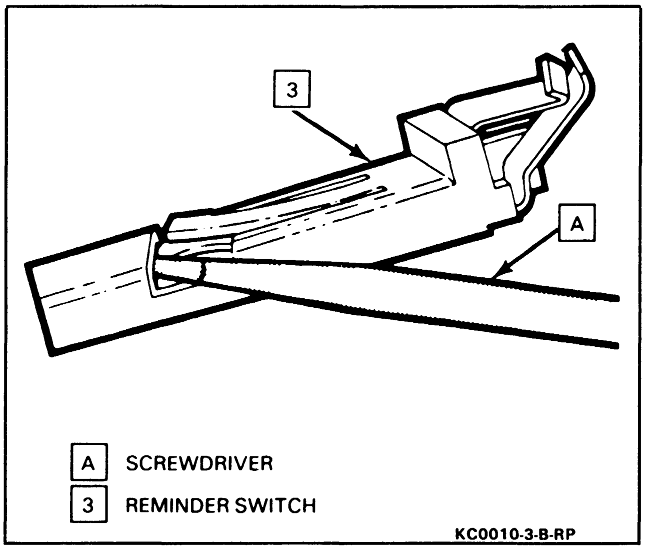


Figure 10 - Increasing Switch Contact Gap

Inspect

- Loose body-to-switch connector.
- Broken or damaged switch.
- Internally damaged or worn switch.

- Connect a new switch without removing the old one.
  - If the system functions, replace the switch.
  - If the system doesn't function, refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

STEERING GEAR AND PUMP LEAK DIAGNOSIS

GENERAL PROCEDURE

Inspect

- For these common complaints about the power steering system:
  - Fluid leakage on garage floor.
  - Fluid leaks visible on steering gear or pump.
  - Growling noise, especially when parking or when engine is cold.
  - Loss of power steering when parking.
  - Heavy steering effort required.
- For an overfilled reservoir.
- For fluid aeration and overflow.
- Hose connections.
- Identify exact point of leakage. Refer to "External Leakage Check" in this section.
  - The point from which the fluid is dripping is not necessarily the point where the system is leaking. It is important to identify the exact point of leakage.

EXTERNAL LEAKAGE CHECK

Figure 11

This procedure will help identify the exact location of the leak. Some leaks can easily be located but seepage type leaks may be more difficult. To locate seepage leaks, use the following method:

NOTICE: See "Notice" on page 3-1 of this section.

1. With the engine off, wipe dry the complete power steering system.
2. Check the fluid level in the pump reservoir. Adjust fluid level as necessary.
3. Start the engine. Then turn the steering wheel from stop to stop several times.
   - Do not hold it at a stop for any length of time as this can damage the power steering pump.
   - It is easier for someone else to operate the steering wheel while you search for the seepage.
4. Find the exact location of the leak and repair (Figure 11).

SEAL REPLACEMENT RECOMMENDATIONS

Rotating shaft lip seals require special treatment. This type of seal is used on the steering gear and on the driveshaft of the pump. When there is a leak in one of these areas, always replace the seal or seals after inspecting and thoroughly cleaning the sealing surfaces. Replace the shaft only if very severe pitting is found. If the corrosion in the lip seal contact zone is slight, clean the surface of the shaft with crocus cloth. Replace the shaft only if the leakage cannot be stopped by first smoothing with crocus cloth.

POWER STEERING SYSTEM TEST PROCEDURE

Figure 12

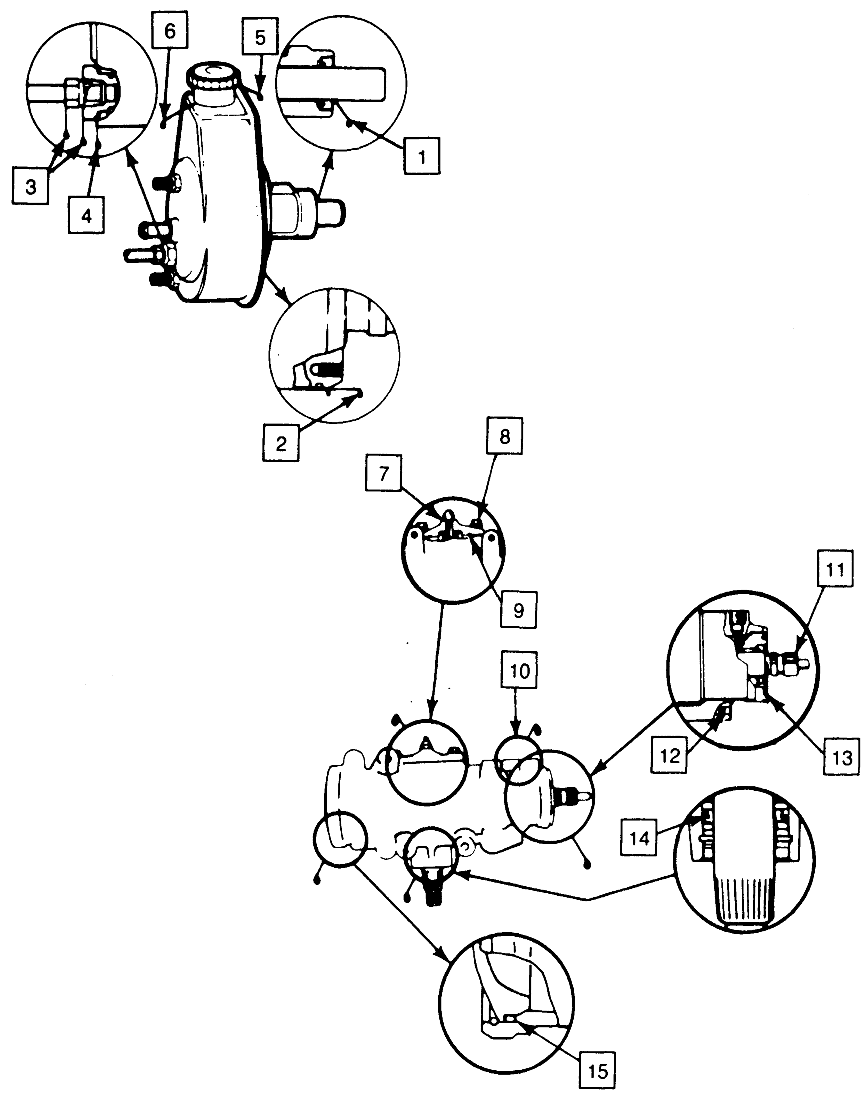
Tools Required:
J 5176-D Power Steering Pressure Tester, 0-2000 psi, or
J 25323-A Power Steering System Analyzer

1. Disconnect pressure hose at pump.
   - Use a small container to catch any fluid which might leak.
2. Connect a spare pressure hose to pump.
3. Connect J 5176-D or J 25323-A to both hoses.
   - The power steering system may be tested using J 5176-D or J 25323-A. Testing with J 25323-A will measure flow rate as well as pressure.
4. Open valve on J 5176-D or J 25323-A.
5. Start the engine.
   - Allow the system to reach operating temperature, then check the fluid level and add fluid if required.
   - When the engine is at normal operating temperature, the pressure reading on J 5176-D or J-25323-A should be 552-862 kPa (80 - 125 psi).
     - If the pressure is more than 1380 kPa (200 psi), check the hoses for restrictions and the poppet valve on the steering gear for proper assembly.

NOTICE: Do not leave the valve fully closed for more than 5 seconds as the pump could be damaged.

6. Fully close the valve 3 times and record the pressure reading each time. Each reading should show at least 6895 kPa (1000 psi). The three readings should be within 345 kPa (50 psi) of each other.
   - If the pressure readings are high enough and are within 345 kPa (50 psi) of each other, the pump is functioning properly.
   - If the pressure readings are high enough but are not within 345 kPa (50 psi) of each other, the control valve in the pump is sticking.
     - Remove the valve, clean it and remove any burrs using crocus cloth or fine hone.
     - If the system contains some contamination, flush it.

GEAR AND PUMP LEAK DIAGNOSIS



1. REPLACE DRIVESHAFT SEAL. MAKE CERTAIN THAT DRIVESHAFT IS CLEAN AND FREE OF PITTING IN SEAL AREA.
2. REPLACE RESERVOIR O-RING SEAL.
3. TORQUE HOSE FITTING NUT TO 28 N·m (21 LB. FT.). IF LEAKAGE PERSISTS, REPLACE O-RING SEAL.
4. TORQUE FITTING TO 75 N·m (55 LB. FT.). IF LEAKAGE PERSISTS, REPLACE O-RING SEAL.
5. CHECK OIL LEVEL; IF LEAKAGE PERSISTS WITH THE LEVEL CORRECT AND CAP TIGHT, REPLACE THE CAP.
6. IF A CRACKED OR BENT RESERVOIR IS DETECTED, REPLACE RESERVOIR.
7. TORQUE NUT TO 50 N·m (37 LB. FT.). REPLACE NUT IF LEAKAGE PERSISTS.
8. TORQUE SIDE COVER BOLTS TO 60 N·m (44 LB. FT.). REPLACE SIDE COVER SEAL IF LEAKAGE PERSISTS.
9. REPLACE SIDE COVER O-RING SEAL.
10. TORQUE HOSE FITTING NUT TO 28 N·m (21 LB. FT.). IF LEAKAGE PERSISTS, REPLACE O-RING SEAL.
11. REPLACE ROTARY VALVE ASSEMBLY.
12. SEAT BALL FLUSH WITH PUNCH AND RESTAKE. IF SEEPAGE PERSISTS, REPLACE HOUSING.
13. REPLACE ADJUSTER PLUG SEALS.
14. REPLACE PITMAN SHAFT SEALS.
15. REPLACE END PLUG O-RING SEAL.

LC0001-3-F-RP

Figure 11 - Gear and Pump Leak Diagnosis

- If the pressure readings are less than 6895 kPa (1000 psi), replace the flow control valve and recheck.
    - If the pressures are still low, replace the rotor and vanes.

7. If the pump checks to specification, leave the valve open and turn the steering wheel (or have someone else turn it) to both stops.
    - Record the highest pressures and compare with the highest pump pressure recorded earlier.
        - If the pressure at both stops is not the same as the maximum pressure, the steering gear is leaking internally and must be repaired.
8. Turn off the engine.
9. Remove J 5176-D or J 25323-A and the spare hose.
10. Reconnect the pressure hose, check the fluid level or make repairs as needed.

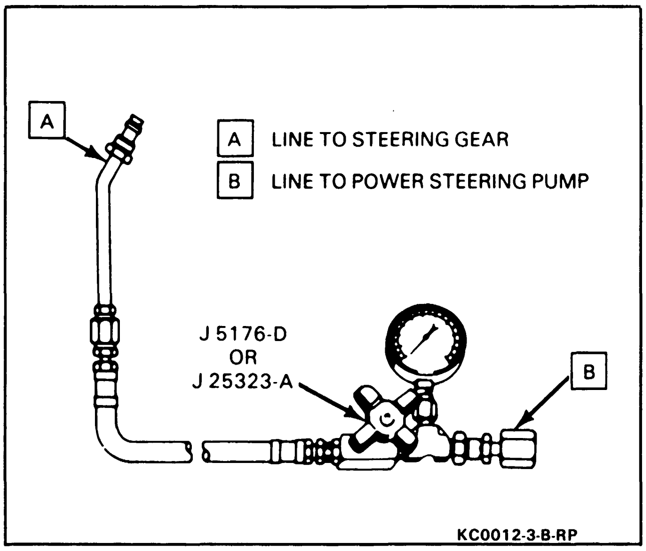


Figure 12 - Power Steering Pressure Gage

STRUT DAMPENER AND SHOCK ABSORBER DIAGNOSIS

The following procedure includes both on-vehicle and bench checks to be done when evaluating the performance of strut dampeners and shock absorbers.

ON-VEHICLE CHECKS

Weak

- For strut dampeners, follow steps 1 through 4.

1. Check and adjust tire pressures to the pressures shown on the tire placard.
2. Note the load conditions under which the vehicle is normally driven.
3. If practical, ride with the owner to be sure you understand the complaint before proceeding to the next step.
4. Test each strut dampener and shock absorber in turn by quickly pushing down, then lifting up, the corner of the bumper nearest the strut dampener or shock absorber being checked.
    - Use the same amount of effort on each test and note the resistance on compression and rebound.
    - Compare this with a similar vehicle having acceptable ride quality.
        - Both strut dampeners or shock absorbers should provide the same feeling of resistance. If there is much difference between the right and left rear shock absorbers, go to the next step.
5. Support the rear axle at least enough to unload the shock mounts.
6. Disconnect the lower shock mountings.
7. Stroke the shock absorbers at various rates of speed, through maximum travel in both directions.
8. Compare the right and left shock absorber for rebound and compression resistance.
    - Rebound resistance is usually stronger than compression resistance, around 2 to 1.
    - The right and left shock absorbers must feel comparable.
    - Differences between front strut dampeners and rear shock absorbers are normal.
    - If in doubt about the condition, compare with a shock absorber known to be good.

Noisy

- For strut dampeners, follow steps 1 through 3.

1. Check all mountings for proper tightening.
    - A loose mounting will cause a noise.
2. If all mountings are intact, jounce the vehicle as in step 4 in "Weak" above to isolate the suspected unit.
3. If practical, ride with the owner to be sure you understand the complaint, before proceeding to the next step.
4. Disconnect the lower mounting of the suspected shock absorber.
    - If one of the rear shock absorbers is suspected, the rear axle should be supported at least enough to unload the shock mounts.
5. Quickly push the shock absorber all the way in; then all the way out.
    - A hissing noise is normal.
6. Other objectionable noises may be detected by stroking.
7. Replace the shock absorber if the detected noise is any sound other than hissing.

Leaks

1. Fully extend the strut dampeners or shock absorbers (wheels unsupported) to expose the seal cover area for inspection.
2. Look for signs of leaks in the seal cover area.
    - A slight trace of fluid is not cause for replacement. The seal permits some seepage to lubricate the piston rod and there is a built-in fluid reserve to allow for seepage.
    - A leaking strut dampener or shock absorber can easily be found because there will be

fluid around the seal cover and an excessive amount of fluid on the strut dampener or shock absorber.

3. A leaking strut dampener or shock absorber must be replaced.

BENCH CHECKS

Regular Strut Dampeners and Shock Absorbers

Regular shock absorbers and strut dampeners use a gas-filled cell in the fluid reservoir. Aeration or foaming of the fluid is eliminated because the gas and the fluid cannot mix. If a lag is noticed when stroking, it indicates that a gas filled cell has ruptured and must be replaced.

NOTICE: Do not clamp on the reservoir tube or the mounting threads or parts will be damaged.

1. Clamp the strut dampener or shock absorber upside down in a vise.
2. Pump strut dampener or shock absorber by hand at various rates of speed and note the resistance.
   - Rebound resistance normally is stronger than compression resistance by about 2 to 1. However, the resistance should be smooth and constant for each stroking rate.
   - Compare with a strut dampener or shock absorber known to be good.
   - It is normal to hear a hissing noise.
3. The following symptoms are abnormal and are reason for replacement.
   - A skip or lag at reversal near mid-stroke.
   - A seize, except at either extreme end of travel.
   - A noise such as a grunt or squeal after completing one full stroke in both directions.
   - A clicking noise at fast reversal.
   - Fluid leakage.

TIRE DIAGNOSIS

Irregular and Premature Wear

Figures 13 and 14

Irregular and premature tire wear has many causes. Some of them are: incorrect inflation pressures, lack of regular rotation, driving habits or improper wheel alignment. If wheel alignment is reset due to a tire wear condition, always reset toe as close to zero degrees as the specification allows.

Rotate the tires if the following conditions are noted:

- Front and rear tire wear is unequal.
- Uneven wear exists across the tread of any tire.
- Left and right front tire wear is unequal.
- Left and right rear tire wear is unequal.

Check wheel alignment if the following conditions are noted:

- Left and right front tire wear is unequal.
- Wear is uneven across the tread of any front tire.
- Front tire treads have a scuffed appearance with "feather" edges on one side of the tread ribs or blocks.

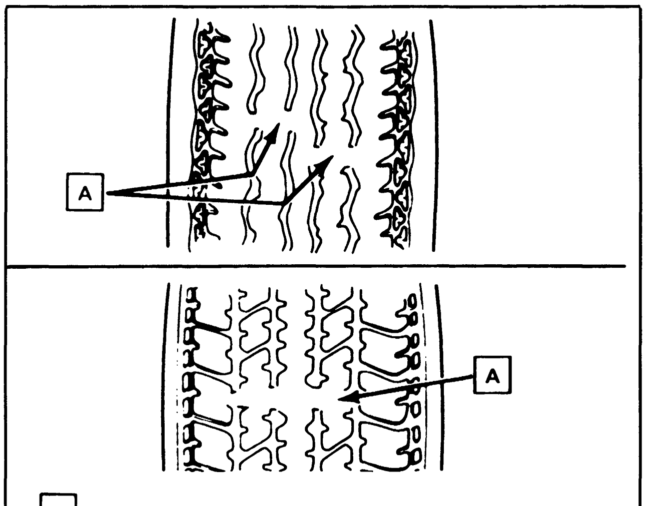


Figure 13 - Tread Wear Indicators

Tread Wear Indicators

Figure 13

The original equipment tires have built-in tread wear indicators to show when the tires should be replaced. These indicators will appear as 12.7 mm (1/2-inch) wide bands when the tire tread depth becomes 1.6 mm (1/16-inch). When the indicators appear in 2 or more grooves at 3 locations, replace the tire.

Radial Tire Waddle

Figure 15

Waddle is side-to-side movement at the front and/or rear of the vehicle. It can be caused by the steel belt not being straight within the tire, or by excessive lateral runout of the tire or wheel. It is most noticeable at low speed, about 8 to 48 km/h (5 to 30 mph). It may also appear as a ride roughness at 80 to 113 km/h (50 to 70 mph).

The vehicle can be road tested to see which end of the vehicle has the faulty tire. If the tire causing the waddle is on the rear, the rear end of the vehicle will "waddle." From the driver's seat, it feels as if someone is pushing on the side of the vehicle.

If the faulty tire is on the front, the waddle is more easily seen. The front sheet metal appears to be moving back and forth. It feels as if the driver's seat is the pivot point in the vehicle.

A more time-consuming method of determining the faulty tire is substituting tire and wheel assemblies that are known to be good. Follow these steps:

1. Drive the vehicle to determine if the waddle is coming from the front or rear.
2. Install tire and wheel assemblies known to be good from a similar vehicle in place of those on the end of the vehicle which is waddling.
   - If the waddle cannot be isolated to front or rear, start with the rear tires.

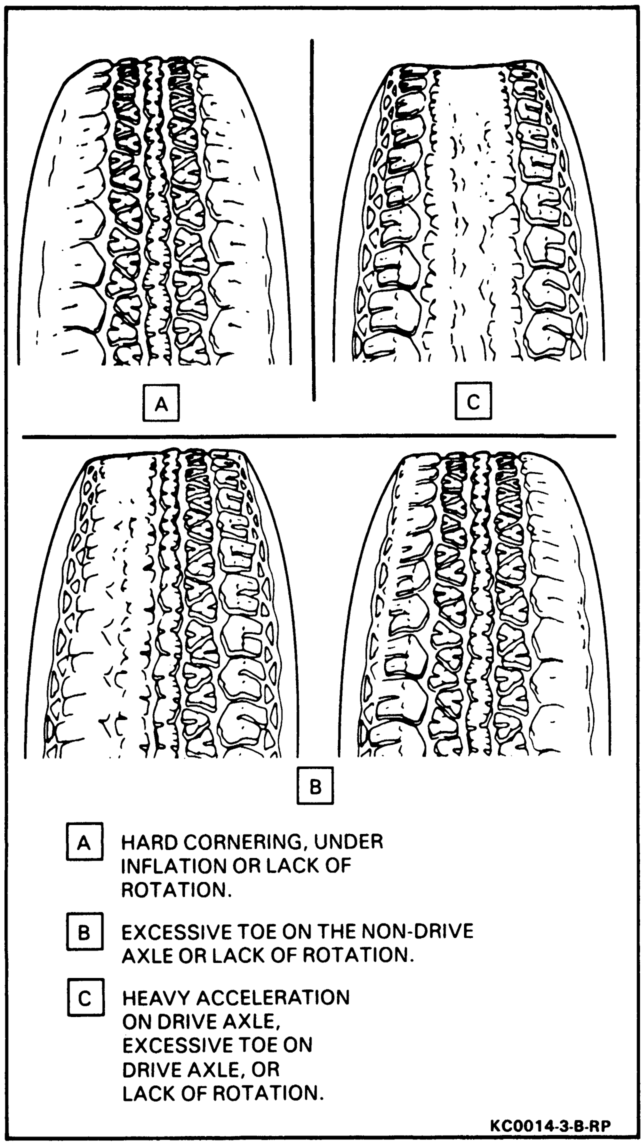


Figure 14 - Tire Wear Diagnosis

3. Road test again.
   - If improvement is noted, install the original tire and wheel assemblies one at a time until the faulty tire is found.
   - If no improvement is noted, install tires known to be good in place of all four. Then, install the originals one at a time until the faulty tire is found.

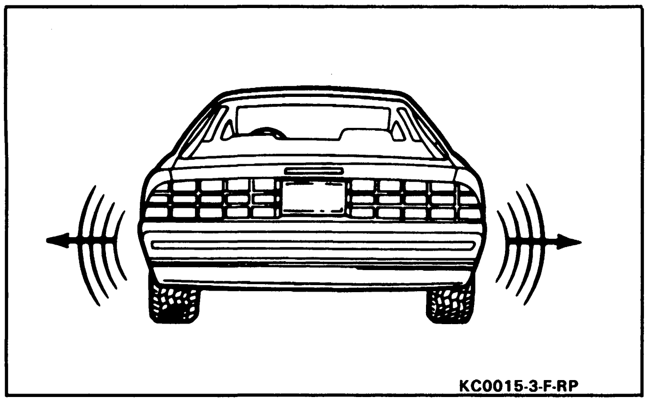


Figure 15 - Tire Waddle

Radial Tire Lead/Pull

Figure 16

Lead/pull is the deviation of the vehicle from a straight path, on a level road with no pressure on the steering wheel.

Lead is usually caused by:

- Poor tire construction.
- Uneven brake adjustment.
- Improper wheel alignment.

The way in which a tire is built can produce lead in a vehicle. An example of this is placement of the belt. Off-center belts on radial tires can cause the tire to develop a side force while rolling straight down the road and the tire will tend to roll like a cone.

The lead/pull correction chart should be used to make sure that front wheel alignment is not mistaken for tire lead (Figure 16). Refer to WHEEL ALIGNMENT (SEC. 3A).

Rear tires will not cause lead.

VIBRATION DIAGNOSIS

Figure 17

Inspect

- Improper tire inflation pressure.
- Bent rims from chuckhole or curb impact.
- Faulty tires, such as tread distortions, separations, or bulges.
  - Slight sidewall indentations are normal and will not affect ride.
  - Sidewall bulges are not normal and indicate impact damage.
- Mud or tar build-up on the tire or wheel.
- Replacement wheel/tire does not conform to the original part, or is of lesser quality or substitute design.
- Loose or missing balance weights or wheel nuts.
- Irregular or excessive tire wear. Tire not match mounted.
- Bent or faulty drive axle.

Road Test

Before performing any work or testing, always road test the vehicle. Warming up the tires is necessary to eliminate any flat spots. For vibrations that appear to be engine related, refer to ENGINE GENERAL INFORMATION AND MECHANICAL DIAGNOSIS (SEC. 6). A road test is also necessary to determine the speed at which the vibration occurs. Low-speed vibration at speeds less than 64 km/h (40 mph) is usually related to runout. High speed vibration at speeds greater than 64 km/h (40 mph) is usually the result of imbalance, but may be a product of both runout and imbalance.

Wheel Balance

Before removing the tire/wheel assembly from the vehicle, mark the stud bolt nearest the valve stem

REAR WHEEL DRIVE
RADIAL TIRE LEAD/PULL CORRECTION

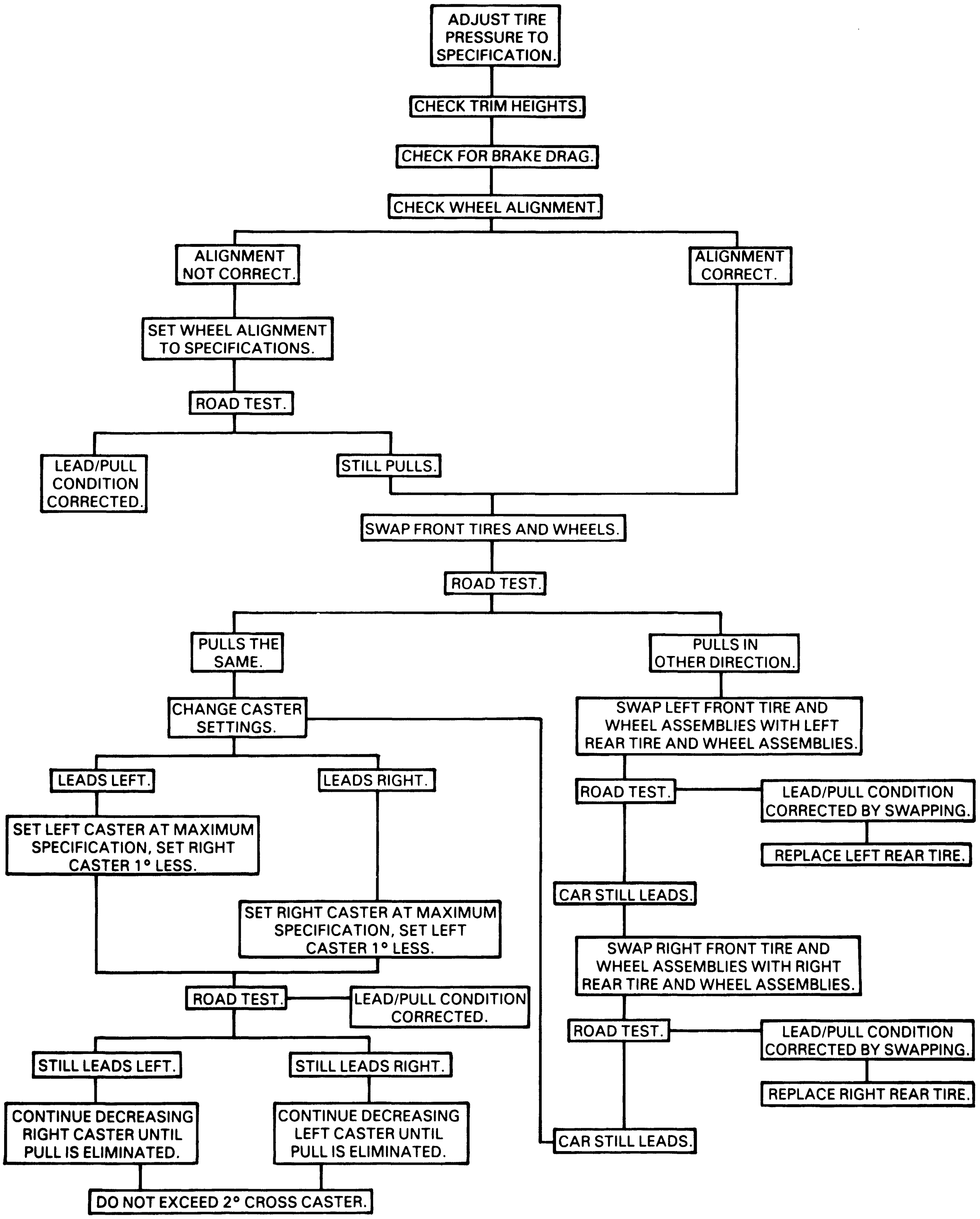


Figure 16 - Radial Tire Lead/Pull Correction - Rear Wheel Drive

for future reference. Also mark the vehicle position (left front, etc.) on each tire.

Balance is the easiest procedure to perform and should be done first if the vibration occurs at highway speeds. An off-vehicle, two-plane dynamic balance should be performed first. This will correct any imbalance in the tire/wheel assembly. An on-vehicle finish balance may also be required. This may offset brake drum, rotor, drive axle, or wheel cover imbalance.

If balance does not correct the highway speed vibration, or if the vibration occurs at low speeds, runout may be the cause. Runout is the term used when components are checked for symmetry. Runout can be caused by the drive axle, tire, the wheel, the bearing assembly or the way the wheel attaches to the vehicle.

Runout Check

This procedure may be stopped at whatever point the acceptable level of runout is reached.

1. Measure the free runout of the tire/wheel assembly on the vehicle using a dial indicator with a roller wheel.
   - Lateral runout (side to side) should be measured on the tire's sidewall as close to the tread shoulder as possible.
   - Radial runout (up and down) should be measured on the center tread rib.
     - Some tread designs may require wrapping a piece of tape tightly around the center tread circumference for better dial indicator contact.
2. Disregard any instantaneous indicator needle jumps due to sidewall depressions, tread blocks, etc.
3. Record the total indicator reading, and the location of the high point of runout.
4. If the radial or lateral runout exceeds 1.52 mm (0.060 inch), mount the tire/wheel assembly on a dynamic balance machine and remeasure runout.
   - Make sure the wheel is centered on the machine by the wheel center hole.
5. Record the total indicator reading, and the location of the high point of runout.
6. If the radial or lateral runout exceeds 1.27 mm (0.050 inch), break down the assembly and rotate the tire on the rim 180 degrees.
   - In many cases, rotating the tire on the wheel will bring the runout to an acceptable range.
   - Whenever a tire is rotated on the wheel in this way, the assembly must be rebalanced.
7. Reinflate, mount on the dynamic balance machine and remeasure runout.
8. Record the total indicator reading and the location of the high point of runout.
9. If the radial or lateral runout still exceeds 1.27 mm (0.050 inch) and the high point has moved approximately 180 degrees, following the tire around the rim, the tire is faulty and should be replaced.
10. If the second high point still exceeds 1.27 mm (0.050 inch) and is close to the original high point, relative to the rim, the wheel is faulty and should be replaced.
    - Before replacing the wheel, break down the assembly and measure the wheel separately.
    - Replace the wheel if radial runout exceeds 1.02 mm (0.040 inch), or lateral runout exceeds 1.14 mm (0.045 inch).
11. If the runout of the tire/wheel assembly is within limits when measured off the vehicle, yet exceeds the limits when measured on the vehicle, the attachment of the tire/wheel assembly to the hub is the probable cause.
12. Rotate the assembly two stud bolts and recheck the runout.
    - Several positions may have to be tried to find the best location.
13. If the runout cannot be reduced to an acceptable level, remove the tire/wheel assembly and measure hub stud runout.
14. If the runout exceeds 0.76 mm (0.030 inch), replace the hub or drive axle shaft.

Tire Defect Check

Tire stiffness variation, or loaded radial runout can also cause a vibration. However, this is difficult to measure without a tire problem detector or a loaded radial runout buffer.

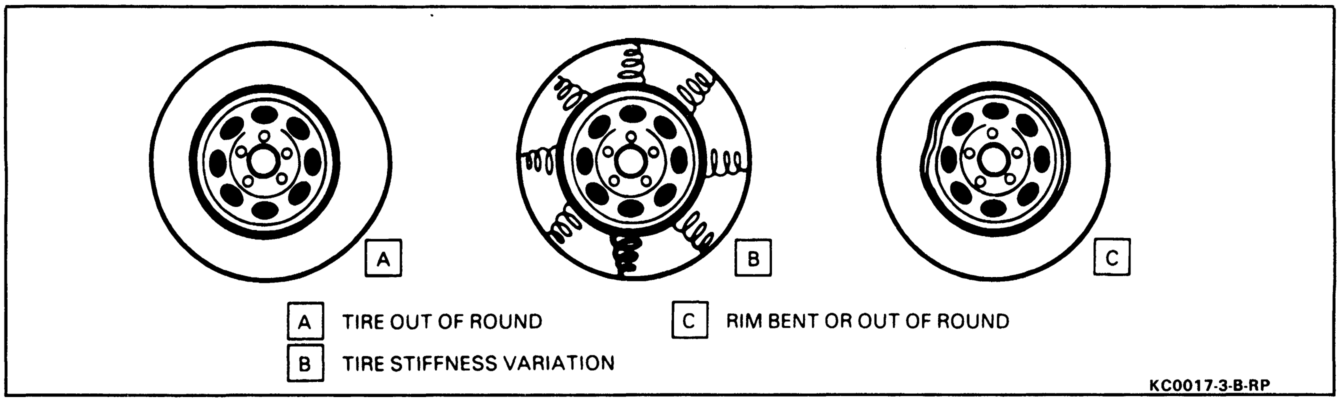


Figure 17 - Causes of Vibration/Runout

The tire problem detector is simply a roller drum that slowly rotates the tire, while under load, (mounted on the vehicle) meauring spindle movement.

The loaded radial runout buffer is a more automated machine that slowly rotates the tire under load with a roller drum off the vehicle and measures the tire's stiffness. It will then "match" the tire to the wheel by buffing off small amounts of rubber from the outer tread rows at the stiff spot. This procedure is usually effective, especially when used as a measuring device and for fine buffing only. This equipment requires careful use. Do not remove too much rubber.

Because this equipment is not always available, the most basic procedure of measuring free runout with a dial indicator, as previously detailed, is usually more practical. The free runout of the tire will usually correspond with the tire's stiff spot.

Substitution Method

Install a known good set of tire/wheel assemblies. If these correct the vibration, the original assemblies should be reinstalled one at a time until the vibration returns.

TAPERED ROLLER BEARING DIAGNOSIS

When diagnosing a bearing condition:

1. Consider the general condition of all parts during disassembly and inspection.
2. Identify the bearing problem (Figure 18).
3. After identifying the bearing problem, refer to the diagnostic chart to identify the cause and appropriate repair procedures.

TAPERED ROLLER BEARING DIAGNOSIS

Condition	Cause	Repair Procedure
Bent Cage	Damage due to improper handling or tool usage.	Replace bearing.
Galling	Metal smears on roller ends due to overheating. Lubricant failure or overload.	Replace bearing. Check seals and check for proper lubrication.
Abrasive Step Wear	Pattern on roller ends caused by fine abrasives.	Clean all parts and housings. Check seals and bearings. Replace if leaking, rough, or noisy.
Etching	Bearing surfaces appear gray or grayish black in color with related etching away of material usually at roller spacing.	Replace bearings. Check seals and check for proper lubrication.
Misalignment	Outer race misalignment due to a foreign object.	Clean related parts and replace bearing. Make sure races are properly seated.
Indentations	Surface depressions on race and rollers caused by hard particles of foreign material.	Clean all parts and housings. Check seals and replace bearings if rough or noisy.
Fatigue Spalling	Flaking of surface metal resulting from fatigue.	Replace bearing. Clean all related parts.

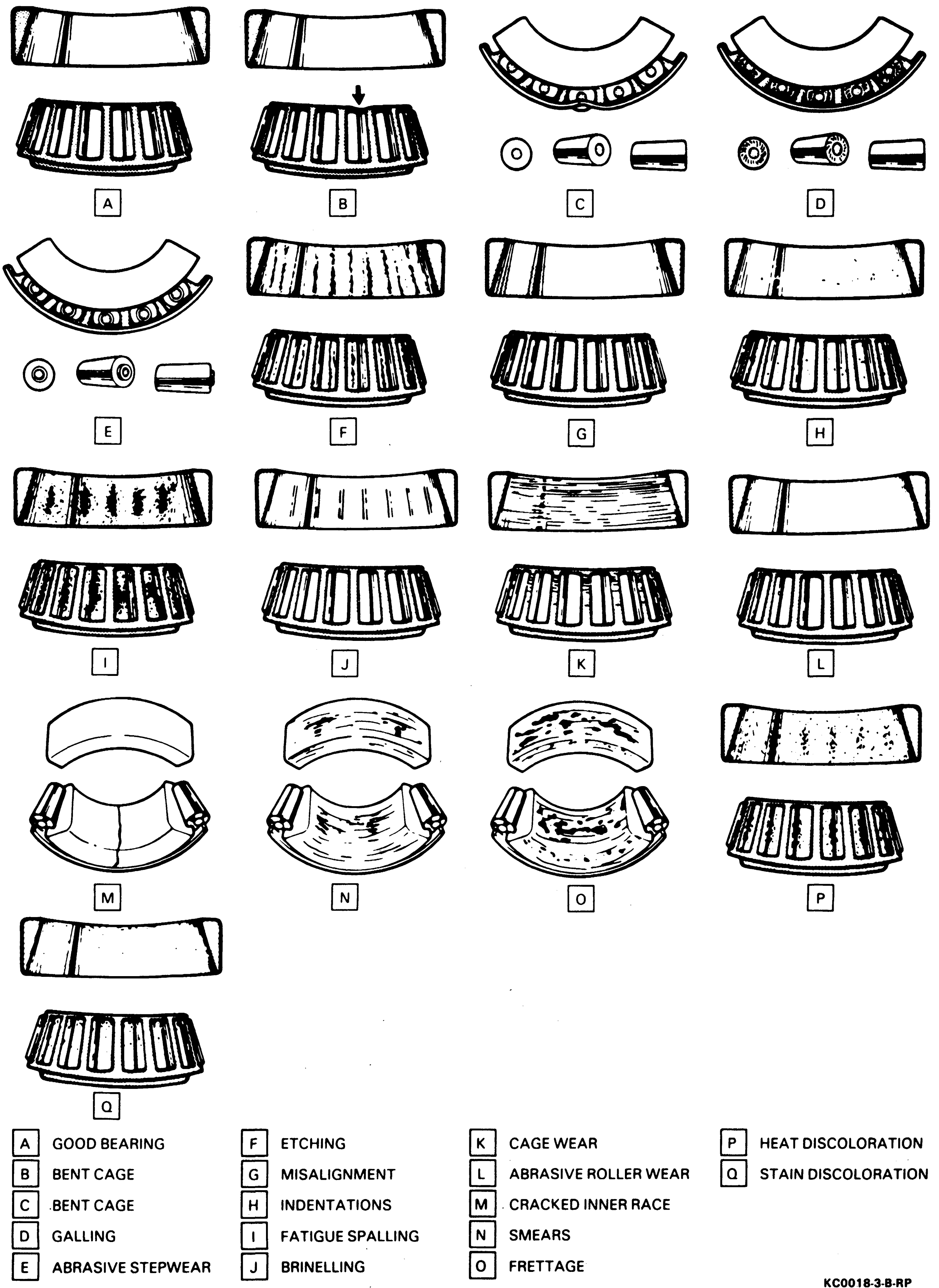


Figure 18 - Tapered Roller Bearing Diagnosis

Brinelling	Surface indentations in raceway caused by rollers either under impact loading or vibration while bearing is not rotating.	Replace bearing if rough or noisy.
Cage wear	Wear around outside diameter of cage and roller pockets caused by abrasive material and inefficient lubrication.	Replace bearings. Check seals.
Abrasive Roller Wear	Pattern on races and rollers caused by fine abrasives.	Clean all parts and housings. Check seals and bearings. Replace if leaking, rough, or noisy.
Cracked Inner Race	Race cracked due to improper fit, cocking, or poor bearing seats.	Replace inner race.
Smears	Smearing of metal due to slippage. Slippage can be caused by poor fits, poor lubrication, overheating, overloads, or handling damage.	Replace bearings. Clean related parts and check for proper fit and lubrication. Replace shaft if damaged.
Frettage	Corrosion set up by small relative movement of parts with no lubrication.	Replace bearings. Clean related parts. Check seals and check for proper lubrication.
Heat Discoloration	Discoloration can range from faint yellow to dark blue and can result from overload or incorrect lubricant, and overheating. Excessive heat can cause softening of the races on rollers. To check for heat tempering on races or rollers a file test can be done. A file drawn over a tempered part will grab and cut metal. A file drawn over a hard part will glide easily without cutting the metal.	Replace bearings if overheating damage is indicated. Check seals and check for proper lubrication.

Stain Discoloration	Discoloration can range from light brown to black and can be caused by incorrect lubricant or moisture.	Reuse bearings if stains can be removed by light polishing if there is no evidence of overheating. Check seals and related parts for damage. Check for proper lubrication.

TRIM HEIGHT DIAGNOSIS

Incorrect trim heights can produce symptoms similar to those produced when there is a problem with the wheel alignment. Trim heights should be checked when diagnosing steering and vibration complaints (Figure 19).

In order to measure trim height accurately, make sure:

- Tires are at the correct pressure.
- Fuel tank is full.
- Vehicle has no additional weight or passengers.
- Front seat is in rear position.
- Trunk is empty except for the spare tire and jack, and simulated fuel load if required.
- Vehicle is on a known level floor.

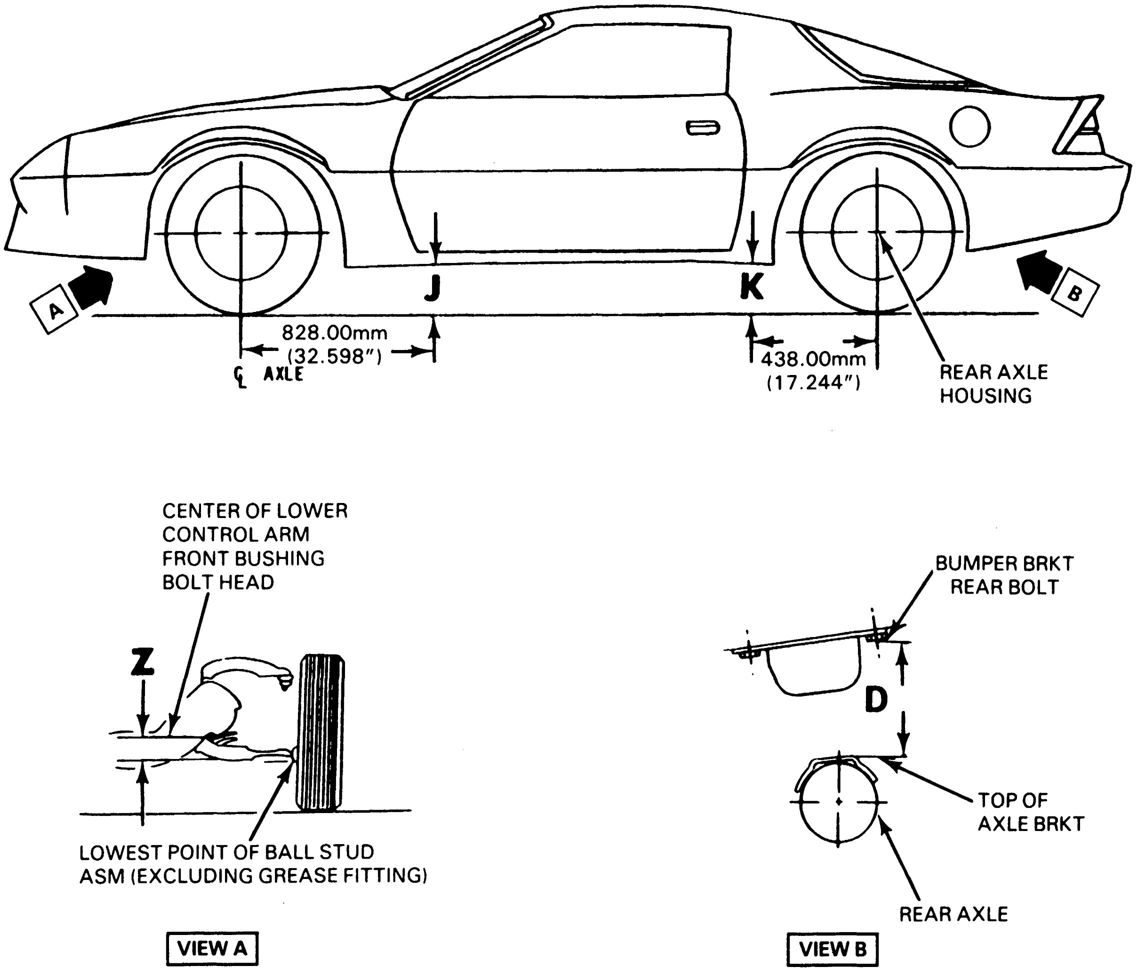
All dimensions shown on Figure 19 are measured vertical to the ground. Trim heights should be within ± 10 mm (0.4 inch) to be considered correct.

Measuring "J" and "Z" Dimensions

1. Lift front bumper of vehicle up approximately 38 mm (1 1/2 inches). Gently remove hands and let vehicle settle.
   - Repeat operation twice for a total of 3 times.
   - After the third time, measure "J" and "Z" dimensions.
2. Push front bumper down approximately 38mm (1 1/2 inches). Gently remove hands and let vehicle rise on its own.
   - Repeat operation twice for a total of 3 times.
   - Measure "J" and "Z" dimensions.
3. Calculate trim heights.
   - Trim heights are the average of the high and low measurements.
4. Verify trim heights with Figure 19.
5. Correct trim heights as necessary.

Measuring "K" and "D" Dimensions

Repeat procedure as described for “Measuring ‘J’ and ‘Z’ Dimensions” using the rear bumper and measuring “K” and “D” at the appropriate times.



VEHICLE	SUSPENSION	TIRE	ENGINE	Z		D		J		K	
				mm	INCH	mm	INCH	mm	INCH	mm	INCH
CAMARO CONVERTIBLE	FE1	P215/65R15	ALL	33.00	1.299	113.00	4.449	212.00	8.346	211.00	8.307
	FE2	P215/65R15		31.00	1.220	111.00	4.370	212.00	8.346	211.00	8.307
		P245/50ZR16		24.00	0.945	110.00	4.331	204.00	8.031	206.00	8.110
CAMARO COUPE	FE1	P215/65R15	ALL	31.00	1.220	112.00	4.409	212.00	8.346	211.00	8.307
	FE2	P215/65R15		30.00	1.181	111.00	4.370	202.00	8.346	211.00	8.307
		P245/50ZR16		23.00	0.906	110.00	4.331	204.00	8.031	206.00	8.110
FIREBIRD	FE1	P215/65R15	LHO	28.00	1.102	111.00	4.370	209.00	8.228	210.00	8.268
	F41	P215/65R15	LO3	30.00	1.181	111.00	4.370	209.00	8.228	210.00	8.268
		P215/65R15	LB9	30.00	1.181	112.00	4.409	209.00	8.228	210.00	8.268
	FE2	P245/50ZR16	ALL	31.00	1.220	113.00	4.449	209.00	8.228	210.00	8.268

NOTE: All dimensions shown are vertical to the ground. Trim heights should be within ±10mm (0.4 inch) to be considered correct.

LC0002-3-F-RP

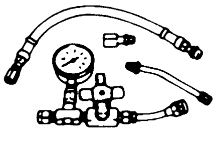
Figure 19 - Trim Height Diagnosis

SPECIFICATIONS

Power Steering Pump Fitting	75 N·m (55 lb. ft.)
Power Steering Pump Hose Fitting Nut	28 N·m (21 lb. ft.)
Power Steering Gear Adjuster Nut	50 N·m (37 lb. ft.)
Side Cover Bolt	60 N·m (44 lb. ft.)
Power Steering Gear Hose Fitting Nut	28 N·m (21 lb. ft.)

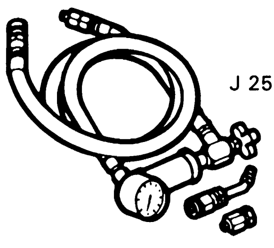
SPECIAL TOOLS

1



J 5176-D

2



J 25323-A

1 POWER STEERING PRESSURE TESTER 0-2000 P.S.I.

2 POWER STEERING SYSTEM ANALYZER

LC0003-3-F-RP

SECTION 3A

WHEEL ALIGNMENT

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 3A-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL INFORMATION

CAMBER

Figures 1 and 2

Camber is the inward or outward tilting of the wheels from the vertical. When the wheels tilt outward (at the top), the camber is positive (+). When the wheels tilt inward (at the top) the camber is negative (-). The amount of tilt is measured in degrees from the vertical and is called the camber angle. Camber influences both directional control and tire wear.

When wheels are set to a positive camber, they will tend to roll in a path away from the vehicle's true path. The effect of each wheel tends to cancel the other. The suspension geometry and camber setting are designed to keep the tire tread flat on the road through bumps or dips.

CASTER

Figures 1 and 3

Caster is the tilting of the front steering axis (at the top) either forward or backward from the vertical. A backward tilt is positive (+) and a forward tilt is negative (-). Caster influences directional control of the steering but does not affect tire wear.

Caster is affected by vehicle height. It is important to keep the body at its designated trim height. Overloading the vehicle or having a weak or sagging rear spring will affect caster. When the rear of the vehicle is lower than its designated trim height, the front suspension moves to more positive caster. If the rear of the vehicle is higher than its designated trim height, the front suspension moves to a less positive caster. For trim height information, refer to STEERING, SUSPENSION, TIRES AND WHEELS DIAGNOSIS (SEC. 3).

TOE

Figures 1 and 4

Toe is a measurement of how much the front of the wheels are turned in or out from a straight-ahead position. When the wheels are turned in, toe is positive (+). When the wheels are turned out, toe is negative (-). The actual amount of toe-in is normally only a fraction of a degree. The purpose of a toe specification is to ensure parallel rolling of the wheels. Excessive toe-in or toe-out may increase tire wear.

Toe also serves to offset the small deflections of the wheel support system which occur when the vehicle is rolling forward. In other words, even when the wheels are set to toe-in slightly when the vehicle is standing still, they tend to roll parallel on the road when the vehicle is moving.

THRUST ANGLE

Figure 5

The front wheels aim or steer the vehicle, but the rear wheels control tracking. This tracking action is relative to thrust angle. Thrust angle is defined as the path that the rear wheels will take. Ideally, the thrust angle would be geometrically aligned with the body centerline.

PRELIMINARY INSPECTIONS

Steering and vibration complaints are not always the result of improper alignment. Additional items to be checked are wheel balance and the possibility of tire

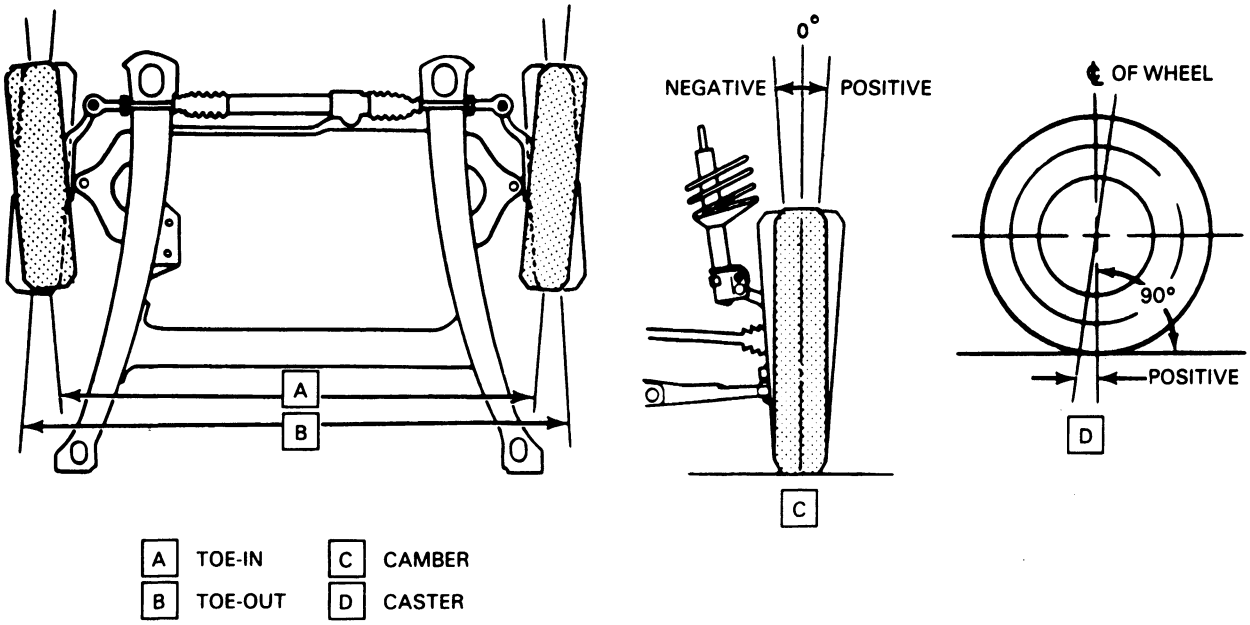


Figure 1 - Alignment Angles

lead due to worn or improperly manufactured tires. "Lead" is the deviation of the vehicle from straight path on a level road without hand pressure on the steering wheel. For the procedure to determine if the vehicle has a tire lead problem, refer to STEERING, SUSPENSION, TIRES AND WHEEL DIAGNOSIS (SEC. 3).

Before making any adjustment affecting caster, camber or toe, the following checks and inspections should be made to insure correct alignment readings and adjustments.

Inspect

- Tires for proper inflation pressures and uniform tread wear.
- Front wheel bearings for proper adjustment; correct if necessary.
- Ball joints, relay rod and tie rod ends for looseness.
  - If a joint is excessively loose, it must be corrected before adjusting wheel alignment.
- Relay rod height.
  - If relay rod height adjustment is necessary, refer to STEERING LINKAGE (SEC. 3B3).
- Wheels and tires for runout conditions.
- Vehicle trim heights.
  - If trim heights are out of limits, corrections must be made before adjusting wheel alignment angles. For the proper procedure for checking trim heights, refer to STEERING, SUSPENSION, TIRES, AND WHEELS DIAGNOSIS (SEC. 3).
- Steering gear for looseness at frame.
- Shock absorbers for improper operation.
- Control arms for looseness.
- Stabilizer bar for loose or missing attachments.
- Vehicle for excess loads, such as tool boxes, or sample cases. If these types of items are normally carried in the vehicle, they should remain in the vehicle during wheel alignment.

ON-VEHICLE SERVICE

MEASURING FRONT ALIGNMENT ANGLES

Satisfactory vehicle operation may occur over a wide range of front wheel alignment settings. However, should the settings vary beyond the specifications, the alignment settings should be corrected. Refer to "Specifications" in this section.

Measure

- Make certain that the vehicle is on level ground both front-to-rear and side-to-side.
- Install alignment equipment according to the manufacturer's instructions.
- Jounce the front and rear bumpers 3 times to normalize suspension.
- Measure the alignment angles and record the readings.
  - If adjustments are required, make them in the following order: camber, caster, and toe.

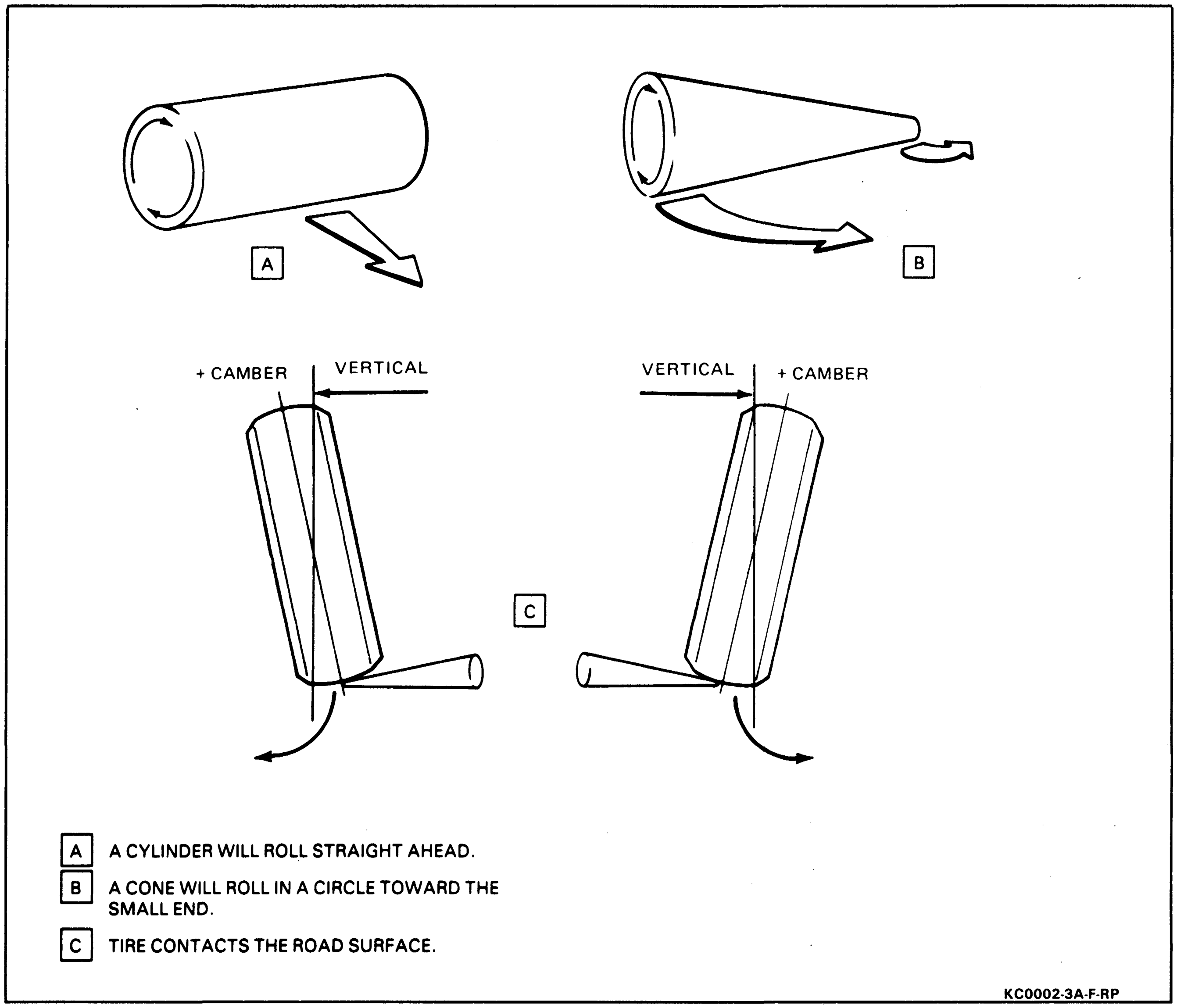


Figure 2 - Camber

CAMBER AND CASTER ADJUSTMENT

Figures 6 and 7

Adjust

Tool Required:

J 29724 Camber Adjusting Tool

- Jounce the vehicle 3 times at the front bumper to normalize vehicle height.
- Remove dust cap (1) and fender bolt (5).
- Install J 29724 using the original fender bolt (5).
- Tighten the turnbuckle on J 29724.
- Loosen the 3 nuts (4) attaching the upper strut mount (2) to the wheelhouse reinforcement (3).
- Adjust the camber by rotating the turnbuckle on J 29724 to allow the upper strut mount (2) to move inboard or outboard.
  - Moving the upper strut mount (2) inboard will decrease camber.
  - Moving the upper strut mount (2) outboard will increase camber.
- After obtaining the correct camber reading adjust caster by lightly tapping the upper strut mount (2) forward or rearward with a rubber mallet.
  - Moving the upper strut mount (2) forward will decrease caster.
  - Moving the upper strut mount (2) rearward will increase caster.

NOTICE: See "Notice" on page 3A-1 of this section.

- When correct camber and caster settings have been obtained tighten the 3 nuts (4) attaching the upper strut mount (2) to the wheelhouse reinforcement (3).

Tighten

- Nuts (4) to 28 N·m (21 lb. ft.).

- Remove J 29724.
- Install original fender bolt (5) and dust cap (1).

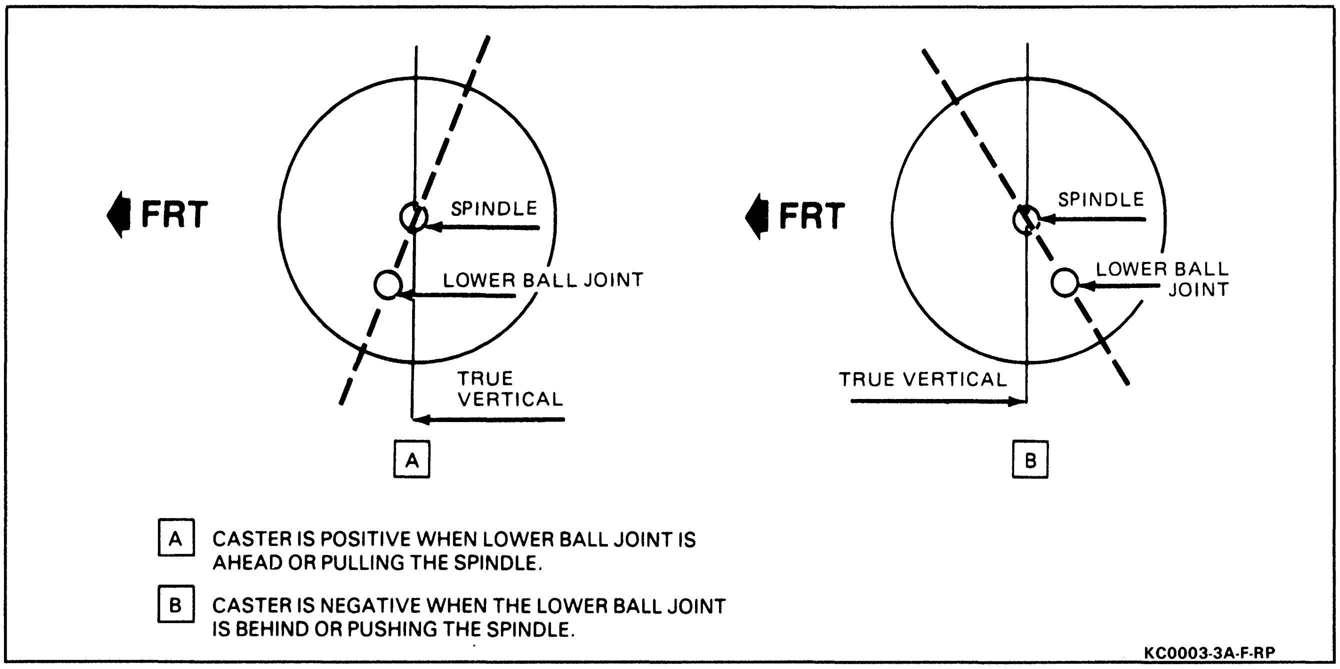


Figure 3 - Caster

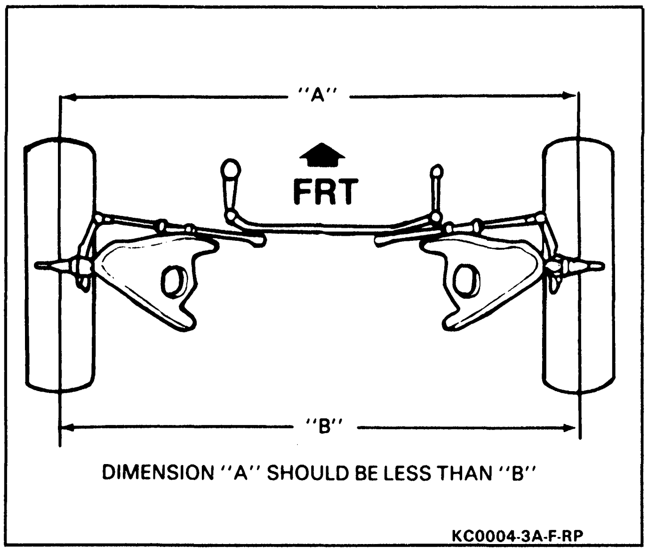


Figure 4 - Toe

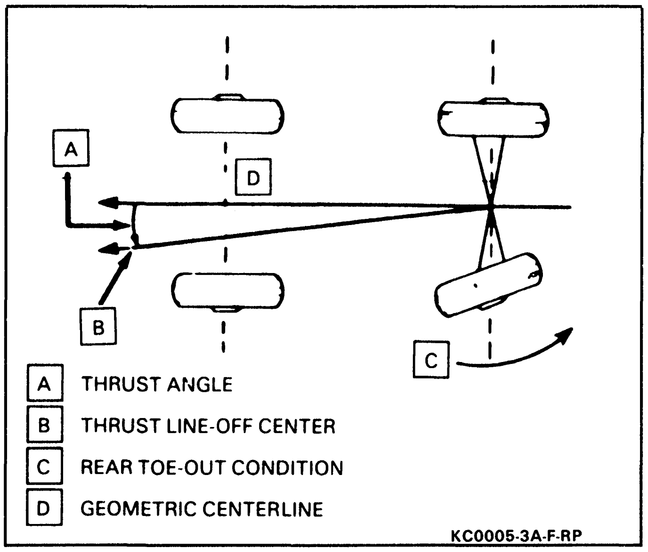


Figure 5 - Thrust Angle

TOE ADJUSTMENT

Figure 8

Tie rod adjuster parts can become rusted in service. In such cases, it is recommended that if the torque required to remove the nut from the bolt after breakaway exceeds 9 N·m (80 lb. in.) discard the nuts and bolts. Apply penetrating oil between the clamp and tube and rotate the clamps until they move freely. Install new bolts and nuts having the same part number to assure proper clamping at the specified torque.

Toe can be increased or decreased by changing the length of the tie rods. A threaded sleeve is provided for this purpose.

Adjust

- Loosen the clamp nuts (12) at each end of the tie rod adjuster tube (7). Bolts (11) must be installed in the direction shown in Figure 8.
- Rotate the inner and outer tie rod sockets to the limit of the ball stud travel.
- With the steering wheel set in a straight ahead position, turn the tie rod adjuster tube (7) to obtain the proper toe adjustment.

NOTICE: See "Notice" on page 3A-1 of this section.

- Position clamps (6) within the angles shown in Figure 8.
  - Slot in tie rod adjuster tube (7) must not be within the gap area of the clamping jaws.
  - Clamps (6) must be between and clear of dimples before tightening nuts (12).

Tighten

- Clamp nuts (12) to 19 N·m (14 lb. ft.).

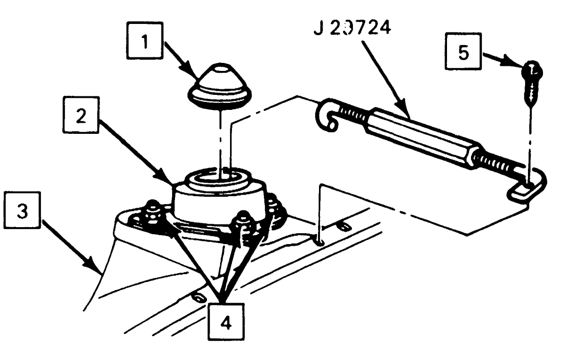


Figure 6 - Upper Strut Mount Assembly

  - Clamp ends may touch when nuts (12) are tightened to specification but a gap must be visible adjacent to the tie rod adjuster tube (7).
- When adjustment has been completed, check to see that the number of threads showing on each end of the adjuster tube (7) are equal and that the outer tie rods (9) are at right angles to the steering arm.

RELAY ROD HEIGHT ADJUSTMENT

The relay rod position can be adjusted at the idler arm attachment. It is important for the height adjustment to be equal from side to side. If not adjusted properly, right and left hand turns could exhibit different characteristics in handling. This is referred to as "orbital steer." For the proper procedure to adjust the relay rod height, refer to STEERING LINKAGE (SEC. 3B3).

MEASURING REAR ALIGNMENT ANGLES

Figure 9

After front wheel alignment has been completed, the rear alignment angles should be checked if there is excessive rear tire wear or wheels do not track properly. Rear wheels should be parallel to, and the same distance from, the vehicle's centerline.

If tires do not track correctly after a front wheel alignment, no amount of adjustment will correct the problem. Poor tracking or excessive rear tire wear after a front wheel alignment usually indicates that the axle housing, frame, or suspension arms have been bent.

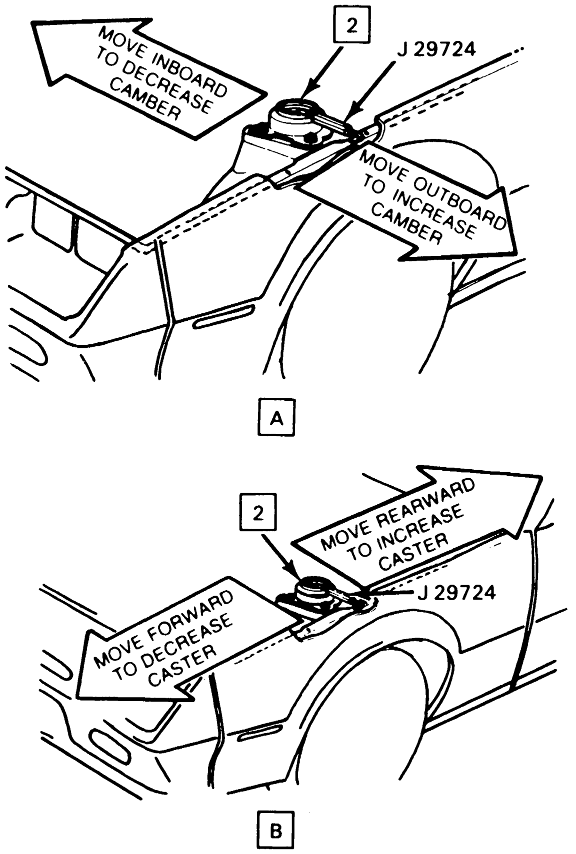


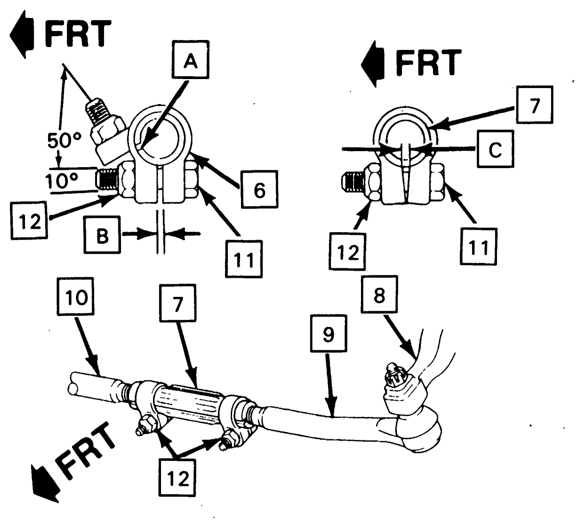
Figure 7 - Adjusting Camber and Caster

Rear alignment angles can be checked as follows:

1. Back vehicle squarely onto an alignment machine.
2. Compensate for wheel runout the same as for checking front wheel toe-in.
3. Check camber reading which should be 0.3 degrees negative to 0.5 degrees positive.
4. Check amount of toe which should be 0.00 degrees ± 0.3 degrees.
   - When using an alignment machine to measure toe-out the measurement will read as toe-in on the scale.
   - When checking toe-out with a tram gage, the measurement will read correctly as toe-out. However, when using a tram gage it will still be necessary to perform steps 1 and 2 in order to check camber.

REAR CAMBER/TOE ADJUSTMENT

To correct a toe/camber problem in the rear alignment, frame straightening equipment may be used to bring the axle housing into specifications. This procedure will allow checks during the straightening operation to determine when the housing is within the prescribed limits.



A	ADJUSTER TUBE SLOT	8	STEERING KNUCKLE
B	GAP	9	OUTER TIE ROD
C	GAP AFTER TIGHTENING	10	INNER TIE ROD
6	CLAMP	11	BOLT
7	ADJUSTER TUBE	12	NUT

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Figure 8 - Positioning Tie Rod Adjuster Tube and Clamps

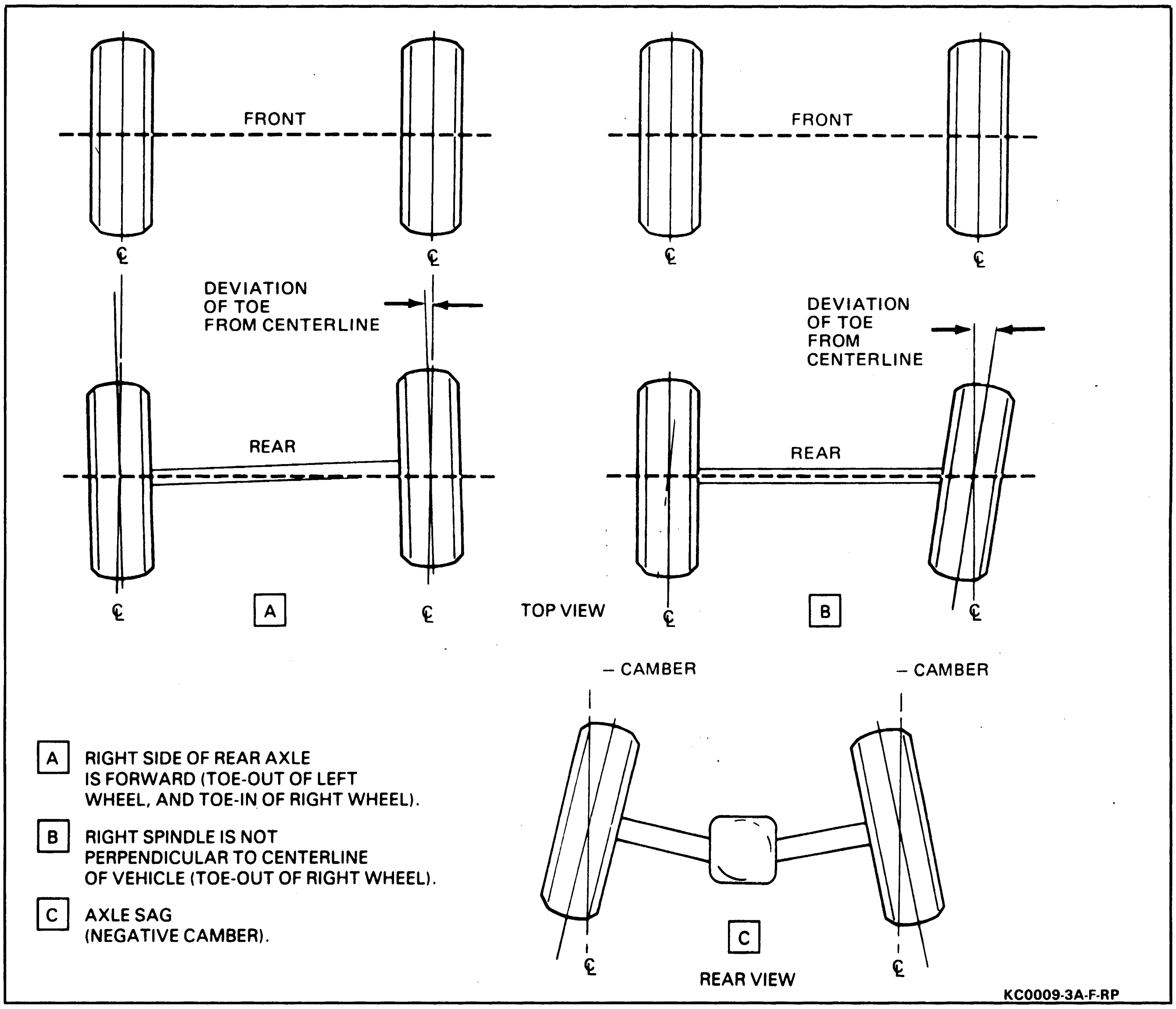


Figure 9 - Rear Wheels

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

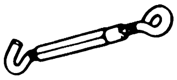
Tie Rod Adjuster Clamp Nuts	19 N·m (14 lb. ft.)
Upper Strut Mount Assembly-to-Wheelhouse Reinforcement Nuts	28 N·m (21 lb. ft.)

FRONT WHEEL ALIGNMENT SPECIFICATIONS

Angle	**Service Setting**
Camber	0.30° ± 0.50°
Caster	4.80° ± 0.50°
Toe	0.00° ± 0.20°

SPECIAL TOOLS

1



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1 CAMBER ADJUSTING TOOL

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SECTION 3B1

POWER STEERING GEAR AND PUMP

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 3B1-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

NOTICE: Do not start the vehicle with any power steering hoses disconnected. When disconnected, cap or plug all openings of components. Failure to do so could result in contamination or loss of fluid and damage to the system.

CONTENTS

GENERAL DESCRIPTION

The steering gear is mounted on the left frame side rail and is secured by three mounting bolts. The gear is joined to the intermediate shaft by a flexible coupling that helps isolate noise and road shock from the vehicle's interior.

A constant displacement vane type pump provides hydraulic pressure and flow for the steering system. The pump is located on the engine and is belt driven by the engine crankshaft pulley.

POWER STEERING GEAR

The major internal components of the steering gear are the rotary valve assembly, steering worm shaft, rack piston assembly, and the pitman shaft. The movement of these parts, while turning or parking, is aided by hydraulic pressure and flow supplied by the pump. Manual steering is always available at times when the engine is not running or in the event of pump or belt failure. Steering effort is increased under such conditions.

The steering stub shaft, rotary valve, worm shaft, and rack piston assembly are all "in line." All oil passages are internal within the gear housing except for the pressure and return hoses between the gear and the pump.

The power steering gear has a recirculating ball system which acts as a rolling thread between the worm shaft and the rack piston. The worm shaft is supported by a thrust bearing preload and two conical thrust races at the lower end, and a bearing assembly in the adjuster plug at the upper end. When the worm shaft is turned right, the rack piston moves up in gear. Turning the worm shaft left moves the rack piston down in gear. The rack piston teeth mesh with the sector, which is part of the pitman shaft. Turning the worm shaft turns the pitman shaft, which turns the wheels through the steering linkage.

The control valve in the steering gear directs the power steering fluid to either side of the rack piston. The rack piston converts the hydraulic pressure into a mechanical force. If the steering system becomes damaged and loses hydraulic pressure, the vehicle can be controlled manually.

POWER STEERING PUMP

The major components of the power steering pump are the oil reservoir, drive shaft, pump housing, cam ring, pressure plate, thrust plate, flow control valve, rotor and vane assembly, a magnet, and internal baffles to allow separation of air bubbles from the steering fluid. The pump housing and component parts are encased in the oil reservoir. The reservoir filler cap has a fluid level indicator attached to show the oil level in the reservoir.

There are two bore openings at the rear of the pump housing. The larger opening contains the cam ring, pressure plate, thrust plate, rotor and vane assembly, and end plate. The smaller opening contains the pressure line union, flow control valve, and spring. The flow control orifice is part of the pressure line union. The pressure relief valve inside the flow control valve limits the pump pressure.

SEAL REPLACEMENT

Lip Seals

Lip seals, which seal rotating shafts, require special treatment. This type of seal is used on the drive shaft of the pump. When leakage occurs in this area, always replace the seal or seals, after inspecting and thoroughly cleaning the sealing surfaces. Replace the shaft if pitting is found. If corrosion in the lip seal contact zone is slight, clean the surface of the shaft with crocus cloth. Replace the shaft only if the leakage cannot be stopped by smoothing with crocus cloth first.

O-Ring Seals

Whenever a part which forms a sealing surface for an O-ring is removed, the O-ring seal should also be removed and replaced with a new seal. Lubricate all new seals with power steering fluid to ease assembly.

DIAGNOSIS

When diagnosis of the power steering system is necessary, refer to STEERING, SUSPENSION, TIRES AND WHEELS DIAGNOSIS (SEC. 3).

ON-VEHICLE SERVICE

CHECKING AND ADDING FLUID

Power steering fluid level is indicated by marks on a fluid level indicator on the fluid reservoir cap.

NOTICE: When adding fluid or making a complete fluid change, always use GM Part No. 1050017 power steering fluid, or equivalent meeting GM Specification No. 9985010. Failure to use the proper fluid will cause hose and seal damage and fluid leaks.

If the fluid is warmed up, about 66°C (150°F) - hot to the touch, the fluid level should be between the "HOT" and "COLD" marks.

If the fluid is cool, about 21°C (70°F), the fluid level should be between the "ADD" and "COLD" marks.

BLEEDING THE POWER STEERING SYSTEM

NOTICE: When adding fluid or making a complete fluid change, always use GM Part No. 1050017 power steering fluid, or equivalent, meeting GM Specification No. 9985010. Failure to use the proper fluid will cause hose and seal damage and fluid leaks.

NOTICE: If the power steering hydraulic system has been serviced, an accurate fluid level reading cannot be obtained unless air is bled from the system. The air in the fluid may cause pump cavitation noise and may cause pump damage over a period of time.

1. With the engine off, raise and suitably support the front wheels of the vehicle off of the ground. Refer to GENERAL INFORMATION (SEC. 0A).
2. Turn the wheels all the way to the left. Add power steering fluid to the "FULL COLD" mark on the fluid level indicator.

NOTICE: Fluid with air in it has a tan appearance. This air must be eliminated before normal steering action can be obtained.

3. Bleed the system by turning the wheels from side to side without hitting stops. It may require turning the wheels from side to side several times. Keep the fluid level at the "FULL COLD" mark.
4. Start the engine. With the engine idling, recheck the fluid level. If necessary, add fluid to bring the level to the "FULL COLD" mark.
5. Return the wheels to the center position. Lower front wheels to ground. Continue running the engine for two or three minutes.
6. Road test the vehicle to be sure the steering functions normally and is free from noise.
7. Inspect for fluid leakage at connection points along the power steering system.
8. Recheck the fluid level as described in steps 1, 2 and 3. Make sure the fluid level is at the "HOT" mark after the system has stabilized at its normal operating temperature.

FLUSHING THE POWER STEERING SYSTEM

NOTICE: When adding fluid or making a complete fluid change, always use GM Part No. 1050017 power steering fluid, or equivalent, meeting GM Specification No. 9985010. Failure to use the proper fluid will cause hose and seal damage and fluid leaks.

1. Raise the front of the vehicle off the ground until the wheels are free to turn. Refer to GENERAL INFORMATION (SEC. 0A).
2. Remove the fluid return line at the pump inlet connector and plug the connector port on the pump.
   - Position the line toward a large container to catch the draining fluid.
3. While an assistant is filling the reservoir with new power steering fluid, run the engine at idle. Turn the steering wheel close to each stop. DO NOT contact wheel stops or hold the wheel near a stop position or fluid will stop and the pump will be in pressure relief mode. A sudden overflow from the reservoir may develop if the wheel is held at a stop.
4. Stop the engine and install all the lines, hoses and components (if removed) on the vehicle.
5. Fill the system. Refer to "Bleeding The Power Steering System" in this section.
6. Operate the engine for 15 minutes.
7. Remove the pump return line at the pump inlet and plug connection on the pump. Repeat the flushing procedure as described in step 3.
8. While refilling the reservoir, check the draining fluid for contamination.
   - If foreign material is still evident, replace all lines and disassemble and clean or replace the power steering system components.
   - If the drained fluid is uncontaminated, install all the removed lines, hoses and other components. Fill and bleed the system.
   - Do not re-use any drained power steering fluid.

SERPENTINE BELT

The power steering pump is driven by a serpentine belt. No adjustment of the belt is required.

To remove or install the serpentine belt, refer to COOLING AND RADIATOR (SEC. 6B).

PUMP DRIVE PULLEY REPLACEMENT

Figure 1

Remove or Disconnect

Tool Required:

J 25034-B Pump Pulley Remover

1. Serpentine belt from pulley. Refer to COOLING AND RADIATOR (SEC. 6B).
2. Pulley (2) from pump (1) using J 25034-B.

Install or Connect

Tool Required:

J 25033-B Pump Pulley Installer

1. Pulley (2) to pump (1) using J 25033-B.
   - Face of pulley hub must be flush with end of pump drive shaft.
2. Serpentine belt. Refer to COOLING AND RADIATOR (SEC. 6B).

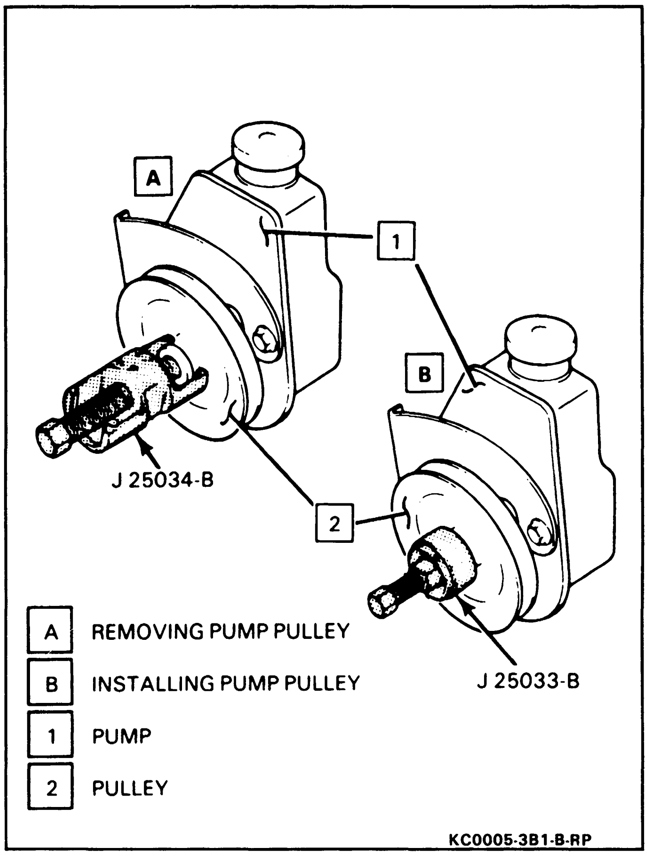

Figure 1 - Removing and Installing Pump Pulley

IDLE SPEED POWER STEERING PRESSURE SWITCH REPLACEMENT

Figure 2

The idle speed power steering pressure switch is used on vehicles equipped with air conditioning.

NOTICE: See "Notice" on page 3B1-1 of this section.

Remove or Disconnect

1. Electrical connection from power steering pressure switch (4).
   - Place drain pan under power steering gear (5).
2. Power steering pressure switch (4) from power steering pressure hose (3).

Install or Connect

- Use power steering fluid to lightly coat threads of power steering pressure switch (4) past the O-ring.

1. Power steering pressure switch (4) to the power steering pressure hose (3).

   Tighten

   - Power steering pressure switch (4) to 13 N·m (115 lb. in.).
2. Electrical connection to power steering pressure switch (4).
   - Bleed power steering. Refer to "Bleeding the Power Steering System" in this section.

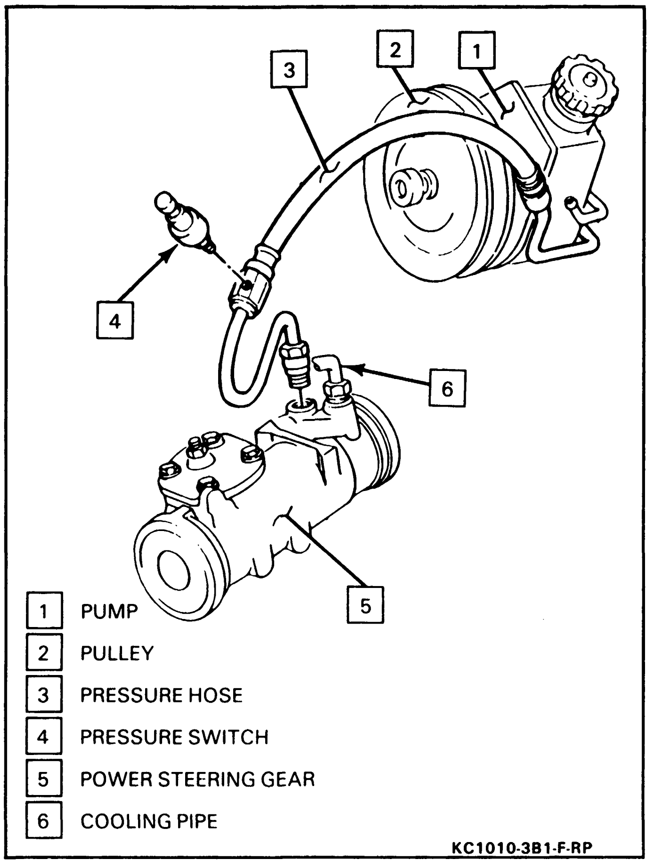

Figure 2 - Power Steering Pressure Switch and Hose (Typical)

FLOW CONTROL VALVE REPLACEMENT

Figure 3

NOTICE: See "Notice" on page 3B1-1 of this section.

Remove or Disconnect

- Place drain pan under power steering pump (1).

1. Pressure hose (3) from fitting (8).
2. Fitting (8) and O-ring seal (9).
3. Flow control valve (10) and spring (11) using a magnet.

Inspect

NOTICE: Do not disassemble the flow control valve (10). If it does not operate properly, replace it with a new one or system damage may result.

- Flow control valve (10) for free movement within housing bore.
  - If sticking occurs check for burrs and clean as necessary.

Install or Connect

NOTICE: See "Notice" on page 3B1-1 of this section.

1. Spring (11) and flow control valve (10).
2. New O-ring seal (9) to fitting (8).
   - Lubricate O-ring seal (9) with power steering fluid.
3. Fitting (8) and O-ring seal (9).

Tighten

- Fitting (8) to 75 N·m (55 lb. ft.).

4. Pressure hose (3) to fitting (8).

Tighten

- Pressure hose (3) to 28 N·m (21 lb. ft.).
- Fill power steering pump reservoir with fluid. Refer to "Checking and Adding Fluid" in this section.
- Bleed system. Refer to "Bleeding the Power Steering System" in this section.

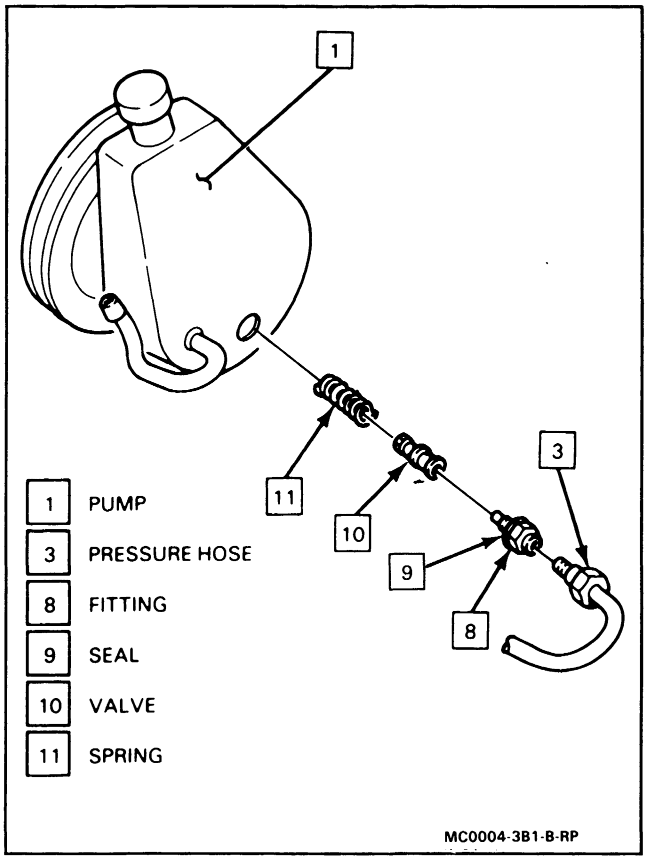

Figure 3 - Removing Flow Control Valve

POWER STEERING HOSE REPLACEMENT

Figures 2 and 4

NOTICE: See "Notice" on page 3B1-1 of this section.

Remove or Disconnect

- Place drain pan under power steering pump and gear.

1. Pressure hose (3).
   - Remove power steering pressure switch, if required. Refer to "Idle Speed Power Steering Pressure Switch Replacement" in this section.

- Disconnect fitting of pressure hose (3) from power steering gear (5).
- Disconnect fitting of pressure hose (3) from power steering pump (1).

2. Return hose (7).
   - Remove clamp (13) and return hose (7) from power steering pump (1).
   - Remove clamp (13) and return hose (7) from cooling pipe (6).

Install or Connect

NOTICE: See "Notice" on page 3B1-1 of this section for the following steps.

NOTICE: Hoses must be installed to clear each other and all surrounding parts to prevent chafing. Use minimum clearance of 12.7 mm (0.50 inch). The return hose must not be twisted during installation. Do not bend or distort pipes to make installation easier. Failure to follow these procedures could result in component damage.

1. Return hose (7).
   - Install return hose (7) and clamp (13) to cooling pipe (6).

     Tighten

     - Clamp (13) to 1.7 N·m (15 lb. in.).
   - Install return hose (7) and clamp (13) to power steering pump (1).

     Tighten

     - Clamp (13) to 1.7 N·m (15 lb. in.).
2. Pressure hose (3).
   - Install fitting of pressure hose (3) to power steering pump (1).

     Tighten

     - Fitting of pressure hose (3) to 28 N·m (21 lb. ft.).
   - Install fitting of pressure hose (3) to power steering gear (5).

     Tighten

     - Fitting of pressure hose (3) to 28 N·m (21 lb. ft.).

- Install power steering pressure switch, if required. Refer to "Idle Speed Power Steering Pressure Switch Replacement" in this section.
- Fill power steering pump reservoir with fluid. Refer to "Checking and Adding Fluid" in this section.
- Bleed system. Refer to "Bleeding the Power Steering System" in this section.

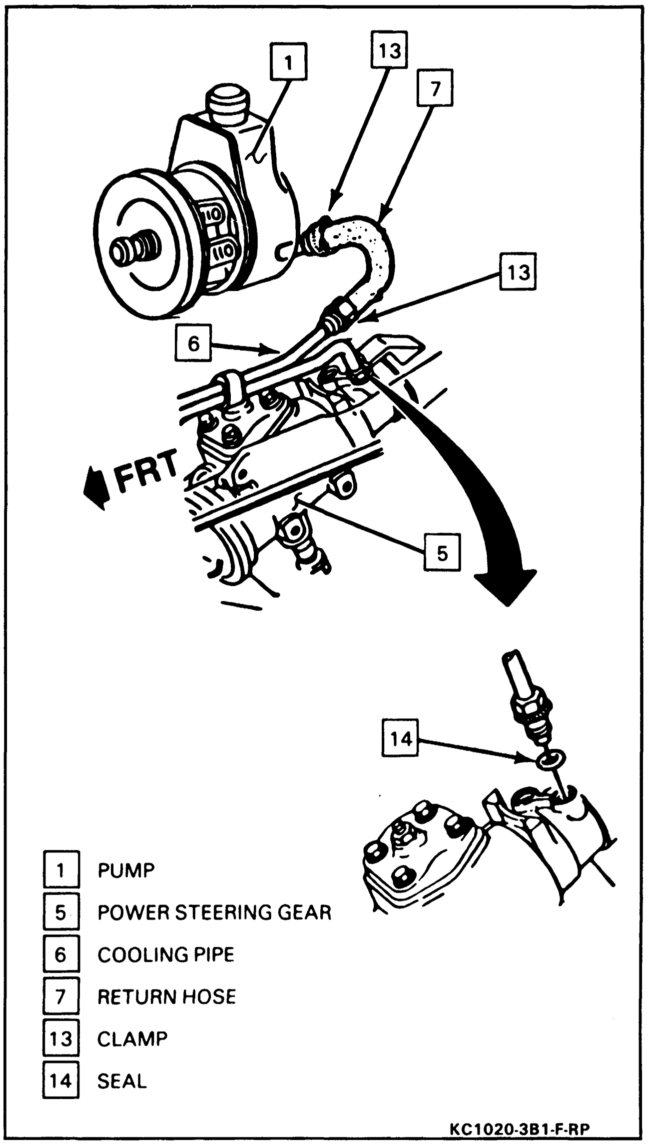

Figure 4 - Cooling Pipe and Return Hose (Typical)

POWER STEERING COOLING PIPE REPLACEMENT

Figures 4 and 5

NOTICE: See "Notice" on page 3B1-1 in this section.

Remove or Disconnect

- Place drain pan under power steering pump (1) and gear (5).

1. Bolts (17).
2. Clips (16).
3. Power steering cooling pipe (6).
   - Remove clamp (13) and end of power steering cooling pipe (6) from return hose (7).
   - Remove fitting of power steering cooling pipe (6) from power steering gear (5).

Install or Connect

NOTICE: See "Notice" on page 3B1-1 of this section.

1. Power steering cooling pipe (6).
   - Install fitting of power steering cooling pipe (6) to power steering gear (5).

     Tighten

     - Fitting of power steering cooling pipe to 28 N·m (21 lb. ft.).
   - Connect end of power steering cooling pipe (6) and clamp (13) to return hose (7).

     Tighten

     - Clamp (13) to 1.7 N·m (15 lb. in.).
2. Clips (16).
3. Bolts (17).

- Fill power steering pump reservoir with fluid. Refer to "Checking and Adding Fluid" in this section.
- Bleed system. Refer to "Bleeding the Power Steering System" in this section.

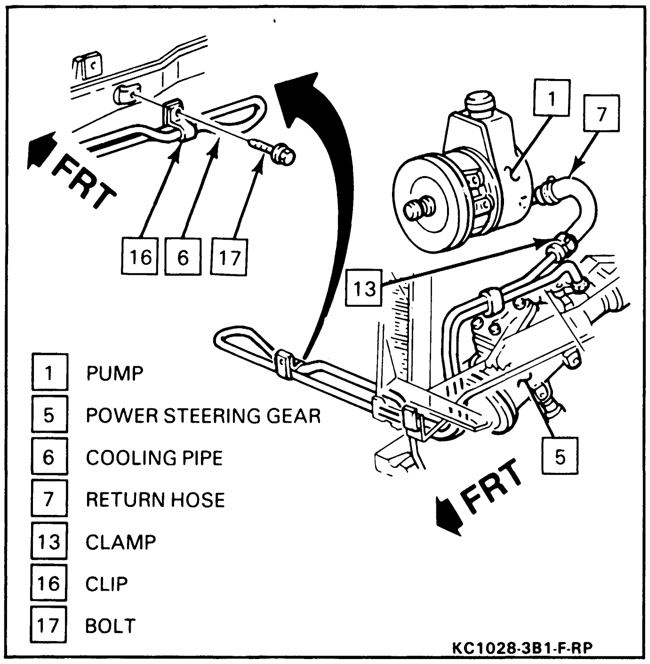

Figure 5 - Power Steering Cooling Pipe

POWER STEERING PUMP AND GENERATOR BRACKET REPLACEMENT

Figure 6

This bracket is used to mount the generator and power steering pump on vehicles equipped with 5.0 L and 5.7 L engines.

Remove or Disconnect

1. Generator. Refer to CHARGING SYSTEM (SEC. 6D3).
2. Power steering pump. Refer to "Power Steering Pump" in this section.
3. Bolts (18, 20 and 23).
4. Nuts (21 and 22).
5. Bracket (19).

Install or Connect

NOTICE: See "Notice" on page 3B1-1 in this section for steps 2 through 5.

1. Bracket (19) to engine studs.
2. Nut (22).

   Tighten

   - Nut (22) to 33 N·m (24 lb. ft.).
3. Bolts (18 and 23).

   Tighten

   - Bolts (18 and 23) to 33 N·m (24 lb. ft.).
4. Nut (21).

   Tighten

   - Nut (21) to 33 N·m (24 lb. ft.).
5. Bolt (20).

   Tighten

   - Bolt (20) to 33 N·m (24 lb. ft.).
6. Power steering pump. Refer to "Power Steering Pump Replacement" in this section.
7. Generator. Refer to CHARGING SYSTEM (SEC. 6D3).

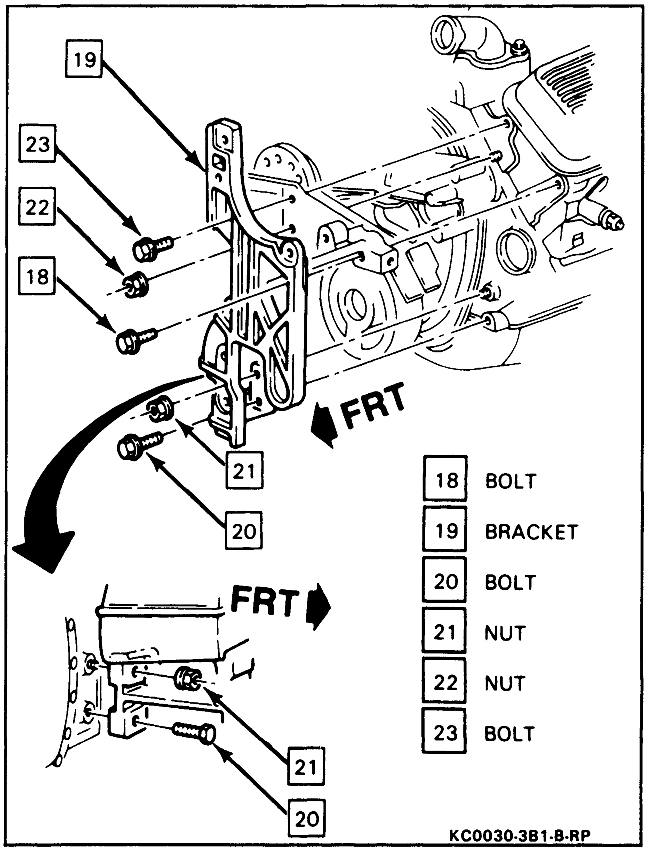

Figure 6 - Power Steering Pump and Generator Bracket, 5.0L and 5.7L Engines

POWER STEERING PUMP REPLACEMENT

Figures 7 and 8

Remove or Disconnect

1. Serpentine belt. Refer to COOLING AND RADIATOR (SEC. 6B).
2. Pulley. Refer to "Pump Drive Pulley Replacement" in this section.
3. Hoses. Refer to "Power Steering Hose Replacement" in this section.
4. Nuts (25 and 27), if present.
5. Nuts (28), if present.
6. Bolt (30), if present.
7. Brace (26).
8. Bolts (24).
9. Pump (1).

Install or Connect

NOTICE: See "Notice" on page 3B1-1 in this section for step 6.

1. Pump (1) to front bracket.
2. Bolts (24), loosely.
3. Brace (26) to pump and engine studs.
4. Bolt (30), loosely, if present.
5. Nuts (28), loosely, if present.
6. Nuts (25 and 27), loosely, if present.

Tighten

- Nut (28), if present, to 25 N·m (18 lb. ft.).
- Nut (27), if present, to 50 N·m (37 lb. ft.).
- Bolts (30), if present, to 25 N·m (18 lb. ft.).
- Nut (25), if present, to 33 N·m (24 lb. ft.).
- Bolts (24) to 50 N·m (37 lb. ft.).

7. Hoses. Refer to "Power Steering Hose Replacement" in this section.
8. Pulley. Refer to "Pump Drive Pulley Replacement" in this section.
9. Serpentine belt. Refer to COOLING AND RADIATOR (SEC. 6B).

- Fill power steering pump reservoir with fluid. Refer to "Checking and Adding Fluid" in this section.
- Bleed system. Refer to "Bleeding Power Steering System" in this section.

POWER STEERING GEAR REPLACEMENT

Figure 9

NOTICE: See "Notice" on Page 3B1-1 in this section.

Remove or Disconnect

1. Pressure hose and cooling pipe from power steering gear (5).

- Raise hoses up to prevent fluid drainage and dirt entry.

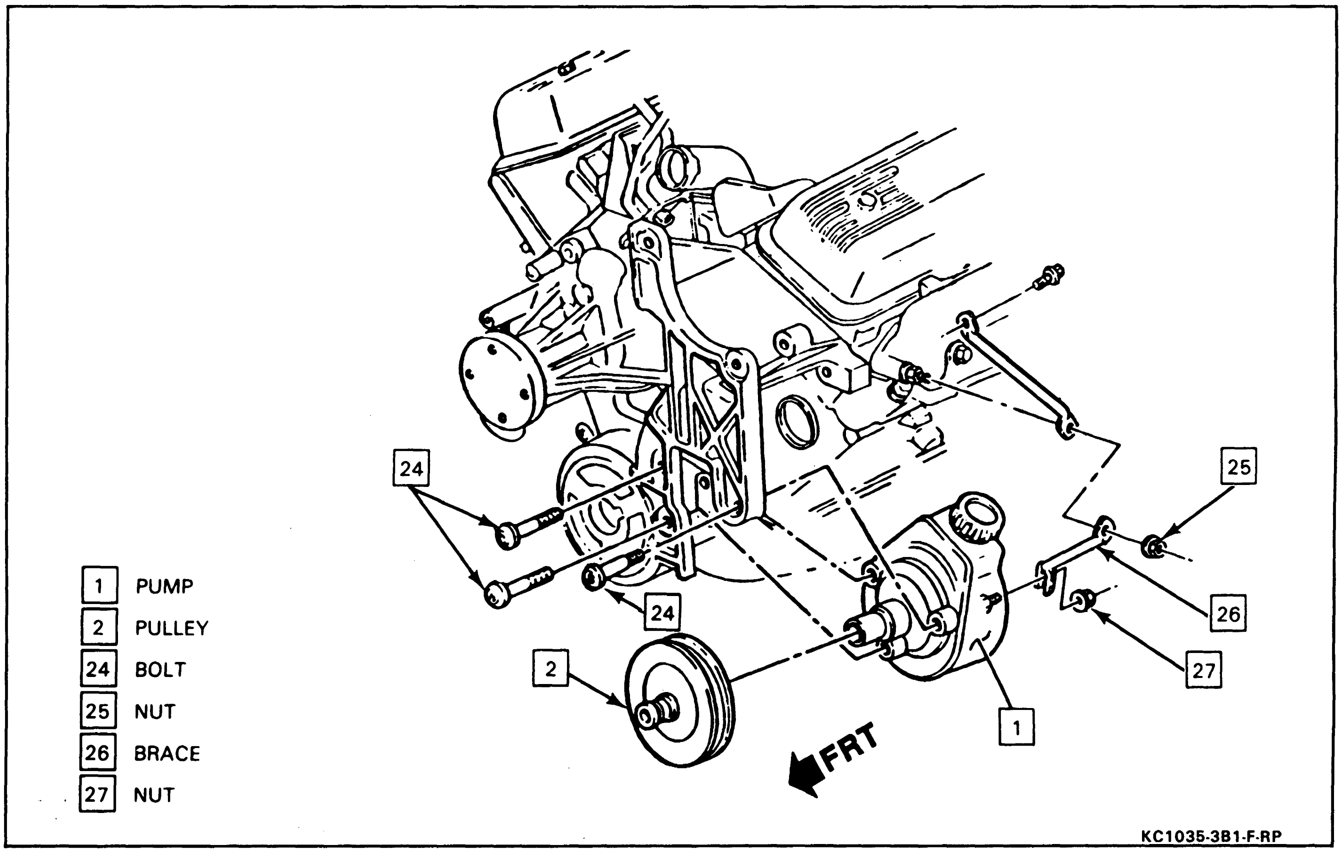

Figure 7 - Mounting Power Steering Pump, 5.0L and 5.7L Engines

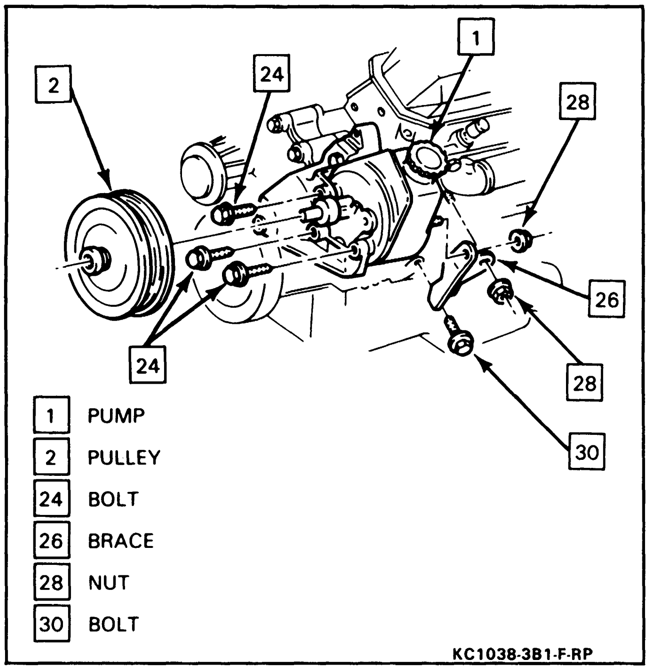

Figure 8 - Mounting Power Steering Pump, 3.1L Engine

2. Intermediate shaft from power steering gear. Refer to STEERING WHEEL UPPER COLUMN ON-VEHICLE SERVICE - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4).
3. Pitman arm. Refer to STEERING LINKAGE (SEC. 3B3).
4. Bolts (15), washers (29) and power steering gear (5).

Install or Connect

- Position power steering gear (5) to frame.

1. Washers (29) and bolts (15) loosely.

   Adjust

   - Power steering gear (5) so that it aligns as straight as possible with the intermediate shaft.

   NOTICE: See "Notice" on page 3B1-1 in this section.

   Tighten

   - Bolts (15) to 90 N·m (66 lb. ft.).

2. Pitman arm. Refer to STEERING LINKAGE (SEC. 3B3).
3. Intermediate shaft to power steering gear. Refer to STEERING WHEEL UPPER COLUMN ON-VEHICLE SERVICE - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4).
4. Pressure hose and cooling pipe.

   Tighten

   - Hose and cooling pipe fittings to 28 N·m (21 lb. ft.).

- Bleed system. Refer to "Bleeding the Power Steering System" in this section.

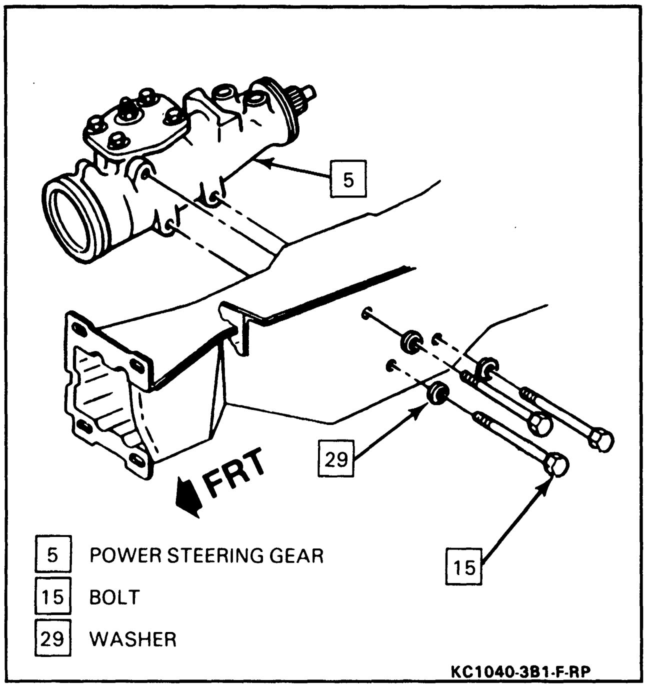

Figure 9 - Mounting Power Steering Gear

UNIT REPAIR - POWER STEERING GEAR

STEERING GEAR ADJUSTMENTS

Important

- Before any adjustments are made on the steering gear, refer to STEERING, SUSPENSION, TIRES AND WHEELS DIAGNOSIS (SEC. 3) for reviewing the possible steering system problems. The steering gear adjustment is made only as a correction and not as a periodic adjustment.

For proper adjustment, remove the steering gear from the vehicle. Drain the power steering fluid from the gear. Mount the gear in a vise and make the following adjustments.

The steering gear requires two adjustments: the worm thrust bearing preload and the pitman shaft over-center preload adjustment.

The worm thrust bearing preload is controlled by the amount of compression force exerted on the conical worm bearing thrust races by the adjuster plug.

The pitman shaft over-center preload is controlled by the pitman shaft adjuster screw, which determines the clearance between the rack piston and the pitman shaft sector teeth.

Important

- Adjust the worm thrust bearing preload first, then adjust the pitman shaft over-center preload.

Worm Bearing Preload Adjustment

Figures 10 through 15

Tool Required:

J 7624 Spanner Wrench

1. Remove steering gear. Refer to "Power Steering Gear Replacement" in this section.
2. Rotate stub shaft (60) back and forth to drain power steering fluid.
3. Remove adjuster plug nut (64).
4. Turn adjuster plug (62) in (clockwise) using J 7624 until adjuster plug (62) and thrust bearing (61) are firmly bottomed in housing (54).

Tighten

- Adjuster plug (62) to 27 N·m (20 lb. ft.).

5. Place an index mark on the housing (54) even with one of the holes in the adjuster plug (62).
6. Measure back counterclockwise 13 mm (0.5 inch) and place a second mark on housing (54).
7. Turn adjuster plug (62) counterclockwise until hole in adjuster plug (62) is aligned with the second mark on the housing (54).
8. Install adjuster plug nut (64) and using a punch in a notch, tighten securely.
    - Hold adjuster plug (62) to maintain alignment of the marks.
9. Install steering gear. Refer to "Power Steering Gear Replacement" in this section.

Pitman Shaft Over-Center Sector Adjustment

Figures 16 through 18

1. Remove steering gear. Refer to "Power Steering Gear Replacement" in this section.
2. Rotate stub shaft (60) back and forth to drain power steering fluid.
3. Turn the pitman shaft adjuster screw (80) counterclockwise until fully extended, then turn back one full turn.
4. Rotate the stub shaft (60) from stop to stop and count the number of turns.
5. Starting at either stop, turn the stub shaft (60) back one-half the total number of turns. This is the "center" of the gear.
    - When the gear is centered, the flat on the stub shaft (60) should face upward and be parallel with the side cover (51) and the master spline on the pitman shaft should be in line with the adjuster screw (80).
6. Rotate the stub shaft (60) 45 degrees each side of the center using a torque wrench with the handle in the vertical position.
    - Record the worm bearing preload measured on or near the center.
7. Adjust over-center drag torque by loosening the adjuster lock nut (50) and turning the pitman shaft adjuster screw (80) clockwise until the correct drag torque is obtained.
    - Add 0.7-1.1 N·m (6-10 lb. in.) torque to the previously measured worm bearing preload torque.

Tighten

- Adjuster lock nut (50) to 27 N·m (20 lb. ft.).
- Prevent adjuster screw (80) from turning while tightening adjuster lock nut (50).

8. Install steering gear. Refer to "Power Steering Gear Replacment" in this section.

PITMAN SHAFT AND SIDE COVER REPLACEMENT

Figures 10 and 11

Remove or Disconnect

- Steering gear. Refer to "Power Steering Gear Replacement" in this section.

Disassemble

- Rotate stub shaft (60) back and forth to drain power steering fluid.

1. Adjuster lock nut (50).
2. Bolts (49).

- Rotate stub shaft (60) to center gear.

3. Side cover (51), gasket (52), and pitman shaft (53) as an assembly.
4. Pitman shaft (53) by unscrewing it from the side cover (51).

Assemble

NOTICE: See "Notice" on page 3B1-1 of this section.

1. Pitman shaft (53) to side cover (51) by screwing pitman shaft (53) in until it fully seats to the side cover (51).
2. Adjuster lock nut (50).

Tighten

- Adjuster lock nut (50) to 27 N·m (20 lb. ft.).

3. Gasket (52) to side cover (51) and bend tabs around edges of side cover (51).
4. Pitman shaft assembly and side cover (51) to housing (54).
5. Bolts (49).

Tighten

- Bolts (49) to 60 N·m (44 lb. ft.).

Adjust

- Pitman shaft. Refer to "Pitman Shaft Over-Center Sector Adjustment" in this section.

Install or Connect

- Steering gear. Refer to "Power Steering Gear Replacement" in this section.

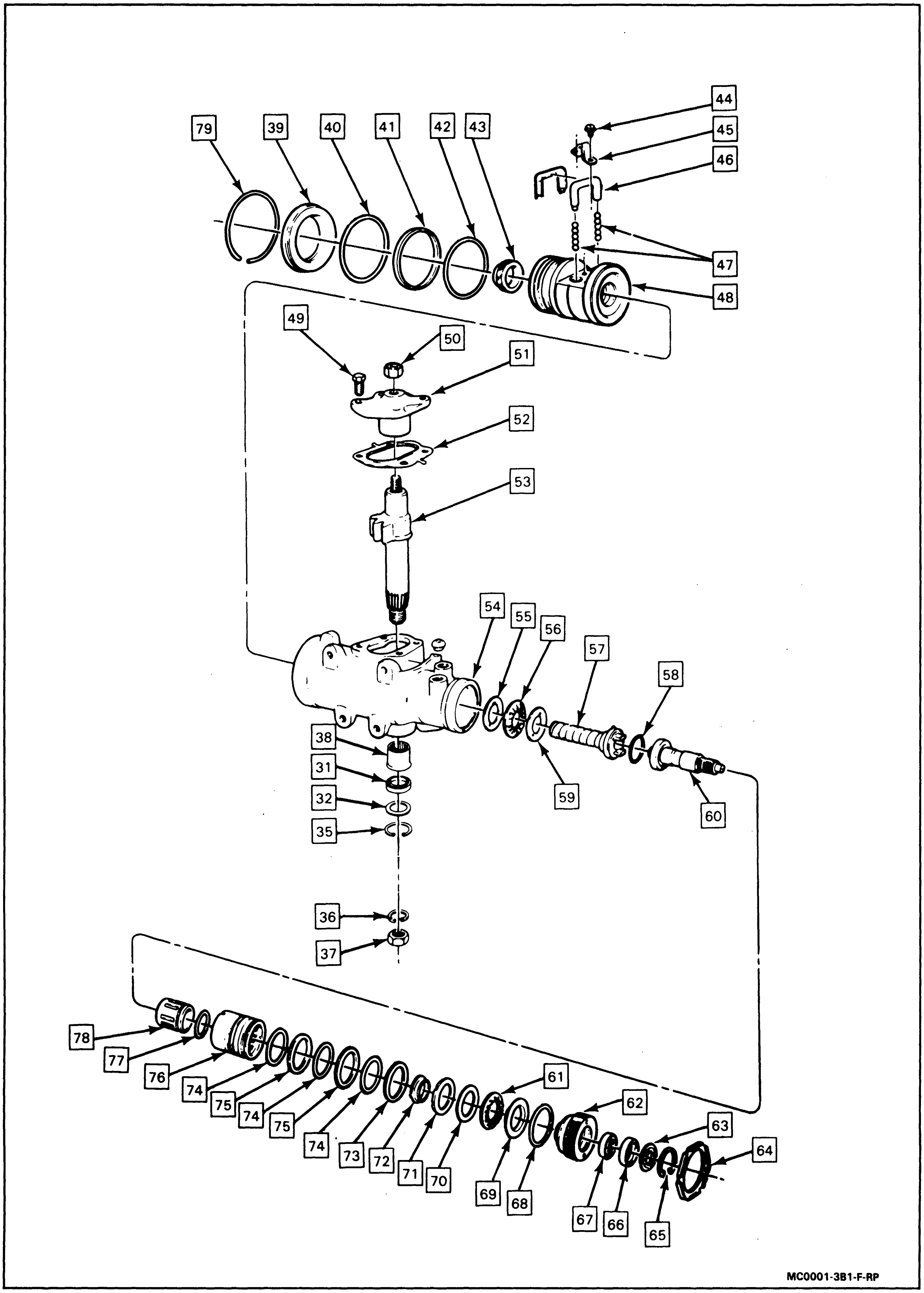

Figure 10 - Power Steering Gear

31	DOUBLE LIP SEAL
32	WASHER
35	RETAINING RING
36	SPRING WASHER
37	NUT
38	BEARING
39	PLUG
40	SEAL
41	RING
42	SEAL
43	PLUG
44	SCREW
45	CLAMP
46	BALL GUIDE
47	BALLS
48	RACK PISTON
49	BOLT
50	NUT
51	SIDE COVER
52	GASKET
53	PITMAN SHAFT
54	HOUSING
55	RACE
56	BEARING
57	WORM SHAFT
58	SEAL
59	RACE
60	STUB SHAFT
61	BEARING
62	ADJUSTER PLUG
63	SEAL
64	NUT
65	RETAINING RING
66	SEAL
67	NEEDLE BEARING
68	SEAL
69	RACE
70	RACE
71	SPACER
72	BEARING RETAINER
73	SPACER
74	SEAL
75	RING
76	VALVE BODY
77	SEAL
78	VALVE SPOOL
79	RETAINING RING

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Figure 11 - Power Steering Gear - Legend

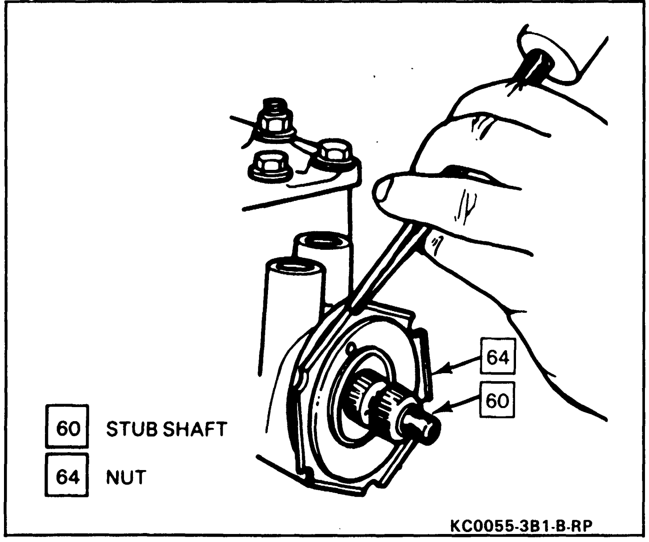

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Figure 12 - Loosening Adjuster Plug Nut

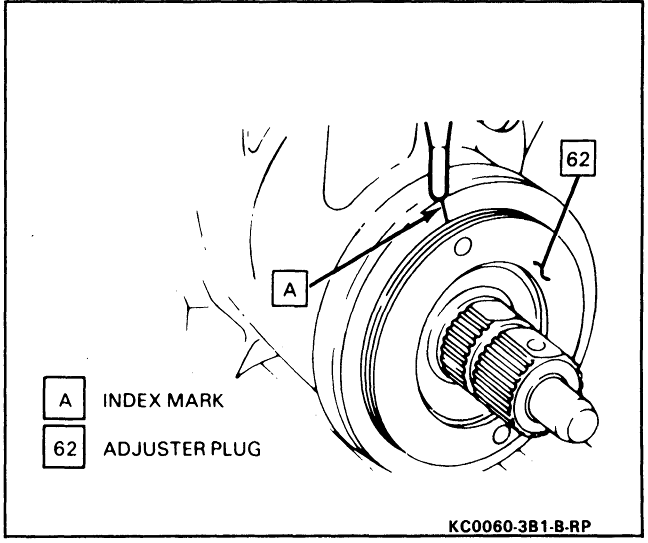

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Figure 13 - Marking Housing Even with Adjuster Plug

HOUSING END PLUG REPLACEMENT

Figure 19

Remove or Disconnect

- Steering gear. Refer to "Power Steering Gear Replacement" in this section.

Disassemble

- Rotate stub shaft back and forth to drain power steering fluid.

1. Retaining ring (79) by using a punch inserted into the housing access hole to unseat it.
2. Plug (39).
3. O-ring seal (40).

Assemble

- Lubricate O-ring seal with power steering fluid.

1. O-ring seal (40).
2. Plug (39).
3. Retaining ring (79).
   - Install retaining ring (79) so that open end is approximately 25 mm (1 inch) from access hole in housing (54).

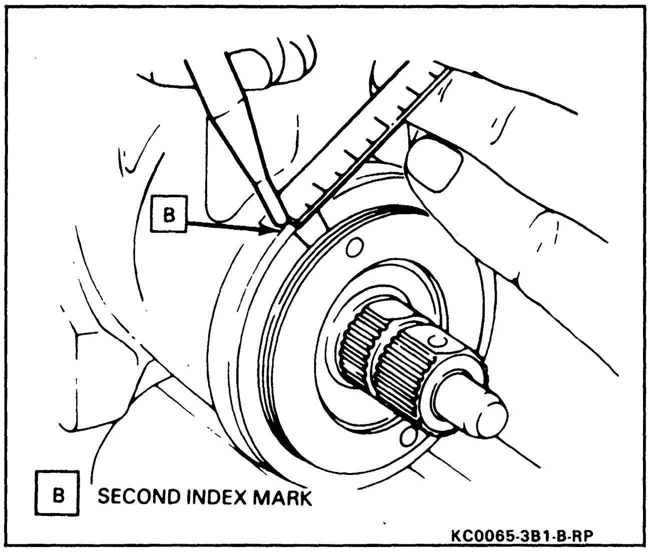


Figure 14 - Remarking the Housing

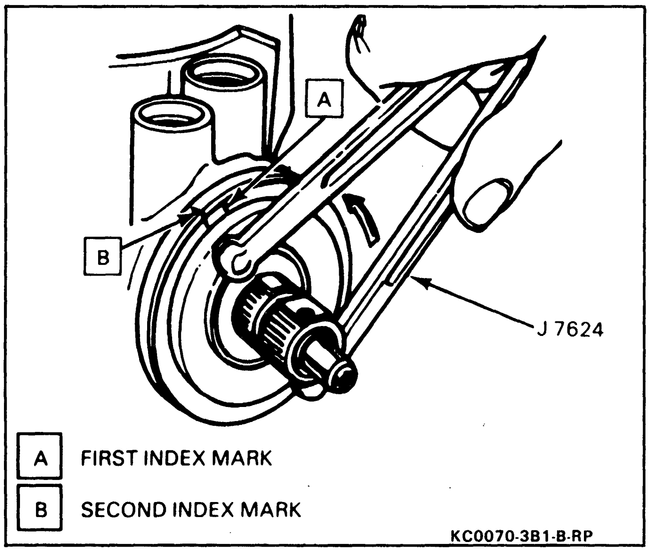


Figure 15 - Aligning the Adjuster Plug to the Second Mark

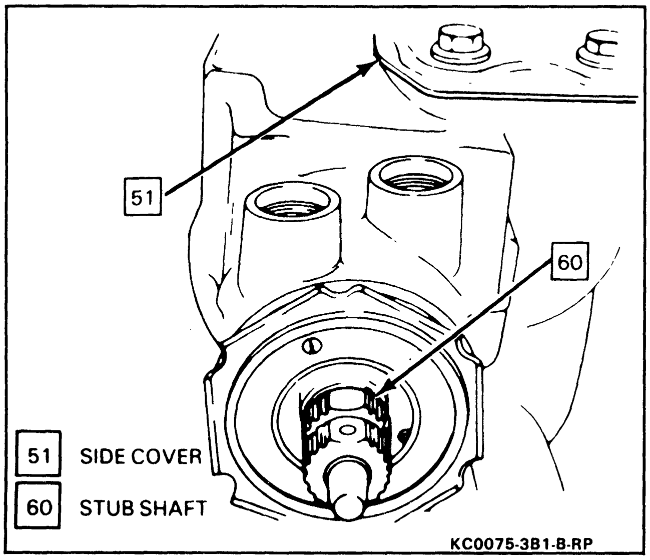


Figure 16 - Aligning the Stub Shaft

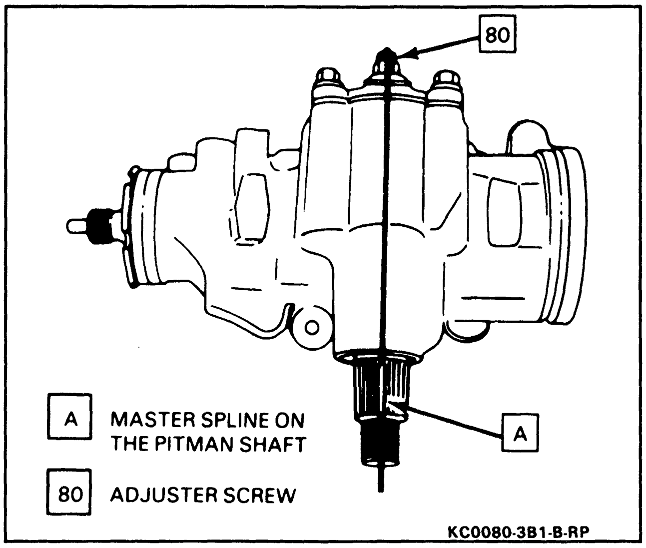


Figure 17 - Aligning Pitman Shaft Master Spline

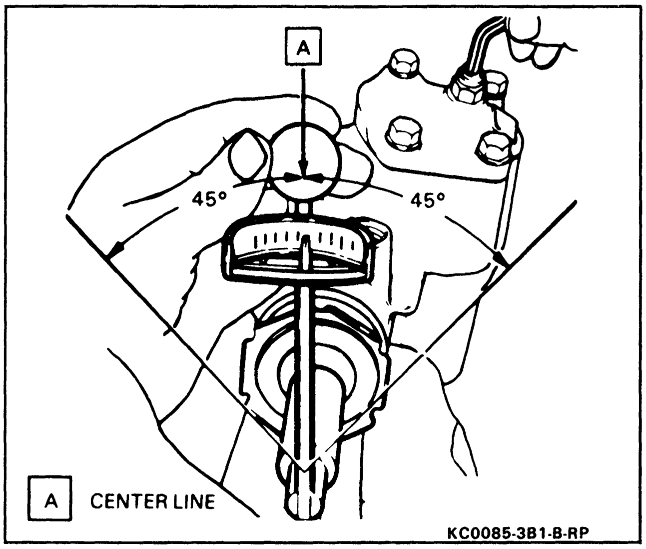


Figure 18 - Checking Over-Center Rotational Torque

Install or Connect

- Steering gear. Refer to "Power Steering Gear Replacement" in this section.

ADJUSTER PLUG ASSEMBLY REPLACEMENT

Figures 10, 11 and 20

Tools Required:

J 7624 Spanner Wrench

J 6221 Adjuster Plug Bearing Remover and Installer

Remove or Disconnect

- Steering gear. Refer to "Power Steering Gear Replacement" in this section.

Disassemble

1. Adjuster plug nut (64) from housing (54) using a punch against the edge of the slots.
2. Adjuster plug (62) from housing (54) using J 7624.

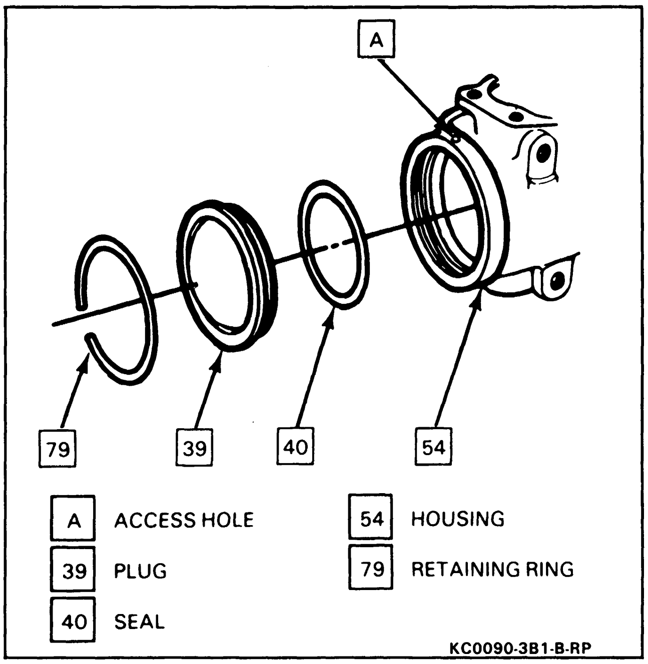


Figure 19 - Housing End Plug

3. Thrust washer bearing retainer (72) from adjuster plug (62) by using a screwdriver to pry at raised area of bearing retainer (72).
4. Bearing spacer (71), races (69 and 70) and thrust bearing (61).
5. O-ring seal (68).
6. Retaining ring (65).

- Place adjuster plug (62) outside face down on suitable support.

7. Needle bearing (67), dust seal (63) and lip seal (66) using J 6221 to drive them from adjuster plug (62).

Assemble

- Place adjuster plug (62) outside face up on suitable support.

NOTICE: Needle bearing must be installed with identification on bearing facing tool to prevent damage to bearing.

1. Needle bearing (67) to adjuster plug (62) using J 6221.
2. Lip seal (66) to adjuster plug (62) using J 6221.
3. Dust seal (63) to adjuster plug (62) using J 6221.
4. Retaining ring (65).
5. O-ring seal (68) to adjuster plug (62).
6. Large bearing race (69), thrust bearing (61), small bearing race (70) and bearing spacer (71) to adjuster plug (62).
7. Thrust washer bearing retainer (72) to adjuster plug (62).
   - Lubricate O-ring seal (68) and rubber lip of seals (63 and 66).

NOTICE: When installing adjuster plug, care should be taken not to cut the seals.

8. Adjuster plug (62) to housing (54) using J 7624.

Adjust

- Thrust bearing preload. Refer to "Worm Bearing Preload Adjustment" in this section.

9. Adjuster plug nut (64) to housing (54) and tighten by using a punch against the edge of the slots.

Adjust

- Pitman shaft over-center sector. Refer to "Pitman Shaft Over-Center Sector Adjustment" in this section.

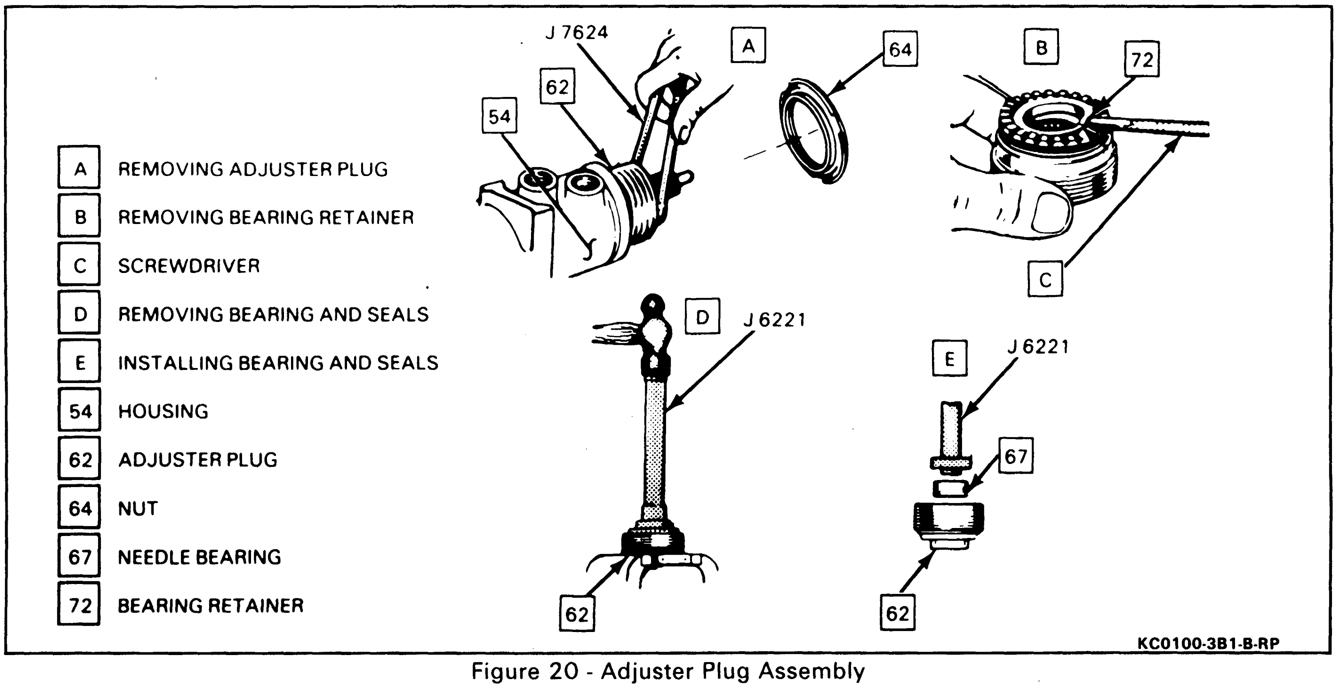


Figure 20 - Adjuster Plug Assembly

Install or Connect

- Steering gear. Refer to "Power Steering Gear Replacement" in this section.

VALVE REPLACEMENT

Figures 10, 11, 21 and 22

Remove or Disconnect

- Steering gear. Refer to "Power Steering Gear Replacement" in this section.

Disassemble

1. Adjuster plug. Refer to "Adjuster Plug Assembly Replacement" in this section.
2. Stub shaft (60) and valve assembly.
3. Stub shaft (60).
    - Tap stub shaft (60) lightly on a wood block to loosen shaft cap.
    - Pull cap and valve spool (78) out from valve body (76) 6 mm (1/4 inch) and disengage stub shaft pin from hole in valve spool (78).
4. Valve spool (78) by pulling and rotating from valve body (76).
5. Valve spool O-ring seal (77).
6. Valve body teflon rings (75) and O-ring seals (74).

Assemble

1. Valve spool O-ring seal (77) to valve spool (78).
    - Lubricate valve spool (78) and O-ring seal (77) with power steering fluid.
2. Valve spool (78) to valve body (76) by pushing and rotating until hole in valve spool (78) for stub shaft pin is accessible from opposite end of valve body (76).
3. Stub shaft (60) to valve spool and insert pin.
    - Notch in stub shaft cap must fully engage valve body pin and seat against valve body shoulder.
4. O-ring seals (74) and teflon rings (75) to valve body (76).
    - Lubricate O-ring seals (74) and teflon rings (75) with power steering fluid.
5. Stub shaft (60) and valve assembly to worm shaft (57), fitting pin on worm shaft (57), to slot in the valve assembly.
6. Adjuster plug. Refer to "Adjuster Plug Assembly Replacement" in this section.

Adjust

- Thrust bearing preload and pitman shaft over-center sector. Refer to "Steering Gear Adjustments" in this section.

Install or Connect

- Steering gear. Refer to "Power Steering Gear Replacement" in this section.

RACK PISTON AND WORM SHAFT REPLACEMENT

Figures 10, 11, 21 and 23

Remove or Disconnect

- Steering gear. Refer to "Power Steering Gear Replacement" in this section.

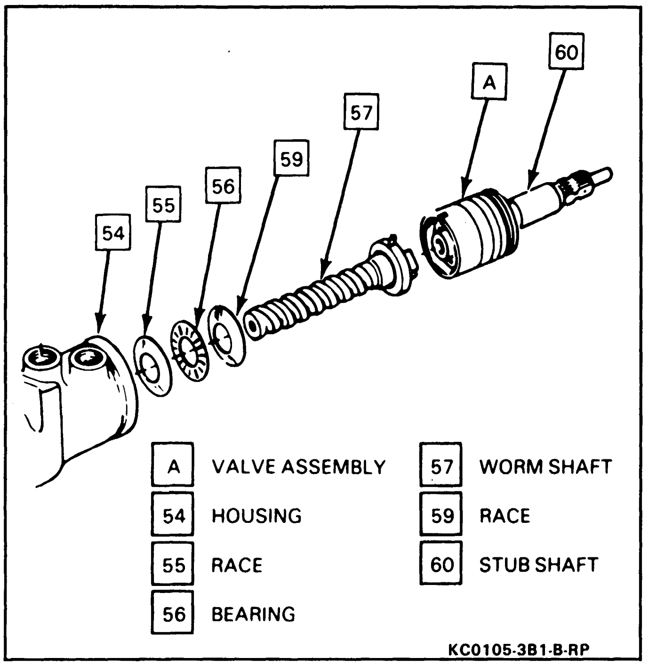


Figure 21 - Bearing, Worm and Valve Assembly

Disassemble

Tool Required:

J 21552 Rack Piston Arbor

1. Pitman shaft and side cover. Refer to "Pitman Shaft and Side Cover Replacement" in this section.
2. Housing end plug. Refer to "Housing End Plug Replacement" in this section.
- Turn stub shaft counterclockwise until the rack piston (48) begins to come out of the housing (54).
3. Rack piston plug (43).
- Insert J 21552 into bore of rack piston (48). Hold tool tightly against worm shaft while turning the stub shaft counterclockwise.
    - The rack piston (48) will be forced onto the tool and hold the rack piston balls (47) in place.
4. Rack piston (48), rack piston balls (47) and J 21552 together from housing (54).
5. Valve. Refer to "Valve Replacement" in this section.
6. Worm shaft.
7. Thrust bearing (56) and races (55 and 59).
8. J 21552 from rack piston (48).
9. Rack piston balls (47).
10. Screws (44), clamp (45) and ball guide (46).
11. Teflon ring (41).

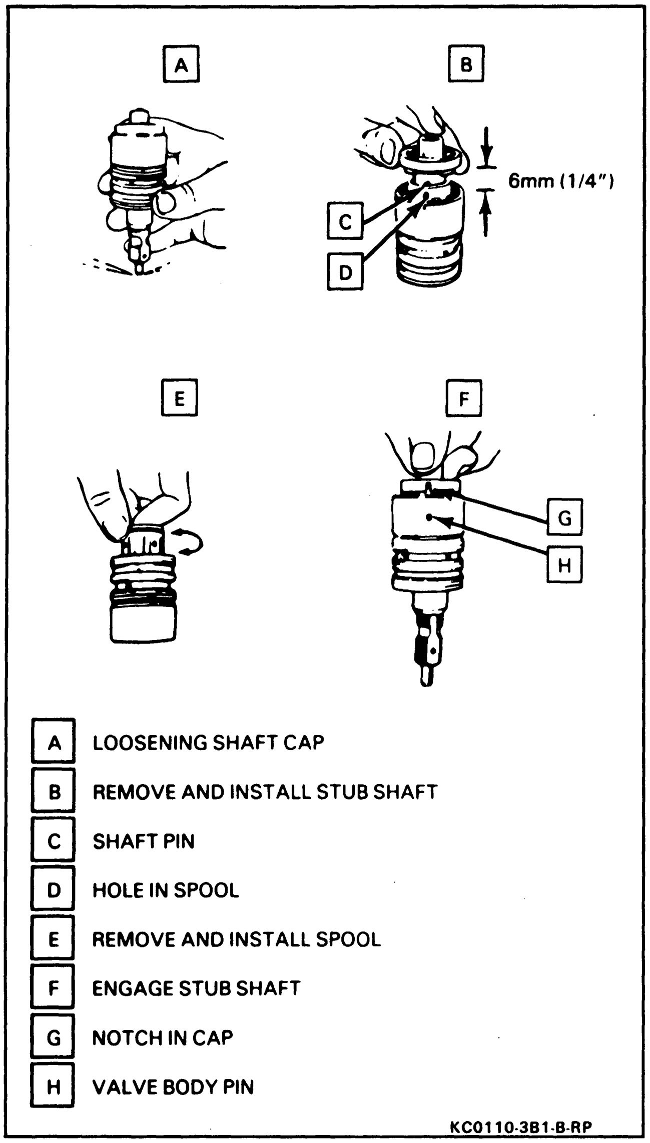


Figure 22 - Disassembling Valve

12. O-ring seal (42).

Clean

- All disassembled parts.

Inspect

- All disassembled parts for wear. Replace if necessary.

Assemble

Tools Required:

J 8947 Rack Piston Teflon Ring Compressor

J 21552 Rack Piston Arbor

1. O-ring seal (42) and teflon ring (41) and lubricate with power steering fluid.
2. Worm shaft (57) to rack piston (48) outside of housing (54).
    - Fully seat worm shaft (57) to rack piston (48) and align worm shaft groove with rack piston (48) and align worm shaft groove with rack piston ball return guide hole.

NOTICE: The black rack piston balls are smaller than the silver balls. The black and silver balls must be installed alternately into the rack piston and ball guide to maintain rack piston to worm shaft preload.

- Lubricate rack piston balls (47) with power steering fluid.

3. Rack piston balls (47) to rack piston (48) by inserting through ball return guide hole while turning worm shaft (57) counterclockwise.
4. Remaining rack piston balls (47) to ball guide (46) using grease at each end to retain balls (47).
5. Ball guide (46) to rack piston (48).

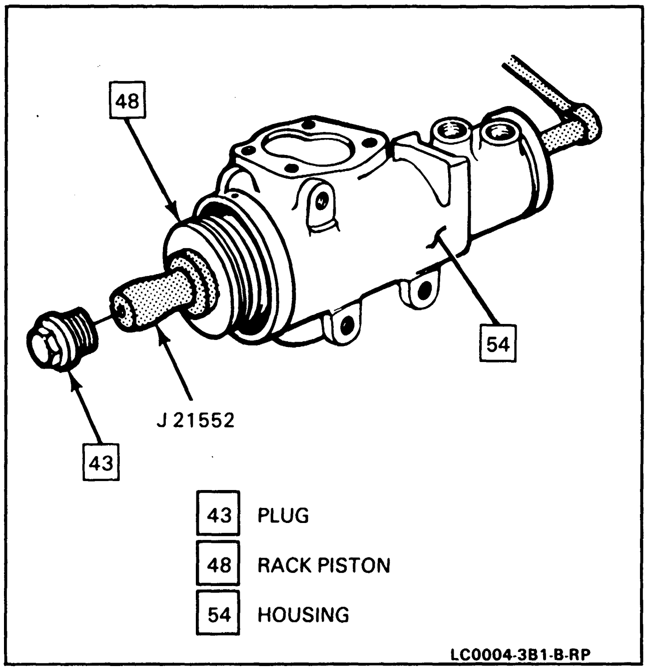


Figure 23 - Rack Piston

NOTICE: See "Notice" on page 3B1-1 in this section.

6. Ball guide clamp (45) and screws (44).

Tighten

- Screws (44) to 5 N·m (44 lb. in.).
- Insert J 21552 into bore of rack piston (48) while turning worm shaft (57) counterclockwise. The rack piston (48) will be forced onto the tool and will hold the rack piston balls (47) in place.

7. Races (55 and 59) and thrust bearing (56) to worm shaft (57).
8. Worm shaft (57) to housing (54).
9. Valve. Refer to "Valve Replacement" in this section.
10. Rack piston (48) to worm shaft (57) from J 21552, using J 8947 to compress seals.
    - Hold J 21552 tightly against worm shaft (57), and turn stub shaft clockwise until rack piston (48) is seated on worm shaft (57).
11. Rack piston plug (43).

12. Housing end plug. Refer to "Housing End Plug Replacement" in this section.
13. Pitman shaft and side cover. Refer to "Pitman Shaft and Side Cover Replacement" in this section.

Adjust

- Steering gear. Refer to "Steering Gear Adjustments" in this section.

Install or Connect

- Steering gear. Refer to "Power Steering Gear Replacement" in this section.

PITMAN SHAFT SEALS AND BEARING REPLACEMENT

Figures 10 and 11

This procedure covers the seal and bearing replacement for steering gears. The steering gear uses only one lip seal. A dust seal is on the outside of the retaining ring.

Tools Required:

J 6278 Pitman Shaft Bearing Remover and Installer

J 6219 Pitman Shaft Oil Seal Installer

J 4245 Internal Snap Ring Pliers

Remove or Disconnect

- Pitman arm from steering gear. Refer to STEERING LINKAGE (SEC. 3B3).

Clean

- End of pitman shaft (53) and housing (54).

Disassemble

1. Retaining ring (35) using J 4245.

NOTICE: Use care not to score the housing bore when prying out seals and washers.

2. Washer (32) and double lip seal (31) using a screwdriver to pry them from the housing (54).

   Inspect

   - Housing (54) for burrs and remove if necessary.

3. Needle bearing (38).
   - Insert J 6278 through the hole in the top of the housing (54) and drive out bearing (38).

Assemble

- Coat double lip seal (31) and washer (32) with grease.

1. Needle bearing (38) to housing (54) using J 6278.
2. Double lip seal (31) using J 6219.
3. Washer (32).
4. Retaining ring (35) using J 4245.

Install or Connect

- Pitman arm to steering gear. Refer to STEERING LINKAGE (SEC. 3B3).

CHECK VALVE REPLACEMENT

Figure 24

Remove or Disconnect

1. Power steering pressure hose at steering gear.

NOTICE: Use care not to damage threads of housing when removing check valve.

2. Check valve (81) by prying from housing with a small screwdriver.

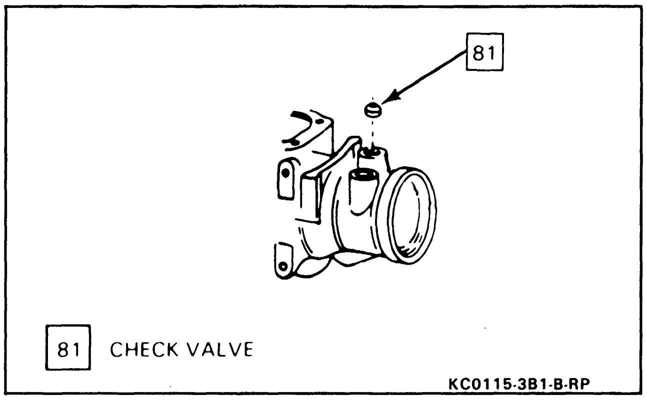


Figure 24 - Check Valve

Install or Connect

1. Check valve (81) using a 3/8-inch diameter piece of tubing 4 inches long to drive into housing.
2. Power steering hose at steering gear.

UNIT REPAIR - POWER STEERING PUMP

DRIVE SHAFT SEAL REPLACEMENT

Figure 25

Remove or Disconnect

- Power steering pump. Refer to "Power Steering Pump Replacement" in this section.

Disassemble

- Protect drive shaft (82) with shim stock.
- Seal (83) by cutting with a chisel.

Assemble

Tool Required:

J 22670 Shaft Oil Seal Installer

- Lubricate seal (83) with power steering fluid.
- Seal (83) using J 22670.

Install or Connect

- Power steering pump. Refer to "Power Steering Pump Replacement" in this section.

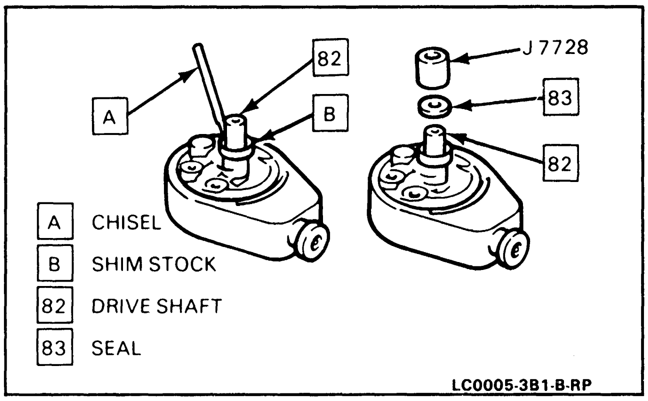


Figure 25 - Drive Shaft Seal

PUMP RESERVOIR REPLACEMENT

Figure 26

Remove or Disconnect

- Power steering pump. Refer to "Power Steering Pump Replacement" in this section.

Disassemble

- Drain power steering fluid from pump.

1. Studs (102).
2. Fitting (8) and O-ring seal (9).
3. Housing (85) from reservoir (100).
4. O-ring seals (12, 84 and 99).
5. Magnet (86).

Clean

- Magnet (86).

Inspect

- Welch plug in housing (85). Do not remove. If plug is deformed or dislodged, replace housing (85).

Important

- Use new seals when assembling pump.

Assemble

NOTICE: See "Notice" on page 3B1-1 in this section for steps 4 and 5.

- Lubricate O-ring seals (9, 12, 84 and 99) with power steering fluid.

1. O-ring seals (12, 84 and 99) to housing (85).
2. Magnet (86) to housing (85).
3. Reservoir (100) to housing (85).
4. Fitting (8) and O-ring seals (9).
5. Studs (102).

Tighten

- Studs (102) to 35 N·m (26 lb. ft.).
- Fitting (8) to 75 N·m (55 lb. ft.).

Install or Connect

- Power steering pump. Refer to "Power Steering Pump Replacement" in this section.

END PLATE AND ROTATING GROUP REPLACEMENT

Figures 26 and 27

Remove or Disconnect

- Power steering pump. Refer to "Power Steering Pump Replacement" in this section.

Disassemble

1. Pump reservoir. Refer to "Pump Reservoir Replacement" in this section.
2. Retaining ring (98).
3. End plate (97) and spring (96).

   NOTICE: Examine exposed portion of pump drive shaft. If it is corroded, clean with crocus cloth before removing. This will prevent damage to the shaft bushing which might require replacement of the entire housing.

4. Pressure plate (95) by using a rubber mallet to tap lightly on the drive shaft (82).
5. Pump ring (94).
6. Pump vanes (93).
7. Shaft retaining ring (92).
8. Shaft, rotor and thrust assembly.
9. Pump rotor (91).
10. Thrust plate (90).
11. Dowel pins (89).
12. O-ring seals (87 and 88).

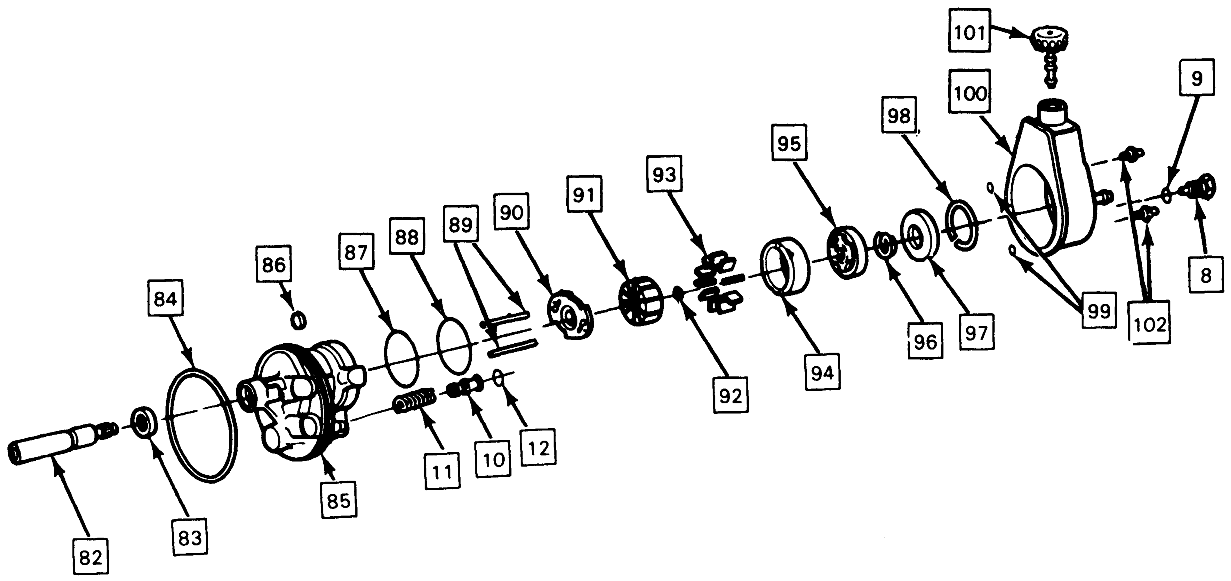
Important

- Use new seals and drive shaft retaining ring when assembling pump.

Assemble

- Lubricate O-ring seals (87 and 88) with power steering fluid.

1. O-ring seals (87 and 88) to housing (85).
2. Dowel pins (89) to housing (85).
3. Thrust plate (90) and pump rotor (91) to drive shaft (82) and secure with retaining rings (92).
4. Shaft, rotor and thrust plate assembly to housing (85).
5. Pump vanes (93) to pump rotor (91).
6. Pump ring (94) to housing (85) with identification arrows on top edge of ring (94) facing outward.



8	FITTING
9	SEAL
10	VALVE
11	SPRING
12	SEAL
82	DRIVE SHAFT
83	SEAL
84	SEAL
85	HOUSING
86	MAGNET
87	SEAL
88	SEAL
89	PINS
90	THRUST PLATE
91	ROTOR
92	RETAINING RING
93	VANES
94	RING
95	PRESSURE PLATE
96	SPRING
97	END PLATE
98	RETAINING RING
99	SEAL
100	RESERVOIR
101	CAP
102	STUDS

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Figure 26 - Power Steering Pump

7. Pressure plate (95).
8. Spring (96) and end plate (97).
9. Retaining ring (98).
10. Pump reservoir. Refer to "Pump Reservoir Replacement" in this section.

→← Install or Connect

- Power steering pump. Refer to "Power Steering Pump Replacement" in this section.

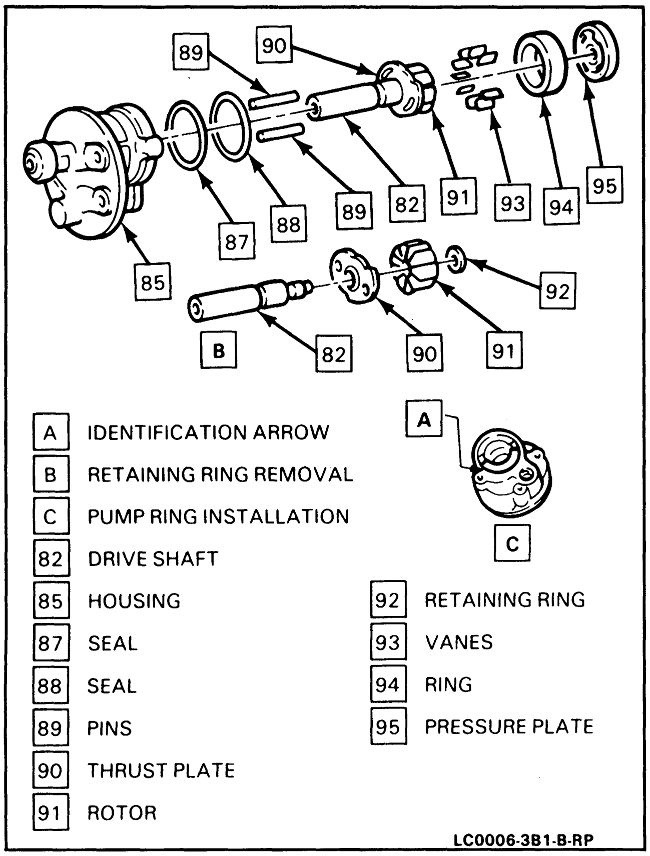


Figure 27 - Rotating Group

SPECIFICATIONS

POWER STEERING FLUID RECOMMENDATION

Power Steering Fluid Requirement .... GM Power Steering Fluid Part No. 1050017 or Equivalent meeting GM Specification 9985010

FITTING TORQUE SPECIFICATIONS

Idle Speed Pressure Switch	13 N·m (115 lb. in.)
Pump Fitting	75 N·m (55 lb. ft.)
Pressure Hose to Pump Fitting	28 N·m (21 lb. ft.)
Return Pipe Fitting to Steering Gear	28 N·m (21 lb. ft.)
Return Hose Fitting to Steering Gear	28 N·m (21 lb. ft.)
Return Hose Clamp	1.7 N·m (15 lb. in.)
Pressure Hose Fitting to Pump	28 N·m (21 lb. ft.)
Pressure Hose Fitting to Gear	28 N·m (21 lb. ft.)
Cooling Pipe Fitting to Gear	28 N·m (21 lb. ft.)

FASTENER TORQUE SPECIFICATIONS

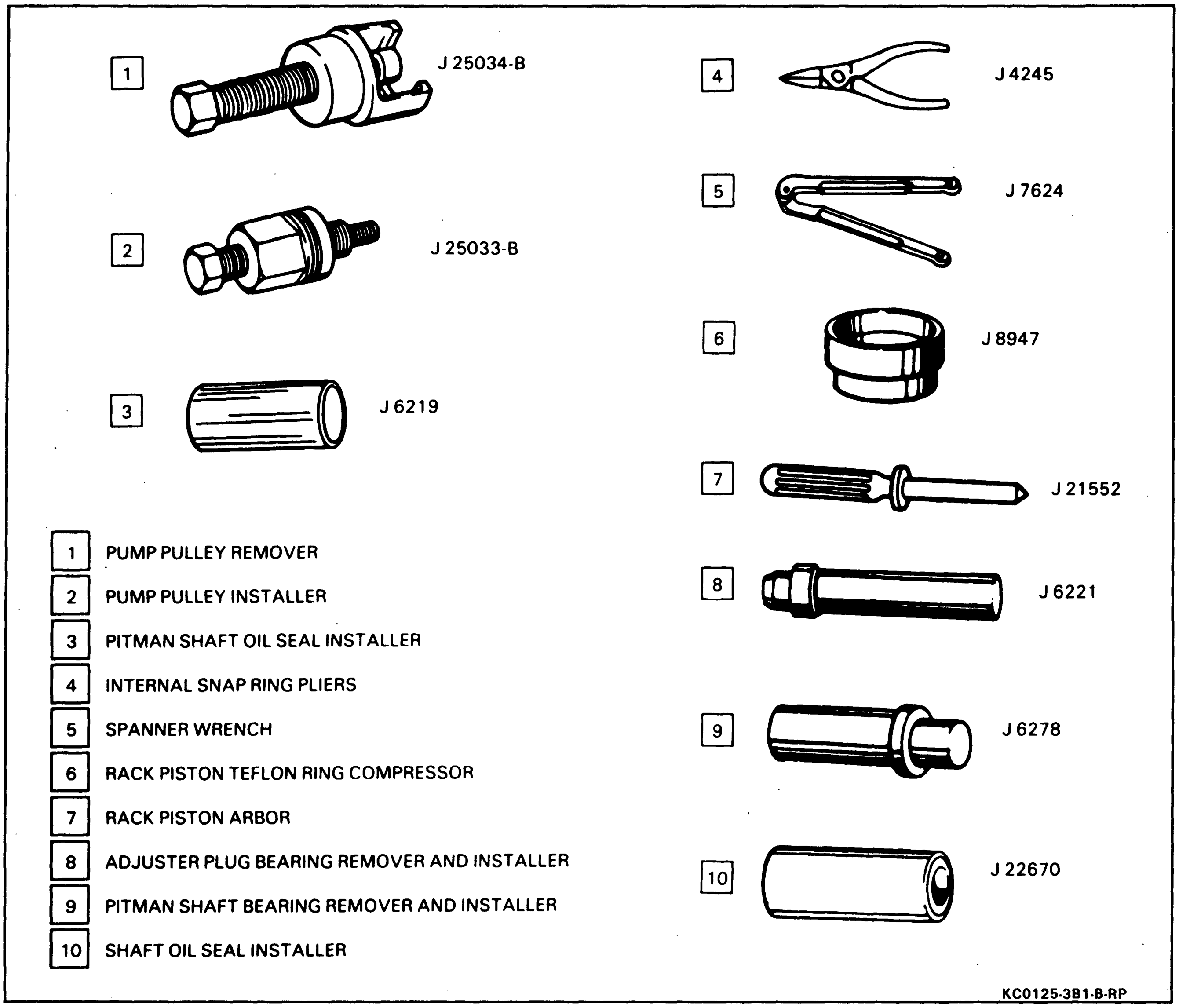
Engine Stud to Pump Bracket Nut	33 N·m (24 lb. ft.)
Pump Bracket to Engine Bolt	33 N·m (24 lb. ft.)
Brace to Pump Nut (3.1L Engine)	25 N·m (18 lb. ft.)
Brace to Pump Nut (5.0L and 5.7L Engines)	50 N·m (37 lb. ft.)
Brace to Engine Bolt	25 N·m (18 lb. ft.)
Brace to Engine Nut	33 N·m (24 lb. ft.)
Bracket to Pump Bolt	50 N·m (37 lb. ft.)
Steering Gear Mounting Bolt	90 N·m (66 lb. ft.)
Steering Gear Side Cover Bolt	60 N·m (44 lb. ft.)
Rack Piston Guide Clamp Screw	5 N·m (44 lb. in.)
Steering Pump Studs	35 N·m (26 lb. ft.)
Steering Gear Adjuster Lock Nut	27 N·m (20 lb. ft.)

ADJUSTMENT TORQUES

Steering Gear Adjuster Plug	27 N·m (20 lb. ft.)
Pitman Shaft Over-Center Preload*	0.7-1.1 N·m (6-10 lb. in.)

*Figure is in addition to worm shaft thrust bearing preload and valve and seal drag.

SPECIAL TOOLS



1	PUMP PULLEY REMOVER
2	PUMP PULLEY INSTALLER
3	PITMAN SHAFT OIL SEAL INSTALLER
4	INTERNAL SNAP RING PLIERS
5	SPANNER WRENCH
6	RACK PISTON TEFLON RING COMPRESSOR
7	RACK PISTON ARBOR
8	ADJUSTER PLUG BEARING REMOVER AND INSTALLER
9	PITMAN SHAFT BEARING REMOVER AND INSTALLER
10	SHAFT OIL SEAL INSTALLER

SECTION 3B3

STEERING LINKAGE

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 3B3-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

A parallelogram type steering linkage connects both front wheels to the steering gear through the pitman arm (13). The right and left tie rods are attached to the steering arms (19) and relay rod (14) by ball studs. The left end of the relay rod (14) is supported by the pitman arm (13) which is driven by the steering gear. The right end of the relay rod (14) is supported by the idler arm (16) which pivots on the idler arm support (18) attached to the frame rail. The pitman arm (13) and idler arm (16) remain parallel to each other while they move through symmetrical arcs (Figure 1).

The steering linkage should be lubricated with any water resistant EP type chassis lubricant at specified intervals. Lubrication points and additional information on chassis lubrication can be found in MAINTENANCE AND LUBRICATION (SEC. 0B).

NOTICE: Do not attempt to disengage a linkage joint by driving a wedge between the joint and attached part. Seal damage may result causing premature failure of the joint.

ON-VEHICLE SERVICE

CHECKING LINKAGE WEAR

Figure 2

1. Raise vehicle on one side at the frame directly behind the front wheel so that the tire is elevated 25.4 mm (1 inch) off the floor.
2. Position dial indicator.
3. Position steering wheel in a straight ahead and locked position.
4. Grasp front wheel and move wheel back and forth.
5. Read indicator. Indicator reading should not exceed 2.74 mm (0.108 inch).
   - If indicator reading is not within specification, a check should be made of all suspension and linkage parts.

TIE RODS

Figures 1 and 3

Tie rod adjuster components often become rusted in service. In such cases, it is recommended that if the torque required to remove the nut from the bolt after breakaway exceeds 9 N·m (80 lb. in.), discard the nuts and bolts. Apply penetrating oil between the clamp and tube and rotate the clamps until they move freely. Install new bolts and nuts having the same part number to assure proper clamping at the specified nut torque.

Inner Tie Rod

↔ Remove or Disconnect

Tools Required:

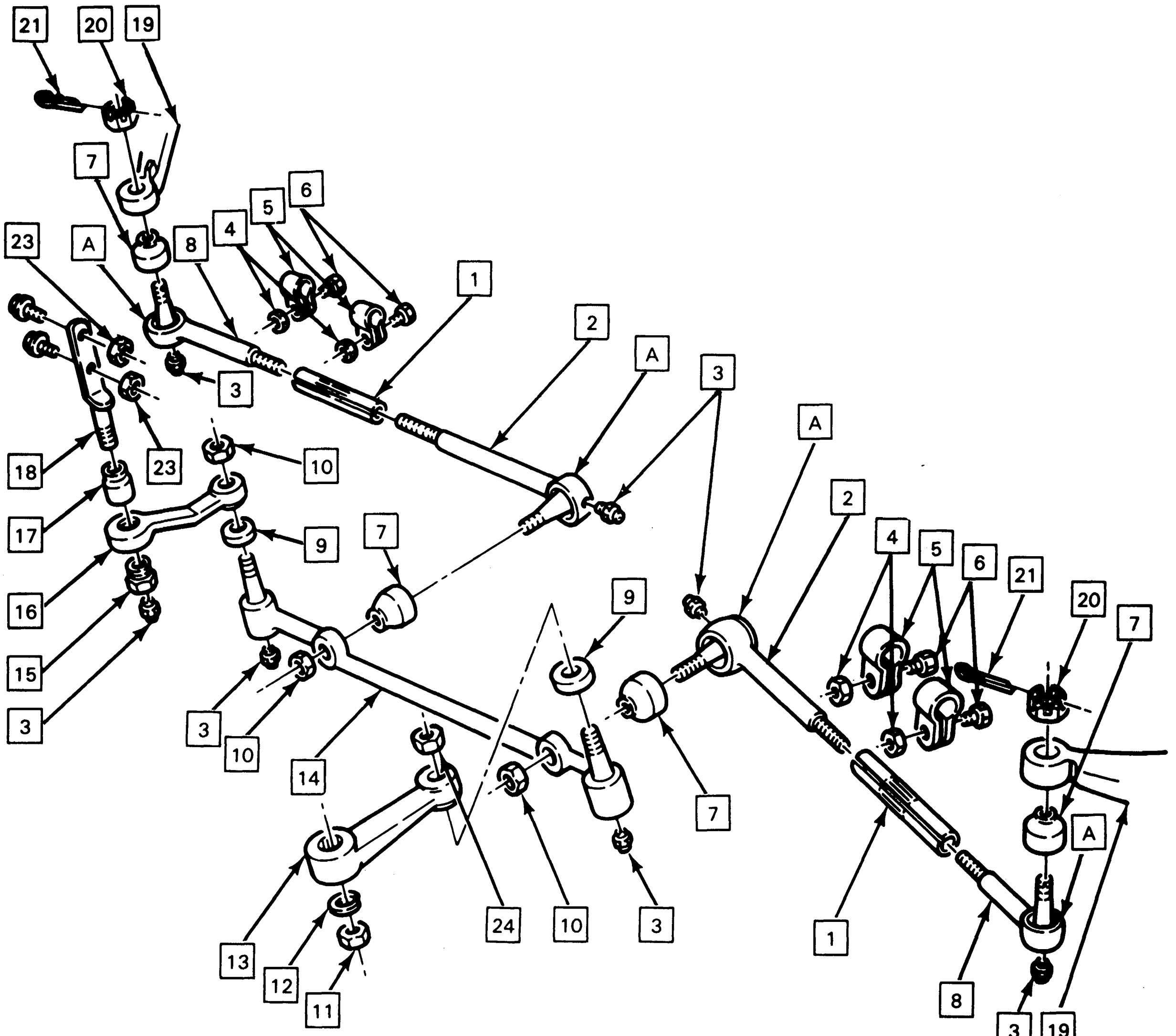
J 29193 Steering Linkage Installer

J 24319-01 Universal Steering Linkage Puller or

J 6627-A Tie Rod Puller

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Nut (10).
2. Inner tie rod ball joint from relay rod (14) using J 24319-01 or J 6627-A.



A	BALL JOINT
1	ADJUSTER TUBE
2	INNER TIE ROD
3	FITTING
4	NUT
5	ADJUSTER TUBE CLAMP
6	BOLT
7	SEAL
8	OUTER TIE ROD
9	SEAL
10	NUT
11	NUT
12	WASHER
13	PITMAN ARM
14	RELAY ROD
15	BUSHING
16	IDLER ARM
17	SEAL
18	IDLER ARM SUPPORT
19	STEERING ARM
20	NUT
21	COTTER PIN
22	BOLT
23	NUT
24	NUT

MC0001-3B3-F-RP

Figure 1 - Steering Linkage

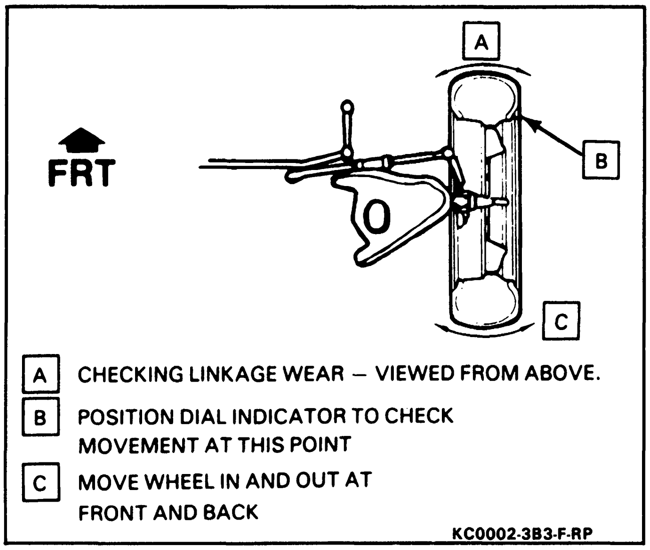


Figure 2 - Checking Linkage Wear

- Loosen clamp bolt (6) at the inner tie rod end of the adjuster tube (1).

Important

- Count the number of turns required to remove the inner tie rod (2) from the adjuster tube (1).

3. Inner tie rod (2) from tie rod adjuster tube (1).

Inspect

- Threads on the ball stud and in the ball stud nut. They should be clean and smooth. If threads are not clean and smooth, the ball may turn inside the tie rod when attempting to tighten the nut during installation.
- Ball stud taper for nicks.
- Seals (7) for damage. Replace seals as necessary. Refer to "Inner Tie Rod Seal" in this section.

Install or Connect

NOTICE: See "Notice" on page 3B3-1 of this section.

- Lubricate tie rod adjuster tube threads with EP chassis lube or equivalent.

1. Threaded end of inner tie rod (2) into the adjuster tube (1) using the same number of turns counted during removal.
2. Inner tie rod ball joint into relay rod (14).
3. J 29193 to seat tapers.

Tighten

- J 29193 to 20 N·m (15 lb. ft.).

- Remove J 29193.

4. Inner tie rod ball joint attaching nut (10).

Tighten

- Nut (10) to 54 N·m (40 lb. ft.).

Important

- Before tightening clamp nut (4) on the tie rod adjuster tube (1), make certain that the tie rod adjuster tube (1) and adjuster tube clamp (5) are positioned properly. Refer to "Tie Rod Adjuster" in this section for proper positioning of the tie rod adjuster tube (1) and adjuster tube clamp (5).

Tighten

- Adjuster clamp nut (4) to 19 N·m (14 lb. ft.).

- Lower vehicle.

Adjust

- Toe to specification. Refer to WHEEL ALIGNMENT (SEC. 3A).

Outer Tie Rod

Remove or Disconnect

Tools Required:

J 24319-01 Universal Steering Linkage Puller or

J 6627-A Tie Rod Puller

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Cotter pin (21) and castellated nut (20) from outer tie rod (8) at the steering arm (19).
2. Outer tie rod (8) from steering arm (19) by using J 24319-01 or J 6627-A.

- Loosen clamp bolt (6) at the outer tie rod end of the adjuster tube (1).

Important

- Count the number of turns required to remove the outer tie rod (8) from the adjuster tube (1).

3. Outer tie rod (8) from adjuster tube (1).

Inspect

- Threads on the ball stud and in the ball stud nut. They should be clean and smooth. If threads are not clean and smooth, the ball may turn inside the tie rod when attempting to tighten the nut during installation.
- Ball stud taper for nicks.
- Seals (7) for damage. Replace seals as necessary. Refer to "Outer Tie Rod Seal" in this section.

Install or Connect

NOTICE: See "Notice" on page 3B3-1 of this section for steps 3 and 4.

- Lubricate the tie rod adjuster tube threads with EP chassis lube or equivalent.

1. Threaded end of the outer tie rod (8) into the tie rod adjuster tube (1) using the same number of turns counted during removal.

2. Outer tie rod (8) into the steering arm (19).
3. Castellated nut (20).

Tighten

- Nut (20) to 48 N·m (35 lb. ft.).
- Nut (20) again just enough to align the slot in the nut with the hole in stud.

4. Cotter pin (21).

Important

- Before tightening clamp nut (4) on the tie rod adjuster tube (1), make certain that the tie rod adjuster tube (1) and adjuster tube clamp (5) are positioned properly. Refer to "Tie Rod Adjuster" in this section for proper positioning of the tie rod adjuster tube (1) and adjuster tube clamp (5).

Tighten

- Adjuster clamp nut (4) to 19 N·m (14 lb. ft.).

- Lower vehicle.

Adjust

- Toe to specification. Refer to WHEEL ALIGNMENT (SEC. 3A).

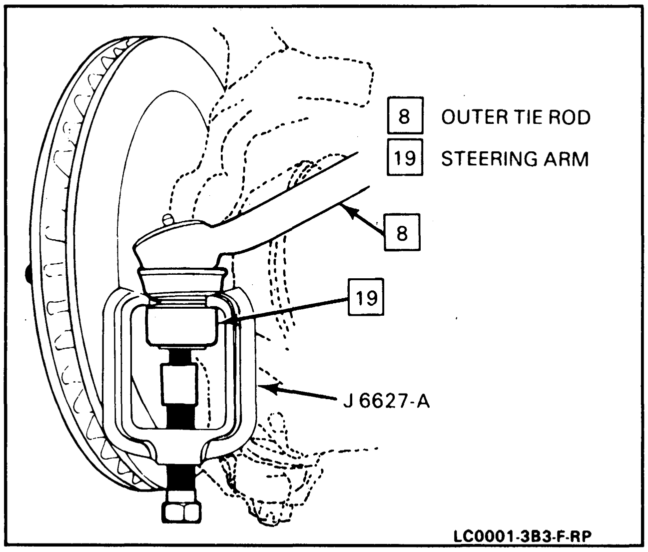


Figure 3 - Freeing Ball Stud

RELAY ROD

Figures 1 and 4

The left and right ends of the relay rod must be held at the same height. The side-to-side height control of the relay rod is controlled by adjusting the position of the idler arm. Before disconnecting the relay rod, it is important to mark the position of the idler arm on the frame in order to reinstall the idler arm in the same position. Whenever replacement of the relay rod or idler arm is required, the procedure for adjusting the relay rod height, as described in this section, must be performed.

Remove or Disconnect

Tools Required:

J 24319-01 Universal Steering Linkage Puller
J 29193 Steering Linkage Installer
J 33093 Relay Rod Adjustment Gage

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Inner tie rods (2) from relay rod (14). Refer to "Inner Tie Rod" in this section.
2. Nut (24) from the relay rod (14) at the pitman arm (13).
3. Relay rod (14) with seal (9) from pitman arm (13) by using J 24319-01.
   - Move steering linkage as required to free pitman arm (13) from relay rod (14).
4. Nut (10) from relay rod (14) at the idler arm (16).
5. Relay rod (14) with seal (9) from idler arm (16) by using J 24319-01.

Inspect

- Seals (9) for damage and replace as necessary.

Install or Connect

NOTICE: See "Notice" on page 3B3-1 of this section.

1. Relay rod (14) with seal (9) to idler arm (16).
2. J 29193 to seat the tapers.

Tighten

- J 29193 to 20 N·m (15 lb. ft.).

- Remove J 29193.

3. Nut (10) to ball stud.

Tighten

- Nut (10) to 48 N·m (35 lb. ft.).

4. Relay rod (14) with seal (9) to pitman arm (13).
5. J 29193 to seat the tapers.

Tighten

- J 29193 to 20 N·m (15 lb. ft.).

- Remove J 29193.

6. Nut (24) to ball stud.

Tighten

- Nut (24) to 48 N·m (35 lb. ft.).

7. Inner tie rods (2) to relay rod (14). Refer to "Inner Tie Rod" in this section.

- Adjust relay rod height. Refer to "Relay Rod Height Adjustment" in this section.
- Lower vehicle.

Relay Rod Height Adjustment

1. Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

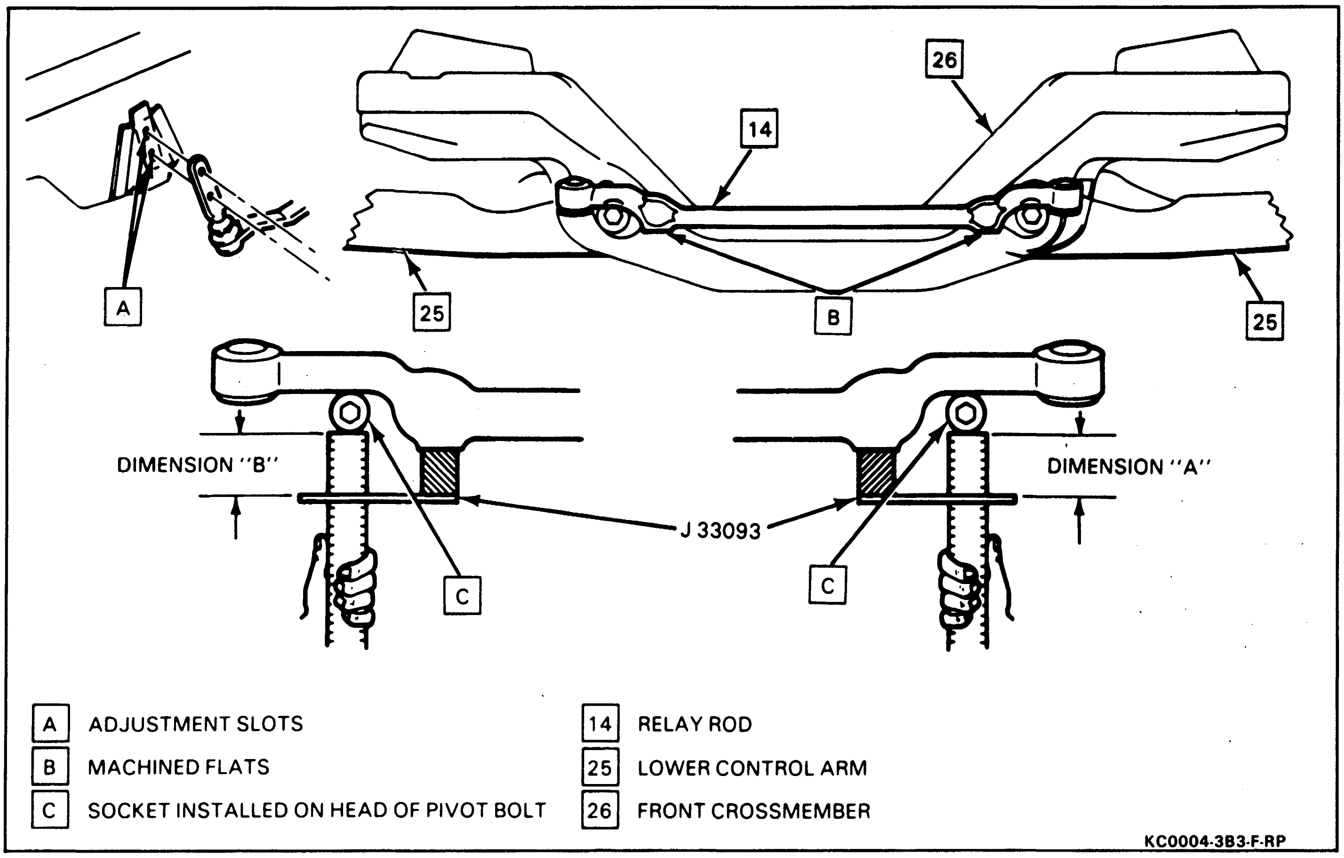


Figure 4 - Adjusting Relay Rod Height

2. Carefully clean both flats of the relay rod (14) with a wire brush.
3. Install J 33093 onto the flat at the pitman arm end.
4. Install a socket onto the head of the pivot bolt on the driver's side lower control arm (25).
5. Measure and record dimension "A" between the flange of J 33093 and the bottom of the socket.
6. Remove J 33093 and the socket from the pivot bolt.
7. Loosen idler arm-to-frame nuts (23) enough to slide the idler arm up and down.
8. Install J 33093 onto the flat at the idler arm end of the relay rod.
9. Install the socket to the pivot bolt at the passenger side lower control arm.
10. Measure and record dimension "B" between the flange of J 33093 and the bottom of the socket.
11. Adjust the position of the idler arm at the frame until dimension "A" and "B" are equal within ± 1.00 mm (0.039 inch).

Tighten

- Idler arm to frame nuts (23) to 70 N·m (52 lb. ft.).

12. Remove socket and J 33093.
13. Lower vehicle.

Adjust

- Toe to specification. Refer to WHEEL ALIGNMENT (SEC. 3A).

TIE ROD ADJUSTER

Figures 1 and 5

Tie rod adjuster parts often become rusted in service. In such cases, it is recommended that if the torque required to remove the nut from the bolt after breakaway exceeds 9 N·m (80 lb. in.), discard the nuts and bolts. Apply penetrating oil between the clamp and tube and rotate the clamps until they move freely. Install new bolts and nuts having the same part number to assure proper clamping at the specified nut torque.

Remove or Disconnect

Tool Required:

J 24319-01 Universal Steering Linkage Puller

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Outer tie rod (8). Refer to "Outer Tie Rod" in this section.

- Loosen clamp bolt (6) at the inner tie rod end of the adjuster tube (1).

Important

- Count the number of turns to remove the adjuster tube (1) from the inner tie rod (2).

2. Tie rod adjuster tube (1) from the inner tie rod (2).

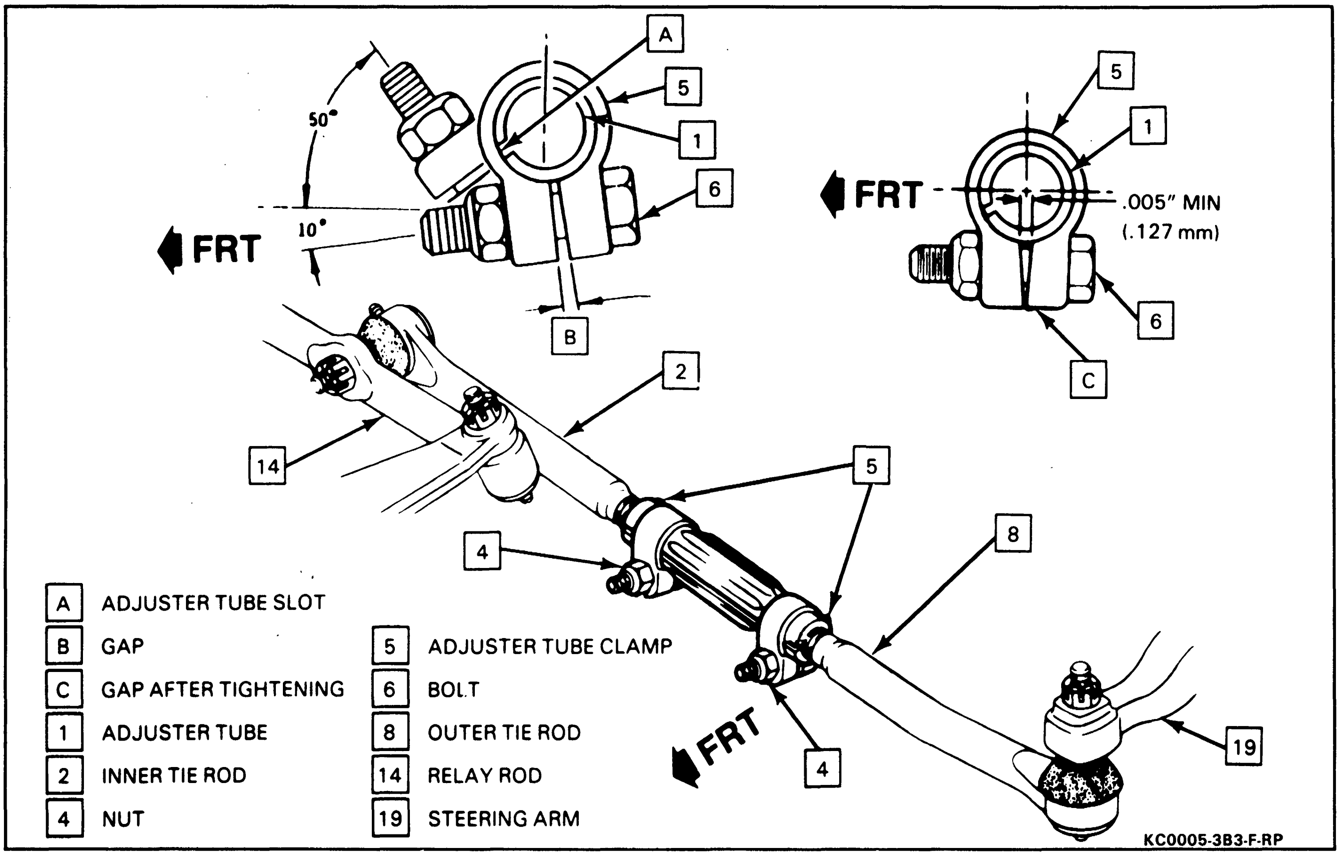


Figure 5 - Positioning Adjuster Tube and Clamps

Install or Connect

NOTICE: See "Notice" on page 3B3-1 of this section.

- Lubricate tie rod threads with EP chassis lube GM part number 1052356, or equivalent.

1. Adjuster tube (1) to inner tie rod (2) using the same number of turns as counted during removal.

Inspect

- Threads on the outer tie rod ball stud and in the ball stud nut. They should be clean and smooth. If threads are not clean and smooth the ball stud may turn in the tie rod when attempting to tighten nut.
- Ball stud taper for nicks.
- Seals for damage. Replace seals as necessary.

2. Outer tie rod (8). Refer to "Outer Tie Rod" in this section.

Adjust

- Tie rod adjuster tube (1) and adjuster tube clamps (5) as follows:
- Install adjuster clamp bolts (6) in the direction shown in Figure 5.
- Rotate inner and outer tie rod sockets rearward to the limit of the ball stud travel.
- Position adjuster tube clamps (5) within the angles shown in Figure 5.
  - Slot in tie rod adjuster tube (1) must not be within the gap area of the clamping jaws.
  - Clamps must be between and clear of dimples before tightening nut (4).

Tighten

- Nut (4) to 19 N·m (14 lb. ft.).
- Check to see that both ends of the tie rod adjuster tube (1) are threaded an equal distance onto the inner and outer tie rods (2 and 8).
- Lower vehicle.

Adjust

- Toe to specification. Refer to WHEEL ALIGNMENT (SEC. 3A).

IDLER ARM

Figures 1 and 6

Measure

- Vertical lash.
  - The idler arm assembly should always be replaced if vertical lash exceeds 3.2 mm (1/8 inch) when an up and down force of 110 Newtons (25 pounds) is applied at the relay rod end of the idler arm.
  - Vertical lash should be measured using a scale or ruler rested against the frame while applying the correct load.

- Jerking the right wheel and tire back and forth is not an acceptable method of checking vertical lash because there is no control on the amount of force being applied.

Remove or Disconnect

Tools Required:

J 24319-01 Universal Steering Linkage Puller

J 29193 Steering Linkage Installer

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Bolts (22) and nuts (23) attaching idler arm assembly to the frame.
2. Nut (10) attaching idler arm to the relay rod ball stud.
3. Idler arm (16) and seal (9) from relay rod (14) using J 24319-01.

Inspect

- Seal (9) for damage. Replace seal as necessary.

Install or Connect

NOTICE: See "Notice" on page 3B3-1 of this section.

1. Bolts (22) and nuts (23) to loosely attach the idler arm (16) to the frame.
2. Relay rod (14) to idler arm (16) with seal (9).
3. J 29193 to seat tapers.

Tighten

- J 29193 to 20 N·m (15 lb. ft.).
- Remove J 29193.

4. Nut (10) to ball stud.

Tighten

- Nut (10) to 48 N·m (35 lb. ft.).

Adjust

- Relay rod height as described in "Relay Rod Height Adjustment" in this section.

Adjust

- Toe to specification. Refer to WHEEL ALIGNMENT (SEC. 3A).

PITMAN ARM

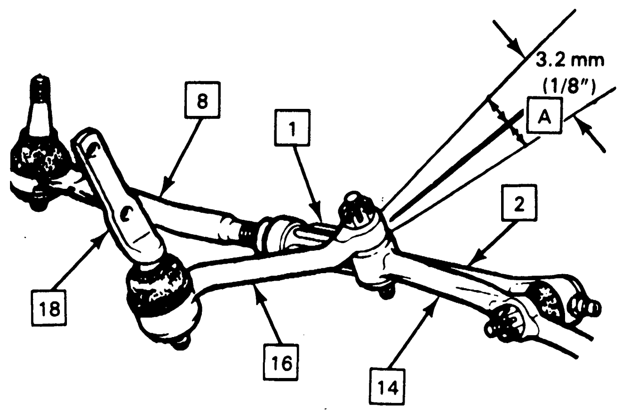
Figures 1 and 7

Remove or Disconnect

Tools Required:

J 6632-01 Pitman Arm Puller

J 24319-01 Universal Steering Linkage Puller



A	IDLER ARM MOVEMENT – VERTICAL LASH
1	ADJUSTER TUBE
2	INNER TIE ROD
8	OUTER TIE ROD
14	RELAY ROD
16	IDLER ARM
18	IDLER ARM SUPPORT

Figure 6 – Idler Arm Movement

J 29193 Steering Linkage Installer

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Nut (24) from relay rod ball stud at pitman arm (13).
2. Relay rod (14) from pitman arm (13) using J 24319-01.
3. Seal (9).

Inspect

- Seal (9) for damage. Replace as necessary.

4. Pitman shaft nut (11) and washer (12).

- Mark position of the pitman arm (13) in relation to pitman shaft on the steering gear.

NOTICE: Do not hammer on J 6632-01 as damage to the pitman arm may result.

5. Pitman arm (13) from pitman shaft using J 6632-01.

Install or Connect

NOTICE: See "Notice" on page 3B3-1 of this section.

1. Pitman arm (13) to the pitman shaft on the steering gear.
   - Align arm with marks made upon removal.
2. Washer (12) and pitman shaft nut (11).

Tighten

  - Nut (11) to 251 N·m (185 lb. ft.).

3. Seal (9) to relay rod (14).
4. Relay rod (14) to pitman arm (13).
5. J 29193 to seat the tapers.

Tighten

  - J 29193 to 20 N·m (15 lb. ft.).

- Remove J 29193.

6. Nut (24) to ball stud.

Tighten

  - Nut (24) to 48 N·m (35 lb. ft.).

Adjust

- Relay rod height as described in "Relay Rod Height Adjustment" in this section.

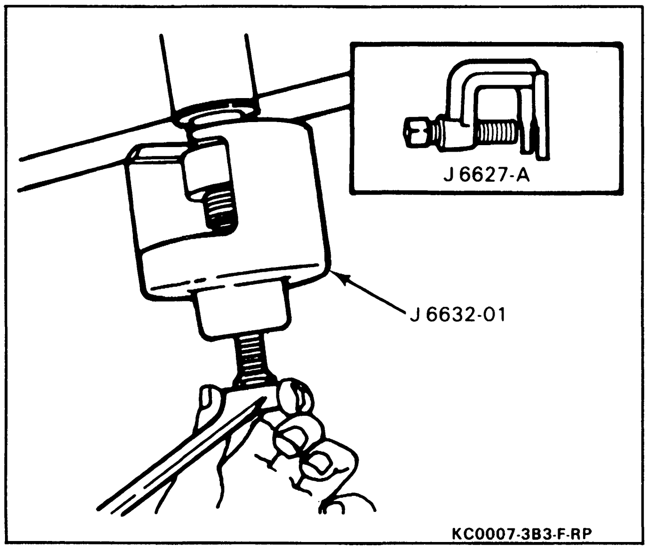


Figure 7 - Removing Pitman Arm

TIE ROD SEAL REPLACEMENT

Figure 1

Outer Tie Rod Seal

Remove or Disconnect

Tool Required:

J 24319-01 Universal Steering Linkage Puller

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Cotter pin (21) and castellated nut (20) from outer tie rod (8).
2. Outer tie rod (8) from steering arm (19) by using J 24319-01.

- Pry old seal (7) off outer tie rod (8).

Install or Connect

NOTICE: See "Notice" on page 3B3-1 of this section.

- Wipe tie rod clean.
- Position new seal on tie rod stud.
- Firmly push flange of seal (7) over seat on housing.

1. Outer tie rod (8) to steering arm (19).

Tighten

  - Nut (20) to 48 N·m (35 lb. ft.).
  - Nut (20) again just enough to align slot in castellated nut with hole in stud. Do not back off nut to insert cotter pin. Turn to next hole.

2. Cotter pin (21).

- Lower vehicle.

Inner Tie Rod Seal

Remove or Disconnect

Tools Required:

J 24319-01 Universal Steering Linkage Puller

J 29193 Steering Linkage Installer

- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Nut (10) from inner tie rod ball joint.
2. Inner tie rod (2) from relay rod (14) using J 24319-01.

- Pry old seal (7) off inner tie rod (2).

Install or Connect

- Wipe tie rod clean.
- Position new seal on tie rod stud.
- Firmly push flange of seal (7) over seat on housing.

1. Inner tie rod (2) to relay rod (14).
2. J 29193 to seat the tapers.

Tighten

  - J 29193 to 20 N·m (15 lb. ft.).

- Remove J 29193.

NOTICE: See "Notice" on page 3B3-1 of this section.

3. Nut (10) to ball stud.

Tighten

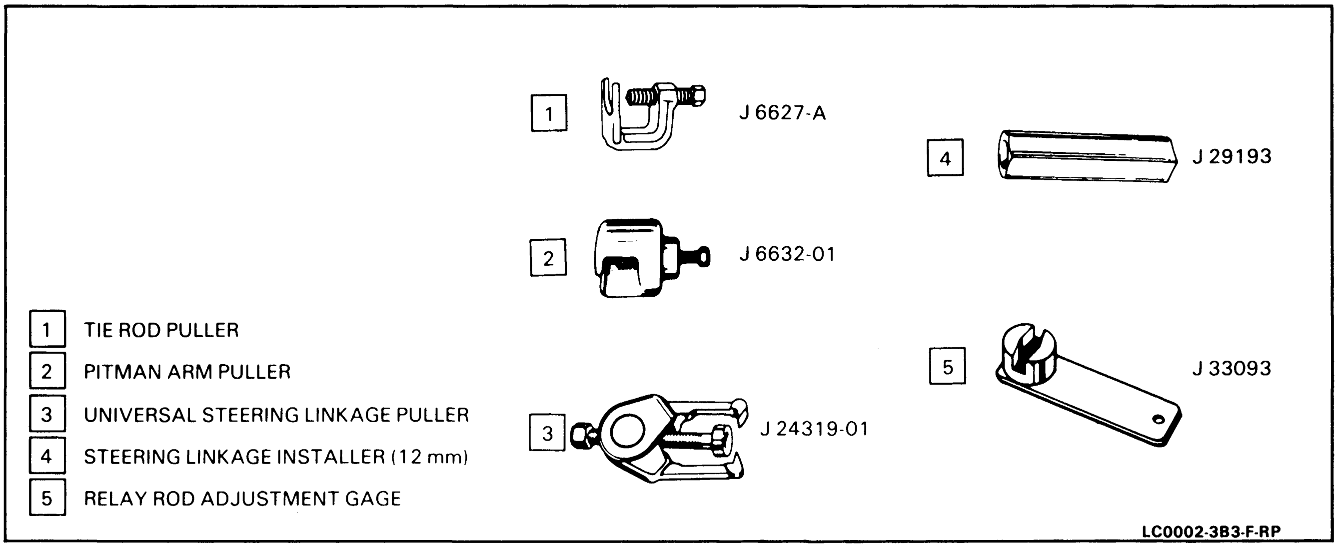
  - Nut (10) to 54 N·m (40 lb. ft.).

- Lower vehicle.

SPECIFICATIONS

Tie Rod Adjuster Clamp Nut	19 N·m (14 lb. ft.)
Outer Tie Rod-to-Steering Arm Nut	48 N·m (35 lb. ft.)
Relay Rod-to-Pitman Arm Nut	48 N·m (35 lb. ft.)
Idler Arm-to-Frame Nut	70 N·m (52 lb. ft.)
Relay Rod-to-Idler Arm Nut	48 N·m (35 lb. ft.)
Pitman Arm-to-Pitman Shaft Nut	251 N·m (185 lb. ft.)
Inner Tie Rod-to-Relay Rod Nut	54 N·m (40 lb. ft.)

SPECIAL TOOLS



SECTION 3C

FRONT SUSPENSION

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 3C-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL INFORMATION

The front suspension is designed to allow each wheel to compensate for changes in the road surface level without appreciably affecting the opposite wheel. Each wheel is independently connected to the frame by a steering knuckle, strut assembly, ball joint, and lower control arm. The steering knuckles move in a prescribed three dimensional arc. The front wheels are held in proper relationship to each other by two tie rods. The tie rods are connected to steering arms on the knuckles and to the relay rod assembly (Figure 1).

Coil chassis springs are mounted between the spring housings on the front crossmember and the lower control arms. Ride control is provided by double, direct acting strut assemblies. The upper portion of each strut assembly extends through the fender well and attaches to the upper mount assembly with a nut.

Side roll of the front suspension is controlled by a steel spring stabilizer shaft. It is mounted in rubber bushings that are held to the frame side rails by brackets. The ends of the stabilizer shaft are connected to the lower control arms by link bolts and are isolated by rubber grommets. Vehicles with 16-inch wheels also have a lower structure brace attached to the frame side rails with the same bolts that secure the stabilizer shaft.

The inner ends of the lower control arms have pressed in bushings. Bolts (passing through the bushings) attach the arm to the suspension crossmember. The lower ball joint assembly is a press fit in the arm and attaches to the steering knuckle with a torque prevailing nut.

Rubber grease seals are provided at ball socket assemblies to keep dirt and moisture from entering the joint and damaging bearing surfaces.

ON-VEHICLE SERVICE

FRONT WHEEL BEARINGS

The proper functioning of the front suspension cannot be maintained unless the front wheel tapered roller bearings are correctly adjusted. Cones must be a slip fit on the spindle. The inside diameter of the cones should be lubricated to insure that the cones will creep. Spindle nut must be a free-running fit on threads.

WHEEL BEARING ADJUSTMENT

Figure 2

1. Raise front of vehicle and suitably support. Refer to GENERAL INFORMATION (SEC. 0A).
2. Remove wheel or center cap. Refer to TIRES AND WHEELS (SEC. 3E).
3. Remove dust cap from hub.

   NOTICE: See "NOTICE" on page 3C-1 of this section.
4. Remove cotter pin from spindle and spindle nut.

   Tighten

   - Spindle nut to 16 N·m (12 lb. ft.) while turning the wheel assembly forward by hand to fully seat the bearings. This will remove any grease or burrs which could cause excessive wheel bearing play later.
5. Back off the nut to the just loose position.
6. Hand tighten the spindle nut. Loosen spindle nut just enough that either hole in the spindle lines up with a slot in the nut (not more than 1/2 flat).

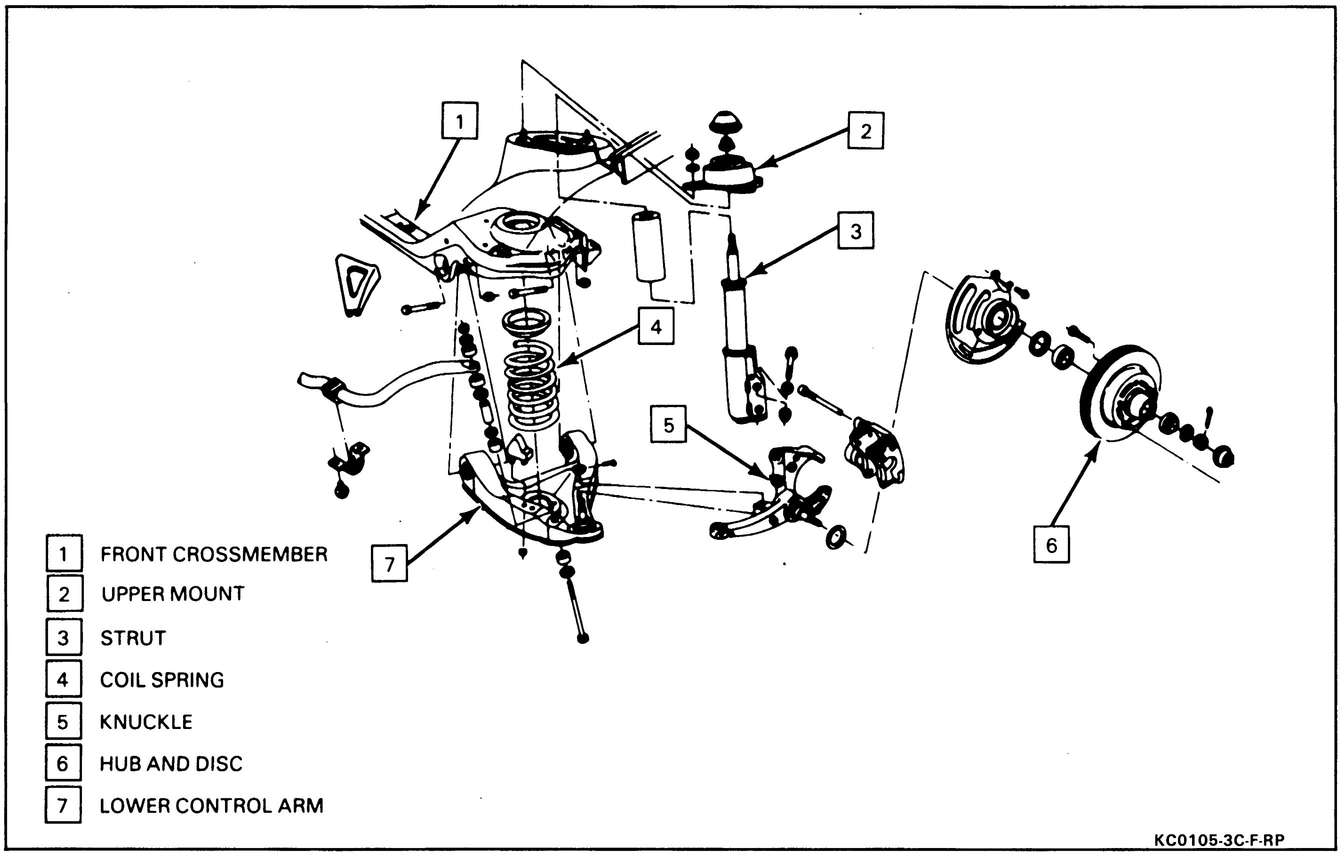


Figure 1 - Front Suspension

7. Install new cotter pin. Bend the ends of the cotter pin against nut, cut off extra length to ensure ends will not interfere with the dust cap.

Measure

- Using a dial indicator, check the hub assembly. There should be from 0.03 to 0.13 mm (0.001 to 0.005 inches) end play when properly adjusted.

8. Install dust cap on hub.
9. Install wheel cover or center cap. Refer to TIRES AND WHEELS (SEC. 3E).
10. Lower vehicle.

HUB ASSEMBLY

Figure 3

Remove or Disconnect

(Wheel and Tire Removed)

1. Brake caliper. Refer to FRONT DISC BRAKE CALIPER ASSEMBLY -3000/3100 SERIES (SEC. 5B1) or FRONT PAD-GUIDED DISC BRAKE CALIPER ASSEMBLY (SEC. 5B2).
2. Dust cap from hub.
3. Cotter pin, nut and washer from spindle.
4. Carefully pull hub assembly from spindle.

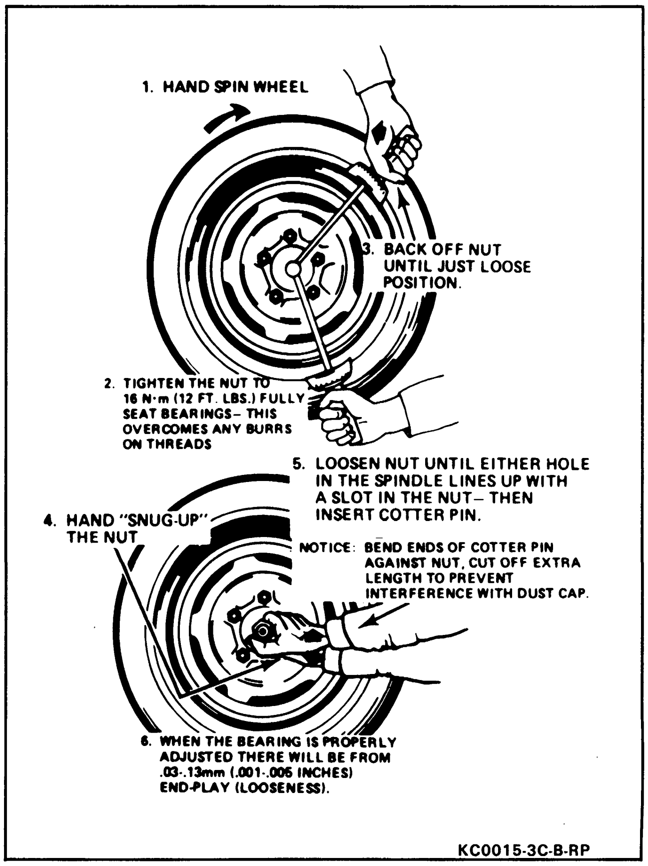


Figure 2 - Wheel Bearing Adjustment

WHEEL BEARING/SEAL

Disassemble

Tool Required:

J 29117-A Wheel Bearing Cup Remover

(Hub Assembly Removed)

1. The outer roller bearing assembly from hub. The inner bearing assembly will remain in the hub and may be removed after prying out the inner bearing lip seal. Discard seal.
2. Old races from hub with a drift or J 29117-A inserted behind races (Figure 3).

Clean

- All parts in clean solvent and air dry.

Inspect

- Bearings for cracked cage and worn or pitted rollers.
- Bearing races for cracks, scores or brinelled condition. Refer to STEERING, SUSPENSION, TIRES AND WHEEL DIAGNOSIS (SEC. 3).

Assemble

Tool Required:

J 33067 Wheel Bearing Packer

1. If the races were removed, drive or press the races into the hub.

   Clean

   - All grease in the hub and spindle, and thoroughly clean out any grease in the bearings. Use clean solvent. Use of a small brush with no loose bristles will be helpful to clean out old grease. Do not spin the bearing with compressed air while drying it or the bearing may be damaged.
2. Use an approved high temperature front wheel bearing grease. Do not mix greases. Mixing may change the grease properties and result in poor performance.
3. Apply a thin film of grease to the spindle at the outer bearing seat and at the inner bearing seat, shoulder, and seal seat.
4. Put a small quantity of grease inboard of each bearing cup in the hub. This can be applied with your finger, forming a dam to provide extra grease availability to the bearing and to keep the thinned grease from flowing out of the bearing.

   NOTICE: If hand packing is used, it is extremely important to work the grease thoroughly into the bearings between the rollers, cone, and the cage. Failure to do this could result in premature bearing failure.
5. Fill the bearing cone and roller assemblies with grease using J 33067. If a cone greaser is not available, the bearings can be packed by hand.
6. Place the inner bearing cone and roller assembly in the hub. Then, using your finger, put an additional quantity of grease outboard of the bearing.
7. Install a new grease seal using a flat plate until the seal is flush with the hub. Lubricate the seal lip with a thin layer of grease.

   NOTICE: See "NOTICE" on page 3C-1 of this section.
8. Carefully install the hub and rotor assembly. Place the outer bearing cone and roller asembly in the outer bearing cup. Install the washer and nut.

   Tighten

   - Nut to 16 N·m (12 lb. ft.) while turning the wheel assembly forward by hand.
   - Put an additional quantity of grease outboard of the bearing. This provides extra grease availability to the bearing.

- Final bearing adjustment should be performed. Refer to "Wheel Bearing Adjustment" in this section.

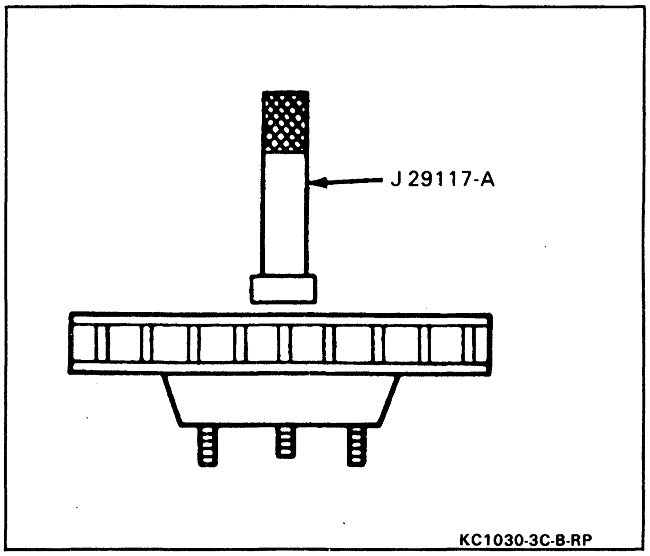


Figure 3 - Removing Front Wheel Bearing

WHEEL HUB STUD

Figure 4

NOTICE: See "Notice" on page 3C-1 of this section regarding the fasteners referred to below.

Remove or Disconnect

Tool Required:

J 9746-02 Rear Pinion Bearing Remover

(Hub Assembly Removed)

- The hub or disc studs with a press. Do not damage wheel mounting surface on hub flange.

Install or Connect

- New serrated stud into hole in hub. Tap lightly with a hammer to start stud serrations in hole, making sure that stud is square with hub flange. The brake disc must be supported as shown in Figure 4, before pressing the wheel stud in or out.

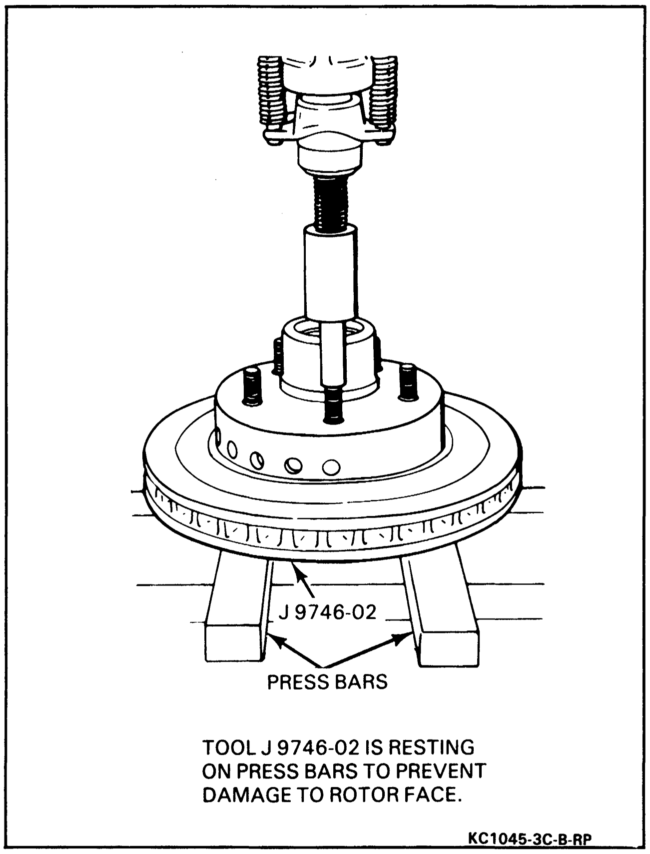


Figure 4 - Pressing Stud Out

STABILIZER SHAFT

Figures 5 and 6

Remove or Disconnect

1. Raise vehicle and suitably support. Refer to GENERAL INFORMATION (SEC. 0A).
2. Each side of stabilizer linkage by removing nut from link bolt, pull bolt from linkage and remove retainers, grommets and spacer.
3. Bracket-to-frame or body bolts and remove stabilizer shaft, rubber bushings and brackets, and lower structure brace, if equipped.

Install or Connect

1. Lower structure brace, if equipped, rubber bushings and brackets to shaft, and bracket-to-frame or body bolts.

NOTICE: See "NOTICE" on page 3C-1 in this section.

2. Link bolts, grommets, spacers, retainers, and nuts.

- Install with the shaft identification tag on the right side of the vehicle. The rubber bushings should be positioned squarely in the brackets with the slit in the bushings facing the front of the vehicle.

Tighten

- Stabilizer link nut/bolt to 22 N·m (16 lb. ft.).
- Bracket bolts to 53 N·m (39 lb. ft.).

LOWER STRUCTURE BRACE (Z28 ONLY)

Figure 6

Remove or Disconnect

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Bolts (1) from stabilizer shaft brackets (2).
2. Stabilizer shaft brackets (2).

- Lower stabilizer shaft (3).

3. Lower structure brace (4).

Install or Connect

NOTICE: See "Notice" on page 3C-1 of this section.

1. Lower structure brace (4).

- Raise stabilizer shaft (3).

2. Stabilizer shaft brackets (2).
3. Bolts (1) to stabilizer shaft brackets (2).

Tighten

- Bolts (1) to 53 N·m (39 lb. ft.).

FRONT SUSPENSION STRUT

Figure 7

Remove or Disconnect

- Raise vehicle and suitably support. Place jackstand to support lower control arm. Refer to GENERAL INFORMATION (SEC. 0A).

1. Wheel and tire assembly. Refer to TIRES AND WHEELS (SEC. 3E).
2. Brake hose bracket.
3. Strut-to-knuckle bolts, washers and nuts, and discard.
4. Cover from upper mount assembly.
5. Nut from upper end of strut.
6. Strut and shield.

Install or Connect

NOTICE: See "NOTICE" on page 3C-1 of this section for steps 2 and 4.

1. Strut and shield to upper mount.
2. Nut to upper end of strut.

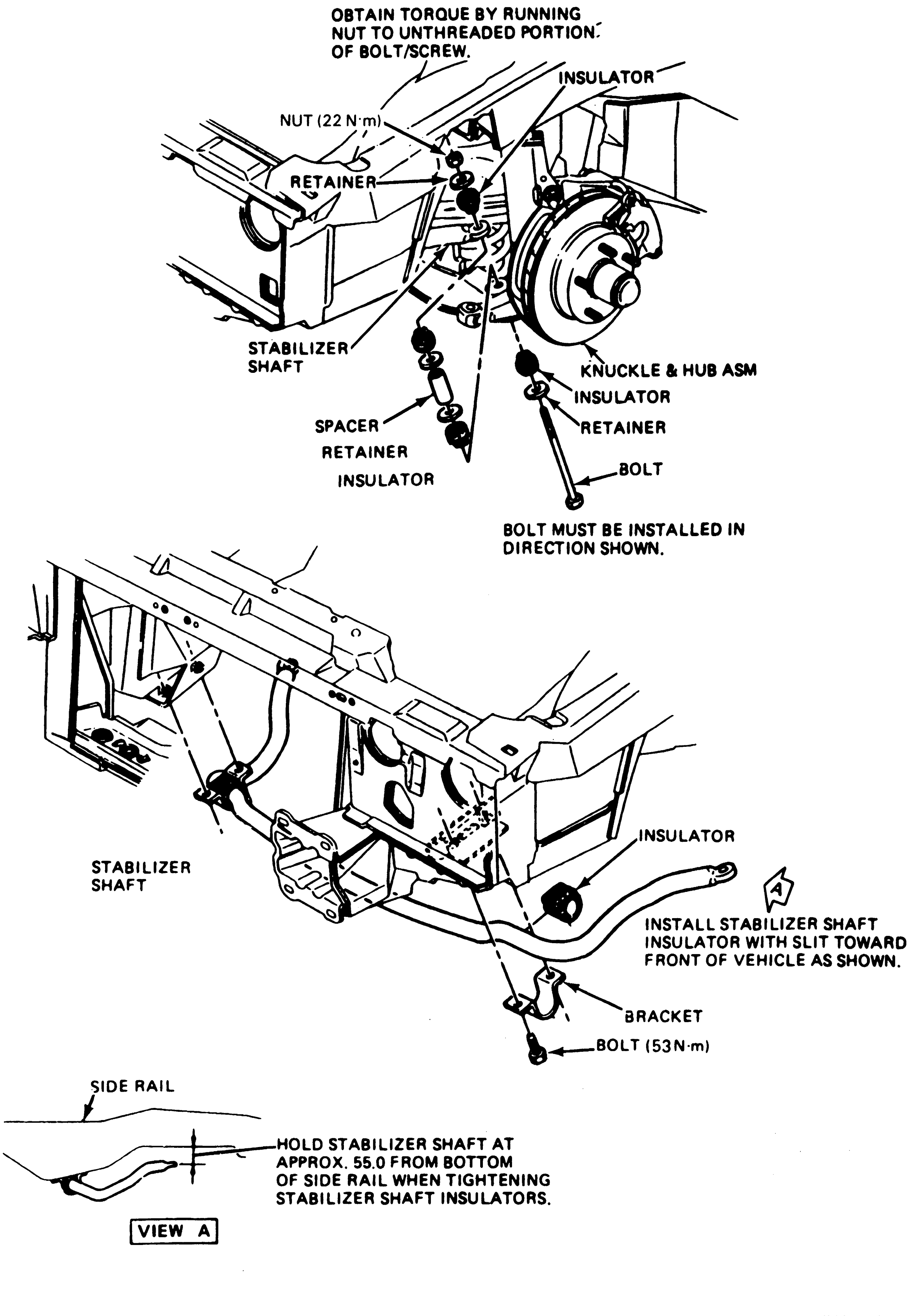


Figure 5 - Removing and Installing Stabilizer Shaft

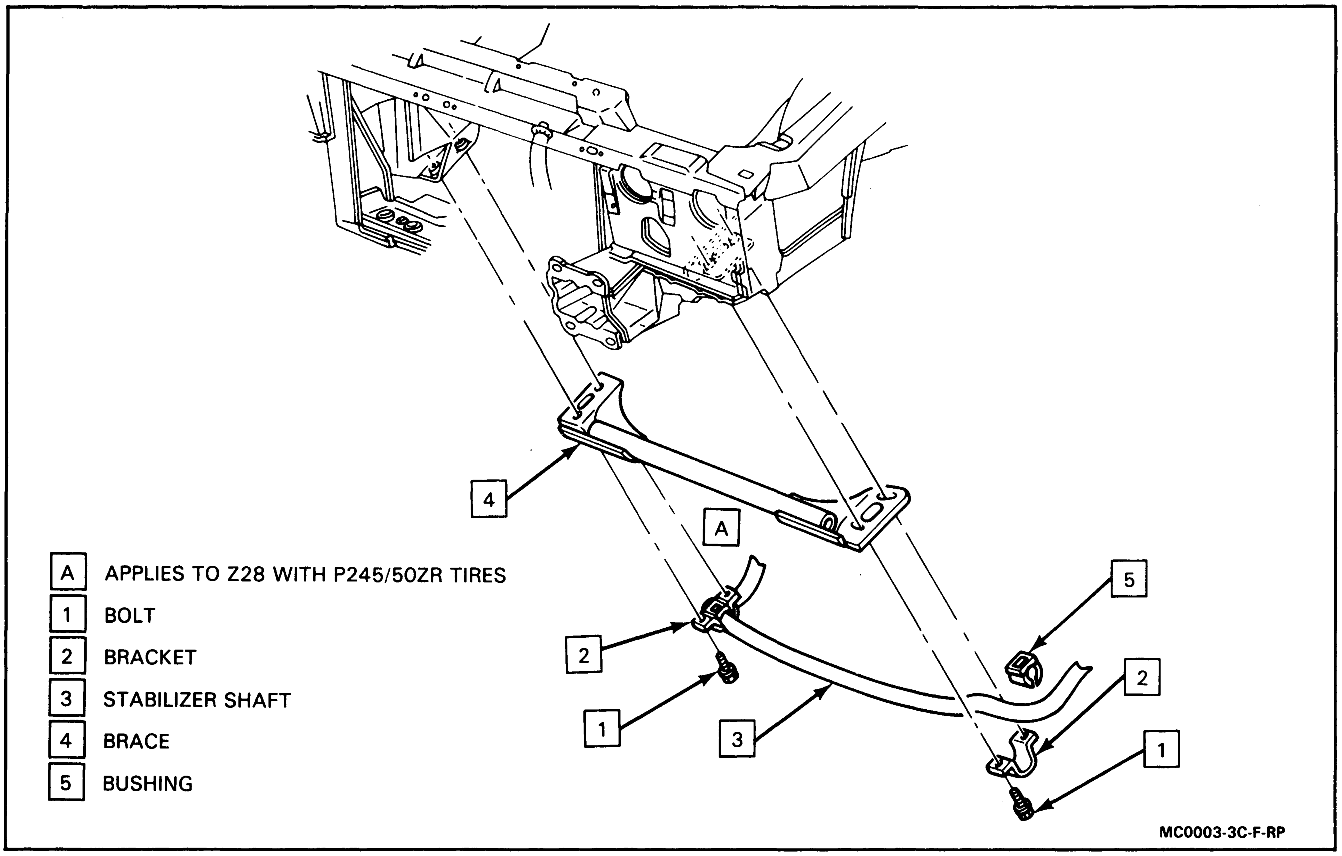


Figure 6 - Lower Structure Brace

Tighten

- Upper strut nut to 63 N·m (46 lb. ft.).

3. Cover to upper mount.
4. New strut-to-knuckle bolts, washers, and nuts.

Tighten

- Two nuts to 170 N·m (125 lb. ft.) followed by 120 degree turn.
  - Final torque must exceed 200 N·m (148 lb. ft.).

5. Brake hose bracket.
6. Wheel. Refer to TIRES AND WHEELS (SEC. 3E).

- Lower vehicle.
- Check front alignment. Refer to WHEEL ALIGNMENT (SEC. 3A).

BALL JOINTS

Figure 8

Inspect

- Ball joint seals should be carefully inspected for cuts and tears. Whenever cuts or tears are found, the ball joint must be replaced.
- Ball joints for wear.

Remove or Disconnect

Tools Required:

J 9519-7 Large Remover
J 9519-18 Ball Joint Pressing Screw
J 9519-23 Ball Joint C-Clamp
J 24292-B Ball Joint Remover

1. Raise vehicle and support with floor stands under frame. Refer to GENERAL INFORMATION (SEC. 0A).
2. Remove tire and wheel assembly. Refer to TIRES AND WHEELS (SEC. 3E).
3. Place floor jack under control arm spring seats.

Important

- Floor jack must remain under control arm spring seat during removal and installation to retain spring and control arm in position.

4. Remove cotter pin, and loosen castellated nut. Use J 24292-B to break ball joint loose from knuckle. Remove tool, and separate joint from knuckle.
5. Guide lower control arm out of opening in splash shield with a putty knife or similar tool.
6. Remove grease fittings, and install tools as shown in Figure 8. Press ball joint out of lower control arm.

Install or Connect

Tools Required:

J 9519-9 Large Installer
J 9519-18 Ball Joint Pressing Screw
J 9519-23 Ball Joint C-Clamp

1. Position ball joint into lower control arm and press in until it bottoms on the control arm, using tools as illustrated in Figure 8. Grease purge on seal must face inboard.
2. Place ball joint in steering knuckle. Ball joint must firmly press into control arm. If it does not, replace control arm.

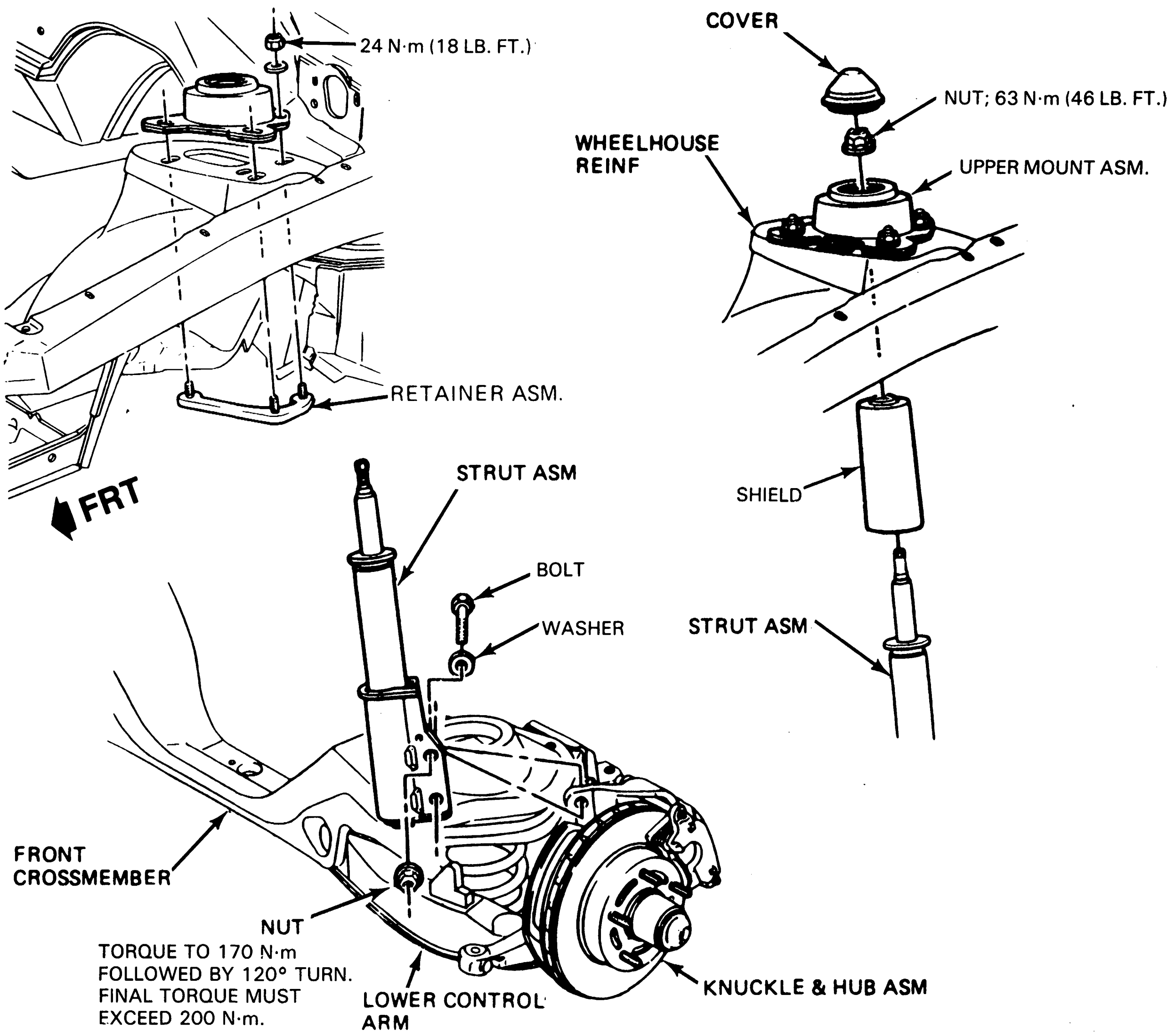


Figure 7 - Removing and Installing Strut

NOTICE: See "NOTICE" on page 3C-1 of this section.

3. Ball joint nut.

Tighten

- Ball joint stud nut to 113 N·m (83 lb. ft.). Then tighten enough to align nut slot with stud hole and install cotter pin.

4. Install and lubricate ball joint fitting until grease appears at the seal.
5. Install tire and wheel assembly.

- Lower vehicle.

6. Check front alignment. Refer to WHEEL ALIGNMENT (SEC. 3A).

LOWER CONTROL ARM/COIL SPRING

Figure 9

Remove or Disconnect

Tool Required:

J 24292-B Ball Joint Remover

1. Raise vehicle using hoist. Refer to GENERAL INFORMATION (SEC. 0A).
2. Remove wheel and tire. Refer to TIRES AND WHEELS (SEC. 3E).
3. Remove stabilizer link and bushings at lower control arm.
4. Remove cotter pin and nut from tie rod end.
5. Remove steering knuckle from tie rod ball joint stud using J 24292-B.
6. Install universal spring compressor as shown in Figure 9.
7. Compress spring.
8. Remove lower control arm pivot bolt.
9. Pivot lower control arm rearward.
10. Remove universal spring compressor.
11. Remove spring.

Install or Connect

NOTICE: See "Notice" on page 3C-1 of this section for steps 5, 7, and 9.

1. Properly position spring on the control arm, making sure the spring insulator is in place. Take care that the spring is properly installed as shown in Figure 9.

NOTICE: Handling must not cause any damage to the corrosion protection coating on the springs. Any removal of coating must be repaired.

2. Install universal spring compressor and compress spring.
3. Pivot lower control arm forward into position.
4. Position control arms into frame.
5. Install bolts (front bolt installs from front to rear first).

Tighten

- Lower control arm pivot bolt/nuts to 90 N·m (66 lb. ft.).

6. Remove universal spring compressor.

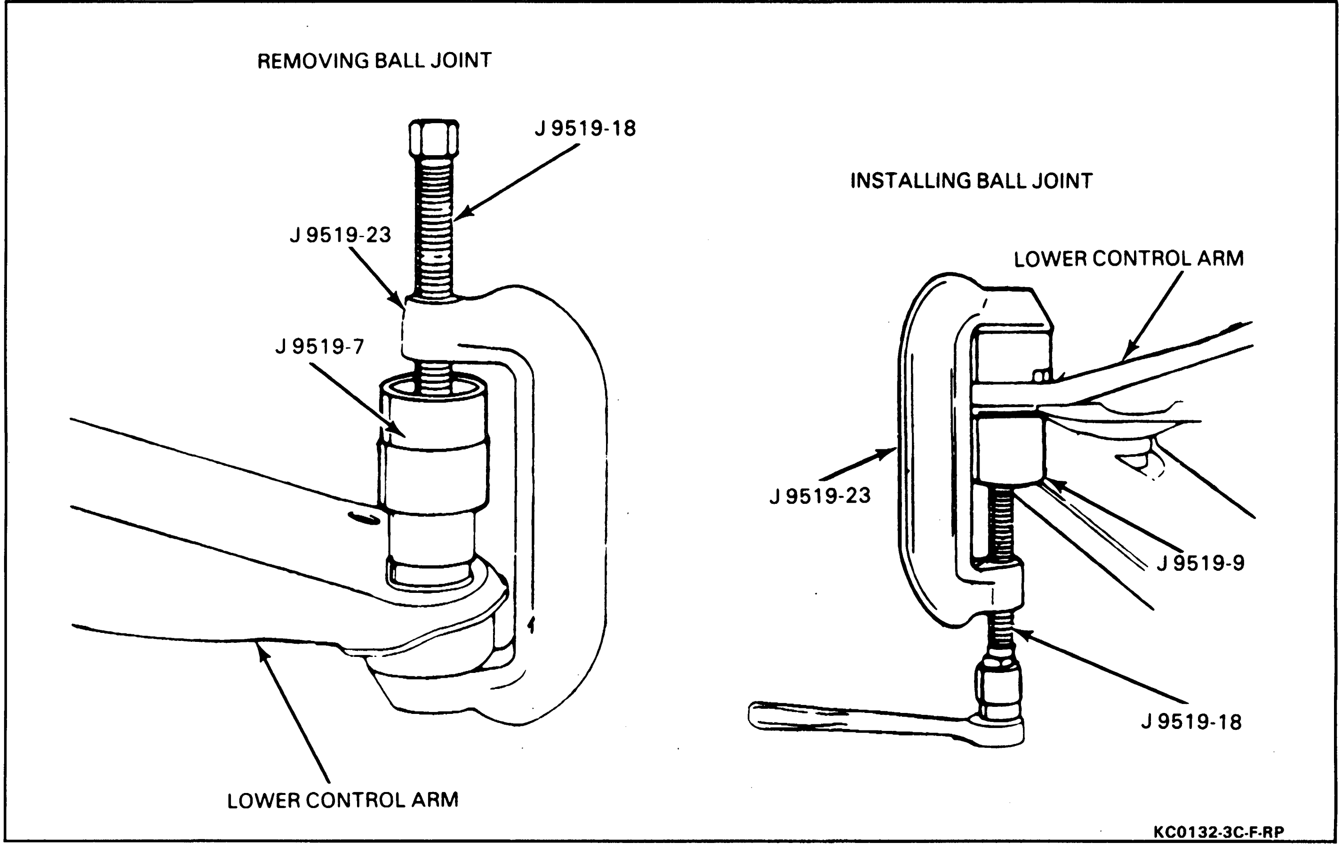


Figure 8 - Removing and Installing Ball Joint

7. Install stabilizer linkage.

Tighten

- Stabilizer link nut to 22 N·m (16 lb. ft.).

8. Install steering knuckle to tie rod ball joint stud.
9. Install ball joint stud nut.

Tighten

- Nut to 113 N·m (83 lb. ft.).

10. Install cotter pin.
11. Install wheel. Refer to TIRES AND WHEELS (SEC. 3E).
12. Lower vehicle.

LOWER CONTROL ARM BUSHINGS

Front Bushing

Figure 10

- Disconnect lower control arm at frame. Refer to "Lower Control Arm/Coil Spring" in this section.

Disassemble

Tools Required:

J 21474-5 Bushing Receiver
J 21474-19 3/8" Bolt
J 21474-18 3/8" Nut
J 21474-23 Bushing Remover
J 22899 Lower Control Arm Spacer

1. Using a blunt chisel, drive bushing flare (inside of control arm) down flush with rubber of bushing.
2. Remove front bushing (Figure 10).

Assemble

Tools Required:

J 21474-2 Bushing Remover/Installer
J 21474-5 Bushing Receiver
J 21474-18 3/8" Nut
J 21474-19 3/8" Bolt
J 21474-20 Bushing Installer
J 22899 Lower Control Arm Spacer

1. Install front bushing (Figure 10).
2. Flare front bushing. (Figure 10).
3. Connect lower control arm at frame. Refer to "Lower Control Arm/Coil Spring" in this section.

Rear Bushing

Figure 10

Remove or Disconnect

Tools Required:

J 21474-5 Bushing Receiver
J 21474-8 Control Arm Bushing Remover
J 21474-12 Control Arm Spacer
J 21474-18 3/8" Nut
J 21474-19 3/8" Bolt

1. Disconnect lower control arm at frame. Refer to "Lower Control Arm/Coil Spring" in this section.
2. Remove rear bushing (Figure 10).

Install or Connect

Tools Required:

J 21474-5 Bushing Receiver
J 21474-12 Control Arm Spacer
J 21474-13 Control Arm Bushing Installer
J 21474-18 3/8" Nut
J 21474-19 3/8" Bolt

1. Install rear bushing (Figure 10).
2. Connect lower control arm at frame. Refer to "Lower Control Arm/Coil Spring" in this section.

KNUCKLE, HUB AND DISC

Figure 11

Remove or Disconnect

Tool Required:

J 24292-B Ball Joint Remover

1. Raise vehicle and suitably support. Refer to GENERAL INFORMATION (SEC. 0A).
2. Remove wheel. Refer to TIRES AND WHEELS (SEC. 3E).
3. Remove caliper mounting bolts.
4. Remove caliper from steering knuckle and support.
5. Remove hub and disc.
6. Remove splash shield.
7. Disconnect tie rod from knuckle.
8. Support lower control arm.
9. Disconnect ball joint from knuckle, using J 24292-B.
10. Remove and discard two bolts, washers and nuts attaching strut to knuckle, and remove knuckle.

Install or Connect

NOTICE: See "Notice" on page 3C-1 of this section for steps 2, 3 and 8.

1. Position knuckle to strut.
2. Install new strut-to-knuckle bolts, washers and nuts to strut.

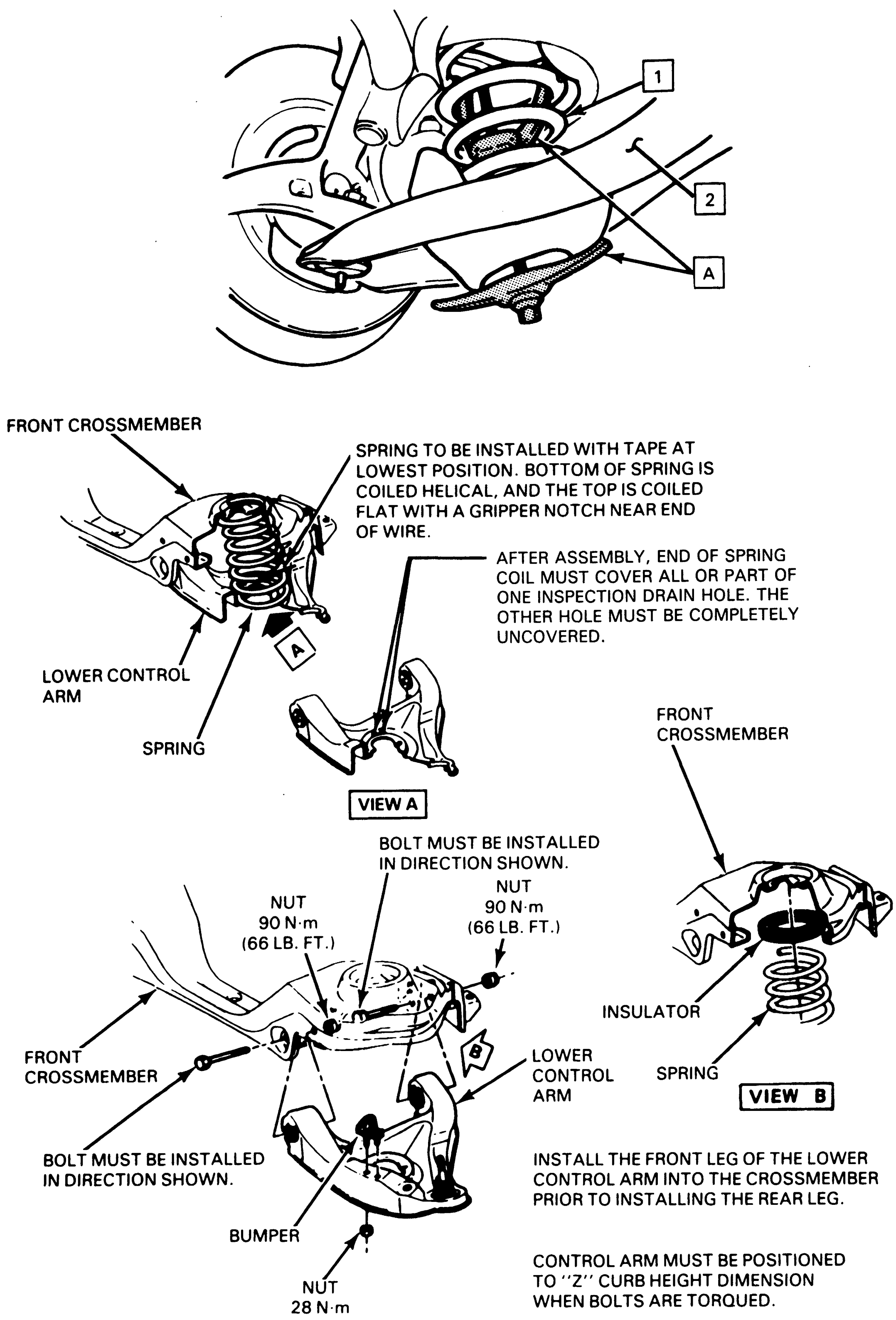
Tighten

- Two nuts to 170 N·m (125 lb. ft.) followed by 120 degree turn.
  - Final torque must exceed 200 N·m (148 lb. ft.).

3. Connect ball joint stud and nut to knuckle.

Tighten

- Ball joint stud nut to 113 N·m (83 lb. ft.).



SPRING TO BE INSTALLED WITH TAPE AT LOWEST POSITION. BOTTOM OF SPRING IS COILED HELICAL, AND THE TOP IS COILED FLAT WITH A GRIPPER NOTCH NEAR END OF WIRE.

AFTER ASSEMBLY, END OF SPRING COIL MUST COVER ALL OR PART OF ONE INSPECTION DRAIN HOLE. THE OTHER HOLE MUST BE COMPLETELY UNCOVERED.

BOLT MUST BE INSTALLED IN DIRECTION SHOWN.

BOLT MUST BE INSTALLED IN DIRECTION SHOWN.

INSTALL THE FRONT LEG OF THE LOWER CONTROL ARM INTO THE CROSSMEMBER PRIOR TO INSTALLING THE REAR LEG.

CONTROL ARM MUST BE POSITIONED TO "Z" CURB HEIGHT DIMENSION WHEN BOLTS ARE TORQUED.

A	UNIVERSAL SPRING INSTALLER
1	FRONT COIL SPRING
2	LOWER CONTROL ARM

Figure 9 - Removing and Installing Coil Spring/Lower Control Arm

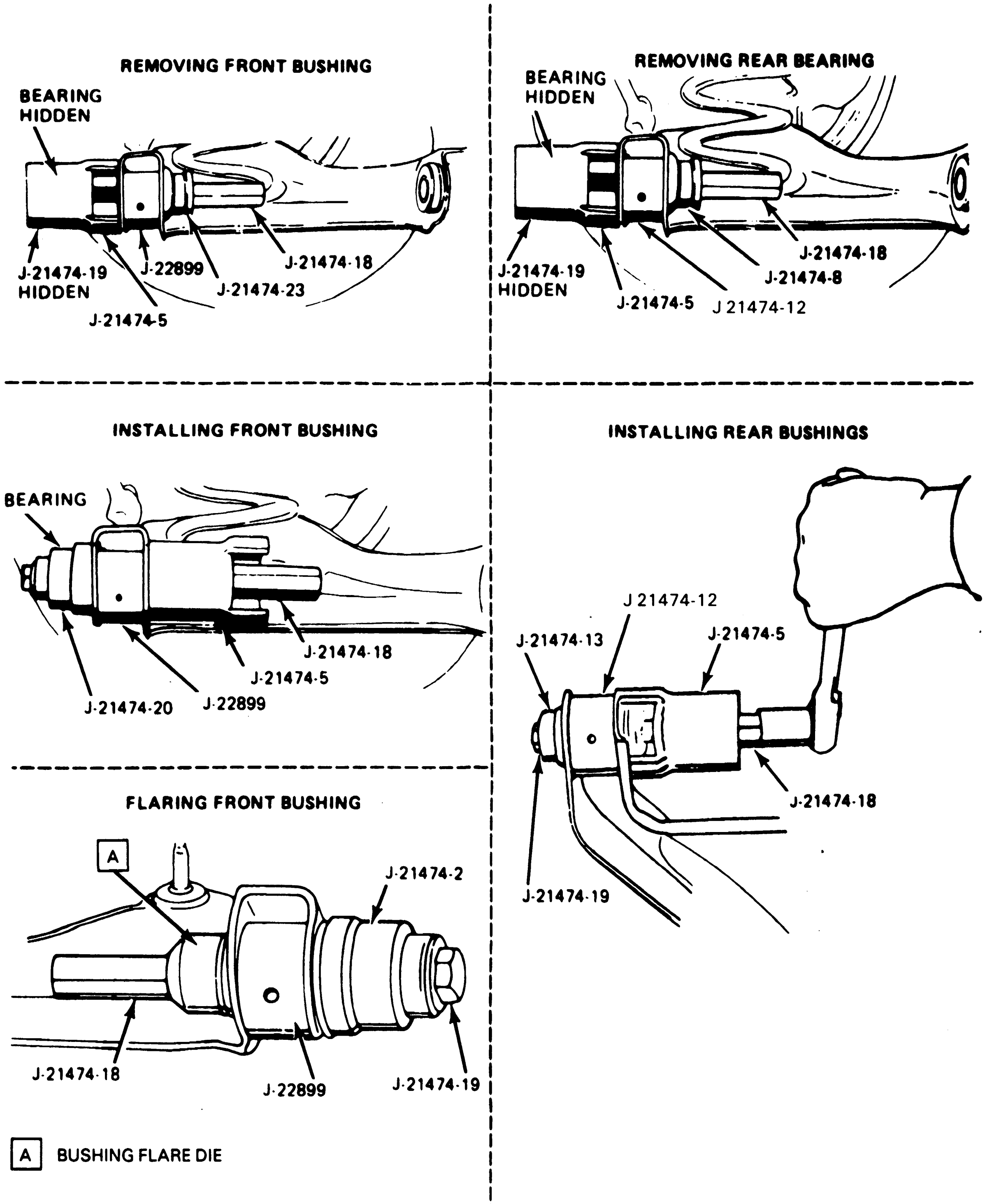


Figure 10 - Removing and Installing Control Arm Bushings

4. Connect tie rod. Refer to STEERING LINKAGE (SEC. 3B3).
5. Install splash shield.
6. Install hub and disc.

Adjust

- Wheel bearings. Refer to "Wheel Bearing Adjustment" in this section.

7. Install caliper to steering knuckle.
8. Install caliper mounting bolts.

Tighten

- Bolts to 51 N·m (38 lb. ft.).

9. Install wheel. Refer to TIRES AND WHEELS (SEC. 3E).
10. Lower vehicle.

Inspect

- Brake fluid for proper level.

FRONT CROSSMEMBER

Figure 12

Remove or Disconnect

1. Brace to crossmember bolts.
2. Bolts from crossmember to side rail.
3. Crossmember.

Install or Connect

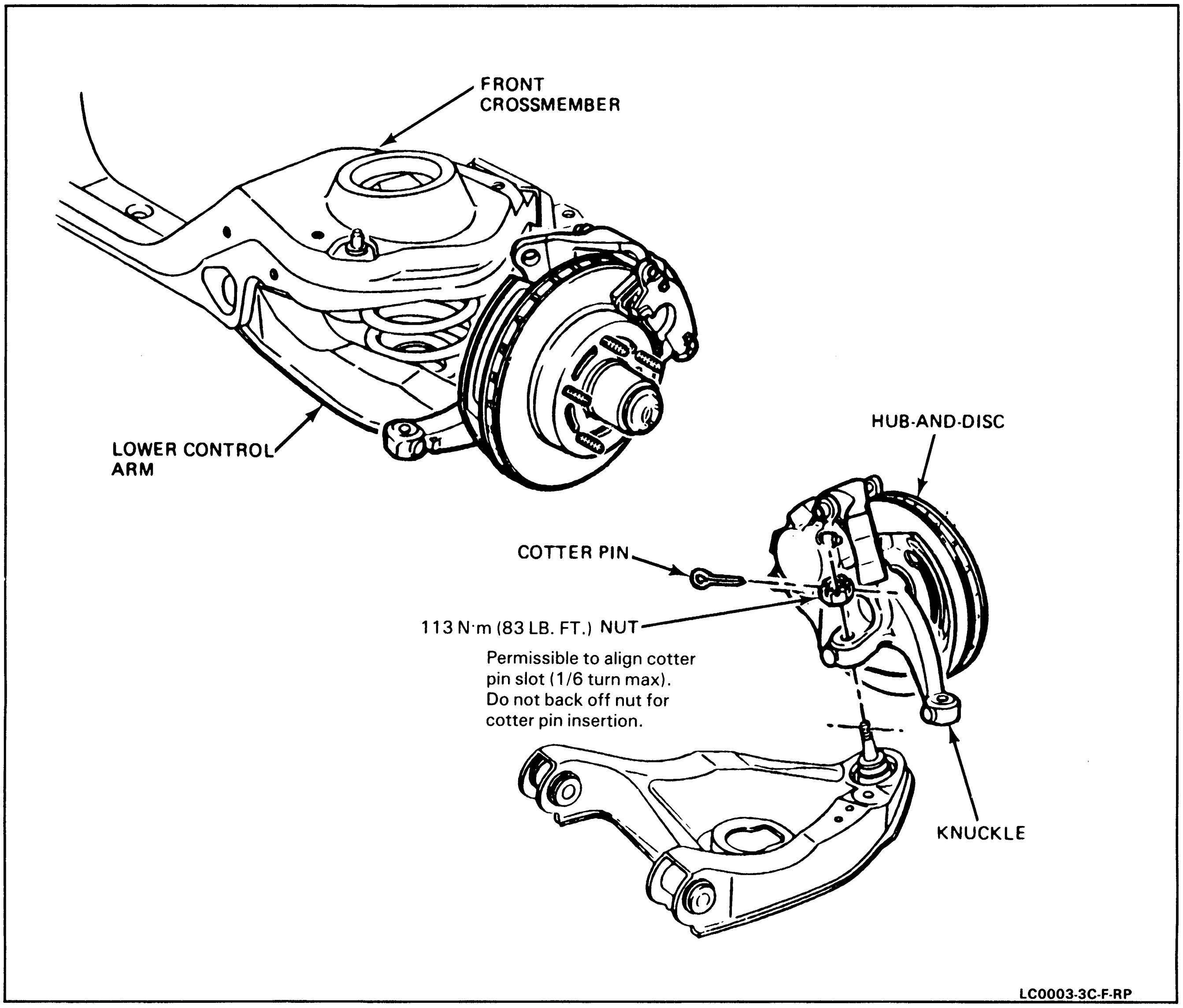
1. Crossmember to side rails.

NOTICE: See "Notice" on page 3C-1 of this section for steps 2 and 3.

2. Brace to crossmember bolts.
3. Bolts to crossmember and side rail.

Tighten

- Crossmember brace bolts to 75 N·m (55 lb. ft.).
- Crossmember bolts to 160 N·m (118 lb. ft.).



Permissible to align cotter pin slot (1/6 turn max). Do not back off nut for cotter pin insertion.

Figure 11 - Removing and Installing Knuckle

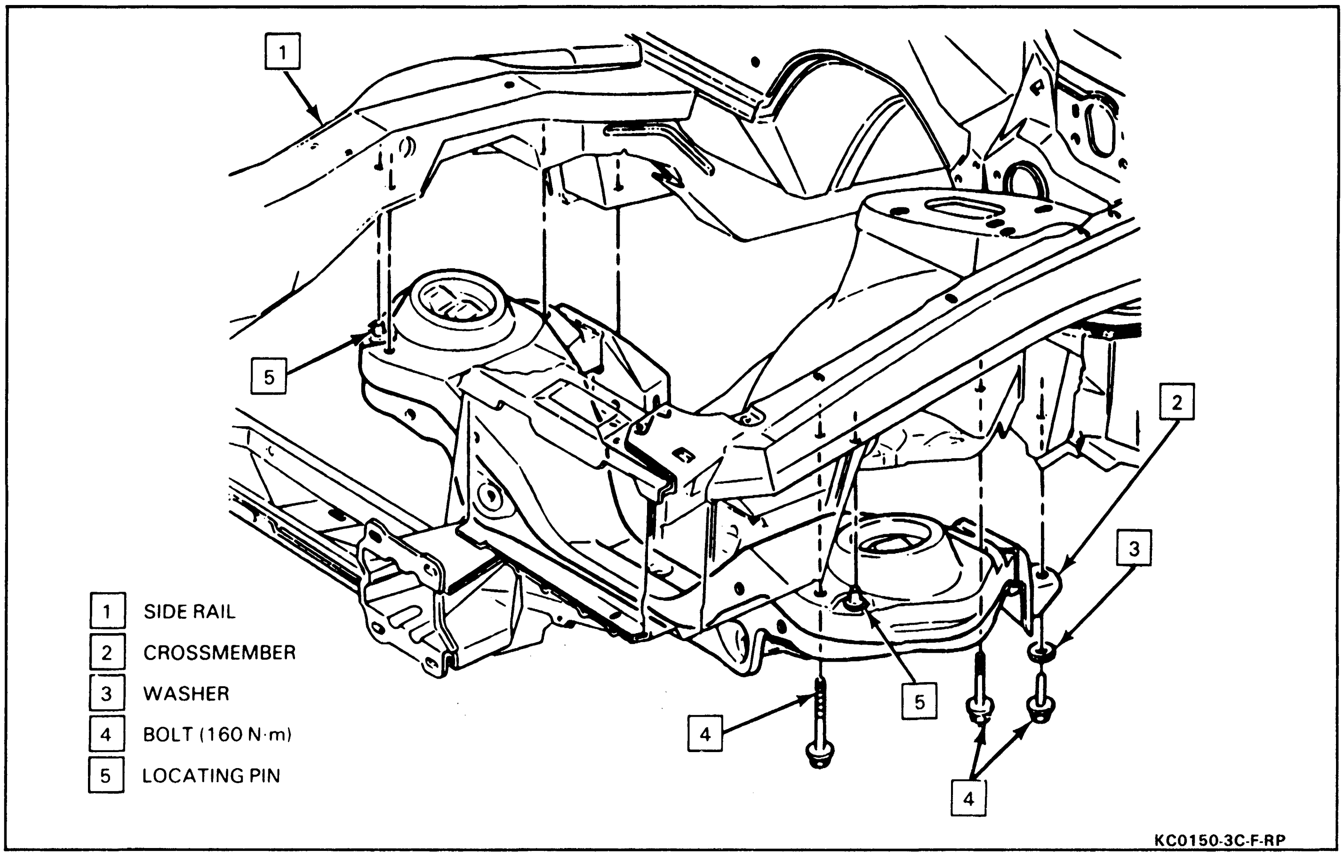


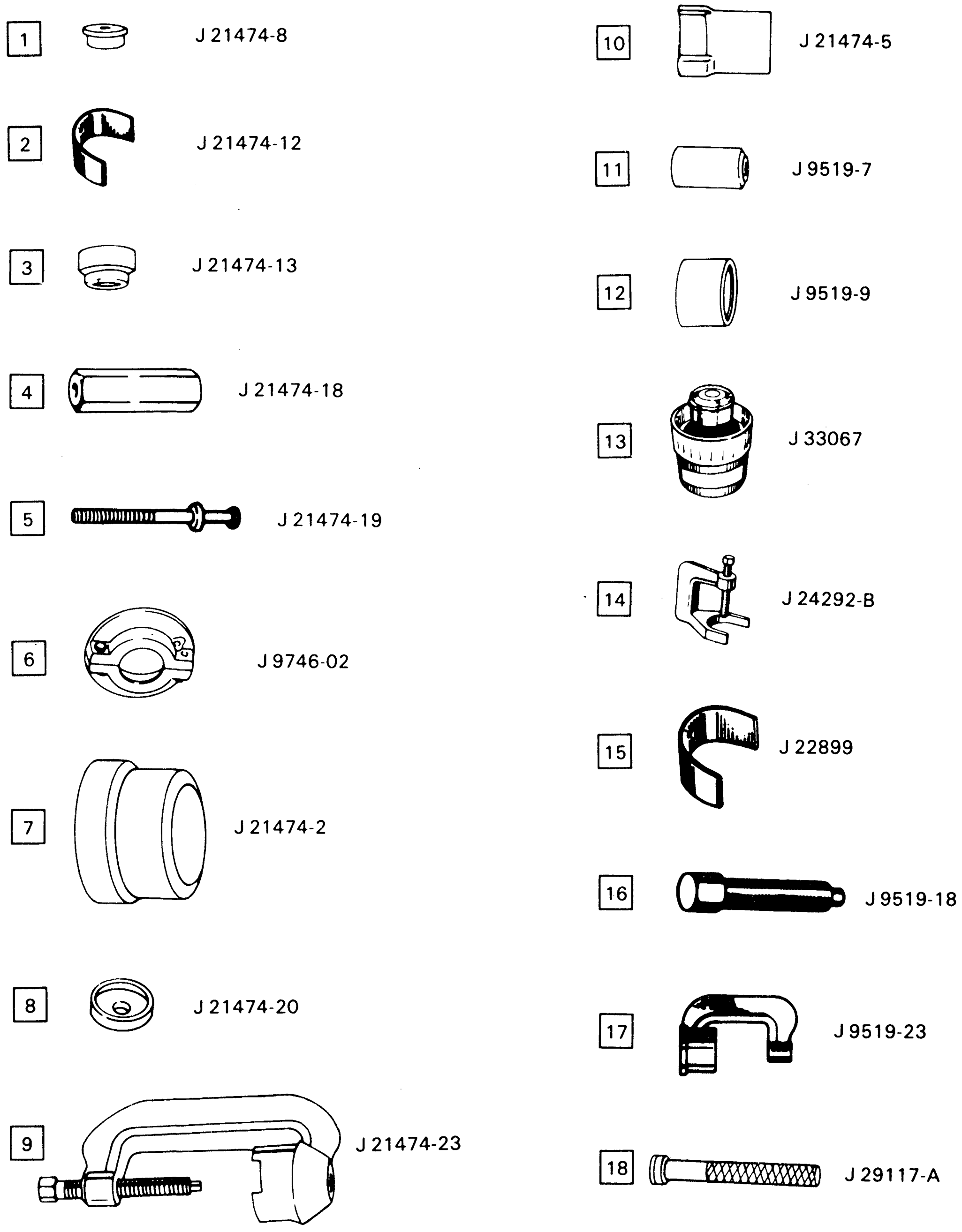
Figure 12 - Front Suspension Crossmember

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Wheel Hub Spindle Nut	16 N·m (12 lb. ft.)
Stabilizer Shaft	
Link Nut	22 N·m (16 lb. ft.)
Bracket Bolt	53 N·m (39 lb. ft.)
Front Suspension Strut	
Upper Nut	63 N·m (46 lb. ft.)
Lower Nut (two for each strut)	
Initial	170 N·m (125 lb. ft.)
Final	120 degree turn after initial tightening must exceed 200 N·m (148 lb. ft.)
Control Arm Pivot Bolt/Nut	90 N·m (66 lb. ft.)
Ball Joint Stud Nut	113 N·m (83 lb. ft.)
Crossmember Bolt	160 N·m (118 lb. ft.)
Strut Upper Mount Bolt	24 N·m (18 lb. ft.)
Crossmember Brace Bolt	75 N·m (55 lb. ft.)
Caliper Mounting Bolt	51 N·m (38 lb. ft.)
Lower Control Arm Bumper Nut	28 N·m (21 lb. ft.).

SPECIAL TOOLS



1 CONTROL ARM BUSHING REMOVER
2 CONTROL ARM SPACER
3 CONTROL ARM BUSHING INSTALLER
4 3/8" NUT
5 3/8" BOLT
6 REAR PINION BEARING REMOVER
7 BUSHING REMOVER/INSTALLER
8 BUSHING INSTALLER
9 BUSHING REMOVER
10 BUSHING RECEIVER
11 LARGE REMOVER
12 LARGE INSTALLER
13 WHEEL BEARING PACKER
14 BALL JOINT REMOVER
15 LOWER CONTROL ARM SPACER
16 BALL JOINT PRESSING SCREW
17 BALL JOINT C-CLAMP
18 WHEEL BEARING CUP REMOVER

LC0002-3C-F-RP

SECTION 3D

REAR SUSPENSION

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 3D-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL INFORMATION

REAR AXLE SUSPENSION SYSTEM

Figure 1

The rear axle assembly is attached to the vehicle through a link type suspension system. The axle housing is connected to the body by two lower control arms and a track bar. A single torque arm is used in place of upper control arm. It is rigidly mounted to the rear axle housing at the rear and through a rubber bushing to the transmission at the front. Coil springs are used to support the weight of the vehicle, and ride control is provided by shock absorbers mounted to the rear of the axle housing. A stabilizer shaft is optional.

The shock absorbers are mounted at the bottom with a bolt and nut to brackets welded to the axle housing, and at the top to the reinforced body area with a nut. The only service the shock absorbers require is replacement if they have lost their resistance, are damaged, or are leaking fluid. For shock absorber diagnosis, refer to STEERING, SUSPENSION, TIRES AND WHEELS DIAGNOSIS (SEC. 3).

ON-VEHICLE SERVICE

REAR AXLE HOUSING

For information on replacement of the rear axle housing, refer to REAR AXLE (SEC. 4B).

SHOCK ABSORBERS

Figure 2

Remove or Disconnect

1. Hoist vehicle and support rear axle.

NOTICE: Axle assembly must be supported before removing upper shock absorber nut to avoid possible damage to brake lines, track bar and propeller shaft.

2. From above, pull back carpeting and remove shock absorber upper mounting nut.
3. Loosen and remove shock absorber lower mounting nut from shock absorber. Remove shock absorber.

Install or Connect

NOTICE: See "Notice" on page 3D-1 of this section for steps 2 and 3.

1. Position shock absorber through body mounting hole and loosely install the lower shock absorber mounting nut.
2. From above, install the upper shock absorber retainer and nut.

   Tighten

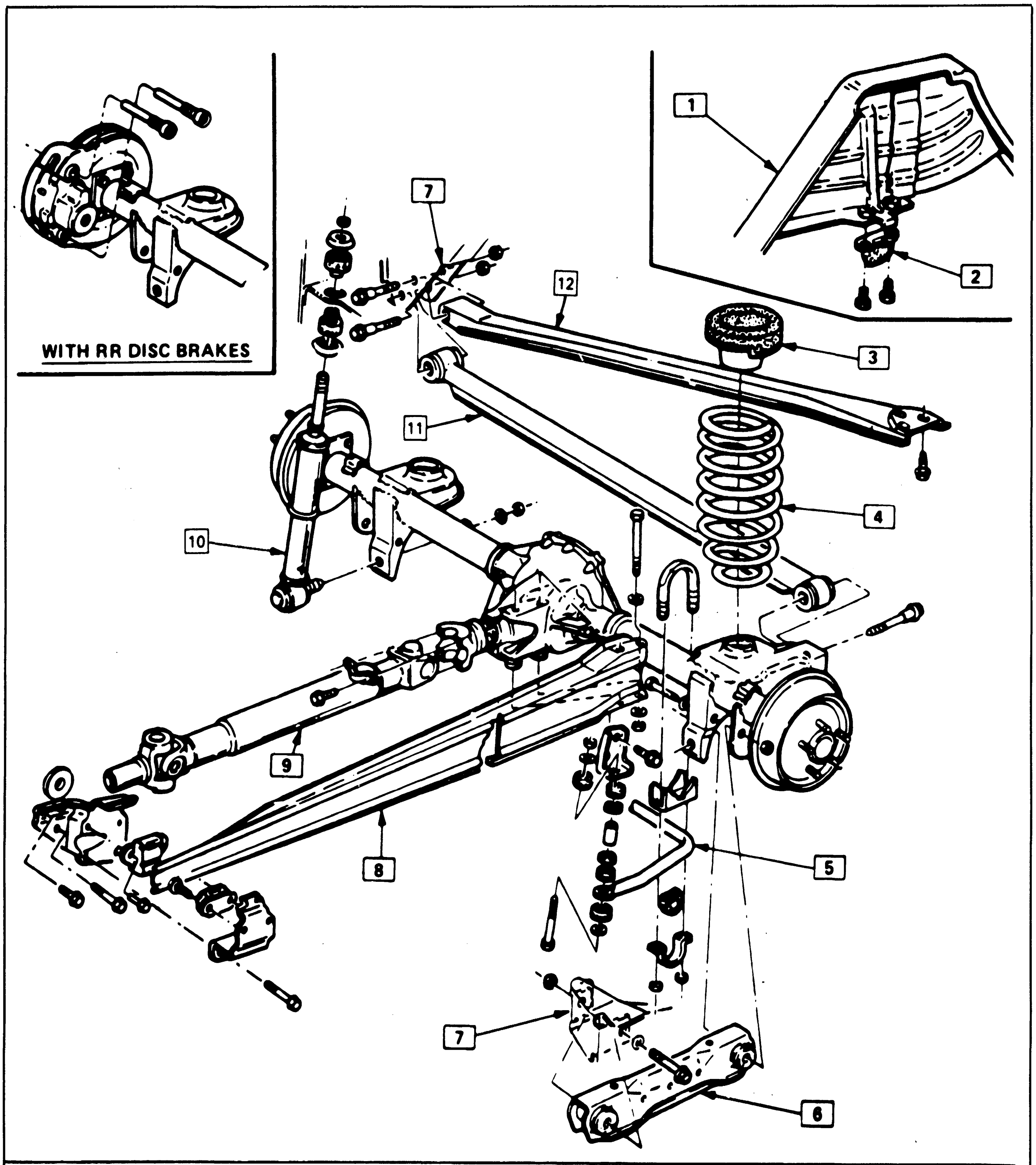
   - Nut to 17 N·m (13 lb. ft.).

3. Lower shock absorber nut.

   Tighten

   - Nut to 95 N·m (70 lb. ft.).

4. Remove rear axle support and lower vehicle.



1. RAIL
2. JOUNCE BUMPER
3. SPRING INSULATOR ASSEMBLY
4. COIL SPRING
5. OPTIONAL STABILIZER BAR
6. LOWER CONTROL ARM
7. UNDERBODY
8. TORQUE ARM
9. PROP SHAFT
10. SHOCK ABSORBER
11. TRACK BAR
12. TRACK BAR BRACE

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Figure 1 - Rear Axle and Suspension Assembly

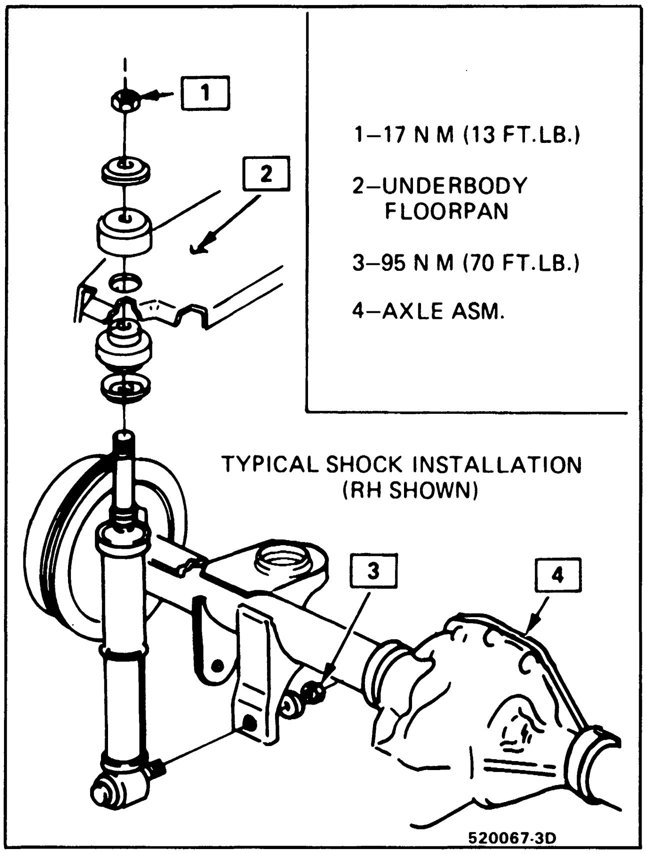


Figure 2 - Shock Absorber

COIL SPRINGS AND INSULATORS

Figure 3

Remove or Disconnect

1. Hoist vehicle on other than twin post type hoist and support rear axle assembly with an adjustable lifting device.
2. Track bar mounting bolt at axle assembly. Loosen track bar bolt at body brace.
3. Rear brake hose clip at underbody to allow additional axle drop.
4. Right and left shock absorber lower attaching nuts.

NOTICE: Do not suspend rear axle by brake hose. Damage to hose could result.

5. Carefully lower rear axle and remove spring(s) and or insulator(s).

Install or Connect

NOTICE: See "Notice" on page 3D-1 of this section for steps 2 and 4.

1. Position springs and insulators in spring seats and raise rear axle until rear axle supports weight of vehicle at normal curb height position.
2. Shocks to rear axle.

Tighten

- Nut to 95 N·m (70 lb. ft.).

3. Thoroughly clean track bar-to-axle assembly bolt and nut as outlined in GENERAL INFORMATION (SEC. 0A).
4. Track bar mounting bolt and nut at axle.

Tighten

- Mounting nut to 108 N·m (80 lb. ft.).
- Bracket nut to 83 N·m (61 lb. ft.).

5. Brake line clip to underbody.
6. Remove adjustable lifting device from beneath axle and lower vehicle.

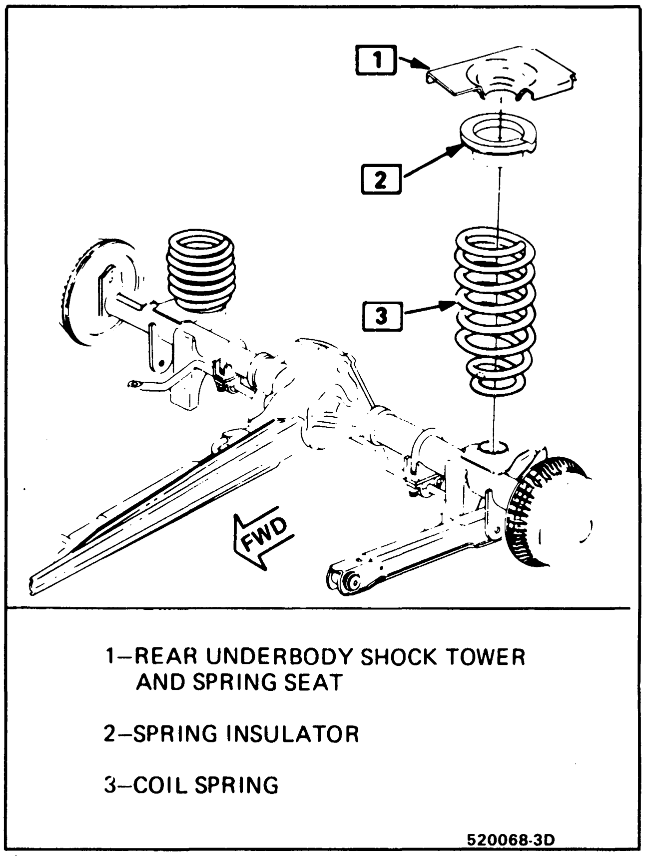


Figure 3 - Coil Spring and Insulator

TRACK BAR

Figure 4

Remove or Disconnect

1. Hoist vehicle and support rear axle at curb height position.
2. Track bar mounting bolts and nuts at spring seat and at body bracket.
3. Track bar.

Install or Connect

NOTICE: See "Notice" on page 3D-1 of this section for steps 3 and 4.

1. Position track bar in body bracket and loosely install bolt and nut.
2. Thoroughly clean track bar-to-spring seat bolt and nut as outlined in GENERAL INFORMATION (SEC. 0A).

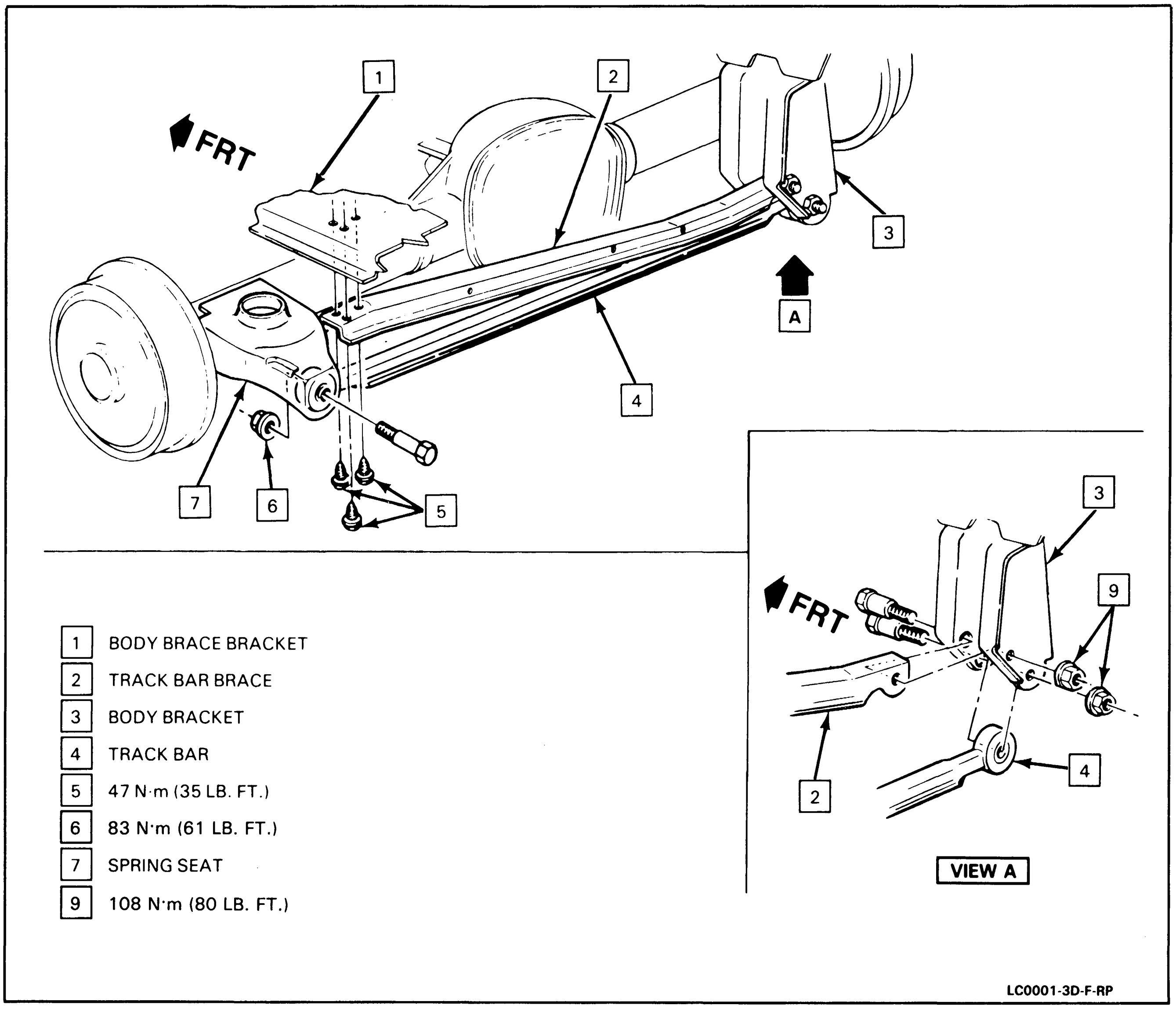


Figure 4 - Track Bar and Track Bar Brace

3. Position track bar at spring seat. Install bolt and nut.

Tighten

- Nut to 83 N·m (61 lb. ft.).

4. Tighten track bar nut at body bracket.

Tighten

- Nut to 108 N·m (80 lb. ft.).

5. Remove rear axle support and lower vehicle.

TRACK BAR BRACE

Remove or Disconnect

Figure 4

1. Hoist vehicle and support rear axle.
2. Heat shield screws from track bar brace.
3. Three track bar brace-to-body brace bracket screws.
4. Nut and bolt at body bracket. Remove track bar brace.

Install or Connect

NOTICE: See "Notice" on page 3D-1 of this section for steps 2 and 3.

1. Position track bar brace and loosely install nut and bolt at body bracket.
2. Position other end of track bar brace at body brace bracket. Install three screws and tighten screws.

Tighten

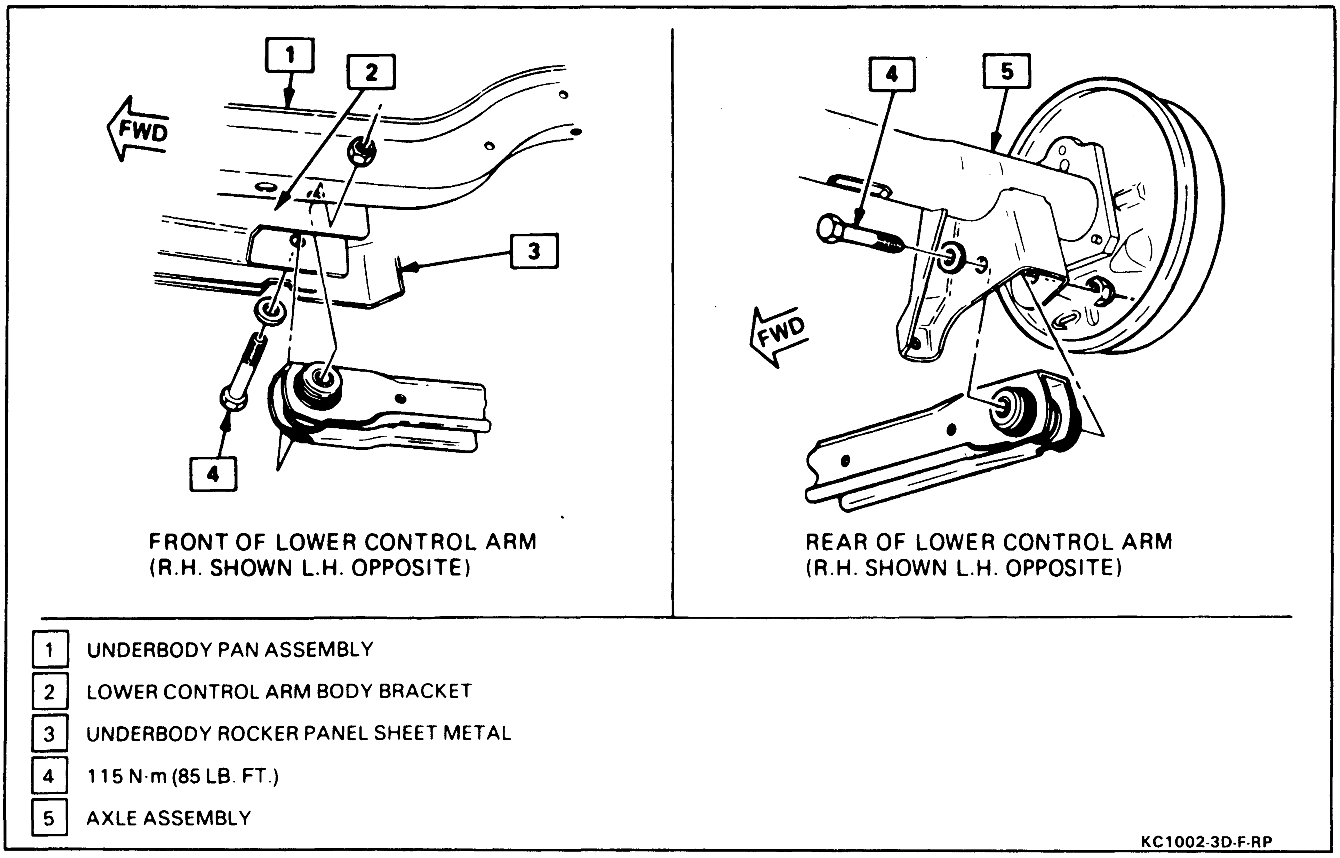
- Screws to 47 N·m (35 lb. ft.).

3. Tighten track bar nut at body bracket.

Tighten

- Nut to 108 N·m (80 lb. ft.).

4. Heat shield screws to track bar brace.
5. Remove rear axle support and lower vehicle.



FRONT OF LOWER CONTROL ARM
(R.H. SHOWN L.H. OPPOSITE)

REAR OF LOWER CONTROL ARM
(R.H. SHOWN L.H. OPPOSITE)

Figure 5 - Rear Lower Control Arm

REAR LOWER CONTROL ARM

Figure 5

Important

If both control arms are being replaced, remove and replace one control arm at a time to prevent the axle from rolling or slipping sideways, making replacement difficult.

Remove or Disconnect

1. Hoist vehicle and support rear axle at curb height position.
2. Lower control arm-to-axle housing bolt and control arm-to-underbody bolt.
3. Control arm.

Install or Connect

1. Position control arm and install front and rear nuts and bolts.

NOTICE: See "Notice" on page 3D-1 of this section.

2. Tighten front and rear bolts.

Tighten

- Bolts to 115 N·m (85 lb. ft.).

3. Remove rear axle support and lower vehicle.

REAR LOWER CONTROL ARM BUSHING

Figures 6 and 7

Remove or Disconnect

1. Control arm as specified in "Rear Lower Control Arm" removal procedure.
2. Place receiver J 25317-2 over flanged side of bushing.

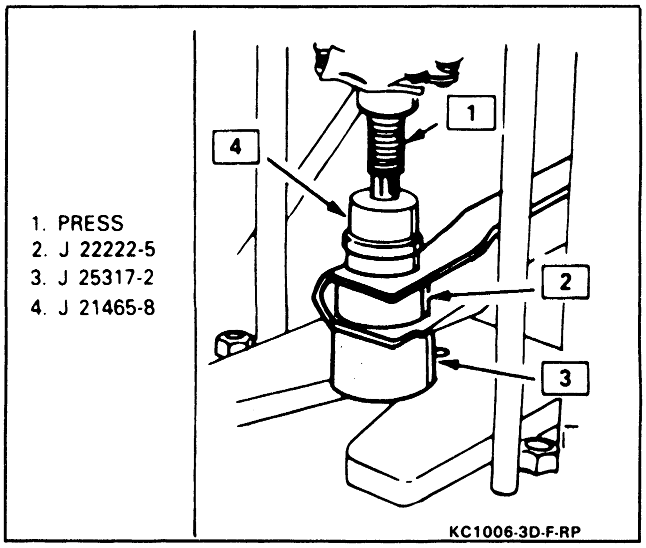


Figure 6 - Removing Control Arm Bushing

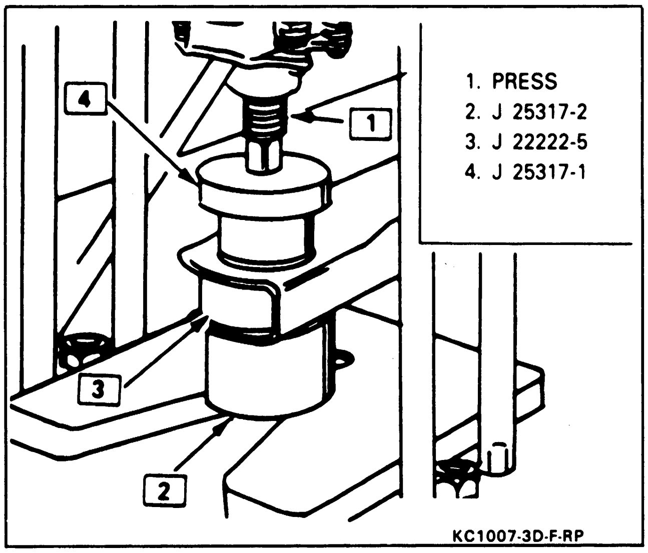


Figure 7 - Installing Control Arm Bushing

3. Use an arbor press to force the bushing out of the arm, using large OD of a driver such as J 21465-8 contacting OD of bushing outer sleeve.

→← Install or Connect

To install the bushing, reverse the tool as shown in Figure 7 and push bushing into position. Connect the rear control arms as outlined in "Rear Lower Control Arm" installation procedure.

TORQUE ARM

Figures 8 and 9

NOTICE: Coil springs must be removed before removing torque arm to avoid rear axle forward twist which may cause axle to shift position and damage vehicle.

←→ Remove or Disconnect

1. Hoist vehicle on other than twin post type hoist and support rear axle assembly with an adjustable lifting device.
2. Track bar mounting bolt at axle assembly and loosen track bar bolt at body brace.
3. Rear brake hose clip at underbody to allow additional axle drop.
4. Right and left shock absorber lower attaching nuts.

NOTICE: Do not suspend rear axle by brake hose. Damage to hose could result.

5. Carefully lower rear axle. Remove coil springs.
6. Torque arm rear attaching bolts.
7. Front torque arm outer bracket and remove torque arm.

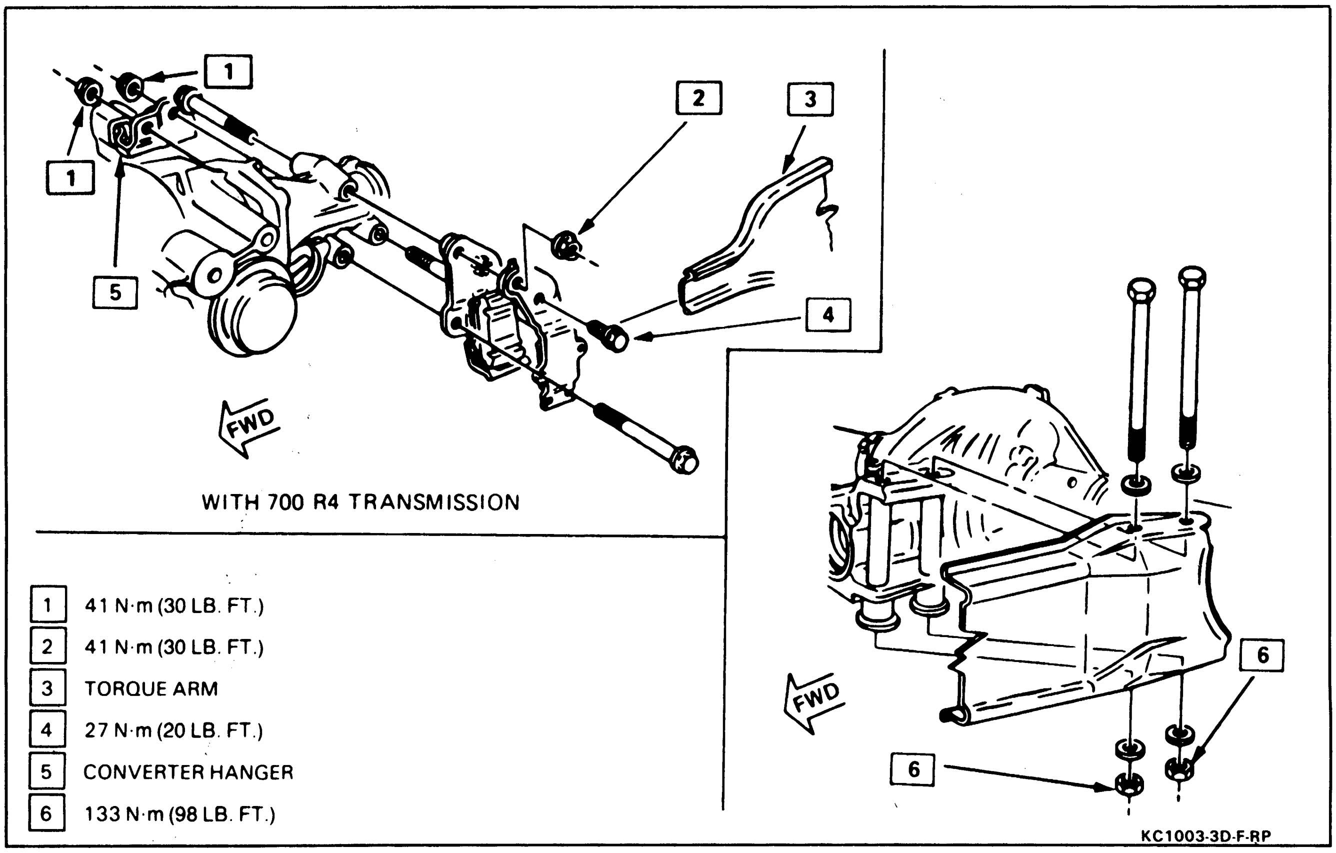
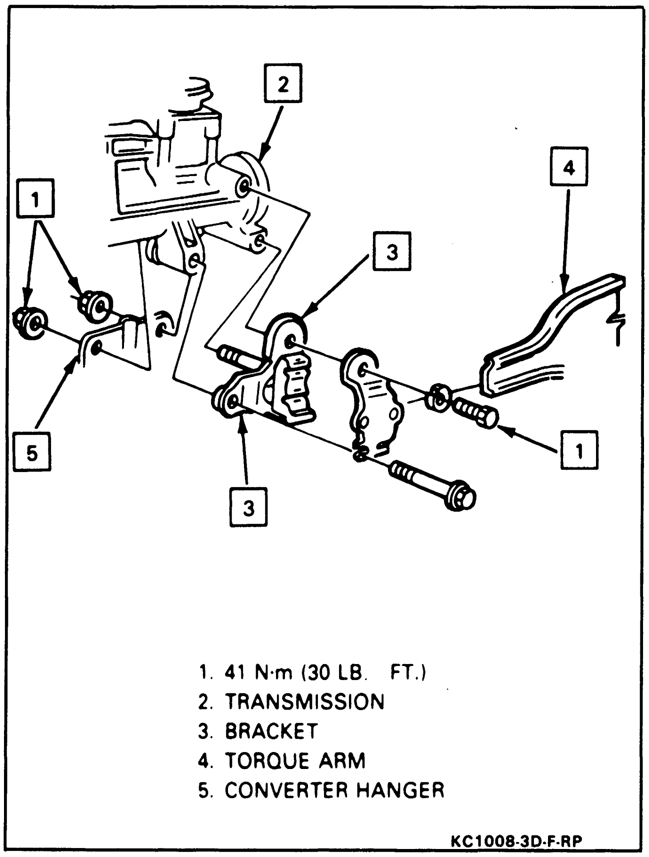


Figure 8 - Torque Arm Attachment-Automatic Transmission



1. 41 N·m (30 LB. FT.)
2. TRANSMISSION
3. BRACKET
4. TORQUE ARM
5. CONVERTER HANGER

Figure 9 - Torque Arm Attachment-Manual Transmission

Install or Connect

NOTICE: See "Notice" on page 3D-1 of this section for steps 2, 3 and 5.

1. Position torque arm and loosely install rear torque arm bolts.
2. Install front torque arm bracket.

Tighten

- Nuts to 41 N·m (30 lb. ft.) as shown in Figures 8 and 9.

3. Tighten rear torque arm nuts.

Tighten

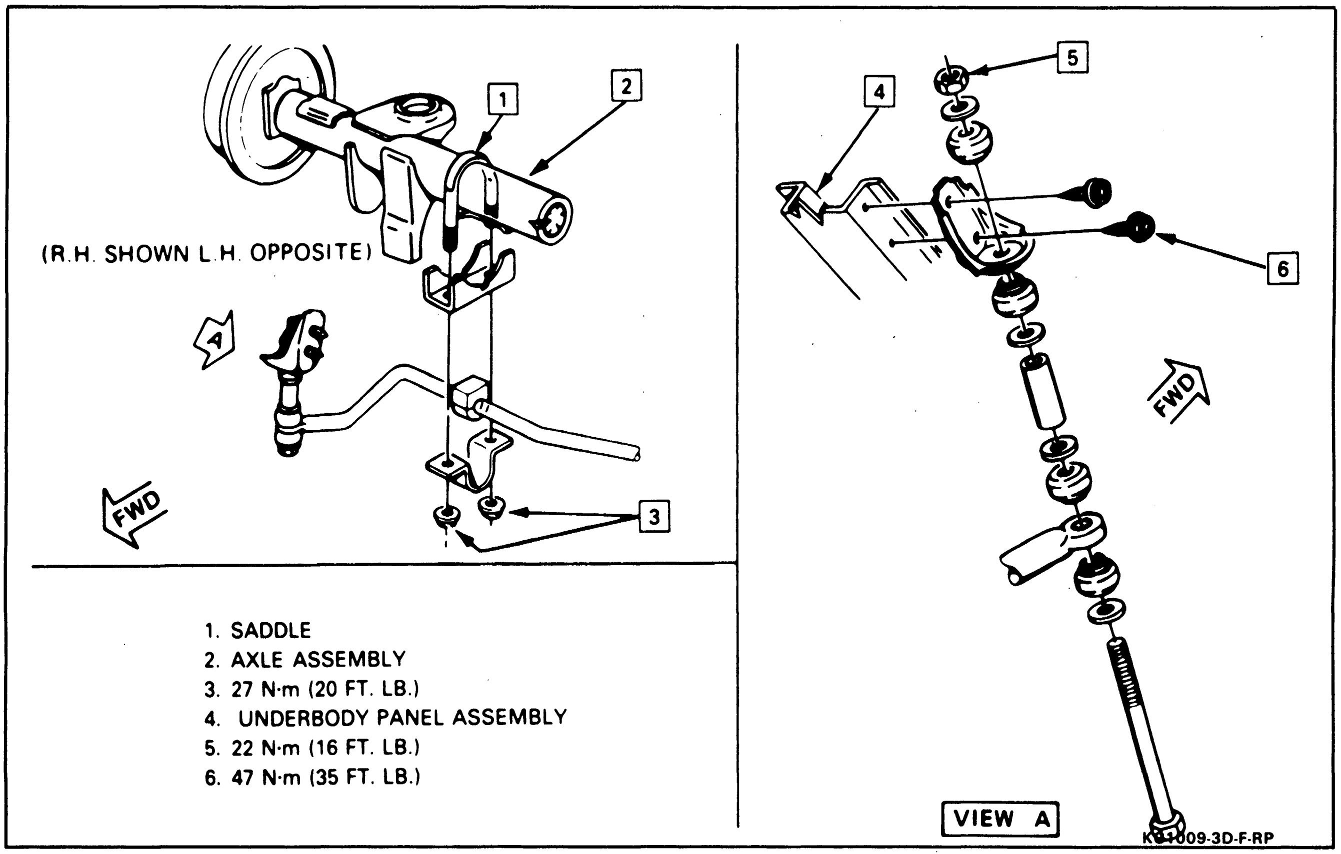
- Nuts to 133 N·m (98 lb. ft.).

4. Postion springs and insulators in spring seats and raise rear axle until rear axle supports weight of vehicle at normal curb height position.
5. Shocks to rear axle.

Tighten

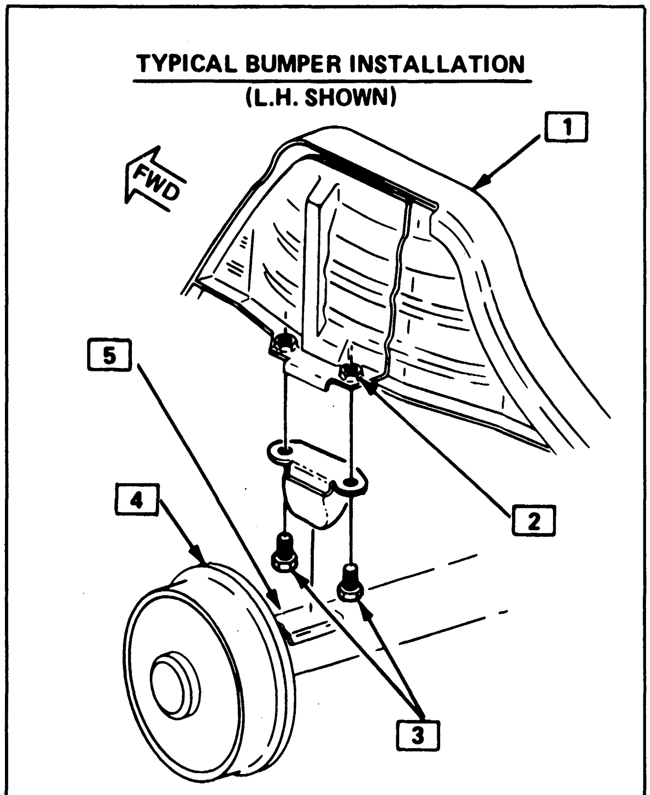
- Nuts to 95 N·m (70 lb. ft.).

6. Thoroughly clean track bar to axle assembly bolt and nut as outlined in GENERAL INFORMATION (SEC. 0A).



1. SADDLE
2. AXLE ASSEMBLY
3. 27 N·m (20 FT. LB.)
4. UNDERBODY PANEL ASSEMBLY
5. 22 N·m (16 FT. LB.)
6. 47 N·m (35 FT. LB.)

Figure 10 - Stabilizer Shaft



1—LONGITUDINAL REINFORCEMENT

2—WELD NUTS

3—27NM (20 FT.LB.)

4—AXLE ASM.

5—JOUNCE STOP REINF.

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Figure 11 - Rubber Bumper Assembly

7. Brake line clip to underbody.
8. Remove adjustable lifting device and lower vehicle.

REAR STABILIZER SHAFT

NOTICE: See "Notice" on page 3D-1 of this section.

The rear stabilizer shaft is available on some models and attaches as shown in Figure 10.

RUBBER BUMPER

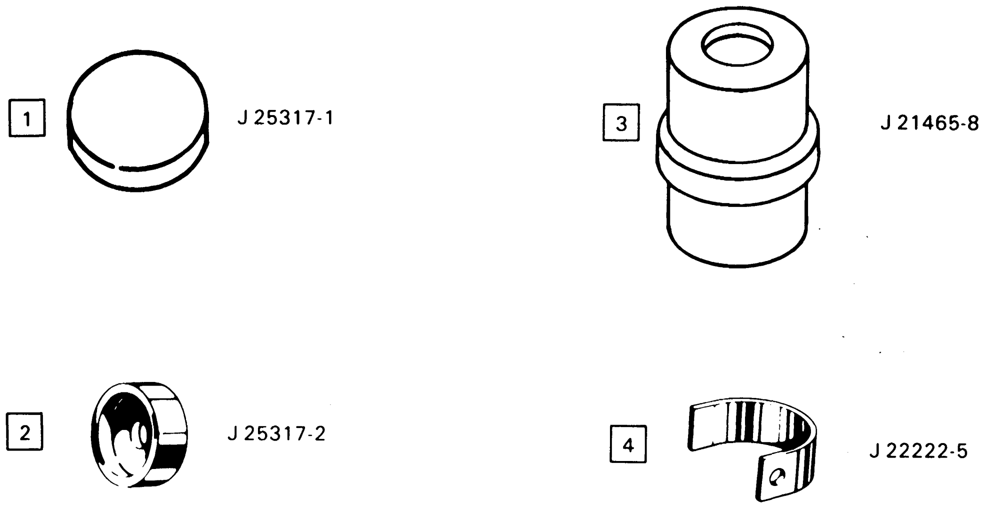
The rear axle bumper is located on the top of the axle housing as shown in Figure 11.

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Nut, Shock Absorber-to-Upper Mount	17 N·m (13 lb. ft.)
Nut, Shock Absorber-to-Axle	95 N·m (70 lb. ft.)
Nut, Track Bar-to-Spring Seat	83 N·m (61 lb. ft.)
Nut, Track Bar-to-Body Bracket	108 N·m (80 lb. ft.)
Nut, Track Bar Brace-to-Body Bracket	108 N·m (80 lb. ft.)
Screw, Track Bar Brace-to-Body Brace Bracket	47 N·m (35 lb. ft.)
Bolt, Control Arm-to-Rear Axle	115 N·m (85 lb. ft.)
Bolt, Control Arm-to-Underbody	115 N·m (85 lb. ft.)
Nut, Torque Arm Outer Bracket	41 N·m (30 lb. ft.)
Nut, Torque Arm-to-Rear Axle Differential	133 N·m (98 lb. ft.)
Bolt, Stabilizer Shaft-to-Body Bracket	22 N·m (16 lb. ft.)
Screw, Stabilizer Bracket-to-Body	47 N·m (35 lb. ft.)
Nut, Stabilizer Shaft Clamp-to-U-Bolt	27 N·m (20 lb. ft.)
Bolt, Axle Bumper Bracket-to-Underbody	27 N·m (20 lb. ft.)

SPECIAL TOOLS



1 BUSHING INSTALLER
2 BUSHING REMOVER
3 BUSHING REMOVER
4 CONTROL ARM SPACER

KC1004-3D-F-RP

SECTION 3E

TIRES AND WHEELS

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 3E-1 of this section."

NOTICE : When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

The factory installed tires and wheels are designed to operate satisfactorily with loads up to and including the full rated load capacity when inflated to the recommended inflation pressures.

Correct tire pressures and driving techniques have an important influence on tire life. Heavy cornering, excessively rapid acceleration, and unnecessarily sharp braking increase tire wear.

REPLACEMENT TIRES

Figure 1

A tire performance criteria (TPC) specification number is molded in the sidewall near the tire size of all original equipment tires. This specification number ensures that the tire meets GM's performance standards for traction, endurance, dimension, noise, handling, rolling resistance, and other qualities. Usually, a specific TPC number is assigned to each tire size.

Replacement tires should be the same size, load range and construction as the original tires. Replace the original tires with tires of the same TPC specification number. Use of any other tire size or type may seriously affect ride, handling, speedometer/odometer calibration, vehicle ground clearance, and tire clearance to the body and chassis.

CAUTION: Do not mix different types of tires on the same vehicle such as radial, bias, and bias-belted tires except in emergencies because vehicle handling may be seriously affected and may result in loss of control. This caution does not apply to the compact spare furnished with the vehicle.

Tires should be replaced when:

1. They are worn to a point where 1.6 mm (1/16 inch) or less tread remains, or the cord or fabric is showing. To help detect this condition, tires have built-in tread wear indicators that appear between the tread grooves when the tread is 1.6 mm (1/16 inch) or less. When the indicators appear in two or more adjacent grooves at three spots around the tire, the tire should be replaced.
2. The tread or sidewall is cracked, cut or snagged deeply enough to expose the cord or fabric.
3. The tire has a bump, bulge or split. Slight sidewall indentations are normal and should not affect ride.

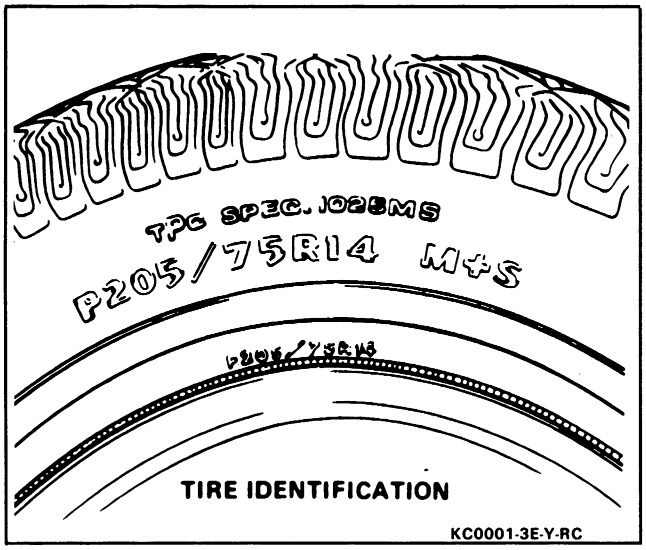


Figure 1 - Tire Identification

4. The tire has a puncture, cut, or other damage that cannot be correctly repaired because of the size or location of the damage.

New tires should be installed in pairs on the same axle. If it is necessary to replace only one tire, it should be paired with the tire having the most tread.

ALL SEASON TIRES

Figure 1

Most GM vehicles are equipped with steel belted all season radial tires as standard equipment. These tires qualify as snow tires, with a 37 percent higher average rating for snow traction than the non-all season radial tires previously used. Other performance areas, such as wet traction, rolling resistance, tread life, and air retention, were also improved slightly. Both tread design and tread compounds were improved. These tires are identified by an "M + S" molded in the tire sidewall following the size. The suffix "MS" is also molded in the sidewall after the TPC specification number.

P-METRIC SIZED TIRES

Figure 2

All GM vehicles now use passenger-metric (P-metric) sized tires. P-metric tires are available in two load ranges: standard load with 240 kPa (35 psi) maximum pressure and extra load with 280 kPa (41 psi) maximum pressure. Most passenger vehicle tires are standard load.

Most P-metric tire sizes do not have exact corresponding alpha-numeric tire sizes. For example, a P205/75R15 is not exactly equal in size and load carrying capacity to an FR78-15. For this reason, replacement tires should be of the same TPC specification number (same size, load range, construction) as those originally on the vehicle. If P-metric tires must be replaced with other sizes, a tire dealer should be consulted. Tire companies can best recommend the closest match of alpha-numeric to P-metric sizes within their own tire lines.

The metric term for tire pressure is the kilopascal (kPa). Tire pressure may be printed in both kPa and psi. One psi equals 6.9 kPa.

See the tire placard or "Specifications" in this section for tire inflation pressures.

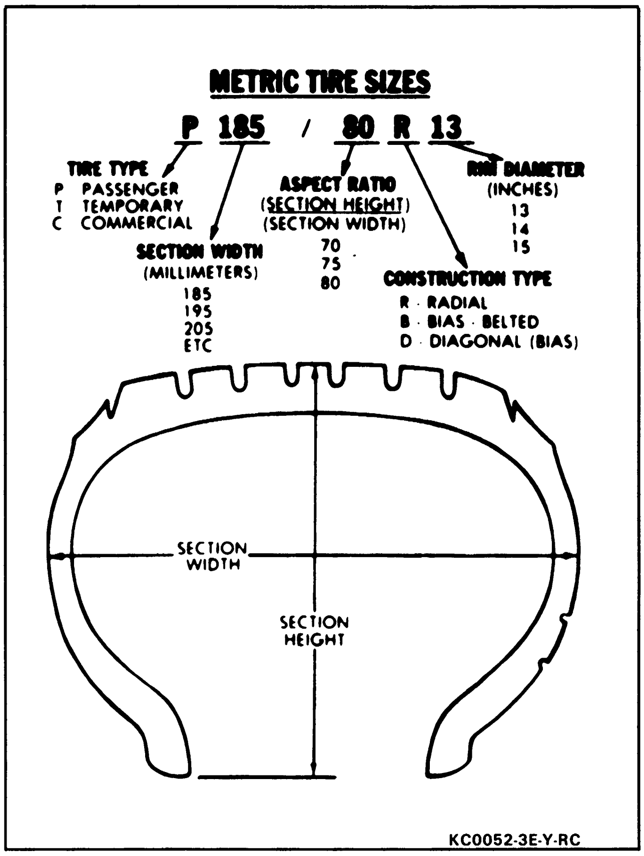


Figure 2 - Metric Tire Size Format

TIRE PLACARD

Figure 3

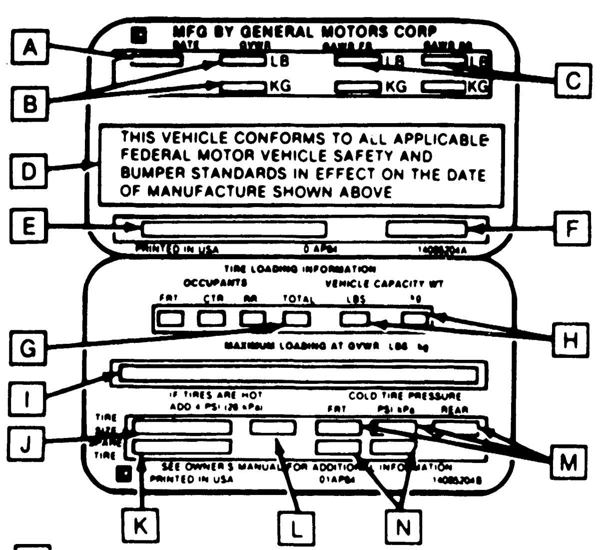
The tire placard is permanently located on the rear face of the driver's door edge and should be referred to for tire information. The placard lists the maximum vehicle load, tire size (including spare), and cold inflation pressure (including spare).

WHEELS

Wheels must be replaced if they are bent or dented, have excessive lateral or radial runout, leak air through welds, have elongated bolt holes, or have wheel nuts that will not stay tight. Wheels with runout greater than specified may cause objectionable vibrations.

Replacement wheels must be equivalent to the original equipment wheels in load capacity, diameter, rim width, offset, and mounting configuration. A wheel of incorrect size or type may affect wheel and bearing life, brake cooling, speedometer/odometer calibration, vehicle ground clearance and tire clearance to the body and chassis.

Steel wheels can be identified by a two or three-letter code stamped into the front side rim near the valve stem. Aluminum wheels have the code, part



A	DATE
B	GROSS VEHICLE WEIGHT RATING
C	GROSS AXLE WEIGHT RATING - FRT & RR
D	CERTIFICATION STATEMENT
E	VEHICLE IDENTIFICATION NUMBER
F	VEHICLE CLASS TYPE: "PASS. CAR"
G	MAXIMUM OCCUPANTS
H	MAXIMUM VEHICLE CAPACITY WEIGHT
I	MAXIMUM LOADING AT GVWR
J	TIRE SIZE
K	SPARE TIRE SIZE
L	TIRE LABEL CODE
M	TIRE PRESS. WITH MAX. OCCUPANTS FRT & RR
N	SPARE TIRE PRESSURE

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Figure 3 - Tire Placard

number, and manufacturer identification cast into the backside.

MAINTENANCE AND ADJUSTMENTS

WHEEL REPAIR

Wheel repairs that use welding, heating, or peening are not approved. An inner tube is not an acceptable repair for leaky wheels or tires. Porosity in aluminum wheels can be repaired. Refer to "Aluminum Wheel Porosity Repair" in this section.

METRIC WHEEL NUTS AND STUDS

A Metric wheel nut is identified by the word "Metric" stamped on its face. The wheel stud has the letter "M" stamped into its end. The thread size of the metric wheel nuts and studs are indicated by a code, such as M12 x 1.5.

INFLATION OF TIRES

Figure 4

The pressure recommended for all models is carefully calculated to give a comfortable ride, responsive steering, maximum tread wear, tire life and resistance to bruises.

The metric term for tire inflation pressure is the kilopascal (kPa). Tire pressure may be printed both kPa and psi. One psi equals 6.9 kPa.

For sustained high speed driving, tires should be set at the pressures recommended. Sustained driving at high speeds, where permitted by law, is not advised unless your vehicle has special high speed tires.

Tire pressure, with tires cold, (after vehicle has set for three hours or more, or driven less than one mile) should be checked monthly or before any extended trip and set to the specifications on the tire placard located on the rear face of driver's door or refer to "Specifications" in this section. Tire pressure will increase about 6.9 kPa (1 psi) for every 5.5°C (10°F).

Valve caps or extensions should be installed on the valves to keep out dust and water.

Higher than recommended pressure can cause:

- Hard ride.
- Tire bruising or carcass damage.
- Rapid tread wear at center of tire.

Lower than recommended pressure can cause:

- Tire squeal on turns.
- Hard steering.
- Rapid and uneven wear on the edges of the tread.
- Tire rim bruises and rupture.
- Tire cord breakage.
- High tire temperatures.
- Reduced handling.
- High fuel consumption.

Unequal pressure on same axle can cause:

- Uneven braking.
- Steering lead.
- Reduced handling.
- Swerve on acceleration.

TIRE ROTATION

Figure 5

To equalize tire wear, rotate tires at intervals specified in the owner's manual. Whenever uneven tire wear is noticed, the cause should be investigated. Due to their design, radial tires tend to wear faster in the shoulder area, particularly in drive locations.

Radial tires in non-drive locations may develop an irregular wear pattern that can generate tire noise. This makes regular tire rotation especially necessary.

Always use 4-wheel rotation. After rotation, be sure to check wheel nut torque and set tire pressure. Never use oil or grease on wheel studs or nuts.

On vehicles with P245/50ZR16 tires and 16 inch wheels, special rotation provisions must be followed.

INFLATION PRESSURE CONVERSION CHART (KILOPASCALS TO PSI)

kPa	psi	kPa	psi
140	20	215	31
145	21	220	32
155	22	230	33
160	23	235	34
165	24	240	35
170	25	250	36
180	26	275	40
185	27	310	45
190	28	345	50
200	29	380	55
205	30	415	60

Conversion: 6.9 kPa = 1 psi

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Figure 4 - Inflation Pressure Conversion

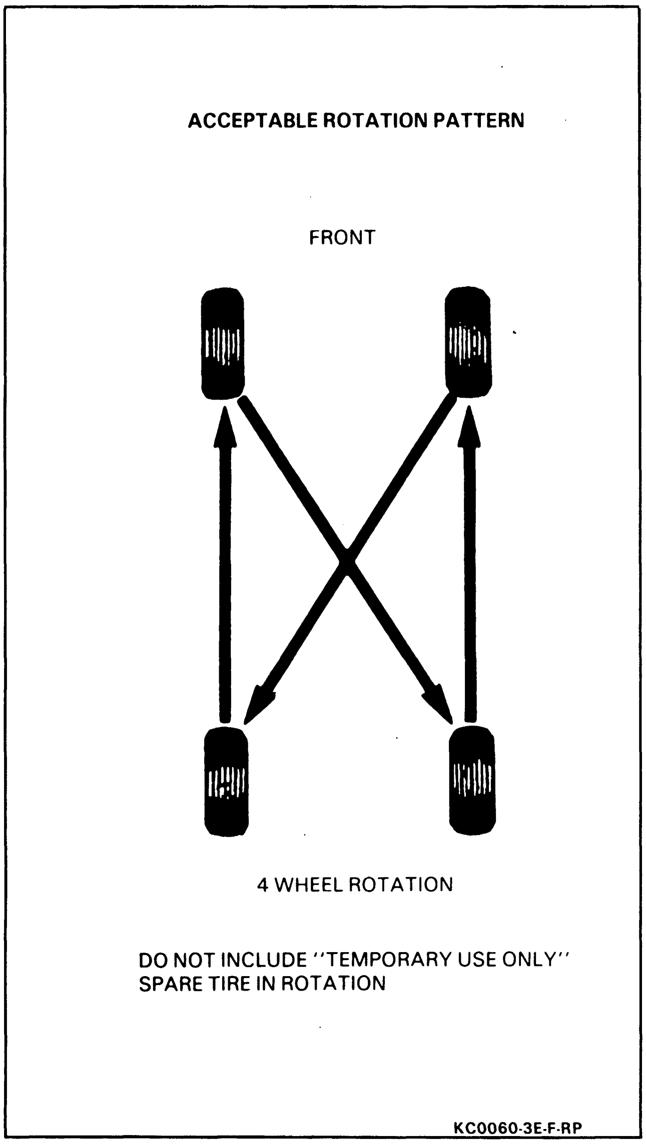


Figure 5 - Acceptable Tire Rotation Pattern

The tires are directional, and the front and rear wheels have different offsets, so the tires must be dismounted from the wheels for rotation. Remove the tires from the wheels, rotate the tire to the appropriate wheel (Figure 5) and mount the tire. Be sure the arrows on the tires point in the direction the tires roll. Balance the tire and wheel assemblies using nylon-coated weights. Adjust tire pressures, and tighten wheel nuts to specified torque.

TIRE CHAIN USAGE

Figure 6

> **NOTICE:** Tire chains should not be used with the 16-inch wheel and tire assembly because the chains may damage the vehicle.

Tire chains are only recommended for emergency use or when required by law. Due to limited tire-to-body clearance, SAE Class "S" tire chains are recommended. They may also be designated as 1100 Series, Type PL tire chains. The chains are designed to limit the "fly off" effect that occurs when the wheel rotates.

Manufacturers of tire chains have a specific chain size for each tire size to ensure proper fit when installed. Therefore, be sure to purchase the correct chains for the tires on which they are to be used. Rubber adjusters should not be used to take up slack or clearance in chains which are loose due to incorrect size. Always drive slowly and follow the chain manufacturer's installation instructions and speed restrictions.

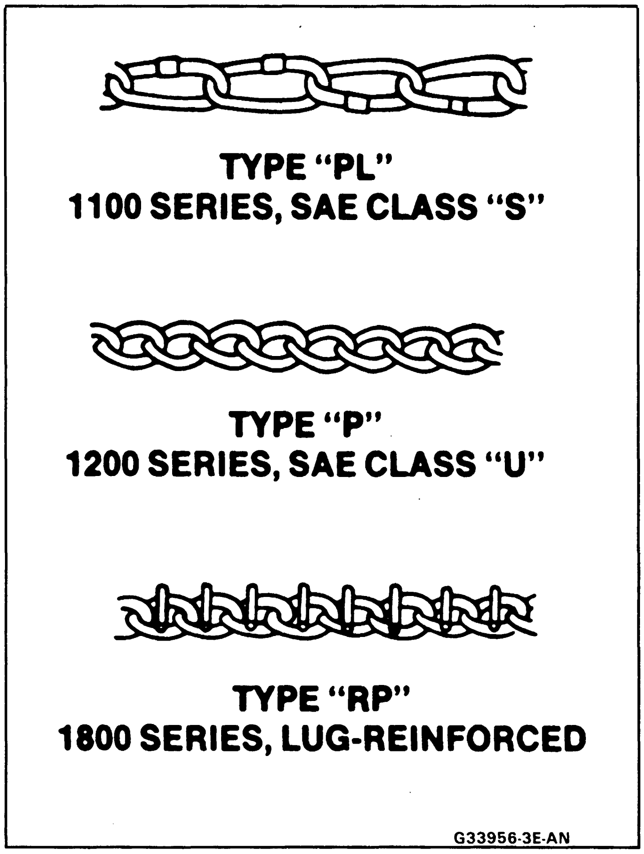


Figure 6 - Examples of Passenger Vehicle Tire Chains

SERVICE OPERATIONS

WHEEL REMOVAL

Figure 7

Penetrating oil has not been found to be effective in removing tight wheels, however, if it is used it should be applied sparingly to the wheel centerhole area only.

CAUTION: Do not allow the penetrating oil to get on the vertical surfaces between the wheel and the rotor because penetrating oil in this area could cause the wheel to work loose as the vehicle is driven, causing loss of control.

NOTICE: Never use heat to loosen a tight wheel. It can shorten the life of the wheel, studs or hub and bearing assemblies. Wheel nuts must be tightened in sequence and to the proper torque to avoid bending the wheel or rotor.

Sometimes wheels can be difficult to remove due to foreign material or a tight fit between the wheel centerhole and the rotor. Excessive force such as hammering the wheel or tire can cause damage and is not recommended. Slight tapping on the tire sidewall using a large rubber mallet is acceptable.

The wheel can be removed without damage as follows:

1. Retighten all wheel nuts on the affected wheel. Then loosen each nut two turns. Rock the vehicle side to side. If this is not effective go to step 2.
2. Rock the vehicle from "DRIVE" to "REVERSE" allowing the vehicle to move several feet in each direction. Apply quick, hard jabs on the brake pedal to loosen the wheel. If the wheel still does not free up, rock the vehicle again from side to side as hard as possible using one or more person's body weight to loosen the wheel. If the wheel is still tight, repeat the procedure.

Remove or Disconnect

- Raise vehicle and suitably support. Refer to GENERAL INFORMATION (SEC. 0A).

1. Wheel nuts.
   - Mark location of tire and wheel assembly to hub assembly.
2. Tire and wheel assembly.

Clean

CAUTION: Before installing a wheel, remove any build up of corrosion on the wheel mounting surface or rotor by scraping and wire brushing. Installing wheels without good metal-to-metal contact at the mounting surfaces can cause wheel nuts to loosen, which can later allow the wheel to come off while the vehicle is in motion.

- Wheel nuts, studs and the wheel and rotor mounting surfaces.

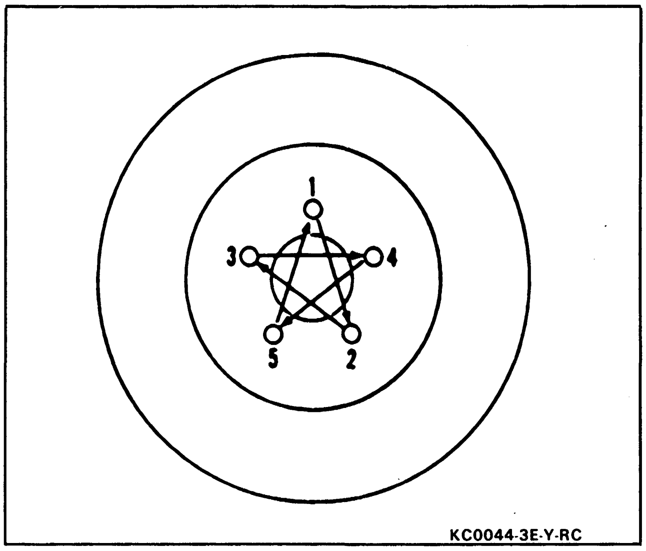


Figure 7 - Hole Wheel Nut Tightening Sequence

Install or Connect

NOTICE: See "Notice" on page 3E-1 of this section.

1. Tire and wheel assembly.
   - Align locating mark of tire and wheel to hub assembly.
2. Wheel nuts.

Tighten

- Wheel nuts in sequence to 110 N·m (81 lb. ft.) (Figure 7).

- Lower vehicle.

OPTIONAL 16-INCH WHEEL

Figure 8

Vehicles equipped with optional 16 inch cast aluminum wheels and cast iron brake drums will require a spacer (1) and spacer retainer (2) between the rear wheel and the cast iron brake drum.

Important

- This spacer is not required on vehicles equipped with four-wheel disc brakes or cast aluminum brake drums.

TIRE MOUNTING AND DISMOUNTING

Figure 9

Use a tire changing machine to mount or dismount tires. Follow the equipment manufacturer's instructions. Do not use hand tools or tire irons to change a tire because they may damage the tires, beads, wheel rim or flanges.

- Rim bead seats should be cleaned with a wire brush or coarse steel wool to remove old rubber and light rust or corrosion. Before mounting or dismounting a tire, the bead area should be well lubricated with GM number 9985555 (50 percent lubricant and 50 percent water) or equivalent.

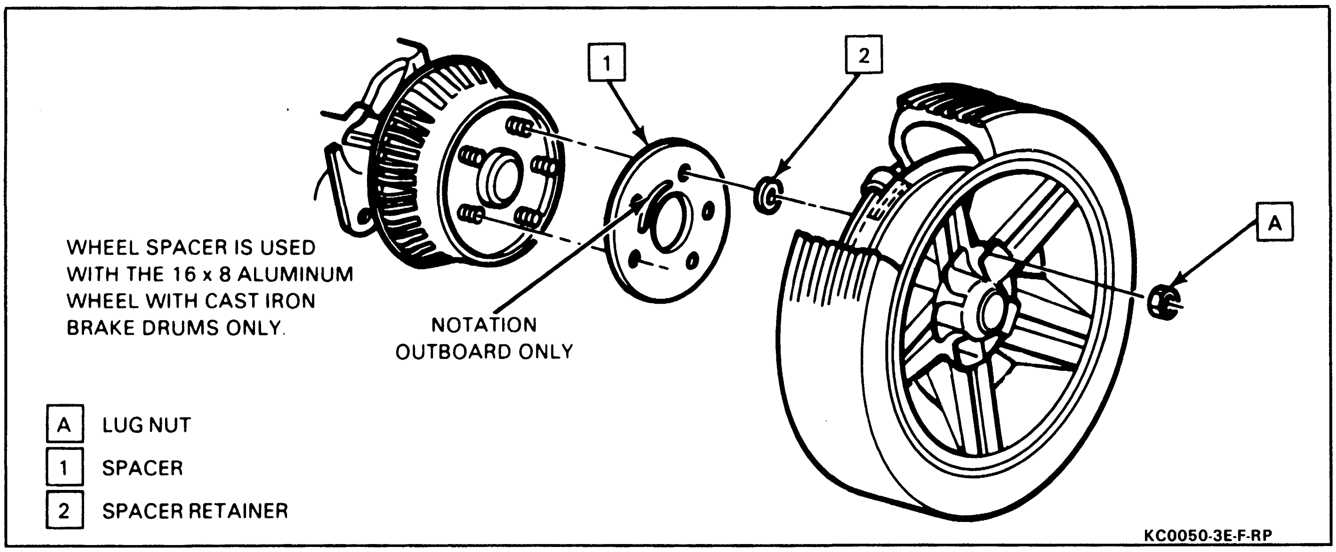


Figure 8 - 16-Inch Rear Wheel Spacers

NOTICE: Do not lubricate the tire beads or wheel rim with lubricant containing silicone. Silicone will allow the tire to rotate on the rim, throwing the wheel and tire assembly out of balance.

- After mounting, inflate tire to 275 kPa (40 psi) so that beads are completely seated.

CAUTION: To avoid serious personal injury, do not stand over the tire when inflating. The bead may break when it snaps over safety hump. Do not exceed 275 kPa (40 psi) pressure when inflating any tire if beads are not seated. If 275 kPa (40 psi) pressure will not seat beads, deflate, relubricate and inflate. Overinflation may cause the bead to break and cause serious personal injury.

- Install the valve core and inflate to the pressure specified on the tire placard. Check the locating rings of the tire to be sure they show around the rim flanges on both sides of the wheel.

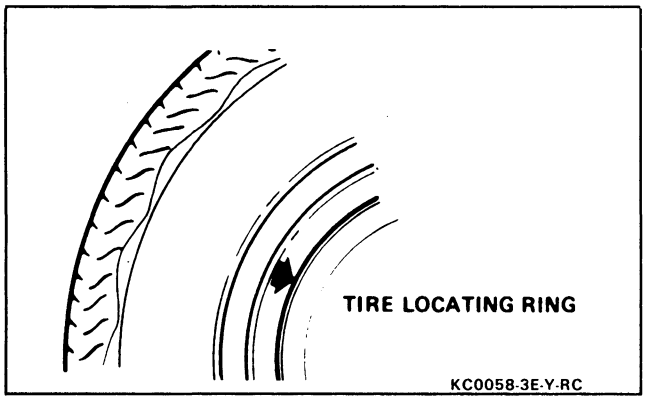


Figure 9 - Tire Locating Ring

TIRE REPAIR

There are many different materials and techniques on the market to repair tires. Not all work on some types of tires. Tire manufacturers have published detailed instructions on how and when to repair tires. The instructions can be obtained from the tire manufacturer. Repair to the compact spare tire is not recommended.

MEASURING WHEEL RUNOUT

Figure 10

Wheel runout should be measured with an accurate dial indicator. Measurements may be taken with the wheel installed on the vehicle, or off the vehicle using an accurate mounting surface such as a wheel balancer. Measurements may be taken with or without the tire mounted on the wheel.

Radial runout and lateral runout should be measured on both the inboard and outboard rim flanges. With the dial indicator firmly in position, slowly rotate the wheel one revolution and record the total indicator reading. If any measurement exceeds specifications, and there is a vibration that wheel balancing will not correct, the wheel should be replaced. Disregard any indicator readings due to welds, paint runs, scratches, etc.

- Steel Wheels
  - Radial runout 1.01 mm (0.040 inch).
  - Lateral runout 1.14 mm (0.045 inch).
- Aluminum Wheels
  - Radial runout 0.76 mm (0.030 inch).
  - Lateral runout 0.76 mm (0.030 inch).

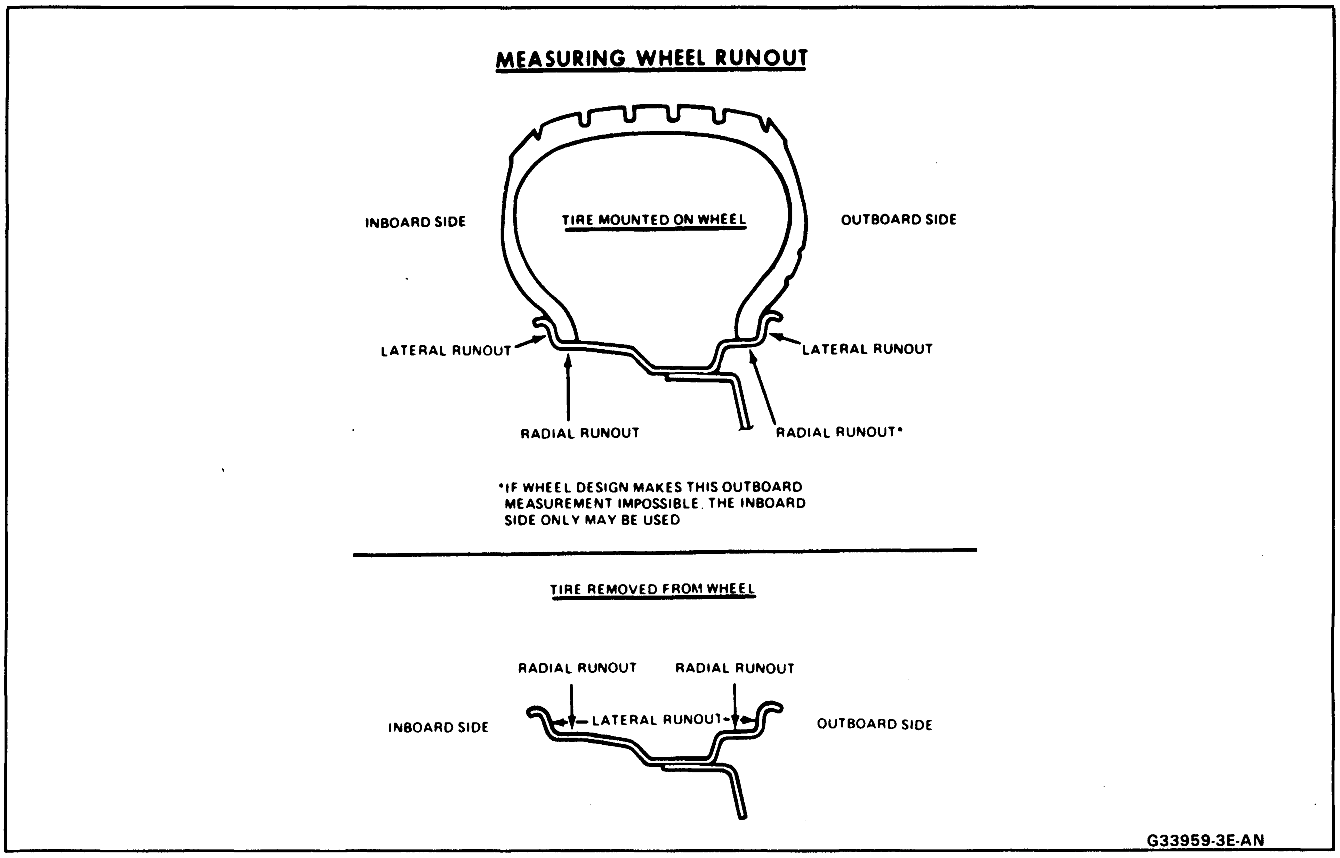


Figure 10 - Wheel Runout

COMPACT SPARE

Figure 11

Some vehicles will be equipped with a high pressure compact spare. The compact spare uses a narrow 4-inch wide rim, although the wheel diameter is usually one inch larger than the road wheels.

> **NOTICE:** The compact spare wheel should not be used with standard tires, snow tires, wheel covers or trim rings. If such use is attempted, damage to these items or other parts of the vehicle may occur. The compact spare should be used only on vehicles that offer it as original equipment.

Inflation pressure of the compact spare must be periodically checked and maintained at 415 kPa (60 psi). It can be mounted and dismounted from its wheel using present tire changing equipment and procedures. As with any other tires, the beads should completely seat at 275 kPa (40 psi).

> **CAUTION: To avoid serious personal injury, do not stand over tire when inflating. Bead may break when it snaps over safety hump. Do not exceed 275 kPa (40 psi) pressure when inflating any tire including compact spares if beads are not seated. If 275 kPa (40 psi) pressure will not seat beads, deflate, relubricate and inflate. Over inflation may cause the bead to break and cause serious personal injury.**

The compact spare is designed to weigh less than standard tires and is easier to handle when the need arises. Check inflation pressure as soon as practical after installing spare and adjust to 415 kPa (60 psi). Repair or replacement of the compact spare should be made only by an authorized dealer.

> **NOTICE:** Do not take the vehicle through an automatic car wash with compact spare installed. The vehicle may get caught, which could result in property damage.

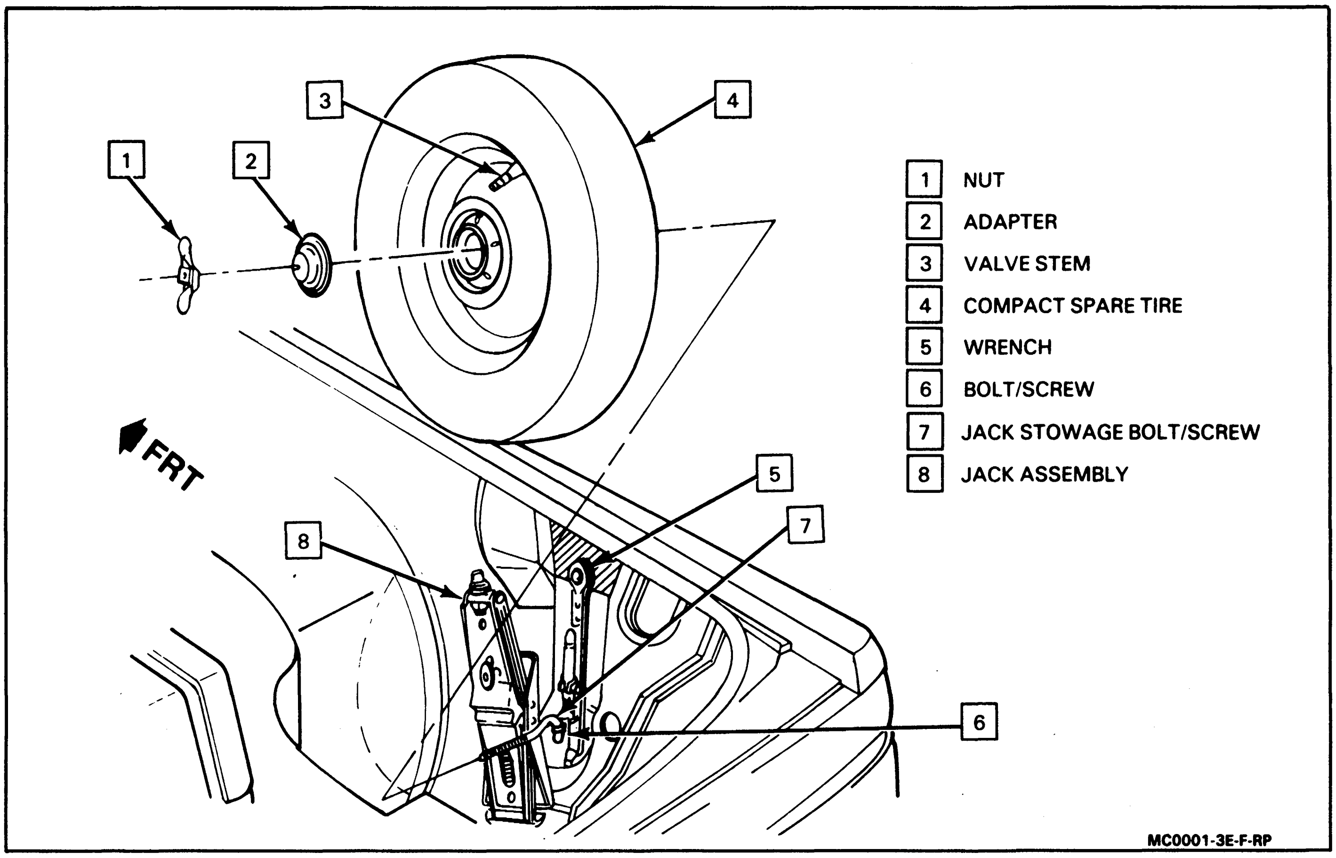


Figure 11 - Compact Spare Tire

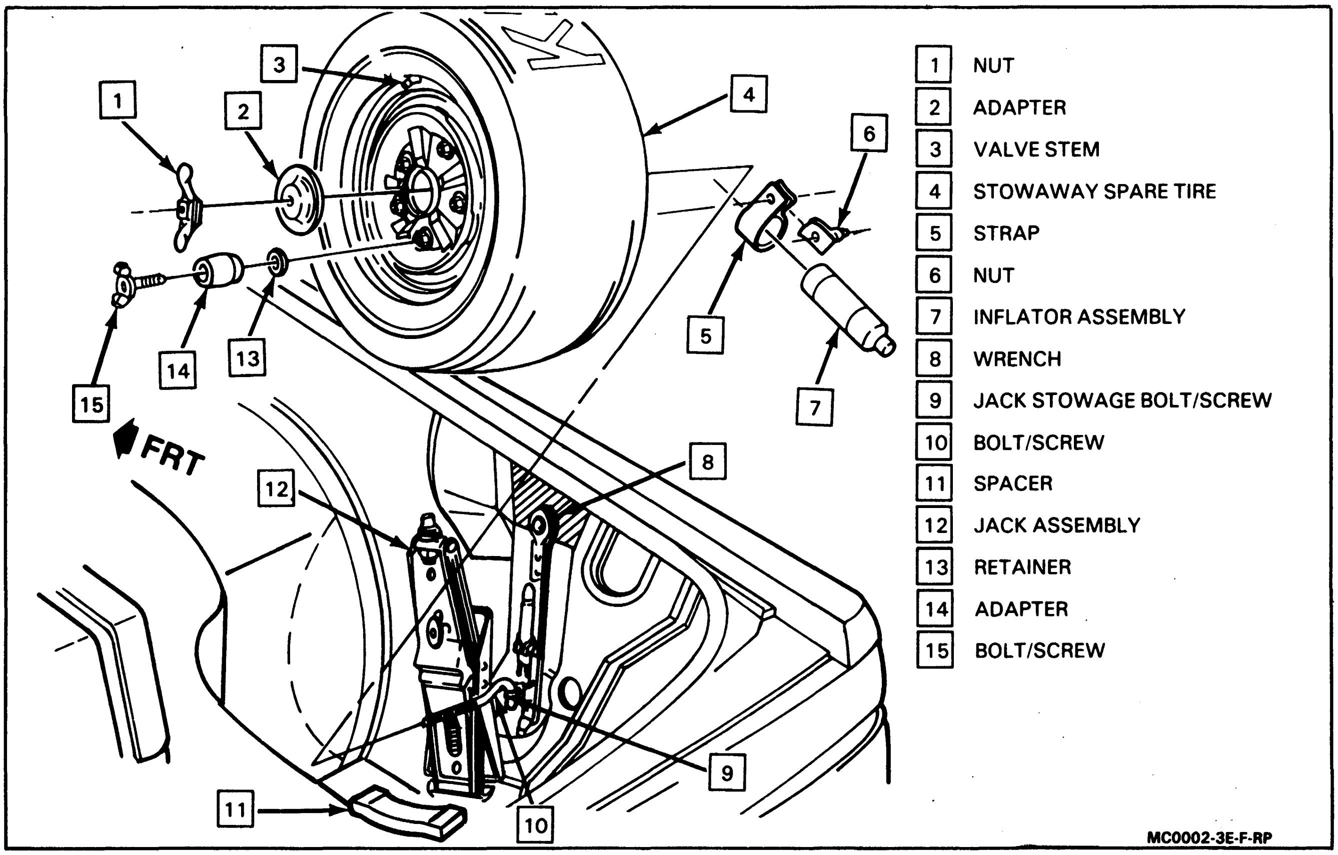


Figure 12 - Stowaway Spare Tire

STOWAWAY SPARE

Figure 12

Some models will be equipped with an inflatable stowaway spare. The stowaway spare uses a pressurized tire inflator filled with carbon dioxide (CO_2), and is refillable after use.

> **NOTICE:** The stowaway spare wheel should not be used with standard tires, snow tires, wheel covers or trim rings. If such use is attempted, damage to these items or other parts of the vehicle may occur. The stowaway spare should be used only on vehicles that offer it as original equipment.

If service is needed on a stowaway spare, contact an authorized retailer of the tire maufacturer.

BALANCING TIRE AND WHEEL

Figures 13 and 14

There are two methods by which tire and wheel assemblies are balanced: static and dynamic. Static balance is the equal distribution of weight around the wheel. Assemblies that are statically unbalanced cause a bouncing action called tramp.

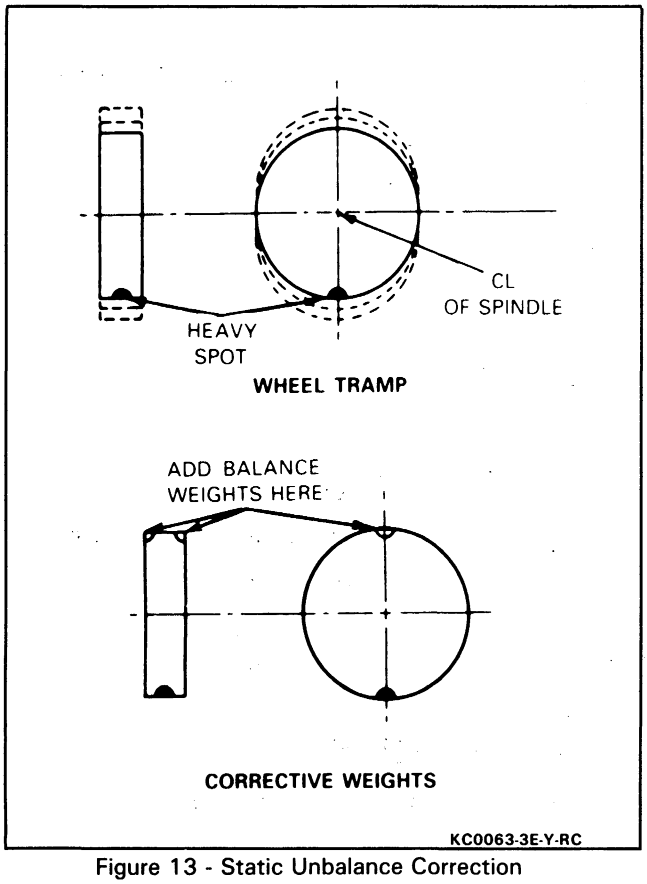


Figure 13 - Static Unbalance Correction

Dynamic balance is the equal distribution of weight on each side of the centerline so that when the tire spins there is no tendency for the assembly to move from side to side. Assemblies that are dynamically unbalanced may cause shimmy.

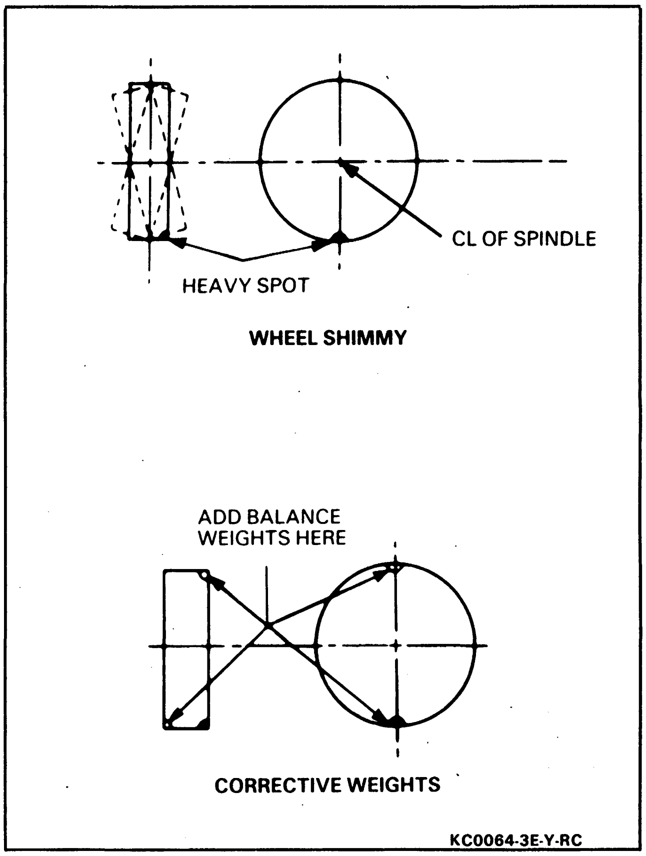


Figure 14 - Dynamic Unbalance Correction

General Balance Precautions

> **CAUTION: It is recommended that eye protection be used to prevent personal injury.**

Deposits of foreign material must be cleaned from the inside of the wheel. Stones should be removed from the tread in order to avoid operator injury during spin balancing and to obtain a good balance. The tire should be inspected for any damage, then balanced according to the equipment manufacturer's recommendations.

Off-Vehicle Balancing

When balancing tire and wheel assemblies off the vehicle, use a balancer that pilots the wheel by the centerhole (not the lug holes) if possible. Always follow the equipment manufacturer's instructions. Some electronic off-vehicle balancers are more accurate than the on-vehicle spin balancers, but do not correct for rotor unbalance. If the vibration is not corrected by the off-vehicle balance, an on-vehicle balance may also be needed.

On-Vehicle Balancing

When balancing tire and wheel assemblies on the vehicle, do not remove the wheel weights added from the electronic off-vehicle balance. Split the new on-vehicle weights equally between the inner and outer rim flanges of the wheel to avoid disturbing the dynamic balance from the electronic off-vehicle balancer. Always follow the equipment manufacturer's instructions.

> **NOTICE:** The driven tire and wheel assemblies should be spun using the engine. Limit speed as stated in the following Caution.

> **CAUTION: Do not spin the drive wheels faster than 55 km/h (35 mph) as indicated by the speedometer. This limit is necessary because the speedometer indicates only one-half of the actual wheel speed when one drive wheel is spinning and the other drive wheel is stopped. Personal injury and damage may result from high speed spinning.**
>
> **CAUTION: On vehicles equipped with limited slip rear axles, do not attempt to balance a tire on a drive wheel with the other drive wheel on the ground. The vehicle may drive through this wheel and cause the vehicle to move unexpectedly, resulting in personal injury and property damage.**

To distinguish between standard rear axle and limited slip, raise rear of vehicle so both tires are clear of ground. With the transmission in "PARK" (in gear with manual transmission), attempt to turn one wheel by hand. If the wheel can be turned, it is standard rear axle; if the wheel cannot be turned, it is a limited slip rear axle.

Wheel Weights

Figure 15

When static balancing, if more than 85 grams (3.0 oz.) are needed, the wheel weights should be split as equally as possible between the inboard and outboard flanges.

Balancing of assemblies with factory aluminum wheels requires the use of special nylon coated clip-on wheel weights. These weights are designed to fit over the thicker rim flanges of the aluminum wheel and should be installed with a plastic-tipped hammer.

Adhesive wheel weights are also available. Use the following procedure to install adhesive wheel weights.

Adhesive Wheel Weight Installation

1. Clean wheel by sanding to bare aluminum where wheel weight is to be located.
2. Wipe wheel weight attachment area with a mixture of half isopropyl alcohol and half water. A clean cloth or paper towel must be used for this operation.
3. Dry the attachment area with hot air. Surface of wheel should be warm to the touch.
4. Warm the adhesive backing on wheel weights to room temperature.
5. Remove tape from back of weights. Do not touch the adhesive surface.
6. Apply wheel weight and press on with hand pressure.
7. Secure wheel weight with a 70-110 N (16-25 lb.) force applied with a roller.

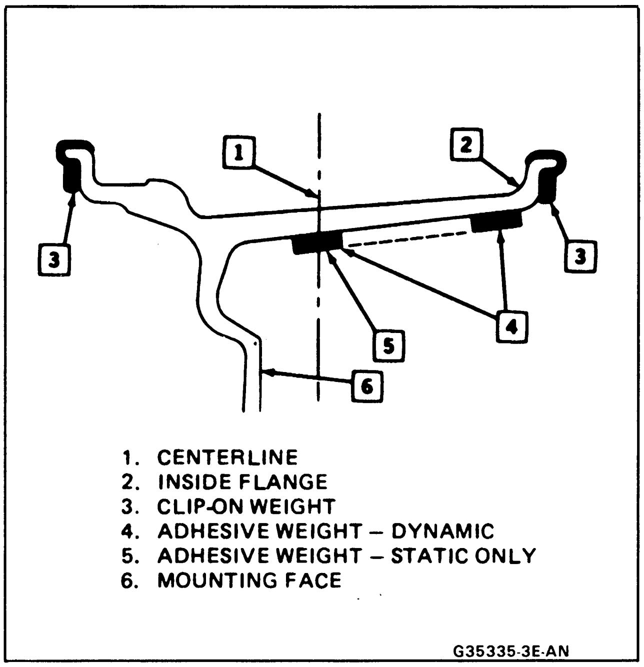


Figure 15 - Adhesive Wheel Weight Placement

CORRECTING NON-UNIFORM TIRES

If a replacement tire cannot be obtained, there are ways to correct a tire that causes a vibration even though it is properly balanced. The best method uses an automatic machine that buffs small amounts of rubber from a selected spot on the outer two tread rows. Correction by this method is usually permanent and, if done properly, does not significantly affect the appearance of tire or tread life. Tire truing with a blade-type machine is not recommended because it reduces the tread life substantially and often does not permanently correct the problem.

Dismounting the tire and rotating it 180 degrees on the rim often eliminates vibrations. It is important that this method be used only on tire assemblies that are known to be causing a vibration because this method may cause good assemblies to vibrate.

Refer to STEERING, SUSPENSION, TIRES AND WHEELS DIAGNOSIS (SEC. 3).

ALUMINUM WHEELS

Aluminum Wheel Hub Cap

Remove or Disconnect

NOTICE: Failure to hit cap squarely without the load distributed evenly could result in permanent damage to the cap.

- Tire and wheel assembly. Refer to "Wheel Removal" in this section.
- Place a block of wood approximately 51 mm (2 inches) in diameter with a squared off end against the back surface of the cap. A sharp hammer blow on the block of wood will remove the cap.

Install or Connect

NOTICE: Failure to hit cap squarely without the load distributed evenly could result in permanent damage to the cap.

- Tire and wheel assembly. Refer to "Wheel Removal" in this section.
- Place the cap into position at the wheel opening and place a block of wood at least 76 mm (3 inches) in diameter against the cap face. Install the cap by striking the block of wood with a hammer.

Aluminum Wheel Porosity Repair

Remove or Disconnect

- Raise vehicle and suitably support. Refer to GENERAL INFORMATION (SEC. 0A).

1. Tire and wheel assembly. Refer to "Wheel Removal" in this section.

- Locate leaking areas by inflating tire to 275 kPa (40 psi) and dipping into water bath.
- Mark leak areas.
- Mark the tire at the valve core.

2. Tire from wheel. Refer to "Tire Mounting and Dismounting" in this section.

- Scuff inside rim surface at leak area with 80 grit sandpaper and clean area with general purpose cleaner such as 3M part number 08984 or equivalent.
- Apply 3 mm (1/8-inch) thick layer of adhesive/sealant part number 1052366 or equivalent to leak test area and allow six hours of drying time.

Install or Connect

1. Tire on wheel. Refer to "Tire Mounting and Dismounting" in this section.

- Align the matchmark on the tire with the valve core.
- Pressurize to 275 kPa (40 psi) and check for leaks.
- Adjust tire pressure to meet specifications on tire placard.
- Balance tire and wheel assemblies. Refer to "Balancing Tire and Wheel" in this section.

2. Tire and wheel assembly. Refer to "Wheel Removal" in this section.

- Lower vehicle.

Aluminum Wheel Refinishing

A protective clear or color coating is applied to the surface of original equipment cast aluminum wheels. A surface degradation condition can begin to develop if frequent, repeated automatic car wash cleaning abrades or wears off the factory applied protective clear coating. Once the protective clear coating is damaged, exposure to caustic cleaners or road salt further causes surface degradation. The service procedure details how to strip, clean and recoat aluminum wheels that are affected by these conditions. Select and follow only those procedures for the conditions that apply to the wheels being refinished.

Required Materials:

Amchem Alumi Prep number 33 - stock number DX533 or equivalent - cleaning and conditioning chemical for aluminum.

Amchem Alodine number 1001 - stock number DX501 or equivalent - coating chemical for aluminum.

Ditzler Delclear Acrylic Urethane Clear - stock number DAU-75 or equivalent.

Ditzler Delthane Ultra-Urethane Additive - stock number DXR-80 or equivalent.

Initial Preparation

Remove or Disconnect

1. Wheel and tire assembly from the vehicle. Refer to "Wheel Removal" in this section.

- Matchmark tire for reinstallation of outboard wheel weights after recoating of wheel.

2. Outboard wheel weights.

Clean

- Grease and oil from the wheel with an aluminum cleansing solvent.
- Remaining dirt from the wheel by washing inside and out with a water base all purpose cleanser to remove any residue.

Accent Color Preparation

- Sand over painted areas that do not require recoloring with 400 grit wet or dry sandpaper to promote adhesion of clear coat.

Surface Damage Preparation

CAUTION: Do not use vehicle power to rotate the wheel while sanding or personal injury may result.

1. Mount wheel on brake lathe and spin slowly.

NOTICE: Do not use abrasive coarser than 80 grit or wheel may be damaged.

2. Sand wheel with backing block or pad by holding abrasive flat to surface of wheel and moving

slowly back and forth from center to outer edge to remove imperfections.

- First sand with 80 grit sandpaper.
- Follow with 150 grit sandpaper.
- Finish sanding with 240 grit sandpaper.

Slight Clear Coat Damage on Unpainted Wheels

CAUTION: Use of rubber gloves and eye protection is necessary to prevent personal injury.

1. Apply chemical stripper.
    - Allow stripper to penetrate coating.
    - Use a small 1/4-inch detail brush dipped in stripper to apply material around the perimeter and spoke-like areas.
2. Remove stripper, following the manufacturer's recommendations.

CAUTION: Do not use vehicle power to rotate the wheel while sanding to avoid serious personal injury.

3. Sand the wheel with 240 grit sandpaper while rotating the wheel on a slowly spinning brake lathe, or by mounting it on the vehicle and spinning it by hand.
    - This procedure restores the machined appearance and promotes adhesion of the finish coats.

Recoating Procedure

CAUTION: Use of rubber gloves and eye protection is necessary to prevent personal injury.

1. Clean the surface of contaminants by washing with soap and water.
2. Spray the wheel with Amchem number 33 or equivalent.
    - Let the wheel soak for 1 to 3 minutes.
    - Rinse with water and blow dry with hot air device.
3. Spray the wheel with Amchem number 1001 or equivalent.

- Let the wheel soak 1 to 3 minutes.
- Rinse with water and blow dry with hot air device.

4. Mark off the tire.

CAUTION: When applying any two part component paint system, wear proper respiratory protection such as Easi-Air Respirator, part number 06986 or equivalent. Follow the specific precautions provided by the paint manufacturer. Failure to follow these precautions may cause lung irritation and allergic respiratory reaction.

5. Finish the wheel with Ditzler Delclear acrylic urethane clear and Ditzler ultra urethane additive, or equivalent. Refer to labels for specific directions.
    - First coat – light mist coat, let flash.
    - Second coat – light, let flash.
    - Third coat – heavy duty, wet coat.
6. Let the wheel dry for 24 hours; or flash for 30 minutes. Force dry at 60°C (140°F) for 30 minutes, and allow to cool for 30 minutes before mounting.

Install or Connect

- Balance tire and wheel assembly. Refer to "Balancing Tire and Wheel" in this section.
    - Replace the original balance weights with nylon-coated weights to avoid discoloration of the wheel.
- Tire and wheel assembly. Refer to "Wheel Removal" in this section.

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Wheel Nut - M12 x 1.5	110 N·m (81 lb. ft.)

RUNOUT SPECIFICATIONS

Maximum Radial Runout	
Steel Wheels	1.01 mm (0.040 inch)
Aluminum Wheels	0.76 mm (0.030 inch)
Maximum Lateral Runout	
Steel Wheels	1.14 mm (0.045 inch)
Aluminum Wheels	0.76 mm (0.030 inch)

TIRE PRESSURES

Compact Spare	415 kPa (60 psi)
Front	205 kPa (30 psi)
Rear	205 kPa (30 psi)

SECTION 3F4

STEERING WHEEL UPPER COLUMN ON-VEHICLE SERVICE - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT

CAUTION: The procedures in this section must be followed in the order listed to temporarily disable the Supplemental Inflatable Restraint (SIR) System and prevent false diagnostic codes from setting. Failure to follow this procedure could result in possible air bag deployment, personal injury, or unneeded SIR system repairs.

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 3F4-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL INFORMATION

STEERING COLUMN - SUPPLEMENTAL INFLATABLE RESTRAINT

Figure 1

The locking energy absorbing steering column includes three important features in addition to the steering function.

1. In a front-end collision, the energy-absorbing column is designed to collapse, minimizing the possibility of injury to the driver.
2. The ignition switch and lock are conveniently mounted on the column.
3. When locked, the column mounted lock acts as a theft deterrent by preventing the operation of both ignition and steering.

The multifunction turn signal lever controls the turn signals, headlamp high beam, windshield washer and wipers, and cruise control.

To ensure the energy-absorbing action, use only the specified screws, bolts and nuts and tighten them to the specified torque. Apply a thin coat of lithium grease to all friction points when reassembling.

When the column assembly is removed from the vehicle, handle it with special care. Using a steering wheel puller other than the one recommended in this manual, hitting the end of the steering shaft or shift lever sharply, leaning on the assembly, or dropping the assembly could shear or loosen the plastic fasteners that keep the column rigid.

During a front end collision, the Supplemental Inflatable Restraint (SIR) system supplements the restraint of the driver's safety belts by deploying an air bag from the inflator module mounted to the center of the steering wheel. The inflator module houses the air bag and inflator and should be handled with care to prevent accidental deployment.

When servicing a vehicle equipped with a Supplemental Inflatable Restraint (SIR) system, be sure to observe all CAUTIONS and NOTICES.

DIAGNOSIS

For descriptions and diagnosis of the Supplemental Inflatable Restraint (SIR) System, refer to SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM INTRODUCTION (SEC. 9J) and SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM DIAGNOSIS (SEC. 9J-A).

HANDLING PRECAUTIONS

LIVE (UNDEPLOYED) INFLATOR MODULES

Special care is necessary when handling and storing a live (undeployed) inflator module. The rapid gas generation produced during deployment of the air bag could cause the inflator module, or another object placed in front of the inflator module, to be thrown through the air in the unlikely event of an accidental deployment.

CAUTION: When carrying a live inflator module, make sure the bag and trim cover are pointed away from you. In case of an accidental deployment, the bag will then deploy with minimal chance of injury. When placing a live inflator module on a bench or other surface, always face the bag and trim cover up, away from the surface. This is necessary so that a free space is provided to allow the air bag to expand in the unlikely event of accidental deployment. Otherwise, personal injury may result. Also, never carry the inflator module by the wires or connector on the underside of the module.

DEPLOYED INFLATOR MODULES

After an inflator module has been deployed, the surface of the air bag may contain harmless corn starch and also a small amount of sodium hydroxide dust (a by-product of the sodium azide reaction which takes place during deployment) that could be irritating to the skin if left on for an extended period of time.

CAUTION: Safety precautions must be observed when handling a deployed inflator module. After deployment, the air bag surface may contain deposits of sodium hydroxide dust, a by-product of the sodium azide reaction during deployment that is irritating to the skin. Always wear gloves and safety glasses when handling a deployed inflator, and wash your hands with mild soap and water afterwards.

Inflator Module Shipping Procedures

NOTICE: Disposal in any manner inconsistent with proper procedures may be a violation of federal, state and/or local laws.

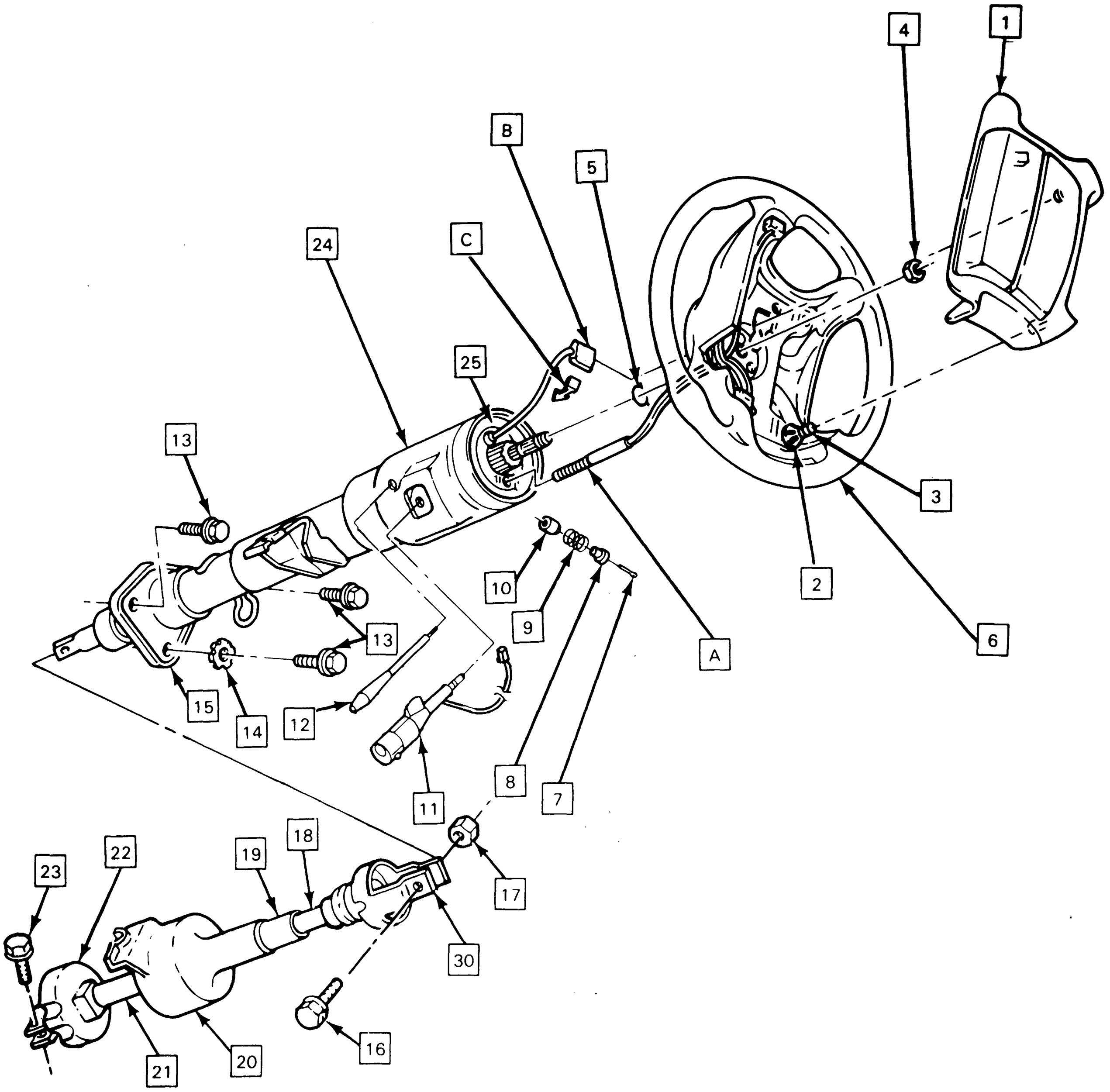
Dealers should refer to the latest service bulletins for proper SIR inflator module shipping procedures.

Inflator Module Scrapping Procedures

CAUTION: Failure to follow proper SIR inflator module disposal procedures can result in air bag deployment which may cause personal injury. Undeployed inflator modules must not be disposed of through normal refuse channels. The undeployed inflator module contains substances that can cause severe illness or personal injury if the sealed container is damaged during disposal. Disposal in any manner inconsistent with proper procedures may be a violaton of federal, state and/or local laws.

Some vehicles equipped with SIR systems that have live (undeployed) inflator modules may have to be scrapped because they have completed their useful life or have been severely damaged in a nondeployment type accident. The following procedure should be followed before scrapping a vehicle with an undeployed restraint module.

1. Turn the engine control switch to "LOCK."
2. Disconnect the CPA clip and the yellow two-way connector at the base of the steering column.
3. Cut the instrument panel harness side of the SIR wiring approximately 74 to 147 mm (3 to 6 inches) from the yellow two-way connector.
4. Splice two wires at least 6 m (20 feet) long to the wiring attached to the yellow two-way connector that was cut from the SIR harness wiring in step 3.
5. Connect yellow two-way connector with two 6 m (20-foot) wires attached to yellow two-way SIR connector at the base of the steering column.
6. Check that inflator module is secured to the steering wheel.
7. Remove all loose objects from front seat.
8. Be sure nobody is in vehicle.
9. Stretch wires away from vehicle to their full length.
10. Apply 12 volts across wires to deploy air bag.
11. Do not touch inflator module area for 20 minutes, due to heat generated during deployment.
12. Wear gloves and safety glasses if you handle the deployed air bag and wash your hands with mild soap and water afterwards.



A	HORN CONNECTOR
B	COIL-TO-INFLATOR CONNECTOR
C	CONNECTOR POSITIVE ASSURANCE
1	INFLATOR MODULE
2	LOCK NUT
3	SCREW
4	NUT
5	RETAINING RING
6	STEERING WHEEL
7	SCREW
8	HAZARD WARNING BUTTON
9	SPRING
10	HAZARD WARNING KNOB
11	MULTIFUNCTION LEVER
12	TILT LEVER
13	BOLT
14	WASHER
15	TOE PLATE
16	BOLT
17	NUT
18	UPPER INTERMEDIATE SHAFT
19	SEAL
20	COUPLING SHIELD
21	LOWER INTERMEDIATE SHAFT
22	FLEXIBLE COUPLING
23	BOLT
24	STEERING COLUMN
25	COIL ASSEMBLY
30	POT JOINT COUPLING

MC0001-3F4-F-RP

Figure 1 - Steering Column Assembly

IGNITION LOCK SYSTEM

PARK LOCK SYSTEM

The park lock system is a safety feature that serves two purposes: to prevent moving the shifter out of "PARK" when the engine control switch is in "LOCK," and to prevent moving the engine control switch to "LOCK" unless the shifter is in "PARK." For information on servicing the park lock cable, refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A).

ON-VEHICLE SERVICE

SIR SYSTEM

Disabling the SIR System

Remove or Disconnect

- Turn the steering wheel so that the vehicle's wheels are pointing straight ahead.
- Turn the ignition switch to "LOCK."

1. SIR fuse from the fuse block.
2. Left sound insulator. Refer to INSTRUMENT PANEL CLUSTER AND CONSOLE (SEC. 8C).
3. Connector position assurance (CPA) and yellow two-way SIR harness connector at the base of the steering column.

Enabling the SIR System

Install or Connect

1. Yellow two-way SIR harness connector to base of steering column and connector position assurance.
2. Left sound insulator. Refer to INSTRUMENT PANEL CLUSTER AND CONSOLE (SEC. 8C).
3. SIR fuse to the fuse block.

- Turn the ignition switch to "RUN" and verify that the inflatable restraint indicator flashes 7 to 9 times and then turns off. If the indicator does not respond as stated, refer to SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM DIAGNOSIS (SEC. 9J-A).

WIRING REPAIR

Wiring repair procedures are included in ELECTRICAL DIAGNOSIS (SEC. 8A) and SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM DIAGNOSIS (SEC. 9J-A). When repairing any wiring associated with the SIR system, always use the crimp and seal splice sleeves contained within J 38125-A.

NOTICE: Do not repair the wiring on the inflator module or the coil assembly. If the wiring on the inflator module or coil assembly requires repair, replace the entire component with a new service replacement part. Failure to follow these instructions may cause the SIR system to malfunction.

COIL ASSEMBLY

For procedures on replacing the coil assembly, refer to STEERING COLUMN UNIT REPAIR - TILT with SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4-A).

IGNITION LOCK CYLINDER

For procedures on replacing the ignition lock cylinder, refer to STEERING COLUMN UNIT REPAIR - TILT with SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4-A).

HAZARD WARNING SYSTEM/TURN SIGNAL SWITCH

Figures 1 through 3

Tool Required:

J 23653-C Lock Plate Compressor

Remove or Disconnect

1. Disable the SIR system. Refer to "Disabling the SIR System" in this section.
2. Inflator module. Refer to "Inflator Module" in this section.
3. Steering wheel. Refer to "Steering Wheel" in this section.
4. Coil assembly retaining ring (5).

- Pull coil assembly (25) out and allow to hang.

CAUTION: Use a 1/2-inch wrench to hold the shaft of J 23653-C stationary when releasing the nut. Failure to do so may cause J 23653-C to fly off the steering shaft causing personal injury.

5. Shaft lock retaining ring using J 23653-C.
6. Shaft lock.
7. Cancelling cam.
8. Upper bearing spring.
9. Screw retaining signal switch arm.
10. Signal switch arm.
11. Screw retaining the hazard warning knob to the steering column.
12. Wiring protector (27) from steering column support.
13. Hazard warning knob (10) from the steering column (24).
14. Turn signal and hazard warning switch connector from the harness connector.

Important

- Use a magnet to remove the loosened screws from the turn signal and hazard warning switch to prevent them from falling down into the column.

15. Screws retaining the turn signal and hazard warning switch (26) to the steering column.

16. Turn signal and hazard warning switch (26) from the steering shaft.

Install or Connect

NOTICE: See "Notice" on page 3F4-1 of this section.

1. Turn signal and hazard warning switch connector to the harness connector.
2. Turn signal and hazard warning switch (26) to steering column shaft.
3. Screws retaining the turn signal and hazard warning switch to the steering column.

   Tighten

   - Screws to 3.1 N·m (27 lb. in.).
4. Wiring protector (27) to steering column support.
5. Hazard warning knob (10) to steering column (24).
6. Screw retaining hazard warning knob (10) to steering column (24).
7. Signal switch arm.
8. Screw retaining signal switch arm to the turn signal switch.

   Tighten

   - Screw to 2.2 N·m (19 lb. in.).
9. Upper bearing spring.
10. Cancelling cam.

    CAUTION: Use a 1/2-inch wrench to hold the shaft of J 23653-C stationary when releasing the nut. Failure to do so may cause J 23653-C to fly off the steering shaft causing personal injury.
11. Shaft lock.
12. Shaft lock retaining ring using J 23653-C.
13. Coil assembly (25) to steering column shaft.
14. Coil assembly retaining ring (5).
15. Steering wheel. Refer to "Steering Wheel" in this section.
16. Inflator module. Refer to "Inflator Module" in this section.
17. Enable the SIR system. Refer to "Enabling the SIR System" in this section.

Hazard Knob Assembly

Figure 1

Remove or Disconnect

1. Screw (7).
2. Hazard warning button (8), spring (9) and hazard warning knob (10).

Install or Connect

1. Hazard warning knob (10), spring (9) and hazard warning button (8).
2. Screw (7).

TILT LEVER

Figure 1

Remove or Disconnect

- Grip tilt lever (12) firmly and twist counterclockwise.

Install or Connect

- Grip tilt lever (12) firmly and twist clockwise.

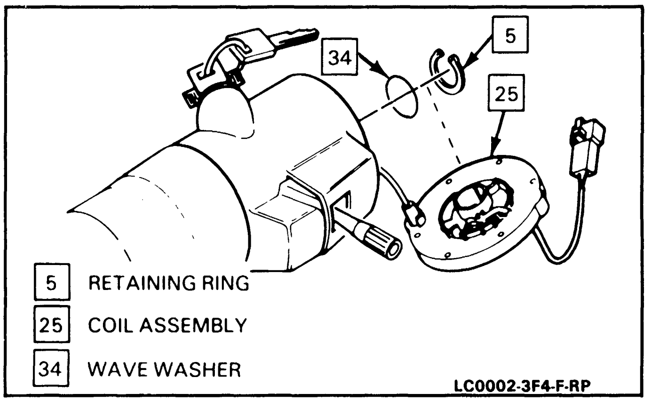


Figure 2 - Coil Assembly Off Shaft

MULTIFUNCTION TURN SIGNAL LEVER

Figure 4

Remove or Disconnect

- Multifunction lever (11).
  - Tilt lever, if equipped with cruise control, by grasping firmly and turning counterclockwise.
  - Make sure that the multifunction lever (11) is in the center or "OFF" position.
  - Housing cover end cap (28), if equipped with cruise control.

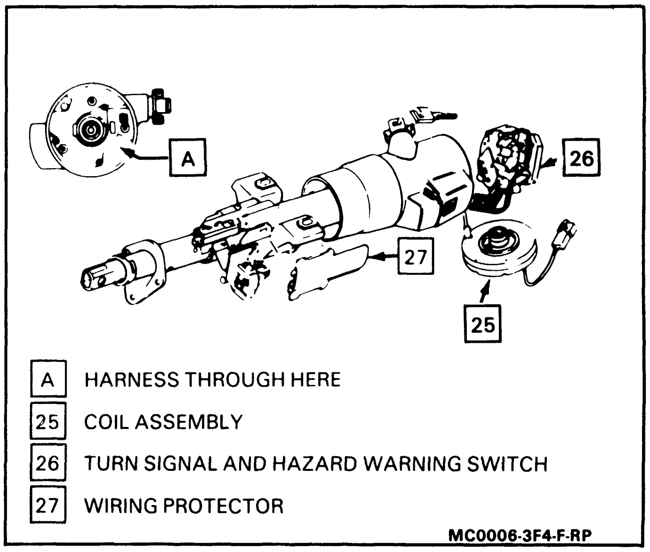


Figure 3 - Removing Turn Signal and Hazard Warning Switch

  - Cruise control connector, if equipped with cruise control.
  - Mulifunction lever (11) by pulling straight out of the turn signal switch.

Install or Connect

- Multifunction lever (11).
  - Push multifunction lever (11) into turn signal switch.
  - Cruise control connector, if equipped, to wiring harness connector.
  - Housing cover end cap (28), if equipped with cruise control.
  - Tilt lever, if removed, by grasping firmly and turning clockwise.

INFLATOR MODULE

Figure 1

Remove or Disconnect

1. Disable the SIR system. Refer to "Disabling the SIR System" in this section.
- Loosen screws (3) and lock nuts (2) from back of steering wheel (6) using a number 30 Torx® driver (or equivalent) until the inflator module (1) can be released from the steering wheel (6).
2. Inflator module (1) from steering wheel (6).

CAUTION: When carrying a live inflator module, make sure the bag and trim cover are pointed away from you. In case of an accidental deployment, the bag will then deploy with minimal chance of injury. When placing a live inflator module on a bench or other surface, always face the bag and trim cover up, away from the surface. This is necessary so that a free space is provided to allow the air bag to expand in the unlikely event of accidental deployment. Otherwise, personal injury may result. Also, never carry the inflator module by the wires or connector on the underside of the module.

3. Coil assembly connector and connector position assurance (CPA) from inflator module terminal.

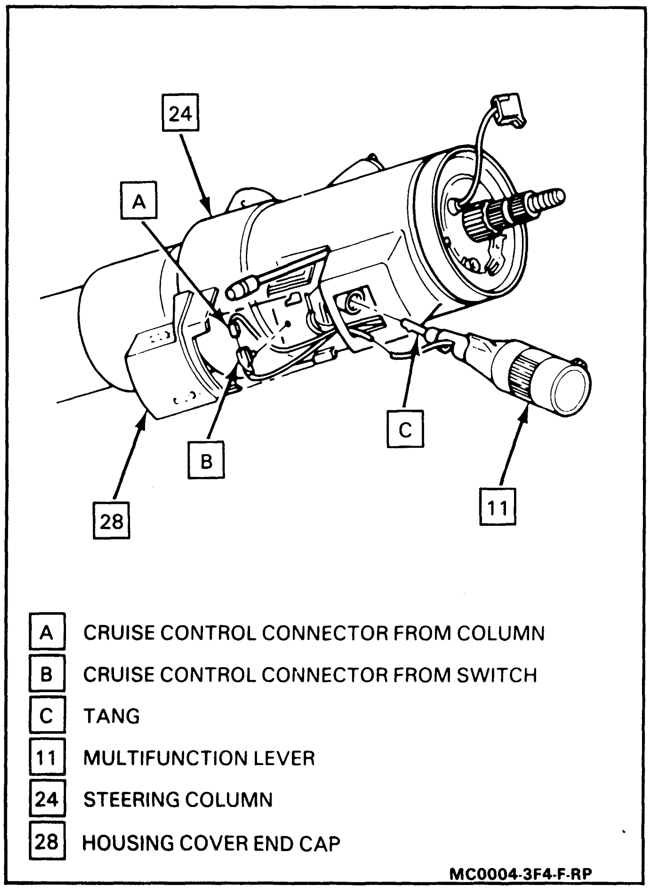


Figure 4 - Multifunction Turn Signal Lever

Install or Connect

NOTICE: See "Notice" on page 3F4-1 of this section.

1. Coil assembly connector and connector position assurance (CPA) to inflator module terminal.
2. Inflator module (1) to steering wheel (6).

Important

- Ensure that wiring is not exposed or trapped between inflator module and steering wheel.

Tighten

- Screws (3) to 2.8 N·m (25 lb. in.).

3. Enable the SIR system. Refer to "Enabling the SIR System" in this section.

STEERING WHEEL

Figure 1

Tool Required:

J 1859-03 Steering Wheel Puller

Remove or Disconnect

1. Inflator module from steering wheel. Refer to "Inflator Module" in this section.
2. Hexagon locking nut (4).

NOTICE: When removing the steering wheel, use only the specified steering wheel puller. Under no conditions should the end of the shaft be hammered on as hammering could loosen the plastic injections which maintain column rigidity.

NOTICE: When attaching J 1859-03 to the steering wheel, use care to prevent threading the side screws into the coil assembly and damaging the coil assembly.

3. Steering wheel (6) using J 1859-03 and horn contact.

Install or Connect

1. Coil assembly connector to steering wheel (6).
2. Horn contact.
3. Steering wheel (6).
    - Align block tooth on steering wheel (6) with block tooth on steering shaft within one female serration.
4. Hexagon locking nut (4).

Tighten

- Hexagon locking nut to 42 N·m (31 lb. ft.).

5. Inflator module. Refer to "Inflator Module" in this section.

INTERMEDIATE STEERING SHAFT

Figures 5 and 6

Remove or Disconnect

- Ensure that the front wheels are pointing straight ahead and the steering wheel is locked.

1. Coupling shield (20).
2. Bolt (23) from the flexible coupling (22) attaching the lower intermediate shaft (21) to the steering gear (29).
    - Push the intermediate shaft assembly rearward to disengage the latch from the steering gear (29).
3. Bolt (16) and nut (17) from the pot joint coupling (30) attaching the upper intermediate shaft (18) to the steering column (24).
4. Intermediate shaft assembly.

Disassemble

1. Upper intermediate shaft (18) and lower intermediate shaft (21) by pressing a 3/8-inch diameter rod up through the bottom of the flexible coupling (22).
2. Seal (19) and spring (33).

Assemble

- Before assembling the lower intermediate shaft (21) and upper intermediate shaft (18), apply lithium grease to the preload spring (33).

1. Spring (33) and seal (19).
2. Upper intermediate shaft (18) and lower intermediate shaft (21).
    - Align the slot in the lower coupling in relation to the upper coupling.
    - Press together.

Install or Connect

NOTICE: See "Notice" on page 3F4-1 of this section.

1. Flexible coupling (22) to the steering gear wormshaft splined ends.
    - Align the flat on the flexible coupling (22) with the flat on the wormshaft.
2. Coupling clamp pinch bolt (23).

Tighten

- Bolt (23) to 40 N·m (30 lb. ft.).

3. Bolt (16) and nut (17) to pot joint coupling attaching the upper intermediate shaft (18) to the steering column (24).

Tighten

- Nut (17) to 60 N·m (44 lb. ft.).

4. Coupling shield (20).
    - Latch of coupling shield (20) must be seated around the steering gear and return pipe nut.

CHECKING STEERING COLUMN FOR ACCIDENT DAMAGE

Figure 7

NOTICE: Vehicles involved in accidents resulting in frame damage, major body or sheet metal damage, or where the steering column has been impacted may also have a damaged or misaligned steering column. Failure to check the steering column for damage may result in component malfunction.

Inspect

1. Capsules on the steering column bracket assembly. They should be within 1.59 mm (0.063 inch) from the bottom of the slots.
    - If capsules are not within 1.59 mm (0.063 inch), the steering column bracket should be replaced, if the bracket is bolted to the jacket. If the bracket is welded to the jacket, replace jacket.
2. Contact surface of bolt to the capsules on the bracket. The bolt head must not contact the surface of the bracket or the capsule shear load will be increased.
    - If contact between bolt and bracket surface is made, replace the bracket if bracket is bolted to jacket. If bracket is welded to the jacket, replace jacket.
3. Jacket for collapse by measuring the distance from the end of the toe plate to the lower edge of the upper jacket.
    - If jacket dimensions are not 183.74 ± 2 mm, (7.234 ± 0.08 inch), a new jacket must be installed.
4. Steering shaft for sheared injected plastic.
    - If steering shaft shows sheared plastic and is not bent, it can be repaired by using a Service Steering Shaft Repair Package.
5. Steering shaft runout if any frame damage may have caused a bent steering shaft.

- Remove inflator module, steering wheel, and coil assembly, allowing coil assembly to hang freely without disconnecting it from the lower column.
- Remove intermediate shaft.

NOTICE: Failure to remove the coil assembly before the steering shaft is rotated may damage the coil assembly.

- Hold dial indicator against lower end of the steering shaft and rotate steering shaft. Runout should not exceed 1.59 mm (0.063 inch).
- If runout exceeds 1.59 mm (0.063 inch) replace the steering shaft.
- Install intermediate shaft.
- Install coil assembly, steering wheel, inflator module.

STEERING COLUMN REMOVAL

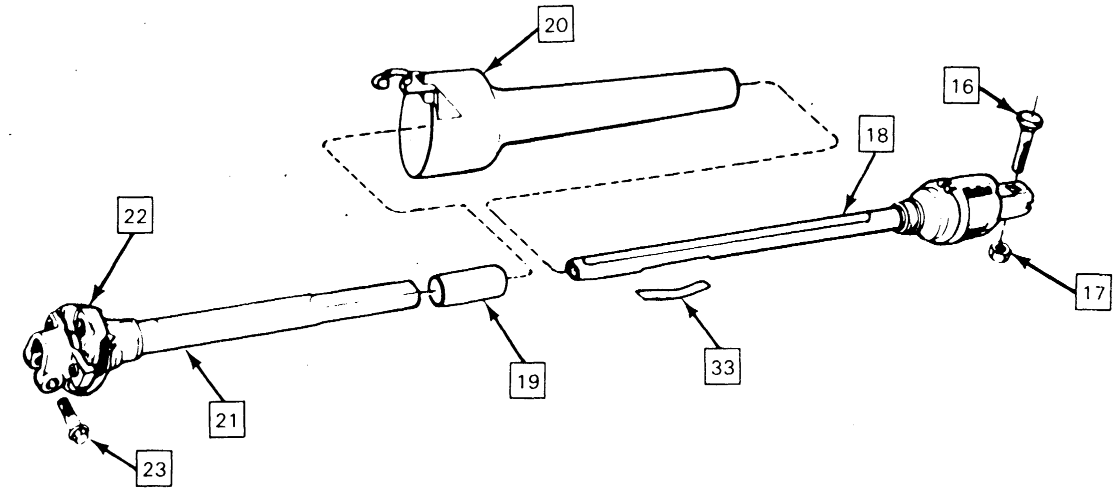
Figures 5, 6 and 8

NOTICE: The wheels of the vehicle must be straight ahead and the steering column in the "LOCK" position before disconnecting the steering column or intermediate shaft from the steering gear. Failure to do so will cause the coil assembly to become uncentered which will cause damage to the coil assembly.

NOTICE: When the steering column is removed from the vehicle, it is extremely susceptible to damage. Dropping column assembly on its end could collapse steering shaft or loosen plastic injections that keep the column rigid. Leaning on the column assembly could cause jacket to bend or deform. Any of the above conditions could impair column's collapsible design. If the steering wheel must be removed, use only the specified steering wheel puller. Never hammer on the end of the shaft because hammering could loosen plastic injections that keep the column rigid.

↔ Remove or Disconnect

1. Disable the SIR system. Refer to "Disabling the SIR System" in this section.
2. Bolt (16) and nut (17) from pot joint coupling (30) attaching upper intermediate shaft (18) to the steering column (24).
3. Steering wheel, if column is to be replaced or repaired on the bench. Refer to "Steering Wheel" in this section.
4. Knee bolster and bracket.
5. Bolts (13) attaching toe plate (15) to the cowl.
6. Electrical connectors.
7. Capsule nuts (32) attaching steering column support bracket (31) to the instrument panel.
8. Park lock cable from the ignition switch inhibitor, on vehicles with an automatic transmission. Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A).
9. Steering column (24) from the vehicle.



16	BOLT	21	LOWER INTERMEDIATE SHAFT
17	NUT	22	FLEXIBLE COUPLING
18	UPPER INTERMEDIATE SHAFT	23	BOLT
19	SEAL	33	SPRING
20	COUPLING SHIELD		

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Figure 5 - Disassembling Intermediate Steering Shaft

Install or Connect

NOTICE: If a service replacement steering column is being installed, do not remove the anti-rotation pin until after the steering column has been connected to the steering gear. Removing the anti-rotation pin before the steering column is connected to the steering gear may damage the SIR coil assembly.

NOTICE: See "Notice" on page 3F4-1 of this section.

1. Steering column (24) into vehicle.
2. Park lock cable to the ignition switch inhibitor on vehicles with an automatic transmission. Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A).
3. Capsule nuts (32) attaching steering column support bracket (31) to the instrument panel.

Tighten

- Capsule nuts (32) to 27 N·m (20 lb. ft.).

4. Bolt (16) and nut (17) to pot joint coupling (30) attaching the upper intermediate shaft (18) to the steering column (24).

Tighten

- Nut (17) to 60 N·m (44 lb. ft.).

5. Bolts (13) attaching toe plate (15) to the cowl.

Tighten

- Bolts to 6.5 N·m (58 lb. in.).

6. Electrical connectors.
7. Anti-rotation pin if service replacement steering column (24) is being installed.
8. Knee bolster and bracket.
9. Sound insulator panel.

- If a service replacement steering column is being installed:
  - Remove hexagon locking nut.
  - Remove coil assembly shipping cover and disengage connector from cover.

10. Steering wheel, if removed. Refer to "Steering Wheel" in this section.

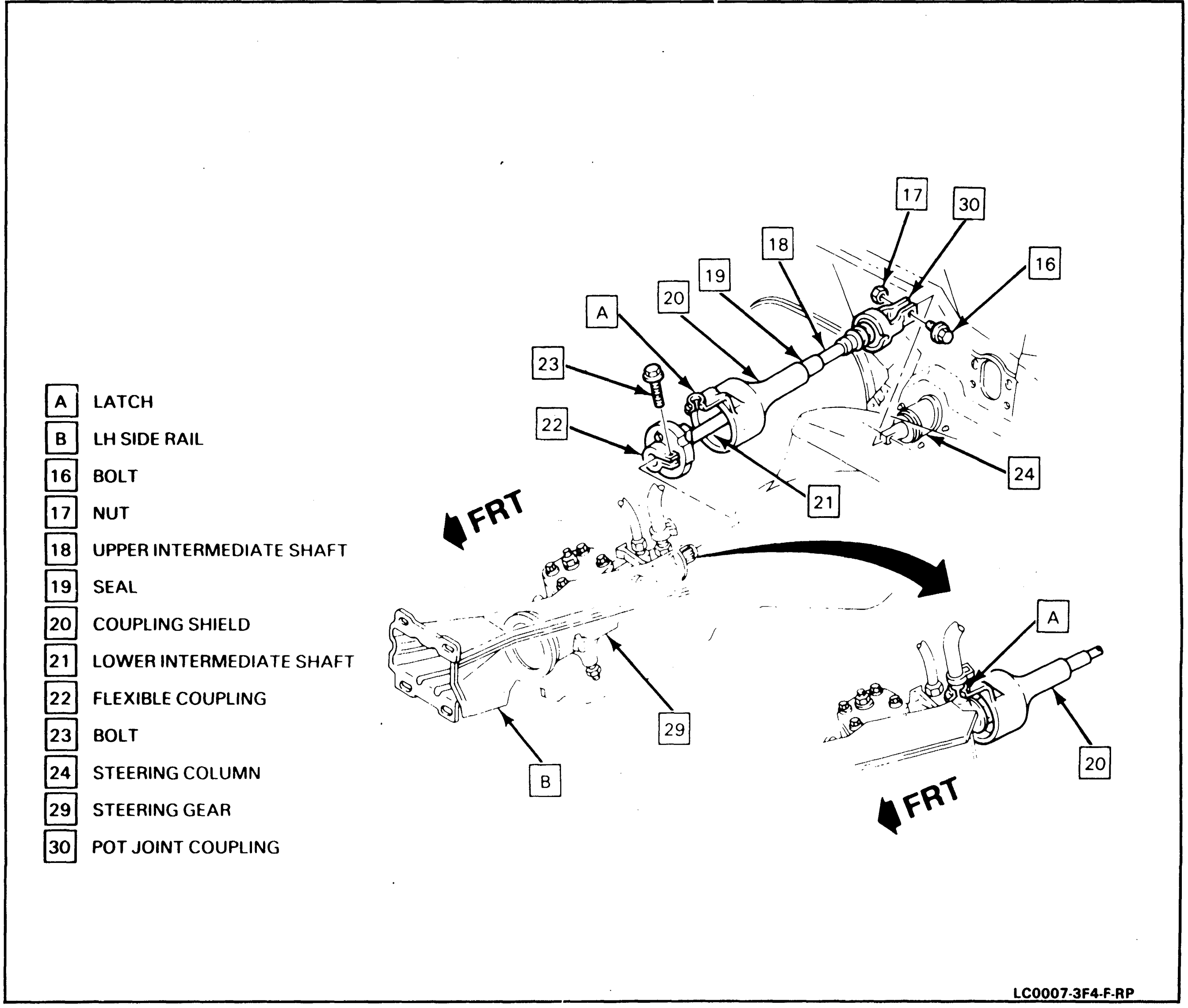

Figure 6 - Installing Intermediate Steering Shaft

11. Enable the SIR system. Refer to "Enabling the SIR System" in this section.

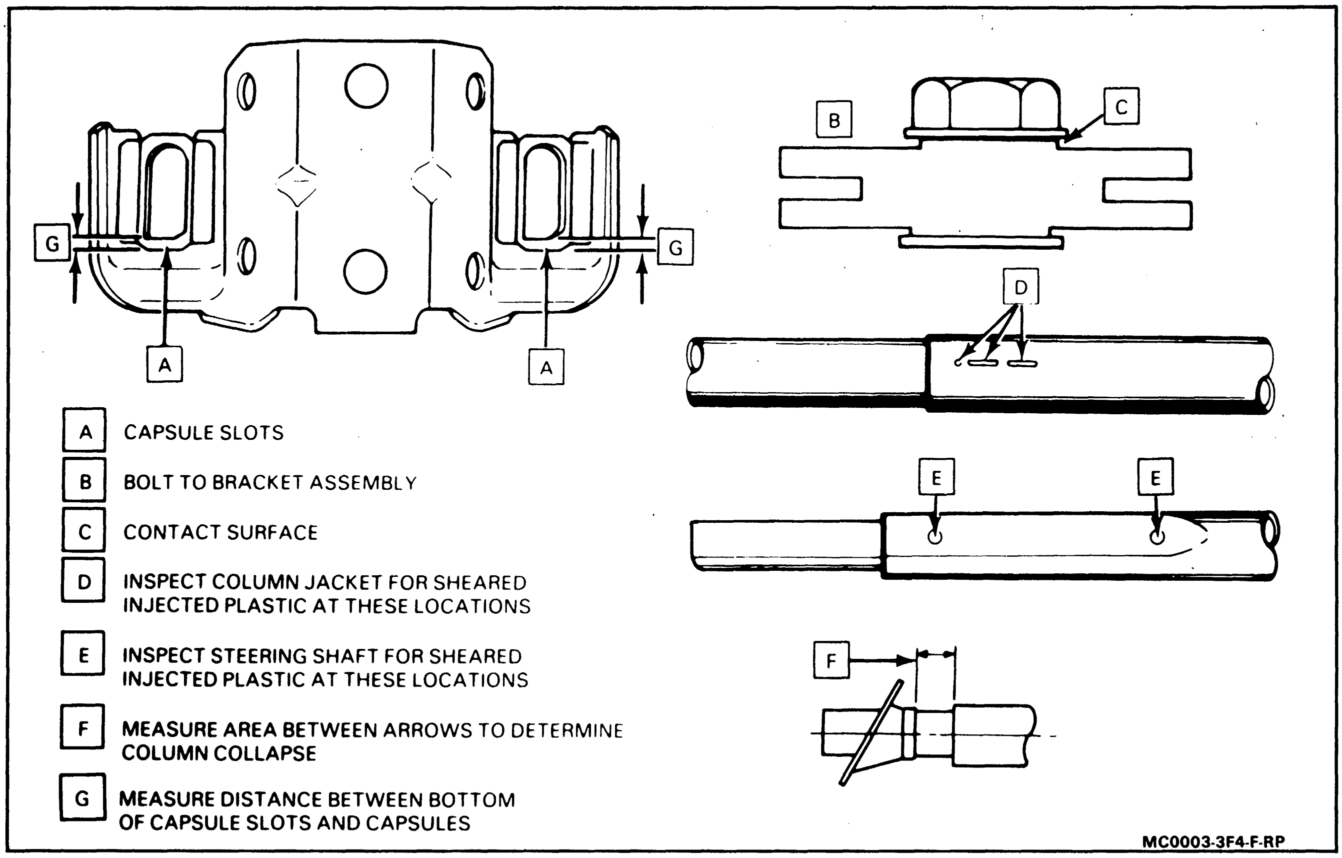

Figure 7 - Checking Steering Column for Accident Damage

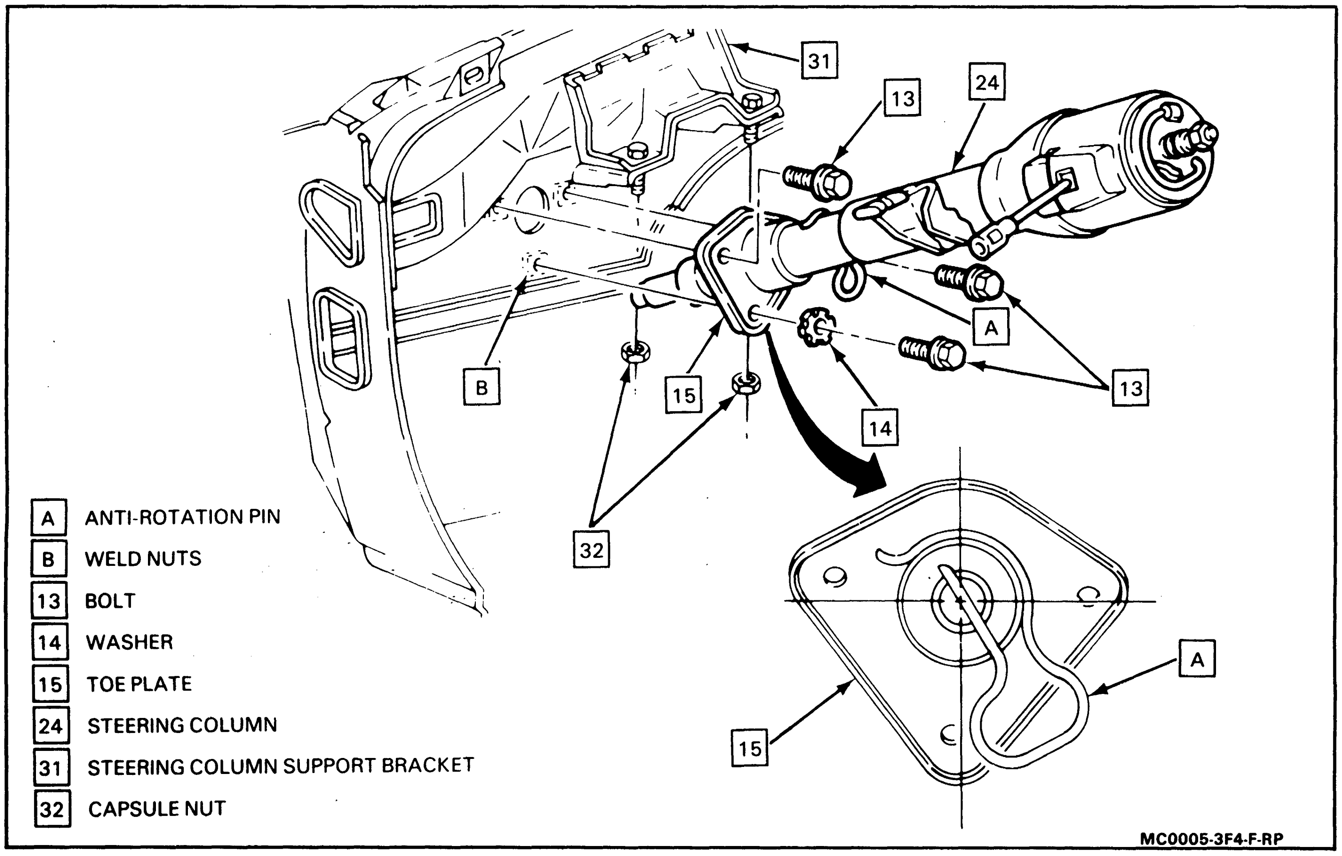

Figure 8 - Installing Steering Column

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Steering Wheel-to-Steering Column Locking Nut	42 N·m (31 lb. ft.)
Turn Signal and Hazard Warning Switch-to-Steering Column Screw	3.1 N·m (27 lb. in.)
Signal Switch Arm-to-Turn Signal and Hazard Warning Switch	2.2 N·m (19 lb. in.)
Inflator Module-to-Steering Wheel Screw	2.8 N·m (25 lb. in.)
Coupling Clamp Pinch Bolt	40 N·m (30 lb. ft.)
Pot Joint Coupling-to-Steering Column Nut	60 N·m (44 lb. ft.)
Steering Column-to-Bracket Capsule Nuts	27 N·m (20 lb. ft.)
Toe Pan-to-Cowl Bolts	6.5 N·m (58 lb. in.)

SPECIAL TOOLS

1 STEERING WHEEL PULLER

2 LOCK PLATE COMPRESSOR

MC0017-3F4-B-RP

SECTION 3F4-A

STEERING COLUMN UNIT REPAIR - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT

CAUTION: Before proceeding with this section, perform the procedures in 3F4 referenced in this section. Review and follow all CAUTIONS and NOTICES in Sections 3F4 and 3F4-A. Failure to do so may result in personal injury, air bag deployment, or unnecessary SIR system repairs.

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 3F4-A-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

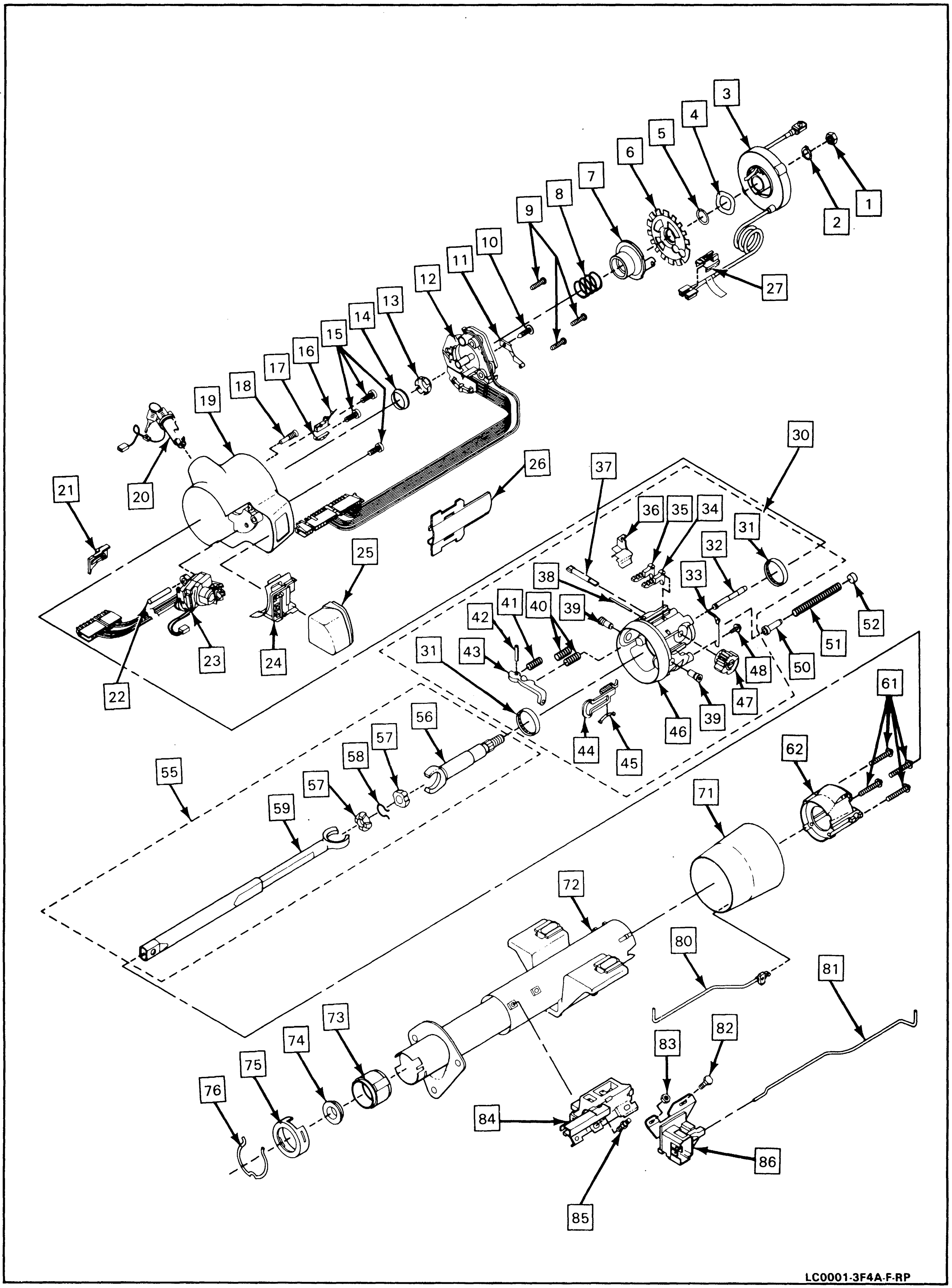

Figure 1 - Steering Column (SIR)

1	HEXAGON LOCKING NUT
2	RETAINING RING
3	COIL ASSEMBLY
4	WAVE WASHER
5	RETAINING RING
6	SHAFT LOCK
7	TURN SIGNAL CANCELLING CAM
8	UPPER BEARING SPRING
9	SCREW
10	SCREW
11	SIGNAL SWITCH ARM
12	TURN SIGNAL AND HAZARD WARNING SWITCH
13	UPPER BEARING INNER RACE SEAT
14	INNER RACE
15	SCREW
16	BUZZER SWITCH
17	BUZZER SWITCH RETAINING CLIP
18	LOCK RETAINING SCREW
19	LOCK HOUSING COVER
20	VATS LOCK CYLINDER SET
21	DIMMER SWITCH ROD ACTUATOR
22	SWITCH ACTUATOR PIVOT PIN
23	PIVOT AND PULSE SWITCH
24	HOUSING COVER END BASE PLATE
25	HOUSING COVER END CAP
26	WIRING PROTECTOR
27	CONNECTOR SHROUD
30	STEERING COLUMN HOUSING
31	BEARING
32	LOCK BOLT
33	LOCK BOLT SPRING
34	STEERING WHEEL LOCK SHOE
35	STEERING WHEEL LOCK SHOE
36	WIRE ABRASION SHIELD
37	DRIVE SHAFT
38	DOWEL PIN
39	PIVOT PIN
40	SHOE SPRING
41	RELEASE LEVER SPRING
42	RELEASE LEVER PIN
43	SHOE RELEASE LEVER
44	SWITCH ACTUATOR RACK
45	RACK PRELOAD SPRING
46	STEERING COLUMN HOUSING
47	SWITCH ACTUATOR SECTOR
48	SCREW
50	SPRING GUIDE
51	WHEEL TILT SPRING
52	SPRING RETAINER
55	STEERING COLUMN SHAFT
56	RACE AND UPPER SHAFT
57	CENTERING SPHERE
58	JOINT PRELOAD SPRING
59	LOWER STEERING SHAFT
61	SCREW
62	STEERING COLUMN HOUSING SUPPORT
71	STEERING COLUMN HOUSING SHROUD
72	STEERING COLUMN JACKET
73	LOWER BEARING ADAPTER
74	BEARING
75	BEARING ADAPTER RETAINER
76	LOWER BEARING CLIP
80	IGNITION SWITCH ACTUATOR
81	DIMMER SWITCH ROD
82	SCREW
83	NUT
84	IGNITION SWITCH
85	DIMMER AND IGNITION SWITCH MOUNTING STUD
86	DIMMER SWITCH

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Figure 2 - Steering Column (SIR) - Legend

UNIT REPAIR

UPPER COLUMN COMPONENTS

Inflator Module, Steering Wheel Coil Assembly, Shaft Lock, Turn Signal Cancelling Cam, Upper Bearing Spring, Upper Bearing Seat, Inner Race, Turn Signal Switch, Buzzer Switch, and VATS Lock Cylinder Set

Figures 1 through 11

Tool Required:

J 23653-C Lock Plate Compressor

↔ Remove or Disconnect

NOTICE: The wheels of the vehicle must be turned to the straight-ahead position prior to beginning service procedures. Failure to do so can result in the coil assembly being removed without being centered. Reinstalling the coil assembly under such circumstances will cause the ribbon in the coil assembly to break when the steering wheel is turned fully in one direction. The key must always be in "LOCK" position to prevent the wheel from turning and uncentering the coil assembly. To recenter the coil assembly, refer to "Centering the Coil Assembly" in this section.

1. Inflator module. Refer to STEERING WHEEL UPPER COLUMN ON-VEHICLE SERVICE - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4).
2. Steering wheel. Refer to STEERING WHEEL UPPER COLUMN ON-VEHICLE SERVICE - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4).
3. Knee bolster.
4. Coil assembly retaining ring (2).

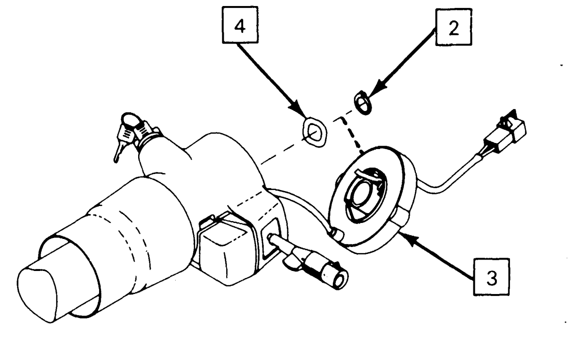
! Important

- The coil assembly will become uncentered if the column is separated from the steering gear and is allowed to rotate, or the centering spring is depressed allowing the hub to rotate while the coil is removed from the column. If the coil becomes uncentered, refer to "Centering the Coil Assembly" in this section.

5. Coil assembly (3) off shaft end, allowing coil to hang freely.
6. Wave washer (4).

CAUTION: Use a 1/2-inch wrench to hold the shaft of J 23653-C stationary when releasing the nut. Failure to do so may cause J 23653-C to fly off the steering shaft causing personal injury.

7. Shaft lock retaining ring (5), using J 23653-C to depress shaft lock (6).
8. Shaft lock (6).
9. Turn signal cancelling cam (7).
10. Upper bearing spring (8).
11. Upper bearing inner race seat (13).
12. Inner race (14).



2 RETAINING RING
3 COIL ASSEMBLY
4 WAVE WASHER

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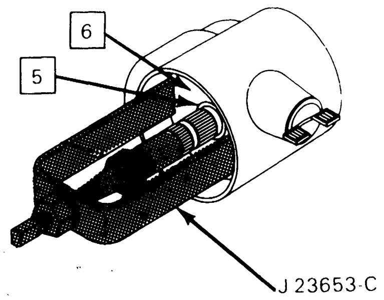
Figure 3 - Removing Coil Assembly



5 RETAINING RING
6 SHAFT LOCK

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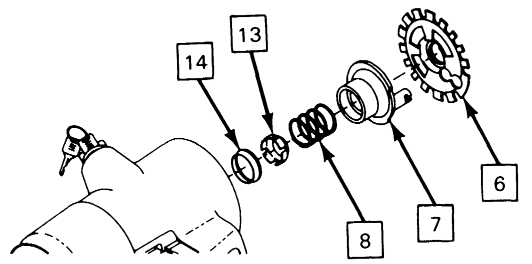
Figure 4 - Removing Shaft Lock Retaining Ring

13. Multifunction lever to "Right Turn" (up) position.
14. Multifunction lever. Refer to STEERING WHEEL UPPER COLUMN ON-VEHICLE SERVICE - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4).
15. Screw (10) and signal switch arm (11).
16. Turn signal switch screws (9).
17. Hazard knob assembly. Refer to STEERING WHEEL UPPER COLUMN ON-VEHICLE SERVICE - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4).



6 SHAFT LOCK
7 TURN SIGNAL CANCELLING CAM
8 UPPER BEARING SPRING
13 UPPER BEARING INNER RACE SEAT
14 INNER RACE

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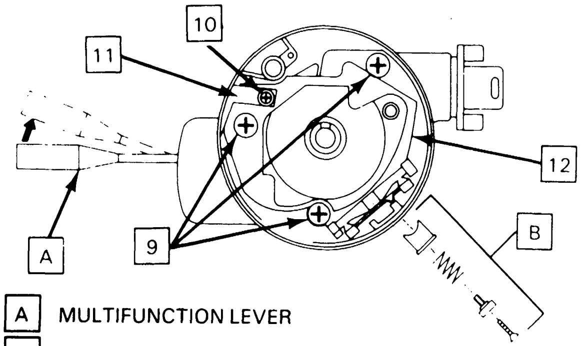
Figure 5 - Removing Components from Upper Shaft



A MULTIFUNCTION LEVER
B HAZARD KNOB ASSEMBLY
9 SCREW
10 SCREW
11 SIGNAL SWITCH ARM
12 TURN SIGNAL AND HAZARD WARNING SWITCH

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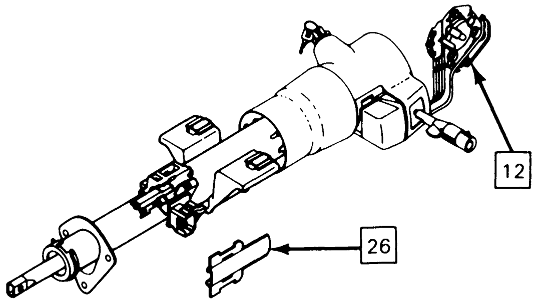
Figure 6 - Preparation for Turn Signal and Hazard Warning Switch Removal

18. Turn signal and hazard warning switch (12). Allow switch to hang freely if removal is not necessary.
    - To remove turn signal and hazard warning switch (12).
        - Remove wiring protector (26).
        - Disconnect turn signal switch connector at lower steering column.
        - Gently pull wire harness through steering column housing (46), and lock housing cover (19).

NOTICE: Connector shroud must be removed from connector before pulling connector through column, or parts may be damaged.

19. Coil assembly (3), if necessary.
    - To remove coil assembly (3):



12 TURN SIGNAL SWITCH
26 WIRING PROTECTOR

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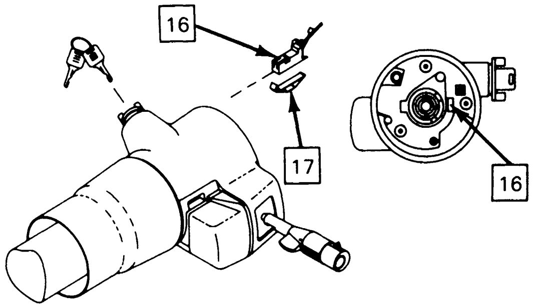
Figure 7 - Removing Turn Signal and Hazard Warning Switch



16 BUZZER SWITCH
17 BUZZER SWITCH RETAINING CLIP

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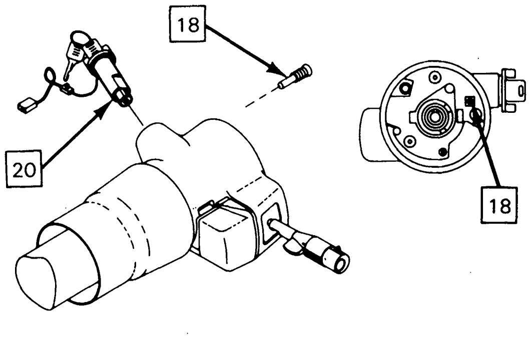
Figure 8 - Removing Buzzer Switch



18 LOCK RETAINING SCREW
20 VATS LOCK CYLINDER SET

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Figure 9 - Removing VATS Lock Cylinder Set

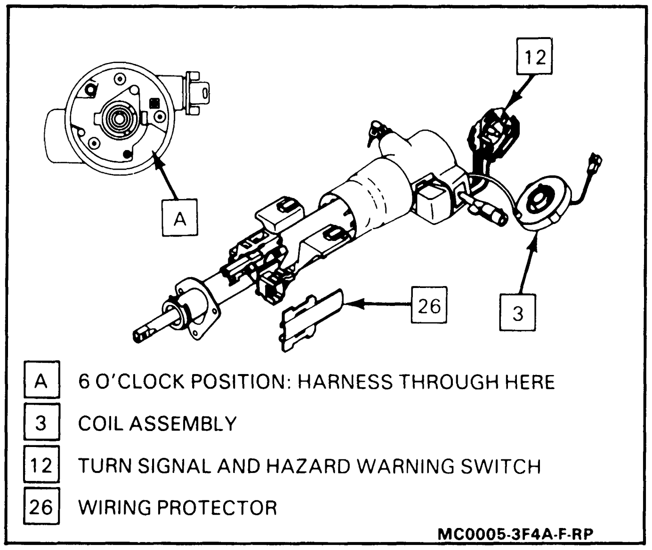


Figure 10 - Wire Harnesses Through Column

- Remove connector shroud (27) from terminal connector.
- Remove wiring protector (26).
- Attach a mechanic's wire to the coil assembly connector at the base of the steering column.
- Gently pull the wire up through the steering column housing shroud (71), steering column housing (46), and lock housing cover (19).

20. Key from VATS lock cylinder set (20).
21. Buzzer switch (16) and buzzer switch retaining clip (17).

- Reinsert key in VATS lock cylinder set (20) and place key in "LOCK" position.

22. Lock retaining screw (18).
23. VATS lock cylinder set (20).
    - Disconnect terminal connector.
    - Gently pull wire through steering column housing shroud (71), steering column housing (46), and lock housing cover (19).

Install or Connect

NOTICE: See "Notice" on page 3F4-A-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying required torque. Failure to do so may result in component damage or malfunctioning of steering column.

1. VATS lock cylinder set (20) by routing wire through lock housing cover (19), steering column housing (46) and steering column housing shroud (71).
2. Lock retaining screw (18).

Tighten

- Lock retaining screw (18) to 2.5 N·m (22 lb. in.).

3. Key in "RUN" position.
4. Buzzer switch (16) and buzzer switch retaining clip (17).
5. Turn signal and hazard warning switch (12) wire harness through lock housing cover (19), steering column housing (46), and steering column housing shroud (71).

Important

- If a deployment has occured, inspect the coil assembly wire for any signs of scorching, melting, or damage due to excesive heat. If the coil assembly wire is damaged, replace the entire coil assembly.

6. Coil assembly (3) wire through lock housing cover (19), steering column housing (46), and steering column housing shroud (71). Allow coil assembly (3) to hang freely.
7. Connector shroud (27) to terminal connector.
8. Turn signal and hazard warning switch (12).
    - If turn signal and hazard warning switch was removed, route wire harness through steering column housing (30) and lock housing cover (19) and connect.
    - Install wiring protector (26).
9. Screws (9).

Tighten

- Screws (9) to 3.1 N·m (27 lb. in.).

10. Signal switch arm (11) and screw (10).

Tighten

- Screw (10) to 2.3 N·m (20 lb. in.).

11. Hazard knob assembly. Refer to STEERING WHEEL UPPER COLUMN ON-VEHICLE SERVICE - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4A).
12. Multifunction lever. Refer to STEERING WHEEL UPPER COLUMN ON-VEHICLE SERVICE - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4A).
13. Inner race (14).
14. Upper bearing inner race seat (13).
15. Upper bearing spring (8).
16. Turn signal cancelling cam (7).
17. Shaft lock (6).

Inspect

- Shaft lock retaining ring (5) for damage or deformation. If damaged or deformed, replace with new retaining ring (5).

18. Shaft lock retaining ring (5). Align to block tooth on shaft using J 23653-C to depress shaft lock (6).

NOTICE: Set the steering shaft so that the block teeth on the steering shaft are at the 12 o'clock and 6 o'clock positions. The alignment mark at the end of the shaft should be at the 12 o'clock position and the vehicle wheels straight ahead. Ensure that the ignition switch is in the "LOCK" position. Failure to follow these procedures may damage the coil assembly.

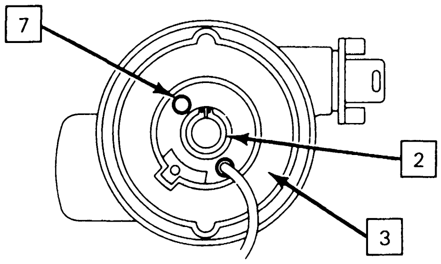
- Ensure coil assembly hub is centered. If the coil assembly (3) needs to be centered, refer to "Centering the Coil Assembly" in this section.

19. Wave washer (4).
20. Coil assembly (3) using horn tower on turn signal cancelling cam inner ring and projections on outer ring for alignment.

! Important

- Pull coil assembly wire down through the column until all the slack has been taken up.

21. Coil assembly retaining ring (2).
22. Knee bolster.
23. Steering wheel. Refer to STEERING WHEEL UPPER COLUMN ON-VEHICLE SERVICE - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4).
24. Inflator module. Refer to STEERING WHEEL UPPER COLUMN ON-VEHICLE SERVICE - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4).



2 RETAINING RING
3 COIL ASSEMBLY
7 TURN SIGNAL CANCELLING CAM

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Figure 11 - Installing Coil Assembly

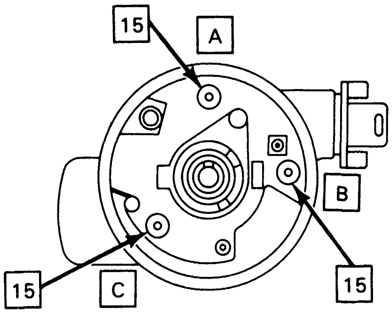
UPPER HOUSING AND TILT MECHANISM

Lock Housing Cover, Cover End Cap, Pivot and Pulse Switch, Dimmer Switch Rod Actuator, and Tilt Spring

Figures 12 through 16

↔ Remove or Disconnect

1. Upper column components. Refer to "Upper Column Components" in this section.
2. Housing cover end cap (25).



A 12 O'CLOCK
B 3 O'CLOCK
C 8 O'CLOCK
15 SCREW

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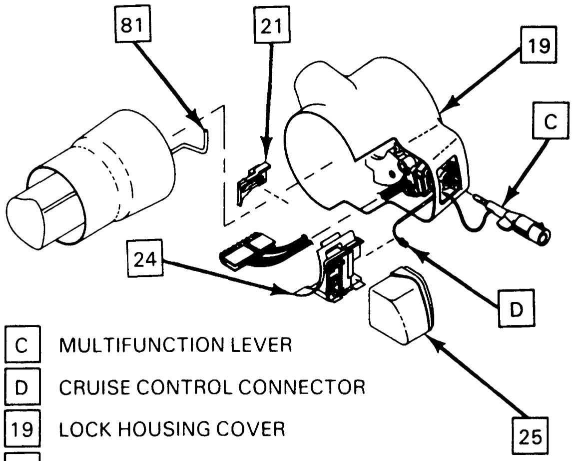
Figure 12 - Lock Housing Cover Screw Positions



C MULTIFUNCTION LEVER
D CRUISE CONTROL CONNECTOR
19 LOCK HOUSING COVER
21 DIMMER SWITCH ROD ACTUATOR
24 HOUSING COVER END BASE PLATE
25 HOUSING COVER END CAP
81 DIMMER SWITCH ROD

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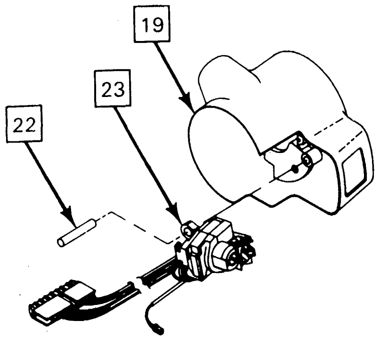
Figure 13 - Removing Lock Housing Cover



19 LOCK HOUSING COVER
22 SWITCH ACTUATOR PIVOT PIN
23 PIVOT AND PULSE SWITCH

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Figure 14 - Pivot and Pulse Switch Removal

- On cruise control equipped columns, unplug connector from housing cover end base plate (24), and remove multifunction lever.

3. Cover screws (15).
4. Tilt lever by grasping firmly and turning counterclockwise.
5. Lock housing cover (19).
6. Housing cover end base plate (24) and dimmer switch rod actuator (21) from lock housing cover (19).

- Gently pull pivot switch wire harness through steering column housing shroud (71) and steering column housing (46).

7. Switch actuator pivot pin (22).
8. Pivot and pulse switch (23).
9. Spring retainer (52), using a cross recess head screwdriver.
    - Push spring retainer (52) down and turn counterclockwise to disengage.
10. Wheel tilt spring (51) and spring guide (50).

Install or Connect

NOTICE: See "Notice" on page 3F4-A-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying required torque. Failure to do so may result in component damage or malfunctioning of steering column.

1. Spring guide (50) and wheel tilt spring (51) coated with lithium grease.
2. Spring retainer (52), using a cross recess head screwdriver.
    - Push spring retainer (52) down and turn clockwise to lock in place
3. Pivot and pulse switch (23) to lock housing cover (19).
4. Switch actuator pivot pin (22) to pivot and pulse switch (23) and lock housing cover (19).
5. Pivot and pulse switch wire harness through steering column housing (46) and steering column housing shroud (71).
6. Dimmer switch rod actuator (21) to housing cover end base plate (24).
7. Housing cover end base plate (24) to lock housing cover (19). Bottom edge of dimmer switch rod actuator (21) should rest on bend in dimmer switch rod (81).
8. Lock housing cover (19).
9. Tilt lever by grasping firmly and turning clockwise.

- On cruise control equipped columns, plug multifunction lever connector and cruise control wires together and mount on housing cover end base plate (24). Install multifunction lever.

10. Housing cover end cap (25).
11. Screws (15). Tighten screw in 12 o'clock position first, screw in 8 o'clock position second, and screw in 3 o'clock position third.

Tighten

- Screws (15), in the order listed above to 9 N·m (80 lb. in.).

12. Upper column components. Refer to "Upper Column Components" in this section.

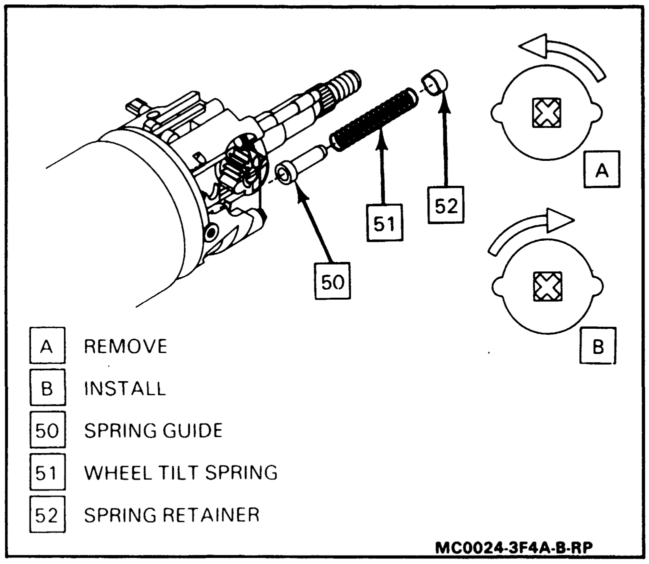


Figure 15 - Removing Tilt Spring Assembly

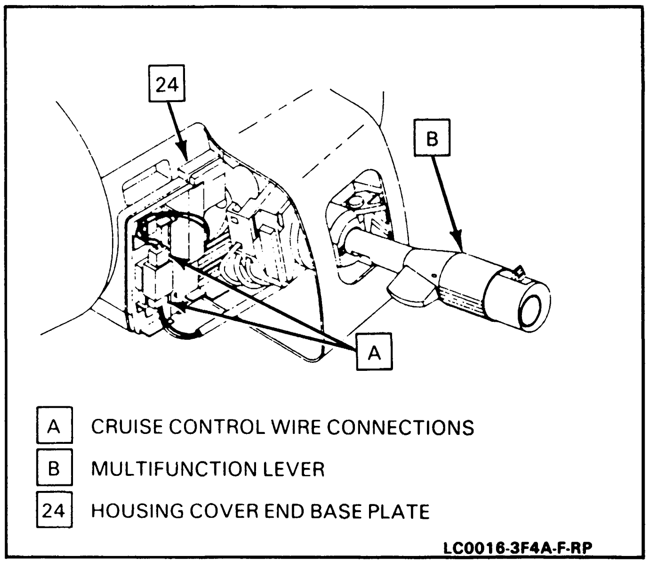


Figure 16 - Cruise Control Connections

MIDDLE COLUMN COMPONENTS

Column Housing, Lock Shoes, Actuator Sector Assembly, Switch Actuator Rack, Bearings, and Lock Bolt Assembly

Figures 1 through 20

Tools Required:

J 21854-01 Pivot Pin Remover

J 22635 Lock Shoe and Release Lever Pin Remover and Installer

Remove or Disconnect

NOTICE: Once steering column is removed from vehicle the column is extremely susceptible to damage. Dropping column assembly on its end could collapse steering shaft or loosen plastic injections which maintain column rigidity. Leaning on column assembly could cause jacket to bend or deform. Any of the above damage could impair column's collapsible design. If it is necessary to remove steering wheel, use only the specified steering wheel puller. Under no conditions should the end of the shaft be hammered on as hammering could loosen plastic injections which maintain column rigidity.

1. Column from vehicle. Refer to STEERING WHEEL UPPER COLUMN ON-VEHICLE SERVICE - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4).
2. Upper column components. Refer to "Upper Column Components" in this section.
3. Upper housing and tilt mechanism. Refer to "Upper Housing and Tilt Mechanism" in this section.
   - It is not necessary to remove switch actuator pivot pin (22) and pivot and pulse switch (23).

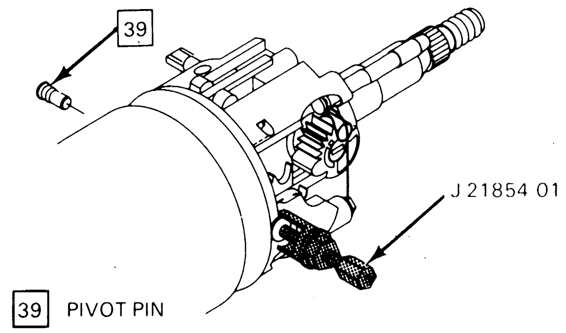
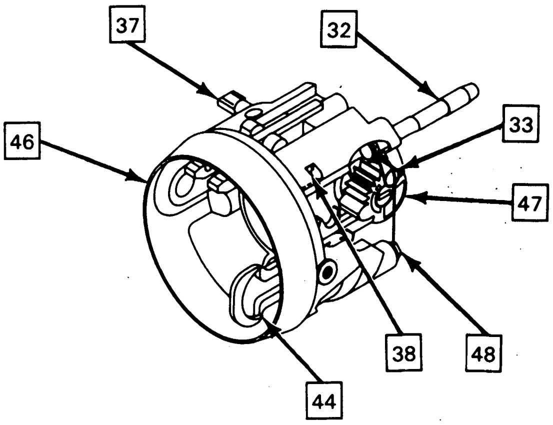


Figure 17 - Removing Pivot Pin

4. Pivot pins (39) using J 21854-01.
   - Reinstall tilt lever by grasping firmly and turning clockwise.
5. Steering column housing (46). Pull back on tilt lever and pull steering column housing (46) down and away from column.
6. Wire abrasion shield (36).
7. Drive shaft (37).
8. Switch actuator sector (47).
9. Switch actuator rack (44) and rack preload spring (45).
10. Release lever pin (42), using J 22635.
11. Shoe release lever (43).
12. Release lever spring (41).
13. Dowel pin (38).
14. Steering wheel lock shoes (34, 35), using J 22635.
15. Shoe springs (40).



32	LOCK BOLT
33	LOCK BOLT SPRING
37	DRIVE SHAFT
38	DOWEL PIN
44	SWITCH ACTUATOR RACK
46	STEERING COLUMN HOUSING
47	SWITCH ACTUATOR SECTOR
48	SCREW

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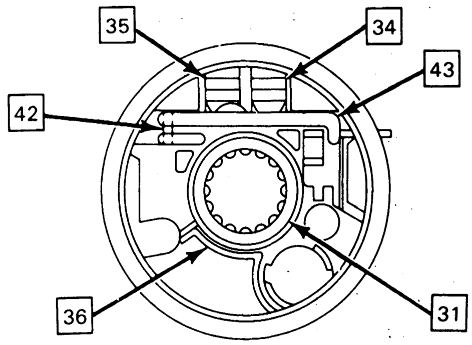
Figure 18 - Lock Housing Cover Assembly, Exterior

16. Bearing (31).
17. Screw (48).
18. Lock bolt spring (33).
19. Lock bolt (32).



31	BEARING
34	STEERING WHEEL LOCK SHOE
35	STEERING WHEEL LOCK SHOE
36	WIRE ABRASION SHIELD
42	RELEASE LEVER PIN
43	SHOE RELEASE LEVER

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Figure 19 - Lock Housing Cover Assembly, Interior

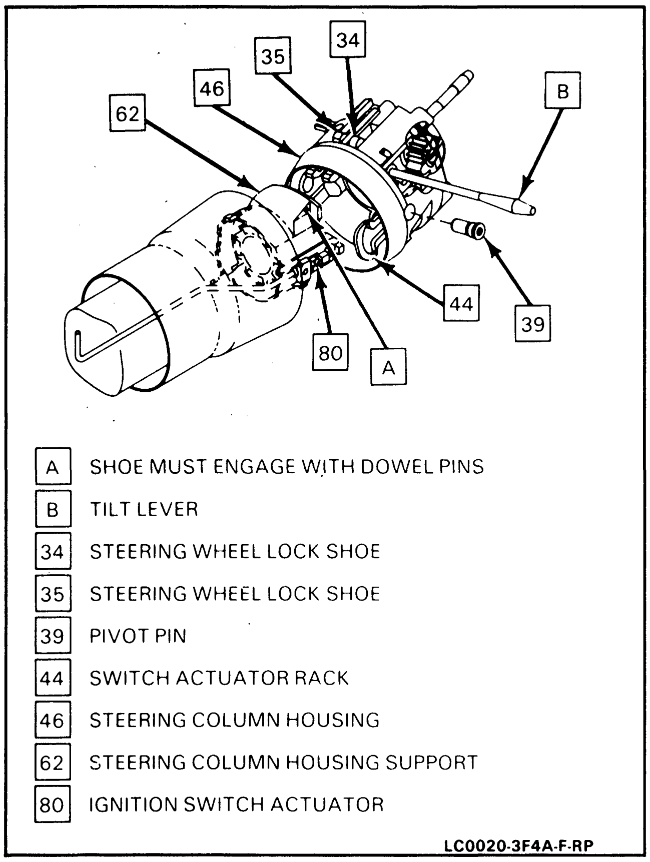


Figure 20 - Column Housing to Housing Support

Install or Connect

NOTICE: See "Notice" on page 3F4-A-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying required torque. Failure to do so may result in component damage or malfunctioning of steering column.

1. Bearing (31) to steering column housing (46).
2. Drive shaft (37).
3. Switch actuator sector (47).
4. Steering wheel lock shoes (34, 35), using J 22635.
5. Dowel pin (38).
6. Shoe springs (40).
7. Release lever spring (41).
8. Shoe release lever (43).
9. Release lever pin (42), using J 22635.
10. Rack preload spring (45).
11. Switch actuator rack (44) to switch actuator sector (47).
12. Lock bolt (32).
13. Lock bolt spring (33).
14. Screw (48).

Tighten

- Screw (48) to 4 N·m (35 lb. in.).

15. Wire abrasion shield (36).
16. Steering column housing (46) to column.
    - Position steering column housing (46) and align switch actuator rack (44) with pin on end of ignition switch actuator (80).
    - Pull back on tilt lever, pushing steering column housing (46) onto steering column housing support (62).
    - Release tilt lever to lock steering wheel lock shoes (34, 35) onto dowel pins.
- Remove tilt lever by grasping firmly and turning counterclockwise.
17. Pivot pins (39) lubricated with lithium grease.
    - Press pivot pin (39) until it is firmly seated.
18. Upper housing and tilt mechanism components. Refer to "Upper Housing and Tilt Mechanism" in this section.
19. Upper colum components. Refer to "Upper Column Components" in this section.
20. Column to vehicle. Refer to STEERING WHEEL UPPER COLUMN ON-VEHICLE SERVICE - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4).

LOWER COLUMN COMPONENTS

Shaft Assembly, Column Housing Support, Ignition Switch, Dimmer Switch, and Lower Bearing Assembly

Figures 1 through 27

Tool Required:

J 21854-01 Pivot Pin Remover

Remove or Disconnect

1. Upper column components. Refer to "Upper Column Components" in this section.
2. Upper housing and tilt mechanism. Refer to "Upper Housing and Tilt Mechanism" in this section.
    - It is not necessary to remove switch actuator pivot pin (22) and pivot and pulse switch (23).
3. The following middle column components:
    - Pivot pins (39) using J 21854-01.
        - Reinstall tilt lever by grasping firmly and turning clockwise.
    - Steering column housing (46). Pull back on tilt lever and pull steering column housing (46) down and away from column.
4. Column from vehicle. Refer to STEERING WHEEL UPPER COLUMN ON-VEHICLE SERVICE - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4).

NOTICE: Once steering column is removed from vehicle, the column is extremely susceptible to damage. Dropping column assembly on its end could collapse steering shaft or loosen plastic injections which maintain column rigidity. Leaning on column assembly could cause jacket to bend or deform. Any of the above damage could impair column's collapsible design. If it is necessary to remove steering wheel, use only the specified steering wheel puller. Under no conditions should the end of shaft be hammered on as hammering could loosen plastic injections which maintain column rigidity.

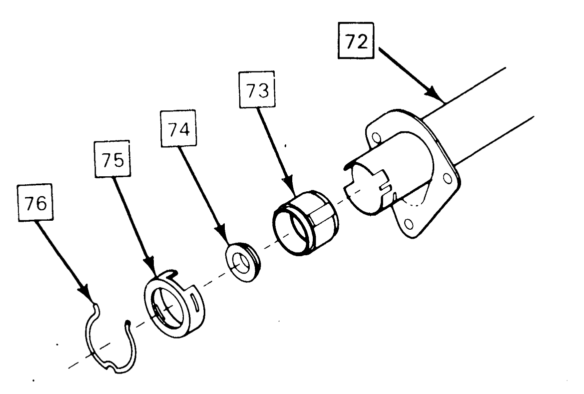
NOTICE: If the vehicle has been in an accident, inspect the column for damage. A damaged column may cause the steering system to malfunction. Refer to STEERING WHEEL UPPER COLUMN ON-VEHICLE SERVICE - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4).

5. Lower bearing adapter clip (76).
6. Bearing adapter retainer (75).
7. Bearing (74).
8. Lower bearing adapter (73).
9. Steering column shaft (55).

Important

- Mark race and upper shaft (56) and lower steering shaft (59) to ensure proper assembly. Failure to assemble properly will cause steering wheel to be turned 180 degrees.

10. Race and upper shaft (56), lower steering shaft (59).
    - Tilt 90 degrees to each other and disengage.
11. Centering sphere (57) from race and upper shaft (56).
    - Rotate centering sphere (57) 90 degrees and slip out.



72 STEERING COLUMN JACKET
73 LOWER BEARING ADAPTER
74 BEARING
75 BEARING ADAPTER RETAINER
76 LOWER BEARING ADAPTER CLIP

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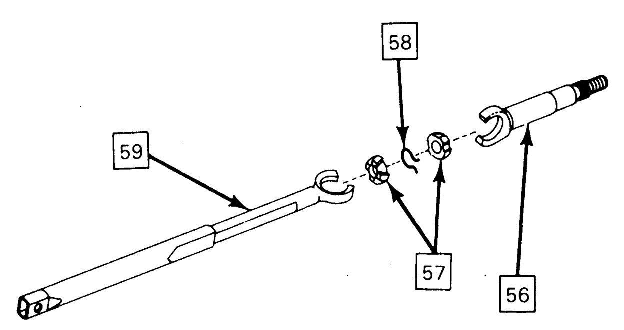
Figure 21 - Lower Bearing Assembly



56 RACE AND UPPER SHAFT
57 CENTERING SPHERE
58 JOINT PRELOAD SPRING
59 LOWER STEERING SHAFT

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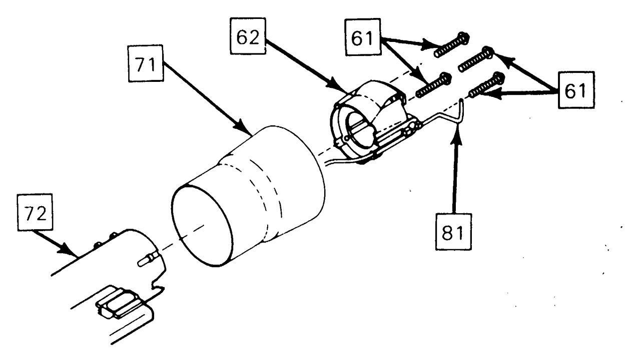
Figure 22 - Shaft Assembly



61 SCREW
62 STEERING COLUMN HOUSING SUPPORT
71 STEERING COLUMN HOUSING SHROUD
72 STEERING COLUMN JACKET
81 DIMMER SWITCH ROD

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Figure 23 - Column Housing Support Assembly

12. Joint preload spring (58) from centering sphere (57).
13. Screws (61).
14. Steering column housing support (62), dimmer switch rod (81), and steering column housing shroud (71) from steering column jacket (72).
15. Dimmer switch rod (81) from steering column housing support (62).
16. Nut (83) and screw (82).
17. Dimmer switch (86).
18. Dimmer and ignition switch mounting stud (85).
19. Ignition switch (84) and ignition switch actuator (80).
20. Ignition switch actuator (80) from ignition switch (84).

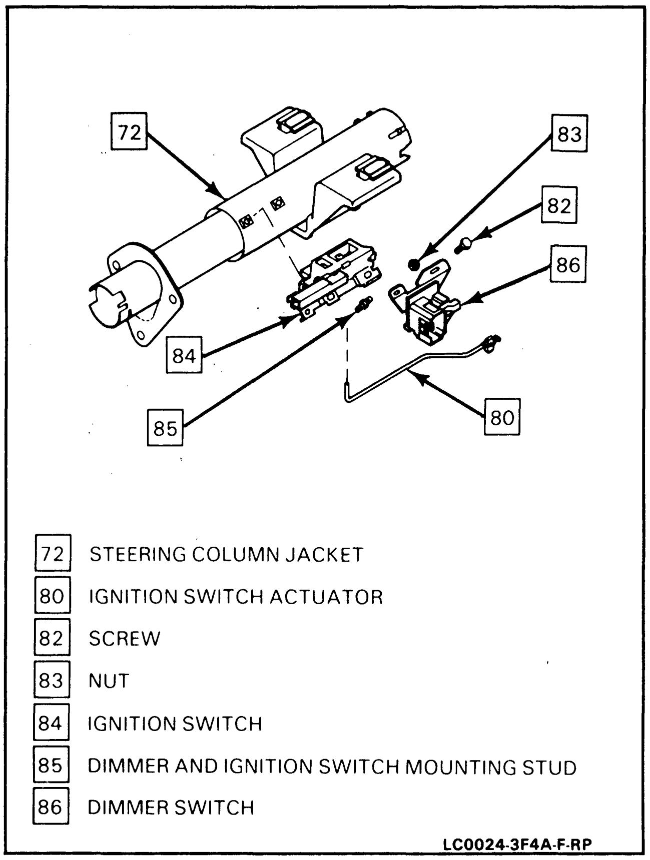


Figure 24 - Ignition and Dimmer Switches

Install or Connect

NOTICE: See "Notice" on page 3F4-A-1 of this section.

NOTICE: Ensure all fasteners are securely seated before applying required torque. Failure to do so may result in component damage or malfunctioning of steering column.

1. Steering column housing shroud (71) to steering column jacket (72).
2. Dimmer switch rod (81) to steering column housing support (62).
3. Steering column housing support (62) and screws (61).

   Tighten

   - Screws (61) to 8.7 N•m (77 lb. in.).
4. Ignition switch actuator (80) to track in steering column housing support (62).
5. Joint preload spring (58) to centering sphere (57).
6. Centering sphere (57). Lubricate with lithium grease and slip into race and upper shaft (56) and rotate 90 degrees.

   Important

   - Marks made on race and upper shaft (56) and lower steering shaft (59) must line up after assembly. Failure to assemble properly will cause steering wheel to be turned 180 degrees.
7. Race and upper shaft (56) to lower steering shaft (59). Block tooth on end of race and upper shaft (56) at the 12 o'clock position; notch at end of lower steering shaft (59) in the 4 o'clock position.
   - Line up marks and tilt assemblies 90 degrees to each other.
8. Steering column shaft (55), lubricated with lithium grease, to steering column jacket (72).
9. Middle column components. Refer to "Middle Column Components" in this section.
10. Upper housing and tilt mechanism. Refer to "Upper Housing and Tilt Mechanism" in this section.
11. Upper column components. Refer to "Upper Column Components" in this section.
12. Lower bearing adapter (73), inner surface lubricated with lithium grease.
13. Bearing (74).
14. Bearing adapter retainer (75).
15. Lower bearing adapter clip (76).
16. Ignition switch actuator (80) to ignition switch (84).
17. Ignition switch (84) and dimmer and ignition switch mounting stud (85).

    Tighten

    - Dimmer and ignition switch mounting stud (85) to 4 N•m (35 lb. in.).

    Adjust

    - Ignition switch (84) (Figure 26).
18. Dimmer switch (86), screw (82), and nut (83).

    Adjust

    - Dimmer switch (86).
      - Depress switch mechanism slightly to insert 3/32-inch drill bit (Figure 27).
      - Move dimmer switch (86) to remove lash.

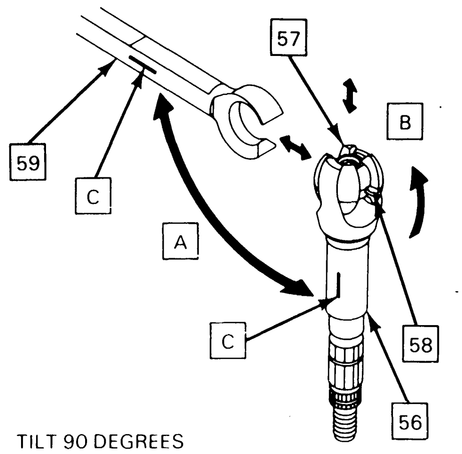
    Tighten

    - Nut (83) to 4 N•m (35 lb. in.).
19. Column to vehicle instrument panel. Refer to STEERING WHEEL UPPER COLUMN ON-VEHICLE SERVICE - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4).

CENTERING THE COIL ASSEMBLY

Figure 28

The following procedure describes centering of a coil assembly that has been removed from the steering column. Replacement coil assemblies are provided precentered and include a blue plastic tab which is snapped off once the coil is installed. Always align the front wheels to the straight-ahead position when installing or removing a coil assembly. If a coil is removed without the wheels in the straight-ahead



A	TILT 90 DEGREES AND SEPARATE
B	ROTATE SPHERE 90 DEGREES AND LIFT
C	ALIGNMENT MARK
56	RACE AND UPPER SHAFT
57	CENTERING SPHERE
58	JOINT PRELOAD SPRING
59	LOWER STEERING SHAFT

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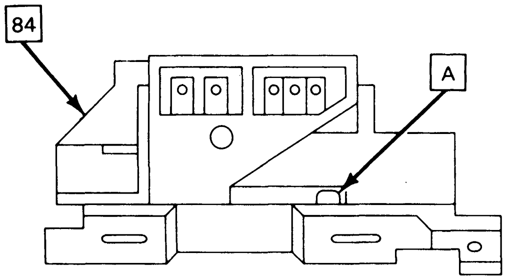
Figure 25 - Upper to Lower Shaft Orientation



A	MOVE SWITCH SLIDER TO EXTREME RIGHT POSITION AND THEN MOVE SLIDER ONE DETENT TO THE LEFT (OFF LOCK)
84	IGNITION SWITCH

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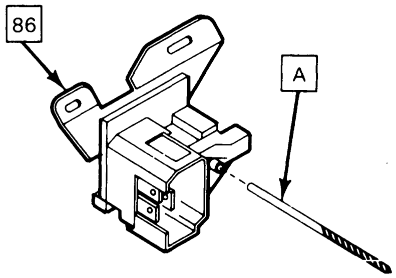
Figure 26 - Ignition Switch Adjustment

position and the steering wheel has not been moved, the same coil can be reinstalled if the coil hub also has not been rotated.



A	3/32 INCH DRILL BIT
86	DIMMER SWITCH

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Figure 27 - Dimmer Switch Adjustment

Remove or Disconnect

- Coil assembly from column. Refer to "Upper Column Components" in this section.

Adjust

- Hold coil assembly with clear bottom up to see coil ribbon.

Important

  - There are two different styles of coil assemblies. One rotates clockwise and the other rotates counterclockwise.

- While holding coil assembly housing, depress lock spring and rotate hub in direction of arrow until it stops. The coil assembly should now be wound up snug against the center hub.
- Rotate coil assembly hub in opposite direction approximately 2 1/2 turns. Release lock spring between locking tabs in front of arrow.

Install or Connect

- Coil assembly to column. Refer to "Upper Column Components" in this section.
- Start engine and rotate the wheels lock to lock.
- Turn the ignition switch to "OFF."
- Turn the ignition switch to "RUN" and verify that the "INFLATABLE RESTRAINT" indicator flashes 7 to 9 times and then turns off. If the indicator does not respond as stated, refer to the SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM DIAGNOSIS (SEC. 9J-A).

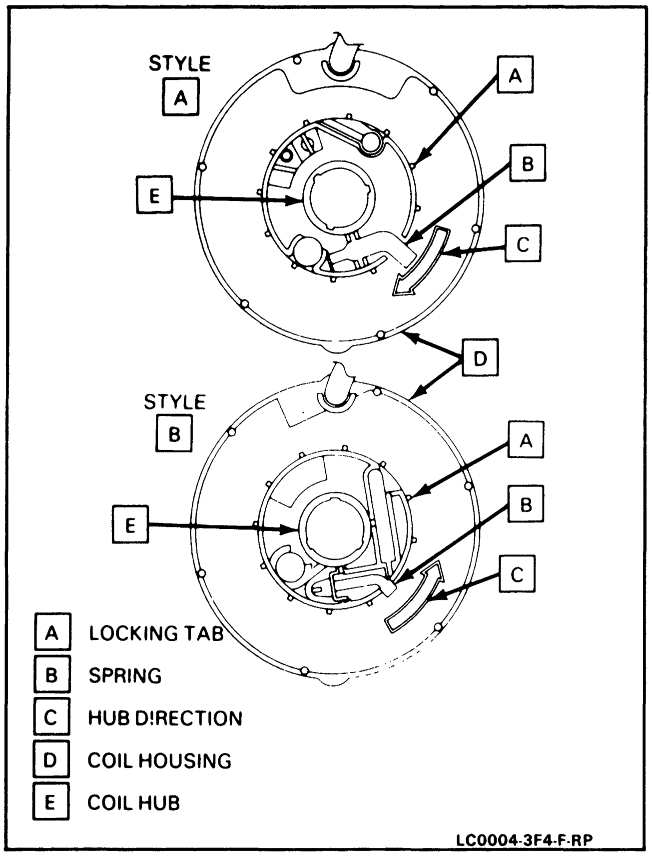


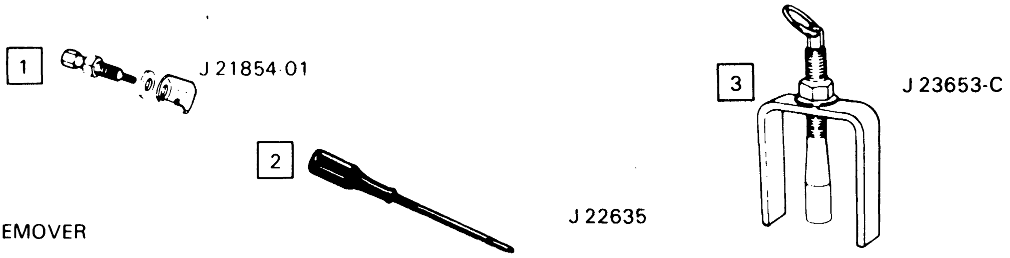
Figure 28 - Centering the Coil Assembly

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Turn Signal Switch-to-Steering Column Screw	3.1 N·m (27 lb. in.)
VATS Lock Cylinder-to-Steering Column Screw	2.5 N·m (22 lb. in.)
Turn Signal Switch Arm-to-Turn Signal Switch Screw	2.3 N·m (20 lb. in.)
Housing Cover End Cap-to-Steering Column Screw	9 N·m (80 lb. in.)
Column Housing Support-to-Steering Column Screw	8.7 N·m (77 lb. in.)
Ignition Switch-to-Steering Column Jacket Stud	4 N·m (35 lb. in.)
Dimmer Switch-to-Steering Column Nut	4 N·m (35 lb. in.)
Lock Bolt Spring-to-Steering Column Housing Screw	4 N·m (35 lb. in.)

SPECIAL TOOLS



1 PIVOT PIN REMOVER

2 LOCK SHOE AND RELEASE LEVER PIN REMOVER AND INSTALLER

3 LOCK PLATE COMPRESSOR

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SECTION 4A

PROPELLER SHAFT

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 4A-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

PROPELLER SHAFT

Figure 1

Torque is transmitted from the transmission to the rear axle differential carrier through the one-piece propeller shaft and universal joint assemblies.

A universal joint (3) and splined slip yoke (1) are located at the transmission end of the propeller shaft (2) where they are held in alignment by a bushing in the transmission extension housing. The slip yoke (1) permits fore-and-aft movement of the propeller shaft (2) as the differential assembly moves up and down. The spline is lubricated internally by transmission lubricant. An oil seal in the transmission extension housing prevents fluid leakage and protects the slip yoke from dust, dirt and other harmful material.

A second universal joint (3) is used where the propeller shaft (2) connects to the rear axle pinion yoke.

If a vehicle is to be undercoated, the propeller shaft (2) must be kept completely free of undercoating material. Undercoating material or any other foreign material will upset the propeller shaft balance and produce serious vibration.

UNIVERSAL JOINT

The universal joints are lubricated for life and consist of spider and bearing assemblies. The spider is shaped like a cross having arms of equal length called trunnions. If it becomes necessary to replace a universal joint, the entire propeller shaft must be removed from the vehicle. Care should be taken to avoid jamming or bending any parts of the assembly.

On vehicles with steel propeller shafts, production universal joint bearing caps are retained by nylon injected rings. Aluminum propeller shafts and all service replacement universal joints use snap rings to retain the bearing caps.

DIAGNOSIS

Four major component groups are usually the cause of or are related to vibration.

- Engine and mounts.
- Transmission and mount.
- Tires, wheels and brake drums/rotors.
- Propeller shafts and universal joints.

Before road testing a vehicle, check the following:

1. All fasteners for tightness at universal joint, wheel nuts and engine transmission mounts.
2. Tire air pressure.
3. Load conditions.

ROAD TEST

Road test the vehicle to verify the vibration. Record the speed and rpm at which the greatest vibration occurs. The vibration is likely to be in two places, in the steering wheel or in the seat bottom. The road test can be helpful in locating the vibration source.

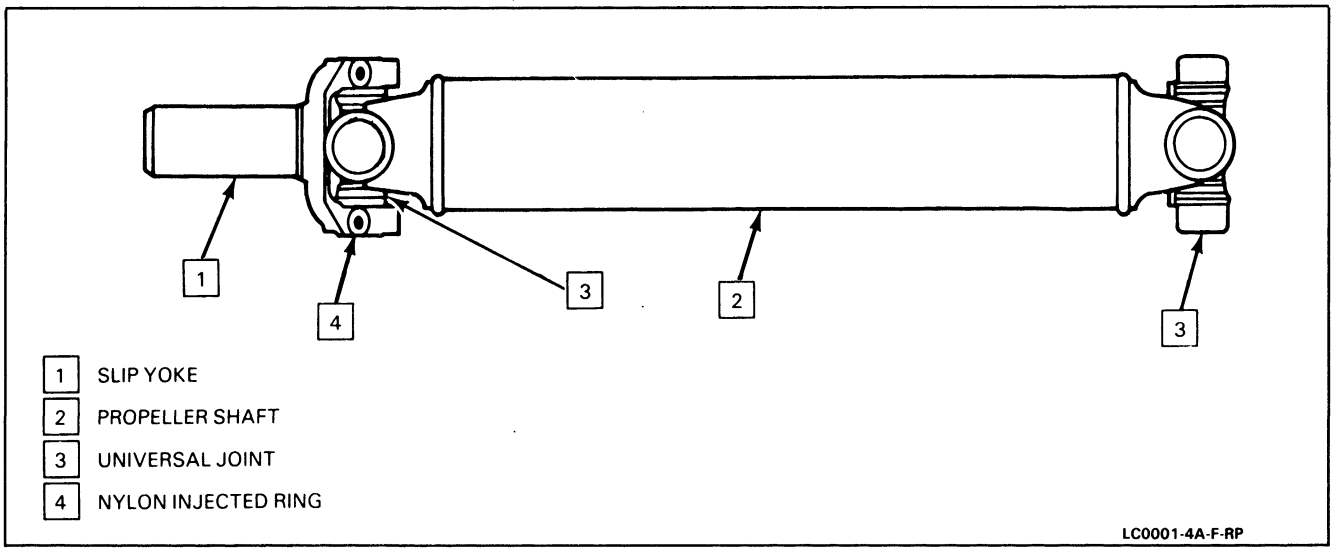


Figure 1 - Typical Propeller Shaft

COAST TEST

NOTICE: When performing a "Coast Test" on a vehicle equipped with an automatic transmission, caution must be taken when returning selector lever from "NEUTRAL"to "DRIVE" to avoid transmission damage. When shifting from "NEUTRAL" to "DRIVE," remember to:

1. Maintain engine speed at 1500 rpm.
2. Brake to 40 km/h (25 mph).
3. Return selector to "DRIVE."

Drive the vehicle past the vibration speed, shift into "NEUTRAL" and coast back through the vibration speed. During a coast test two kinds of vibration normally occur: a shaking or a buzzing. A shaking vibration is usually the tires or a wheel and brake drum or rotor assembly problem. A buzzing vibration is usually a driveline problem.

DIAGNOSIS OF PROPELLER SHAFT

PROBLEM	POSSIBLE CAUSE	CORRECTION
Leak at front slip yoke. (An occasional drop of lubricant leaking from the slip yoke is normal and requires no attention.)	1. Rough outside surface on slip yoke.	1. Replace the seal if cut by burrs on yoke. Minor burrs can be smoothed by careful use of crocus cloth or honing with a fine stone. Replace the yoke if the outside surface is rough or burred badly.
	2. Faulty transmission rear oil seal.	2. Replace the transmission rear oil seal. Bring transmission oil up to the proper level after correction.
Knock in driveline; clunking noise when vehicle is operated under float condition at 16 km/h (10 mph) in high gear or "NEUTRAL."	1. Worn or damaged universal joints.	1. Replace universal joints.
	2. Side gear hub counterbore in differential worn oversize.	2. Replace the differential case and/or side gears as required.

Ping, snap, or clicking noise in driveline.	1. Loose upper or lower control arm bushing bolts. 2. Worn or damaged universal joints.	1. Tighten the bolts to specified torque. 2. Replace universal joint.
Scraping noise.	1. Slinger rubbing on the rear axle carrier.	1. Straighten the slinger to remove interference.

To determine whether the propeller shaft is causing the problem, drive the vehicle through the speed range and note at which vehicle speed the problem is most pronounced. Shift the transmission into a lower gear range and drive the vehicle at the same speed as when the problem was most pronounced.

If the problem is still present at the same vehicle speed, the propeller shaft may be at fault. Refer to the propeller shaft diagnostic chart.

ON-VEHICLE SERVICE

PROPELLER SHAFT RUNOUT MEASUREMENT

Noise or vibration at high speed could be caused by a bent propeller shaft. The propeller shaft could have been damaged by rough handling or a collision. Check for propeller shaft straightness.

1. Raise the vehicle on a twin post hoist so that the rear is supported on the rear axle housing and the wheels can spin. Refer to GENERAL INFORMATION (SEC. 0A).
2. Mount a dial indicator on a movable support that is high enough to permit contact of the indicator button with the propeller shaft, or mount the dial indicator to a magnetic base and attach to a smooth place on the vehicle underbody. Readings are to be taken at points indicated as shown (Figure 3).
3. With transmission in "NEUTRAL," check for runout by turning a rear wheel to rotate the propeller shaft.

NOTICE: Care must be taken not to include indicator variation caused by ridges, flat spots or other variations in the tube.

4. If runout exceeds specifications, disconnect propeller shaft at pinion yoke and rotate the propeller 180 degrees. Reinstall propeller shaft. Check runout again.
5. If runout is still over specifications, check rear axle pinion yoke for runout. If runout is still over specifications, replace the propeller shaft, but only after checking for vibration or noise.
6. Lower the vehicle.

PINION YOKE RUNOUT MEASUREMENT

Figure 4

Tools Required:

J 35819 Companion Flange Runout Gage

J 8001 Dial Indicator Set

1. Raise the vehicle on a twin post hoist so the rear is supported on the rear axle housing and the wheels can spin. Refer to GENERAL INFORMATION (SEC. 0A).
2. Measure pinion yoke runout using J 35819 and J 8001. Record runout and mark high and low points of pinion yoke.
3. If pinion yoke runout is 0.15 mm (0.006 inch) or less, remove the pinion yoke balance weight, if used. No further action is required.
4. If pinion yoke runout is over 0.15 mm (0.006 inch), but less than 0.28 mm (0.011 inch) and the balance weight is at or near the low point of pinion yoke runout, no further action is required. If balance weight is not at or near the low point of pinion yoke runout, remove the weight.
5. If pinion yoke runout is over 0.28 mm (0.011 inch), but no greater than 0.38 mm (0.015 inch) and the balance weight is at or near the low point of pinion yoke runout, no further action is required.
6. If the balance weight is not at or near the low point of pinion yoke runout, remove the weight and rotate the pinion yoke until runout is 0.25 mm (0.010 inch) or less.
7. If impossible to achieve 0.25 mm (0.010 inch) or less runout, install a new pinion yoke and recheck for 0.25 mm (0.010 inch) or less runout.

— Service replacement pinion yokes are not equipped with balance weights and no weights should be added.

8. Lower the vehicle.

UNIVERSAL JOINT ANGLE MEASUREMENT

Figures 3 and 4

When torque is transmitted through any ordinary universal joint, the driven yoke fluctuates slightly in speed. In other words, although the driving yoke rotates at a constant speed, the driven yoke speeds up and slows down twice per revolution. This fluctuation of the driven yoke is in direct proportion to the angle through which the universal joint is operating; the greater the angle, the greater the fluctuation.

When two universal joints are used, this fluctuation effect can be eliminated by staggering the joints so that the driving yokes are 90 degrees apart, provided the two joints are transmitting torque through the same angle.

Therefore, when two universal joints are used, the angles through which they operate must be very nearly the same. This allows the alternate acceleration and deceleration of one joint to be offset by the alternate acceleration and deceleration of the second joint. When the two joints do not run at approximately the same angle, operation is rough and an objectionable vibration is produced.

PROPELLER SHAFT DIAGNOSIS

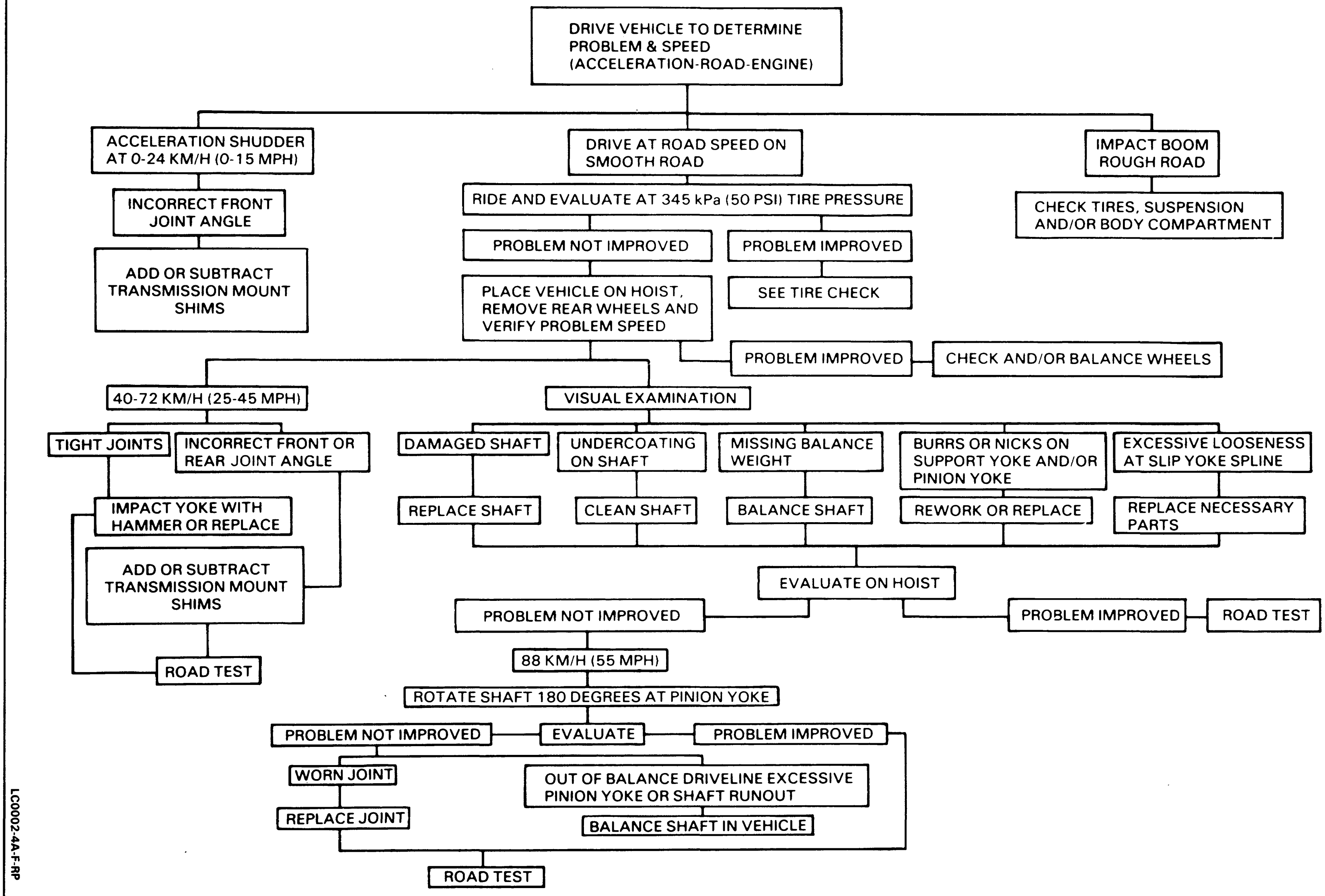


Figure 2 - Propeller Shaft Diagnostic Chart

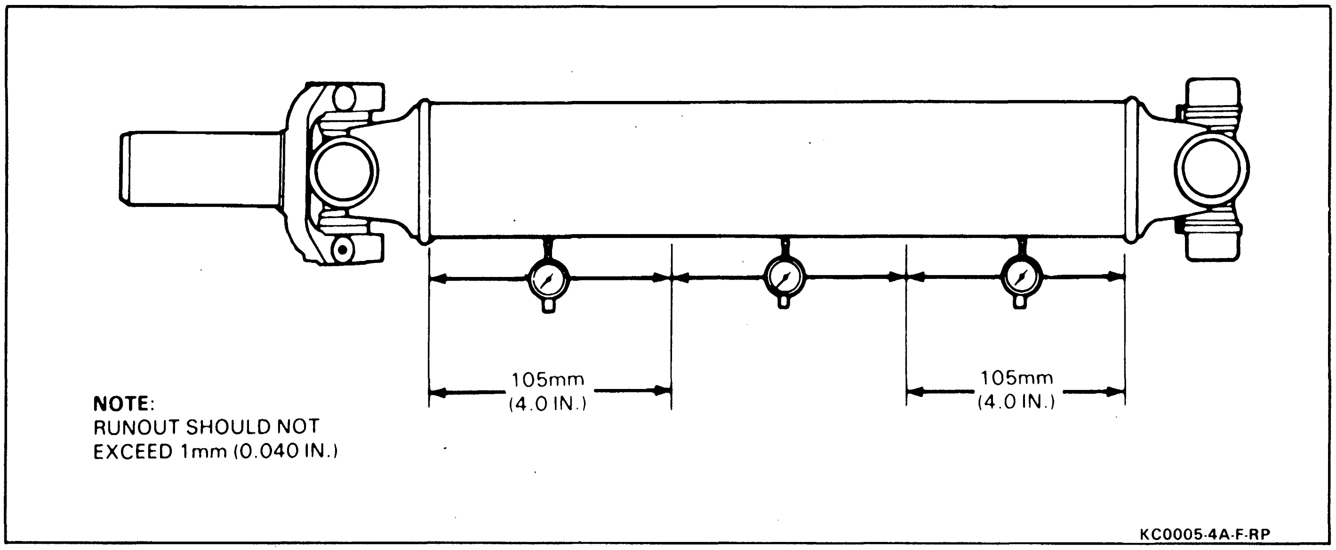


Figure 3 - Propeller Shaft Runout Measurement

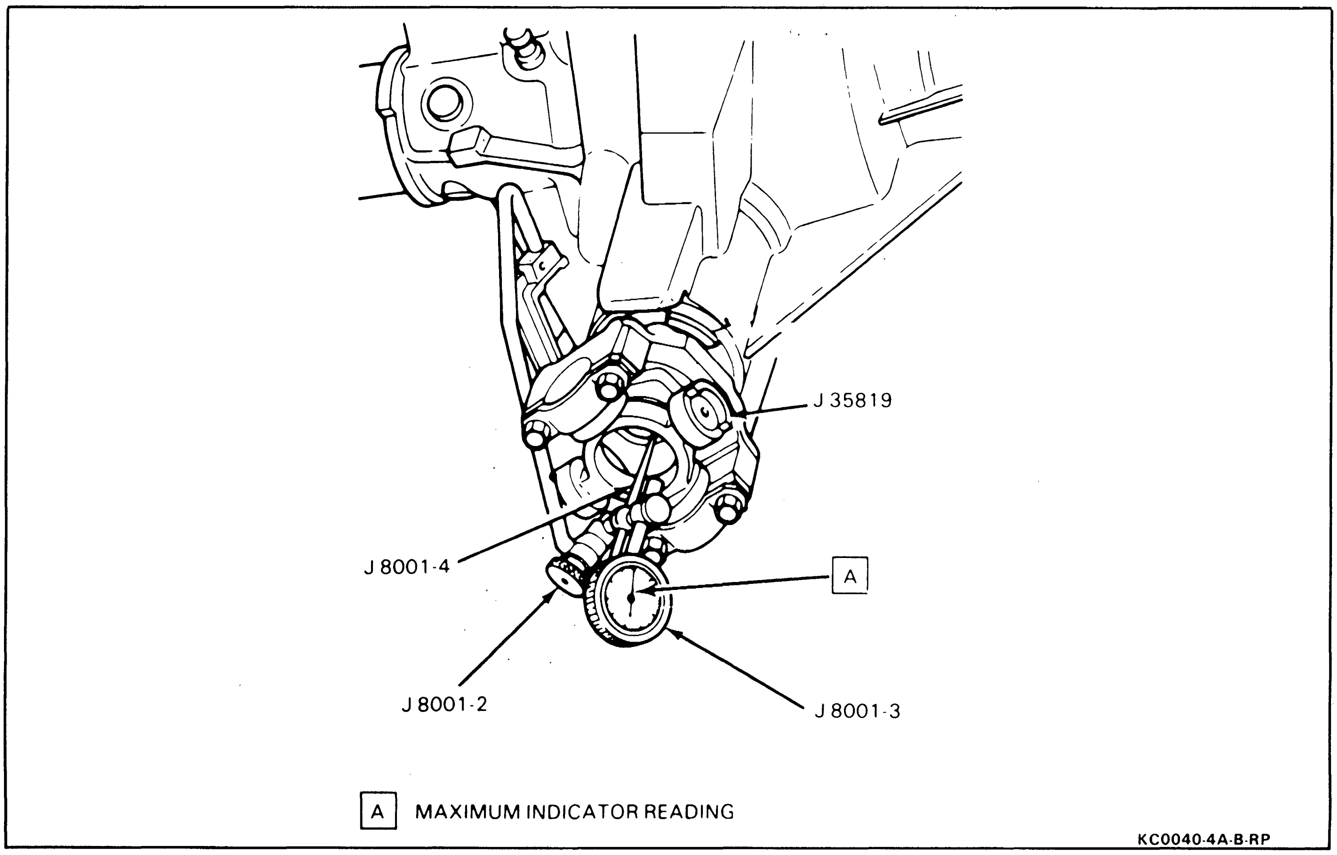


Figure 4 - Pinion Yoke Runout

The actual optimum angles desired must take into consideration the effects of various passenger load and rear axle windup during acceleration. It is unlikely that the front and rear universal joint angles will be found to be the same in actual practice.

Universal joints are designed to operate safely and efficiently within certain angles. If the designed angle is exceeded, the joint may be broken or otherwise damaged.

The front universal joint angle is actually the angle between the engine-transmission centerline and the propeller shaft centerline. This angle is determined by the design of the frame assembly and may be altered by adding or removing shims between the transmission and the transmission mount.

Adding one shim at the transmission mount will decrease the transmission universal joint angle by 1/2 degree and increase the differential universal joint by 1/4 degree. If one shim is removed, the transmission angle will increase 1/2 degree and decrease differential angle 1/4 degree. The production transmission mount bolt is an M10-1.5 x 30 mm. When installing two or more shims, a longer bolt must be used.

All vehicles with propeller shaft vibration complaints should be checked for correct rear trim height measurements at curb weight. An incorrect trim height may cause some vibration. If vibration is severe enough, removal or installation of spring shims may be required. If any irregular roughness or vibration is detected in the driveline, the front and rear universal joint angles should be checked. If the vehicle is involved in a severe rear end collision, or if the rear axle carrier is replaced, the rear universal joint angle should be checked and the control arms replaced if necessary.

Inclinometer Method

Figures 5 through 9

Tool Required:

J 23498-A Driveshaft Inclinometer

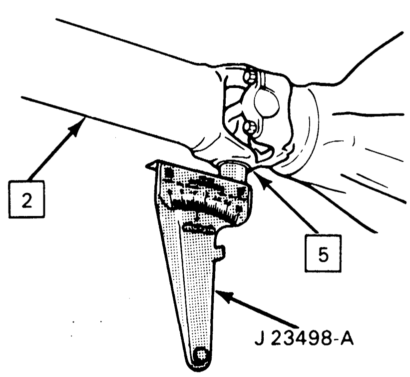
This method can be used with the vehicle over a pit or on a drive-on platform hoist, as long as the vehicle is at curb weight with a full tank of gasoline. Jounce vehicle up and down to assure curb height. Before universal joint angles can be checked, the measurements specified (the distance between the top of the axle tube and the bottom of the frame) must be met. To ensure an accurate measurement, weight may have to be added to the vehicle to reach these specifications.

Readings should be taken at the following locations in the following manner:

Angle at Rear Universal Joint

Measure

1. Rear propeller shaft universal joint bearing cap (5) using J 23498-A. Record. The bearing cap must be straight up and down and free of dirt or other foreign material (Figure 6).
   - Rotate the propeller shaft 90 degrees.
2. Pinion yoke bearing cap (6), using J 23498-A. Record (Figure 7).



2 PROPELLER SHAFT
5 REAR UNIVERSAL JOINT BEARING CAP

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Figure 6 - Measuring Angle at Rear of Propeller Shaft

- Subtract the smaller figure from the larger figure for the existing rear universal joint angle.

Angle at Front Universal Joint

Measure

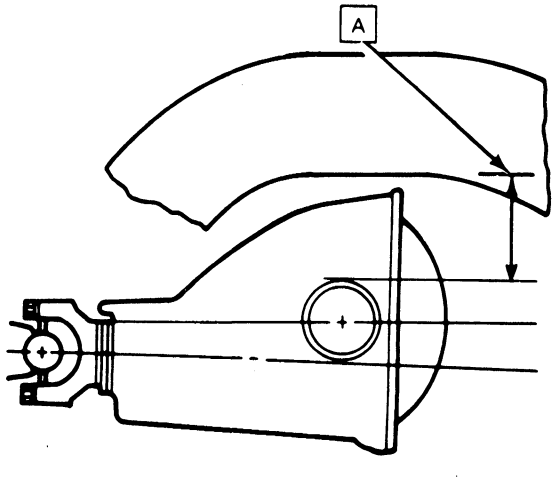
1. Front propeller shaft universal joint bearing cap (7), using J 23498-A. Record (Figure 8).
   - Rotate the propeller shaft 90 degrees.
2. Slip yoke bearing cap (8), using J 23498-A. Record (Figure 9).
   - Subtract the smaller figure from the larger figure for the existing front universal joint angle.

PROPELLER SHAFT BALANCE CHECK

- Raise the vehicle on a twin post hoist so the wheels can spin. Refer to GENERAL INFORMATION (SEC. 0A).

ALL VEHICLES
AXLE TUBE TO FRAME HEIGHT*
110-113 mm ($4^{21}/_{64}$"-$4^{28}/_{64}$")

*ALL MEASUREMENTS ARE ± 10 mm (3/8")



A AXLE TUBE TO FRAME HEIGHT

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Figure 5 - Axle Tube to Frame Height

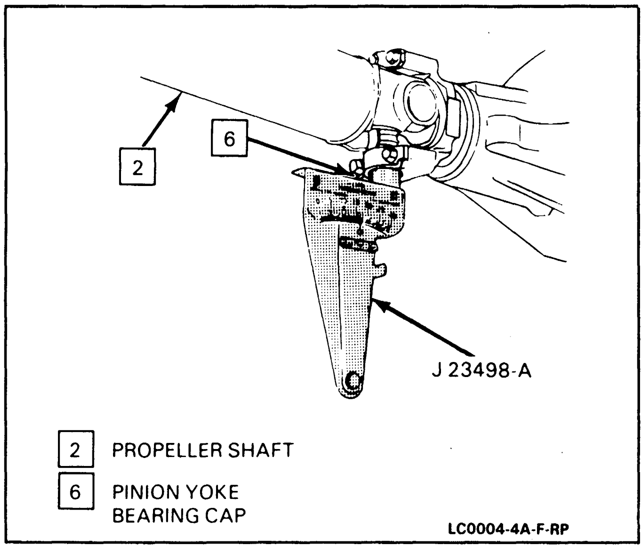


Figure 7 - Measuring Angle at Pinion Yoke

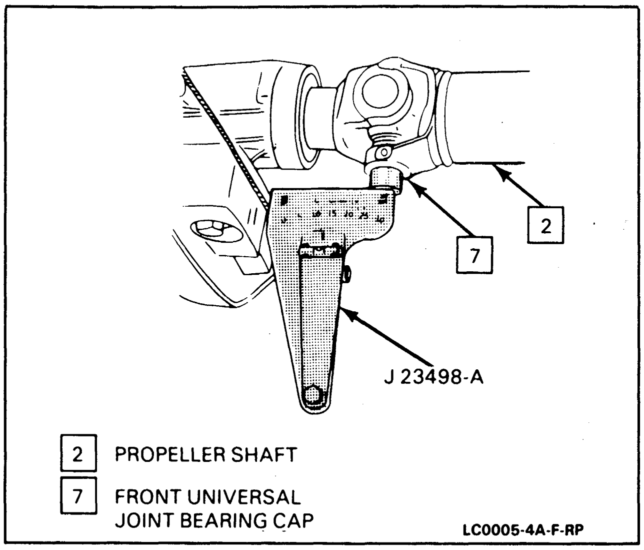


Figure 8 - Measuring Angle at Front of Propeller Shaft

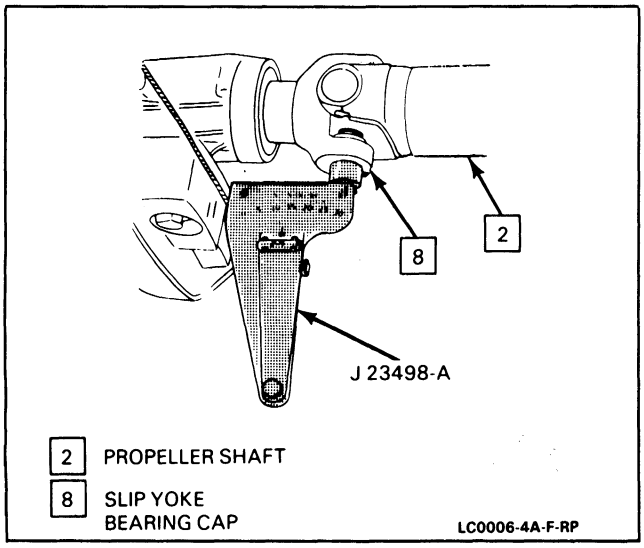


Figure 9 - Measuring Angle at Slip Yoke

Remove or Disconnect

1. Rear tire and wheel assemblies. Refer to TIRES AND WHEELS (SEC. 3E).

Inspect

- Propeller shaft, universal joint, and attachments for mud, undercoating or loose fasteners.

  Clean

  - Propeller shaft, universal joint, and attachments.

  Tighten

  - Any loose attachments or fasteners to specifications. Refer to "Specifications" in this section.
- Run the vehicle in gear at the speed where the disturbance peaks; observe the intensity of the disturbance.

NOTICE: On vehicles equipped with automatic transmissions, allow the driveline components to stop rotating with the transmission in "NEUTRAL" before placing the transmission in "PARK" or parts may be damaged.

- Stop the engine.

2. Propeller shaft from the pinion yoke only. Refer to "Propeller Shaft Replacement" in this section.
   - Rotate the propeller shaft 180 degrees from the original position, at the pinion yoke.

Install or Connect

1. Propeller shaft to the pinion yoke. Refer to "Propeller Shaft Replacement" in this section.
2. Wheel and tire assemblies. Refer to TIRES AND WHEELS (SEC. 3E).

- Determine the position that gives the best driveline response by road testing the vehicle for a final check of the propeller shaft balance.
- If balance is unacceptable, refer to "Propeller Shaft Balancing" in this section.

PROPELLER SHAFT BALANCING

Hose Clamp Method

Figures 10 through 12

1. Place the vehicle on a twin post hoist so that the rear of the vehicle is supported on the rear axle housing and the rear wheels are free to rotate. Refer to GENERAL INFORMATION (SEC. 0A).
2. Remove both rear wheel assemblies. Refer to TIRES AND WHEELS (SEC. 3E). Install and tighten the wheel lug nuts.
3. Mark and number the propeller shaft at four points 90 degrees apart at the rear of the propeller shaft just forward of the balance weight.
4. Install two hose clamps (9) on the rear of the propeller shaft (2) and slide them rearward until the clamps stop at the nearest balance weight welded to the tube. Align both clamps at any one of the four marks made on the shaft in step 3 and tighten.
   - Be sure sufficient clearance is maintained so clamp heads do not contact the floor pan of

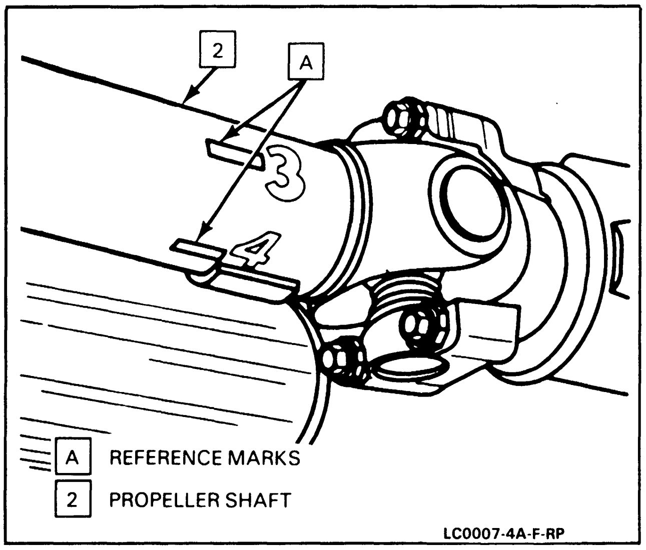


Figure 10 - Propeller Shaft Reference Marks

the vehicle when the axle is in contact with the frame rebound bumpers. In case of insufficient clearance, position the clamps over the balance weights.

CAUTION: Do not run the vehicle faster than 89 km/h (55 mph). Stay clear of the universal joint and balance weight areas to avoid possible personal injury. Do not run the vehicle on the hoist for extended periods due to the danger of overheating the transmission or engine.

5. Run the vehicle through the speed range to 81-89 km/h (50-55 mph). Note amount of imbalance.

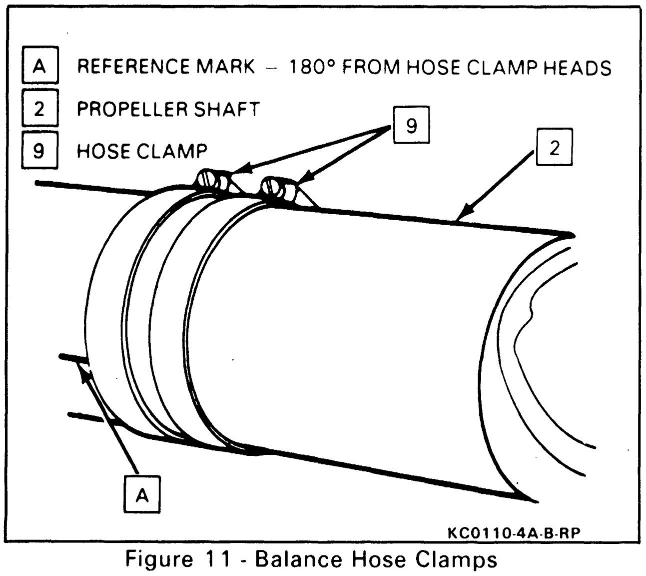


Figure 11 - Balance Hose Clamps

6. Loosen clamps and rotate the clamp heads 90 degrees to the next mark on the propeller shaft. Tighten clamps and repeat step 5.
7. Repeat step 6 until the vehicle has been run with the clamp heads located at all four marks on the propeller shaft.
8. Position the clamps at the point of least imbalance. Rotate the clamp heads away from each other 45 degrees, one on each side of the position (Figure 12). Run the vehicle and note if balance has improved.

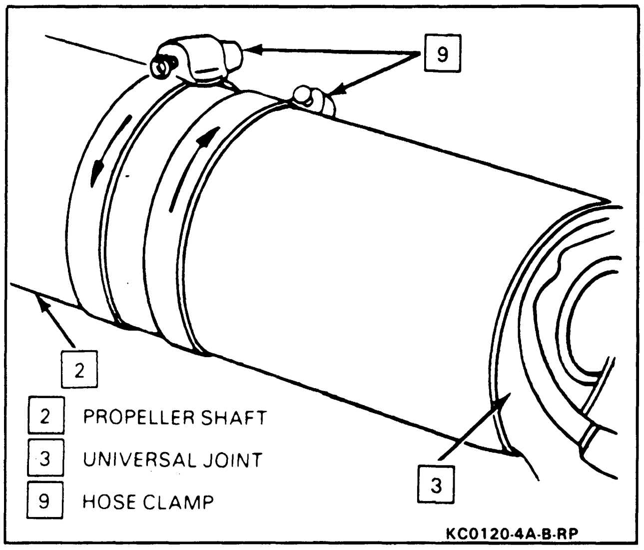


Figure 12 - Rotating Balance Hose Clamps

- In some cases it may be necessary to use one clamp or possibly three clamps in order to obtain a good balance. Replace propeller shaft (2) if three hose clamps (9) do not improve the balance.

9. Continue to rotate the clamps apart in smaller angular increments until the imbalance is at its minimum.
10. Remove wheel lug nuts.
11. Install wheel assemblies. Refer to TIRES AND WHEELS (SEC. 3E).
12. Lower the vehicle.
13. Road test the vehicle to check the final balance.
    - A small vibration felt while the vehicle is on the hoist may not be noticed on a road test.

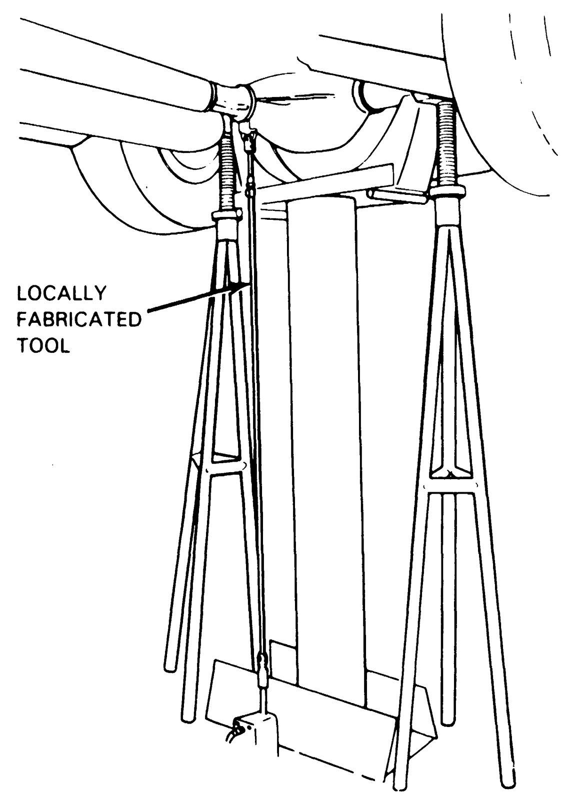
Strobe Light Method

Figures 10 through 14

If a strobe light type wheel balancer is used, it will help in the balancing of the propeller shaft. The balance pick-up unit should be placed directly under the nose of the rear axle carrier and as far forward as possible. Make up an extension for the balance pick-up unit by using 3/8-inch tube and compression fittings (Figure 13).

1. Place the vehicle on a twin post hoist so the rear of the vehicle is supported on the rear axle housing and the rear wheels are free to rotate. Lower the rear hoist and allow the axle to rest on jackstands.
2. Remove both rear wheel assemblies. Refer to TIRES AND WHEELS (SEC. 3E). Install and tighten wheel lug nuts. The system is now released and free to respond to the propeller.
3. Mark and number the propeller shaft at four points 90 degrees apart at the rear of the propeller shaft just forward of the balance weights.
4. Place the strobe light wheel balancer pick-up under the nose of the carrier.

CAUTION: Stay clear of the universal joint and balance weight areas to



NOTE: LOCALLY FABRICATED EXTENSION FOR BALANCER PICK-UP CONSISTS OF 3/8" TUBE AND COMPRESSION FITTINGS

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Figure 13 - Pick-Up Unit at Differential Pinion Yoke

avoid possible personal injury. Do not run the vehicle on the hoist for extended periods due to the danger of overheating the transmission or the engine.

5. Run the vehicle in gear at the speed where the disturbance is at its peak.
6. Allow the driveline to stabilize by holding at a steady speed.
7. Point strobe light up at the spinning propeller shaft and note the position of one of the reference numbers.

NOTICE: On vehicles equipped with automatic transmissions, allow the driveline components to stop rotating with the transmission in "NEUTRAL" before placing the transmission in "PARK" or parts may be damaged.

8. Shut off the engine.
9. Position the propeller shaft so the reference numbers will be in the same position as was noted while the shaft was rotating.
   - When the strobe light flashed, the heaviest point of the propeller shaft was at the bottom (6 o'clock). To balance the propeller shaft, it is necessary to apply the balancing weights (hose clamps) 180 degrees away from the heaviest point or at the top of the propeller shaft (2) (12 o'clock).
10. Install two screw-type hose clamps (9) on the propeller shaft (2) as close to the rear as possible. Position both clamp heads 180 degrees from the heaviest point of the propeller shaft as indicated by the strobe light. Tighten the clamps.
    - Be sure sufficient clearance is maintained so the clamp heads do not contact the floor pan of the vehicle when the axle is in contact with the rebound bumper on the frame. In order to gain sufficient clearance, it may be necessary to position the clamps over the balance weights.
11. Run the vehicle through the speed range 81-89 km/h (50-55 mph).
    - If the disturbance is not gone and the strobe light shows the clamp heads at the bottom (6 o'clock) of the propeller shaft (2), go to step 12.
    - If the strobe light shows the two clamp heads at the top of the propeller shaft, add one more hose clamp and check.
    - If the strobe light shows the three clamp heads at the top of the propeller shaft, remove the propeller shaft and rotate 180 degrees on the pinion yoke. Check again, without the clamps.
    - Repeat balancing, starting with step 10.
    - If the propeller shaft still needs more than three hose clamps (9) at the same clock position, replace the propeller shaft (2).
    - If the clamps are also 180 degrees from their original position after rotating the propeller shaft 180 degrees, the rear axle pinion yoke is out of balance and must be replaced.

Important

- Do not use more than three hose clamps (9) to balance the propeller shaft.
  - If the strobe light shows the hose clamps (9) at the bottom of the propeller shaft, but the disturbance still exists, go to step 12.

12. Rotate two of the hose clamps (9) equally away from each other toward the top (one on each side of the position) in small increments until the best balance is achieved. In some cases it may be necessary to use one clamp or possibly three clamps in order to obtain a good balance. Replace the propeller shaft (2) if three hose clamps (9) do not correct the problem.
13. Remove wheel lug nuts.
14. Install wheel and tire assemblies. Refer to TIRES AND WHEELS (SEC. 3E).
15. Remove the support and lower the vehicle.
16. Road test the vehicle to check the final balance.
17. A small vibration felt while the vehicle is on the hoist may not be noticed on a road test.

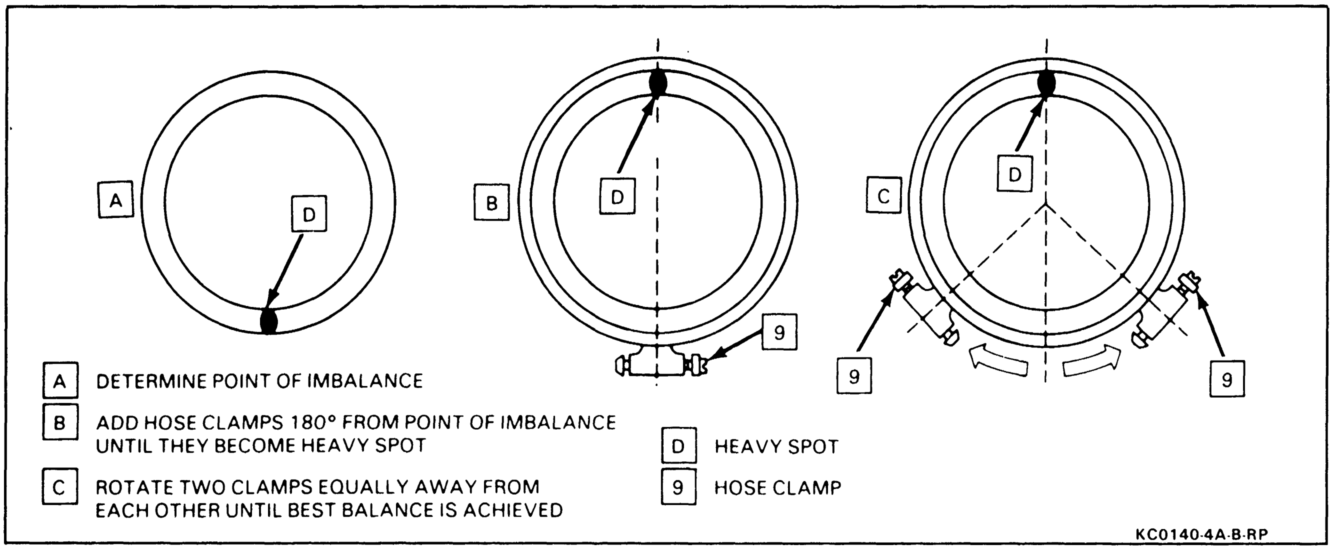


Figure 14 - Positioning Hose Clamps to Achieve Best Balance

PROPELLER SHAFT REPLACEMENT

Remove or Disconnect

NOTICE: Do not strike or drop the propeller shaft or allow the universal joints to bend to extreme angles, as this might fracture a joint internally.

- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).
- Mark relationship of the propeller shaft to the rear axle pinion yoke with a center punch or cold chisel.

1. Propeller shaft strap bolts.
2. Retaining straps.
3. Propeller shaft by withdrawing the slip yoke from the transmission, moving the shaft rearward and passing it under the rear axle housing.
    - Support the propeller shaft during removal.
    - If the bearing caps are loose, tape them together to prevent dropping and losing the bearing rollers.

Inspect

- Transmission output shaft splines for burrs.
- Outer diameter of the slip yoke for burrs.
- Splines of the yoke for damage, twisting or wear. They should agree in number and fit with the transmission output shaft splines.
- Pinion yoke at the universal joint cap connecting surface for burrs or foreign material.

Install or Connect

NOTICE: The propeller shaft must be supported carefully during handling to avoid jamming or bending any of the parts.

1. Slip yoke onto the transmission output shaft after lubricating the spline with engine oil.
2. Rear of propeller shaft to the pinion yoke.

NOTICE: To prevent transmission seal damage, do not place any tool between the slip yoke and splines.

Important

- When making the rear shaft connection, be sure to align the mark on the pinion yoke with the mark on the propeller shaft.

3. Rear universal joint to the pinion yoke, making sure the bearing caps are properly seated.
4. Retaining straps.

NOTICE: See "Notice" on page 4A-1 of this section.

5. Strap bolts.

Tighten

- Propeller shaft strap bolts evenly to 22 N·m (16 lb. ft.).
- Lower the vehicle.

UNIT REPAIR

UNIVERSAL JOINTS

Figures 15 through 21

When taking apart a propeller shaft, two types of universal joints may be found: nylon injected ring type and snap ring type.

NOTICE: Never clamp propeller shaft tubing in a vise, as the tube may be dented. Always clamp on one of the yokes and support the shaft horizontally. Avoid damaging the slip yoke sealing surface. Nicks may damage the bushing or cut the transmission extension housing seal. Mark the slip joint and propeller shaft to ensure correct reassembly.

Nylon Injected Ring Type

Figures 15 through 18

Remove or Disconnect

Tools Required:

J 9522-3 U-Joint Bearing Separator

J 9522-5 U-Joint Bearing Spacer Remover

- Support the propeller shaft in a horizontal position in line with the base plate of a press.
- Place the universal joint so that the lower ear of the shaft yoke is supported on a 1 1/8-inch socket.

1. Lower bearing cap (12) out of the yoke ear by placing J 9522-3 on the open horizontal bearing caps (12) and pressing the lower bearing cap (12) out of the yoke ear.
   - This shears the nylon injected ring on the lower bearing cap (12). If the bearing cap (12) is not completely removed, lift J 9522-3 and insert J 9522-5 between the seal and the bearing cap (12). Complete the removal of the bearing cap (12) by pressing it out of the yoke.
   - Rotate the propeller shaft. Shear the opposite nylon injected ring.
2. Opposite bearing cap (12) out of the yoke.
3. Spider (10) from yoke.
   - There are no bearing retainer grooves in production bearing caps. They cannot be reused.
   - If the front universal joint is being replaced, remove the pair of bearing caps (12) from the slip yoke in the same manner.

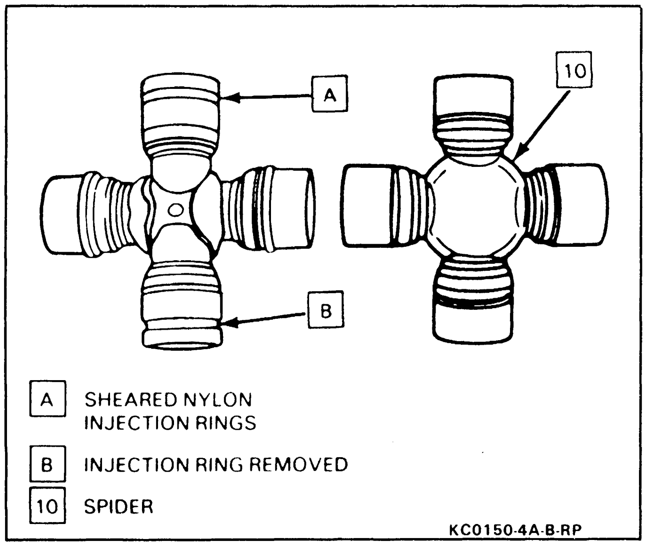


Figure 15 - Production Universal Joints

Clean

- Yoke in area where locating the snap ring to ensure proper assembly.

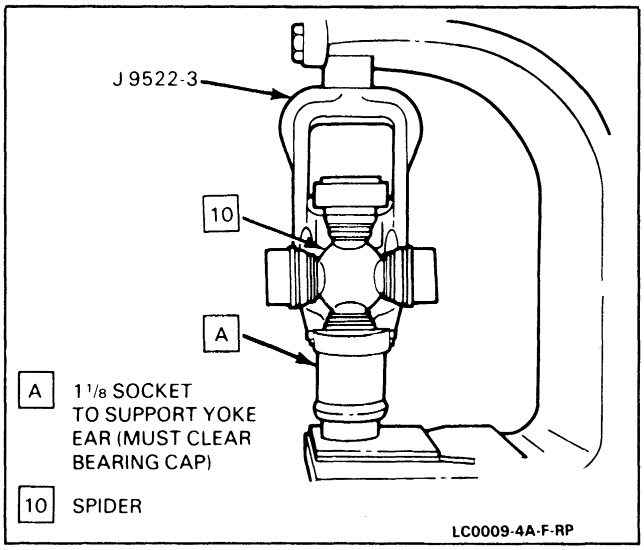


Figure 16 - Pressing Out Universal Joint Bearing Cap

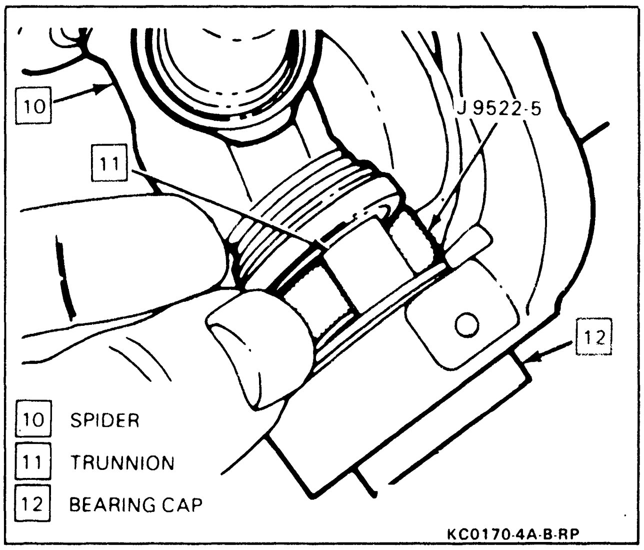


Figure 17 - Installing Universal Joint Bearing Spacer Remover

- All sheared nylon from the universal joint cup bore.

NOTICE: Production universal joints of this type cannot be reassembled. Nylon injected ring types are replaced by external snap ring types.

When reassembling a propeller shaft, always install a complete universal joint service kit. This kit includes one pregreased spider (10), four service bearing cap assemblies with seals (17), needle roller bearings (15), round delrin washers (14), flat delrin washers (16), grease and four snap rings (13). Make sure the seals (17) are in place on the service bearing caps (12) to hold the needle roller bearings (15) in place during handling.

Install or Connect

Tool Required:

J 9522-3 U-Joint Bearing Separator

1. One bearing cap (12) part way into one side of yoke. Turn this yoke ear to the bottom.
   - Insert J 9522-3, seating the trunnion (11) in the bearing cap (12).

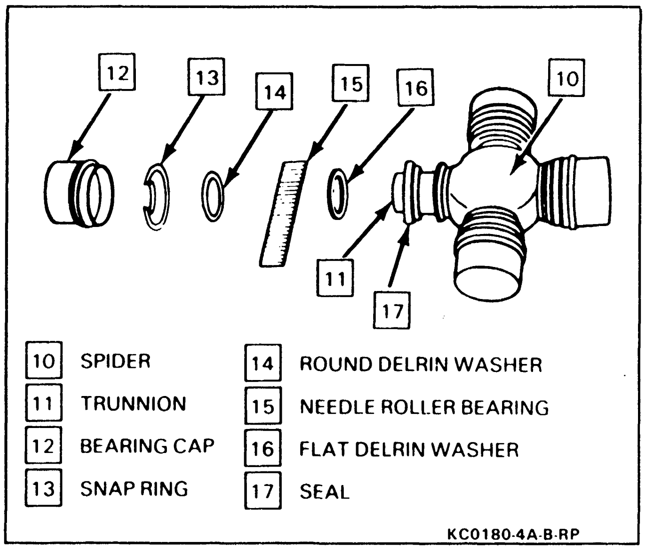


Figure 18 - Service Universal Joint

2. Opposite bearing cap (12) part way.

Inspect

  - Both trunnions (11) to ensure positioning is straight and true into the bearing caps (12).
- Press against the opposite bearing caps (12), working the spider (10) all of the time to ensure free movement of the trunnions (11) in the bearings.

Inspect

  - Needle roller bearings (15) for binding. If binding, one or more needle roller bearings (15) has probably tipped under the end of the trunnion (11).
- Stop pressing when one bearing retainer groove clears the inside of the yoke.

3. Snap ring (13) by pressing into place.
   - Continue pressing until opposite snap ring (13) can be snapped into place. If needed, strike the yoke firmly with a hammer to aid in seating the snap rings (Figure 21). This springs the yoke ears slightly.
- Repeat steps 1 through 3 for the other half of the universal joint.

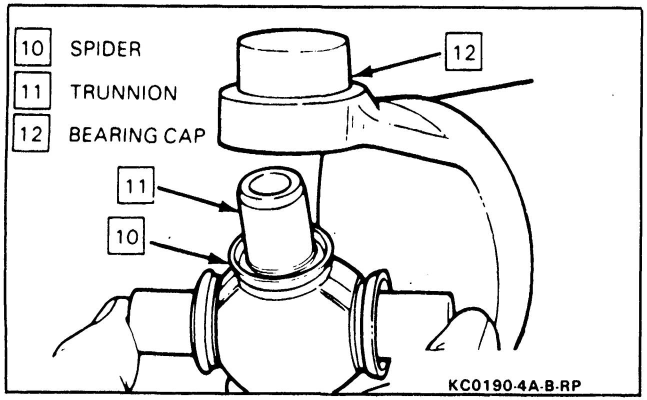


Figure 19 - Partially Inserted Bearing Cap

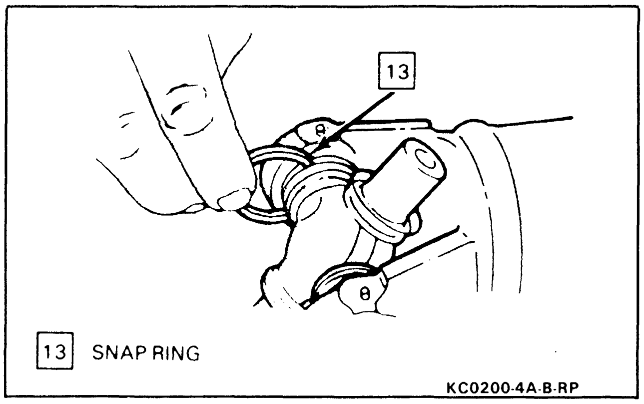


Figure 20 - Installing Snap Ring

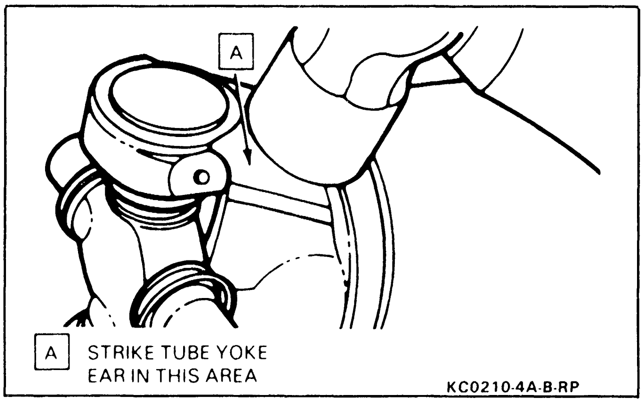


Figure 21 - Seating Universal Joint Snap Ring

Snap Ring Type

Figures 18 through 21

These universal joints are designed for extended life and do not require periodic inspections or lubrication. When these joints are taken apart, repack bearings and lubricate reservoir at the end of trunnions with chassis lubricant. Use care not to loosen or damage dust seals. If dust seals are loose or damaged, replace the entire universal joint.

Remove or Disconnect

Tools Required:

J 9522-3 U-Joint Bearing Separator
J 9522-5 U-Joint Bearing Spacer Remover

1. Snap rings (13). If snap ring (13) does not readily snap out of the grooves, tap the end of the bearing cap (12) lightly to relieve the pressure against the snap ring (13).
- Support the propeller shaft in a horizontal position in line with the base plate of a press.
- Place the universal joint so the lower ear of the propeller shaft yoke is supported on a 1 1/8-inch socket.

2. Lower bearing cap (12) out of the yoke ear by placing J 9522-3 on the open horizontal bearing cap (12) and pressing the lower bearing cap (12) out of the yoke (Figure 19).
- If the bearing cap (12) is not completely removed, lift J 9522-3 and insert J 9522-5 between the seal and bearing cap (12) being removed. Complete the removal of the bearing cap (12) by pressing it out of the yoke.
- Rotate the propeller shaft.

3. Opposite bearing cap (12) from yoke by pressing.

4. Spider (10) from yoke.

Install or Connect

Tool Required:
J 9522-3 U-Joint Bearing Separator

1. One bearing cap (12) part way into one side of yoke. Turn this yoke ear to the bottom.
   - Insert J 9522-3, seating the trunnion (11) in the bearing cap (12).
2. Opposite bearing cap (12) part way.

Inspect

- Both trunnions (11) to insure positioning is straight and true into the bearing caps.
- Press against the opposite bearing caps (12), working the spider (10) all of the time to insure free movement of the trunnions (11) in the bearings.

Inspect

- Needle roller bearings (15) for binding. If binding, one or more needle roller bearings (15) has probably tipped under the end of the trunnion (11).
- Stop pressing when one bearing retainer groove clears the inside of the yoke.

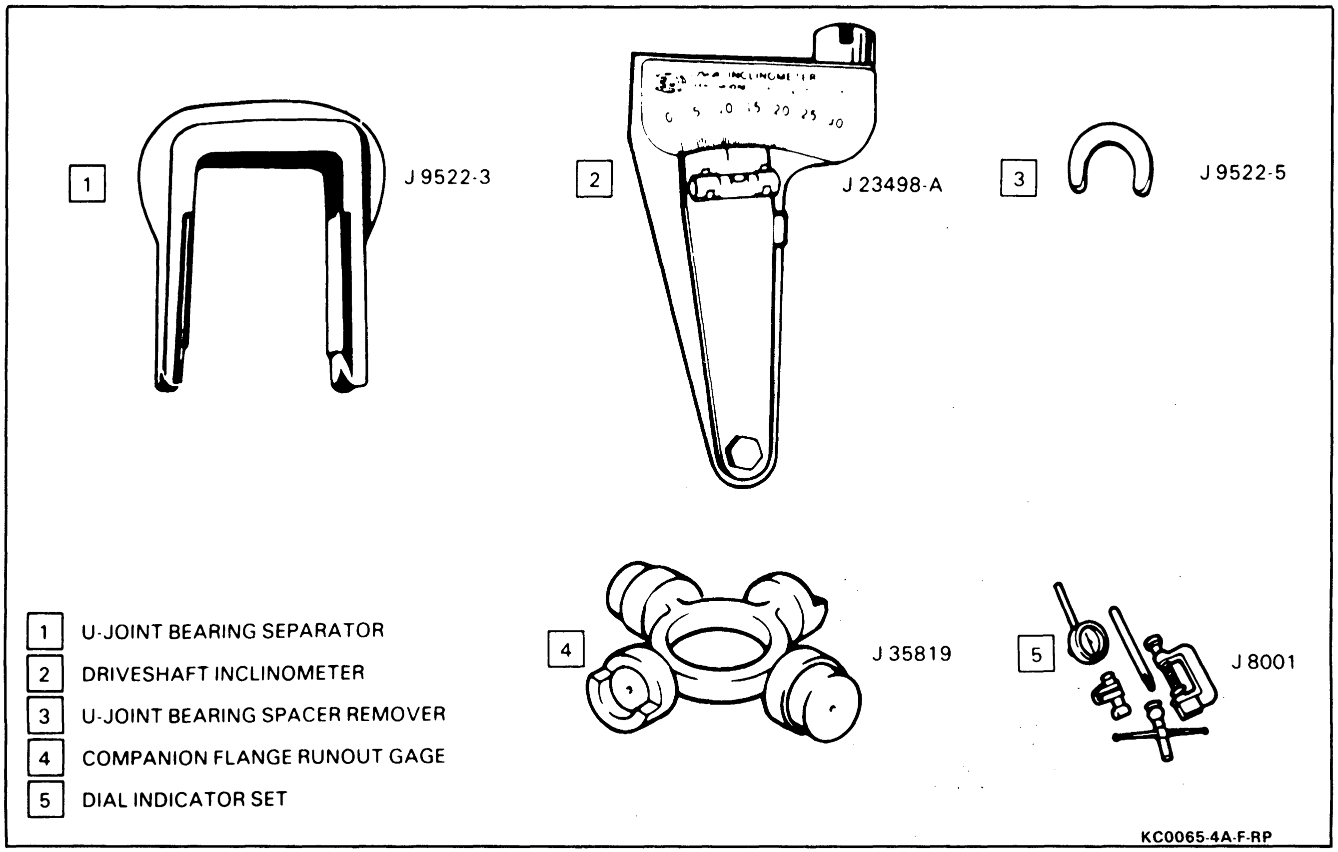
3. Snap ring (13) by pressing into place.
   - Continue pressing until opposite snap ring (13) can be snapped into place. If needed, strike the yoke firmly with a hammer to aid in seating the snap rings (Figure 21). This springs the yoke ears slightly.
- Repeat steps 1 through 3 the other half of the universal joint.

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Propeller Shaft Retaining Bolt (5/16-24) .... 22 N·m (16 lb. ft.)

SPECIAL TOOLS



1 U-JOINT BEARING SEPARATOR
2 DRIVESHAFT INCLINOMETER
3 U-JOINT BEARING SPACER REMOVER
4 COMPANION FLANGE RUNOUT GAGE
5 DIAL INDICATOR SET

SECTION 4B

REAR AXLE

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 4B-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size or strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL INFORMATION

STANDARD REAR AXLE

Figures 1 and 2

The rear axle assembly is the semifloating type in which the vehicle weight is carried on the axle housing (20). The rear axle assembly is designed for use with an open driveline and coil springs. The rear axle has a hypoid-type ring gear and pinion with the centerline of the pinion gear below the centerline of the ring gear.

All parts necessary to transmit power from the propeller shaft to the rear wheels are enclosed in an axle housing (20). A removable steel cover bolted to the rear of the housing permits service of the rear axle without removing the entire assembly from the vehicle.

Most rear axle service repairs can be made with the rear axle assembly in the vehicle, by raising the rear end of the vehicle with the rear axle hanging on the shock absorbers.

A universal joint connects the rear end of the propeller shaft to a pinion yoke (27), having a splined end which fits over and drives the pinion gear (12). Two preloaded tapered roller bearings support the hypoid pinion gear (12) in the housing. The inner race of the rear pinion bearing is a tight press fit on the pinion stem. The outer race of the front pinion bearing combines a light press fit to a close sliding fit on the pinion yoke end of the pinion stem. The outer race of each bearing is pressed against a shoulder recessed in the housing. Tightening the pinion yoke nut (29) compresses a collapsible spacer (23) that bears against the outer race of the front bearing and a shoulder on

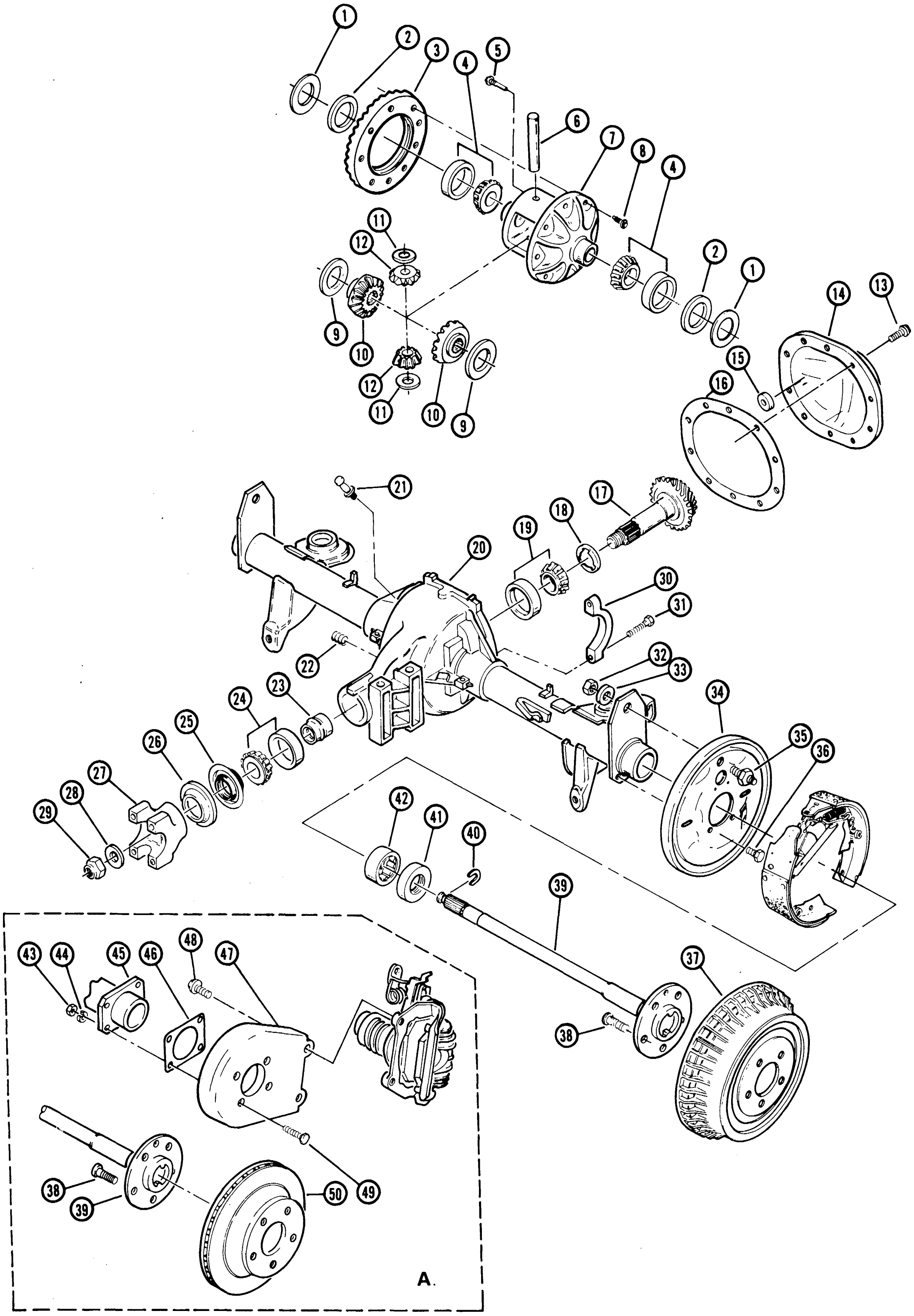


Figure 1 - Standard Rear Axle

A	OPTIONAL DISC BRAKE ASSEMBLY
1	SPACER
2	SHIM
3	RING GEAR
4	BEARING ASSEMBLY
5	LOCK SCREW
6	PINION GEAR SHAFT
7	DIFFERENTIAL CASE
8	BOLT
9	THRUST WASHER
10	SIDE GEAR
11	THRUST WASHER
12	PINION GEAR
13	COVER BOLT
14	CARRIER COVER
15	MAGNET
16	COVER GASKET
17	DRIVE PINION
18	SHIM
19	REAR BEARING ASSEMBLY
20	AXLE HOUSING
21	VENT
22	PLUG
23	SPACER
24	FRONT BEARING ASSEMBLY
25	SEAL (PINION YOKE)
26	FLANGE
27	PINION YOKE
28	WASHER
29	NUT
30	DIFFERENTIAL BEARING CAP
31	DIFFERENTIAL BEARING CAP BOLT
32	NUT (ANCHOR PIN ATTACH)
33	WASHER
34	BACKING PLATE
35	ANCHOR PIN
36	SCREW
37	DRUM BRAKE
38	WHEEL BOLT
39	AXLE SHAFT
40	"C" LOCK
41	SEAL (AXLE SHAFT)
42	BEARING ASSEMBLY
43	NUT
44	LOCK WASHER
45	REAR AXLE HOUSING
46	SHIM
47	CALIPER MOUNTING PLATE
48	BOLT
49	BOLT
50	ROTOR

LC0010-4B-F-RP

Figure 2 - Standard Rear Axle - Legend

the pinion stem. This spacer (23) is used to enable accurate bearing preload adjustment and maintain a preload on both front and rear pinion bearings. Adjustment of the fore-and-aft position of the pinion is obtained by placing shims between the head of the drive pinion (17) and the rear bearing assembly (19). The differential case (7) is one piece and is supported in the axle housing (20) by two tapered roller side bearings. These are preloaded by inserting shims (2) between the bearing assemblies (4) and the axle housing (20). The differential case (7) is positioned for proper ring gear to pinion backlash by varying the shim (2) thickness from side to side. The ring gear (3) is bolted to the case. Two side gears (10) have splined bores for driving the axle shafts (39). They are positioned to turn in counterbored cavities in the case. The two pinion gears (12) have smooth bores and are held in position by a solid pinion cross shaft, mounted and locked in the differential case (7). All four gears are in mesh with each other. The pinion gears (12) turn freely on their shaft, acting as idler gears when the rear wheels are turning at different speeds. The pinion gears (12) and side gears (10) are backed by steel thrust washers (9 and 11).

Operation

When the vehicle turns a corner, the differential allows the outer rear wheel to turn faster than the inner wheel. The inner wheel turning with respect to the outer wheel, slows its differential side gear (as the axle shaft is splined to the side gear) and the differential pinion gears roll around the slowed differential side gear, driving the other differential side gear and wheel faster.

LIMITED SLIP REAR AXLE

Limited slip rear axles have several definite operating characteristics. An understanding of these characteristics is necessary to aid diagnosis.

The energizing force comes from the thrust side of the gears. Consequently, a free spinning wheel may not have enough resistance to driving torque to apply the cones. If this occurs, apply the parking brake a few notches which will provide enough resistance to energize the cones.

Energizing the cones is independent of acceleration; therefore, a very slow application of the throttle on starting is recommended to provide maximum traction by preventing "break away" of either rear wheel.

All rear axle parts of vehicles equipped with the limited slip rear axle are interchangeable with those equipped with the standard rear axle, except for the case assembly. It is similar in all respects to the standard case assembly, with the addition of cone clutches splined to each side gear. The Auburn limited slip differential case is non-serviceable and must be replaced if damaged.

REAR AXLE IDENTIFICATION

The rear axle identification code and manufacturer's code must be known before attempting to adjust or repair axle shafts or the differential case assembly. Rear axle ratio, differential type, manufacturer, and build date information are stamped on the right axle tube on the forward side and a metal tag by the carrier cover. The Service Parts Identification label also has RPO codes for the rear axle printed on it. Refer to "Specifications" in this section.

MAINTENANCE AND LUBRICATION

For information on rear axle maintenance and lubrication, refer to MAINTENANCE AND LUBRICATION (SEC. OB).

LIMITED SLIP CONVERSION INFORMATION

The case assembly (less ring gear and side bearings) is available for converting a standard rear axle to limited slip. The ring gear and side bearings of the standard rear axle, if in good condition, can be used with the limited slip case assembly.

DIAGNOSIS

Many noises reported as coming from the rear axle actually originate from other sources such as tires, road surfaces, wheel bearings, engine, transmission, muffler or body. A thorough and careful check should be made to determine the source of the noise before taking apart the rear axle. Noise which originates in other places cannot be corrected by adjustment or replacement of parts in the rear axle. Rear axle gears, like any other mechanical device, are not absolutely quiet and should be accepted as being commercially quiet unless some abnormal noise is present.

To make a systematic check for axle noise under standard conditions, observe the following:

1. Select a level asphalt road to reduce tire noise and body drumming.
2. Check rear axle lubricant to assure correct level, then drive vehicle far enough to thoroughly warm up rear axle lubricant.
3. Note speed at which noise occurs. Then stop vehicle and with automatic transmission in "NEUTRAL," run engine slowly up and down through engine speeds, corresponding to vehicle speed at which noise was most pronounced, to determine if it is caused by exhaust, muffler roar or other engine conditions.
4. Tire noise changes with different road surfaces, but rear axle noise does not. Temporarily inflating all tires to approximately 345 kPa (50 psi) for test purposes only, will alter noise caused by the tires, but will not affect noise caused by the rear axle. Rear axle noise usually stops when coasting at speeds under 48 km/h (30 mph). Tire noise continues, but with a lower tone as vehicle speed is reduced. Rear axle noise usually changes when comparing drive and coast, but tire noise remains about the same.
5. Distinguish between tire noise and rear axle noise by noting if noise varies with various speeds or sudden acceleration and deceleration; exhaust and axle noise show variations under these conditions while tire noise remains constant and is more noticeable at speeds of 32 to 48 km/h (20 to 30 mph). Check for tire noise by driving vehicle over smooth pavement or dirt roads (not gravel) with tires at normal pressure. If noise is caused by tires, it will noticeably change or disappear and appear again with changes in the road surface.
6. Loose or rough front wheel bearings will cause a noise which may be confused with rear axle noises. Front wheel bearing noise does not change when comparing drive and coast. Light application of the brake while holding the vehicle speed steady will often cause wheel bearing noise to diminish, as this takes some weight off the bearing. Front wheel bearings may be easily checked for noise by jacking up the wheels and spinning them or by shaking the wheels to determine if the bearings are loose.
7. Rear suspension rubber bushings and spring insulators dampen out rear axle noise when correctly installed. Check that no metallic contact exists between the spring and spring opening in the frame or between lower control arm bushings and frame or axle housing brackets. Metal-to-metal contact at those points may result in telegraphing road noise and normal axle noise which would not be objectionable if dampened by bushings.
8. Make sure that the floor of the body is not in metallic contact with the frame.

REAR AXLE NOISES

Gear Noise

After the noise has been determined as being in the axle by following the above procedure, the type of axle noise should be established to help in making repairs if necessary.

Gear noise (whine) is audible from 32 to 89 km/h (20 to 55 mph) under four driving conditions:

1. Drive - acceleration or heavy pull.
2. Road load - vehicle driving load or constant speed.
3. Float - using enough throttle to keep the vehicle from driving the engine, the vehicle slows down gradually but the engine still pulls slightly.
4. Coast - throttle closed and vehicle in gear. Gear noise most frequently has periods where noise is more noticeable, usually 48 to 64 km/h (30 to 40 mph) and 80 to 89 km/h (50 to 55 mph).

Bearing Noise

Bad bearings generally produce more of a rough growl or grating sound, rather than the whine typical of gear noise. Bearing noise frequently "wow-wows" at constant bearing rpm, indicating a faulty pinion or rear axle case side bearing. This noise could easily be confused with rear wheel bearing noise. Inspect and replace as required.

Rear Wheel Bearing Noise

A rough rear wheel bearing produces a noise that continues with the vehicle coasting at low speed and transmission in "NEUTRAL." Noise may diminish some by gentle braking. With rear wheels jacked up, spin rear wheels by hand while listening at hubs for evidence of rough (noisy) wheel bearing.

Knock at Low Speeds

Low speed knock can be caused by a worn universal joint or a side gear hub counterbore in the differential case worn oversize. Inspect and replace universal joint or the differential case and side gear as required.

Backlash Clunk

Excessive clunk with acceleration and deceleration is caused by worn differential pinion gear shaft, worn differential case, excessive clearance between the axle shaft and side gear splines, excessive clearance between side gear hub and counterbore in case, worn pinion and side gear teeth, worn thrust washers and excessive drive pinion and ring gear backlash. Remove worn parts and replace as required, selecting close fitting parts when possible. Adjust drive pinion and ring gear backlash.

LIMITED SLIP REAR AXLE

Improper operation is generally indicated by clutch slippage or grabbing. Sometimes this produces a chatter or whirring sound. These sounds are not always indicative of failure as they could be produced from a lack of proper lubrication. For example, under certain conditions where one wheel is on a very slippery surface and the other on dry pavement, wheel spin can occur if hard acceleration is attempted. Continued spinning may cause audible noise, such as a whirring sound, if the cones lack sufficient lubricant. This does not necessarily indicate a failure of the unit.

During regular operation (straight ahead driving when both wheels rotate at equal speeds), there is an equal driving force delivered to each wheel. When cornering, the inside wheel requires extra driving force causing slippage in the clutch cone. Consequently, the operational life of the limited slip unit is dependent upon equal rotation of both wheels during straight ahead operation. If wheel rotation for both rear wheels is not equal during straight ahead operation, the limited slip unit will constantly be functioning as if the vehicle were cornering. This will impose constant slippage on the clutch and will eventually lead to abnormal wear on the clutch cone. It is important that there are no excessive differences in the rear wheel tire sizes, air pressures, or tire wear patterns. One indication of this condition is "swerving upon acceleration." If swerving upon acceleration is encountered, check the above items before proceeding with an overhaul operation.

Checking Limited Slip Operation

Figure 3

Tools Required:

J 2619-01 Slide Hammer with 1/2-13 Adapter

J 21579 Axle Shaft Remover

1. Place transmission in "PARK" position, or in gear if a manual transmission, parking brake released.
2. Raise rear of vehicle until wheels are off the ground, remove one wheel and tire assembly.
3. Attach J 2619-01 and J 21579 to axle shaft flange and install 1/2-13 adapter.
4. The Auburn rear axle: check with both tires elevated and transmission in "PARK" (differential case not allowed to rotate).
   - The torque required to rotate one wheel should be 169 to 305 N·m (125 to 225 lb. ft.).
5. The Auburn rear axle: check with only one rear wheel raised and transmission in "NEUTRAL" (differential case free to rotate).
   - The torque required to rotate one wheel is 58 to 91 N·m (43 to 67 lb. ft.).
6. Install wheel and tire assembly.

The differential case must be replaced as an assembly if any of the above checks do not fall within the specifications.

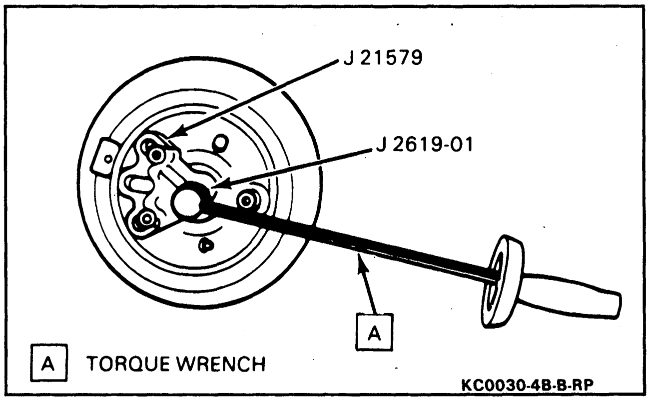


Figure 3 - Measuring Limited Slip Rotating Torque

REAR AXLE STANDARD AND LIMITED SLIP DIAGNOSIS

Condition	Cause
1. Noise is the same in drive or coast.	a. Road noise. b. Tire noise. c. Front wheel bearing noise. d. Incorrect driveline angles.
2. Noise changes on a different type of road.	a. Road noise. b. Tire noise.
3. Noise tone lower as vehicle speed is lowered.	a. Tire noise.
4. Noise is produced with vehicle standing and driving.	a. Engine noise. b. Transmission noise.

Condition	Cause
5. Vibration.	a. Rough rear wheel bearing. b. Unbalanced or damaged propeller shaft. c. Tire unbalance. d. Worn universal joint in propeller shaft. e. Incorrect driveline angles. f. Mis-indexed propeller shaft at pinion yoke. g. Pinion yoke runout too great.
6. A knock or click approximately every two revolutions of the rear wheel.	a. Rear wheel bearing noise.
7. Noise most pronounced on turns.	a. Rear axle side gear and pinion noise.
8. A continuous low pitch whirring or scraping noise starting at relatively low speed.	a. Pinion bearing noise.
9. Drive noise, coast noise or float noise.	a. Ring and pinion gear noise.
10. Clunk on acceleration or deceleration.	a. Worn rear axle pinion shaft in case or side gear hub counterbore in case worn oversize. b. Worn universal joint on propeller shaft. c. Slip yoke lubrication insufficient.
11. Groan in forward or reverse.	a. Wrong lubricant in rear axle. b. Worn bushings.
12. Chatter on turns.	a. Wrong lubricant in rear axle. b. Clutch cone worn and/or spring worn.
13. Clunk or knock on rough road operation.	a. Excessive end play of axle shafts. b. Worn bushings.

PRE-REPAIR INVESTIGATION AND TROUBLE DIAGNOSIS

Figures 4 through 7

A close examination of the differential prior to taking it apart will often reveal valuable information as to the extent and type of repairs or adjustments necessary. This information and the report of the malfunction provide a basis for determining the degree of tearing down required. Frequent causes of axle noise are improper backlash, pinion bearing preload, side bearing preload, or a combination of these items. A few simple adjustments may be all that are necessary to correct the problem.

Before removing the case from the housing, the following checks should be made with the results recorded and analyzed: 1) backlash; 2) total assembly preload; 3) tooth contact pattern; 4) fluid level; and 5) fluid contamination.

Use care at all times to keep dirt and other foreign matter, such as grinder dust, soot, or sand, away from the rear axle to prevent the possibility of subsequent failure.

Gear Tooth Nomenclature

Figures 8 and 9

The side of the ring gear tooth which curves outward, or is convex, is referred to as the "drive" side. The concave side is the "coast" side. The end of the tooth nearest center of the ring gear (3) is referred to as the "toe" end. The end of the tooth farthest away from the center is the "heel" end. The toe end of the tooth is smaller than the heel end.

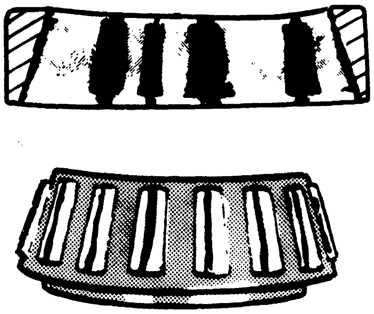
> **NOTICE:** It is very important that tooth contact be tested before the rear axle housing assembly is taken apart. Variations in the housing or pinion rear bearing assembly may cause the pinion to be too far away from, or close to, the ring gear (3). Thus, the tooth contact must be tested and corrected, if necessary, or the gears may be noisy.

Tooth Contact Pattern Test

Figures 8 and 9

> **NOTICE:** See "Notice" on page 4B-1 of this section.

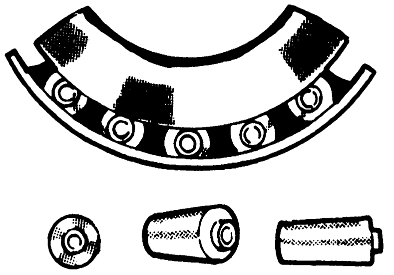
1. Wipe oil out of the carrier and carefully clean each tooth of the ring gear (3).



ABRASIVE ROLLER WEAR

Pattern on races and rollers caused by fine abrasives.

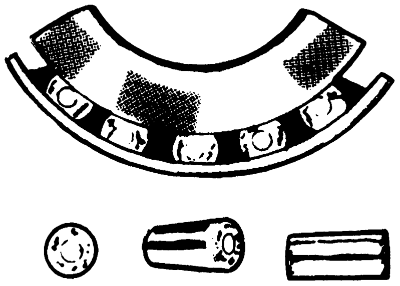
Clean all parts and housings, check seals and bearings and replace if leaking, rough or noisy.



ABRASIVE STEP WEAR

Pattern on roller ends caused by fine abrasives.

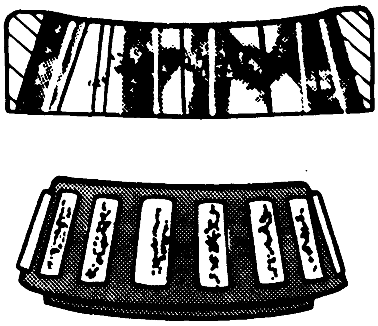
Clean all parts and housings, check seals and bearings and replace if leaking, rough or noisy.



GALLING

Metal smears on roller ends due to overheat, lubricant failure or overload.

Replace bearing, check seals and check for proper lubrication.



ETCHING

Bearing surfaces appear gray or grayish black in color with related etching away of material usually at roller spacing.

Replace bearings, check seals and check for proper lubrication.

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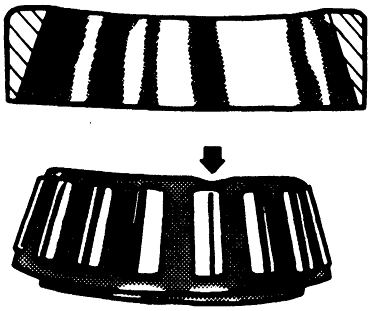
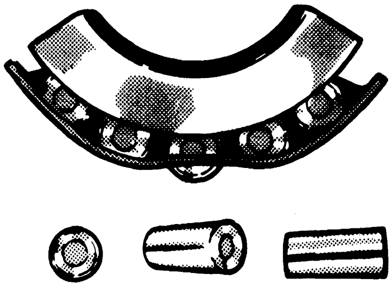
Figure 4 - Diagnosis of Tapered Wheel Bearings (1 of 4)



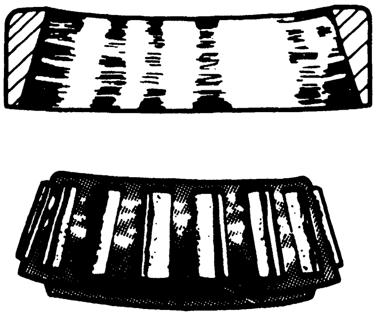
BENT CAGE

Cage damaged due to improper handling or tool usage.
Replace bearing.



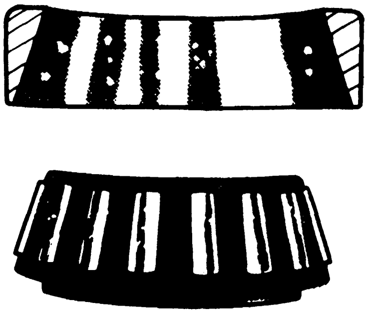
BENT CAGE

Cage damaged due to improper handling or tool usage.
Replace bearing.



CAGE WEAR

Wear around outside diameter of cage and roller pockets caused by abrasive material and inefficient lubrication.
Clean related parts and housings.
Check seals and replace bearings.



INDENTATIONS

Surface depressions on race and rollers caused by hard particles of foreign material.
Clean all parts and housings. Check seals and replace bearings if rough or noisy.

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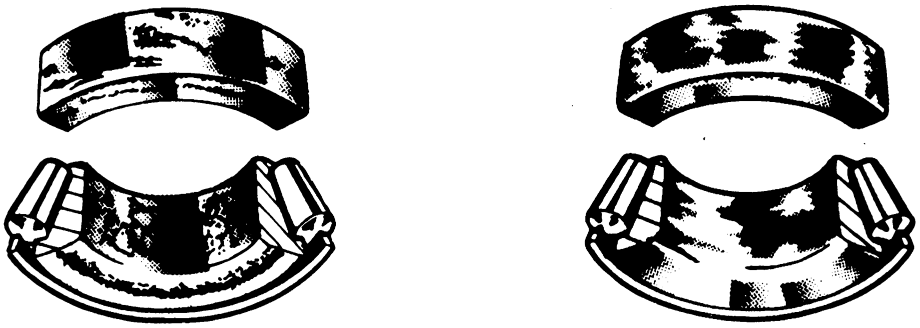
Figure 5 - Diagnosis of Tapered Wheel Bearings (2 of 4)

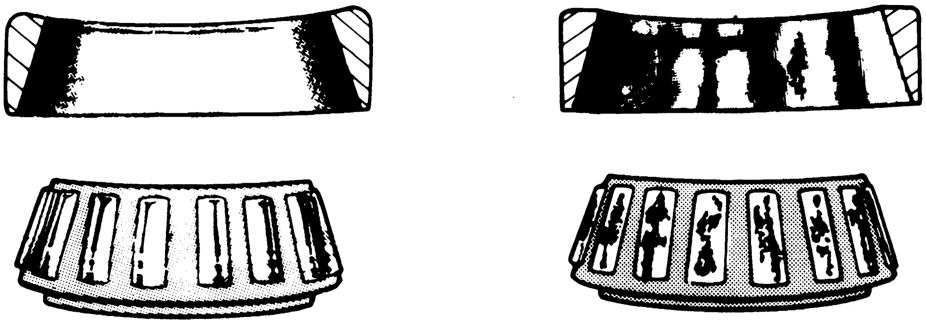


FRETTAGE

Corrosion set up by small relative movement of parts with no lubrication.
Replace bearing. Clean related parts. Check seals and check for proper lubrication.

SMEARS

Smearing of metal due to slippage. Slippage can be caused by poor fits, lubrication, overheating, overloads or handling damage. Replace bearings, clean related parts and check for proper fit and lubrication.



STAIN DISCOLORATION

Discoloration can range from light brown to black caused by incorrect lubricant or moisture.
Re-use bearings if stains can be removed by light polishing or if no evidence of overheating is observed.
Check seals and related parts for damage.

HEAT DISCOLORATION

Heat discoloration can range from faint yellow to dark blue resulting from overload or incorrect lubricant.
Excessive heat can cause softening of races or rollers. To check for loss of temper on races or rollers a simple file test may be made. A file drawn over a tempered part will grab and cut metal, whereas, a file drawn over a hard part will glide readily with no metal cutting.
Replace bearings if over heating damage is indicated. Check seals and other parts.

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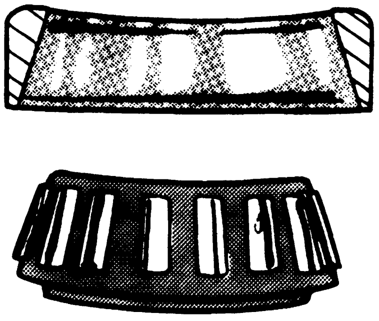
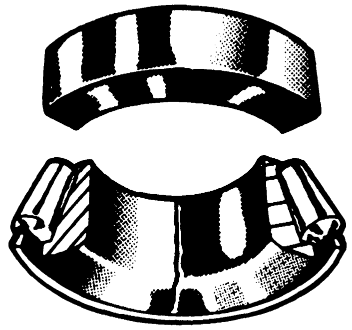
Figure 6 - Diagnosis of Tapered Wheel Bearings (3 of 4)



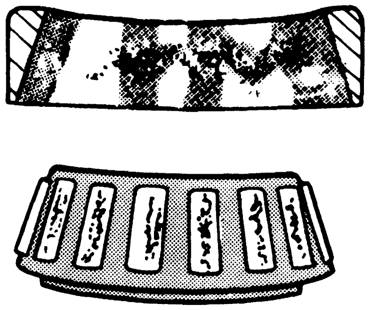
MISALIGNMENT

Outer race misalignment due to foreign object.
Clean related parts and replace bearing. Make sure races are properly seated.



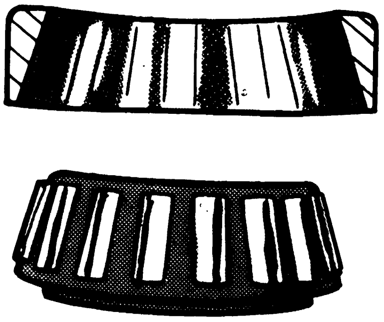
CRACKED INNER RACE

Race cracked due to improper fit, cocking, or poor bearing seats.
Replace bearing and correct bearing seats.



FATIGUE SPALLING

Flaking of surface metal resulting from fatigue.
Replace bearing, clean all related parts.



BRINELLING

Surface indentations in raceway caused by rollers either under impact loading or vibration while the bearing is not rotating.
Replace bearing if rough or noisy.

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Figure 7 - Diagnosis of Tapered Wheel Bearings (4 of 4)

2. Use gear marking compound GM part number 1052351 or equivalent and apply this mixture sparingly to all ring gear teeth, using a medium stiff brush. When properly used, the area of pinion tooth contact will be visible when hand load is applied.

Tighten

- Bearing cap bolts to 75 N·m (55 lb. ft.).

3. Apply parking brake until a torque of 54 to 70 N·m (40 to 52 lb. ft.) is required to turn the pinion.

   A test made without loading the gears will not give a satisfactory pattern. Turn the pinion yoke with a wrench so that the ring gear (3) rotates one full revolution. Reverse rotation so that the ring gear (3) rotates one revolution in the opposite direction.

4. Observe the pattern on the ring gear teeth and compare with the chart (Figure 9).

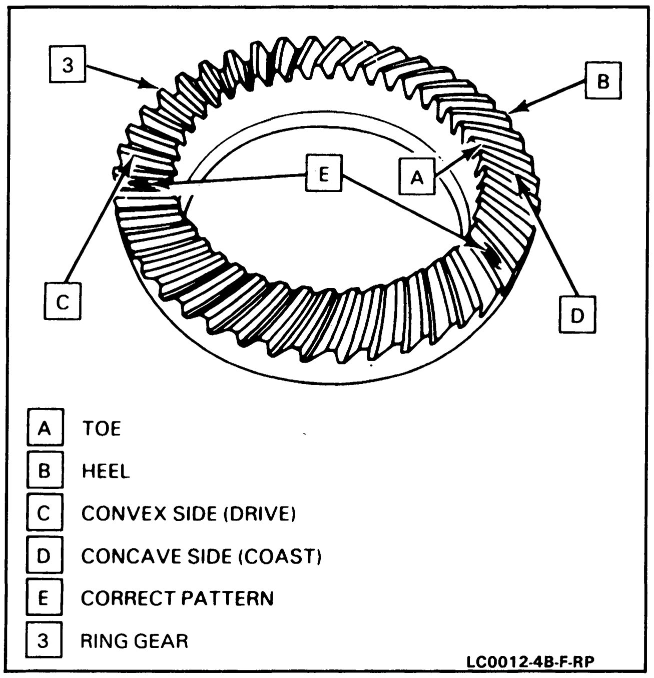


Figure 8 - Desired Tooth Contact Under Light Load and Gear Tooth Nomenclature

Effects of Increasing Load on Tooth Contact Pattern

When the "load" on the ring and pinion gear (29) is increased, such as when the vehicle is accelerated forward from standstill or from normal drive, the tooth contact will tend to spread out and, under very heavy load, will extend from near toe to near heel on the drive side. The entire contact also tends to shift toward the heel under increasingly heavier loads and will become somewhat broader with respect to tops and bottoms of teeth. The patterns obtained by this tooth contact pattern test approximate a light load and, for this reason, they will extend only about halfway.

The important thing to note is that the contact pattern is centrally located up and down on the face of the ring gear teeth.

Adjustments Affecting Tooth Contact

Figures 1, 2 and 9

Two adjustments can be made which will affect tooth contact pattern: backlash and position of drive pinion (17) in the axle housing (20). The effects of bearing preloads are not readily apparent on hand-loaded tooth contact pattern tests. These adjustments should be within specifications before proceeding with backlash and drive pinion adjustments.

Backlash is adjusted by means of the side bearing adjusting shims (2). The shims move the entire differential case (7) and ring gear assembly closer to, or farther from, the drive pinion (17). The adjusting shims (2) are also used to set side bearing preload. The position of the drive pinion (17) is adjusted by increasing or decreasing the shim thickness between the pinion head and inner race of the rear bearing assembly (19). The shim (2) is used in the rear axle to compensate for manufacturing tolerances. Increasing shim thickness moves the pinion closer to the centerline of the ring gear (3). Decreasing shim thickness moves the pinion farther away from the centerline of the ring gear (3).

Effects of Pinion Position on Tooth Pattern

Figure 1, 2 and 9

When the drive pinion (17) is too far away from the centerline of the ring gear (3), the pattern will be a high heel contact on the drive side and high toe contact on the coast side. Moving the drive pinion (17) closer to the centerline of the ring gear (3) by decreasing backlash will cause the high heel contact on the drive side to lower and move toward the toe; the high toe contact on the coast side will lower and move toward the heel.

When the drive pinion (17) is too close to the centerline of the ring gear (3), the pattern will be a low toe contact on the drive side, and a low heel contact on the coast side. Moving the drive pinion (17) farther away from the ring gear (3) by increasing backlash will cause low toe contact on the drive side to raise and move toward the heel; the low heel contact on the coast side will raise and move toward the toe.

ON-VEHICLE SERVICE

CARRIER COVER AND GASKET

Figures 1 and 2

Remove or Disconnect

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. OA).

Clean

- All dirt from area of carrier cover (14) before removing carrier cover (14).

1. Cover bolts (13) and pry carrier cover (14) loose to drain lubricant.
2. Cover gasket (16).

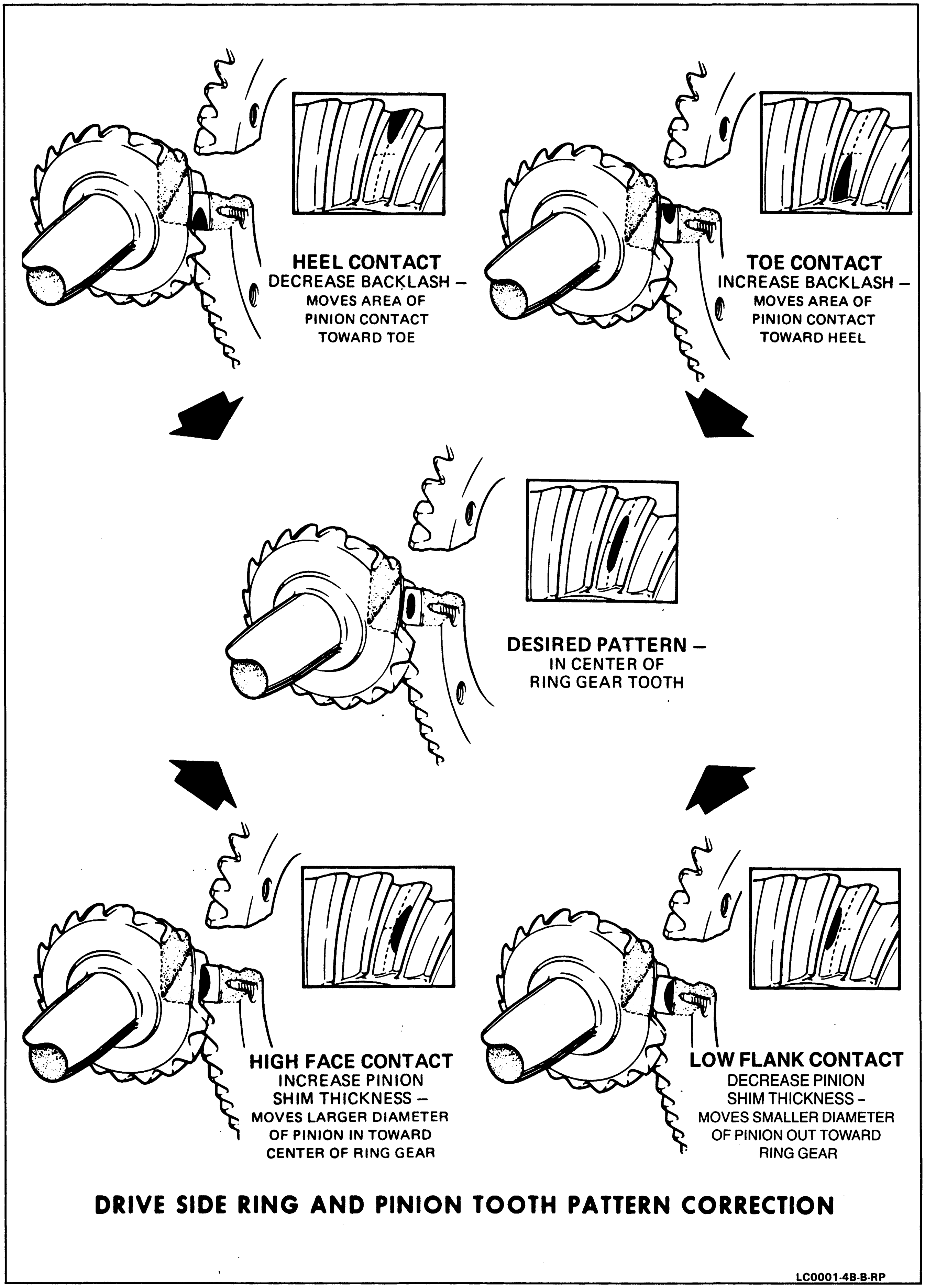


Figure 9 - Gear Tooth Contact Pattern and Adjustments Affecting Tooth Contact

Clean

- Both gasket sealing surfaces.

Install or Connect

NOTICE: See "Notice" on page 4B-1 of this section.

- Use sealant GM part number 1052366 or cover gasket (16) only.

1. Cover gasket (16) and carrier cover (14).
2. Cover bolts (13) in a crosswire pattern.

Tighten

- Cover bolts (13) to 30 N·m (22 lb. ft.).

- Remove plug (22).

3. Axle lubricant. Refer to MAINTENANCE AND LUBRICATION (SEC. 0B).
4. Plug (22).

- Lower vehicle.

AXLE SHAFT

Figures 1, 2 and 10

Remove or Disconnect

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. OA).

1. Wheel and tire. Refer to TIRES AND WHEELS (SEC. 3E).
2. Brake drum if equipped. Refer to DIRECT TORQUE DRUM BRAKE ASSEMBLY (SEC. 5C3).
3. Brake rotor, if equipped. Refer to REAR DISC BRAKE CALIPER ASSEMBLY (SEC. 5B3).

Clean

- All dirt from area of carrier cover (14).

4. Lubricant from carrier by removing cover bolts (13) and carrier cover (14).
5. Rear axle pinion shaft lock screw (5) and the pinion gear shaft (6).
6. C-lock (40) from the bottom end of the shaft by pushing the flanged end of the axle shaft (39) into the axle housing (20).
7. Axle shaft (39) from axle housing (20), being careful not to damage seal (41).

Install or Connect

NOTICE: See "Notice" on page 4B-1 of this section.

1. Axle shaft (39) into place taking care that splines on the end of the shaft do not damage the seal (41) and that they engage with the splines of the side gear (10).
2. C-lock (40) on bottom end of axle shaft (39). Push shaft outward so that shaft lock seats in counterbore of rear axle side gear.
3. Rear axle pinion gear shaft (6) through the differential case (7), thrust washer (11) and pinion gears (12), aligning hole in shaft with lock screw hole.
4. Lock screw (5).

Tighten

- Lock screw (5) to 36 N·m (27 lb. ft.).

5. Carrier cover and bolts, using a new cover gasket. Refer to "Carrier Cover and Gasket" in this section.
6. Brake rotor, if equipped. Refer to REAR DISC BRAKE CALIPER ASSEMBLY (SEC 5B3).
7. Brake drum. Refer to DIRECT TORQUE DRUM BRAKE ASSEMBLY (SEC. 5C3).
8. Wheel and tire. Refer to TIRES AND WHEELS (SEC. 3E).
9. Lower vehicle.

Inspect

- Operation of axle.

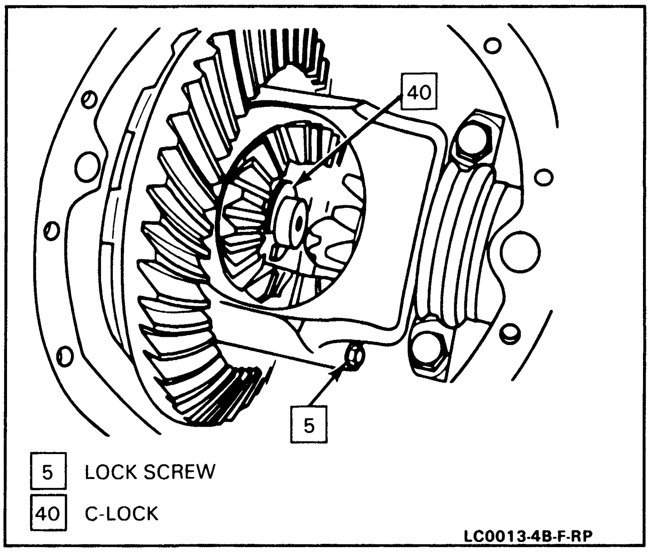


Figure 10 - Pinion Shaft Lock Screw

AXLE OIL SEAL AND/OR BEARING REPLACEMENT WITH AXLE SHAFTS REMOVED

Figures 11 through 14

Tools Required:

J 2619-01 Slide Hammer with 1/2-13 Adapter
J 8092 Driver Handle
J 22813-01 Axle Bearing Remover
J 23765 Axle Bearing Installer
J 23771 Axle Oil Seal Installer

Remove or Disconnect

1. Oil seal (41) from axle housing (20) with a pry bar behind steel case of oil seal (41), being careful not to damage axle housing (20).

- Insert J 22813-01 into bore and position it behind bearing so tangs on tool engage bearing outer race.

2. Bearing assembly (42) using J 2619-01.

Install or Connect

- Lubricate new bearing with gear lubricant.

1. Bearing assembly (42) so that tool bottoms against shoulder in axle housing (20), using J 23765 and J 8092.

- Lubricate sealing lips with gear lubricant.
- Position oil seal (41) on J 23771 and insert seal (41) into housing bore.

2. Seal (41) into place, flush with axle tube.

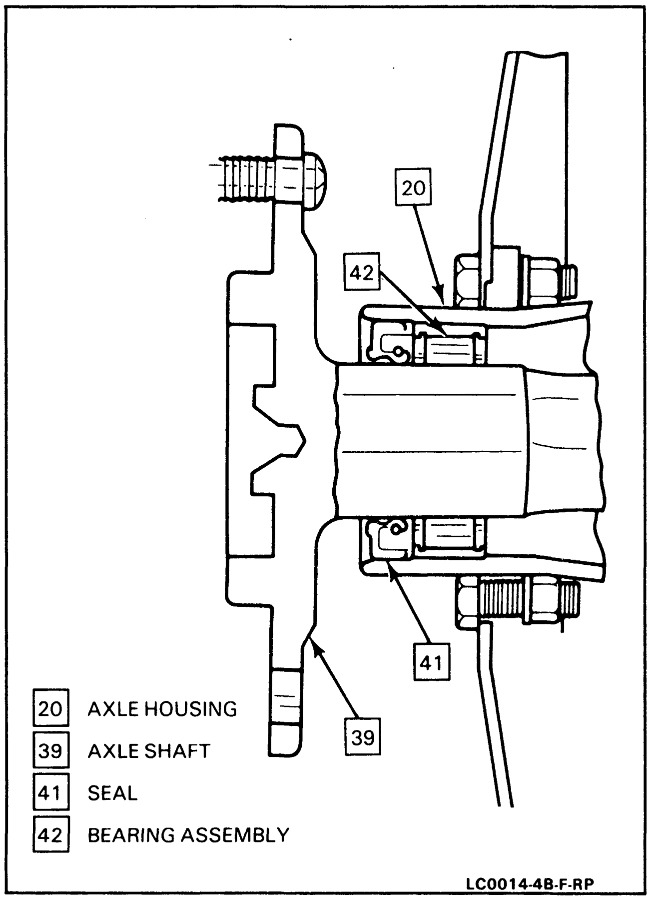


Figure 11 - Axle Shaft Assembly

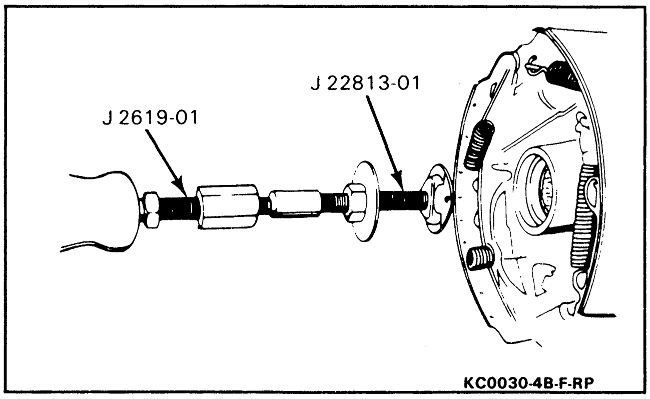


Figure 12 - Removing Axle Bearing

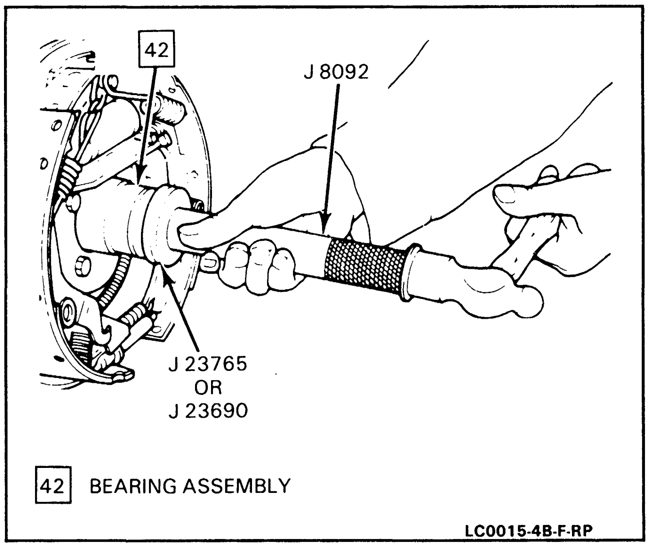


Figure 13 - Installing Axle Bearing

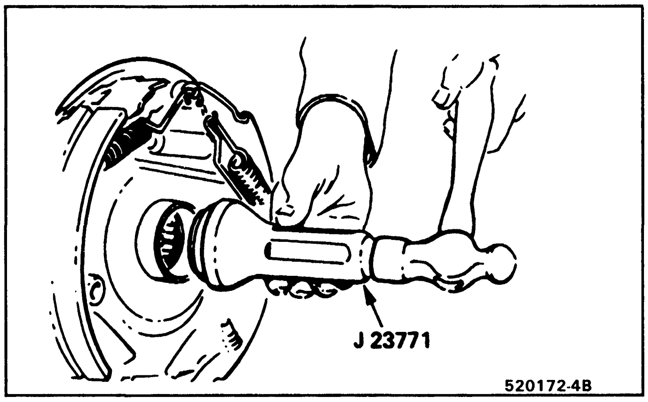


Figure 14 - Installing Axle Seal

PINION YOKE OIL SEAL

Figures 1, 2 and 15 through 18

Tools Required:

J 8614-2 Pinion Flange Remover Adapter
J 8614-3 Pinion Flange Remover Screw
J 8614-10 Pinion Flange Remover
J 23911 Pinion Oil Seal Installer

Remove or Disconnect

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).
- Mark the propeller shaft and pinion yoke (27) with a punch or cold chisel so they can be assembled in the same position.

1. Propeller shaft from the rear axle pinion yoke (27). Support shaft up in body tunnel by wiring propeller shaft to the exhaust pipe.

- If joint bearings are not retained by a retainer strap, use a piece of tape to hold bearings on their journals.
- With rear wheels off floor, turn rear wheels and tap brake backing plates with a soft hammer to ensure that brakes are free.
- Mark the position of the pinion yoke (27), pinion gear shaft (6) and nut (29) with a punch so the proper pinion bearing preload can be maintained.

2. Nut (29) and washer (28), using J 8614-10.
- Use a suitable container to hold any fluid that may drain from the rear axle.
3. Pinion yoke (27), using J 8614-2, J 8614-3 and J8614-10.
4. Seal (25) by driving it out of the carrier with a blunt chisel. Do not damage carrier.

Inspect

- Seal surface of pinion yoke (27) for tool marks, nicks, or damage, such as a groove worn by the seal. If damaged, replace pinion yoke. Refer to "Pinion Yoke" in this section.
- Carrier bore and remove any burrs that might cause leaks around the outer diameter (OD) of the seal.

Install or Connect

1. New seal (25) using J 23911.
2. Seal lubricant, number 1050169 or equivalent, to the outer diameter of the pinion yoke (27) and sealing lip of the new seal (25).
3. Pinion yoke (27) on drive pinion (17) by tapping with a soft hammer until a few pinion threads project through the pinion yoke (27).
4. Pinion washer (28) and tighten nut (29) to the same position as marked in removal procedure. While holding pinion yoke (27), tighten nut (29) 1.59 mm (1/16 inch) beyond alignment marks.
- Lower vehicle.

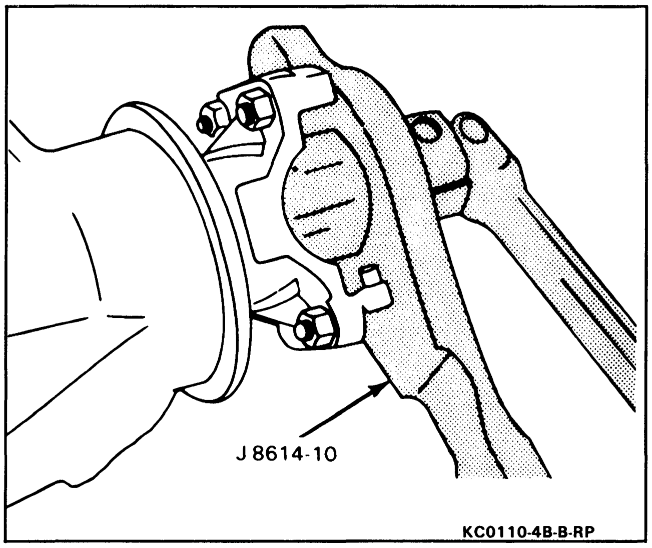


Figure 15 - Removing Pinion Nut

PINION YOKE

Figures 1, 2 and 15 through 18

Tools Required:

J 8614-2 Pinion Flange Remover Adapter
J 8164-3 Pinion Flange Remover Screw
J 8614-10 Pinion Flange Remover
J 23911 Pinion Oil Seal Installer

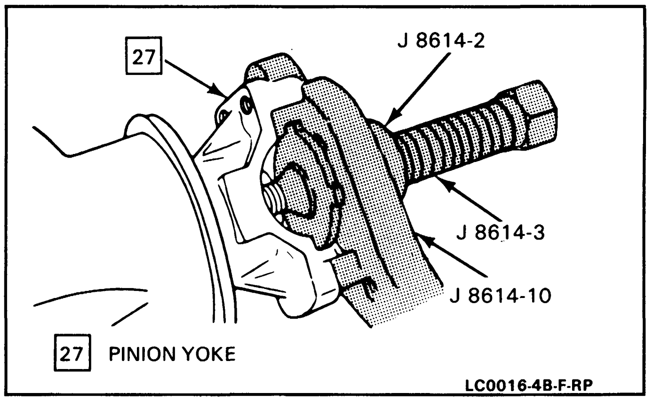


Figure 16 - Removing Pinion Yoke

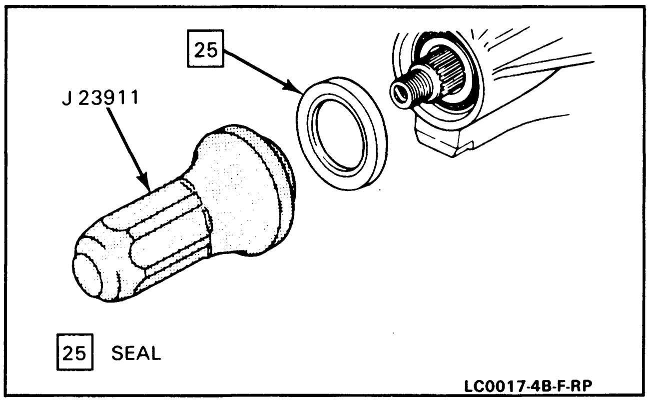


Figure 17 - Installing Pinion Yoke Oil Seal

Remove or Disconnect

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. OA).
1. Both rear wheels and tires.
2. Brake drums, if equipped. Refer to DIRECT TORQUE DRUM BRAKE ASSEMBLY (SEC. 5C3).
3. Rotors, if equipped. Refer to REAR DISC BRAKE CALIPER ASSEMBLY (SEC. 5B3).
- Mark propeller shaft and pinion yoke (27) relationship.
4. Rear joint and support propeller shaft out of the way.
- If joint bearings are not retained by a retainer strap, use a piece of tape to hold bearings on their journals.
- Check preload with a pound inch torque wrench and record. This will give combined pinion bearing, carrier bearing, axle bearing and seal preload.
5. Pinion yoke nut (29) and washer (28), using J 8614-10.
- Use with a suitable container to hold any fluid that may drain from the rear axle.
6. Pinion yoke (27), using J 8614-2, J 8614-3 and J 8614-10.
7. Seal (25) by driving it out of carrier with a blunt chisel. Do not damage carrier.

Install or Connect

NOTICE: See "Notice" on page 4B-1 of this section.

1. Seal (25) using J 23911.
2. Seal lubricant, 1050169 or equivalent, to the outer diameter of the pinion yoke (27) and sealing lip of the new seal.
3. Pinion yoke (27).
4. Washer (28) and nut (29) finger tight.

- While holding pinion yoke (27), tighten the nut (29) gradually and turn drive pinion (17) several revolutions after each tightening to set the bearings. Check the preload of bearings each time with a pound inch torque wrench until preload is 0.3 to 0.6 N·m (3 to 5 lb. in.) more than reading obtained in the removal procedure.

5. Propeller shaft to pinion yoke (27). Refer to PROPELLER SHAFT (SEC. 4A).
6. Brake drums if equipped. Refer to DIRECT TORQUE DRUM BRAKE ASSEMBLY (SEC. 5C3).
7. Rotors, if equipped. Refer to REAR DISC BRAKE CALIPER ASSEMBLY (SEC. 5B3).
8. Wheels and tires.
9. Axle lubricant. Refer to MAINTENANCE AND LUBRICATION (SEC. 0B).

- Lower vehicle.

Inspect

- Operation of axle.

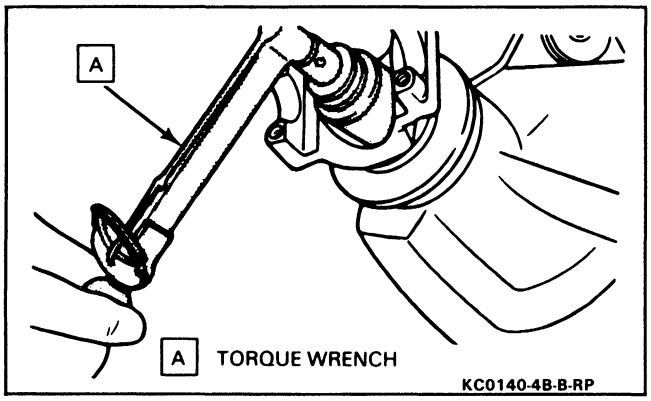


Figure 18 - Checking Pinion Preload

REAR AXLE ASSEMBLY

Figures 1 and 2

It is not necessary to remove the rear axle assembly for any normal repairs. However, if the housing is damaged, the rear axle assembly may be removed and installed using the following procedure.

Remove or Disconnect

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. OA).
- Support vehicle frame.
- Hoist must remain under axle housing (20).

1. Shock absorbers from axle housing. Refer to REAR SUSPENSION (SEC. 3D).
2. Track bar. Refer to REAR SUSPENSION (SEC. 3D).
3. Brake line junction block bolt at axle housing. Refer to GENERAL BRAKES (SEC. 5).
4. Brake lines at junction block. Refer to GENERAL BRAKES (SEC. 5).

- Lower rear axle assembly on the jackstand.

5. Springs. Refer to REAR SUSPENSION (SEC. 3D).
6. Axle shaft. Refer to "Axle Shaft" in this section.
7. Brake lines from axle housing clips. Refer to GENERAL BRAKES (SEC. 5).
8. Brake backing plates (34).
9. Lower control arms from rear axle housing. Refer to REAR SUSPENSION (SEC. 3D).
10. Torque arm at axle.

- Mark propeller shaft and pinion yoke (27).

11. Propeller shaft and support out of way. Refer to PROPELLER SHAFT (SEC. 4A).
12. Axle housing (20).

Install or Connect

1. Axle housing (20).

Important

- If a new axle housing was installed and the vehicle is equipped with disc brakes, refer to "Rear Axle Housing Replacement (Disc Brakes)" in this section.

2. Propeller shaft, aligning marks made at time of removal. Refer to PROPELLER SHAFT (SEC. 4A).
3. Torque arm to axle.
4. Lower control arms and tighten. Refer to REAR SUSPENSION (SEC. 3D).
5. Brake backing plates (34).
6. Brake lines to axle housing under axle housing clips. Refer to GENERAL BRAKES (SEC. 5).
7. Axle shaft. Refer to "Axle Shaft" in this section.

- Raise axle assembly on jackstands.

8. Springs. Refer to REAR SUSPENSION (SEC. 3D).
9. Brake lines to junction block. Refer to GENERAL BRAKES (SEC. 5).
10. Brake line junction block bolt to axle housing (20).
11. Track bar. Refer to REAR SUSPENSION (SEC. 3D).
12. Shock absorbers to axle housing. Refer to REAR SUSPENSION (SEC. 3D).
13. Axle lubricant. Refer to MAINTENANCE AND LUBRICATION (SEC. 0B).

- Bleed hydraulic brake system. Refer to GENERAL BRAKES (SEC. 5).

- Lower control arm bolts with weight of the vehicle on the axle. Refer to REAR SUSPENSION (SEC. 3D).
- Remove jackstands and lower vehicle.

REAR AXLE HOUSING REPLACEMENT (DISC BRAKES)

Figures 1, 2 and 19

A shim (46) must be installed between the rear brake caliper mounting plate (47) and the tube flange on the rear axle housing (45). This shim (46) centers the brake caliper and shoes over the brake disc, ensuring even brake pad pressure during braking. This shim (46) may have to be changed when the rear axle housing (45) is replaced.

Assemble

NOTICE: See "Notice" on page 4B-1 of this section.

1. Rear axle housing (45).
2. Propeller shaft, aligning marks made at time of removal. Refer to PROPELLER SHAFT (SEC. 4A).
3. Torque arm to axle.
4. Lower control arms and tighten. Refer to REAR SUSPENSION (SEC. 3D).
5. Brake lines to the axle housing under axle housing clips. Refer to GENERAL BRAKES (SEC. 5).
6. Brake caliper mounting plate (47) to tube flange.
   - Omit shim (46) at this time.
7. Caliper mounting plate bolts (49).

Tighten

- Bolts (49) to 50 N·m (37 lb. ft.).

8. Axle shaft (39) in place.
   - Ensure splines on the end of the axle shaft (39) do not damage the seal (41) and they engage with splines of the side gear (10).
9. C-lock (40) on bottom end of axle shaft (39) and push shaft outward so shaft lock seats in counterbore of the side gear (10).

- Position pinion gear shaft (6) through the differential case (7) and pinion gears (12), aligning the hole in the pinion gear shaft (6) with the lock screw (5).

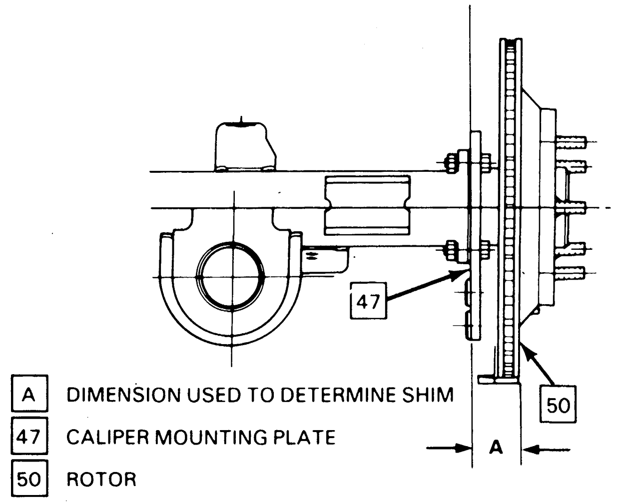
10. Lock screw (5). Leave finger tight.

Measure

1. The distance from the rear face of the caliper mounting plate (47) to the front face of the machined axle shaft flange, using a caliper.
2. Select the shim (46). Refer to Figure 19.

Remove or Disconnect

1. Lock screw (5) from differential case (7).
2. Pinion gear shaft (6) from differential case (7).
3. C-lock (40) from the axle shaft (39).
4. Axle shaft (39) from the rear axle housing (45).
5. Brake caliper mounting plate (47) from the tube flange.



DISTANCE "A"	SHIM THICKNESS REQUIRED*	PART NUMBER
64.04-65.34 mm (2.521-2.572 IN.)	NO SHIM REQUIRED	
65.35-66.10 mm (2.573-2.602 IN.)	0.81 mm (0.032 IN.)	26013017
66.11-66.86 mm (2.603-2.633 IN.)	1.57 mm (0.062 IN.)	26013018
66.87-67.62 mm (2.634-2.662 IN.)	2.33 mm (0.092 IN.)	26013019
67.63-68.38 mm (2.663-2.692 IN.)	3.09 mm (0.121 IN.)	26013020

*ORIGINAL SHIM, IF INCLUDED, MAY BE PROPER THICKNESS TO REUSE.

LC0018-4B-F-RP

Figure 19 - Brake Caliper Mounting Plate Shim Selection

Install or Connect

NOTICE: See "Notice" on page 4B-1 of this section.

1. Shim (46).
2. Brake caliper mounting plate (47).
3. Caliper mounting plate bolts (49).

   Tighten

   - Bolts (49) to 50 N·m (37 lb. ft.).
4. Axle shaft (39) in place.
   - Ensure splines on the end of the axle shaft (39) do not damage the seal (41) and they engage with the splines of the side gear (10).
5. C-lock (40) on bottom end of the axle shaft (39).
   - Push shaft outward so the shaft lock seats in the counterbore of the side gear (10).
6. Pinion gear shaft (6) through the differential case (7) and pinion gears (12), aligning the hole in the pinion gear shaft (6) with the lock screw (5).
7. Lock screw (5).

   Tighten

   - Lock screw (5) to 36 N·m (27 lb. ft.).
8. Carrier cover, new cover gasket and bolts. Refer to "Carrier Cover and Gasket" in this section.
9. Wheels and tires. Refer to TIRES AND WHEELS (SEC. 3E).

- Raise axle assembly on jackstands.

10. Springs. Refer to REAR SUSPENSION (SEC. 3D).
11. Brake lines to junction block. Refer to GENERAL BRAKES (SEC. 5).
12. Brake line junction block bolt to rear axle housing (45).
13. Track bar. Refer to REAR SUSPENSION (SEC. 3D).
14. Shock absorbers to the rear axle housing. Refer to REAR SUSPENSION (SEC. 3D).
15. Axle lubricant. Refer to MAINTENANCE AND LUBRICATION (SEC. 0B).

- Bleed hydraulic brake system. Refer to GENERAL BRAKES (SEC. 5).
- Lower control arm bolts with the weight of the vehicle on the axle. Refer to REAR SUSPENSION (SEC. 3D).
- Remove jackstands and lower vehicle.

REAR WHEEL BOLT

For information on rear wheel bolts, refer to TIRES AND WHEELS (SEC. 3E).

UNIT REPAIR

Before attempting any service procedures, the technician must know what type rear axle is to be serviced. Refer to "Specifications" to identify codes, ring gear size, rations and "Service Parts Identification" label information.

Most rear axle service repairs can be made by supporting the vehicle by the frame with the axle housing supported and lowered to its lowest travel. On some vehicles it may be necessary to disconnect shock absorbers to obtain additional clearance. When doing this, do not allow the rear brake hose to become kinked or stretched.

Lubricant may be drained by removing all cover bolts and breaking the cover loose at the bottom.

If the axle housing is removed for any reason, rear axle service can be performed on the bench.

When a new ring gear and pinion are installed, the owner should be advised not to accelerate rapidly or exceed 80 km/h (50 mph) for the first 80 kilometers (50 miles) of driving.

Any time the differential is taken apart for service, the following cleaning and inspecting procedures should be followed:

Clean

- All rear axle bearings thoroughly in clean solvent.

Inspect

- Bearings visually and by feel. All bearings should feel smooth when oiled and rotated while applying as much hand pressure as possible. Minute scratches and pits that appear on rollers and races at low mileage are due to the initial preload, and bearings having these marks should not be replaced.
- Sealing surface of pinion yoke for nicks, burrs, or rough tool marks which would cause damage to the seal and result in an oil leak. Replace if damaged.
- Carrier bore and remove any burrs that might cause leaks around the outer diameter of the drive pinion gear oil seal.
- Ring gear and drive pinion teeth for excessive wear and scoring. If any of these conditions exist, replacement of the gears as a set will be required.
- Pinion gear shaft for unusual wear; also check the pinon gears, side gears and thrust washers.
- Press fit of the side bearing inner race on the differential case hub by prying against the shoulder at the puller recess in the case. Side bearings must be tight press fit on the hub.
- Diagnosis of the rear axle failure such as: chipped bearings, loose (lapped-in) bearings, chipped gears, etc. is a warning that some foreign material is present. The axle housing must be cleaned.

DIFFERENTIAL CASE REMOVAL WITH AXLE SHAFT REMOVED

Figures 1, 2, 20 through 24

Tools Required:

J 8001 Dial Indicator Set

J 8107-2 Differential Side Bearing Remover Plug

J 8092 Driver Handle

J 22888-20 Differential Side Bearing Remover

J 25299 Differential Side Bearing Installer

Remove or Disconnect

- **Before removing the differential case (7) from the axle housing (20), ring gear to drive pinion backlash must be checked using J 8001. Refer to "Rear Axle Backlash" in this section. This will indicate gear or bearing wear or an error in backlash or preload setting that will help in determining the cause of axle noise.**

1. Differential bearing cap bolts (31).

Important

- Differential bearing caps (30) should be marked "L" and "R" to make sure they will be assembled in their original location.
- Place right and left bearing outer races of side bearing assemblies (4) and shims (2) in sets with marked differential bearing caps (30) so they can be reinstalled in their original positions.

NOTICE: Exercise caution in prying on the rear axle housing so gasket sealing surface is not damaged.

2. Differential case (7).

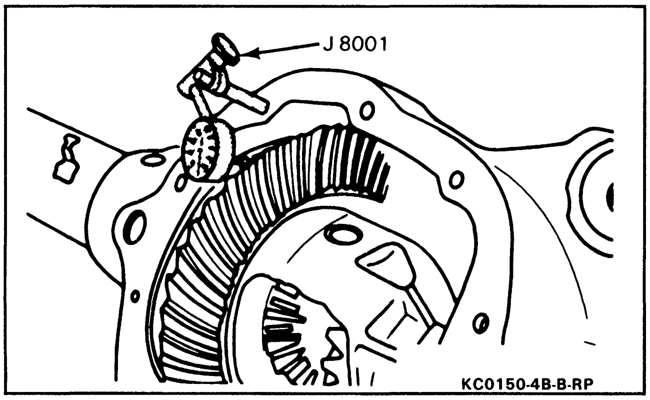


Figure 20 - Checking Ring Gear to Pinion Backlash

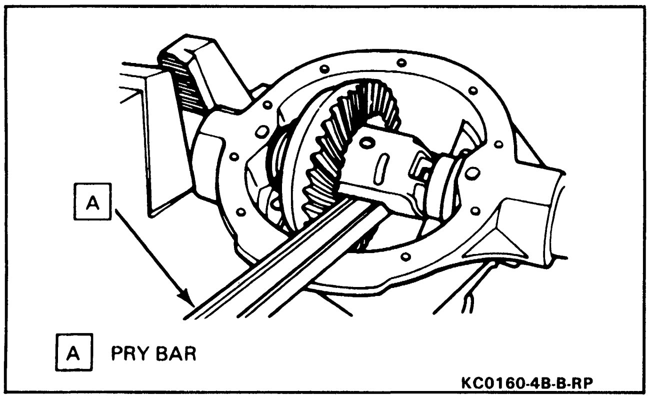


Figure 21 - Removing Differential Case Assembly

Disassemble

1. Bearing assemblies (4), using J 22888-20 and J 8107-2 (Figure 22).
2. Lock screw (5) that holds the pinion gear shaft (6).
3. Pinion gears (12), side gears (10) and thrust washers (9 and 11) from differential case (7). Mark side gears (10) and differential case (7).
4. Ring gear bolts (8) (LH threads).
5. Ring gear (3) using a brass drift and hammer.
    - Do not pry between ring gear (3) and differential case (7).

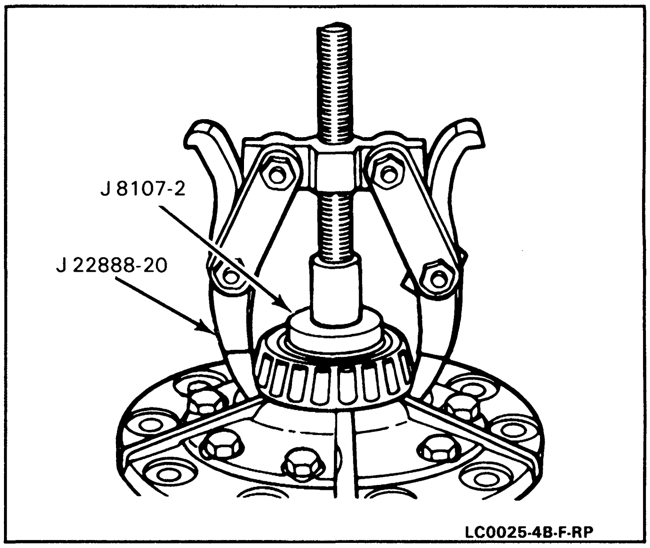


Figure 22 - Removing Differential Case Side Bearings

Assemble

NOTICE: See "Notice" on page 4B-1 of this section.

- Before assembling the differential case (7), lubricate all parts with rear axle lubricant.

1. Side gear thrust washers (9 and 11) over side gear hubs and install side gears (10) in differential case (7). If the same parts are reused, install in original sides.

- Position one pinion gear (12) (without washer) between side gears (10) and rotate gears until pinion gear (12) is directly opposite loading opening in case. Place other pinion gear (12) between side gears (10) so that pinion shaft holes are in line; then rotate gears lining up holes in pinion gears (12) with holes in differential case (7).
- Rotate pinion gears (12) back toward loading opening just enough to permit sliding in pinion thrust washers (9 and 11).

2. Pinion gear shaft (6).
3. Pinion lock screw (5).

Tighten

- Lock screw (5) to 36 N·m (27 lb. ft.).

- Clean connecting surfaces of the differential case (7) and ring gear (3).

- Position ring gear (3) on the differential case (7).

4. Two new bolts (8) into opposite sides of the ring gear (3). (Figure 23).
5. Remaining new bolts (8) with bolts just snug.
   - Never use old bolts.

Tighten

- New bolts (8) alternately in progressive stages to 120 N·m (89 lb. ft.).

6. Bearing assemblies (4) using J 8092 and J 25299 (Figure 24).

- Continue with "Side Bearing Shim Selection."

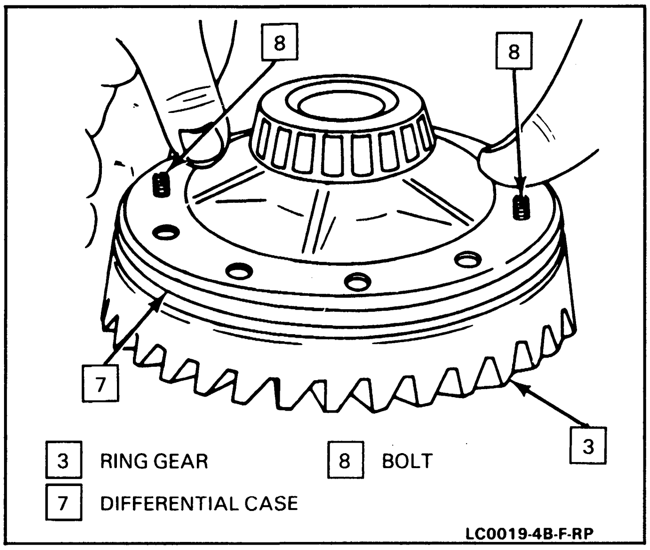


Figure 23 - Installing Ring Gear on Case Assembly

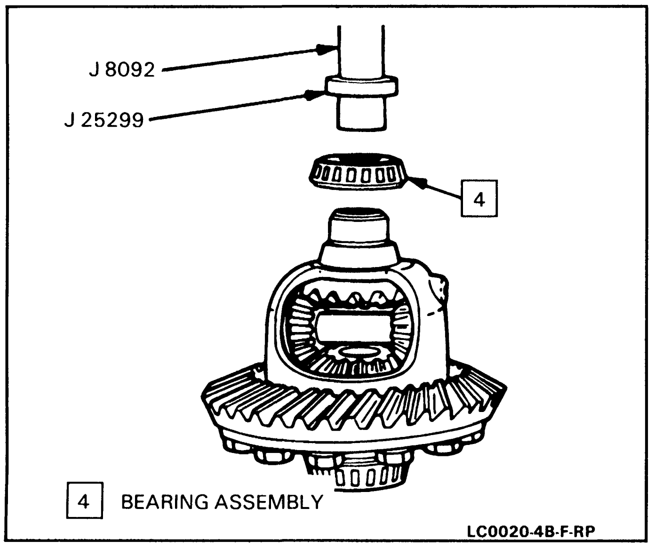


Figure 24 - Installing Differential Case Side Bearings

Side Bearing Shim Selection

Figures 1, 2 and 25

Adjust

The side bearing preload adjustment is to be made before installing the pinion. If the pinion is installed, remove ring gear (3).

- Differential case side bearing preload is adjusted by changing the thickness of both the right and left shims (2) by an equal amount.
- By changing the thickness of both shims (2) equally, the original backlash will be maintained.
- Production shims (2) are cast iron and vary in thickness from 5.33 mm to 6.91 mm (0.210 inch to 0.272 inch) in increments of 0.05 mm (0.002 inch).
- Standard service spacers (1) are 4.32 mm (0.0170 inch) thick and steel service shims (2) are available from 1.02 mm to 2.08 mm (0.040 inch to 0.082 inch) in increments of 0.05 mm (0.002 inch).

NOTICE: Do not attempt to reinstall the production shims as they may break when tapped into place. If service shims were previously installed, they can be reused, but whether using new or old bearings adhere to the following procedure in all cases. If bearings are used again, they must have original outer races in place.

1. Determine the approximate thickness of shims (2) needed by measuring each production shim (2) or each service spacer (1) and shim pack.
2. In addition to the service spacer (1), service shims (2) will be needed. To select a starting point in service shim thickness, refer to Figure 25.

4.32mm (0.170") SERVICE SPACER

TOTAL THICKNESS OF BOTH PROD. SHIMS REMOVED	TOTAL THICKNESS OF SERVICE SHIMS TO BE USED AS A STARTING POINT
10.57mm 0.420"	1.52mm 0.060"
10.92mm 0.430"	1.78mm 0.070"
11.18mm 0.440"	2.03mm 0.080"
11.43mm 0.450"	2.29mm 0.090"
11.68mm 0.460"	2.54mm 0.100"
11.94mm 0.470"	2.79mm 0.110"
12.19mm 0.480"	3.05mm 0.120"
12.45mm 0.490"	3.30mm 0.130"
12.70mm 0.500"	3.56mm 0.140"
12.95mm 0.510"	3.81mm 0.150"
13.21mm 0.520"	4.06mm 0.160"
13.46mm 0.530"	4.32mm 0.170"
13.97mm 0.550"	4.83mm 0.190"

KC0200-4B-B-RP

Figure 25 - Shim Thickness

3. Place differential case (7) with bearing outer races in position in the axle housing (20).
4. Slip the service spacer (1) between each bearing race and axle housing (20) with chamfered edge against axle housing (20).

NOTICE: Install the left bearing cap loosely so that the differential case may be moved while checking adjustments. Another bearing cap bolt can be added in the lower right bearing cap hole. This will prevent the case from dropping while making shim adjustments.

Measure

- Select one or two shims (2) totalling the amount shown in the right hand column and position between the right bearing race and the service spacer (1).
- Be sure the left bearing race and spacer (1) are against the left side of axle housing (20).

1. Insert progressively larger feeler gage sizes 0.25 mm, 0.30 mm, 0.36 mm, etc. (0.010 inch, 0.012 inch, 0.014 inch, etc.) between the right shim (2) and service spacer (1) until there is noticeable increase in drag.
2. Push the feeler gage downward until the end of the gage makes contact with the carrier bore to obtain a correct reading.
3. The point just before additional drag begins is the correct feeler gage thickness.
4. Rotate the differential case (7) while using the feeler gage to ensure an even reading.
    - The original light drag is caused by weight of the differential case (7) against the axle housing (20) while additional drag is caused by side bearing preload.
    - By starting with a thin feeler gage, a sense of "feel" is obtained. The beginning of preload can be recognized to obtain ZERO clearance.
    - It will be necessary to work the differential case (20) in and out and to the left in order to insert the feeler gage.
5. Remove the left differential bearing cap (30) and shim from the axle housing (20).
6. The total shim pack needed (with no preload on side bearings) is the feeler gage reading found in step 1 plus the thickness of shims (2) installed in step 3.
7. Select two shims (2) of approximately equal size whose total thickness is equal to the value obtained in step 1.
    - These shims (2) will be installed between each side bearing assembly (4) and service spacer (1) when the case is installed in the rear axle housing (20). This gives a "slip fit" of the differential case (7) in the axle housing (20).
    - The preload will not be added until the final step.
8. If the drive pinion (17) is in position, install the ring gear (3), then proceed to "Rear Axle Backlash."

Rear Axle Backlash

Tools Required:

J 8001 Dial Indicator Set

J 25588 Side Bearing Shim Installer

Adjust

- Install differential case into axle housing using shims as determined by "Side Bearing Shim Selection."
- Rotate differential case several times to seat bearings. Mount J 8001.
    - Use a small button on the indicator stem so that contact can be made near the heel end of tooth.
    - Set J 8001 so that stem is in line with gear rotation and perpendicular to tooth angle for accurate backlash reading.
- Check backlash at three or four points around ring gear.
    - Lash must not vary over 0.05 mm (0.002 inch) around ring gear.
    - Drive pinion must be held stationary when checking backlash.

Important

- If variation is over 0.05 mm (0.002 inch), check for burrs, uneven bolting conditions or distorted case flange and make corrections as necessary.

1. Backlash at the point of minimum lash should be between 0.13 mm and 0.23 mm (0.005 inch and 0.009 inch) for all new gears.
2. Backlash by increasing thickness of one shim and decreasing thickness of other shim the same amount.
    - For each 0.03 mm (0.001 inch) change in backlash desired, transfer 0.05 mm (0.002 inch) in shim thickness.
    - To decrease backlash 0.03 mm (0.001 inch), decrease thickness of right shim 0.05 mm (0.002 inch) and increase thickness of left shim 0.05 mm (0.002 inch). To increase backlash 0.05 mm (0.002 inch), increase thickness of right shim 0.10 mm (0.004 inch) and decrease thickness of left shim 0.10mm (0.004 inch).

- Continue with "Side Bearing Preload and Case Installation."

Side Bearing Preload and Case Installation

Figure 26

Tool Required:

J 25588 Side Bearing Shim Installer

Adjust

NOTICE: See "Notice" on page 4B-1 of this section.

- Keep shim packs in their respective position, right or left side.
- Select a shim 0.10 mm (0.004 inch) thicker than one removed from the left side, then insert left side shim pack between the spacer and the left bearing race.
- Loosely install bearing cap.
- Select a shim 0.10 mm (0.004 inch) thicker than the one removed from the right side and insert between the spacer and the right bearing race.

- It will be necessary to drive the right shim into position using J 25588.

Tighten

  - Differential side bearing caps to 75 N·m (55 lb. ft.).
- Check backlash and correct if necessary.

Install or Connect

- Axles. Refer to "Rear Axle Assembly" in this section.

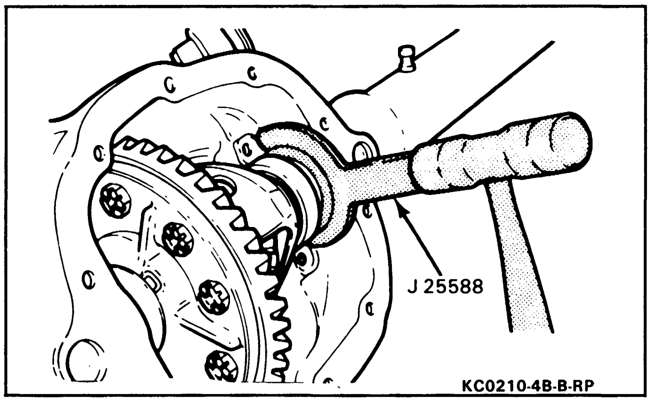


Figure 26 - Installing Case Preload Adjusting Shims

DRIVE PINION, BEARINGS AND RACES WITH CASE REMOVED

Drive Pinion

Figures 1, 2 and 27

Tools Required:

J 22536 Pinion Driver
J 23911 Pinion Oil Seal Installer

Remove or Disconnect

1. Differential case. Refer to "Differential Case Removal with Axle Shaft Removed" in this section.
   - Check the drive pinion bearing preload. If there is no preload reading, check for looseness of pinion assembly by shaking. Looseness could be caused by defective bearings or worn pinion yoke (27). If the rear axle was operated for an extended period with very loose bearings, the ring gear (3) and drive pinion (17) will also require replacement.
2. Pinion yoke. Refer to "Pinion Yoke" in this section.
3. Drive pinion (17), using J 22536. Apply heavy hand pressure on pinion remover toward axle housing (20) to keep front bearing seated to avoid damage to outer race.

Install or Connect

- If installing a new ring and pinion measure pinion depth before installing rear bearing assembly. Refer to "Pinion Depth" in this section.

1. Rear pinion bearing inner race. Refer to "Rear Pinion Bearing" in this section.
2. Front pinion bearing outer race. Refer to "Front Pinion Bearing" in this section.

NOTICE: There are two types of collapsible spacers. Be sure to use the inverted type on the 7-5/8 inch axle.

3. New collapsible spacer (23) on drive pinion (17) and position lubricated assembly in axle housing (20).
   - Hold forward on drive pinion (17) into axle housing assembly.
4. Front bearing on drive pinion (17) and drive bearing on pinion shaft until seated in race.

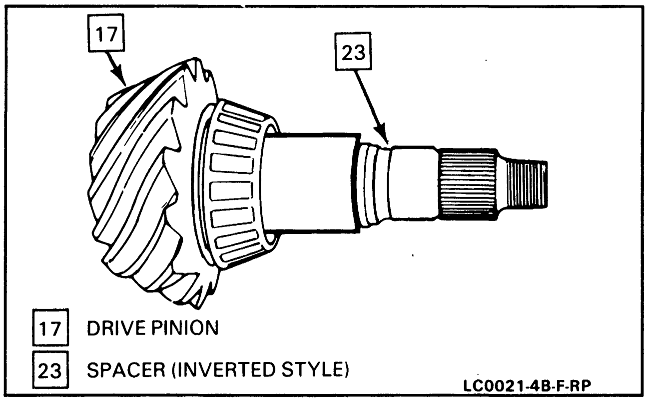


Figure 27 - Collapsible Inverted Spacer on Drive Pinion

5. Seal (25), using J 23911.
6. Seal lubricant, number 1050169 or equivalent, to the seal surface of the pinion yoke (27) and sealing lip of the new seal (25).
7. Pinion yoke (27) on the drive pinion (17) by tapping with a soft hammer until a few pinion threads project through the pinion yoke (27).
8. Washer (28) and nut (29).
   - Hold pinion yoke (27).
   - While intermittently rotating the drive pinion (17) to seat the front bearing assembly (24) and rear bearing assembly (19), tighten nut (29) until end play begins to be taken up.

Important

- When no further end play is detectable and when holder will no longer pivot freely as the drive pinion (17) is rotated, preload specifications are being approached.
- No further tightening should be attempted until the preload has been checked. Check preload by using a torque wrench.
- After preload has been checked, final tightening should be done very carefully.
- Additional tightening of the pinion nut (29) can add many additional pound-inches of torque.
- The nut (29) should be further tightened only slightly and the preload should be checked after each tightening.

  - Exceeding preload specifications will compress the spacer (23) too far and require the installation of a new spacer (23).
- Set preload as 1.7 to 3.4 N·m (15 to 30 lb. in.) on new bearings or 1.0 to 1.7 N·m (9 to 15 lb. in.) on used bearings.
- Rotate drive pinion (17) several times to ensure that bearings have been seated.
  - Check preload again.
  - If preload has been reduced by rotating the drive pinion (17), reset preload to specifications.
- Continue with differential case service. Refer to "Differential Case Removal with Axle Shaft Removed" in this section.

Rear Pinion Bearing

Figures 1, 2, and 28 through 30

Tools Required:

J 5590 Rear Pinion Bearing Cone Installer
J 8092 Driver Handle
J 22912-01 Rear Pinion Bearing Remover
J 29609 Rear Pinion Bearing Cup Installer
J 33868 Rear Pinion Bearing Remover

Remove or Disconnect

1. Drive pinion. Refer to "Drive Pinion, Bearings and Races with Case Removed" in this section.
2. Rear bearing assembly (19) and shim (18) from the drive pinion (17), using J 22912-01 or J 33868 (Figure 28).
3. Inner race (52) from the axle housing (20) using a punch in the slots provided for this purpose (if bearing is being replaced).

Install or Connect

1. Inner race (52), using J 8092 and J 29609.
2. Rear pinion bearing and shim (18) on drive pinion (17) using J 5590 and press.
3. Drive pinion. Refer to "Drive Pinion, Bearings and Races with Cage Removed" in this section.

Front Pinion Bearing

Figure 31

Tools Required:

J 7817 Front Pinion Bearing Cup Installer
J 8092 Driver Handle

Remove or Disconnect

1. Drive pinion. Refer to "Drive Pinion, Bearings and Races with Case Removed" in this section.
2. Front pinion bearing outer race from axle housing using a punch in slots provided for this purpose.

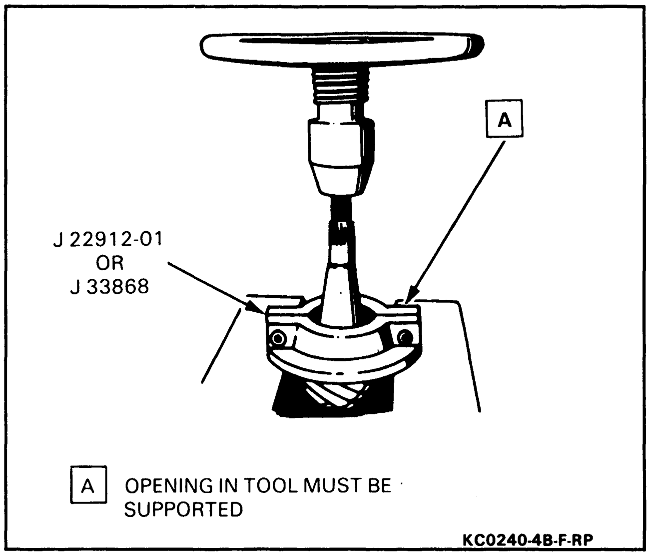


Figure 28 - Removing Rear Pinion Bearing

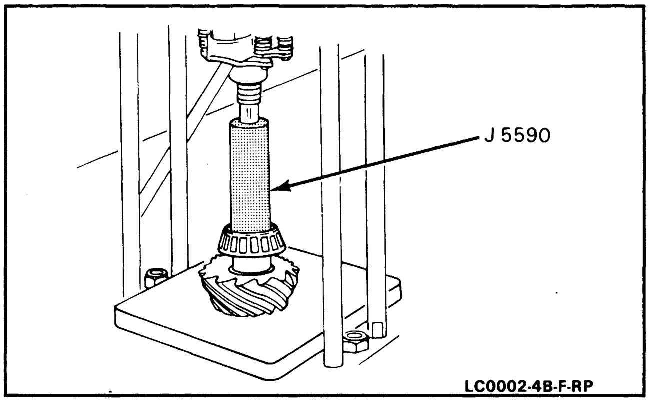


Figure 29 - Installing Rear Pinion Bearing

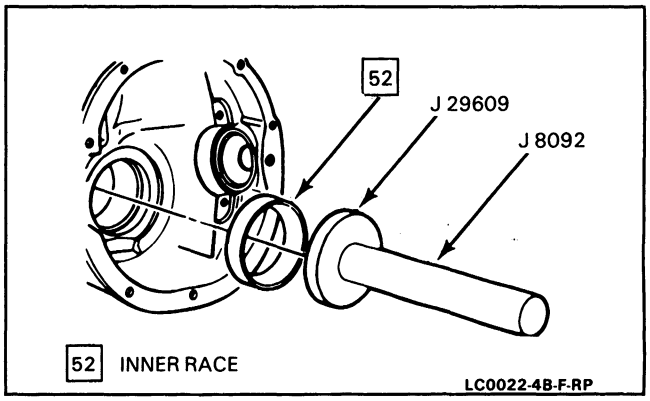


Figure 30 - Installing Rear Pinion Bearing Inner Race

Install or Connect

1. Front pinion bearing outer race to axle housing, using J 8092 and J 7817.
2. Drive pinion. Refer to "Drive Pinion, Bearings and Races with Case Removed" in this section.

PINION DEPTH

Figures 32 and 33

Tools Required:

J 8001 Dial Indicator Set

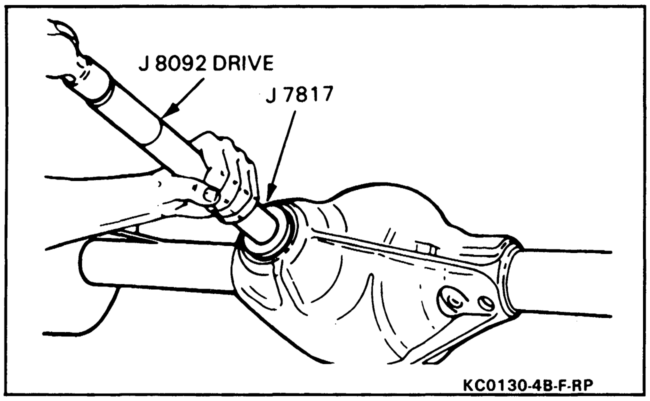


Figure 31 - Installing Front Pinion Bearing Outer Race

J 23597-1 Arbor
J 23597-11 Gage Plate
J 23597-12 Rear Pilot Washer
J 21777-42 Front Pilot Washer
J 21777-43 Stud Assembly Bolt
J 21777-45 Side Bearing Discs

Measure

- Pinion depth is measured with a pinion setting gage. The gage provides a "nominal" or "zero" pinion as a gaging reference.

Clean

- All parts of gage.
- Side bearing bore.
- Front and rear bearing cups.
- Lubricate front and rear bearings with rear axle lubricant.

Install or Connect

NOTICE: See "Notice" on page 4B-1 of this section.

1. J 21777-43 through J 23597-12.
2. J 23597-11.
3. J 21777-42 and nut in carrier.

Tighten

- Nut to 2.3 N·m (20 lb. in).

- Rotate J 23597-1 to seat the rear bearing assembly (19) and front bearing assembly (24).
- Mount J 8001 on J 23257-1 and preload indicator against plunger about 1.27 mm (0.050 inch).

4. J 21777-45 on J 23597-1 and position unit in carrier.
5. Differential bearing caps (30) and differential bearing cap bolts (31).

Tighten

- Differential bearing cap bolts (31) to 75 N·m (55 lb. ft.).

Measure

- Pinion depth.
  - Rotate J 23597-1 slowly back and forth until J 8001 reads the greatest deflection (the point where the needle changes direction). At that point, set J 8001 to zero. Repeat rock action to verify the zero setting.
  - After zero setting is obtained, rotate J 23597-1 until the plunger no longer touches J 23597-11. This provides the gaging reference of a "zero" or "nominal" pinion.
- Record J 8001 reading at pointer position. This indicates the proper shim (18) to use. Example: if pointer moved counterclockwise 1.70 mm (0.067 inch) to a dial reading of 0.84 mm (0.033 inch), this indicates a shim thickness of 0.84 mm (0.033 inch). (Figure 33).

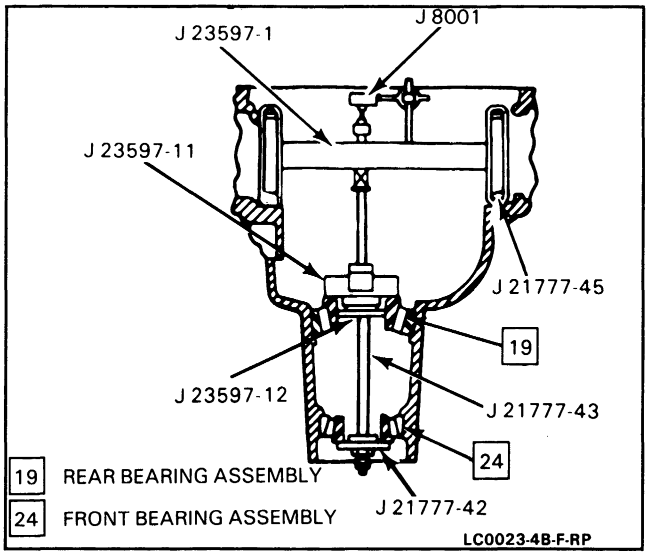


Figure 32 - Pinion Gage Installed in Carrier

- Select the correct drive pinion shim (18) to be used during reassembly.
  - Correct shim (18) has thickness equal to J 8001 reading.
- Shims (18) are available in 0.03 mm to 0.94 mm (0.001 inch to 0.037 inch). Shim thickness is etched on the flat surface for easy identification.

Remove or Disconnect

- Loosen J 21777-43 and remove special tools and both bearings from carrier.

Install or Connect

1. Correct shim (18) on drive pinion (17).
2. Rear pinion rear bearing assembly (19).

Assemble

- Differential case. Refer to "Differential Case Removal with Axle Shaft Removed" in this section.

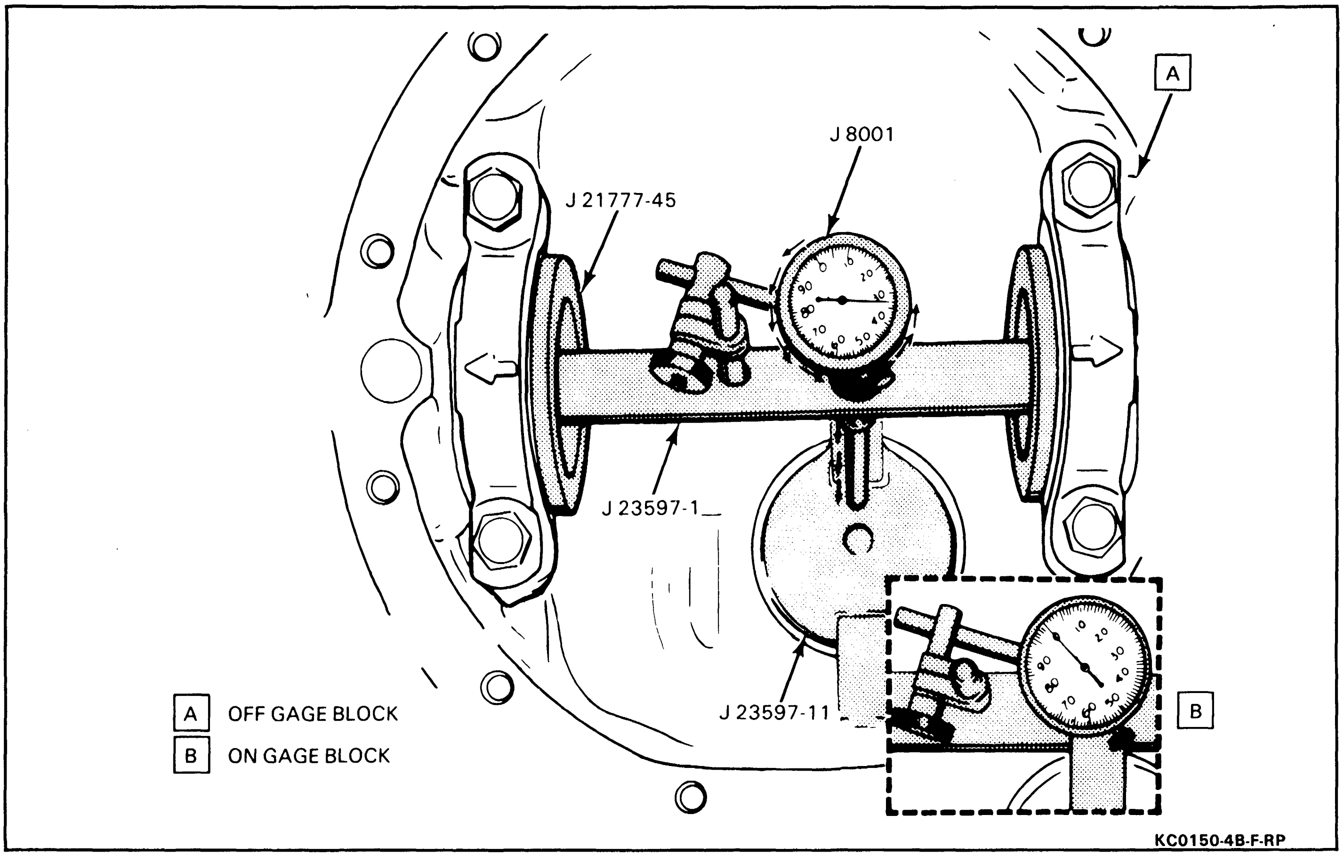


Figure 33 - Checking Pinion Depth

Measure

- Preload of the total assembly at the pinion yoke nut. With new bearings, preload is 3.6 to 6.2 N·m (32 to 55 lb. in.) rotating torque with a new seal. With used bearings, preload is 1.8 to 3.1 N·m (16 to 28 lb. in.) rotating torque with a new seal.

LIMITED SLIP REAR AXLE

Differential Case

Figure 34

CAUTION: To avoid possible injury, never raise one wheel and run the engine with the transmission in gear. The driving force to the wheel on the floor will cause the vehicle to move. Do not use "on the vehicle" type wheel balancers on the rear wheels unless both wheels are off the floor.

The Auburn limited slip differential case is non-serviceable and must be replaced as an assembly. Removal and replacement of the differential case and service on the side bearings and ring gear is the same as for the standard rear axle. For service procedure, see "Standard Rear Axle" in this section.

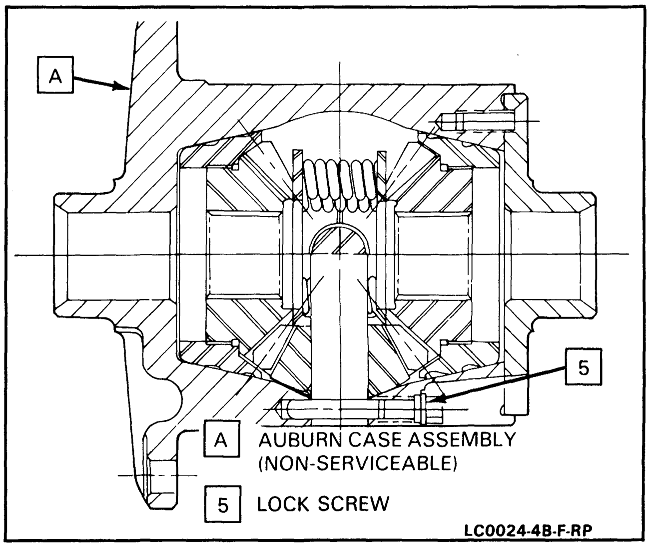


Figure 34 - Limited Slip Rear Axle - Auburn Type

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Rear Universal Joint-to-Pinion Yoke U-Bolt	22 N·m (16 lb. ft.)
Rear Axle Housing Cover-to-Carrier Bolt	30 N·m (22 lb. ft.)
Ring Gear-to-Differential Case Bolt	120 N·m (89 lb. ft.)
Bearing Cap-to-Carrier Bolt	75 N·m (55 lb. ft.)
Lock Screw	36 N·m (27 lb. ft.)
Pinion Setting Gage Nut	2.3 N·m (20 lb. in.)
Brake Caliper Mounting Plate-to-Axle Housing Bolt	50 N·m (37 lb. ft.)

ADJUSTMENT SPECIFICATIONS

Pinion Bearing Preload (Measured at Pinion Yoke Nut)	
New Bearings	1.7 to 3.4 N·m (15 to 30 lb. in.) Rotating Torque
Reused Bearings	1.0 to 1.7 N·m (9 to 15 lb. in.) Rotating Torque
Total Assembly Preload (Measured at Pinion Yoke Nut)	
New Bearings	3.6 to 6.2 N·m (32 to 55 lb. in.)
Reused Bearings	1.8 to 3.1 N·m (16 to 28 lb. in.)
Ring Gear Position	0.13 mm to 0.23 mm (0.005 inch to 0.009 inch)
Limited Slip Operation	
Torque Required to Rotate One Wheel with Manual Transmission in Gear or Automatic Transmission in "PARK," Both Tires Off Ground	169 to 305 N·m (125to 225 lb. ft.)
Torque Required to Rotate One Wheel with Transmission in "NEUTRAL," One Tire Off Ground	58 to 91 N·m (43 to 67 lb. ft.)

AXLE USAGE

RING GEAR DIAMETER	STD AXLE CODE	L/S AXLE CODE	AXLE GEAR RATIO	REAR BRAKE DRUM/DISC	TEETH RING GEAR: PINION	AXLE RPO
7.62"	8HP	8HT	2.73	CAST IRON DRUM	41 : 15	GU2
		8HE		ALUMINUM DRUM		
	8HK	8HF	3.08	CAST IRON DRUM	40 : 13	GU4
		8HB		ALUMINUM DRUM		
	8HJ		3.23	CAST IRON DRUM	42 : 13	GU5
		2PM		DISC		
	8HL		3.42	CAST IRON DRUM	41 : 12	GU6
		2PN		DISC		

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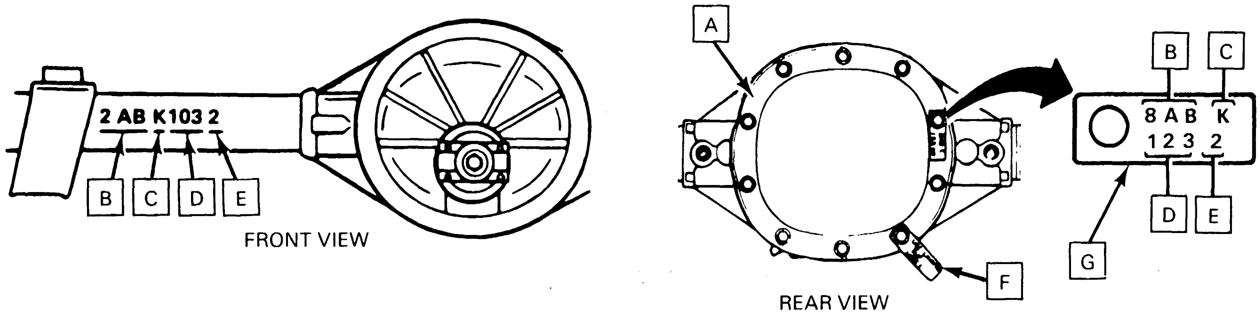
REAR AXLE IDENTIFICATION



A	AXLE COVER
B	AXLE CODE
C	MANUFACTURER
D	DAY BUILT
E	SHIFT
F	LIMITED SLIP TAG
G	AXLE CODE TAG

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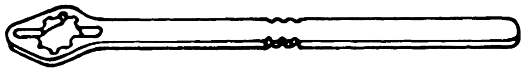
SPECIAL TOOLS

J 8614-01 SET



J 8614-01 SET,

1 PINION FLANGE REMOVER ADAPTER
2 PINION FLANGE REMOVER SCREW
3 PINION FLANGE REMOVER

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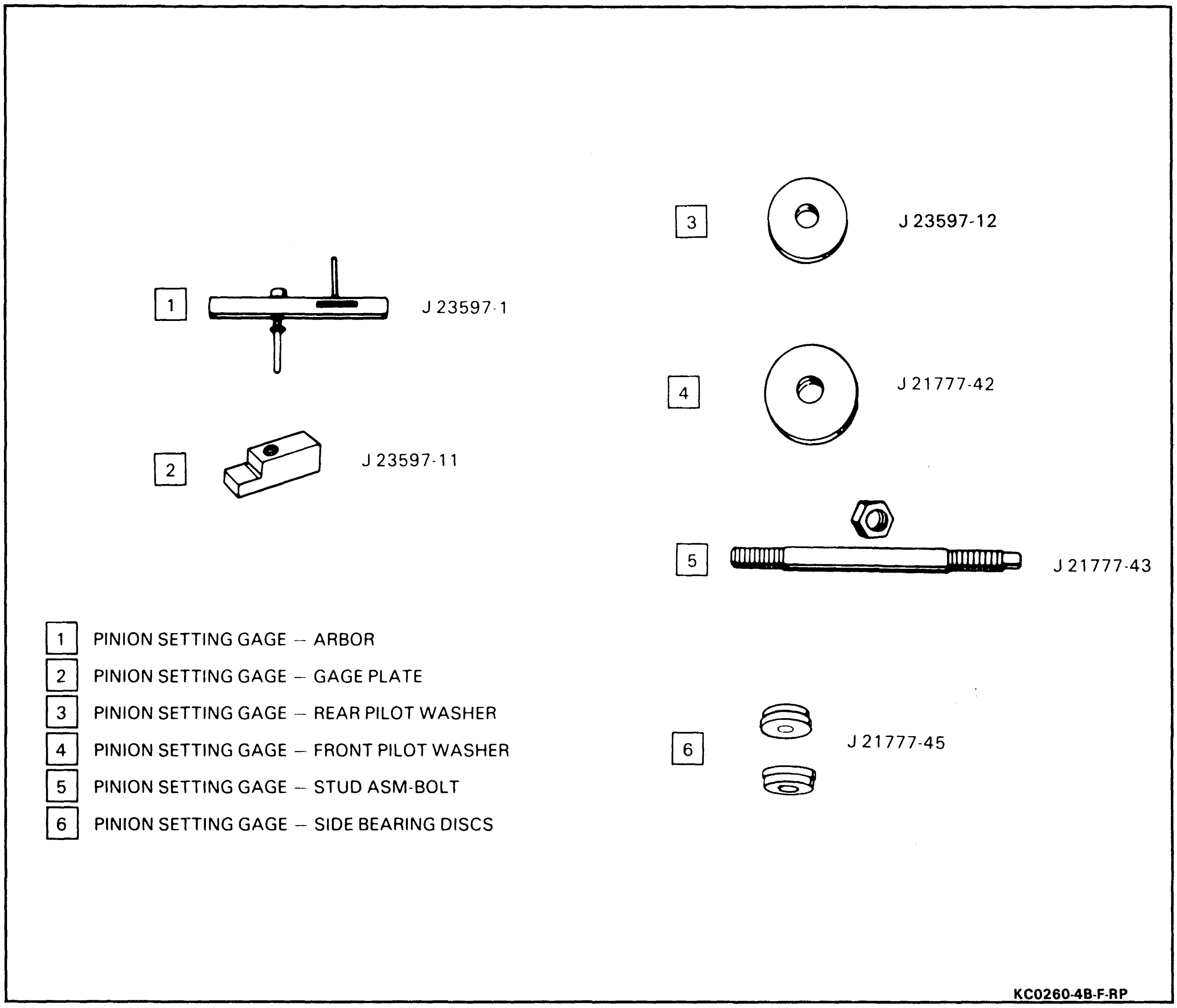
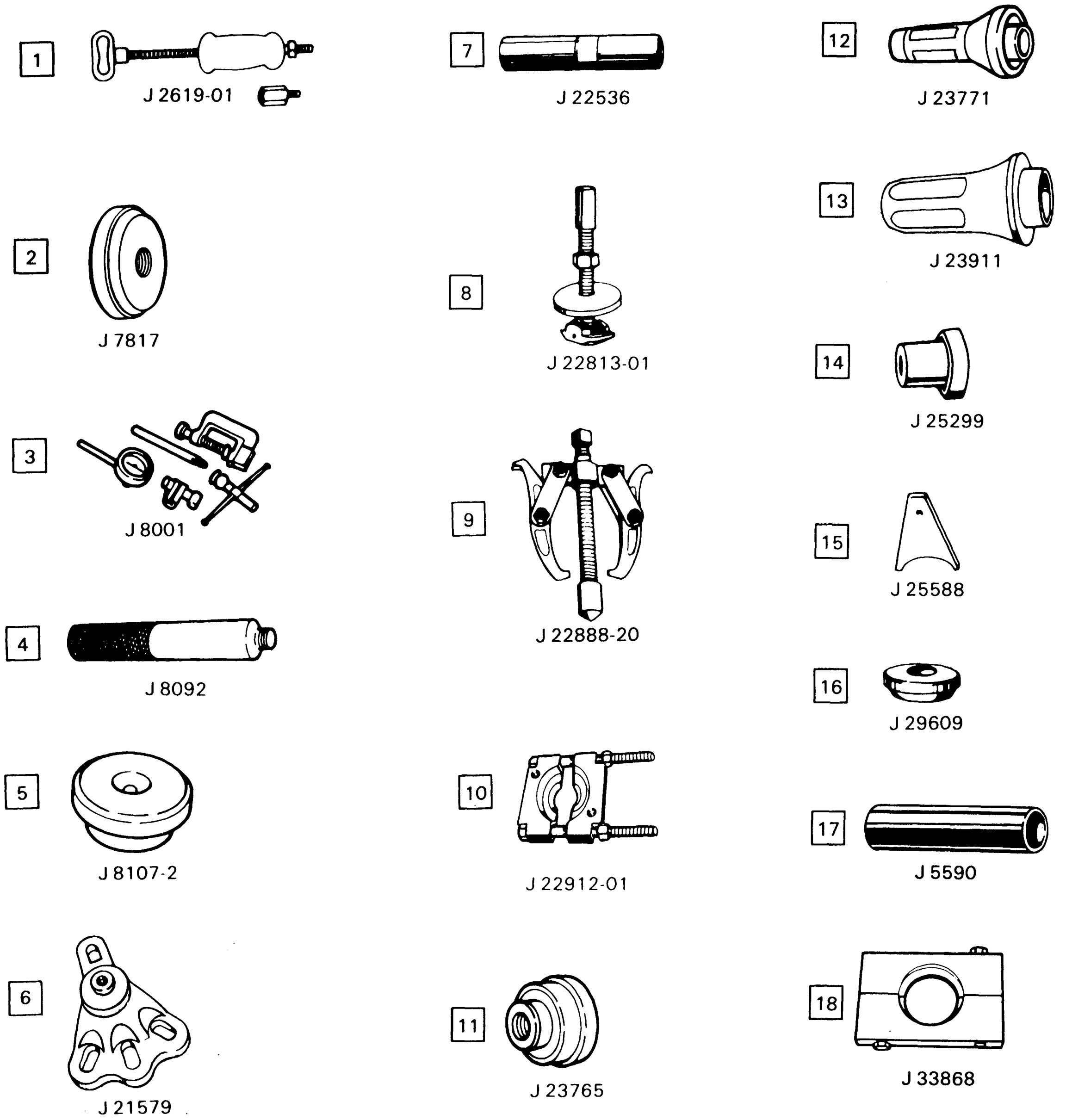


1 PINION SETTING GAGE – ARBOR
2 PINION SETTING GAGE – GAGE PLATE
3 PINION SETTING GAGE – REAR PILOT WASHER
4 PINION SETTING GAGE – FRONT PILOT WASHER
5 PINION SETTING GAGE – STUD ASM-BOLT
6 PINION SETTING GAGE – SIDE BEARING DISCS



1	SLIDE HAMMER WITH 1/2-13 ADAPTER
2	FRONT PINION BEARING CUP INSTALLER
3	DIAL INDICATOR SET
4	DRIVER HANDLE
5	DIFFERENTIAL SIDE BEARING REMOVER PLUG
6	AXLE SHAFT REMOVER
7	PINION DRIVER
8	AXLE BEARING REMOVER
9	DIFFERENTIAL SIDE BEARING REMOVER
10	REAR PINION BEARING REMOVER
11	AXLE BEARING INSTALLER
12	AXLE OIL SEAL INSTALLER
13	PINION OIL SEAL INSTALLER
14	DIFFERENTIAL SIDE BEARING INSTALLER
15	SIDE BEARING SHIM INSTALLER
16	REAR PINION BEARING CUP INSTALLER
17	REAR PINION BEARING CONE INSTALLER
18	REAR PINION BEARING REMOVER

LC0026-4B-F-RP

SECTION 5
BRAKES
CONTENTS

SECTION 5
GENERAL BRAKES

CAUTION: When servicing brake parts, do not create dust by grinding or sanding brake linings, or by cleaning brake parts with a dry brush or with compressed air. Many brake parts contain asbestos fibers which can become airborne if dust is created during servicing. Breathing dust containing asbestos fibers may cause serious bodily harm. A water dampened cloth or water based solution should be used to remove any dust on brake parts. Equipment is commercially available to perform this washing function. These wet methods will prevent asbestos fibers from becoming airborne.

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 5-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

This section describes the brake system general items for the standard brake system.

COMPOSITE MASTER CYLINDER

This vehicle uses a composite master cylinder which has an aluminum body and a clear nylon reservoir with fluid level indicators. This master cylinder has a quick take-up feature.

QUICK TAKE-UP OPERATION

The quick take-up feature provides a large volume of fluid at low pressure with initial brake application. The low pressure fluid provides the displacement requirements of the system created by the seal retracting pistons into the calipers and retraction of rear drum brake shoes.

BRAKE FLUID LEVEL INDICATOR

Figure 1

The nylon master cylinder reservoir has two windows which allow the brake fluid level to be checked without removal of the reservoir cover.

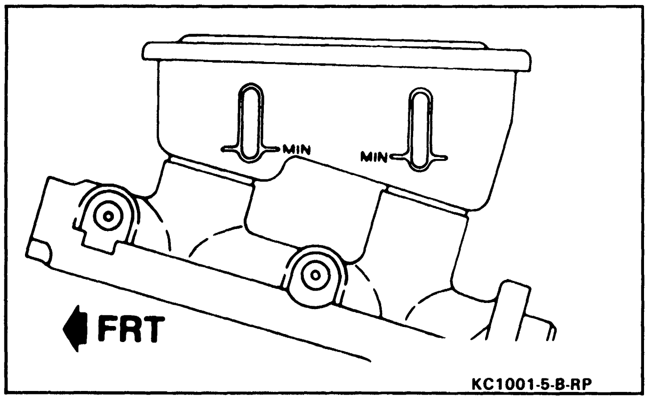


Figure 1 - Master Cylinder Reservoir Windows

OPERATION OF DISC BRAKE

When the brakes are applied, fluid pressure behind the caliper piston increases. Pressure is exerted equally against the bottom of the piston and also against the bottom of the piston bore. The pressure applied to the piston is transmitted to the inner shoe and lining, forcing the lining against the inner rotor surface. The pressure applied to the bottom of the piston bore forces the caliper to slide on the mounting bolts toward the center of the vehicle. This movement causes the outer section of the caliper to apply pressure against the back of the outer shoe and lining assembly, forcing the lining against the outer rotor surface. As line pressure builds, the shoe and lining assemblies are pressed against the rotor surfaces with increased force, bringing the vehicle to a stop. When the brake pedal is released, line pressure is released and the seal and seal groove cause the piston to be slightly retracted, resulting in less drag on the rotor by both shoe and lining assemblies.

Outward movement of the piston and inward movement of the caliper automatically compensate for lining wear. As the linings wear, the increased area behind the piston is filled with brake fluid from the master cylinder reservoir.

Each heavy duty front caliper on this vehicle has two pistons in an aluminum housing. The principles of operation are basically the same as single piston calipers.

OPERATION OF DRUM BRAKE

The drum brake assembly is a duo-servo design. In the duo-servo brake, the force that the wheel cylinder applies to the primary shoe is multiplied by the primary lining friction to provide a very high force applied to the secondary shoe. Torque from the brake shoes is transferred to the anchor pin directly to the axle flange. Adjustment is automatic when the brakes are applied while the vehicle is moving in reverse.

OPERATION OF COMBINATION VALVE

The metering or hold off section of the combination valve limits pressure to the front disc brakes until a predetermined front input pressure is reached, approximating the pressure to overcome the rear shoe and lining retractor springs. There is no restriction at inlet pressures below 20 kPa (3 psi) to allow for the pressure to be equalized when the brakes are not applied.

The proportioning section of the combination valve proportions outlet pressure to the rear brakes after a predetermined rear input pressure has been reached.

The valve has a by-pass feature which insures full system pressure to the rear brakes in the event of a front brake system failure. Similarly, full front pressure is retained in the event of a rear brake pressure failure.

BRAKE PRESSURE DIFFERENTIAL WARNING SWITCH

The brake pressure differential warning switch constantly compares brake pressure in both parts of the system. The switch will activate the red "BRAKE" warning lamp on the instrument panel in the event of a failure in either part. The combination valve is designed so the switch will stay in the warning position once a failure has occurred. The lamp can only be turned off by repairing the failure and applying a pedal force as required to develop up to 3100 kPa (450 psi) line pressure.

DIAGNOSIS AND INSPECTION

BRAKE SYSTEM TESTING

Figures 2 through 4

Brakes should be tested on a dry, clean, reasonably smooth and level roadway. A true test of brake performance cannot be made if the roadway is wet, greasy or covered with loose dirt so that all tires do not grip the road equally. Testing will also be affected if the roadway is crowned which would throw the weight of the vehicle toward the wheels on one side. If the roadway is too rough, the wheels will tend to bounce.

Test brakes at different vehicle speeds with both light and heavy pedal pressure. Avoid locking the brakes and sliding the tires. Locked brakes and sliding tires do not indicate brake efficiency because heavily braked, but turning wheels will stop vehicle in less distance than locked brakes. More tire-to-road friction is present with a heavily braked turning tire than with a sliding tire.

The brake system is designed and balanced to avoid locking the wheels, except at very high deceleration levels. The shortest stopping distance and best control is achieved without brake lock-up.

Because of high deceleration capability, a firmer pedal may be felt at higher deceleration levels.

External Conditions That Affect Brake Performance

Tires

Tires having unequal contact and grip on road will cause unequal braking. Tires must be equally inflated, and the tread pattern of right and left tires must be approximately equal.

Vehicle Loading

A heavily loaded vehicle requires more braking effort. When a vehicle has unequal loading, the most heavily loaded wheels require more braking power than others.

Wheel Alignment

Misalignment of the wheels, particularly excessive camber and caster, will cause the brakes to pull to one side.

Front Wheel Bearings

A loose front wheel bearing permits the front wheel to tilt and lose contact with the brake shoe linings causing erratic brake operation.

WARNING LAMP OPERATION

The brake system uses a single red "BRAKE" warning lamp located in the instrument panel cluster. When the ignition switch is in the "START" position, the "BRAKE" warning lamp should come on. It should go off when the ignition switch returns to the "RUN" position.

The following conditions will activate the "BRAKE" warning lamp:

- Parking brake applied. The lamp should be on when the parking brake is applied and the ignition switch is "ON."
- Pressure differential switch detects a failure. See "Brake Pressure Differential Warning Switch" in this section.
- During engine cranking the "BRAKE" lamp should remain on. This notifies the driver that the warning circuit is operating properly.

BRAKE FLUID LEAKS

With engine running at idle and the shift lever in "NEUTRAL," depress the brake pedal and hold a constant foot pressure. If the pedal gradually falls away with the constant pressure, the hydraulic system may be leaking. Perform a visual check to confirm any suspected leak.

Check the master cylinder fluid levels. While a slight drop in reservoir level does result from normal lining wear, an abnormally low level in either reservoir indicates a leak in the system. The hydraulic system may be leaking either internally or externally. Refer to "Master Cylinder Check" in this section. Also, the system may appear to pass this test but still have slight leakage.

If fluid leaks are normal, check the vacuum booster pushrod length. If an incorrect length pushrod is found, adjust or replace the pushrod. Check the service brake pedal travel and the parking brake adjustment.

When checking the fluid levels, the master cylinder reservoir may be as low as one inch from the top if the front or rear disc brake linings are worn. This is not abnormal.

MASTER CYLINDER CHECK

These checks will help locate some master cylinder malfunctions. Use the brake diagnosis charts to help isolate the problem if it is not found by using these tests (Figures 2 through 4).

1. Check for a cracked master cylinder casting or brake fluid around the master cylinder. Leaks are indicated only if there is at least a drop of fluid. A damp condition is not abnormal.
2. Check for a binding pedal linkage and incorrect pushrod length. If both of these are satisfactory,

disassemble the master cylinder and check for swollen or elongated piston seal(s). If swollen seals are found, substandard or contaminated brake fluid should be suspected. If contaminated, all components should be disassembled and cleaned; all rubber components should be replaced and all pipes flushed.

SUBSTANDARD OR CONTAMINATED BRAKE FLUID

NOTICE: Use only DOT 3 brake fluid from a clean, sealed container. Do not use any fluid from a container which is wet with water. Do not use DOT 5 silicone brake fluid. Improper brake fluid, mineral oil or water in the fluid may cause the brake fluid to boil or the rubber components to deteriorate.

If piston cups are swollen, the rubber parts have deteriorated. This deterioration may also be seen by swollen master cylinder cover diaphragm.

If rubber deterioration is evident, disassemble all hydraulic parts and wash with alcohol. Dry parts with compressed air before assembly to keep alcohol out of the system. Replace all rubber parts in the system, including hoses. Check for fluid on the linings. If excessive fluid is found, replace the linings.

If master cylinder piston seals are satisfactory, check for leakage or excessive heat conditions. If condition is not found, drain fluid, flush with brake fluid, fill and bleed the system.

ON-VEHICLE SERVICE

BRAKE PEDAL TRAVEL

Most low pedal problems are caused by air in the hydraulic system. Bleed the system until air is purged. See "Bleeding Brake Hydraulic System." Other less frequent causes of excessive pedal travel are incorrect pushrod length, improperly adjusted parking brake, rear shoe adjusters not operating, linings excessively worn, and hydraulic system leakage.

Measure

Tool Required:

J 28662 Brake Pedal Effort Gage

1. With engine off and key off, pump brake pedal until all reserve is exhausted from the brake booster. A definite change in pedal feel will occur.
2. Install J 28662 onto brake pedal.
3. Hook end of tape measure over top edge of brake pedal and measure the distance to the rim of the steering wheel.
4. Apply brake pedal with 445N (100 lbs.) force and remeasure. The difference between both readings is the actual pedal travel and should not exceed specifications. See "Specifications" in this section.
5. On rear drum brake equipped vehicles, if pedal travel is more than specifications, drive the vehicle in reverse while intermittently applying the brakes. In rare cases, too much pedal travel develops if the vehicle is not driven in reverse. Duo-servo self-adjusting mechanisms will only operate when the brakes are applied in reverse.

STOPLAMP SWITCH ADJUSTMENT

Figure 5

Adjust

With brake pedal in fully released position, the stoplamp switch plunger should be fully depressed against the brake pedal shank. Adjust switch (2 or 3) by moving it in or out as necessary.

1. Insert switch (2 or 3) into retainer (4) until switch body seats on the retainer (4).
2. Pull brake pedal to the rear, against internal pedal stop. The stoplamp switch (2 or 3) will be moved in the retainer (4) giving the proper adjustment.
    - When no clicks are heard when the brake pedal is pulled up, and the brake lamps do not stay on without the brakes being applied, the proper switch adjustment is obtained.
    - For diagnosis of the stoplamps, refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

FILLING MASTER CYLINDER RESERVOIRS

The master cylinder must be kept properly filled to insure adequate reserve and to prevent air from entering the hydraulic system. However, because of expansion due to heat absorbed from brakes and from engine, the master cylinder must not be overfilled.

The brake fluid reservoir is on the master cylinder which is located under the hood on the left side of the cowl.

Thoroughly clean reservoir cover before removal to avoid getting dirt into reservoir. Remove cover and diaphragm.

NOTICE: Use only DOT 3 brake fluid from a clean, sealed container. Do not use any fluid from a container which is wet with water. Do not use DOT 5 silicone brake fluid. Improper brake fluid, mineral oil or water in the fluid may cause the brake fluid to boil or the rubber components to deteriorate.

Add fluid as required to bring level to the full mark located inside the reservoir. Use Delco Supreme No. 11 Hydraulic Brake Fluid or equivalent. Fluid must be "DOT 3."

BLEEDING BRAKE HYDRAULIC SYSTEM

A bleeding operation is necessary to remove air from the hydraulic brake system whenever it is introduced into the hydraulic system.

It may be necessary to bleed the hydraulic system at all four brakes if air has been introduced through a low fluid level or by disconnecting brake pipes at the master cylinder. If a brake pipe is disconnected at one wheel, then that wheel cylinder/caliper only needs to be bled. If pipes are disconnected at any fitting located between master cylinder and brakes, then the brake system served by the disconnected pipe must be bled.

SYMPTOM CAUSE	Excessive Brake Pedal Travel	Brake Pedal Travel Gradually Increases	Excessive Brake Pedal Effort	Excessive Braking Action	Brakes Slow To Respond	Brakes Slow To Release	Brakes Drag	Uneven Braking Action (Side To Side)	Uneven Braking Action (Front To Rear)	Scraping Noise From Brakes	Brakes Squeak During Application*	Brakes Squeak During Stop*	Brakes Chatter (Roughness)	Brakes Groan At End Of Stop*	Brake Warning Lamp Glows During Stop
Leaking Brake Line or Connection	X	XX							X						XX
Leaking Wheel Cylinder or Piston Seal	X	XX		X				X							X
Leaking Master Cylinder	X	XX													X
Air in Brake System	XX								X						XX
Contaminated or Improper Brake Fluid					X	X	X								X
Leaking Vacuum System			XX		X										
Restricted Air Passage in Power Head			X		XX	X									
Damaged Power Head			X	X	X	X	X								
Improperly Assembled Power Head Valving			X	X	X	X	XX								
Worn Out Brake Lining-Replace			X	X				X	X	X	X	X		X	
Uneven Brake Lining Wear-Replace and Correct	X			X				X	X	X	X	XX		X	X
Glazed Brake Lining			XX		X			X	X		X	X			
Incorrect Lining Material-Replace			X	X				X	X			X		X	
Contaminated Brake Lining-Replace				XX				XX	XX	X	X	X		X	
Linings Damaged by Abusive Use-Replace			X	XX				X	X	X	X	X		X	
Excessive Brake Lining Dust			X	XX				XX	XX		X	XX		X	
Heat Spotted or Scored Brake Drums or Rotors				X				X	X		X	X	XX	X	
Out-of-Round or Vibrating Brake Drums												X	XX		
Improper Thickness Variation on Brake Rotors													XX		
Excessive Lateral Run-Out													X		
Faulty Automatic Adjusters	X						X	X	X						X
Incorrect Wheel Cylinder Sizes			X	X				X	X						
Weak or Incorrect Brake Shoe Retention Springs				X		X	XX	X	X	XX	X	XX			
Brake Assembly Attachments-Missing or Loose	X						X	X	X	X		X	X	X	
Insufficient Brake Shoe Guide Lubricant						X	X	X	X	XX	XX				
Restricted Brake Fluid Passage or Sticking Wheel Cylinder Piston		X	X		X	X	X	X	X						
Faulty Metering Valve	X		X	X	X	X	X		X						X
Brake Pedal Linkage Interference or Binding			X		X	XX	XX								
Improperly Adjusted Parking Brake							X								
Drums Tapered or Threaded										XX					
Incorrect Front End Alignment								XX							
Incorrect Tire Pressure								X	X						
Incorrect Wheel Bearing Adjustment	X									X			X		
Loose Front Suspension Attachments								X		XX			X	X	
Out-of-Balance Wheel Assemblies													XX		
Operator Riding Brake Pedal	X	X	X				X		X					X	
Improperly Adjusted Booster Pushrod	X					X	XX								X
Sticking Wheel Cylinder or Caliper Pistons			X			X	X	X	X						
Faulty Proportioning Valve			X		X	X	X								

XX — Indicates more probable cause(s) X — Indicates other causes *May be a normal condition.

KC1020-5-F-RP

Figure 2 - Brake System Diagnosis

BRAKE DIAGNOSIS CHART — 4 WHEEL DISC SYSTEMS

CAUSE / SYMPTOM	Excessive Brake Pedal Travel	Brake Pedal Travel Gradually Increases	Excessive Brake Pedal Effort	Excessive Braking Action	Brakes Slow To Respond	Brakes Slow To Release	Brakes Drag	Uneven Braking Action (Side To Side)	Uneven Braking Action (Front To Rear)	Scraping Noise From Brakes	Brakes Squeak During Application*	Brakes Squeak During Stop*	Brakes Chatter (Roughness)	Brakes Groan At End Of Stop*	Brake Warning Lamp Glows
Leaking Brake Line or Connection	X	XX	X						X						XX
Leaking Piston Seal	X	XX	X	X				X	X						X
Leaking Master Cylinder	X	XX	X						X						X
Air in Brake System	XX		X						X						XX
Contaminated or Improper Brake Fluid	X				X	X	X	X	X						X
Leaking Vacuum System			XX		X										
Restricted Air Passage in Power Head		X	X		XX	X									
Damaged Power Head		X	X	X	X	XX									
Worn Out Brake Lining			X	X				X	X	X	X	X		X	
Uneven Brake Lining Wear-Replace	X			X				X	X	X	X	XX		X	X
Glazed Brake Lining			XX		X			X	X		X	X			
Incorrect Lining Material-Replace			X	X		X		X	X			X		X	
Contaminated Brake Lining-Replace				XX		X		XX	XX	X	X	X		X	
Linings Damaged by Abusive Use-Replace			X	XX				X	X	X	X	X		X	
Heat Spotted or Scored Discs				X				X	X		X	X	XX	X	
Improper Thickness Variation	X												XX		
Excessive Lateral Run-Out	X												X		
Automatic Adjuster Problem	X	X					X	X	X						X
Brake Assembly Attachments-Missing or Loose	X						X	X	X	X		X	X	X	
Restricted Brake Fluid Passage		X	X		X	X	X	X	X						X
Improperly Adjusted Stoplamp Switch Or Cruise Control Vacuum Dump							X								
Metering Valve Problem		X	X	X	X	X	X		X						X
Proportioning Valve Problem		X	X	X	X	X	X		X						X
Brake Pedal Linkage Interference or Binding			X		X	XX	XX								
Improperly Adjusted Parking Brake							X		X						
Improper Length Booster Pushrod	X			X		X	XX		X						
Incorrect Front End Alignment								XX							
Incorrect Tire Pressure								X	X						
Incorrect Wheel Bearing Adjustment	X									X			X		
Loose Front Suspension Attachments							X	X		XX			X	X	
Out-of-Balance Wheel Assemblies													XX		
Operator Riding Brake Pedal			X				X		X					X	
Sticking Caliper or Wheel Cylinder Pistons					X	X	XX	X	X						
Park Brake Switch Circuit Grounded															XX
Park Brake Not Releasing						X		X							XX

XX — Indicates more probable cause(s)

X — Indicates other causes

*May be a normal condition.

KC2025-5-F-RP

Figure 3 - 4-Wheel Disc Brake Diagnosis

The same types of brake trouble are encountered with power brakes as with standard brakes. Before checking power brake system for source of trouble, refer to the brake system diagnosis charts. After these possible causes have been eliminated, check for cause as outlined below:

HARD PEDAL

CAUSE	CORRECTION
Broken or damaged hydraulic brake pipes.	Inspect and replace as necessary.
Vacuum failure.	Check for: Faulty vacuum check valve or grommet. Replace. Collapsed or damaged vacuum hose. Replace. Plugged or loose vacuum fitting. Repair. Faulty air valve seal or support plate seal. Replace. Damaged floating control valve. Replace. Bad stud welds on front or rear housing or power head. Replace unless easily repaired.
Faulty diaphragm.	Replace.
Restricted air filter element.	Replace.
Worn or distorted reaction plate or levers.	Replace plate or levers.
Cracked or broken power pistons or retainer.	Replace power pistons and piston rod retainer.

GRABBY BRAKES
(Apparent Off-On Condition)

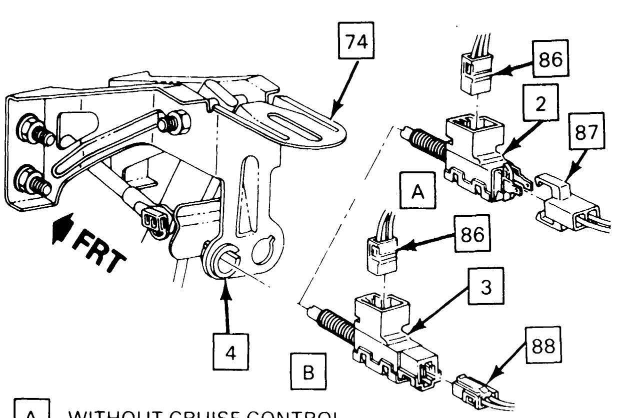
CAUSE	CORRECTION
Broken or damaged hydraulic brake pipes.	Inspect and replace as necessary.
Insufficient fluid in master cylinder.	Fill reservoirs with approved brake fluid. Check for leaks.
Faulty master cylinder seals.	Repair or replace as necessary.
Cracked master cylinder casting.	Replace.
Leaks in pipes or connections at disc brake calipers or wheel cylinders.	Inspect and repair as necessary.
Air in hydraulic system.	Bleed system.

BRAKES FAIL TO RELEASE

CAUSE	CORRECTION
Blocked passage in power piston.	Inspect and repair or replace as necessary.
Air valve sticking shut.	Check for proper lubrication of air valve "O" ring.
Broken piston return spring.	Replace.
Broken air valve spring.	Replace.
Tight pedal linkage.	Repair or replace as necessary.

KC1030-5-F-RP

Figure 4 - Vacuum Booster Diagnosis Chart



A	WITHOUT CRUISE CONTROL
B	WITH CRUISE CONTROL
2	SWITCH
3	SWITCH
4	RETAINER
74	BRAKE PEDAL BRACKET
86	STOPLAMP CONNECTOR
87	TRANSMISSION CONVERTER CLUTCH CONNECTOR
88	CRUISE CONTROL CONNECTOR

Figure 5 - Stoplamp Switch Adjustment

Manual Bleeding

Figure 6

Tools Required:

J 21472 Bleeder Wrench

J 28434 Rear Wheel Cylinder Bleeder Wrench

Remove the vacuum reserve by applying the brakes several times, with the engine off.

1. Fill the master cylinder reservoirs with brake fluid and keep at least half full of fluid during the bleeding operation.
2. If the master cylinder is known or suspected to have air in the bore, bleed it before any wheel cylinder or caliper in the following manner:
   - Disconnect the forward brake pipe connection at the master cylinder.
   - Allow brake fluid to fill the master cylinder bore until it begins to flow from the forward pipe connector port.
   - Connect the forward brake pipe to the master cylinder and tighten.
   - Have a helper depress the brake pedal slowly one time and hold. Loosen the forward brake pipe connection at the master cylinder to purge air from the bore. Tighten the connection and then have your helper release the brake pedal slowly. Wait 15 seconds. Repeat the sequence, including the 15 second wait, until all air is removed from the bore. Care must be taken to prevent brake fluid from contacting any painted surface.
   - After all air has been removed at the forward connection, repeat procedure outlined above to bleed the master cylinder at the rear connection.
   - If it is known that the calipers and wheel cylinders do not contain any air, it will not be necessary to bleed them.
3. If it is necessary to bleed all of the wheel cylinders and calipers, follow this sequence.
   - Right rear
   - Left rear
   - Right front
   - Left front
4. Bleed individual wheel cylinders or calipers only after all air is removed from the master cylinder.
   - Place a proper size box end wrench or J 21472 over the bleeder valve.
   - Attach a clear tube over bleeder valve and allow tube to hang submerged in a clear container partially filled with brake fluid. Rear wheel cylinder bleeder screws require tool J 28434.
   - Have a helper depress the brake pedal slowly one time and hold. Loosen the bleeder valve to purge the air from the cylinder. Tighten bleeder screw and have your helper slowly release pedal; wait 15 seconds. Repeat the sequence, including the 15 second wait until air is removed.
     - It may be necessary to repeat the sequence ten or more times to remove all the air.
     - Rapid pumping of the brake pedal pushes the master cylinder secondary piston down the bore in a way that makes it difficult to bleed the rear side of the system.
5. Check the brake pedal for "sponginess" and the red "BRAKE" warning lamp for indication of unbalanced pressure.
   - Repeat entire bleeding procedure to correct either of these two conditions.

Pressure Bleeding

Figures 6 and 7

Tools Required:

J 21472 Bleeder Wrench

J 28434 Rear Wheel Cylinder Bleeder Wrench

J 29532 Power Brake Bleeder

J 29567 Brake Bleeder Adapter

J 35856 Proportioning Valve Depressor

NOTICE: Pressure bleeding equipment must be the diaphragm type and must have a rubber diaphragm between the air supply and the brake fluid to prevent air, moisture, oil and other contaminants from entering the hydraulic system.

1. Install J 29567 to the master cylinder (85).
2. Charge J 29532 to 140-172 kPa (20-25 psi).
3. Connect line to adapter.
   - Open line valve and depress bleed-off valve on top of adapter until a few drops of fluid appear.
4. Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).
5. A manual override of the combination valve is required on rear drum brakes, to permit fluid flow to the front wheels when pressure bleeding. Use J 35856 to hold the valve stem open during pressure bleeding.
6. Bleed the brakes in the following sequence:
   - Right rear
   - Left rear
   - Right front
   - Left front
7. Place a proper size box end wrench or J 21472 over the bleeder valve. Use J 28434 on the bleeder screws of rear drum brakes.
8. Attach a clear tube over valve and allow tube to hang submerged in a clear container partially filled with brake fluid.
9. Open the bleeder valve and allow fluid to flow until no air is seen in the fluid.
10. Close the bleeder valve.
    - Be sure it seals.
11. Repeat steps 7 through 10 until all calipers and wheel cylinders have been bled.
12. Remove J 35856 from combination valve.
13. Lower vehicle.
14. Check the brake pedal for "sponginess" and the red "BRAKE" warning lamp for indication of unbalanced pressure.
    - Repeat entire bleeding procedure to correct either of these two conditions.
15. Remove brake bleeding equipment from master cylinder.

FLUSHING BRAKE HYDRAULIC SYSTEM

NOTICE: Use only DOT 3 brake fluid from a clean, sealed container. Do not use any fluid from a container which is wet with water. Do not use DOT 5 silicone brake fluid. Improper brake fluid, mineral oil or water in the fluid may cause the brake fluid to boil or the rubber components to deteriorate.

The complete hydraulic system should be flushed thoroughly with clean brake fluid whenever new parts are installed in the hydraulic system. The system must be flushed if there is any doubt about the grade of fluid in the system or if fluid has been used which contains the slightest trace of mineral oil. Approximately one-quart of fluid is required to flush the hydraulic system. All rubber parts that have been subjected to a contaminated fluid must be replaced.

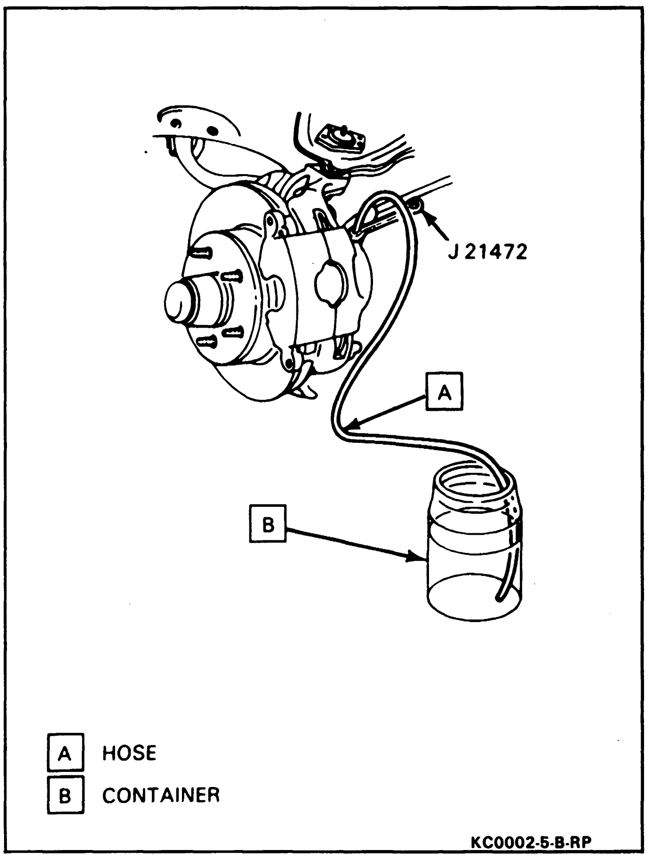


Figure 6 - Bleeding Brakes

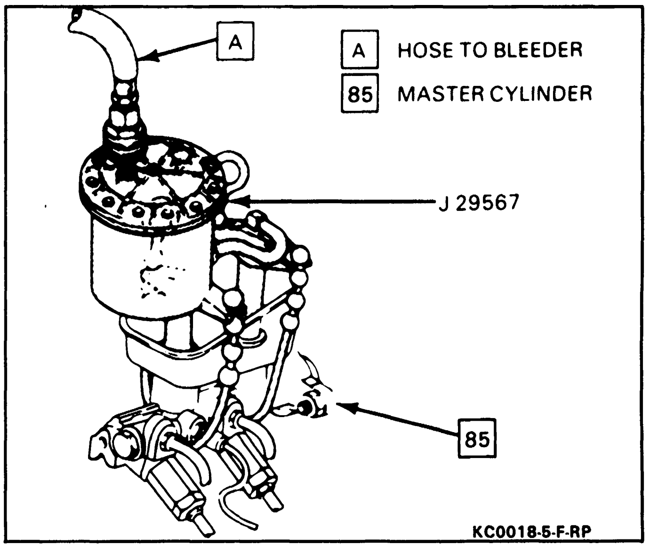


Figure 7 - Pressure Bleeding Adapter

BRAKE PIPE REPLACEMENT

Refer to Figures 8 through 11 for brake pipe routing and replacement.

ISO Flare

Figures 8 and 12 through 14

Tool Required:

J 29803-A ISO Flaring Kit

CAUTION: Never use copper tubing because copper is subject to fatigue, cracking and corrosion which could

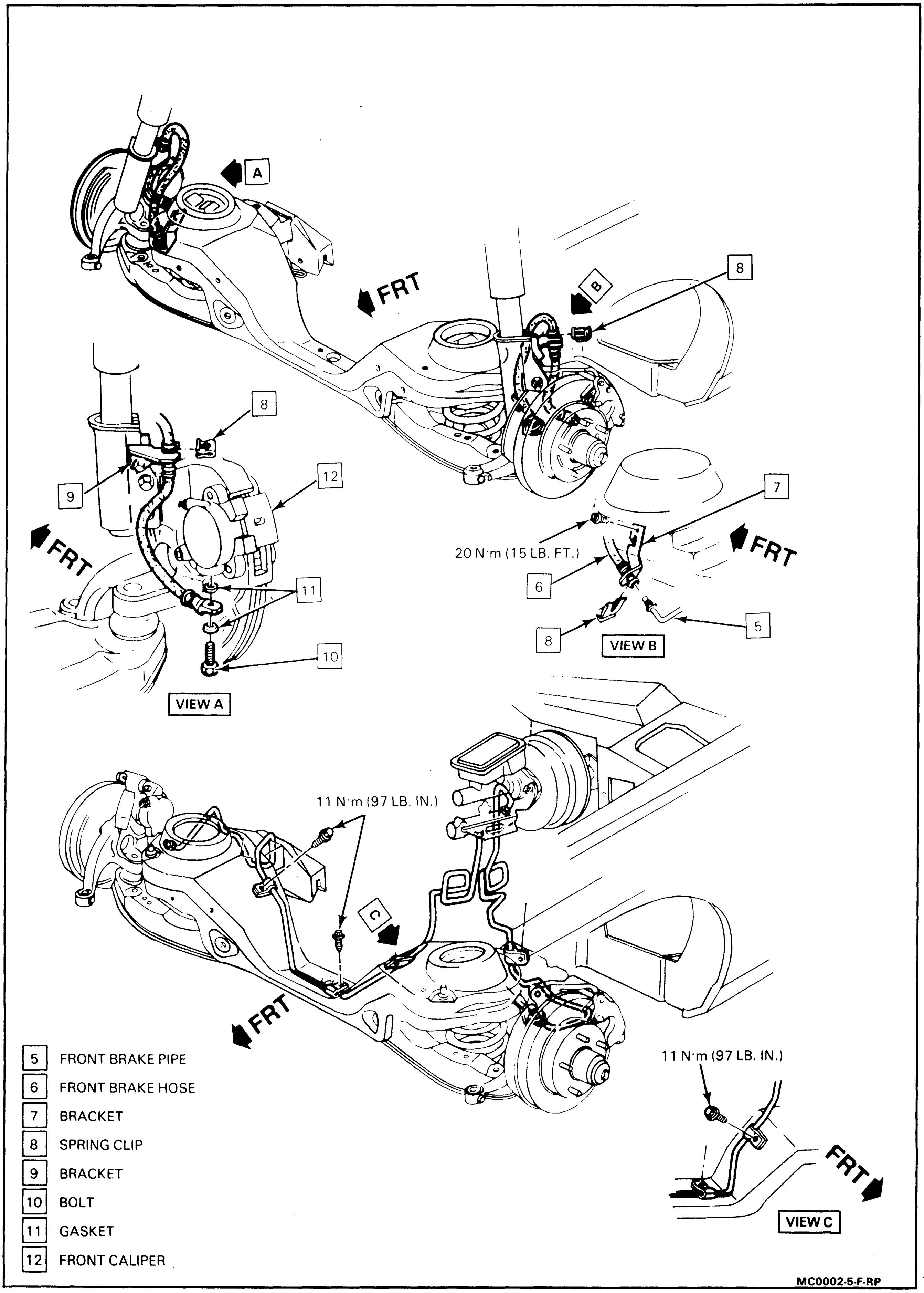


Figure 8 - Front Brake Hoses and Pipes

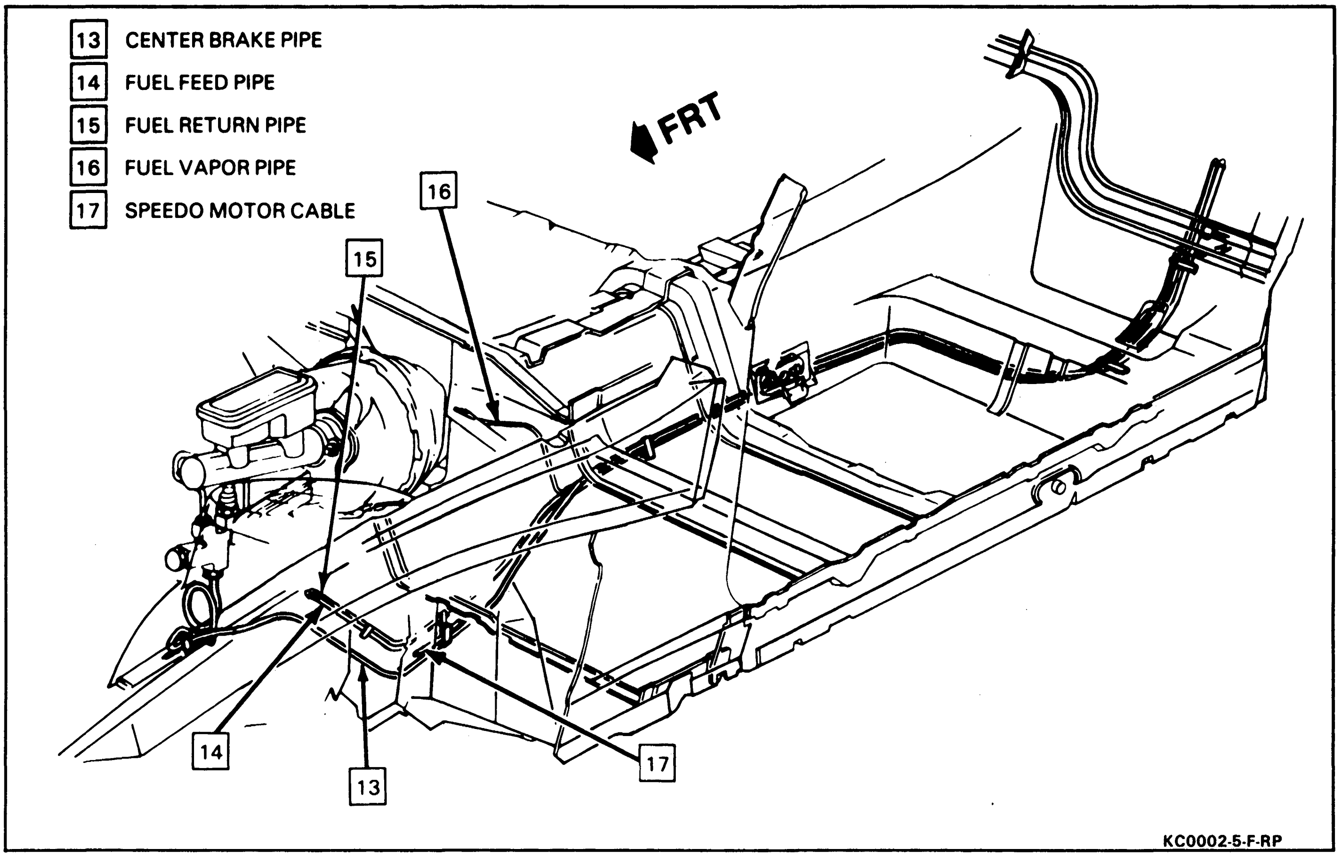
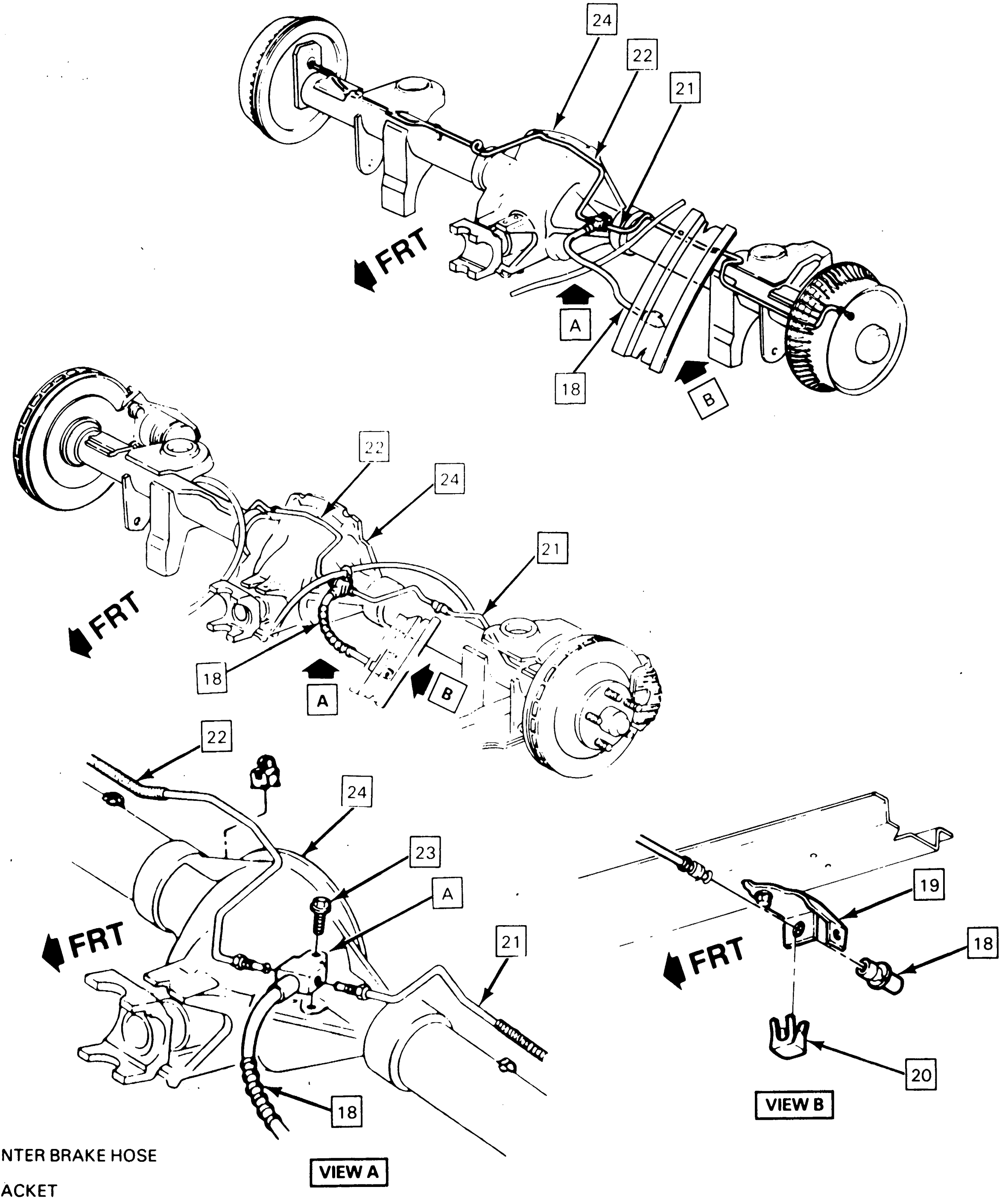


Figure 9 - Center Brake Pipes (Typical)

result in brake failure. Always use double walled steel tubing when replacing brake pipes. The use of any other pipe is not recommended and may cause brake system failure. Carefully route and retain replacement brake pipes. Always use the correct fasteners and the original location for replacement brake pipes. Failure to properly route and retain brake pipes may cause damage to the brake pipes and cause brake system failure.

1. Obtain the recommended pipe and steel fitting nuts of the correct size.
   - Outside diameter of pipe is used to specify size.
2. Cut pipe to length with a pipe cutter.
   - Do not force the cutter.
   - Advance the tool only a small amount per turn of the tool.
   - Correct length of pipe may be determined by measuring old pipe using a string and adding 3.2 mm (1/8 inch) for each ISO flare.
3. Make sure fittings are installed before starting flare.
4. Chamfer the inside and outside diameter of the pipe with the de-burring tool.
5. Remove all traces of lubricant from front brake pipe (5) and flaring tool.
6. Clamp the flaring tool body in vise.
7. Select the correct size collet and forming mandrel for pipe size used.
8. Insert the proper forming mandrel into the tool body.
   - While holding forming mandrel in place with your finger, thread in the forcing screw until it makes contact and begins to move the forming mandrel.
   - When contact is made, turn the forcing screw back one complete turn.
9. Slide the clamping nut over the front brake pipe (5) into the correct collet.
   - Leave approximately 19 mm (3/4 inch) of tubing extending out the collet.
10. Insert the assembly into the tool body.
    - The brake pipe end must contact the face of the forming mandrel.
11. Tighten the clamping nut into the tool body very tight or the pipe may push out.
12. Wrench tighten the forcing screw in until it bottoms.
    - Do not over-tighten the forcing screw or the flare may become over-sized.
13. Back the clamping nut out of the tool body and disassemble the clamping nut and collet assembly. The flare is now ready for use.
14. Bend front brake pipe (5) to match old pipe. Clearance of 19 mm (3/4 inch) must be maintained to all moving or vibrating parts.



18	CENTER BRAKE HOSE
19	BRACKET
20	SPRING CLIP
21	LEFT REAR BRAKE PIPE
22	RIGHT REAR BRAKE PIPE
23	BOLT
24	REAR AXLE HOUSING

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Figure 10 - Rear Brake Pipes and Center Brake Hose

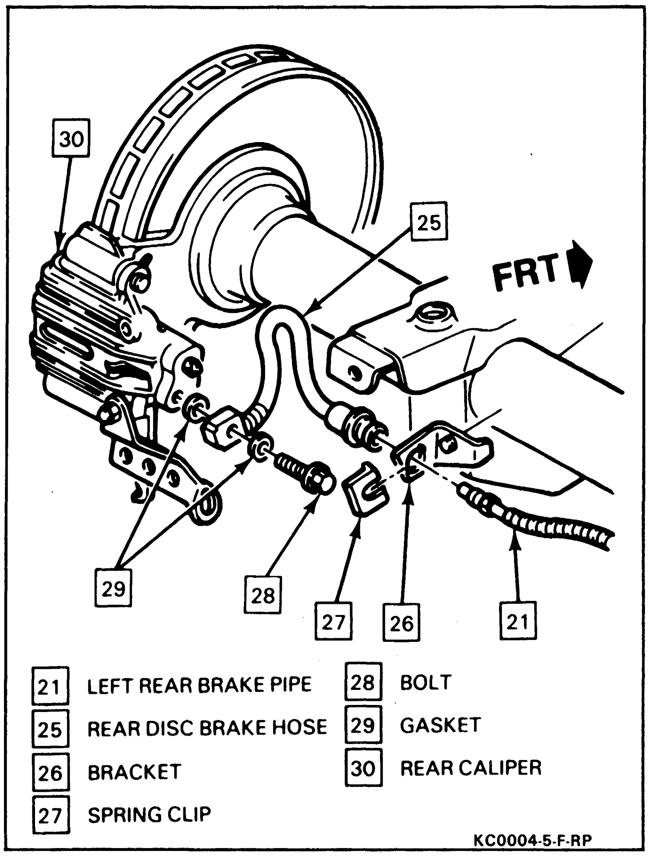


Figure 11 - Rear Disc Brake Hose Replacement

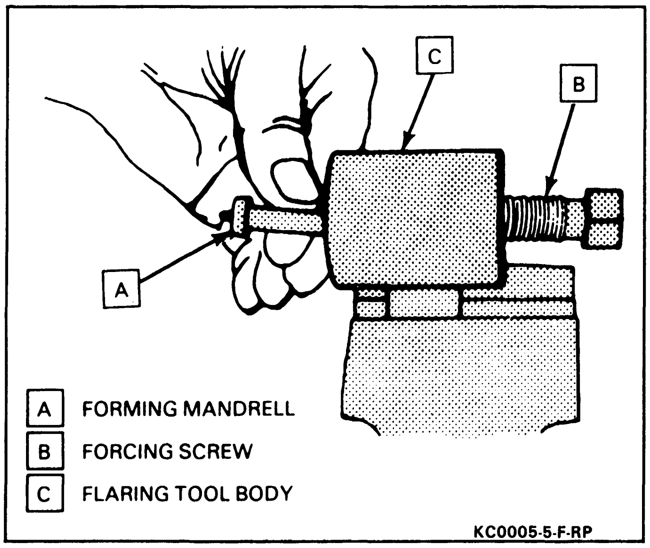


Figure 12 - Forming Mandrel and Forcing Screw

BRAKE HOSE INSPECTION

Figures 8, 10 and 11

Inspect

NOTICE: Do not allow brake components to hang from the flexible hoses as damage to the hoses may occur. Some brake hoses have protective rings or covers to prevent direct contact of the hose with other chassis parts. Besides causing possible structural damage to the hose, excessive tension could cause the hose rings to move out of their proper locations.

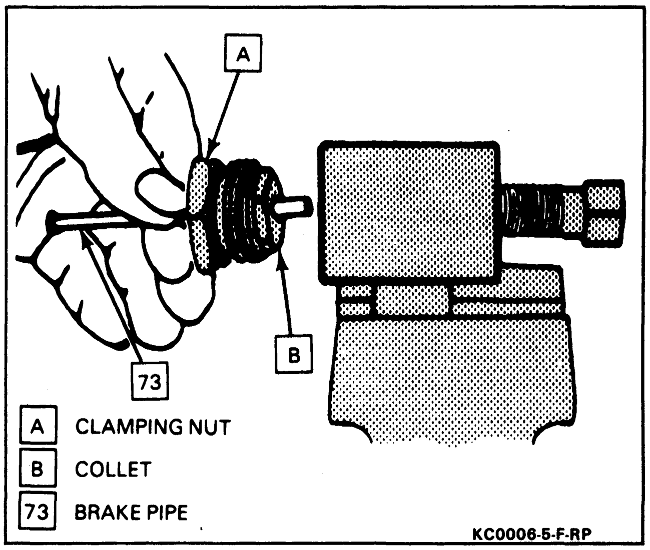


Figure 13 - Clamping Nut and Collet

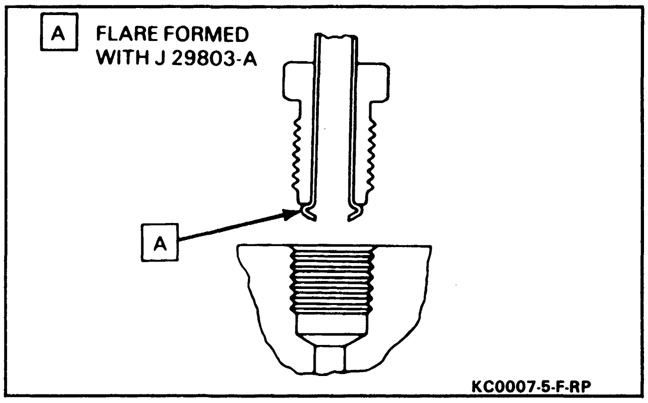


Figure 14 - ISO Flare

- Flexible hydraulic brake hoses, which transmit hydraulic pressure from the steel brake lines on the body to the rear brakes and to the calipers, at least twice a year when the vehicle is on a lift for lubrication.
- Brake hoses for road hazard damage, cracks and chafing of the outer cover, and for leaks and blisters.
  - A light and mirror may be needed for an adequate inspection.
  - If any of the above conditions are observed on a brake hose, it will be necessary to replace it.

BRAKE HOSE REPLACEMENT

Front Brake Hose

Figure 8

Remove or Disconnect

- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

Clean

- Dirt and foreign material from front brake hose (6) and fittings.

1. Wheel and tire. Refer to TIRES AND WHEELS (SEC. 3E).
   - Mark relationship between wheel and hub.
2. Front brake pipe (5) from front brake hose (6).
   - Use a backup wrench on hose fitting.
   - Be careful not to bend front brake pipe (5) or bracket (7).
3. Spring clips (8) from front brake hose (6) at brackets (7 and 9).
4. Front brake hose (6) from brackets (7 and 9).
5. Bolt (10), two gaskets (11) and front brake hose (6) from front caliper (12).
   - Discard the two gaskets (11).

Install or Connect

NOTICE: See "Notice" on page 5-1 of this section for steps 1 and 4.

1. Bolt (10), two gaskets (11) and front brake hose (6) to front caliper (12).
   - Use new gaskets (11).
   - Lubricate bolt threads with brake fluid.
   - Fitting flange on front brake hose (6) must engage caliper orientation ledge.

   Tighten

   - Bolt (10) to 44 N·m (32 lb. ft.).
2. Front brake hose (6) into brackets (7 and 9).
   - There should be no kinks in the front brake hose (6).
3. Spring clips (8) to brackets (7 and 9) and front brake hose (6).
4. Front brake pipe (5) to front brake hose (6).
   - Use a backup wrench on hose fitting.
   - Make sure that the front brake hose (6) does not contact any part of the suspension. Check in extreme right and extreme left turn conditions.

   Tighten

   - Front brake pipe (5) to 15 N·m (11 lb. ft.).

- Bleed brake system. Refer to "Bleeding Brake Hydraulic System" in this section.

5. Wheel and tire. Refer to TIRES AND WHEELS (SEC. 3E).

- Align previous marks on wheel and hub.
- Lower vehicle.

Center Brake Hose

Figures 9 and 10

Remove or Disconnect

- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

Clean

- Dirt and foreign material from center brake hose (18) and fittings.

1. Center brake pipe (13) from center brake hose (18).
   - Use a backup wrench on hose fitting.
   - Be careful not to bend bracket (19) or center brake pipe (13).
2. Spring clip (20) from bracket (19) and center brake hose (18).
3. Center brake hose (18) from bracket (19).
4. Left and right rear brake pipes (21 and 22) from center brake hose junction block.
5. Bolt (23) and center brake hose junction block from rear axle housing (24).
   - Note position of junction block for proper positioning during installation.

Install or Connect

NOTICE: See "Notice" on page 5-1 of this section.

1. Bolt (23) and center brake hose junction block to rear axle housing (24).
   - Do not fully tighten bolt (23) at this time.
2. Left and right rear brake pipes (21 and 22) to center brake hose junction block.

   Tighten

   - Bolt (23) to 27 N·m (20 lb. ft.).
   - Left and right rear brake pipes (21 and 22) to 15 N·m (11 lb. ft.).
3. Center brake hose (18) into bracket (19).
   - Center brake hose (18) will only fit in bracket (19) one way. Be sure that hose is properly seated.
   - Center brake hose (18) should not be kinked or twisted.
4. Spring clip (20) to bracket (19) and center brake hose (18).
5. Center brake pipe (13) to center brake hose (18).
   - Use a backup wrench on center brake hose fitting.
   - Be careful not to bend bracket (19) or center brake pipe (13).

   Tighten

   - Center brake pipe (13) to 15 N·m (11 lb. ft.).

- Lower the vehicle.
- Bleed hydraulic brake system. Refer to "Bleeding Brake Hydraulic System" in this section.

Rear Disc Brake Hose

Figures 10 and 11

Remove or Disconnect

- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Wheel and tire. Refer to TIRES AND WHEELS (SEC. 3E).
   - Mark relationship of wheel to axle flange.

   Clean

   - Dirt and foreign material from rear disc brake hose (25) and fittings.
2. Rear disc brake hose (25) from left or right rear brake pipe (21 or 22).
   - Use a backup wrench on rear disc brake hose fitting.
   - Be careful not to bend bracket (26) and left or right rear brake pipe (21 or 22).
3. Spring clip (27) from bracket (26) and rear disc brake hose (25).
4. Bolt (28), two gaskets (29) and rear disc brake hose (25) from rear caliper (30).
   - Discard two gaskets (29).

Install or Connect

> **NOTICE:** See "Notice" on page 5-1 of this section.

1. Bolt (28), two gaskets (29) and rear disc brake hose (25) to rear caliper (30).
   - Use two new gaskets (29).
   - Lubricate threads on bolt (28) with brake fluid.

   Tighten

   - Bolt (28) to 30 N·m (22 lb. ft.).
2. Spring clip (27) to bracket (26) and rear disc brake hose (25).
3. Rear disc brake hose (25) to left or right rear brake pipe (21 or 22).
   - Use a backup wrench on rear disc brake hose fitting.
   - Be careful not to bend bracket (26) and left or right rear brake pipe (21 or 22).

   Tighten

   - Left or right rear brake pipe (21 or 22) to 15 N·m (11 lb. ft.).

- Bleed hydraulic brake system. Refer to "Bleeding Hydraulic Brake System" in this section.

4. Wheel and tire. Refer to TIRES AND WHEELS (SEC. 3E).
   - Align previous marks on wheel and axle flange.

- Lower the vehicle.

PARKING BRAKE

This vehicle is equipped with coated parking brake cable assemblies. The wire strand is coated with a plastic material which slides over plastic seals inside the conduit end fittings. This is for corrosion protection and reduced parking brake effort.

> **NOTICE:** Handling these cables while servicing the parking brake system requires extra care. Damage to the plastic coating will reduce corrosion protection and if the damaged area passes through the seal, increased parking brake effort could result. Contacting the coating with sharp-edged tools, or with sharp surfaces of the vehicle underbody, should be avoided.

PARKING BRAKE CONTROL ASSEMBLY

Figures 15 and 16

Remove or Disconnect

1. Carpet finish molding.
2. Console. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
3. Wiring from parking brake light switch.
4. Parking brake light switch from control assembly (33).

- With lever in down position, rotate arm toward the front of the vehicle until a 3mm metal pin can be inserted into the hole.
- Insert metal pin into hole, locking out self-adjuster.
- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

5. Rear cables from equalizer (41).

- Lower vehicle.

6. Barrel-shaped button from adjuster track.
7. Two bolts (42) and control assembly (33) from floor pan.
8. Front cable (36) and casing from control assembly (33) and bracket using locally fabricated tool (Figure 16).

Install or Connect

> **NOTICE:** See "Notice" on page 5-1 of this section.

1. Front cable (36) and casing to control assembly (33) and bracket.
2. Two bolts (42) and control assembly (33) to floor pan.

   Tighten

   - Bolts (42) to 10 N·m (89 lb. in.).
3. Light switch and wiring to parking brake switch.
4. Barrel-shaped button to adjuster track.

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

5. Rear cables to equalizer (41).

- Lower vehicle.
- Remove pin from hole.
- Rotate adjuster arm toward the rear of the vehicle.
- Cycle lever.

6. Console. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
7. Carpet finish molding.

PARKING BRAKE CABLES

Parking Brake Front Cable

Figures 15 and 16

Remove or Disconnect

1. Carpet finish molding.
2. Console. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
   - With lever in down position, rotate arm toward the front of the vehicle until a 3mm metal pin can be inserted into the hole.
   - Insert metal pin into hole, locking out self adjuster.
   - Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).
3. Rear cables from equalizer (41).
4. Front cable (36) from bracket using locally frabricated tool (Figure 16).
5. Grommet (31) from hole.

- Lower vehicle.

6. Barrel-shaped button from adjuster track.
7. Front casing and cable (36) from control assembly (33) using locally fabricated tool (Figure 16).
8. Front cable (36) from floor pan.

Install or Connect

1. Front cable (36) and grommet (31) into floor pan.
   - Seat grommet in floor pan.
2. Front casing to control assembly (33).
3. Barrel-shaped button into adjuster track.

- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

4. Rear cables to equalizer (41).

- Lower the vehicle.

5. Metal pin from hole.

- Rotate adjuster arm toward rear of vehicle and cycle lever.

6. Console. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
7. Carpet finish molding.

Parking Brake Rear Cable (Drum Brakes)

Figure 17

Remove or Disconnect

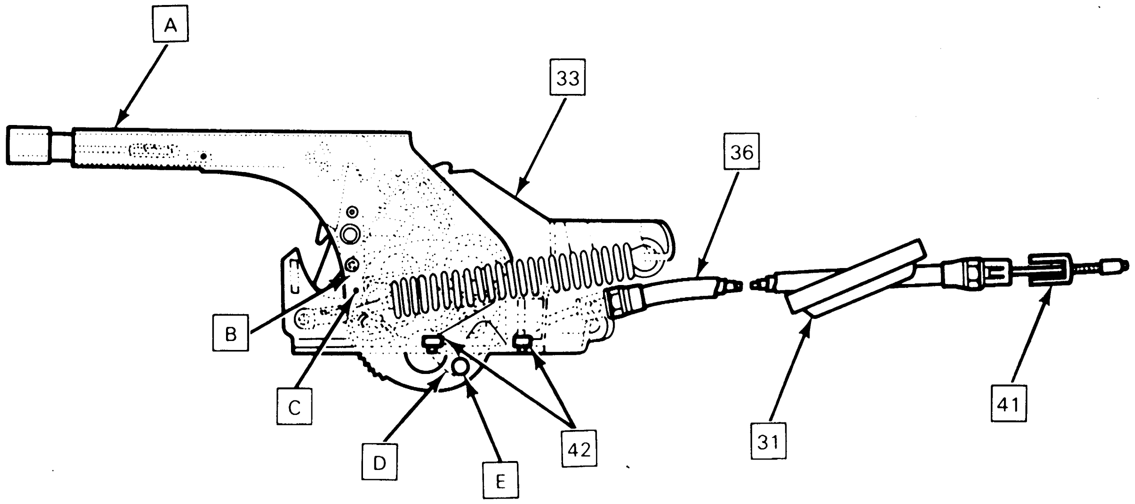
- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Left or right rear cable (37 or 38) from equalizer (41).
   - Pull equalizer (41) rearward to gain necessary cable slack.
   - Insert a spacer to hold the equalizer (41) in place.
   - Remove the left or right rear cable (37 or 38) from the equalizer (41).
2. Left or right rear cable (37 or 38) and casing from seat belt plate (45) and retainer (46).
   - Compress retainer fingers on casing and pull left or right rear cable (37 or 38) out of seat belt plate (45).
3. On the left side, pull left rear cable (37) through the clip (47) on the axle housing (48).
4. On the right side, screw (49) and clamp (50) from right rear cable (38).
5. Wheel and tire. Refer to TIRES AND WHEELS (SEC. 3E).
   - Mark relationship of wheel to axle flange.
6. Brake drum (51).
7. Left or right rear cable (37 or 38) from brake shoe operating lever. Refer to DIRECT TORQUE DRUM BRAKE ASSEMBLY (SEC. 5C3).
8. Left or right rear cable (37 or 38) from backing plate (52).
   - Compress retainer fingers and pull out.

Install or Connect

1. Left or right rear cable (37 or 38) to backing plate (52).
2. Left or right rear cable (37 or 38) to brake shoe actuating lever. Refer to DIRECT TORQUE DRUM BRAKE ASSEMBLY (SEC. 5C3).
3. Brake drum (51).
   - Align previous marks on axle flange and brake drum (51).
4. Wheel and tire. Refer to TIRES AND WHEELS (SEC. 3E).
   - Align previous marks on axle flange and wheel.
5. On the right side, screw (49) and clamp (50) to right rear cable (38).
6. On the left side, left rear cable (37) through clip (47) on axle housing (48).
7. Left or right rear cable (37 or 38) into seat belt plate (45) and retainer (46).
8. Left or right rear cable (37 or 38) to equalizer (41).

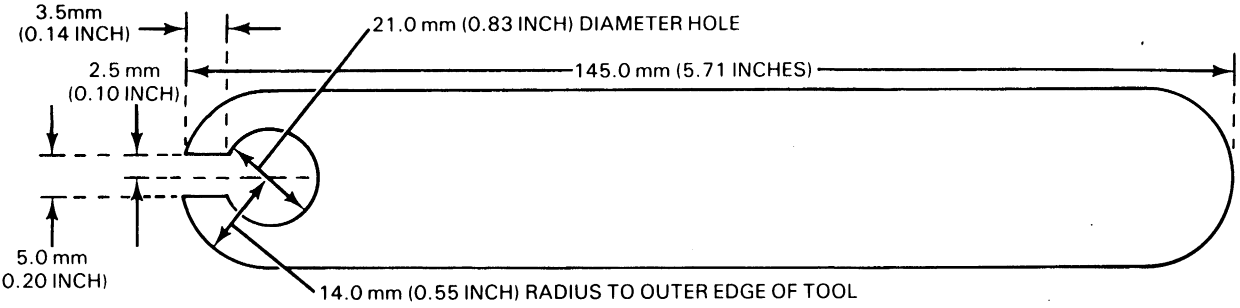
- Remove spacer.
- Lower vehicle.



A	LEVER	31	GROMMET
B	ARM	33	CONTROL ASSEMBLY
C	HOLE	36	FRONT CABLE
D	ADJUSTER TRACK	41	EQUALIZER
E	BARREL-SHAPED BUTTON	42	BOLT

LC0001-5-F-RP

Figure 15 - Parking Brake Control and Front Cable



MAKE PARKING BRAKE CABLE RETAINER COMPRESSOR TOOL FROM 28 mm (1.10 INCH) BAR STOCK, 3.2 mm (0.13 INCH) THICK.

LC0002-5-F-RP

Figure 16 - Locally Fabricated Parking Brake Cable Retainer Compressor Tool

- Cycle parking brake lever.

Parking Brake Rear Cable (Disc Brakes)

Figure 17

↔ Remove or Disconnect

- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Left or right rear cable (37 or 38) from equalizer (41).
   - Pull equalizer (41) rearward to gain necessary cable slack.
   - Insert a spacer to hold the equalizer (41) in place.
   - Remove the left or right rear cable (37 or 38) from the equalizer (41).
2. Left or right rear cable (37 or 38) and casing from seat belt plate (45) and retainer (46).
   - Compress retainer fingers on casing and pull left or right rear cable (37 or 38) out of seat belt plate (45).
3. On the left side, pull left rear cable (37) through the clip (47) on the axle housing (48).
4. On the right side, screw (49) and clamp (50) from right rear cable (38).
5. Wheel and tire. Refer to TIRES AND WHEELS (SEC. 3E).
   - Mark relationship of wheel to axle flange.
6. Left or right rear cable (37 or 38) from caliper lever (53) and bracket (54).
   - Push forward on caliper lever (53).
   - Remove right or left rear cable (37 or 38) from tang on caliper lever (53).
   - Release caliper lever (53).
   - Compress retainer fingers on cable casing and pull out of bracket (54).

→← Install or Connect

1. Right or left rear cable (37 or 38) to caliper lever (53) and bracket (54).
   - Push forward on caliper lever (53).
   - Install right or left rear cable (37 or 38) in tang on caliper lever (53).
   - Release caliper lever (53).
   - Seat retainer fingers into bracket (54).
2. Wheel and tire. Refer to TIRES AND WHEELS (SEC. 3E).
3. On the right side, screw (49) and clamp (50) to right rear cable (38).
4. On the left side, left rear cable (37) through clip (47) on axle housing (48).
5. Left or right rear cable (37 or 38) into seat belt plate (45) and retainer (46).
6. Left or right rear cable (37 or 38) to equalizer (41).

- Remove spacer.
- Lower vehicle.
- Cycle parking brake lever.

Parking Brake Adjustment

Refer to REAR DISC BRAKE CALIPER ASSEMBLY (SEC. 5B3) for parking brake free-travel adjustment procedures.

COMBINATION VALVE

Testing Combination Valve Electrical Circuit

Figure 18

When removing the electrical wire connector (55) from the pressure differential switch, squeeze the elliptical shaped plastic locking ring and pull up. This will move the locking tangs away from the switch. Pliers can be used to help remove the connector.

1. Remove connector (55) from brake switch terminal and use a jumper to connect wire to a good ground.
   - Squeeze sides of connector (55) to release tabs and pull up.
2. Turn ignition key to "ON." The warning lamp should light.
   - If lamp does not light, bulb is burned out or electrical circuit is faulty. Replace bulb or repair electrical circuit as necessary. Refer to ELECTRICAL DIAGNOSIS (SEC. 8A) for specific electrical information.
3. When warning lamp lights, turn ignition switch "OFF." Disconnect jumper and install connector (55) to brake switch terminal.

Testing Combination Valve Warning Lamp Switch

Figures 18 and 19

1. Attach a bleeder hose to a rear brake bleed screw and immerse the other end of the hose in a container partially filled with clean brake fluid.
   - Be sure master cylinder reservoirs are full.
2. Turn ignition switch to "ON."
   - Open bleeder screw while an assistant applies moderate pressure to the brake pedal. The warning lamp should light.
   - Close bleeder screw before assistant releases brake pedal.
   - Apply brake pedal with moderate-to-heavy pressure. The warning lamp should go out.
3. Attach the bleeder hose to a front brake bleeder screw and repeat steps 1 and 2. Warning lamp action should be the same as in step 2. Turn ignition switch "OFF."
4. If the warning lamp does not light during steps 2 and 3, but does light when a jumper is connected to ground, the warning lamp switch portion of the combination valve is faulty. Replace combination valve (56).

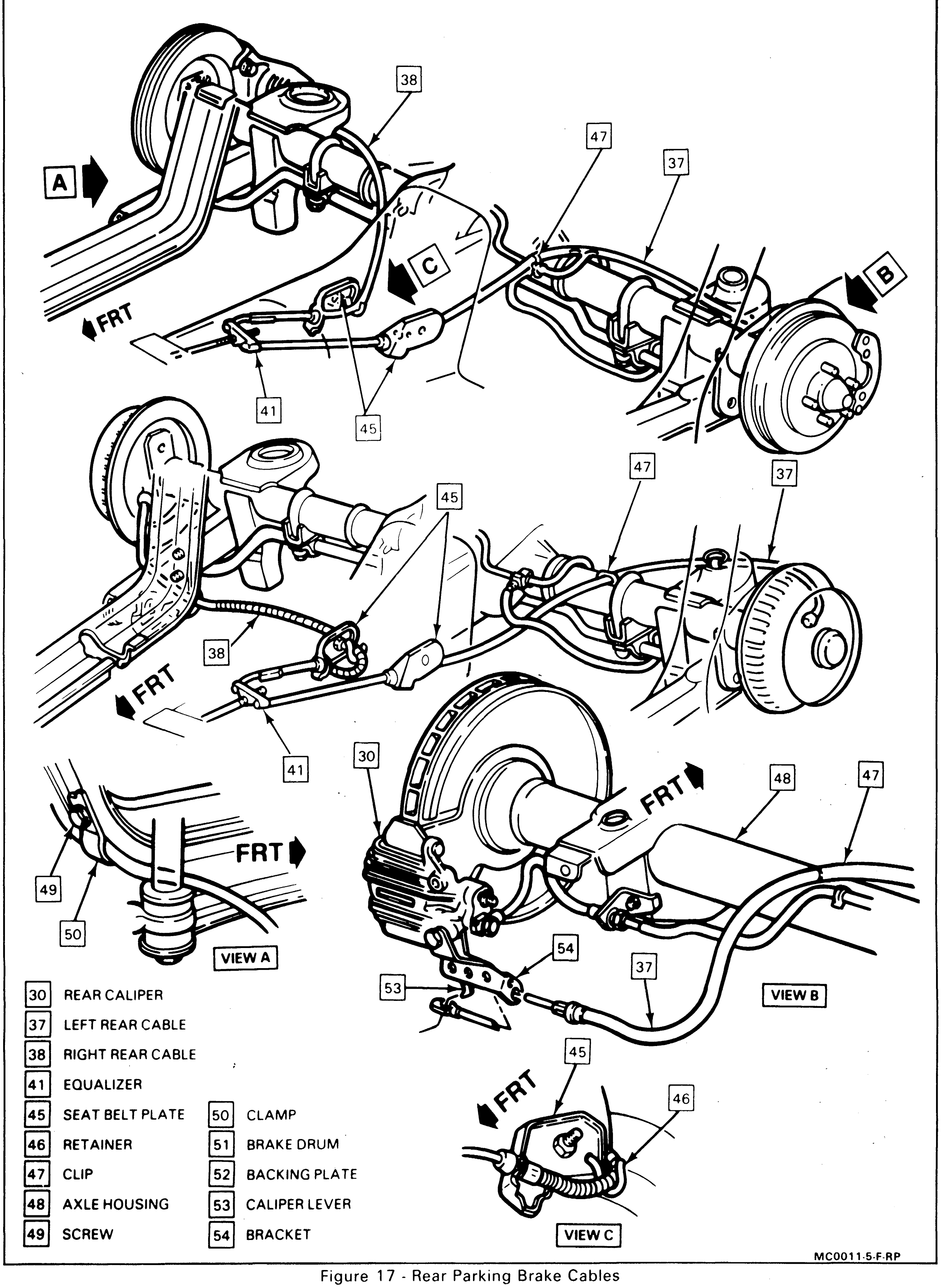


Figure 17 - Rear Parking Brake Cables

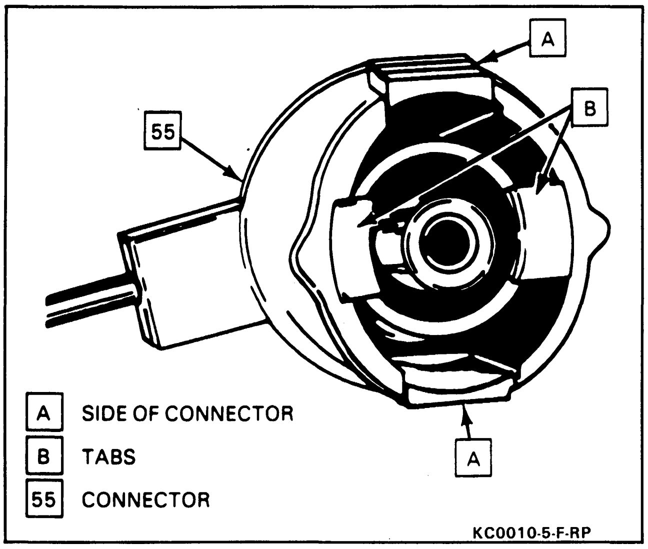


Figure 18 - Removing Brake Switch Connector

Combination Valve Replacement

Figures 18 and 19

The combination valve (56) is not repairable and must be serviced as a complete assembly.

Remove or Disconnect

1. Brake pipes (57 through 61) from combination valve (56).
   - Plug brake pipes (57 through 61) to prevent loss of fluid and entrance of dirt.
2. Connector (55) from the combination valve switch terminal.
3. Two nuts (63) attaching combination valve (56) to booster (62).
4. Clutch master cylinder reservoir if vehicle is equipped with manual transmission. Refer to CLUTCH (SEC. 7C).
5. Combination valve (56) from booster (62).

Install or Connect

NOTICE: See "Notice" on page 5-1 of this section.

1. Combination valve (56) to booster (62).
2. Clutch master cylinder reservoir, if vehicle is equipped with manual transmission. Refer to CLUTCH (SEC. 7C).
3. Two nuts (63) attaching combination valve (56) to booster (62).

   Tighten

   - Nuts (63) to 25 N·m (18 lb. ft.).
4. Connector (55) to the combination valve switch terminal.
5. Brake pipes (57 through 61) to combination valve (56).

   Tighten

   - Brake pipes (60 and 61) to 24 N·m (18 lb. ft.).
   - Brake pipes (57 through 59) to 15 N·m (11 lb. ft.).

- Bleed the brakes. Refer to "Bleeding Brake Hydraulic System" in this section.

CAUTION: Do not move the vehicle until a firm brake pedal is obtained. Air in the brake system can cause loss of brakes.

BRAKE LINING INSPECTION

Figure 20

Inspect the brake linings at least twice a year when the wheels are removed (tire rotation, etc.). When inspecting disc brakes, check both ends of the outer shoe by looking in at each end of the caliper. These are the points at which the highest rate of wear normally occurs. Also, check the lining thickness of the inner shoe to make sure that it has not worn prematurely. Look through the hole in the top of the caliper to view the inner shoe. Disc brake linings should be replaced when the thickness of any lining is worn to within 0.76 mm (0.030-inch) of the shoe or rivet. All disc brake shoes and linings should be replaced in axle sets.

All disc brakes have a wear indicator that makes a noise when the linings wear to a degree where replacement is required. The wear indicator is an integral part of the shoe and lining. When the lining is worn, the clip indicator contacts the rotor and produces a warning noise.

Check the flatness of brake linings. Place inner shoe lining and outer shoe lining surfaces together and check for gap between surfaces. If more than 0.13 mm (0.005-inch) gap is measured midway betweeen attaching lugs, shoe and lining assembly must be replaced.

Inspect rear drum brake shoe and lining assemblies. When the thickness of any lining is worn within 0.76 mm (0.030-inch) of the shoe or rivet, the shoe and lining assemblies must be replaced. Replace shoe and lining assemblies in axle sets.

BRAKE LINING REPLACEMENT

GM replacement brake lining material is recommended for all GM vehicles to maintain the balance between front and rear brake performance. GM replacement brake parts have been carefully selected to provide the proper brake balance for purposes of both stopping distance and controllability over the full range of operating conditions. Installation of front or rear brake lining material with performance different from that of the GM replacement parts recommended for this vehicle can change the intended brake balance of this vehicle.

Refer to FRONT DISC BRAKE CALIPER ASSEMBLY - 3000/3100 series (SEC. 5B1) or FRONT PAD-GUIDED DISC BRAKE CALIPER ASSEMBLY (SEC. 5B2) for front disc brake shoe and lining replacement. Refer to DIRECT TORQUE DRUM BRAKE ASSEMBLY (SEC. 5C3) for rear drum brake shoe and lining replacement. Refer to REAR DISC BRAKE CALIPER ASSEMBLY (SEC. 5B3) for rear disc brake shoe and lining replacement.

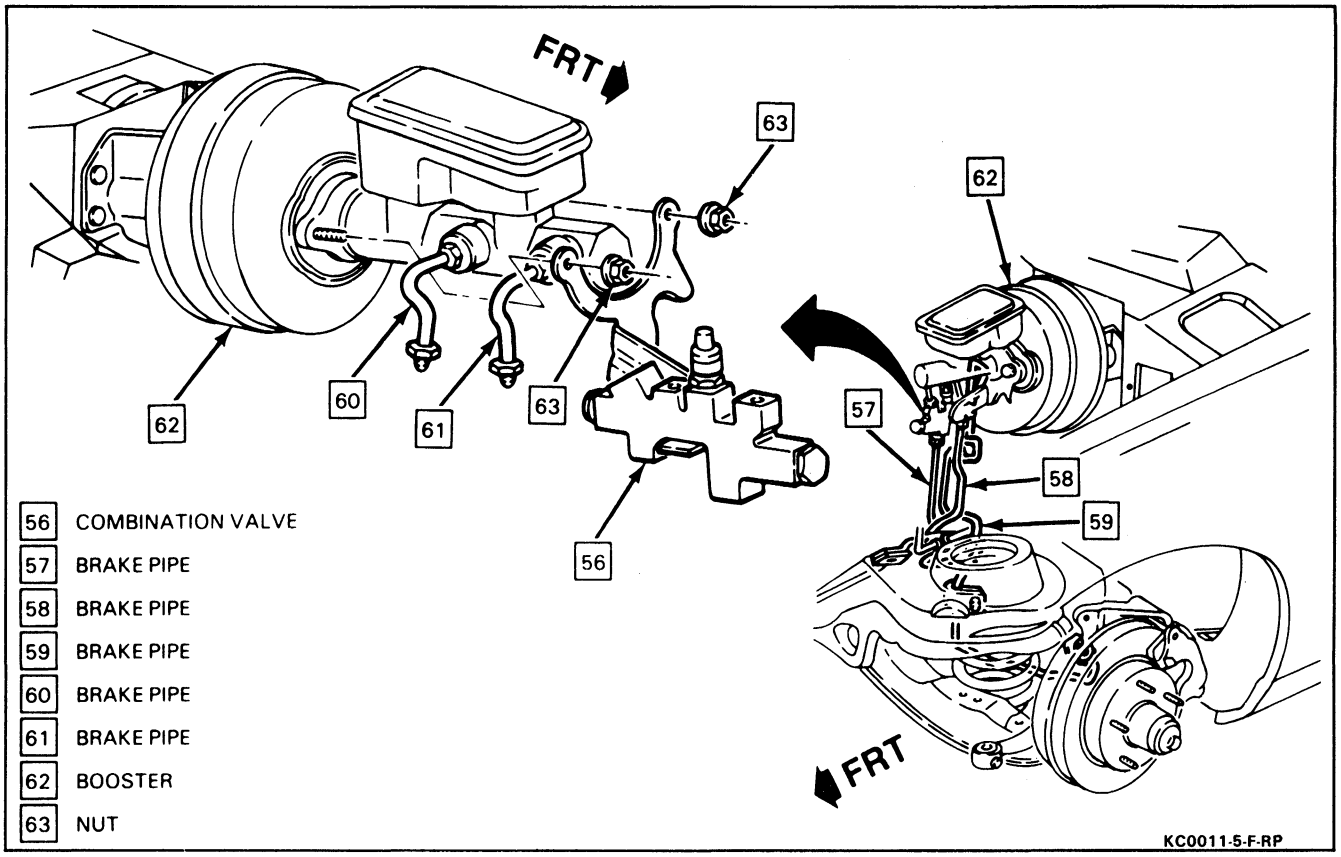


Figure 19 - Combination Valve Replacement

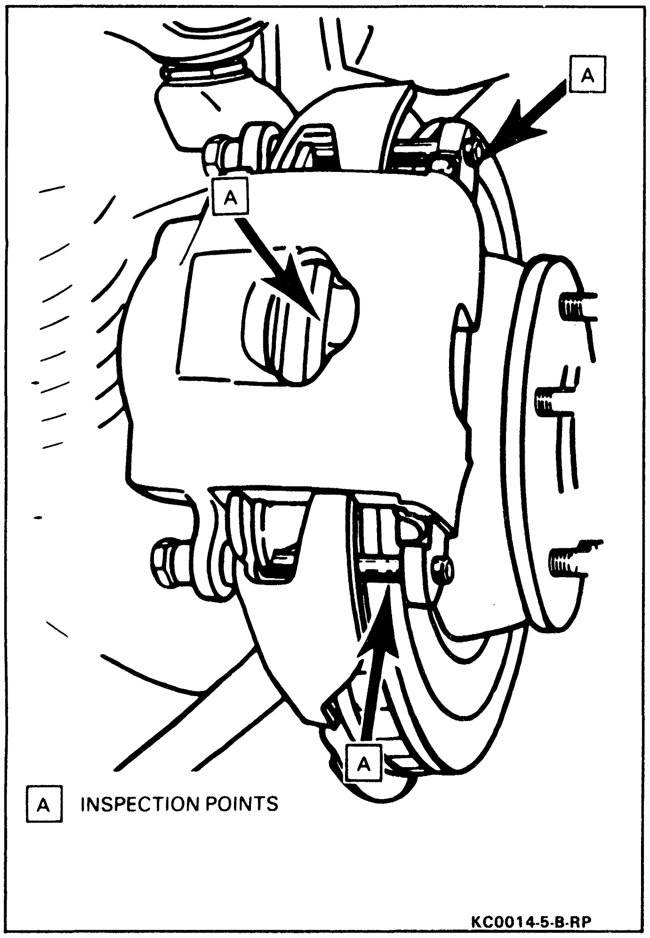


Figure 20 - Brake Lining Inspection

INSPECTING AND REFINISHING ROTORS

Thickness Variation Check

Thickness variation can be checked by measuring the thickness of the rotor at four or more points around its circumference. All measurements must be made at the same distance in from the edge of the rotor. A rotor that varies by more than 0.013 mm (0.0005 inch) can cause pedal pulsation and/or front end vibration during brake applications. A rotor that does not meet these specifications should be refinished to specifications or replaced.

Lateral Runout Check

Figure 21

1. Tighten wheel bearings until all the play is out of the bearings. Refer to FRONT SUSPENSION (SEC. 3C).
2. Remove caliper. Refer to FRONT DISC BRAKE CALIPER ASSEMBLY - 3000/3100 SERIES (SEC. 5B1) or FRONT PAD-GUIDED DISC BRAKE CALIPER ASSEMBLY (SEC. 5B2).
3. Fasten a dial indicator to the steering knuckle so that the indicator button contacts the rotor (64) about 25 mm (1 inch) from the rotor edge.
4. Zero the dial indicator.
5. Move the rotor (64) one complete revolution, and observe total indicated runout (TIR).
   - Lateral runout should not be more than specifications. See "Specifications" in this section.

- A rotor (64) that does not meet the lateral runout specification should be resurfaced or replaced as necessary.

6. Readjust wheel bearings. Refer to FRONT SUSPENSION (SEC. 3C).
7. Install caliper. Refer to FRONT DISC BRAKE CALIPER ASSEMBLY - 3000/3100 SERIES (SEC. 5B1) or FRONT PAD-GUIDED DISC BRAKE CALIPER ASSEMBLY (SEC. 5B2).

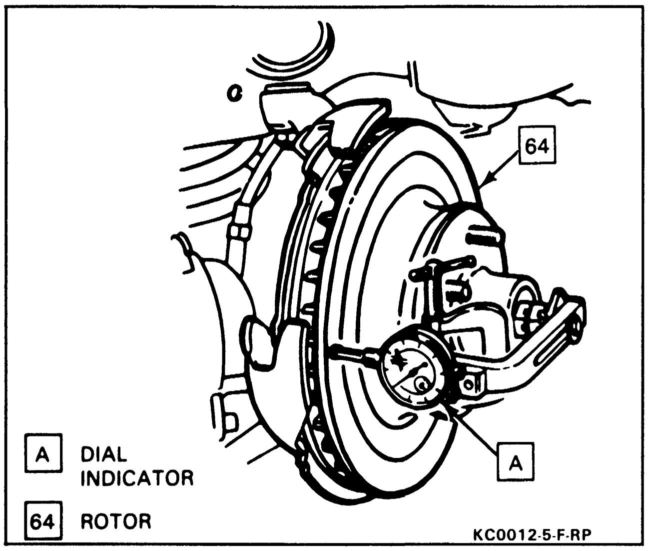


Figure 21 - Checking Lateral Runout

Replacing Brake Rotors

When installing new brake rotors, do not refinish the surfaces of these parts. New parts have the correct level of surface finish.

Rotor Tolerance and Surface Finish

In manufacturing the brake rotor, tolerances of the braking surfaces for flatness, thickness variation and lateral runout are held very close. The maintenance of close tolerances on the shape of the braking surfaces is necessary to prevent brake roughness.

In addition to these tolerances, the surface finish must be held to a specified range. The control of the braking surface finish is necessary to avoid pulls and erratic performance and to extend lining life.

Light scoring of the rotor surfaces not exceeding 0.38 mm (0.015-inch) in depth, which may result from normal use, will not affect brake operation.

Refinishing Brake Rotors

All brake rotors have a minimum thickness dimension cast into them. This dimension is the minimum wear dimension and not a refinish dimension. The minimum refinish dimension is greater than the discard dimension. Do not use a brake rotor that will not meet specifications. Refer to "Specifications" in this section.

Since accurate control of the rotor tolerances is necessary for proper performance of the disc brakes, the rotor should be machined only with precision equipment.

When refinishing rotors, always use sharp cutting tools or bits. Dull or worn tools leave a poor surface finish which will affect initial braking performance. Vibration dampening attachments should always be used when refinishing braking surfaces. These attachments eliminate tool chatter and will result in better surface finish.

The optimum speed for refinishing braking surfaces is a spindle speed of 200 rpm. Crossfeed for rough cutting should range from 0.25-0.15 mm (0.010-0.006-inch) per revolution. Finish cuts should be made at crossfeeds no greater than 0.05 mm (0.002-inch) per revolution.

INSPECTING AND REFINISHING BRAKE DRUMS

When brake drums are removed, thoroughly clean and inspect them for cracks, scores, deep grooves, out-of-round and taper.

Cracked, Scored or Grooved Drum

A cracked drum is unsafe for further service and must be replaced. Do not attempt to weld a cracked drum.

Smooth up any slight scores. Heavy or extensive scoring will cause excessive brake lining wear, and it may be necessary to refinish the drum braking surface.

If the brake linings are slightly worn but still reusable, and the drum is grooved, polish the drum with fine emery cloth but do not refinish. Eliminating all grooves in drum and smoothing the ridges on lining would require removing too much metal and lining, while if left alone, the grooves and ridges match and satisfactory service can be obtained.

If brake linings are to be replaced, refinish a grooved drum. A grooved drum, if used with new lining, will not only wear the lining, but will make it difficult, if not impossible, to obtain proper brake performance.

Out-Of-Round or Tapered Drum

An out-of-round or tapered drum makes accurate brake shoe adjustment impossible and is likely to cause excessive wear of other parts of brake mechanism due to its eccentric action. An out-of-round drum can also cause severe and irregular tire tread wear as well as a pulsating brake pedal. When the drum exceeds the specification limits in taper and/or out-of-round, refinish drum to true up the braking surface. Out-of-round as well as taper and wear can be accurately measured with an inside micrometer fitted with proper extension rods.

When measuring a drum for out-of-round, taper, and wear, take measurements at the open and closed edges of machined surface and at right angles (90 degrees) to each other.

Replacing Brake Drums

When installing new brake drums, do not refinish the braking surface. New drums have the correct level of surface finish.

Refinishing Brake Drums

All brake drums have a maximum diameter cast into them. This diameter is the maximum wear diameter and not a refinish diameter. Do not refinish a brake drum that will not meet the specifications. Refer to "Specifications" at the end of this section.

Any drum that does not meet the specifications shown should be replaced.

If a drum must be refinished, remove only enough metal to obtain a true, smooth braking surface. If a drum does not clean-up when refinished to a maximum rebore diameter as shown in "Specifications" in this section, replace it.

Removal of more metal will affect heat dissipation and may cause drum distortion.

When refinishing drums, always use sharp cutting tools or bits. Dull or worn tools leave a poor surface finish which will affect initial braking performance. Vibration dampening attachments should always be used when refinishing braking surfaces. These attachments eliminate tool chatter and will result in better surface finish.

The optimum spindle speed for refinishing braking surfaces is 200 rpm. Crossfeed for rough cutting should range from 0.25-0.15 mm (0.010-0.006-inch) per revolution. Finish cuts should be made at crossfeeds no greater than 0.05 mm (0.002-inch) per revolution.

Brake Drum Balance

During manufacture, weights are used to balance brake drums. These weights must not be removed.

After drums have been refinished or if difficulty is experienced in maintaining proper wheel balance, brake drums should be checked for balance. Brake drums may be checked for balance on most off-the-vehicle wheel balancers.

POWER BRAKE VACUUM BOOSTER HOSES AND PIPES

Refer to Figures 22 through 24 for vacuum booster hose routing.

BRAKE PEDAL MOUNTING

Refer to Figure 25 for brake pedal mounting. Refer to "Specifications" in this section for torque specifications.

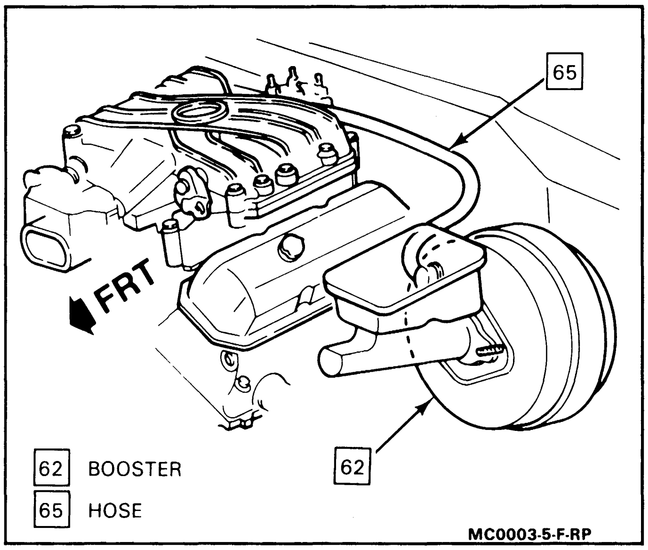


Figure 22 - Vacuum Booster Hose Routing - 3.1L LHO

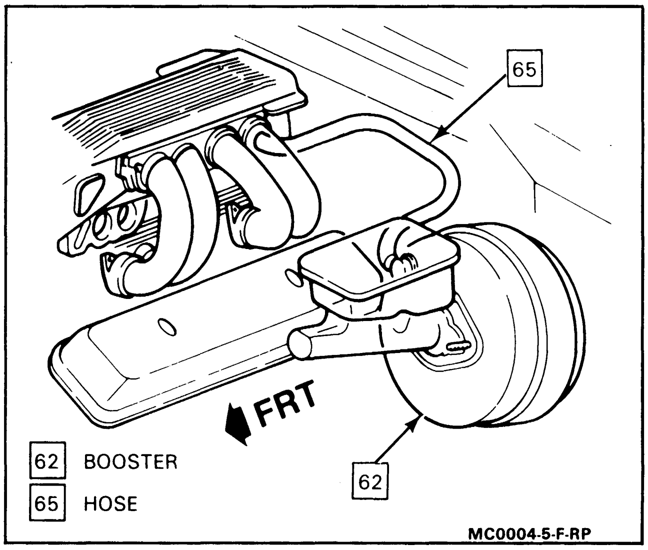


Figure 23 - Vacuum Booster Hose Routing - 5.0L LB9 and 5.7L L98

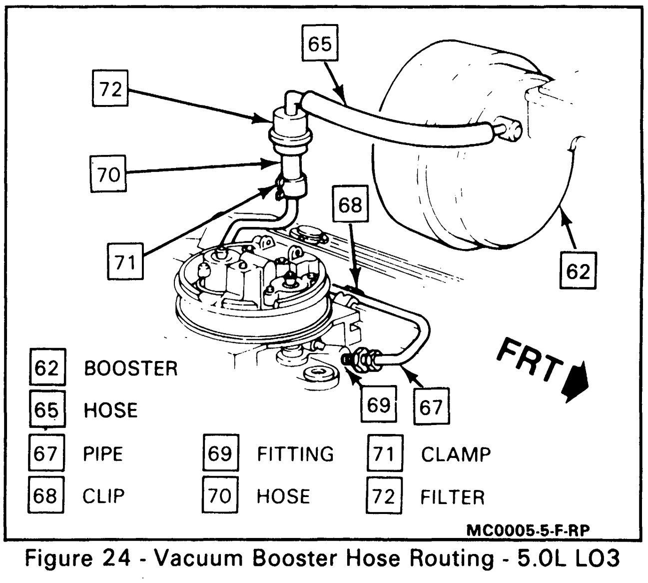
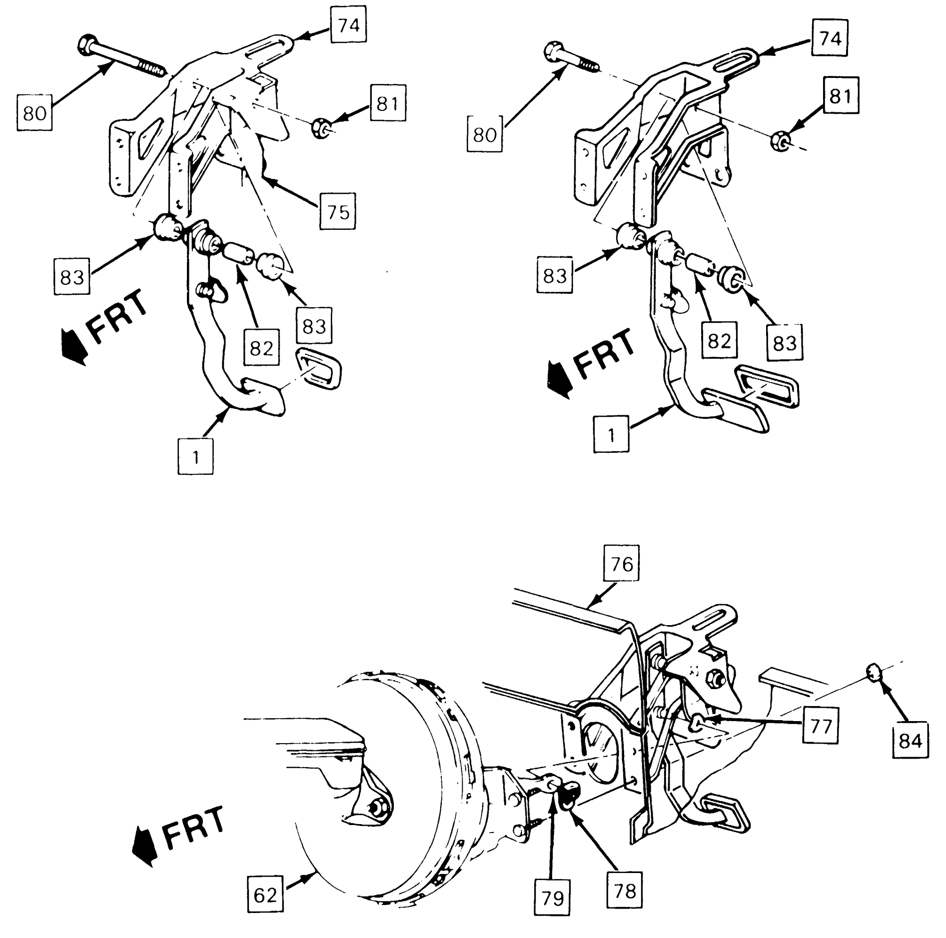


Figure 24 - Vacuum Booster Hose Routing - 5.0L LO3



1	BRAKE PEDAL
62	BOOSTER
74	BRAKE PEDAL BRACKET
75	CLUTCH PEDAL
76	INSTRUMENT PANEL
77	WASHER
78	RETAINER
79	PUSHROD
80	PIVOT BOLT
81	PIVOT NUT
82	SLEEVE
83	BUSHING
84	NUT

Figure 25 - Brake Pedal Mounting

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Front Brake Hose-to-Caliper Bolt	44 N·m (32 lb. ft.)
Brake Hose-to-Caliper Bolt (Base)	30 N·m (22 lb. ft.)
Brake Hose-to-Caliper Bolt (Heavy Duty)	40 N·m (30 lb. ft.)
Brake Hose Bracket Bolt	20 N·m (15 lb. ft.)
Brake Pedal Pivot Nut	34 N·m (25 lb. ft.)
Brake Pipe Bracket Bolt	11 N·m (97 lb. in.)
Booster-to-Pedal Bracket Nut	21 N·m (15 lb. ft.)
Master Cylinder-to-Booster Nut	25 N·m (18 lb. ft.)
Brake Pipe	15 N·m (11 lb. ft.)
Caliper Mounting Bolts	
Base Front Caliper	50 N·m (37 lb. ft.)
Heavy Duty Front Caliper Bracket	185 N·m (137 lb. ft.)
Heavy Duty Caliper Adapter Bracket	115 N·m (85 lb. ft.)
Rear Caliper Guide Pin (Hex Head)	35 N·m (26 lb. ft.)
Rear Caliper Guide Pin (Allen Head)	22 N·m (16 lb. ft.)
Rear Caliper Bracket	95 N·m (70 lb. ft.)
Pivot Pin Nut	22 N·m (16 lb. ft.)
Bleeder Valve	
Base Front Caliper	13 N·m (115 lb. in.)

Heavy Duty Front Caliper	9 N·m (80 lb. in.)
Rear Caliper	9 N·m (80 lb. in.)
Wheel Cylinder	6 N·m (53 lb. in.)
Parking Brake Control Assembly to Floor Pan Bolt	10 N·m (89 lb. in.)
Backing Plate-to-Axle Housing Nut	58 N·m (45 lb. ft.)
Junction Block to Rear Axle Bolt	27 N·m (20 lb. ft.)
Inlet Tube Nut	17 N·m (13 lb. ft.)
Anchor Pin Nut	140 N·m (103 lb. ft.)
Master Cylinder-to-Combination Valve Pipes	24 N·m (18 lb. ft.)

BRAKE SPECIFICATIONS

BRAKE PEDAL TRAVEL (DISC/DRUM) (Nominal)	57.00 mm (2.250 in.)

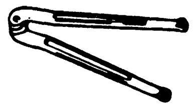
Brake pedal travel maximum with 445 N (100 lbs.) force applied to pedal with ignition "OFF" and vacuum assist depleted.

BRAKE DRUMS	
Inside Diameter	241.00 mm (9.5 in.)
Maximum Rebore Diameter	242.81 mm (9.56 in.)
*Discard Diameter	243.59 mm (9.59 in.)
Runout	0.15 mm (0.006 in.)
BRAKE ROTORS	
Front Disc Brake Rotor (Base)	
Rotor Diameter (Nominal)	267.00 mm (10.5 in.)
Lateral Runout	0.13 mm (0.005 in.)
Thickness Variation	0.013 mm (0.0005 in.)
Rotor Thickness (Maximum)	26.5 mm (1.043 in.)
Minimum Thickness After Refinish	24.89 mm (0.980 in.)
*Discard Thickness	24.5 mm (0.965 in.)
Front Disc Brake Rotor (Heavy Duty)	
Rotor Diameter (Nominal)	305.00 mm (12.000 in.)
Lateral Runout	0.13 mm (0.005 in.)
Thickness Variation	0.013 mm (0.0005 in.)
Rotor Thickness (Maximum)	26.50 mm (1.043 in.)
Minimum Thickness After Refinish	24.89 mm (0.980 in.)
*Discard Thickness	24.50 mm (0.965 in.)
Rear Disc Brake Rotor (Nominal)	
Rotor Diameter	296.00 mm (11.5 in.)
Lateral Runout	0.13 mm (0.005 in.)
Thickness Variation	20.2 mm (0.795 in.)
Rotor Thickness (Maximum)	18.9 mm (0.744 in.)
*Discard Thickness	18.4 mm (0.724 in.)

* All brake drums and rotors have a discard dimension cast into them. This is a wear dimension and not a refinish dimension. Any drum or rotor which does not meet the specification should be replaced.

MASTER CYLINDER BORE DIAMETER	
Disc/Drum	24.00 mm (0.945 in.)
Disc/Disc	25.40 mm (1.00 in.)
FRONT CALIPER BORE DIAMETER	
Base Caliper	64.00 mm (2.52 in.)
Heavy Duty Caliper (Each Piston Bore)	38.0 mm (1.50 in.)
REAR CALIPER BORE DIAMETER	40.5 mm (1.60 in.)
WHEEL CYLINDER BORE DIAMETER	19.00 mm (0.748 in.)

SPECIAL TOOLS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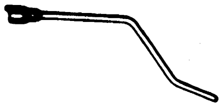
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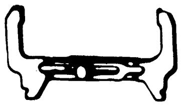
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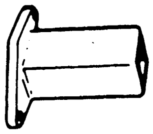
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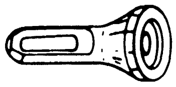
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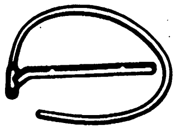
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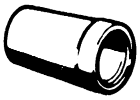
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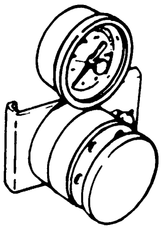
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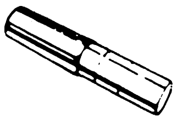
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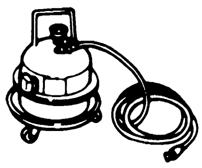
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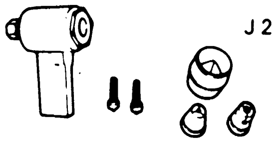
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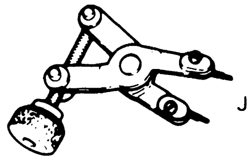
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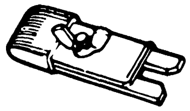
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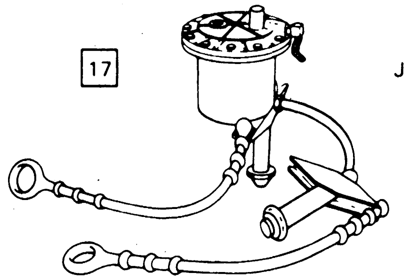
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1 SPANNER WRENCH
2 BRAKE SPRING REMOVER AND INSTALLER
3 BRAKE SPRING PLIERS
4 DRUM TO BRAKE SHOE CLEARANCE GAGE
5 BLEEDER WRENCH
6 PUSHROD HEIGHT GAGE
7 BRAKE BOOSTER HOLDER
8 BOOT SEAL INSTALLER
9 REAR WHEEL CYLINDER BLEEDER WRENCH
10 RETAINER INSTALLER
11 BRAKE PEDAL EFFORT GAGE
12 AIR VALVE PUSHROD RETAINER INSTALLER
13 POWER BRAKE BLEEDER
14 ISO FLARING KIT
15 BRAKE CYLINDER RETAINER REMOVER
16 PROPORTIONING VALVE DEPRESSOR
17 BRAKE BLEEDER ADAPTER

KC0017-5-F-RP

SECTION 5A3

COMPOSITE MASTER CYLINDER

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 5A3-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

This master cylinder is a composite design (plastic reservoir and aluminum body) incorporating a conventional front to rear brake system split. The primary piston provides the fluid pressure to the front brakes, while the secondary piston provides the fluid pressure to the rear brakes. If pressure is lost from either system, the remaining system will function to stop the vehicle.

A quick take-up feature provides a large volume of fluid to the wheel brakes at low pressure with initial brake apply. The low pressure fluid quickly provides the displacement requirements created by the seal retraction of the pistons into the front calipers.

Important

- Replace all components included in repair kits used to service this master cylinder.
- Lubricate rubber parts with clean brake fluid to ease assembly.
- Do not use lubricated shop air on brake parts as damage to rubber components may result.
- If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.
- The torque values specified are for dry, unlubricated fasteners.
- Perform service operations on a clean bench free from all mineral oil materials.

ON-VEHICLE SERVICE

MASTER CYLINDER ASSEMBLY

Figures 1 and 2

Remove or Disconnect

1. Brake pipes (14).
   - Plug open brake pipes (14) to prevent fluid loss and contamination.
2. Two attaching nuts (15).
3. Clutch master cylinder reservoir bracket (18) with assembled clutch master cylinder reservoir (19) and move out of the way, on vehicles with manual transmissions.
4. Combination valve (16) and move out of the way.
5. Master cylinder (13).

Install or Connect

1. Master cylinder (13).
2. Combination valve (16).
3. Clutch master cylinder reservoir bracket (18) with assembled clutch master cylinder reservoir (19), on vehicles with manual transmissions.

NOTICE: See Notice on page 5A3-1 of this section.

4. Two attaching nuts (15).

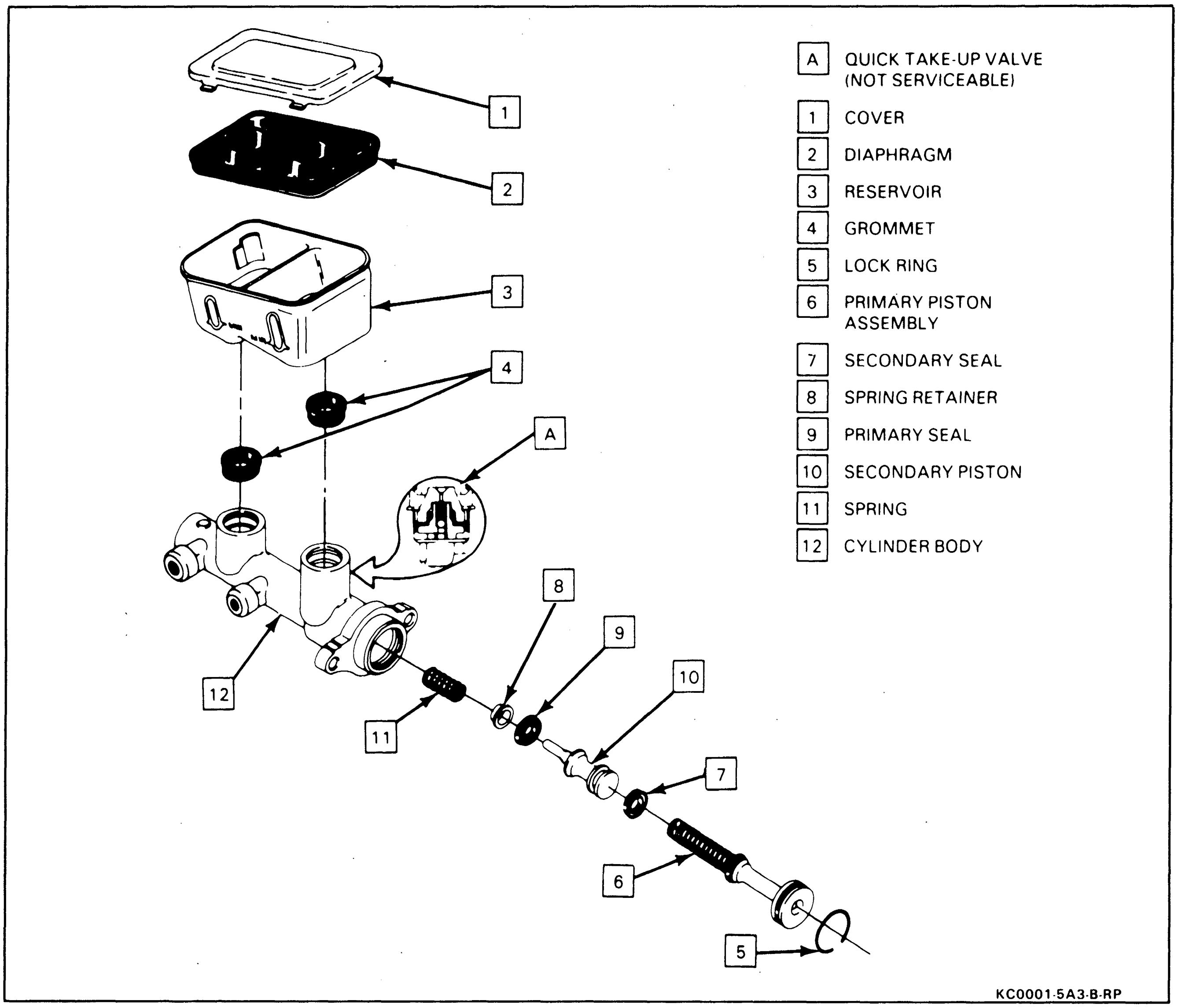
   Tighten

   - Two attaching nuts (15) to 25 N·m (18 lb. ft.).
5. Brake pipes (14).

   Tighten

   - Brake pipes (14) to 24 N·m (18 lb. ft.).

- Fill master cylinder reservoir (3) to the proper level with clean brake fluid.
- Bleed hydraulic brake system. Refer to GENERAL BRAKES (SEC. 5).



KC0001-5A3-B-RP

Figure 1 — Composite Master Cylinder Components

UNIT REPAIR

MASTER CYLINDER OVERHAUL

Figures 1 and 2

Disassemble

Important

- Reservoir cover (1) and diaphragm (2) can be inspected and/or serviced without removing the master cylinder (13) from the vehicle.
- Do not remove the quick take-up valve from the cylinder body (12). This valve cannot be serviced.

- Remove master cylinder from the vehicle. Refer to "Master Cylinder Assembly" in this section.

1. Reservoir cover (1) and diaphragm (2) from reservoir (3).

- Wipe reservoir cover (1) clean before removing.
- Empty fluid from reservoir (3) if master cylinder (13) is to be completely removed and overhauled).

NOTICE: Take care not to damage the piston, bore or retainer groove during lock ring removal.

2. Lock ring (5) while depressing primary piston assembly (6).
3. Primary piston assembly (6), secondary piston (10), spring (11) and spring retainer (8).
   - To remove parts, apply low pressure dry compressed air into the outlet port near the closed end of the bore with the other outlet port plugged.
4. Secondary seal (7), primary seal (9) and spring retainer (8) from the secondary piston (10).

Clean

- All parts in clean, denatured alcohol.
- Dry with unlubricated compressed air.

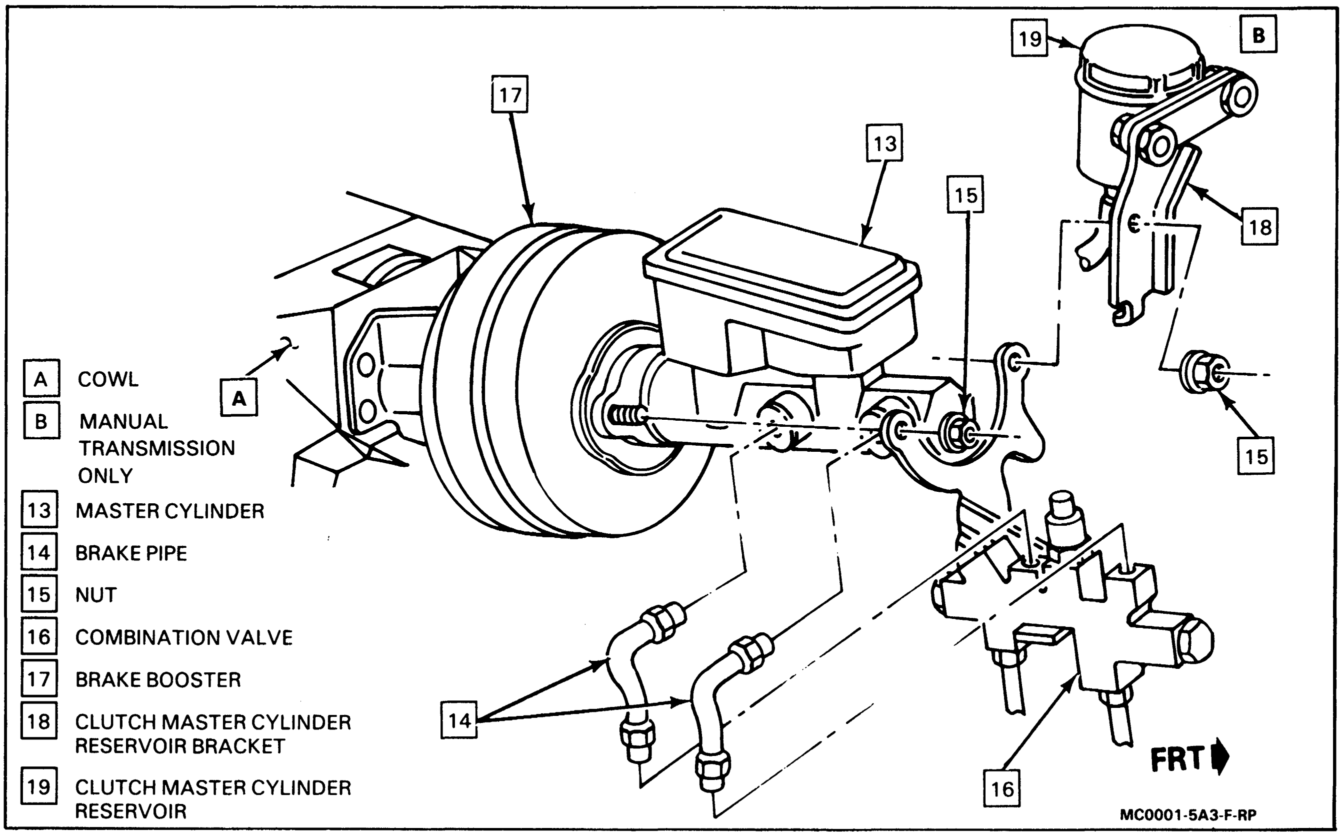


Figure 2 - Master Cylinder Replacement

- Abrasives should not be used in master cylinder bore.

Inspect

- Reservoir cover (1) and diaphragm (2) for cuts, cracks, nicks and deformation.
- Master cylinder bore for scoring or corrosion. If noted, replace master cylinder (13).
- Replace damaged parts.

Assemble

- Lubricate rubber parts with clean brake fluid to ease assembly.

1. Lubricated secondary seal (7), primary seal (9) and spring retainer (8) onto secondary piston (10).
2. Spring (11) and assembled secondary seal (7), primary seal (9), spring retainer (8) and secondary piston (10) into cylinder bore.
3. Lubricated primary piston assembly (6) into cylinder bore.
4. Lock ring (5) while depressing primary piston assembly (6).
5. Diaphragm (2) into cover (1).
6. Diaphragm (2) and cover (1) onto reservoir (3).

- Install master cylinder. Refer to "Master Cylinder Assembly" in this section.

MASTER CYLINDER RESERVOIR

Figures 3 and 4

Disassemble

- Remove and disassemble master cylinder. Refer to "Master Cylinder Overhaul" in this section.

NOTICE: Do not clamp housing area of master cylinder body (12) in vise or the part may be damaged.

- Clamp the flange of the master cylinder body (12) in a vise.

1. Reservoir (3) from grommets (4), using a pry bar.
2. Reservoir grommets (4) from cylinder body (12).

Clean

- Reservoir (3) with clean denatured alcohol.
- Dry with unlubricated compressed air.

Inspect

- Reservoir (3) for cracks or deformation. Replace reservoir (3) if any damage is found.

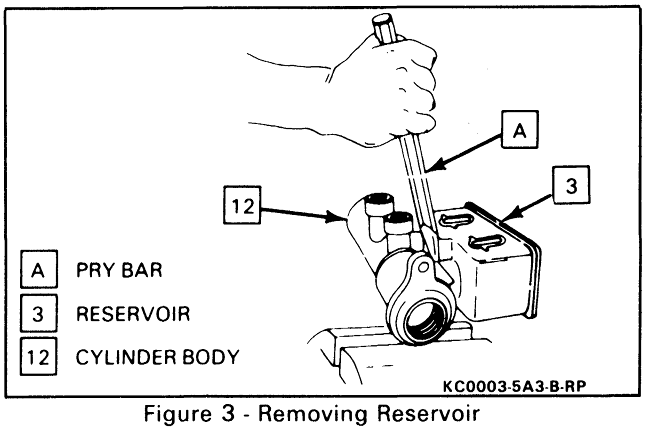


Figure 3 - Removing Reservoir

Assemble

- Lubricate new grommets (4) and reservoir flanges with clean brake fluid.

1. Lubricated grommets (4) into cylinder body (12).
   - Make sure grommets (4) are properly seated.
2. Reservoir (3) into cylinder body (12) and grommets (4), using a rocking motion.

- Assemble and install master cylinder. Refer to "Master Cylinder Overhaul" in this section.

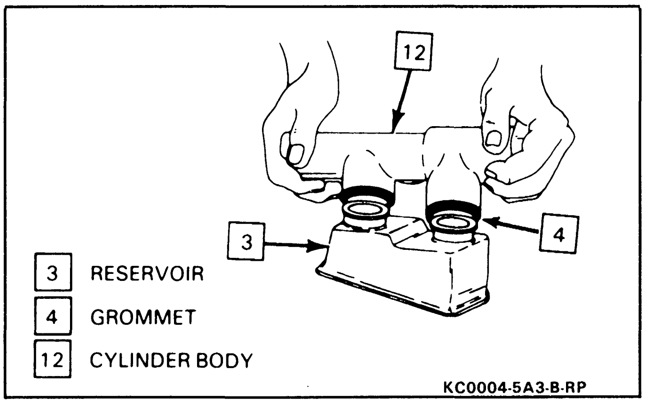


Figure 4 - Installing Reservoir

SECTION 5B1

FRONT DISC BRAKE CALIPER ASSEMBLY

3000/3100 SERIES

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 5B1-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

This caliper has a single bore and is mounted to the support bracket with two mounting bolts. Hydraulic pressure, created by applying the brake pedal, is converted by the caliper to a stopping force. This force acts equally against the piston and the bottom of the caliper bore to move the piston outward and to move (slide) the caliper inward resulting in clamping action on the rotor. This clamping action forces the linings against the rotor, creating friction to stop the vehicle.

CAUTION: When servicing brake parts, do not create dust by grinding, sanding brake linings, or by cleaning brake parts with a dry brush or with compressed air. Many brake parts contain asbestos fibers which can become airborne if dust is created during servicing. Breathing dust containing asbestos fibers may cause serious bodily harm. A water dampened cloth or water based solution should be used to remove any dust on brake parts. Equipment is commercially available to perform this washing function. These wet methods will prevent asbestos fibers from becoming airborne.

Important

- Replace all components included in repair kits used to service this master cylinder.
- Lubricate rubber parts with clean brake fluid to ease assembly.
- Do not use lubricated shop air on brake parts as damage to rubber components may result.
- If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.
- Replace shoe and linings in axle sets only.
- The torque values specified are for dry, unlubricated fasteners.
- Perform service operations on a clean bench free from all mineral oil materials.

ON-VEHICLE SERVICE

CALIPER ASSEMBLY

Figures 1 through 6

Remove or Disconnect

1. Two-thirds of the brake fluid from the master cylinder.

- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).
- Mark the relationship of the wheel to the hub.

2. Wheel and tire. Refer to TIRES AND WHEELS (SEC. 3E).
    - Reinstall two wheel nuts to retain the rotor (17).

- Bottom piston (10) into the caliper bore using a C-clamp (Figure 2).
    - Position the C-clamp over the outboard shoe and lining (5) and the caliper housing (13).

Important

- If removing caliper assembly brake only to access other brake parts, skip step 3.
- If brake hose (16) is disconnected, caliper must be bled during installation.

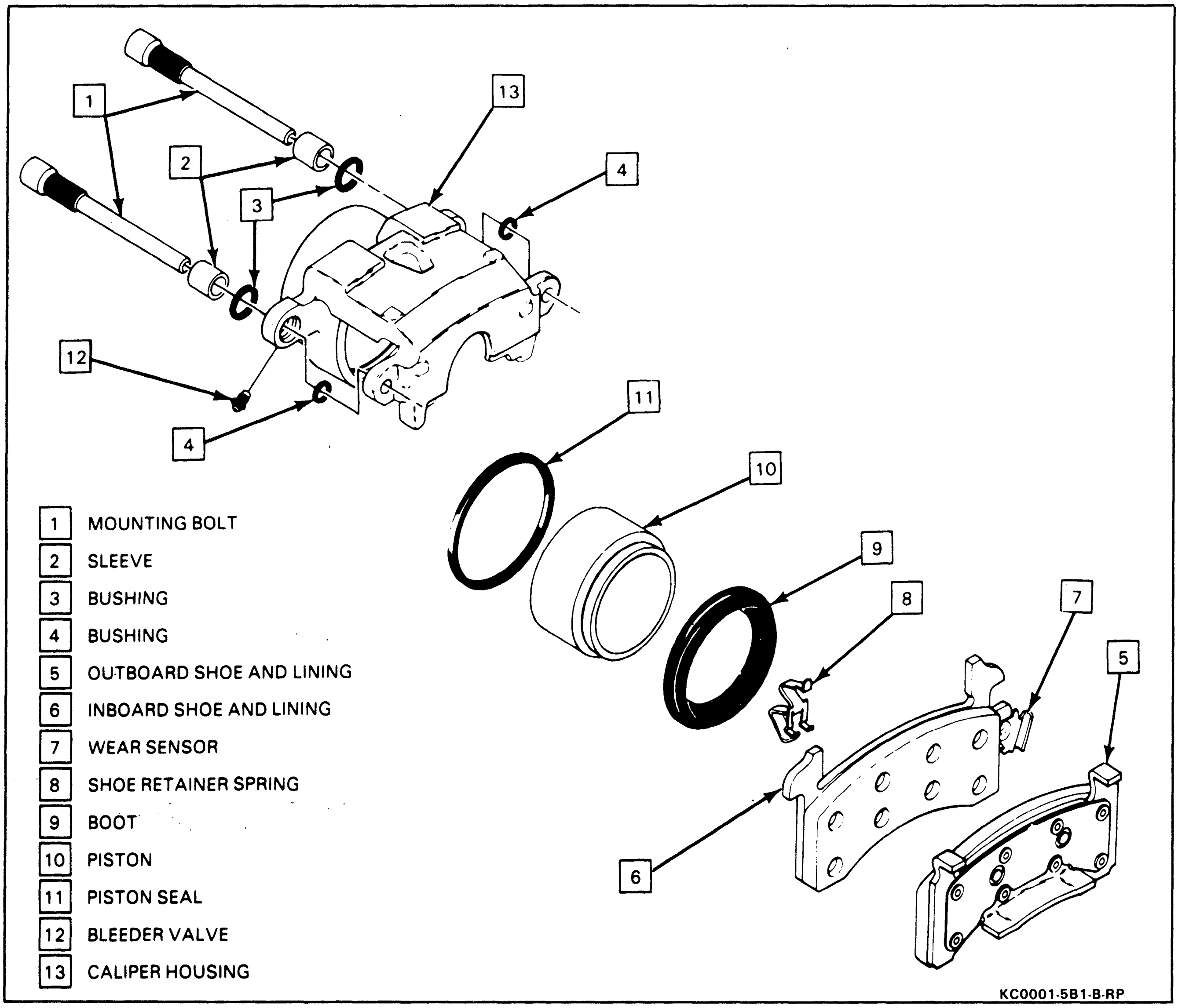


Figure 1 - Front Caliper Assembly Components

3. Bolt (14), copper washers, and inlet fitting (15) from the caliper housing (13), if removing the caliper assembly entirely from the vehicle.
   - Plug the openings in the inlet fitting (15) and caliper housing (13) to prevent fluid loss and contamination.
4. Mounting bolts (1) and the sleeves (2).
5. Caliper assembly from the rotor (17) and bracket (18).
   - If the caliper assembly is not being removed from the vehicle for unit repair, suspend it from the front suspension using a locally fabricated wire hook (Figure 4).

Inspect

- Mounting bolts (1) and the sleeves (2) for corrosion.
  - If corrosion is found, use new parts, including bushings (3 and 4) when installing caliper.
  - Do not attempt to polish away corrosion.
- Bolt (14).
  - If through hole in bolt (14) is blocked, remove blockage or replace bolt (14).

Install or Connect

NOTICE: See "Notice" on page 5B1-1 of this section for steps 3 and 4.

- Lubricate sleeves (2) and bushings (3 and 4) with silicone grease.

1. Sleeves (2) into the caliper housing (13).
2. Caliper assembly onto rotor (17) and bracket (18).
3. Mounting bolts (1).

Tighten

- Bolts to 50 N·m (37 lb. ft.).

Measure

- Clearance between the caliper housing (13) and the stops on the bracket (18) (Figure 5). Clearance should be 0.13 to 0.30 mm (0.005 to 0.012 inch).

- If necessary, remove the caliper assembly and file the ends of the stops on the bracket (18) to provide proper clearance.

4. Bolt (14), new copper washers, and inlet fitting (15) to the caliper housing (13), if removed.

Tighten

- Bolt (14) to 44 N·m (32 lb. ft.)

5. Wheel and tire. Refer to TIRES AND WHEELS (SEC. 3E).
   - Remove the wheel nuts securing the rotor (17).
   - Align the marks on the wheel and hub.

- Lower the vehicle.
- Fill the master cylinder to the proper level. Refer to GENERAL BRAKES (SEC. 5).
- If inlet fitting (15) was removed, bleed the caliper. Refer to GENERAL BRAKES (SEC. 5).

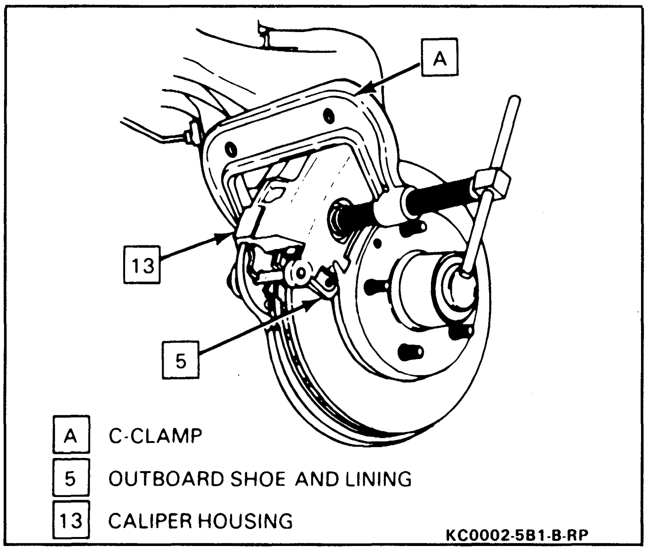


Figure 2 - Compressing Caliper Piston

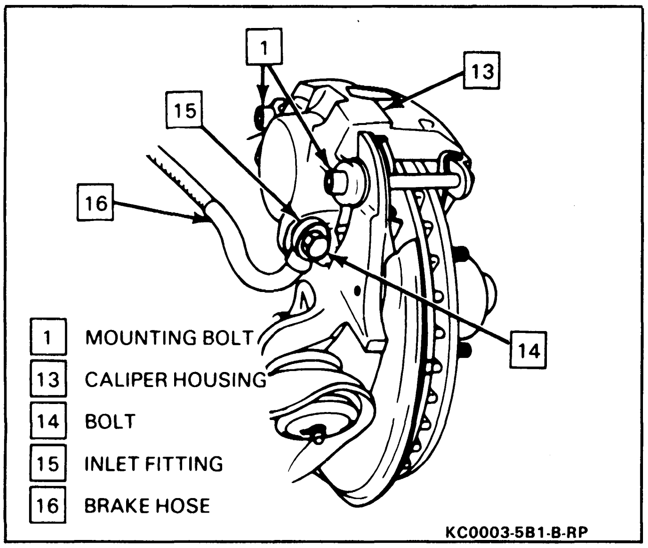


Figure 3 - Caliper Attachment

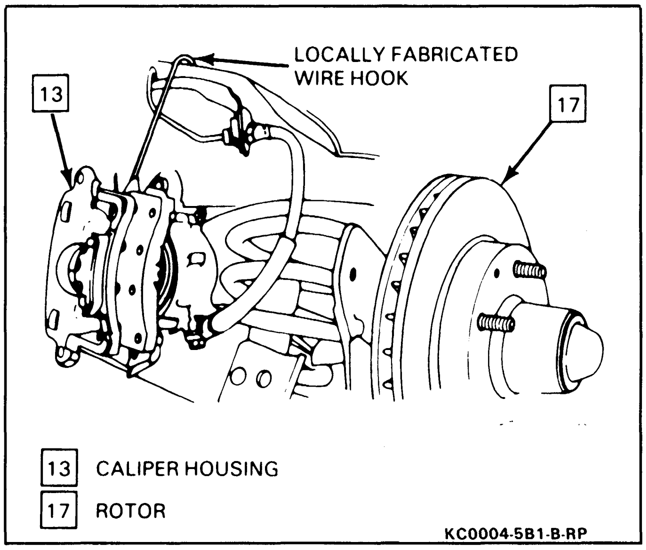


Figure 4 - Suspending Caliper

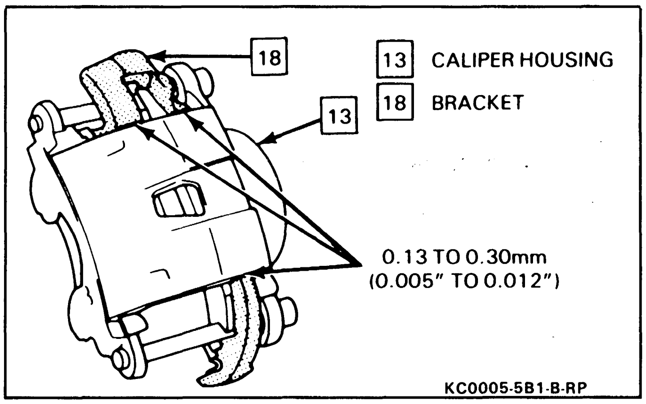


Figure 5 - Caliper Housing to Bracket Clearance

SHOE AND LINING ASSEMBLIES

Figures 1 and 6 through 10

Remove or Disconnect

1. Caliper assembly. Refer to "Caliper Assembly" in this section.
2. Outboard shoe and lining (5).
3. Inboard shoe and lining (6).
4. Bushings (3 and 4) from the grooves in the caliper housing (13).
5. Shoe retainer spring (8) from the inboard shoe and lining (6).

Install or Connect

NOTICE: See "Notice" on page 5B1-1 of this section.

- Lubricate new bushings (3 and 4) and sleeves (2) with silicone grease.

1. Bushings (3 and 4) into the grooves in the caliper housing (13).
2. Shoe retainer spring (8) on the inboard shoe and lining (6).
3. Inboard shoe and lining (6).
   - Snap the shoe retainer spring (8) into the piston (10).

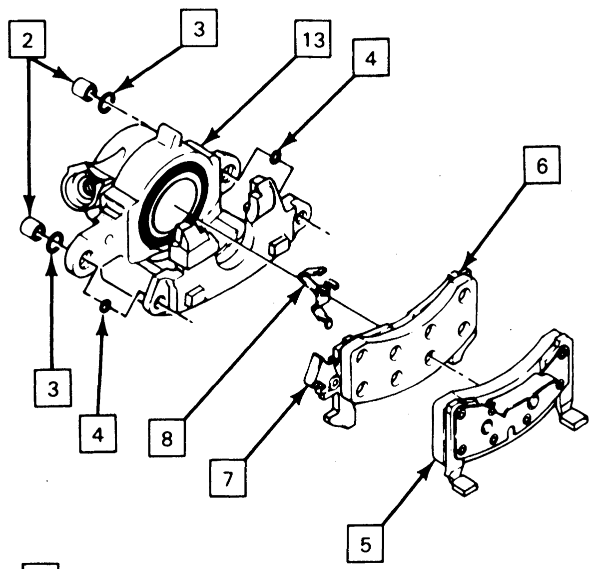


Figure 6 — Shoe and Lining Replacement

- The wear sensor (7) should be at the leading edge of the inboard shoe and lining (6) during forward wheel rotation.
- The inboard shoe and lining (6) must lay flat against the piston (10).

4. Outboard shoe and lining (5).
   - The back of the outboard shoe and lining (5) must lay flat against the caliper housing (13).
5. Caliper assembly. Refer to "Caliper Assembly" in this section.

- Apply approximately 778 N (175 lb.) of force to the brake pedal three times to seat the linings.
- Position a pair of channel lock pliers over the outboard brake shoe ears and the bottom edge of the caliper housing (13) (Figure 10). While a helper holds a moderate force on the brake pedal, clinch the outboard brake shoe ears to the caliper housing (13).

UNIT REPAIR

CALIPER OVERHAUL

Figures 11 through 15

Tool Required:
J 26267 Boot Seal Installer

Disassemble

- Remove the caliper assembly completely from the vehicle. Refer to "Caliper Assembly" in this section.

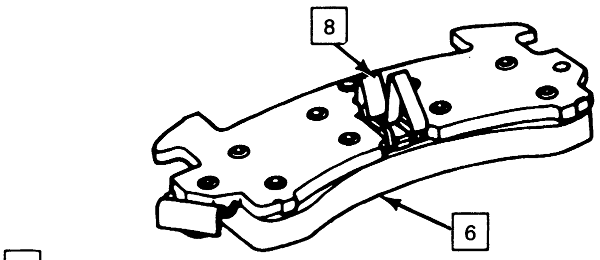


Figure 7 - Inboard Shoe Retainer Spring Location

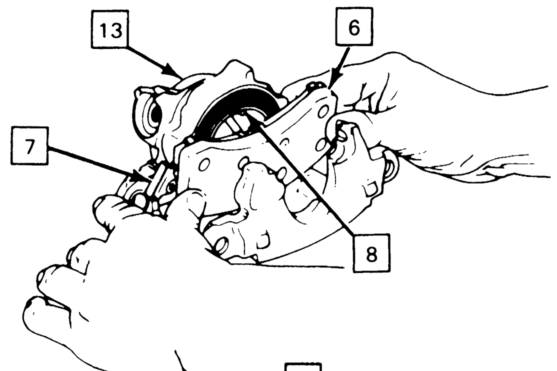


Figure 8 - Installing Inboard Shoe and Lining

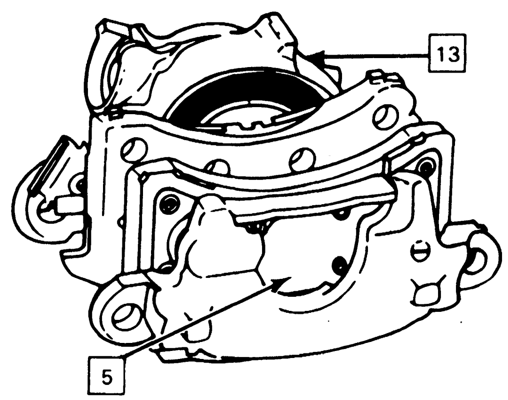


Figure 9 - Installing Outboard Shoe and Lining

CAUTION: Do not place fingers in front of the piston in an attempt to catch or protect it when applying compressed air. This could result in serious injury.

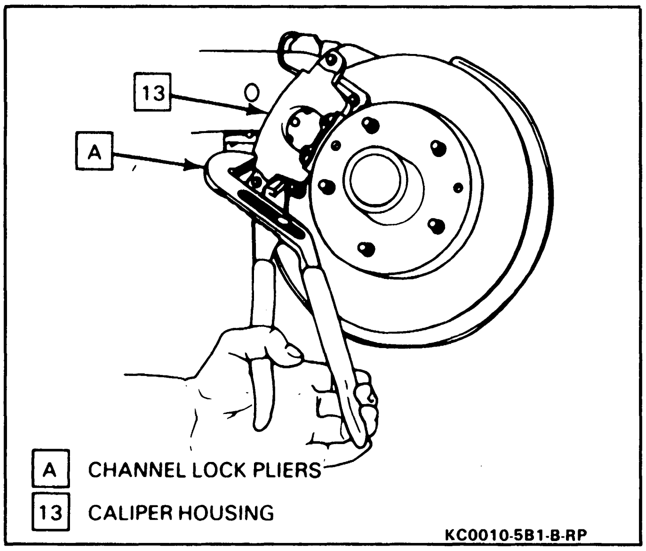


Figure 10 - Clinching Procedure

NOTICE: Use clean shop towels to pad the interior of the caliper housing during piston removal.

1. Piston (10) from the caliper housing (13).
   - Apply compressed air to the caliper housing inlet hole (Figure 11).
2. Boot (9) from the caliper housing (13).

NOTICE: Do not use a metal tool to remove the piston seal from the caliper housing bore. Using a metal tool may damage the caliper bore or seal groove.

3. Piston seal (11) from the caliper housing (13).
   - Use a small wood or plastic tool.
4. Bleeder valve (12) from the caliper housing (13).

Clean

- All parts in clean, denatured alcohol.
- Dry with unlubricated compressed air.
- Blow out all passages in caliper housing (13) and bleeder valve (12).

Inspect

- Piston (10) for scoring, nicks, corrosion, and worn or damaged chrome plating.
  - Replace piston if any of the above are found.
- Caliper bore and seal groove for scoring, nicks, corrosion, and wear.
  - Use crocus cloth to polish out light corrosion.
  - Replace caliper housing if corrosion in and around seal groove will not clean up with crocus cloth.

Assemble

NOTICE: See "Notice" on page 5B1-1 of this section.

- Lubricate all rubber parts with clean brake fluid.

1. Bleeder valve (12) into the caliper housing (13).

Tighten

- Bleeder valve (12) to 13 N·m (115 lb. in.).

2. Piston seal (11) into the bore groove of the caliper housing (13).
   - Make sure the piston seal (11) is not twisted.
3. Boot (9) onto the piston (10).
4. Piston (10) with assembled boot (9) into the bore of the caliper housing (13).
   - Push the piston (10) to the bottom of the caliper housing bore.

- Seat boot (9) into the counterbore of the caliper housing (13) using J 26267 (Figure 15).
- Install caliper assembly. Refer to "Caliper Assembly" in this section.

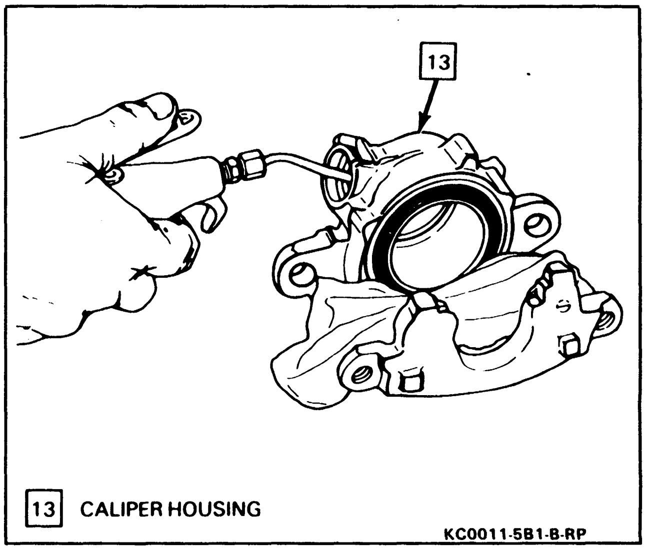


Figure 11 - Removing Caliper Piston

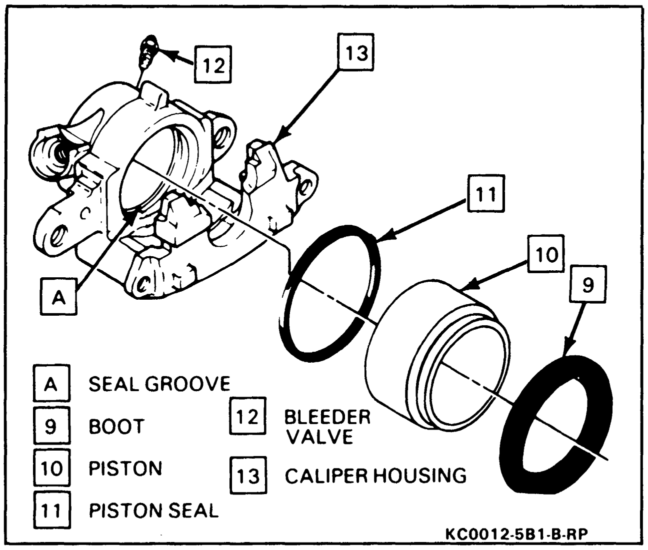


Figure 12 - Caliper Disassembly

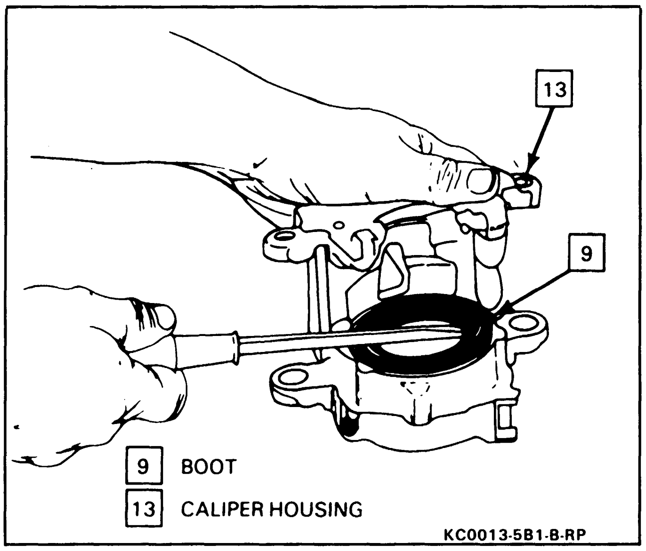


Figure 13 - Removing Boot

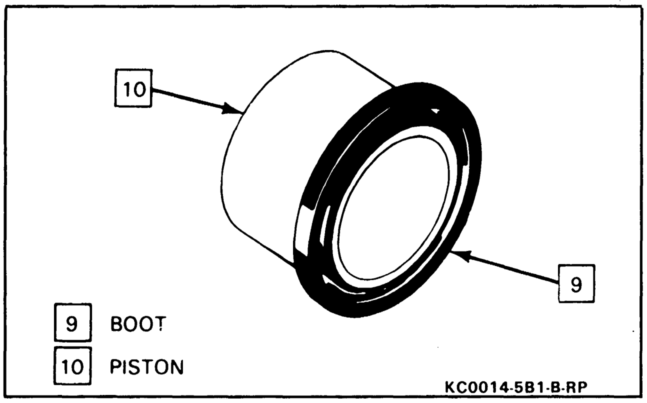


Figure 14 - Installing Boot Onto Piston

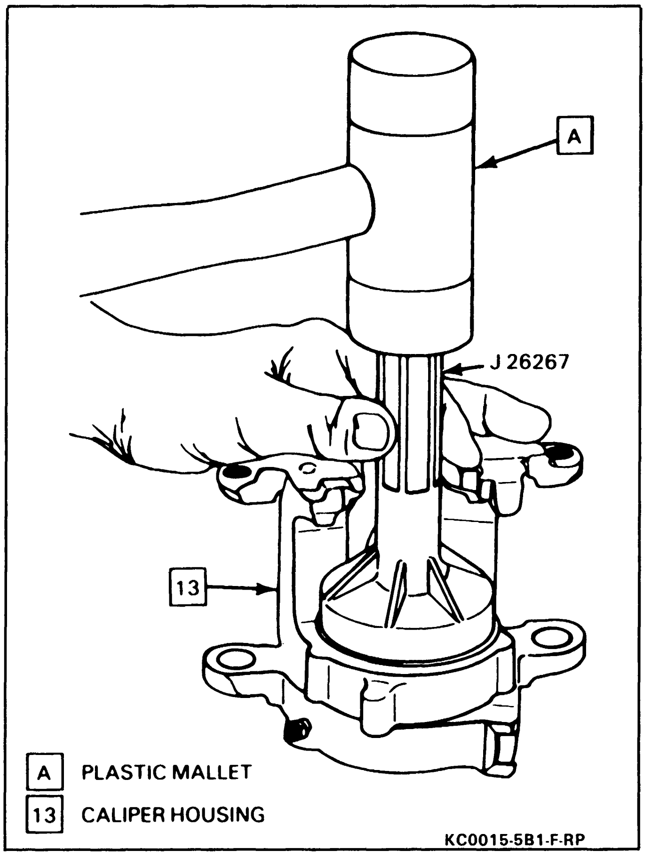


Figure 15 - Seating Boot Into Caliper Housing

SECTION 5B2

FRONT PAD-GUIDED DISC BRAKE CALIPER ASSEMBLY

CAUTION: When servicing brake parts, do not create dust by grinding, sanding brake linings, or by cleaning brake parts with a dry brush or compressed air. Many brake parts contain asbestos fibers which can become airborne if dust is created during servicing. Breathing dust containing asbestos fibers may cause serious bodily harm. A water dampened cloth or water based solution should be used to remove any dust on brake parts. Equipment is commercially available to perform this washing function. These wet methods will prevent asbestos fibers from becoming airborne.

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 5B2-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

This caliper has dual pistons in an aluminum housing which is suspended on the shoe and lining assemblies. Hydraulic pressure, created by applying force to the brake pedal, acts equally against the pistons and the bottom of the caliper piston bores to move the pistons outward and to slide the caliper inward, resulting in a clamping action on the rotor. This clamping action forces the linings against the rotor, creating friction to stop the vehicle.

NOTICE: Do not use lubricated compressed air on brake parts as damage to rubber components may result.

Important

- Replace all components included in repair kits used to service this caliper.
- Lubricate rubber parts with clean brake fluid to make assembly easier.
- If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.
- Replace shoe and lining assemblies in axle sets only.
- The torque values specified are for dry, unlubricated fasteners.
- Perform service operations on a clean bench, free from all mineral oil materials.

ON-VEHICLE SERVICE

CALIPER ASSEMBLY

Figures 1 through 7

Remove or Disconnect

1. Two-thirds of the brake fluid from the master cylinder.
- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).
- Mark the relationship of the wheel to the hub.
2. Wheel and tire. Refer to TIRES AND WHEELS (SEC. 3E).
3. Bolt (13), two gaskets (14) and inlet fitting (15) only if caliper housing (3) is being removed from the vehicle for overhaul.
    - Plug openings in caliper housing (3) and inlet fitting (15) to prevent fluid loss and contamination.
    - Discard the two gaskets (14).
4. Circlip (11) and retainer pin (7).
5. Caliper housing (3) from rotor (16) and mounting bracket (10).

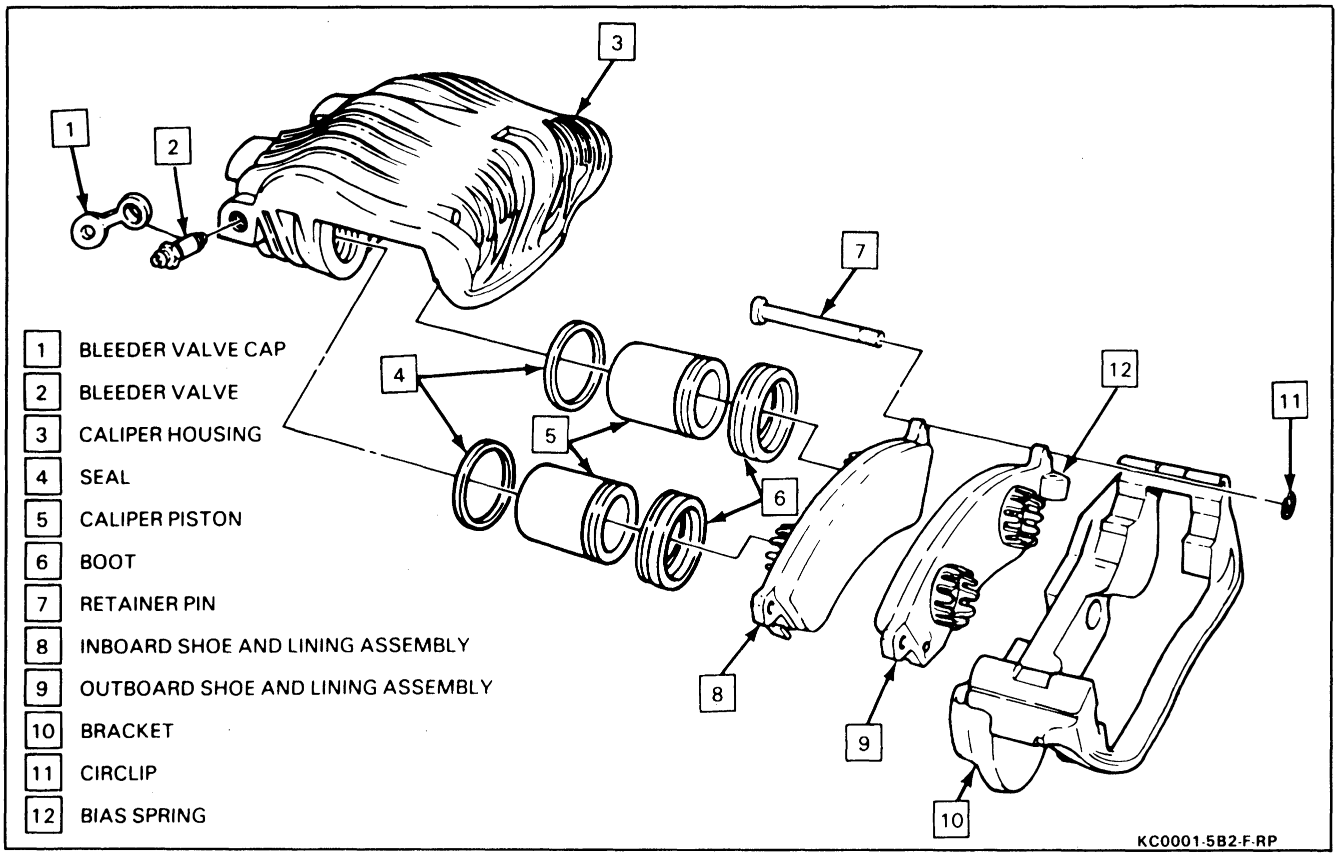


Figure 1 - Front Caliper Assembly Components

- If only the inboard and outboard shoe and lining assemblies (8 and 9) are being replaced, suspend the caliper from the front suspension to avoid damaging the brake hose.

Inspect

- Bolt (13).
  - If through hole in bolt (13) is blocked, remove blockage or replace bolt (13).

Install or Connect

NOTICE: See "Notice" on page 5B2-1 of this section.

1. Caliper housing (3) over rotor (16) and onto mounting bracket (10).
   - Make sure that guiding surfaces on the inboard and outboard shoe and lining assemblies (8 and 9) and mounting bracket (10) are seated correctly.
2. New retainer pin (7) and new circlip (11).
   - Press caliper housing (3) down to compress bias springs (12).
   - Slide retainer pin (7) into position and install circlip (11).
3. Inlet fitting (15), two new gaskets (14) and bolt (13), if removed.

   Tighten

   - Bolt (13) to 40 N·m (30 lb. ft.).

- If inlet fitting (15) was removed, bleed brakes. Refer to GENERAL BRAKES (SEC. 5).

4. Wheel and tire. Refer to TIRES AND WHEELS (SEC. 3E).
   - Align previous marks on wheel and hub.

- Lower the vehicle.
- With engine running, pump brake pedal slowly and firmly three times to seat linings.

Inspect

- Brake system for fluid leaks.

SHOE AND LINING ASSEMBLIES

Figures 1 through 7

Remove or Disconnect

1. Caliper. Refer to "Caliper Assembly" in this section.

- Bottom caliper pistons (5), using C-clamp or pliers.
  - Position C-clamp or pliers over caliper housing (3) and center of inboard shoe and lining assembly (8).
  - Squeeze pliers or tighten C-clamp to compress caliper pistons (5) into bores.

2. Inboard and outboard shoe and lining assemblies (8 and 9).

Clean

- All residue from the mounting bracket and caliper shoe contact surfaces.

Install or Connect

Important

- Outboard shoe and lining assembly (9) with insulator is installed in the caliper housing (3). The inboard shoe and lining assembly (8) with wear sensor is pressed into the caliper pistons (5).
- Replace the inboard and outboard shoe and lining assemblies (8 and 9) in sets of four.

1. Inboard and outboard shoe and lining assemblies (8 and 9).
   - Push in firmly until flush and fully seated in caliper housing (3).
   - Make sure that the lining surfaces remain free of grease and oil.
2. Caliper. Refer to "Caliper Assembly" in this section.

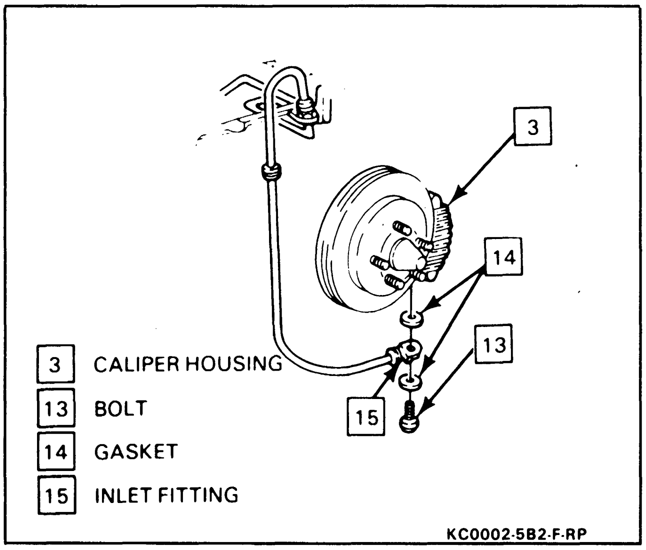


Figure 2 - Removing Inlet Fitting (Typical)

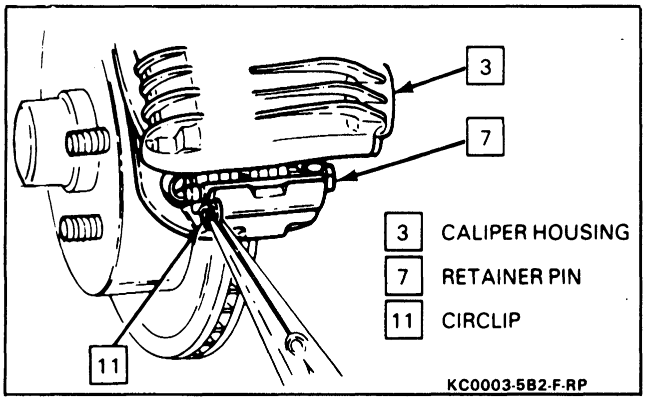


Figure 3 - Removing Circlip

CALIPER MOUNTING BRACKET

Figure 8

Remove or Disconnect

1. Caliper. Refer to "Caliper Assembly" in this section.

Important

- Remove mounting bracket (10) only if it is damaged or if rotor (16) is being removed for refinishing or other service operations.

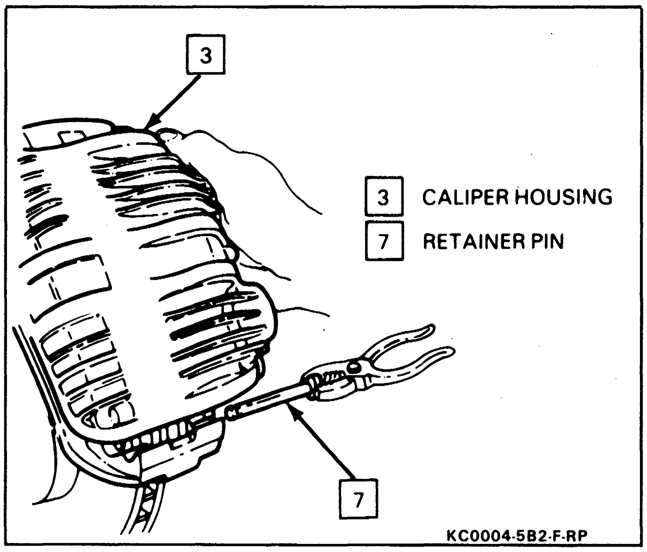


Figure 4 - Removing Retainer Pin

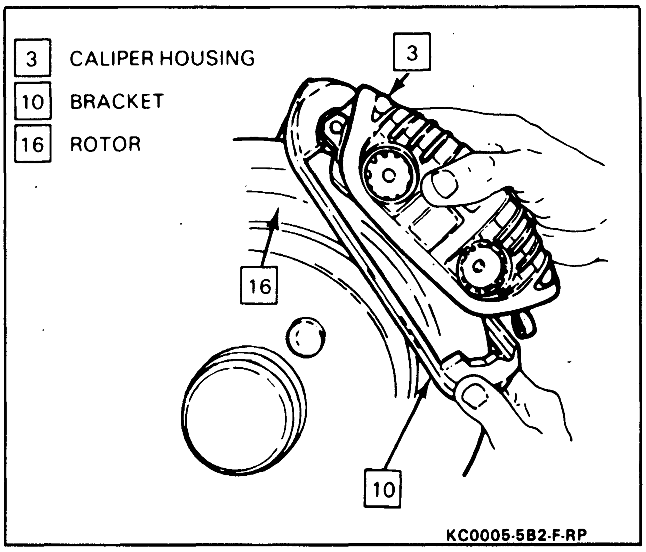


Figure 5 - Removing Caliper

2. Two bracket mounting bolts (18) and washers (19), if equipped.
3. Mounting bracket (10) from knuckle (20). (If equipped with high performance brakes RPO 1LE, mounting bracket (10) from mounting bracket adapter (17).)

Clean

- All bolt adhesive residue from mounting bracket and knuckle mating surfaces.

Install or Connect

1. Mounting bracket (10) to knuckle (20). (If equipped with high performance brakes RPO 1LE, mounting bracket (10) to mounting bracket adapter (17).)

   NOTICE: See "Notice" on page 5B2-1 of this section.
2. Two bracket mounting bolts (18) and washers (19), if equipped.

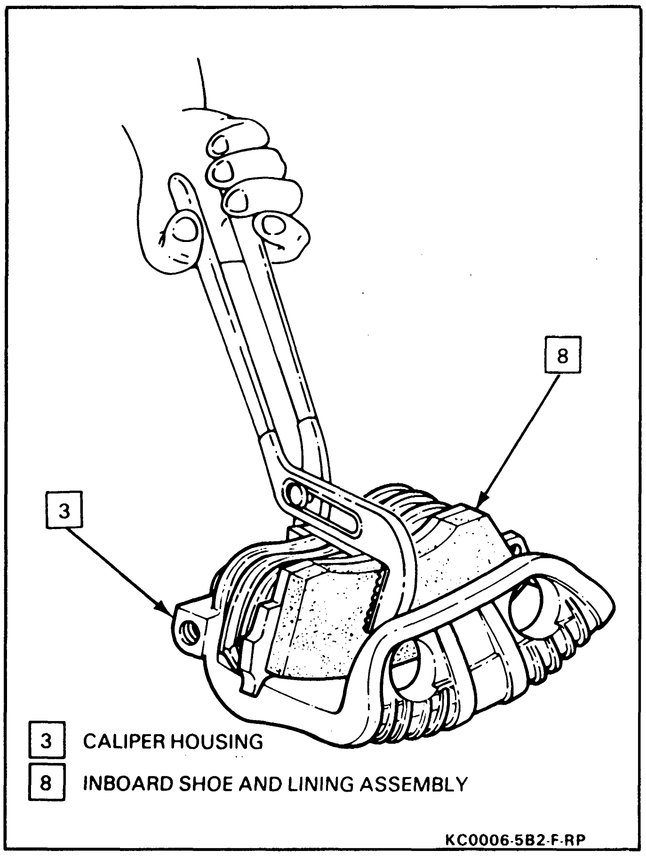


Figure 6 - Compressing Caliper Pistons

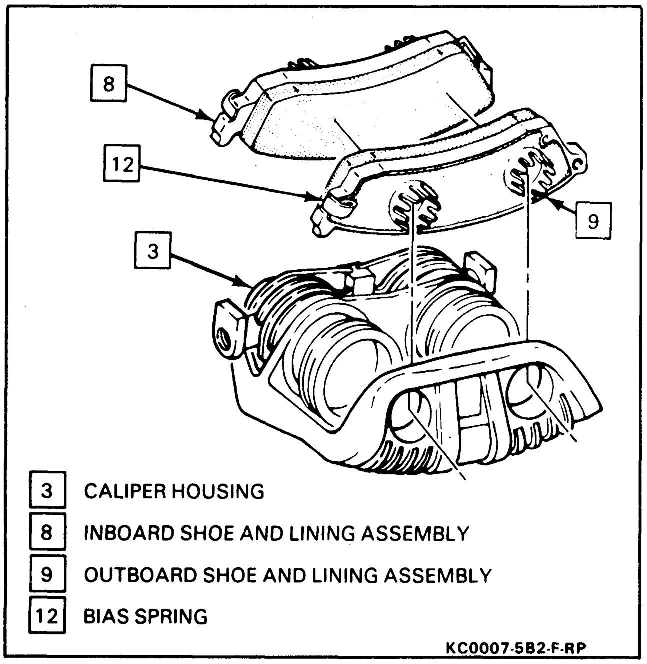


Figure 7 - Shoe and Lining Assemblies

- Coat threads of mounting bolts (18) with thread adhesive.

Tighten

- Two bracket mounting bolts (18) to 185 N·m (137 lb. ft.).
- Recheck torque on both bolts (18) immediately.
- Allow adhesive on bracket bolts (18) to cure for two hours before moving vehicle.

3. Caliper. Refer to "Caliper Assembly" in this section.

UNIT REPAIR

CALIPER OVERHAUL

Figures 1, 9 and 10

Disassemble

- Remove shoe and lining assemblies. Refer to "Shoe and Lining Assemblies" in this section.

CAUTION: Do not place fingers in front of the pistons in an attempt to catch or protect them when applying compressed air. This could result in serious injury.

NOTICE: To prevent damage, be careful when handling piston.

1. Caliper pistons (5) by directing compressed air into the brake hose port of the caliper housing (3).

Important

- Use clean shop towels to pad the interior of the caliper housing (3) during piston removal.
- Be careful not to damage port or washer sealing face on the caliper housing (3).
- If caliper pistons (5) do not come out at the same time, remove piston boot (6) from the empty cylinder and install the extracted caliper piston (5) into the caliper bore far enough to seal. Install a spacer to hold extracted caliper piston (5) in position. Use compressed air to remove the other caliper piston (5) as described above.

2. Piston boots (6).

NOTICE: Do not use a metal tool to remove piston seals. Metal tools may damage caliper bores or seal grooves.

3. Piston seals (4).
   - Use a small wood or plastic tool.
4. Bleeder valve cap (1) and bleeder valve (2).

Inspect

1. Caliper pistons (5) for scoring, nicks, corrosion and wear. Replace caliper pistons (5) if any of the above are found.
2. Caliper bores and seal grooves for scoring and corrosion. If badly scored or corroded around the seal area, replace the caliper housing (3).
3. Mounting bracket guide surfaces for corrosion and wear. Remove and replace, if necessary. Refer to "Caliper Mounting Bracket" in this section.

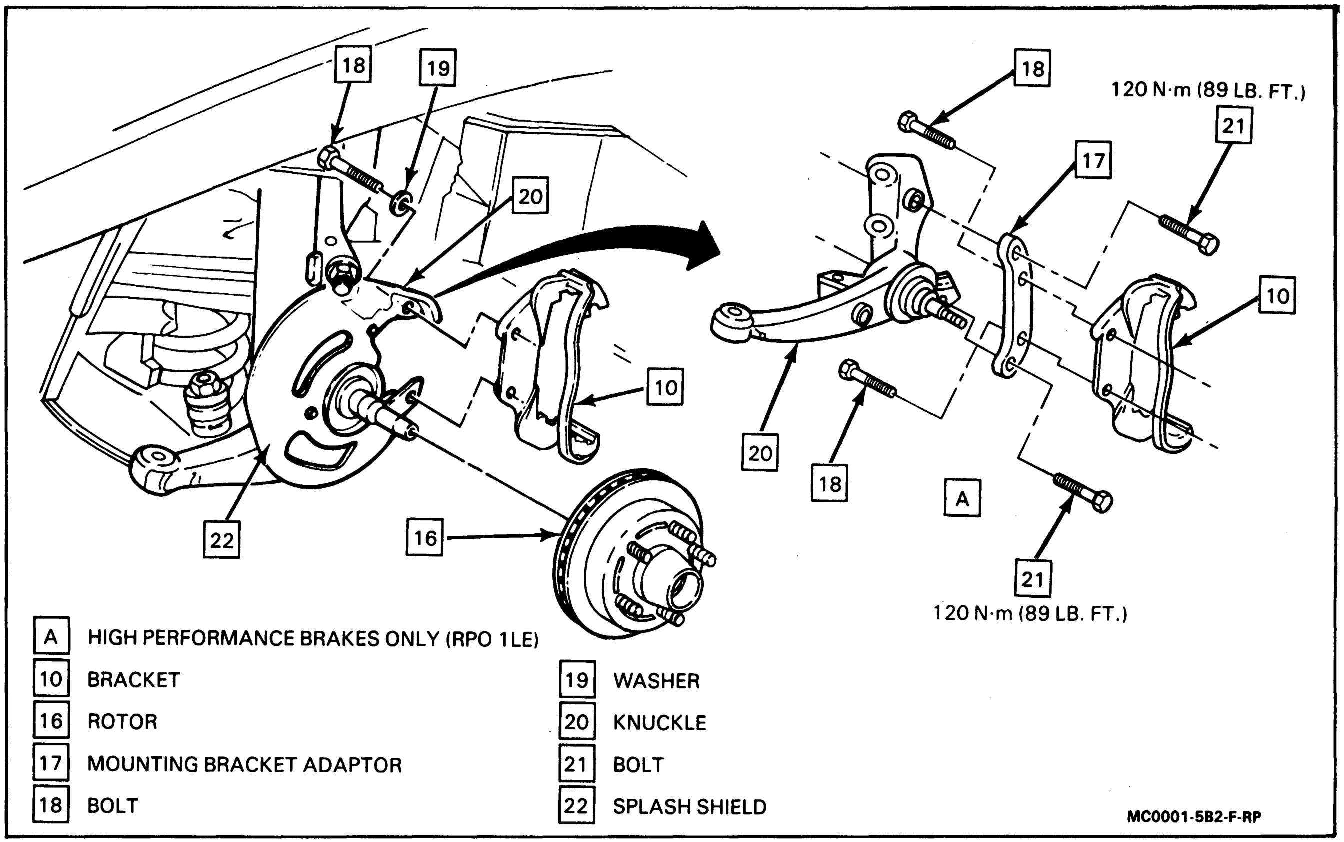


Figure 8 - Caliper Mounting Bracket

Clean

- Residue from mounting bracket shoe contact surfaces.
- All parts not included in the repair kit with denatured alcohol.
- Dry with filtered, unlubricated compressed air.
- Blow out all passages in caliper housing (3) and bleeder valve (2).

Assemble

NOTICE: See "Notice" on page 5B2-1 of this section.

1. Bleeder valve cap (1) and bleeder valve (2).

   #### Tighten

   - Bleeder valve (2) to 9 N·m (80 lb. in.).

- Lubricate new piston seals (4) and caliper bore seal grooves with silicone grease or brake fluid.

2. New seals (4) into caliper bore seal grooves.
   - Make sure seals (4) are not twisted.

- Lubricate caliper bores and caliper pistons (5) with brake fluid.

3. Boot (6) and caliper piston (5).
   - Install the boot (6) over the end of the caliper piston (5) so that the fold will face outboard as shown in Figure 10.
   - Seat boot (6) into caliper bore groove and slide caliper piston (5) into caliper bore.
   - Push down caliper piston (5), by hand, to the bottom of the caliper bore.
   - Make sure that boot (6) is properly seated into the piston groove and into groove in caliper bore.
   - Repeat step 3 for the remaining caliper piston (5).

4. Shoe and lining assemblies. Refer to "Shoe and Lining Assemblies" in this section.

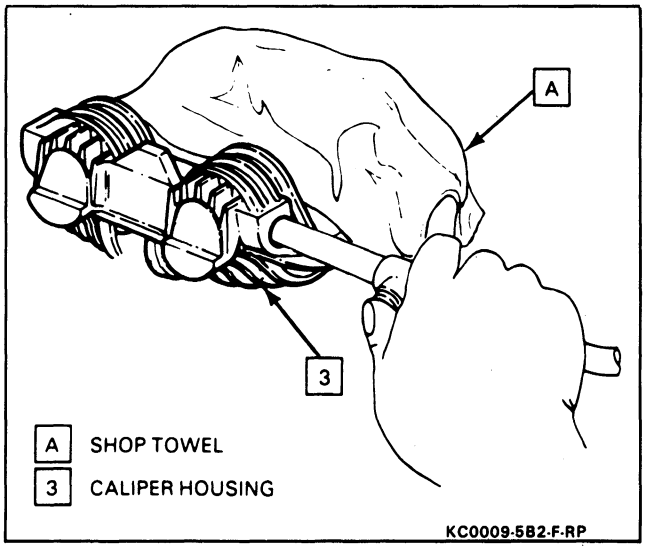


Figure 9 - Removing Caliper Pistons

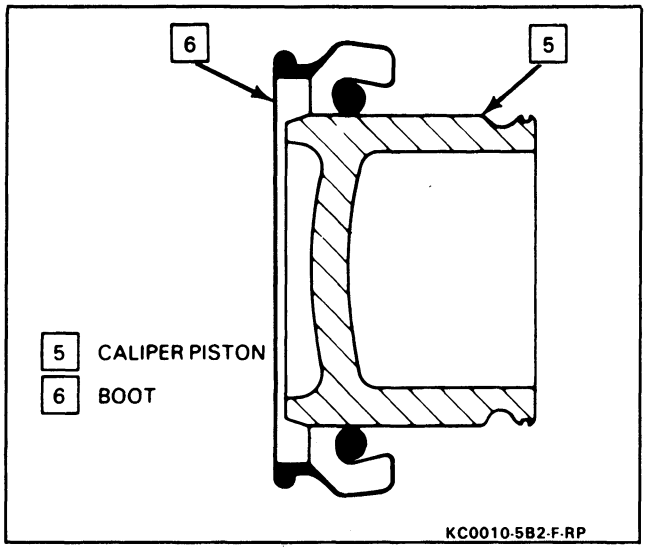


Figure 10 - Installing Piston Boot

SECTION 5B3

REAR DISC BRAKE CALIPER ASSEMBLY

CAUTION: When servicing brake parts, do not create dust by grinding, sanding brake linings, or by cleaning brake parts with a dry brush or compressed air. Many brake parts contain asbestos fibers which can become airborne if dust is created during servicing. Breathing dust containing asbestos fibers may cause serious bodily harm. A water dampened cloth or water based solution should be used to remove any dust on brake parts. Equipment is commercially available to perform this washing function. These wet methods will prevent asbestos fibers from becoming airborne.

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 5B3-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

This caliper has a single piston in an aluminum housing which is suspended in the mounting bracket on two guide pins. Hydraulic pressure, created by applying force to the brake pedal, acts equally against the piston and the bottom of the caliper bore to move the piston outward and to slide the caliper inward resulting in a clamping action on the rotor. This clamping action forces the linings against the rotor creating friction to stop the vehicle. When the parking brake is applied, the lever on the caliper causes the pushrod, actuating collar and clamp rod assembly to be moved outward and the caliper to slide inward, mechanically forcing the linings against the rotor. Parking brake application is completely independent of the hydraulic braking system.

NOTICE: Do not use lubricated compressed air on brake parts as damage to rubber components may result.

Important

- Replace all components included in repair kits used to service this caliper.
- Lubricate rubber parts with clean brake fluid to make assembly easier.
- If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.
- Replace shoe and linings in axle sets only.
- The torque values specified are for dry, unlubricated fasteners.
- Perform service operations on a clean bench, free from all mineral oil materials.

ON-VEHICLE SERVICE

SHOE AND LINING ASSEMBLIES

Figures 1 through 5

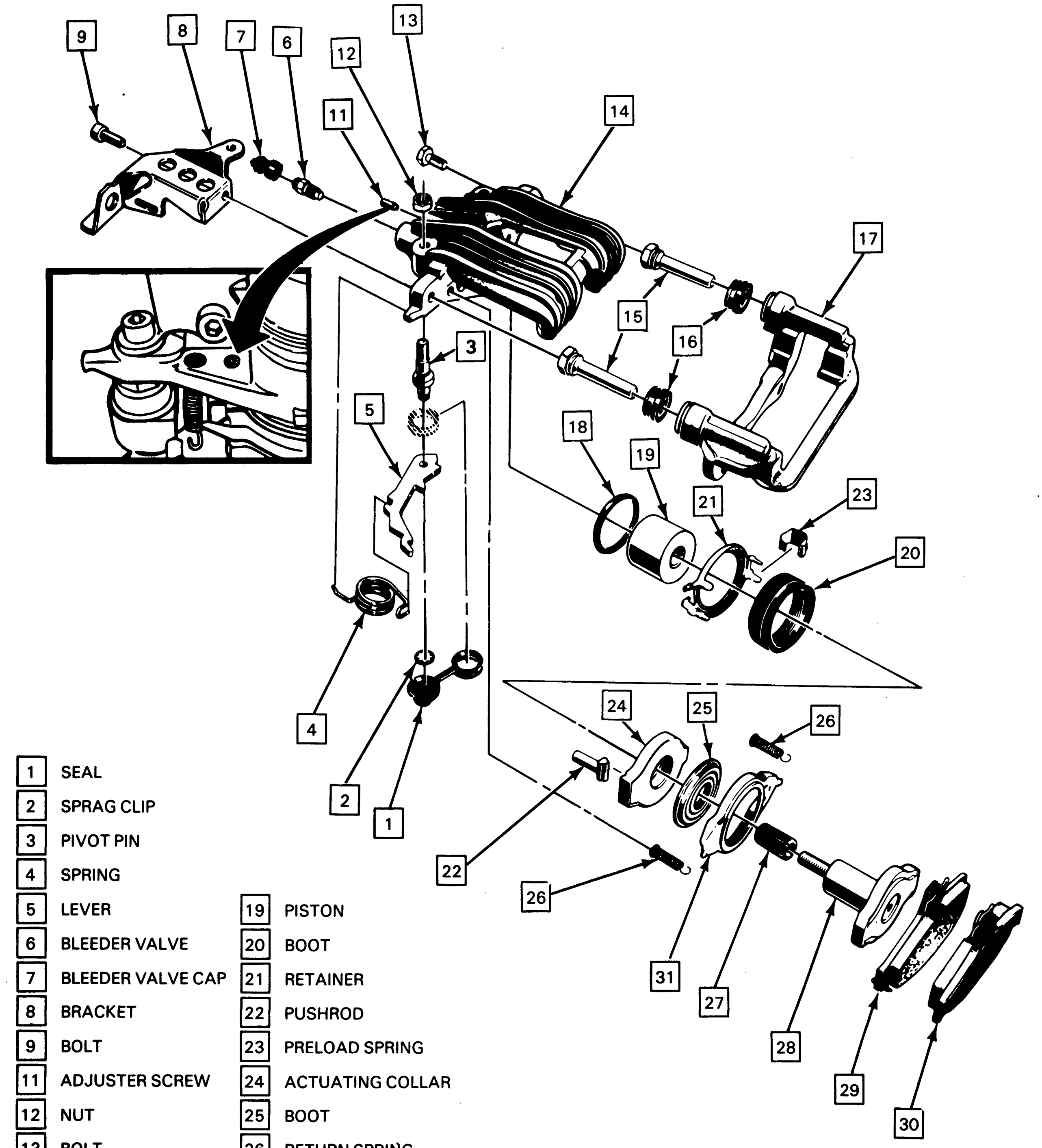
Remove or Disconnect

1. Two-thirds of the brake fluid from the master cylinder reservoir.

- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).
- Mark relationship of wheel to axle flange.

2. Wheel and tire. Refer to TIRES AND WHEELS (SEC. 3E).
   - Install two wheel nuts to retain rotor (39).

- Position a C-clamp and tighten until piston (19) bottoms in base of caliper housing (14) (Figure 2).
  - Make sure one end of C-clamp rests on inlet fitting bolt (32) and the other end against the outboard shoe and lining assembly (30).



1	SEAL
2	SPRAG CLIP
3	PIVOT PIN
4	SPRING
5	LEVER
6	BLEEDER VALVE
7	BLEEDER VALVE CAP
8	BRACKET
9	BOLT
11	ADJUSTER SCREW
12	NUT
13	BOLT
14	CALIPER HOUSING
15	GUIDE PIN
16	BOOT
17	BRACKET
18	SEAL
19	PISTON
20	BOOT
21	RETAINER
22	PUSHROD
23	PRELOAD SPRING
24	ACTUATING COLLAR
25	BOOT
26	RETURN SPRING
27	BUSHING
28	CLAMP ROD
29	INBOARD SHOE AND LINING ASSEMBLY
30	OUTBOARD SHOE AND LINING ASSEMBLY
31	RETAINER

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Figure 1 - Rear Disc Brake Caliper Assembly Components

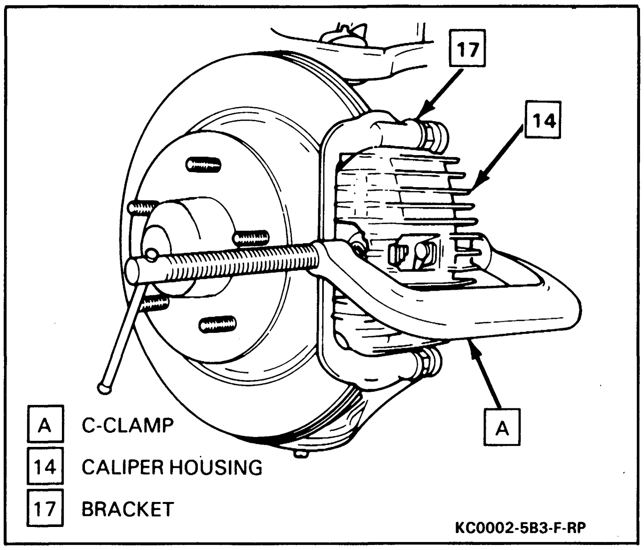


Figure 2 - Compressing Piston

Important

- It is not necessary to remove the parking brake caliper lever return spring (4) to replace the shoe and lining assemblies (29 and 30).

3. Upper caliper guide pin bolt (13).
    - Discard bolt (13).
4. Shoe and lining assemblies (29 and 30).
    - Rotate the caliper housing about the lower caliper mounting bolt (9) and guide pin (15). Be careful not to strain hose or cable conduit.
    - Lift out inboard and outboard shoe and lining assemblies (29 and 30).

Clean

- All residue from shoe guide surfaces on mounting bracket (17) and caliper housing (14).

Inspect

- Guide pins (15) for free movement in mounting bracket (17).
    - Replace guide pins (15) or boots (16) if corroded or damaged. See "Caliper Assembly" in this section.

Install or Connect

1. New shoe and lining assemblies (29 and 30) on mounting bracket (17).
    - Outboard shoe and lining assembly (30) with insulator (40) is installed toward the caliper housing (14), the inboard shoe and lining assembly (29) with the wear sensor (41) is installed nearest the caliper piston (19).
    - Wear sensor (41) must be in the trailing position with forward wheel rotation. If not, use the other inboard shoe and lining assembly (29) in the replacement kit.
    - Replace shoe and lining assemblies (29 and 30) in sets of four.

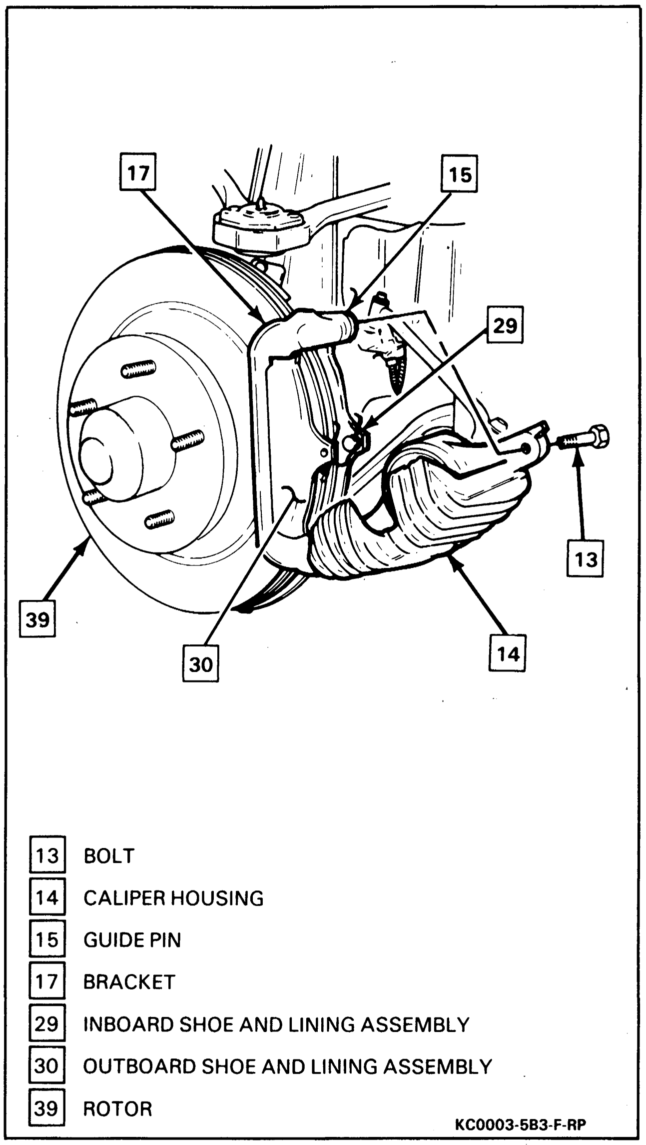


Figure 3 - Shoe and Lining Replacement

- Rotate the caliper housing (14) into its operating position.
    - Springs on the outboard shoe and lining assemblies (30) must not stick through the inspection hole in the caliper housing (14). If springs are sticking through the inspection hole in the caliper housing (14), lift caliper housing (14) and make the necessary corrections to the outboard shoe and lining assembly positions.

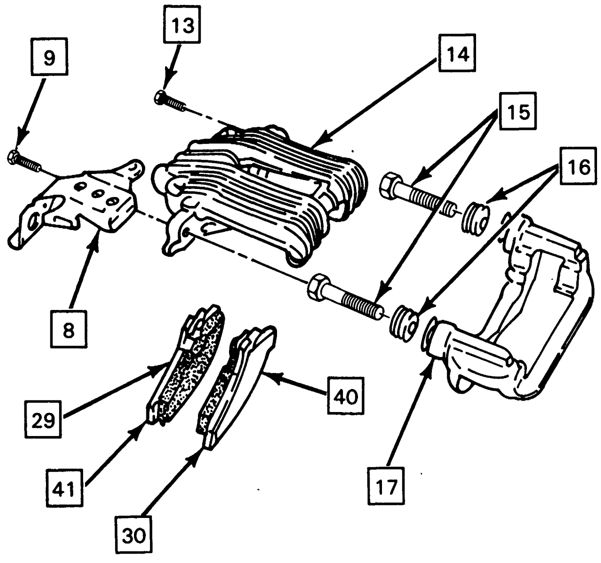
NOTICE: See "Notice" on page 5B3-1 of this section.

2. New upper caliper guide pin bolt (13).

Tighten

- Upper caliper guide pin bolt (13) to 35 N·m (26 lb. ft.).
- Lower caliper guide pin bolt (9) to 22 N·m (16 lb. ft.).

- With engine running, pump the brake pedal slowly and firmly to seat linings.



8	BRACKET
9	BOLT
13	BOLT
14	CALIPER HOUSING
15	GUIDE PIN
16	BOOT
17	BRACKET
29	INBOARD SHOE AND LINING ASSEMBLY
30	OUTBOARD SHOE AND LINING ASSEMBLY
40	INSULATOR
41	WEAR SENSOR

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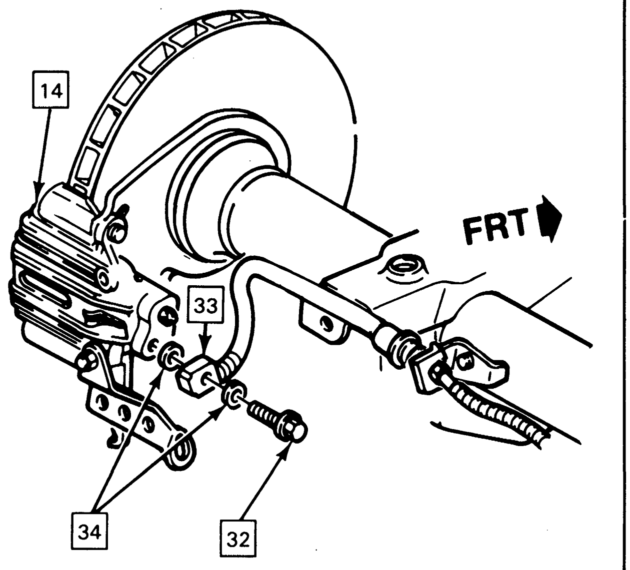
Figure 4 - Rear Caliper Assembly

Inspect

- Caliper parking brake levers (5) to make sure they are against the stops on the caliper housing (14).
  - If levers (5) are not on their stops, refer to GENERAL BRAKES (SEC. 5) for parking brake linkage repairs.

3. Wheel and tire. Refer to TIRES AND WHEELS (SEC. 3E).
   - Remove nuts securing rotor (39).
   - Align previous marks on wheel and axle flange.

- Lower vehicle.
- Fill master cylinder reservoirs. Refer to GENERAL BRAKES (SEC. 5).



14	CALIPER HOUSING
32	BOLT
33	INLET FITTING
34	GASKET

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Figure 5 - Removing Inlet Fitting

CALIPER ASSEMBLY

Figures 1 through 6

Remove or Disconnect

- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).
- Loosen parking brake cable at equalizer. Refer to GENERAL BRAKES (SEC. 5).

1. Wheel and tire. Refer to TIRES AND WHEELS (SEC. 3E).
   - Mark relationship of wheel to axle flange.
   - Install two wheel nuts to retain rotor (39).
2. Bolt (32), inlet fitting (33) and two gaskets (34) only if caliper is being removed for overhaul.
   - Discard old gaskets (34).
   - Plug hole in caliper housing (14) and inlet fitting (33).
3. Caliper lever return spring (4) only if defective.
   - Discard spring if coils are opened.
4. Parking brake cable (35) from caliper lever (5) and caliper bracket (8).
5. Two caliper guide pin bolts (9 and 13).
6. Caliper housing (14) from rotor (39) and mounting bracket (17).

- If caliper overhaul or replacement is not required, hang caliper housing (14) from suspension to avoid damage to brake hose.

7. Shoe and lining assemblies (29 and 30) only if they are being replaced or if mounting bracket (17) is being removed.

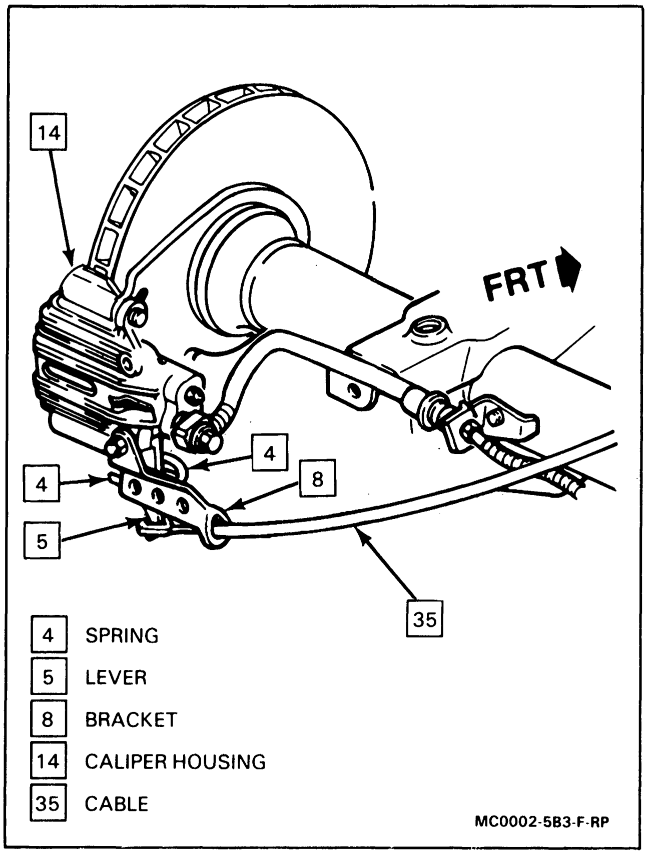


Figure 6 - Parking Brake Cable Attachment

Inspect

- Guide pins (15) for free movement in mounting bracket (17). Replace guide pins (15) or boots (16) if corroded, worn or damaged.
- Shoe and lining assemblies (29 and 30) for wear and maximum taper of 0.15 mm (0.006 inch).
  - Replace shoe and lining assemblies (29 and 30) in sets of four.
  - Replace with new shoe and lining assemblies (29 and 30) if they are tapered beyond specification.
- Bolt (32).
  - If through hole in bolt (32) is blocked, remove blockage or replace bolt (32).

Install or Connect

NOTICE: See "Notice" on page 5B3-1 of this section for steps 3 and 6.

1. Shoe and lining assemblies (29 and 30), if removed.
   - Outboard shoe and lining assembly (30) with insulator (40) is installed toward the caliper housing (14), the inboard shoe and lining assembly (29) with the wear sensor (41) is installed nearest the caliper piston (19).
   - Wear sensor (41) must be in the trailing position with forward wheel rotation. If not, use the other inboard shoe and lining assembly (29) in the replacement kit.
2. Caliper housing (14) over rotor (39) and into mounting bracket (17).
3. Two caliper guide pin bolts (9 and 13).

Tighten

- Upper caliper guide pin bolt (13) to 35 N·m (26 lb. ft.).
- Lower caliper guide pin bolt (9) to 22 N·m (16 lb. ft.).

4. Parking brake cable (35) to caliper bracket (8) and caliper lever (5).
5. Caliper lever return spring (4), if removed.
6. If removed, inlet fitting (33), two new gaskets (34) and bolt (32).

Tighten

- Bolt (32) to 30 N·m (22 lb. ft.).

- If inlet fitting was removed, bleed hydraulic brake system. Refer to GENERAL BRAKES (SEC. 5).

Adjust

- Parking brake free travel if caliper was overhauled. Refer to "Parking Brake Free-Travel Adjustment" in this section.

- Lower vehicle.
- Cycle parking brake.
- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

Inspect

- Caliper parking brake levers (5) to make sure they are against the stops on the caliper housing (14). If levers (5) are not on their stops, refer to GENERAL BRAKES (SEC. 5) for parking brake linkage repairs.

7. Wheel and tires. Refer to TIRES AND WHEELS (SEC. 3E).
   - Remove nuts securing rotor (39).
   - Align previous marks on wheel and axle flange.

- Lower the vehicle.
- With engine running, pump the brake pedal slowly and firmly three times to seat linings.
- Check brake hydraulic system for leaks.

CALIPER MOUNTING BRACKET

Figure 7

Remove or Disconnect

1. Caliper assembly. Refer to "Caliper Assembly" in this section.

Important

- Remove mounting bracket (17) only if it is damaged or if rotor (39) is being removed for refinishing or other service operations.

2. Two bracket mounting bolts (36) and washers (37).
   - Discard bolts (36).
3. Mounting bracket (17) from mounting plate (38).

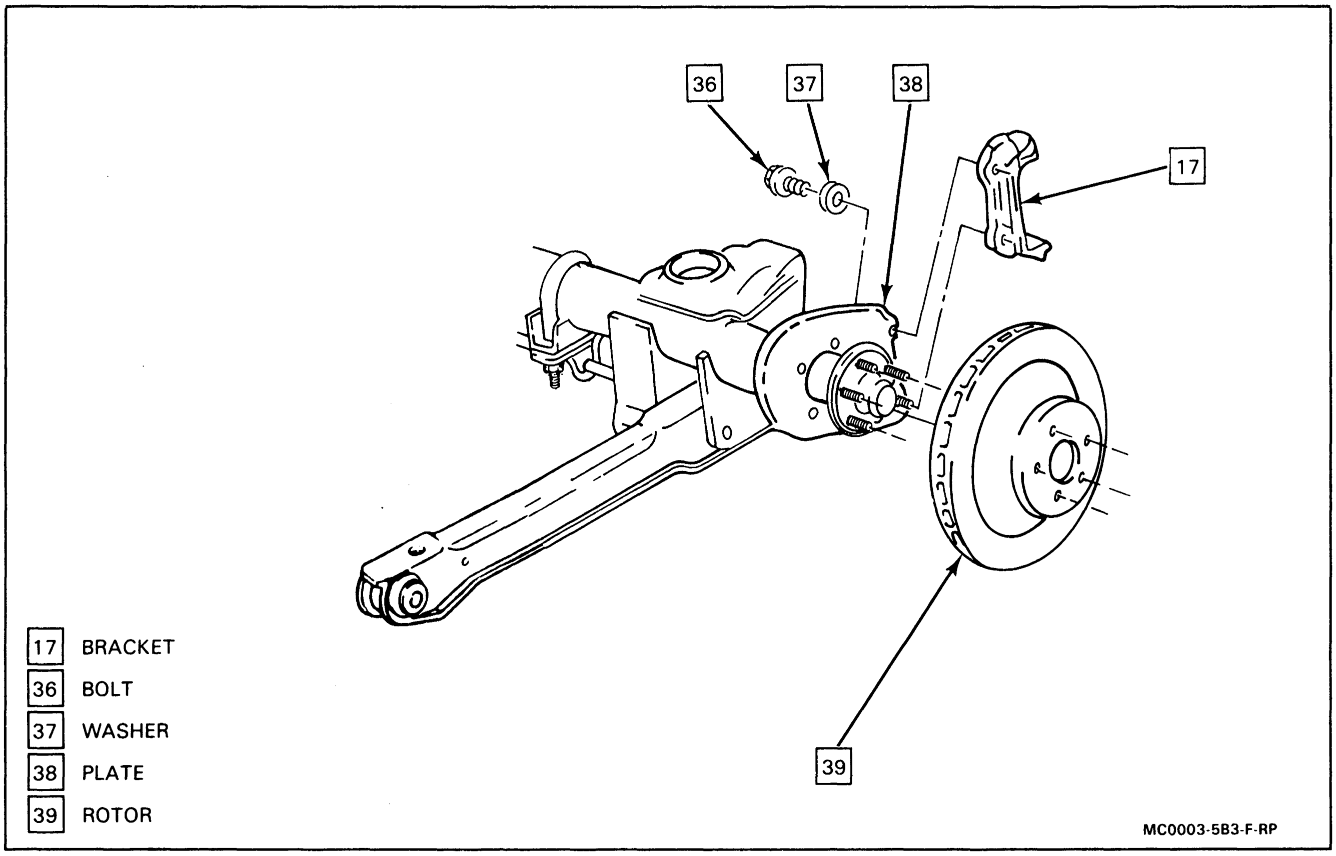


Figure 7 - Caliper Mounting Bracket

Clean

- All bolt adhesive residue from connecting surfaces on the mounting bracket (17) and mounting plate (38).

Install or Connect

1. Mounting bracket (17) to mounting plate (38).

   NOTICE: See "Notice" on page 5B3-1 of this section.

2. Two new bracket mounting bolts (36) and washers (37).

   Tighten

   - Two bracket mounting bolts (36) to 95 N·m (70 lb. ft.).
     - Recheck torque on both bolts immediately.

- Allow bolt adhesive to dry for two hours before driving the vehicle.

3. Caliper assembly. Refer to "Caliper Assembly" in this section.

PARKING BRAKE FREE-TRAVEL ADJUSTMENT

Figure 8

The adjustment process requires a second person to apply a light brake pedal load. Lever free-travel is set by the position of the adjuster screw (11). Turning the adjuster screw (11) clockwise increases the free-travel; turning the adjuster screw (11) counterclockwise decreases the free-travel.

NOTICE: Shoe and lining assemblies must be new or parallel to within 0.15 mm (0.006 inch). Parking brake adjustment is not valid with heavily tapered pads and may cause caliper/parking brake binding.

Important

- Inspect the old shoe and lining assemblies and replace with new if they are tapered.
- Parking brake free-travel should only be made if the caliper has been taken apart.
- This adjustment will not correct a condition where caliper levers (5) will not return to their stops.

1. Have an assistant apply a light brake pedal load, enough to stop the rotor from turning by hand.
   - This takes up all clearances and ensures that components are correctly aligned.
2. Apply light pressure to caliper lever (5) (Figure 8).

Measure

- Free-travel between caliper lever (5) and caliper housing (14).
  - Free-travel must be 0.6 mm to 0.7 mm (0.024 to 0.028 inch).

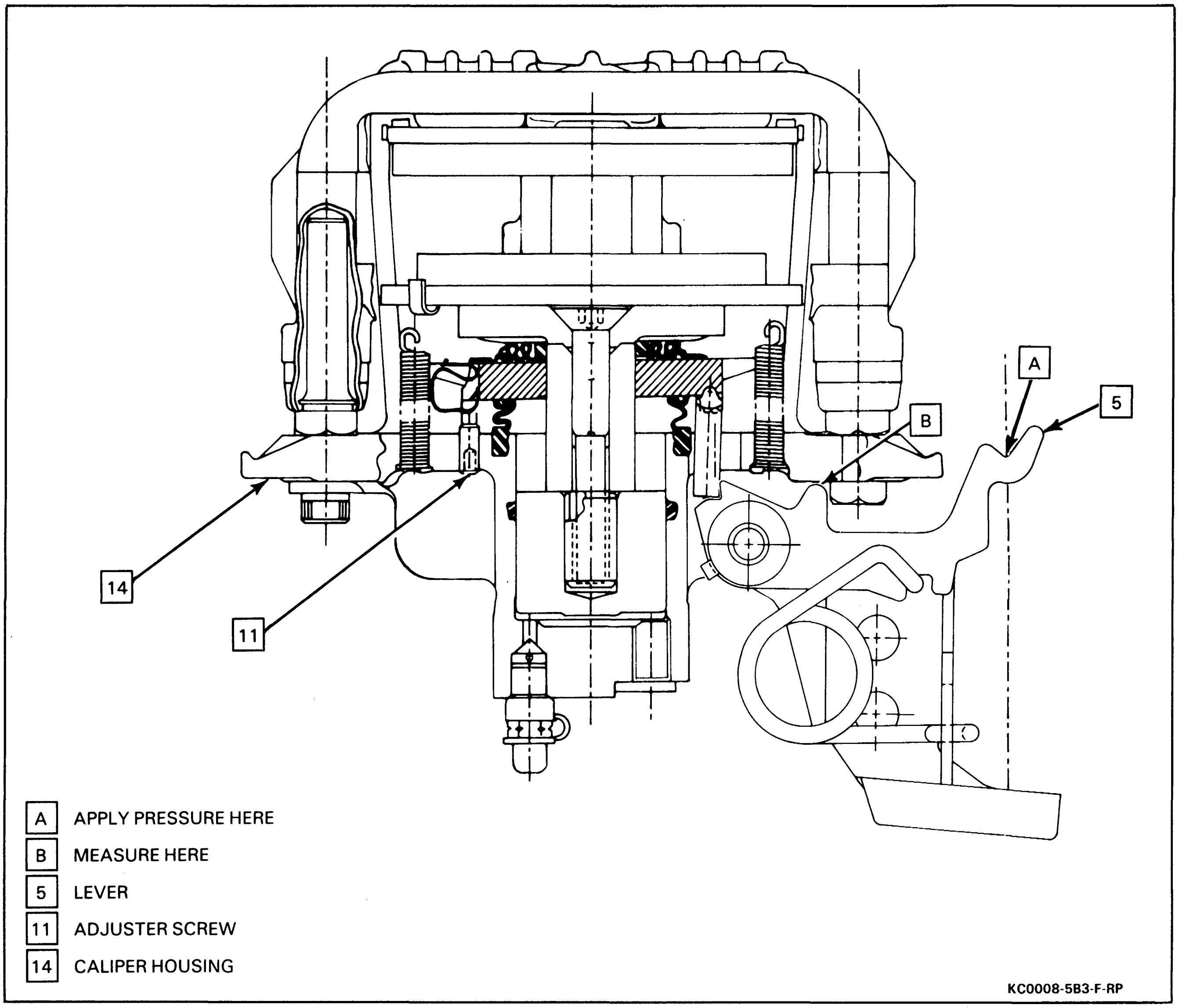


Figure 8 - Parking Brake Free-Travel Adjustment

3. If free-travel is incorrect, do the following:
   - Remove adjuster screw (11).
   - Clean thread adhesive residue from threads.
   - Coat threads with adhesive.
   - Screw in the adjuster screw (11) far enough to obtain 0.6 mm to 0.7 mm (0.024 to 0.028 inch) free-travel between caliper lever (5) and caliper housing (14).
4. Have assistant release brake pedal, then apply brake pedal firmly three times.
5. Recheck free-travel as described in steps 1 and 2 and adjust as necessary.

UNIT REPAIR

CALIPER OVERHAUL

Figures 1, 9 and 10

Disassemble

- Remove caliper assembly. Refer to "Caliper Assembly" in this section.

1. Two collar return springs (26) from actuating collar (24).
2. Actuating collar (24) with assembled parts.
   - Firmly but gently pull the actuating collar (24) with assembled parts out of the caliper housing (14) by pulling on both ends of the actuating collar (24).
3. Clamp rod (28) and compliance bushing (27) from actuating collar (24).
   - Discard compliance bushing (27).
4. Boot retainers (21 and 31), two boots (20 and 25) and pushrod (22) from actuating collar (24).
   - Bend back retainer tabs and take apart.
   - Discard retainers (21 and 31) and boots (20 and 25).
5. Preload spring (23) from retainer (31).

CAUTION: Do not place fingers in front of the piston in an attempt to catch or protect it when applying compressed air. The piston can fly out with force and could result in serious injury.

Important

- Use clean shop towels to pad the inside of the caliper housing (14) during piston removal.

NOTICE: To prevent damage, be careful when handling piston.

6. Piston (19) by directing compressed air into the brake hose port of the caliper housing (14).

Inspect

- Piston (19) for scoring, nicks, corrosion and wear.
    - Replace piston (19) if necessary.

NOTICE: Do not use a metal tool to remove piston seal. Metal tools may damage the caliper housing bore or the seal groove.

7. Piston seal (18).
    - Use a small wood or plastic tool.
8. Bleeder valve cap (7) and bleeder valve (6).
    - Discard bleeder valve cap (7).
9. Caliper lever pivot pin seal (1), sprag clip (2), spring (4) and caliper lever (5) from pivot pin (3).
    - Discard sprag clip (2).

Inspect

- Contact points on lever (5) and pivot pin (3) for wear and corrosion.
    - Replace, if necessary.

10. Pivot pin (3) and nut (12), if worn.
11. Adjuster screw (11) from caliper housing (14).
    - Discard if damaged or worn.

Inspect

- Caliper mounting bracket (17) for wear and damage.
    - Replace if necessary. Refer to "Caliper Mounting Bracket" in this section.

Clean

- Shoe contact area on mounting bracket (17).

12. Two guide pins (15) and boots (16) from mounting bracket (17).

Clean

- All parts not included in the repair kit in denatured alcohol.
- Use dry filtered compressed air to dry parts.
- Blow out all passages in the caliper housing (14) and bleeder valve (6).

Inspect

- Caliper housing bore for scoring and corrosion. Replace caliper housing (14) if badly scored or corroded around the seal area.

Assemble

NOTICE: See "Notice" on page 5B3-1 of this section for steps 8 and 9.

- Lubricate new piston seal (18) and caliper housing bore seal groove with silicone grease or clean brake fluid.

1. New piston seal (18) into caliper housing seal groove.

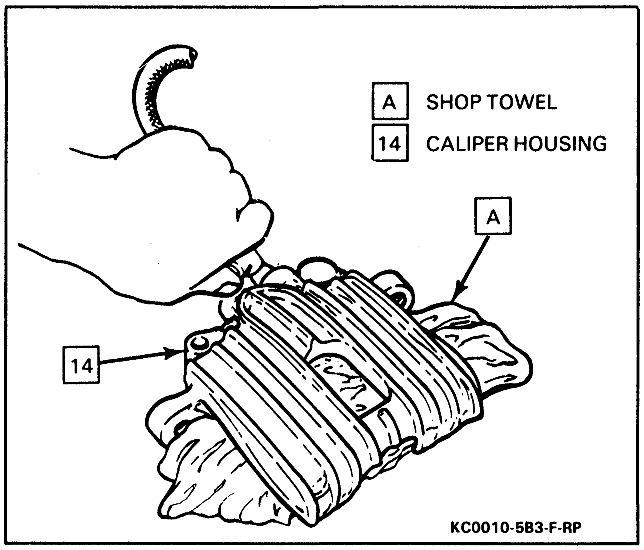


Figure 9 - Removing Caliper Piston

- Make sure seal (18) is not twisted.

- Lubricate the bore of the caliper housing (14) and the caliper piston (19) with clean brake fluid.

2. Caliper piston (19) into the bore of the caliper housing.
    - Push down, by hand, to the bottom of the bore.

Inspect

- Actuating collar (24) and clamp rod (28) for corrosion and excessive wear on the working faces.
    - If corrosion or excessive wear is present, replace the actuating collar assembly.

3. Pushrod (22), new boots (20 and 25) and new retainers (21 and 31) to actuating collar (24).
    - Lightly coat actuating collar (24) with liquid lubricant provided in the repair kit. Do not use any other fluid or grease.
    - Clamp retainers (21 and 31) firmly against the actuating collar (24).
    - Bend tabs on retainer (21) to hold assembly together.

4. Preload spring (23) into boot retainers (21 and 31).
5. Clamp rod (28) to actuating collar (24) and boot (25).
    - Lightly coat clamp rod (28) with liquid lubricant provided in repair kit.
    - Slide clamp rod (28) through holes in boot (25) and actuating collar (24).
    - Boot (25) must be against the reaction plate on the clamp rod (28).
6. New compliance bushing (27) to clamp rod (28).
    - Lubricate the outside of the bushing with the provided lubricant.
7. Clamp rod (28) with assembled parts into the connecting hole in the caliper piston (19).
    - Lubricate the grooved bead of the inner boot (20) and the boot groove in the caliper housing (14) with provided lubricant. Use the remainder of liquid lubricant to coat the actuating collar (24), especially around the center hole.
    - Push clamp rod (28) firmly to the bottom of the connecting hole in the piston (19).
    - Pull on the actuating collar (24) and seat inner boot (20) into the boot groove in the caliper housing (14).
    - Make sure that pushrod (22) enters the hole in the caliper housing (14).
8. New bleeder valve cap (7) and bleeder valve (6) into caliper housing (14).

    Tighten

    - Bleeder valve (6) to 9 N·m (80 lb. in.).
9. Pivot pin (3) and new nut (12) to caliper housing (14), if removed.

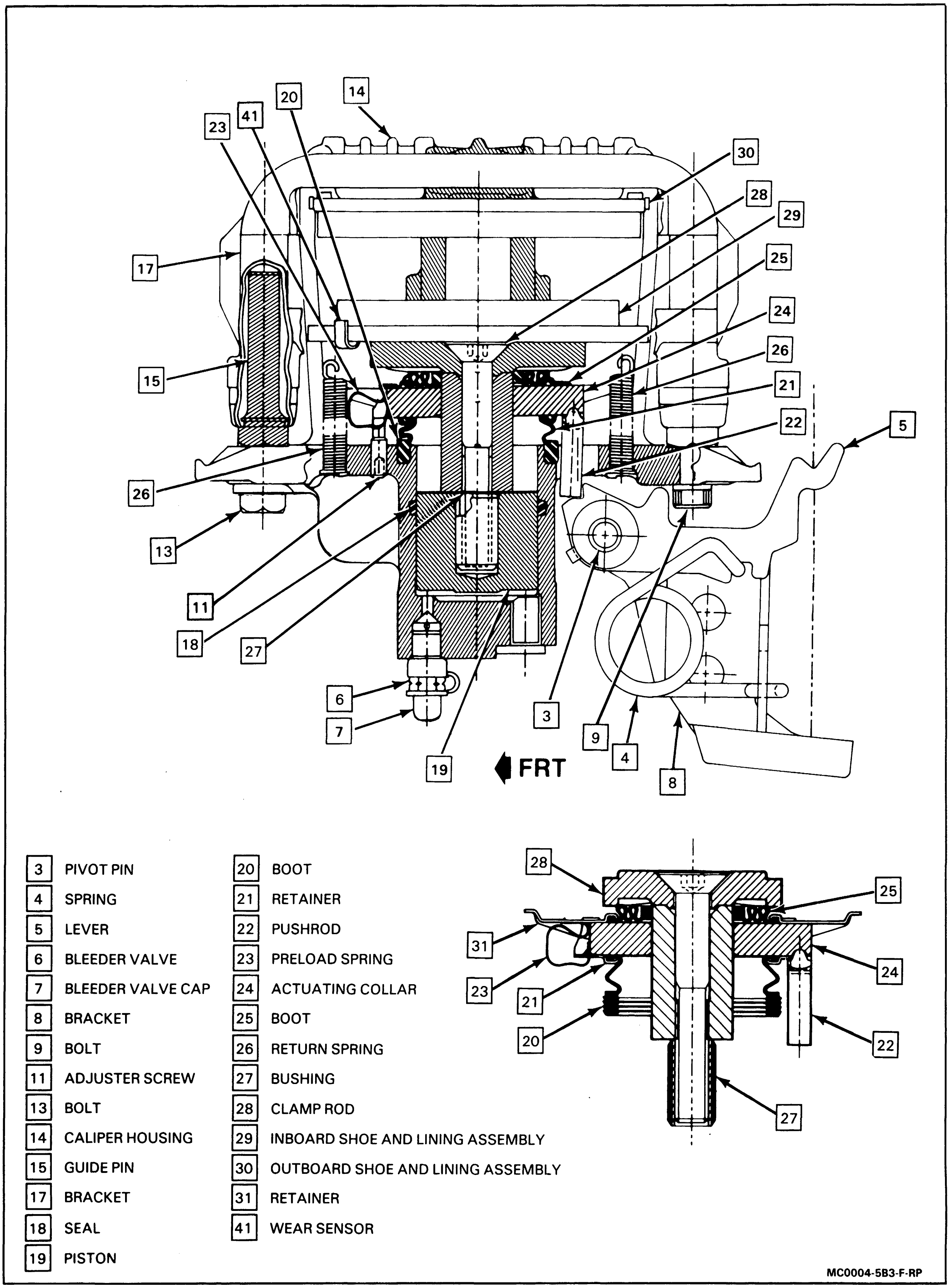
    Tighten

    - Pivot pin nut (12) to 22 N·m (16 lb. ft.).

- Lubricate caliper parking brake lever (5) and pivot pin (3) with the grease provided in the repair kit.

10. Pivot pin seal (1), caliper parking brake lever (5), new sprag clip (2) and spring (4), in that order.
    - Teeth of sprag clip must face away from lever.
    - Snap pivot pin seal cap over pivot pin (3).
11. Two collar return springs (26) to retainer (31).
    - Retainer (31) must enter return springs (26) at the end of the second coil.
12. Adjuster screw (11) into caliper housing (14) until actuating collar (24) is about parallel to the piston bore face of the caliper housing (14).
13. New guide pin boots (16) and guide pins (15).
    - Lubricate the two guide pins (15) with the grease provided in the repair kit.
    - Slide boots (16) on guide pins (15).
    - Fill boots (16) with the provided grease.
    - Assemble to mounting bracket (17).
    - Make sure boots (16) fit into the grooves of the guide pins (15) and mounting bracket (17).

- Install caliper assembly. Refer to "Caliper Assembly" in this section.



3	PIVOT PIN
4	SPRING
5	LEVER
6	BLEEDER VALVE
7	BLEEDER VALVE CAP
8	BRACKET
9	BOLT
11	ADJUSTER SCREW
13	BOLT
14	CALIPER HOUSING
15	GUIDE PIN
17	BRACKET
18	SEAL
19	PISTON
20	BOOT
21	RETAINER
22	PUSHROD
23	PRELOAD SPRING
24	ACTUATING COLLAR
25	BOOT
26	RETURN SPRING
27	BUSHING
28	CLAMP ROD
29	INBOARD SHOE AND LINING ASSEMBLY
30	OUTBOARD SHOE AND LINING ASSEMBLY
31	RETAINER
41	WEAR SENSOR

Figure 10 - Rear Caliper Assembly - Cutaway View

SECTION 5C3

DIRECT TORQUE DRUM BRAKE ASSEMBLY

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 5C3-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

This drum brake assembly is a duo-servo, direct torque design. In the duo-servo brake, the force which the wheel cylinder applies to the primary shoe is multiplied by the primary lining friction to provide a very large force applied to the secondary shoe. With the direct torque design, torque from the brake shoes is transferred directly through the anchor pin to the axle flange. Adjustment for both the primary and secondary shoe and linings is automatic during reverse brake applications.

CAUTION: When servicing brake parts, do not create dust by grinding or sanding brake linings or by cleaning wheel brake parts with a dry brush or with compressed air. A water dampened cloth should be used. Many brake parts contain asbestos fibers which can become airborne if dust is created during servicing. Breathing dust containing asbestos fibers may cause serious bodily harm.

Important

- Replace all components included in repair kits used to service this drum brake.
- Lubricate parts as specified.
- Do not use lubricated shop air on brake parts as damage to rubber components may result.
- If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.
- Replace shoes and linings in axle sets only.
- The torque values specified are for dry, unlubricated fasteners.
- Perform service operations on a clean bench, free from all mineral oil materials.

ON-VEHICLE SERVICE

BRAKE COMPONENTS

Figures 1 through 4

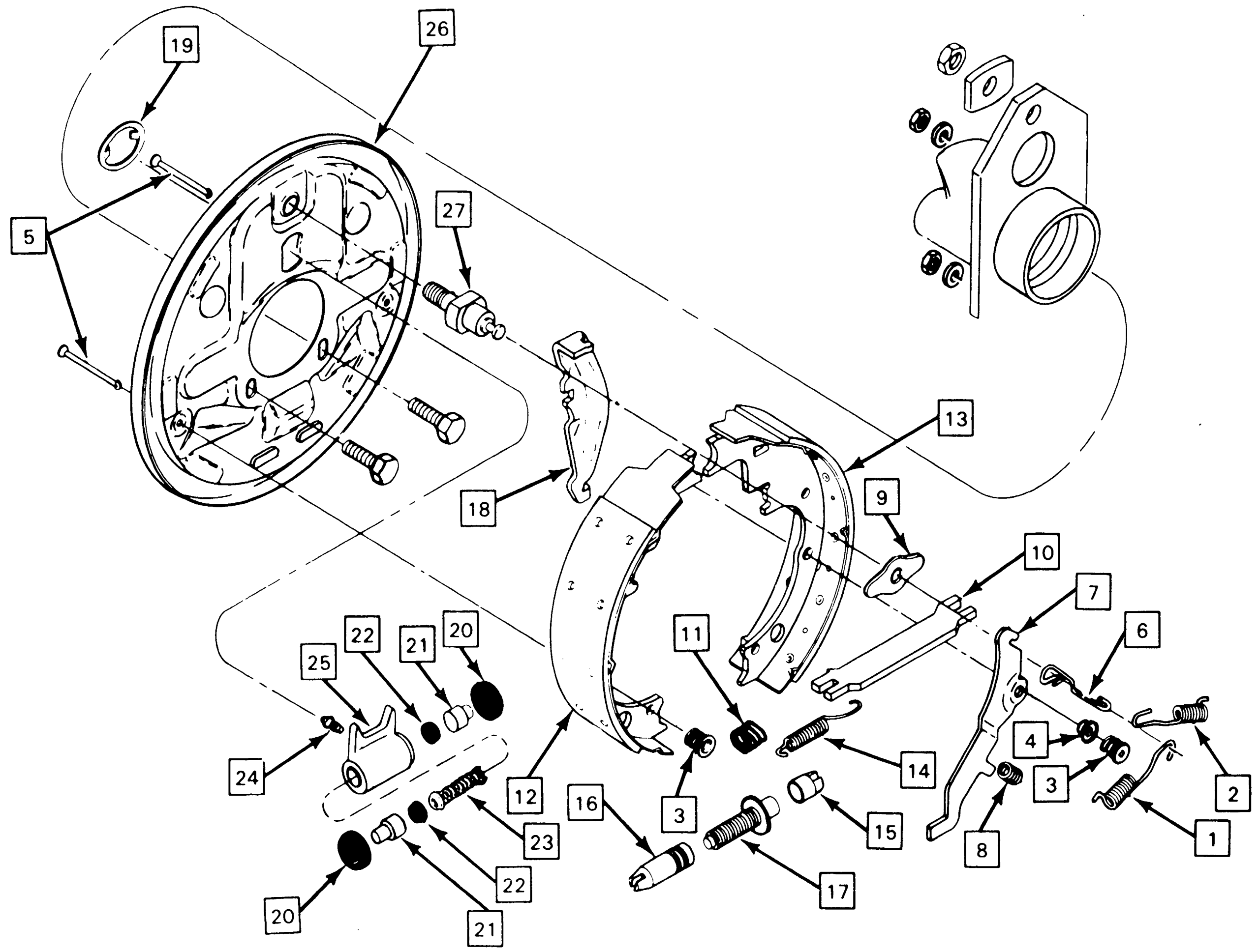
Tools Required:

J 8049 Brake Spring Remover and Installer
J 8057 Brake Spring Pliers

↔ Remove or Disconnect

- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Wheel and tire. Refer to TIRES AND WHEELS (SEC. 3E).
   - Mark the relationship of the wheel to the axle flange.
2. Brake drum.
   - Mark the relationship of the drum to the axle flange.
   - If you have trouble removing the brake drum, try the following:
     - Make sure the parking brake is released.
     - Back off the parking brake cable adjustment. Refer to GENERAL BRAKES (SEC. 5).
     - Remove the adjusting hole cover or knockout plate from the backing plate (26) and back off the adjusting screw (17), using a screwdriver and a brake adjusting tool (Figure 3).
     - Use a rubber mallet to tap gently on the outer rim of the drum and/or around the inner drum diameter by the spindle. Take care not to deform the drum by excessive use of force.
3. Return springs (1 and 2), using J 8049.



1	RETURN SPRING
2	RETURN SPRING
3	HOLD-DOWN SPRING
4	LEVER PIVOT
5	HOLD-DOWN PIN
6	ACTUATOR LINK
7	ACTUATOR LEVER
8	LEVER RETURN SPRING
9	SHOE GUIDE
10	PARKING BRAKE STRUT
11	STRUT SPRING
12	PRIMARY SHOE AND LINING
13	SECONDARY SHOE AND LINING
14	ADJUSTING SCREW SPRING
15	SOCKET
16	PIVOT NUT
17	ADJUSTING SCREW
18	PARKING BRAKE LEVER
19	WHEEL CYLINDER RETAINER
20	BOOT
21	PISTON
22	SEAL
23	SPRING ASSEMBLY
24	BLEEDER VALVE
25	CYLINDER BODY
26	BACKING PLATE
27	ANCHOR PIN

KC0001-5C3-F-RP

Figure 1 - Direct Torque Drum Brake Assembly

4. Hold-down springs (3) and hold-down pins (5), using suitable pliers.
5. Lever pivot (4).
6. Actuator link (6) while lifting up on actuator lever (7).
7. Actuator lever (7) and lever return spring (8).
8. Shoe guide (9), parking brake strut (10) and strut spring (11).
9. Primary shoe and lining (12) and secondary shoe and lining (13) from the backing plate (26) and parking brake cable.
10. Adjusting screw assembly (29) and adjusting screw spring (14).
11. Parking brake lever (18) by unhooking lever tab from slot in primary shoe and lining (12) or secondary shoe and lining (13).

Clean

1. Adjusting screw assembly (29).
   - Clean adjusting screw threads with a wire brush.
   - Wash all components in clean denatured alcohol.
   - Apply brake lubricant, part number 5450032 or equivalent, to the adjusting screw threads, inside diameter of socket (15) and socket face.
   - Adequate lubrication is achieved when a continuous bead of lubricant is at open end of pivot nut (16) and socket (15) when threads are fully engaged.
2. Backing plate (26) and lubricate shoe pads (33) with brake lubricant, part number 5450032 or equivalent.

Inspect

1. Threads of adjusting screw (17) for smooth rotation over full length.
2. All parts.
   - If any parts are of doubtful strength or quality due to discoloration from heat, overstress, or wear, the parts should be replaced.

Install or Connect

NOTICE: See "Notice" on page 5C3-1 of this section.

1. Parking brake lever (18) by hooking lever tab into slot in primary shoe and lining (12) or secondary shoe and lining (13).
2. Adjusting screw assembly (29) and adjusting screw spring (14).
3. Primary shoe and lining (12) and secondary shoe and lining (13) to backing plate (26) and parking brake cable.
4. Parking brake strut (10) and strut spring (11) by spreading primary shoe and lining (12) and secondary shoe and lining (13) apart. For proper positioning:
   - The end without the strut spring (11) engages the parking brake lever (18) and primary shoe and lining (12) or secondary shoe and lining (13).
   - The end with the strut spring (11) engages the opposite primary shoe and lining or secondary shoe and lining (13).
5. Shoe guide (9).
6. Actuator lever (7) and lever return spring (8).
7. Hold-down pins (5), lever pivot (4) and hold-down springs (3).
8. Actuator link (6) on anchor pin (27).
9. Actuator link (6) into actuator lever (7) while holding up on actuator lever (7).
10. Return springs (1 and 2), using J 8057.

Adjust

- Brakes. Refer to "Brake Adjustment" in this section.

11. Brake drum.
    - Align locating marks on drum and axle flange.
12. Wheel and tire. Refer to TIRES AND WHEELS (SEC. 3E).
    - Align locating marks on wheel and axle flanges.

- Lower vehicle.
- Cycle parking brake.

BRAKE ADJUSTMENT

Figures 5 and 6

Tool Required

J 21177-A Drum-to-Brake Shoe Clearance Gage

Remove or Disconnect

- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC 0A).

1. Wheels and tires. Refer to TIRES AND WHEELS (SEC. 3E).
   - Mark the relationship of the wheel to the axle flange.
2. Brake drums (32).
   - Mark the relationship of the brake drum (32) to the axle flange.

Adjust

- Brakes.
  - Set J 21177-A so that it contacts the inside diameter of the brake drum (32).
  - Position J 21177-A over the primary shoe and lining (12) and secondary shoe and lining (13).
  - Turn the star wheel on the adjusting screw (17) until the primary shoe and lining (12) and secondary shoe and lining (13) contact J 21177-A.

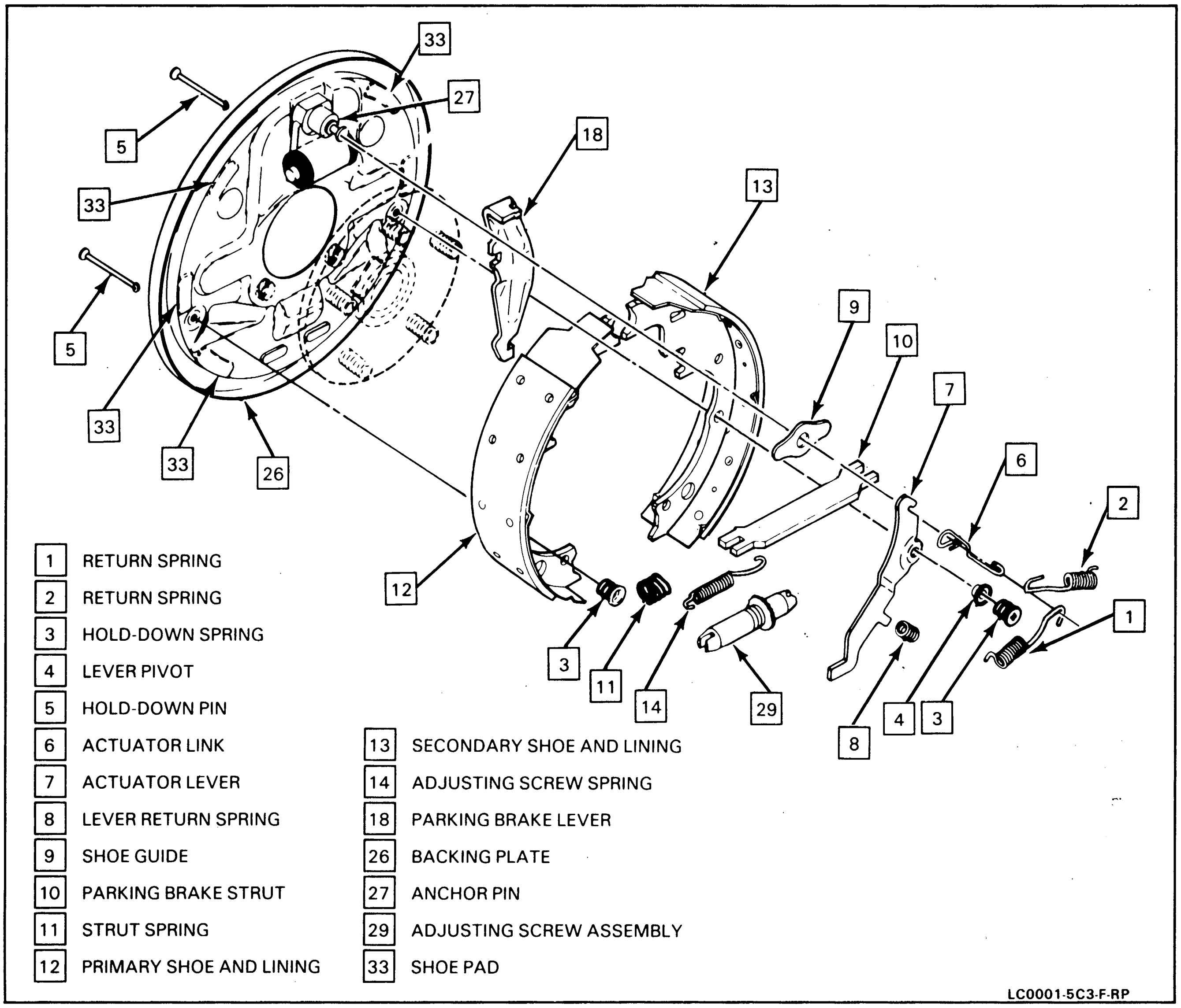


Figure 2 - Brake Components

- The outside diameter of the primary shoe and lining (12) and secondary shoe and lining (13) will be approximately 1.27 mm (0.050 inch) less than the inside diameter of the brake drum (32) on each wheel.

Install or Connect

1. Brake drums (32).
   - Align locating marks on brake drum (32) and axle flange.
2. Wheels and tires. Refer to TIRES AND WHEELS (SEC. 3E).
   - Align locating marks on wheel and axle flange.
   - Lower the vehicle.
   - Make several alternate forward and reverse stops, applying firm force to the brake pedal. Repeat until ample pedal reserve is built up.

WHEEL CYLINDER

Figures 7 through 10

Tool Required:

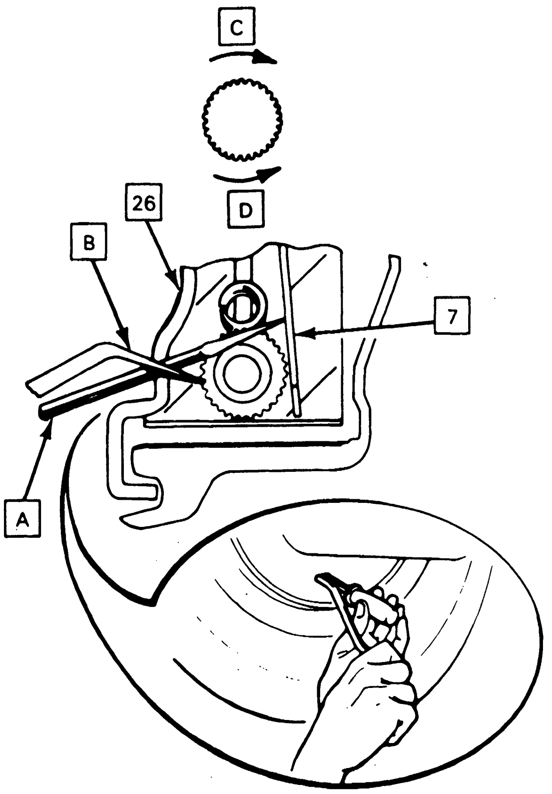
J 29839 Brake Cylinder Retainer Remover

Remove or Disconnect

Clean

- Dirt and foreign material around wheel cylinder (28) and brake pipe.
- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Brake components. Refer to "Brake Components" in this section.
2. Brake pipe from wheel cylinder (28).
   - Plug opening in brake pipe to prevent fluid loss and contamination.
3. Wheel cylinder retainer (19), using J 29839 or two awls.



A SCREWDRIVER USED ONLY WHEN BACKING OFF ADJUSTMENT

B BRAKE ADJUSTING TOOL

C STAR WHEEL ROTATION TO RETRACT BRAKE SHOES

D STAR WHEEL ROTATION TO EXPAND BRAKE SHOES

7 ACTUATOR LEVER

26 BACKING PLATE

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Figure 3 - Backing Off Brake Adjustment

- If using awls, insert into access slots between wheel cylinder pilot and locking tabs of retainer (19).
- Bend both tabs away from the wheel cylinder (28) at the same time.

4. Wheel cylinder (28).

Install or Connect

1. Wheel cylinder (28).
   - Hold in place with a wooden block between the wheel cylinder (28) and the axle flange.
2. Wheel cylinder retainer (19) over abutment on wheel cylinder (28).
   - Use a 1 1/8-inch, 12 point socket and socket extension.

NOTICE: See "Notice" on page 5C3-1 of this section.

3. Brake pipe to wheel cylinder (28).

Tighten

- Brake pipe to 15 N·m (11 lb. ft.).

4. Bleed the wheel cylinder (28). Refer to GENERAL BRAKES (SEC. 5).

- Lower the vehicle.

BACKING PLATE

Figures 1 and 7

Remove or Disconnect

- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Brake components. Refer to "Brake Components" in this section.
2. Axle shaft. Refer to REAR AXLE (SEC. 4B).
3. Parking brake cable from backing plate (26).
4. Brake pipe from wheel cylinder (28).
5. Wheel cylinder. Refer to "Wheel Cylinder" in this section.
6. Backing plate bolts, nuts and washers.
7. Anchor pin nut and anchor pin (27).
8. Backing plate (26) from axle flange.

Install or Connect

NOTICE: See "Notice" on page 5C3-1 of this section for steps 2, 3 and 5.

1. Backing plate (26) to axle flange.
2. Backing plate bolts, nuts and washers.

   Tighten

   - Nuts to 58 N·m (43 lb. ft.).

3. Anchor pin (27) and nut.

   Tighten

   - Nut to 140 N·m (103 lb. ft.).

4. Wheel cylinder. Refer to "Wheel Cylinder" in this section.
5. Brake pipe to wheel cylinder.

   Tighten

   - Brake pipe to 15 N·m (11 lb. ft.).

6. Parking brake cable to brake backing plate (26).
   - Make sure retainer fingers are seated.
7. Axle shaft. Refer to REAR AXLE (SEC. 4B).
8. Brake components. Refer to "Brake Components" in this section.

- Bleed the hydraulic brake system. Refer to GENERAL BRAKES (SEC. 5).

Adjust

- Brakes. Refer to "Brake Adjustment" in this section.

- Lower the vehicle.

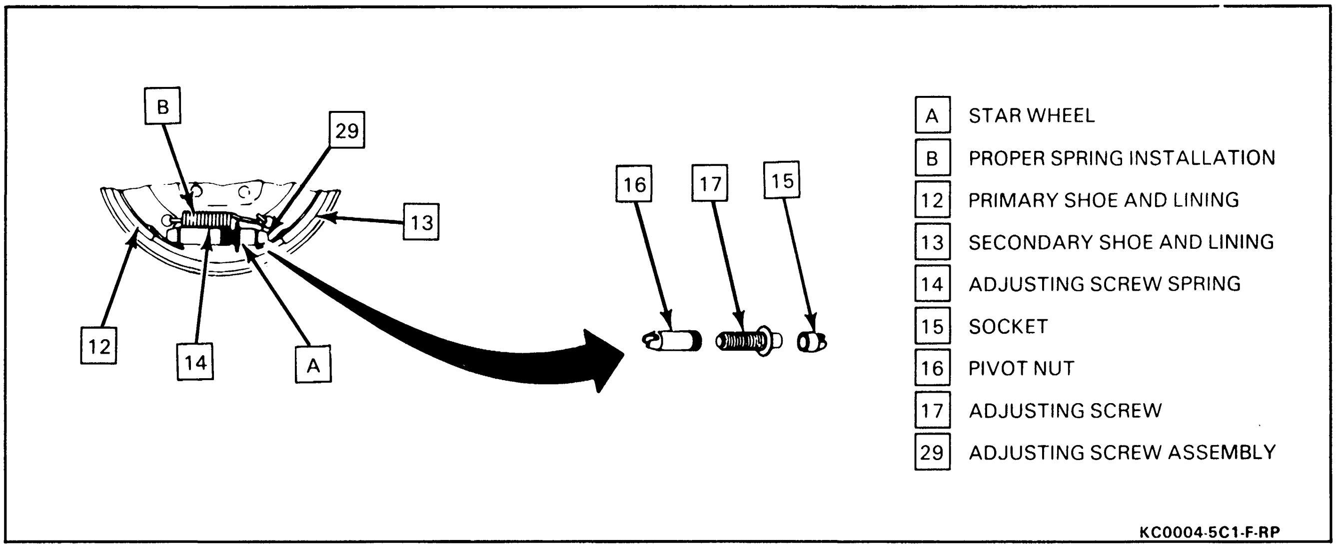


Figure 4 - Adjusting Screw Assembly (Typical - Left Side Shown)

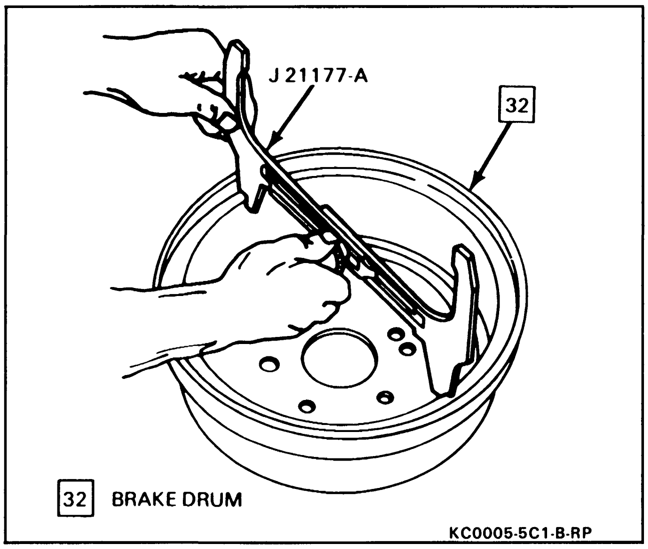


Figure 5 - Setting Tool to Drum

- Cycle parking brake.

UNIT REPAIR

WHEEL CYLINDER OVERHAUL

Figure 11

Disassemble

1. Wheel cylinder completely from vehicle. Refer to "Wheel Cylinder" in this section.
2. Boots (20).
3. Pistons (21) and seals (22).
4. Spring assembly (23).
5. Bleeder valve (24) from cylinder body (25).

Inspect

- Cylinder bore for scoring, nicks, corrosion and wear.

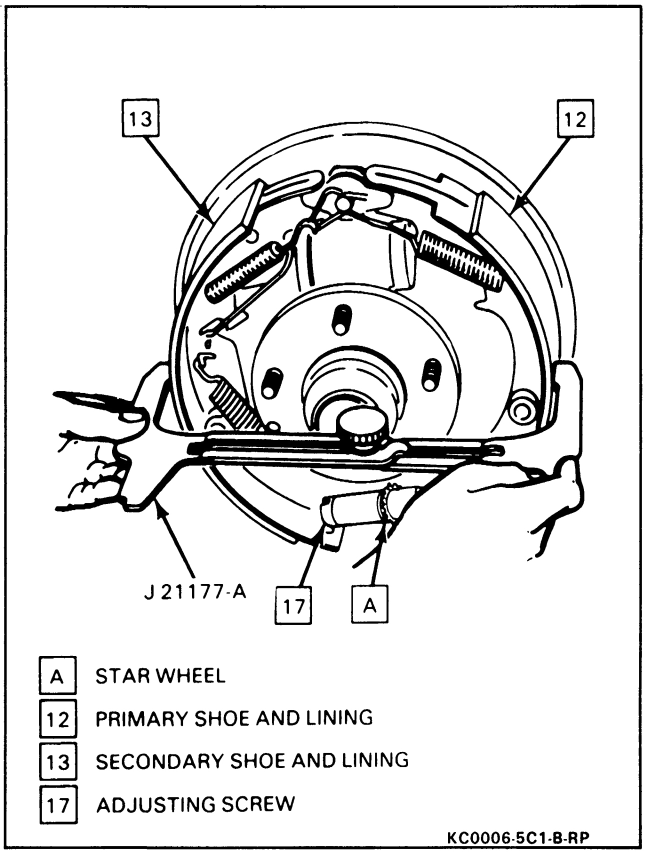


Figure 6 - Setting Brake Shoes to Tool

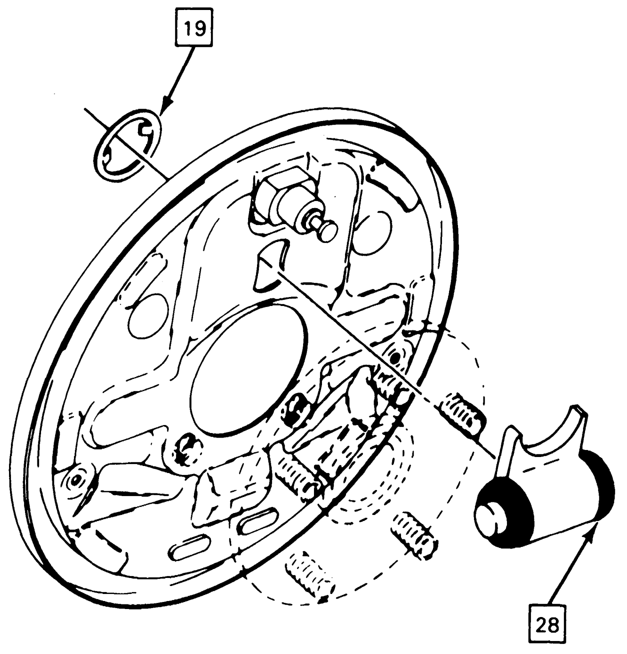
Clean

- All parts in clean denatured alcohol.
- Dry with unlubricated compressed air.
- Lubricate new seals (22) with clean brake fluid.

Assemble

NOTICE: See "Notice" on page 5C3-1 of this section.

1. Bleeder valve (24).



19 WHEEL CYLINDER RETAINER

28 WHEEL CYLINDER

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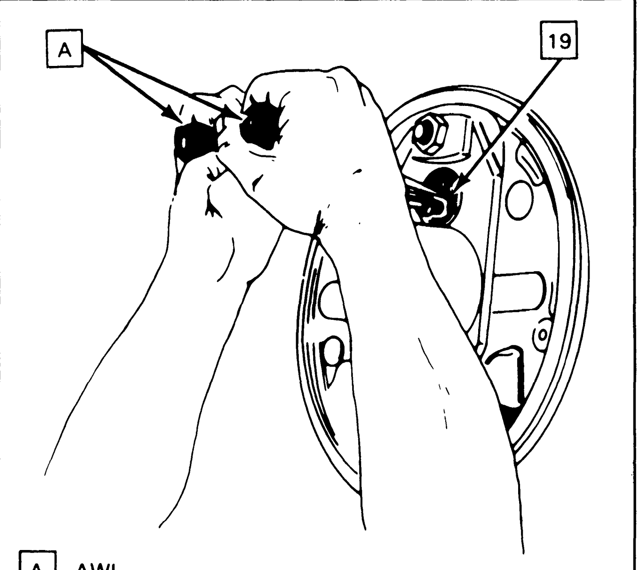
Figure 7 - Wheel Cylinder Replacement



A AWL

19 WHEEL CYLINDER RETAINER

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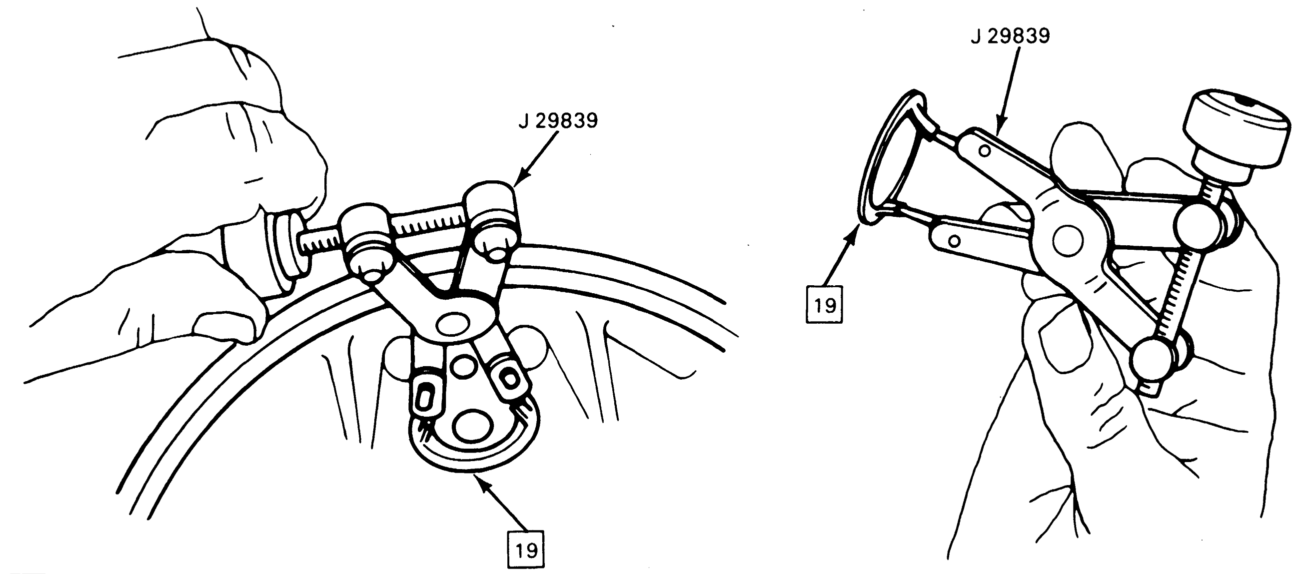
Figure 8 - Removing Wheel Cylinder Retainer Using Awls

Tighten

- Bleeder valve (24) to 6 N·m (53 lb. in.).

2. Spring assembly (23).
3. Seals (22), pistons (21) and boots (20).
4. Wheel cylinder. Refer to "Wheel Cylinder" in this section.



19 WHEEL CYLINDER RETAINER

KC0006-5C3-F-RP

Figure 9 - Removing Wheel Cylinder Retainer Using J 29839

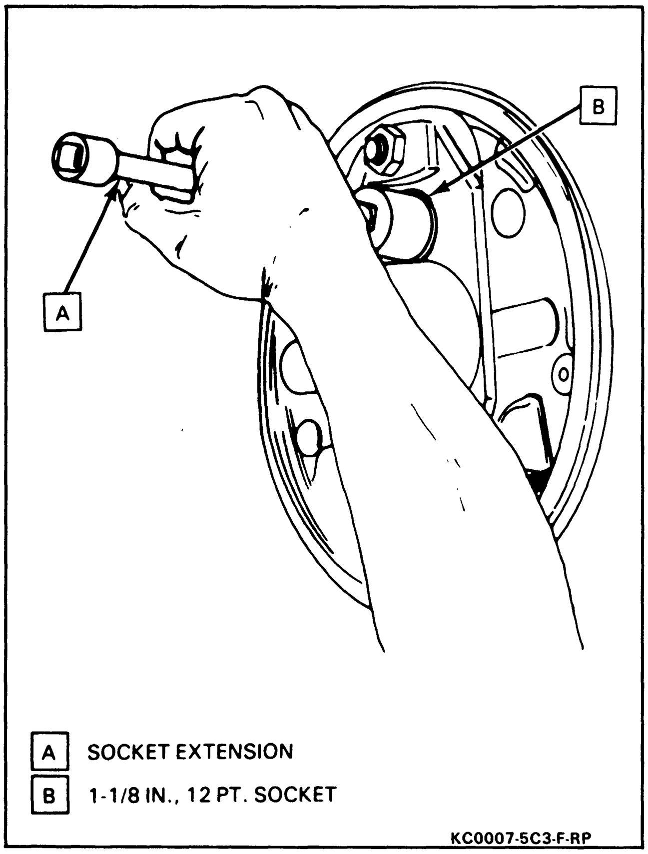


Figure 10 - Installing Wheel Cylinder Retainer

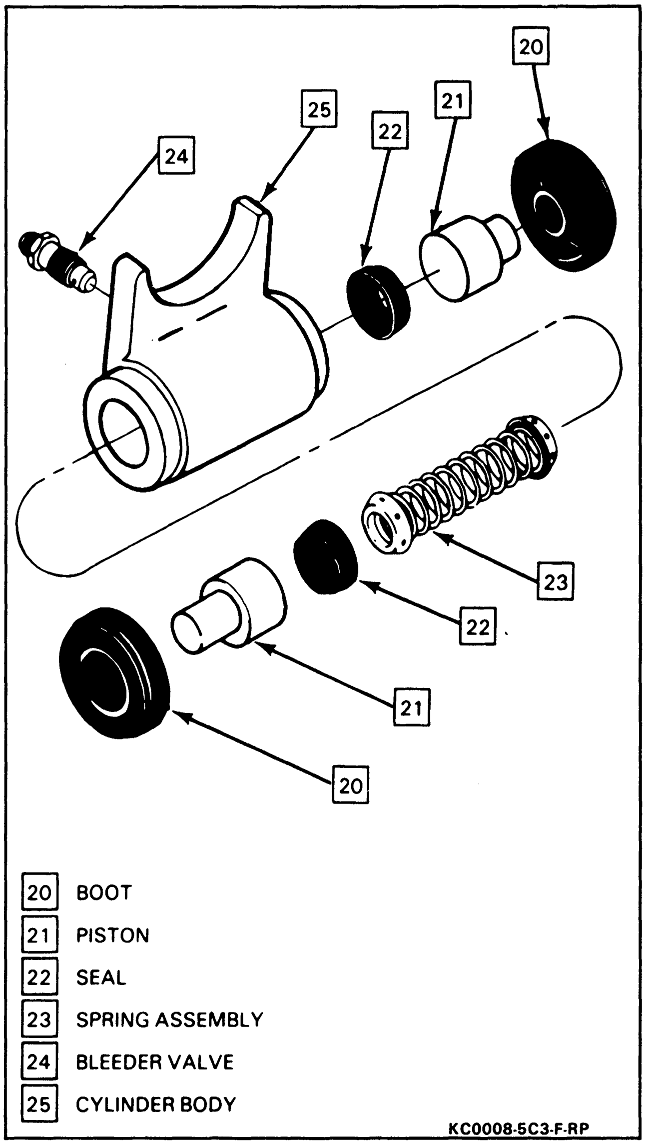


Figure 11 - Wheel Cylinder Components

SECTION 5D2

POWER HEAD ASSEMBLY TANDEM DIAPHRAGM

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 5D2-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

This booster is a tandem vacuum suspended unit. In a normal operating mode, with the service brakes in the released position, the tandem vacuum suspended booster operates with vacuum on both sides of its diaphragms. When the brakes are applied, air at atmospheric pressure is admitted to one side of each diaphragm to provide the power assist. When the service brake is released, the atmospheric air is shut off from one side of each diaphragm. The air is then drawn from the booster through a vacuum check valve to the vacuum source.

Important

- Replace all components included in repair kits used to service this booster.
- Lubricate rubber parts with silicone grease, provided in kits, to ease assembly.
- Do not use lubricated shop air on brake parts as damage to rubber parts may result.
- If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.
- The torque values specified are for dry, unlubricated fasteners.
- Perform service operations on a clean bench free from all mineral oil materials.

ON-VEHICLE SERVICE

BOOSTER ASSEMBLY REPLACEMENT

Figures 1 and 2

Remove or Disconnect

1. Vacuum hose (42) from the vacuum check valve (3).
2. Master cylinder attaching nuts (37).
3. Clutch master cylinder reservoir bracket (5) with assembled clutch master cylinder reservoir (6) and move out of the way, on vehicles equipped with manual transmissions.
4. Combination valve (39) with attached combination valve bracket and move out of the way.
5. Master cylinder (36) from the booster (35).
6. Retainer (40) and booster pushrod (32) from the brake pedal (43).
7. Booster attaching nuts (34).
8. Booster (35).

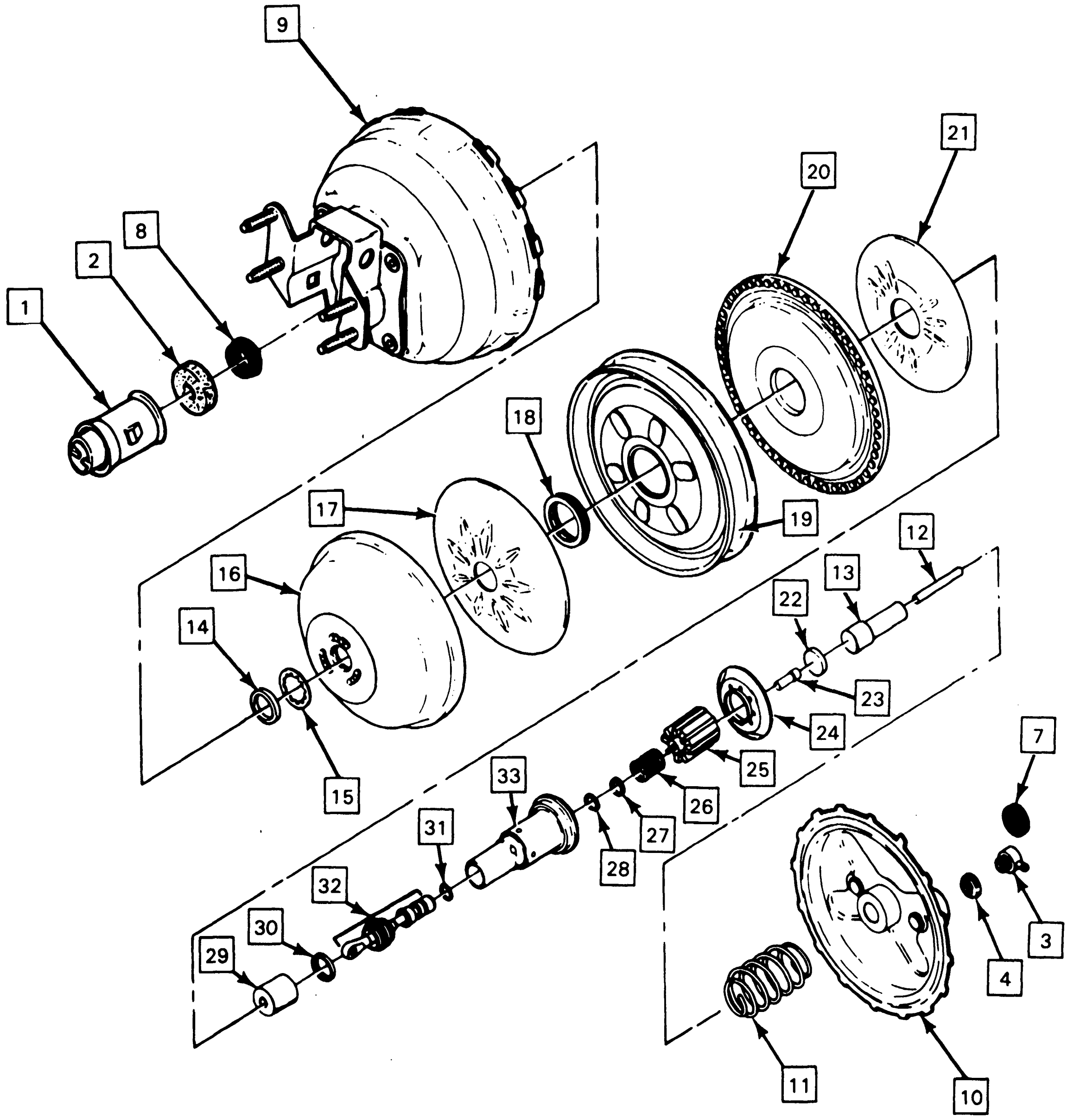
Install or Connect

NOTICE: See "Notice" on page 5D2-1 of this section.

1. Booster (35).
2. Booster attaching nuts (34).

Tighten

- Nuts (34) to 21 N·m (15 lb. ft.).



1	BOOT
2	SILENCER
3	VACUUM CHECK VALVE
4	GROMMET
7	FRONT HOUSING SEAL
8	PRIMARY PISTON BEARING
9	REAR HOUSING
10	FRONT HOUSING
11	RETURN SPRING
12	PISTON ROD
13	REACTION RETAINER
14	POWER HEAD SILENCER
15	DIAPHRAGM RETAINER
16	PRIMARY DIAPHRAGM
17	PRIMARY SUPPORT PLATE
18	SECONDARY PISTON BEARING
19	HOUSING DIVIDER
20	SECONDARY DIAPHRAGM
21	SECONDARY SUPPORT PLATE
22	REACTION DISC
23	REACTION PISTON
24	REACTION BODY RETAINER
25	REACTION BODY
26	AIR VALVE SPRING
27	REACTION BUMPER
28	RETAINING RING
29	FILTER
30	RETAINER
31	O-RING
32	PUSHROD
33	POWER PISTON

KC0001-5D2-F-RP

Figure 1 - Tandem Diaphragm Power Head Assembly

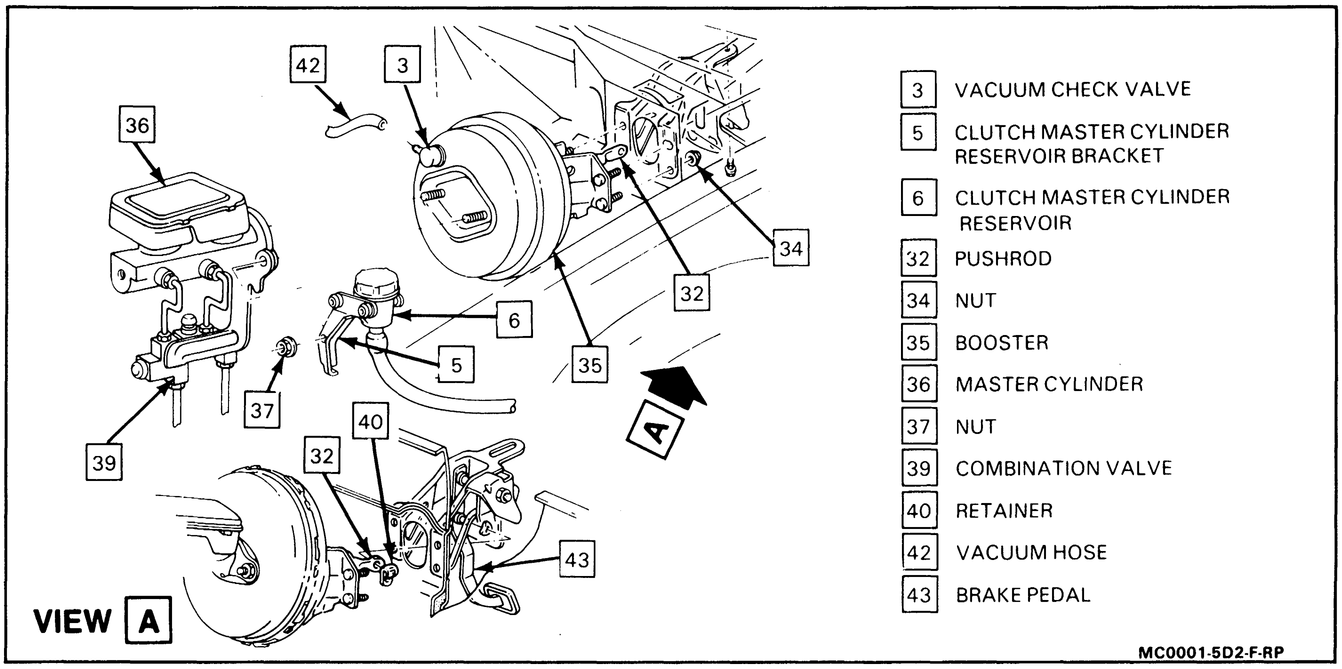


Figure 2 - Removing Booster Assembly

3. Booster pushrod (32) and retainer (40) to the brake pedal (43).
4. Master cylinder (36) to the booster (35).
5. Combination valve (39) with attached combination valve bracket.
6. Clutch master cylinder reservoir bracket (5) with assembled clutch master cylinder reservoir (6), on vehicles equipped with manual transmissions.
7. Master cylinder attaching nuts (37).

Tighten

- Nuts (37) to 25 N·m (18 lb. ft.).

8. Vacuum hose (42) to the vacuum check valve (3).

EXTERIOR COMPONENTS

Figure 3

Remove or Disconnect

1. Booster. Refer to "Booster Assembly Replacement" in this section.
2. Boot (1) and the silencer (2).
3. Vacuum check valve (3) and the grommet (4).
4. Front housing seal (7).

Inspect

- Boot (1) front housing seal (7), and grommets (4) for cuts, nicks, and excessive wear.

Clean

- Boot (1), front housing seal (7), and grommet (4) in clean denatured alcohol.
  - Dry with unlubricated compressed air.

Install or Connect

- Lubricate the inside and outside diameters of the grommet (4) and front housing seal (7) with a thin layer of silicone grease.

1. Grommet (4) and the vacuum check valve (3).
2. Front housing seal (7).
3. Silencer (2) and the boot (1).
4. Booster. Refer to "Booster Assembly Replacement " in this section.

UNIT REPAIR

BOOSTER ASSEMBLY OVERHAUL

Figures 4 through 6

Tool Required:

J 22805-01 Vacuum Booster Holder

Disassemble

- Remove booster from the vehicle. Refer to "Booster Assembly Replacement" in this section.
- Remove exterior components. Refer to "Exterior Components" in this section.
- Scribe a mark on the front and rear housings (10 and 9) to aid in assembly.
- Unlock staked tabs on the front and rear housings (10 and 9).

1. Front housing (10) from the rear housing (9).
   - Attach J 22805-01 to the studs on the front housing (10).
   - Install J 22805-01, with the booster (35) attached, in a vise.
   - Insert a steel bar through the holes on the bracket of the rear housing (9).

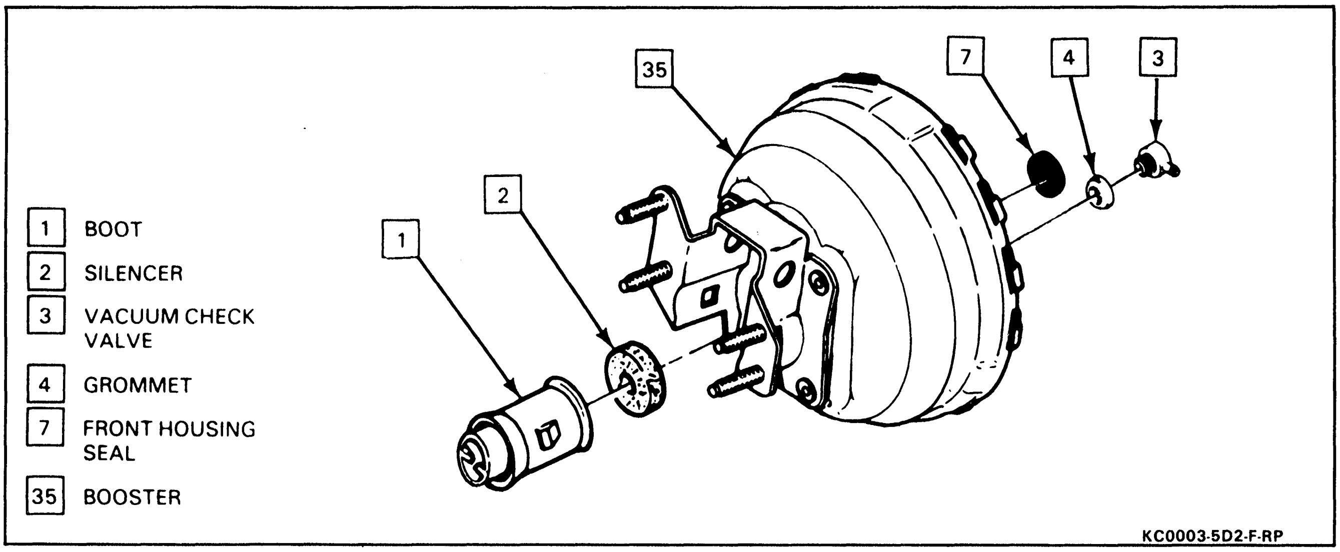


Figure 3 - Exterior Components

NOTICE: Housings are under spring tension. If bar is not held firmly, the housing or spring may come free and be damaged. Separate housing slowly.

- Press down on the steel bar and apply a force in a counterclockwise direction to unlock and separate the front and rear housings (10 and 9).

2. Return spring (11) from the power piston group (38).
3. Power piston group (38) from the rear housing (9).
   - For power piston group disassembly information, refer to "Power Piston Group" in this section.
4. Primary piston bearing (8) from the rear housing (9).

Inspect

- Front and rear housing (10 and 9) for corrosion, cracks, distortion, and excessive wear.
  - Use crocus cloth to polish away minor corrosion.
- Primary piston bearing (8) for cuts and nicks.

Clean

- Front and rear housings (10 and 9) and primary piston bearing (8) in clean denatured alcohol.
  - Dry with unlubricated compressed air.

Assemble

- Lubricate inside and outside diameters of the primary piston bearing (8) with silicone grease.

1. Primary piston bearing (8) into the rear housing (9).
2. Power piston group (38) into the rear housing (9).
   - For power piston group assembly information, refer to "Power Piston Group" in this section.
3. Return spring (11).
4. Front and rear housings (10 and 9).
   - Attach J 22805-01 to the studs on front housing (10).
   - Install J 22805-01 with the front housing (10) attached in a vise.
   - Set the assembled rear housing (9), primary piston bearing (8), power piston group (38) and return spring (11) on front housing (10).
   - Insert the steel bar through the holes in the rear housing bracket.
   - Align the scribe marks on the front and rear housings (10 and 9).
   - Press down on the bar and apply force in a clockwise direction to lock the front and rear housings (10 and 9).
   - Assembly can be aided by connecting a vacuum source to the booster (35).
   - Remove J 22805-01 from the studs on the front housing (10).
   - Stake tabs on front and rear housings (10 and 9) (Figure 6).
     - Stake tabs in two locations 180 degrees apart.
     - Do not stake a tab that has previously been staked.

- Install exterior components. Refer to "Exterior Components" in this section.
- Install booster. Refer to "Booster Assembly Replacement" in this section.

POWER PISTON GROUP

Figures 7 through 11

Tool Required:

J 28458 Retainer Installer (Power Piston Seal Protector)

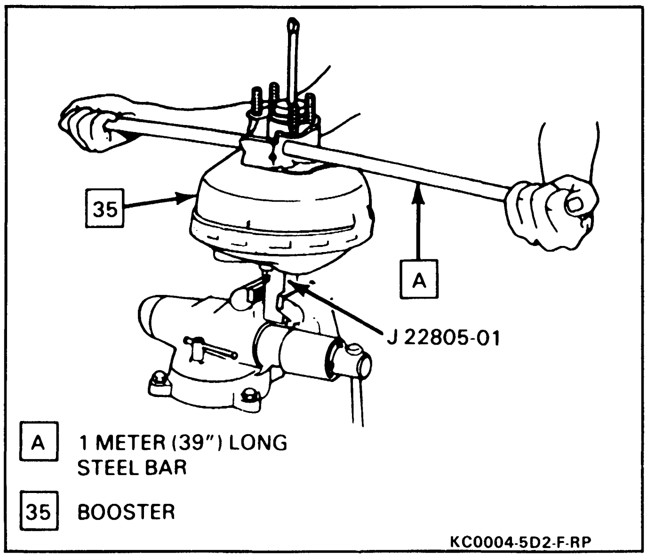


Figure 4 - Unlocking and Locking Booster

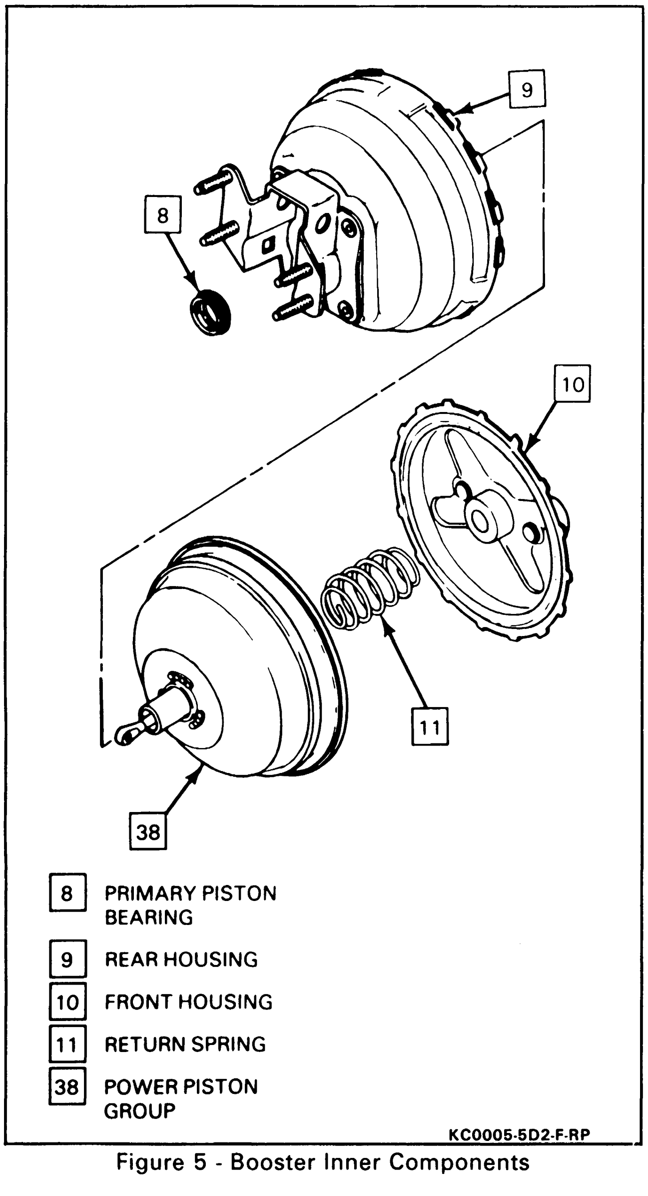


Figure 5 - Booster Inner Components

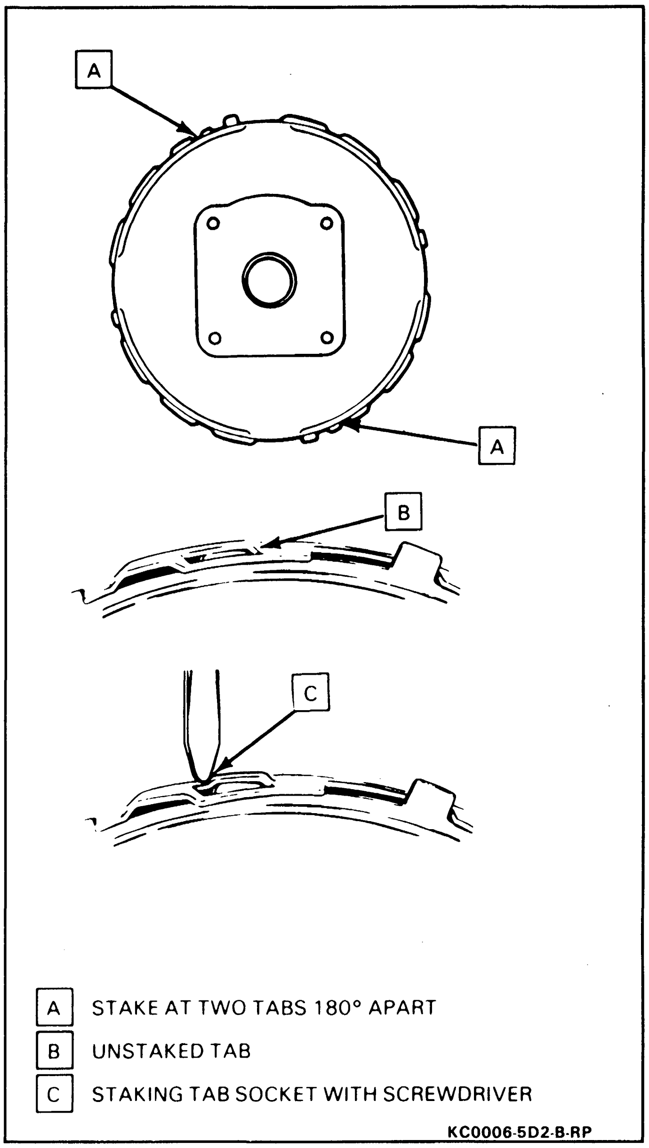


Figure 6 - Staking Procedure

Disassemble

- Remove booster from the vehicle. Refer to "Booster Assembly Replacement" in this section.

1. Booster. Refer to "Booster Assembly Overhaul" in this section.
2. Piston rod (12), the reaction retainer (13) and the power head silencer (14).
3. Power piston assembly (41) and the pushrod (32).
   - Grasp the assembly at the outside edge of the housing divider (19) and the primary and secondary diaphragms (16 and 20).
   - Hold with the pushrod (32) down against a hard surface.
   - Use a slight force or impact to dislodge the diaphragm retainer (15).
4. Primary diaphragm (16) and the primary support plate (17) from the housing divider (19).
5. Primary diaphragm (16) from the primary support plate (17).
6. Secondary diaphragm (20) and the secondary support plate (21) from the housing divider (19).

7. Secondary piston bearing (18) from the housing divider (19).
8. Secondary diaphragm (20) from the secondary support plate (21).

Inspect

- Parts for corrosion, nicks, cracks, scoring, distortion, and excessive wear.
  - Use crocus cloth to polish away minor corrosion on primary and secondary support plates (17 and 21) or housing divider (19).

Clean

- All parts in clean denatured alcohol.
  - Do not immerse power assembly (41) and pushrod (32) in alcohol. Wipe clean only with an alcohol dampened cloth.
  - Dry all parts with unlubricated compressed air.

Assemble

- Lubricate inside diameter of secondary diaphragm lip, inside diameter of primary diaphragm lip and secondary piston bearing (18) with a thin layer of silicone grease.

1. Secondary diaphragm (20) into the secondary support plate (21).
2. Secondary diaphragm (20) and the support plate (21) over the power piston assembly (41) and the pushrod (32).
   - Use J 28458 as a guide to protect the power piston.
3. Secondary piston bearing (18) into the housing divider (19) with flat surface of the bearing on the same side as the raised lugs on the divider.
4. Secondary piston bearing (18) and the housing divider (19) over the power piston assembly (41) and the pushrod (32).
   - Use J 28458 as a guide.
5. Primary diaphragm (16) into the primary support plate (17).
6. Primary diaphragm (16) by folding it up, away from the primary support plate (17).
7. Primary diaphragm (16) and the support plate (17) over the power piston assembly (41) and the pushrod (32).
8. Primary diaphragm (16) by folding it back into position and pulling the diaphragm outside diameter over the formed flange of the housing divider (19).
   - Check that the beads on the secondary diaphragm (20) are seated evenly all the way around.
9. New diaphragm retainer (15) and seat it using J 28458.
10. Power head silencer (14), the reaction retainer (13), and the piston rod (12).
11. Booster. Refer to "Booster Assembly Overhaul" in this section.

- Install booster. Refer to "Booster Assembly Replacement" in this section.

POWER PISTON OVERHAUL

Figures 12 through 14

Tool Required:

J 29282 Air Valve Pushrod Retainer Installer

Disassemble

1. Power piston group. Refer to "Power Piston Group" in this section.
2. Reaction body retainer (24).
3. Reaction body (25).
4. Reaction disc (22) and the reaction piston (23) from the reaction body (25).
5. Air valve spring (26) and the reaction bumper (27) from the end of pushrod (32).
6. Retaining ring (28) from the pushrod (32) using retaining ring pliers.
7. Pushrod (32) by inserting a screwdriver through the pushrod eyelet and pulling straight out with considerable force.
8. Filter (29), the retainer (30) and the O-ring (31) from the pushrod (32).

Inspect

- Power piston (33) for cracks.
- Rubber parts for cuts or nicks.
- Pushrod (32) for corrosion.

Clean

- All parts in clean denatured alcohol.
  - Dry with unlubricated compressed air.

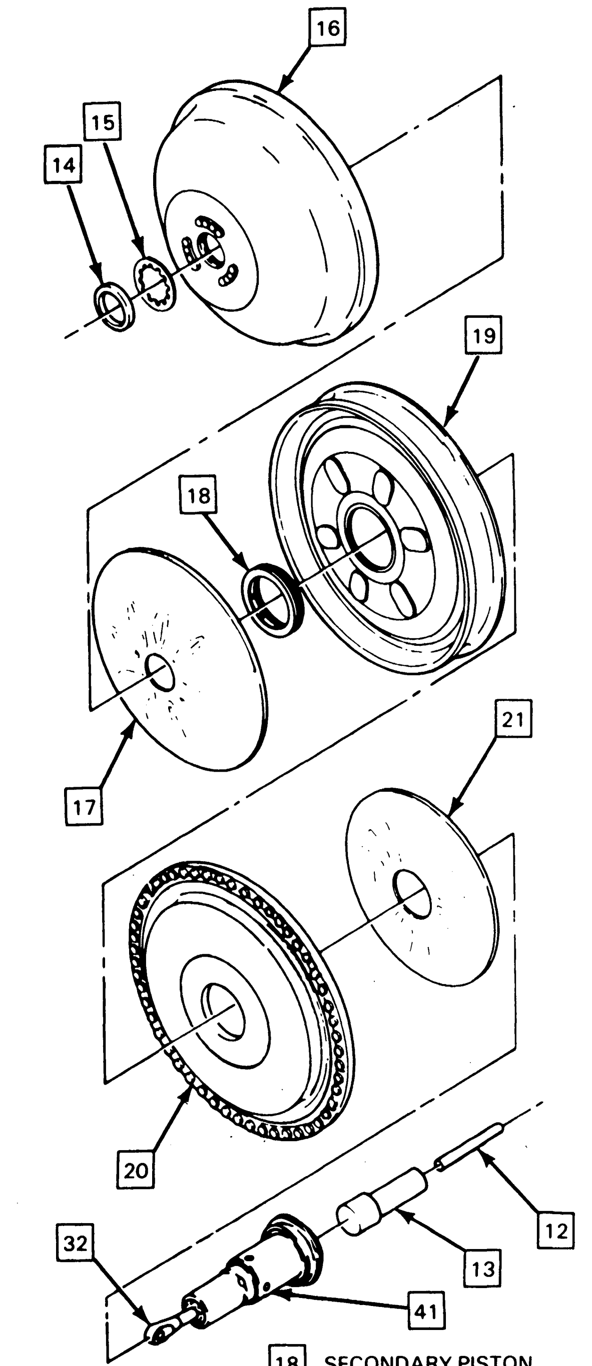
Assemble

- Lubricate O-ring (31) with silicone grease.

1. Lubricated O-ring (31) onto the pushrod (32).
2. Pushrod (32) into the power piston assembly (41).
3. Retainer (30) and seat it using J 29282.
4. Filter (29) over the pushrod eyelet into the power piston assembly (41).
5. Retaining ring (28) onto the pushrod (32) using retaining ring pliers.
6. Reaction bumper (27) and the air valve spring (26).
7. Reaction piston (23) and the reaction disc (22) into the reaction body (25).
8. Reaction body (25).
9. Reaction body retainer (24).
10. Power piston group. Refer to "Power Piston Group" in this section.

Measure

- Height of piston rod. Refer to "Gaging Procedure" in this section.



12 PISTON ROD
13 REACTION RETAINER
14 POWER HEAD SILENCER
15 DIAPHRAGM RETAINER
16 PRIMARY DIAPHRAGM
17 PRIMARY SUPPORT PLATE
18 SECONDARY PISTON BEARING
19 HOUSING DIVIDER
20 SECONDARY DIAPHRAGM
21 SECONDARY SUPPORT PLATE
32 PUSHROD
41 POWER PISTON ASSEMBLY

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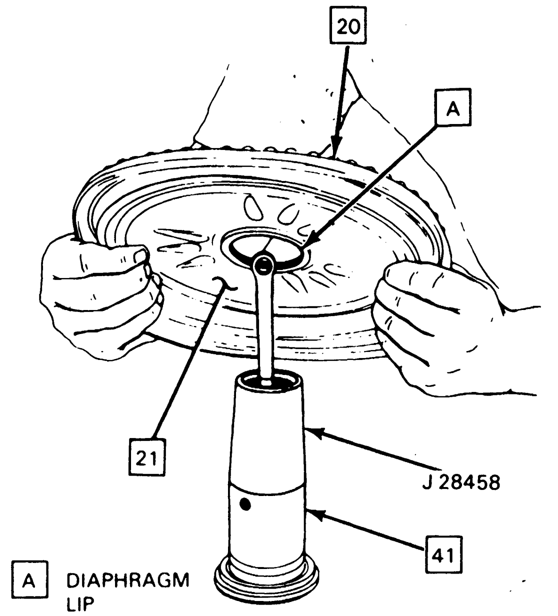
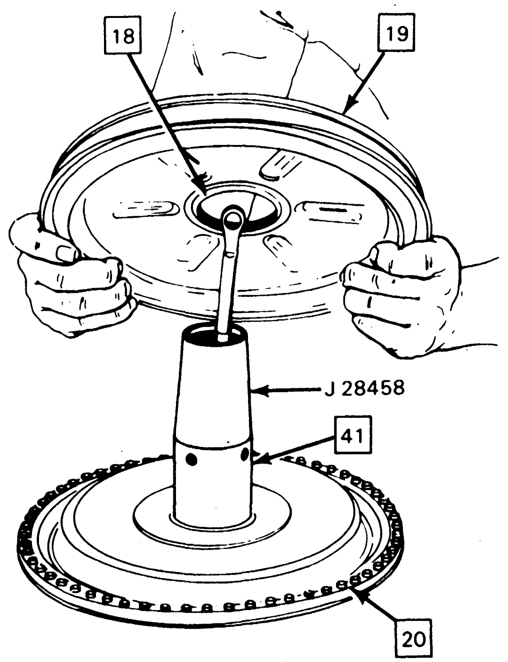
Figure 7 - Power Piston Group



A DIAPHRAGM LIP
20 SECONDARY DIAPHRAGM
21 SECONDARY SUPPORT PLATE
41 POWER PISTON ASSEMBLY

KC0008-5D2-B-RP

Figure 8 - Assembling Secondary Diaphragm and Support Plate



18 SECONDARY PISTON BEARING
19 HOUSING DIVIDER
20 SECONDARY DIAPHRAGM
41 POWER PISTON ASSEMBLY

KC0009-5D2-B-RP

Figure 9 - Assembling Housing Divider

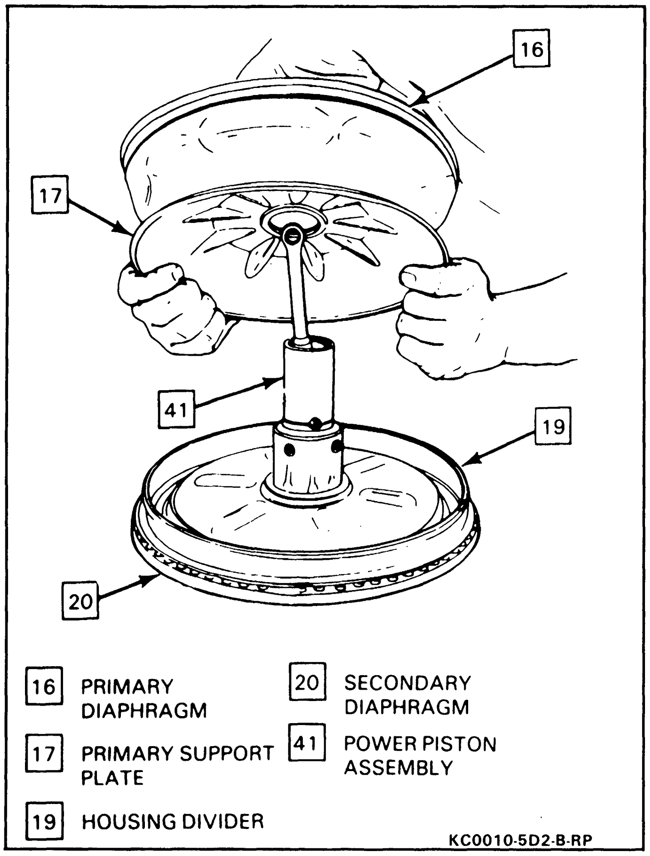


Figure 10 - Assembling Primary Diaphragm and Support Plate

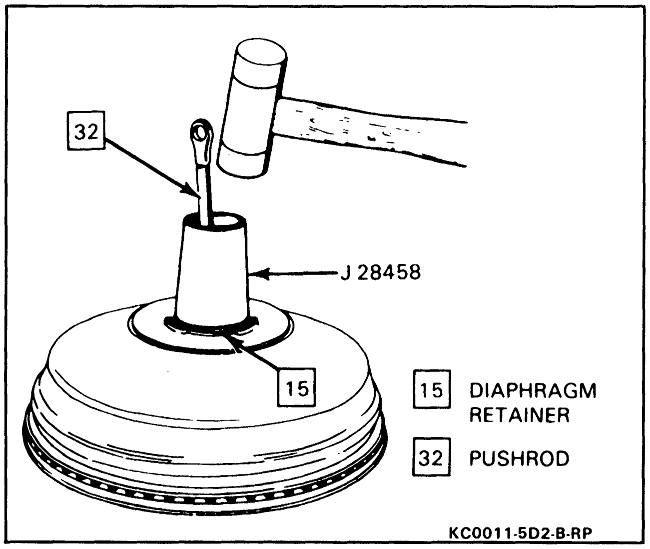


Figure 11 - Sealing Diaphragm Retainer

GAGING PROCEDURE

Figure 15

Tool Required:

J 37839 Pushrod Height Gage

1. Gage the booster with 85 kPa (25 in. Hg) vacuum.
   - The booster can be gaged without being installed on the vehicle by using either a suitable vacuum source or the maximum vacuum available from the engine.

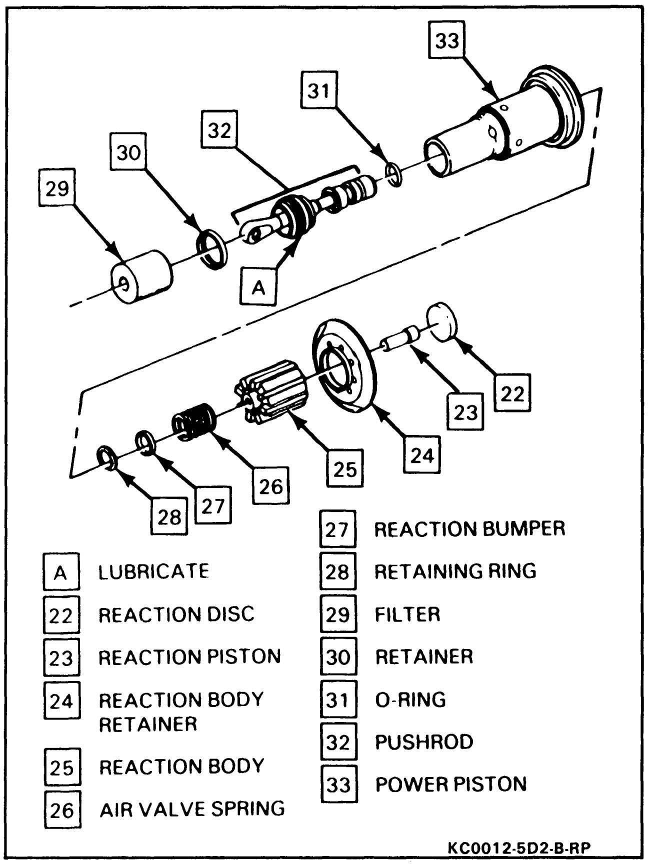


Figure 12 - Power Piston Assembly

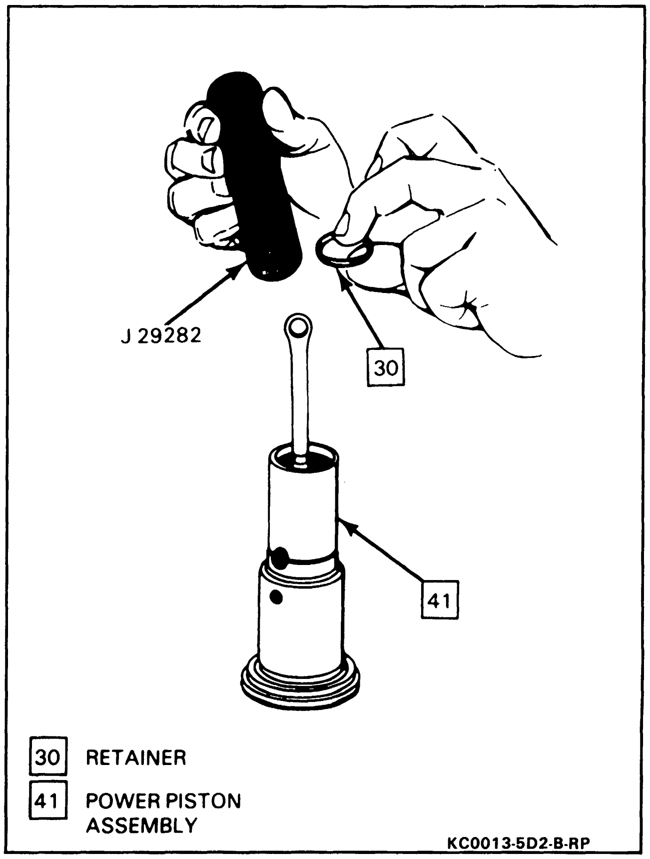


Figure 13 - Retainer Assembly

2. After the booster has been assembled, position J 37839 over piston rod (12).
   - Check both maximum and minimum rod length.
3. If the piston rod length does not fall between the maximum and minimum dimensions, use a service-adjustable piston rod (12) to obtain the correct length.

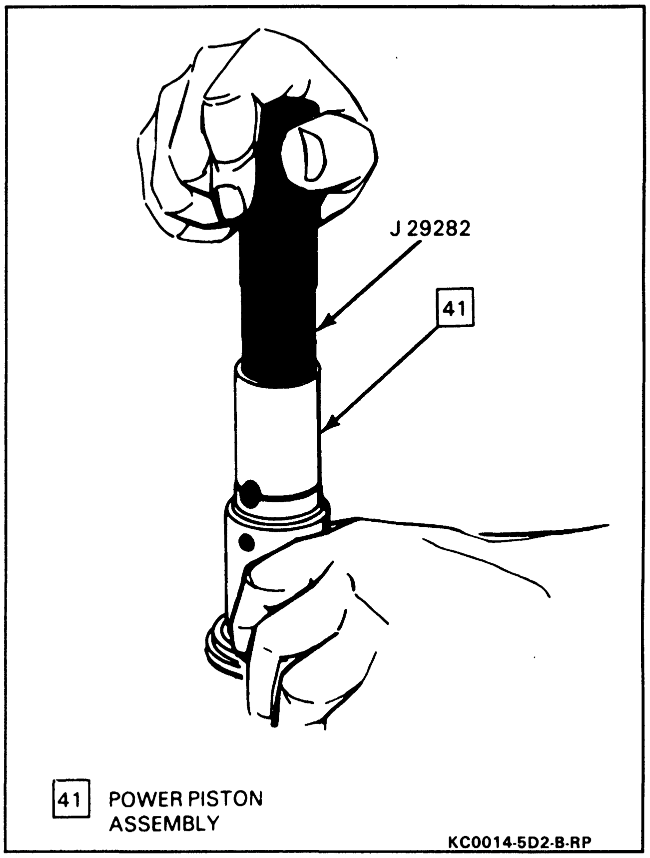


Figure 14 - Installing Retainer Into Piston

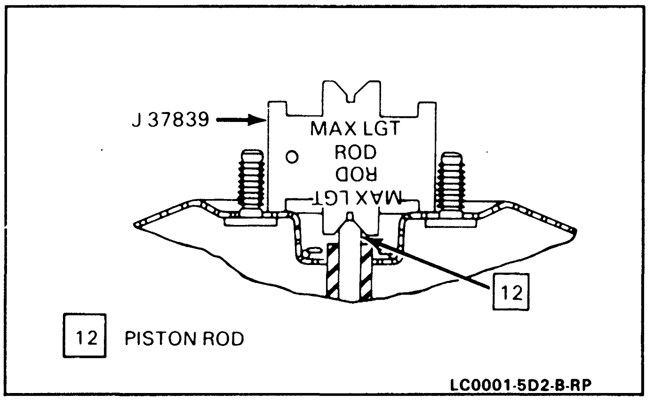


Figure 15 - Gaging Piston Rod

SECTION 6

ENGINE

CONTENTS

SECTION 6

ENGINE GENERAL INFORMATION AND MECHANICAL DIAGNOSIS

CONTENTS

ALL NEW GENERAL MOTORS VEHICLES ARE CERTIFIED BY THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY AS CONFORMING TO THE REQUIREMENTS OF THE REGULATIONS FOR THE CONTROL OF AIR POLLUTION FROM NEW MOTOR VEHICLES. THIS CERTIFICATION IS CONTINGENT ON CERTAIN ADJUSTMENTS BEING SET TO FACTORY STANDARDS. IN MOST CASES, THESE ADJUSTMENT POINTS EITHER HAVE BEEN PERMANENTLY SEALED AND/OR MADE INACCESSIBLE TO PREVENT INDISCRIMINATE OR ROUTINE ADJUSTMENT IN THE FIELD. FOR THIS REASON, THE FACTORY PROCEDURE FOR TEMPORARILY REMOVING PLUGS, CAPS, ETC., FOR PURPOSES OF SERVICING THE PRODUCT MUST BE STRICTLY FOLLOWED AND, WHEREVER PRACTICABLE, RETURNED TO THE ORIGINAL INTENT OF THE DESIGN.

DESCRIPTION OF SECTION 6

SECTION 6A - ENGINE MECHANICAL

This section contains information on the mechanical parts of the engine, such as block, crankshaft, pistons, valve train, and camshaft. Overhaul procedures, removal and replacement procedures, and specifications are also covered. Specific subsections are:

6A2 - 3.1 Liter V6

6A3 - V8 Engines

SECTION 6B - COOLING AND RADIATOR

Engine cooling system components such as radiator, water pump, hoses, thermostat, and cooling fan, are covered in this section.

SECTION 6C - ENGINE FUEL

This section contains information on all the parts of the fuel system except the fuel injectors, or Throttle Body Injection (TBI) unit itself. Items covered are: fuel tank, fuel pump, fuel filter, and fuel lines.

SECTION 6D - ENGINE ELECTRICAL

Items covered in this section are battery, generator, starter, distributor, engine wire harness, spark plugs and wires.

Ignition system diagnosis can be found in the appropriate 6E Section as a "C-4" chart.

Specific subsections are:

6D – Engine Electrical

6D1 – Battery

6D2 – Cranking System

6D3 – Charging System

6D4 – Ignition System

6D5 – Engine Wiring

SECTION 6E - DRIVEABILITY AND EMISSIONS - GENERAL INFORMATION

This section covers emission control systems, general information, and diagnostic procedures which will lead to repairing performance and driveability related problems. Emission components are covered, as well as removal and replacement procedures. Instructions on use of special tools are also given. Specific subsections are:

6E – Driveability and Emissions - General Information

6E2 – Driveability and Emissions - Fuel Injection (TBI)

6E3 – Driveability and Emissions - Fuel Injection (Port)

SECTION 6F - EXHAUST SYSTEM

This section has information on all exhaust system parts, such as tailpipes, mufflers, and the catalytic converter.

GENERAL INFORMATION

CLEANLINESS AND CARE

An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in the ten-thousandths of an inch. When any internal engine parts are serviced, care and cleanliness are important. A liberal coating of engine oil should be applied to friction areas during assembly, to protect and lubricate the surfaces on initial operation. Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure. This is considered standard shop practice even if not specifically stated.

Whenever valve train components are removed for service, they should be kept in order. They should be installed in the same locations, and with the same mating surfaces, as when removed.

Battery cables should be disconnected before any major work is performed on the engine. Failure to disconnect cables may result in damage to wire harness or other electrical parts.

GENERAL INFORMATION ON ENGINE SERVICE

! Important

THE FOLLOWING INFORMATION ON ENGINE SERVICE SHOULD BE NOTED CAREFULLY, AS IT IS IMPORTANT IN PREVENTING DAMAGE AND IN CONTRIBUTING TO RELIABLE ENGINE PERFORMANCE.

When raising or supporting the engine for any reason, do not use a jack under the oil pan. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen resulting in a damaged oil pick-up unit.

When working on the engine, remember that the 12-volt electrical system is capable of causing short circuits. When performing any work where electrical terminals could possibly be grounded, the ground cable of the battery should be disconnected at the battery.

Any time the air cleaner is removed, the intake opening should be covered. This will protect against accidental entrance of foreign material, which could follow the intake passage into the cylinder and cause extensive damage when the engine is started.

IN THE MECHANICAL PROCEDURES DESCRIBED IN THIS SECTION, GENERALLY REFERENCES WILL BE MADE TO THE REMOVAL OF EQUIPMENT SUCH AS POWER STEERING PUMP, AIR CONDITIONING COMPRESSOR, ETC.

SHOULD IT BECOME NECESSARY TO REMOVE ANY SUCH ITEM TO PERFORM OTHER SERVICES, REFER TO THE APPROPRIATE SECTION OF THIS SERVICE MANUAL FOR SPECIFIC INFORMATION.

ENGINE PERFORMANCE DIAGNOSIS

Engine performance diagnosis procedures are covered in Section 6E and should be consulted for diagnosis of any driveability, emissions, or "Service Engine Soon" light complaint.

Refer to:

- Section 6E - Driveability and Emissions - General Information
- Section 6E2 - Driveability and Emissions - Fuel Injection (TBI)
- Section 6E3 - Driveability and Emissions - Fuel Injection (Port)

ENGINE MECHANICAL DIAGNOSIS

The following diagnostic information covers common problems and possible causes. When the proper diagnosis is made, the problem should be corrected by adjustment, repair or part replacement as required. Refer to the appropriate section of the manual for these procedures.

EXCESSIVE OIL LOSS

Excessive oil consumption not due to leaks, is the use of 2 quarts (1.9L) or more of engine oil within 2,000 miles or 3,200 kilometers.

- External oil leaks. Tighten bolts and/or replace gaskets and seals as necessary.
- Improper reading of oil level indicator (dipstick). Check oil with vehicle on a level surface and allow adequate drain-down time.
- Improper oil viscosity. Use recommended S.A.E. viscosity for prevailing temperatures. Refer to MAINTENANCE AND LUBRICATION (SEC. OB) for engine oil specifications.
- Continuous high speed driving, and/or severe usage such as trailer hauling, will normally cause decreased oil mileage.
- Crankcase ventilation system malfunctioning.
- Valve guides and/or valve stem seals worn, or seals omitted. Ream guides and install oversize service valves and/or new valve stem seals.
- Piston rings broken, improperly installed, worn, or not seated. Allow adequate time for rings to seat. Replace broken or worn rings as necessary.
- Piston improperly installed or misfitted.

OIL LEAK DIAGNOSIS

Most fluid oil leaks are easily located and repaired by visually finding the leak and replacing or repairing the necessary parts. On some occasions a fluid leak may be difficult to locate or repair. The following procedure may help in locating and repairing most leaks.

Finding the Leak

1. Identify the fluid, determine whether it is engine oil, automatic transmission fluid, power steering fluid, etc.
2. At what point is the fluid leaking from? After running the vehicle at normal operating temperature, park the vehicle over a large sheet of paper. After a few minutes, the approximate location of the leak should be found by the drippings on the paper.
3. Visually check around the suspected component. Check around all gasket mating surfaces for leaks. A mirror is useful for finding leaks in areas that are hard to reach.
4. If the leak still cannot be found, it may be necessary to clean the suspected area with a degreaser, steam or spray solvent. Clean the area well, then dry the area. Operate the vehicle for several miles at normal operating temperature and varying speeds. After operating the vehicle, visually check the suspected component. If leak still cannot be located, try using the powder or black light and dye method.

Powder Method

1. Clean the suspected area.
2. Apply an aerosol-type powder (such as foot powder) to the suspected area.
3. Operate the vehicle under normal operating conditions.
4. Visually inspect the suspected component. The leak path to the source should be found by tracing the white powder surface.

Black Light and Dye Method

A dye and light kit is available for finding leaks. Refer to the manufacturer's directions when using the kit.

1. Pour specified amount of dye into leaking component.
2. Operate the vehicle under normal operating conditions as directed in the kit.
3. Direct the light toward the suspected area. The dyed fluid will appear as a yellow path leading to the source.

Repairing the Leak

Once the origin of the leak has been pinpointed and traced back to its source, the cause of the leak must be determined in order for it to be repaired properly. If a gasket is replaced, but the sealing flange is bent, the new gasket will not repair the leak. The bent flange must be repaired also. Before attempting to repair a leak, check to be sure that the following conditions are correct as they may cause a leak.

Gaskets

Inspect

1. Fluid level/pressure is too high.
2. Crankcase ventilation system malfunctioning.
3. Improperly tightened fasteners or dirty/damaged threads.

4. Warped flanges or sealing surface.
5. Scratches, burrs or other damage to the sealing surface.
6. Damaged or worn gasket.
7. Cracking or porosity of the component.
8. Improper sealant used (where applicable).

Seals

Inspect

1. Fluid level/pressure is too high.
2. Crankcase ventilation system malfunctioning.
3. Damaged seal bore (scratched, burred or nicked).
4. Damaged or worn seal.
5. Improper installation.
6. Cracks in component.
7. Shaft surface scratched, nicked or damaged.
8. Loose or worn bearing causing excess seal wear.

LOW OR NO OIL PRESSURE

- Low oil level. Fill to full mark on oil level indicator.
- Slow idle speed.
- Incorrect or malfunctioning oil pressure switch.
- Incorrect or malfunctioning oil pressure gage. Replace with proper gage.
- Improper oil viscosity or diluted oil. Install oil of proper viscosity for expected temperature, or install new oil if diluted with moisture or unburned fuel mixtures.
- Oil pump worn or dirty.
- Plugged oil filter.
- Oil pickup screen loose or plugged.
- Hole in oil pickup tube.
- Excessive bearing clearance. Replace if necessary.
- Cracked, porous or plugged oil galleries. Repair or replace block.
- Gallery plugs missing or misinstalled. Install plugs or repair as necessary.
- Camshaft worn, or poorly machined. Replace camshaft.

ENGINE NOISE DIAGNOSIS

There are four steps to diagnosing engine noise. You must determine:

- Type of noise.
- Under which operating conditions it exists.
- At what rate, and at what location in the engine.
- Compare sounds in other engines to make sure the condition is not normal.

Identify the type of noise, for example, a light rattle or a low rumble. Determine the exact operating conditions under which the noise appears.

Remember, engine noises are generally synchronized to either engine speed (caused by the crankshaft, connecting rods or pistons) or one-half engine speed (valve train noises). Try to determine the rate at which the noise is occuring.

MAIN BEARING NOISE

Damaged or worn main bearing noise is revealed by dull thuds or knocks which happen on every engine revolution, and this noise is loudest when the engine is under heavy load.

Excessive crankshaft end play is indicated by an intermittent rap or knock sharper than a worn main bearing. On manual transmission-equipped vehicles, the disengagement of the clutch can cause a change in the noise. Cause of main bearing noises include:

- Low oil pump pressure.
- Thin, diluted or dirty oil and/or filter.
- Excessive main bearing clearance.
- Excessive crankshaft end play.
- Out-of-round crankshaft journals.
- Excessive belt tension.
- Loose crankshaft pulley.
- Loose flywheel or torque converter.
- Loose main bearing cap.

CONNECTING ROD BEARING NOISE

A damaged or worn connecting rod bearing will produce knock under all speeds. During the early stages of wear, connecting rod noise may be confused with piston slap or loose wrist pins. Connecting rod knock noise increases in volume with engine speed and is at its loudest on deceleration. Causes of connecting rod bearing noise include:

- Excessive bearing clearance.
- Worn crankshaft connecting rod journal.
- Thin, diluted or dirty oil and/or filter.
- Low oil pressure.
- Crankshaft connecting rod journals out-of-round.
- Misaligned connecting rod.
- Connecting rod bolts not properly torqued.
- Wrong bearing inserts or misaligned bearing half.

TIMING GEAR OR CHAIN AND SPROCKET NOISES

Engines designed with timing gears, or those equipped with a timing chain and sprockets, can produce different noises. The most common noise is a high frequency, light-knocking sound. This sound will generally be the same in intensity whether the engine is idling, operating at high speeds, or under load. Causes of timing gear or chain and sprocket noises include:

- Worn timing chain and/or gears.
- Misaligned gears.
- Excessive backlash.
- Damaged tooth.
- Gear or sprocket loose on shaft.
- Too much end play in the camshaft or crankshaft.

PISTON NOISES

Piston pin, piston, and connecting rod noises are hard to separate. A loose piston pin, for example, causes a sharp double knock usually heard when the engine is idling, or during sudden acceleration then deceleration of the engine. A piston pin that has been improperly fitted will emit a light ticking noise that is more noticeable with no load on the engine.

Excessive piston-to-cylinder bore clearance will cause piston slap noise. The noise is similar to a metallic knock, as if the piston were "slapping" the cylinder wall during its stroke. As with most engine noises, understanding the cause of the noise will help you imagine what the noise sounds like. An indication of piston slap is a decrease in noise as the engine warms up. When the engine is cold, the piston to bore clearance is greater and piston slap will be louder. Causes of piston noises include:

- Worn or loose piston pin or bushing.
- Improper fit of pin.
- Excessive piston-to-cylinder bore clearance (piston slap).
- Lack of lubrication.
- Carbon deposits on top of piston striking cylinder head.
- Worn or broken piston ring land.
- Broken or cracked piston.
- Misaligned connecting rods.
- Worn or damaged rings.
- Worn or out-of-round cylinder walls.
- Excessive ring land clearance.
- Insufficient ring-end gap clearance.
- Piston 180 degrees out of position.
- Incorrect piston cam grind.

VALVE MECHANISM OR VALVE TRAIN NOISES

A light tapping at one-half engine speed, or any varying frequency, can indicate a valve train problem. These tapping noises increase with engine speed.

Before attempting to judge valve train noises, thoroughly warm up the engine. This will bring all engine components to a normal state of expansion. Also, run the engine at various speeds and listen for engine noise with the hood closed while sitting in the driver's seat.

If the valve mechanism is abnormally noisy, remove the rocker arm covers and use an engine stethoscope to determine which valves or valve train parts are causing the noise.

CAUTION: This procedure is not recommended on engines with stainless steel exhaust manifolds because manifold temperature will exceed the flash point of the oil causing a fire with possible personal injury.

The cause of valve mechanism noises include:

- Broken or weak valve spring(s).
- Sticking or warped valves.
- Bent pushrods.
- Dirty, stuck, worn or defective valve lifters.
- Damaged or improperly machined camshaft lobes.
- Insufficient or poor oil supply to valve train (low oil pressure).
- Excessive valve stem-to-guide clearance.
- Worn valve guides.
- Worn rocker arms or pushrods.
- Broken rocker arm stud.
- Loose or worn rocker arm attachments.
- Missing or mispositioned lifter guides (roller lifter engines).

FLYWHEEL NOISES (AUTOMATIC TRANSMISSION)

A loose or cracked flywheel will produce an irregular thud or click. To test for a loose or cracked flywheel, operate the vehicle at approximately 20 mph (32 km/h) and shut off the engine. If a thud is heard, the flywheel may be loose or damaged. This type of thud is loudest on deceleration.

Loose torque converter-to-flywheel or flywheel-to-crankshaft bolts will sound similar to bearing knock. This condition produces several raps during quick acceleration on a free running engine. Depending on the idle smoothness, when the tranmission is in gear, the noise may or may not appear. Check the torque converter-to-flywheel and flywheel-to-crankshaft bolts before attempting to investigate any bearing-related knock.

NOTICE: Be sure the converter-to-flywheel bolts are not too long. Converter bolts that are too long may dimple the torque converter clutch apply surface causing a shudder condition.

ENGINE KNOCK DIAGNOSIS

Noises in engines are sometimes characteristic of the design. Compare the sounds in other engines to make sure the condition is not normal.

KNOCKS COLD AND CONTINUES FOR TWO TO THREE MINUTES AND INCREASES WITH TORQUE

- Flywheel contacting splash shield. Reposition splash shield.
- Loose or broken balancer or drive pulleys. Tighten or replace as necessary.
- Excessive piston to bore clearance. Replace piston.
- Bent connecting rod.
  - Cold engine piston knock usually disappears when the cylinder is grounded out. Cold engine piston knock which disappears in 1.5 minutes should be considered acceptable.

HEAVY KNOCK HOT WITH TORQUE APPLIED

- Broken balancer or pulley hub. Replace parts as necessary.
- Loose torque converter bolts.
- Accessory belt too tight or nicked. Replace as necessary.
- Exhaust system grounded. Reposition as necessary.
- Flywheel cracked.
- Excessive main bearing clearance. Replace as necessary.
- Excessive rod bearing clearance. Replace as necessary.

LIGHT KNOCK HOT

- Detonation or spark knock. Check operation of EST or ESC Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (TBI) (SEC. 6E2) or DRIVEABILITY AND EMISSIONS - FUEL INJECTION (Port) (SEC. 6E3). Check engine timing and fuel quality.
- Loose torque converter bolts.
- Exhaust leak at manifold. Tighten bolts and/or replace manifold.
- Excessive rod bearing clearance. Replace bearings as necessary.

KNOCKS ON INITIAL START-UP BUT ONLY LASTS A FEW SECONDS

- Improper oil viscosity. Install proper oil viscosity for expected temperatures. Refer to MAINTENTANCE AND LUBRICATION (SEC. OB) for engine oil specifications.
- Hydraulic lifter bleed down. Clean, test and replace as necessary.
  - When the engine is stopped, some valves will be open. Spring pressure against lifters will tend to bleed lifter down. Attempts to repair should be made only if the problem is consistent.
  - An engine that is operated for only short periods between start-ups may have lifter noise that lasts for a few minutes. This is a normal condition.
- Excessive crankshaft end clearance. Replace crankshaft thrust bearing.
- Excessive front main bearing clearance. Replace worn parts.

KNOCKS AT IDLE HOT

- Loose or worn drive belt. Replace as necessary.
- A/C compressor or generator bearing. Replace as necessary.
- Valve train. Replace parts as necessary.
- Improper oil viscosity. Install proper viscosity oil for expected temperature. Refer to MAINTENANCE AND LUBRICATION (SEC. OB) for engine oil specifications.
- Excessive piston pin clearance. Replace piston and pin.
- Connecting rod alignment. Check and replace rods as necessary.
- Loose crankshaft balancer. Torque and/or replace worn parts.
- Piston pin offset to wrong side. Install correct piston.

ENGINE COMPRESSION TEST

A compression pressure test is performed on the engine cylinders to determine the condition of the rings, valves and head gasket.

Remove or Disconnect

- Run engine until it reaches normal operating temperature. Battery must be at or near full charge.

1. "BAT" terminal connector from distributor.
2. Spark plugs from all cylinders.
3. Air duct or air cleaner from throttle body.
   - Block throttle plate in open position.

Measure

- Engine compression.
  - Install compression gage firmly to cylinder spark plug hole.
  - Have a helper crank the engine through at least four compression strokes in the cylinder being tested and check the readings on the gage at each stroke. Record the results.
  - Disconnect gage.
  - Repeat compression test for each cylinder.

Inspect

- Recorded compression readings for all cylinders. The lowest reading should not be less than 70% of the highest and no cylinder reading should be less than 689 kPa (100 psi).
- Problem areas can be identified as follows:
  - Normal - Compression builds up quickly and evenly to specified compression on each cylinder.
  - Piston Rings - Compression is low on first stroke and tends to build up on following strokes, but does not reach normal. Compression improves considerably with the addition of oil.
  - Valves - Compression is low on first stroke and it does not tend to build up on following strokes. Compression does not improve much with the addition of oil. Use approximately three squirts from a plunger type oiler.
  - Head Gaskets - Leaking head gaskets give nearly the same test results as valve problems but may be recognized by engine coolant in the crankcase. Head gasket leakage between two cylinders will give low readings on both cylinders.

→← Install or Connect

- Remove block from throttle plate.

1. Air duct or air cleaner to throttle body.
2. Spark plugs.
3. "BAT" terminal connector to distributor.

SECTION 6A2

3.1 LITER V6

VIN CODE T - RPO LHO

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 6A2-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

CONSTRUCTION

Cylinder Block

The cylinder block is made of cast alloy iron and has 6 cylinders arranged in a "V" shape with 3 cylinders in each bank. The cylinder banks are set at a 60 degree angle from each other.

The right bank cylinders are numbers 1, 3, and 5. The left bank cylinders are numbers 2, 4, and 6.

Four main bearings support the crankshaft which is retained by bearing caps that are machined with the block for proper alignment and clearances.

Cylinder Head

The cast alloy iron cylinder heads have individual intake and exhaust ports for each cylinder. Valve guides are integral, and rocker arms are retained on individual threaded studs.

Crankshaft and Bearings

The crankshaft is cast nodular iron with deep rolled fillets on all six crankpins and two center main journals. Four steel-backed aluminum bearings are used. The number 3 bearing is the end-thrust bearing.

Camshaft and Drive

The camshaft is cast alloy iron with tapered 13.2 mm (0.52 inch) wide lobes, offset from the lifters and tapered to provide positive valve lifter rotation. The camshaft is supported by four journals and includes a distributor/oil pump drive gear.

A 3/8 inch pitch chain drives the camshaft through a hardened sintered iron sprocket. The crankshaft sprocket is also hardened sintered iron, and is pressed onto the nose of the crankshaft.

Pistons and Connecting Rods

The pistons are cast aluminum with steel struts using two compression rings and one oil control ring. The piston pin is offset 0.8 mm (0.031 inch) toward the major thrust side. This allows a gradual change in thrust pressure against the cylinder wall as the piston travels its path. Pins are chromium steel and have a floating fit in the pistons. They are retained in the connecting rods by a press fit.

Connecting rods are made of forged steel. Full pressure lubrication is directed to the connecting rods by drilled oil passages from the adjacent main bearing journal.

Valve Train

A ball pivot-type train is used. Motion is transmitted from the camshaft through the hydraulic lifter and pushrod to the rocker arm. The rocker arm pivots on its ball and transmits the camshaft motion to the valve. The rocker arm ball is located on a stud, threaded into the head, and is retained by a nut. The pushrod is located by a guide plate held under the rocker arm stud, assuring that the rocker arm operates in the plane of the valve.

Intake Manifold

The intake manifold is a three piece cast aluminum unit. It centrally supports a fuel rail with six fuel injectors.

Exhaust Manifolds

The exhaust manifolds are cast nodular iron.

ENGINE LUBRICATION

Figures 1 through 4

Full pressure lubrication, through a full flow oil filter is furnished by a gear type oil pump. Oil is drawn up through the pickup screen and tube and passed through the pump to the oil filter.

The oil filter is a full flow paper element unit. An oil filter by-pass is used to ensure adequate oil supply should the filter develop excessive pressure drop. The by-pass is designed to open at 69-83 kPa (10-12 psi).

From the filter, oil is routed to the main oil gallery, rifle drilled above the camshaft to the left of the camshaft centerline. This gallery supplies the left bank hydraulic lifters with oil.

From the left gallery, oil is directed by means of intersecting passages to the camshaft bearings and right oil gallery.

The hydraulic lifters pump oil up through the pushrods to the rocker arms. Oil draining back from the rocker arms is directed, by cast dams which are part of the crankcase casting, to supply the camshaft lobes.

The passages supplying oil to the camshaft bearings also supply the crankshaft main bearings through intersecting vertical drilled holes. Oil from the crankshaft main bearings is supplied to the connecting rod bearings by means of intersecting passages drilled in the crankshaft.

Oil also drains past specific hydraulic lifter flats to oil camshaft lobes directly.

The front cam bearing has a 0.25 mm (0.010 inch) deep slot on its outside diameter to supply oil to the cam sprocket thrust face.

ON-VEHICLE SERVICE

SERPENTINE DRIVE BELT

For information on routing and checking the serpentine drive belt tension, refer to COOLING AND RADIATOR (SEC. 6B).

ENGINE MOUNTS AND BRACKETS

Figure 5

Engine mounts are the nonadjustable type and seldom require service. Broken or deteriorated mounts should be replaced immediately, because of the added strain placed on other mounts and drive line components.

Checking Engine Mounts

Front Mount

NOTICE: See "Notice" on page 6A2-1 of this section.

Raise the engine to remove weight from the mounts and to place a slight tension in the rubber. Observe both mounts while raising engine. If an engine mount exhibits hard rubber surface covered with heat check cracks, rubber separated from a metal plate of the mount, or rubber split through center, replace the mount. If there is relative movement between a metal plate of the mount and its attaching points, lower the engine on the mounts and tighten the screws or nuts attaching the mount to the engine, frame, or bracket.

Rear Mount

NOTICE: See "Notice" on page 6A2-1 of this section.

Raise the vehicle on a hoist. Push up and pull down on the transmission tailshaft while observing the transmission mount. If the rubber separates from the metal plate of the mount or if the tailshaft moves up but not down (mount bottomed out), replace the mount. If there is relative movement between a metal plate of the mount and its attaching point, tighten the screws or nuts attaching the mount to the transmission or crossmember.

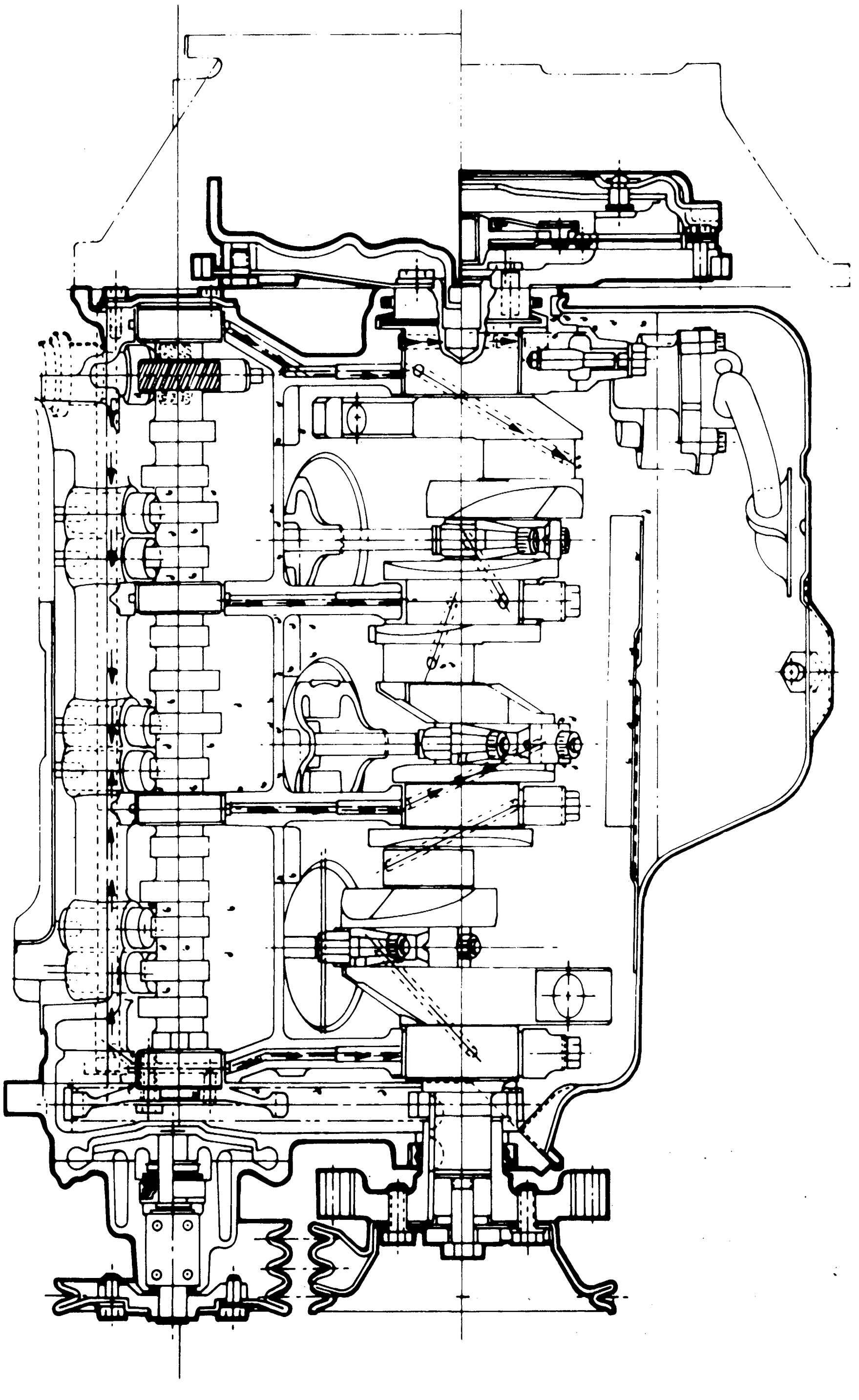


Figure 1 - Engine Lubrication (1 of 4)

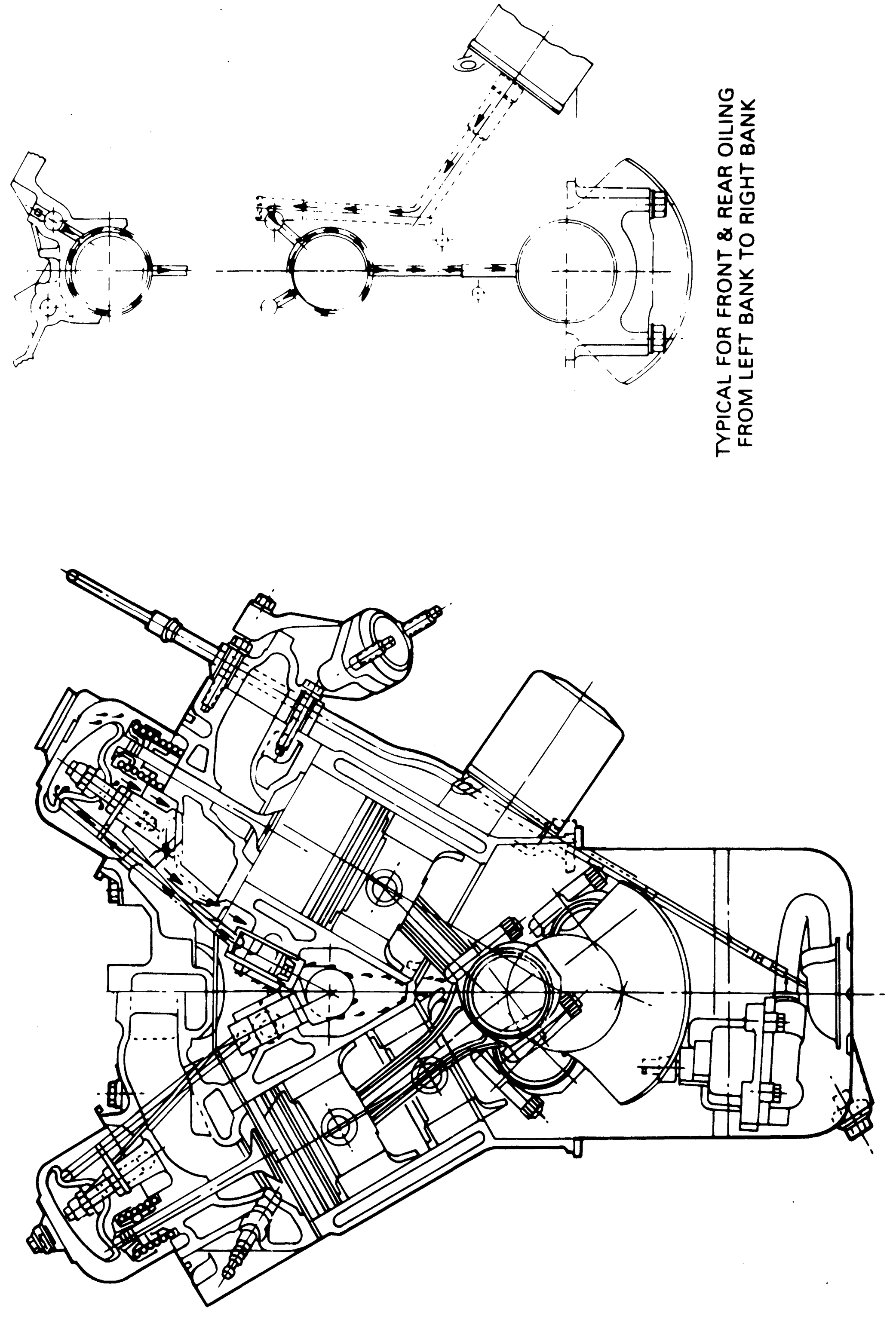


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Figure 2 - Engine Lubrication (2 of 4)

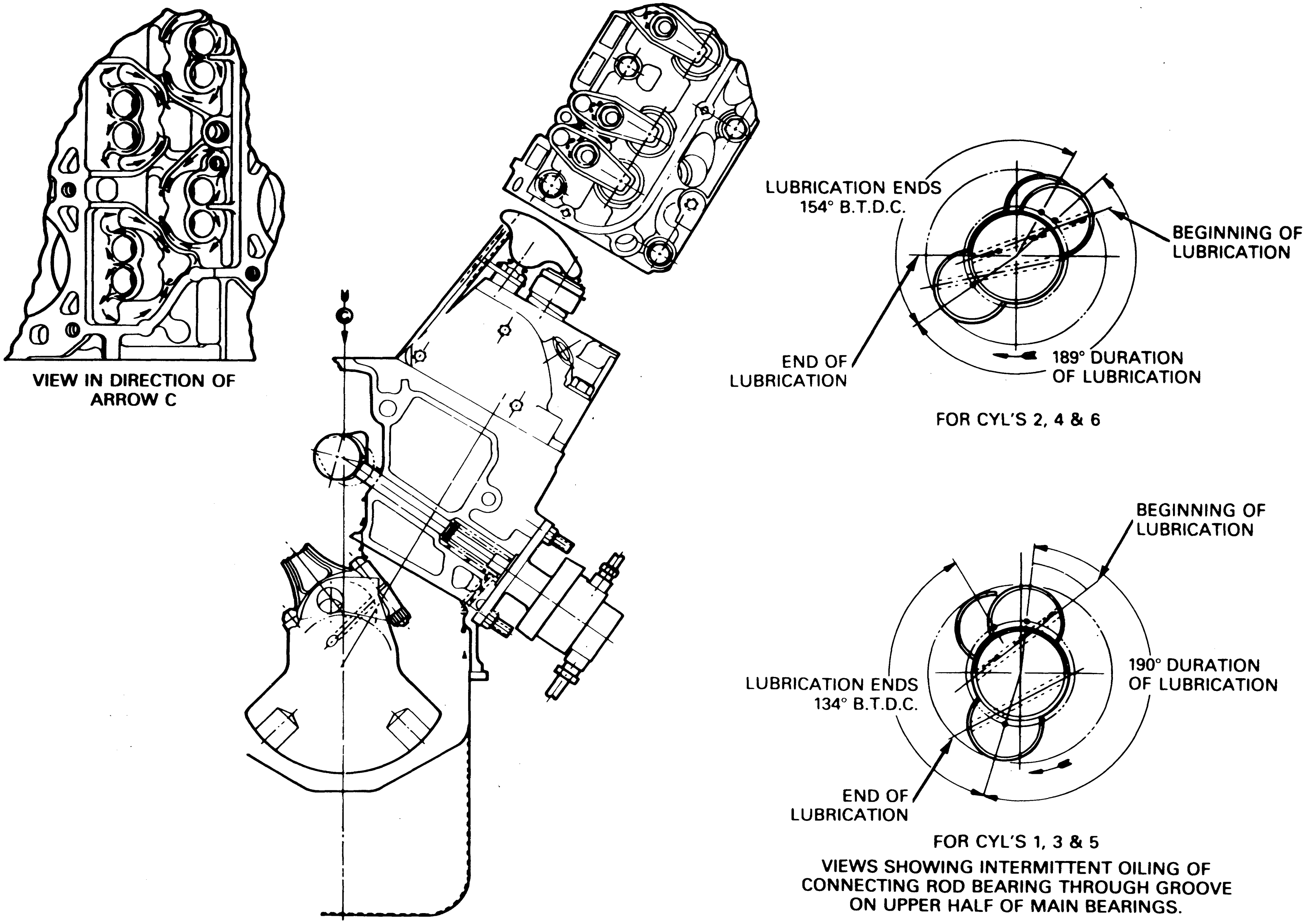

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Figure 3 - Engine Lubrication (3 of 4)

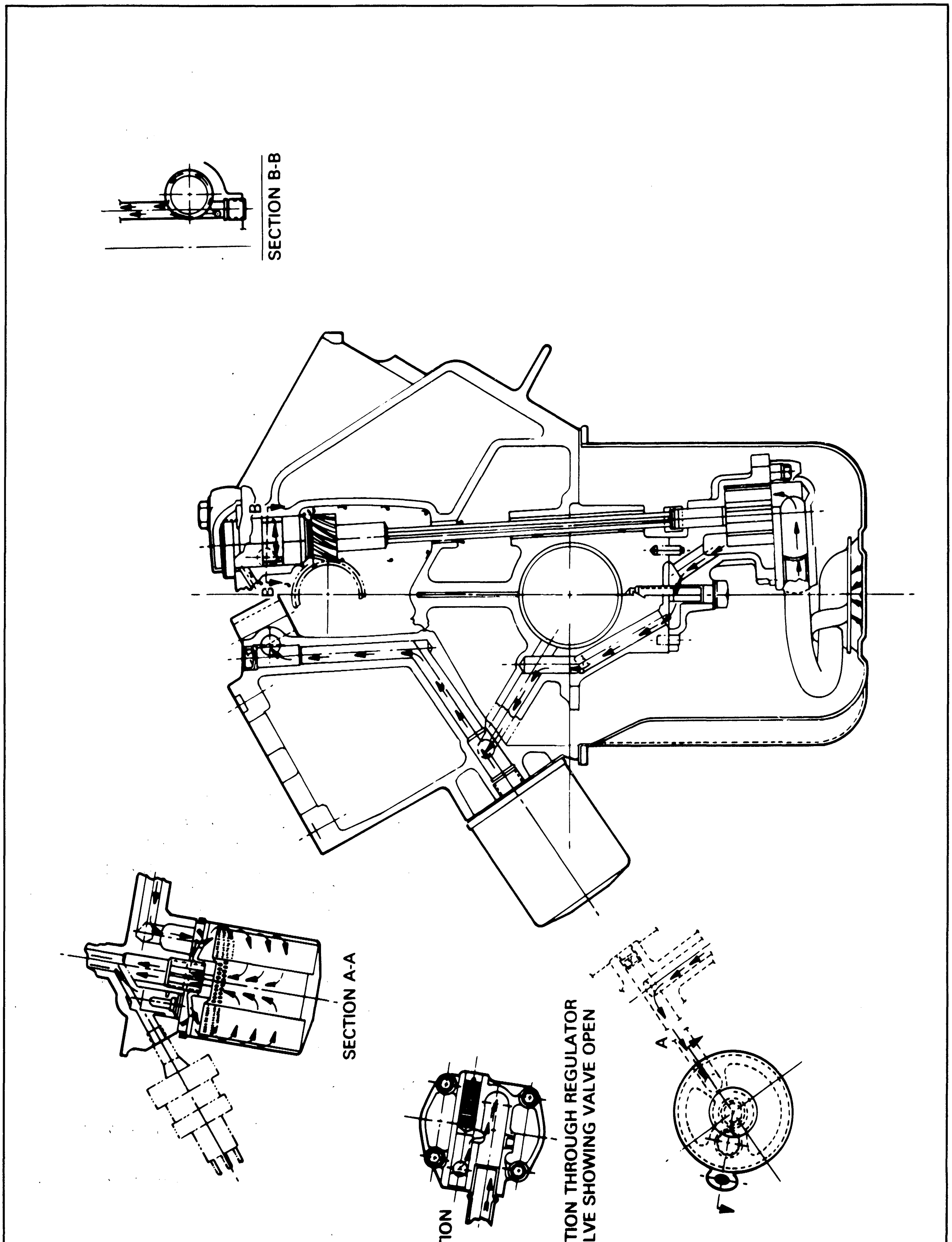

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Figure 4 - Engine Lubrication (4 of 4)

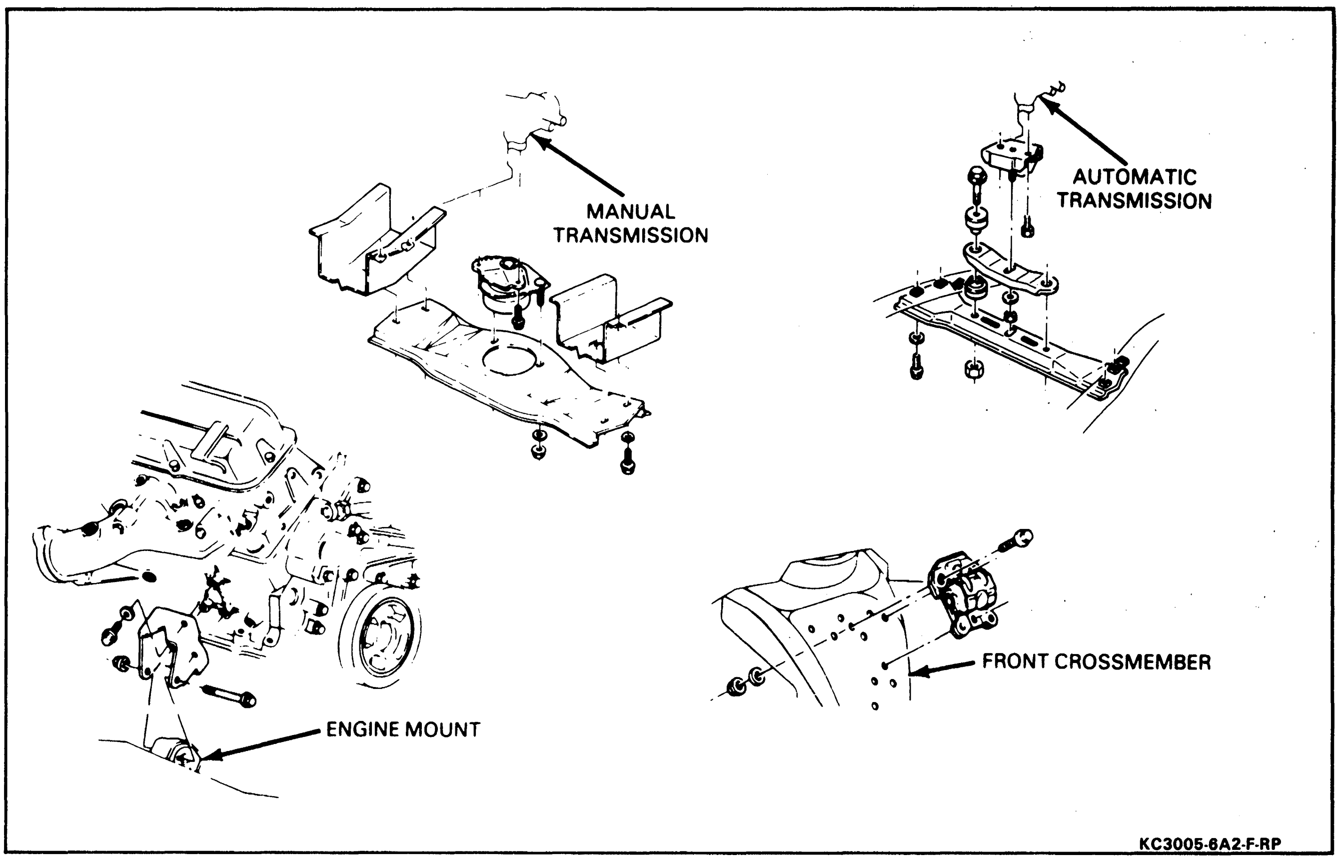


Figure 5 - Engine Mounting

Front Mount Replacement

↔ Remove or Disconnect

1. Negative battery cable.
- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).
2. Engine mount-to-engine bracket through-bolt nuts and through-bolts.
- Raise engine to remove weight from mounts.
3. Engine mount bolts, nuts and washers from front crossmember.
4. Engine mount.

→← Install or Connect

NOTICE: See "Notice" on page 6A2-1 of this section.

1. Engine mount, bolts, nuts and washers to front crossmember.

Tighten

- Engine mount nuts to 41 N·m (30 lb. ft.).

- Lower engine.
2. Engine mount-to-engine bracket through-bolts and nuts.

Tighten

- Engine mount through-bolt nuts to 68 N·m (50 lb. ft.).

- Lower vehicle.
3. Negative battery cable.

Rear Mount Replacement

↔ Remove or Disconnect

1. Negative battery cable.
- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).
2. Crossmember-to-transmission mount nuts and washers (manual and automatic transmission).
3. Crossmember-to-transmission support nuts, bolts and insulators (automatic transmission).
- Raise transmission for clearance.
4. Transmission support (automatic transmission).
5. Transmission mount bolts and mount from transmission (manual and automatic transmission).

→← Install or Connect

NOTICE: See "Notice" on page 6A2-1 of this section.

1. Transmission mount and transmission mount bolts to transmission.

Tighten

- Transmission mount bolts to 54 N·m (40 lb. ft.).

2. Transmission support, insulators, bolts and nuts to crossmember.

Tighten

  - Support nuts to 65 N·m (48 lb. ft.).

- Lower transmission.

3. Transmission mount washers and nuts to crossmember.

Tighten

  - Mount nuts to 47 N·m (35 lb. ft.).

- Lower vehicle.

4. Negative battery cable.

OIL LEVEL INDICATOR AND GUIDE TUBE

Removal

1. Disconnect negative battery cable.
2. Remove nut attaching tube with bracket to engine.
3. Remove oil level indicator and guide tube.

Clean

- Guide tube.

Installation

NOTICE: See "Notice" on page 6A2-1 of this section.

- Apply sealant around the guide tube approximately 12.7 mm (1/2-inch) below the bead.

1. Install oil level indicator and guide tube and rotate into position.
2. Install nut retaining oil level indicator and guide tube to the engine. Torque the nut to 37 N·m (27 lb. ft.).
3. Connect the negative battery cable.

INTAKE MANIFOLD

Figure 6

Removal

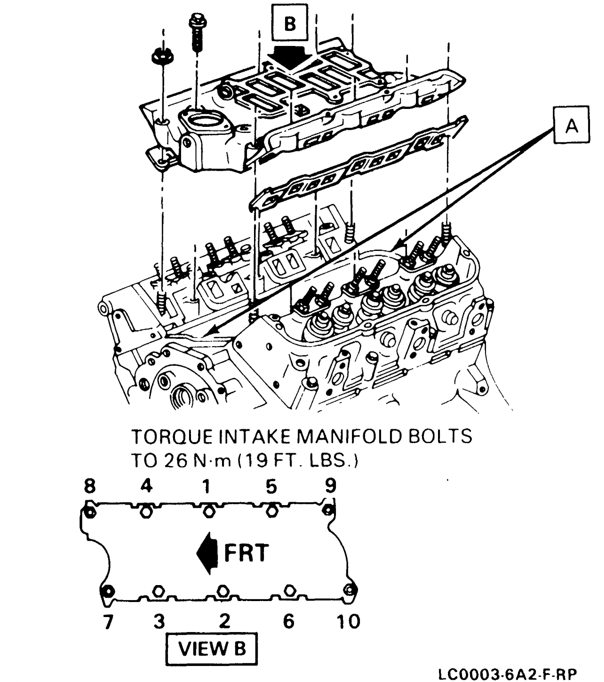
1. Disconnect negative battery cable.
2. Drain coolant.
3. Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (PORT) (SEC. 6E3) for removal of the following PFI sub-assemblies.
    - Throttle body.
    - Plenum.
    - Fuel rail.
4. Disconnect spark plug wires at spark plugs.
5. Disconnect wires at coil.
6. Remove distributor cap and spark plug wires.
7. Mark distributor position and remove hold down bracket.
8. Remove distributor.
9. Disconnect emission canister hoses.
10. Remove valve covers. Refer to "Valve Cover" in this section.
11. Remove upper radiator hose at manifold.
12. Disconnect coolant switch sensors.
13. Heater inlet pipe from manifold and generator bracket.
14. Remove center intake manifold bolts.
15. Remove center intake manifold and gasket.
16. Remove transmission dipstick.
17. Remove manifold bolts.
18. Remove manifold. Discard manifold gaskets and remove loose RTV from front and rear ridges of cylinder case.

Installation

NOTICE: See "Notice" on page 6A2-1 of this section.

1. Make sure that no oil or water is present on surface when new RTV is applied. Place a 5 mm (3/16 inch) diameter bead of RTV, number 1052751 or equivalent, on each ridge.
2. Install new intake gaskets on cylinder heads. Hold in place by extending ridge RTV bead up 6 mm (1/4 inch) onto the gasket ends. The new intake gasket will have to be cut, where indicated, to install behind pushrods. Cut only those areas that are necessary.
3. Install intake manifold on engine. Make sure areas between case ridges and intake are completely sealed.
4. Install manifold retaining bolts and nuts and torque in the sequence shown in Figure 6.
5. Install center intake manifold with new gasket.
6. Install center intake manifold bolts and tighten to 21 N·m (15 lb. ft.).
7. Install upper radiator hose.
8. Install valve covers. Refer to "Valve Cover" in this section.
9. Install heater inlet pipe to manifold and generator bracket.
10. Connect coolant switch sensors.
11. Install distributor, distributor cap and retaining nut. Do not tighten.
12. Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (PORT) (SEC 6E3) for installation of PFI sub-assemblies removed.
13. Install transmission dipstick.
14. Connect necessary wires and hoses.
15. Connect negative battery cable.
16. Fill cooling system with the proper mixture of ethylene glycol anti-freeze and water. Do not install radiator cap.
17. Start engine, set initial timing. Refer to IGNITION SYSTEM (SEC. 6D4). After set, torque distributor hold down clamp bolt 34 N·m (25 lb. ft.). Recheck timing after torquing bolt.
18. Let engine run until radiator upper hose becomes hot (thermostat open).

19. With engine idling, add coolant to radiator, if necessary, until level reaches bottom of filler neck.
20. Install radiator cap, making sure arrows on cap line up with overflow tube.



A APPLY A SMOOTH CONTINUOUS BEAD APPROX 2.0-3.0 MM (0.08-0.12-INCH) WIDE AND 3.0-5.0 MM (0.12-INCH-0.2-INCH) THICK ON BOTH SURFACES. BEAD CONFIGURATION MUST INSURE COMPLETE SEALING OF WATER AND OIL. SURFACE MUST BE FREE OF OIL AND DIRT TO INSURE ADEQUATE SEAL.

TORQUE INTAKE MANIFOLD BOLTS TO 26 N·m (19 FT. LBS.)

Figure 6 - Intake Manifold

EXHAUST MANIFOLD

Figure 7

Left Exhaust Manifold

Removal

1. Disconnect negative battery cable.
2. Raise vehicle.
3. Disconnect exhaust crossover pipe.
4. Lower vehicle.
5. Remove rear power steering pump bracket.
6. Remove manifold bolts and nut.
7. Remove manifold.

Installation

NOTICE: See "Notice" on page 6A2-1 of this section.

1. Clean connecting surfaces on manifold and head, then install manifold in position and install bolts and nut.
2. Torque manifold bolts and nut to 34 N·m (25 lb. ft.).
3. Install rear power steering pump bracket and tighten to 25 N·m (18 lb. ft.).
4. Raise vehicle.
5. Install exhaust crossover pipe.
6. Lower vehicle.
7. Connect negative battery cable.

Right Exhaust Manifold

Remove or Disconnect

1. Negative battery cable.
2. Throttle body air duct.
3. EGR transfer tube at plenum.
4. EGR valve adapter with EGR valve and shield from exhaust manifold.
5. Serpentine belt. Refer to COOLING AND RADIATOR (SEC. 6B).
6. AIR pump pulley.
7. AIR pump upper bracket nuts, bolt and upper bracket.
8. AIR hose from check valve.

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

9. Exhaust crossover pipe nuts at exhaust manifold.
10. Vacuum line from diverter valve.
11. Electrical connector from diverter valve.

- Lower vehicle.

12. AIR pump bolt and AIR pump with diverter valve from lower bracket.
13. AIR pipe from exhaust manifold.
14. Generator brace nut, bolts, and brace.
15. Exhaust manifold bolts and manifold.

Install or Connect

NOTICE: See "Notice" on page 6A2-1 of this section.

1. Exhaust manifold and bolts.

   Tighten

   - Exhaust manifold bolts to 34 N·m (25 lb. ft.).

2. AIR pipe to exhaust manifold.

   Tighten

   - AIR pipe nut to 34 N·m (25 lb. ft.).

3. Generator brace with nuts and bolt.

   Tighten

   - Generator brace nuts to 25 N·m (18 lb. ft.).
   - Generator brace bolt to 50 N·m (37 lb. ft.).

4. AIR pump and diverter valve with bolt to lower bracket.

   Tighten

   - AIR pump lower bracket bolt to 35 N·m (26 lb. ft.).

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

5. Electrical connector to diverter valve.
6. Vacuum line to diverter valve.
7. Exhaust crossover pipe and nuts to exhaust manifold.

Tighten

- Exhaust crossover pipe nuts to 20 N·m (15 lb. ft.).

- Lower vehicle.

8. AIR hose to check valve.
9. AIR pump upper bracket with nuts and bolt.

Tighten

- Upper bracket nuts to 50 N·m (37 lb. ft.).
- Upper bracket bolt to 33 N·m (24 lb. ft.).

10. AIR pump pulley with bolts.

Tighten

- AIR pump pulley bolts to 26 N·m (19 lb. ft.).

11. Serpentine belt. Refer to COOLING AND RADIATOR (SEC. 6B).
12. EGR valve adapter, EGR valve and shield to exhaust manifold with nuts.

Tighten

- EGR valve adapter nuts to 31 N·m (23 lb. ft.).

13. EGR transfer tube to plenum with bolts.

Tighten

- EGR transfer tube bolts to 26 N·m (19 lb. ft.).

14. Throttle body air duct.
15. Negative battery cable.

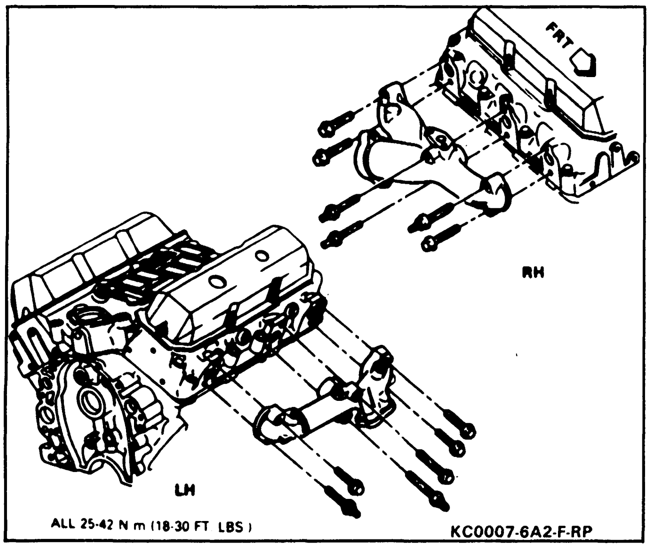


Figure 7 - Exhaust Manifold

VALVE COVER

Figure 8

Removal (Left)

1. Disconnect negative battery cable.
2. Remove serpentine belt. Refer to COOLING AND RADIATOR (SEC. 6B).
3. Remove plenum and fuel rail and disconnect throttle body. Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (PORT) (SEC 6E3).
4. Remove center intake manifold. Refer to "Intake Manifold" in this section.
5. Remove transmission dipstick.
6. Remove valve cover reinforcements and nuts.
7. Remove cover. If cover adheres to cylinder head, shear off by bumping end of valve cover with palm of hand or rubber mallet. If cover still will not come loose CAREFULLY pry until loose. DO NOT DISTORT SEALING FLANGE. It may be necessary to remove the two spark plug wire harness studs in order to get the valve cover past the windshield wiper motor.

Installation (Left)

NOTICE: See "Notice" on page 6A2-1 of this section.

1. Clean sealing surface on cylinder head, intake manifold and valve cover. Make sure sealing flange or rocker cover is not bent.
2. Place a 3 mm (1/8 inch) diameter dot of RTV sealant, number 1052751 or equivalent, at the intake manifold and cylinder head splitline.
3. Install valve cover gasket over studs in the manifold and cylinder head.
4. Install the reinforcements and nuts and torque to 14 N·m (10 lb. ft.).
5. Install transmission dipstick.
6. Install center intake manifold. Refer to "Intake Manifold" in this section.
7. Install the plenum and fuel rail and connect the throttle body. Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (PORT) (SEC. 6E3).
8. Install serpentine belt. Refer to COOLING AND RADIATOR (SEC. 6B).
9. Connect negative battery cable.

Removal (Right)

1. Disconnect negative battery cable.
2. Remove EGR valve adapter with EGR valve and shield from exhaust manifold.
3. Remove coil and coil mounting bracket from cylinder head.
4. Disconnect crankcase vent pipe.
5. Remove plenum and fuel rail and disconnect throttle body. Refer to DRIVEABILITY AND

EMISSIONS - FUEL INJECTION (PORT) (SEC. 6E3).

6. Remove center intake manifold. Refer to "Intake Manifold" in this section.
7. Disconnect spark plug wire clips.
8. Remove valve cover reinforcements and nuts.
9. Remove cover. If cover adheres to cylinder head, shear off by bumping end of valve cover with palm of hand or rubber mallet. If cover still does not come loose, CAREFULLY pry until loose. DO NOT DISTORT SEALING FLANGE.

Installation (Right)

NOTICE: See "Notice" on page 6A2-1 of this section.

1. Clean sealing surface on cylinder head, intake manifold, and valve cover. Make sure sealing flange or valve cover is not bent.
2. Place a 3 mm (1/8 inch) diameter dot of RTV sealant, number 1052751 or equivalent, at the intake manifold and cylinder head splitline.
3. Install valve cover gasket over studs in the manifold and cylinder head.
4. Install the reinforcements and nuts and torque to 14 N·m (10 lb. ft.).
5. Install center intake manifold. Refer to "Intake Manifold" in this section.
6. Install plenum and fuel rail and connect throttle body. Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (PORT) (SEC. 6E3).
7. Install coil and coil mounting bracket at cylinder head.
8. Connect crankcase vent pipe.
9. Install EGR valve adapter with EGR valve and shield to exhaust manifold. Torque nuts to 31 N·m (23 lb. ft.).
10. Install spark plug wire clips.
11. Connect negative battery cable.

ROCKER ARM

Figures 9 and 10

Removal

1. Remove valve cover. Refer to "Valve Cover" in this section.
2. Remove rocker arm nuts, rocker arm balls, rocker arms and pushrods. Place components in a rack so they can be reinstalled in the same location.

Installation and Adjustment

Whenever new rocker arms and/or rocker arm balls are being installed, coat bearing surfaces of rocker arms and rocker balls with a thin even coating of "Molykote" or its equivalent.

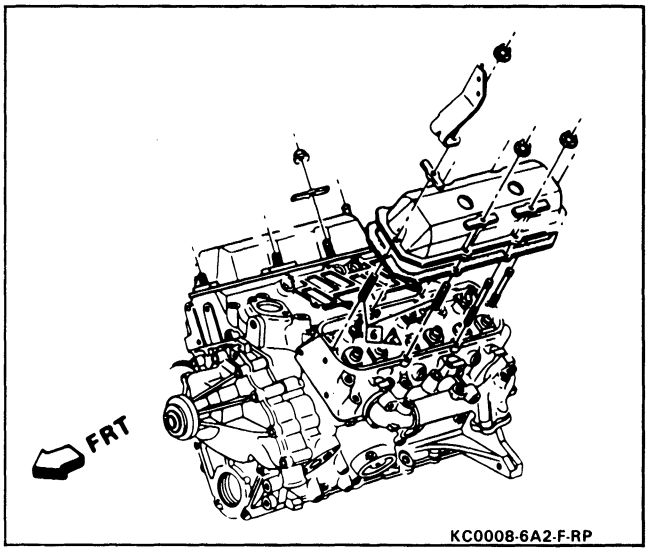


Figure 8 - Valve Cover

1. Install pushrods. Be sure pushrods seat in lifter.
2. Install rocker arms, rocker arm balls and rocker arm nuts. Tighten rocker arm nuts until all lash is eliminated.
3. Adjust valves when lifter is on base circle of camshaft lobe as follows:
   a. Crank engine until mark on torsional damper lines up with "O" mark on the timing tab. The engine should also be in the number 1 firing position. This may be determined by placing fingers on the number 1 rocker arms as the mark on the damper comes near the "O" mark. If the valves are not moving, the engine is in the number 1 firing position. If the valves move as the mark comes up to the timing tab, the engine is in the number 4 firing position and should be rotated one revolution to reach the number 1 position.
   b. With the engine in the number 1 firing position, exhaust valves 1, 2, and 3 and intake valves 1, 5, and 6 may be adjusted.
   c. Back out adjusting nut until lash is felt at the pushrod, then turn in adjusting nut until all lash is removed (Figure 10). (This can be determined by rotating pushrod while turning adjusting nut). When lash has been removed, turn adjusting nut in 1-1/2 additional turns (to center lifter plunger).
   d. Crank the engine one revolution until the timing tab "O" mark and torsional damper mark are again in alignment. This is the number 4 firing position. With the engine in this position, exhaust valves 4, 5, and 6 and intake valves 2, 3, and 4 may be adjusted.
4. Install valve covers. Refer to "Valve Cover" in this section.
5. Start engine and check timing and idle speed.

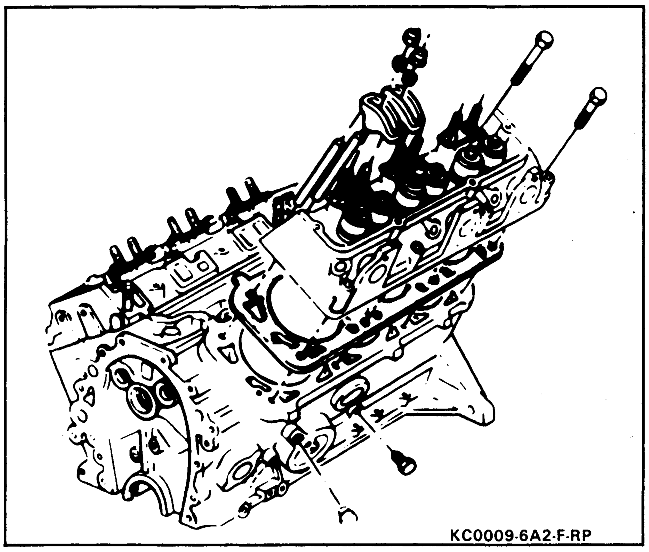


Figure 9 - Rocker Arms and Pushrods

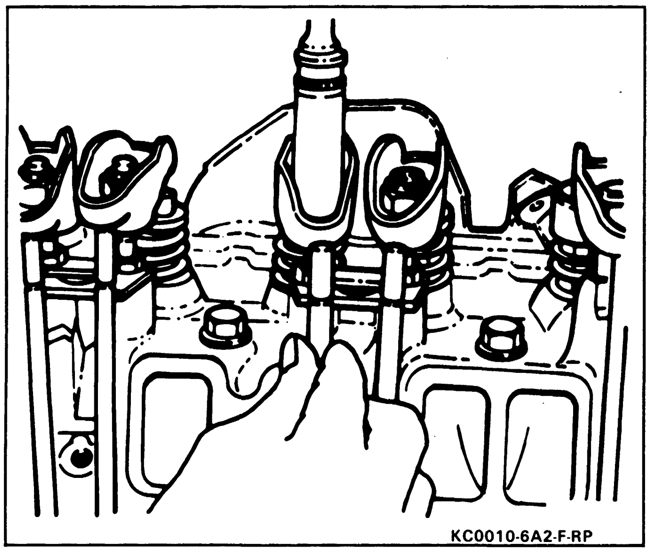


Figure 10 - Adjusting Valve Lash

VALVE LIFTERS

Figures 11 and 12

Valve Lifter Diagnosis

If valve lifters are:

- Momentarily noisy when the engine is started.
  - This is normal. Oil drains from some of the lifters when the engine is not running. It takes a few seconds for the lifters to fill after the engine is started.
- Intermittently noisy when the engine is idling. The noise disappears when the engine speed is increased.
  - This may be caused by dirt in a lifter or a pitted or damaged check ball in a lifter. Remove, take apart, and clean the lifters. If a damaged check ball is found in any lifter, replace the lifter.
- Noisy when the engine is idling slowly or when the engine is hot. The lifters are quiet when engine speed is increased or when the engine is cold.
  - This may be caused by a high leak down rate in one or more of the lifters. Replace any suspect lifters.
- Noisy at high speeds and quiet at low speeds.
  - This is caused by an incorrect oil level, either too high or too low, or improper oil flow at oil pump pickup. Check for the following:
    - High oil level. Oil level above the oil level indicator "FULL" mark allows the crankshaft counterweights to churn the oil into foam. When foam is pumped into the lifters, they will become noisy. A solid column of oil is required for proper lifter operations. Drain oil to proper level.
    - Low oil level. Oil level below level indicator "ADD" mark allows the oil pump to pump air at high speeds which results in noisy lifters. Add oil to proper level.
    - Damaged oil pan, or loose or cocked oil pump screen. Repair or replace parts as necessary.
- Noisy at idle, becoming louder as engine speed is increased to 1500 rpm. Noise is most noticeable in the vehicle at 16 to 24 km/h (10 to 15 mph) in "LOW" transmission range, or 48 to 56 km/h (30 to 35 mph) in "DRIVE" transmission range. The noise is best described as a "hashy" sound. At slow idle, it may be gone or may appear as a light ticking noise in one or more valves. This noise is not caused by lifter malfunction. It is caused by one or more of the following:
  - Badly worn or scuffed valve tip and rocker arm pad.
  - Excessive valve stem to guide clearance.
  - Excessive valve seat runout.
  - Off square valve face runout.
  - Valve spring damper clicking on rotator.

Valve Lifter Replacement

Valve lifters should be kept in order so they may be reinstalled in their original position. Some engines will have both standard and 0.25 mm (0.010 inch) oversize (O.S.) valve lifters. Where O.S. lifters are used, the cylinder case will be marked with a dab of white paint and/or "0.25 O.S." stamped on the lifter boss (Figure 11).

If the lifters are removed, they must be reinstalled in their original location. If replacement is necessary, use lifters with a narrow flat ground along the lower 3/4 of lifter. These flats provide additional oil to the cam lobe and lifter surfaces.

Removal

1. Remove intake manifold. Refer to "Intake Manifold" in this section.
2. Remove rocker arm nuts, rocker arm balls, rocker arms and pushrods. Place components in a rack so they can be reinstalled in the same location.

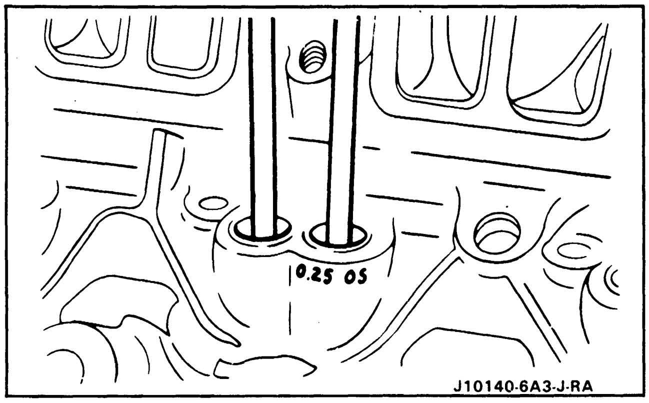


Figure 11 - Oversize Lifter Marking

3. Remove lifters.

Cleaning and Inspection

Thoroughly clean lifter in cleaning solvent, and inspect carefully. If damaged or worn, the entire lifter assembly should be replaced. If the lifter body wall is scuffed or worn, inspect the cylinder block lifter bore. If the bottom of the lifter is scuffed or worn, inspect the camshaft lobe. If the pushrod seat is scuffed or worn, inspect the pushrod. An additive containing EP lube, such as EOS, should always be added to crankcase oil for run-in when any new camshaft or lifters are installed. All damaged or worn lifters should be replaced. For proper lifter rotation during engine operation, lifter foot must be convex.

Installation

1. Install valve lifters. Whenever new valve lifters are being installed, coat foot of valve lifters with "Molykote" or its equivalent. Make sure lifter foot is very slightly convex. It can be detected by holding a good straight edge to the surface and looking into a light source.
2. Install and adjust valve mechanism. Refer to "Rocker Arm" in this section.
3. Install intake manifold. Refer to "Intake Manifold" in this section.

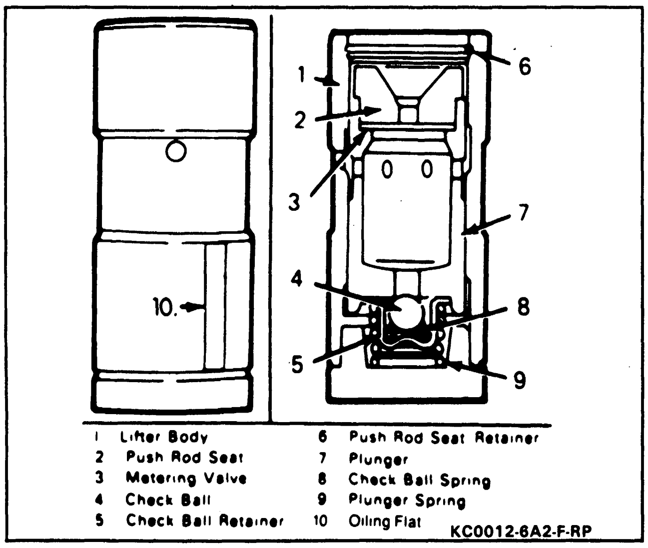


Figure 12 - Valve Lifter

ENGINE FRONT COVER

Figure 13

Removal

1. Remove oil pan. Refer to "Oil Pan" in this section.
2. Lower vehicle.
3. Remove power steering pump and bracket. Refer to POWER STEERING GEAR AND PUMP (SEC. 3B1).
4. Remove coolant pump. Refer to COOLING AND RADIATOR (SEC. 6B).
5. Remove torsional damper. Refer to "Torsional Damper" in this section.
6. Disconnect lower radiator hose at front cover.
7. Remove front cover bolts and remove cover.

Installation

NOTICE: See "Notice" on page 6A2-1 of this section.

1. Install new gasket. When installing new gasket, be sure sealing surfaces are clean. Care should be taken not to damage sealing surfaces.
2. Place front cover on the engine, install the three bolts and torque to 21 N•m (15 lb. ft.).
3. Connect lower radiator hose to front cover.
4. Install torsional damper. Refer to "Torsional Damper" in this section.
5. Install coolant pump. Refer to COOLING AND RADIATOR (SEC. 6B). Tighten bolts according to Figure 13.
6. Install power steering pump bracket and pump. Refer to POWER STEERING GEAR AND PUMP (SEC. 3B1).
7. Raise vehicle.
8. Inspect oil pan gasket replace if necessary.
9. Install oil pan. Refer to "Oil Pan" in this section.
10. Lower vehicle.
11. Fill cooling system. Leave radiator cap off.
12. Connect battery negative cable and start engine.
13. Run engine until upper radiator hose becomes hot (thermostat open).
14. Check coolant level and add as necessary.
15. Install radiator cap, making sure arrows in cap line up with overflow tube.

ENGINE FRONT COVER OIL SEAL

Replacement

Tool Required:

J 35468 Front Cover Aligner and Oil Seal Installer

With Cover Removed

1. With cover removed, pry oil seal out of cover from the front with a large screwdriver.

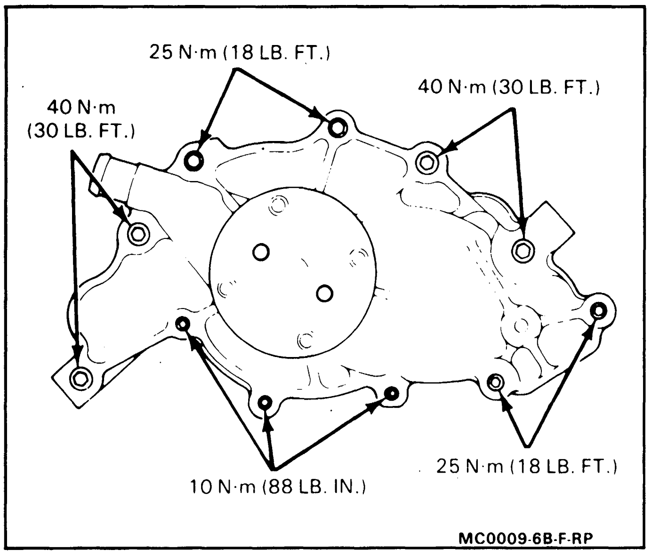


Figure 13 - Coolant Pump Bolt Torques

2. Install new seal so that open end of the seal is toward the inside of cover and drive it into position with J 35468. Support cover at seal area. Pre-lube seal with engine oil prior to installation of torsional damper.

With Cover Installed

1. With torsional damper removed, refer to "Torsional Damper" in this section, pry seal out of cover from the front with a large screwdriver, being careful not to damage the surface on the crankshaft.
2. Install new seal so that open end of seal is toward the inside of cover and drive it into position with J 35468.
3. Install torsional damper. Refer to "Torsional Damper" in this section.

TIMING CHAIN AND SPROCKETS

Figures 14 and 15

Tools Required:

J 5825-A Crankshaft Gear Remover
J 5590 Crankshaft Gear Installer

Removal

1. Remove engine front cover. Refer to "Engine Front Cover" in this section.
2. Place number 1 piston at top dead center with the marks of the camshaft and crankshaft sprockets aligned (number 4 firing position).
3. Remove sprocket mounting bolts, camshaft sprocket, and chain.

Important

- If the sprocket does not come off easily, a light blow in the lower edge of the sprocket with a plastic mallet should dislodge the sprocket.

4. Remove crankshaft sprocket using J 5825-A.

Installation

NOTICE: See "Notice" on page 6A2-1 of this section.

1. Install crankshaft sprocket using J 5590.
2. Apply "Molykote" or equivalent to the sprocket thrust surface.
3. Hold the sprocket with the chain hanging down and align the marks on the camshaft and crankshaft sprockets (Figure 15).
4. Align dowel in camshaft with dowel hole in camshaft sprocket.
5. Draw the camshaft sprocket onto camshaft using the sprocket mounting bolts. Torque the sprocket mounting bolts to 28 N·m (21 lb. ft.).
6. Lubricate timing chain with engine oil.
7. Install engine cover. Refer to "Engine Front Cover" in this section.

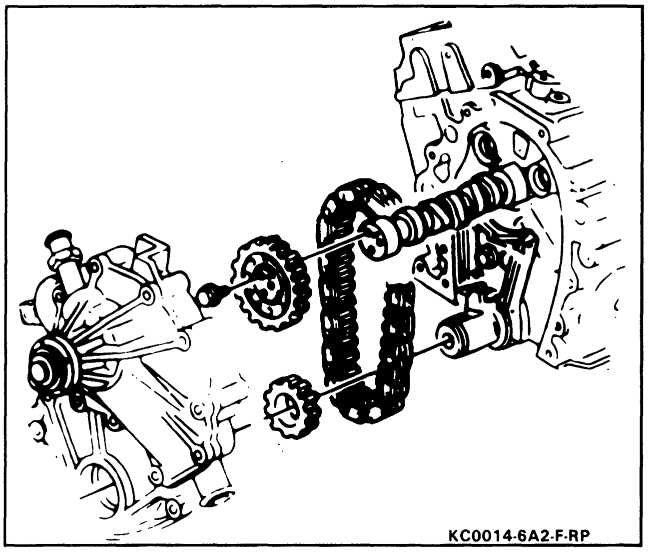


Figure 14 - Timing Chain and Sprockets

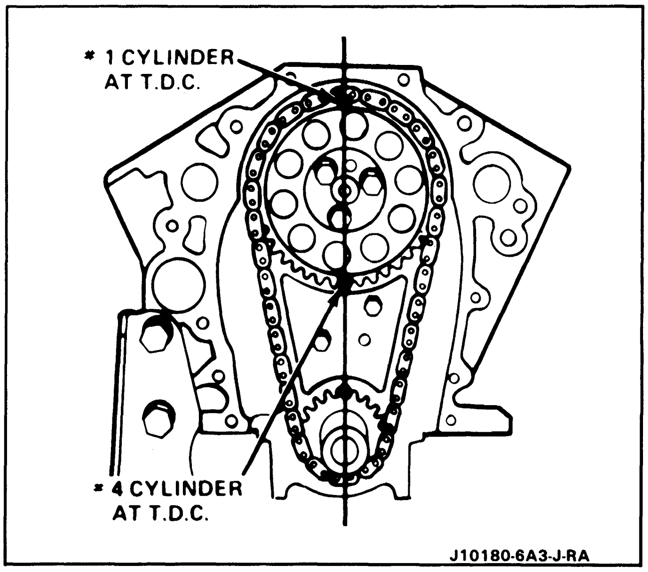


Figure 15 - Camshaft Timing

CAMSHAFT

Figures 16 and 17

Tool Required:

J 8520 Cam Lobe Lift Indicator

Measuring lobe lift procedure is similar to that used for checking valve timing. If improper valve operation is indicated, measure the lift of each pushrod in consecutive order and record the readings.

1. Remove the valve mechanism. Refer to "Rocker Arm" in this section.
2. Position J 8520 with ball socket adapter on pushrod. Make sure pushrod is in the lifter socket.
3. Rotate the crankshaft slowly in the direction of rotation until the lifter is on the heel of the cam lobe. At this point, the pushrod is in its lowest position.

CAUTION: Whenever the engine is cranked remotely at the starter with a special jumper cable or other means, the distributor primary lead must be disconnected from the coil to prevent electrical shock.

4. Set the dial indicator on zero, then rotate the crankshaft slowly, or attach an auxiliary starter switch and "bump" the engine over until the pushrod is in the fully raised position (Figure 16).
5. Compare the total lift recorded from the dial indicator with the specifications.
6. If camshaft readings for all lobes are within specifications, remove dial indicator assembly.
7. Install and adjust valve mechanism. Refer to "Rocker Arm" in this section.

Removal

1. Remove valve lifters. Refer to "Valve Lifters" in this section.
2. Remove engine front cover. Refer to "Engine Front Cover" in this section.
3. Remove timing chain and sprocket. Refer to "Timing Chain and Sprockets" in this section.

NOTICE: All camshaft journals are the same diameter and care must be exercised in removing camshaft to avoid damage to bearings.

4. Remove camshaft.

Inspection

The camshaft bearing journals should be measured with a micrometer for an out-of-round condition. If the journals exceed 0.025 mm (0.001 inch) out-of-round, the camshaft should be replaced.

Installation

Whenever a new camshaft is installed, coat camshaft lobes with GM EOS or equivalent, install new oil and a new filter. Replacement of all valve lifters is recommended to insure durability of the camshaft lobes and lifter feet.

1. Lubricate camshaft journals with engine oil and install camshaft.
2. Install timing chain and sprocket. Refer to "Timing Chain and Sprockets" in this section.
3. Install engine front cover. Refer to "Engine Front Cover" in this section.
4. Install lifters. Refer to "Valve Lifters" in this section.
5. Complete build up of engine.

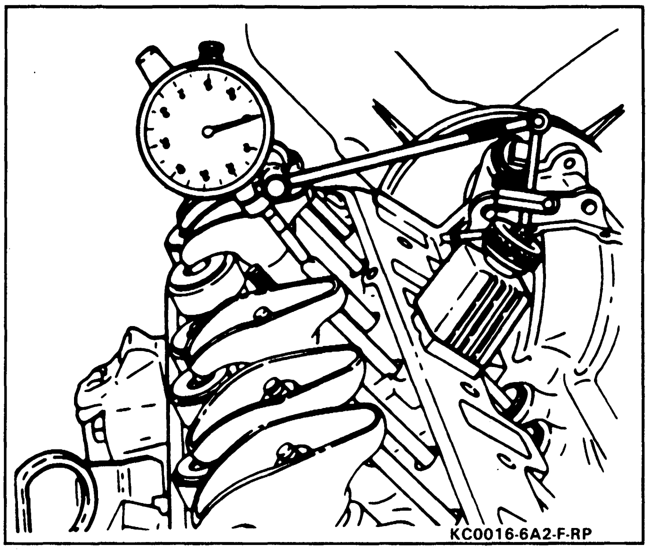


Figure 16 - Measuring Camshaft Lobe Lift

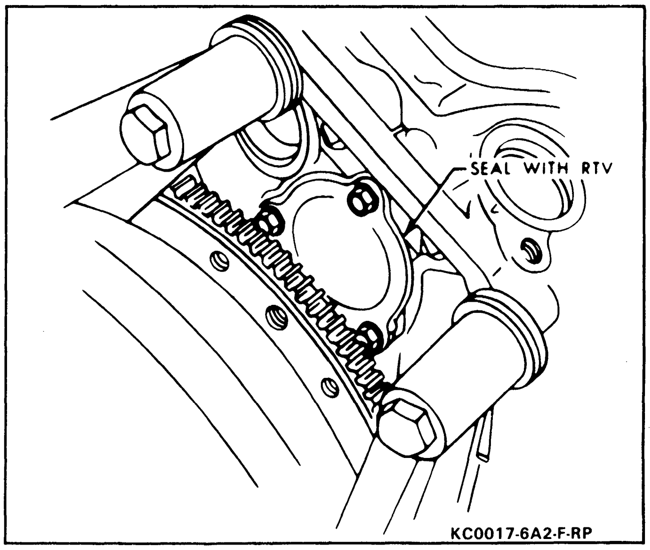


Figure 17 - Camshaft Rear Cover

CAMSHAFT BEARINGS

Figure 17

Tool Required:

J 6098-01 Camshaft Bearing Remover and Installer

Removal

Camshaft bearings can be replaced while engine is disassembled for overhaul or without complete disassembly of the engine. To replace bearings without complete disassembly remove the camshaft and crankshaft, leaving cylinder heads attached and pistons in place. Before removing crankshaft, tape threads of connecting rod bolts to prevent damage to crankshaft. Fasten connecting rods against sides of engine so they will not be in the way while replacing camshaft bearings.

1. With camshaft and crankshaft removed, remove camshaft rear cover from cylinder block (Figure 17).
2. Using J 6098-01, with nut and thrust washer installed to end of threads, index pilot in camshaft front bearing and install puller screw through pilot.
3. Install remover and installer tool with shoulder toward bearing, making sure a sufficient amount of threads are engaged.
4. Using two wrenches, hold puller screw while turning nut. When bearing has been pulled from bore, remove remover and installer tool and bearing from puller screw.
5. Remove remaining bearings (except front and rear) in the same manner. It will be necessary to index pilot in camshaft rear bearing to remove the rear intermediate bearing.
6. Assemble remover and installer tool in driver handle and remove camshaft front and rear bearings by driving towards center of cylinder block.

Installation

NOTICE: See "Notice" on page 6A2-1 of this section.

1. Assemble remover and installer tool on driver handle and install camshaft bearings.
2. Using J 6098-01, with nut then thrust washer installed to end of threads, index pilot in camshaft bearing and install puller screw through pilot.
3. Index camshaft bearing in bore with oil hole aligned at 2:30 o'clock on rear and intermediate bearing. Front bearing has oil holes at 1:00 o'clock and 2:30 o'clock.
4. Using two wrenches, hold puller screw while turning nut. After bearing has been pulled into bore, remove the remover and installer tool from puller screw and check alignment of oil hole in camshaft bearing.
5. Install remaining bearings in the same manner.

NOTICE: Prior to rear cover installation check that the sealing surfaces on the cover and block are clean or free of oil. Be sure that all loose RTV, or equivalent, is removed from block groove and blind attaching holes.

6. Install the camshaft rear cover after applying a fresh 3 mm (1/8-inch) diameter bead of RTV, number 1052751 or equivalent. Apply RTV or equivalent on engine block in machined groove. Sealant must be wet to touch when bolts are torqued. Torque cover bolts to 10 N·m (89 lb. in.).

VALVES

Valves that are pitted can be refaced to the proper angle, insuring correct relation between the head and stem, on a valve refacing machine. Valve stems that show excessive wear, or valves that are warped excessively should be replaced. When a valve head that is warped excessively is refaced, a knife edge will be ground on part or all of the valve head due to the amount of metal that must be removed to completely reface the valve. Knife edges lead to breakage, burning or preignition due to heat localizing on this knife edge. If the edge of the valve head is less than 0.8 mm (0.03-inch) thick after grinding, replace the valve.

Several different types of equipment are available for refacing valves. The recommendations of the equipment manufacturer should be carefully followed to attain the proper results.

Valve Guides

Valves with oversize stems are available in 0.003, 0.015 and 0.030-inch oversizes. To ream the valve guide bores for oversize valves use J 5830-02.

Valve Seats

Reconditioning the valve seats is important because the seating of the valves must be perfect for the engine to deliver the power and performance designed into it.

Another important factor is the cooling of the valve heads. Good contact between each valve and its seat in the head is imperative to insure that the heat in the valve head will be properly carried away.

Several different types of equipment are available for reseating valve seats. The recommendations of the equipment manufacturer should be carefully followed to attain proper results.

Valve Springs, Stem Seal and Rotator

Figures 18 through 20

Tools Required:

J 23738-A Valve Stem Seal Tester
J 23590 Spark Plug Port Adapter
J 5892-C Valve Spring Compressor

Removal

1. Remove valve cover. Refer to "Valve Cover" in this section.
2. Remove spark plug, rocker arm and pushrod on the cylinder(s) to be serviced.
3. Install air line adapter J 23590 to spark plug port and apply compressed air to hold the valves in place.

NOTICE: When using the valve spring compressor, be careful not to scratch or gouge the valve stem.

4. Using J 5892-C to compress the valve spring, remove the valve locks, valve cap, oil shedder (exhaust only) and valve spring and damper (Figure 18).

5. Remove the intake valve stem oil seal.

Installation

1. Install a valve stem seal over the intake valve stem and valve guide base.
2. Drop an oil shedder and valve rotator over the exhaust valve and a valve spring cap over the intake valve spring.

NOTICE: When using the valve spring compressor, be careful not to scratch or gouge the valve stem.

3. Using J 5892-C, compress the valve spring.
4. Install the square cut O-ring around the valve stem in the lower groove, making sure it is not twisted.
5. Insert valve, stem key locks and release tool.
6. Install the valve locks and release the compressor tool making sure that the locks seat properly in the upper groove of the valve stem. Grease may be used to hold the locks in place while releasing the compressor tool.
7. Check each valve stem oil seal by placing valve stem leak detector J 23738-A over the end of the valve stem and against the cap. Operate the vacuum pump and make sure no air leaks past the seal.
8. Check the installed height of the valve springs, using a narrow thin scale. Measure from the top of the spring damper "feet" to the bottom inside of the oil shedder for exhaust and from the top of the valve cap for intake. If this is found to exceed the specified height, install valve spring seat shim approximately 0.76 mm (0.03-inch) thick. At no time should the spring be shimmed to give an installed height under the minimum specified of 41 mm (1.6 inch).

CYLINDER HEAD

Figure 21

Removal (Left)

1. Remove intake manifold. Refer to "Intake Manifold" in this section.
2. Remove spark plugs.
3. Raise vehicle.
4. Drain engine coolant from block. Refer to COOLING AND RADIATOR (SEC. 6B).
5. Drain engine oil.
6. Remove oil filter.
7. Lower vehicle.
8. Remove dipstick tube and bracket.
9. Remove exhaust manifold. Refer to "Exhaust Manifold" in this section.
10. Remove serpentine belt. Refer to COOLING AND RADIATOR (SEC. 6B).
11. Remove A/C compressor and bracket and lay aside. Refer to MANUALLY CONTROLLED AIR CONDITIONING (SEC. 1B).

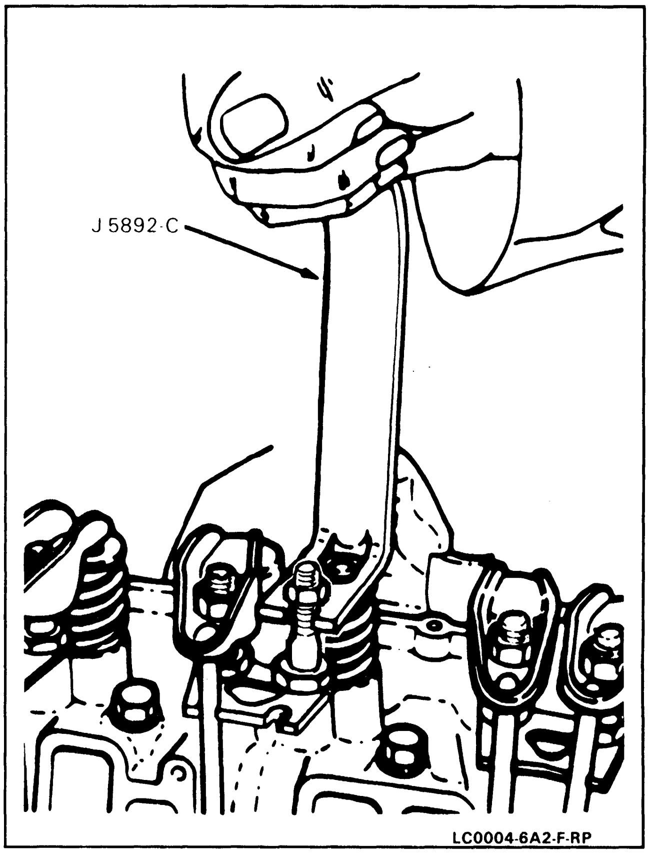


Figure 18 - Depressing Valve Spring

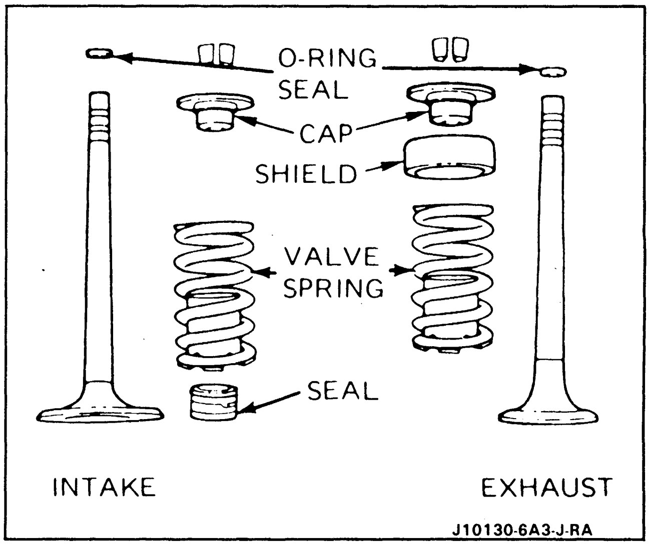


Figure 19 - Valve Stem Seal

12. Remove engine lift bracket.
13. Remove ground cable from rear of cylinder head.
14. Remove power steering pump and bracket and lay aside. Refer to POWER STEERING GEAR AND PUMP (SEC. 3B1).
15. Loosen rocker arm until able to remove pushrod.
16. Remove head bolts.
17. Remove head.

Installation (Left)

NOTICE: See "Notice"on page 6A2-1 of this section.

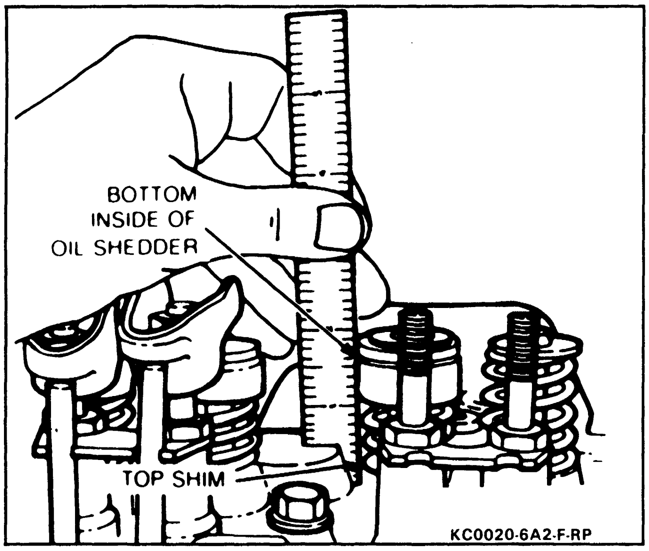


Figure 20 - Checking Valve Spring Installed Height

The gasket surfaces on both head and cylinder case deck must be clean of any foreign matter and free of nicks or heavy scratches. Cylinder bolt threads in the case and threads on the cylinder head bolts must be clean. Dirt will affect bolt torque.

1. Place the gasket in position, over the dowel pins, with the note "This Side Up" showing.
2. Install cylinder head.
3. Coat cylinder head bolt threads with sealer number 1052080 or equivalent and install bolts. Torque bolts as shown in Figure 21.
4. Install pushrods and loosely retain with rocker arms. Make sure lower ends of pushrods are in lifter seats.
5. Install power steering pump bracket and pump. Refer to "POWER STEERING GEAR AND PUMP (SEC. 3B1).
6. Install ground cable to rear of cylinder head.
7. Install engine lift bracket.
8. Install A/C compressor bracket and compressor. Refer to MANUALLY CONTROLLED AIR CONDITIONING (SEC. 1B).
9. Install dipstick tube and bracket.
10. Install exhaust manifold. Refer to "Exhaust Manifold" in this section.
11. Adjust valve lash. Refer to "Rocker Arm" in this section.
12. Install intake manifold. Refer to "Intake Manifold" in this section.
13. Install spark plugs.
14. Install serpentine belt. Refer to COOLING AND RADIATOR (SEC. 6B).
15. Adjust engine coolant as necessary. Refer to COOLING AND RADIATOR (SEC. 6B).
16. Install engine oil filter and oil to proper level.

Removal (Right)

1. Remove intake manifold. Refer to "Intake Manifold" in this section.
2. Remove spark plugs.
3. Remove exhaust manifold. Refer to "Exhaust Manifold" in this section.
4. Raise vehicle.
5. Drain engine coolant from block. Refer to COOLING AND RADIATOR (SEC. 6B).
6. Drain engine oil.
7. Remove engine oil filter.
8. Lower vehicle.
9. Loosen rocker arms until able to remove pushrod.
10. Remove serpentine belt.
11. Remove tensioner.
12. Remove generator and brackets. Refer to CHARGING SYSTEM (SEC. 6D3).
13. Remove ground cable from rear of cylinder head.
14. Remove head bolts.
15. Remove head.

Installation (Right)

NOTICE: See "Notice" on page 6A2-1 of this section.

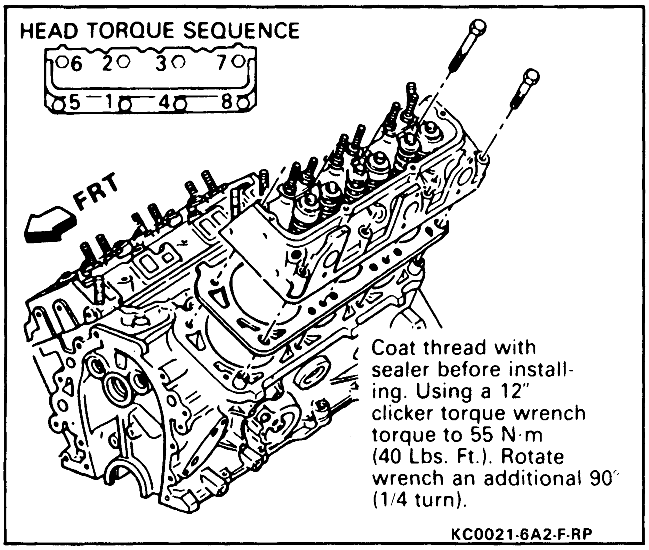
The gasket surfaces on both the head and cylinder case deck must be clean of any foreign matter and free of nicks or heavy scratches. Cylinder bolt threads in the case and threads on the cylinder head bolts must be clean. Dirt will affect bolt torque.

1. Place the gasket in position, over the dowel pins, with the note "This Side Up" showing.
2. Install cylinder head.
3. Coat cylinder head bolt threads with sealer number 1052080 or equivalent and install bolts. Torque bolts as shown in Figure 21.
4. Install pushrods and loosely retain with rocker arms. Make sure lower ends of push rods are in lifter seats.
5. Raise vehicle.
6. Install exhaust manifold. Refer to "Exhaust Manifold" in this section.
7. Install engine oil filter.
8. Lower vehicle.
9. Adjust valve lash. Refer to "Rocker Arm" in this section.
10. Install ground cable to rear of cylinder head.
11. Install generator bracket and generator. Refer to CHARGING SYSTEM (SEC. 6D3).
12. Install tensioner.
13. Install serpentine belt.
14. Install intake manifold. Refer to "Intake Manifold" in this section.
15. Install spark plugs.
16. Adjust engine coolant as necessary. Refer to COOLING AND RADIATOR (SEC. 6B).
17. Install engine oil to proper level.

Cylinder Head and Valve Off-Vehicle Service

Tools Required:

J 8062 Valve Spring Compressor



Coat thread with sealer before installing. Using a 12" clicker torque wrench torque to 55 N·m (40 Lbs. Ft.). Rotate wrench an additional 90° (1/4 turn).

Figure 21 - Cylinder Head Installation

J 8089 Carbon Removing Brush
J 8101 Valve Guide Cleaner
J 9666 Valve Spring Tester

Disassembly

1. With cylinder head removed, remove rocker arm nuts, balls and rocker arms (if not previously done).
2. Using J 8062, compress the valve springs and remove valve keys. Release the compressor tool and remove spring caps, oil shedders, springs and damper assemblies, then remove oil seals.
3. Remove valves from cylinder head and place them in a rack so they can be installed in their original positions.

Cleaning and Inspection

1. Clean all carbon from combustion chambers and valve ports using J 8089.
2. Thoroughly clean valve guides using J 8101.
3. Clean all carbon and sludge from pushrods, rocker arms and pushrod guides.
4. Clean valve stems and heads on a buffing wheel.
5. Clean carbon deposits from head gasket connecting surface.
6. Inspect cylinder head for cracks in the exhaust ports, combustion chambers, or external cracks to the water jacket.
7. Inspect the valves for burned heads, cracked faces or damaged stems.

   NOTICE: Excessive valve stem to bore clearance will cause high oil consumption and may cause valve breakage. Insufficient clearance will result in noise and sticky functioning of the valve and disturb engine smoothness.

8. Measure valve stem clearance as follows:
   a. Clamp a dial indicator on one side of the cylinder head. Locate the indicator so that movement of the valve stem from side to side (crosswise to the head) will cause direct movement of the indicator stem. The indicator stem must contact the side of the valve stem just above the guide.
   b. Drop the valve head 1.5 mm (0.06 inch) off the valve seat.
   c. Move the stem of the valve from side to side, using light pressure, to obtain a clearance reading. If clearance exceeds specifications, it will be necessary to ream valve guides for oversize valves. Service valves are available in standard, 0.003, 0.015 and 0.030-inch O.S. sizes.
9. Check valve spring tension with spring tester J 9666. Springs should be compressed to the specified height and checked against the specifications chart. Springs should be replaced if not within 44 N (10 lbs.) of the specified load without dampers.
10. Inspect rocker arm studs for wear or damage.

OIL PAN

Figure 22

Removal

1. Disconnect negative battery cable.
2. Raise vehicle.
3. Remove catalytic converter hanger bolts.
4. Disconnect transmission fluid cooler lines from oil pan clips.
5. Move timing mark to the 7 o'clock position.
6. Drain engine oil.
7. Remove converter dust cover.
8. Remove exhaust crossover pipe at manifolds.
9. Remove engine mount through-bolts.
10. Raise engine.
11. Remove oil pan bolts.
12. Remove oil pan.

Installation

NOTICE: See "Notice" on page 6A2-1 of this section.

1. Clean sealing surfaces on cylinder case and oil pan.
2. Install gasket and oil pan and attach retaining bolts. Tighten retaining bolts to specification (Figure 22).
3. Lower engine.
4. Install engine mount through-bolts. Tighten engine mount through-bolt nuts to 68 N·m (50 lb. ft.).
5. Install exhaust crossover pipe at manifolds.
6. Install converter dust cover.
7. Connect transmission fluid cooler lines to the oil pan clips.
8. Install catalytic converter hanger bolts.
9. Lower vehicle.

10. Refill engine with oil to proper level.
11. Connect negative battery cable.
12. Start engine, check for leaks.

OIL PUMP

Figure 22

Removal

1. Remove oil pan. Refer to "Oil Pan" in this section.
2. Remove pump to rear main bearing cap bolt and remove pump and extension shaft.

Installation

NOTICE: See "Notice" on page 6A2-1 of this section.

1. Assemble pump and extension shaft with retainer to rear main bearing cap, aligning top end of hexagon extension shaft with hexagon socket lower end of distributor drive gear.
2. Install pump-to-rear bearing cap bolt and torque to specifications.
3. Install oil pan. Refer to "Oil Pan" in this section.

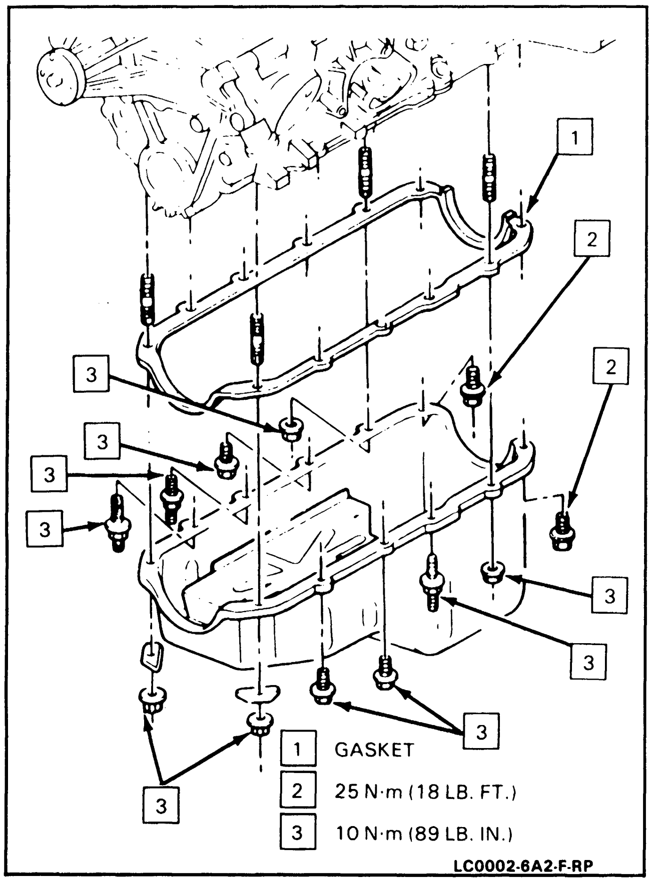


Figure 22 - Oil Pan

Oil Pump Overhaul

Tool Required:

J 21882 Oil Suction Pipe Installer

Disassembly

(Oil Pump Removed)

1. Remove the pump cover attaching bolts and the pump cover. Mark gear teeth so they may be reassembled with the same teeth indexing.
2. Remove the idler gear and the drive gear and shaft from the pump body.
3. Remove the pressure regulator valve retaining pin, pressure regulator spring and valve.
4. If the pickup screen and pipe assembly need replacing, mount the pump in a soft-jawed vise and extract pipe from pump cover. Do not disturb the pickup screen on the pipe. This is serviced as an assembly.

Cleaning and Inspection

1. Wash all parts in cleaning solvent and dry with compressed air.
2. Inspect the pump body and cover for cracks or excessive wear.
3. Inspect pump gears for damage or excessive wear. The pump gears and body are not serviced separately. If the pump gears or body are damaged or worn, replacement of the entire oil pump assembly is necessary.
4. Check the drive gear shaft for looseness in the pump body.
5. Inspect inside of pump cover for wear that would permit oil to leak past the ends of the gears.
6. Inspect the pickup screen and pipe assembly for damage to screen or pipe.
7. Check the pressure regulator valve for fit.

Assembly

NOTICE: See "Notice" on page 6A2-1 of this section.

1. If the pickup screen and pipe assembly was removed, it should be replaced with a new part. Loss of press fit condition could result in an air leak and loss of oil pressure. Mount the pump in a soft-jawed vise, apply sealer to outside diameter of swaged end of pipe, and using J 21882 tap the pipe in place with a plastic hammer.

   NOTICE: Be careful of twisting, shearing or collapsing pipe while installing in pump.

2. Install the pressure regulator valve and related parts.
3. Install the drive gear and shaft in the pump body.
4. Install the idler gear in the pump body in the original orientation.
5. Install cover gasket.
6. Install the pump cover and torque attaching screws to specifications.
7. Turn drive shaft by hand to check for smooth operation.

TORSIONAL DAMPER

Tools Required:

J 23523-E Harmonic Balancer Remover and Installer

J 29113 Harmonic Balancer Installer

NOTICE: The inertial weight section of the torsional damper is assembled to the hub with a rubber sleeve. The removal and installation procedures must be followed using the correct tools or movement of the inertia weight section of the hub will destroy the tuning of the torsional damper and the engine timing reference.

Removal

1. Disconnect negative (-) battery cable at battery.
2. Remove serpentine drive belt.
3. Remove drive pulley and remove damper retaining bolt.
4. Install J 23523-E on damper and then turning puller screw, remove damper.

Installation

NOTICE: See "Notice" on page 6A2-1 of this section.

1. Coat front cover seal contact area on damper with engine oil.
2. Place damper in position over key on crankshaft.
3. Pull damper onto crankshaft as follows:
    a. Install J 29113 into crankshaft so that at least 6 mm (0.2 inch) of thread engagement is obtained.
    b. Pull damper into position and remove tool from damper.
4. Install drive pulley and damper retaining bolts. Torque to specifications.
5. Install serpentine belt.

PISTONS AND CONNECTING RODS

Tool Required:

J 8037 Piston Ring Compressor

Removal

1. Remove cylinder heads. Refer to "Cylinder Head" in this section.
2. Remove oil pan. Refer to "Oil Pan" in this section.
3. Examine the cylinder bores above the ring travel. If bores are worn so that a shoulder or ridge exists at the top of the cylinder, remove the ridges with a ridge reamer to avoid damaging rings or cracking ring lands in pistons during removal.
4. Remove connecting rod bearing cap and bearing insert.
5. Install guide hose over threads of rod bolts to prevent damage to bearing journal and connecting rod bolt threads.
6. Push connecting rod and piston assembly through the top of the cylinder bore.

Installation

NOTICE: See "Notice" on page 6A2-1 of this section.

Cylinder bores must be clean before piston installation. This may be accomplished with a hot water and detergent wash or with light honing as necessary. After cleaning, the bores should be swabbed several times with light engine oil and a clean dry cloth.

1. Lubricate connecting rod bearings and install in rods and rod caps.
2. Lightly coat pistons, rings and cylinder walls with light engine oil.
3. With bearing caps removed, install guide hose over connecting rod bolts. These guide hoses protect the crankpin journal from damage during installation of connecting rod and piston assembly.
4. Make sure the gap in the oil ring rails are in up position toward center of engine and the gaps of the compression rings are positioned as shown in Figure 25.
5. Install each connecting rod and piston assembly in its respective bore. Install with connecting rod bearing tang slots on side opposite camshaft. Use J 8037 to compress the rings. Guide the connecting rod into place on the crankshaft journal. Use a hammer handle and light blows to install the piston into the bore. Hold the ring compressor firmly against the cylinder block until all piston rings have entered the cylinder bore.
6. Install the bearing caps and torque nuts to specifications. If bearing replacement is required, refer to "Connecting Rod Bearings" in this section.

    Be sure to install new pistons in the same cylinders for which they were fitted and used pistons in the same cylinder from which they were removed. Each connecting rod and bearing cap should be marked, beginning at the front of the engine. On V-6 engines, 1, 3, and 5 are in the right bank and 2, 4, and 6 are in the left bank. The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.
7. Install oil pan. Refer to "Oil Pan" in this section.
8. Install cylinder head. Refer to "Cylinder Head" in this section.

CONNECTING ROD BEARINGS

Figure 23

Connecting rod bearings are of the precision insert type and do not utilize shims for adjustment. Do not file rods or rod caps. If clearances are found to be excessive, a new bearing will be required. Service bearings are available in standard size and 0.013 mm and 0.026 mm undersize for use with new and used standard size crankshafts.

Inspection and Replacement

NOTICE: See "Notice" on page 6A2-1 of this section.

1. With oil pan and oil pump removed, remove the connecting rod cap and bearing.
2. Inspect the bearing for evidence of wear or damage. Bearings showing wear or damage should not be reinstalled.
3. Wipe both upper and lower bearing shells and crankpin clean of oil.
4. Measure the crankpin for out-of-round or taper with micrometer. If not within specifications, replace or recondition crankshaft. If within specifications and a new bearing is to be installed, measure the maximum diameter of the crankpin to determine new bearing size required.
5. If within specifications, measure new or used bearing clearance with gaging plastic.

NOTICE: If a bearing is being fitted to an out-of-round crankpin, be sure to fit the maximum diameter of the crankpin. If the bearing is fitted to the minimum diameter and the crankpin is out-of-round 0.025 mm (0.001 inch), interference between the bearing and crankpin will result in a rapid bearing failure.

   a. Place a piece of gaging plastic the full width of the crankpin as contacted by the bearing (parallel to the crankshaft).
   b. Install the bearing in the connecting rod and cap.
   c. Install the rod cap and evenly torque nuts to specifications. Do not turn the crankshaft with gaging plastic installed.
   d. Remove the rod cap and using the scale on the gaging plastic envelope, measure the gaging plastic width at the widest point.

6. If the clearance exceeds specifications, select a new, correct-size, bearing and remeasure the clearance. If clearance cannot be brought to within specifications, the crankpin will have to be ground undersize. If the crankpin is already at maximum undersize, replace crankshaft.
7. Coat the bearing surface with oil, install the rod cap and torque nuts to 53 N·m (39 lb. ft.).
8. When all connecting rod bearings have been installed, tap each rod lightly parallel to the crankpin to make sure they have clearance.
9. Measure all connecting rod side clearances (see specifications) between the rod cap and crankshaft throw (Figure 23).

PISTON AND CONNECTING ROD OFF-VEHICLE SERVICE

Tools Required:

J 24086-B Piston Pin Remover and Installer Set

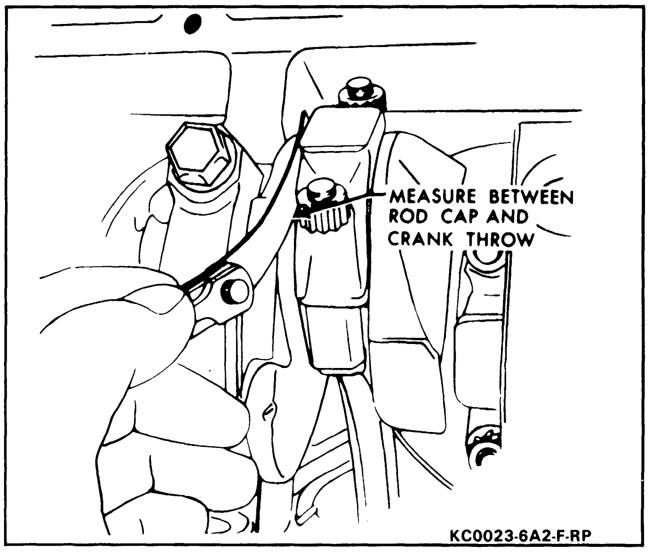


Figure 23 - Measuring Connecting Rod Side Clearance

J 8037 Piston Ring Compressor

Figures 24 and 25

Disassembly

1. Remove compression rings and oil ring.
2. Install piston and connecting rod assembly on J 24086-B and place in an arbor press. Press pin out of connecting rod.

Inspection

1. Inspect cylinder walls for scoring, roughness, or ridges that indicate excessive wear. Check cylinder bores for taper and out-of-round with an accurate cylinder gage at top, middle and bottom of bore.
2. If a cylinder bore is moderately rough or slightly scored but is not out-of-round or tapered, it is usually possible to remedy the situation by honing the bore to fit a standard service piston because standard service pistons are high limit production pistons. If cylinder bore is very rough or deeply scored, however, it may be necessary to rebore the cylinder to fit an oversize piston in order to insure satisfactory results.
3. If cylinder bore is tapered 0.1 mm (0.004 inch) or more or is out-of-round 0.1 mm (0.004 inch) or more, it is advisable to rebore for the smallest possible oversize piston and rings. Below these limits, the cylinder bore can be trued up with honing.
4. Clean carbon from piston surfaces and underside of piston heads. Clean carbon from ring grooves with suitable tool and remove any gum or varnish from piston skirts with suitable solvent.
5. Carefully examine pistons for rough or scored surfaces, cracks in skirt or head, or cracked or broken ring lands. Chipped or uneven wearing pistons would cause rings to seat improperly or have excessive clearance in ring grooves. Damaged or faulty pistons should be replaced. The pistons are cam ground, which means that the diameter at a right angle to the wrist pin is

greater than the diameter parallel to the wrist pin. When a piston is checked for size, it must be done at points 90 degrees to the piston pin. The piston should be checked for fitting purposes in a plane through the piston pin centerline.

6. Inspect surfaces of wrist pins and check for wear by measuring worn or unworn surfaces with micrometers. Occasionally pins will be found tight due to gum or varnish deposits. This may be corrected by removing the deposit with a suitable solvent. If piston bosses are worn out-of-round or oversize, the piston and pin assembly must be replaced. Oversize pins are not practical due to the pin being a press fit in the connecting rod. Piston pins must fit the piston with an easy finger push at 70°F (21°C) (0.0096 to 0.0215 mm (0. 00037 to 0.00085 inch) clearance).
7. Examine all piston rings for scores, chips or cracks. Check compression rings for tension by comparing with new rings. Check gap of compression rings by placing rings in bore at bottom of ring travel. Measure gap with feeler gage. Gap should be between 0.25 mm and 0.50 mm (0.010 and 0.020 inch) If gaps are excessive (over 0.50 mm) (0.020 inch), it indicates that the rings have worn considerably and should be replaced. Bore wear should be checked before rings are replaced, 0.125 mm (0.0049-inch) bore wear will result in 0.39 mm (0.015-inch) increase in ring gap.

Assembly

There is a machined hole or a cast notch in the top of all pistons to facilitate proper installation. The piston assemblies should always be installed with the hole toward the front of the engine (Figure 24).

1. Lubricate piston pin holes in piston and connecting rod with light engine oil.
2. Position connecting rod in its respective piston. Hold in place with piston pin guide and piston pin. Place assembly on fixture and support assembly J 24086-B.
3. Press the piston pin into the piston and connecting rod.

NOTICE: After installer hub bottoms on support assembly, do not exceed 34 475 kPa (5,000 psi) pressure, because this could cause structural damage to the tool.

4. Remove piston and connecting rod assembly from tool and check piston pin for freedom of movement on piston.

Installation

NOTICE: See "Notice" on page 6A2-1 of this section.

Cylinder bores must be clean before piston installation. This may be accomplished with a hot water and detergent wash or with light honing as necessary. After cleaning, the bores should be swabbed several times with light engine oil and a clean dry cloth.

1. Lubricate connecting rod bearings and install in rods and rod caps.
2. Lightly coat pistons, rings and cylinder walls with light engine oil.
3. With bearing caps removed, install guide hose over connecting rod bolts. These guide hoses protect the crankpin journal from damage during installation of connecting rod and piston assembly.
4. Make sure the gap in the oil ring rails are in "up" position toward center of engine and the gaps of the compression rings are positioned as shown in Figure 25.
5. Install each connecting rod and piston assembly in its respective bore. Install with connecting rod bearing tang slots on side opposite camshaft. Use J 8037 to compress the rings. Guide the connecting rod into place on the crankshaft journal. Use a hammer handle and light blows to install the piston into the bore. Hold the ring compressor firmly against the cylinder block until all piston rings have entered the cylinder bore.
6. Install the bearing caps and torque nuts to specifications. If bearing replacement is required refer to "Connecting Rod Bearings" in this section.

Be sure to install new pistons in the same cylinders for which they were fitted and used pistons in the same cylinder from which they were removed. Each connecting rod and bearing cap should be marked, beginning at the front of the engine.

On V-6 engines, 1, 3 and 5 are in the right bank and 2, 4 and 6 are in the left bank. The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.

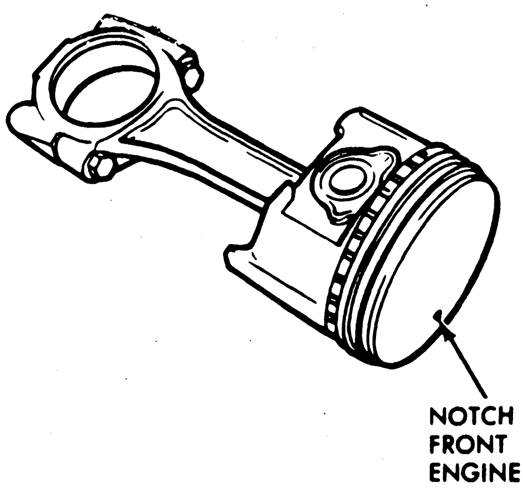


Figure 24 - Piston

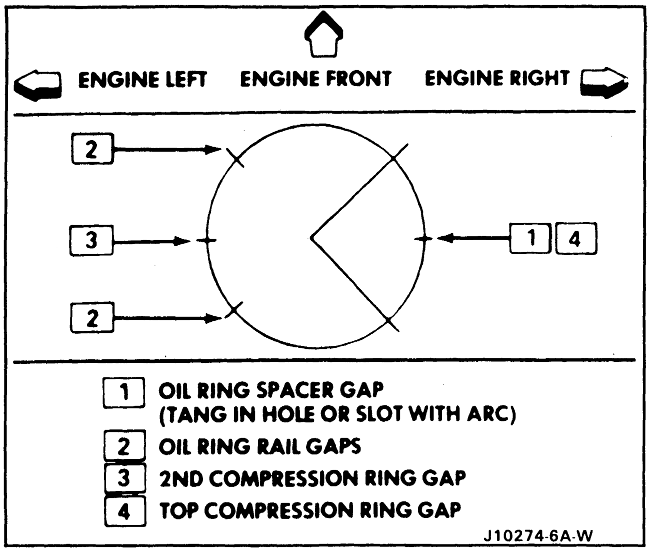


Figure 25 - Ring Gap Locations

Piston Selection

1. Remove all rings from pistons to be fitted. It is not necessary to separate rods from pistons. If an excess amount of varnish or carbon appears as a ridge at the top of the cylinder, remove by scraping or sanding.

   NOTICE: Caution must be used to insure piston is not damaged when it "falls" through the cylinder. If the piston does not "fall" freely, the piston fit is too tight and another piston should be selected until the piston will slide freely through the bore without any force being applied. Mark piston and bore for proper assembly.

2. Wipe bores and pistons clean, removing oil or other foreign material. Select a piston-rod assembly for the bore to be fitted, or piston and pin if a new piston is being fitted, and position down into the bore with the top of piston down. The piston should fall free by its own weight through the bore when the bottom of the piston skirt is 12 to 25 mm (0.5 to 1.0 inch) from top of block.
3. After a piston that will slide freely through a bore, has been selected it must be determined if piston fit will be too loose. This is done by placing a 0.060 mm feeler gage for used pistons and a .050 mm feeler gage for new pistons at least 150 mm (6 inches) long and not over 12 mm (0.5 inch) wide, down into the same bore with selected piston while holding feeler to top of the bore.
4. Position selected piston and feeler down into the bore until the bottom of the skirt is again 12 to 25 mm (0.5 to 1.0 inch) from top of block, being sure that the feeler gage is 90 degrees from the pin. If the piston hangs on the feeler gage and does not fall free, it indicates that the piston is correctly fitted to that respective bore. Mark both piston and bore before going to the next bore. If the piston fell free during this check with the 0.060 mm feeler gage (0.050 mm feeler gage for new pistons) then that particular piston is too small for the bore and a larger diameter piston will be required.

When checking more than one bore, it is possible that what may be a piston too small for one bore will be a correct fit in another.

Piston Rings

When new piston rings are installed without reboring cylinders, the glazed cylinder walls should be slightly dulled, without increasing the bore diameter, with the finest grade of stones in a cylinder hone.

New piston rings must be checked for clearance in piston grooves and for gap in cylinder bores. The cylinder bores and piston grooves must be clean, dry and free of carbon and burrs.

With rings installed, check clearance in grooves by inserting feeler gages between each ring and its lower land because any wear that occurs forms a step at inner portion of the lower land.

If the piston grooves have worn to the extent that relatively high steps exist on the lower lands, the piston should be replaced because the steps will interfere with the operation of new rings and the ring clearances will be excessive. Piston rings are not furnished in oversize widths to compensate for ring groove wear.

All compression rings are marked on the upper side of the ring. When installing compression rings, make sure the marked side is toward the top of the piston. The top ring is treated with molybdenum for maximum life.

The oil control rings are of three piece type, consisting of two segments (rails) and a spacer.

Piston Ring Selection

Figures 26 and 27

1. Select rings comparable in size to the piston being used.
2. Slip the compression ring in the cylinder bore; then press the ring down into the cylinder bore about 6 mm (0.2 inch) above ring travel. Be sure ring is square with cylinder wall.
3. Measure the space or gap between the ends of the ring with a feeler gage (Figure 26).
4. If the gap between the ends of the ring is below specifications, remove the ring and try another for fit.
5. Fit each compression ring to the cylinder in which it is going to be used.
6. If the pistons have not been cleaned and inspected as previously outlined, do so.
7. Slip the outer surface of the top and second compression ring into the respective piston ring groove and roll the ring entirely around the groove (Figure 27). If binding occurs at any point, the cause should be determined. If caused by a ring groove, remove by dressing with a fine cut file. If the binding is caused by a distorted ring, check a new ring.

Installation

1. Install oil ring spacer in groove being sure ends are butted and not overlapped.

2. Hold spacer ends butted and install lower steel oil ring rail.
3. Install upper steel oil ring rail with gap staggered.
4. Flex the oil ring assembly to make sure ring is free. If binding occurs, the cause should be determined. If caused by ring groove, remove by dressing groove with a fine cut file. If binding is caused by a distorted ring, check a new ring.
5. Install second compression ring. Stagger gap from other rings.
6. Install top compression ring with gap properly located.

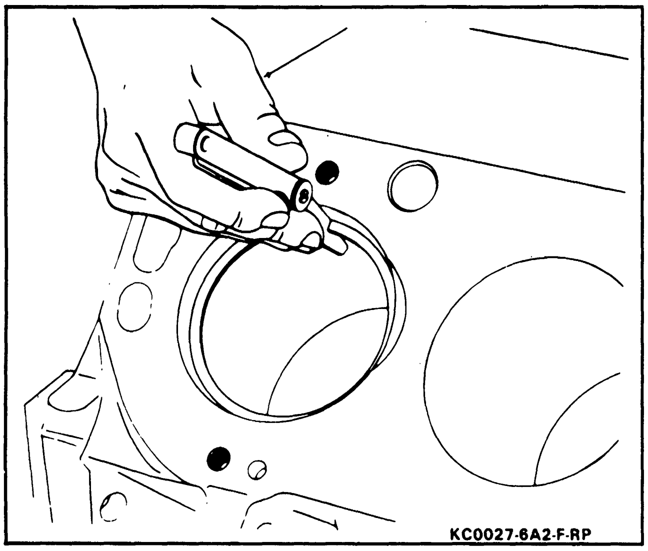


Figure 26 - Measuring Ring Gap

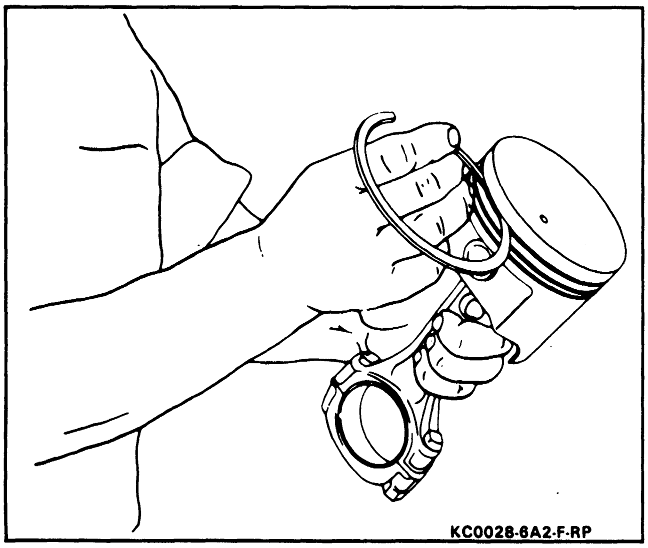


Figure 27 - Checking Ring in Groove

MAIN BEARINGS

Figures 28 and 29

Main bearings are of the precision insert type and do not utilize shims for adjustment. If clearances are found to be excessive, a new bearing, both upper and lower halves, will be required. Service bearings are available in standard size and undersize.

Selective fitting of both rod and main bearing inserts is necessary in production in order to obtain close tolerances. For this reason you may find one half of a standard insert, with one half of a 0.016 mm undersize insert which will decrease the clearance 0. 008 mm (0.0003 inch) from using a full standard bearing.

Inspection

In general, the lower half of the bearing (except number 1 bearing) shows a greater wear and the most distress from fatigue. If upon inspection the lower half is suitable for use, it can be assumed that the upper half is also satisfactory. If the lower half shows evidence of wear or damage, both upper and lower halves should be replaced. Never replace one half without replacing the other half.

Main Bearing Fitting

Checking Clearance

NOTICE: See "Notice" on page 6A2-1 of this section.

To obtain the most accurate results with gaging plastic certain precautions should be observed. If the engine is out of the vehicle and upside down, the crankshaft will rest on the upper bearings and the total clearance can be measured between the lower bearing and journal. If the engine is to remain in the vehicle, the crankshaft should be supported both front and rear to remove the clearance from the upper bearing. The total clearance can then be measured between the lower bearing and journal. When checking number 1 main bearing, remove accessory drive belt to prevent a tapered reading with gaging plastic.

NOTICE: To assure the proper seating of the crankshaft, all bearing cap bolts should be at their specified torque. In addition, prior to checking the bearing fit, the surface of the crankshaft journal and bearing should be wiped clean of oil.

1. With the oil pan and oil pump removed, and starting with the rear main bearing, remove bearing cap and wipe oil from journal and bearing cap.
2. Place a piece of gaging plastic the full width of the bearing, parallel to the crankshaft on the journal. Do not rotate the crankshaft while the gaging plastic is between the bearing and journal.
3. Install the bearing cap and evenly torque the retaining bolts to 99 N·m (73 lb. ft.). Bearing cap must be torqued to specification in order to assure proper reading. Variations in torque affect the compression of the plastic gage.
4. Remove bearing cap. The flattened gaging plastic will be found adhering to either the bearing shell or journal.
5. On the edge of gaging plastic envelope, there is a graduated scale that is correlated in thousandths of a millimeter. Without removing the gaging plastic, measure its compressed width at the widest point with the graduations on the gaging plastic envelope. Normally, main bearing journals wear evenly and are not out-of-round.

However, if a bearing is being fitted to an out-of-round journal (0.025 mm (0.001 inch) max.), be sure to fit to the maximum diameter of the journal. If the bearing is fitted to the minimum diameter and the journal is out-of-round 0.025 mm (0.001 inch), interference between the bearing and journal will result in rapid bearing failure. If the flattened gaging plastic tapers toward the middle or ends, there is a difference in clearance indicating taper, low spot or other irregularity of the bearing or journal. Be sure to measure the journal with a micrometer if the flattened gaging plastic indicates more than 0.025 mm (0.001 inch) difference.

6. If the bearing clearance is within specifications, the bearing insert is satifactory. If the clearance is not within specifications, replace the insert. Always replace both upper and lower inserts as a unit.
7. A standard, 0.016 mm and 0.032 mm undersize bearing may produce the proper clearance. If not, it will be necessary to regrind the crankshaft journal for use with the next undersize bearing. After selecting new bearing, recheck clearance.
8. Proceed to the next bearing. After all bearings have been checked rotate the crankshaft to see that there is no excessive drag.
9. Measure crankshaft end play (see specifications) by forcing the crankshaft to the extreme front position. Measure at the front end of the number 3 main bearing with a feeler gage (Figure 29).
10. Install a new rear main bearing oil seal in the cylinder block and main bearing cap.

Replacement

Main bearings may be replaced with or without removing the crankshaft.

With Crankshaft Removal

1. Remove and inspect the crankshaft. Refer to "Crankshaft" in this section.
2. Remove the main bearings from the cylinder block and main bearing caps.
3. Coat bearing surfaces of new, correct size, main bearings with oil and install in the cylinder block and main bearing caps.
4. Install crankshaft. Refer to "Crankshaft" in this section.

Without Crankshaft Removal

NOTICE: See "Notice" on page 6A2-1 of this section.

1. With oil pan, oil pump and spark plugs removed, remove cap of main bearing requiring replacement and remove bearing from cap.
2. Install a main bearing removing and installing tool in oil hole in crankshaft journal. If such a tool is not available, a cotter pin may be bent as required to do the job.
3. Rotate the crankshaft clockwise as viewed from the front of engine. This will roll upper bearing out of block.
4. Oil new selected size upper bearing and insert plain, unnotched end between crankshaft and indented or notched side of block. Rotate the bearing into place and remove tool from oil hole in crankshaft journal. Inspect for burrs at oil holes, remove if required.
5. Oil new lower bearing and install in bearing cap.
6. Install main bearing cap with arrows pointing toward front of engine.
7. Torque all main bearing caps, except the number 3 main cap, to 99 N·m (73 lb. ft.). Torque number 3 main bearing cap to 15 N·m (11 lb. ft.) then tap end of crankshaft, first rearward then forward with a lead hammer. This will line up rear main bearing and crankshaft thrust surfaces. Retorque all main bearing caps to 99 N·m (73 lb. ft.).

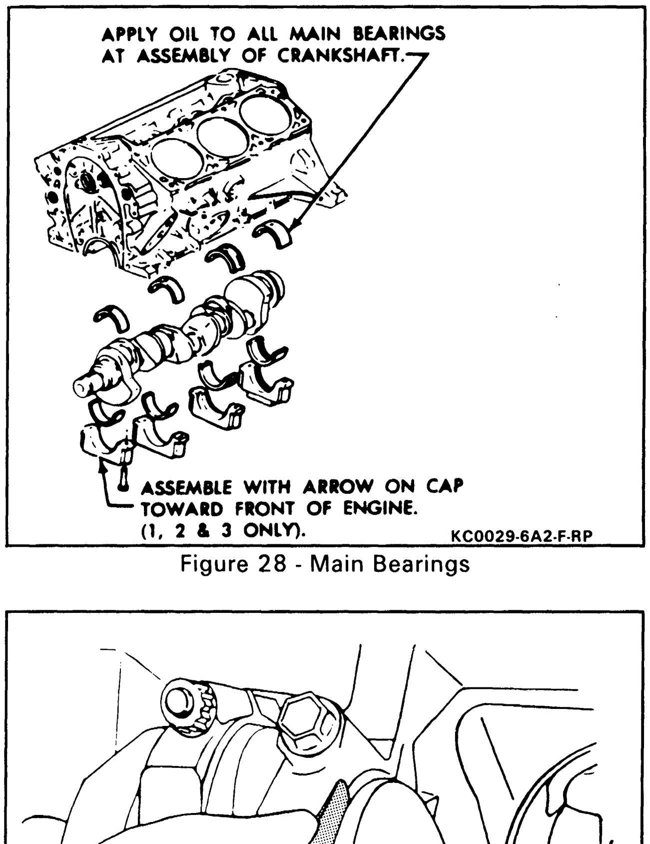


Figure 28 - Main Bearings

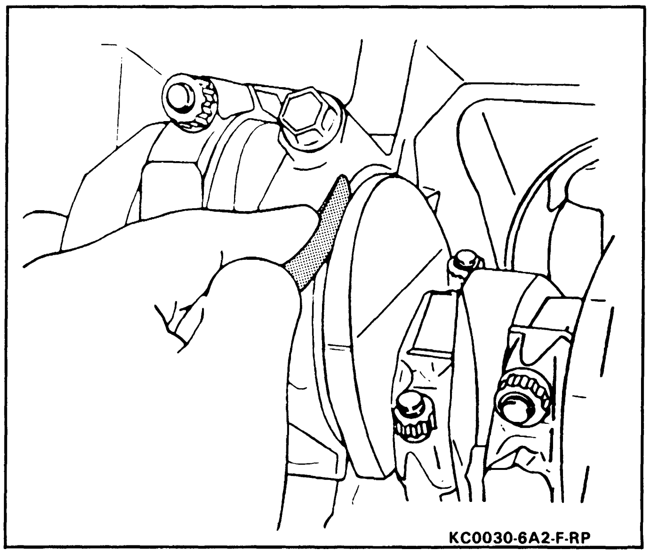


Figure 29 - Measuring Crankshaft End Play

FLYWHEEL

Manual Transmission

Refer to CLUTCH (SEC. 7C) for removal of flywheel.

Automatic Transmission

Removal

1. Remove the transmission. Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A).
2. Remove the bolts attaching the flywheel to the crankshaft.
3. Remove the flywheel.

Installation

NOTICE: See "Notice" on page 6A2-1 of this section.

1. Position the flywheel to the crankshaft, aligning the dowel pin on the crankshaft to the proper hole on the flywheel.
2. Install the bolts retaining the flywheel to the crankshaft.

   Tighten

   - Flywheel-to-crankshaft bolts to 71 N·m (52 lb. ft.).
3. Install the transmission. Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A).

Flywheel Balancing

Adjust

- Flywheel to correct any imbalance by adding balance weights to one or more of the holes provided in the flywheel.
- Install one balance weight to one of the flywheel holes.
- Start engine and, with transmission in "NEUTRAL," note the vibration.
  - If vibration has increased, relocate balance weight 180 degrees from its present position.
  - If vibration has decreased install an additional balance weight next to the first one.
  - If no change is noticed, relocate the balance weight 60 degrees from its present location.
  - Continue until vibration is reduced.

REAR CRANKSHAFT SEAL

Tool Required:

J 34686 Rear Main Bearing Oil Seal Installer

Figures 30 through 32

Repair

1. Remove transmission. Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A) or MANUAL TRANSMISSION (SEC 7B).
2. Remove flywheel. Refer to "Flywheel" in this section.

   NOTICE: Care must be taken not to damage the crankshaft outside diameter surface with the pry tool.
3. Remove old seal. Insert a screwdriver or similar tool through the dust lip at an angle as shown in Figure 30. Pry seal out by moving handle of tool towards the end of the crankshaft. Repeat as required around the seal until seal is removed.
4. Check the inside diameter of bore for nicks or burrs and correct as required. Inspect crankshaft for burrs or nicks that contact seal. Repair or replace crankshaft as required.
5. Install new seal using J 34686 (Figure 31).
6. Apply a light coat of oil to inside diameter of new seal and install over mandril, slide the seal in the mandril until the dust lip at back of seal bottoms squarely against collar of tool (Figure 32).
7. Align dowel pin of tool with dowel pin hole in crankshaft and attach tool to crankshaft by hand or torque attaching screw to 2.7 to 6.8 N·m (24 to 60 lb. in.).
8. Turn "T" handle of tool so that collar pushes seal into the bore, turn handle until the collar is tight against the case. This will insure that the seal is seated properly.
9. Loosen the "T" handle of the tool until it comes to a stop. This will insure that the collar will be in the proper position for installing a new seal. Remove attaching screws.
10. Check seal, making sure seal is seated squarely in the bore.
11. Install flywheel. Refer to "Flywheel" in this section.
12. Install transmission. Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A) or MANUAL TRANSMISSION (SEC. 7B).
13. Start engine, check for leaks.

ENGINE ASSEMBLY

Removal

1. Disconnect negative battery cable.
2. Remove air cleaner duct.
3. Remove hood.
4. Remove serpentive belt.
5. Disconnect air conditioning compressor from bracket and lay aside.
6. Drain radiator.
7. Remove lower radiator hose.
8. Remove upper radiator hose and coolant recovery hose.
9. Remove heater hoses at coolant pump and valve.
10. Disconnect throttle linkage, including cruise control detent cable.

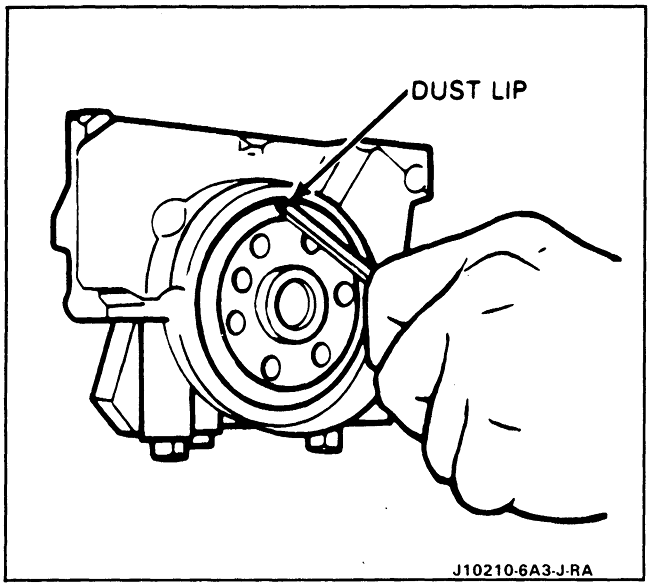


Figure 30 - Removing Seal

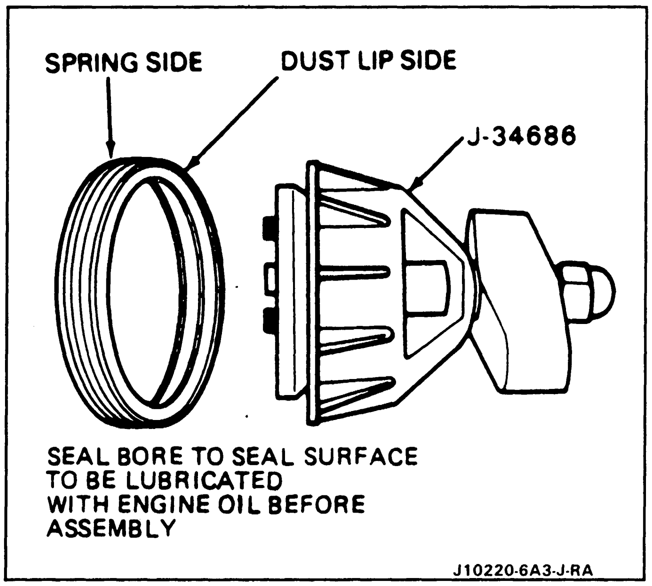


Figure 31 - Seal and J 34686

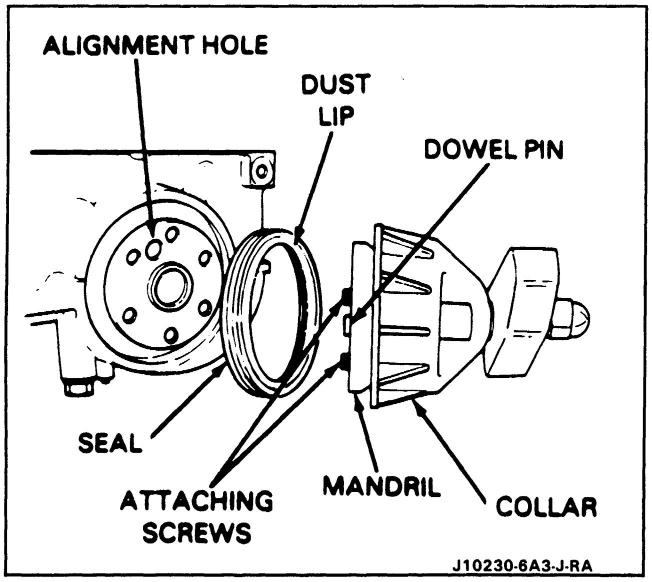


Figure 32 - Installing Seal

11. Remove vacuum brake booster line.
12. Remove distributor cap and lay wiring aside.
13. Disconnect necessary wires and hoses.
14. Remove power steering pump and lay aside.
15. Raise vehicle.
16. Disconnect transmission fluid cooler lines at oil pan clips.
17. Disconnect exhaust crossover pipe at exhaust manifold.
18. Remove dust cover.
19. Remove converter bolts.
20. Disconnect starter wires.
21. Remove bell housing bolts.
22. Remove motor mount through-bolts.
23. Lower vehicle.
24. Disconnect fuel lines.
25. Support transmission.
26. Connect engine lifting device.
27. Remove engine. Include removing wire from bracket at rear left of engine.

Installation

NOTICE: See "Notice" on page 6A2-1 of this section.

1. Position engine assembly in vehicle.
2. Attach motor mount to engine brackets and lower engine in place.
3. Remove engine lifting device.
4. Remove transmission floor jack.
5. Raise vehicle on hoist.
6. Install mount through-bolts. Torque to specifications.
7. Install bell housing bolts. Torque to specifications.
8. On vehicles with automatic transmission, install converter to flywheel attaching bolts. Torque to specifications.
9. Install flywheel splash shield or converter housing cover as applicable. Torque attaching bolts to specifications.
10. Install transmission fluid cooler lines to oil pan clips.
11. Install starter wires.
12. Connect exhaust crossover pipe at manifold.
13. Lower vehicle on hoist.
14. Connect fuel lines.
15. Reinstall power steering pump.
16. Connect necessary wires and hoses.
17. Connect radiator and heater hoses.
18. Connect throttle linkage and cruise control cable.
19. Connect vacuum brake booster line.
20. Install distributor cap.
21. Connect air conditioning compressor to bracket.
22. Fill cooling system

23. Fill crankcase with oil. Refer to MAINTENANCE AND LUBRICATION (SEC. 0B).
24. Install air cleaner duct.
25. Install hood.

NOTICE: To avoid possible arcing of battery, connect positive battery cable first.

26. Connect battery cables.
27. Install serpentine belt.
28. Start engine, check for leaks and check timing.

Cylinder Block Service

Figure 33

If one or more cylinder bores are rough, scored or worn beyond limits, it will be necessary to smooth or true up such bores to fit new pistons.

If relatively few bores require correction, it will not be necessary to rebore all cylinders to the same oversize in order to maintain engine balance. All oversize service pistons are held to the same weights as standard size pistons.

No attempt should be made to cut down oversize pistons to fit cylinder bores as this will destroy the surface treatment and affect the weight. The smallest possible oversize service pistons should be used and the cylinder bores should be honed to size for proper clearances.

Before the honing or reboring operation is started, measure all new pistons with micrometer contacting at points exactly 90 degrees from piston pin centerline then select the smallest piston for the first fitting. The slight variation usually found beween pistons in a set may provide for correction in case the first piston is fitted too free.

If wear at top of cylinder does not exceed 0.10 mm (0.004 inch) on the diameter or exceed 0.10 mm (0.004 inch) out-of-round, honing is recommended for truing the bore. If wear or out-of-round exceeds these limits, the bore should be trued up with a boring bar of the fly cutter type, then finish honed.

When reboring cylinders, all crankshaft bearing caps must be in place and tightened to proper torque to avoid distortion of bores in final assembly. Always be sure the crankshaft is out of the way of the boring cutter when boring each cylinder. When taking the final cut with boring bar, leave 0.025 mm (0.001 inch) on the diameter for finish honing to give the required clearance specified.

When honing cylinders, use clean sharp hones of proper grade for the amount of metal to be removed, in accordance with manufacturer's instructions. Dull or dirty stones cut unevenly and generate excessive heat. When using coarse or medium grade stones use care to leave sufficient metal so that all stone marks may be removed with the fine stones used for finishing to provide proper clearance.

It is important that refinished cylinder bores are trued up to have not over 0.02 mm (0.0008 inch) out-of-round or taper. Each bore must be final honed to remove all stone or cutter marks and provide a smooth surface. During final honing, each piston must be fitted individually to the bore in which it will be installed and should be marked to insure correct installation.

After final honing and before the piston is checked for fit, each cylinder bore must be thoroughly washed to remove all traces of abrasives and then dried thoroughly. The dry bore should then be brushed clean with a power-driven fiber brush. If all traces of the abrasives are not removed, rapid wear of new pistons and rings will result.

HONED SURFACE

1. Cross Hatch Angle 20° - 32°
2. Uniformly Cut in Both Directions
3. Clean Cut Not Sharp Free of Torn and Folded Metal
4. Micro Ave. 10-20 Micro In. (0.25-0.30 micrometers) Range 10-15 micro in. (0.25-0.38 micrometers)
5. Cross Hatch Ave. .0004"-.0006" Wide Range .0002"-.0009"
6. Cross Hatch Ave. .00015"-.00025" Deep Range .0001"-.0003"
7. Plateau to be 1/2 to 2/3 of Surface
8. Free of Burnish or Glaze
9. Free of Imbedded Particles

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Figure 33 - Honing Specifications

CRANKSHAFT

The crankshaft can be removed while the engine is dissassembled for overhaul, or without complete disassembly.

Removal

1. With the engine removed from the vehicle, remove the clutch assembly (if equipped) and flywheel. Mount engine in stand and clamp securely.
2. Remove the spark plugs.
3. Remove crankshaft pulley and torsional damper. Refer to "Torsional Damper" in this section.
4. Remove oil pan and oil pump. Refer to "Oil Pump" in this section.
5. Remove starter. Refer to CRANKING SYSTEM (SEC. 6D2).
6. Remove coolant pump, engine front cover, camshaft sprocket and timing chain. Refer to "Timing Chain and Sprockets" in this section.
7. Check the connecting rod caps for cylinder number identification. If necessary, mark them.
8. Remove the connecting rod nuts and caps and push the pistons to top of bores.
9. Remove main bearing caps and lift crankshaft out of cylinder block.

10. Remove rear main bearing oil seal and main bearings from cylinder block and main bearing caps.

Cleaning and Inspection

1. Wash crankshaft in solvent and dry with compressed air.
2. Measure dimensions of main bearing journals and crankpins with a micrometer for out-of-round, taper or undersize (See Specifications).
3. Check crankshaft for run-out by supporting at the front and rear main bearings journals in "V" blocks and check at the front and rear intermediate journals with a dial indicator (See Specifications).
4. Replace or recondition the crankshaft if out of specifications.

Installation

1. Install rear main bearing oil seal in cylinder block and rear bearing cap grooves.
2. Lubricate seal with engine oil. Keep oil off parting line surface.
3. Install main bearings in cylinder block and main bearing caps then lubricate bearing surface with engine oil.
4. Install crankshaft, being careful not to damage bearing surfaces.
5. Recheck bearing clearances using gaging plastic.
6. Apply a thin coat of an anerobic sealant number 1052357 or equivalent to rear of the block connecting surface or corresponding surface of rear main cap only. Do not allow sealer on crankshaft or seal.
7. Install main bearing caps with arrow pointing toward front of engine.
8. Torque all except number 3 main bearing cap bolts to specifications. Torque number 3 main bearing cap bolts to 15 N·m (11 lb. ft.) then tap end of crankshaft, first rearward then forward with a lead hammer. This will line up rear main bearing and crankshaft thrust surfaces. Retorque all main bearing cap bolts to specifications.
9. Measure crankshaft end play with a feeler gage. Force crankshaft forward and measure clearance between the front of the number 3 main bearing and crankshaft thrust surface.
10. Install connecting rod caps and nuts. Torque nuts to 53 N·m (39 lb. ft.).
11. Install timing chain, camshaft sprocket, crankcase front cover and coolant pump. Refer to "Timing Chain and Sprockets" in this section.
12. Install oil pump and oil pan. Refer to "Oil Pump" in this section.
13. Install starter. Refer to CRANKING SYSTEM (SEC. 6D2).
14. Install torsional damper and crankshaft pulley. Refer to "Torsional Damper" in this section.
15. Install spark plugs.
16. Install flywheel and clutch assembly (if equipped) and torque to specifications.

Sprocket or Gear Replacement

Remove crankshaft sprocket using J 5825-A, install using J 5590.

THREAD REPAIR

Figure 34

Damaged threads may be re-conditioned by drilling out, re-threading and installing a suitable thread insert.

CAUTION: Wear safety glasses to avoid eye damage.

1. Determine size, pitch and depth of damaged thread. If necessary, adjust stop collars on cutting tool and tap to the required depth.
    - Refer to the kit manufacturer's instructions regarding the size of drill and tap to be used.
2. Drill out damaged thread. Clean out chips.
3. Tap hole. Lubricate tap with light engine oil. Clean the thread.
    - Avoid build-up of chips. Back the tap out every few turns and remove chips.
4. Thread the thread insert onto the mandrel of the installer. Engage the tang of the insert onto the end of the mandrel.
5. Lubricate the insert with light engine oil, except when installing in aluminum, and install.
    - When correctly installed, the insert should be flush to one turn below the surface.
6. If the tang of the insert does not break off when backing out the installer, break the tang off with a drift pin.

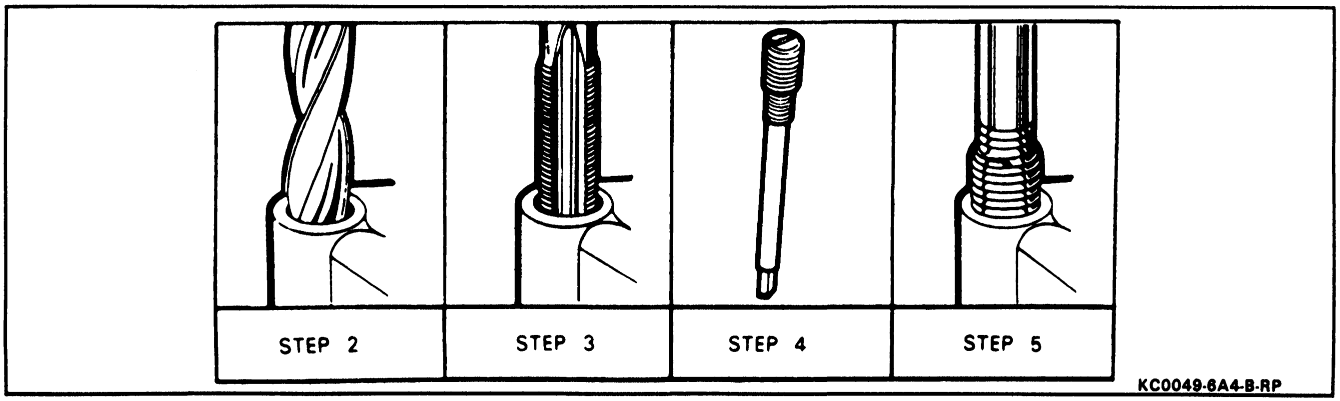


Figure 34 - Repairing Threaded Holes

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Engine Mount Nut	41 N·m (30 lb. ft.)
Engine Mount Through-Bolt Nut	68 N·m (50 lb. ft.)
Transmission Mount-to-Transmission Bolt	54 N·m (40 lb. ft.)
Transmission Support Nut	65 N·m (48 lb. ft.)
Transmission-to-Crossmember Nut	47 N·m (35 lb. ft.)
Center Intake Manifold Bolt	21 N·m (15 lb. ft.)
AIR Injection Pipe Fitting	34 N·m (25 lb. ft.)
Generator Rear Brace Bolt	50 N·m (37 lb. ft.)
Power Steering Pump Rear Bracket Bolt	25 N·m (18 lb. ft.)
Generator Rear Brace Nut	25 N·m (18 lb. ft.)
EGR Valve Adapter Nut	31 N·m (23 lb. ft.)
Engine Front Cover Bolt	21 N·m (15 lb. ft.)
Rear Oil Pan Bolt (two)	25 N·m (18 lb. ft.)
Oil Pan Bolt/Nut (except rear two)	10 N·m (89 lb. in.)
Coolant Pump Bolt	Refer to Figure 13
Cylinder Head Bolt	Refer to Assembly Procedure
Oil Level Indicator Guide Tube Nut	37 N·m (27 lb. ft.)
Camshaft Sprocket Bolt	28 N·m (21 lb. ft.)
Camshaft Rear Cover Bolt	10 N·m (89 lb. in.)
Connecting Rod Cap Nut	53 N·m (39 lb. ft.)
Torsional Damper Bolt	95 N·m (70 lb. ft.)
Distributor Hold Down Bolt	34 N·m (25 lb. ft.)
Exhaust Manifold Bolt/Nut	34 N·m (25 lb. ft.)
Exhaust Crossover Pipe Nut	20 N·m (15 lb. ft.)
Water Drain Plug	13 N·m (115 lb. in.)
Thermostat Housing	25 N·m (18 lb. ft.)
Lower Intake Manifold	26 N·m (19 lb. ft.)
Timing Chain Damper Bolt	21 N·m (15 lb. ft.)
Valve Cover Nut	14 N·m (10 lb. ft.)
Spark Plug	34 N·m (25 lb. ft.)
Flywheel-to-Crankshaft Bolt	71 N·m (52 lb. ft.)
Main Bearing Cap Bolt	99 N·m (73 lb. ft.)
Oil Pump	41 N·m (30 lb. ft.)
Oil Filter Adapter Bolt	85 N·m (63 lb. ft.)
Crankshaft Pulley Bolt	50 N·m (37 lb. ft.)
EGR Transfer Tube Bolt	26 N·m (19 lb. ft.)
Oil Pan Drain Plug	25 N·m (18 lb. ft.)
AIR Pump Lower Bracket Bolt	35 N·m (26 lb. ft.)
AIR Pump Upper Bracket Nut	50 N·m (37 lb. ft.)
AIR Pump Upper Bracket Bolt	33 N·m (24 lb. ft.)
AIR Pump Pulley Bolt	26 N·m (19 lb. ft.)

ENGINE SPECIFICATIONS

Type	60° V6
Displacement	3.1 Liter (191 CID)
RPO	LH0
Bore	89 mm (3.503")
Stroke	84 mm (3.3122")
Compression Ratio	8.5:1
Firing Order	1-2-3-4-5-6
Oil Pressure	55 kPa (8 psi) at 600 rpm (Minimum)

Cylinder Bore

Diameter	89.016-89.034 mm (3.5046-3.5053")
Out of Round	0.013 mm (0.0005")
Taper-Thrust Side	0.014 mm (0.0005")

Piston

Clearance	0.030-0.072 mm (0.0012-0.0028")

Piston Ring

Compression	
Groove Clearance	
Top	0.05-0.09 mm (0.002-0.0035")
Second	0.05-0.09 mm (0.002-0.0035")
Gap	
Top	0.25-0.50 mm (0.010-0.020")
Second	0.50-0.71 mm (0.020-0.028")
Oil	
Groove Clearance	0.181 mm (0.007") Max.
Gap	0.25-0.75 mm (0.010-0.030")

Piston Pin

Diameter	22.9915-22.9964 mm (0.9052-0.9054")
Clearance to Piston	0.0051-0.0178 mm (0.0002-0.0007")
Fit in Rod	0.0165-0.0464 mm (0.0006-0.0018") Press

Camshaft

Lift	
Intake	6.67 mm (0.2626")
Exhaust	6.94 mm (0.2732")
Journal Diameter	47.44-47.49 mm (1.8678-1.8697")
Journal Clearance	0.026-0.101 mm (0.0010-0.0040")

Crankshaft

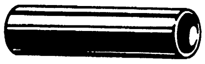
Main Journal	
Diameter All	67.241-67.265 mm (2.6473-2.6483")
Taper	0.005 mm (0.0002") Max.
Out of Round	0.005 mm (0.0002") Max.
Main Bearing Clearance *	0.032-0.077 mm (0.0012-0.0030")
Main Thrust Bearing Clearance *	0.032-0.077 mm (0.0016-0.0030")
Crankshaft End Play	0.06-0.21 mm (0.0024-0.0083")
Crank Pin	
Diameter	50.758-50.784 mm (1.9983-1.9994")
Taper	0.005 mm (0.0002") Max.
Out of Round	0.005 mm (0.0002") Max.
Rod Bearing Clearance *	0.028-0.083 mm (0.0011-0.0033")
Rod Side Clearance	0.36-0.60 mm (0.014-0.029")

* Build Paper Clearance - distortion and wear not included

Valve System

Lifter	Hydraulic
Rocker Arm Ratio	1.5:1
Valve Lash	1-1/2 Turns from Zero Lash
Face Angle	45°
Seat Angle	46°
Seat Runout	0.05 mm (0.002″)
Seat Width	
Intake	1.25-1.50 mm (0.049-0.059″)
Exhaust	1.60-1.90 mm (0.063-0.075″)
Stem Clearance	
Intake	0.036 - 0.064 mm (0.0014 - 0.0025″)
Exhaust	0.041 - 0.074 mm (0.0016-0.0029″)
Valve Spring	
Free Length	48.5 mm (1.91″)
Pressure	
Closed	356N at 40 mm (80 lb. at 1.61″)
Open	841N at 30.5 mm (189 lb. at 1.20″)
Installed Height	40.9 mm (1.61″)
Damper	
Free Length	29.5 mm (1.16″)

SPECIAL TOOLS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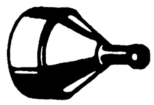
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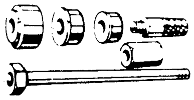
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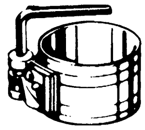
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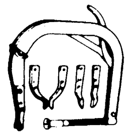
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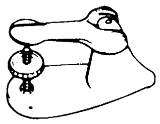
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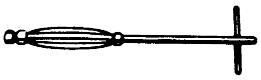
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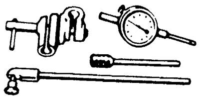
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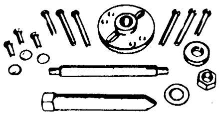
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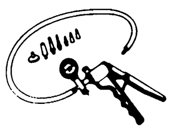
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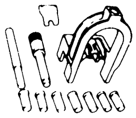
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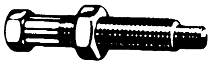
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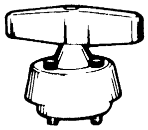
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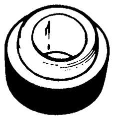
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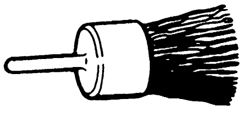
19 J 8089

1 CRANKSHAFT GEAR INSTALLER
2 CRANKSHAFT GEAR REMOVER
3 VALVE GUIDE REAMER SET (INCLUDES J 5830-1, -2, -3, -4, -5)
4 VALVE SPRING COMPRESSOR (HEAD-ON)
5 CAMSHAFT BEARING REMOVER & INSTALLER
6 PISTON RING COMPRESSOR
7 VALVE SPRING COMPRESSOR (HEAD-OFF)
8 VALVE SPRING TESTER
9 OIL SUCTION PIPE INSTALLER
10 VALVE GUIDE CLEANER
11 CAM LOBE LIFT INDICATOR
12 HARMONIC BALANCER REMOVER & INSTALLER
13 SPARK PLUG PORT ADAPTER (14 mm tapered seat)
14 VALVE STEM SEAL TESTER (Mity-Vac)
15 PISTON PIN REMOVER & INSTALLER SET
16 HARMONIC BALANCER INSTALLER
17 REAR MAIN BEARING OIL SEAL INSTALLER
18 FRONT COVER ALIGNER & OIL SEAL INSTALLER
19 CARBON REMOVING BRUSH

MC0001-6A2-F-RP

SECTION 6A3

V8 ENGINES

5.0L V8-RPO L03

5.0L V8-RPO LB9

5.7L V8-RPO L98

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 6A3-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

ENGINE CONSTRUCTION

Cylinder Block

The cylinder block is made of cast iron and has eight cylinders arranged in a "V" shape with four cylinders in each bank. Five main bearings support the crankshaft which is retained by bearing caps that are machined with the block for proper alignment and clearances. Cylinders are completely encircled by coolant jackets.

Cylinder Heads

The cast iron cylinder heads feature individual intake and exhaust ports for each cylinder. Valve guides are integral, and rocker arms are retained on individual pressed studs.

Crankshaft and Bearings

The crankshaft is cast nodular iron and is supported by five main bearings. Number 5 is the end thrust bearing.

Main bearings are lubricated from oil holes which intersect the camshaft bearings. The camshaft bearings are fed oil by the main oil gallery which is rifle drilled down the center of the block, above the camshaft. Two additional oil galleries are on either side of the main oil gallery to provide an oil supply for the hydraulic lifters.

Camshaft and Drive

The cast iron camshaft is supported by five bearings and is chain driven. A steel crankshaft sprocket drives the timing chain which in turn drives the camshaft through a metal sprocket.

Camshaft bearings are lubricated through oil holes which intersect the main oil gallery. The main oil gallery is rifle drilled down the center of the block, above the camshaft.

Pistons and Connecting Rods

The pistons are made of cast aluminum alloy using two compression rings and one oil control ring. Piston pins are offset 1.6 mm (1/16 inch) toward the thrust side (right hand side) to provide a gradual change in thrust pressure against the cylinder wall as the piston travels its path. Pins are chromium steel and have a floating fit in the pistons. They are retained in the connecting rods by a press fit. Connecting rods are made of forged steel. Full pressure lubrication is directed to the connecting rods by drilled oil passages from the adjacent main bearing journal.

Valve Train

A very simple ball pivot-type train is used. Motion is transmitted from the camshaft through the hydraulic lifter and pushrod to the rocker arm. The rocker arm pivots on its ball and transmits the camshaft motion to the valve. The rocker-arm ball is retained by a nut.

Hydraulic Valve Lifters

Hydraulic valve lifters are used to keep all parts of the valve train in constant contact.

The hydraulic lifter assembly consists of: a roller, the lifter body, which rides in the cylinder block boss, a plunger, a pushrod seat, a metering valve, a plunger spring, a check ball and spring, a check ball retainer and a pushrod seat retainer.

When the lifter is riding on the low point of the cam, the plunger spring keeps the plunger and pushrod seat in contact with the pushrod.

When the lifter body begins to ride up the cam lobe, the check ball cuts off the transfer of oil from the reservoir below the plunger. The plunger and lifter body then rise as a unit, pushing up the pushrod and opening the valve.

As the lifter body rides down the other side of the cam, the plunger follows with it until the valve closes. The lifter body continues to follow the cam to its low point, but the plunger spring keeps the plunger in contact with the pushrod. The ball check valve will then move off its seat and the lifter reservoir will remain full.

Intake Manifold

The intake manifold is made of cast iron or aluminum double level design for efficient fuel distribution. An Exhaust Gas Recirculation (EGR) port is also cast into the manifold for the mixture of exhaust gases with the fuel air mixture.

The intake manifold for those vehicles equipped with Port Fuel Injection (PFI) is a cast aluminum unit. It centrally supports a fuel rail with eight fuel injectors.

Exhaust Manifolds

Two cast iron exhaust manifolds are used to direct exhaust gases from the combustion chambers to the exhaust system. The L03 engine left hand side manifold receives a heat shield that is used to route heated air to the air cleaner for better fuel vaporization during warmup.

Combustion Chambers

Combustion chambers are cast to insure uniform shape for all cylinders. Spark plugs are located between the intake and exhaust valves. The contoured wedge shape of the combustion chamber minimizes the possibility of detonation, facilitates breathing and provides swirling turbulence for smooth, complete combustion.

ENGINE LUBRICATION

Figures 1 and 2

The gear-type oil pump is driven from the distributor shaft, which is gear-driven from the camshaft. Oil is drawn into the oil pump through a pickup screen and pipe.

Pressurized oil is routed to the oil filter. In case of excessive oil pressure, a bypass valve is provided. Filtered oil flows into the main gallery and then to the camshaft and crankshaft bearings. The valve lifter oil gallery supplies oil to the valve lifters. Oil flows from the hydraulic lifters through the hollow pushrods to the rocker arms. Oil from the overhead drains back to the crankcase through oil drain holes.

The timing chain is drip-fed from the front camshaft bearing. The pistons and piston pins are lubricated by oil splash.

ON-VEHICLE SERVICE

SERPENTINE DRIVE BELT

For information on routing and tensioning the serpentine drive belt, refer to COOLING AND RADIATOR (SEC 6B).

ENGINE MOUNTS

Figure 3

NOTICE: Broken or deteriorated mounts can cause the misalignment and eventual destruction of certain drivetrain components. When a single mount breakage occurs, the remaining mounts are subjected to abnormally high stresses.

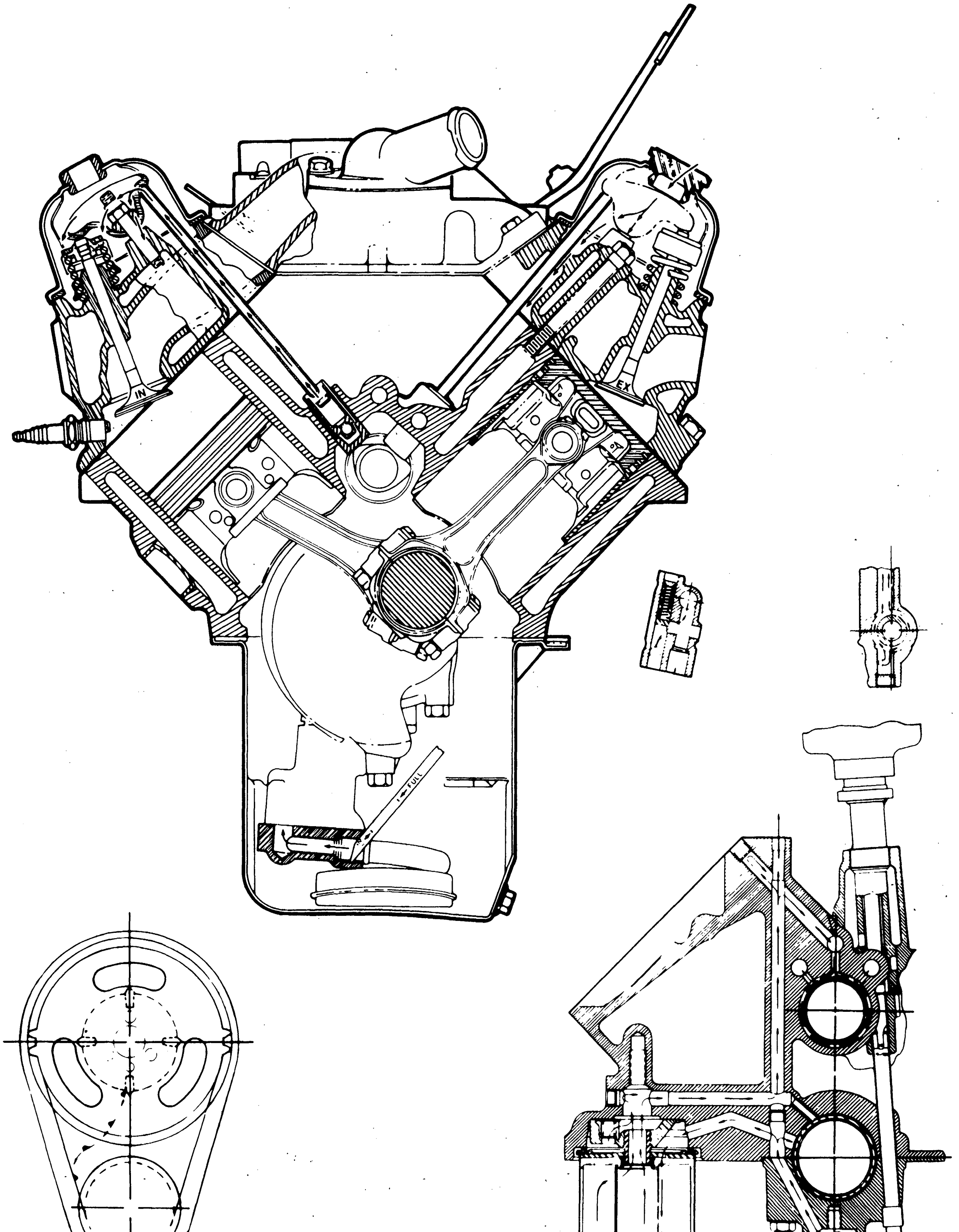

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Figure 1 - Engine Lubrication

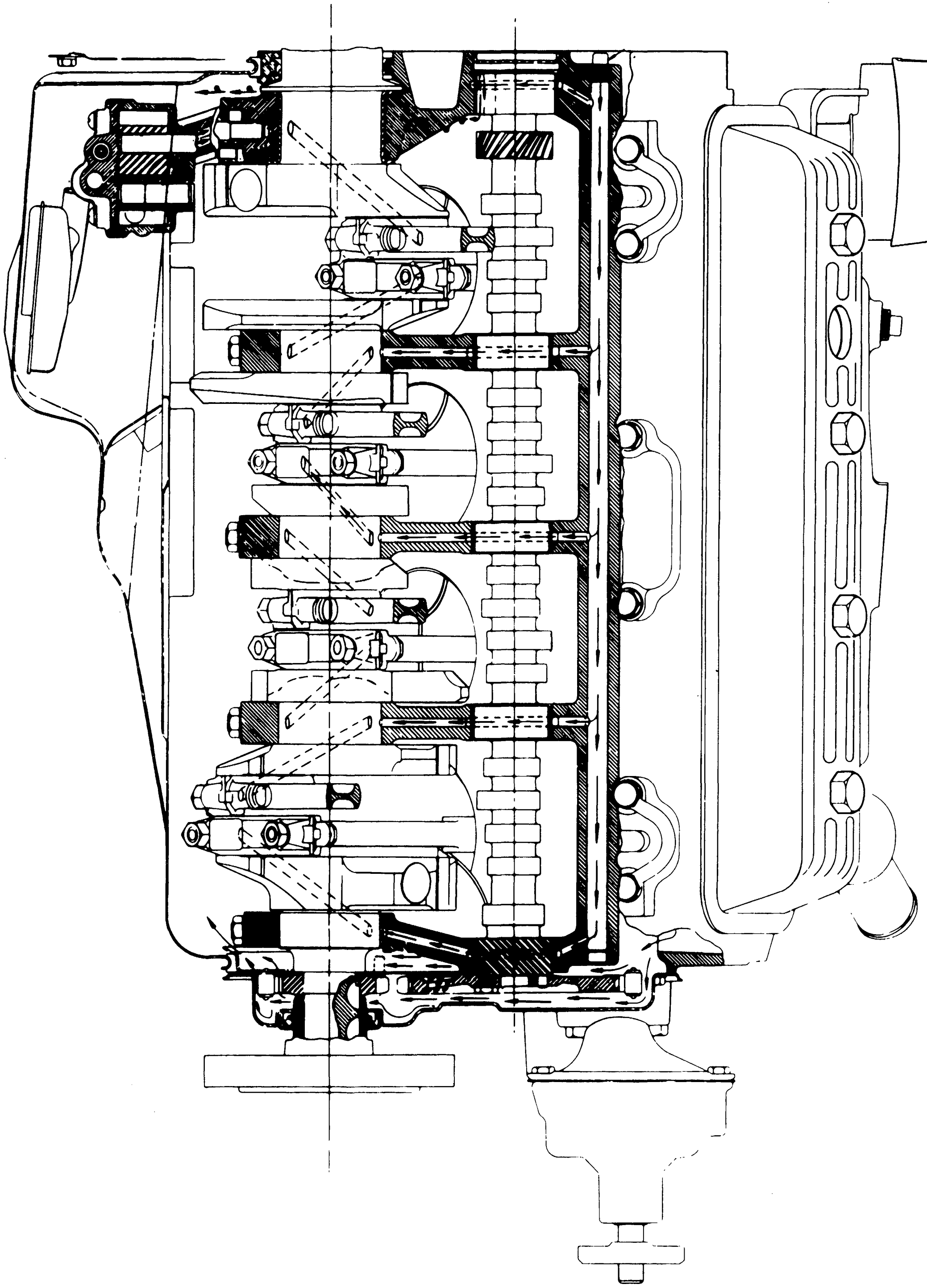


Figure 2 - Engine Lubrication

Checking Engine Mounts

Front Engine Mounts

Inspect

NOTICE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, crankshaft pulley, or any sheet metal. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen, resulting in a damaged oil pickup unit.

- Raise the engine to remove weight from the mounts and to place a slight tension on the rubber cushion. Observe both mounts while raising the engine.
- Replace the mount if the following conditions exist:
  - Hard rubber surface covered with heat check cracks.
  - Rubber cushion separated from the metal plate of the mount.
  - Rubber cushion split through the center.
- If there is movement between a metal plate of the mount and its attaching points, lower the engine and tighten the bolts or nuts attaching the mount to the engine, frame, or bracket.

Rear Mount

Inspect

- Push up and pull down on the transmission tailshaft. Observe the transmission mount.
- Replace the mount if the following conditions exist:
  - Rubber cushion separated from the metal plate of the mounting.
  - Mount bottomed out (tailshaft can be moved up but not down).
- If there is relative movement between a metal plate of the mount and its attaching point, tighten the bolts or nuts attaching the mount to the transmission or crossmember.

Front Mount Replacement

Figure 3

Remove or Disconnect

NOTICE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, crankshaft pulley, or any sheet metal. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen, resulting in a damaged oil pickup unit.

- Support the engine with a suitable jack. Do not load the engine mount (1).

1. Engine mount through-bolt (6) and nut (2).

NOTICE: Raise the engine only enough for sufficient clearance. Check for any interference between the rear of the engine and the dash panel which could cause distributor housing damage.

- Raise the engine only enough to permit removal of the engine mount (1) and bracket (7).

2. Mount and bracket assembly bolts (4), nuts (8), and washers (5).
3. Mount (1) and bracket (7).

Install or Connect

1. Bracket (7) to engine and mount (1) to crossmember.

NOTICE: See "Notice" on page 6A3-1 of this section for steps 2 and 4.

2. Mount and bracket bolts (4), nuts (8), and washers (5).

Tighten

- Bolts (4) to 52 N·m (38 lb. ft.).
- Nuts (8) to 41 N·m (30 lb. ft.).

3. Engine mount through-bolt (6).
   - Lower the engine until the through-bolt (6) can be inserted.
4. Through-bolt nut (2).

Tighten

- Through-bolt nut (2) to 68 N·m (50 lb. ft.).

Rear Mount Replacement

Figure 3

Remove or Disconnect

NOTICE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, crankshaft pulley, or any sheet metal. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen, resulting in a damaged pickup unit.

- Support the rear of the engine to relieve the weight on the rear mount (9).

1. Mount-to-crossmember nut (11) and washer (12).
2. Mount-to-transmission bolt (10).

- Raise the rear of the engine only enough to permit removal of the rear mount (9).

3. Rear mount (9).

Install or Connect

1. Rear mount (9).

- Lower the rear of the engine.

NOTICE: See "Notice" on page 6A3-1 of this section.

2. Mount-to-transmission bolt (10)

3. Mount-to-crossmember nut (11) and washer (12).

Tighten

- Bolts (10) to 54 N·m (40 lb. ft.).
- Nut (11) to 47 N·m (35 lb. ft.).

OIL LEVEL INDICATOR AND TUBE

Remove or Disconnect

1. Negative (-) battery cable.
2. Oil level indicator from tube.
3. Nut attaching the bracket to engine.
4. Oil level indicator tube with the bracket.

Clean

- Oil level indicator and tube with suitable solvent.

Install or Connect

- Apply sealant (GM part number 1052080 or equivalent) around tube 13 mm (1/2-inch) below bead.

1. Oil level indicator tube in block.

- Rotate the tube into position.

NOTICE: See "Notice" on page 6A3-1 of this section.

2. Nut to bracket.

Tighten

- Nut to 34 N·m (25 lb. ft.).

3. Oil level indicator into tube.
4. Negative (-) battery cable.

ENGINE OIL COOLER

Remove or Disconnect

- Drain radiator.

1. Oil filter.
2. Hoses from oil cooler.
3. Engine oil cooler by unscrewing retainer from oil filter adapter.
4. Engine oil cooler gasket.
    - Discard gasket.

Install or Connect

NOTICE: See "Notice" on page 6A3-1 of this section.

1. Engine oil cooler gasket to engine oil cooler.
2. Engine oil cooler to oil filter adapter.
    - Align hose fittings parallel to crankshaft pointing to front of engine.

Tighten

- Engine oil cooler retainer to 23 N·m (17 lb. ft.).

3. Hoses to engine oil cooler.
4. Oil filter.

- Refill engine with oil to proper level. Refer to MAINTENANCE AND LUBRICATION (SEC. OB).
- Refill radiator. Refer to COOLING AND RADIATOR (SEC. 6B).

INTAKE MANIFOLD

L03 Engine

Figures 4 and 5

Remove or Disconnect

1. Negative (-) battery cable.
2. Air cleaner. Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (TBI) (SEC 6E2).

- Drain the radiator.

3. Throttle body assembly. Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (TBI) (SEC. 6E2).
4. ECM engine control harness and lay aside on V8 engines.
5. Upper radiator hose at thermostat housing and heater hose at intake manifold (17).
6. Thermostat housing and gasket. Refer to COOLING AND RADIATOR (SEC. 6B).
7. Wires and hoses as necessary.
8. Power brake vacuum pipe at intake manifold (17).
9. Fuel line clips and lines at cylinder head and intake manifold (17).
10. Accelerator and TV cable bracket.
11. Spark plug wires at distributor cap.
12. EGR valve and solenoid. Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (TBI) (SEC. 6E2).
13. Distributor cap.

- Mark position of the rotor.

14. Distributor. Refer to IGNITION SYSTEM (SEC. 6D4).
15. Coil.
16. Coolant temperature sensor.
17. Intake manifold bolts (16) and studs (15).
18. Intake manifold (17) and gaskets (18 and 19).

Clean

- Gasket and seal surfaces on intake manifold (17), cylinder block, and cylinder heads (20) with degreaser.
- Remove all loose RTV.

Install or Connect

1. Gaskets (18 and 19) on cylinder heads (20).

- Apply a 5 mm (3/16-inch) bead of RTV sealer, GM part number 1052914 or equivalent, on the front and rear of the cylinder block.

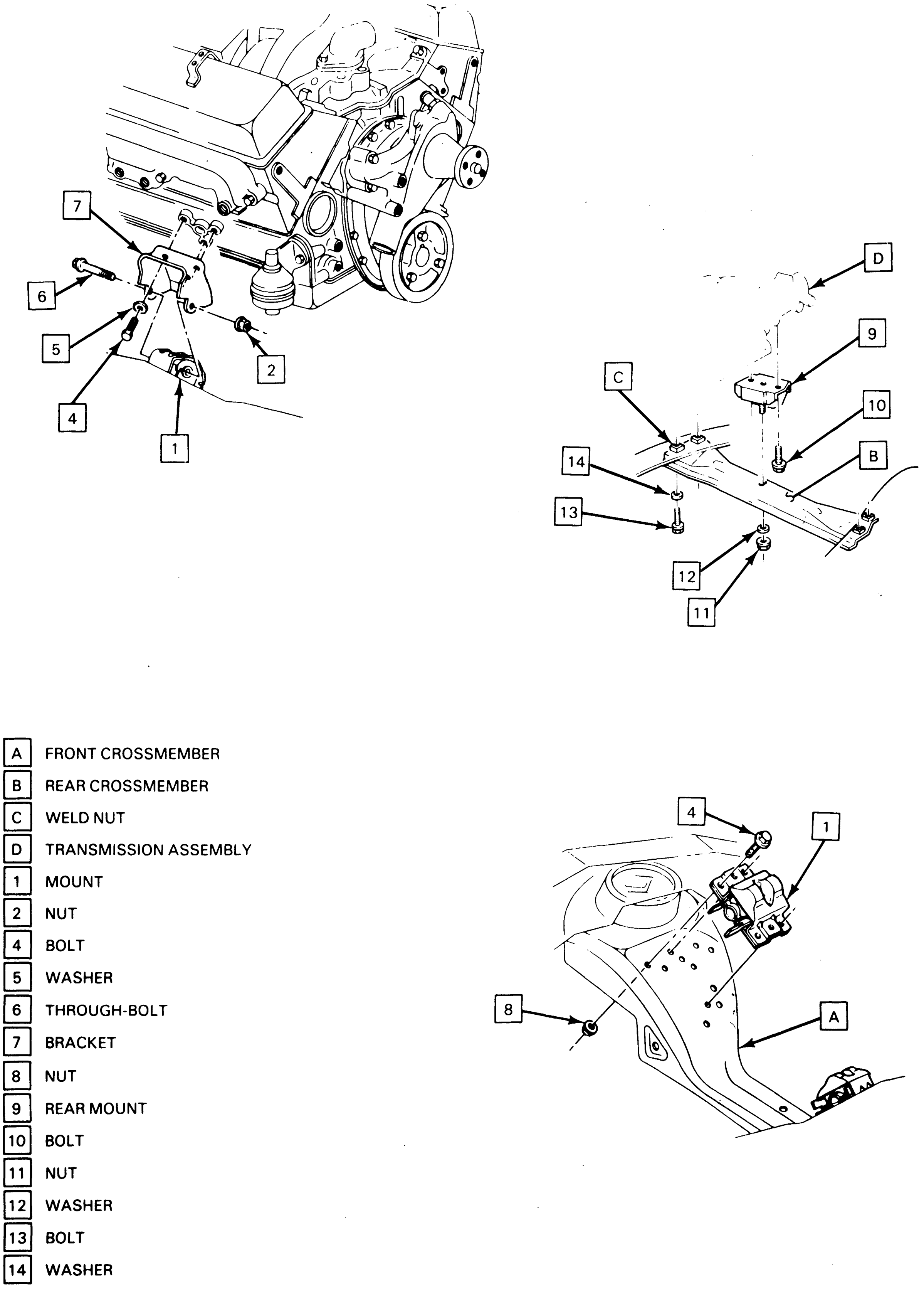


Figure 3 - Engine Mounts

- Extend the RTV bead 13mm (1/2 inch) up each cylinder head (20) to seal and retain the gaskets (18 and 19).

2. Intake manifold (17).

NOTICE: See "Notice" on page 6A3-1 of this section.

3. Intake manifold retaining bolts (16) and studs (15).

Tighten

- Bolts (16) and studs (15) alternately in proper sequence to 47 N·m (35 lb. ft.).

4. ECM engine control harness.
5. Coolant temperature sensor.
6. Distributor. Refer to IGNITION SYSTEM (SEC. 6D4).
   - Align rotor with mark.
7. Distributor cap.
8. Coil.
9. Spark plug wires at distributor cap.
10. Accelerator and TV cable bracket.
11. Fuel line clips and lines at cylinder head and intake manifold (17).
12. Power brake vacuum pipe at intake manifold (17).
13. Wires and hoses as necessary.
14. EGR valve and solenoid. Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (TBI) (SEC. 6E2).
15. Thermostat housing and gasket. Refer to COOLING AND RADIATOR (SEC. 6B).
16. Heater and radiator hoses.
17. Throttle body assembly. Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (TBI) (SEC. 6E2).

- Fill cooling system. Refer to COOLING AND RADIATOR (SEC. 6B).

18. Air cleaner. Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (TBI) (SEC. 6E2).
19. Negative (-) battery cable.

- Start engine.

Adjust

- Ignition timing. Refer to IGNITION SYSTEM (SEC. 6D4).

Inspect

- For leaks.

LB9 and L98 Engines

Figures 4 and 5

Remove or Disconnect

1. Negative (-) battery cable.

- Drain cooling system. Refer to COOLING AND RADIATOR (SEC. 6B).

2. Accelerator cable. Refer to ENGINE FUEL (SEC. 6C).
3. TV cable. Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A).
4. Cruise control cable. Refer to CRUISE CONTROL (SEC. 9B).
5. Air intake duct.
6. Heater hoses at throttle body.
7. Electrical connections at throttle body and intake manifold (17).
8. Vacuum hoses.
9. Fuel lines. Refer to ENGINE FUEL (SEC. 6C).
10. Vent valve assembly and hoses.
11. Vapor pipe assembly.
12. Plenum extension.
13. Spark plug wires at distributor cap.
14. Distributor. Refer to IGNITION SYSTEM (SEC. 6D4).
15. Port injection assembly. Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (PORT) (SEC. 6E3).
16. Ignition coil and EGR solenoid.
17. Upper radiator hose.
18. Thermostat housing and gasket. Refer to COOLING AND RADIATOR (SEC. 6B).
19. EGR valve and pipe. Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (PORT) (SEC. 6E3).
20. Electrical wires as necessary.
21. Intake manifold bolts (16) and studs (15).
22. Intake manifold (17) and gaskets (18 and 19).

Clean

- Gasket and seal surfaces on manifold, block and cylinder heads with degreaser.

Install or Connect

1. Gaskets (18 and 19) to cylinder heads (20).

- Apply a 5 mm (3/16-inch) bead of RTV sealer, GM part number 1052914 or equivalent, on the front and rear ridges of the cylinder case.
- Extend the RTV bead 13 mm (1/2-inch) up each cylinder head to seal and retain the intake manifold side gaskets.

2. Intake manifold (17).

NOTICE: Refer to "Notice" on page 6A3-1 of this section.

3. Intake manifold attaching bolts (16) and studs (15).

Tighten

- Bolts (16) and studs (15) to 47 N·m (35 lb. ft.).

4. Electrical wires.
5. EGR valve and pipe. Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (PORT) (SEC. 6E3).
6. Thermostat housing and gasket. Refer to COOLING AND RADIATOR (SEC. 6B).
7. Upper radiator hose.
8. Ignition coil and EGR solenoid.
9. Port injection assembly. Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (PORT) (SEC. 6E3).
10. Distributor. Refer to IGNITION SYSTEM (SEC. 6D4).
11. Spark plug wires at distributor cap.
12. Plenum extension.
13. Vapor pipe assembly.
14. Vent valve assembly and hoses.
15. Fuel lines. Refer to ENGINE FUEL (SEC. 6C).
16. Vacuum hoses.
17. Electrical connections at throttle body and intake manifold (17).
18. Heater hoses at throttle body.
19. Air intake duct.
20. Cruise control cable. Refer to CRUISE CONTROL (SEC. 9B).
21. TV cable. Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A).
22. Accelerator cable. Refer to ENGINE FUEL (SEC. 6C).

- Fill cooling system. Refer to COOLING AND RADIATOR (SEC. 6B).

23. Negative (-) battery cable.

- Start engine.

Inspect

- For leaks.

Adjust

- Ignition timing. Refer to IGNITION SYSTEM (SEC. 6D4).

EXHAUST MANIFOLD

Figure 6

Remove or Disconnect

1. Negative (-) battery cable.
2. Spark plug wires, if necessary.
3. AIR pipes.
4. AIR valve.

- Raise vehicle and suitably support. Refer to GENERAL INFORMATION (SEC. 0A).

5. Exhaust pipe nuts and bolts.

- Lower vehicle.

6. Exhaust manifold bolts (24 and 26) and studs (23 and 25).
7. Exhaust manifold (27).

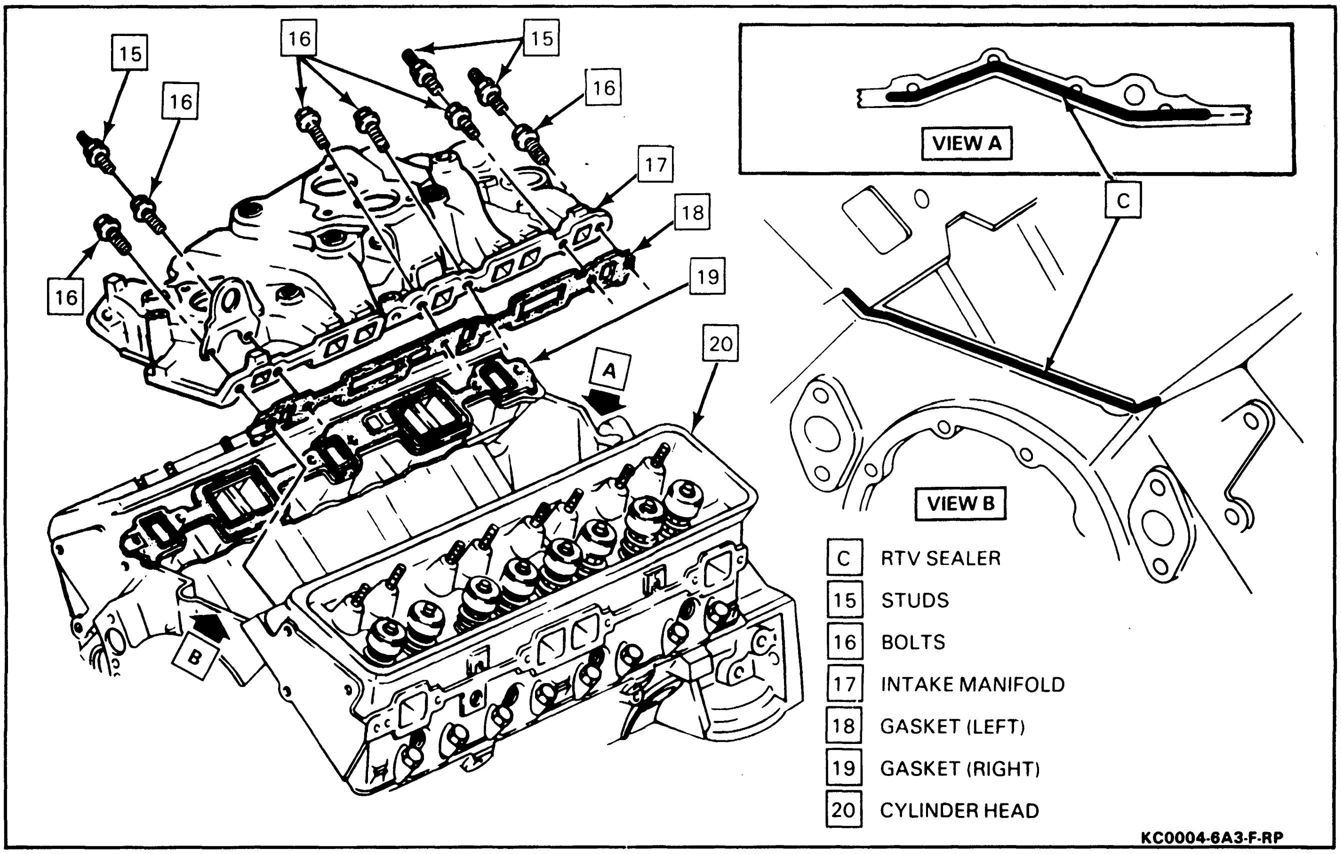


Figure 4 - Intake Manifold

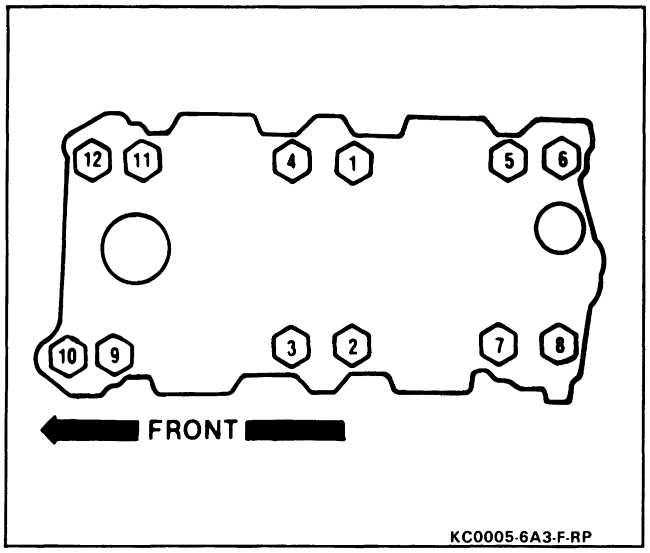


Figure 5 - Intake Manifold Torque Sequence

Clean

- Mating surfaces on manifold and cylinder head.

Install or Connect

1. Exhaust manifold (27) into position.

   NOTICE: Refer to "Notice" on page 6A3-1 of this section.

2. Exhaust manifold bolts (24 and 26) and studs (23 and 25).

   #### Tighten

   - Studs (23) and bolts (24) to 27 N·m (20 lb. ft.).
   - Studs (25) and bolts (26) to 35 N·m (26 lb. ft.).

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

3. Exhaust pipe nuts and bolts.

- Lower vehicle.

4. AIR valve.
5. AIR pipes.
6. Spark plug wires, if necessary.
7. Negative (-) battery cable.

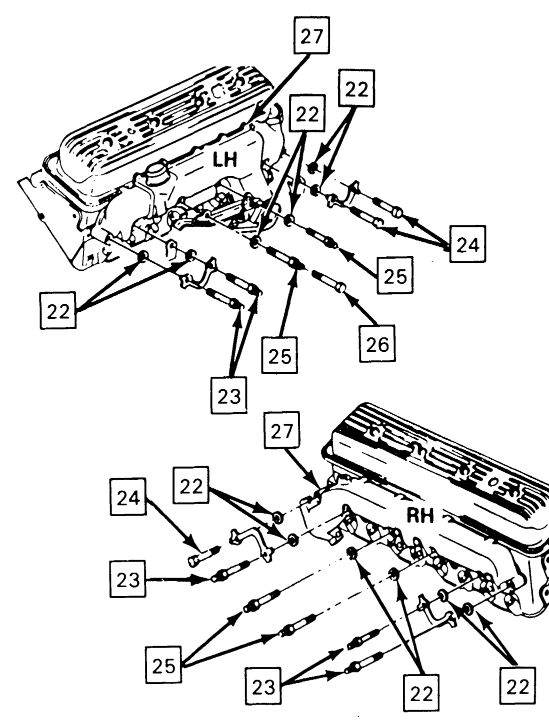
VALVE ROCKER COVER

Figure 7

Right Side

Remove or Disconnect

1. Negative (-) battery cable.
2. Air cleaner, if necessary.
3. EGR pipe assembly, if necessary.
4. Electrical connections and wiring harnesses as necessary.
5. Spark plug wires from distributor.



22 WASHER
23 STUD
24 BOLT
25 STUD
26 BOLT (LO3 ENGINE)
27 EXHAUST MANIFOLD

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Figure 6 - Installing Exhaust Manifold

6. Crankcase vent hoses and valves.
7. Coil (LB9, L98).
8. Heater hose at throttle body (LB9, L98).
9. AIR control valve.
10. AIR check valve, pipes and hoses.
11. Valve rocker cover bolts (30) and washers (31).
12. Valve rocker cover (28).
13. Valve rocker cover gasket (29).

- If valve cover adheres to the cylinder head, shear the cover off by bumping the end with a block of wood and a rubber mallet. If the cover does not come loose, carefully pry it loose. Make sure not to distort the sealing flange.

Clean

- Gasket surface on valve rocker cover (28) and cylinder head.

Inspect

- Valve rocker cover (28) for damage or distortion. Replace if necessary.

Install or Connect

1. New valve rocker cover gasket (29).
2. Valve rocker cover (28).

NOTICE: See "Notice" on page 6A3-1 of this section.

3. Valve rocker cover bolts (30) and washers (31).

Tighten

- Bolts (30) to 11 N·m (95 lb. in.).

4. AIR check valve, pipes and hoses.
5. AIR control valve.
6. Coil (LB9, L98).
7. Heater hose throttle body (LB9, L98).
8. EGR pipe assembly, if necessary.
9. Crankcase vent hoses and valves.
10. Spark plug wires to distributor.
11. Electrical connections and wiring harnesses as necessary.
12. Air cleaner, if necessary.
13. Negative (-) battery cable.

- Start engine.

Inspect

- For leaks around valve rocker cover (28).

Left Side

Remove or Disconnect

1. Negative (-) battery cable.
2. Air cleaner, if necessary.
3. Electrical connections and wiring harnesses as necessary.
4. Generator. Refer to CHARGING SYSTEM (SEC. 6D3).
5. Crankcase vent hoses and valve.
6. Valve rocker cover bolts (30) and washers (31).
7. Valve rocker cover (28).
8. Valve rocker cover gasket (29).

- If valve rocker cover adheres to the cylinder head, shear off by bumping end of rocker arm cover with a block of wood and a rubber mallet. If cover does not come loose, carefully pry until loose. Do not distort the sealing flange.

Clean

- Gasket surface on valve rocker cover and cylinder head.

Inspect

- Valve rocker cover (28) for damage or distortion. Replace, if necessary.

Install or Connect

1. New valve rocker cover gasket (29).
2. Valve rocker cover (28) to cylinder head.

NOTICE: See "Notice" on page 6A3-1 of this section.

3. Valve rocker cover bolts (30) and washers (31).

Tighten

- Bolts (30) to 11 N·m (95 lb. in.).

4. Crankcase vent hoses and valve.
5. Generator. Refer to CHARGING SYSTEM (SEC. 6D3).
6. Electrical connections and wiring harnesses as necessary.
7. Air cleaner, if necessary.
8. Negative (-) battery cable.

- Start engine.

Inspect

- For leaks around valve rocker cover (28).

ROCKER ARMS AND PUSHRODS

Figures 8 and 9

Remove or Disconnect

1. Valve rocker cover. Refer to "Valve Rocker Cover" in this section.

Important

- Place rocker arm balls (33), rocker arms (34) and pushrods (36) in a rack so they may be installed in the same location from which they were removed.

2. Rocker arm nuts (32).
3. Rocker arm balls (33).
4. Rocker arms (34).
5. Pushrods (36).

Install or Connect

- When installing new rocker arms (34) or rocker arm balls (33) coat bearing surfaces of rocker arms (34) and rocker arm balls (33) with "Molykote" or its equivalent. Install these components and the pushrods (36) in the same location from where they were removed.

1. Pushrods (36). Make sure the pushrods (36) seat in the lifter sockets.
2. Rocker arms (34).
3. Rocker arm balls (33).
4. Rocker arm nuts (32).

Tighten

- Rocker arm nuts (32) until all lash is eliminated.

Adjust

- Crank the engine until the mark on the torsional damper lines up with the center or "O" mark on the timing tab fastened to the engine front cover.

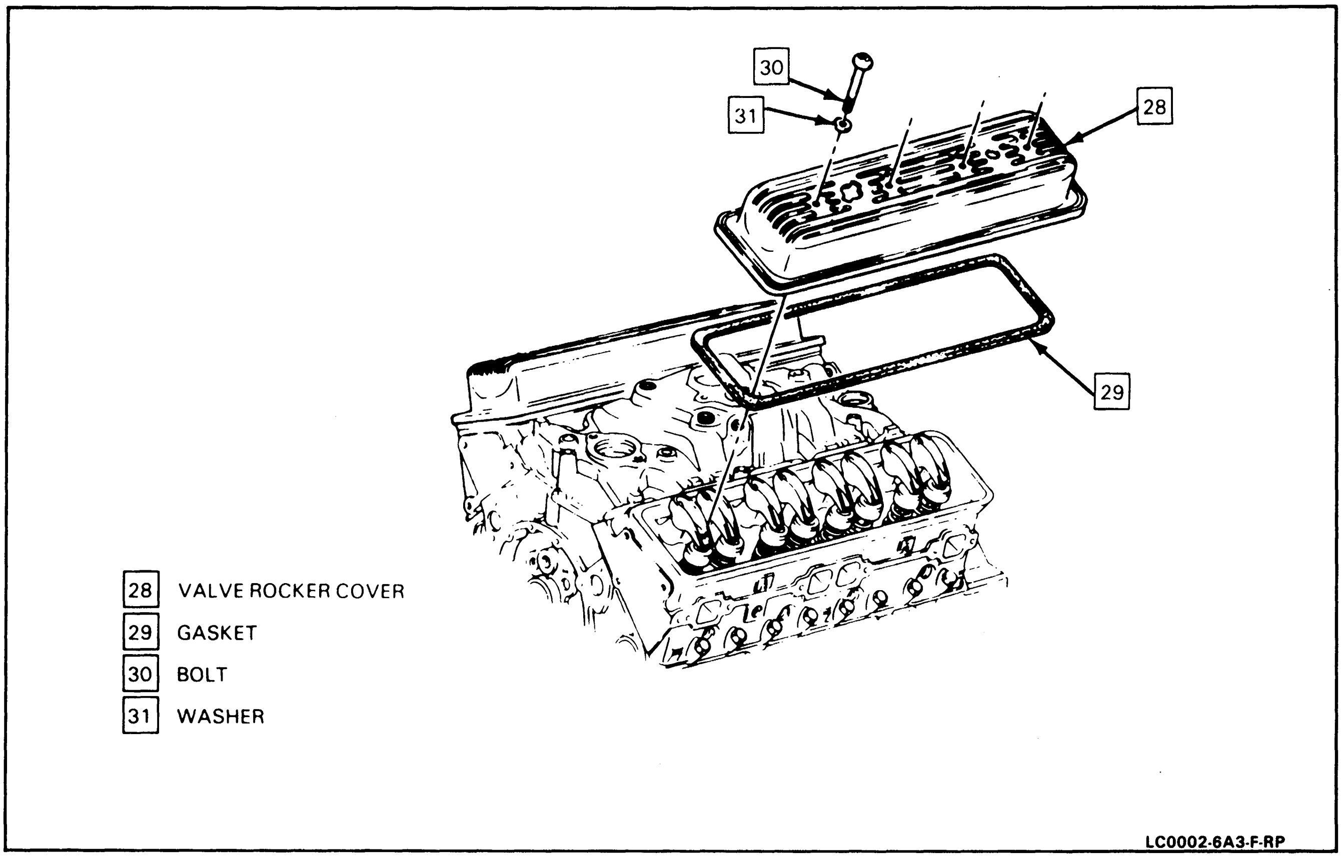

Figure 7 - Valve Rocker Cover

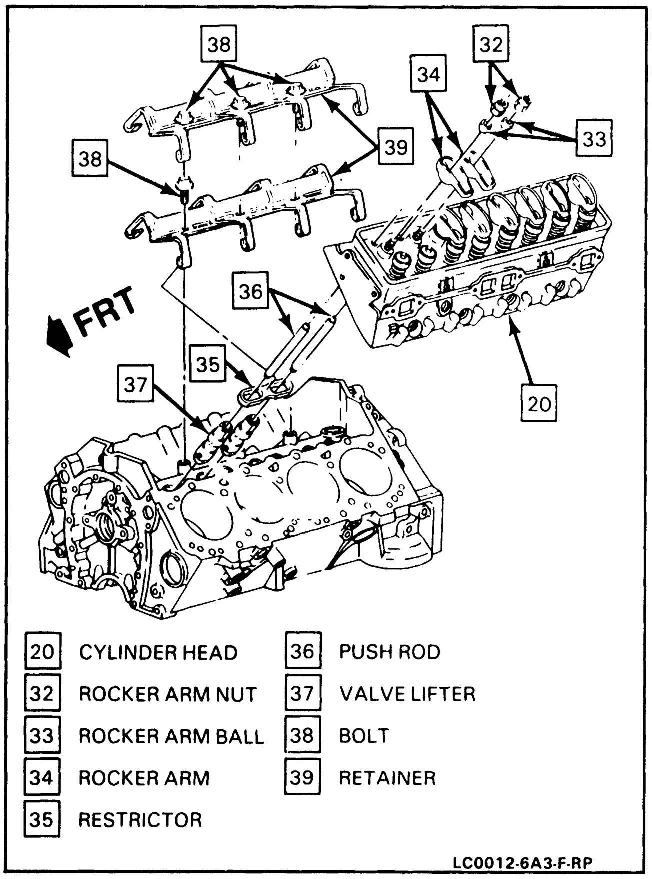

Figure 8 - Rocker Arms and Pushrods

- Make sure the engine is in the number one firing position by:
  - Placing fingers on the number one cylinder valves as the mark on the damper comes near the "O" mark on the crankcase front cover.
  - If the valves are not moving, the engine is in the number one firing position.
  - If the valves move as the mark comes up to the timing tab, the engine is in the number six firing position and should be turned over one more time to reach the number one position.
- With the engine in the number one firing position the following valves may be adjusted:
  - Exhaust 1, 3, 4, 8
  - Intake 1, 2, 5, 7
  - When viewed from the rear of the engine, even numbered cylinders are in the right bank; odd numbered cylinders are in the left bank.
- Back out the rocker arm nut (32) until lash is felt at the pushrod (36).
- Turn in the rocker arm nut (32) until all lash is removed. This can be determined by rotating the pushrod (36) while turning the rocker arm nut (32). When the play has been removed, turn the rocker arm nut (32) one full turn (Figure 9).
- Crank the engine one revolution until the pointer "O" mark and torsional damper mark are again in alignment. This is the number six firing position.
- With the engine in the number six firing position, the following valves may be adjusted:

- Exhaust 2, 5, 6, 7
- Intake 3, 4, 6, 8

- Install valve rocker covers. Refer to "Valve Rocker Cover" in this section.

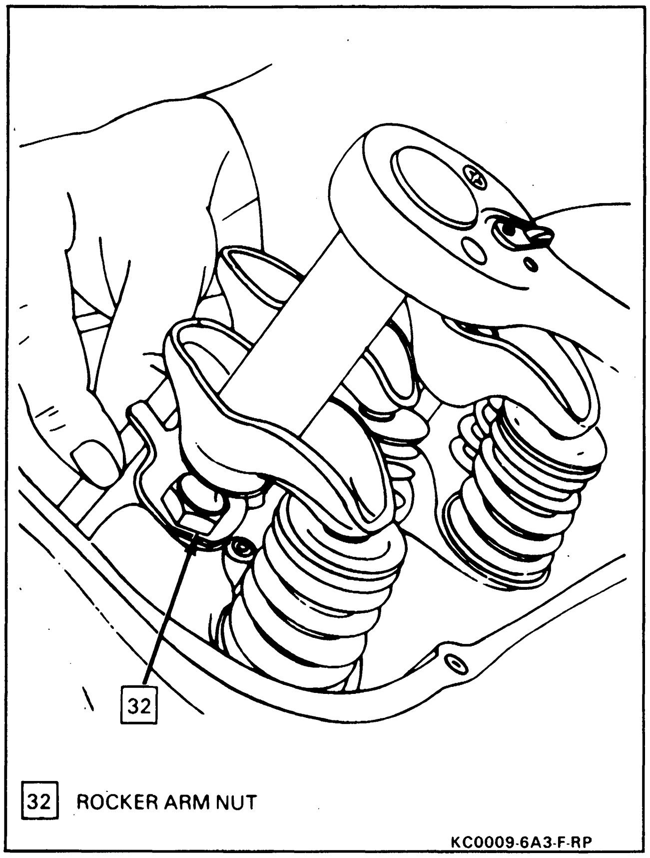

Figure 9 - Adjusting Valves

ROCKER ARM STUDS

Figures 10 through 12

Rocker arm studs (40) that have damaged threads or are loose in cylinder heads should be replaced with new rocker arm studs (40) available in 0.075 mm (0.003 inch) and 0.33 mm (0.013 inch) oversize.

↔ Remove or Disconnect

Tool Required:

J 5802-01 Rocker Arm Stud Remover

1. Valve rocker cover. Refer to "Valve Rocker Cover" in this section.
2. Rocker arm. Refer to "Rocker Arms and Pushrods" in this section.
3. Rocker arm stud (40).
   - Place J 5802-01 over the rocker arm stud (40).
   - Install a nut and a flat washer.
   - Turn the nut to remove the rocker arm stud (40).

→← Install or Connect

Tools Required:

J 5715 Rocker Arm Stud Hole Reamer 0.003-inch oversize

J 6036 Rocker Arm Stud Hole Reamer 0.013-inch oversize

J 6880 Rocker Arm Stud Installer

NOTICE: Do not attempt to install an oversize rocker arm stud without reaming the stud hole as this could damage the cylinder head.

- Ream the hole to the proper size for the replacement oversize rocker arm stud (40). Use J 5715 for 0.003-inch oversize studs; J 6036 for 0.013-inch oversize studs.
- Coat the lower end (press-fit area) of rocker arm stud (40) with hypoid axle lubricant.

1. Rocker arm stud (40) using J 6880.
   - Rocker arm stud (40) is installed to the proper depth when the tool bottoms out on the cylinder head.
2. Rocker arm. Refer to "Rocker Arms and Pushrods" in this section.

Adjust

- Rocker arms and pushrods. Refer to "Rocker Arms and Pushrods" in this section.

3. Valve rocker cover. Refer to "Valve Rocker Cover" in this section.

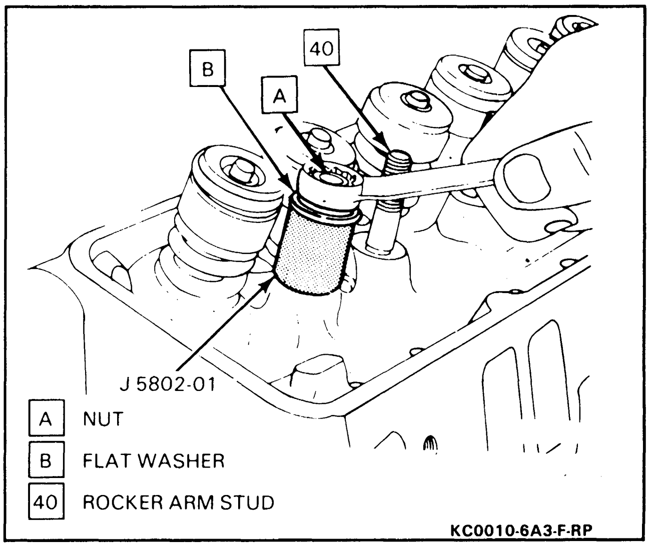

Figure 10 - Removing the Rocker Arm Stud

VALVE LIFTERS

Hydraulic valve lifters very seldom require service. The valve lifters have a simple design and are not adjustable. When servicing the valve lifters, use care and cleanliness when handling the parts.

Valve Lifter Diagnosis

If valve lifters are:

- Momentarily noisy when the engine is started.
  - This is normal. Oil drains from some of the lifters when the engine is not running. It takes a few seconds for the lifters to fill after the engine is started.

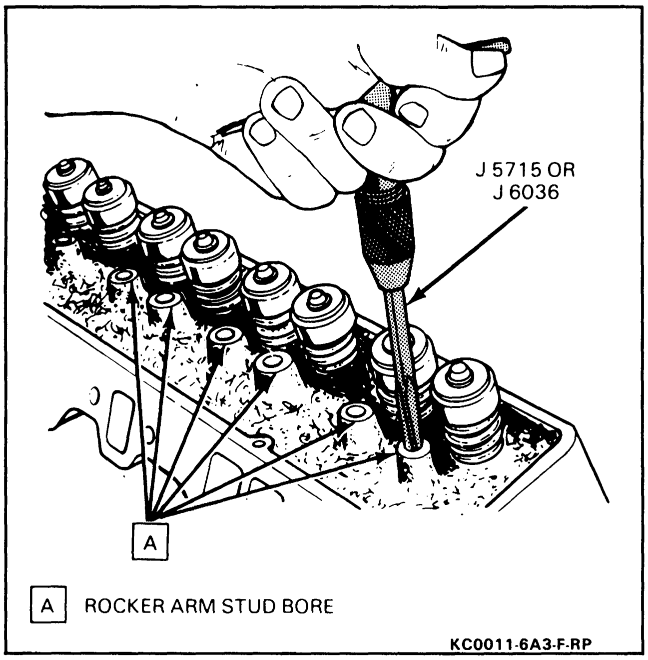

Figure 11 - Reaming the Rocker Arm Stud Bore

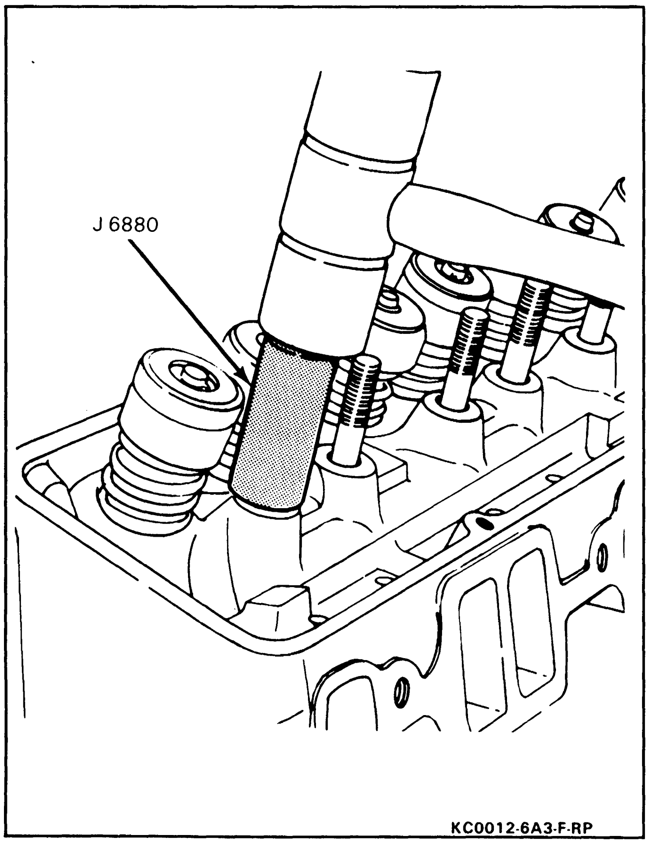

Figure 12 - Installing the Rocker Arm Stud

- Intermittently noisy when the engine is idling. The noise disappears when the engine speed is increased.
  - This may be caused by dirt in a lifter or a pitted or damaged check ball in a lifter. Remove, take apart, and clean the lifters. If a damaged check ball is found in any lifter, replace the lifter.
- Noisy when the engine is idling slowly or when the engine is hot. The lifters are quiet when engine speed is increased or when the engine is cold.
  - This may be caused by a high leak down rate in one or more of the lifters. Replace any suspect lifters.
- Noisy at high speeds and quiet at low speeds.
  - This is caused by an incorrect oil level, either too high or too low, or improper oil flow at oil pump pickup. Check for the following:
    - High oil level. Oil level above the oil level indicator "FULL" mark allows the crankshaft counterweights to churn the oil into foam. When foam is pumped into the lifters, they will become noisy. A solid column of oil is required for proper lifter operations. Drain oil to proper level.
    - Low oil level. Oil level below the oil level indicator "ADD" mark allows the oil pump to pump air at high speeds which results in noisy lifters. Add oil to proper level.
    - Damaged oil pan, or loose or cocked oil pump screen. Repair or replace parts as necessary.
- Noisy at idle, becoming louder as engine speed is increased to 1500 rpm. Noise is most noticeable in the vehicle at 16 to 24 km/h (10 to 15 mph) in "LOW" transmission range, or 48 to 56 km/h (30 to 35 mph) in "DRIVE" transmission range. The noise is best described as a "hashy" sound. At slow idle, it may be gone or may appear as a light ticking noise in one or more valves. This noise is not caused by lifter malfunction. It is caused by one or more of the following:
  - Badly worn or scuffed valve tip and rocker arm pad.
  - Excessive valve stem to guide clearance.
  - Excessive valve seat runout.
  - Off square valve face runout.
  - Valve spring damper clicking on rotator.

Valve Lifters

Figures 8, 13 and 14

Remove or Disconnect

Tools Required:

J 3049 Valve Lifter Remover (Plier Type)
J 9290-01 Valve Lifter Remover (Slide Hammer Type)

1. Intake manifold. Refer to "Intake Manifold" in this section.
2. Rocker arms. Refer to "Rocker Arms and Pushrods" in this section.
3. Valve lifter retainer bolts (38).
4. Valve lifter retainer (39).
5. Valve lifter restrictor (35).

6. Valve lifters (37).
   - Remove the valve lifters (37) one at a time using a magnet. If the valve lifters (37) are stuck in their bores due to gum or varnish deposits, remove them using J 3049 or J 9290-01.

Important

- Place the valve lifters (37) in a rack or tag them to ensure that they are installed in the same bore from which they were removed.

Inspect

- Lifter carefully. If damaged or worn, replace the entire lifter assembly.
- Lifter body for:
  - Wear.
  - Scuffing. Also inspect the bore in the cylinder block for scuffing.
- Roller for:
  - Freedom of movement. Replace the lifter if it binds or if roughness can be felt.
  - Excessive looseness in the roller bearings. Replace the lifter if necessary.
  - Flat spots. Replace lifter, if worn.
  - Pitting. Replace lifter, if pitted.
- Pushrod seat and pushrod for:
  - Wear. Replace the pushrod if the pushrod is worn.
- Camshaft lobe for:
  - Wear. Look for flat spots and grooves. Replace the camshaft if necessary. Refer to "Camshaft" in this section.

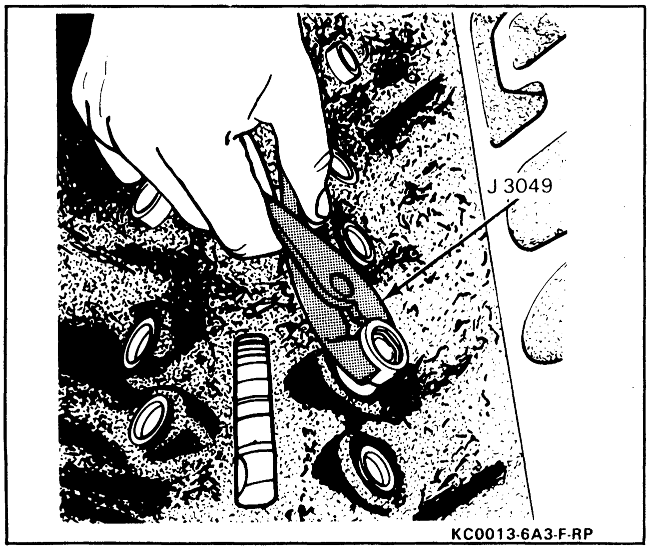

Figure 13 - Removing the Hydraulic Lifter

Install or Connect

Figure 8

- Coat valve lifter rollers with "Molykote" or its equivalent.

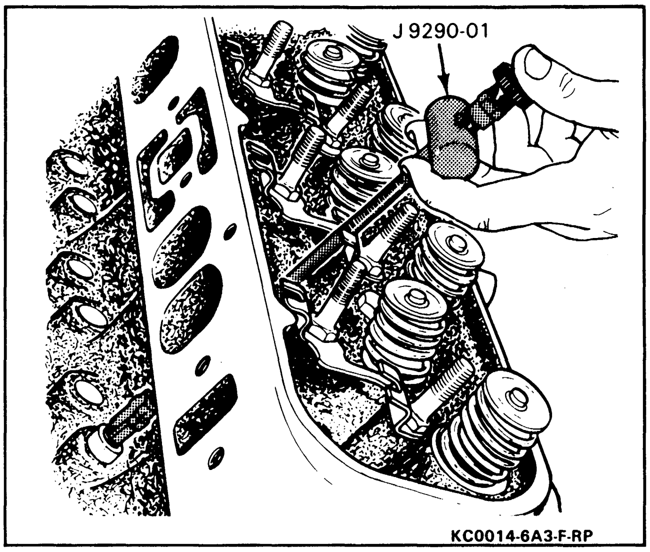

Figure 14 - Removing the Hydraulic Lifter

1. Valve lifters (37) to the same location from which they were removed.
2. Valve lifter restrictor (35).
3. Valve lifter retainer (39).

NOTICE: See "Notice" on page 6A3-1 of this section.

4. Valve lifter retainer bolts (38).

Tighten

- Bolts (38) to 20 N·m (15 lb. ft.).

5. Intake manifold. Refer to "Intake Manifold" in this section.
6. Rocker arms. Refer to "Rocker Arms and Pushrods" in this section.

Adjust

- Rocker arms and pushrods. Refer to "Rocker Arms and Pushrods" in this section.

ENGINE FRONT COVER

Remove or Disconnect

1. Torsional damper. Refer to "Torsional Damper" in this section.
2. Oil pan. Refer to "Oil Pan" in this section.
3. Coolant pump. Refer to COOLING AND RADIATOR (SEC. 6B).
4. Bolts attaching engine front cover to engine.
5. Engine front cover.
6. Gasket.
   - Discard the gasket.

Clean

- Gasket surface on block and engine front cover.
  - Using a sharp knife remove any excess oil pan gasket material on the oil pan and the cylinder block.

Inspect

- Engine cover for damage or distortion. Replace if necessary.

Install or Connect

1. Gasket on engine front cover.
- Position the cover and assembled gasket over the crankshaft end.
2. Loosely install the engine cover-to-block upper attaching bolts.

NOTICE: Do not force the cover over the dowels to the point where the cover flange or the dowels become distorted.

- Tighten bolts alternately and evenly while pressing downward on the cover so the dowels in the block are aligned with the corresponding holes in the cover. Position the engine front cover so that the dowels enter the holes in the cover without binding.

NOTICE: See "Notice" on page 6A3-1 of this section.

3. Remaining cover bolts.

Tighten

- Bolts alternately and evenly to 11 N·m (100 lb. in.).

4. Torsional damper. Refer to "Torsional Damper" in this section.
5. Coolant pump. Refer to COOLING AND RADIATOR (SEC. 6B).
6. Oil pan. Refer to "Oil Pan" in this section.

ENGINE FRONT COVER OIL SEAL

Figure 15

The oil seal may be removed with the engine front cover installed or removed.

Engine Front Cover Removed

Remove or Disconnect

NOTICE: Care should be taken not to damage the cover when removing the seal.

- Pry the oil seal out of the cover from the front using a large screwdriver.

Install or Connect

Tool Required:

J 35468 Front Cover Aligner and Oil Seal Installer

- New oil seal so that the open end of the seal is toward the inside of the engine front cover using J 35468.
  - Support the rear of the cover at the seal area.

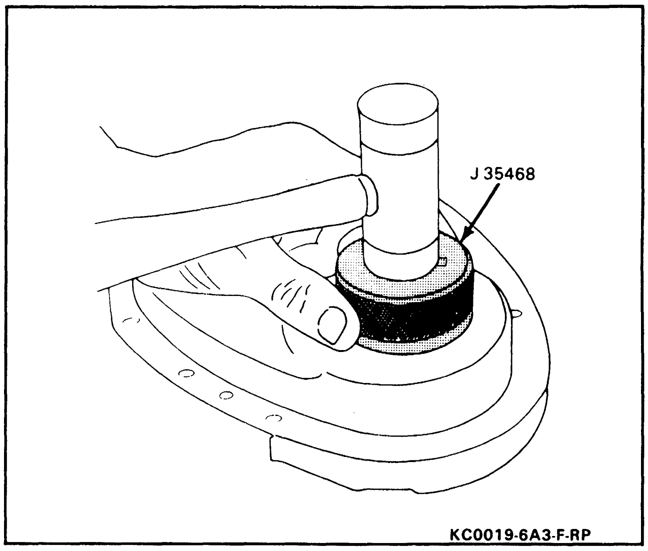

Figure 15 - Installing the Oil Seal

Engine Front Cover Installed

Remove or Disconnect

- Torsional Damper. Refer to "Torsional Damper" in this section.

NOTICE: Care should be taken not to damage the cover when removing the seal.

- Pry the seal out of the cover from the front using a large screwdriver.

Install or Connect

Tool Required:

J 35468 Front Cover Aligner and Oil Seal Installer

1. New oil seal so that the open end of the seal is toward the inside of the engine front cover using J 35468.
2. Torsional damper. Refer to "Torsional Damper" in this section.

TIMING CHAIN

Figure 16

Remove or Disconnect

1. Engine front cover. Refer to "Engine Front Cover" in this section.
- Crank the engine until the timing marks punched on crankshaft sprocket (54) and camshaft sprocket (52) line up with shaft centers.
2. Bolts attaching the camshaft sprocket (52) to the camshaft.
3. Timing chain (53) with the camshaft sprocket (52).

NOTICE: Do not turn the crankshaft after the timing chain and camshaft sprocket have been removed to prevent damage to engine parts.

Install or Connect

Important

- When installing a new timing chain, a new crankshaft sprocket and camshaft sprocket must also be installed.

1. Timing chain (53) with the camshaft sprocket (52) on the camshaft.
   - Ensure that the timing marks on the crankshaft sprocket (54) and camshaft sprocket (52) are as close together as possible and lined up with the shaft centers.

NOTICE: See "Notice" on page 6A3-1 of this section.

2. Bolts (51) attaching the camshaft sprocket (52) to the camshaft.

Tighten

- Bolts (51) to 28 N·m (21 lb. ft.).

- Lubricate the timing chain (53) with engine oil.

3. Engine front cover. Refer to "Engine Front Cover" in this section.

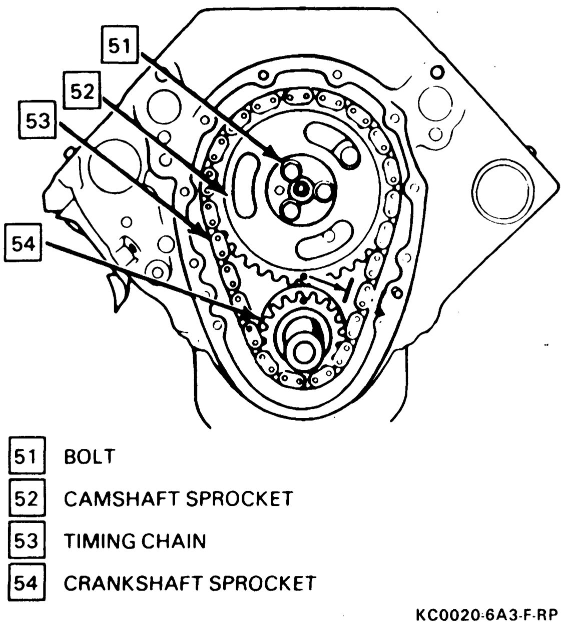

Figure 16 - Timing Chain and Sprockets

CRANKSHAFT SPROCKET

Figures 16 and 17

Remove or Disconnect

Tool Required:

J 5825-A Crankshaft Gear Remover

1. Timing chain. Refer to "Timing Chain" in this section.
2. Crankshaft sprocket (54), using J 5825-A.
3. Key, if required.

Inspect

- Sprocket for chipped teeth or wear. Replace as necessary.

Install or Connect

Tool Required:

J 5590 Crankshaft Gear Installer

1. Key, if removed.
2. Crankshaft sprocket (54), using J 5590. Make sure timing mark faces outside.

Important

- When installing a new crankshaft sprocket, a new timing chain (53) must also be installed.

3. Timing chain. Refer to "Timing Chain" in this section.

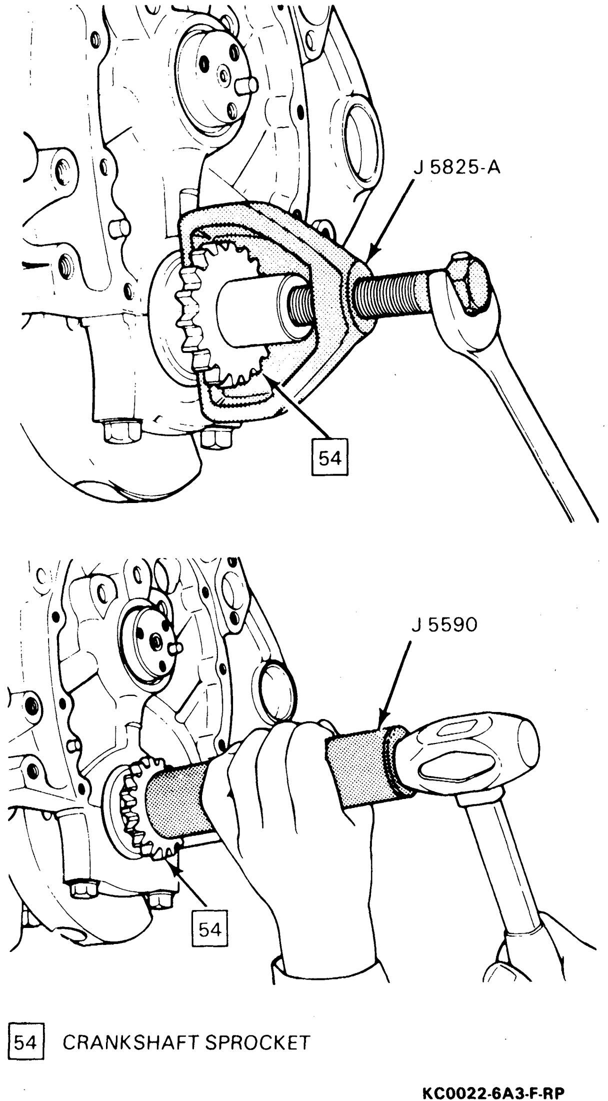

Figure 17 - Replacing Crankshaft Sprocket

CAMSHAFT

Figures 18 through 21

Camshaft Lobe Lift

Measure

Tool Required:

J 8520 Cam Lobe Lift Indicator

- Remove the rocker arms. Refer to "Rocker Arms and Pushrods" in this section.
- Position J 8520 with a ball socket adapter on the pushrod. Make sure the pushrod is in the lifter socket.
- Rotate the crankshaft slowly in the direction of engine rotation until the lifter is on the heel of the cam lobe. At this point, the pushrod will be in its lowest position.
- Set J 8520 to zero.

NOTICE: When the engine is cranked remotely at the starter with a special jumper cable or by other means, the distributor primary lead should be disconnected from the distributor (coil) or parts may be damaged.

- Rotate the crankshaft slowly, or attach an auxiliary starter switch and "bump" the engine over until the pushrod is in the fully raised position.
- Compare the total lift recorded from J 8520 with the specifications. Refer to "Specifications" in this section.
- Remove the dial indicator if the readings for all the lobes are within specifications.
- Install and adjust the rocker arms and pushrods. Refer to "Rocker Arms and Pushrods" in this section.

Camshaft Replacement

Remove or Disconnect

1. Intake manifold. Refer to "Intake Manifold" in this section.
2. Rocker arms and pushrods. Refer to "Rocker Arms and Pushrods" in this section.
3. Serpentine drive belt. Refer to COOLING AND RADIATOR (Sec. 6B).
4. Upper fan shroud. Refer to COOLING AND RADIATOR (SEC. 6B).
5. Radiator hoses. Refer to COOLING AND RADIATOR (SEC. 6B).
6. Oil cooler lines. Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A).
7. Radiator. Refer to COOLING AND RADIATOR (SEC. 6B).
8. Timing chain. Refer to "Timing Chain" in this section.

- Purge and evacuate A/C system. Refer to MANUALLY CONTROLLED AIR CONDITIONING (SEC. 1B).

9. Air conditioning condenser. Refer to MANUALLY CONTROLLED AIR CONDITIONING (SEC. 1B).
10. Grille support rods.
11. Valve lifters. Refer to "Valve Lifters" in this section.
12. Camshaft retainer bolts and camshaft retainer.

NOTICE: All camshaft journals are the same diameter.Care must be used in removing the camshaft to avoid damage to bearings.

13. Camshaft (55).
    - Install three 5/16 - 18 x 4-inch bolts in the camshaft bolt holes.
    - Carefully pull camshaft (55) out of bearings.

Inspect

- Camshaft bearings for scratches, pits, or loose fit in their bores. Replace the camshaft bearings, if necessary. Refer to "Camshaft Bearings" in this section.

Measure

Tools Required:

J 7872 Magnetic Base Indicator Set

J 26900-2 Digital Outside Micrometer

- Camshaft journals with J 26900-2.
  - If journals are more than 0.025 mm (0. 001 inch) out of round, replace camshaft (55).
- Camshaft using J 7872.
  - Mount the camshaft (55) in V-blocks or between centers. Using J 7872, check the intermediate camshaft journal. If runout exceeds 0.038 mm (0.0015 inch) the camshaft (55) is excessively bent and should be replaced.

Install or Connect

- When installing a new camshaft (55) coat camshaft lobes with "Molykote" or its equivalent.
- When installing a new camshaft (55) replace all lifters to ensure durability of the camshaft lobes and lifter rollers.
- Lubricate all camshaft journals with engine oil.

1. Camshaft (55).

NOTICE: See "Notice" on page 6A3-1 of this section.

2. Camshaft retainer and camshaft retainer bolts.

Tighten

- Camshaft retainer bolts to 12 N·m (106 lb. in.).

3. Timing chain. Refer to "Timing Chain" in this section.
4. Valve lifters. Refer to "Valve Lifters" in this section.

5. Grille support rods.
6. A/C condensor. Refer to MANUALLY CONTROLLED AIR CONDITIONING (SEC. 1B).
7. Radiator. Refer to COOLING AND RADIATOR (SEC. 6B).
8. Oil cooler lines. Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A).
9. Radiator hoses. Refer to COOLING AND RADIATOR (SEC. 6B).
10. Serpentine drive belt. Refer to COOLING AND RADIATOR (SEC. 6B).
11. Upper fan shroud. Refer to COOLING AND RADIATOR (SEC. 6B).
12. Rocker arms and pushrods. Refer to "Rocker Arms and Pushrods" in this section.
13. Intake manifold. Refer to "Intake Manifold" in this section.

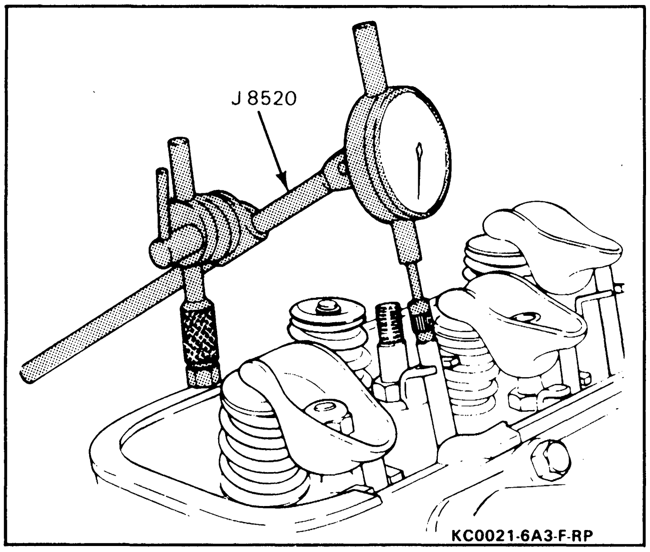

Figure 18 - Measuring the Camshaft Lobe Lift

CAMSHAFT BEARINGS

↔ Remove or Disconnect

Tool Required:

J 6098-01 Camshaft Bearing Remover and Installer

1. Crankshaft. Refer to "Crankshaft" in this section.
   - Fasten connecting rods against the sides of the engine to keep them out of the way during camshaft bearing replacement.
2. Camshaft. Refer to "Camshaft Replacement" in this section.
3. Rear camshaft bearing plug.
4. Inner camshaft bearings using J 6098-01.
   - With nut and thrust washer installed to end of puller screw threads, index pilot in camshaft front bearing and install puller screw through pilot and bearing to be removed.

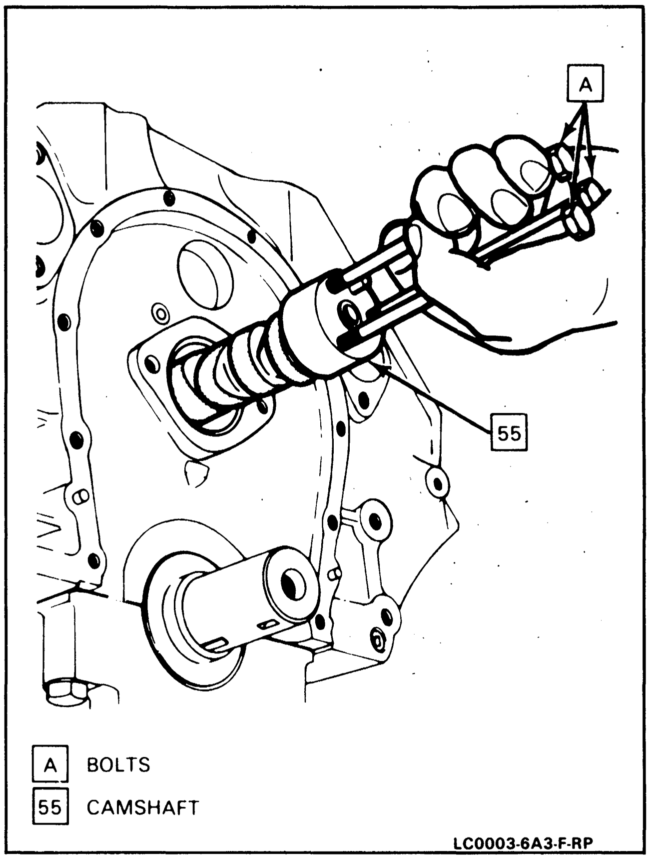

Figure 19 - Removing the Camshaft

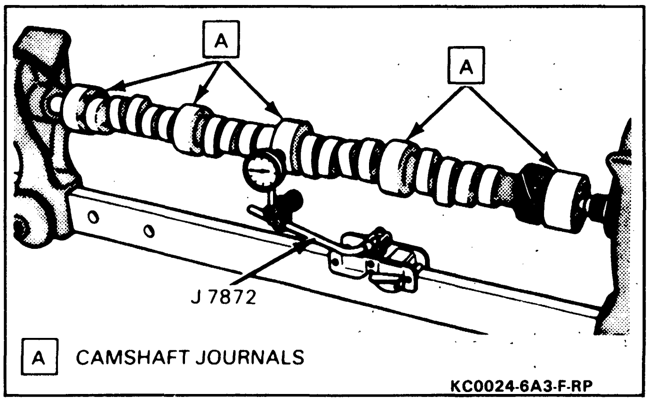

Figure 20 - Measuring the Camshaft Runout

   - Install bearing tool with shoulder toward bearing. Make sure that enough threads are engaged.
   - Using two wrenches, hold puller screw while turning nut to draw bearing out of bore.
     - When bearing has been pulled from bore, remove bearing tool and bearing from puller screw.
   - Repeat above steps for remaining inner camshaft bearings.
     - Index pilot in the rear camshaft bearing to remove the rear inner bearing.
5. Front and rear camshaft bearings using J 6098-01.
   - Assemble bearing tool to driver handle.

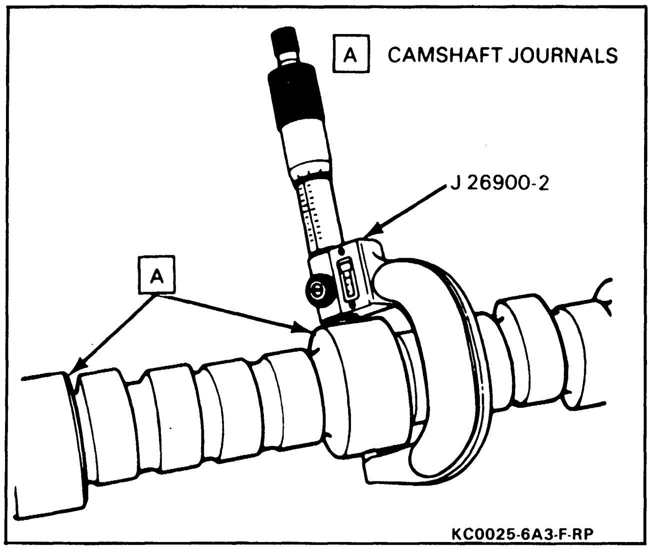

Figure 21 - Measuring the Camshaft Journals

- Drive front and rear bearings out, toward center of cylinder blocks.

Clean

- Camshaft bearing bores in the cylinder block.

Install or Connect

Tool Required:

J 6098-01 Camshaft Bearing Remover and Installer

- The outer front and rear camshaft bearings must be installed first. These bearings serve as guides for the tool pilot, and help center the inner bearings during the installation process.

Important

- Align camshaft bearing oil holes properly during installation.
  - Number one (front) camshaft bearing oil holes must be positioned so that they are an equal distance from 6 o'clock position.
  - Number two through number four inner camshaft bearing oil holes must be positioned at 5 o'clock toward the left side of the engine and even with the bottom of the cylinder bore.
  - Number five (rear) camshaft bearing oil hole must be positioned at 12 o'clock.

1. Front and rear camshaft bearings using J 6098-01.
   - Assemble bearing tool to driver handle.
   - Align oil holes outlined above.
   - Drive front and rear bearings in, toward center of cylinder block.
2. Inner camshaft bearings using J 6098-01.
   - With nut and thrust washer assembled to end of puller screw threads, index pilot in camshaft front bearing and install puller screw through pilot.
   - Index camshaft bearing in bore, aligning oil hole as outlined above.
   - Install puller screw through bearing bore and bearing to be installed and assemble bearing tool to puller screw with shoulder toward bearing. Make sure that enough threads are engaged.
   - Using two wrenches, hold puller screw while turning nut to draw bearing into bore.
     - When bearing has been pulled into bore, remove bearing tool and puller screw and check alignment of bearing oil hole to bore oil hole.
   - Repeat above steps for remaining inner camshaft bearings.
     - Index pilot in the rear camshaft bearing to install the rear inner bearing.
3. New rear camshaft bearing plug.
   - Coat plug outside diameter with GM part number 1052080 sealant, or equivalent.
   - Install plug flush to 0.79 mm (1/32-inch) deep.
4. Camshaft. Refer to "Camshaft Replacement" in this section.
5. Crankshaft. Refer to "Crankshaft" in this section.

VALVE SPRING, STEM SEAL AND ROTATOR

Figures 22 and 23

Remove or Disconnect

Tools Required:

J 23590 Spark Plug Port Adapter (14 mm Tapered Seat)

J 5892-C Valve Spring Compressor

J 23738-A Valve Stem Seal Tester

1. Rocker arms and pushrods at cylinder to be serviced. Refer to "Rocker Arms and Pushrods" in this section.
2. Spark plug at cylinder to be serviced.
   - Install J 23590 to the spark plug hole and apply compressed air to hold the valves in place.
   - Compress the valve spring using J 5892-C (Figure 22).
3. Valve stem keys.
4. Cap from intake valve or rotator from exhaust valve.
5. Stem oil shield.
6. Valve spring.
7. Upper stem oil seal.
8. Lower stem oil seal on intake valve.

Install or Connect

1. Lower stem oil seal on intake valve and seat the seal against the cylinder head.
2. Valve spring.

3. Stem oil shield.
4. Cap on intake valve stem or rotator on exhaust valve stem.

- Compress the valve spring using J 5892-C.

5. Upper stem oil seal into the lower groove of the stem.
   - Make sure the seal is flat and not twisted.
   - A light coat of oil will ease installation and help prevent twisting.
6. Valve stem keys.
   - Use grease to hold keys in place while disconnecting J 5892-C.
   - Remove J 23590.
   - Make sure keys seat properly in the upper groove of the valve stem.

- Tap the end of the stem with a plastic faced hammer to seat the keys, if necessary.
- Use J 23738-A to make sure air does not leak past the seal (Figure 23).

7. Spark plug.

Tighten

- Spark plug to 30 N·m (22 lb. ft.).

8. Rocker arms and pushrods. Refer to "Rocker Arms and Pushrods" in this section.

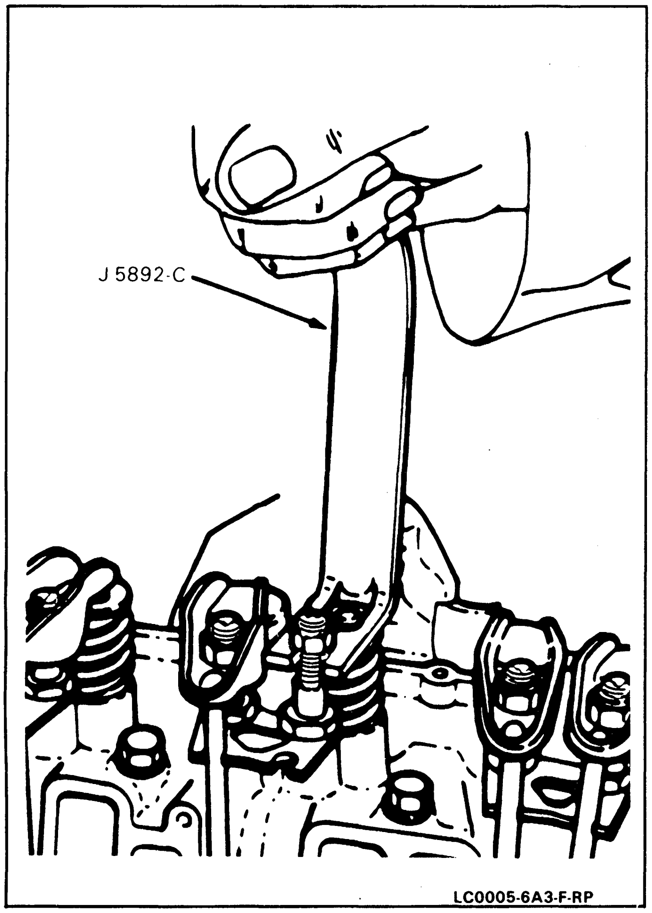

Figure 22 - Compressing Valve Spring

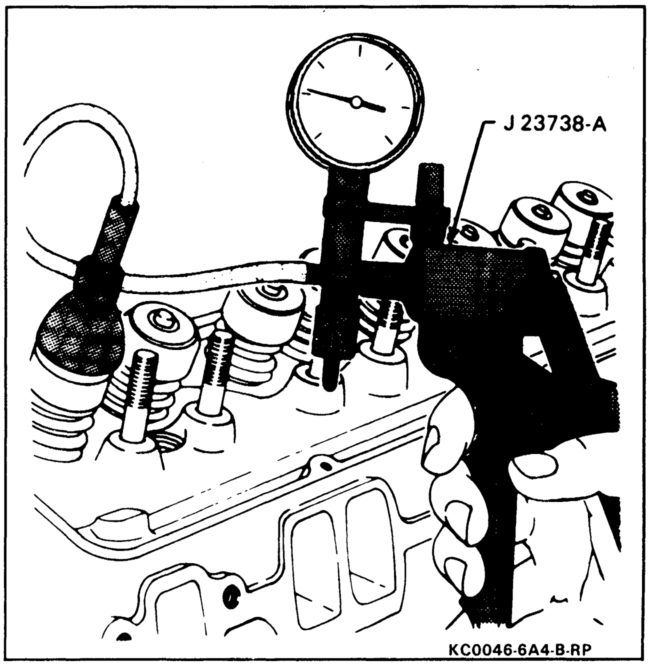

Figure 23 - Testing the Valve Seals

CYLINDER HEAD AND GASKET

Figures 22 through 28

Remove or Disconnect

Tools Required:

J 5830-02 Valve Guide Reamer Set
J 8001 Dial Indicator Set
J 8056 Valve Spring Tester
J 8062 Valve Spring Compressor (Head-off)
J 8089 Carbon Removing Brush (Cast Iron Heads)
J 8101 Valve Guide Cleaner
J 23738-A Valve Stem Seal Tester

- Drain cooling system. Refer to COOLING AND RADIATOR (SEC. 6B).

1. Intake manifold. Refer to "Intake Manifold" in this section.
2. Exhaust manifolds. Refer to "Exhaust Manifold" in this section.
3. Valve rocker cover. Refer to "Valve Rocker Cover" in this section.
4. Power steering pump and generator bracket, or A/C compressor mounting bracket, as necessary. Refer to POWER STEERING GEAR AND PUMP (SEC. 3B1), or MANUALLY CONTROLLED AIR CONDITIONING (SEC. 1B).
5. Cylinder head bolts (57 and 58).

NOTICE: After removal, place the cylinder head (20) on two wood blocks to prevent damage.

6. Cylinder head (20) and gasket (60).

Disassemble

1. Rocker arms and pushrods. Refer to "Rocker Arms and Pushrods" in this section.

- Compress valve springs using J 8062.

2. Valve stem keys.
3. Caps from intake valve.
4. Rotators from exhaust valves.
5. Stem oil shields.
6. Upper stem oil seals.
7. Valve spring.
8. Lower stem oil seal on intake valve.
9. Valves.
   - Place valves in a rack in proper sequence so they can be assembled in their original order.

Clean

- Carbon from combustion chambers and valve parts using J 8089.
- Valve guides using J 8101 (Figure 25).
- Carbon and sludge from the pushrods, rocker arms and pushrod guides.
- Valve stems and heads on a buffing wheel.
- Head and cylinder block gasket surfaces.
- Bolt hole threads in the cylinder head (20) and cylinder block (59).

Inspect

- Cylinder head (20) for cracks in the exhaust ports, combustion chambers, or external cracks to the water chamber.
- Valves for burned heads, cracked faces, or damaged stems.
- Valve springs for squareness.
- Rocker arm studs for wear or damage. For service, refer to "Rocker Arm Studs" in this section.

Measure

1. Valve spring tension (without dampers) using J 8056 (Figure 26).
   - If spring tension is less than 300 N (67 lb.) at 44 mm (1-23/32 inch), replace the spring.
2. Valve stem to bore clearance.
   - Excessive valve stem to bore clearance will cause excessive oil consumption and may cause valve breakage. Insufficient clearance will result in noisy and sticky functioning of the valve and disturb engine smoothness.
   - Clamp J 8001 on one side of the cylinder head rocker arm cover gasket rail.
   - Locate the indicator so movement of the valve stem from side to side (crosswise to the head) will cause a direct movement of the indicator stem. The indicator stem must contact the side of the valve stem just above the valve guide.
   - Drop the valve head about 1.6 mm (1/16 inch) off the valve seat.
   - Move the stem of the valve from side to side using light pressure to obtain a clearance reading. If clearance exceeds specifications, it will be necessary to ream valve guides for oversize valves. Refer to "Specifications" in this section.
   - Service valves are available in standard, 0.003, 0.015, 0.030 inch oversize.

Reconditon

- Valves with oversize stems are available as outlined above. Ream the valve guide bores for oversize valves as necessary using J 5830-02.
- Reconditioning the valve seats is very important.
  - The seating of the valves must be perfect for the engine to deliver optimum power and performance.
  - Another important factor is the cooling of the valve heads. Good contact between each valve and its seat in the head is necessary to insure that the heat in the valve head will be properly carried away.
  - Several different types of equipment are available for reconditioning valve seats. The recommendations of the manufacturer of the equipment being used should be carefully followed to attain proper results.
  - Regardless of what type of equipment is used, it is essential that valve guide bores be free from carbon or dirt to ensure proper centering of pilot in the guide. Valve seats should be concentric to within 0.05 mm (0. 002 inch) total indicator reading.
- Valves that are pitted can be refaced to the proper angle, insuring correct relation between the head and stem on a valve refacing mechanism. Valve stems which show excessive wear, or valves that are warped excessively should be replaced. If the edge of the valve head is less than 0.79 mm (1/32-inch) thick after grinding, replace the valve.
  - Several different types of equipment are available for refacing valves. The recommendation of the manufacturer of the equipment being used should be carefully followed to attain proper results.

Assemble

1. Valve into the proper port.
2. Lower stem oil seal on intake valve and seat the seal against the cylinder head (20).
3. Valve spring.
4. Stem oil shield.
5. Cap on intake valve stem or rotator on exhaust valve stem.
   - Compress the valve spring using J 8062.
6. Upper stem oil seal into the lower groove of the stem.
   - Make sure the seal is flat and not twisted.
   - A light coat of oil will ease installation and help prevent twisting.
7. Valve stem keys.

- Tap the end of the stem with a plastic-faced hammer to seat the keys, if necessary.

8. Remaining valves.

- Use J 23738-A to make sure air does not leak past the seals (Figure 23).

Measure

- Valve spring installed height from the valve spring seat to the top of the rotator or cap (Figure 28).
  - If installed height exceeds 44.4 mm (1. 75 inch), install a valve spring seat shim approximately 1.6 mm (1/16-inch) thick.
  - Do not shim a valve spring to obtain a less than specified installed height.

9. Rocker arms and pushrods. Refer to "Rocker Arms and Pushrods" in this section.

Install or Connect

1. New cylinder head gasket (60).
   - On engines using a steel gasket, coat both sides of the new gasket with a good sealer. Spread the sealer thinly and evenly. A paint roller is a good tool for this job. Too much sealer may hold the gasket away from the head or block.
   - Do not use a sealer on engines using a composition gasket.
2. Gasket (60) over dowel pins, with the bead up.
3. Cylinder head (20) over dowel pins and gasket (60).

- Coat the threads of the cylinder head bolts (57 and 58) with sealing compound, (GM part number 1052080 or equivalent).

NOTICE: See "Notice" on page 6A3-1 of this section.

4. Cylinder head bolts (57 and 58) finger tight.

Tighten

- Cylinder head bolts (57 and 58) in sequence to 92 N·m (68 lb. ft.) (Figure 24).

5. Power steering pump and generator bracket, or A/C compressor mounting bracket, as necessary. Refer to POWER STEERING GEAR AND PUMP (SEC. 3B1), or MANUALLY CONTROLLED AIR CONDITIONING (SEC. 1B).
6. Exhaust manifolds. Refer to "Exhaust Manifold" in this section.
7. Intake manifold. Refer to "Intake Manifold" in this section.
8. Valve rocker cover. Refer to "Valve Rocker Cover" in this section.
9. Fill cooling system. Refer to COOLING AND RADIATOR (SEC. 6B).

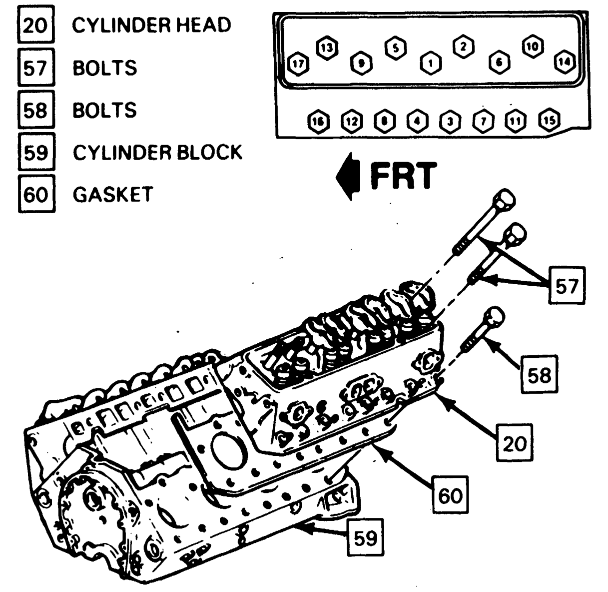

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Figure 24 - Cylinder Head and Bolt Tightening Sequence

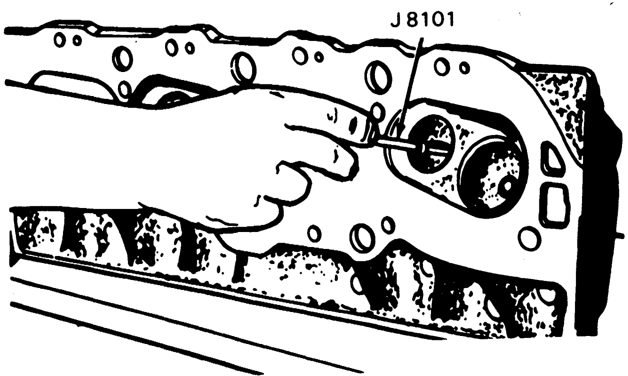

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Figure 25 - Cleaning the Valve Guides

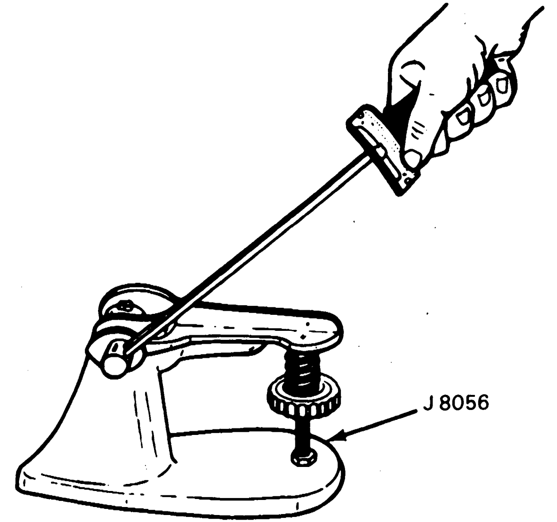

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Figure 26 - Measuring Valve Spring Tension

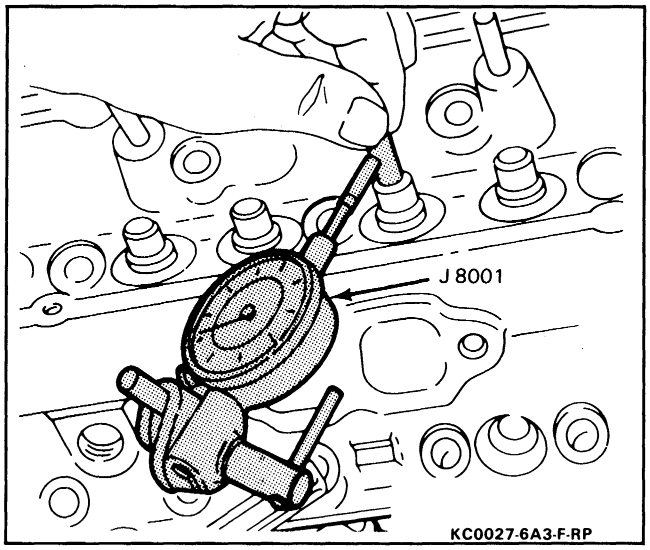


Figure 27 - Measuring Stem to Bore Clearance

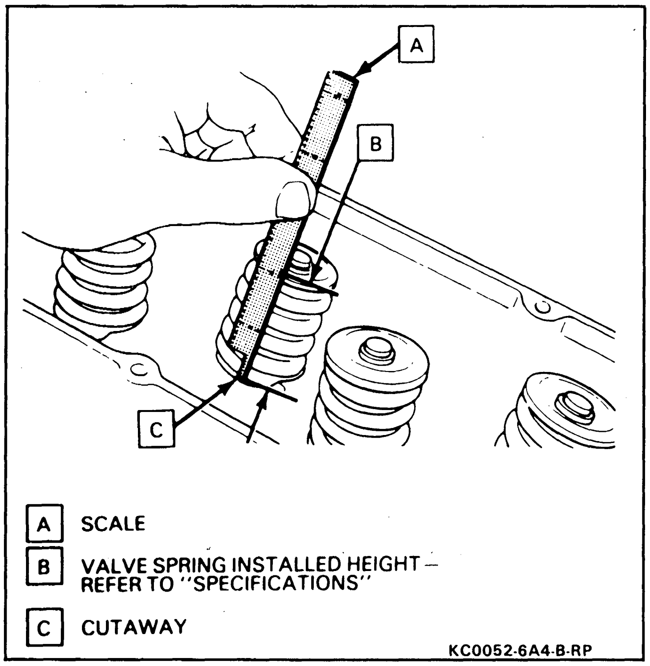


Figure 28 - Measuring Valve Spring Height

OIL PAN

Figure 29

Remove or Disconnect

1. Negative (-) battery cable.
2. Air cleaner (LO3 engine). Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (TBI) (SEC. 6E2).
3. Plenum extension, if equipped.
4. Spark plug wires.
5. Distributor cap.
6. A/C compressor without disconnecting lines and lay aside. Refer to MANUALLY CONTROLLED AIR CONDITIONING (SEC. 1B).

- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

7. AIR hose at the converter pipe.
8. Engine oil pan drain plug and oil.
9. Exhaust pipe at the manifolds. Refer to EXHAUST SYSTEM (SEC. 6F).
10. Flywheel cover. Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A).
11. Transmission oil cooler lines at the clips (67) on the oil pan.
12. Starter. Refer to CRANKING SYSTEM (SEC. 6D2).
13. Engine mount through bolts. Refer to "Front Mount Replacement" in this section.
14. Oil pan nuts (62) and bolts (61) with the reinforcement (65), retainers (66), clips (67) and clamp.

- Lower the oil pan (63) and check that the forward crankshaft throw and counterbalance weight are not in the way of oil pan removal.
  - Turn the crankshaft to the 6 o'clock position on the timing mark.
- Raise the engine enough to remove the oil pan (63).

15. Oil pan (63).
16. Oil pan gasket (64).

Clean

- Oil pan and cylinder block gasket surfaces.

Install or Connect

NOTICE: Only a small amount of sealant is required. Excessive amounts of sealant may cause an improper seal and oil leakage.

- Apply a small amount of sealer (GM part number 1052914, or equivalent), to the front cover and cylinder block junction and rear seal retainer and cylinder block junction. Apply sealer 25 mm (1 inch) in either direction of the radius cavity.

1. New gasket (64) to oil pan (63).

NOTICE: See "Notice" on page 6A3-1 of this section.

2. Oil pan (63).
   - Turn the crankshaft as necessary.
   - Loosely install the nuts (62) and bolts (61) with the reinforcement (65), retainers (66), clips (67) and clamp.
   - Ensure the pipe clamps are installed on the bolts they were removed from.

- Lower the engine.

Tighten

- Nuts (62) to 23 N·m (17 lb. ft.).
- Bolts (61) to 11 N·m (101 lb. in.).

3. Engine mount through bolts. Refer to "Front Mount Replacement" in this section.
4. Starter. Refer to CRANKING SYSTEM (SEC. 6D2).

5. Transmission oil cooler lines to the clips (67) on the oil pan (63).
6. Flywheel cover. Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A).
7. Exhaust pipe at the manifold. Refer to EXHAUST SYSTEM (SEC. 6F).
8. AIR hose at the converter pipe.
9. Oil pan drain plug.

Tighten

- Oil pan drain plug to 22 N·m (16 lb. ft.).

- Lower the vehicle.

10. A/C compressor. Refer to MANUALLY CONTROLLED AIR CONDITIONING (SEC. 1B).
11. Distributor cap.
12. Spark plug wires.
13. Plenum extension, if equipped.
14. Air cleaner. Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (TBI) (SEC. 6E2).
15. Negative (-) battery cable.

- Refill the crankcase with engine oil of the proper type and amount. Refer to MAINTENANCE AND LUBRICATION (SEC. 0B).

Inspect

- For leaks, after running the engine.

OIL PUMP

Figures 30 and 31

Remove or Disconnect

1. Oil pan. Refer to "Oil Pan" in this section.
2. Bolt attaching the oil pump to the rear main bearing cap.
3. Oil pump and shaft extension (69).

Disassemble

1. Oil pump cover attaching screws (77) and pump cover (73).

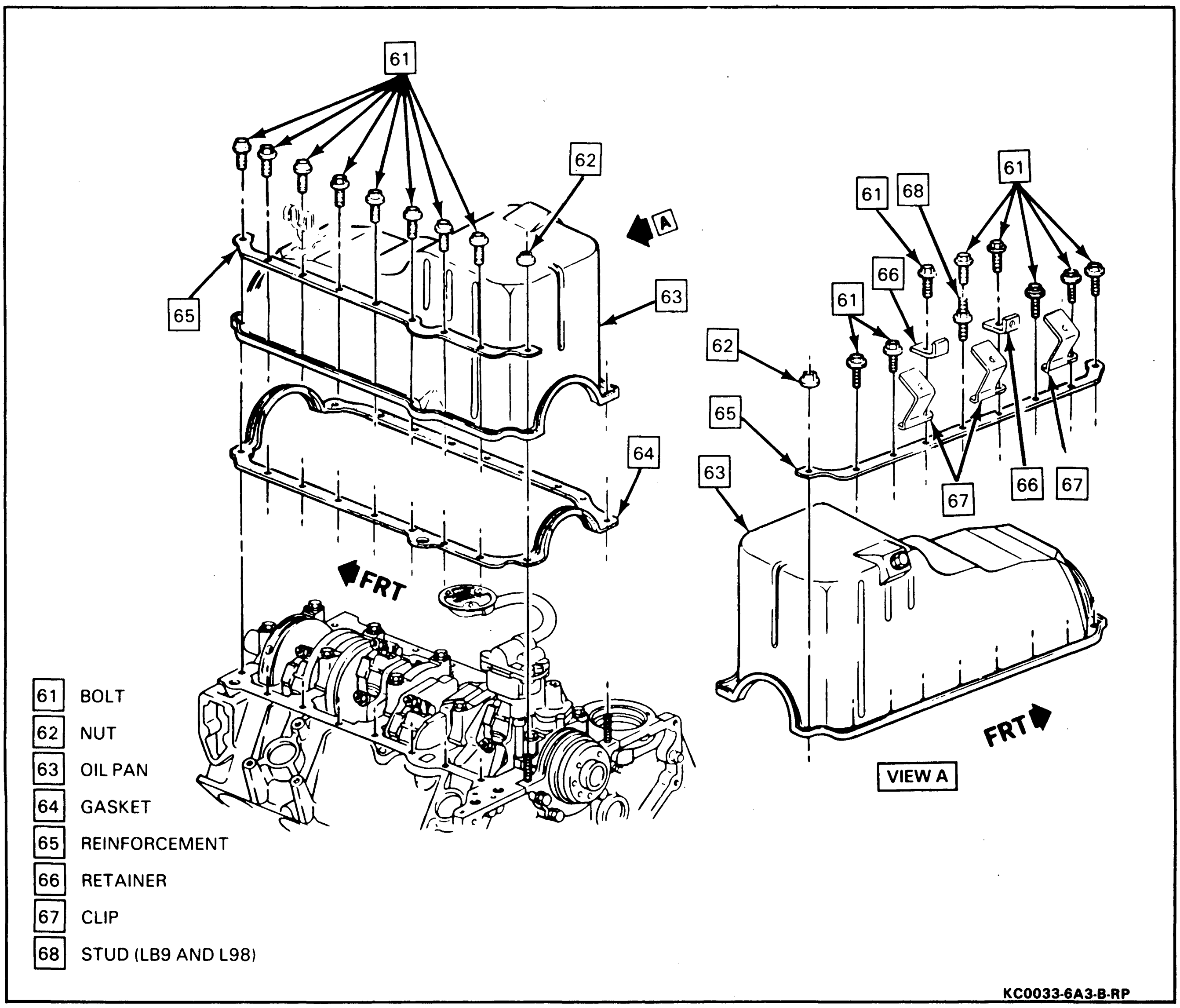


Figure 29 - Oil Pan

- Mark the gear teeth so they may be reassembled with the same teeth indexed.

2. Idler gear (72), drive gear and shaft (71) from the pump body (70).
3. Pressure regulator valve retaining pin (76), pressure regulator spring (75) and pressure regulator valve (74) from pump cover (73).
4. Pickup screen and pipe (78) from the pump cover (73), if replacement is necessary.
   - Mount the pump in a soft-jaw vise and extract the pickup screen and pipe (78).
   - Do not disturb the pickup screen on the pipe. They are serviced as an assembly.

Clean

- All parts in cleaning solvent.
  - Dry parts with compressed air.

Inspect

- Pump body (70) and pump cover (73) for cracks, scoring, casting imperfections, and damaged threads.
- Idler gear shaft. If loose in the pump body (70), replace the oil pump.
- Pressure regulator valve (74) for scoring and sticking.
  - Burrs may be removed with a fine oil stone.
- Pressure regulator spring (75) for loss of tension.
- Pick-up screen and pipe (78) for broken wire mesh or screen, or looseness.
  - If the pipe is loose or has been removed, the pickup screen and pipe (78) must be replaced.
- Gears for chipping, galling, and wear.
- Driveshaft and shaft extension (69) for looseness and wear.

Assemble

Tool Required:

J 21882 Oil Suction Pipe Installer

NOTICE: Be careful not to twist, shear, or collapse the pipe while installing it to the oil pump.

1. A new pickup screen and pipe (78), if previously taken apart, to the pump cover (73).
   - Mount the oil pump cover (73) in a soft-jaw vise.
   - Apply sealer, GM part number 1050026 or equivalent, to the end of the pipe.
   - Tap the pipe into place using J 21882 and a plastic-faced hammer.
2. Pressure regulator valve (74), pressure regulator spring (75) and retaining pin (76).
3. Drive gear and shaft (71) to the pump body (70).
4. Idler gear (72) to pump body (70) with the smooth side of the gear toward the pump cover (73).
5. Pump cover (73).

NOTICE: See "Notice" on page 6A3-1 of this section.

6. Pump cover screws (77).

Tighten

- Screws (77) to 9 N·m (80 lb. in.).

Inspect

- For smoothness of operation by turning the pump shaft extension by hand.

Install or Connect

1. Oil pump, and shaft extension (69).
   - Align the slot on the end of the shaft extension (69) with the drive tang on the distributor shaft.

NOTICE: See "Notice" on page 6A3-1 of this section.

2. Bolt attaching the oil pump to the rear main bearing cap.

Tighten

- Bolt to 88 N·m (65 lb. ft.).

3. Oil pan. Refer to "Oil Pan" in this section.

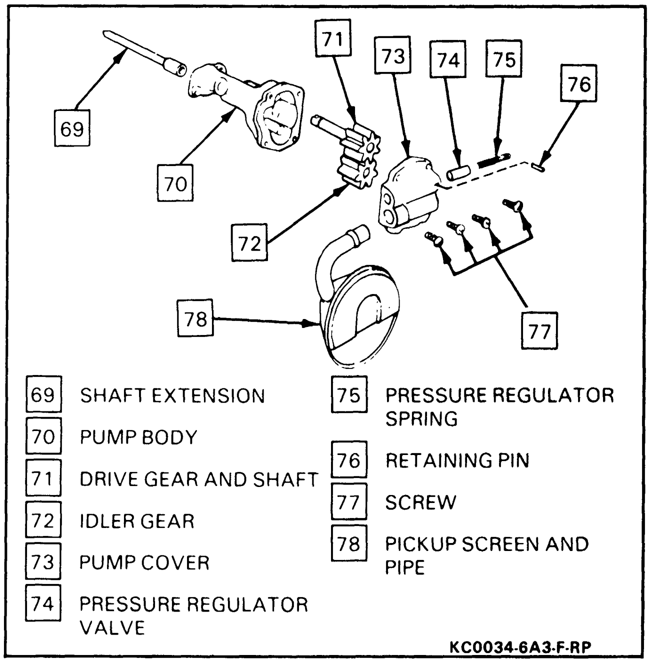


Figure 30 - Oil Pump

TORSIONAL DAMPER

Figures 32 and 33

Remove or Disconnect

Tool Required:

J 23523-E Harmonic Balancer Remover and Installer

1. Negative (-) battery cable.
2. Serpentine drive belt. Refer to COOLING AND RADIATOR (SEC. 6B).

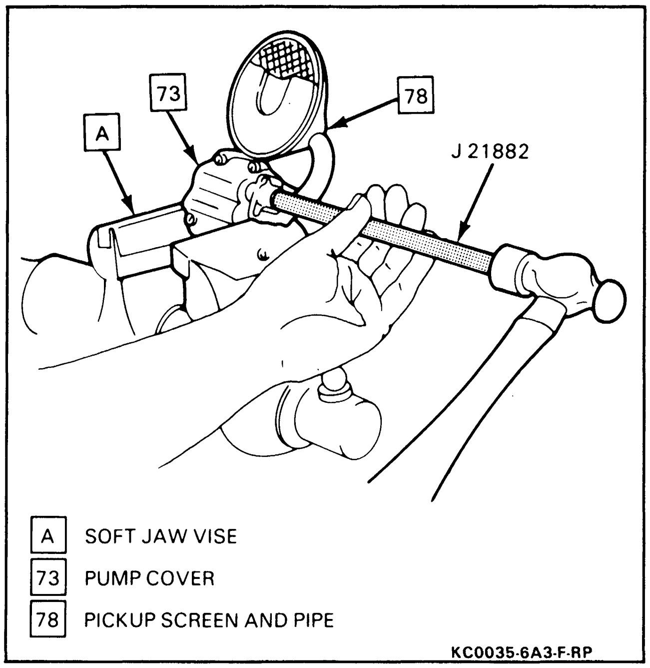


Figure 31 - Installing Pickup Screen

- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

3. Bolts retaining the crankshaft pulley (79) to the torsional damper (83).
4. Crankshaft pulley (79).
5. Bolt retaining the torsional damper to the crankshaft.
6. Torsional damper (83) using J 23523-E.

Inspect

- Torsional damper seal surface for damage or grooving. Replace, if necessary.

Install or Connect

NOTICE: The inertial weight section of the torsional damper (83) is assembled to the hub with a rubber type material. The installation procedures (with proper tool) must be followed. Movement of the inertial weight section on the hub will destroy the tuning of the torsional damper (83).

NOTICE: See "Notice" on page 6A3-1 of this section for steps 4 and 5.

- Before installing the torsional damper (83), coat with oil the area of the damper which contacts the front engine cover seal.

1. Torsional damper (83) into position over the key on the crankshaft.
2. Torsional damper (83) using J 23523-E.
   - Thread the installation stud of J 23523-E fully into the crankshaft.
   - Place the torsional damper (83) over the end of the stud. Align the keyway in the torsional damper shaft with the crankshaft key.
   - Plate, thrust bearing and nut over the torsional damper (83). Tool assembly is now complete.
   - Turn the nut to pull the torsional damper (83) into place.
   - Remove J 23523-E.
   - Apply a small amount of RTV sealant to seal the keyway to the crankshaft joint.
3. Crankshaft pulley (79) to the torsional damper (83).
4. Bolts (82) retaining the crankshaft pulley (79) to the torsional damper (83).

Tighten

- Bolts (82) to 58 N·m (43 lb. ft.).

5. Bolt (81) and washer (80) retaining the torsional damper (83) to the crankshaft.

Tighten

- Bolt (81) to 95 N·m (70 lb. ft.).
- Lower the vehicle.

6. Serpentine drive belt. Refer to COOLING AND RADIATOR (SEC. 6B).
7. Negative (-) battery cable.

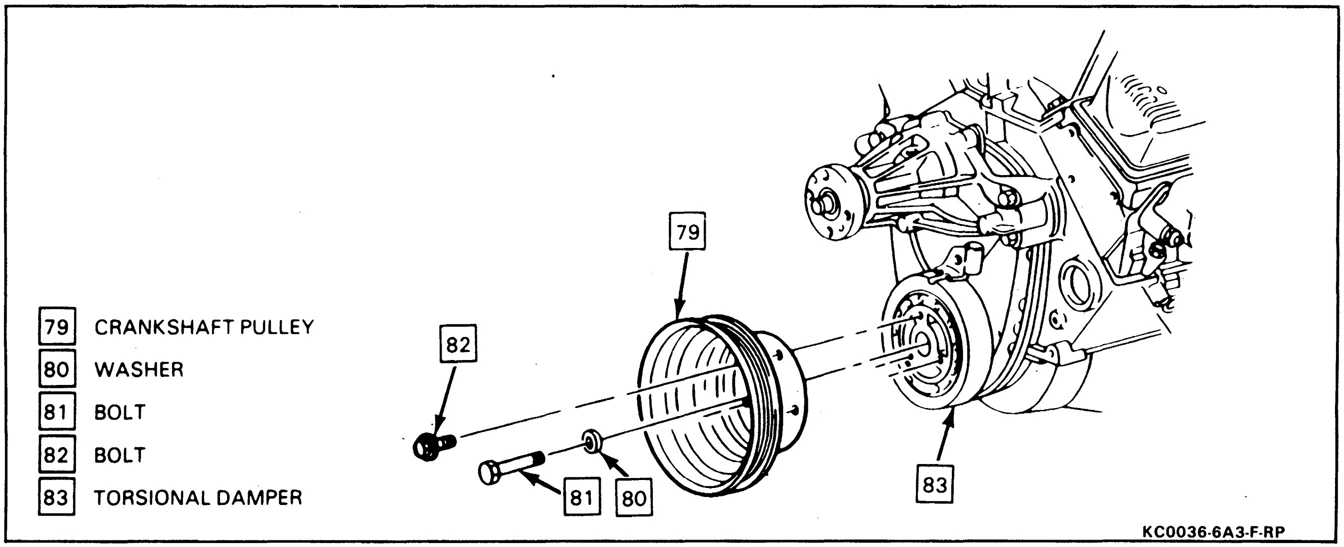


Figure 32 - Crankshaft Pulley

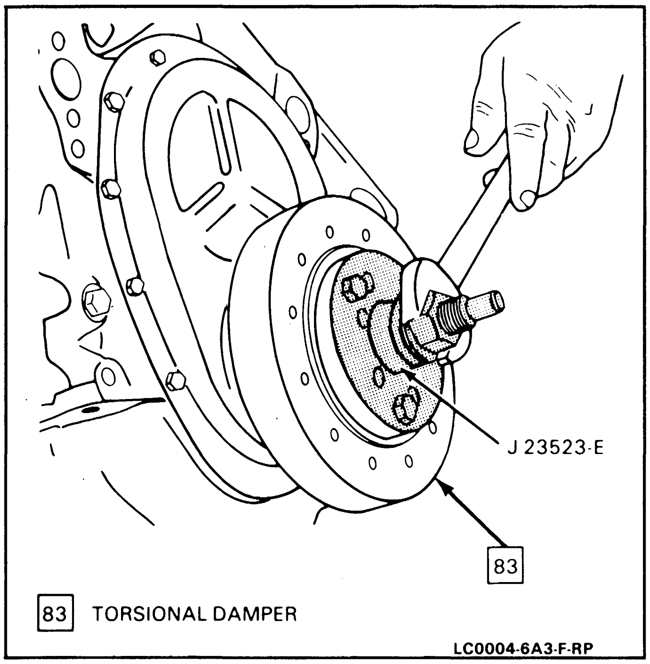


Figure 33 - Installing Torsional Damper

CONNECTING ROD BEARINGS

Figures 34 through 36

Connecting rod bearings are the precision insert type and do not use shims for adjustment. Do not file rods or rod caps. If clearances are found to be excessive, a new bearing will be required. Service bearings are available in standard size and 0.001-inch and 0.002-inch undersize for use with new and used standard size crankshafts. For use with reconditioned crankshafts, 0.010-inch and 0.020-inch bearings are available.

Remove or Disconnect

1. Oil pump. Refer to "Oil Pump" in this section.

   Important

   - Before removing a connecting rod cap, mark the side of the rod and the cap with the cylinder number to ensure that they are matched during assembly.
2. Connecting rod cap nuts.
3. Connecting rod cap and bearings.
   - Keep bearings with their original connecting rod and cap for reassembly.

   Inspect

   - The bearing for evidence of wear or damage.

Clean

- Oil from upper and lower bearing shells, connecting rods and caps.

Measure

1. Crankpin for out-of-round and taper with a micrometer. Refer measurements to "Specifications" in this section.
   - If not within specifications, replace or recondition the crankshaft.
   - If installing new bearings, determine new bearing size from the maximum crankpin diameter.

NOTICE: If a bearing is being fitted to an out-of-round crankpin, be sure to fit to the maximum diameter of the crankpin. If the bearing is fitted to the minimum diameter and the crankpin is out-of-round 0.02 mm (0.001 inch), the interference between the bearing and crankpin will result in rapid bearing failure.

NOTICE: See "Notice" on page 6A3-1 of this section.

2. Bearing clearances, using gaging plastic.
   - Place a piece of gaging plastic the full width of the bearing (parallel to the crankshaft), onto the crankpin.
     - Plastic gage should be positioned in the middle of the bearing shell. The bearing is thickest in the center of the shell and false readings could occur if placed elsewhere.
   - Install the connecting rod cap with the bearing onto the connecting rod.
   - Install the connecting rod cap nuts.

Tighten

- Nuts to 60 N·m (44 lb. ft.).

NOTICE: Do not turn the crankshaft with the gaging plastic installed or the accuracy of the measurement will be affected.

- Remove the connecting rod cap nuts and cap.
- Measure the gaging plastic at its widest point, using the scale provided with the gaging plastic. Refer measurements to "Specifications" in this section.
  - If clearance is greater than specifications, select an undersize connecting rod bearing and measure the clearance again.
  - If clearance cannot be brought to specifications, regrind the crankpin. If the crankpin is already at the maximum undersize, replace the crankshaft.

Install or Connect

- Coat the inside bearing surfaces with engine oil.

1. Connecting rod cap and bearings.

NOTICE: See "Notice" on page 6A3-1 of this section.

2. Connecting rod cap nuts.

Tighten

- Nuts to 60 N·m (44 lb. ft.).

Measure

- Side clearance between connecting rod and connecting rod caps using a feeler gage or dial indicator.

- When all connecting rod bearings have been installed, tap each rod lightly parallel to the crankpin to make sure they have clearance.
  - Rod side clearance should be 0.16 to 0.35 mm (0.006 to 0.014 inch).

3. Oil Pump. Refer to "Oil Pump" in this section.

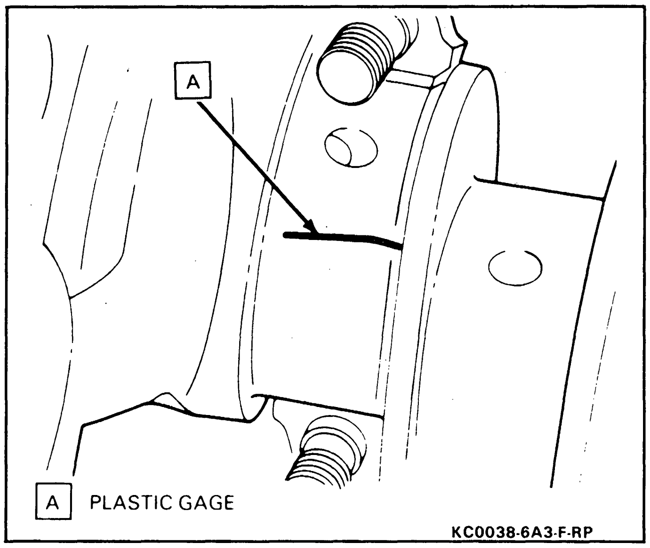


Figure 34 - Gaging Plastic on Crankpin - Typical

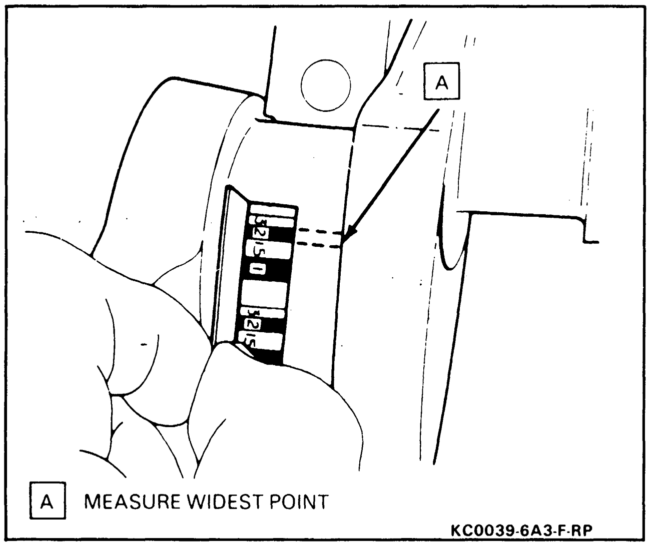


Figure 35 - Measuring Gaging Plastic

PISTON AND CONNECTING RODS

Figures 37 through 43

Remove or Disconnect

1. Oil Pump. Refer to "Oil Pump" in this section.
2. Cylinder head. Refer to "Cylinder Head and Gasket" in this section.
3. Ring ridge.
   - Turn the crankshaft until the piston is at the bottom of the stroke.

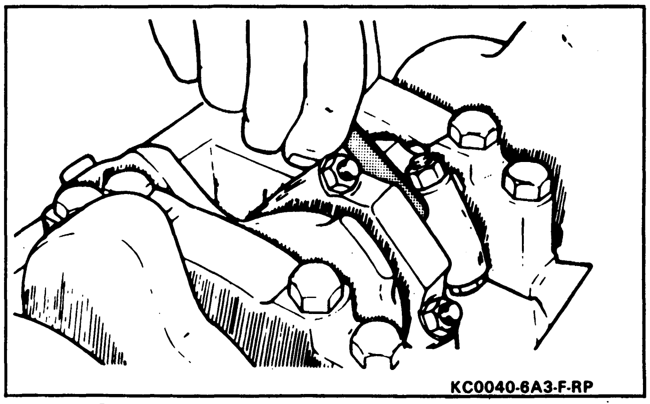


Figure 36 - Measuring Connecting Rod Side Clearance

   - Place a cloth on the top of the piston.
   - Use a ridge reamer to remove the ring ridge.
   - Turn the crankshaft so the piston is at the top of its stroke.
   - Remove the cloth and cutting debris.

Important

   - Place matchmarks or numbers on the connecting rods and caps. Connecting rod caps must be assembled to their original connecting rods.

4. Connecting rod cap nuts.

NOTICE: To protect the connecting rod bearing surfaces, and stud threads, place a short length of fuel hose over the studs.

5. Connecting rod and piston assembly out of the top of the cylinder block.

Disassemble

Tool Required:

J 24086-B Piston Pin Remover and Installer Set

1. Connecting rod bearings from the connecting rods and caps.
   - If bearings are being reused, place them in a rack so they may be installed in their original rod and cap.
2. Piston rings from the piston.
3. Piston pin (84) from the piston using J 24086-B (Figure 37).

Clean

- Connecting rod in cleaning solvent.
  - Dry the connecting rod with compressed air.
- Varnish from the piston skirts and pins with a cleaning solvent.
- Ring grooves with a ring cleaner.
- Oil ring holes and slots.

Inspect

- Connecting rod for twisting, nicks and cracks. Replace if necessary.

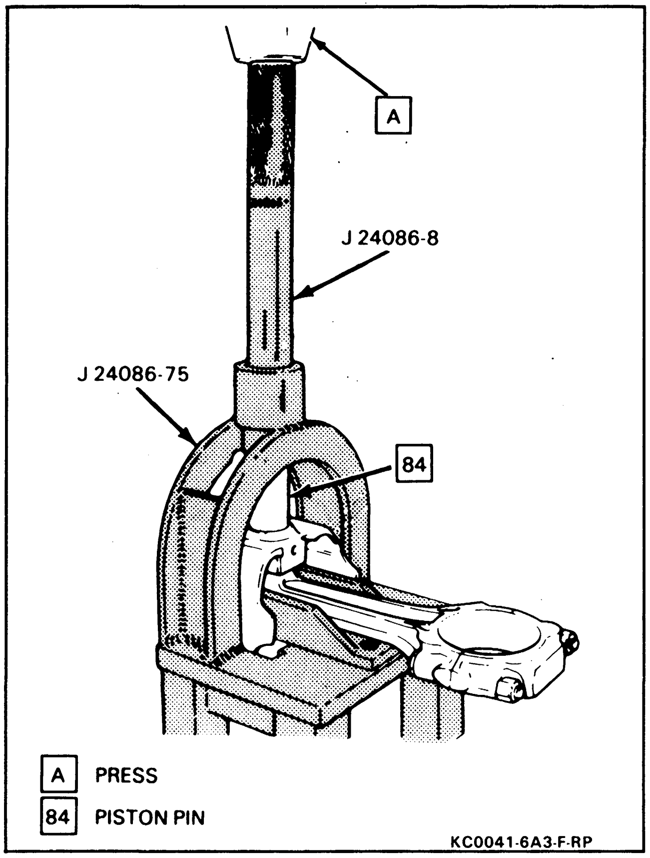


Figure 37 - Removing Piston Pin

- Piston for:
  - Cracked ring lands, skirts, or pin bosses.
  - Grooves for nicks or burrs that may cause binding.
  - Warped or worn ring lands.
  - Scuffed or damaged skirts.
  - Eroded areas at the top of the piston.
    - Worn piston bores and piston pins (84).
    - Replace damaged or excessively worn pistons.

Measure

1. Piston pin bore-to-piston pin clearance.
   - Piston pin bores and piston pins (84) must be free of varnish or scuffing when being measured.
   - Use a micrometer to measure the piston pin (84) and an inside micrometer to measure the piston pin bore.
   - If clearance is in excess of 0.025 mm (0.001 inch), the piston and piston pin (84) should be replaced. The piston and the piston pin (84) are matched and are not serviced separately.
2. Piston compression ring end gap.

   ### Important

   - Fit each compression ring to the cylinder in which it will be used.
   - Place the ring into the cylinder bore.
   - Push the ring into the cylinder bore to approximately 6.5 mm (1/4 inch) above the ring travel. Ring must be square to cylinder wall.
   - Measure the end gap with a feeler gage. Refer to "Specifications" in this section for acceptable end gaps.
     - If the end gap exceeds specifications, select another size ring set.
3. Piston ring side clearance.
   - Roll the ring entirely around its ring groove on the piston.
     - If any binding is caused by the ring groove, dress the groove with a fine cut file.
     - If any binding is caused by a distorted ring, replace the ring.
   - Measure side clearance of the piston ring and groove with a feeler gage. For acceptable side clearances, refer to "Specifications" in this section.
     - If the side clearance is too small, try another ring.
4. Piston-to-cylinder bore clearance to determine the suitability of a used piston. Measure the piston-to-cylinder bore clearance as follows:
   - Measure the cylinder bore diameter at a point 64 mm (2-1/2 inches) from the top of the cylinder bore using a bore gage.
   - Measure the 5.0L engine piston diameter across the skirt at right angles to the centerline of the piston pin bore using a caliper or micrometer.
   - Measure the 5.7L engine pistion diameter 11.5 mm (0.45 inch) above the bottom of the skirt at right angles to the piston pin bore.
   - Subtract the piston diameter from the cylinder bore diameter. This will indicate the piston-to-bore clearance.
   - Compare measurements to "Specifications" in this section.
   - If the clearance exceeds the specifications, subtract the size of a new piston from the cylinder bore diameter previously measured.
     - If the clearance with a new piston is within the specifications, mark that piston to the cylinder to which it is to be installed.
   - If the clearance is within the specifications, the used piston may be installed again.

Assemble

Tool Required:

J 24086-B Piston Pin Remover and Installer Set

NOTICE: After J 24086-9 hub bottoms on support assembly, do not exceed 34 475 kPa (5000 psi) or the tool may be damaged.

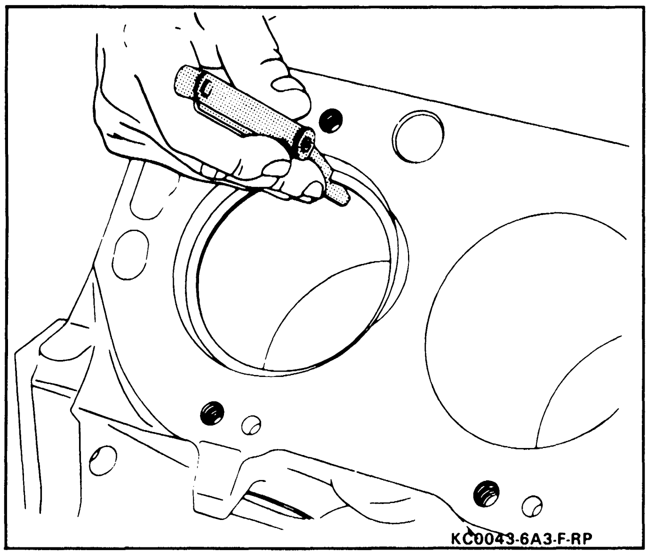


Figure 38 - Measuring Ring Gap

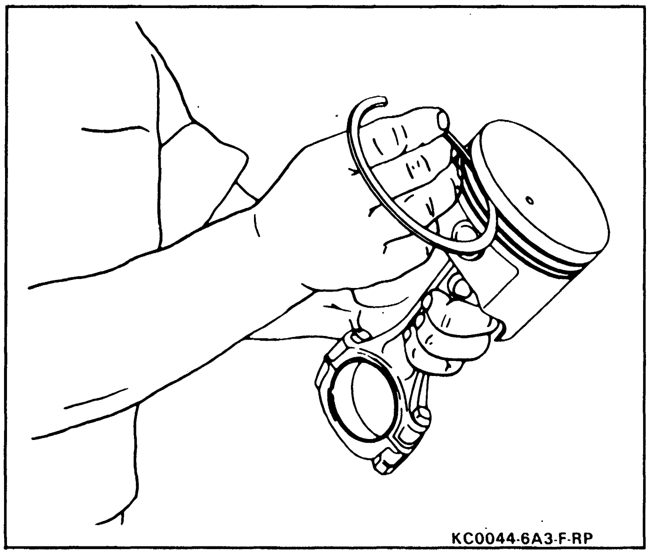


Figure 39 - Checking Ring in Groove

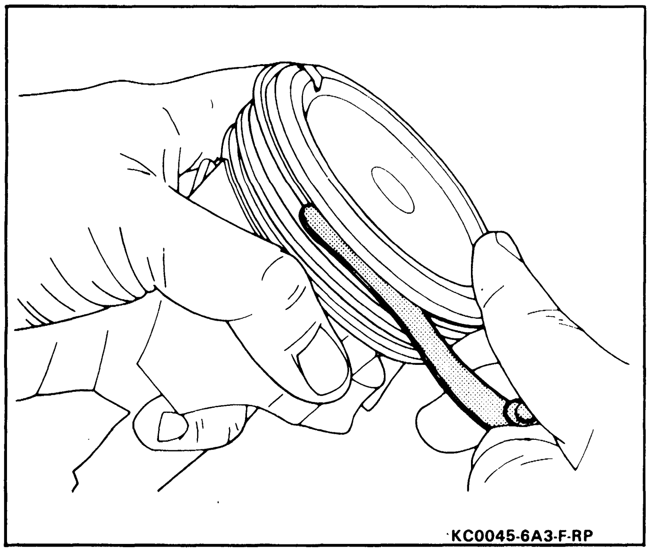


Figure 40 - Measuring Ring Groove Clearance

1. Piston and connecting rod.
   - Lubricate piston pin holes in both the piston and connecting rod.
   - Press piston pin (84) into the piston and connecting rod using J 24086-B.

Inspect

   - For freedom of movement of the piston on the piston pin (84).

2. Piston rings onto the piston.
   - The marked side of the rings must face toward the top of the piston.
     - The top ring is chrome or molybdenum faced.
     - The second ring has a tapered face.
   - Install oil ring spacer in groove and insert anti-rotation tang, in drilled hole, if applicable.
   - Hold the spacer ends together and install the lower oil ring rail with gap properly located.
   - Install the upper oil ring rail with gap properly located.
     - Flex the oil ring assembly to make sure rings are free.
   - Install second compression ring with gap properly located.
   - Install top compression ring with gap properly located.

- Lubricate connecting rod bearings.

3. Connecting rod bearings into the original connecting rods and caps.

Install or Connect

Tool Required:

J 8037 Piston Ring Compressor

Clean

- Cylinder bores with hot water and detergent or with a light honing.
- Swab bores with engine oil and a clean, dry cloth.

NOTICE: Place a short length of fuel hose over the connecting rod studs to protect the bearing surface and threads.

- Coat piston, rings, cylinder bore, and inside bearing surfaces with engine oil.

1. Piston into its original bore using J 8037 and lightly tapping the top of the piston with a wooden hammer handle.
   - Connecting rod bearing tang slots should be on the side opposite the camshaft.
   - Hold J 8037 firmly against the cylinder block until all piston rings have entered the cylinder bore.
2. Connecting rod caps onto their original connecting rods.

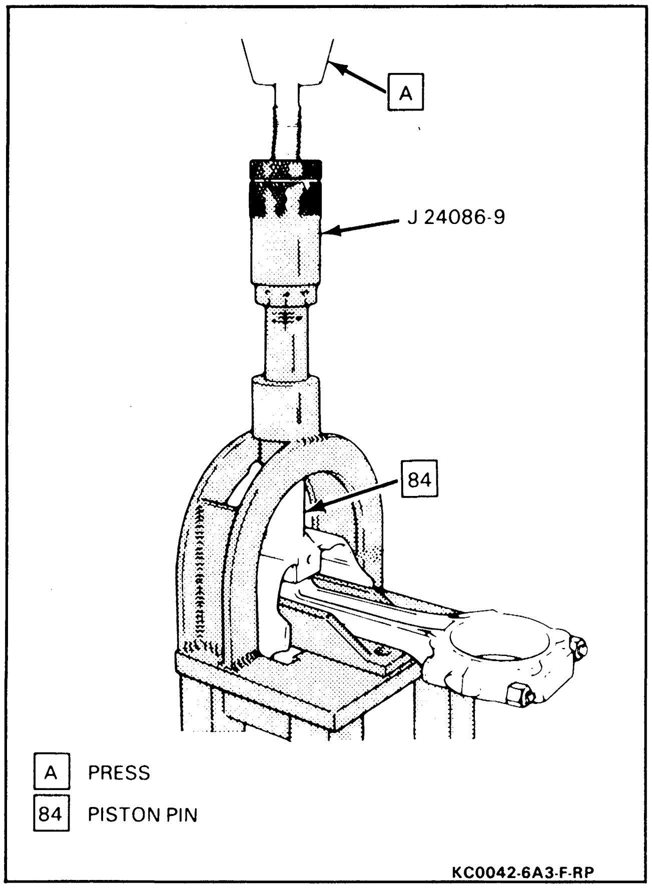


Figure 41 - Installing Piston Pin

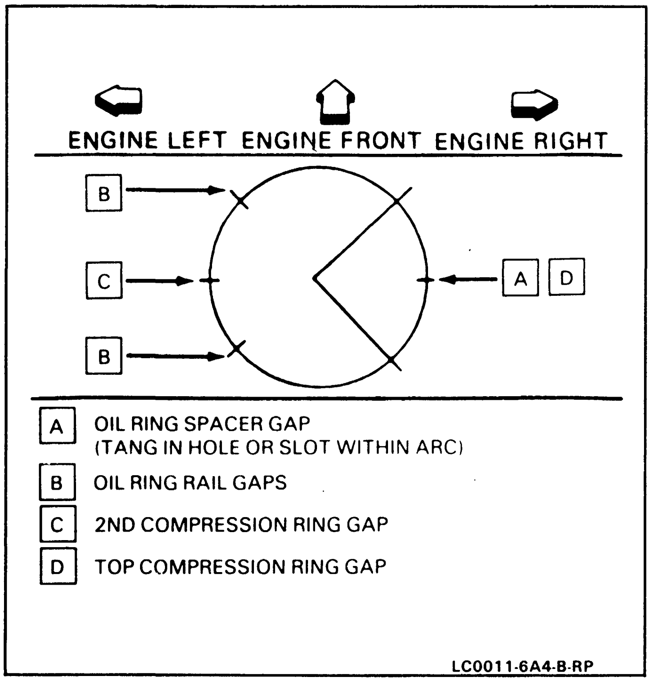


Figure 42 - Piston Ring Gap Locations

- Align the matchmarks or numbers which were placed on the connecting rod and cap during removal.

NOTICE: See "Notice" on page 6A3-1 of this section.

3. Connecting rod cap nuts.

Tighten

- Nuts to 60 N·m (44 lb. ft.).

4. Cylinder head. Refer to "Cylinder Head and Gasket" in this section.
5. Oil pump. Refer to "Oil Pump" in this section.

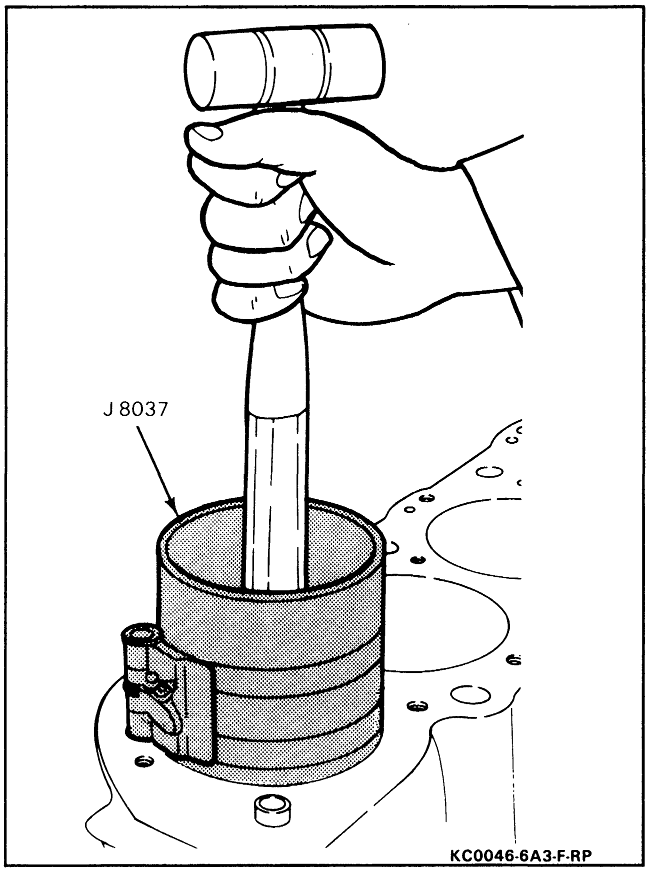


Figure 43 - Installing the Piston

MAIN BEARINGS

Figure 44

Crankshaft Removed from Engine

Remove or Disconnect

1. Crankshaft. Refer to "Crankshaft" in this section.
2. Main bearings from the cylinder block.
3. Main bearings from the bearing caps.

Install or Connect

- To determine proper main bearing size for installation, refer to "Main Bearing Fitting" in this section.

1. Main bearings of the correct size into the cylinder block.
2. Main bearings of the correct size into the main bearing caps.
   - Coat the inside bearing surfaces with oil.
3. Crankshaft. Refer to "Crankshaft" in this section.

Crankshaft Installed in Engine

Remove or Disconnect

Tool Required:

J 8080 Main Bearing Shell Remover and Installer

1. Oil pump. Refer to "Oil Pump" in this section.
2. Main bearing cap bolts.
3. Main bearing cap with lower bearing.
4. Upper main bearings.
   - Install J 8080 into the oil hole of the crankshaft journal.
   - Rotate the crankshaft clockwise as viewed from the front of the engine. This will roll the upper main bearing out of the block.

Install or Connect

Tool Required:

J 8080 Main Bearing Shell Remover and Installer

- To determine proper main bearing size for installation, refer to "Main Bearing Fitting" in this section.

1. Upper main bearing.
   - Coat the inside bearing surfaces with oil.
   - Insert the unnotched end between the crankshaft and the notched end of the cylinder block.
   - Rotate crankshaft in a clockwise direction, as viewed from the front of the engine.
   - Remove J 8080 from the oil hole in the journal.

- Coat the lower main bearing inside surface with oil.

2. Lower main bearing into the bearing cap.
3. Main bearing cap, with arrows toward the front of the engine.

NOTICE: See "Notice" on page 6A3-1 of this section.

4. Main bearing cap bolts.
   - With crankshaft, bearing and bearing caps installed and bolts started, thrust crankshaft rearward to set and align bearing caps. Then thrust crankshaft forward to align rear faces of rear main bearings. This procedure is mandatory except where the rear bearing cap is located with a dowel pin.

Tighten

- Bolts to 105 N·m (77 lb. ft.).

5. Oil pump. Refer to "Oil Pump" in this section.

Main Bearing Fitting

Remove or Disconnect

1. Main bearings. Refer to "Main Bearings" in this section.

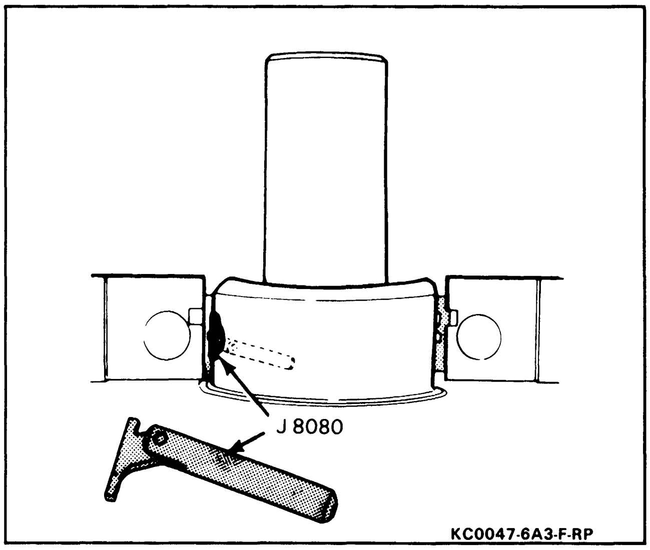


Figure 44 - Removing the Main Bearing

2. Serpentine accessory drive belt. Refer to COOLING AND RADIATOR (SEC. 6B).

Inspect

- Lower half of main bearing.
  - If the lower half is worn or damaged, both the upper and lower half should be replaced.
  - If the lower half is suitable for use, the upper half will also be suitable for use.

Measure

Important

- If replacing the rear main bearing, check for the correct part number. Some rear main bearings are 0.20 mm (0.008-inch) wider than standard. The crankshaft will be identified by "0.008" stamped on the rear counterweight.
- It is necessary to measure the clearance of each main bearing to determine proper sizes. Factory installed bearings may not be the same size for each journal. Also, a production crankshaft may have one or more journals ground undersize.
- When measuring #1 main bearing clearance, accessory drive belt must be removed. This will prevent a tapered gaging plastic reading.

1. Main bearing clearance, using gaging plastic.
   - Place a piece of gaging plastic the full width of the bearing onto the journal.
   - If the crankshaft is removed from the engine, measure all five bearing clearances at the same time.

Important

- Do not rotate the crankshaft while the gaging plastic is between the journal and the bearing.

  - If the engine is in the vehicle, support the crankshaft upward to remove clearance from upper bearing.
- Install the bearing cap with the arrows pointing toward the front of the engine.

NOTICE: See "Notice" on page 6A3-1 of this section.

- Install the bearing cap bolts.

Tighten

  - Bearing cap bolts to 105 N·m (77 lb. ft.).
- Remove the bearing cap and bolts.
- Measure the gaging plastic at its widest, using the scale provided with the gaging plastic. Refer measurement to "Specifications" in this section.
  - If the gaging plastic shows an irregularity in the journal exceeding 0.025 mm (0.001 inch), measure the journal with a micrometer.
  - If clearance is greater than specified, select an undersize bearing and measure the clearance again. Always replace both upper and lower bearings as a unit.
  - If a new bearing cap is being installed and clearance is less than 0.025 mm (0.001 inch), inspect for burrs and nicks. If none are found, install the new cap as required. Laminated shims are available for service.
  - If clearance cannot be brought to specifications using a standard undersize bearing, regrind the crankshaft for use with the next undersize bearing.
- Proceed to the next bearing if the crankshaft is installed.

2. Crankshaft end play, using a dial indicator or feeler gage. Refer measurement to "Specifications" in this section.

Install or Connect

1. Main bearings. Refer to "Main Bearings" in this section.
2. Serpentine accessory drive belt. Refer to COOLING AND RADIATOR (SEC. 6B).

FLYWHEEL

Flywheel Replacement

Figure 45

Remove or Disconnect

1. Transmission assembly. Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A).
2. Bolts (88) attaching flywheel (87) to crankshaft (85).
3. Flywheel (87).

Install or Connect

1. Flywheel (87).
   - Align the crankshaft dowel pin to the proper hole on the flywheel.

NOTICE: See "Notice" on page 6A3-1 of this section.

2. Bolts (88) attaching flywheel (87) to crankshaft (85).

Tighten

  - Bolts (88) to 100 N·m (74 lb. ft.).

3. Transmission assembly. Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A).

Flywheel Balancing

Figure 45

Inspect

- Flywheel (87) for missing or loose converter-to-flywheel bolts. Tighten or replace as necessary.
- Converter for damage or missing balance weights (89). If the converter is damaged or balance weights (89) are missing, replace the converter.

Adjust

- Flywheel (87) to correct any imbalance by adding balance weights (89) to one or more of the holes provided in the flywheel (87).
- Install one balance weight (89) to one of the flywheel holes.
- Start engine and, with transmission in "NEUTRAL," note the vibration.
  - If vibration has increased, relocate balance weight (89) 180 degrees from its present position.
  - If vibration has decreased, install an additional balance weight (89) next to the first one.
  - If no change is noticed, relocate the balance weight (89) 60 degrees from its present location.
  - Continue until vibration is reduced.

REAR CRANKSHAFT SEAL

Figures 45 through 47

Remove or Disconnect

1. Flywheel. Refer to "Flywheel Replacement" in this section.

NOTICE: Care should be taken not to nick the crankshaft sealing surface when removing the seal.

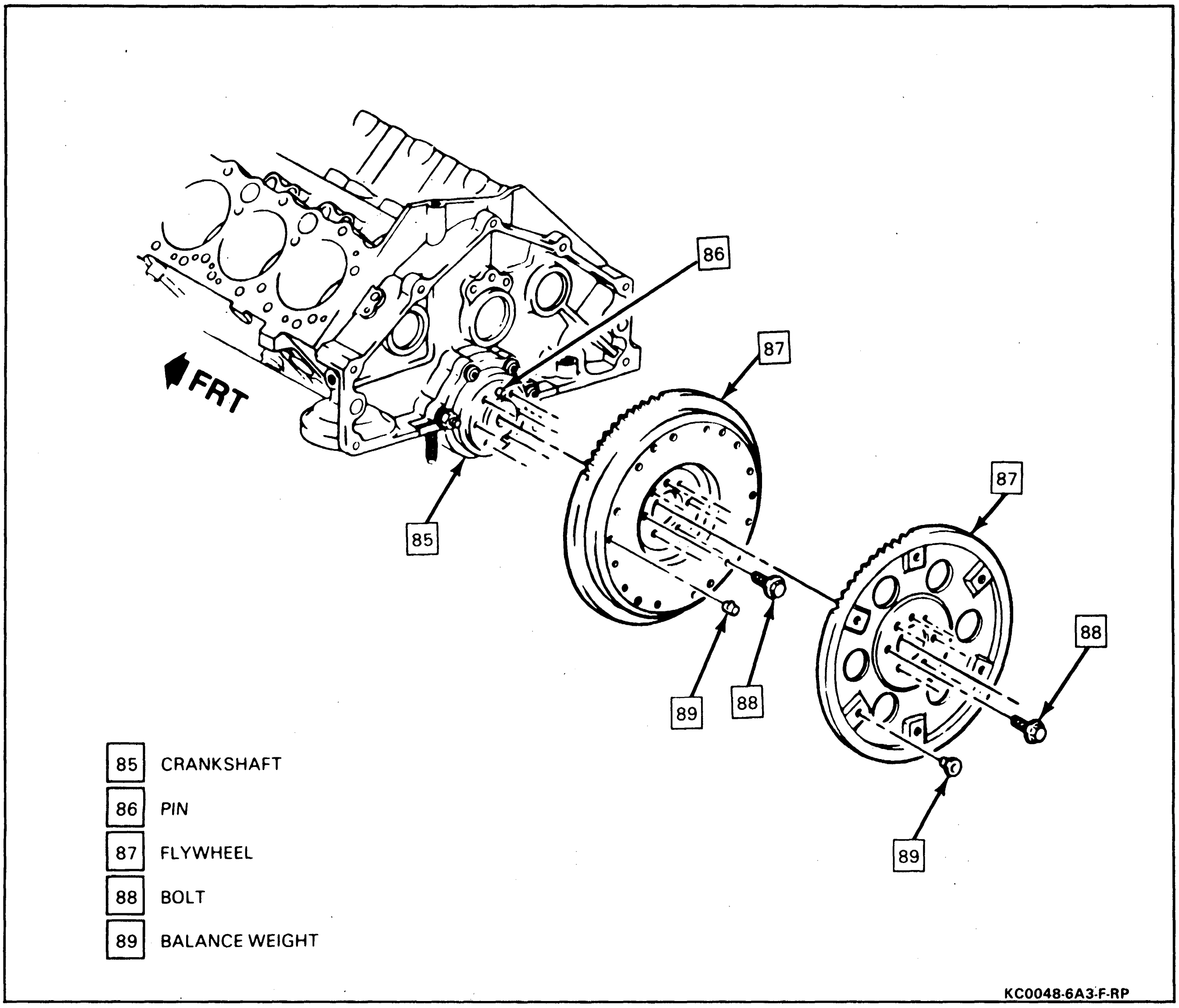


Figure 45 - Flywheel

2. Rear crankshaft seal.
   - Using the notches provided in the seal retainer (90), pry out the seal with a screwdriver.

Install or Connect

Tool Required:

J 35621 Rear Main Seal Installer

- Coat the new seal entirely with engine oil.

1. Seal onto J 35621.
2. J 35621 onto the rear of the crankshaft. Tighten the screws snugly to ensure the seal will be installed squarely over the crankshaft.
3. Rear crankshaft seal to crankshaft and seal retainer (90).
   - Tighten the wing nut on J 35621 until it bottoms.

- Remove J 35621 from the seal retainer (90).

4. Flywheel. Refer to "Flywheel Replacement" in this section.

Inspect

- Engine oil level.
- For leaks.

REAR CRANKSHAFT SEAL RETAINER AND GASKET

Figure 46

Remove or Disconnect

1. Flywheel. Refer to "Flywheel Replacement" in this section.
2. Oil pan and lower it from the cylinder block and rear crankshaft seal retainer (90). Refer to "Oil Pan" in this section.
   - It is not necessary to loosen the engine mounts to remove the oil pan completely.
3. Rear crankshaft seal retainer (90) and the bolts.
4. Rear crankshaft seal retainer (90) with the assembled seal, and the gasket.
5. Rear crankshaft seal from the rear crankshaft seal retainer (90).

Clean

- Gasket surfaces.

Install or Connect

Important

- Always use a new rear crankshaft seal and a new retainer gasket during the installation of the rear crankshaft seal retainer (90).

1. New gasket and rear crankshaft seal retainer (90) on the studs.
   - It is not necessary to use any type of sealant to hold the gasket in place.

NOTICE: See "Notice" on page 6A3-1 of this section.

2. Rear crankshaft seal retainer nuts and the bolts.

Tighten

- Nuts and bolts to 15 N•m (11 lb. ft.).

Inspect

- Oil pan gasket for damage.
  - Replace the gasket if necessary.

3. Oil pan. Refer to "Oil Pan" in this section.
4. New rear main seal. Refer to "Rear Crankshaft Seal" in this section.
5. Flywheel. Refer to "Flywheel Replacement" in this section.

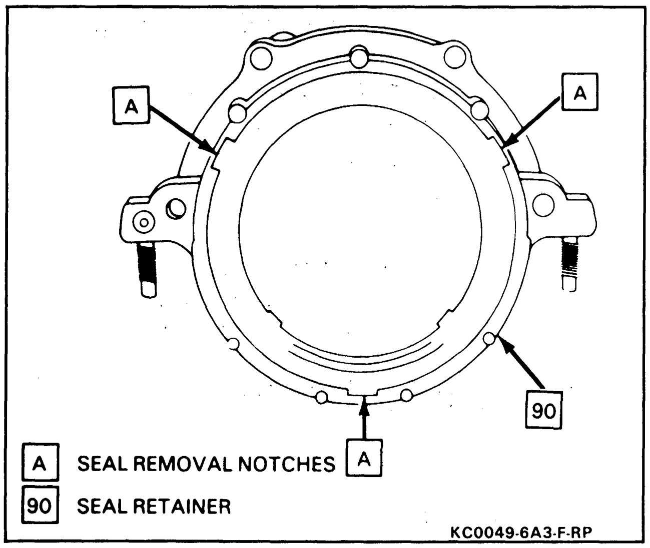


Figure 46 - Removing the Rear Crankshaft Seal

ENGINE ASSEMBLY

Remove or Disconnect

1. Negative (-) battery cable from the battery.
2. Hood. Refer to FRONT END BODY PANELS (SEC. 2C).
3. Air cleaner.

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

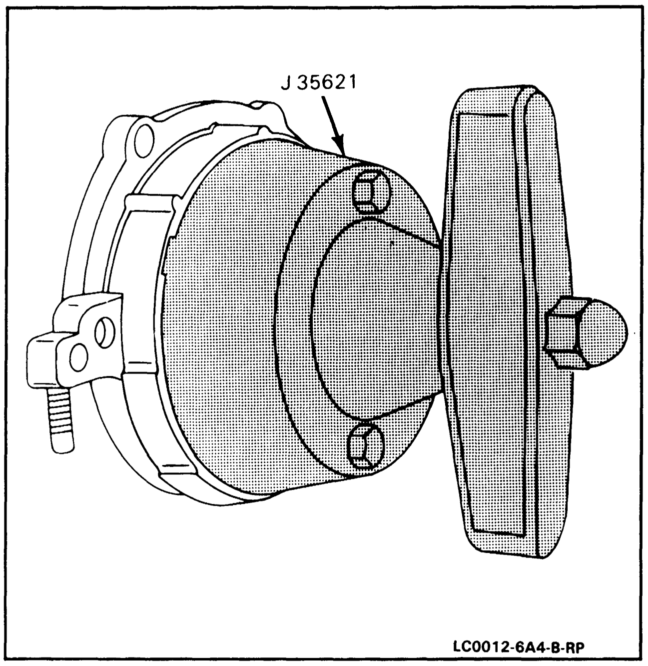


Figure 47 - Installing the Rear Crankshaft Seal

- Drain cooling system. Refer to COOLING AND RADIATOR (SEC. 6B).

4. Lower radiator hose and clamps. Refer to COOLING AND RADIATOR (SEC. 6B).
5. Lower fan mounting bolts.
6. Electrical connectors and retaining clips at the fan.

- Lower vehicle.

7. Upper radiator hose and clamps. Refer to COOLING AND RADIATOR (SEC. 6B).
8. Upper radiator fan shroud and fan assembly. Refer to COOLING AND RADIATOR (SEC. 6B).
9. Radiator. Refer to COOLING AND RADIATOR (SEC. 6B).
10. Serpentine accessory drive belt. Refer to COOLING AND RADIATOR (SEC. 6B).
11. Accelerator control cable. Refer to ENGINE FUEL (SEC. 6C).
12. Plenum extension screws and plenum extension, if equipped. Refer to IGNITION SYSTEM (SEC. 6D4).
13. Spark plug wires at distributor. Refer to IGNITION SYSTEM (SEC. 6D4).
14. Distributor. Refer to IGNITION SYSTEM (SEC. 6D4).
15. External coil, if equipped. Refer to IGNITION SYSTEM (SEC. 6D4).
16. Necessary vacuum hoses. Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (TBI) (SEC. 6E2) or DRIVEABILITY AND EMISSIONS - FUEL INJECTION (PORT) (SEC. 6E3).
17. Necessary wiring and clips. Refer to ENGINE WIRING (SEC. 6D5).
18. Fuel lines at fuel hoses. Refer to ENGINE FUEL (SEC. 6C).

19. Power steering pump drive pulley. Refer to POWER STEERING GEAR AND PUMP (SEC. 3B1).
20. Power steering pump. Refer to POWER STEERING GEAR AND PUMP (SEC. 3B1).
21. Air conditioning compressor. Refer to MANUALLY CONTROLLED AIR CONDITIONING (SEC. 1B).
22. Negative (-) battery cable at engine block.
23. AIR hoses and pipe. Refer to EXHAUST SYSTEM (SEC. 6F).

- Raise vehicle and suitably support. Refer to GENERAL INFORMATION (SEC. 0A).

24. Crossover pipe. Refer to EXHAUST SYSTEM (SEC. 6F).
25. Flywheel cover. Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A).
26. Torque converter to flywheel bolts. Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A).
27. Starter. Refer to CRANKING SYSTEM (SEC. 6D2).
28. Transmission oil cooler lines at the oil pan. Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A).
29. Engine mounting bolts. Refer to "Engine Mounts" in this section.

- Support transmission with an adjustable lifting device.

30. Transmission crossmember bolts. Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A).

- Lower transmission.

31. Bellhousing bolts.

- Raise transmission.
- Install two transmission crossmember bolts. Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A).

32. Adjustable lifting device from transmission.

- Lower vehicle.
- Install a lifting device onto the engine.
- Support transmission with an adjustable lifting device.

33. Engine.
    - Disconnect ground wires and catalytic converter AIR pipe bracket at the back of the cylinder heads.

- Mount the engine on a stand.
- Drain the crankcase.
- Drain the engine block. Refer to COOLING AND RADIATOR (SEC. 6B).

Install or Connect

- Engine in reverse order of removal with the following exceptions:
  - Fill the crankcase with the proper amount and grade of oil and the cooling system with the proper coolant, after all other installation operations have been completed. Refer to MAINTENANCE AND LUBRICATION (SEC. 0B) and COOLING AND RADIATOR (SEC. 6B).
  - Set ignition timing. Refer to IGNITION SYSTEM (SEC. 6D4).
  - Check engine and related systems for proper operation and for fluid leaks.

Cylinder Block

Remove or Disconnect

1. Engine. Refer to "Engine Assembly" in this section.
2. Cylinder heads. Refer to "Cylinder Head and Gasket" in this section.
3. Valve lifters. Refer to "Valve Lifters" in this section.
4. Crankshaft. Refer to "Crankshaft" in this section.
5. Pistons and connecting rods. Refer to "Piston and Connecting Rods" in this section.
6. Camshaft bearings. Refer to "Camshaft Bearings" in this section.
7. Oil filter.
8. Oil cooler, if equipped. Refer to "Engine Oil Cooler" in this section.
9. Oil filter adapter bolts and adapter.
10. Cylinder block coolant drain plugs.
11. Fuel pump cover bolts.
12. Fuel pump cover.
13. Fuel pump cover gasket.
14. Front and rear oil gallery plugs.
15. Oil pressure switch and fittings. Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (TBI) (SEC. 6E2) or DRIVEABILITY AND EMISSIONS - FUEL INJECTION (PORT) (SEC. 6E3).

Clean

- Cylinder block in solvent.
- Gasket surfaces.
- Coolant passages.
- Oil passages.

Inspect

- For cracks in the cylinder walls, coolant jacket, valve lifter bores and main bearing webs.

Measure

- Cylinder bores for taper, out-of-round, or excessive ring ridge at the top of the ring travel using a dial indicator. Compare the measurements taken with "Specifications" at the end of this section.

  - Cylinders with less than 0.127 mm (0.005 inch) of wear or taper may be reconditioned with a hone.
  - Cylinders with more than 0.127 mm (0.005 inch) of wear or taper must be bored and honed to the smallest oversize piston that will permit complete resurfacing of all the cylinders.

Boring

1. Draw a flat across the top of the cylinder block several times to remove any burrs or gasket material. If the cylinder block surface is not completely smooth and flat, the boring bar may be tilted which would result in the cylinder having an incorrect angle to the crankshaft.
2. Measure the piston to be installed at the center of the piston skirt and at right angles to the piston pin.
3. Bore the cylinder to the same diameter as the piston.
4. Hone the cylinder as outlined below to provide the specified clearance.
   - Follow the instructions provided by the manufacturer of the boring equipment being used.

NOTICE: Handle pistons with care. Do not attempt to force them into the cylinder. The piston may be easily distorted.

Honing

1. Follow the instructions provided by the manufacturer of the honing equipment being used.
2. Occasionally during the honing operation:
   - Clean the cylinder bore.
   - Measure the cylinder bore for proper piston fit.
3. Finish the operation with a 45 to 65 degree cross-hatch pattern on the cylinder walls.
   - The finish marks should be clean but not sharp, free from imbedded particles and torn or faded metal.
4. Place a permanent mark on each piston to match it to its proper cylinder.

Clean

- Cylinder bores and block with hot water and detergent, using a stiff bristle brush. Rinse thoroughly and dry with a clean cloth.
  - Any abrasive material left in the cylinder bores will cause rapid wear of the piston rings bearings, and other engine parts.
  - Do not use kerosene or gasoline for cleaning.
  - After cleaning, swab the cylinder bores with light engine oil and a clean cloth. Then wipe them out with a clean dry cloth.

Install or Connect

NOTICE: See "Notice" on page 6A3-1 of this section for steps 2, 5, 7, 9 and 10

1. Oil pressure switch and fittings. Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (TBI) (SEC. 6E2) or DRIVEABILITY AND EMISSIONS - FUEL INJECTION (PORT) (SEC. 6E3).
2. Front and rear oil pressure hole plugs.

Tighten

- Oil gallery plugs to 13 N·m (115 lb. in.).

3. Fuel pump cover gasket.
4. Fuel pump cover.
5. Fuel pump cover bolts.

Tighten

- Upper fuel pump cover bolts to 34 N·m (25 lb. ft.).
- Lower fuel pump cover bolts to 12 N·m (106 lb. in.).

Inspect

- Oil filter bypass valve and spring for proper operation.
- For cracked or broken bypass valve.
  - The oil filter adapter and bypass valve assembly must be replaced as a unit.

6. Oil filter adapter with new seal.
7. Oil filter adapter bolts.

Tighten

- Bolts to 25 N·m (18 lb. ft.).

8. Oil cooler, if equipped. Refer to "Engine Oil Cooler" in this section.

NOTICE: Slow take-up for compression of oil filter gasket is necessary to prevent damage to the gasket. Over tightening may rupture the filter can.

9. New oil filter.

Tighten

- Oil filter to 23 N·m (17 lb. ft.).

10. Cylinder block coolant drain plugs.

Tighten

- Plugs to 21 N·m (15 lb. ft.).

11. Camshaft bearings. Refer to "Camshaft Bearings" in this section.
12. Pistons and connecting rods. Refer to "Piston and Connecting Rods" in this section.
13. Crankshaft. Refer to "Crankshaft" in this section.
14. Valve lifters. Refer to "Valve Lifters" in this section.

15. Cylinder heads. Refer to "Cylinder Head and Gasket" in this section.
16. Engine. Refer to "Engine Assembly" in this section.

CRANKSHAFT

Figure 48

Remove or Disconnect

1. Engine. Refer to "Engine Assembly" in this section.
2. Flywheel. Refer to "Flywheel" in this section.
3. Oil filter.
4. Oil pan. Refer to "Oil Pan" in this section.
5. Water pump. Refer to COOLING AND RADIATOR (SEC. 6B).
6. Oil pump. Refer to "Oil Pump" in this section.
7. Timing chain. Refer to "Timing Chain" in this section.
8. Rear crankshaft seal retainer and gasket. Refer to "Rear Crankshaft Seal Retainer and Gasket" in this section.
9. Oil level indicator and tube. Refer to "Oil Level Indicator and Tube" in this section.
10. Spark plugs. Refer to IGNITION SYSTEM (SEC. 6D4).
11. Connecting rod cap nuts.
12. Connecting rod caps.
    - Place matchmarks on the connecting rod cap and the connecting rod.

NOTICE: Place a short length of fuel hose over the connecting rod studs to protect the bearing surfaces and threads.

13. Main bearing cap bolts (92).
14. Main bearing cap assembly (93) and caps (96).
15. Crankshaft (85).
16. Main bearings (94 and 95). For main bearing service, refer to "Main Bearings" in this section.

Clean

- Crankshaft (85) in solvent and dry it with compressed air.

Measure

- Main bearing journals and crankpins for out-of-round, taper, or undersize with a micrometer. Refer to "Specifications" in this section.
- Crankshaft runout at the front and rear intermediate journals with a dial indicator. Support the crankshaft front and rear journals on V-blocks. Refer to "Specifications" in this section.
  - Replace or recondition the crankshaft (85) if measurements are outside of the specifications.
- Main bearing clearance. Refer to "Main Bearing Fitting" in this section.

Install or Connect

NOTICE: See "Notice" on page 6A3-1 of this section for steps 4, 7 and 14.

- To determine proper main bearing size for installation, refer to "Main Bearing Fitting" in this section.

1. Main upper and lower bearings (94 and 95) into cylinder block (59) and main bearing cap assembly (93) and caps (96).
    - Coat the inside bearing surfaces (94 and 95) with oil.
2. Crankshaft (85).
3. Main bearing cap assembly (93) and caps (96). with assembled upper and lower bearings (94 and 95) with the arrows pointing toward the front of the engine.
4. Main bearing cap bolts (92).
    - With crankshaft (85), upper and lower bearings (94 and 95) and bearing cap assembly (93) and caps (96) installed and bolts started, thrust crankshaft (85) rearward to set and align bearing cap assembly (93) and caps (96). Then thrust crankshaft (85) forward to align rear faces of rear main upper and lower bearings (94 and 95). This procedure is mandatory except where the rear bearing cap assembly (93) is located with a dowel pin.

Tighten

- Bolts (92) to 105 N·m (77 lb. ft.).

Measure

- Crankshaft end play, using a dial indicator or feeler gage. Refer to "Specifications" in this section.
  - If using a feeler gage, measure between the front of the rear main bearing (94) and the crankshaft thrust surface.

5. Rear crankshaft seal retainer and gasket. Refer to "Rear Crankshaft Seal Retainer and Gasket" in this section.
6. Connecting rod caps onto their original connecting rods.
    - Align matchmarks that were replaced on the rods and caps during removal.
7. Connecting rod cap nuts.

Tighten

- Nuts to 60 N·m (44 lb. ft.).

8. Spark plugs. Refer to IGNITION SYSTEM (SEC. 6D4).
9. Timing chain. Refer to "Timing Chain" in this section.
10. Oil pump. Refer to "Oil Pump" in this section.
11. Oil lever indicator and tube. Refer to "Oil Level Indicator and Tube" in this section.

12. Oil pan. Refer to "Oil Pan" in this section.
13. Water pump. Refer to COOLING AND RADIATOR (SEC. 6B).

NOTICE: Slow take-up for compression of oil filter gasket is necessary to prevent damage to the gasket. Overtightening may rupture the filter can.

14. Oil filter.

Tighten

- Oil filter to 23 N·m (17 lb. ft.).

15. Flywheel. Refer to "Flywheel" in this section.
16. Engine. Refer to "Engine Assembly" in this section.

THREAD REPAIR

Damaged threads may be reconditioned by drilling out, rethreading and installing a suitable thread insert. General purpose thread repair kits are available commercially.

CAUTION: Wear safety glasses to avoid eye damage.

1. Determine size, pitch and depth of damaged thread. If necessary, adjust stop collars on cutting tool and tap to the required depth.

Important

- Refer to the kit manufacturer's instructions regarding the size of drill and tap to be used.

2. Drill out damaged thread. Clean out chips.
3. Tap hole.
   - Lubricate tap with light engine oil.
   - Clean the thread.

Important

- Avoid build-up of chips. Back out the tap every few turns and remove chips.

4. Thread the thread insert onto the mandrel of the installer. Engage the tang of the insert onto the end of the mandrel.
5. Lubricate the insert with light engine oil (except when installing in aluminum) and install.

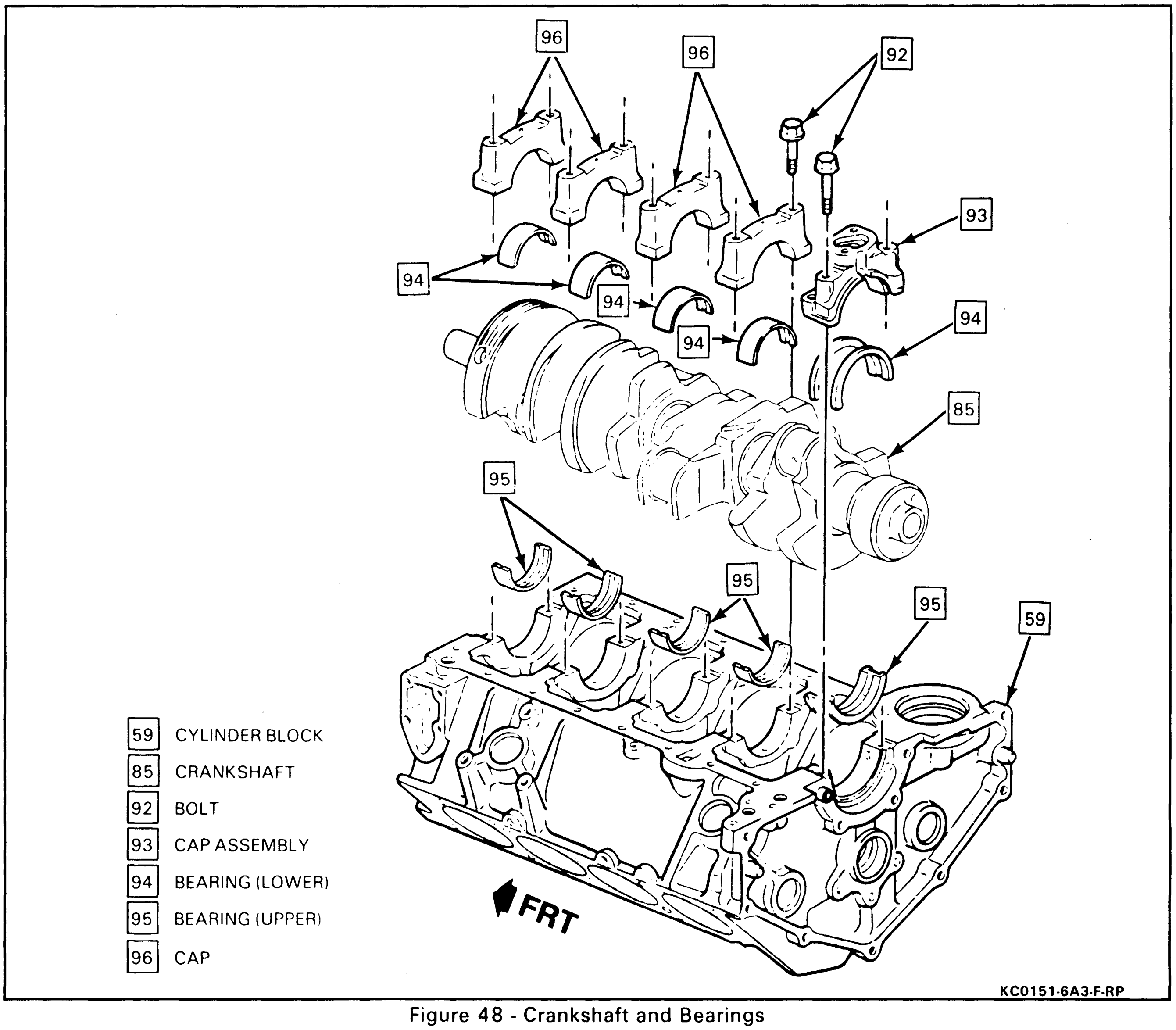


Figure 48 - Crankshaft and Bearings

Important

- When correctly installed, the insert should be flush to one turn below the surface.

6. If the tang of the insert does not break off when backing out the installer, break the tang off with a drift pin.

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Rear Transmission Mount Bolt	54 N·m (40 lb. ft.)
Rear Transmission Mount Nut	47 N·m (35 lb. ft.)
Engine Mount Through Bolt	68 N·m (50 lb. ft.)
Engine Mount Nut	41 N·m (30 lb. ft.)
Engine Bracket Bolt	52 N·m (38 lb. ft.)
Intake Manifold Bolt	47 N·m (35 lb. ft.)
Exhaust Manifold Bolt and Stud (Center)	27 N·m (20 lb. ft.)
Exhaust Manifold Bolt and Stud (Outer)	35 N·m (26 lb. ft.)
Engine Front Cover Bolt	11 N·m (100 lb. in.)
Camshaft Sprocket-to-Camshaft Bolt	28 N·m (21 lb. ft.)
Cylinder Head Bolt	92 N·m (68 lb. ft.)
Oil Pan-to-Cylinder Block Bolt	11 N·m (101 lb. in.)
Oil Pan-to-Cylinder Block Nut	23 N·m (17 lb. ft.)
Oil Pump-to-Rear Main Bearing Cap Bolt	88 N·m (65 lb. ft.)
Oil Pump Cover Screw	9 N·m (80 lb. in.)
Torsional Dampers-to-Crankshaft Bolt	95 N·m (70 lb. ft.)
Crankshaft Pulley-to-Torsional Damper Bolt	58 N·m (43 lb. ft.)
Connecting Rod Cap Nut	60 N·m (44 lb. ft.)
Main Bearing Cap Bolt	105 N·m (77 lb. ft.)
Flywheel-to-Crankshaft Bolt	100 N·m (74 lb. ft.)
Camshaft Retainer Bolt	12 N·m (106 lb. in.)
Rear Crankshaft Seal Retainer Nut and Bolt	15 N·m (11 lb. ft.)
Oil Gallery Plug	13 N·m (115 lb. in.).
Upper Fuel Pump Cover Bolt	34 N·m (25 lb. ft.)
Lower Fuel Pump Cover Bolt	12 N·m (106 lb. in.)
Oil Filter Adapter Bolt	25 N·m (18 lb. ft.)
Coolant Drain Plug	21 N·m (15 lb. ft.)
Valve Cover Bolt	11 N·m (95 lb. in.)
Valve Lifter Retainer Bolt	20 N·m (15 lb. ft.)
Oil Level Indicator Tube Bracket Bolt	34 N·m (25 lb. ft.)
Engine Oil Cooler Retainer	23 N·m (17 lb. ft.)
Oil Pan Drain Plug	22 N·m (16 lb. ft.)

ENGINE SPECIFICATIONS - 5.0L (L03)

Type	V8
Displacement	5.0L (305 CID)
Bore	94.99 mm (3.740″)
Stroke	88.39 mm (3.480″)
Compression Ratio	9.3:1
Firing Order	1-8-4-3-6-5-7-2
Cylinder Bore Diameter	94.869-94.958 mm (3.7350″-3.7385″)
Camshaft Lobe Lift ± 0.050 mm (0.002″)	
Intake	5.94 mm (0.234″)
Exhaust	6.53 mm (0.257″)
Valve Lift	
Intake	8.89 mm (0.350″)
Exhaust	9.78 mm (0.385″)
Spark Plugs	
Type	R45TS, or equivalent
Gap	0.89 mm (0.035″)
Torque	30 N·m (22 lb. ft.)

ENGINE SPECIFICATIONS - 5.0L (LB9)

Type	V8
Displacement	5.0L (305 CID)
Bore	94.99 mm (3.740")
Stroke	88.39 mm (3.480")
Compression Ratio	9.3:1
Firing Order	1-8-4-3-6-5-7-2
Cylinder Bore Diameter	94.869-94.958 mm (3.7350-3.7385")
Camshaft Lobe Lift ± 0.050 mm (0.002")	
Intake	6.99 mm (0.275")
Exhaust	7.24 mm (0.285")
Valve Lift	
Intake	10.49 mm (0.413")
Exhaust	10.87 mm (0.428")
Spark Plugs	
Type	R45TS, or equivalent
Gap	0.89 mm (0.035")
Torque	30 N·m (22 lb. ft.)

ENGINE SPECIFICATIONS - 5.7L (L98)

Type	V8
Displacement	5.7L (350 CID)
Bore	101.60 mm (4.000")
Stroke	88.39 mm (3.480")
Compression Ratio	9.75:1
Firing Order	1-8-4-3-6-5-7-2
Camshaft Lobe Lift ± 0.050 mm (0.002")	
Intake	6.99 mm (0.275")
Exhaust	7.24 mm (0.285")
Valve Lift	
Intake	10.49 mm (0.413")
Exhaust	10.87 mm (0.428")
Spark Plugs	
Type	R45TS, or equivalent
Gap	0.89 mm (0.035")
Torque	30 N·m (22 lb. ft.)

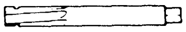
GENERAL ENGINE SPECIFICATIONS

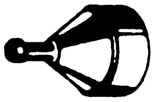
Oil Pressure (Minimum)	41.4 kPa (6.0 psig) at 1,000 engine rpm 124.1 kPa (18.0 psig) at 2,000 engine rpm 165.5 kPa (24.0 psig) at 4,000 engine rpm
Oil Filter Torque	23 N·m (17 lb. ft.)
Cylinder Bore	
Out-of-Round	
Production	0.02 mm (0.001") MAX.
Service Limit	0.05 mm (0.002") MAX.
Taper	
Production	
Thrust Side	0.012 mm (0.0005") MAX.
Relief Side	0.025 mm (0.0010") MAX.
Service Limit	0.025 mm (0.0010") MAX.
Piston Clearance	
Production	0.018-0.053 mm (0.0007-0.0021")
Service Limit	0.068 mm (0.0027") MAX.

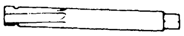
Piston Compression Ring	
Groove Clearance	
Production Top	0.030-0.081 mm (0.0012"-0.0032")
Production 2nd	0.030-0.081 mm (0.0012"-0.0032")
Service Limit	0.107 mm (0.0042") MAX.
Gap	
Production Top	0.25-0.50 mm (0.010"-0.020")
Production 2nd (5.0L)	0.25-0.63 mm (0.010"-0.025") MAX.
Production 2nd (5.7L)	0.46-0.66 mm (0.018"-0.026") MAX.
Service Limit	0.88 mm (0.035") MAX.
Piston Oil Ring	
Groove Clearance	
Production	0.051 mm-0.17 mm (0.002"-0.007")
Service Limit	0.20 mm (0.008") MAX.
Gap	
Production	0.25-0.76 mm (0.010"-0.030")
Service Limit	1.65 mm (0.065") MAX.
Piston Pin	
Diameter	23.546-23.548 mm (0.9270"-0.9271")
Clearance in Piston	
Production (5.0L)	0.0051-0.0152 mm (0.0002"-0.0006")
Production (5.7L)	0.0127-0.0203 mm (0.0005"-0.0008")
Service Limit	0.025 mm (0.001") MAX.
Fit In Rod	0.021-0.040 mm (0.0008"-0.0016") Interference
Crankshaft	
Main Journal	
Diameter #1	62.189-62.212 mm (2.4484"-2.4493")
Diameter #2, #3, #4	62.182-62.205 mm (2.4481"-2.4490")
Diameter #5	62.177-62.120 mm (2.4479"-2.4488")
Taper	
Production	0.005 mm (0.0002") MAX.
Service Limit	0.025 mm (0.0010") MAX.
Out-of-Round	
Production	0.005 mm (0.0002") MAX.
Service Limit	0.025 mm (0.0010") MAX.
Main Bearing Clearance	
Production #1	0.020-0.051 mm (0.0008"-0.0020")
Production #2, #3, #4	0.028-0.051 mm (0.0011"-0.0020")
Production #5	0.043-0.081 mm (0.0017"-0.0032")
Service Limit #1	0.025-0.038 mm (0.0010"-0.0015")
Service Limit #2, #3, #4	0.025-0.064 mm (0.0010"-0.0025")
Service Limit #5	0.064-0.089 mm (0.0025"-0.0035")
Crankshaft End Play	0.03-0.17 mm (0.001"-0.007")
Crankpin	
Diameter	53.068-53.334 mm (2.0893"-2.0998")
Taper	
Production	0.013 mm (0.0005") MAX.
Service Limit	0.025 mm (0.0010") MAX.
Out-of-Round	
Production	0.013 mm (0.0005") MAX.
Service Limit	0.025 mm (0.0010") MAX.
Rod Bearing Clearance	
Production	0.033-0.088 mm (0.0013"-0.0035")
Service Limit	0.076 mm (0.0030") MAX.
Rod Side Clearance	0.16-0.35 mm (0.006"-0.014")
Journal Out-of-Round	0.025 mm (0.001")
Camshaft Journal Diameter	47.452-47.477 mm (1.8682"-1.8692")
Camshaft End Play	0.11-0.30 mm (0.004"-0.012")
Valve System	
Lifter	Hydraulic
Rocker Arm Ratio	1.50:1
Valve Lash	1 ± 1/4 turn down from zero lash
Face Angle	45°
Seat Angle	46°
Seat Runout	0.05 mm (0.002") MAX.
Seat Width	
Intake	0.79-1.58 r

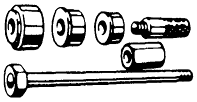
Exhaust	1.59-2.38 mm (1/16"-3/32")
Stem Clearance	
Production	
Intake	0.027-0.069 mm (0.0011"-0.0027")
Exhaust	0.027-0.069 mm (0.0011"-0.0027")
Service	
Intake	0.093 mm (0.0037") MAX.
Exhaust	0.119 mm (0.0047") MAX.
Valve Spring	
Free Length	51.5 mm (2.03")
Pressure	
Closed	338-373 N at 43 mm (76-84 lb. at 1.7")
Open	863-916 N at 32 mm (194-206 lb. at 1.25")
Installed Height	
Intake	43.7 mm (1-23/32")
Exhaust	40.5 mm (1-19/32")
Damper	
Free Length	47.2 mm (1.86")
Approximate number of coils	4

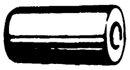
SPECIAL TOOLS

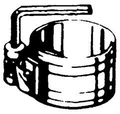


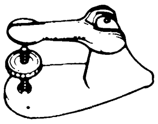


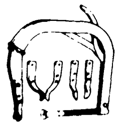












1 CRANKSHAFT GEAR INSTALLER
2 3/8" ROCKER ARM STUD REAMER (0.003" OVERSIZE)
3 CRANKSHAFT GEAR REMOVER
4 VALVE SPRING COMPRESSOR (HEAD-ON)
5 3/8" ROCKER ARM STUD HOLE REAMER (0.013" OVERSIZE)

6 CAMSHAFT BEARING REMOVER AND INSTALLER
7 ROCKER ARM STUD INSTALLER
8 PISTON RING COMPRESSOR
9 VALVE SPRING TESTER
10 VALVE SPRING COMPRESSOR (HEAD-OFF)

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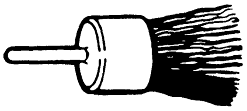

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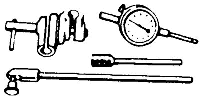

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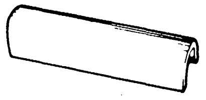

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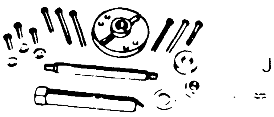

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15 J 23590

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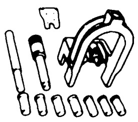

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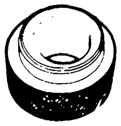

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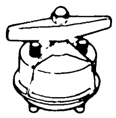

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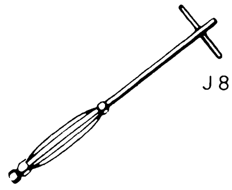

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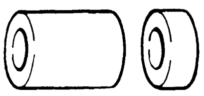

21 J 5802-01

11	CARBON REMOVING BRUSH (CAST IRON HEADS)
12	CAM LOBE LIFT INDICATOR
13	OIL SUCTION PIPE INSTALLER
14	HARMONIC BALANCER REMOVER AND INSTALLER
15	SPARK PLUG PORT ADAPTOR (14 mm TAPERED SEAT)
16	VALVE STEM SEAL TESTER (MITY-VAC)
17	PISTON PIN REMOVER AND INSTALLER SET
18	FRONT COVER ALIGNER AND OIL SEAL INSTALLER
19	REAR MAIN SEAL INSTALLER
20	VALVE GUIDE CLEANER
21	ROCKER ARM STUD REMOVER

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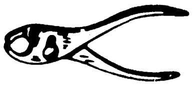
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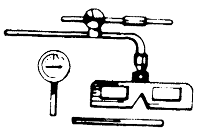
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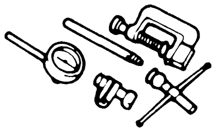
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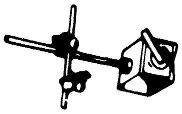
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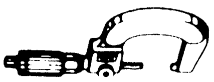
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22 HYDRAULIC VALVE
LIFTER REMOVER (PLIER TYPE)

23 VALVE GUIDE REAMER SET

24 MAGNETIC BASE INDICATOR
SET

25 DIAL INDICATOR SET

26 MAGNETIC BASE
(FOR 1/4" AND 3/8" INDICATOR STEMS)

27 MAIN BEARING SHELL
REMOVER & INSTALLER

28 DIGITAL OUTSIDE MICROMETER

29 HYDRAULIC VALVE
LIFTER REMOVER
(SLIDE HAMMER TYPE)

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SECTION 6B

COOLING AND RADIATOR

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 6B-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

The cooling system, which consists of a radiator and coolant recovery sub-system, cooling fan, thermostat and housing, and coolant pump and drive belt works to maintain engine temperature at an efficient level during all engine operating conditions.

Coolant is drawn from the radiator by the coolant pump and circulated through coolant jackets in the engine cylinder block, intake manifold, and cylinder heads. It is then directed back to the radiator.

The system directs some coolant through hoses to the heater core to provide defrost and passenger compartment heat. A coolant recovery reservoir is connected to the radiator to recover coolant displaced by expansion. As the engine cools, the coolant is drawn back into the radiator by vacuum.

RADIATOR

Core and Tanks

A cross-flow radiator core is used on all models. Tanks are located to the right and left of the core.

Radiators used with automatic transmissions have oil coolers with inlet and outlet fittings for transmission fluid circulation. Vehicles with manual transmissions use radiators without oil coolers. Vehicles equipped with air conditioning use a radiator with extra cooling capability.

An aluminum-plastic radiator can be identified by a note on the outlet tank 127 mm (5 inches) below the filler neck which reads, "Important - for repair see Harrison Service Manual." Service procedures for the aluminum-plastic radiator are described in that manual and in this section.

Radiator Cap

Figure 1

A pressure-type radiator cap is used with the cross-flow radiator to allow a buildup of 103 kPa (15 psi) in the cooling system. This pressure raises the boiling point of coolant to approximately 125°C (257°F) at sea level.

CAUTION: Do not remove radiator cap to check engine coolant level; check coolant visually at the see-through coolant reservoir. Add coolant to the reservoir only when the system cools. As long as there is pressure in the cooling system, the temperature can be considerably higher than the boiling temperature of the solution. Removal of the radiator cap while engine is hot and pressure is high will cause the solution to boil instantaneously and possibly with explosive force, spewing the solution over engine, fenders and person removing cap. If the solution contains flammable antifreeze, such as alcohol (not recommended for use at any time), there is also the possibility of causing a serious fire.

The pressure-type radiator cap contains a blow-off (pressure) valve and a vacuum (atmospheric) valve. The pressure valve is held against its seat by a heavy spring. This spring protects the radiator by relieving pressure exceeding 103 kPa (15 psi).

To prevent radiator collapse caused by vacuum as the engine cools, the vacuum valve prevents excessive pressure differences between the cooling system and the atmosphere.

The radiator cap has been designed without finger grips to discourage inadvertent removal. To safely remove the radiator cap, rotate the cap slowly counterclockwise (do not press down) to detent. Allow any pressure to relieve. Next, press down on the cap and continue to rotate cap counterclockwise and lift off the cap.

Under the diaphragm spring at the top of the radiator cap is a rubber-asbestos gasket. Embossed on the cap is a caution against opening it and arrows indicating the proper closed position.

Transmission Oil Cooler

A transmission oil cooler is located in the right tank of the radiator on models equipped with an automatic transmission.

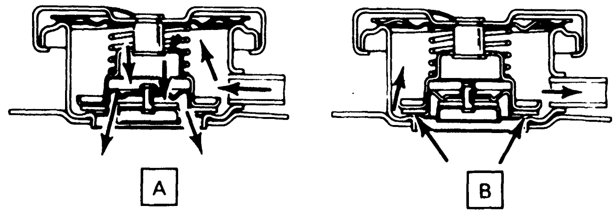


Figure 1 - Closed System Pressure-Type Radiator Cap

Drain Cock

The radiator drain cock is located on the inner right side of the radiator, near the bottom. The drain cock assembly includes the drain cock and the drain cock sealer.

ENGINE OIL COOLER

The LB9 and L98 V8 engines are equipped with an oil cooler. The oil cooler is attached to the engine block and has coolant hoses running to it. The oil filter attaches to the bottom of the oil cooler.

COOLING FAN

An electric cooling fan aids air flow through the radiator. There are five plastic blades on each fan. The fan is driven by a motor attached to the radiator support. LB9 and L98 engines equipped with air conditioning have two cooling fans attached to radiator support.

The fan motor is activated by a coolant temperature switch. If the vehicle is equipped with air conditioning, a second switch can activate the fan motor when the compressor is operating.

CAUTION: If a fan blade is bent or damaged in any way, no attempt should be made to repair and reuse the damaged part. A bent or damaged fan assembly should always be replaced with a new fan assembly. It is essential that fan assemblies remain in proper balance and proper balance cannot be assured once a fan assembly has been bent or damaged. A fan assembly that is not in proper balance could fail and fly apart during subsequent use, creating an extremely dangerous condition.

TEMPERATURE LAMP SWITCH

This switch activates a warning lamp in the instrument cluster if the engine overheats. With optional instrumentation, a temperature gage replaces the warning lamp and the temperature switch is replaced with a transducer. Refer to ELECTRICAL DIAGNOSIS (SEC. 8A) for temperature switch diagnosis and location.

COOLANT TEMPERATURE FAN SWITCH

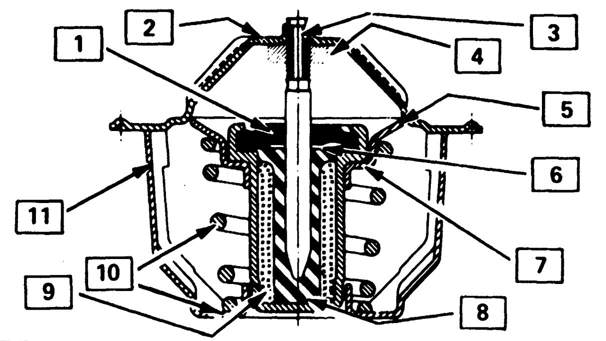
This switch regulates voltage to the coolant fan relay, which operates the fan when the engine coolant temperature exceeds 110°C (230°F). Refer to ELECTRICAL DIAGNOSIS (SEC. 8A) for fan switch diagnosis and location.

THERMOSTAT

Figure 2

A pellet-type thermostat is used in the coolant outlet passage to control the flow of engine coolant to provide fast engine warm-up and to regulate engine temperatures. A wax pellet element in the thermostat expands when heated and contracts when cooled. The pellet element is connected through a piston to a valve. The valve remains closed while the coolant is cold, preventing circulation of coolant through the radiator and allowing the circulation of coolant only through the engine.

As the engine warms, the pellet element expands and the thermostat valve opens, permitting coolant to flow through the radiator.



1—FLANGE SEAL
2—FLANGE
3—PISTON
4—NUT
5—VALVE SEAT
6—TEFLON SEAL
7—VALVE
8—RUBBER DIAPHRAGM
9—WAX PELLET
10—COIL SPRING
11—FRAME

G20007-6B

Figure 2 - Pellet Type Thermostat

COOLANT RECOVERY SYSTEM

A "see-through" plastic reservoir is connected to the radiator by a hose. As the vehicle is driven, the coolant is heated and expands. The portion of the fluid displaced by this expansion flows from the radiator into the recovery bottle. When the engine is stopped and the coolant cools and contracts, the displaced coolant is drawn back into the radiator by vacuum. Thus, the radiator is kept filled with coolant to the desired level at all times, resulting in increased cooling efficiency. Coolant level should be at or above the appropriate mark on recovery bottle when system is cold.

MAINTENANCE RECOMMENDATIONS

COOLING SYSTEM CARE

CAUTION: Do not remove radiator cap to check engine coolant level; check coolant visually at the see-through coolant reservoir. Add coolant to the reservoir only when the system cools. As long as there is pressure in the cooling system, the temperature can be considerably higher than the boiling temperature of the solution. Removal of the radiator cap while engine is hot and pressure is high will cause the solution to boil instantaneously and possibly with explosive force, spewing the solution over the engine, fenders and person removing cap. If the solution contains flammable antifreeze, such as alcohol (not recommended for use at any time), there is also the possibility of causing a serious fire.

Check the coolant level visually in the "see-through" coolant recovery tank every time the hood is up. The level should be near appropriate mark when the system is cold. At normal operating temperature the coolant level should increase. Coolant should be added only to the reservoir to raise level to the appropriate mark. Use a 50/50 mixture of high-quality ethylene glycol antifreeze and water when adding coolant.

NOTICE: If recommended quality antifreeze is used, supplemental inhibitors or additives claiming to provide increased cooling capability are not necessary. These may be detrimental to the efficient operation of the system and represent an unnecessary operating expense.

Every 12 months or 24 000 km (15,000 miles), the cooling system should be serviced as follows:

1. Wash the radiator cap with clean water.
2. Check the coolant for proper level and freeze protection. Refer to "Coolant Testing" in this section.
3. Pressure test the system and radiator cap for the proper pressure holding capacity of 103 kPa (15 psi). If a replacement cap is required, use the proper cap specified for the vehicle model.
4. Inspect all hoses. Replace cracked, swollen, or deteriorated hoses.
5. Clean the front of the radiator and air conditioning condenser with compressed air.

Every two years or 48 000 km (30,000 miles), whichever comes first, the cooling system should be drained and refilled. Refer to "Draining and Refilling the Cooling System" in this section.

COOLANT TESTING

Tool Required:

J 26568 or J23688 Coolant Tester

Coolant testers J 26568 (Centigrade Scale) or J 23688 (Fahrenheit Scale) can be used to check the antifreeze protection of the coolant. Make sure the refractometer markings are correct. Unless J 26568 or J 23688 has a provision for temperature correction, test the temperature at which J 26568 or J 23688 is calibrated. If the coolant is warmer or cooler the reading may be incorrect. Follow the manufacturers directions when using J 26568 or J 23688.

Clean

- Before each use, swing open the plastic cover at the slanted end of J 26568 or J 23688, exposing the measuring window and the bottom of the plastic cover.
- Wipe dry with a tissue or a clean soft cloth.
- Close the plastic cover.

Measure

- Coolant strength.
  - Do not remove the clear plastic pump from J 26568 or J 23688.
  - Release the tip of the pump from J 26568 or J 23688 housing.
  - Insert the tip on the pump into the radiator filler neck.
    - Make sure the tip of the pump is below the level of the coolant.
  - Press and release the bulb to get a sample.
  - Insert the tip of the pump into the cover plate opening.
  - Press the bulb and allow a few drops to fall onto the measuring surface.
    - Do not open the plastic cover when taking readings because water evaporation can change the readings.
- Point J 26568 or J 23688 toward any light and look into the eyepiece.
  - Coolant protection reading is at the point where the dividing line between light and dark crosses the scale (antifreeze protection is the scale on the right).
  - Temperature scale is reversed from a standard thermometer scale.
  - Below zero readings are on the upper half of the scale.
  - Readings on the lower half of the scale indicate solutions without enough antifreeze concentration to provide adequate rust protection.
  - If the readings are not clear, the measuring surfaces were not cleaned and dried properly. Wipe dry and do a new test.

DIAGNOSIS

COOLING SYSTEM OVERHEATS

Figure 3

- If overheating occurs while in slow city traffic, prolonged idling in gear, etc., instruct the operator on driving techniques which would reduce the possibility of the engine overheating, such as:
  - Idle in "NEUTRAL" as much as possible and raise the engine rpm using the accelerator pedal.
  - Turn the air conditioning "OFF" during extended idling.
- If the above does not apply, refer to the diagnosis chart.

CONDITION	POSSIBLE CAUSE	CORRECTION
Engine overheats.	Loss of coolant.	Refer to the next condition - "Loss of Coolant."
	Loss of system pressure.	Perform the radiator cap pressure test.
	Weak coolant solution.	Test the coolant for proper 50 - 50 mixture.
	Retarded timing.	Refer to DRIVEABILITY AND EMISSIONS - GENERAL INFORMATION (SEC. 6E).
	Obstructed radiator fins.	Remove or relocate added-on parts that block air to the radiator. Clean away bugs, leaves, etc., with compressed air.

CONDITION	POSSIBLE CAUSE	CORRECTION
	Cooling system passages blocked by rust or scale.	Flush the cooling system or flow check the radiator. Remove the cylinder heads and inspect, if required.
	Kinked coolant recovery reservoir hose.	Re-route the coolant recovery reservoir hose.
	Inoperative cooling fan.	Refer to ELECTRICAL DIAGNOSIS (SEC. 8A).
	Loose, damaged, and/or missing radiator baffles or deflectors.	Repair or replace as required.
	Thermostat stuck in the closed position.	Replace the thermostat. Refer to "Thermostat" in this section.
	Faulty coolant pump.	Replace the coolant pump. Refer to "Coolant Pump" in this section.
	Incorrect radiator.	Determine the proper radiator for the vehicle and replace the radiator if necessary.
	Incorrect or damaged fan.	Check for the correct part number. Replace the fan if required.
	Faulty emission system components. These may cause overheating at idle: – Positive Crankcase Ventilation (PCV) valve. – Thermal Vacuum Switch (TVS).	Refer to DRIVEABILITY AND EMISSIONS - GENERAL INFORMATION (SEC. 6E).
	Engine oil overfill.	Check the engine oil level.
Loss of coolant.	Leaking radiator.	Inspect the radiator. Repair or replace as necessary.
	Radiator cap faulty.	Perform the radiator cap pressure test.
	Distorted radiator filler neck.	If the neck upper sealing area is distorted, use a wood block and mallet to reform the neck to fit the radiator cap. Pressure test the cooling system. Refer to "On-Vehicle Pressure Testing" in this section.

CONDITION	POSSIBLE CAUSE	CORRECTION
	Leaking coolant recovery reservoir or hose.	Replace the reservoir or hose.
	Loose or damaged radiator or heater hoses or connections.	Reseat the hoses. Replace the hoses or clamps.
	Coolant pump seal leaking.	Replace the coolant pump.
	Coolant pump gasket leaking.	Replace the gasket.
	Improper cylinder head torque.	Re-tighten the cylinder head bolts to specifications. Refer to V8 ENGINES (SEC. 6A3). Replace the cylinder head gasket if required.
	Leaking – intake manifold. – cylinder head gasket. – cylinder block plug. – heater core. – heater water valve, if equipped.	Make repairs or replace components as necessary to correct the leak.
Engine fails to reach normal operating temperature. (Cool air from the heater.)	Thermostat stuck open or wrong type of thermostat.	Install a new thermostat of the correct type and heat range.
	Coolant is below the "ADD" mark.	Add coolant.
Engine hot light is "ON" or a high temperature gage reading (no loss of coolant).	Faulty engine temperature switch or circuit.	Refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

THERMOSTAT TEST

Figure 3

Inspect

Tools Required:

J 24731-188 Tempil Stick
J 24731-206 Tempil Stick

- Thermostat opening temperature. Refer to Figure 3.

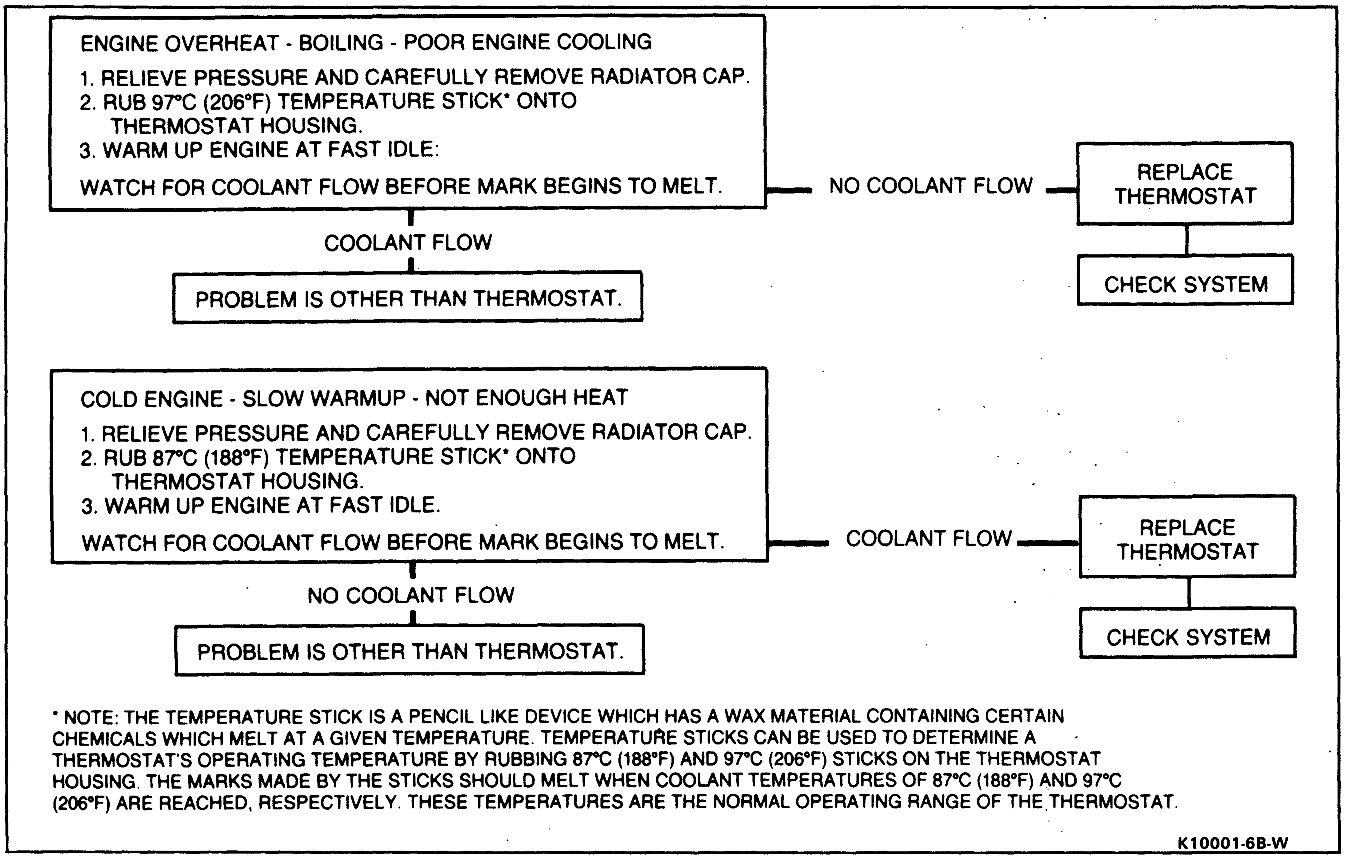
RADIATOR CAP

Inspect

- Hose connections for leaks.
- Radiator cap for a weak spring washer or damage to the gasket. If the spring washer is weak, replace the radiator cap.
- For damage or debris on the relief valve gasket in the cap and the inner sealing surface of the filler neck.
- Coolant recovery hose fitting on the radiator filler neck for cracks. If the fitting is loose or cracked, replace the radiator end tank.

PRESSURE TEST

To pressure test the cooling system, refer to "On-Vehicle Pressure Testing" in this section.



* NOTE: THE TEMPERATURE STICK IS A PENCIL LIKE DEVICE WHICH HAS A WAX MATERIAL CONTAINING CERTAIN CHEMICALS WHICH MELT AT A GIVEN TEMPERATURE. TEMPERATURE STICKS CAN BE USED TO DETERMINE A THERMOSTAT'S OPERATING TEMPERATURE BY RUBBING 87°C (188°F) AND 97°C (206°F) STICKS ON THE THERMOSTAT HOUSING. THE MARKS MADE BY THE STICKS SHOULD MELT WHEN COOLANT TEMPERATURES OF 87°C (188°F) AND 97°C (206°F) ARE REACHED, RESPECTIVELY. THESE TEMPERATURES ARE THE NORMAL OPERATING RANGE OF THE THERMOSTAT.

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Figure 3 - Thermostat Diagnosis

ON-VEHICLE SERVICE

THERMOSTAT

Figures 4 and 5

Remove or Disconnect

1. Negative battery cable.
- Drain the radiator to below the level of the thermostat.
2. Air cleaner if required.
3. Intake duct.
4. Throttle body. Refer to DRIVEABILITY AND EMISSIONS -FUEL INJECTION (TBI) (SEC. 6E2) or DRIVEABILITY AND EMISSIONS -FUEL INJECTION (PORT) (SEC. 6E3).
5. Plenum (LH0). Refer to DRIVEABILITY AND EMISSIONS -FUEL INJECTION (TBI) (SEC. 6E2).
6. Fuel pipes and brackets (LH0). Refer to ENGINE FUEL (SEC. 6C).
7. Radiator inlet hose and clamp.
8. Thermostat housing bolts.
9. Thermostat housing.
10. Thermostat.
11. Gasket, if not attached to thermostat.

Clean

- Gasket surfaces on the intake manifold and thermostat housing.

Install or Connect

NOTICE: See "Notice" on page 6B-1 of this section.

1. New gasket, if not attached to thermostat.
2. Thermostat.
3. Thermostat housing.
4. Thermostat housing bolts.

Tighten

- Bolts (LB9 and L98) to 34 N·m (25 lb. ft.).
- Bolts (L03) to 28 N·m (21 lb. ft.).
- Bolts (LH0) to 21 N·m (15 lb. ft.).

5. Radiator inlet hose and clamp.
6. Fuel pipes and brackets (LH0). Refer to ENGINE FUEL (SEC. 6C).
7. Plenum (LH0). Refer to DRIVEABILITY AND EMISSIONS -FUEL INJECTION (TBI) (SEC. 6E2).
8. Throttle body. Refer to DRIVEABILITY AND EMISSIONS -FUEL INJECTION (TBI) (SEC. 6E2) or DRIVEABILITY AND EMISSIONS - FUEL INJECTION (PORT) (SEC. 6E3).
9. Intake duct.
10. Air cleaner. if required.
11. Negative battery cable.
- Refill the radiator. Refer to "Draining and Refilling the Coolin

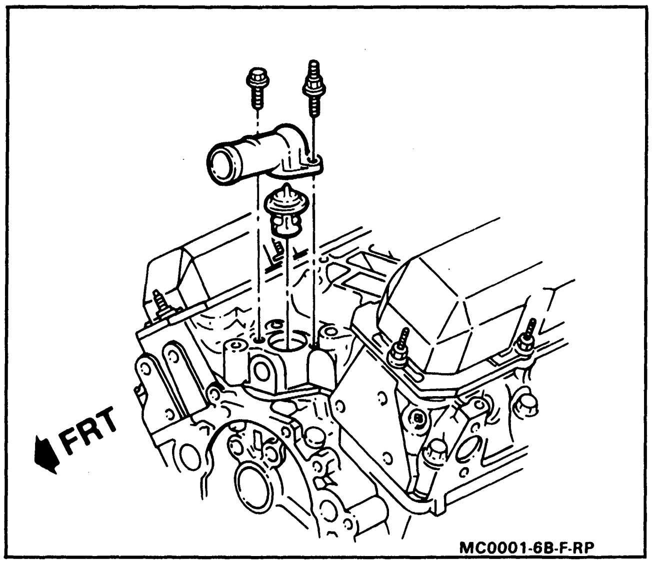


Figure 4 - Thermostat (LHO)

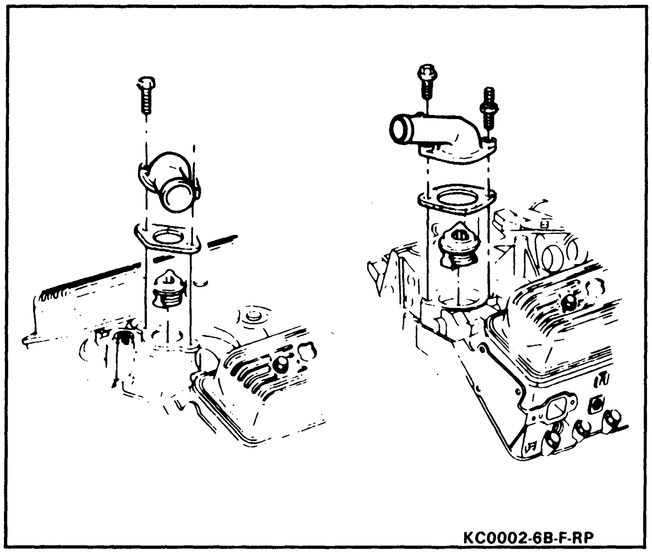


Figure 5 - Thermostat (LB9, L98, and L03)

COOLING FAN

Figures 6 and 7

CAUTION: Keep hands, tools, and clothing away from engine cooling fan to help prevent personal injury. This fan is electric and can come on whether or not the engine is running. The fan can start automatically in response to a heat sensor with the ignition in the "ON" position.

←→ Remove or Disconnect

1. Negative battery cable.
2. Air cleaner top, if equipped.
3. Wire harness.
4. Cooling fan-to-radiator support bolts.
5. Bracket.
6. Cooling fan assembly.

→← Install or Connect

1. Cooling fan assembly.

   NOTICE: See "Notice" on page 6B-1 of this section.

2. Bracket.
3. Cooling fan-to-radiator support bolts.

   Tighten

   - Bolts to 27 N·m (20 lb. ft.).

4. Wire harness.
5. Air cleaner top, if equipped.
6. Negative battery cable.

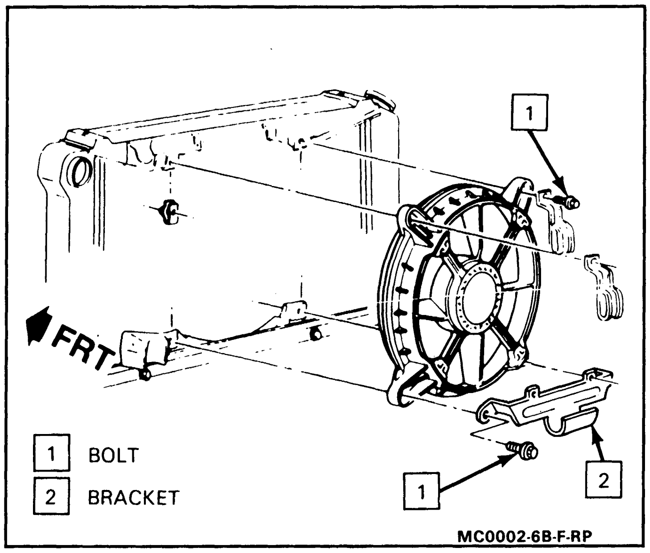


Figure 6 - Cooling Fan (LHO and L03, LB9 and L98 without A/C)

AIR BAFFLES

Lower Radiator Baffle

Figure 8

←→ Remove or Disconnect

1. Negative battery cable.
- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).
2. Screws from the impact bar.
3. Lower radiator baffle.

→← Install or Connect

1. Lower radiator baffle.

   NOTICE: See "Notice" on page 6B-1 of this section.

2. Screws to the impact bar.

   Tighten

   - Screws to 5 N·m (44 lb. in.).

- Lower the vehicle.
3. Negative batte

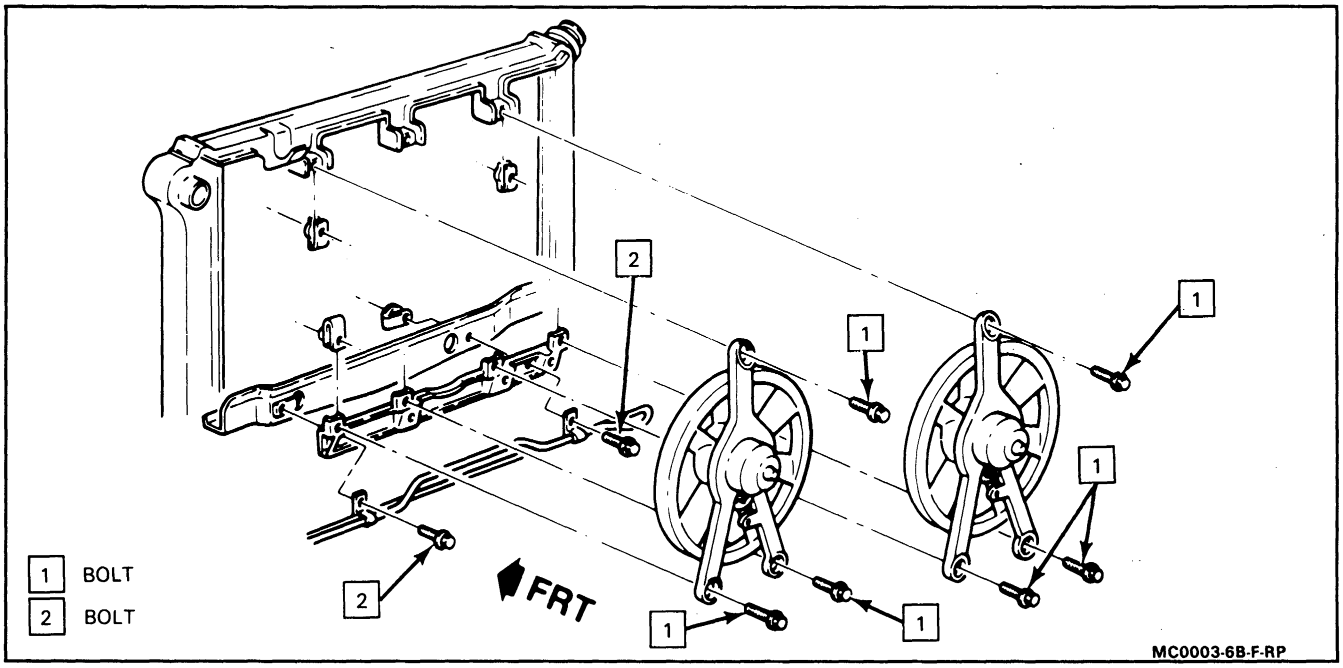


Figure 7 - Cooling Fans (LB9 and L98 with A/C)

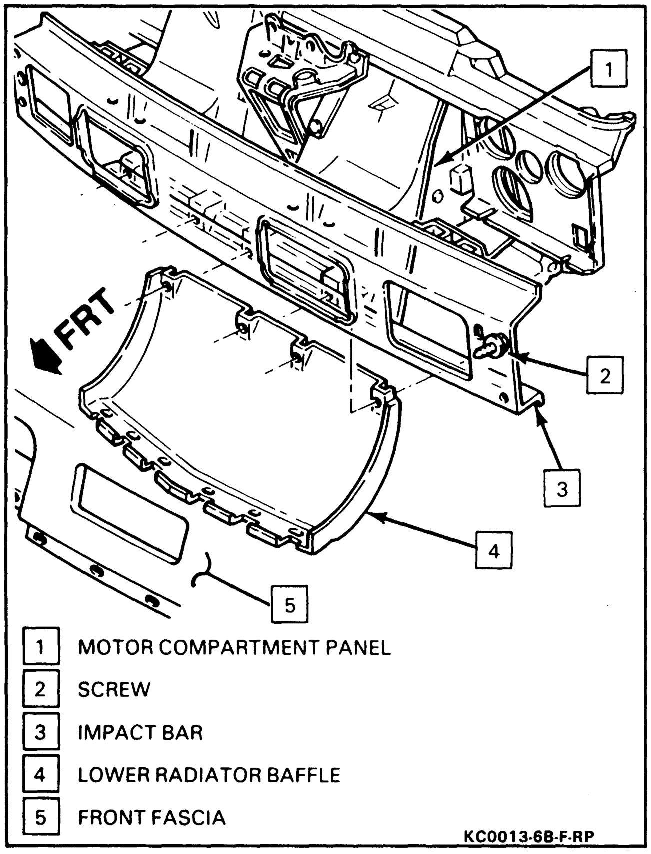


Figure 8 - Lower Radiator Baffle (LB9, L03, and L98 with A/C - LB9 M/T without A/C)

Upper Radiator Baffle

Figure 9

Remove or Disconnect

1. Negative battery cable.
- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).
2. Screws from the impact bar.
3. Retainers from the center baffle.
4. Retainers from the motor compartment panel.
5. Upper radiator baffle.

Install or Connect

1. Upper radiator baffle.
2. Retainers to the motor compartment panel.
3. Retainers to the center baffle.

NOTICE: See "Notice" on page 6B-1 of this section.

4. Screws to the impact bar.

Tighten

- Screws to 5 N·m (44 lb. in.).

- Lower the vehicle.
5. Negative battery cable.

Side Radiator Baffles

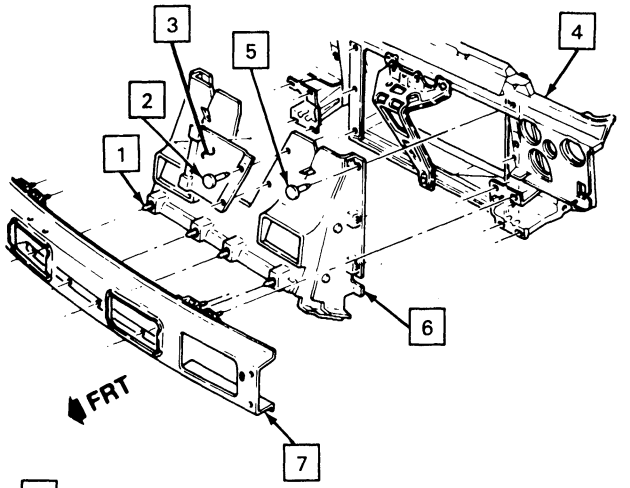
Figures 10, 11, and 12

Remove or Disconnect

1. Negative battery cable.
- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).
2. Retainers from the motor compartment panel.
3. Side radiator baffle.

Install or Connect

1. Side radiator baffle.
2. Retainers to the motor compartment panel.
- Lower the vehicle.



1 SCREW
2 RETAINER
3 CENTER BAFFLE
4 MOTOR COMPARTMENT PANEL
5 RETAINER
6 UPPER RADIATOR BAFFLE
7 IMPACT BAR

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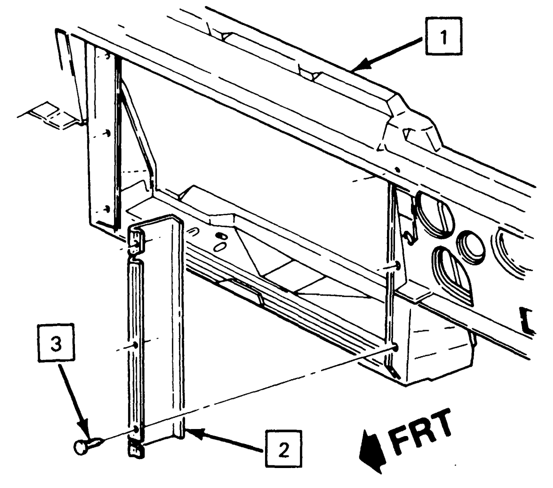
Figure 9 - Upper Radiator Baffle (LB9, LO3, and L98 with A/C - LB9 M/T without A/C)



1 MOTOR COMPARTMENT PANEL
2 SIDE RADIATOR BAFFLE
3 RETAINER

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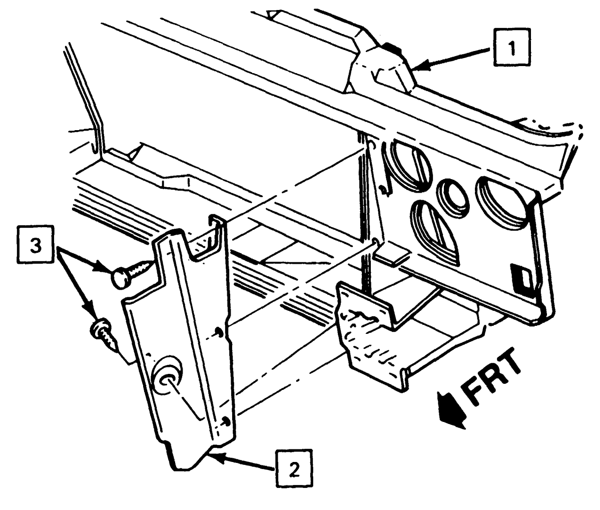
Figure 10 - Side Radiator Baffle (LO3 without A/C, LHO Similar)

3. Negative battery cables.



1 MOTOR COMPARTMENT PANEL
2 SIDE RADIATOR BAFFLE
3 RETAINER

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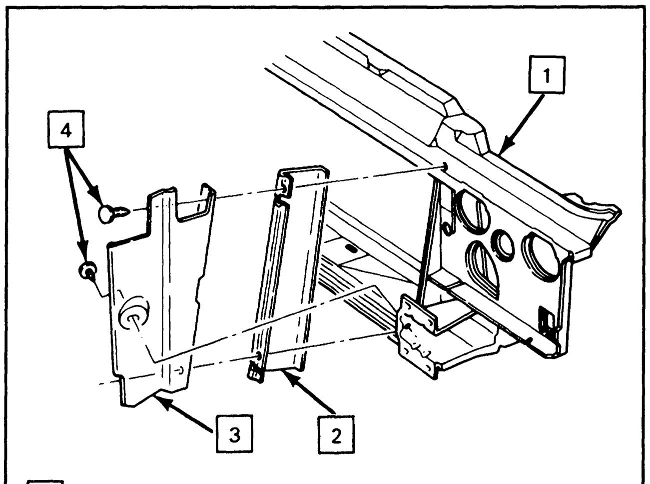
Figure 11 - Side Radiator Baffle (LHO, LO3 with A/C)



1 MOTOR COMPARTMENT PANEL
2 SIDE RADIATOR BAFFLE
3 SIDE RADIATOR BAFFLE
4 RETAINER

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Figure 12 - Side Radiator Baffles (L98 M/T without A/C - LB9 with A/T)

COOLANT PUMP

Coolant Pump (LHO)

Figure 13

↔ Remove or Disconnect

1. Negative battery cable.
- Drain the radiator.
2. Intake duct.
3. Drive belt. Refer to "Drive Belt" in this section.
4. Heater hose and clamp from the coolant pump.
5. Radiator inlet hose and clamp from the thermostat.

6. Power steering pump bracket. Refer to POWER STEERING GEAR AND PUMP (SEC. 3B1).
7. Coolant pump bolts.
8. Coolant pump.
9. Gasket.

Clean

- Gasket surface on the coolant pump sealing areas.

Install or Connect

NOTICE: See "Notice" on page 6B-1 of this section.

1. New gasket.
2. Coolant pump.
- Apply sealer to bolt threads.
3. Coolant pump bolts.

Tighten

- Coolant pump bolts. Refer to Figure 13.

4. Power steering pump bracket. Refer to POWER STEERING GEAR AND PUMP (SEC. 3B1).
5. Radiator inlet hose and clamp to the thermostat.
6. Heater hose and clamp to the coolant pump.
7. Drive belt. Refer to "Drive Belt" in this section.
8. Intake duct.
9. Negative battery cable.
- Refill the radiator. Refer to "Draining and Refilling the Cooling System" in this section.

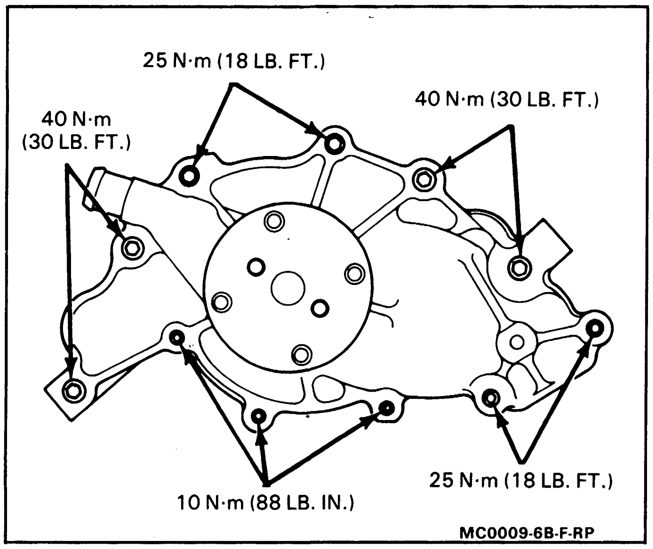


Figure 13 - Coolant Pump Bolt Torques (LHO)

Coolant Pump (Except LHO)

Figure 14

Remove or Disconnect

1. Negative battery cable.
- Drain the radiator.
2. Intake duct.
3. Drive belt. Refer to "Drive Belt" in this section.
4. Radiator inlet hose and clamp from the thermostat.
5. Coolant pump pulley bolts.
6. Coolant pump pulley.
7. Radiator outlet hose and clamp from the coolant pump.
8. Coolant pump bolts.
9. Coolant pump.
10. Gaskets.

Clean

- Gasket surfaces on the coolant pump sealing areas.

Install or Connect

NOTICE: See "Notice" on page 6B-1 of this section for steps 3, 4, 6, and 7.

1. New gaskets.
2. Coolant pump.
3. Coolant pump bolts.

Tighten

- Bolts to 41 N·m (30 lb. ft.).

4. Radiator outlet hose and clamp to the coolant pump.
5. Coolant pump pulley.
6. Coolant pump pulley bolts.

Tighten

- Bolts to 31 N·m (23 lb. ft.).

7. Radiator inlet hose and clamp to the thermostat.
8. Drive belt. Refer to "Drive Belt" in this section.
9. Intake duct.
10. Negative battery cable.
- Refill the radiator. Refer to "Draining and Refilling the Cooling System" in this section.

Inspect

- For leaks, after running the engine to normal operating temperature.

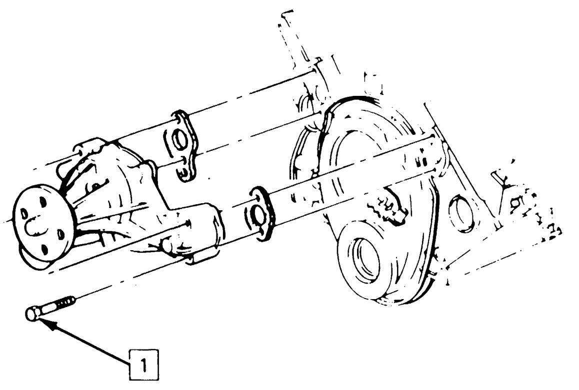
COOLANT HOSES

Remove or Disconnect

1. Negative battery cable.
- Drain the radiator so the level of the coolant is below the hose being removed.
2. Radiator inlet hose and clamp from the radiator and thermostat housing.
3. Radiator outlet hose and clamp from the radiator and coolant pump or cylinder block.

Install or Connect

NOTICE: Make sure the reference marks on the hoses and the radiator are lined up. A twist in the hose would place strain on the radiator fitting which could cause the fitting to crack or break.



1. 41 N·m (30 LBS. FT.)

Figure 14 - Coolant Pump (Except LHO)

1. Radiator outlet hose and clamp to the radiator and coolant pump, or cylinder block.
2. Radiator inlet hose and clamp to the radiator and thermostat.
3. Negative battery cable.

- Refill the radiator. Refer to "Draining and Refilling the Cooling System" in this section.

COOLANT RECOVERY RESERVOIR

Remove or Disconnect

1. Negative battery cable.
2. Coolant recovery reservoir hose and clamp.
3. Push-on retainer.
4. Nut.
5. Coolant recovery reservoir.

- Drain the reservoir.

Clean

- Coolant recovery reservoir with soap and water. Rinse thoroughly.

Install or Connect

NOTICE: See "Notice" on page 6B-1 of this section.

1. Coolant recovery reservoir.
2. Push-on retainer.
3. Nut.

Tighten

- Nut to 8 N·m (71 lb. in.).

4. Coolant recovery reservoir hose and clamp.
5. Negative battery cable.

- Add coolant to the "FULL COLD" mark on the coolant recovery reservoir.

ROUTING AND TENSIONING ACCESSORY DRIVE BELT

NOTICE: Routine inspection of the belt may reveal cracks in the belt ribs. These cracks will not impair belt performance and is not a basis for belt replacement. If sections of the belt are missing, the belt should be replaced.

Drive Belt Tension (LHO)

Figures 15 and 16

If belt slippage occurs and the drive belt tensioner is within its operating range, check the belt tension. Tension value is to be the average of three readings.

Tool Required:

J 23600-B Belt Tension Gage

1. Run the engine for 5 to 10 minutes.
2. Shut the engine off and check the belt tension.
   - On vehicles not equipped with air conditioning, check the belt tension between the tensioner and the power steering pump pulley.
   - On vehicles equipped with air conditioning, check the belt tension between the tensioner and the air compressor pulley.
3. Run the engine for 30 seconds and recheck the belt tension.
4. Repeat the above step. Belt tension is the average of the three readings taken.
   - Belt tension should be 422 to 623 N (95 to 140 lb.) - without air conditioning.
   - Belt tension should be 378 to 490 N (85 to 110 lb.) - with air conditioning.
5. Replace the drive belt tensioner if belt tension is below the minimum specified and if the drive belt tensioner is within its operating range. Refer to "Drive Belt Tensioner (LHO)" in this section.

Drive Belt Tension (Except LHO)

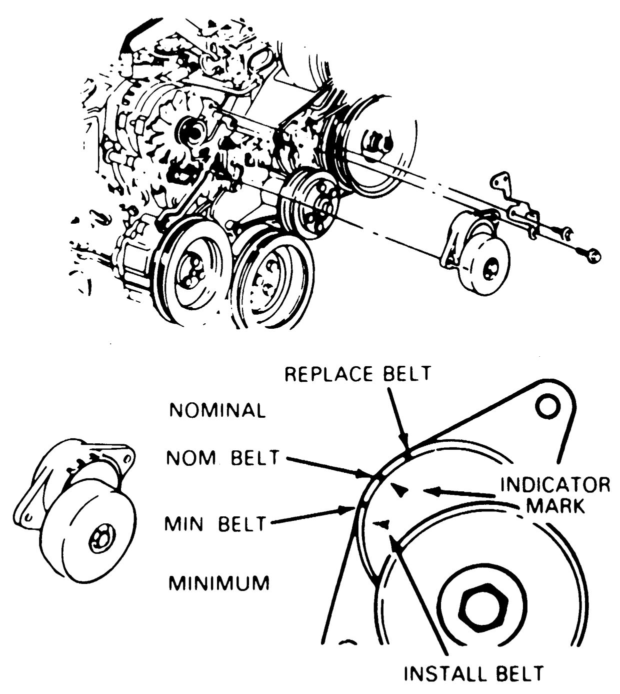
Figures 18 through 20

If belt slippage occurs and the drive belt tensioner is within its operating range, check the belt tension. Tension value is to be the average of the three readings.

Tool Required:

J 23600-B Belt Tension Gage

1. Run the engine for 5 to 10 minutes.
2. Shut the engine off and check the belt tension between any two pulleys.
3. Run the engine for 30 seconds and recheck the belt tension.
4. Repeat the above step. Belt tension is the average of the three readings taken.
   - Belt tension should be 440 to 538 N (99 to 121 lb.).
5. Replace the drive belt tensioner if belt tension is below the minimum specified and if the drive belt tensioner is within its operating range. Refer to "Drive Belt Tensioner (except LHO)" in this section.



THE INDICATOR MARK ON THE MOVEABLE PORTION OF THE TENSIONER MUST BE WITHIN THE LIMITS OF THE SLOTTED AREA ON THE STATIONARY PORTION OF THE TENSIONER. ANY READING OUTSIDE THESE LIMITS INDICATES EITHER A DEFECTIVE BELT OR TENSIONER.

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Figure 15 - Drive Belt Tensioner (LHO)

Drive Belt

Figures 15 through 19

Inspect

- Belt length scale on the drive belt tensioner for the proper installed length. If the belt length scale does not indicate the proper installed length, install a new drive belt.

Remove or Disconnect

1. Negative battery cable.
- Lift the drive belt tensioner upward off the drive belt.
    - Use a breaker bar with socket (LHO).
    - Use a breaker bar (except LHO).
2. Drive Belt.

Clean

- Accessory drive pulley belt surfaces.

Install or Connect

1. Drive belt under the tensioner pulley by lifting the drive belt tensioner.
    - Use a breaker bar with socket (LHO).
    - Use a breaker bar (except LHO).

Important

- Be sure the belt is aligned into the proper grooves of the accessory drive pulleys.

2. Negative battery cable.

Drive Belt Tensioner (LHO)

Figure 15

Remove or Disconnect

1. Negative battery cable.
2. Drive belt. Refer to "Drive Belt" in this section.
3. Bolts attaching the drive belt tensioner to the generator bracket and brace.
4. Bolt attaching the brace to the cylinder block.
5. Drive belt tensioner.

Install or Connect

NOTICE: See "Notice" on page 6B-1 of this section for steps 2 and 3.

1. Drive belt tensioner.
2. Bolt attaching the brace to the cylinder block.

Tighten

- Bolt to 25 N·m (18 lb. ft.).

3. Bolts attaching the drive belt tensioner to the generator bracket and brace.

Tighten

- Bolts to 35 N·m (26 lb. ft.).

4. Drive belt. Refer to "Drive Belt" in this section.
5. Negative battery cable.

Drive Belt Tensioner (Except LHO)

Figures 17 and 18

Remove or Disconnect

1. Negative battery cable.
2. Drive belt. Refer to "Drive Belt" in this section.
3. Drive belt tensioner attaching bolt.
4. Drive belt tensioner.

Install or Connect

1. Drive belt tensioner.

NOTICE: See "Notice" on page 6B-1 of this section.

2. Drive belt tensioner attaching bolt.

Tighten

- Bolt to 50 N·m (37 lb. ft.).

3. Drive belt. Refer to "Drive Belt" in this section.
4. Negative battery cable.

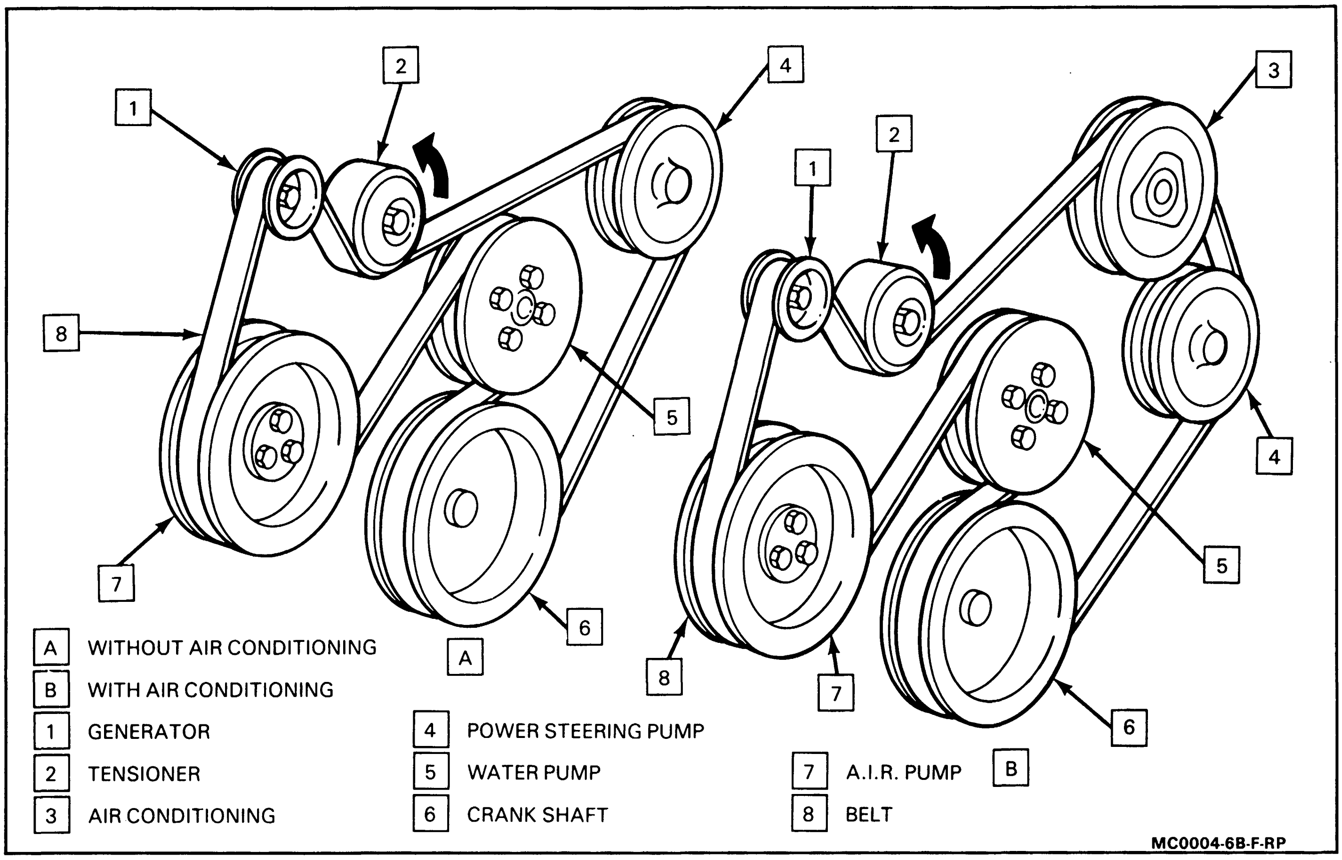


Figure 16 - Drive Belt and Pulleys (LHO)

Drive Belt Idler Pulley (Except LHO)

Figures 17 and 20

Remove or Disconnect

1. Drive belt. Refer to "Drive Belt" in this section.
2. Idler pulley bolts.
3. Drive belt idler pulley.

Install or Connect

1. Drive belt idler pulley.

   NOTICE: See "Notice" on page 6B-1 of this section.

2. Idler pulley bolts.

   Tighten

   - Short bolt to 50 N·m (37 lb. ft.).
   - Long bolts to 83 N·m (61 lb. ft.).

3. Drive belt. Refer to "Drive Belt" in this section.

DRAINING AND REFILLING THE COOLING SYSTEM

CAUTION: To avoid the danger of being burned, do not remove the radiator cap while the engine and radiator are still hot. Scalding fluid and steam will be blown out under pressure.

1. Remove the radiator cap.
   - Turn the cap slowly counterclockwise until it reaches the "stop." Do not press down while turning the cap.
   - Wait until any remaining pressure (indicated by a hissing sound) is relieved.
   - After all hissing ceases, press down on the cap and continue to rotate the cap counterclockwise.
2. Open the radiator drain cock.
3. Remove the cylinder block drain plugs. One plug is located on each side of the cylinder block. Remove the cooling sensor if the left plug cannot be reached.
4. Remove the coolant recovery reservoir. Refer to "Coolant Recovery Reservoir" in this section.
5. Close the radiator drain cock.

   NOTICE: See "Notice" on page 6B-1 of this section.

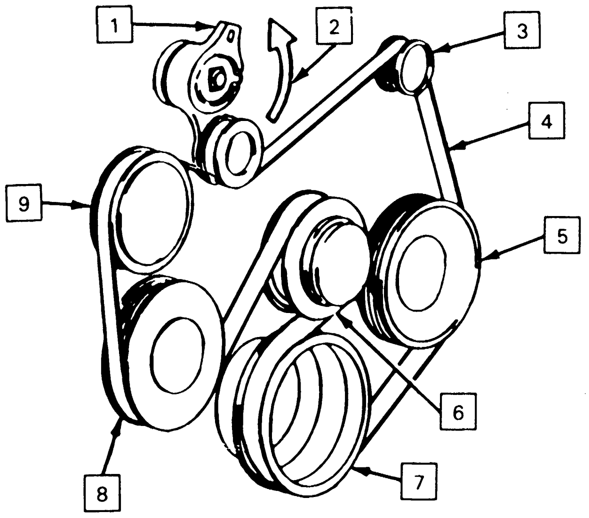
6. Install the cylinder block drain plugs.

   Tighten

   - Drain plugs to 21 N·m (15 lb. ft.).

7. Add enough water to fill the cooling system.
8. Run the engine until the thermostat opens.
9. Stop the engine. Repeat steps 1 through 8, until the drained fluid is nearly colorless.

NOTICE: Use ethylene glycol coolant, meeting GM specification 1825-M, to provide the required freezing and corrosion protection — at least 50 percent solution, -37°C (-34°F). Alcohol or



1 TENSIONER ASSEMBLY

2 ROTATE TENSIONER IN DIRECTION SHOWN TO INSTALL OR REMOVE BELT

3 GENERATOR ASSEMBLY

4 ACCESSORY DRIVE BELT

5 P/S PUMP

6 WATER PUMP

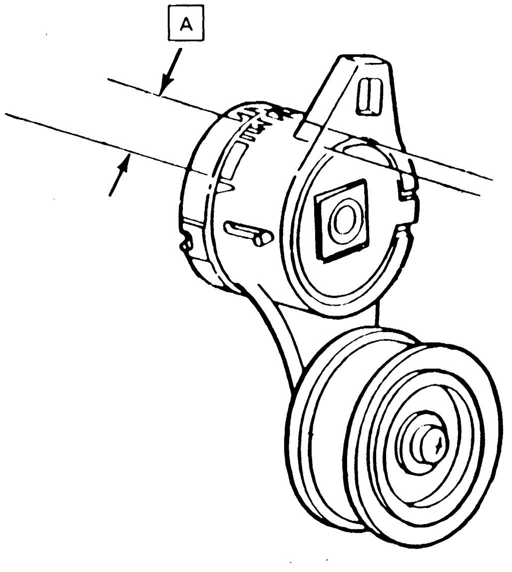
7 CRANKSHAFT

8 AIR PUMP

9 A/C COMPRESSOR OR BELT IDLER

LC0003-6B-F-RP

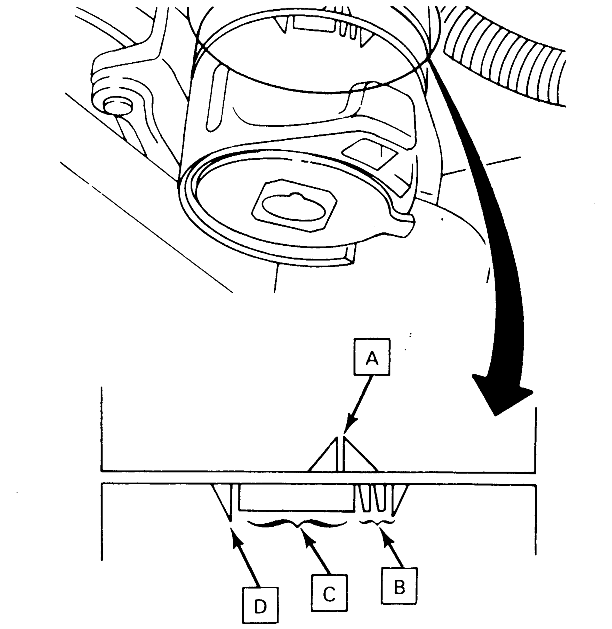
Figure 17 - Drive Belt and Pulley (Except LHO)



A BELT LENGTH SCALE

KC0006-6B-F-RP

Figure 18 - Drive Belt Tensioner (Except LHO)



A FIXED BELT LENGTH INDICATOR

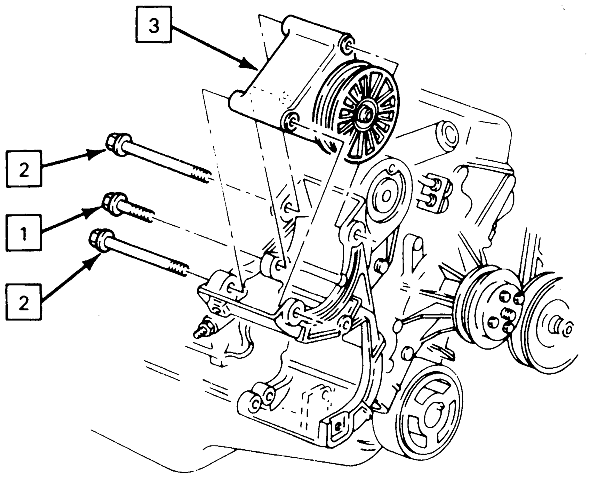
B NEW BELT RANGE

C USED BELT ACCEPTABLE WEAR RANGE

D REPLACE BELT POSITION

KC0007-6B-F-RP

Figure 19 - Drive Belt Length Scale (Except LHO)



1 SHORT BOLT

2 LONG BOLT

3 DRIVE BELT IDLER PULLEY

MC0007-6B-F-RP

Figure 20 - Drive Belt Idler Pulley (Except LHO)

methanol base coolants or plain water are not recommended at any time. This is due to their poor corrosion protection and protection against freezing. A solution stronger than 70 percent should never be used. The solution's freeze point rises after this point. Pure antifreeze will freeze at -20°C (-4°F).

10. Install the coolant recovery reservoir. Refer to "Coolant Recovery Reservoir" in this section. Leave the cap off.

11. Add enough water and ethylene glycol antifreeze (meeting GM specification 1825-M) to provide a solution that is at least 50 percent antifreeze, but no more than 70 percent antifreeze. For cooling system capacities, refer to MAINTENANCE AND LUBRICATION (SEC. 0B).
    - Fill the radiator to below the filler neck.
    - Fill the coolant recovery reservoir to the "COLD FILL" mark.
    - Install the coolant recovery reservoir cap.
12. Run the engine with the radiator cap removed until normal operating temperature is reached (radiator inlet hose becomes hot).
13. With the engine idling, add coolant to the radiator until the level reaches the bottom of the filler neck.

CAUTION: Under some conditions, ethylene glycol in engine coolant is flammable. To avoid being burned when adding coolant, do not spill it on the exhaust system or on hot engine parts.

14. Install the radiator cap.
    - The arrows on the cap must line up with the coolant recovery reservoir hose.

Important

- It is the owner's responsibility to:
  - Keep the freeze protection at a level appropriate to the temperatures which may occur in the area the vehicle may be operating.
  - Maintain cooling system freeze protection at -37°C (-34°F) to ensure protection against corrosion.

RADIATOR

Figure 21

Remove or Disconnect

1. Negative battery cable.
- Drain the radiator.
2. Radiator inlet hose and clamp.
3. Air duct bracket, if equipped.
4. Air cleaner top, if equipped.
5. Intake duct.
6. Mass air flow (MAF) sensor, if equipped.
7. Coolant recovery hose.
8. Connector.
9. Heater hose and clamp, if equipped.
10. Cooling fan. Refer to "Cooling Fan" in this section.
11. Transmission oil cooler pipes, if equipped.
12. Radiator outlet hose and clamp.
13. Upper radiator mount screws.
14. Upper radiator mount.
15. Radiator.

Install or Connect

NOTICE: See "Notice" on page 6B-1 of this section.

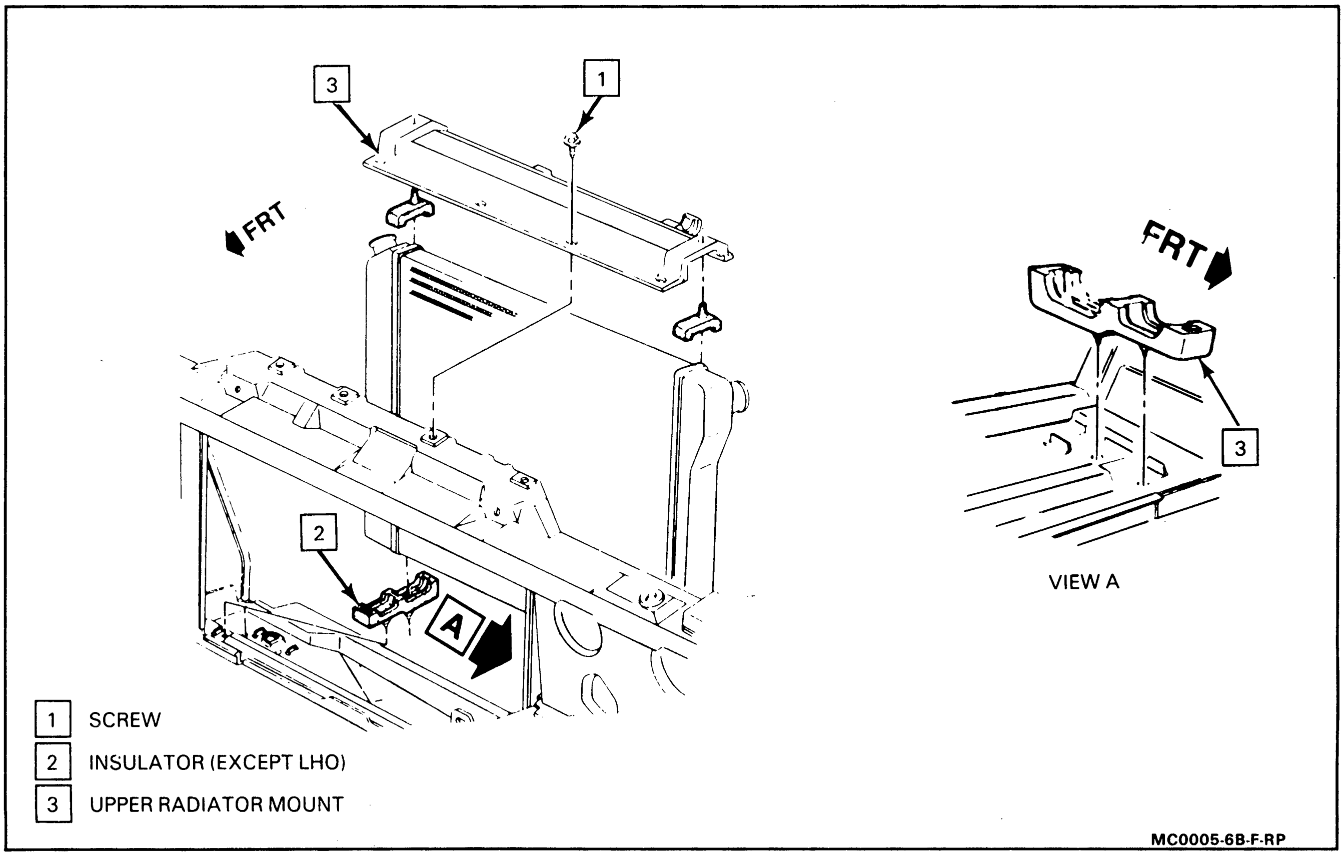


Figure 21 - Radiator Insulators and Mounting

1. Radiator.
   - Make sure the radiator is seated on the insulators.
2. Upper radiator mount.
3. Upper radiator mount screws.

Tighten

   - Screws to 6 N·m (53 lb. in.).
4. Radiator outlet hose and clamp.
5. Cooling fan. Refer to "Cooling Fan" in this section.
6. Transmission oil cooler pipes, if equipped.

Tighten

   - Pipe connections to 20 N·m (15 lb. ft.).
7. Heater hose and clamp, if equipped.
8. Connector.
9. Coolant recovery hose and clamp.
10. MAF sensor, if equipped.
11. Intake duct.
12. Air duct bracket, if equipped.
13. Air cleaner top, if equipped.
14. Radiator inlet hose and clamp.
15. Negative battery cable.

- Refill the radiator. Refer to "Draining and Refilling the Cooling System" in this section.

Inspect

   - For leaks, after running the engine until normal operating temperature is reached.

ALUMINUM RADIATOR SERVICE

Figures 22 and 23

This radiator uses an aluminum core with plastic side tanks. The core and side tanks can be replaced separately. Core repair is easily made with the hot melt adhesive method. A transmisson oil cooler may be located in one of the side tanks. The drain cock is located on the lower part of one of the tanks.

The following components are serviceable:

– Radiator core.
– Tanks and gaskets (Tanks cannot be repaired if broken or cracked).
– Oil cooler and gaskets.
– Drain cock and gasket.

PRECAUTIONS

CAUTION: Failing to follow any one of these procedures could result in personal injury or component damage.

- Do not remove the radiator cap while the engine is at normal operating temperature. The cooling system will release scalding fluid and steam under pressure if the cap is removed while the engine and radiator are still hot.
- Do not use boil-out tanks or any tank that has been used for copper and brass radiators.
- Do not open the hood if steam or coolant can be seen escaping from the engine compartment.
- Do not remove the cap on the coolant recovery reservoir if the coolant in the reservoir looks like it is boiling.
- Do not allow dirt or water to enter the transmission oil cooler.

LEAKS

Some core leaks can be detected by adding water to the radiator. Clean the core so the damaged area is easier to find.

- Remove dirt and insects from the fins with a water hose (without a nozzle), or with compressed air. Excessive water pressure could damage the fins.
- Scrub the core with a soft-bristle brush using clean hot water or hot water with a mild detergent solution.

On-Vehicle Pressure Testing

Figure 24

Tool Required:

J 24460-01 Cooling System Tester

1. Make sure radiator hose clamps and heater hose clamps are properly positioned and secured.
2. Inspect the connections for leaks. Repair as required.

CAUTION: To avoid being burned, do not remove the radiator cap while the engine is at normal operating temperature. The cooling system will release scalding fluid and steam under pressure if the cap is removed while the engine and radiator are still hot.

3. Remove the radiator cap.
4. Fill the cooling system to the base of the fill neck.
5. Attach J 24460-01 to the fill neck.
   - Follow the instructions supplied with J 24460-01.
6. Build up pressure to no more than 138 kPa (20 psi).
7. The system should hold the pressure for about two minutes.
   - If a measurable amount of pressure drops in less than two minutes, check for a leak.
   - Mark the leaking area and remove the radiator for repair. Refer to "Radiator" in this section.

Off-Vehicle Leak Testing

NOTICE: Do not use boil-out tanks or any tank that has been used for copper and brass radiators. The remaining solutions or chemicals in these tanks could cause radiator failure.

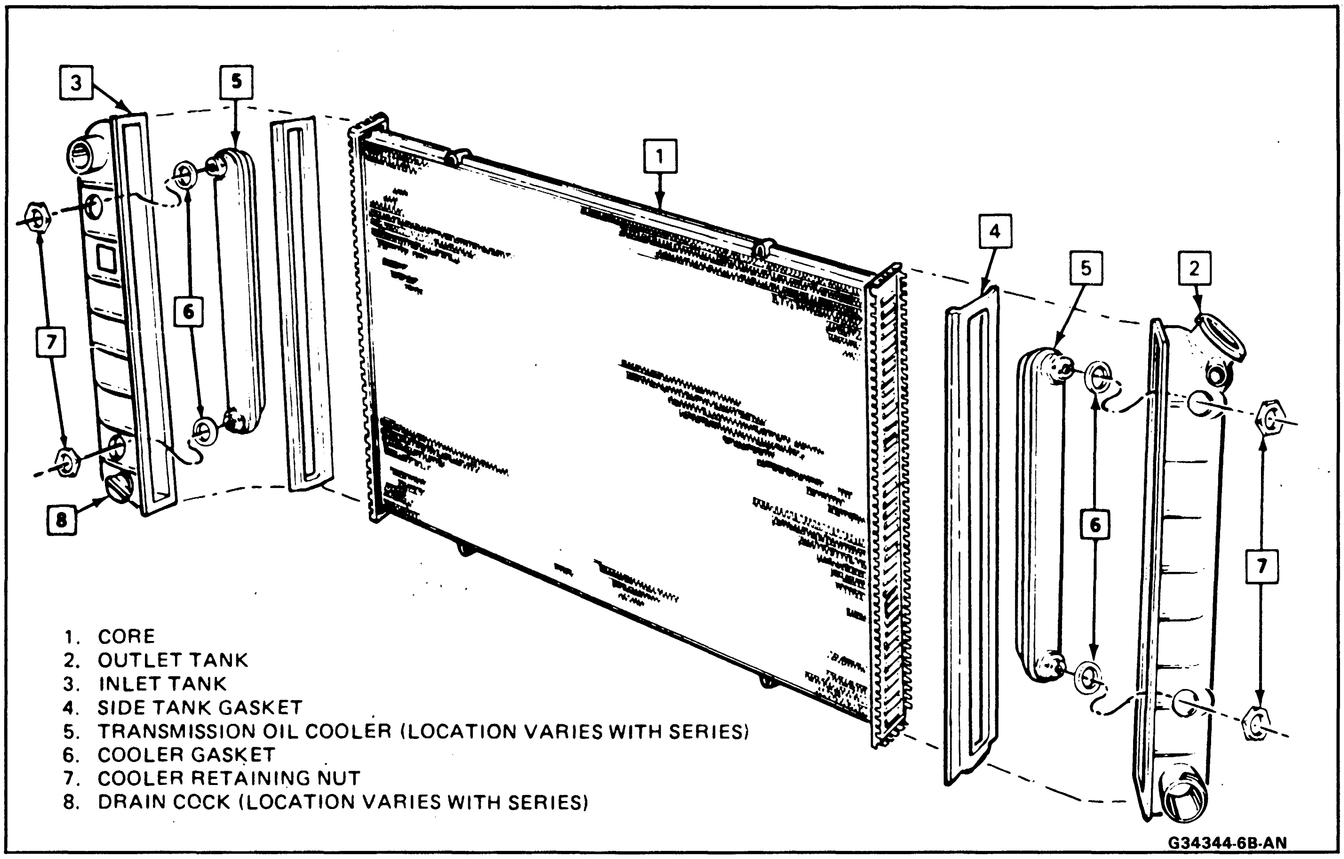


Figure 22 - Aluminum Radiator

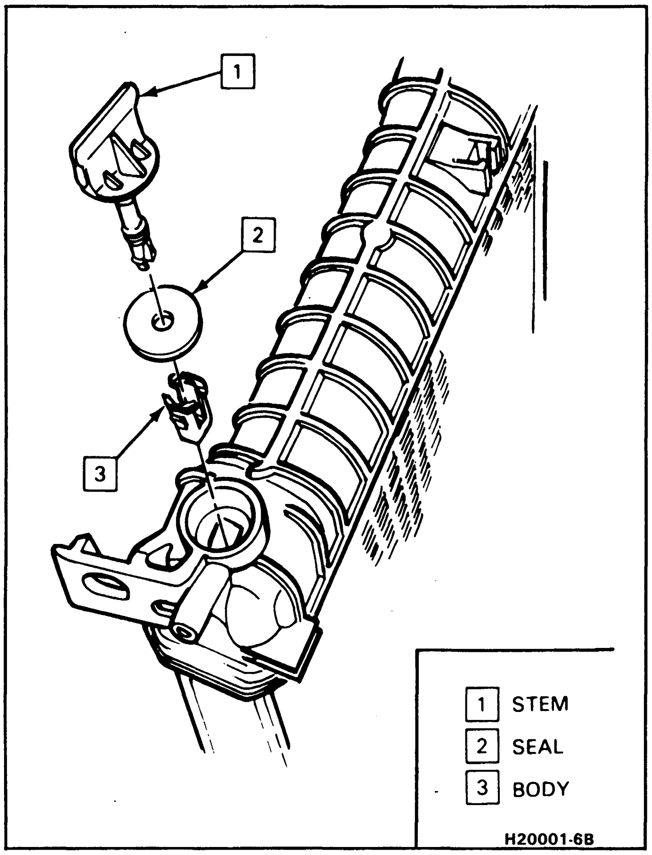


Figure 23 - Aluminum Radiator Drain Cock

Figures 25 and 26

Tool Required:

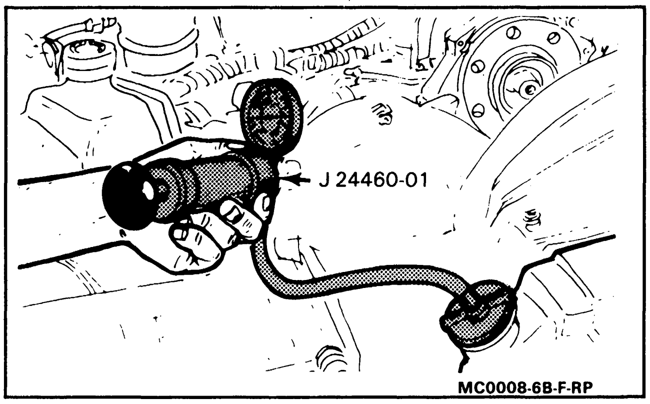


Figure 24 - Pressure Testing the Radiator

J 24460-01 Cooling System Tester

- Plug radiator inlet and outlet tubes. Make sure drain cock is closed.

1. Attach J 24460-01 to the radiator.
2. Build up pressure to 138 kPa (20 psi).
   - Do not exceed 138 kPa (20 psi).
3. Observe the gage for any pressure loss.
4. Run water over the repair area and look for any bubbles.
   - If a large water tank is available, the radiator can be submerged to check for air bubbles.

Repairable Leaks

Core leaks and gasket leaks are the two types of leaks that can be repaired on the radiator. Core leaks

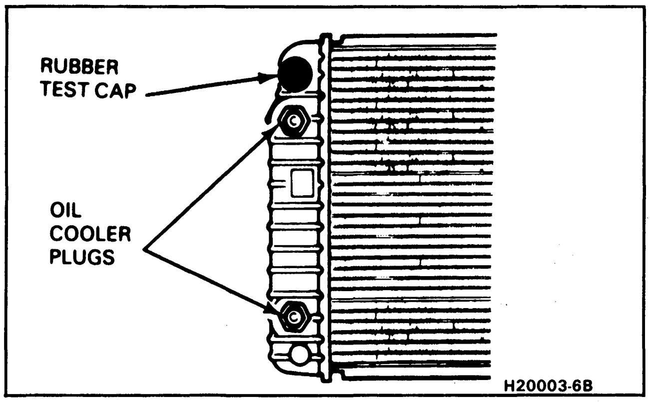


Figure 25 - Aluminum Radiator and Oil Cooler Plugs

can occur in a tube or in the joints between the tubes and headers. Gasket leaks can occur in the joints between the plastic tanks and the headers, or in the joints between the oil cooler fittings and the tank. Some leaks can be repaired while the radiator is on the vehicle; however, it is more practical to remove the radiator from the vehicle.

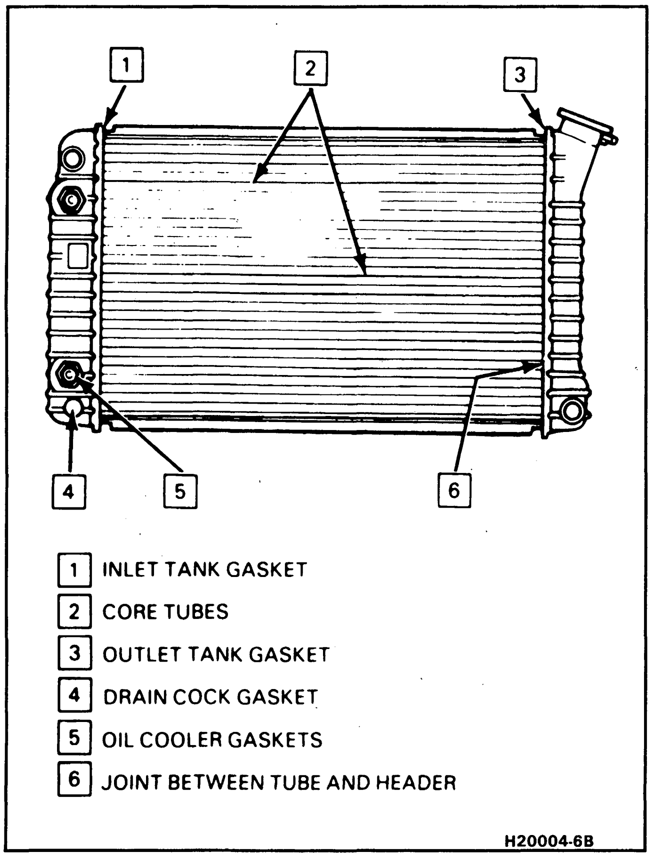


Figure 26 - Possible Leak Areas

Repair Methods

Figures 27 through 31

The hot melt adhesive is the most effective method of repairing the radiator core. The hot melt adhesive kit contains adhesive sticks, cotton swabs, wire brush, and primer. The adhesive kit is reusable, has an indefinite shelf life, and is waste-free. The sticks must be stored in a sealed container to keep them dry.

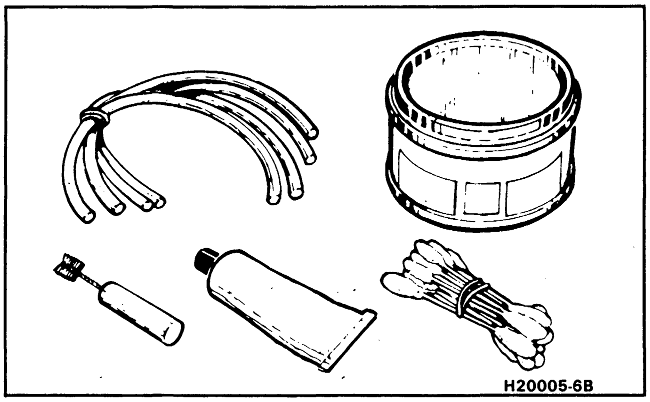


Figure 27 - Hot Melt Adhesive Repair Kit

Cooling Fin Removal

For damaged areas that are between the cooling fins, it may be necessary to remove some of the fins. Do not remove more fins than necessary. Usually removal of fins 6 mm (1/4 inch) beyond the leak or damage area is enough to make an accurate repair.

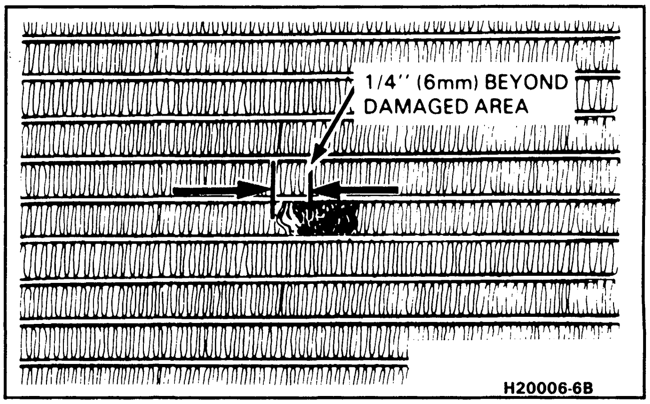


Figure 28 - Fins Removed from Damaged Area

Tube Blocking

If a tube is severely damaged, it can be blocked off.

NOTICE: Do not block off more than two tubes in a radiator. Blocking off more than two tubes will reduce the cooling capability of the system.

The tube should be cut off 6 mm (1/4 inch) from the header and pinched shut before it is cleaned and sealed.

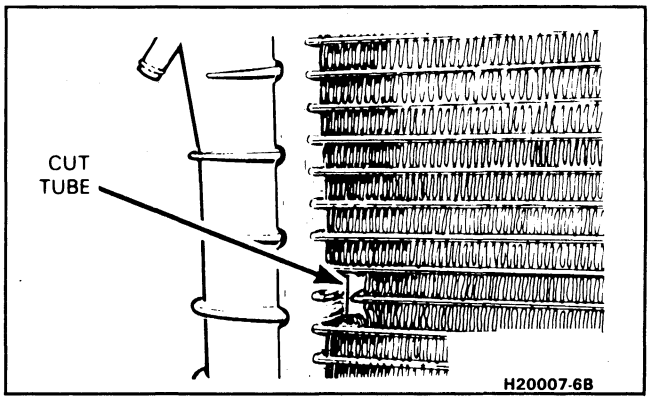


Figure 29 - Tube Blocking

Header Repair

NOTICE: To prevent damage to the tank or gasket, the following procedures must be used when repairs are made on or near the header.

If the header or the tube near the header requires a repair, the side tank does not have to be removed. A damp cloth can be placed against the side tank where the repair has to be made. The side tank can also be submerged in a tank of water up to the header.

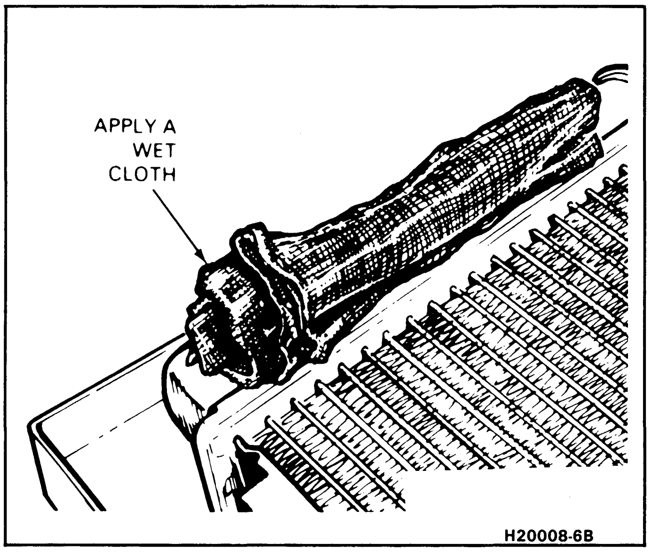


Figure 30 - Using a Wet Cloth on the Side Tank

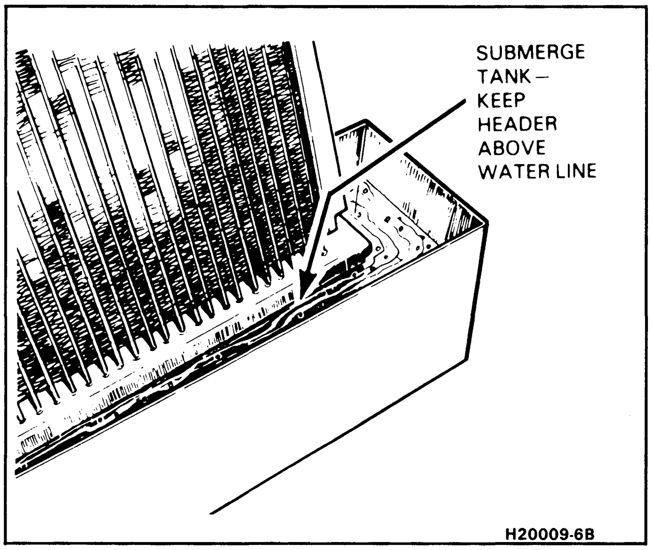


Figure 31 - Submerging the Side Tank

General Core Repair

Figures 32 through 35

If the leak area surface is not clean, the repair materials will not stick to the surface.

1. Position the core so the repair area is accessible.
2. Apply a wet cloth if working near the plastic tanks or the joints between the core tubes and header, or submerge the tank in water.
3. Heat the repair area slightly with a small torch or heat gun to be sure it is dry.
   - Do not use a blow torch.
4. Brush the area to be repaired with the small steel brush that is supplied in the kit and remove dust away from repair area.

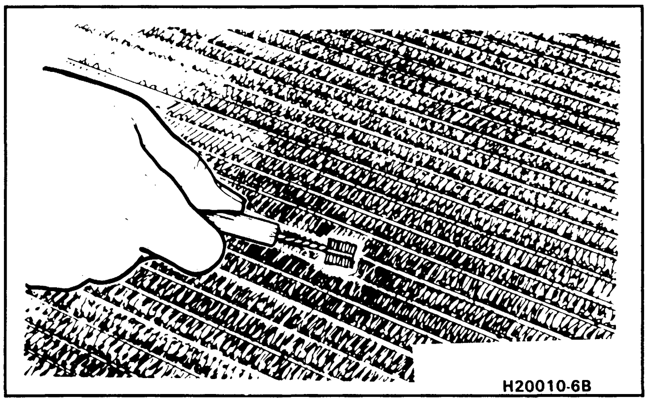


Figure 32 - Cleaning the Area with a Steel Brush

CAUTION: To help avoid personal injury when using the primer (which contains trichlorethane), the following precautions and steps should be followed.

- **If primer is swallowed, seek medical attention.**
- **If primer contacts the eyes, do not rub the eyes. Splash the affected area with large quantities of cold water and seek medical attention.**
- **If primer contacts the body, wash thoroughly with soap and water.**
- **Use primer with adequate ventilation.**
- **Do not mix the primer with water.**

5. Open the tube of primer, using the spurred cap or a pin, and apply primer to the repair area only. Use of the primer produces a stronger repair.
6. Scrub the repair area with a cotton swab until a fresh swab stays clean.
   - The clear, yellow-brown coating does not have to be removed.

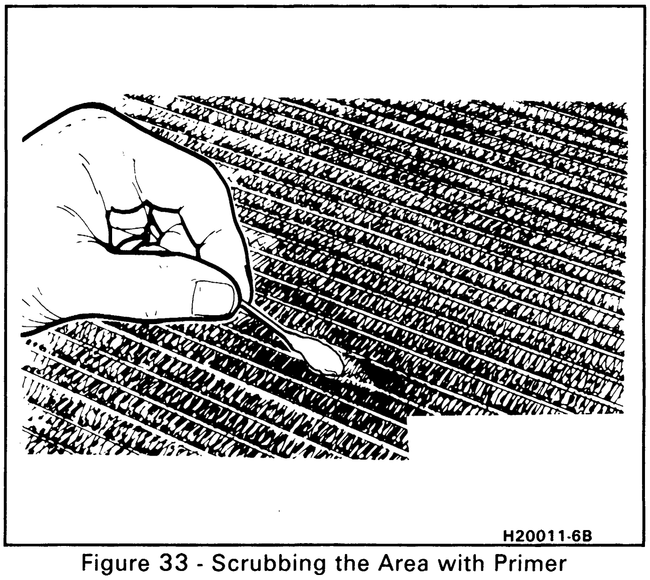


Figure 33 - Scrubbing the Area with Primer

7. Heat the repair area with the heat gun or by moving the small torch in a circular pattern using a soft, blue flame.

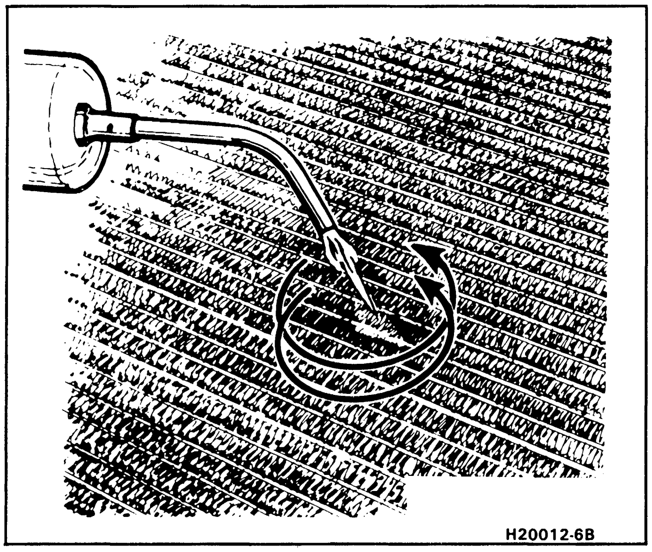


Figure 34 - Heating the Repair Area

8. Withdraw the small torch or heat gun and rub the adhesive stick on the repair area. The adhesive will flow at a temperature of approximately 260°C (500°F).
   - If the stick doesn't start to melt, remove it and reapply the heat. Do not heat the stick directly with a flame. High heat will burn and char the adhesive.

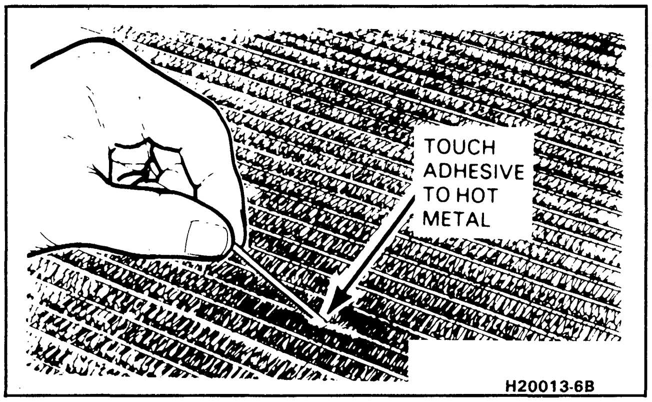


Figure 35 - Applying Hot Melt Adhesive

9. Continue heating until the adhesive flows and wets the entire repair area and fills the joint. If a hole is in the center of a tube, heat the tube and let the hot surface melt and pull in the adhesive. The force of the heat gun will also tend to guide the adhesive toward the hole. For leaks between a tube and header, flow the adhesive completely around the tube and header joint with the tank installed.
10. Heat the repair area until the adhesive is bubble-free, smooth, and has a light yellow color. Curing is not required.
11. Test the radiator for leaks, when cool. Refer to "Off-Vehicle Leak Testing" in this section. If the repair area still leaks, heat it gently to dry it. Heat and flow the adhesive, or apply more as necessary to repair the leak.

Tank Gasket Leak Repair

Figures 36 through 39

Tool Required:

J 33419-A Radiator Core Remover/ Installer

Tank gasket leaks can easily be mistaken for tank or header leaks. If a plastic tank leaks from the header joint gasket, tighten the clinch tabs with J 33419-A or locking-type pliers.

- If still leaking, remove the tank and repair.

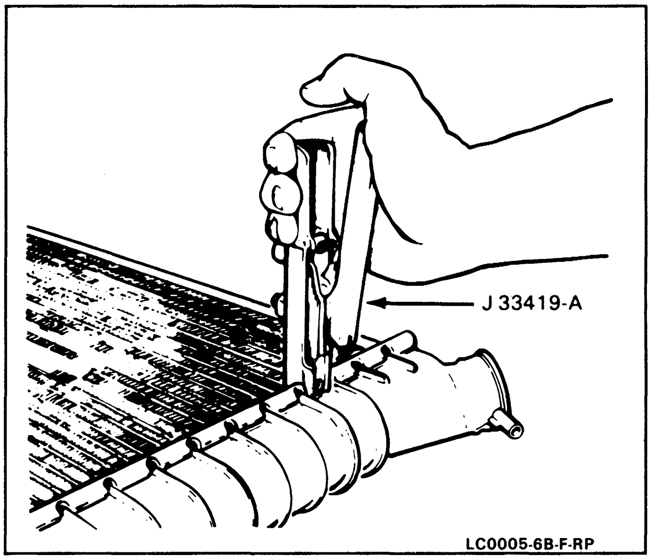


Figure 36 - Tightening the Clinch Tabs

1. Pry open the clinch tabs, except those under inlet, outlet, and filler necks, using J 33419-A or a screwdriver.
   - Lift the tabs only enough to allow removal.

NOTICE: Do not overbend the tabs. Overbending the tabs could result in breaking the tab. If more than three tabs are broken on one side of the header, or more than two adjacent tabs are broken, the core must be replaced.

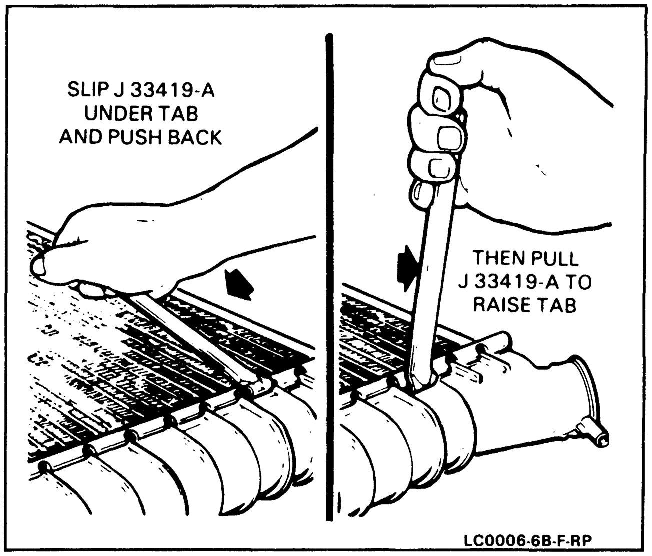


Figure 37 - Opening the Clinch Tabs

2. Lift the tank and slide it out from under the remaining clinched tab.
   - Tapping the tank with your hand may be required to dislodge the gasket.
3. Lift the remaining tab(s) with pliers.
4. Remove and discard the gasket.

Clean

- Header and gasket groove of dirt and old rubber.
- Sealing edge of the plastic tank.

Inspect

- Header gasket surface and tank flange for evidence of leaks.
- Surfaces and remove dirt, burrs, and bumps.

5. Remove the oil cooler, if equipped, and install it into the new tank.
6. Dip or coat the new gasket in engine coolant and position it on the header surface.
   - The coolant helps hold the gasket in place.
7. Position the tank and gasket to the header. Clamp it in place and secure it by bending four clinch tabs.

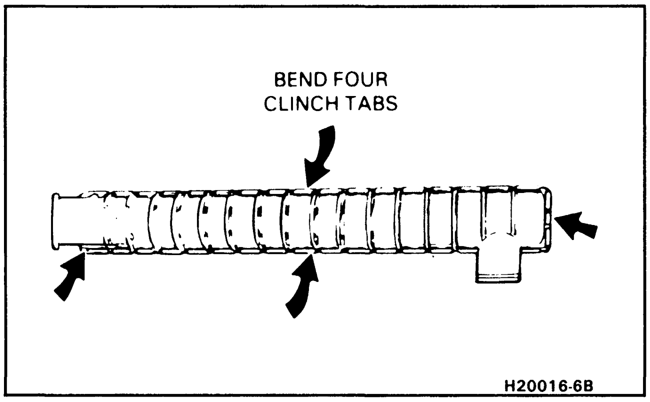


Figure 38 - Seating the Tank to the Core

8. Clamp remaining clinch tabs around the header using J 33419-A or pliers.

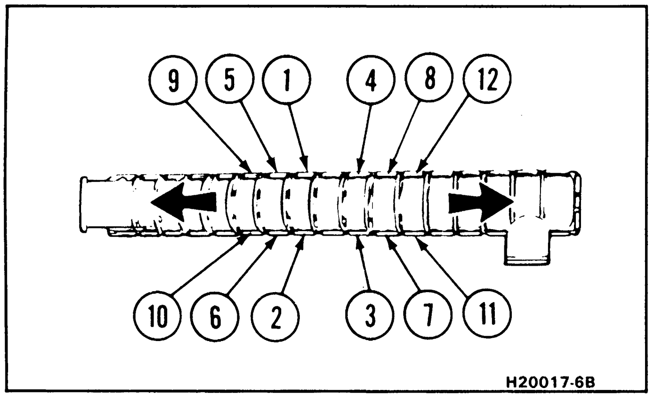


Figure 39 - Clinching Sequence

   - Start at the center and work towards the ends.
9. Replace the core if there are more than three tabs broken on one side or if two adjacent tabs are broken.
10. Install the drain cock, if removed.
11. Test the radiator for leaks. Refer to "Off-Vehicle Leak Testing" in this section.

TRANSMISSION OIL COOLER GASKET

Figure 40

The outlet tank must be removed to replace the oil cooler, but the oil gasket can be replaced without removing the tank.

1. Remove the radiator. Refer to "Radiator" in this section.
   - Lay the radiator on a flat surface.
2. Remove the bottom oil cooler pipe and loosen the top pipe connection.
3. Press the oil cooler into the hole and remove the gasket using a small hook.

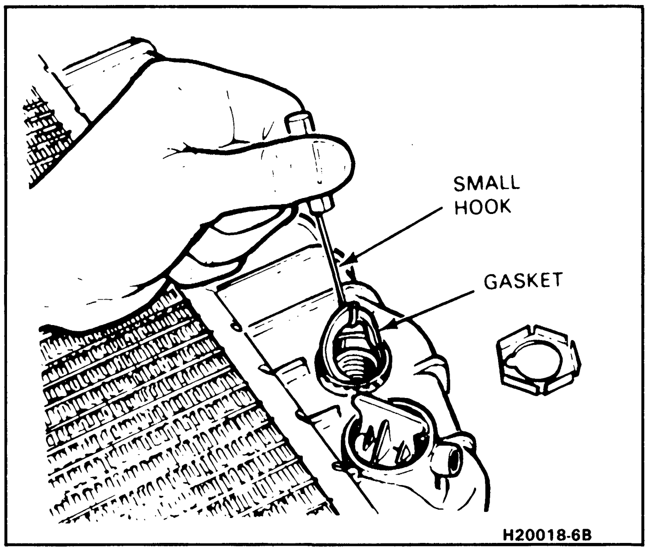


Figure 40 - Removing the Transmission Oil Cooler Gasket

4. Blow-dry all surfaces on the tank and oil cooler.
5. Install new gasket, without lubrication.
   - Be sure the gasket is properly seated inside the lip of the fitting.
6. Reach into the inlet or outlet opening and push the oil cooler into position against the tank.

   NOTICE: See "Notice" on page 6B-1 of this section.

7. Install the oil cooler pipe loosely.
   - To replace the other gasket, follow the previous steps in order.

Tighten

- Oil cooler pipe connections to 20 N·m (15 lb. ft.).
  - Do not overtighten.

8. Leak test the radiator. Refer to "Off-Vehicle Leak Testing" in this section.
9. Install the radiator. Refer to "Radiator" in this section.

TRANSMISSION OIL COOLER

Figure 22

Remove or Disconnect

1. Radiator. Refer to "Radiator" in this section.
2. Outlet tank.
3. Cooler retaining nut.
4. Cooler gaskets.
5. Transmission oil cooler.

Clean

- Sealing surfaces.

Install or Connect

1. New cooler gaskets, without lubrication.
2. Transmission oil cooler into the outlet tank.

NOTICE: See "Notice" on page 6B-1 of this section.

3. Cooler retaining nut.
4. Outlet tank.
   - Be careful not to loosen or misalign the gaskets.
5. Radiator. Refer to "Radiator" in this section.

RECORE

If the radiator core is damaged beyond repair and the other parts are serviceable, install the original inlet and outlet tanks, oil cooler, radiator cap, and drain valve onto a new core and install new gaskets.

DRAIN COCK

Figure 23

If the drain cock does not seal when tightened snugly, remove the drain cock, clean the drain and replace the drain cock. If the body of the drain cock is broken, remove the body from the tank by squeezing the sides together with needle nose pliers.

SPECIFICATIONS

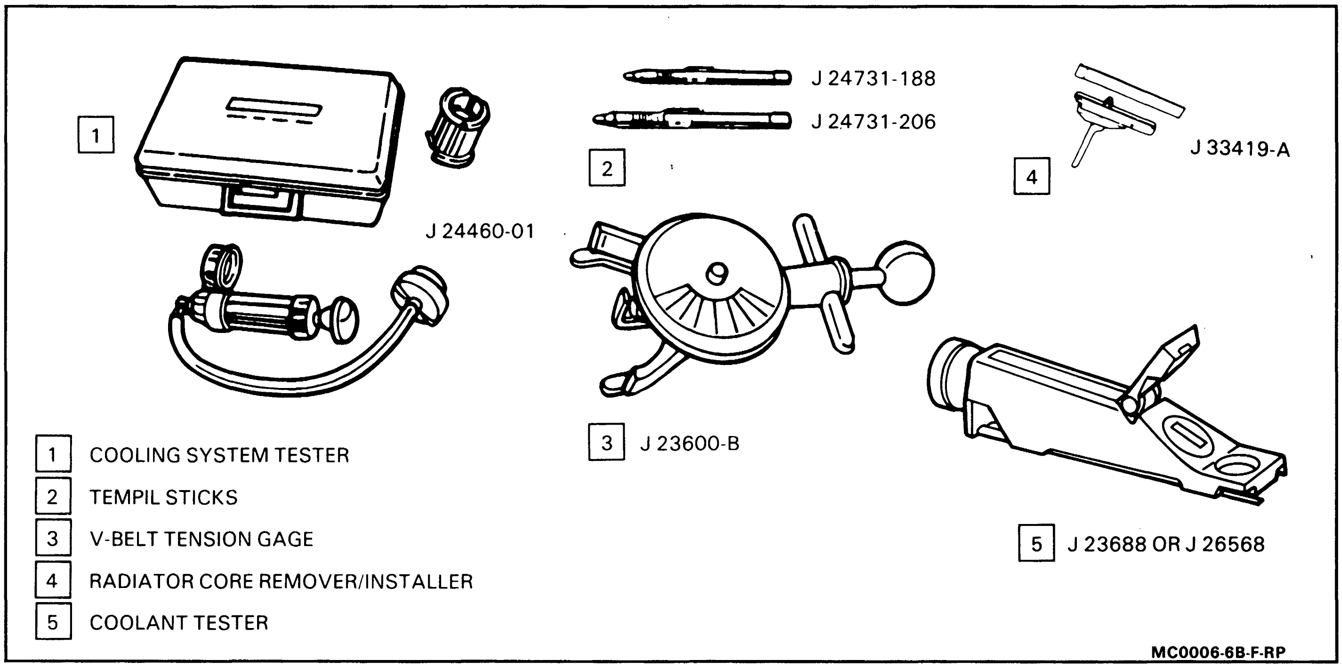
FASTENER TORQUE SPECIFICATIONS

Thermostat Housing Bolt (LB9 and L98)	34 N·m (25 lb. ft.)
Thermostat Housing Bolt (L03)	28 N·m (21 lb. ft.)
Thermostat Housing Bolt (LH0)	21 N·m (15 lb. ft.)
Cooling Fan-to-Radiator Support Bolt	27 N·m (20 lb. ft.)
Lower Radiator Baffle-to-Impact Bar Screw	5 N·m (44 lb. in.)
Upper Radiator Baffle Screw	5 N·m (44 lb. in.)
Coolant Pump Bolt (LH0) Refer to Figure 13	10 N·m (88 lb. in.)
Coolant Pump Bolt (LH0) Refer to Figure 13	25 N·m (18 lb. ft.)
Coolant Pump Bolt (LH0) Refer to Figure 13	40 N·m (30 lb. ft.)
Coolant Pump Bolt (Except LH0)	41 N·m (30 lb. ft.)
Coolant Pump Pulley Bolt	31 N·m (23 lb. ft.)
Coolant Recovery Reservoir Nut	8 N·m (71 lb. in.)
Drive Belt Tensioner Brace-to-Cylinder Block Bolt (LH0)	25 N·m (18 lb. ft.)
Drive Belt Tensioner-to-Generator Bracket Bolt (LH0)	35 N·m (26 lb. ft.)
Drive Belt Tensioner Bolt (Except LH0)	50 N·m (37 lb. ft.)
Belt Idler Pulley (Except LH0)	
Short Bolt	50 N·m (37 lb. ft.)
Long Bolt	83 N·m (61 lb. ft.)
Cylinder Block Drain Plug	21 N·m (15 lb. ft.)
Upper Radiator Mount Screw	6 N·m (53 lb. in.)
Transmission Oil Cooler Pipe-to-Radiator	20 N·m (15 lb. ft.)

BELT TENSION SPECIFICATIONS

Drive Belt Tension (LH0)	
Without Air Conditioning	422 to 623 N (95 to 140 lb.)
With Air Conditioning	378 to 490 N (85 to 110 lb.)
Drive Belt Tension (Except LH0)	
With or Without Air Conditioning	440 to 538 N (99 to 121 lb.)

SPECIAL TOOLS



1 COOLING SYSTEM TESTER
2 TEMPIL STICKS
3 V-BELT TENSION GAGE
4 RADIATOR CORE REMOVER/INSTALLER
5 COOLANT TESTER

SECTION 6C

ENGINE FUEL

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

The fuel supply is stored in the fuel tank. An electric fuel pump, attached to the fuel level sender assembly (inside the fuel tank) pumps fuel through an in-line filter to the TBI unit or fuel rail assembly. The pump is designed to provide fuel at a pressure above the regulated pressure needed by the injectors. A pressure regulator keeps fuel available to the injectors at a regulated pressure. Unused fuel is returned to the fuel tank by a separate line. For further information on the fuel injection system, refer to "Fuel Metering System" located in DRIVEABILITY AND EMISSIONS - TBI (SECTION 6E2-C2) or DRIVEABILITY AND EMISSIONS - PFI (SECTION 6E3-C2).

Unleaded fuel must be used with all gasoline engines for proper emission control system operation. Using unleaded fuel will also decrease spark plug fouling and extend engine oil life. Leaded fuel can damage the emission control system, and its use can result in loss of emission warranty coverage.

All cars with gasoline engines are equipped with an Evaporative Emission System that minimizes the

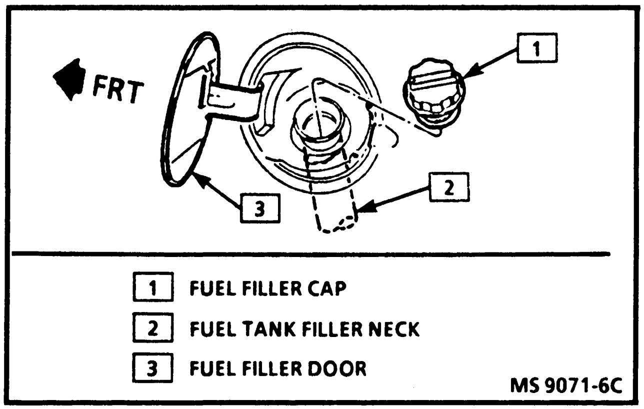


Figure 1 - Fuel Filler Cap

escape of fuel vapors to the atmosphere. Information on this system is located in DRIVEABILITY AND EMISSIONS - TBI (SECTION 6E2-C3) or DRIVEABILITY AND EMISSIONS - PFI (SECTION 6E3-C3).

FUEL TANK

The fuel tank is used to store fuel for the vehicle and has a 15½ gallon capacity. The tank is located in the rear of the vehicle and is held in place by two metal straps that are attached to the frame. The fuel tank is made of steel and is coated internally with a special corrosion inhibiter.

Fuel Tank Filler Neck

Figure 1

To prevent refueling with leaded fuel, the fuel filler neck has a built-in restrictor and deflector.

Fuel Filler Cap

Figure 1

Failure to use the correct cap can result in a serious malfunction of the system. The fuel tank filler neck is equipped with a non-vented threaded-type cap. The threaded part of the cap requires several turns counterclockwise to remove. A built-in torque-limiting device prevents over tightening. To install, turn the cap clockwise two full turns until a clicking noise is heard. This signals that the correct torque has been reached and the cap is fully seated.

NOTICE: If a fuel filler cap requires replacement, use only a cap with the same features.

FUEL LEVEL SENDER ASSEMBLY

Figure 2

The fuel level sender assembly is attached to the top of the tank, and extends from the top of the tank to the sump.

The fuel level sender assembly consists of the following major components: a fuel level sender, fuel pump, fuel pump strainer, pulsator and a roll-over valve.

Fuel Level Sender

Figure 2

The fuel level sender consists of the fuel tank cover plate, fuel feed, return, vapor & vent pipe, a float, wire float arm, sensor and the roll-over valve. The fuel level is sensed by the position of the float arm, and a signal is sent to the display in the vehicle instrument cluster.

The roll-over valve is pressed into the vapor tube of the fuel level sender and is not serviced separately. The roll-over valve prevents fuel spilling from the fuel level sender vapor tube if the vehicle rolls over.

Fuel Pump

Figure 2

There are three different electric fuel pumps used;

- A medium pressure turbing vain pump for vehicles equipped with the 5.0L VIN E TBI engine.
- A high pressure roller vane pump for all vehicles equipped with the 3.1L VIN T.
- A volume, high pressure roller vane pump for the 5.0L VIN F or 5.7L VIN 8 PFI engine.

The fuel pump is mounted to the fuel level sender assembly inside the fuel tank. The fuel is pumped to the engine at a specified flow and pressure via the fuel feed pipe. Excess fuel is returned to the fuel tank via the return line. The fuel pump delivers a constant flow of fuel to the engine even during low fuel conditions and aggressive vehicle maneuvers.

The electric fuel pump operation is controlled by the ECM through a fuel pump relay. Refer to to "Fuel Metering System" located in DRIVEABILITY AND EMISSIONS - TBI (SECTION 6E2-C2) or DRIVEABILITY AND EMISSIONS - PFI (SECTION 6E3-C2) and ELECTRICAL DIAGNOSIS (SECTION 8A) of this manual for further description and a wiring diagram of fuel pump relay.

Fuel Pump Strainer

Figure 2

A woven plastic fuel pump strainer is attached to the lower end of the fuel pump in the fuel tank. The functions of the fuel pump strainer is to filter contaminants and to wick fuel.

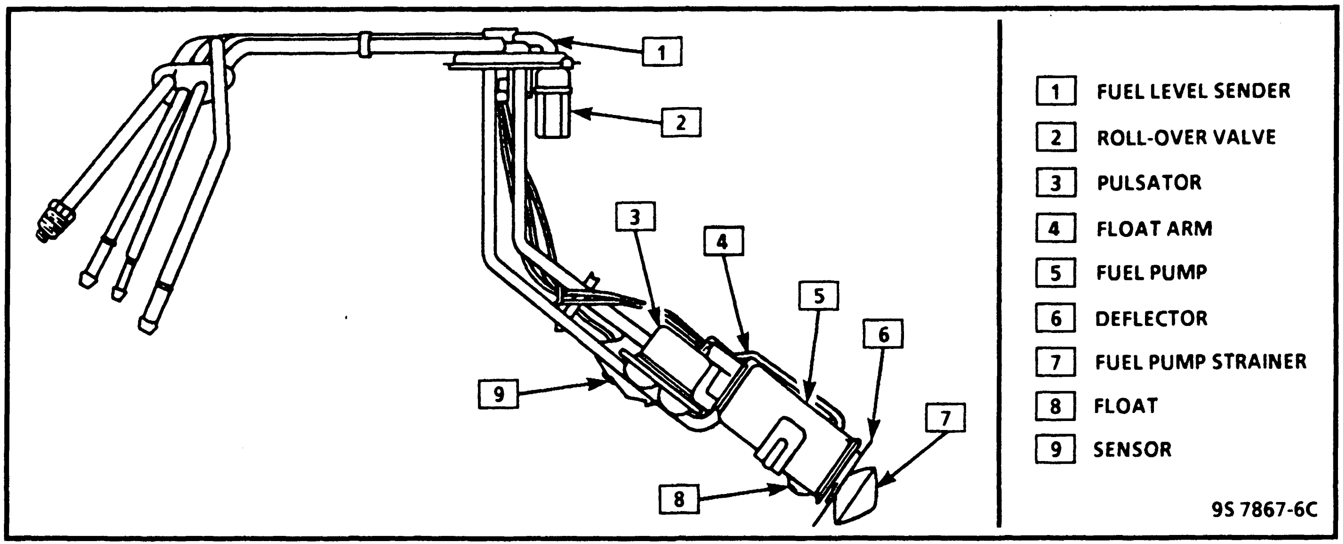


Figure 2 - Fuel Level Sender Assembly (TBI Fuel Level Sender Assembly Similar)

The life of the fuel pump strainer is generally considered to be that of the fuel pump. The fuel pump strainer is self-cleaning and normally requires no maintenance. Fuel stoppage at this point indicates that the fuel tank contains an abnormal amount of sediment or water. In which case the tank should be thoroughly cleaned. (See "Fuel System Cleaning.") If the fuel pump strainer is plugged, replace it with a new one.

Pulsator (P F I engines only)
Figure 2

The pulsator is installed between the fuel pump and the fuel level sender assembly feed pipe to dampen fuel pulsation and reduce noise generated by the fuel pump. It is used with the roller vane pumps only. A fifteen micron fuel filter is used in the fuel feed pipe ahead of the fuel injection system and mounted directly in front of the rear axle. The filter housing is constructed of steel with threaded fittings at both ends. The fittings are sealed with O-rings. The filter element is made of paper, and is designed to trap particles in the fuel that may damage the injection system.

IN-LINE FUEL FILTER
Figure 3

A fifteen micron fuel filter is used in the fuel feed pipe ahead of the fuel injection system and mounted directly in front of the rear axle. The filter housing is constructed of steel with threaded fittings at both ends. The fittings are sealed with O-rings. The filter element is made of paper, and is designed to trap particles in the fuel that may damage the injection system.

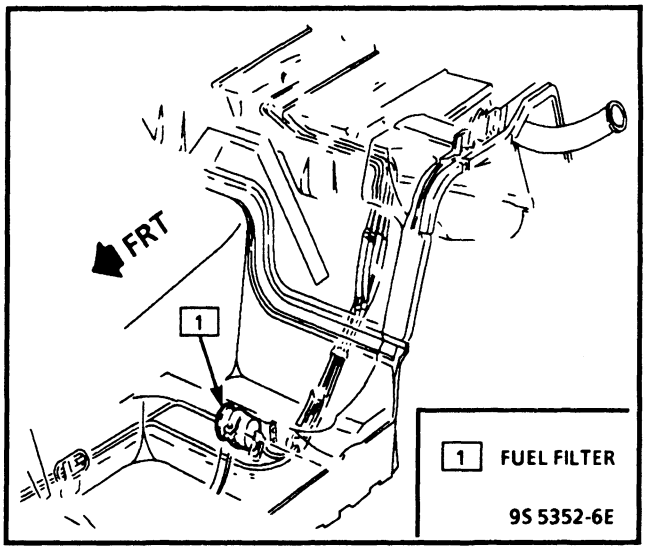


Figure 3 - In-Line Fuel Filter

FUEL FEED AND RETURN PIPES/HOSES

The fuel feed and return pipes and hoses carry fuel from the fuel level sender assembly to the fuel rail assembly. An accumulator is attached to the fuel feed pipe on the 3.1L engine to absorb pulsations that are generated by the injectors cycling. The fuel feed and return pipes and hoses consist of four sections:

- The rear fuel feed pipe assembly is located in front of the fuel tank and connects the in-line fuel filter to the fuel level sender assembly. The fuel feed pipe assembly is constructed of steel and fuel resistant rubber hose.
- The fuel feed and return pipes are located under the vehicle and connect the rear fuel feed pipe assembly and the fuel level sender assembly to the front fuel hose assemblies. These pipes are constructed of steel.

- The front fuel hose assemblies are located in the engine compartment and connect the fuel feed and return pipes to the engine fuel pipes. These fuel hose assemblies are constructed of steel fittings and fuel resistant rubber hose assemblies.
- The engine fuel pipes are attached to the engine and connect the front fuel pipe assemblies to the fuel rail or TBI unit. These pipes are constructed of steel.

Fuel Line O-rings

The feed and return pipe connections are sealed with O-ring seals. Fuel system O-ring seals are made of special material, and should only be serviced with the correct service part.

FUEL VAPOR PIPES AND HOSES

The vapor pipe extend from the fuel level sender assembly to the charcoal canister. It consists of one section of steel vapor pipe and two fuel resistant rubber connecting hoses.

ACCELERATOR CONTROLS

The accelerator control system is cable type. There are no linkage adjustments. Therefore, the specific cable must be used.

DIAGNOSIS

ALCOHOL-IN-FUEL

Alcohol-in-fuel can be detrimental to fuel system components and may cause driveability problems such as hesitation, lack of power, stall, no start, etc.

The problems may be due to fuel system corrosion and subsequent fuel filter or strainer plugging, deterioration of rubber components and/or air-fuel mixture leaning.

Various types and concentrations of alcohol are used in commercial fuel. Some alcohol are more detrimental to fuel system components than others. If an excessive amount of alcohol in the fuel is suspected as the cause of a driveability condition, the following procedure may be used to detect the presence of alcohol in the fuel. In this procedure, water is used to extract the alcohol from the fuel.

Testing Procedure

The fuel sample should be drawn from the bottom of the tank so that any water present in the tank will be detected. The sample should be bright and clear. If the sample appears cloudy, or contaminated with water (as indicated by a water layer at the bottom of the sample), this procedure should not be used, and the fuel system should be cleaned (see "Fuel System Cleaning").

1. Using a 100 ml cylinder with 1 ml graduation marks, fill with fuel to the 90 ml mark.
2. Add 10 ml of water to bring the total fluid volume to 100 ml and install a stopper.
3. Shake vigorously for 10 to 15 seconds.
4. Carefully loosen the stopper to release pressure.
5. Close the stopper and shake vigorously again for 10 to 15 seconds.
6. Put the graduated cylinder on a level surface for approximately 5 minutes to allow adequate liquid separation.

If alcohol is present in the fuel, the volume of the lower layer (which would now contain both alcohol and water) will be greater than 10 ml. For example, if the volume of the lower layer is increased to 15 ml, it will indicate at least 5 percent alcohol in fuel. The actual amount of alcohol may be somewhat greater because this procedure does not extract all of the alcohol from the fuel.

FUEL TANK LEAK CHECK

Important

- Before attempting "Fuel Tank Leak Check " place a dry chemical (Class B) fire extinguisher near work area.
- Before removing the fuel tank for a suspected leak, make sure fuel pipes are not leaking onto the tank. Once removed, make sure fuel is not leaking around fuel level meter assembly O-ring.
- This check requires a fuel level sender assembly, fuel filler cap, and a O-ring to be installed in the fuel tank.

1. Relieve fuel system pressure (see applicable "Fuel System Pressure Relief" procedure).
2. Drain fuel tank (see"Draining Fuel Tank")
3. Remove fuel tank (see "Fuel Tank Replacement").
4. Cap fuel feed tube, fuel return tube, and vapor tube on fuel level sender assembly.
5. Connect a piece of hose to the vent tube.
6. Submerge tank in water or apply soap solution to outside of tank.
7. Apply 7 to 10 kPa (1 to 1½ psi) air pressure to the piece of hose on the fuel tank vent tube.
   - Air bubbles appearing from fuel tank indicate a leak. Replace fuel tank if it is leaking (see "Fuel Tank Replacement").

ON-VEHICLE SERVICE

Important

- Before attempting any "On-Vehicle Service" place a dry chemical (Class B) fire extinguisher near work area.

FUEL SYSTEM PRESSURE RELIEF (TBI)

CAUTION:
- **To reduce the risk of fire and personal injury, it is necessary to relieve the fuel system pressure before servicing fuel system components.**
- **A small amount of fuel may be released when servicing fuel lines or connections. In order to reduce the chance of personal injury, cover fuel line fittings with a shop towel before disconnecting, to catch any fuel that may leak out. Place the towel in an approved container when disconnect is completed.**

1. Disconnect negative battery terminal to avoid possible fuel discharge if an accidental attempt is made to start the engine.
2. Loosen fuel filler cap to relieve tank vapor pressure. (Do not tighten until service has been completed.)
3. The internal constant bleed feature of TBI Model 220 relieves fuel pump system pressure when the engine is turned "OFF." Therefore, no further action is required.

FUEL SYSTEM PRESSURE RELIEF (PFI)

Tool required: J 34730-1 Fuel Pressure Gage

CAUTION:
- **To reduce the risk of fire and personal injury, it is necessary to relieve the fuel system pressure before servicing fuel system components.**
- **A small amount of fuel may be released when servicing fuel pipes or connections. In order to reduce the chance of personal injury, cover fuel pipe fittings with a shop towel before disconnecting, to catch any fuel that may leak out. Place the towel in an approved container when disconnect is completed.**

1. Disconnect negative battery terminal to avoid possible fuel discharge if an accidental attempt is made to start the engine.
2. Loosen fuel filler cap to relieve tank pressure.
3. Connect J 34730-1 to fuel pressure valve. Wrap a shop towel around fitting while connecting gage to avoid spillage.
4. Install bleed hose into an approved container and open valve to bleed system pressure. Fuel connections are now safe for servicing.
5. Drain any fuel remaining in gage into an approved container.

IDLE LEARN PROCEDURE (3.1L, VIN T)

Any time the battery is disconnected, the programmed position of the IAC valve pintle is lost, and replaced with a "default" value. To return the IAC valve pintle to the correct position, perform the following procedure:

1. Restore battery power.
2. Connect TECH I "Scan" tool.
3. Select "IAC System," then select "Idle Learn" in the "Misc. Test" mode.
4. Proceed with idle learn as directed.

This procedure allows the ECM memory to be updated with the correct IAC valve pintle position, for the vehicle, and provide a stable idle speed.

IN-LINE FUEL FILTER REPLACEMENT
Figure 4

↔ Remove or Disconnect

1. Relieve fuel system pressure (see applicable "Fuel System Pressure Relief" procedure).
2. Raise vehicle on hoist.

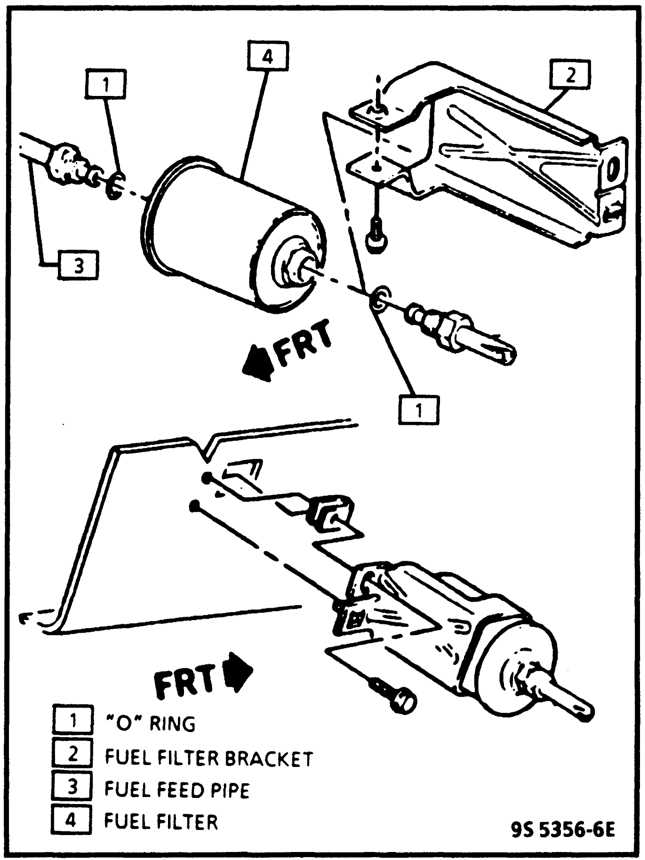


Figure 4 - In-Line Fuel Filter Replacement

Clean

- Clean both fuel feed pipe connections and surrounding areas at in-line fuel filter before disconnecting to avoid possible contamination of the fuel system.

3. Fuel feed pipe and rear fuel feed pipe assembly from filter.
4. Fuel filter bracket screw from fuel filter bracket.
5. Slide fuel filter out of fuel filter bracket.

Inspect

- Fuel line O-rings for cuts, nicks, swelling or distortion. Replace if necessary.

Install or Connect

1. Position new filter in fuel filter bracket. Flow arrow must point toward engine.
2. Fuel filter bracket screw on fuel filter bracket.
3. Fuel feed pipe and rear fuel feed pipe assembly to the fuel filter.

Tighten

- Use back-up wrench to prevent filter from turning.
- In-line fuel filter fittings to 27 N·m (20 lb. ft.).

4. Lower vehicle.
5. Tighten fuel filler cap.
6. Negative battery terminal.

Inspect

- Turn ignition switch to "ON," position for two seconds, then turn to "OFF" for five seconds. Again turn to"ON" position, and check for fuel leaks.

7. For vehicles equipped with the 3.1L engine, refer to "Idle Learn Procedure." The ECM will need to relearn the IAC valve pintle position following battery reconnect.

DRAINING FUEL TANK

CAUTION: **Never drain or store fuel in an open container due to the possibility of fire or explosion.**

- Use a hand operated pump device to drain fuel through the fuel filler tube. Remove fuel and install fuel filler cap.

FUEL TANK REPLACEMENT

Figure 5

Remove or Disconnect

CAUTION: **To help avoid personal injury when a vehicle is on a hoist, provide additional support for the vehicle on the opposite end from which components are being removed. This will reduce the possibility of the vehicle falling off the hoist.**

Remove or Disconnect

1. Relieve fuel system pressure (see applicable "Fuel System Pressure Relief" procedure).
2. Fuel filler neck shield and attaching screws (3).
3. Drain fuel tank (see "Draining Fuel Tank").
4. Raise vehicle on hoist.
5. Rear axle assembly, refer to REAR AXLE (SECTION 4B).
6. Exhaust system (pipe & muffler) refer to, ENGINE EXHAUST (SECTION 6F).
7. Muffler heat shield and attaching screws (6).

Clean

- Clean all fuel pipe and hose connections and surrounding areas before disconnecting to avoid possible contamination of the fuel system.

8. Rear fuel feed pipe assembly from fuel level sender assembly.
9. Fuel return, vapor, and vent hoses and clamps at fuel level sender assembly.
10. Electrical connector.

NOTICE: Do not bend fuel tank straps, as this may damage straps.

11. With aid of an assistant,support fuel tank, and remove fuel tank strap front attaching bolts (2), fuel tank straps (2) and remove fuel tank.
    - Fuel tank from vehicle and place in a suitable work area.

Disassemble

1. Fuel tank insulator pads (2) and tank strap insulator pads (2). If damaged, otherwise leave on.
2. Fuel level sender assembly (see "Fuel Level Sender Assembly Replacement").

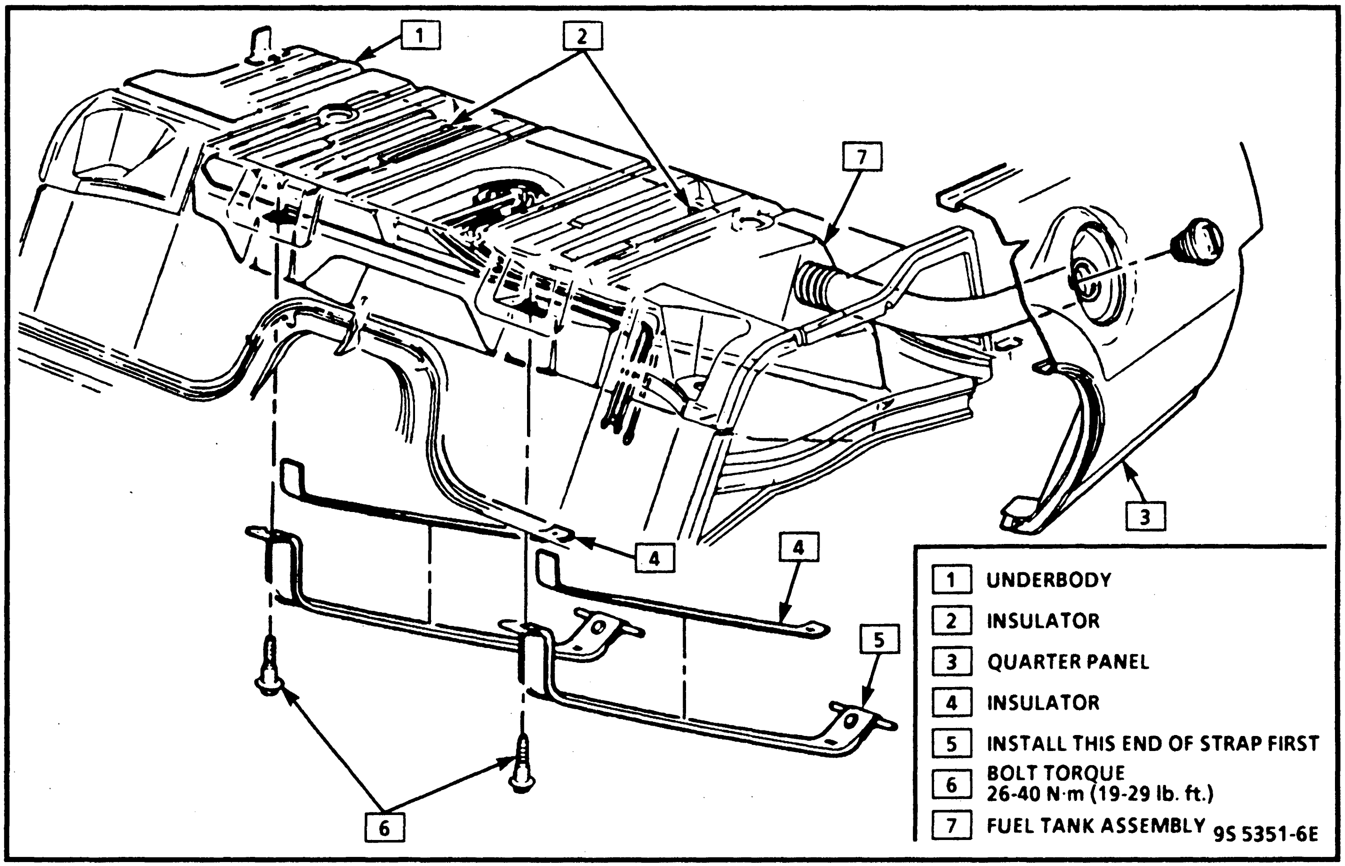


Figure 5 - Fuel Tank Insulators & Fuel Tank Mounting

Inspect

- Fuel pipe O-rings for cuts, nicks, swelling or distortion. Replace if necessary.

Assemble

1. Install fuel level sender assembly (see "Fuel Level Sender Assembly Replacement").
2. Install tank strap insulator pads (2) and fuel tank insulator pads (2). If needed.
   - Peel off release paper on insulators and apply to tank and straps.

Install or Connect

1. Hook rear end of fuel tank straps (2) into underbody bracket.
2. With the aid of assistant, position and support fuel tank. position fuel tank straps (2), loosely install front fuel tank strap attaching bolts.

Tighten

- Front fuel tank strap attaching bolts (2) to 34 N·m (25 lb. ft.).

2. Electrical connector.
3. Fuel return, vapor, and vent hoses and clamps at fuel level sender assembly.
4. Rear fuel feed and return pipe assemblies to fuel level sender assembly.

Tighten

- Use back-up wrench to prevent filter from turning.
- Rear fuel feed and return pipe assembly fittings to 27 N·m (20 lb. ft.).

5. Muffler heat shield and attaching screws (6).
6. Exhaust system (pipe & muffler) refer to, ENGINE EXHAUST (SECTION 6F).
7. Rear axle assembly, refer to REAR AXLE (SECTION 4B).
8. Lower vehicle.
9. Fuel filler neck shield and attaching screws (3).
10. Add fuel and install fuel filler cap.
11. Negative battery terminal.

Inspect

- Turn ignition switch to "ON," position for two seconds, then turn to "OFF" for five seconds. Again turn to"ON" position, and check for fuel leaks.

12. For vehicles equipped with the 3.1L engine, refer to "Idle Learn Procedure." The ECM will need to relearn the IAC valve pintle position following battery reconnect.

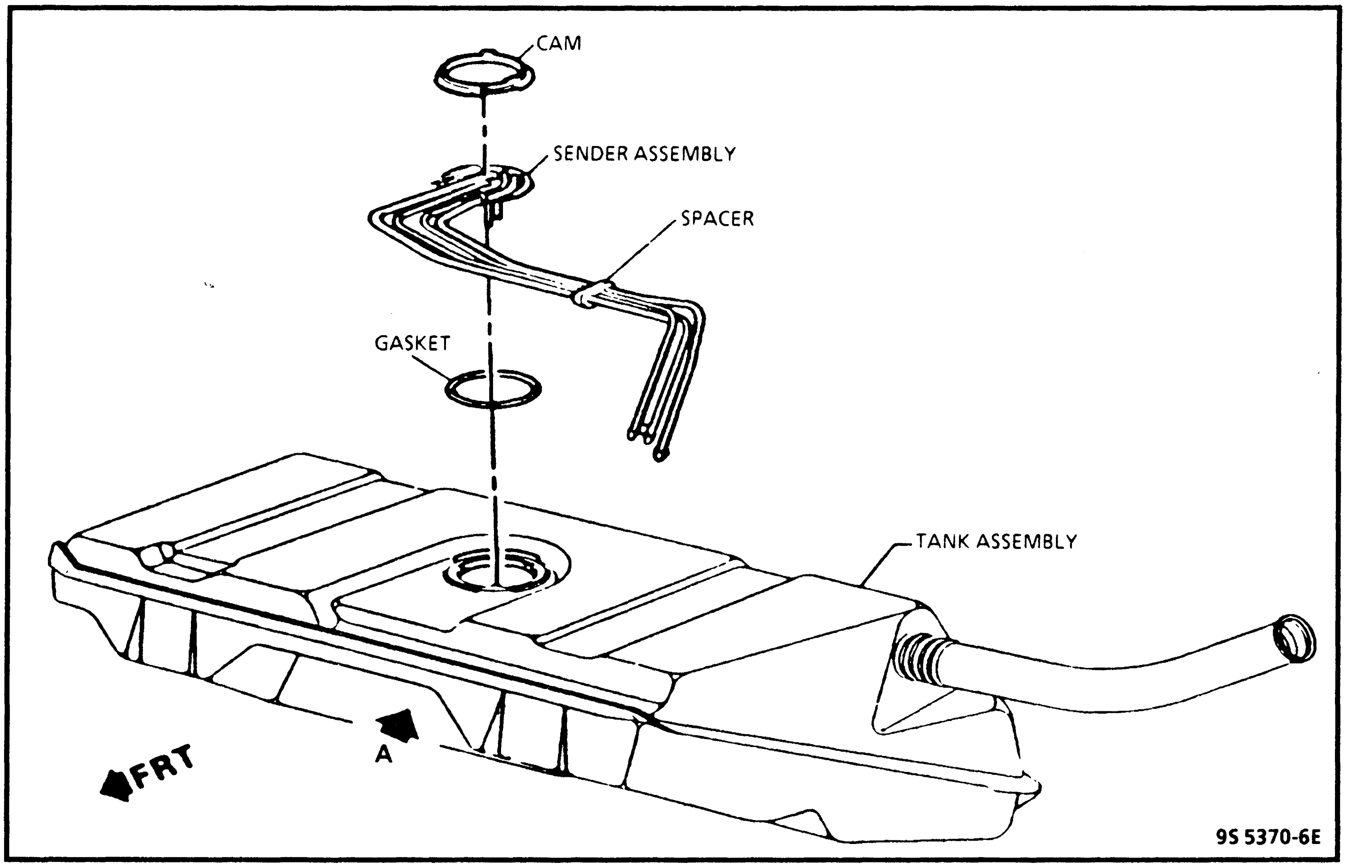


Figure 6 - Fuel Level Meter Assembly Replacement

FUEL LEVEL SENDER ASSEMBLY REPLACEMENT

Figure 6

NOTICE: Do not handle the fuel tank by the fuel level sender fuel tubes. Due to the length of the tubes, the amount of leverage generated could damage the solder joints.

Important

- Always replace fuel level sender assembly O-rings, when reinstalling fuel level sender assembly with the special reinforced O-ring.

Remove or Disconnect

1. Relieve fuel system pressure (see applicable "Fuel System Pressure Relief" procedure).
2. Drain fuel tank (see "Draining Fuel Tank").
3. Fuel tank (see "Fuel Tank Replacement").

Clean

- Clean all fuel pipe and hose connections and surrounding areas before disconnecting to avoid possible contamination of the fuel system.

Disassemble

- Tool Required: J 24187 Fuel Tank Sending Unit Spanner Wrench.

1. Using J 24187 remove fuel level sender assembly retaining cam, fuel level sender assembly and O-ring from fuel tank. Discard fuel level sender, assembly O-ring, and fuel level sender feed tube O-ring.

Cleaning and Inspection

- Fuel level sender assembly O-ring sealing surfaces.

Assemble

1. Position new fuel level sender assembly O-ring on fuel tank.
2. Position new O-ring on fuel level sender assembly fuel feed tube.

Important

- Fuel pump strainer must be in a horizontal position. When installing the fuel level sender assembly, assure that the fuel pump strainer does not block full travel of float arm.

3. Gently fold fuel strainer over itself.

- Slowly position fuel level sender assembly in fuel tank so that fuel strainer is not damaged or trapped by sump walls.

4. Install fuel level sender assembly retainer cam using J 24187.

Install or Connect.

1. Fuel tank and check for leaks (see "Fuel Tank Replacement").
2. For vehicles equipped with the 3.1L engine, refer to "Idle Learn Procedure." The ECM will need to relearn the IAC valve pintle position following battery reconnect.

Fuel Pump Strainer Replacement
Figure 7

Remove or Disconnect

1. Relieve fuel system pressure (see applicable "Fuel System Pressure Relief" procedure).
2. Drain fuel tank (see "Draining Fuel Tank").
3. Fuel tank (see "Fuel Tank Replacement").
4. Fuel level sender assembly (see "Fuel Level Sender Assembly Replacement").

Disassemble

- Support pump with one hand and grasp strainer with other hand.
  - Rotate strainer in one direction and pull fuel strainer and deflector off of pump. Discard strainer after inspection.

Inspect

- Fuel pump strainer. If strainer is contaminated, the fuel tank should be cleaned.
- Fuel pump inlet for dirt and debris. If found, fuel pump should be replaced.

Assemble

- Support pump with one hand and position deflector on fuel pump.
  - Position new pump strainer on fuel pump in same position as noted during removal. Push on outer edge of strainer ferrule until fully seated.

Install or Connect

1. Fuel level sender assembly (see "Fuel Level Sender Assembly Replacement").
2. Fuel tank and check for leaks (see "Fuel Tank Replacement").
3. For vehicles equipped with the 3.1L engine, refer to "Idle Learn Procedure." The ECM will need to relearn the IAC valve pintle position following battery reconnect.

Fuel Pump Replacement
Figure 7

Remove or Disconnect

1. Relieve fuel system pressure (see applicable "Fuel System Pressure Relief" procedure).
2. Drain fuel tank (see "Draining Fuel Tank").
3. Fuel tank (see "Fuel Tank Replacement").
4. Fuel level sender assembly (see "Fuel Level Sender Assembly Replacement").

Disassemble

1. Support pump with one hand and grasp strainer with other hand.
   - Rotate strainer in one direction and pull fuel strainer and deflector off of pump. Discard strainer after inspection.
2. Fuel pump electrical connector.

If working on 5.0L VIN E (TBI model), proceed to and complete steps 4 and 5.

3. Place fuel level sender assembly upside down on bench.
   - Pull fuel pump downward to remove from mounting bracket, then tilt pump outward and remove from pulsator.

NOTICE: Do not run fuel pump unless submerged in fuel.

4. Loosen coupler clamps (2).
5. Place fuel level sender assembly upside down on bench.
   - Pull fuel pump downward to remove from mounting bracket, then tilt pump outward and remove from coupler.

NOTICE: Do not run fuel pump unless submerged in fuel.

Inspect

- Fuel pump strainer. If strainer is contaminated, the fuel tank should be cleaned.
- Fuel pump inlet for dirt and debris. If found, fuel pump should be replaced.

Assemble

1. Rubber bumper and rubber insulator on fuel pump.

If working on 5.0L VIN E (TBI model), proceed to and complete step 3.

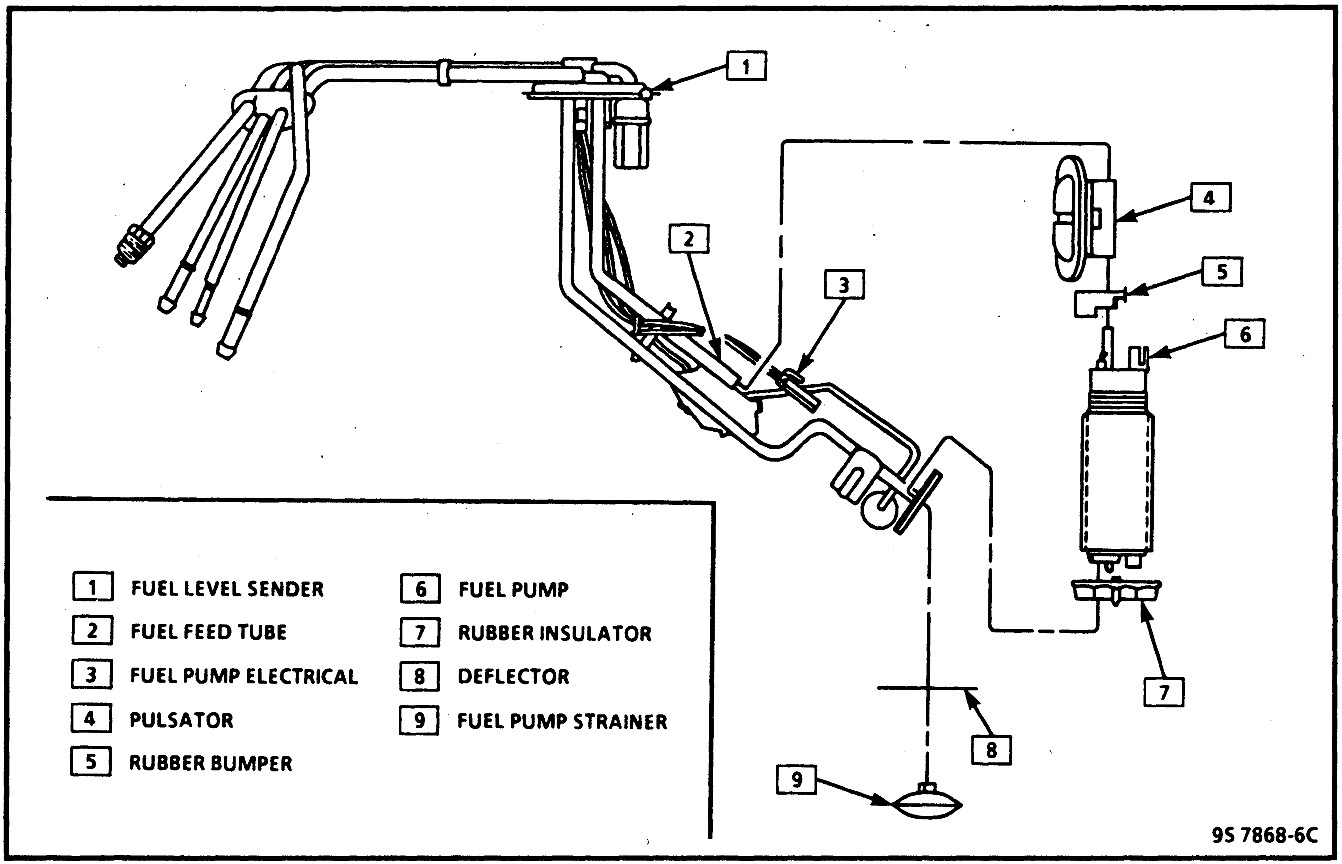


Figure 7 - Fuel Level Sender Assembly Disassembly (5.0L VIN E TBI Similar)

2. Position fuel level sender assembly upside down.
   - Install fuel pump between pulsator and mounting bracket.
3. Position fuel level sender assembly upside down and install coupler and coupler clamps (2) on inlet tube (do not tighten clamps at this time).
   - Install fuel pump between coupler and mounting bracket and tighten clamps (2) so that 5 to 8 teeth are engaged.
4. Fuel pump electrical connector.

Important

- Always install a new pump strainer when installing fuel pump.

5. Position deflector and new pump strainer on fuel pump in same position as noted during removal. Push on outer edge of strainer ferrule until fully seated.

Install or Connect

1. Fuel level sender assembly (see "Fuel Level Sender Assembly Replacement").
2. Fuel tank and check for leaks (see"Fuel Tank Replacement").
3. For vehicles equipped with the 3.1L engine, refer to "Idle Learn Procedure." The ECM will need to relearn the IAC valve pintle position following battery reconnect.

Pulsator Replacement (PFI Engines)

Figure 7

Remove or Disconnect

1. Relieve fuel system pressure (see applicable "Fuel System Pressure Relief" procedure).
2. Drain fuel tank (see "Draining Fuel Tank").
3. Fuel tank (see "Fuel Tank Replacement").
4. Fuel level sender assembly (see "Fuel Level Sender Assembly Replacement").

Disassemble

1. Support pump with one hand and grasp strainer with other hand.
   - Rotate strainer in one direction and pull fuel strainer and deflector off of pump. Discard strainer after inspection.
2. Fuel pump electrical connector.
3. Place fuel level sender assembly upside down on bench.
   - Pull fuel pump downward to remove from mounting bracket, then tilt pump outward and remove from pulsator.

NOTICE: Do not run fuel pump unless submerged in fuel.

4. Note position of pulsator on inlet tube, then remove pulsator from tube.

Inspect

- Dry pulsator with a shop towel.
- Shake pulsator while listening for trapped fuel movement inside pulsator. If fuel is heard inside pulsator, replace pulsator.
- Fuel pump strainer. If strainer is contaminated, the fuel tank should be cleaned.
- Fuel pump inlet for dirt and debris. If found, fuel pump should be replaced.

Assemble

1. Pulsator in same position as noted during disassembly.
2. Rubber bumper and rubber insulator on fuel pump.
3. Position fuel level sender assembly upside down.
   - Install fuel pump between pulsator and mounting bracket.
4. Fuel pump electrical connector.

Important

- Always install a new pump strainer when installing fuel pump.

5. Position deflector and new pump strainer on fuel pump in same position as noted during removal. Push on outer edge of strainer ferrule until fully seated.

Install or Connect

1. Fuel level sender assembly (see "Fuel Level Sender Assembly Replacement").
2. Fuel tank and check for leaks (see "Fuel Tank Replacement").
3. For vehicles equipped with the 3.1L engine, refer to "Idle Learn Procedure." The ECM will need to relearn the IAC valve pintle position following battery reconnect.

Fuel Level Sender Replacement
Figure 7

Remove or Disconnect

1. Relieve fuel system pressure (see applicable "Fuel System Pressure Relief" procedure).
2. Drain fuel tank (see "Draining Fuel Tank").
3. Fuel tank (see "Fuel Tank Replacement").
4. Fuel level sender assembly (see "Fuel Level Sender Assembly Replacement").

Disassemble

- Vehicle with 5.0L VIN E: Disassemble fuel level sender assembly according to instructions for "Fuel Pump Replacement." Transfer fuel pump coupler and clamps (2) to new fuel level sender.
- Vehicle with 3.1L VIN T, 5.0L VIN F or 5.7L VIN 8: Disassemble fuel level sender assembly according to instructions for "Fuel Pump Pulsator Replacement." Transfer fuel pump and pulsator to new fuel level sender.

Assemble

- Vehicle with 5.0L VIN E: Assemble fuel level sender assembly according to instructions for "Fuel Pump Replacement."
- Vehicle with 3.1L VIN T, 5.0L VIN F or 5.7L VIN 8: Assemble fuel level sender assembly according to instructions for "Fuel Pump Pulsator Replacement."

Install or Connect

1. Fuel level sender assembly (see "Fuel Level Sender Assembly Replacement").
2. Fuel tank and check for leaks (see "Fuel Tank Replacement").
3. For vehicles equipped with the 3.1L engine, refer to "Idle Learn Procedure." The ECM will need to relearn the IAC valve pintle position following battery reconnect.

FUEL SYSTEM CLEANING

The following procedure covers disassembly and inspection of the complete fuel supply system. If the fuel system is contaminated it can be cleaned. The extent of fuel system contamination can usually be determined during disassembly.

1. Relieve fuel system pressure (see applicable "Fuel System Pressure Relief" procedure).
2. Remove in-line fuel filter (see "In-Line Fuel Filter Replacement").

Inspect

- Contamination of the in-line fuel filter. If filter is plugged or contaminated, replace it after cleaning fuel lines.

3. Drain fuel tank (see "Draining Fuel Tank").
4. Remove fuel tank (see "Fuel Tank Replacement").
5. Locate tank in a suitable work area away from heat, flame or other source of ignition.
6. Remove fuel level sender assembly (see "Fuel Level Sender Assembly Replacement").

Inspect

- Fuel pump strainer. If strainer is contaminated, it must be replaced and the fuel tank should be cleaned.
- Fuel pump inlet for dirt and debris. If found, fuel pump should be replaced.

7. Flush fuel tank with running hot water for at least five minutes. Pour water out of fuel level sender assembly opening and fuel filler opening. (Rock tank to be sure that removal of water from tank is complete).
8. Disconnect front fuel feed and return pipe/hose assemblies from front fuel feed and return pipes (at engine compartment bulk head).
9. Using oil free compressed air, apply air pressure to front fuel feed and return pipe/hose assemblies (at the engine compartment) and to the rear fuel feed assembly (rear of inline filter) in opposite direction of normal fuel flow.

Inspect

- Fuel pipe O-rings for cuts, nicks, swelling or distortion. Replace if necessary.

10. Connect front fuel feed and return pipe/hose assemblies to the front fuel feed and return pipes.

Tighten

- Front fuel feed and return pipe/hose assembly fittings to 27 N·m (20 lb. ft.).

11. Install fuel level sender assembly (see "Fuel Level Sender Assembly Replacement").
12. Install fuel tank (see "Fuel Tank Replacement").
13. Install in-line fuel filter (see "In-Line Fuel Filter Replacement").
14. Add fuel and install fuel filler cap.
15. Reconnect negative battery terminal.

Inspect

- Turn ignition switch to "ON," position for two seconds, then turn to "OFF" for five seconds. Again turn to"ON" position, and check for fuel leaks.

16. For vehicles equipped with the 3.1L engine, refer to "Idle Learn Procedure." The ECM will need to relearn the IAC valve pintle position following battery reconnect.

FUEL FEED AND RETURN PIPES/HOSES REPLACEMENT

Rear Fuel Feed Pipe/Hose Assembly (Fuel Tank)

Figure 8

NOTICE: Do not attempt to repair rear fuel feed pipe/hose assembly. If damaged, replace.

Remove or Disconnect

1. Relieve fuel system pressure (see applicable "Fuel System Pressure Relief" procedure).

Clean

- Clean all fuel pipe and hose connections and surrounding areas before disconnecting to avoid possible contamination of the fuel system.

2. Rear fuel feed pipe/hose assembly from fuel level sender assembly and inlet side of in-line fuel filter. Discard O-rings.

Install or Connect

1. Position new O-rings on fuel feed pipe/hose assembly.
2. Rear fuel feed pipe/hose assembly to fuel level sender assembly and inlet side of in-line fuel filter.

Tighten

- Rear fuel feed pipe/hose assembly fittings to 27 N·m (20 lb. ft.).

3. Negative battery terminal.
4. Tighten fuel filler cap.

Inspect

- Turn ignition switch to "ON," position for two seconds, then turn to "OFF" for five seconds. Again turn to"ON" position, and check for fuel leaks.

5. For vehicles equipped with the 3.1L engine, refer to "Idle Learn Procedure." The ECM will need to relearn the IAC valve pintle position following battery reconnect.

Fuel Feed and Return Pipes (Under Body)

Figure 8

NOTICE:

- When replacing fuel pipes, always replace them with original equipment or parts that meet the GM specifications for those parts. The replacement pipes must have the same type of fittings as the original pipes to ensure the integrity of the connection.
- Do not use copper or aluminum tubing to replace steel tubing. Only tubing meeting the 124M specification or its equivalent is capable of meeting all pressure, corrosion and vibration characteristics necessary to ensure the durability standard required.
- When replacing fuel hoses or repairing fuel pipes with hoses, always replace them with original equipment or parts meeting GM specifications, use only reinforced fuel-resistant hose which is identified with the word "Fluroelastomer" or "GM 6163-M" on the hose. Inside hose diameter must match outside pipe diameter.

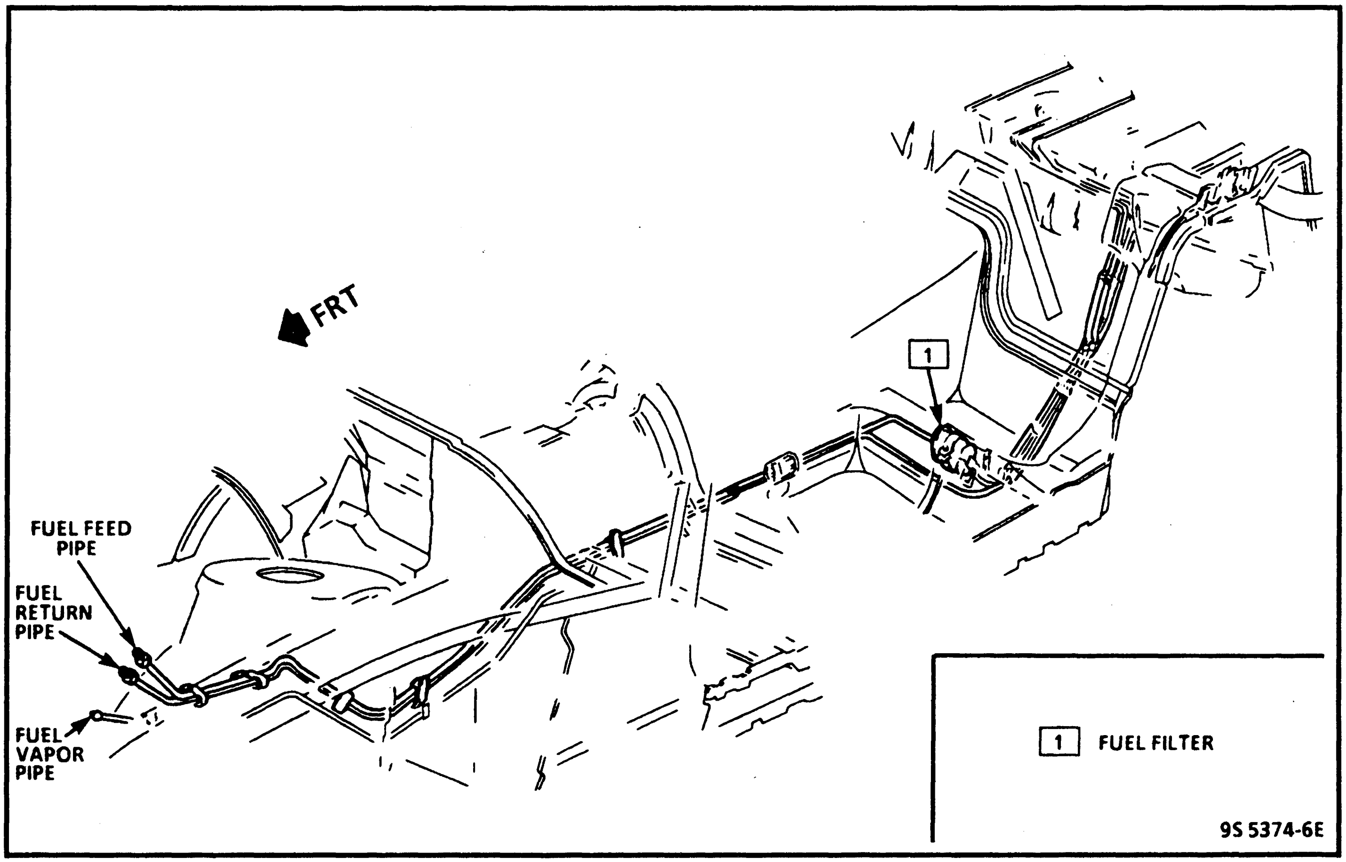


Figure 8 - Fuel and Vapor Pipe Replacement

- Do not use rubber hose within 100 mm (4") of any part of the exhaust system or within 254 mm (10") of the catalytic converter.
- A minimum of 13 mm ($\frac{1}{2}$") clearance must be maintained around sharp edges such as flanges, pinch welds, etc., to prevent contact and chaffing. A minimum of 19 mm ($\frac{3}{4}$") clearance must be maintained around all moving parts.

Remove or Disconnect

1. Relieve fuel system pressure (see applicable "Fuel System Pressure Relief" procedure).

Clean

- Clean all fuel feed and return pipe/hose connections and surrounding areas before disconnecting to avoid possible contamination of the fuel system.

2. Front fuel feed and return pipe/hose assemblies from engine fuel feed and return pipes (at engine compartment bulk head).
3. Raise vehicle.
4. Fuel feed pipe from outlet side of in-line fuel filter. Discard O-ring.
5. Fuel return pipe connecting hose and clamps from fuel level sender assembly and fuel return pipe.
6. Desired fuel pipe and attaching hardware from under body.
   - Note position of coupler for installation.
   - Note position of fuel pipe to be removed for installation.

Inspect

- Pipes for bends, kinks and cracks. Repair or replace pipe or pipes as required.
  - In the repairable areas, cut a piece of fuel hose 100 mm (4") longer than portion of the pipe removed. If more than a 152 mm (6") length of pipe is removed, use a combination of steel pipe and hose so that the total hose lengths, including the 100 mm (4") additional length will not be more than 254 mm (10") long.

Install or Connect

1. Position new or repaired fuel pipe or pipes in body clips as noted during removal and install with attaching hardware.
2. Install coupler in same location as noted during removal.
3. Position new O-rings on fuel feed pipe and connect to outlet side of in-line fuel filter.

Tighten

- Fuel feed pipe fitting to 27 N·m (20 lb. ft.).

4. Fuel return pipe to fuel level sender assembly with connecting hose and clamps.
5. Lower vehicle.
6. Front fuel feed and return pipes to front fuel feed and return pipe/hose assemblies.

Tighten

- Front fuel feed and return pipe/hose assembly fittings to 27 N·m (20 lb. ft.).

7. Tighten fuel filler cap.
8. Negative battery terminal.

Inspect

- Turn ignition switch to "ON," position for two seconds, then turn to "OFF" for five seconds. Again turn to"ON" position, and check for fuel leaks.

9. For vehicles equipped with the 3.1L engines, refer to "Idle Learn Procedure." The ECM will need to relearn the IAC valve pintle position following battery reconnect.

Front Fuel Pipe/Hose Assemblies (Body To Engine)

Figures 9,10,11

NOTICE: • Do Not attempt to repair sections of front fuel pipe/hose assemblies. If damaged, replace.

Remove or Disconnect

1. Relieve fuel system pressure (see applicable "Fuel System Pressure Relief" procedure).

Clean

- Clean all front fuel pipe assembly connections and surrounding areas before disconnecting to avoid possible contamination of the fuel system.

2. Front fuel feed and return pipe/hose assemblies routing strap.
3. Front fuel feed and return pipe/hose assemblies from fuel feed and return pipes (at engine compartment bulk head). Discard O-rings.
4. Front fuel feed and return pipe/hose assemblies from engine fuel pipes.

Install or Connect

1. Position new O-rings on front fuel feed and return pipes.
2. Front fuel feed and return pipe/hose assemblies to engine fuel pipes.
3. Front fuel feed and return pipe/hose assemblies to fuel feed and return pipes.

Tighten

- Front fuel feed and return pipe/hose assembly fittings to 27 N·m (20 lb. ft.).

4. Tighten fuel filler cap.
5. Negative battery terminal.

Inspect

- Turn ignition switch to "ON," position for two seconds, then turn to "OFF" for five seconds. Again turn to "ON" position, and check for fuel leaks.

6. For vehicles equipped with the 3.1L engine, refer to "Idle Learn Procedure." The ECM will need to relearn the IAC valve pintle position following battery reconnect.

Engine Fuel Pipes

Figures 9,10,11

Remove or Disconnect

1. Relieve fuel system pressure (see applicable "Fuel System Pressure Relief" procedure).
2. Air duct or air cleaner from throttle body.

Clean

- Clean all engine fuel pipe connections and surrounding areas before disconnecting to avoid possible contamination of the fuel system.

3. Front fuel feed and return pipe/hose assemblies from engine fuel feed and return pipes (at engine compartment).

Perform step 4. for vehicles equipped with the 3.1L engine.

4. Intake manifold Plenum. Refer to "Fuel Metering System" in DRIVEABILITY AND EMISSIONS (Section 6E3-C2).
5. Engine fuel feed and return pipes attaching hardware.

Perform steps 6. and 7. for all vehicles except those equipped with the 5.0L VIN E engine.

6. Engine fuel feed pipe from fuel rail. Discard O-ring.
7. Engine fuel return pipe from fuel rail. Discard O-ring.

Perform step 8 for vehicles equipped with 5.0L VIN F and 5.7L VIN 8 engines.

8. Loosen generator and rotate outboard to remove fuel pipes. Refer to CHARGING SYSTEM (Section 6D3).

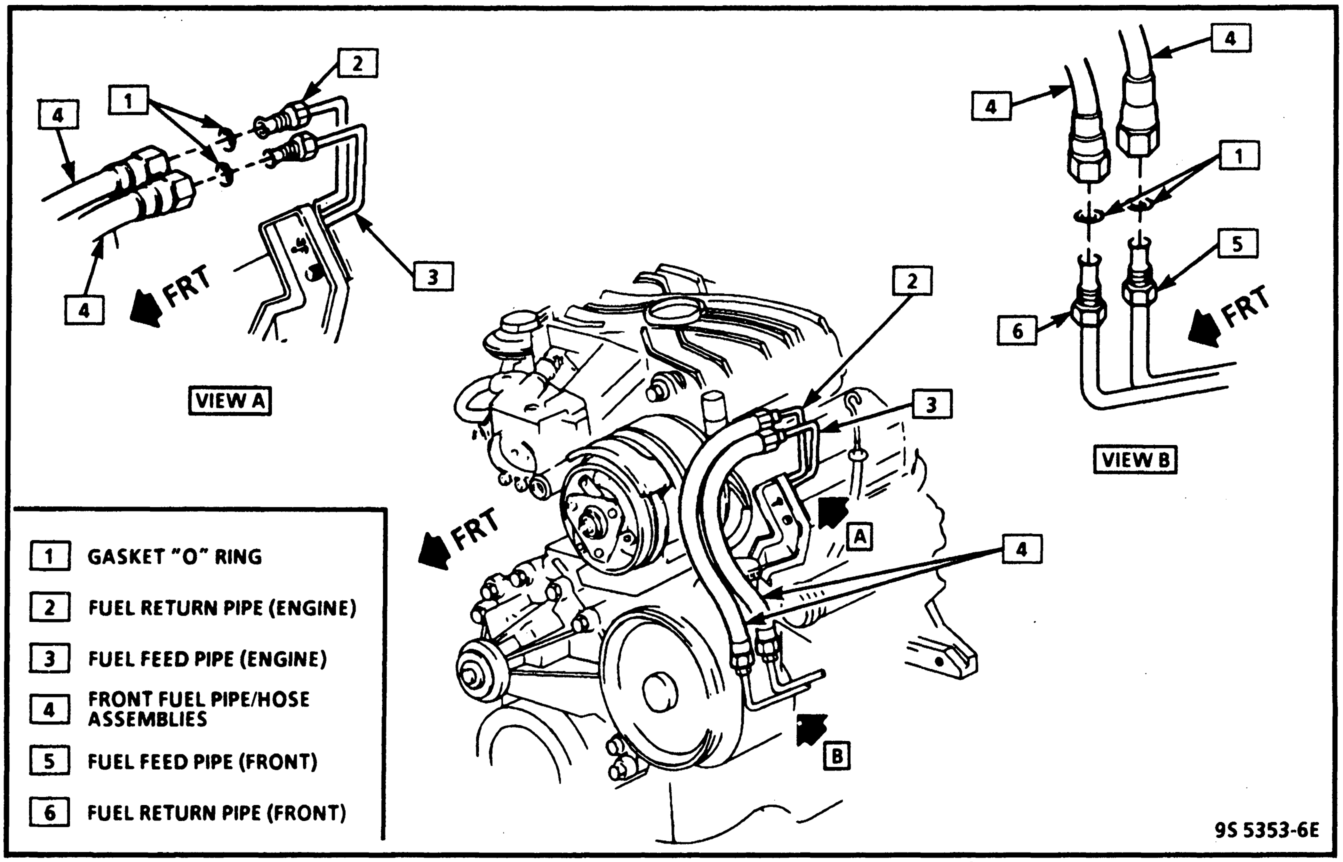


Figure 9 - Engine Fuel Pipes Replacement (3.1L VIN T)

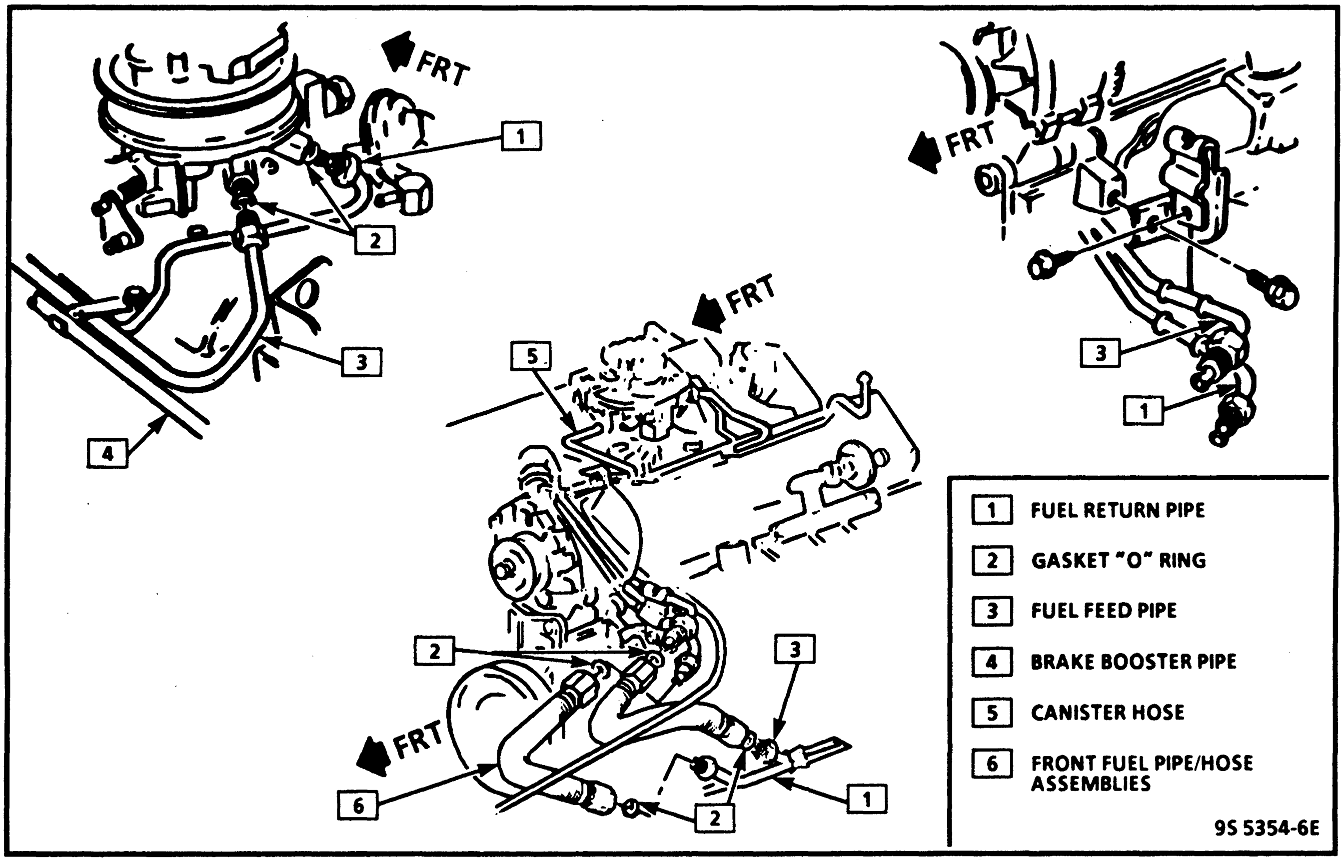


Figure 10 - Engine Fuel Pipes Replacement (5.0L VIN E)

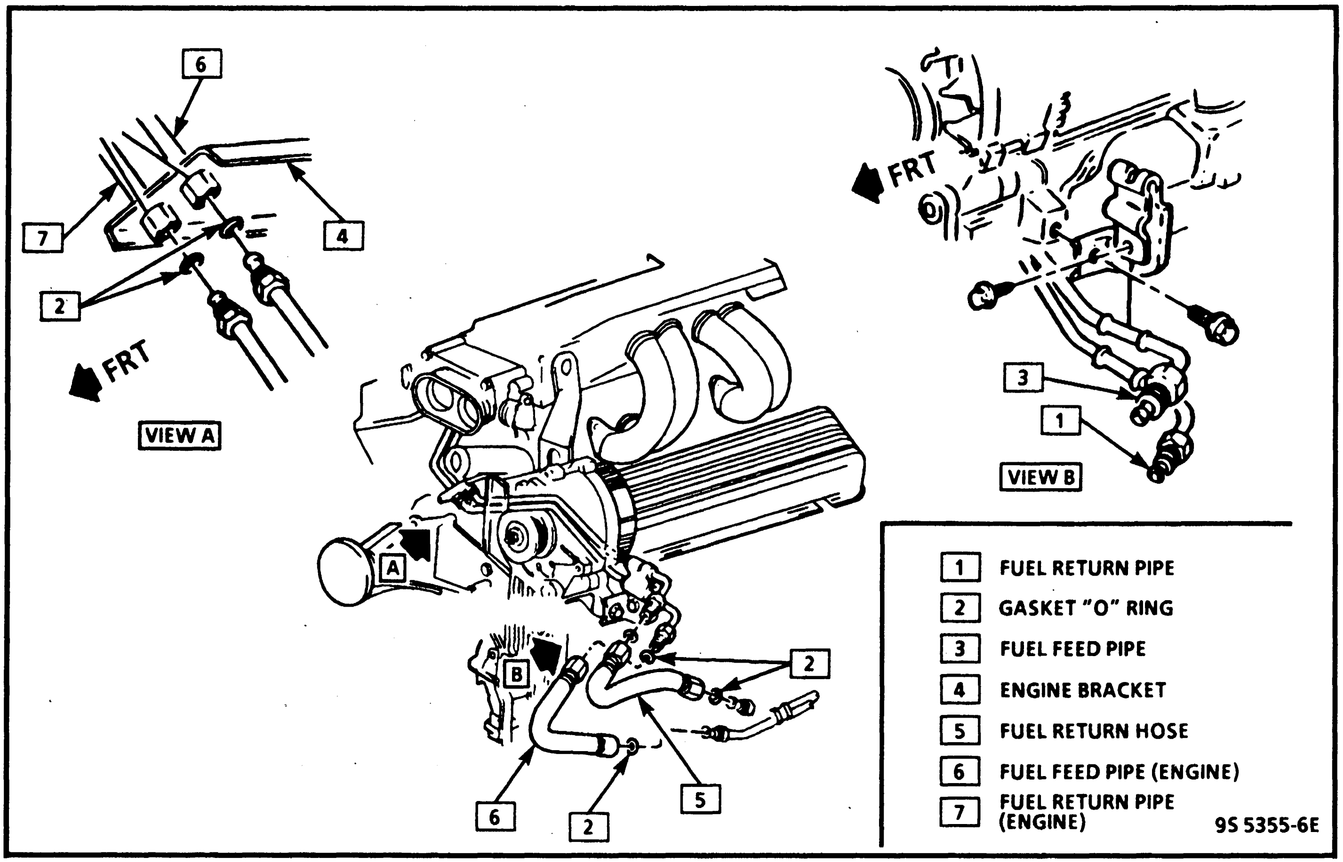


Figure 11 - Engine Fuel Pipes Replacement (5.0L VIN F and 5.7L VIN 8)

Perform steps 9, 10, 11 and 12 for all vehicles equipped with the 5.0L VIN E engine.

9. Brake vacuum pipe
10. Loosen generator and rotate outboard. Refer to CHARGING SYSTEM (SECTION 6D3).
11. Engine fuel feed pipe from throttle body unit. Discard O-ring.
12. Engine fuel return pipe from throttle body unit. Discard O-ring.

Install or Connect

1. New O-rings on engine fuel feed and return pipes.

Perform step 2. for all vehicles except those equipped with the 5.0L VIN E engine.

2. Position engine fuel feed and return pipes to fuel rail and regulator.
   - Finger tighten only.

Perform step 3. for all vehicles equipped with the 5.0L VIN E engine.

3. Position engine fuel feed and return pipes to fuel throttle body unit..
   - Finger tighten only.
4. Engine fuel feed and return pipes to front fuel feed and return pipe/hose assemblies.
   - Finger tighten only.
5. Engine fuel feed and return pipes mounting clamp and attaching screw.

Tighten

- Engine fuel pipe fittings to 27 N·m (20 lb. ft.).

Perform step 6. for vehicles equipped with the 3.1L engine.

6. Intake manifold Plenum. Refer to "Fuel Metering System" in DRIVEABILITY AND EMISSIONS (SECTION 6E3-C2).

Perform step 7. for vehicles equipped with the 5.0L VIN F and 5.7L VIN 8 engines.

7. Generator and adjust belt tension. Refer to CHARGING SYSTEM (SECTION 6D3).

Perform steps 8, 9, 10, 11 and 12 for all vehicles equipped with the 5.0L VIN E engine.

8. Brake vacuum pipe.
9. Generator and adjust belt tension. Refer to CHARGING SYSTEM (SECTION 6D3).

10. Tighten fuel filler cap.
11. Negative battery terminal.

Inspect

- Turn ignition switch to "ON," position for two seconds, then turn to "OFF" for five seconds. Again turn to"ON" position, and check for fuel leaks.

12. For vehicles equipped with the 3.1L engine, refer to "Idle Learn Procedure." The ECM will need to relearn the IAC valve pintle position following battery reconnect.

FUEL VAPOR PIPES AND HOSES REPAIR/ REPLACEMENT

Figure 8

NOTICE:

- When replacing vapor pipes, always replace them with original equipment or parts that meet the GM specifications for those parts.
- Do not use copper or aluminum tubing to replace steel tubing. Only tubing meeting the 124M specification or its equivalent is capable of meeting all pressure, corrosion and vibration characteristics necessary to ensure the durability standard required.
- When replacing vapor hoses or repairing sections of vapor pipe with vapor hoses, always replace them with original equipment or parts meeting GM specifications, use only reinforced fuel-resistant hose which is identified with the word "Fluroelastomer" or "GM 6163-M" on the hose. Inside hose diameter must match outside pipe diameter.
- Do not use rubber hose within 100 mm (4") of any part of the exhaust system or within 254 mm (10") of the catalytic converter.
- A minimum of 13 mm (½") clearance must be maintained around sharp edges such as flanges, pinch welds, etc., to prevent contact and chaffing. A minimum of 19 mm (¾") clearance must be maintained around all moving parts.

Remove or Disconnect

1. Hardware retaining section of pipe to be replaced.
   - Note location of attaching hardware for installation.
2. Section of pipe and hoses.

Inspect

- Hoses for cuts, swelling, cracks and distortion. Replace as required.
- Pipes for kinks and cracks. Repair or replace sections as required.
  - In the repairable areas, cut a piece of fuel hose 100 mm (4") longer than portion of the line removed. If more than a 152 mm (6") length of pipe is removed, use a combination of steel pipe and hose so that the total hose lengths, including the 100 mm (4") additional length will not be more than 254 mm (10") long.

Install or Connect

Important

- Follow the same routing as the original hoses and pipes.
- Hoses and pipes must be properly secured to prevent chafing.
- Reverse removal procedure.

ACCELERATOR CONTROL CABLE REPLACEMENT (3.1L VIN T)

Figures 12, 15

Remove or Disconnect

1. Lower instrument panel trim attaching screws (2), retaining clip and lower instrument panel trim.
2. Accelerator cable from accelerator pedal.
3. Squeeze accelerator cable cover tangs and push cable through dash panel (bulkhead).

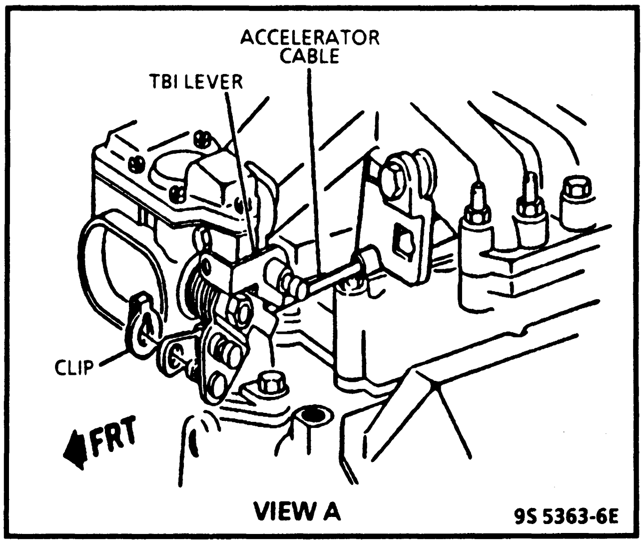


Figure 12 - Accelerator Controls - Engine Compartment (3.1L VIN T)

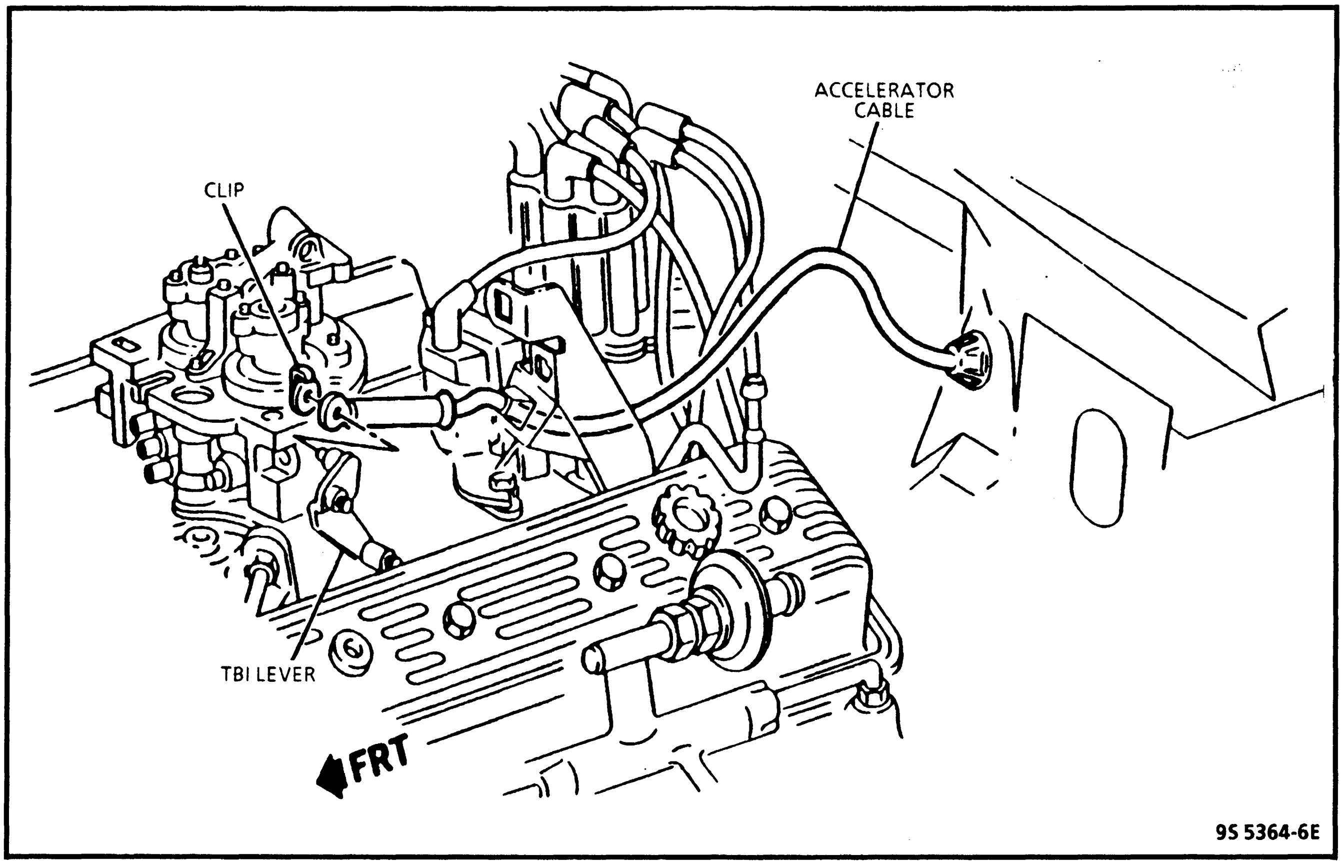


Figure 13 - Accelerator Controls - Engine Compartment (5.0LVIN E)

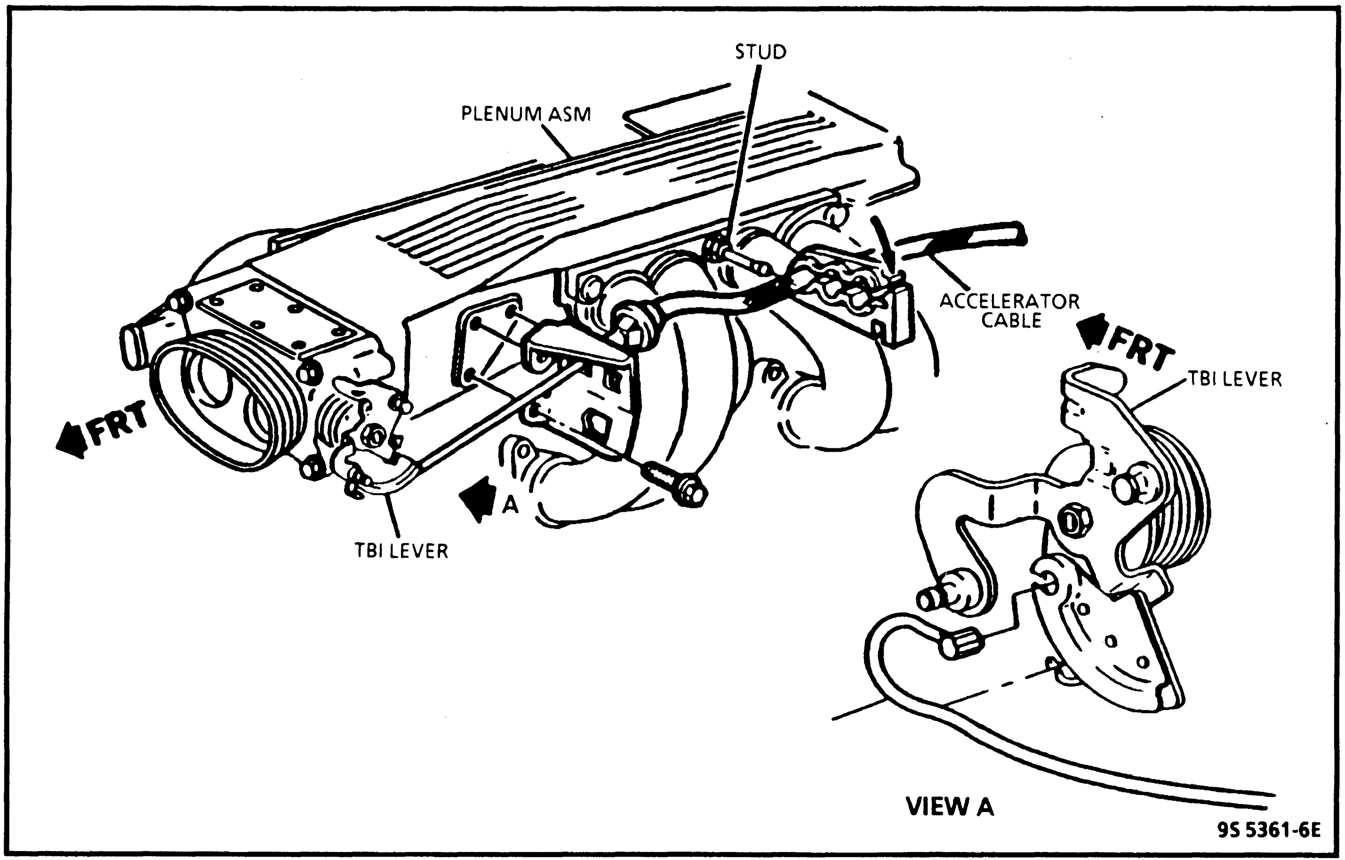


Figure 14 - Accelerator Controls - Engine Compartment (5.0L VIN F and 5.7L VIN 8)

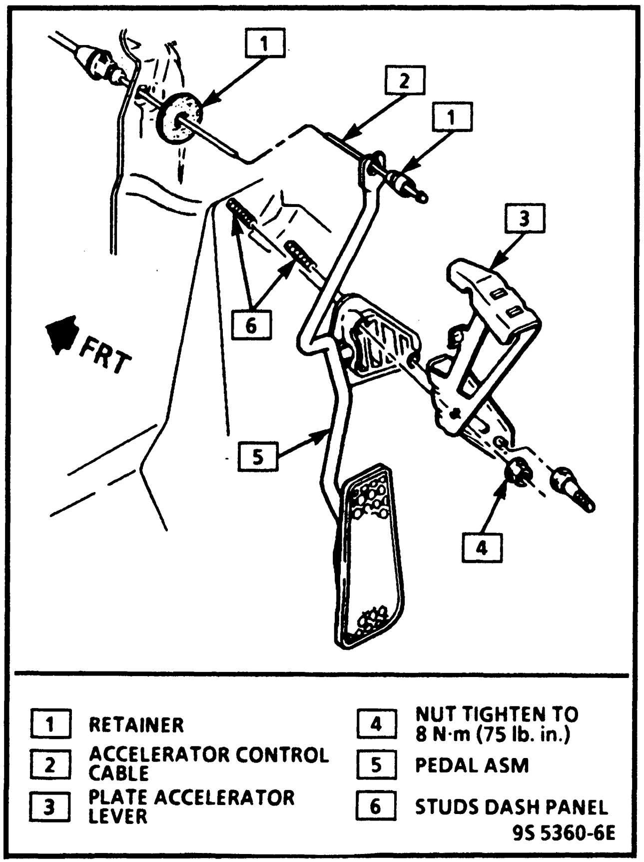


Figure 15 - Accelerator Controls - Pass Compartment

4. (Perform this step for the 3.1L turbo VIN V only) Release cable clamps (2) and remove accelerator cable.
5. (Perform this step and step 6 for the 3.1L VIN T only) Cable clamp attaching screws (2) and cable clamp.
6. Rosebud routing clip and accelerator cable.
7. Accelerator cable retainer and accelerator cable from throttle body lever.
8. Squeeze accelerator cable cover tangs and push cable through accelerator cable bracket.

Install or Connect

NOTICE: To prevent possible interference, flexible components (hoses,wires, conduits, etc.) must not be routed within 50 mm (2") of moving parts, unless routing is positively controlled.

1. Apply Accelerator Linkage Lubricant, 1052541 or equivalent to throttle body lever.
2. Reverse removal procedure.

Inspect

- Check for complete throttle opening and closing positions by operating accelerator pedal. Also check for poor carpet fit under the accelerator pedal. Throttle should operate freely without bind between full closed and wide open throttle.

3. Apply heavy bodied sealer around accelerator cable at engine compartment side of dash panel (bulkhead).

ACCELERATOR CONTROL CABLE REPLACEMENT (5.0L VIN E)

Figures 13, 15

Remove or Disconnect

1. Lower instrument panel trim attaching screws (4), nut and lower instrument panel trim.
2. Accelerator cable from accelerator pedal.
3. Squeeze accelerator cable cover tangs and push cable through dash panel (bulkhead).
4. Accelerator cable retainer and accelerator cable from throttle body lever.
5. Squeeze accelerator cable cover tangs and push cable through accelerator cable bracket.

Install or Connect

NOTICE: To prevent possible interference, flexible components (hoses,wires, conduits, etc.) must not be routed within 50 mm (2") of moving parts, unless routing is positively controlled.

1. Apply Accelerator Linkage Lubricant, 1052541 or equivalent to throttle body lever.
2. Reverse removal procedure.

Inspect

- Check for complete throttle opening and closing positions by operating accelerator pedal. Also check for poor carpet fit under the accelerator pedal. Throttle should operate freely without bind between full closed and wide open throttle.

3. Apply heavy bodied sealer around accelerator cable at engine compartment side of dash panel (bulkhead).

ACCELERATOR CONTROL CABLE REPLACEMENT (5.0L VIN F and 5.7L VIN 8)

Figures 14 and 15

Remove or Disconnect

1. Lower instrument panel trim attaching screws (4), nut and lower instrument panel trim.
2. Accelerator cable from accelerator pedal.
3. Squeeze accelerator cable cover tangs and push cable through dash panel (bulkhead).

4. Accelerator cable routing strap.
5. Release accelerator cable clip and remove accelerator cable.

NOTICE: The accelerator cam is made of steel and is spring loaded. Care should be taken not to damage accelerator cable cam on throttle body when removing cable.

6. Turn accelerator cable cam clockwise and hold.
   - Slide accelerator cable off accelerator cam.
7. Squeeze accelerator cable cover tangs and push cable through accelerator cable bracket.

Install or Connect

NOTICE: To prevent possible interference, flexible components (hoses, wires, conduits, etc.) must not be routed within 50 mm (2") of moving parts unless routing is positively controlled.

1. Reverse removal procedure.

Inspect

- Check for complete throttle opening and closing positions by operating accelerator pedal. Also check for poor carpet fit under the accelerator pedal. Throttle should operate freely without bind between full closed and wide open throttle.

2. Apply heavy bodied sealer around accelerator cable at engine compartment side of dash panel (bulkhead).

ACCELERATOR PEDAL REPLACEMENT
Figure 15

Remove or Disconnect

1. Lower instrument panel trim attaching screws (4), nut and lower instrument panel trim.
2. Accelerator cable from accelerator pedal.
3. Accelerator pedal attaching nuts (2) and accelerator pedal.

Install or Connect

Important

- The mounting surface between support and dash panel must be free of insulation. The carpet and padding in pedal and tunnel area must be positioned to lay flat and be free of wrinkles and bunches.

1. Accelerator pedal, attaching nut and screw.

Tighten

- Accelerator pedal attaching nuts (2) to 8 N·m (75 lb. in.).

2. Accelerator cable on accelerator pedal.

Inspect

- Check for complete throttle opening and closing positions by operating accelerator pedal. Also check for poor carpet fit under the accelerator pedal.
- Throttle should operate freely without bind between full closed and wide open throttle.

3. Lower instrument panel trim, lower instrument panel trim attaching screws (4) and nut.

TORQUE SPECIFICATIONS

In-line Fuel Filter Fittings ..	27 N·m (20 lb. ft.)
Rear Fuel Feed Pipe Assembly Fittings	27 N·m (20 lb. ft.)
Fuel Tank Strap Attaching Bolts (2)	34 N·m (25 lb. ft.)
Engine Fuel Pipe Fittings (3.1L VIN T)	27 N·m (20 lb. ft.)
Engine Fuel Pipe Fittings (5.0L VIN E)	27 N·m (20 lb. ft.)
Engine Fuel Pipe Fittings (5.0L VIN F and 5.7L VIN 8)	27 N·m (20 lb. ft.)
Accelerator Pedal Attaching nuts (2)	8 N·m (71lb. in.)

SECTION 6D

ENGINE ELECTRICAL

CONTENTS

GENERAL DESCRIPTION

The engine electrical system includes the battery, ignition (primary and secondary), starter motor (and related wiring) and the generator (and related wiring). To diagnose and troubleshoot system faults, refer to ELECTRICAL DIAGNOSIS (SEC. 8A) for wiring diagrams, component locations and system checks. When a fault is traced to a particular component, refer to that component's section of the service manual.

DIAGNOSIS

ELECTRICAL SYSTEM GENERAL DIAGNOSIS

Figures 1 and 2

Diagnosis and repair procedures for engine electrical subsystems are located in the following subsections:

6D1 – Battery
6D2 – Cranking System
6D3 – Charging System
6D4 – Ignition System
6D5 – Engine Wiring

Where a driveability complaint exists, or an ECM code is set, refer to DRIVEABILITY AND EMISSIONS-GENERAL INFORMATION (SEC. 6E).

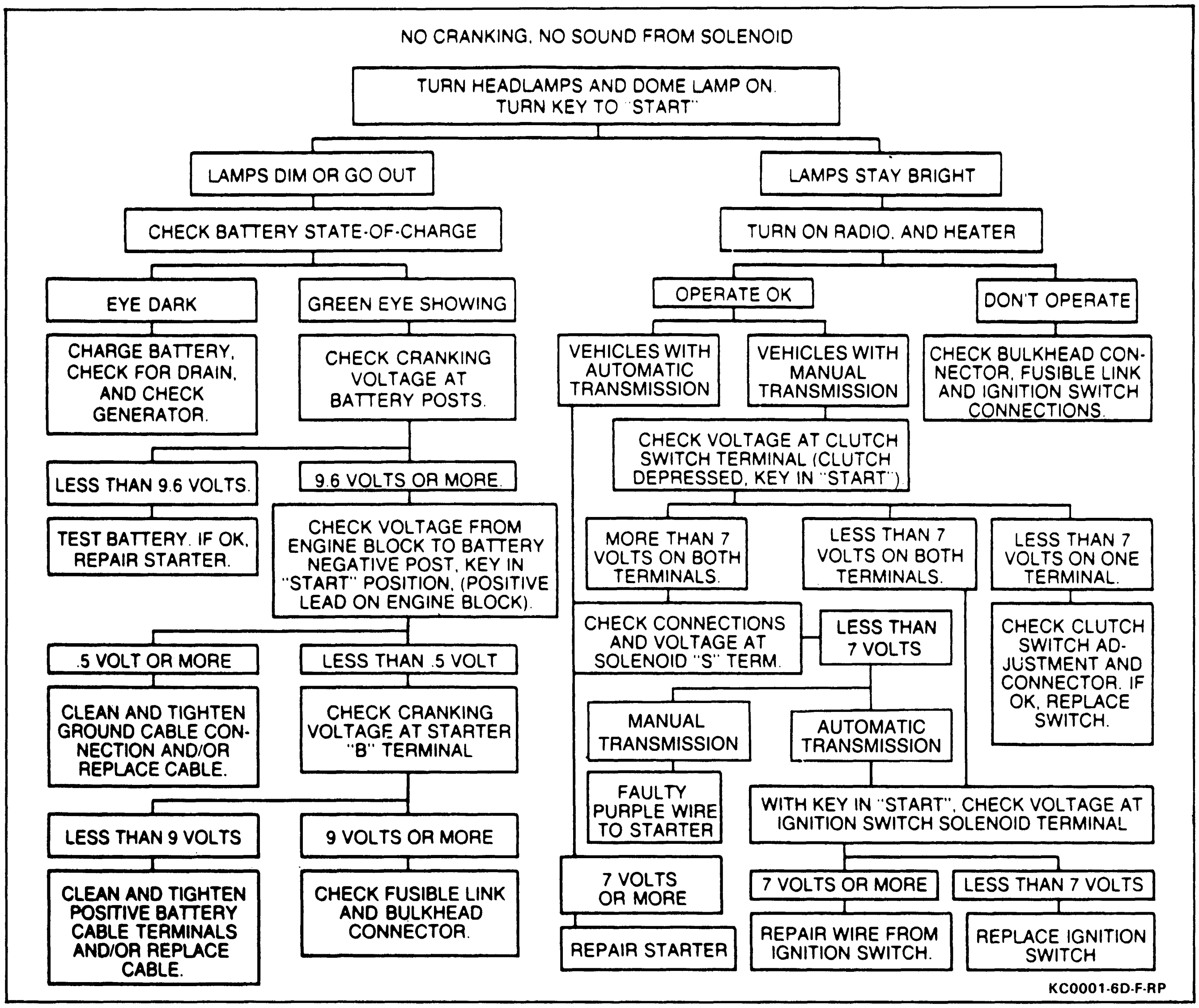
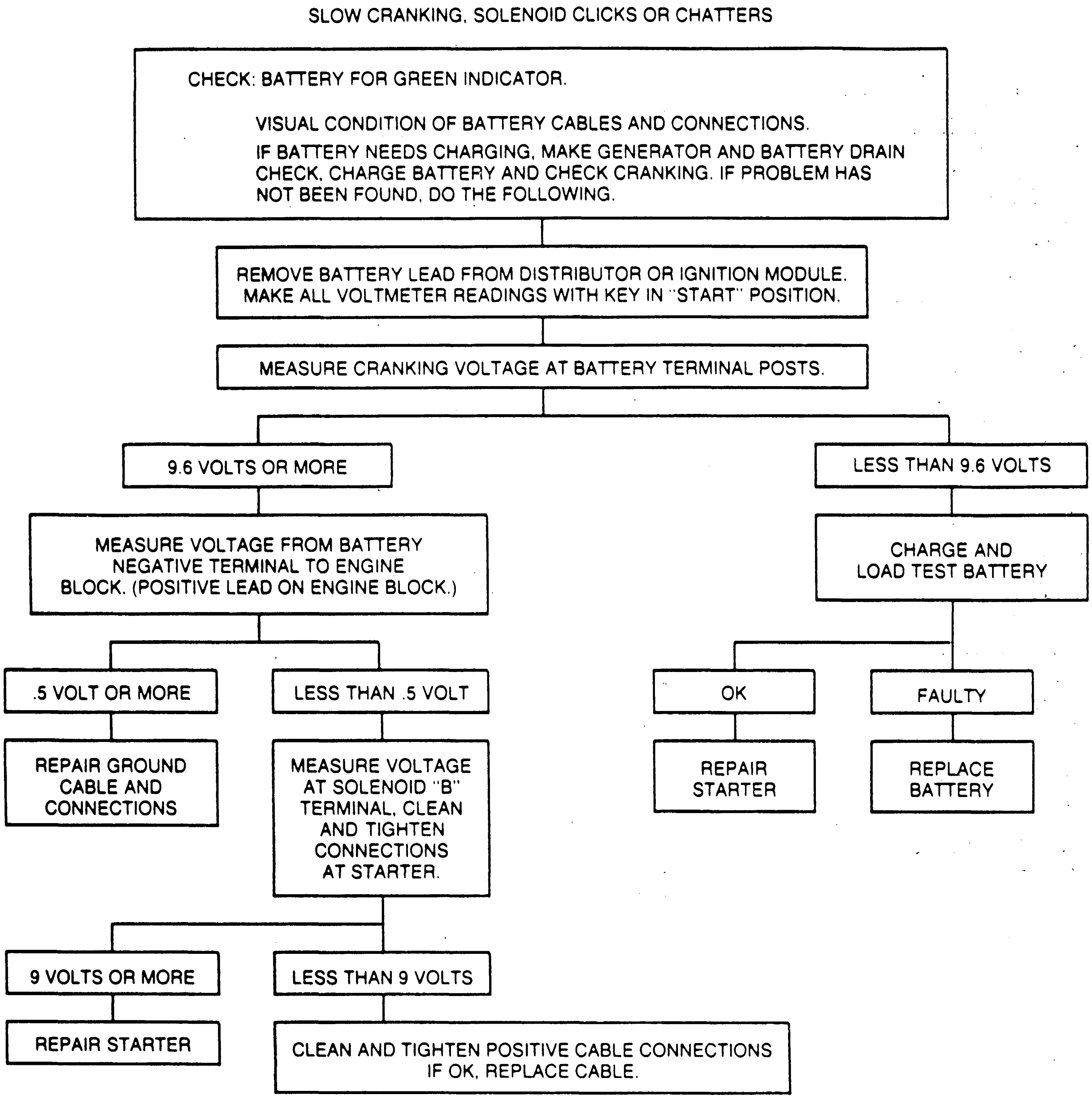


Figure 1 - Electrical System General Diagnosis (1 of 2)



THIS PROCEDURE IS DESIGNED FOR USE ON ENGINES AND BATTERIES AT ROOM OR NORMAL OPERATING TEMPERATURES. IT ALSO ASSUMES THERE ARE NO ENGINE DEFECTS WHICH WOULD CAUSE CRANKING PROBLEMS. TO USE IT UNDER OTHER CONDITIONS MIGHT RESULT IN AN IMPROPER DIAGNOSIS.

K10002-6D-W-RA

Figure 2 - Electrical System General Diagnosis (2 of 2)

SECTION 6D1

BATTERY

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 6D1-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

CAUTION: All batteries generate hydrogen gas which is extremely flammable. If ignited by a spark or flame, the gas may explode violently, causing spraying of acid, fragmentation of the battery and possible severe personal injuries. Wear approved eye protection. Battery fluid is corrosive acid. Flush any contacted area with water immediately and thoroughly.

GENERAL DESCRIPTION

Figures 1 through 3

The sealed battery is standard on all vehicles. See "Specifications" in this section for battery usage applications. There are no vent plugs in the cover. The battery is completely sealed except for two small vent holes in the sides. These vent holes allow the small amount of gas produced in the battery to escape.

The battery has three major functions in the electrical system: first, it provides a source of energy for cranking the engine; second, it acts as a voltage stabilizer for the electrical system; and third, it provides energy for a limited time when the electrical load used exceeds the output of the generator.

The battery specification label contains information important for servicing the battery. This information includes test ratings and both original equipment and recommended replacement part numbers. This information is also included in "Specifications" at the end of this section.

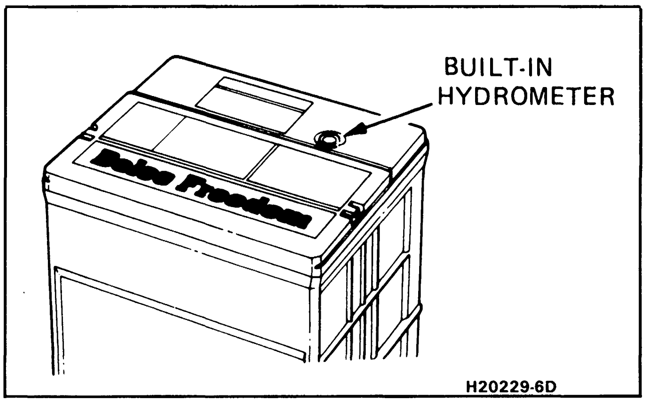


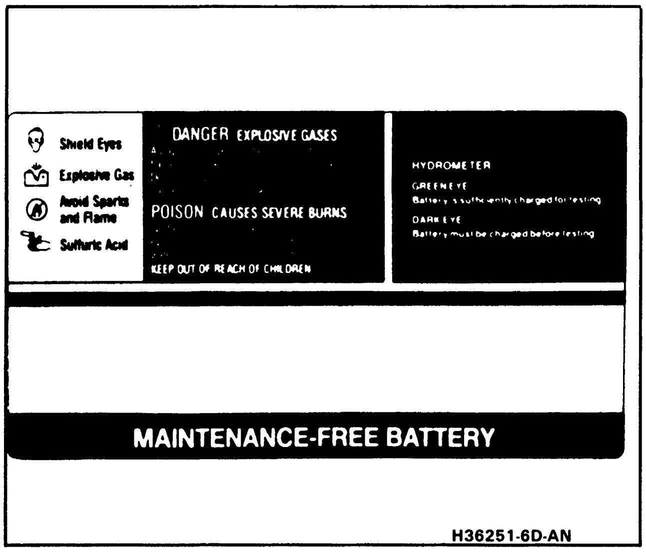
Figure 1 - Sealed-Top Battery

GENERAL INFORMATION

COMMON CAUSES OF FAILURE

The battery is not designed to last indefinitely; however, with proper care, it will provide many years of service.

If the battery tests good, but fails to perform satisfactorily in service for no apparent reason; the



Shield Eyes
Explosive Gas
Avoid Sparks and Flame
Sulfuric Acid

DANGER EXPLOSIVE GASES

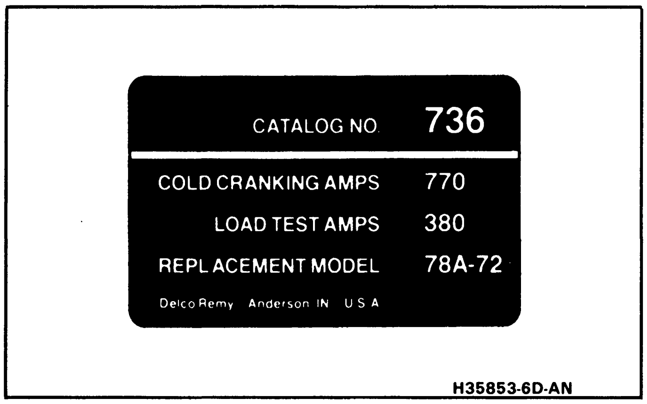
POISON CAUSES SEVERE BURNS

KEEP OUT OF REACH OF CHILDREN

HYDROMETER
GREEN EYE
Battery is sufficiently charged for testing
DARK EYE
Battery must be charged before testing

MAINTENANCE-FREE BATTERY

Figure 2 - Battery Label (Typical)



CATALOG NO.	736
COLD CRANKING AMPS	770
LOAD TEST AMPS	380
REPLACEMENT MODEL	78A-72

Delco Remy Anderson IN U S A

Figure 3 - Battery Specification Label (Typical)

following are some of the more important factors that may point to the cause of trouble:

1. Vehicle accessories left on overnight.
2. Slow average driving speeds for short periods.
3. The vehicle's electrical load being more than the generator output, particularly with the addition of aftermarket equipment.
4. Conditions in the charging system such as electrical shorts, slipping fan belt, or faulty generator or voltage regulator.
5. Battery abuse, including failure to keep the battery cable terminals clean and tight, or loose battery hold-down. See "Battery Replacement" in this section for torque specifications.
6. Mechanical conditions in the electrical system, such as shorted or pinched wires.
7. Extended storage of vehicles.
8. Batteries being less than adequately charged when received.
9. Extended cranking periods due to plug fouling.
10. Incorrect interpretation of the hydrometer.
11. Insufficient ampere-hour charge for a discharged battery.
12. Burned out charge/generator lamp bulb causing "No Charge" condition.
13. Continuous current draw on the battery through increased parasitic drain.

ELECTROLYTE FREEZING

The freezing point of electrolyte depends on its specific gravity. Since freezing may ruin a battery, it should be protected against freezing by keeping it in a charged condition.

BATTERY TRAY AND HOLD-DOWN RETAINER

The battery tray and hold-down retainer should be clean and free from corrosion before installing battery.

The battery tray should be in a sound condition so that it will hold the battery securely and keep it level. Make certain there are no parts in the carrier before installing battery.

To prevent the battery from shaking in its battery tray, the hold-down retainers should be tight, but not overtight.

VISUAL INSPECTION

Check for obvious damage, such as cracked or broken case or cover, which allows loss of electrolyte. If obvious damage is noted, replace the battery. Determine the cause of damage and correct as needed. If battery terminals are severely damaged - loose, burned, or broken - replacement of the battery is recommended. Evidence of small amounts of electrolyte leakage, especially around the vent holes, does not necessarily indicate the battery is bad; the leakage could have been caused by overcharging or by excessive battery tipping.

RATINGS

A battery has two ratings: (1) a reserve capacity rating at 27°C (80°F) which is the time a fully charged battery will operate the car with no generator operation; and (2) a cold rating at –18°C (0°F) which indicates the cranking load capacity. See battery label or "Specifications" at the end of this section for specific battery ratings.

RESERVE CAPACITY

The "Reserve Capacity" is the maximum length of time it is possible to travel at night with minimum electrical load and no generator output.

Expressed in minutes it is the time required for a fully charged battery, at a temperature of 27°C (80°F) being discharged at a constant current of 25 amps, to reach a terminal voltage of 10.5 volts.

COLD CRANKING AMPERAGE

The cold cranking amperage test is expressed at a battery temperature of -18°C (0°F.) The current rating is the minimum amperage which must be maintained by the battery for 30 seconds, at the specified temperature, while meeting a minimum voltage requirement of 7.2 volts. This rating is a measure of cold cranking capacity.

BUILT-IN TEST HYDROMETER

Figure 4

The sealed battery has a built-in temperature compensated hydrometer in the top of the battery. This hydrometer is used with the following diagnostic procedure.

When observing the hydrometer, make sure that the battery has a clean top. A light may be required in some poorly-lit areas.

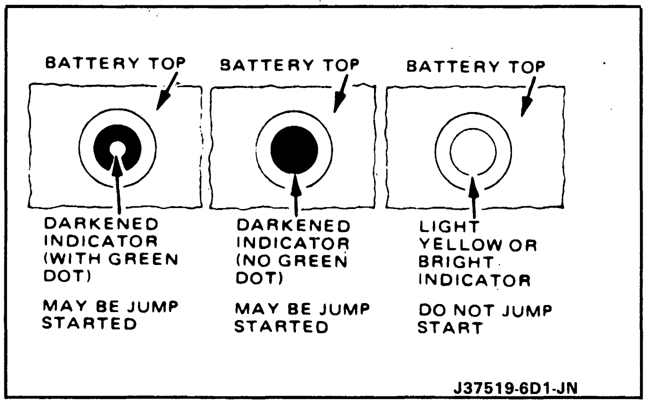


Figure 4 - Built-In Hydrometer

Under normal operation, two indications can be observed:

1. GREEN DOT VISIBLE

   Any green appearance is interpreted as a "green dot" and the battery is ready for testing.
2. DARK; GREEN DOT NOT VISIBLE

   If there is a cranking complaint, the battery should be tested as described in the "Diagnosis" in this section. The charging and electrical systems should also be checked at this time.

Occasionally, a third condition may appear:

3. CLEAR OR LIGHT YELLOW

   This means the fluid level is below the bottom of the hydrometer. This may have been caused by excessive or prolonged charging, a broken case, excessive tipping or normal battery wearout. When finding a battery in this condition it may indicate high charging voltages caused by a faulty charging system, therefore, the charging and electrical systems may need to be checked. If a cranking complaint exists and is caused by the battery, the battery should be replaced.

BATTERY PROTECTION DURING VEHICLE STORAGE

Today's vehicles have many high technology electronic devices which result in very small but continuous current drains on the batteries, commonly referred to as "parasitic loads." Vehicles that are not used for an extended period of time may develop extremely discharged and/or permanently damaged batteries resulting from parasitic loads.

Any battery discharged by parasitic loading and then allowed to stand in this condition for a period of time may not readily accept recharge. However, if properly recharged, most batteries will return to a good usable condition.

Extremely discharged batteries can freeze at temperatures as high as -6°C (20°F) causing permanent damage. Permanent damage to discharged batteries can also be accelerated by high temperatures.

To prevent this condition, the negative (-) battery cable should be disconnected on vehicles which are not going to be in service within a 30-day period, beginning from the time the vehicle is shipped. If this is not possible, batteries should be recharged periodically (every 30-65 days) until the green dot is visible.

DIAGNOSIS

The following procedure should be used for testing batteries:

1. VISUAL INSPECTION

   Check for obvious damage, such as a cracked or broken case or cover that could permit loss of electrolyte. If obvious damage is noted, replace the battery. Determine cause of damage and correct as needed. If not, proceed to step 2.
2. HYDROMETER CHECK (Figure 4)
   - GREEN DOT VISIBLE – Go to step 3.
   - DARK; GREEN DOT NOT VISIBLE

     Charge the battery as outlined under "Charging Procedure" in this section and proceed to step 3.
3. LOAD TEST

   Load testing requires using battery side terminal adapters to ensure good connections (Figure 5). Do not load test a frozen battery.
   - Connect a voltmeter and a battery load tester across the battery terminals.
   - Apply a 300 amp load for 15 seconds to remove surface charge from the battery. Remove load.
   - Wait 15 seconds to let battery recover. Apply specified load located on battery label or in "Specifications" at the end of this section. Read voltage after 15 seconds, then remove load.
   - If voltage does not drop below the minimum listed in Figure 6, the battery is good and should be returned to service. The battery temperature must be estimated by feel and by the temperature the battery has been exposed to for the past few hours.
   - If voltage drops below the minimum listed, replace the battery.

CURRENT DRAIN TEST

For current drain test, refer to Figure 7.

ON-VEHICLE SERVICE

BATTERY CHARGING

When it is necessary to charge the battery, follow these basic rules:

1. Do not charge battery if hydrometer is clear or light yellow. Replace battery.
2. If the battery feels hot 52°C (125°F), or if electrolyte violently gasses or spews through the

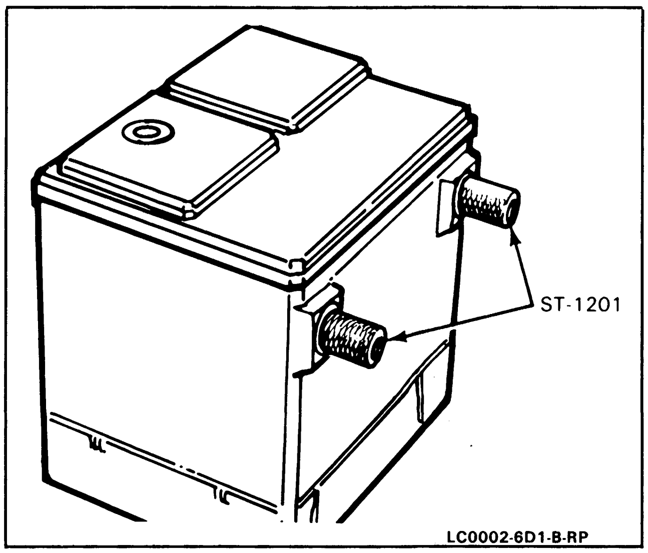


Figure 5 - Side Terminal Battery Adapters

ESTIMATED TEMPERATURE	MINIMUM VOLTAGE
21° C (70° F)	9.6
10° C (50° F)	9.4
0° C (30° F)	9.1
- 10° C (15° F)	8.8
- 18° C (0° F)	8.5
BELOW: - 18° C (0° F)	8.0

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Figure 6 - Battery Temperature vs. Voltage Drop

vent holes, discontinue charging or reduce charging rate.

3. Do not charge a battery if it seems to be frozen.

CHARGING PROCEDURE

1. Batteries with green dot showing do not require charging unless they have just been discharged (such as in cranking vehicle).
2. When charging side terminal batteries out of car, install adapter kit (AC Delco part number ST-1201, GM part number 1846855 or equivalent). Refer to Figure 5.

   The adapter should be snugged up against the lead terminals of the battery to keep resistance between the adapter and the battery terminals to a minimum. If an adapter kit is not available, an alternative method may be used. The alternative method uses a 3/8–16 nut and bolt for each battery terminal. Bolts alone should not be used, since the mating threads inside the battery terminals provide a very small contact surface which has high resistance to current flow. The high resistance can prevent adequate charging current from reaching the battery, making it appear that the battery will not accept a charge. Follow this procedure to install the bolts:

   - Screw the nut onto the bolt. The bolt should be at least 1 1/2 inches long.
   - Screw one bolt finger tight into each battery terminal until the bolt bottoms out. (Do not tighten with a wrench since the bolts can be driven through the case.) Then, back the bolt out of the terminal one full turn.
   - While holding the bolt, screw the nut against the battery terminal lead pad. Snug nut with pliers; do not overtighten because the threads inside the battery terminal could pull out.
   - Attach the charger to the nuts and follow normal charging procedures. The main charging current flows through the lead pads of the battery terminals and not through the threads in the terminals.
3. Make sure all charger connections are clean and tight.
4. For best results, batteries should be charged while electrolyte and plates are at room temperature. A battery that is extremely cold may not accept current for several hours after starting charger.
5. Charge battery until green dot appears. See "Charging Time Required" in this section. Battery should be checked every half-hour while charging. Tap the hydrometer lightly on top to dislodge any air bubbles that might cause a false indication.
6. After charging, battery should be tested as outlined in "Diagnosis" in this section.

CHARGING TIME REQUIRED

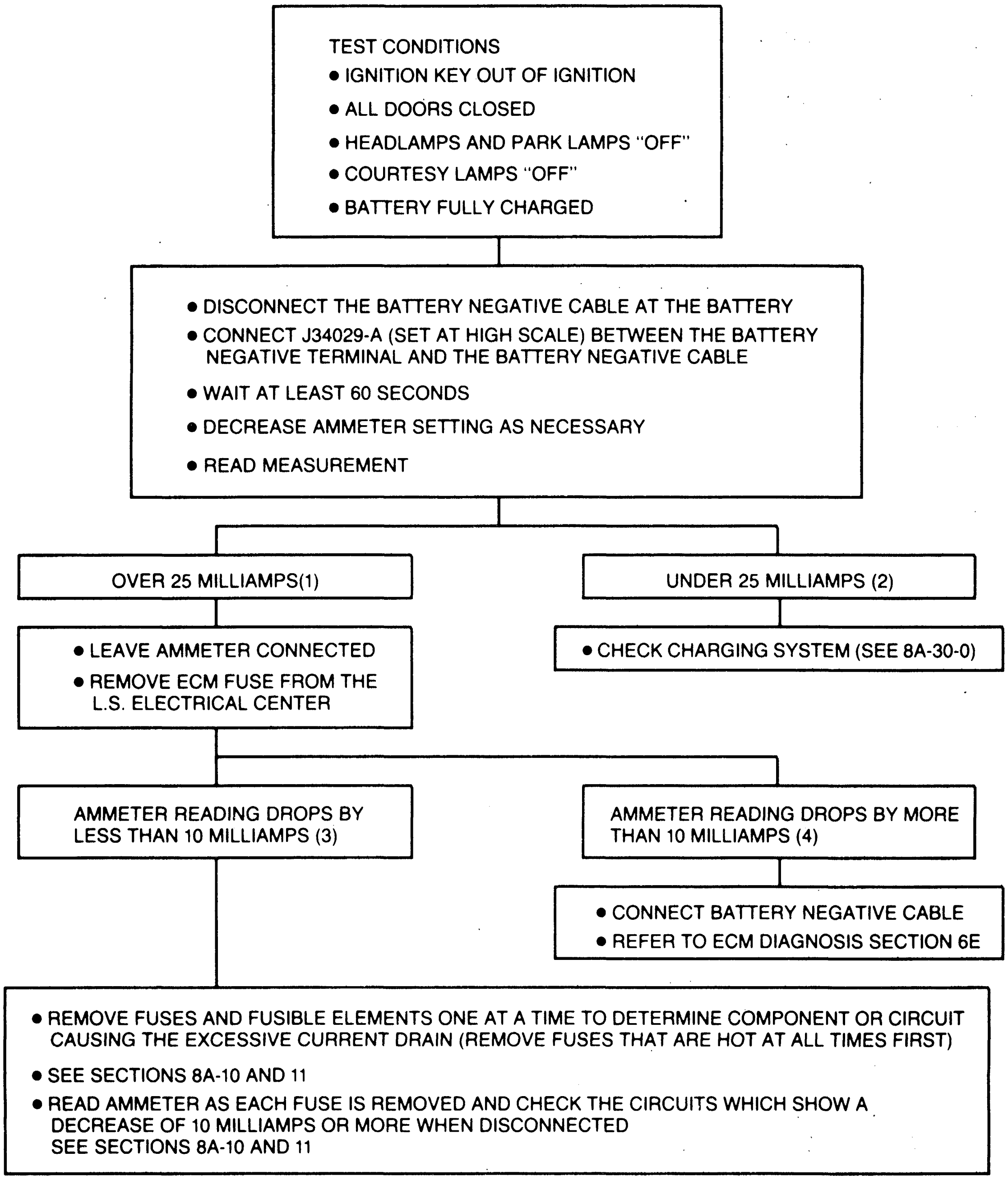
The time required to charge a battery will vary depending on the following factors:

- **Size of Battery** – A completely discharged large heavy-duty battery requires more than twice the recharging as a completely discharged small passenger vehicle battery.
- **Temperature** – A longer time will be needed to charge any battery at –18°C (0°F) than at 27°C (80°F). When a fast charger is connected to a cold battery the current accepted by the battery will be very low at first, then in time, the battery will accept a higher rate as the battery warms.
- **Charger Capacity** – A charger which can supply only five amps will require a much longer period of charging than a charger that can supply 30 amps or more.
- **State-Of-Charge** – A completely discharged battery requires more than twice as much charge as a half-charged battery. Because the electrolyte is nearly pure water and a poor conductor in a completely discharged battery, the current accepted by the battery is very low at first. Later, as the charging current causes the electrolyte acid content to increase, the charging current will also increase.

Any battery discharged by parasitic loading and then allowed to stand in this condition for a period of time may not accept charge readily. However, if recharged long enough, most batteries will return to a good usable condition.

If the battery remains in an extremely discharged

CURRENT DRAIN TEST



TEST CONDITIONS
- IGNITION KEY OUT OF IGNITION
- ALL DOORS CLOSED
- HEADLAMPS AND PARK LAMPS "OFF"
- COURTESY LAMPS "OFF"
- BATTERY FULLY CHARGED

- DISCONNECT THE BATTERY NEGATIVE CABLE AT THE BATTERY
- CONNECT J34029-A (SET AT HIGH SCALE) BETWEEN THE BATTERY NEGATIVE TERMINAL AND THE BATTERY NEGATIVE CABLE
- WAIT AT LEAST 60 SECONDS
- DECREASE AMMETER SETTING AS NECESSARY
- READ MEASUREMENT

OVER 25 MILLIAMPS(1)

- LEAVE AMMETER CONNECTED
- REMOVE ECM FUSE FROM THE L.S. ELECTRICAL CENTER

UNDER 25 MILLIAMPS (2)

- CHECK CHARGING SYSTEM (SEE 8A-30-0)

AMMETER READING DROPS BY LESS THAN 10 MILLIAMPS (3)

AMMETER READING DROPS BY MORE THAN 10 MILLIAMPS (4)

- CONNECT BATTERY NEGATIVE CABLE
- REFER TO ECM DIAGNOSIS SECTION 6E

- REMOVE FUSES AND FUSIBLE ELEMENTS ONE AT A TIME TO DETERMINE COMPONENT OR CIRCUIT CAUSING THE EXCESSIVE CURRENT DRAIN (REMOVE FUSES THAT ARE HOT AT ALL TIMES FIRST)
- SEE SECTIONS 8A-10 AND 11
- READ AMMETER AS EACH FUSE IS REMOVED AND CHECK THE CIRCUITS WHICH SHOW A DECREASE OF 10 MILLIAMPS OR MORE WHEN DISCONNECTED SEE SECTIONS 8A-10 AND 11

NOTE: PERFORM BATTERY ELECTRICAL DRAIN TEST AGAIN AFTER MAKING ANY REPAIRS

Battery current should be less than 25 milliamps with no circuits active. This test determines the value of battery current with all systems off.

(1) A current drain over 25 milliamps indicates a fault.

(2) A current drain under 25 milliamps is OK.

(3) A current drain drop under 10 milliamps indicates the problem is not ECM related.

(4) A current drain drop over 10 milliamps indicates the problem is ECM related.

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Figure 7 - Current Drain Test

condition for a prolonged period, it can become permanently damaged. This damage can be accelerated by high temperatures. Batteries which are extremely discharged can freeze at temperatures as high as -6°C (+20°F) and be permanently damaged.

To prevent battery damage and recharge problems, vehicles which are not going to be in service within a 30 day period should have the negative battery cable disconnected to remove the constant drain on the batteries. If this is not possible, batteries should be recharged periodically every 30-65 days until the green dot is visible.

CHARGING A VERY LOW/DISCHARGED BATTERY (OFF-VEHICLE)

The following procedure should be used to recharge a very low or completely discharged battery.

Unless the procedure is properly followed, a perfectly good battery may be needlessly replaced.

1. Measure voltage at battery terminals with an accurate voltmeter. If below 11 volts, the charge current will be very low and it could take some time before it accepts a current in excess of a few milliamps. Such low current may not be detectable on ammeters available in the field.
2. Set battery charger on high setting.
3. Some chargers feature polarity protection circuitry which prevents charging unless the charger leads are connected to the battery terminals correctly. A completely discharged battery may not have enough voltage to activate this circuitry even though leads are connected properly, making it appear that the battery will not accept charging current. Therefore, follow the specific charger manufacturer's instruction telling how to bypass or override the circuitry so that the charger will turn on and charge a low-voltage battery.
4. Battery chargers vary in the amount of voltage and current they provide. The time required for the battery to accept measurable charger current at various voltages may be as follows:

CHARGING VOLTAGE	HOURS
16.0 or more	Up to 4 Hours
14.0-15.9	Up to 8 Hours
13.9 or less	Up to 16 Hours

If the charge current is still not measurable at the end of the above charging times, the battery should be replaced.

If the charge current is measurable during the charging time, the battery is considered good and charging should be completed in the normal manner.

5. It is important to remember that a completely discharged battery must be recharged for a sufficient number of Ampere Hours (AH) to restore it to a usable state. As a general rule of thumb, using the Reserve Capacity Rating (RC) of the battery as the number of ampere hours of charge will usually bring the green dot into view. Refer to "Specifications" in this section for RC. If battery is rated at 75 RC minutes, it would be completely recharged as follows:

   10 ampere charge x 7 1/2 hours = 75 AH
   or
   25 ampere charge x 3 hours = 75 AH, etc.
6. It is recommended that any battery recharged by this procedure be LOAD TESTED to establish serviceability.

JUMP STARTING

NOTICE: Do not push or tow the vehicle to start. Damage to the emission system and/or to other parts of the vehicle may result.

Both booster and discharged battery should be treated carefully when using jumper cables. Follow the procedure outlined below, being careful not to cause sparks.

CAUTION: Departure from these conditions or the procedure below could result in: (1) serious personal injury (particularly to eyes) or property damage from such causes as battery explosion, battery acid, or electrical burns; and/or (2) damage to electronic components of either vehicle.

Never expose battery to open flame or electric spark - batteries generate a gas which is flammable and explosive. Remove rings, watches, and other jewelry. Wear approved eye protection.

Do not allow battery fluid to contact eyes, skin, fabrics, or painted surfaces - fluid is a corrosive acid. Flush any contacted area with water immediately and thoroughly. Be careful that metal tools or jumper cables do not contact the positive battery terminal (or metal in contact with it) and any other metal on the vehicle because a short circuit could occur.

- Do not permit vehicles to touch each other as this could cause a ground connection and counteract the benefits of this procedure.

1. Set parking brake and place automatic transmission in "PARK." Turn "OFF" the ignition, lamps and all other electrical loads.
2. Check the built-in hydrometer. If it is clear or light yellow, replace the battery.

NOTICE: When jump starting a vehicle with charging equipment, be sure equipment used is 12 volt and negative ground. Do not use 24-volt charging equipment. Using such equipment can cause serious damage to the electrical system or electronic parts.

3. Attach the end of one jumper cable to the positive terminal of the booster battery and the other end of the same cable to the positive terminal of the discharged battery.

CAUTION: DO NOT CONNECT JUMPER CABLE DIRECTLY TO THE NEGATIVE TERMINAL OF THE DEAD BATTERY TO PREVENT SPARKING AND POSSIBLE EXPLOSION OF BATTERY GASES.

4. Attach one end of the remaining negative cable to the negative terminal of the booster battery, and the other end to a solid engine ground (such as A/C compressor bracket or generator mounting bracket) at least 46 cm (18 inches) from the battery of the vehicle being started.
5. Start the engine of the vehicle that is providing the jump start and turn off electrical accessories. Then start the engine in the car with the discharged battery.
6. Reverse these directions exactly when removing the jumper cables. The negative cable must be disconnected from the engine that was jump started first.

BATTERY REPLACEMENT

Figures 8 through 10

Remove or Disconnect

1. Negative battery cable (3).
2. Any brackets or braces that are in the way.
3. Positive battery cable (2).
4. Retainer bolt and retainer.
5. Battery (1).

Install or Connect

NOTICE: See "NOTICE" on page 6D1-1 of this section.

1. Battery (1).
2. Retainer and retainer bolt.

Tighten

- Retainer bolt to 17 N·m (13 lb. ft.).

3. Positive battery cable (2).
4. Any brackets or braces that were removed.
5. Negative battery cable (3).

Tighten

- Battery cable bolts to 17 N·m (13 lb. ft.).

BATTERY CABLE REPLACEMENT AND ROUTING

Figures 8 through 10

Whenever battery cables are replaced, always be certain to use a replacement cable that is the same type and length. Some positive cables have additional feed wires attached to them and some negative cables have additional ground leads attached.

Always be certain when replacing a battery cable to route it the same as the one being replaced.

GROUND STRAPS

Additional ground straps are used to connect the body and frame to the engine and transmission. Always connect all ground straps to ensure a good ground path to the battery from all electrical components.

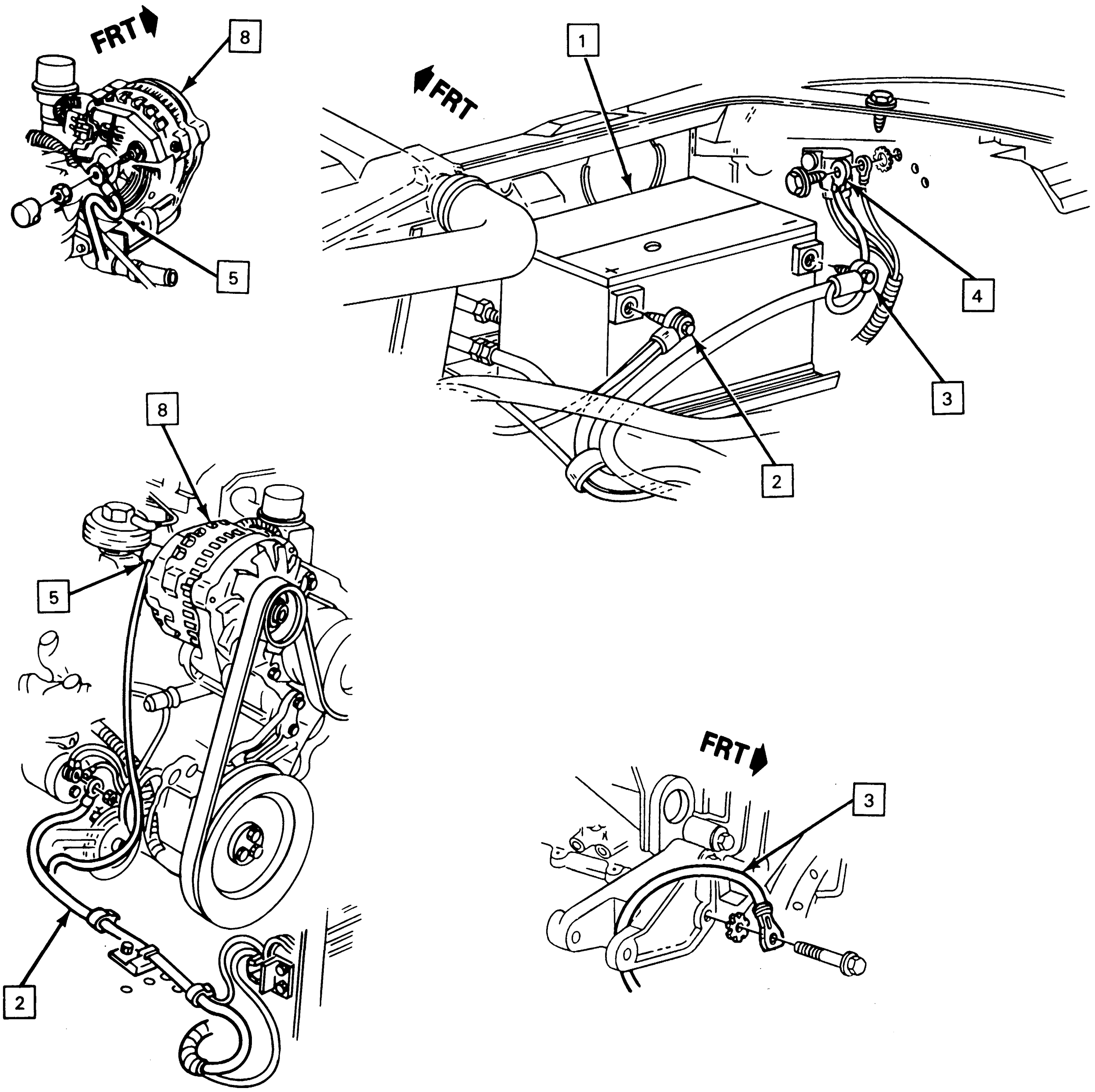
EQUIPMENT

A battery charger that is classified as a "fast charge" unit generally is considered sufficient as it is usually capable of about an 18-volt output. When choosing a charger, the following items should be considered essential:

1. A 40-50 amp minimum charge rate.
2. To prevent overcharging, the unit should have a timer (1 to 2 hours) or a voltage regulator that would regulate a maximum of 18 volts.
3. Ammeter or charging rate meter.
4. An automatic polarity protector.

Some equipment that is available includes the Associated No. 6001 and the Sun 720 or eqivalent. Very few chargers have sensitive low voltage meters, therefore, separate voltmeters may be necessary.

A suitable load tester such as the Sun VAT-40 (or equivalent) is available and is a very useful tool to properly diagnose battery problems.



1 BATTERY
2 POSITIVE BATTERY CABLE
3 NEGATIVE BATTERY CABLE
4 NEGATIVE GROUND LEAD
5 POSITIVE BATTERY CABLE LEAD
8 GENERATOR

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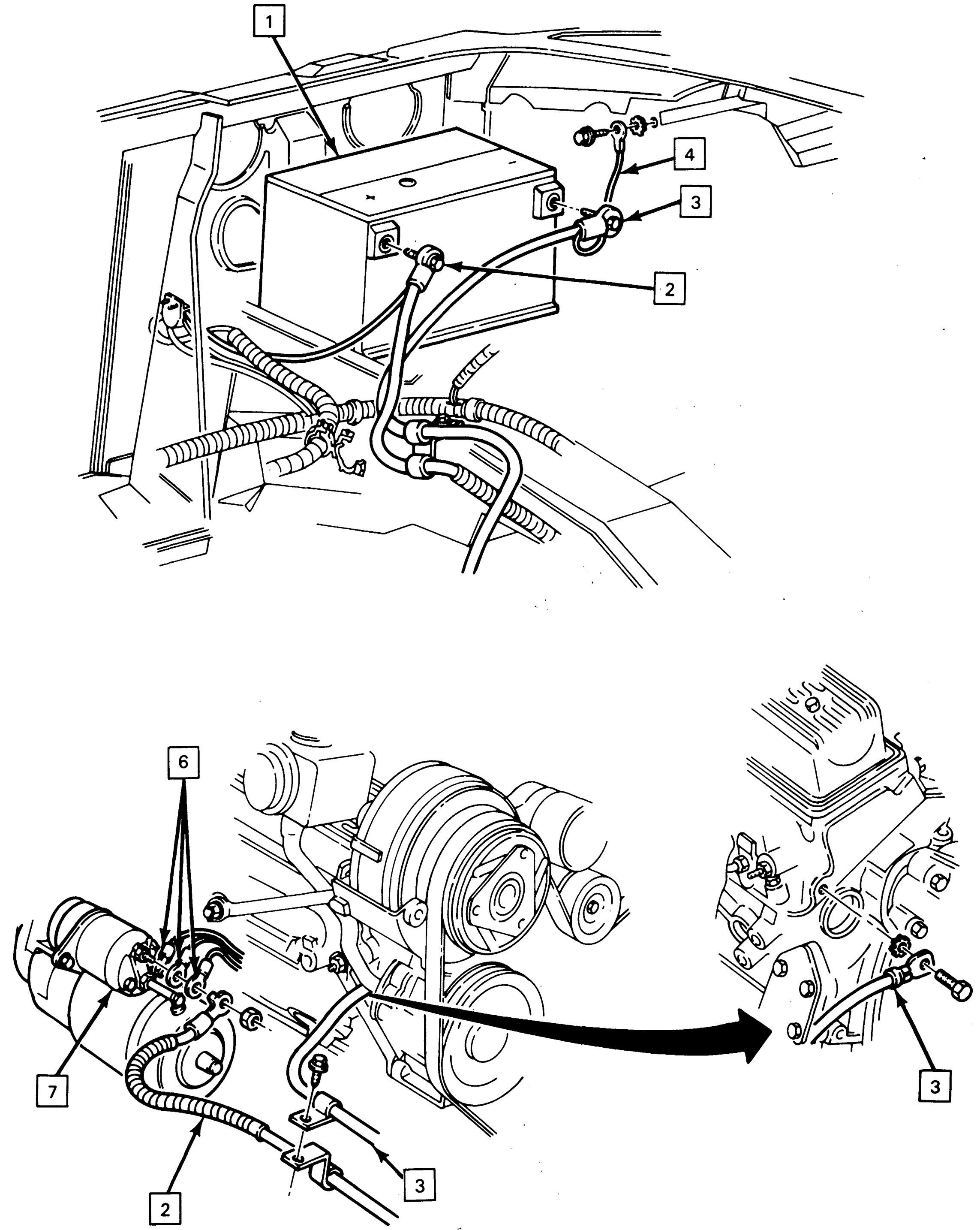
Figure 8 - Battery Cable Routing (LHO)



1	BATTERY
2	POSITIVE BATTERY CABLE
3	NEGATIVE BATTERY CABLE
4	NEGATIVE GROUND LEAD
6	ENGINE WIRING HARNESS
7	SOLENOID SWITCH

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Figure 9 - Battery Cable Routing (LO3)

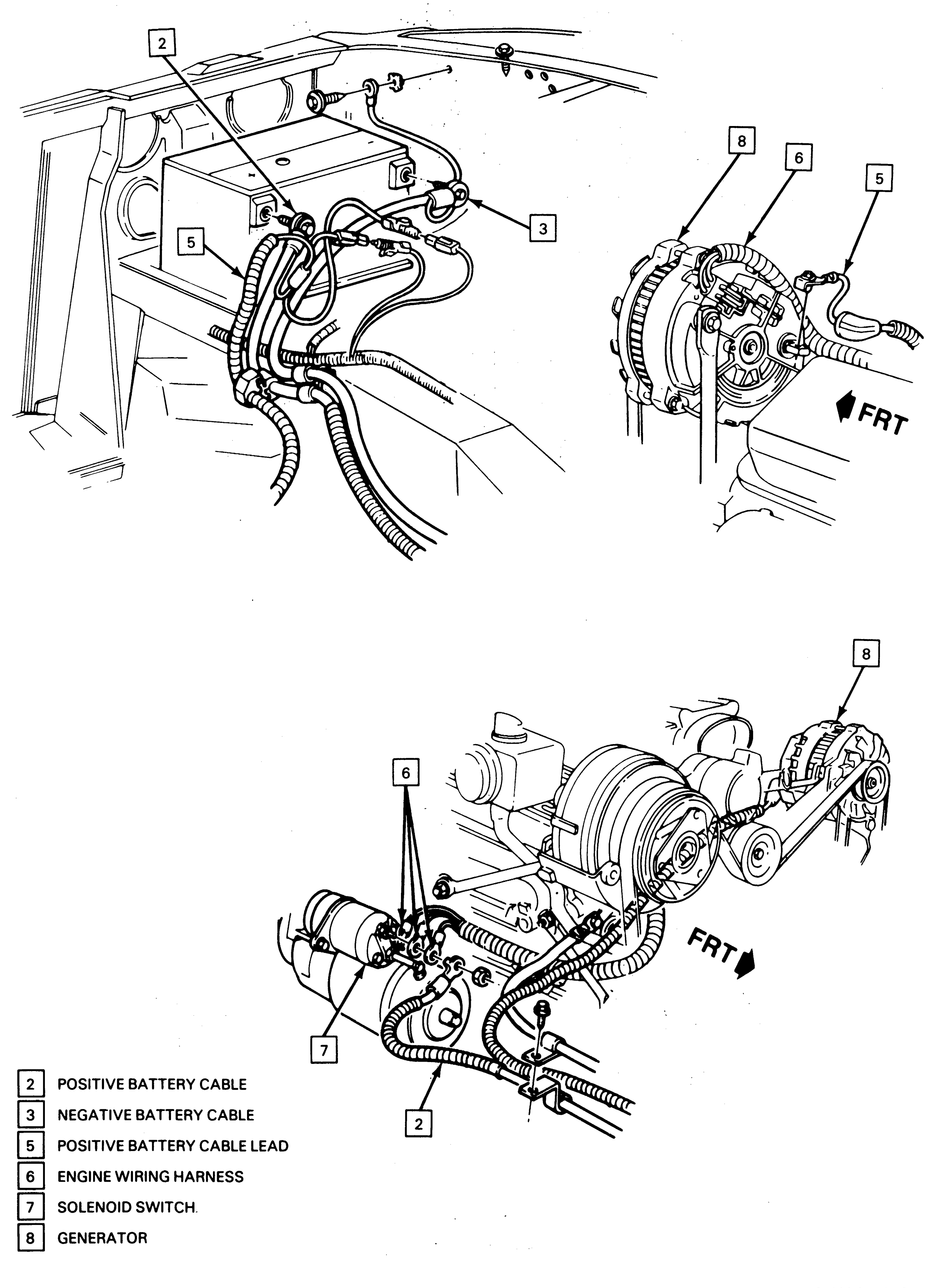

Figure 10 - Battery Cable Routing (LB9 and L98)

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Battery Cable Bolt	17 N·m (13 lb. ft.)
Retainer Bolt	17 N·m (13 lb. ft.)
Starter-to-Positive Battery Cable Nut	17 N·m (13 lb. ft.)
Ignition Harness-to-Solenoid Nut	2 N·m (18 lb. in.)
Engine-to-Negative Battery Cable Bolt	25 N·m (18 lb. ft.)
Positive Battery Cable (Hold Down Bracket) Bolt	5 N·m (44 lb. in.)

BATTERY USAGE

CATALOG NUMBER	TEST LOAD AMPS	COLD CRANKING AMPS #	RESERVE CAPACITY MINUTES*	REPLACEMENT NUMBER
601 (Std. L98)	310	630	90	75A-72
730 (Std. LHO, LO3, LB9)	260	525	90	75-60
731 (Opt. LO3, LB9)	280	570	90	75A-72

#Cold Cranking = Amperage available for 30 seconds of engine cranking at −18° C (0°F).

*Reserve Capacity = The approximate time in minutes a battery can support a 25 amp load without the terminal voltage dropping below 10.5 volts at 27° C (80°F) in the event of a charging system failure.

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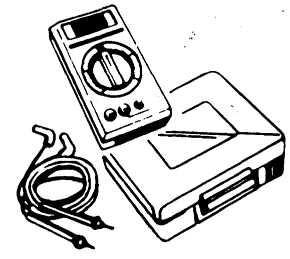
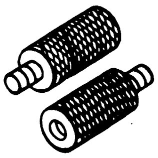
SPECIAL TOOLS





1 HIGH IMPEDANCE MULTIMETER

2 BATTERY SIDE TERMINAL ADAPTERS (PAIR)

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SECTION 6D2

CRANKING SYSTEM

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 6D2-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

CRANKING CIRCUIT

Figure 1

The cranking circuit consists of the battery, starter motor, ignition switch, and related electrical wiring. These components are connected electrically as shown in Figure 1.

STARTER MOTOR

Figure 2

In the basic circuit shown in Figure 1, the solenoid windings are energized when the switch is

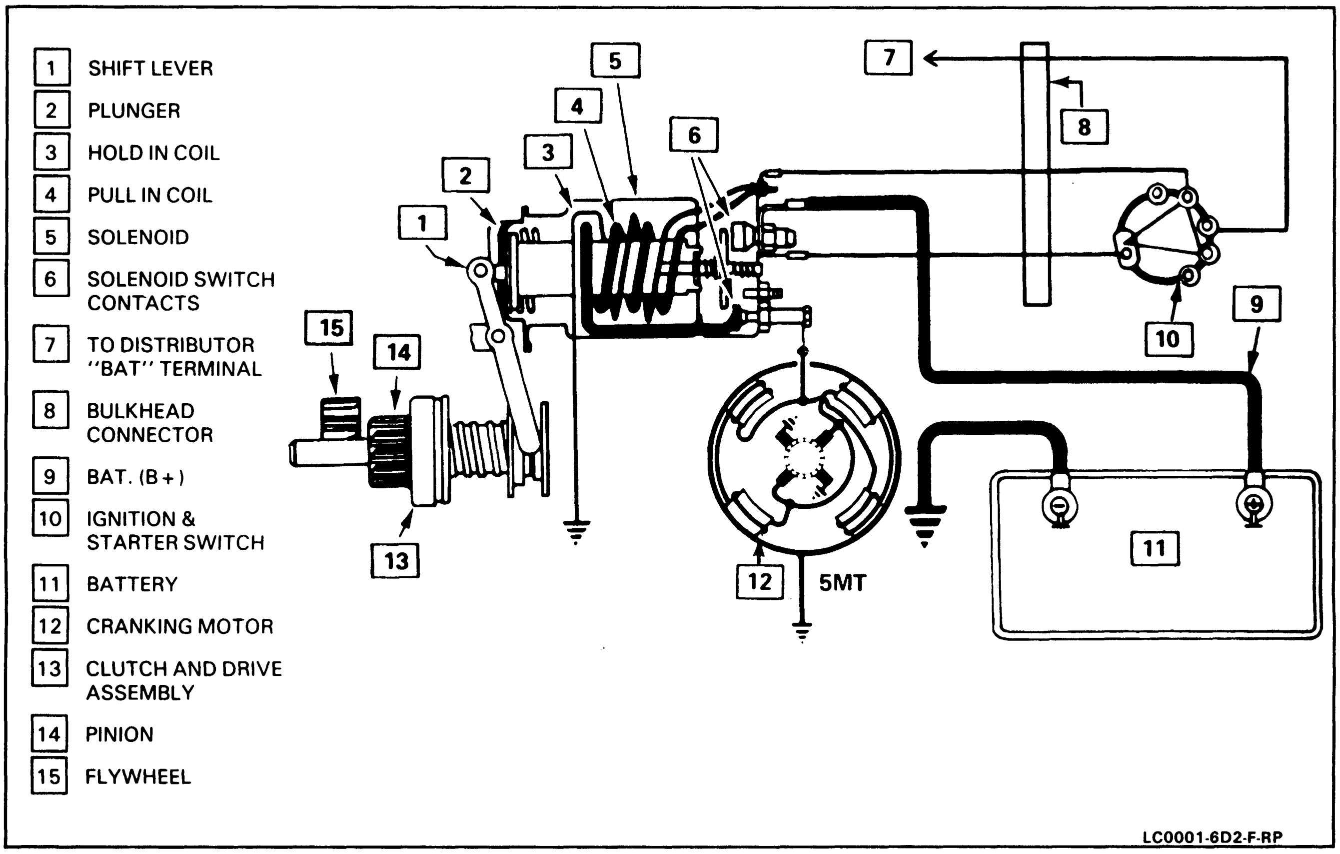

Figure 1 - Starter Motor Circuit

closed. The resulting plunger and shift lever movement causes the pinion to engage the engine flywheel ring gear and the solenoid main contacts to close, and cranking takes place. When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened, at which time the return spring causes the pinion to disengage. To prevent excessive overrun, the switch should be opened immediately when the engine starts.

DIAGNOSIS

Before removing any unit in a cranking circuit for repair, perform the diagnosis procedures recommended in ELECTRICAL DIAGNOSIS (SEC. 8A), then check the following items:

Battery: To determine the condition of the battery, follow the testing procedure outlined in BATTERY (SEC. 6D1).

Wiring: Inspect the wiring for damage. Inspect all connections to the starter, solenoid, ignition switch, and battery, including all ground connections. Clean and tighten all connections as required.

Solenoid and Ignition Switch: Inspect all switches to determine their condition.

Cranking or Slow Cranking: If the engine does not crank, or cranks slowly, follow the diagnostic procedure in ELECTRICAL DIAGNOSIS (SEC. 8A). If a faulty starter is diagnosed, remove the starter and follow test procedures.

Starter Motor Noise: To correct starter motor noise during starting, use the following procedure:

1. Refer to Figure 3 to determine the problem.
2. If the complaint is similar to problem 1 or 2 in Figure 3, correction can be achieved by proper "shimming" as follows:
   - If there is starter noise during cranking, remove one 0.38 mm (0.015 inch) double shim (8) or add one 0.38 mm (0.015 inch) single shim (9) to outer bolt only.
   - If there is a high pitched whine after engine fires, add 0.38 mm (0.015 inch) double shims (8) until the noise disappears. The number of shims should not exceed 1.14 mm (0.045 inch).

Starter Motor: A general diagnosis is part of the starter testing procedure. If the battery, wiring and switches are in satisfactory condition, and the engine is known to be functioning properly, and the problem has been traced to the starter, remove the starter (refer to "Starter Replacement" in this section) and proceed to disassembly, test, and reassembly in Figures 6 through 12.

NOTICE: Never operate the starter motor more than 30 seconds at a time without pausing to allow it to cool for at least two minutes. Overheating, caused by excessive cranking, will seriously damage the starter motor.

ON-VEHICLE SERVICE

Starter motors do not require lubrication except during overhaul.

STARTER REPLACEMENT

Figure 4

↔ Remove or Disconnect

! Important

- If shims (3) are removed, they must be reinstalled in their original location to ensure proper drive pinion-to-flywheel engagement. Refer to Figure 5.

1. Negative battery cable.
2. Raise vehicle and suitably support. Refer to GENERAL INFORMATION (SEC. 0A).
3. Attaching bolt (7), nut (5), washer (6), and bracket (4) (except LH0).
4. Flywheel housing cover.
5. Two starter mounting bolts, (2) and lower starter motor (1).
6. Electrical leads from starter motor (1).

- Note position of wires, before disconnecting.

1	CONTACT DISC
2	PLUNGER
3	SOLENOID
4	RETURN SPRING
5	SHIFT LEVER
6	BUSHING
7	PINION STOP
8	CLUTCH AND DRIVE ASSEMBLY
9	FIELD COIL
10	ARMATURE
11	BRUSH
12	TERMINALS

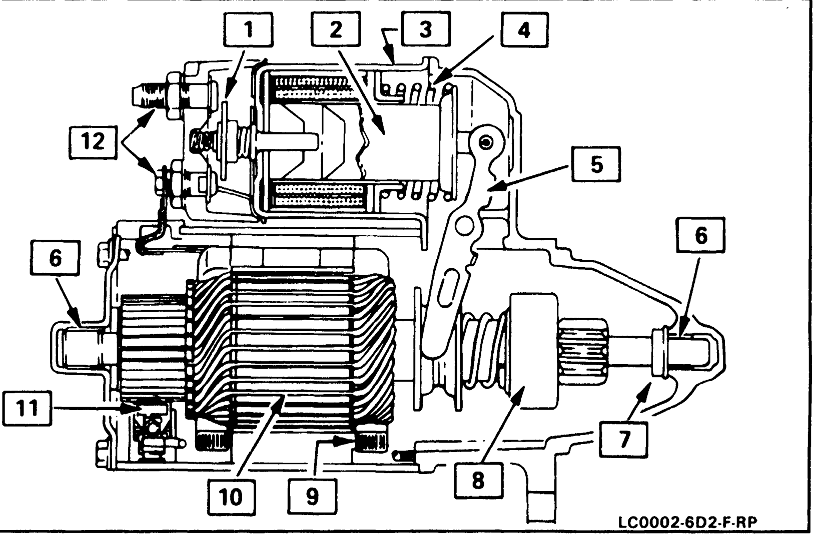

Figure 2 - SD200 and SD300 Starter Motor

	PROBLEM	CAUSE
1.	HIGH PITCHED WHINE DURING CRANKING (BEFORE ENGINE FIRES) BUT ENGINE CRANKS AND FIRES OK.	DISTANCE TOO GREAT BETWEEN STARTER PINION AND FLYWHEEL.
2.	HIGH PITCHED "WHINE" AFTER ENGINE FIRES, AS KEY IS BEING RELEASED. ENGINE CRANKS AND FIRES OK. THIS INTERMITTENT COMPLAINT IS OFTEN DIAGNOSED AS "STARTER HANG-IN" OR "SOLENOID WEAK".	DISTANCE TOO SMALL BETWEEN STARTER PINION AND FLYWHEEL. FLYWHEEL RUNOUT CONTRIBUTES TO THE INTERMITTENT NATURE.
3.	A LOUD "WHOOP" AFTER THE ENGINE FIRES BUT WHILE THE STARTER IS STILL HELD ENGAGED. SOUNDS LIKE A SIREN IF THE ENGINE IS REVVED WHILE STARTER IS ENGAGED.	A NEW CLUTCH WILL OFTEN CORRECT THIS PROBLEM.
4.	A "RUMBLE", "GROWL" OR (IN SEVERE CASES) A "KNOCK" AS THE STARTER IS COASTING DOWN TO A STOP AFTER STARTING THE ENGINE.	MOST PROBABLE CAUSE IS A BENT OR UNBALANCED STARTER ARMATURE. A NEW ARMATURE WILL OFTEN CORRECT THIS PROBLEM.

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Figure 3 - Starter Motor Noise Diagnosis

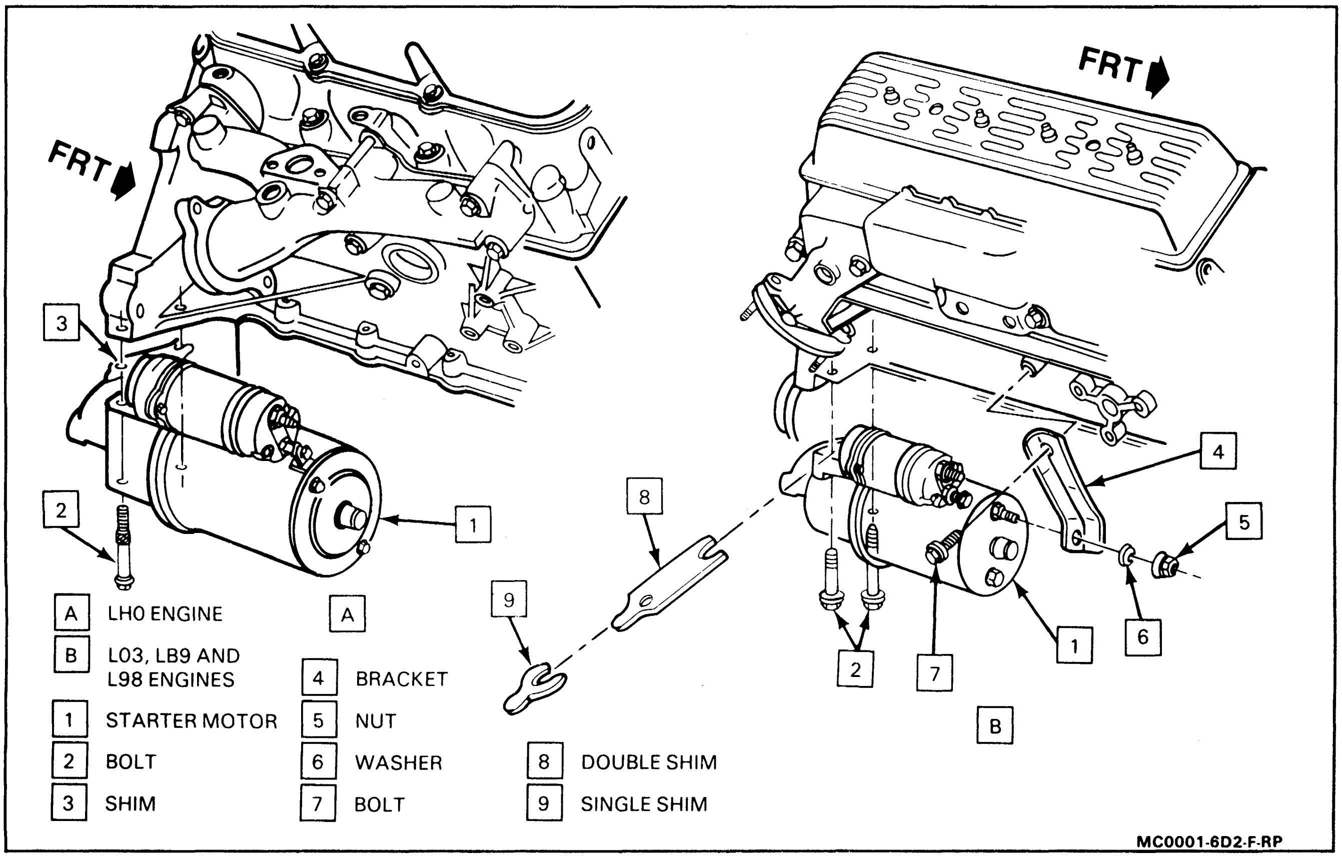


Figure 4 - Mounting the Starter Motor

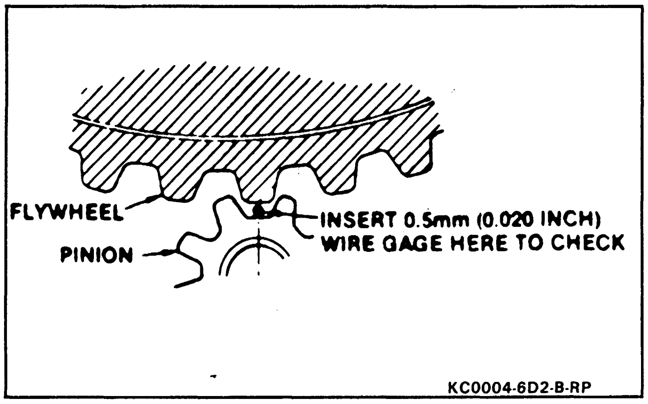


Figure 5 - Flywheel to Pinion Clearance

7. Starter motor (1).

Install or Connect

NOTICE: See "Notice" on page 6D2-1 of this section.

1. Electrical leads to starter motor (1).
2. Starter motor (1) to engine.

Measure

- Pinion to flywheel clearance (see Figure 5). Add shims (7) as necessary.

3. Starter mounting bolts (2).

Tighten

- Bolts (2) to 47 N·m (35 lb. ft.).

4. Flywheel housing cover.
5. Bracket (4) and attaching bolt (7), washer (6) and nut (5).

Tighten

- Bolts (7) to 24 N·m (18 lb. ft.).
- Nuts (5) to 8 N·m (71 lb. in.).

6. Lower vehicle.
7. Negative battery cable.

Tighten

- Cable to 17 N·m (13 lb. ft.).

UNIT REPAIR

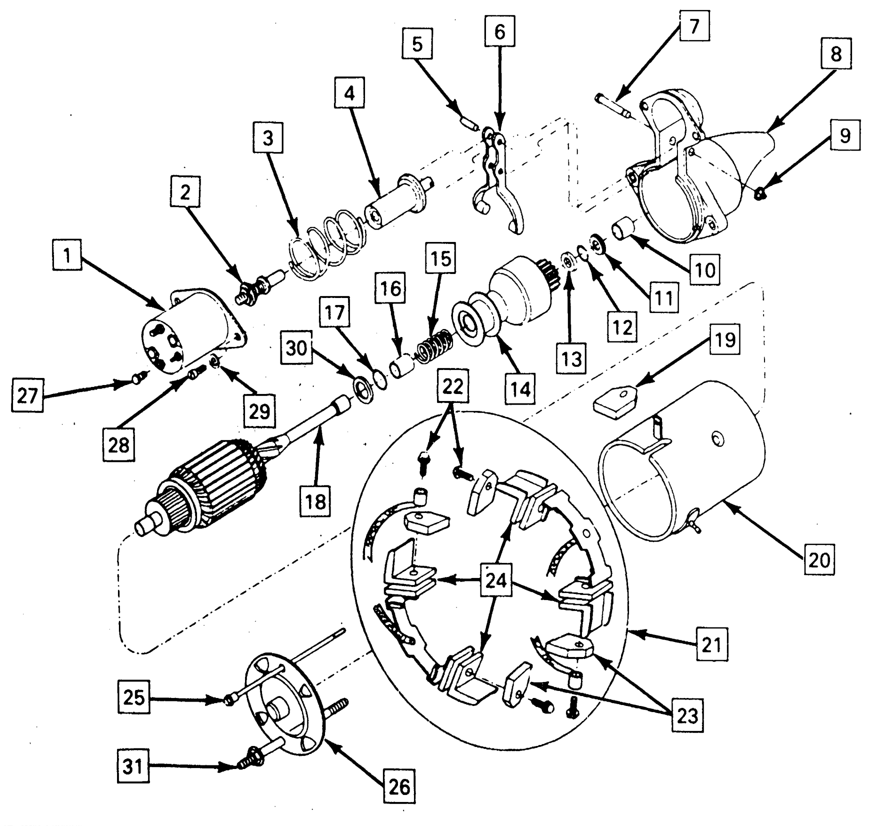
STARTER REPAIR

Figures 6 through 13

Starter motors do not require lubrication except during overhaul. When the motor is taken apart for any reason, lubricate as follows:

NOTICE: Do not clean the clutch in any degreasing tank, or grease dissolving solvents; this will dissolve the lubricant in the clutch mechanism.

- The roll type overrunning clutch requires no lubrication; however, the drive assembly should be wiped clean.
- Use silicon grease on the shaft underneath the overrunning clutch assembly.
- Avoid excessive lubrication.



1	SOLENOID	17	LOCKWIRE
2	CONTACT	18	ARMATURE
3	SPRING	19	GROMMET
4	PLUNGER	20	FRAME
5	PIN	21	HOLDER KIT
6	LEVER	22	SCREW
7	SHAFT	23	BRUSH
8	HOUSING	24	HOLDER
9	SNAP RING	25	BOLT
10	BUSHING	26	FRAME
11	COLLAR	27	SCREW
12	RING	28	SCREW
13	COLLAR	29	WASHER
14	DRIVE	30	WASHER
15	SPRING	31	BOLT
16	BUSHING		

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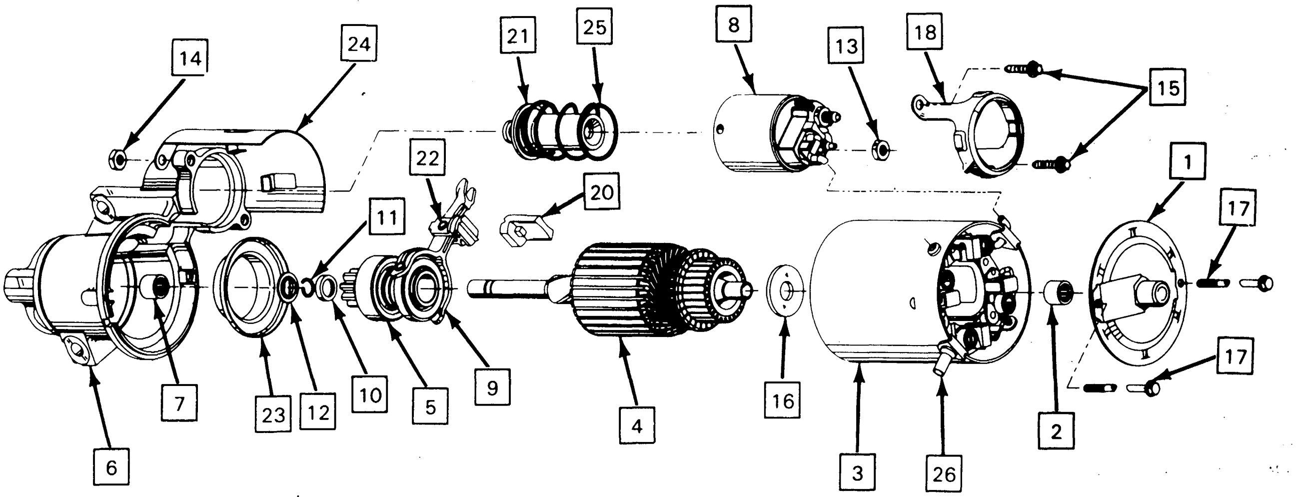
Figure 6 - SD300 Starter Motor Disassembled View



1	FRAME	7	BEARING	13	NUT	20	PLUG	25	SPRING
2	BEARING	8	SOLENOID	14	NUT	21	PLUNGER	26	DRAIN TUBE
3	FRAME AND FIELD	9	SHIFT LEVER	15	SCREW	22	LEVER RETAINER		
4	ARMATURE	10	COLLAR	16	BRAKE WASHER	23	DRIVE SHIELD		
5	DRIVE ASSEMBLY	11	RETAINER RING	17	BOLT	24	HEAT SHIELD		
6	DRIVE HOUSING	12	THRUST COLLAR	18	CLAMP				

MC0005-6D2-B-RP

Figure 7 - SD210/260 Starter Motor - Disassembled View

Solenoid

←→ Remove or Disconnect

1. Field strap.
2. Solenoid to drive housing attaching screws.
3. Motor terminal bolt, and remove solenoid from starter by twisting.

→← Install or Connect

1. Solenoid to starter with terminal bolt.
2. Drive housing attaching screws.
3. Field strap.

Overrunning Clutch

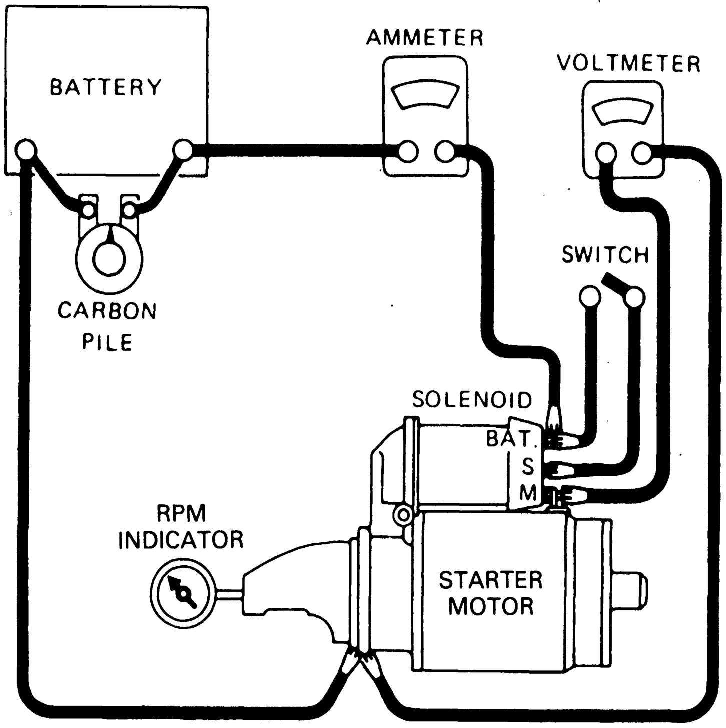
1. Test overrunning clutch action. The pinion should turn freely in the overrunning direction. Check pinion teeth to see that they have not been chipped, cracked, or excessively worn. Replace assembly if necessary. Badly chipped pinion teeth may indicate chipped teeth on the ring gear. This should be checked under such conditions and replaced if necessary.
2. Check the overrunning clutch for slipping by leaving the clutch attached to the armature. Wrap the armature with a shop towel and clamp the armature in a vice. Using a 12-point deep socket and torque wrench, put the socket on the clutch and turn counterclockwise. The clutch should not slip up to 68 N•m (50 lb. ft.) of torque. If it does, replace the clutch.

Disassembly, Test and Reassembly

For disassembly, test, and reassembly, refer to Figures 8 through 13.

STARTER MOTOR
DISASSEMBLY, TEST AND REASSEMBLY
(STARTER REMOVED FROM ENGINE)

NO-LOAD TEST



The pinion should be checked for freedom of operation by turning it on the screw shaft. The armature should be checked for freedom of rotation by prying the pinion with a screwdriver. If the armature does not turn freely, the motor should be disassembled. If the armature does rotate freely, make a no-lead test on the starter before disassembly.

Make connections as shown. Close the switch and compare the RPM, current, and voltage readings with the specifications.

If the specified current draw does not inlcude the solenoid, deduct from the ammeter reading the specified current draw of the solenoid hold-in winding. Make disconnections only with the switch open. Use the test results as follows:

1. Rated current draw and no-load speed indicates normal condition of the starter motor.
2. Low free speed and high current draw indicates:
   - Too much friction — tight, dirty, or worn bearings, bent armature shaft.
   - Shorted armature. Check on a growler after disassembly.
   - Grounded armature or fields. Check further after disassembly.
3. Failure to operate with high current draw indicates:
   - A direct ground in the terminal or fields.
   - "Frozen" bearings (this should have been determined by turning the armature by hand).
4. Failure to operate with no current draw indicates:
   - Open field circuit. After disassembly inspect the internal connections and tracing circuit with a test lamp.
   - Open armature coils. Inspect the commutator for badly burned bars after disassembly.
   - Broken brush springs, worn brushes, high insulation between the commutator bars or other causes which would prevent good contact between the brushes and commutator.
5. Low no-load speed and low current draw indicates:
   - High internal resistance due to poor connections, faulty leads, dirty commutator and causes listed under Number 4.
6. High free speed and high current draw usually indicate shorted fields. If shorted fields are suspected, replace the field coil assembly. Also check for shorted armature, using a growler.

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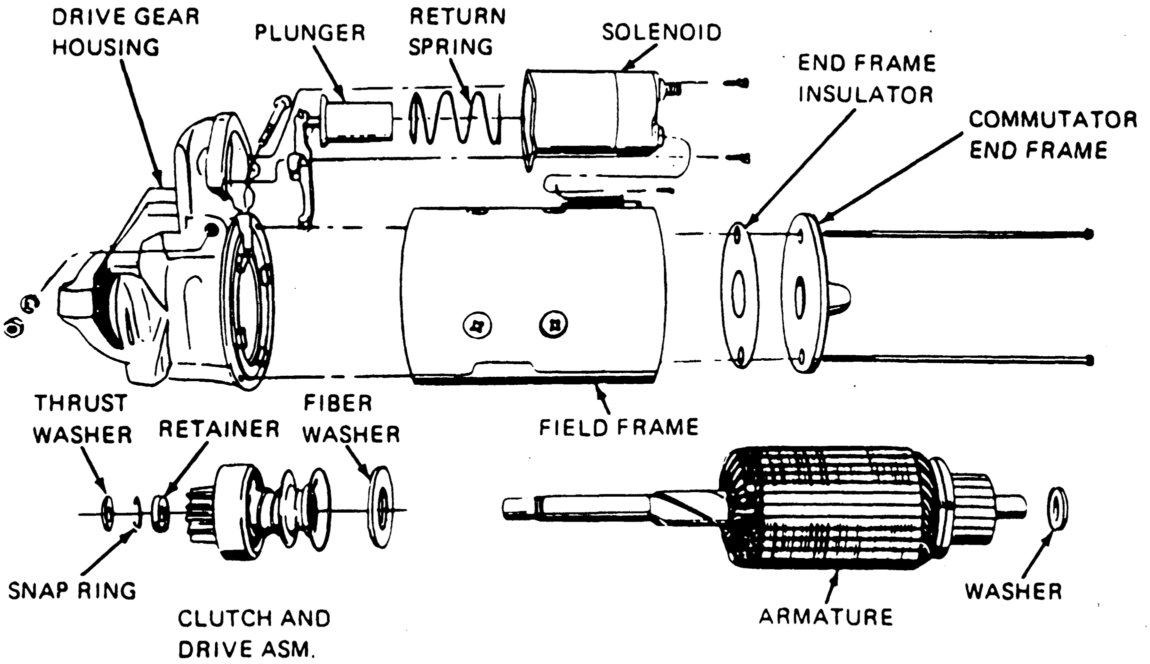
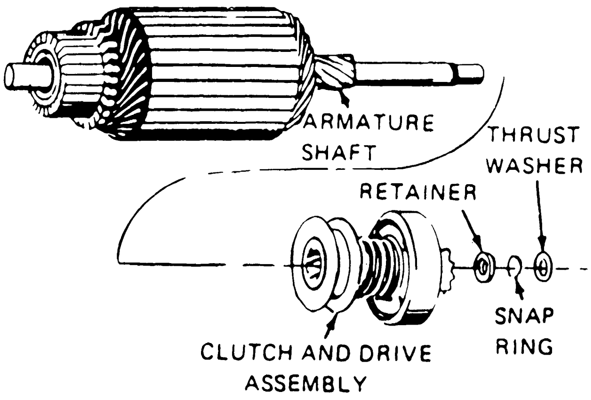
Figure 8 - SD200 and SD300 Starter Motor Disassembly, Test, and Reassembly (1 of 6)

STARTER DISASSEMBLY



7. Remove screw from field coil connector and solenoid mounting screws. Rotate solenoid 90° and remove along with plunger return spring. Solenoid may now be serviced without further starter disassembly at this time.
8. Remove 2 through bolt, then remove commutator end frame and washer.
9. Remove field frame assembly from drive gear housing.

REMOVE DRIVE ASSEMBLY FROM SHAFT



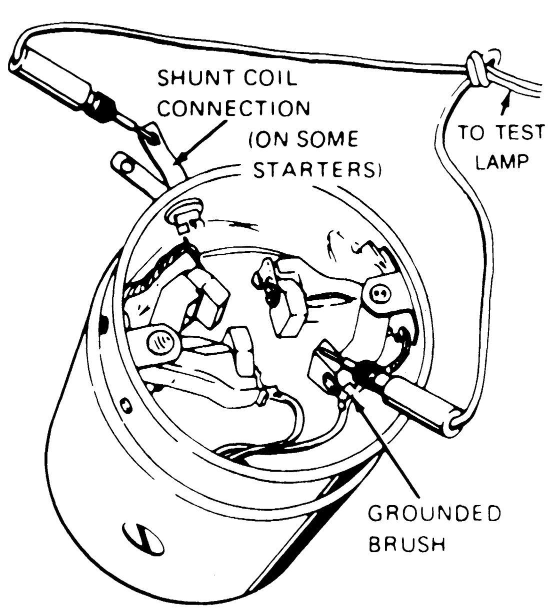
10. If necessary to remove overrunning clutch from armature shaft, proceed as follows:
    a. Remove thrust washer or collar from armature shaft.
    b. Slide a 5/8" deep socket or piece of pipe of suitable size over shaft against retainer as a driving tool. Tap tool to move retainer off snap ring.
    c. Remove snap ring from groove in shaft. If snap ring is distorted, it will be necessary to use a new one on reassembly.
    d. Remove retainer and clutch assembly from armature shaft.
11. The shift lever and plunger may be disassembled at this time by removing the roll pin.

LC0003-6D2-F-RP

Figure 9 - SD200 and SD300 Starter Motor Disassembly, Test, and Reassembly (2 of 6)

CLEANING INSPECTION AND TESTS

TESTING SHUNT COIL FOR OPEN

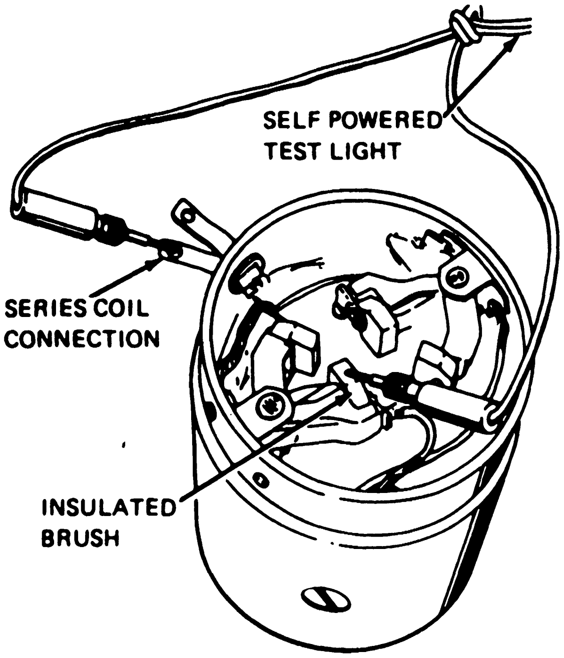


13. Clean all starting motor parts, but DO NOT USE GREASE DISSOLVING SOLVENTS FOR CLEANING THE OVERRUNNING CLUTCH, ARMATURE, AND FIELD COILS, solvent would dissolve the grease packed in the clutch and would damage armature and field coil insulation.
14. Inspect armature commutator, shaft and bushings, overrunning clutch pinion, brushes and springs for discoloration, damage or wear. Replace as required.
15. Check fit of armature shaft in bushing in drive housing. Shaft should fit snugly in the bushing. If the bushing is worn, it should be replaced.
16. Inspect armature commutator. If commutator is rough, it should be polished using emery cloth. If commutator is too rough for polishing or out of round, replace. Inspect the points where the armature conductors join the commutator bars to make sure they have a good connection. A burned commutator bar is usually evidence of a poor connection.
17. If test equipment is available:
    a. Check the armature for short circuits by placing on growler and holding hack saw blade over armature core while armature is rotated. If saw blade vibrates, armature is shorted. Check after cleaning between the commutator bars. If saw blade still vibrates, replace the armature.
    b. Using a test lamp, place one lead on the shunt coil terminal and connect the ohter lead to a ground brush. This test should be made from both ground brushes to insure continuity through both brushes and leads. If the lamp fails to light, the field coil is open and will require replacement.

MC0004-6D2-F-RP

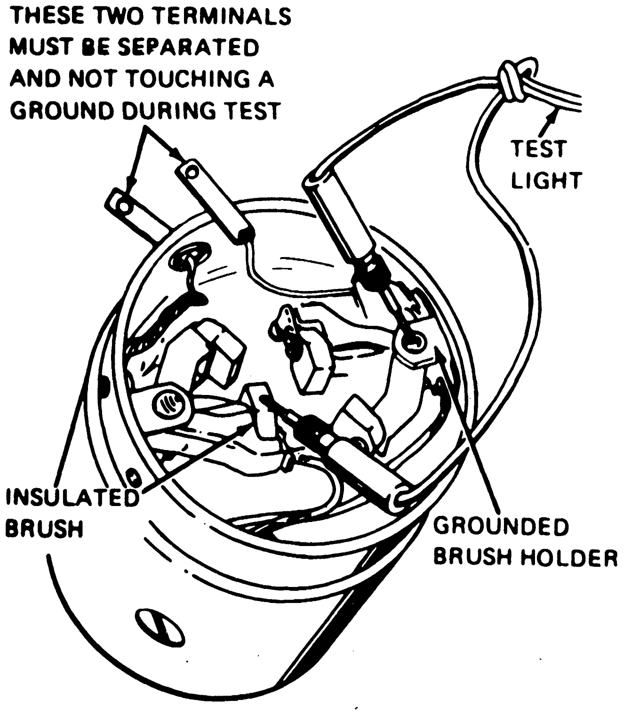
Figure 10 - SD200 and SD300 Starter Motor Disassembly, Test, and Reassembly (3 of 6)

TESTING SERIES COIL FOR OPEN



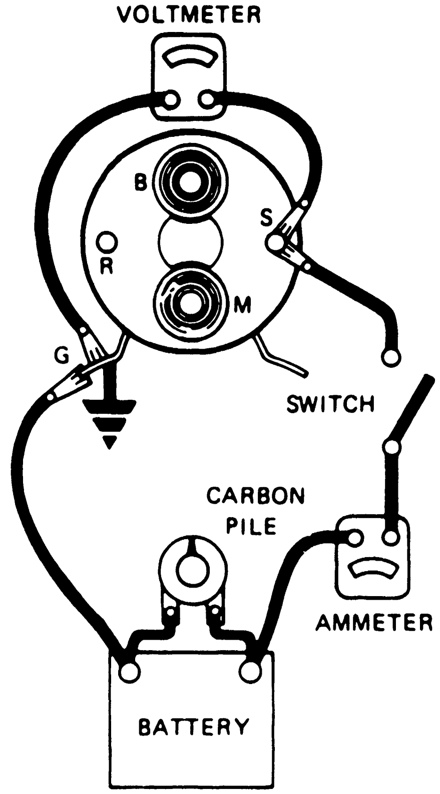
c. Using a test lamp, place one lead on the series coil terminal and the other lead on the insulated brush. If the lamp fails to light, the series coil is open and will require repair or replacement. This test should be made from each insulated brush to check brush and lead continuity.

TESTING SERIES COIL FOR GROUND



d. On starters with shunt coil, separate series and shunt coil strap terminals during this test. Do not let strap terminals touch case or other ground. Using a test lamp place one lead on the grounded brush holder and the other lead on either insulated brush. If the lamp lights, a grounded series coil is indicated and must be repaired or replaced.

TESTING SOLENOID WINDINGS



e. Check the current draw of the solenoid winding as follows:

If solenoid is not removed from starting motor, the connector strap terminals must be removed from the terminal on the solenoid before making these tests. Complete tests in 15 seconds or less to prevent overheating of the solenoid.

To check hold-in winding, connect an ammeter in series with 12-volt battery and the "switch" terminal on the solenoid. Connect a voltmeter to the "switch" terminal and to ground. Connect carbon pile across battery. Adjust the voltage to 10 volts and note the ammeter reading. It should be 13 to 19 amperes.

To check both windings, connect as for previous test. Ground the solenoid motor terminal. Adjust the voltage to 10 volts and note the ammeter reading. It should be 55 to 80 amperes.

NOTE: Current will decrease as windings heat up.

Current draw readings that are over specifications indicate shorted turns or a ground in the windings of the solenoid and the solenoid should be replaced. Current draw readings that are under specifications indicate excessive resistance. No reading indicates an open circuit. Check connections then replace solenoid if necessary.

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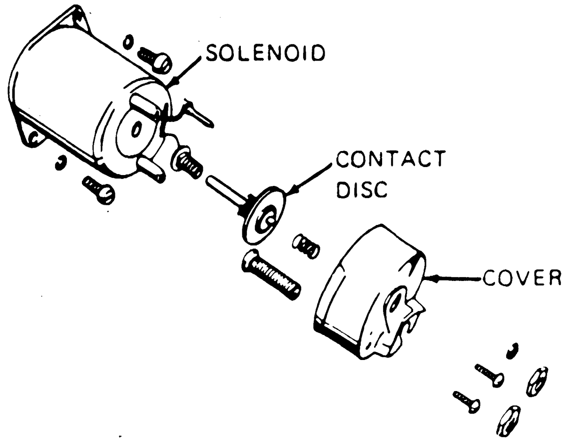
Figure 11 - SD200 and SD300 Starter Motor Disassembly, Test, and Reassembly (4 of 6)

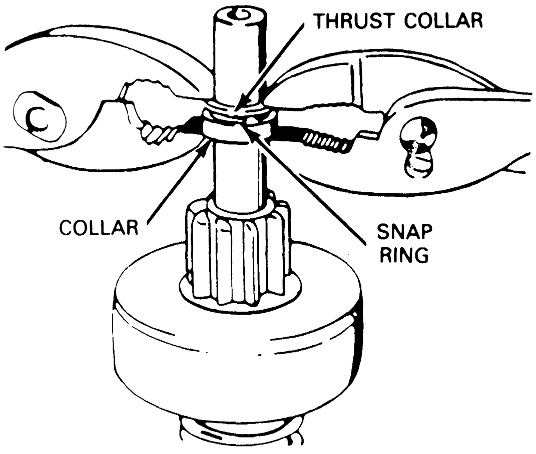
SOLENOID SWITCH DISASSEMBLY (SD 300)



f. The starter solenoid switch is serviced as an assembly. The cover can be removed to inspect the contacts and contact disc if necessary.

STARTER ASSEMBLY

INSTALLING COLLARS AND RING

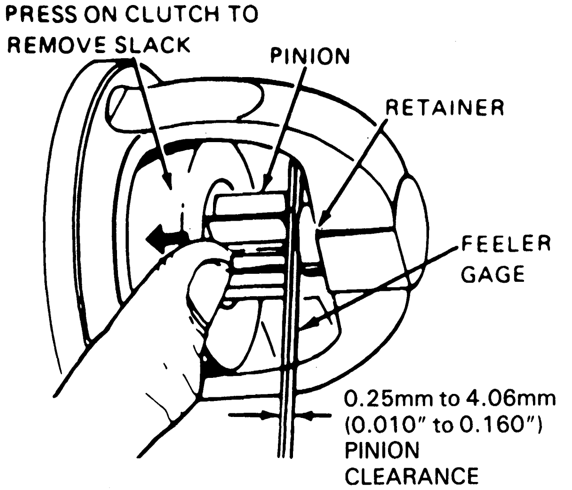


18. Assemble the armature and drive assembly as follows:
    a. Lubricate drive end of armature shaft with lubricant 1960954 or equivalent.
    b. Install the brake washer on the armature shaft.
    c. Slide drive assembly onto armature shaft with pinion away from armature.
    d. Slide collar onto shaft with cupped side facing the end of shaft.
    e. Install snap ring into groove on armature shaft.
    f. Install thrust collar on shaft.
    g. **Position collar and thrust collar with snap ring in between. Using two pliers, grip collar and thrust collar and squeeze until snap ring is forced into collar and is held securely in groove in armature shaft.**
19. Lubricate drive gear housing bushing with lubricant 1960954 or equivalent.
20. Engage shift lever yoke with clutch and slide complete assembly into drive gear housing.
    The shift lever may be installed in drive gear housing first.
21. Install the shift lever pivot bolt. Tighten securely.
22. Install solenoid assembly.
23. Apply sealer, No. 1050026 or equivalent to solenoid flange where field frame contacts it.
24. Position field frame against drive gear housing on alignment pin using care to prevent damage to brushes.
25. Lubricate commutator end-frame bushing with lubricant 1960954 or equivalent.
26. Install washer on armature shaft and slide end frame onto shaft, then install and tighten through-bolts.
27. Connect the field coil connect to the solenoid terminal.
28. Check pinion clearance as outlined in Figure 12.

MC0002-6D2-B-RP

Figure 12 - SD200 and SD300 Starter Motor Disassembly, Test, and Reassembly (5 of 6)

CHECKING PINION CLEARANCE



When the starter motor has been disassembled or the solenoid has been replaced, it is necessary to check the pinion clearance. Pinion clearance must be correct to prevent the buttons on the shift lever yoke from rubbing on the clutch collar during cranking.

29. Disconnect the motor field coil connector from the solenoid motor terminal and insulate it carefully.
30. Connect one 12 volt battery lead to the solenoid switch terminal and the other to the starter frame.
31. Flash a jumper lead momentarily from the solenoid motor terminal to the starter frame. This will shift the pinion into cranking position and it will remain so until the battery is disconnected.
32. Push the pinion back as far as possible to take up any movement, and check the clearance with a feeler gage. The clearance should be 0.25mm to 4.06mm (0.010" to 0.160").

Means for adjusting pinion clearance is not provided on the starter motor. If the clearance does not fall within limits, check for improper installation and replace all worn parts.

MC0003-6D2-B-RP

Figure 13 - SD200 and SD300 Starter Motor Disassembly, Test, and Reassembly (6 of 6)

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Starter Mounting Bolt	47 N·m (35 lb. ft.)
Bracket Attaching Bolt	24 N·m (18 lb. ft.)
Bracket Nut	8 N·m (71 lb. in.)
Negative Battery Cable	17 N·m (13 lb. ft.)
Clutch	68 N·m (50 lb. ft.)

STARTER SPECIFICATIONS

LHO, 3.1L Engine	
Production Part Number	10455011
Type SD210	
No Load Test @ 10 volts	
Amps – Minimum	45
Amps – Maximum	75
RPM at Drive Pinion	
Minimum	6,000
Maximum	11,000
LO3, LB9, 5.0L Engines	
Production Part Number	10455012
Type SD260	
No Load Test @ 10 Volts	
Amps - Minimum	45
Amps-Maximum	70
RPM at Drive Pinion	
Minimum	6,500
Maximum	11,000
L98, 5.7L Engine	
Production Part Number	1998591
Type SD300	
No Load Test @ 10 Volts	
Amps - minimum	70
Amps - maximum	110
RPM at Drive Pinion	
Minimum	6,500
Maximum	10,700

SECTION 6D3

CHARGING SYSTEM

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology "NOTICE: See "Notice" on page 6D3-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

The CS generator uses a new type of regulator which has a built-in fault detection; it does not have a diode trio or test hole. Refer to ELECTRICAL DIAGNOSIS (SEC. 8A) for operation and additional charging circuit diagnosis.

The delta stator, rectifier bridge, and rotor with slip rings and brushes are electrically similar to earlier generators. A conventional pulley and fan is used to cool the slip ring end frame, rectifier bridge and regulator.

This generator uses two connections in addition to the ground circuit through the mounting bracket for operation. The "BAT" terminal is connected to the battery positive terminal to charge the battery, and either the "L," "F" or "I" terminal is connected to the ignition switch to turn on the generator. The "I" or "F" terminal can be connected directly to the battery voltage, instead of or in addition to the "L" terminal which must be stepped down through the indicator light bulb or a resistor. Vehicles with gages only commonly use a single connection to the "I" or "F" terminal. Both "F" or "I" terminals may be present even though only one is used to turn on the generator.

Use of the "P" and "S" terminals is optional. The "P" terminal is connected internally to the stator and can be connected to a tachometer or other device, and the "S" terminal can be used to sense system voltage at some other location on the vehicle.

As on other charging systems, the charge indicator illuminates when the switch is closed and goes out when the engine is running. If the charge indicator is illuminated with the engine running, a charging system condition requiring diagnosis is indicated. Also, the charge indicator will be on with the engine running if system voltage is too high or too low.

The regulator voltage setting varies with temperature and limits system voltage by controlling rotor field current. This regulator switches rotor field current on and off at a fixed frequency of about 400 cycles per second. By varying the on-off time, correct average field current for proper system voltage control can be obtained. At high speeds, the on-time may be 10%, and the off-time 90%. At low speeds, with high electrical loads, on-off time may be 90% and 10%, respectively.

DIAGNOSIS

CS GENERATOR

Figure 1

When the CS charging system is operating normally, the indicator lamp will come on when the engine control switch is turned "ON" and will go out when the engine starts. If the lamp operates abnormally, or if an undercharged or overcharged battery condition occurs, the following procedure may be used to diagnose the charging system. Remember that an undercharged battery is often caused by accessories being left on overnight, or if a trunk or glove box lamp stays on. Also, remember that this generator does not have a test hole and is serviced as a complete assembly.

Noise from a generator may be caused by a loose drive pulley, loose mounting bolts, worn or dirty bearings, defective diode or defective stator.

A basic wiring diagram showing lead connections is shown in Figure 1. To avoid damage to the electrical equipment, always observe the following precautions:

- Do not reverse connections to the generator.
- Do not short across or ground any of the terminals in the charging circuit, except as directed by the instructions.
- NEVER disconnect the generator output terminal with the generator operating.

- Before connecting a charger or a booster battery to the vehicle battery, refer to BATTERY (SEC. 6D1).
- In some vehicles, a voltmeter may be used instead of an indicator lamp. In this case, the item pertaining to faulty indicator lamp operation should be omitted from the troubleshooting procedure below.
- Do not attempt to disassemble a CS-130 generator. Damage to the generator could result.

Trouble in the charging system will show up as one or more of the following conditions:

- Faulty indicator lamp operation.
- An undercharged battery, indicated by slow cranking or dark hydrometer.
- An overcharged battery, indicated by electrolyte spewing from the vents.

To diagnose the CS-130 charging system, use the following procedure:

1. Visually check belt and wiring.
2. For vehicles without a charge indicator lamp, go to step 5.
3. With engine control switch "ON" and engine stopped, lamp should be on. If lamp is not on, detach the harness at the generator and ground the "L" terminal in the wiring harness.
    - If lamp lights, replace the generator.
    - If lamp does not light, locate open circuit between grounding lead and ignition switch. Also, check for a faulty bulb.
4. With engine control switch "ON" and engine running at moderate speed, lamp should be off. If lamp is not off, detach wiring harness at generator.
    - If lamp goes off, replace generator.
    - If lamp stays on, check for grounded "L" terminal wire in harness.
5. Battery undercharged or overcharged.
    - Detach wiring harness connector from generator.
    - With engine control switch "ON" and engine not running, connect multimeter from ground to "L" terminal. Connect to "F" or "I" terminal for gage equipped vehicle. At least one terminal should have battery voltage.
    - Zero volts indicates open circuit between terminal and battery. Repair as required.
    - Reconnect harness connector to generator and run engine at moderate speed.
    - Measure voltage across battery. If the voltage is above 16 volts, replace generator.
    - Turn all accessories "ON" and load battery with carbon pile to obtain maximum generator output. Maintain voltage at 13 volts or above.
        - If within 15 amps of rated output, generator is OK.
        - If not within 15 amps of rated output, replace the generator.

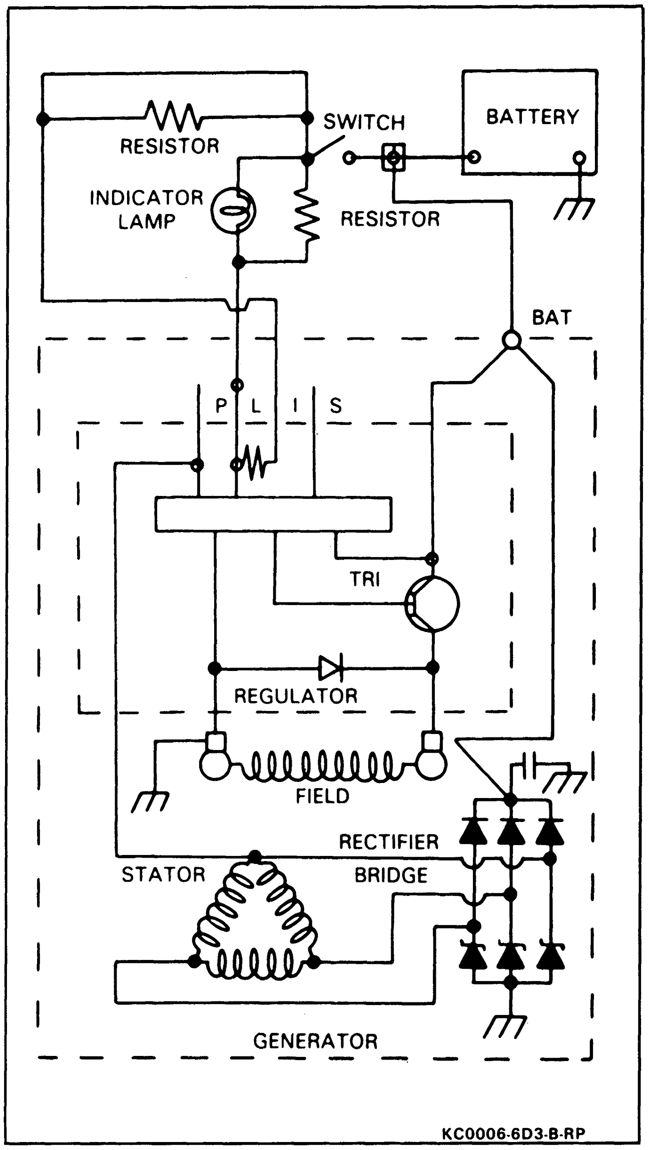


Figure 1 - CS Charging System Wiring Diagram

CS GENERATOR BENCH CHECK

Figure 2

1. Remove the generator. Refer to "Generator Replacement" in this section.
2. Make connections as shown in Figure 2, except leave the carbon pile disconnected. The ground polarity of generator and battery must be the same. The battery must be fully charged. Use a 30-500 ohm resistor between battery and "L" terminal of the generator.
3. Slowly increase generator speed and observe voltage.
    - If the voltage is uncontrolled and increases above 16.0 volts, the rotor field is shorted or grounded, the regulator is defective, or both. A shorted rotor field coil can make the regulator defective.
    - If voltage is below 16.0 volts, increase speed and adjust carbon pile to obtain maximum amperage output. Maintain voltage above 13.0 volts.
    - If output is within 15 amps of rated output, generator is good.
    - If output is not within 15 amps of rated output, generator is defective and requires replacement.

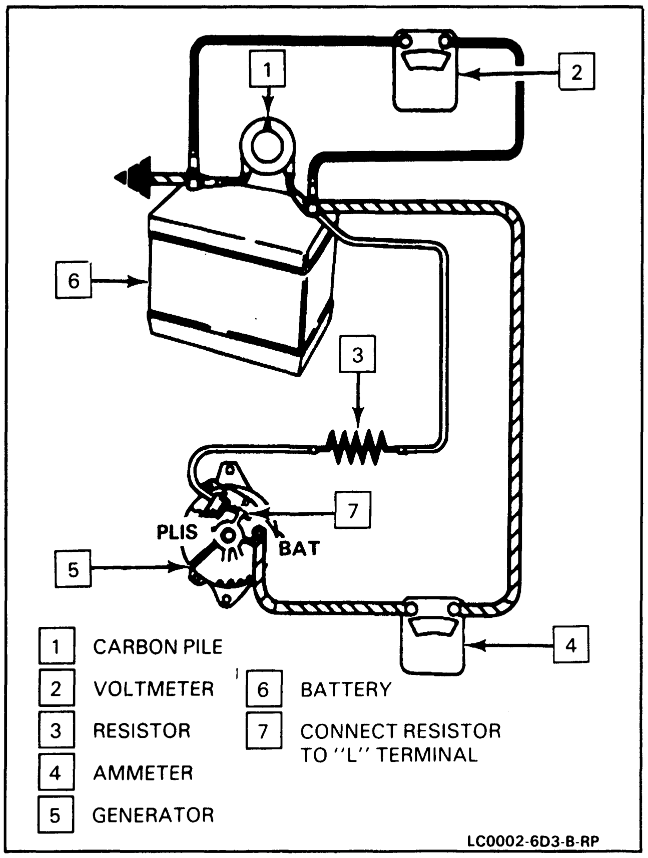


Figure 2 - Generator Bench Check

ON-VEHICLE SERVICE

The CS generator does not require periodic lubrication. The rotor shaft is mounted on ball bearings at the drive end and at the slip ring end. The bearing assemblies are permanently lubricated. At periodic intervals, check mounting bolts for tightness and inspect belt tension. Refer to COOLING AND RADIATOR (SEC. 6B).

GENERATOR REPLACEMENT

Figures 3 and 4

For generator replacement, refer to Figure 3 or 4 as applicable.

Disconnect negative battery cable before replacing the generator.

POWER STEERING PUMP AND GENERATOR BRACKET REPLACEMENT

Figure 3

This bracket is used to mount the generator and power steering pump on vehicles equipped with fuel injected 5.0L, and 5.7L engines.

↔ Remove or Disconnect

1. Generator. Refer to "Generator Replacement" in this section.
2. Power steering pump. Refer to POWER STEERING GEAR AND PUMP (SEC. 3B1).
3. Bolts (13, 16 and 20).
4. Nuts (15 and 18).
5. Bracket assembly (4).

→← Install or Connect

NOTICE: See "Notice" on page 6D3-1 in this section for steps 2 through 5.

1. Bracket assembly (4) to engine studs.
2. Nut (18).

   Tighten

   - Nut (18) to 33 N·m (24 lb. ft.).
3. Bolts (16 and 20).

   Tighten

   - Bolts (16 and 20) to 33 N·m (24 lb. ft.).
4. Nut (15).

   Tighten

   - Nut (15) to 33 N·m (24 lb. ft.).
5. Bolt (13).

   Tighten

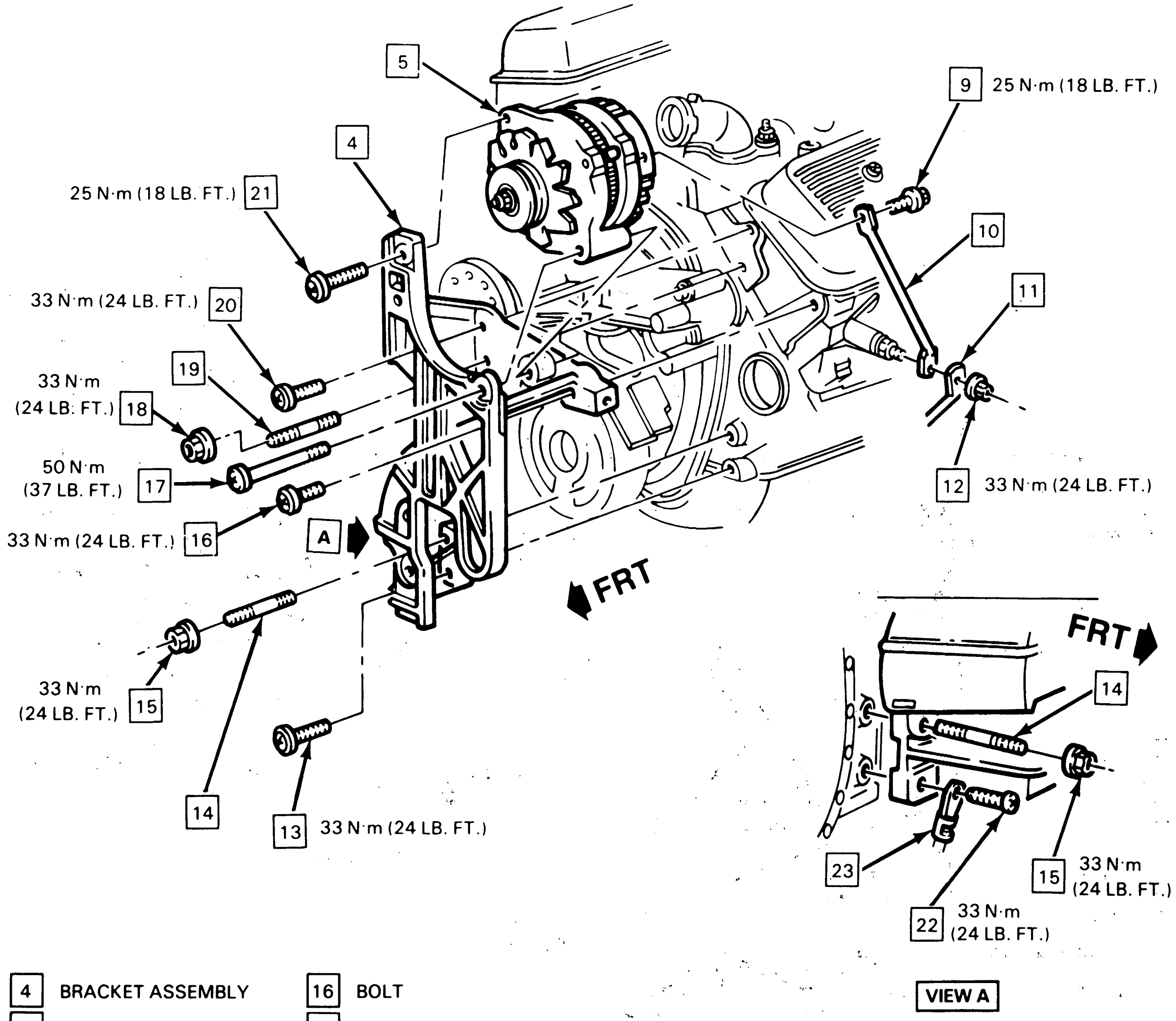
   - Bolt (13) to 33 N·m (24 lb. ft.).
6. Power steering pump. Refer to POWER STEERING GEAR AND PUMP (SEC. 3B1).
7. Generator. Refer to "Generator Replacement" in this section.
8. Negative battery cable.

UNIT REPAIR

CS-130 GENERATOR

The CS-130 generator must be replaced as a unit.

NOTICE: Do not attempt to disassemble a CS-130 generator. Damage to the generator could result.



4	BRACKET ASSEMBLY
5	GENERATOR
9	BOLT
10	BRACE
11	BRACE
12	NUT
13	BOLT
14	STUD
15	NUT
16	BOLT
17	BOLT
18	NUT
19	STUD
20	BOLT
21	BOLT
22	SCREW
23	NEGATIVE BATTERY CABLE

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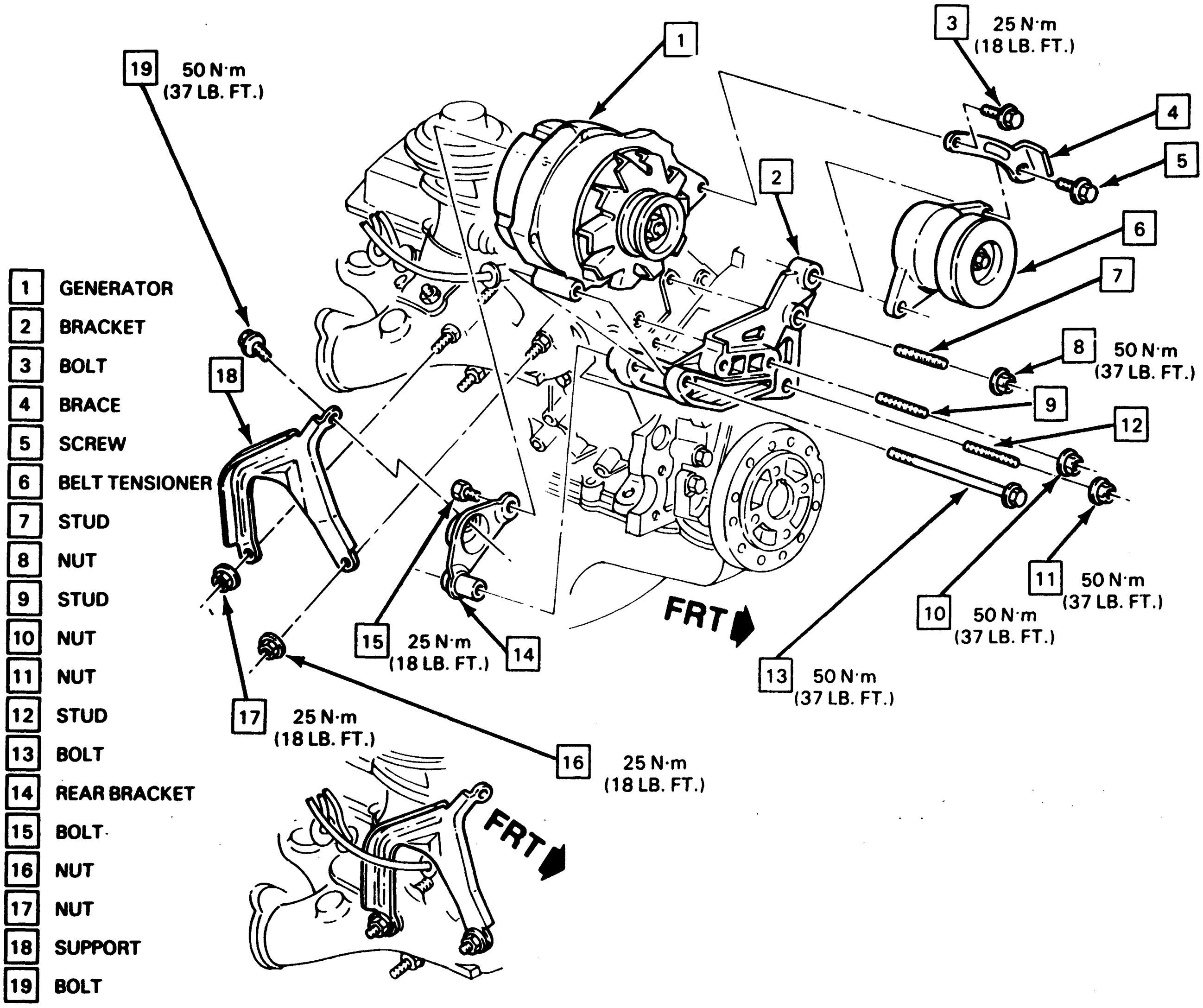
Figure 3 - Generator Mounting (V8)



1	GENERATOR
2	BRACKET
3	BOLT
4	BRACE
5	SCREW
6	BELT TENSIONER
7	STUD
8	NUT
9	STUD
10	NUT
11	NUT
12	STUD
13	BOLT
14	REAR BRACKET
15	BOLT
16	NUT
17	NUT
18	SUPPORT
19	BOLT

Figure 4 - Generator Mounting (V6)

SPECIFICATIONS

GENERATOR USAGE

ENGINE	EQUIPMENT	GEN/MOD	AMPERES
LH0	All	1101593/CS130	100
LO3	All	1101645/CS130	100
LB9	All	1101600/CS130	105
L98	All	1101600/CS130	105

FASTENER TORQUE SPECIFICATIONS

V8 Engines	
Power Steering Pump and Generator Bracket Attaching Nut and Bolt	33 N·m (24 lb. ft.)
Brace-to-Generator Bolt	25 N·m (18 lb. ft.)
Brace-to-Engine Nut	33 N·m (24 lb. ft.)
Bracket-to-Generator Upper Bolt	25 N·m (18 lb. ft.)
Bracket -to-Generator Lower Bolt	50 N·m (37 lb. ft.)
V6 Engine	
Support-to-Engine Nut	25 N·m (18 lb. ft.)
Support-to-Rear Bracket Bolt	50 N·m (37 lb. ft.)
Rear Bracket-to-Generator Bolt	25 N·m (18 lb. ft.)
Bracket-to-Rear Bracket Bolt	50 N·m (37 lb. ft.)
Bracket-to-Engine Nut	50 N·m (37 lb. ft.)
Brace-to-Generator Bolt	25 N·m (18 lb. ft.)

SECTION 6D4

IGNITION SYSTEM

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 6D4-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

The ignition circuit consists of the battery, the distributor, the ignition switch, the spark plugs, and the primary and secondary wiring.

HEI DISTRIBUTOR

Figures 1 through 3

All vehicles use a High Energy Ignition (HEI) distributor with Electronic Spark Timing (EST). The distributor has an exterior ignition coil and connects to the rotor through a high tension wire.

The distributor has a magnetic pick-up assembly located inside the distributor which contains a permanent magnet, a pole piece with internal teeth, and a pick-up coil. When the teeth of the timer core, rotating inside the pole piece, line up with the teeth of the pole piece, an induced voltage in the pick-up coil signals the electronic module to trigger the coil primary circuit. The primary current decreases and a high voltage is induced in the ignition coil secondary winding which is directed through the rotor and secondary leads to fire the spark plugs. The capacitor in the distributor is for radio noise suppression.

All spark timing changes in the HEI distributor with EST are done electronically by an Electronic Control Module (ECM) which monitors information from various engine sensors, computes the desired spark timing and signals the distributor to change the timing accordingly. A back-up spark advance system is incorporated to signal the ignition module in case of ECM failure. No vacuum or mechanical advance is used.

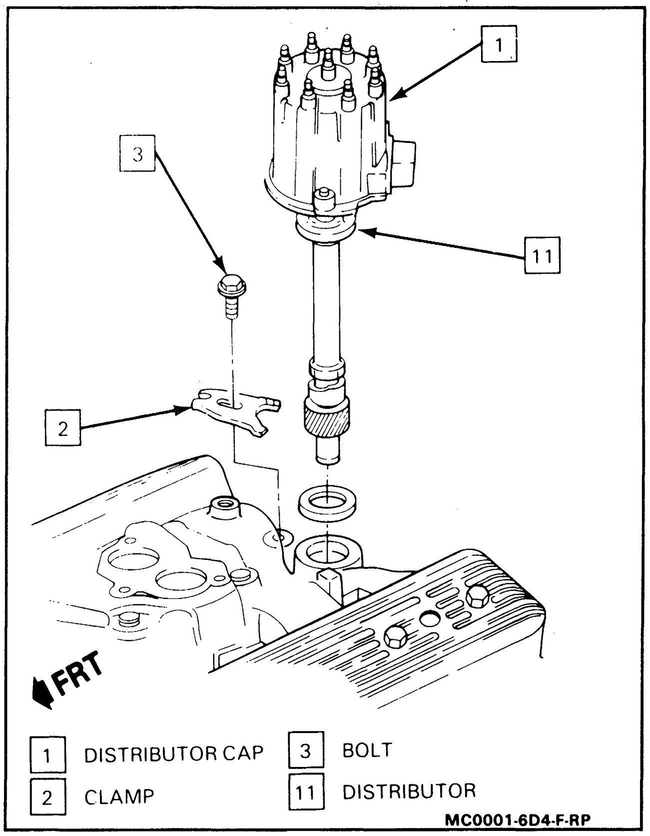


Figure 1 - HEI Distributor (Typical)

IGNITION TIMING

Timing specifications for each engine are listed in "Specifications" in this section. When using a timing light, connect an adapter between the spark plug and the spark plug wire or use an inductive type pick-up.

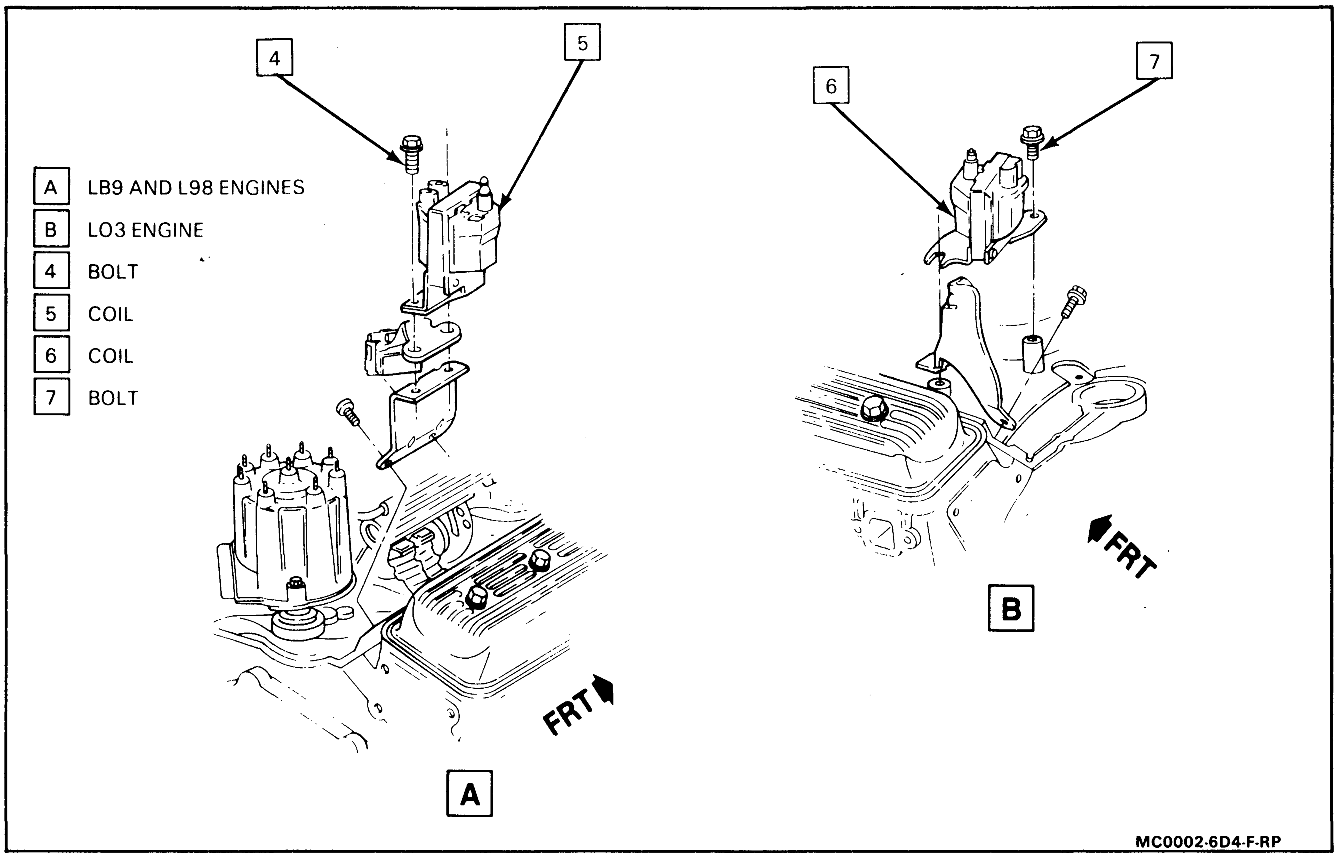


Figure 2 - Ignition Coils (V8)

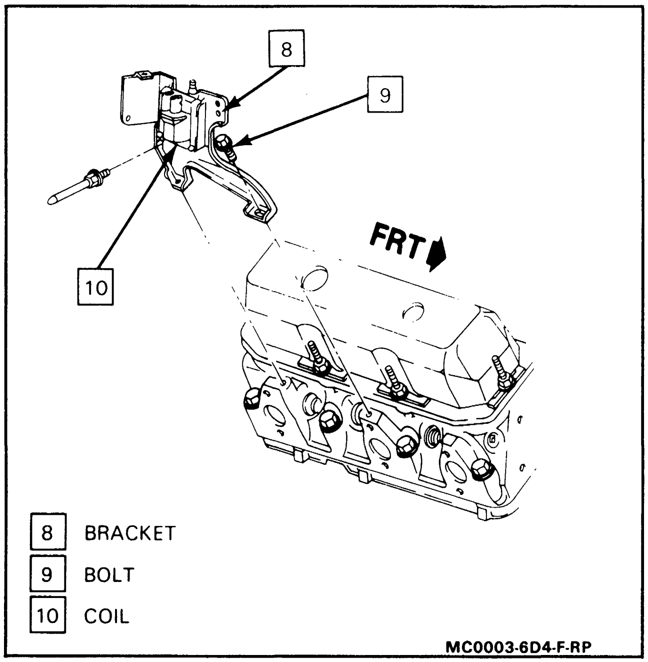


Figure 3 - Ignition Coil (V6)

NOTICE: Do not pierce the plug lead. Once the insulation of the spark plug cable has been broken, current will jump to the nearest ground and the spark plug will not fire properly.

Always follow the procedures when adjusting timing. (Ignition timing procedures follow in "On-Vehicle Service.") After the timing has been set, clear the ECM memory as called for, as a code will be stored if you disconnect the distributor EST connector.

SECONDARY WIRING

The spark plug wiring used with the ignition system is a carbon impregnated cord conductor encased in an 8 mm (5/16 inch) diameter silicone rubber jacket. The silicone wiring will withstand very high temperatures and also provides an excellent insulator for the higher voltage of the HEI system. The silicone spark plug boots form a tight seal on the plug and the boot should be twisted 1/2 turn before removing. Care should also be exercised when connecting a timing light or other pick-up equipment. Do not force anything between the boot and wiring, or through the silicone jacket. Connections should be made in parallel using an adapter. Do not pull on the wire to be removed. Pull on the boot or use a tool designed for this purpose.

SPARK PLUGS

Figure 4

Refer to MAINTENANCE AND LUBRICATION (SEC. 0B) for spark plug type and gap sizes. Always replace plugs with the correct one listed.

Normal service is assumed to be a mixture of idling, slow speed, and high speed driving. Occasional or intermittent highway driving is needed for good spark plug performance because it gives increased combustion heat that burns away any excess deposits of carbon or oxides that have built up from frequent idling or continual stop-and-go driving. Spark plugs are protected by an insulating boot made of special heat-resistant material which covers the spark plug terminal and extends downward over a portion of the plug insulator. These boots prevent flash-over which causes engine misfiring. Do not mistake corona discharge for flash-over or a shorted insulator. Corona is a steady blue light appearing around insulator, just above the shell crimp. It is the visible evidence of high-tension field, and has no effect on ignition performance. Usually it can be detected only in darkness. This discharge may repel dust particles, leaving a clear ring on the insulator just above the shell. This ring is sometimes mistakenly regarded as evidence that combustion gases have blown out between shell and insulator.

Spark plugs must operate within certain temperature limits if they are to provide the performance and service life expected. The spark plug selected for an engine is based on the normal service for which the engine was designed. Refer to MAINTENANCE AND LUBRICATION (SEC. 0B). The spark plug may not operate satisfactorily under certain other operating conditions. For almost exclusive city driving, a spark plug one step higher in heat range might deliver longer service life than the spark plug recommended for normal operation. Conversely, a spark plug one step colder for heavy loads or sustained high speed operation may prove more beneficial.

Three rules to follow in selecting spark plugs for an engine in good condition.

1. Select the spark plug with the heat range specified.
2. Should overheating occur, select the spark plug specified for the engine but one heat range lower.
3. If fouling is the problem, selecting a spark plug one heat range higher (hotter) could help improve the condition. Refer to Figure 4 for spark plug identification.

DIAGNOSIS

SPARK PLUGS

Worn or dirty plugs may give satisfactory operation at idling speed, but under operating conditions they frequently fail. Faulty plugs are indicated in a number of ways: poor fuel economy, power loss, loss of speed, hard starting and generally poor engine performance.

Spark plugs may also fail due to carbon fouling, excessive gap, or a broken insulator.

Fouled plugs are identified by black carbon deposits. The black deposits are usually the result of slow-speed driving and short runs where sufficient engine operating temperature is seldom reached. Worn pistons, rings, faulty ignition, an over-rich fuel mixture and spark plugs which are too cold will also result in carbon deposits.

Excessive gap wear on plugs of low mileage usually indicates the engine is operating at high speeds or loads that are consistently greater than normal or that a plug which is too hot is being used. Electrode wear may also be the result of plug overheating caused by combustion gases leaking past the threads due to insufficient spark plug torque. An excessively lean fuel mixture will also result in excessive electrode wear.

Broken insulators are usually the result of improper installation or carelessness when regapping the plug. Broken upper insulators usually result from a poor fitting wrench or an outside impact. The cracked insulator may not show up right away, but will as soon as oil or moisture penetrates the crack. The crack is usually just below the crimped part of the shell and may not be visible.

Broken lower insulators usually result from carelessness when regapping and generally are visible. This type of break may result from the plug operating too "hot," which may happen in periods of high-speed operation or under heavy loads. When regapping a spark plug, always make the gap adjustment by bending the ground (side) electrode. Spark plugs with broken insulators should always be replaced.

HEI DISTRIBUTOR

Figures 5 and 6

See Figures 5 and 6 for distributor disassembly, test and reassembly of individual distributor components when the distributor is off the vehicle. See "On-Vehicle Service" in this section for distributor removal and installation and for component removal with distributor in vehicle. For HEI and EST diagnosis refer to DRIVEABILITY AND EMISSIONS-FUEL INJECTION (TBI) (SEC. 6E2) or DRIVEABILITY AND EMISSIONS-FUEL INJECTION (PORT) (SEC. 6E3).

ON-VEHICLE SERVICE

HEI DISTRIBUTOR

Service Precautions

1. When making compression checks, disconnect the ignition switch feed wire at the distributor. When disconnecting this connector do not use a screwdriver or tool to release the locking tab as it may break.
2. No periodic lubrication is required. Engine oil lubricates the lower bushing and an oil-filled reservoir provides lubrication for the upper bushing.
3. The tachometer (TACH-C) terminal is next to the ignition switch (BAT+) connector on the distributor cap.

   NOTICE: The tachometer terminal must never be allowed to touch ground, as damage to the module and/or ignition coil can result.

   Some tachometers currently in use may not be compatible with the high energy ignition system. Consult the manufacturer of the tachometer if questions arise.
4. Dwell adjustment is controlled by the module and cannot be adjusted.
5. The material used to construct the spark plug cables is very soft. This cable will withstand more heat and carry a higher voltage, but scuffing and

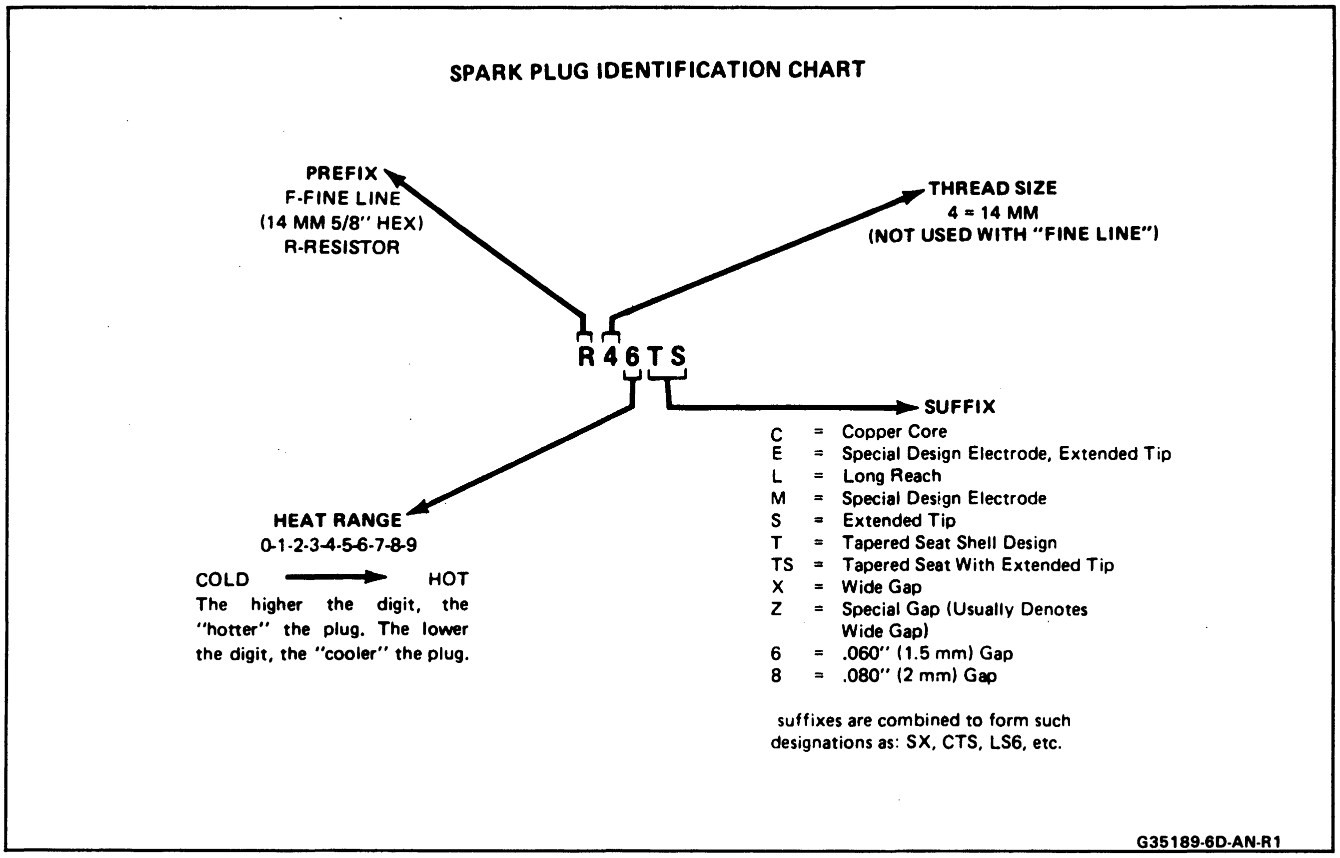


Figure 4 - Spark Plug Identification Chart

cutting become easier. The spark plug cables must be routed correctly to prevent chafing or cutting. Refer to "Secondary Wiring" in this section. When removing a spark plug wire from a spark plug, twist the boot on the spark plug and pull on the boot only.

Distributor with Separate Coil

Figure 1

Remove or Disconnect

1. Negative (-) battery cable.
2. Wiring harness connectors at the side of the distributor cap (1).
3. Distributor cap (1) and move it out of the way.
- Note position of rotor and distributor housing in relation to engine.
4. Distributor clamp bolt (3) and hold-down clamp (2).
5. Distributor (11).
   - Note position of rotor as distributor (11) is pulled up and mark final position.

Install or Connect

NOTICE: See "Notice" on page 6D4-1 of this section.

Important

- To ensure correct timing of the distributor, the distributor must be installed with the rotor correctly positioned as noted.

1. Distributor (11).
2. Hold-down clamp (2) and distributor clamp bolt (3).

Tighten

- Distributor clamp bolt (3) to 36 N·m (27 lb. ft.).

3. Distributor cap (1).
4. Wiring harness connector at the side of the distributor cap (1).
5. Negative (-) battery cable.
6. Check ignition timing.

Coil Replacement

Figures 2 and 3

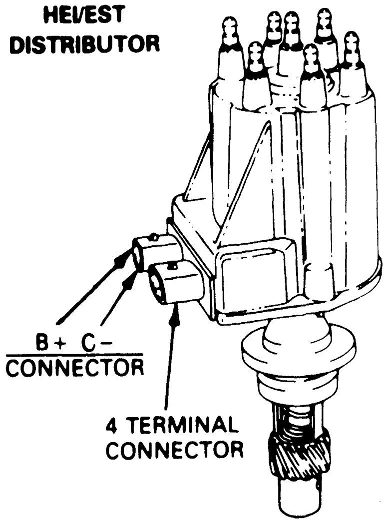
Remove or Disconnect

1. Negative battery cable.
2. Engine wiring harness from coil (5, 6 or 10).
3. Coil-to-distributor lead at coil (5, 6 or 10).
4. Bolts (4, 7, or 9).
5. Coil (5 or 6) on V8 engines.
6. Coil (10) with bracket (8) on V6 engines.
7. Rivets holding coil (10) to coil bracket (8) on V6 engines if necessary.

Install or Connect

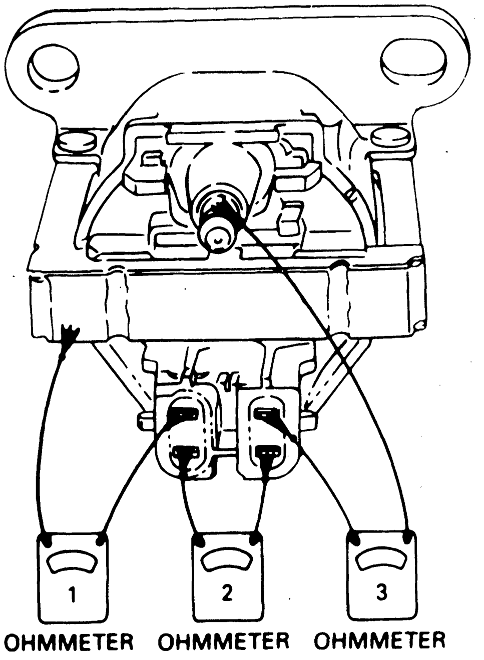
NOTICE: See "Notice" on page 6D4-1 of this section.

DISTRIBUTOR DISASSEMBLY TEST AND REASSEMBLY (SEPARATELY MOUNTED COIL)



1. A TYPICAL DISTRIBUTOR USED WITH A SEPARATELY MOUNTED COIL IS SHOWN.

TESTING IGNITION COIL



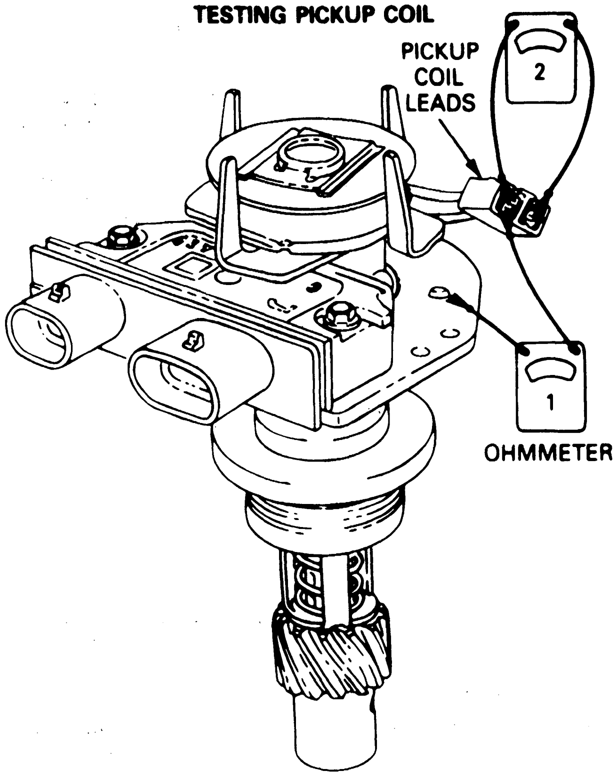
2. CHECK IGNITION COIL WITH OHMMETER FOR OPENS AND GROUNDS:

STEP 1. — USE HIGH SCALE. SHOULD READ VERY HIGH (INFINITE). IF NOT, REPLACE COIL.

STEP 2. — USE LOW SCALE. SHOULD READ VERY LOW OR ZERO. IF NOT, REPLACE COIL.

STEP 3. — USE HIGH SCALE. SHOULD NOT READ INFINITE. IF IT DOES, REPLACE COIL.

TESTING PICKUP COIL



3. REMOVE ROTOR AND PICKUP COIL LEADS FROM MODULE.

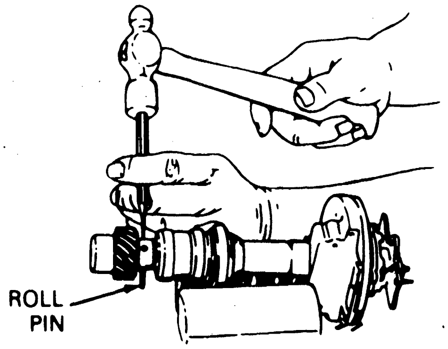
4. CONNECT OHMMETER PART 1 AND PART 2.

5. OBSERVE OHMMETER. FLEX LEADS BY HAND TO CHECK FOR INTERMITTENT OPENS.

STEP 1 — SHOULD READ INFINITE AT ALL TIMES. IF NOT, PICKUP COIL IS DEFECTIVE.

STEP 2 — SHOULD READ ONE STEADY VALUE BETWEEN 500-1500 OHMS AS LEADS ARE FLEXED BY HAND. IF NOT, PICKUP COIL IS DEFECTIVE.

DRIVING PIN FROM SHAFT



6. DRIVE ROLL PIN FROM GEAR AND REMOVE SHAFT ASSEMBLY. MARK GEAR AND SHAFT FOR CORRECT REASSEMBLY.

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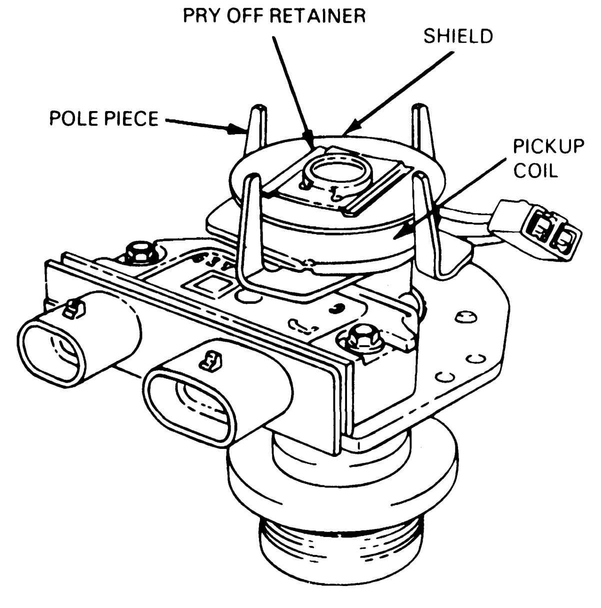
Figure 5 - Distributor Disassembly, Test and Reassembly - External Coil (1 of 2)

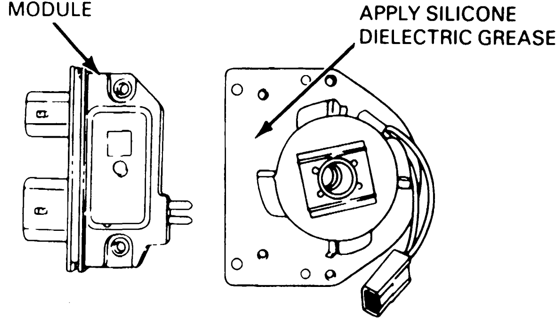
REMOVE PICKUP COIL



7 TO REMOVE PICKUP COIL, REMOVE RETAINER AND SHIELD.

8 LIFT PICKUP COIL ASSEMBLY STRAIGHT UP TO REMOVE FROM DISTRIBUTOR.

REMOVING MODULE



9 DISCONNECT WIRING CONNECTORS FROM MODULE. REMOVE TWO SCREWS TO REMOVE MODULE TEST MODULE WITH AN APPROVED MODULE TESTER.

REASSEMBLY

10 WIPE DISTRIBUTOR BASE AND MODULE CLEAN, APPLY SILICONE DIELECTRIC GREASE BETWEEN MODULE AND BASE FOR HEAT DISSIPATION.

11 ATTACH MODULE TO BASE. ATTACH PICKUP COIL CONNECTOR TO MODULE.

12 ASSEMBLE PICKUP COIL, SHIELD AND RETAINER.

13 ASSEMBLE SHAFT, GEAR PARTS AND ROLL PIN.

14 SPIN SHAFT TO INSURE THAT TEETH DO NOT TOUCH POLE PIECE.

15 INSTALL ROTOR AND CAP.

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Figure 6 - Distributor Disassembly, Test and Reassembly - External Coil (2 of 2)

1. Screws to hold coil (10) to coil bracket (8) on V6 engines if necessary.
2. Coil (10) with coil bracket (8) on V6 engines.
3. Coil (5 or 6) on V8 engines.
4. Bolts (4, 7, or 9).

Tighten

- Bolts (9) to 50 N·m (37 lb. ft.).
- Bolts (7) to 22 N·m (16 lb. ft.).
- Bolts (4) to 6 N·m (50 lb. in.).

5. Coil-to-distributor lead.
6. Engine wiring harness.
7. Negative battery cable.

HEI Module

Figure 6

It is not necessary to remove the distributor from the vehicle.

Remove or Disconnect

1. Distributor cap and rotor.
2. Pick up coil.
3. Two module attaching screws, and lift module up.
4. Leads from module. (Observe color code on leads as these cannot be interchanged.)
5. Module.

Important

- Do not wipe grease from module or distributor base if same module is to be replaced. If a new module is to be installed, a package of silicone grease will be included with it. Spread the grease on the metal face of the module and on the distributor base where the module seats. This grease is necessary for module cooling.

Install or Connect

1. Module.
2. Leads to module.
3. Module attaching screws.
4. Pick up coil.
5. Distributor cap and rotor.

Pick-Up Coil

- Remove distributor from vehicle and follow instructions in Figures 5 and 6.

IGNITION TIMING

The ignition timing marks are located on the engine front cover. A saw slot on the balancer indicates No. 1 piston position.

Refer to "Specifications" in this section for base timing information.

Setting Ignition Timing

Figure 7

Adjust

1. With the engine running at normal operating temperature, turn off all accessories and disconnect the EST By-Pass connector.
   - An ECM code will be set when the EST By-Pass connector is disconnected.
2. Use a timing light and tachometer to set the timing at the specified RPM by loosening the distributor clamp bolt and rotating the distributor until specified timing is obtained.
3. Tighten the distributor clamp bolt and recheck timing to make sure the distributor was not moved when the clamp was tightened.
4. Turn the engine off and connect the EST By-Pass connector.
5. Clear the ECM code by disconnecting the negative battery cable for at least 30 seconds.
   - For more information and diagnosis on the EST ignition system, refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (TBI) (SEC. 6E2) or DRIVEABILITY AND EMISSIONS - FUEL INJECTION (PORT) (SEC. 6E3).

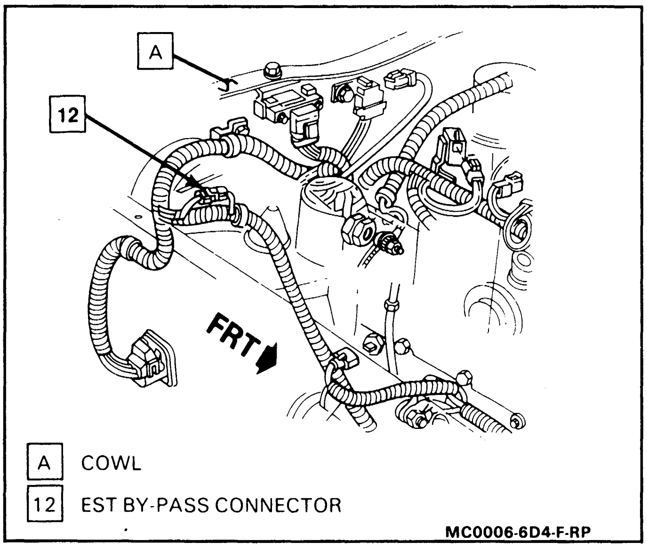


Figure 7 - EST By-Pass Connector

SPARK PLUGS

Important

- Use care when removing spark plug wire boots from spark plugs. Twist the boot 1/2 turn before removing, and pull on the boot only to remove the wire.

1. Remove screws from plenum, and plenum, if equipped.
2. Remove foreign material from around the spark plug holes and remove the spark plugs.
3. Adjust spark plug gap using a spark plug feeler gage. Refer to Emission Control Information Label.

NOTICE: See "Notice" on page 6D4-1 of this section.

4. Install new plugs.

Tighten

- Spark plugs on V6 engines to 34 N·m (25 lb. ft.).
- Spark plugs on V8 engines to 30 N·m (22 lb. ft.).

SECONDARY WIRING

Figures 8 through 10

When replacing spark plug cables (secondary wiring), route the cables correctly and through the proper retainers. Use care when unlocking retainers. Failure to route the cables properly can lead to radio ignition noise and crossfiring of the plugs, or shorting of the leads to ground.

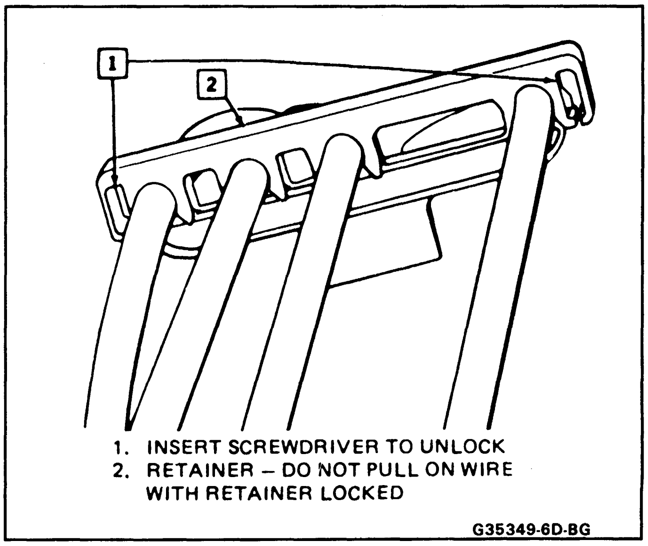


Figure 8 - Unlocking Spark Plug Cable Retainer (Typical)

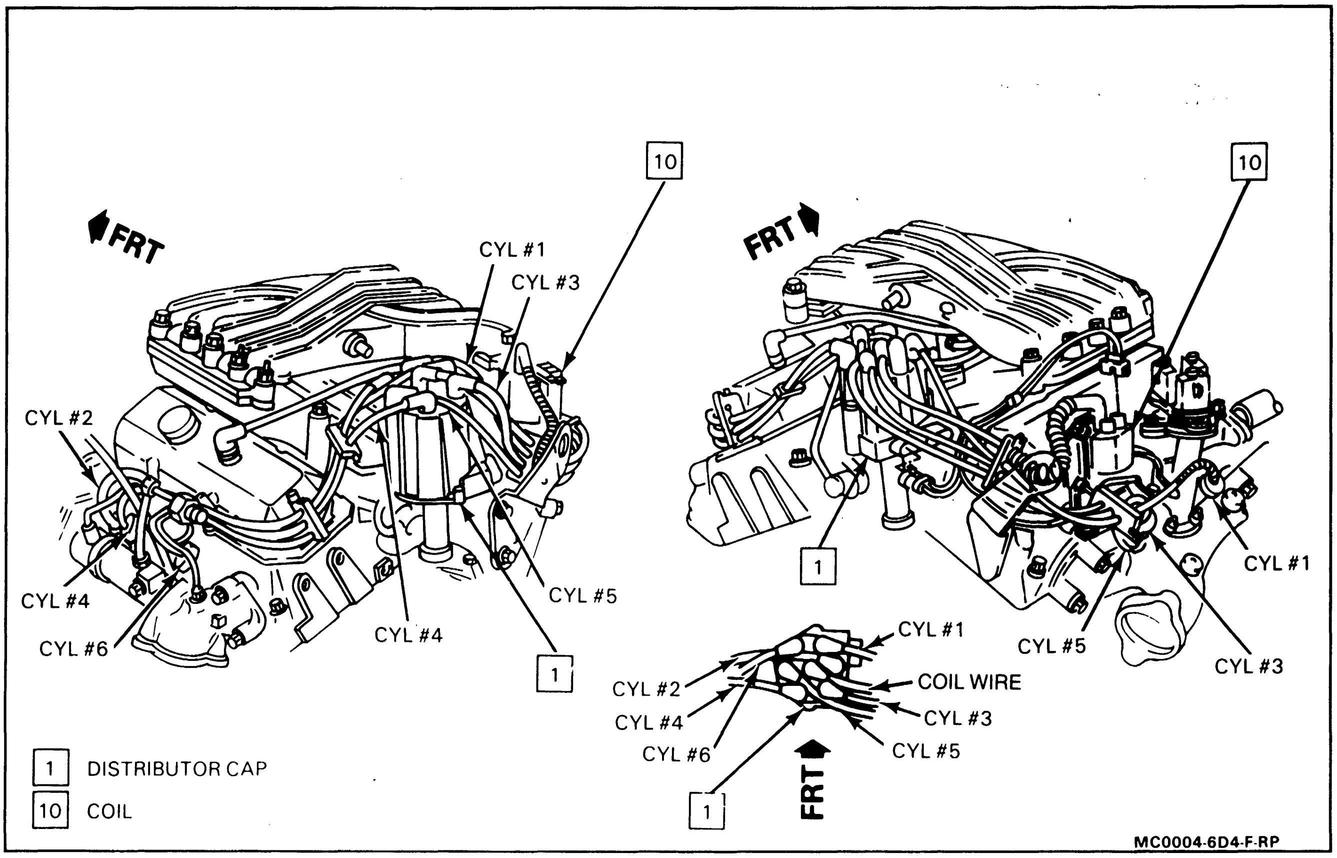


Figure 9 - Spark Plug Cables (V6)

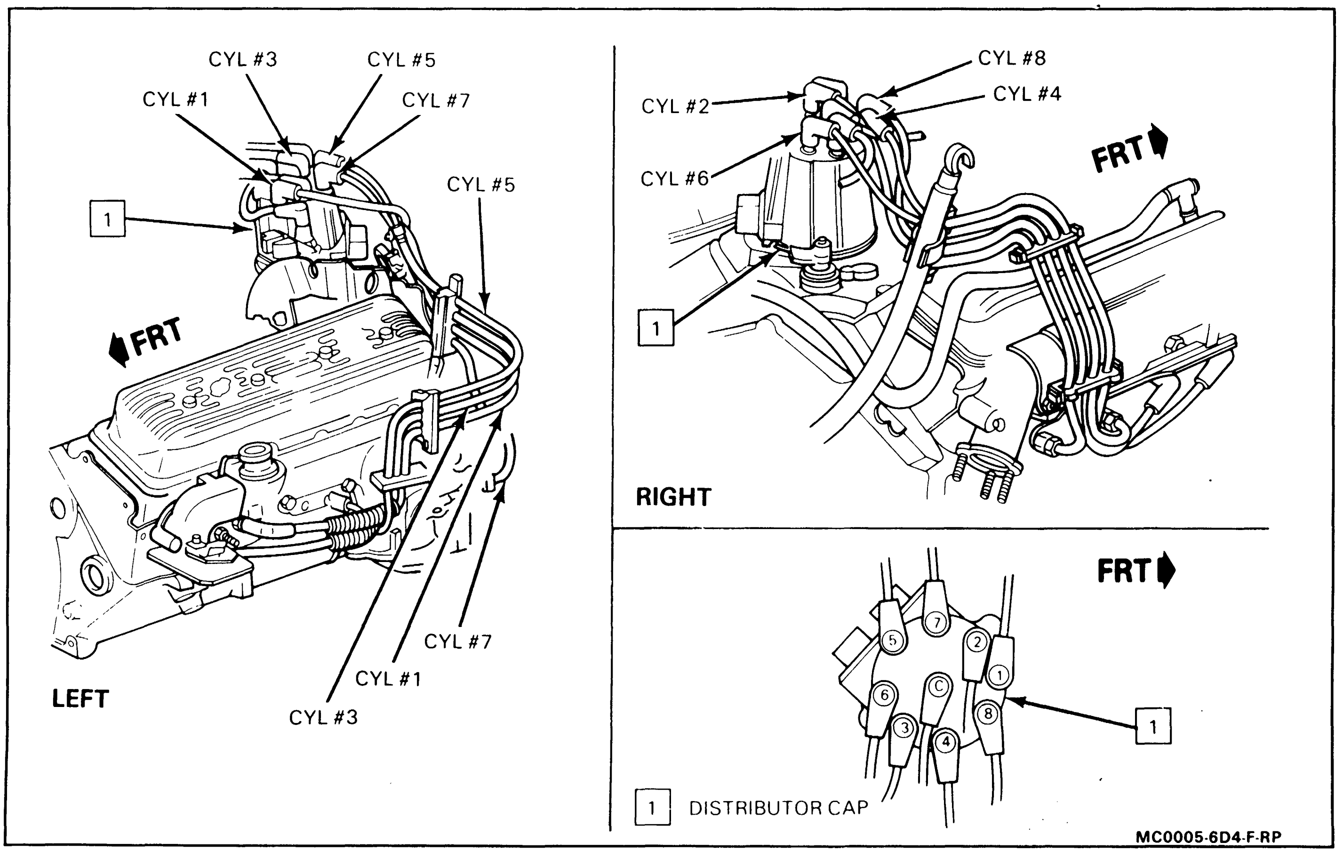


Figure 10 - Spark Plug Cables (Typical V8)

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Spark Plug (V6)	34 N·m (25 lb. ft.)
Spark Plug (V8)	30 N·m (22 lb. ft.)
Coil Bracket Bolt (LO3)	22 N·m (16 lb. ft.)
Coil Bracket Bolt (LHO)	50 N·m (37 lb. ft.)
Coil Bracket Bolt (LB9, L98)	5.6 N·m (50 lb. in.)

ENGINE TIMING SPECIFICATIONS

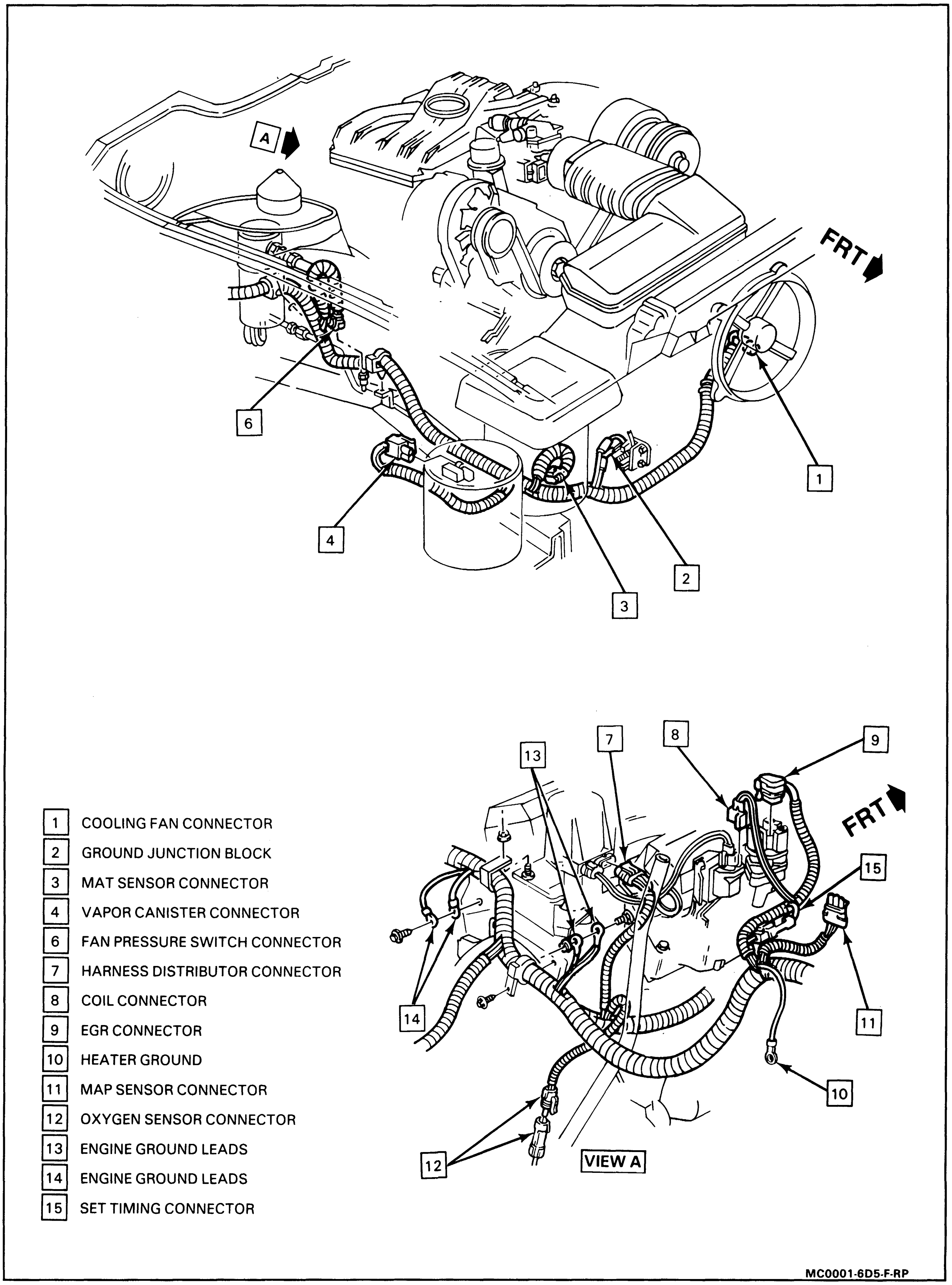
LH0 Base Timing	10° BTDC at 675 RPM
L03 Base Timing	0° TDC at 600 RPM
LB9, L98 Base Timing	6° BTDC at 600 RPM

SECTION 6D5

ENGINE WIRING

CONTENTS

Refer to ELECTRICAL DIAGNOSIS (SEC. 8A) for detailed diagnostics.



1	COOLING FAN CONNECTOR
2	GROUND JUNCTION BLOCK
3	MAT SENSOR CONNECTOR
4	VAPOR CANISTER CONNECTOR
6	FAN PRESSURE SWITCH CONNECTOR
7	HARNESS DISTRIBUTOR CONNECTOR
8	COIL CONNECTOR
9	EGR CONNECTOR
10	HEATER GROUND
11	MAP SENSOR CONNECTOR
12	OXYGEN SENSOR CONNECTOR
13	ENGINE GROUND LEADS
14	ENGINE GROUND LEADS
15	SET TIMING CONNECTOR

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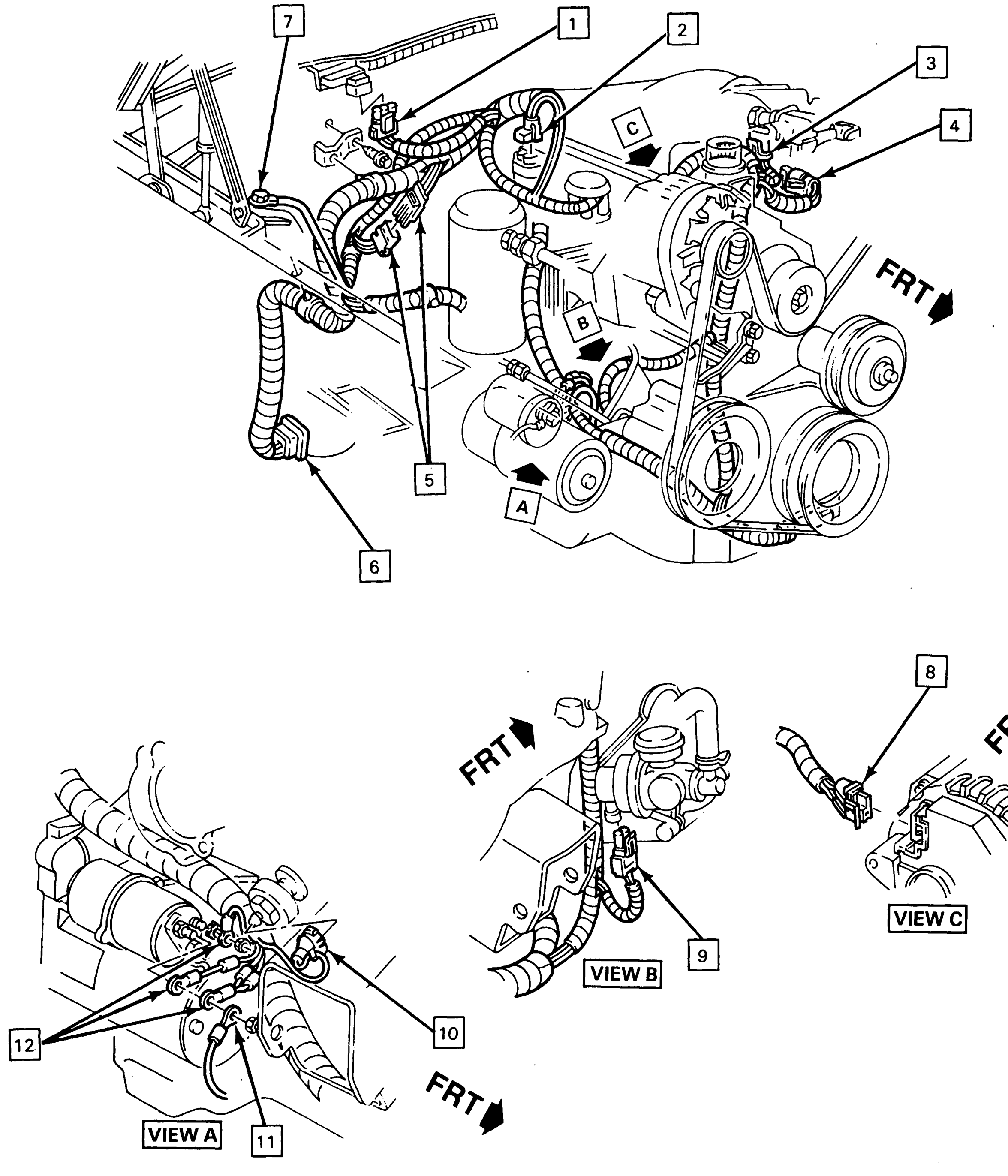
Figure 1 - Engine Wiring Harness, Right Hand Side (LHO)



1	MAP SENSOR CONNECTOR
2	COIL CONNECTOR
3	IAC CONNECTOR
4	TPS CONNECTOR
5	A/C HARNESS CONNECTOR
6	GROMMET
7	BODY GROUND
8	GENERATOR CONNECTOR
9	AIR VALVE CONNECTOR
10	SPARK SENSOR CONNECTOR
11	POSITIVE BATTERY CABLE
12	STARTER LEADS

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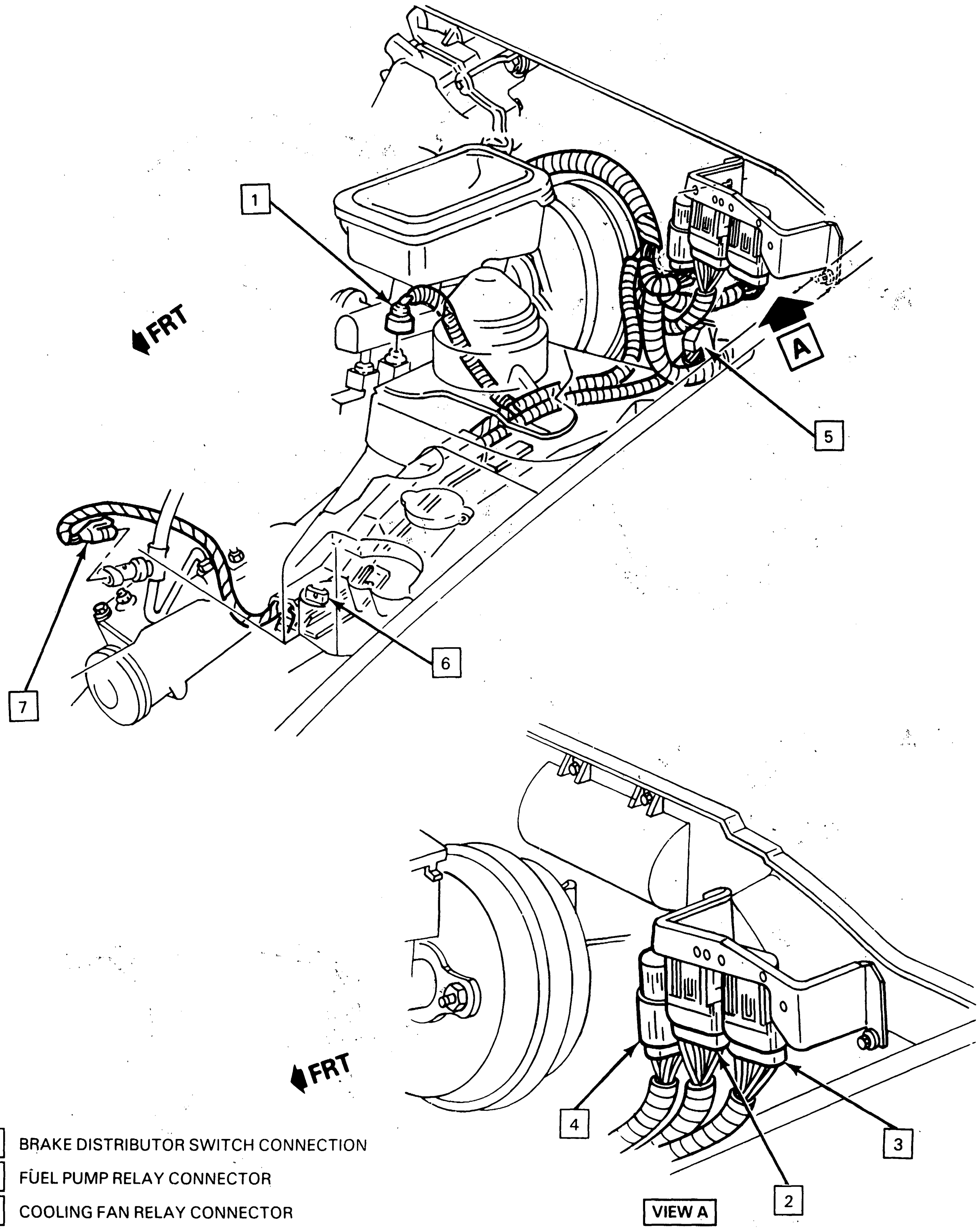
Figure 2 - Engine Wiring Harness, Right Hand Side (LH0)



1	BRAKE DISTRIBUTOR SWITCH CONNECTION
2	FUEL PUMP RELAY CONNECTOR
3	COOLING FAN RELAY CONNECTOR
4	A/C CONTROL RELAY CONNECTOR
5	BULKHEAD CONNECTOR
6	WINDSHIELD WASHER PUMP
7	POWER STEERING SWITCH

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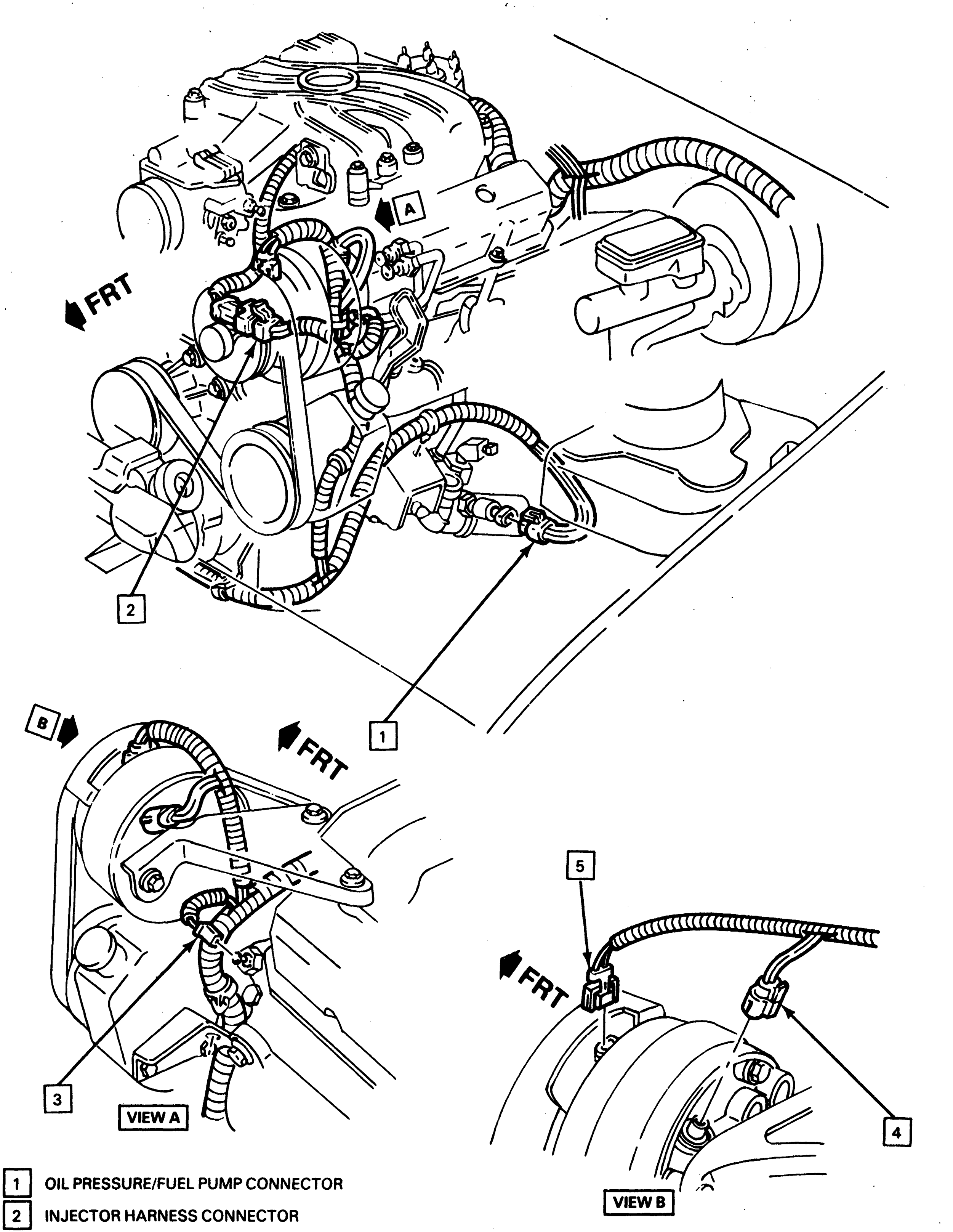
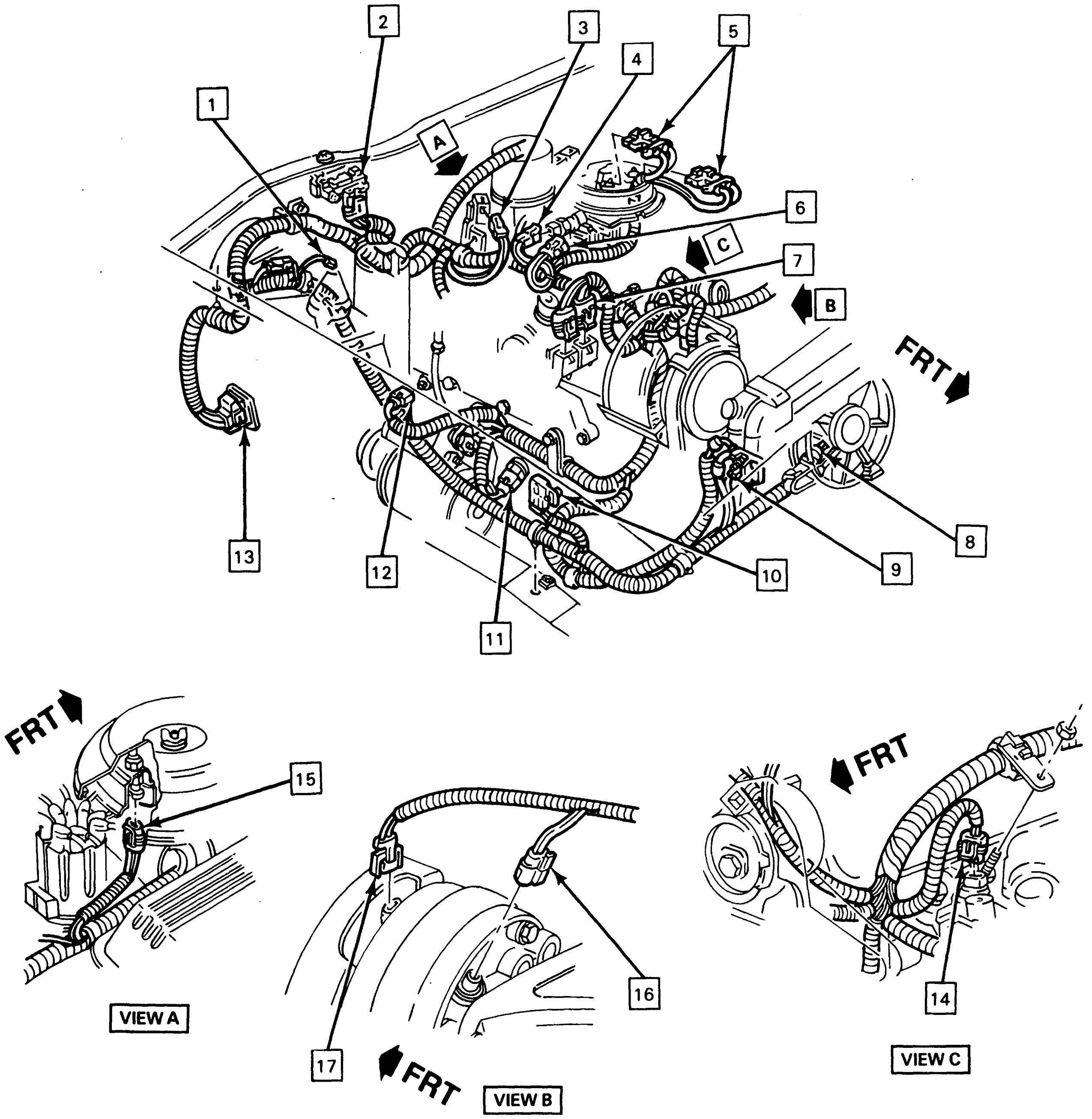
Figure 3 - Engine Wiring Harness, Left Hand Side (LHO)



- 1 OIL PRESSURE/FUEL PUMP CONNECTOR
- 2 INJECTOR HARNESS CONNECTOR
- 3 TEMPERATURE SWITCH CONNECTOR
- 4 A/C COMPRESSOR PRESSURE SWITCH CONNECTOR
- 5 A/C COMPRESSOR CLUTCH CONNECTOR

Figure 4 - Engine Wiring Harness, Left Hand Side (LHO)



1	FUEL PUMP PRIME CONNECTOR
2	MAP SENSOR
3	EGR SOLENOID CONNECTOR
4	IAC CONNECTOR
5	INJECTOR CONNECTOR
6	TPS CONNECTOR
7	AIR SOLENOID CONNECTOR
8	COOLING FAN CONNECTOR
9	GROUND JUNCTION BLOCK
10	FUEL PUMP FUSE
11	ESC SENSOR CONNECTOR
12	COOLANT FAN SWITCH CONNECTOR
13	GROMMET
14	COOLANT TEMPERATURE SENSOR CONNECTOR
15	MAT SENSOR CONNECTOR
16	A/C COMPRESSOR PRESSURE SWITCH CONNECTOR
17	A/C COMPRESSOR CLUTCH CONNECTOR

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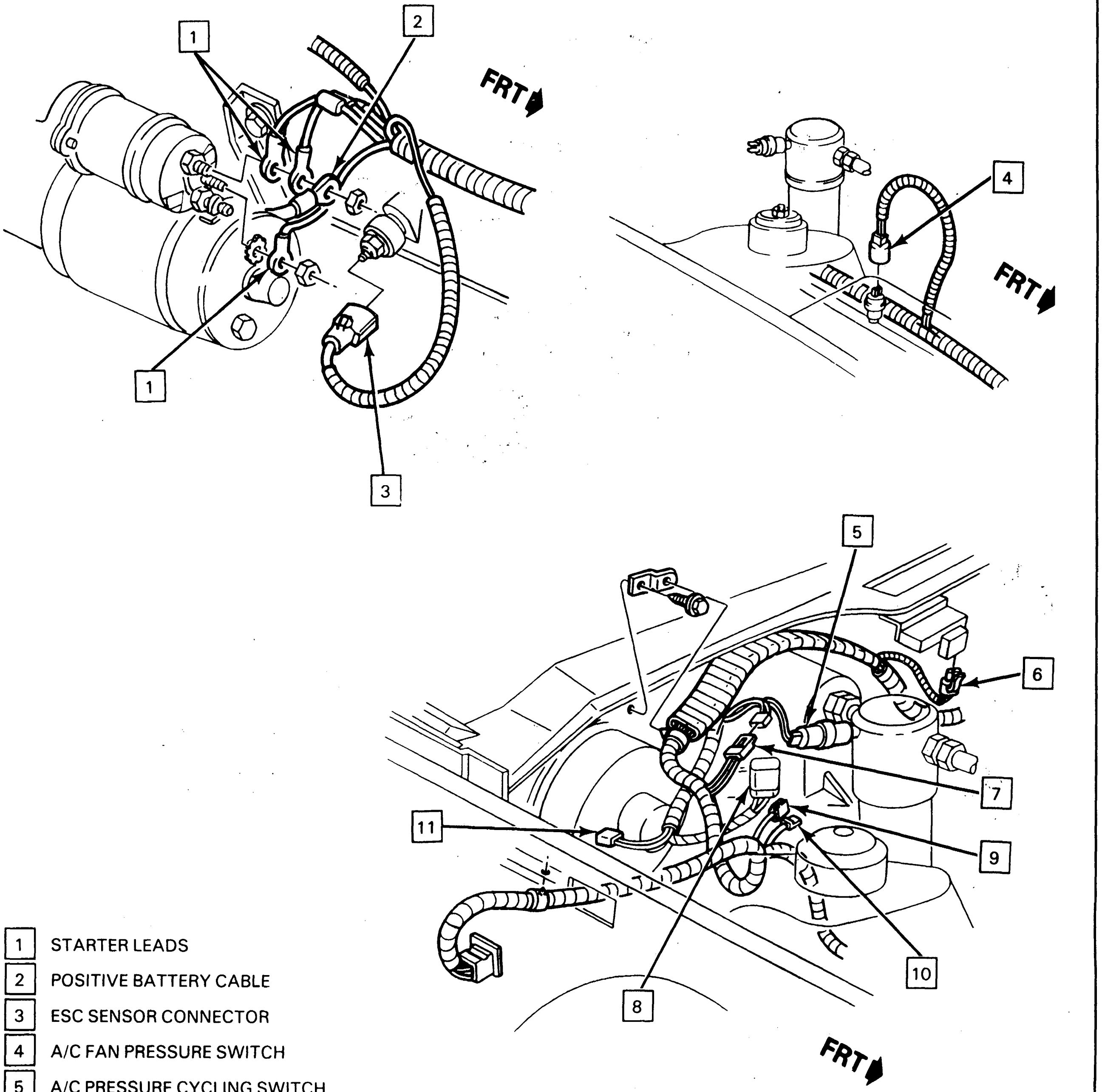
Figure 5 - Engine Wiring Harness, Right Hand Side (L03)



1	STARTER LEADS
2	POSITIVE BATTERY CABLE
3	ESC SENSOR CONNECTOR
4	A/C FAN PRESSURE SWITCH
5	A/C PRESSURE CYCLING SWITCH
6	MAP SENSOR CONNECTOR
7	A/C MODULE HARNESS
8	BLOWER MOTOR RELAY
9	UNDERHOOD LAMP CONNECTOR
10	FUEL PUMP PRIME CONNECTOR
11	BLOWER MOTOR FEED CONNECTOR

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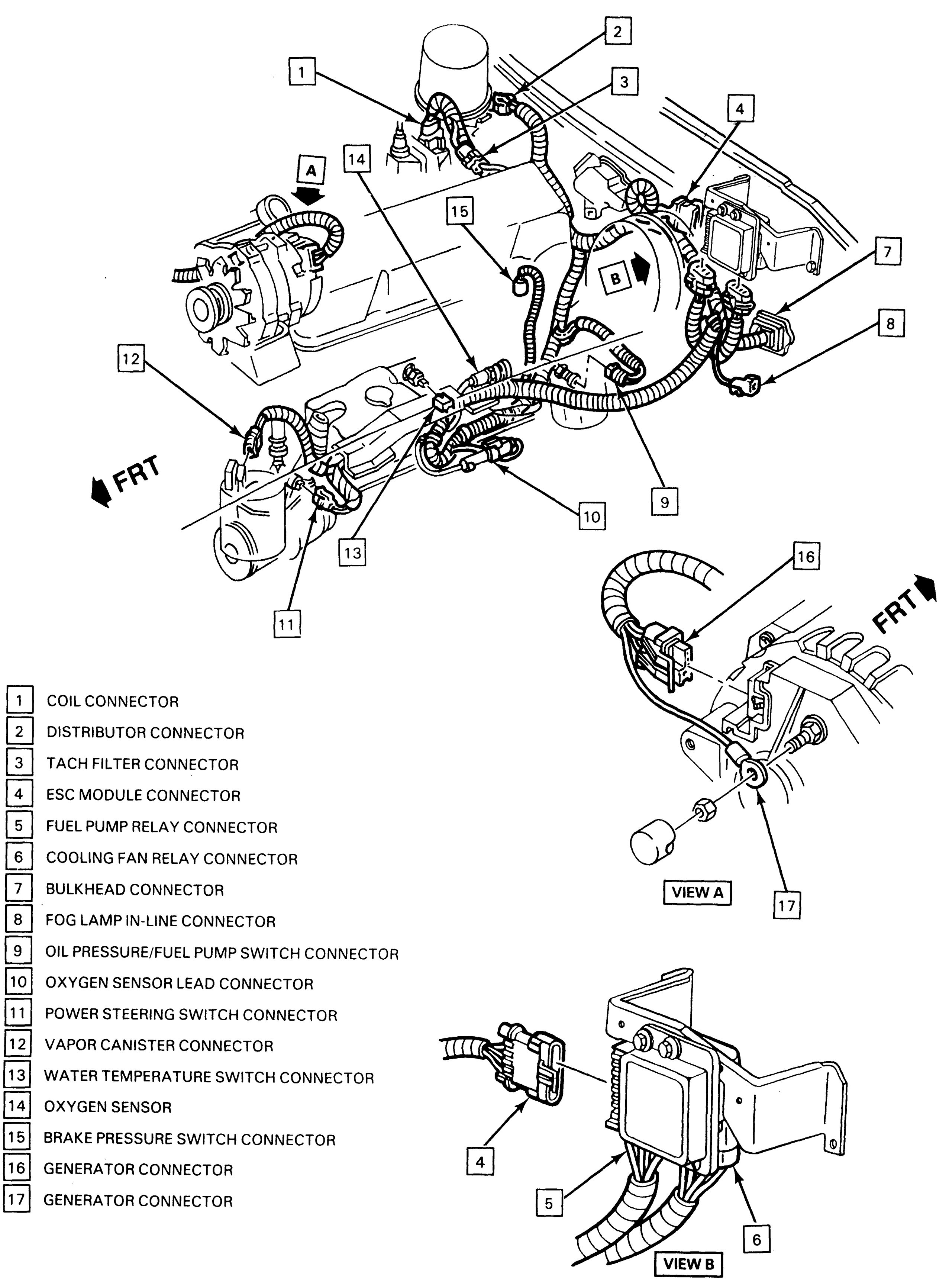
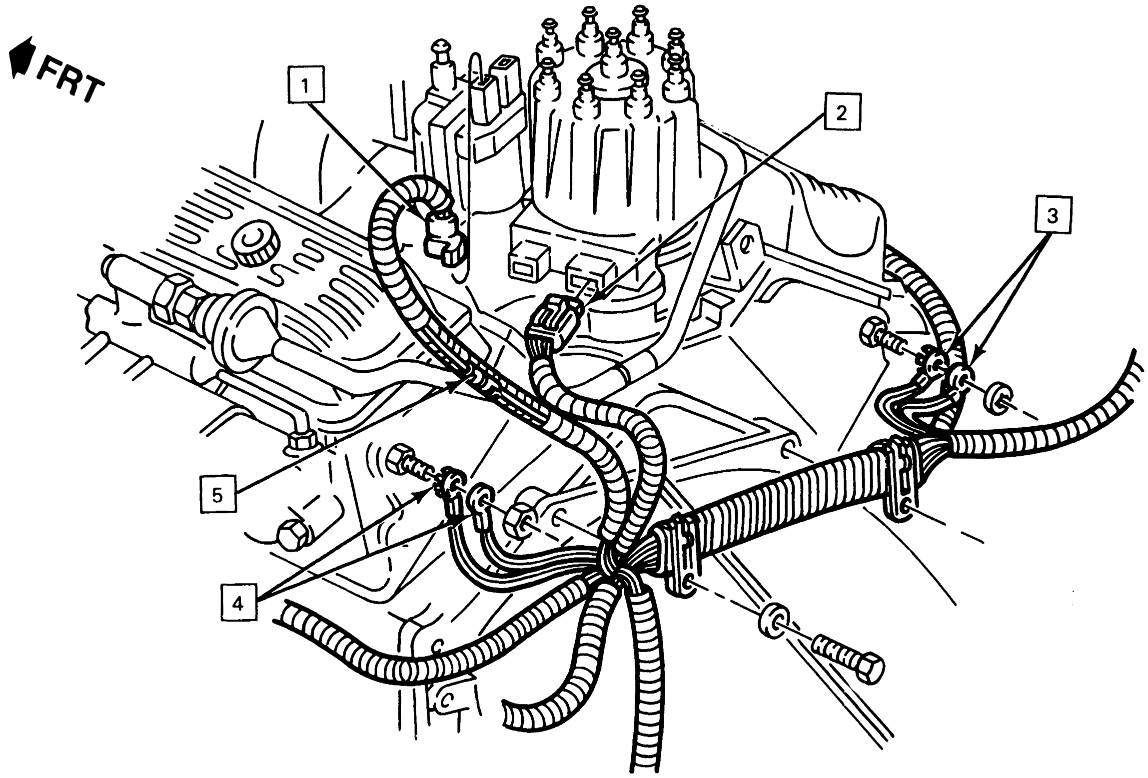
Figure 6 - Engine Wiring Harness, Right Hand Side (L03)



1	COIL CONNECTOR
2	DISTRIBUTOR CONNECTOR
3	TACH FILTER CONNECTOR
4	ESC MODULE CONNECTOR
5	FUEL PUMP RELAY CONNECTOR
6	COOLING FAN RELAY CONNECTOR
7	BULKHEAD CONNECTOR
8	FOG LAMP IN-LINE CONNECTOR
9	OIL PRESSURE/FUEL PUMP SWITCH CONNECTOR
10	OXYGEN SENSOR LEAD CONNECTOR
11	POWER STEERING SWITCH CONNECTOR
12	VAPOR CANISTER CONNECTOR
13	WATER TEMPERATURE SWITCH CONNECTOR
14	OXYGEN SENSOR
15	BRAKE PRESSURE SWITCH CONNECTOR
16	GENERATOR CONNECTOR
17	GENERATOR CONNECTOR

MC0005-6D5-F-RP

Figure 7 - Engine Wiring Harness, Left Hand Side (L03)



1 COIL CONNECTOR
2 DISTRIBUTOR CONNECTOR
3 ENGINE GROUND
4 ENGINE GROUND
5 TACH FILTER

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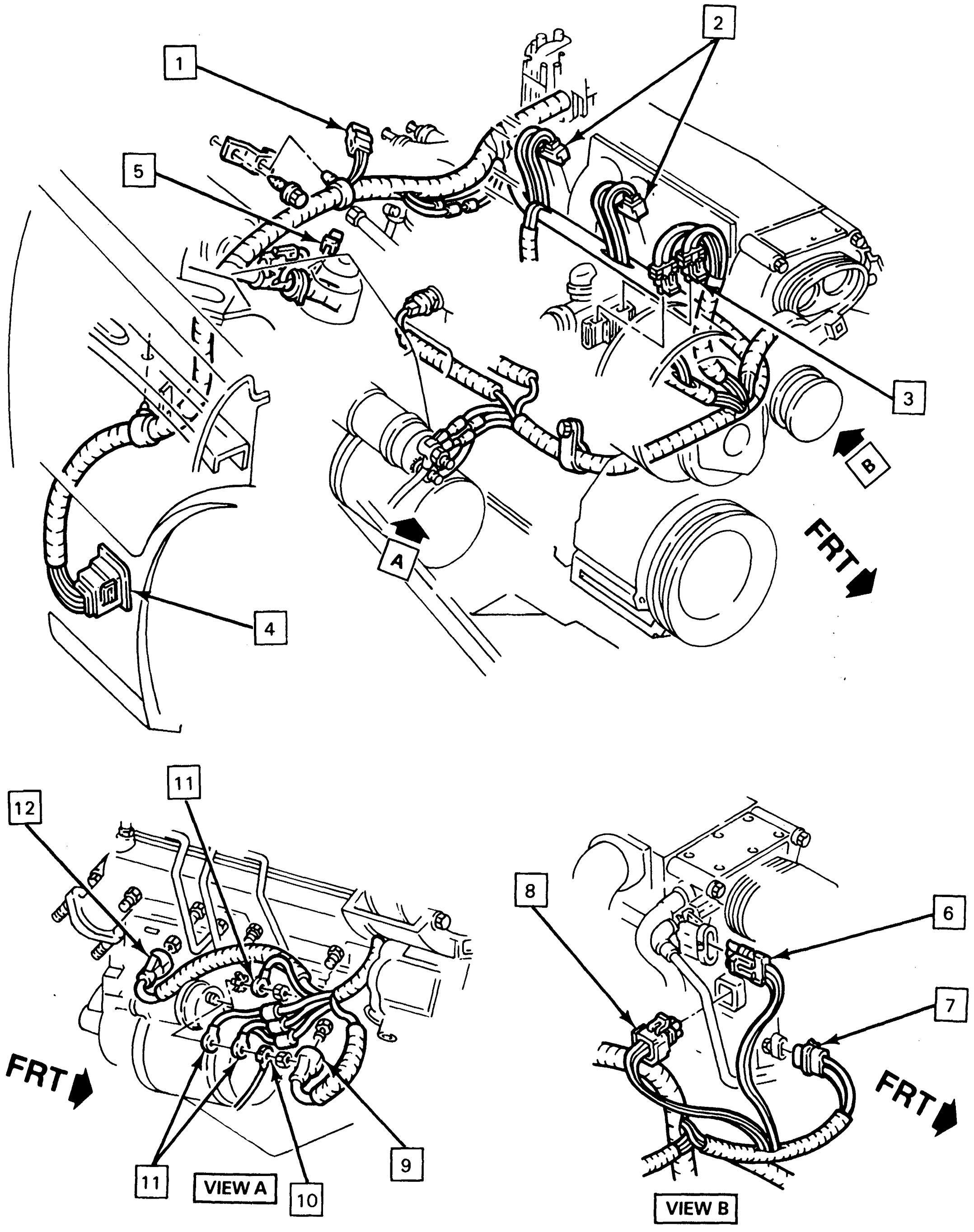
Figure 8 - Engine Wiring Harness, Rear (L03)



1	A/C MODULE CONNECTOR
2	INJECTOR CONNECTORS
3	AIR VALVE CONNECTOR
4	GROMMET
5	FUEL PUMP PRIME CONNECTOR
6	TPS CONNECTOR
7	COOLANT TEMPERATURE SWITCH CONNECTOR
8	IAC CONNECTOR
9	ESC SENSOR CONNECTOR
10	POSITIVE BATTERY CABLE
11	STARTER LEADS
12	FAN TEMPERATURE SWITCH

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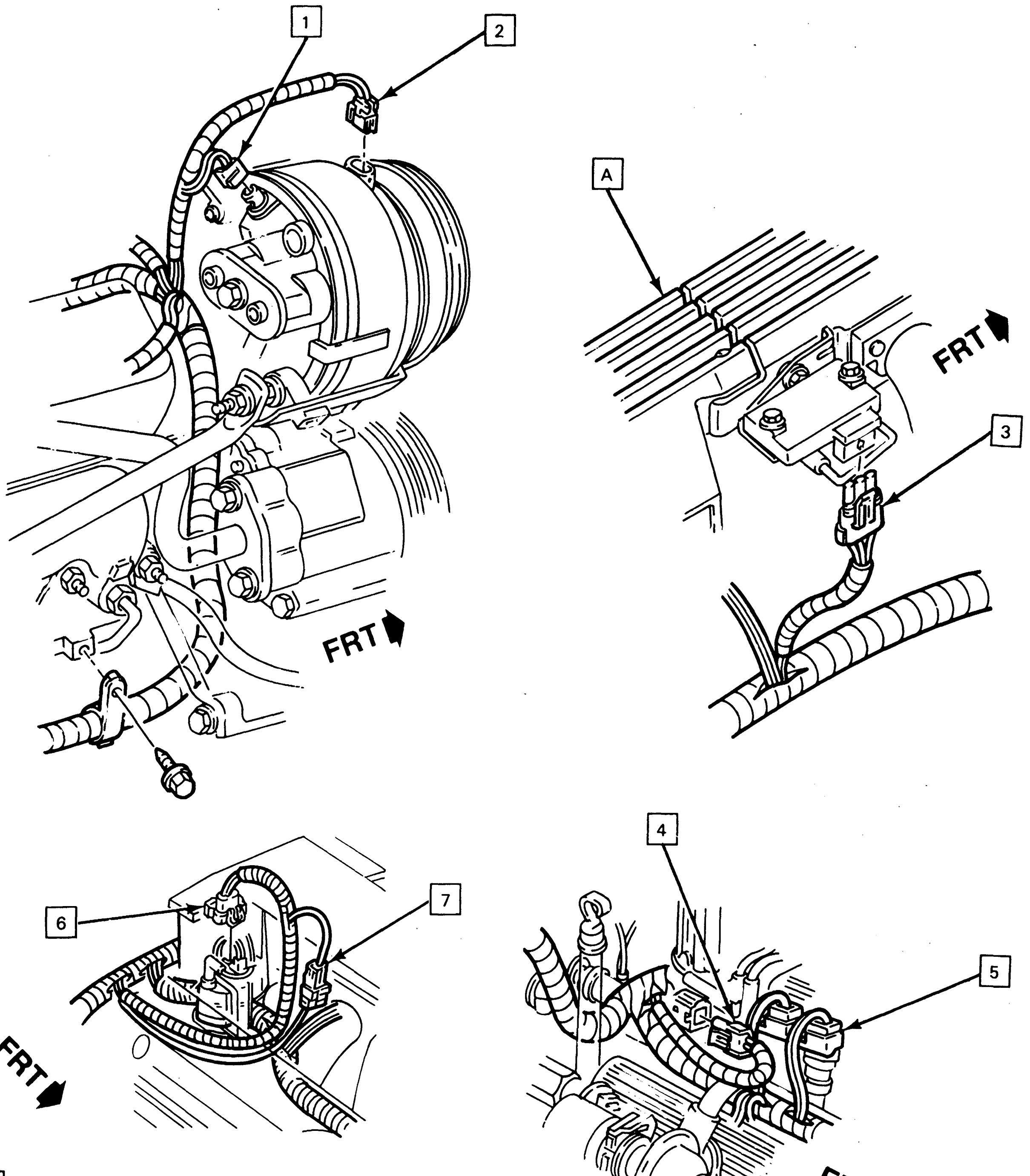
Figure 9 - Engine Wiring Harness, Right Hand Side (LB9, L98)



A	PLENUM
1	A/C COMPRESSOR PRESSURE SWITCH CONNECTOR
2	A/C COMPRESSOR CLUTCH CONNECTOR
3	MAP SENSOR CONNECTOR
4	EGR SOLENOID CONNECTOR
5	INJECTOR CONNECTOR
6	COIL CONNECTOR
7	TACH FILTER

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Figure 10 - Engine Wiring Harness, Right Hand Side (LB9, L98)

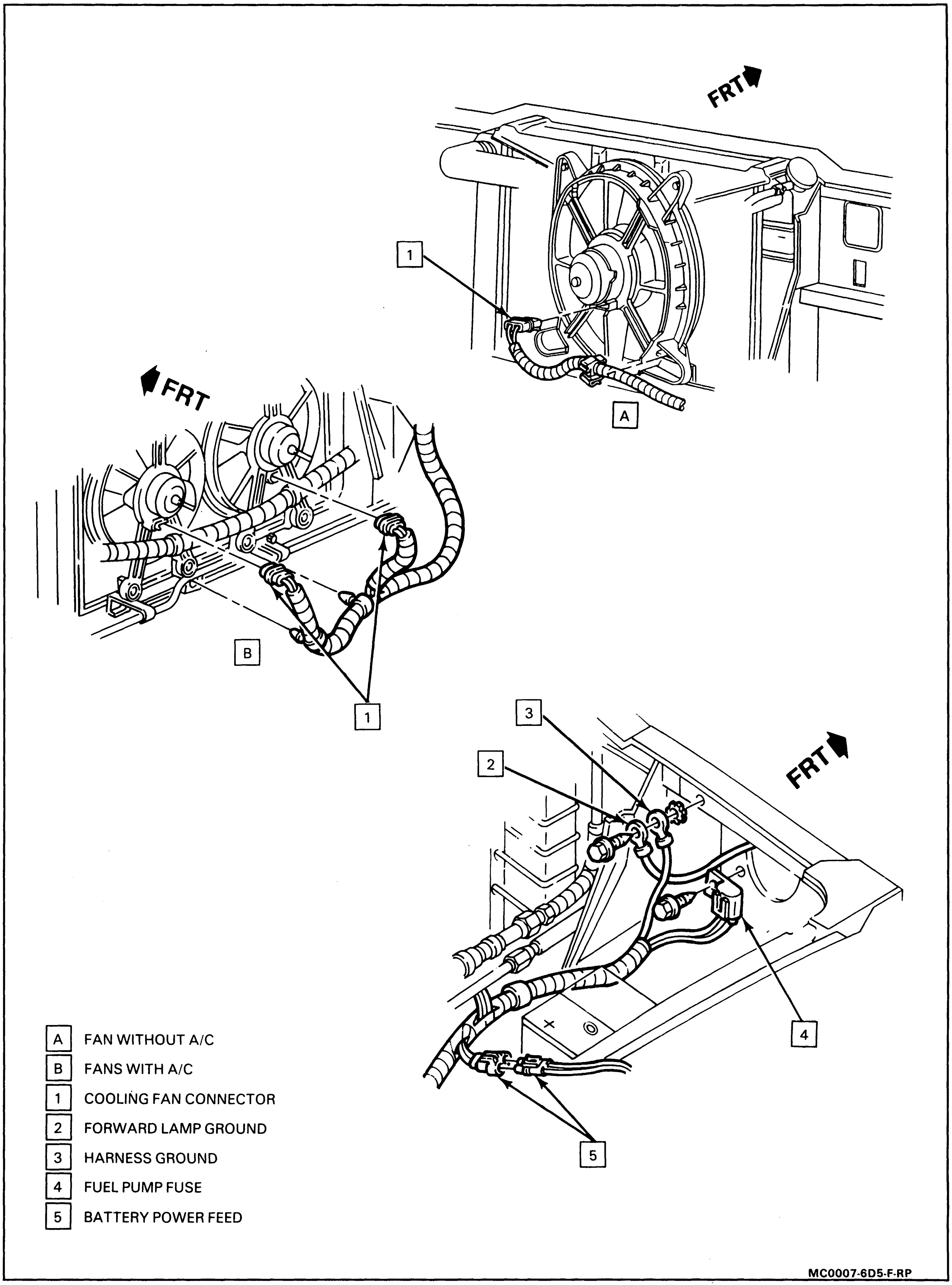
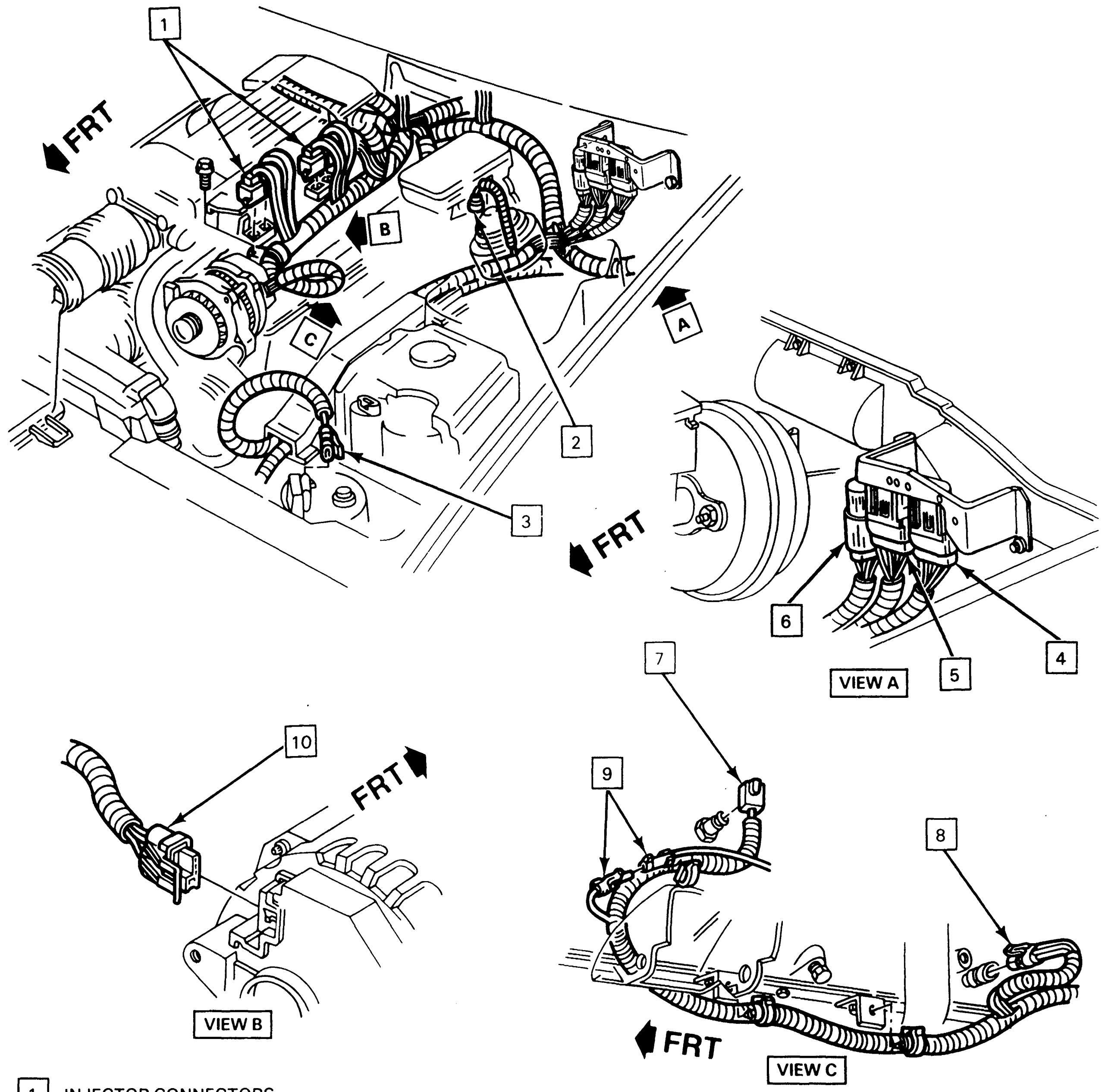


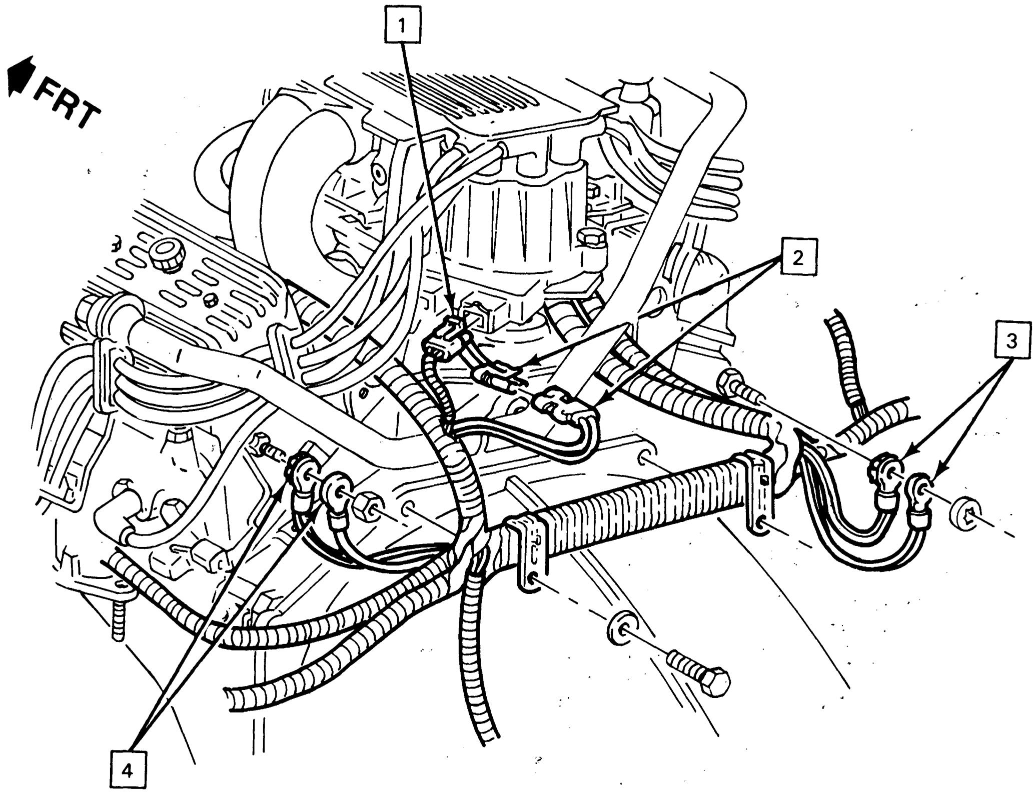
Figure 11 - Engine Wiring Harness, Right Hand Side (LB9, L98)



1	INJECTOR CONNECTORS
2	BRAKE PRESSURE SWITCH CONNECTOR
3	VAPOR CANISTER CONNECTOR
4	COOLING FAN RELAY CONNECTOR
5	FUEL PUMP RELAY CONNECTOR
6	SECONDARY COOLING FAN RELAY CONNECTOR
7	COOLANT TEMPERATURE SENSOR CONNECTOR
8	FUEL PUMP/OIL PRESSURE SWITCH CONNECTOR
9	OXYGEN SENSOR CONNECTOR
10	GENERATOR CONNECTOR

MC0008-6D5-F-RP

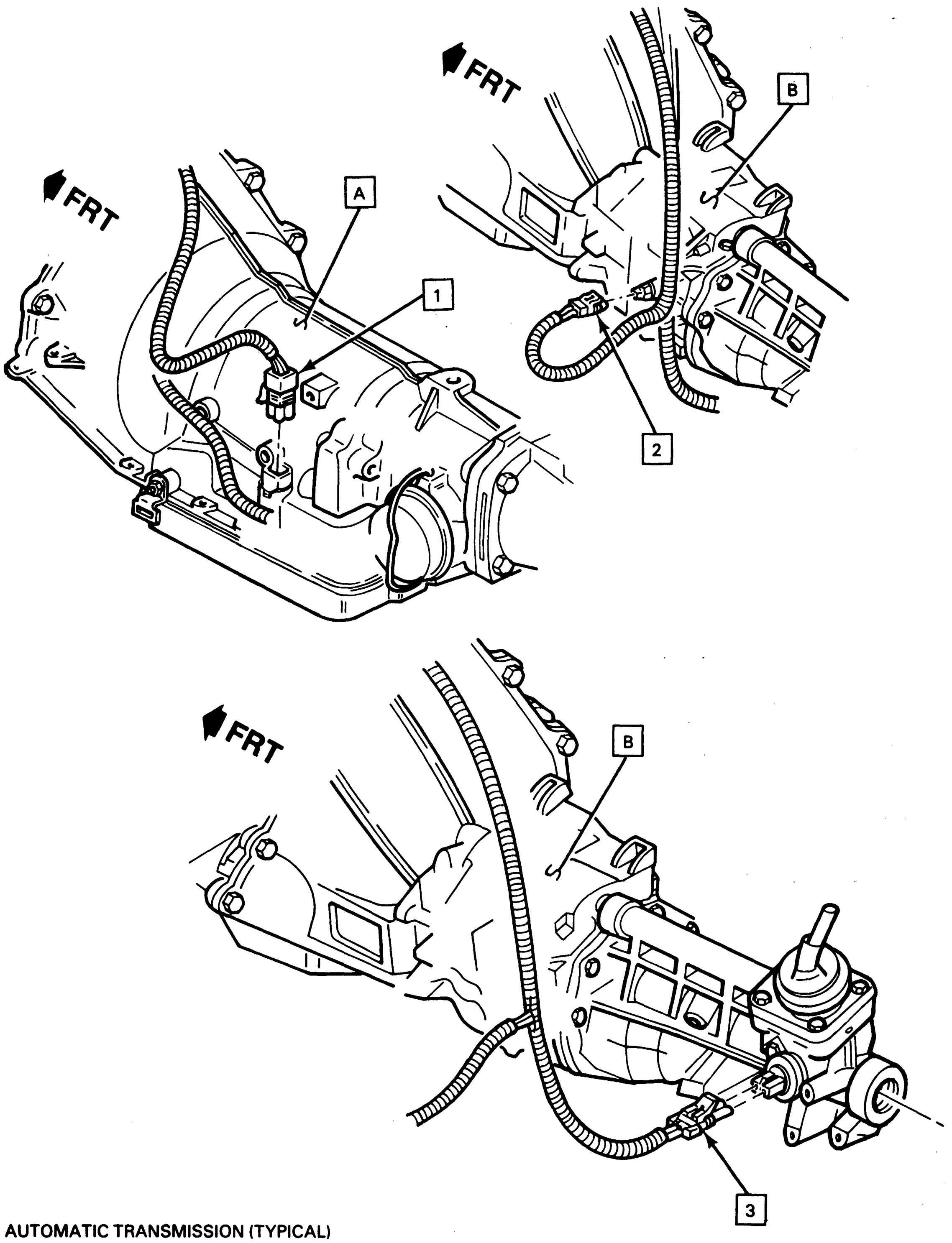
Figure 12 - Engine Wiring Harness, Left Hand Side (LB9, L98)



1	DISTRIBUTOR CONNECTOR
2	MAT SENSOR JUMPER CONNECTOR
3	ENGINE GROUNDS
4	ENGINE GROUNDS

LC0015-6D5-F-RP

Figure 13 - Engine Wiring Harness, Rear (LB9, L98)



A	AUTOMATIC TRANSMISSION (TYPICAL)
B	MANUAL TRANSMISSION (TYPICAL)
1	TCC SWITCH CONNECTOR
2	BACK-UP SWITCH CONNECTOR
3	VEHICLE SPEED SENSOR CONNECTOR (MANUAL SHOWN, AUTOMATIC SIMILAR)

LC0016-6D5-F-RP

Figure 14 - Engine Wiring Harness, Transmission (All)

SECTION 6E

DRIVEABILITY AND EMISSIONS GENERAL INFORMATION

CONTENTS

DRIVEABILITY AND EMISSIONS CONTROL

The computer command control system, which is controlled by the Electronic Control Module (ECM), is designed to maintain exhaust emission levels at federal standards while providing good driveability and fuel efficiency. The functions of the system are based on data gathered by sensors and switches located throughout the vehicle. The ECM maintains control over fuel delivery, ignition, idle air flow, the fuel pump and other system components, while monitoring the system for faulty operation with its diagnostic capabilities. See Figure 1.

It is important to review the component sections and wiring diagrams in Sections "6E2" and "6E3" to determine which systems are controlled by the ECM.

EMISSIONS CONTROL INFORMATION LABEL

The underhood Vehicle Emissions Control Information label (Figure 2) contains important emission specifications and setting procedures. In the upper left corner is exhaust emission information which identifies the year, the manufacturing division of the engine, the displacement of the engine in liters, the class of vehicle, and type of fuel metering. There is also an illustrated emission component and vacuum hose schematic.

This label is located in the engine compartment of every General Motors vehicle. If the label has been removed, it can be ordered from GM Service Parts Operations (GMSPO).

ALL NEW GENERAL MOTORS VEHICLES ARE CERTIFIED BY THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY AS CONFORMING TO THE REQUIREMENTS OF THE REGULATIONS FOR THE CONTROL OF AIR POLLUTION FROM NEW MOTOR VEHICLES. THIS CERTIFICATION IS CONTINGENT ON CERTAIN ADJUSTMENTS BEING SET TO FACTORY STANDARDS. IN MOST CASES, THESE ADJUSTMENT POINTS EITHER HAVE BEEN PERMANENTLY SEALED AND/OR MADE INACCESSIBLE TO PREVENT INDISCRIMINATE OR ROUTINE ADJUSTMENT IN THE FIELD. FOR THIS REASON, THE FACTORY PROCEDURE FOR TEMPORARILY REMOVING PLUGS, CAPS, ETC., FOR PURPOSES OF SERVICING THE PRODUCT, MUST BE STRICTLY FOLLOWED AND, WHEREVER PRACTICABLE, RETURNED TO THE ORIGINAL INTENT OF THE DESIGN.

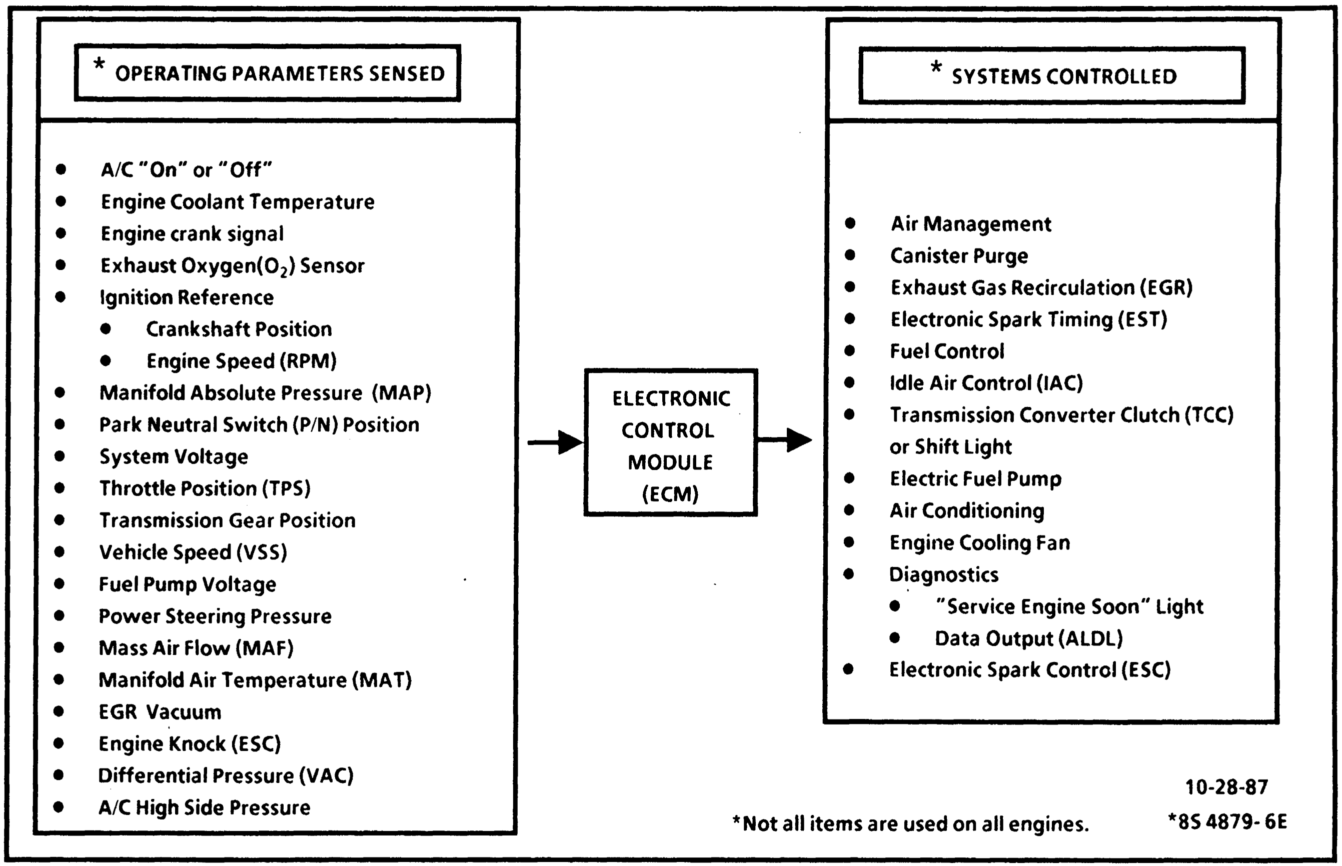


Figure 1 - ECM Inputs and Outputs

MAINTENANCE SCHEDULE

Refer to the General Motors Maintenance Schedule in MAINTENANCE AND LUBRICATION (SECTION 0B) for the maintenance service that should be performed to retain emission control performance.

BLOCKING DRIVE WHEELS

The vehicle drive wheels always should be blocked and parking brake firmly set while checking the system.

WHAT THIS SECTION CONTAINS

Section 6E has been developed to describe the function and operation of the electronic engine control system that controls the driveability and emissions of the vehicle. Emphasis is placed on the diagnosis and repair of problems related to the system.

Section "6E" provides general diagnostic procedures, Tech 1 Diagnostic Computer use, wiring and terminal repair procedures, and descriptions of special tools. It then leads into Sections "6E2" or "6E3". Section "6E2" deals with engine control systems using throttle body injection for fuel delivery and Section "6E3" deals with port fuel injection systems.

Sections "6E2" and "6E3" are divided into three major sub-sections dealing with diagnosis and repair. They can be summarized as follows.

SECTION A: CIRCUIT INFORMATION & DIAGNOSIS

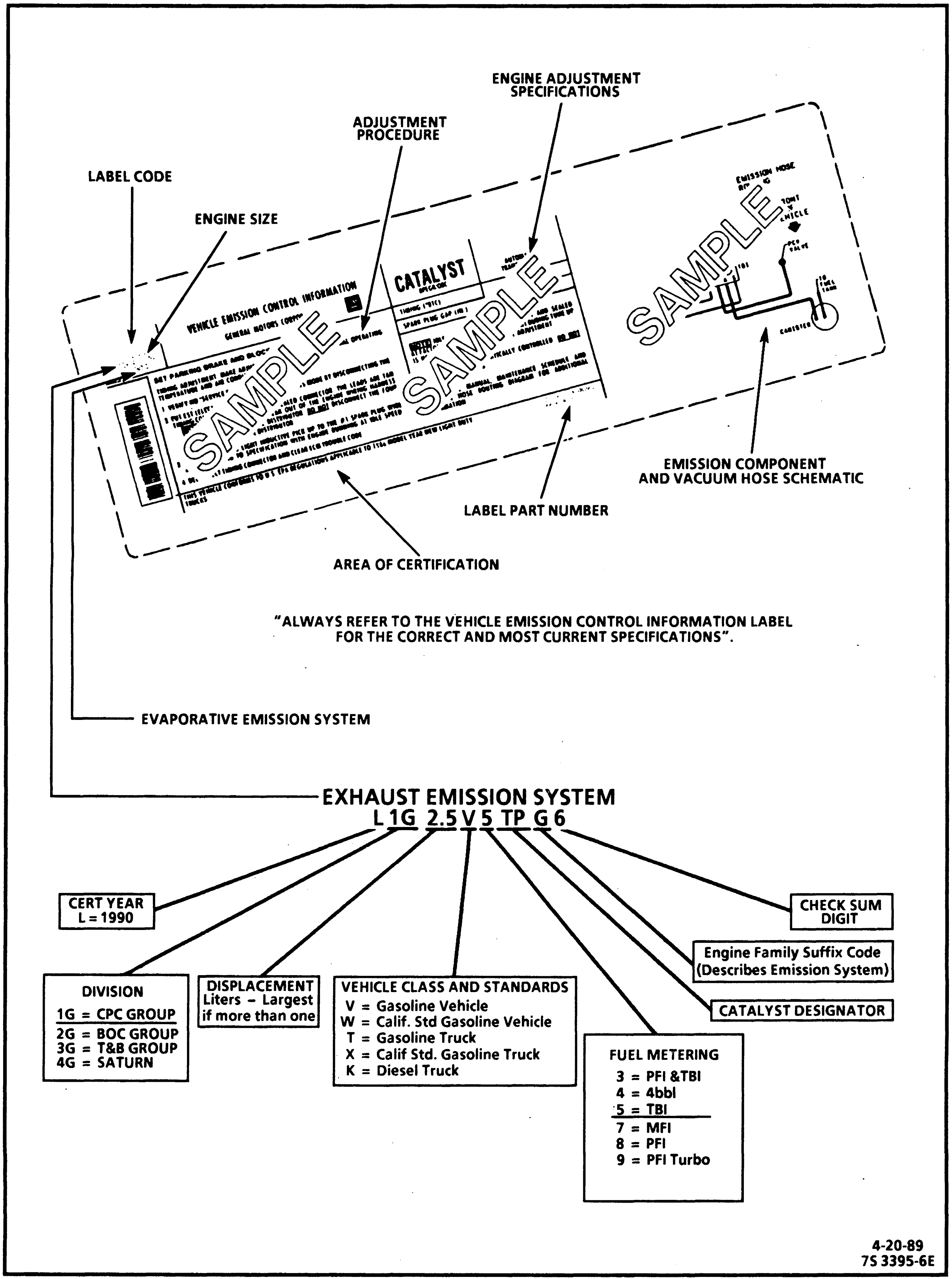
- Component Locations
- Wiring Diagrams
- ECM Terminal End View and Terminal Definitions
- Diagnostic Circuit Check. This must be the first step of any diagnostic procedure.
- Diagnostic Code Charts with facing pages containing circuit diagrams, circuit operation information, and helpful diagnostic information.

SECTION B: DRIVEABILITY & EMISSIONS SYMPTOMS

- This sub-section assists in diagnosis of intermittent problems or problems which don't result in the storing of diagnostic trouble codes. It is arranged by symptoms of poor driveability and emissions and lists possible causes of the problems.

SECTION C: COMPONENT CHECKS & SERVICE

- Component and Circuit Descriptions
- On-Vehicle Service
- Functional Checks/Diagnostic Charts



"ALWAYS REFER TO THE VEHICLE EMISSION CONTROL INFORMATION LABEL FOR THE CORRECT AND MOST CURRENT SPECIFICATIONS".

Figure 2 - Vehicle Emission Control Information Label

VISUAL/PHYSICAL UNDERHOOD INSPECTION

A careful visual and physical underhood inspection must be performed as part of any diagnostic procedure or in finding the cause of an emissions test failure. This can often lead to fixing a problem without further steps. Inspect all vacuum hoses for correct routing, pinches, cuts, or disconnects. Be sure to inspect hoses that are difficult to see beneath the air cleaner, compressor, generator, etc. Inspect all the wires in the engine compartment for proper connections, burned or chafed spots, pinched wires, or contact with sharp edges or hot exhaust manifolds. This visual/physical inspection is very important. It must be done carefully and thoroughly.

BASIC KNOWLEDGE AND TOOLS REQUIRED

To use this manual most effectively, a general understanding of basic electrical circuits and circuit testing tools is required. One should be familiar with wiring diagrams, the meaning of voltage, ohms, amps, the basic theories of electricity, and understand what happens in an open or shorted wire.

To perform system diagnosis, the use of a Tech 1 Diagnostic Computer or equivalent "Scan" tool is required. A tachometer, test light, ohmmeter, digital voltmeter with 10 megohms impedance, vacuum gauge, and jumper wires are also required. Please become acquainted with the tools and their use before attempting to diagnose a vehicle. Special tools which are required for system service and the ones described above are illustrated at the end of this section.

Electrostatic Discharge Damage

Electronic components used in control systems are often designed to carry very low voltage, and are very susceptible to damage caused by electrostatic discharge. It is possible for less than 100 volts of static electricity to cause damage to some electronic components. By comparison, it takes as much as 4,000 volts for a person to even feel the zap of a static discharge.

There are several ways for a person to become statically charged. The most common methods of charging are by friction and by induction. An example of charging by friction is a person sliding across a car seat, in which a charge of as much as 25,000 volts can build up. Charging by induction occurs when a person with well insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off, leaving the person highly charged with the opposite polarity. Static charges of either type can cause damage, therefore, it is important to use care when handling and testing electronic components.

NOTICE: To prevent possible Electrostatic Discharge damage:

- Do Not touch the ECM connector pins or soldered components on the ECM circuit board.
- When handling a PROM, CALPAK or MEM-CAL, Do Not touch the component leads, and Do Not remove integrated circuit from carrier.

DIAGNOSTIC INFORMATION

The diagnostic "tree" charts and functional checks in this manual are designed to locate a faulty circuit or component through logic based on the process of elimination. The charts are prepared with the requirement that the vehicle functioned correctly at the time of assembly and that there are no multiple failures.

The ECM performs a continual self-diagnosis on certain control functions. This diagnostic capability is complemented by the diagnostic procedures contained in this manual. The ECM's language for communicating the source of a malfunction is a system of diagnostic trouble codes. The codes are two or three digit numbers that can range from 12 to 999. When a malfunction is detected by the ECM, a code is set and the "Service Engine Soon" light is illuminated.

"Service Engine Soon" Light

This light is on the instrument panel and has the following functions.

- It informs the driver that a problem has occurred and that the vehicle should be taken for service as soon as reasonably possible.
- It displays "Codes" stored by the ECM which help the technician diagnose system problems.
- It indicates "Open Loop" or "Closed Loop" operation.

As a bulb and system check, the light will come "ON" with the key "ON" and the engine not running. When the engine is started, the light will turn "OFF." If the light remains "ON," the self-diagnostic system has detected a problem. If the problem goes away, the light will go out in most cases after 10 seconds, but a Code will remain stored in the ECM.

When the light remains "ON" while the engine is running, or when a malfunction is suspected due to a driveability or emissions problem, a **"Diagnostic Circuit Check" must be performed**. The procedures for these checks are given in Section "A" of "6E2" and "6E3". These checks will expose malfunctions which may not be detected if other diagnostics are performed prematurely.

Intermittent "Service Engine Soon" Light

In the case of an "intermittent" problem, the "Service Engine Soon" light will light for ten (10) seconds and then will go out. However, the corresponding code will be stored in the memory of the ECM until the battery voltage to the ECM has been removed. When unexpected codes appear during the code reading process, one can assume that these codes were set by an intermittent malfunction and could be helpful in diagnosing the system.

An intermittent code may or may not re-set. If it is an intermittent failure, a Diagnostic Code Chart is not used. Consult the "Diagnostic Aids" on the page facing the diagnostic chart corresponding to the intermittent trouble code. Section "B" also covers the topic of "Intermittents." A physical inspection of the applicable sub-system most often will resolve the problem.

Reading Codes

The provision for communicating with the ECM is the Assembly Line Diagnostic Link (ALDL) connector (See Figure 3). It is usually located under the instrument panel and is sometimes covered by a plastic cover labeled "DIAGNOSTIC CONNECTOR." It is used in the assembly plant to receive information in checking that the engine is operating properly before it leaves the plant. The code(s) stored in the ECM's memory can be read either through a hand-held diagnostic scanner plugged into the ALDL connector or by counting the number of flashes of the "Service Engine Soon" light when the diagnostic terminal of the ALDL connector is grounded. The ALDL connector terminal "B" (diagnostic terminal) is the second terminal from the right of the ALDL connector's top row. The terminal is most easily grounded by connecting it to terminal "A" (internal ECM ground), the terminal to the right of terminal "B" on the top row of the ALDL connector.

Once terminals "A" and "B" have been connected, the ignition switch must be moved to the "ON" position, with the engine *not* running. At this point, the "Service Engine Soon" light should flash Code 12 three times consecutively. This would be the following flash sequence: "flash, pause, flash-flash, long pause, flash, pause, flash-flash, long pause, flash, pause, flash-flash." Code 12 indicates that the ECM's diagnostic system is operating. If Code 12 is not indicated, a problem is present within the diagnostic system itself, and should be addressed by consulting the appropriate diagnostic chart in Section "A" of Section 6E2 or Section 6E3.

Following the output of Code 12, the "Service Engine Soon" light will indicate a diagnostic code three times if a code is present, or it will simply continue to output Code 12. If more than one diagnostic code has been stored in the ECM's memory, the codes will be output from the lowest to the highest, with each code being displayed three times.

Clearing Codes

To clear the codes from the memory of the ECM, either to determine if the malfunction will occur again or because repair has been completed, the ECM power feed must be disconnected for at least thirty (30) seconds. Depending on how the vehicle is equipped, the ECM power feed can be disconnected at the positive battery terminal "pigtail", the inline fuseholder that originates at the positive connection at the battery, or the ECM fuse in the fuse block. (The negative battery terminal may be disconnected, but other on-board memory data, such as preset radio tuning, will also be lost.)

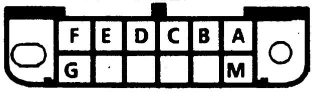
NOTICE: To prevent ECM damage, the key must be "OFF" when disconnect-ing or reconnecting ECM power.

When using a hand-held Tech 1 Diagnostic Computer, or "Scan" tool to read the codes, clearing the diagnostic codes is done in the same manner as in the above procedure.

Diagnostic Mode

When the Diagnostic terminal is grounded with the ignition "ON" and the engine "OFF," the system will enter what is called the Diagnostic Mode. In this mode the ECM will

1. Display a Code 12 by flashing the "Service Engine Soon" light (indicating the system is operating correctly).
2. Display any stored codes by flashing the "Service Engine Soon" light. Each code will be flashed three times, then Code 12 will be flashed again.
3. Energize all ECM controlled relays and solenoids except fuel pump relay. This allows checking circuits which may be difficult to energize without driving the vehicle and being under particular operating conditions.
4. The IAC valve moves to its fully extended position on most models, blocking the idle air passage. This is useful in checking the minimum idle speed.



TERMINAL IDENTIFICATION

A	GROUND	E	SERIAL DATA
B	DIAGNOSTIC TERMINAL	F	TCC (IF USED)
C	A.I.R. (IF USED)	G	FUEL PUMP (IF USED)
D	SERVICE ENGINE SOON LIGHT (IF USED)	M	SERIAL DATA (IF USED)

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Figure 3 - ALDL Connector

Field Service Mode

If the diagnostic terminal is grounded with the engine running, the system will enter the Field Service mode. In this mode, the "Service Engine Soon" light will indicate whether the system is in "Open Loop" or "Closed Loop."

In "Open Loop" the "Service Engine Soon" light flashes two and one-half times per second.

In "Closed Loop," the light flashes once per second. Also, in "Closed Loop," the light will stay "OFF" most of the time if the system is running lean. It will stay "ON" most of the time if the system is running rich.

While the system is in Field Service Mode, new codes cannot be stored in the ECM and the "Closed Loop" timer is bypassed.

ECM Learning Ability

The ECM has a "learning" ability which allows it to make corrections for minor variations in the fuel system to improve driveability. If the battery is disconnected, to clear diagnostic codes or for other repair, the "learning" process resets and begins again. A change may be noted in the vehicle's performance. To "teach" the vehicle, ensure that the engine is at operating temperature. The vehicle should be driven at part throttle, with moderate acceleration and idle conditions until normal performance returns.

DIAGNOSTIC CIRCUIT CHECK

After the visual/physical underhood inspection, the "Diagnostic Circuit Check" (Figure 4) is the starting point for all diagnostic procedures or finding the cause of an emissions test failure.

The correct procedure to diagnose a problem is to follow three basic steps.

1. Are the On-Vehicle Diagnostics working? This is determined by performing the "Diagnostic Circuit Check." Since this is the starting point for the diagnostic procedures or finding the cause of an emissions test failure, *always begin here.*

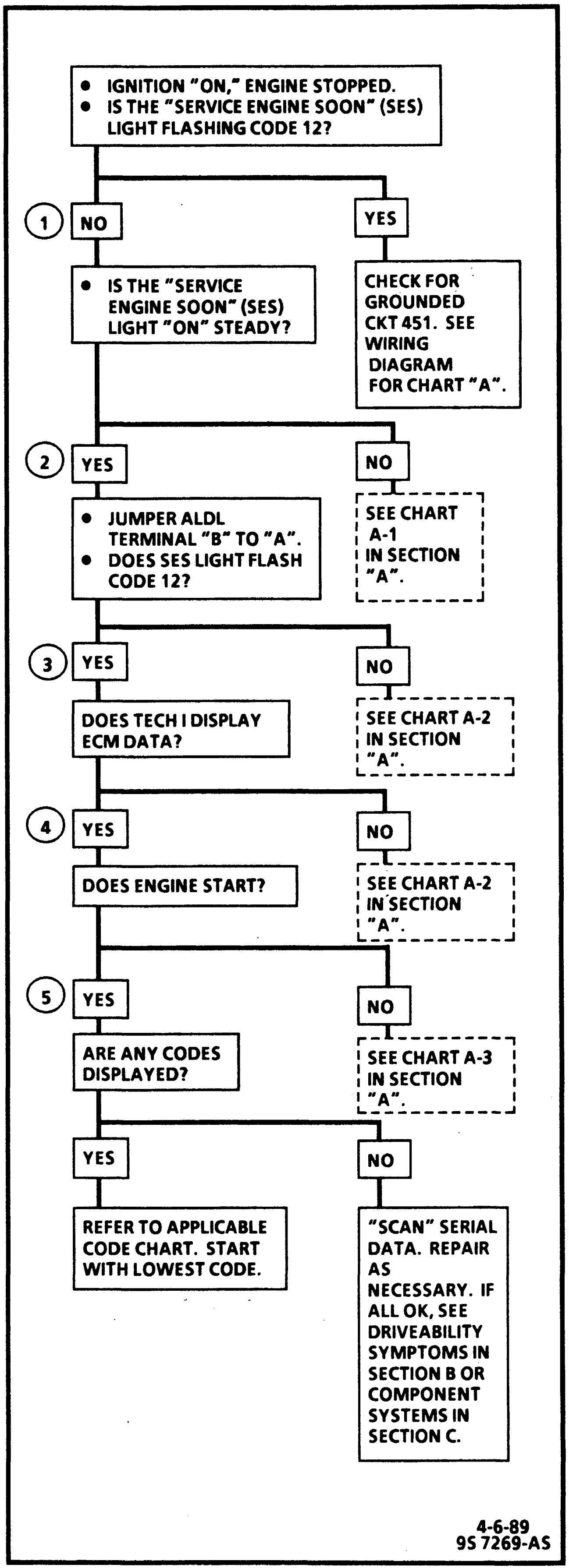


Figure 4 - Diagnostic Circuit Check

If the On-Vehicle Diagnostics aren't working, the "Diagnostic Circuit Check" will lead to a diagnostic chart in Section "A" of Section 6E2 or Section 6E3 to correct the problem. If the On-Vehicle Diagnostics are working correctly, the next step is

2. Is there a Code stored? If a code is stored, go directly to the numbered code chart in Section "A" of Section 6E2 or Section 6E3. This will determine if the fault is still present. If no code is stored, then
3. "Scan" Serial Data transmitted by the ECM. This involves reading the information available on the Serial Data Stream with Tech 1 or one of the tools available for that purpose. Information on these tools and the meaning of the various displays can be found in the succeeding paragraphs. Expected readings under a particular operating condition can be found on the facing page of the Diagnostic Circuit Check.

ALDL "SCAN" TOOLS

The ECM can communicate a variety of information through ALDL connector terminals "E" or "M" (depending on the engine). This data is transmitted at a high frequency which requires a Tech 1 Diagnostic Computer tool for interpretation. There are several "Scan" tools available for reading this information.

With an understanding of the data which the tool displays, and knowledge of the circuits involved, the tool can be very useful in obtaining information which would be more difficult or impossible to obtain with other equipment.

Tech 1 and "Scan" tools do not make the use of diagnostic charts unnecessary, nor can they indicate exactly where a problem is in a particular circuit. Trouble Tree Charts incorporate diagnosis procedures using a "Scan" tool where possible and most charts *require* the use of a Tech 1 when it is applicable.

A "SCAN" TOOL THAT DISPLAYS FAULTY DATA SHOULD NOT BE USED AND THE PROBLEM SHOULD BE REPORTED TO THE MANUFACTURER. THE USE OF A FAULTY "SCAN" TOOL CAN RESULT IN MISDIAGNOSIS AND UNNECESSARY PARTS REPLACEMENT.

ECM's have three modes for transmitting information. The following information will describe the system operation in each of the three modes.

Normal (Open) Mode

On engines that can be monitored in the "Open" mode, certain parameters can be observed without changing the engine operating characteristics. The parameters capable of being read vary with engine families. Most "Scan" tools are programmed so that the system will go directly into the ALDL mode if the "Open" mode is not available.

ALDL Mode (Also Called 10K or Special)

In this mode, all obtainable data is readable. However, in this mode, the system operating characteristics are modified as follows.

- "Closed Loop" timers are bypassed.
- EST (spark) is advanced.
- P/N restrict functions are disabled.
- IAC valve controls engine idle to 1000 rpm ± 50 rpm (if applicable).
- On some engines, canister purge solenoid is enabled.

Factory Test Mode (Also Called Back-up or 3.9 K)

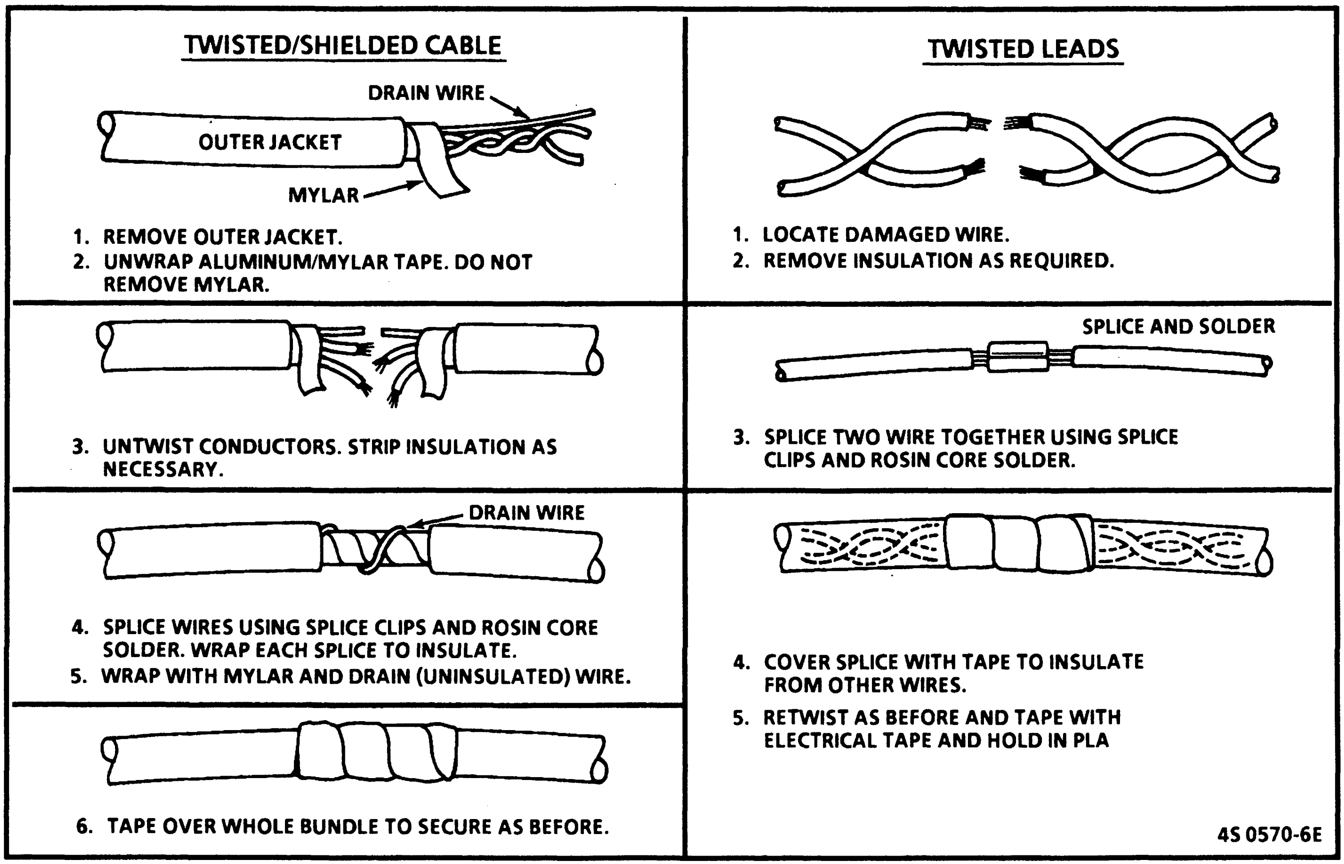
In this mode, the ECM is operating on the fuel back-up logic used to control the fuel delivery if the ECM fails. This mode verifies that the back-up feature is OK. The parameters that can be read on a "Scan" tool in this mode are not of much use for service.

"SCAN" TOOL USE WITH INTERMITTENTS

In some "Scan" tool applications, the data update rate makes the tool less effective than a voltmeter, such as when trying to detect an intermittent problem which lasts for a very short time. However, the Tech 1 allows manipulation of wiring harnesses or components under the hood with the engine not running, while observing the Tech 1 readout.

The "Scan" tool can be plugged in and observed while driving the vehicle under the condition when the "Service Engine Soon" light turns "ON" momentarily or when the engine driveability is momentarily poor. If the problem seems to be related to certain parameters that can be checked on the Tech 1, they should be checked while driving the vehicle. If there does not seem to be any correlation between the problem and any specific circuit, the Tech 1 can be checked on each position, watching for a period of time to see if there is any change in the readings that indicates intermittent operation.

The Tech 1 is also an easy way to compare the operating parameters of a poorly operating engine with those of a known good one. For example, a sensor may shift in value but not set a trouble code. Comparing the sensor's readings with those of a known good vehicle may uncover the problem.



1. REMOVE OUTER JACKET.
2. UNWRAP ALUMINUM/MYLAR TAPE. DO NOT REMOVE MYLAR.
3. UNTWIST CONDUCTORS. STRIP INSULATION AS NECESSARY.
4. SPLICE WIRES USING SPLICE CLIPS AND ROSIN CORE SOLDER. WRAP EACH SPLICE TO INSULATE.
5. WRAP WITH MYLAR AND DRAIN (UNINSULATED) WIRE.
6. TAPE OVER WHOLE BUNDLE TO SECURE AS BEFORE.

1. LOCATE DAMAGED WIRE.
2. REMOVE INSULATION AS REQUIRED.
3. SPLICE TWO WIRE TOGETHER USING SPLICE CLIPS AND ROSIN CORE SOLDER.
4. COVER SPLICE WITH TAPE TO INSULATE FROM OTHER WIRES.
5. RETWIST AS BEFORE AND TAPE WITH ELECTRICAL TAPE AND HOLD IN PLA

4S 0570-6E

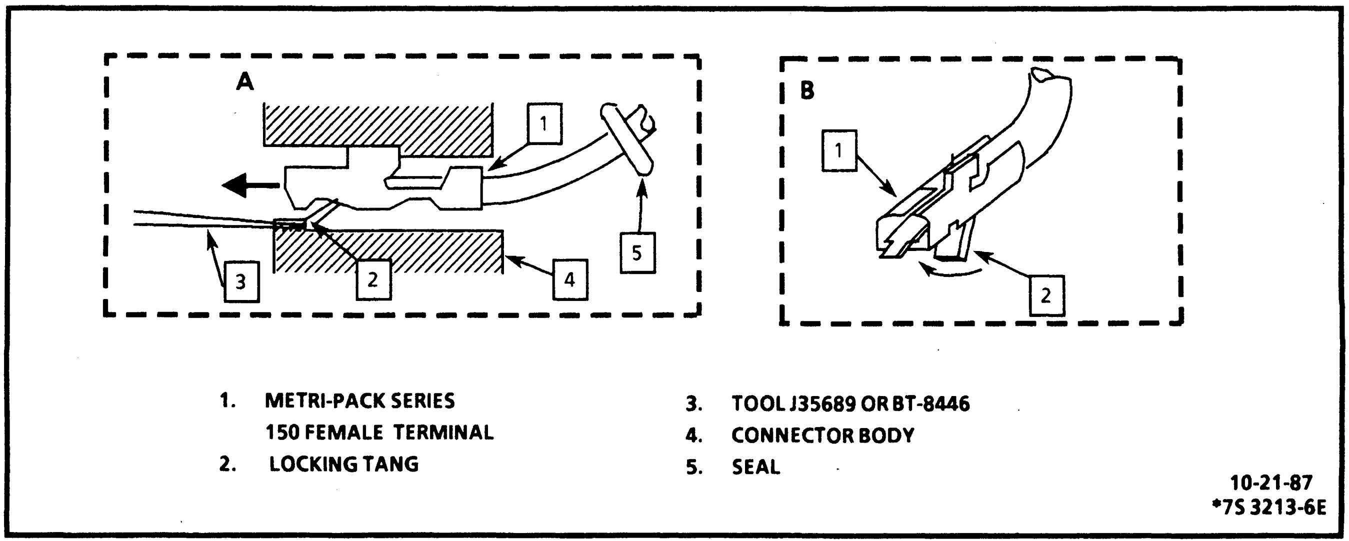
Figure 5 - Wiring Harness Repair

The Tech 1 has the ability to save time in diagnosis and prevent the replacement of good parts. The key to using the Tech 1 successfully for diagnosis lies in the technician's ability to understand the system he is trying to diagnose as well as an understanding of the Tech 1 operation and limitations. The technician should read the tool manufacturer's operating manual to become familiar with the tool's operation.

WIRING HARNESS SERVICE

Wire harnesses should be replaced with proper part number harnesses. When signal wires are spliced into a harness, use wire with high temperature insulation only. See Figure 5 for instructions.

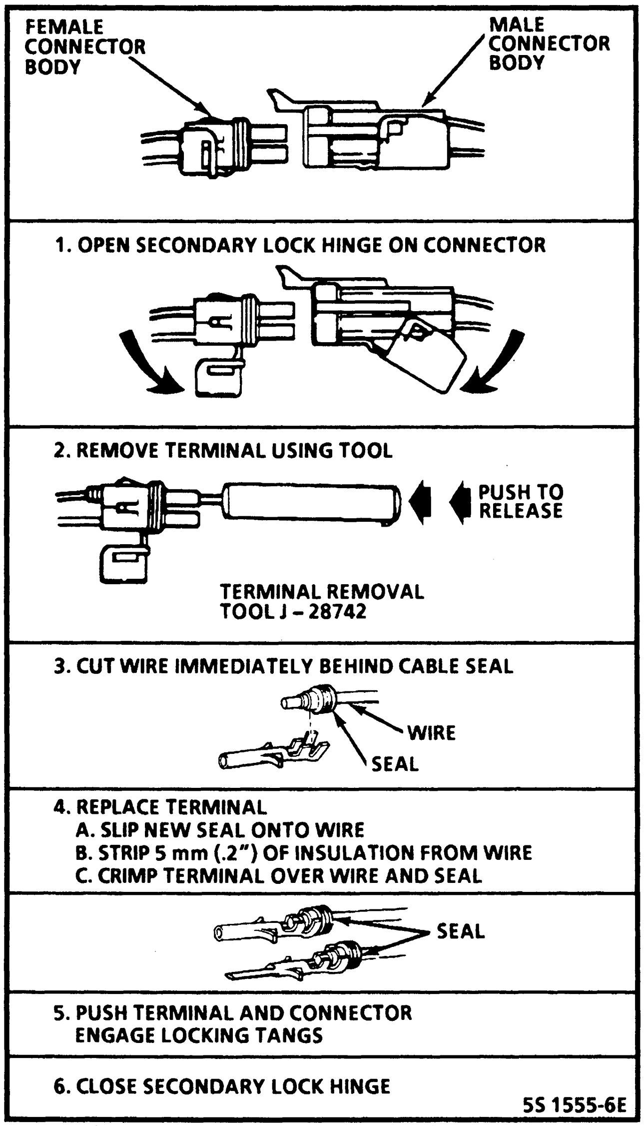
With the low current and voltage levels found in the system, it is important that the best possible bond be made at all wire splices by soldering the splices as shown.



1. METRI-PACK SERIES 150 FEMALE TERMINAL
2. LOCKING TANG
3. TOOL J35689 OR BT-8446
4. CONNECTOR BODY
5. SEAL

10-21-87
*7S 3213-6E

Figure 6 - Metri-Pack Series 150 Terminal Removal



1. OPEN SECONDARY LOCK HINGE ON CONNECTOR

2. REMOVE TERMINAL USING TOOL

3. CUT WIRE IMMEDIATELY BEHIND CABLE SEAL

4. REPLACE TERMINAL
   A. SLIP NEW SEAL ONTO WIRE
   B. STRIP 5 mm (.2") OF INSULATION FROM WIRE
   C. CRIMP TERMINAL OVER WIRE AND SEAL

5. PUSH TERMINAL AND CONNECTOR ENGAGE LOCKING TANGS

6. CLOSE SECONDARY LOCK HINGE

Figure 7 - Weather-Pack Terminal Repair

Use care when probing a connector or replacing connector terminals. It is possible to short between opposite terminals. If this happens, certain components can be damaged. Always use jumper wires between connectors for circuit checking. NEVER probe through connector seals, wire insulation, secondary ignition wires, boots, nipples, or covers. Even microscopic damage or holes may result in eventual water intrusion, corrosion and/or component or circuit failure.

WIRING CONNECTOR SERVICE

Most connectors in the engine compartment are protected against moisture and dirt which could create oxidation and deposits on the terminals. This protection is important because of the very low voltage and current levels found in the electronic system. The connectors have a lock which secures the male and female terminals together. A secondary lock holds the seal and terminal into the connector.

When diagnosing, open circuits are often difficult to locate by sight because oxidation or terminal misalignment are hidden by the connectors. Merely wiggling a connector on a sensor or in the wiring harness may locate the open circuit condition. This should always be considered when an open circuit or failed sensor is indicated. Intermittent problems may also be caused by oxidized or loose connections.

Before making a connector repair, be certain of the type of connector. Weather-Pack and Compact Three connectors look similar but are serviced differently. Replacement connectors and terminals are listed in Group 8.965 of the Standard Parts Catalog.

Metri-Pack Series 150 Terminals

Some ECM harness connectors contain terminals called Metri-Pack (Figure 6). These may be used at the coolant sensors as well as at ignition modules.

Metri-Pack terminals are also called "Pull-To-Seat" terminals because to install a terminal on a wire, the wire is first inserted through the seal (5) and connector (4). The terminal is then crimped on the wire, and the terminal pulled back into the connector to seat it in place.

To remove a terminal:

1. Slide the seal back on the wire.
2. Insert tool (3) BT 8518, J 35689, or equivalent as shown in insert "A" and "B" to release the terminal locking tang (2).
3. Push the wire and terminal out through the connector.

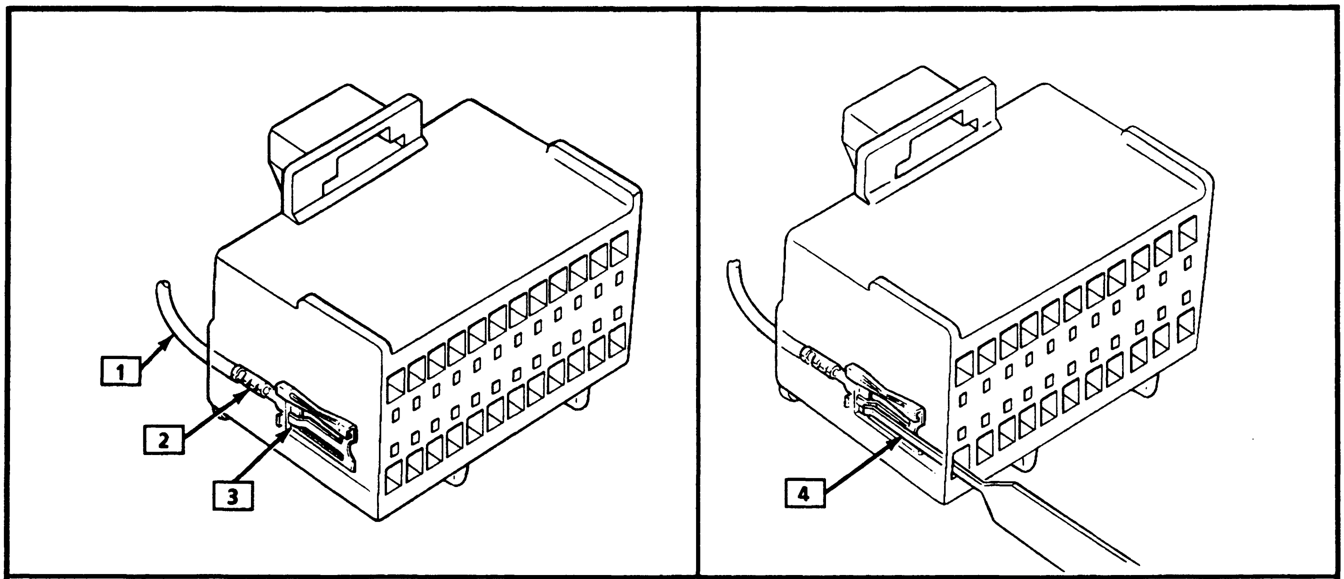
If the terminal is being reused, reshape the locking tang (2).

Weather-Pack Connectors

Figure 7 shows a Weather-Pack connector and the tool (J 28742, BT 8234-A or equivalent) required to service it. This tool is used to remove the pin and sleeve terminals. If terminal removal is attempted with an ordinary pick, there is a good chance that the terminal will be bent or deformed, and unlike standard blade type terminals, these terminals cannot be straightened once they are bent.

Make certain that the connectors are properly seated and all of the sealing rings in place when connecting leads. The hinge-type flap provides a secondary locking feature for the connector. It improves the connector reliability by retaining the terminals if the small terminal lock tangs are not positioned properly.

Weather-Pack connections cannot be replaced with standard connections. Instructions are provided with Weather-Pack connector and terminal packages.



1 CABLE
2 TERMINAL
3 LOCKING TANG
4 TOOL J33095

1. GRASP CABLE AND PUSH TERMINAL TO THE MOST FORWARD POSITION.
2. INSERT TOOL J33095 STRAIGHT INTO THE FRONT OF THE CONNECTOR CAVITY. DO NOT USE CONVENTIONAL PICK TO REMOVE TERMINAL.
3. WITH TOOL IN PLACE, GENTLY PULL ON THE CABLE TO REMOVE TERMINAL.
4. VISUALLY CHECK TERMINAL AND REPLACE IF TERMINAL CAVITY OR TANG IS DAMAGED.
5. INSTALL TERMINAL INTO CONNECTOR CAVITY UNTIL LOCKING TANG HAS SNAPPED INTO POSITION.

5S 1418-6E

Figure 8 - Micro-Pack Terminal Replacement

Compact Three Connectors

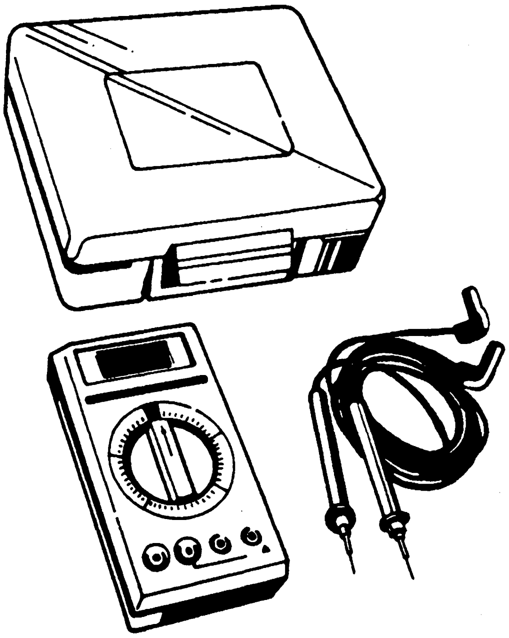
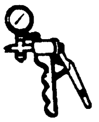
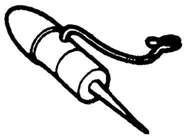
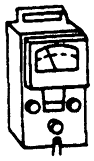
The Compact Three connector, which looks similar to a Weather-Pack connector, is not sealed and is used where resistance to the environment is not required. This type of connector most likely is used at the AIR control solenoid. Use the standard method when repairing a terminal. Do not use the Weather-pack terminal tool J 28742.

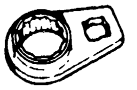
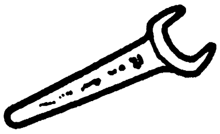
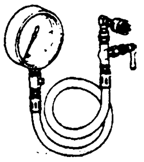
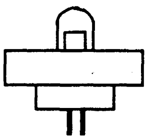
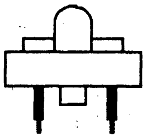
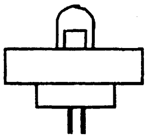
Micro-Pack Connectors

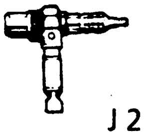
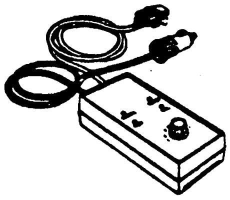
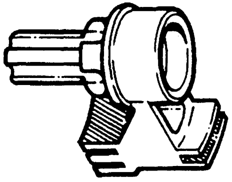
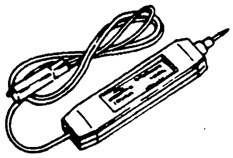
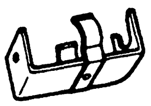
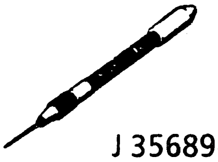
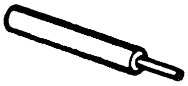
Micro-Pack terminal (Figure 8) replacement requires the use of special tool J 33095, BT 8234-A or equivalent.

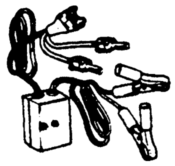
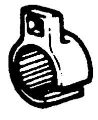
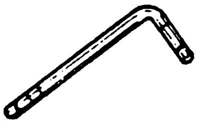
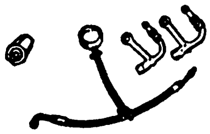
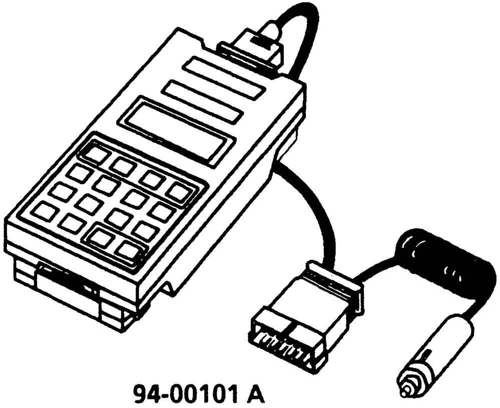
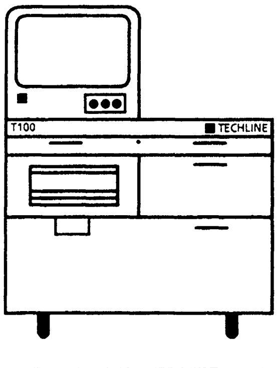
TOOLS NEEDED TO SERVICE THE SYSTEM

The system requires a Tech 1 Diagnostic Computer or equivalent "Scan" tool, tachometer, test light, ohmmeter, digital voltmeter with 10 megohms impedance (J 29125-A, J 34029-A or equivalent), vacuum gage and jumper wires for diagnosis. A test light or voltmeter must be used when specified in the procedures. See Page 6E-11 through Page 6E-14 for Special Tools needed to diagnosis or repair a system. For more complete information on the operation of these tools, consult the tool manufacturer's instructions.

 HIGH IMPEDANCE MULTIMETER (DIGITAL VOLTMETER-DVM) J34029-A	VOLTMETER - Voltage position measures magnitude of voltage when connected in parallel to an existing circuit. A digital voltmeter with a 10 meg ohm input impedance is used because this type of meter will not load down the circuit and result in faulty readings. Some circuits require accurate low voltage readings because they have a very high resistance . AMMETER - When used as an ammeter, this meter accurately measures extremely low current flow. Refer to meter instructions for more information. ● Selector must be set properly for both function and range. DC is used for most automotive measurements. OHMMETER - Measures resistance of circuit directly in ohms. Refer to meter instructions for more information. ● OL display in all ranges indicates open circuit. ● Zero display in all ranges indicates a short circuit. ● An intermittent connection in a circuit may be indicated by a digital reading that will not stabilize on the circuit. ● Range Switch. ☐ 200Ω – Reads ohms directly 2K,20K,200KΩ – Reads ohms in thousands 2M and 20MΩ - Reads ohms in millions
 J 23738-A	**VACUUM PUMP WITH GAGE (20 IN. HG. MINIMUM)** Use the gage to monitor manifold engine vacuum and use the hand pump to check vacuum sensors, solenoids and valves.
 J 34142-B	**UNPOWERED TEST LIGHT** Used for checking wiring for complete circuit, short to ground, or voltage.
	**TACHOMETER** Must have inductive trigger signal pickup. 8-4-89 7S 3382-6E

 J 29533-A/BT 8127	**OXYGEN SENSOR WRENCH** Used for removing or installing the oxygen sensor.
 J 33031/BT 8130	**IDLE AIR CONTROL WRENCH** Used for removing or installing IAC valve on throttle body.
 J 34730-B	**PORT FUEL INJECTION DIAGNOSTIC KIT** Used to diagnose port fuel injection systems. The kit includes: ● Fuel Pressure Gage - used for checking fuel pump pressure and compare injector pressure drop for equal fuel distribution. ● Injector Test Light - used for checking electrical circuit to an injector. ● Injector Tester - used for energizing each fuel injector for a precise amount of time to perform injector balance test.
 J 34730-1	**FUEL PRESSURE GAGE** Used for checking and monitoring fuel line pressure of port fuel system. Part of Diagnostic Kit J34730-B.
 J 34730-2	**INJECTOR TEST LIGHT** Used for checking the electrical circuit to a port fuel injector. Part of Diagnostic Kit J34730-B.
 BT 8320	**INJECTOR TEST LIGHT** Used for checking the electrical circuit to a TBI fuel injector. (except TBI 700).
 BT 8329A	**INJECTOR TEST LIGHT** Used for checking the electrical circuit to a TBI 700 fuel injector and a port fuel injector. 8-18-89 7S 3396-6E

 J 26792/BT 7220-1	**SPARK TESTER** Used for checking available secondary ignition voltage. Also called an ST125.
 J 36101	**MASS AIR FLOW (MAF) SENSOR TESTER** Used for static test of MAF Sensor on vehicles equipped with an AC type MAF Sensor.
 J 37089	**CRANKSHAFT SENSOR ALIGNMENT TOOL (C^{3}I SYSTEMS)** Used for properly aligning crank or combination sensor to harmonic balancer interrupter.
 J 35616	**CONNECTOR TEST ADAPTER KIT** Used for making electrical test connections in current Weather Pack, Metri-Pack and Micro-Pack style terminals.
 J 34636	**CIRCUIT TESTER** Used for checking all relays and solenoids before connecting them to a new ECM. Measures the circuit resistance and indicates pass or fail via green or red LED. Amber LED indicates current polarity. Can also be used as a non-powered continuity checker.
 J28687-B/BT8220	**OIL PRESSURE TRANSDUCER WRENCH** Used for removing or installing oil pressure transducer on engine.
 J 35689-A/BT 8446	**METRI-PACK TERMINAL REMOVER** Used for removing 150 series Metri-Pack "pull-to-seat" terminals from connectors. Refer to wiring harness service in Section "6E" for removal procedure.
 J 28742-A/BT 8234-A	**WEATHER PACK TERMINAL REMOVER** Used for removing terminals from Weather Pack connectors. Refer to wiring harness service in Section "6E" for removal procedure.
 J 33095/BT 8234-A	**ECM CONNECTOR TERMINAL REMOVER** Used for removing terminals from Micro-Pack connectors. Refer to wiring harness service Section "6E" for removal procedure 8-18-89 7S 3384-6E

 J 34730-3	**INJECTOR TESTER** Used for energizing each fuel injector for a precise amount of time to perform injector balance test. Part of Diagnostic Kit J34730-B.
 J 29698-A/BT 8251	**FUEL LINE WRENCH** Used for disconnecting or connecting fuel lines at throttle body unit by holding fuel nut at throttle body.
 J 33179-20	**MINIMUM AIR RATE ADJUSTING WRENCH** Used for adjusting throttle stop screw on TBI unit.
 J 38336 OR J 29658-100 J 29658-B	**FUEL PRESSURE GAGE** Used for checking and monitoring fuel line pressure of port fuel system.
 94-00101 A	**TECH 1 DIAGNOSTIC COMPUTER** A hand-held "SCAN" tool used to analyze and diagnose fuel and emission system. Also can be used to analyze other computer systems.
	**T100 - GM CAMS (COMPUTERIZED AUTOMOTIVE MAINTENANCE SYSTEM)** Used to help technicians analyze and repair difficult and intermittent vehicle system problems. 8-18-89 8S 4861-6E

GENERAL SPECIFICATIONS

Many of the specifications used in this section are located on the Vehicle Emission Control Information label under the hood.

Listed on the chart below are locations of specifications used in this Section.

SPECIFICATION	LOCATION OF INFORMATION
Engine Timing	Vehicle Emission Control Information label.
Idle Speed, ECM Controlled	Not adjustable. ECM controls idle.
Spark Plug Type	Owner's Manual, Section "8".
Spark Plug Gap	Vehicle Emission Control Information label.
Engine Code	8th digit of VIN number. Also Owner's Manual, Section "8".
Engine Family	Vehicle Emission Control Information label.
Filter Part Numbers	Owner's Manual, Section "8".
Part Numbers of Major Components	GMSPO Parts Book.
Replacement of Vehicle Emission Control Information label	GMSPO Label Catalog.

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SECTION 6E2

DRIVEABILITY AND EMISSIONS FUEL INJECTION (TBI)

THIS SECTION APPLIES TO:

5.0L (VIN E) "F" CARLINE

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts of system damage could result.

CONTENTS

5.0L L03 (VIN E) "F" CARLINE

ALL NEW GENERAL MOTORS VEHICLES ARE CERTIFIED BY THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY AS CONFORMING TO THE REQUIREMENTS OF THE REGULATIONS FOR THE CONTROL OF AIR POLLUTION FROM NEW MOTOR VEHICLES. THIS CERTIFICATION IS CONTINGENT ON CERTAIN ADJUSTMENTS BEING SET TO FACTORY STANDARDS. IN MOST CASES, THESE ADJUSTMENT POINTS EITHER HAVE BEEN PERMANENTLY SEALED AND/OR MADE INACCESSIBLE TO PREVENT INDISCRIMINATE OR ROUTINE ADJUSTMENT IN THE FIELD. FOR THIS REASON, THE FACTORY PROCEDURE FOR TEMPORARILY REMOVING PLUGS, CAPS, ETC., FOR PURPOSES OF SERVICING THE PRODUCT, MUST BE STRICTLY FOLLOWED AND, WHEREVER PRACTICABLE, RETURNED TO THE ORIGINAL INTENT OF THE DESIGN.

INTRODUCTION

GENERAL DESCRIPTION

This section applies to engines which have a fuel injector mounted above a throttle body assembly. The entire assembly is mounted to the intake manifold and is referred to as "Throttle Body Injection."

These engines have controls to reduce exhaust emissions, while maintaining good driveability and fuel economy.

An Engine Control Module (ECM) is the heart of this control system and has sensors used to provide information about engine operation and the various systems it controls. Details of basic operation, diagnosis, functional checks, and on-vehicle service are covered in "Component Systems," Section "6E2-C".

The ECM has the ability to do some diagnosis of itself, and of other parts of the system. When it finds a problem, it lights a "Service Engine Soon" Light on the instrument panel and a trouble code will be stored in the ECM memory. This does not mean that the engine should be stopped right away, but that the cause of the light coming on should be checked as soon as reasonably possible.

DIAGNOSIS PROCEDURE

The following sections are written for specific engine applications and are clearly identified. Be sure to use only the section which applies to the engine family being diagnosed.

Before using this section of the manual, you should be familiar with the information and the proper diagnosing procedures as described in "Driveability and Emissions," Section "6E". If the proper diagnosis procedures are not followed, as described in "Driveability and Emissions," Section "6E", it may result in unnecessary replacement of good parts.

Diagnostic Charts incorporate diagnosis procedures using an ALDL "SCAN" tool, such as the Tech I Diagnostic Computer, where possible. The "SCAN" tool has the ability to save time in diagnosis and prevent the replacement of good parts. **The key to using the "SCAN" tool successfully for diagnosis lies in the technician's ability to understand the system he is trying to diagnose, as well as an understanding of the "SCAN" tool's limitations. See "Driveability and Emissions," Section "6E" for more information.**

SECTION A
5.0L ENGINE

DIAGNOSTIC CIRCUIT CHECK

The "Diagnostic Circuit Check" verifies the system is functioning correctly. Some special considerations to keep in mind while making the diagnostic circuit check are:

Blocking Drive Wheels

The vehicle drive wheels must always be blocked while checking the system.

Cold Oxygen Sensor

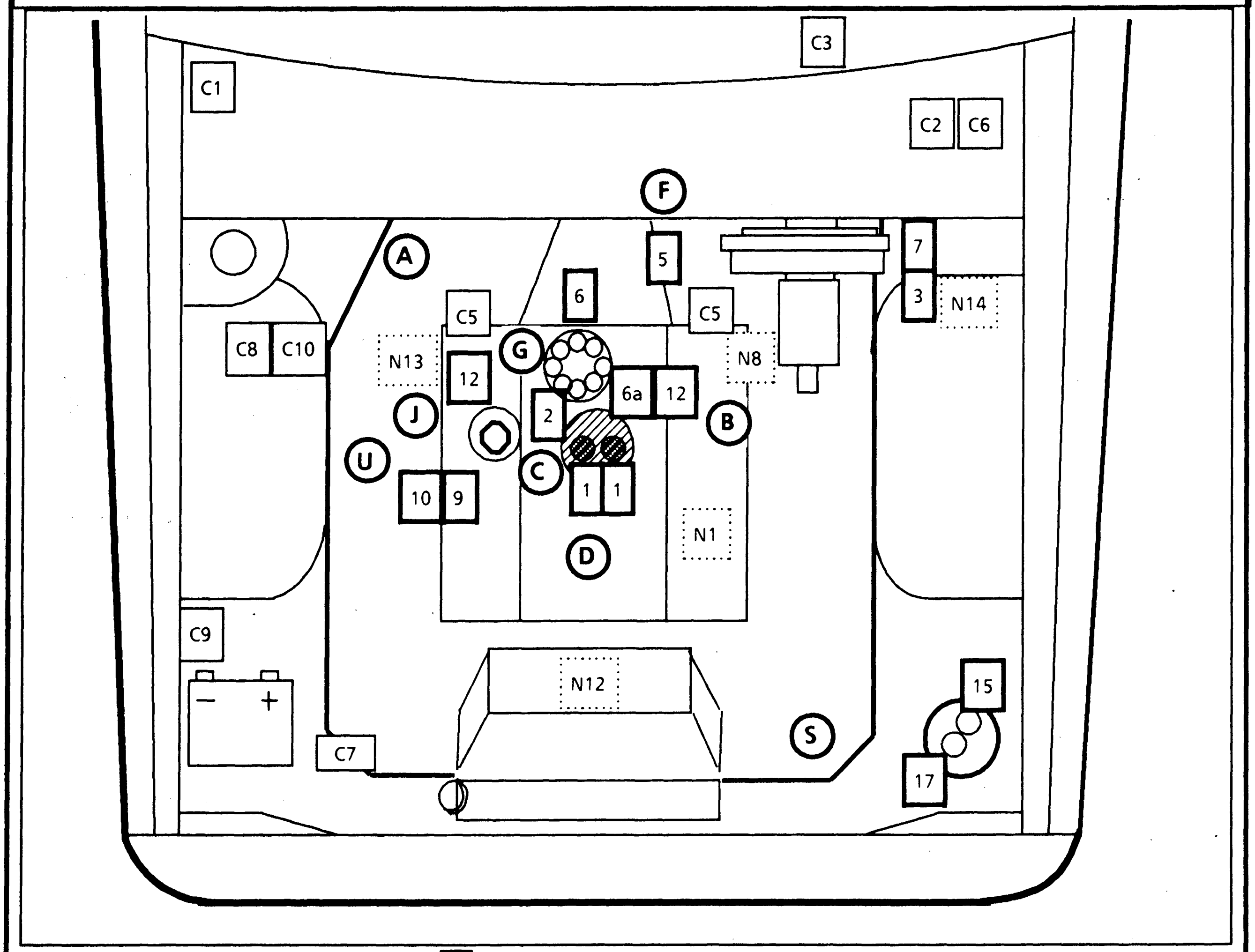
On some engines, the oxygen sensor may cool down after only a short period of operation at idle. This will put the system into "Open Loop." To restore "Closed Loop" operation, run the engine at part throttle several minutes and accelerate from idle to part throttle a few times.

BASIC PROCEDURE

If you have not reviewed the basic information on how to use the diagnostic procedures, go to the "Introduction" of this section. The facing page of each chart in this section will provide a general circuit description and in some instances, alternate diagnostic steps or other diagnostic aids specific to that chart or circuit.

SECTION A
ENGINE COMPONENTS/WIRING DIAGRAMS/DIAGNOSTIC CHARTS

"F" CARLINE RPO: LO3 VIN CODE: E 5.0L V8 TBI



☐ COMPUTER HARNESS

C1 Electronic Control Module (ECM)
C2 ALDL diagnostic connector
C3 "SERVICE ENGINE SOON" light
C5 ECM harness grounds
C6 Fuse panel
C7 Battery junction block
C8 Fuel pump test connector
C9 Fuel pump/ECM fuse
C10 Set timing connector

⬚ NOT ECM CONNECTED

N1 Positive Crankcase Ventilation (PCV) valve
N8 Oil pressure sensor (gage) and switch (fuel pump)
N12 Electric cooling fan (FAN 1)
N13 Cooling fan temperature switch
N14 Electric cooling fan (FAN 1) relay

☐ CONTROLLED DEVICES

1 Fuel injector
2 Idle Air Control (IAC) valve
3 Fuel pump relay
5 Torque Converter Clutch (TCC) connector
6 EST distributor
6a Remote ignition coil
7 Electronic Spark Control (ESC) module
9 AIR port solenoid
10 AIR converter solenoid
12 EGR solenoid
15 Fuel vapor canister solenoid
17 Fuel vapor canister
⊙ Exhaust Gas Recirculation valve

○ INFORMATION SENSORS

A Manifold Absolute Pressure (MAP) sensor
B Exhaust Oxygen (O_2) sensor
C Throttle Position Sensor (TPS)
D Coolant Temperature Sensor (CTS)
F Vehicle Speed Sensor (VSS)
G Manifold Air Temperature (MAT) sensor (in air cleaner)
J ESC knock sensor
S Power Steering Pressure Switch (PSPS)
U A/C cooling fan switch

1-12-90
8S 4419-6E

Figure A-1 - Component Locations 5.0L (VIN E) "F" Carline

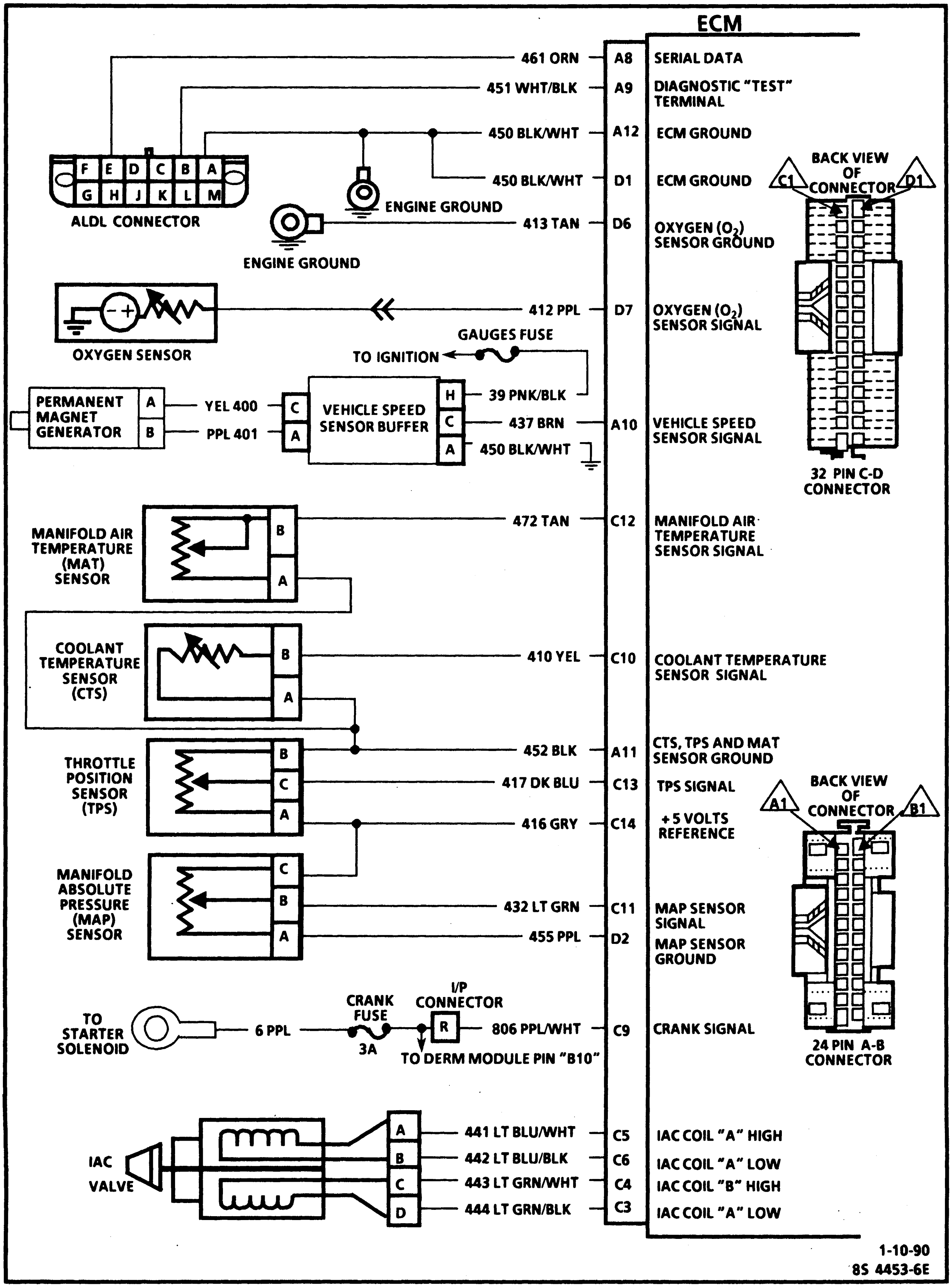


Figure A-2 - ECM Wiring Diagram 5.0L (VIN E) "F" Carline (1 of 3)

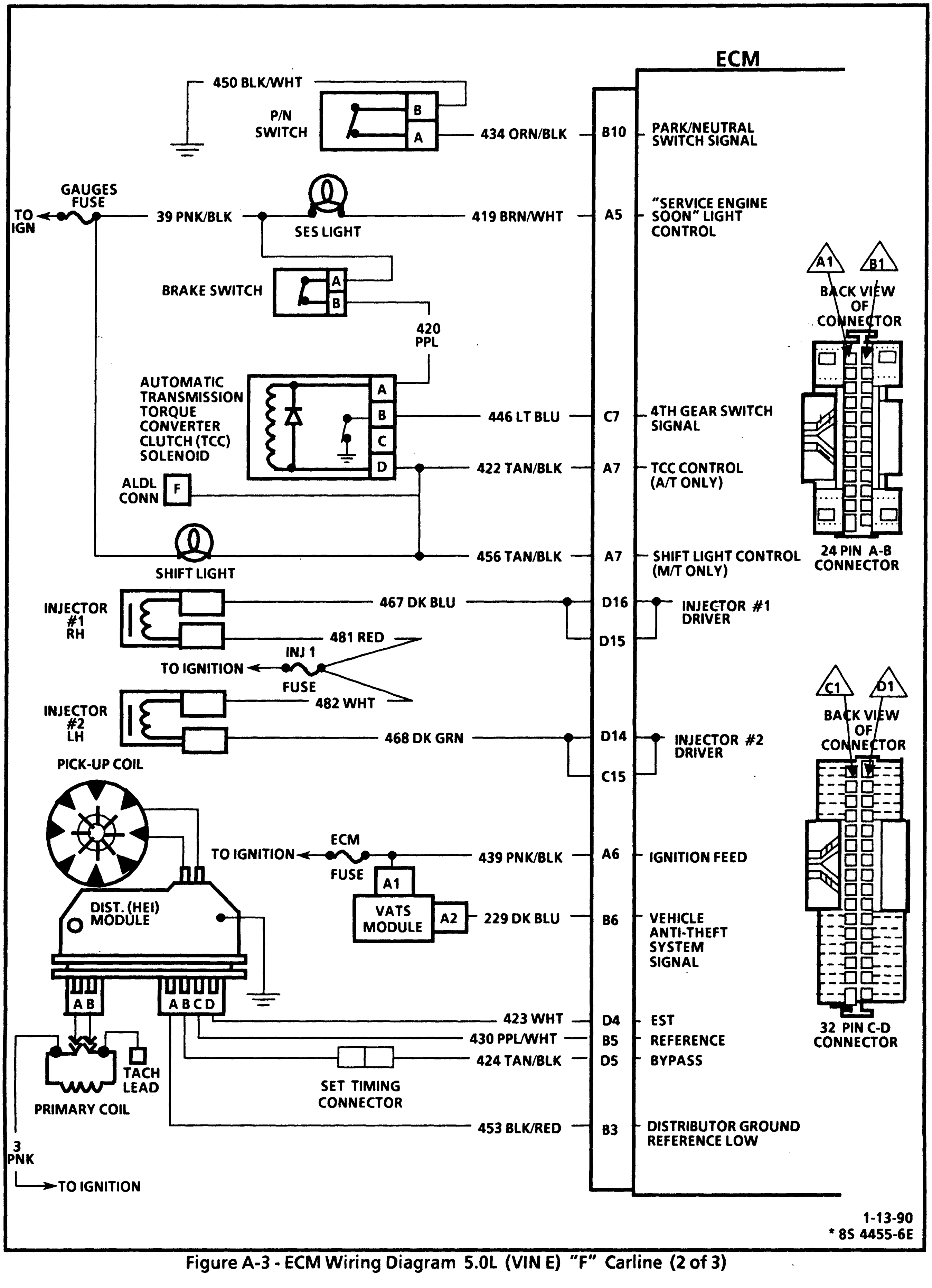


Figure A-3 - ECM Wiring Diagram 5.0L (VIN E) "F" Carline (2 of 3)

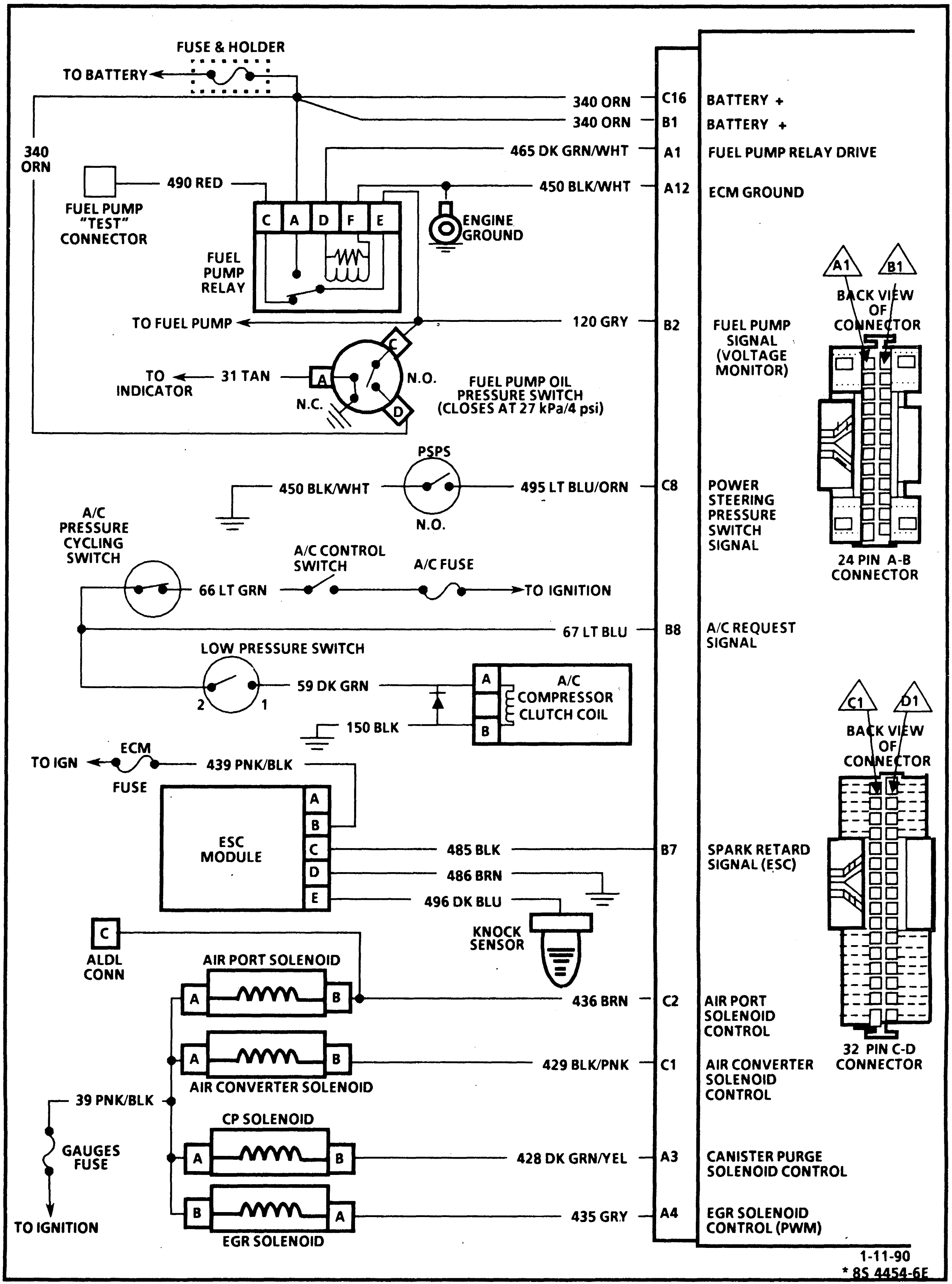


Figure A-4 - ECM Wiring Diagram 5.0L (VIN E) "F" Carline (3 of 3)

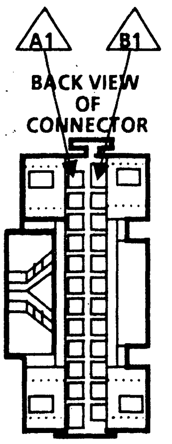
FUEL INJECTION ECM CONNECTOR IDENTIFICATION

This ECM voltage chart is for use with a digital voltmeter to further aid in diagnosis. The voltages you get may vary due to low battery charge or other reasons, but they should be very close.

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

- Engine at operating temperature
- Engine idling in closed loop (for "Engine Run" column)
- Diagnostic "Test" terminal not grounded
- "Scan" tool not installed

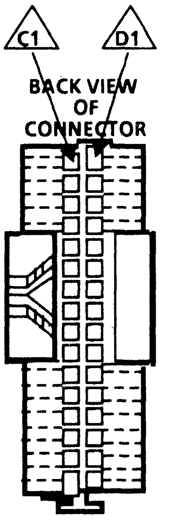
VOLTAGE				
KEY "ON"	ENG. RUN	CIRCUIT	PIN	WIRE COLOR
② 0*	B+	FUEL PUMP RELAY DRIVE	A1	DK GRN/ WHT
		NOT USED	A2	
0*	B+	CANISTER PURGE SOL. CONTROL	A3	DK GRN/ YEL
B+	B+	EGR SOLENOID CONTROL	A4	GRY
0*	B+	"SERVICE ENGINE SOON" LIGHT	A5	BRN/ WHT
B+	B+	IGNITION FEED	A6	PNK/ BLK
B+	B+	M/T SHIFT LIGHT A/T TCC CONTROL	A7	TAN/ BLK
2-5 VARYING	2-5	SERIAL DATA	A8	ORN
5	5	DIAGNOSTIC "TEST" TERMINAL	A9	WHT/ BLK
① 0 OR 12	0 OR 12	VEHICLE SPEED SENSOR SIGNAL	A10	BRN
0*	0*	CTS, TPS AND MAT SENSOR GROUND	A11	BLK
0*	0*	ECM GROUND	A12	BLK/ WHT



24 PIN A-B CONNECTOR

			VOLTAGE	
WIRE COLOR	PIN	CIRCUIT	KEY "ON"	ENG. RUN
ORN	B1	BATTERY	B+	B+
GRY	B2	FUEL PUMP SIGNAL	0	B+ ④
BLK/ RED	B3	DIST. GROUND REFERENCE LOW	0*	0*
	B4	NOT USED		
PPL/ WHT	B5	REFERENCE	0	1.3
DK BLU	B6	VATS	5	5
BLK	B7	SPARK RETARD SIGNAL (ESC)	9.2	9.3
LT BLU	B8	A/C REQUEST SIGNAL "OFF" "ON"	0 B+	0 B+
	B9	NOT USED		
ORN/ BLK	B10	PARK/NEUTRAL SWITCH SIGNAL	0	0 ⑥
	B11	NOT USED		
	B12	NOT USED		

KEY "ON"	ENG. RUN	CIRCUIT	PIN	WIRE COLOR
B+	B+	A.I.R. CONVERTER SOLENOID	C1	BLK/ PNK
B+	B+	A.I.R. PORT SOLENOID	C2	BRN
NOT USEABLE		IAC "B" LO	C3	LT GRN/ BLK
NOT USEABLE		IAC "B" HI	C4	LT GRN/ WHT
NOT USEABLE		IAC "A" HI	C5	LT BLU/ WHT
NOT USEABLE		IAC "A" LO	C6	LT BLU BLK
0	0	4 TH GEAR SWITCH SIGNAL	C7	LT BLU
B+	B+	POWER STEERING PRESSURE SWITCH	C8	LT BLU/ ORN
⑦ 0	0	CRANK SIGNAL	C9	PPL/ WHT
⑤ 1.6	1.6	CTS SIGNAL	C10	YEL
③ 4.75	1.1	MAP SENSOR SIGNAL	C11	LT GRN
2.5	2.5	MAT SENSOR SIGNAL	C12	TAN
.7	.7	TPS SIGNAL	C13	DK BLU
5	5	+5 VOLTS REFERENCE	C14	GRY
B+	B+	INJECTOR 2 DRIVER	C15	DK GRN
B+	B+	BATTERY	C16	ORN



32 PIN C-D CONNECTOR

WIRE COLOR	PIN	CIRCUIT	KEY "ON"	ENG. RUN
BLK/ WHT	D1	ECM GROUND	0	0
PPL	D2	MAP SENSOR GROUND	0	0
	D3	NOT USED		
WHT	D4	EST	0	1.3
TAN/ BLK	D5	BYPASS	0	4.75
TAN	D6	0_2 SENSOR GROUND	0	0
PPL	D7	0_2 SENSOR SIGNAL	.3 - .5	.1 - .9 ③
	D8	NOT USED		
	D9	NOT USED		
	D10	NOT USED		
	D11	NOT USED		
	D12	NOT USED		
	D13	NOT USED		
DK GRN	D14	INJECTOR 2 DRIVER	B+	B+
DK BLU	D15	INJECTOR 1 DRIVER	B+	B+
DK BLU	D16	INJECTOR 1 DRIVER	B+	B+

1 Varies from .60 to battery voltage, depending on position of drive wheels.
2 12 volts for first two seconds.
3 Varies.
4 12 volts when fuel pump is running.
5 Varies with temperature.
6 Reads battery voltage in gear.
7 12 volts, when engine is cranking.
* Less than .5 volt.

ENGINE 5.0 L

12-21-89
8S 4588-6E

Figure A-5 - ECM Connector Terminal End View 5.0L (VIN E) "F" Carline

BLANK

DIAGNOSTIC CIRCUIT CHECK

The Diagnostic Circuit Check is an organized approach to identifying a problem created by an electronic engine control system malfunction. It must be the starting point for any driveability complaint diagnosis, because it directs the service technician to the next logical step in diagnosing the complaint.

The "Scan Data" listed in the table may be used for comparison, after completing the diagnostic circuit check and finding the on-board diagnostics functioning properly and no trouble codes displayed. The "Typical Values" are an average of display values recorded from normally operating vehicles and are intended to represent what a normally functioning system would typically display.

A "SCAN" TOOL THAT DISPLAYS FAULTY DATA SHOULD NOT BE USED, AND THE PROBLEM SHOULD BE REPORTED TO THE MANUFACTURER. THE USE OF A FAULTY "SCAN" CAN RESULT IN MISDIAGNOSIS AND UNNECESSARY PARTS REPLACEMENT.

Only the parameters listed below are used in this manual for diagnosis. If a "Scan" tool reads other parameters, the values are not recommended by General Motors for use in diagnosis. For more description on the values and use of the "Scan" to diagnosis ECM inputs, refer to the applicable diagnosis section in "Component Systems," Section "6E2-C". If all values are within the range illustrated, refer to "Symptoms," Section "6E2-B".

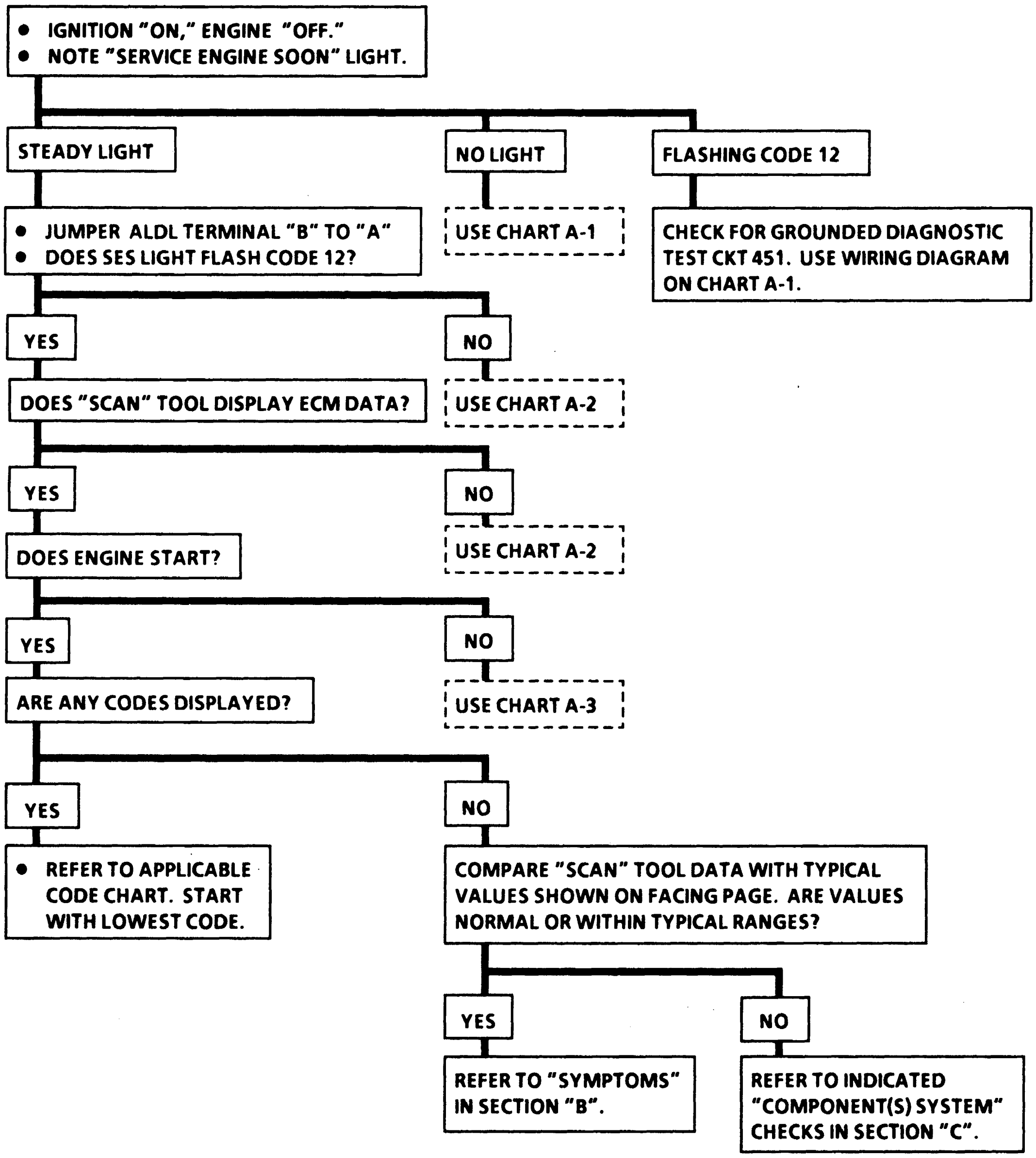
"SCAN" DATA

Idle / Upper Radiator Hose Hot / Closed Throttle / Park or Neutral / Closed Loop / Acc. off

"SCAN" Position	Units Displayed	Typical Data Value
Coolant Temp	C°/F°	85° - 105° C/185° - 221°F
Mani Air Temp	C°/F°	10° - 90°C/50° - 194°F (Depends on air cleaner temperature).
MAP	kpa/Volts	35/.6 - 2 (Depends on Vacuum & Barometric pressure)
Throt Position	Volts	.45 - 1.25
Oxygen Sensor	Volts	.001 - 999 and varies
Open/Closed Loop	Open/Closed	Closed Loop (may go open with extended idle)
Engine Speed	RPM	650 ± 100 RPM (550 ± 50 in drive)
Knock Signal	Yes/No	No
Fuel Integrator	Counts	Varies
Block Learn	Counts	118 - 138
Idle Air Control	Counts (steps)	1 - 50
Park/Neutral	P/N and RDL	Park/Neutral (P/N)
MPH KPH	MPH KPH	0
Torque Conv Cl	On/Off	Off/ (On, with TCC commanded)
Air Control Sol	Normal/Divert	Normal
Air Switch Sol	Converter/Port	Converter
4th Gear Switch	Yes/No	No (Yes, if in 4th Gear)
Power Steering	Normal/Hi Pressure	Normal
A/C Clutch	Yes/No	No (Yes, with A/C requested)
Battery Voltage	Volts	13.5 - 14.5
Prom ID	0-9999	Varies

DIAGNOSTIC CIRCUIT CHECK

5.0L (VIN E) "F" CARLINE (TBI)



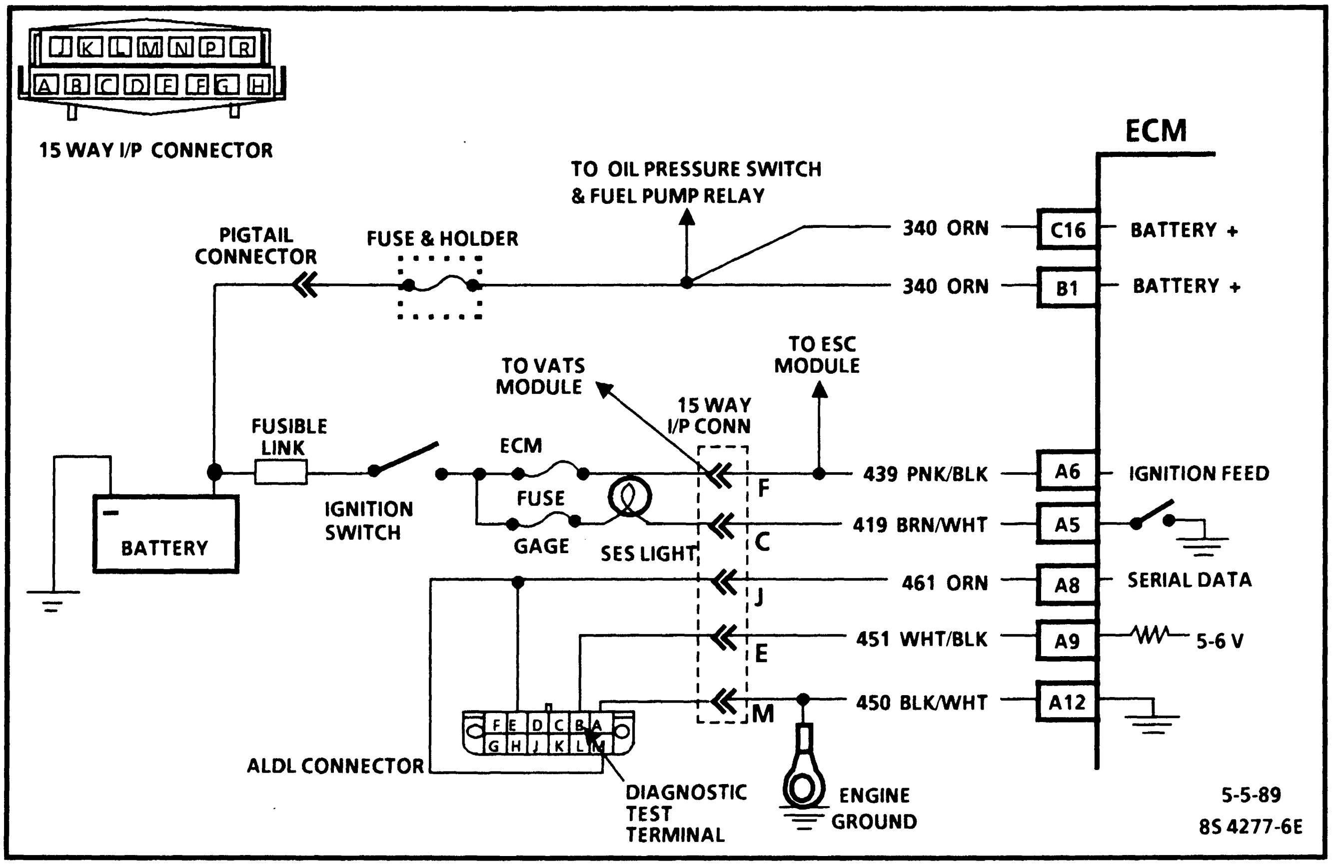


CHART A-1

NO "SERVICE ENGINE SOON" LIGHT
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

There should always be a steady "Service Engine Soon" light, when the ignition is "ON" and engine stopped. Ignition voltage is supplied directly to the light bulb. The Electronic Control Module (ECM) will control the light and turn it "ON" by providing a ground path through CKT 419 to the ECM.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Battery feed CKT 340 is protected by a 20 amp in-line fuse. If this fuse was blown, refer to wiring diagram on the facing page of Code 54.
2. Using a test light connected to 12 volts, probe each of the system ground circuits to be sure a good ground is present. Refer to the "ECM Connector Terminal End View" in front of this section for ECM pin locations of ground circuits.

Diagnostic Aids:

Engine runs OK, check:

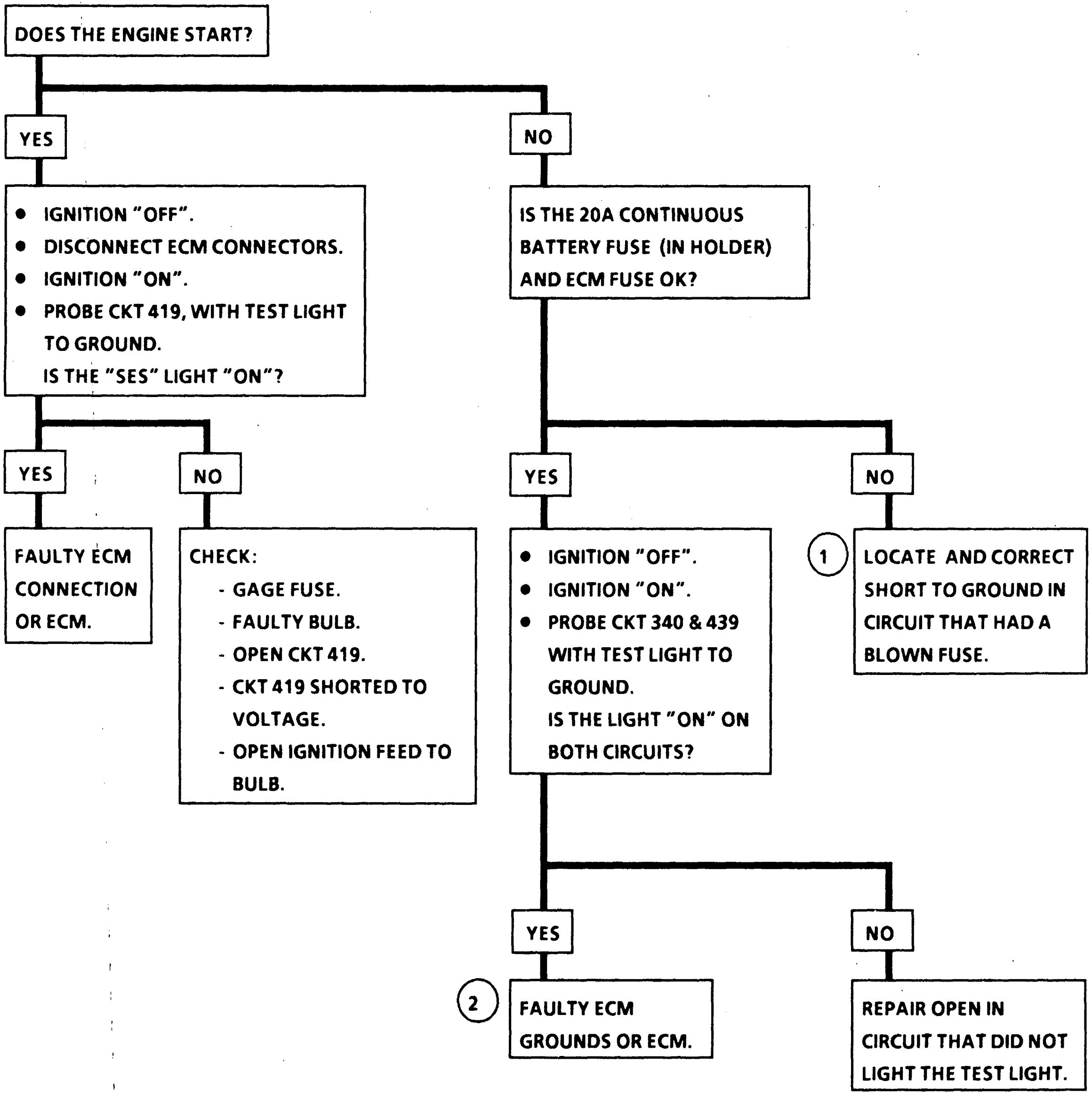
- Faulty light bulb
- CKT 419 open
- Gage fuse blown. This will result in no oil light, generator light, seat belt reminder, etc.

Engine cranks but will not run, check:

- Continuous battery - fuse or fusible link open.
- ECM/Ignition fuse open
- Battery CKT 340 to ECM open
- Ignition CKT 439 to ECM open
- Poor connection to ECM

CHART A-1

NO "SERVICE ENGINE SOON" LIGHT
5.0L (VIN E) "F" CARLINE (TBI)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

7-21-87
7S 3185-6E

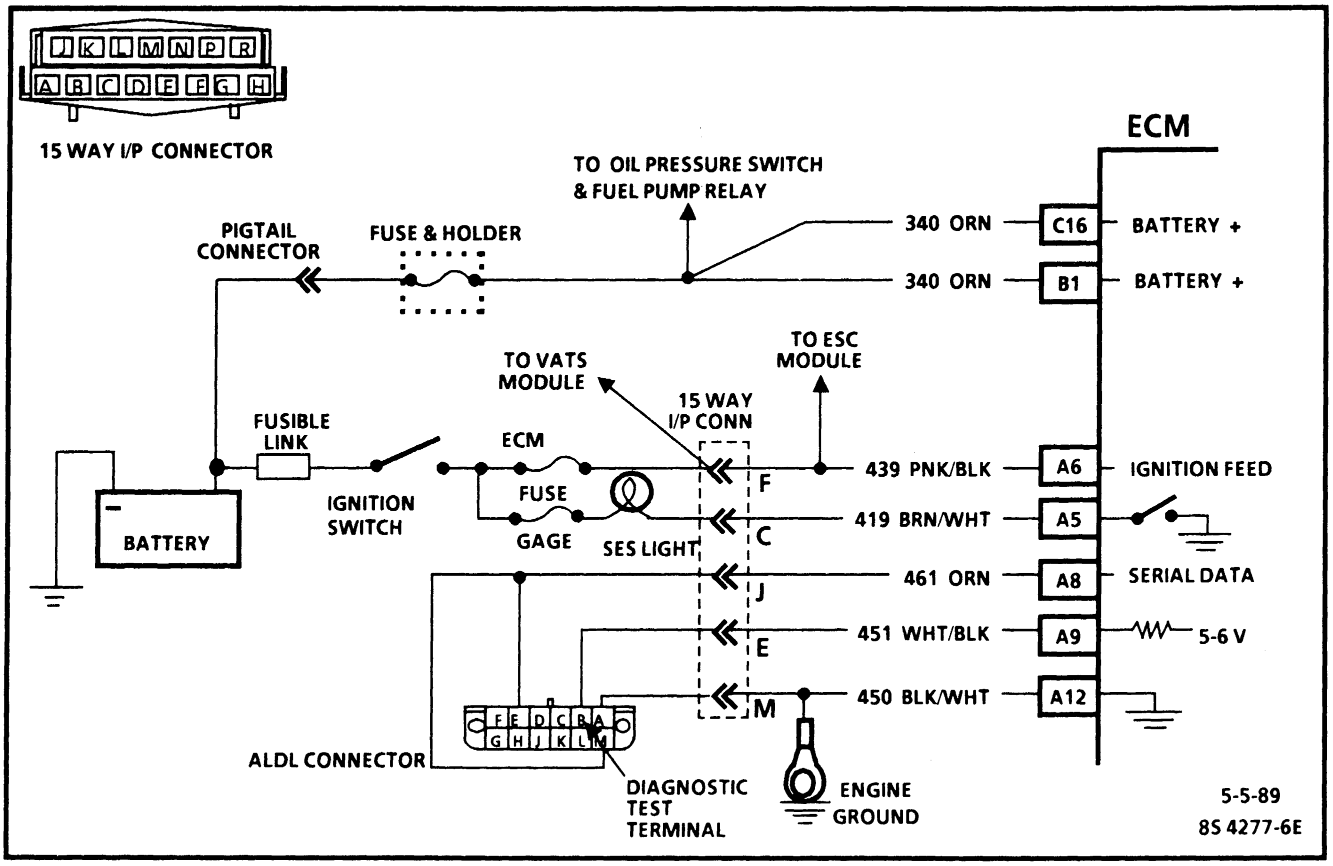


CHART A-2

NO ALDL DATA OR WILL NOT FLASH CODE 12
"SERVICE ENGINE SOON" LIGHT "ON" STEADY
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

There should always be a steady "Service Engine Soon" light, when the ignition is "ON" and engine stopped. Ignition voltage is supplied directly to the light bulb. The Electronic Control Module (ECM) will turn the light "ON" by grounding CKT 419 in the ECM.

With the diagnostic "test" terminal grounded the light should flash a Code 12, followed by any trouble code(s) stored in memory.

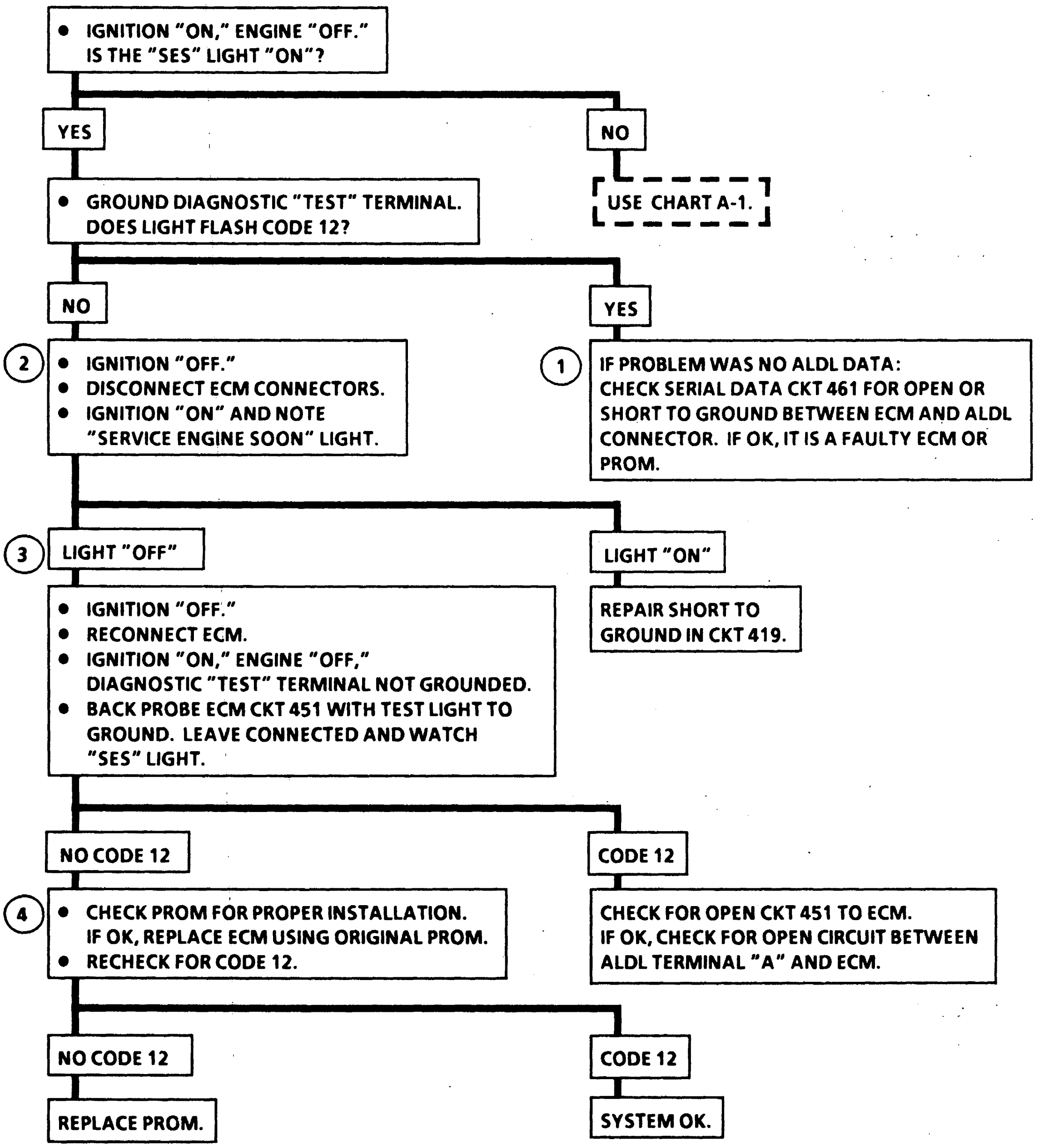
A steady light suggests a short to ground in the light control CKT 419, or an open in diagnostic CKT 451.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. If there is a problem with the ECM that causes a "Scan" tool to not read serial data, the ECM should not flash a Code 12. If Code 12 does flash, be sure that the "Scan" tool is working properly on another vehicle. If the "Scan" tool is functioning properly and CKT 461 is OK, the PROM or ECM may be at fault for the NO ALDL symptom.
2. If the "SES" light goes "OFF" when the ECM connector is disconnected, then CKT 419 is not shorted to ground.
3. This step will check for an open diagnostic CKT 451.
4. At this point, the "Service Engine Soon" light wiring is OK. The problem is a faulty ECM or PROM. If Code 12 does not flash, the ECM should be replaced using the original PROM. Replace the PROM only after trying an ECM, as a defective PROM is an unlikely cause of the problem.

CHART A-2

NO ALDL DATA OR WILL NOT FLASH CODE 12 "SERVICE ENGINE SOON" LIGHT "ON" STEADY
5.0L (VIN E) "F" CARLINE (TBI)



- IGNITION "ON," ENGINE "OFF." IS THE "SES" LIGHT "ON"?

USE CHART A-1.

- GROUND DIAGNOSTIC "TEST" TERMINAL. DOES LIGHT FLASH CODE 12?

① IF PROBLEM WAS NO ALDL DATA: CHECK SERIAL DATA CKT 461 FOR OPEN OR SHORT TO GROUND BETWEEN ECM AND ALDL CONNECTOR. IF OK, IT IS A FAULTY ECM OR PROM.

②
- IGNITION "OFF."
- DISCONNECT ECM CONNECTORS.
- IGNITION "ON" AND NOTE "SERVICE ENGINE SOON" LIGHT.

REPAIR SHORT TO GROUND IN CKT 419.

- IGNITION "OFF."
- RECONNECT ECM.
- IGNITION "ON," ENGINE "OFF," DIAGNOSTIC "TEST" TERMINAL NOT GROUNDED.
- BACK PROBE ECM CKT 451 WITH TEST LIGHT TO GROUND. LEAVE CONNECTED AND WATCH "SES" LIGHT.

CHECK FOR OPEN CKT 451 TO ECM. IF OK, CHECK FOR OPEN CIRCUIT BETWEEN ALDL TERMINAL "A" AND ECM.

④
- CHECK PROM FOR PROPER INSTALLATION. IF OK, REPLACE ECM USING ORIGINAL PROM.
- RECHECK FOR CODE 12.

REPLACE PROM.

SYSTEM OK.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

5-13-89
7S 3341-6E

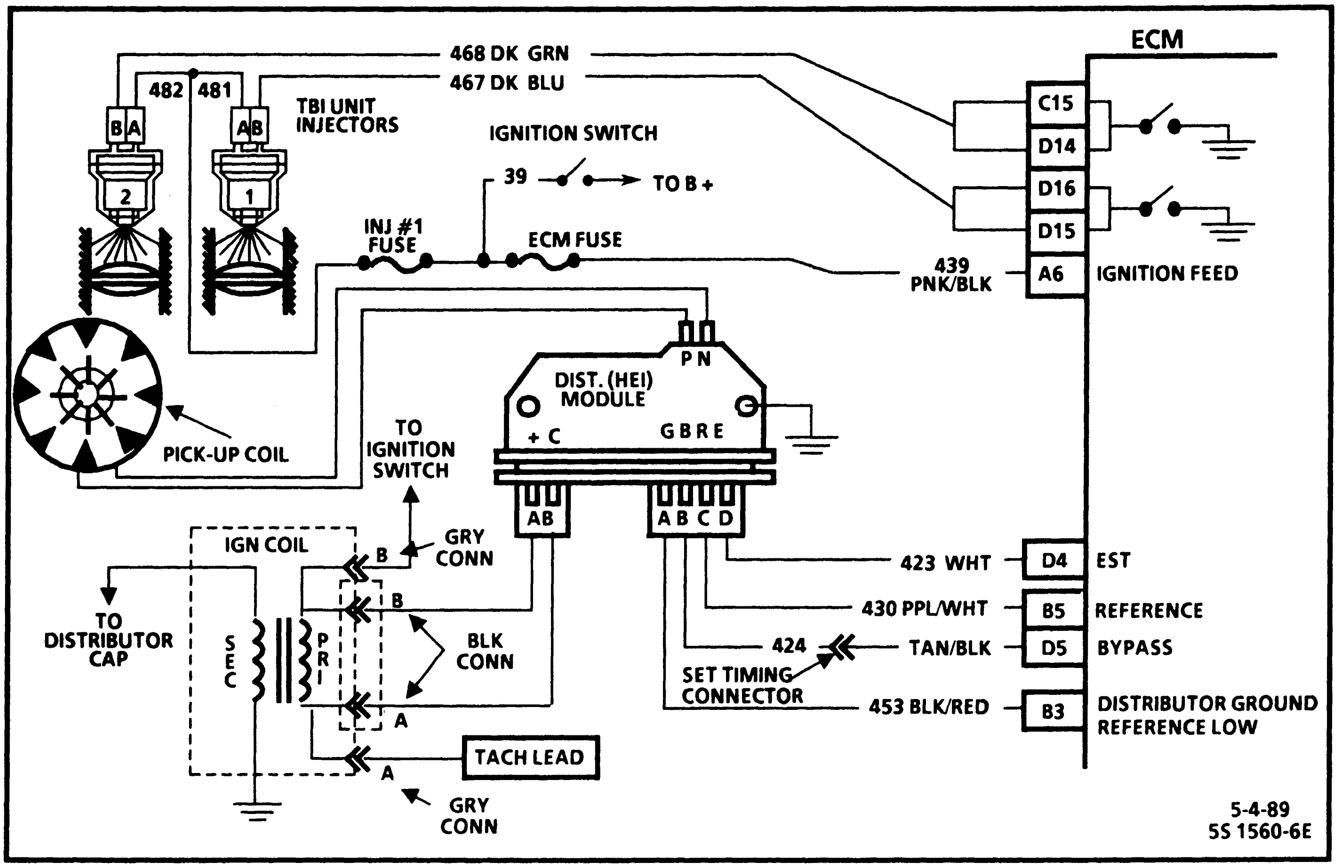


CHART A-3

(Page 1 of 2)

ENGINE CRANKS BUT WILL NOT RUN 5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

This chart assumes that battery condition and engine cranking speed are OK, and there is adequate fuel in the tank.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. A "Service Engine Soon" light "ON" is a basic test to determine if there is a 12 volt supply and ignition 12 volts to ECM. No ALDL may be due to an ECM problem and CHART A-2 will diagnose the ECM. If TPS is over 2.5 volts, the engine may be in the clear flood mode, which will cause starting problems.
2. No spark may be caused by one of several components related to the Ignition/EST System. CHART C-4 will address all problems related to the causes of a no spark condition.
3. Fuel spray from the injector(s) indicates that fuel is available. However, the engine could be severely flooded due to too much fuel.
4. While cranking engine, there should be no fuel spray with injector disconnected. Replace an injector if it sprays fuel or drips like a leaking water faucet.
5. The fuel pressure will drop after the fuel pump stops running due to a controlled bleed in the fuel system. Use of the fuel pressure gage will determine if fuel system pressure is enough for the engine to start and run. The key may have to be cycled, "ON" and "OFF," 2 or more times for an accurate reading.
6. No fuel spray from injector indicates a faulty fuel system or no ECM control of injector.
7. This test will determine if the ignition module is not generating the reference pulse, or if the wiring or ECM is at fault. By touching and removing a test light to 12 volts on CKT 430, a reference pulse should be generated. If injector test light blinks, the ECM and wiring are OK.

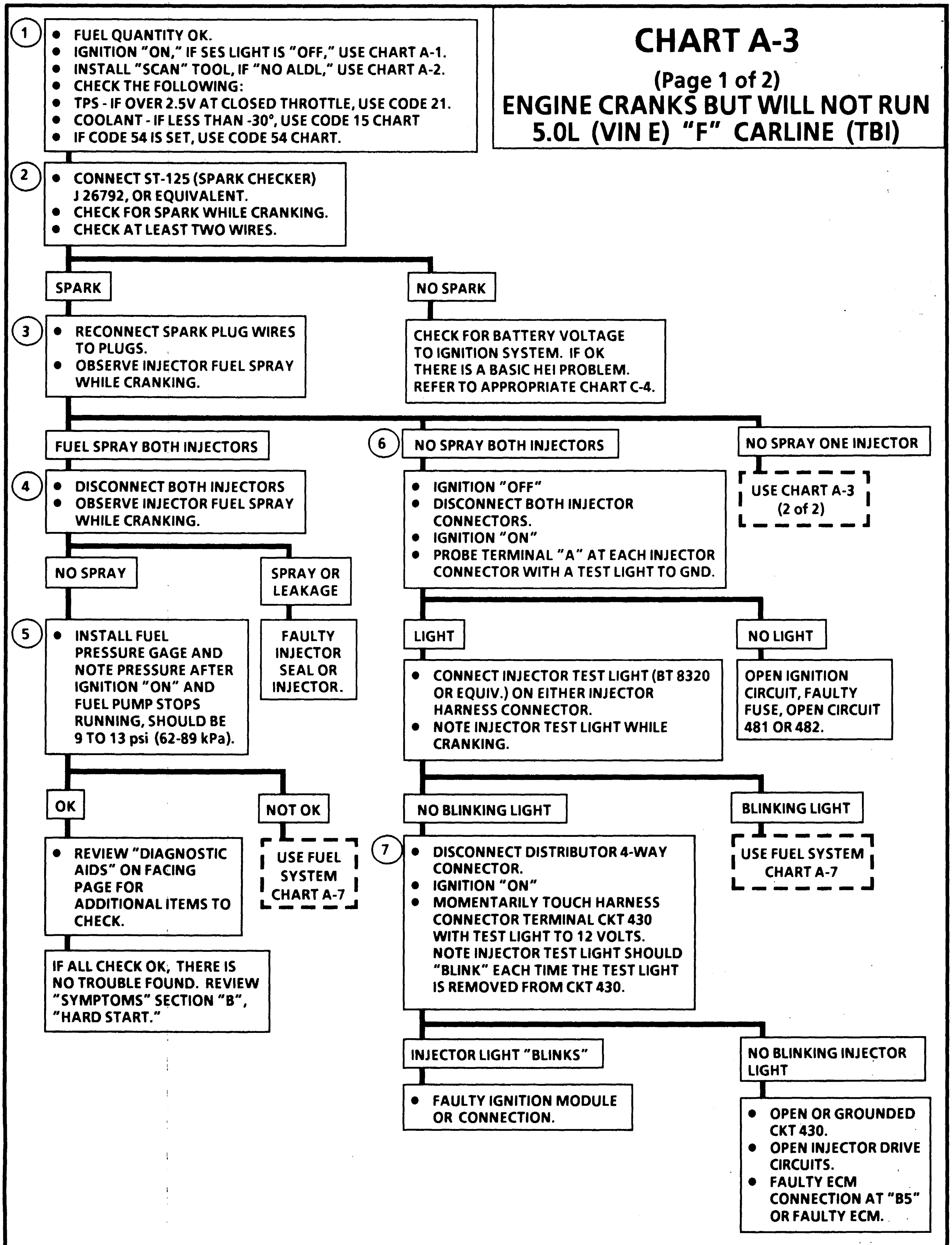
Diagnostic Aids:

- Water or foreign material in the fuel system can cause a no start during freezing weather.
- An EGR valve sticking open can cause a low air/fuel ratio during cranking.
- Fuel pressure: Low fuel pressure can result in a very lean air/fuel ratio. See CHART A-7.
- A grounded CKT 423 (EST) may cause a "No-Start" or a "Start then Stall" condition.

CHART A-3

(Page 1 of 2)

ENGINE CRANKS BUT WILL NOT RUN 5.0L (VIN E) "F" CARLINE (TBI)



5-13-89

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

5S 1559-6E

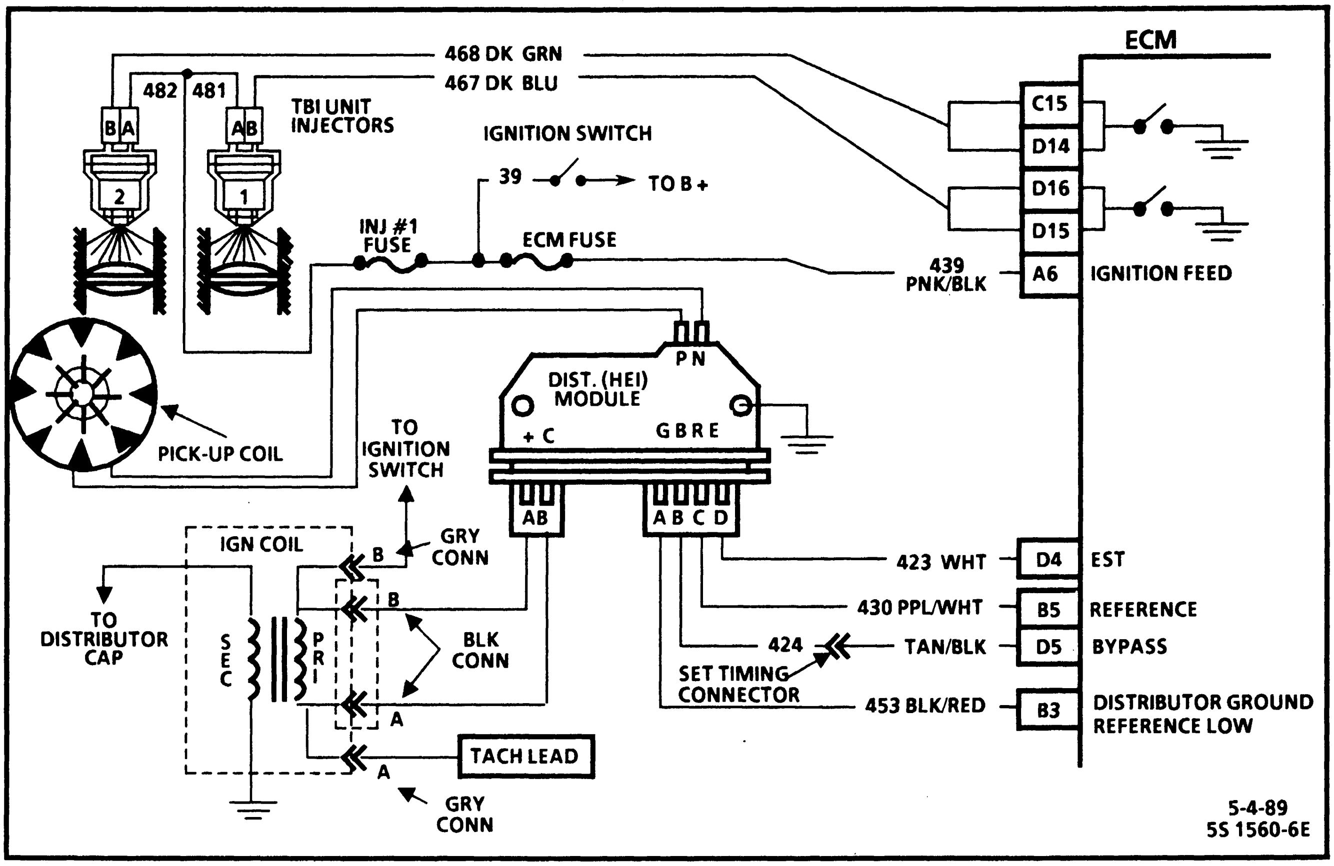


CHART A-3

(Page 2 of 2)

ENGINE CRANKS BUT WILL NOT RUN 5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

This chart assumes that battery condition and engine cranking speed are OK, and there is adequate fuel in the tank.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

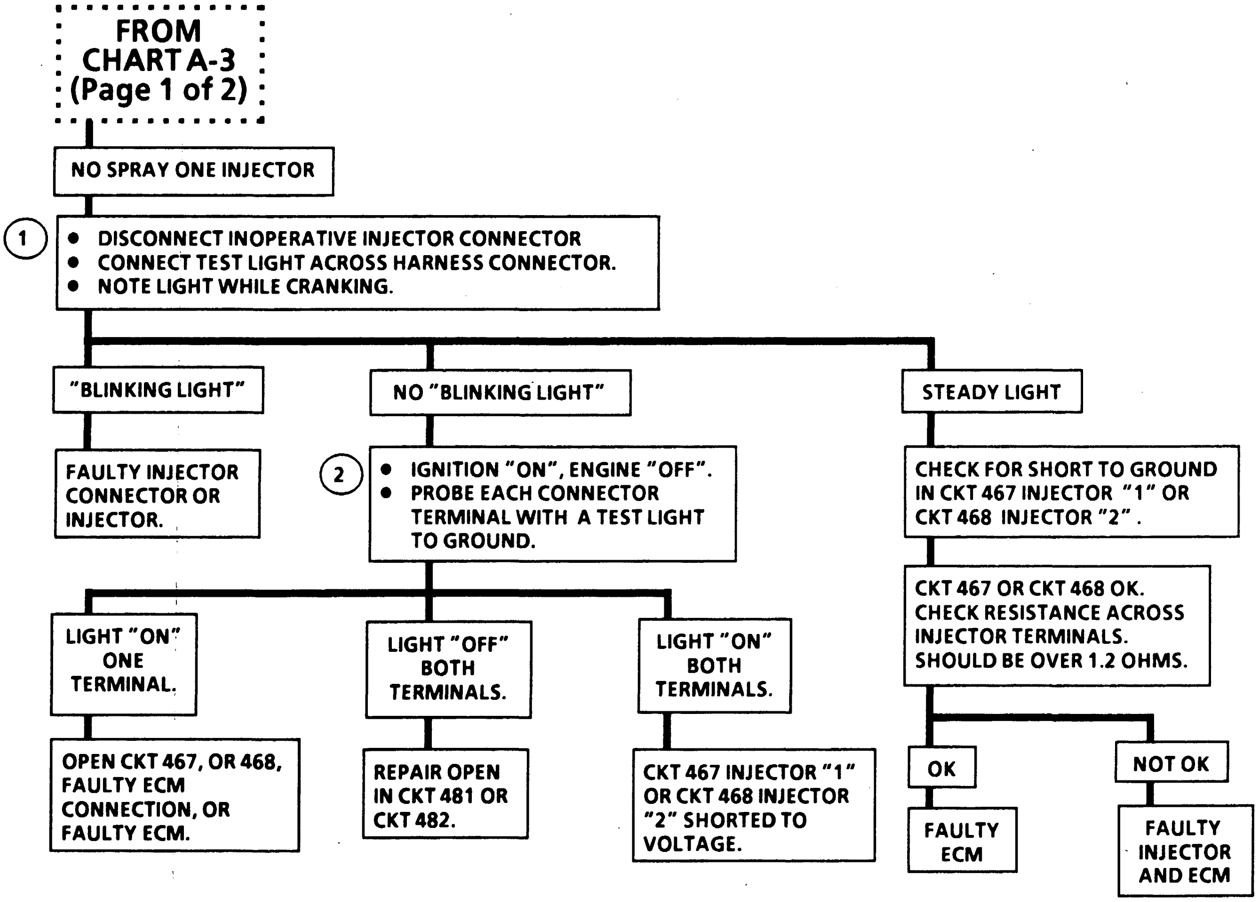
1. No fuel spray from one injector indicates a faulty fuel injector or no ECM control of injector. If the test light "blinks" while cranking, then ECM control should be considered OK. Be sure test light makes good contact between connector terminals during test. The light may be a little dim when "blinking." This is due to current draw of the test light. How bright it "blinks" is not important. However, the test light should be a BT 8320 or equivalent.
2. CKT 481 and CKT 482 supply ignition voltage to the injectors. Probe each connector terminal with a test light to ground. There should be a light "ON" at one terminal on each connector. If the test light confirms ignition voltage at the connector, the ECM injector control CKT 467 or CKT 468 may be open. Reconnect the injector. Using a test light connected to ground, check for a light at the applicable ECM connector terminal. A light at this point indicates that the injector drive circuit involved is OK.

   If an ECM repeat failure has occurred, the injector is shorted. Replace the injector and ECM.

CHART A-3

(Page 2 of 2)

ENGINE CRANKS BUT WILL NOT RUN 5.0L (VIN E) "F" CARLINE (TBI)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

5-31-88
* 5S 1561-6E

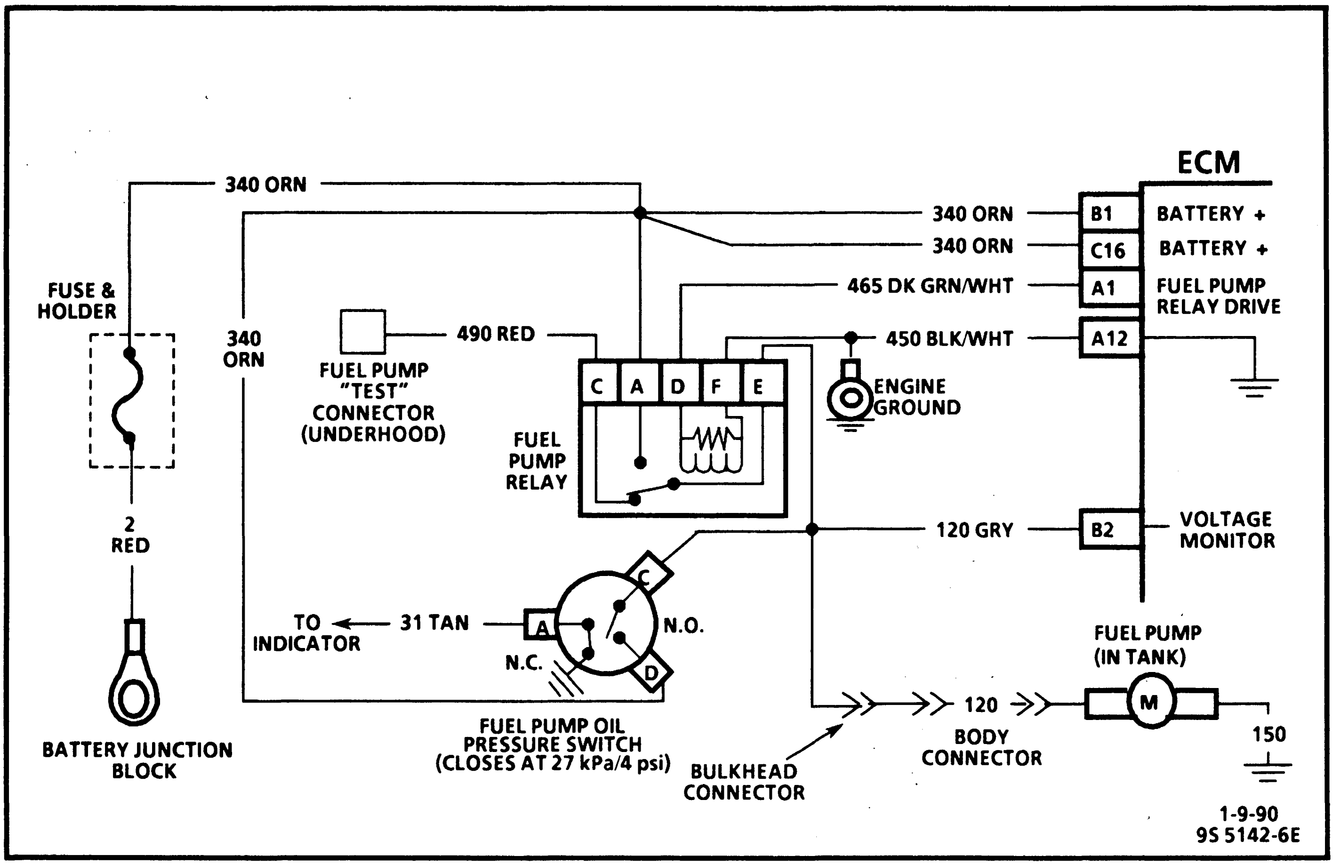


CHART A-7

(Page 1 of 2)

FUEL SYSTEM DIAGNOSIS

5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

When the ignition switch is turned "ON," the Electronic Control Module (ECM) will turn "ON" the in-tank fuel pump. It will remain "ON" as long as the engine is cranking or running, and the ECM is receiving ignition reference pulses. If there are no reference pulses, the ECM will shut "OFF" the fuel pump within 2 seconds after key "ON."

The pump will deliver fuel to the TBI unit where the system pressure is controlled from 62 to 90 kPa (9 to 13 psi). Excess fuel is then returned to the fuel tank.

When the engine is stopped, the fuel pump can be turned "ON" by applying battery voltage to the fuel pump "test" terminal, located on passenger side of the engine compartment.

Test Description: Numbers below refer to circled numbers on the diagnostic chart

1. Fuel pressure should be noted while fuel pump is running. Fuel pressure will drop immediately after fuel pump stops running due to a controlled bleed in the fuel system.
   The fuel pump "test" terminal is located on the passenger side of the engine compartment.

Diagnostic Aids:

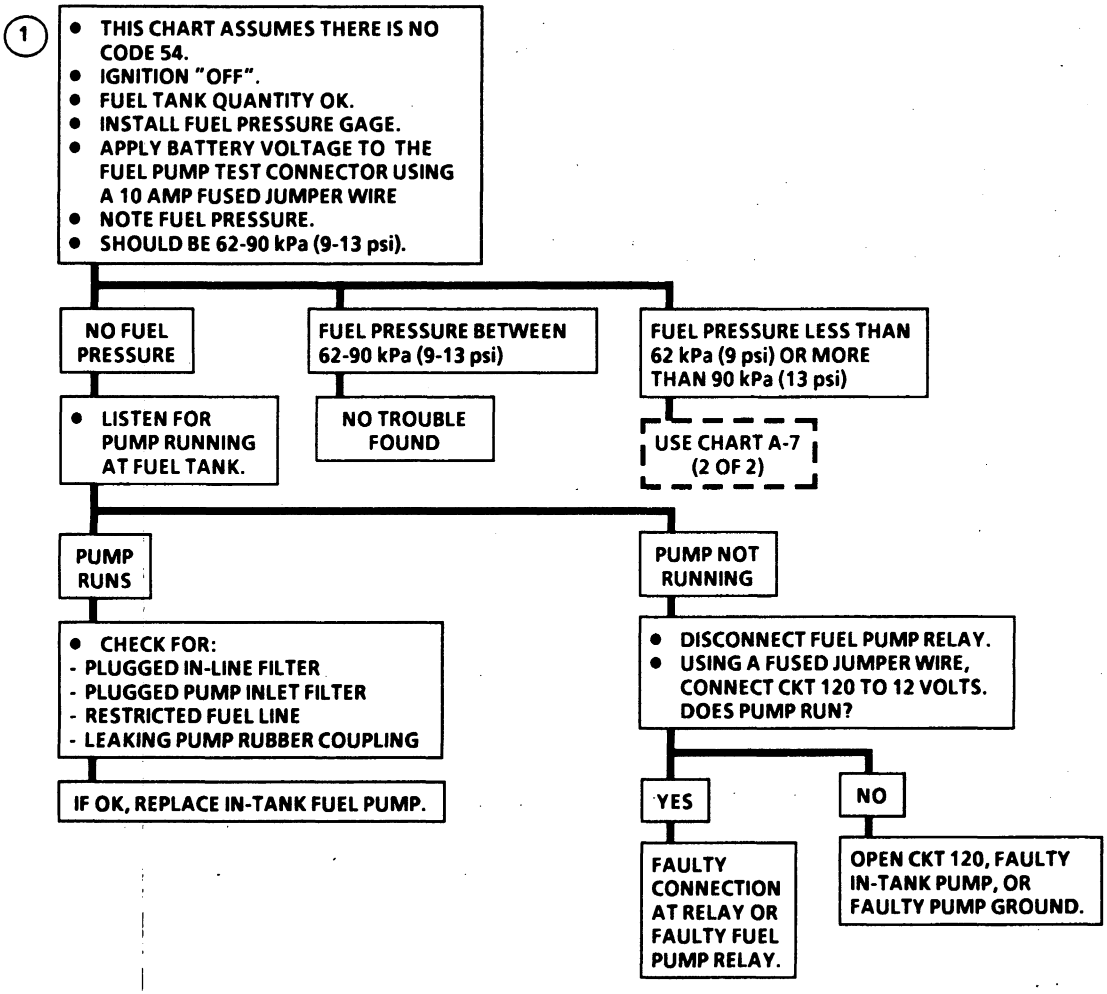
Improper fuel system pressure can result in one of the following symptoms:

- Extended cranking time before the engine starts
- Rough idle
- Low idle speed
- Cranks, but will not run
- Code 44
- Code 45
- Cuts out, may feel like ignition problem
- Poor fuel economy, loss of power
- Hesitation

CHART A-7

(Page 1 of 2)

FUEL SYSTEM DIAGNOSIS 5.0L (VIN E) "F" CARLINE (TBI)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

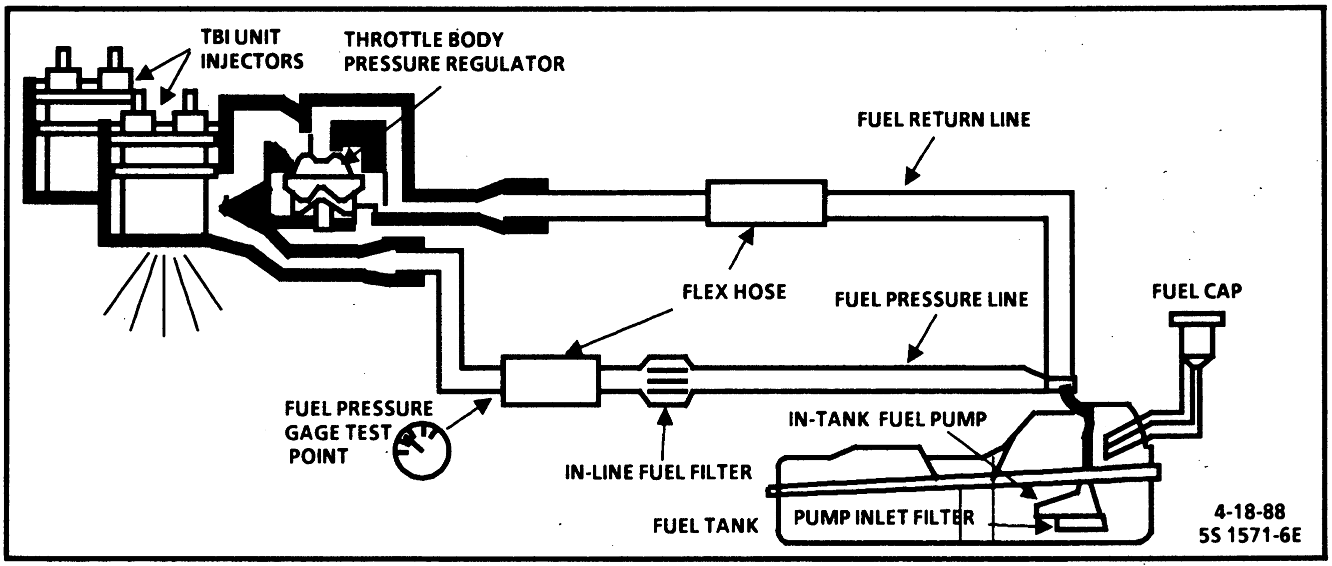


CHART A-7

(Page 2 of 2)

FUEL SYSTEM DIAGNOSIS
5.0L (VIN E) "F" CARLINE (TBI)

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

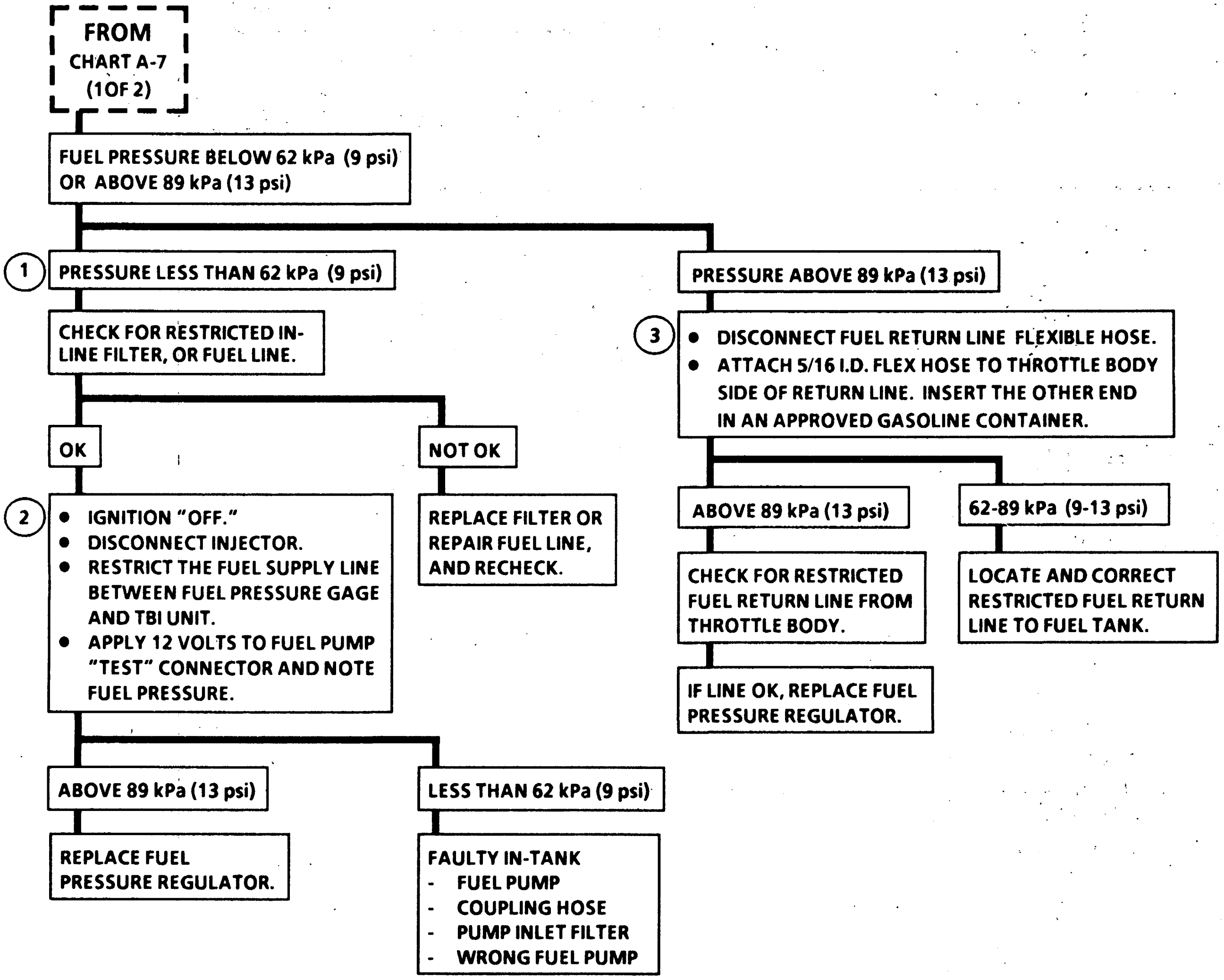
1. Fuel pressure less than 62 kPa (9 psi) falls into two areas:
   - Amount of fuel to injectors OK but, pressure is too low. System will be lean and may set Code 44. Also, hard starting cold and poor overall performance.
   - Restricted flow causing pressure drop. Normally, a vehicle with a fuel pressure of less than 62 kPa (9 psi) at idle, will not be driveable. However, if the pressure drop occurs only while driving, the engine will surge then stop as pressure begins to drop rapidly.
2. Restricting the fuel supply line between the gage and TBI unit and turning the fuel pump "ON" will determine if the fuel pump can supply enough fuel pressure at the injector to operate properly, above 62 kPa (9 psi).

NOTICE: Do not restrict the fuel return line as this may damage the fuel pressure regulator.

3. This test determines if the high fuel pressure is due to a restricted fuel return line or a throttle body pressure regulator problem.

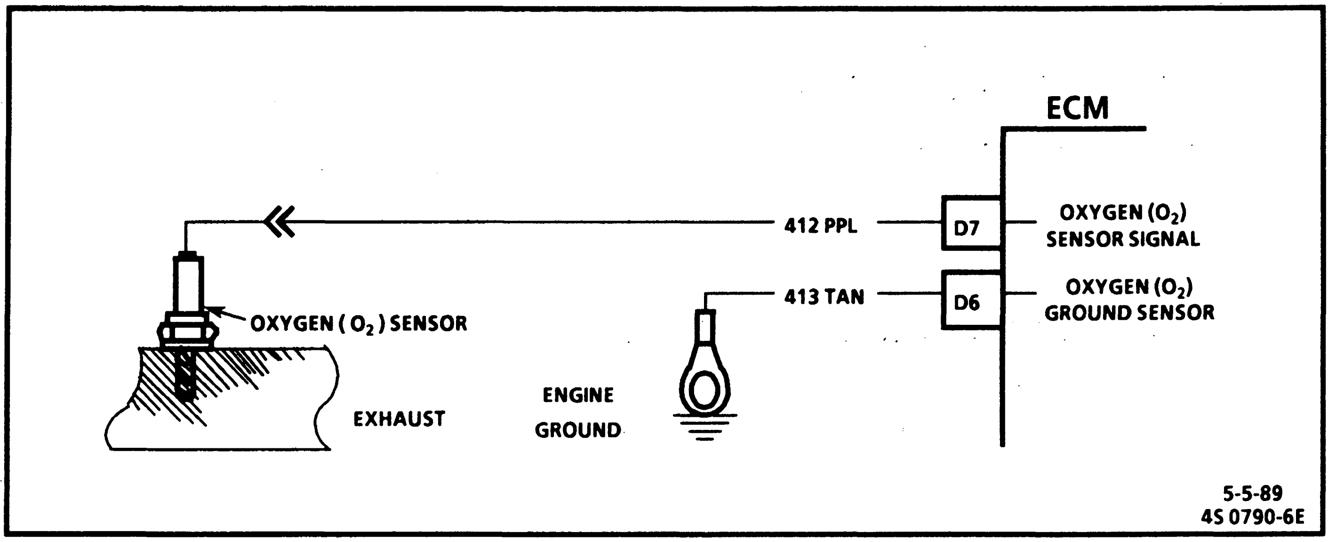
CHART A-7

(Page 2 of 2)
FUEL SYSTEM DIAGNOSIS
5.0L (VIN E) "F" CARLINE (TBI)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

6-11-89
5S 1572-6E



CODE 13

OXYGEN SENSOR CIRCUIT
(OPEN CIRCUIT)
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

The ECM supplies a voltage of about .45 volt between terminals "D7" and "D6". (If measured with a 10 megaohm digital voltmeter, this may read as low as .32 volt). The Oxygen (O_2) sensor varies the voltage within a range of about 1 volt if the exhaust is rich, down through about .10 volt if the exhaust is lean.

The sensor is like an open circuit and produces no voltage when it is below 360°C (600°F). An open sensor circuit or cold sensor causes "Open Loop" operation.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 13 will set:
   - Engine at normal operating temperature.
   - At least 2 minutes engine time after start.
   - O_2 signal voltage steady between .35 and .55 volt.
   - Rpm above 1600.
   - Throttle position sensor signal above 5% (about .3 volt above closed throttle voltage).
   - All conditions must be met for about 60 seconds.

     If the conditions for a Code 13 exist, the system will not go "Closed Loop."
2. This will determine if the sensor is at fault or the wiring or ECM is the cause of the Code 13.
3. To perform this test, use only a high impedance digital volt ohmmeter. This test checks the continuity of CKT 412 and CKT 413. If CKT 413 is open, the ECM voltage on CKT 412 will be over .60 volt (600 mv).

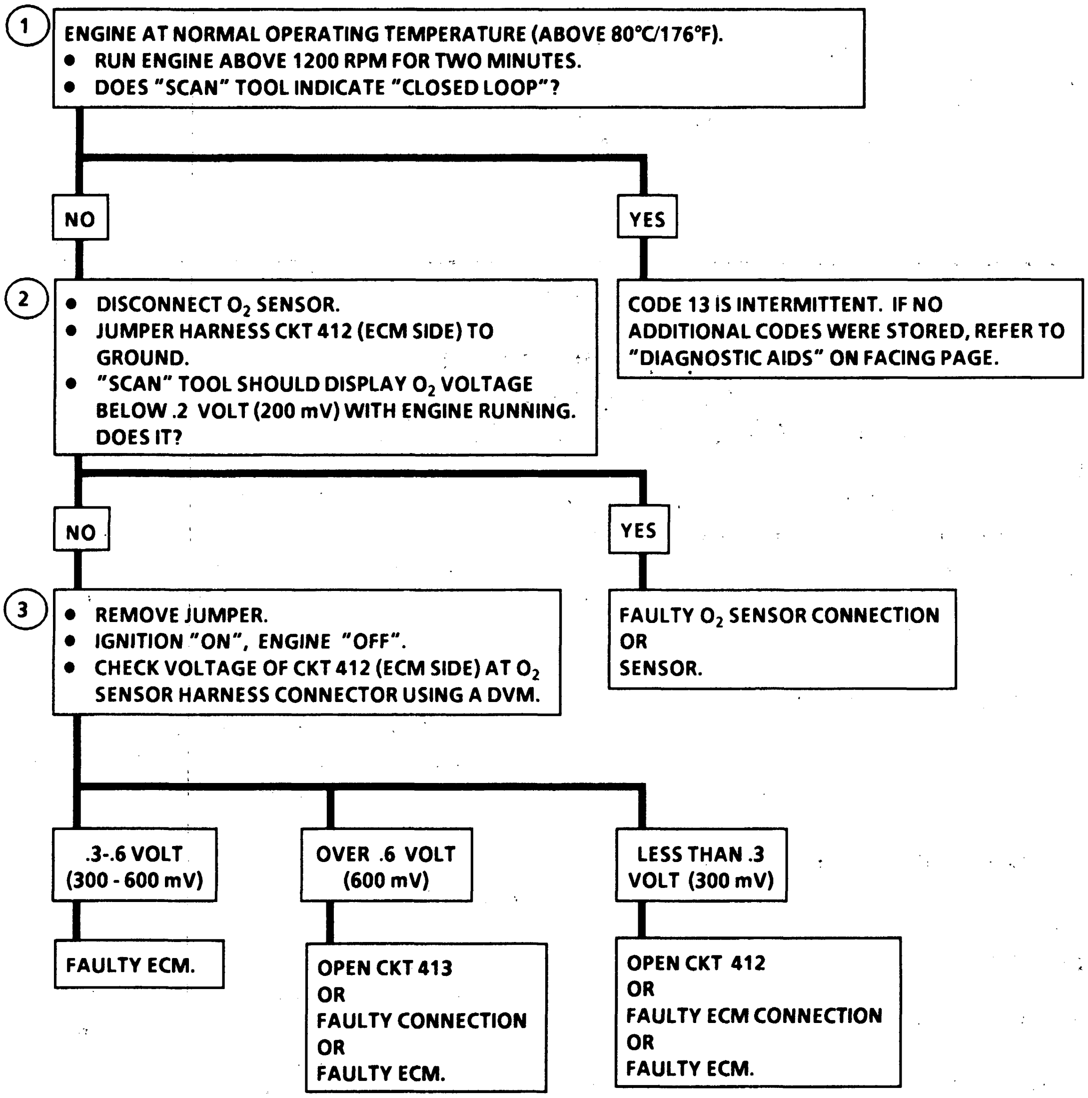
Diagnostic Aids:

Normal "Scan" tool voltage reading varies between 100 mv to 999 mv (.1 and 1.0 volt), while in "Closed Loop." Code 13 sets in one minute if voltage remains between .35 and .55 volt, the system will go "Open Loop" in about 15 seconds.

Refer to "Intermittents" in "Symptoms," Section "6E2-B".

CODE 13

OXYGEN SENSOR CIRCUIT
(OPEN CIRCUIT)
5.0L (VIN E) "F" CARLINE (TBI)



① ENGINE AT NORMAL OPERATING TEMPERATURE (ABOVE 80°C/176°F).
- RUN ENGINE ABOVE 1200 RPM FOR TWO MINUTES.
- DOES "SCAN" TOOL INDICATE "CLOSED LOOP"?

NO

②
- DISCONNECT O_2 SENSOR.
- JUMPER HARNESS CKT 412 (ECM SIDE) TO GROUND.
- "SCAN" TOOL SHOULD DISPLAY O_2 VOLTAGE BELOW .2 VOLT (200 mV) WITH ENGINE RUNNING. DOES IT?

YES

CODE 13 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

NO

③
- REMOVE JUMPER.
- IGNITION "ON", ENGINE "OFF".
- CHECK VOLTAGE OF CKT 412 (ECM SIDE) AT O_2 SENSOR HARNESS CONNECTOR USING A DVM.

YES

FAULTY O_2 SENSOR CONNECTION
OR
SENSOR.

.3-.6 VOLT (300 - 600 mV)

FAULTY ECM.

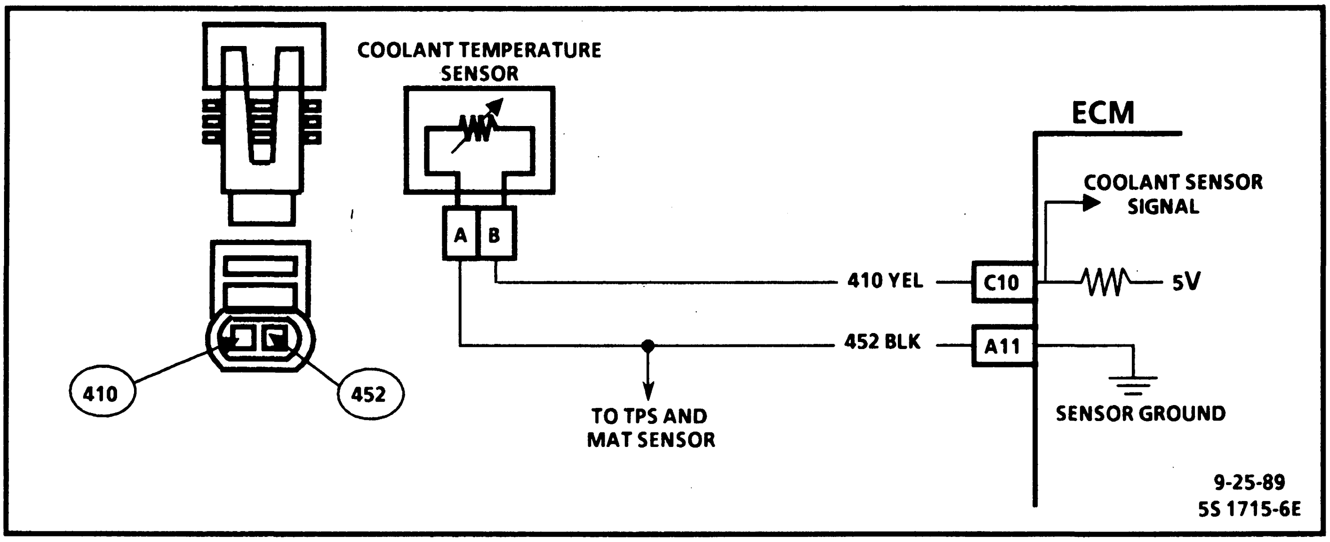
OVER .6 VOLT (600 mV)

OPEN CKT 413
OR
FAULTY CONNECTION
OR
FAULTY ECM.

LESS THAN .3 VOLT (300 mV)

OPEN CKT 412
OR
FAULTY ECM CONNECTION
OR
FAULTY ECM.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.



CODE 14

COOLANT TEMPERATURE SENSOR (CTS) CIRCUIT
(HIGH TEMPERATURE INDICATED)
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

The Coolant Temperature Sensor (CTS) uses a thermistor to control the signal voltage at the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine coolant is cold the sensor (thermistor) resistance is high, therefore the ECM will see high signal voltage.

As the engine coolant warms, the sensor resistance becomes less, and the voltage drops. At normal engine operating temperature (85°C-95°C or 185°F-203°F) the coolant sensor signal voltage will be about 1.5 to 2.0 volts.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 14 will set if:
   - Signal voltage indicates a coolant temperature above 135°C (275°F) for 2 seconds.
2. This test will determine if CKT 410 is shorted to ground which will cause the conditions for Code 14.

Diagnostic Aids:

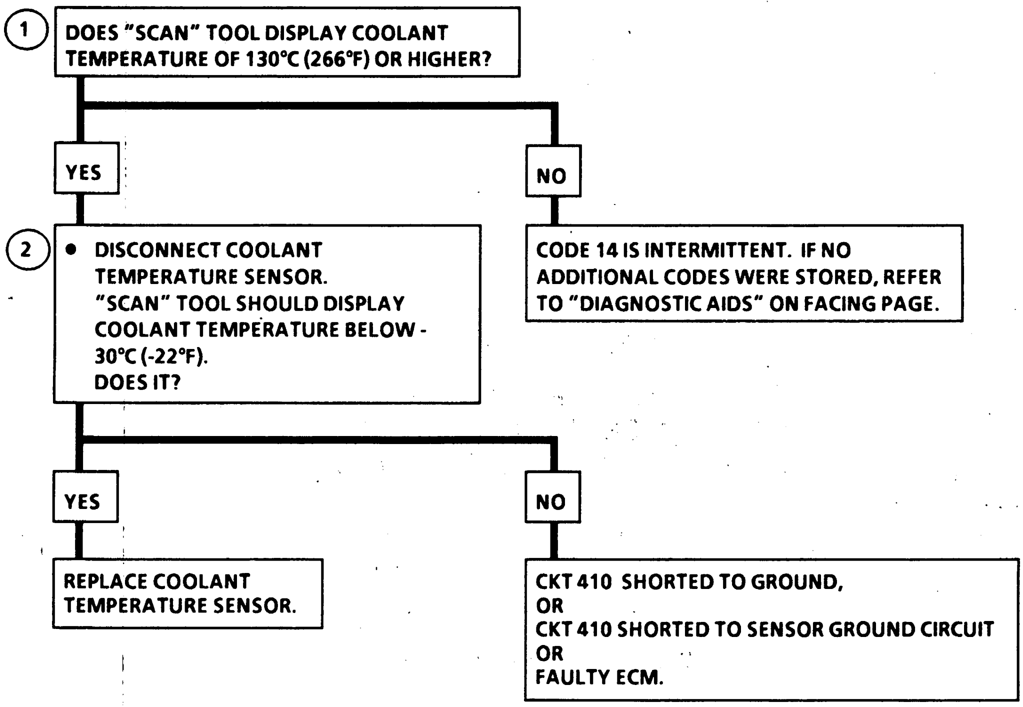
Check harness routing for a potential short to ground in CKT 410.

"Scan" tool displays engine temperature in degrees centigrade. After engine is started, the temperature should rise steadily to about 90°C (194°F) then stabilize when the thermostat opens.

Refer to "Intermittents" in "Symptoms," Section "B".

CODE 14

COOLANT TEMPERATURE SENSOR (CTS) CIRCUIT
(HIGH TEMPERATURE INDICATED)
5.0L (VIN E) "F" CARLINE (TBI)



① DOES "SCAN" TOOL DISPLAY COOLANT TEMPERATURE OF 130°C (266°F) OR HIGHER?

YES

② • DISCONNECT COOLANT TEMPERATURE SENSOR.
"SCAN" TOOL SHOULD DISPLAY COOLANT TEMPERATURE BELOW - 30°C (-22°F).
DOES IT?

YES

REPLACE COOLANT TEMPERATURE SENSOR.

NO

CKT 410 SHORTED TO GROUND,
OR
CKT 410 SHORTED TO SENSOR GROUND CIRCUIT
OR
FAULTY ECM.

NO

CODE 14 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

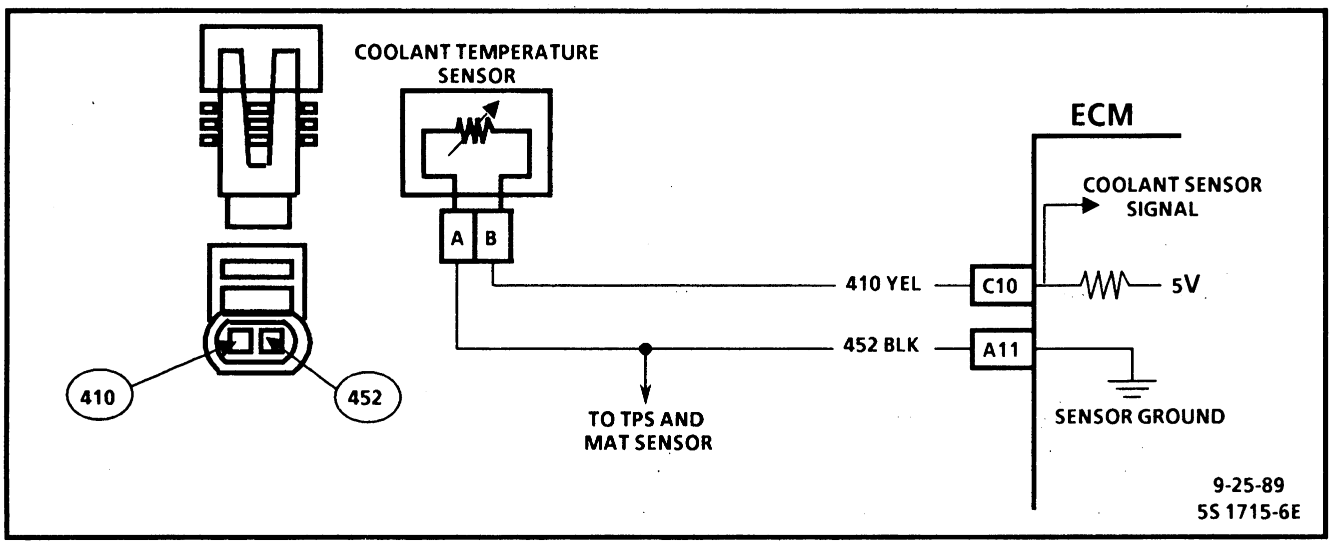
DIAGNOSTIC

COOLANT SENSOR

TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)

°C	°F	OHMS
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

AFTER REPAIRS CLEAR CODES, RUN ENGINE 5 MINUTES, AND RECHECK FOR



CODE 15

COOLANT TEMPERATURE SENSOR (CTS) CIRCUIT
(LOW TEMPERATURE INDICATED)
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

The Coolant Temperature Sensor (CTS) uses a thermistor to control the signal voltage at the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see high signal voltage.

As the engine coolant warms, the sensor resistance becomes less, and the voltage drops. At normal engine operating temperature (85°C-95°C/185°F-203°F) the CTS signal voltage will be about 1.5 to 2.0 volts at the ECM.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 15 will set if:
   - Engine running longer than 30 seconds
   - Engine coolant temperature less than -30°C (-22°F), for 3 seconds
2. This test simulates a Code 14. If the ECM recognizes the low signal voltage, (high temperature) and the "Scan" tool reads 130°C (266°F) or above, the ECM and wiring are OK.
3. This test will determine if CKT 410 is open. There should be 5 volts present at sensor connector if measured with a DVM.

Diagnostic Aids:

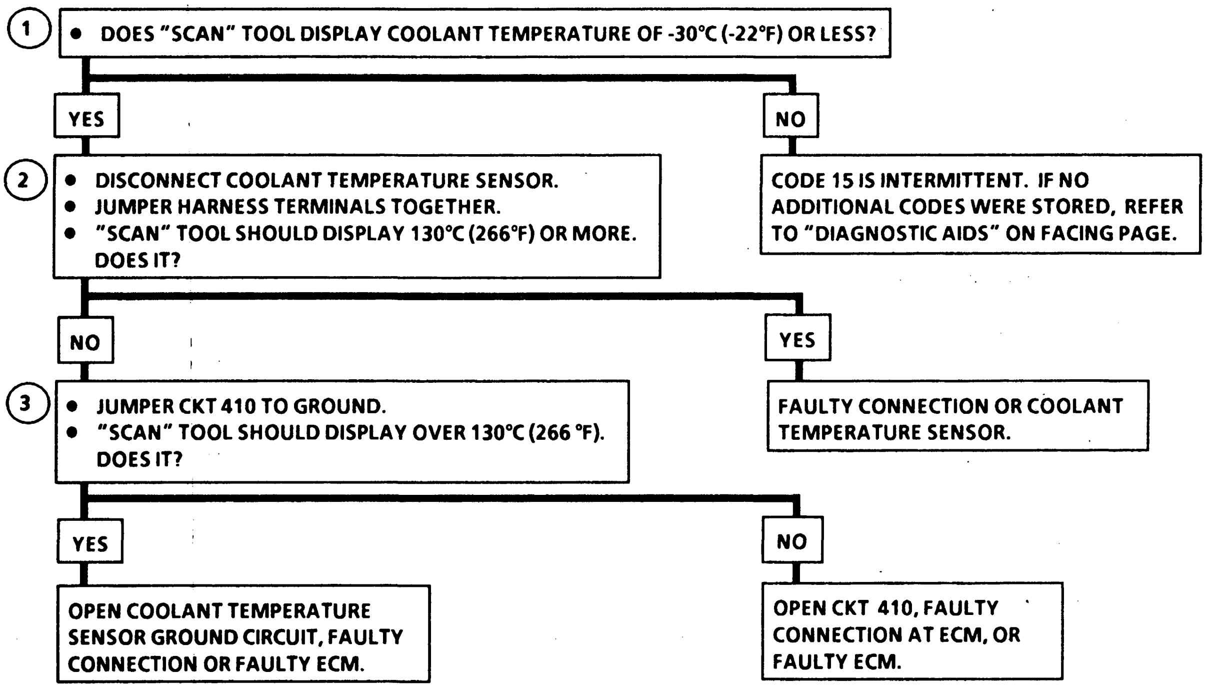
A "Scan" tool reads engine coolant temperature in degrees centigrade. After engine is started the temperature should rise steadily to about 90°C (194°F) then stabilize when the thermostat opens.

If Code 21 is also set, check CKT 452 for faulty wiring or connections. Check terminals at sensor for good contact.

Refer to "Intermittents" in "Symptoms," Section "B".

CODE 15

COOLANT TEMPERATURE SENSOR (CTS) CIRCUIT
(LOW TEMPERATURE INDICATED)
5.0L (VIN E) "F" CARLINE (TBI)



① • DOES "SCAN" TOOL DISPLAY COOLANT TEMPERATURE OF -30°C (-22°F) OR LESS?

YES:

② • DISCONNECT COOLANT TEMPERATURE SENSOR.
• JUMPER HARNESS TERMINALS TOGETHER.
• "SCAN" TOOL SHOULD DISPLAY 130°C (266°F) OR MORE. DOES IT?

NO:

CODE 15 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

② NO:

③ • JUMPER CKT 410 TO GROUND.
• "SCAN" TOOL SHOULD DISPLAY OVER 130°C (266 °F). DOES IT?

② YES:

FAULTY CONNECTION OR COOLANT TEMPERATURE SENSOR.

③ YES:

OPEN COOLANT TEMPERATURE SENSOR GROUND CIRCUIT, FAULTY CONNECTION OR FAULTY ECM.

③ NO:

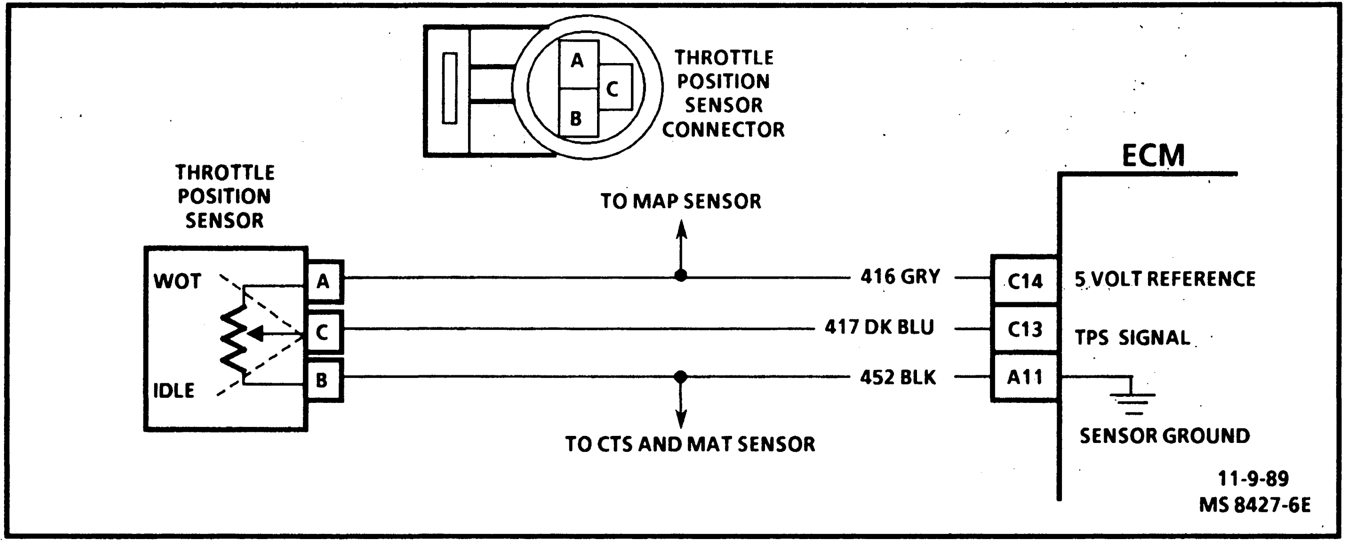
OPEN CKT 410, FAULTY CONNECTION AT ECM, OR FAULTY ECM.

DIAGNOSTIC

COOLANT SENSOR TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)		
°C	°F	OHMS
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

AFTER REPAIRS, CLEAR CODES, RUN ENGINE 5 MINUTES, AND RECHECK FOR

11-21-89
• 7S 3261-6E



CODE 21

THROTTLE POSITION SENSOR (TPS) CIRCUIT
(SIGNAL VOLTAGE HIGH)
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

The Throttle Position Sensor (TPS) provides a voltage signal that changes relative to the throttle blade. TPS signal voltage will vary from about .5 at idle to about 5 volts at Wide Open Throttle (WOT).

The TPS signal is one of the most important inputs used by the ECM for fuel control and for most of the ECM controlled outputs.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 21 will set if:
   - TPS signal voltage is greater than 2.5 volts.
   - All conditions met for 8 seconds.
   - MAP less than 52 kPa (or greater than 15" HG).
2. With the TPS sensor disconnected, the TPS signal voltage should go low if the ECM and wiring are OK.
3. Probing CKT 452 with a test light to 12 volts checks the sensor ground circuit. A faulty sensor ground will cause a Code 21.

Diagnostic Aids:

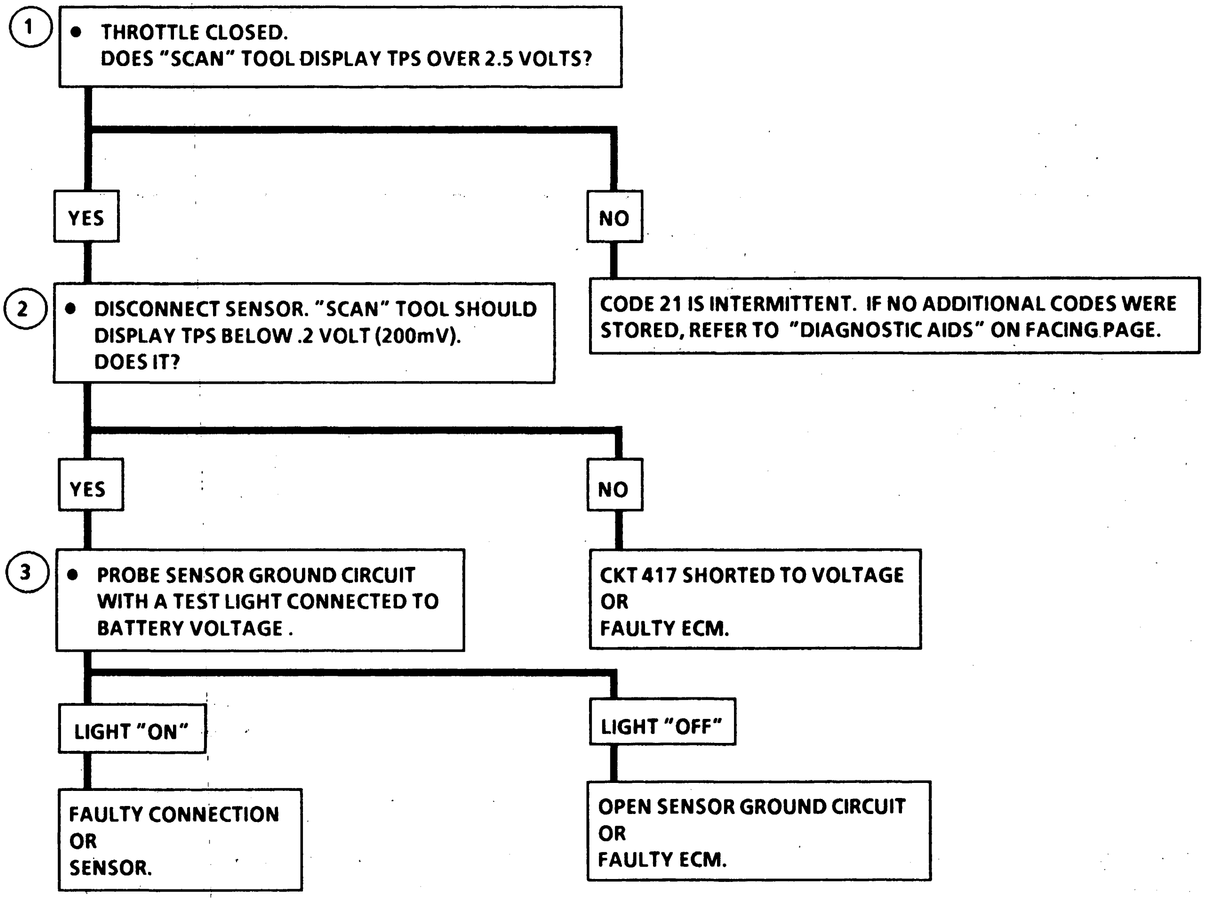
A "Scan" tool reads throttle position in volts. With ignition "ON" or at idle, TPS signal voltage should read less than 1.25 volts with the throttle closed and increase at a steady rate as throttle is moved toward Wide Open Throttle (WOT).

An open in CKT 452 will result in a Code 21.

Refer to "Intermittents" in "Symptoms," Section "6E2-B".

CODE 21

THROTTLE POSITION SENSOR (TPS) CIRCUIT
(SIGNAL VOLTAGE HIGH)
5.0L (VIN E) "F" CARLINE (TBI)



① • THROTTLE CLOSED.
DOES "SCAN" TOOL DISPLAY TPS OVER 2.5 VOLTS?

YES

② • DISCONNECT SENSOR. "SCAN" TOOL SHOULD DISPLAY TPS BELOW .2 VOLT (200mV).
DOES IT?

NO

CODE 21 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

YES

③ • PROBE SENSOR GROUND CIRCUIT WITH A TEST LIGHT CONNECTED TO BATTERY VOLTAGE .

NO

CKT 417 SHORTED TO VOLTAGE
OR
FAULTY ECM.

LIGHT "ON"

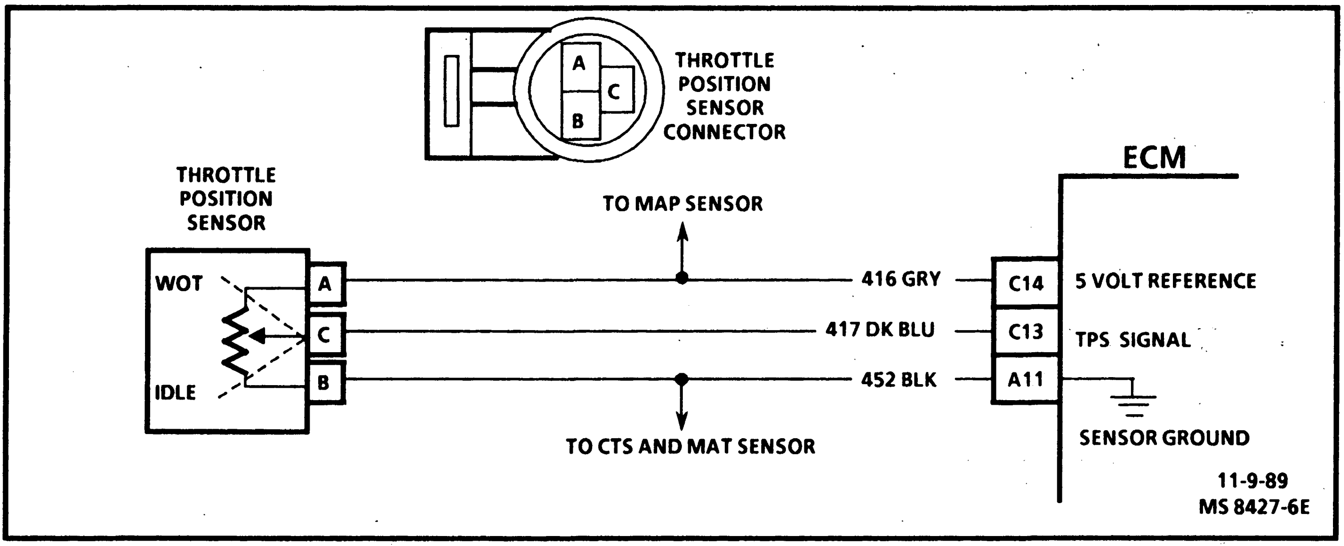
FAULTY CONNECTION
OR
SENSOR.

LIGHT "OFF"

OPEN SENSOR GROUND CIRCUIT
OR
FAULTY ECM.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

3-9-88
• 7S 3057-6E



CODE 22

THROTTLE POSITION SENSOR (TPS) CIRCUIT
(SIGNAL VOLTAGE LOW)
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

The Throttle Position Sensor (TPS) provides a voltage signal that changes relative to the throttle blade. TPS signal voltage will vary from about .5 at idle to about 5 volts at Wide Open Throttle (WOT).

The TPS signal is one of the most important inputs used by the ECM for fuel control and for most of the ECM controlled outputs.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 22 will set if:
   - Engine running
   - TPS signal voltage is less than about .2 volt for 3 seconds.
2. Simulates Code 21: (high voltage) If the ECM recognizes the high signal voltage the ECM and wiring are OK.
3. The TPS has an auto zeroing feature. If the voltage reading is within the range of 0.35 to 0.7 volt, the ECM will use that value as closed throttle. If the voltage reading is out of the auto zero range at closed throttle, check for a binding throttle cable or damaged linkage. If OK, replace the TPS. Refer to "Electronic Control Module (ECM) and Sensors," Section "6E2-C1" On-Vehicle Service.
4. This simulates a high signal voltage to check for an open in CKT 417. The "Scan" tool will not read up to 12 volts, but what is important is that the ECM recognizes the signal on CKT 417.

Diagnostic Aids:

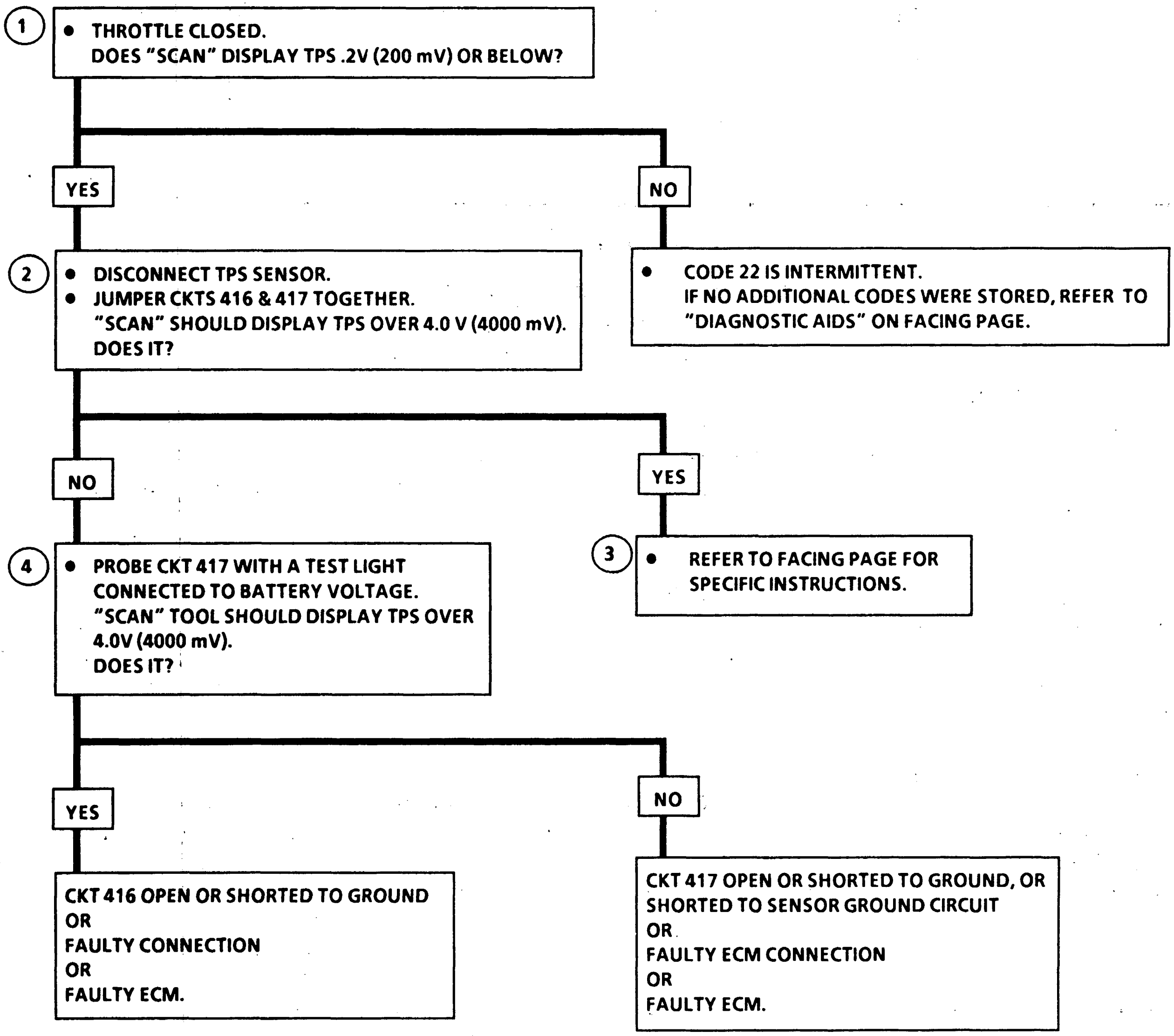
A "Scan" tool reads throttle position in volts. With ignition "ON" or at idle, TPS signal voltage should read less than 1.25 volts with the throttle closed and increase at a steady rate as throttle is moved toward Wide Open Throttle (WOT).

An open or short to ground in CKT 416 or CKT 417 will result in a Code 22.

Refer to "Intermittents" in "Symptoms," Section "6E2-B".

CODE 22

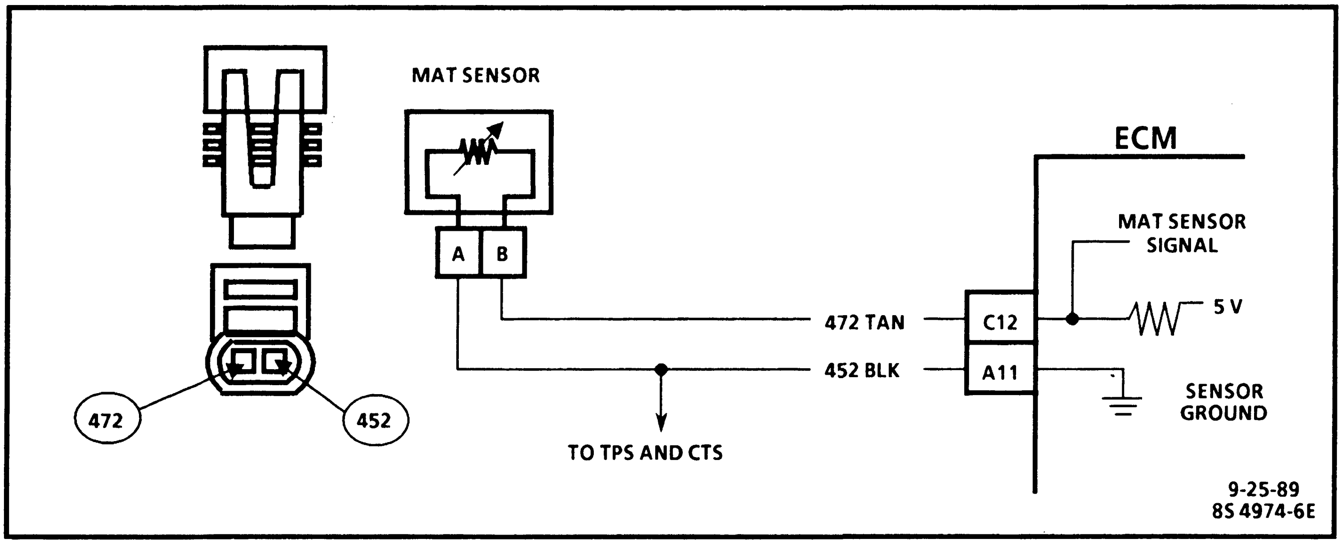
THROTTLE POSITION SENSOR (TPS) CIRCUIT
(SIGNAL VOLTAGE LOW)
5.0L (VIN E) "F" CARLINE (TBI)



5-25-89

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

• 7S 3365-6E



CODE 23

MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT

(LOW TEMPERATURE INDICATED)

5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

The Manifold Air Temperature (MAT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage (about 5 volts) on CKT 472 to the sensor. When the manifold air is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see a high signal voltage. If the manifold air is warm, the sensor (thermistor) resistance is low, therefore, the ECM will see a low voltage.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 23 will set if:
   - A signal voltage indicates a Manifold Air Temperature (MAT) below -30°C (-22°F) for 12 seconds.
   - Time since engine start is 1 minute or longer
2. A Code 23 will set, due to an open sensor, wire or connection. This test will determine if the wiring and ECM are OK.
3. This will determine if the MAT sensor signal (CKT 472) or the MAT sensor ground (CKT 452) is open.

Diagnostic Aids:

A "Scan" tool indicates the temperature of the air in the air cleaner because the MAT sensor is mounted in the air cleaner.

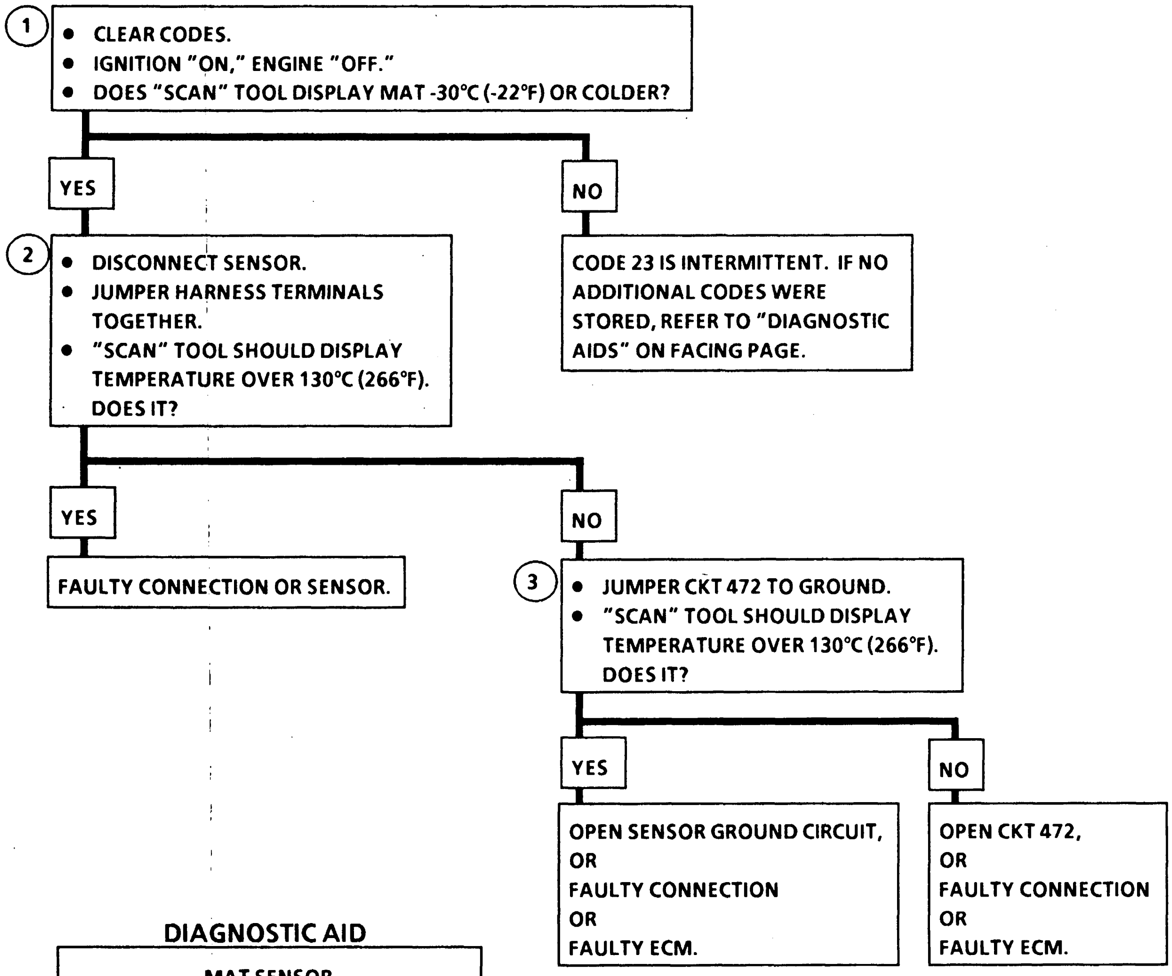
Carefully check harness and connections for possible open CKT 472 or CKT 452.

If the engine has been allowed to sit overnight, the manifold air temperature and coolant temperature values should read within a few degrees of each other. After the engine is started, the MAT will increase due to Thermac operation and underhood temperatures.

Refer to "Intermittents" in "Symptoms," Section "6E2-B".

CODE 23

MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT
(LOW TEMPERATURE INDICATED)
5.0L (VIN E) "F" CARLINE (TBI)



①
- CLEAR CODES.
- IGNITION "ON," ENGINE "OFF."
- DOES "SCAN" TOOL DISPLAY MAT -30°C (-22°F) OR COLDER?

YES

②
- DISCONNECT SENSOR.
- JUMPER HARNESS TERMINALS TOGETHER.
- "SCAN" TOOL SHOULD DISPLAY TEMPERATURE OVER 130°C (266°F). DOES IT?

YES

FAULTY CONNECTION OR SENSOR.

NO

③
- JUMPER CKT 472 TO GROUND.
- "SCAN" TOOL SHOULD DISPLAY TEMPERATURE OVER 130°C (266°F). DOES IT?

YES

OPEN SENSOR GROUND CIRCUIT,
OR
FAULTY CONNECTION
OR
FAULTY ECM.

NO

OPEN CKT 472,
OR
FAULTY CONNECTION
OR
FAULTY ECM.

NO

CODE 23 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

DIAGNOSTIC AID

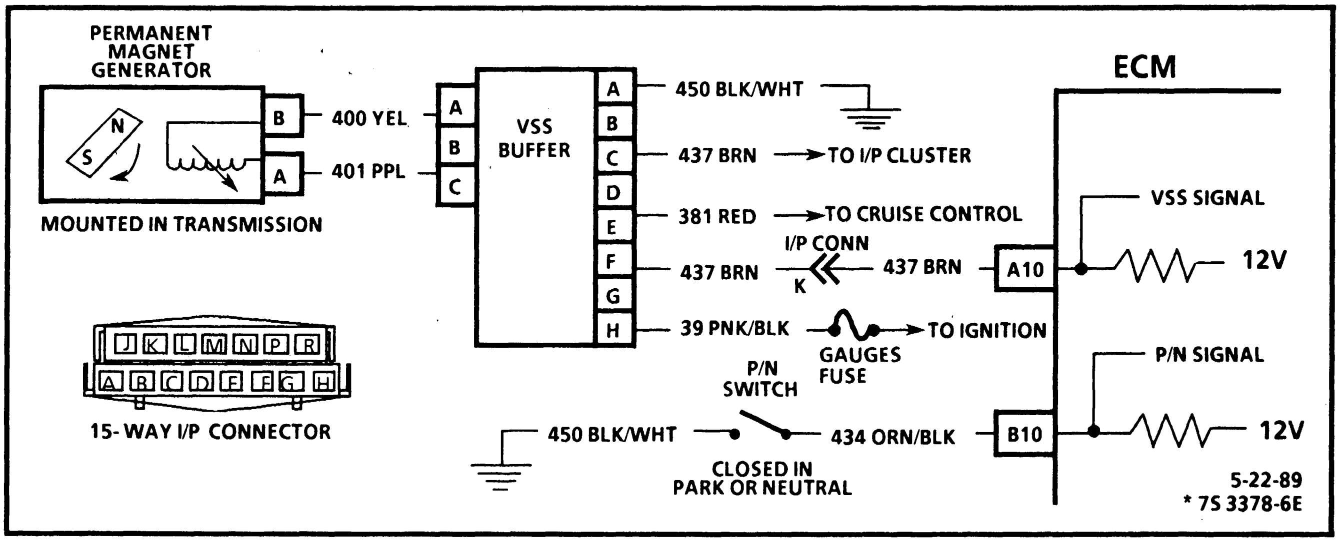
MAT SENSOR

TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)

°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

5-13-89
9S 5267-6E



5-22-89
* 7S 3378-6E

CODE 24

VEHICLE SPEED SENSOR (VSS) CIRCUIT
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

The ECM applies and monitors 12 volts on CKT 437. CKT 437 connects to the Vehicle Speed Sensor (VSS) which alternately grounds CKT 437 when drive wheels are turning. This pulsing action takes place about 2000 times per mile and the ECM will calculate vehicle speed based on the time between "pulses."

"Scan" tool reading should closely match with speedometer reading with drive wheels turning.

Disregard a Code 24 set when drive wheels are not turning.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 24 will set if:
   - CKT 437 voltage is constant.
   - Engine speed is between 1400 and 3600 rpm.
   - TPS is less than 2% throttle opening.
   - Low load condition.
   - Not in park or neutral.
   - All conditions must be met for 4 seconds.

   These conditions are met during a road load deceleration. Disregard Code 24 that sets when drive wheels are not turning.
2. A voltage of less than 1 volt, at the 15-way I/P connector indicates that the CKT 437 wire may be shorted to ground. Disconnect CKT 437 at the vehicle speed sensor buffer.

   If voltage remains less than 10 volts, then CKT 437 wire is grounded or open. If 437 is not grounded or open, check for a faulty ECM connector or ECM.

Diagnostic Aids:

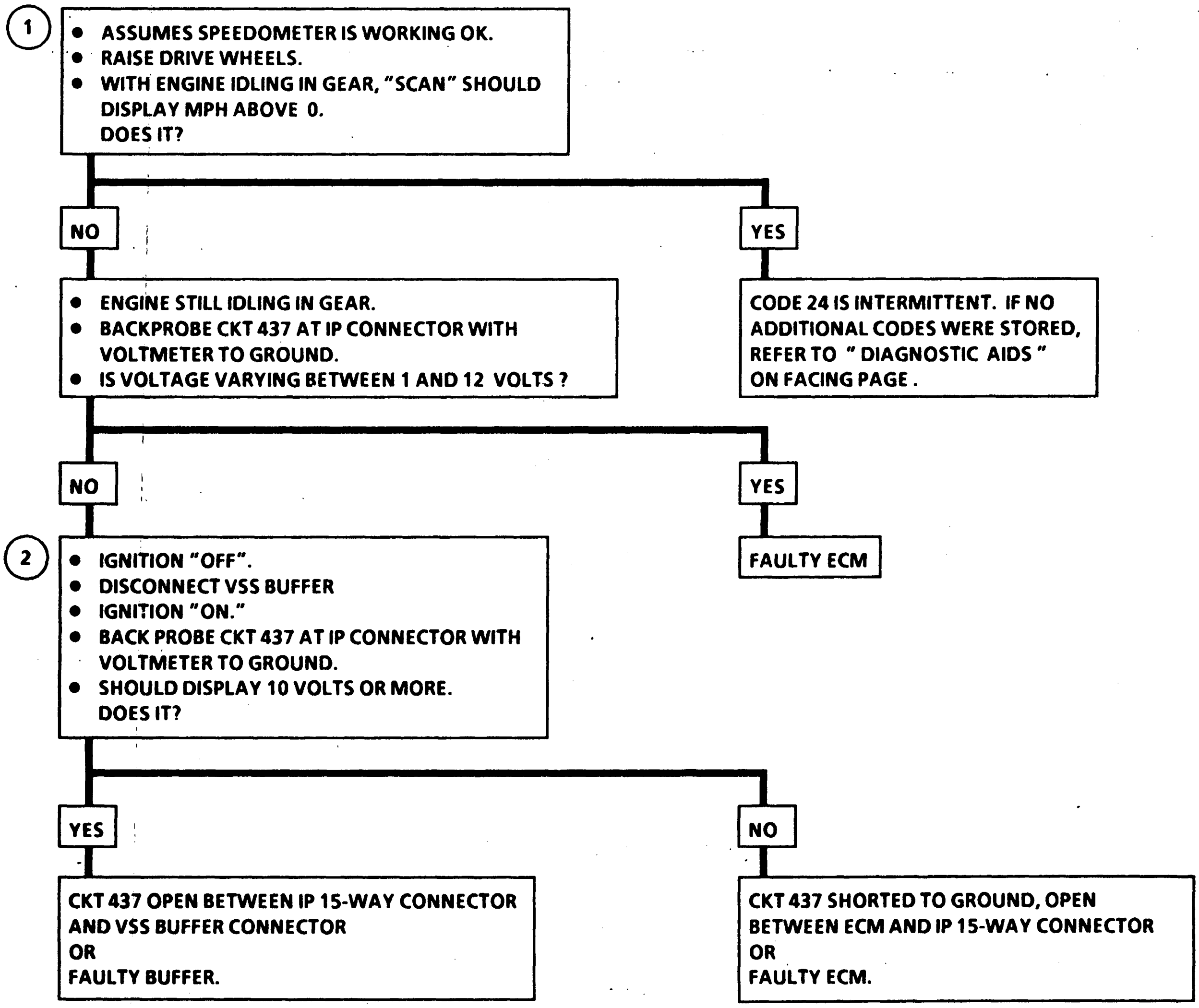
The "Scan" tool displays vehicle speed, check park/neutral switch CHART C-1A on vehicle with automatic transmission. If switch is OK, check for intermittent connections. An open or short to ground in CKT 437 will result in a Code 24. For information on the Vehicle Speed Sensor (VSS), refer to (Section "8A").

Refer to "Intermittents" in "Symptoms," Section "6E2-B".

CODE 24

VEHICLE SPEED SENSOR (VSS) CIRCUIT
5.0L (VIN E) "F" CARLINE (TBI)

NOTE: TO PREVENT MISDIAGNOSIS, THE TECHNICIAN SHOULD REVIEW ELECTRICAL SECTION "8A" OR THE ELECTRICAL TROUBLESHOOTING MANUAL AND IDENTIFY THE TYPE OF VEHICLE SPEED SENSOR USED PRIOR TO USING THIS CHART. DISREGARD CODE 24 IF SET WHEN DRIVE WHEELS ARE NOT TURNING.



①
- ASSUMES SPEEDOMETER IS WORKING OK.
- RAISE DRIVE WHEELS.
- WITH ENGINE IDLING IN GEAR, "SCAN" SHOULD DISPLAY MPH ABOVE 0.
  DOES IT?

NO:
- ENGINE STILL IDLING IN GEAR.
- BACKPROBE CKT 437 AT IP CONNECTOR WITH VOLTMETER TO GROUND.
- IS VOLTAGE VARYING BETWEEN 1 AND 12 VOLTS ?

YES:
CODE 24 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO " DIAGNOSTIC AIDS " ON FACING PAGE.

NO:

②
- IGNITION "OFF".
- DISCONNECT VSS BUFFER
- IGNITION "ON."
- BACK PROBE CKT 437 AT IP CONNECTOR WITH VOLTMETER TO GROUND.
- SHOULD DISPLAY 10 VOLTS OR MORE.
  DOES IT?

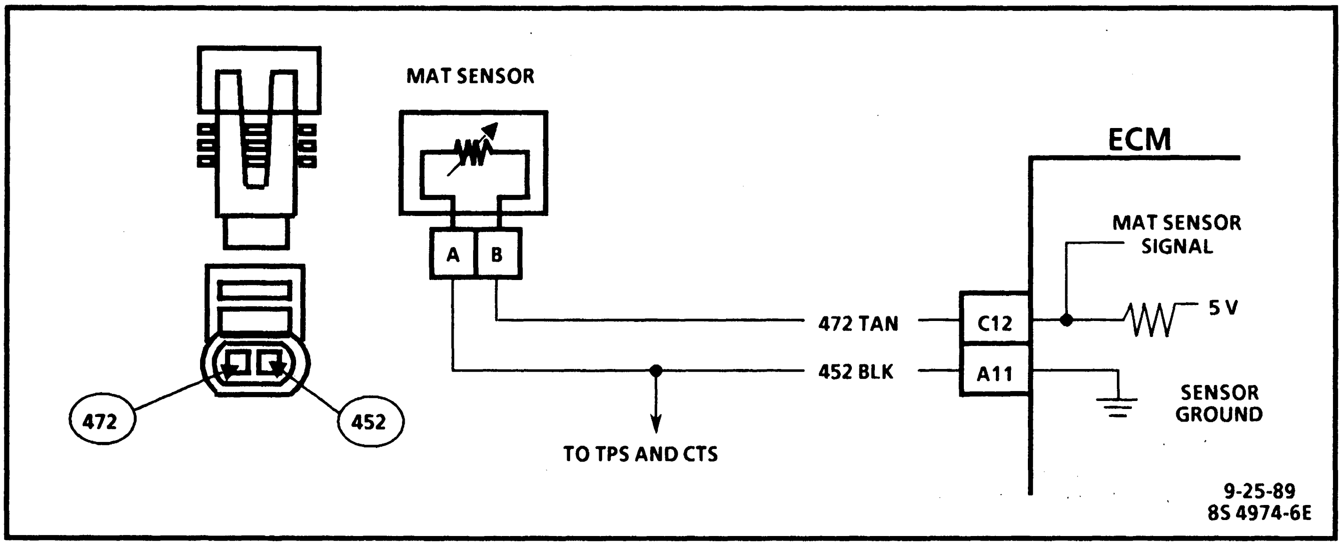
YES:
FAULTY ECM

YES:
CKT 437 OPEN BETWEEN IP 15-WAY CONNECTOR AND VSS BUFFER CONNECTOR
OR
FAULTY BUFFER.

NO:
CKT 437 SHORTED TO GROUND, OPEN BETWEEN ECM AND IP 15-WAY CONNECTOR
OR
FAULTY ECM.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

1-6-88
● 8S 4684-6E



CODE 25

MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT

(HIGH TEMPERATURE INDICATED)

5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

The Manifold Air Temperature (MAT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage (about 5 volts) on CKT 472 to the sensor. When manifold air is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see a high signal voltage. If the manifold air is warm, the sensor (thermistor) resistance is low, therefore, the ECM will see a low signal voltage.

Test Description: Number below refers to the circled number on the diagnostic chart.

1. Code 25 will set if:
   - Signal voltage indicates a Manifold Air Temperature (MAT) greater than 150°C (302°F) for 2 seconds.
   - Time since engine start is 2 minutes or longer.
   - A vehicle speed is present, greater than 5 mph.

Diagnostic Aids:

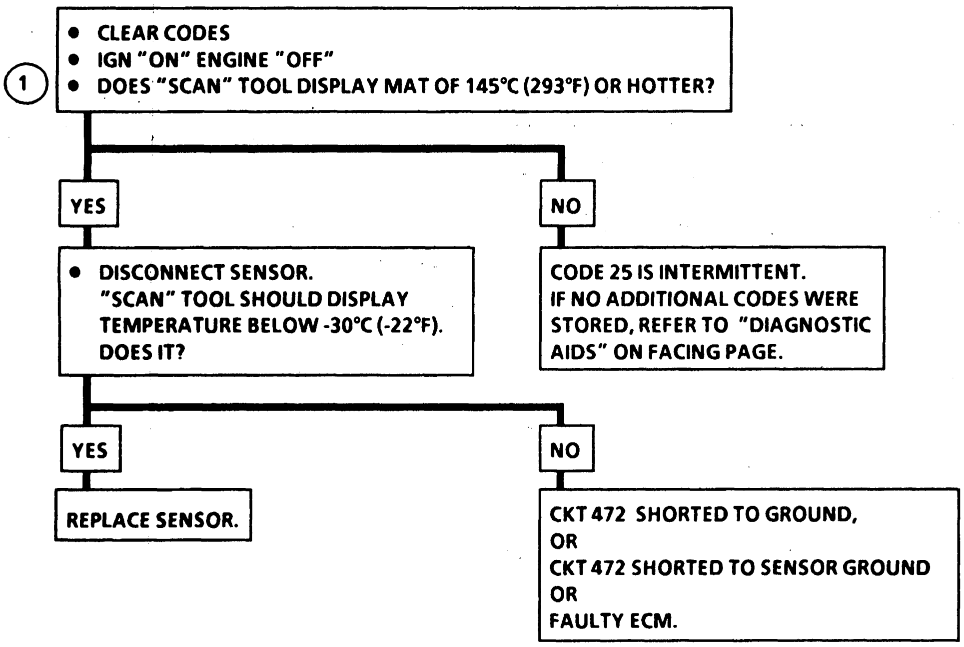
Manifold Air Temperature (MAT) on a "Scan" tool indicates the temperature of the air in the air cleaner, because the MAT sensor is located in the air cleaner. If the engine has been allowed to sit overnight, the manifold air temperature and coolant temperature values should read within a few degrees of each other. After the engine is started, the MAT will increase due to Thermac operation and underhood temperatures, however, MAT will rarely exceed 80°C. If a higher MAT than 80°C is noted, check for proper Thermac operation, see "Thermostatic Air Cleaner (THERMAC) System," Section "6E2-C14".

Check harness routing for possible short to ground in CKT 472.

Refer to "Intermittents" in "Symptoms," Section "6E2-B".

CODE 25

MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT
(HIGH TEMPERATURE INDICATED)
5.0L (VIN E) "F" CARLINE (TBI)



- CLEAR CODES
- IGN "ON" ENGINE "OFF"
- DOES "SCAN" TOOL DISPLAY MAT OF 145°C (293°F) OR HOTTER?

YES:

- DISCONNECT SENSOR. "SCAN" TOOL SHOULD DISPLAY TEMPERATURE BELOW -30°C (-22°F). DOES IT?

NO:

CODE 25 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

YES:

REPLACE SENSOR.

NO:

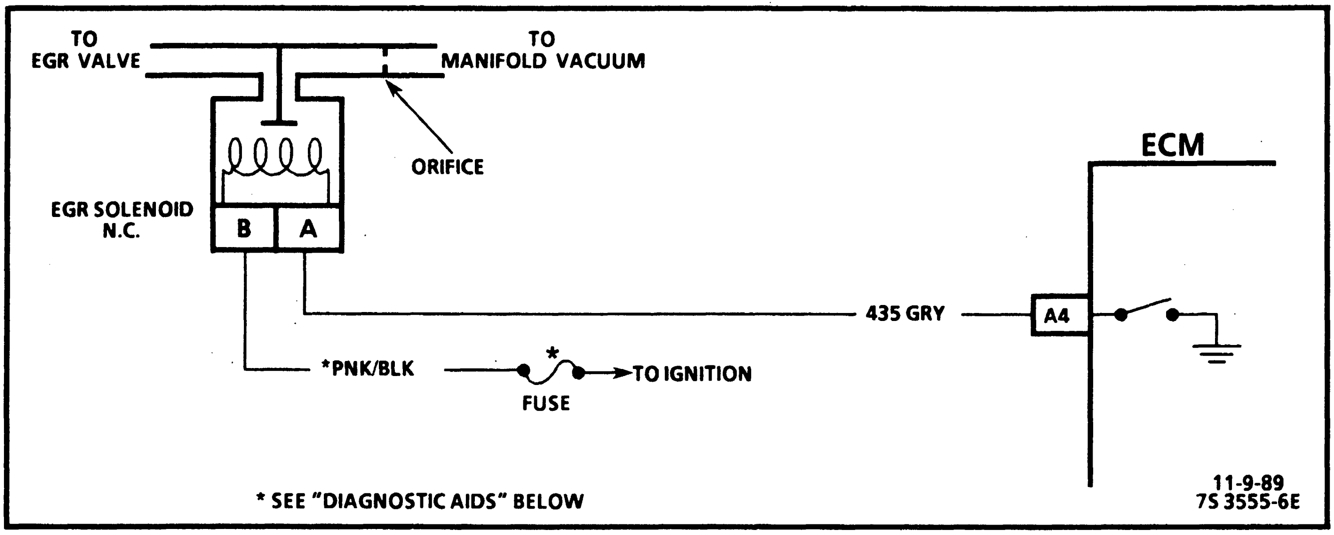
CKT 472 SHORTED TO GROUND,
OR
CKT 472 SHORTED TO SENSOR GROUND
OR
FAULTY ECM.

DIAGNOSTIC AID

MAT SENSOR
TEMPERATURE VS. RESISTANCE VALUES
(APPROXIMATE)

°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.



CODE 32

EXHAUST GAS RECIRCULATION (EGR) CIRCUIT
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

The ECM operates a solenoid to control the Exhaust Gas Recirculation (EGR) valve. This solenoid is normally closed. By providing a ground path, the ECM energizes the solenoid which then allows vacuum to pass to the EGR valve.

The ECM monitors EGR effectiveness by de-energizing the EGR control solenoid thereby shutting off vacuum to the EGR valve diaphragm. With the EGR valve closed, manifold vacuum will be greater than it was during normal EGR operation and this change will be relayed to the ECM by the MAP sensor. If the change is not within the calibrated window, a Code 32 will be set.

The ECM will check EGR operation when:

- Vehicle speed is above 50 mph.
- Engine vacuum is between 40 and 51 kPa (or 12" HG and 15" HG).
- No change in throttle position while test is being run.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. By grounding the diagnostic "test" terminal, the EGR solenoid should be energized and allow vacuum to be applied to the EGR valve and the vacuum should hold.
2. When the diagnostic "test" terminal is ungrounded, the vacuum to the EGR valve should bleed off through a vent in the solenoid and the valve should close, The gage may or may not bleed off but this does not indicate a problem.
3. This test will determine if the electrical control part of the system is at fault or if the connector or solenoid is at fault.
4. This system uses a negative backpressure EGR valve which should hold vacuum with engine "OFF."
5. When engine is started, exhaust backpressure should cause vacuum to bleed off and valve to fully close.

Diagnostic Aids:

* CKT 39 - Gauges fuse

Vacuum lines should be thoroughly checked for internal restrictions and proper routing. Refer to underhood Vehicle Emission Control Information label.

Remove EGR valve and start engine, check both exhaust and intake EGR passages for restrictions or blockage.

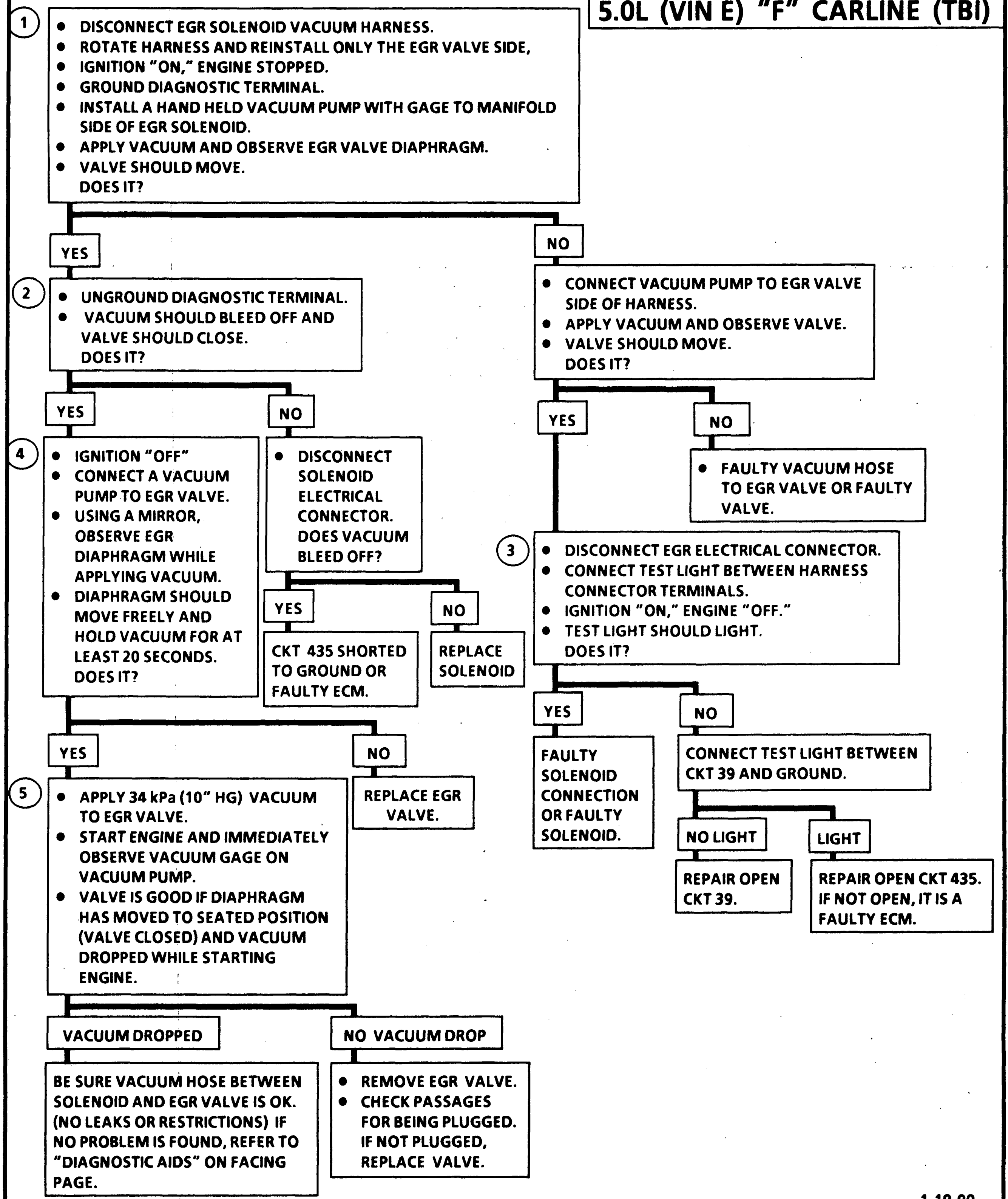
The ECM uses the MAP sensor for checking EGR operation. If there is a question of MAP sensor accuracy, use CHART C-1D MAP output check in "Component Systems," Section "6E2-C".

If no problems are found refer to "Intermittents" in "Symptoms," Section "6E2-B".

CODE 32

EXHAUST GAS RECIRCULATION (EGR) CIRCUIT
5.0L (VIN E) "F" CARLINE (TBI)

BEFORE USING THIS CHART CHECK FOR MANIFOLD VACUUM TO EGR SOLENOID, THERE SHOULD BE AT LEAST 25 kPa (7" HG) OF VACUUM AT 2000 RPM. CHECK VACUUM HOSES FOR LEAKS OR RESTRICTIONS.



①
- DISCONNECT EGR SOLENOID VACUUM HARNESS.
- ROTATE HARNESS AND REINSTALL ONLY THE EGR VALVE SIDE.
- IGNITION "ON," ENGINE STOPPED.
- GROUND DIAGNOSTIC TERMINAL.
- INSTALL A HAND HELD VACUUM PUMP WITH GAGE TO MANIFOLD SIDE OF EGR SOLENOID.
- APPLY VACUUM AND OBSERVE EGR VALVE DIAPHRAGM.
- VALVE SHOULD MOVE.

DOES IT?

YES

②
- UNGROUND DIAGNOSTIC TERMINAL.
- VACUUM SHOULD BLEED OFF AND VALVE SHOULD CLOSE.

DOES IT?

YES

④
- IGNITION "OFF"
- CONNECT A VACUUM PUMP TO EGR VALVE.
- USING A MIRROR, OBSERVE EGR DIAPHRAGM WHILE APPLYING VACUUM.
- DIAPHRAGM SHOULD MOVE FREELY AND HOLD VACUUM FOR AT LEAST 20 SECONDS.

DOES IT?

YES

⑤
- APPLY 34 kPa (10" HG) VACUUM TO EGR VALVE.
- START ENGINE AND IMMEDIATELY OBSERVE VACUUM GAGE ON VACUUM PUMP.
- VALVE IS GOOD IF DIAPHRAGM HAS MOVED TO SEATED POSITION (VALVE CLOSED) AND VACUUM DROPPED WHILE STARTING ENGINE.

VACUUM DROPPED

BE SURE VACUUM HOSE BETWEEN SOLENOID AND EGR VALVE IS OK. (NO LEAKS OR RESTRICTIONS) IF NO PROBLEM IS FOUND, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

NO VACUUM DROP

- REMOVE EGR VALVE.
- CHECK PASSAGES FOR BEING PLUGGED. IF NOT PLUGGED, REPLACE VALVE.

NO (④)

REPLACE EGR VALVE.

NO (②)

- DISCONNECT SOLENOID ELECTRICAL CONNECTOR. DOES VACUUM BLEED OFF?

YES

CKT 435 SHORTED TO GROUND OR FAULTY ECM.

NO

REPLACE SOLENOID

NO (①)

- CONNECT VACUUM PUMP TO EGR VALVE SIDE OF HARNESS.
- APPLY VACUUM AND OBSERVE VALVE.
- VALVE SHOULD MOVE.

DOES IT?

NO

- FAULTY VACUUM HOSE TO EGR VALVE OR FAULTY VALVE.

YES

③
- DISCONNECT EGR ELECTRICAL CONNECTOR.
- CONNECT TEST LIGHT BETWEEN HARNESS CONNECTOR TERMINALS.
- IGNITION "ON," ENGINE "OFF."
- TEST LIGHT SHOULD LIGHT.

DOES IT?

YES

FAULTY SOLENOID CONNECTION OR FAULTY SOLENOID.

NO

CONNECT TEST LIGHT BETWEEN CKT 39 AND GROUND.

NO LIGHT

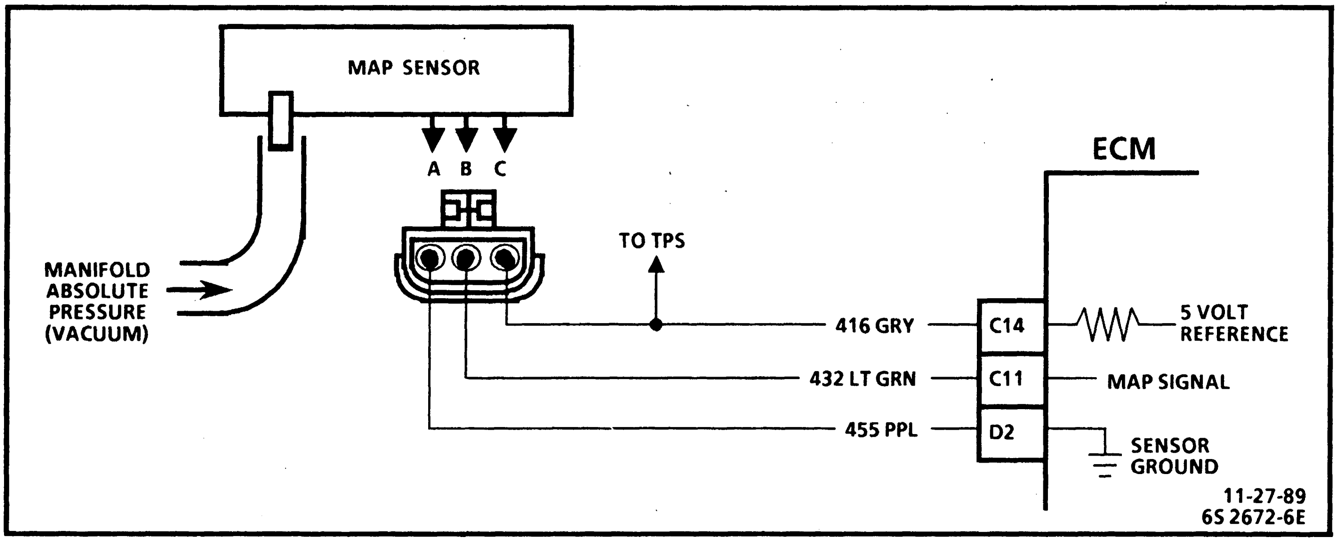
REPAIR OPEN CKT 39.

LIGHT

REPAIR OPEN CKT 435. IF NOT OPEN, IT IS A FAULTY ECM.

1-19-90
7S 3554-6E

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.



CODE 33

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT
(SIGNAL VOLTAGE HIGH - LOW VACUUM)
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1-1.5 volts at idle to 4.5-4.8 volts at Wide Open Throttle.

A "Scan" tool displays manifold pressure in volts. Low pressure (high vacuum) reads a low voltage while a high pressure (low vacuum) reads a high voltage.

If the MAP sensor fails the ECM will substitute a fixed MAP value and use the Throttle Position Sensor (TPS) to control fuel delivery.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 33 will set when:
   - Signal is too high, (greater than 68 kPa or less than 9" HG), for a time greater than 5 seconds.
   - TPS less than 4%

   Engine misfire or a low unstable idle may set Code 33. Disconnect MAP sensor and system will go into backup mode. If the misfire or idle condition remains, see "Symptoms," Section "6E2-B".
2. If the ECM recognizes the low MAP signal, the ECM and wiring are OK.

Diagnostic Aids:

If the idle is rough or unstable, refer to "Symptoms," Section "6E2-B" for items which can cause an unstable idle.

An open in CKT 455 will result in a Code 33.

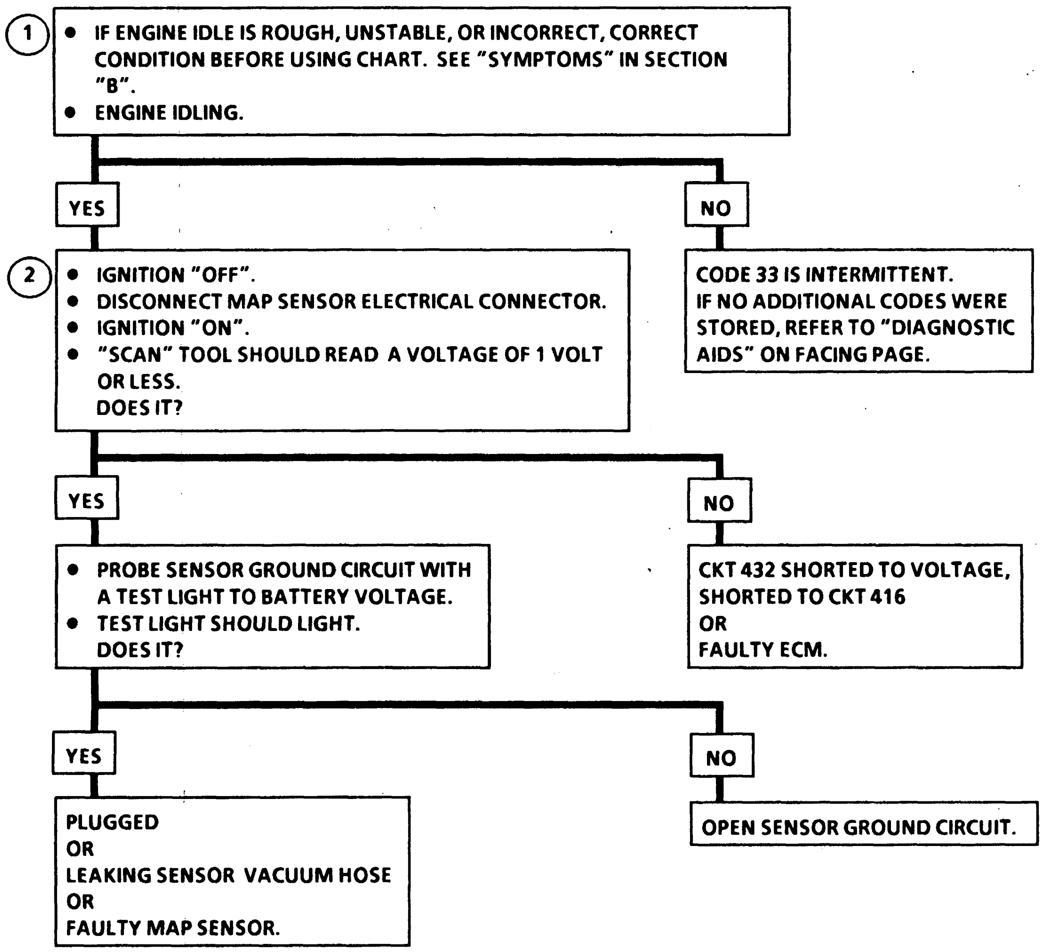
With the ignition "ON" and the engine "OFF," the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of vehicle altitude and is referred to as BARO. Comparison of this BARO reading with a known good vehicle with the same sensor is a good way to check accuracy of a "suspect" sensor. Reading should be the same, ± .4 volt.

Also CHART C-1D can be used to test the MAP sensor.

Refer to "Intermittents" in "Symptoms," Section "6E2-B".

CODE 33

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT
(SIGNAL VOLTAGE HIGH - LOW VACUUM)
5.0L (VIN E) "F" CARLINE (TBI)



①
- IF ENGINE IDLE IS ROUGH, UNSTABLE, OR INCORRECT, CORRECT CONDITION BEFORE USING CHART. SEE "SYMPTOMS" IN SECTION "B".
- ENGINE IDLING.

NO: CODE 33 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

YES: ②
- IGNITION "OFF".
- DISCONNECT MAP SENSOR ELECTRICAL CONNECTOR.
- IGNITION "ON".
- "SCAN" TOOL SHOULD READ A VOLTAGE OF 1 VOLT OR LESS.

DOES IT?

NO: CKT 432 SHORTED TO VOLTAGE, SHORTED TO CKT 416 OR FAULTY ECM.

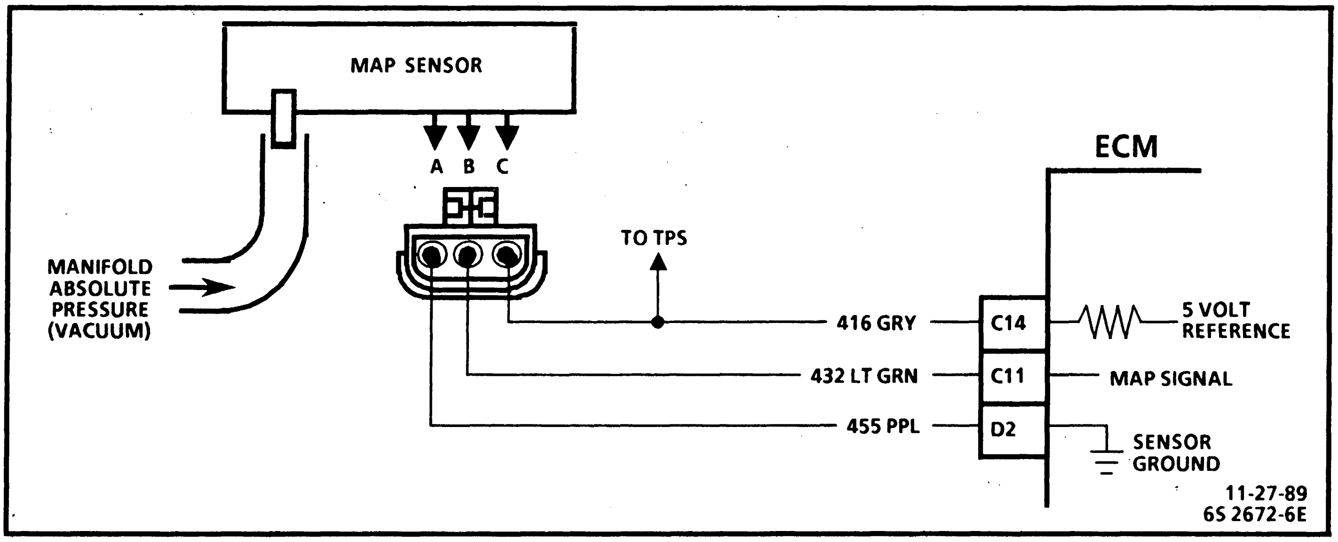
YES:
- PROBE SENSOR GROUND CIRCUIT WITH A TEST LIGHT TO BATTERY VOLTAGE.
- TEST LIGHT SHOULD LIGHT.

DOES IT?

YES: PLUGGED OR LEAKING SENSOR VACUUM HOSE OR FAULTY MAP SENSOR.

NO: OPEN SENSOR GROUND CIRCUIT.

10-13-89
• 7S 3210-6E



CODE 34

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT

(SIGNAL VOLTAGE LOW - HIGH VACUUM)

5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1-1.5 volts at idle to 4.5-4.8 volts at Wide Open Throttle (WOT).

A "Scan" tool displays manifold pressure in volts. Low pressure (high vacuum) reads a low voltage while a high pressure (low vacuum) reads a high voltage.

If the MAP sensor fails the ECM will substitute a fixed MAP value and use the Throttle Position Sensor (TPS) to control fuel delivery.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 34 will set when:
   - Signal is too low, (less than 14 kPa or greater than 28" HG) and engine running less than 1200 rpm

     OR
   - Engine running greater than 1200 rpm
   - Throttle position greater than 21% (over 1.5 volts)
2. If the ECM recognizes the high MAP signal, the ECM and wiring are OK.
3. The "Scan" tool may not display 12 volts. The important thing is that the ECM recognizes the voltage as more than 4 volts, indicating that the ECM and CKT 432 are OK.

Diagnostic Aids:

An intermittent open in CKT 432 or CKT 416 will result in a Code 34.

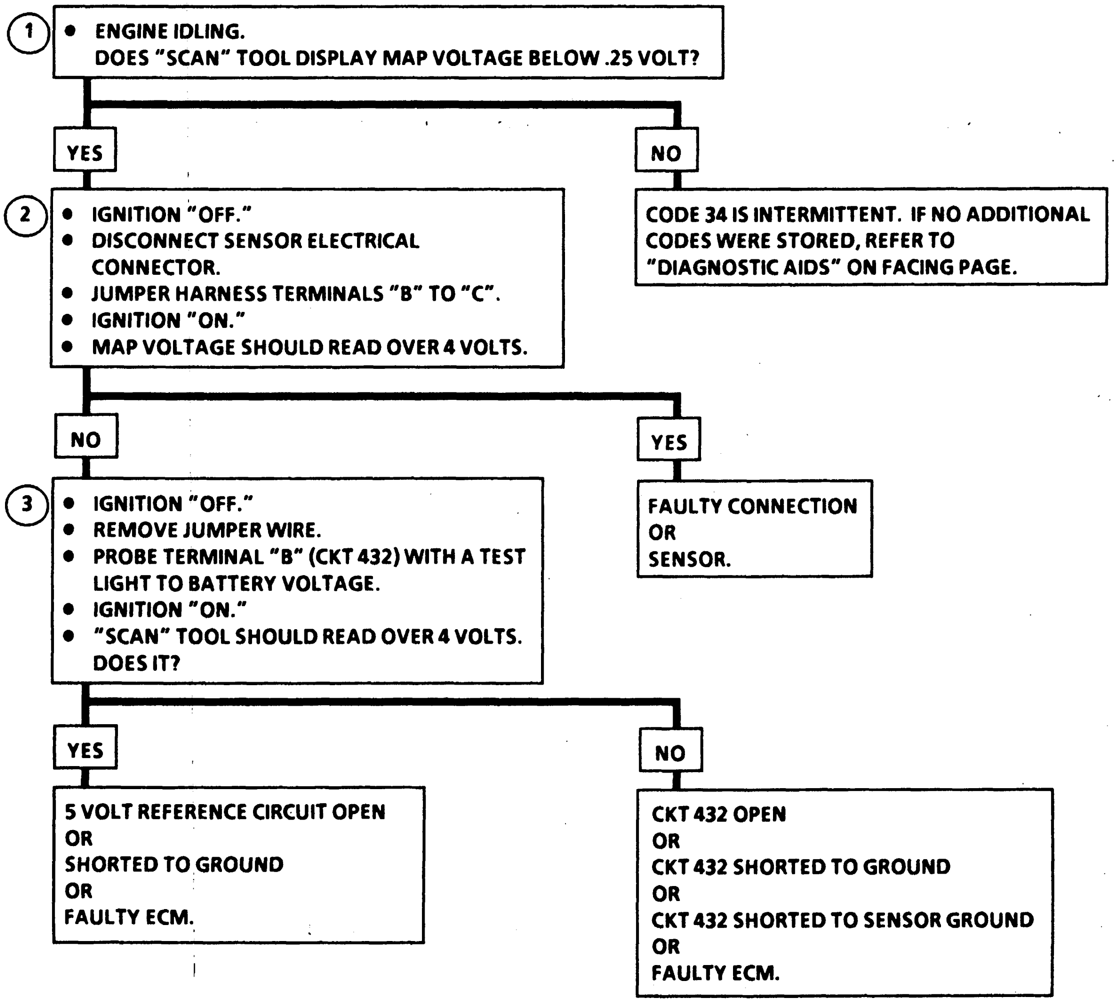
With the ignition "ON" and engine "OFF," the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of vehicle altitude and is referred to as BARO. Comparison of this BARO reading with a known good vehicle with the same sensor is a good way to check accuracy of a "suspect" sensor. Reading should be the same, ± .4 volt.

Also CHART C-1D can be used to test the MAP sensor.

Refer to "Intermittents" in "Symptoms," Section "6E2-B".

CODE 34

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT
(SIGNAL VOLTAGE LOW - HIGH VACUUM)
5.0L (VIN E) "F" CARLINE (TBI)



①
- ENGINE IDLING.

DOES "SCAN" TOOL DISPLAY MAP VOLTAGE BELOW .25 VOLT?

②
- IGNITION "OFF."
- DISCONNECT SENSOR ELECTRICAL CONNECTOR.
- JUMPER HARNESS TERMINALS "B" TO "C".
- IGNITION "ON."
- MAP VOLTAGE SHOULD READ OVER 4 VOLTS.

CODE 34 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

③
- IGNITION "OFF."
- REMOVE JUMPER WIRE.
- PROBE TERMINAL "B" (CKT 432) WITH A TEST LIGHT TO BATTERY VOLTAGE.
- IGNITION "ON."
- "SCAN" TOOL SHOULD READ OVER 4 VOLTS.

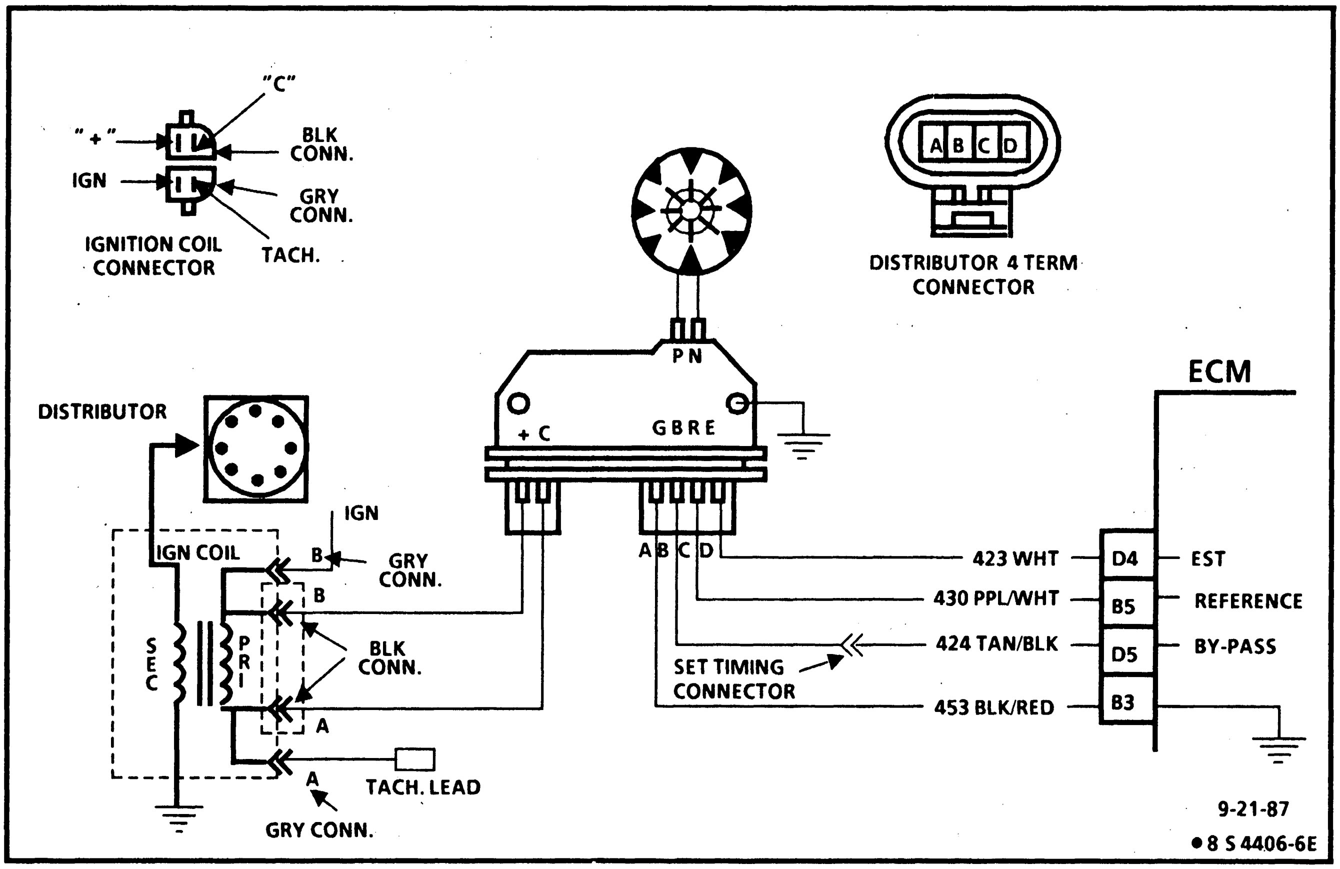
DOES IT?

FAULTY CONNECTION
OR
SENSOR.

5 VOLT REFERENCE CIRCUIT OPEN
OR
SHORTED TO GROUND
OR
FAULTY ECM.

CKT 432 OPEN
OR
CKT 432 SHORTED TO GROUND
OR
CKT 432 SHORTED TO SENSOR GROUND
OR
FAULTY ECM.

10-13-89
• 7S 3211-6E



9-21-87
• 8 S 4406-6E

CODE 42

ELECTRONIC SPARK TIMING (EST) CIRCUIT 5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

When the system is running on the ignition module, that is, no voltage on the bypass line, the ignition module grounds the EST signal. The ECM expects to see no voltage on the EST line during this condition. If it sees a voltage, it sets Code 42 and will not go into the EST mode.

When the rpm for EST is reached (about 400 rpm), and bypass voltage applied, the EST should no longer be grounded in the ignition module so the EST voltage should be varying.

If the bypass line is open or grounded, the ignition module will not switch to EST mode so the EST voltage will be low and Code 42 will be set.

If the EST line is grounded, the ignition module will switch to EST, but because the line is grounded there will be no EST signal. A Code 42 will be set.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 42 means the ECM has seen an open or short to ground in the EST or bypass circuits. This test confirms Code 42 and that the fault causing the code is present.
2. Checks for a normal EST ground path through the ignition module. An EST CKT 423 shorted to ground will also read less than 500 ohms; however, this will be checked later.
3. As the test light voltage touches CKT 424, the module should switch. The important thing is that the module "switched."
4. The module did not switch and this step checks for:
   - EST CKT 423 shorted to ground.
   - Bypass CKT 424 open.
   - Faulty ignition module connection or module.
5. Confirms that Code 42 is a faulty ECM and not an intermittent in CKT 423 or CKT 424.

Diagnostic Aids:

If a Code 42 was stored and the customer complains of a "Hard Start," the problem is most likely a grounded EST line (CKT 423).

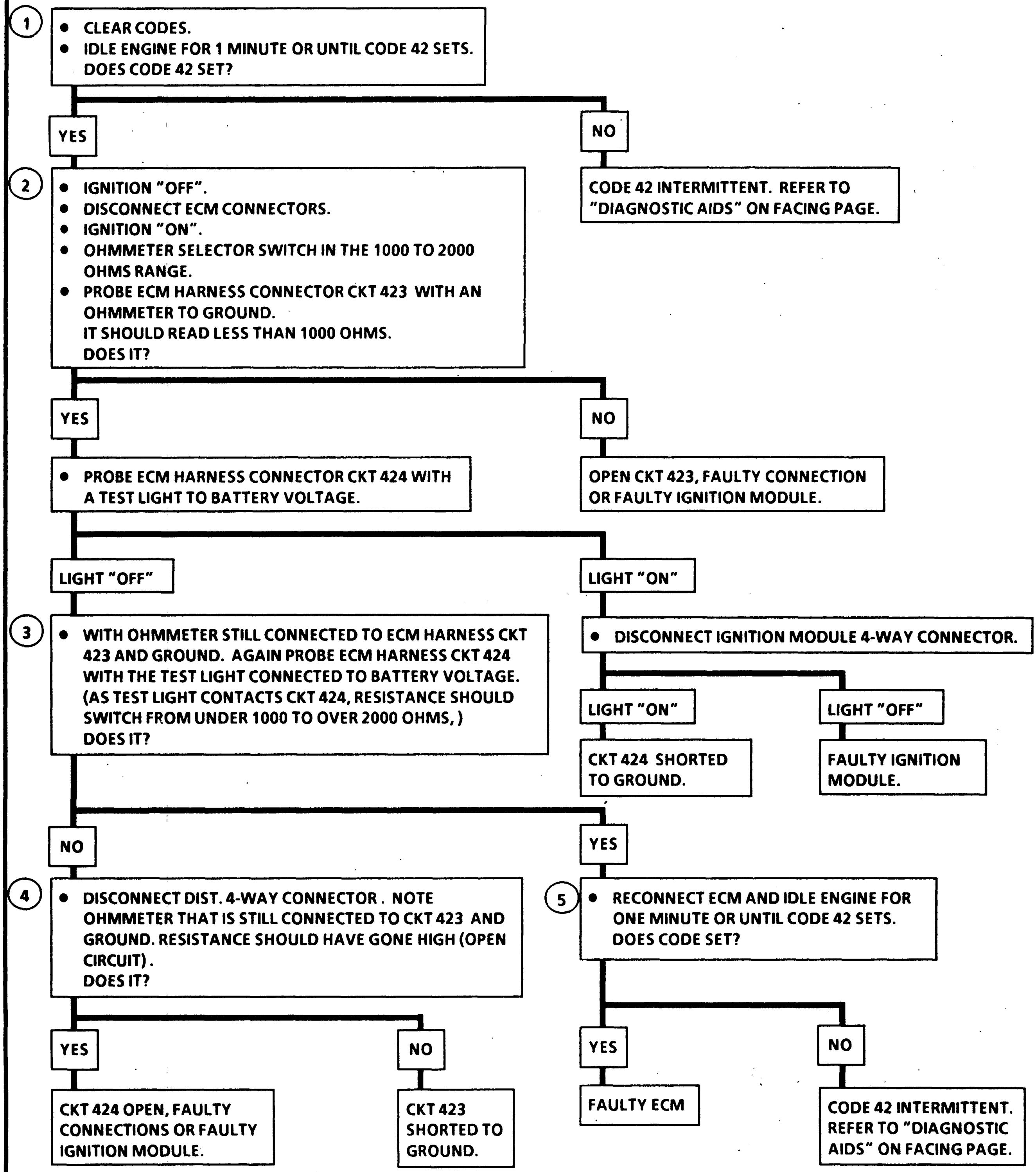
The "Scan" tool does not have any ability to help diagnose a Code 42 problem.

A PROM not fully seated in the ECM can result in a Code 42.

Refer to "Intermittents" in ""Symptoms," Section "6E2-B".

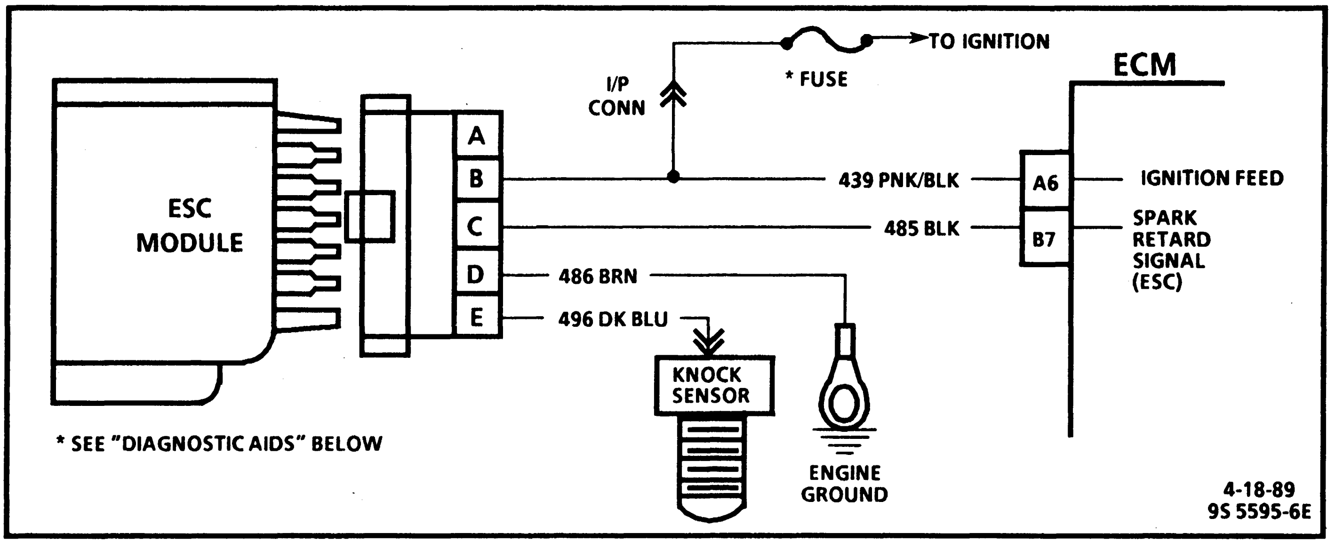
CODE 42

ELECTRONIC SPARK TIMING (EST) CIRCUIT 5.0L (VIN E) "F" CARLINE (TBI)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

6-21-88
• 7S 3291-6E



CODE 43

ELECTRONIC SPARK CONTROL (ESC) CIRCUIT
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

Electronic Spark Control (ESC) is accomplished with a module that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage from the ESC module to the ECM drops, and this signals the ECM to retard timing. The ECM will retard the timing when knock is detected and rpm is above about 900 rpm.

This system performs a functional check once per start up to check the ESC system. To perform this test, the ECM will advance the spark when coolant is above 95°C (194°F) and at a high load condition (near WOT). The ECM then checks the signal on CKT 485 to see if a knock is detected. The functional check is performed once per start up. If knock is detected when coolant is below 95°C (194°F), the test has passed and the functional check will not be run. If the functional check fails, the "Service Engine Soon" light will remain "ON" until ignition is turned "OFF" or until a knock signal is detected.

Code 43 means the ECM has read low voltage on CKT 485 for longer than 5 seconds with the engine running or the system has failed the functional check.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. If the conditions for a Code 43 are present the "Scan" tool will always display "YES." There should not be a knock at idle unless an internal engine problem, or a system problem exists.
2. This test will determine if the system is functioning at this time. Usually a knock signal can be generated by taping on the exhaust manifold. If no knock signal can be generated by tapping on the engine block, tap close to the area of the sensor.
3. Because Code 43 sets when the signal voltage on CKT 485 remains low this test should cause the signal on CKT 485 to go high. The 12 volts signal should be seen by the ECM as "no knock" if the ECM and wiring are OK.
4. This test will determine if the knock signal is being detected on CKT 496 or if the ESC module is at fault.
5. If CKT 496 is routed to close to secondary ignition wires the ESC module may see the interference as a knock signal.
6. This checks the ground circuit to the module. An open ground will cause the voltage on CKT 485 to be about 12 volts which would cause the Code 43 functional test to fail.
7. Contacting CKT 496 with a test light to 12 volts should generate a knock signal. This will determine if the ESC module is operating correctly.

Diagnostic Aids:

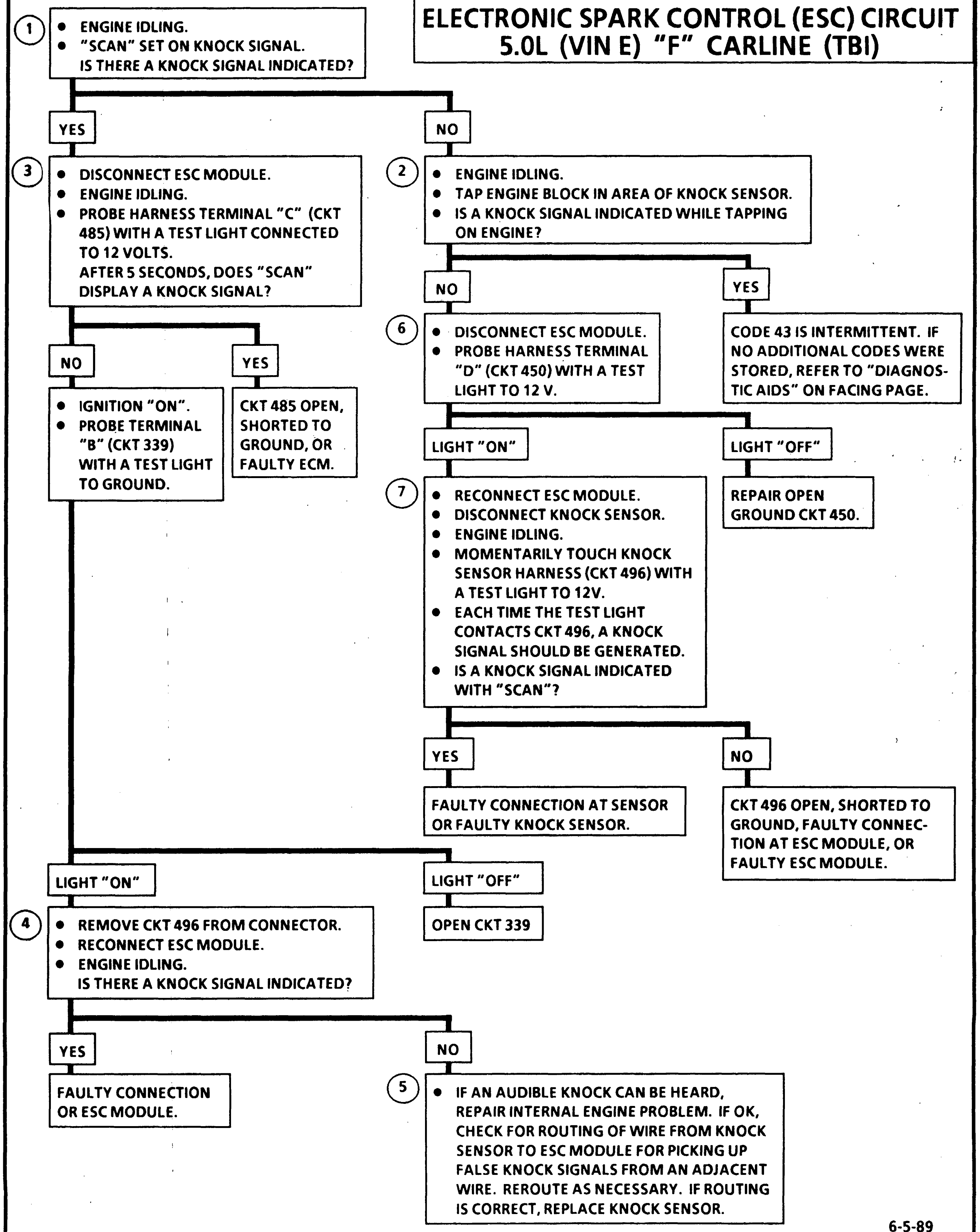
* ECM fuse

Code 43 can be caused by a faulty connection at the knock sensor at the ESC module or at the ECM. Also check CKT 485 for possible open or short to ground.

Refer to "Intermittents" in "Symptoms," Section "6E2-B".

CODE 43

ELECTRONIC SPARK CONTROL (ESC) CIRCUIT 5.0L (VIN E) "F" CARLINE (TBI)



①
- ENGINE IDLING.
- "SCAN" SET ON KNOCK SIGNAL.

IS THERE A KNOCK SIGNAL INDICATED?

③
- DISCONNECT ESC MODULE.
- ENGINE IDLING.
- PROBE HARNESS TERMINAL "C" (CKT 485) WITH A TEST LIGHT CONNECTED TO 12 VOLTS.

AFTER 5 SECONDS, DOES "SCAN" DISPLAY A KNOCK SIGNAL?

- IGNITION "ON".
- PROBE TERMINAL "B" (CKT 339) WITH A TEST LIGHT TO GROUND.

CKT 485 OPEN, SHORTED TO GROUND, OR FAULTY ECM.

②
- ENGINE IDLING.
- TAP ENGINE BLOCK IN AREA OF KNOCK SENSOR.
- IS A KNOCK SIGNAL INDICATED WHILE TAPPING ON ENGINE?

⑥
- DISCONNECT ESC MODULE.
- PROBE HARNESS TERMINAL "D" (CKT 450) WITH A TEST LIGHT TO 12 V.

CODE 43 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

⑦
- RECONNECT ESC MODULE.
- DISCONNECT KNOCK SENSOR.
- ENGINE IDLING.
- MOMENTARILY TOUCH KNOCK SENSOR HARNESS (CKT 496) WITH A TEST LIGHT TO 12V.
- EACH TIME THE TEST LIGHT CONTACTS CKT 496, A KNOCK SIGNAL SHOULD BE GENERATED.
- IS A KNOCK SIGNAL INDICATED WITH "SCAN"?

REPAIR OPEN GROUND CKT 450.

FAULTY CONNECTION AT SENSOR OR FAULTY KNOCK SENSOR.

CKT 496 OPEN, SHORTED TO GROUND, FAULTY CONNECTION AT ESC MODULE, OR FAULTY ESC MODULE.

④
- REMOVE CKT 496 FROM CONNECTOR.
- RECONNECT ESC MODULE.
- ENGINE IDLING.

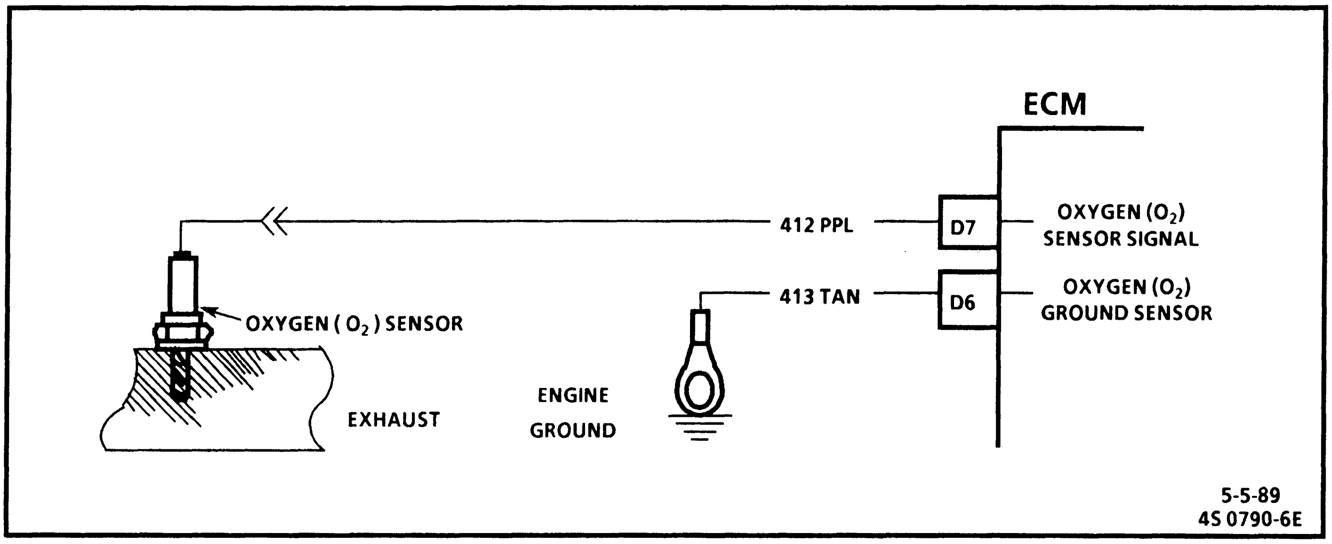
IS THERE A KNOCK SIGNAL INDICATED?

OPEN CKT 339

FAULTY CONNECTION OR ESC MODULE.

⑤
- IF AN AUDIBLE KNOCK CAN BE HEARD, REPAIR INTERNAL ENGINE PROBLEM. IF OK, CHECK FOR ROUTING OF WIRE FROM KNOCK SENSOR TO ESC MODULE FOR PICKING UP FALSE KNOCK SIGNALS FROM AN ADJACENT WIRE. REROUTE AS NECESSARY. IF ROUTING IS CORRECT, REPLACE KNOCK SENSOR.

6-5-89
* 7S 3292-6E



CODE 44

OXYGEN SENSOR CIRCUIT
(LEAN EXHAUST INDICATED)
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

The ECM supplies a voltage of about .45 volt between terminals "D6" and "D7". (If measured with a 10 megohm digital voltmeter, this may read as low as .32 volt.) The Oxygen (O_2) sensor varies the voltage within a range of about 1 volt if the exhaust is rich, down through about .10 volt if exhaust is lean.

The sensor is like an open circuit and produces no voltage when it is below about 360°C (600°F). An open sensor circuit or cold sensor causes "Open Loop" operation.

Test Description: Number below refers to the circled number on the diagnostic chart.

1. Code 44 is set when the Oxygen (O_2) sensor signal voltage on CKT 412.
   - Remains below .2 volt for 50 seconds.
   - And the system is operating in "Closed Loop."

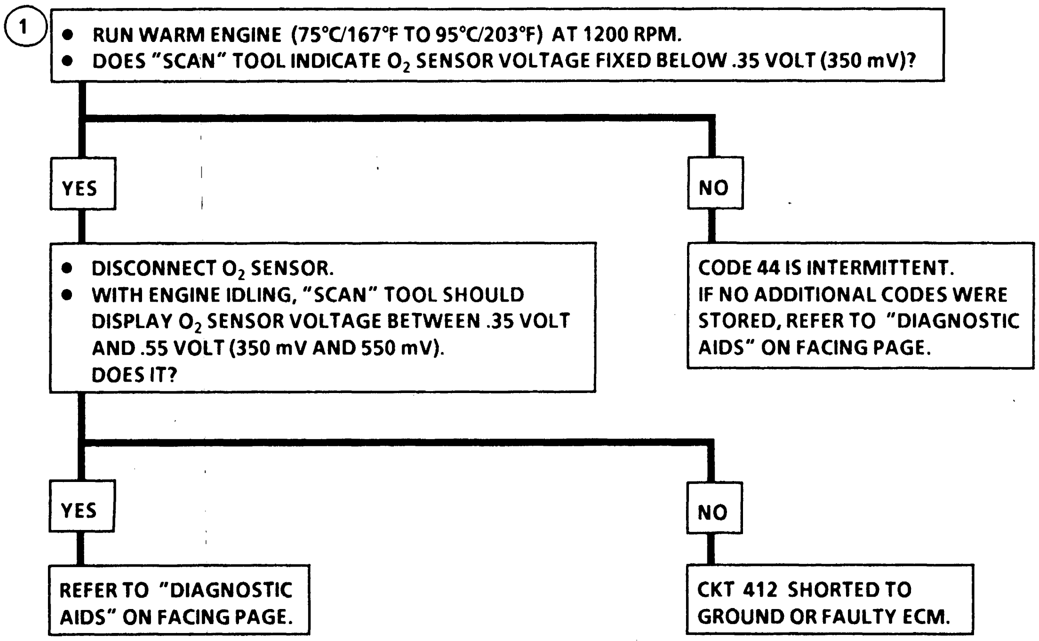
Diagnostic Aids:

Using the "Scan" tool, observe the block learn values at different rpm and air flow conditions to determine when the Code 44 may have been set. If the conditions for Code 44 exists, the block learn values will be around 150.

- O_2 Sensor Wire Sensor pigtail may be mispositioned and contacting the exhaust manifold.
- Check for intermittent ground in wire between connector and sensor.
- MAP Sensor A Manifold Absolute Pressure (MAP) sensor output that causes the ECM to sense a higher than normal vacuum will cause the system to go lean. Disconnect the MAP sensor and if the lean condition is gone, replace the MAP sensor.
- Lean Injector(s)
- Fuel Contamination Water, even in small amounts, near the in-tank fuel pump inlet can be delivered to the injectors. The water causes a lean exhaust and can set a Code 44.
- Fuel Pressure System will be lean if pressure is too low. It may be necessary to monitor fuel pressure while driving the car at various road speeds and/or loads to confirm. See "Fuel System Diagnosis," CHART A-7.
- Exhaust Leaks If there is an exhaust leak, the engine can cause outside air to be pulled into the exhaust and past the sensor. Vacuum or crankcase leaks can cause a lean condition.
- AIR System Be sure air is not being directed to the exhaust ports while in "Closed Loop." If the block learn value goes down while squeezing air hose to left side exhaust ports, refer to CHART C-6.
- If the above are OK, it is a faulty oxygen sensor.

CODE 44

OXYGEN SENSOR CIRCUIT
(LEAN EXHAUST INDICATED)
5.0L (VIN E) "F" CARLINE (TBI)



①
- RUN WARM ENGINE (75°C/167°F TO 95°C/203°F) AT 1200 RPM.
- DOES "SCAN" TOOL INDICATE O_2 SENSOR VOLTAGE FIXED BELOW .35 VOLT (350 mV)?

YES

- DISCONNECT O_2 SENSOR.
- WITH ENGINE IDLING, "SCAN" TOOL SHOULD DISPLAY O_2 SENSOR VOLTAGE BETWEEN .35 VOLT AND .55 VOLT (350 mV AND 550 mV). DOES IT?

YES

REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

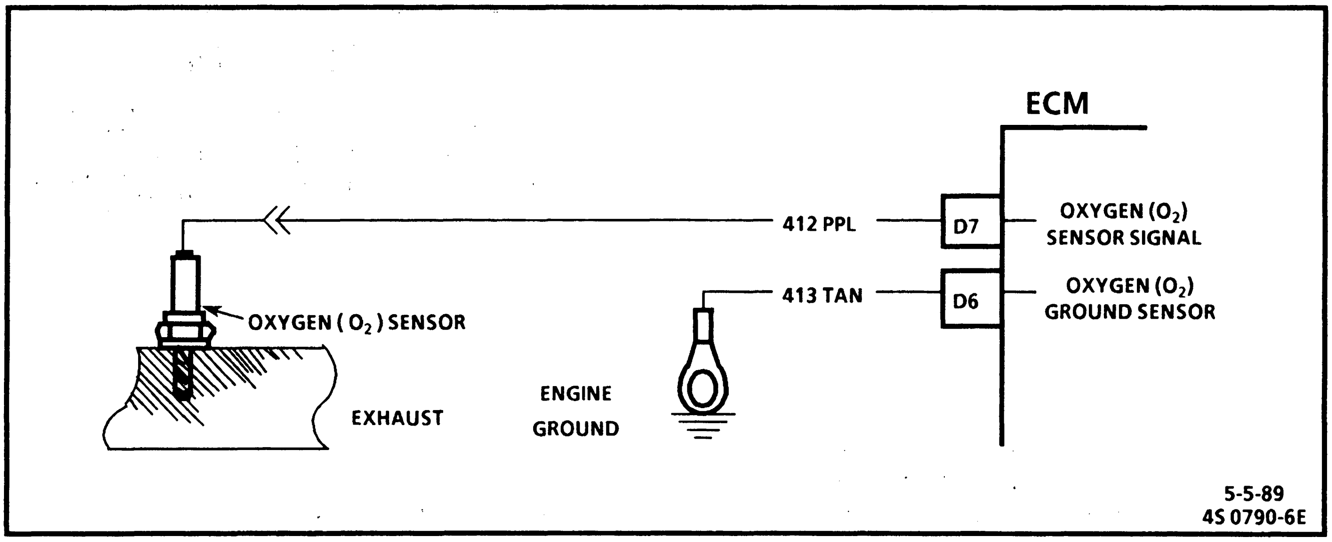
NO

CKT 412 SHORTED TO GROUND OR FAULTY ECM.

NO

CODE 44 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.



CODE 45

OXYGEN SENSOR CIRCUIT

(RICH EXHAUST INDICATED)

5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

The ECM supplies a voltage of about .45 volt between terminals "D6" and "D7". (If measured with a 10 megohm digital voltmeter, this may read as low as .32 volt.) The oxygen (O_2) sensor varies the voltage within a range of about 1 volt if the exhaust is rich, down through about .10 volt if exhaust is lean.

The sensor is like an open circuit and produces no voltage when it is below about 360°C (600°F). An open sensor circuit or cold sensor causes "Open Loop" operation.

Test Description: Number below refers to the circled number on the diagnostic chart.

1. Code 45 is set when the oxygen (O_2) sensor signal voltage on CKT 412.
   - Remains above .7 volt for 50 seconds; and in "Closed Loop."
   - Engine time after start is 1 minute or more.
   - Throttle angle greater than 2% (about .2 volt above idle voltage) but less than 25%.

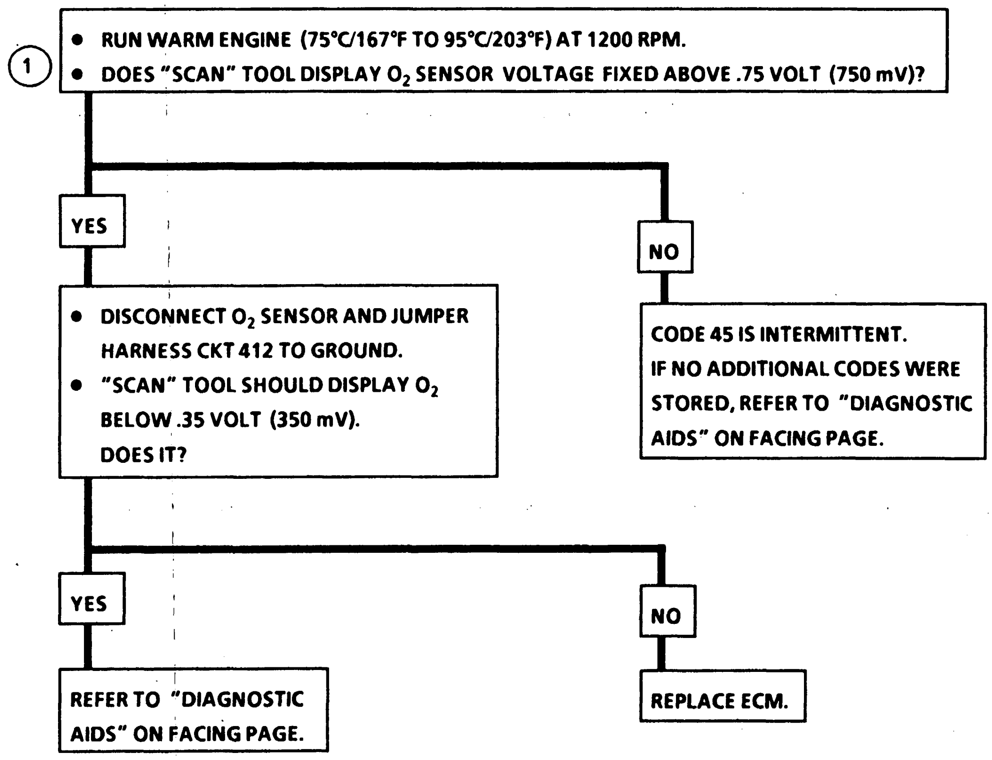
Diagnostic Aids:

Using the "Scan" tool, observe the block learn values at different rpm conditions to determine when the Code 45 may have been set. If the conditions for Code 45 exists, The block learn values will be around 115.

- Fuel Pressure System will go rich if pressure is too high. The ECM can compensate for some increase. However, if it gets too high, a Code 45 may be set. See "Fuel System Diagnosis," CHART A-7.
- Leaking injector See CHART A-7.
- Check for fuel contaminated oil.
- HEI Shielding An open ground CKT 453 (distributor ground, reference low) may result in Electro- Magnetic Interference (EMI), or induced electrical "noise." The ECM looks at this "noise" as reference pulses. The additional pulses result in a higher than actual engine speed signal. The ECM then delivers too much fuel, causing system to go rich. Engine tachometer will also show higher than actual engine speed, which can help in diagnosing this problem.
- Canister Purge Check for fuel saturation. If full of fuel, check canister control and hoses. See "Canister Purge," "Evaporative Emission Control System (EECS)," Section "6E2-C3".
- MAP Sensor An output that causes the ECM to sense a lower than normal vacuum can cause the system to go rich. Disconnecting the MAP sensor will allow the ECM to set a fixed value for the sensor. Substitute a different MAP sensor if the the rich condition is gone while the sensor is disconnected.
- TPS An intermittent TPS output will cause the system to go rich, due to a false indication of the engine accelerating.

CODE 45

OXYGEN SENSOR CIRCUIT
(RICH EXHAUST INDICATED)
5.0L (VIN E) "F" CARLINE (TBI)



①
- RUN WARM ENGINE (75°C/167°F TO 95°C/203°F) AT 1200 RPM.
- DOES "SCAN" TOOL DISPLAY O_2 SENSOR VOLTAGE FIXED ABOVE .75 VOLT (750 mV)?

YES

- DISCONNECT O_2 SENSOR AND JUMPER HARNESS CKT 412 TO GROUND.
- "SCAN" TOOL SHOULD DISPLAY O_2 BELOW .35 VOLT (350 mV). DOES IT?

YES

REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

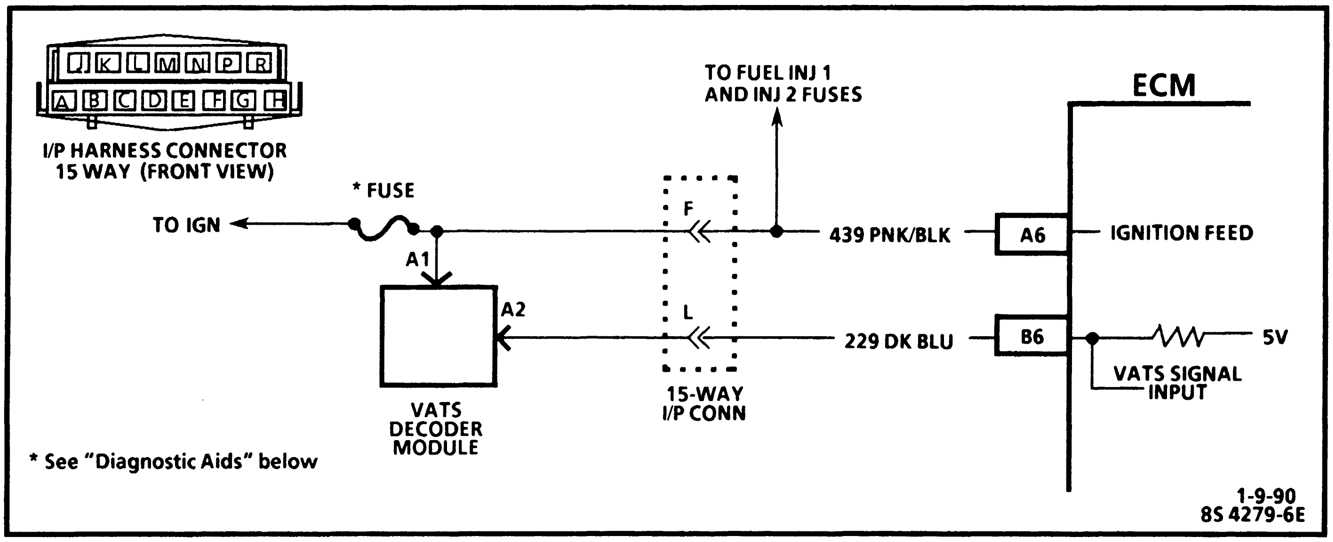
NO

REPLACE ECM.

NO

CODE 45 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.



CODE 53

VEHICLE ANTI-THEFT SYSTEM (VATS) CIRCUIT 5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

The VATS (PASS-key) system is designed to disable vehicle operation if the incorrect key or starting procedure is used. The VATS decoder module sends a signal to the ECM if the correct key is being used. If the proper signal does not reach the ECM on CKT 229, the ECM will not pulse the injectors "ON" and thus not allow the vehicle to be started.

Code 53 will set if the proper signal is not being received on CKT 229 by the ECM when the ignition is turned "ON." Code 53 does not store in the ECM memory but is only present when the conditions stated above are met.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

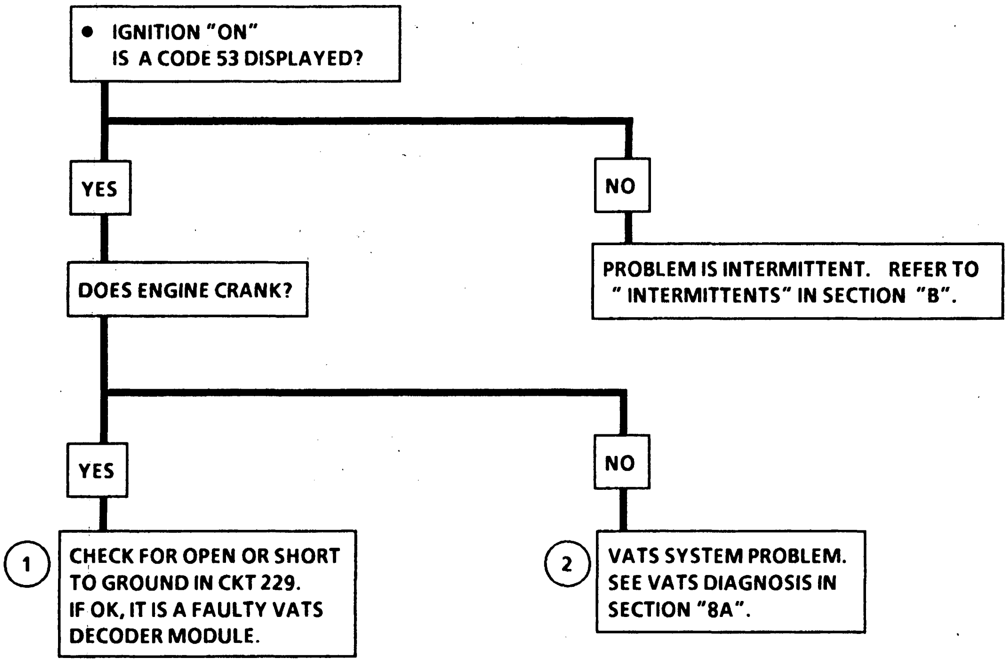
1. If the engine cranks but doesn't start. It indicates that the portion of the module which generates the signal to the ECM is not operating or CKT 229 is open or shorted to ground. If the decoder module is found to be OK, as determined from ELECTRICAL DIAGNOSIS (SECTION 8A), the ECM may be at fault, but this is not a likely condition.
2. The engine will not crank, it indicates that there is a VATS problem or an incorrect key or starting procedure is being used.

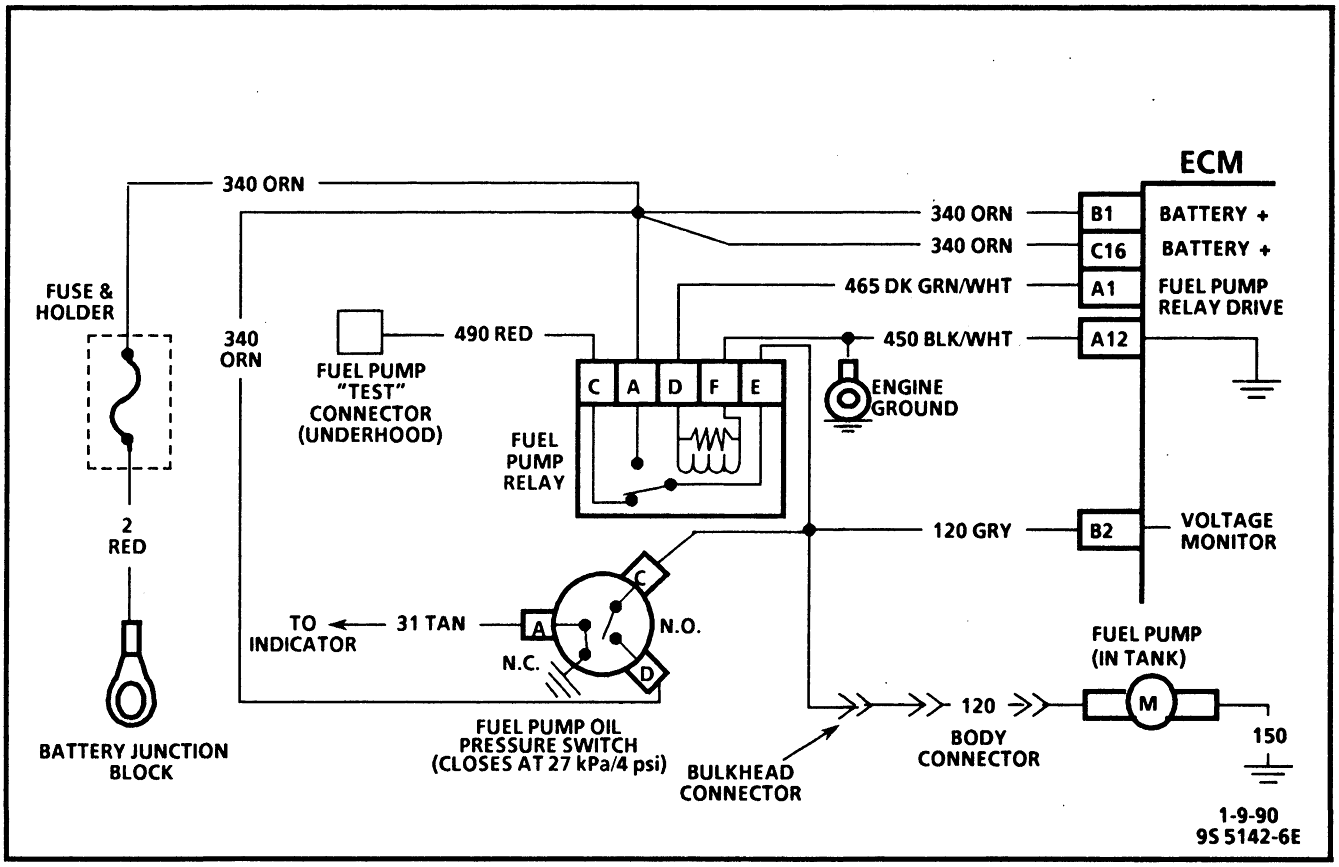
Diagnostic Aids:

* ECM FUSE

CODE 53

VEHICLE ANTI-THEFT SYSTEM (VATS) CIRCUIT
5.0L (VIN E) "F" CARLINE (TBI)





CODE 54

FUEL PUMP CIRCUIT
(LOW VOLTAGE)
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

When the ignition switch is turned "ON," the Electronic Control Module (ECM) will activate the fuel pump relay and run the in-tank fuel pump. The fuel pump will operate as long as the engine is cranking or running, and the ECM is receiving ignition reference pulses.

If there are no reference pulses, the ECM will shut "OFF" the fuel pump within 2 seconds after ignition "ON," or engine stops.

Should the fuel pump relay, or the 12 volt relay drive from the ECM fail, the fuel pump will be run through an oil pressure switch back-up circuit.

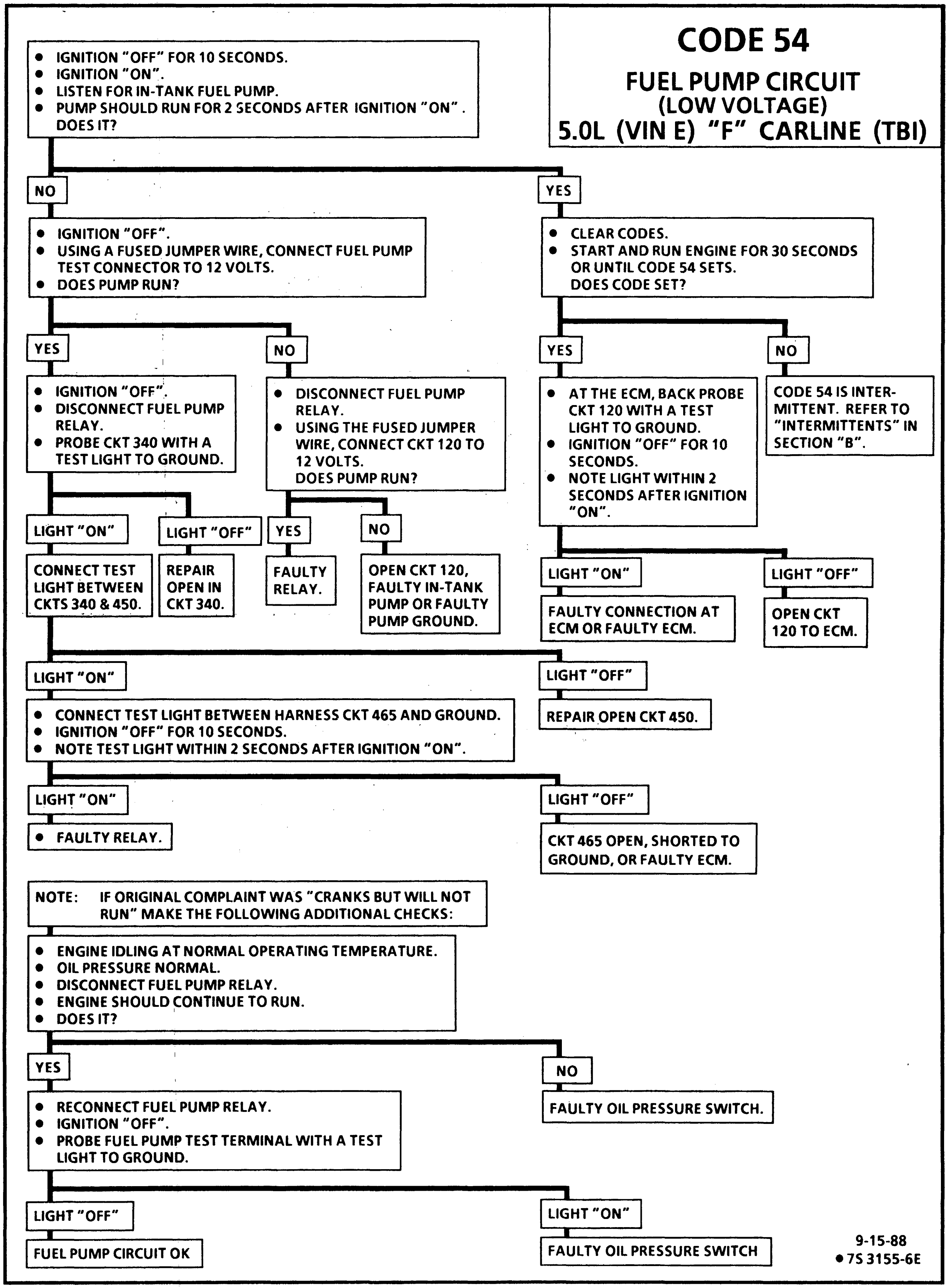
Code 54 will set if the ECM does not see the 12 volts signal on CKT 120 during the 2 seconds that the ECM is energizing the fuel pump relay.

Diagnostic Aids:

An inoperative fuel pump relay can result in long cranking times, particularly if the engine is cold or engine oil pressure is low. The extended crank period is caused by the time necessary for oil pressure to build enough to close the oil pressure switch and turn "ON" the fuel pump.

CODE 54

FUEL PUMP CIRCUIT (LOW VOLTAGE) 5.0L (VIN E) "F" CARLINE (TBI)



CODE 51

PROM ERROR
(FAULTY OR INCORRECT PROM)
5.0L (VIN E) "F" CARLINE (TBI)

CHECK THAT ALL PINS ARE FULLY INSERTED IN THE SOCKET. IF OK, REPLACE PROM, CLEAR MEMORY AND RECHECK. IF CODE 51 REAPPEARS, REPLACE ECM.

CLEAR ALL CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT

CODE 52

CALPAK ERROR
(FAULTY OR INCORRECT CALPAK)

CHECK THAT ALL PINS ARE FULLY INSERTED IN THE SOCKET. IF OK, REPLACE CALPAK, CLEAR MEMORY AND RECHECK. IF CODE 52 REAPPEARS, REPLACE ECM.

CLEAR ALL CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT

CODE 55

ECM ERROR

REPLACE ELECTRONIC CONTROL MODULE (ECM).

CLEAR ALL CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT

9-22-87
● 7S 3491-6E

SECTION B
SYMPTOMS
CONTENTS

IMPORTANT PRELIMINARY CHECKS

- Before using this section you should have performed the "Diagnostic Circuit Check."
- Verify the customer complaint, and locate the correct SYMPTOM below. Check the items indicated under that symptom.
- If the ENGINE CRANKS BUT WILL NOT RUN, use CHART A-3.
- Several of the following symptom procedures call for a careful visual/physical check.

The importance of this step cannot be stressed too strongly - it can lead to correcting a problem without further checks and can save valuable time.

BEFORE STARTING

This check should include:

- Vacuum hoses for splits, kinks, and proper connections, as shown on Vehicle Emission Control Information label.
- Air leaks at throttle body mounting and intake manifold.
- Ignition wires for cracking, hardness, proper routing, and carbon tracking.
- Wiring for proper connections, pinches, and cuts.
  If wiring harness or connector repair is necessary, refer to the "Introduction," "Driveability and Emissions," Section "6E" for correct procedure.
- The following symptoms cover several engines.

To determine if a particular system or component is used, refer to the ECM wiring diagrams for application.

INTERMITTENTS
(Page 1 of 2)

DEFINITION: Problem may or may not turn "ON" the "Service Engine Soon" light, or store a code.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms," Section "6E2-B".

TROUBLE CODE CHARTS IN "ENGINE COMPONENTS/WIRING DIAGRAMS/DIAGNOSTIC CHARTS," SECTION "6E2-A"

- DO NOT use the Trouble Code Charts in "Engine Components/Wiring Diagrams/Diagnostic Charts," Section "6E2-A" for intermittent problems. The fault must be present to locate the problem. If a fault is intermittent, use of Trouble Code Charts may result in replacement of good parts.

FAULTY ELECTRICAL CONNECTIONS OR WIRING

- Most intermittent problems are caused by faulty electrical connections or wiring. Perform careful check of suspect circuits for:
  - Poor mating of the connector halves, or terminals, not fully seated in the connector body (backed out).
  - Improperly formed or damaged terminals. All connector terminals in problem circuit should be carefully reformed or replaced to insure proper contact tension.
  - Poor terminal to wire connection. This requires removing the terminal from the connector body to check. See "Introduction" in "Driveability and Emissions," Section "6E", "Wiring Harness Service."

ROAD TEST

- If a visual (physical) check does not find the cause of the problem, the car can be driven with a voltmeter connected to a suspected circuit or a "Scan" tool may be used. An abnormal voltage or "Scan" reading, when the problem occurs, indicates the problem may be in that circuit. If the wiring and connectors check OK and a Trouble Code was stored for a circuit having a sensor, except for Codes 44 and 45.

INTERMITTENTS
(Page 2 of 2)

DEFINITION: Problem may or may not turn "ON" the "Service Engine Soon" light, or store a code.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms," Section "6E2-B".

INTERMITTENT "SERVICE ENGINE SOON LIGHT"

- An intermittent "Service Engine Soon" light, and No Trouble Codes, may be caused by:
  - Electrical system interference caused by a defective relay, ECM driven solenoid, or switch. They can cause a sharp electrical surge. Normally, the problem will occur when the faulty component is operated.
  - Improper installation of electrical options, such as lights, 2-way radios, etc.
  - EST wires should be routed away from spark plug wires, ignition system components, and generator. Wire for CKT 453 from ECM to ignition system should be a good ground.
  - Ignition secondary shorted to ground.
  - CKT 419 ("Service Engine Soon" light) or CKT 451 (Diagnostic "Test" Terminal) intermittently shorted to ground.
  - ECM power grounds.

LOSS OF TROUBLE CODE MEMORY

- To check, disconnect TPS and idle engine until "Service Engine Soon" light comes "ON." Code 22 should be stored, and kept in memory, when ignition is turned "OFF" for at least 10 seconds. If not, the ECM is faulty.

HARD START
(Page 1 of 2)

Definition: Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms," Section "6E2-B".
- Make sure the driver is using the correct starting procedure.

SENSORS

- CHECK: COOLANT TEMPERATURE SENSOR - Using a "Scan" tool compare coolant temperature with ambient temperature on cold engine.
  - If coolant temperature reading 5 degrees greater than or less than ambient air temperature, check for high resistance in coolant sensor circuit or sensor itself. Compare resistance value to CODE 15 chart.
- CHECK: TPS - If a sticking throttle shaft or binding linkage causes a high TPS voltage (open throttle indication), the ECM will not control idle. Monitor TPS voltage. A "Scan" tool and/or Voltmeter should read less than 1.2 volts with throttle closed.

FUEL SYSTEM

- NOTE: Fuel pump relay operation - pump should turn "ON" for 2 seconds when ignition is turned "ON." SEE CHART A-7 and A-5.
- CHECK: Fuel Pressure, CHART A-7
- CHECK: Water contaminated fuel. For a faulty in-tank fuel pump check valve, which would allow the fuel in the lines to drain back to the tank after the engine is stopped. To check for this condition:
  1. Ignition "OFF."
  2. Disconnect fuel line at the filter.
  3. Remove the tank filler cap.
  4. Connect a radiator test pump to the fuel line and apply 103 kPa (15 psi) pressure. If the pressure will hold for 60 seconds, the check valve is OK.
- CHECK: Fuel pump relay - Connect test light between fuel pump "test" terminal and ground. Light should be "ON" for 2 seconds following ignition "ON." If not, refer to CODE 54 chart.

HARD START
(Page 2 of 2)

Definition: Engine Cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms," Section "6E2-B".
- Make sure the driver is using the correct starting procedure.

IGNITION SYSTEM

- **CHECK:** Ignition system for:
  - Proper output with ST-125.
  - Worn distributor shaft.
  - Bare and shorted wires.
  - Pickup coil resistance and connections.
  - Loose ignition coil connections.
  - Moisture in distributor cap.
  - Spark plugs, wet plugs, cracks, wear, improper gap, burned electrodes or heavy deposits.
- **NOTE:** If engine starts but then, immediately stalls, disconnect the set timing connector. If engine then starts, and runs OK, replace distributor pickup coil.
- **CHECK:** CKT 423 (EST) for short to ground.

ADDITIONAL CHECKS

- **CHECK:** IAC operation - see CHART C-2C
- **CHECK:** No crank signal - see CHART C-1B
- **CHECK:** EGR operation - see CHART C-7

SURGES AND/OR CHUGGLES

Definition: Engine power variation, under steady throttle or cruise. Feels like the car speeds up and slows down, with no change in the accelerator pedal.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms," Section "6E2-B".
- Be sure driver understands transmission/transaxle converter clutch and A/C compressor operation in owner's manual.
- Use a "Scan" tool to make sure reading of VSS matches vehicle speedometer. See "Special Information," "Driveability and Emissions," Section "6E".

SENSORS

- **CHECK:** Oxygen sensor for silicon contamination from fuel, or use of improper RTV sealant. The sensor may have a white, powdery coating and result in a high but false signal voltage (rich exhaust indication). The ECM will then reduce the amount of fuel delivered to the engine, causing a severe driveability problem.

FUEL SYSTEM

- **NOTE:** To determine if the condition is caused by a rich or lean system, the car should be driven at the speed of the complaint. Monitoring block learn will help identify problem.

Lean - Block learn greater than 150	Refer to "Diagnostic Aids" on facing page of CODE 44.
Rich - Block learn less than 115	Refer to "Diagnostic Aids" on facing page of CODE 45.

- **CHECK:** Fuel pressure while condition exists. See CHART A-7.
- **CHECK:** In-line fuel filter. Replace if dirty or plugged.

IGNITION SYSTEM

- **CHECK:** For proper output voltage using spark tester (ST-125) J 26792 or equivalent.
- **CHECK:** Spark plugs. After removing spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. repair or replace as necessary.

ADDITIONAL CHECKS

- **CHECK:** Generator output voltage. Repair if less than 9 or more than 16 volts.
- **CHECK:** Vacuum lines for kinks or leaks.
- **CHECK:** For intermittent EGR at idle, use CHART C-7.
- **CHECK:** TCC operation. Use CHART C-8A.

LACK OF POWER, SLUGGISH, OR SPONGY

(Page 1 of 3)

Definition: Engine delivers less than expected power. Little or no increase in speed, when accelerator pedal is pushed down part way.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms," Section "6E2-B".
- Compare customer's car to similar unit. Make sure the customer has an actual problem.
- Remove air filter and check air filter for dirt, or for being plugged, replace as necessary.
- If there is spray from only one injector, then, there is a malfunction in the injector assembly, or in the signal to the injector assembly. The malfunction can be isolated, by switching the injector connectors. If the problem remains with the original injector, after switching the connector, the injector is defective. Replace the injector. If the problem moves with the injector connector, the problem is an improper signal in the injector circuits, use CHART A-3.

FUEL SYSTEM

CHECK: For restricted fuel filter, contaminated fuel or improper fuel pressure, use CHART A-7.

IGNITION SYSTEM

- **CHECK:** Proper output with spark tester J 26792 or equivalent (ST-125).
- **CHECK:** Ignition timing. See "Vehicle 'Emission Control Information" label.
- **CHECK:** Proper operation of EST. Refer to "Ignition "System/EST," Section "6E2-C4".

LACK OF POWER, SLUGGISH, OR SPONGY

(Page 2 of 3)

Definition: Engine delivers less than expected power. Little or no increase in speed, when accelerator pedal is pushed down part way.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms," Section "6E2-B".
- Make sure the customer has an actual problem.
- Remove air filter and check air filter for dirt, or for being plugged, replace as necessary.
- If there is spray from only one injector, then, there is a malfunction in the injector assembly, or in the signal to the injector assembly. The malfunction can be isolated, by switching the injector connectors. If the problem remains with the original injector, after switching the connector, the injector is defective. Replace the injector. If the problem moves with the injector connector, the problem is an improper signal in the injector circuits, use CHART A-3.

EXHAUST SYSTEM

- CHECK: Exhaust System for possible restriction: See CHART B-1.
  Inspect exhaust system for damaged or collapsed pipes. Inspect muffler for heat distress or possible internal failure.
  1. With engine at normal operating temperature, connect a vacuum gage to any convenient vacuum port on intake manifold.
  2. Run engine at 1000 rpm and record vacuum reading.
  3. Increase rpm slowly to 2500 rpm. Note vacuum reading at steady 2500 rpm.
  4. If vacuum at 2500 rpm decreases more than 3", from reading at 1000 rpm, the exhaust system should be inspected for restrictions.
  5. Disconnect exhaust pipe from engine and repeat steps 3 & 4. If vacuum still drops more than 3", with exhaust disconnected, check valve timing.

ADDITIONAL CHECKS

- CHECK: ECM power grounds, see wiring diagrams.
- CHECK: Engine valve timing and compression.
- CHECK: EGR operation for being open or partly open, all the time. Use CHART C-7.
- CHECK: Engine, for proper or worn camshaft. Refer to ENGINE MECHANICAL DIAGNOSIS (SECTION 6A).
- CHECK: Transmission torque converter operation. Refer to AUTOMATIC TRANSMISSION DIAGNOSIS (SECTION 7A).
- CHECK: A/C operation. A/C clutch should cut out at Wide Open Throttle (WOT). See A/C CHART C-10.
- CHECK: Generator output voltage. Repair if less than 9 or more than 16 volts.

LACK OF POWER, SLUGGISH, OR SPONGY

(Page 3 of 3)

Definition: Engine delivers less than expected power. Little or no increase in speed, when accelerator pedal is pushed down part way.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms," Section "6E2-B".
- Make sure the customer has an actual problem.
- Remove air filter and check air filter for dirt, or for being plugged, replace as necessary.
- If there is spray from only one injector, then, there is a malfunction in the injector assembly, or in the signal to the injector assembly. The malfunction can be isolated, by switching the injector connectors. If the problem remains with the original injector, after switching the connector, the injector is defective. Replace the injector. If the problem moves with the injector connector, the problem is an improper signal in the injector circuits, use CHART A-3.

ENGINE MECHANICAL

- **CHECK:** Engine valve timing and compression.
- **CHECK:** Engine, for proper or worn camshaft. Refer to ENGINE MECHANICAL DIAGNOSIS (SECTION 6A).

DETONATION/SPARK KNOCK
(Page 1 of 3)

Definition: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms," Section "6E2-B".
- Make sure the customer has an actual problem.
- Remove air filter and check air filter for dirt, or for being plugged, replace as necessary.
- If there is spray from only one injector, then, there is a malfunction in the injector assembly, or in the signal to the injector assembly. The malfunction can be isolated, by switching the injector connectors. If the problem remains with the original injector, after switching the connector, the injector is defective. Replace the injector. If the problem moves with the injector connector, the problem is an improper signal in the injector circuits, use CHART A-3.

COOLING SYSTEM

- CHECK: For obvious over heating problems. Refer to COOLING AND RADIATOR (SECTION 6B).
- CHECK: Low coolant.
- CHECK: Loose water pump belt
- CHECK: Restricted air flow to radiator, or restricted water flow thru radiator.
- CHECK: Faulty or incorrect thermostat.
- CHECK: Correct coolant solution - should be a 50/50 mix of GM #1052753 anti-freeze coolant (or equivalent) and water.

SENSOR

- CHECK: Coolant Temperature Sensor (CTS), which has shifted in value.

DETONATION/SPARK KNOCK

(Page 2 of 3)

Definition: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms," Section "6E2-B".
- Make sure the customer has an actual problem.
- Remove air filter and check air filter for dirt, or for being plugged, replace as necessary.
- If there is spray from only one injector, then, there is a malfunction in the injector assembly, or in the signal to the injector assembly. The malfunction can be isolated, by switching the injector connectors. If the problem remains with the original injector, after switching the connector, the injector is defective. Replace the injector. If the problem moves with the injector connector, the problem is an improper signal in the injector circuits, use CHART A-3.

FUEL SYSTEM

- **NOTE:** To determine if the condition is caused by a rich or lean system, the car should be driven at the speed of the complaint. Monitoring block learn will help identify problem.

Lean - Block learn greater than 150	Refer to "Diagnostic Aids" on facing page of CODE 44.
Rich - Block learn less than 115	Refer to "Diagnostic Aids" on facing page of CODE 45.

- **CHECK:** Fuel pressure, CHART A-7.
- **CHECK:** For poor fuel quality, proper octane rating.
- **CHECK:** If "Scan" tool readings are normal (see facing page of "Diagnostic Circuit Check") and there are no engine mechanical faults, fill fuel tank with a premium gasoline that has a minimum octane rating of 92 and reevaluate vehicle performance.

IGNITION SYSTEM

- **CHECK:** ESC system operation see CHART C-5.
- **CHECK:** Ignition timing. See "Vehicle Emission "Control Information" label.

DETONATION/SPARK KNOCK

(Page 3 of 3)

Definition: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms," Section "6E2-B".
- Compare customer's car to similar unit. Make sure the customer has an actual problem.
- Remove air filter and check air filter for dirt, or for being plugged, replace as necessary.
- If there is spray from only one injector, then, there is a malfunction in the injector assembly, or in the signal to the injector assembly. The malfunction can be isolated, by switching the injector connectors. If the problem remains with the original injector, after switching the connector, the injector is defective. Replace the injector. If the problem moves with the injector connector, the problem is an improper signal in the injector circuits, use CHART A-3.

ADDITIONAL CHECKS

- CHECK: For carbon buildup. Remove carbon with top engine cleaner, follow instructions on can.
- CHECK: For proper transmission shift points. Refer to AUTOMATIC TRANSMISSION DIAGNOSIS (SECTION 7A).
- CHECK: TCC operation. Use CHART C-8.
- CHECK: For incorrect basic engine parts such as cam, heads, pistons, etc.
- CHECK: Excessive oil entering combustion chamber.
- CHECK: For correct PROM.
- CHECK: Spark plugs for correct heat range.
- CHECK: Proper operation of Thermac.

ENGINE MECHANICAL

- CHECK: For incorrect basic engine parts such as cam, heads, pistons, etc.
- CHECK: Excessive oil entering combustion chamber.

HESITATION, SAG, STUMBLE

Definition: Momentary lack of response as the accelerator is pushed down. Can occur at all car speeds. Usually most severe when first trying to make the car move, as from a stop sign. May cause the engine to stall if severe enough.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms," Section "6E2-B".

FUEL SYSTEM

- **CHECK:** TPS - Check TPS for binding or sticking. Voltage should increase at a steady rate as throttle is moved toward Wide Open Throttle (WOT).
- **CHECK:** MAP SENSOR - See CHART C-1D.

IGNITION SYSTEM

- **CHECK:** Spark plugs for being fouled or for there being faulty wiring.
- **CHECK:** For open ignition system ground, CKT 453.
- **CHECK:** Ignition timing. See "Vehicle Emission Control Information" label.

ADDITIONAL CHECKS

- **CHECK:** Generator output voltage. Repair, if less than 9 or more than 16 volts.
- **CHECK:** EGR valve operation. Use CHART C-7

CUTS OUT, MISSES

(Page 1 of 2)

Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases. The exhaust has a steady spitting sound at idle or low speed.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms," Section "6E2-B".
- If there is spray from only one injector, then, there is a malfunction in the injector assembly, or in the signal to the injector assembly. The malfunction can be isolated, by switching the injector connectors. If the problem remains with the original injector, after switching the connector, the injector is defective. Replace the injector. If the problem moves with the injector connector, the problem is an improper signal in the injector circuits, use CHART A-3.

FUEL SYSTEM

- CHECK: Fuel Pressure, CHART A-7.
- CHECK: Water contaminated fuel or restricted fuel filter.

IGNITION SYSTEM

- CHECK: For missing cylinder by:

1. Start engine, allow engine to stabilize then disconnect IAC motor. Remove one spark plug wire at a time, using insulated pliers.

CAUTION: Do not perform this test for more than 2 minutes, as this may cause damage to the catalytic converter.

2. If there is an rpm drop, on all cylinders, (equal to within 50 rpm), go to ROUGH, UNSTABLE OR INCORRECT IDLE, STALLING symptom. Reconnect IAC motor with engine running, ignition "OFF."
3. If there is no rpm drop on one or more cylinders, or excessive variation in drop, check for spark, on the suspected cylinder(s) with J 26792 (ST-125) Spark Tester or equivalent. If no spark, use CHART C-4. If there is spark, remove spark plug(s) in these cylinders and check for:
   - Cracks
   - Wear
   - Improper Gap
   - Burned Electrodes
   - Heavy Deposits

- CHECK: Wire resistance (should not exceed 30,000 ohms), also, check rotor and distributor cap.

- NOTE: If the previous checks did not find the problem:
  - Visually inspect ignition system for moisture, dust, cracks, burns, etc. Spray plug wires with fine water mist to check for shorts.

CUTS OUT, MISSES
(Page 2 of 2)

Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases. The exhaust has a steady spitting sound at idle or low speed.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms," Section "6E2-B".
- If there is spray from only one injector, then, there is a malfunction in the injector assembly, or in the signal to the injector assembly. The malfunction can be isolated, by switching the injector connectors. If the problem remains with the original injector, after switching the connector, the injector is defective. Replace the injector. If the problem moves with the injector connector, the problem is an improper signal in the injector circuits, use CHART A-3.

ENGINE MECHANICAL

- CHECK: For proper valve timing. Remove rocker covers. Check for bent pushrods, worn rocker arms, broken or weak valve springs, worn camshaft lobes. Repair as necessary. Refer to ENGINE MECHANICAL DIAGNOSIS (SECTION 6A).
- CHECK: For casting flash.
- CHECK: Intake and exhaust manifolds.
- CHECK: Low compression. Perform compression check. Refer to ENGINE MECHANICAL DIAGNOSIS (SECTION 6A).

POOR FUEL ECONOMY

Definition: Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, economy is noticeably lower than it was on this car at one time, as previously shown by an actual road test.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms," Section "6E2-B".
- Perform "Diagnostic Circuit Check."
- Check owner's driving habits.
  - Is A/C "ON" full time (Defroster mode "ON")?
  - Are tires at correct pressure?
  - Are excessively heavy loads being carried?
  - Is acceleration too much, too often?
- Check air cleaner element (filter) for dirt or being plugged.
- Visually (physically) check: Vacuum hoses for splits, kinks, and proper connections as shown on "Vehicle Emission Control Information" label.

FUEL SYSTEM

- **CHECK:** For exhaust system restriction. See CHART B-1.
- **CHECK:** Fuel pressure. See CHART A-7
- **CHECK:** Compression. See Section "6A".

IGNITION SYSTEM

- **CHECK:** ESC operation. Refer to "Electronic Spark Control (ESC) System," Section "6E2-C5".
- **CHECK:** Spark plugs. After removing spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary.
- **CHECK:** Ignition wires for cracking, hardness, and proper connections.
- **CHECK:** Ignition timing. See "Vehicle Emission "Control Information label.

COOLING SYSTEM

- **CHECK:** Engine thermostat for faulty part (always open) or for wrong heat range. See Section "6B".

ADDITIONAL CHECKS

- **CHECK:** TCC Operation - Check for proper operation. See CHART C-8. A "Scan" should indicate an rpm drop, when the TCC is commanded "ON."
- **CHECK:** For proper calibration of speedometer.
- **CHECK:** For dragging brakes.
- Suggest owner fill fuel tank and recheck fuel economy.
- Suggest driver read "Important Facts on Fuel Economy" in Owner's Manual.

STALLING, ROUGH, UNSTABLE OR INCORRECT IDLE

(Page 1 of 2)

Definition: The engine runs unevenly at idle. If bad enough, the car may shake. Also, the idle may vary in rpm (called "hunting"). Either condition may be severe enough to cause stalling. Engine idles at incorrect speed.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms," Section "6E2-B".

SENSORS

- CHECK: OXYGEN SENSOR - Inspect sensor for silicon contamination from fuel, or use of improper RTV sealant. The sensor will have a white, powdery coating, and will result in a high but false signal voltage (rich exhaust indication). The ECM will then reduce the amount of fuel delivered to the engine, causing a severe driveability problem.
- CHECK: TPS - If a sticking throttle shaft or binding linkage causes a high TPS voltage (open throttle indication, the ECM will not control idle. Monitor TPS voltage. A "Scan" tool and/or voltmeter should read less than 1.2 volts with throttle closed.
- CHECK: COOLANT TEMPERATURE SENSOR (CTS) - Using a "Scan" tool compare coolant temperature with ambient temperature on cold engine.
  - If coolant temperature reading 5 degrees greater than or less than ambient air temperature. Check for high resistance in coolant sensor circuit or sensor itself. Compare resistance value to CODE 15 chart.
- CHECK: MAP SENSOR - Refer to CHART C-10 MAP voltage output check.

FUEL SYSTEM

- **NOTE:** To determine if the condition is caused by a rich or lean system, the car should be driven at the speed of the complaint. Monitoring block learn will help identify problem.

Lean - Block learn greater than 150	Refer to "Diagnostic Aids" on facing page of CODE 44.
Rich - Block learn less than 115	Refer to "Diagnostic Aids" on facing page of CODE 45.

- CHECK: For fuel in pressure regulator hose. If present, replace regulator assembly.
- CHECK: Evaporative Emission Control System. CHART C-3.
- CHECK: Run a cylinder compression check. See Section "6".
- CHECK: For injector(s) leaking. Check fuel pressure, see CHART A-7.

STALLING, ROUGH, UNSTABLE OR INCORRECT IDLE

(Page 2 of 2)

Definition: The engine runs unevenly at idle. If bad enough, the car may shake. Also, the idle may vary in rpm (called "hunting"). Either condition may be severe enough to cause stalling. Engine idles at incorrect speed.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms," Section "6E2-B".

IGNITION SYSTEM

- **CHECK:** Ignition System. Refer to "Ignition System/EST," Section "6E2-C4".
- **CHECK:** Ignition Timing. See "Vehicle Emission Control Information" label.

ADDITIONAL CHECKS

- **CHECK:** IAC valve will not move, if system voltage is below 9 or greater than 16 volts.
- **CHECK:** IAC Operation - See CHART C-2C
- **CHECK:** ECM Ground circuits.
- **CHECK:** P/N Switch Circuit. See CHART C-1A, or use "Scan" tool, and be sure tool indicates vehicle is in drive with gear selector in drive (125c).

- **NOTE:** Use "Scan" tool to determine if ECM is receiving A/C request signal. If problem exists with A/C "ON," check A/C system operation CHART C-10.

- **CHECK:** EGR "ON," while idling, will cause roughness, stalling, and hard starting. Use CHART C-7.
- **CHECK:** Battery cables and ground straps should be clean and secure. Erratic voltage will cause IAC to change its position, resulting in poor idle quality.
- **CHECK:** A/C refrigerant pressure too high.
- **CHECK:** For overcharge or faulty pressure switch.
- **CHECK:** PCV valve for proper operation by placing finger over inlet hole in valve end several times. Valve should snap back. If not, replace valve.

ENGINE MECHANICAL

- **CHECK:** Vacuum leaks can cause higher than normal idle.
- **CHECK:** For Broken motor mounts.
- **CHECK:** For low compression.

EXCESSIVE EXHAUST EMISSIONS OR ODORS

(Page 1 of 2)

Definition: Vehicle fails an emission test. Vehicle has excessive "rotten egg" smell. Excessive odors do not necessarily indicate excessive emissions.

PRELIMINARY CHECKS

- Perform "Diagnostic Circuit Check."
- If Emission Test shows excessive CO and HC check items which cause car to run RICH. Make sure engine is at normal operating temperature.
- If Emission Test shows excessive NOx check items which cause car to run LEAN or too hot.

SENSORS

- NOTE: If the "Scan" tool indicates a very high coolant temperature and the system is running LEAN:
  Check the Coolant System and Coolant Fan for proper operation. Also check for vacuum leaks.

FUEL SYSTEM

- NOTE: If the system is running rich, (block learn less than 110), refer to "Diagnostic Aids" on facing page of Code 45. If the system is running lean, (block learn greater than 138), refer to "Diagnostic Aids" on facing page of Code 44.
- CHECK: For properly insulated fuel cap.
- CHECK: Fuel pressure. "CHART A-7.
- NOTE: If test shows excessive NOx, check items which cause car to run LEAN or too hot.
- CHECK: Canister for fuel loading. See CHART C-3.

EXCESSIVE EXHAUST EMISSIONS OR ODORS

(Page 1 of 2)

Definition: Vehicle fails an emission test. Vehicle has excessive "rotten egg" smell. Excessive odors do not necessarily indicate excessive emissions.

PRELIMINARY CHECKS

- Perform "Diagnostic Circuit Check."
- If Emission Test shows excessive CO and HC check items which cause car to run RICH. Make sure engine is at normal operating temperature.
- If Emission Test shows excessive NOx check items which cause car to run LEAN or too hot.

COOLING SYSTEM

- **CHECK:** Coolant system and coolant fan for proper operation. Use CHART C-12.

IGNITION SYSTEM

- **CHECK:** Ignition system. See "Ignition System/EST," Section "C4".
- **CHECK:** For incorrect timing or excessive buse advance. See "Vehicle Emission Control Information" label.
- **CHECK:** Spark plugs, plug wires, and ignition components. Refer to ENGINE ELECTRICAL (SECTION 6D).

ADDITIONAL CHECKS

- **CHECK:** For lead contamination of catalytic converter (look for the removal of fuel filler neck restrictor).
- **CHECK:** Remove carbon with top engine cleaner. Follow instructions on can.
- **CHECK:** EGR valve for not opening. See CHART C-7. Vacuum leaks.
- **CHECK:** PCV valve for being plugged, stuck, or blocked PCV hose, or fuel in the crankcase.

ENGINE MECHANICAL

- **CHECK:** EGR valve for not opening. See CHART C-7. Vacuum leaks.
- **CHECK:** PCV valve for being plugged, stuck, or blocked PCV hose, or fuel in the crankcase.

DIESELING, RUN-ON

Definition: Engine continues to run after key is turned "OFF," but runs very roughly. If engine runs smoothly, check ignition switch and adjustment.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms," Section "6E2-B".

FUEL SYSTEM

- **CHECK:** Injector(s) for leaking. Apply 12 volts to fuel pump "test" terminal (located underhood) to turn "ON" fuel pump and pressurize fuel system. Visually check injector(s) and TBI assembly for fuel leakage. Refer to CHART A-7 "Fuel System Diagnosis."

BACKFIRE

Definition: Fuel ignites in intake manifold, or in exhaust system, making a loud popping noise.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms," Section "6E2-B".

FUEL SYSTEM

- **CHECK:** Compression. Perform a compression check - look for sticking or leaking valves. Refer to ENGINE MECHANICAL DIAGNOSIS (SECTION 6A).
  - For proper valve timing.

IGNITION SYSTEM

- **CHECK:** Proper output with spark tester J 26792 or equivalent (ST-125).
- **CHECK:** Spark plugs. After removing spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. "Repair or replace as necessary.
- **CHECK:** Ignition system. See "Ignition System/EST," Section "6E2-C4".
- **CHECK:** For crossfire between spark plugs (distributor cap, spark plug wires, and proper routing of plug wires.) "Refer to ENGINE ELECTRICAL (SECTION 6D).
- **CHECK:** Ignition timing. See "Vehicle Emission Control Information" label.

ENGINE MECHANICAL

- **CHECK:** Valve timing.
- **CHECK:** Intake manifold gasket for vacuum leaks.
- **CHECK:** Intake and exhaust manifolds for casting flash.
- **CHECK:** Faulty A.I.R. check valve.
- **CHECK:** EGR operation for being open all the time. Use CHART C-7.

BLACK 24 PIN A - B CONNECTOR

PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR CAVITY	NORMAL VOLTAGES ⑥		CODES AFFECT	POSSIBLE SYMPTOMS FROM FAULTY CIRCUIT
				KEY "ON"	ENG RUN		
A1 FUEL PUMP RELAY DRIVE	465	DK GRN/ WHT	FUEL PUMP RELAY CONN. "D"	0* ②	B +	NONE	HARD TO START, LONG CRANK TIME. SEE CHART A-7.
A2 NC							
A3 CANISTER PURGE SOLENOID CONTROL	428	DK GRN/ YEL	CANISTER PURGE SOLENOID CONN. "B"	0*	B +	NONE	FUEL LOSS OR FUEL VAPOR ODOR, POOR IDLE, STALLING, POOR DRIVEABILITY. SEE SECTION C3.
A4 EGR SOLENOID CONTROL	435	GRY	EGR SOLENOID CONN. "A"	B +	B +	32	ROUGH IDLE, SPARK KNOCK, STALLS AFTER COLD START, SURGE DURING CRUISE. SEE SECTION C7.
A5 "SERVICE ENGINE SOON" LIGHT	419	BRN/ WHT	**	0*	B +	NONE	BULB CHECK, NO SES LIGHT ⑧ LIGHT "ON" ALL TIME, DOES NOT FLASH. ⑩ SEE DIAGNOSTIC CIRCUIT CHECK.
A6 IGNITION FEED	439	PNK/ BLK	**	B +	B +	NONE	NO START, NO SES LIGHT, NO DATA ⑧ ECM FUSE BLOWN, GAUGES FUSE BLOWN ⑩ VATS. ** SEE DIAGNOSTIC CIRCUIT CHECK.
A7 M/T SHIFT LIGHT	456	TAN/ BLK	I/P PRINTED CIRCUIT CONN. "H"	B +	B +	NONE	NO SHIFT LIGHT. ⑧ SEE SECTION C8.
A7 A/T TCC CONTROL	422	TAN/ BLK	AUTO TRANS. TCC CONN. "D"	B +	B +	NONE	NO 4TH GEAR SWITCH, POOR FUEL ECONOMY, CHUGGLE OR SURGE CONDITION. SEE SECTION C8.
A8 SERIAL DATA	461	ORN	ALDL CONN. "E"	VARIES 2-5	2-5	NONE	NO ALDL DATA OR WILL NOT FLASH CODE 12. ⑨ SEE DIAGNOSTIC CIRCUIT CHECK.
A9 DIAGNOSTIC "TEST" TERMINAL	451	WHT/ BLK	ALDL CONN. "B"	5	5	NONE	NO ALDL DATA OR WILL NOT FLASH CODE 12. ⑨ SEE DIAGNOSTIC CIRCUIT CHECK.
A10 VEHICLE SPEED SENSOR SIGNAL	437	BRN	VSS BUFFER CONN. "C"	0 OR 12 ①	0 OR 12 ①	24	SPEEDOMETER INOPERATIVE ⑨ SCAN VSS NOT EQUAL TO SPEEDOMETER. ** SEE SECTION C8.
A11 CTS, TPS, AND MAT SENSOR GROUND	452	BLK	CTS, TPS, MAT SENSOR CONN. "A"	0*	0*	15, 21 23	HIGH IDLE, ROUGH IDLE, HARD TO START, POOR PERFORMANCE, EXCESSIVE EXHAUST EMISSIONS OR ODORS. ⑧
A12 ECM GROUND	450	BLK/ WHT	ENG. GND. ALDL CONN. "A"	0*	0*	NONE	A12 AND D1 OPEN, NO START. SEE DIAGNOSTIC CIRCUIT CHECK.

① VARIES FROM .60 TO BATTERY VOLTAGE, DEPENDING ON POSITION OF DRIVE WHEELS.
② 12 VOLTS FOR FIRST TWO SECONDS.
③ VARIES.
④ 12 VOLTS WHEN FUEL PUMP IS RUNNING.
⑤ VARIES WITH TEMPERATURE.
⑥ READS BATTERY VOLTAGE IN GEAR.
⑦ 12 VOLTS, WHEN ENGINE IS CRANKING.
⑧ OPEN.
⑨ OPEN/GROUNDED CIRCUIT.
⑩ GROUNDED CIRCUIT.

* LESS THAN .5 VOLT.
** REFER TO SECTION 8A ELECTRICAL DIAGNOSIS.

1-11-90
MS 9091-6E

BLACK 24 PIN A - B CONNECTOR

PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR CAVITY	NORMAL VOLTAGES ⑥		CODES AFFECT	POSSIBLE SYMPTOMS FROM FAULTY CIRCUIT
				KEY "ON"	ENG RUN		
B1 BATTERY	340	ORN	**	B+	B+	NONE	IF C16 AND B1 OPEN, NO START. SEE DIAGNOSTIC CIRCUIT CHECK.
B2 FUEL PUMP SIGNAL	120	GRY	FUEL PUMP RELAY CONN. "E" O.P.S. CONN. "C"	0	B+ ④	54	HARD TO START. SEE CHART A-7.
B3 DIST. GROUND REFERENCE LOW	453	BLK/ RED	DIST. FOUR PIN CONN. "A"	0*	0*	NONE	POOR PERFORMANCE. ⑧
B4 N/C							
B5 REFERENCE	430	PPL/ WHT	DIST. FOUR PIN CONN. "C"	0	1.3	NONE	NO START. SEE DIAGNOSTIC CIRCUIT CHECK.
B6 VATS (PASS-KEY) SIGNAL	229	DK BLU	VATS MODULE CONN. "A2"	5	5	53	NO START. SEE DIAGNOSTIC CIRCUIT CHECK. **
B7 SPARK RETARD SIGNAL (ESC)	485	BLK	ESC MODULE CONN. "C"	9.2	9.3	43	POOR PERFORMANCE, POOR FUEL ECONOMY. SEE SECTION C5.
B8 A/C REQUEST SIGNAL	67	LT BLU	A/C PRESS. CYCLE SWITCH LOW PRESS. SWITCH	"OFF" 0 "ON" B+	"OFF" 0 "ON" B+	NONE	NO A/C CLUTCH ENGAGEMENT. ⑧
B9 N/C							
B10 PARK/NEUTRAL SWITCH SIGNAL	434	ORN/ BLK	PARK/NEUTRAL (P/N) SWITCH CONN. "B"	0	0 ⑥	NONE	STALLING, ROUGH UNSTABLE OR INCORRECT IDLE. SEE CHART C-1A.
B11 N/C							
B12 N/C							

① VARIES FROM .60 TO BATTERY VOLTAGE, DEPENDING ON POSITION OF DRIVE WHEELS.
② 12 VOLTS FOR FIRST TWO SECONDS.
③ VARIES.
④ 12 VOLTS WHEN FUEL PUMP IS RUNNING.
⑤ VARIES WITH TEMPERATURE.
⑥ READS BATTERY VOLTAGE IN GEAR.
⑦ 12 VOLTS, WHEN ENGINE IS CRANKING.
⑧ OPEN.
⑨ OPEN/GROUNDED CIRCUIT.
⑩ GROUNDED CIRCUIT.

* LESS THAN .5 VOLT.
** REFER TO SECTION 8A ELECTRICAL DIAGNOSIS.

BLACK 32 PIN C - D CONNECTOR

PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR CAVITY	NORMAL VOLTAGES ⑥		CODES AFFECT	POSSIBLE SYMPTOMS FROM FAULTY CIRCUIT
				KEY "ON"	ENG RUN		
C1 A.I.R. CONVERTER (DIVERT) SOL CONTROL	429	BLK/ PNK	A.I.R. E.A.C. SOLENOID CONN. "B"	B +	B +	NONE	HC AND CO EMISSION LEVELS TOO HIGH. BACKFIRE UPON DECELERATION. SEE SECTION C6.
C2 A.I.R. PORT (SWITCH) SOLENOID CONTROL	436	BRN	A.I.R. E.A.S. SOLENOID CONN. "B"	B +	B +	NONE	HC AND CO EMISSION LEVELS TOO HIGH. BACKFIRE UPON DECELERATION. SEE SECTION C6.
C3 IAC "B" LOW	444	LT GRN/ BLK	IAC VALVE "D"	NOT	USABLE	NONE	STALLING, ROUGH UNSTABLE OR INCORRECT IDLE. SEE CHART C-2C.
C4 IAC "B" HIGH	443	LT GRN/ WHT	IAC VALVE "C"	NOT	USABLE	NONE	STALLING, ROUGH UNSTABLE OR INCORRECT IDLE. SEE CHART C-2C.
C5 IAC "A" HIGH	441	LT BLU/ WHT	IAC VALVE "A"	NOT	USABLE	NONE	STALLING, ROUGH UNSTABLE OR INCORRECT IDLE. SEE CHART C-2C.
C6 IAC "A" LOW	442	LT BLU/ BLK	IAC VALVE "B"	NOT	USABLE	NONE	STALLING, ROUGH UNSTABLE OR INCORRECT IDLE. SEE CHART C-2C.
C7 4th GEAR SWITCH	446	LT BLU	AUTO TRANS. TCC CONN. "B"	0	0	NONE	POOR FUEL ECONOMY, "CHUGGLE" OR "SURGE" CONDITION. SEE SECTION C8.
C8 POWER STEERING PRESSURE SWITCH	495	LT BLU/ ORN	PSPS CONN. "A"	B +	B +	NONE	STALLING AROUND CONNER, RETARD TIMING AT IDLE, ROUGH IDLE. SEE CHART C-1E.
C9 CRANK SIGNAL	806	PPL/ WHT	I/P PRINTED CIRCUIT CONN. "R"	0 ⑦	0	NONE	HARD TO START. SEE CHART C-1B. DERM**
C10 CTS SIGNAL	410	YEL	CTS "B"	1.6 ⑤	1.6 ⑤	14, 15	HARD TO START, EXCESSIVE EXHAUST EMISSIONS OR ODORS. ⑨
C11 MAP SENSOR SIGNAL	432	LT GRN	MAP SENSOR "B"	4.75 ③	1.1 ③	33, 34	POOR PERFORMANCE, ROUGH IDLE, ENGINE MISFIRE. ⑨ SEE CHART C-1D.
C12 MAT SENSOR SIGNAL	472	TAN	MAT SENSOR "B"	2.5	2.5	23, 25	POOR PERFORMANCE, HARD TO START. ⑨ SEE SECTION C14.
C13 TPS SIGNAL	417	DK BLU	TPS "B"	.7	.7	22	POOR PERFORMANCE, HIGH IDLE. ⑨
C14 +5 VOLTS REFERENCE	416	GRY	TPS CONN. "A" MAP SENSOR CONN. "C"	5	5	22, 34, 45	SURGE, RUNS ROUGH, HIGH IDLE, HARD TO START, EXCESSIVE EXHAUST EMISSIONS OR ODORS, POOR PERFORMANCE, ROUGH IDLE. ⑨
C15 INJECTOR 2 DRIVER	468	DK GRN	INJECTOR CONN. "B"	B +	B +	NONE	OPEN C-15 NO SYMPTOM, OPEN C-15 AND D14 HARD TO START, POOR OVERALL PERFORMANCE, ROUGH IDLE. SEE CHART A-7.
C16 BATTERY	340	ORN	**	B +	B +	NONE	IF C16 AND B1 OPEN, NO START. SEE DIAGNOSTIC CIRCUIT CHECK.**

① VARIES FROM .60 TO BATTERY VOLTAGE, DEPENDING ON POSITION OF DRIVE WHEELS.
② 12 VOLTS FOR FIRST TWO SECONDS.
③ VARIES.
④ 12 VOLTS WHEN FUEL PUMP IS RUNNING.
⑤ VARIES WITH TEMPERATURE.
⑥ READS BATTERY VOLTAGE IN GEAR.
⑦ 12 VOLTS, WHEN ENGINE IS CRANKING.
⑧ OPEN.
⑨ OPEN/GROUNDED CIRCUIT.
⑩ GROUNDED CIRCUIT.

* LESS THAN .5 VOLT.
** REFER TO SECTION 8A ELECTRICAL DIAGNOSIS.

1-12-90
MS 9089-6E

BLACK 32 PIN C - D CONNECTOR

PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR CAVITY	NORMAL VOLTAGES ⑥		CODES AFFECT	POSSIBLE SYMPTOMS FROM FAULTY CIRCUIT
				KEY "ON"	ENG RUN		
D1 ECM GROUND	450	BLK/ WHT	ENG. GND	0	0	NONE	A-12 AND D-1 OPEN, NO START. SEE DIAGNOSTIC CIRCUIT CHECK.
D2 MAP SENSOR GROUND	455	PPL	MAP SENSOR CONN. "A"	0	0	33	ROUGH OR UNSTABLE IDLE, POOR PERFORMANCE, SEE CHART C-1D.
D3 N/C							
D4 EST	423	WHT	DIST. FOUR PIN CONN. "D"	0	1.3	42	HARD TO START, STALLS, WILL RESTART IN BYPASS MODE, ⑨ SEE SECTION C4.
D5 BYPASS	424	TAN/ BLK	DIST. FOUR PIN CONN. "B"	0	4.75	42	LACK OF POWER, POOR PERFORMANCE, ⑨ FIXED TIMING, SEE SECTION C4.
D6 OXYGEN SENSOR GROUND	413	TAN	ENG. GND	0	0	13	NO CLOSED LOOP OPERATION. ⑧
D7 OXYGEN SENSOR SIGNAL	412	PPL	OXYGEN SENSOR CONN. "A"	.3 - .5 ③	.1 - .9 ③	13	NO CLOSED LOOP OPERATION. ⑧
D8 N/C							
D9 N/C							
D10 N/C							
D11 N/C							
D12 N/C							
D13 N/C							
D14 INJECTOR 2 DRIVER 2, 4, 6, 8	468	DK GRN	INJECTOR CONN. "B"	B+	B+	NONE	OPEN D14 NO SYMPTOM, OPEN D14 AND C-15 HARD TO START, POOR OVERALL PERFORMANCE, ROUGH IDLE. SEE CHART A-7.
D15 INJECTOR 1 DRIVER 1, 3, 5, 7	467	DK BLU	INJECTOR CONN. "B"	B+	B+	NONE	OPEN D15 NO SYMPTOM, OPEN D15 AND D16 HARD TO START, POOR OVERALL PERFORMANCE, ROUGH IDLE. SEE CHART A-7.
D16 INJECTOR 1 DRIVER 1, 3, 5, 7	467	DK BLU	INJECTOR CONN. "B"	B+	B+	NONE	OPEN D16 NO SYMPTOM, OPEN D15 AND D16 HARD TO START, POOR OVERALL PERFORMANCE, ROUGH IDLE. SEE CHART A-7.

① VARIES FROM .60 TO BATTERY VOLTAGE, DEPENDING ON POSITION OF DRIVE WHEELS.
② 12 VOLTS FOR FIRST TWO SECONDS.
③ VARIES.
④ 12 VOLTS WHEN FUEL PUMP IS RUNNING.
⑤ VARIES WITH TEMPERATURE.
⑥ READS BATTERY VOLTAGE IN GEAR.
⑦ 12 VOLTS, WHEN ENGINE IS CRANKING.
⑧ OPEN.
⑨ OPEN/GROUNDED CIRCUIT.
⑩ GROUNDED CIRCUIT.

* LESS THAN .5 VOLT.
** REFER TO SECTION 8A ELECTRICAL DIAGNOSIS.

1-12-90
MS 9092-6E

CHART B-1

RESTRICTED EXHAUST SYSTEM CHECK

ALL ENGINES

Proper diagnosis for a restricted exhaust system is essential before any components are replaced. Either of the following procedures may be used for diagnosis, depending upon engine or tool used:

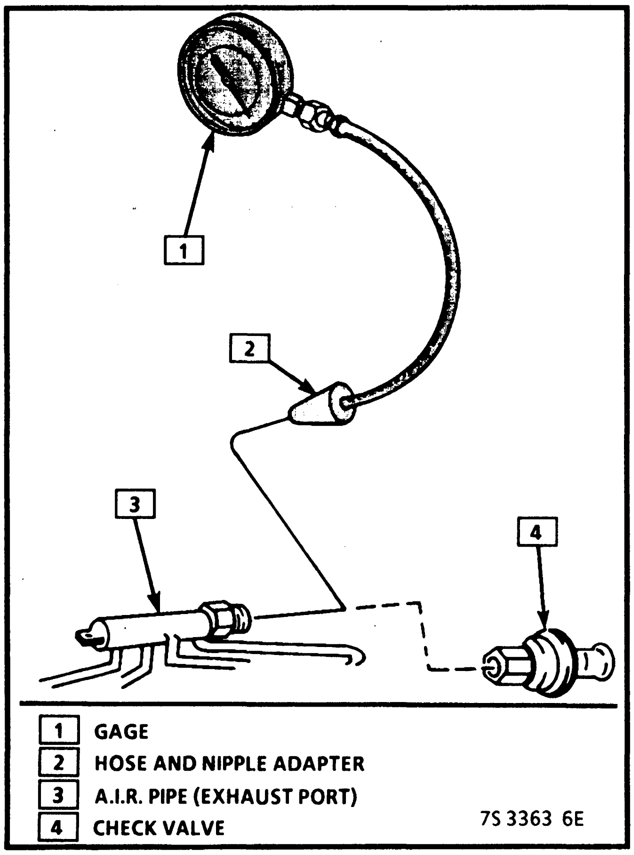
CHECK AT A. I. R. PIPE:

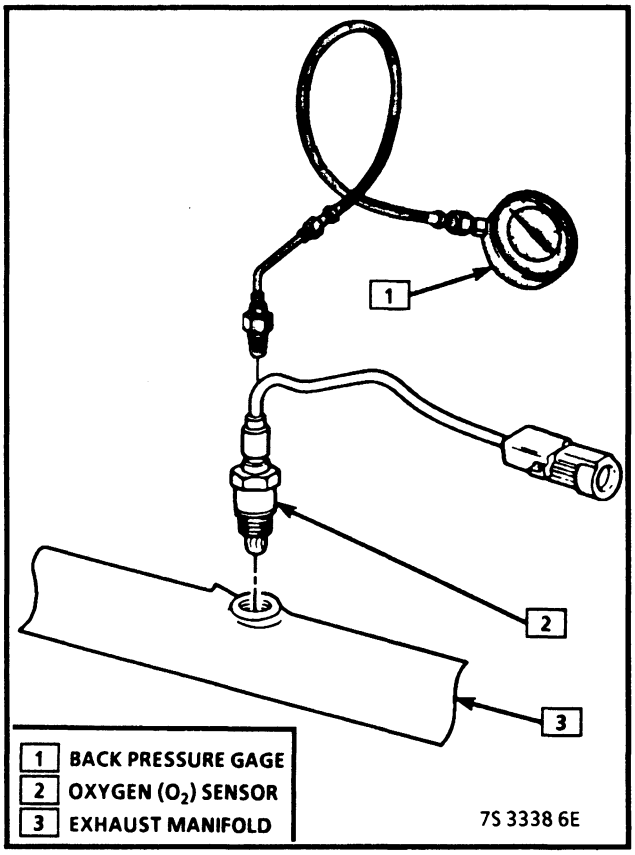
1. Remove the rubber hose at the exhaust manifold A.I.R. pipe check valve. Remove check valve.
2. Connect a fuel pump pressure gauge to a hose and nipple from a Propane Enrichment Device (J 26911) (see illustration).
3. Insert the nipple into the exhaust manifold A.I.R. pipe.

OR

CHECK AT O_2 SENSOR:

1. Carefully remove O_2 sensor.
2. Install Borroughs exhaust backpressure tester (BT 8515 or BT 8603) or equivalent in place of O_2 sensor (see illustration).
3. After completing test described below, be sure to coat threads of O_2 sensor with anti-seize compound P/N 5613695 or equivalent prior to re-installation.





DIAGNOSIS:

1. With the engine idling at normal operating temperature, observe the exhaust system backpressure reading on the gage. Reading should not exceed 8.6 kPa (1.25 psi).
2. Increase engine speed to 2000 rpm and observe gage. Reading should not exceed 20.7 kPa (3 psi).
3. If the backpressure at either speed exceeds specification, a restricted exhaust system is indicated.
4. Inspect the entire exhaust system for a collapsed pipe, heat distress, or possible internal muffler failure.
5. If there are no obvious reasons for the excessive backpressure, the catalytic converter is suspected to be restricted and should be replaced using current recommended procedures.

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Figure 13 - Exhaust System Check

BLANK

SECTION C
COMPONENT SYSTEMS

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

Section "C" provides information on the following:

- General description of components and systems.
- On-vehicle service.
- Part names and group numbers.
- Diagnostic charts. These include a functional check of the system as well as diagnosis of any problem found in the functional check.

For locations of components, wiring diagrams, and ECM Terminal End View, refer to the front of the Section "A" for the engine being diagnosed.

Following are the sub-section identification and the system covered:

DIAGNOSTIC CHARTS

The Diagnostic Charts for each system are found after the on-vehicle service and parts information at the back of each section. Following are the charts found in this section.

SECTION C1

ELECTRONIC CONTROL MODULE (ECM) AND SENSORS

CONTENTS

GENERAL DESCRIPTION

ELECTRONIC CONTROL MODULE (ECM)

The Electronic Control Module (ECM) (Figure C1-1) is the control center of the fuel injection system. It constantly looks at the information from various sensors, and controls the systems that affect vehicle performance. The ECM performs a diagnostic function check of the system. It can recognize operational problems, alert the driver through the "Service Engine Soon" light, and store a code or codes which identify the problem areas to aid the technician in making repairs. Refer to the "Introduction" for more information on using the diagnostic function of the ECM. For service, the ECM has three parts: a Controller (the ECM without the PROM), a separate calibrator (PROM), and a CAL-PAK.

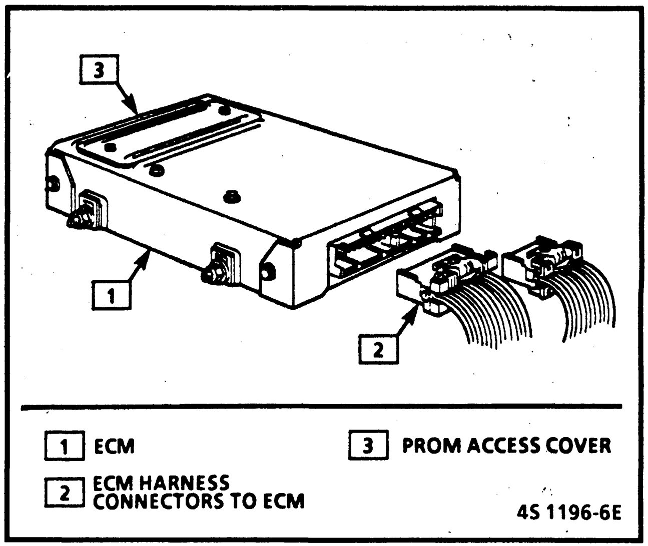


Figure C1-1 - Electronic Control Module (ECM)

PROM

To allow one model of ECM to be used for many different cars, a device called a calibrator (or PROM) (Programmable Read Only Memory) is used (see Figure C1-2). The PROM is located inside the ECM and has information on the vehicle's weight, engine, transmission, axle ratio, and other items specific to each vehicle. While one ECM part number can be used by many car lines, a PROM is very specific and must be used for the right car. For this reason, it is very important to check the latest parts book and service bulletin information for the correct part number when replacing a PROM.

An ECM used for service (called a controller) comes without a PROM. The PROM from the old ECM must be carefully removed and installed in the new ECM, see "On-Vehicle Service" for procedure.

CAL-PAK

A device called a CAL-PAK is used to allow fuel delivery if other parts of the ECM are damaged. An access door in the ECM allows removal and replacement of the CAL-PAK similar to a PROM.

If the CAL-PAK is missing, it will result in a no start condition. The CAL-PAK must be transferred to a replacement ECM.

ECM Function

The ECM contains a power supply which regulates the 12 volt vehicle supply input to 5, 8 and 12 volts, and these voltages are used for various internal and external functions.

The ECM supplies a buffered 5 or 12 volts to power various sensors or switches. This is done through resistances in the ECM which are so high in value that a test light will not light when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give an accurate reading because its resistance is too low. Therefore, the use of a 10 megaohm input impedance digital voltmeter is necessary to assure accurate voltage readings.

The Input/Output (I/O) devices in the ECM include analog to digital converters, signal buffers, counters, and special drivers. The ECM controls output circuits such as the injectors, IAC, cooling fan relay, etc. by controlling the ground circuit through transistors or a device called a quad-driver in the ECM.

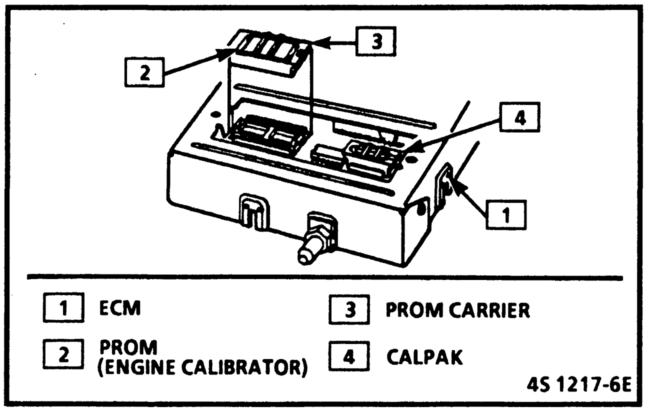


Figure C1-2 - PROM (Calibrator) and CAL-PAK 5.0L

Memory

There are three types of memory storage within the ECM: ROM, RAM and PROM.

ROM

Read Only Memory (ROM) is a permanent memory that is physically soldered to the circuit boards within the ECM. The ROM contains the overall control algorithms. Once the ROM is programmed, it cannot be changed. The ROM memory is non-volatile, and does not need power to be retained.

RAM

Random Access Memory (RAM) is the microprocessor "scratch pad." The processor can write into, or read from this memory as needed. This memory is volatile and needs a constant supply of voltage to be retained. If the voltage is lost, the memory is lost and the ECM logs a code indicating this loss.

PROM

Programmable Read Only Memory (PROM) is the portion of the ECM that contains the different engine calibration information that is specific to year, model and emissions. The PROM is a non-volatile memory that is read only by the ECM.

The PROM is removable from the ECM. The PROM and CAL-PAK should be retained with the vehicle following ECM replacement.

Integrator

The integrator is an ECM volatile memory register that will contain a number between 0 and 255. The neutral value for the integrator is 128; any deviation from this value indicates the integrator is changing the injector pulse width. The amount of pulse width change depends on how far the integrator value is from 128. The integrator changes the pulse width by varying the "Closed Loop" factor of the base pulse width equation. As the ECM monitors the O_2 sensor input, it is constantly varying the integrators value.

The value is updated very quickly, therefore, the integrator only corrects for short term mixture trends. The correction of long term mixture trends is the function of the Block Learn.

Block Learn

The Block Learn is a matrix of cells arranged by RPM and MAP. Each cell of the block learn is a register like the integrator. As the engine operating conditions change, the ECM will switch from cell to cell to determine what "block learn" factor to use in the base pulse width equation.

While in any given block, the ECM also monitors the integrator. If the integrator is far enough from 128, the ECM will change the block learn value. Once the block learn value is changed, it should force the integrator back toward 128.

If the mixture is still not correct (as judged by the Oxygen (O_2) sensor), the integrator will continue to have a large deviation from the ideal 128. In this case, the block learn value will continue to change until the integrator becomes balanced.

Both the integrator and block learn have limits which will vary with each PROM. If the mixture is off enough so that block learn reaches the limit of its control and still cannot correct the condition, the integrator would also go to its limit of control in the same direction. If the mixture is still not corrected by both integrator and block learn at their extreme values, a Code 44 or Code 45 will likely result. Under the conditions of power enrichment, the ECM sets the integrator to 128 and freezes it there until power enrichment is no longer in effect. This is done so the "Closed Loop" factor and the block learn will not try to correct for the commanded richness of power enrichment.

SPEED DENSITY SYSTEM

The Throttle Body Injection (TBI) system is a speed and air density system. The system is based on "speed density" fuel management, let's define their basis of operation.

Three specific data sensors provide the ECM with the basic information for the fuel management portion of its operation. That is, three specific signals to the ECM establish the engine speed and air density factors.

Speed

The engine speed signal comes from the Distributor High Energy Ignition (HEI) module to the ECM on the crank reference high, CKT 430. The ECM uses this information to determine the "speed" or rpm factor for fuel and ignition management.

Density

Two sensors contribute to the density factor, the Manifold Air Temperature (MAT) and the Manifold Absolute Pressure (MAP) sensors.

The MAT sensor is a 2-wire sensor that measures the temperature of the air entering the intake manifold. The MAT sensor is a thermistor that changes its resistance as an inverse function of temperature. When the temperature is low, the resistance is high, and when the temperature is high, the resistance is low.

The Manifold Absolute Pressure (MAP) sensor is a 3-wire sensor that monitors the changes in intake manifold pressure which results from changes in engine loading. These pressure changes are supplied to the ECM in the form of analog electrical signals.

As intake manifold pressure increases, the air density in the intake manifold also increases, and additional fuel is required. The MAP sensor sends this pressure information to the ECM, and the ECM increases the amount of fuel injected, by increasing the injector pulse width. Conversely, as manifold pressure decreases, the amount of fuel is decreased.

These three inputs MAP, MAT, and RPM are the major determinants of the air/fuel mixture delivered by the fuel injection system.

The remaining sensors and switches provide electrical inputs to the ECM which are used for modification of the air/fuel mixture, as well as for other ECM control functions, such as Idle Air Control (IAC).

INFORMATION SENSORS

Coolant Temperature Sensor (CTS)

The Coolant Temperature Sensor (CTS) (Figure C1-3) is a thermistor (a resistor which changes value based on temperature) that is immersed in the engine coolant stream.

Low coolant temperature produces a high resistance (100,000 ohms at -40°C/-40°F) while high temperature causes low resistance (70 ohms at 130°C/266°F).

The ECM supplies a 5 volt signal to the CTS thru a resistor in the ECM and measures the voltage. The voltage will be high when the engine is cold, and low when the engine is hot. By measuring the voltage, the ECM can determine engine coolant temperature. Engine coolant temperature affects most systems the ECM controls.

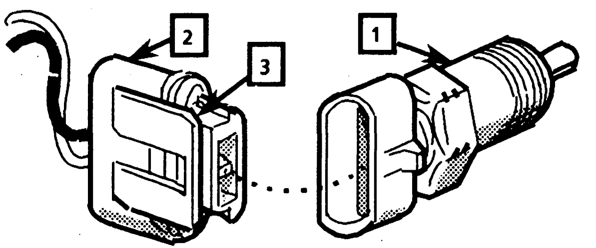


Figure C1-3 - Coolant Temperature Sensor (CTS)

A failure in the CTS circuit should set either a Code 14 or Code 15. Remember, these codes indicate a failure in the coolant temperature sensor circuit, so proper use of the chart will lead to either repairing a wiring problem or replacing the sensor, to properly repair a problem.

MAP Sensor

The Manifold Absolute Pressure (MAP) sensor (Figure C1-4) measures the changes in the intake manifold pressure which result from engine load and speed changes, and converts this to a voltage output.

A closed throttle on engine coastdown would produce a relatively low MAP output voltage, while a wide-open throttle would produce a high MAP output voltage. This high output voltage is produced because the pressure inside the manifold is the same as outside the manifold, so you measure 100% of outside air pressure. Manifold Absolute Pressure (MAP) is the OPPOSITE of what you would measure on a vacuum gage.

When manifold pressure is high, vacuum is low. The MAP sensor is also used to measure barometric pressure under certain conditions, which allows the ECM to automatically adjust for different altitudes.

The ECM sends a 5 volt reference signal to the MAP sensor. As the manifold pressure changes, the electrical resistance of the MAP sensor also changes.

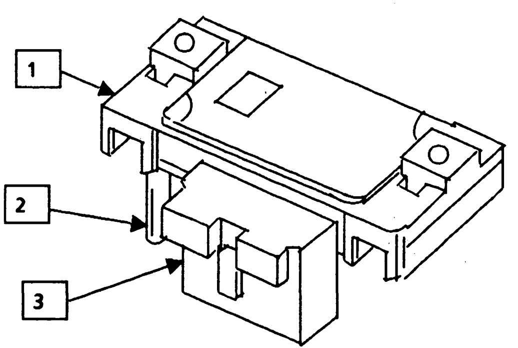


Figure C1-4 - MAP Sensor

By monitoring the sensor output voltage, the ECM knows the manifold pressure. A higher pressure, low vacuum (high voltage) requires more fuel, while a lower pressure, higher vacuum (low voltage) requires less fuel. The ECM uses the MAP sensor to control fuel delivery and ignition timing.

A failure in the MAP sensor circuit should set a Code 33 or Code 34.

VACUUM

kPa	0	10	20	30	40	50	60	70	80	90	100
Hg	0	29	5.9	8.9	11.8	14.8	17.7	20.7	23.7	26.7	29.6
V	4.9	4.4	3.8	3.3	2.7	2.2	1.7	1.1	0.6	0.3	0.3

MAP

kPa	100	90	80	70	60	50	40	30	20	10	0
Hg	29.6	26.6	23.7	20.7	17.7	14.8	11.8	8.9	5.9	2.9	0
V	4.9	4.4	3.8	3.3	2.7	2.2	1.7	1.1	0.6	0.3	0.3

Manifold Air Temperature (MAT) Sensor

The Manifold Air Temperature (MAT) sensor is a thermistor (a resistor which changes value based on temperature) mounted in the air cleaner. Low temperature produces a high resistance (100,000 ohms at -40°C/-40°F), while high temperature causes low resistance (70 ohms at 130°C/226°F). The ECM supplies a 5 volt signal to the MAT sensor through a resistor in the ECM and measures the voltage. The voltage will be high when the intake air is cold and low when the intake air is hot. By measuring the voltage, the ECM knows the intake air temperature.

The MAT sensor signal is also used by the ECM to control spark timing and to delay EGR when intake air is cold.

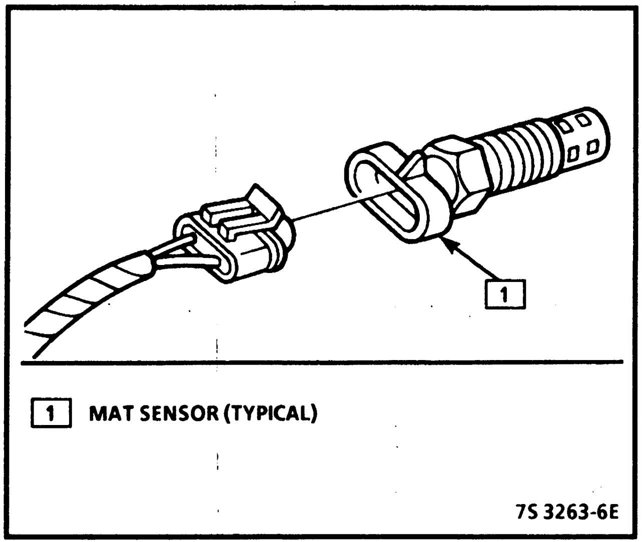


Figure C1-5 - MAT Sensor - Typical

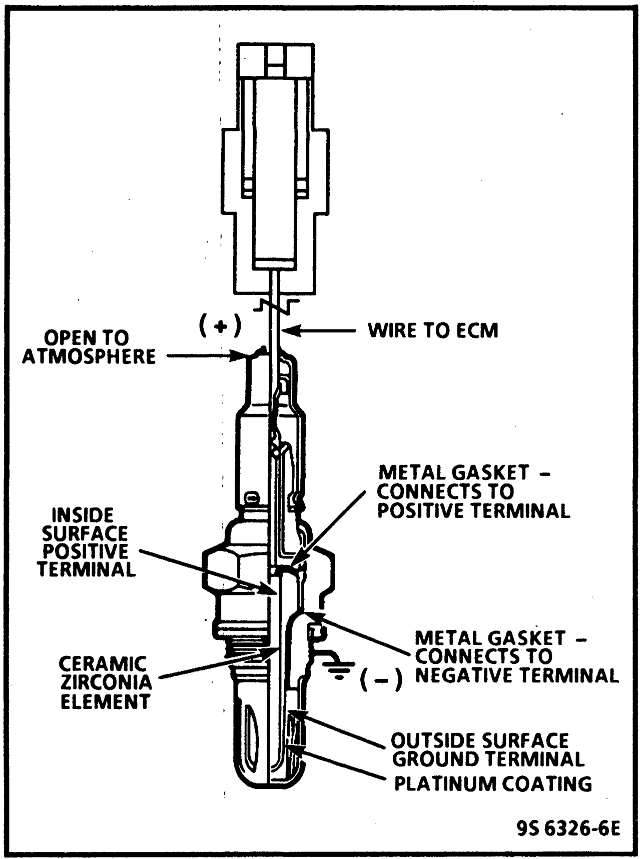


Figure C1-6 - Oxygen (O_2) Sensor Cutaway

A failure in the MAT sensor circuit should set either a Code 23 or Code 25.

Oxygen (O_2) Sensor

The Oxygen (O_2) sensor is essentially a small variable battery; it has the ability to produce a low voltage signal that feeds information on engine exhaust oxygen content to the ECM.

The Oxygen (O_2) sensor is constructed from a zirconia/platinum electrolytic element.

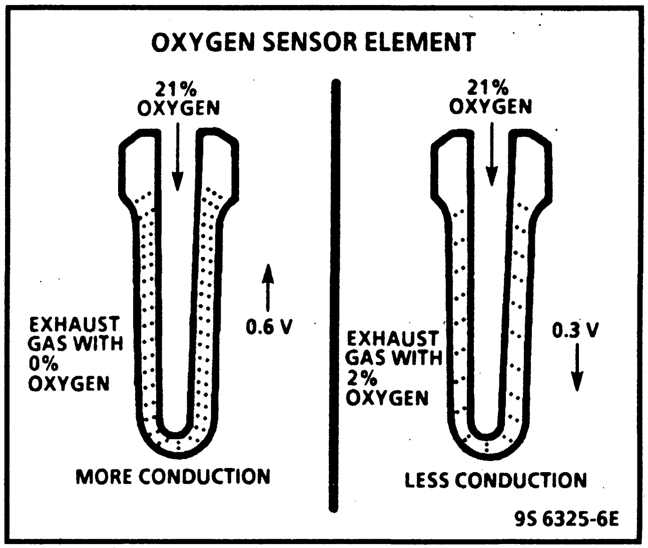


Figure C1-7 - Oxygen Sensor Element

Zirconia is an electrolyte that conducts electricity under certain chemical conditions. The element is made of a ceramic material. The element is an insulator when cold. At operating temperature, 315°C (600°F), the element becomes a semiconductor. A platinum coating on the outer surface of the element stimulates further combustion of the exhaust gases right at the surface and this helps keep the element up to the desired temperature. The oxygen sensor has an inter cavity which is filled with atmospheric (reference) air. The atmosphere has approximately 21% oxygen in it. In the electrical circuit this inter cavity is the positive (+) terminal. The outer surface of the element is exposed to the exhaust gas stream. It is the negative (-) or ground terminal. Due to the electrolytic properties of the element the oxygen concentration differences between the reference air and exhaust gases produce small voltages, (see figure C1-7).

A rich exhaust (excessive fuel) has almost no oxygen. When there is a large difference in the amount of oxygen touching the inside and outside surfaces, there is more conduction, and the sensor puts out a voltage signal above 0.6 volt. With lean exhaust (excessive oxygen) there is about two percent oxygen in the exhaust. This is a smaller difference in oxygen from the outside surfaces which results in less conduction and a voltage signal below 0.3 volt. The voltages are monitored and used by the ECM to "fine tune" the air/fuel ratio to achieve the ideal mixture desired.

The ECM puts out a reference signal of 0.45 volt. (See Figure C1-8). The reference signal serves two purposes. The first is to run the engine when it is in "Open Loop" mode of operation. When the air/fuel ratio is correct the ECM "sees" 0.45 volt. When the engine is operating with a rich air/fuel ratio there is a reduction of free oxygen in the exhaust stream and the O_2 voltage rises above the reference voltage.

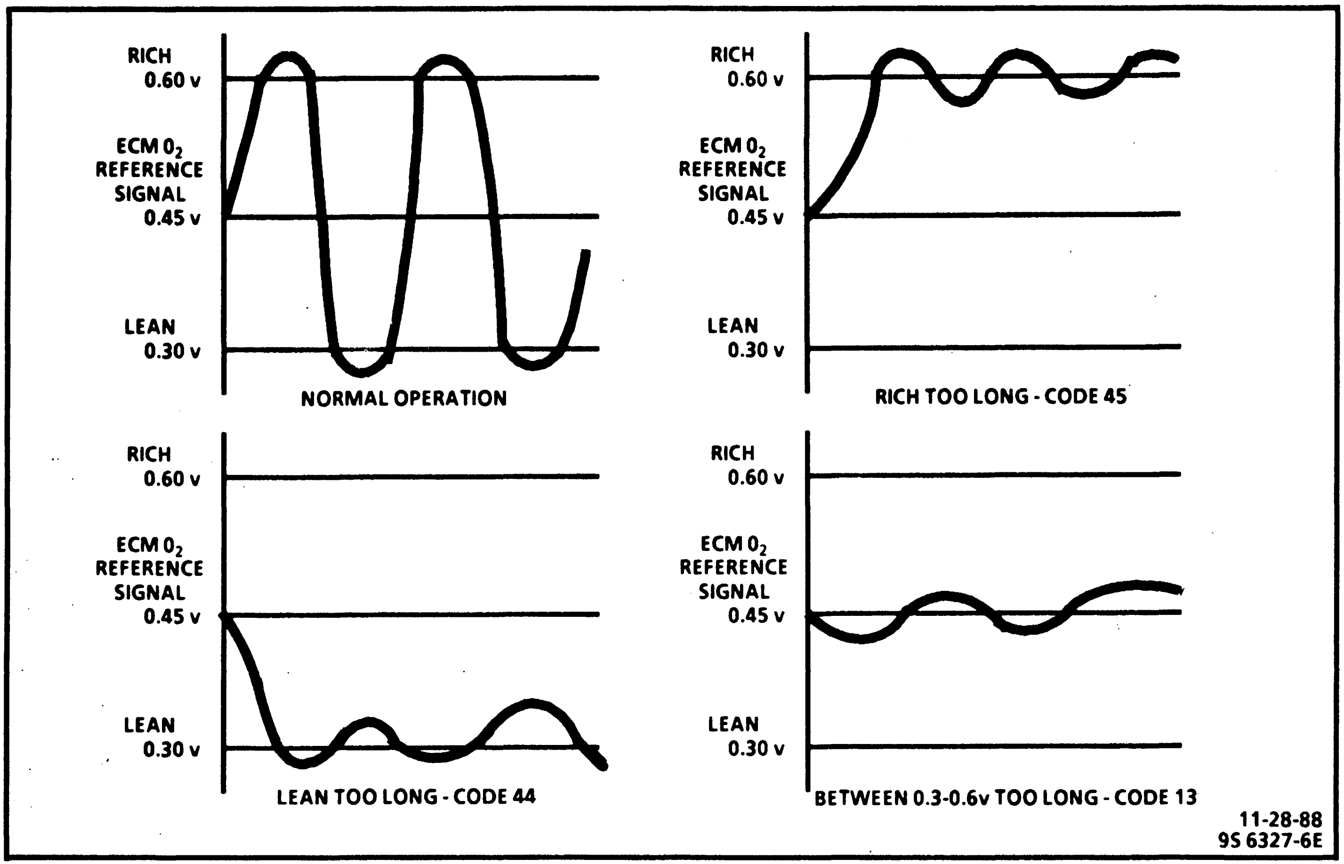


Figure C1-8 - Normal Voltage and Abnormal Trends

When the engine is run lean the voltage drops below the reference voltage due to excess oxygen in the exhaust stream. The oxygen sensor provides the feedback information for the "Closed Loop" operating mode of the fuel delivery system. The oxygen sensor indicates to the ECM what is happening in the exhaust. It does not cause things to happen. It is a type of gage: Low voltage output = lean mixture = high oxygen content in exhaust; high voltage output = rich mixture = low oxygen content in the exhaust.

An open Oxygen (O_2) sensor, should set a Code 13. A constant low voltage in the Oxygen (O_2) sensor circuit should set a Code 44. A constant high voltage in the circuit should set a Code 45. Code 44 or Code 45 could also be set as a result of fuel system problems. See "Code Charts" for conditions that can cause a lean or rich system.

Throttle Position Sensor (TPS)

The Throttle Position Sensor (TPS) is connected to the throttle shaft on the TBI unit (see Figure C1-9). It is a potentiometer with one end connected to 5 volts from the ECM and the other to ECM ground. A third wire is connected to the ECM to measure the voltage from the TPS. As the throttle valve angle is changed (accelerator pedal moved), the output of the TPS also changes. At a closed throttle position, the output of the TPS is low (approximately .5 volt). As the throttle valve opens, the output increases so that, at wide open throttle, the output voltage should be approximately 5 volts.

By monitoring the output voltage from the TPS, the ECM can determine fuel delivery based on throttle valve angle (driver demand). If the TPS circuit is open, the ECM will set a Trouble Code 22. If the TPS circuit is shorted, the ECM will think the vehicle is at Wide Open Throttle (WOT), and a Trouble Code 21 will be set.

A broken or loose TPS can cause intermittent bursts of fuel from the injector, and an unstable idle, because the ECM thinks the throttle is moving. Once a trouble code is set, the ECM will use an artificial value for TPS, and some vehicle performance will return.

On all engines, the TPS is not adjustable. The ECM uses the reading at idle for the zero reading, so no adjustment is necessary.

See "On-Vehicle Service" for replacement of TPS.

Knock Sensor

The knock sensor is mounted in the engine block. When abnormal engine vibrations (spark knock) are present, the sensor produces a voltage signal, which is sent to the ESC module.

See "Electronic Spark Control (ESC) System," Section "6E2-C5" for further information on the Electronic Spark Control (ESC) system.

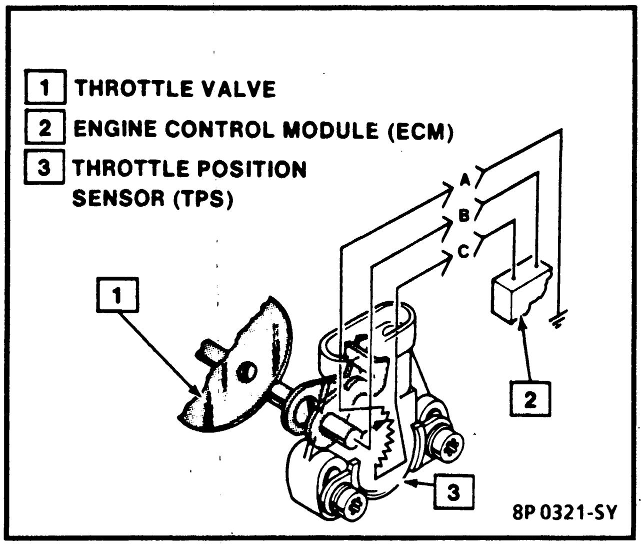


Figure C1-9 - Throttle Position Sensor (Typical)

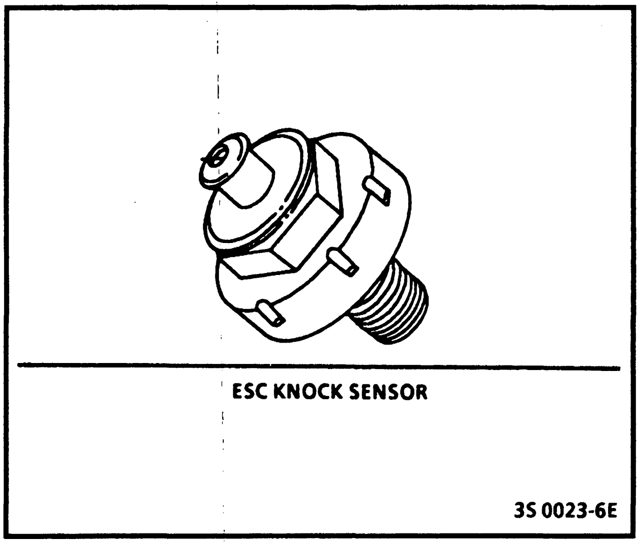


Figure C1-10 - ESC Knock Sensor

Park/Neutral Switch (Automatic Only)

The Park/Neutral (P/N) switch indicates to the ECM when the transmission is in park or neutral. This information is used for the TCC, and the IAC valve operation.

Important

- Vehicle should not be driven with park/neutral switch disconnected as idle quality will be affected and a possible false Code 24 (VSS) may be set. See ELECTRICAL DIAGNOSIS (SECTION 8A) for more information on the P/N switch, which is part of the neutral/start and backup light switch assembly.

Crank Signal

The ECM looks at the starter solenoid to tell when the engine is cranking. It uses this to tell when the car is in the Starting Mode.

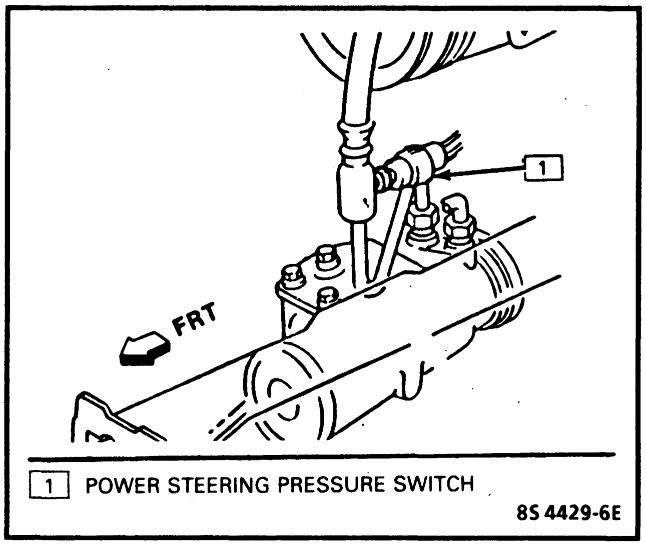


Figure C1-11 - Power Steering Pressure Switch (PSPS)

If this signal is not available, the car may be hard to start in extremely cold weather.

A/C Request Signal

This signal tells the ECM that the A/C selector switch is turned "ON," and that the pressure cycling switch is closed. The ECM uses this to adjust the idle speed when the air conditioning is operating.

If this signal is not available to the ECM, idle may be rough, especially when the A/C compressor cycles. The voltage at ECM terminal "B8" should equal battery voltage on a C60 system and about 5 volts on a C68 option, when A/C is requested and the pressure cycling switch is closed.

Vehicle Speed Sensor (VSS)

The Vehicle Speed Sensor (VSS) sends a pulsing voltage signal to the ECM which the ECM converts to miles per hour. This sensor mainly controls the operation of the TCC system. See Code 24 (VSS) or "Torque Converter Clutch (TCC) System," Section "6E2-C8," for more information.

Distributor Reference Signal

The distributor sends a signal to the ECM to tell it both engine speed (rpm) and crankshaft position. See "Ignition System/EST," Section "6E2-C4" for further information.

Power Steering Pressure Switch (PSPS)

This switch tells the ECM that the power steering fluid pressure is high, such as when the vehicle is in a parking maneuver. The ECM uses this information to compensate for the additional engine load by moving the IAC valve. The ECM will, also, turn "OFF" the A/C clutch when high pressure is detected.

DIAGNOSIS

ECM

Since the ECM can have a failure which may effect only one circuit, following the diagnostic procedures in this section can reliably tell when a failure has occurred in the ECM. Also, a Code 55 indicates a failure of the ECM.

If a diagnostic chart indicates that the ECM connections or ECM is the cause of a problem, and the ECM is replaced, but does not correct the problem, one of the following may be the reason:

- There is a problem with the ECM terminal connections. - The diagnostic chart will say "ECM connections or ECM." The terminals may have to be removed from the connector in order to check them properly.
- The ECM or PROM is not correct for the application. - The incorrect ECM or PROM may cause a malfunction and may or may not set a code.
- The problem is intermittent. - This means that the problem is not present at the time the system is being checked. In this case, refer to the "Symptoms" portion of the manual and make a careful visual/physical inspection of all portions of the system involved.
- Shorted solenoid, relay coil, or harness. - Solenoids and relays are turned "ON" and "OFF" by the ECM, using internal electronic switches called "Drivers." Each driver is part of a group of four called "Quad-Drivers."

A shorted solenoid, relay coil, or harness will not damage the ECM, but will cause the circuit and controlled component to be inoperative. When the circuit fault is not present or has been repaired, the "Quad-Driver" will again operate in a normal manner due to it's fault protected design. If a fault has been repaired in a circuit controlled by a "Quad-Driver," the original ECM should be reinstalled and the circuit checked for proper operation. ECM replacement will not be necessary if the repaired circuit or component now operates correctly.

J 34636 or BT8405 testers or equivalent provide a fast, accurate means of checking for a shorted coil or a short to battery voltage.

- The PROM may be faulty. - Although the PROM rarely fails,it operates as part of the ECM. Therefore, it could be the cause of the problem. Substitute a known good PROM.
- The replacement ECM may be faulty. - After the ECM is replaced, the system should be rechecked for proper operation. If the diagnostic chart again indicates the ECM is the problem, substitute a known good ECM. Although this is a rare condition, it could happen.

The components or circuits and the codes or charts, related to them are:

- Code 55 indicates a failure of the ECM.
- PROM - Code 51.
- Coolant Temperature Sensor - Code 14 or Code 15.
- MAP sensor - Code 33 or 34. To check the MAP sensor with no code set, use CHART C-1D.
- TPS - Code 21 or Code 22.
- P/N switch - CHART C-1A.
- Crank Signal - CHART C-1B.
- O_2 Sensor - Codes 13, 44, 45.
- A/C Request Signal - If the A/C request signal is not reaching the ECM, it can cause rough idle, with A/C "ON." See "Rough Idle" in "Symptoms," Section "6E2-B".
- VSS - Code 24 and in TCC system, "Torque Converter Clutch (TCC) System," Section "6E2-C8".
- Distributor - CHART C-4 or Code 42.

ECM

A faulty ECM will be determined in the diagnostic charts, or by a Code 55.

PROM

An incorrect or faulty PROM, which is part of the ECM, may set a Code 51.

ECM INPUTS

All of the sensors and input switches can be diagnosed by the use of a "Scan" tool. Following is a short description of how the sensors and switches can be diagnosed by the use of a "Scan" tool. The "Scan" tool can also be used to compare the values for a normal running engine with the engine you are diagnosing.

Coolant Temperature Sensor (CTS)

A "Scan" tool displays engine temperature in degrees centigrade and fahrenheit. After the engine is started, the temperature should rise steadily to about 90°C (194°F), then stabilize when the thermostat opens. If the engine has not been run for several hours (overnight), the CTS and MAT temperature readings should be close to each other. A fault in the coolant sensor circuit should set a Code 14 or Code 15. The code charts also contain a chart to check for coolant temperature sensor resistance values relative to temperature.

MAP Sensor

A "Scan" tool reads manifold pressure and will display either volts or kPa of pressure.

Key "ON," engine stopped, (no vacuum), MAP will read high voltage or pressure, while at idle (high vacuum), MAP will read low voltage or pressure. Likewise, on acceleration, MAP will read high and on deceleration, will read low voltage.

A failure in the MAP sensor, or circuit, should result in a Code 33 or Code 34.

MAT Sensor

A "Scan" tool displays temperature of the air entering the engine and should read close ambient air temperature, when engine is cold, and rise as underhood temperature increases. If the engine has not been run for several hours (overnight), the MAT sensor temperature and CTS temperature readings should be close to each other. A failure in the MAT sensor circuit should set a Code 23 or Code 25. The code charts also contain a chart to check for sensor resistance values relative to temperature.

Oxygen (O_2) Sensor

The "Scan" tool has several positions that will indicate the state of the exhaust gases, oxygen sensor voltage, integrator, and block learn. See "Scan" tool position information in "Introduction," "Driveability and Emissions," Section "6E".

Normal "Scan" voltage varies between 100 mv to 999 mv (.1 and 1.0 volt) while in "Closed Loop." Code 13 sets in one minute if voltage remains between .35 and .55 volt, but the system will go "Open Loop" in about 15 seconds. The ECM counts each time the voltage crosses the 0.45 volt reference signal. These "cross counts" are indicated on a "Scan" tool.

Disconnecting the O_2 sensor and grounding the lead from the ECM will simulate a lean exhaust condition (low voltage signal).

Applying voltage to the ECM through a digital voltmeter on the 20 volt scale will simulate a rich exhaust condition (high voltage signal).

The ECM self-diagnostic circuit looks for trends in oxygen sensor voltage. If a trend is detected, the "Service Engine Soon" light comes "ON."

A rich exhaust trend causes the sensor voltage to stay above 0.6 volt for too long. This sets Code 45.

Lean exhaust causes voltage to stay below 0.3 volt for too long. This sets Code 44. If voltage stays between 0.3 volt and 0.6 volt for too long, the ECM sets Code 13. This indicates an open oxygen sensor circuit.

Response Time

Not only is it necessary for the oxygen sensor to produce a voltage signal for rich or lean exhaust, it is also important to respond quickly to changes. The ECM senses the response times.

If the oxygen sensor responses slowly the customer may complain of poor fuel economy, rough idle or lack of performance. It may also set false ECM codes because the ECM uses oxygen sensor voltages for system checks.

Oxygen Sensor Contaminants

Carbon

Black carbon or soot deposits result from over-rich mixtures. However, carbon does not harm a sensor. Deposits can be burned off in the engine by running it at least part throttle for two minutes.

Silica

Certain RTV silicone gasket materials give off vapors that contaminate the oxygen sensor. The sand-like particles from the RTV silica imbed in the molecules of the sensor element and plug up the surface. This results in "lazy" oxygen sensor response and engine control. The sensor will also have a whitish appearance.

There is also a possibility of silica contamination caused by silicone in the fuel. Careless fuel handling practices with the transport containers can result in unacceptable concentrations of silicone in the fuel at the pump.

There is also a possibility of silica contamination caused by silicon in lubricants used to install vacuum hoses on fittings.

Lead

Lead glazes sensors. It can be introduced when regular, or leaded fuel, is burned. Fuel containing large amounts of methanol will also result in lead contamination.

The methanol dissolves the terne coat of the fuel tank, introduces lead into the fuel system, and into the exhaust after combustion. It is difficult to detect lead contamination by visual inspection.

Other Substances

Oil deposits will ultimately prevent sensor operation. The sensor will have a dark brown appearance. Causes of high oil consumption should be checked. The additives in ethylene glycol can also affect sensor performance.

This produces a whitish appearance. If antifreeze enters the exhaust system, you will likely encounter other, more obvious, symptoms of cooling system trouble.

Multiple Failures

If you encounter multiple or repeat oxygen sensor failures on the same car, consider contamination.

Leaded fuel, silica contamination from uncured, low-grade (unapproved) RTV sealant, and high oil consumption are possible.

A problem in the oxygen sensor circuit or fuel system should set a Code 13 (open circuit), Code 44 (lean indication) or Code 45 (rich indication). Refer to applicable chart if any of these codes were stored in memory.

Throttle Position Sensor (TPS)

A "Scan" tool displays throttle position in volts and should read under 1.25 volts with throttle closed and ignition "ON," or at idle. Voltage should increase at a steady rate as throttle is moved toward Wide Open Throttle (WOT).

The ECM has the ability to Auto-Zero the TPS voltage, if it is below about 1.25 volts. This means that any voltage less than 1.25 volts volts will be determined by the ECM to be 0% throttle. Some "Scan" tools have the ability to read the percentage of throttle angle and should read 0%, when the throttle is closed. A failure in the TPS circuit or TPS, should set a Code 21 or Code 22.

Vehicle Speed Sensor (VSS)

A "Scan" tool reading should closely match with speedometer reading, with the drive wheels turning. A failure in the VSS circuit should set a Code 24.

Park/Neutral (P/N) Switch

A "Scan" tool should read "ON," when in park or neutral and "OFF," when in drive or reverse. This reading may vary with different makes of tools. Refer to CHART C-1A for P/N switch diagnosis.

Power Steering Pressure Switch (PSPS)

A "Scan" tool should read "OFF" normally, and "ON" with high pressure. This reading may vary with different makes of tools. Refer to CHART C-1E for PSPS diagnosis.

A/C Request Signal

If the low pressure switch is closed and A/C is "ON," the "Scan" tool should indicate A/C "ON." See ELECTRICAL DIAGNOSIS (SECTION "8A") for A/C electrical system diagnosis.

Distributor Reference Signal

A "Scan" tool will read this signal and is displayed in rpm. See "Ignition System/EST," Section "6E2-C4", for more information on the Ignition/EST System .

Knock Signal

A "Scan" tool will indicate when the ESC module signals the ECM that knock is present. See "Electronic Spark Control (ESC) System," Section "6E2-C5" for further information on the ESC System.

ON-VEHICLE SERVICE

ELECTRONIC CONTROL MODULE (ECM)

Service of the ECM should normally consist of either replacement of the ECM or a PROM change.

If the diagnostic procedures call for the ECM to be replaced, the engine calibrator (PROM) and ECM should be checked first to see if they are the correct parts. If they are, remove the PROM from the faulty ECM and install it in the new service ECM. THE SERVICE ECM WILL NOT CONTAIN A PROM. Trouble Code 51 indicates the PROM is installed improperly or has malfunctioned. When Code 51 is obtained, check the PROM installation for bent pins or pins not fully seated in the socket. If the PROM is installed correctly and Code 51 still shows, replace the PROM.

Important

- When replacing the production ECM with a service ECM (controller), it is important to transfer the Broadcast Code and production ECM number to the service ECM label. Please do not record on ECM cover. This will allow positive identification of ECM parts throughout the service life of the vehicle.

NOTICE: To prevent internal ECM damage, the ignition must be "OFF" when disconnecting or reconnecting power to ECM (for example, battery cable, ECM pigtail, ECM fuse, jumper cables, etc.).

NOTICE: To prevent possible Electrostatic Discharge damage to the ECM, Do Not touch the connector pins or soldered components on the circuit board.

Remove or Disconnect

1. Negative battery cable.
2. Right hand hush panel.
3. Connectors to ECM.

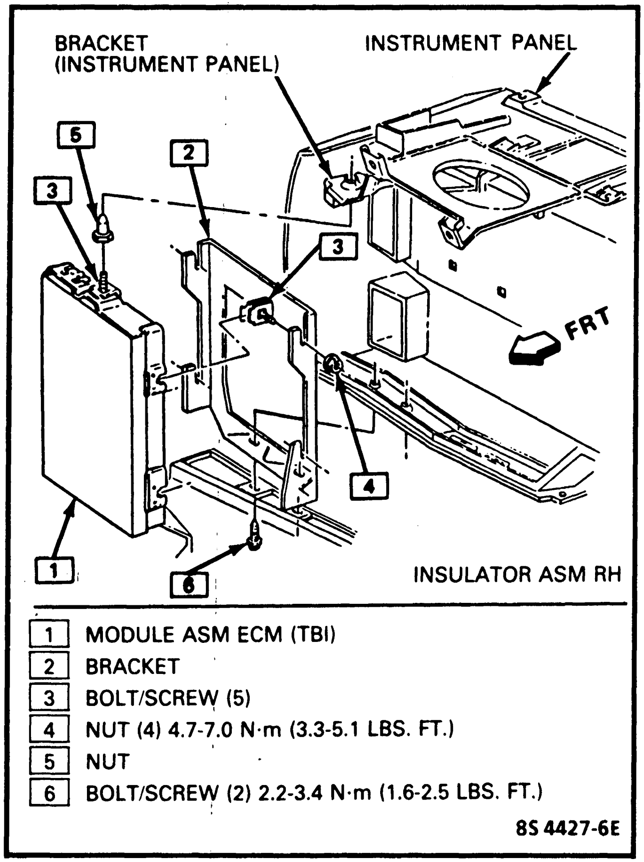


Figure C1-12 - ECM Mounting

4. ECM.
5. PROM from ECM.

Install or Connect

1. Old PROM in new ECM.
2. ECM into car.
3. Connectors.
4. Hush panel.
5. Negative battery cable.

PROM

Code 51 indicates a faulty PROM, bent pins, or incorrect installation.

Important

- It is possible to install a PROM backward. If the PROM is installed backward and the ignition key turned to "ON," the PROM circuitry will be destroyed, requiring PROM replacement.

Important

- The ignition should always be "OFF" when installing or removing the ECM connectors.

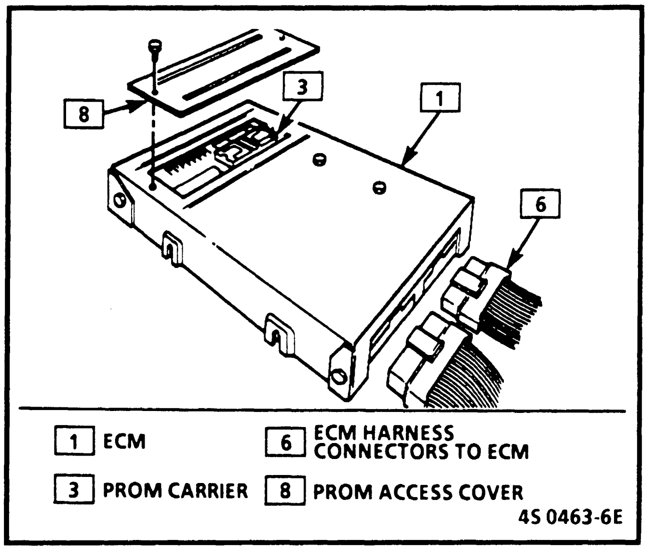


Figure C1-13 - PROM Access Cover

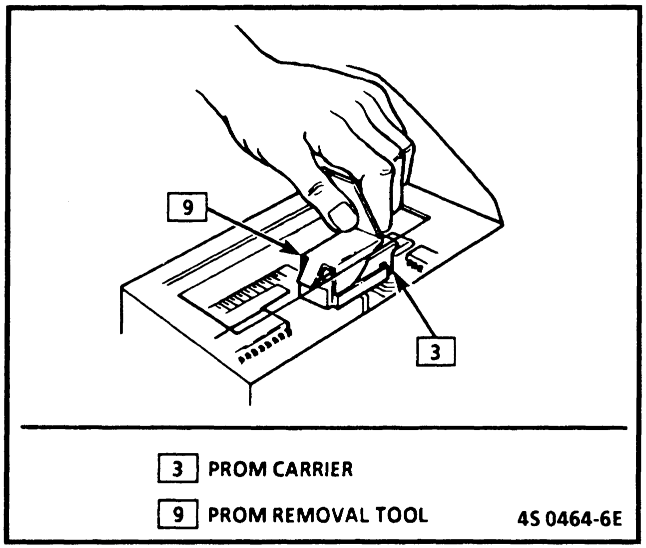


Figure C1-14 - PROM Removal Tool

NOTICE: To prevent possible Electrostatic Discharge damage to the PROM or CAL-PAK, Do Not touch the component leads, and Do Not remove integrated circuit from carrier.

Remove or Disconnect

1. Connectors from ECM.
2. ECM mounting hardware.
3. ECM from passenger compartment.
4. Prom access cover (see Figure C1-13).
5. Remove PROM assembly.

Important

- Using the rocker-type PROM removal tool, engage one end of the PROM carrier with the hook end of the tool (see Figure C1-11). Press on the vertical bar end of the tool and rock the engaged end of the PROM carrier up as far as possible. Engage the opposite end of the PROM carrier in the same manner and rock this end up as far as possible.

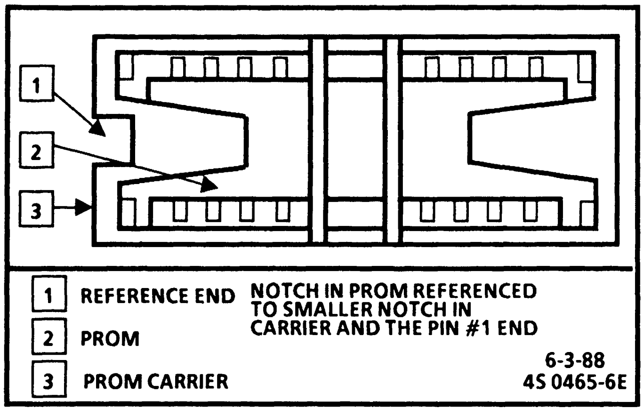


Figure C1-15 - PROM in PROM Carrier

Repeat this process until the PROM carrier and PROM are free of the PROM socket. The PROM carrier with PROM in it should lift off of the PROM socket easily. PROM carrier should only be removed by using the pictured PROM removal tool. Other methods could cause damage to the PROM or PROM socket.

Remove or Disconnect

1. New PROM carrier in PROM socket.

Inspect

1. New PROM for same part number as old or updated number per service bulletin.

Important

- Do not remove PROM from carrier to check PROM number.

2. For correct reference of PROM in carrier, see Figure C1-15.

Important

- Small notch of carrier should be aligned with small notch in socket. Press on PROM carrier until it is firmly seated in the socket. Do not press on PROM; only the carrier.

3. Access cover on ECM.
4. ECM in passenger compartment.
5. Connectors to ECM.

Functional Check

1. Turn ignition "ON."
2. Enter diagnostics (see "Diagnostic Circuit Check" for procedure).
   A. Allow Code 12 to flash four times to verify that no other codes are present. This indicates the PROM is installed properly.
   B. If trouble Code 51 occurs or if the "Service Engine Soon" light is "ON" constantly with no codes, the PROM is not fully seated, installed backwards, has bent pins, or is defective.

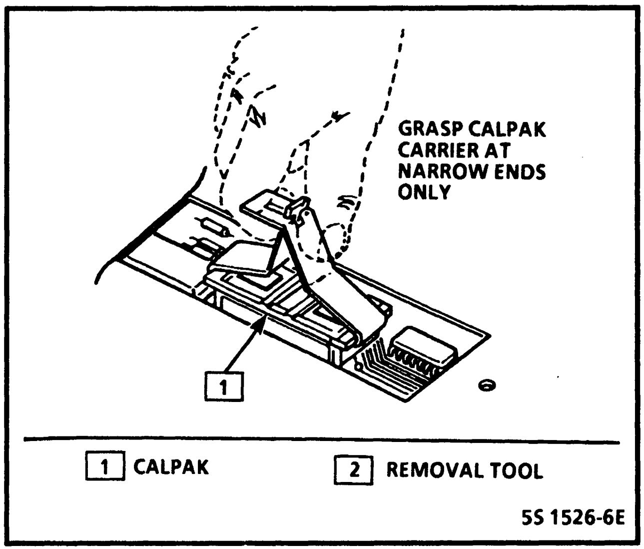


Figure C1-16 - Removing CAL-PAK

- If not fully seated, press firmly on PROM carrier.
- If it is necessary to remove the PROM, follow instructions in Steps "A" and "B" installed backwards, REPLACE THE PROM.
- If pins bend, remove PROM, straighten pins, and reinstall. If bent pins break or crack during straightening, discard PROM and replace it.

NOTICE: Any time the PROM is installed backward and the ignition switch turned "ON," the PROM is destroyed.

CAL-PAK

NOTICE: To prevent possible Electrostatic Discharge damage to the PROM or CAL-PAK, Do Not touch the component leads, and Do Not remove integrated circuit from carrier.

Remove or Disconnect

1. Remove ECM access cover.
2. Remove CAL-PAK (Figure C1-16) using removal tool shown. Grasp the CAL-PAK carrier at the narrow end only. Gently rock the carrier from end to end while applying a firm upward force.

Inspect

3. Inspect reference end of the CAL-PAK carrier and carefully set aside. Do not remove CAL-PAK from the carrier to confirm CAL-PAK correctness. Notch in CAL-PAK referenced to smaller notch in carrier and the (1).

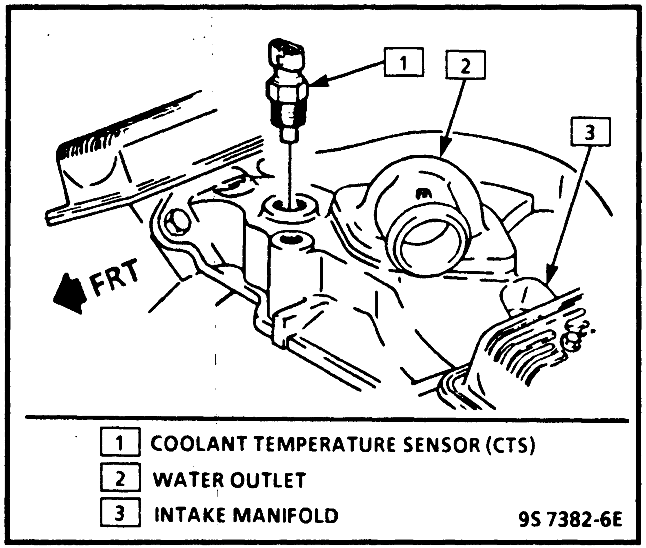


Figure C1-17 - CTS Service

Install or Connect

4. Install CAL-PAK. If a service CAL-PAK is being installed, make sure it has the same part number as the removed CAL-PAK. Do not press on the CAL-PAK - only the carrier.
   Small notch of the carrier must be aligned with small notch in socket. Press on CAL-PAK carrier until it is firmly seated in the socket.
5. Install ECM access cover.
6. Install ECM in passenger compartment and perform a "Diagnostic Circuit Check" to confirm proper installation.

COOLANT TEMPERATURE SENSOR (CTS)

NOTICE: Care must be taken when handling coolant temperature sensor. Damage to coolant temperature sensor will affect proper operation of the fuel injection system.

Remove or Disconnect

1. Negative battery cable.
2. Electrical connector.
3. Carefully back out coolant temperature sensor.

Install or Connect

1. Coolant temperature sensor in engine.
2. Electrical connector.
3. Negative battery cable.

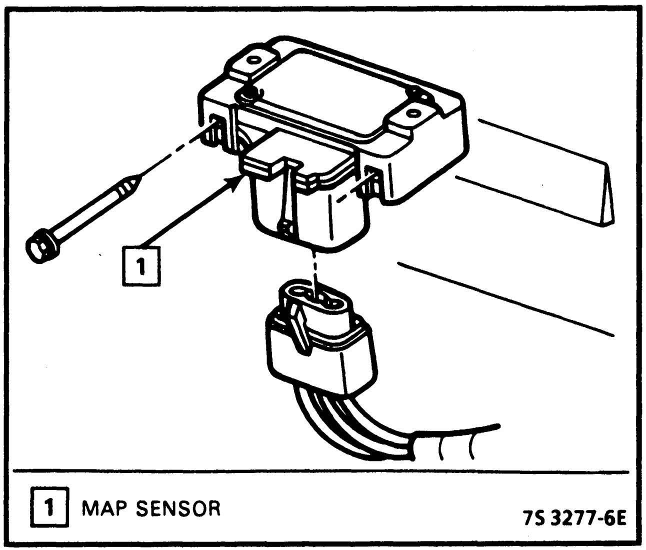


Figure C1-18 - MAP Sensor Service

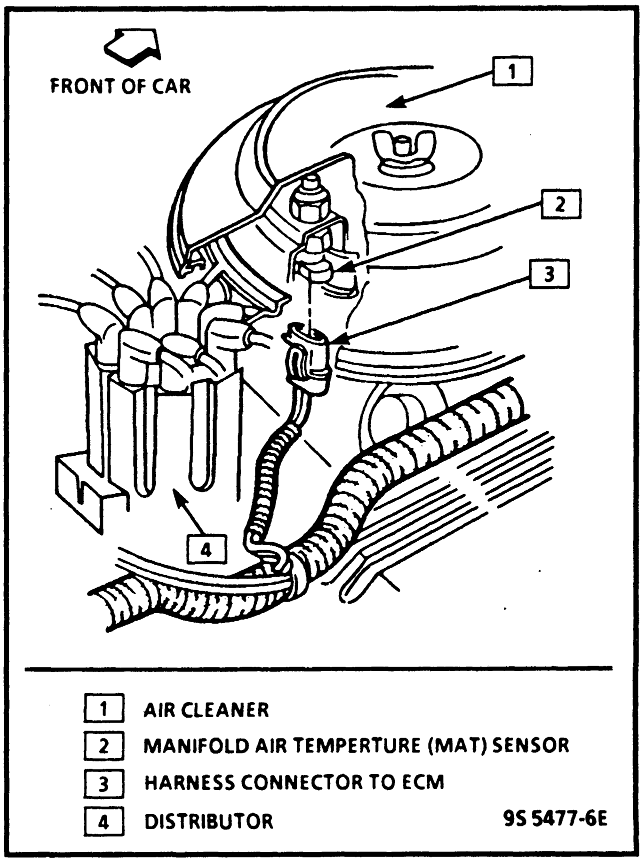


Figure C1-19 - MAT Sensor Service

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

Remove or Disconnect

1. Negative battery cable.
2 Vacuum hose.
3. Electrical connector.
4. Attaching screws.
5. MAP Sensor.

Install or Connect

1. Sensor and attaching screws.

Tighten

- Map sensor screws to 2 N·m (18 lb. in.).

2. Electrical connector.

3. Vacuum hose.
4. Negative battery cable.

MANIFOLD AIR TEMPERATURE (MAT) SENSOR

Remove or Disconnect

1. Negative battery cable.
2. Air cleaner assembly.
3. Electrical connector.
4. Squeeze the retainer clips together.
5. Carefully back out MAT sensor.

Install or Connect

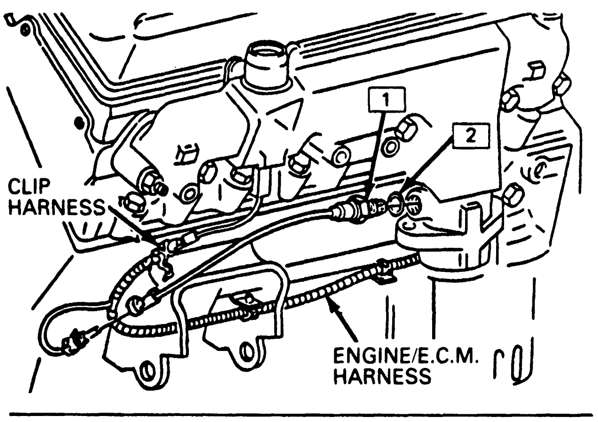
1. MAT sensor in air cleaner until retainer clips snap in place.
2. Electrical connector.
3. Air cleaner assembly.
4. Negative battery cable.

OXYGEN (O_2) SENSOR

NOTICE: The oxygen (O_2) sensor uses a permanently attached pigtail and connector. This pigtail should not be removed from the oxygen sensor. Damage or removal of the pigtail or connector could affect proper operation of the oxygen sensor.

Important

- Use care when handling the oxygen (O_2) sensor. The in-line electrical connector and louvered end must be kept free of grease, dirt or other contaminants. Also, avoid using cleaning solvents of any type. Do not drop or roughly handle the oxygen (O_2) sensor.



1 OXYGEN SENSOR 38-46 N·m (28-33 LBS. FT.)
2 GASKET

Figure C1-20 - Oxygen Sensor

Remove or Disconnect

- The oxygen sensor may be difficult to remove when engine temperature is below 48°C (120°F). Excessive force may damage threads in exhaust manifold or exhaust pipe.

1. Negative battery cable.
2. Electrical connector.
3. Carefully back out oxygen (O_2) sensor.

Install or Connect

Important

- A special anti-seize compound is used on the oxygen (O_2) sensor threads. The compound consists of a liquid graphite and glass beads. The graphite will tend to burn away, but the glass beads will remain, making the sensor easier to remove.

  New or service oxygen (O_2) sensors will already have the compound applied to the threads. If a sensor is removed from an engine, and, if for any reason it is to be reinstalled, the threads must have anti-seize compound applied before reinstallation.

1. Coat threads of oxygen (O_2) sensor with anti-seize compound P/N 3613695 or equivalent if necessary.

Tighten

1. Oxygen sensor to 41 N·m (30 lb. ft.).
2. Electrical connector.
3. Negative battery cable.

THROTTLE POSITION SENSOR (TPS)

Remove or Disconnect

1. Air cleaner assembly.
2. Electrical connector.
3. Two TPS attaching screws, lockwashers and retainers.
4. Throttle Position Sensor.

Install or Connect

1. With throttle valve in the normal closed idle position, install throttle position sensor on throttle body assembly, making sure TPS pickup lever is located ABOVE tang on throttle actuator lever.

Tighten

- TPS attaching screws to 2.0 N·m (18 lb. in.)

2. Electrical connector.
3. Air cleaner assembly.

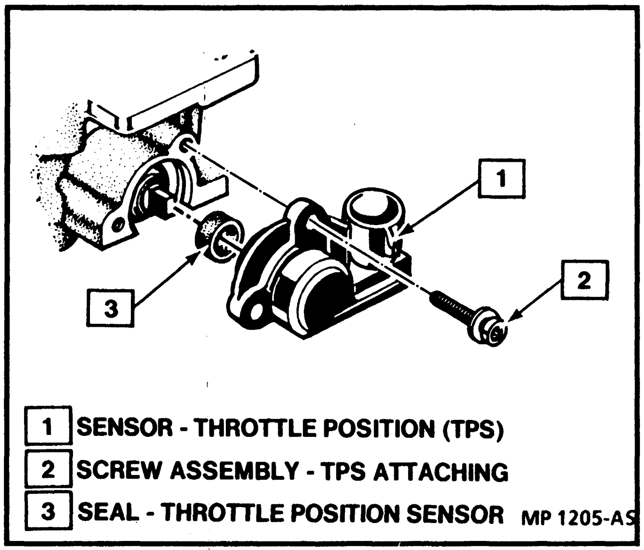


Figure C1-21 - TPS Service

PARK/NEUTRAL SWITCH

See ELECTRICAL DIAGNOSIS (SECTION 8A) for location of park/neutral (P/N) switch. "On-Vehicle Service" and adjustment procedures are also listed there.

PARTS INFORMATION

PART NAME	GROUP
Controller, ECM	3.670
Calibrator, PROM	3.670
Sensor, Coolant Temp.	3.682
MAT Sensor	3.682
Sensor, Exhaust Oxygen	3.682
Sensor, MAP	3.682
Sensor Kit, Throttle Position	3.764
Switch, Neutral Safety and Backing LP	2.698

TORQUE SPECIFICATIONS

Sensor, Throttle position	2.0 N·m (18 lb. in.)
Sensor, Oxygen	41 N·m (30 lb. ft.)
Sensor, Manifold Absolute Pressure (Map)	2 N·m (18 lb. in.)

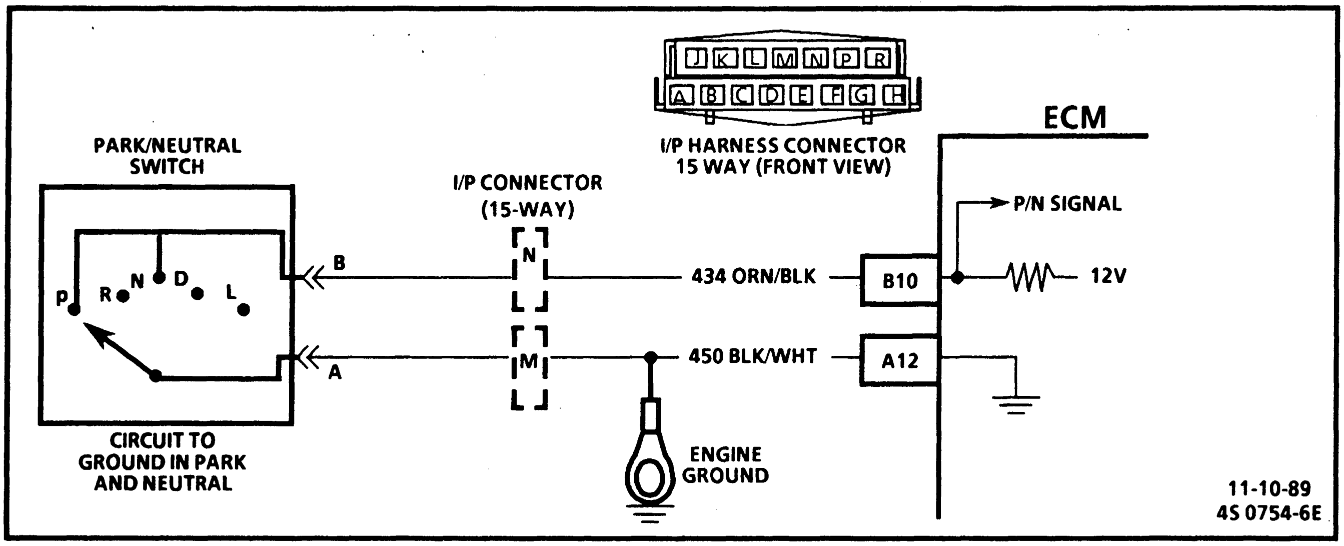


CHART C-1A

PARK/NEUTRAL SWITCH DIAGNOSIS
(AUTOMATIC TRANSMISSION ONLY)
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

The Park/Neutral (P/N) switch contacts are a part of the neutral start switch and are closed to ground in park or neutral and open in drive ranges.

The ECM supplies ignition voltage through a current limiting resistor to CKT 434 and senses a closed switch when the voltage on CKT 434 drops to less than one volt.

The ECM uses the P/N signal as one of the inputs to control:

Idle Air Control (IAC)
Vehicle Speed Sensor (VSS) diagnostics
Exhaust Gas Recirculation (EGR)

If CKT 434 indicates P/N (grounded), while in drive range, the EGR would be inoperative, resulting in possible detonation.

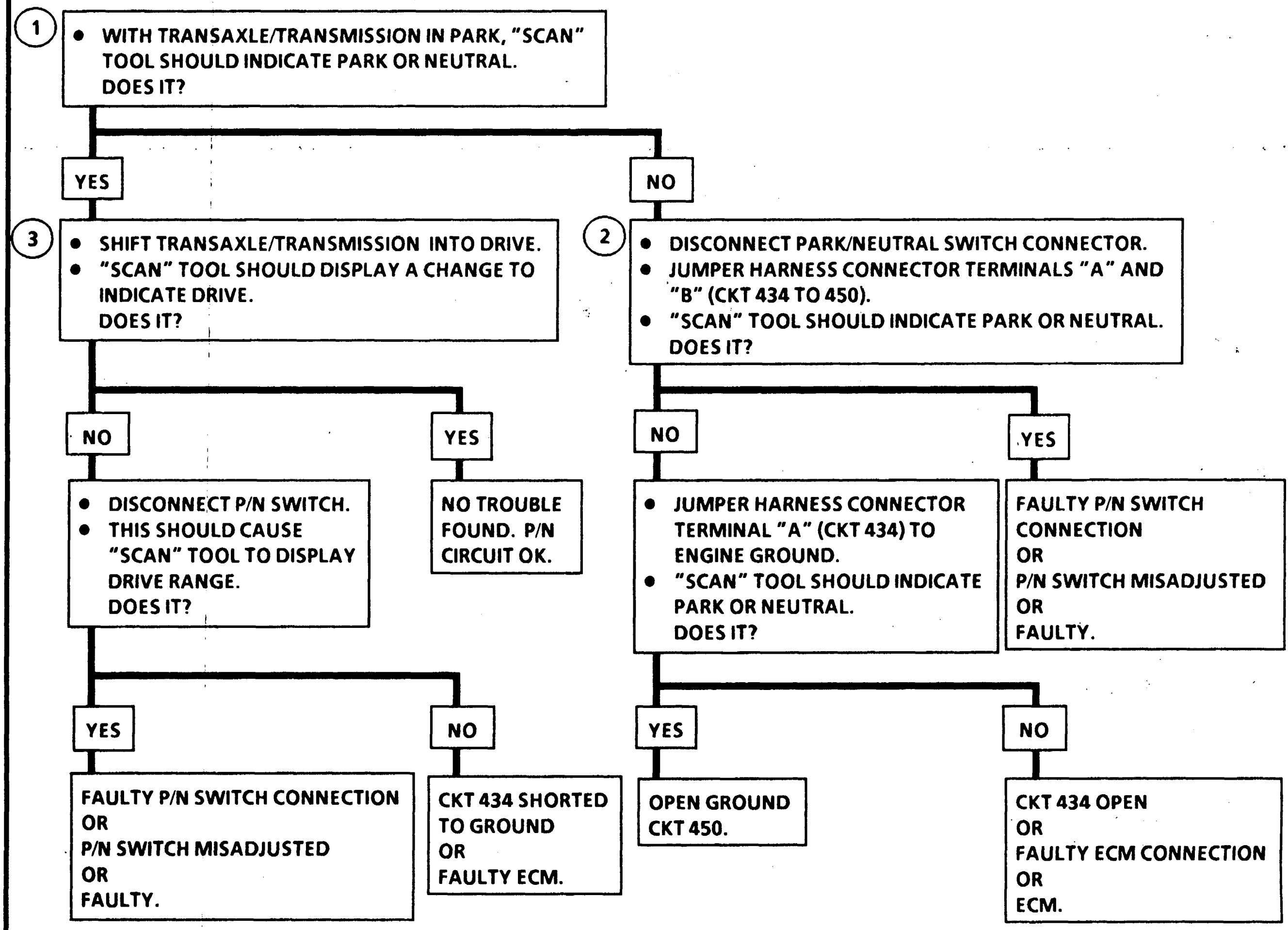
If CKT 434 always indicates drive (open), a drop in the idle may exist when the gear selector is moved into drive range.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Checks for a closed switch to ground in park position.
2. Checks for an open switch in drive range.
3. Make sure "Scan" tool indicates drive, even while wiggling shifter to test for an intermittent or misadjusted switch in drive range.

CHART C-1A

PARK/NEUTRAL SWITCH DIAGNOSIS
(AUTOMATIC TRANSMISSION ONLY)
5.0L (VIN E) "F" CARLINE (TBI)



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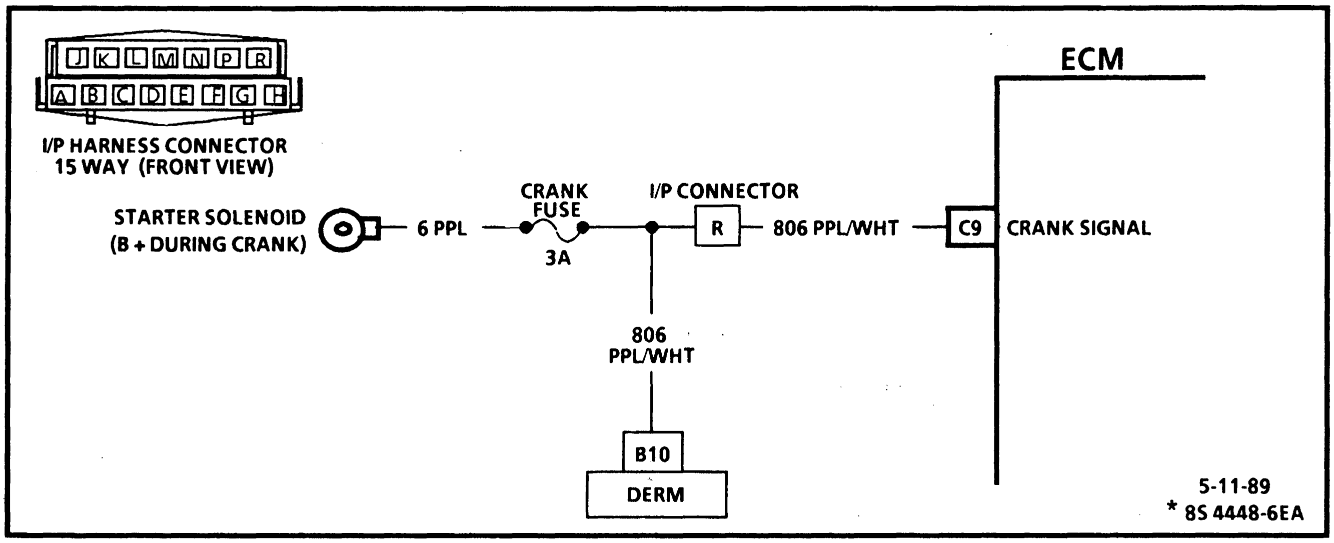


CHART C-1B

CRANK SIGNAL
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

Crank signal is a 12 volt signal to the ECM during cranking to allow enrichment and cancel diagnostics until engine is running. The crank signal is also an input to the Diagnostic Energy Reserve Module (DERM) for the Supplemental Inflatable Restraint (SIR) system. When the DERM senses the engine is being cranked, it will perform a bulb check on the INFL REST light.

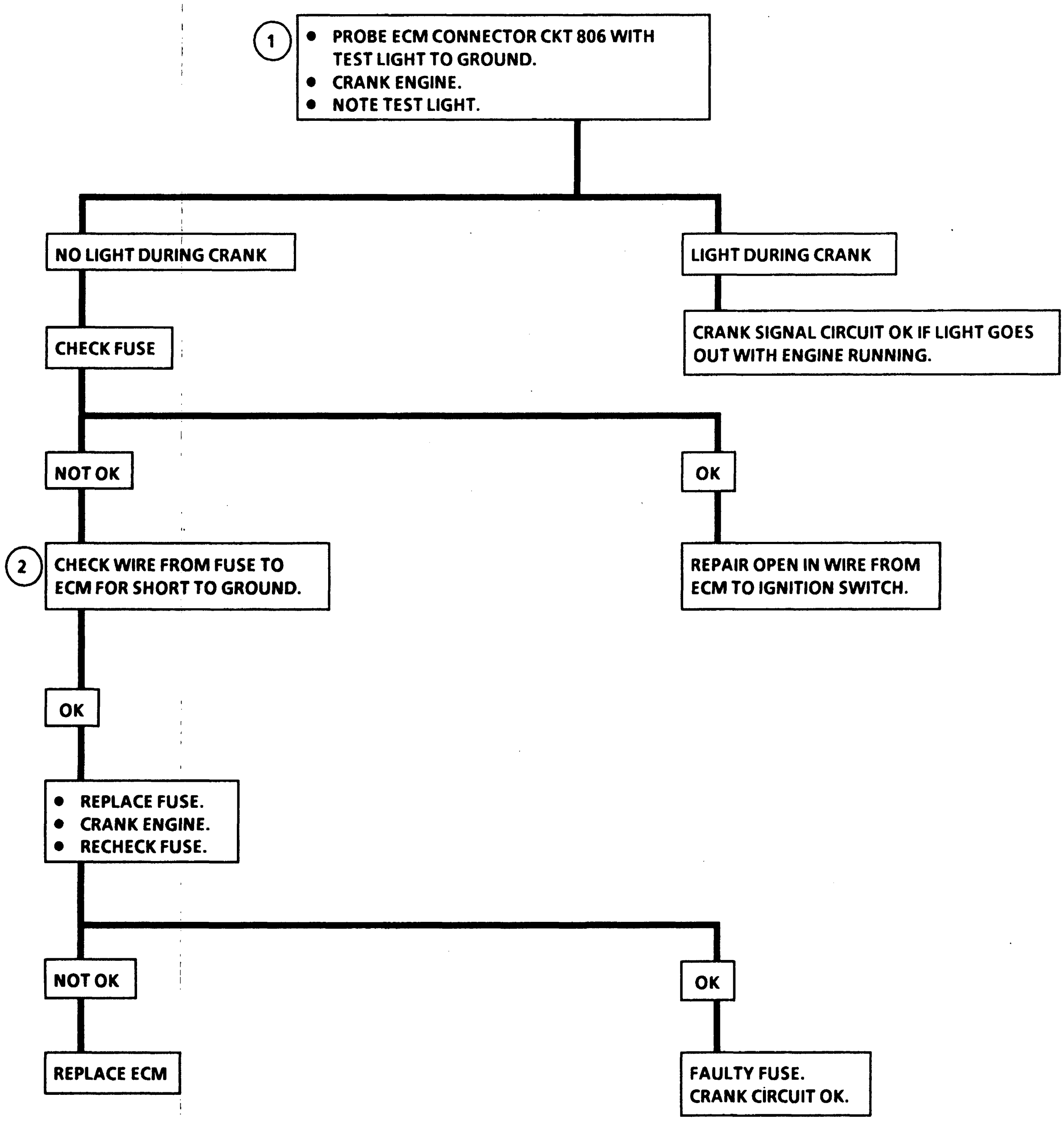
Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Checks for normal (cranking) voltage to terminal "C9" of ECM. Test light should be "ON" during cranking.
2. Checks to determine if source of blown fuse was a faulty ECM. Also, check crank signal to DERM for short to ground. Follow CAUTION on this page when working around SIR system.

CAUTION: **This vehicle is equipped with Supplemental Inflatable Restraint (SIR). Refer to CAUTIONS in SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) (Section 9J) under On-Vehicle Service before performing service on or around SIR components or wiring. Failure to follow CAUTIONS could result in possible air bag deployment, personal injury, or unneeded SIR system repairs.**

CHART C-1B

CRANK SIGNAL
5.0L (VIN E) "F" CARLINE (TBI)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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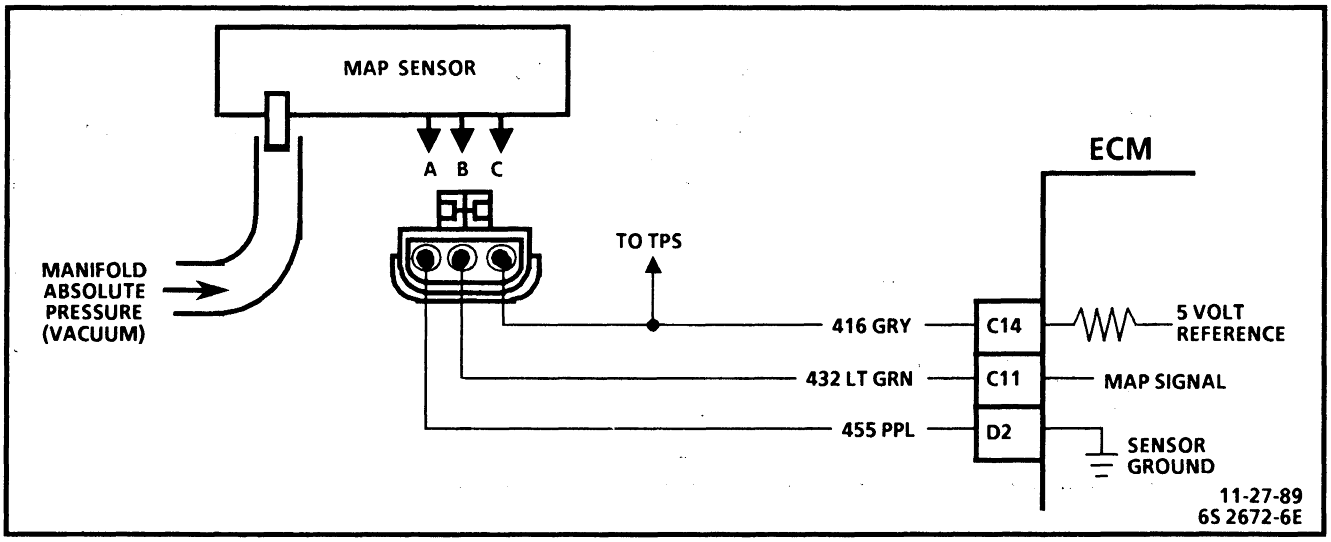

CHART C-1D

MANIFOLD ABSOLUTE PRESSURE (MAP) OUTPUT CHECK

5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

Manifold Absolute Pressure (MAP) sensor measures the changes in the intake manifold pressure which result from engine load (intake manifold vacuum) and rpm changes; and converts these into a voltage output. The ECM sends a 5-volt reference voltage to the MAP sensor. As the manifold pressure changes, the output voltage of the sensor also changes. By monitoring the sensor output voltage, the ECM knows the manifold pressure. A lower pressure (low voltage) output voltage will be about 1 - 2 volts at idle. While higher pressure (high voltage) output voltage will be about 4 - 4.8 at Wide Open Throttle (WOT). The MAP sensor is also used, under certain conditions, to measure barometric pressure, allowing the ECM to make adjustments for different altitudes. The ECM uses the MAP sensor to control fuel delivery and ignition timing.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

Important

- Be sure to use the same Diagnostic Test Equipment for all measurements.

1. When comparing "Scan" readings to a known good vehicle, it is important to compare vehicles that use a MAP sensor having the same color insert or having the same "Hot Stamped" number. See figures on facing page.
2. Applying 34 kPa (10" Hg) vacuum to the MAP sensor should cause the voltage to be 1.5 to 2.1 volts less than the voltage at Step 1. Upon applying vacuum to the sensor, the change in voltage should be instantaneous. A slow voltage change indicates a faulty sensor.
3. Check vacuum hose to sensor for leaking or restriction. Be sure that no other vacuum devices are connected to the MAP hose.

NOTE: Make sure electrical connector remains securely fastened.

4. Disconnect sensor from bracket and twist sensor by hand (only) to check for intermittent connection. Output changes greater than .10 volt indicate a bad sensor.

CHART C-1D

MANIFOLD ABSOLUTE PRESSURE (MAP) VOLTAGE OUTPUT CHECK 5.0L (VIN E) "F" CARLINE (TBI)

①
- IGNITION "ON," ENGINE "OFF."
- "SCAN" TOOL SHOULD INDICATE A MAP SENSOR VOLTAGE.
- COMPARE THIS READING WITH THE READING OF A KNOWN GOOD VEHICLE. SEE FACING PAGE TEST DESCRIPTION, STEP 1.
- VOLTAGE READING SHOULD BE THE SAME, ± .4 VOLT.

IS IT?

YES

②
- DISCONNECT VACUUM HOSE AT MAP SENSOR AND PLUG HOSE.
- CONNECT A HAND VACUUM PUMP TO MAP SENSOR.
- START ENGINE.
- APPLY 34 kPa (10" Hg) OF VACUUM AND NOTE VOLTAGE CHANGE. VOLTAGE CHANGE SHOULD BE 1.5 - 2.1 VOLTS LESS THAN STEP 1.

IS IT?

NO

REPLACE SENSOR.

YES

③ NO TROUBLE FOUND. CHECK SENSOR HOSE FOR LEAKAGE OR RESTRICTION. BE SURE THIS HOSE SUPPLIES VACUUM TO MAP SENSOR ONLY.

NO

④ CHECK SENSOR CONNECTION. IF OK, REPLACE SENSOR.

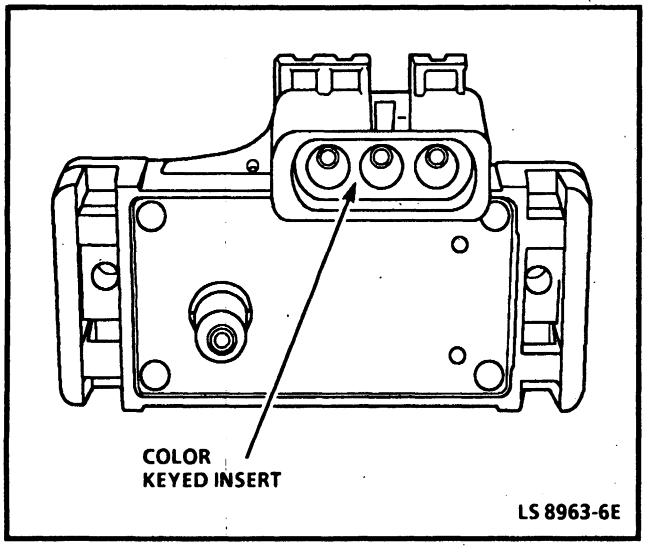

Figure 1 - Color Key Insert

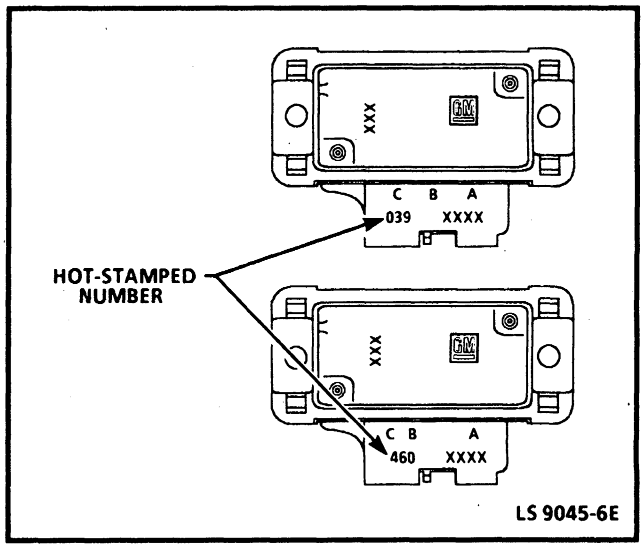

Figure 2 - Hot-Stamped

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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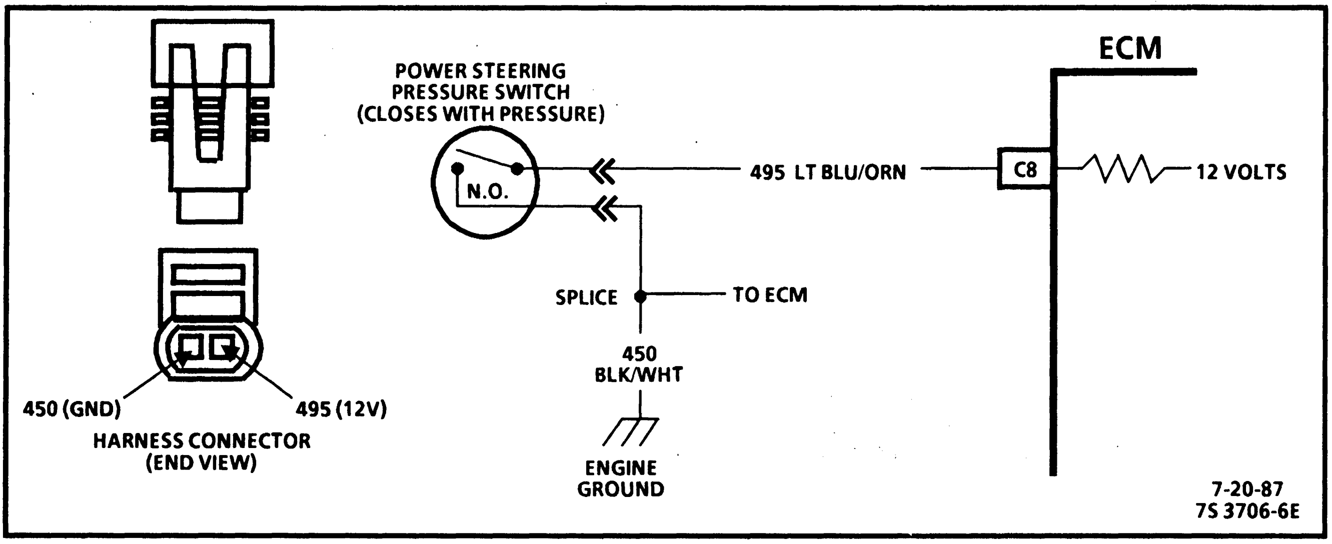


CHART C-1E

POWER STEERING PRESSURE SWITCH (PSPS) DIAGNOSIS
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

The Power Steering Pressure Switch (PSPS) is normally open to ground, and CKT 495 will be near battery voltage. Turning the steering wheel increases power steering oil pressure and applies more load on an idling engine. The pressure switch will close before the load can cause an idle problem.

Closing the switch causes CKT 495 to read less than 1 volt and the ECM will increase the idle air rate and retard the timing.

- A pressure switch that will not close, or an open CKT 495 or 450, may cause the engine to stop when power steering loads are high.
- A switch that will not open, or a CKT 495 shorted to ground, may affect idle quality.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Check for ECM signal voltage on CKT 495 and confirms that ground CKT 450 is OK.
2. Maximum resistance, or infinity, indicates an open switch.
3. Less than 1 ohm indicates that the switch is closed when the power steering pressure is high. Switch is OK.

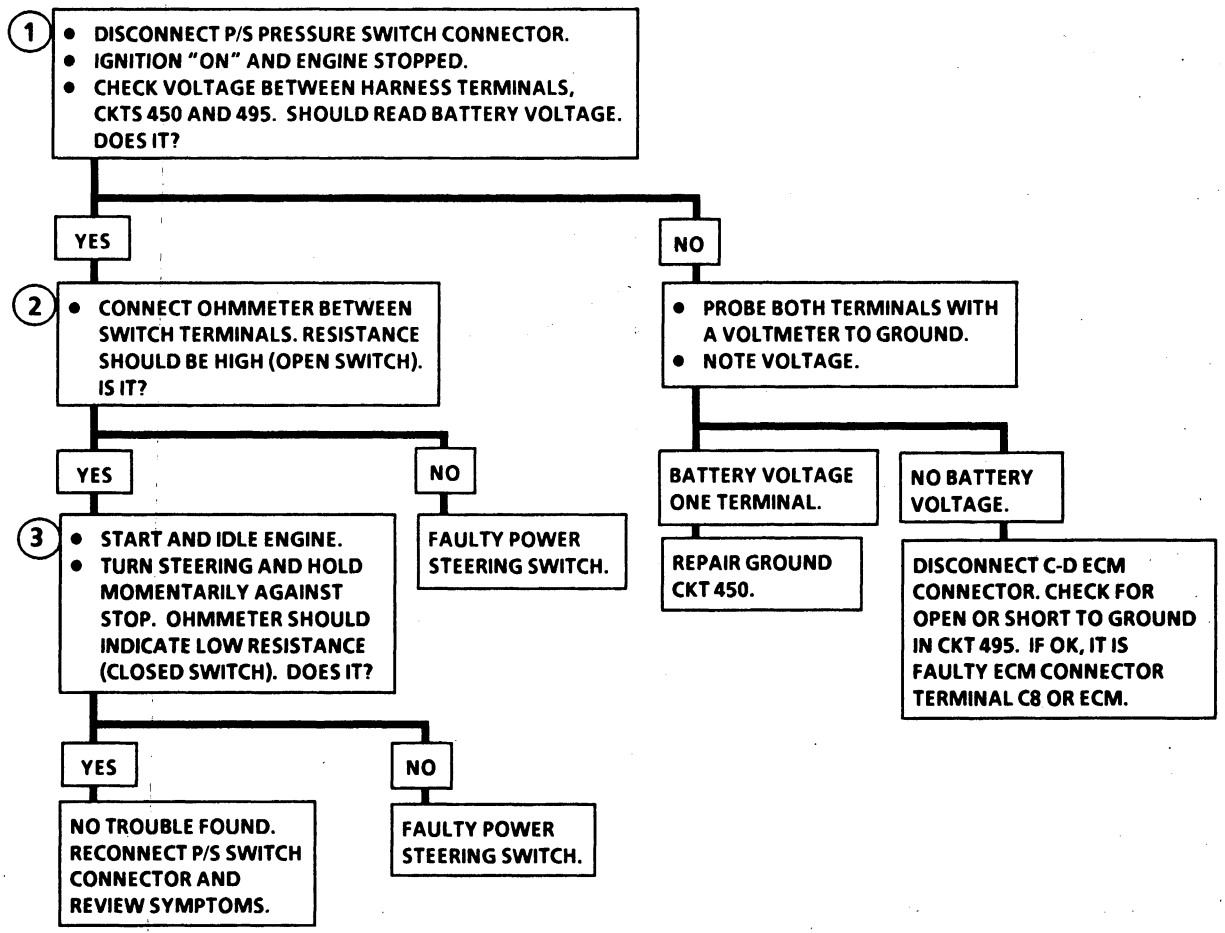
Diagnostic Aids:

A pressure switch that will not close, or an open CKT 495 or 450, may cause the engine to stop when power steering loads are high.

A switch that will not open, or CKT 495, shorted to ground, will cause timing to retard at idle, and may affect idle quality.

CHART C-1E

POWER STEERING PRESSURE SWITCH (PSPS) CHECK 5.0L (VIN E) "F" CARLINE (TBI)



①
- DISCONNECT P/S PRESSURE SWITCH CONNECTOR.
- IGNITION "ON" AND ENGINE STOPPED.
- CHECK VOLTAGE BETWEEN HARNESS TERMINALS, CKTS 450 AND 495. SHOULD READ BATTERY VOLTAGE. DOES IT?

②
- CONNECT OHMMETER BETWEEN SWITCH TERMINALS. RESISTANCE SHOULD BE HIGH (OPEN SWITCH). IS IT?

③
- START AND IDLE ENGINE.
- TURN STEERING AND HOLD MOMENTARILY AGAINST STOP. OHMMETER SHOULD INDICATE LOW RESISTANCE (CLOSED SWITCH). DOES IT?

NO TROUBLE FOUND. RECONNECT P/S SWITCH CONNECTOR AND REVIEW SYMPTOMS.

FAULTY POWER STEERING SWITCH.

FAULTY POWER STEERING SWITCH.

- PROBE BOTH TERMINALS WITH A VOLTMETER TO GROUND.
- NOTE VOLTAGE.

BATTERY VOLTAGE ONE TERMINAL.

REPAIR GROUND CKT 450.

NO BATTERY VOLTAGE.

DISCONNECT C-D ECM CONNECTOR. CHECK FOR OPEN OR SHORT TO GROUND IN CKT 495. IF OK, IT IS FAULTY ECM CONNECTOR TERMINAL C8 OR ECM.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON LIGHT.

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BLANK

SECTION C2

FUEL METERING SYSTEM

CONTENTS

GENERAL DESCRIPTION

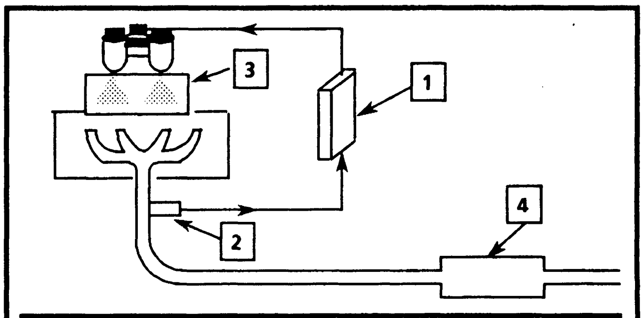
PURPOSE

The function of the fuel metering system is to deliver the correct amount of fuel to the engine under all operating conditions. Fuel is delivered by the Throttle Body Injection (TBI) unit, which is controlled by the Electronic Control Module (ECM).

The main control sensor is the Oxygen (O_2) sensor, located in the exhaust manifold. The O_2 sensor tells the Engine Control Module (ECM) the amount of oxygen in the exhaust gas, and the ECM changes the air/fuel ratio to the engine by controlling the fuel injector. A 14.7:1 air/fuel ratio is required for efficient catalytic converter operation. Because of the constant measuring and adjusting of the air/fuel ratio, the fuel injection system is called a "Closed Loop" system (Figure C2 -1).

MODES OF OPERATION

The ECM monitors voltages from several sensors to determine how much fuel to give the engine. The fuel is delivered under one of several conditions, called "modes." All the modes are controlled by the ECM.



1	ENGINE CONTROL MODULE (ECM)
2	EXHAUST OXYGEN (O_2) SENSOR
3	THROTTLE BODY INJECTION UNIT (TBI)
4	CATALYTIC CONVERTER

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Figure C2-1 - Closed Loop System

Starting Mode

When the ignition switch is turned to the "ON" position (before engaging starter), the ECM turns "ON" the fuel pump relay for two seconds, and the fuel pump builds up pressure to the TBI unit.

The ECM checks the Coolant Temperature Sensor (CTS), Throttle Position Sensor (TPS), Manifold Absolute Pressure (MAP) sensor, and crank signal, then determines the proper air/fuel ratio for starting. This ranges from 1.5:1 at -36°C (-33°F) to 14.7:1, at 94°C (201°F) coolant temperature .

The ECM controls the amount of fuel delivered in the starting mode by changing how long the injector is turned "ON" and "OFF." This is done by "pulsing" the injector for very short times.

Clear Flood Mode

If the engine floods, it can be cleared by pushing the accelerator pedal down all the way. The ECM then pulses the injector at a 20:1 air/fuel ratio, and holds this injector rate as long as the throttle stays wide open, and the engine is below 600 rpm. If the throttle position becomes less than 80%, the ECM returns to the starting mode.

Run Mode

The run mode has three conditions called "Open Loop," "Closed Loop," and "Highway Mode (Semi-Closed Loop.")

Open Loop

When the engine is first started, and it is above 400 rpm, the system goes into "Open Loop" operation. In "Open Loop," the ECM ignores the signal from the O_2 sensor, and calculates the air/fuel ratio based on inputs from the Coolant Temperature and MAP sensors.

The system stays in "Open Loop" until the following conditions are met:

1. The O_2 sensor has varying voltage output, showing that it is hot enough to operate properly. (This depends on temperature.)
2. The Coolant Temperature Sensor is above a specified temperature.
3. A specific amount of time has elapsed after starting the engine.

Closed Loop

The specific values for the above conditions vary with different engines, and are stored in the Programmable Read Only Memory (PROM). When these values are met, the system goes into "Closed Loop" operation. In "Closed Loop," the ECM calculates the air/fuel ratio (injector on-time) based on the signal from the O_2 sensor. This allows the air/fuel ratio to stay very close to 14.7:1.

Highway Mode (Semi-Closed Loop)

When the vehicle is driven at highway speeds, the system may enter "Highway" or "Semi-Closed Loop" mode for improved fuel economy. For the system to enter the "Highway" mode, the ECM must first see the correct engine temperature, spark timing, canister purge activity, and constant vehicle speed.

While operating in this mode, the air/fuel mixture may be leaned out somewhat for optimum fuel economy.

During "Highway" mode operation, the ECM will periodically switch back to "Closed Loop" mode to allow a check of the engine systems. If all systems meet the requirements, the ECM will switch to the "Highway" mode again.

Using a "Scan" tool, it is possible to determine when the system is operating in "Highway" mode by looking at integrator/block learn values and oxygen sensor voltage:

- Integrator and block learn values will show very little change.
- Oxygen sensor voltage, normally between 0 and 1000 millivolts, will be less than 100 millivolts.

Acceleration Mode

The ECM looks at rapid changes in throttle position and manifold pressure, and provides extra fuel.

Deceleration Mode

When deceleration occurs, the fuel remaining in the intake manifold can cause excessive emissions and backfiring. Again, the ECM looks at changes in throttle position and manifold pressure and reduces the amount of fuel. When deceleration is very fast, the ECM can cut off fuel completely for short periods of time.

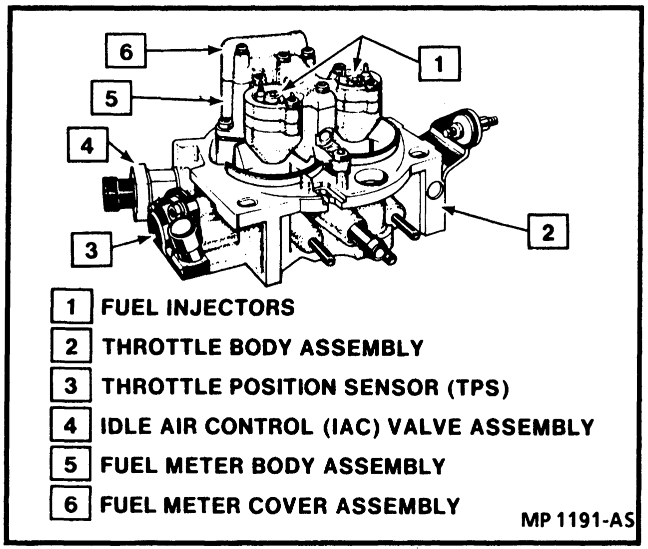


Figure C2-2 - Model 220 Throttle Body Injection Unit

Battery Voltage Correction Mode

When battery voltage is low, the ECM can compensate for a weak spark delivered by the distributor by:

- Increasing injector "ON" time of fuel delivered;
- Increasing the idle rpm.

Fuel Cutoff Mode

No fuel is delivered by the injectors when the ignition is "OFF." This prevents dieseling. Also, fuel is not delivered if no reference pulses are seen from the distributor, which means the engine is not running.

FUEL METERING SYSTEM COMPONENTS

The fuel metering system consists of the following:

- Fuel supply components (fuel tank, pump and lines)
- Fuel pump electrical circuit.
- Throttle body injection (TBI) unit.

FUEL SUPPLY SYSTEM

The fuel supply is stored in the fuel tank. An electric fuel pump, located in the fuel tank with the gage sending unit, pumps fuel through an in-line fuel filter to the TBI unit. The pump is designed to provide fuel at a pressure greater than is needed by the injectors. The pressure regulator, part of the TBI assembly, keeps fuel available to the injectors at a regulated pressure. Unused fuel is returned to the fuel tank by a separate line. See ENGINE FUEL (SECTION 6C) for replacement procedures covering the fuel tank, fuel pump, in-line filter and fuel lines.

FUEL PUMP ELECTRICAL CIRCUIT

When the ignition switch is turned to the "ON" position (before engaging starter), the ECM turns the fuel pump relay "ON" for two seconds, and the fuel pump builds up pressure to the TBI unit. If the engine is not started within two seconds, the ECM shuts the fuel pump "OFF" and waits until the engine starts. As soon as the engine is cranked, the ECM turns the relay "ON" and runs the fuel pump.

As a backup system to the fuel pump relay, the fuel pump also can be turned "ON" by the oil pressure switch. The oil pressure sender has two internal circuits. One operates the oil pressure indicator or gage in the instrument cluster, and the other is a normally open switch which closes when oil pressure reaches about 28 kPa (4 psi). If the fuel pump relay fails, a Code 54 is set in the ECM, and the oil pressure switch runs the fuel pump.

An inoperative fuel pump relay can result in long cranking times, particularly if the engine is cold. The oil pressure switch will turn "ON" the fuel pump as soon as oil pressure reaches about 28 kPa (4 psi).

THROTTLE BODY INJECTION (TBI) UNIT

The Model 220 unit (Figure C2-2) consists of three major assemblies:

- Fuel Meter Cover
  - Fuel pressure regulator
- Fuel Meter Body
  - Fuel injectors
- Throttle Body
  - Two throttle valves to control air flow into the engine.
  - Idle Air Control (IAC) valve
  - IAC air passage splitter for improved distribution of idle air flow
  - Throttle Position Sensor (TPS)
  - Vacuum ports located at, above, or below the throttle valves to generate vacuum signals to various controls and accessories.

Fuel Injectors

A fuel injector (Figure C2-3) is a solenoid-operated device controlled by the ECM. When the ECM energizes the solenoid, a normally closed ball valve is lifted off its seat. Pressurized fuel is injected in a conical spray pattern against the walls of the throttle bore above the throttle valve. Excess fuel, which is not needed by the injector, passes through the pressure regulator before being returned to the fuel tank. Model 220 TBI uses two injectors designed with the flow capacity required for the engine application.

A fuel injector which does not open may cause a no start condition. An injector which is stuck partly open will cause a loss of pressure after setting, so long crank times would be noticed. Also, dieseling could occur because some fuel would be delivered to the engine after the key is turned "OFF." An injector stuck completely open will cause a stall or no start condition.

Pressure Regulator

The pressure regulator (see Figure C2-3) is part of the fuel meter cover, and contains an air chamber and a fuel chamber that are separated by a diaphragm-operated relief valve and a calibrated spring. The regulator's function is to maintain constant pressure drop across the injector at all times. Fuel pressure is regulated by the difference between fuel pump pressure acting on one side of the diaphragm and the force of the calibrated spring (and air cleaner air pressure) acting on the other side.

The system operates in an acceptable pressure range of 62 to 90 kPa (9 to 13 psi).The fuel meter cover includes a bleed that relieves system pressure when the engine is turned "OFF." The bleed also helps purge vapors from the injector and regulator after a hot restart.

The pressure regulator is serviced as part of the fuel meter cover and should not be disassembled.

If the pressure regulator in the TBI supplies pressure which is too low (below 62 kPa or 9 psi), poor performance could result. If the pressure is too high, excess emissions and unpleasant exhaust odor may result.

Idle Air Control (IAC) Valve

Engine idle speed is controlled by the ECM through the IAC valve mounted on the throttle body (Figures C2-4, 5). The ECM sends voltage pulses to the IAC motor windings causing the IAC pintle to move "IN" (retract) or "OUT" (extend) a given distance (number of steps) for each pulse, called counts. The pintle movement controls the airflow around the throttle valves, which in turn, controls engine idle speed.

- Engine idle speed is a function of total airflow into the engine based on IAC valve pintle position + PCV flow + throttle valve opening + calibrated vacuum loss through accessories.
- "Controlled" idle speed is programmed into the ECM, which determines the correct IAC valve pintle position to maintain the desired idle speed for all engine operating conditions and loads.
- The minimum idle air rate is set at the factory with a stop screw. This setting allows enough air flow by the throttle valves to cause the IAC valve pintle to be positioned a calibrated number of steps (counts), from the seat, during "controlled" idle operation.
- If the IAC valve is disconnected and reconnected with the engine running, the idle speed may be wrong. In this case, the IAC valve can be reset by doing the following: depress accelerator pedal slightly, start and run engine for five seconds, then turn ignition "OFF" for ten seconds.

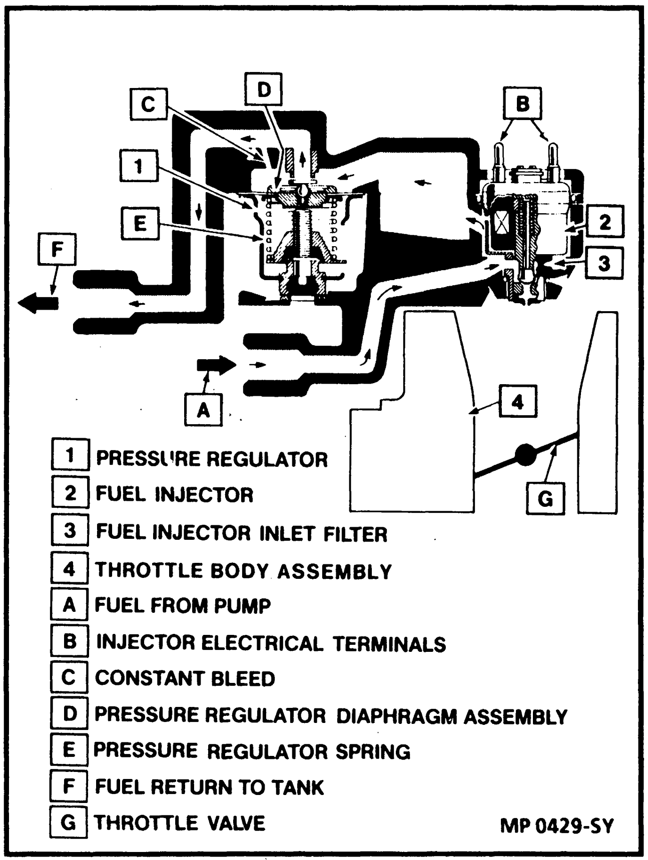


Figure C2-3 - TBI 220 Fuel Flow Diagram

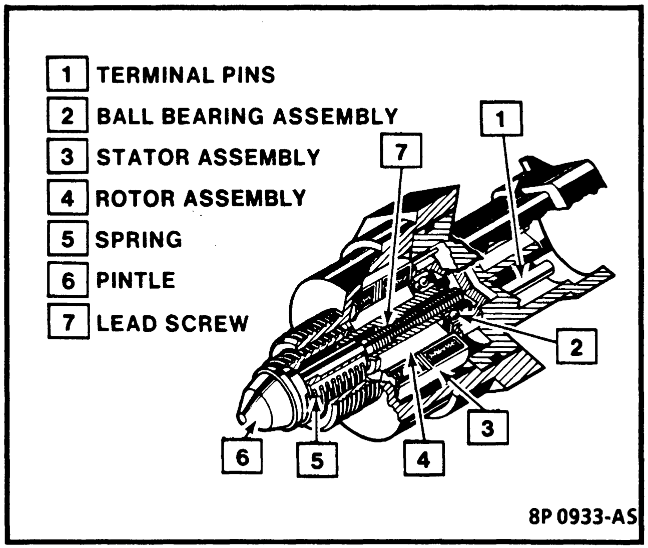


Figure C2-4 - Idle Air Control (IAC) Valve

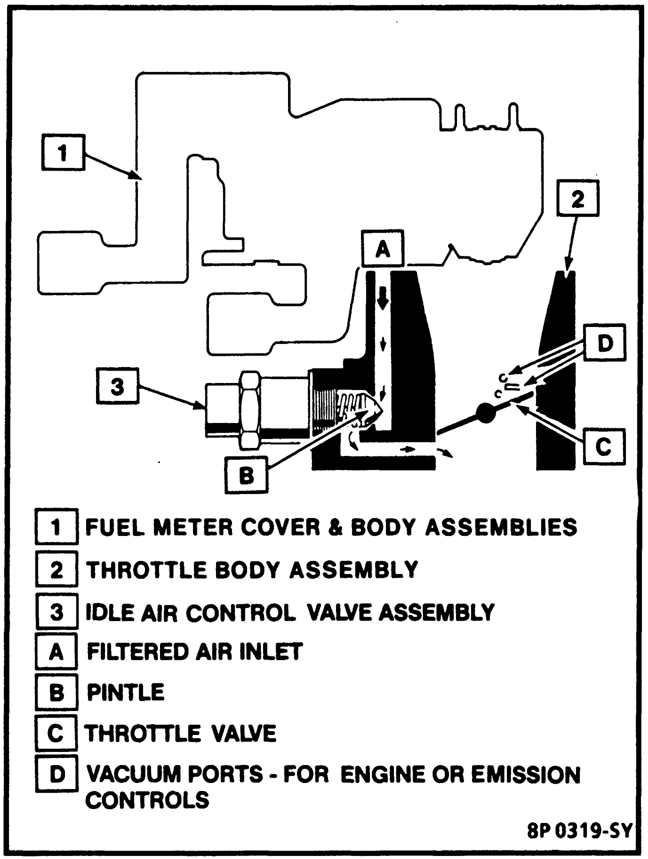


Figure C2-5 - IAC valve Air Flow Diagram

Throttle Position Sensor (TPS)

The nonadjustable TPS is mounted on the side of the throttle body opposite the throttle lever assembly. It senses the current throttle valve position and relays that information to the ECM. Knowledge of throttle position allows the ECM to generate the required injector control signals (pulses). Refer to "Electronic Control Module (ECM) and Sensors," Section "6E2-C1" for further information.

DIAGNOSIS

FUEL PUMP RELAY

The fuel pump relay is mounted in the engine compartment, next to the power brake booster, as shown in Figure C2-6. For diagnosis of the fuel pump relay circuit, refer to the Code 54 chart.

OIL PRESSURE SENSOR/SWITCH

The oil pressure sensor/switch is threaded into the engine block, above the oil filter. See illustration in "On Vehicle Service." For diagnosis of the fuel pump relay circuit, refer to the Code 54 chart.

FUEL METERING SYSTEM

Always start with the "Diagnostic Circuit Check" in "Engine Components/Wiring Diagrams/Diagnostic Charts," Section "6E2-A". This will reduce diagnosis time, and prevent unnecessary parts replacement. The diagnosis of the "Fuel Metering System" is covered in CHART A-3, "Engine Cranks But Will Not Run," and CHART A-7, "Fuel System Diagnosis." These charts cover the diagnosis of the injectors, pressure regulator, and the fuel pump.

If a malfunction occurs in the fuel metering system, it usually results in either a rich or lean exhaust condition. This condition is sensed by the O_2 sensor and causes the ECM to change the fuel calculation (injector pulse width). The change made to the fuel calculation is indicated by a change in the integrator and block learn values, which can be monitored by a "Scan" tool. A short term change to the fuel calculation is indicated by the integrator value, while a long term change is indicated by the block learn value. Average integrator and block learn values are around 128, but vary slightly from engine to engine.

Important

- When using a "Scan" tool to observe integrator and block learn values, remember that if the system is in control, no action is required unless a driveability symptom is present. Listed below are examples of lean and rich conditions with the system in control and out of control.
- A momentary *lean* condition (system is *in* control) will appear on "Scan" tool as:
  - Integrator value above 128 (adding fuel)
  - Block learn value around 128
- A long term *lean* condition (system is *in* control) will appear on "Scan" tool as:
  - Integrator value around 128
  - Block learn value above 128 (added fuel)
- A long term *lean* condition (system is *out of control)* will appear on "Scan" tool as:
  - Integrator value well above 128 (adding fuel)
  - Block learn value well above 128 (added fuel)

If both the integrator and block learn values are fixed well above 128, see Code 44, for items which can cause a lean system.

- A momentary *rich* condition (system is *in* control) will appear on "Scan" tool as:
  - Integrator value less than 128 (reducing fuel)
  - Block learn value around 128
- A long term *rich* condition (system is *in* control) will appear on "Scan" tool as:
  - Integrator value around 128
  - Block learn value less than 128 (reduced fuel)

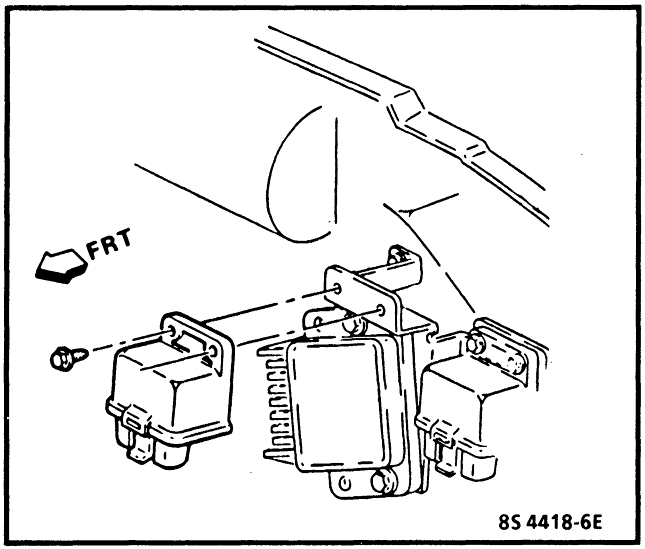


Figure C2-6 - Fuel Pump Relay

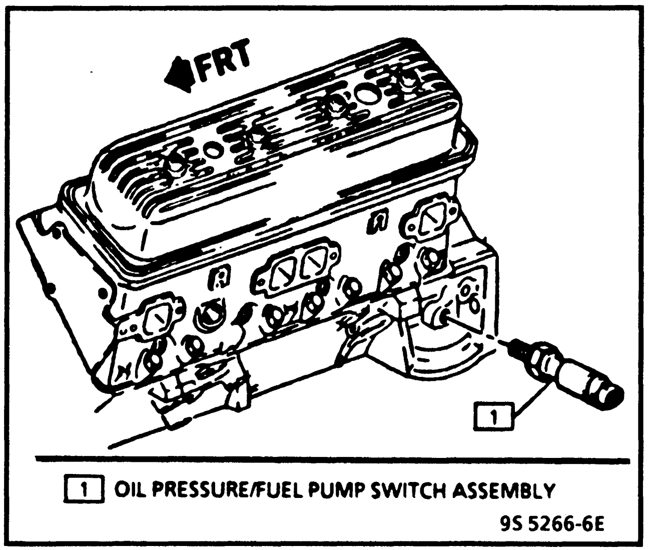


Figure C2-7 - Oil Pressure Switch

- A long term *rich* condition (system is *out of control)* will appear on "Scan" tool as:
  - Integrator value much less than 128 (reducing fuel)
  - Block learn value much less than 128 (reduced fuel)

If the integrator and block learn values are fixed well below 128, see Code 45, for items which can cause the system to run rich. If a driveability symptom exists, refer to the particular symptom in "Symptoms," Section "6E2-B" for additional items to check.

ON-VEHICLE SERVICE

FUEL PUMP RELAY *Figure C2-6*

The fuel pump relay is mounted in the engine compartment, next to the power brake booster, as shown in Figure C2-6.

Remove or Disconnect

1. Fuel pump relay electrical connector.
2. Fuel pump relay.

Install or Connect

- Reverse removal procedure.

OIL PRESSURE SENSOR/SWITCH *Figure C2-7*

The oil pressure sensor/switch is threaded into the engine block, above the oil filter.

Remove or Disconnect

1. Oil pressure sensor/switch electrical connector.
2. Oil pressure sensor/switch.

Install or Connect

- Reverse removal procedure.

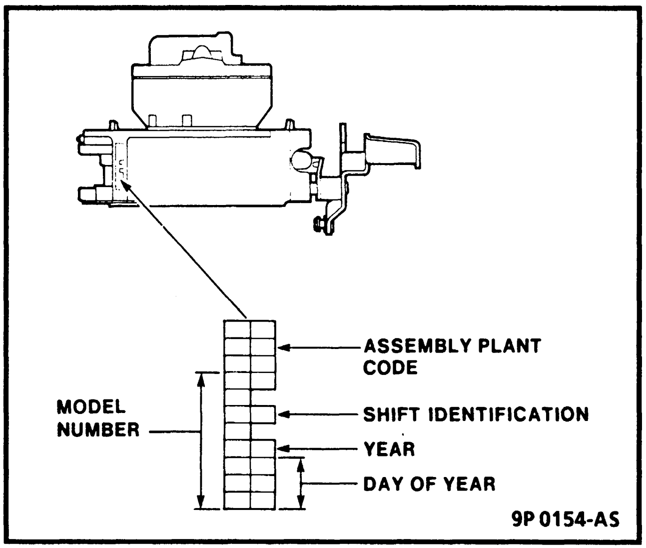


Figure C2-8 - TBI Model 220 Identification

TBI SERVICE INFORMATION

The TBI unit repair procedures cover component replacement with the unit on the vehicle. However, throttle body replacement requires that the complete unit be removed from the engine.

An eight digit part identification number is stamped on the throttle body (Figure C2-8). Refer to this number if servicing or part replacement is required.

Refer to the disassembled view (Figure C2-10) for identification of parts during repair procedures.

CAUTION:

- To reduce the risk of fire and personal injury, relieve the fuel system pressure before servicing fuel system components.
- A small amount of fuel may be released when servicing fuel lines or connections. To reduce the chance of personal injury, cover fuel line fittings with a shop towel before disconnecting, to catch any fuel that may leak out. Place the towel in an approved container when disconnect is completed.

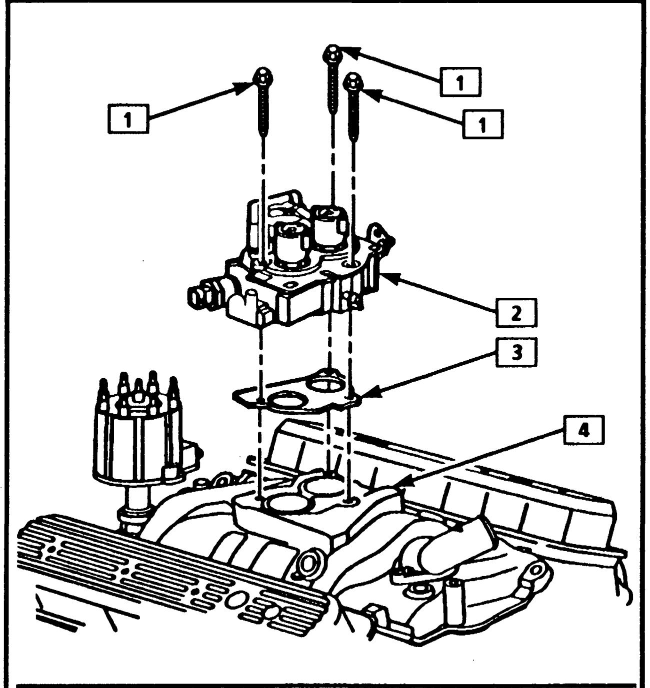
Fuel Pressure Relief Procedure

1. Disconnect negative battery terminal to avoid possible fuel discharge if an accidental attempt is made to start the engine.
2. Loosen fuel filler cap to relieve tank vapor pressure.
3. The internal constant bleed feature of TBI Model 220 relieves fuel pump system pressure when the engine is turned "OFF." Therefore, no further pressure relief procedure is required.

Cleaning Procedures

All TBI component parts, with the exception of those noted below, should be cleaned in a cold immersion cleaner such as GM X-55 or equivalent.

NOTICE: The TPS, IAC valve, fuel meter cover assembly, fuel injectors or other components containing rubber, should NOT be placed in a solvent or cleaner bath. A chemical reaction will cause these parts to swell, harden or distort. Do not soak the throttle body with the above parts attached. If the throttle body assembly requires cleaning, keep soaking time in the cleaner to a minimum. Some models have hidden throttle shaft dust seals that could lose their effectiveness by extended soaking.



1 BOLTS
2 TBI UNIT
3 GASKET
4 ENGINE INTAKE MANIFOLD

MS 9053-6E

Figure C2-9 - TBI Removal and Installation

Thread-Locking Materials

Important

- The hardware used to attach the fuel meter body assembly and TPS are factory coated with thread-locking adhesive. If the fuel meter body assembly or TPS is removed for service, inspect the attaching hardware screw threads for thread-locking material. The screw threads should have enough of thread-locking material (adhesive or compound) on the threads to insure proper re-locking. If not, the screw threads should be cleaned and Loctite 262 or equivalent must be applied to the screw threads before reassembly. Replacement screws for the fuel meter body assembly are included in the service screw assortment package. New TPS attaching hardware is included in the TPS service package.
- If the fuel meter cover is removed for service, Loctite 262 or equivalent must be applied to the screw threads of the attaching screws before installing the cover . Replacement screws for the fuel meter cover and a vial of thread-locking compound are included in the service screw assortment package.

TBI UNIT
Figure C2-9

Remove or Disconnect

1. Negative battery terminal.
2. Relieve fuel system pressure. (Refer to "Fuel Pressure Relief Procedure.")
3. Air cleaner assembly and extension (spacer).
4. Electrical connectors to IAC valve, TPS and fuel injectors.
5. Injector wiring harness.
6. Throttle cable, transmission control cable, and cruise control cable (wherever applicable).
7. Vacuum hoses (noting position of hoses) and bracket.
8. Fuel feed and return lines.
    - Use a backup wrench on TBI fuel nuts to prevent them from turning.
9. Fuel line O-rings (30, 37) and discard.
10. TBI attaching bolts.
11. TBI unit and flange gasket (70).
    - Discard gasket.

Important

- Stuff manifold opening with a shop towel to prevent dirt and other contaminants from entering the engine.

NOTICE: Use care in cleaning old gasket material from machined aluminum surfaces. Sharp tools may damage sealing surfaces.

Clean

- Gasket sealing surfaces.

Install or Connect

1. New TBI flange gasket (70).
2. TBI unit.
3. TBI attaching bolts.

Tighten

- TBI attaching bolts to 22.0 N·m (16 lb. ft.).

4. New O-rings (30, 37) on fuel lines.
5. Fuel feed and return lines.

Tighten

- Fuel line nuts to 27.0 N·m (20 lb. ft.).
- Use a backup wrench on the TBI fuel nuts to prevent them from turning.

6. Vacuum hoses and bracket.
7. Throttle cable, transmission control cable, and cruise control cable (wherever applicable).

Important

- Make sure throttle and cruise control cables do not hold throttle open. Refer to ENGINE FUEL (SECTION 6C) for additional information on accelerator controls.

8. Injector wiring harness.
9. Electrical connectors, making sure connectors are fully seated and latched.
10. Tighten fuel filler cap.
11. Negative battery terminal.

Inspect

- With the engine "OFF," check to see that the accelerator pedal is free.
    - Depress pedal to the floor and release.
- Turn ignition switch to "ON" position for two seconds, then turn to "OFF" position for five seconds. Again turn switch to "ON" position, and check for fuel leaks.

12. Air cleaner extension, and air cleaner assembly.
13. Reset IAC valve pintle position:
    a. Depress accelerator pedal slightly.
    b. Start and run engine for three seconds.
    c. Turn ignition "OFF" for ten seconds.
    d. Restart engine and check for proper idle operation.

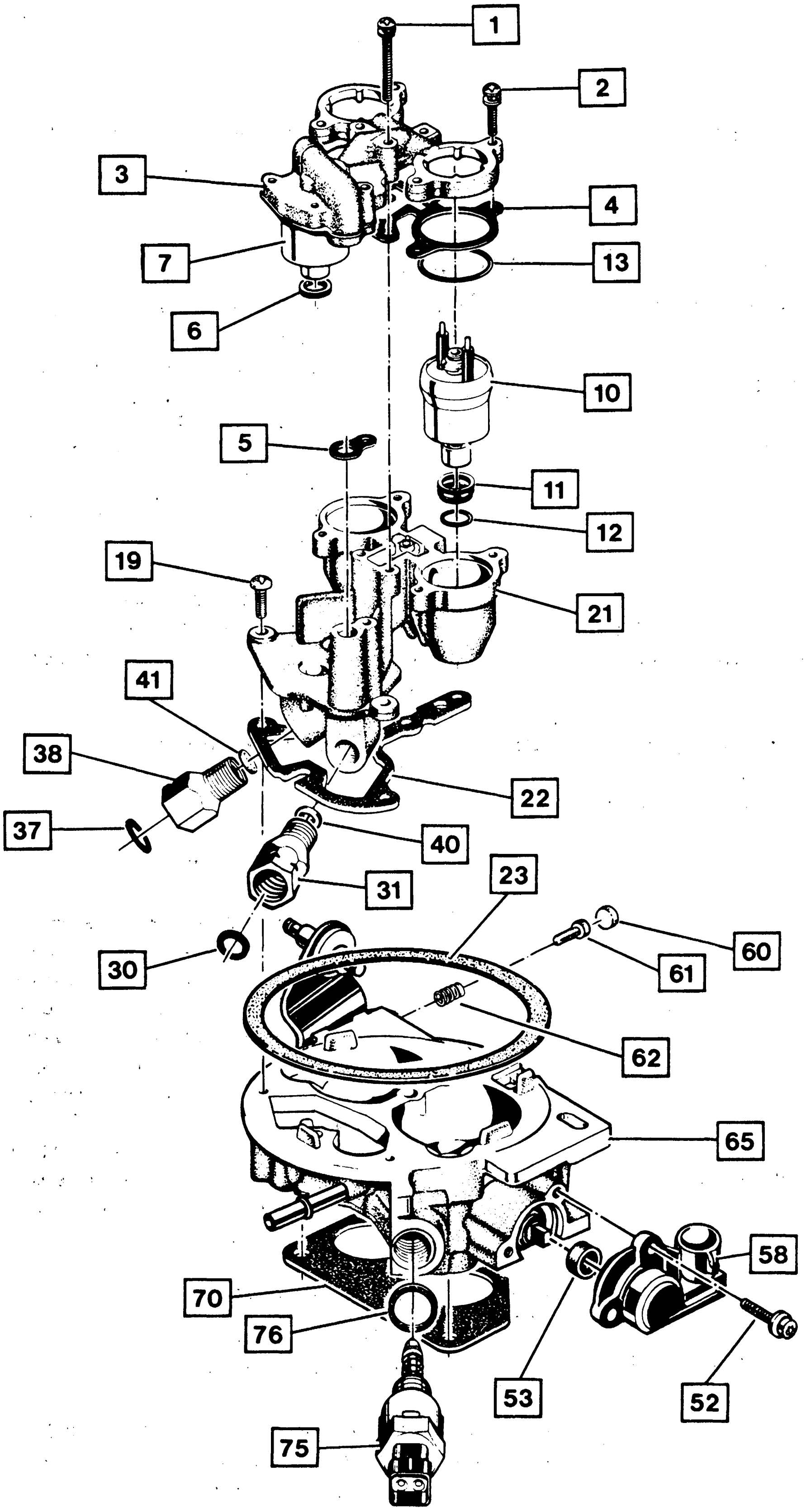
FUEL METER COVER ASSEMBLY
Figure C2-11

The fuel meter cover and pressure regulator are serviced as a complete assembly only.

CAUTION: **DO NOT remove the screws securing the pressure regulator to the fuel meter cover. The fuel pressure regulator includes a spring under compression which, if released, could cause personal injury. Disassembly might also result in a fuel leak between the diaphragm and the regulator container.**

Remove or Disconnect

1. Negative battery terminal.
2. Relieve fuel system pressure. (Refer to "Fuel Pressure Relief Procedure.")
3. Air cleaner assembly and extension (spacer).
4. Electrical connectors to fuel injectors. (Squeeze plastic tabs and pull straight up.)
5. Fuel meter cover attaching screws (1, 2).
6. Fuel meter cover assembly (3).



Part Names

1	Screw Assembly - Fuel Meter Cover Attaching - Long
2	Screw Assembly - Fuel Meter Cover Attaching - Short
3	Fuel Meter Cover Assembly
4	Gasket - Fuel Meter Cover
5	Gasket - Fuel Meter Outlet
6	Seal - Pressure Regulator
7	Pressure Regulator
10	TBI Fuel Injector Assembly
11	Filter - Fuel Injector Inlet
12	O-ring - Fuel Injector - Lower
13	O-ring - Fuel Injector - Upper
19	Screw Assembly - Fuel Meter Body - Throttle Body Attaching
21	Fuel Meter Body Assembly
22	Gasket - Throttle Body to Fuel Meter Body
23	Gasket - Air Cleaner
30	O-ring - Fuel Return Line
31	Nut - Fuel Outlet
37	O-ring - Fuel Inlet Line
38	Nut - Fuel Inlet
40	Gasket - Fuel Outlet Nut
41	Gasket - Fuel Inlet Nut
52	Screw Assembly - TPS Attaching
53	Seal - Throttle Position Sensor
58	Sensor -Throttle Position (TPS)
60	Plug - Idle Stop Screw
61	Screw Assembly - Idle Stop
62	Spring - Idle Stop Screw
65	Throttle Body Assembly
70	Gasket - Flange
75	Valve Assembly - Idle Air Control
76	Gasket - Idle Air Control Valve Assembly

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Figure C2-10 - Model 220 TBI

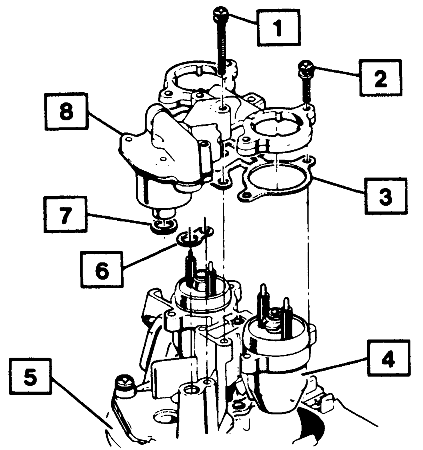


Figure C2-11 - Fuel Meter Cover Assembly

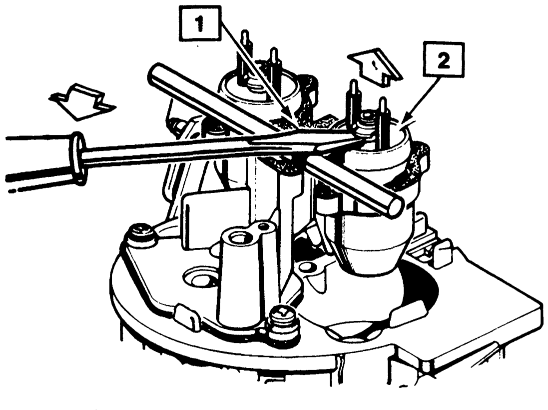


Figure C2-12 - Removing TBI 220 Fuel Injector

NOTICE: DO NOT immerse the fuel meter cover (with pressure regulator) in cleaner, as damage to the regulator diaphragm could occur.

7. Fuel meter outlet gasket (5), cover gasket (4), and pressure regulator dust seal (6). Discard gaskets and seal.

Clean

- Gasket sealing surfaces.

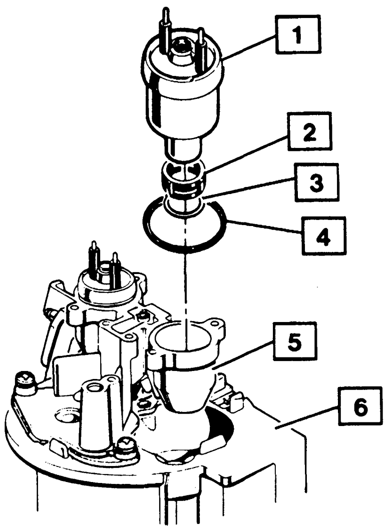


Figure C2-13 - Fuel Injector and O-rings

Install or Connect

1. New pressure regulator dust seal (6), fuel meter outlet passage gasket (5), and cover gasket (4).
2. Fuel meter cover assembly (3).
3. Fuel meter cover attaching screws (1, 2).
   - Install short screws next to injectors
   - Refer to "Thread-Locking Materials."

Tighten

- Fuel meter cover attaching screws to 3.0 N·m (27 lb. in.).

4. Electrical connectors to fuel injectors.
5. Tighten fuel filler cap.
6. Negative battery terminal.

Inspect

- Turn ignition switch to "ON" position for two seconds, then turn to "OFF" position for five seconds. Again turn switch to "ON" position, and check for fuel leaks.

7. Air cleaner extension, and air cleaner assembly.

FUEL INJECTORS

Each fuel injector is serviced as a complete assembly only.

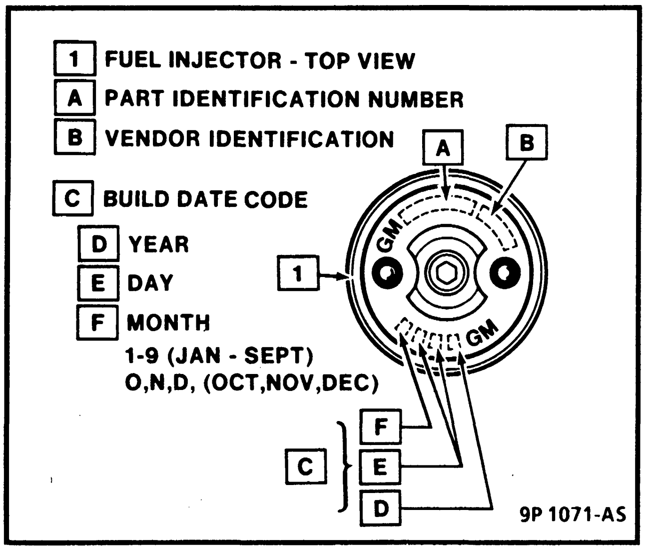


Figure C2-14 - Fuel Injector Part Number Location

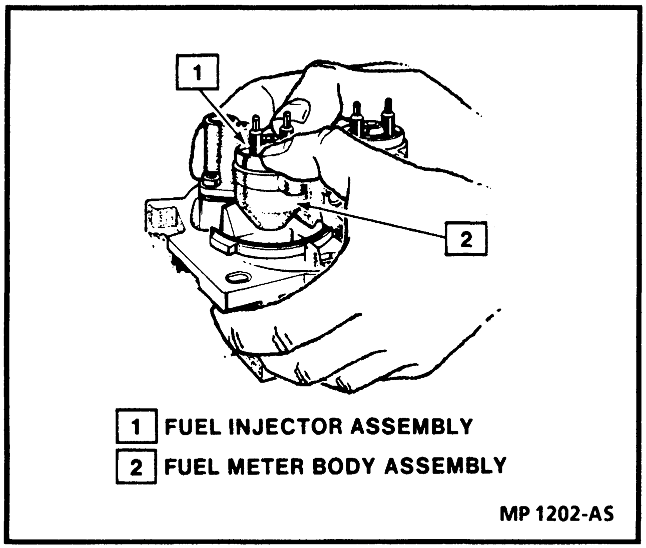


Figure C2-15 - Installing Fuel Injector

NOTICE: Use care in removing injectors to prevent damage to the electrical connector terminals, the injector filter, and the fuel nozzle. Also, since the injectors are electrical components, they should not be immersed in any liquid solvent or cleaner as damage may occur.

Remove or Disconnect

Figures C2-10, 11, 12, 13

1. Negative battery terminal.
2. Relieve fuel system pressure. (refer to "Fuel Pressure Relief Procedure.")
3. Air cleaner assembly and extension (spacer).
4. Electrical connectors to fuel injectors. (Squeeze plastic tabs and pull straight up.)
5. Fuel meter cover attaching screws (1, 2).
6. Fuel meter cover assembly (3).
7. Fuel meter outlet passage gasket (5) and pressure regulator dust seal (6). If fuel meter cover gasket (4) stuck to fuel meter body, leave it in place. If it stuck to fuel meter cover, remove it, and place it on the fuel meter body.
   - The fuel meter cover gasket. will be used to protect the fuel meter body in the next step.
8. With fuel meter cover gasket on fuel meter body, use a screwdriver and fulcrum to carefully pry out injector (10).
9. Lower (small) O-ring (12) from nozzle end of injector and discard.
10. Fuel meter cover gasket (4) and discard.
11. Upper (large) O-ring (13) from top of injector cavity. Discard O-ring.

Inspect

- Fuel injector filter (11) for evidence of dirt and contamination. If present, check for presence of dirt in fuel lines and fuel tank.

Important

Figure C2-13, and C2-14

- Be sure to replace the injector with an identical part. Injectors from other models can fit, but are calibrated for different flow rates.
- Service fuel injector packages may contain a fuel injector washer (spacer). The washer is not required for this TBI 220 application. Install injector and O-rings as shown in Figure C2-13.

CAUTION: **When installing an injector, install the upper O-ring before the injector, to ensure proper seating of the O-ring. Reversing these steps could result in a fuel leak and possible fire.**

Install or Connect

Figures C2-10, C2-11, C2-13, and C2-15

1. Lubricate new upper (large) O-ring (13) with engine oil, and install in fuel meter body cavity.
   - Be sure O-ring is seated properly, and is flush with top of fuel meter body surface.
2. Lubricate new lower (small) O-ring (12) with engine oil, and install on nozzle end of injector.
   - Push O-ring on far enough to contact filter.
3. Fuel injector (10):
   a. Align raised lug on injector base with notch in fuel meter body cavity.
   b. Push down on injector until it is fully seated in fuel meter body. (Electrical terminals of injector should be parallel with throttle shaft.)

4. New pressure regulator dust seal (6), fuel meter outlet gasket (5), and cover gasket (4).
5. Fuel meter cover assembly (3).
6. Fuel meter cover attaching screws (1, 2).
   - Refer to "Thread-Locking Materials".

Tighten

- Fuel meter cover attaching screws to 3.0 N·m (27 lb. in.).

7. Electrical connectors to fuel injectors.
8. Tighten fuel filler cap.
9. Negative battery terminal.

Inspect

- Turn ignition switch to "ON" position for two seconds, then turn to "OFF" position for five seconds. Again turn switch to "ON" position, and check for fuel leaks.

10. Air cleaner extension, and air cleaner assembly.

FUEL METER BODY ASSEMBLY

Remove or Disconnect

Figures C2-10, C2-11, C2-13, and C2-16

1. Negative battery terminal.
2. Relieve fuel system pressure. (Refer to "Fuel Pressure Relief Procedure").
3. Air cleaner assembly and extension (spacer).
4. Electrical connectors to injectors. (Squeeze plastic tabs and pull straight up.)
5. Fuel meter cover (3) and fuel injectors (10).
6. Fuel feed and return lines.
7. Fuel line O-rings (30, 37) and discard.

Important

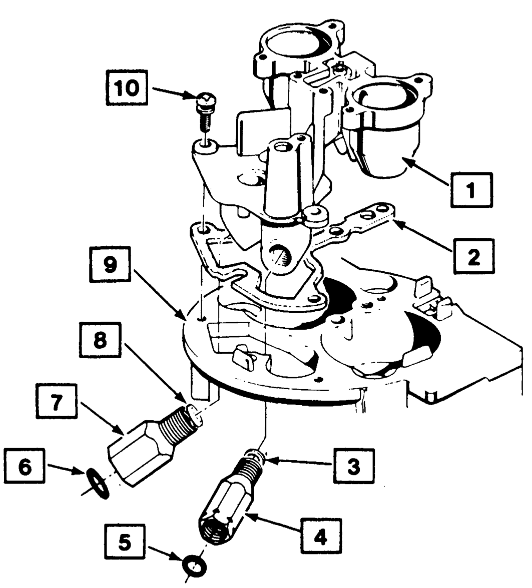
- Note locations of nuts, for proper reassembly later. Inlet nut has a larger passage than outlet nut.

8. Fuel inlet and outlet nuts (31, 38) and gaskets (40, 41) from the fuel meter body assembly.
   - Discard gaskets.
9. Fuel meter body to throttle body attaching screws (19).
10. Fuel meter body (21) and gasket (22) from throttle body.
    - Discard gasket.

Install or Connect

Figures C2-10, C2-11, C2-13, and C2-16

1. New throttle body to fuel meter body gasket (22).
   - Match cutout portions in gasket with openings in throttle body.
2. Fuel meter body assembly (21) on throttle body assembly.



1 FUEL METER BODY ASSEMBLY
2 THROTTLE BODY TO FUEL METER BODY GASKET
3 FUEL OUTLET NUT GASKET
4 FUEL OUTLET NUT
5 FUEL RETURN LINE "O" RING
6 FUEL INLET LINE "O" RING
7 FUEL INLET NUT
8 FUEL INLET NUT GASKET
9 THROTTLE BODY ASSEMBLY
10 FUEL METER BODY - THROTTLE BODY ATTACHING SCREW ASSEMBLY

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Figure C2-16 - Fuel Meter Body Assembly

3. Fuel meter body-to-throttle body attaching screws (19).
   - Refer to "Thread-Locking Materials."

Tighten

- Fuel meter body attaching screws to 4.0 N·m (35 lb. in.).

4. Fuel inlet and outlet nuts (31, 38) with new gaskets (40, 41).

Tighten

- Inlet nut to 40.0 N·m (30 lb. ft.).
- Outlet nut to 29.0 N·m (21 lb. ft.).

5. New O-rings (30, 37) on fuel feed and return lines.
6. Fuel lines.

Tighten

- Fuel line nuts to 27.0 N·m (20 lb. ft.).
- Use a backup wrench on the TBI fuel nuts to prevent them from turning.

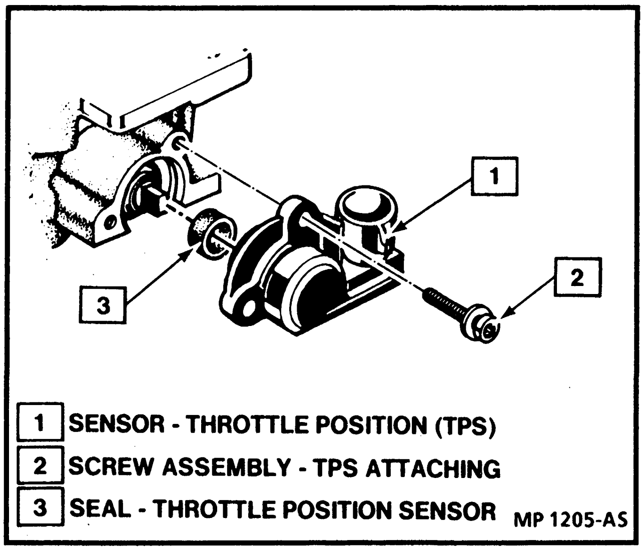

Figure C2-17 - Throttle Position Sensor

7. Fuel injectors (10) and fuel meter cover (3).
8. Electrical connectors to injectors.
9. Tighten fuel filler cap.
10. Negative battery terminal.

Inspect

- Turn ignition switch to "ON" position for two seconds, then turn to "OFF" position for five seconds. Again turn switch to "ON" position, and check for fuel leaks.

11. Air cleaner extension (spacer), and air cleaner assembly.

THROTTLE POSITION SENSOR (TPS)

Figures C2-10 and C2-17

Remove or Disconnect

1. Air cleaner assembly and extension (spacer).
2. TPS electrical connector.
3. TPS attaching screws.
4. Throttle position sensor.
5. TPS seal.

NOTICE: The TPS is an electrical component and must not be soaked in any liquid cleaner or solvent, as damage may result.

Install or Connect

1. Throttle position sensor (58) and seal (53).
   - Insert TPS onto TPS drive shaft on throttle body.
2. TPS attaching screws (52).
   - Refer to "Thread-Locking Materials."

Tighten

- TPS attaching screws to 2.0 N·m (18 lb. in.).

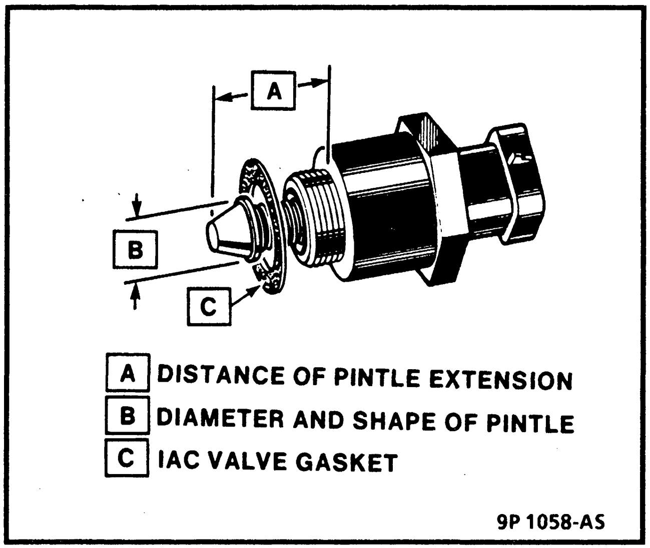

Figure C2-18 - Idle Air Control IAC Valve

3. Electrical connector.
4. Air cleaner extension, and air cleaner assembly.

IDLE AIR CONTROL (IAC) VALVE

Figures C2-10 and C2-18

Remove or Disconnect

1. Air cleaner assembly and extension (spacer).
2. IAC valve electrical connector.
3. IAC valve assembly (75) and gasket (76).

NOTICE: On IAC valves that have been in service: Do Not push or pull on the IAC valve pintle. The force required to move the pintle may damage the threads on the worm drive.

Also, Do Not soak IAC valve in any liquid cleaner or solvent, as damage may result.

Cleaning and Inspection

- Both original and replacement IAC valves have a special factory applied thread-locking compound applied to the screw threads. If the valve removed from the throttle body is being reinstalled, Do Not remove thread-locking compound that may be remaining on the threads.
- Clean IAC valve gasket sealing surface, pintle valve seat and air passage.
  - Use carburetor cleaner to remove carbon deposits. Do Not use a cleaner that contains methyl ethyl ketone, an extremely strong solvent, and not necessary for this type of deposit.
  - Shiny spots on the pintle or seat are normal, and do not indicate misalignment or a bent pintle shaft.
  - If air passage has heavy deposits, remove throttle body for complete cleaning.

Important

- If installing a new IAC valve, be sure to replace with an identical part. IAC valve pintle shape and diameter are designed for the specific application.

Measure (If Installing a New IAC Valve)

Figures C2-18

- Distance between tip of IAC valve pintle and mounting surface.
  - If greater than 28 mm, use finger pressure to slowly retract the pintle. The force required to retract the pintle of a *new* valve will not cause damage to the valve.

Install or Connect

1. IAC valve assembly (75) and gasket (76).

   Tighten

   - IAC valve to 18.0 N·m (13 lb. ft.).
   - Use a socket or box wrench on valve hex.
2. IAC valve electrical connector.
3. Air cleaner extension, and air cleaner assembly.
4. Reset IAC valve pintle position:
   a. Depress accelerator pedal slightly.
   b. Start and run engine for five seconds.
   c. Turn ignition "OFF" for ten seconds.
   d. Restart engine and check for proper idle operation.

THROTTLE BODY REPLACEMENT

Remove or Disconnect

- TBI unit from engine. (Refer to "TBI Unit")

Inspect

- Replacement throttle body for items that are to be transferred from unit removed from engine.

Disassemble

- TBI unit, following component repair procedures.

Assemble

- Replacement throttle body with transferred parts, following component repair procedures.

Install or Connect

- TBI unit onto engine. (Refer to "TBI Unit")

PARTS INFORMATION

PART NAME	GROUP
Relay, Fuel Pump	3.900
Sensor/Switch, Oil Press	1.800
Seals, Fuel Feed/Return Pipes (O-rings)	3.163
Throttle Body Injection Unit	3.725
Gasket, Throttle Body (Flange)	3.726
Gasket Kit	3.724
Fuel Meter Cover Kit	3.734
Fuel Injector Kit	3.774
Fuel Meter Body Kit	3.734
Sensor Kit, Throttle Position	3.440
Control Kit, Idle Air Valve	3.820
Body Kit, Throttle	3.729
Fastener Assortment Kit	3.724

TORQUE SPECIFICATIONS

TBI Attach. Bolts	22.0 N·m (16 lb.ft.)
Fuel Line Nuts	27.0 N·m (20 lb.ft.)
Fuel Meter Cover Screws	3.0 N·m (27 lb.in.)
Fuel Meter Body-Throttle Body Screws	4.0 N·m (35 lb.in.)
TBI Fuel Inlet Nut	40.0 N·m (30 lb.ft.)
TBI Fuel Outlet Nut	29.0 N·m (21 lb.ft.)
Throttle Position Sensor	2.0 N·m (18 lb.in.)
Idle Air Control Valve	18.0 N·m (13 lb.ft.)

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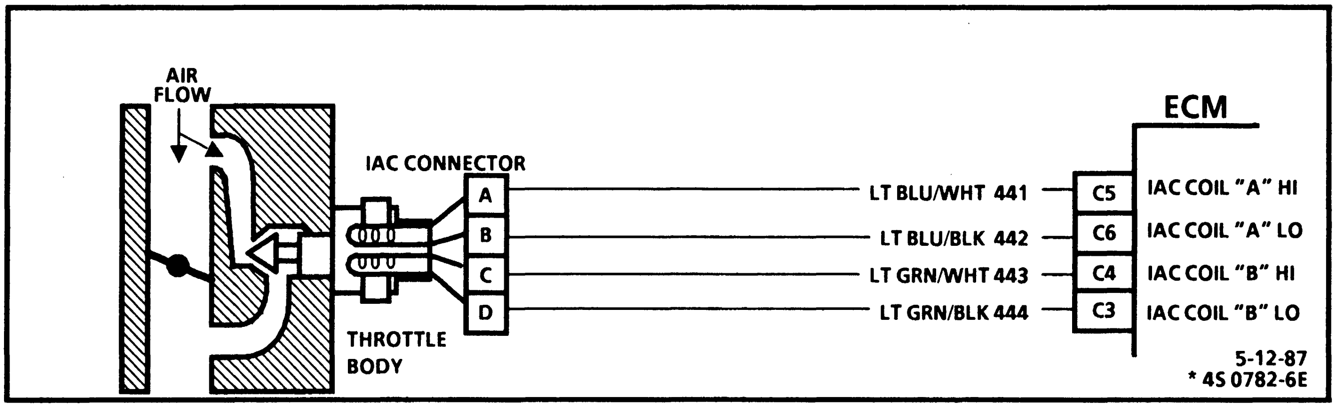


CHART C-2C

IDLE AIR CONTROL (IAC) VALVE CHECK
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

The ECM controls engine idle speed with the IAC valve. To increase idle speed, the ECM retracts the IAC valve pintle away from its seat, allowing more air to bypass the throttle bore. To decrease idle speed, it extends the IAC valve pintle towards its seat, reducing bypass air flow. A "Scan" tool will read the ECM commands to the IAC valve in counts. Higher the counts indicate more air bypass (higher idle). The lower the counts indicate less air is allowed to bypass (lower idle).

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. The IAC tester is used to extend and retract the IAC valve. Valve movement is verified by an engine speed change. If no change in engine speed occurs, the valve can be retested when removed from the throttle body. Unless field service mode is used with 2.8L/3.1L speed density engines, incorrect IAC control will result.
2. This step checks the quality of the IAC movement in Step 1. Between 700 rpm and about 1500 rpm, the engine speed should change smoothly with each flash of the tester light in both extend and retract. If the IAC valve is retracted beyond the control range (about 1500 rpm), it may take many flashes in the extend position before engine speed will begin to drop. This is normal on certain engines, fully extending IAC may cause engine stall. This may be normal.
3. Steps 1 and 2 verified proper IAC valve operation while this step checks the IAC circuits. Each lamp on the node light should flash red and green while the IAC valve is cycled. While the sequence of color is not important if either light is "OFF" or does not flash red and green, check the circuits for faults, beginning with poor terminal contacts.

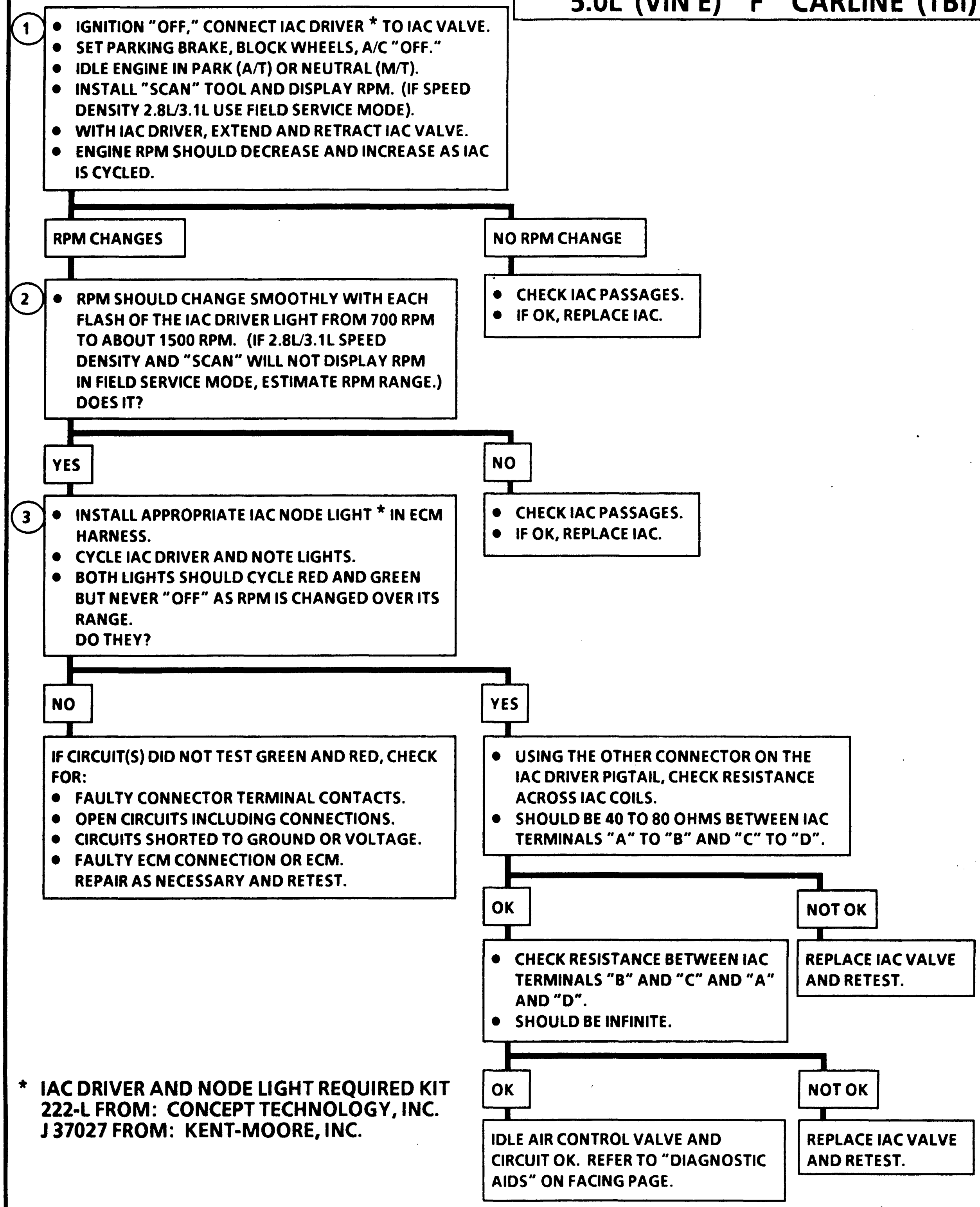
Diagnostic Aids:

A slow, unstable or fast idle may be caused by a non-IAC system problem that cannot be overcome by the IAC valve. Out of control range IAC "Scan" tool counts will be above 60 if idle is too low, and zero counts if idle is too high. The following checks should be made to repair a non-IAC system problem:

- Vacuum Leak (High Idle) - If idle is too high, stop the engine. Fully extend (low) IAC with tester. Start engine. If idle speed is above 800 rpm, locate and correct vacuum leak including PCV system. Also, check for binding of throttle blade or linkage.
- System too lean (High Air/Fuel Ratio) - The idle speed may be too high or too low. Engine speed may vary up and down and disconnecting the IAC valve does not help. Code 44 may be set. "Scan" O_2 voltage will be less than 300 mv (.3 volt). Check for low regulated fuel pressure, water in the fuel or a restricted injector.
- System too rich (Low Air/Fuel Ration) - The Idle speed will be too low. "Scan" tool IAC counts will usually be above 80. System is obviously rich and may exhibit black smoke in exhaust.
  "Scan" tool O_2 voltage will be fixed above 800 mv (.8 volt).
  Check for high fuel pressure, leaking or sticking injector. Silicone contaminated O_2 sensors "Scan" voltage will be slow to respond.
- Throttle Body - Remove IAC valve and inspect bore for foreign material.
- IAC Valve Electrical Connections - IAC valve connections should be carefully checked for proper contact.
- PCV Valve - An incorrect or faulty PCV valve may result in an incorrect idle speed.
- Refer to "Rough, Unstable, Incorrect Idle or Stalling" in "Symptoms," Section "6E2-B".
- If intermittent poor driveability or idle symptoms are resolved by disconnecting the IAC, carefully recheck connection, valve terminal resistance or replace IAC.

CHART C-2C

IDLE AIR CONTROL (IAC) VALVE CHECK
5.0L (VIN E) "F" CARLINE (TBI)



①
- IGNITION "OFF," CONNECT IAC DRIVER * TO IAC VALVE.
- SET PARKING BRAKE, BLOCK WHEELS, A/C "OFF."
- IDLE ENGINE IN PARK (A/T) OR NEUTRAL (M/T).
- INSTALL "SCAN" TOOL AND DISPLAY RPM. (IF SPEED DENSITY 2.8L/3.1L USE FIELD SERVICE MODE).
- WITH IAC DRIVER, EXTEND AND RETRACT IAC VALVE.
- ENGINE RPM SHOULD DECREASE AND INCREASE AS IAC IS CYCLED.

RPM CHANGES

②
- RPM SHOULD CHANGE SMOOTHLY WITH EACH FLASH OF THE IAC DRIVER LIGHT FROM 700 RPM TO ABOUT 1500 RPM. (IF 2.8L/3.1L SPEED DENSITY AND "SCAN" WILL NOT DISPLAY RPM IN FIELD SERVICE MODE, ESTIMATE RPM RANGE.) DOES IT?

YES

③
- INSTALL APPROPRIATE IAC NODE LIGHT * IN ECM HARNESS.
- CYCLE IAC DRIVER AND NOTE LIGHTS.
- BOTH LIGHTS SHOULD CYCLE RED AND GREEN BUT NEVER "OFF" AS RPM IS CHANGED OVER ITS RANGE.

DO THEY?

NO

IF CIRCUIT(S) DID NOT TEST GREEN AND RED, CHECK FOR:
- FAULTY CONNECTOR TERMINAL CONTACTS.
- OPEN CIRCUITS INCLUDING CONNECTIONS.
- CIRCUITS SHORTED TO GROUND OR VOLTAGE.
- FAULTY ECM CONNECTION OR ECM.

REPAIR AS NECESSARY AND RETEST.

YES

- USING THE OTHER CONNECTOR ON THE IAC DRIVER PIGTAIL, CHECK RESISTANCE ACROSS IAC COILS.
- SHOULD BE 40 TO 80 OHMS BETWEEN IAC TERMINALS "A" TO "B" AND "C" TO "D".

OK

- CHECK RESISTANCE BETWEEN IAC TERMINALS "B" AND "C" AND "A" AND "D".
- SHOULD BE INFINITE.

OK

IDLE AIR CONTROL VALVE AND CIRCUIT OK. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

NOT OK

REPLACE IAC VALVE AND RETEST.

NOT OK

REPLACE IAC VALVE AND RETEST.

NO

- CHECK IAC PASSAGES.
- IF OK, REPLACE IAC.

NO RPM CHANGE

- CHECK IAC PASSAGES.
- IF OK, REPLACE IAC.

* IAC DRIVER AND NODE LIGHT REQUIRED KIT
222-L FROM: CONCEPT TECHNOLOGY, INC.
J 37027 FROM: KENT-MOORE, INC.

CLEAR CODES, CONFIRM "CLOSED LOOP" OPERATION, NO "SERVICE ENGINE SOON" LIGHT, PERFORM IAC RESET PROCEDURE PER APPLICABLE SERVICE MANUAL AND VERIFY CONTROLLED IDLE SPEED IS CORRECT.

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SECTION C3

EVAPORATIVE EMISSION CONTROL (EECS) SYSTEM

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The basic Evaporative Emission Control System (EECS) used on all vehicles is the charcoal canister storage method. This method transfers fuel vapor from the fuel tank to an activated carbon (charcoal) storage device (canister) to hold the vapors when the vehicle is not operating. When the engine is running, the fuel vapor is purged from the carbon element by intake air flow and consumed in the normal combustion process.

FUEL VAPOR CANISTER

Gasoline vapors from the fuel tank flow into the tube labeled tank. Any liquid fuel goes into a reservoir in the bottom of the fuel vapor canister to protect the integrity of the carbon bed above (Figure C3-1). These vapors are absorbed into the carbon. The fuel vapor canister is purged when the engine is running above idle speed. Ambient air is allowed into the fuel vapor canister through the air tube in the top. The air mixes with the vapor and the mixture is drawn into the intake manifold.

EVAPORATIVE EMISSION SYSTEM

The fuel vapor canister is equipped with a Normally Closed (N/C) solenoid to control canister purge. The ECM operates the solenoid which controls vacuum to the purge valve in the fuel vapor canister. Under cold engine or idle conditions, the solenoid is turned "OFF" by the ECM, which closes the solenoid and blocks vacuum to the canister purge valve.
The ECM turns "ON" the solenoid valve and allows purge when:

- Engine is warm.
- After the engine has been running a specified time.
- Above a specified road speed.
- Above a specified throttle opening.

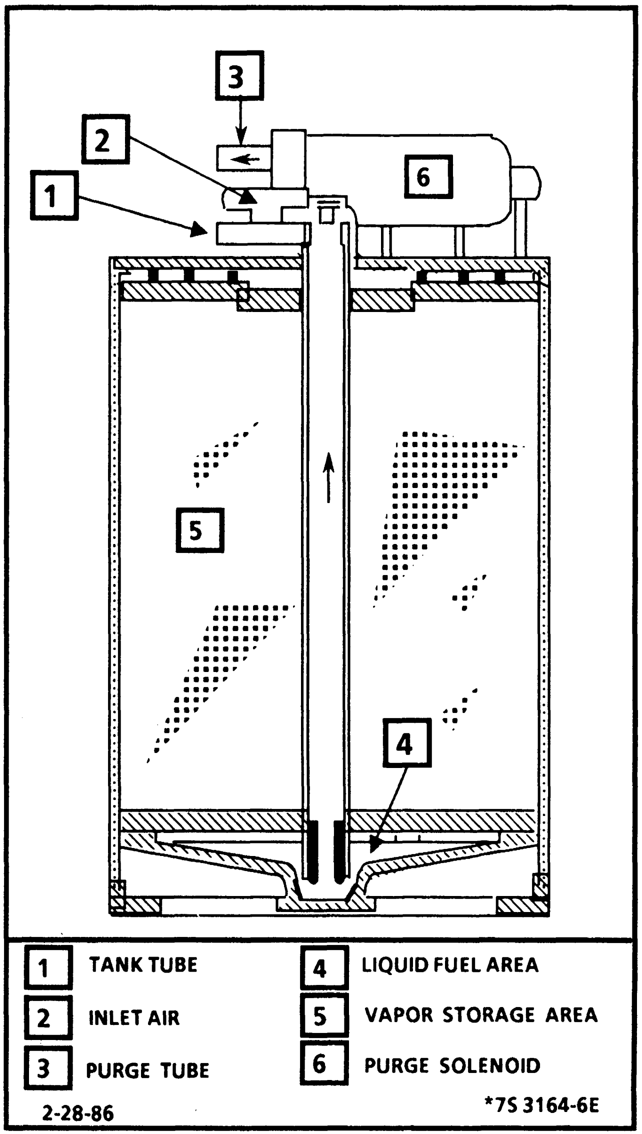


Figure C3-1 - Inverted Function Fuel Vapor Canister - With Encapsulated Canister Purge Solenoid

This is an ECM feedback system that increases purge until the ECM senses a rich condition from the oxygen sensor. The purge is then regulated until the ECM no longer receives a rich signal from the Oxygen (O_2) sensor.

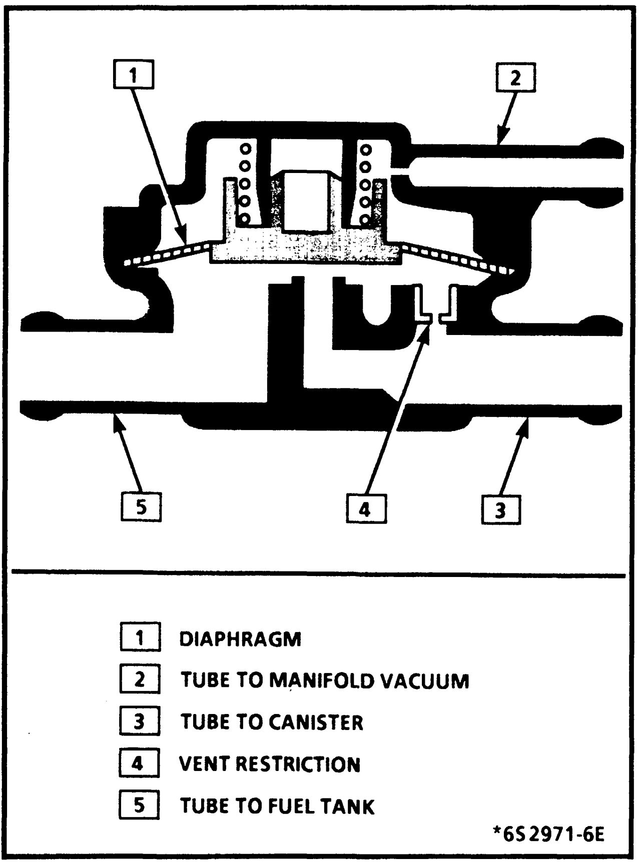


Figure C3-2 - Tank Pressure Control Valve

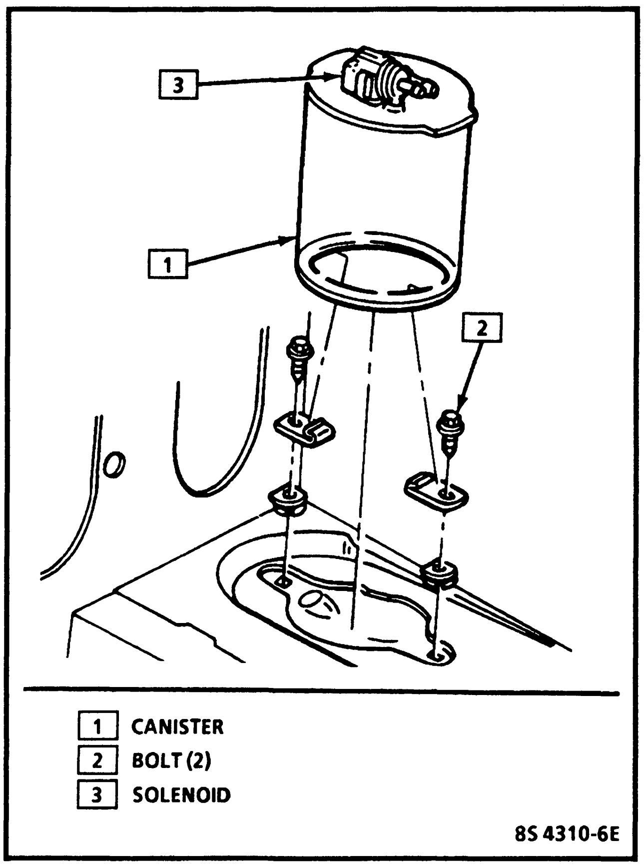


Figure C3-3 - Canister & Solenoid Service

This system uses tank pressure control valve to control the flow of vapors from the fuel tank to the fuel vapor canister.

TANK PRESSURE CONTROL VALVE

The tank pressure control valve, a combination roll-over, integral pressure and vacuum relief valve. When vapor pressure in the tank exceeds (5 kPa) the valve opens and allows vapors to vent to the canister and then be purged. When the tank pressure drops below the opening point of the valve it will close, keeping vapors in the fuel tank. The valve provides vacuum relief to protect against vacuum build up in the fuel tank and roll-over protection to prevent liquid fuel from entering the fuel vapor canister during normal driving maneuvers.

RESULTS OF INCORRECT OPERATION

Poor idle, stalling and poor driveability can be caused by:

- Inoperative canister purge solenoid.
- Damaged fuel vapor canister.
- Hoses split, cracked and, or not connected to the proper tubes.

Evidence of fuel loss or fuel vapor odor can be caused by:

- Liquid fuel leaking from fuel lines.
- Cracked or damaged fuel vapor canister.
- Disconnected, misrouted, kinked, deteriorated or damaged vapor hoses, or control hoses.

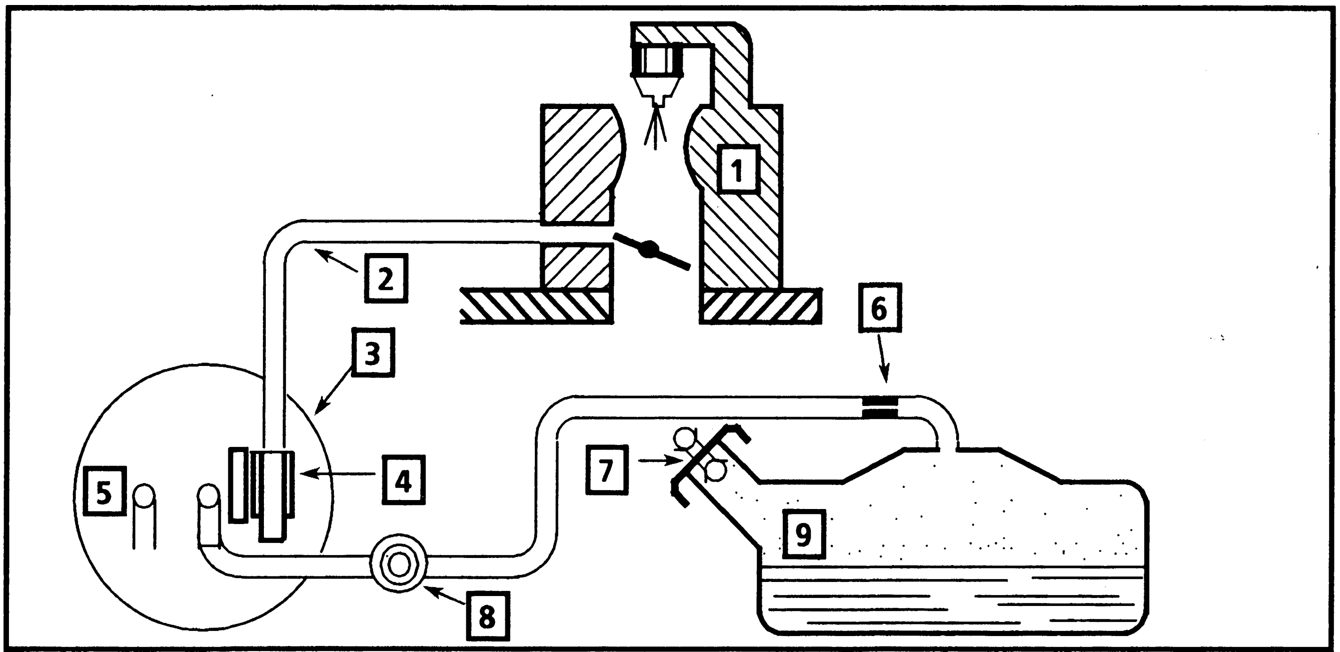
DIAGNOSIS

CANISTER PURGE SOLENOID

The canister purge solenoid operation is covered in CHART C-3 at the end of this section.

VISUAL CHECK OF FUEL VAPOR CANISTER

Cracked or damaged, replace fuel vapor canister.



1	TBI UNIT	4	CANISTER PURGE SOLENOID ASSEMBLY	7	PRESSURE / VACUUM RELIEF VENTED FUEL FILLER CAP
2	PURGE LINE	5	AIR INLET	8	TANK PRESSURE CONTROL VALVE
3	VAPOR CANISTER	6	VAPOR RESTRICTION	9	FUEL TANK

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Figure C3-4 - Evaporative Emissions Control System Schematic 5.0L (VIN E)

FUNCTIONAL TESTS

Tank Pressure Control Valve

With a hand vacuum pump, apply vacuum (15" or 51 kPa) to the control vacuum tube. The diaphragm should hold vacuum for at least 20 seconds. If it does not hold vacuum, the diaphragm is leaking and the valve must be replaced.

Apply a short hose to the valve's tank tube side, blow into the tube. You should feel the diaphragm pop open and air pass through the valve. If the air does not pass through, the valve should be replaced.

ON-VEHICLE SERVICE

FUEL VAPOR CANISTER

Remove or Disconnect

1. Hoses from fuel vapor canister. Mark hoses to install on new fuel vapor canister.
2. Bolts from fuel vapor canister.
3. Fuel vapor canister.

Install or Connect

1. Fuel vapor canister as removed.

Tighten

- Canister hold down bolts to 2.8 N·m (25 lb. in.).

2. Hoses. Make sure connections are correct.

CANISTER PURGER SOLENOID

Remove or Disconnect

1. Negative battery cable.
2. Electrical connector and hoses from the solenoid.
3. Squeeze the retainer clips together.
4. Carefully back out the solenoid from the canister.

Install or Connect

1. Solenoid into the canister. Carefully press firmly until retainer clips snap in place.
2. Electrical connector and hoses on the solenoid.
3. Negative battery cable.

FUEL VAPOR CANISTER HOSES

Refer to "Vehicle Emission Control Information" label for routing of fuel vapor canister hoses.

PARTS INFORMATION

PART NAME	GROUP
Filter, Fuel Vapor Canister	3.130
Canister, Fuel Vapor	3.130
Bolts	8.977
Clip	8.950
Hose, Fuel-Oil Evap (5/15" x 24')	8.962
Retainer, Plastic 7" Adjustable strap	8.965
Valve, Fuel Vapor Pressure Cont.	3.130
Connector, Fuel Vpr Cnstr Harn.	3.130
Harness, Fuel Vpr Cnstr	3.130

TORQUE SPECIFICATIONS

Fuel Vapor Canister Hold Down Bolt to	2.8 N·m (25 lb. in.).

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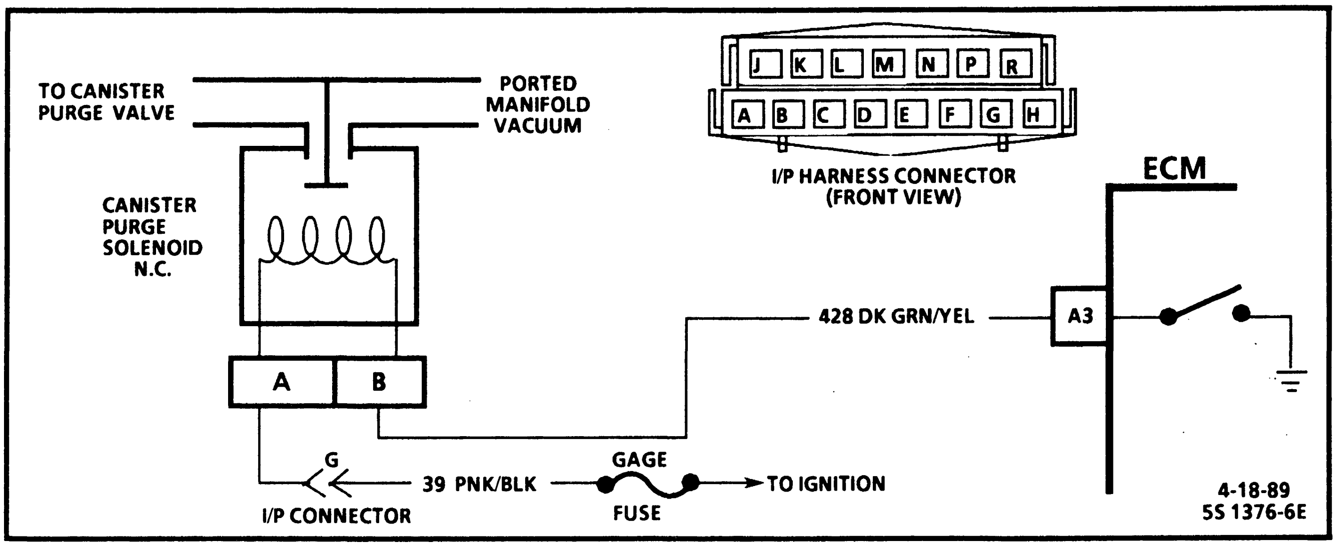


CHART C-3

CANISTER PURGE VALVE CHECK
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

Canister purge is controlled by a solenoid that allows ported manifold vacuum to purge the fuel vapor canister when energized. The ECM supplies a ground to energize the solenoid (purge "ON").

If the following conditions are met with the engine running, the canister purge solenoid is energized (purge "ON").

- Engine run time after start more than 1 minute
- Coolant temperature above 80°C (176°F)
- Vehicle speed above 5 mph
- Throttle "OFF" idle. TPS signal about .75 volt

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Checks to see if the canister purge solenoid is opened or closed. The canister purge solenoid is energized in this step so it should be open.
2. Completes functional check, by grounding diagnostic "test" terminal. This should, normally, de-energize the canister purge solenoid and allow the vacuum to drop (purge "ON").
3. Checks for a complete circuit. Normally, there is battery voltage on CKT 39, and the ECM provides a ground on CKT 428. A shorted canister purge solenoid could cause an open circuit in the ECM.

Diagnostic Aids:

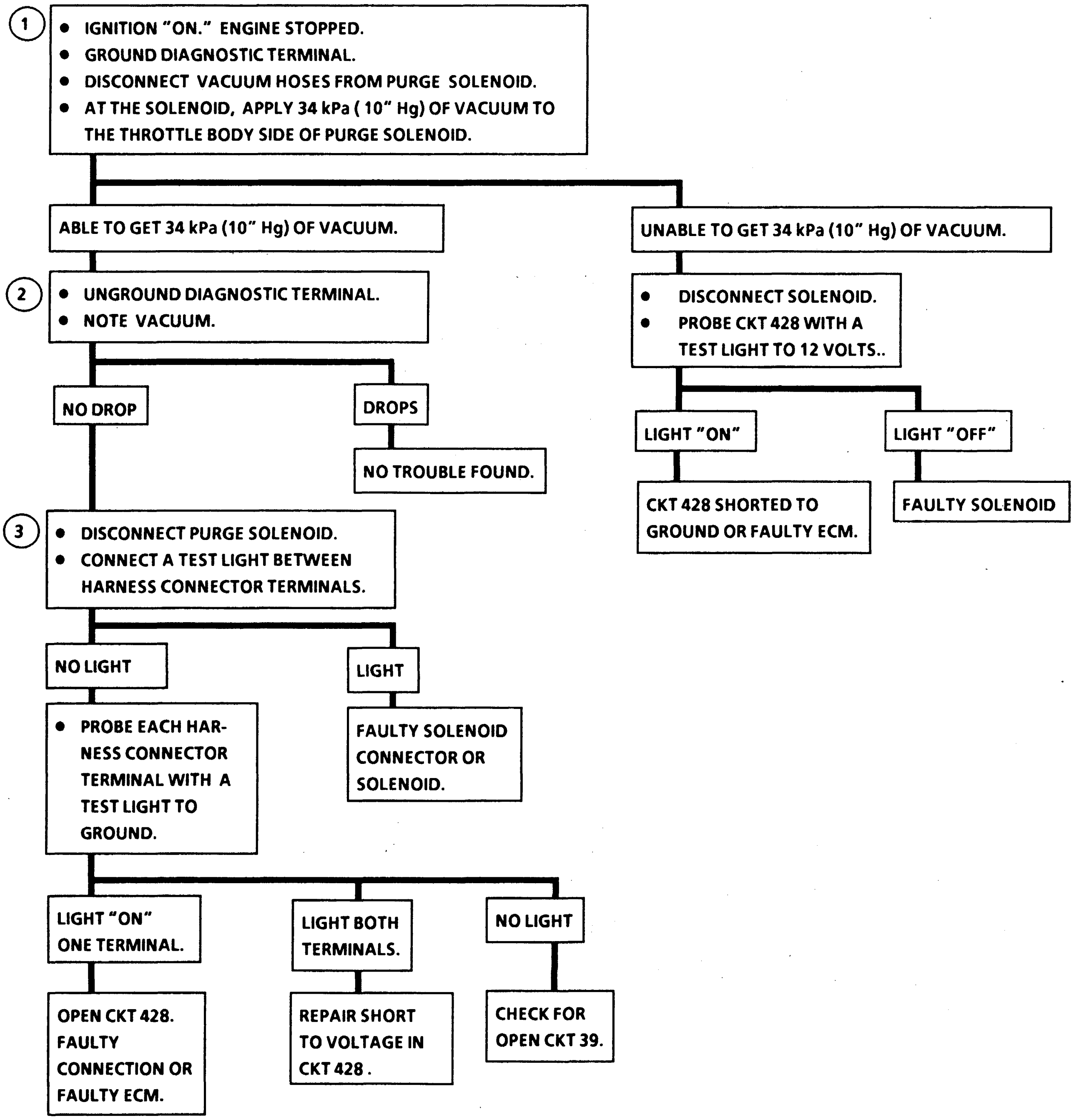
Normal operation of the canister purge solenoid is described as follows:

With ignition "ON," engine "OFF," diagnostic "test" terminal ungrounded, the canister purge solenoid will be energized.

With ignition "ON," engine "OFF," diagnostic "test" terminal grounded, the canister purge solenoid will be de-energized.

CHART C-3

CANISTER PURGE VALVE CHECK
5.0L (VIN E) "F" CARLINE (TBI)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT

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SECTION C4

IGNITION SYSTEM (EST)

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The High Energy Ignition (HEI) system controls fuel combustion by providing a spark to ignite the compressed air/fuel mixture at the correct time. To provide improved engine performance, fuel economy, and control of exhaust emissions, the ECM controls distributor spark advance (timing) with the Electronic Spark Timing (EST) system.

Only the Electronic Spark Timing (EST) system will be described here. Additional information on the HEI system is found in ENGINE ELECTRICAL (SECTION 6D).

OPERATION

The standard High Energy Ignition (HEI) system (described in ENGINE ELECTRICAL SECTION 6D) has a modified distributor module, which is used in connection with EST. The module has eight terminals. (See Figure C4-1).

To properly control ignition/combustion timing, the ECM needs to know:

- Crankshaft position
- Engine speed (rpm)
- Engine load (manifold pressure or vacuum)
- Atmospheric (barometric) pressure
- Engine temperature

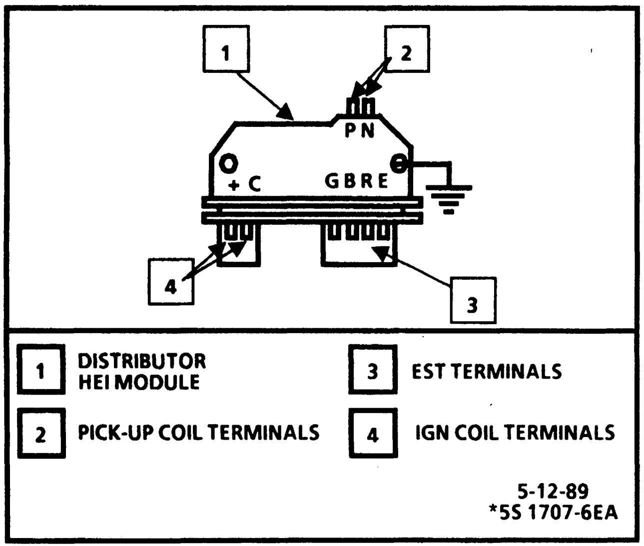

Figure C4-1 - Distributor Module

The EST system consists of the distributor module, ECM, and connecting wires. The distributor has four wires, from the HEI module, connected to the ECM.

These circuits perform the following functions:

- Reference (CKT 430)
  This provides the ECM with rpm and crankshaft position information.
- Distributor Ground (CKT 453)
  This wire is grounded in the distributor provides a reference ground from the ignition module to the ECM for use by the ECM to compare with reference high voltage. If it is open, it may cause poor performance.
- Bypass (CKT 424)
  At about 400 rpm, the ECM applies 5 volts to this circuit to switch spark timing control from the HEI module to the ECM. An open or grounded bypass circuit will set a Code 42 and the engine will run at base timing, plus a small amount of advance built into the HEI module.
- EST (CKT 423)
  After bypass voltage is applied, the ECM uses this circuit to trigger the HEI module. The ECM uses the distributor reference signal to base its calculation of the amount of spark advance needed, under present engine conditions. If the base timing of the engine is incorrect, the entire spark curve will be incorrect.

DIAGNOSIS

RESULTS OF INCORRECT EST OPERATION

An open, or ground, in the EST circuit, will set a Code 42 and cause the engine to run on the HEI module timing. This will cause poor performance and poor fuel economy.

The ECM uses information from the MAP and coolant temperature sensors, in addition to rpm, to calculate spark advance as follows.

Low MAP output voltage = More spark advance
Cold engine = More spark advance
High MAP output voltage = Less spark advance
Hot engine = Less spark advance

Therefore, detonation could be caused by low MAP output or high resistance in the coolant temperature sensor circuit.

Poor performance could be caused by high MAP output or low resistance in the coolant sensor circuit.

HOW CODE 42 IS DETERMINED

When the system is running on the HEI module, that is, no voltage on the bypass line, the HEI module grounds the EST signal. The ECM expects to see no voltage on the EST line during this condition. If it sees a voltage, it sets Code 42 and will not go into the EST mode.

When the rpm for EST is reached (about 400 rpm), the ECM applies 5 volts to the bypass line and the EST should no longer be grounded in the HEI module, so, the EST voltage should be varying.

If the bypass line is open, the HEI module will not switch to EST mode, so, the EST voltage will be low and Code 42 will be set.

If the EST line is grounded, the HEI module will switch to EST but, because the line is grounded, there will be no EST signal and the engine will not run.

The description, operation, and diagnosis of the HEI system are found in ENGINE ELECTRICAL (SECTION 6D) of this manual. This section will address diagnosis of that portion of the ignition system pertaining to the EST operation.

CODE 12

Code 12 is used during the "Diagnostic Circuit Check" procedure to test the code display ability of the ECM. This code indicates that the ECM is not receiving the engine rpm (reference) signal. This occurs with the ignition key "ON" and the engine not running.

The "Reference" signal, also, triggers the fuel injection system. Without the "Reference" signal, the engine cannot run.

ON-VEHICLE SERVICE

SETTING TIMING

Set timing according to instructions on Vehicle Emission Control Information label.

PARTS INFORMATION

PART NAME	GROUP
Module, Control	2.383
Coil, Distributor	2.170

TORQUE SPECIFICATIONS

Distributor Hold-Down Bolt	34 N·m (25 lb. ft.)
Coil Mounting Bolts/Screws .	1.5 N·m (131 lb. in.)
Ignition Module Screws ...	2.0 N·m (18 lb. in.)

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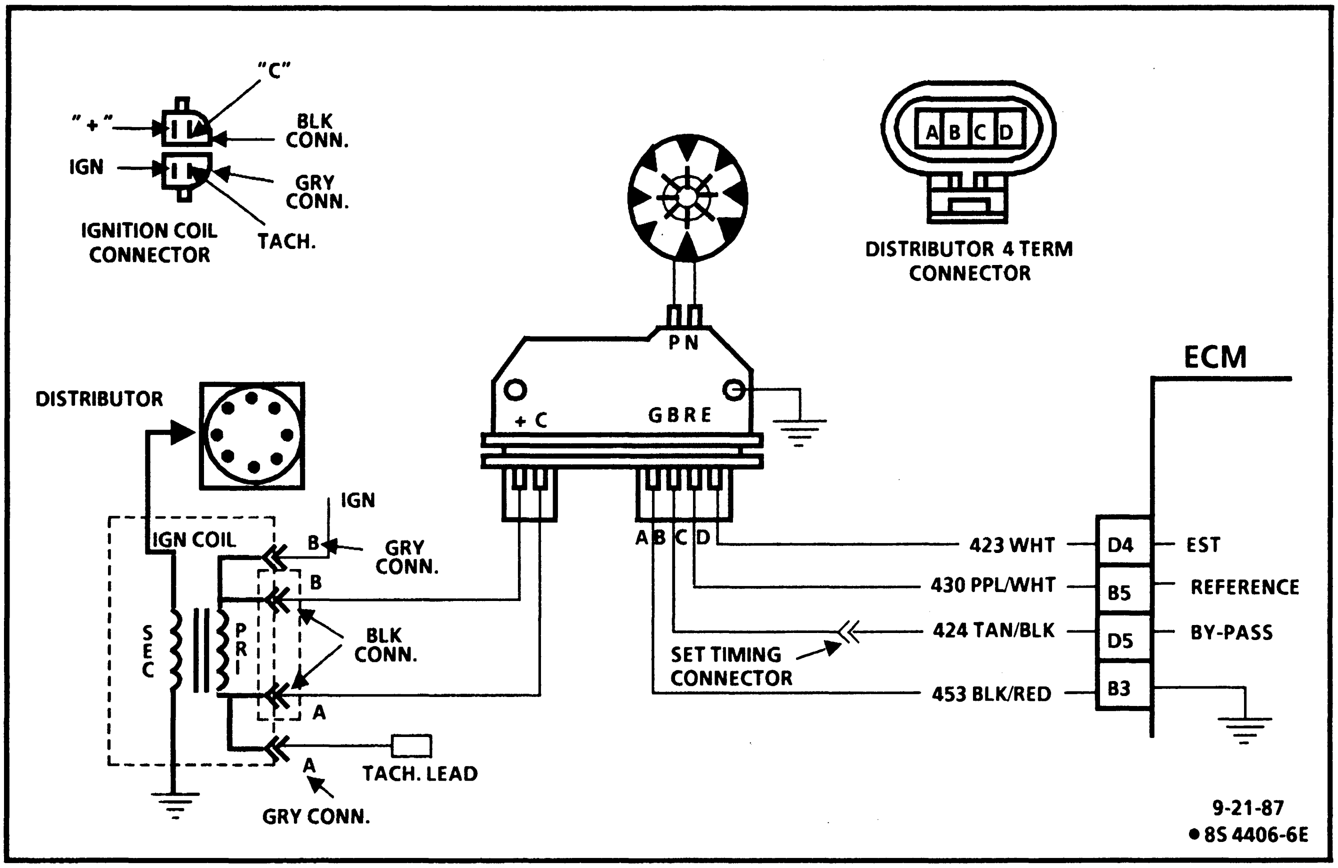

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CHART C-4

IGNITION SYSTEM CHECK
(REMOTE COIL/SEALED MODULE CONNECTOR DISTRIBUTOR)
5.0L (VIN E) "F" CARLINE (TBI)

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Two wires are checked, to ensure that an open is not present in a spark plug wire.

1A. If spark occurs with EST connector disconnected, pick-up coil output is too low for EST operation.

2. A spark indicates the problem must be the distributor cap or rotor.

3. Normally, there should be battery voltage at the "C" and "+" terminals. Low voltage would indicate an open or a high resistance circuit from the distributor to the coil or ignition switch. If "C" terminal voltage was low, but "+" terminal voltage is 10 volts or more, circuit from "C" terminal to ignition coil or ignition coil primary winding is open.

4. Checks for a shorted module or grounded circuit from the ignition coil to the module. The distributor module should be turned "OFF," so normal voltage should be about 12 volts.

   If the module is turned "ON," the voltage would be low, but above 1 volt. This could cause the ignition coil to fail from excessive heat.

   With an open ignition coil primary winding, a small amount of voltage will leak through the module from the "B+" to the "Tach" terminal.

5. Applying a voltage (1.5 to 8 volts) to module terminal "P" should turn the module "ON" and the "Tach" terminal voltage should drop to about 7-9 volts. This test will determine whether the module or coil is faulty or if the pick-up coil is not generating the proper signal to turn the module "ON." This test can be performed by using a DC battery with a rating of 1.5 to 8 volts. The use of the test light is mainly to allow the "P" terminal to be probed more easily. Some digital multi-meters can also be used to trigger the module by selecting ohms, usually the diode position. In this position the meter may have a voltage across it's terminals which can be used to trigger the module. The voltage in the ohm's position can be checked by using a second meter or by checking the manufacturer's specification of the tool being used.

6. This should turn "OFF" the module and cause a spark. If no spark occurs, the fault is most likely in the ignition coil because most module problems would have been found before this point in the procedure. A module tester could determine which is at fault.

CHART C-4
IGNITION SYSTEM CHECK
(REMOTE COIL/SEALED MODULE CONNECTOR DISTRIBUTOR)
5.0L (VIN E) "F" CARLINE (TBI)

①
- Perform Diagnostic Circuit Check before proceeding with this test. (If a tachometer is connected to the Tach term., disconnect it before proceeding with the test).
- Check spark at plug with spark tester J-26792 or equivalent (ST-125) while cranking (if no spark on one wire, check a second wire) <u>A few sparks and then nothing is considered no spark.</u>

- **No Spark**
  - (1A) Disconnect 4 term. distributor connector and check for spark.
    - **No spark**
      - ② Check for spark at coil wire with tester while cranking. (Leave spark tester connected to coil wire for Steps 3-6).
        - **No Spark**
          - ③ Disconnect distributor 2 term. "C/+" connector.
            - Ignition switch "on", Engine stopped.
            - Check volts at "+" and "C" term's. of dist. harn. conn.
            - **Both term's. 10 volts or more**
              - ④ Reconnect dist. 2 term. conn.
                - With ign. "ON", check voltage from tach. term. to gnd. (term. may be taped back in harness).
                - **Over10 volts**
                  - Connect test light from tach. term. to ground.
                  - Crank engine and observe light.
                  - **Light on steady**
                    - ⑤ Disconnect distributor 4 term. connector.
                      - Remove dist. cap.
                      - Disconnect pick-up coil connector from module.
                      - Connect voltmeter from tach. term. to ground.
                      - Ignition on.
                      - Insulate a test light probe to 1/4" from tip and note voltage, as test light is momentarily connected from a voltage source (1.5 to 8V) to module term. "P". (Fig. 1).
                      - **Voltage drops**
                        - ⑥ Check for spark from coil wire with spark tester as test light is removed from module term.
                          - **No Spark**
                            - If no module tester (J24642) is available; Replace ign. coil and repeat Step 5.
                              - **No Spark** — Ign. coil removed is OK, reinstall coil and check coil wire from dist. cap. if OK, replace dist. module.
                              - **Spark** — System OK
                            - If module tester (J24642) is available: test module
                              - **OK** — Check coil wire from cap to coil. If OK, replace coil.
                              - **Not OK** — Replace module
                          - **Spark**
                            - Is rotating pole piece still magnetized?
                              - **Yes** — Check pick-up coil or conns. (Coil resistance should be 500-1500 ohms and not grounded).
                              - **No** — Replace pole piece and shaft assy.
                      - **No drop in voltage** — Check module ground. If OK, replace module.
                  - **Light blinks** — Replace ignition coil and recheck for spark with spark tester. If still no spark, re-install original coil and replace dist. module..
                - **Under 1 volt** — Repair open tach. lead or conn and repeat test #4.
                - **1 to 10 volts** — Replace module and check for spark from coil as in Step 6.
                  - **Spark** — System OK
                  - **No Spark** — Replace ign. coil, it too is faulty
            - **Both term's. under 10 volts** — Repair wire from module "+" term. to "B" term. of black Ign. coil connector or primary ckt. to ign. sw.
            - **Under 10 volts "C" term. only** — Check for open or gnd. in ckt. from "C" term. to ign. coil. If Ckt. is OK, fault is. ign. coil or conn..
        - **Spark** — Inspect cap for water, cracks, etc. If OK, replace rotor.
    - **Spark** — Replace pick-up coil
- **Spark** — Check fuel,spark plugs, etc. See section "B" symptoms.

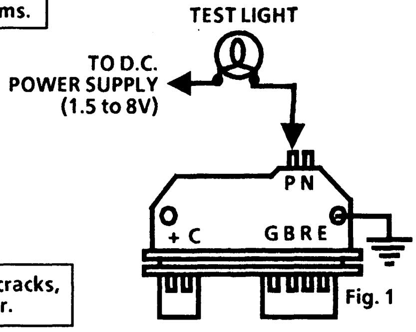

Fig. 1

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SECTION C5

ELECTRONIC SPARK CONTROL (ESC) SYSTEM

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The Electronic Spark Control (ESC) system is used to reduce detonation (spark knock) in the engine. This system allows the engine to use maximum spark advance to improve driveability and fuel economy and compensate for varying octane levels in gasoline.

OPERATION

The ESC system has two major components:

- ESC Module
- ESC Knock Sensor

The knock sensor is mounted in the engine block near the cylinders. When the ESC knock sensor detects abnormal vibration (spark knocking) in the engine, it produces a voltage that is received by the ESC module. As long as the ESC module sees no voltage from the knock sensor (knock not present), it sends a signal voltage (8 to 10 volts) to the ECM and the ECM provides normal spark advance.

When the module detects voltage from the knock sensor (knock present), it turns "OFF" the signal to the ECM and the voltage on CKT 485 goes to 0 volts. The ECM then retards EST to reduce spark knock.

DIAGNOSIS

RESULTS OF INCORRECT ESC OPERATION

Loss of the ESC knock sensor signal or loss of ground at ESC module would cause the signal to the ECM to remain high.This condition would cause the ECM to control EST, as if no spark knocking were happening. No retard would occur, and spark knocking could become severe under heavy engine load conditions.

Loss of the ESC signal to the ECM would cause the ECM to constantly retard EST. This could result in sluggish performance and cause a Code 43 to set.

The Tech 1 "Scan" tool will read the knock signal as either "Yes" or "No." When detonation is detected, knock signal display will read "Yes" as long as knock is present. The Tech 1 "Scan" tool will read how much spark advance is being taken out of the total spark advance in degrees.

If Code 43 is present, use that chart to diagnose the system. If no code is present and ESC system is suspected, use CHART C-5.

ON-VEHICLE SERVICE

ESC KNOCK SENSOR

The ESC knock sensor is located on the passenger side of the block above the oil pan rail. (Refer to Figure C5-1.)

←→ Remove or Disconnect

1. Negative battery cable.
2. Raise car.
3. ESC wiring harness connector from ESC sensor.
4. ESC knock sensor from engine block.

→← Install or Connect

NOTICE: Do not apply thread sealant to sensor threads. Sensor is coated at factory and applying additional sealant will affect the sensors ability to detect detonation.

1. ESC sensor into engine block.

Tighten

- ESC Knock Sensor to 17.6 N·m (13 lb. ft.).

2. ESC wiring harness connector to the ESC knock sensor.
3. Lower car.
4. Negative battery cable.

ESC MODULE

The ESC module is located on a bracket in the left rear engine compartment, next to the fuel pump relay. (Refer to Figure C5-1)

Remove or Disconnect

1. ESC module connector.
2. Attaching screws from bracket holding ESC module.
3. ESC module.

Install or Connect

1. ESC module.
2. Attaching screws to ESC module into bracket.

Tighten

- ESC module to bracket 1.8 N·m (16 lb. in.).

3. ESC module connector.

PARTS INFORMATION

PART NAME	GROUP
Sensor, ESC Knock	2.383
Module, Elek Spark Cont	2.383

TORQUE SPECIFICATIONS

ESC Knock Sensor to Engine Block	17.6 N·m (13 lb. ft.)
ESC Module to Bracket	1.8 N·m (16 lb. in.)

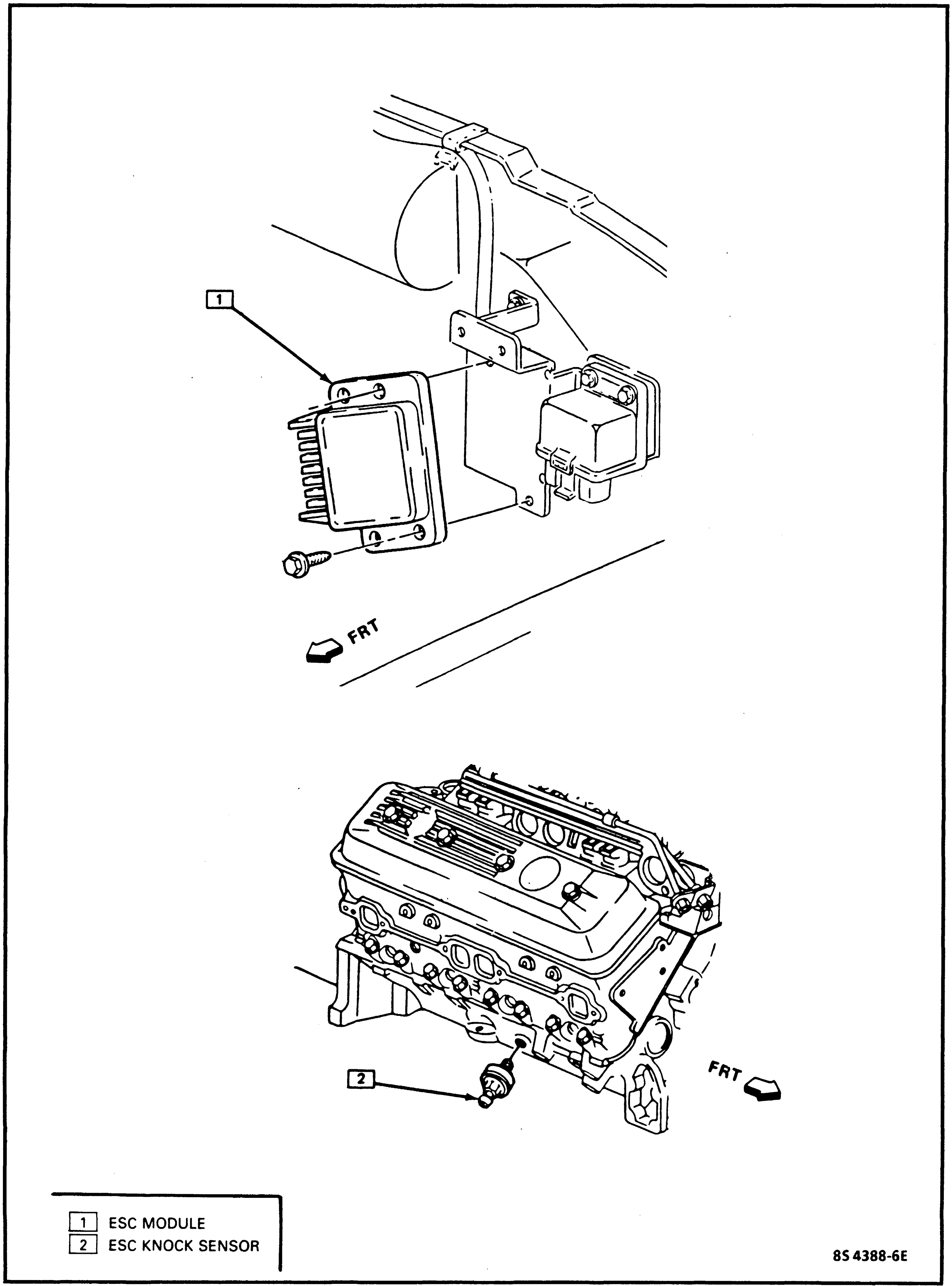


Figure C5-1 - ESC Module and ESC Knock Sensor

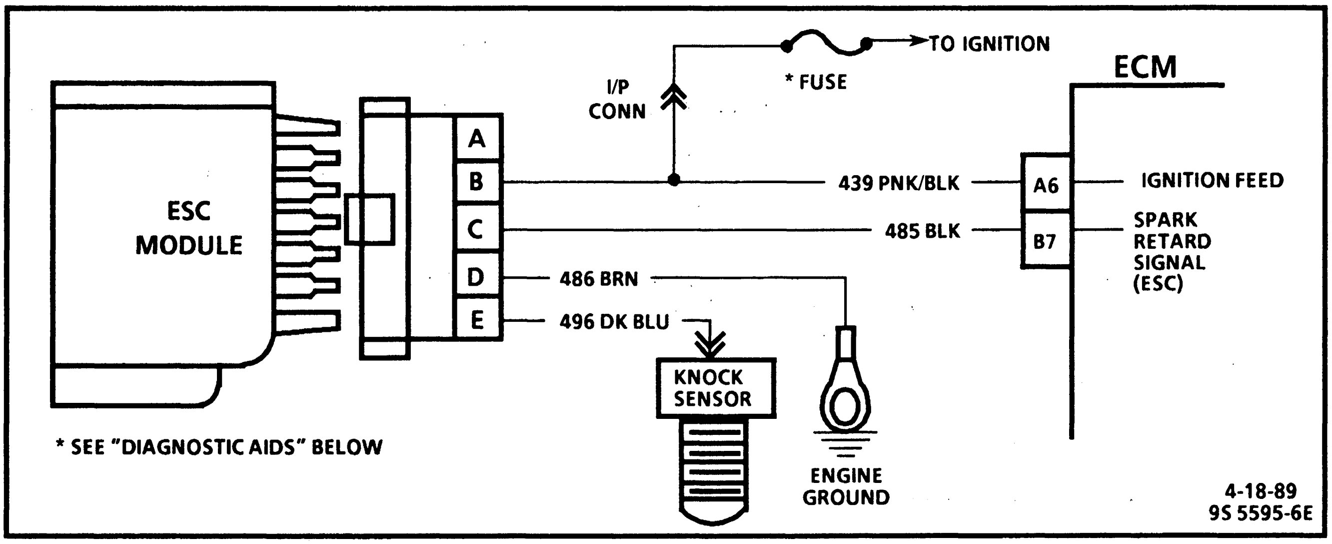


CHART C-5

ELECTRONIC SPARK CONTROL (ESC) SYSTEM CHECK
(ENGINE KNOCK, POOR PERFORMANCE, OR POOR ECONOMY)
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

Electronic Spark Control (ESC) is accomplished with a module that sends a voltage signal to the ECM. When the knock sensor detects engine knock, the voltage from the ESC module to the ECM is shut "OFF" and this signals the ECM to retard timing, if engine rpm is over about 900.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. If a Code 43 is not set, but a knock signal is indicated while running at 1500 rpm, listen for an internal engine noise. Under a no load condition, there should not be any detonation, and if knock is indicated, an internal engine problem may exist.
2. Usually a knock signal can be generated by tapping on the exhaust manifold. This test can also be performed at idle. Test number 1 was run at 1500 rpm, to determine if a constant knock signal was present, which would affect engine performance.
3. This tests whether the knock signal is due to the knock sensor, a basic engine problem, or the ESC module.
4. If the ESC module ground circuit is faulty, the ESC module will not function correctly. The test light should light indicating the ground circuit is OK.
5. Contacting CKT 496, with a test light to 12 volts, should generate a knock signal to determine whether the knock sensor is faulty, or the ESC module can't recognize a knock signal.

Diagnostic Aids:

* ECM Fuse

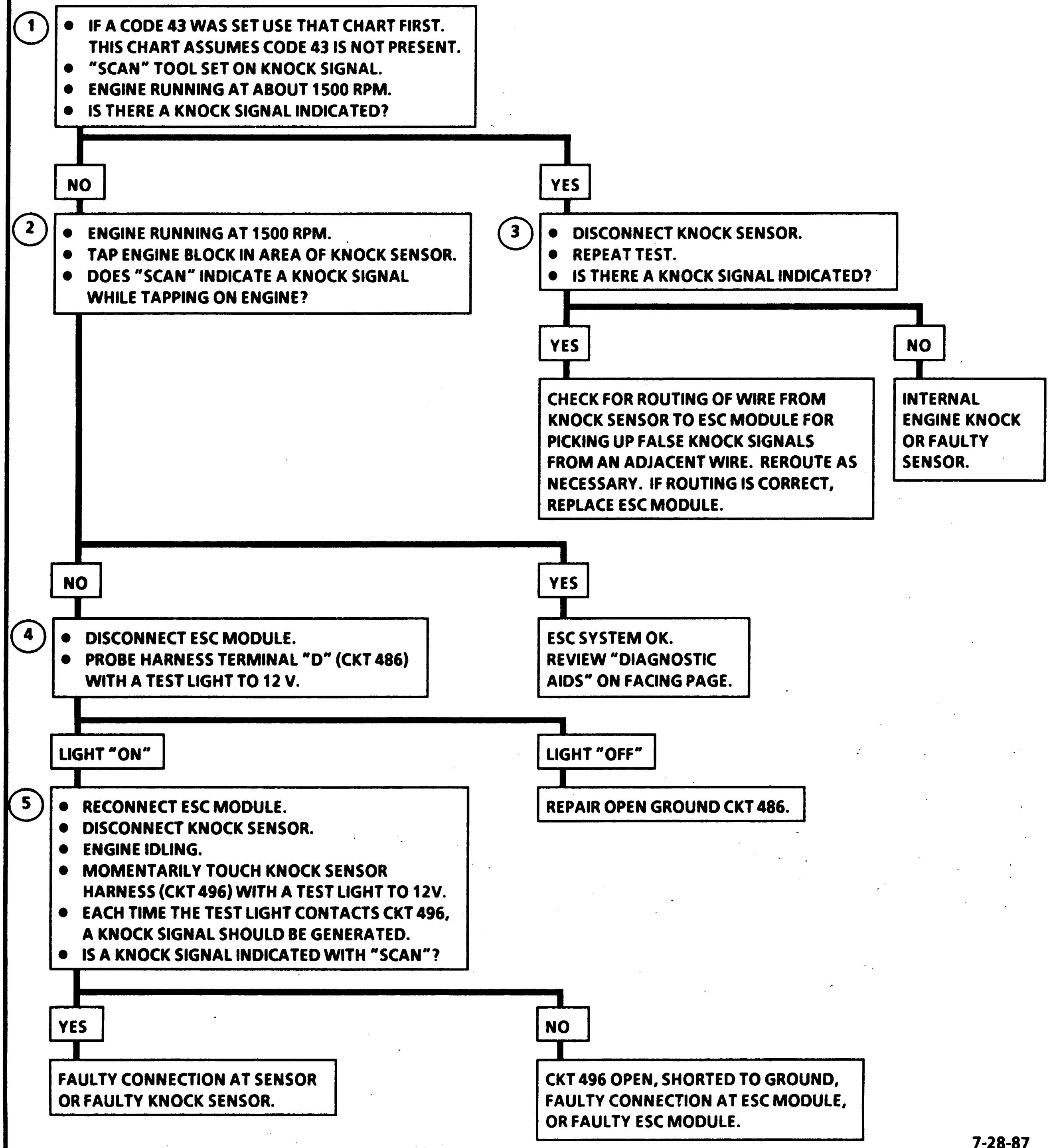
"Scan" tools have two positions to diagnose the ESC system. The knock signal can be monitored to see if the knock sensor is detecting a knock condition and if the ESC module is functioning, knock signal should display "YES," whenever detonation is present. The knock retard position on the "Scan" displays the amount of spark retard the ECM is commanding. The ECM can retard the timing up to 20 degrees.

If the ESC system checks OK, but detonation is the complaint, refer to "Detonation/Spark Knock" in "Symptoms," Section "6E2-B".

CHART C-5

ELECTRONIC SPARK CONTROL (ESC) SYSTEM CHECK
(ENGINE KNOCK, POOR PERFORMANCE, OR POOR ECONOMY)
5.0L (VIN E) "F" CARLINE (TBI)

THIS CHART SHOULD BE USED AFTER ALL OTHER CAUSES OF SPARK KNOCK HAVE BEEN CHECKED. I.E., TIMING, EGR, ENGINE TEMPERATURE OR EXCESSIVE ENGINE NOISE, ETC. IF CODE 43 IS SET, USE THAT CHART FIRST.



①
- IF A CODE 43 WAS SET USE THAT CHART FIRST. THIS CHART ASSUMES CODE 43 IS NOT PRESENT.
- "SCAN" TOOL SET ON KNOCK SIGNAL.
- ENGINE RUNNING AT ABOUT 1500 RPM.
- IS THERE A KNOCK SIGNAL INDICATED?

②
- ENGINE RUNNING AT 1500 RPM.
- TAP ENGINE BLOCK IN AREA OF KNOCK SENSOR.
- DOES "SCAN" INDICATE A KNOCK SIGNAL WHILE TAPPING ON ENGINE?

③
- DISCONNECT KNOCK SENSOR.
- REPEAT TEST.
- IS THERE A KNOCK SIGNAL INDICATED?

CHECK FOR ROUTING OF WIRE FROM KNOCK SENSOR TO ESC MODULE FOR PICKING UP FALSE KNOCK SIGNALS FROM AN ADJACENT WIRE. REROUTE AS NECESSARY. IF ROUTING IS CORRECT, REPLACE ESC MODULE.

INTERNAL ENGINE KNOCK OR FAULTY SENSOR.

④
- DISCONNECT ESC MODULE.
- PROBE HARNESS TERMINAL "D" (CKT 486) WITH A TEST LIGHT TO 12 V.

ESC SYSTEM OK. REVIEW "DIAGNOSTIC AIDS" ON FACING PAGE.

⑤
- RECONNECT ESC MODULE.
- DISCONNECT KNOCK SENSOR.
- ENGINE IDLING.
- MOMENTARILY TOUCH KNOCK SENSOR HARNESS (CKT 496) WITH A TEST LIGHT TO 12V.
- EACH TIME THE TEST LIGHT CONTACTS CKT 496, A KNOCK SIGNAL SHOULD BE GENERATED.
- IS A KNOCK SIGNAL INDICATED WITH "SCAN"?

REPAIR OPEN GROUND CKT 486.

FAULTY CONNECTION AT SENSOR OR FAULTY KNOCK SENSOR.

CKT 496 OPEN, SHORTED TO GROUND, FAULTY CONNECTION AT ESC MODULE, OR FAULTY ESC MODULE.

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SECTION C6

AIR INJECTION REACTION (A.I.R.) SYSTEM

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The A.I.R. system helps reduce Hydrocarbon (HC), Carbon Monoxide (CO), and Oxides of Nitrogen (NO_x) exhaust emissions. It also heats up the catalytic converter quickly on engine start-up so conversion of exhaust gases can occur sooner. A dual bed converter is used. It consists of a three way catalyst (which controls all three emissions) in series with a two way catalyst (which controls only HC and CO) both are in one housing. A pipe between the two converters allows air to be injected into the second (two way) converter to increase its efficiency to further control HC and CO.

As shown in Figure C6-1, air can be directed to:

- Atmosphere
- Exhaust ports; or
- Catalytic converter

OPERATION

The system includes:

- An A.I.R. Pump
  The A.I.R. pump is driven by a belt on the front of the engine and supplies the air to the system. Intake air passes through a centrifugal filter fan at the front of the pump; where foreign materials are separated from the air by centrifugal force.
- A Control Valve (PEDES)
  The A.I.R. control valve directs the flow of air from the A.I.R. pump to the atmosphere, exhaust ports or catalytic converter. Two electrical solenoids control the Pressure Operated Electric Divert/Electric Switching (PEDES) valve, which are in the control valve. The ECM provides the ground to complete the circuit and energize the solenoids.

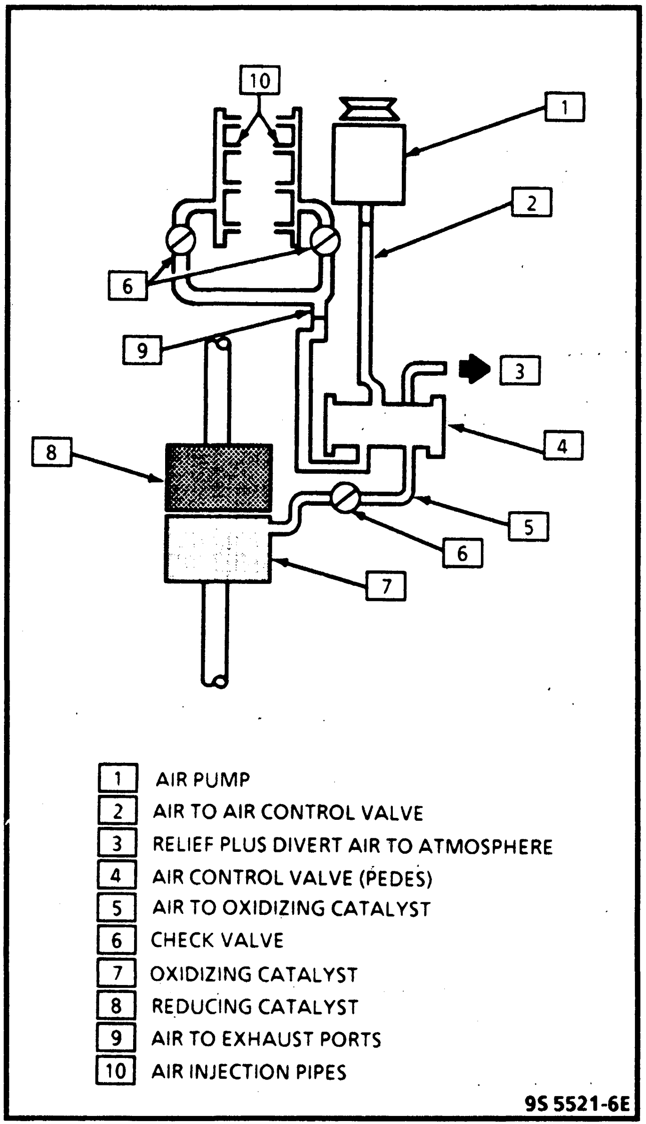

Figure C6-1 - A.I.R. System Operation

- Check Valves
  The check valves prevent back flow of exhaust into the pump in the event of an exhaust backfire or pump drive belt failure.
- Necessary Plumbing

A.I.R. CONTROL VALVE (PEDES)

Air from the A.I.R. pump enters the body of the control valve and builds pressure against the port valve. The port solenoid controls the port valve which performs a switching operation by directing air flow from the A.I.R. pump to the exhaust ports (solenoid energized) or the converter valve (solenoid de-energized). The converter solenoid controls the converter valve which directs air to the catalytic converter (solenoid energized) or diverts air to the atmosphere (solenoid de-energized).

- Cold Mode - The port (switch) solenoid is energized which in turn opens the port valve and allows flow to the exhaust ports.
- Warm (Normal) Mode - The port (switch) solenoid is de-energized and the converter (divert) solenoid energized which closes the port valve and keeps the converter valve seated, thus forcing flow past the converter valve and to the catalytic converter.
- Divert Mode - Both solenoids are de-energized which opens the converter valve, allowing air to take the path of least resistance, i.e., out the divert/relief tube to atmosphere.

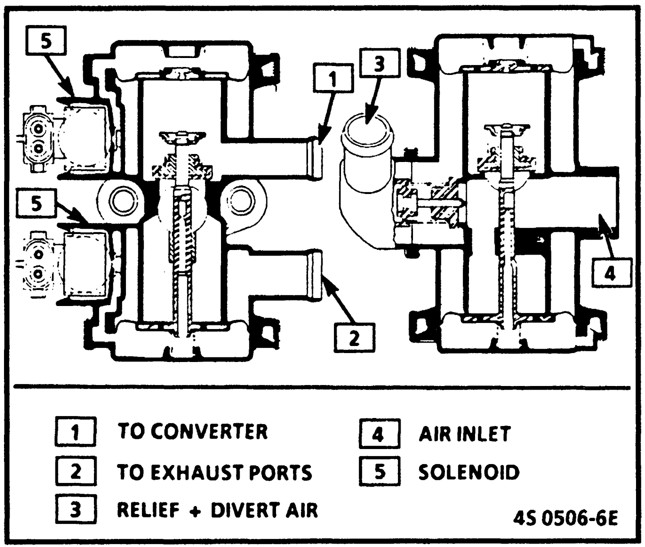

Figure C6-2 - A.I.R. Control Valve

Air is diverted to the atmosphere under the following conditions:

- Rich operation.
- When the ECM recognizes a problem and sets the "Service Engine Soon" light.
- During deceleration.
- During high rpm operation when air pressure is greater than the setting for the internal relief valve.

RESULTS OF INCORRECT OPERATION

If no air (oxygen) flow enters the exhaust stream at the exhaust ports or converter pipe, HC and CO emission levels will be too high.

Air flowing to the exhaust ports at all times could increase temperature of the catalytic converter. It may also cause a backfire upon deceleration.

Air flowing at all times to the catalytic converter may cause converter overheating during rich operation.

DIAGNOSIS

When the ECM directs air to the exhaust ports, a "Scan" tool will indicate the converter (divert) solenoid as "normal" and port (switch) solenoid as "port."

When the ECM directs air to the converter "Scan" will indicate the converter (divert) solenoid as "normal" and port (switch) solenoid as "converter."

When the ECM diverts air to the atmosphere, "Scan" will indicate converter (divert) solenoid as "divert" and port (switch) solenoid as "converter."

The diagnosis of the AIR system is covered in CHART C-6 at the end of this section.

OPERATIONAL CHECKS

A.I.R. Pump

The A.I.R. pump is a positive displacement vane type which is permanently lubricated and requires no periodic maintenance.

NOTICE: If the engine or underhood compartment is to be cleaned with steam or high-pressure detergent, the centrifugal filter fan should be masked off to prevent liquids from entering the pump.

Accelerate engine to approximately 1500 rpm's and observe air flow from hose(s). If air flow increases as engine is accelerated, pump is operating satisfactorily. If air flow does not increase or is not present, proceed as follows:

Inspect

1. For proper drive belt tension.
2. For a leaky pressure relief valve. Air may be heard leaking with the A.I.R. pump running.

Important

- The A.I.R. system is not completely noiseless. Under normal conditions, noise rises in pitch as engine speed increases. To determine if excessive noise is the fault of the A.I.R. pump, operate the engine with the pump drive belt removed. If excessive noise does not exist with the belt removed, proceed as follows:

3. For a seized A.I.R. pump.
4. Hoses, tubes and all connections for leaks and proper routing.
5. For air flow from A.I.R. control valve.
6. A.I.R. pump for proper mounting and bolt torque.
7. If no irregularities exist and the A.I.R. pump noise is still excessive, remove and replace pump.

NOTICE: Do Not oil A.I.R. pump as damage may result.

Hoses and Pipes

Inspect

1. Hose or pipe for deterioration or holes.
2. All hoses or pipe connections, and clamp tightness.
3. Hose or pipe routing. Interference may cause wear.
4. If a leak is suspected on the pressure side of the system or if a hose or pipe has been disconnected on the pressure side, the connections should be checked for leaks with a soapy water solution. With the A.I.R. pump running, bubbles will form if a leak exists.

Check Valve

Inspect

1. A check valve should be inspected whenever the hose is disconnected form a check valve or whenever check valve failure is suspected. (A pump that had become inoperative and had shown indications of having exhaust gases in the pump would indicate check valve failure).
2. Blow through the check valve (toward the cylinder head) then attempt to suck back through the check valve. Flow should only be in one direction (toward the exhaust manifold). Replace valve which does not operate properly.

ON-VEHICLE SERVICE

A.I.R. PUMP

Remove or Disconnect

1. Hold pump pulley from turning by compressing drive belt, then loosen pump pulley bolts.
2. Lift drive tensioner to raised position.
3. Drive belt and pulley.
4. Hoses, vacuum, and electrical connections from A.I.R. control valve.
5. A.I.R. pump mounting bolts and pump assembly (See Figure C6-3).

Install or Connect

1. A.I.R. pump assembly, and tighten mounting bolts.
2. Pump pulley against centrifugal filter fan.
3. Pump pulley bolts.

Tighten

- Pump pulley bolts (tighten equally) to 25.8 N·m (19 lb. ft.).

4. Check A.I.R. system for proper operation, use Chart C-6.

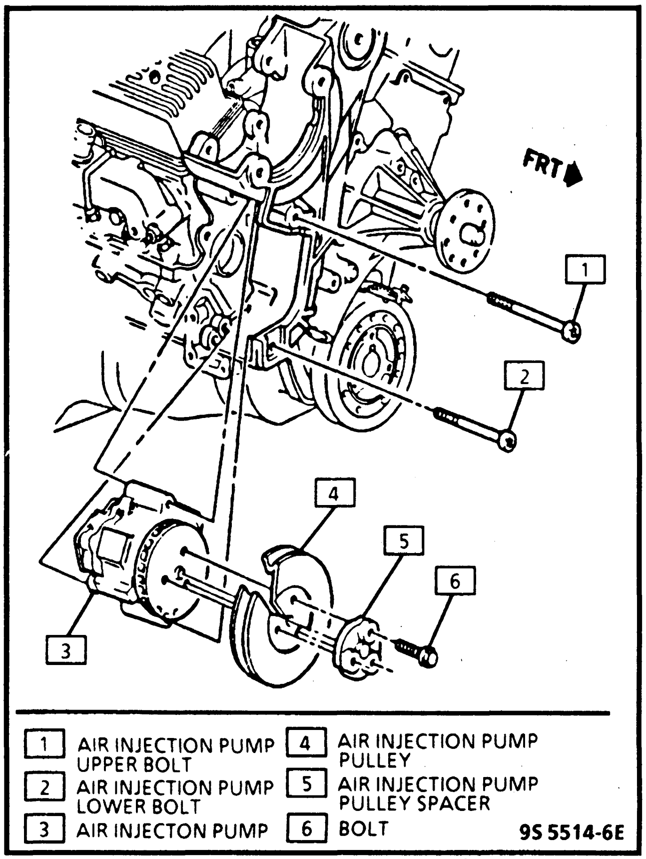

Figure C6-3 - Air Pump Service

A.I.R. CONTROL VALVE (PEDES)

Remove or Disconnect

1. Battery ground cable.
2. Adapter bolts.
3. Air outlet hoses from valve.
4. Splash guard cover.
5. Electrical connectors and hoses to valve.
6. A.I.R. control valve.

Install or Connect

1. A.I.R. control valve.
2. Electrical connectors and hoses to valve.
3. Splash guard/cover.
4. Air outlet hoses to valve.
5. Battery ground cable.
6. Check system operation, use CHART C-6.

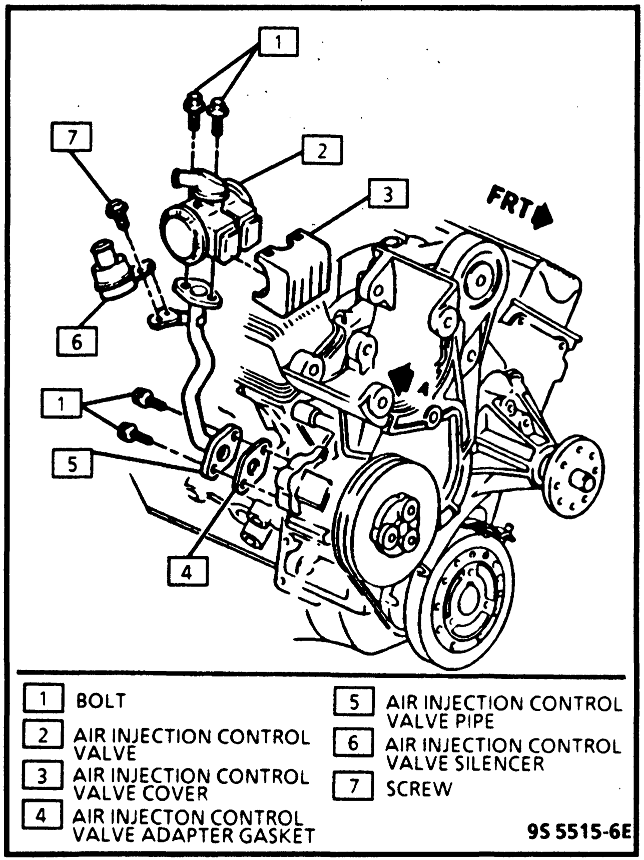

Figure C6-4 - PEDES Valve Service

A.I.R. CHECK VALVE

Remove or Disconnect

1. Release clamp and disconnect air hoses from check valve. (See Figure C6-5).
2. Unscrew check valve from A.I.R. injection pipe.

Install or Connect

1. Screw check valve onto A.I.R. injection pipe.

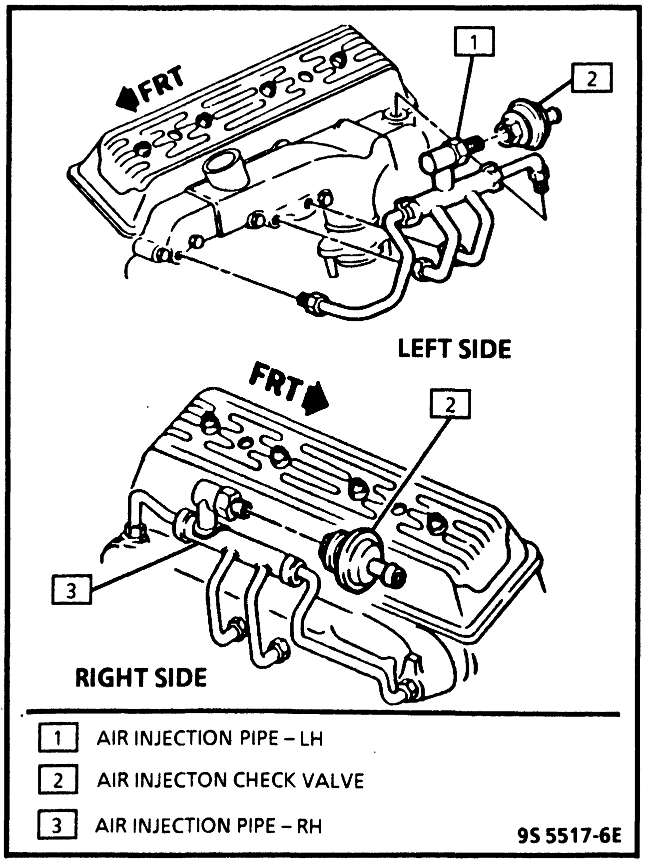

Figure C6-5 - A.I.R. System Check Valve Service

Tighten

- Check valve to 23 N·m (17 lb. ft.).

2. Position air hoses on check valve and secure with clamp.

PARTS INFORMATION

PART NAME	GROUP
Adapter, AIR Inj Cont Vlv	3.671
Brace, AIR Inj Pump	3.655
Bracket, AIR Inj Pump	3.655
Gasket, AIR Inj Dvtr Vlv El	3.671
Harness, AIR Inj Cont Vlv Vac	3.675
Hose, AIR Inj Cont Vlv	3.675
Hose, AIR Inj Cont Vlv Dvtr	3.675
Hose, Ctltc Conv AIR Inj Chk Vlv	3.675
Pipe, AIR Inj Ctltc Conv Chk Vlv	3.690
Pipe, Ctltc Conv AIR Inj	3.675
Pulley, AIR Inj Pump	3.650
Pump, AIR Inj	3.660
Silencer AIR Inj Cont Vlv	3.660
Support, AIR Inj Pump	3.660
Valve, AIR Inj Cont	3.670
Valve, AIR Inj Eng Chk	3.670
Valve, Ctltc Conv AIR Inj Chk	3.670

TORQUE SPECIFICATIONS

Bolt, Air Injection Pump	32.5 N·m (24 lb. ft.)
Bolt, Air Injection Pump 13 mm head	33.9 N·m (25 lb. ft.)
Bolt, Air Injection Pump Bracket 15 mm head	59.7 N·m (44 lb. ft.)
Bolt, Air Injection Pump Pivot 13 mm head	33.9 N·m (24 lb. ft.)
Bolt, Air Injection Pump and Drive Belt Tension Bracket	32.5 N·m (24 lb. ft.)
Stud, Air Injection Pump and Drive Belt Tension Bracket	20.3 N·m (15 lb. ft.)
Bolt, Air Injection Converter Valve 10 mm head	5.6 N·m (50 lb. in.)
Bolt, Air Injection Pump Pulley 10 mm head	25.8 N·m (19 lb. ft.)
Bolt, Air Injection Converter Valve Silencer 10 mm head	5.6 N·m (50 lb. in.)
Bolt, Air Injection Converter Valve Pipe 10 mm head	25.8 N·m (19 lb. ft.)
Valve, A.I.R. Check	23 N·m (17 lb. ft.)

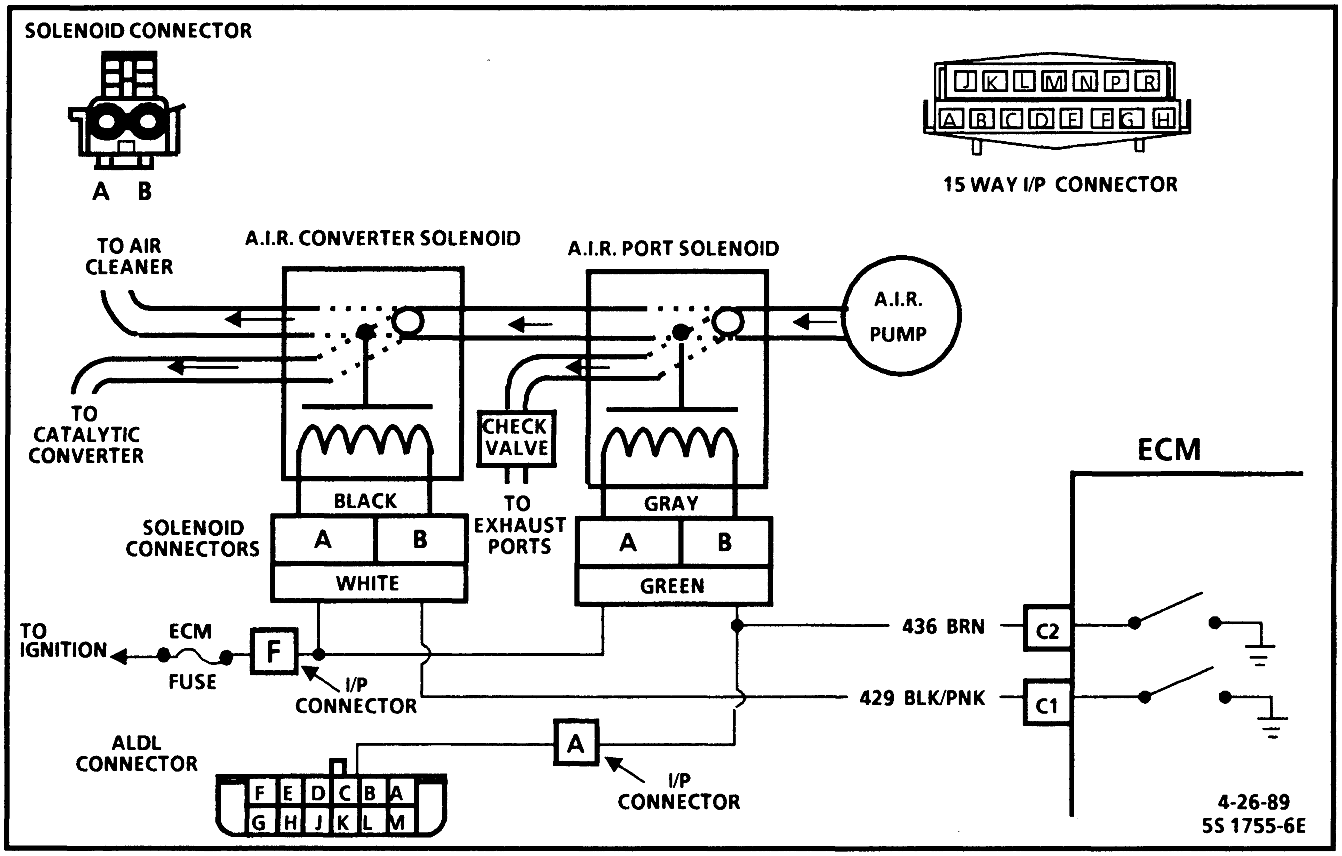

CHART C-6

AIR MANAGEMENT CHECK - CONTROL VALVE (PEDES)
(PRESSURE OPERATED ELECTRIC DIVERT/ELECTRIC SWITCHING)
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

Air management is controlled by a port valve and a converter valve, each with an ECM controlled electrical solenoid. When the solenoid is grounded by the ECM, A.I.R. pump pressure will activate the valve and allow pump air to be directed as follows:

- Cold Mode - The port (switch) solenoid is energized which in turn opens the port valve and allows flow to the exhaust ports.
- Warm Mode - The port (switch) solenoid is de-energized and the converter (divert) solenoid energized which closed the port valve and keeps the converter valve seated, thus forcing flow past the converter valve and to the catalytic converter.
- Divert Mode - Both solenoids are de-energized, which opens the converter valve, allowing air to take the path of lease resistance, i.e., out the divert/relief tube to atmosphere.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. This is a system functional check. Air is directed to ports during "Open Loop" and all engine start in "Open Loop" even on a warm engine. Since the air to the ports time is very short on some engines, prepare to observe port air prior to engine start up. On some engines, this can be done by squeezing a hose. On others, steel pipes have to be disconnected.
2. This should normally set a Code 22. When any code is set, the ECM opens the ground to the A.I.R. control valve and allows air to divert. This checks for ECM response to a fault. A ground in the A.I.R. control valve circuit to the ECM would prevent divert action.
3. This checks for a grounded circuit to the ECM. Test light "OFF" is normal and would indicate the circuit is not grounded.
4. Checks for an open in the solenoid control circuits. Grounding the diagnostic "test" terminal should ground both solenoid circuits. Normally, the test light should be "ON" which indicates the problem is not in the ECM or wiring but at the solenoid connections or A.I.R. control valve itself.
5. Checks for a grounded port (switching valve) solenoid circuit. Test light "OFF" would indicate the circuit is normal and fault is in the valve.

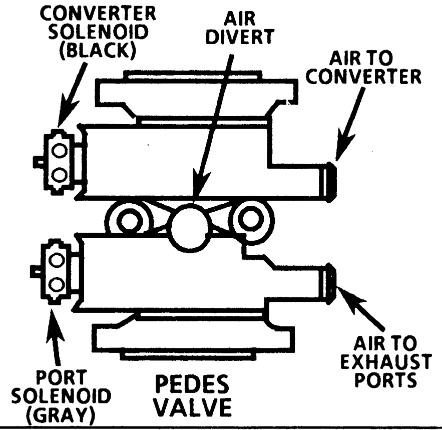

CHART C-6

AIR MANAGEMENT CHECK - CONTROL VALVE (PEDES)

(PRESSURE OPERATED ELECTRIC DIVERT/ELECTRIC SWITCHING)

5.0L (VIN E) "F" CARLINE (TBI)

①
- "DIAGNOSTIC" TERMINAL UNGROUNDED.
- START ENGINE, RUNNING AT PART THROTTLE, BELOW 2000 RPM, AIR SHOULD BE FELT AT OUTLET TO EXHAUST PORTS DURING "OPEN LOOP" OPERATION (FROM 6 SECONDS TO 3 MINUTES ON WARM ENGINE DEPENDING ON APPLICATION) AND SWITCH TO CONVERTER WHEN SYSTEM GOES "CLOSED LOOP".

OK

②
- DISCONNECT TPS CONNECTOR AT IDLE AND AIR SHOULD DIVERT TO ATMOSPHERE AFTER A FEW SECONDS.

- **NO DIVERT**

  ③
  - IGNITION "ON", ENGINE STOPPED.
  - DISCONNECT CONVERTER SOLENOID ELECT. CONNECTOR AND CONNECT TEST LIGHT BETWEEN HARNESS CONNECTOR TERMINALS
  - NOTE LIGHT.

  - **LIGHT "ON"**
    - CHECK CKT 429 FOR SHORT TO GROUND. IF NOT GROUNDED, IT IS A FAULTY ECM.
  - **LIGHT "OFF"**
    - REPLACE PEDES VALVE.
- **OK**
  - NO TROUBLE FOUND. CLEAR MEMORY WITH SCAN TOOL AND REVIEW SYMPTOMS SECTION "B".

PORT THEN DIVERT ONLY

④
- IGNITION "ON", ENGINE STOPPED
- INSTALL "SCAN" TOOL
- SELECT MISC. TEST
- OUTPUT TEST
- A.I.R. SYSTEM ENABLE A.I.R SYSTEM
- DISCONNECT CONVERTER VALVE SOLENOID
- CONNECT TEST LIGHT BETWEEN HARNESS CONNECTOR TERMINALS AND NOTE LIGHT.

- **LIGHT "OFF"**
  - CONNECT TEST LIGHT BETWEEN CKT 39 AND GROUND.
  - **LIGHT "OFF"**
    - OPEN CKT 39
  - **LIGHT "ON"**
    - OPEN IN CKT 429. FAULTY ECM CONNECTION OR ECM.
- **LIGHT "ON"**
  - FAULT IS CONVERTER VALVE SOLENOID, CONNECTION, OR VALVE.

CONSTANT PORT OR CONVERTER AIR

⑤
- IGNITION "ON", ENGINE STOPPED.
- "SCAN" TOOL EXIT A.I.R. SYSTEM
- DISCONNECT PORT VALVE SOLENOID
- CONNECT TEST LIGHT BETWEEN HARNESS CONNECTOR TERMINALS AND NOTE LIGHT.

- **LIGHT "OFF"**
  - "SCAN" TOOL ENABLE A.I.R. SYSTEM
  - NOTE TEST LIGHT.
  - **LIGHT "OFF"**
    - CONNECT TEST LIGHT BETWEEN CKT 39 AND GROUND.
    - **LIGHT "OFF"**
      - REPAIR OPEN CKT 39
    - **LIGHT "ON"**
      - OPEN CKT 436. FAULTY CONNECTION OR ECM.
  - **LIGHT "ON"**
    - FAULTY CONNECTION AT PORT SOLENOID OR FAULTY PEDES VALVE.
- **LIGHT "ON"**
  - GROUNDED CKT 436 OR FAULTY ECM.

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SECTION C7

EXHAUST GAS RECIRCULATION (EGR) SYSTEM

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The EGR system is used to lower NO_x (oxides of nitrogen) emission levels caused by high combustion temperatures. It does this by decreasing combustion temperature.

The main element of the system is an EGR valve operated by vacuum, and mounted on the intake manifold.

The EGR valve feeds small amounts of exhaust gas back into the combustion chamber as shown in Figure C7-1.

OPERATION

The EGR valve is opened by ported manifold vacuum regulated by an ECM controlled solenoid to let exhaust gas flow into the intake manifold. The exhaust gas then moves with the air/fuel mixture into the combustion chamber. If too much exhaust gas enters, combustion will not occur. For this reason, very little exhaust gas is allowed to pass through the valve, especially at idle. The EGR valve is usually open during warm engine operation and when the vehicle is above idle speed.

EGR CONTROL

The EGR vacuum control has a vacuum solenoid that uses Pulse Width Modulation (PWM). This means the ECM turns the solenoid "ON" and "OFF" many times a second and varies the amount of "ON" time ("pulse width") to vary the amount of EGR.

The ECM uses information from the following sensors to regulate the EGR solenoid:

- Coolant Temperature Sensor (CTS)
- Manifold Air Temperature (MAT)
- Throttle Position Sensor (TPS)
- P/N Switch

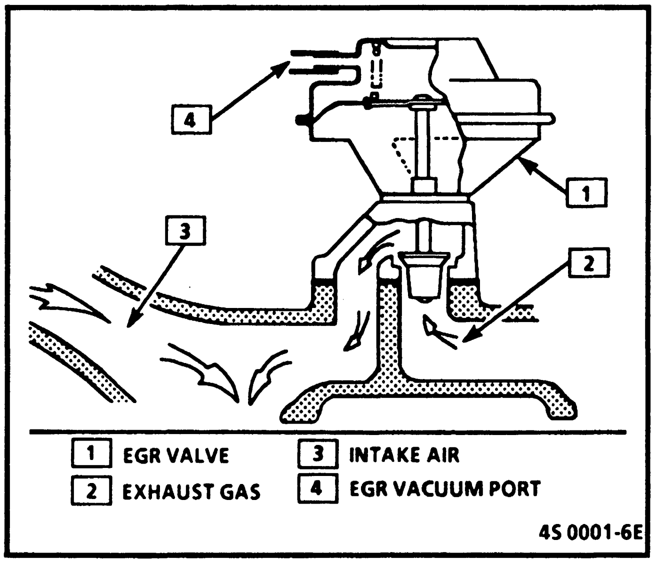


Figure C7-1 - Exhaust Gas Recirculation

During cold operation and at idle, the solenoid circuit is not grounded by the ECM. This blocks vacuum to the EGR valve.

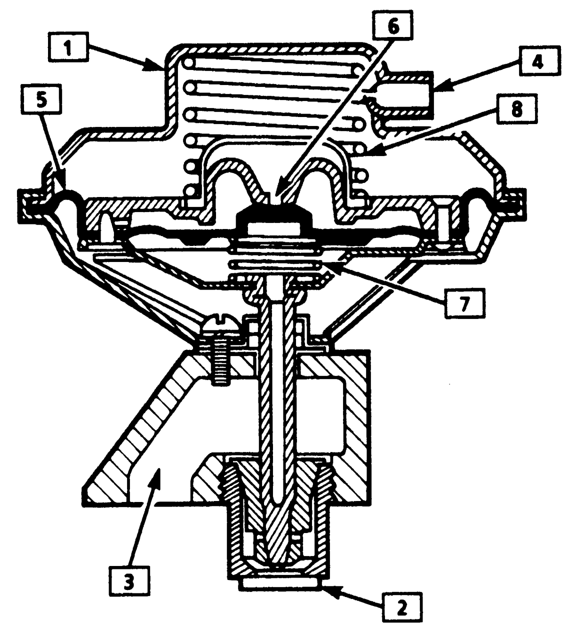
A system malfunction should trigger a "Service Engine Soon" light, and set a Code 32. For more information see Code 32.

NEGATIVE BACKPRESSURE EGR VALVE

The EGR valve used on this engine is a negative backpressure valve. It varies the amount of exhaust gas flow into the manifold depending on manifold vacuum and variations in exhaust backpressure.

The diaphragm on this EGR valve (shown in Figure C7-2) has an internal vacuum bleed hole which is held closed by a small spring when there is no exhaust backpressure. The amount of vacuum to the valve is controlled by the ECM controlling a solenoid.

Engine vacuum opens the EGR valve against the pressure of a large spring. When ported manifold vacuum combines with negative exhaust backpressure, the vacuum bleed hole opens and the EGR valve closes.



1 EGR VALVE
2 EXHAUST GAS
3 INTAKE AIR
4 VACUUM PORT
5 DIAPHRAGM
6 AIR BLEED HOLE
7 SMALL SPRING
8 LARGE SPRING

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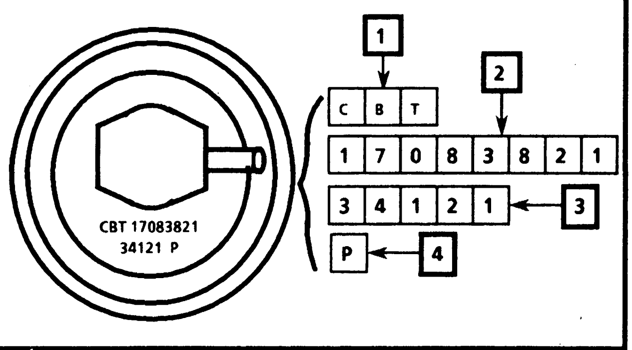
Figure C7-2 - Negative Backpressure EGR Valve

EGR VALVE IDENTIFICATION

- Negative backpressure EGR valves will have an "N" stamped on the top side of the valve after the part number (Figure C7-3).
- Positive backpressure EGR valves will have a "P" stamped on the top side of the valve, after the part number.
- Port EGR valves have no identification stamped after the part number.

When replacing an EGR valve, always check for correct part number in the parts catalog or supplemental bulletin.



1. ASSEMBLY PLANT CODE
2. PART NUMBER
3. DATE BUILT
4. LOOK HERE FOR LETTER:
   P = POSITIVE BACK PRESSURE
   N = NEGATIVE BACK PRESSURE
   BLANK = PORTED VALVE

* 4S 0538-6E
2-27-87

Figure C7-3 - EGR Valve Identification

RESULTS OF INCORRECT OPERATION

Too much EGR flow (at idle, cruise, or cold operation) and may result in any of the following conditions:

- Engine stops after cold start
- Engine stops at idle after deceleration
- Car surges during cruise
- Rough idle

Too little or no EGR flow allows combustion temperatures to get too high during acceleration and load conditions. This could cause:

- Spark knock (detonation)
- Engine overheating
- Emission test failure

DIAGNOSIS

Diagnosis of the ECM controlled EGR system is covered in CHART C-7 at the end of this section. If the vehicle has a stored Code 32 see that chart first.

ON-VEHICLE SERVICE

EGR VALVE

↔ Remove or Disconnect

1. Air cleaner.
2. EGR valve vacuum hose at valve.
3. Bolts.
4. EGR valve from manifold.

EGR Manifold Passage

Inspect

- If EGR passages in the inlet manifold indicate excessive build-up of deposits, the passages should be cleaned. Care should be taken to ensure that all loose particles are completely removed to prevent them from clogging the EGR valve or from being ingested into the engine.

Clean

1. With a wire wheel, buff the exhaust deposits from the mounting surface and around the valve.
2. Look for exhaust deposits in the valve outlet. Remove deposit build-up with a screwdriver.
3. Clean mounting surfaces of intake manifold and valve assembly.

Install or Connect

1. EGR valve on intake manifold using new gasket.

Tighten

- Bolts and tighten to 22 N·m (16 lb. ft.).

2. Vacuum hose to valve.
3. Air cleaner.

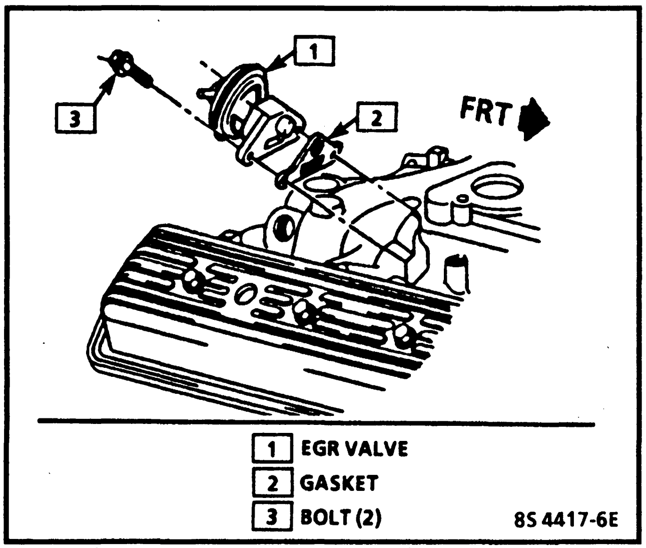


Figure C7-4 - EGR to Manifold Mounting

EGR CONTROL SOLENOID

Remove or Disconnect

1. Negative battery cable.
2. Air cleaner assembly.
3. Electrical connector at solenoid.
4. Vacuum hoses.
5. Nut and solenoid.

Install or Connect

1. Solenoid and bracket.

Tighten

- Tighten nut to 24 N·m (17 lb. ft.).

2. Vacuum hoses.
3. Electrical connector at solenoid.
4. Air cleaner assembly.
5. Negative battery cable.

PARTS INFORMATION

PART NAME	GROUP
Harness, EGR Vlv Vac	3.675
Nut	8.917
Stud	1.428
Valve, EGR	3.670
Gasket, EGR Vlv	3.680
Solenoid, EGR Cont Vlv Rly	3.670
Bracket, EGR Sol	3.671

TORQUE SPECIFICATIONS

EGR Valve to Intake Manifold	22 N·m (16 lb. ft.)
EGR Solenoid and Bracket to Intake Manifold	24 N·m (17 lb. ft.)

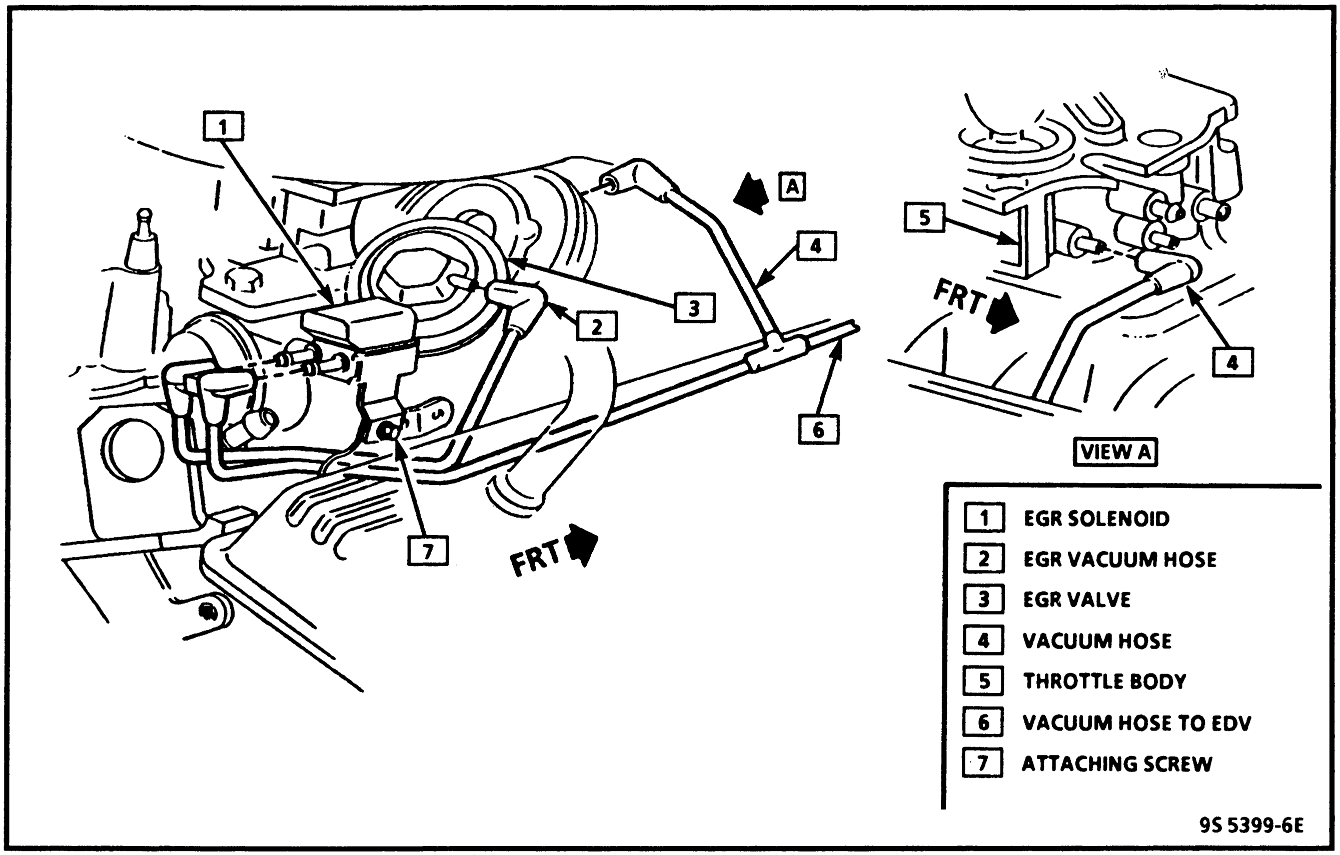


Figure C7-5 - EGR Control Solenoid

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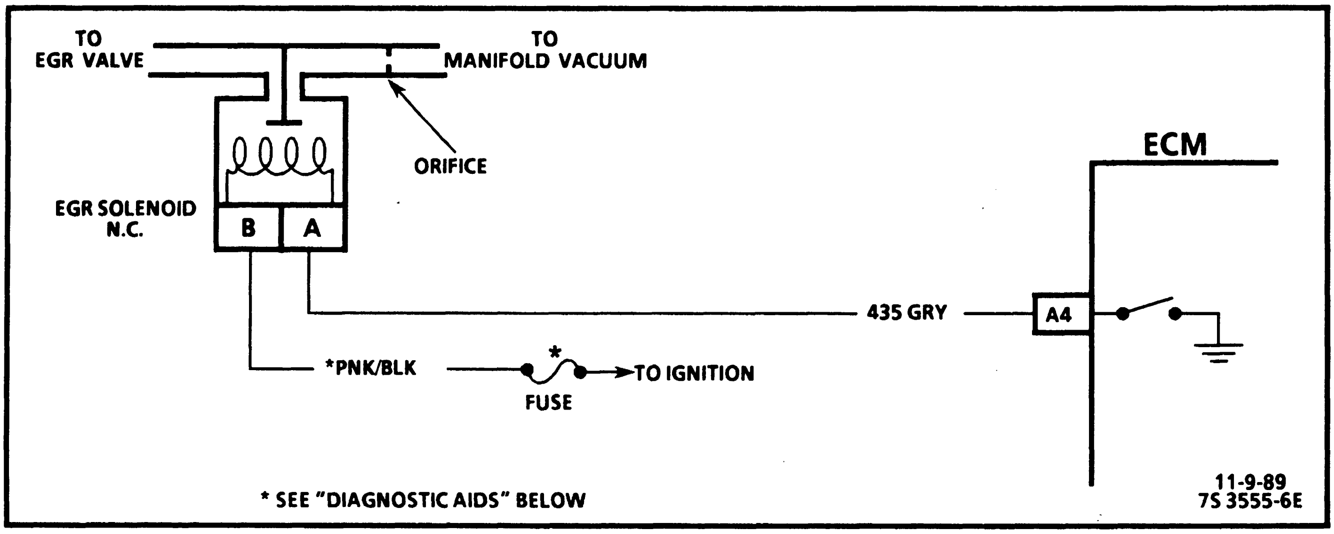


CHART C-7

EXHAUST GAS RECIRULATION (EGR) CHECK
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

The ECM operates a solenoid to control the Exhaust Gas Recirculation (EGR) valve. This solenoid is normally closed. By providing a ground path, the ECM energizes the solenoid which then allows vacuum to pass to the EGR valve. The ECM control of the EGR is based on the following inputs:

- Engine coolant temperature above 25°C (77°F).
- TPS off idle
- MAP

If Code 24 is stored, use that chart first.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. By grounding the diagnostic "test" terminal, the EGR solenoid should be energized and allow vacuum to be applied to the EGR valve and the vacuum should hold.
2. When the diagnostic "test" terminal is ungrounded, the vacuum to the EGR valve should bleed off through a vent in the EGR solenoid and the valve should close. The gage may or may not bleed off but this does not indicate a problem.
3. This test will determine if the electrical control part of the system is at fault or if the connector or solenoid is at at fault.
4. This system uses a negative backpressure EGR valve which should hold vacuum with engine "OFF."
5. When engine is started, exhaust backpressure should cause vacuum to bleed off and EGR valve should fully close.

Diagnostic Aids:

* CKT 39 - Gauges fuse

Vacuum lines should be thoroughly checked for internal restrictions and proper routing. Refer to underhood "Vehicle Emission Control Information" label.

Remove the EGR valve and start engine, check both exhaust and intake EGR passages for restrictions or blockage.

The ECM uses the MAP sensor for checking EGR operation. If there is a question of MAP sensor accuracy, use CHART C-1D MAP output check in "Component Systems," Section "6E2-C".

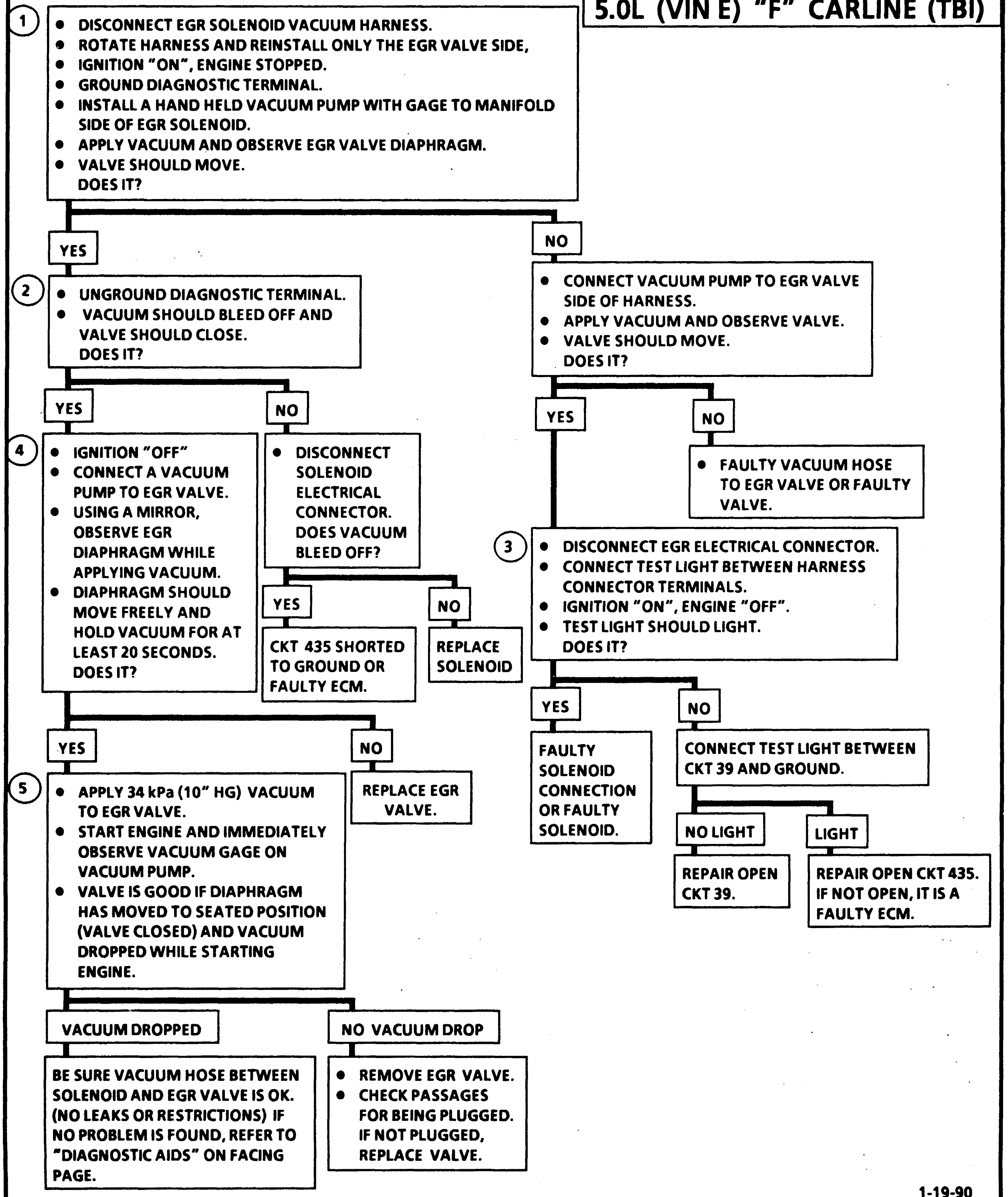
If no problems are found, refer to "Intermittents" in "Symptoms," Section "6E2-B".

CHART C-7

EXHAUST GAS RECIRCULATION (EGR) CHECK

5.0L (VIN E) "F" CARLINE (TBI)

BEFORE USING THIS CHART CHECK FOR MANIFOLD VACUUM TO EGR SOLENOID, THERE SHOULD BE AT LEAST 25 kPa (7" HG) OF VACUUM AT 2000 RPM. CHECK VACUUM HOSES FOR LEAKS OR RESTRICTIONS.



①
- DISCONNECT EGR SOLENOID VACUUM HARNESS.
- ROTATE HARNESS AND REINSTALL ONLY THE EGR VALVE SIDE,
- IGNITION "ON", ENGINE STOPPED.
- GROUND DIAGNOSTIC TERMINAL.
- INSTALL A HAND HELD VACUUM PUMP WITH GAGE TO MANIFOLD SIDE OF EGR SOLENOID.
- APPLY VACUUM AND OBSERVE EGR VALVE DIAPHRAGM.
- VALVE SHOULD MOVE.

DOES IT?

YES

②
- UNGROUND DIAGNOSTIC TERMINAL.
- VACUUM SHOULD BLEED OFF AND VALVE SHOULD CLOSE.

DOES IT?

YES

④
- IGNITION "OFF"
- CONNECT A VACUUM PUMP TO EGR VALVE.
- USING A MIRROR, OBSERVE EGR DIAPHRAGM WHILE APPLYING VACUUM.
- DIAPHRAGM SHOULD MOVE FREELY AND HOLD VACUUM FOR AT LEAST 20 SECONDS.

DOES IT?

YES

⑤
- APPLY 34 kPa (10" HG) VACUUM TO EGR VALVE.
- START ENGINE AND IMMEDIATELY OBSERVE VACUUM GAGE ON VACUUM PUMP.
- VALVE IS GOOD IF DIAPHRAGM HAS MOVED TO SEATED POSITION (VALVE CLOSED) AND VACUUM DROPPED WHILE STARTING ENGINE.

VACUUM DROPPED

BE SURE VACUUM HOSE BETWEEN SOLENOID AND EGR VALVE IS OK. (NO LEAKS OR RESTRICTIONS) IF NO PROBLEM IS FOUND, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

NO VACUUM DROP

- REMOVE EGR VALVE.
- CHECK PASSAGES FOR BEING PLUGGED. IF NOT PLUGGED, REPLACE VALVE.

NO

REPLACE EGR VALVE.

NO

- DISCONNECT SOLENOID ELECTRICAL CONNECTOR. DOES VACUUM BLEED OFF?

YES

CKT 435 SHORTED TO GROUND OR FAULTY ECM.

NO

REPLACE SOLENOID

NO

- CONNECT VACUUM PUMP TO EGR VALVE SIDE OF HARNESS.
- APPLY VACUUM AND OBSERVE VALVE.
- VALVE SHOULD MOVE.

DOES IT?

YES

③
- DISCONNECT EGR ELECTRICAL CONNECTOR.
- CONNECT TEST LIGHT BETWEEN HARNESS CONNECTOR TERMINALS.
- IGNITION "ON", ENGINE "OFF".
- TEST LIGHT SHOULD LIGHT.

DOES IT?

YES

FAULTY SOLENOID CONNECTION OR FAULTY SOLENOID.

NO

CONNECT TEST LIGHT BETWEEN CKT 39 AND GROUND.

NO LIGHT

REPAIR OPEN CKT 39.

LIGHT

REPAIR OPEN CKT 435. IF NOT OPEN, IT IS A FAULTY ECM.

NO

- FAULTY VACUUM HOSE TO EGR VALVE OR FAULTY VALVE.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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SECTION C8

TORQUE CONVERTER CLUTCH (TCC) SYSTEM

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The Torque Converter Clutch (TCC) system is designed to eliminate power loss by the torque converter (slippage), thus, increasing fuel economy. By locking the Torque Converter Clutch (TCC), a more effective coupling to the flywheel is achieved. The Torque Converter Clutch (TCC) is operated by an ECM controlled solenoid.

OPERATION

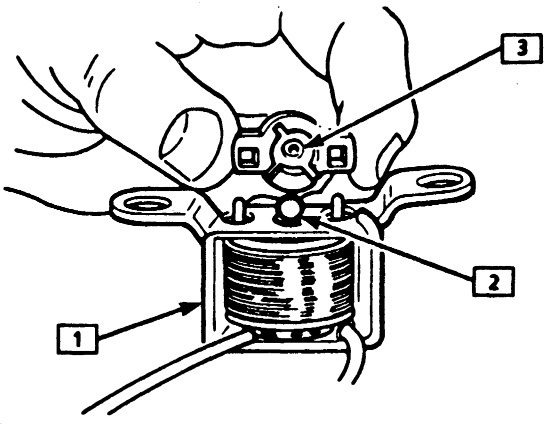
Engagement of the TCC is accomplished by a solenoid operated valve within the transmission. The solenoid is activated when an internal switch in the ECM is grounded. Although the ECM may command the TCC "ON," the Torque Converter Clutch (TCC) will not apply until internal transmission fluid pressure requirements are met.

Before the ECM activates the TCC apply solenoid, several inputs must be monitored:

- Vehicle Speed Sensor (VSS) - Must be above a certain value before the TCC can be applied.
- Coolant Temperature Sensor (CTS) - The engine coolant temperature must be above a certain value before the TCC can be applied.
- Throttle Position Sensor (TPS) - After the TCC is applied, during low engine load condition, the ECM uses the information from the TPS to release the clutch when the car is accelerating or decelerating at a certain rate.

CIRCUIT DESCRIPTION

The 12 volt power supply for the TCC solenoid in the transmission is provided through a normally closed switch located on the brake pedal linkage. When the brake pedal is depressed (switch open), the power supply to the TCC solenoid is interrupted and the TCC is disengaged regardless of any other conditions.



1 TCC SOLENOID
2 CHECK BALL
3 CHECK BALL SEAT
4S 0548-6E

Figure C8-1 - TCC Solenoid

When the brake pedal is not depressed (switch closed), battery voltage will be fed to the TCC solenoid. If the ECM has determined that conditions are correct, the circuit from the TCC solenoid will be completed to ground through the ECM and the TCC solenoid will be activated.

Some transmission use other internal switches in addition to the TCC solenoid.

- Transmissions normally use a 4th gear switch to send a signal to the ECM telling it when the transmission is in 4th gear. The ECM uses this information to vary the conditions under which the torque converter clutch applies or releases. However, the transmission does not have to be in 4th gear in order for the ECM to turn the clutch "ON."

RESULTS OF INCORRECT TCC OPERATION

An engine stall will result if the converter clutch remains applied at all times.

If the torque converter clutch does not apply, fuel economy may be lower than expected.

DIAGNOSIS

The Torque Converter Clutch (TCC) system has different operating characteristics than an automatic transmission without TCC. If the driver complains of a "chuggle" or "surge" condition, the car should be road tested and compared to a similar car to see if a real problem exists. Another TCC complaint may be a downshift felt when going up a grade, especially with cruise control. This may not be a downshift, but a torque converter clutch disengagement due to the change in TPS to maintain cruising speed. The Owner's Manual section on TCC operation should be reviewed with the driver.

The diagnosis of the TCC system is covered in CHART C-8. If the ECM detects a problem in the Vehicle Speed Sensor (VSS) system, a Code 24 should set. In this case see Code 24 Chart.

If the ECM doesn't switch the TCC "ON" when driving, but will turn it "ON" when the diagnostic "test" terminal is grounded with ignition "ON" and engine stopped, the sensors such as coolant, vehicle speed, and throttle position should be checked.

ON-VEHICLE SERVICE

- See TRANSMISSION (SECTION 7) for TCC Solenoid.
- See ELECTRICAL DIAGNOSIS (SECTION 8A) for Vehicle Speed Sensor (VSS) and brake electrical system.

PARTS INFORMATION

PART NAME	GROUP
Sensor, VSS	3.682
Solenoid, TCC	4.122

TORQUE SPECIFICATIONS

VSS Retainer Bolt to	10 N·m (89 lb. in.)

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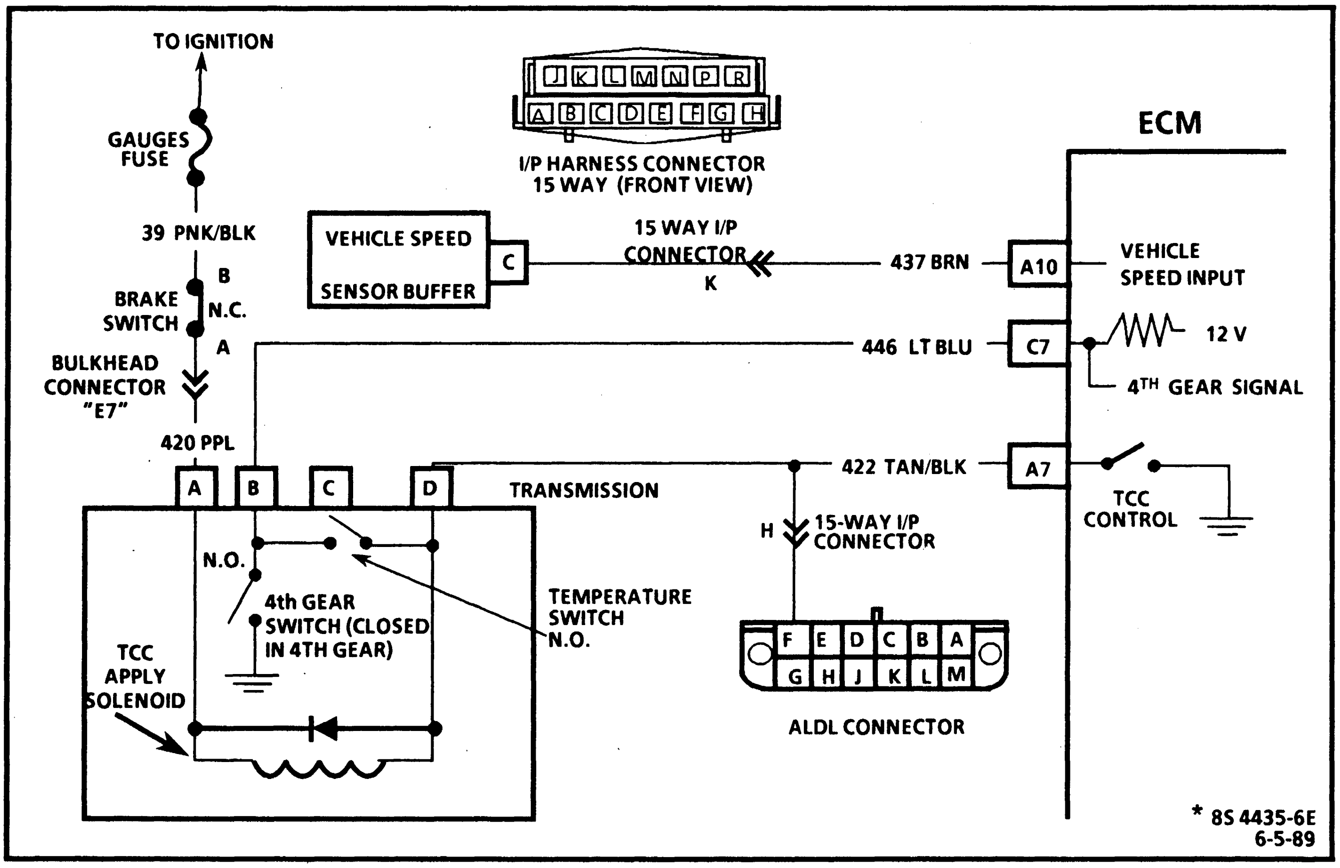


CHART C-8A

(Page 1 of 2)

TORQUE CONVERTER CLUTCH (TCC) SYSTEM

(ELECTRICAL DIAGNOSIS)

5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

The purpose of the automatic transmission Torque Converter Clutch (TCC) is to eliminate the power loss of the torque converter when the vehicle is in a cruise condition. This allows the convenience of the automatic transmission and the fuel economy of a manual transmission.

Fused battery ignition voltage is supplied to the TCC solenoid through the brake switch, the ECM will engage TCC by grounding CKT 422 to energize the TCC solenoid.

TCC will engage when:

- Vehicle speed above 24 mph
- Engine at normal operating temperature (above 70°C/156°F)
- Throttle position sensor output not changing, indicating a steady road speed
- Brake switch closed

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Confirms 12 volt supply as well as continuity of TCC circuit.
2. Grounding the diagnostic "test" terminal with engine "OFF," should energize the capability of the ECM to control the TCC solenoid.
3. TCC solenoid coil resistance must measure more than 20 ohms. Less resistance will cause early failure of the ECM "Driver." Using an ohmmeter, check the solenoid coil resistance of all ECM controlled solenoids and relays before installing a replacement ECM. Replace any solenoid or relay that measures less than 20 ohms.

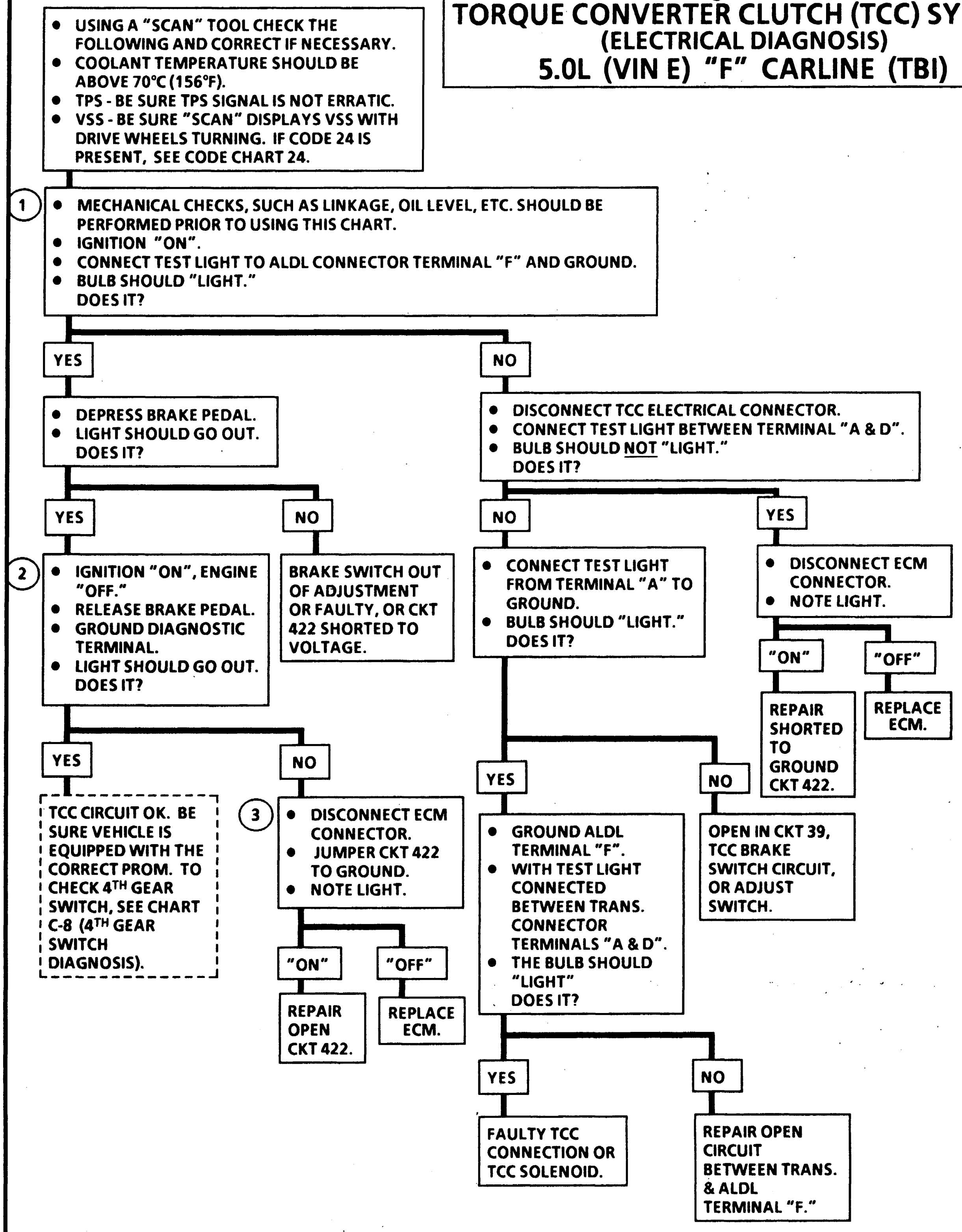
Diagnostic Aids:

An engine coolant thermostat that is stuck open or opens at too low a temperature may result in an inoperative TCC.

CHART C-8A

(Page 1 of 2)

TORQUE CONVERTER CLUTCH (TCC) SYSTEM
(ELECTRICAL DIAGNOSIS)
5.0L (VIN E) "F" CARLINE (TBI)



- USING A "SCAN" TOOL CHECK THE FOLLOWING AND CORRECT IF NECESSARY.
- COOLANT TEMPERATURE SHOULD BE ABOVE 70°C (156°F).
- TPS - BE SURE TPS SIGNAL IS NOT ERRATIC.
- VSS - BE SURE "SCAN" DISPLAYS VSS WITH DRIVE WHEELS TURNING. IF CODE 24 IS PRESENT, SEE CODE CHART 24.

①
- MECHANICAL CHECKS, SUCH AS LINKAGE, OIL LEVEL, ETC. SHOULD BE PERFORMED PRIOR TO USING THIS CHART.
- IGNITION "ON".
- CONNECT TEST LIGHT TO ALDL CONNECTOR TERMINAL "F" AND GROUND.
- BULB SHOULD "LIGHT."

DOES IT?

YES

- DEPRESS BRAKE PEDAL.
- LIGHT SHOULD GO OUT.

DOES IT?

YES

②
- IGNITION "ON", ENGINE "OFF."
- RELEASE BRAKE PEDAL.
- GROUND DIAGNOSTIC TERMINAL.
- LIGHT SHOULD GO OUT.

DOES IT?

YES

TCC CIRCUIT OK. BE SURE VEHICLE IS EQUIPPED WITH THE CORRECT PROM. TO CHECK 4TH GEAR SWITCH, SEE CHART C-8 (4TH GEAR SWITCH DIAGNOSIS).

NO

③
- DISCONNECT ECM CONNECTOR.
- JUMPER CKT 422 TO GROUND.
- NOTE LIGHT.

"ON"

REPAIR OPEN CKT 422.

"OFF"

REPLACE ECM.

NO

BRAKE SWITCH OUT OF ADJUSTMENT OR FAULTY, OR CKT 422 SHORTED TO VOLTAGE.

NO

- DISCONNECT TCC ELECTRICAL CONNECTOR.
- CONNECT TEST LIGHT BETWEEN TERMINAL "A & D".
- BULB SHOULD NOT "LIGHT."

DOES IT?

NO

- CONNECT TEST LIGHT FROM TERMINAL "A" TO GROUND.
- BULB SHOULD "LIGHT."

DOES IT?

YES

- GROUND ALDL TERMINAL "F".
- WITH TEST LIGHT CONNECTED BETWEEN TRANS. CONNECTOR TERMINALS "A & D".
- THE BULB SHOULD "LIGHT"

DOES IT?

YES

FAULTY TCC CONNECTION OR TCC SOLENOID.

NO

REPAIR OPEN CIRCUIT BETWEEN TRANS. & ALDL TERMINAL "F."

NO

OPEN IN CKT 39, TCC BRAKE SWITCH CIRCUIT, OR ADJUST SWITCH.

YES

- DISCONNECT ECM CONNECTOR.
- NOTE LIGHT.

"ON"

REPAIR SHORTED TO GROUND CKT 422.

"OFF"

REPLACE ECM.

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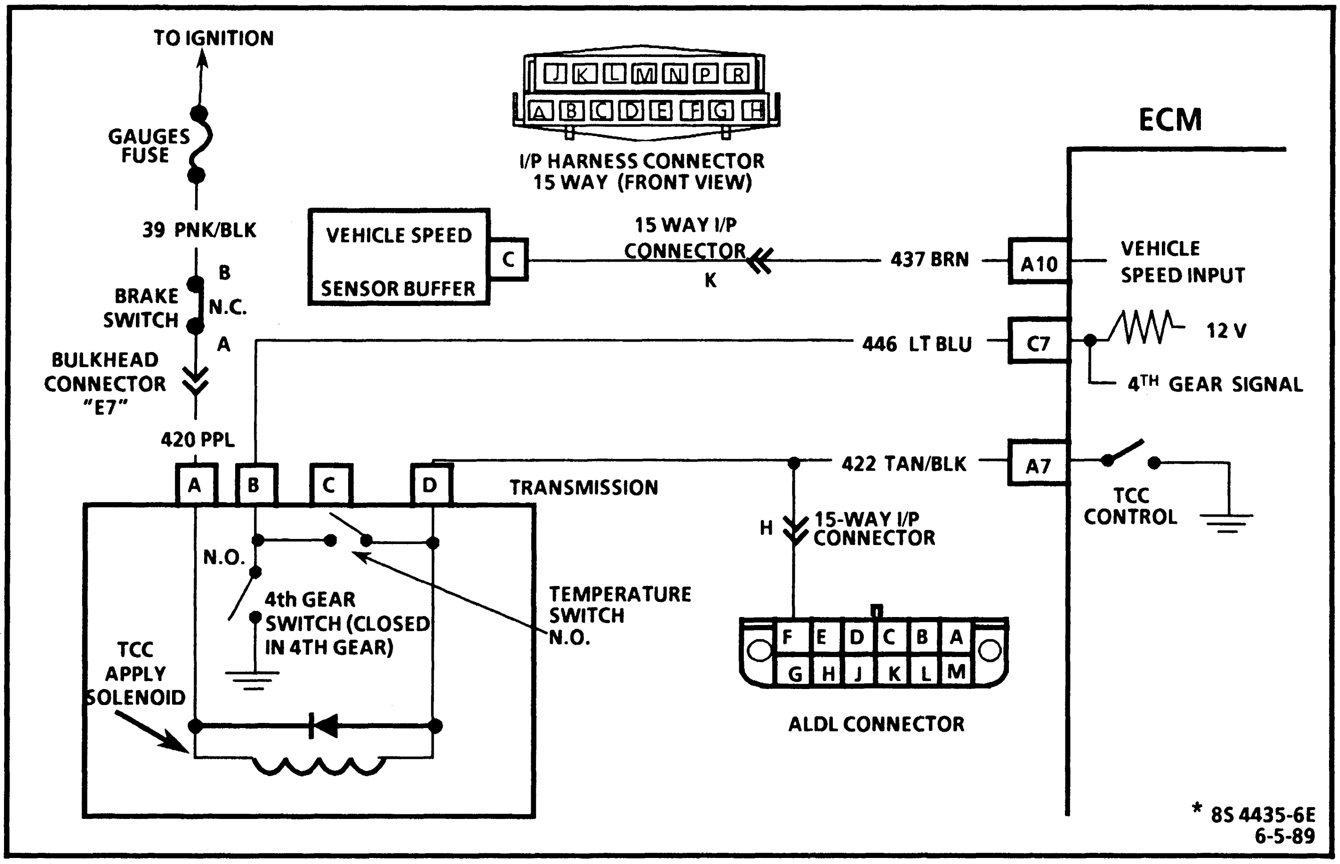


CHART C-8A

(Page 2 of 2)

TORQUE CONVERTER CLUTCH (TCC) SYSTEM
(4th GEAR SWITCH DIAGNOSIS)
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

A 4th gear switch (mounted in the transmission) is normally open and closes when the transmission shifts into 4th gear. This switch is used by the ECM to modify TCC lock and unlock points, when in a 4-3 downshift maneuver.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Unless the switch is stuck closed or CKT 446 is shorted to ground, the "Scan" tool should display "NO," indicating the transmission is not in 4th gear. The 4th gear switch should only be closed while in 4th gear.
2. Checks the operation of the 4th gear switch. When the transmission shifts into 4th gear the switch should close and the "Scan" tool should display "YES."
3. Disconnecting the TCC connector simulates an open switch to determine if CKT 446 is shorted to ground or the problem is in the transmission.
4. This step determines if the ECM and wiring are OK. Grounding CKT 446 should cause the "Scan" tool to display "YES," indicating the transmission is in 4th gear.

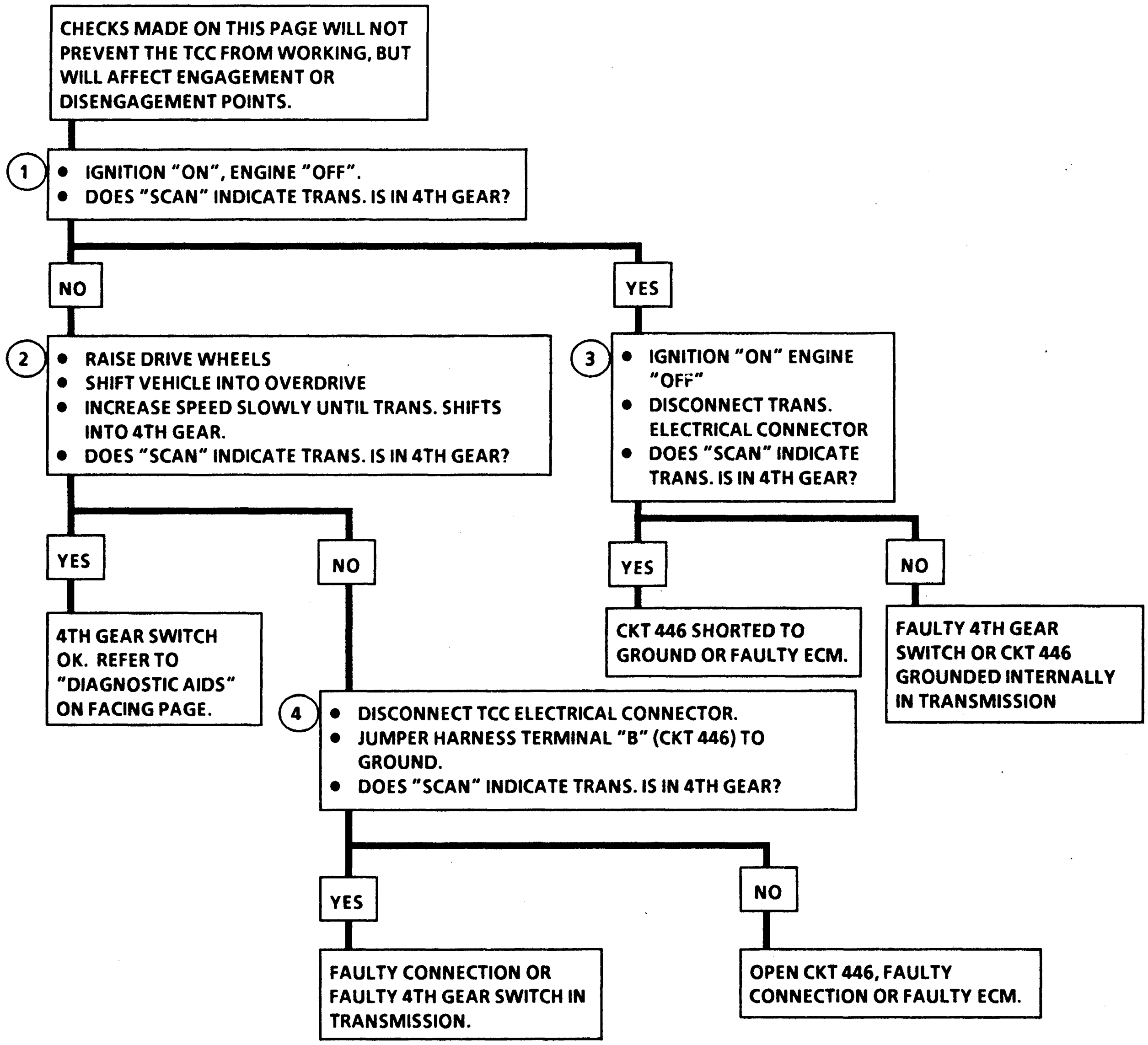
Diagnostic Aids:

A road test may be necessary to verify the customer complaint. If the "Scan" indicates TCC is turning "ON" and "OFF" erratically, check the state of the 4th gear switch to be sure it is not changing states under a steady throttle position. If the switch is changing states, check connections and wire routing carefully. Also if the 4th gear switch is always closed the TCC may engage as soon as sufficient oil pressure is reached.

CHART C-8A

(Page 2 of 2)

TORQUE CONVERTER CLUTCH (TCC) SYSTEM
(4th GEAR SWITCH DIAGNOSIS)
5.0L (VIN E) "F" CARLINE (TBI)



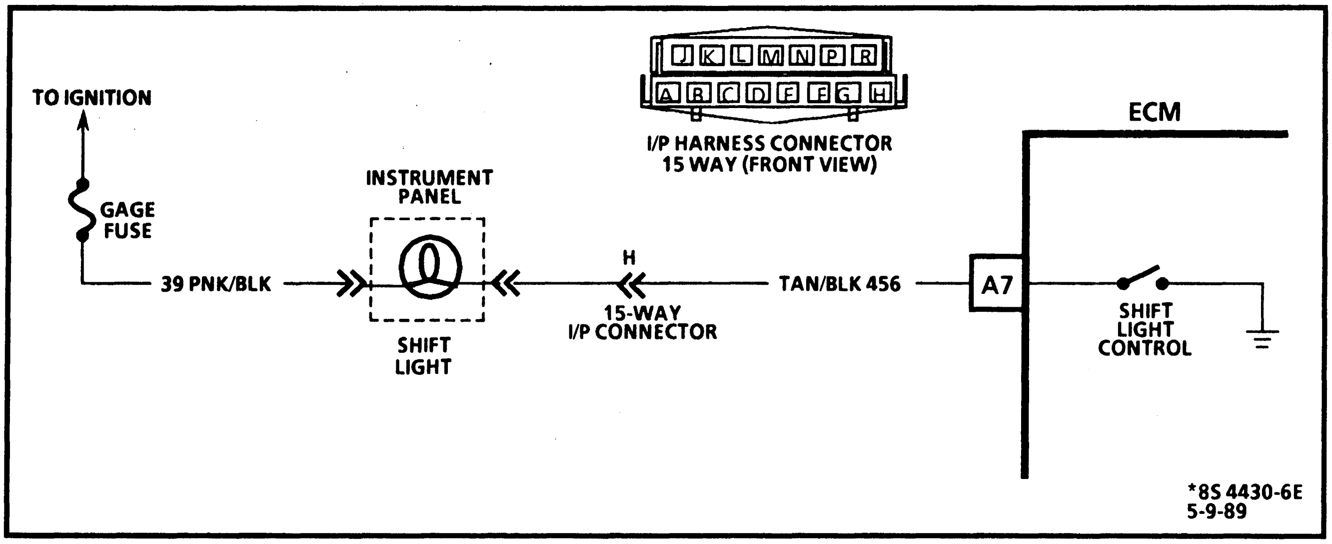


CHART C-8B

MANUAL TRANSMISSION (M/T) SHIFT LIGHT CHECK
5.0L (VIN E) "F" CARLINE (TBI)

Circuit Description:

The shift light indicates the best transmission shift point for maximum fuel economy. The shift light is controlled by the ECM and is turned "ON" by grounding CKT 456.

The ECM uses information from the following inputs to control the shift light:

- Coolant Temperature Sensor (CTS)
- Throttle Position Sensor (CTS)
- Vehicle Speed Sensor (VSS)
- RPM

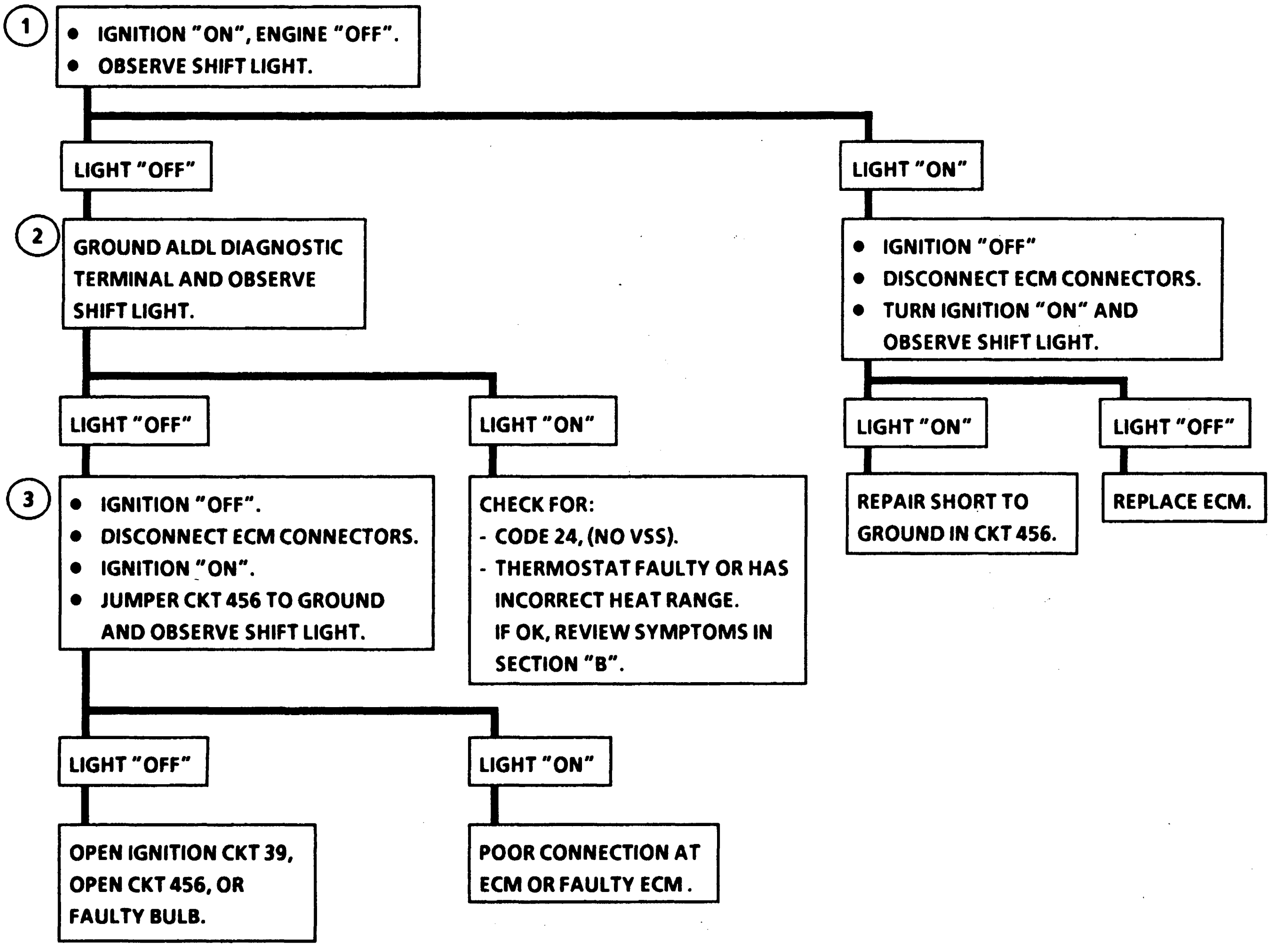
The ECM uses the measured rpm and the vehicle speed to calculate what gear the vehicle is in. It is this calculation that determines when the shift light should be turned "ON."

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. This should not turn "ON" the shift light. If the light is "ON," there is a short to ground in CKT 456 wiring, or a fault in the ECM.
2. When the diagnostic "test" terminal is grounded, the ECM should ground CKT 456, and the shift light should come "ON."
3. This checks the shift light circuit up to the ECM connector. If the shift light illuminates, then the ECM connector is faulty, or the ECM does not have the ability to ground the circuit.

CHART C-8B

MANUAL TRANSMISSION (M/T) SHIFT LIGHT CHECK 5.0L (VIN E) "F" CARLINE (TBI)



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SECTION C13

POSITIVE CRANKCASE VENTILATION (PCV)

CONTENTS

GENERAL DESCRIPTION

A Positive Crankcase Ventilation (PCV) system is used to consume crankcase vapors in the combustion process instead of venting to atmosphere. Fresh air from the air cleaner is supplied to the crankcase, mixed with blow-by gases and then passed through a Positive Crankcase Ventilation (PCV) valve into the intake manifold (Figure C13-2).

The primary control is through the PCV valve which meters the flow at a rate depending on manifold vacuum.

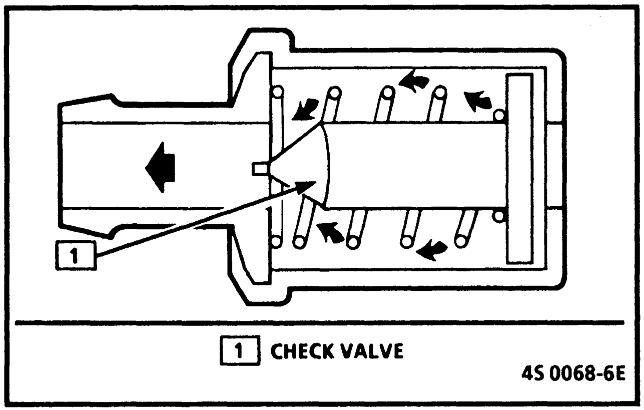

Figure C13-1 - PCV Valve Cross Section

To maintain idle quality, the PCV valve restricts the flow when intake manifold vacuum is high. If abnormal operating conditions arise, the system is designed to allow excessive amounts of blow-by gases to back flow through the crankcase vent tube into the air cleaner to be consumed by normal combustion.

- A leaking valve or hose would cause:
  - Rough idle
  - Stalling
  - High idle speed

DIAGNOSIS

FUNCTIONAL CHECK OF PCV VALVE

If an engine is idling rough, check for a clogged PCV valve or plugged hose. Replace as required. Use the following procedure:

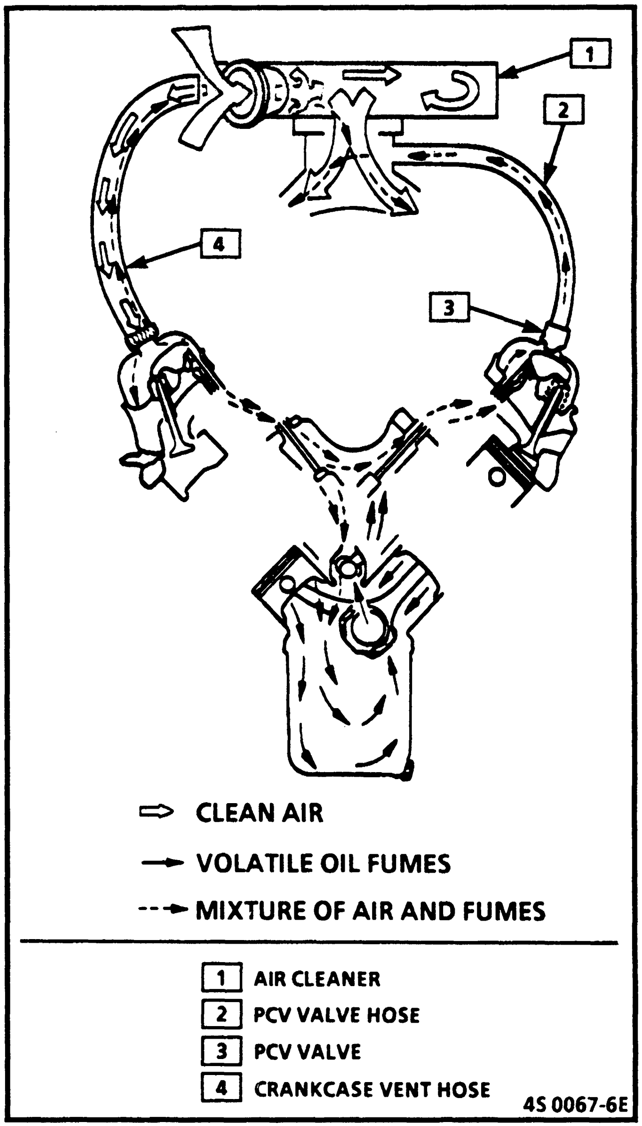

Figure C13-2 - PCV-Flow

1. Remove PCV valve from rocker arm cover.
2. Run the engine at idle.
3. Place your thumb over end of valve to check for vacuum. If there is no vacuum at valve, check for plugged hoses or manifold port, or PCV valve. Replace plugged or deteriorated hoses.

4. Turn "OFF" the engine and remove PCV valve. Shake valve and listen for the rattle of check needle inside the valve. If valve does not rattle, replace valve.

With this system, any blow-by in excess of the system capacity (from a badly-worn engine, sustained heavy load, etc.) is exhausted into the air cleaner and is drawn into the engine.

Proper operation of the PCV System is dependent upon a sealed engine. If oil sludging or dilution is noted, and the PCV System is functioning properly, check engine for possible cause and correct to ensure that system will function as intended.

FUNCTIONAL CHECK OF PCV VALVE SYSTEM

1. Check PCV Valve for correct application.
2. Engine at normal operating temperature.
3. Block off PCV system fresh air intake passage.
4. Remove engine oil dipstick and install a vacuum gage on dipstick tube.
5. Run engine at 1500 rpm for 30 seconds the read vacuum gage while at 1500 rpm.

   If a vacuum is present, the PCV system is functioning properly.

   No vacuum indicates the engine may not be sealed and/or is drawing in outside air. Check valve cover, oil pan gasket for leaks.

   If the vacuum gage registers a pressure or the vacuum gage is pushed out of the dipstick tube, check for the correct PCV valve, a plugged hose or excessive engine blow-by.

With this system, any blow-by in excess of the system capacity (from a badly-worn engine, sustained heavy load, etc.) is exhausted into the intake manifold and is drawn into the engine.

RESULTS OF INCORRECT PCV OPERATION

- A plugged valve or hose may cause:
  - Rough idle
  - Stalling or slow idle speed
  - Oil leaks
  - Oil in air cleaner
  - Sludge in engine

ON-VEHICLE SERVICE

An engine which is operated without any crankcase ventilation can be damaged. Therefore, it is important to replace the PCV valve and air cleaner breather at intervals shown in Section "0B".

Periodically, inspect the hoses and clamps and replace any showing signs of deterioration.

PARTS INFORMATION

PART NAME	GROUP
Air Cleaner	3.402
Valve Asm, C/Case Vent	1.745
Grommet,C/Case Vent	1.745
Pipe, C/Case Vent	1.762
Hose, Vent (3/4")	8.962

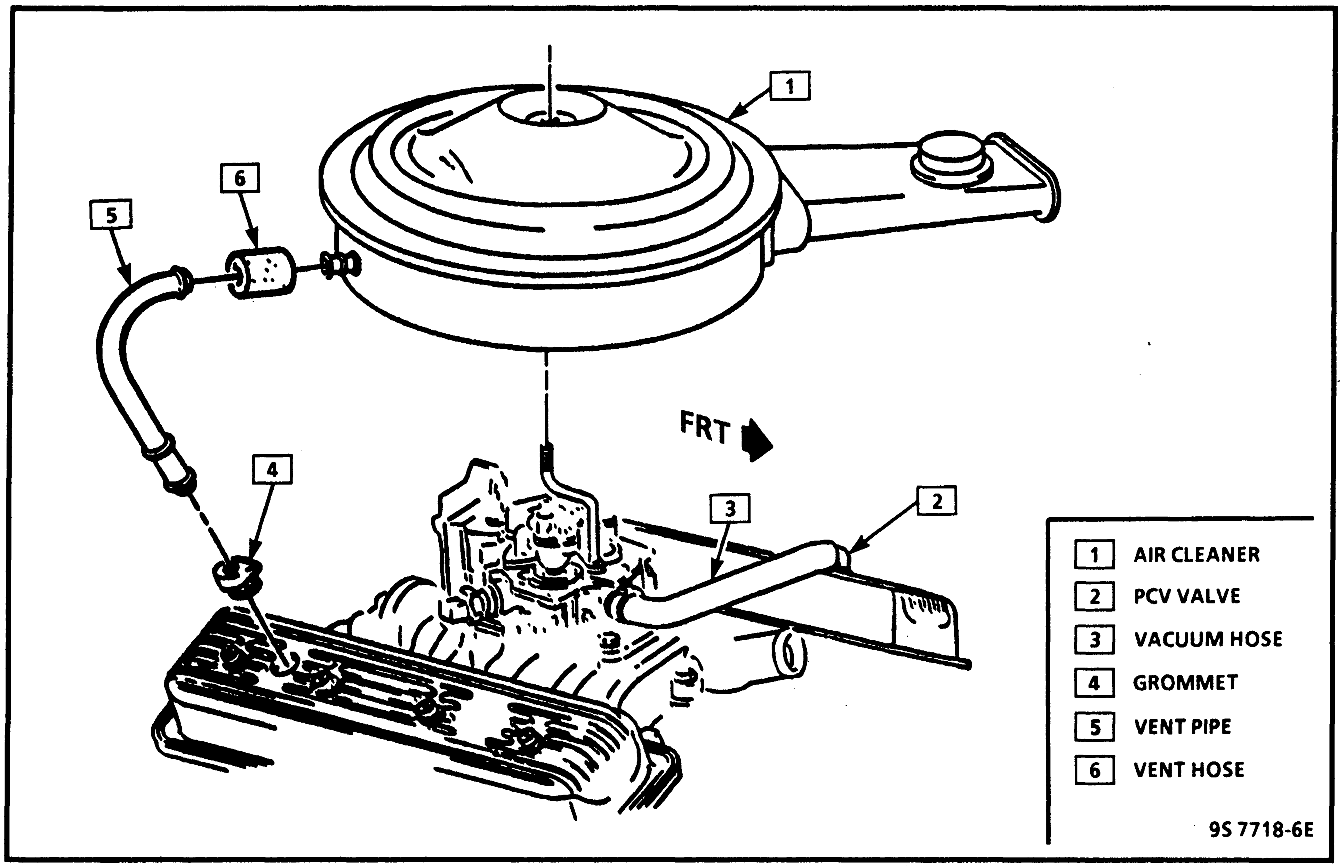

Figure C13-3 - Positive Crankcase Ventilation (PCV) System

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SECTION C14

THERMOSTATIC AIR CLEANER (THERMAC)

CONTENTS

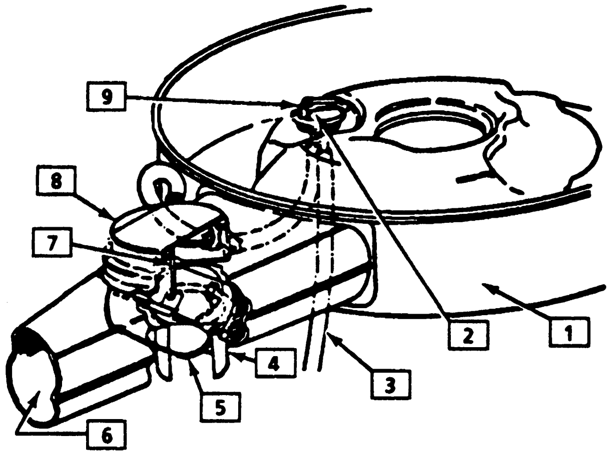
GENERAL DESCRIPTION

PURPOSE

A heated intake air system is used to give good driveability under varying climatic conditions. By having a uniform inlet air temperature, the fuel system can be calibrated to reduce exhaust emissions and to eliminate throttle valve icing.

OPERATION

The THERMAC air cleaner operates by heated air and manifold vacuum (Figure C14-1). Air can enter the air cleaner from outside the engine compartment or from a heat stove built around the exhaust manifold. A vacuum diaphragm motor, built into the air cleaner snorkel, moves a damper door, to admit hot air from the exhaust manifold, outside air, or a combination of both. Inside the air cleaner is a temperature sensor that reacts to air intake temperature and controls the amount of vacuum going to the motor.



1 AIR CLEANER ASSEMBLY
2 AIR BLEED VALVE
3 VACUUM HOSE (TO MANIFOLD VACUUM)
4 HEAT STOVE DUCT
5 DAMPER DOOR
6 SNORKEL
7 LINKAGE
8 VACUUM DIAPHRAGM MOTOR
9 TEMPERATURE SENSOR

Figure C14-1 - THERMAC Air Cleaner - Typical

- Hot Air Delivery Mode - When the temperature is below 30°C (86°F), the sensor allows vacuum to the motor and the damper door will shut "OFF" outside air and allowing only heated air from the exhaust manifold to enter the air cleaner.
- Outside Air Delivery Mode - When the temperature is above 55°C (131°F), the damper door drops down and only outside air enters the air cleaner.
- Regulating Mode - Between 30°C (86°F) and 55°C (131°F) the damper door allows both heated and outside air to enter the air cleaner.

DIAGNOSIS

RESULTS OF INCORRECT THERMAC OPERATION

Hesitation during warm-up can be caused by:

- Heat stove tube disconnected.
- Vacuum diaphragm motor inoperative (open to snorkel).
- No manifold vacuum.
- Damper door does not move.
- Missing air cleaner to carburetor seal.
- Missing air cleaner cover seal or loose cover.
- Loose air cleaner.

Lack of power, sluggish, spongy or detonation on a hot engine can be caused by:

- Damper door does not open to outside air.
- Temperature sensor doesn't bleed off vacuum.

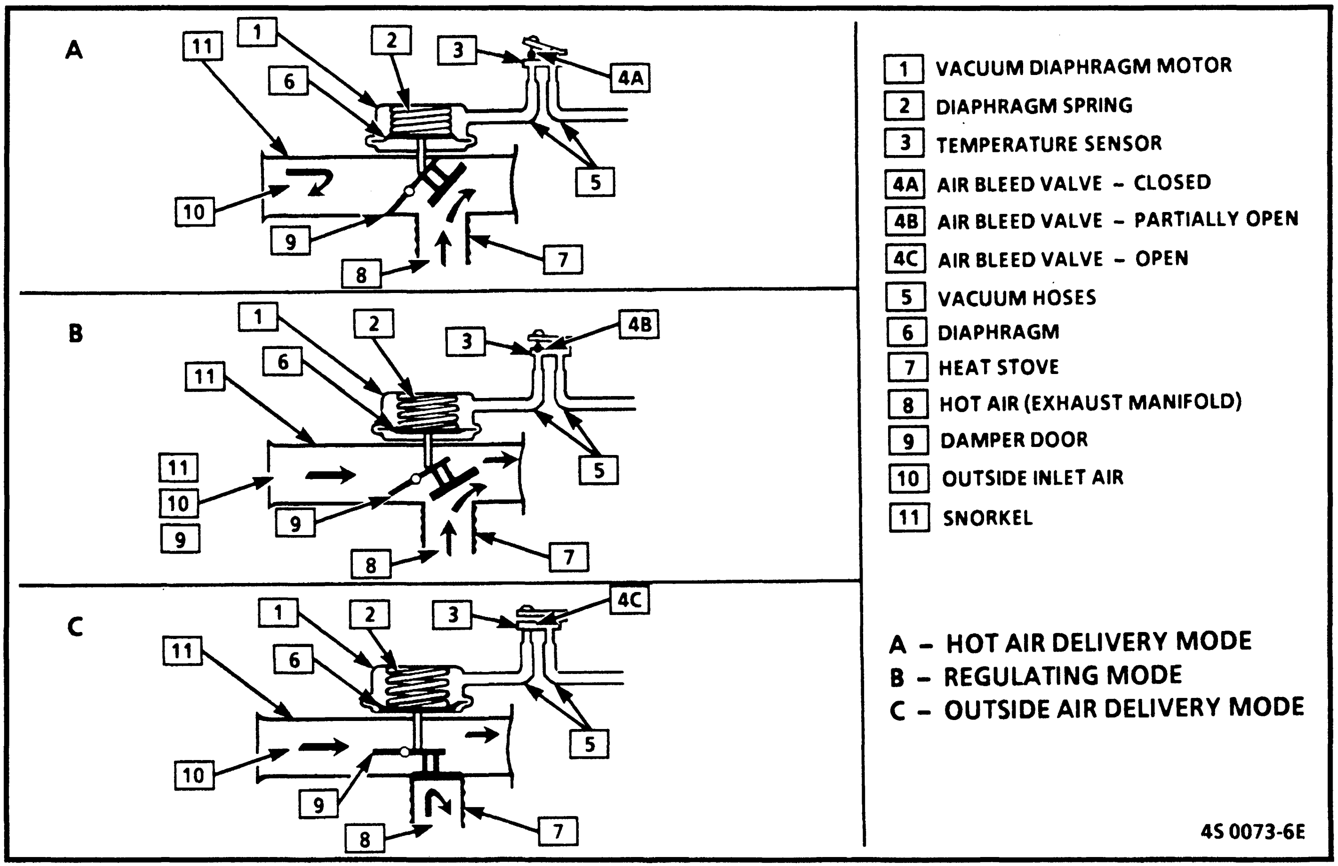


Figure C14-2 - Thermac Operation

THERMAC AIR CLEANER CHECK

1. Inspect system to be sure all hoses and heat stove tube are connected. Check for kinked, plugged or deteriorated hoses.
2. Check for presence and condition of air cleaner to carburetor gasket seal.
3. With air cleaner assembly installed, damper door should be open to outside air, with engine "OFF."
4. Start engine. Watch damper door in air cleaner snorkel. When engine is first started, damper door should move and close off outside air.
   As temperature in air cleaner warms up, damper door should open slowly to outside air in.
5. If the damper door fails to operate as described above, perform vacuum diaphragm motor check.If it operates, the door may not be moving at the right temperature. If the driveability problem is during warm-up, perform the temperature sensor check.

VACUUM DIAPHRAGM MOTOR CHECK

1. With engine "OFF," disconnect vacuum hose at vacuum diaphragm motor.
2. Apply at least 23 kPa (7" Hg.) of vacuum to the vacuum diaphragm motor. Damper door should close and completely block off to outside air when vacuum is applied. If not, check to see if linkage is hooked up correctly.
3. With vacuum still applied, trap vacuum in vacuum diaphragm motor by bending hose.
   Damper door should remain closed. If not, replace vacuum diaphragm motor assembly. (Failure of the vacuum diaphragm motor assembly is more likely to be caused from binding linkage or a corroded snorkel than from a failed diaphragm. This should be checked first, before replacing the diaphragm.)
4. If vacuum motor checks OK, check vacuum hoses and connections. If OK, replace the temperature sensor.

TEMPERATURE SENSOR CHECK

1. Start test with air cleaner temperature below 30°C (86°F). If engine has been run recently, remove air cleaner cover and place thermometer as close as possible to the sensor. Let air cleaner cool until thermometer reads below 30°C (86°F) about 5 to 10 minutes. Reinstall air cleaner on engine and continue to Step 2.
2. Start and idle engine. Damper door should move to close off outside air immediately if engine is cool enough. When damper door starts to open the snorkel passage (in a few minutes), remove air cleaner cover and read thermometer. It must read about 55°C (131°F).
3. If the damper door is not open to outside air at temperature indicated, temperature sensor is malfunctioning and must be replaced.

ON-VEHICLE SERVICE

AIR CLEANER ELEMENT

Remove or Disconnect

1. Air cleaner cover.
2. Old element.

Install or Connect

1. New element.
2. Air cleaner cover. Do not over-torque nuts (install finger- tight).

VACUUM DIAPHRAGM MOTOR

Remove or Disconnect

1. Air cleaner assembly.
2. Vacuum hose from motor.
3. Drill out the two spot welds initially with a 1.6 mm (1/16") drill, then enlarge as required to remove the retaining strap. Do not damage the snorkel tube.
4. Motor retaining strap.
5. Lift up motor, cocking it to one side to unhook the motor linkage at the control damper assembly.

Install or Connect

1. Drill a 2.8mm (7/64") hole in snorkel tube at center of vacuum motor retaining strap.
2. Vacuum motor linkage into control damper assembly.
3. Use the motor retaining strap and sheet metal screw provided in the motor service package to secure motor to the snorkel tube. Make sure the screw does not interfere with the operation of the damper assembly. Shorten screw if required.
4. Vacuum hose to motor and install air cleaner.

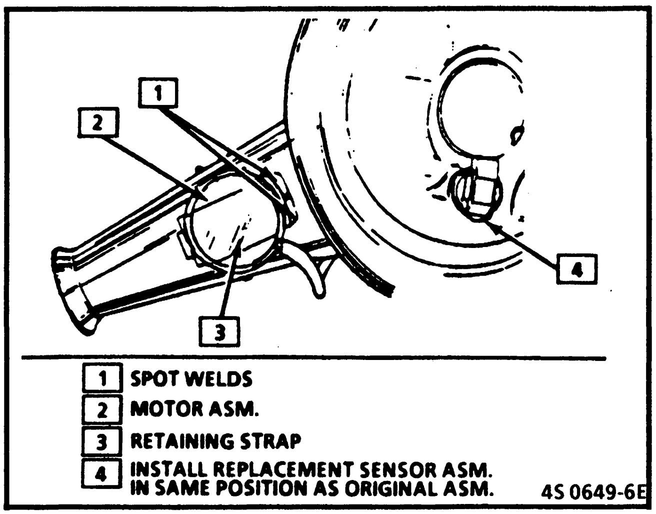


Figure C14-3 - Replacing THERMAC Vacuum Motor

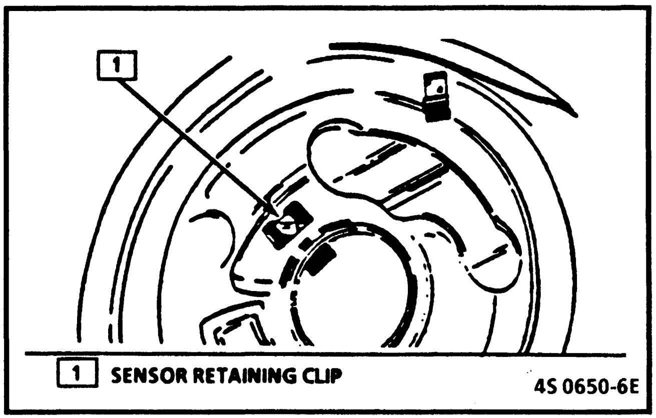


Figure C14-4 - Replacing THERMAC Temperature Sensor

TEMPERATURE SENSOR

Remove or Disconnect

1. Air cleaner assembly.
2. Hoses at temperature sensor.
3. Pry up tabs on temperature sensor retaining clip. Remove clip and temperature sensor from air cleaner. Note position of temperature sensor for installation.

Install or Connect

1. Temperature sensor and gasket assembly in original position.
2. Retainer clip on hose connectors.
3. Vacuum hoses and air cleaner on engine.

PARTS INFORMATION

PART NAME	GROUP
Sensor, A/C	3.415
Motor, A/C Vac Diaph	3.415

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SECTION 6E3

DRIVEABILITY AND EMISSIONS
FUEL INJECTION (PORT)

THIS SECTION APPLIES TO:

3.1L (VIN T) "F" CARLINE

5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed, If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts of system damage could result.

CONTENTS

3.1L (VIN T) "F" CARLINE

5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE

ALL NEW GENERAL MOTORS VEHICLES ARE CERTIFIED BY THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY AS CONFORMING TO THE REQUIREMENTS OF THE REGULATIONS FOR THE CONTROL OF AIR POLLUTION FROM NEW MOTOR VEHICLES. THIS CERTIFICATION IS CONTINGENT ON CERTAIN ADJUSTMENTS BEING SET TO FACTORY STANDARDS. IN MOST CASES, THESE ADJUSTMENT POINTS EITHER HAVE BEEN PERMANENTLY SEALED AND/OR MADE INACCESSIBLE TO PREVENT INDISCRIMINATE OR ROUTINE ADJUSTMENT IN THE FIELD. FOR THIS REASON, THE FACTORY PROCEDURE FOR TEMPORARILY REMOVING PLUGS, CAPS, ETC., FOR PURPOSES OF SERVICING THE PRODUCT, MUST BE STRICTLY FOLLOWED AND, WHEREVER PRACTICABLE, RETURNED TO THE ORIGINAL INTENT OF THE DESIGN.

INTRODUCTION

GENERAL DESCRIPTION

This section applies to engines which have a fuel injector in the intake manifold near the intake valve for each cylinder. It is commonly referred to as "Port Fuel Injection".

These engines have controls to reduce exhaust emissions, while maintaining good driveability and fuel economy.

An Engine Control Module (ECM) is the heart of this control system and has sensors used to provide information about engine operation and the various systems it controls. Details of basic operation, diagnosis, functional checks, and on-vehicle service are covered in Section "C", "Component Systems".

The ECM has the ability to do some diagnosis of itself, and of other parts of the system. When it finds a problem, it lights a "Service Engine Soon" Light on the instrument panel and a trouble code will be stored in the ECM memory. This does not mean that the engine should be stopped right away, but that the cause of the light coming "ON" should be checked as soon as reasonably possible.

DIAGNOSIS PROCEDURE

The following sections(s) are written for specific engine applications and are clearly identified. Be sure to use only the section which applies to the engine family being diagnosed.

Before using this section of the manual, you should be familiar with the information and the proper diagnosing procedures as described in Section "6E". If the proper diagnosis procedures are not followed, as described in Section "6E", it may result in unnecessary replacement of good parts.

Trouble Tree Charts incorporate diagnosis procedures using an ALDL "Scan" tool, where possible. The "Scan" tool has the ability to save time in diagnosis and prevent the replacement of good parts. **The key to using the "Scan" tool successfully for diagnosis lies in the technician's ability to understand the system he is trying to diagnose, as well as an understanding of the "Scan" tool's limitations. See Section "6E" for more information.**

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SECTION A
3.1L ENGINE

BASIC PROCEDURE

If you have not reviewed the basic information on how to use the diagnostic procedures, go to the "Introduction" of this section. The facing page of each chart in this section will provide a general circuit description and in some instances, alternate diagnostic steps or other diagnostic aids specific to that chart or circuit.

DIAGNOSTIC CIRCUIT CHECK

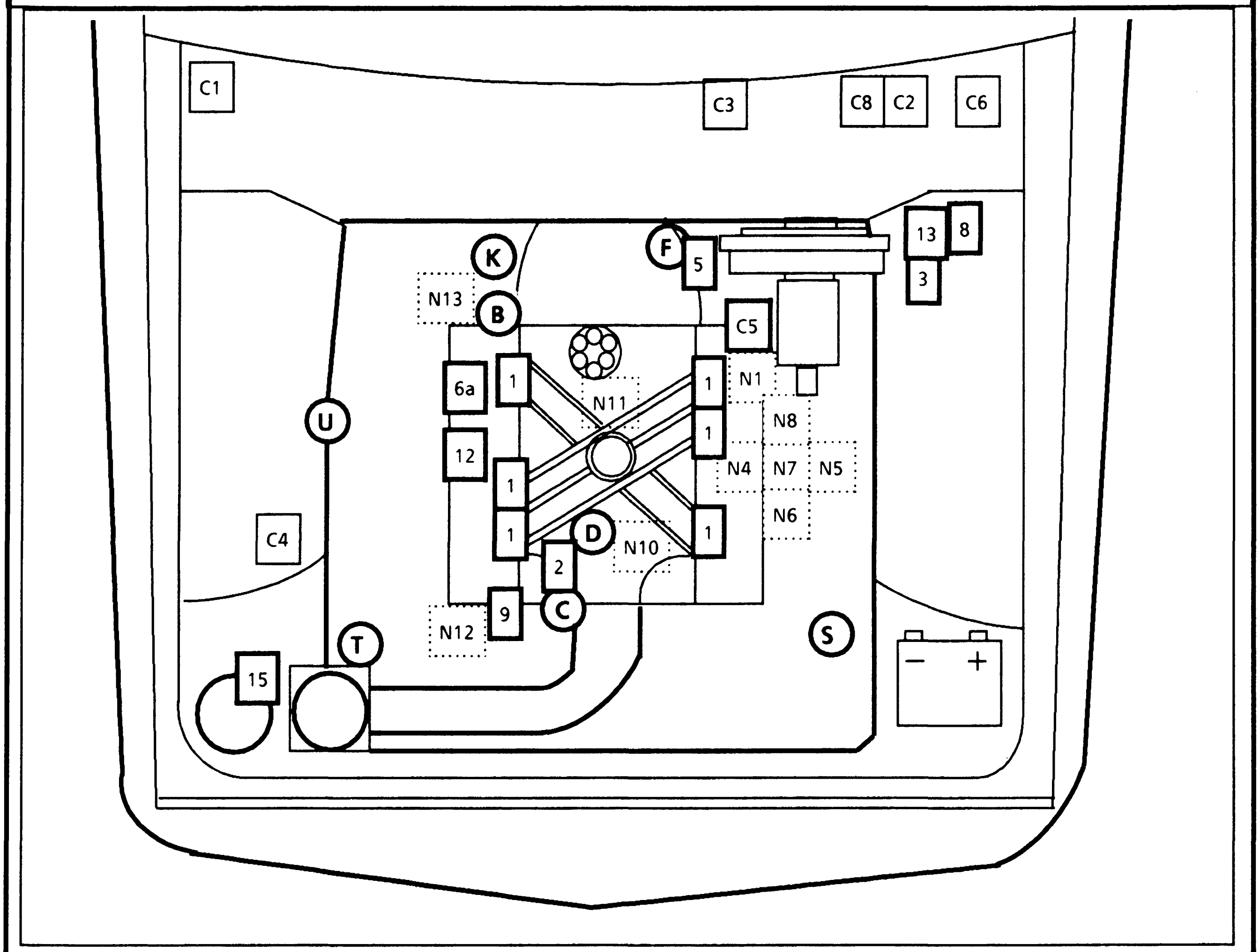
The diagnostic circuit check verifies the system is functioning correctly and is the starting point for diagnosing. Some special considerations to keep in mind when diagnosing are:

Blocking Drive Wheels

The vehicle drive wheels should always be blocked and the emergency brake set while checking the system.

SECTION A
ENGINE COMPONENTS / WIRING DIAGRAMS / DIAGNOSTIC CHARTS

'F' CARLINE RPO:LHO VIN CODE:T 3.1L V6 PFI



☐ COMPUTER HARNESS

- C1 Electronic Control Module (ECM)
- C2 ALDL diagnostic connector
- C3 "SERVICE ENGINE SOON" light
- C4 ECM power/fuel pump fuse
- C5 ECM harness ground
- C6 Fuse panel
- C8 Fuel pump test connector (ALDL "G")

NOT ECM CONNECTED

- ⬚ Crankcase vent valve (PCV)
- N4 Engine temp. switch (telltale)
- N5 Engine temp. sensor (gage)
- N6 Oil press. switch (telltale)
- N7 Oil press. sensor (gage)
- N8 Oil press. switch (fuel pump)
- N10 Cold start fuel injection switch
- N11 Cold start valve
- N12 Deceleration Valve (M/T only)
- N13 Fan Override Switch

☐ CONTROLLED DEVICES

- 1 Fuel injector
- 2 Idle air control motor
- 3 Fuel pump relay
- 5 Trans. Conv. Clutch connector
- 6a Remote ignition coil
- 8 Engine coolant fan relay
- 9 Air control solenoid (M.T. only)
- 12 Exhaust Gas Recirculation valve
- 13 A/C compressor relay
- 15 Fuel vapor canister solenoid

○ INFORMATION SENSORS

- B Exhaust oxygen sensor
- C Throttle position sensor
- D Coolant Temperature sensor
- F Vehicle speed sensor
- K Manifold absolute pressure sensor
- S Power steering pressure switch
- T Manifold Air Temperature sensor
- U A/C pressure fan switch

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5S 2127-6E

Figure A-1 - Engine Component Locations 3.1L (VIN T) "F" Carline

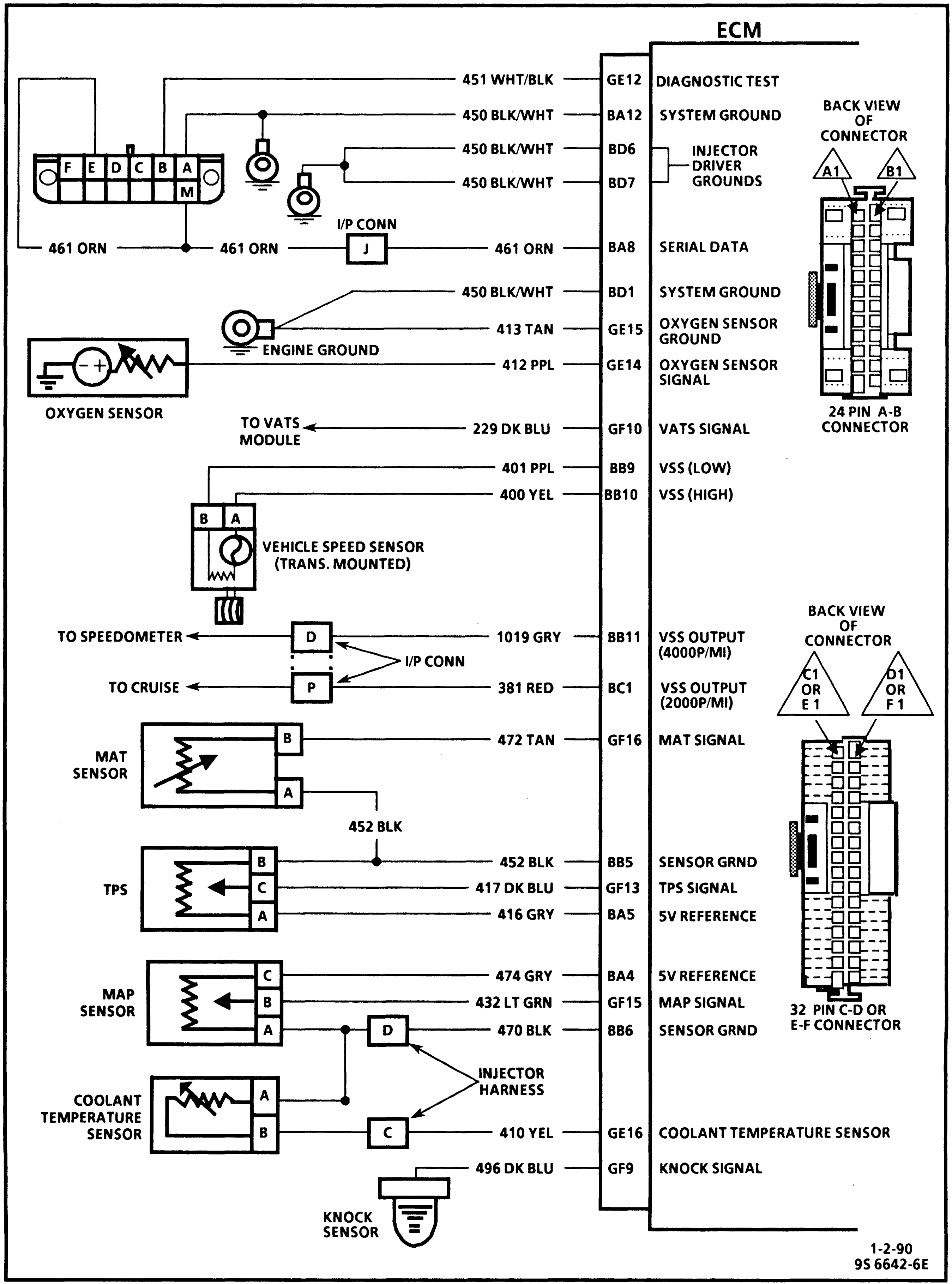

Figure A-2 - ECM Wiring Diagram 3.1L (VIN T) "F" Carline (1 of 3)

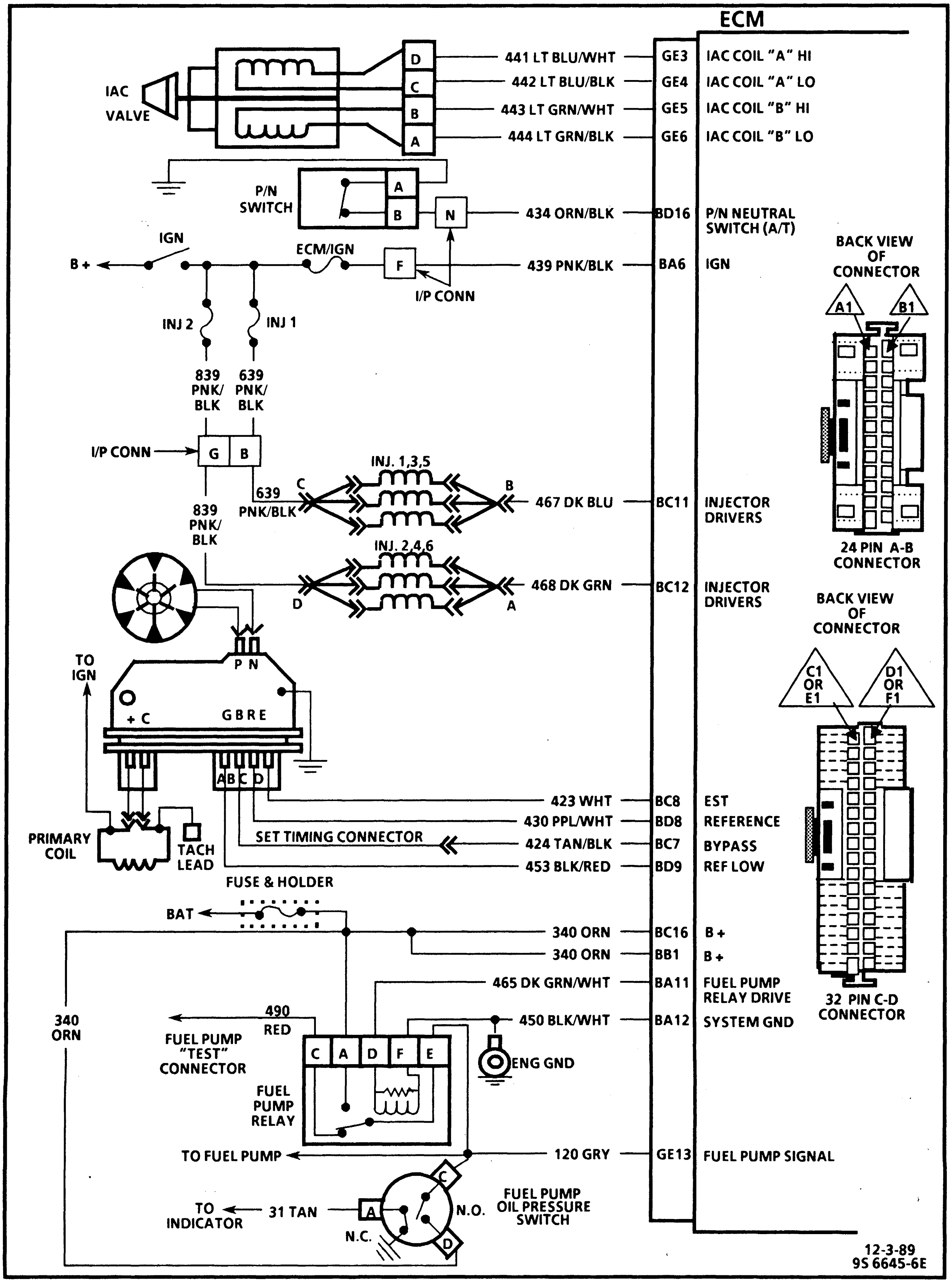

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Figure A-3 - ECM Wiring Diagram 3.1L (VIN T) "F" Carline (2 of 3)

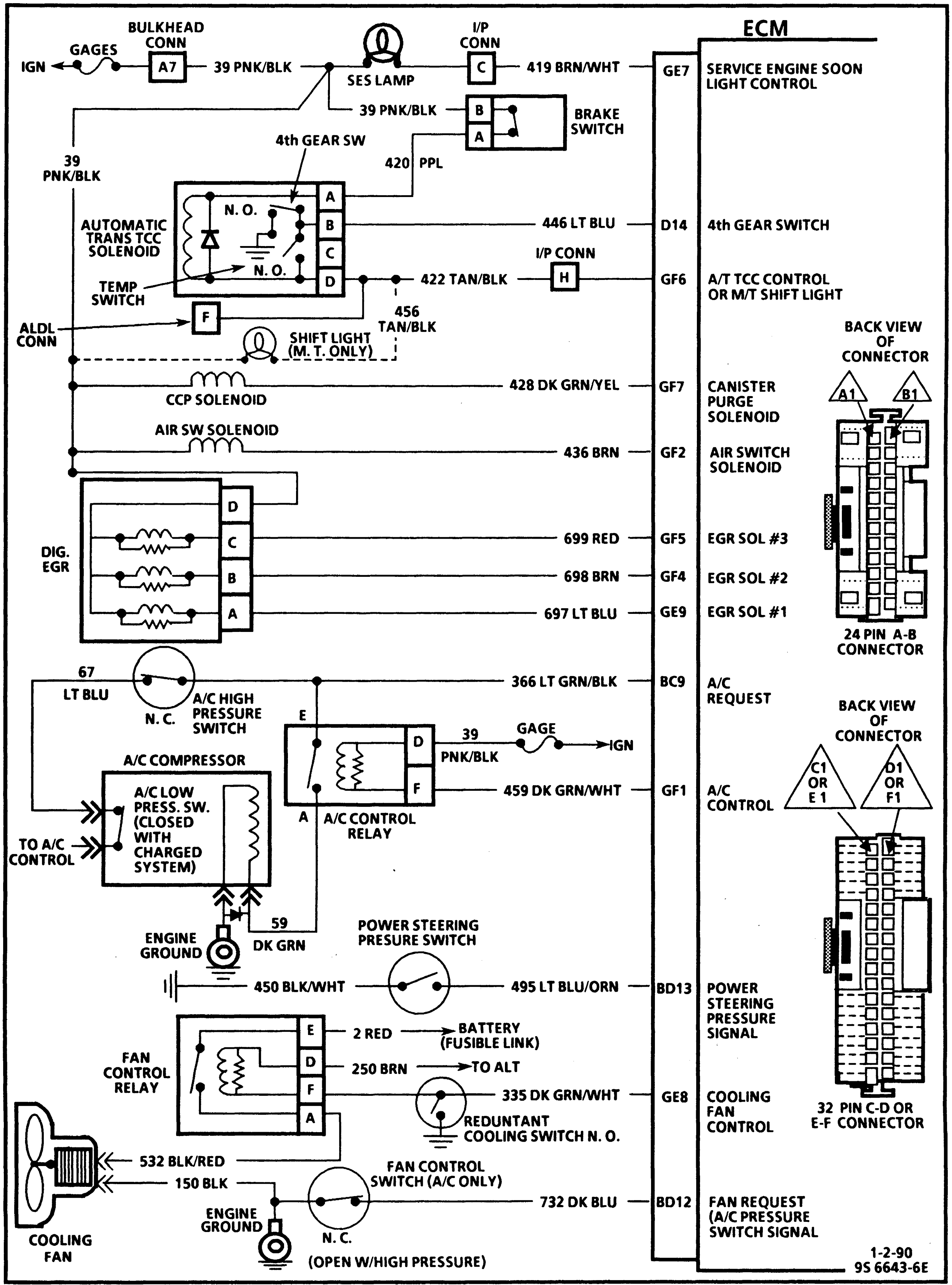


Figure A-4 - 3.1L Wiring Diagram (3 of 3)

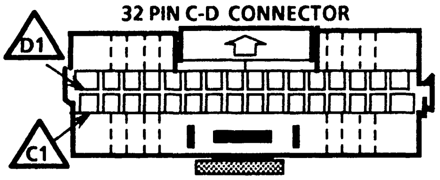
PORT FUEL INJECTION ECM CONNECTOR IDENTIFICATION

This ECM voltage chart is for use with a digital voltmeter to further aid in diagnosis. The voltages you get may vary due to low battery charge or other reasons, but they should be very close.

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

- Engine at operating temperature
- Engine idling in closed loop (For "Engine Run" column) in park or neutral
- Test terminal not grounded
- ALDL tool not installed

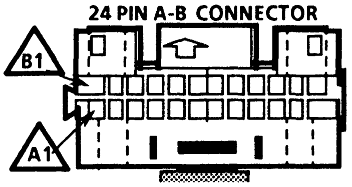
32 PIN C-D CONNECTOR



BACK VIEW OF CONNECTOR

(BLACK)

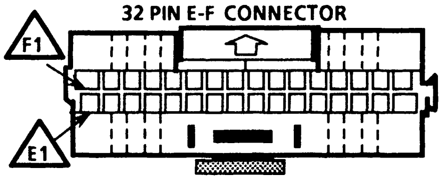
24 PIN A-B CONNECTOR



BACK VIEW OF CONNECTOR

(BLACK)

32 PIN E-F CONNECTOR



BACK VIEW OF CONNECTOR

(YELLOW)

VOLTAGE KEY "ON"	VOLTAGE ENG. RUN	CIRCUIT	PIN	WIRE COLOR
			BA3	
5	5	5V REF	BA4	GRY
5	5	5V REF	BA5	GRY
B +	B +	IGN	BA6	PNK/BLK
③ 4.8	4.8	SERIAL DATA	BA8	ORN
④ 0*	B +	FUEL PUMP RELAY CONTROL	BA11	DK GRN/ WHT
0*	0*	POWER GND.	BA12	BLK/WHT

BLACK

WIRE COLOR	PIN	CIRCUIT	VOLTAGE KEY "ON"	VOLTAGE ENG RUN
ORN	BB1	BATTERY	B +	B +
BLK	BB5	SENSOR GROUND	0*	0*
BLK	BB6	SENSOR GROUND	0*	0*
PPL	BB9	VSS (LOW)	0*	①
YEL	BB10	VSS (HIGH)	0*	①
GRY	BB11	TO I.P. 4000 P/mi	B +	B +

1. Increases with vehicle speed (measure on A/C scale)
2. Normal operating temperature.
3. Varies.
4. 12V First two seconds.
5. Varies with temperature.

* Less than 1 volt

ENGINE 3.1L LHO
CARLINE "F"

1-2-90
9S 6640-6E

Figure A-5 - ECM Connector Terminal End View 3.1L (VIN T) "F" Carline (1 of 2)

	VOLTAGE				
	KEY "ON"	ENG. RUN	CIRCUIT	PIN	WIRE COLOR
①	0*		VSS BUFF	BC1	RED
	0*	5	BYPASS	BC7	TAN/BLK
	0*	1.3	EST	BC8	WHT
	B+ 0*	B+ 0*	WITH A/C "ON" A/C REQUEST	BC9	LT GRN/ BLK
	B+	B+	INJECTOR 2,4,6	BC11	DK BLU
	B+	B+	INJECTOR 1,3,5	BC12	GRN
	B+	B+	BATTERY	BC16	ORN

BLACK

			VOLTAGE	
WIRE COLOR	PIN	CIRCUIT	KEY "ON"	ENG. RUN
BLK/WHT	BD1	POWER GROUND	0*	0*
BLK/WHT	BD6	INJ DRIVE LOW	0*	0*
BLK/WHT	BD7	INJ DRIVE LOW	0*	0*
PPL/WHT	BD8	REFERENCE	0*	2.3
BLK/RED	BD9	REFERENCE LOW	0*	0*
DK BLU	BD12	A/C PRESS FAN SW.	0*	0*
LT BLU/ ORN	BD13	PSPS	B+	B+
LT BLU	BD14	4TH GEAR	0*	0*
ORN/BLK	BD16	P/N SWITCH	0*	0*

	VOLTAGE				
	KEY "ON"	ENG. RUN	CIRCUIT	PIN	WIRE COLOR
	NOT USEABLE		IAC "A" HI	GE3	LT BLU/ WHT
	NOT USEABLE		IAC "A" LO	GE4	LT BLU/ BLK
	NOT USEABLE		IAC "B" HI	GE5	LT GRN/ WHT
	NOT USEABLE		IAC "B"LO	GE6	LT GRN/ BLK
	0*	B+	"SERVICE ENGINE SOON" LIGHT	GE7	BRN/ WHT
	0* B+	0* B+	"ON" FAN RELAY "OFF" CONTROL	GE8	DK GRN/ WHT
	B+	B+	EGR SOL #1	GE9	LT BLU
	5	5	DIAG. TERMINAL	GE12	WHT/BLK
	④	B+	FUEL PUMP SIGNAL	GE13	GRY
③	.35-.55	.1 -.9	O_2 SIGNAL	GE14	PPL
	0*	0*	O_2 GROUND	GE15	TAN
	⑤	⑤	COOLANT TEMP.	GE16	YEL

GREEN

			VOLTAGE	
WIRE COLOR	PIN	CIRCUIT	KEY "ON"	ENG. RUN
DK GRN/ WHT	GF1	A/C RELAY "ON" CONTROL "OFF"	0* B+	0* B+
BRN	GF2	A/SW/SOL		
BRN	GF4	EGR SOL #2	B+	B+
RED	GF5	EGR SOL #3	B+	B+
TAN/BLK	GF6	TCC CONTROL A/T SHIFT LIGHT M/T	0* B+	0* B+
DK GRN/ YEL	GF7	PURGE CONTROL	0*	0*
	GF8			
DK BLU	GF9	ESC SIGNAL	2.5	2.5
DK BLU	GF10	VATS MODULE		
DK BLU	GF13	TPS SIGNAL	.65	.65
LT GRN	GF15	MAP SIGNAL	4.57	③
TAN	GF16	MAT SIGNAL	⑤	⑤

1. Increases with vehicle speed (measure on A/C scale.)
2. Normal operating temperature.
3. Varies.
4. 12 volts first two seconds.
5. Varies with temperature.

* Less than 1 volt.

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9S 6378-6E

Figure A-6 - ECM Connector Terminal End View 3.1L (VIN T) "F" Carline (2 of 2)

DIAGNOSTIC CIRCUIT CHECK

The Diagnostic Circuit Check is an organized approach to identifying a problem created by an Electronic Engine Control System malfunction. It must be the starting point for any driveability complaint diagnosis, because it directs the Service Technician to the next logical step in diagnosing the complaint.

The "Scan Data" listed in the table may be used for comparison, after completing the Diagnostic Circuit Check and finding the on-board diagnostics functioning properly and no trouble codes displayed. The "Typical Values" are an average of display values recorded from normally operating vehicles and are intended to represent what a normally functioning system would typically display.

A "SCAN" TOOL THAT DISPLAYS FAULTY DATA SHOULD NOT BE USED, AND THE PROBLEM SHOULD BE REPORTED TO THE MANUFACTURER. THE USE OF A FAULTY "SCAN" CAN RESULT IN MISDIAGNOSIS AND UNNECESSARY PARTS REPLACEMENT.

Only the parameters listed below are used in this manual for diagnosing. If a "Scan" reads other parameters, the values are not recommended by General Motors for use in diagnosing. For more description on the values and use of the "Scan" to diagnosis ECM inputs, refer to the applicable "Diagnosis" in Section "6E3-C." If all values are within the range illustrated, refer to "Symptoms" in Section "6E3-B."

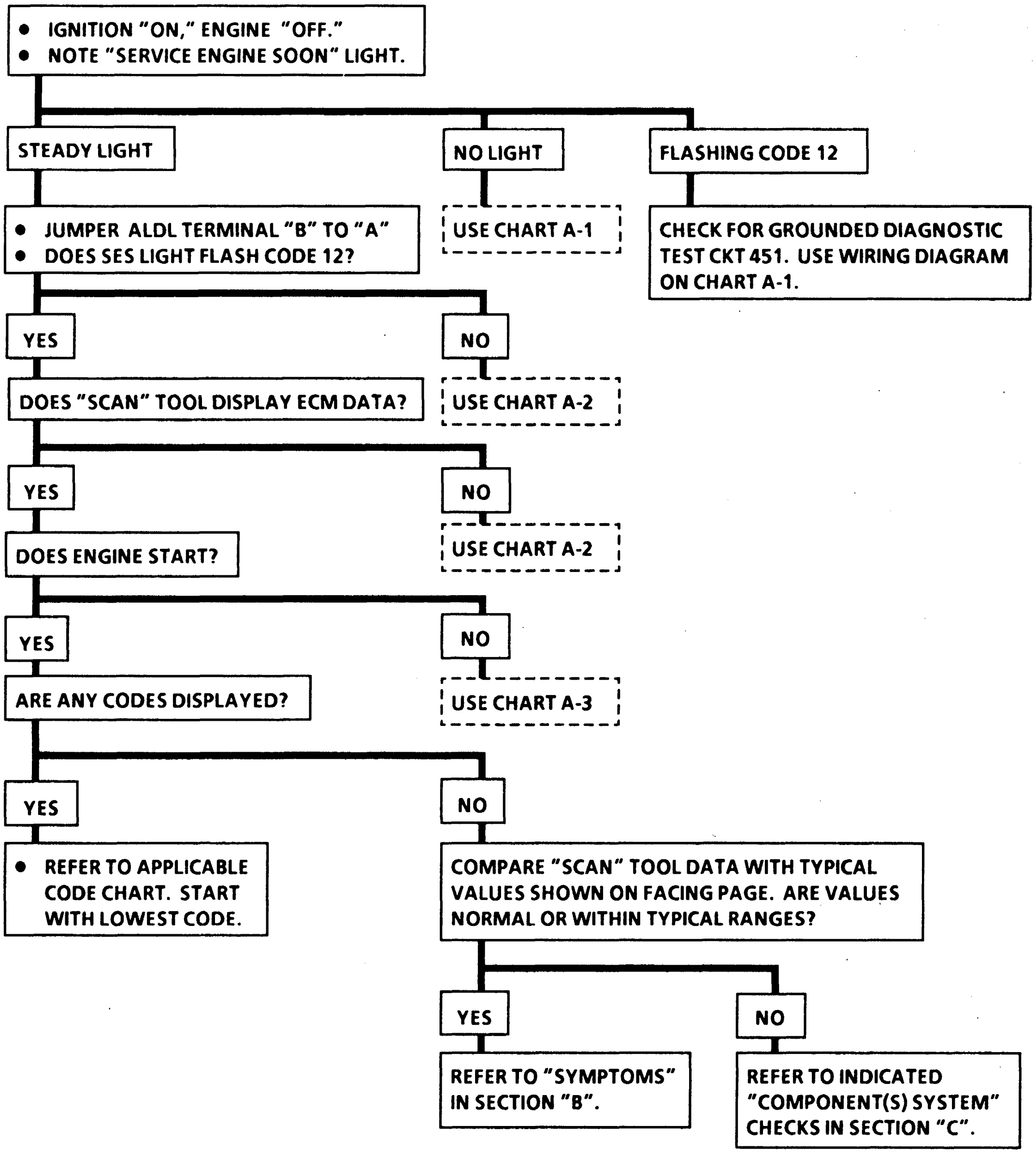
"SCAN" DATA

Idle / Upper Radiator Hose Hot / Closed Throttle / Park or Neutral / Closed Loop / Acc. off

"SCAN" Position	Units Displayed	Typical Data Value
Engine Speed	RPM	ECM idle command (varies with temp.)
Desired Idle	RPM	± 100 RPM from desired RPM (± 50 in drive)
Coolant Temp.	C°	85° - 105°
Manifold Air Temp.	C°	10° - 80° (depends on underhood temp.)
MAP	kPa, Volts	29-48, 1 - 2 (depends on Vac. & Baro pressure)
BARO	kPa, Volts	58-114, 2.5 - 5.5 (depends on altitude & Baro pressure)
Throttle Position	Volts	.29 - .98
Throttle Angle	0 - 100%	0%
Oxygen Sensor	mv	100 - 1000 and varying.
Injector Pulse Width	m/Sec	1 - 4 and varying
Spark Advance	# of Degrees	Varies
Fuel Integrator	Counts	Varies
Block Learn	Counts	118 - 138
Open/Closed Loop	Open/Closed	Closed Loop (may go open with extended idle)
Block Learn Cell	Cell Number	0 or 1 (depends on Air Flow & RPM)
Knock Retard	Degrees of Retard	Varies
Knock Signal	Yes/No	No
EGR 1/ EGR 2	On/Off	Off, Off
EGR 3	On/Off	Off
Idle Air Control	Counts	5-50
Park/Neutral	P/N or RDL	P/N
MPH/KPH	MPH, KPH	0, 0
Torque Converter Clutch	On/Off	Off
Battery Voltage	Volts	13.5 - 14.5
Fuel Pump Volts	Volts	13.5 - 14.5
A/C Request	Yes/No	No (Yes, with A/C On)
A/C Clutch	On/Off	Off (On, with A/C On)
Cooling Fan Relay	On/Off	Off (On, with Coolant Temp. above 109°C)
Power Steering	Normal/Hi pressure	Normal
Purge Duty Cycle	0 - 100%	0%
Crank RPM	RPM	Varies
4th Gear Switch	Yes/No	No

DIAGNOSTIC CIRCUIT CHECK

3.1L (VIN T) "F" CARLINE (PORT)



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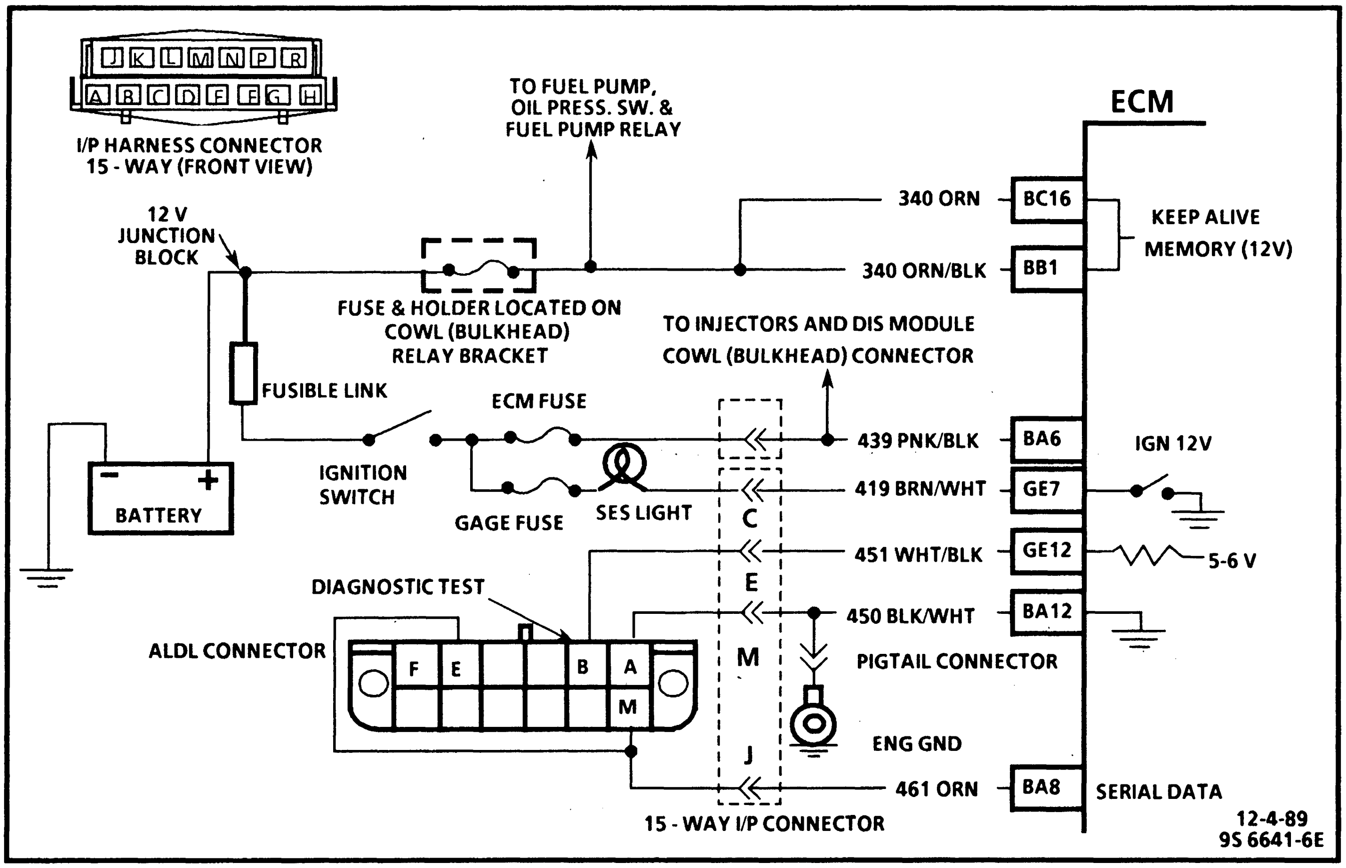


CHART A-1

NO "SERVICE ENGINE SOON" LIGHT
3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

There should always be a steady "Service Engine Soon" light when the ignition is "ON" and engine stopped. Battery is supplied directly to the light bulb. The Electronic Control Module (ECM) will control the light and turn it "ON" by providing a ground path through CKT 419 to the ECM.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. If the fuse in holder is blown, refer to facing page of Code 54 for complete circuit.
2. Using a test light connected to 12 volts probe each of the system ground circuits to be sure a good ground is present. See ECM terminal end view in front of this section for ECM pin locations of ground circuits.

Diagnostic Aids:

Engine runs OK, check:

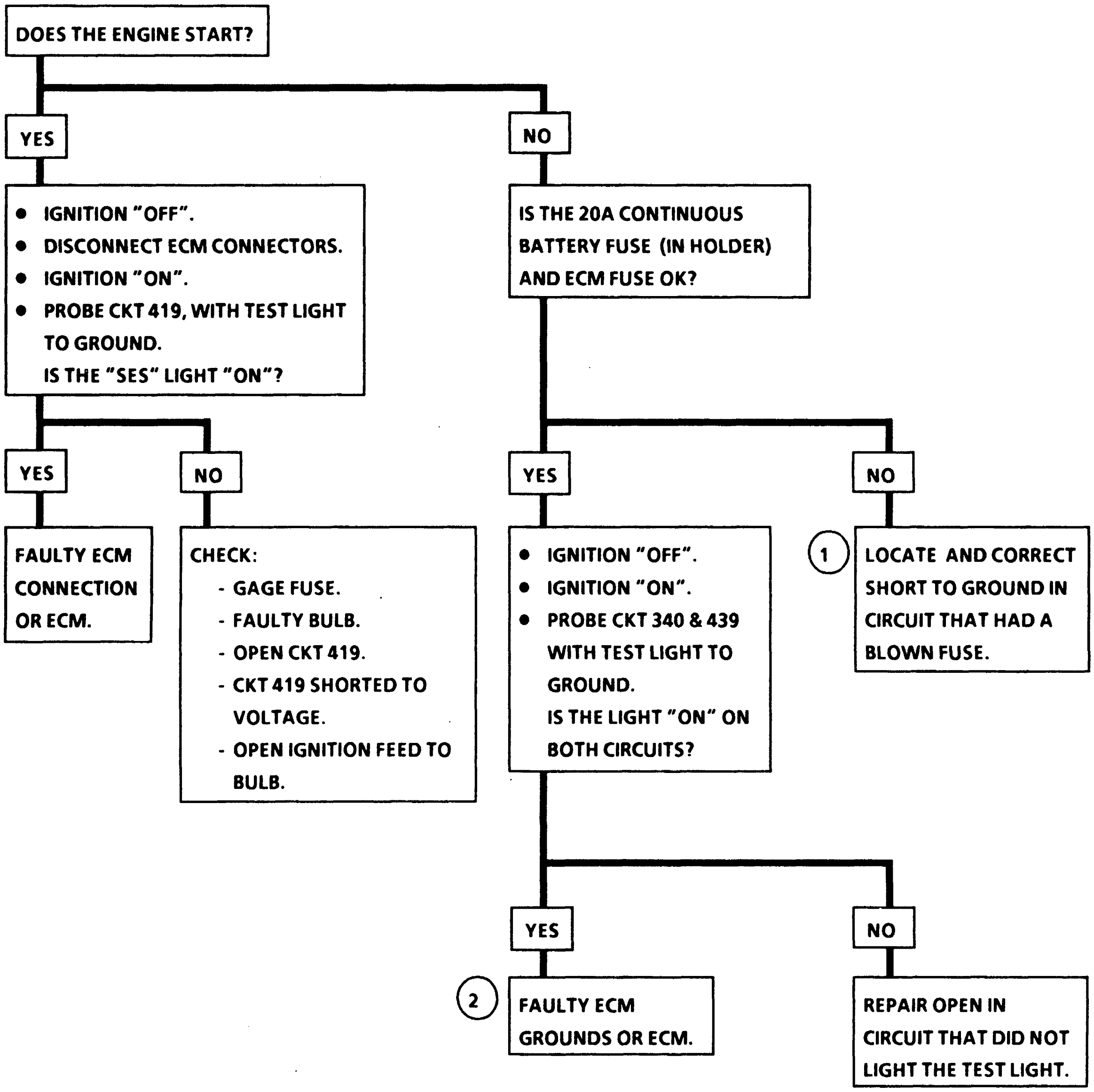
- Faulty light bulb.
- CKT 419 open.
- Gage fuse blown. This will result in no stop lights, oil or generator lights, seat belt reminder, etc.

Engine cranks but will not run:

- Continuous battery - fuse or fusible link open.
- ECM ignition fuse open.
- Battery CKT 340 to ECM open.
- Ignition CKT 439 to ECM open.
- Poor connection to ECM.

CHART A-1

NO "SERVICE ENGINE SOON" LIGHT
3.1L (VIN T) "F" CARLINE (PORT)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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7S 3185-6E

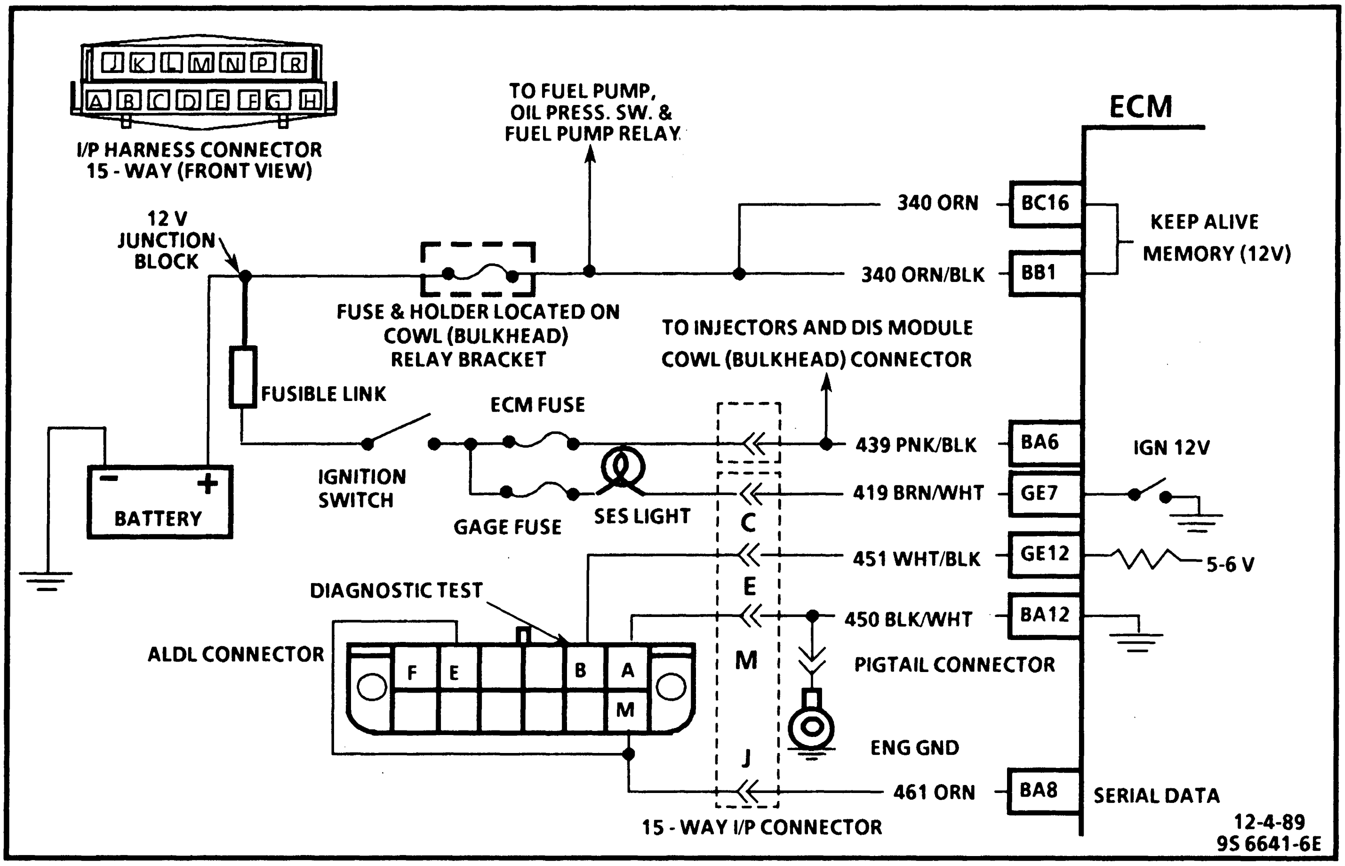


CHART A-2

NO ALDL DATA OR WILL NOT FLASH CODE 12 "SERVICE ENGINE SOON" LIGHT "ON" STEADY 3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

There should always be a steady "Service Engine Soon" light when the ignition is "ON" and engine stopped. Battery ignition voltage is supplied to the light bulb. The Electronic Control Module (ECM) will turn the light "ON" by grounding CKT 419 at the ECM.

With the diagnostic terminal grounded, the light should flash a Code 12, followed by any trouble code(s) stored in memory.

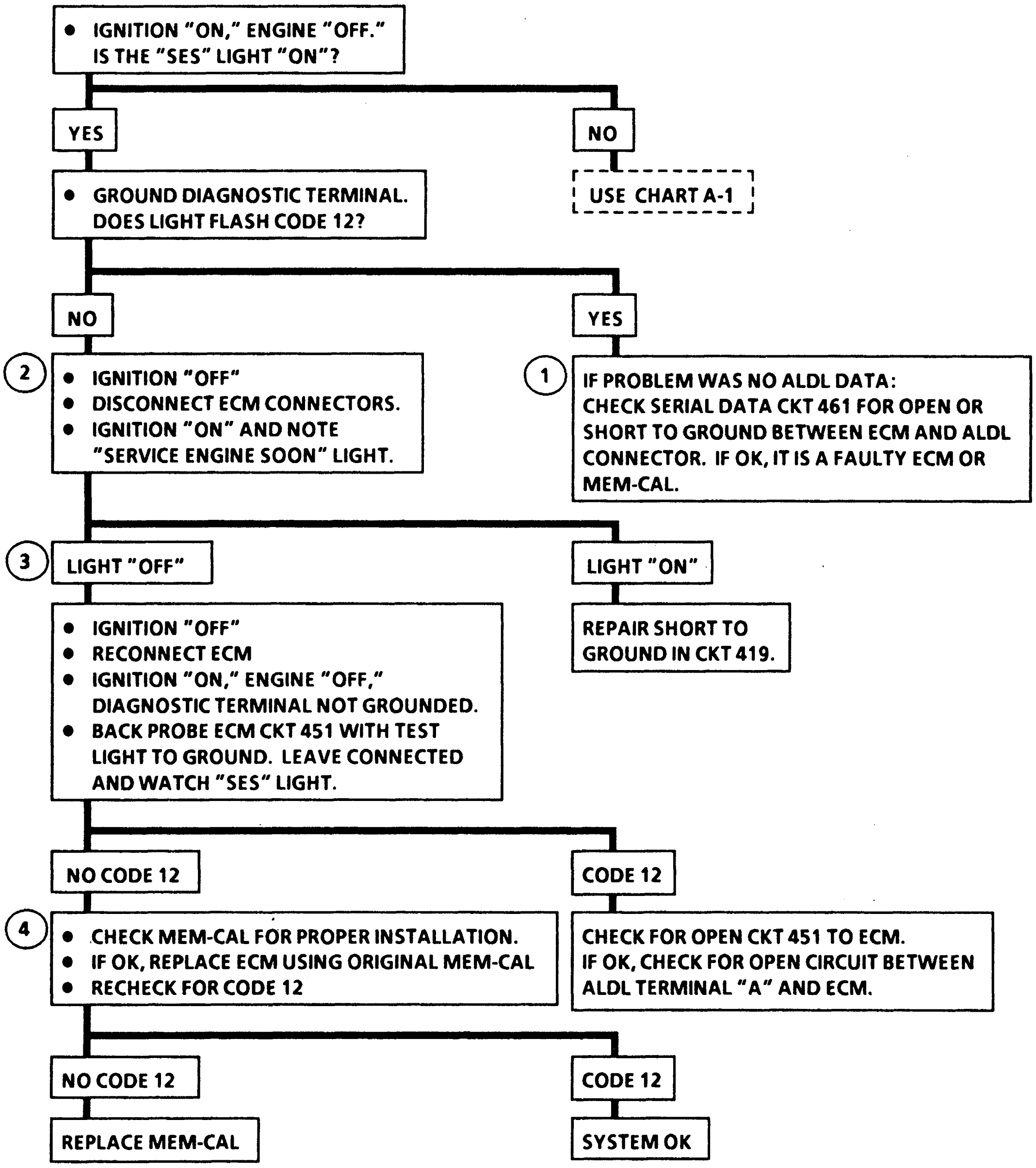
A steady light suggests a short to ground in the light control CKT 419, or an open in diagnostic CKT 451.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. If there is a problem with the ECM that causes a "Scan" tool to not read serial data, the ECM should not flash a Code 12. If Code 12 is flashing, check for CKT 451 short to ground. If Code 12 does flash, be sure that the "Scan" tool is working properly on another vehicle. If the "Scan" is functioning properly and CKT 461 is OK, the MEM-CAL or ECM may be at fault for the no ALDL symptom.
2. If the light goes "OFF" when the ECM connector is disconnected, CKT 419 is not shorted to ground.
3. This step will check for an open diagnostic CKT 451.
4. At this point the "Service Engine Soon" light wiring is OK. The problem is a faulty ECM or MEM-CAL. If Code 12 does not flash, the ECM should be replaced using the original MEM-CAL. Replace the MEM-CAL only after trying an ECM, as a defective MEM-CAL is an unlikely cause of the problem.

CHART A-2

NO ALDL DATA OR WILL NOT FLASH CODE 12 "SERVICE ENGINE SOON" LIGHT "ON" STEADY 3.1L (VIN T) "F" CARLINE (PORT)



- IGNITION "ON," ENGINE "OFF." IS THE "SES" LIGHT "ON"?

YES

- GROUND DIAGNOSTIC TERMINAL. DOES LIGHT FLASH CODE 12?

NO

USE CHART A-1

NO

②
- IGNITION "OFF"
- DISCONNECT ECM CONNECTORS.
- IGNITION "ON" AND NOTE "SERVICE ENGINE SOON" LIGHT.

YES

① IF PROBLEM WAS NO ALDL DATA: CHECK SERIAL DATA CKT 461 FOR OPEN OR SHORT TO GROUND BETWEEN ECM AND ALDL CONNECTOR. IF OK, IT IS A FAULTY ECM OR MEM-CAL.

③ LIGHT "OFF"

- IGNITION "OFF"
- RECONNECT ECM
- IGNITION "ON," ENGINE "OFF," DIAGNOSTIC TERMINAL NOT GROUNDED.
- BACK PROBE ECM CKT 451 WITH TEST LIGHT TO GROUND. LEAVE CONNECTED AND WATCH "SES" LIGHT.

LIGHT "ON"

REPAIR SHORT TO GROUND IN CKT 419.

NO CODE 12

④
- CHECK MEM-CAL FOR PROPER INSTALLATION.
- IF OK, REPLACE ECM USING ORIGINAL MEM-CAL
- RECHECK FOR CODE 12

CODE 12

CHECK FOR OPEN CKT 451 TO ECM. IF OK, CHECK FOR OPEN CIRCUIT BETWEEN ALDL TERMINAL "A" AND ECM.

NO CODE 12

REPLACE MEM-CAL

CODE 12

SYSTEM OK

CLEAR CODES AND CONFIRM "CLOSED LOOP " OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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7S 3186-6E

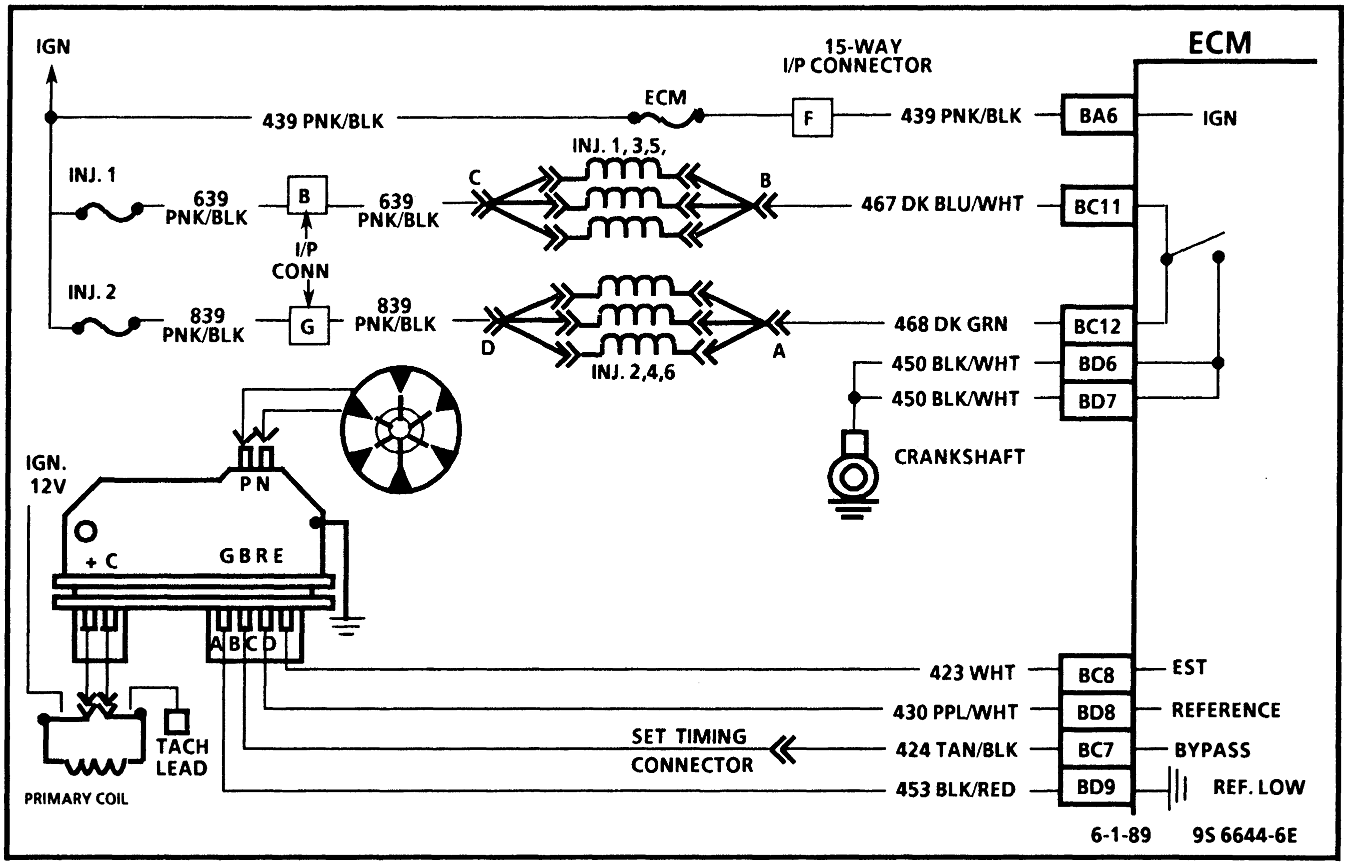


CHART A-3

(Page 1 of 2)

ENGINE CRANKS BUT WILL NOT RUN
3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

This chart assumes that battery condition and engine cranking speed are OK, and there is adequate fuel in the tank.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. This chart assumes that the battery condition and engine cranking speed are OK, and there is adequate fuel in the tank. If the engine starts but immediately stalls, see "Symptoms," Section "6E3-B" (Hard Start). A "Service Engine Soon" light "ON" is a basic check for ignition and battery supply to the Electronic Control Module (ECM).
2. No spark indicates a basic HEI problem.
3. This test will determine if the ECM is receiving the reference signal and controlling the injectors. This test could also be performed at the 4-way injector connector by using a test light between terminals "A" and "D".

   If the test light "blinks" when cranking. then ECM control should be considered OK. How bright the test light "blinks" is not important. However, the test light should be a J 34730-2 or equivalent.
4. Use pressure gage J 34730-1. Wrap a shop towel around the fuel pressure tap to absorb any small amount of fuel leakage that may occur when installing the gage.

Diagnostic Aids:

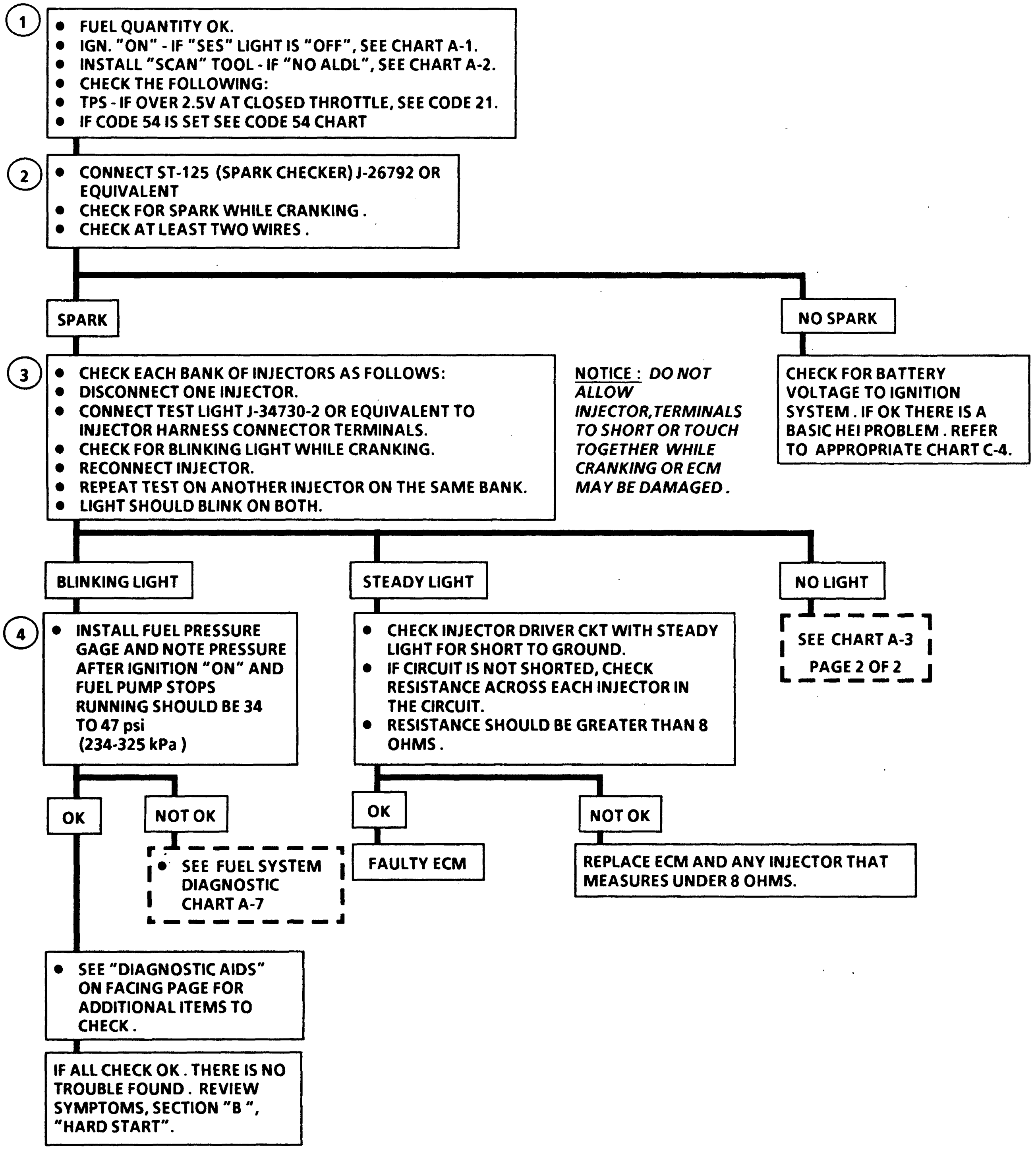
- An EGR valve sticking open can cause a low air/fuel ratio during cranking. Unless engine enters "Clear Flood" at the first indication of a flooding condition, it can result in a no start.
- Check for fouled plugs:
  - If the TPS is sticking or binding in the Wide Open Throttle (WOT) position, the ECM will be in the "Clear Flood" mode.
  - Also check that injectors on both sides of engine will cause a test light to "blink." Checking of two injectors on each bank in this manner will locate a shorted injector.
  - If above are all OK, refer to "Symptoms" in Section "6E3-B" (Hard Start).
  - Also check that injectors are not open or shorted. Injector resistance should be greater than ohms.

NOTICE: *FUEL SYSTEM UNDER PRESSURE. TO AVOID FUEL SPILLAGE, REFER TO FIELD SERVICE PROCEDURES FOR TESTING OR MAKING REPAIRS REQUIRING DISASSEMBLY OF FUEL LINES OR FITTINGS.*

CHART A-3

(Page 1 of 2)

ENGINE CRANKS BUT WILL NOT RUN 3.1L (VIN T) "F" CARLINE (PORT)



①
- FUEL QUANTITY OK.
- IGN. "ON" - IF "SES" LIGHT IS "OFF", SEE CHART A-1.
- INSTALL "SCAN" TOOL - IF "NO ALDL", SEE CHART A-2.
- CHECK THE FOLLOWING:
- TPS - IF OVER 2.5V AT CLOSED THROTTLE, SEE CODE 21.
- IF CODE 54 IS SET SEE CODE 54 CHART

②
- CONNECT ST-125 (SPARK CHECKER) J-26792 OR EQUIVALENT
- CHECK FOR SPARK WHILE CRANKING.
- CHECK AT LEAST TWO WIRES.

SPARK

③
- CHECK EACH BANK OF INJECTORS AS FOLLOWS:
- DISCONNECT ONE INJECTOR.
- CONNECT TEST LIGHT J-34730-2 OR EQUIVALENT TO INJECTOR HARNESS CONNECTOR TERMINALS.
- CHECK FOR BLINKING LIGHT WHILE CRANKING.
- RECONNECT INJECTOR.
- REPEAT TEST ON ANOTHER INJECTOR ON THE SAME BANK.
- LIGHT SHOULD BLINK ON BOTH.

<u>NOTICE:</u> *DO NOT ALLOW INJECTOR,TERMINALS TO SHORT OR TOUCH TOGETHER WHILE CRANKING OR ECM MAY BE DAMAGED.*

BLINKING LIGHT

④
- INSTALL FUEL PRESSURE GAGE AND NOTE PRESSURE AFTER IGNITION "ON" AND FUEL PUMP STOPS RUNNING SHOULD BE 34 TO 47 psi (234-325 kPa)

OK

- SEE "DIAGNOSTIC AIDS" ON FACING PAGE FOR ADDITIONAL ITEMS TO CHECK.

IF ALL CHECK OK. THERE IS NO TROUBLE FOUND. REVIEW SYMPTOMS, SECTION "B", "HARD START".

NOT OK

- SEE FUEL SYSTEM DIAGNOSTIC CHART A-7

STEADY LIGHT

- CHECK INJECTOR DRIVER CKT WITH STEADY LIGHT FOR SHORT TO GROUND.
- IF CIRCUIT IS NOT SHORTED, CHECK RESISTANCE ACROSS EACH INJECTOR IN THE CIRCUIT.
- RESISTANCE SHOULD BE GREATER THAN 8 OHMS.

OK

FAULTY ECM

NOT OK

REPLACE ECM AND ANY INJECTOR THAT MEASURES UNDER 8 OHMS.

NO LIGHT

SEE CHART A-3 PAGE 2 OF 2

NO SPARK

CHECK FOR BATTERY VOLTAGE TO IGNITION SYSTEM. IF OK THERE IS A BASIC HEI PROBLEM. REFER TO APPROPRIATE CHART C-4.

* CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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8S 4692-6E

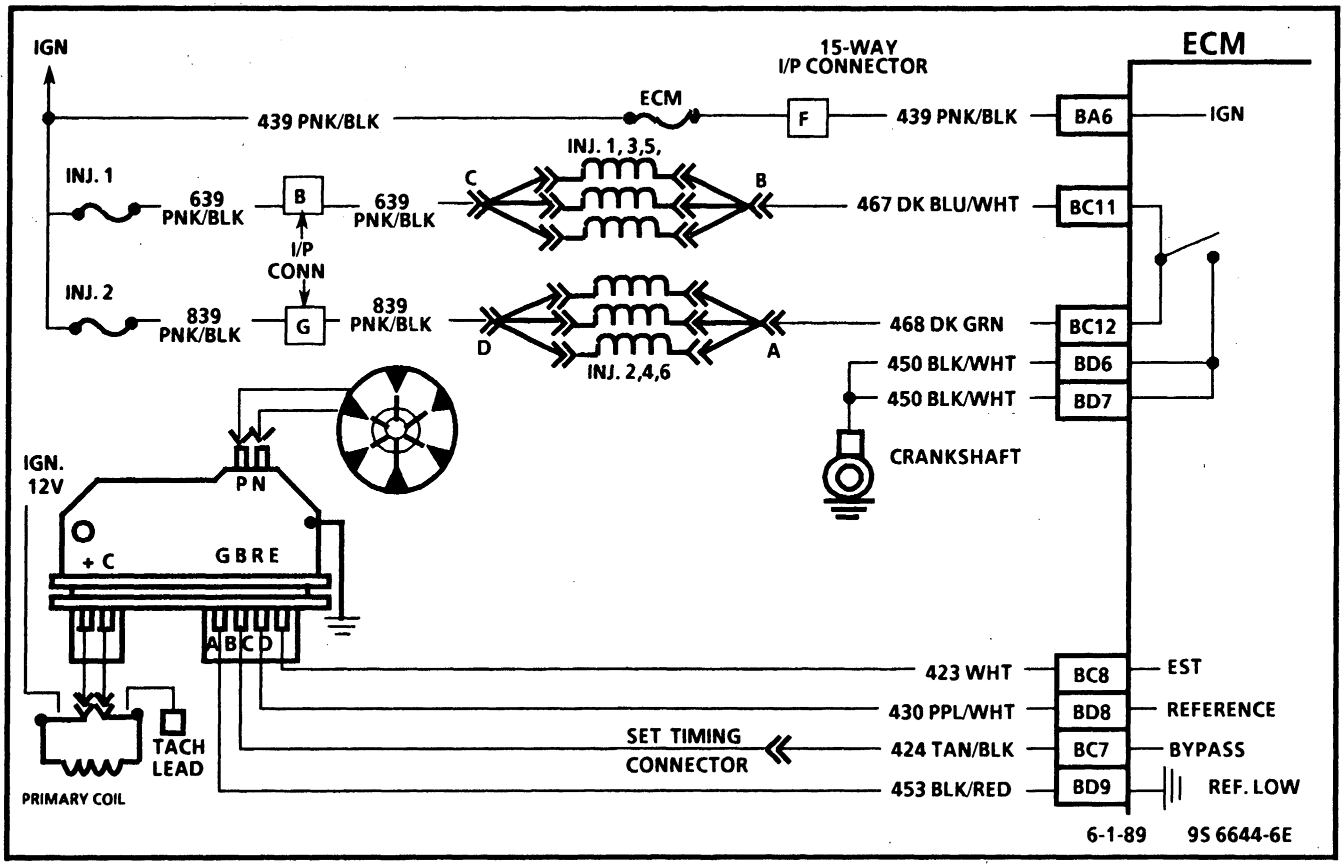


CHART A-3

(Page 2 of 2)

ENGINE CRANKS BUT WILL NOT RUN 3.1L (VIN T) "F" CARLINE (PORT)

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

5. Checks for 12 volt supply to injectors.
6. This test will determine if the distributor module is not generating the reference pulse or if the wiring or ECM are at fault. By touching CKT 430 with a test light a reference signal is being generated. If the test light (J 34730-2) blinks at the injector, then the ECM and wiring is OK.
7. Each time the test light touches CKT 430, the ECM should turn "ON" the fuel pump for 2 seconds.
8. All checks made to this point would indicate that the ECM is at fault. However, there is a possibility of CKT 467 or CKT 468 being shorted to a voltage source either in the engine harness or in the injector harness.

To test for this condition:

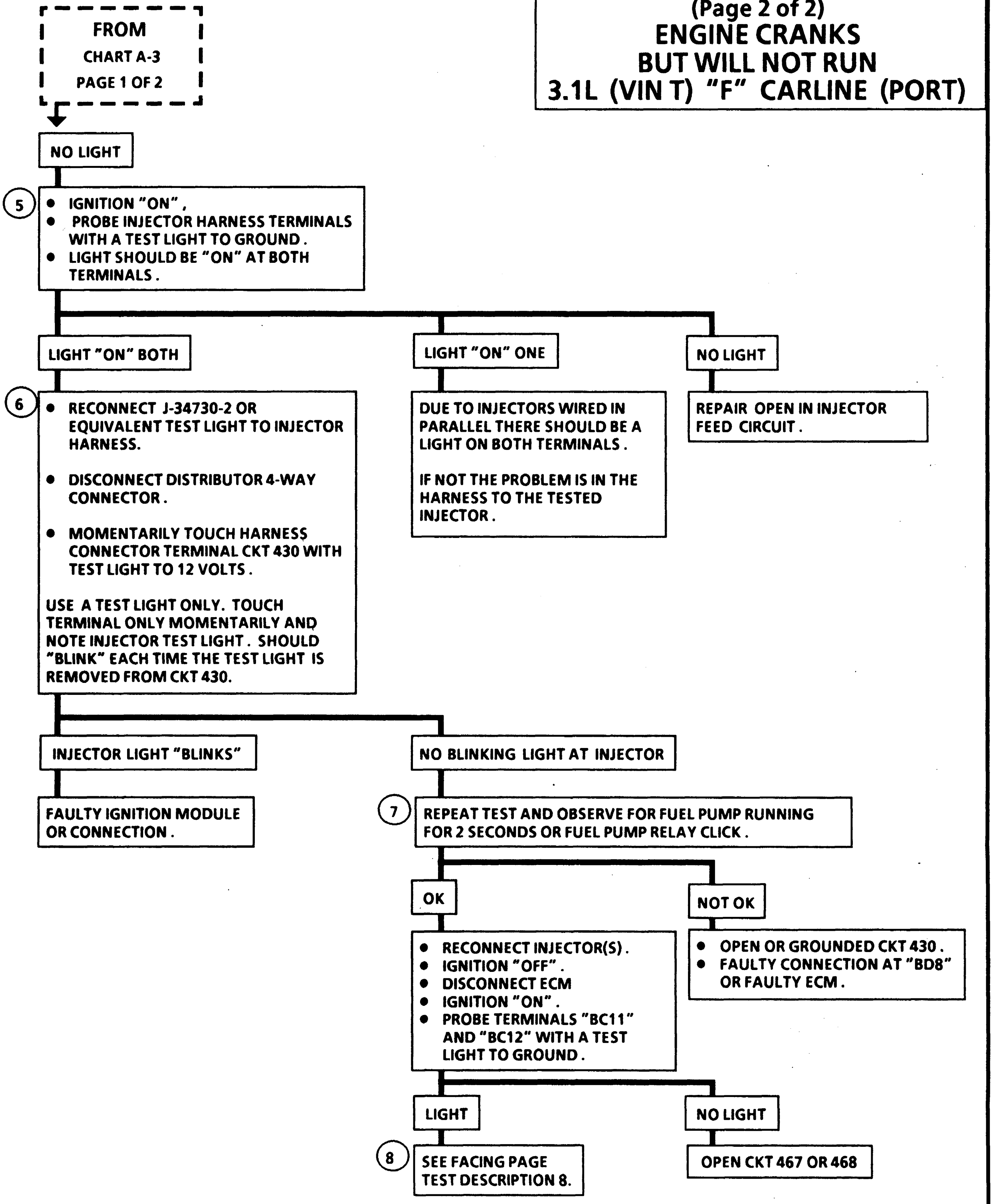
- Disconnect the injector 4 way connector.
- Ignition "ON."
- Probe CKT 467 and CKT 468 on the ECM side of harness with a test light connected to ground. There should be no light.
- If OK, check the resistance of the injector harness between terminals "A & C", "A & D", "B & D", and "B & C".
- Should be more than 4 ohms.
- If less than 4 ohms check harness for wires shorted together and check each injector resistance.
- Resistance should be more than 10 ohms.
- If all OK, replace ECM.

NOTICE: *EFI SYSTEM UNDER PRESSURE. TO AVOID FUEL SPILLAGE, REFER TO FIELD SERVICE PROCEDURES FOR TESTING OR MAKING REPAIRS REQUIRING DISASSEMBLY OF FUEL LINES OR FITTINGS*

CHART A-3

(Page 2 of 2)

ENGINE CRANKS BUT WILL NOT RUN 3.1L (VIN T) "F" CARLINE (PORT)



FROM CHART A-3 PAGE 1 OF 2

NO LIGHT

⑤
- IGNITION "ON",
- PROBE INJECTOR HARNESS TERMINALS WITH A TEST LIGHT TO GROUND.
- LIGHT SHOULD BE "ON" AT BOTH TERMINALS.

LIGHT "ON" BOTH

⑥
- RECONNECT J-34730-2 OR EQUIVALENT TEST LIGHT TO INJECTOR HARNESS.
- DISCONNECT DISTRIBUTOR 4-WAY CONNECTOR.
- MOMENTARILY TOUCH HARNESS CONNECTOR TERMINAL CKT 430 WITH TEST LIGHT TO 12 VOLTS.

USE A TEST LIGHT ONLY. TOUCH TERMINAL ONLY MOMENTARILY AND NOTE INJECTOR TEST LIGHT. SHOULD "BLINK" EACH TIME THE TEST LIGHT IS REMOVED FROM CKT 430.

INJECTOR LIGHT "BLINKS"

FAULTY IGNITION MODULE OR CONNECTION.

NO BLINKING LIGHT AT INJECTOR

⑦ REPEAT TEST AND OBSERVE FOR FUEL PUMP RUNNING FOR 2 SECONDS OR FUEL PUMP RELAY CLICK.

OK

- RECONNECT INJECTOR(S).
- IGNITION "OFF".
- DISCONNECT ECM
- IGNITION "ON".
- PROBE TERMINALS "BC11" AND "BC12" WITH A TEST LIGHT TO GROUND.

LIGHT

⑧ SEE FACING PAGE TEST DESCRIPTION 8.

NO LIGHT

OPEN CKT 467 OR 468

NOT OK

- OPEN OR GROUNDED CKT 430.
- FAULTY CONNECTION AT "BD8" OR FAULTY ECM.

LIGHT "ON" ONE

DUE TO INJECTORS WIRED IN PARALLEL THERE SHOULD BE A LIGHT ON BOTH TERMINALS.

IF NOT THE PROBLEM IS IN THE HARNESS TO THE TESTED INJECTOR.

NO LIGHT

REPAIR OPEN IN INJECTOR FEED CIRCUIT.

* CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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9S 6703-6E

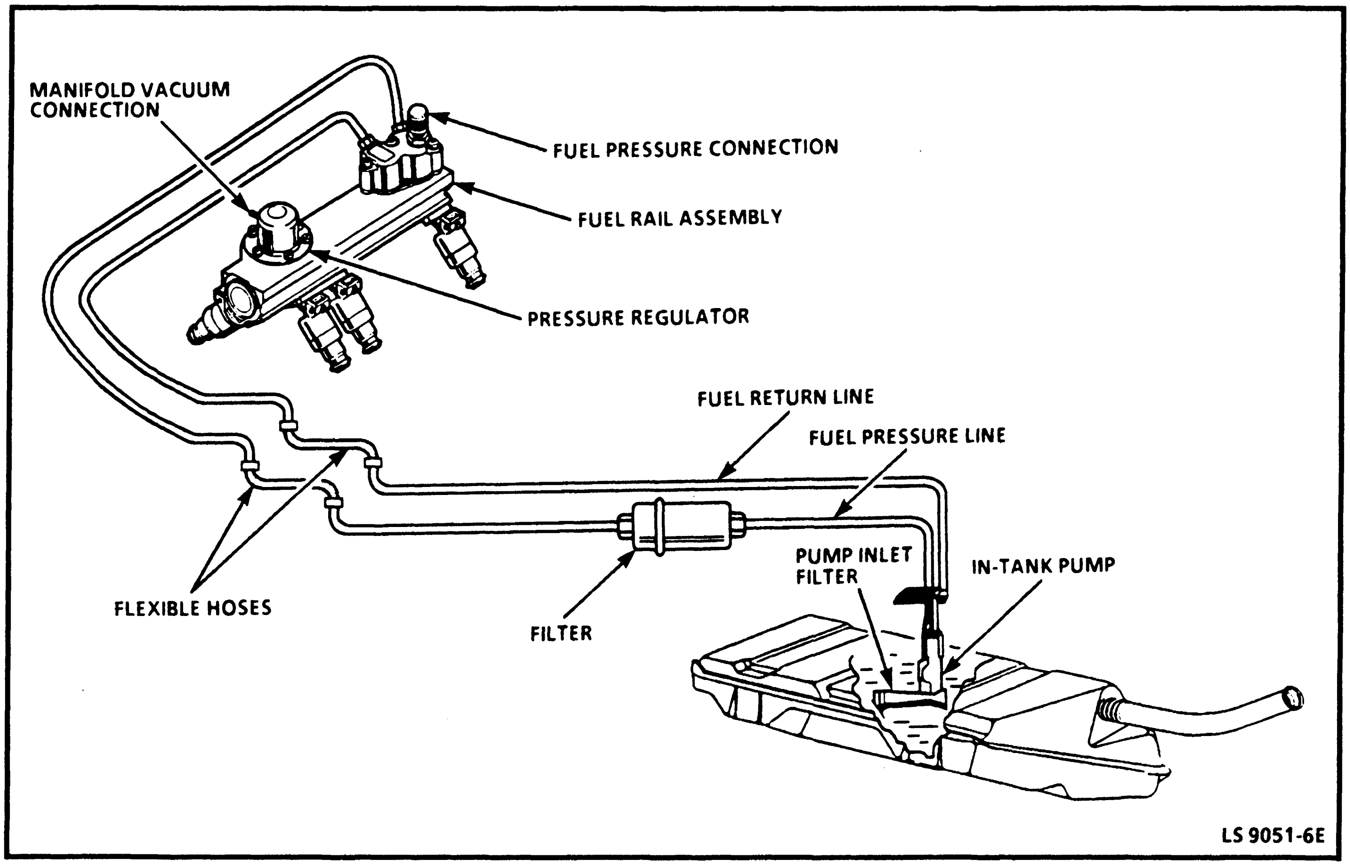


CHART A-7 (Page 1 of 2)

FUEL SYSTEM DIAGNOSIS
3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

When the ignition switch is turned "ON," the Electronic Control Module (ECM) will turn "ON" the in-tank fuel pump. It will remain "ON" as long as the engine is cranking or running, and the ECM is receiving reference pulses. If there are no reference pulses, the ECM will shut "OFF" the fuel pump within 2 seconds after ignition "ON" or engine stops.

The pump will deliver fuel to the fuel rail and injectors, then to the pressure regulator, where the system pressure is controlled to about 234 to 325 kPa (34 to 47 psi). Excess fuel is then returned to the fuel tank.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Wrap a shop towel around the fuel pressure connector to absorb any small amount of fuel leakage that may occur when installing the gage. Ignition "ON" pump pressure should be 280-325 kPa (40.5-47 psi). This pressure is controlled by spring pressure within the regulator assembly.
2. When the engine is idling, the manifold pressure is low (high vacuum) and is applied to the fuel regulator diaphragm. This will offset the spring and result in a lower fuel pressure. This idle pressure will vary somewhat depending on barometric pressure, however, the pressure idling should be less indication pressure regulator control.
3. Pressure that continues to fall is caused by one of the following:
   - In-tank fuel pump check valve not holding.
   - Pump coupling hose or pulsator leaking.
   - Fuel pressure regulator valve leaking.
   - Injectors(s) sticking open.
4. An injector sticking open can best be determined by checking for a fouled or saturated spark plug(s). If a leaking injector cannot be determined by a fouled or saturated spark plug the following procedure should be used.
   - Remove plenum, and remove fuel rail bolts. Follow procedures in the Fuel Control Section of this manual, but leave fuel lines connected.
   - Lift fuel rail out just enough to leave injector nozzles in the ports.

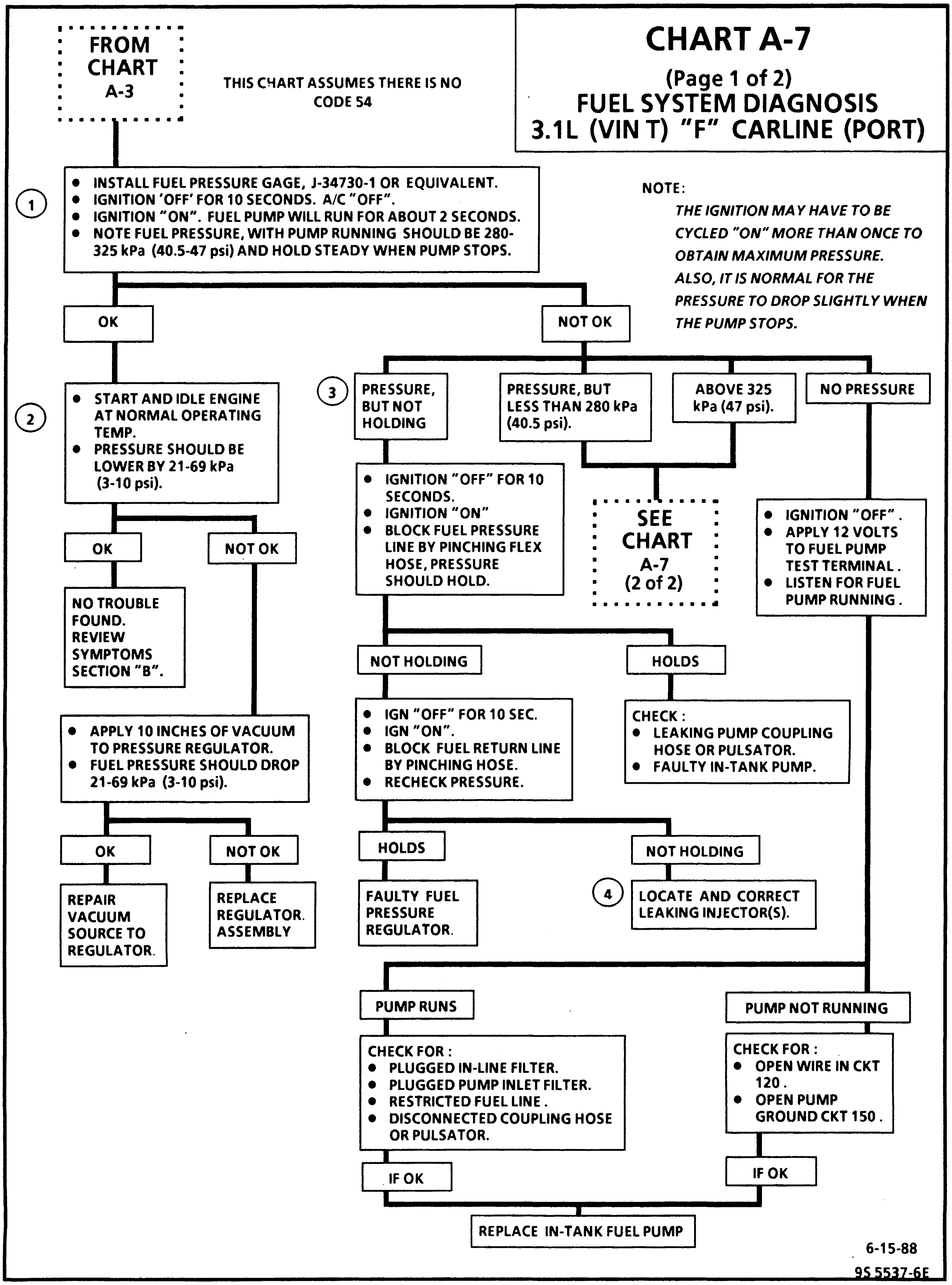
CAUTION: **Be sure injectors(s) are not allowed to spray on engine and that injector retaining clips are intact. This should be carefully followed to prevent fuel spray on engine which would cause a fire hazard.**

- Pressurize the fuel system and observe injector nozzles.

CHART A-7

(Page 1 of 2)

FUEL SYSTEM DIAGNOSIS
3.1L (VIN T) "F" CARLINE (PORT)



FROM CHART A-3

THIS CHART ASSUMES THERE IS NO CODE 54

NOTE:
THE IGNITION MAY HAVE TO BE CYCLED "ON" MORE THAN ONCE TO OBTAIN MAXIMUM PRESSURE. ALSO, IT IS NORMAL FOR THE PRESSURE TO DROP SLIGHTLY WHEN THE PUMP STOPS.

①
- INSTALL FUEL PRESSURE GAGE, J-34730-1 OR EQUIVALENT.
- IGNITION 'OFF' FOR 10 SECONDS. A/C "OFF".
- IGNITION "ON". FUEL PUMP WILL RUN FOR ABOUT 2 SECONDS.
- NOTE FUEL PRESSURE, WITH PUMP RUNNING SHOULD BE 280-325 kPa (40.5-47 psi) AND HOLD STEADY WHEN PUMP STOPS.

OK

②
- START AND IDLE ENGINE AT NORMAL OPERATING TEMP.
- PRESSURE SHOULD BE LOWER BY 21-69 kPa (3-10 psi).

OK: NO TROUBLE FOUND. REVIEW SYMPTOMS SECTION "B".

NOT OK:
- APPLY 10 INCHES OF VACUUM TO PRESSURE REGULATOR.
- FUEL PRESSURE SHOULD DROP 21-69 kPa (3-10 psi).

OK: REPAIR VACUUM SOURCE TO REGULATOR.

NOT OK: REPLACE REGULATOR. ASSEMBLY

NOT OK

③ PRESSURE, BUT NOT HOLDING
- IGNITION "OFF" FOR 10 SECONDS.
- IGNITION "ON"
- BLOCK FUEL PRESSURE LINE BY PINCHING FLEX HOSE, PRESSURE SHOULD HOLD.

NOT HOLDING
- IGN "OFF" FOR 10 SEC.
- IGN "ON".
- BLOCK FUEL RETURN LINE BY PINCHING HOSE.
- RECHECK PRESSURE.

HOLDS: FAULTY FUEL PRESSURE REGULATOR.

NOT HOLDING: ④ LOCATE AND CORRECT LEAKING INJECTOR(S).

HOLDS
CHECK:
- LEAKING PUMP COUPLING HOSE OR PULSATOR.
- FAULTY IN-TANK PUMP.

PRESSURE, BUT LESS THAN 280 kPa (40.5 psi).

ABOVE 325 kPa (47 psi).

SEE CHART A-7 (2 of 2)

NO PRESSURE
- IGNITION "OFF".
- APPLY 12 VOLTS TO FUEL PUMP TEST TERMINAL.
- LISTEN FOR FUEL PUMP RUNNING.

PUMP RUNS
CHECK FOR:
- PLUGGED IN-LINE FILTER.
- PLUGGED PUMP INLET FILTER.
- RESTRICTED FUEL LINE.
- DISCONNECTED COUPLING HOSE OR PULSATOR.

IF OK

PUMP NOT RUNNING
CHECK FOR:
- OPEN WIRE IN CKT 120.
- OPEN PUMP GROUND CKT 150.

IF OK

REPLACE IN-TANK FUEL PUMP

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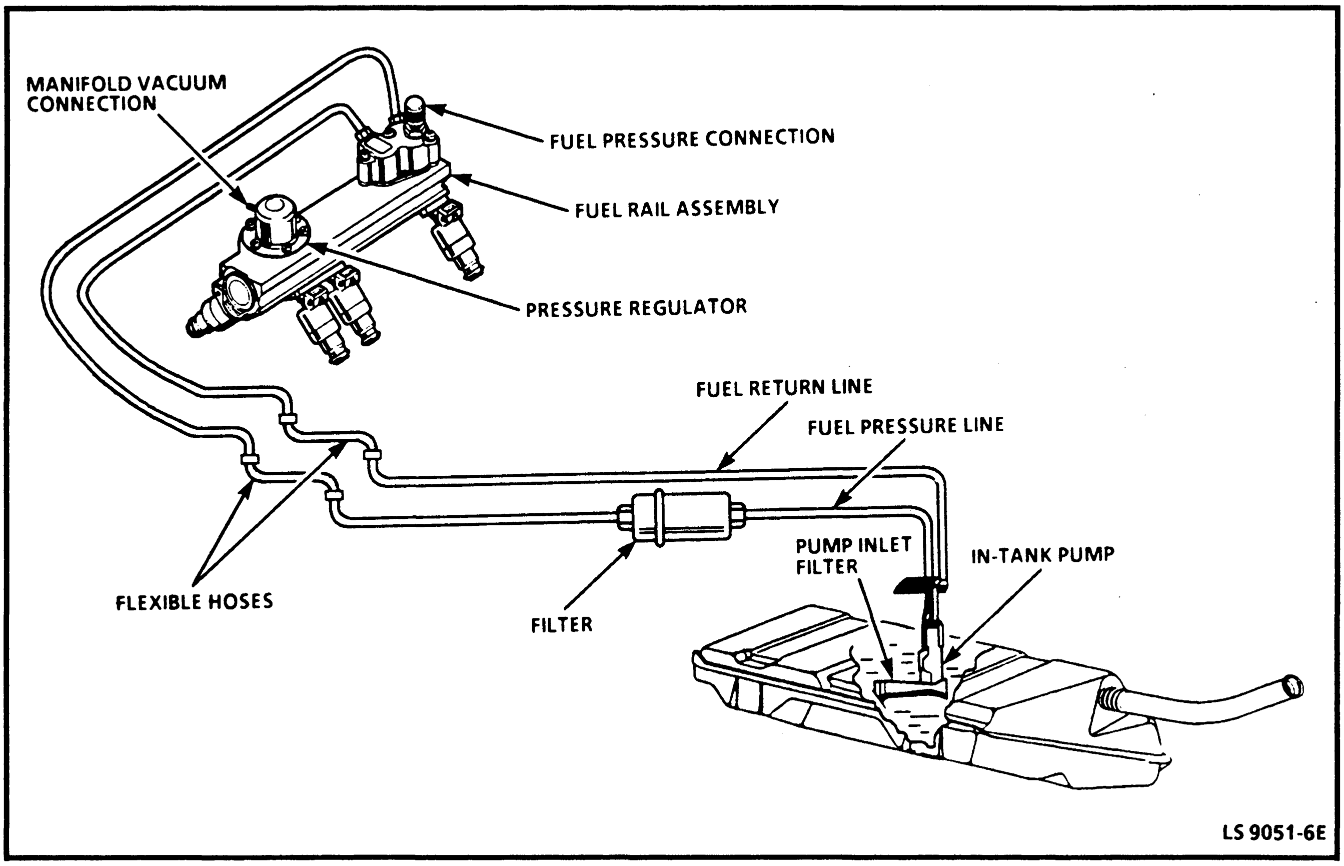


CHART A-7

(Page 2 of 2)

FUEL SYSTEM DIAGNOSIS
3.1L (VIN T) "F" CARLINE (PORT)

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Pressure but less than 280 kPa (40.5 psi) falls into two areas:
   - Regulated pressure but less than 280 kPa (40.5 psi). Amount of fuel to injectors OK but pressure is too low. System will be lean running and may set Code 44. Also, hard starting cold and overall poor performance.
   - Restricted flow causing pressure drop - Normally, a vehicle with a fuel pressure of less than 165 kPa (24 psi) at idle will not be driveable. However, if the pressure drop occurs only while driving, the engine will normally surge then stop running as pressure begins to drop rapidly. This is most likely caused be a restricted fuel line or plugged filter.
2. Restricting the fuel return line allows fuel pressure to build above regulated pressure. With battery voltage applied to the pump "test" terminal, pressure should rise above 325 (47 psi) as the fuel return hose is gradually pinched.

NOTICE: Do not allow pressure to exceed 414 (60 psi), as damage to the regulator may result.

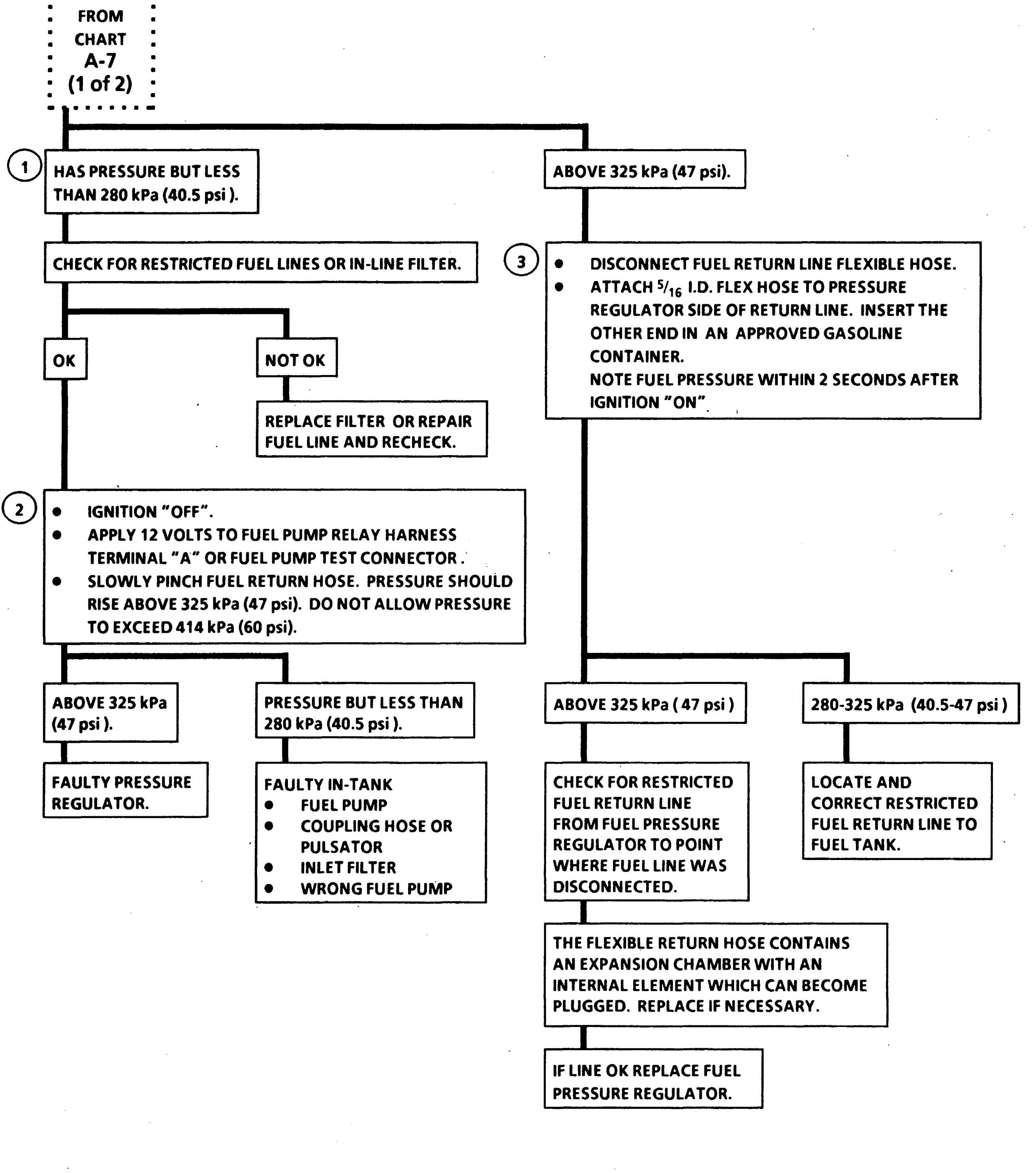
3. This test determines if the high fuel pressure is due to a restricted fuel return line or a pressure regulator problem.

NOTICE: *FUEL SYSTEM UNDER PRESSURE. TO AVOID FUEL SPILLAGE, REFER TO FIELD SERVICE PROCEDURES FOR TESTING OR MAKING REPAIRS REQUIRING DISASSEMBLY OF FUEL LINES OR FITTINGS.*

CHART A-7

(Page 2 of 2)

FUEL SYSTEM DIAGNOSIS
3.1L (VIN T) "F" CARLINE (PORT)



FROM CHART A-7 (1 of 2)

① HAS PRESSURE BUT LESS THAN 280 kPa (40.5 psi).

CHECK FOR RESTRICTED FUEL LINES OR IN-LINE FILTER.

OK

NOT OK

REPLACE FILTER OR REPAIR FUEL LINE AND RECHECK.

②
- IGNITION "OFF".
- APPLY 12 VOLTS TO FUEL PUMP RELAY HARNESS TERMINAL "A" OR FUEL PUMP TEST CONNECTOR.
- SLOWLY PINCH FUEL RETURN HOSE. PRESSURE SHOULD RISE ABOVE 325 kPa (47 psi). DO NOT ALLOW PRESSURE TO EXCEED 414 kPa (60 psi).

ABOVE 325 kPa (47 psi).

FAULTY PRESSURE REGULATOR.

PRESSURE BUT LESS THAN 280 kPa (40.5 psi).

FAULTY IN-TANK
- FUEL PUMP
- COUPLING HOSE OR PULSATOR
- INLET FILTER
- WRONG FUEL PUMP

ABOVE 325 kPa (47 psi).

③
- DISCONNECT FUEL RETURN LINE FLEXIBLE HOSE.
- ATTACH $^5/_{16}$ I.D. FLEX HOSE TO PRESSURE REGULATOR SIDE OF RETURN LINE. INSERT THE OTHER END IN AN APPROVED GASOLINE CONTAINER.

  NOTE FUEL PRESSURE WITHIN 2 SECONDS AFTER IGNITION "ON".

ABOVE 325 kPa (47 psi)

CHECK FOR RESTRICTED FUEL RETURN LINE FROM FUEL PRESSURE REGULATOR TO POINT WHERE FUEL LINE WAS DISCONNECTED.

THE FLEXIBLE RETURN HOSE CONTAINS AN EXPANSION CHAMBER WITH AN INTERNAL ELEMENT WHICH CAN BECOME PLUGGED. REPLACE IF NECESSARY.

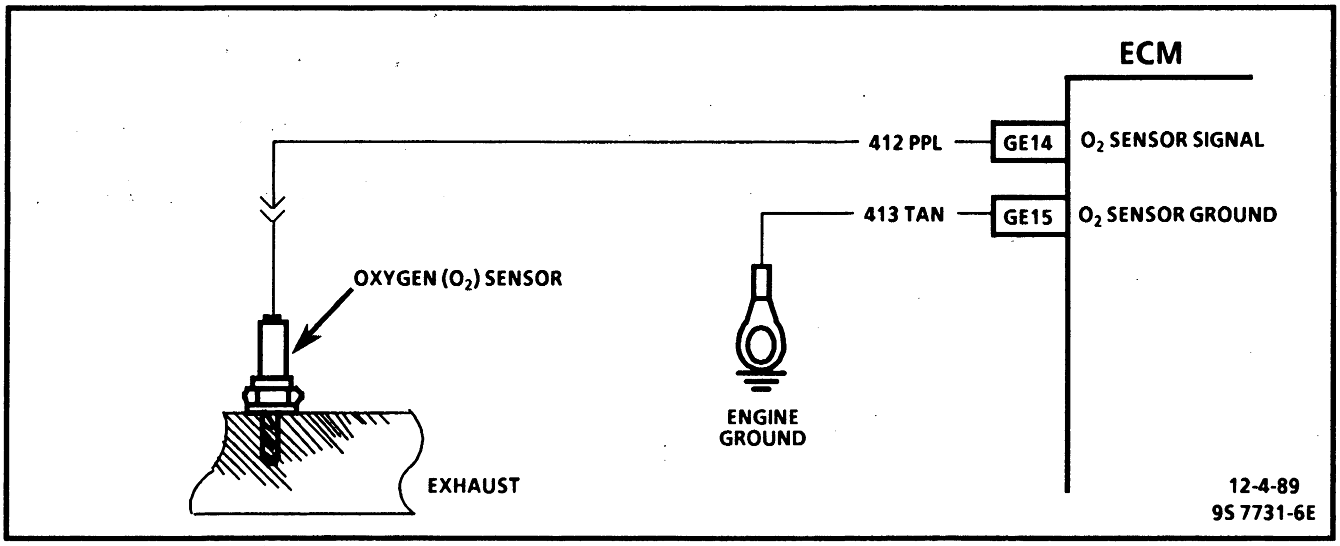
IF LINE OK REPLACE FUEL PRESSURE REGULATOR.

280-325 kPa (40.5-47 psi)

LOCATE AND CORRECT RESTRICTED FUEL RETURN LINE TO FUEL TANK.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

6-14-88
* 8S 4172-6E



CODE 13

OXYGEN (O_2) SENSOR CIRCUIT
(OPEN CIRCUIT)
3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The ECM supplies a voltage of about .45 volt between terminals "GE14" and "GE15". (If measured with a 10 megohm digital voltmeter, this may read as low as .32 volt). The O_2 sensor varies the voltage within a range of about 1 volt if the exhaust is rich, down through about .10 volt if exhaust is lean.

The sensor is like an open circuit and produces no voltage when it is below 315°C (600°F). An open sensor circuit or cold sensor causes "Open Loop" operation.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 13 will set:
   - Engine at normal operating temperature.
   - At least 2 minutes engine time after start.
   - O_2 signal voltage steady between .35 and .55 volt.
   - Throttle Position Sensor (TPS) signal above 4%.
   - All conditions must be met for about 60 seconds.

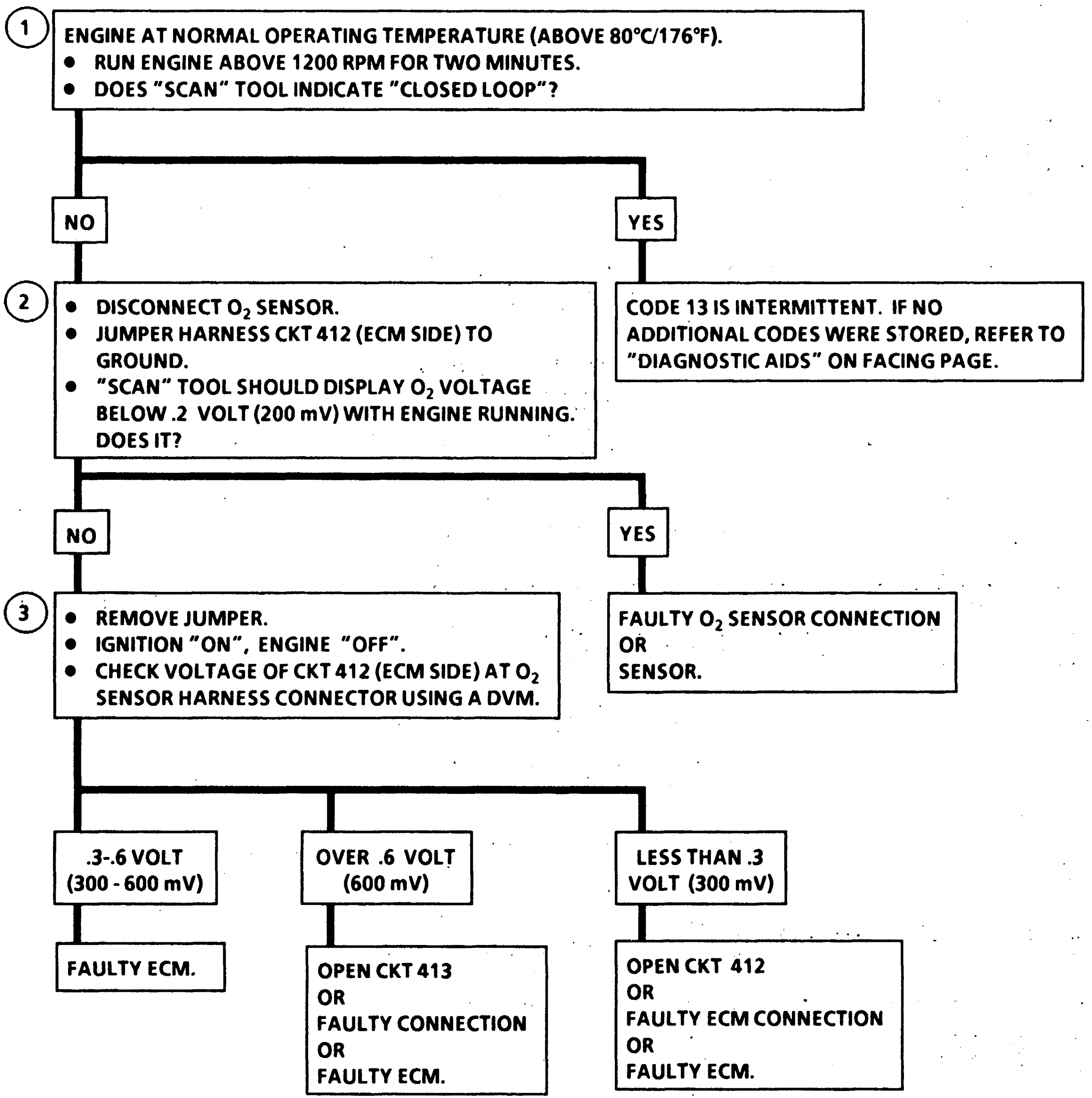
   If the conditions for a Code 13 exist, the system will not go "Closed Loop."
2. This will determine if the sensor is at fault or the wiring or ECM is the cause of the Code 13.
3. In doing this test use only a high impedence digital volt ohmmeter. This test checks the continuity of CKTs 412 and 413 because if CKT 413 is open the ECM voltage on CKT 412 will be over .6 volt (600 mv).

Diagnostic Aids:

Normal "Scan" voltage varies between 100 mv to 999 mv (.1 and 1.0 volt) while in "Closed Loop." Code 13 sets in one minute if voltage remains between .35 and .55 volt, but the system will go "Open Loop" in about 15 seconds. Refer to "Intermittents" in "Symptoms," Section "6E3-B".

CODE 13

OXYGEN (O_2) SENSOR CIRCUIT
(OPEN CIRCUIT)
3.1L (VIN T) "F" CARLINE (PORT)



① ENGINE AT NORMAL OPERATING TEMPERATURE (ABOVE 80°C/176°F).
- RUN ENGINE ABOVE 1200 RPM FOR TWO MINUTES.
- DOES "SCAN" TOOL INDICATE "CLOSED LOOP"?

YES: CODE 13 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

NO:

②
- DISCONNECT O_2 SENSOR.
- JUMPER HARNESS CKT 412 (ECM SIDE) TO GROUND.
- "SCAN" TOOL SHOULD DISPLAY O_2 VOLTAGE BELOW .2 VOLT (200 mV) WITH ENGINE RUNNING. DOES IT?

YES: FAULTY O_2 SENSOR CONNECTION OR SENSOR.

NO:

③
- REMOVE JUMPER.
- IGNITION "ON", ENGINE "OFF".
- CHECK VOLTAGE OF CKT 412 (ECM SIDE) AT O_2 SENSOR HARNESS CONNECTOR USING A DVM.

.3-.6 VOLT (300 - 600 mV): FAULTY ECM.

OVER .6 VOLT (600 mV): OPEN CKT 413 OR FAULTY CONNECTION OR FAULTY ECM.

LESS THAN .3 VOLT (300 mV): OPEN CKT 412 OR FAULTY ECM CONNECTION OR FAULTY ECM.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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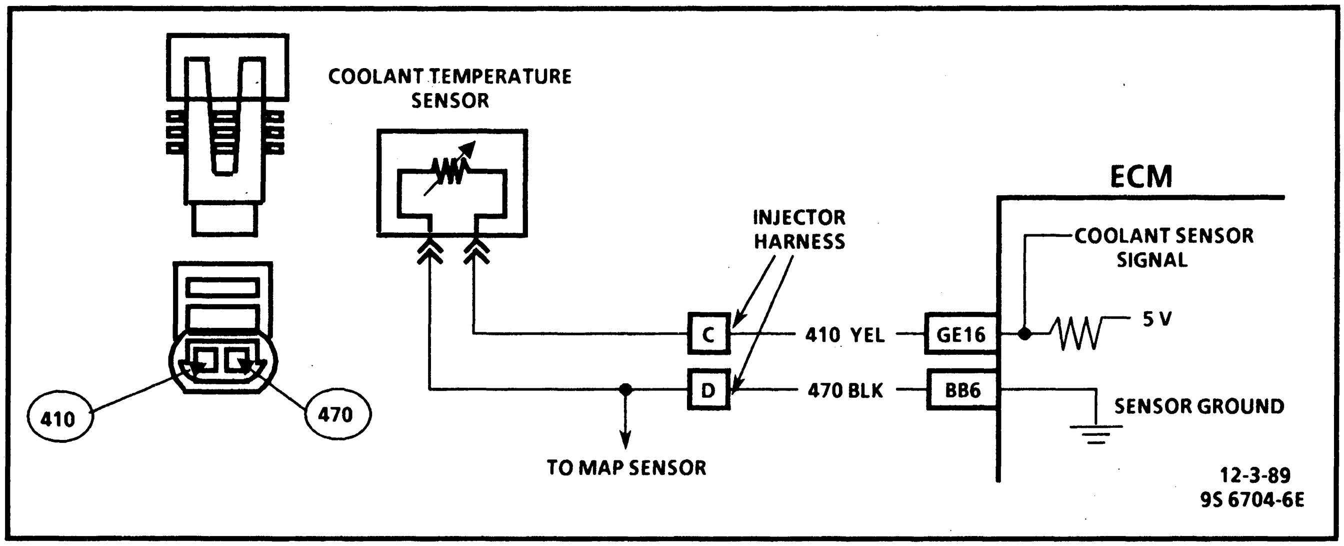
• 7S 3054-6E



CODE 14

COOLANT TEMPERATURE SENSOR (CTS) CIRCUIT

(HIGH TEMPERATURE INDICATED)

3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The Coolant Temperature Sensor (CTS) uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see high signal voltage.

As the engine warms, the sensor resistance becomes less, and the voltage drops. At normal engine operating temperature (85°C to 95°C), the voltage will measure about 1.5 to 2.0 volts.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

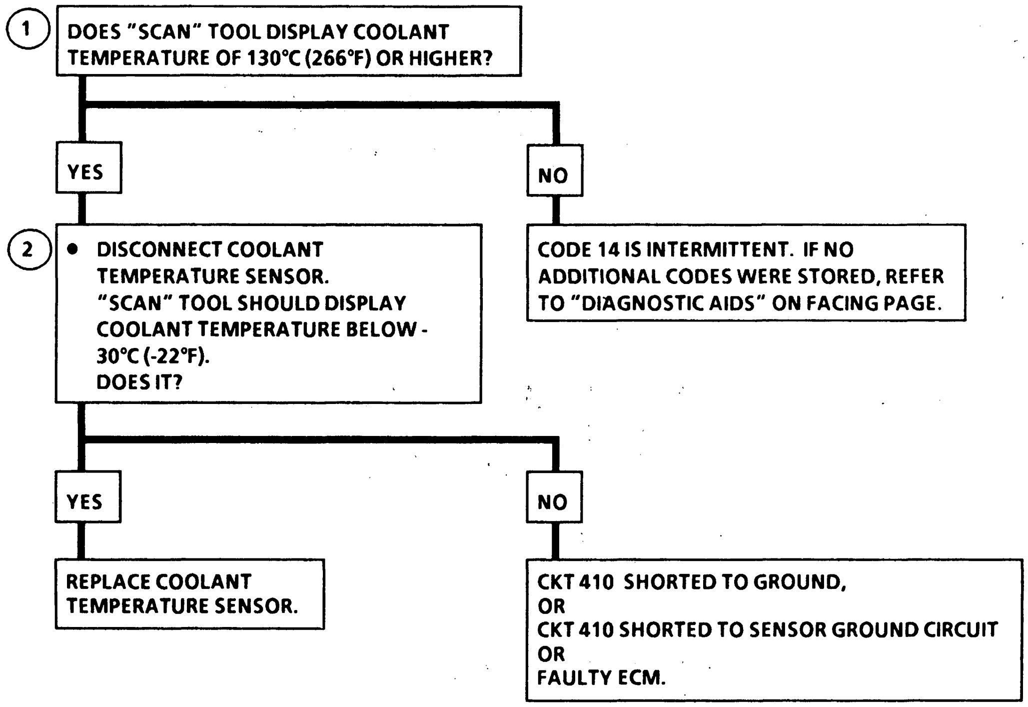
1. Code 14 will set if:
   - Signal voltage indicates a coolant temperature above 135°C (275°F) for 20 seconds.
2. This test will determine if CKT 410 is shorted to ground which will cause the conditions for Code 14.

Diagnostic Aids:

Check harness routing for a potential short to ground in CKT 410. "Scan" tool displays engine temperature in degrees centigrade. After engine is started, the temperature should rise steadily to about 90°C, then stabilize when thermostat opens. Refer to "Intermittents" in "Symptoms," Section "6E3-B".

CODE 14

COOLANT TEMPERATURE SENSOR (CTS) CIRCUIT
(HIGH TEMPERATURE INDICATED)
3.1L (VIN T) "F" CARLINE (PORT)



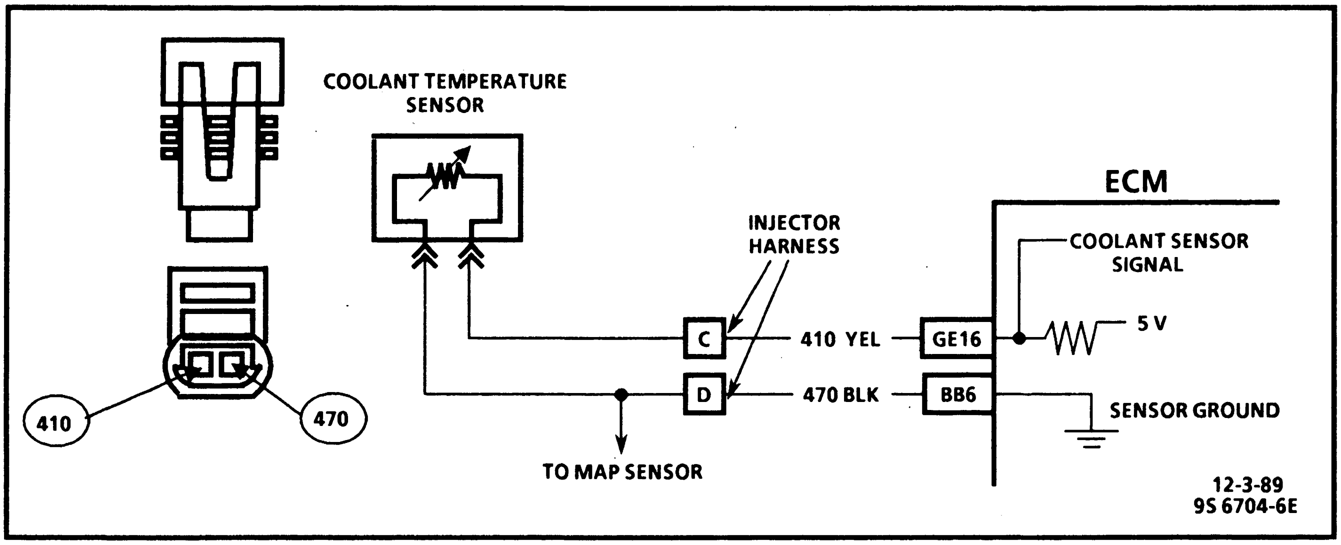
DIAGNOSTIC

COOLANT SENSOR

TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)

°C	°F	OHMS
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

AFTER REPAIRS CLEAR CODES, RUN ENGINE 5 MINUTES, AND RECHECK FOR



CODE 15

COOLANT TEMPERATURE SENSOR (CTS) CIRCUIT

(LOW TEMPERATURE INDICATED)

3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The Coolant Temperature Sensor (CTS) uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see high signal voltage.

As the engine warms, the sensor resistance becomes less and the voltage drops. At normal engine operating temperature (85°C to 95°C), the voltage will measure about 1.5 to 2.0 volts at the ECM.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 15 will set if:
   - Signal voltage indicates a coolant temperature less than -39°C (-38°F) for 20 second.
2. This test simulates a Code 14. If the ECM recognizes the low signal voltage, (high temperature) and the "Scan" reads 130°C, the ECM and wiring are OK.
3. This test will determine if CKT 410 is open. There should be 5 volts present at sensor connector, if measured with a DVOM.

Diagnostic Aids:

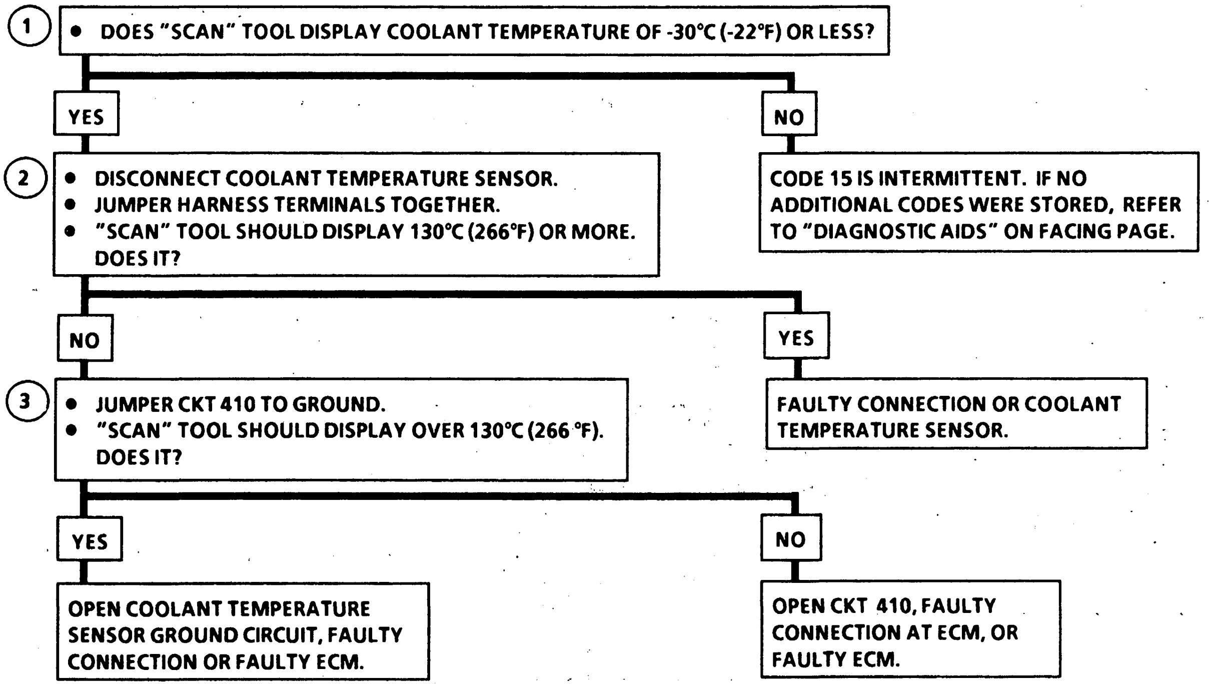
A "Scan" tool reads engine temperature in degrees centigrade. After engine is started, the temperature should rise steadily to about 90°C then stabilize when thermostat opens.

A faulty connection, or an open in CKT 410 or CKT 470 will result in a Code 15.

If Code 23 or CODE 33 is also set, check CKT 470 for faulty wiring or connections. Check terminals at sensor for good contact. Refer to "Intermittents" in "Symptoms," Section "6E3-B".

CODE 15

COOLANT TEMPERATURE SENSOR (CTS) CIRCUIT
(LOW TEMPERATURE INDICATED)
3.1L (VIN T) "F" CARLINE (PORT)



① • DOES "SCAN" TOOL DISPLAY COOLANT TEMPERATURE OF -30°C (-22°F) OR LESS?

YES

②
- DISCONNECT COOLANT TEMPERATURE SENSOR.
- JUMPER HARNESS TERMINALS TOGETHER.
- "SCAN" TOOL SHOULD DISPLAY 130°C (266°F) OR MORE. DOES IT?

NO

CODE 15 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

NO

③
- JUMPER CKT 410 TO GROUND.
- "SCAN" TOOL SHOULD DISPLAY OVER 130°C (266 °F). DOES IT?

YES

FAULTY CONNECTION OR COOLANT TEMPERATURE SENSOR.

YES

OPEN COOLANT TEMPERATURE SENSOR GROUND CIRCUIT, FAULTY CONNECTION OR FAULTY ECM.

NO

OPEN CKT 410, FAULTY CONNECTION AT ECM, OR FAULTY ECM.

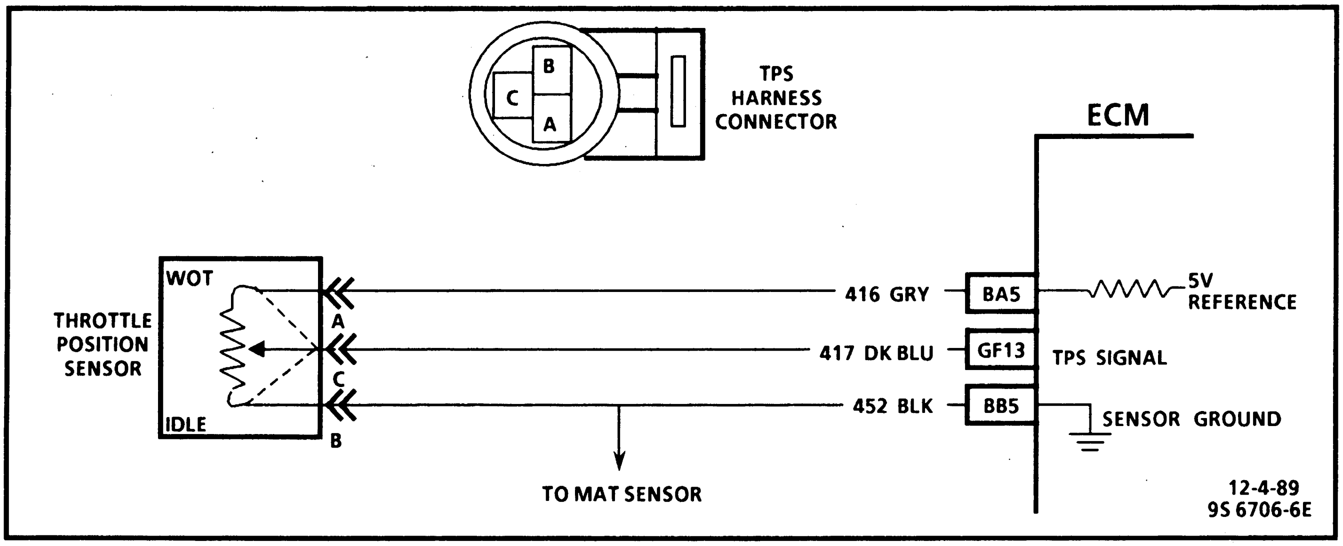
DIAGNOSTIC

COOLANT SENSOR

TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)

°C	°F	OHMS
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

AFTER REPAIRS, CLEAR CODES, RUN ENGINE 5 MINUTES, AND RECHECK FOR



CODE 21

THROTTLE POSITION SENSOR (TPS) CIRCUIT

(SIGNAL VOLTAGE HIGH)

3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The Throttle Position Sensor (TPS) provides a voltage signal that changes relative to the throttle blade. Signal voltage will vary from about .29 volt at idle to about 4.8 volts at Wide Open Throttle (WOT).

The TPS signal is one of the most important inputs used by the ECM for fuel control and for most of the ECM control outputs.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 21 will set if:
   - Engine is running.
   - TPS signal voltage is greater than 3.8 volts.
   - Air flow is less than 17 GM/sec.
   - All conditions met for 10 seconds.

   or
   - TPS check: The TPS has an auto zeroing feature. If the voltage reading is within the range of 0.29 to 0.98 volt, the ECM will use that value as closed throttle. If the voltage reading is out of the auto zero range on an existing or replacement TPS, make sure the cruise control and throttle cables are not being held open.
2. With the TPS sensor disconnected, the TPS voltage should go low if the ECM and wiring are OK.
3. Probing CKT 452 with a test light checks the 5 volts return circuit, because a faulty 5 volts return will cause a Code 21.

Diagnostic Aids:

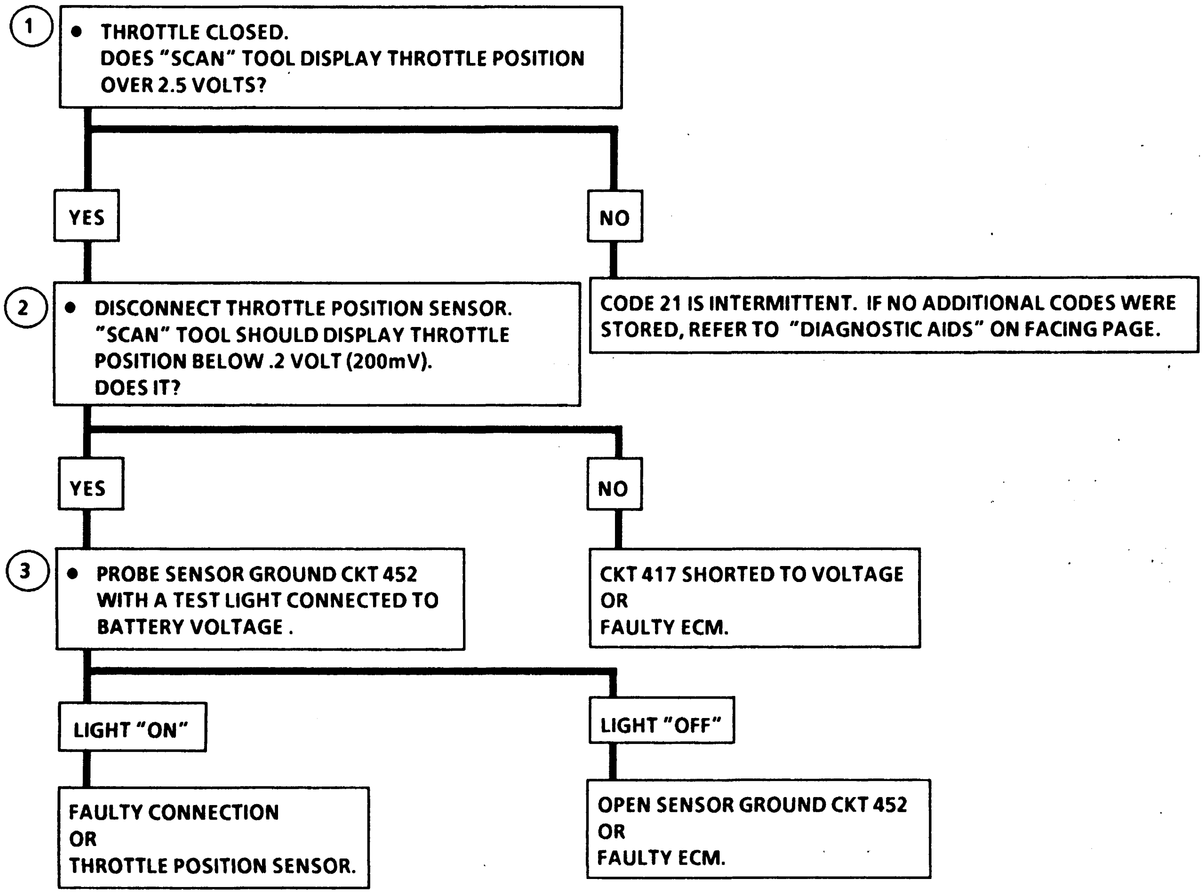
A "Scan" tool reads throttle position in volts. Voltage should increase at a steady rate as throttle is moved toward WOT.

Also, some "Scan" tools will read throttle angle 0% = closed throttle, 100% = WOT.

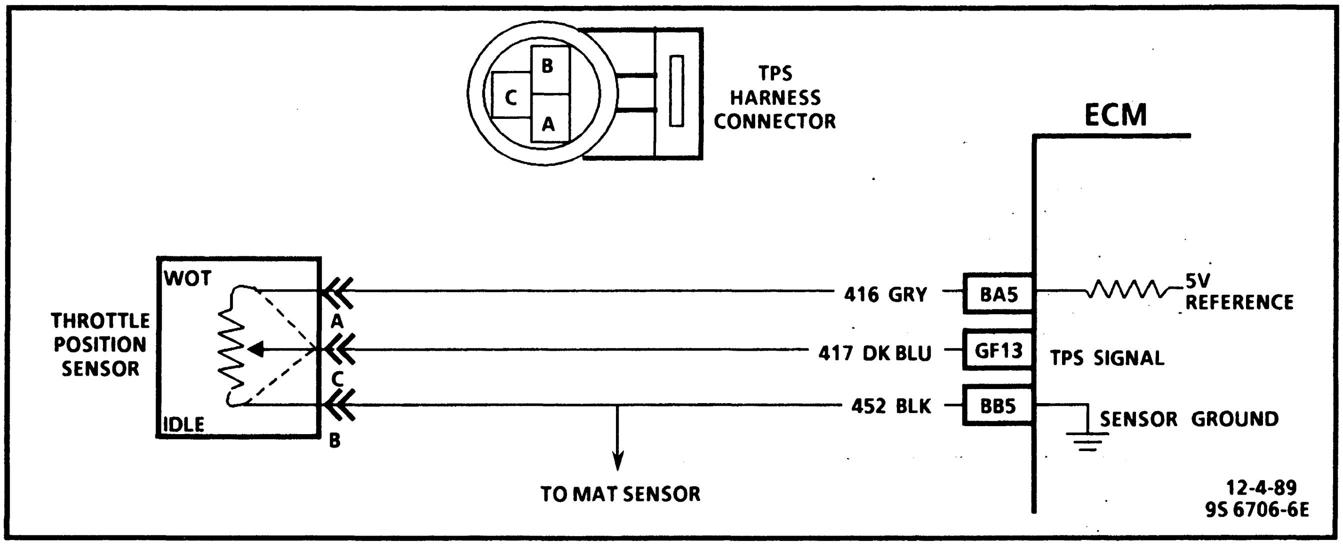
An open in CKT 452 will result in a Code 21. Refer to "Intermittents" in "Symptoms," Section "6E3-B".

CODE 21

THROTTLE POSITION SENSOR (TPS) CIRCUIT
(SIGNAL VOLTAGE HIGH)
3.1L (VIN T) "F" CARLINE (PORT)



AFTER REPAIRS, CLEAR CODES, RUN ENGINE FOR 2 MINUTES, AND RECHECK FOR



CODE 22

THROTTLE POSITION SENSOR (TPS) CIRCUIT

(SIGNAL VOLTAGE LOW)

3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The Throttle Position Sensor (TPS) provides a voltage signal that changes relative to the throttle blade. Signal voltage will vary from about .29 volt at idle to about 4.8 volts at Wide Open Throttle (WOT).

The TPS signal is one of the most important inputs used by the ECM for fuel control and for most of the ECM control outputs.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 22 will set if
   - Engine running
   - TPS signal voltage is less than about .2 volt.
2. Simulates Code 21: (high voltage) if the ECM recognizes the high signal voltage, the ECM and wiring are OK.
3. TPS check: The TPS has an auto zeroing feature. If the voltage reading is within the range of 0.29 to 0.98 volt, the ECM will use that value as closed throttle. If the voltage reading is out of the auto zero range on an existing or replacement TPS, make sure the cruise control and throttle cables are not being held open.
4. This simulates a high signal voltage to check for an open in CKT 417.
5. CKTs 416 and CKT 474 share a common sensor ground buffered reference signal. If either of these circuits is shorted to ground, Code 22 will set. To determine if the MAP sensor is causing the 22 problem, disconnect it to see if Code 22 resets. Be sure TPS is connected and clear codes before testing.

Diagnostic Aids:

A "Scan" tool reads throttle position in volts. Voltage should increase at a steady rate as throttle is moved toward WOT.

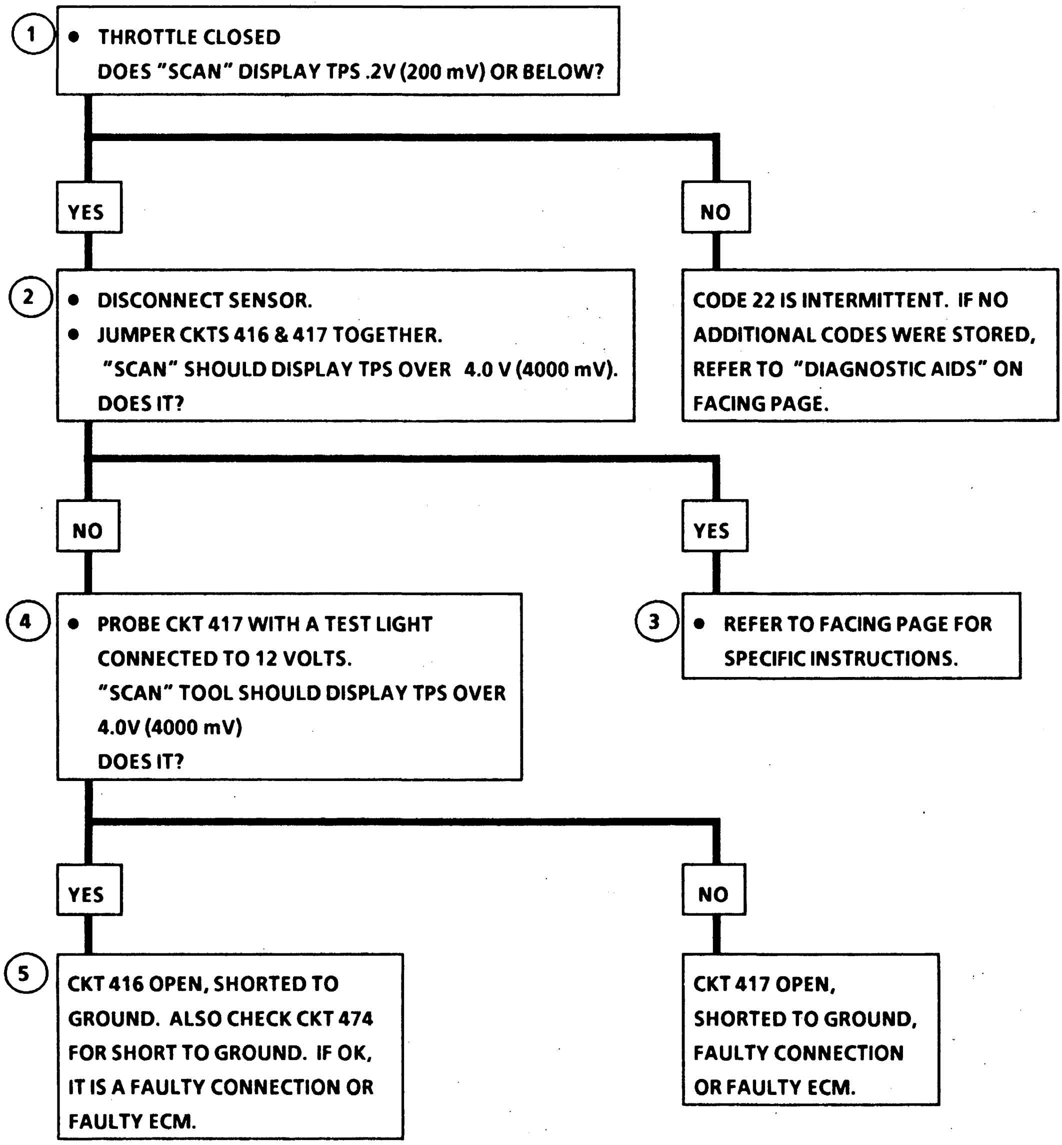
Also, some "Scan" tools will read: throttle angle 0% = closed throttle, 100% = WOT.

An open or short to ground in CKT 416 or CKT 417 will result in a Code 22. Also, a short to ground in CKT 474 will result in a Code 22.

Refer to "Intermittents" in "Symptoms," Section "6E3-B".

CODE 22

THROTTLE POSITION SENSOR (TPS) CIRCUIT
(SIGNAL VOLTAGE LOW)
3.1L (VIN T) "F" CARLINE (PORT)



① • THROTTLE CLOSED
DOES "SCAN" DISPLAY TPS .2V (200 mV) OR BELOW?

YES

② • DISCONNECT SENSOR.
• JUMPER CKTS 416 & 417 TOGETHER.
"SCAN" SHOULD DISPLAY TPS OVER 4.0 V (4000 mV).
DOES IT?

NO

CODE 22 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

NO

④ • PROBE CKT 417 WITH A TEST LIGHT CONNECTED TO 12 VOLTS.
"SCAN" TOOL SHOULD DISPLAY TPS OVER 4.0V (4000 mV)
DOES IT?

YES

③ • REFER TO FACING PAGE FOR SPECIFIC INSTRUCTIONS.

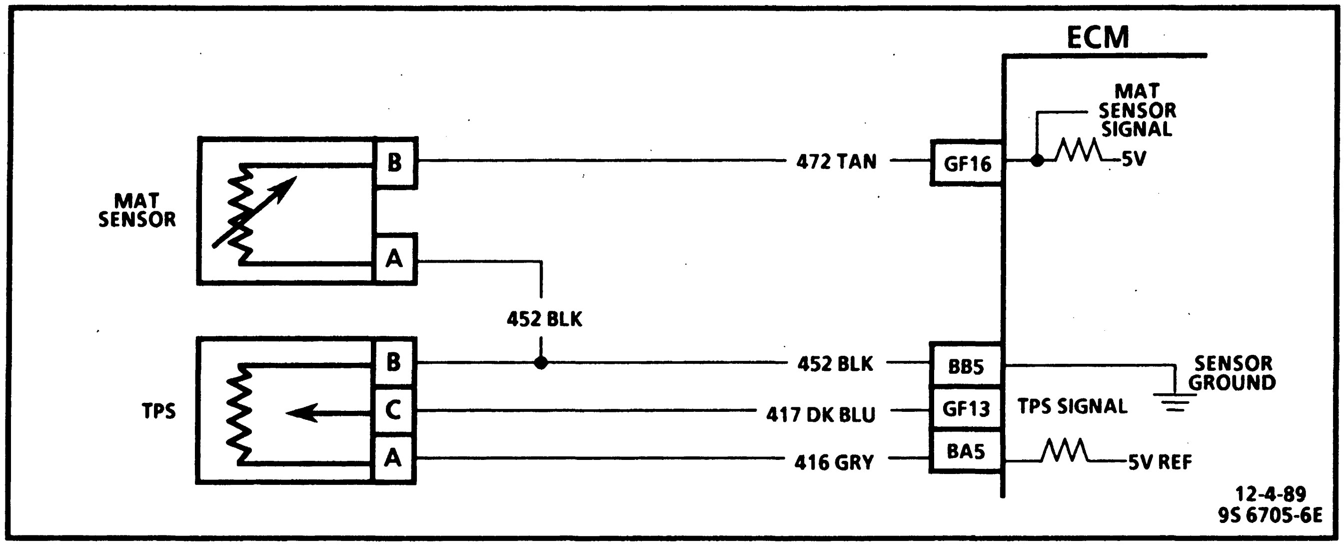
YES

⑤ CKT 416 OPEN, SHORTED TO GROUND. ALSO CHECK CKT 474 FOR SHORT TO GROUND. IF OK, IT IS A FAULTY CONNECTION OR FAULTY ECM.

NO

CKT 417 OPEN, SHORTED TO GROUND, FAULTY CONNECTION OR FAULTY ECM.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.



CODE 23

MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT

(LOW TEMPERATURE INDICATED)

3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The Manifold Air Temperature (MAT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage (about 5 volts) on CKT 472 to the sensor. When the air is cold, the sensor (thermistor) resistance is high, therefore the ECM will see a high signal voltage. If the air is warm, the sensor resistance is low, therefore, the ECM will see a low voltage.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 23 will set if:
   - A signal voltage indicates a manifold air temperature below -35°C (-31°F) for 10 seconds.
   - Time since engine start is 4 minutes or longer.
   - No VSS.
2. A Code 23 will set, due to an open sensor, wire, or connection. This test will determine if the wiring and ECM are OK.
3. This will determine if the signal CKT 472 or the sensor ground return CKT 452 is open.

Diagnostic Aids:

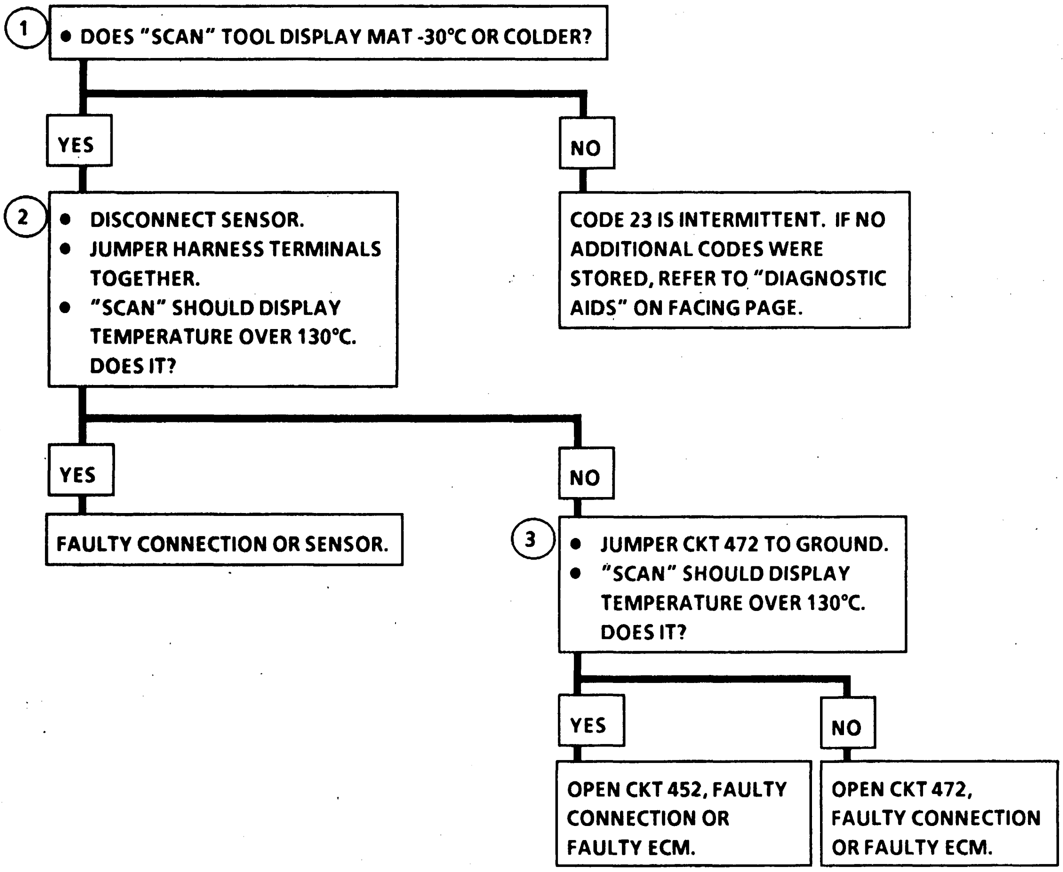
A "Scan" tool reads temperature of the air entering the engine and should read close to ambient air temperature when engine is cold, and rises as underhood temperature increases.

A faulty connection, or an open in CKT 472 or CKT 452 will result in a Code 23.

Refer to "Intermittents" in "Symptoms," Section "6E3-B".

CODE 23

MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT
(LOW TEMPERATURE INDICATED)
3.1L (VIN T) "F" CARLINE (PORT)



① • DOES "SCAN" TOOL DISPLAY MAT -30°C OR COLDER?

YES

② • DISCONNECT SENSOR.
• JUMPER HARNESS TERMINALS TOGETHER.
• "SCAN" SHOULD DISPLAY TEMPERATURE OVER 130°C. DOES IT?

YES

FAULTY CONNECTION OR SENSOR.

NO

③ • JUMPER CKT 472 TO GROUND.
• "SCAN" SHOULD DISPLAY TEMPERATURE OVER 130°C. DOES IT?

YES

OPEN CKT 452, FAULTY CONNECTION OR FAULTY ECM.

NO

OPEN CKT 472, FAULTY CONNECTION OR FAULTY ECM.

NO

CODE 23 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

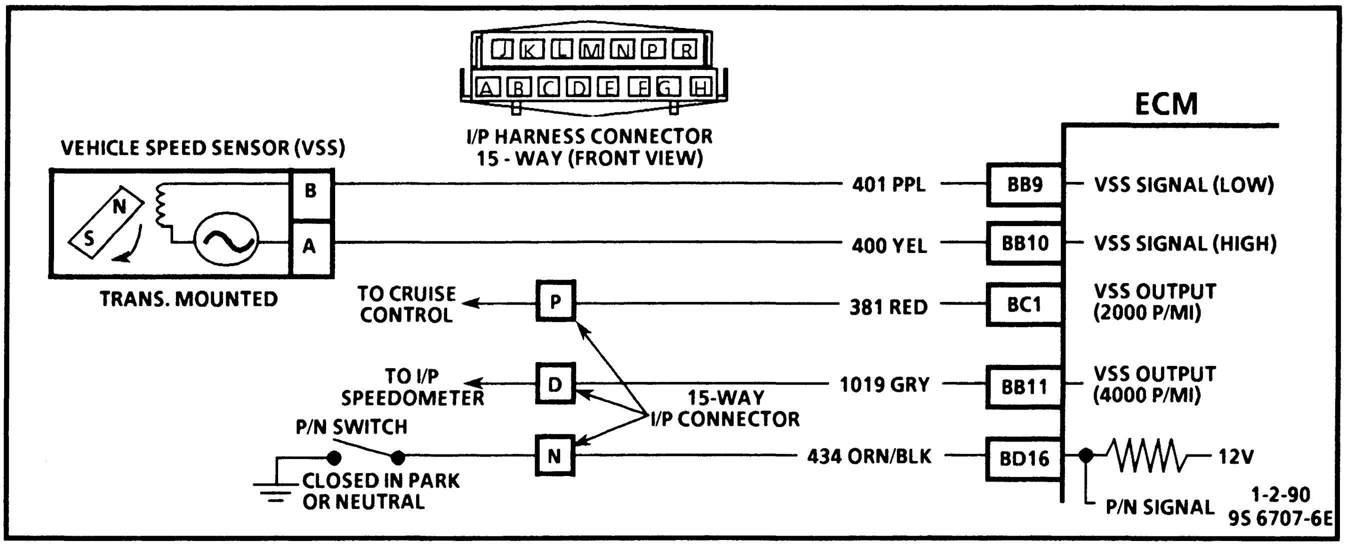
DIAGNOSTIC AID

MAT SENSOR

TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)

°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.



CODE 24

VEHICLE SPEED SENSOR (VSS) CIRCUIT
3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

Vehicle speed information is provided to the ECM by the Vehicle Speed Sensor (VSS), which is a Permanent Magnet (PM) generator and it is mounted in the transaxle. The PM generator produces a pulsing voltage, whenever vehicle speed is over about 3 mph. The A/C voltage level and the number of pulses increases with vehicle speed. The ECM then converts the pulsing voltage to mph which is used for calculations, and the mph can be displayed with a "Scan" tool.

The function of VSS buffer used in past model years has been incorporated into the ECM. The ECM then supplies the necessary signal for the instrument panel (4000 pulses per mile) for operating the speedometer and the odometer. If the vehicle is equipped with cruise control, the ECM also provides a signal (2000 pulses per mile) to the cruise control module

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 24 will set if vehicle speed equals 0 mph when:
   - Coolant temperature is greater than 85°C
   - Engine speed is between 2200 and 4400 rpm
   - TPS is less than 2%
   - Low load condition (low air flow)
   - Not in park or neutral
   - All conditions met for 3 seconds

   These conditions are met during a road load deceleration. Disregard Code 24 that sets when drive wheels are not turning.
   - The PM generator only produces a signal if drive wheels are turning greater than 3 mph.
2. CKTs 400, 401 and 381 are OK if the speedometer works properly. Code 24 is being caused by a faulty ECM, faulty MEM-CAL or an incorrect MEM-CAL.

Diagnostic Aids:

"Scan" should indicate a vehicle speed whenever the drive wheels are turning greater than 3 mph.

A problem in CKT 437 or CKT 381 will not affect the VSS input or the readings on a "Scan."

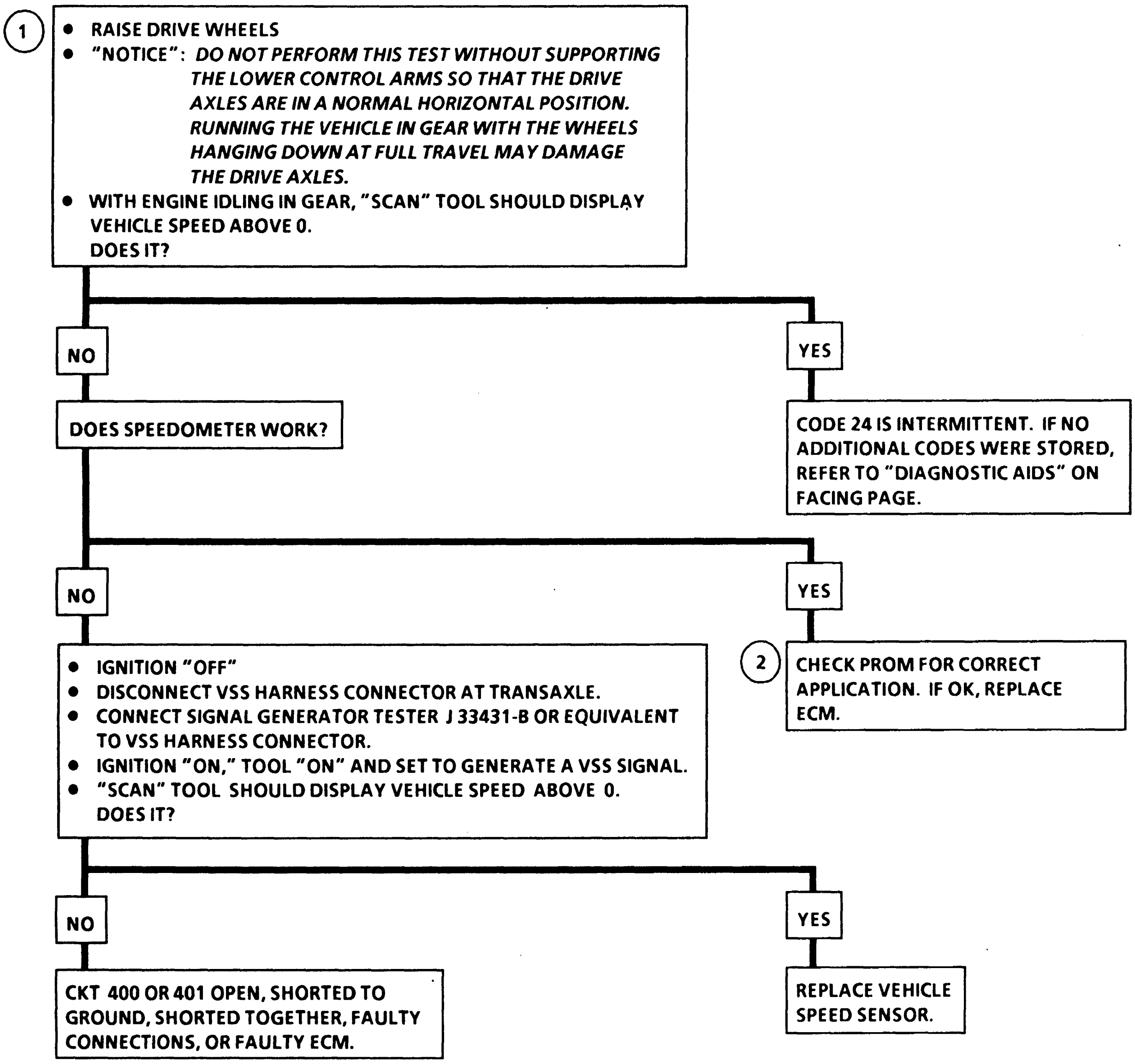
Check CKTs 400 and 401 for proper connections to be sure they're clean and tight and the harness is routed correctly. Refer to "Intermittents" in "Symptoms," Section "6E3-B".

(A/T) A faulty or misadjusted Park/Neutral (P/N) switch can result in a false Code 24. Use a "Scan" and check for proper signal while in drive 3L40 or overdrive 4L60. Refer to CHART C-1A for P/N switch diagnosis check.

CODE 24

VEHICLE SPEED SENSOR (VSS) CIRCUIT
3.1L (VIN T) "F" CARLINE (PORT)

DISREGARD CODE 24 IF SET WHILE DRIVE WHEELS ARE NOT TURNING.



①
- RAISE DRIVE WHEELS
- "NOTICE": *DO NOT PERFORM THIS TEST WITHOUT SUPPORTING THE LOWER CONTROL ARMS SO THAT THE DRIVE AXLES ARE IN A NORMAL HORIZONTAL POSITION. RUNNING THE VEHICLE IN GEAR WITH THE WHEELS HANGING DOWN AT FULL TRAVEL MAY DAMAGE THE DRIVE AXLES.*
- WITH ENGINE IDLING IN GEAR, "SCAN" TOOL SHOULD DISPLAY VEHICLE SPEED ABOVE 0. DOES IT?

DOES SPEEDOMETER WORK?

CODE 24 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

- IGNITION "OFF"
- DISCONNECT VSS HARNESS CONNECTOR AT TRANSAXLE.
- CONNECT SIGNAL GENERATOR TESTER J 33431-B OR EQUIVALENT TO VSS HARNESS CONNECTOR.
- IGNITION "ON," TOOL "ON" AND SET TO GENERATE A VSS SIGNAL.
- "SCAN" TOOL SHOULD DISPLAY VEHICLE SPEED ABOVE 0. DOES IT?

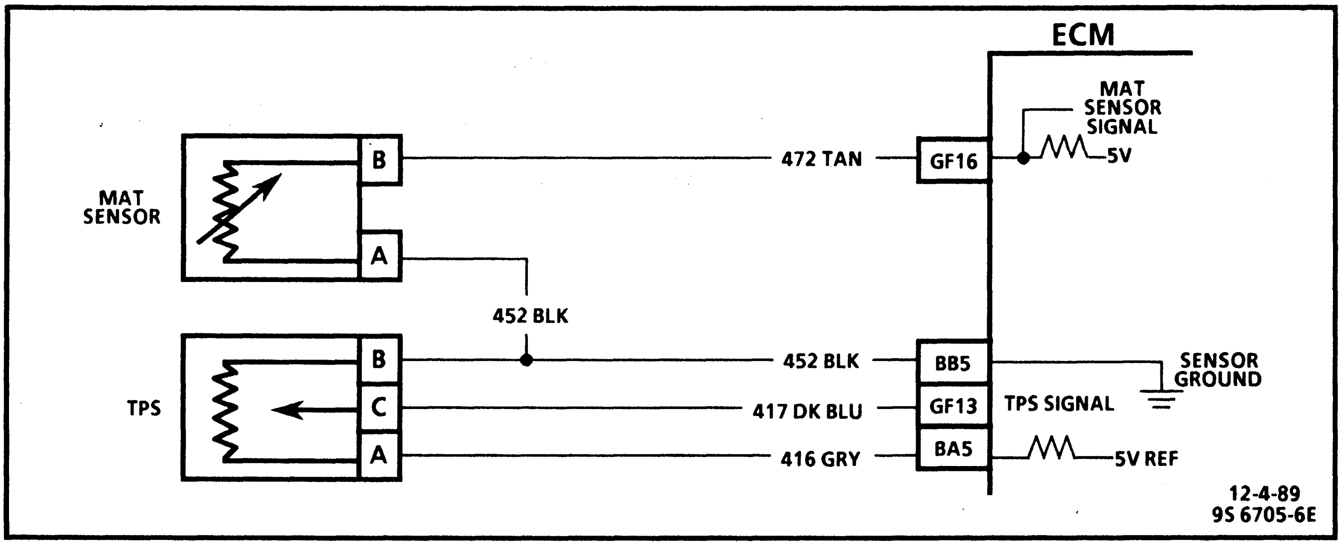
② CHECK PROM FOR CORRECT APPLICATION. IF OK, REPLACE ECM.

CKT 400 OR 401 OPEN, SHORTED TO GROUND, SHORTED TOGETHER, FAULTY CONNECTIONS, OR FAULTY ECM.

REPLACE VEHICLE SPEED SENSOR.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

5-23-88
• 7S 3269-6E



CODE 25

MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT

(HIGH TEMPERATURE INDICATED)

3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The Manifold Air Temperature (MAT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage (about 5 volts) on CKT 472 to the sensor. When manifold air is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see a high signal voltage. As the air warms, the sensor resistance becomes less, and the voltage drops.

Test Description: Number below refers to circled number on the diagnostic chart.

1. Code 25 will set if:
   - MAT signal voltage is less than or equal to .04 volts.
   - Signal voltage indicates a Manifold Air Temperature (MAT) greater than 145°C (293°F) for .2 second.
   - Time since engine start is 4 minutes or longer.
   - A vehicle speed is present.

Diagnostic Aids:

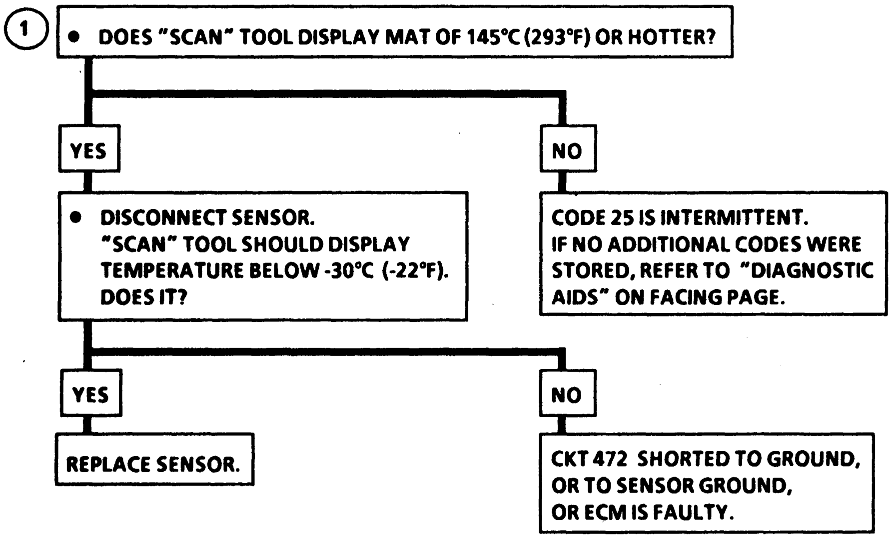
A "Scan" tool reads temperature of the air entering the engine and should read close to ambient air temperature when engine is cold and rises as underhood temperature increases.

A short to ground in CKT 472 will result in a Code 25.

Refer to "Intermittents" in "Symptoms," Section "6E3-B".

CODE 25

MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT
(HIGH TEMPERATURE INDICATED)
3.1L (VIN T) "F" CARLINE (PORT)

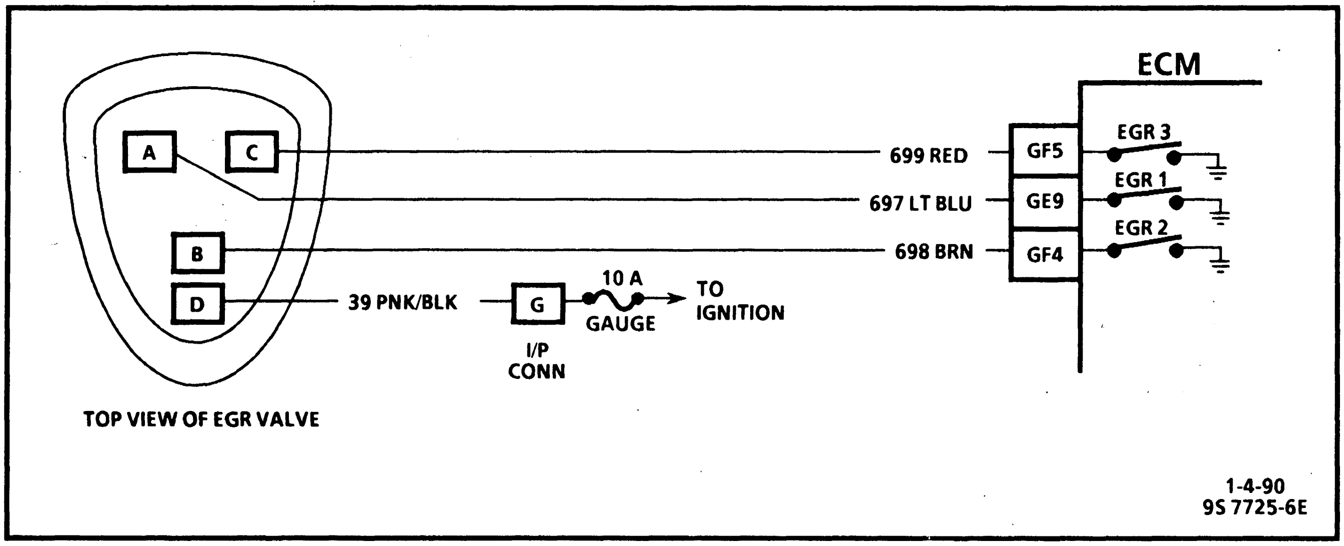


DIAGNOSTIC AID

MAT SENSOR		
TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)		
°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

3-6-89
• 7S 3190-6E



CODE 32

DIGITAL EGR
EXHAUST GAS RECIRCULATION (EGR) CIRCUIT
(ELECTRICAL DIAGNOSIS)
3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The ECM is programmed with an EGR diagnostic check to monitor flow through each individual valve in the three solenoid EGR valve.

When the vehicle is in the decel mode with the valves normally closed, the ECM opens each valve in succession (while keeping previous valves open) and manifold pressure is monitored for an appropriate increase associated with each valve's application. Should the calibrated response in manifold pressure not be seen by the ECM, a Code 32 will set.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

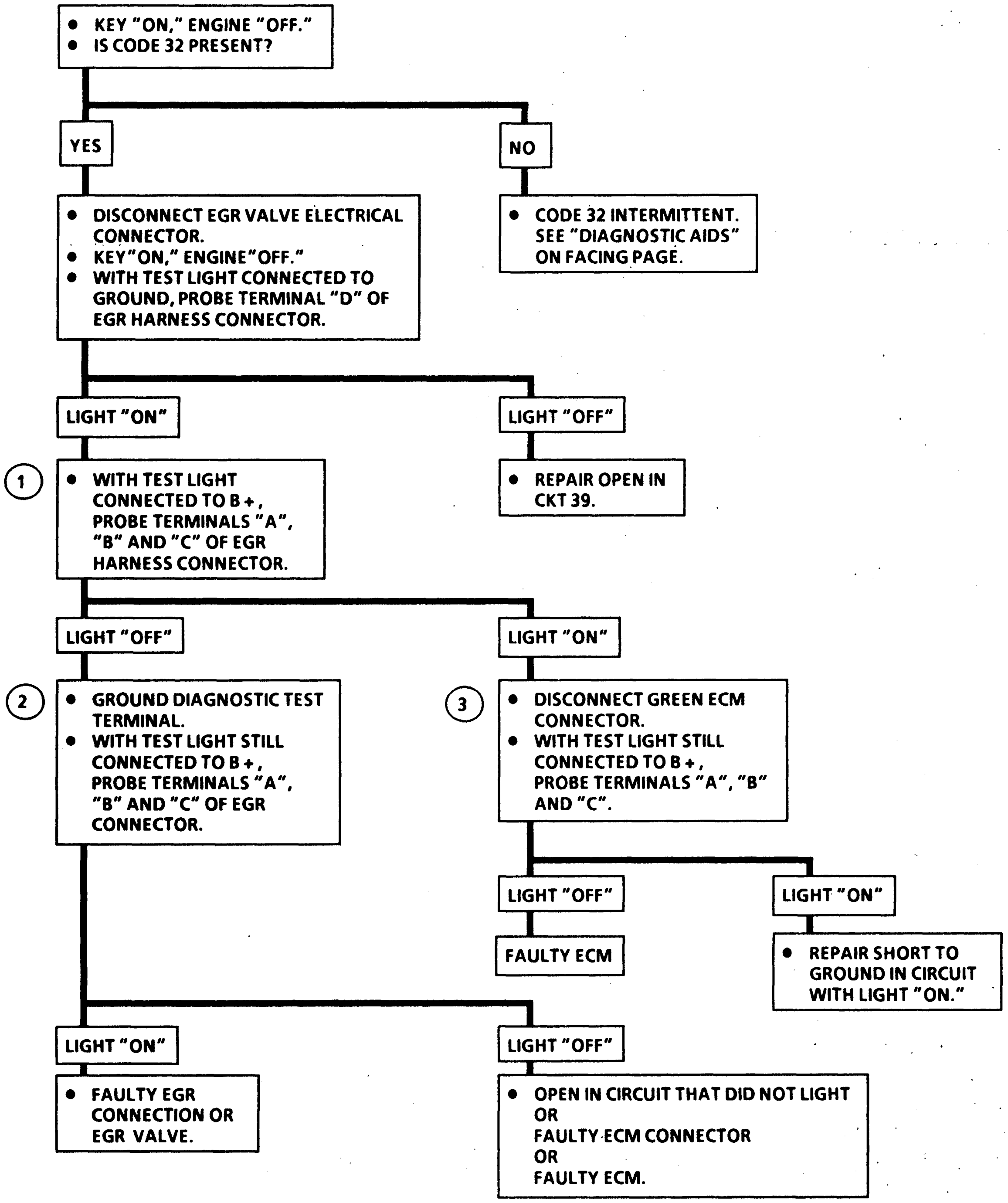
1. This test determines if there is power to the EGR valve.
2. This test will determine if there is an open circuit in the EGR wiring or if the EGR valve is at fault.
3. This test will determine if there is a short to ground in any circuit going to the EGR valve or if the ECM is at fault.

Diagnostic Aids:

An intermittent may be caused by a poor connection, rubbed-through wire insulation, or a wire broken inside the insulation.

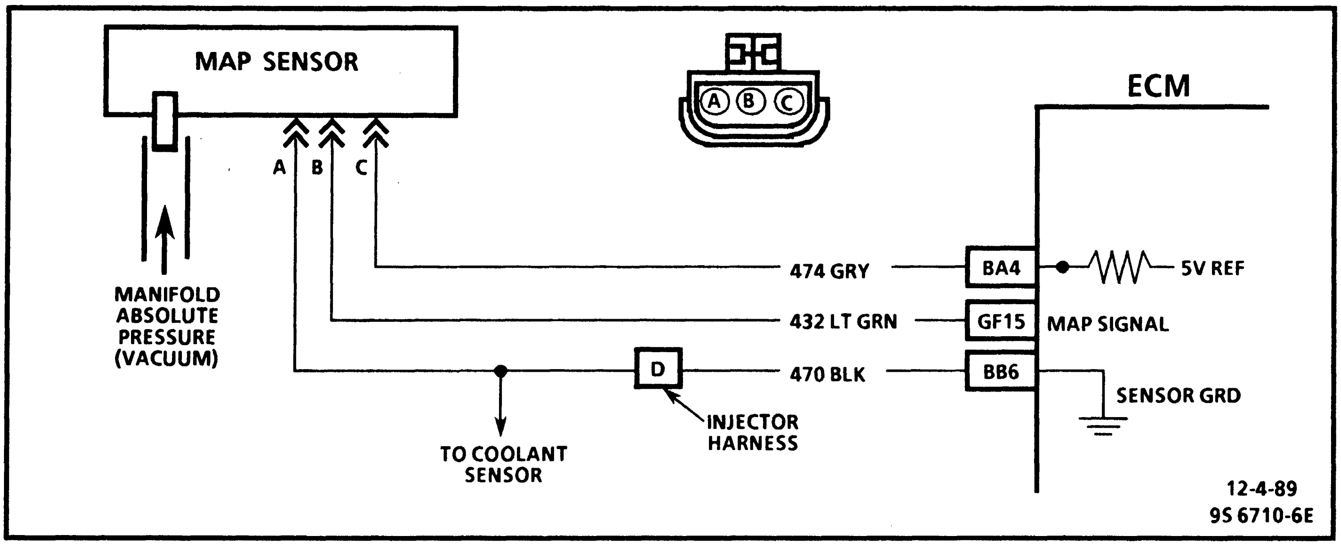
CODE 32

DIGITAL EGR
EXHAUST GAS RECIRCULATION (EGR) CIRCUIT
(ELECTRICAL DIAGNOSIS)
3.1L (VIN T) "F" CARLINE (PORT)



* THESE STEPS MUST BE DONE VERY QUICKLY AS THE ECM WILL COMPENSATE FUEL DELIVERY.

5-13-89
9S-6069-6E



CODE 33

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT

(SIGNAL VOLTAGE HIGH - LOW VACUUM)

3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1–1.5 volts at idle (high vacuum) to 4–4.5 volts at Wide Open Throttle (WOT) (low vacuum).

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 33 will set when:
   - Engine running
   - Manifold pressure greater than 74 kPa (A/C "OFF") 83.4 kPa (A/C "ON").
   - Throttle angle less than 2%
   - Conditions met for 5 seconds

     and
   - Vehicle in first gear

     or
   - Vehicle not in first gear and TPS is less than or equal to 6%

   Engine misfire or a low unstable idle may set Code 33.
2. With the MAP sensor disconnected, the ECM should see a low voltage if the ECM and wiring are OK.

Diagnostic Aids:

If idle is rough or unstable, refer to "Symptoms," in Section "6E3-B" for items which can cause an unstable idle.

An open in CKT 470 or the connection will result in a Code 33.

Ignition "ON" engine "OFF," voltages should be within the values shown in the table in "Electronic Control Module (ECM) and Sensors," Section "6E3-C1" CHART C-1D, this chart can be used to test the MAP sensor.

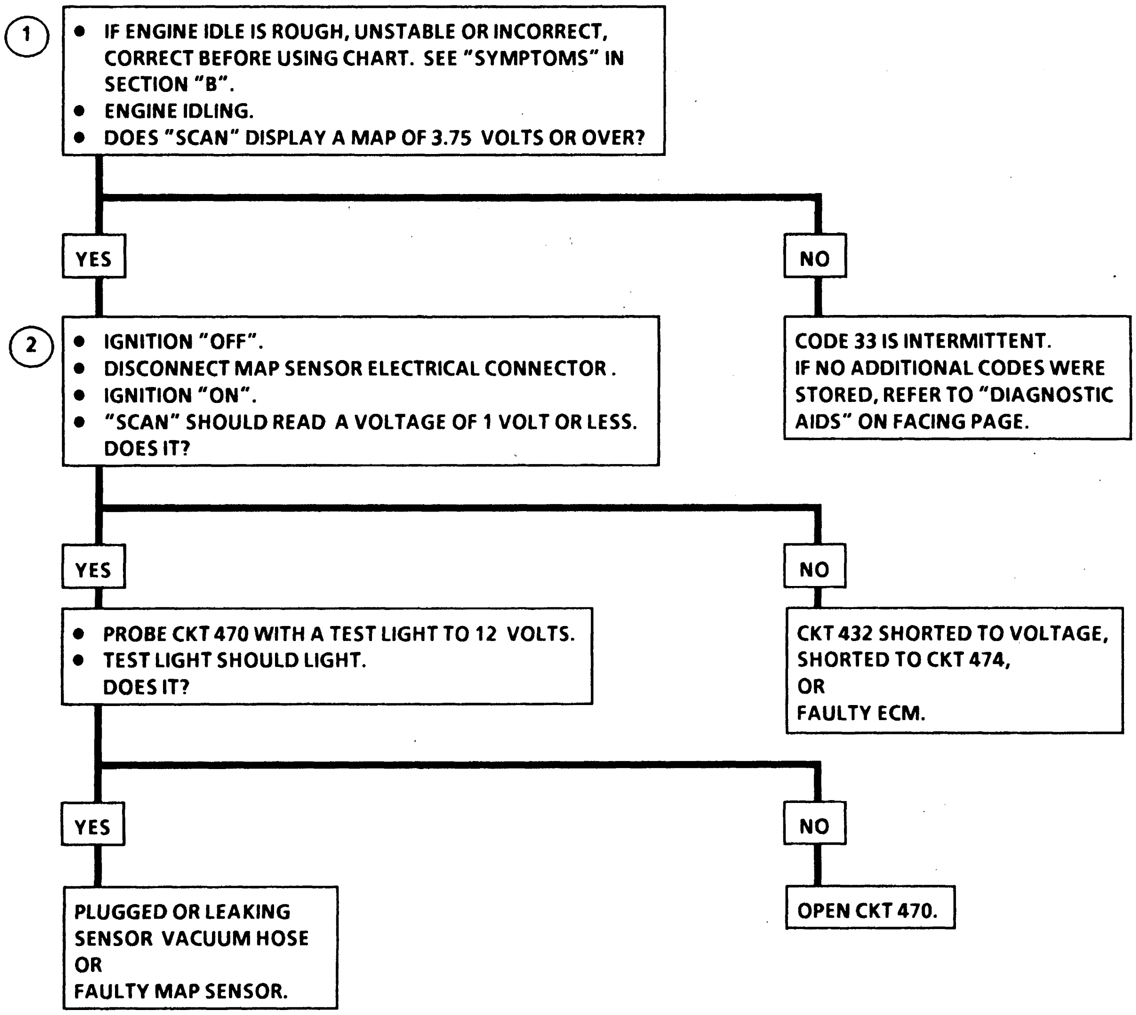
Refer to "Intermittents" in "Symptoms," Section "6E3-B".

CODE 33

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT

(SIGNAL VOLTAGE HIGH - LOW VACUUM)

3.1L (VIN T) "F" CARLINE (PORT)



- IF ENGINE IDLE IS ROUGH, UNSTABLE OR INCORRECT, CORRECT BEFORE USING CHART. SEE "SYMPTOMS" IN SECTION "B".
- ENGINE IDLING.
- DOES "SCAN" DISPLAY A MAP OF 3.75 VOLTS OR OVER?

- IGNITION "OFF".
- DISCONNECT MAP SENSOR ELECTRICAL CONNECTOR .
- IGNITION "ON".
- "SCAN" SHOULD READ A VOLTAGE OF 1 VOLT OR LESS. DOES IT?

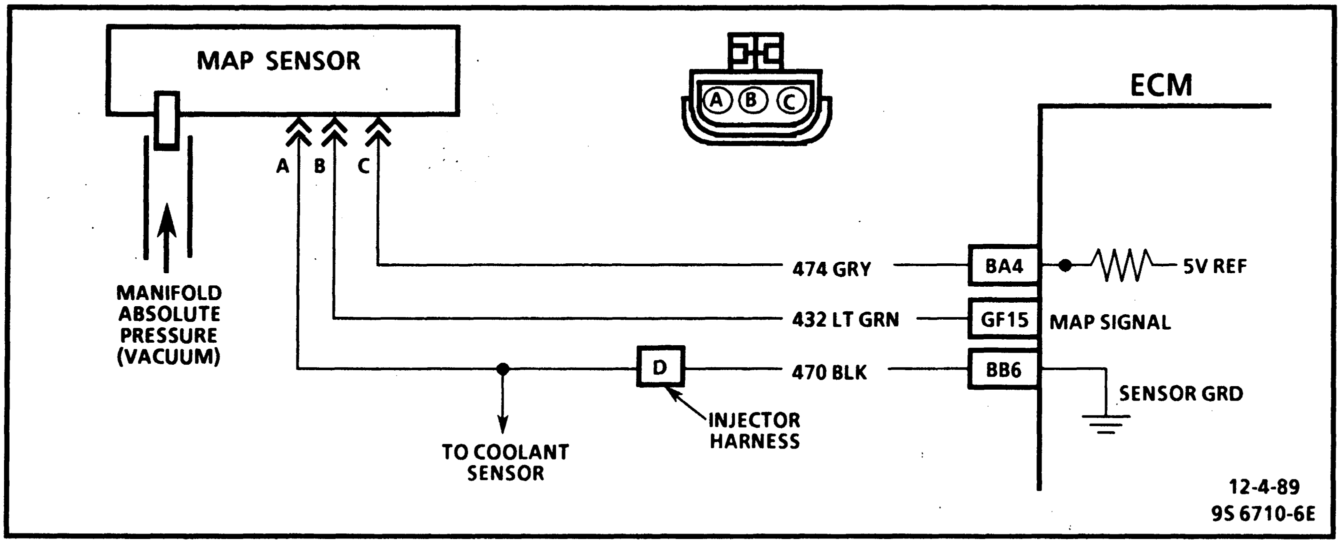
- PROBE CKT 470 WITH A TEST LIGHT TO 12 VOLTS.
- TEST LIGHT SHOULD LIGHT. DOES IT?

PLUGGED OR LEAKING SENSOR VACUUM HOSE
OR
FAULTY MAP SENSOR.

OPEN CKT 470.

CKT 432 SHORTED TO VOLTAGE,
SHORTED TO CKT 474,
OR
FAULTY ECM.

CODE 33 IS INTERMITTENT.
IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.



CODE 34

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT

(SIGNAL VOLTAGE LOW - HIGH VACUUM)

3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1–1.5 volts at idle (high vacuum) to 4–4.5 volts at Wide Open Throttle (WOT) (low vacuum).

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 34 will set if:
   - Engine rpm less than 1200
   - Manifold pressure reading less than 13 kPa
   - Conditions met for 1 second

   or
   - Engine rpm greater than 1200
   - Throttle angle over 20%
   - Manifold pressure less than 13 kPa
   - Conditions met for 1 second
2. This test to see if the sensor is at fault for the low voltage, or if there is an ECM or wiring problem.
3. This simulates a high signal voltage to check for an open in CKT 432. If the test light is bright during this test, CKT 432 is probably shorted to ground. If "Scan" reads over 4 volts at this test, CKT 474 can be checked by measuring the voltage at terminal "C" (should be 5 volts).

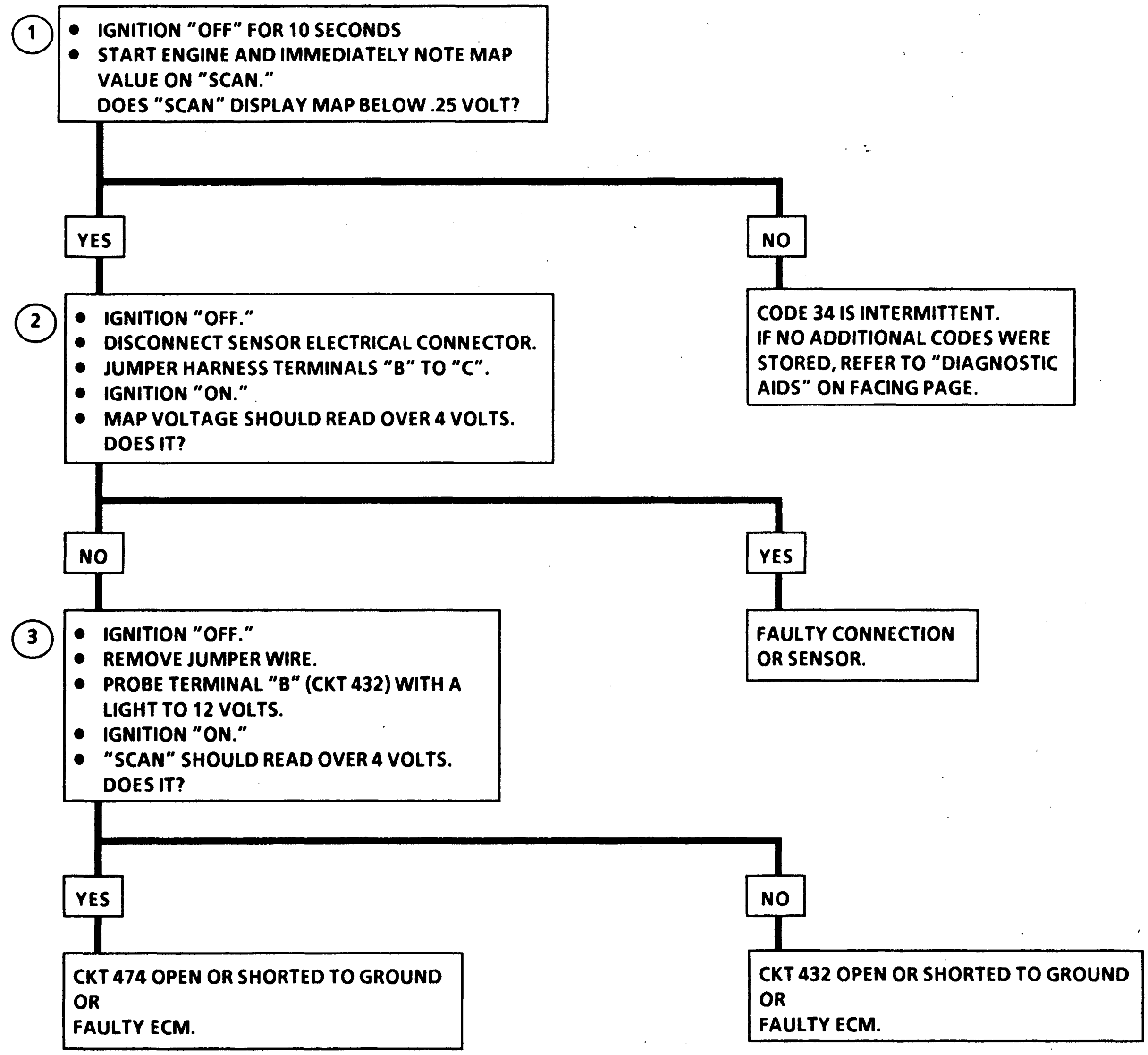
Diagnostic Aids:

An intermittent open in CKTs 432 or 474 will result in a Code 34.

Ignition "ON" engine "OFF," voltages should be within the values shown in the table in "Electronic Control Module (ECM) and Sensors," Section "6E3-C1" CHART C-1D, this chart can be used to test MAP sensor.

Refer to "Intermittents" in "Symptoms," Section "6E3-B".

CODE 34
MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT
(SIGNAL VOLTAGE LOW - HIGH VACUUM)
3.1L (VIN T) "F" CARLINE (PORT)



(1)
- IGNITION "OFF" FOR 10 SECONDS
- START ENGINE AND IMMEDIATELY NOTE MAP VALUE ON "SCAN."

DOES "SCAN" DISPLAY MAP BELOW .25 VOLT?

YES

(2)
- IGNITION "OFF."
- DISCONNECT SENSOR ELECTRICAL CONNECTOR.
- JUMPER HARNESS TERMINALS "B" TO "C".
- IGNITION "ON."
- MAP VOLTAGE SHOULD READ OVER 4 VOLTS.

DOES IT?

NO

(3)
- IGNITION "OFF."
- REMOVE JUMPER WIRE.
- PROBE TERMINAL "B" (CKT 432) WITH A LIGHT TO 12 VOLTS.
- IGNITION "ON."
- "SCAN" SHOULD READ OVER 4 VOLTS.

DOES IT?

YES

CKT 474 OPEN OR SHORTED TO GROUND
OR
FAULTY ECM.

NO

CKT 432 OPEN OR SHORTED TO GROUND
OR
FAULTY ECM.

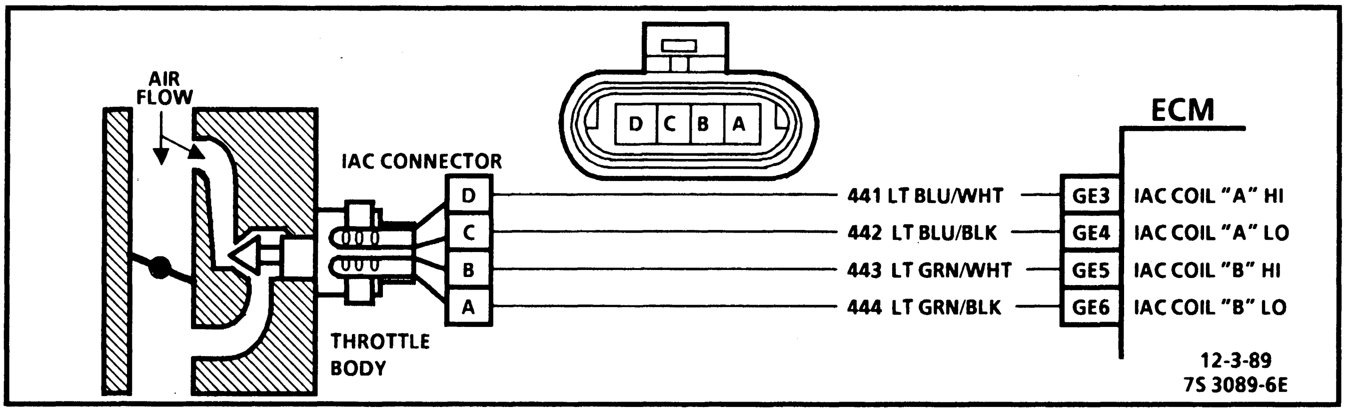
(2) YES

FAULTY CONNECTION
OR SENSOR.

(1) NO

CODE 34 IS INTERMITTENT.
IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

12-4-89
9S 5201-6E



CODE 35

IDLE AIR CONTROL (IAC) CIRCUIT SYSTEM CHECK (TECH 1)

3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

Code 35 will set when the closed throttle engine speed is 125 rpm above or below the desired (commanded) idle speed for 45 seconds. Review the general description of the IAC operation in "Fuel Metering System" Section "6E3-C2".

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. The Tech 1 rpm control mode is used to extend and retract the IAC valve. The valve should move smoothly within the specified range. If the idle speed is commanded (IAC extended) too low (below 700 rpm), the engine may stall. This may be normal and would not indicate a problem. Retracting the IAC beyond its controlled range (above 1500 rpm) will cause a delay before the rpm's start dropping. This too is normal.
2. This test uses the Tech 1 to command the IAC controlled idle speed. The ECM issues commands to obtain commended idle speed. The node lights each should flash red and green to indicate a good circuit as the ECM issues commands. While the sequence of color is not important if either light is "OFF" or does not flash red and green, check the circuits for faults, beginning with poor terminal contacts.

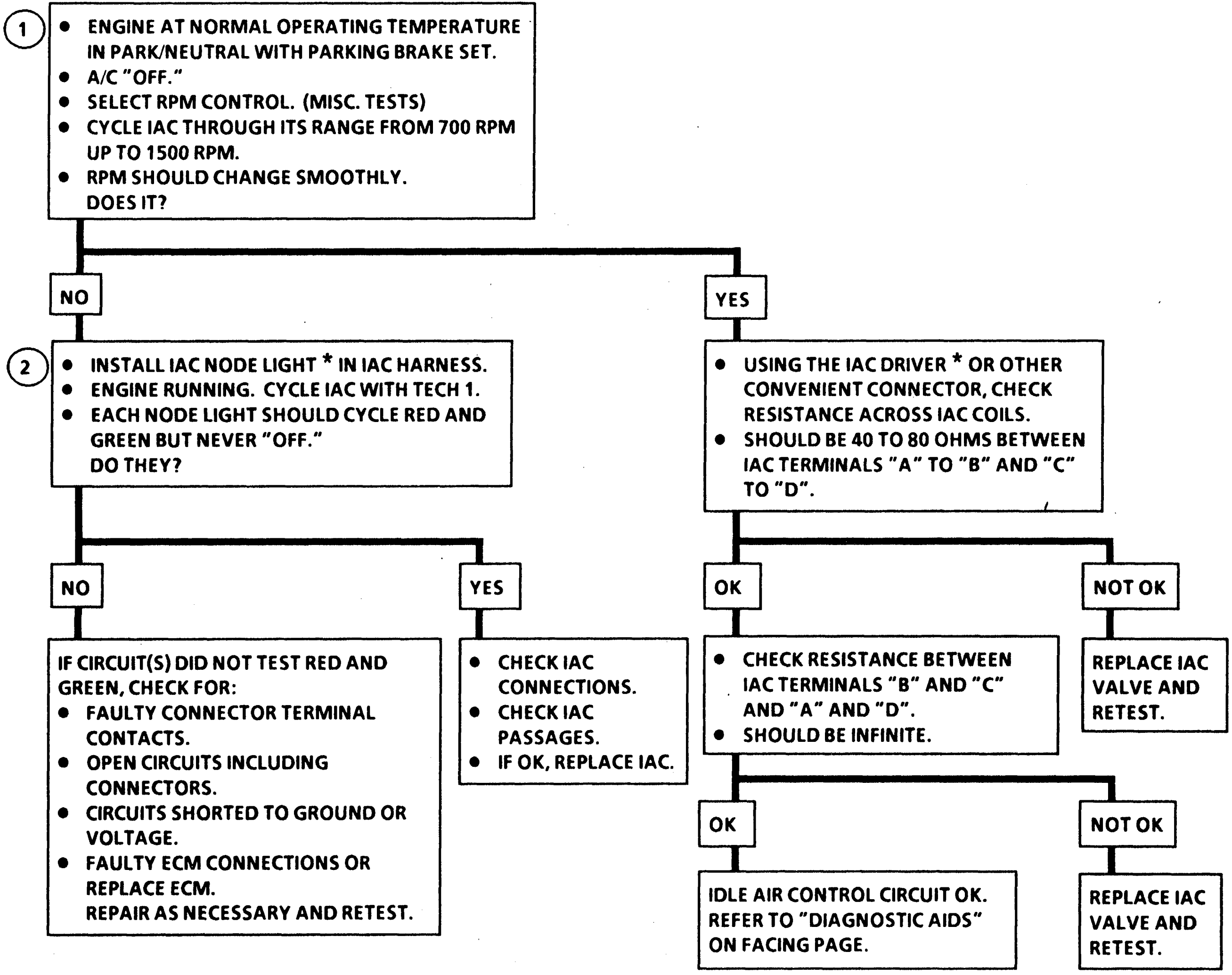
Diagnostic Aids:

A slow unstable, or fast idle may be caused by a non-IAC system problem that cannot be overcome by the IAC valve. Out of control range IAC "Scan" tool counts will be above 60 if idle is too low, and zero counts if idle is too high. The following checks should be made to repair a non-IAC system problem:

- Vacuum Leak (High Idle) If idle is too high, stop the engine. Fully extend (low) IAC with tester. Start engine. If idle speed is above 800 rpm, locate and correct vacuum leak including PCV system. Also check for binding of throttle blade or linkage.
- System too lean (High Air/Fuel Ratio) The idle speed may be too high or too low. Engine speed may vary up and down and disconnecting the IAC valve does not help. Code 44 may be set. "Scan" O_2 voltage will be less than 300 mv (.3 volt). Check for low regulated fuel pressure, water in the fuel or a restricted injector.
- System too rich (low air/fuel ratio) Idle speed too low. "Scan" tool IAC counts will usually be above 80. System is obviously rich and may exhibit black smoke in exhaust.
  "Scan" O_2 voltage will be fixed above 800 mv (.8 volt).
  Check for high fuel pressure, leaking or sticking injector. Silicone contaminated O_2 sensors "Scan" voltage will be slow to respond.
- Throttle body Remove IAC valve and inspect bore for foreign material.
- IAC Valve Electrical Connections IAC valve connections should be carefully checked for proper contact.
- PCV Valve An incorrect or faulty PCV valve may result in an incorrect idle speed.
- Refer to "Rough, Unstable, Incorrect Idle or Stalling" in "Symptoms," Section "6E3-B".
- If intermittent poor driveability or idle symptoms are resolved by disconnecting the IAC, carefully recheck connections, valve terminal resistance, or replace IAC.

CODE 35

IDLE AIR CONTROL (IAC) CIRCUIT SYSTEM CHECK (TECH 1) 3.1L (VIN T) "F" CARLINE (PORT)



①
- ENGINE AT NORMAL OPERATING TEMPERATURE IN PARK/NEUTRAL WITH PARKING BRAKE SET.
- A/C "OFF."
- SELECT RPM CONTROL. (MISC. TESTS)
- CYCLE IAC THROUGH ITS RANGE FROM 700 RPM UP TO 1500 RPM.
- RPM SHOULD CHANGE SMOOTHLY.

DOES IT?

②
- INSTALL IAC NODE LIGHT * IN IAC HARNESS.
- ENGINE RUNNING. CYCLE IAC WITH TECH 1.
- EACH NODE LIGHT SHOULD CYCLE RED AND GREEN BUT NEVER "OFF."

DO THEY?

IF CIRCUIT(S) DID NOT TEST RED AND GREEN, CHECK FOR:
- FAULTY CONNECTOR TERMINAL CONTACTS.
- OPEN CIRCUITS INCLUDING CONNECTORS.
- CIRCUITS SHORTED TO GROUND OR VOLTAGE.
- FAULTY ECM CONNECTIONS OR REPLACE ECM.

REPAIR AS NECESSARY AND RETEST.

- CHECK IAC CONNECTIONS.
- CHECK IAC PASSAGES.
- IF OK, REPLACE IAC.

- USING THE IAC DRIVER * OR OTHER CONVENIENT CONNECTOR, CHECK RESISTANCE ACROSS IAC COILS.
- SHOULD BE 40 TO 80 OHMS BETWEEN IAC TERMINALS "A" TO "B" AND "C" TO "D".

- CHECK RESISTANCE BETWEEN IAC TERMINALS "B" AND "C" AND "A" AND "D".
- SHOULD BE INFINITE.

IDLE AIR CONTROL CIRCUIT OK. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

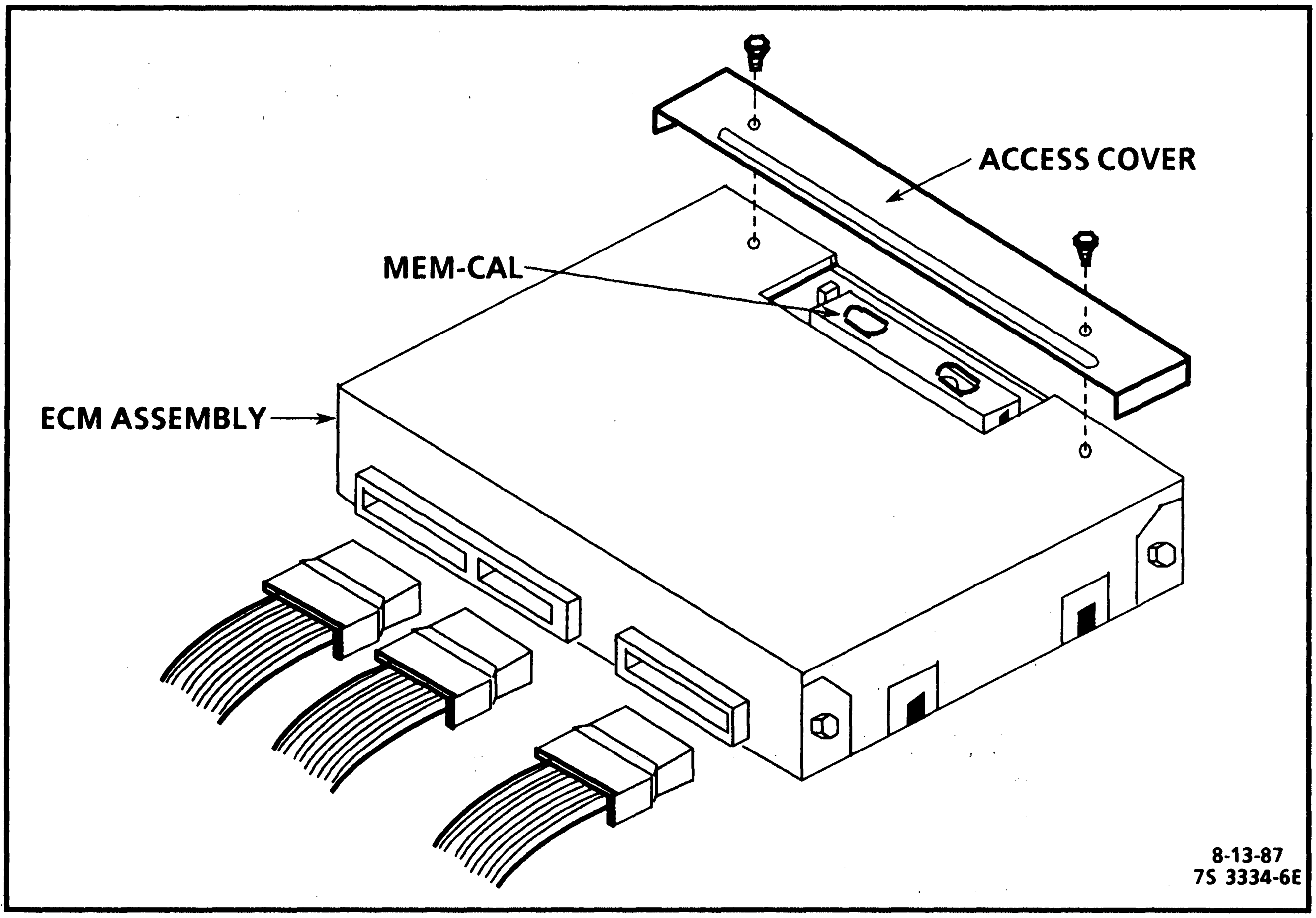
REPLACE IAC VALVE AND RETEST.

REPLACE IAC VALVE AND RETEST.

* IAC DRIVER AND NODE LIGHT REQUIRED KIT
222-L FROM: CONCEPT TECHNOLOGY, INC.
J 37027 FROM: KENT-MOORE, INC.

CLEAR CODES, CONFIRM "CLOSED LOOP" OPERATION, NO "SERVICE ENGINE SOON" LIGHT, PERFORM IAC RESET PROCEDURE PER APPLICABLE SERVICE MANUAL AND VERIFY CONTROLLED IDLE SPEED IS CORRECT.

4-26-89
• 9S 6034-6E



CODE 41

CYLINDER SELECT ERROR
(FAULTY OR INCORRECT MEM-CAL)
3.1L (VIN T) "F" CARLINE (PORT)

Test Description: Number below refers to circled number on the diagnostic chart.

1. The ECM used for this engine can also be used for other engines, and the difference is in the MEM-CAL. If a Code 41 sets, the incorrect MEM-CAL has been installed, or it is faulty and must be replaced.

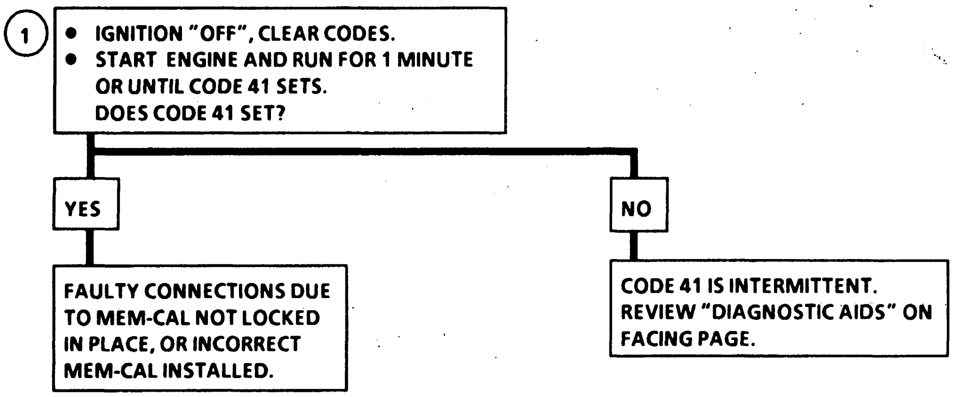
Diagnostic Aids:

Check MEM-CAL to be sure locking tabs are secure.

Also check the pins on both the MEM-CAL and ECM to assure they are making proper contact. Check the MEM-CAL part number to assure it is the correct part. If the MEM-CAL is faulty it must be replaced. It is also possible that the ECM is faulty, however, it should not be replaced until all of the above have been checked. For additional information, refer to "Intermittents" in "Symptoms," Section "6E3-B".

CODE 41

CYLINDER SELECT ERROR
(FAULTY OR INCORRECT MEM-CAL)
3.1L (VIN T) "F" CARLINE (PORT)

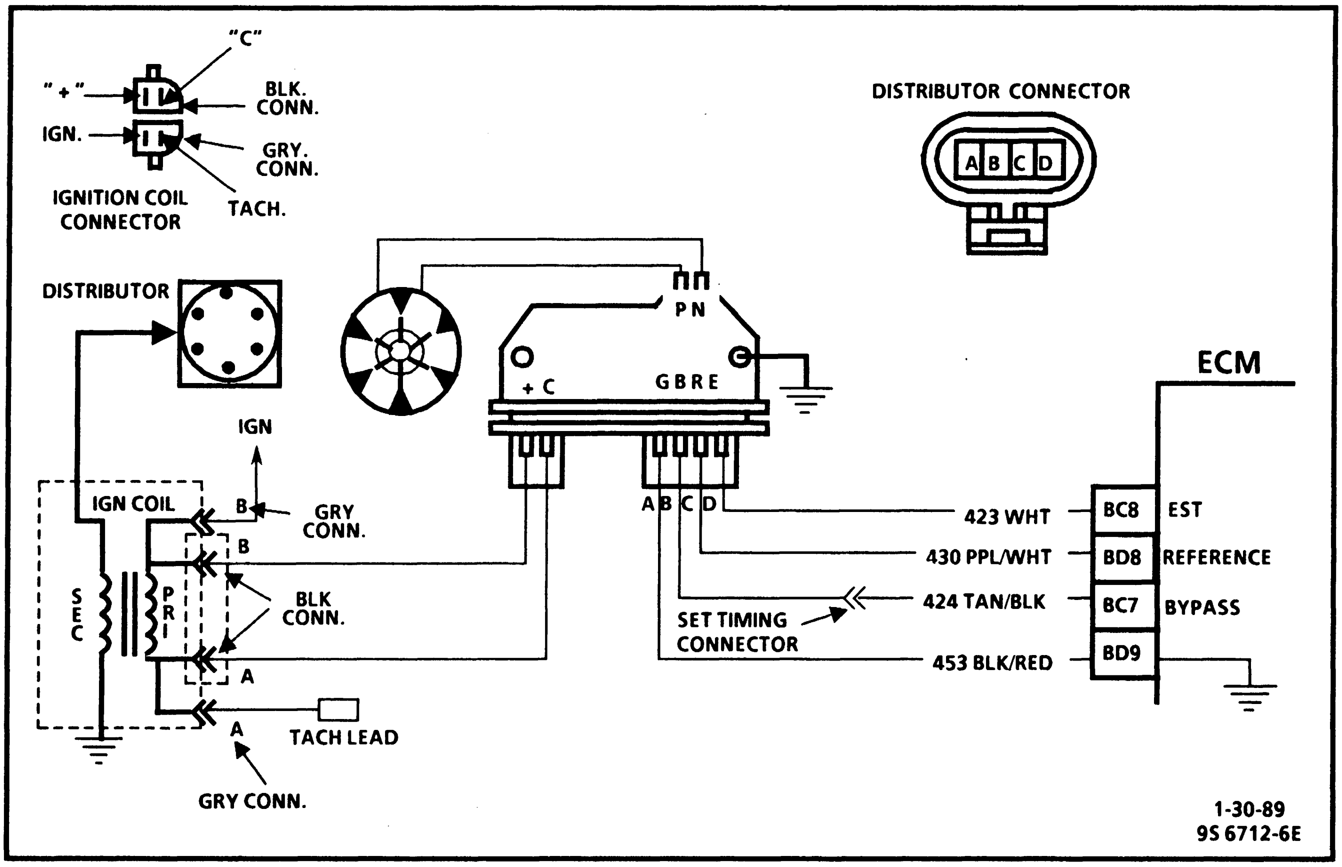


- IGNITION "OFF", CLEAR CODES.
- START ENGINE AND RUN FOR 1 MINUTE OR UNTIL CODE 41 SETS.
DOES CODE 41 SET?

FAULTY CONNECTIONS DUE TO MEM-CAL NOT LOCKED IN PLACE, OR INCORRECT MEM-CAL INSTALLED.

CODE 41 IS INTERMITTENT. REVIEW "DIAGNOSTIC AIDS" ON FACING PAGE.

9-21-87
•7S 3152-6E



CODE 42

ELECTRONIC SPARK TIMING (EST) CIRCUIT
3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

When the system is running on the ignition module, that is, no voltage on the bypass line, the ignition module grounds the EST signal. The ECM expects to see no voltage on the EST Line during this condition. If it sees a voltage, it sets Code 42 and will not go into the EST mode.

When the rpm for EST is reached (about 400 rpm), and bypass voltage applied, the EST should on longer be grounded in the ignition module so the EST voltage should be varying.

If the bypass line is open or grounded, the ignition module will not switch to EST mode so the EST voltage will be low and Code 42 will be set.

If the EST line is grounded, the ignition module will switch to EST, but because the line is grounded there will be no EST signal. A Code 42 will be set.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 42 means the ECM has seen an open or short to ground in the EST or bypass circuits. This test confirms Code 42 and that the fault causing the code is present.
2. Checks for a normal EST ground path through the ignition module. An EST CKT 423 shorted to ground will also read less than 500 ohms; however, this will be checked later.
3. As the test light voltage touches CKT 424, the module should switch causing the ohmmeter to "overrange" if the meter is in the 1000-2000 ohms position. Selecting the 10-20,000 ohms position will indicate above 5000 ohms. The important thing is that the module "switched."
4. The module did not switch and this step checks for:
   - EST CKT 423 shorted to ground.
   - Bypass CKT 424 open.
   - Faulty ignition module connection or module.
5. Confirms that Code 42 is a faulty ECM and not an intermittent in CKTs 423 or 424.

Diagnostic Aids:

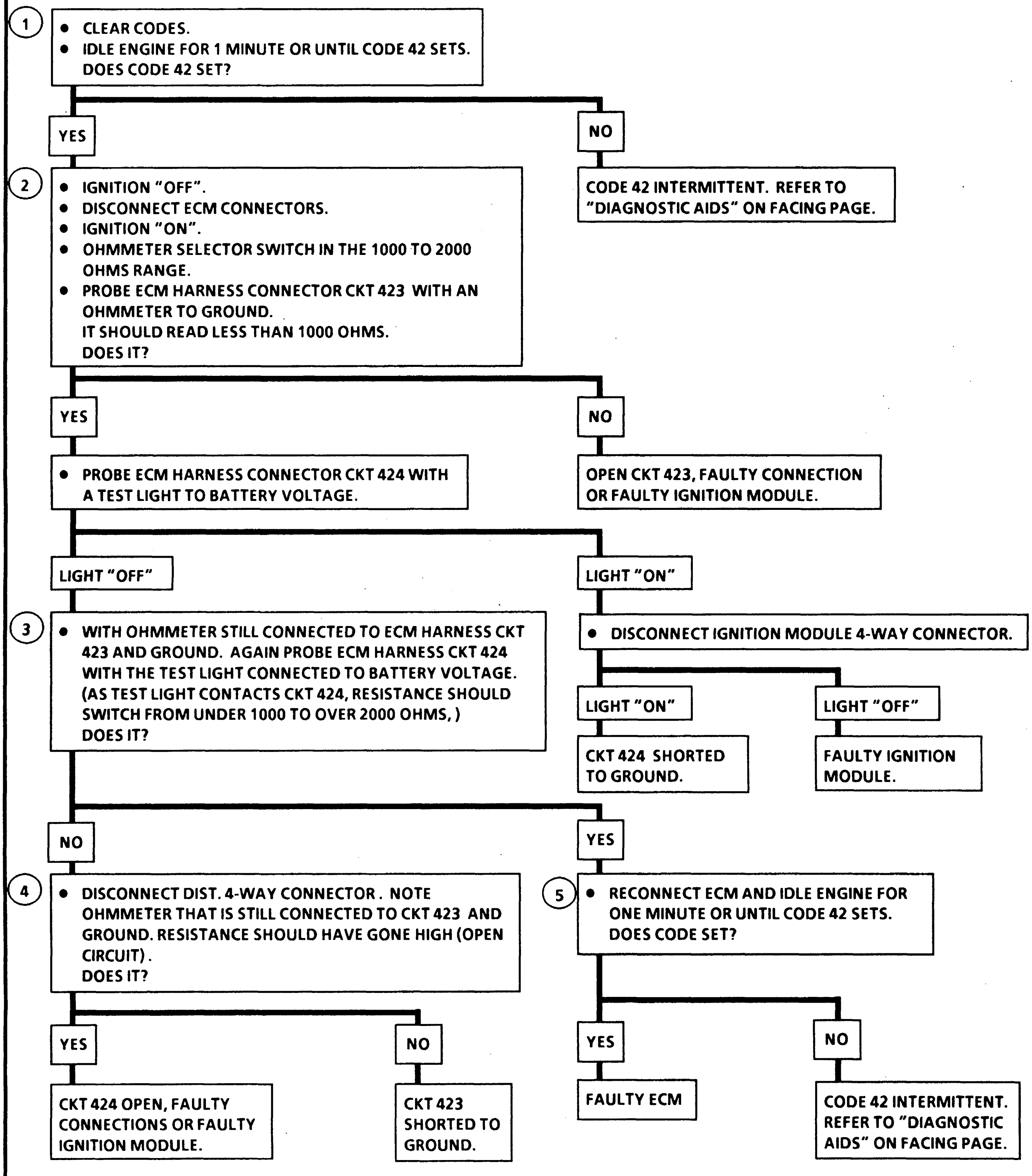
The "Scan" tool does not have any ability to help diagnose a Code 42 problem.

A MEM-CAL not fully seated in the ECM can result in a Code 42.

Refer to "Intermittents" in "Symptoms," Section "6E3-B".

CODE 42

ELECTRONIC SPARK TIMING (EST) CIRCUIT 3.1L (VIN T) "F" CARLINE (PORT)



①
- CLEAR CODES.
- IDLE ENGINE FOR 1 MINUTE OR UNTIL CODE 42 SETS.

DOES CODE 42 SET?

YES → ②

NO → CODE 42 INTERMITTENT. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

②
- IGNITION "OFF".
- DISCONNECT ECM CONNECTORS.
- IGNITION "ON".
- OHMMETER SELECTOR SWITCH IN THE 1000 TO 2000 OHMS RANGE.
- PROBE ECM HARNESS CONNECTOR CKT 423 WITH AN OHMMETER TO GROUND.

IT SHOULD READ LESS THAN 1000 OHMS.
DOES IT?

YES
- PROBE ECM HARNESS CONNECTOR CKT 424 WITH A TEST LIGHT TO BATTERY VOLTAGE.

NO → OPEN CKT 423, FAULTY CONNECTION OR FAULTY IGNITION MODULE.

LIGHT "OFF" → ③

LIGHT "ON"
- DISCONNECT IGNITION MODULE 4-WAY CONNECTOR.

LIGHT "ON" → CKT 424 SHORTED TO GROUND.

LIGHT "OFF" → FAULTY IGNITION MODULE.

③
- WITH OHMMETER STILL CONNECTED TO ECM HARNESS CKT 423 AND GROUND. AGAIN PROBE ECM HARNESS CKT 424 WITH THE TEST LIGHT CONNECTED TO BATTERY VOLTAGE. (AS TEST LIGHT CONTACTS CKT 424, RESISTANCE SHOULD SWITCH FROM UNDER 1000 TO OVER 2000 OHMS,)

DOES IT?

NO → ④

YES → ⑤

④
- DISCONNECT DIST. 4-WAY CONNECTOR . NOTE OHMMETER THAT IS STILL CONNECTED TO CKT 423 AND GROUND. RESISTANCE SHOULD HAVE GONE HIGH (OPEN CIRCUIT) .

DOES IT?

YES → CKT 424 OPEN, FAULTY CONNECTIONS OR FAULTY IGNITION MODULE.

NO → CKT 423 SHORTED TO GROUND.

⑤
- RECONNECT ECM AND IDLE ENGINE FOR ONE MINUTE OR UNTIL CODE 42 SETS.

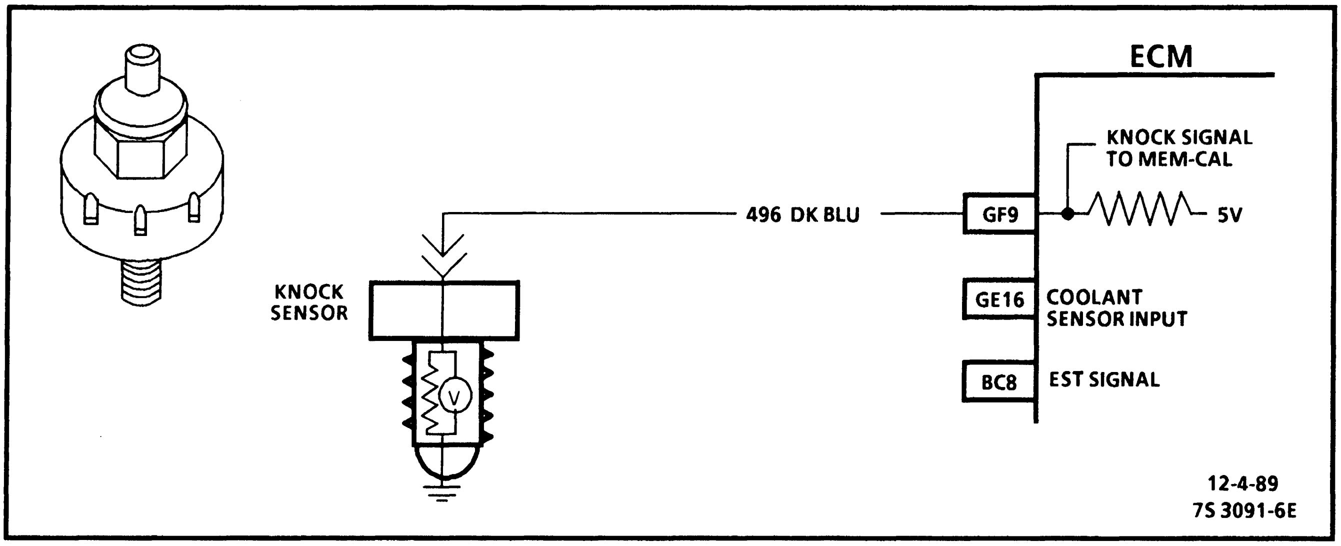
DOES CODE SET?

YES → FAULTY ECM

NO → CODE 42 INTERMITTENT. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

6-21-88
• 7S 3291-6E



CODE 43

ELECTRONIC SPARK CONTROL (ESC) CIRCUIT
3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The knock sensor is used to detect engine detonation and the ECM will retard the electronic spark timing based on the signal being received. The circuitry within the knock sensor causes the ECM 5 volts to be pulled down so that, under a no knock condition, CKT 496 would measure about 2.5 volts. The knock sensor produces an A/C signal which rides on the 2.5 volts DC voltage. The amplitude and signal frequency is dependent upon the knock level.

If CKT 496 becomes open or shorted to ground, the voltage will either go above 4.8 volts or below .62 volt. If either of these conditions are met for about 10 seconds, a Code 43 will be stored.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. This step determines if conditions for Code 43 still exist (voltage on CKT 496 above 4.8 volts or below .62 volt). The system is designed to retard the spark 15° if either condition exists.
2. The ECM has a 5 volt pullup resistor, which applies 5 volts to CKT 496. The 5 volt signal should be present at the knock sensor terminal during these test conditions.
3. This step determines if the knock sensor resistance is 3300 to 4500 ohms the sensor is OK.

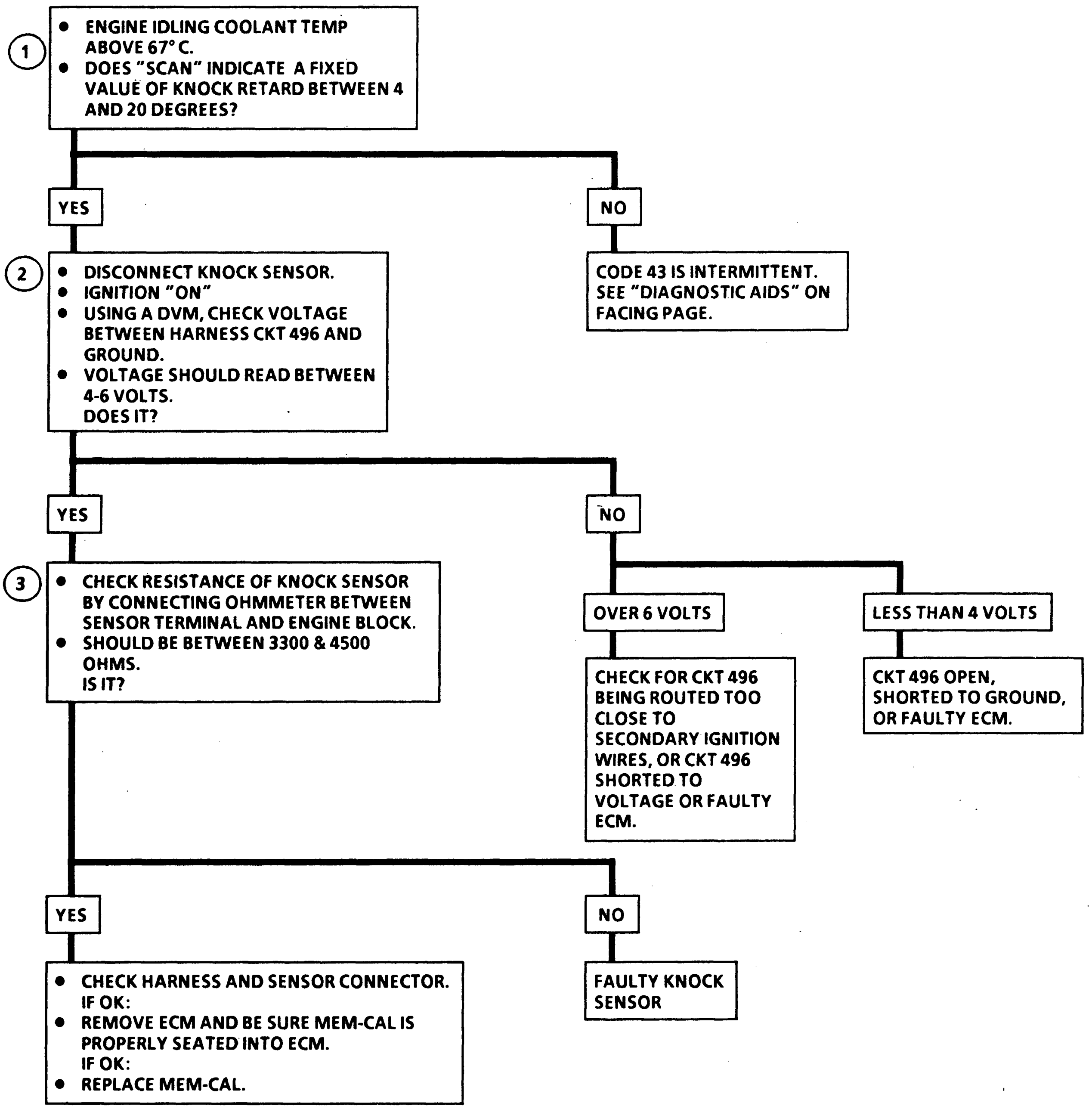
Diagnostic Aids:

If CKT 496 is not open or shorted to ground and the voltage reading is below 4 volts, the most likely cause is an open circuit in the ECM. It is possible that a faulty MEM-CAL could be drawing the 5 volt signal down, and it should be replaced, if a replacement ECM did not correct the problem.

Refer to "Intermittents" in "Symptoms," Section "6E3-B".

CODE 43

ELECTRONIC SPARK CONTROL (ESC) CIRCUIT
3.1L (VIN T) "F" CARLINE (PORT)



①
- ENGINE IDLING COOLANT TEMP ABOVE 67° C.
- DOES "SCAN" INDICATE A FIXED VALUE OF KNOCK RETARD BETWEEN 4 AND 20 DEGREES?

YES

②
- DISCONNECT KNOCK SENSOR.
- IGNITION "ON"
- USING A DVM, CHECK VOLTAGE BETWEEN HARNESS CKT 496 AND GROUND.
- VOLTAGE SHOULD READ BETWEEN 4-6 VOLTS.
  DOES IT?

YES

③
- CHECK RESISTANCE OF KNOCK SENSOR BY CONNECTING OHMMETER BETWEEN SENSOR TERMINAL AND ENGINE BLOCK.
- SHOULD BE BETWEEN 3300 & 4500 OHMS.
  IS IT?

YES

- CHECK HARNESS AND SENSOR CONNECTOR.
  IF OK:
- REMOVE ECM AND BE SURE MEM-CAL IS PROPERLY SEATED INTO ECM.
  IF OK:
- REPLACE MEM-CAL.

NO

FAULTY KNOCK SENSOR

NO (from ②)

OVER 6 VOLTS

CHECK FOR CKT 496 BEING ROUTED TOO CLOSE TO SECONDARY IGNITION WIRES, OR CKT 496 SHORTED TO VOLTAGE OR FAULTY ECM.

LESS THAN 4 VOLTS

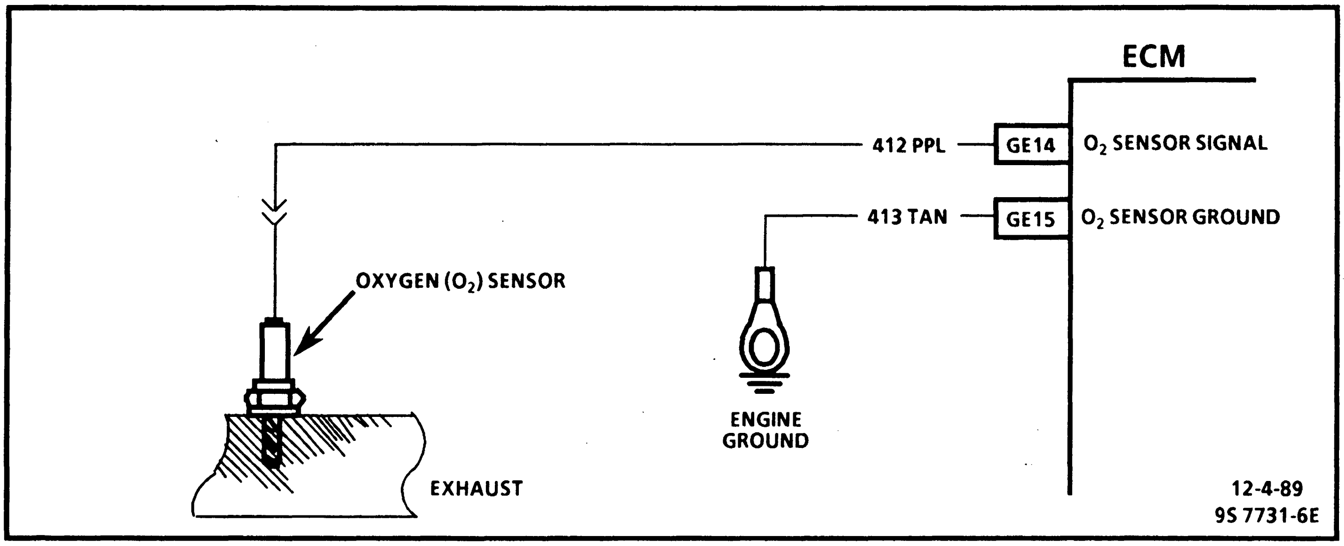
CKT 496 OPEN, SHORTED TO GROUND, OR FAULTY ECM.

NO (from ①)

CODE 43 IS INTERMITTENT. SEE "DIAGNOSTIC AIDS" ON FACING PAGE.

AFTER REPAIRS, CLEAR CODES, DISCONNECT "SCAN" TOOL FROM ALDL, RUN ENGINE 2 MINUTES, AND RECHECK FOR CODES.

11-17-89
9S 7767-6E



CODE 44

OXYGEN (O_2) SENSOR CIRCUIT
(LEAN EXHAUST INDICATED)
3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The ECM supplies a voltage of about .45 volt between terminals "GE14" and "GE15". (If measured with a 10 megohm digital voltmeter, this may read as low as .32 volt). The O_2 sensor varies the voltage within a range of about 1 volt if the exhaust is rich, down through about .10 volt if exhaust is lean.

The sensor is like an open circuit and produces no voltage when it is below about 315°C (600°F). An open sensor circuit or cold sensor causes "Open Loop" operation.

Test Description: Number below refers to circled number on the diagnostic chart.

1. Code 44 is set when the O_2 sensor signal voltage on CKT 412.
   - Remains below .2 volt for 60 seconds or more,
   - And the system is operating "Closed Loop."

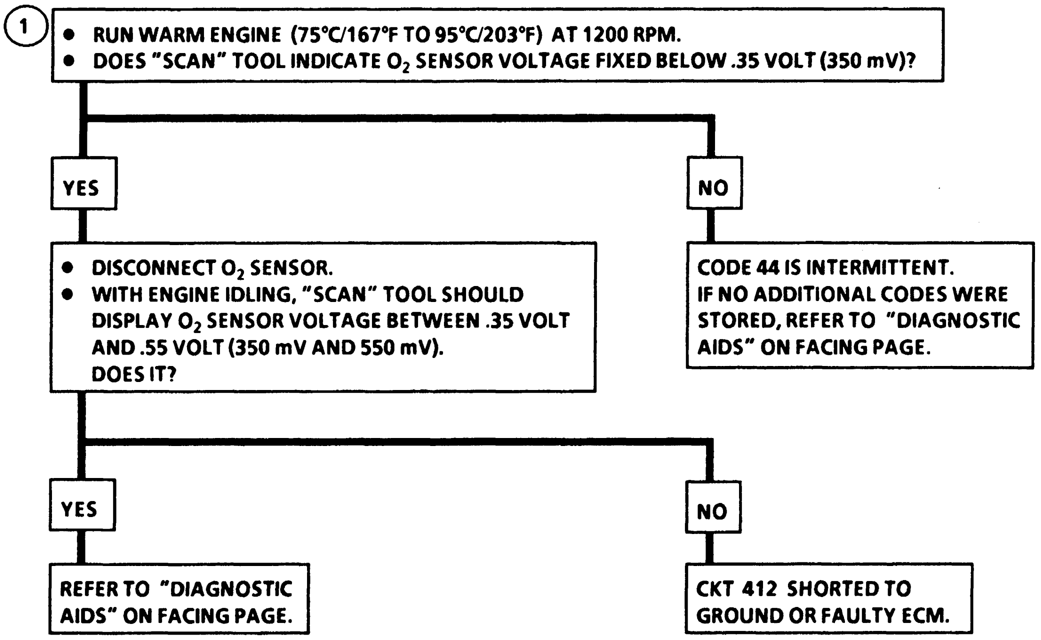
Diagnostic Aids:

Using the "Scan," observe the block learn values at different rpm and air flow conditions. The "Scan" also displays the block cells, so the block learn values can be checked in each of the cells to determine when the Code 44 may have been set. If the conditions for Code 44 exist, the block learn values will be around 150.

- O_2 Sensor Wire. Sensor pigtail may be mispositioned and contacting the exhaust manifold.
- Check for intermittent ground in wire between connector and sensor.
- Lean Injector(s). Perform injector balance test CHART C-2A.
- Fuel Contamination. Water, even in small amounts, near the in-tank fuel pump inlet can be delivered to the injectors. The water causes a lean exhaust and can set a Code 44.
- Fuel Pressure. System will be lean if pressure is too low. It may be necessary to monitor fuel pressure while driving the car at various road speeds and/or loads to confirm. See "Fuel System Diagnosis" CHART A-7.
- Exhaust Leaks. If there is an exhaust leak, the engine can cause outside air to be pulled into the exhaust and past the sensor. Vacuum or crankcase leaks can cause a lean condition.
- Air System (manual trans "A" series only). Be sure air is not being directed to the exhaust ports while in "Closed Loop." If the block learn value goes down while squeezing air hose to exhaust ports , refer to CHART C-6.
- If the above are OK, it is a faulty oxygen sensor.

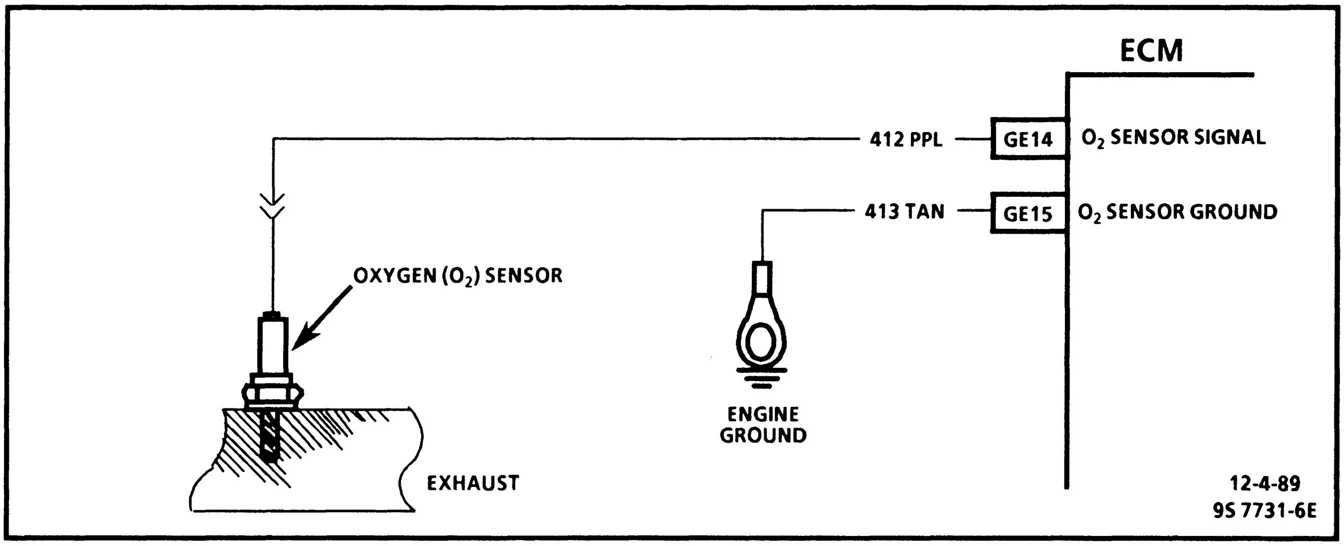
CODE 44

OXYGEN (O_2) SENSOR CIRCUIT
(LEAN EXHAUST INDICATED)
3.1L (VIN T) "F" CARLINE (PORT)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

5-3-88
• 7S 3191-6E



CODE 45

OXYGEN (O_2) SENSOR CIRCUIT

(RICH EXHAUST INDICATED)

3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The ECM supplies a voltage of about .45 volt between terminals "GE14" and "GE15". (If measured with a 10 megohm digital voltmeter, this may read as low as .32 volt). The O_2 sensor varies the voltage within a range of about 1 volt if the exhaust is rich, down through about .10 volt if exhaust is lean.

The sensor is like an open circuit and produces no voltage when it is below about 315°C (600°F). An open sensor circuit or cold sensor causes "Open Loop" operation.

Test Description: Number below refers to circled number on the diagnostic chart.

1. Code 45 is set when the O_2 sensor signal voltage or CKT 412.
   - Remains above .7 volt for 50 seconds, and in "Closed Loop."
   - Engine time after start is 1 minute or more.
   - Throttle angle between 3% and 45%.

Diagnostic Aids:

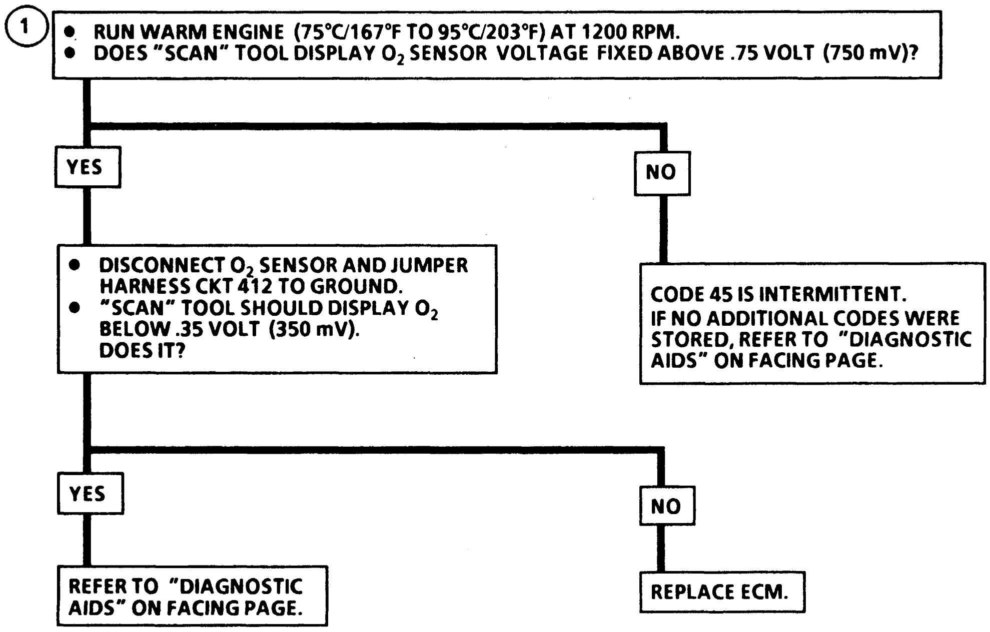
Using the "Scan," observe the block learn values at different rpm and air flow conditions. The "Scan" also displays the block cells, so the block learn values can be checked in each of the cells to determine when the Code 45 may have been set. If the conditions for Code 45 exist, the block learn values will be around 115.

- Check for short to voltage on CKT 412.
- Fuel Pressure. System will go rich if pressure is too high. The ECM can compensate for some increase. However, if it gets too high, a Code 45 may be set. See "Fuel System Diagnosis" CHART A-7.
- Rich Injector. Perform injector balance test Chart C-2A.
- Leaking Injector. See CHART A-7.
- Check for fuel contaminated oil.
- HEI Shielding. An open ground CKT 453 (ignition system reflow) may result in EMI, or induced electrical "noise." The ECM looks at this "noise" as reference pulses. The additional pulses result in a higher than actual engine speed signal. The ECM then delivers too much fuel, causing system to go rich. Engine tachometer will also show higher than actual engine speed, which can help in diagnosing this problem.
- Canister Purge. Check for fuel saturation. If full of fuel, check canister control and hoses. See "Canister Purge," Section "C3".
- Check for leaking fuel pressure regulator diaphragm by checking vacuum line to regulator for fuel.
- TPS. An intermittent TPS output will cause the system to go rich, due to a false indication of the engine accelerating.
- EGR. An EGR staying open (especially at idle) will cause the O_2 sensor to indicate a rich exhaust, and this could result in a Code 45.

CODE 45

OXYGEN (O_2) SENSOR CIRCUIT
(RICH EXHAUST INDICATED)

3.1L (VIN T) "F" CARLINE (PORT)



①
- RUN WARM ENGINE (75°C/167°F TO 95°C/203°F) AT 1200 RPM.
- DOES "SCAN" TOOL DISPLAY O_2 SENSOR VOLTAGE FIXED ABOVE .75 VOLT (750 mV)?

- DISCONNECT O_2 SENSOR AND JUMPER HARNESS CKT 412 TO GROUND.
- "SCAN" TOOL SHOULD DISPLAY O_2 BELOW .35 VOLT (350 mV). DOES IT?

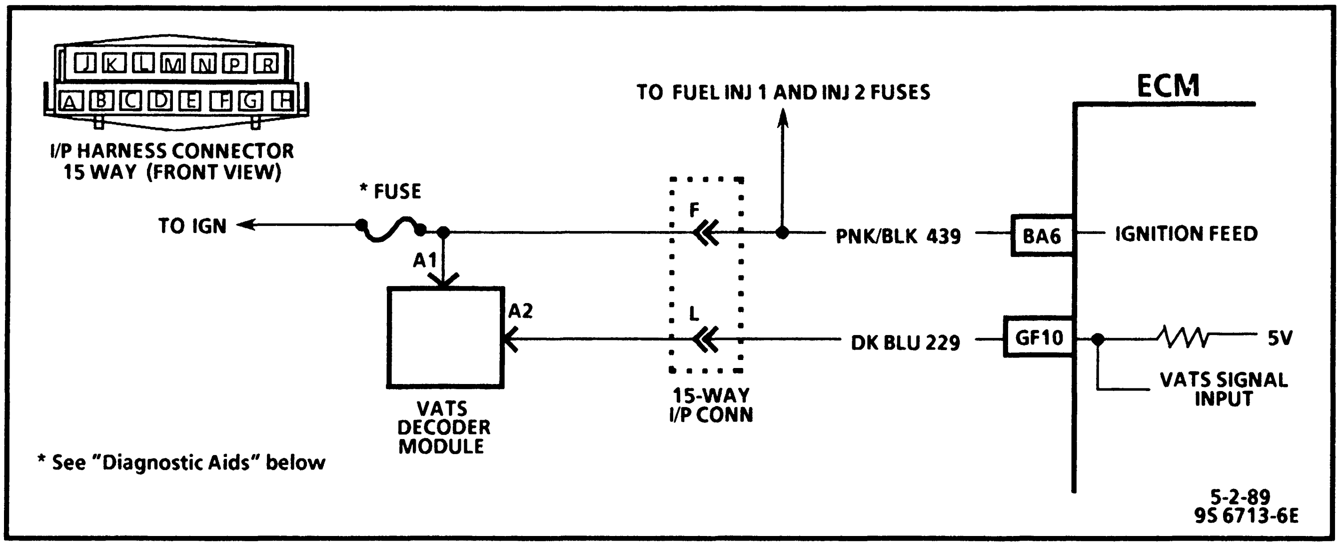
CODE 45 IS INTERMITTENT.
IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

REPLACE ECM.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

7-24-89
• 7S 3192-6E



CODE 46

VEHICLE ANTI-THEFT SYSTEM (VATS) CIRCUIT
3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The Vehicle Anti-Theft System (VATS) system is designed to disable vehicle operation if the incorrect key or starting procedure is used. The VATS decoder module sends a signal to the ECM if the correct key is being used. If the proper signal does not reach the ECM on CKT 229, the ECM will not pulse the injectors "ON" and thus not allow the vehicle to be started.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

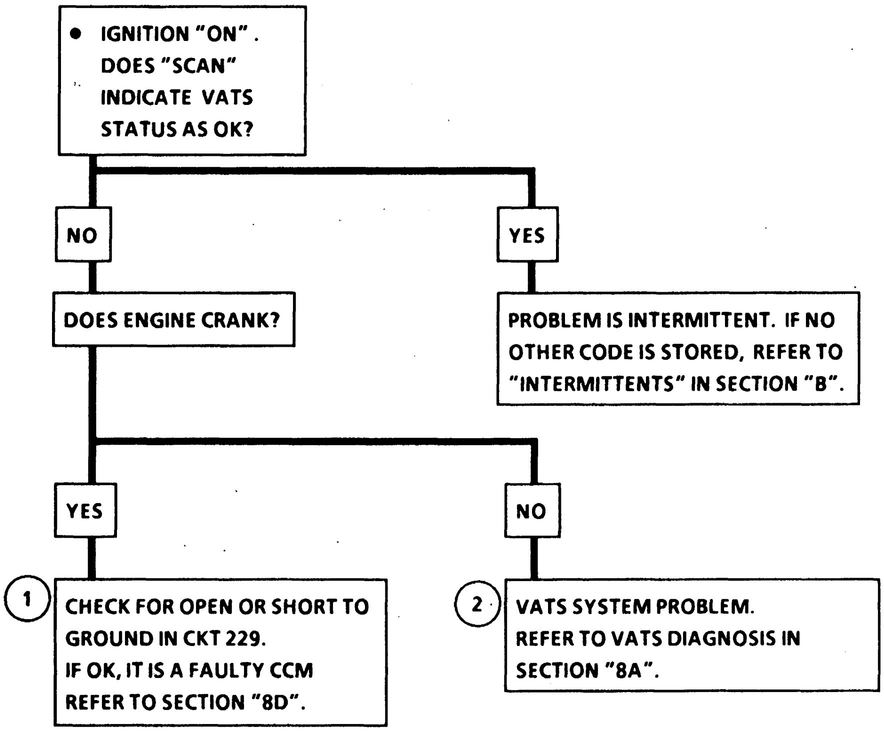
1. If the engine cranks, but doesn't start. It indicates that the portion of the module which generates the signal to the ECM is not operating or CKT 229 is open or shorted to ground. If the decoder module is found to be OK, as determined from Section "8A", the ECM may be at fault, but this is not a likely condition.
2. If the engine will not crank, it indicates that there is a VATS problem or an incorrect key or starting procedure is being used.

Diagnostic Aids:

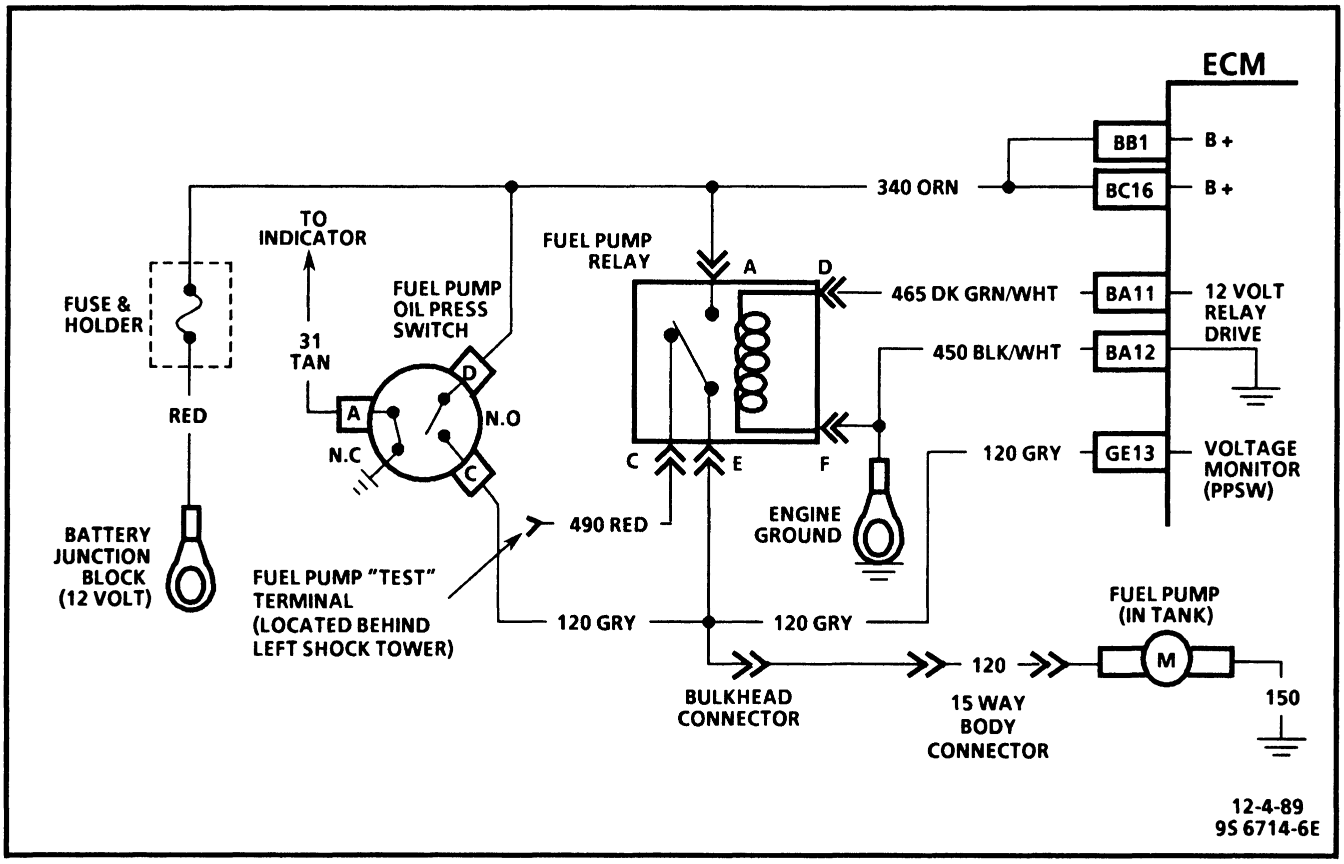
* The fuse for the VATS system is the ECM/IGN fuse.

CODE 46

VEHICLE ANTI-THEFT SYSTEM (VATS) CIRCUIT 3.1L (VIN T) "F" CARLINE (PORT)



6-6-89
*6S 2700-6E



CODE 54

FUEL PUMP CIRCUIT
(LOW VOLTAGE)
3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

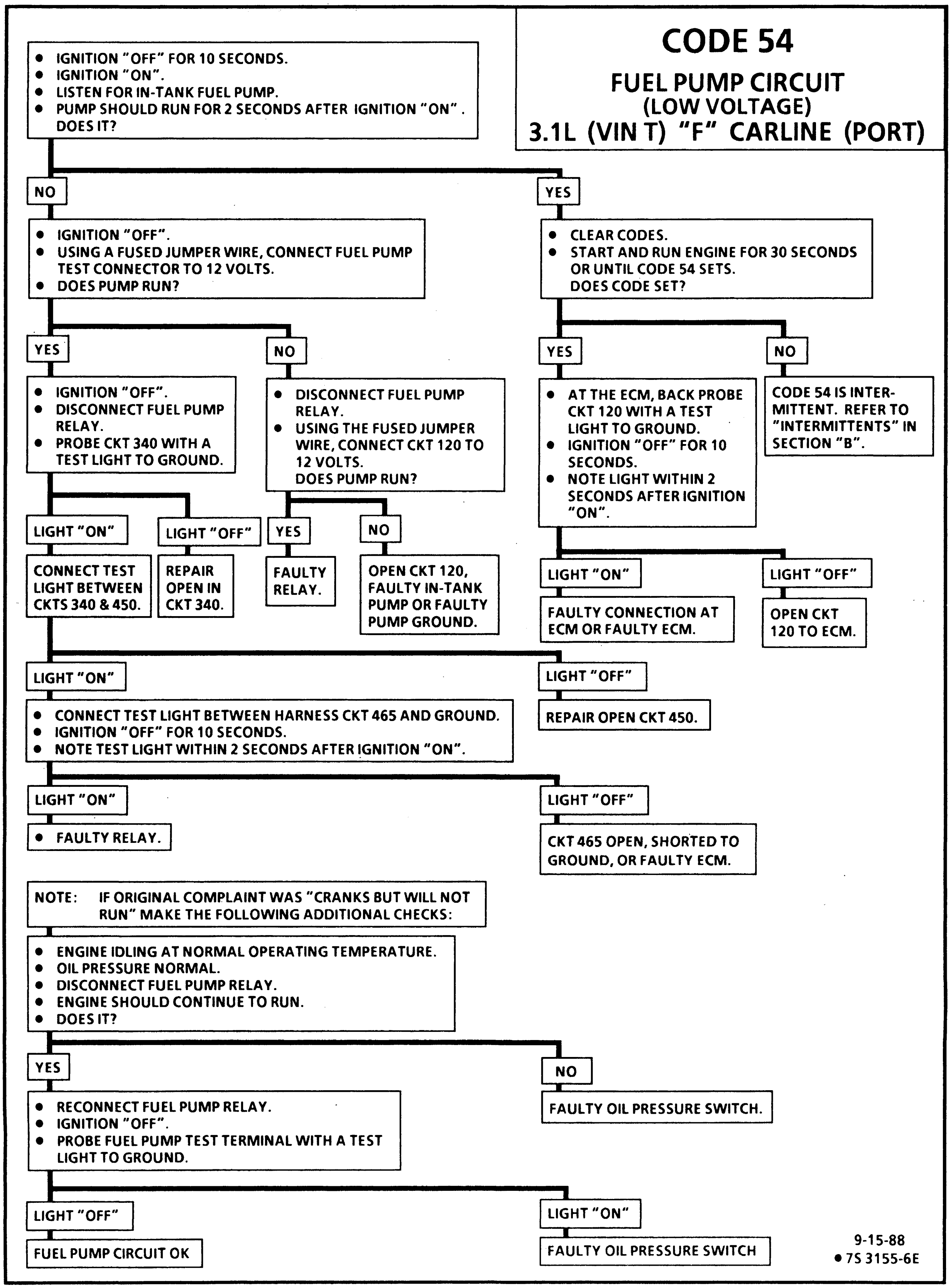
The status of the fuel pump CKT 120 is monitored by the ECM at terminal "GE13" and is used to compensate fuel delivery based on system voltage. This signal is also used to store a trouble code if the fuel pump relay is defective or fuel pump voltage is lost while the engine is running. There should be about 12 volts on CKT 120 for 2 seconds after the ignition is turned or any time references pulses are being received by the ECM.

Code 54 will set if the voltage at terminal "GE13" is less than 4 volts for .4 second since the last reference pulse was received. This code is designed to detect a faulty relay, causing extended crank time, and the code will help the diagnosis of an engine that "Cranks But Will Not Run."

If a fault is detected during start-up, the "Service Engine Soon" light will stay "ON" until the ignition is cycled "OFF." However, if the voltage is detected below 4 volts with the engine running, the light will only remain "ON" while the condition exists.

CODE 54

FUEL PUMP CIRCUIT
(LOW VOLTAGE)
3.1L (VIN T) "F" CARLINE (PORT)



9-15-88
• 7S 3155-6E

CODE 51
CODE 52
CODE 53
3.1L (VIN T) "F" CARLINE (PORT)

CODE 51

MEM-CAL ERROR
(FAULTY OR INCORRECT MEM-CAL)

CHECK THAT ALL PINS ARE FULLY INSERTED IN THE SOCKET AND THAT MEM-CAL IS PROPERLY LATCHED. IF OK, REPLACE MEM/CAL, CLEAR MEMORY, AND RECHECK. IF CODE 51 REAPPEARS, REPLACE ECM.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

CODE 52

CALPAK ERROR
(FAULTY OR INCORRECT CALPAK)

CHECK THAT THE MEM-CAL IS FULLY SEATED AND LATCHED INTO THE MEM-CAL SOCKET. IF OK, REPLACE MEM-CAL, CLEAR MEMORY, AND RECHECK. IF CODE 52 REAPPEARS, REPLACE ECM.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

CODE 53

SYSTEM OVER VOLTAGE

THIS CODE INDICATES THERE IS A BASIC GENERATOR PROBLEM.

- CODE 53 WILL SET, IF VOLTAGE AT ECM IGNITION INPUT PIN IS GREATER THAN 16.9 VOLTS FOR 10 SECONDS.
- CHECK AND REPAIR CHARGING SYSTEM. REFER TO SECTION "6D".

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

5-31-89
6S 2652-6E

CODE 61

DEGRADED OXYGEN SENSOR
3.1L (VIN T) "F" CARLINE (PORT)

IF A CODE 61 IS STORED IN MEMORY THE ECM HAS DETERMINED THE OXYGEN SENSOR IS CONTAMINATED OR DEGRADED, BECAUSE THE VOLTAGE CHANGE TIME IS SLOW OR SLUGGISH.

THE ECM PERFORMS THE OXYGEN SENSOR RESPONSE TIME TEST WHEN:

COOLANT TEMPERATURE IS GREATER THAN 85°C.

MAT TEMPERATURE IS GREATER THAN 10°C.

IN CLOSED LOOP.

IN DECEL FUEL CUT-OFF MODE.

IF A CODE 61 IS STORED THE OXYGEN SENSOR SHOULD BE REPLACED. A CONTAMINATED SENSOR CAN BE CAUSED BY FUEL ADDITIVES, SUCH AS SILICON, OR BY USE OF NON-GM APPROVED LUBRICANTS OR SEALANTS. SILICON CONTAMINATION IS USUALLY INDICATED BY A WHITE POWDERY SUBSTANCE ON THE SENSOR FINS.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

4-7-86
7S 3156-6E

BLANK

SECTION B

SYMPTOMS

CONTENTS

IMPORTANT PRELIMINARY CHECKS

BEFORE STARTING

Before using this section you should have performed the "Diagnostic Circuit Check" and found out that:

1. The ECM and "Service Engine Soon" light are operating.
2. There are no diagnostic codes stored, or there is a diagnostic code but no "Service Engine Soon" light.

SYMPTOM

Verify the customer complaint, and locate the correct symptom in the table of contents. Check the items indicated under that symptom.

VISUAL/PHYSICAL CHECK

Several of the symptom procedures call for a Careful Visual/Physical Check. This check should include:

- ECM grounds for being clean and tight.
- Vacuum hoses for splits, kinks, and proper connections, as shown on "Vehicle Emission Control Information" label.
- Air leaks at throttle body mounting and intake manifold.
- Ignition wires for cracking, hardness, proper routing and carbon tracking.
- Wiring for proper connections, pinches and cuts.

The importance of this step cannot be stressed too strongly - it can lead to correcting a problem without further checks and can save valuable time.

INTERMITTENTS

(Page 1 of 2)

Definition: Problem may or may not turn "ON" the "Service Engine Soon" light or store a code.

DO NOT use the diagnostic code charts in "Engine Components/Wiring Diagrams/Diagnostic Charts" Section "6E3-A" for intermittent problems. The fault must be present to locate the problem. If a fault is intermittent, use of diagnostic code charts may result in replacement of good parts.

- Most intermittent problems are caused by faulty electrical connections or wiring. Perform careful visual/physical check as described at start of "Symptoms" Section "6E3-B." Check for:
  - Poor mating of the connector halves. or terminal not fully seated in the connector body (backed out).
  - Improperly formed or damaged terminal. All connector terminals in problem circuit should be carefully reformed or replaced to insure proper contact tension.
  - Poor terminal to wire connection. This requires removing the terminal from the connector body to check. Refer to "Introduction" in "Driveability and Emissions," Section "6E," "Wiring Harness Service."

- If a visual/physical check does not find the cause of the problem, the car can be driven with a voltmeter connected to a suspected circuit. A "Scan" tool can also be used for monitoring input signal to the ECM to help detect intermittent conditions. An abnormal voltage, or "Scan" reading, when the problem occurs, indicates the problem may be in that circuit. If the wiring and connectors check OK, and a diagnostic code was stored for a circuit having a sensor, except for Codes 43, 44 and 45, substitute a known good sensor and recheck.

- Loss of diagnostic code memory. To check, disconnect TPS and idle engine until "Service Engine Soon" light comes "ON." Code 22 should be stored, and kept in memory when ignition is turned "OFF." If not, the ECM is faulty.

- An intermittent "Service Engine Soon" light with no stored diagnostic code may be caused by:
  - Ignition coil shorted to ground and arcing at spark plug wires or plugs.
  - "Service Engine Soon" light wire to ECM shorted to ground (CKT 419).
  - Diagnostic "test" terminal wire to ECM, shorted to ground (CKT 451).
  - ECM grounds, refer to ECM wiring diagrams.

INTERMITTENTS
(Page 2 of 2)

Definition: Problem may or may not turn "ON" the "Service Engine Soon" light or store a code.

- Check for an electrical system interference caused by a defective relay, ECM driven solenoid, or switch. They can cause a sharp electrical surge. Normally, the problem will occur when the faulty component is operated.

- Check for improper installation of electrical options such as lights, 2 way radios, etc.

- EST wires should be routed away from spark plug wires, distributor wires, distributor housing, coil and generator. Wire from ECM to distributor (CKT 453) would have a good connection.

- Check for open diode across A/C compressor clutch, and for other open diodes (see wiring diagrams).

HARD START

Definition: Engine Cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms" Section "6E3-B."
- Make sure the driver is using the correct starting procedure.

SENSORS

- **CHECK:** Coolant Temperature Sensor using a "Scan" tool, compare coolant temperature with ambient temperature on cold engine.
  - If coolant temperature readings is 5 degrees greater than or less than ambient air temperature on a cold engine, check resistance in coolant sensor circuit or sensor itself. Compare CTS resistance value to "Diagnostic Aids" chart on Code 15 chart.

- **CHECK:** TPS for binding or a high TPS voltage with the throttle closed (should read between .29 volt and .98 volt.)

FUEL SYSTEM

- **CHECK:** Fuel pump relay operation - pump should turn "ON" for 2 seconds when ignition is turned "ON." Use CHART A-7.
- **CHECK:** Fuel pressure, use CHART A-7.
- **CHECK:** Contaminated fuel
- **CHECK:** Both injector fuses (visual inspect).
- **NOTE:** A faulty in-tank fuel pump check valve will allow the fuel in the lines to drain back to the tank after engine is stopped. To check for this condition, perform fuel system diagnosis CHART A-7.

IGNITION SYSTEM

- **CHECK:** For proper ignition voltage output with spark tester J 26792 or equivalent (ST-125).
- **CHECK:** Spark plugs. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary.
- **CHECK:** Moisture in distributor cap
- **CHECK:** Bare or shorted wires
- **CHECK:** Worn distributor shaft
- **CHECK:** Loose ignition coil ground
- **CHECK:** Pickup coil resistance and connections.

ADDITIONAL CHECKS

- **CHECK:** IAC Operation - use CHART C-2C.
- **CHECK:** Basic engine problem. Refer to ENGINE MECHANICAL DIAGNOSIS (SECTION 6A).

SURGES AND/OR CHUGGLES

Definition: Engine power variation under steady throttle or cruise. feels like the car speeds up and slows down with no change in the acceleration pedal.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms" Section "6E3-B."
- Be sure driver understands transmission torque converter clutch, and A/C compressor operation as explained in the owner's manual.

SENSORS

- **CHECK:** Oxygen Sensor (O_2) Sensor. The Oxygen (O_2) sensor should respond quickly to different throttle position, if it does not, check the Oxygen (O_2) sensor for silicon contamination from fuel, or use of improper RTV sealant. The sensor may have a white, powdery coating and result in a high but false signal voltage (rich exhaust indication). The ECM will then reduce the amount of fuel delivered to the engine, causing a severe driveability problem.

FUEL SYSTEM

- **NOTE:** To determine if the condition is caused by a rich or lean system, the car should be driven at the speed of the complaint. Monitoring block learn will help identify problem.
  Lean - Block learn above 150. Refer to "Diagnostic Aids" on facing page of Code 44.
  Rich - Block learn below 110. Refer to "Diagnostic Aids" on facing page of Code 45.
- **CHECK:** Fuel pressure while condition exists. Use CHART A-7.
- **CHECK:** In-line fuel filter. Replace if dirty or plugged.

IGNITION SYSTEM

- **CHECK:** For proper ignition voltage output using spark tester (ST-125) J 26792 or equivalent.
- **CHECK:** Spark Plugs. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary. Also, check condition of distributor cap, rotor and spark plug wires.
- **CHECK:** Ignition timing. Refer to "Vehicle Emission Control Information" label.

ADDITIONAL CHECKS

- **CHECK:** Vacuum lines for kinks or leaks.
- **CHECK:** EGR - There should be no EGR at idle. Refer to CHART C-7.
- **CHECK:** Generator output voltage. Repair if less than 9 or more than 16 volts.

LACK OF POWER, SLUGGISH OR SPONGY

Definition: Engine delivers less than expected power. Little or no increase in speed when accelerator pedal is pushed down part way.

PRELIMINARY CHECKS

- Perform the careful visual/physical checks as described at start of "Symptoms" Section "6E3-B."
- Compare customer's car to similar unit. Make sure the customer has an actual problem.
- Remove air filter and check air filter for dirt, or for being plugged. Replace as necessary.

FUEL SYSTEM

- **CHECK:** Restricted fuel filter.
- **CHECK:** Fuel pressure, use CHART A-7.
- **CHECK:** Contaminated fuel.

IGNITION SYSTEM

- **CHECK:** Ignition timing. See "Vehicle Emission Control Information" label.
- **CHECK:** Spark advance for excessive retarded ignition timing. Refer to CHART C-5. Use "Scan" tool.
- **CHECK:** Secondary voltage using a shop oscilloscope or a spark tester J 26792 (ST-125), or equivalent, to check for a weak coil.

ADDITIONAL CHECKS

- **CHECK:** ECM grounds for being clean and tight. See ECM wiring diagrams.
- **CHECK:** EGR operation for being open or partly open all the time. Refer to CHART C-7.
- **CHECK:** Generator output voltage. Repair if less than 9 or more than 16 volts.
- **CHECK:** A/C operation. A/C clutch should cut out at Wide Open Throttle (WOT).
- **CHECK:** Exhaust system for possible restriction. Refer to CHART B-1.
  - Inspect exhaust system for damaged or collapsed pipes.
  - Inspect muffler for heat distress or possible internal failure.
  - For possible plugged catalytic converter by comparing exhaust system back pressure on each side at engine. Check back pressure by removing A.I.R. check valves near exhaust manifolds.

ENGINE MECHANICAL

- **CHECK:** Engine valve timing and compression.
- **CHECK:** Engine for correct or worn camshaft. Refer to ENGINE MECHANICAL DIAGNOSIS (SECTION 6A).

DETONATION/SPARK KNOCK

Definition: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening. Sounds like popcorn popping.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms" Section "6E3-B."
- Park/Neutral (P/N) Switch. Be sure "Scan" indicates drive with gear selector in drive or overdrive. Use CHART C-1A.
- If "Scan" tool readings are normal (see facing page of "Diagnostic Circuit Check") and there are no engine mechanical faults, fill fuel tank with a premium gasoline that has a minimum octane reading of 92 and revaluate vehicle performance.

COOLING SYSTEM

- Check for obvious overheating problems:
  - Low engine coolant
  - Loose water pump belt
  - Restricted air flow to radiator, or restricted water flow through radiator.
  - Inoperative electric cooling fan circuit, use CHART C-12.
  - Correct coolant solution should be a 50/50 mix of GM #1052753 anti-freeze coolant (or equivalent) and water.

FUEL SYSTEM

- **NOTE:** To determine if the condition is caused by a rich or lean system, the car should be driven at the speed of the complaint. Monitoring block learn will help identify problem.
  Lean - Block learn above 150. Refer to "Diagnostic Aids" on facing page of Code 44.
  Rich - Block learn below 110. Refer to "Diagnostic Aids" on facing page of Code 45.
- **CHECK:** Fuel pressure, use CHART A-7.

IGNITION SYSTEM

- **CHECK:** Ignition timing. See "Vehicle Emission Control Information" label.
- **CHECK:** ESC system for no retard, use CHART C-5.

ENGINE MECHANICAL

- **CHECK:** For excessive oil in the combustion chamber.
  - Valve oil seals for leaking.
- **CHECK:** Combustion chambers for excessive carbon build up. Remove carbon with top engine cleaner and follow instructions on can.
- **CHECK:** Combustion chamber pressure by performing a compression test. See ENGINE MECHANICAL DIAGNOSIS (SECTION 6A).
- **CHECK:** For incorrect basic engine parts such as cam, heads, pistons, etc.

ADDITIONAL CHECKS

- **CHECK:** EGR system for not opening. Use CHART C-7.
- **CHECK:** TCC operation, TCC applying too soon. Use CHART C-8.
- **CHECK:** For correct MEM-CAL. (See Service Bulletins.)

HESITATION, SAG, STUMBLE

Definition: Momentary lack of response as the accelerator is pushed down. Can occur at all car speeds. Usually most severe when first trying to make the car move, as from a stop sigh. May cause engine to stall severe enough.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms" Section "6E3-B."

SENSORS

- **CHECK:** TPS - Check TPS for binding or sticking. Voltage should increase at a steady rate as throttle is moved toward Wide Open Throttle (WOT).
- **CHECK:** MAP sensor - use CHART C-1D.

FUEL SYSTEM

- **CHECK:** Fuel pressure, use CHART A-7.
- **CHECK:** Contaminated fuel.
- **CHECK:** Canister Purge System for proper operation. Use CHART C-3.
- **CHECK:** Fuel injectors. Perform injector balance test, use CHART C-2A.

IGNITION SYSTEM

- **CHECK:** Spark plugs for being fouled, or for there being faulty secondary wiring.
- **CHECK:** Ignition timing. Refer to "Vehicle Emission Control Information" label.
- **CHECK:** Ignition system ground, CKT 453.

ADDITIONAL CHECKS

- **CHECK:** For correct MEM-CAL. (See Service Bulletins.)
- **CHECK:** EGR operation, refer to CHART C-7.
- **CHECK:** Engine thermostat functioning correctly and proper heat range.
- **CHECK:** Generator output voltage. Repair if less than 9 or more than 16 volts.

CUTS OUT, MISSES
(Page 1 of 2)

Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases, not normally felt above 1500 rpm or 48 kph (30 mph). The exhaust has a steady spitting sound at idle or low speed.

PRELIMINARY CHECKS

- Perform the careful visual/physical checks as described at start of "Symptoms" Section "6E3-B."

IGNITION SYSTEM

- Check for missing cylinder by:
  1. Start engine, allow engine to stabilize then disconnect IAC motor. Remove one spark plug wire at a time, using insulated pliers.

     CAUTION: Do Not perform this test for more than 2 minutes, as this test may cause damage to the catalytic converter.

  2. If there is an rpm drop on all cylinders (equal to within 50 rpm), go to "Rough, Unstable, or Incorrect Idle, Stalling" symptom. Reconnect IAC valve.
  3. If there is no rpm drop on one or more cylinders, or excessive variation is drop, check for spark on the suspected cylinder(s) using a shop oscilloscope or with J 26792 (ST-125) spark tester or equivalent. If no spark, refer to ENGINE ELECTRICAL (SECTION 6D) for intermittent operation of miss. If there is a spark, remove spark plug(s) in these cylinders and check for:
     - Cracks
     - Wear
     - Improper Gap
     - Burned Electrodes
     - Heavy Deposits
- **CHECK:** Spark plug wires by connecting ohmmeter to ends of each wire in question. If meter reads over 30,000 ohms, replace wire(s).
- **CHECK:** Distributor cap and rotor (visually) for moisture, dust, cracks, burns, etc. Spray cap and plug wires with fine water mist to check for shorts.

FUEL SYSTEM

- **CHECK:** Fuel system - Plugged fuel filter, low pressure. Use CHART A-7.
- **CHECK:** Contaminated fuel
- **CHECK:** Injector drivers. Disconnect all injector harness connectors. Connect J 34730-2 Injector Test Light or equivalent 6 volts test light between the harness terminal, of each injector connector and note light while cranking. If test light fails to blink at any connector, it is a faulty injector drive circuit harness, connector or terminal.
- **CHECK:** Fuel Injectors. Perform the Injector Balance Test. Refer to CHART C-2A.

CUTS OUT, MISSES
(Page 2 of 2)

Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases, not normally felt above 1500 rpm or 48 kph (30 mph). The exhaust has a steady spitting sound at idle or low speed.

ENGINE MECHANICAL

- **CHECK:** Engine Compression. Perform compression check on questionable cylinder(s) found above. If compression is low, repair as necessary. Refer to ENGINE MECHANICAL DIAGNOSIS (SECTION 6A).
- **CHECK:** Base engine. Remove rocker covers. Check for bent pushrods, worn rocker arms, broken valve springs, worn camshaft lobes and valve timing. Repair as necessary. See ENGINE MECHANICAL DIAGNOSIS (SECTION 6A).

ADDITIONAL CHECKS

- **CHECK:** For EMI interference. A missing condition can be caused by Electromagnetic Interference (EMI) on the reference circuit. EMI can usually be detected by monitoring engine rpm with a "Scan" tool. A sudden increase in rpm with little change in actual engine rpm change, indicates EMI is present. If the problem exists, check routing of secondary wires, check distributor ground circuit.
- **CHECK:** Intake and exhaust manifolds for casting flash.

ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING

Definition: Engine Cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms" Section "6E3-B."
- **CHECK:** For vacuum leaks
- **CHECK:** ECM grounds for being clean and tight. See ECM wiring diagrams.

FUEL SYSTEM

- **NOTE:** Monitoring block learn will help identify the cause of the problem. If the system is running lean (block learn greater than 150), refer to "Diagnostic Aids" on facing page of Code 44. If the system is running rich (block learn less than 110), refer to "Diagnostic Aids" on facing page of Code 45.
- **NOTE:** Incorrect minimum idle speed may be caused by foreign material accumulation in the throttle bore, on the throttle valve or on the throttle shaft.
- **CHECK:** Injector balance. Refer to CHART C-2A or use "Scan" tool.
- **CHECK:** Clean injectors.
- **CHECK:** For fuel in pressure regulator hose. If fuel is present, replace regulator assembly.
- **CHECK:** Evaporative Emission Control System (EECS), use CHART C-3.
- **CHECK:** The Oxygen (O_2) sensor should respond quickly to different throttle positions, if it does not, check the Oxygen (O_2) sensor for silicon contamination from fuel, or use for improper RTV sealant. The sensor will have a white, powdery coating, and will result in a high but false signal voltage (rich exhaust indication). The ECM will then reduce the amount of fuel delivered to the engine, causing a severe driveability problem.

IGNITION SYSTEM

- **CHECK:** Ignition system; wires, plugs, rotor, etc.

ENGINE MECHANICAL

- **CHECK:** Perform a cylinder compression check. See ENGINE MECHANICAL DIAGNOSIS (SECTION 6).

ADDITIONAL CHECKS

- **CHECK:** Throttle linkage for sticking or binding.
- **CHECK:** P/N switch circuit. See CHART C-1A, or use "Scan" tool and be sure tool indicates vehicle is in drive with gear selector in drive or overdrive.
- **CHECK:** IAC operation, use CHART C-2B.
- **CHECK:** EGR valve. There should be no EGR at idle.
- **CHECK:** A/C signal to ECM, "Scan" tool should indicate A/C is being requested when ever A/C is selected. If problem exists with A/C "ON," check A/C system operation CHART C-10.
- **CHECK:** Check A.I.R. system. There should be no A.I.R. to ports while in "Closed loop." Refer to CHART C-6.
- **CHECK:** PCV valve for proper operation by placing finger over inlet hole in valve end several times. Valve should snap back. If not, replace valve. See "Positive Crankcase Ventilation (PCV)" Section "6E3-C13."
- **CHECK:** Generator output voltage. Repair if less than 9 or more than 16 volts.

POOR FUEL ECONOMY

Definition: Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, economy is noticeably lower than it was on this car at one time, as previously shown by an actual road test.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms" Section "6E3-B."
- Check owner's driving habits.
  - Is A/C "ON" full time (Defroster mode "ON")?
  - Are tires at correct pressure.
  - Are excessively heavy loads being carried?
  - Is acceleration too much, too often?
- **CHECK:** Air cleaner element (filter) for dirty or being plugged.
- Visually (physically) check: Vacuum hoses for splits, kinks, and proper connections as shown on "Vehicle Emission Control Information" label.

IGNITION SYSTEM

- **CHECK:** Ignition timing. Refer to "Vehicle Emission Control Information" label.
- **CHECK:** Spark plugs. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary.

COOLING SYSTEM

- **CHECK:** Engine coolant level.
- **CHECK:** Engine thermostat for faulty part (always open) or for wrong heat range. Refer to ENGINE COOLING (SECTION 6B).

ENGINE MECHANICAL

- **CHECK:** Compression. See ENGINE MECHANICAL DIAGNOSIS (SECTION 6A).

ADDITIONAL CHECKS

- **CHECK:** TCC operation. Use CHART C-8. A "Scan" tool should indicate an rpm drop, when the TCC is commanded "ON."
- **CHECK:** For exhaust system restriction. Use CHART B-1.
- **CHECK:** For proper calibration of speedometer.
- **CHECK:** Induction system and crankcase for air leaks.

EXCESSIVE EXHAUST EMISSIONS OR ODORS

Definition: Vehicle fails an emission test. Vehicle has excessive "rotten egg" smell. Excessive odors do not necessarily indicate excessive emissions.

PRELIMINARY CHECKS

- Perform "Diagnostic Circuit Check."
- IF EMISSION TEST shows excessive CO and HC check items which cause car to run RICH (Block Learn Memory (BLM) less than 110), refer to "Diagnostic Aids" on facing page of Code 45.
- If EMISSION TEST shows excessive NOx, check items which cause car to run lean or too hot.

COOLING SYSTEM

- If the "Scan" tool indicates a very high coolant temperature and the system is running lean:
  - CHECK: Engine coolant level
  - CHECK: Engine thermostat for faulty part (always open) or for wrong heat range. Refer to ENGINE COOLING (SECTION 6B).
  - CHECK: Cooling fan operation, uee CHART C-12.

FUEL SYSTEM

- If the system is running rich (block learn near 110), refer to "Diagnostic Aids" on facing page of Code 45.
- If the system is running lean (block learn near 150) refer to "Diagnostic Aids" on facing page of Code 44.
- **CHECK:** For properly installed fuel cap.
- **CHECK:** Fuel pressure. Use CHART A-7.
- **CHECK:** Injector balance test. Use CHART C-2A.
- **CHECK:** Canister for fuel loading. Use CHART C-3.

IGNITION SYSTEM

- **CHECK:** Ignition timing. Refer to "Vehicle Emission Control Information" label.
- **CHECK:** Spark plugs. plug wires, and ignition components. Refer to ENGINE ELECTRICAL (SECTION 6D).

ADDITIONAL CHECKS

- **CHECK:** For vacuum leaks.
- **CHECK:** EGR valve for not opening. Use CHART C-7.
- **CHECK:** For lead contamination for catalytic converter (look for the removal of fuel filler neck restrictor).
- **CHECK:** Carbon build-up. Remove carbon with top engine cleaner. Follow instructions on can.
- **CHECK:** PCV valve for being plugged, stuck or blocked PCV hose or fuel in the crankcase.
- **CHECK:** For correct MEM-CAL (see Service Bulletins).

DIESELING, RUN-ON

Definition: Engine continues to run after key is turned "OFF," but runs very roughly. If engine runs smoothly, check ignition switch and adjustment.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms" Section "6E3-B."

FUEL SYSTEM

- **CHECK:** Injectors for leaking. Refer to "Fuel System Diagnosis" CHART A-7.

BACKFIRE

Definition: Fuel ignites its intake manifold, or in exhaust system, making loud popping noise.

PRELIMINARY CHECKS

- Perform the careful visual/physical checks as described at start of "Symptoms" Section "6E3-B."

IGNITION SYSTEM

- **CHECK:** Ignition coil output voltage with spark tester J 26792 or equivalent (ST-125).
- **CHECK:** Spark plugs. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary.
- **CHECK:** Spark plug wires for crossfire, also inspect distributor cap, spark plug wires, and proper routing of plug wires.
- **CHECK:** Ignition timing. Refer to "Vehicle Emission Control Information" label.
- **NOTE:** If an intermittent condition exists in the ignition system, see "Ignition System/EST" Section "6E3-C4" or ENGINE ELECTRICAL (SECTION 6D).

BASE ENGINE

- **CHECK:** Compression - Look for sticking or leaking valves.
- **CHECK:** Valve timing, refer to ENGINE MECHANICAL DIAGNOSIS (SECTION 6A).
- **CHECK:** Intake and exhaust manifold for casting flash.

FUEL SYSTEM

- **CHECK:** Perform fuel system diagnosis check, see CHART A-7.
- **CHECK:** Fuel Injectors. Perform injector balance test, refer to CHART C-2A.

ADDITIONAL CHECKS

- **CHECK:** EGR gasket for faulty or loose fit.
- **CHECK:** EGR operation for being open all the time. Refer to "Exhaust Gas Recirculation (EGR)" CHART C-7.
- **CHECK:** Air Injection Reaction (AIR) system, refer to CHART C-6.
- **CHECK:** Intake and exhaust manifold for casting flash.

CHART B-1

RESTRICTED EXHAUST SYSTEM CHECK

ALL ENGINES

Proper diagnosis for a restricted exhaust system is essential before any components are replaced. Either of the following procedures may be used for diagnosis, depending upon engine or tool used:

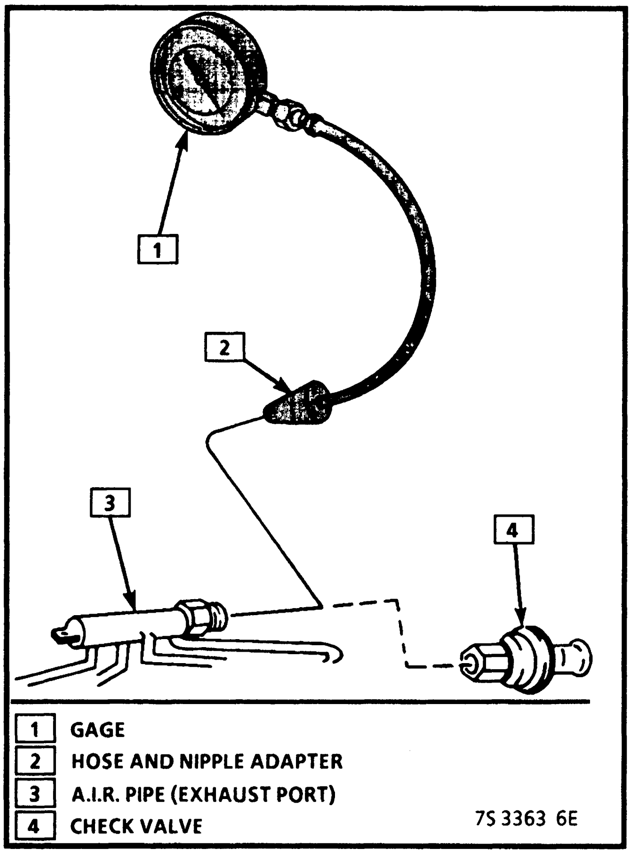
CHECK AT A. I. R. PIPE:

1. Remove the rubber hose at the exhaust manifold A.I.R. pipe check valve. Remove check valve.
2. Connect a fuel pump pressure gauge to a hose and nipple from a Propane Enrichment Device (J 26911) (see illustration).
3. Insert the nipple into the exhaust manifold A.I.R. pipe.

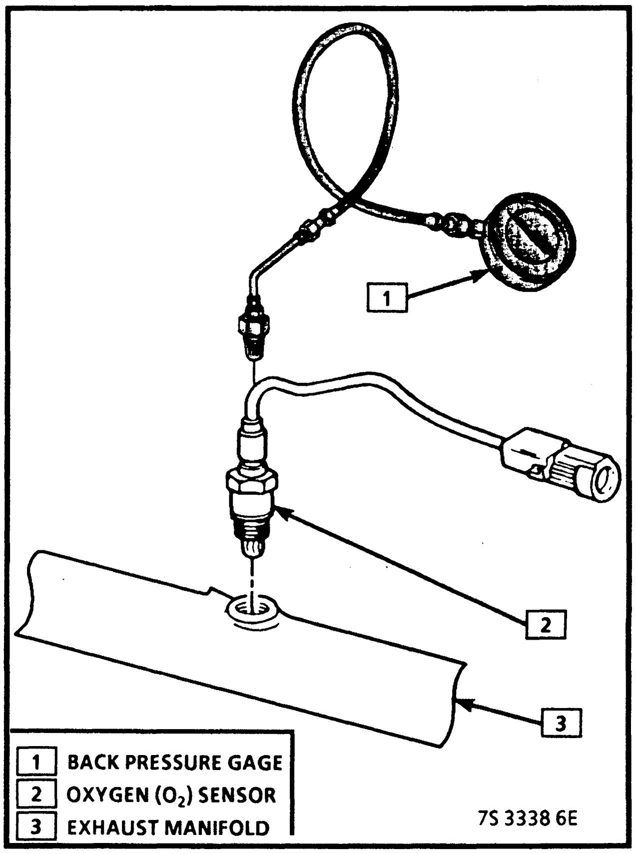
OR

CHECK AT O_2 SENSOR:

1. Carefully remove Oxygen (O_2) sensor.
2. Install Borroughs exhaust backpressure tester (BT 8515 or BT 8603) or equivalent in place of O_2 sensor (see illustration).
3. After completing test described below, be sure to coat threads of O_2 sensor with anti-seize compound P/N 5613695 or equivalent prior to re-installation.



7S 3363 6E



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DIAGNOSIS:

1. With the engine idling at normal operating temperature, observe the exhaust system backpressure reading on the gage. Reading should not exceed 8.6 kPa (1.25 psi).
2. Increase engine speed to 2000 rpm and observe gage. Reading should not exceed 20.7 kPa (3 psi).
3. If the backpressure at either speed exceeds specification, a restricted exhaust system is indicated.
4. Inspect the entire exhaust system for a collapsed pipe, heat distress, or possible internal muffler failure.
5. If there are no obvious reasons for the excessive backpressure, the catalytic converter is suspected to be restricted and should be replaced using current recommended procedures.

4-26-88
7S 3340-6E

ECM CONNECTOR "A"

PIN FUNCTION	PIN	WIRE COLOR	COMPONENT CONNECTOR CAVITY	NORMAL VOLTAGES		CODES AFFECT	POSSIBLE SYMPTOMS FROM FAULTY CIRCUIT
				KEY "ON"	ENG RUN		
BA1							
BA2							
BA3							
BA4 MAP SENSOR 5 VOLT REFERENCE	474	GRY	MAP SENSOR "C"	5V	5V	33 34 ⑧	LACK OF POWER ROUGH IDLE SURGE
BA5 TPS 5 VOLT REFERENCE	416	GRY	TPS "C"	5V	5V	21 22 ⑧	HIGH IDLE
BA6 IGNITION FEED	439	PNK/BLK	ECM FUSE AND VATS MODULE "A1"	B+	B+	46 ⑩	NO SES LIGHT, ENGINE CRANKS BUT WILL NOT START, VATS INOPERATIVE
BA7							
BA8 SERIAL DATA	461	ORN	ALDL "E" AND "M"	③ 2.5	③ 2.5		NO SERIAL DATA "SCAN" TOOL WILL NOT WORK
BA9							
BA10							
BA11 FUEL PUMP RELAY DRIVE	465	DK GRN/WHT	FUEL PUMP RELAY "D"	④ B+ ②	④ B+	54 ⑩	LONG CRANKING TIME BEFORE ENGINE STARTS
BA12 ECM GROUND	450	BLK/WHT		0	0	ENGINE BLOCK	

① Varies from .60 to battery voltage, depending on position of drive wheels.
② Battery voltage for first two seconds
③ Varies
④ Battery voltage when fuel pump is running
⑤ Varies with temperature
⑥ Reads battery voltage in gear
⑦ Battery voltage where engine is cranking
⑧ Open circuit
⑨ Grounded circuit
⑩ Open/grounded circuit
* Less than .5 volt (500 mv)
⑪ Less than 1 volt

1-11-90
MS 9083-6E

ECM Symptom Chart (1 of 6)

ECM CONNECTOR "B"

PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR CAVITY	NORMAL VOLTAGES		CODES AFFECT	POSSIBLE SYMPTOMS FROM FAULTY CIRCUIT
				KEY "ON"	ENG RUN		
BB1 BATTERY FEED	340	ORN	FUEL PUMP RELAY	B+	B+	54 ⑩	NO SES LIGHT ENGINE CRANKS BUT WILL NOT START
BB2							
BB3							
BB4							
BB5 TPS AND MAT SENSOR GROUND	452	BLK	MAT "A" TPS "A"	0	0	21 ⑧ 23 ⑧	HIGH IDLE
BB6 CTS AND MAP SENSOR GROUND	470	BLK	CTS "A" MAP SENSOR "A"	0	0	14 ⑧ 33 ⑧	ROUGH IDLE LACK OF PERFORMANCE EXHAUST ODOR
BB7							
BB8							
BB9 VEHICLE SPEED SENSOR (VSS) SIGNAL LOW	401	PPL	VEHICLE SPEED SENSOR (VSS) "B"	①	①	24 ⑩	NO VSS SIGNAL INOPERATIVE SPEEDOMETER INOPERATIVE CRUISE CONTROL
BB10 VEHICLE SPEED SENSOR (VSS) SIGNAL HIGH	400	YEL	VEHICLE SPEED SENSOR (VSS) "A"	①	①	24 ⑩	NO VSS SIGNAL INOPERATIVE SPEEDOMETER INOPERATIVE CRUISE CONTROL
BB11 ECM TO INSTRUMENT CLUSTER VSS	1019	GRY	I/P CLUSTER "C8"	①	①		INOPERATIVE SPEEDOMETER
BB12							

① Varies from .60 to battery voltage, depending on position of drive wheels.
② Battery voltage for first two seconds
③ Varies
④ Battery voltage when fuel pump is running
⑤ Varies with temperature
⑥ Reads battery voltage in gear
⑦ Battery voltage where engine is cranking
⑧ Open circuit
⑨ Grounded circuit
⑩ Open/grounded circuit
* Less than .5 volt (500 mv)
⑪ Less than 1 volt

1-13-90
MS 8266-6E

ECM Symptom Chart (2 of 6)

ECM CONNECTOR "C"

PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR CAVITY	NORMAL VOLTAGES		CODES AFFECT	POSSIBLE SYMPTOMS FROM FAULTY CIRCUIT
				KEY "ON"	ENG RUN		
BC1 VEHICLE SPEED SENSOR SIGNAL	381	RED	I/P CONNECTOR "P"				
BC2							
BC3							
BC4							
BC5							
BC6							
BC7 BYPASS	424	TAN/BLK	DISTRIBUTOR 4 PIN CONNECTOR "B"	0 *	5V	42 ⑩	LACK OF POWER (SET TIMING CONNECTOR)
BC8 ELECTRONIC SPARK TIMING (EST)	423	WHT	DISTRIBUTOR 4 PIN CONNECTOR "D"	0 *	1.3V	42 ⑩	LACK OF POWER DETONATION HARD START
BC9 A/C REQUEST SIGNAL	59	DK GRN	A/C COMPRESSOR CLUTCH "A" "OFF" "ON"	 0 * B +	 0 * B +		INOPERATIVE A/C INCORRECT IDLE
BC10							
BC11 INJECTOR DRIVER 2, 4, 6	467	DK BLU	INJECTOR CONNECTOR "B"	B +	B +		ROUGH IDLE, ENGINE CRANKS BUT WILL NOT START LACK OF PERFORMANCE
BC12 INJECTOR DRIVER 1, 3, 5	468	DK GRN	INJECTOR CONNECTOR "A"	B +	B +		ROUGH IDLE, ENGINE CRANKS BUT WILL NOT START LACK OF PERFORMANCE
BC13							
BC14							
BC15							
BC16 BATTERY FEED	340	ORN	FUEL PUMP RELAY	B +	B +	54 ⑩	NO SES LIGHT ENGINE CRANKS BUT WILL NOT START

① Varies from .60 to battery voltage, depending on position of drive wheels.
② Battery voltage for first two seconds
③ Varies
④ Battery voltage when fuel pump is running
⑤ Varies with temperature
⑥ Reads battery voltage in gear
⑦ Battery voltage where engine is cranking
⑧ Open circuit
⑨ Grounded circuit
⑩ Open/grounded circuit
* Less than .5 volt (500 mv)
⑪ Less than 1 volt

1-13-90
MS 8267-6E

ECM Symptom Chart (3 of 6)

ECM CONNECTOR "D"

PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR CAVITY	NORMAL VOLTAGES		CODES AFFECT	POSSIBLE SYMPTOMS FROM FAULTY CIRCUIT
				KEY "ON"	ENG RUN		
BD1 ECM GROUND	450	BLK/WHT	ENGINE BLOCK	0	0		ENGINE CRANKS BUT WILL NOT START NO SES LIGHT
BD2							
BD3							
BD4							
BD5							
BD6 INJECTOR GROUND	450	BLK/WHT	ENGINE BLOCK	0	0	44 ⑧	ENGINE CRANKS BUT WILL NOT START IF CONNECTION AT ENGINE BLOCK IS FAULTY
BD7 INJECTOR GROUND	450	BLK/WHT	ENGINE BLOCK	0	0	44 ⑧	ENGINE CRANKS BUT WILL NOT START IF CONNECTION AT ENGINE BLOCK IS FAULTY
BD8 REFERENCE	430	PPL/WHT	DISTRIBUTOR 4 PIN TERMINAL "C"	0	1.3V		ENGINE CRANKS BUT WILL NOT START
BD9 REFERENCE GROUND	453	BLK/RED	DISTRIBUTOR 4 PIN TERMINAL "A"	0*	0*		LACK OF PERFORMANCE
BD10							
BD11							
BD12 FAN REQUEST (A/C PRESSURE SWITCH SIGNAL)	732	DK BLU	FAN CONTROL SWITCH				INOPERATIVE FAN WITH A/C "ON"
BD13 PSPS	495	LT BLU/ORN	POWER STEERING PRESSURE SWITCH	B +	B +		A/C INOPERATIVE, IDLE ROUGH AND STALLING
BD14 4th GEAR SWITCH	446	LT BLU	TCC CONNECTOR "B"	B +	B +		POOR FUEL ECONOMY
BD15							
BD16 PARK/NEUTRAL (P/N) SWITCH SIGNAL	434	ORN/BLK	PARK/NEUTRAL (P/N) SWITCH "B"	0 ⑥	0 ⑥	24 ⑩	POOR FUEL ECONOMY STALL INCORRECT IDLE

① Varies from .60 to battery voltage, depending on position of drive wheels.
② Battery voltage for first two seconds
③ Varies
④ Battery voltage when fuel pump is running
⑤ Varies with temperature
⑥ Reads battery voltage in gear
⑦ Battery voltage where engine is cranking
⑧ Open circuit
⑨ Grounded circuit
⑩ Open/grounded circuit
* Less than .5 volt (500 mv)
⑪ Less than 1 volt

1-13-90
MS 8268-6E

ECM Symptom Chart (4 of 6)

ECM CONNECTOR "E"

PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR CAVITY	NORMAL VOLTAGES		CODES AFFECT	POSSIBLE SYMPTOMS FROM FAULTY CIRCUIT
				KEY "ON"	ENG RUN		
GE1							
GE2							
GE3 IAC COIL "A" HIGH	441	LT BLU/WHT	IAC VALVE "D"	0 OR B +	0 OR B +		INCORRECT IDLE SURGE
GE4 IAC COIL "A" LOW	442	LT BLU/BLK	IAC VALVE "C"	0 OR B +	0 OR B +		INCORRECT IDLE SURGE
GE5 IAC COIL "B" HIGH	443	LT GRN/WHT	IAC VALVE "B"	0 OR B +	0 OR B +		INCORRECT IDLE SURGE
GE6 IAC COIL "B" LOW	444	LT GRN/BLK	IAC VALVE "A"	0 OR B +	0 OR B +		INCORRECT IDLE SURGE
GE7 SERVICE ENGINE SOON LIGHT	419	BRN/WHT	I/P PRINTED CIRCUIT CONNECTOR	0*	B +		NO SES LIGHT
GE8 FAN CONTROL	335	DK GRN/WHT	FAN CONTROL RELAY "ON" "OFF"	0 * B +	0 * B +		INOPERATIVE FAN 1
GE9 EGR SOLENOID CONTROL	435	GRY	EGR SOLENOID "A"	B +	B +	32 ⑩	DETONATION, STALL, ROUGH IDLE POOR PERFORMANCE
GE10							
GE11							
GE12 DIAGNOSTIC "TEST" TERMINAL	451	WHT/BLK	ALDL CONNECTOR "B"	5V ②	5V ②		NO "SCAN" TOOL DATA WILL NOT FLASH CODE 12
GE13 FUEL PUMP SIGNAL (PPSW)	120	GRY	FUEL PUMP RELAY "A"	0 ④	B +	54 ⑩	ENGINE CRANKS BUT WILL NOT START
GE14 OXYGEN (O_2) SENSOR SIGNAL	412	PPL	OXYGEN (O_2) SENSOR	.35 -.55	③ .1 - .9	13 ⑧ 44 ⑨	EXHAUST ODOR POOR PERFORMANCE
GE15 OXYGEN (O_2) SENSOR GROUND	413	TAN	ENGINE GROUND	0	0	13 ⑧ 44 ⑧	ROUGH IDLE, INCORRECT IDLE, LEAN EXHAUST POOR PERFORMANCE
GE16 CTS SIGNAL	410	YEL	CTS "B"	1.6V ⑤	1.6V ⑤	14 ⑨ 15 ⑧	EXHAUST ODOR, ROUGH IDLE LACK OF PERFORMANCE

① Varies from .60 to battery voltage, depending on position of drive wheels.
② Battery voltage for first two seconds
③ Varies
④ Battery voltage when fuel pump is running
⑤ Varies with temperature
⑥ Reads battery voltage in gear
⑦ Battery voltage where engine is cranking
⑧ Open circuit
⑨ Grounded circuit
⑩ Open/grounded circuit
* Less than .5 volt (500 mv)
⑪ Less than 1 volt

1-13-90
MS 8269-6E

ECM Symptom Chart (5 of 6)

ECM CONNECTOR "F"

PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR CAVITY	NORMAL VOLTAGES ⑥		CODES AFFECT.	POSSIBLE SYMPTOMS FROM FAULTY CIRCUIT
				KEY "ON"	ENG RUN		
GF1 A/C CONTROL	459	DK GRN/WH	A/C CONTROL RELAY	B +	B +		INOPERATIVE A/C
GF2 A.I.R. PORT (SWITCH) SOLENOID CONTROL	436	BRN	A.I.R. E.A.S. SOLENOID "B"	B +	B +		INCORRECT IDLE ROUGH IDLE FAIL EMISSIONS TEST OVERHEAT CATALYTIC CONVERTER
GF3							
GF4 EGR SOLENOID CONTROL	698	BRN	EGR SOLENOID "B"	B +	B +	32 ⑩	DETONATION, STALL, ROUGH IDLE, POOR PERFORMANCE
GF5 EGR SOLENOID CONTROL	699	RED	EGR SOLENOID "C"	B +	B +	32 ⑩	DETONATION, STALL, ROUGH IDLE, POOR PERFORMANCE
GF6 A/T TCC CONTROL M/T SHIFT LIGHT CONTROL	422 456	TAN/BLK	TCC CONNECTOR "D"	B +	B +		POOR FUEL ECONOMY CHUGGLE INOPERATIVE SHIFT LIGHT
GF7 CANISTER PURGE SOLENOID CONTROL	428	DK GRN/ YEL	CANISTER PURGE SOLENOID "B"	0*	B +	45	FUEL ODOR ROUGH IDLE
GF8							
GF9 ESC KNOCK SENSOR SIGNAL	496	DK BLU	KNOCK SENSOR	9.2	9.3	43 ⑩	LACK OF PERFORMANCE
GF10 VATS (PASS-KEY) SIGNAL	229	DK BLU	VATS MODULE "A2"	2.5	2.5	46 ⑩	ENGINE CRANKS BUT WILL NOT START
GF11							
GF12							
GF13 TPS SIGNAL	417	DK BLU	TPS "B"	.54	.54	22 ⑩	LACK OF PERFORMANCE, ROUGH IDLE, MISS
GF14							
GF15 MAP SIGNAL	432	LT GRN	MAP SENSOR "B"	② 4.57	② .6-20	34 ⑩	LACK OF PERFORMANCE ROUGH IDLE SURGE
GF16 MAT SIGNAL	472	TAN	MAT SENSOR "B"	③	③	23 ⑧ 25 ⑨	POOR PERFORMANCE, HARD TO START

① Varies from .60 to battery voltage, depending on position of drive wheels.
② Battery voltage for first two seconds
③ Varies
④ Battery voltage when fuel pump is running
⑤ Varies with temperature
⑥ Reads battery voltage in gear
⑦ Battery voltage where engine is cranking
⑧ Open circuit
⑨ Grounded circuit
⑩ Open/grounded circuit
* Less than .5 volt (500 mv)
⑪ Less than 1 volt

1-13-90
MS 8270-6E

ECM Symptom Chart (6 of 6)

SECTION C

COMPONENT SYSTEMS

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed, If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts of system damage could result.

Section "C" provides information on the following:

- General description of components and systems.
- On-vehicle service.
- Part names and group numbers.
- Diagnostic charts. These include a functional check of the system as well as diagnosis of any problem found in the functional check.

For locations of components, wiring diagrams, and ECM terminal end view, refer to the front of the "A" Section of the engine being diagnosed.

Following are the sub-section identification and the system covered:

DIAGNOSTIC CHARTS

The diagnostic charts for each system are found after the on-vehicle service and parts information at the back of each section. Following are the charts found in this section.

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SECTION C1

ELECTRONIC CONTROL MODULE (ECM) AND SENSORS

CONTENTS

GENERAL DESCRIPTION

ELECTRONIC CONTROL MODULE (ECM)

NOTICE: To prevent possible Electrostatic Discharge damage to the ECM, Do Not touch the connector pins or soldered components on the circuit board.

The Electronic Control Module (ECM) (Figure C1-1), located under the right side of the instrument panel, is the control center of the fuel injection system. It constantly looks at the information from various sensors, and controls the systems that affect vehicle performance. The ECM also performs the diagnostic function of the system. It can recognize operational problems, alert the driver through the "Service Engine Soon" light, and store a code or codes which identify the problem areas to aid the technician in making repairs. See "Introduction" Section "6E3" for more information on using the diagnostic function of the ECM.

The (3.1L LH0) uses a new type ECM (referred to as GMP4). For service, this ECM consists of two parts: a controller (the ECM without a MEM-CAL) and an assembly called a MEM-CAL. (This stands for "Memory and Calibration" Unit.)

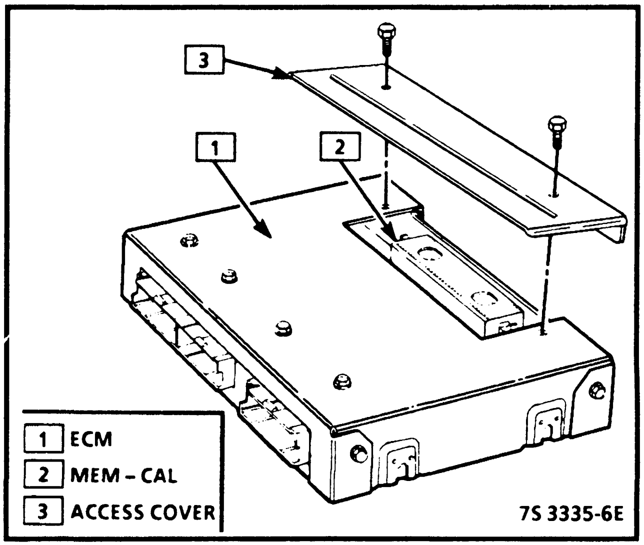


Figure C1-1 - Electronic Control Module (ECM)

MEM-CAL

NOTICE: To prevent possible Electrostatic Discharge damage to the PROM, CAL-PAK or MEM-CAL, Do Not touch the component leads, and Do Not remove integrated circuit from carrier.

This assembly contains the functions of the PROM, CAL-PAK and the ESC module used on other GM applications. Like the PROM, it contains the calibrations needed for a specific vehicle as well as the back-up fuel control circuitry required if the rest of the ECM becomes damaged or faulty.

ECM FUNCTIONS

The ECM supplies either 5 or 12 volts to power various sensors or switches. This is done through resistances in the ECM which are so high in value that a test light will not light when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give an accurate reading because its resistance is too low. Therefore, a 10 megohms input impedance digital voltmeter is required to assure accurate voltage readings.

The ECM controls output circuits such as the injector(s), IAC, coolant fan relay, etc. by controlling the ground circuit through transistors or a device called a quad-driver.

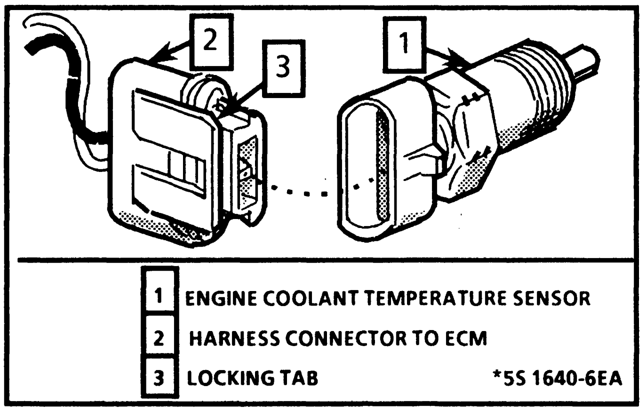


Figure C1-2 - Engine Coolant Temperature Sensor

INFORMATION SENSORS

Engine Coolant Temperature Sensor
Figure C1-2

The coolant sensor is a thermistor (a resistor which changes value based on temperature) mounted in the engine coolant stream. Low coolant temperature produces a high resistance (100,000 ohms at -40°C/-40°F) while high temperature causes low resistance (70 ohms at 130°C/266°F).

The ECM supplies a 5 volt signal to the coolant sensor thru a resistor in the ECM and measures the voltage. The voltage will be high when the engine is cold, and low when the engine is hot. By measuring the voltage, the ECM knows the engine coolant temperature. Engine coolant temperature affects most systems the ECM controls.

A failure in the coolant sensor circuit should set either a Code 14 or Code 15. Remember these codes indicate a failure in the coolant temperature circuit, so proper use of the chart will lead to either repairing a wiring problem or replacing the sensor, to properly repair a problem. Once the trouble code is set, the ECM will use a default valve for engine coolant temperature.

Manifold Air Temperature (MAT) Sensor

The Manifold Air Temperature (MAT) sensor is a thermistor (a resistor which changes value based on the temperature of air entering the engine). Low temperature produces a high resistance (100,000 ohms at -40°C/-40°F) while high temperature causes low resistance (approximately 70 ohms at 130°C/266°F). The ECM supplies a 5 volts signal to the sensor through a resistor in the ECM and measures the voltage. The voltage will be high when the intake air is cold and low when the air is hot. By measuring the voltage, the ECM knows the manifold air temperature.

The MAT sensor is used to control spark timing and delays EGR when intake air is cold.

A failure in the MAT sensor circuit should set either a Code 23 or Code 25. Once a trouble code is set, the ECM will use an artificial default value for MAT and some vehicle performance will return.

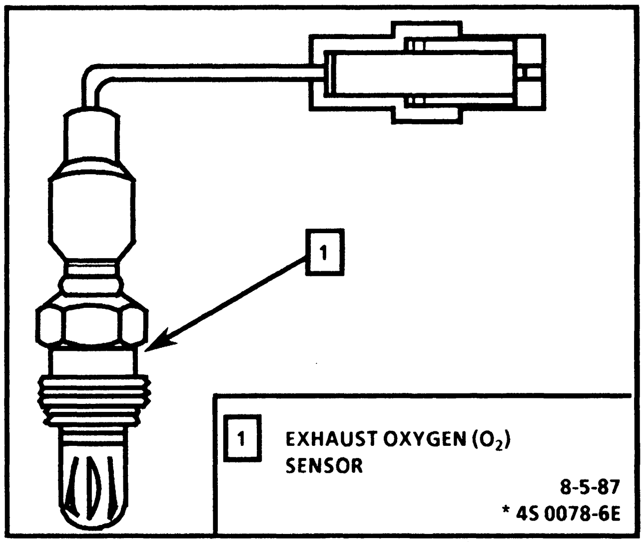


Figure C1-3 - Exhaust Oxygen (O_2) Sensor

Oxygen (O_2) Sensor
Figure C1-3

The exhaust Oxygen (O_2) sensor is mounted in the exhaust system where it can monitor the oxygen content of the exhaust gas stream. The oxygen content in the exhaust reacts with the sensor to produce a voltage output. This voltage ranges from approximately .1 volt (high O_2 - lean mixture) to .9 volt (low O_2 - rich mixture).

This voltage can be measured with a digital voltmeter having at least 10 megohms input impedance. Use of standard shop type voltmeters will result in very inaccurate readings.

By monitoring the voltage output of the O_2 sensor, the ECM will know what fuel mixture command to give to the injector (lean mixture-low O_2 voltage = rich command, rich mixture-high O_2 voltage = lean command).

The O_2 sensor, if open, should set a Code 13. A constant low voltage in the sensor circuit should set a Code 44, while a constant high voltage in the circuit should set a Code 45. Codes 44 and 45 could also be set as a result of fuel system problems. See code charts for conditions that can cause a lean or rich system.

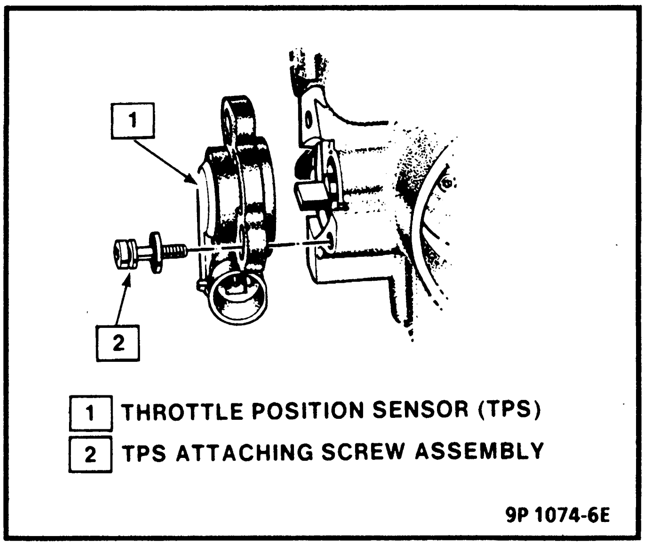


Figure C1-4 - Throttle Position Sensor

Throttle Position Sensor (TPS)
Figure C1-4

The Throttle Position Sensor (TPS) is potentiometer connected to the throttle shaft on the throttle body. The TPS electrical circuit consists of a 5 volts supply line and a ground line, both provided by the ECM. By monitoring the voltage on this signal line the ECM calculates throttle position. As the throttle valve angle is changed (accelerator pedal moved), the output of the TPS also changes.

At a closed throttle position, the output of the TPS is low (between .29 to .98 volts). As the throttle valve opens, the output increases so that, at wide-open throttle, the output voltage should be approximately 5 volts.

The ECM can determine fuel delivery based on throttle valve angle (driver demand). A broken or loose TPS can cause intermittent bursts of fuel from the injector, and an unstable idle, because the ECM thinks the throttle is moving. A problem in any of the TPS circuits should set either a Code 21 or Code 22. Once a trouble code is set, the ECM will use an artificial default value for TPS, and some vehicle performance will return. A high idle will result when either Code 21 or Code 22 is set.

See On-Vehicle Service for replacement or adjustment of TPS.

Manifold Absolute Pressure (MAP) Sensor

The Manifold Absolute Pressure (MAP) sensor (see Figure C1-5) measures the changes in the intake manifold pressure which result from engine load and speed changes, and converts this to a voltage output.

A closed throttle on engine coastdown would produce a relatively low MAP output, while a Wide-Open Throttle (WOT) would produce a high output. Manifold Absolute Pressure (MAP) is the OPPOSITE of what you would measure on a vacuum gage. When manifold pressure is high, vacuum is low. The MAP sensor is also used to measure barometric pressure under certain conditions, which allows the ECM to automatically adjust for different altitudes. The ECM sends a 5 volts reference signal to the MAP sensor. As the manifold pressure changes, the electrical resistance of the sensor also changes. By monitoring the sensor output voltage, the ECM knows the manifold pressure. A higher pressure, low vacuum (high voltage) requires more fuel, while a lower pressure, higher vacuum (low voltage) requires less fuel. Once a trouble code is set, the ECM will use a default value for MAP.

A failure in the MAP sensor circuit should set a Code 33 or Code 34.

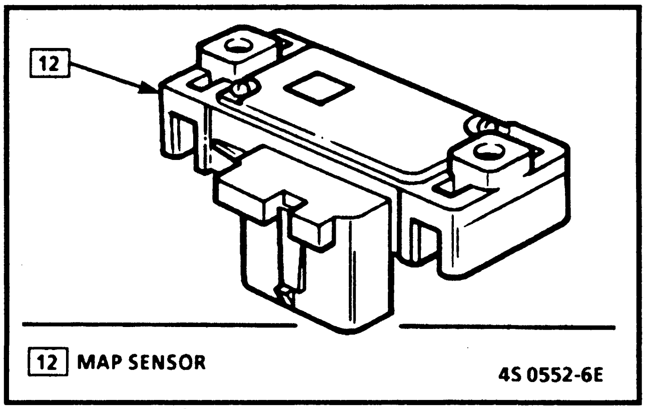


Figure C1-5 - MAP Sensor

Vehicle Speed Sensor (VSS)

The Vehicle Speed Sensor (VSS), sends a pulsing voltage signal to the ECM, which the ECM converts to miles per hour. This sensor mainly controls the operation of the TCC system. There are several different types of vehicle speed sensors. See "Torque Converter Clutch (TCC) System," Section "6E3-C8", Code 24 or Section "8A" for more information.

Knock Sensor

Refer to "Electronic Spark Control (ESC) System," Section "6E3-C5" for description of ESC system.

A/C "Request" Signal

This signal tells the ECM that the A/C selector switch is turned "ON," and that the A/C pressure switches are closed. The ECM uses this to adjust the idle speed before turning "ON" the A/C clutch.

If this signal is not available to the ECM, the A/C compressor will be inoperative.

See "ECM Controlled Air Conditioning," Section "6E3-C10" for A/C wiring diagrams and diagnosis of A/C electrical system.

Idle Speed Power Steering Pressure Switch (PSPS)

This switch tells the ECM that the vehicle is in a parking maneuver. The ECM uses this information to compensate for the additional engine load by moving the IAC valve. The ECM will also turn "OFF" the A/C clutch when high pressure is detected.

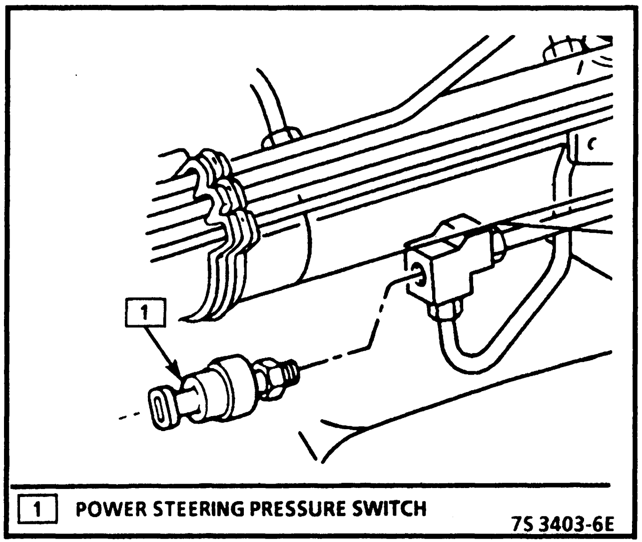


Figure C1-6 - PSPS 3.1L

Park/Neutral (P/N) Switch (Auto Only)

The Park/Neutral (P/N) switch indicates to the ECM when the transmission is in park or neutral or drive. This information is used for the TCC, EGR, and the IAC valve operation.

Important

- Vehicle should not be driven with park/neutral switch disconnected, as idle quality will be affected and a possible false Code 24 (VSS).

  See Section "7A" for more information on the P/N switch, which is part of the neutral/start and backup light switch assembly mounted on the transaxle. See CHART C-1A for P/N switch check.

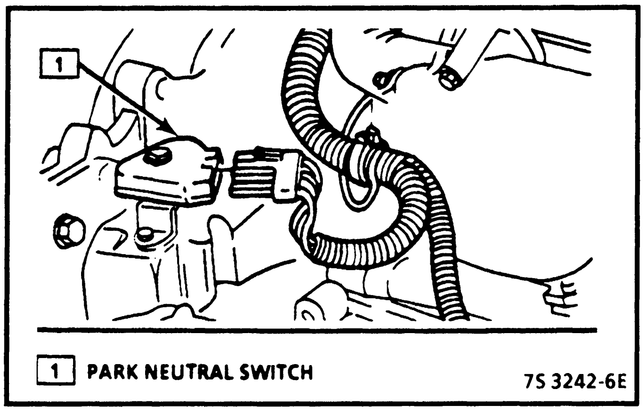


Figure C1-7 - P/N Switch

Distributor Reference Signal

The distributor sends a signal to the ECM to tell it both engine rpm and crankshaft position. See EST System for further information.

DIAGNOSIS

To read the codes, use a "Scan" tool, or ground the diagnostic terminal, with the engine not running and the ignition "ON." The "Service Engine Soon" light will flash Code 12 three times and then flash each code stored in memory three times. All codes stored in memory would have been read when Code 12 was flashed again. No new codes can be stored when in the diagnostics mode (diagnostics lead grounded). This eliminates confusion while the system is being worked on.

To clear the codes from memory:

- Ignition "OFF"
- Disconnect fuse in holder, (located to right side of radiator on the relay bracket), for 30 seconds.

Since the ECM can have a failure which may affect only one circuit, following the diagnostic procedures in this section will determine which circuit has a problem and where it is.

If a diagnostic chart indicates that the ECM connections or ECM is the cause of a problem, and the ECM is replaced, but does not correct the problem, one of the following may be the reason:

- There is a problem with the ECM terminal connections. - The diagnostic chart will say ECM connections or ECM. The terminals may have to be removed from the connector in order to check them properly.
- The ECM, or MEM-CAL is not correct for the application. - The incorrect components may cause a malfunction and may or may not set a code.

- The problem is intermittent. - This means that the problem is not present at the time the system is being checked. In this case, refer to "Symptoms," Section "6E3-B" of the manual and make a careful physical inspection of all portions of the system involved.
- Shorted solenoid, relay coil, or harness. - Solenoids and relays are turned "ON" and "OFF" by the ECM, using internal electronic switches called "drivers." Each driver is part of a group of four called "quad-drivers." Failure of one driver can damage any other driver in the set.

A shorted solenoid, relay coil, or harness in a GMP4 computer will not damage the ECM but will cause the component to be inoperative.

J 34636 or BT 8405 testers or equivalent provide a fast, accurate means of checking for a shorted coil or a short to battery voltage.

- The MEM-CAL may be faulty. - Although these rarely fail, it operates as part of the ECM; therefore, it could be the cause of the problem. Substitute a known good MEM-CAL.
- The replacement ECM may be faulty. - After the ECM is replaced, the system should be rechecked for proper operation. If the diagnostic chart again indicates the ECM is the problem, substitute a known good ECM. Although this is a rare condition, it could happen.

ECM

A faulty ECM will be determined in the diagnostic charts or by a Code 55.

MEM-CAL

An incorrect or faulty MEM-CAL, which is part of the ECM, may set a Code 41 or 51.

ECM INPUTS

All of the sensors and input switches can be diagnosed by the use of a "Scan" tool. Following is a short description of how the sensors and switches can be diagnosed by the use of "Scan." The "Scan" can also be used to compare the values for a normal running engine with the engine you're diagnosing.

Coolant Temperature Sensor

A "Scan" tool displays engine temperature in degrees centigrade. After engine is started, the temperature should rise steadily to about 90°C then stabilize when thermostat opens. If the engine has not been run for several hours (overnight) the coolant temperature and MAT temperatures should read close to each other. A fault in the coolant sensor circuit should set a Code 14 or 15. The code charts also contain a chart to check for sensor resistance values relative to temperature.

MAT Sensor

A "Scan" tool displays temperature of the air entering the engine and should read close to ambient air temperature when engine is cold, and rise as underhood temperature increases. If the engine has not been run for several hours (overnight) the MAT sensor temperature and coolant temperature should read close to each other. A failure in the MAT sensor circuit should set a Code 23 or 25. The code charts also contain a chart to check for sensor resistance values relative to temperature.

Oxygen (O_2) Sensor

The "Scan" tool has several positions that will indicate the state of the exhaust gases, O_2 voltage, integrator, and block learn. See "Scan" position information in "Introduction," Section "6E3".

A problem in the O_2 sensor circuit, or fuel system, should set a Code 13 (open circuit), Code 44 (lean indication), Code 45 (rich indication) or Code 61 degraded, or contaminated O_2 sensor. Refer to applicable chart if any of these codes were stored in memory.

Throttle Position Sensor (TPS)

A "Scan" tool displays throttle position in volts. Voltage should increase at a steady rate as throttle is moved toward WOT.

The TPS has an auto zeroing feature. If the voltage reading is within the range of .29 to .98 volts, the ECM will use that value as closed throttle. If the voltage reading is out of the auto zero range on an existing or replacement TPS, the TPS should be adjusted. A failure in the TPS or circuit should set a Code 21 or 22.

Manifold Absolute Pressure (MAP) Sensor

"Scan" tool displays manifold pressure in volts. Low pressure (high vacuum) reads a low voltage while a high pressure (low vacuum) reads a high voltage. A failure in the MAP sensor circuit should set a Code 33 or Code 34 and using the chart will find the cause of the problem. A Code 33 may be set if a rough or unstable idle exists. CHART C-1D can also be used to check MAP sensor.

Vehicle Speed Sensor (VSS)

A "Scan" tools reading should closely match with speedometer reading with drive wheels turning. A failure in the VSS circuit should set a Code 24.

Park/Neutral (P/N) Switch

A "Scan" tool should read P/N when in park, or neutral, and R-D, L, when in drive or overdrive. This reading may vary with different makes of tools. Refer to CHART C-1A for P/N switch diagnosis.

A/C Request Signal

If the low pressure switch is closed (A/C system charged) and A/C is on the "Scan" tool should indicate A/C "ON."

See ECM Controlled Air Conditioning," Section "6E3-C10" for electrical system diagnosis.

Idle Speed Power Steering Pressure (PSPS) Switch

A "Scan" tool should read "OFF" normally and "ON" with high pressure. This reading may vary with different make of tools. Refer to CHART C-1E for PSPS diagnosis.

Distributor (DIS) Reference Signal

A "Scan" tool will read this signal and is displayed in rpm. See "Ignition System/EST," Section "6E3-C4" for more information on the EST system.

ON-VEHICLE SERVICE

NOTICE: To prevent possible Electrostatic Discharge damage to the ECM, Do Not touch the connector pins or soldered components on the circuit board.

ELECTRONIC CONTROL MODULE (ECM)

Service of the ECM should normally consist of either replacement of the ECM or a MEM-CAL change.

If the diagnostic procedures call for the ECM to be replaced, the engine calibrator (MEM-CAL) and ECM should be checked first to see if they are the correct parts. If they are, remove the MEM-CAL from the faulty ECM and install it in the new service ECM. THE SERVICE ECM WILL NOT CONTAIN A MEM-CAL. Trouble Code 51 indicates the MEM-CAL is installed improperly or has malfunctioned. When Code 51 is obtained, check the ECM installation for bent pins or pins not fully seated in the socket. If it is installed correctly and Code 51 still shows, replace the MEM-CAL.

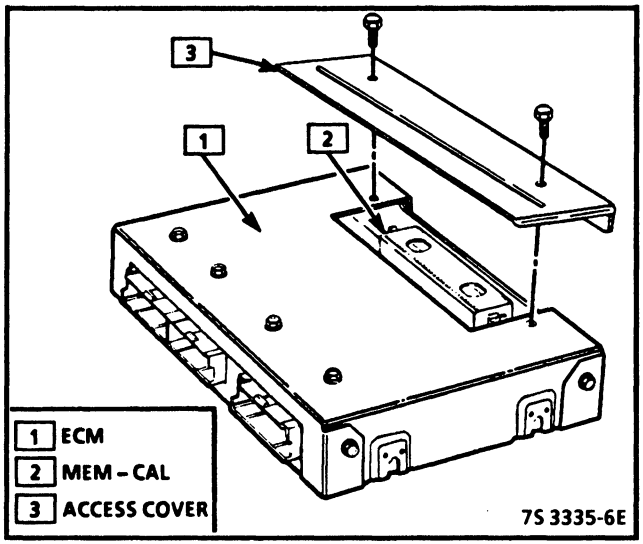


Figure C1-8 - ECM

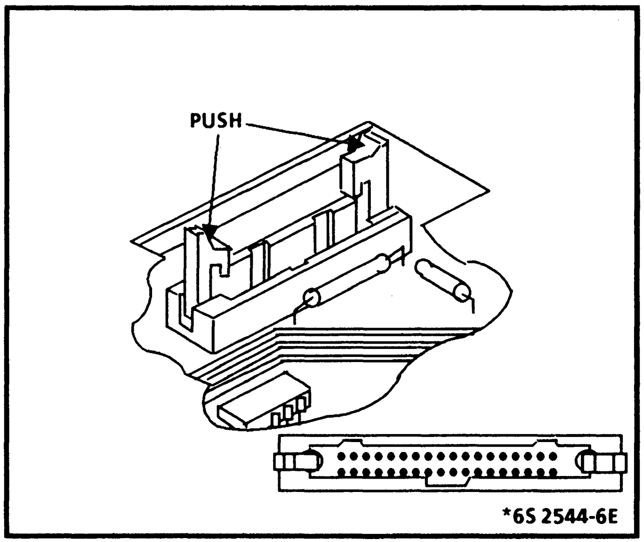


Figure C1-9 - MEM-CAL Unit Socket

Important

- When replacing the production ECM with a service ECM (controller), it is important to transfer the broadcast code and production ECM number to the service ECM label. Please do not record on ECM cover. This will allow positive identification of ECM parts throughout the service life of the vehicle.

Important

- To prevent internal ECM damage, the ignition must be "OFF" when disconnecting or reconnecting power to ECM (for example, battery cable, ECM pigtail, ECM fuse, jumper cables, etc.).

NOTICE: To prevent possible Electrostatic Discharge damage to the PROM, CAL-PACK or MEM-CAL, Do Not touch the component leads, and Do Not remove integrated circuit from carrier.

ECM OR MEM-CAL Replacement

Remove or Disconnect

1. Negative battery cable.
2. Glove compartment.
3. Connectors from ECM.

4. ECM mounting hardware.
5. ECM from passenger compartment.
6. ECM access cover. (Figure C1-8)
7. MEM-CAL removal. (Figure C1-9)

Important

- Replacement ECM is supplied without a MEM-CAL, so care should be used when removing it from the defective ECM because it will be reused in the new ECM.

  Using two fingers, push both retaining clips back away from the MEM-CAL. At the same time, grasp it at both ends and lift it up out of the socket. Do not remove the cover of the MEM-CAL. Use of unapproved MEM-CAL removal methods may cause damage to the MEM-CAL or socket.

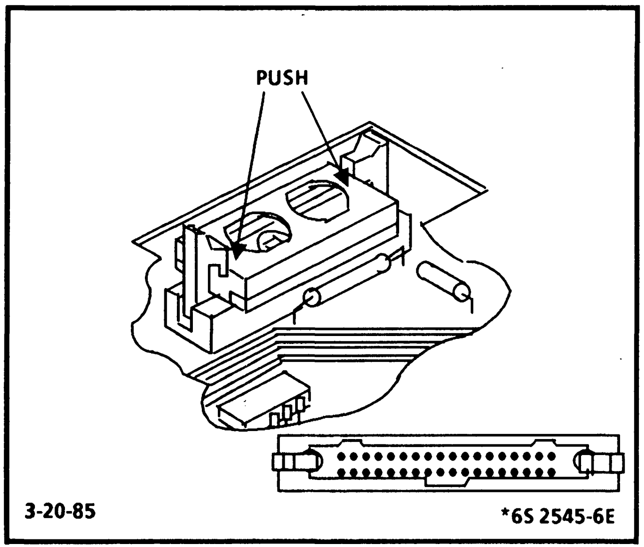


Figure C1-10 - MEM-CAL Unit Installation

IF ECM IS BEING REPLACED:

Remove or Disconnect

1. New ECM from its packaging and check the service number to make sure it is the same as the defective ECM.
2. Access cover.

Install or Connect

1. MEM-CAL in MEM-CAL socket.

Important

- Press only on the ends of the MEM-CAL. Small notches in the MEM-CAL must be aligned with the small notches in the MEM-CAL socket.Press on the ends of the MEM-CAL until the retaining clips snap into the ends of the MEM-CAL. Do not press on the middle of the MEM-CAL, only on the ends.

2. Access cover on ECM.
3. ECM in passenger compartment.
4. Connectors to ECM.
5. Glove compartment.
6. Negative battery cable.

Important

- Before starting engine, follow the "Idle Learn Procedure" as follows:

1. Install Tech 1 "Scan" tool.
2. Ignition "ON," engine "OFF."
3. Select "IAC SYSTEM," then "IDLE LEARN" in the "MISC TEST" mode.
4. Proceed with idle learn as directed.

This procedure allows the ECM memory to be updated with the correct IAC valve pintle position for the vehicle, and provides for a stable idle speed.

Functional Check

1. Turn ignition "ON."
2. Enter diagnostics.
   - A. Code 12 should flash four times (if no other codes are present). This indicates the MEM-CAL is installed properly and the ECM is functioning.
   - B. If trouble Codes 41, 42, 43, or 51 occur, or if the "Service Engine Soon" light is "ON" constantly with no codes, the MEM-CAL is not fully seated or is defective.
     - If not fully seated, press firmly on the ends of the MEM-CAL.
     - If it is necessary to remove the MEM-CAL, follow the previous removal instructions.

COOLANT SENSOR

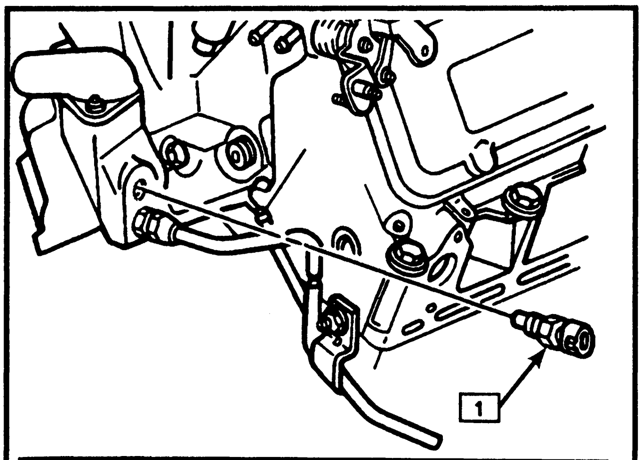
NOTICE: Care must be taken when handling coolant sensor. Damage to coolant sensor will affect proper operation of the fuel injection system.

Remove or Disconnect

1. Relieve coolant sensor pressure.
2. Negative battery cable.
3. Electrical connector.
4. Carefully back out coolant sensor.

Install or Connect

1. Coat threads (only) with sealer P/N 1052080 or equivalent torque to 30 N·m (22 lb. ft.)
2. Sensor in engine.
3. Electrical connector.
4. Negative battery cable.
5. Refill lost coolant.



1 COOLANT TEMPERATURE SENSOR
14 N·m (10 FT.LB.)

7S 3246-6E

Figure C1-11 - Coolant Sensor 3.1L

Important

- Before starting engine, follow the "Idle Learn Procedure" as follows:

1. Install Tech 1 "Scan" tool.
2. Ignition "ON," engine "OFF."
3. Select "IAC SYSTEM," then "IDLE LEARN" in the "MISC TEST" mode.
4. Proceed with idle learn as directed.

This procedure allows the ECM memory to be updated with the correct IAC valve pintle position for the vehicle, and provides for a stable idle speed.

MAT SENSOR

The MAT sensor is located in the air cleaner.

Remove or Disconnect

1. Electrical connector.
2. Clamps.
3. Sensor.

Install or Connect

1. Sensor.
2. Clamps.
3. Electrical connector.

OXYGEN (O_2) SENSOR

NOTICE: The oxygen sensor uses a permanently attached pigtail and connector. This pigtail should not be removed from the oxygen sensor. Damage or removal of the pigtail or connector could affect proper operation of the oxygen sensor.

Important

- Take care when handling the oxygen sensor. The in-line electrical connector and louvered end must be kept free of grease, dirt or other contaminants. Also, avoid using cleaning solvents of any type. Do not drop or roughly handle the oxygen sensor.

Remove or Disconnect

The oxygen sensor may be difficult to remove when engine temperature is below 48°C (120°F). Excessive force may damage threads in exhaust manifold or exhaust pipe.

1. Negative battery cable.
2. Electrical connector.
3. Carefully back out oxygen sensor.

Install or Connect

Important

- A special anti-seize compound is used on the oxygen sensor threads. The compound consists of a liquid graphite and glass beads.The graphite will burn away, but the glass beads will remain, making the sensor easier to remove.

  New or service sensors will already have the compound applied to the threads. If a sensor is removed from an engine, and, if for any reason it is to be reinstalled, the threads must have anti-seize compound applied before reinstallation.

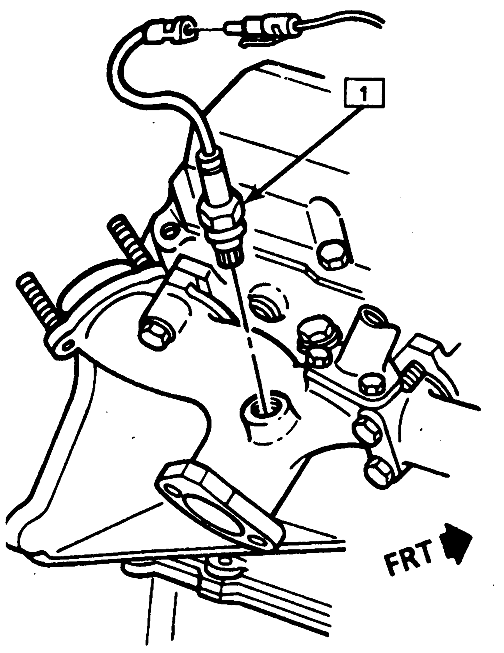
1. Coat threads of oxygen sensor with anti-seize compound P/N 5613695, or equivalent if necessary.
2. Sensor, and torque to 41 N·m (30 lb. ft.).
3. Electrical connector.
4. Negative battery cable.

Important

- Before starting engine, follow the "Idle Learn Procedure" as follows:

1. Install Tech 1 "Scan" tool.
2. Ignition "ON," engine "OFF."
3. Select "IAC SYSTEM," then "IDLE LEARN" in the "MISC TEST" mode.
4. Proceed with idle learn as directed.

This procedure allows the ECM memory to be updated with the correct IAC valve pintle position for the vehicle, and provides for a stable idle speed.



1 OXYGEN (O_2) SENSOR

7S 3278-6E

Figure C1-12 - O_2 Sensor 3.1L

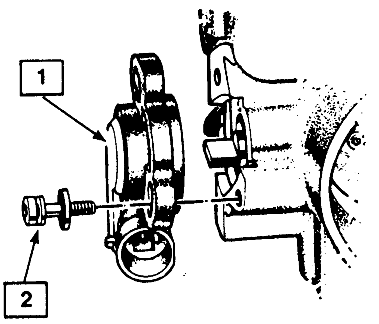
THROTTLE POSITION SENSOR (TPS)

Remove or Disconnect

1. Throttle cables.
2. Throttle body inlet boot.
3. Throttle body vacuum line connector.
4 TPS electrical connector.
5. Throttle body bolts.
6. Lift throttle body until TPS clears fuel line.
7. Remove TPS attaching screws.
8. Sensor.

Install or Connect

1. With throttle valve in the normal closed idle position, install throttle position sensor on throttle body assembly (see Figure C1-12).
2. TPS attaching screws.
3. Tighten TPS attaching screws to 2.0 N·m (18 lb. in.)
4. Throttle body bolts.
5. TPS electrical connector.

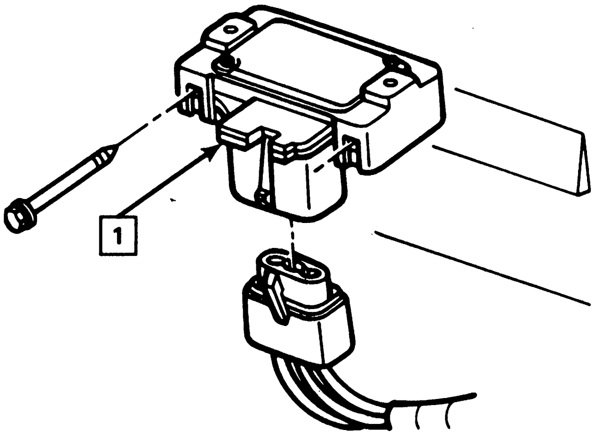


1 THROTTLE POSITION SENSOR (TPS)

2 TPS ATTACHING SCREW ASSEMBLY

9P 1074-6E

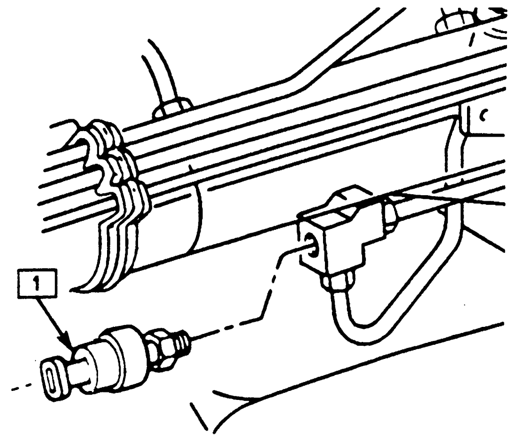
Figure C1-13 - Throttle Position Sensor Service



1 MAP SENSOR

7S 3277-6E

Figure C1-14 - MAP Sensor Service 3.1L



1 POWER STEERING PRESSURE SWITCH

7S 3403-6E

Figure C1-15 - PSPS 3.1L

MAP SENSOR

Remove or Disconnect

1. Vacuum hose.
2. Electrical connector.
3. Attaching screws.
4. Sensor.

Install or Connect

1. Sensor using attaching screws.
2. Electrical connector.
3. Vacuum hose.

VSS

Refer to Section "7" for trans. mounted VSS.

IDLE SPEED POWER STEERING PRESSURE (PSPS) SWITCH

Remove or Disconnect

1. Negative battery cable.
2. Electrical connector.
3. Switch.

Install or Connect

1. Switch.
2. Electrical connector.
3. Negative battery cable.
4. Replace lost fluid.

Important

- Before starting engine, follow the "Idle Learn Procedure" as follows:

1. Install Tech 1 "Scan" tool.
2. Ignition "ON," engine "OFF."
3. Select "IAC SYSTEM," then "IDLE LEARN" in the "MISC TEST" mode.
4. Proceed with idle learn as directed.

This procedure allows the ECM memory to be updated with the correct IAC valve pintle position for the vehicle, and provides for a stable idle speed.

PARK/NEUTRAL (P/N) SWITCH

See Section "7A" for Park/Neutral (P/N) switch. On-Vehicle Service and adjustment procedures are also listed there.

PARTS INFORMATION

PART NAME	GROUP
Controller, ECM	3.670
Memory Calibration Unit, MEM/CAL	3.670
Sensor, Coolant Temp	3.682
Sensor, Exhaust Oxygen	3.682
Sensor, Throttle Position: Part of Sensor Kit, Throttle Position	3.440
Sensor, Manifold Pressure	3.682
Sensor, Vehicle Speed	3.682

BLANK

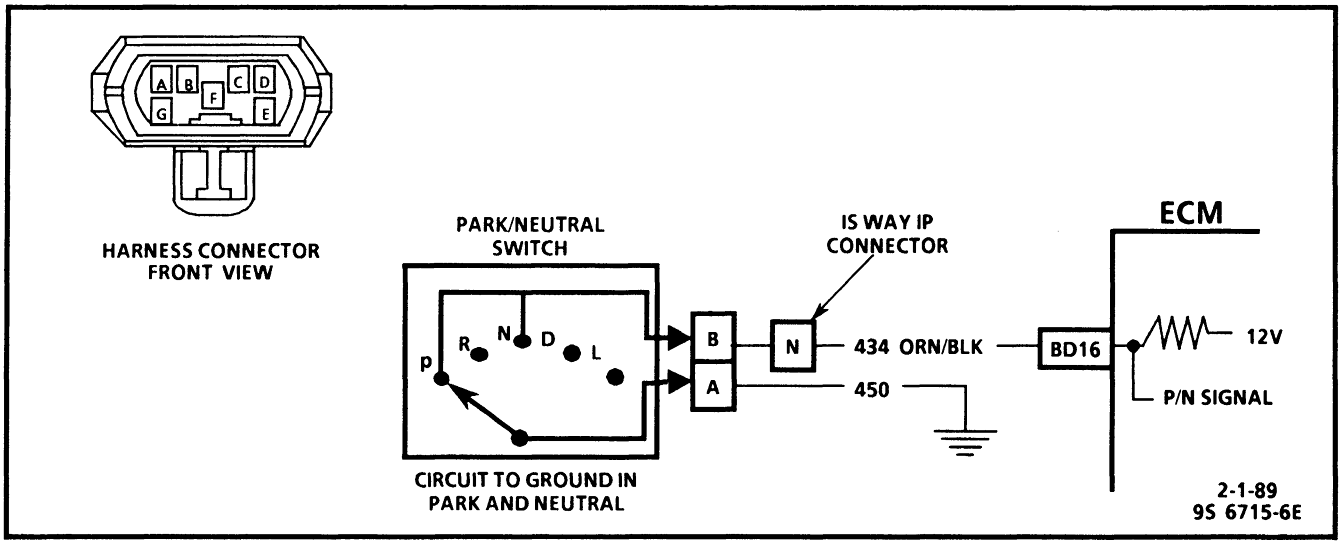


CHART C-1A

PARK/NEUTRAL (P/N) SWITCH DIAGNOSIS
3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The Park/Neutral (P/N) switch contacts are a part of the neutral start switch and are closed to ground in park or neutral, and open in drive ranges.

The ECM supplies ignition voltage through a current limiting resistor to CKT 434 and senses a closed switch when the voltage on CKT 434 drops to less than one volt.

The ECM uses the P/N signal as one of the inputs to control:

Idle air control
VSS diagnostics
EGR

If CKT 434 indicates P/N (grounded) while in drive range, the EGR would be inoperative, resulting in possible detonation.

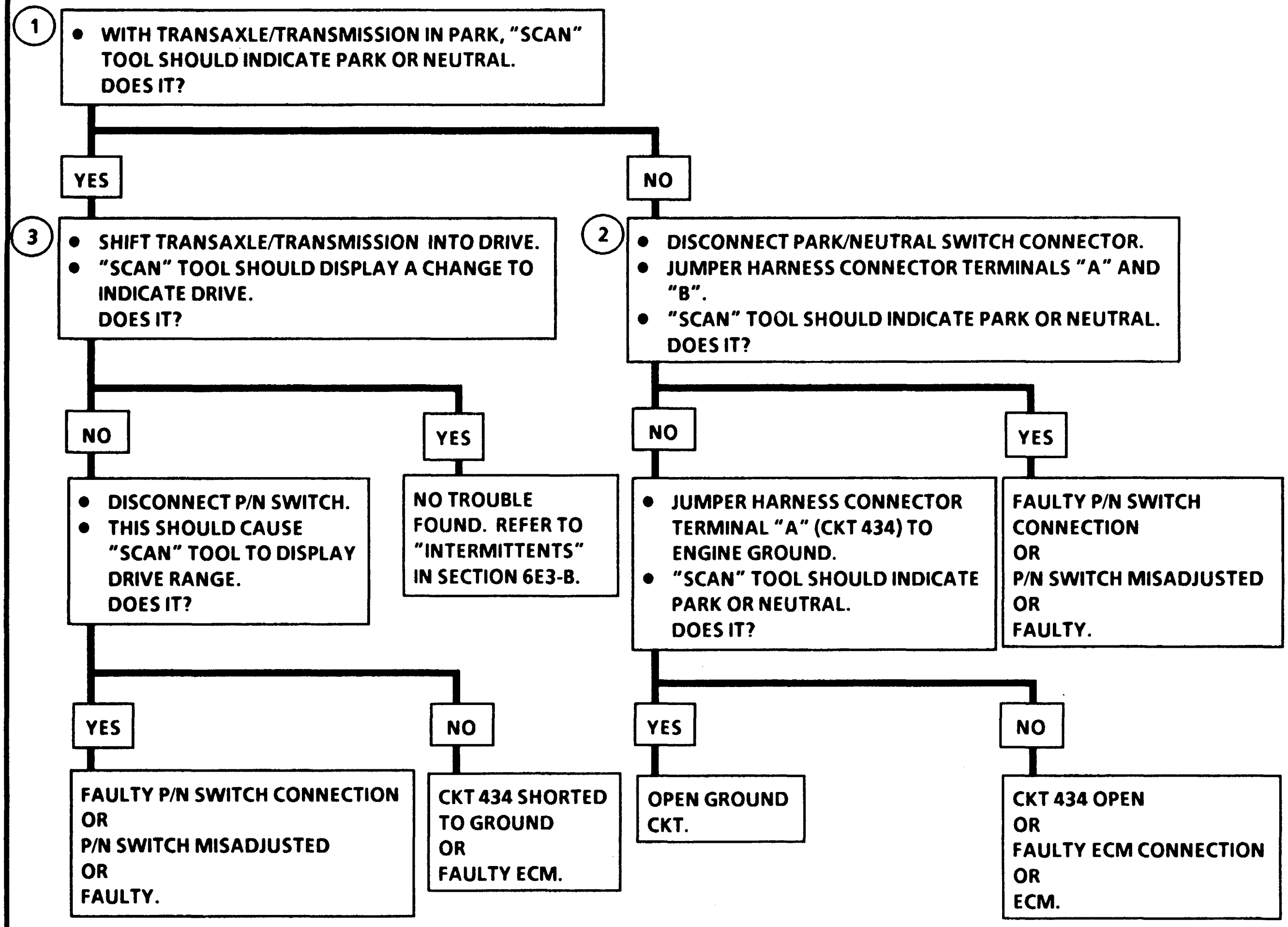
If CKT 434 indicates drive (open) a dip in the idle may exist when the gear selector is moved into drive range.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Checks for a closed switch to ground in park position. Different makes of "Scan" tools will read P/N differently. Refer to tool operator's manual for type of display used for a specific tool.
2. Checks for an open switch in drive range.
3. Be sure "Scan" indicates drive, even while wiggling shifter, to test for an intermittent or misadjusted switch in drive or overdrive range.

CHART C-1A

PARK/NEUTRAL (P/N) SWITCH DIAGNOSIS
3.1L (VIN T) "F" CARLINE (PORT)



① WITH TRANSAXLE/TRANSMISSION IN PARK, "SCAN" TOOL SHOULD INDICATE PARK OR NEUTRAL. DOES IT?

③
- SHIFT TRANSAXLE/TRANSMISSION INTO DRIVE.
- "SCAN" TOOL SHOULD DISPLAY A CHANGE TO INDICATE DRIVE. DOES IT?

- DISCONNECT P/N SWITCH.
- THIS SHOULD CAUSE "SCAN" TOOL TO DISPLAY DRIVE RANGE. DOES IT?

FAULTY P/N SWITCH CONNECTION
OR
P/N SWITCH MISADJUSTED
OR
FAULTY.

CKT 434 SHORTED TO GROUND
OR
FAULTY ECM.

NO TROUBLE FOUND. REFER TO "INTERMITTENTS" IN SECTION 6E3-B.

②
- DISCONNECT PARK/NEUTRAL SWITCH CONNECTOR.
- JUMPER HARNESS CONNECTOR TERMINALS "A" AND "B".
- "SCAN" TOOL SHOULD INDICATE PARK OR NEUTRAL. DOES IT?

- JUMPER HARNESS CONNECTOR TERMINAL "A" (CKT 434) TO ENGINE GROUND.
- "SCAN" TOOL SHOULD INDICATE PARK OR NEUTRAL. DOES IT?

OPEN GROUND CKT.

CKT 434 OPEN
OR
FAULTY ECM CONNECTION
OR
ECM.

FAULTY P/N SWITCH CONNECTION
OR
P/N SWITCH MISADJUSTED
OR
FAULTY.

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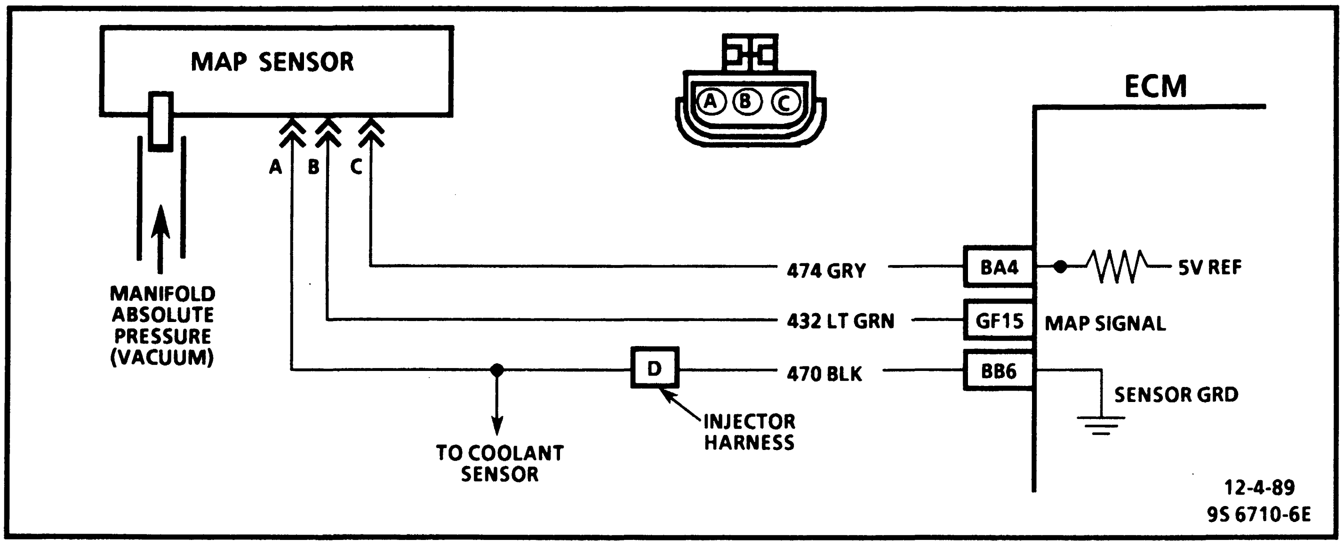


CHART C-1D

MANIFOLD ABSOLUTE PRESSURE (MAP) OUTPUT CHECK
3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The Manifold Absolute Pressure (MAP) sensor measures the changes in the intake manifold pressure which result from engine load (intake manifold vacuum) and rpm changes: and converts theses into a voltage output. The ECM sends a 5 volt reference voltage to the MAP sensor. As the manifold pressure changed, the output voltage of the sensor also changes. By monitoring the sensor output voltage, the ECM knows the manifold pressure. A lower pressure (low voltage will be about 1 - 2 volts at idle. While higher pressure (high voltage) output voltage will be about 4 - 4.8 at Wide Open Throttle (WOT). The MAP sensor is also used, under certain conditions, to measure barometric pressure, allowing the ECM to make adjustments for different altitudes. The ECM used the MAP sensor to control fuel delivery and ignition timing.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

Important

- Be sure to use the same Diagnostic Test Equipment for all measurements.

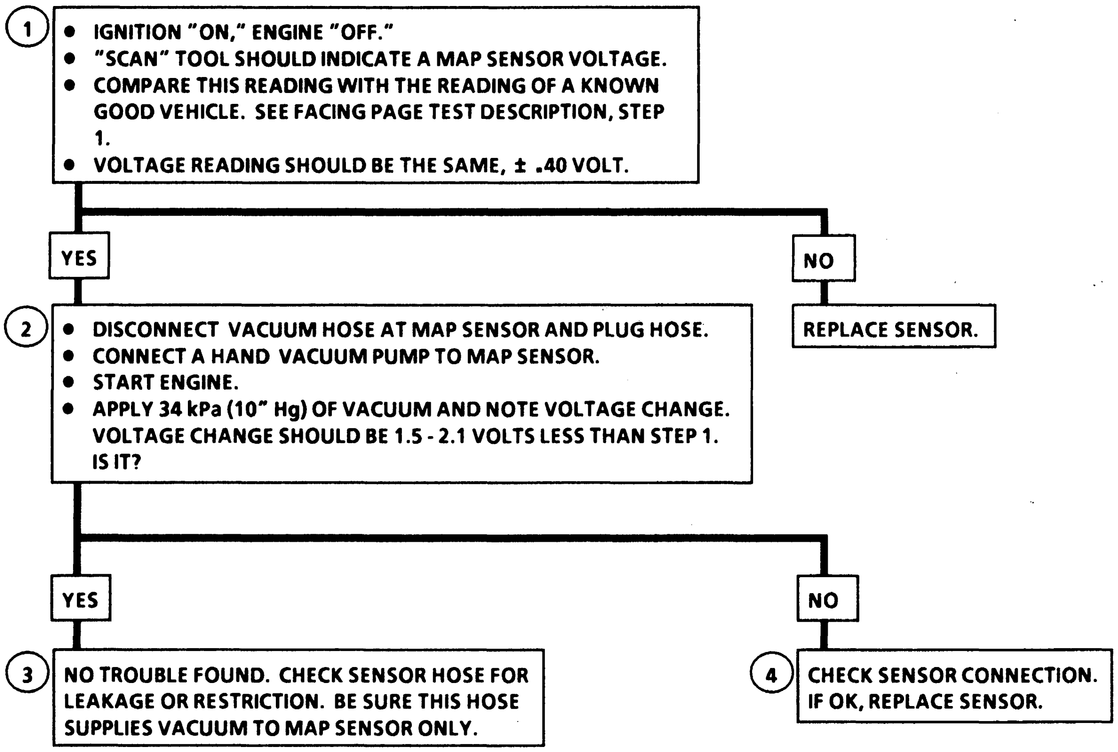
1. When comparing "Scan" readings to a known good vehicle, it is important to compare vehicles that use a MAP sensor having the same color insert or having the same "Hot Stamped" number.
2. Applying 34 kPa (10" Hg) vacuum to the MAP sensor should cause the voltage to be 1.5 to 2.1 volts less than the voltage at Step 1. Upon applying vacuum to the sensor, the change in voltage should be instantaneous. A slow voltage change indicates a faulty sensor.
3. Check vacuum hose to sensor for leaking or restriction. Be sure that no other vacuum devices are connected to the MAP hose.

NOTE: Make sure electrical connector remains securely fastened.

4. Disconnect sensor from bracket and twist sensor by hand (only) to check for intermittent connection. Output changes greater than .10 volt indicates a bad sensor.

CHART C-1D

MANIFOLD ABSOLUTE PRESSURE (MAP) OUTPUT CHECK
3.1L (VIN T) "F" CARLINE (PORT)



①
- IGNITION "ON," ENGINE "OFF."
- "SCAN" TOOL SHOULD INDICATE A MAP SENSOR VOLTAGE.
- COMPARE THIS READING WITH THE READING OF A KNOWN GOOD VEHICLE. SEE FACING PAGE TEST DESCRIPTION, STEP 1.
- VOLTAGE READING SHOULD BE THE SAME, ± .40 VOLT.

YES

②
- DISCONNECT VACUUM HOSE AT MAP SENSOR AND PLUG HOSE.
- CONNECT A HAND VACUUM PUMP TO MAP SENSOR.
- START ENGINE.
- APPLY 34 kPa (10" Hg) OF VACUUM AND NOTE VOLTAGE CHANGE. VOLTAGE CHANGE SHOULD BE 1.5 - 2.1 VOLTS LESS THAN STEP 1. IS IT?

YES

③ NO TROUBLE FOUND. CHECK SENSOR HOSE FOR LEAKAGE OR RESTRICTION. BE SURE THIS HOSE SUPPLIES VACUUM TO MAP SENSOR ONLY.

NO

④ CHECK SENSOR CONNECTION. IF OK, REPLACE SENSOR.

NO

REPLACE SENSOR.

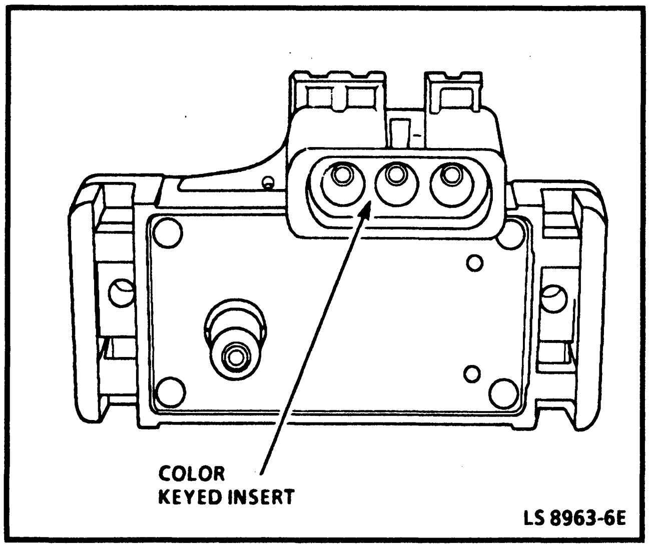


Figure 1 - Color Key Insert

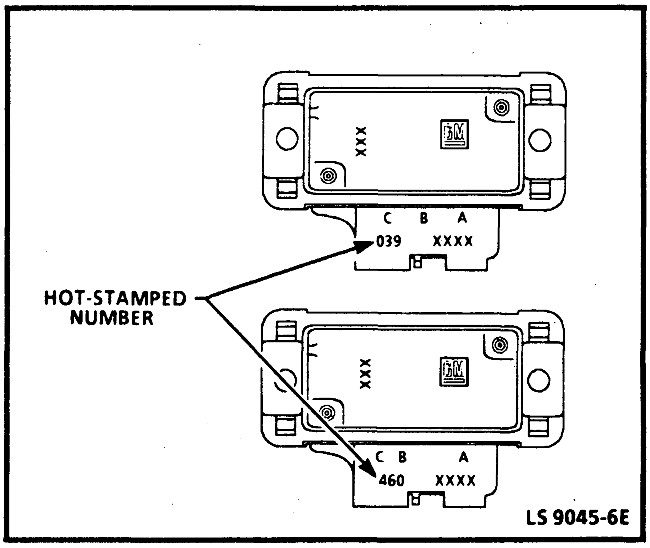


Figure 2 - Hot-Stamped

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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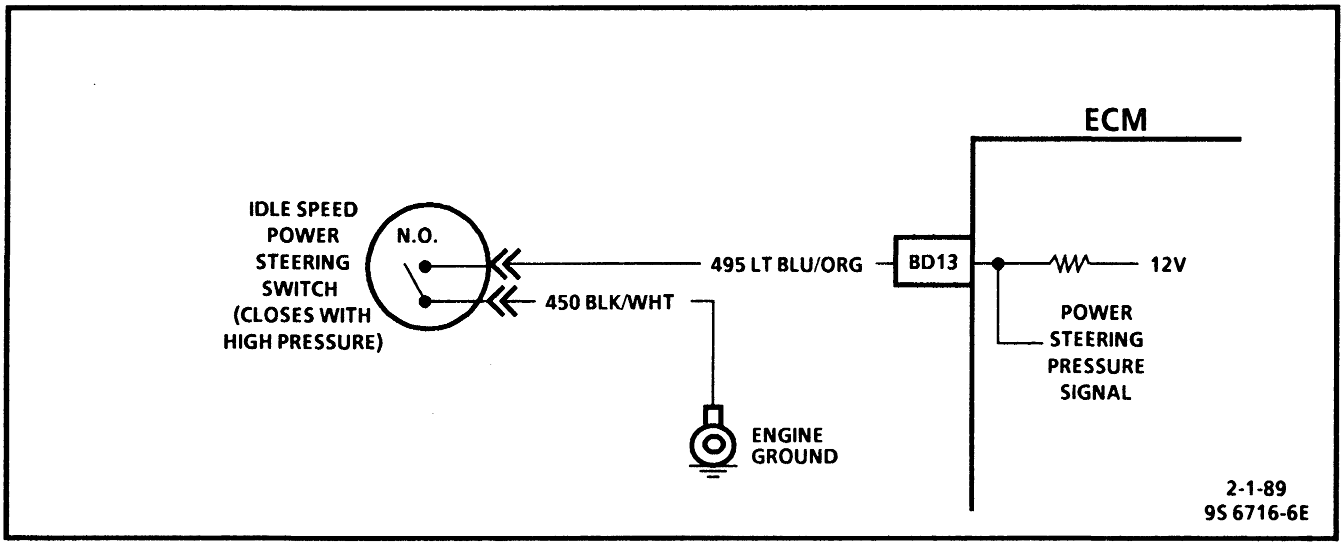


CHART C-1E

IDLE SPEED POWER STEERING PRESSURE SWITCH (PSPS) DIAGNOSIS
3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The idle speed Power Steering Pressure Switch (PSPS) is normally open to ground, and CKT 495 will near the battery voltage.

Turning the steering wheel increases power steering oil pressure and its load on an idling engine. The pressure switch will close before the load can cause an idle problem.

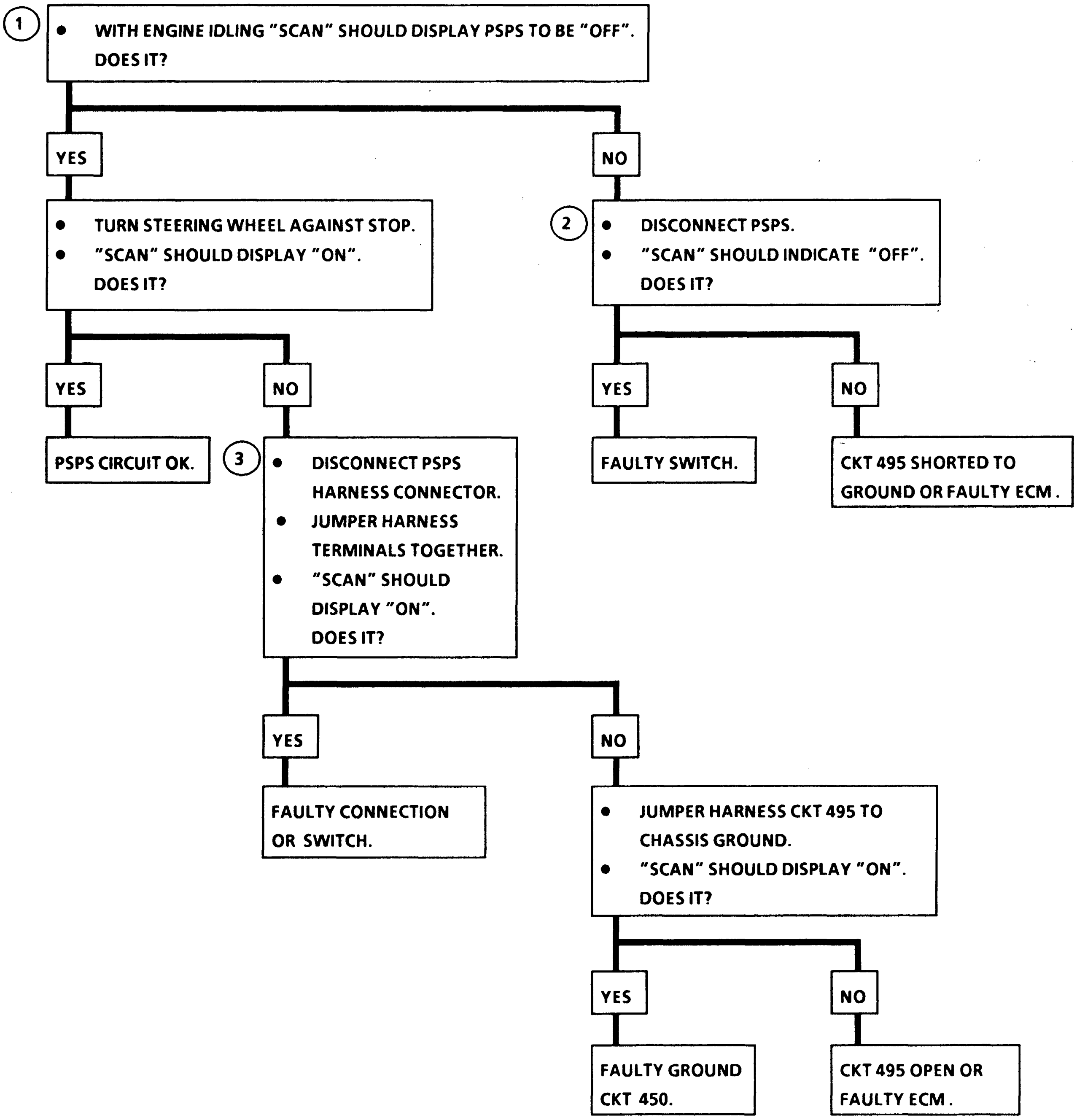
Closing the switch causes CKT 495 to read less than 1 volt. The ECM will increase the idle air rate and disengage the A/C relay.

- A pressure switch that will not close, or an open CKT 495 or CKT 450, may cause the engine to stop when power steering loads are high.
- A switch that will not open or a CKT 495 shorted to ground may affect idle quality and will cause the A/C relay to be de-engerized.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Different makes of "Scan" tools may display the state of this switch in defferent ways. Refer to "Scan" tool operators manual to determine how this input is indicated.
2. Checks to determine if CKT 495 is shorted to ground.
3. This should simulate a closed switch.

CHART C-1E
IDLE SPEED POWER STEERING PRESSURE SWITCH (PSPS) DIAGNOSIS
3.1L (VIN T) "F" CARLINE (PORT)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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BLANK

SECTION C2

FUEL METERING SYSTEM

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The function of the fuel metering system is to deliver the correct amount of fuel to the engine under all operating conditions.

Fuel is delivered to the engine by individual fuel injectors mounted in the intake manifold near each cylinder.

The main control sensor is the Oxygen (O_2) sensor, which is located in the exhaust manifold. This sensor tells the Electronic Control Module (ECM) how much oxygen is in the exhaust gas, and the ECM changes the air/fuel ratio to the engine by controlling the fuel injectors. The best mixture to minimize exhaust emissions is 14.7:1, which allows the catalytic converter to operate most efficiently. Because of the constant measuring and adjusting of the air/fuel ratio, the fuel injection system is called a "Closed Loop" system (shown in Figure C2-1).

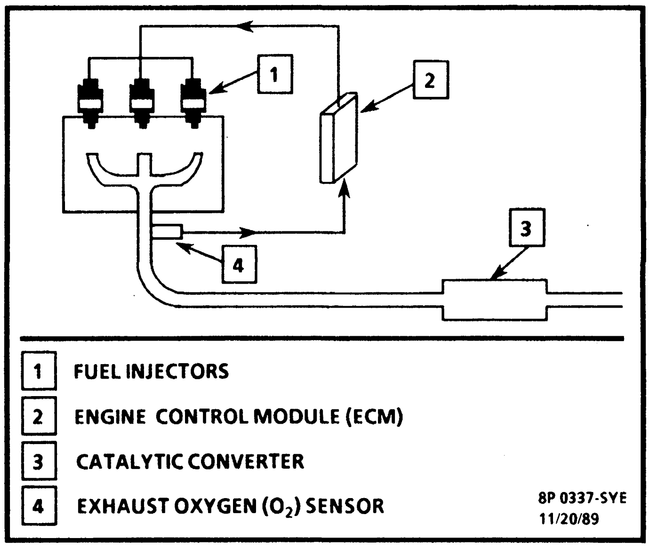


Figure C2-1 - "Closed Loop" System

MODES OF OPERATION

The ECM monitors information from several sensors to determine how much fuel to give the engine. The fuel is delivered under one of several conditions called "modes." All the modes are controlled by the ECM and are described below.

Starting Mode

When the ignition switch is turned to the "ON" position (before engaging starter), the ECM turns "ON" the fuel pump relay for two seconds and the fuel pump builds up pressure. The ECM then checks the Coolant Temperature Sensor (CTS) and Throttle Position Sensor (TPS) and determines the proper air/fuel ratio for starting. This ranges from 1.5:1 at -36°C (-33°F) to 14.7:1 at 94°C (201°F) running temperature. The ECM controls the amount of fuel delivered in the starting mode by changing how long the injectors are turned "ON" and "OFF." This is done by "pulsing" the injectors for very short times.

Clear Flood Mode

If the engine floods, it can be cleared by pushing the accelerator pedal down all the way. The ECM then completely turns "OFF" the fuel. The ECM holds this injector rate as long as the throttle stays wide open, and the engine rpm is below 600. If the throttle position becomes less than 80%, the ECM returns to the starting mode.

Run Mode

The run mode has two conditions, called "Open Loop" and "Closed Loop."

When the engine is first started and rpm is above 400, the system goes into "Open Loop" operation. The ECM ignores the signal from the O_2 sensor, and calculates the air/fuel ratio based on inputs from the coolant temperature and Manifold Absolute Temperature (MAT) sensors.

The system stays in "Open Loop" until the following conditions are met:

1. The O_2 sensor has varying voltage output, showing that it is hot enough to operate properly. (This depends on temperature).
2. The coolant temperature sensor is above a specified temperature.
3. A specific amount of time has elapsed after starting the engine.

The specific values for the above conditions vary with different engines, and are stored in the Memory Calibrator (MEM-CAL) portion of the ECM. When these values are met, the system goes into "Closed Loop" operation. In "Closed Loop," the ECM calculates the air/fuel ratio (injector on-time) based on the signal from the O_2 sensor. This allows the air/fuel ratio to stay very close to 14.7:1.

Acceleration Mode

When the driver pushes on the accelerator pedal, air flow into the cylinders increases rapidly, while fuel flow tends to lag behind. To prevent possible hesitation, the ECM increases the pulse width to the injectors to provide extra fuel during acceleration. The amount of fuel required is based on throttle position, manifold air pressure and engine speed.

Fuel Cut-off Mode

To prevent possible engine damage from over-speed, the ECM "cuts-off" fuel from the injectors when engine speed is above 6200 rpm with the vehicle in any forward gear position, or in reverse. The ECM also "cuts-off" fuel to the injectors at vehicle speeds above 115 mph to prevent tire damage.

Deceleration Mode

When the driver releases the accelerator pedal, air flow into the engine is reduced. The corresponding changes in throttle position and manifold air pressure are relayed to the ECM, which reduces the injector pulse width to reduce fuel flow. If the deceleration is very rapid, or for long periods (such as long closed throttle coast-down), the ECM shuts "OFF" fuel completely to protect the catalytic converter.

Converter Protection Mode

The ECM constantly monitors engine operation, and estimates conditions that could result in high converter temperatures. If the ECM determines the converter may overheat, it causes the system to return to "Open Loop" operation and enriches the fuel mixture.

Battery Voltage Correction Mode

When battery voltage is low, the ECM can compensate for the weak spark by:

- Increasing the amount of fuel delivered
- Increasing the idle rpm
- Increasing ignition dwell time.

FUEL METERING SYSTEM COMPONENTS

The fuel metering system (see Figure C2-2) consists of the following parts:

- Fuel supply components (fuel tank, pump, lines).
- Fuel pump electrical circuit.
- Fuel rail assembly, including:
    - Fuel injectors
    - Pressure regulator
- Throttle body assembly, including:
    - Idle Air Control (IAC) valve
    - Throttle Position Sensor (TPS).

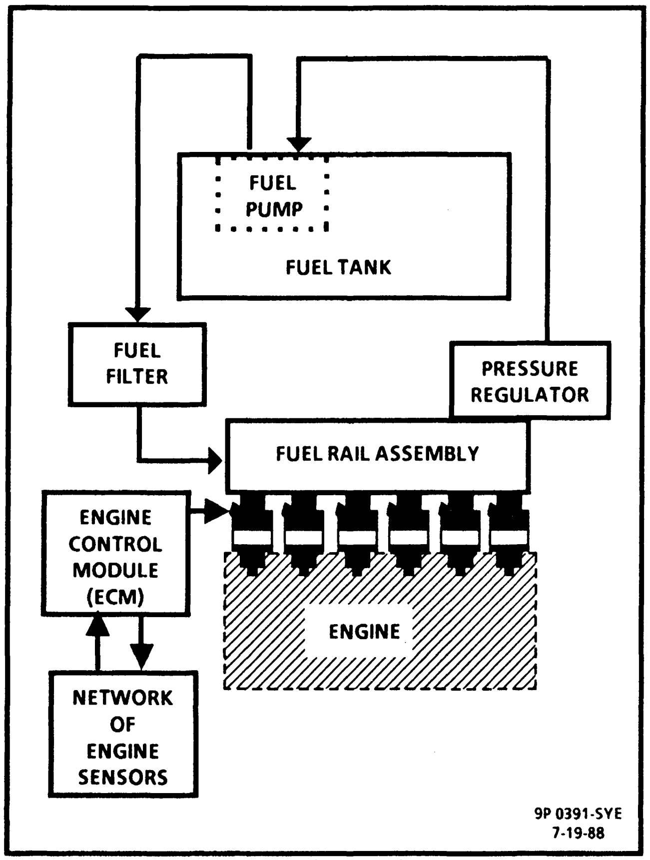


Figure C2-2 - Fuel Metering System

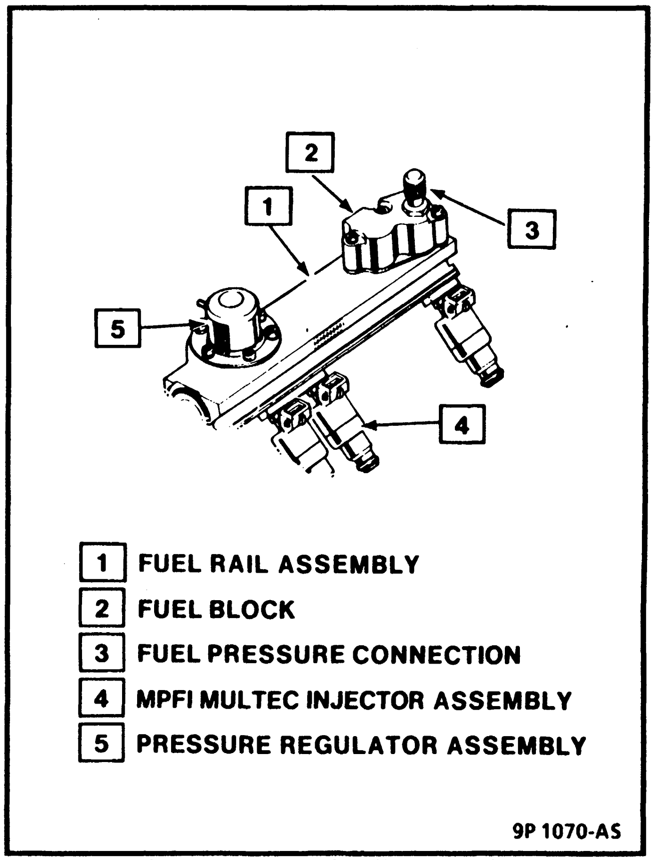


Figure C2-3 - Fuel Rail Assembly

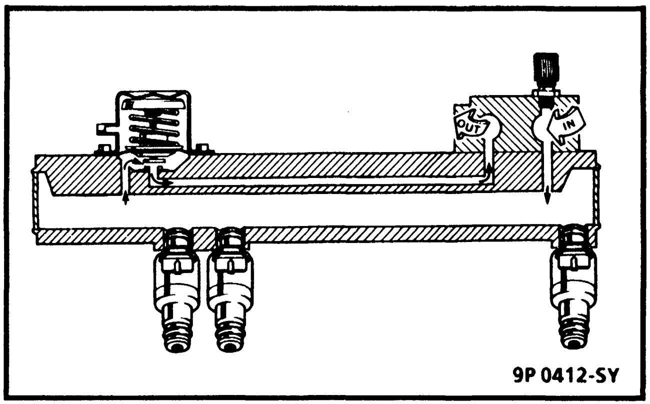


Figure C2-4 - Fuel Rail Assembly Flow Diagram

FUEL SUPPLY COMPONENTS

The fuel supply is stored in the fuel tank. An electric fuel pump, located in the fuel tank with the gage sending unit, pumps fuel through an in-line fuel filter to the fuel rail assembly. The pump is designed to provide fuel at a pressure greater than is needed by the injectors. The pressure regulator, part of the fuel rail assembly, keeps fuel available to the injectors at a regulated pressure. Unused fuel is returned to the fuel tank by a separate line. (For further information see ENGINE FUEL (SECTION 6C) for replacement procedures covering the fuel tank, fuel pump, in-line filter and fuel lines.)

FUEL PUMP ELECTRICAL CIRCUIT

When the ignition switch is turned to the "ON" position (before engaging starter), the ECM turns the fuel pump relay "ON" for two seconds, causing the fuel pump to pressurize the fuel system. If the ECM does not receive ignition reference pulses (engine cranking or running) within two seconds, it shuts "OFF" the fuel pump relay, causing the fuel pump to stop.

As a backup system to the fuel pump relay, the fuel pump also can be turned on by the oil pressure sensor/switch. The oil pressure sender has two internal circuits. One operates the oil pressure indicator or gage in the instrument cluster, and the other is a normally open switch which closes when oil pressure reaches about 28 kPa (4 psi). If the fuel pump relay fails, a Code 54 is set in the ECM, and the oil pressure switch runs the fuel pump.

An inoperative fuel pump relay can result in long cranking times, particularly if the engine is cold. The oil pressure switch turns "ON" the fuel pump as soon as oil pressure reaches about 28 kPa (4 psi).

FUEL RAIL ASSEMBLY

The fuel rail assembly (Figure C2-3) is mounted to the engine intake manifold, and performs several functions. It positions the injectors in the intake manifold, distributes fuel evenly to the injectors, and

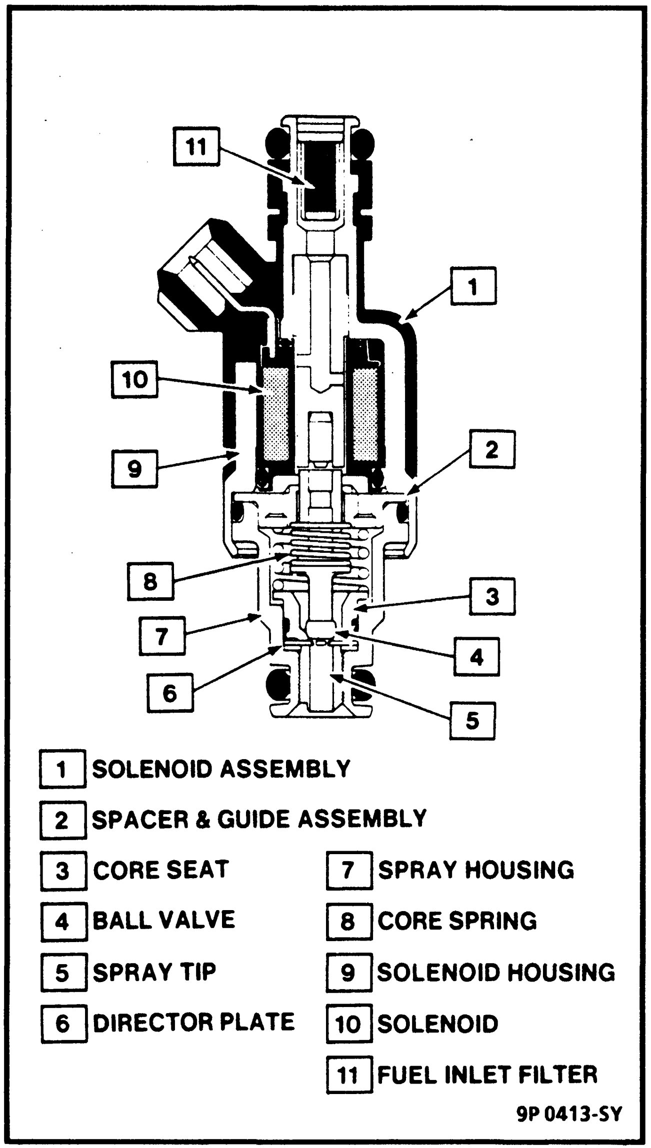


Figure C2-5 - MPFI Injector Assembly Cross-Sectional View

integrates the fuel pressure regulator into the fuel metering system. Fuel flow within the rail can be seen in Figure C2-4.

Fuel Injector

An MPFI injector assembly (Figure C2-5) is a solenoid- operated device, controlled by the ECM, that meters pressurized fuel to a single engine cylinder. The ECM energizes the injector solenoid, which opens a ball valve, allowing fuel to flow past the ball valve, and through a recessed flow director plate. The director plate has six machined holes that control the fuel flow, generating a conical spray pattern of finely atomized fuel at the injector tip. Fuel is directed at the intake valve, causing it to become further atomized and vaporized before entering the combustion chamber.

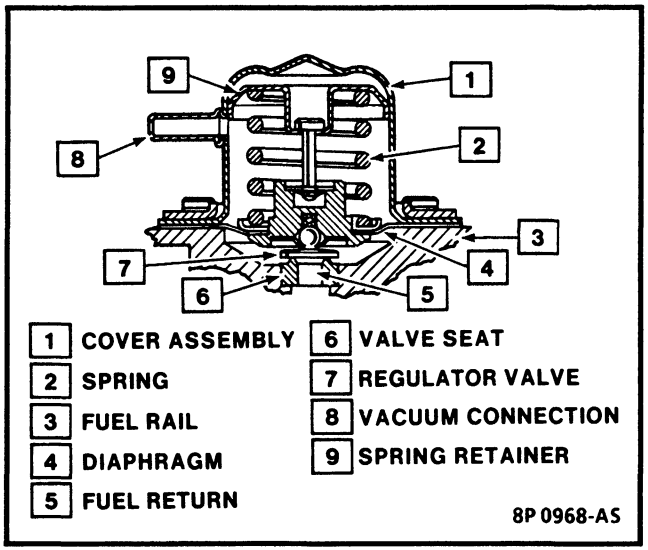


Figure C2-6 - Pressure Regulator Assembly

An injector that is stuck partly open would cause loss of pressure after engine shut down. Consequently, long cranking times would be noticed on some engines. Dieseling also could occur because some fuel could be delivered to the engine after the ignition is turned "OFF."

Pressure Regulator Assembly

The pressure regulator (see Figure C2-6) is a diaphragm-operated relief valve with fuel pump pressure on one side, and regulator spring pressure and intake manifold vacuum on the other. The regulator's function is to maintain a constant pressure differential across the injectors at all times. The pressure regulator compensates for engine load by increasing fuel pressure as engine vacuum drops.

With the ignition "ON" and engine "OFF" (zero vacuum), fuel pressure at the pressure test connection should be 284 - 325 kPa (41 - 47 psi). If the pressure is too low, poor performance could result. If the pressure is too high, excessive odor and a Code 45 may result. CHART A-7 has information on diagnosing fuel pressure conditions.

THROTTLE BODY ASSEMBLY

The throttle body assembly (Figure C2-7) is attached to the intake manifold air plenum, and is used to control air flow into the engine, thereby controlling engine output. The throttle valve within the throttle body is opened by the driver through the accelerator controls. During engine idle, the throttle valve is almost closed, and air flow control is handled by the Idle Air Control (IAC) valve, described below. To ensure proper air flow by the throttle valve during cool weather operation, engine coolant is directed through the coolant cavity, on the bottom of the throttle body, to prevent throttle valve icing.

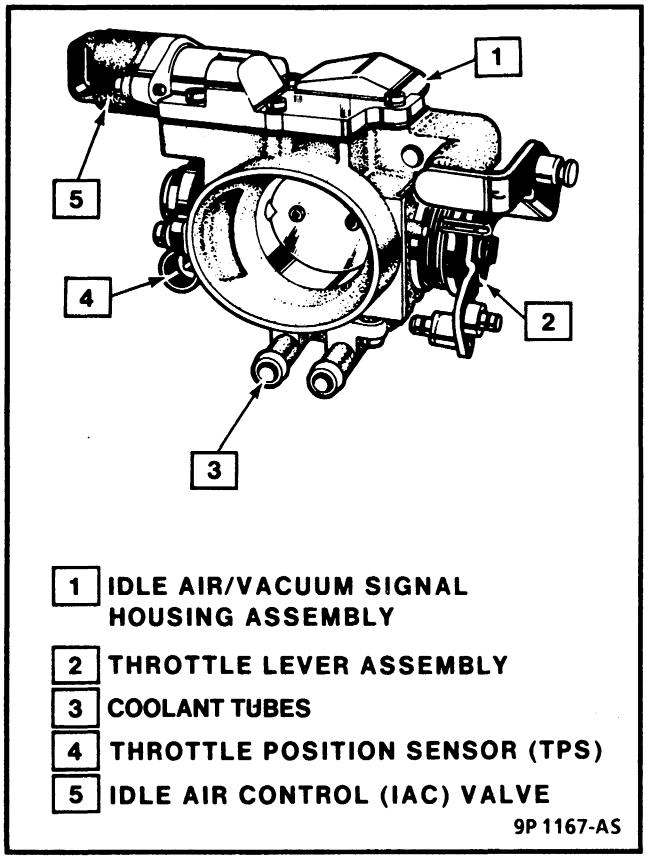


Figure C2-7 - Throttle Body

The throttle body also provides the location for mounting the TPS, for sensing changes in engine vacuum due to throttle valve position. Vacuum ports are located at, above, or below the throttle valve to generate vacuum signals needed by various components.

Idle Air Control (IAC) Valve Assembly

The purpose of the IAC valve assembly (shown in Figure C2-8) is to control engine idle speed, while preventing stalls due to changes in engine load.

The IAC valve, mounted in the throttle body, controls bypass air around the throttle valve (Figure C2-9). By moving a conical valve known as a pintle, IN toward the seat (to decrease air flow); or OUT away from the seat (to increase airflow), a controlled amount of air moves around the throttle plate. If rpm is too low, more air is bypassed around the throttle valve to increase it. If rpm is too high, less air is bypassed around the throttle valve to decrease it.

The ECM moves the IAC valve in small steps, called "counts." These can be measured by "Scan" tool test equipment, which plugs into the ALDL connector.

During idle, the proper position of the IAC valve is calculated by the ECM, based on battery voltage, coolant temperature, engine load, and engine rpm. If the rpm drops below specification and the throttle valve is closed, the ECM senses a near stall condition and calculates a new valve position to prevent stalling.

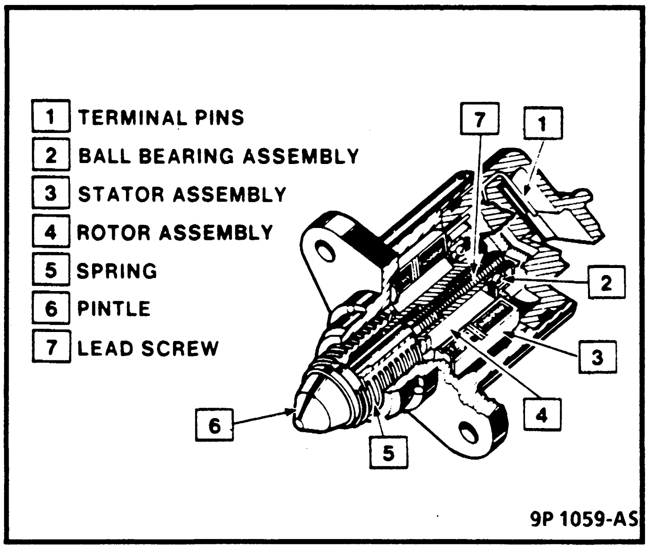


Figure C2-8 - Idle Air Control (IAC) Valve Assembly

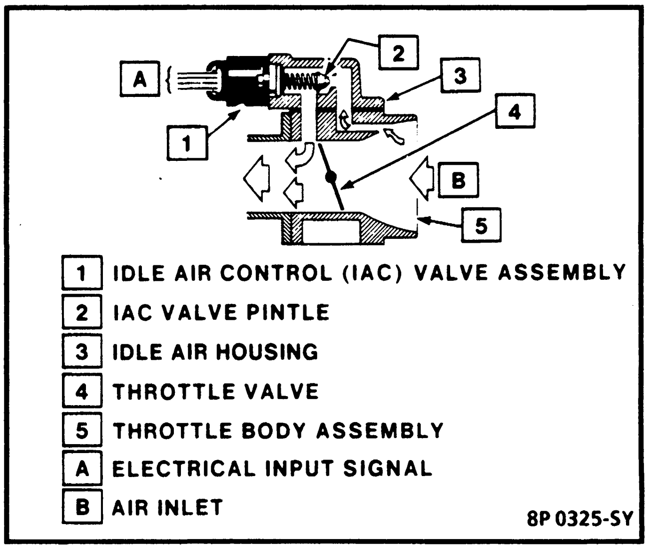


Figure C2-9 - IAC Valve Air Flow Diagram

If the IAC valve is disconnected and reconnected while the engine is running, the resulting idle rpm may be wrong and resetting of the IAC valve will be required.

After running the engine, the IAC valve resets when the ignition is turned "OFF." When servicing the IAC valve, it should only be disconnected or connected with the ignition "OFF."

If the ECM is without battery power for any reason, the programmed position of the IAC valve pintle is lost, and is replaced with a "default" value. This causes the engine idle to be unstable for a period of approximately seven minutes. To return the IAC valve pintle to the correct position, see "Idle Learn Procedure."

Different shaped pintles are used for different IAC valve applications. Be sure to use the correct part number, with the correct pintle shape and diameter, when replacement is required.

The IAC valve affects only the idle characteristics of the vehicle. If it is fully retracted, too much air will be allowed into the manifold and idle speed will be high. If it is stuck closed, too little air will be allowed in the manifold, and idle speed will be too low. If it is stuck part way open, the idle may be rough, and will not respond to engine load changes. A Code 35 should set if a controlled idle cannot be maintained.

Throttle Position Sensor (TPS)

The nonadjustable TPS is mounted on the side of the throttle body opposite the throttle lever. It senses the throttle valve angle and relays that information to the ECM. Knowledge of throttle angle is needed by the ECM to generate the required injector control signals (pulses). For further information, refer to "Electronic Control Module (ECM) and Sensors," Section "6E3-C1".

DIAGNOSIS

FUEL PUMP RELAY

The fuel pump relay is mounted in the engine compartment, next to the power brake booster. See illustration in "On Vehicle Service." For diagnosis of the fuel pump relay circuit, refer to the Code 54 Chart.

OIL PRESSURE SENSOR/SWITCH

The oil pressure switch is threaded into the oil filter adapter. See illustration in "On Vehicle Service." For diagnosis of the fuel pump relay circuit, refer to the Code 54 Chart.

FUEL METERING SYSTEM

Some failures of this system will result in an "Engine Cranks But Won't Run." If this condition exists, see CHART A-3. This chart will determine if the problem is caused by the ignition system, ECM or fuel pump circuit. If it's determined to be a fuel problem, CHART A-7 will be used. This includes the injectors, pressure regulator, fuel pump and fuel pump relay.

If a problem occurs in the fuel metering system, it usually results in either a rich or lean exhaust condition. This condition is sensed by the O_2 sensor and causes the ECM to change the fuel calculation (injector pulse width). The change made to the fuel calculation is indicated by a change in the integrator and block learn values, which can be monitored by a "Scan" tool. A short term change to the fuel calculation is indicated by the integrator value, while a long term change is indicated by the block learn value. Average integrator and block learn values will be around 128, but vary slightly from engine to engine.

Important

- When using a "Scan" tool to observe integrator and block learn values, remember that if the system is in control, no action is required unless a driveability symptom is present.

Listed below are examples of lean and rich conditions with the system in control and out of control.

- A momentary *lean* condition (system is *in* control) will appear on "Scan" tool as:
  - Integrator value above 128 (adding fuel)
  - Block learn value around 128
- A long term *lean* condition (system is *in* control) will appear on "Scan" tool as:
  - Integrator value around 128
  - Block learn value above 128 (added fuel)
- A long term *lean* condition (system is *out of control)* will appear on "Scan" tool as:
  - Integrator value well above 128 (adding fuel)
  - Block learn value well above 128 (added fuel)

If both the integrator and block learn values are fixed well above 128, see Code 44, for items which can cause a lean system.

- A momentary *rich* condition (system is *in* control) will appear on "Scan" tool as:
  - Integrator value less than 128 (reducing fuel)
  - Block learn value around 128
- A long term *rich* condition (system is *in* control) will appear on "Scan" tool as:
  - Integrator value around 128
  - Block learn value less than 128 (reduced fuel)
- A long term *rich* condition (system is *out of control)* will appear on "Scan" tool as:
  - Integrator value much less than 128 (reducing fuel)
  - Block learn value much less than 128 (reduced fuel)

If the integrator and block learn values are fixed well below 128, see Code 45, for items which can cause the system to run rich. If a driveability symptom exists, refer to the particular symptom in "Symptoms," Section "6E3-B" for additional items to check.

ON-VEHICLE SERVICE

IDLE LEARN PROCEDURE

Any time the battery is disconnected, the programmed position of the IAC valve pintle is lost, and replaced with a "default" value. To return the IAC valve pintle to the correct position, perform the following procedure.

1. Restore battery power.
2. Connect GM TECH I® scan tool.
3. Select "IAC System," then select "Idle Learn" in the "Misc. Test" mode.
4. Proceed with idle learn as directed.

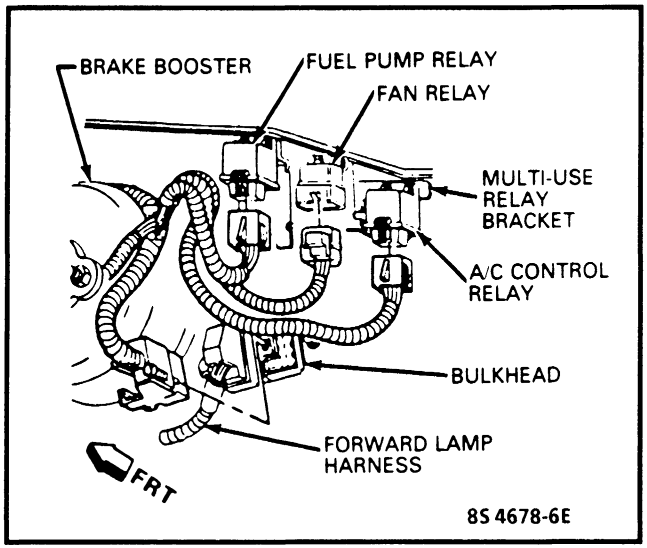


Figure C2-10 - Fuel Pump Relay

This procedure allows the ECM memory to be updated with the correct IAC valve pintle position, for the vehicle, and provide a stable idle speed.

FUEL PUMP RELAY
Figure C2-10

The fuel pump relay is mounted in the engine compartment, next to the power brake booster.

Remove or Disconnect

1. Fuel pump relay electrical connector.
2. Fuel pump relay.

Install or Connect

- Reverse removal procedure.

OIL PRESSURE SENSOR/SWITCH
Figure C2-11

The oil pressure switch is threaded into the oil filter adapter.

Remove or Disconnect

1. Oil pressure sensor/switch electrical connector.
2. Oil pressure sensor/switch.

Install or Connect

- Reverse removal procedure.

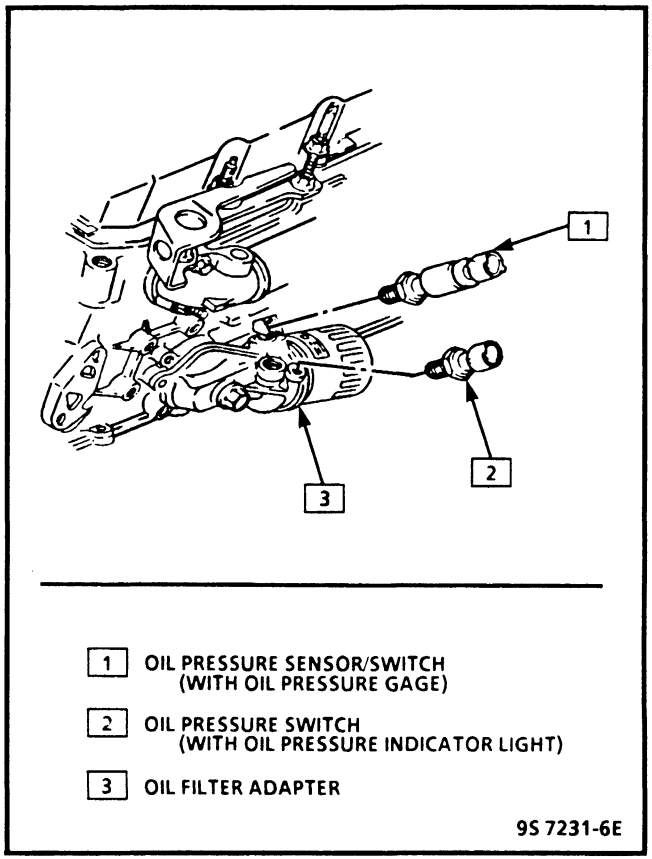


Figure C2-11 - Oil Pressure Sensor/Switch

PORT FUEL INJECTION COMPONENTS

CAUTION:

- **To reduce the risk of fire and personal injury, relieve the fuel system pressure before servicing fuel system components.**
- **After relieving system pressure, a small amount of fuel may be released when servicing fuel lines or connections. To reduce the chance of personal injury, cover fuel line fittings with a shop towel before disconnecting, to catch any fuel that may leak out. Place the towel in an approved container when disconnect is completed.**

FUEL PRESSURE RELIEF PROCEDURE

Tool required: J 34730-1, Fuel Pressure Gage

1. Disconnect negative battery terminal to avoid possible fuel discharge if an accidental attempt is made to start the engine.
2. Loosen fuel filler cap to relieve tank vapor pressure.

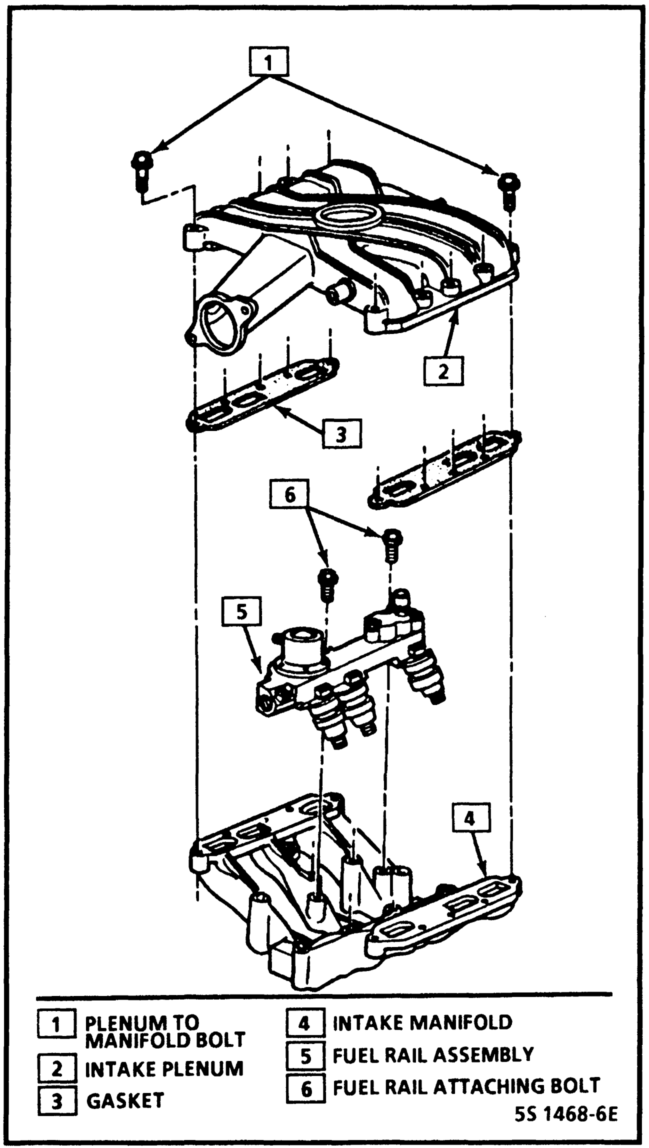


Figure C2-12 - Removing Plenum and Fuel Rail

3. Connect gage J 34730-1 or equivalent to fuel pressure valve. Wrap a shop towel around fitting while connecting gage to avoid spillage.
4. Install bleed hose into an approved container and open valve to bleed system pressure. Fuel connections are now safe for servicing.
5. Drain any fuel remaining in gage into an approved container.

INTAKE MANIFOLD PLENUM

Figure C2-12

Removing the fuel rail assembly from the engine requires removing the top portion of the tuned intake manifold, called the "plenum."

Remove or Disconnect

1. Negative battery terminal.
2. Air inlet duct at throttle body, and crankcase vent pipe at valve cover grommet.
3. Vacuum harness connector from throttle body.
4. Throttle cable bracket bolt.
5. Throttle body attaching bolts.
6. Throttle body and gasket.
   - Discard gasket.
7. EGR transfer tube to plenum bolts.
8. EGR transfer tube and gasket.
   - Discard gasket.
9. A/C compressor to plenum bracket attaching hardware, and bracket.
10. Plenum bolts/studs.
11. Plenum and gaskets.
    - Discard gaskets.

NOTICE: Use care in cleaning old gasket material from machined aluminum surfaces. Sharp tools will damage sealing surfaces.

Clean

- Gasket sealing surfaces.

Install or Connect

1. New plenum gaskets.
2. Plenum.
3. Plenum bolts/studs.

Tighten

- Plenum bolts/studs to 25 N·m (18 lb. ft.).

4. A/C compressor to plenum bracket and attaching hardware.
5. EGR transfer tube with new gasket.
6. EGR transfer tube bolts.

Tighten

- EGR transfer tube bolts to 26 N·m (19 lb. ft.).

7. Throttle body with new gasket.
8. Throttle body attaching bolts.

Tighten

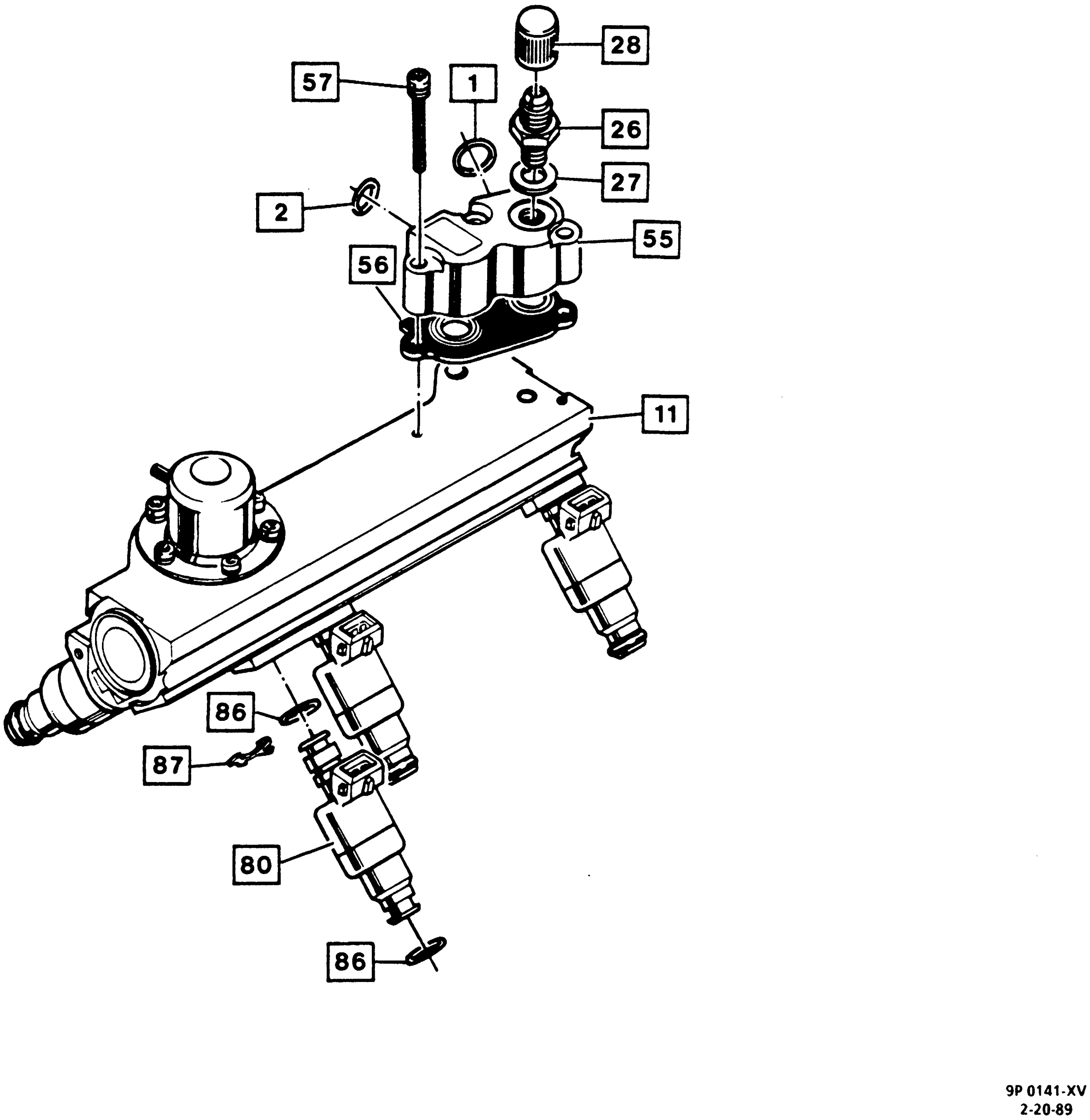
- Throttle body attaching bolts to 27 N·m (20 lb. ft.).

9. Throttle cable bracket bolt.
10. Vacuum harness connector to throttle body.
11. Air inlet duct to throttle body, and crankcase vent pipe to valve cover grommet.
12. Negative battery terminal.

Inspect

- With the engine "OFF," check to see that the accelerator pedal is free.
  - Depress pedal to the floor and release.

13. Refer to "Idle Learn Procedure." The ECM will need to relearn the IAC valve pintle position following battery reconnect.



PART NAMES

1	O-ring - Fuel Inlet Line	55	Fuel Block
2	O-ring - Fuel Return Line	56	Seal - Fuel Block
11	Fuel Rail and Pressure Regulator Assembly	57	Screw Assembly - Fuel Block Attaching
26	Fuel Pressure Connection Assembly	80	MPFI Injector Assembly
27	Seal - Fuel Pressure Connection Assembly	86	O-ring Seal - Injector
28	Cap - Fuel Pressure Connection	87	Clip - Injector Retainer

Figure C2-13 - Fuel Rail Assembly

FUEL RAIL ASSEMBLY

The names of component parts appear in the numbered list on the disassembled view (Figure C2-13) on the previous page.

An eight digit identification number is stamped on the side of the fuel rail (Figure C2-14). Refer to this number if servicing or part replacement is required.

NOTICE:
- Use care in removing the fuel rail assembly, to prevent damage to the injector electrical connector terminals and the injector spray tips. When removed, support the rail to avoid damaging its components.
- Prevent dirt and other contaminants from entering open lines and passages. Fittings should be capped, and holes plugged, during servicing.

Clean

- Before removal, the fuel rail assembly may be cleaned with a spray type engine cleaner, GM X-30A or equivalent, following package instructions. Do not immerse fuel rail in liquid cleaning solvent.

Remove or Disconnect

Figures C2-12, 13

1. Negative battery terminal.
2. Relieve fuel system pressure. (Refer to "Fuel Pressure Relief Procedure.")
3. Intake manifold plenum.
4. Fuel feed and return lines at rail.
5. Fuel line O-rings (1, 2), and discard.
6. Vacuum line at pressure regulator.
7. Injector electrical connectors.
8. Fuel rail attaching bolts.
9. Fuel rail assembly.

Disassemble

Figure C2-13

- Injector O-ring seal (86) from spray tip end of each injector. Discard seals.

Assemble

- Lubricate new injector O-ring seal (86) with engine oil, and install on spray tip end of each injector.

Install or Connect

Figures C2-12, 13

1. Fuel rail assembly in intake manifold.
   - Tilt rail assembly to install injectors.
2. Fuel rail attaching bolts.

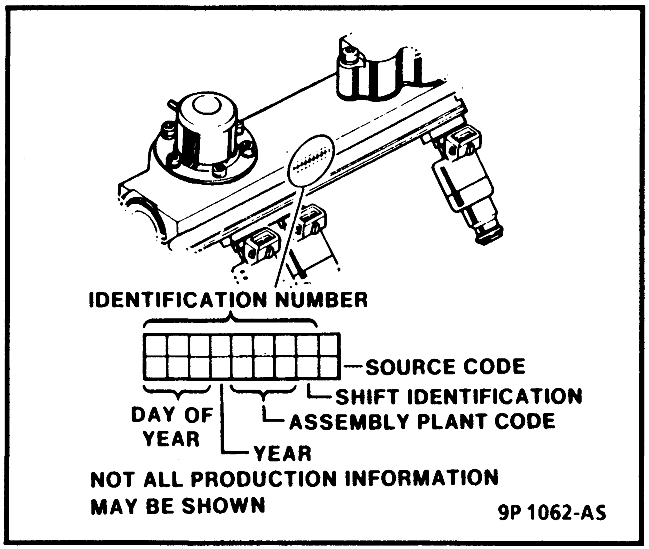


Figure C2-14 - Fuel Rail Assembly Identififcation

Tighten

- Fuel rail attaching bolts to 25 N·m (18 lb. ft.).

3. Injector electrical connectors.
   - Rotate injector(s) as required to avoid stretching wire harness.
4. Vacuum line to pressure regulator.
5. New O-rings (1, 2) on fuel feed and return lines.
6. Fuel lines.

Tighten

- Fuel line nuts to 27 N·m (20 lb. ft.).

Inspect

A. Temporarily connect negative battery terminal.
B. With engine "OFF" and ignition "ON," check for fuel leaks.
C. Disconnect negative battery terminal.

7. Intake manifold plenum.
8. Tighten fuel filler cap.
9. Negative battery terminal.
10. Refer to "Idle Learn Procedure." The ECM will need to relearn the IAC valve pintle position following battery reconnect.

FUEL PRESSURE CONNECTION

Figure C2-15

Clean

- Area around fuel pressure connection with GM X-30A or equivalent.

Remove or Disconnect

1. Negative battery terminal.
2. Relieve fuel system pressure. (Refer to "Fuel Pressure Relief Procedure.")
3. Fuel pressure connection (26) and seal (27).

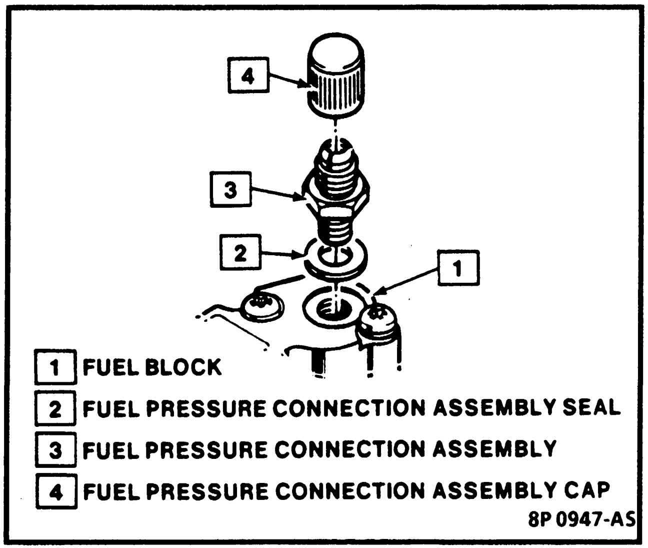


Figure C2-15 - Fuel Pressure Connection Assembly

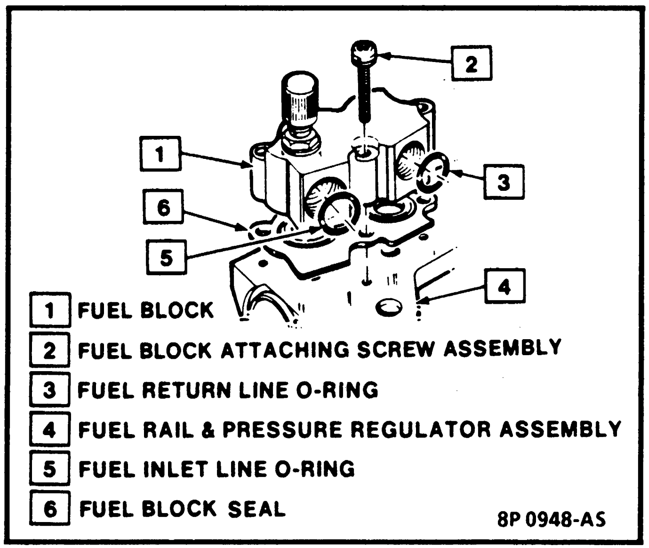


Figure C2-16 - Fuel Block Assembly

Install or Connect

1. New seal (27) on fuel pressure connection (26).
2. Fuel pressure connection in fuel block.

Tighten

- Fuel pressure connection to 13 N·m (115 lb. in.).

3. Tighten fuel filler cap.
4. Negative battery terminal.

Inspect

- Turn ignition switch to the "ON" position for two seconds, then turn to the "OFF" position for ten seconds. Again turn to the "ON" position and check for leaks.

FUEL BLOCK ASSEMBLY

Remove or Disconnect

Figures C2-12, 13, 15, 16

1. Negative battery terminal.
2. Relieve fuel system pressure. (Refer to "Fuel Pressure Relief Procedure.")
3. Intake manifold plenum.

Clean

- Area around fuel pressure connection, fuel block, and fuel line connections with GM X-30A or equivalent.

4. Fuel pressure connection (26) and seal (27).
   - Discard seal.
5. Fuel feed and return lines.
6. Fuel line O-rings (1, 2), and discard.
7. Fuel block attaching screws (57).
8. Fuel block (55) and seal (56). Discard seal.

Clean

- Fuel block sealing surfaces.

Install or Connect

Figures C2-12, 13, 16

1. New fuel block seal (56).
2. Fuel block (55).
3. Fuel block attaching screws (57).

Tighten

- Fuel block attaching screws to 5.0 N·m (44 lb. in.).

4. New seal (27) on fuel pressure connection (26).
5. Fuel pressure connection in fuel block.

Tighten

- Fuel pressure connection to 13 N·m (115 lb. in.).

6. New O-rings (1, 2) on fuel feed and return lines.
7. Fuel lines.

Tighten

- Fuel line nuts to 27 N·m (20 lb. ft.)

Inspect

A. Temporarily connect negative battery terminal.
B. Turn ignition switch to the "ON" position for two seconds, then turn to the "OFF" position for ten seconds. Again turn to the "ON" position and check for leaks.
C. Disconnect negative battery terminal.

8. Intake manifold plenum.
9. Tighten fuel filler cap.
10. Negative battery terminal.

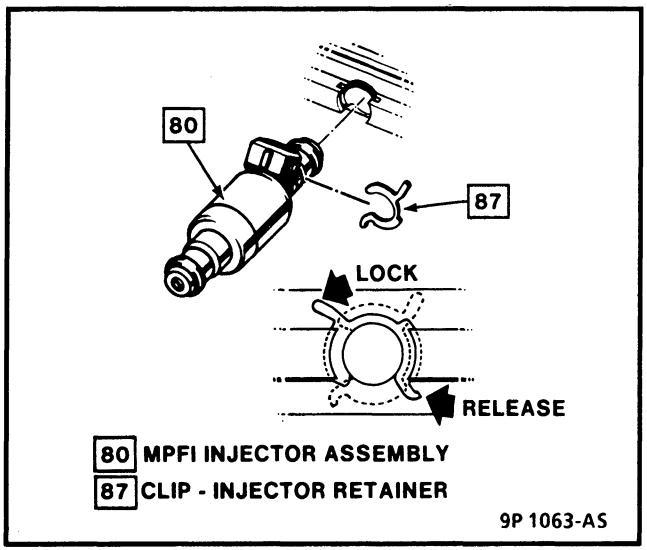


Figure C2-17 - MPFI Fuel Injector

11. Refer to "Idle Learn Procedure." The ECM will need to relearn the IAC valve pintle position following battery reconnect.

FUEL INJECTORS

NOTICE: Use care in removing injectors to prevent damage to the electrical connector pins on the injector, and the nozzle. The fuel injector is serviced as a complete assembly only. Since it is an electrical component, do not immerse it in cleaner.

Remove or Disconnect

Figures C2-12, 17

1. Negative battery terminal.
2. Relieve fuel system pressure. (Refer to "Fuel Pressure Relief Procedure.")
3. Intake manifold plenum.
4. Fuel rail assembly.

Disassemble

Figures C2-13, 17

1. Rotate injector retainer clip (87) to release position.
2. MPFI injector (80).
3. Injector O-ring seals (86) from both ends of injector, and discard.
4. Discard injector retainer clip (87).

Important

Figure C2-18

Each injector is calibrated for a specific flow rate. When replacing fuel injectors, order replacements with the identical part number as the old injectors.

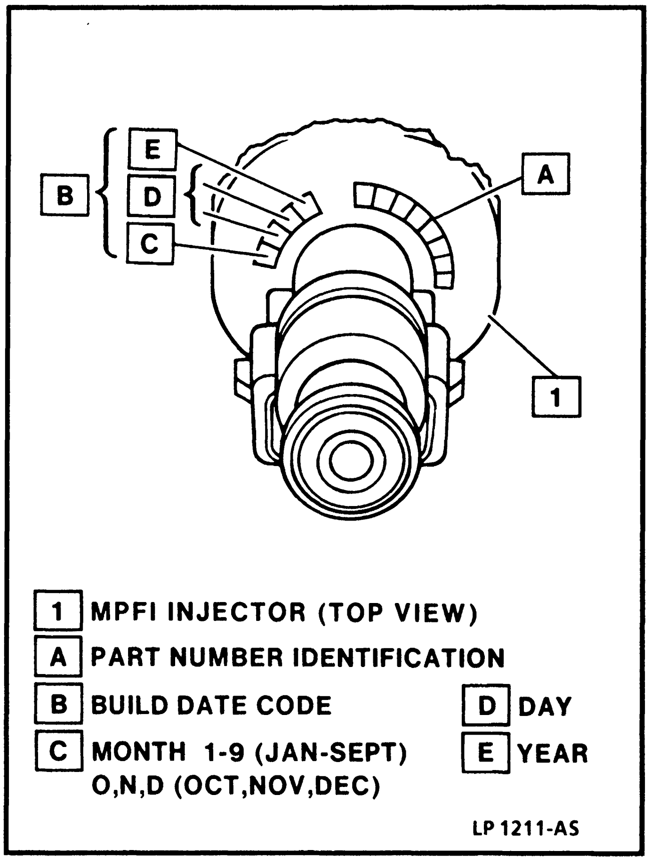


Figure C2-18 - Injector Part Number Location

Assemble

Figures C2-13, 17

1. Lubricate new injector O-ring seals (86) with engine oil, and install on injector.
2. New retainer clip (87) onto injector.
3. MPFI injector (80) into fuel rail injector socket with electrical connectors facing outward.
4. Rotate injector retainer clip (87) to lock position.

Install or Connect

Figure C2-13

1. Fuel rail assembly.

   Inspect

   A. Temporarily connect negative battery terminal.
   B. Turn ignition switch to the "ON" position for two seconds, then turn to the "OFF" position for ten seconds. Again turn to the "ON" position and check for leaks.
   C. Disconnect negative battery terminal.
2. Intake manifold plenum.
3. Tighten fuel filler cap.
4. Negative battery terminal.

5. Refer to "Idle Learn Procedure." The ECM will need to relearn the IAC valve pintle position following battery reconnect.

PRESSURE REGULATOR ASSEMBLY

Important

- The pressure regulator and fuel rail are serviced as a complete assembly only. Do not attempt to remove the regulator cover from the fuel rail.

THROTTLE BODY ASSEMBLY
Figure C2-21

The throttle body assembly repair procedures cover component replacement with the unit on the vehicle. However, throttle body replacement requires that the complete unit be removed from the engine.

An eight digit part identification number is stamped on the bottom of the throttle body casting, next to the coolant cover (Figure C2-19). Refer to this number if servicing, or part replacement is required. For identification of parts during repair, refer to the disassembled view (Figure C2-20).

NOTICE: The TPS and IAC valve should NOT come in contact with solvent or cleaner, as they may be damaged.

Clean

- The throttle bore and valve deposits may be cleaned on-vehicle, using carburetor cleaner and a parts cleaning brush. **Do Not** use a cleaner that contains methyl ethyl ketone, an extremely strong solvent, and not necessary for this type of deposit.
- The throttle body metal parts may be cleaned following disassembly, in a cold immersion-type cleaner such as GM X-55 or equivalent.

Remove or Disconnect

1. Negative battery terminal.
2. Partially drain radiator, to allow coolant hoses at throttle body to be removed.
3. Air inlet duct at throttle body, and crankcase vent pipe at valve cover grommet.
4. TPS and IAC valve electrical connectors.
5. Vacuum harness connector from throttle body.
6. Throttle, T.V. (transmission control), and cruise control cables.
7. Coolant hoses from throttle body.
8. Throttle body attaching bolts.
9. Throttle body assembly and flange gasket.
   - Discard gasket.

NOTICE: Use care in cleaning old gasket material from machined aluminum surfaces. Sharp tools may damage sealing surfaces.

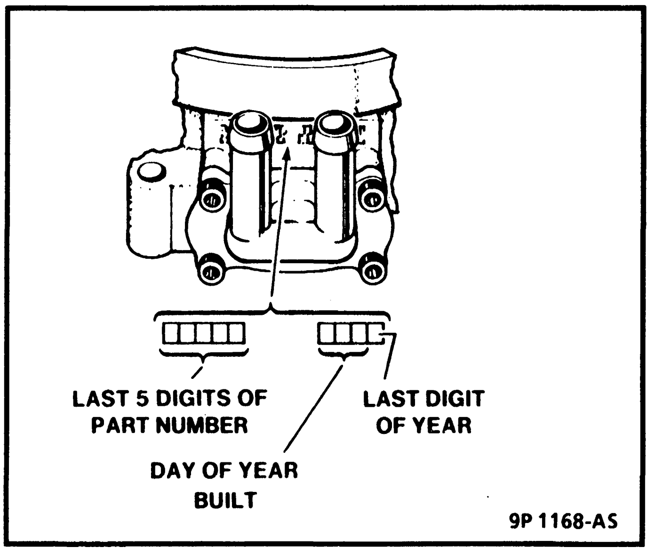


Figure C2-19 - Throttle Body Identification

Clean

- Gasket surface on intake manifold.

Install or Connect

1. Throttle body assembly with new flange gasket.
2. Throttle body attaching bolts.

Tighten

- Throttle body attaching bolts to 27 N·m (20 lb. ft.).

3. Coolant hoses to throttle body.
4. Throttle, T.V., and cruise control cables.

Important

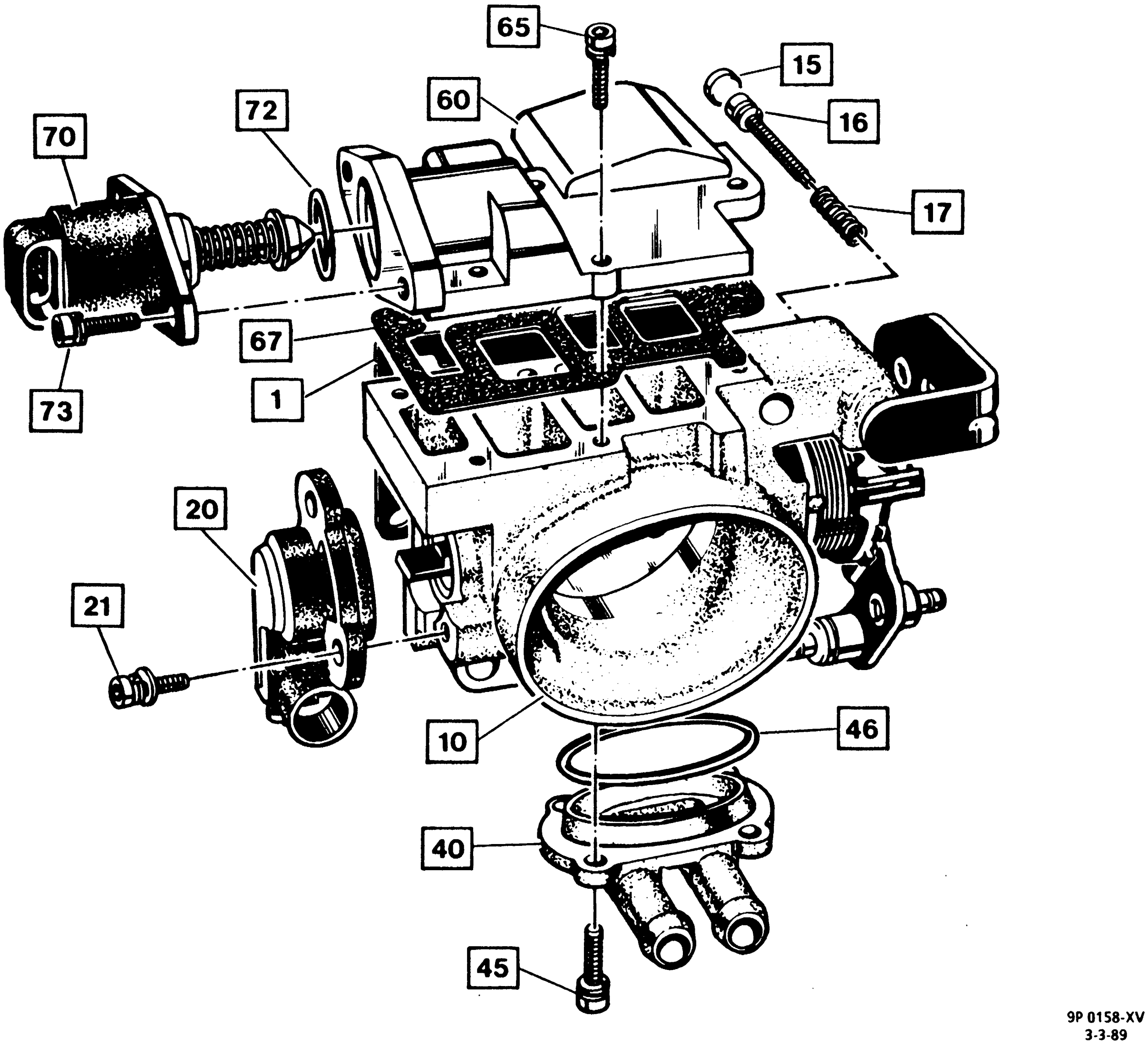
- Make sure throttle and cruise control linkage does not hold throttle open. Refer to ENGINE FUEL (SECTION 6C), for additional information on accelerator controls.

5. Vacuum harness connector.
6. TPS and IAC valve electrical connectors.
7. Air inlet duct to throttle body, and crankcase vent pipe to valve cover grommet.
8. Refill radiator.
9. Negative battery terminal.

Inspect

- With the engine "OFF," check to see that the accelerator pedal is free:
  - Depress pedal to the floor and release.

10. Refer to "Idle Learn Procedure." The ECM will need to relearn the IAC valve pintle position following battery reconnect.



PART NAMES

1	Gasket - Flange	45	Screw Assembly - Coolant Cover Attaching
10	Throttle Body Assembly	46	O-Ring - Coolant Cover to Throttle Body
15	Plug - Idle Stop Screw	60	Idle Air/Vacuum Signal Housing Assembly
16	Screw Assembly - Idle Stop	65	Screw Assembly - Idle Air/Vacuum Signal Assembly
17	Spring - Idle Stop Screw Assembly	67	Gasket - Idle Air/Vacuum Signal Assembly
20	Sensor - Throttle Position (TPS)	70	Valve Assembly - Idle Air Control (IAC)
21	Screw Assembly - TPS Attaching	72	O-Ring - Idle Air Control Valve
40	Cover - Coolant Cavity	73	Screw Assembly - Idle Air Control Valve Attaching

Figure C2-20 - Throttle Body Assembly

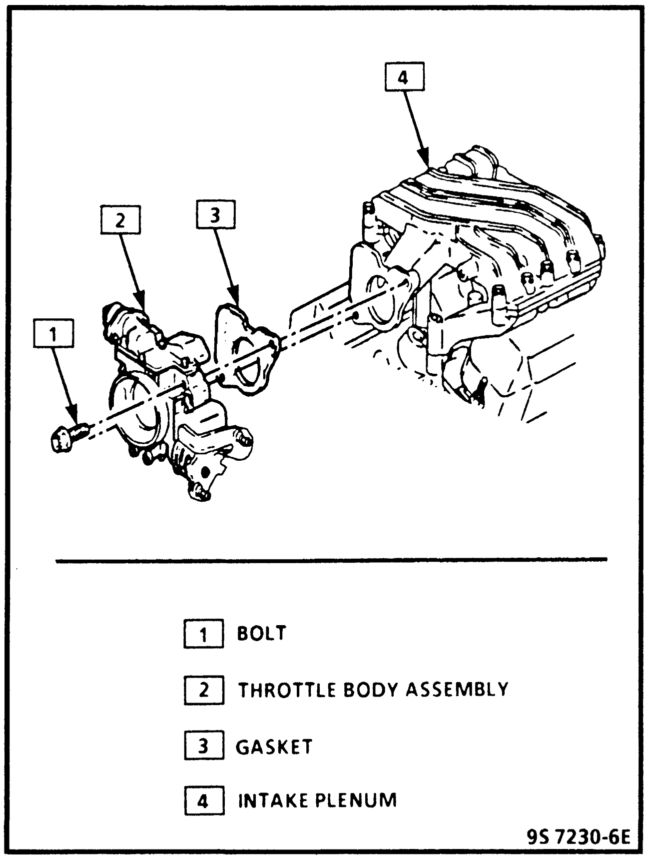


Figure C2-21 - Throttle Body Removal

THROTTLE POSITION SENSOR (TPS)
Figure C2-22

Remove or Disconnect

1. Electrical connector.
2. TPS attaching screws (21).
3. TPS (20).

NOTICE: The TPS is an electrical component and must not be soaked in any liquid cleaner or solvent, as damage may result.

Install or Connect

1. With throttle valve closed, position TPS (20) on throttle shaft, then align with screw holes.
2. TPS attaching screws (21).

Tighten

- TPS attaching screws to 2.0 N·m (18 lb. in.).

3. Electrical connector.

IDLE AIR CONTROL (IAC) VALVE

Remove or Disconnect (Figure C2-23)

1. Electrical connector.
2. IAC valve attaching screws (73).
3. IAC valve assembly (70).

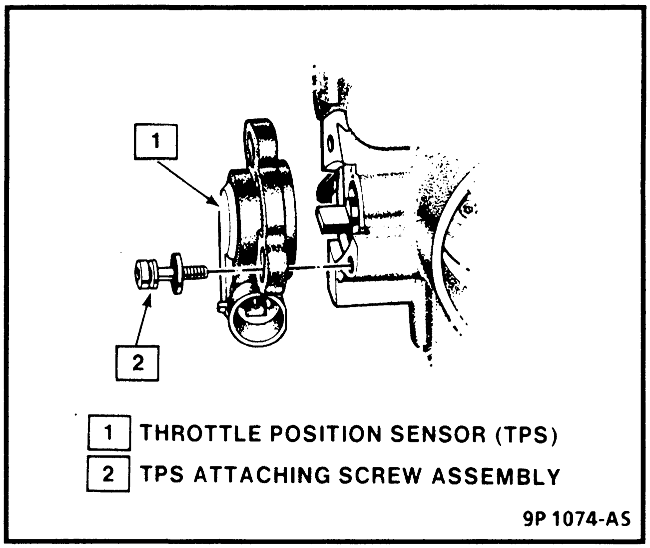


Figure C2-22 - Throttle Position Sensor (TPS)

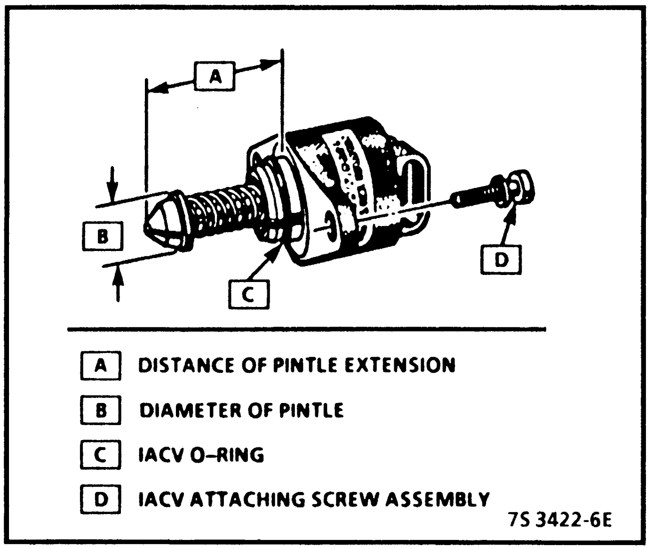


Figure C2-23 - Idle Air Control (IAC) Valve

NOTICE: On IAC valves that have been in service: Do Not push or pull on the IAC valve pintle. The force required to move the pintle may damage the threads on the worm drive. Also, **Do Not** soak IAC valve in any liquid cleaner or solvent, as damage may result.

Clean and Inspect

- Clean IAC valve O-ring sealing surface, pintle valve seat and air passage.
  - Use carburetor cleaner and a parts cleaning brush to remove carbon deposits. Do Not use a cleaner that contains methyl ethyl ketone, an extremely strong solvent, and not necessary for this type of deposit.
  - Shiny spots on the pintle or seat are normal, and do not indicate misalignment or a bent pintle shaft.

  - If air passage has heavy deposits, remove throttle body for complete cleaning.
- Inspect IAC valve O-ring (72) for cuts, cracks or distortion. Replace if damaged.

Important

- If installing a new IAC valve, be sure to replace with an identical part. IAC valve pintle shape and diameter are designed for the specific application.

Measure (If Installing a New IAC Valve)

Figure C2-23

- Distance between tip of IAC valve pintle and mounting flange.
  - If greater than 28 mm, use finger pressure to slowly retract the pintle. The force required to retract the pintle of a *new* valve will not cause damage to the valve.

Install or Connect

1. Lubricate IAC valve O-ring (72) with engine oil.
2. IAC valve assembly (70).
3. Attaching screws (73).

Tighten

- IAC valve attaching screws to 3.4 N·m (30 lb. in.)

4. Electrical connector.
5. Reset IAC valve pintle position:
   a. Turn ignition "ON" for five seconds.
   b. Turn ignition "OFF" for ten seconds.
   c. Start engine and check for proper idle operation.

IDLE AIR/VACUUM SIGNAL HOUSING

Figure C2-24

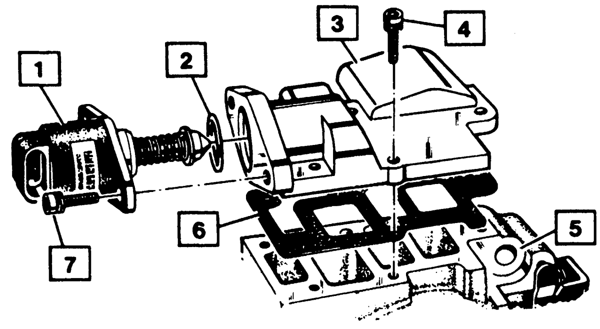
Remove or Disconnect

1. Negative battery terminal.
2. Vacuum harness connector.
3. IAC valve electrical connector.
4. Idle Air Control (IAC) valve (70).
5. Idle air/vacuum signal housing screws (65).
6. Idle air/vacuum signal housing assembly (60) and gasket (67). Discard gasket.

NOTICE: Use care in cleaning old gasket material from machined aluminum surfaces. Sharp tools may damage sealing surfaces.

Clean

- Gasket mounting surfaces to ensure a good seal.



1 IDLE AIR CONTROL (IAC) VALVE ASSEMBLY
2 IDLE AIR CONTROL VALVE O-RING
3 IDLE AIR/VACUUM SIGNAL HOUSING ASSEMBLY
4 IDLE AIR/VACUUM SIGNAL ASSEMBLY SCREW ASSEMBLY
5 THROTTLE BODY ASSEMBLY
6 IDLE AIR/VACUUM SIGNAL ASSEMBLY GASKET
7 IDLE AIR CONTROL VALVE ATTACHING SCREW ASSEMBLY

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Figure C2-24 - Idle Air /Vacuum Signal Housing

Install or Connect

Figures C2-23, 24

1. New idle air/vacuum signal assembly gasket (67).
2. Idle air/vacuum signal housing assembly (60).
3. Idle air/vacuum signal housing screws (65).

Tighten

- Idle air/vacuum signal housing screws (starting in center and moving outward) to 3.4 N·m (30 lb. in.).

Measure (If Installing a New IAC Valve)

Figure C2-23

- Distance between tip of IAC valve pintle and mounting flange.
  - If greater than 28 mm, use finger pressure to slowly retract the pintle. The force required to retract the pintle of a *new* valve will not cause damage to the valve.

4. Lubricate IAC valve O-ring (72) with engine oil.
5. IAC valve assembly (70).
6. Attaching screws (73).

Tighten

- IAC valve Attaching screws to 3.0 N·m (27 lb. in.).

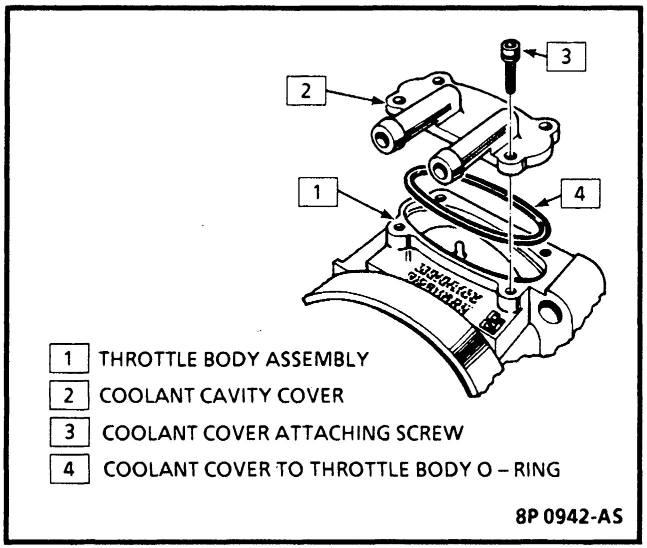


Figure C2-25 - Coolant Cavity Cover Assembly

7. IAC valve electrical connector.
8. Vacuum harness connector.
9. Negative battery terminal.
10. Reset IAC valve pintle position:
    a. Turn ignition "ON" for five seconds.
    b. Turn ignition "OFF" for ten seconds.
    c. Start engine and check for proper idle operation.

COOLANT CAVITY COVER AND O-RING
Figure C2-25

Remove or Disconnect

- Throttle body from intake plenum. (Refer to "Throttle Body R/R.")

Disassemble

1. Coolant cover attaching screws (45).
2. Coolant cavity cover (40) and O-ring (46).
   - Discard O-ring.

Clean and Inspect

- Clean O-ring sealing surfaces.
- Inspect sealing surfaces for corrosion or damage that could cause a coolant leak. Replace coolant cavity cover or throttle body if necessary.

Assemble

1. Lubricate new coolant cover to throttle body O-ring (46) with ethylene glycol antifreeze.
2. O-ring in cavity of throttle body.
3. Coolant cavity cover (40).
   - Hold cover in place.
4. Coolant cover attaching screws (45).

Tighten

- Coolant cover attaching screws to 3.0 N·m (27 lb. in.).

Install or Connect

- Throttle body to intake plenum. (Refer to "Throttle Body Assembly.")

THROTTLE BODY REPLACEMENT

Remove or Disconnect

- Throttle body from intake plenum. (Refer to "Throttle Body Assembly.")

Inspect

- Replacement throttle body for items to be transferred from old unit.

Disassemble

- Throttle body removed from engine, following component repair procedures.

Assemble

- Replacement throttle body with transferred parts, following component repair procedures.

Install or Connect

1. Replacement throttle body to intake plenum. (Refer to "Throttle Body Assembly.")
2. Adjust minimum throttle valve position.

Important

- Adjustment should be performed only when installing a replacement throttle body.
- The idle stop screw is used to regulate the minimum throttle valve position. On original equipment throttle bodies, it is adjusted at the factory, then covered with a plug to discourage unnecessary readjustment.

NOTICE: The minimum throttle valve position is critical to vehicle performance and component durability. If the throttle valve is adjusted too far open, it will cause the IAC valve pintle to constantly bottom on its seat and result in early valve failure. If the throttle valve is not open far enough, the vehicle may not start in cold weather or may stall during warm-up.

Adjust

Tool required: "Scan" tool

1. Back throttle stop screw out until an air gap between the screw and the throttle lever can be seen by looking downward from above the throttle body.
2. Turn the stop screw in until it just contacts the throttle lever.
3. Turn the stop screw in 1 1/2 turns further.
4. Refer to "Idle Learn Procedure." The ECM will need to relearn the IAC valve pintle position following battery reconnect.
5. Connect "Scan" tool to ALDL connector.
6. Place transmission selector in "Park" (A/T) or "Neutral" (M/T).
7. Start engine, allow it to reach normal operating temperature (about 90°C) and "Closed Loop."
8. Using "Scan" tool, observe IAC valve counts.

Important

- Battery must have been disconnected during replacement procedure and then reconnected before checking IAC valve counts. This enables the ECM to relearn the IAC valve pintle position.
- IAC valve counts should be checked with all accessories (A/C, rear defog, etc.), transmission in "PARK" (A/T) or "Neutral" (M/T), and engine cooling fan "OFF."
- Make sure throttle and cruise control cables do not hold throttle open.
- With engine stabilized, IAC valve position should be 10 to 20 counts. If not, repeat adjustment procedure.

PARTS INFORMATION

PART NAME	GROUP
Relay, Fuel Pump	3.900
Sensor/Switch, Oil Pressure	1.800
Seals, Fuel Feed/Return Pipes (O-rings)	3.163
Rail Kit, W/Pressure Regulator	3.330
Injector Kit, Fuel	3.300
Sensor Kit, Throttle Position	3.339
Valve Kit, Idle Air Control	3.338
Gasket Kit (Throttle Body)	3.336
Throttle Body Kit	3.335

TORQUE SPECIFICATIONS

EGR Transfer Tube Bolts	26.0 N·m (19 lb. ft.)
Intake Plenum Bolts/Studs	25.0 N·m (18 lb. ft.)
Fuel Line Nuts	27.0 N·m (20 lb. ft.)
Rail Rail Attaching Bolts	25.0 N·m (18 lb. ft.)
Fuel Pressure Connection	13.0 N·m (115 lb. in.)
Fuel Block Assembly	5.0 N·m (44 lb. in.)
Throttle Body Attach. Bolts	27.0 N·m (20 lb. ft.)
Throttle Position Sensor	2.0 N·m (18 lb. in.)
Idle Air Control Valve	3.4 N·m (30 lb. in.)
Idle Air/Vac. Signal Housing	3.4 N·m (30 lb. in.)
Coolant Cavity Cover	3.0 N·m (27 lb. in.)

BLANK

CHART C-2A

INJECTOR BALANCE TEST

NOTE: ***Injectors cannot be cleaned.***

The injector balance tester is a tool used to turn the injector on for a precise amount of time, thus spraying a measured amount of fuel into the manifold. This causes a drop in fuel rail pressure that we can record and compare between each injector. All injectors should have the same amount of pressure drop (± 10 kPa). Any injector with a pressure drop that is 10 kPa (or more) greater or less than the average drop of the other injectors should be considered faulty and replaced.

STEP 1

Engine "cool down" period (10 minutes) is necessary to avoid irregular readings due to "Hot Soak" fuel boiling. With ignition "OFF" connect fuel gauge J 347301 or equivalent to fuel pressure tap. Wrap a shop towel around fitting while connecting gage to avoid fuel spillage.

Disconnect harness connectors at all injectors, and connect injector tester J 34730-3, or equivalent, to one injector. On Turbo equipped engines, use adaptor harness furnished with injector tester to energize injectors that are not accessible. Follow manufacturers instructions for use of adaptor harness. Ignition must be "OFF" at least 10 seconds to complete ECM shutdown cycle. Fuel pump should run about 2 seconds after ignition is turned "ON." At this point, insert clear tubing attached to vent valve into a suitable container and bleed air from gauge and hose to insure accurate gauge operation. Repeat this step until all air is bled from gauge.

STEP 2

Turn ignition "OFF" for 10 seconds and then "ON" again to get fuel pressure to its maximum. Record this initial pressure reading. Energize tester one time and note pressure drop at its lowest point (Disregard any slight pressure increase after drop hits low point.). By subtracting this second pressure reading from the initial pressure, we have the actual amount of injector pressure drop.

STEP 3

Repeat step 2 on each injector and compare the amount of drop. Usually, good injectors will have virtually the same drop. Retest any injector that has a pressure difference of 10 kPa, either more or less than the average of the other injectors on the engine. Replace any injector that also fails the retest. If the pressure drop of all injectors is within 10 kPa of this average, the injectors appear to be flowing properly. Reconnect them and review "Symptoms," Section "6E3-B".

NOTE: ***The entire test should not be repeated more than once without running the engine to prevent flooding. (This includes any retest on faulty injectors).***

NOTE: The fuel pressure test in Section "A", CHART A-7, should be completed prior to this test.

CHART C-2A

INJECTOR BALANCE TEST
3.1L (VIN T) "F" CARLINE (PORT)

Step 1. If engine is at operating temperature, allow a 10 minute "cool down" period then connect fuel pressure gauge and injector tester.

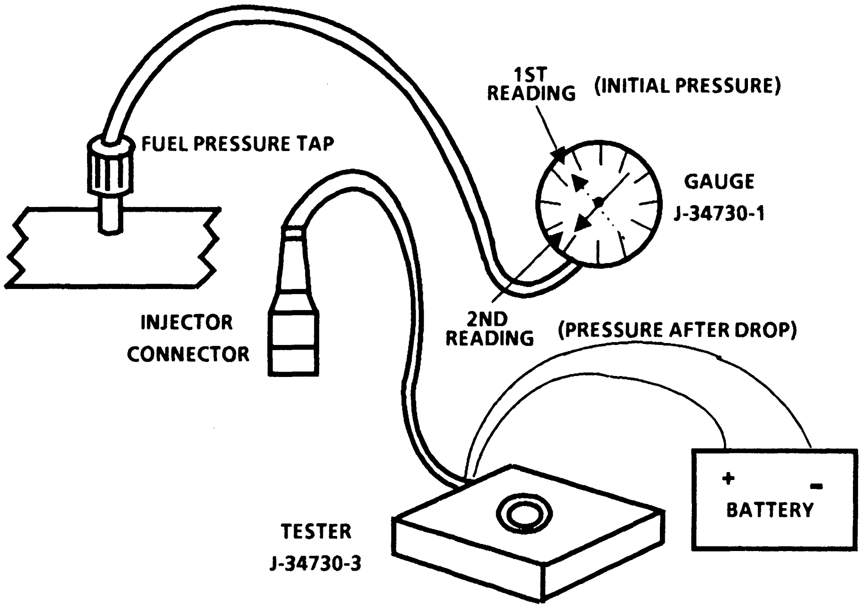
1. Ignition "OFF".
2. Connect fuel pressure gauge and injector tester.
3. Ignition "ON".
4. Bleed off air in gauge. Repeat until all air is bled from gauge.

Step 2. Run test:

1. Ignition "OFF" for 10 seconds.
2. Ignition "ON". Record gauge pressure. (Pressure must hold steady, if not see the Fuel System diagnosis, Chart A-7, in Section "A").
3. Turn injector on, by depressing button on injector tester, and note pressure at the instant the gauge needle stops.

Step 3.

1. Repeat step 2 on all injectors and record pressure drop on each.
   Retest injectors that appear faulty (Any injectors that have a 10 kPa difference, either more or less, in pressure from the average). If no problem is found, review "Symptoms" Section "B".



— EXAMPLE —

CYLINDER	1	2	3	4	5	6
1ST READING	225	225	225	225	225	225
2ND READING	100	100	100	90	100	115
AMOUNT OF DROP	125	125	125	135	125	110
	OK	OK	OK	FAULTY, RICH (TOO MUCH) (FUEL DROP)	OK	FAULTY, LEAN (TOO LITTLE) (FUEL DROP)

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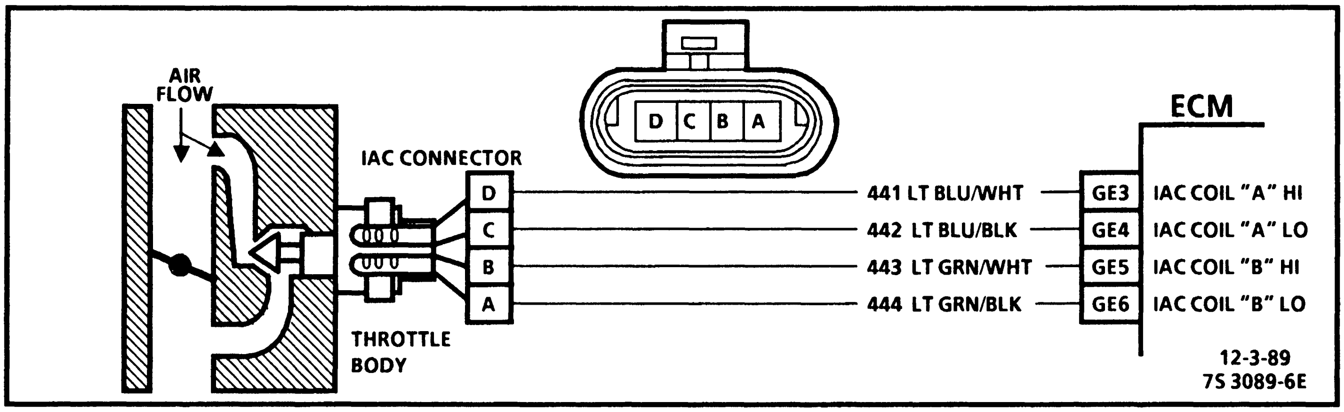


CHART C-2B

IDLE AIR CONTROL (IAC) SYSTEM CHECK 3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The ECM controls engine idle speed with the IAC valve. To increase idle speed, the ECM retracts the IAC valve pintle away from its seat, allowing more air to bypass the throttle bore. To decrease idle speed, it extends the IAC valve pintle towards its seat, reducing bypass air flow. A "Scan" tool will read the ECM commands to the IAC valve in counts. Higher the counts indicate more air bypass (higher idle). The lower the counts indicate less air is allowed to bypass (lower idle).

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. The TECH 1 rpm control mode is used to extend and retract the IAC valve. The valve should move smoothly within the specified range. If the idle speed is commanded (IAC extended) too low (below 700 rpm), the engine may stall. This may be normal and would not indicate a problem. Retracting the IAC beyond its controlled range (above 1500 rpm) will cause a delay before the rpm's start dropping. This too is normal.
2. This test uses the TECH 1 to command the IAC controlled idle speed. The ECM issues commands to obtain commended idle speed. The node lights each should flash red and green to indicate a good circuit as the ECM issues commands. While the sequence of color is not important if either light is "OFF" or does not flash red and green, check the circuits for faults, beginning with poor terminal contacts.

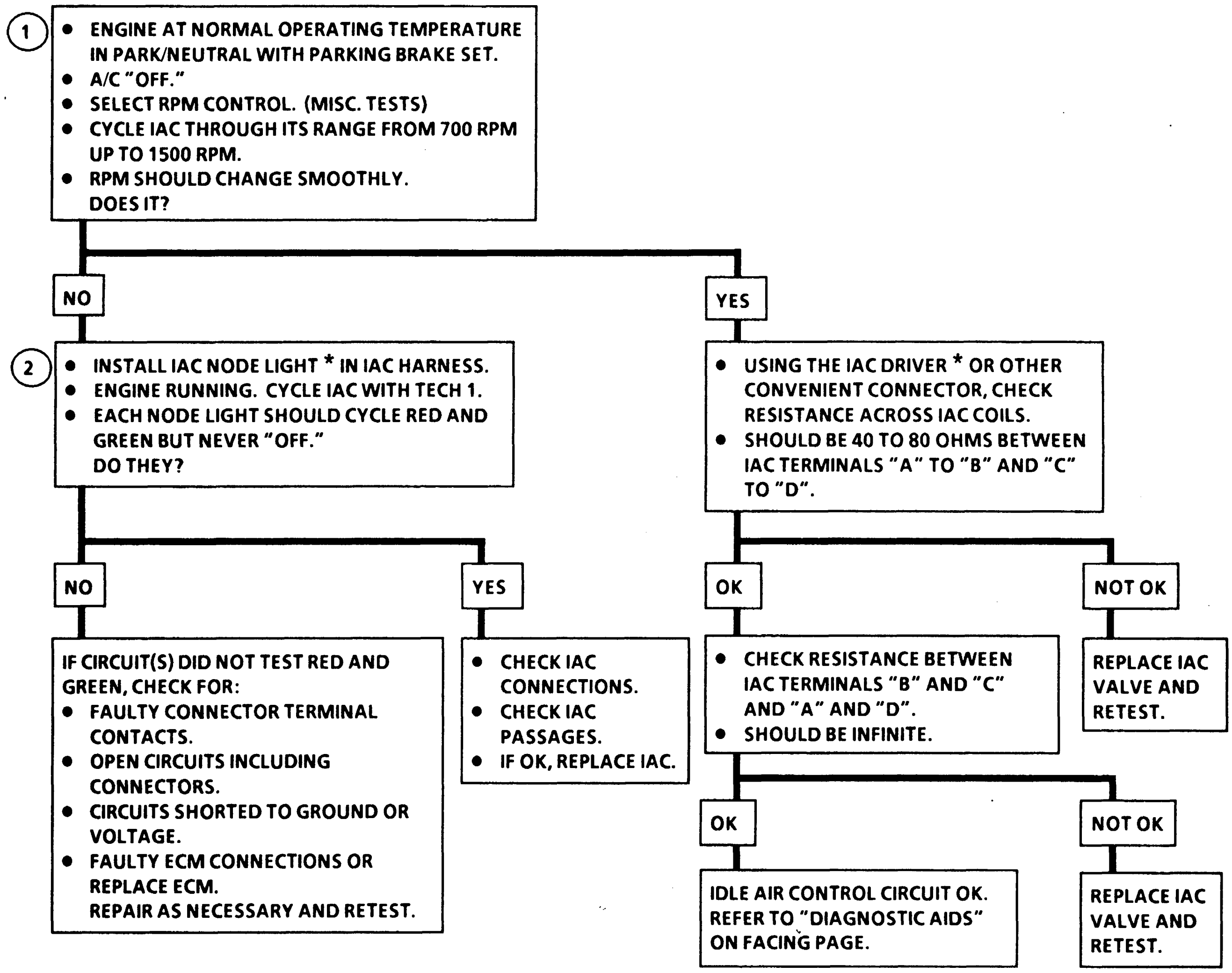
Diagnostic Aids:

A slow, unstable, or fast idle may be caused by a non-IAC system problem that cannot be overcome by the IAC valve. Out of control range IAC "Scan" tool counts will be above 60 if idle is too low, and zero counts if idle is too high. The following checks should be made to repair a non-IAC system problem:

- Vacuum Leak (High Idle)
  If idle is too high, stop the engine. Fully extend (low) IAC with tester. Start engine. If idle speed is above 800 rpm, locate and correct vacuum leak including PCV system. Also check for binding of throttle blade or linkage.
- System too lean (High Air/Fuel Ratio)
  The idle speed may be too high or too low. Engine speed may vary up and down and disconnecting the IAC valve does not help. Code 44 may be set. "Scan" O_2 voltage will be less than 300 mv (.3 volt). Check for low regulated fuel pressure, water in the fuel or a restricted injector.
- System too rich (Low Air/Fuel Ratio)
  The idle speed will be too low. "Scan" tool IAC counts will usually be above 80. System is obviously rich and may exhibit black smoke in exhaust.
  "Scan" tool O_2 voltage will be fixed above 800 mv (.8 volt).
  Check for high fuel pressure, leaking or sticking injector. Silicone contaminated O_2 sensors "Scan" voltage will be slow to respond.
- Throttle Body
  Remove IAC valve and inspect bore for foreign material.
- IAC Valve Electrical Connections
  IAC valve connections should be carefully checked for proper contact.
- PCV Valve
  An incorrect or faulty PCV valve may result in an incorrect idle speed.
- Refer to "Rough, Unstable, Incorrect Idle or Stalling" in "Symptoms," Section "6E3-B".
- If intermittent poor driveability or idle symptoms are resolved by disconnecting the IAC, carefully recheck connections, valve terminal resistance, or replace IAC.

CHART C-2B

IDLE AIR CONTROL (IAC) SYSTEM CHECK
3.1L (VIN T) "F" CARLINE (PORT)



①
- ENGINE AT NORMAL OPERATING TEMPERATURE IN PARK/NEUTRAL WITH PARKING BRAKE SET.
- A/C "OFF."
- SELECT RPM CONTROL. (MISC. TESTS)
- CYCLE IAC THROUGH ITS RANGE FROM 700 RPM UP TO 1500 RPM.
- RPM SHOULD CHANGE SMOOTHLY.

DOES IT?

NO

②
- INSTALL IAC NODE LIGHT * IN IAC HARNESS.
- ENGINE RUNNING. CYCLE IAC WITH TECH 1.
- EACH NODE LIGHT SHOULD CYCLE RED AND GREEN BUT NEVER "OFF."

DO THEY?

NO

IF CIRCUIT(S) DID NOT TEST RED AND GREEN, CHECK FOR:
- FAULTY CONNECTOR TERMINAL CONTACTS.
- OPEN CIRCUITS INCLUDING CONNECTORS.
- CIRCUITS SHORTED TO GROUND OR VOLTAGE.
- FAULTY ECM CONNECTIONS OR REPLACE ECM.

REPAIR AS NECESSARY AND RETEST.

YES

- CHECK IAC CONNECTIONS.
- CHECK IAC PASSAGES.
- IF OK, REPLACE IAC.

YES

- USING THE IAC DRIVER * OR OTHER CONVENIENT CONNECTOR, CHECK RESISTANCE ACROSS IAC COILS.
- SHOULD BE 40 TO 80 OHMS BETWEEN IAC TERMINALS "A" TO "B" AND "C" TO "D".

OK

- CHECK RESISTANCE BETWEEN IAC TERMINALS "B" AND "C" AND "A" AND "D".
- SHOULD BE INFINITE.

OK

IDLE AIR CONTROL CIRCUIT OK. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

NOT OK

REPLACE IAC VALVE AND RETEST.

NOT OK

REPLACE IAC VALVE AND RETEST.

* IAC DRIVER AND NODE LIGHT REQUIRED KIT
222-L FROM: CONCEPT TECHNOLOGY, INC.
J 37027 FROM: KENT-MOORE, INC.

CLEAR CODES, CONFIRM "CLOSED LOOP" OPERATION, NO "SERVICE ENGINE SOON" LIGHT, PERFORM IAC RESET PROCEDURE PER APPLICABLE SERVICE MANUAL AND VERIFY CONTROLLED IDLE SPEED IS CORRECT.

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SECTION C3

EVAPORATIVE EMISSION CONTROL SYSTEM (EECS)

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The basic Evaporative Emission Control System (EECS) used on all vehicles is the charcoal canister storage method. This method transfers fuel vapor from the fuel tank to an activated carbon (charcoal) storage device (canister) to hold the vapors when the vehicle is not operating. When the engine is running, the fuel vapor is purged from the carbon element by intake air flow and consumed in the normal combustion process.

VAPOR CANISTER

Gasoline vapors from the fuel tank flow into the tube labeled tank. Any liquid fuel goes into a reservoir in the bottom of the canister to protect the integrity of the carbon bed above (Figure C3-1). These vapors are absorbed into the carbon. The canister is purged when the engine is running above idle speed. Ambient air is allowed into the canister through the air tube in the top. The air mixes with the vapor and the mixture is drawn into the intake manifold.

EVAPORATIVE EMISSION SYSTEM

The ECM operates a normally opened pulse width modulated solenoid valve which controls vacuum to the purge valve in the charcoal canister. Under cold engine or idle conditions, the solenoid is turned "ON" by the ECM, which closes the solenoid and blocks vacuum to the canister purge valve.

The ECM turns "OFF" the solenoid valve and allows purge when:

- Engine is warm.
- After the engine has been running a specified time.
- Above a specified road speed.
- Above a specified throttle opening.

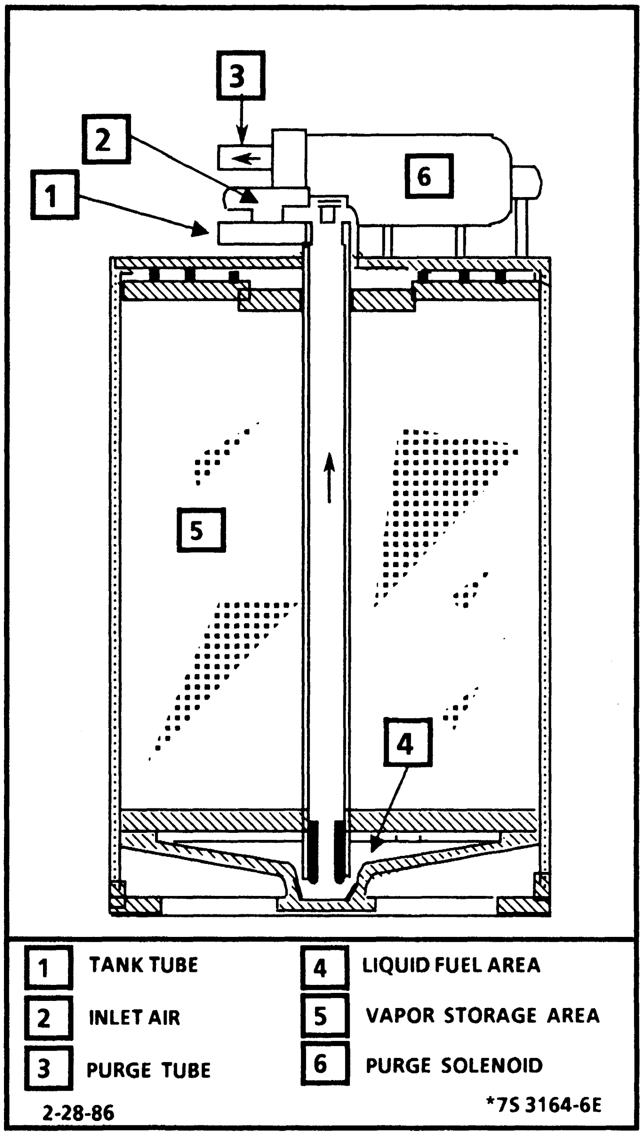


Figure C3-1 - Inverted Function Vapor Canister - With Encapsulated Purge Solenoid

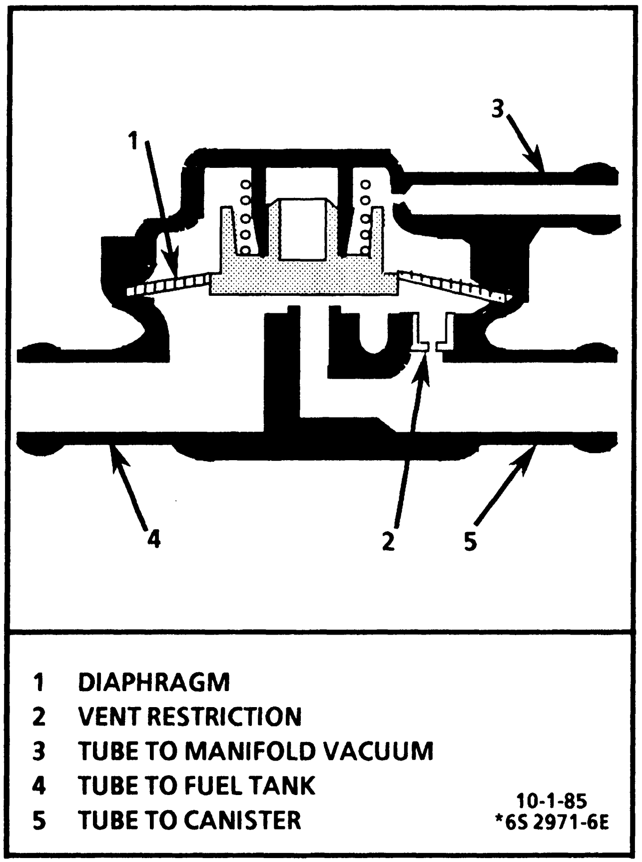


Figure C3-2 - Fuel Tank Pressure Control Valve

FUEL TANK PRESSURE CONTROL VALVE

The fuel tank pressure control valve, located in the engine compartment, is a spring biased diaphragm valve, normally closed (Figure C3-2). When the vapor pressure in the fuel tank exceeds 6.0 kPa the valve will open allowing the vapors to vent to the canister and then be purged. When the tank pressure drops sufficiently the tank pressure control valve will close, thus keeping the vapors in the fuel tank. The control vacuum tube of the control valve is connected into the canister line to prevent contamination from entering the valve.

RESULTS OF INCORRECT OPERATION

Poor idle, stalling and poor driveability can be caused by:

- Inoperative purge solenoid
- Damaged canister
- Hoses split, cracked and, or not connected to the proper tubes.

Evidence of fuel loss or fuel vapor odor can be caused by:

- Liquid fuel leaking from fuel lines
- Cracked or damaged canister
- Disconnected, misrouted, kinked, deteriorated or damaged vapor hoses, or control hoses.

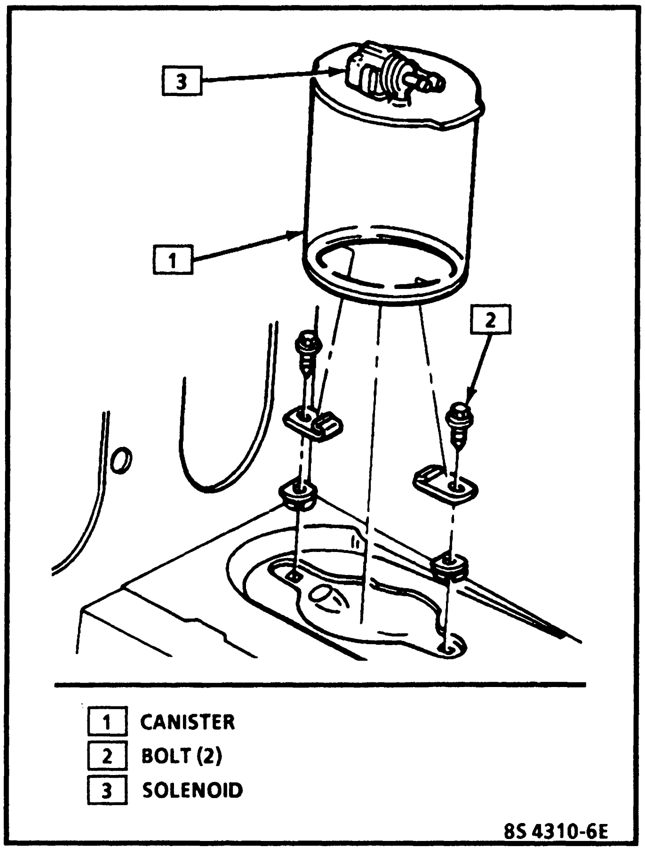


Figure C3-3 - Canister & Solenoid Service

If the solenoid is open, or is not receiving power, the canister can purge to the intake manifold at all times. This can allow extra fuel at idle or during warm-up, which can cause rough or unstable idle, or too rich operation during warm-up.

DIAGNOSIS

The canister purge solenoid operation is covered in CHART C-3 at the end of this section.

VISUAL CHECK OF CANISTER

Cracked or damaged, replace canister.

ON-VEHICLE SERVICE

FUEL VAPOR CANISTER AND PURGE SOLENOID

Figure C3-3

↔ Remove or Disconnect

1. Negative battery cable.
2. Electrical connector and hoses from solenoid.
3. Canister bolts and canister.

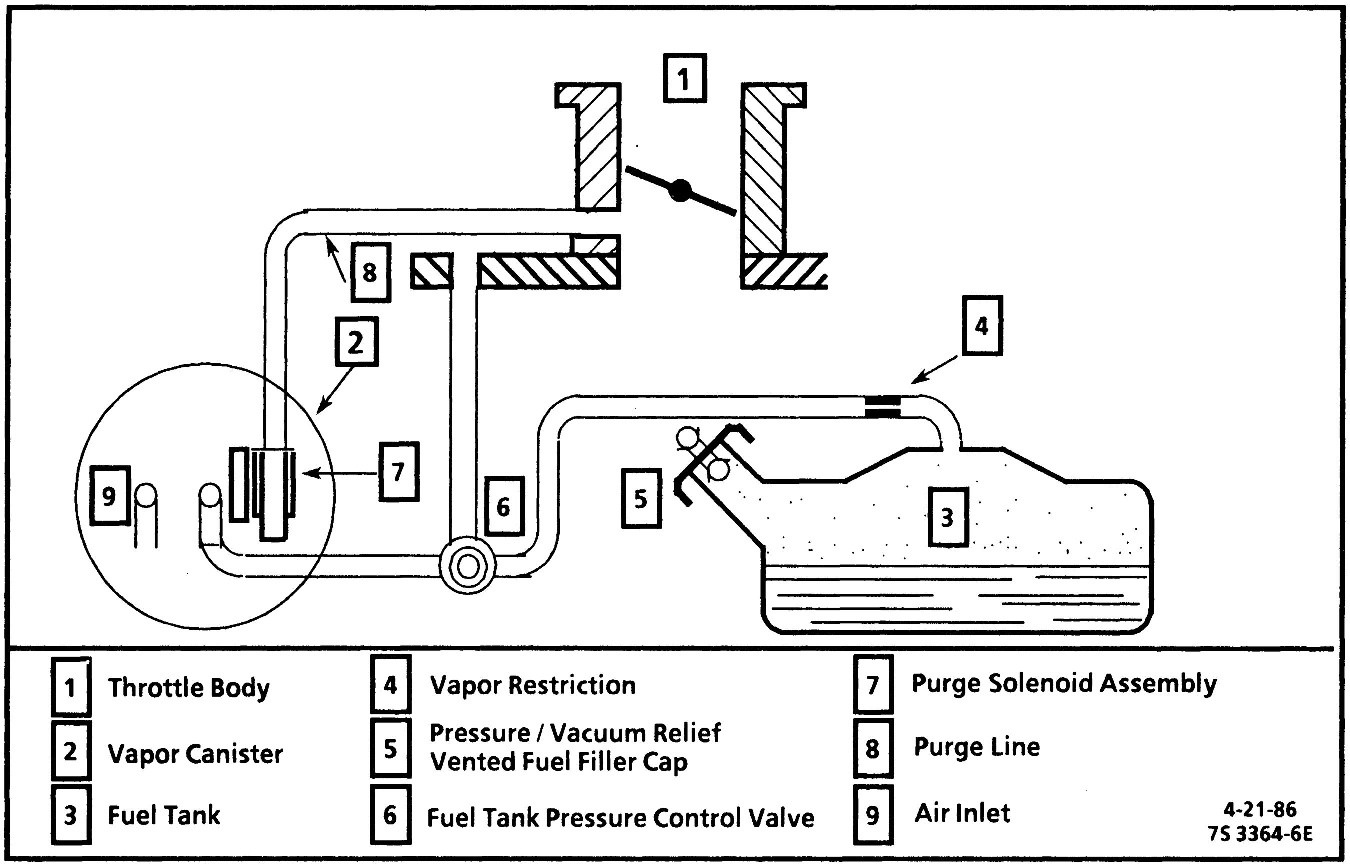


Figure C3- 4 - Evaporative Emissions Control System Schematic 3.1L

Install or Connect

1. Canister, as removed.
2. Hoses. Make sure connections are correct.

Important

- Before starting engine, follow the "Idle Learn Procedure" as follows:

1. Install Tech 1 "Scan" tool.
2. Ignition "ON," engine "OFF."
3. Select "IAC SYSTEM," then "IDLE LEARN" in the "MISC TEST" mode.
4. Proceed with idle learn as directed.

This procedure allows the ECM memory to be updated with the correct IAC valve pintle position for the vehicle, and provides for a stable idle speed.

CANISTER HOSES

Refer to Vehicle Emission Control Information Label for routing of canister hoses.

PARTS INFORMATION

PART NAME	GROUP
Canister, Fuel Vapor	3.130
Valve, Tank Pressure Control	3.140

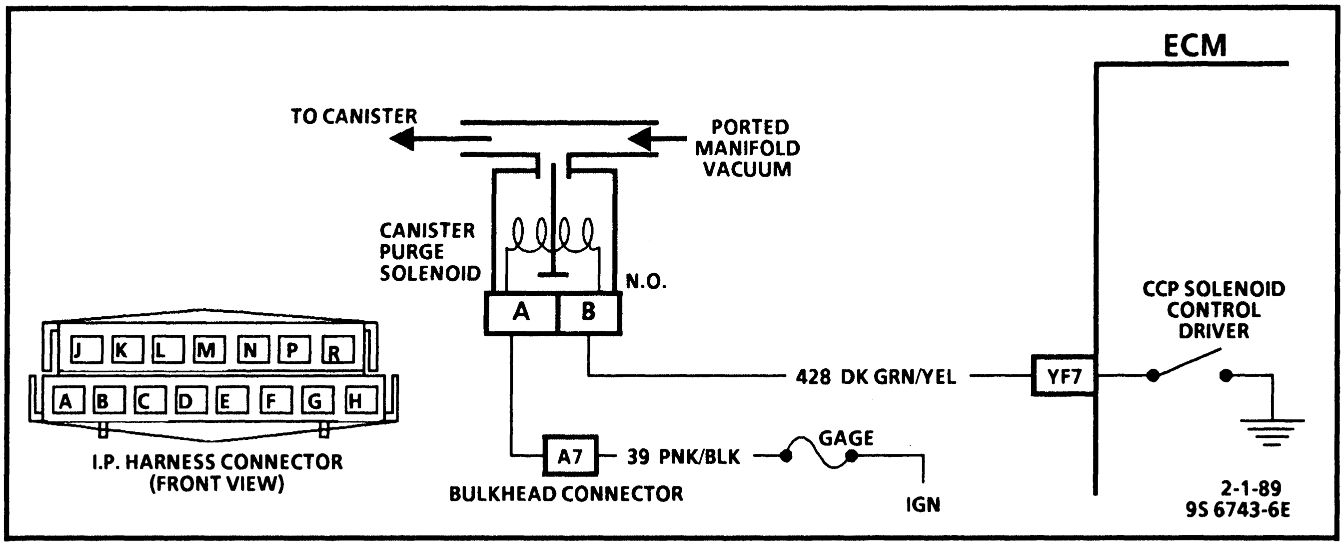


CHART C-3

CANISTER PURGE VALVE DIAGNOSIS
3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

Canister purge is controlled by a solenoid that allows manifold vacuum to purge the canister when de-energized. The ECM supplies a ground to energize the solenoid (purge "OFF"). The purge solenoid controlled by the ECM is pulse width modulated (turned "ON" and "OFF" several times a second). The duty cycle (pulse width) is determined by the amount of air flow, and the engine vacuum as determined by the MAP sensor input. The duty cycle is calculated by the ECM and the output commanded when the following conditions have been met:

- Engine run time after start more than 3 minutes
- Coolant temperature above 80°C
- Vehicle speed above 15 mph
- Throttle "OFF" idle

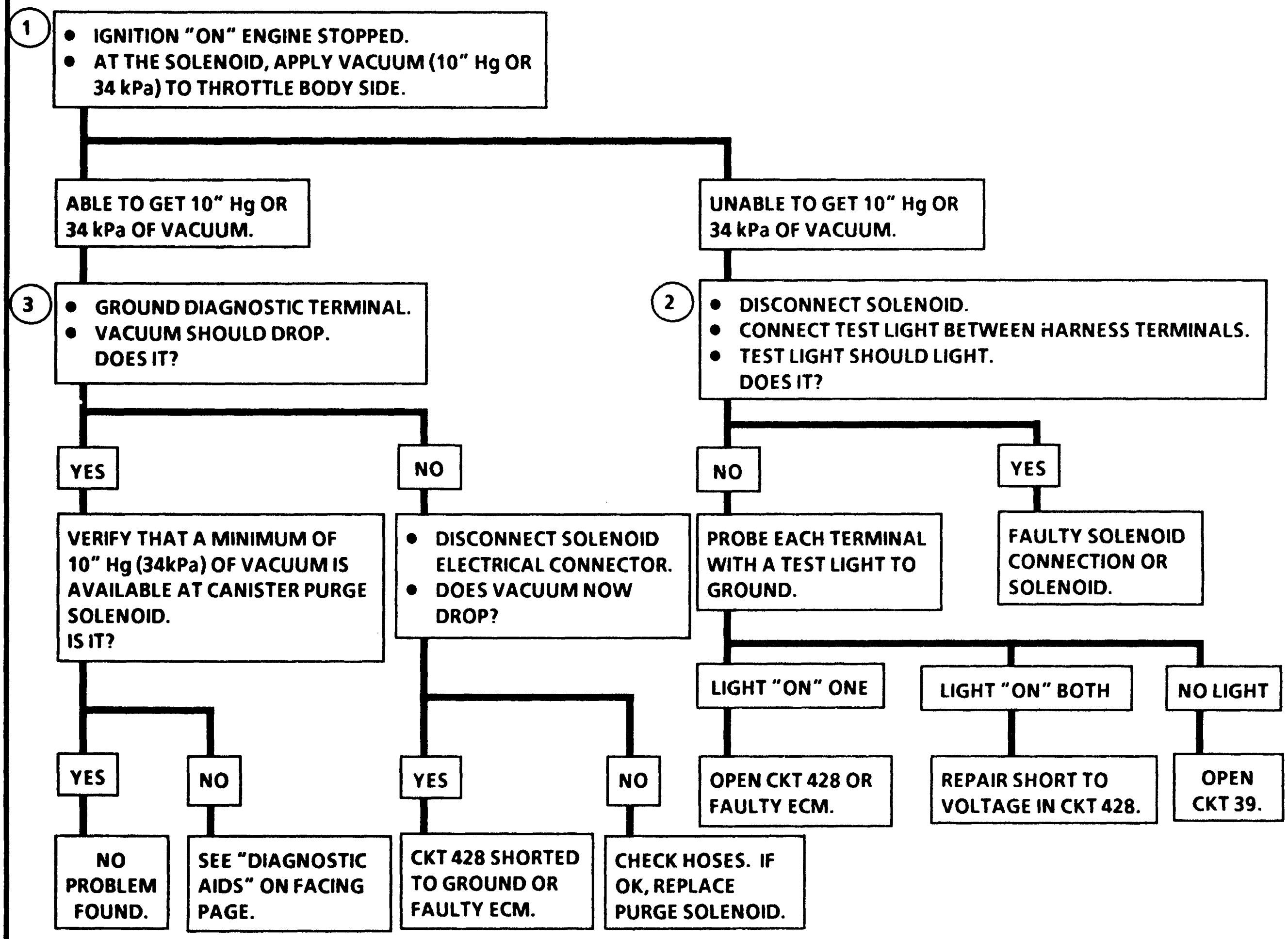
Also, if the diagnostic test terminal is grounded, with the engine stopped, the purge solenoid is de-energized (purge "ON").

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Checks to see if the solenoid is opened or closed. The solenoid is normally energized in this step; so it should be closed.
2. Checks for a complete circuit. Normally there is ignition voltage on CKT 39 and the ECM provides a ground on CKT 428.
3. Completes functional check by grounding test terminal. This should normally de-energize the solenoid opening the valve which should allow the vacuum to drop (purge "ON").

CHART C-3

CANISTER PURGE VALVE DIAGNOSIS
3.1L (VIN T) "F" CARLINE (PORT)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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SECTION C4

IGNITION SYSTEM / EST

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The High Energy Ignition (HEI) system controls fuel combustion by providing a spark to ignite the compressed air/fuel mixture at the correct time. To provide improved engine performance, fuel economy, and control of exhaust emissions, the ECM controls distributor spark advance (timing) with the Electronic Spark Timing (EST) system.

Only the Electronic Spark Timing (EST) system will be described here. Additional information on the HEI system is found in Section "6D".

To properly control ignition/combustion timing the ECM needs to know:

- Crankshaft position
- Engine speed (rpm)
- Engine temperature

OPERATION

The EST system consists of the distributor module, ECM, and connecting wires. The connector terminals are lettered as shown in Figure C4-1 for the 3.1L.

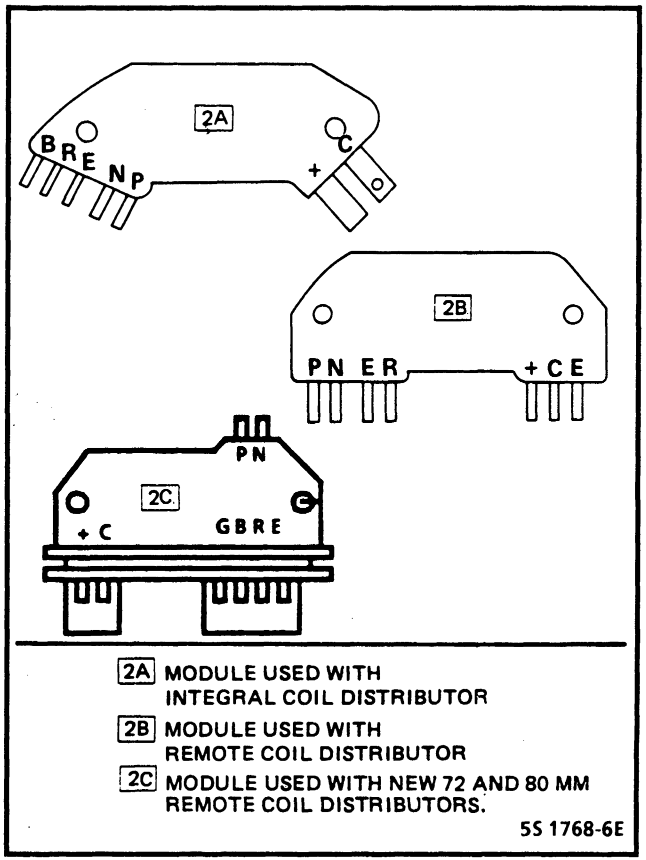

Figure C4-1 - Distributor Modules

These circuits perform the following functions:

- Distributor reference (CKT 430).

This provides the ECM with rpm and crankshaft position information. If the wire becomes open or grounded the engine will not run, because the ECM will not operate the injectors. If the engine cranks but will not run, see CHART A-3.

- Reference ground (CKT 453).

This wire is grounded in the distributor and makes sure the ground circuit has no voltage drop which could affect performance. If it is open, it may cause poor performance.

- Bypass (CKT 424).

At about 400 rpm, the ECM applies 5 volts to this circuit to switch spark timing control from the HEI module to the ECM. The wire goes through a connector between the 4 wire connector and the ECM. This is disconnected to the set base timing. An open or grounded bypass circuit will set a Code 42 and the engine will run at base timing, plus a small amount of advance built into the HEI module.

- EST (CKT 423).

This circuit triggers the HEI module. The ECM does not know what the actual timing is, but it does know when it gets the reference signal. It then advances or retards the spark from that point. Therefore, if the base timing is set incorrectly, the entire spark curve will be incorrect.

RESULTS OF INCORRECT OPERATION

An open or ground in the EST circuit will set a Code 42 and cause the engine to run on the HEI module timing. This will cause reduced performance and poor fuel economy.

The ECM uses air flow information along with rpm and coolant sensor information to calculate spark advance as follows:

- Cold engine = more spark advance.
- Engine under minimum load based on rpm and low amount of air flow- more spark advance.
- Hot engine = less spark advance.
- Engine under heavy load based on rpm and high amount of air flow- less spark advance.

DIAGNOSIS

The description, operation, and diagnosis of the HEI system are found in Section "6D" of this manual.

CODE 12

Code 12 is used during the Diagnostic Circuit Check procedure to test the code display ability of the ECM. This code indicates that the ECM is not receiving the engine rpm (REFERENCE) signal. This occurs with the ignition key "ON" and the engine not running.

The "Reference" signal also triggers the fuel injection system. Without the "Reference" signal the engine cannot run.

ON-VEHICLE SERVICE

SETTING TIMING

The initial base timing is set by disconnecting the timing connector, located near the blower motor. Refer to Emission Control Information Label for procedure. This will cause Code 42 to store in the code memory of the ECM. The memory must be cleared after setting timing.

How Code 42 Is Determined

When the system is running on the HEI module, that is no voltage on the bypass line, the HEI module grounds the EST signal. The ECM expects to see no voltage on the EST line during this condition. If it sees a voltage, it sets code 42 and will not go into the EST mode.

When the rpm for EST is reached (about 400 rpm) the ECM applies 5 volts to the bypass line and the EST should no longer be grounded in the HEI module so the EST voltage should be varying.

If the bypass line is open or grounded, the HEI module will not switch to EST mode so the EST voltage will be low and Code 42 will be set. Refer to Section "6D" for on vehicle service.

PARTS INFORMATION

PART NAME	GROUP
Controller, ECM (Remanufactured)	3.670
Distributor	2.361
Module, Distr	2.383
Coil, Distr	2.170

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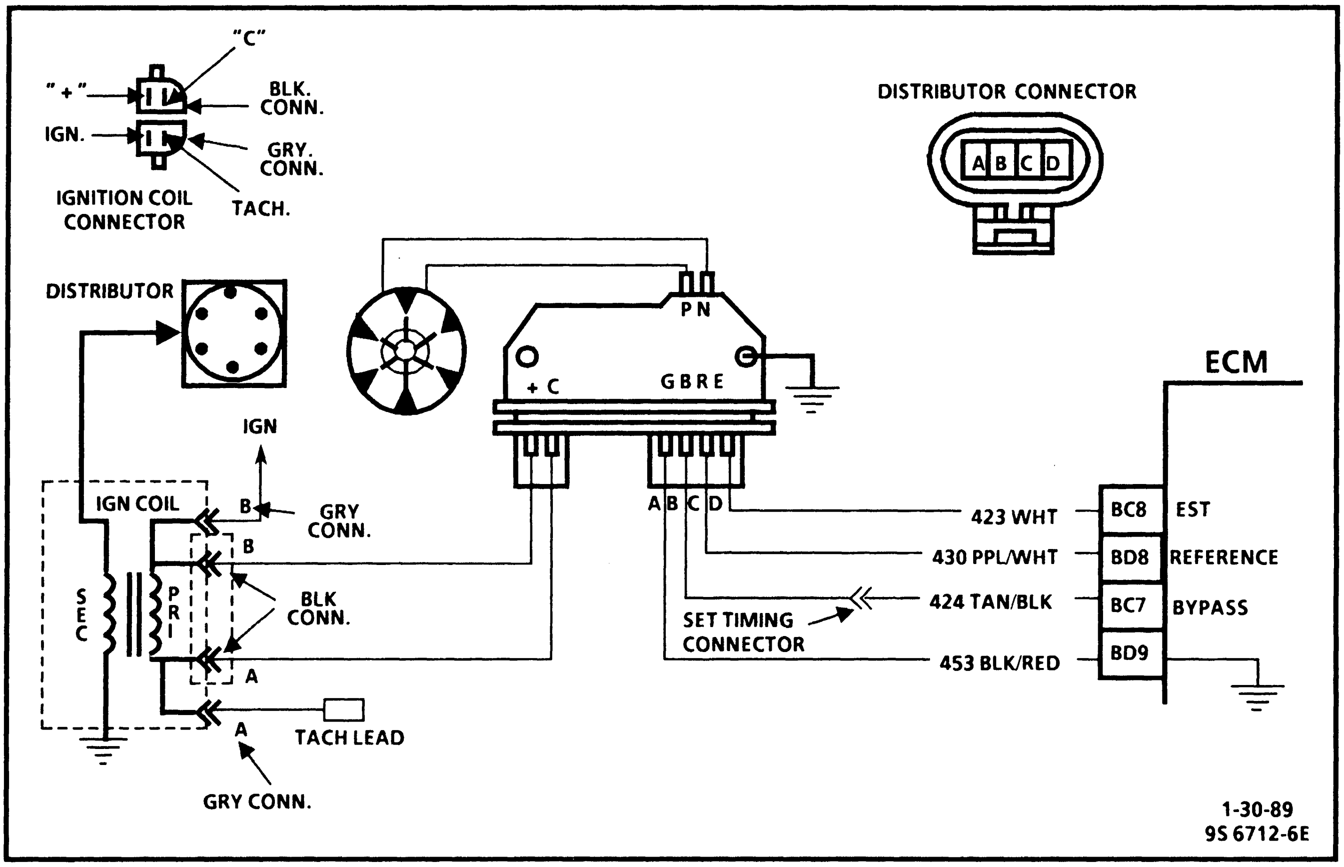

CHART C-4A

IGNITION SYSTEM CHECK
(REMOTE COIL / SEALED MODULE CONNECTOR DISTRIBUTOR)
3.1L (VIN T) "F" CARLINE (PORT)

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Two wires are checked, to ensure that an open is not present in a spark plug wire.

1A. If spark occurs with EST connector disconnected, pick-up coil output is too low for EST operation.

2. A spark indicates the problem must be the distributor cap or rotor.
3. Normally, there should be battery voltage at the "C" and "+" terminals. Low voltage would indicate an open or a high resistance circuit from the distributor to the coil or ignition switch. If "C" terminal voltage was low, but "+" terminal voltage is 10 volts or more, circuit from "C" terminal to ignition coil or ignition coil primary winding is open.
4. Checks for a shorted module or grounded circuit from the ignition coil to the module. The distributor module should be turned "OFF," so normal voltage should be about 12 volts.

   If the module is turned "ON," the voltage would be low, but above 1 volt. This could cause the ignition coil to fail from excessive heat.

   With an open ignition coil primary winding, a small amount of voltage will leak through the module from the "Batt" to the "tach" terminal.
5. Applying a voltage (1.5 to 8 volts) to module terminal "P" should turn the module "ON" and the tach. terminal voltage should drop to about 7-9 volts. This test will determine whether the module or coil is faulty or if the pick-up coil is not generating the proper signal to turn the module "ON." This test can be performed by using a DC battery with a rating of 1.5 to 8 volts. The use of the test light is mainly to allow the "P" terminal to be probed more easily.

   Some digital multi-meters can also be used to trigger the module by selecting ohms, usually the diode position. In this position the meter may have a voltage across it's terminals which can be used to trigger the module. The voltage in the ohm's position can be checked by using a second meter or by checking the manufacture's specification of the tool being used.
6. This should turn "OFF" the module and cause a spark. If no spark occurs, the fault is most likely in the ignition coil because most module problems would have been found before this point in the procedure. A module tester could determine which is at fault.

CHART C-4A
IGNITION SYSTEM CHECK
(REMOTE COIL / SEALED MODULE CONNECTOR DISTRIBUTOR)

3.1L (VIN T) "F" CARLINE (PORT)

①
- Perform Diagnostic Circuit Check before proceeding with this test. (If a tachometer is connected to the Tach term., disconnect it before proceeding with the test).
- Check spark at plug with spark tester J-26792 or equivalent (ST-125) while cranking (if no spark on one wire, check a second wire) A few sparks and then nothing is considered no spark.

No Spark | Spark

Spark: Check fuel, spark plugs, etc. See section "B" symptoms.

No Spark:

(1A)
- Disconnect 4 term. distributor connector and check for spark.

No spark | Spark

Spark: Replace pick-up coil

No spark:

②
- Check for spark at coil wire with tester while cranking. (Leave spark tester connected to coil wire for Steps 3-6).

No Spark | Spark

Spark: Inspect cap for water, cracks, etc. If OK, replace rotor.

No Spark:

③
- Disconnect distributor 2 term. "C / +" connector.
- Ignition switch "on", Engine stopped.
- Check volts at "+" and "C" term's. of dist. harn. conn.

Both term's. 10 volts or more | Both term's. under 10 volts | Under 10 volts "C" term. only

Both term's. under 10 volts: Repair wire from module "+" term. to "B" term. of black Ign. coil connector or primary ckt. to ign. sw.

Under 10 volts "C" term. only: Check for open or gnd. in ckt. from "C" term. to ign. coil. If Ckt. is OK, fault is. ign. coil or conn..

Both term's. 10 volts or more:

④
- Reconnect dist. 2 term. conn.
- With ign. "ON", check voltage from tach. term. to gnd. (term. may be taped back in harness).

Over10 volts | Under 1 volt | 1 to 10 volts

Under 1 volt: Repair open tach. lead or conn and repeat test #4.

1 to 10 volts: Replace module and check for spark from coil as in Step 6.
- Spark: System OK
- No Spark: Replace ign. coil, it too is faulty

Over10 volts:
- Connect test light from tach. term. to ground.
- Crank engine and observe light.

Light on steady | Light blinks

Light blinks: Replace ignition coil and recheck for spark with spark tester. If still no spark, re-install original coil and replace dist. module..

Light on steady:

⑤
- Disconnect distributor 4 term. connector.
- Remove dist. cap.
- Disconnect pick-up coil connector from module.
- Connect voltmeter from tach. term. to ground.
- Ignition on.
- Insulate a test light probe to 1/4" from tip and note voltage, as test light is momentarily connected from a voltage source (1.5 to 8V) to module term. "P". (Fig. 1).

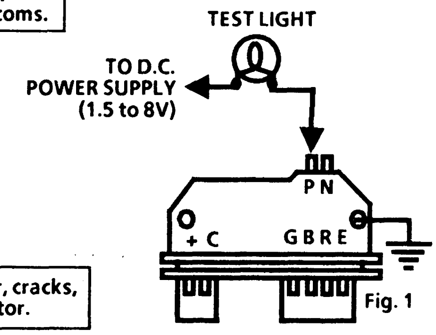

Fig. 1

Voltage drops | No drop in voltage

No drop in voltage: Check module ground. If OK, replace module.

Voltage drops:

⑥
- Check for spark from coil wire with spark tester as test light is removed from module term.

No Spark | Spark

No Spark:
- If no module tester (J24642) is available; Replace ign. coil and repeat Step 5.
  - No Spark: Ign. coil removed is OK, reinstall coil and check coil wire from dist. cap. if OK, replace dist. module.
  - Spark: System OK
- If module tester (J24642) is available: test module
  - OK: Check coil wire from cap to coil. If OK, replace coil.
  - Not OK: Replace module

Spark:
- Is rotating pole piece still magnetized?
  - Yes: Check pick-up coil or conns. (Coil resistance should be 500-1500 ohms and not grounded).
  - No: Replace pole piece and shaft assy.

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SECTION C5

ELECTRONIC SPARK CONTROL (ESC) SYSTEM

CONTENTS

GENERAL DESCRIPTION

PURPOSE

Varying octane levels in today's gasoline can cause detonation in high performance engines. Detonation is sometimes called spark knock. This condition causes the pistons and rings to vibrate and rattle producing the spark knocking sound.

To control spark knock an Electronic Spark Control (ESC) system is used. This system is designed to retard spark timing up to 15° to reduce spark knock in the engine. This allows the engine to use maximum spark advance to improve driveability and fuel economy.

OPERATION

The ESC system has two major components:

- ESC module (part of MEM-CAL)
- ESC knock sensor

The ESC knock sensor detects abnormal vibration (spark knocking) in the engine. The sensor is mounted in the engine block near the cylinders. The sensor produces an A/C output voltage which increases with the severity of the knock. This signal voltage inputs to the ECM. The ECM then adjusts the Electronic Spark Timing (EST) to reduce spark knocking.

DIAGNOSIS

The "Scan" tool will have two positions to check for diagnosing this circuit. Knock signal is used to monitor the input signal from the knock sensor. This position should display "yes" to indicate knock is being detected. Knock retard is the indication of how much the ECM is retarding the spark.

Code 43 is designed to diagnose the knock sensor and wiring, so problems encountered with this circuit should set the code. However, if no Code 43 was set but the ESC system is suspected because detonation was the customers complaint, refer to CHART C-5.

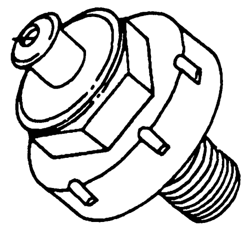

Figure C5-1 - ESC Sensor

ON-VEHICLE SERVICE

ESC SENSOR

Remove or Disconnect

1. Negative battery cable.
2. Raise car.
3. ESC wiring harness connector from ESC sensor.
4. ESC sensor from engine block.

Install or Connect

1. ESC sensor into engine block. Be sure threads are clean.

   Tighten

   - 19 N·m (14 lb. ft.).

2. ESC wiring harness connector to the ESC sensor.
3. Lower car.
4. Negative battery cable.

Important

- Before starting engine, follow the "Idle Learn Procedure" as follows:

1. Install Tech 1 "Scan" tool.
2. Ignition "ON," engine "OFF."
3. Select "IAC SYSTEM," then "IDLE LEARN" in the "MISC TEST" mode.
4. Proceed with idle learn as directed.

This procedure allows the ECM memory to be updated with the correct IAC valve pintle position for the vehicle, and provides for a stable idle speed.

MEM-CAL

Refer to "Electronic Control Module (ECM) and Sensors," Section "6E3-C1" for replacement procedure.

PARTS INFORMATION

PART NAME	GROUP
Sensor, ESC Knock	2.383

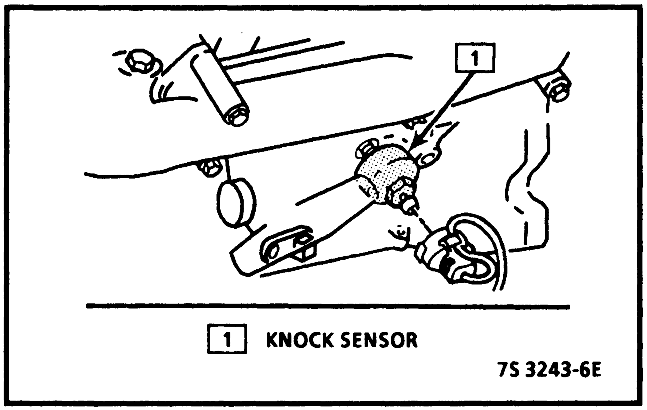

Figure C5-2 - ESC Sensor

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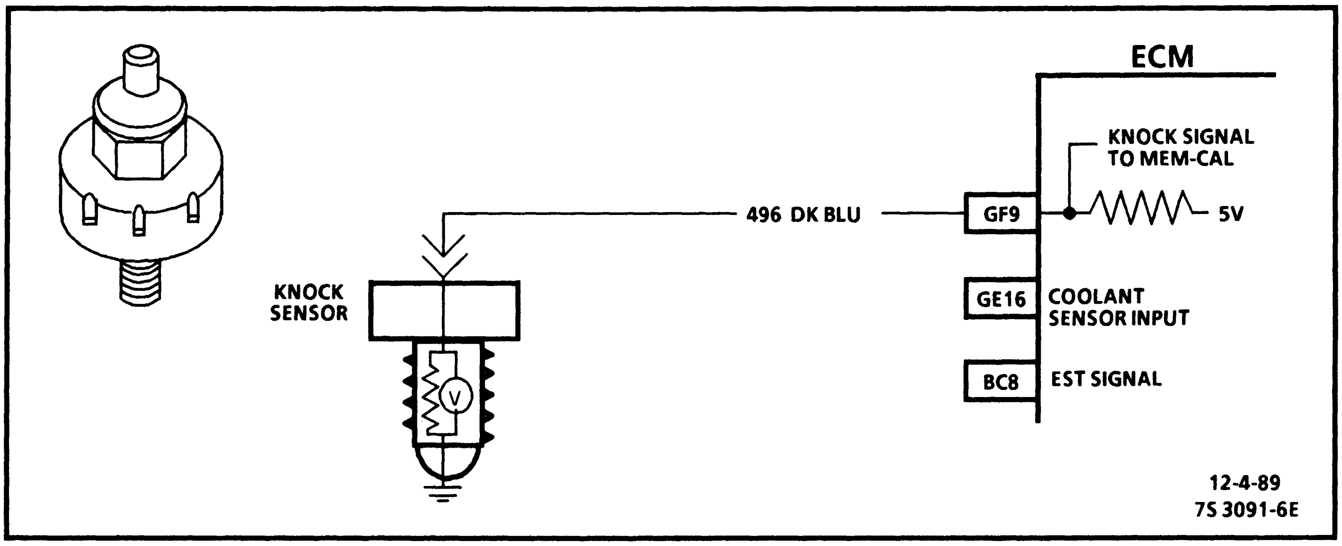


CHART C-5

ELECTRONIC SPARK CONTROL (ESC) SYSTEM CHECK
3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The knock sensor is used to detect engine detonation and the ECM will retard the electronic spark timing based on the signal being received. The circuitry within the knock sensor causes the ECM's 5 volts to be pulled down so that under a no knock condition, CKT 496 would measure about 2.5 volts. The knock sensor produces an A/C signal which rides on the 2.5 volt DC voltage. The amplitude and frequency are dependent upon the knock level.

The MEM-CAL used with this engine, contains the functions which were part of remotely mounted ESC modules used on other GM vehicles. The ESC portion of the MEM-CAL then sends a signal to other parts of the ECM which adjusts the spark timing to retard the spark and reduce the detonation.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

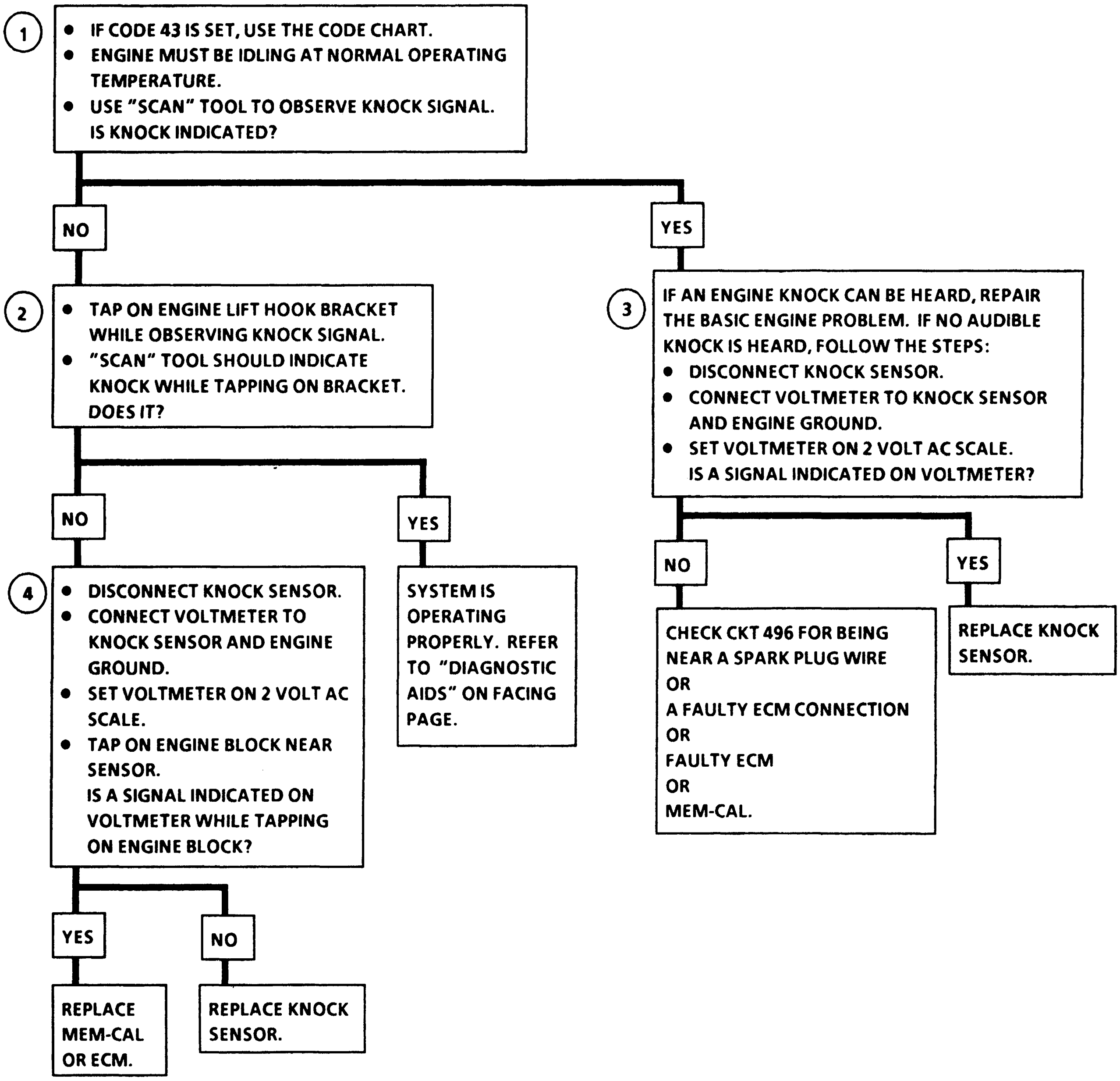
1. With engine idling, there should not be a knock signal present at the ECM because detonation is not likely under a no load condition.
2. Tapping on the engine lift hood bracket should simulate a knock signal to determine if the sensor is capable of detecting detonation. If no knock is detected, try tapping on engine block closer to sensor before replacing sensor.
3. If the engine has an internal problem which is creating a knock, the knock sensor may be responding to the internal failure.
4. This test determines if the knock sensor is faulty or if the ESC portion of the MEM-CAL is faulty. If it is determined that the MEM-CAL is faulty, be sure that it is properly installed and latched into place. If not properly installed, repair and retest.

Diagnostic Aids:

While observing knock signal on the "Scan," there should be an indication that knock is present when detonation can be heard. Detonation is most likely to occur under high engine load conditions.

CHART C-5

ELECTRONIC SPARK CONTROL (ESC) SYSTEM CHECK 3.1L (VIN T) "F" CARLINE (PORT)



①
- IF CODE 43 IS SET, USE THE CODE CHART.
- ENGINE MUST BE IDLING AT NORMAL OPERATING TEMPERATURE.
- USE "SCAN" TOOL TO OBSERVE KNOCK SIGNAL.

IS KNOCK INDICATED?

NO

②
- TAP ON ENGINE LIFT HOOK BRACKET WHILE OBSERVING KNOCK SIGNAL.
- "SCAN" TOOL SHOULD INDICATE KNOCK WHILE TAPPING ON BRACKET.

DOES IT?

NO

④
- DISCONNECT KNOCK SENSOR.
- CONNECT VOLTMETER TO KNOCK SENSOR AND ENGINE GROUND.
- SET VOLTMETER ON 2 VOLT AC SCALE.
- TAP ON ENGINE BLOCK NEAR SENSOR.

IS A SIGNAL INDICATED ON VOLTMETER WHILE TAPPING ON ENGINE BLOCK?

YES

REPLACE MEM-CAL OR ECM.

NO

REPLACE KNOCK SENSOR.

YES

SYSTEM IS OPERATING PROPERLY. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

YES

③ IF AN ENGINE KNOCK CAN BE HEARD, REPAIR THE BASIC ENGINE PROBLEM. IF NO AUDIBLE KNOCK IS HEARD, FOLLOW THE STEPS:
- DISCONNECT KNOCK SENSOR.
- CONNECT VOLTMETER TO KNOCK SENSOR AND ENGINE GROUND.
- SET VOLTMETER ON 2 VOLT AC SCALE.

IS A SIGNAL INDICATED ON VOLTMETER?

NO

CHECK CKT 496 FOR BEING NEAR A SPARK PLUG WIRE
OR
A FAULTY ECM CONNECTION
OR
FAULTY ECM
OR
MEM-CAL.

YES

REPLACE KNOCK SENSOR.

CLEAR CODES, DISCONNECT "SCAN" TOOL FROM ALDL, START ENGINE AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT

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SECTION C6

AIR INJECTION REACTION (A.I.R.) SYSTEM MANUAL TRANSMISSION ONLY

CONTENTS

GENERAL DESCRIPTION

PURPOSE

These systems are used to reduce Carbon Monoxide (CO), Hydrocarbon (HC) and Oxides of Nitrogen (NO_X) emissions. They also heat up the catalytic converter quickly "ON" engine start-up so conversion of exhaust gases will start quickly.

A.I.R. PUMP OPERATION

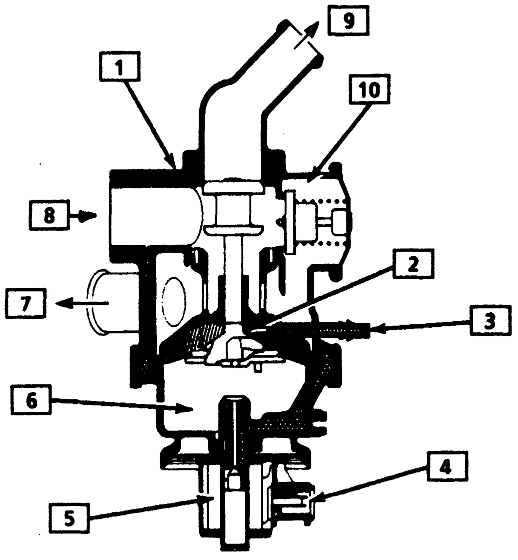
The system (Figure C6-1) includes:

- An Air Pump
  The air pump is driven by a belt on the front of the engine and supplies the air to the system. Intake air passes through a centrifugal filter fan at the front of the pump; where foreign materials are separated from the air by centrifugal force.
- A Control Valve
  Air flows from the pump through an ECM controlled valve (called a control valve) through check valves to either the exhaust ports or the silencer (overboard).
- Check Valves
  The check valves prevent back flow of exhaust into the pump in the event of an exhaust backfire or pump drive belt failure.
- Necessary Plumbing

AIR CONTROL

Electric Air Control Valve (EAC)

The Electric Air Control Valve (EAC) combines electronic control with the normal diverter valve function. This valve can be electronically controlled to provide divert air under any driving mode.



1 ELECTRIC AIR CONTROL VALVE
2 DECEL TIMING ASSEMBLY
3 VERY HIGH VACUUM SIGNAL PORT
4 ELECTRICAL TERMINAL
5 SOLENOID
6 DECEL TIMING CHAMBER
7 DIVERT AIR TO AIR CLEANER
8 AIR FROM PUMP
9 AIR TO EXHAUST PORTS
10 PRESSURE RELIEF ASSEMBLY

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Figure C6-1 - Electric Air Control Valve

When the solenoid is energized, the valve will perform like a standardized diverter valve. Air from the air pump is directed to the exhaust ports, unless there is a great sudden rise in manifold vacuum due to throttle deceleration.

When the solenoid is de-energized, the pressurized air from the air pump is allowed to enter the decel timing chamber. This places sufficient pressure on the metering valve diaphragm to overcome spring tension, closing the valve,causing air to divert to the silencer.

At higher engine speeds, excess air is exhausted to the silencer through the pressure relief valve. (Figure C6-1)

Deceleration Valve

To help prevent backfiring during high vacuum conditions a deceleration (gulp) valve is used to allow air to flow into the intake manifold (shown in Figure C6-2). This air enters the air/fuel mixture to lean the rich condition created by high vacuum when the throttle valve closes on deceleration.

The vacuum draws the deceleration valve diaphragm down and opens the valve allowing air inlet duct to flow into the intake manifold.

RESULTS OF INCORRECT OPERATION

- If no air (oxygen) flow enters the exhaust stream at the exhaust ports, HC and CO emission levels will be too high.
- Air flowing to the exhaust ports at all times could cause a rich ECM command and increased temperature of the converter. This may also cause a Code 44 due to oxygen being pumped passed the oxygen sensor. There should be no air going to the exhaust ports while operating in the "Closed Loop" mode.

DIAGNOSIS

The diagnosis of the AIR system is covered in CHART C-6 at the end of this section.

OPERATIONAL CHECKS

A.I.R. Pump

1. The air pump is a positive displacement vane type which is permanently lubricated and requires no periodic maintenance.

Accelerate engine to approximately 1500 rpm's and observe air flow from hose(s). If air flow increases as engine is accelerated, pump is operating satisfactorily. If air flow does not increase or is not present, proceed as follows:

Inspect

For proper drive belt tension.

2. For a leaky pressure relief valve. Air may be heard leaking with the pump running.

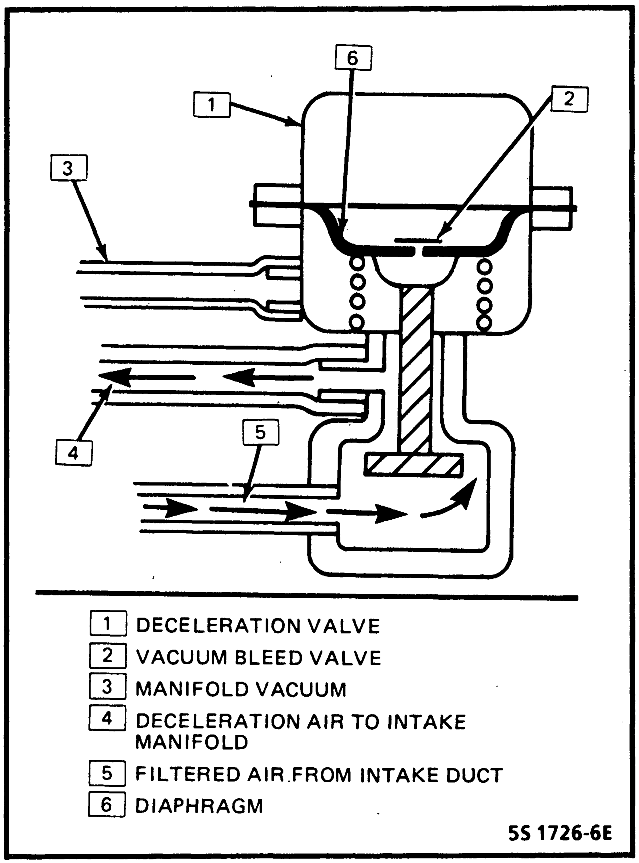


Figure C6-2 - Deceleration Valve

NOTICE: If the engine or underhood compartment is to be cleaned with steam or high-pressure detergent, the centrifugal filter fan should be masked "OFF" to prevent liquids from entering the pump.

Inspect

3. For a seized Air Injection Pump.
4. Hoses, tubes and all connections for leaks and proper routing.
5. For air flow from control/switching valve.
6. AIR injection pump for proper mounting and bolt torque.
7. If no irregularities exist and the AIR injection pump noise is still excessive, remove and replace pump.

CAUTION: Do Not Oil Air Pump

Hoses and Pipes

Inspect

1. Hose or pipe for deterioration or holes.
2. All hoses or pipe connections, and clamp tightness.
3. Hose or pipe routing. Interference may cause wear.

4. If a leak is suspected on the pressure side of the system or if a hose or pipe has been disconnected on the pressure side, the connections should be checked for leaks with a soapy water solution. With the pump running, bubbles will form if a leak exists.

Deceleration Valve

1. Connect tachometer, start engine and allow idle to stabilize.
2. With the engine running at specified idle speed, remove the small deceleration valve signal hose from the manifold vacuum source.
3. Reconnect the signal hose and listen for air flow through the ventilation pipe and into the deceleration valve. There should also be a noticeable speed drop when the signal hose is reconnected.
4. If the air flow does not continue for at least one second or the engine speed does not drop noticeably, check the deceleration valve hoses for restrictions or leaks.
5. If no restrictions or leaks are found, replace the deceleration valve.

Check Valve

Inspect

1. A check valve should be inspected whenever the hose is disconnected form a check valve or whenever check valve failure is suspected. (A pump that had become inoperative and had shown indications of having exhaust gases in the pump would indicate check valve failure).
2. Blow through the check valve (toward the exhaust manifold) then attempt to suck back through the check valve. Flow should only be in one direction(toward the exhaust manifold). Replace valve which does not operate properly.

ON-VEHICLE SERVICE

DRIVE BELT

Remove or Disconnect

1. Inspect drive belt for ware, cracks or deterioration and replace if required. When installing new belt, it must be seated and fully secured in grooves of A/C compressor, AIR pump, generator, and crankshaft pulleys.

A.I.R. PUMP

Remove or Disconnect

1. Hold pump pulley from turning by compressing drive belt, then loosen pump pulley bolts.
2. Loosen bolt, holding pump to mounting brackets, release tension on drive belts.
3. Move belts out of the way, then remove pump hoses, vacuum and electrical connections, and control valve.
4. Pulley, then pump.
5. If required, insert needle nose pliers and pull filter fan from hub.

Install or Connect

1. Air pump assembly, and tighten mounting bolts.
2. Hoses, vacuum and electrical connections, and control valve.
3. New filter fan on pump hub.
4. Spacer and pump pulley against centrifugal filter fan.
5. Pump pulley bolts and tighten equally to 13 N·m (10 lb. ft.). This will compress the centrifugal filter fan onto the pump hole. Do not drive filter fan on with a hammer. A slight amount of interference with the housing bore is normal. After a new filter fan has been installed, it may squeal upon initial operation or until O.D. sealing lip has worn in. This may require a short period of pump operation at various engine speeds.
6. Pump drive belt and adjust.
7. Check air injection system for proper operation (see CHART C-6).

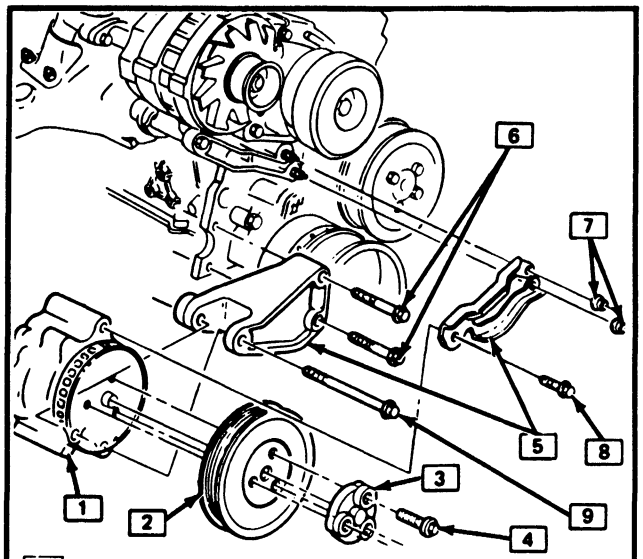
AIR CONTROL VALVE

Remove or Disconnect

1. Battery ground cable.
2. Adapter bolts (See Figure C6-3).
3. Air outlet hoses from valve.
4. Adapter.
5. Electrical connectors and vacuum hoses from valve.
6. Control valve.

Install or Connect

1. Control valve.
2. Electrical connectors and vacuum hoses.
3. Adapter.
4. Air hoses to valve.
5. Adapter bolts to pump.
6. Battery ground cable.
7. Check system operation (see CHART C-6).



1 A.I.R. PUMP ASM
2 PULLEY
3 SPACER
4 PULLEY BOLT 27 N·m (20 FT. LBS.)
5 BRACKETS (UPPER AND LOWER)
6 BOLTS (2) 80 N·m (60 FT. LBS.)
7 NUTS (2) 50 N·m (36 FT. LBS.)
8 UPPER PUMP BOLT 35 N·m (26 FT. LBS.)
9 LOWER PUMP BOLT 35 N·m (26 FT. LBS.)

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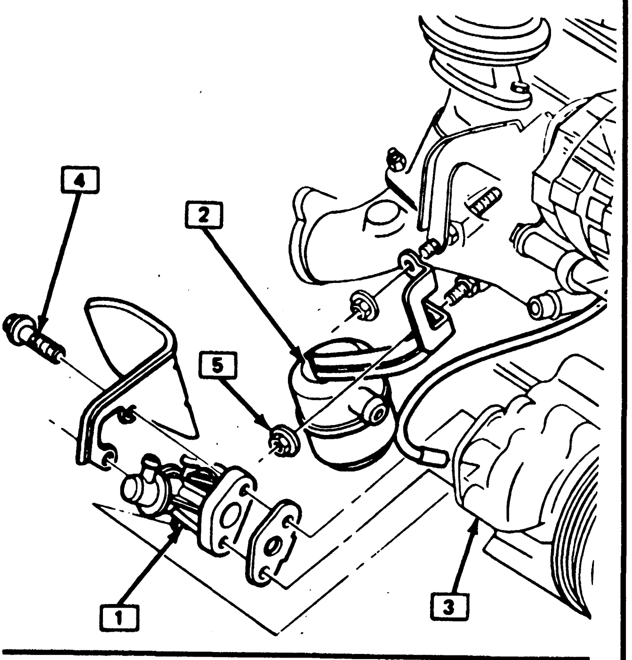
Figure C6-3 - Air Pump Mounting



1 CONTROL VALVE
2 DIVERT SILENCER
3 A.I.R. PUMP ASM
4 BOLT (2) 16 N·m (12 FT. LBS.)
5 NUTS (2) 24 N·m (18 FT. LBS.)

7S 3315-6E

Figure C6-4 - Control Valve Service

CHECK VALVE

Remove or Disconnect

1. Any parts required for access.
2. Release clamp and disconnect air hoses from check valve.
3. Unscrew check valve from air injection pipe.

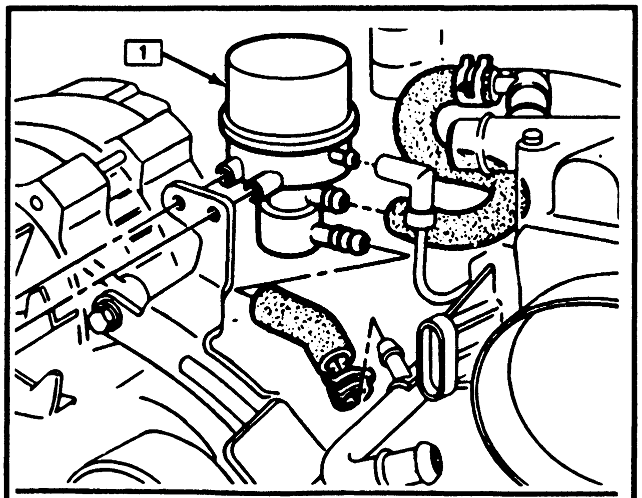
Install or Connect

1. Screw check valve onto air injection pipe.
2. Position air hoses on check valve and secure with clamp.
3. Any parts removed for access.

DECELERATION VALVE

Remove or Disconnect

1. Vacuum hoses from valve.
2. Screws securing valve to engine bracket.
3. Deceleration valve.



1 DECELERATION VALVE ASM

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Figure C6-5 - Control Valve Service

Install or Connect

1. Deceleration valve.
2. Screws securing valve to engine bracket.
3. Vacuum hoses to valve.

PARTS INFORMATION

PART NAME	GROUP
Bracket, AIR Inj Pump Supt (RR)	3.655
Bracket, AIR Inj Pump (Frt)	3.655
Bracket, Dclr Vlv	3.671
Gasket, AIR Cont Vlv	3.671
Hose, AIR Inj Cont Vlv	3.675
Hose, C/case Vent Pipe to Dclr Vlv	3.675
Pipe, AIR Inj Ctltc Conv Chk Vlv	3.690
Pipe, AIR Inj Cont Vlv	3.675
Pulley, AIR Inj Pump	3.650
Pump, AIR Inj	3.660
Silencer, AIR Inj Cont Vlv	3.675
Valve, AIR Inj Cont	3.670
Valve, AIR Inj Eng Chk	3.670
Valve, Dclr	3.670

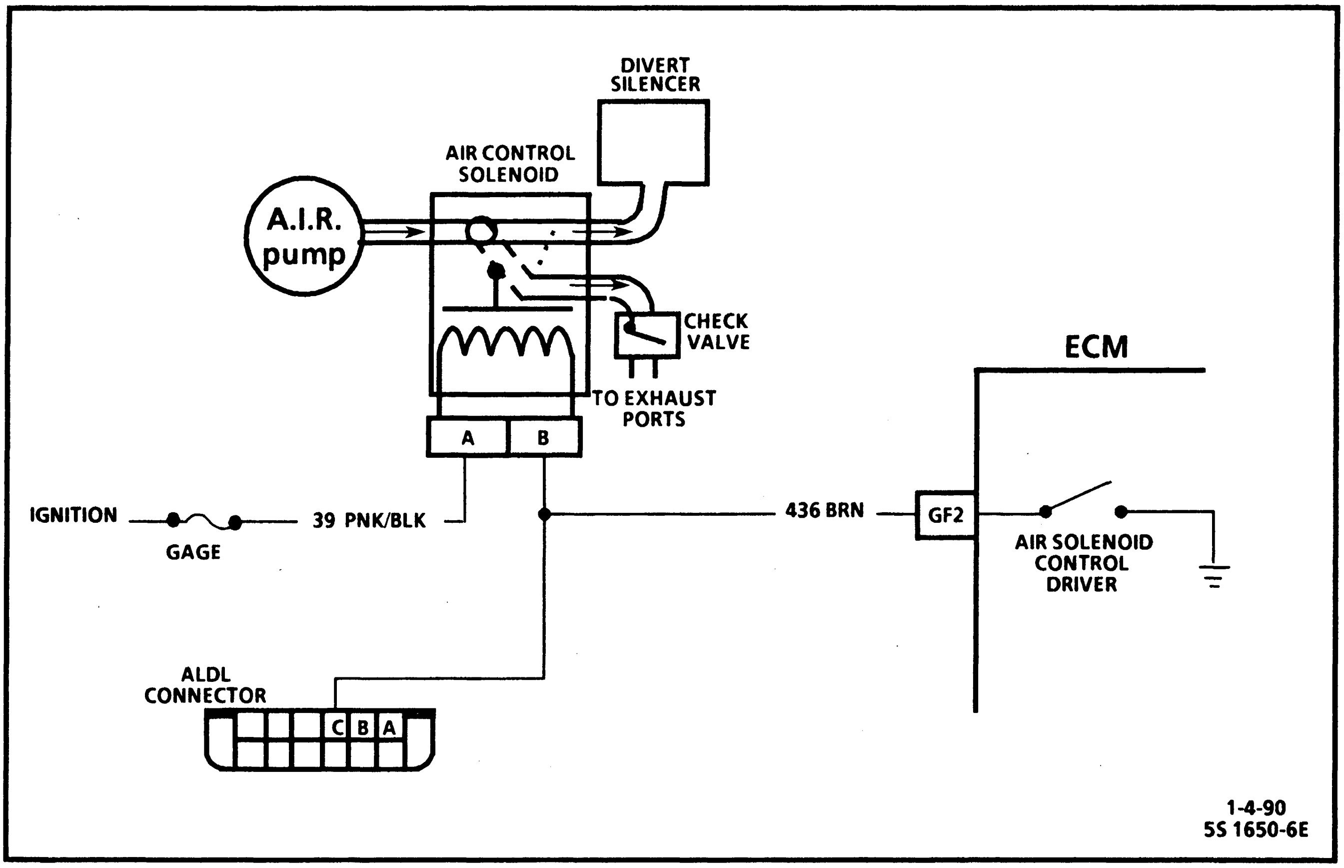


CHART C-6

ELECTRIC CONTROL (DIVERT)

(MANUAL TRANSMISSION)

3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

This system uses a single bed converter and Air Management is controlled by an Air Control Valve (divert valve).

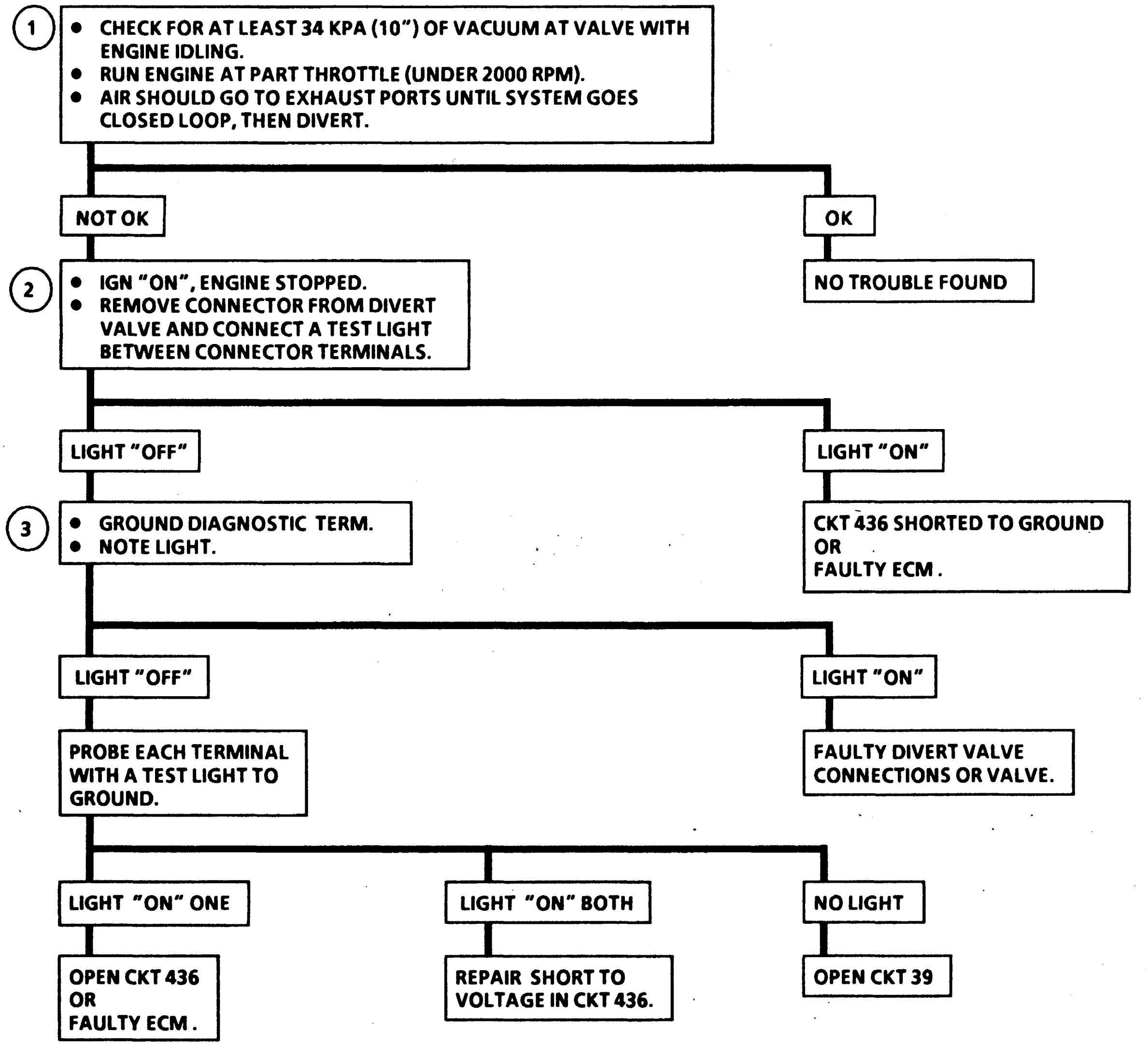
When grounded by the ECM, the solenoid causes the valve to direct air to the exhaust ports. When de-energized air diverts to the atmosphere, air will go to the ports provided the valve has a ground to the ECM and good manifold vacuum.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. This is a system performance test. When vehicle goes to "Closed Loop," air will switch from the ports to divert.
2. Tests for a grounded electric divert circuit. Normal system light will be "OFF."
3. Checks for an open control circuit. Grounding test terminal will energize the solenoid if ECM and circuits are normal. In this step, if test light is "ON," circuits are normal and faulty is in valve connections or valve.

CHART C-6

ELECTRIC CONTROL (DIVERT)
(MANUAL TRANSMISISON)
3.1L (VIN T) "F" CARLINE (PORT)



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SECTION C7

EXHAUST GAS RECIRCULATION (EGR) SYSTEM

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The EGR system is used to lower NOx (oxides of nitrogen) emission levels caused by high combustion temperature. It does this by decreasing combustion temperature.

The main element of the system is the digital EGR valve.

The digital EGR valve feeds small amounts of exhaust gas back into the intake manifold and then into the combustion chamber.

The ECM is programmed with an EGR diagnostic check to monitor flow through each individual valve in the three solenoid EGR valve.

When the vehicle is in the decel mode with the valves normally closed, the ECM opens each valve in succession (while keeping previous valves open) and manifold pressure is monitored for an appropriate increase associated with each valve's application. Should the calibrated response in manifold pressure not be seen by the ECM, a Code 32 will set.

OPERATION
Digital EGR Valve

The digital (EGR) valve is designed to accurately supply EGR to an engine, independent of intake manifold vacuum. The valve controls EGR flow from the exhaust to the intake manifold through three orifices, which increment in size, to produce seven combinations. When a solenoid is energized, the armature, with attached shaft and swivel pintle, is lifted opening the orifice.

The flow accuracy is dependent on metering orifice size only, which results in improved control.

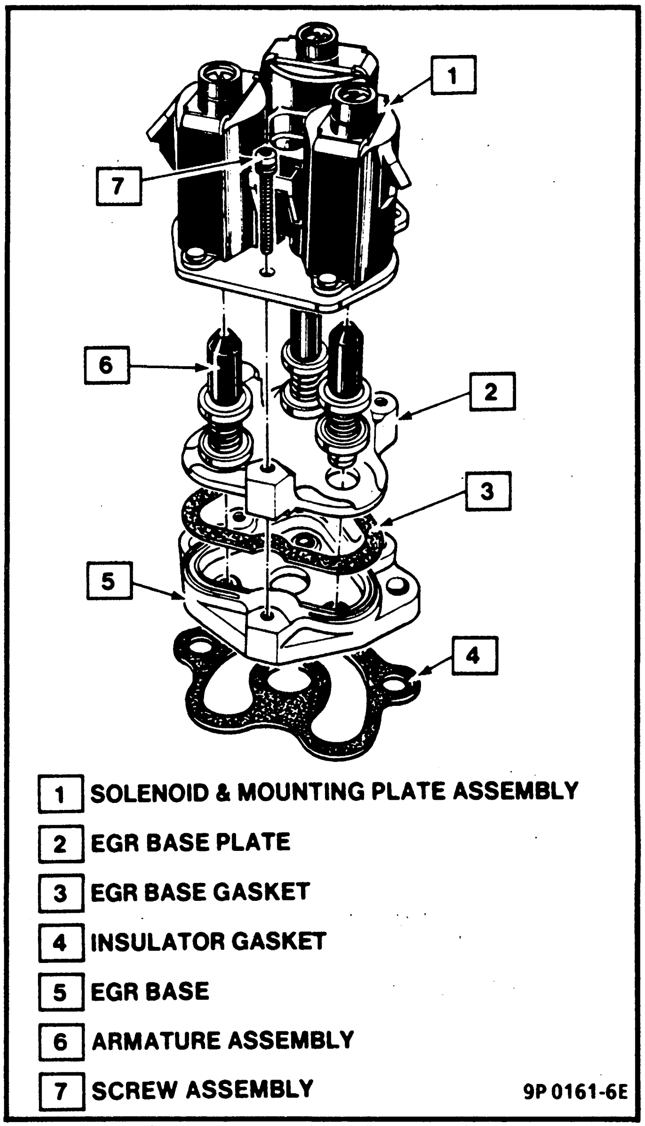

Figure C7-1 - Digital EGR Valve

The swivel pintle feature insures good sealing of exhaust gas, reducing the need of critical assembly alignment. In addition, the effects of EGR leakage on idle quality are reduced because the shaft and seals are exposed to exhaust pressure instead of manifold vacuum. The shafts are sealed from the exhaust chamber by floating seals held in place by the seal spring. These springs also hold the upper seals that seal the armature cavity in the solenoids.

The solenoid coils are fastened together to maximize reliability and to seal the coils from the environment. The coils use a common power terminal with individual ground terminals.

The digital EGR valve is opened by the ECM QDR, grounding each respective solenoid circuit. This activates the solenoid, raises the pintle, and allows exhaust gas flow into the intake manifold. The exhaust gas then moves with the air/fuel mixture into the combustion chamber. If too much exhaust gas enters, combustion will not occur. For this reason, very little exhaust gas is allowed to pass through the valve, especially at idle. The EGR valve is usually open under the following conditions:

- Warm engine operation.
- Above idle speed.

EGR CONTROL

To regulate EGR flow, the ECM controls the EGR solenoids to vary the amount of EGR flow. The ECM uses information from the following sensors to regulate the solenoid:

- Coolant Temperature (CTS)
- Throttle Position (TPS)
- Manifold Absolute Pressure (MAP)

DIAGNOSIS

An EGR flow check diagnosis of the digital EGR system is covered in CHART C-7.

RESULTS OF INCORRECT EGR SYSTEM OPERATION

Too much EGR flow at idle, cruise, or cold operation, any of the following conditions may occur:

- Engine stops after cold start.
- Engine stops at idle after deceleration.
- Car surges during cruise.
- Rough idle.

Too little or no EGR flow allows combustion temperatures to get too high. This could cause:

- Spark knock (detonation)
- Engine overheating
- Emission test failure

EGR

Remove or Disconnect

1. Electrical connector at solenoid.
2. Two base to flange bolts and digital EGR.

Install or Connect

1. Digital EGR - two bolts, tighten nuts to 15 N·m (11 lb. ft.), then 30 N·m (22 lb. ft.).
2. Electrical connector.

PARTS INFORMATION

PARTS NAME	GROUP
Gasket, EGRValve	3.680
Valve, EGR	3.670

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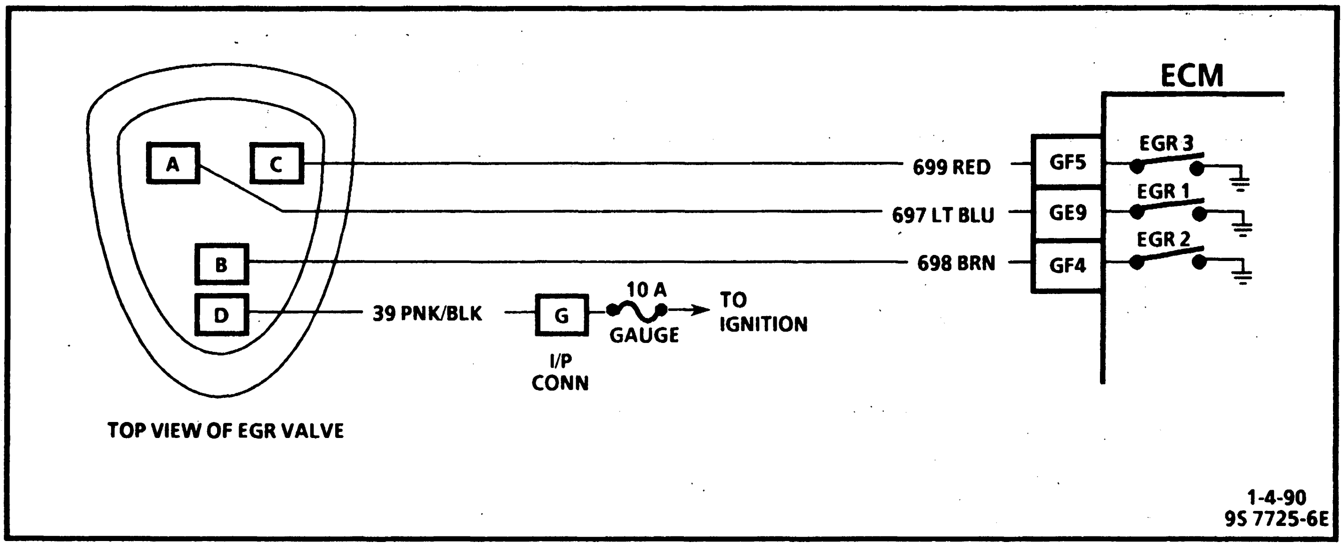


CHART C-7

EXHAUST GAS RECIRCULATION (EGR) FLOW CHECK
3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The digital Exhaust Gas Recirculation (EGR) valve is designed to accurately supply EGR to an engine independent of intake manifold vacuum. The valve controls EGR flow from the exhaust to the intake manifold through three orifices which increment in size to produce seven combinations. When a solenoid is energized, the armature with attached shaft and swivel pintle is lifted opening the orifice.

The flow accuracy is dependent on metering orifice size only, which results in improved control.

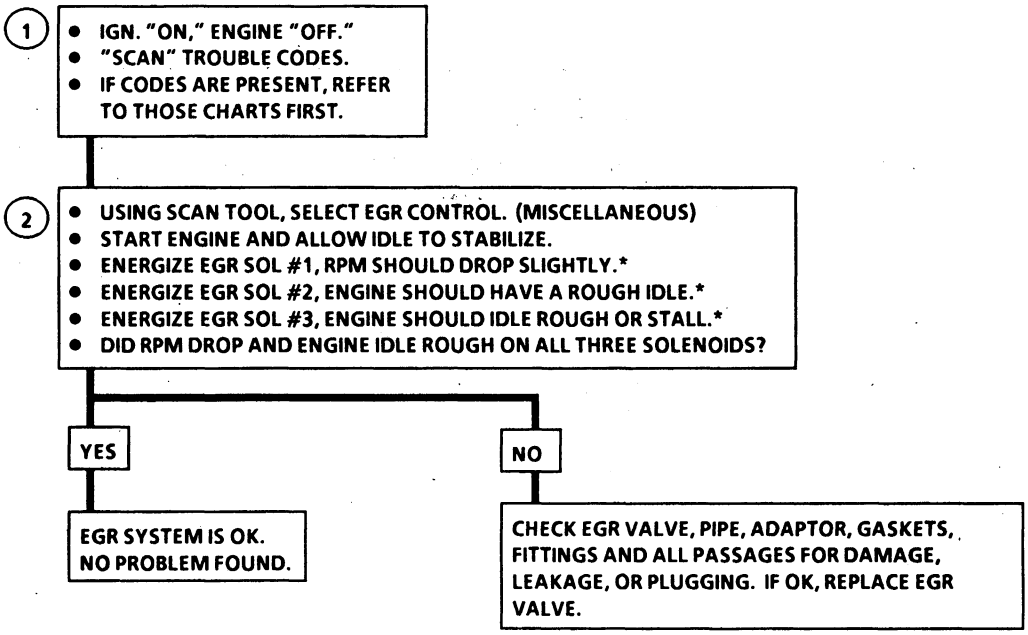
Test Description: Numbers below refer to circled numbers on diagnostic chart.

1. Codes should be diagnoses using appropriate chart before preparing a functional check.
2. This step activates each solenoid individually. As you energize #1 or #2 solenoid, the engine rpm should drop. #3 solenoid has the large port and may stall the engine when energized.

NOTE: If the digital EGR valve shows signs of excessive heat, a melted condition. Check the exhaust system for blockage (possibly a plugged converter) using the procedure found on CHART B1. If the exhaust system is restricted repair the cause, one of which might be an injector which is open due to one of the following: a. stuck, b. grounded driver CKT, c. possibly defective ECM.
If this condition is found the oil should be checked for possible fuel contamination.

CHART C-7

EXHAUST GAS RECIRCULATION (EGR) FLOW CHECK 3.1L (VIN T) "F" CARLINE (PORT)



①
- IGN. "ON," ENGINE "OFF."
- "SCAN" TROUBLE CODES.
- IF CODES ARE PRESENT, REFER TO THOSE CHARTS FIRST.

②
- USING SCAN TOOL, SELECT EGR CONTROL. (MISCELLANEOUS)
- START ENGINE AND ALLOW IDLE TO STABILIZE.
- ENERGIZE EGR SOL #1, RPM SHOULD DROP SLIGHTLY.*
- ENERGIZE EGR SOL #2, ENGINE SHOULD HAVE A ROUGH IDLE.*
- ENERGIZE EGR SOL #3, ENGINE SHOULD IDLE ROUGH OR STALL.*
- DID RPM DROP AND ENGINE IDLE ROUGH ON ALL THREE SOLENOIDS?

YES

EGR SYSTEM IS OK.
NO PROBLEM FOUND.

NO

CHECK EGR VALVE, PIPE, ADAPTOR, GASKETS, FITTINGS AND ALL PASSAGES FOR DAMAGE, LEAKAGE, OR PLUGGING. IF OK, REPLACE EGR VALVE.

* THESE STEPS MUST BE DONE VERY QUICKLY, AS THE ECM WILL ADJUST THE IDLE AIR CONTROL VALVE TO CORRECT IDLE SPEED.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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9S 7595-6E

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SECTION C8

TORQUE CONVERTER CLUTCH (TCC) SYSTEM AND MANUAL TRANSMISSION SHIFT LIGHT

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The Torque Converter Clutch (TCC) system uses a solenoid operated valve in the automatic transmission to couple the engine flywheel to the output shaft of the transmission thru the torque converter. This reduces the slippage losses in the converter, which increases fuel economy.

OPERATION

For the converter clutch to apply, two conditions must be met:

- Internal transmission fluid pressure must be correct. For information on internal transmission operation, see Section "7A". This section will cover only the electrical operation of the TCC system.
- The ECM grounds a switch internally to turn "ON" a solenoid in the transmission. This moves a check ball, which will allow the converter clutch to apply, if the hydraulic pressure is correct, as described above.

The ECM controls the TCC apply solenoid by looking at several sensors:

- Speedo Buffer Sensor [also called Vehicle Speed Sensor (VSS)]. Speed must be above a certain value before the clutch can apply.
- Coolant Temperature Sensor. Engine must be warmed up before clutch can apply about 65°C (149°F).
- Throttle Position Sensor (TPS). After the converter clutch applies, the ECM uses the information from the TPS to release the clutch when the car is accelerating or decelerating at a certain rate.
- The brake switch is also part of the TCC circuit as it will remove battery voltage to the TCC solenoid when the brake pedal is depressed.
- Gear Select Switch. The 4th gear switch is used to send a signal to the ECM telling it when the transmission is in 4th gear. The ECM uses this information to vary the conditions under which the clutch applies or releases. However, the transmission does not have to be in fourth gear in order for the ECM to turn the clutch "ON."

If the converter clutch is applied at all times, the engine will stall immediately, just as in a manual transmission with the clutch applied.

If the converter clutch does not apply, fuel economy may be lower than expected. If the vehicle speed sensor fails, the TCC will not apply. If the 4th gear switch does not operate, the TCC may not apply at the right time.

DIAGNOSIS

The diagnosis of the TCC system is covered in CHART C-8. If the ECM detects a problem in the system, a Code 24 should set. In this case see Code 24 CHART.

SHIFT LIGHT (M/T) DESCRIPTION

The purpose of the shift light is to provide a display which indicates the optimum fuel economy point for up shifting the manual transmission based on engine speed and load. The display is a lamp on the instrument panel. Activation of the ECM driver turns the lamp "ON."

DIAGNOSIS

The shift light circuit can be checked using CHART C-8A.

ON-VEHICLE SERVICE

- See Section "8B" if the shift light bulb needs replacement.
- See "Driveability and Emissions," Section "6E3" to repair wiring problem.
- See "Driveability and Emissions," Section "6E3" if ECM is to be replaced.

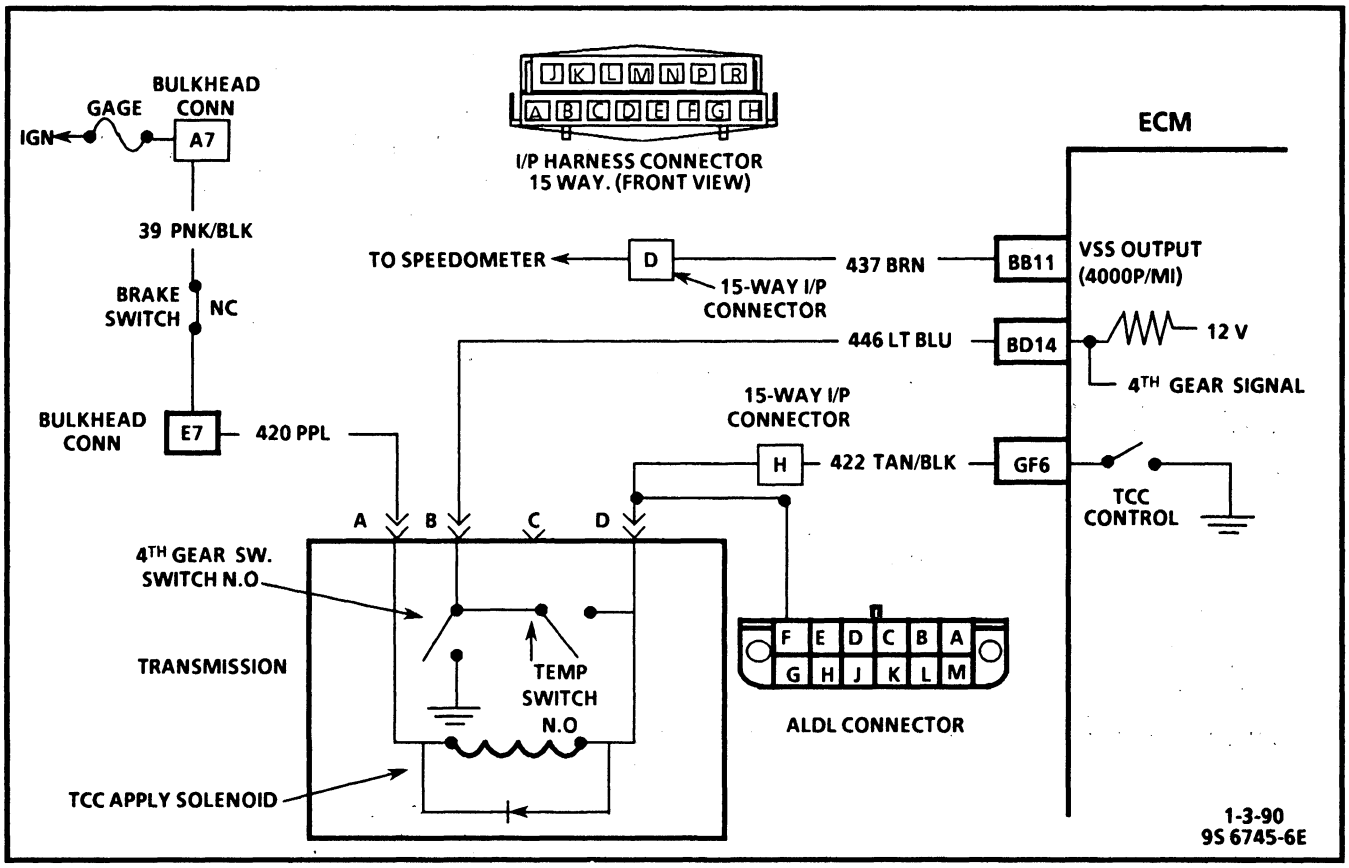


CHART C-8

(Page 1 of 2)

AUTOMATIC TORQUE CONVERTER CLUTCH (TCC) 3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The purpose of the automatic transmission torque converter clutch feature is to eliminate the power loss of the torque converter stage when the vehicle is in a cruise condition. This allows the convenience of the automatic transmission and the fuel economy of a manual transmission. The heart of the system is a solenoid located inside the automatic transmission which is controlled by the ECM.

When the solenoid coil is activated ("ON"), the torque converter clutch is applied which results in straight through mechanical coupling from the engine to transmission. When the transmission solenoid is deactivated, the torque converter clutch is released which allows the torque converter to operate in the conventional manner (fluidic coupling between engine and transmission).

The ECM turns "ON" the TCC when coolant temperature is above 65°C (149°F), TPS not changing, and vehicle speed above a specified value.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. When a test light is connected from ALDL terminal "F" to ground, a test light "ON" indicates battery voltage is OK and the TCC solenoid is disengaged.
2. When the diagnostic terminal is grounded, the ECM should energize the TCC solenoid and the test light should go out.

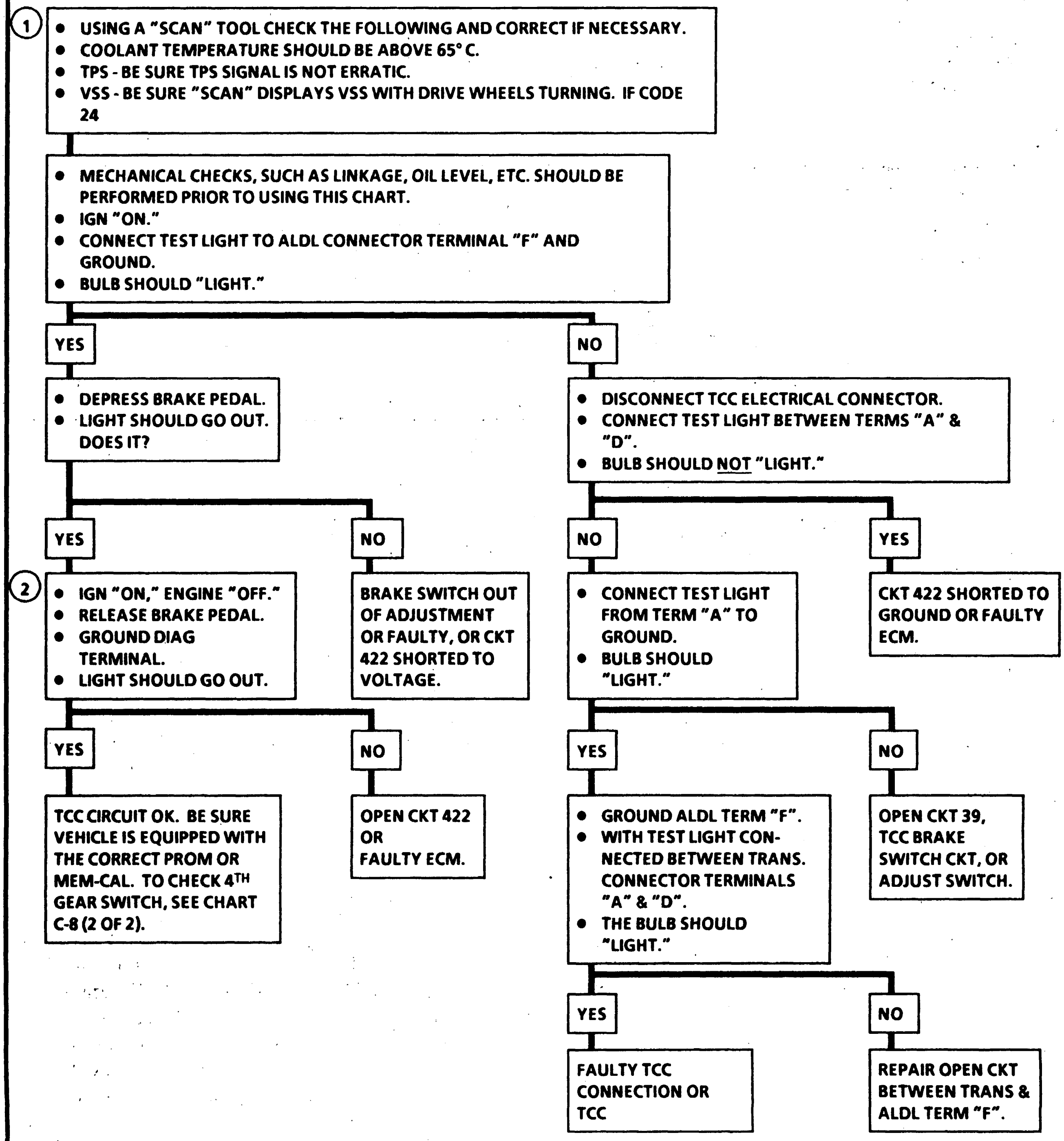
Diagnostic Aids:

A "Scan" tool only indicates when the ECM has turned "ON" the TCC driver (grounded CKT 422), but this does not confirm that the TCC has engaged. To determine if TCC is functioning properly, engine rpm should decrease when the "Scan" indicates the TCC driver has turned "ON." To determine if the 4th gear switch is functioning properly, perform the checks in CHART C-8 (Page 2 of 2). The switches will not prevent TCC from functioning but will affect TCC lock and unlock points.

CHART C-8

(Page 1 OF 2)

AUTOMATIC TORQUE CONVERTER CLUTCH (TCC) 3.1L (VIN T) "F" CARLINE (PORT)



①
- USING A "SCAN" TOOL CHECK THE FOLLOWING AND CORRECT IF NECESSARY.
- COOLANT TEMPERATURE SHOULD BE ABOVE 65° C.
- TPS - BE SURE TPS SIGNAL IS NOT ERRATIC.
- VSS - BE SURE "SCAN" DISPLAYS VSS WITH DRIVE WHEELS TURNING. IF CODE 24

- MECHANICAL CHECKS, SUCH AS LINKAGE, OIL LEVEL, ETC. SHOULD BE PERFORMED PRIOR TO USING THIS CHART.
- IGN "ON."
- CONNECT TEST LIGHT TO ALDL CONNECTOR TERMINAL "F" AND GROUND.
- BULB SHOULD "LIGHT."

- DEPRESS BRAKE PEDAL.
- LIGHT SHOULD GO OUT. DOES IT?

②
- IGN "ON," ENGINE "OFF."
- RELEASE BRAKE PEDAL.
- GROUND DIAG TERMINAL.
- LIGHT SHOULD GO OUT.

TCC CIRCUIT OK. BE SURE VEHICLE IS EQUIPPED WITH THE CORRECT PROM OR MEM-CAL. TO CHECK 4TH GEAR SWITCH, SEE CHART C-8 (2 OF 2).

OPEN CKT 422 OR FAULTY ECM.

BRAKE SWITCH OUT OF ADJUSTMENT OR FAULTY, OR CKT 422 SHORTED TO VOLTAGE.

- DISCONNECT TCC ELECTRICAL CONNECTOR.
- CONNECT TEST LIGHT BETWEEN TERMS "A" & "D".
- BULB SHOULD NOT "LIGHT."

- CONNECT TEST LIGHT FROM TERM "A" TO GROUND.
- BULB SHOULD "LIGHT."

- GROUND ALDL TERM "F".
- WITH TEST LIGHT CONNECTED BETWEEN TRANS. CONNECTOR TERMINALS "A" & "D".
- THE BULB SHOULD "LIGHT."

FAULTY TCC CONNECTION OR TCC

REPAIR OPEN CKT BETWEEN TRANS & ALDL TERM "F".

OPEN CKT 39, TCC BRAKE SWITCH CKT, OR ADJUST SWITCH.

CKT 422 SHORTED TO GROUND OR FAULTY ECM.

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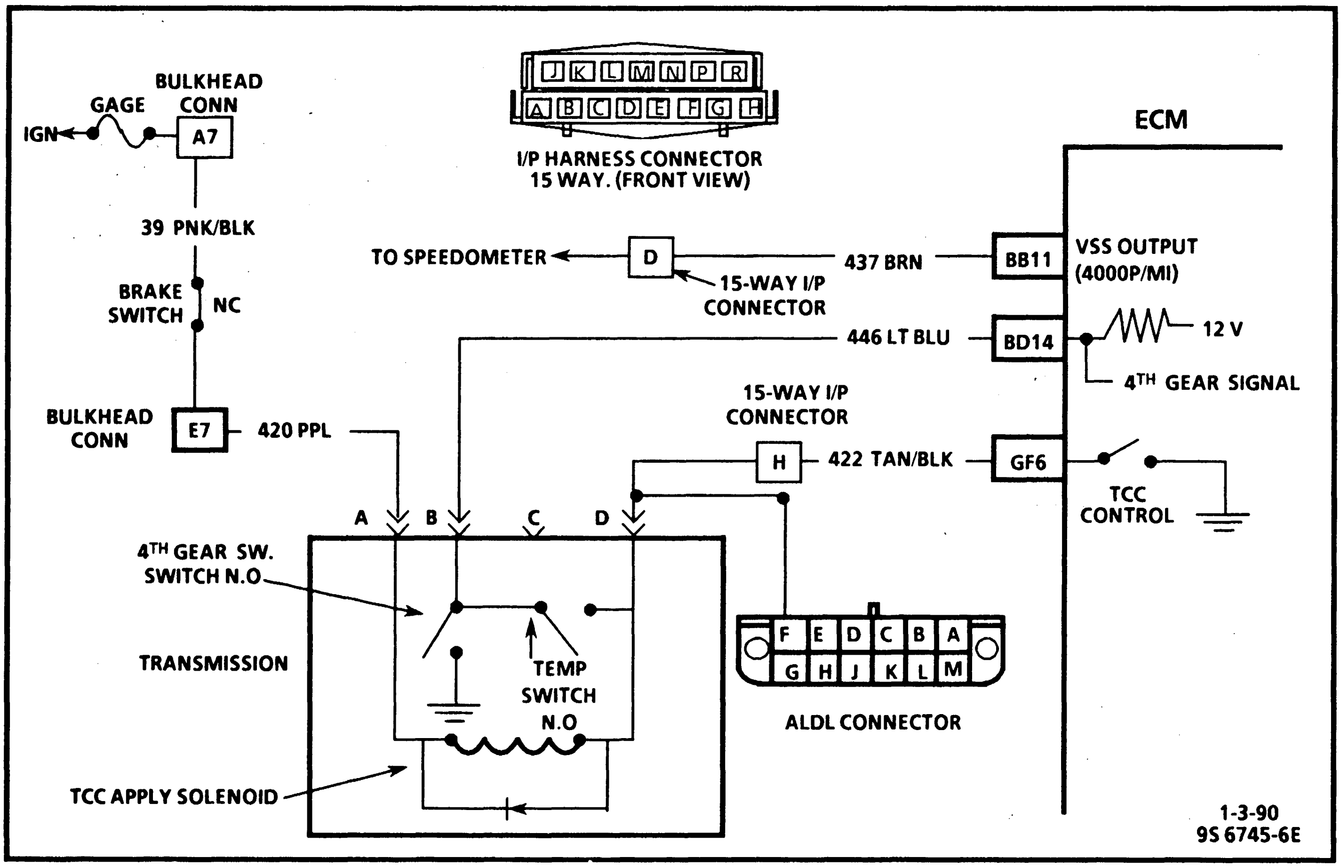


CHART C-8

(Page 2 of 2)

AUTOMATIC TORQUE CONVERTER CLUTCH (TCC) 3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

A 4th gear switch (mounted in the trans.) closes when the trans. shifts into 4th gear, and this switch is used by the ECM to modify TCC lock and unlock points, when in a 4-3 downshift maneuver.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Unless the switch or CKT 446 is closed the "Scan" should display "NO," indicating the trans. is not in 4th gear. The 4th gear switch should only be closed while in 4th gear.
2. Checks the operation of the 4th gear switch. When the trans. shifts into 4th gear the switch should close and the "Scan" should display "YES."
3. Disconnecting the TCC connector simulates an open switch to determine if CKT 446 is shorted to ground or the problem is in the transmission.
4. This step determines if the ECM and wiring are OK. Grounding CKT 446 should cause the "Scan" to display "YES" indicating the trans. is in 4th gear.

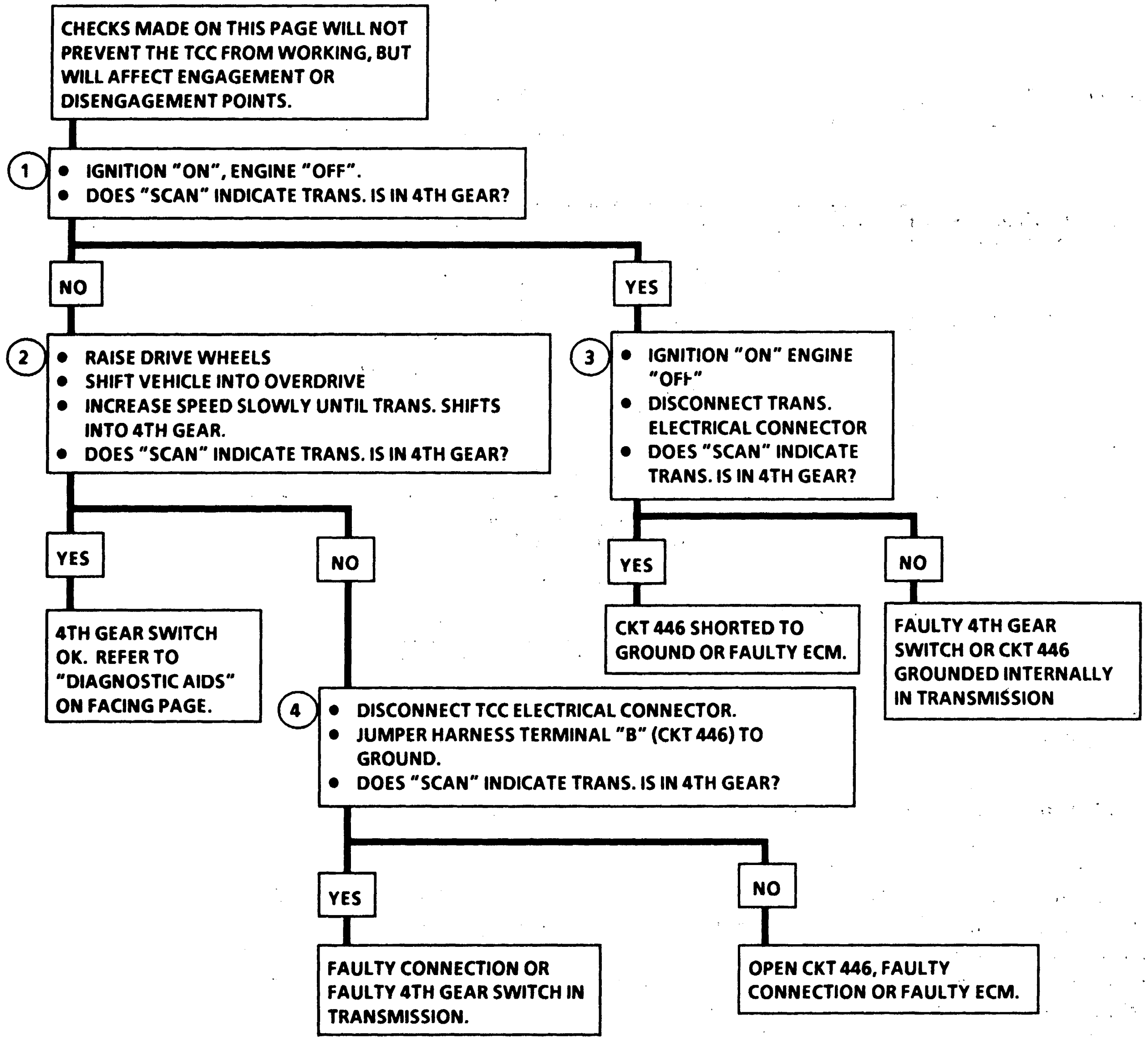
Diagnostic Aids:

A road test may be necessary to verify the customer complaint. If the "Scan" indicates TCC is turning "ON" and "OFF" erratically, check the state of the 4th gear switch to be sure it is not changing states under a steady throttle position. If the switch is changing states, check connections and wire routing carefully. Also if the 4th gear switch is always closed the TCC may engage as soon as sufficient oil pressure is reached.

CHART C-8

(Page 2 of 2)

AUTOMATIC TORQUE CONVERTER CLUTCH (TCC)
3.1L (VIN T) "F" CARLINE (PORT)



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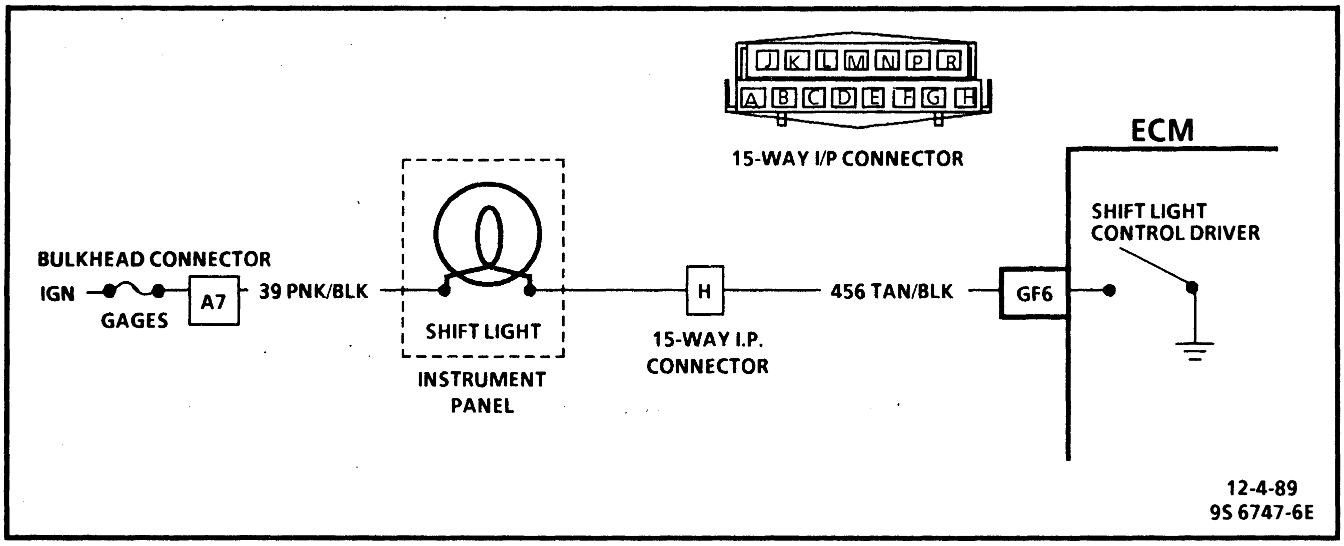


CHART C-8A

M/T SHIFT LIGHT CHECK
3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The shift light indicates the best transmission shift point for maximum fuel economy. The light is controlled by the ECM and is turned "ON" by grounding CKT 456.

The ECM uses information from the following inputs to control the shift light:

- Coolant temperature
- TPS
- VSS
- rpm

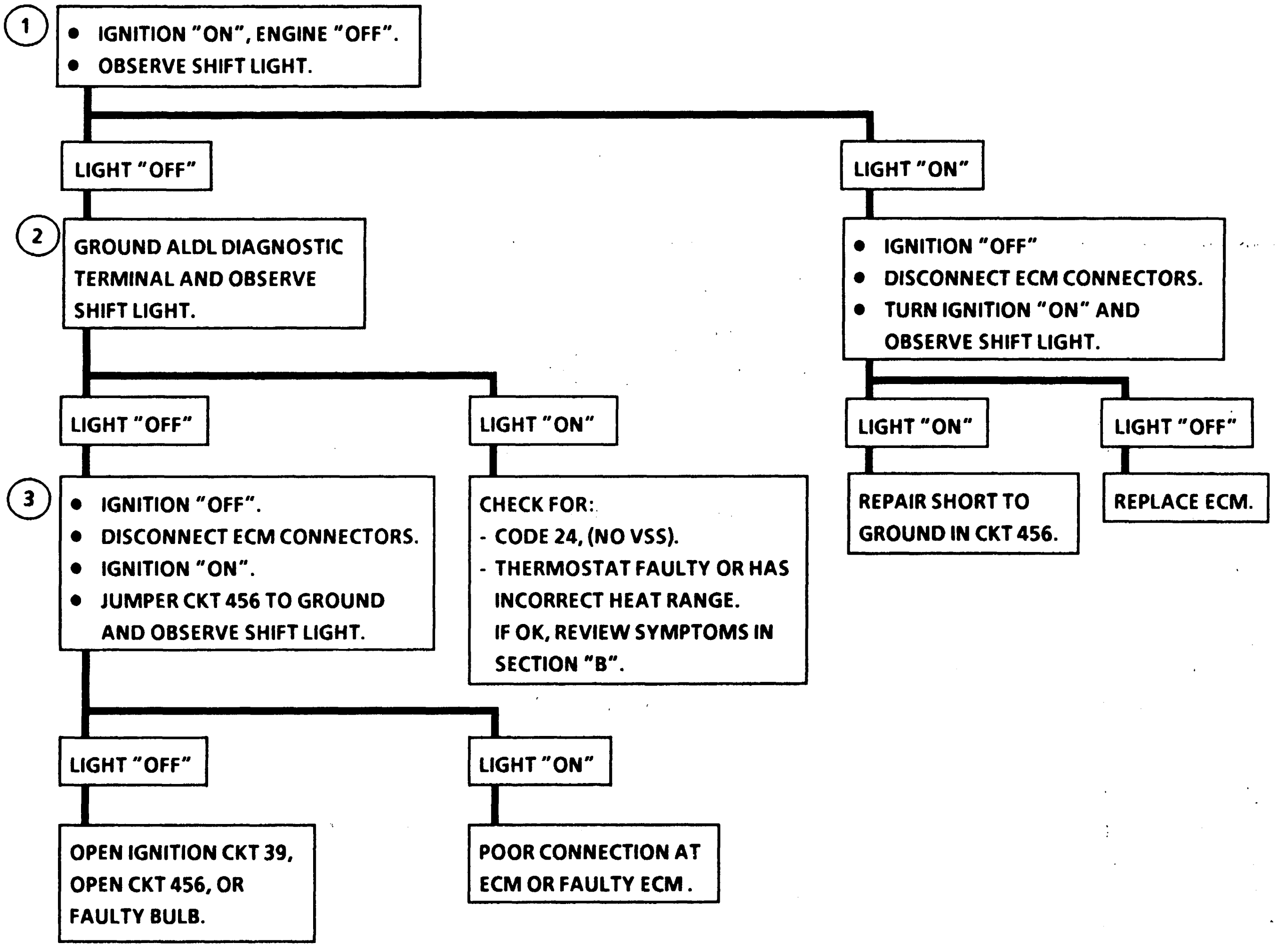
The ECM uses the measured rpm and the vehicle speed to calculate what gear the vehicle is in. It's this calculation that determines when the shift light should be turned "ON."

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. This should not turn "ON" the shift light. If the light is "ON," there is a short to ground in CKT 456 wiring or a fault in the ECM.
2. When the diagnostic terminal is grounded, the ECM should ground CKT 456 and the shift light should come "ON."
3. This checks the shift light circuit up to the ECM connector. If the shift light illuminates, then the ECM connector is faulty or the ECM does not have the ability to ground the circuit.

CHART C-8A

M/T SHIFT LIGHT CHECK
3.1L (VIN T) "F" CARLINE (PORT)



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SECTION C10

ECM CONTROLLED AIR CONDITIONING

CONTENTS

GENERAL DESCRIPTION

In order to improve idle quality and wide open throttle performance, the A/C compressor is controlled by the ECM.

There are two different types of A/C systems used in GM vehicles. One is referred to as CCOT (cycling clutch orifice tube), which uses a fixed displacement compressor. The other type of system uses a compressor with a variable displacement, and is referred to as the V-5 type system. The V-5 type meets A/C requirements without cycling. For descriptions of both types, and an explanation of the components used, refer to Section "1B" of the service manual.

OPERATION: V-5 Type (3.1L)

This system consists of a low pressure switch, a high pressure cut-out switch, a control relay, and the compressor. An A/C fan control pressure switch is also used with A/C equipped vehicles, to tell the ECM to turn "ON" the cooling fan when A/C head pressure is high. This switch opens, when A/C pressure exceeds about 200 psi (1380 kPa).

The low pressure switch, mounted in the compressor, is closed when the system contains a sufficient refrigerant charge. This switch opens, when pressure is less than about 40 psi (276 kPa).

The high pressure cut-out switch (normally closed) opens when head pressure gets too high. This disables the A/C clutch, before damage can occur to the system. This switch opens, when pressure is greater than about 440 psi (3034 kPa).

The A/C control relay is controlled by the ECM, so that the ECM can increase idle speed before turning "ON" the clutch, to disable the clutch during WOT, or during high power steering loads.

See appropriate C-10 CHART for specific wiring and circuit description.

DIAGNOSIS

CHARTS C-10 should be used for diagnosing the electrical portion of the A/C circuit. Section "1B" should be used for diagnosing the refrigerant portion of the system.

The "Scan" tool will be used in diagnosing the system, as it has the ability to read the A/C request input to the ECM, as well as displaying when the ECM has commanded the A/C clutch "ON."

ON-VEHICLE SERVICE

For removal and replacement procedures of A/C components, refer to Section "1" of the service manual.

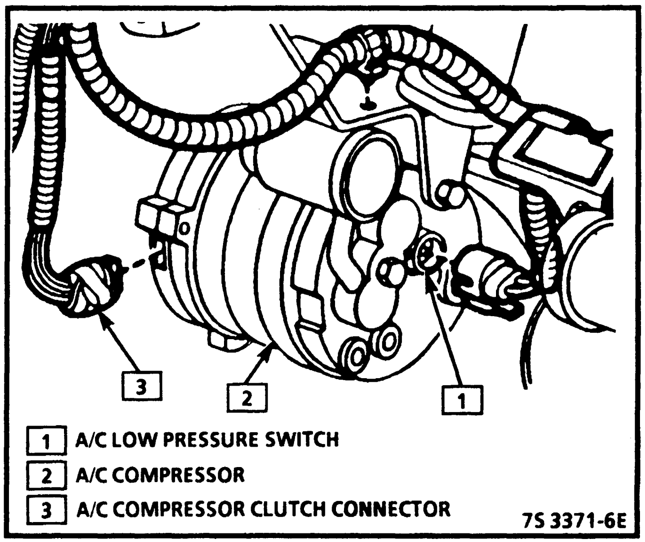

Figure C10-1 - A/C Low Press. Switch 3.1L

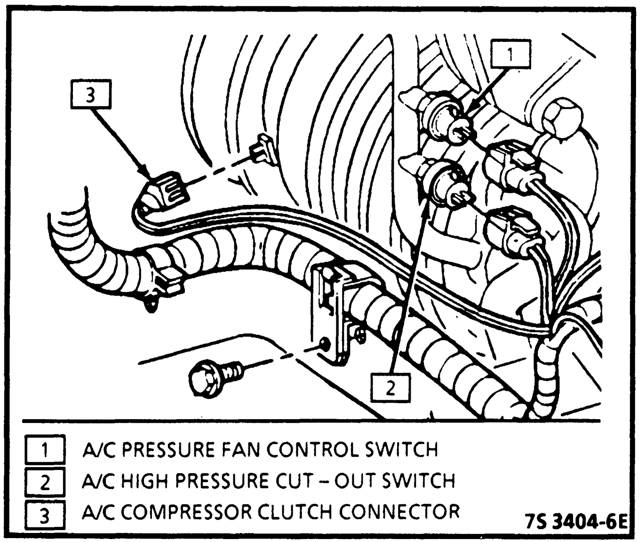

Figure C10-2 - A/C High Press. Switch 3.1L "F" Carline

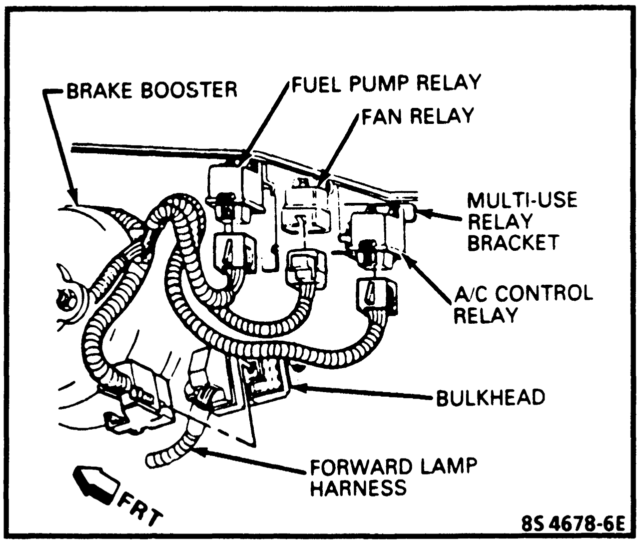

Figure C10-3 - A/C Control Relay 3.1L "F" Carline

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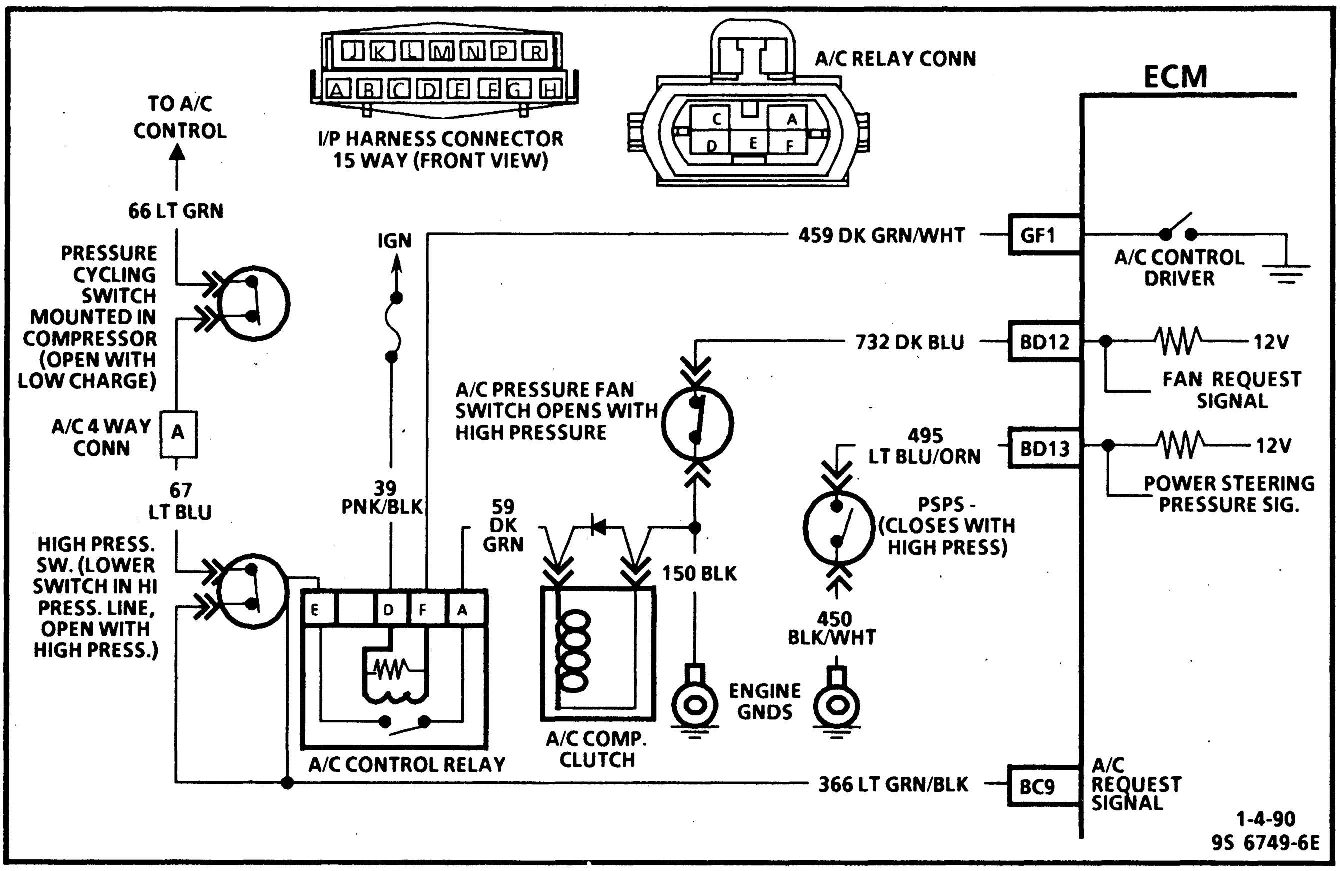


CHART C-10

A/C CLUTCH CONTROL CIRCUIT DIAGNOSIS
3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The A/C clutch control relay is ECM controlled to delay A/C clutch engagement about .4 second after A/C is turned "ON." This allows the IAC to adjust engine rpm, before the A/C clutch engages. The ECM, also, causes the relay to disengage the A/C clutch during WOT, when high power steering pressure is present, or if engine is overheating. The A/C clutch control relay is energized, when the ECM provides a ground path for CKT 459. The low pressure switch will open if A/C pressure is less than 40 psi (276 kPa). The high pressure switch will open, if A/C pressure exceeds about 440 psi (3034 kPa). The A/C pressure fan switch opens when A/C pressure exceeds about 200 psi (1380 kPa).

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. The ECM will only energize the A/C relay, when the engine is running. This test will determine if the relay or CKT 459 is faulty.
2. In order for the clutch to properly be engaged, the pressure cycling switch must be closed to provide 12 volts to the relay, and the high pressure switch must be closed, so the A/C request (12 volts) will be present at the ECM.
3. Determines if the signal is reaching the ECM on CKT 366 from the A/C control panel. Signal should only be present when the A/C mode or defrost mode has been selected.
4. A short to ground in any part of the A/C request circuit, CKT 67 to the relay, CKT 59 to the A/C clutch, or the A/C clutch, could be the cause of the blown fuse.
5. If the ECM is seeing a high power steering pressure signal, the A/C clutch will be disengaged by the ECM.
6. With the engine idling and A/C "ON," the ECM should be grounding CKT 459, which should cause the test light to be "ON."

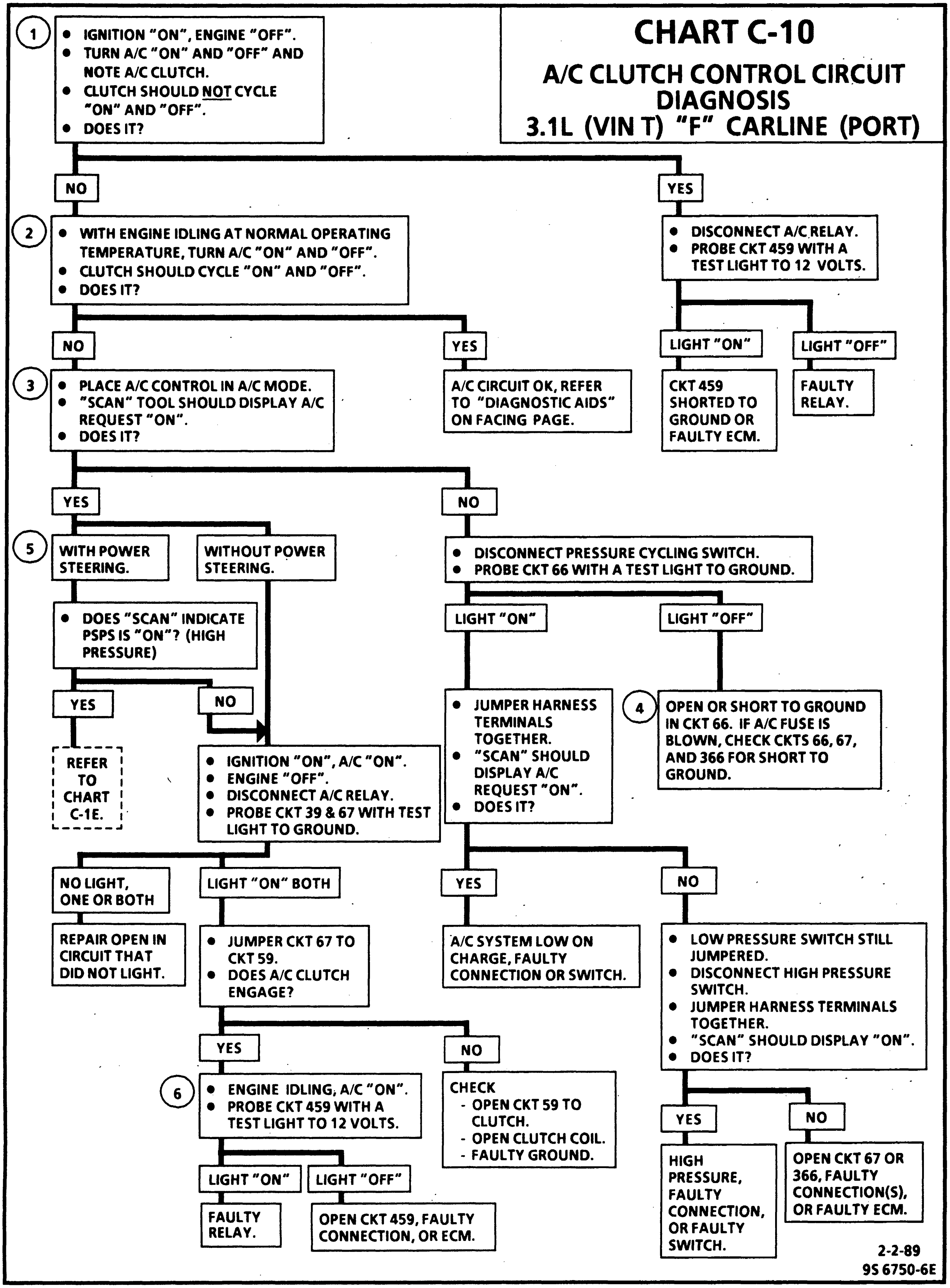
Diagnostic Aids:

If complaint was insufficient cooling, the problem may be caused by a inoperative cooling fan, or A/C pressure fan switch. The engine cooling fan should turn "ON," when A/C pressure exceeds a value to open the switch, which causes the ECM to energize the cooling fan relay. See CHART C-12, for cooling fan diagnosis. If fan operates correctly, see "A/C Diagnosis" in Section "1".

CHART C-10

A/C CLUTCH CONTROL CIRCUIT DIAGNOSIS

3.1L (VIN T) "F" CARLINE (PORT)



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SECTION C12

ELECTRIC COOLING FAN

CONTENTS

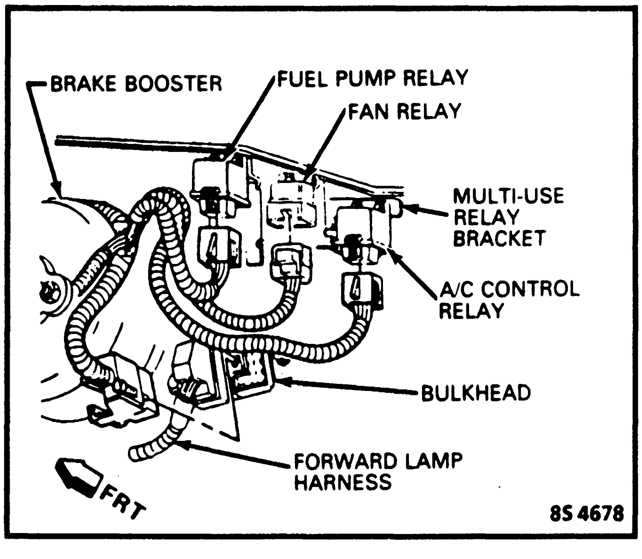
GENERAL DESCRIPTION

The fan is used for engine and A/C condenser cooling but the fan only operates under certain conditions.

OPERATION

The electric cooling fan on this engine is controlled by the ECM. The ECM will ground the cooling fan relay, which turns "ON" the fan, when the following conditions are met.

- Coolant temperature sensor signal indicating a temperature greater than 106°C (222°F).
- Or: A/C head pressure greater than about 200 psi and vehicle speed less than 40 mph.
- When the cooling fan is turned "ON," it will stay "ON" for a minimum time of 15 seconds on the 3.1L.
- The 3.1L also uses an override switch which will also turn on the cooling fan if the ECM fails.



DIAGNOSIS

The following charts will diagnose the ECM controlled cooling fan.

PARTS INFORMATION

PART NAME	GROUP
Fan, Engine	1.055
Motor, Fan	1.055
Relay, Engine Fan	1.055

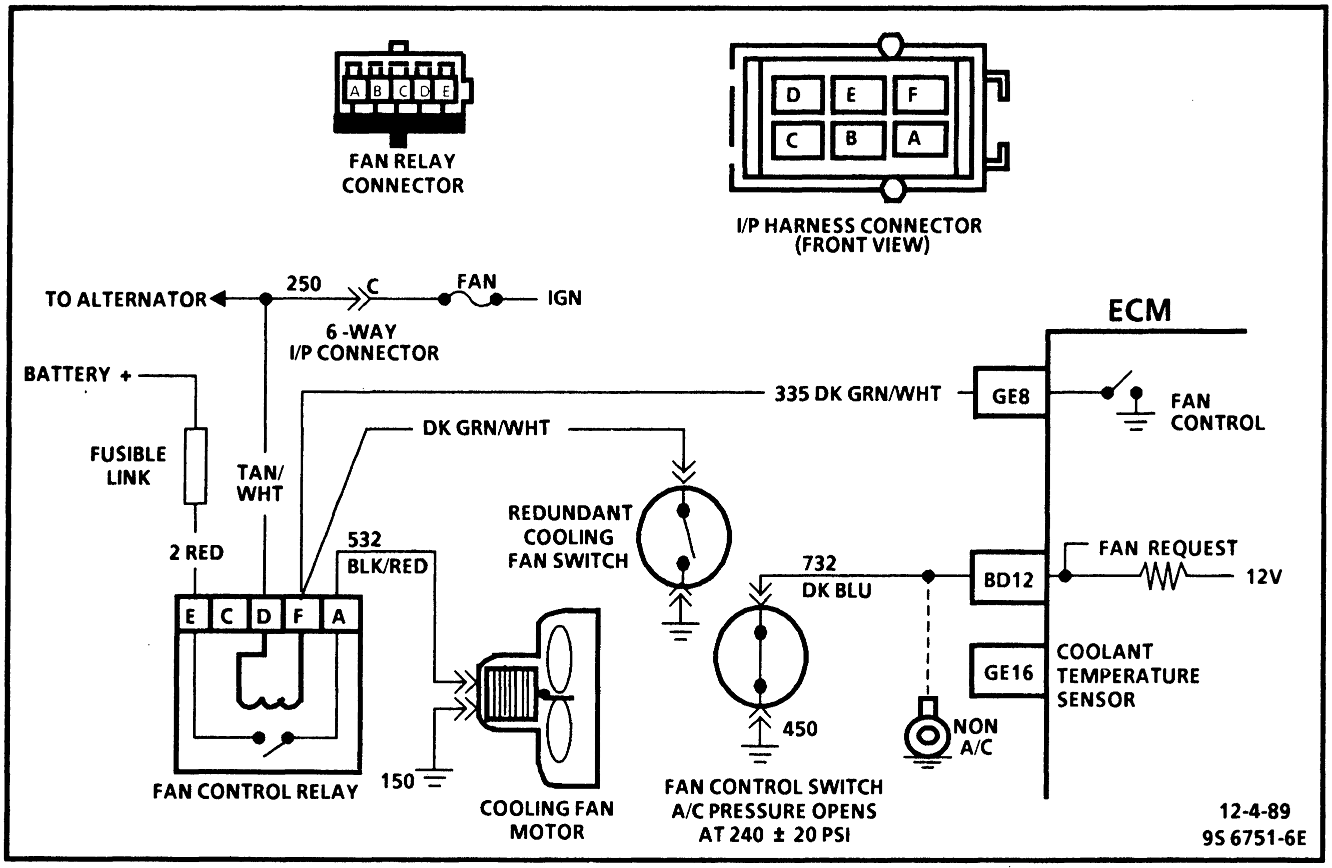


CHART C-12

(Page 1 of 2)

ELECTRIC COOLING FAN CONTROL CIRCUIT 3.1L (VIN T) "F" CARLINE (PORT)

Circuit Description:

The electric cooling fan is controlled by the ECM, based on inputs from the coolant temperature sensor, the A/C fan control switch, and vehicle speed. The ECM controls the fan by grounding CKT 335, which energizes the fan control relay. Battery voltage is then supplied to the fan motor.

The ECM grounds CKT 335, when coolant temp. is over about 107°C (225°F), or when A/C has been requested, and the fan control switch opens with high A/C pressure, about 240 psi (1655 kPa). Once the ECM turns the relay "ON," it will keep it "ON" for a minimum of 30 seconds, or until vehicle speed exceeds 70 mph.

Also, if Code 14 or Code 15 sets, or the ECM is in throttle body back up, the fan will run at all times.

On a vehicle not equipped with A/C, CKT 732 is jumpered to ground so that the fan does not run at all times.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. With the diagnostic terminal grounded, the cooling fan control driver will close, which should energize the fan control relay.
2. If the A/C fan control switch or circuit is open, the fan would run whenever the engine is running.
3. With A/C clutch engaged, the A/C fan control switch should open, when A/C high pressure exceeds about 200 psi (1380 kPa). This signal should cause the ECM to energize the fan control relay.

Diagnostic Aids:

If the owner complained of an overheating problem, it must be determined if the complaint was due to an actual boil over, or the hot light, or temperature gage indicated over heating.

If the gage, or light, indicates overheating, but no boil over is detected, the gage circuit should be checked. The gage accuracy can, also, be checked by comparing the coolant sensor reading using a "Scan" tool and comparing its reading with the gage reading.

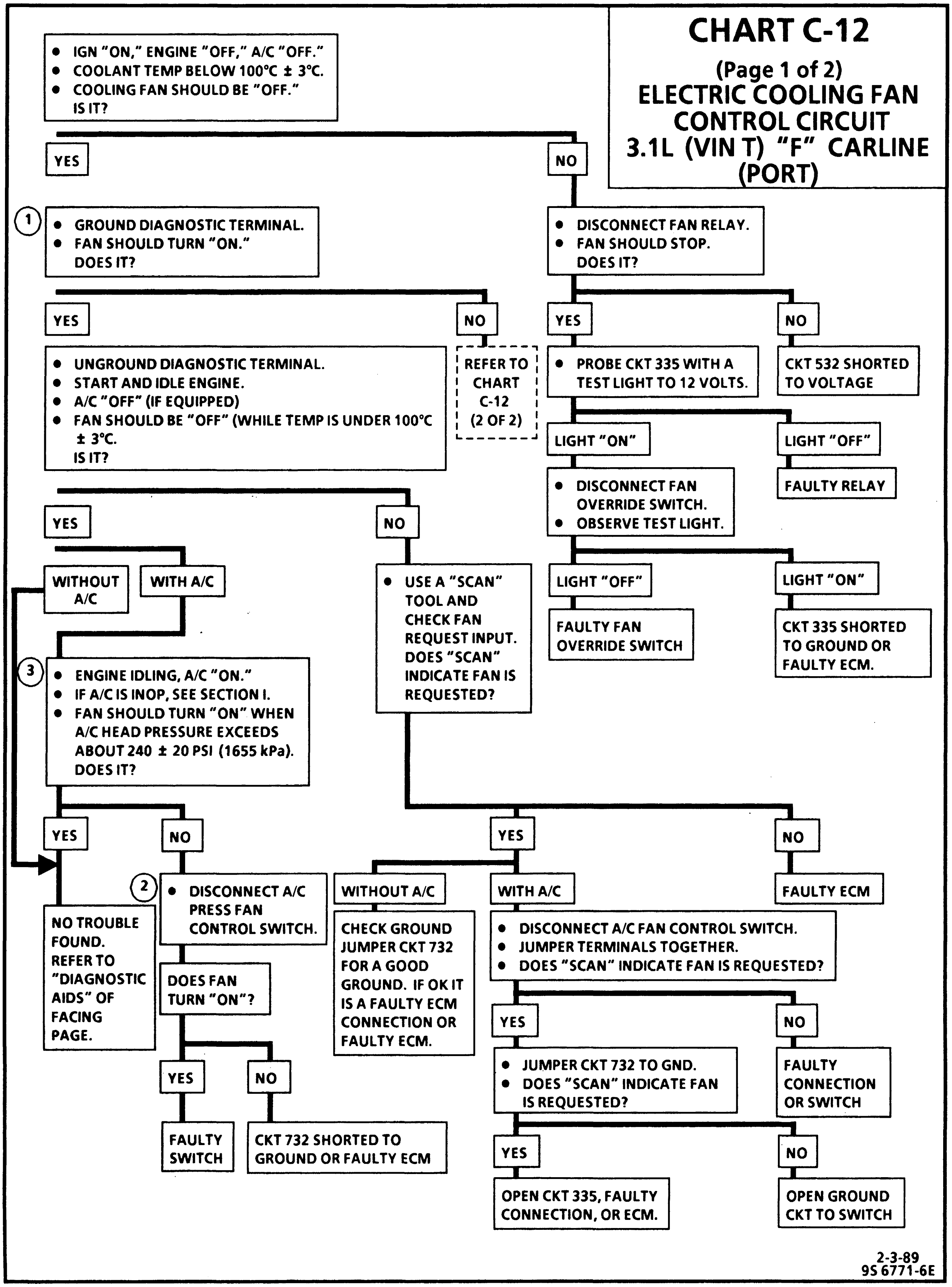
If the engine is actually overheating, and the gage indicates overheating, but the cooling fan is not coming "ON," the coolant sensor has probably shifted out of calibration and should be replaced.

If the engine is overheating, and the cooling fan is "ON," the cooling system should be checked.

CHART C-12

(Page 1 of 2)

ELECTRIC COOLING FAN CONTROL CIRCUIT 3.1L (VIN T) "F" CARLINE (PORT)



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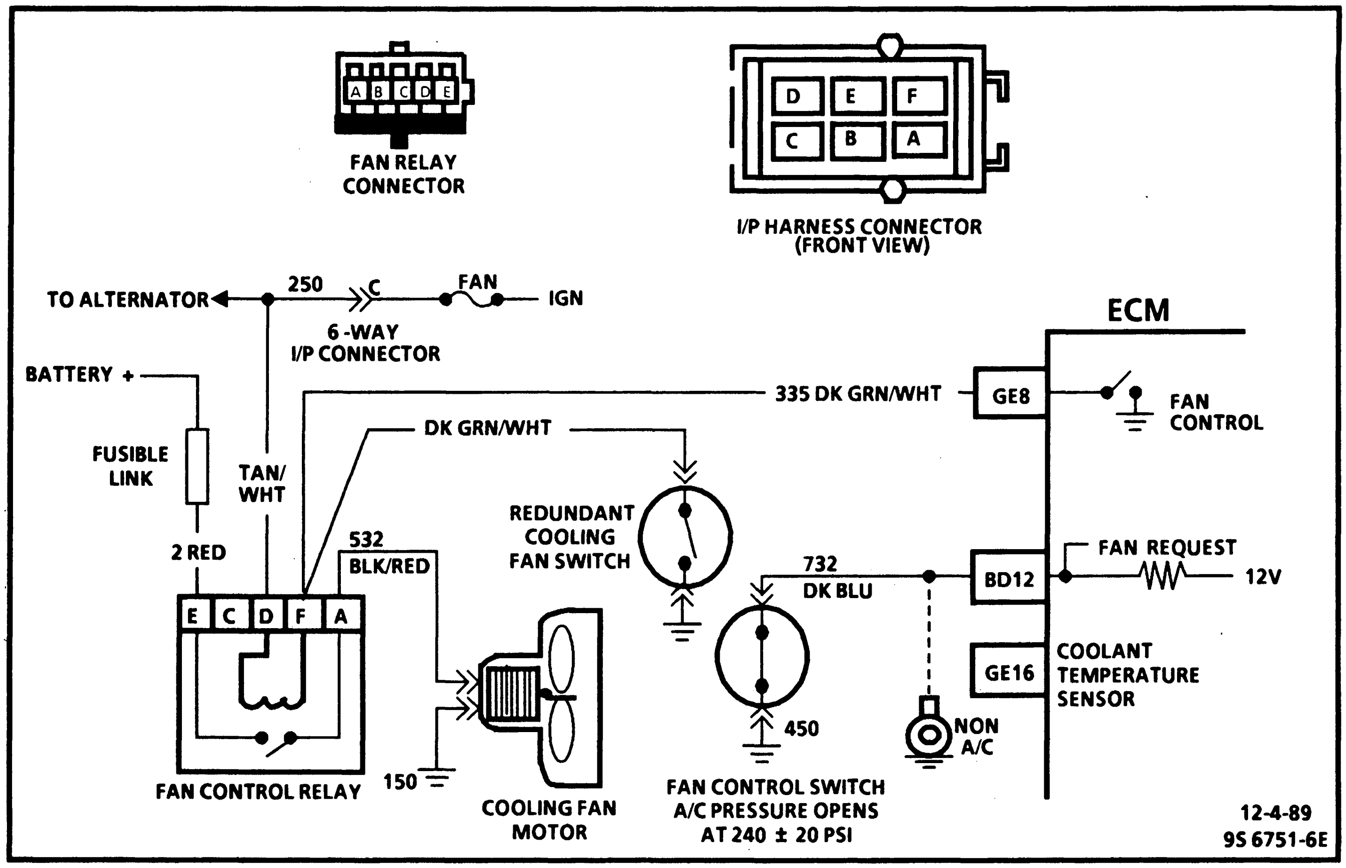


CHART C-12

(Page 2 of 2)

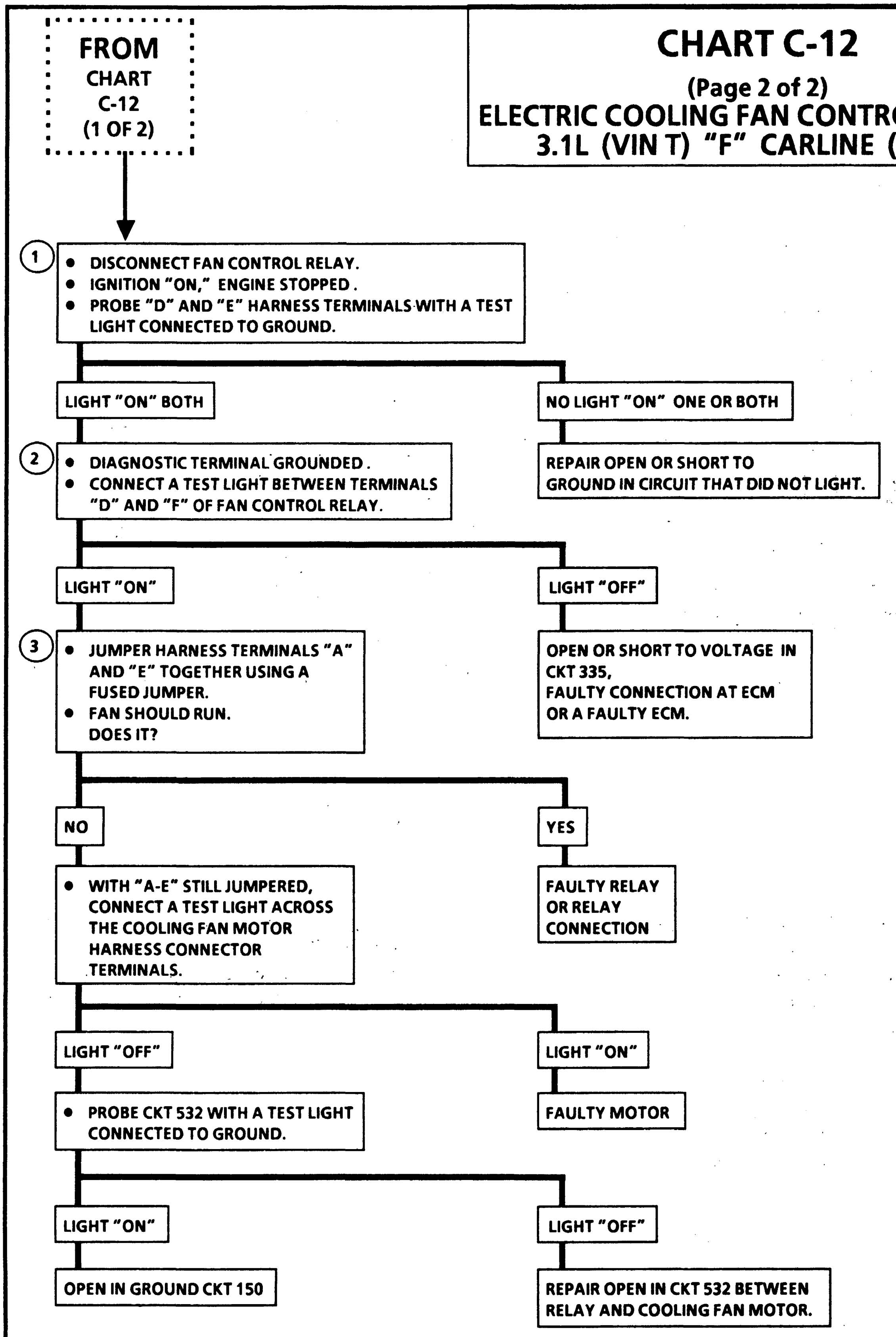
ELECTRIC COOLING FAN CONTROL CIRCUIT
3.1L (VIN T) "F" CARLINE (PORT)

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. 12 volts should be available to both terminal "E" & "D", when the ignition is "ON."
2. This test checks the ability of the ECM to ground CKT 335. The SES light should also be flashing, at this point. If it isn't flashing, see CHART A-2.
3. By jumpering "A" and "E" together, the relay is being bypassed. Cooling fan motor should be "ON."

CHART C-12

(Page 2 of 2)
ELECTRIC COOLING FAN CONTROL CIRCUIT 3.1L (VIN T) "F" CARLINE (PORT)



FROM CHART C-12 (1 OF 2)

①
- DISCONNECT FAN CONTROL RELAY.
- IGNITION "ON," ENGINE STOPPED.
- PROBE "D" AND "E" HARNESS TERMINALS WITH A TEST LIGHT CONNECTED TO GROUND.

LIGHT "ON" BOTH

②
- DIAGNOSTIC TERMINAL GROUNDED.
- CONNECT A TEST LIGHT BETWEEN TERMINALS "D" AND "F" OF FAN CONTROL RELAY.

LIGHT "ON"

③
- JUMPER HARNESS TERMINALS "A" AND "E" TOGETHER USING A FUSED JUMPER.
- FAN SHOULD RUN. DOES IT?

NO

- WITH "A-E" STILL JUMPERED, CONNECT A TEST LIGHT ACROSS THE COOLING FAN MOTOR HARNESS CONNECTOR TERMINALS.

LIGHT "OFF"

- PROBE CKT 532 WITH A TEST LIGHT CONNECTED TO GROUND.

LIGHT "ON"

OPEN IN GROUND CKT 150

LIGHT "OFF"

REPAIR OPEN IN CKT 532 BETWEEN RELAY AND COOLING FAN MOTOR.

LIGHT "ON"

FAULTY MOTOR

YES

FAULTY RELAY OR RELAY CONNECTION

LIGHT "OFF"

OPEN OR SHORT TO VOLTAGE IN CKT 335, FAULTY CONNECTION AT ECM OR A FAULTY ECM.

NO LIGHT "ON" ONE OR BOTH

REPAIR OPEN OR SHORT TO GROUND IN CIRCUIT THAT DID NOT LIGHT.

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SECTION C13

POSITIVE CRANKCASE VENTILATION (PCV)

CONTENTS

GENERAL DESCRIPTION

A Positive Crankcase Ventilation (PCV) system is used to provide more complete scavenging of crankcase vapors. Fresh air from the air cleaner is supplied to the crankcase, mixed with blow-by gases and then passed through a Positive Crankcase Ventilation (PCV) valve into the intake manifold (Figure C13-1).

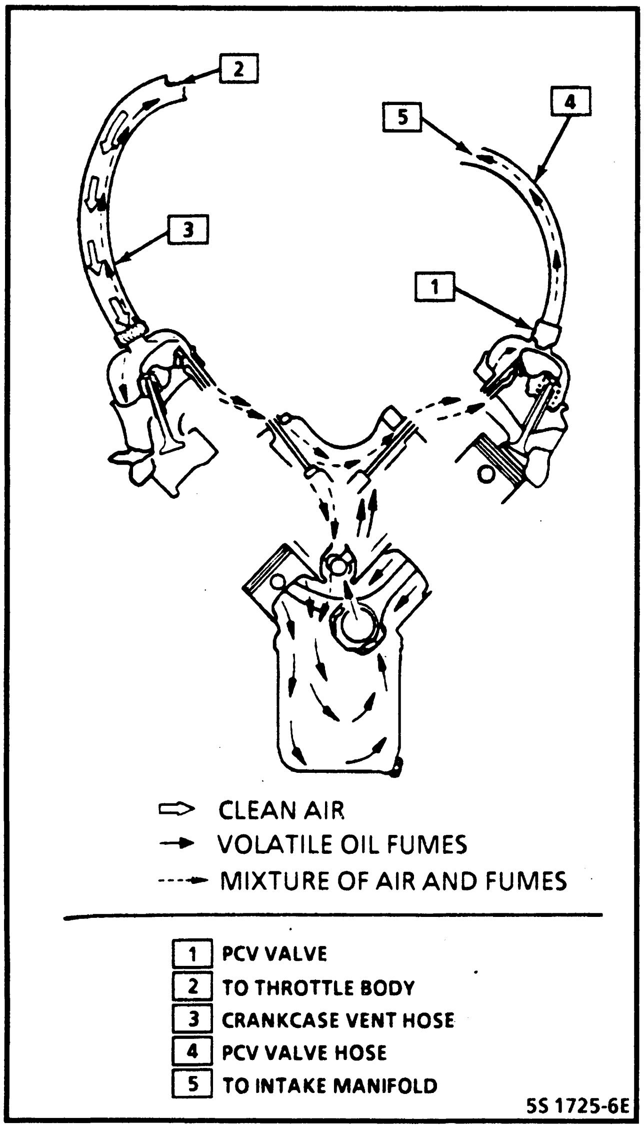


Figure C13-1 - PCV Flow

OPERATION

The primary control is through the PCV valve (Figure C13-2) which meters the flow at a rate depending on manifold vacuum.

To maintain idle quality, the PCV valve restricts the flow when intake manifold vacuum is high. If abnormal operating conditions arise, the system is designed to allow excessive amounts of blow-by gases to back flow through the crankcase vent tube into the air inlet duct to be consumed by normal combustion.

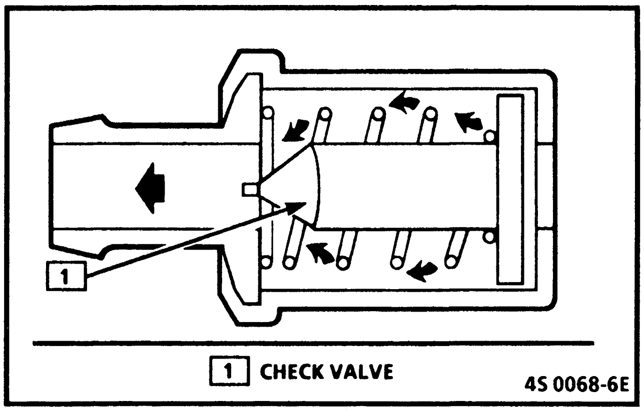


Figure C13-2 - PCV Valve Cross Section

RESULTS OF INCORRECT OPERATION

A plugged valve or hose may cause:

- Rough idle
- Stalling or slow idle speed
- Oil leaks
- Oil in throttle body or plenum
- Sludge in engine

A leaking valve or hose would cause:

- Rough idle
- Stalling
- High idle speed

DIAGNOSIS

FUNCTIONAL CHECK OF PCV VALVE

If an engine is idling rough, check for a clogged PCV valve or plugged hose. Check PCV part number to be sure the correct PCV is installed. Replace as required. Use the following procedure:

1. Remove PCV valve from rocker arm cover.
2. Run the engine at idle.
3. Place your thumb over end of valve to check for vacuum. If there is no vacuum at valve, check for plugged hoses or manifold port, or PCV valve. Replace plugged or deteriorated hoses.
4. Turn "OFF" the engine and remove PCV valve. Shake valve and listen for the rattle of check needle inside the valve. If valve does not rattle, replace valve.

With this system, any blow-by in excess of the system capacity (from a badly-worn engine, sustained heavy load, etc.) is exhausted into the inlet duct and is drawn into the engine.

Proper operation of the PCV system is dependent upon a sealed engine. If oil sludging or dilution is noted, and the PCV system is functioning properly, check engine for possible cause and correct to ensure that system will function as intended.

ON-VEHICLE SERVICE

An engine which is operated without any crankcase ventilation can be damaged. Therefore, it is important to replace the PCV valve and air cleaner breather at intervals shown in Section "OB".

Periodically, inspect the hoses and clamps and replace any showing signs of deterioration.

PARTS INFORMATION

PART NAME	GROUP
Air Cleaner	3.402
Valve Asm, C/Case Vent	1.745
Tube, C/Case Vent	1.762
Hose, C/Case Vent Valve	1.162

SECTION C14

AIR INDUCTION SYSTEM

CONTENTS

GENERAL DESCRIPTION

AIR INDUCTION SYSTEM

Air induction system draws outside air in through a remotely mounted canister style air cleaner assembly. (See Figure C14-1). The air then enters the engine by flowing through adapter to flexible air intake duct into throttle body and plemun. The air is then directed into plenun intake runners, and into the cylinders.

ON VEHICLE SERVICE

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced use the correct part number fastener for that application. The correct torque value must be used, as specified, during reassembly to assure proper retention of all parts, or damage to the part may result.

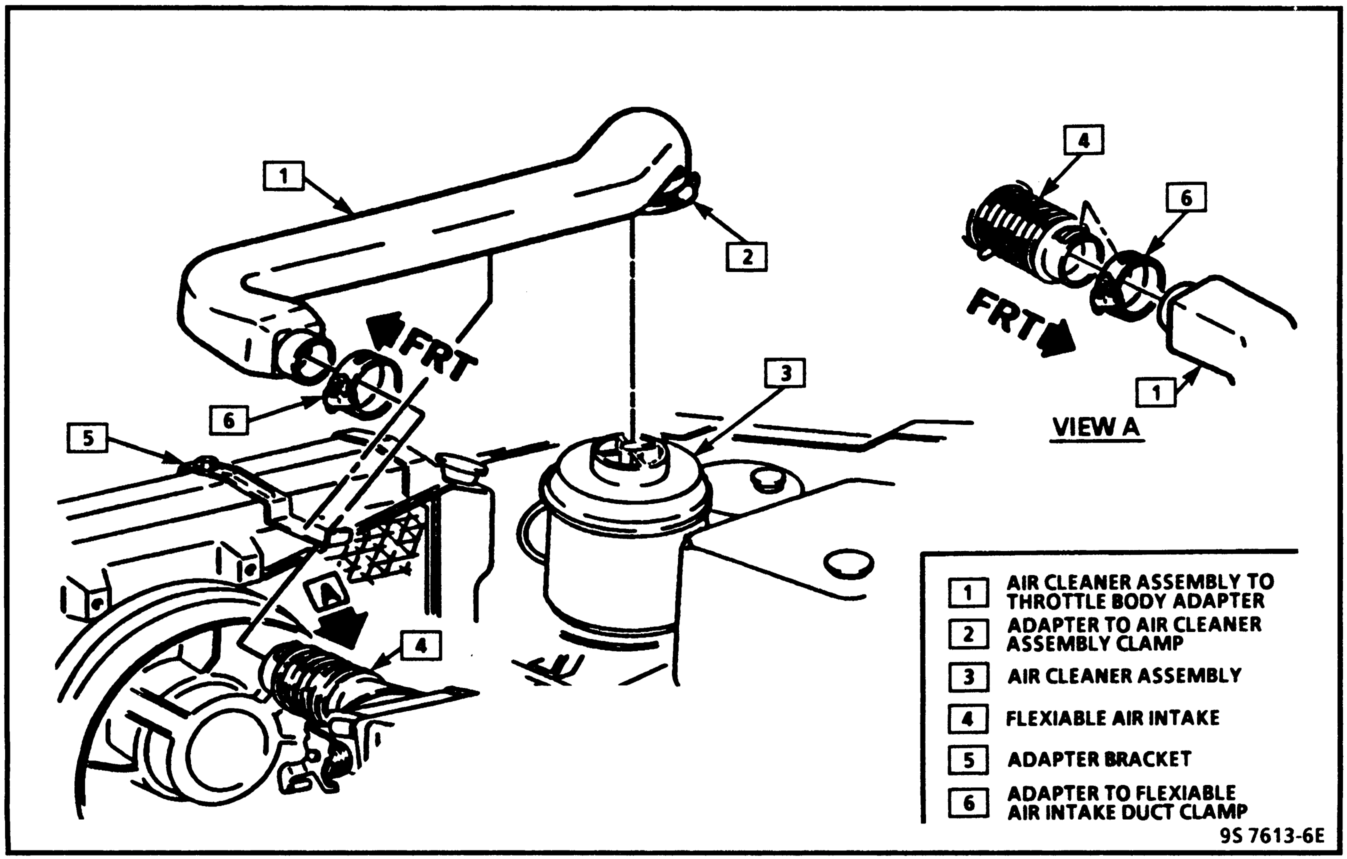


Figure C14-1 - Air Induction System

AIR FILTER ELEMENT

Remove or Disconnect

1. Two clamps from adapter.
2. Bracket
3. Adapter
4. Bolt/screw from air cleaner assembly.
5. Air cleaner cover and element. Inspect air filter element for dust, dirt, water and clean or replace if required. Refer to MAINTENANCE AND LUBRICATION (SECTION 0B).

Install or Connect

1. Air filter element and cover.
2. Bolt/screw to air cleaner assembly.
3. Adapter
4. Bracket
5. Two clamps to adapter.

Tighten

- Air cleaner assembly bolt/screw to 20-27 N·m (15 lb. ft. - 20 lb. ft.)

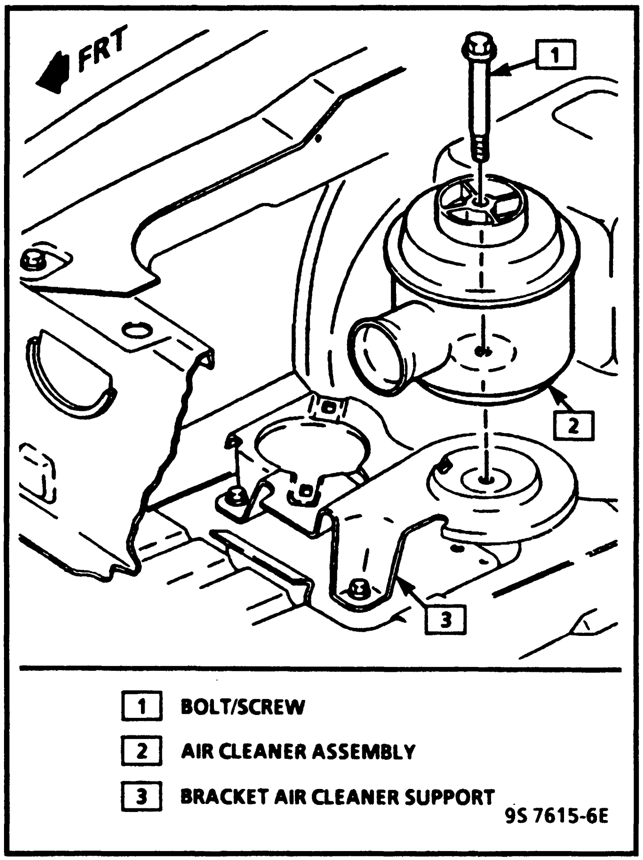


Figure C14-2 - Air Cleaner Assembly

AIR CLEANER ASSEMBLY

Remove or Disconnect

1. One clamp from adapter to air cleaner assembly.
2. Bolt/screw from air cleaner assembly.
3. Air cleaner assembly.

Install or Connect

1. Position air cleaner assembly support bracket. (See Figure C14-2), and tighten bolt/screw.
2. Clamp and position adapter air intake duct to air cleaner assembly and tighten.

Tighten

- Air cleaner assembly bolt/screw to 20-27 N·m (15 lb. ft. - 20 lb. ft.)

TORQUE SPECIFICATIONS

Air Cleaner Assembly	20-27 N·m (151 lb. ft. 20 lb. ft.)
Air Cleaner Assembly .... Support Bracket	20-34 N·m (151 lb. ft. 26 lb. ft.)

PARTS INFORMATION

PART NAME	GROUP
Air Cleaner Element	3.410
Air Cleaner Assembly	3.402
Clamp, Adapter to Air Cleaner Assembly Front	3.417
Clamp, Adapter to Flexible Air Intake Duct Rear	1.166
Duct Flexible Air Intake from Throttle Body to Adapter	3.417
Clamp, Flexible Air Intake to Throttle Body	3.417
Air Cleaner Assembly	3.403
Air Cleaner Assembly Support Bracket .	3.405
Bracket Adapter	3.417

SECTION A
5.0L & 5.7L ENGINE

BASIC PROCEDURE

If you have not reviewed the basic information on how to use the Diagnostic Procedures, go to the Introduction of this section.

DIAGNOSTIC CIRCUIT CHECK

The "Diagnostic Circuit Check" verifies the system is functioning correctly. Some special considerations to keep in mind while making the "Diagnostic Circuit Check" are:

Blocking Drive Wheels

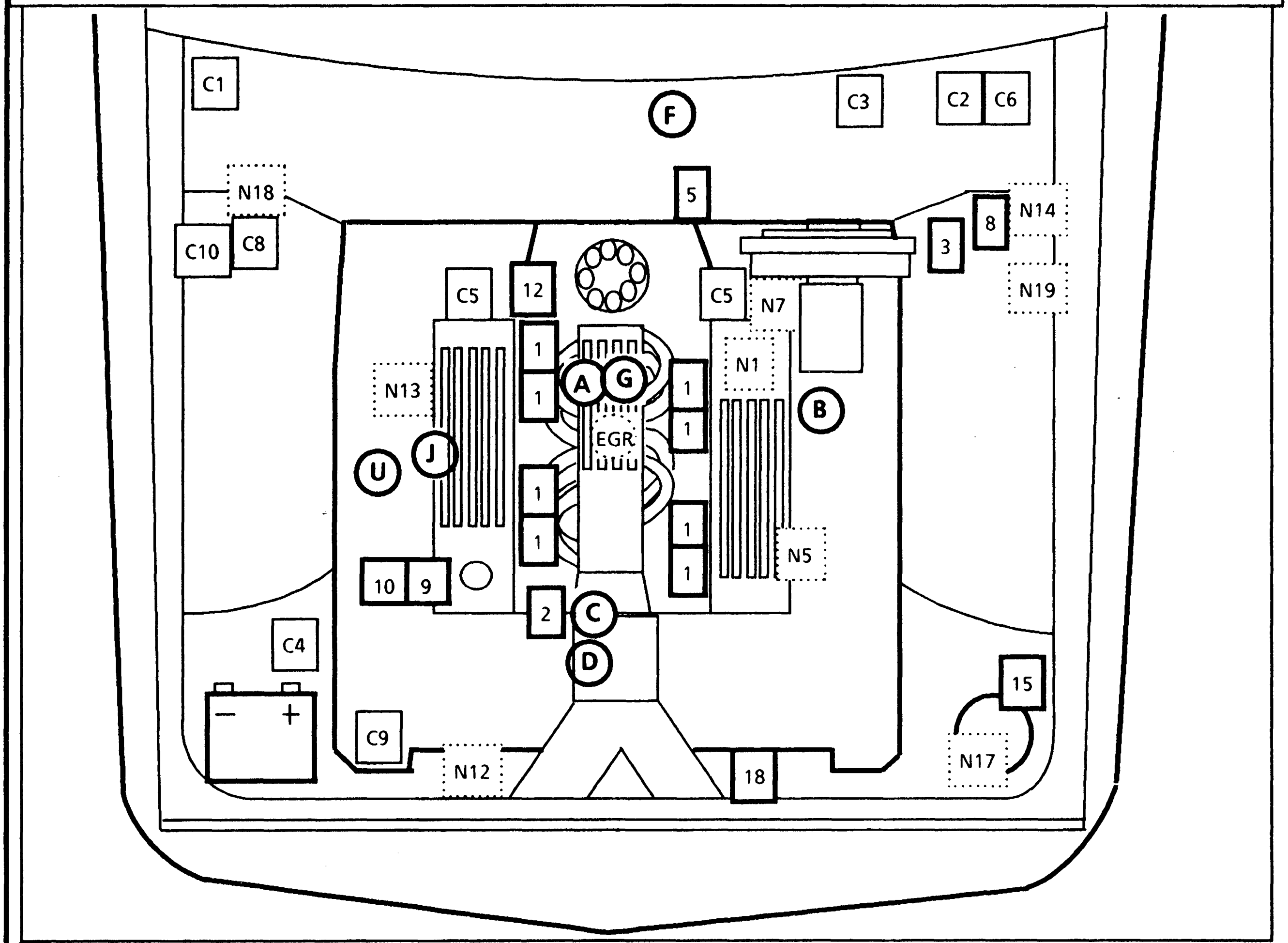
The vehicle drive wheels must be blocked while checking the system.

Cold Oxygen Sensor

On some engines, the Oxygen Sensor will cool off after only a short period of operation at idle. This will put the system into "Open Loop." To restore "Closed Loop" operation, run the engine at part throttle several minutes and accelerate from idle to part throttle a few times.

SECTION A
ENGINE COMPONENTS / WIRING DIAGRAMS / DIAGNOSTIC CHARTS

"F" CARLINE RPO:LB9,L98 VIN CODE:F&8 5.0L& 5.7L V8 PFI



□ COMPUTER HARNESS

- C1 Electronic Control Module (ECM)
- C2 ALDL diagnostic connector
- C3 "SERVICE ENGINE SOON" light
- C4 Power feed connector
- C5 ECM harness grounds
- C6 Fuse panel
- C8 Fuel pump test connector
- C9 Fuel pump/ECM fuse
- C10 Set timing connector

⬚ NOT ECM CONNECTED

- N1 Positive Crankcase Ventilation (PCV) Valve
- N5 Engine temp. sensor (gage overheat)
- N7 Oil pressure sensor (gage) and switch (fuel pump)
- N12 Secondary cooling fan
- N13 Cooling fan temperature switch
- N14 Secondary cooling fan relay
- N17 Fuel vapor canistor
- N18 High blower relay
- N19 Fog light relay

□ CONTROLLED DEVICES

- 1 Fuel injector
- 2 Idle Air Control (IAC) valve
- 3 Fuel pump relay
- 5 Torque Converter Clutch (TCC) connector
- 8 Primary cooling fan relay
- 9 AIR port solenoid
- 10 AIR converter solenoid
- 12 EGR solenoid
- 15 Fuel vapor canister solenoid
- 18 Primary cooling fan

○ INFORMATION SENSORS

- A Manifold Absolute Pressure (MAP)
- B Exhaust Oxygen (O_2) sensor
- C Throttle Position Sensor (TPS)
- D Coolant Temperature Sensor (CTS)
- F Vehicle Speed Sensor (VSS)
- G Manifold Air Temperature (MAT)
- J ESC knock sensor
- U A/C cooling fan switch

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Figure A-1 - Engine Component Locations 5.0L (VIN F) & 5.7L (VIN 8) "F" Carline

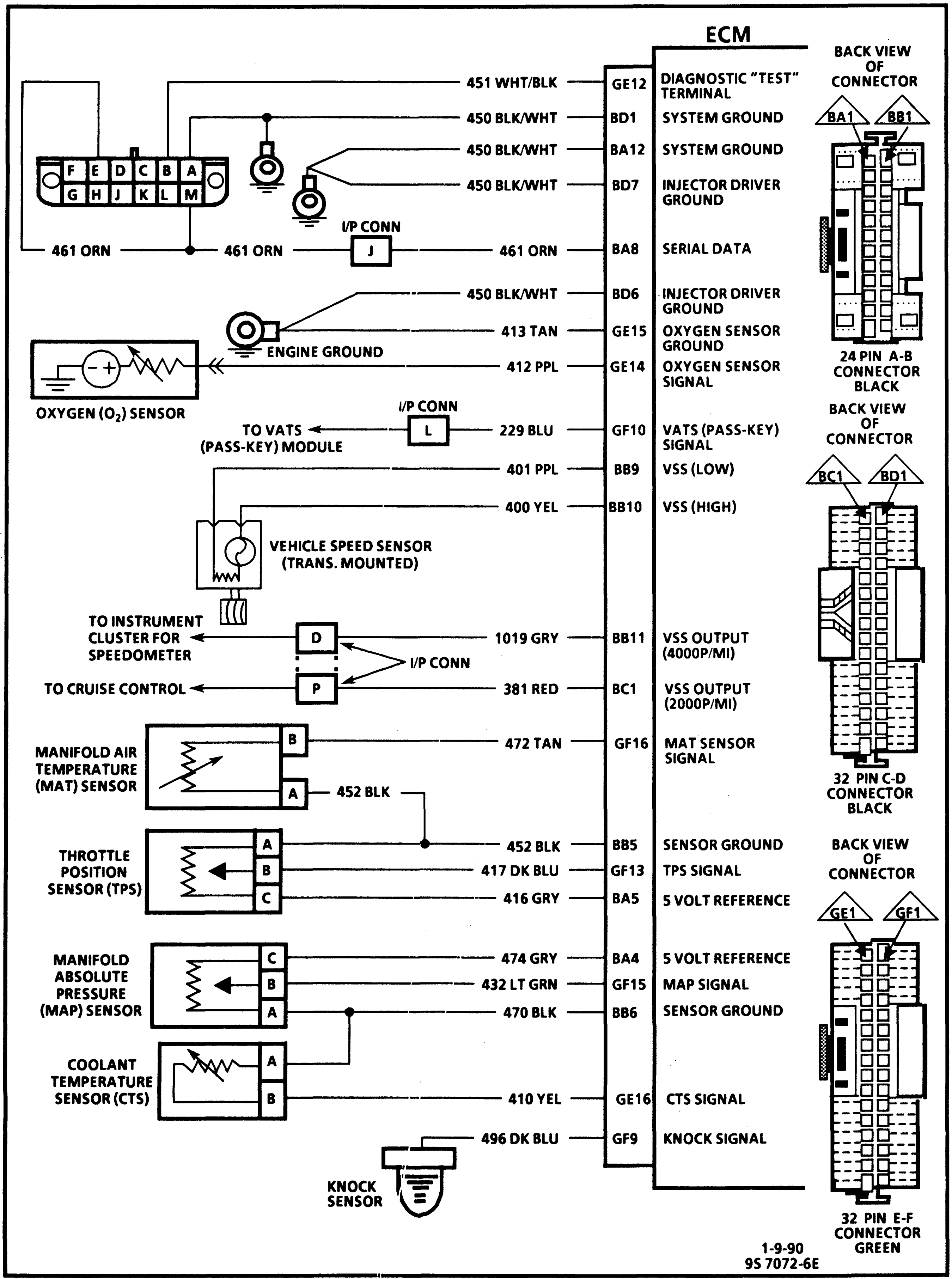


Figure A-2 - ECM Wiring Diagram 5.0L (VIN F) & 5.7L (VIN 8) "F" Carline (1 of 4)

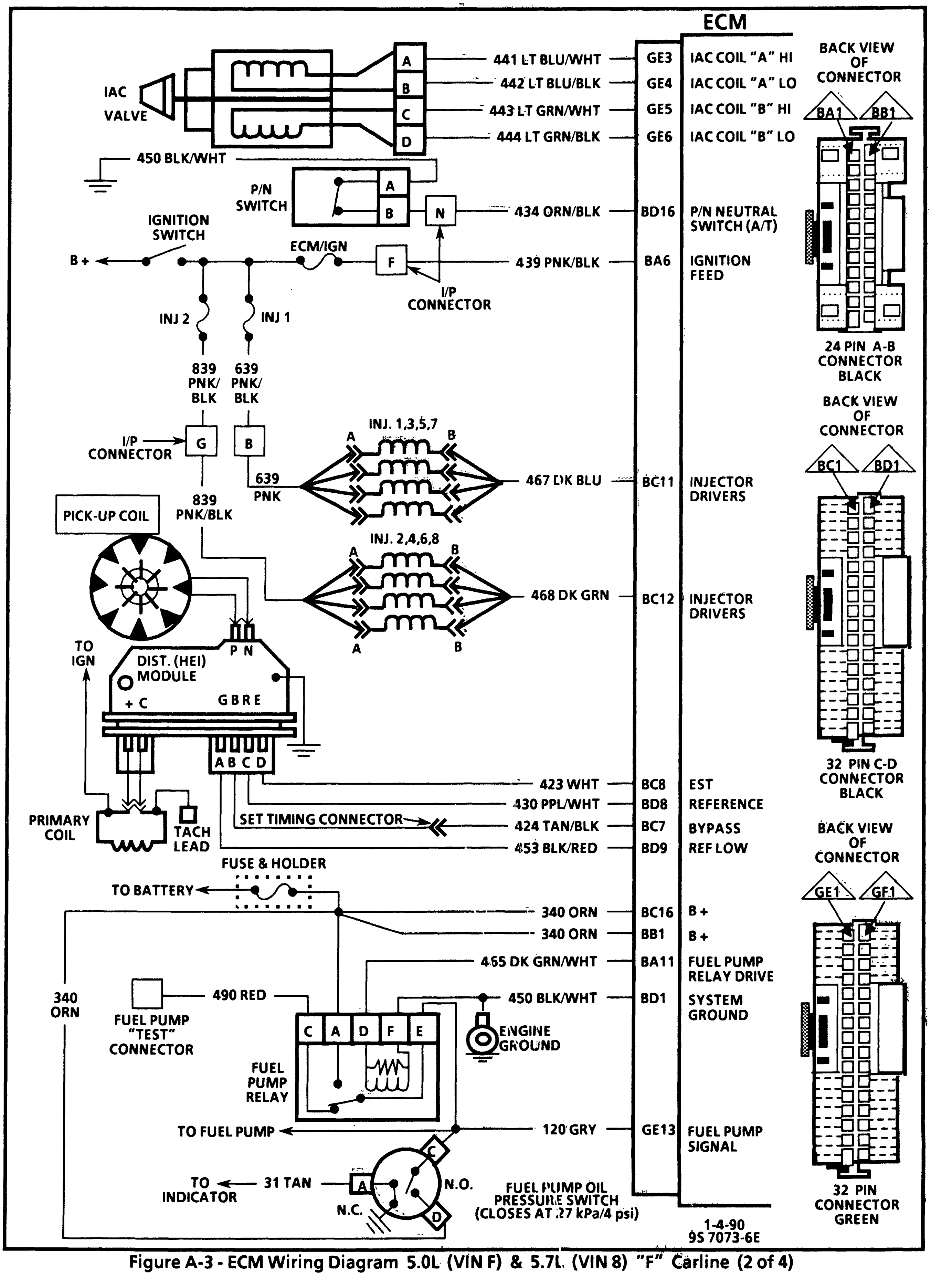


Figure A-3 - ECM Wiring Diagram 5.0L (VIN F) & 5.7L (VIN 8) "F" Carline (2 of 4)

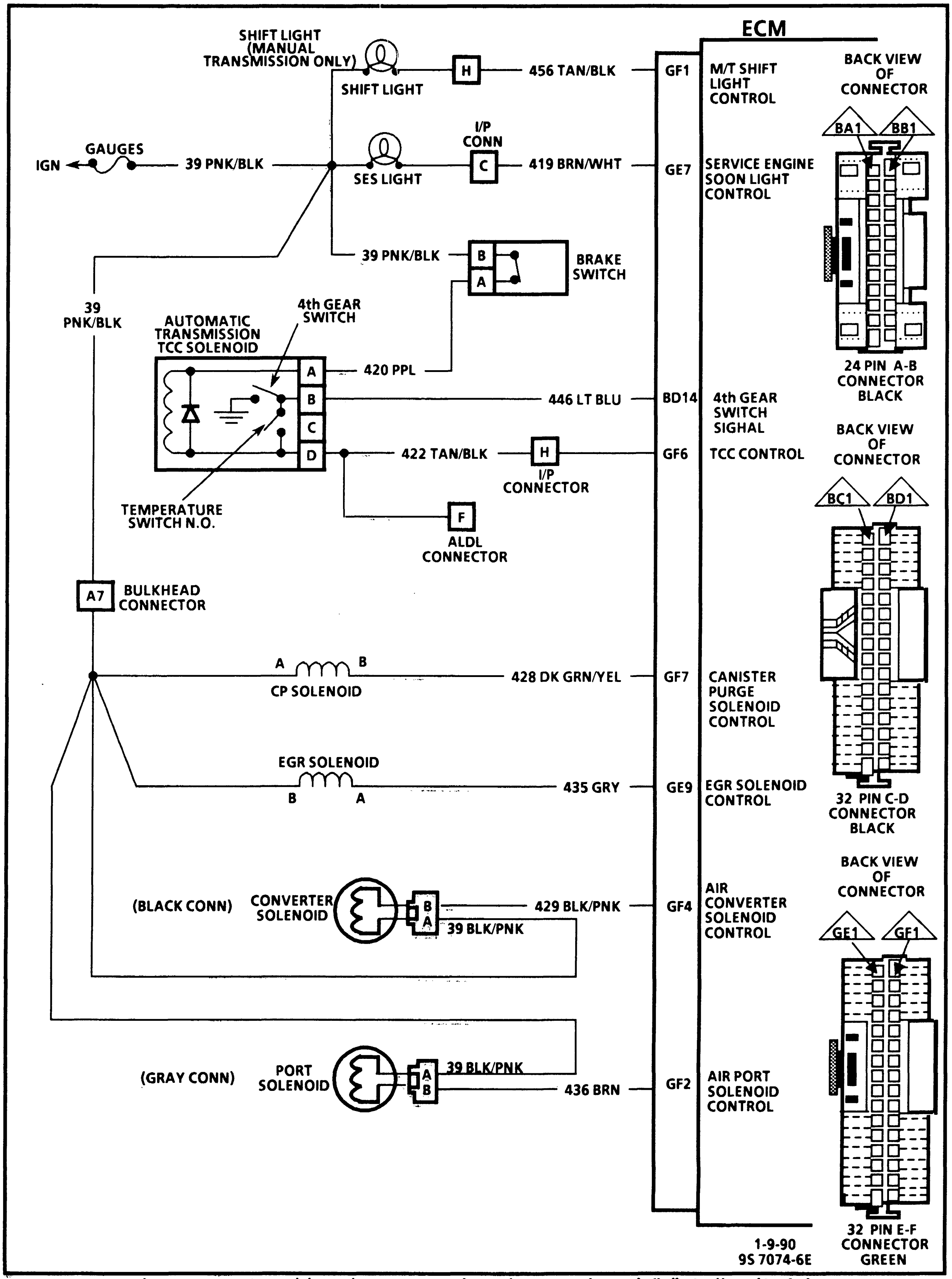


Figure A-4 - ECM Wiring Diagram 5.0L (VIN F) & 5.7L (VIN 8) "F" Carline (3 of 4)

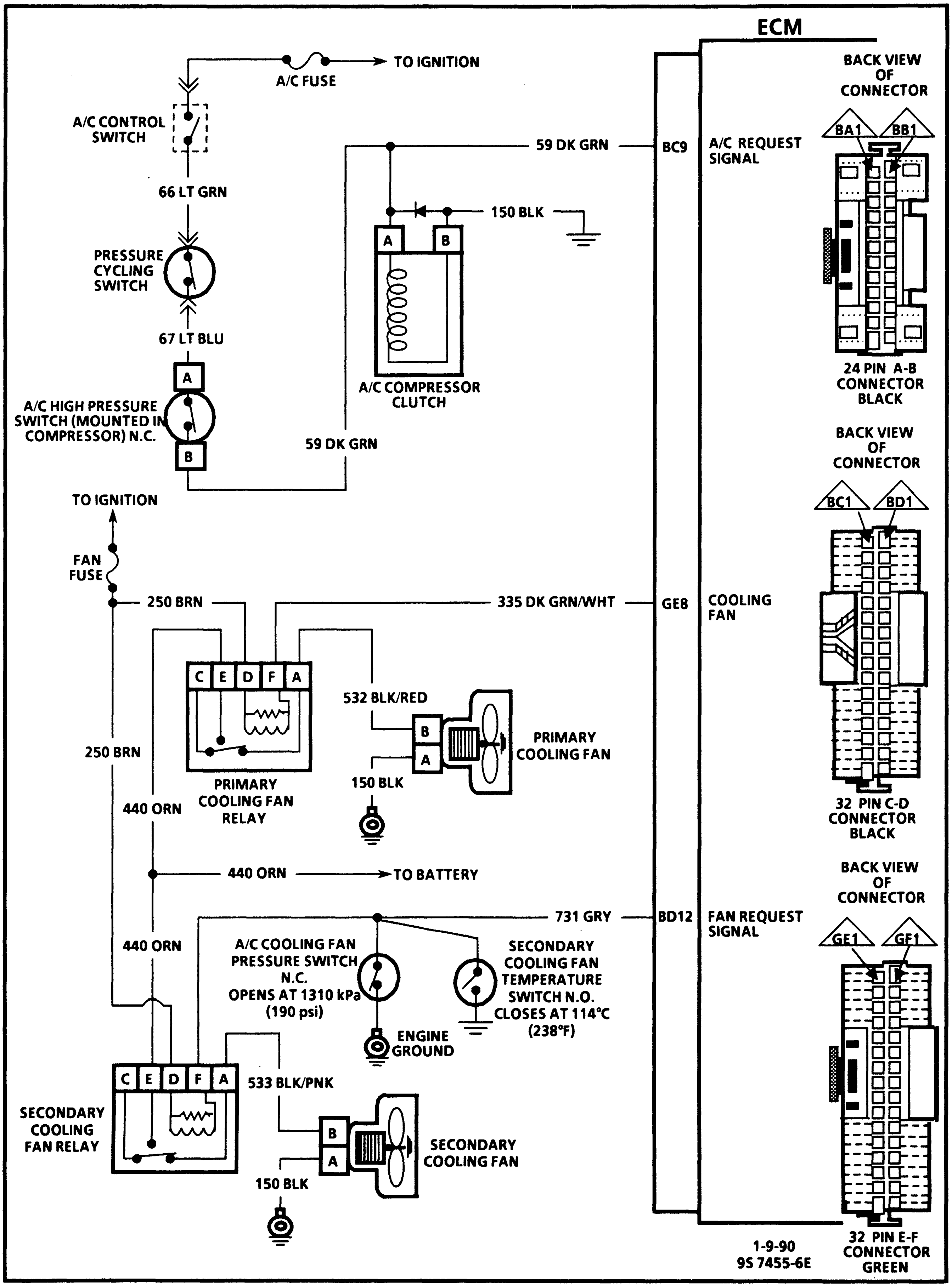


Figure A-5 - Wiring Diagram 5.0L (VIN F) & 5.7L (VIN 8) "F" Carline (4 of 4)

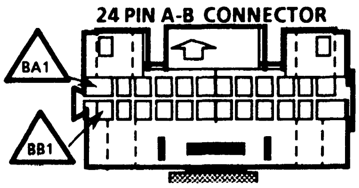
PORT FUEL INJECTION ECM CONNECTOR IDENTIFICATION

This ECM voltage chart is for use with a digital voltmeter to further aid in diagnosis. The voltages you get may vary due to low battery charge or other reasons, but they should be very close.

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

● Engine at operating temperature ● Engine idling in closed loop (For "Engine Run" column) in park or neutral ● Diagnostic "Test" terminal not grounded ● ALDL "Scan" tool not installed

VOLTAGE					
KEY "ON"	ENG. RUN	CIRCUIT	PIN	WIRE COLOR	CKT #
			BA1		
5	5	+5V REFERENCE (MAP)	BA4	GRY	474
5	5	+5V REFERENCE (TPS)	BA5	GRY	416
B+	B+	IGNITION FEED	BA6	PNK/BLK	439
② 4.8	4.8	SERIAL DATA	BA8	ORN	461
④ 0*	B+	FUEL PUMP RELAY DRIVE	BA11	DK GRN/WHT	465
0*	0*	ECM GROUND	BA12	BLK/WHT	450



BACK VIEW OF CONNECTOR

(BLACK)

VOLTAGE					
KEY "ON"	ENG. RUN	CIRCUIT	PIN	WIRE COLOR	CKT #
B+	B+	BATTERY FEED	BB1	ORN	340
0*	0*	TPS & MAT SENSOR GROUND	BB5	BLK	452
0*	0*	CTS & MAP SENSOR GROUND	BB6	BLK	470
0*	①	VSS (LOW)	BB9	PPL	401
0*	①	VSS (HIGH)	BB10	YEL	400
B+	B+	VSS TO I/P 4000 P/MI	BB11	GRY	1019
			BB12		

▽ Less than 1 volt.

* Less than .5 volt.

① Varies from .60 volt to Battery Voltage depending on position of drivewheels.

② Varies

③ Varies with temperature.

④ Battery Voltage for first two seconds.

⑤ Battery Voltage when fuel pump is running.

⑥ Reads battery voltage when in gear.

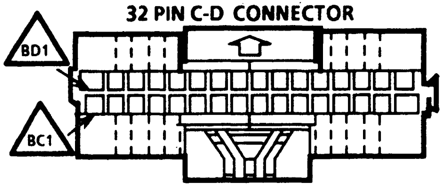
ENGINE	5.0L LB9 5.7L L98
CARLINE	"F"

1-9-90
9S 7026-6E

Figure A-6 - ECM Connector Terminal End View 5.0L (VIN F) & 5.7L (VIN 8) "F" Carline (1 of 3)

VOLTAGE					
KEY "ON"	ENG. RUN	CIRCUIT	PIN	WIRE COLOR	CKT #
①		VEHICLE SPEED SIGNAL	BC1	RED	381
0*	5	BYPASS	BC7	TAN/BLK	424
0*	1.3	EST	BC8	WHT	423
B+ 0*	B+ 0*	WITH A/C "ON" A/C REQUEST	BC9	DK GRN	59
B+	B+	INJECTOR 1, 3, 5, 7	BC11	DK BLU	467
B+	B+	INJECTOR 2, 4, 6, 8	BC12	DK GRN	468
B+	B+	BATTERY FEED	BC16	ORN	340

32 PIN C-D CONNECTOR



BACK VIEW OF CONNECTOR

(BLACK)

VOLTAGE					
KEY "ON"	ENG. RUN	CIRCUIT	PIN	WIRE COLOR	CKT #
0*	0*	ECM GROUND	BD1	BLK/WHT	450
0*	0*	INJECTOR GROUND	BD6	BLK/WHT	450
0*	0*	INJECTOR GROUND	BD7	BLK/WHT	450
0*	2.3	REFERENCE	BD8	PPL/WHT	430
0*	0*	REFERENCE LOW	BD9	BLK/RED	453
		FAN #2 REQUEST	BD12	GRY	731
0*	0*	4TH GEAR SWITCH	BD14	LT BLU	446
0*	0*	PARK/NEUTRAL (P/N) SWITCH SIG.	BD16	ORN/BLK	434

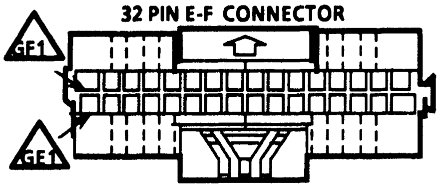
▽ Less than 1 volt.
* Less than .5 volt.
① Varies from .60 volt to Battery Voltage depending on position of drivewheels.
② Varies
③ Varies with temperature.
④ Battery Voltage for first two seconds.
⑤ Battery Voltage when fuel pump is running.
⑥ Reads battery voltage when in gear.

ENGINE 5.0L LB9 5.7L L98
CARLINE "F"

1-9-90
9S 7027-6E

Figure A-7 - ECM Connector Terminal End View 5.0L (VIN F) & 5.7L (VIN 8) "F" Carline (2 of 3)

VOLTAGE					
KEY "ON"	ENG. RUN	CIRCUIT	PIN	WIRE COLOR	CKT #
			GE1		
NOT USEABLE		IAC "A" HIGH	GE3	LT BLU/WHT	441
NOT USEABLE		IAC "A" LOW	GE4	LT BLU/BLK	442
NOT USEABLE		IAC "B" HIGH	GE5	LT GRN/WHT	443
NOT USEABLE		IAC "B" LOW	GE6	LT GRN/BLK	444
0*	B+	"SERVICE ENGINE SOON LIGHT"	GE7	BRN/WHT	419
0* B+	0* B+	"ON" FAN RELAY "OFF" CONTROL	GE8	DK GRN/WHT	335
B+	1▽	EGR SOLENOID CONTROL	GE9	GRY	435
5	5	DIAGNOSTIC "TEST" TERMINAL	GE12	BLK/WHT	451
④	B+	FUEL PUMP SIGNAL PPSW	GE13	GRY	120
② .35 - .55	.1 - .9	OXYGEN (O_2) SENSOR SIGNAL	GE14	PPL	412
0*	0*	OXYGEN (O_2) SENSOR GROUND	GE15	TAN	413
③	③	CTS SIGNAL	GE16	YEL	410



BACK VIEW OF CONNECTOR

(GREEN)

VOLTAGE					
KEY "ON"	ENG. RUN	CIRCUIT	PIN	WIRE COLOR	CKT #
0* B+	0* B+	M/T SHIFT LIGHT CONTROL	GF1	TAN/BLK	456
B+	B+	PORT (SWITCH) SOLENOID	GF2	BRN	436
B+	1▽	CONVERTER (DIVERT) SOLENOID	GF4	BLK/PNK	429
0* B+	0* B+	TCC CONTROL A/T	GF6	TAN/BLK	422
B+	B+	CANISTER PURGE SOL CONTROL	GF7	DK GRN/YEL	428
9.2	9.3	ESC KNOCK SENSOR SIGNAL	GF9	DK BLU	496
2.5	2.5	(PASS-KEY) VATS SIGNAL	GF10	DK BLU	229
.65	.65	TPS SIGNAL	GF13	DK BLU	417
4.57	②	MAP SIGNAL	GF15	LT GRN	432
③	③	MAT SIGNAL	GF16	TAN	472

▽ Less than 1 volt.
* Less than .5 volt.
① Varies from .60 volt to Battery Voltage
② Varies
③ Varies with temperature.
④ Battery Voltage for first two seconds.
⑤ Battery Voltage when fuel pump is running.
⑥ Reads battery voltage when in gear.

ENGINE 5.0L LB9
5.7L L98
CARLINE "F"

1-2-90
9S 7028-6E

Figure A-8 - ECM Connector Terminal End View 5.0L (VIN F) & 5.7L (VIN 8) "F" Carline (3 of 3)

DIAGNOSTIC CIRCUIT CHECK

The Diagnostic Circuit Check is an organized approach to identifying a problem created by an Electronic Engine Control System malfunction. It must be the starting point for any driveability complaint diagnosis, because it directs the Service Technician to the next logical step in diagnosing the complaint.

The "Scan Data" listed in the table may be used for comparison, after completing the Diagnostic Circuit Check and finding the on-board diagnostics functioning properly and no trouble codes displayed. The "Typical Data Values" are an average of display values recorded from normally operating vehicles and are intended to represent what a normally functioning system would typically display.

A "SCAN" TOOL THAT DISPLAYS FAULTY DATA SHOULD NOT BE USED, AND THE PROBLEM SHOULD BE REPORTED TO THE MANUFACTURER. THE USE OF A FAULTY "SCAN" CAN RESULT IN MISDIAGNOSIS AND UNNECESSARY PARTS REPLACEMENT.

Only the parameters listed below are used in this manual for diagnosing. If a "Scan" reads other parameters, the values are not recommended by General Motors for use in diagnosing. For more description on the values and use of the "Scan" to diagnosis ECM inputs, refer to the applicable diagnosis section in Section "C". If all values are within the range illustrated, refer to "Symptoms" in Section "B".

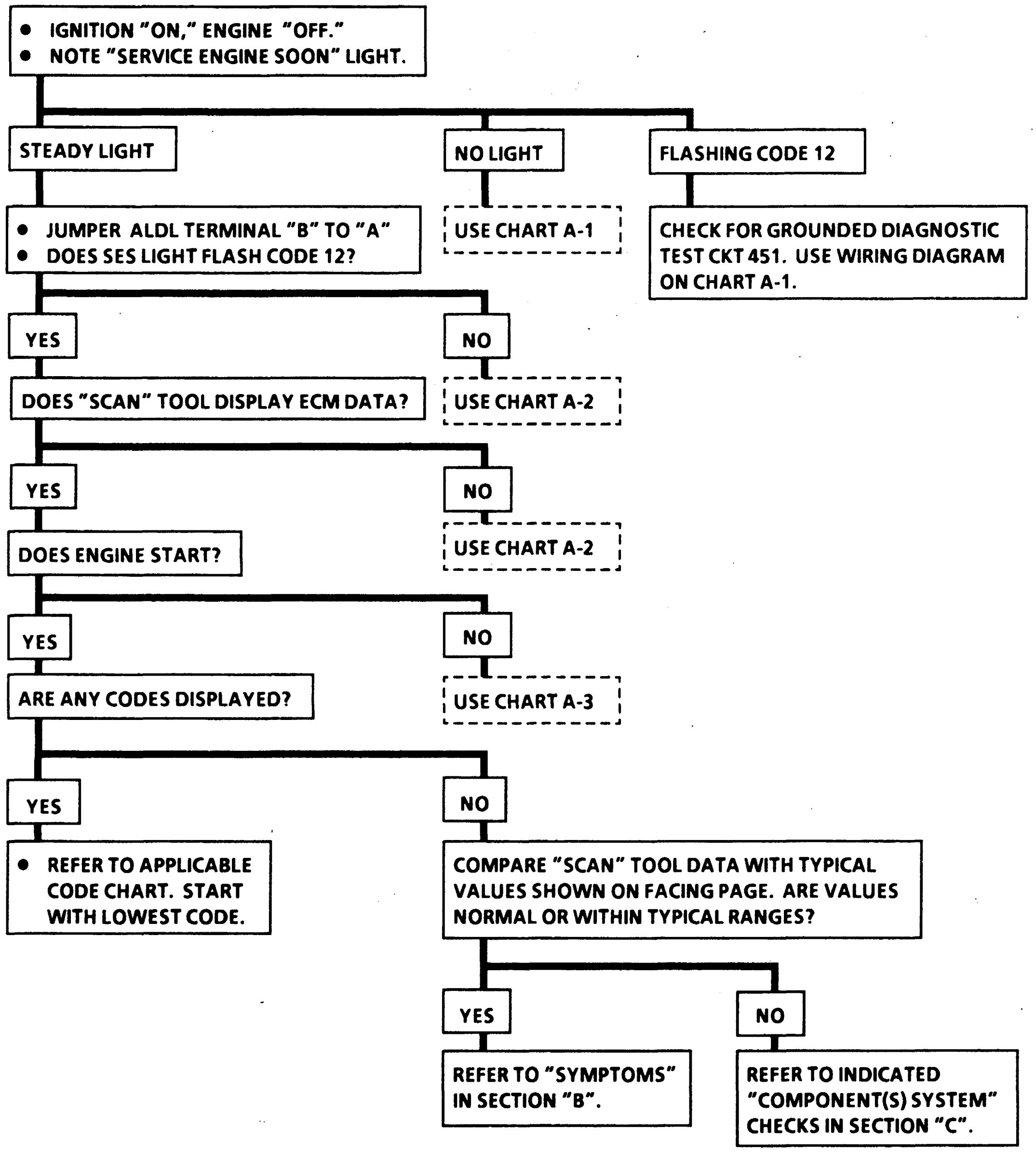
"SCAN" DATA

Idle / Upper Radiator Hose Hot / Closed Throttle / Park or Neutral / Closed Loop / Acc. off

"SCAN" Position	Units Displayed	Typical Data Values
Engine Speed	RPM	ECM idle command (700 rpm ± 100 rpm in Park.)
Desired Idle	RPM	± 100 RPM from desired RPM in park(± 50 in drive)
Coolant Temp	C°/F°	85°C - 105°C (185°F - 221°F)
Mani Air Temp	C°/F°	10°C - 90°C (50°F-104°F) (Depends on underhood temp.)
MAP	KPa/Volts	30 - 70/1.02 - 1.50 (varies with altitude)
Throt Position	Volts	.36 - 62
Throttle Angle	Percentage	0% at Idle
Oxygen Sensor	Millivolts	1 - 1000 and varying
Open/Close Loop	Open/Closed	Closed Loop (may go open with extended idle)
Block Learn Cell	Cell Number	4 (depends on Air Flow & RPM)
BLK Learn Enable	No/Yes	Yes (when BLM is enabled)
Fuel Integrator	Counts	Varies
Block Learn	Counts	118 - 138
Spark Advance	# of Degrees	Varies
INJ. Pulse Width	M/Sec	1 - 4 and varying
Knock Retard	Degrees of Retard	0
Knock Signal	Yes/No	No (Yes, when knock is detected)
Exhaust Recirc.	0 - 100%	0% at Idle
Purge Duty Cycle	0 - 100%	0% at Idle
Idle Air Control	Counts (Steps)	5 - 50
Learn IAC	Counts (Steps)	5 - 50
MPH/KPH	MPH/KPH	0 at Idle
Torque Conv CL	OFF/ON	"OFF" ("ON" with TCC commanded)
Battery Voltage	Volts	13.5 - 14.5
Fuel Pump Volts	Volts	13.5 - 14.5
Air Control Sol	Normal/Divert	Normal
Air Switch Sol	Port/Converter	Converter
A/C Request	Yes/No	No (Yes, with A/C Request)
VATS Status	Not OK/OK	OK
Fan 2 Request	Yes/No	No (Yes, with A/C High Pressure)
Fan 1	ON/OFF	"OFF" (below 226°F)
4th Gear (5.0L)		
No	No/Yes	No (Yes, when in 4th gear)
4th Gear (5.7L)		
No	No/Yes	No (Yes, when in 4th gear)
Park/Neutral	P-N--/R-DL	Park/Neutral
Shift Light	OFF/ON	OFF
Prom ID	0 - 9999	Prom ID Numbers (Vary)
Time From Start	Hrs/Min/sec	Varies (Time from start measure how long the engine has been running (if the engine stops, time from start will reset to 0:00:00)

DIAGNOSTIC CIRCUIT CHECK

5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



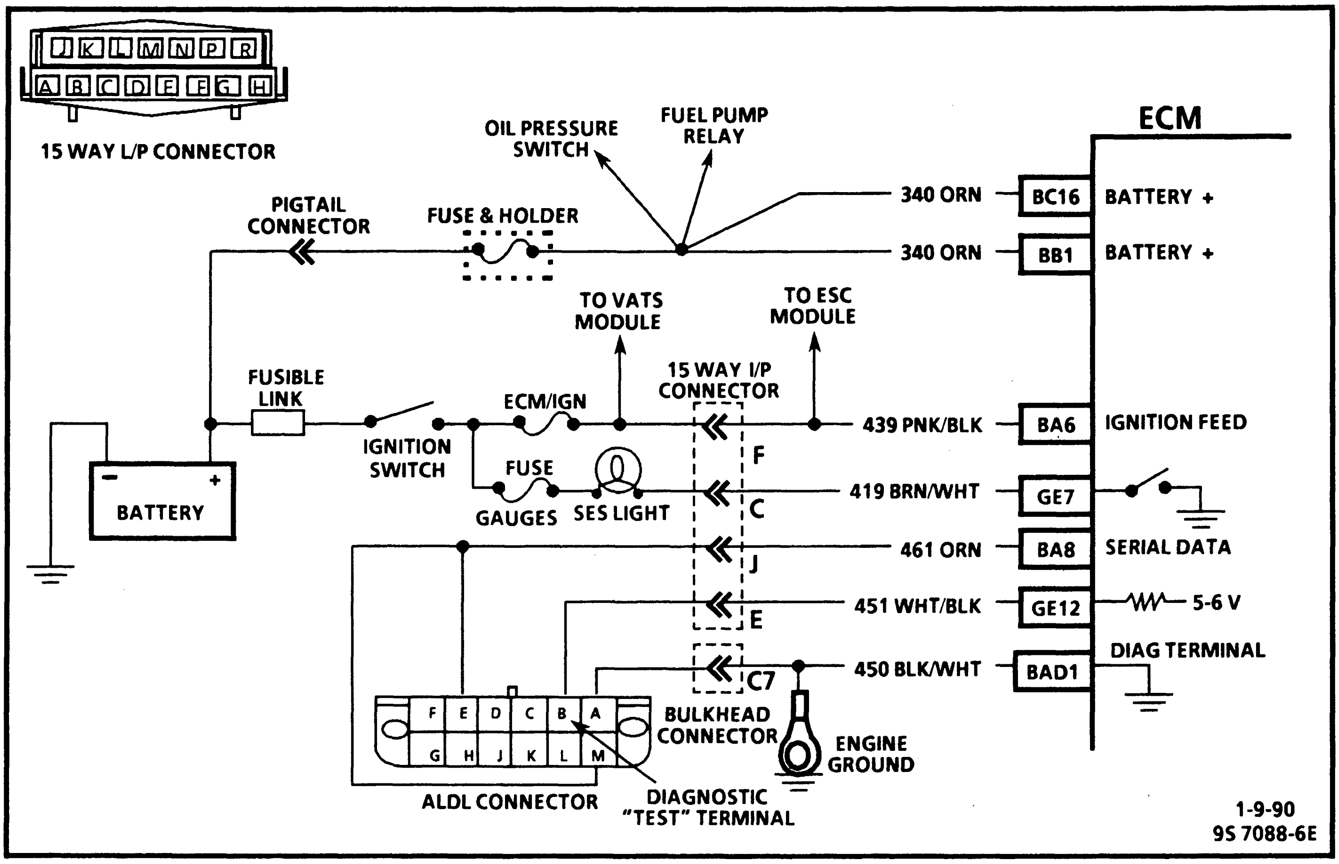


CHART A - 1

NO "SERVICE ENGINE SOON" LIGHT
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

There should always be a steady "Service Engine Soon" light when the ignition is "ON" and engine stopped. Ignition voltage is supplied directly to the light bulb. The Electronic Control Module (ECM) will control the light and turn it "ON" by providing a ground path through CKT 419 to the ECM.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Battery feed CKT 340 is protected by a 20 amp in-line fuse. If this fuse was blown, refer to wiring diagram on the facing page of Code 54.
2. Using a test light connected to 12 volts probe each of the system ground circuits to be sure a good ground is present. Refer to the ECM terminal end view in front of this section for ECM pin locations of ground circuits.

Diagnostic Aids:

Engine runs OK, check:

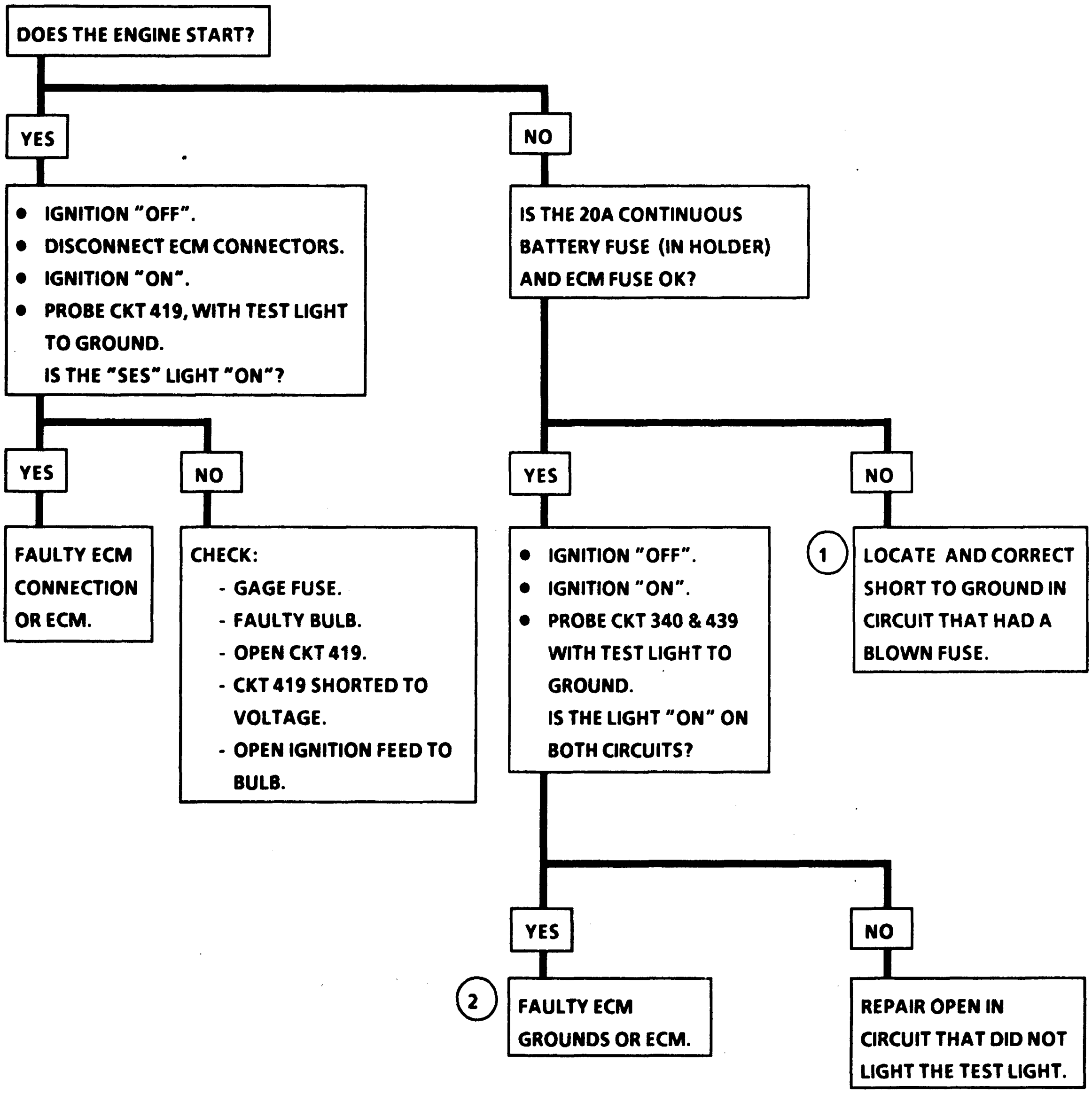
- Faulty light bulb.
- CKT 419 open.
- Gage fuse blown, this will result in no oil or generator lights, seat belt reminder, etc.

Engine cranks but will not run, check:

- Continuous battery - fuse or fusible link open.
- ECM/Ignition fuse open.
- Battery CKT 340 to ECM open.
- Ignition CKT 439 to ECM open.
- Poor connection to ECM.
- Faulty ECM ground circuit(s).

CHART A-1

NO "SERVICE ENGINE SOON" LIGHT
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



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CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

7S 3185-6E

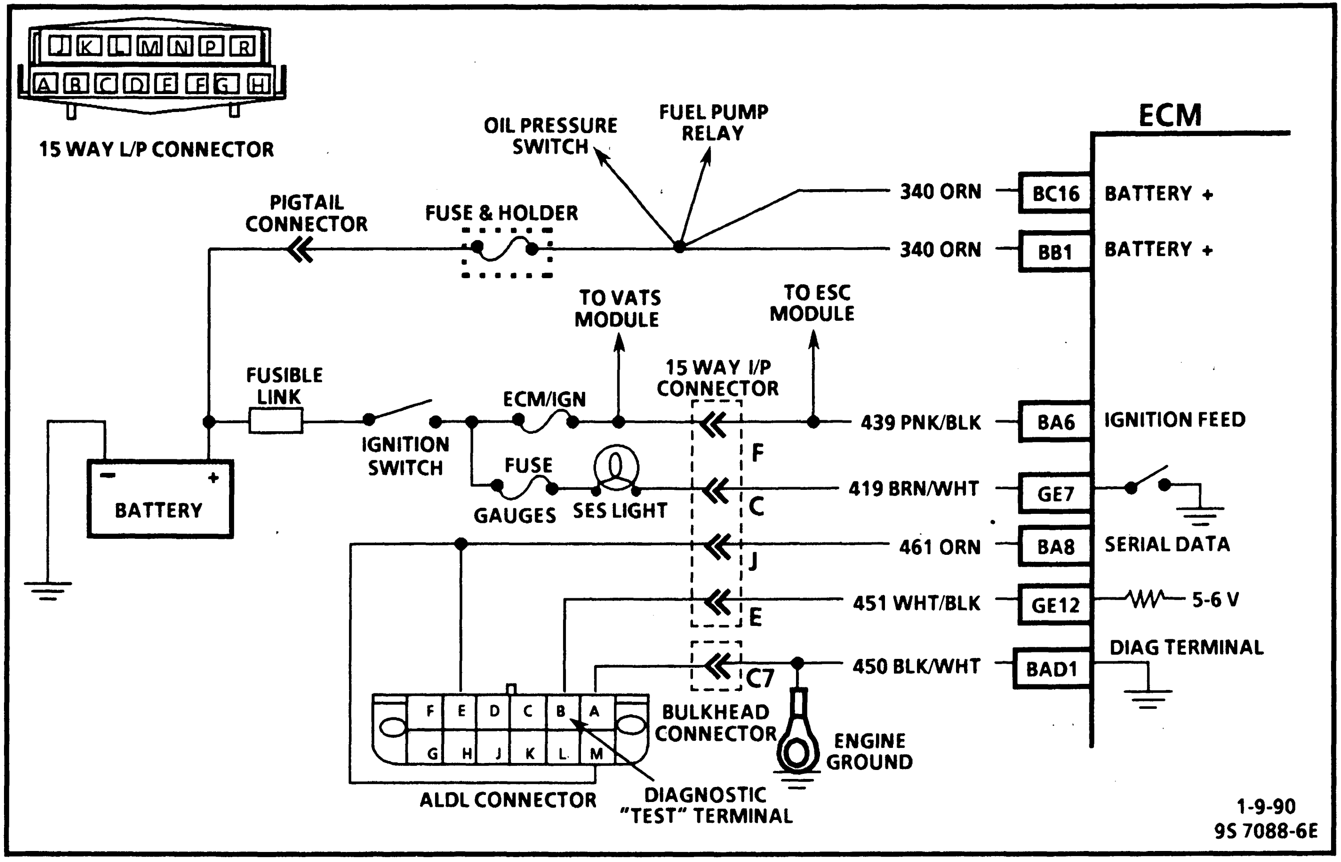


CHART A-2

NO ALDL DATA OR WILL NOT FLASH CODE 12 "SERVICE ENGINE SOON" LIGHT "ON" STEADY 5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

There should always be a steady "Service Engine Soon" light when the ignition is "ON" and engine stopped. Ignition voltage is supplied to the light bulb. The Electronic Control Module (ECM) will turn the light "ON" by grounding CKT 419 in the ECM.

With the diagnostic "test" terminal grounded the light should flash a Code 12, followed by any trouble code(s) stored in memory.

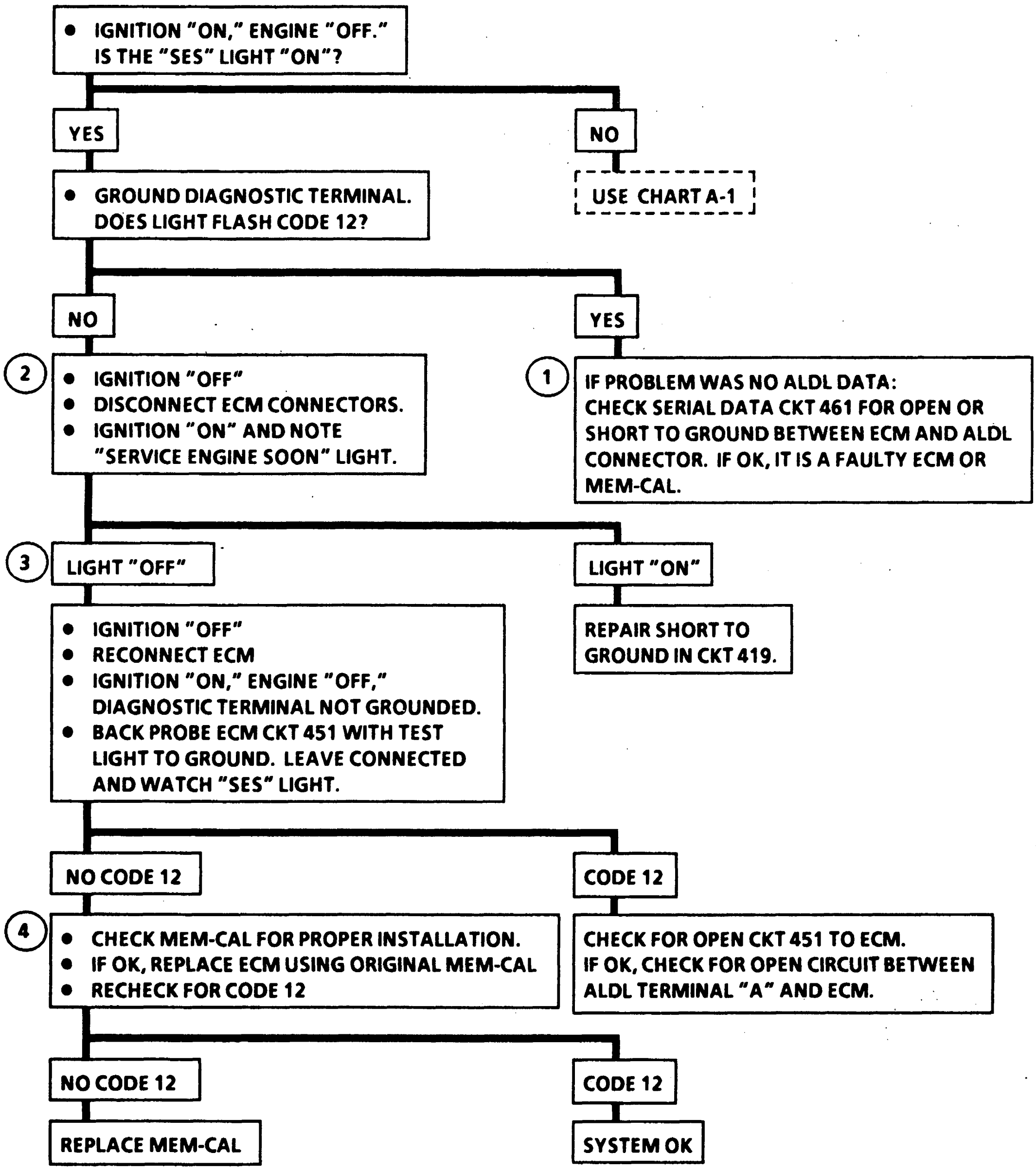
A steady light suggests a short to ground in the light control CKT 419, or an open in diagnostic CKT 451.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. If there is a problem with the ECM that causes a "Scan" tool to not read Serial data, the ECM should not flash a Code 12. If Code 12 is flashing check for CKT 451 short to ground. If Code 12 does flash, make sure that the "Scan" tool is working properly on another vehicle. If the "Scan" tool is functioning properly and CKT 461 is OK, the MEM-CAL or ECM may be at fault for the NO ALDL symptom.
2. If the light goes "OFF" when the ECM connector is disconnected, CKT 419 is not shorted to ground.
3. This step will check for an open diagnostic CKT 451.
4. At this point the "Service Engine Soon" light wiring is OK. The problem is a faulty ECM or MEM-CAL. If Code 12 does not flash, the ECM should be replaced using the original MEM-CAL. Replace the MEM-CAL only after trying an ECM, as a defective MEM-CAL is an unlikely cause of the problem.

CHART A-2

NO ALDL DATA OR WILL NOT FLASH CODE 12 "SERVICE ENGINE SOON" LIGHT "ON" STEADY 5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

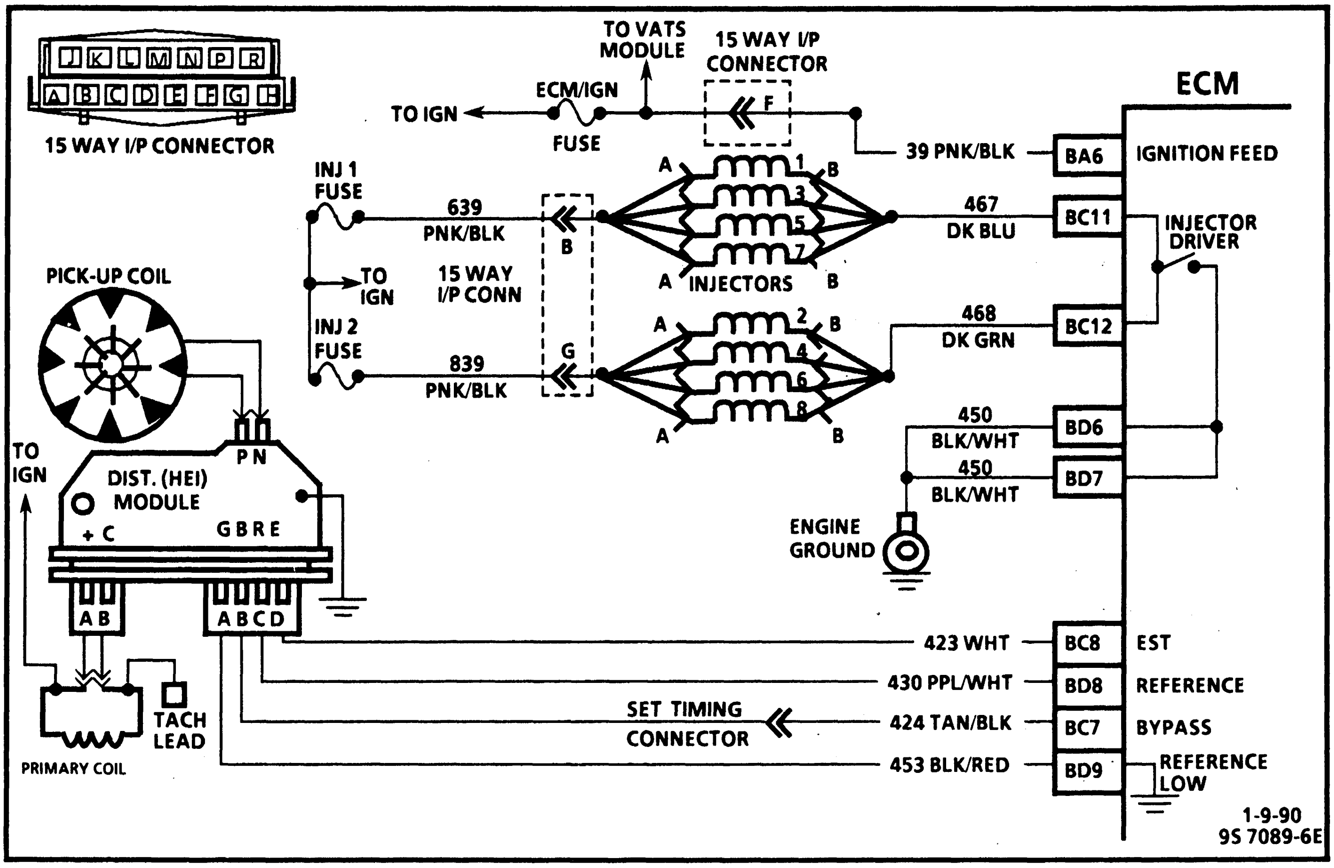


CHART A-3

(Page 1 of 2)

ENGINE CRANKS BUT WILL NOT RUN
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

This chart assumes that battery condition and engine cranking speed are OK, and there is adequate fuel in the tank.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. A "Service Engine Soon" light "ON" is a basic test to determine if there is a 12 volt supply and ignition 12 volts to ECM. No ALDL may be due to an ECM problem and CHART A-2 will diagnose the ECM. If TPS is over 2.5 volts the engine may be in the clear flood mode which will cause starting problems. The engine will not start without reference pulses and therefore the "Scan" tool should read engine rpm (reference) during crank.
2. No spark may be caused by one of several components related to the Ignition/EST System. CHART C-4 will address all problems related to the causes of a no spark condition.
3. The test light should blink, indicating the ECM is controlling the injectors OK. How bright the light blinks is not important. However, the test light should be a J 34730-3 or equivalent.
4. Use fuel pressure gage J 34730-1 or equivalent. Wrap a shop towel around the fuel pressure tap to absorb any small amount of fuel leakage that may occur when installing the gage.

Diagnostic Aids:

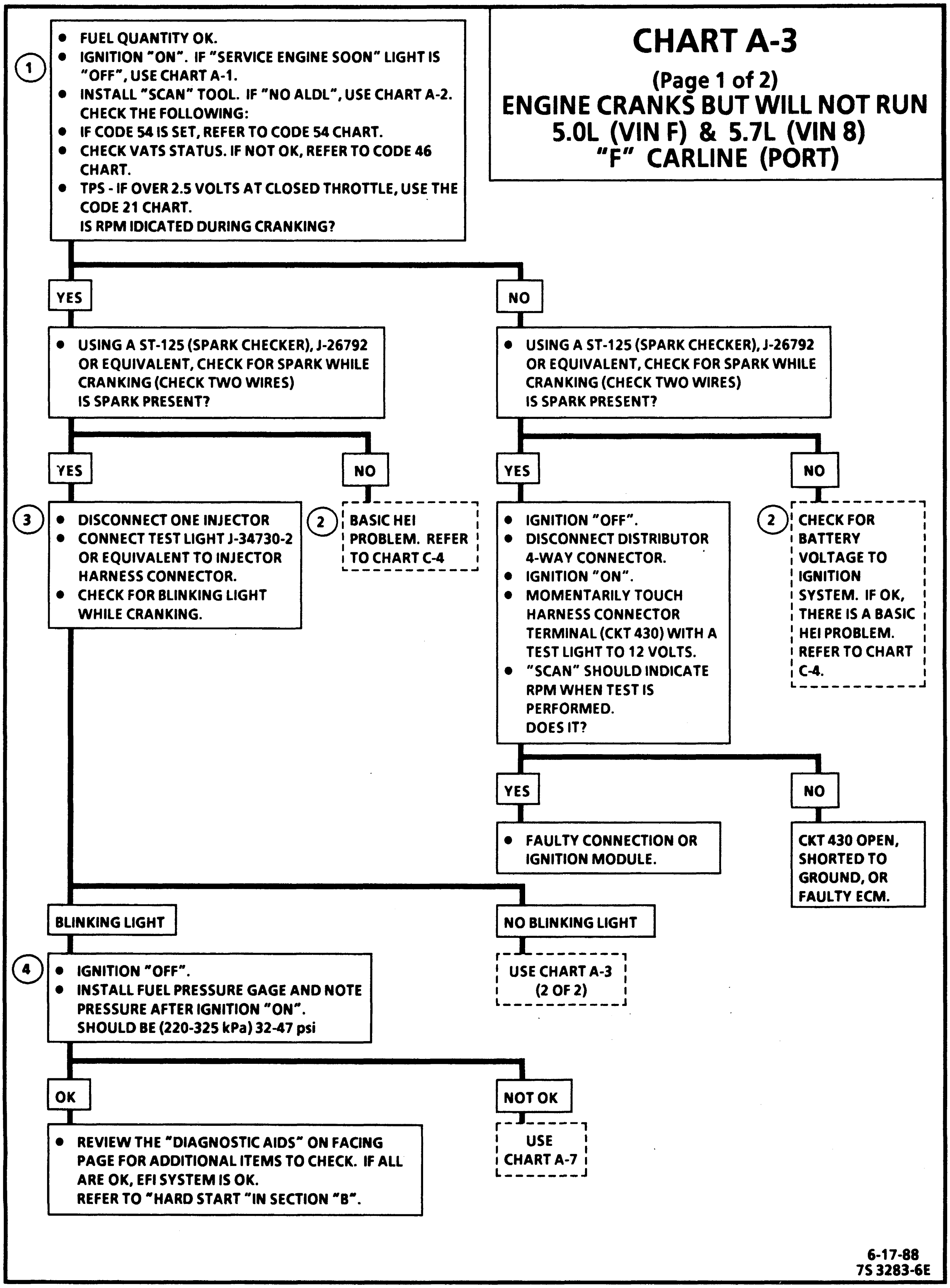
- An EGR valve sticking open can cause a low air/fuel ratio during cranking. Unless engine enters "Clear Flood" at the first indication of a flooding condition, it can result in a no start.
- Check for fouled plugs.
- Water or foreign material in fuel line can cause a no start in freezing weather.
- Also check that injectors on both sides of engine will cause a test light to "blink." If not OK, check injector fuses.

If above are all OK, Refer to "Symptoms," Section "B" in Hard Start.

CHART A-3

(Page 1 of 2)

ENGINE CRANKS BUT WILL NOT RUN
5.0L (VIN F) & 5.7L (VIN 8)
"F" CARLINE (PORT)



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7S 3283-6E

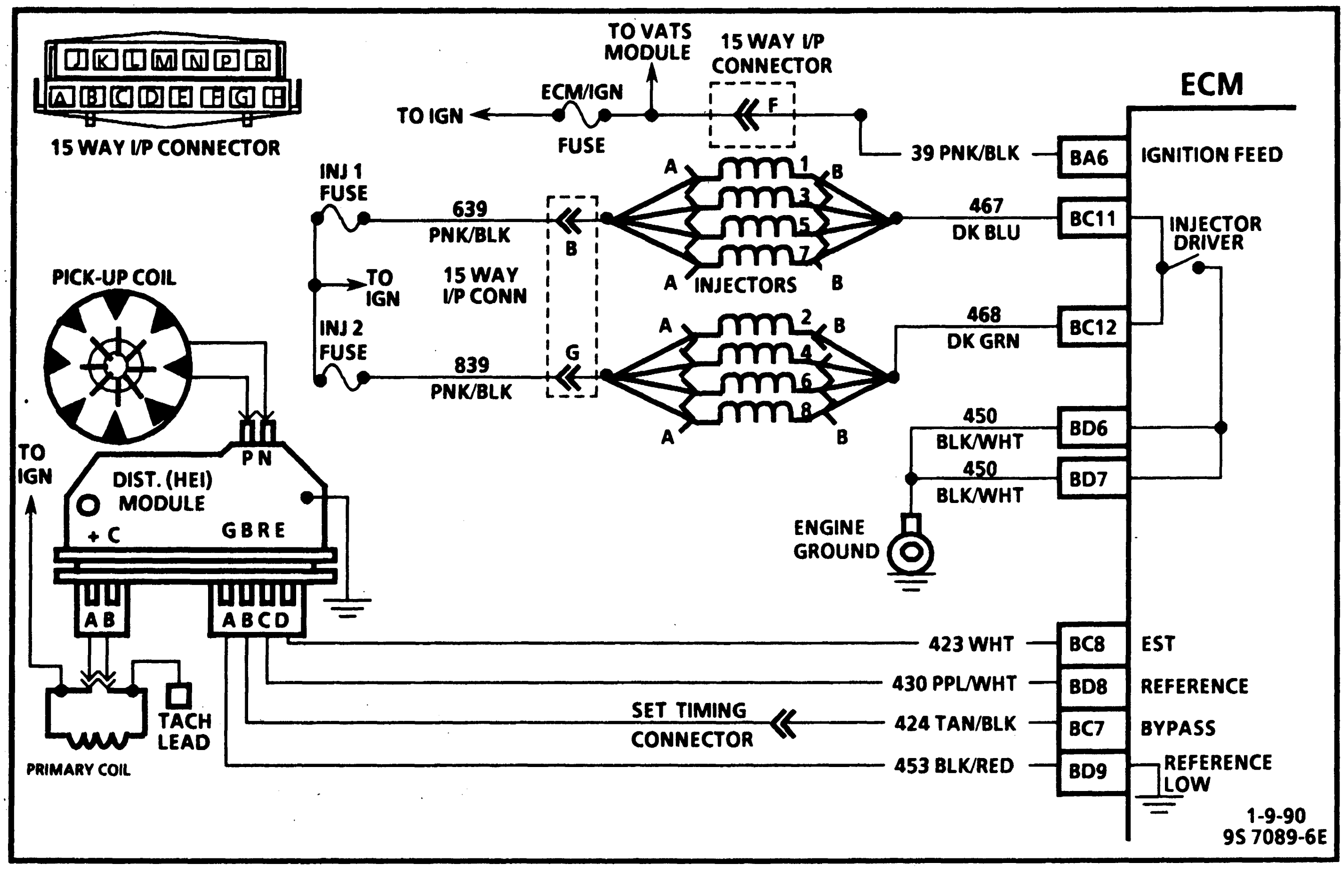


CHART A-3

(Page 2 of 2)

ENGINE CRANKS BUT WILL NOT RUN
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Checks for 12 volt supply to injectors. Due to the injectors wired in parallel there should be a light "ON" on both terminals.
2. Checks continuity of CKT 467 and CKT 468.
3. All checks made to this point would indicate that the ECM is at fault. However, there is a possibility of CKT 467 or CKT 468 being shorted to a voltage source either in the engine harness or in the injector harness.

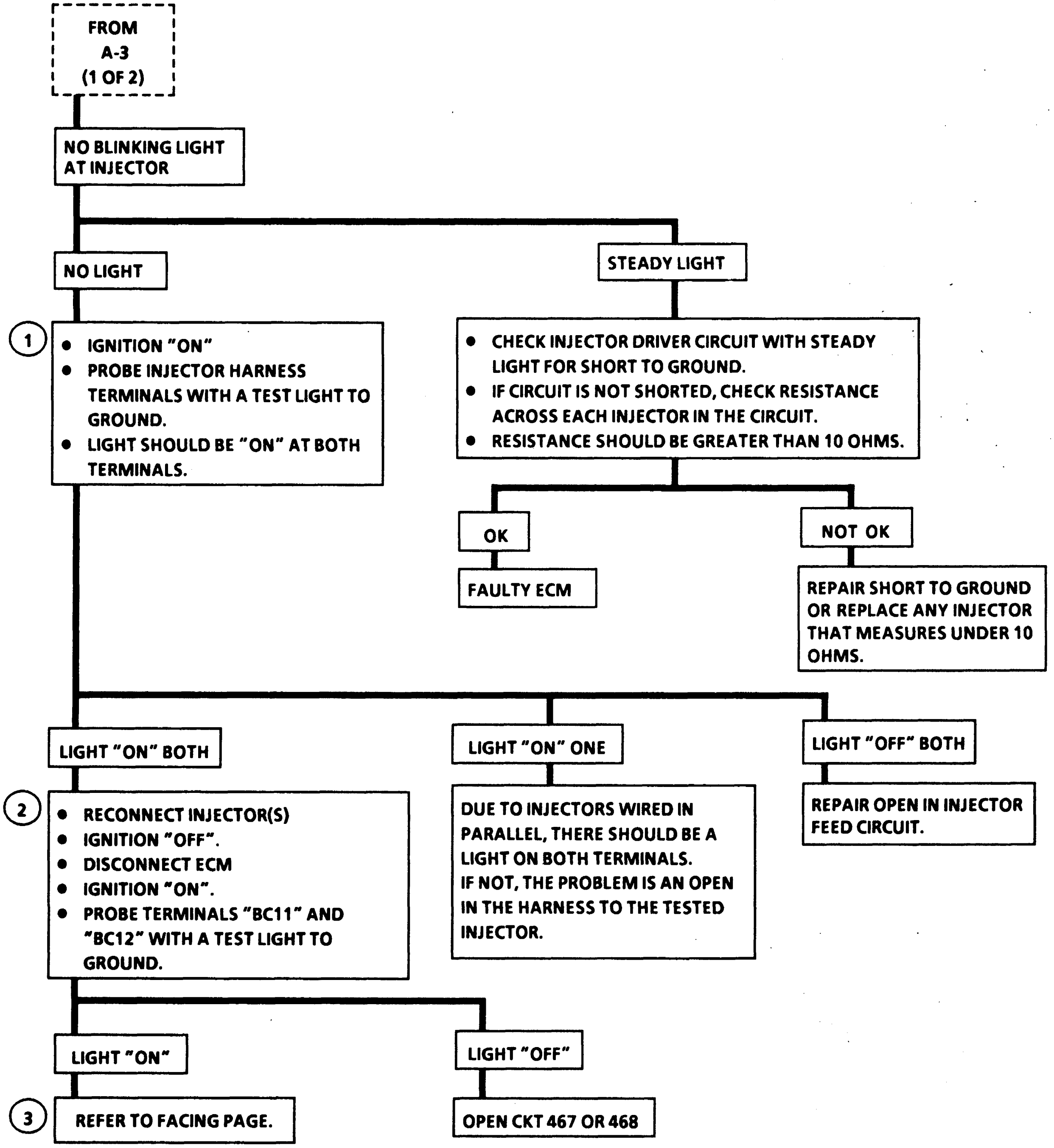
To test for this condition:

- Disconnect all injectors
- Ignition "ON."
- Probe CKT 467 and CKT 468 on the ECM side of injector harness with a test light connected to ground. (Test one injector harness on each side of engine). There should be no light. If light is "ON" repair short to voltage.
- If OK, check the resistance of the injectors.
- Should be 10 ohms or more.
- Check injector harness connector. Be sure terminals are not backed out of connector and contacting each other.
- If all OK, replace ECM.

CHART A-3

(Page 2 of 2)

ENGINE CRANKS BUT WILL NOT RUN 5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



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* 7S 3284-6E

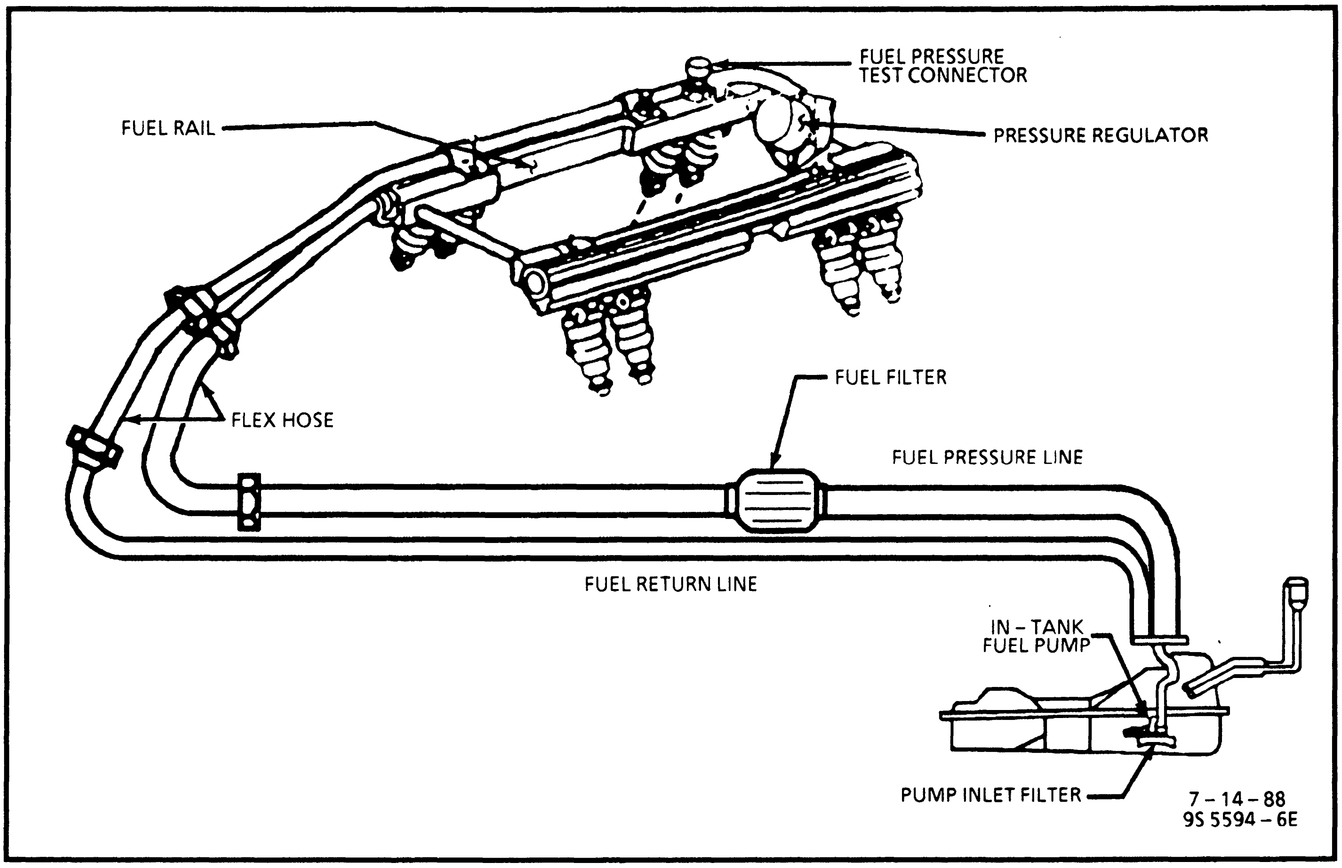


CHART A-7

(Page 1 of 2)

FUEL SYSTEM DIAGNOSIS 5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

When the ignition switch is turned "ON," the Electronic Control Module (ECM) will turn "ON" the in-tank fuel pump. It will remain "ON" as long as the engine is cranking or running, and the ECM is receiving reference pulses. If there are no reference pulses, the ECM will shut "OFF" the fuel pump within 2 seconds after ignition "ON" or engine stops.

The pump will deliver fuel to the fuel rail and injectors, then to the pressure regulator, where the system pressure is controlled at 234 to 325 kPa (34 to 47 psi). Excess fuel is then returned to the fuel tank.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Wrap a shop towel around the fuel pressure connector to absorb any small amount of fuel leakage that may occur when installing the gage. Ignition "ON," pump pressure should be 280-325 KPa (40.5-47 psi). This pressure is controlled by spring pressure within the regulator assembly.
2. When the engine is idling, the manifold pressure is low (high vacuum) and is applied to the fuel regulator diaphragm. This will offset the spring and result in a lower fuel pressure. This idle pressure will vary somewhat depending on barometric pressure; however, the pressure idling should be less, indicating pressure regulator control.
3. Pressure that leaks down is caused by one of the following:
   - In-tank fuel pump check valve not holding.
   - Pump coupling hose or pulsator leaking.
   - Fuel pressure regulator valve leaking.
   - Injector(s) sticking open.
4. An injector sticking open can best be determined by checking for a fouled or saturated spark plug(s). If a leaking injector cannot be determined by a fouled or saturated spark plug, the following procedure should be used:
   - Remove Plenum, and remove fuel rail bolts. Follow the procedures in the Fuel Control Section of this manual, but leave fuel lines connected.
   - Lift fuel rail out just enough to observe injector nozzles in the ports.

CAUTION: ***BE SURE INJECTOR(S) ARE NOT ALLOWED TO SPRAY ON ENGINE AND THAT INJECTOR RETAINING CLIPS ARE INTACT. THIS SHOULD BE CAREFULLY FOLLOWED TO PREVENT FUEL SPRAY ON ENGINE WHICH WOULD CAUSE A FIRE HAZARD.***

- Pressurize the fuel system and observe injector nozzles.

CHART A-7

(Page 1 of 2)

FUEL SYSTEM DIAGNOSIS

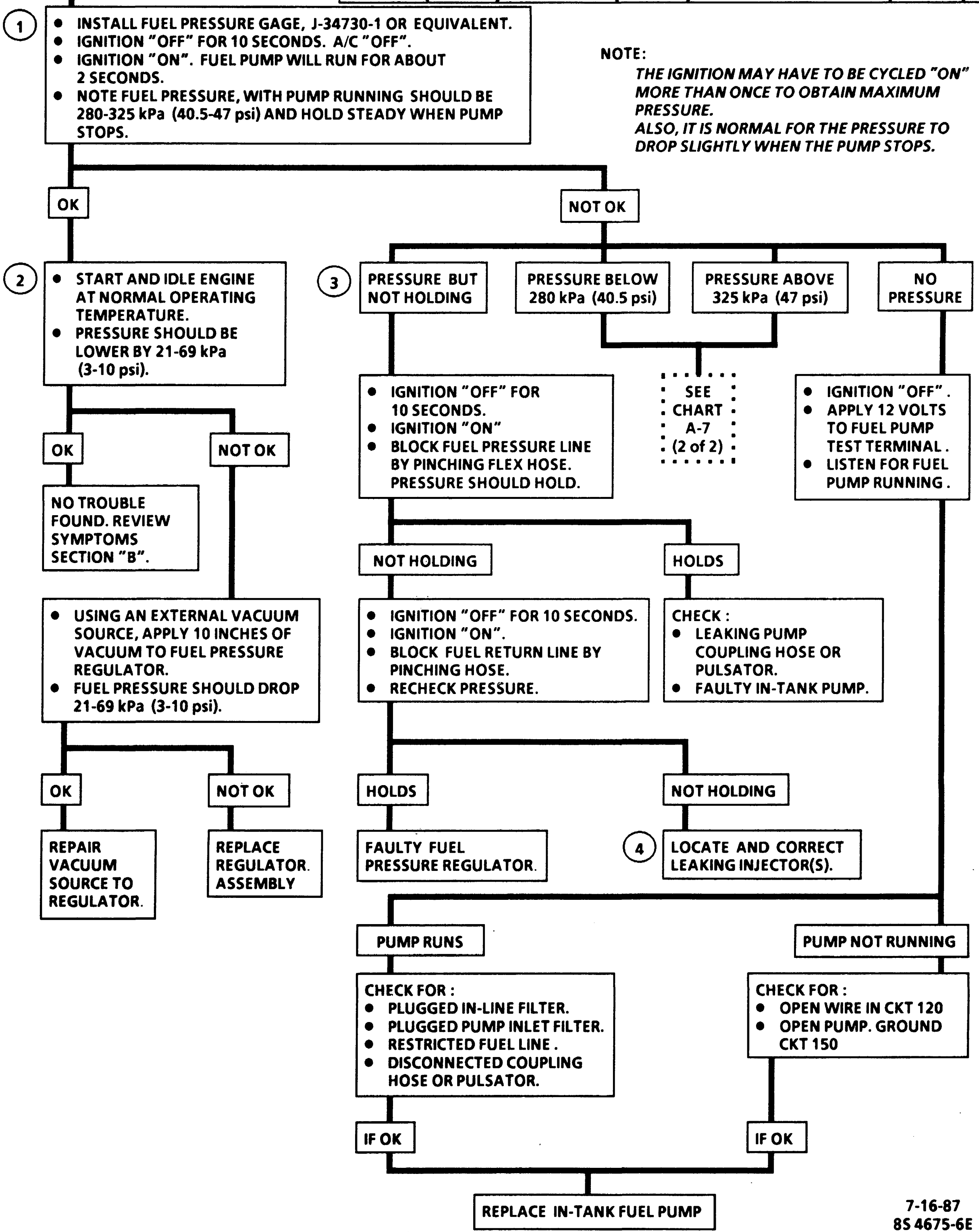
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

FROM CHART A-3 PAGE 1.

THIS CHART ASSUMES THERE IS NO CODE 54

NOTE:

THE IGNITION MAY HAVE TO BE CYCLED "ON" MORE THAN ONCE TO OBTAIN MAXIMUM PRESSURE. ALSO, IT IS NORMAL FOR THE PRESSURE TO DROP SLIGHTLY WHEN THE PUMP STOPS.



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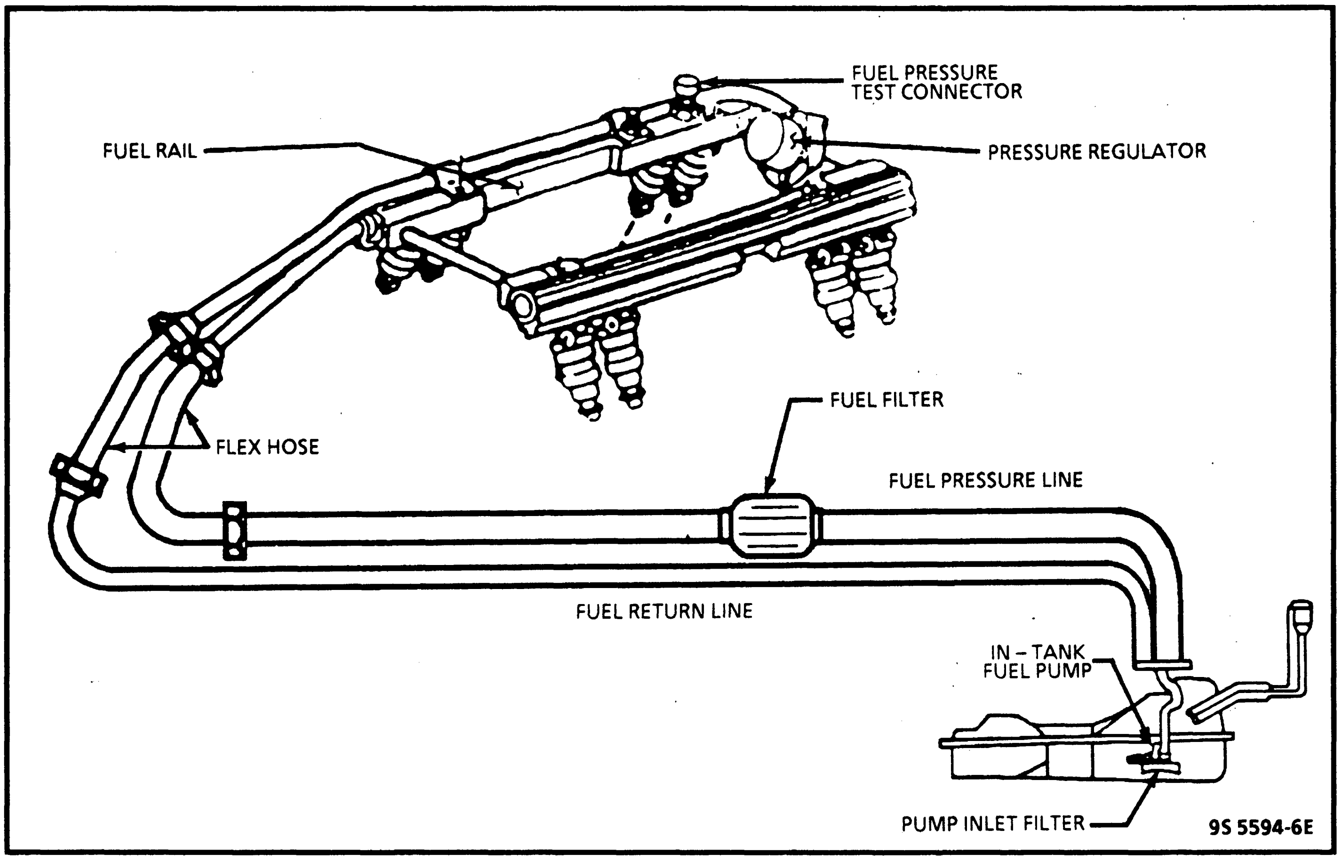


CHART A-7

(Page 2 of 2)

FUEL SYSTEM DIAGNOSIS

5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Fuel pressure less than 280 kPa (40.5 psi) falls into two areas:
   - Regulated pressure less than 280 kPa (40.5 psi). System will be lean and may set Code 44. Also, hard starting cold and overall poor performance.
   - Restricted flow causing pressure drop - Normally, a vehicle with a fuel pressure of less than 165 kPa (24 psi) at idle will not be drivable. However, if the pressure drop occurs only while driving, the engine will normally surge then stop running as pressure begins to drop rapidly. This is most likely caused by a restricted fuel line or plugged filter.
2. Restricting the fuel return line allows the fuel pressure to build above regulated pressure. With battery voltage applied to the fuel pump test terminal, pressure should rise to 414 kPa (60 psi) as the fuel return hose is gradually pinched.

NOTICE: Do not allow fuel pressure to exceed 414 kPa (60 psi), damage to the pressure regulator may result.

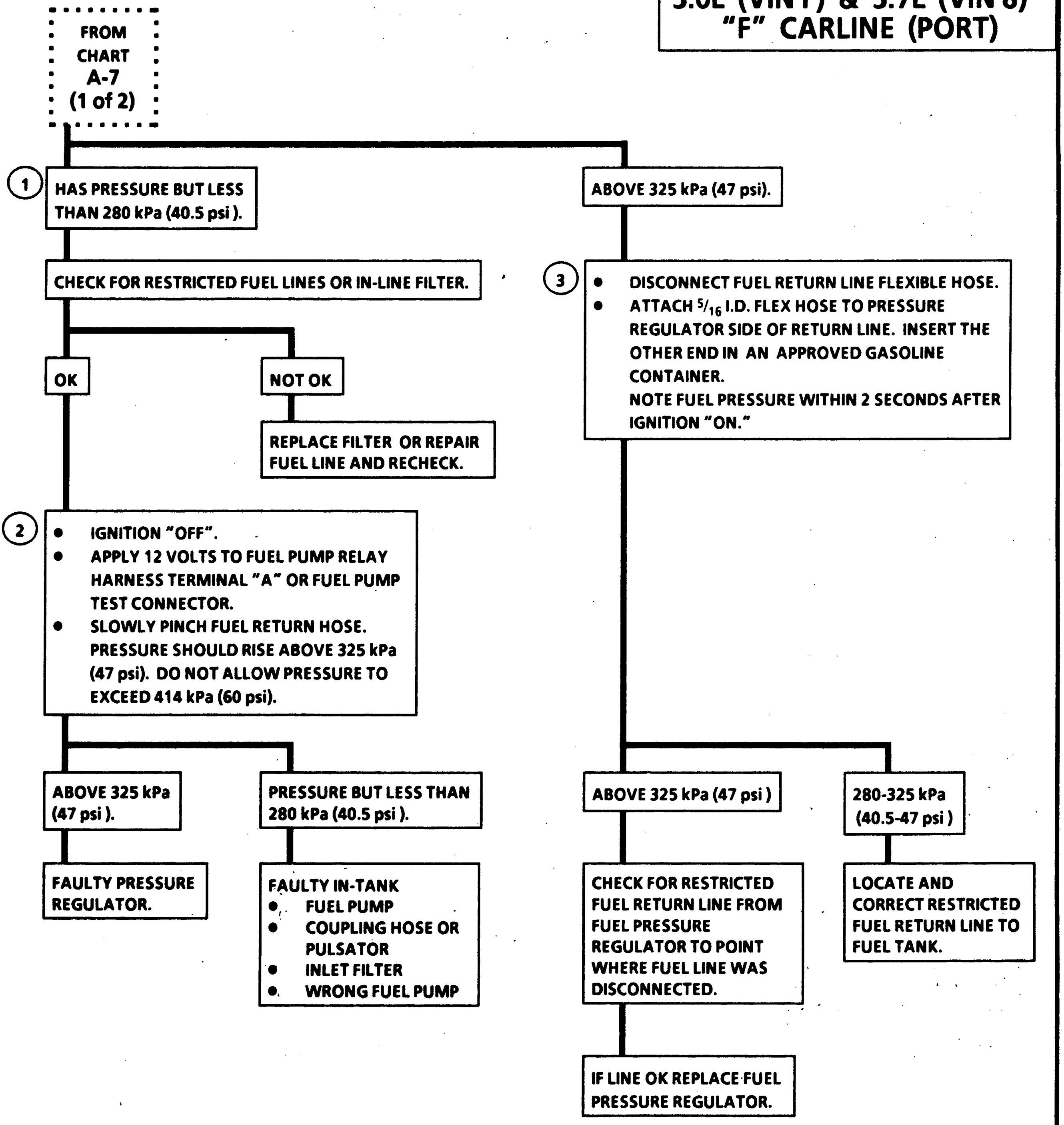
3. This test determines if the high fuel pressure is due to a restricted fuel return line or a pressure regulator problem.

NOTICE: ***FUEL SYSTEM UNDER PRESSURE. TO AVOID FUEL SPILLAGE, REFER TO FIELD SERVICE PROCEDURES FOR TESTING OR MAKING REPAIRS REQUIRING DISASSEMBLY OF FUEL LINES OR FITTINGS.***

CHART A-7

(Page 2 of 2)

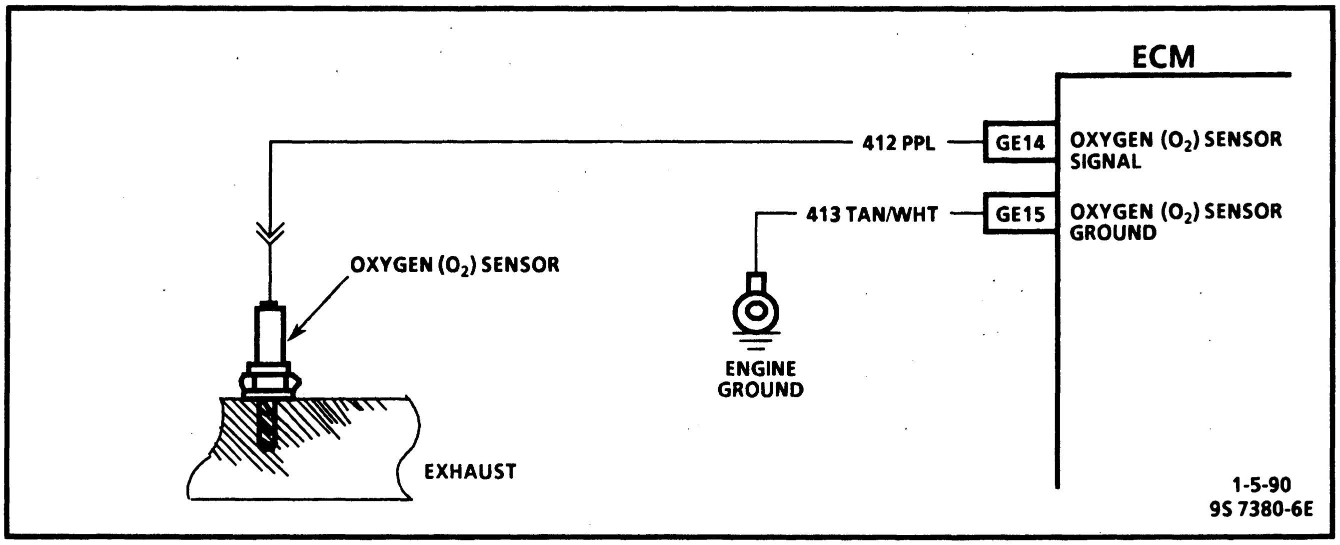
FUEL SYSTEM DIAGNOSIS 5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



* 5S 1627-6E

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

4-27-88



CODE 13

OXYGEN SENSOR CIRCUIT
(OPEN CIRCUIT)
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

The ECM supplies a voltage of about .45 volt between terminals "GE14" and "GE15." (If measured with a 10 megohm digital voltmeter, this may read as low as .32 volt.) The O_2 sensor varies the voltage within a range of about 1 volt if the exhaust is rich, down through about .10 volt if exhaust is lean.

The sensor is like an open circuit and produces no voltage when it is below 360 °C (600°F). An open sensor circuit or cold sensor causes "Open Loop" operation.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 13 will set:
   - Engine at normal operating temperature (above 80°C/176°F).
   - At least 2 minutes engine time after start.
   - O_2 signal voltage steady between .35 and .55 volt.
   - Throttle position sensor signal above 5%. (about .3 volt above closed throttle voltage).
   - All conditions must be met for about 60 seconds.

   If the conditions for a Code 13 exist, the system will not go "Closed Loop."
2. This will determine if the oxygen sensor is at fault or the wiring or ECM is the cause of the Code 13.
3. For this test use only a high impedance digital volt ohmmeter. This test checks the continuity of CKT 412 and CKT 413. If CKT 413 is open, the ECM voltage on CKT 412 will be over .6 volt (600 mv).

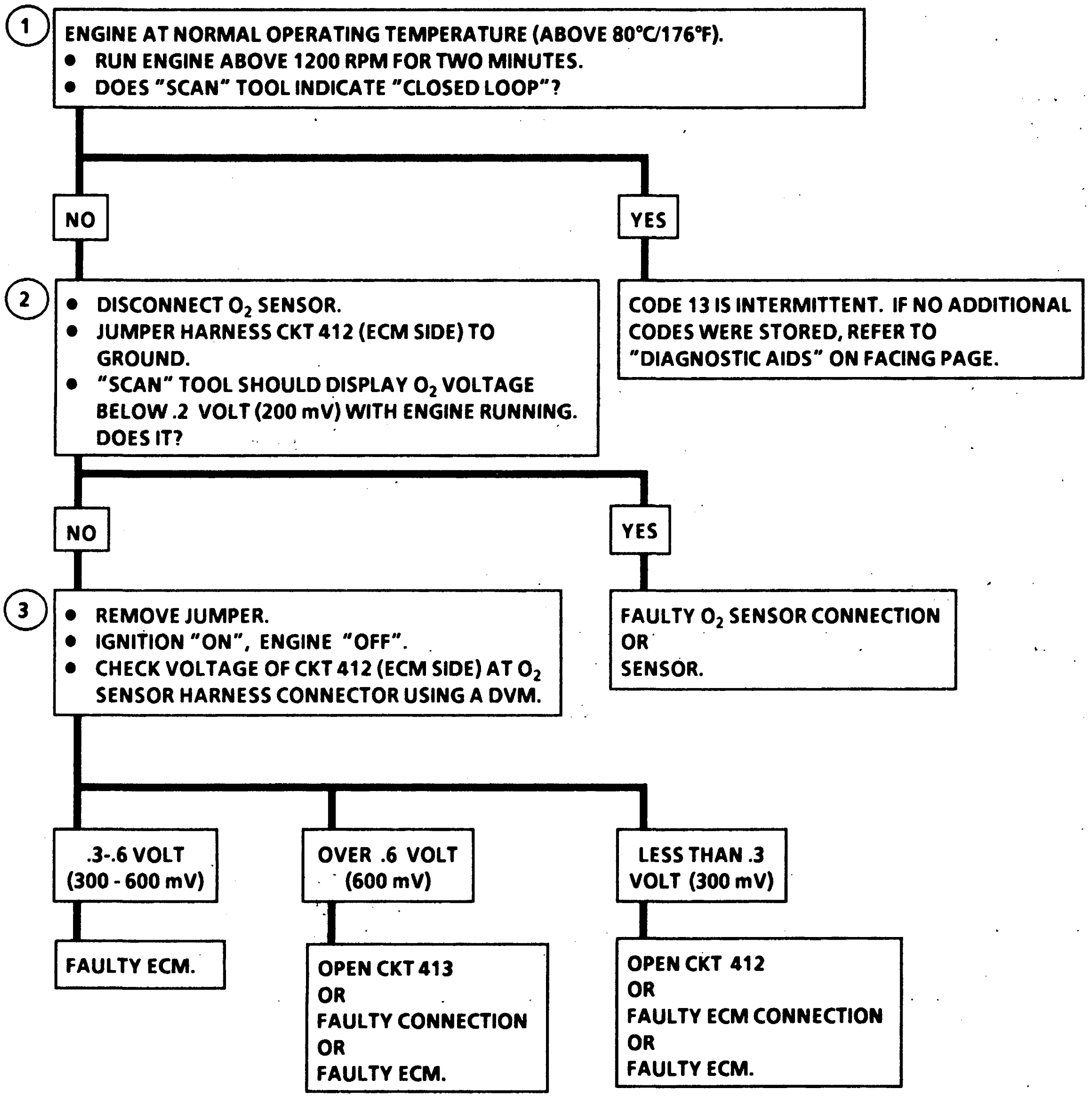
Diagnostic Aids:

Normal "Scan" tool voltage readings varies between 100mv to 999mv (.1 and 1.0 volt) while in "Closed Loop." Code 13 sets in one minute if voltage remains between .35 and .55 volts, the system will go "Open Loop" in about 15 seconds.

Refer to "Intermittents" in Section "B".

CODE 13

OXYGEN SENSOR CIRCUIT
(OPEN CIRCUIT)
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



① ENGINE AT NORMAL OPERATING TEMPERATURE (ABOVE 80°C/176°F).
- RUN ENGINE ABOVE 1200 RPM FOR TWO MINUTES.
- DOES "SCAN" TOOL INDICATE "CLOSED LOOP"?

NO

②
- DISCONNECT O_2 SENSOR.
- JUMPER HARNESS CKT 412 (ECM SIDE) TO GROUND.
- "SCAN" TOOL SHOULD DISPLAY O_2 VOLTAGE BELOW .2 VOLT (200 mV) WITH ENGINE RUNNING. DOES IT?

YES

CODE 13 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

NO

③
- REMOVE JUMPER.
- IGNITION "ON", ENGINE "OFF".
- CHECK VOLTAGE OF CKT 412 (ECM SIDE) AT O_2 SENSOR HARNESS CONNECTOR USING A DVM.

YES

FAULTY O_2 SENSOR CONNECTION
OR
SENSOR.

.3-.6 VOLT (300 - 600 mV)

FAULTY ECM.

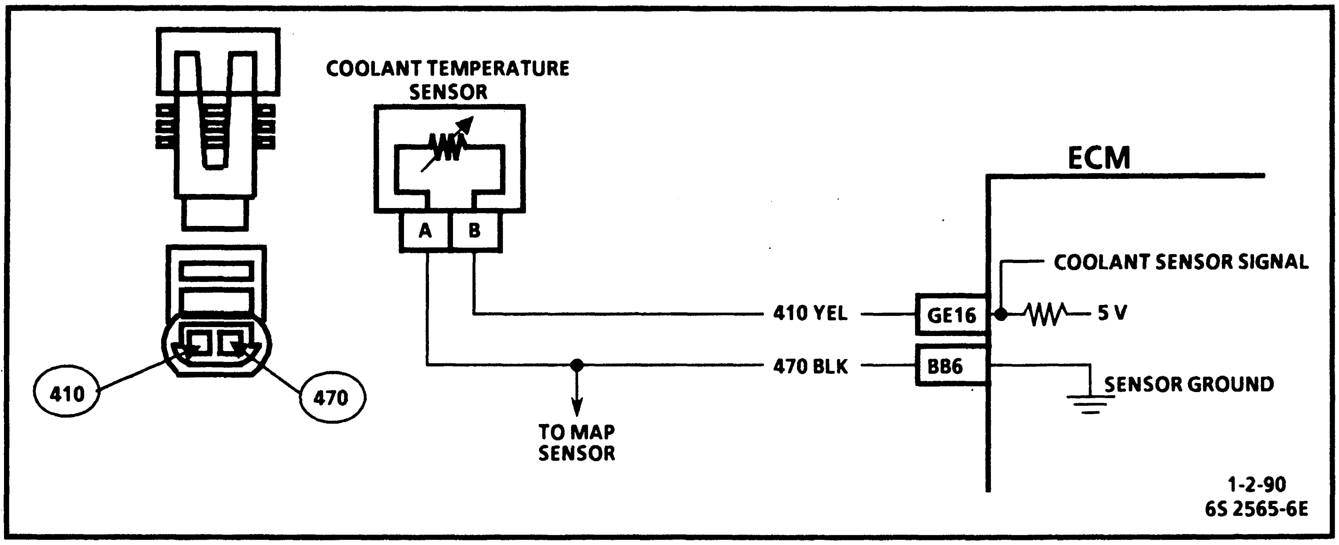
OVER .6 VOLT (600 mV)

OPEN CKT 413
OR
FAULTY CONNECTION
OR
FAULTY ECM.

LESS THAN .3 VOLT (300 mV)

OPEN CKT 412
OR
FAULTY ECM CONNECTION
OR
FAULTY ECM.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.



CODE 14

COOLANT TEMPERATURE SENSOR CIRCUIT

(HIGH TEMPERATURE INDICATED)

5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

The Coolant Temperature Sensor (CTS) uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see high signal voltage.

As the engine coolant warms, the sensor resistance becomes less, and the voltage drops. At normal engine operating temperature (85°C - 95°C or 185°F - 203°F), the voltage will measure about 1.5 to 2.0 volts.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 14 will set if:
   - signal voltage indicates a coolant temperature above 130°C (266°F) for 3 seconds
2. This test will determine if CKT 410 is shorted to ground which will cause the conditions for Code 14.

Diagnostic Aids:

Check harness routing for a potential short to ground in CKT 410.

"Scan" tool displays engine temperature in degrees centigrade and farenheit. After engine is started, the temperature should rise steadily to about 90°C (194°F), then stabilize when thermostat opens.

Refer to "Intermittents" in Section "B".

Check For:

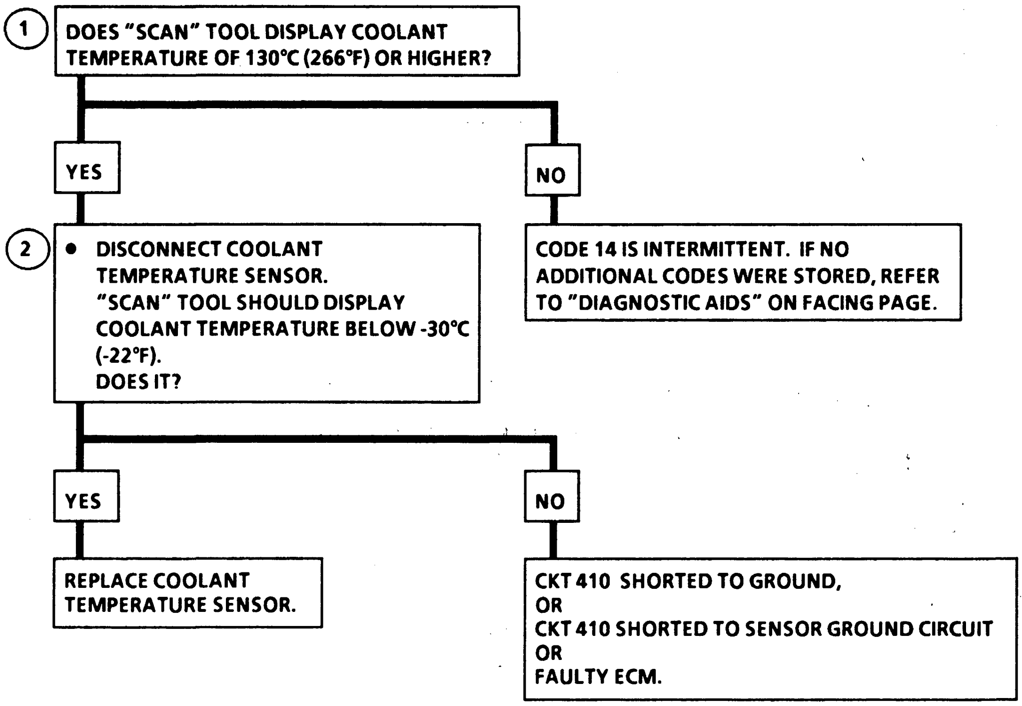
- An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation.
- Poor Connection or Damaged Harness Inspect ECM harness connectors for backed out terminals GE16 or BB6, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection and damaged harness.
- Intermittent Test If connections and harness checks out OK, "Scan" coolant temperature while moving related connectors and wiring harness. If the failure is induced, the "coolant temperature" display will change. This may help to isolate the location of the malfunction.
- Shifted Sensor The "Temperature To Resistance Value" scale may be used to test the coolant sensor at various temperature levels to evaluate the possibility of a "shifted" (mis-scaled) sensor which may result in driveability complaints.

CODE 14

COOLANT TEMPERATURE SENSOR CIRCUIT

(HIGH TEMPERATURE INDICATED)

5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



① DOES "SCAN" TOOL DISPLAY COOLANT TEMPERATURE OF 130°C (266°F) OR HIGHER?

YES

②
- DISCONNECT COOLANT TEMPERATURE SENSOR.
  "SCAN" TOOL SHOULD DISPLAY COOLANT TEMPERATURE BELOW -30°C (-22°F).
  DOES IT?

YES

REPLACE COOLANT TEMPERATURE SENSOR.

NO

CKT 410 SHORTED TO GROUND,
OR
CKT 410 SHORTED TO SENSOR GROUND CIRCUIT
OR
FAULTY ECM.

NO

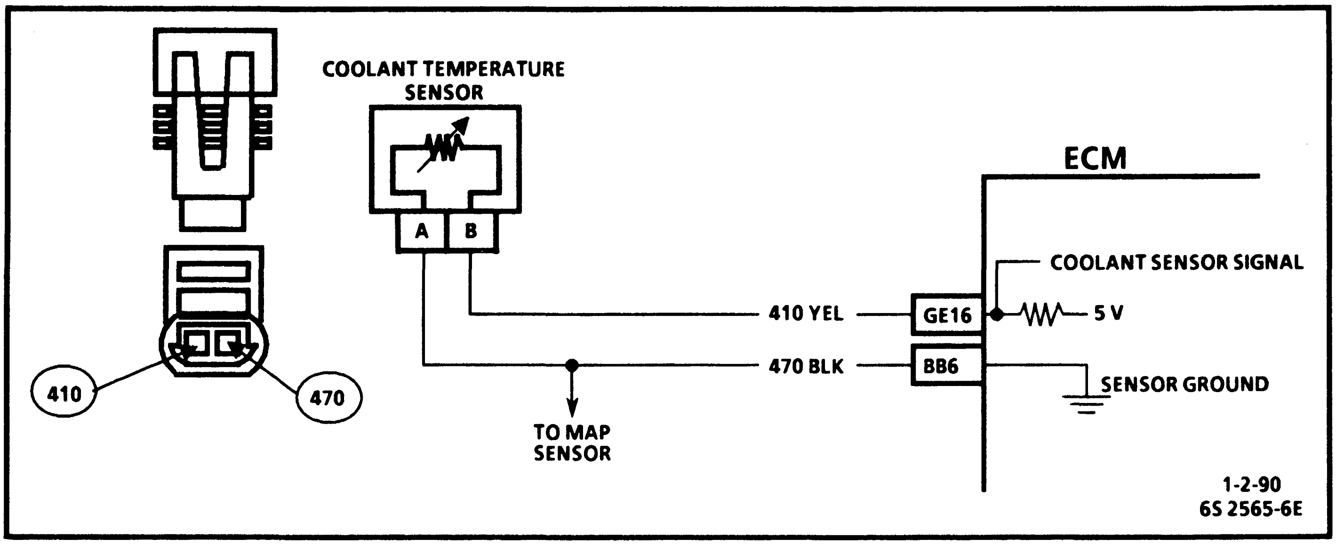
CODE 14 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

DIAGNOSTIC AID

COOLANT SENSOR TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)		
°C	°F	OHMS
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

AFTER REPAIRS CLEAR CODES, RUN ENGINE 5 MINUTES, AND RECHECK FOR CODES.

11-22-89
• 7S 3055-6E



CODE 15

COOLANT TEMPERATURE SENSOR CIRCUIT

(LOW TEMPERATURE INDICATED)

5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

The Coolant Temperature Sensor (CTS) uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see high signal voltage.

As the engine coolant warms, the sensor resistance becomes less, and the voltage drops. At normal engine operating temperature (85°C - 95°C or 185°F - 203°F), the voltage will measure about 1.5 to 2.0 volts.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 15 will set if:
   - Signal voltage indicates an engine coolant temperature less than -49°C (-48°F) for 3 seconds
2. This test simulates a Code 14. If the ECM recognizes the low signal voltage, (high temperature) and the "Scan" tool reads 130°C (266°F) or above, the ECM and wiring are OK.
3. This test will determine if CKT 410 is open. There should be 5 volts present at sensor connector if measured with a DVM.

Diagnostic Aids:

After engine is started the temperature should rise steadily to about 90°C (190°F) than stabilize when the thermostat opens.

A faulty connection or an open in CKT 410 or 470 will result in a Code 15.

If Code 21 or 23 is also set, check CKT 470 for faulty wiring or connections. Check terminals at sensor for good contact.

Refer to "Intermittents" in Section "B".

Check For:

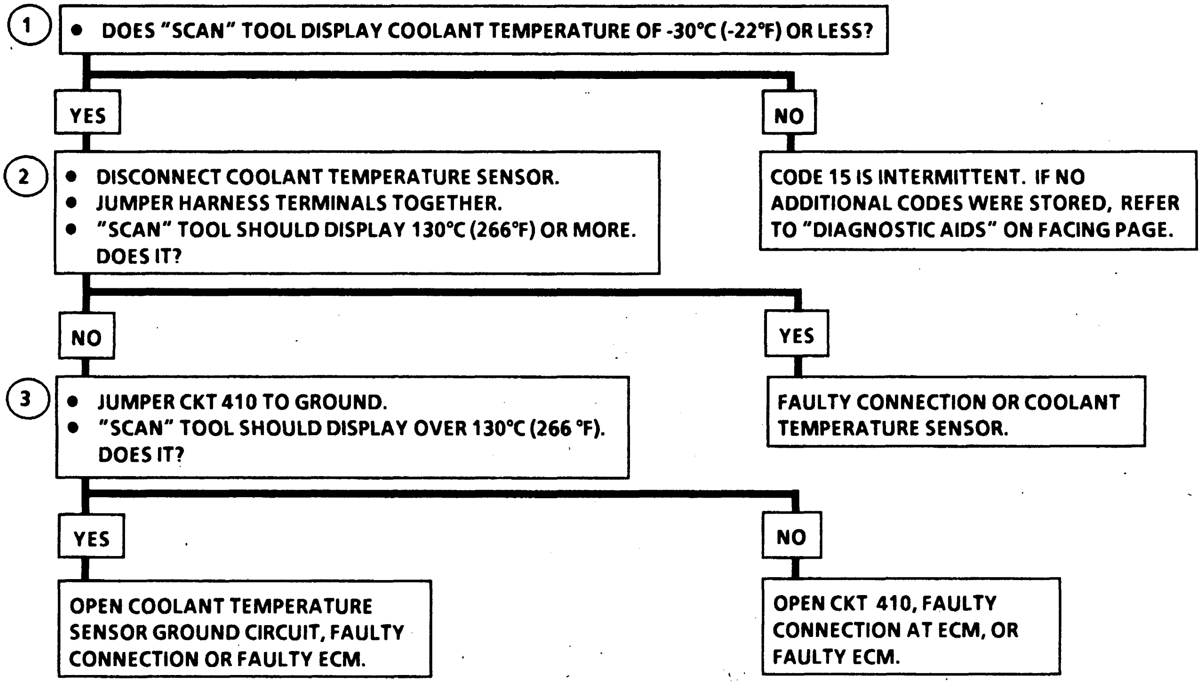
- An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation.
- Poor Connection or Damaged Harness Inspect ECM harness connectors for backed out terminals GE16 or BB6, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection and damaged harness.
- Intermittent Test If connections and harness checks out OK, "Scan" coolant temperature while moving related connectors and wiring harness. If the failure is induced, the "coolant temperature" display will change. This may help to isolate the location of the malfunction.
- Shifted Sensor The "Temperature To Resistance Value" scale may be used to test the coolant sensor at various temperature levels to evaluate the possibility of a "shifted" (mis-scaled) sensor which may result in driveability complaints.

CODE 15

COOLANT TEMPERATURE SENSOR CIRCUIT

(LOW TEMPERATURE INDICATED)

5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



① • DOES "SCAN" TOOL DISPLAY COOLANT TEMPERATURE OF -30°C (-22°F) OR LESS?

YES

② • DISCONNECT COOLANT TEMPERATURE SENSOR.
• JUMPER HARNESS TERMINALS TOGETHER.
• "SCAN" TOOL SHOULD DISPLAY 130°C (266°F) OR MORE. DOES IT?

NO

CODE 15 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

NO

③ • JUMPER CKT 410 TO GROUND.
• "SCAN" TOOL SHOULD DISPLAY OVER 130°C (266 °F). DOES IT?

YES

FAULTY CONNECTION OR COOLANT TEMPERATURE SENSOR.

YES

OPEN COOLANT TEMPERATURE SENSOR GROUND CIRCUIT, FAULTY CONNECTION OR FAULTY ECM.

NO

OPEN CKT 410, FAULTY CONNECTION AT ECM, OR FAULTY ECM.

DIAGNOSTIC AID

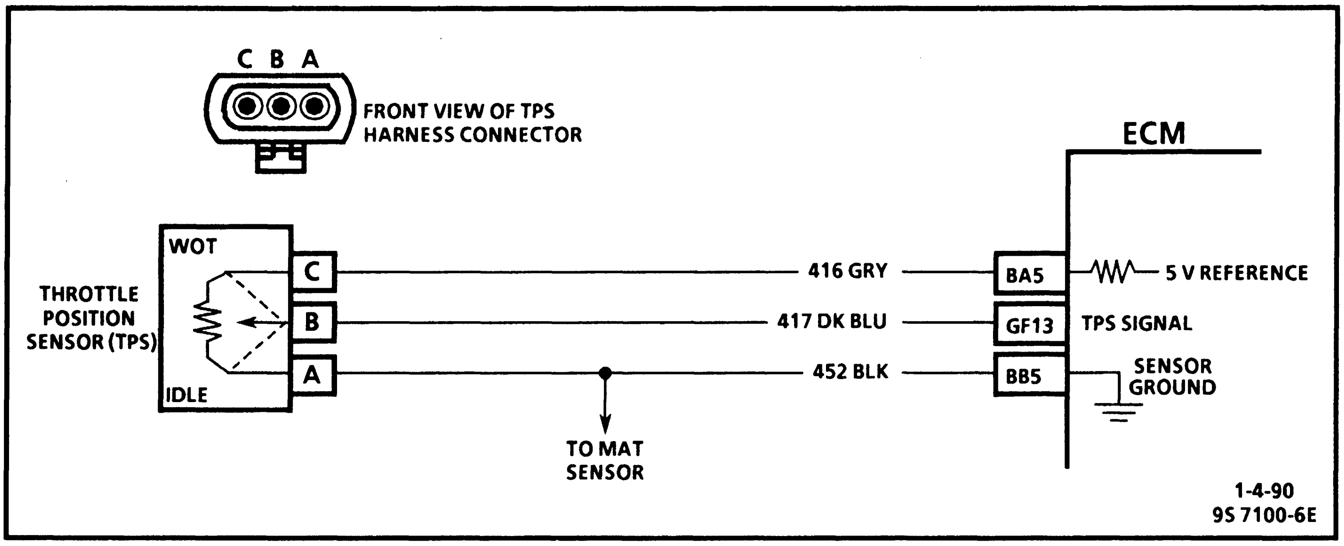
COOLANT SENSOR

TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)

°C	°F	OHMS
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

11-21-89

AFTER REPAIRS, CLEAR CODES, RUN ENGINE 5 MINUTES, AND RECHECK FOR CODES.



CODE 21

THROTTLE POSITION SENSOR (TPS) CIRCUIT

(SIGNAL VOLTAGE HIGH)

5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

The Throttle Position Sensor (TPS) provides a voltage signal that changes relative to the throttle blade. Signal voltage will vary from about .5 at idle to about 5 volts at wide open throttle.

The TPS signal is one of the most important inputs used by the ECM for fuel control and for most of the ECM controlled outputs.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 21 will set if:
   - TPS signal voltage is greater than 2.5 volts
   - Engine is running
   - Air flow is less than 15 GM/sec.
   - All conditions met for 3 seconds.

   OR
   - TPS signal voltage over about 4.9 volts with ignition "ON."

   With throttle closed, the TPS should read less than .96 volt. If it doesn't replace TPS sensor.
2. With the TPS sensor disconnected, the TPS voltage should go low if the ECM and wiring are OK.
3. Probing circuit with a test light to 12 volts checks the sensor ground CKT 452. A faulty sensor ground will cause a Code 21.

Diagnostic Aids:

A "Scan" tool reads throttle position in volts. With ignition "ON" or at idle TPS signal, voltage should read between .36V and .96V with the throttle closed and increase at a steady rate as throttle is moved toward WOT.

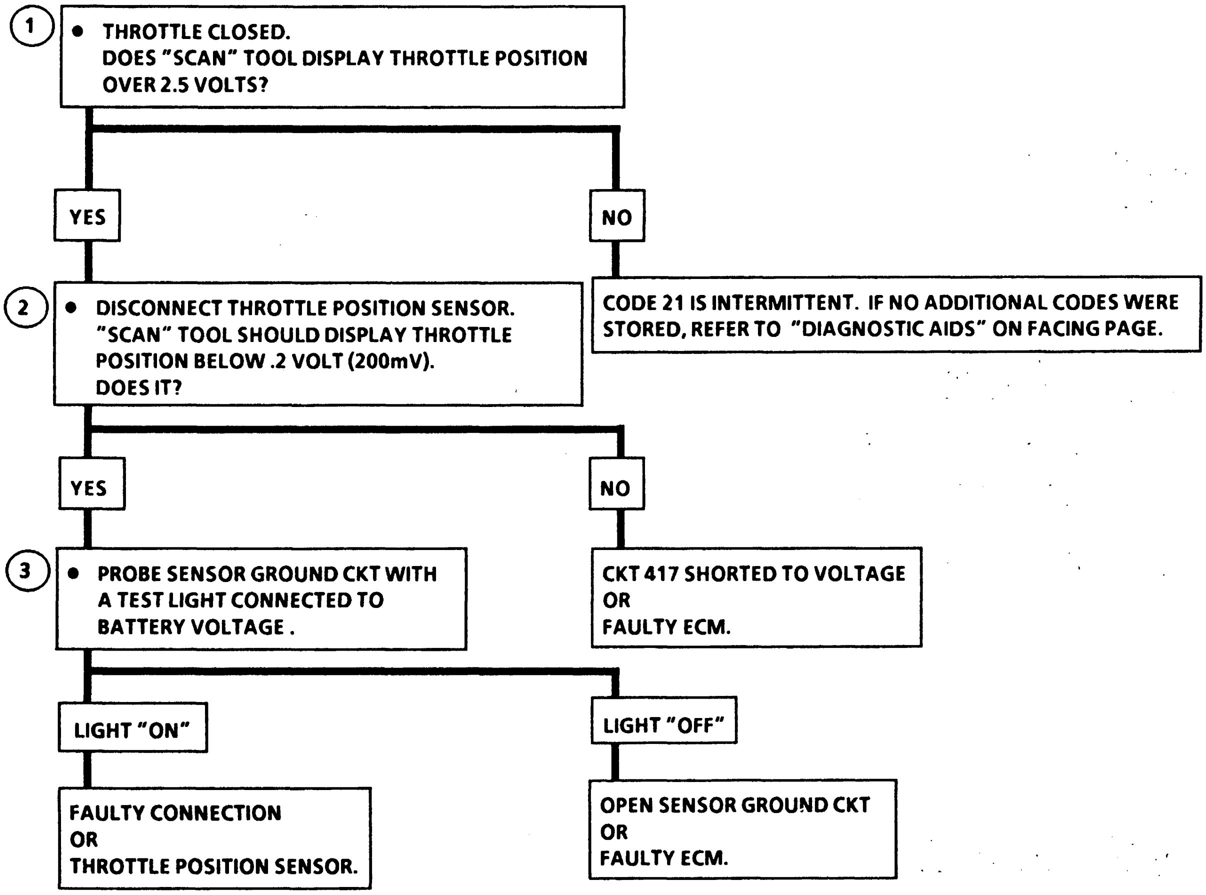
Also some "Scan" tools will read throttle angle, closed throttle equals 0% and wide open throttle equals 100%.

An open in CKT 452 will result in a Code 21.

Refer to "Intermittents" in Section "B".

CODE 21

THROTTLE POSITION SENSOR (TPS) CIRCUIT
(SIGNAL VOLTAGE HIGH)
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



① • THROTTLE CLOSED. DOES "SCAN" TOOL DISPLAY THROTTLE POSITION OVER 2.5 VOLTS?

CODE 21 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

② • DISCONNECT THROTTLE POSITION SENSOR. "SCAN" TOOL SHOULD DISPLAY THROTTLE POSITION BELOW .2 VOLT (200mV). DOES IT?

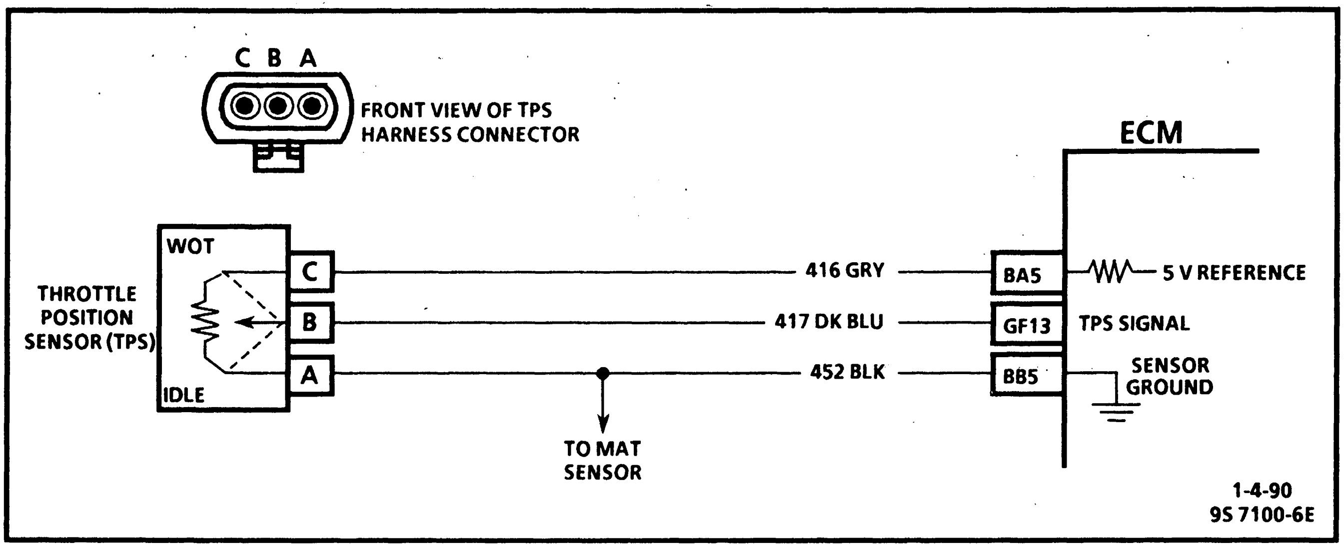
CKT 417 SHORTED TO VOLTAGE
OR
FAULTY ECM.

③ • PROBE SENSOR GROUND CKT WITH A TEST LIGHT CONNECTED TO BATTERY VOLTAGE.

FAULTY CONNECTION
OR
THROTTLE POSITION SENSOR.

OPEN SENSOR GROUND CKT
OR
FAULTY ECM.

"*AFTER REPAIRS*, CLEAR CODES, RUN ENGINE FOR 2 MINUTES, AND RECHECK FOR CODES."



CODE 22

THROTTLE POSITION SENSOR (TPS) CIRCUIT
(SIGNAL VOLTAGE LOW)
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

The Throttle Position Sensor (TPS) provides a voltage signal that changes relative to the throttle blade. Signal voltage will vary from about .54 at idle to about 5 volts at Wide Open Throttle (WOT).

The TPS signal is one of the most important inputs used by the ECM for fuel control and for most of the ECM controlled outputs.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 22 will set if:
   - Engine running
   - TPS signal voltage is less than about .2 volt for 3 seconds.
2. Simulates Code 21: (high voltage) If the ECM recognizes the high signal voltage the ECM and wiring are OK.
3. TPS: With throttle closed, the TPS voltage reading should be between .36V and 96V.
4. Simulates a high signal voltage to check for an open in CKT 417.

Diagnostic Aids:

A "Scan" tool reads throttle position in volts. With ignition "ON" or at idle, TPS signal voltage should read between 36V and .96V with the throttle closed and increase at a steady rate as throttle is moved toward WOT.

An open or short to ground in CKT 416 or CKT 417 will result in a Code 22.

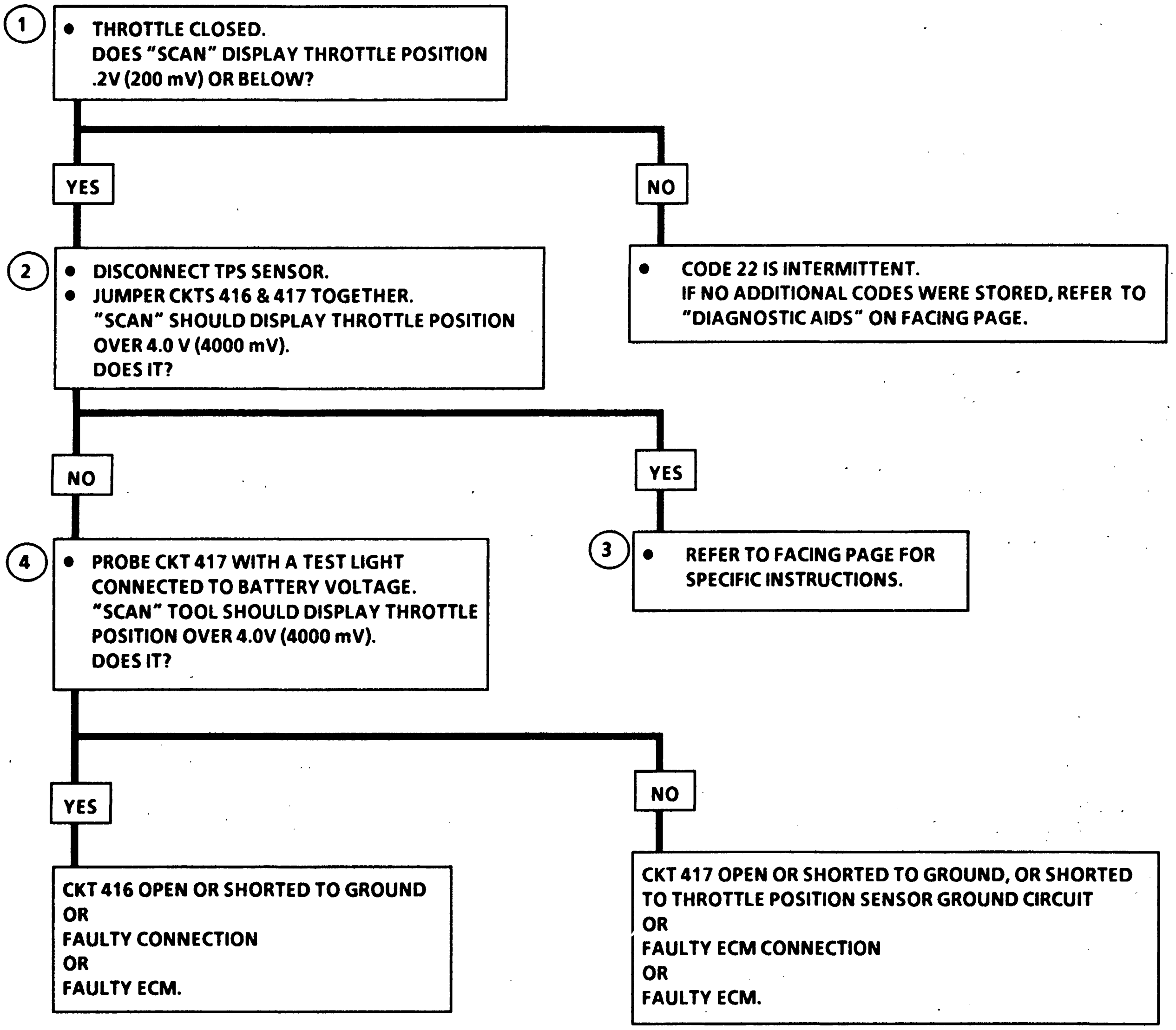
Refer to "Intermittents" in Section "B".

CODE 22

THROTTLE POSITION SENSOR (TPS) CIRCUIT

(SIGNAL VOLTAGE LOW)

5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



①
- THROTTLE CLOSED.
  DOES "SCAN" DISPLAY THROTTLE POSITION .2V (200 mV) OR BELOW?

②
- DISCONNECT TPS SENSOR.
- JUMPER CKTS 416 & 417 TOGETHER.
  "SCAN" SHOULD DISPLAY THROTTLE POSITION OVER 4.0 V (4000 mV).
  DOES IT?

- CODE 22 IS INTERMITTENT.
  IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

④
- PROBE CKT 417 WITH A TEST LIGHT CONNECTED TO BATTERY VOLTAGE.
  "SCAN" TOOL SHOULD DISPLAY THROTTLE POSITION OVER 4.0V (4000 mV).
  DOES IT?

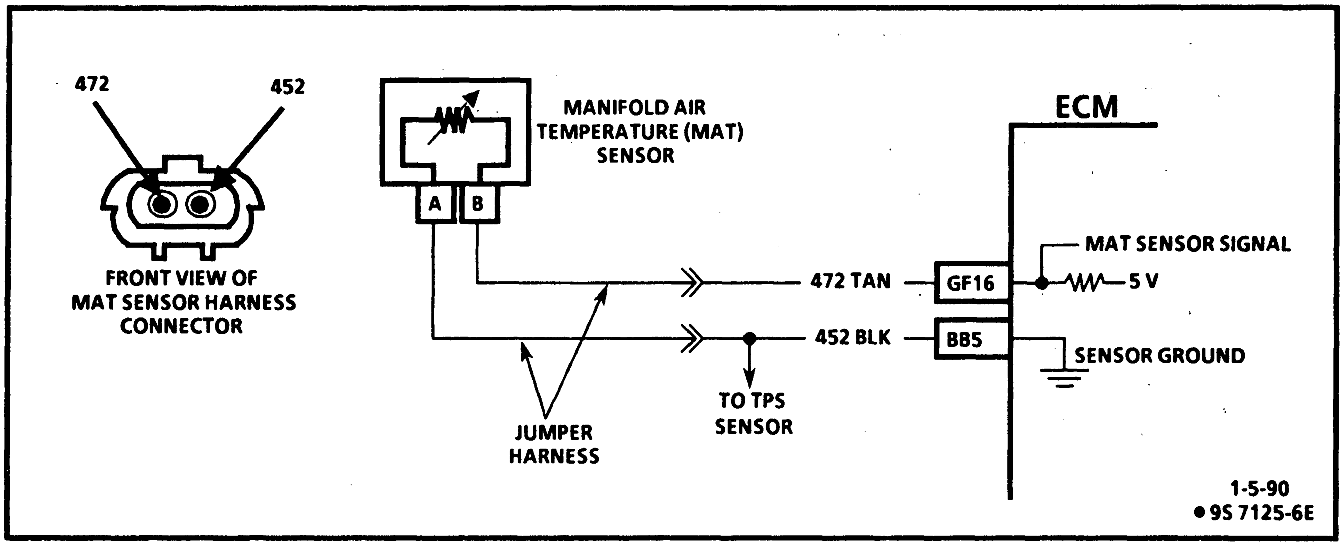
③
- REFER TO FACING PAGE FOR SPECIFIC INSTRUCTIONS.

CKT 416 OPEN OR SHORTED TO GROUND
OR
FAULTY CONNECTION
OR
FAULTY ECM.

CKT 417 OPEN OR SHORTED TO GROUND, OR SHORTED TO THROTTLE POSITION SENSOR GROUND CIRCUIT
OR
FAULTY ECM CONNECTION
OR
FAULTY ECM.

AFTER REPAIRS, CLEAR CODES, RUN ENGINE FOR 2 MINUTES, AND RECHECK FOR CODES.

1-4-90
● 7S 3365-6E



CODE 23

MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT
(LOW TEMPERATURE INDICATED)
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

The Manifold Air Temperature (MAT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage (about 5 volts) on CKT 472 to the sensor. When the manifold air is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see a high signal voltage. If the manifold air is warm, the sensor (thermistor) resistance is low, therefore, the ECM will see a low voltage.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 23 will set if:
   - A signal voltage indicates a manifold air temperature below -30°C (-22°F) for 12 seconds.
   - Time since engine start is 1 minute or longer.
   - No VSS (vehicle not moving).
2. A Code 23 will set, due to an open sensor, wire or connection. This test will determine if the wiring and ECM are OK. The MAT sensor is difficult to reach and this test can be performed by disconnecting the MAT jumper harness connector. If the "Scan" indicates a temperature of over 130°C (266°F) the jumper harness to the sensor should be checked before replacing the sensor.
3. This will determine if the MAT sensor signal (CKT 472) or the MAT sensor ground (CKT 452) is open.

Diagnostic Aids:

A "Scan" tool reads temperature of the air entering the engine and should read close to ambient air temperature when engine is cold, and rises as underhood temperature increases. If the engine has been allowed to sit overnight, the manifold air temperature and coolant temperature values should read within a few degrees of each other.

Carefully check harness and connections for possible open CKT 472 or CKT 452.

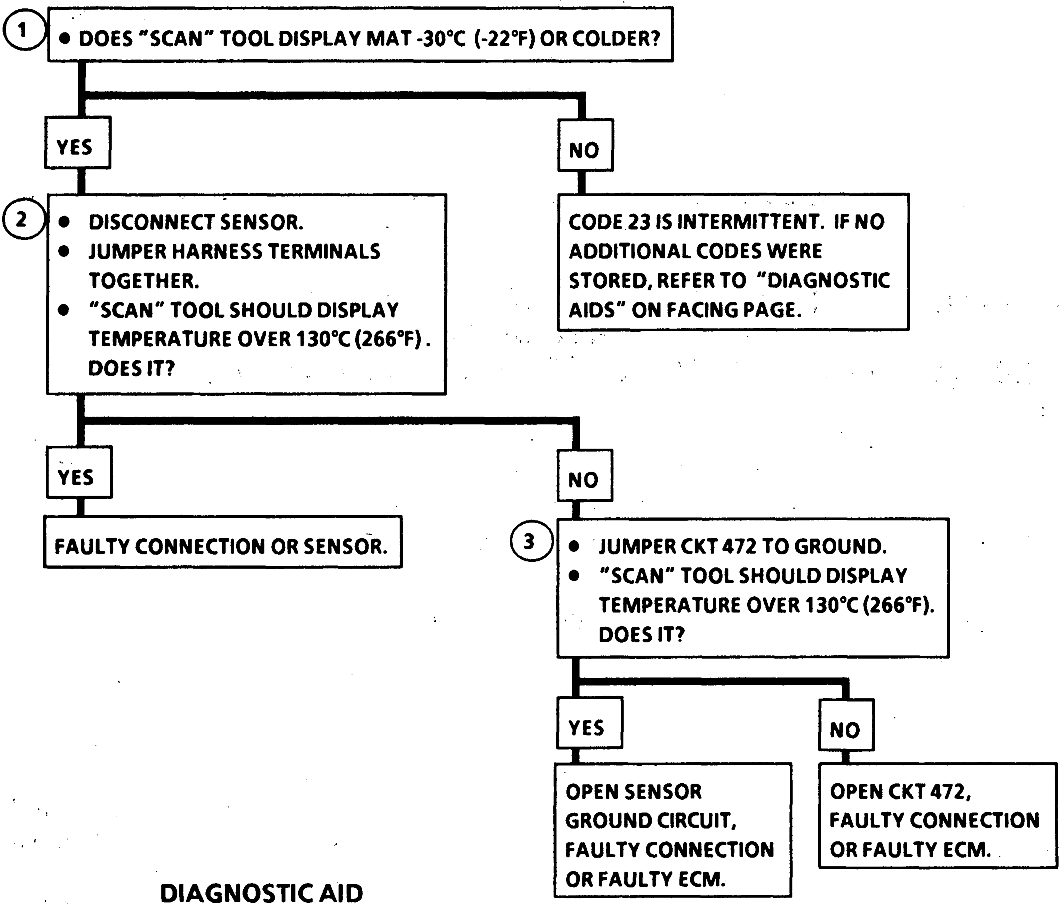
Refer to "Intermittents" in Section "B".

CODE 23

MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT

(LOW TEMPERATURE INDICATED)

5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



① • DOES "SCAN" TOOL DISPLAY MAT -30°C (-22°F) OR COLDER?

YES:

② • DISCONNECT SENSOR.
• JUMPER HARNESS TERMINALS TOGETHER.
• "SCAN" TOOL SHOULD DISPLAY TEMPERATURE OVER 130°C (266°F). DOES IT?

YES: FAULTY CONNECTION OR SENSOR.

NO:

③ • JUMPER CKT 472 TO GROUND.
• "SCAN" TOOL SHOULD DISPLAY TEMPERATURE OVER 130°C (266°F). DOES IT?

YES: OPEN SENSOR GROUND CIRCUIT, FAULTY CONNECTION OR FAULTY ECM.

NO: OPEN CKT 472, FAULTY CONNECTION OR FAULTY ECM.

NO: CODE 23 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

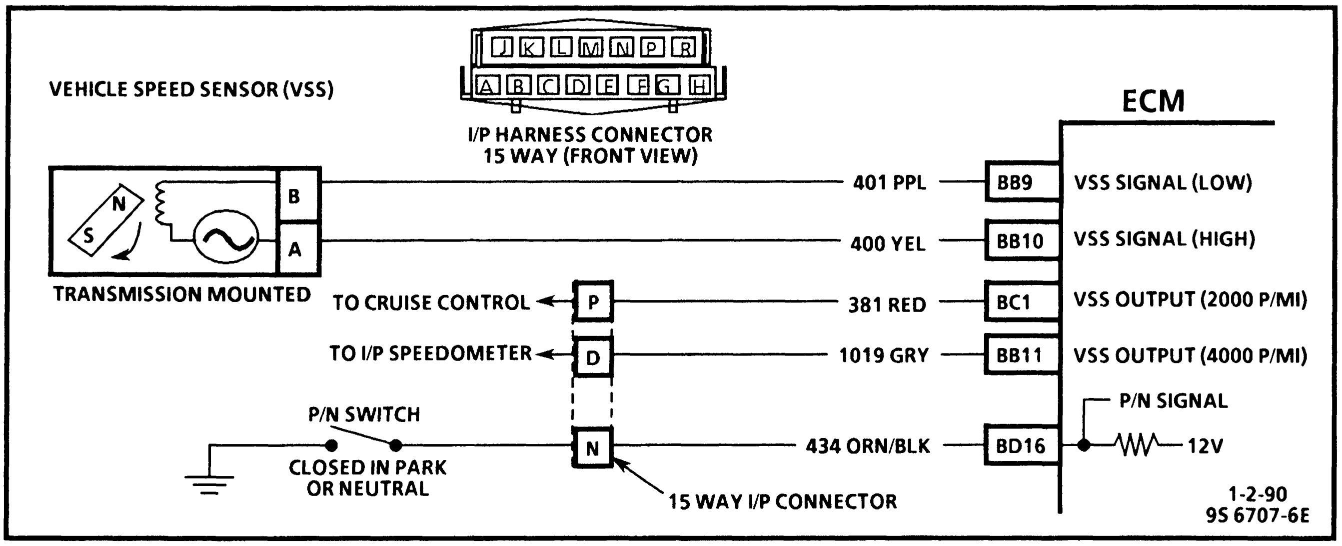
DIAGNOSTIC AID

MAT SENSOR

TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)

°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.



CODE 24

VEHICLE SPEED SENSOR (VSS) CIRCUIT
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

Vehicle speed information is provided to the ECM by the Vehicle Speed Sensor (VSS), which is a Permanent Magnet (PM) generator and it is mounted in the transmission. The PM generator produces a pulsing voltage whenever vehicle speed is over about 3 mph. The A/C voltage level and the number of pulses increases with vehicle speed. The ECM then converts the pulsing voltage to mph which is used for calculations, and the mph can be displayed with a "Scan" tool.

The function of VSS buffer used in past model years has been incorporated into the ECM. The ECM then supplies the necessary signal for the instrument panel (4000 pulses per mile) for operating the speedometer and the odometer. If the vehicle is equipped with cruise control, the ECM also provides a signal (2000 pulses per mile) to the cruise control module.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 24 will set if vehicle speed equals 0 mph when:
   - Coolant temperature is greater than 85°C (185°F)
   - Engine speed is between 2200 and 4400 rpm
   - TPS is less than 2%
   - Low load condition (low air flow)
   - Not in park or neutral
   - All conditions met for 3 seconds

   These conditions are met during a road load deceleration. Disregard Code 24 that sets when drive wheels are not turning.
   - The PM generator only produces a signal if drive wheels are turning greater than 3 mph.
2. CKTs 400, 401 and 1019 are OK if the speedometer works properly. Code 24 is being caused by a faulty ECM, faulty MEM-CAL or an incorrect MEM-CAL.

Diagnostic Aids:

"Scan" should indicate a vehicle speed whenever the drive wheels are turning greater than 3 mph.

A problem in CKT 1019 or CKT 381 will not affect the VSS input or the readings on a "Scan."

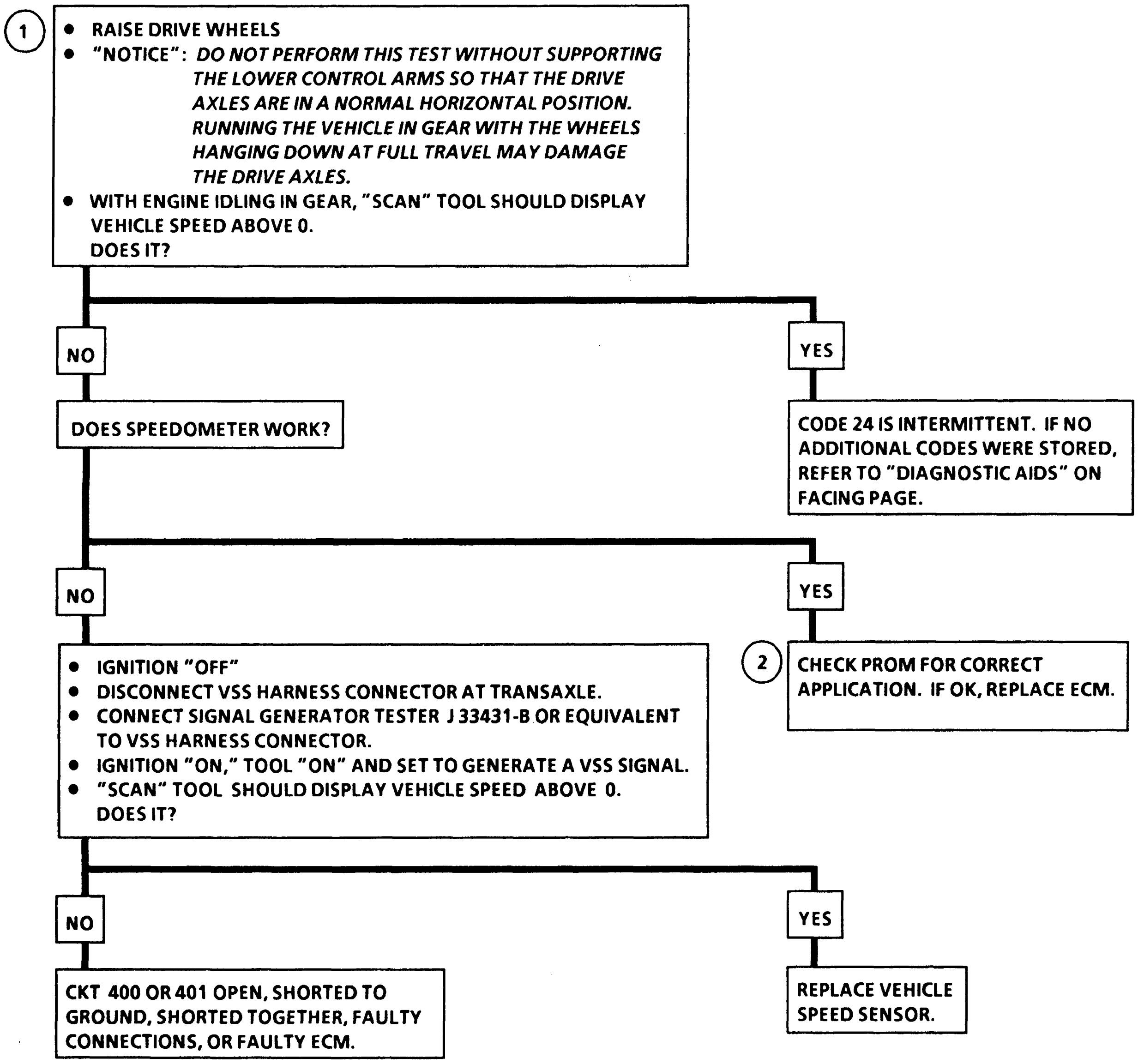
Check CKTs 400 and 401 for proper connections to be sure they're clean and tight and the harness is routed correctly. Refer to "Intermittents" in "Symptoms," Section "6E3-B".

(A/T) A faulty or misadjusted Park/Neutral (P/N) switch can result in a false Code 24. Use a "Scan" and check for proper signal while in drive or overdrive. Refer to CHART C-1A for P/N switch diagnosis check.

CODE 24

VEHICLE SPEED SENSOR (VSS) CIRCUIT
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

DISREGARD CODE 24 IF SET WHILE DRIVE WHEELS ARE NOT TURNING.



①
- RAISE DRIVE WHEELS
- "NOTICE": *DO NOT PERFORM THIS TEST WITHOUT SUPPORTING THE LOWER CONTROL ARMS SO THAT THE DRIVE AXLES ARE IN A NORMAL HORIZONTAL POSITION. RUNNING THE VEHICLE IN GEAR WITH THE WHEELS HANGING DOWN AT FULL TRAVEL MAY DAMAGE THE DRIVE AXLES.*
- WITH ENGINE IDLING IN GEAR, "SCAN" TOOL SHOULD DISPLAY VEHICLE SPEED ABOVE 0.
  DOES IT?

NO

DOES SPEEDOMETER WORK?

YES

CODE 24 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

NO

- IGNITION "OFF"
- DISCONNECT VSS HARNESS CONNECTOR AT TRANSAXLE.
- CONNECT SIGNAL GENERATOR TESTER J 33431-B OR EQUIVALENT TO VSS HARNESS CONNECTOR.
- IGNITION "ON," TOOL "ON" AND SET TO GENERATE A VSS SIGNAL.
- "SCAN" TOOL SHOULD DISPLAY VEHICLE SPEED ABOVE 0.
  DOES IT?

YES

② CHECK PROM FOR CORRECT APPLICATION. IF OK, REPLACE ECM.

NO

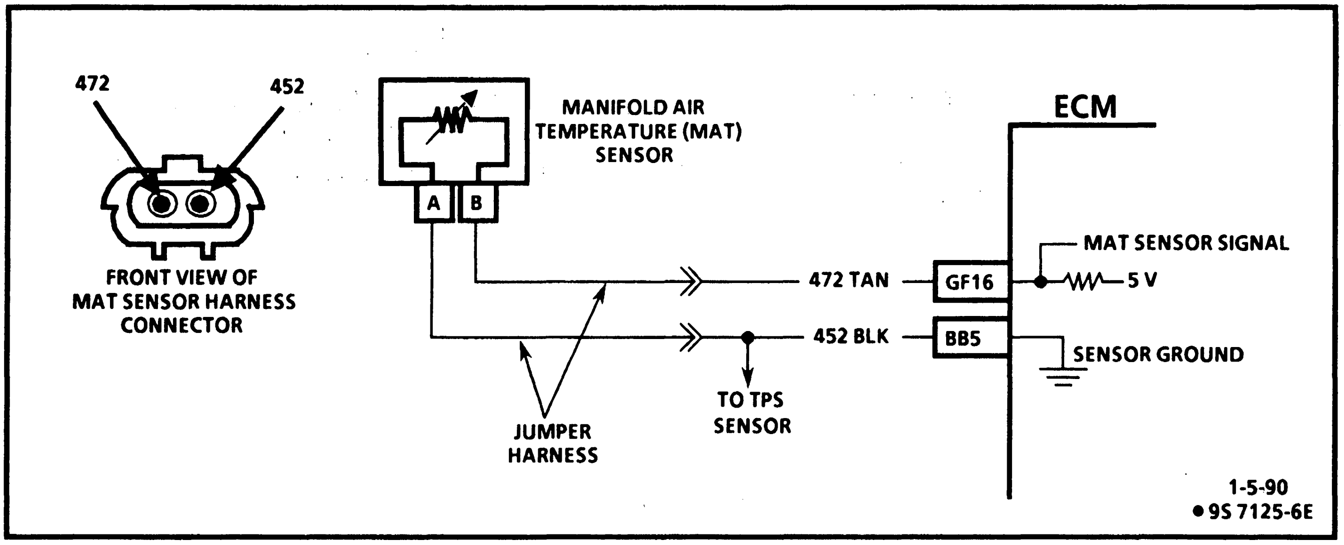
CKT 400 OR 401 OPEN, SHORTED TO GROUND, SHORTED TOGETHER, FAULTY CONNECTIONS, OR FAULTY ECM.

YES

REPLACE VEHICLE SPEED SENSOR.

CLEAR CODES AND CONFIRM "CLOSED LOOP " OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

5-23-88
• 7S 3269-6E



CODE 25

MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT
(HIGH TEMPERATURE INDICATED)
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

The Manifold Air Temperature (MAT) sensor uses a thermistor to control the signal-voltage to the ECM. The ECM applies a voltage (about 5 volts) on CKT 472 to the sensor. When manifold air is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see a high signal voltage. If the manifold air is warm, the sensor (thermistor) resistance is low, therefore, the ECM will see a low signal voltage.

Test Description: Number below refers to the circled number on the diagnostic chart.

1. Code 25 will set if:
   - Signal voltage indicates a manifold air temperature greater than 150°C (302° F) for 2 seconds.
   - Time since engine start is 2 minutes or longer.
   - A vehicle speed is present, greater than 5 mph.

Diagnostic Aids:

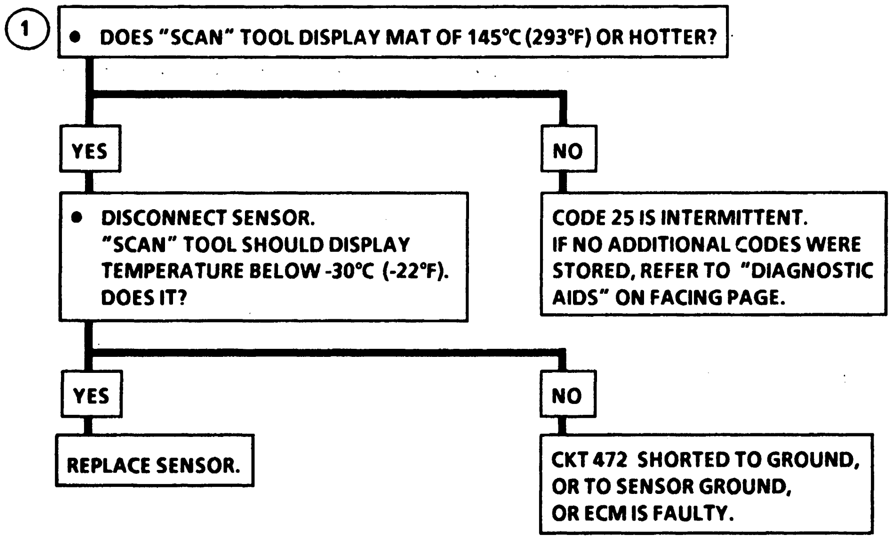
A "Scan" tool reads temperature of the air entering the engine and should read close to ambient air temperature when engine is cold, and rise as underhood temperature increases.

Check harness routing for possible short to ground in CKT 472.

Refer to "Intermittents" in Section "B".

CODE 25

MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT
(HIGH TEMPERATURE INDICATED)
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



① • DOES "SCAN" TOOL DISPLAY MAT OF 145°C (293°F) OR HOTTER?

YES

• DISCONNECT SENSOR.
"SCAN" TOOL SHOULD DISPLAY TEMPERATURE BELOW -30°C (-22°F).
DOES IT?

YES

REPLACE SENSOR.

NO

CKT 472 SHORTED TO GROUND, OR TO SENSOR GROUND, OR ECM IS FAULTY.

NO

CODE 25 IS INTERMITTENT.
IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

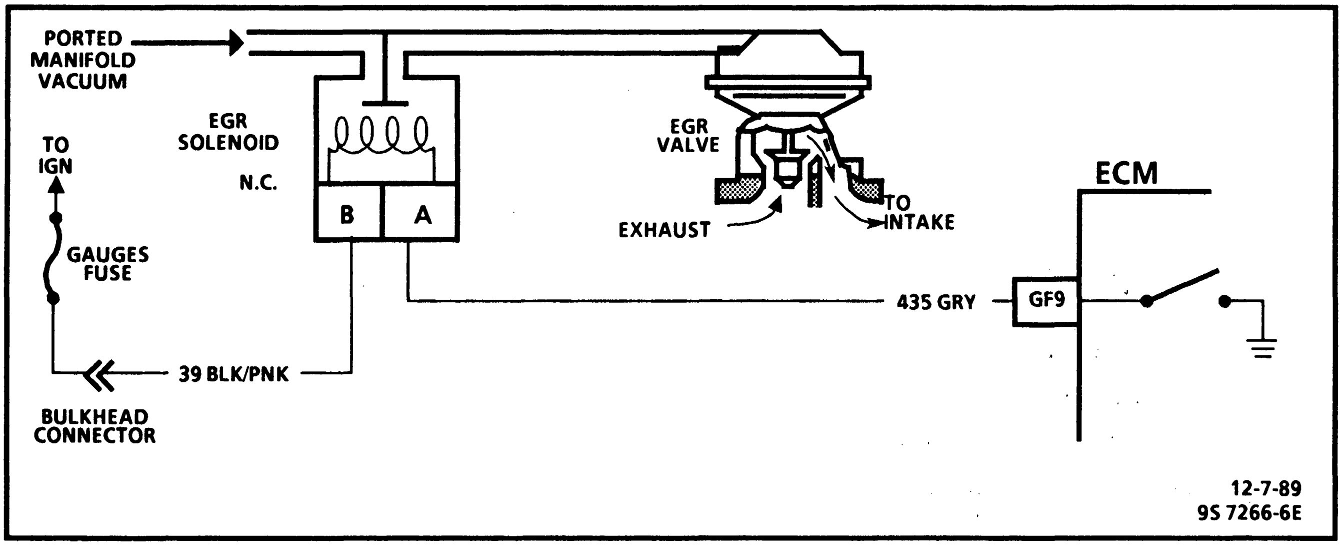
DIAGNOSTIC AID

MAT SENSOR

TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)

°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.



CODE 32

EXHAUST GAS RECIRCULATION (EGR) CIRCUIT 5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

The Exhaust Gas Recirculation (EGR) valve vacuum is controlled by an ECM controlled solenoid. The ECM will turn the EGR "ON" and "OFF" (Duty Cycle) by grounding CKT 435. The duty cycle is calculated by the ECM, based on information from the coolant temperatures, air flow and engine rpms. There should be no EGR when in park or neutral, TPS input below a specified value or TPS indicating Wide Open Throttle (WOT).

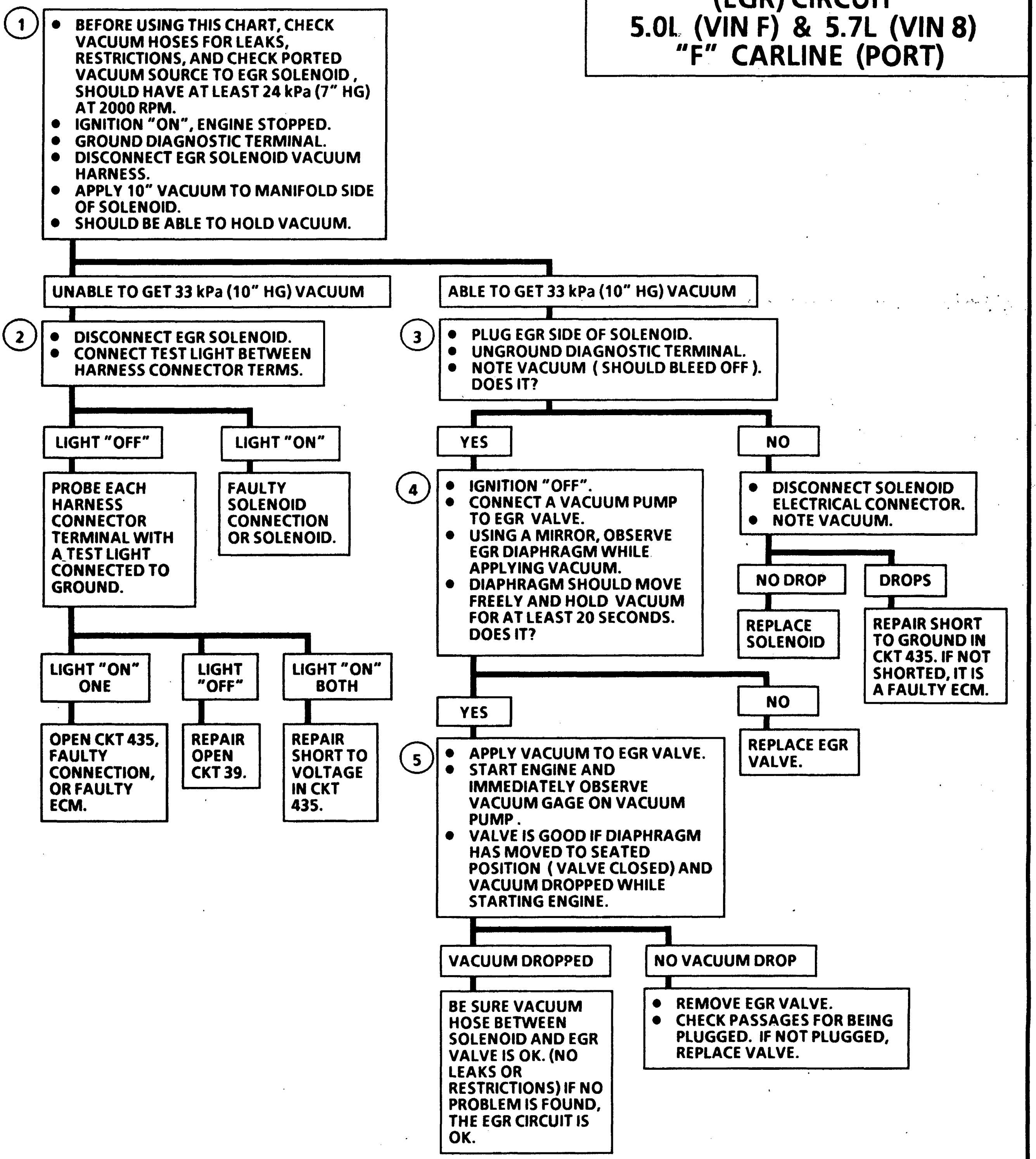
With the ignition "ON" engine stopped, the EGR solenoid is de-energized and, by grounding the diagnostic "test" terminal the solenoid is energized.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. By grounding the diagnostic "test" terminal, the EGR solenoid should close, and allow vacuum to be applied and the vacuum should hold.
2. This test will determine if the electrical control part of the system is at fault or if the connector or solenoid are at fault.
3. By plugging the EGR valve side and ungrounding the diagnostic "test" terminal, the solenoid valve should open and allow vacuum to bleed off through the vent.
4. With the engine not running and vacuum is applied to the valve, the valve should move to the fully open position.
5. This engine uses a negative back pressure EGR valve, and the valve should close when the engine is cranked over.

CODE 32

EXHAUST GAS RECIRCULATION (EGR) CIRCUIT 5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



①
- BEFORE USING THIS CHART, CHECK VACUUM HOSES FOR LEAKS, RESTRICTIONS, AND CHECK PORTED VACUUM SOURCE TO EGR SOLENOID, SHOULD HAVE AT LEAST 24 kPa (7" HG) AT 2000 RPM.
- IGNITION "ON", ENGINE STOPPED.
- GROUND DIAGNOSTIC TERMINAL.
- DISCONNECT EGR SOLENOID VACUUM HARNESS.
- APPLY 10" VACUUM TO MANIFOLD SIDE OF SOLENOID.
- SHOULD BE ABLE TO HOLD VACUUM.

UNABLE TO GET 33 kPa (10" HG) VACUUM

②
- DISCONNECT EGR SOLENOID.
- CONNECT TEST LIGHT BETWEEN HARNESS CONNECTOR TERMS.

LIGHT "OFF"

PROBE EACH HARNESS CONNECTOR TERMINAL WITH A TEST LIGHT CONNECTED TO GROUND.

LIGHT "ON" ONE

OPEN CKT 435, FAULTY CONNECTION, OR FAULTY ECM.

LIGHT "OFF"

REPAIR OPEN CKT 39.

LIGHT "ON" BOTH

REPAIR SHORT TO VOLTAGE IN CKT 435.

LIGHT "ON"

FAULTY SOLENOID CONNECTION OR SOLENOID.

ABLE TO GET 33 kPa (10" HG) VACUUM

③
- PLUG EGR SIDE OF SOLENOID.
- UNGROUND DIAGNOSTIC TERMINAL.
- NOTE VACUUM (SHOULD BLEED OFF). DOES IT?

YES

④
- IGNITION "OFF".
- CONNECT A VACUUM PUMP TO EGR VALVE.
- USING A MIRROR, OBSERVE EGR DIAPHRAGM WHILE APPLYING VACUUM.
- DIAPHRAGM SHOULD MOVE FREELY AND HOLD VACUUM FOR AT LEAST 20 SECONDS. DOES IT?

YES

⑤
- APPLY VACUUM TO EGR VALVE.
- START ENGINE AND IMMEDIATELY OBSERVE VACUUM GAGE ON VACUUM PUMP.
- VALVE IS GOOD IF DIAPHRAGM HAS MOVED TO SEATED POSITION (VALVE CLOSED) AND VACUUM DROPPED WHILE STARTING ENGINE.

VACUUM DROPPED

BE SURE VACUUM HOSE BETWEEN SOLENOID AND EGR VALVE IS OK. (NO LEAKS OR RESTRICTIONS) IF NO PROBLEM IS FOUND, THE EGR CIRCUIT IS OK.

NO VACUUM DROP

- REMOVE EGR VALVE.
- CHECK PASSAGES FOR BEING PLUGGED. IF NOT PLUGGED, REPLACE VALVE.

NO

REPLACE EGR VALVE.

NO

- DISCONNECT SOLENOID ELECTRICAL CONNECTOR.
- NOTE VACUUM.

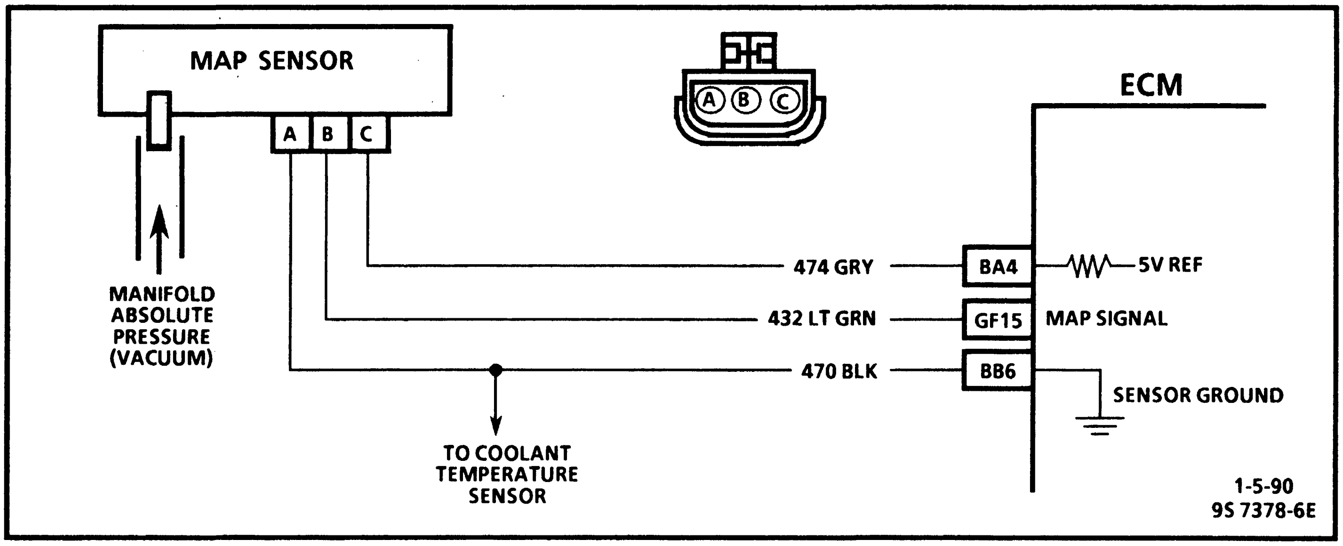
NO DROP

REPLACE SOLENOID

DROPS

REPAIR SHORT TO GROUND IN CKT 435. IF NOT SHORTED, IT IS A FAULTY ECM.

5-4-89
*7S 3286-6E



CODE 33

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT

(SIGNAL VOLTAGE HIGH-LOW VACUUM)

5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1-1.5 volts at idle to 4.5-4.8 volts at wide open throttle.

A "Scan" tool displays manifold pressure in volts. Low pressure (high vacuum) reads a low voltage while a high pressure (low vacuum) reads a high voltage.

If the MAP sensor fails, the ECM will substitute a fixed MAP value and use the Throttle Position Sensor (TPS) to control fuel delivery.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 33 will set when:
   - Signal is too high, (kPa greater than 68 kPa or less than 9" HG), for a time greater than 5 seconds.
   - TPS less than 4%.

   Engine misfire or a low unstable idle may set Code 33. Disconnect MAP sensor and system will go into backup mode. If the misfire or idle condition remains, see "Symptoms" in Section "B".
2. If the ECM recognizes the low MAP signal, the ECM and wiring are OK.

Diagnostic Aids:

If the idle is rough or unstable refer to "Symptoms" in Section "B" for items which can cause an unstable idle.

An open in CKT 470 will result in a Code 33.

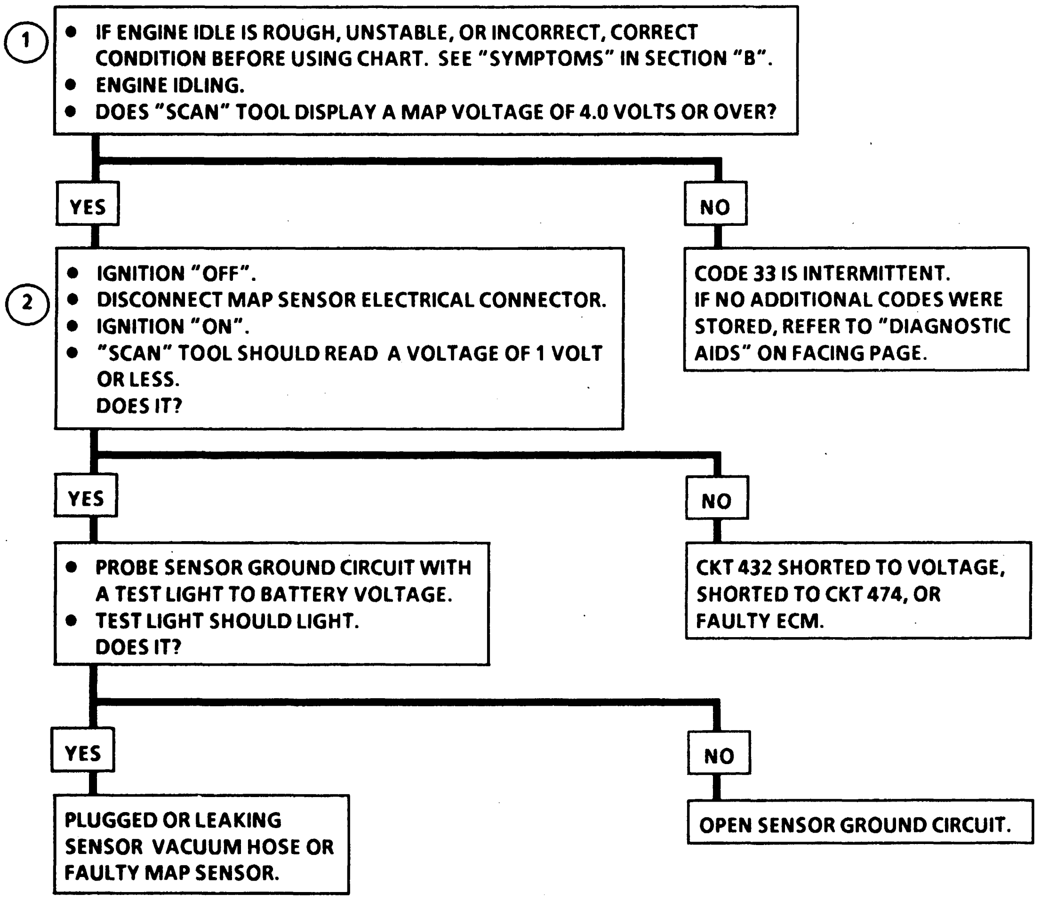
With the ignition "ON" and the engine stopped, the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of vehicle altitude and is referred to as BARO. Comparison of this BARO reading with a known good vehicle with the same sensor is a good way to check accuracy of a "suspect" sensor. Reading should be the same, ± .4 volt.

Also Refer to "Map Output Check," CHART C-1D can be used to test the MAP sensor.

Refer to "Intermittents" in Section"B".

CODE 33

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT
(SIGNAL VOLTAGE HIGH - LOW VACUUM)
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



①
- IF ENGINE IDLE IS ROUGH, UNSTABLE, OR INCORRECT, CORRECT CONDITION BEFORE USING CHART. SEE "SYMPTOMS" IN SECTION "B".
- ENGINE IDLING.
- DOES "SCAN" TOOL DISPLAY A MAP VOLTAGE OF 4.0 VOLTS OR OVER?

YES

②
- IGNITION "OFF".
- DISCONNECT MAP SENSOR ELECTRICAL CONNECTOR.
- IGNITION "ON".
- "SCAN" TOOL SHOULD READ A VOLTAGE OF 1 VOLT OR LESS.
  DOES IT?

NO

CODE 33 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

YES

- PROBE SENSOR GROUND CIRCUIT WITH A TEST LIGHT TO BATTERY VOLTAGE.
- TEST LIGHT SHOULD LIGHT.
  DOES IT?

NO

CKT 432 SHORTED TO VOLTAGE, SHORTED TO CKT 474, OR FAULTY ECM.

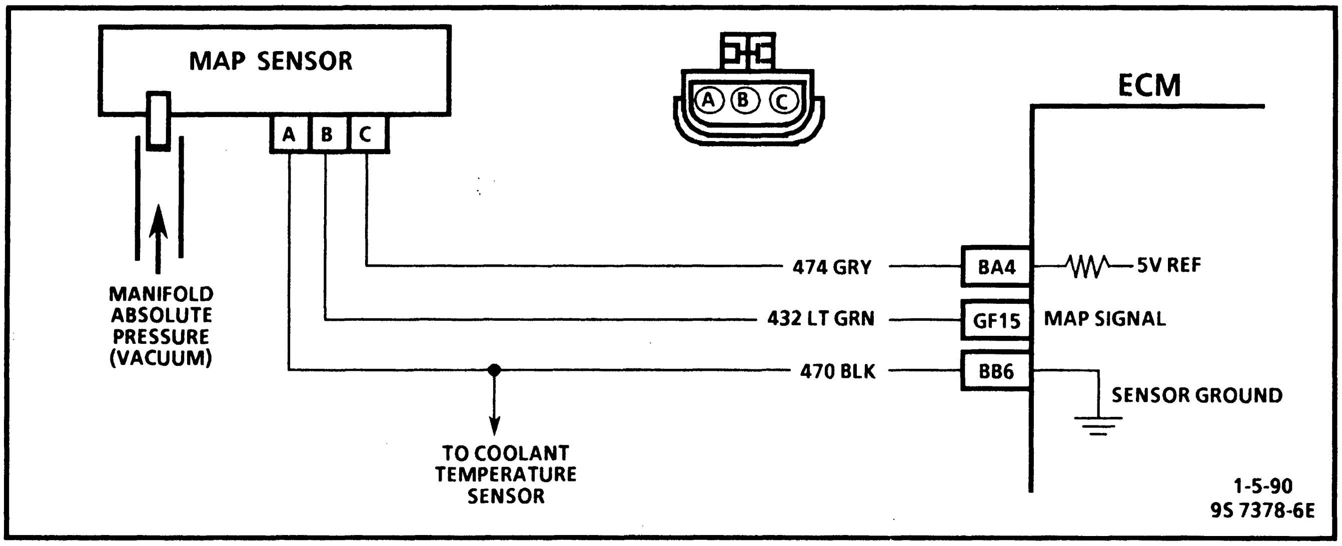
YES

PLUGGED OR LEAKING SENSOR VACUUM HOSE OR FAULTY MAP SENSOR.

NO

OPEN SENSOR GROUND CIRCUIT.

1-12-90
9S 7087-6E



CODE 34

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT
(SIGNAL VOLTAGE LOW-HIGH VACUUM)
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1-1.5 volts at idle to 4.5-4.8 volts at wide open throttle.

A "Scan" tool displays manifold pressure in volts. Low pressure (high vacuum) reads a low voltage while a high pressure (low vacuum) reads a high voltage.

If the MAP sensor fails the ECM will substitute a fixed MAP value and use the Throttle Position Sensor (TPS) to control fuel delivery.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 34 will set when:
   - Signal is too low, (less than 14 kPa or greater than 28" HG), and engine running less than 1200 rpm.

OR

   - Engine running greater than 1200 rpm.
   - Throttle position greater than 21% (over 1.5 volts).
2. If the ECM recognizes the high MAP signal, the ECM and wiring are OK.
3. The "Scan" tool may not display 12 volts. The important thing is that the ECM recognizes the voltage as more than 4 volts, indicating that the ECM and CKT 432 are OK.

Diagnostic Aids:

An intermittent open in CKT 432 or 474 will result in a Code 34.

With the ignition "ON" and the engine stopped, the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of vehicle altitude and is referred to as BARO. Comparison of this BARO reading with a known good vehicle with the same sensor is a good way to check accuracy of a "suspect" sensor. Reading should be the same, ± .4 volt.

Also Refer to MAP Output Check (CHART C-1D) can be used to test the MAP sensor.

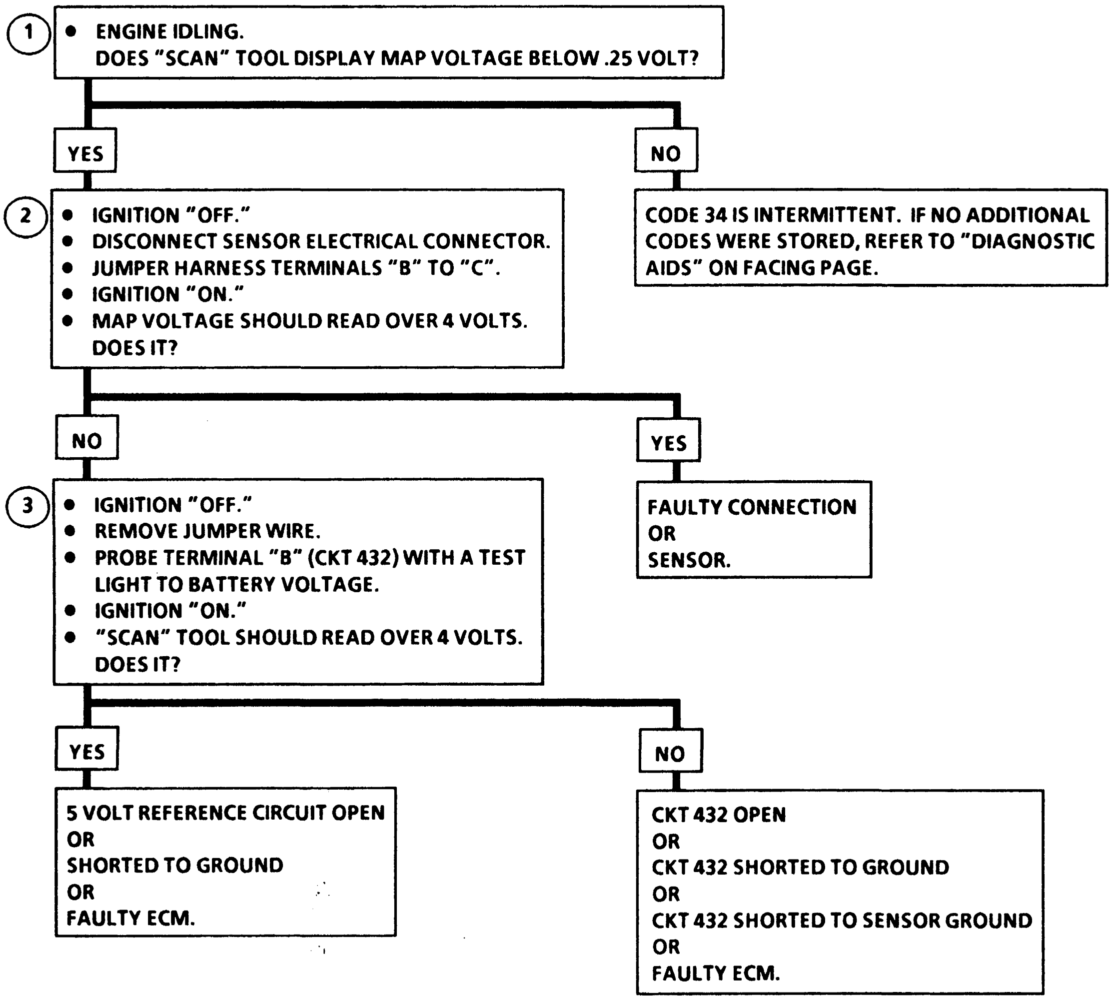
Refer to "Intermittents" in Section"B".

CODE 34

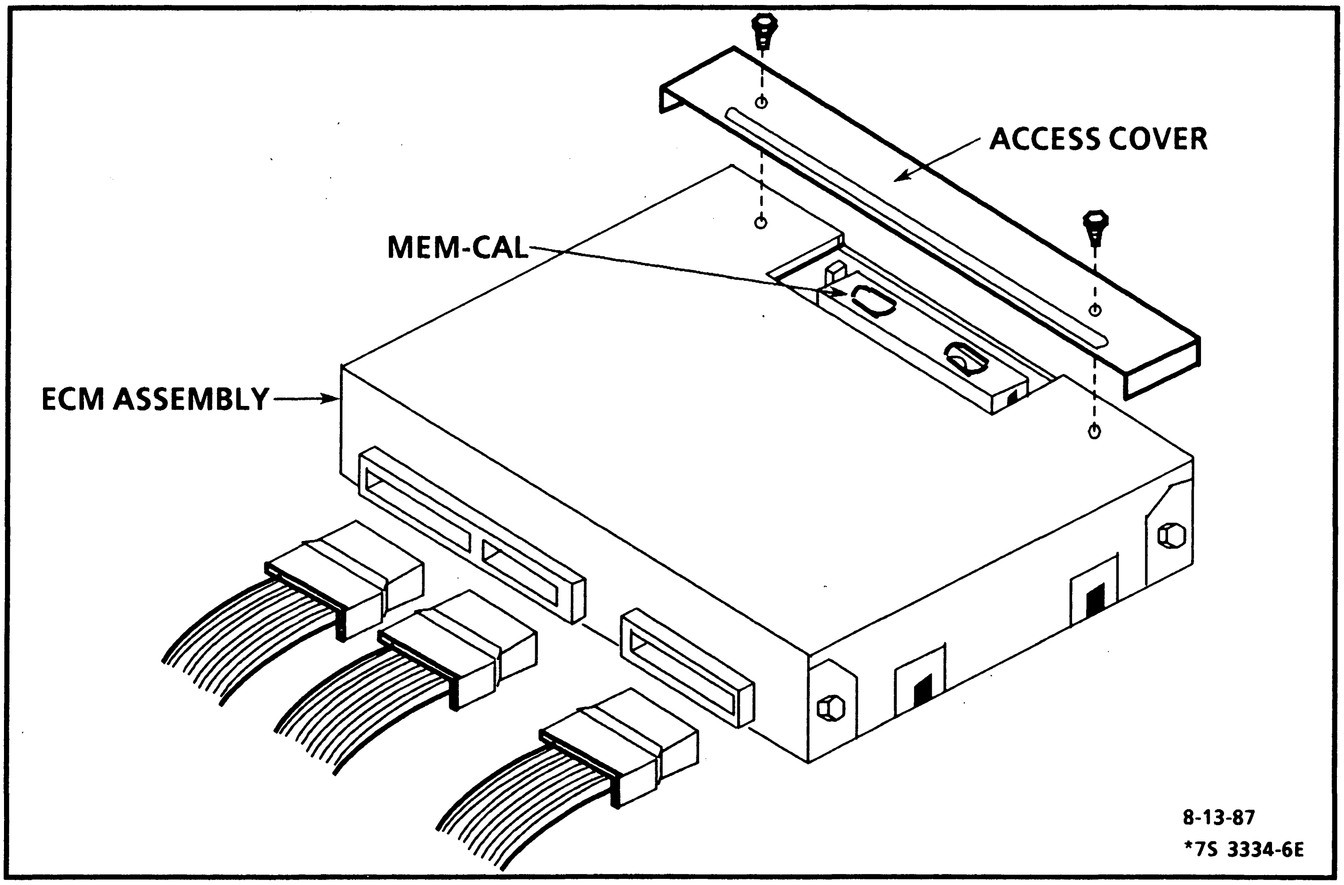
MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT

(SIGNAL VOLTAGE LOW - HIGH VACUUM)

5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



10-13-89
• 7S 3211-6E



CODE 41

CYLINDER SELECT ERROR
(FAULTY OR INCORRECT MEM-CAL)
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Test Description: Number below refers to the circled number on the diagnostic chart.

1. The ECM used for this engine can also be used for other engines, and the difference is in the MEM-CAL. If a Code 41 sets, the incorrect MEM-CAL has been installed, may not be installed properly, or it is faulty and it must be replaced.

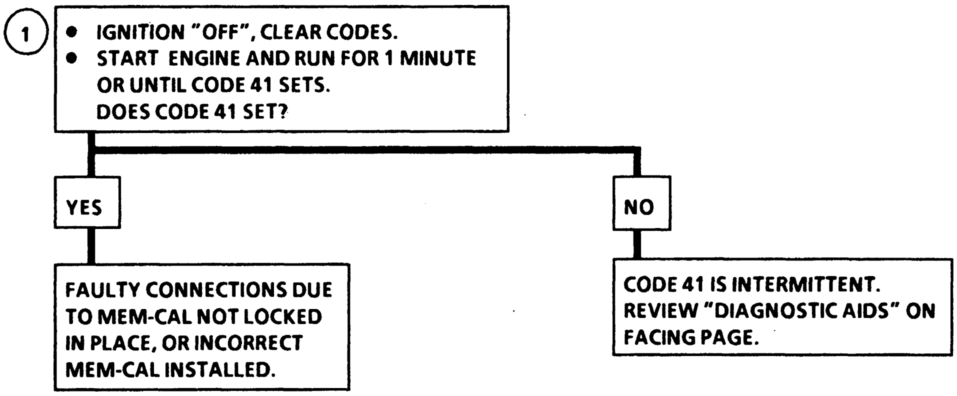
Diagnostic Aids:

Check MEM-CAL to be sure locking tabs are secure.

Also check the pins on both the MEM-CAL and ECM to assure they are making proper contact. Check the MEM-CAL part number to assure it is the correct part. If the MEM-CAL is faulty, it must be replaced. It is also possible that the ECM is faulty, however, it should not be replaced until all of the above have been checked. For additional information, Refer to "Intermittents" in Section "B".

CODE 41

CYLINDER SELECT ERROR
(FAULTY OR INCORRECT MEM-CAL)
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



①
- IGNITION "OFF", CLEAR CODES.
- START ENGINE AND RUN FOR 1 MINUTE OR UNTIL CODE 41 SETS.

DOES CODE 41 SET?

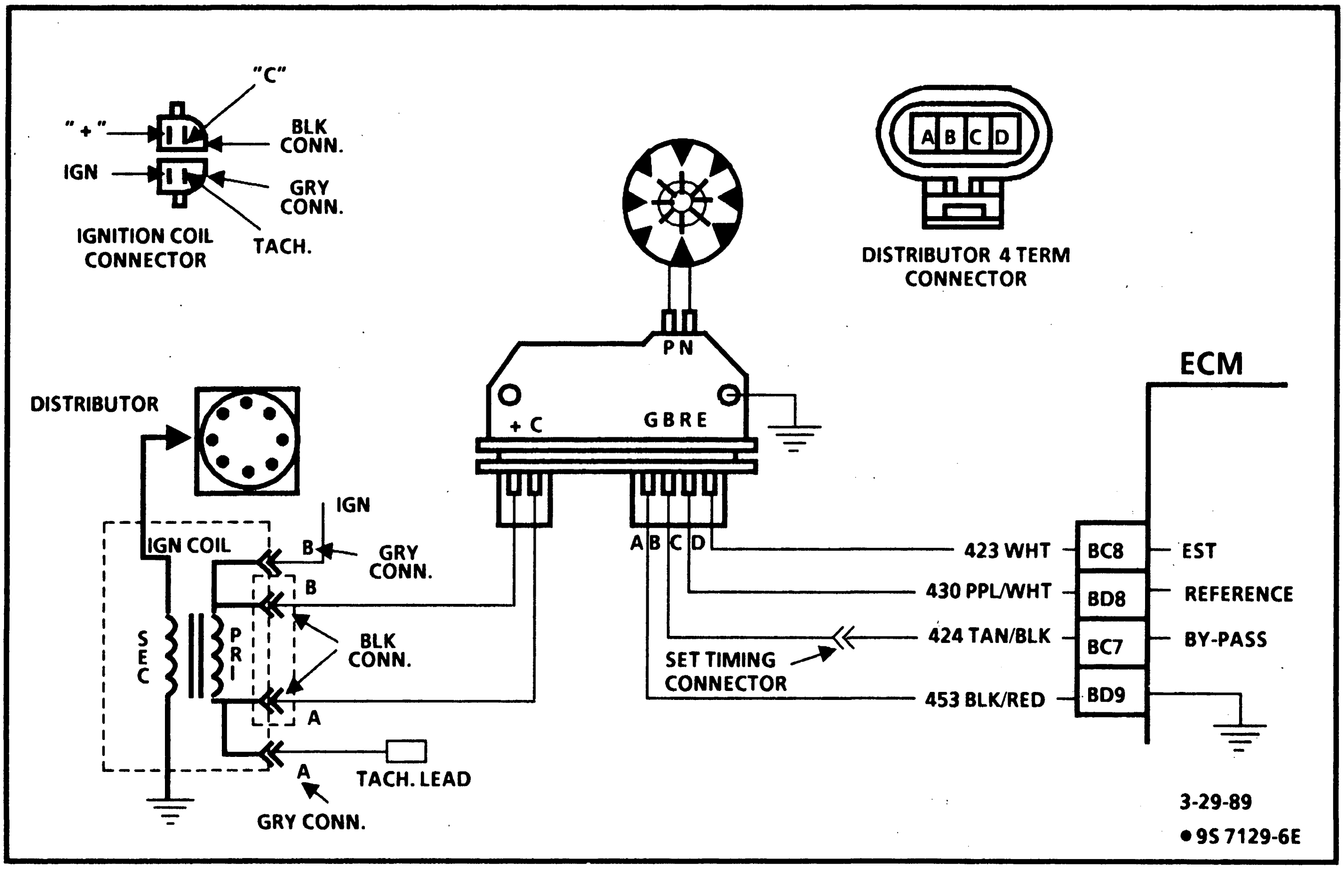
YES

FAULTY CONNECTIONS DUE TO MEM-CAL NOT LOCKED IN PLACE, OR INCORRECT MEM-CAL INSTALLED.

NO

CODE 41 IS INTERMITTENT. REVIEW "DIAGNOSTIC AIDS" ON FACING PAGE.

9-21-87
•7S 3152-6E



CODE 42

ELECTRONIC SPARK TIMING (EST) CIRCUIT 5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

When the system is running on the ignition module, that is, no voltage on the bypass line, the ignition module grounds the EST signal. The ECM expects to see no voltage on the EST line during this condition. If it sees a voltage, it sets Code 42 and will not go into the EST mode.

When the rpm for EST is reached (about 400 rpm), and bypass voltage applied, the EST should no longer be grounded in the ignition module, so the EST voltage should be varying.

If the bypass line is open or grounded, the ignition module will not switch to EST mode so the EST voltage will be low and Code 42 will be set.

If the EST line is grounded, the ignition module will switch to EST but, because the line is grounded there will be no EST signal. A Code 42 will be set.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Code 42 means the ECM has seen an open or short to ground in the EST or bypass circuits. This test confirms Code 42 and that the fault causing the code is present.
2. Checks for a normal EST ground path through the ignition module. An EST CKT 423 shorted to ground will also read less than 500 ohms; however, this will be checked later.
3. As the test light voltage touches CKT 424 the module should switch. The ohmmeter may "overrange" if the meter is in the 1000-2000 ohms position. The important thing is that the module "switched."
4. The module did not switch and this step checks for:
   - EST CKT 423 shorted to ground.
   - Bypass CKT 424 open.
   - Faulty ignition module connection or module.
5. Confirms that Code 42 is a faulty ECM and not an intermittent in CKT 423 or CKT 424.

Diagnostic Aids:

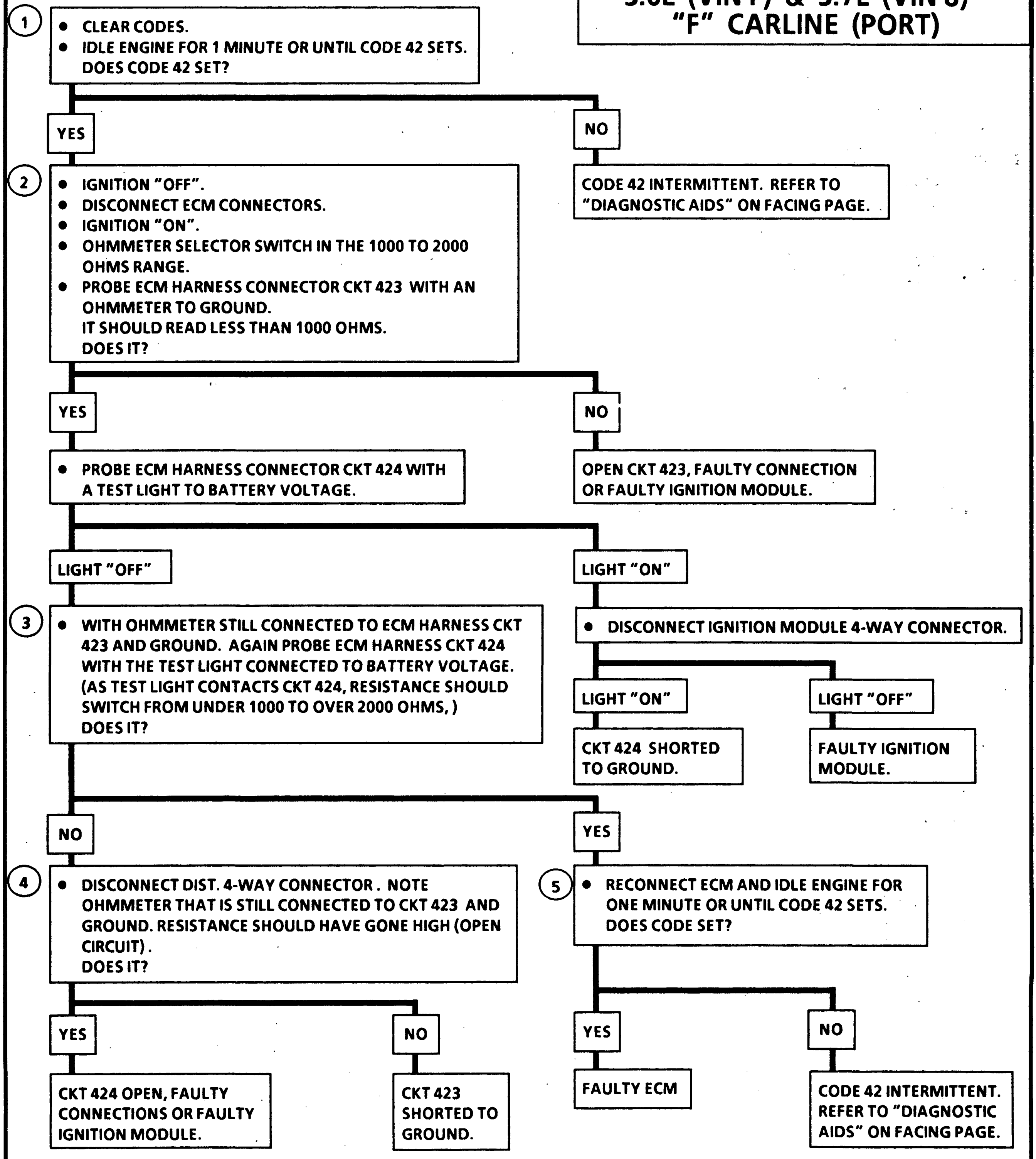
The "Scan" tool does not have any ability to help diagnose a Code 42 problem.

A MEM-CAL not fully seated in the ECM can result in a Code 42.

Refer to "Intermittents" in Section "B".

CODE 42

ELECTRONIC SPARK TIMING (EST) CIRCUIT
5.0L (VIN F) & 5.7L (VIN 8)
"F" CARLINE (PORT)



①
- CLEAR CODES.
- IDLE ENGINE FOR 1 MINUTE OR UNTIL CODE 42 SETS.

DOES CODE 42 SET?

YES → ②

NO → CODE 42 INTERMITTENT. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

②
- IGNITION "OFF".
- DISCONNECT ECM CONNECTORS.
- IGNITION "ON".
- OHMMETER SELECTOR SWITCH IN THE 1000 TO 2000 OHMS RANGE.
- PROBE ECM HARNESS CONNECTOR CKT 423 WITH AN OHMMETER TO GROUND.

IT SHOULD READ LESS THAN 1000 OHMS.
DOES IT?

NO → OPEN CKT 423, FAULTY CONNECTION OR FAULTY IGNITION MODULE.

YES →
- PROBE ECM HARNESS CONNECTOR CKT 424 WITH A TEST LIGHT TO BATTERY VOLTAGE.

LIGHT "ON" →
- DISCONNECT IGNITION MODULE 4-WAY CONNECTOR.

LIGHT "ON" → CKT 424 SHORTED TO GROUND.

LIGHT "OFF" → FAULTY IGNITION MODULE.

LIGHT "OFF" → ③

③
- WITH OHMMETER STILL CONNECTED TO ECM HARNESS CKT 423 AND GROUND. AGAIN PROBE ECM HARNESS CKT 424 WITH THE TEST LIGHT CONNECTED TO BATTERY VOLTAGE. (AS TEST LIGHT CONTACTS CKT 424, RESISTANCE SHOULD SWITCH FROM UNDER 1000 TO OVER 2000 OHMS,)

DOES IT?

NO → ④

④
- DISCONNECT DIST. 4-WAY CONNECTOR . NOTE OHMMETER THAT IS STILL CONNECTED TO CKT 423 AND GROUND. RESISTANCE SHOULD HAVE GONE HIGH (OPEN CIRCUIT) .

DOES IT?

YES → CKT 424 OPEN, FAULTY CONNECTIONS OR FAULTY IGNITION MODULE.

NO → CKT 423 SHORTED TO GROUND.

YES → ⑤

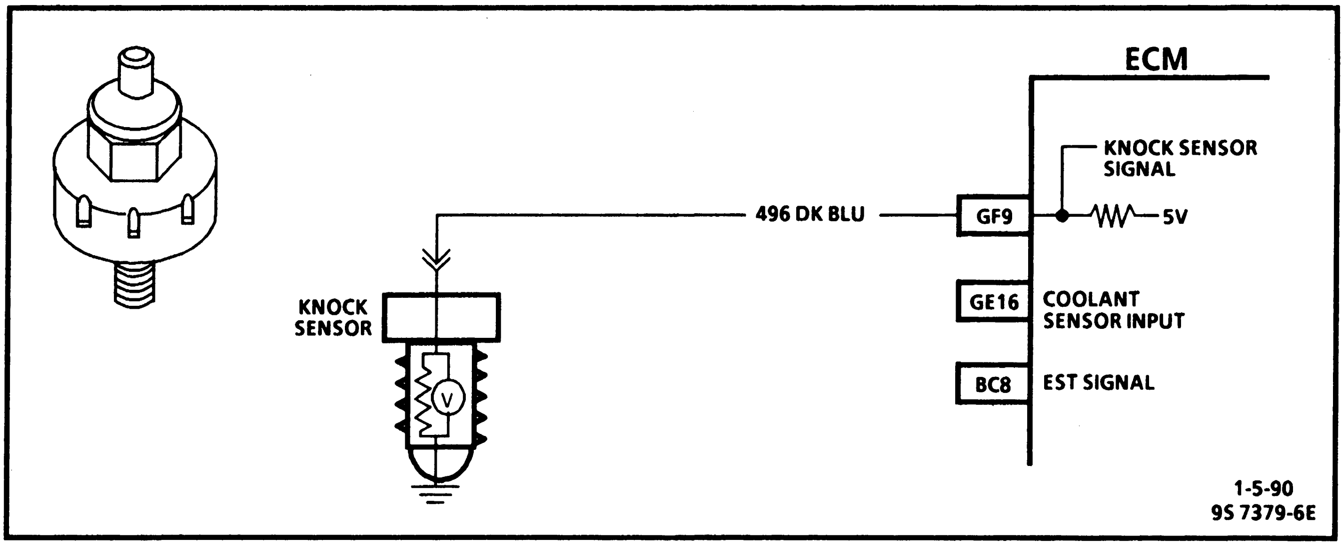
⑤
- RECONNECT ECM AND IDLE ENGINE FOR ONE MINUTE OR UNTIL CODE 42 SETS.

DOES CODE SET?

YES → FAULTY ECM

NO → CODE 42 INTERMITTENT. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.



1-5-90
9S 7379-6E

CODE 43

ELECTRONIC SPARK CONTROL (ESC) CIRCUIT 5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

The knock sensor is used to detect engine detonation and the ECM will retard the electronic spark timing based on the signal being received. The circuitry within the knock sensor causes the ECM 5 volts to be pulled down so that, under a no knock condition, CKT 496 would measure about 2.5 volts. The knock sensor produces an A/C signal which rides on the 2.5 volts DC voltage. The amplitude and signal frequency is dependent upon the knock level.

If CKT 496 becomes open or shorted to ground, the voltage will either go above 3.5 volts or below 1.5 volts. If either of these conditions are met for about 1/2 second, a Code 43 will be stored.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. This step determines if conditions for Code 43 still exist (voltage on CKT 496 above 3.5 volts or below 1.5 volts). The system is designed to retard the spark 15° if either condition exists.
2. The ECM has a 5 volt pullup resistor, which applies 5 volts to CKT 496. The 5 volt signal should be present at the knock sensor terminal during these test conditions.
3. This step determines if the knock sensor resistance is 3300 to 4500 ohms the sensor is OK.

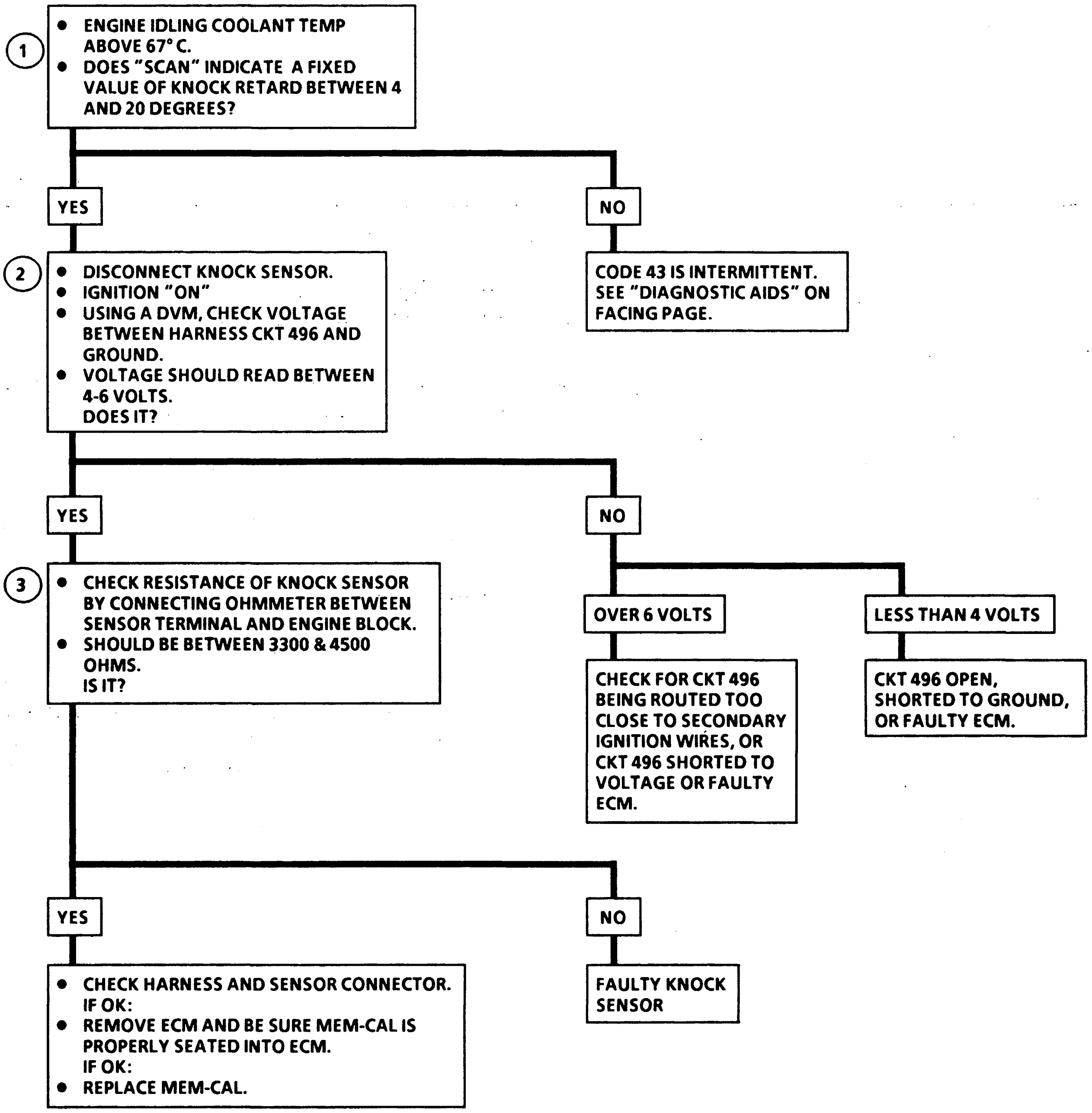
Diagnostic Aids:

If CKT 496 is not open or shorted to ground and the voltage reading is below 4 volts, the most likely cause is an open circuit in the ECM. It is possible that a faulty MEM-CAL could be drawing the 5 volt signal down, and it should be replaced, if a replacement ECM did not correct the problem.

Refer to "Intermittents" in Section "B".

CODE 43

ELECTRONIC SPARK CONTROL (ESC) CIRCUIT 5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



①
- ENGINE IDLING COOLANT TEMP ABOVE 67° C.
- DOES "SCAN" INDICATE A FIXED VALUE OF KNOCK RETARD BETWEEN 4 AND 20 DEGREES?

YES

②
- DISCONNECT KNOCK SENSOR.
- IGNITION "ON"
- USING A DVM, CHECK VOLTAGE BETWEEN HARNESS CKT 496 AND GROUND.
- VOLTAGE SHOULD READ BETWEEN 4-6 VOLTS.
  DOES IT?

NO

CODE 43 IS INTERMITTENT. SEE "DIAGNOSTIC AIDS" ON FACING PAGE.

YES

③
- CHECK RESISTANCE OF KNOCK SENSOR BY CONNECTING OHMMETER BETWEEN SENSOR TERMINAL AND ENGINE BLOCK.
- SHOULD BE BETWEEN 3300 & 4500 OHMS.
  IS IT?

NO

OVER 6 VOLTS

CHECK FOR CKT 496 BEING ROUTED TOO CLOSE TO SECONDARY IGNITION WIRES, OR CKT 496 SHORTED TO VOLTAGE OR FAULTY ECM.

LESS THAN 4 VOLTS

CKT 496 OPEN, SHORTED TO GROUND, OR FAULTY ECM.

YES

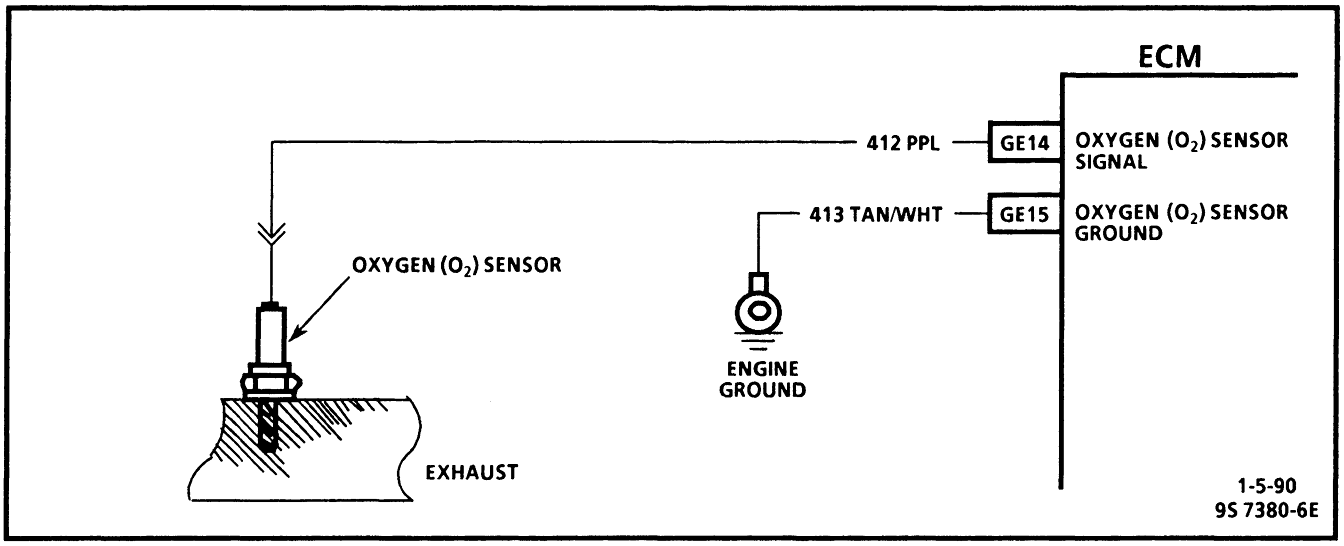
- CHECK HARNESS AND SENSOR CONNECTOR.
  IF OK:
- REMOVE ECM AND BE SURE MEM-CAL IS PROPERLY SEATED INTO ECM.
  IF OK:
- REPLACE MEM-CAL.

NO

FAULTY KNOCK SENSOR

AFTER REPAIRS, CLEAR CODES, DISCONNECT "SCAN" TOOL FROM ALDL, RUN ENGINE 2 MINUTES, AND RECHECK FOR CODES.

11-17-89
9S 7767-6E



CODE 44

OXYGEN SENSOR CIRCUIT
(LEAN EXHAUST INDICATED)
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

The ECM supplies a voltage of about .45 volt (450 mv) between terminals "GE14" and "GE15". (If measured with a 10 megohm digital voltmeter, this may read as low as .32 volt.) The Oxygen (O_2) sensor varies the voltage within a range of about 1 volt (1000 mv) if the exhaust is rich, down through about .10 (100 mv) volt if exhaust is lean.

The sensor is like an open circuit and produces no voltage when it is below about 360°C (600°F). An open sensor circuit or cold sensor causes "Open Loop" operation.

Test Description: Number below refers to the circled number on the diagnostic chart.

1. Code 44 is set when the O_2 sensor signal voltage on CKT 412.
   - Remains below .2 volt for 50 seconds.
   - And the system is operating in "Closed Loop."

Diagnostic Aids:

Using the "Scan" tool observe the block learn values at different rpm and air flow conditions. The "Scan" tool also displays the block cells, so the block learn values can be checked in each of the cells to determine when the Code 44 may have been set. If the conditions for Code 44 exist, the block learn values will be around 150.

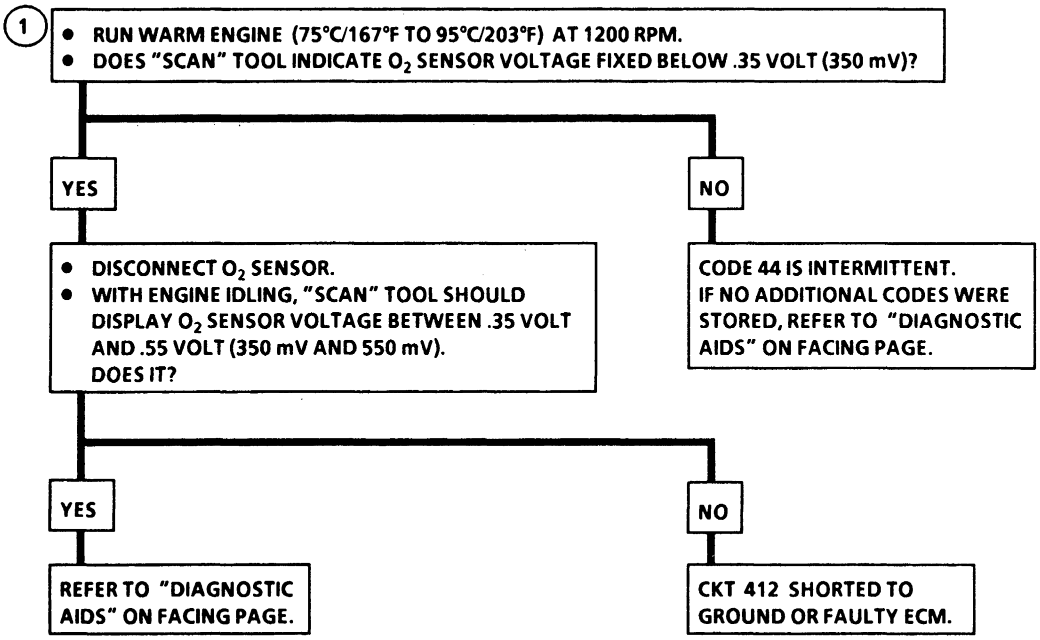
- Oxygen Sensor wire Sensor pigtail may be mispositioned and contacting the exhaust manifold.
- Check for a poor sensor ground connection.
- Check for intermittent ground in wire between connector and sensor.
- MAP Sensor. A Manifold Absolute Pressure (MAP) sensor output that causes the ECM to sense a higher than normal vacuum will cause the system to go lean. Disconnect the MAP sensor and if the lean condition is gone, replace the sensor.
- Lean Injector(s) Perform injector balance test CHART C-2A.
- Fuel Contamination Water, even in small amounts, near the in-tank fuel pump inlet can be delivered to the injectors. The water causes a lean exhaust and can set a Code 44.
- Fuel Pressure System will be lean if pressure is too low. It may be necessary to monitor fuel pressure while driving the car at various road speeds and/or loads to confirm. Refer to "Fuel System Diagnosis," CHART A-7.
- Exhaust Leaks If there is an exhaust leak above the oxygen sensor, outside air can be pulled into the exhaust stream and flow past the sensor causing a lean condition. Vacuum or crankcase leaks can cause a lean condition.
- AIR System Make sure air is not being directed to the exhaust ports while in "Closed Loop." If the block learn value goes down while squeezing air hose to left side exhaust ports, Refer to "Air Management Check - Control Pedes Valve," CHART C-6.
- If the above are OK, it is a faulty oxygen sensor.

CODE 44

OXYGEN SENSOR CIRCUIT

(LEAN EXHAUST INDICATED)

5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



①

- RUN WARM ENGINE (75°C/167°F TO 95°C/203°F) AT 1200 RPM.
- DOES "SCAN" TOOL INDICATE O_2 SENSOR VOLTAGE FIXED BELOW .35 VOLT (350 mV)?

YES

- DISCONNECT O_2 SENSOR.
- WITH ENGINE IDLING, "SCAN" TOOL SHOULD DISPLAY O_2 SENSOR VOLTAGE BETWEEN .35 VOLT AND .55 VOLT (350 mV AND 550 mV). DOES IT?

YES

REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

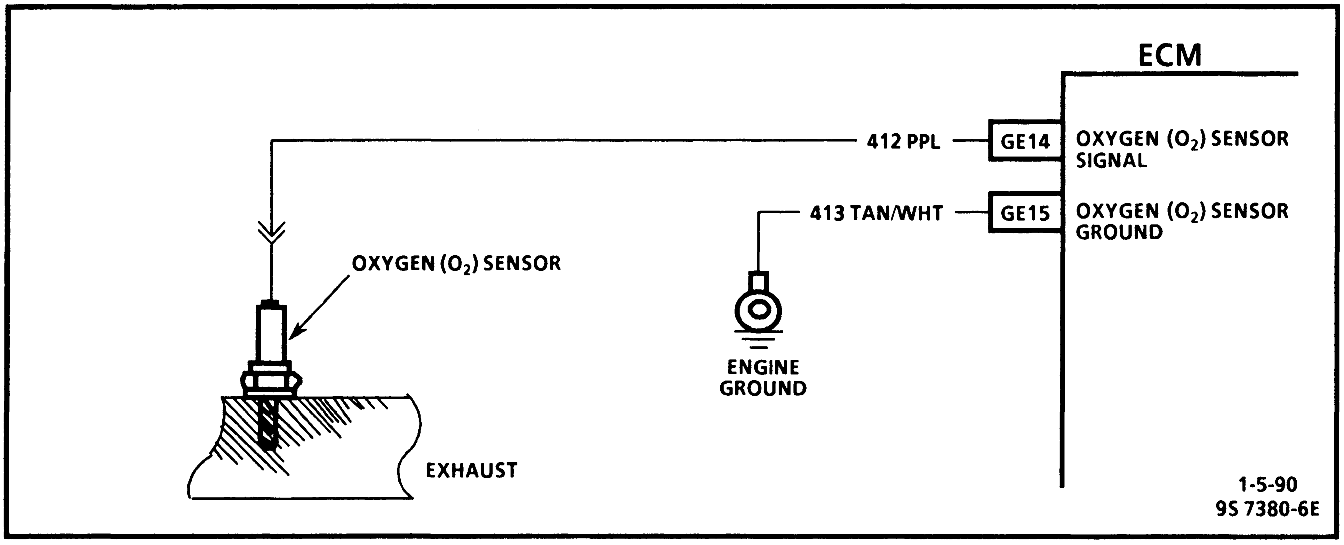
NO

CKT 412 SHORTED TO GROUND OR FAULTY ECM.

NO

CODE 44 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.



CODE 45

OXYGEN SENSOR CIRCUIT
(RICH EXHAUST INDICATED)
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

The ECM supplies a voltage of about .45 volt (450 mv) between terminals "GE14" and "GE15". (If measured with a 10 megohm digital voltmeter, this may read as low as .32 volts.) The O_2 sensor varies the voltage within a range of about 1 volt (1000 mv) if the exhaust is rich, down through about .10 volt (100 mv) if exhaust is lean.

The sensor is like an open circuit and produces no voltage when it is below about 360°C (600°F). An open sensor circuit or cold sensor causes "Open Loop" operation.

Test Description: Number below refers to the circled number on the diagnostic chart.

1. Code 45 is set when the O_2 sensor signal voltage on CKT 412.
   - Remains above .7 volt for 50 seconds; and in "Closed Loop."
   - Engine time after start is 1 minute or more.
   - Throttle angle greater than 2% (about .2 volts above idle voltage)

Diagnostic Aids:

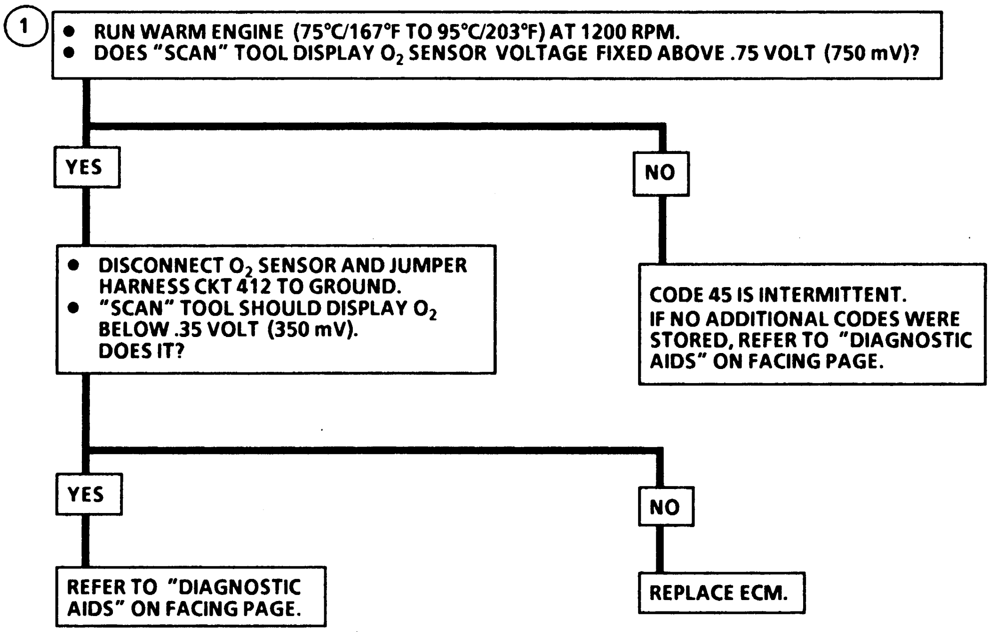
Using the "Scan" tool observe the block learn values at different rpm and air flow conditions. The "Scan" tool also displays the block cells, so the block learn values can be checked in each of the cells to determine when the Code 45 may have been set. If the conditions for Code 45 exists, the block learn values will be around 115.

- Fuel Pressure System will go rich if pressure is too high. The ECM can compensate for some increase. However, if it gets too high, a Code 45 may be set.

  Refer to Fuel System diagnosis CHART A-7.
- Rich injector Perform injector balance test CHART C-2A.
- Leaking injector Refer to "Fuel System Diagnosis," CHART A-7.
- Check for fuel contaminated oil.
- HEI Shielding An open ground CKT 453 (distributor ground, reference low) may result in Electromagnetic Interference (EMI), or induced electrical "noise." The ECM looks at this "noise" as reference pulses. The additional pulses result in a higher than actual engine speed signal. The ECM then delivers too much fuel, causing system to go rich. Engine tachometer will also show higher than actual engine speed, which can help in diagnosing this problem.
- Canister purge Check for fuel saturation. If full of fuel, check canister control and hoses. Refer to EVAPORATIVE EMISSION CONTROL SYSTEM (SECTION C3).
- MAP sensor. An output that causes the ECM to sense a lower than normal vacuum can cause the system to go rich. Disconnecting the MAP sensor will allow the ECM to set a fixed value for the sensor. Substitute a different MAP sensor if the rich condition is gone while the sensor is disconnected.
- Check for leaking fuel pressure regulator diaphragm by checking vacuum line to regulator for fuel.
- TPS An intermittent TPS output will cause the system to go rich, due to a false indication of the engine accelerating.
- EGR An EGR staying open (especially at idle) will cause the O_2 sensor to indicate a rich exhaust, and this could result in a Code 45.

CODE 45

OXYGEN SENSOR CIRCUIT
(RICH EXHAUST INDICATED)
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



①
- RUN WARM ENGINE (75°C/167°F TO 95°C/203°F) AT 1200 RPM.
- DOES "SCAN" TOOL DISPLAY O_2 SENSOR VOLTAGE FIXED ABOVE .75 VOLT (750 mV)?

YES

- DISCONNECT O_2 SENSOR AND JUMPER HARNESS CKT 412 TO GROUND.
- "SCAN" TOOL SHOULD DISPLAY O_2 BELOW .35 VOLT (350 mV). DOES IT?

YES

REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

NO

REPLACE ECM.

NO

CODE 45 IS INTERMITTENT.
IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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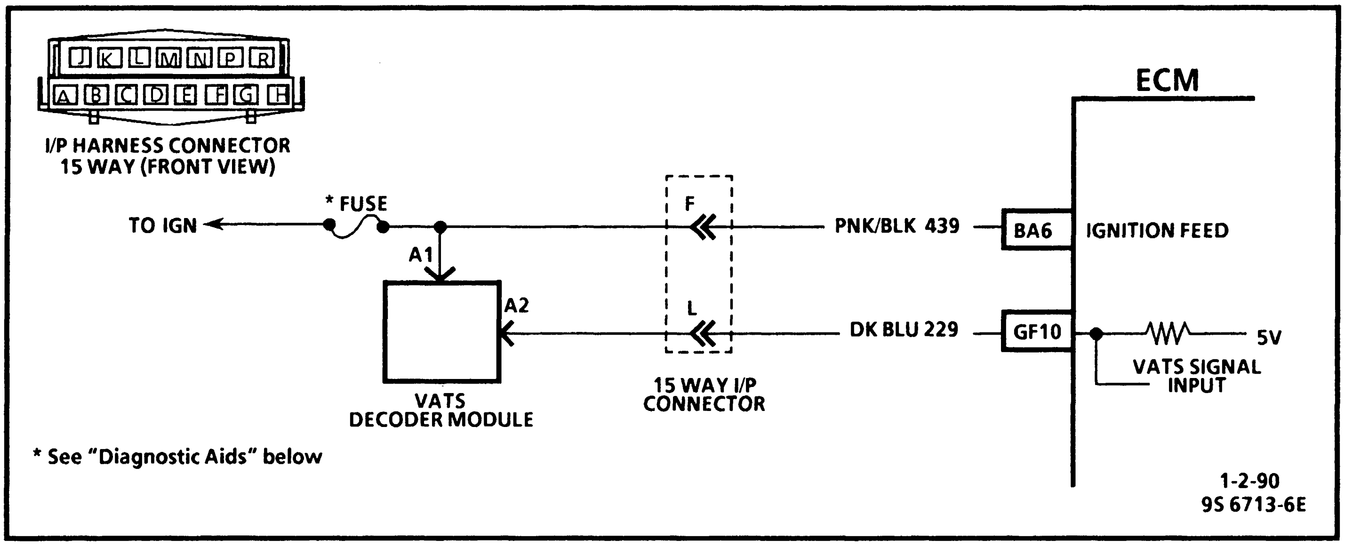


CODE 46

VEHICLE ANTI-THEFT SYSTEM (VATS) (PASS Key)CIRCUIT

5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

The VATS (PASS Key) system is designed to disable vehicle operation if the incorrect key or starting procedure is used. The VATS decoder module sends a signal to the ECM if the correct key is being used. If the proper signal does not reach the ECM on CKT 229, the ECM will not pulse the injectors "ON" and thus not allow the vehicle to be started.

Code 46 will set, if the proper signal is not being received on CKT 229 ECM when the ignition is turned "ON." Code 46 does not store in the ECM memory but is only present when the conditions stated above are met.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

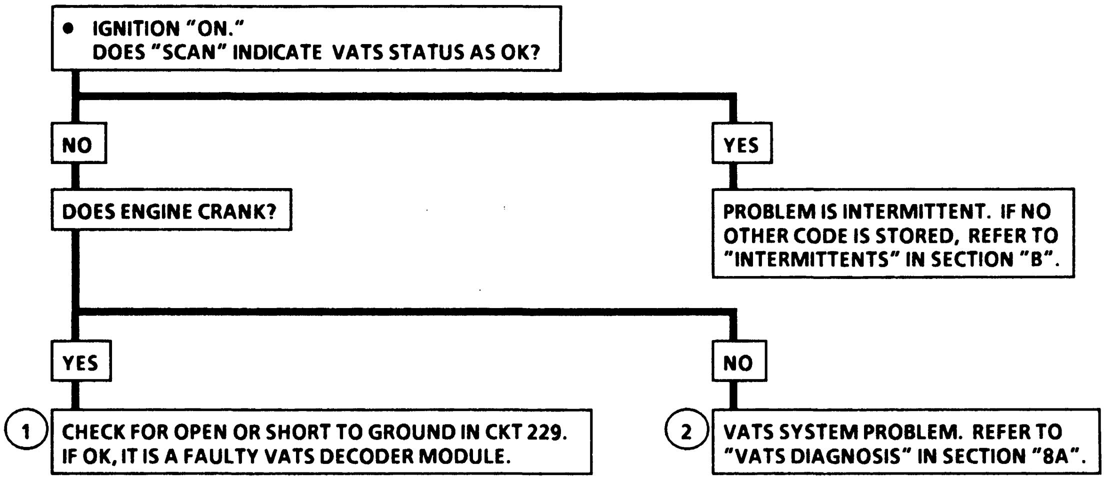
1. If the engine cranks, but doesn't start. It indicates that the portion of the module which generates the signal to the ECM is not operating or CKT 229 is open or shorted to ground. If the decoder module is found to be OK, as determined from Section "8A", the ECM may be at fault, but this is not a likely condition.
2. If Code 46 is stored, and the engine will not crank, it indicates that there is a VATS problem or an incorrect key or starting procedure is being used.

Diagnostic Aids:

* ECM/IGN fuse.

CODE 46

VEHICLE ANTI-THEFT SYSTEM (VATS) (PASS Key) CIRCUIT 5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



- IGNITION "ON."
  DOES "SCAN" INDICATE VATS STATUS AS OK?

DOES ENGINE CRANK?

PROBLEM IS INTERMITTENT. IF NO OTHER CODE IS STORED, REFER TO "INTERMITTENTS" IN SECTION "B".

① CHECK FOR OPEN OR SHORT TO GROUND IN CKT 229. IF OK, IT IS A FAULTY VATS DECODER MODULE.

② VATS SYSTEM PROBLEM. REFER TO "VATS DIAGNOSIS" IN SECTION "8A".

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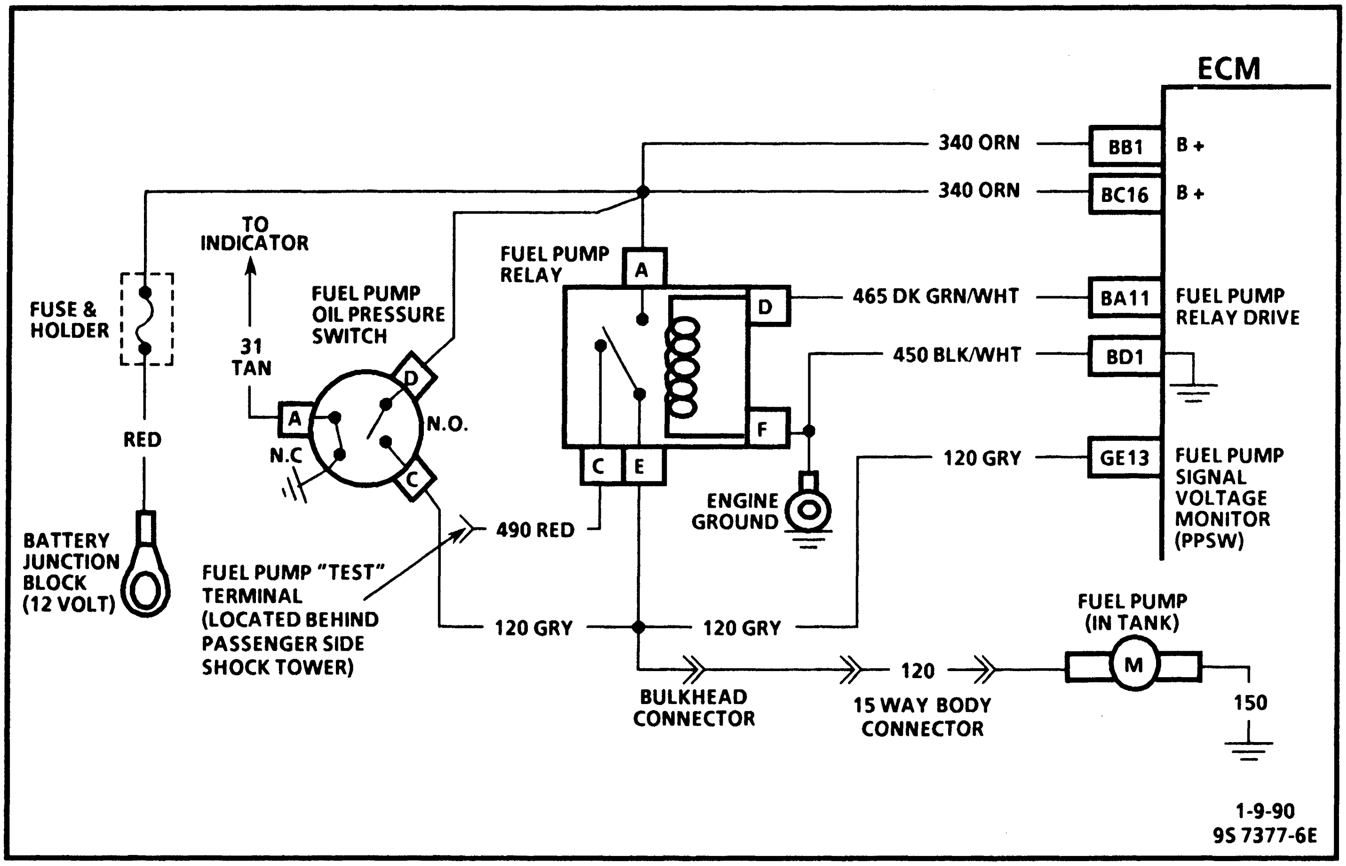


CODE 54

FUEL PUMP CIRCUIT
(LOW VOLTAGE)
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

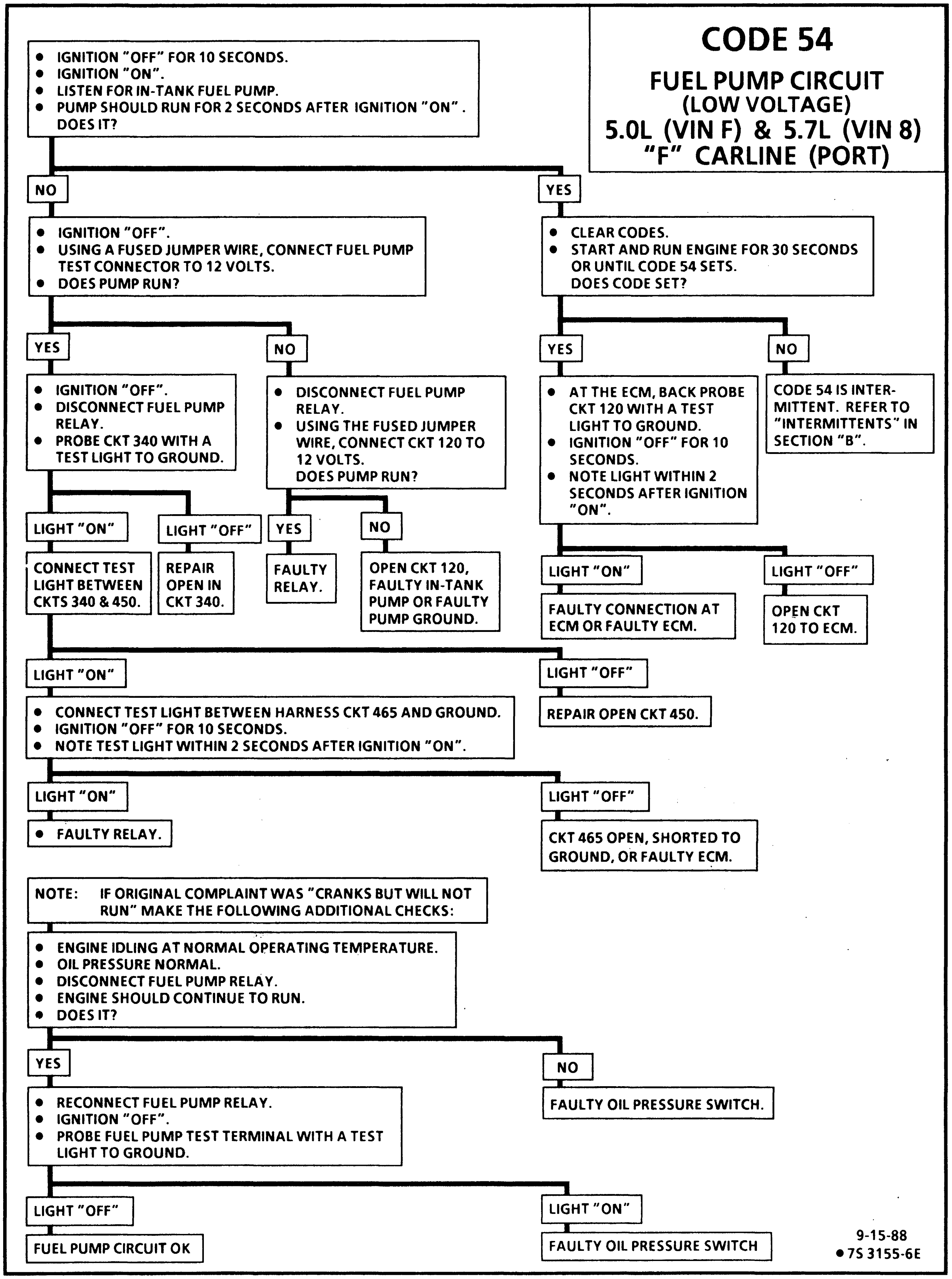
The status of the fuel pump signal (CKT 120) is monitored for voltage by the ECM, and is used to compensate fuel delivery based on system voltage. This fuel pump signal is also used to store a trouble code if the fuel pump relay is defective or fuel pump voltage is lost while the engine is running. There should be about 12 volts on CKT 120 for 2 seconds after the ignition is turned "ON," or any time references pulses are being received by the ECM.

Code 54 will set, if the voltage on CKT 120 is less than 2 volts for 1.5 seconds since the last reference pulse was received. This code is designed to detect a faulty relay, causing extended crank time, and the code will help the diagnosis of an engine that "CRANKS BUT WILL NOT RUN."

If a fault is detected during start-up, the "Service Engine Soon" light will stay "ON" until the ignition is cycled "OFF." However, if the voltage is detected below 2 volts, with the engine running, the light will only remain "ON" while the condition exists. The fuel pump test connector is located under the hood. Refer to "Component Location," Figure "A-1".

CODE 54

FUEL PUMP CIRCUIT
(LOW VOLTAGE)
5.0L (VIN F) & 5.7L (VIN 8)
"F" CARLINE (PORT)



- IGNITION "OFF" FOR 10 SECONDS.
- IGNITION "ON".
- LISTEN FOR IN-TANK FUEL PUMP.
- PUMP SHOULD RUN FOR 2 SECONDS AFTER IGNITION "ON". DOES IT?

NO

- IGNITION "OFF".
- USING A FUSED JUMPER WIRE, CONNECT FUEL PUMP TEST CONNECTOR TO 12 VOLTS.
- DOES PUMP RUN?

YES

- IGNITION "OFF".
- DISCONNECT FUEL PUMP RELAY.
- PROBE CKT 340 WITH A TEST LIGHT TO GROUND.

LIGHT "ON"

CONNECT TEST LIGHT BETWEEN CKTS 340 & 450.

LIGHT "ON"

- CONNECT TEST LIGHT BETWEEN HARNESS CKT 465 AND GROUND.
- IGNITION "OFF" FOR 10 SECONDS.
- NOTE TEST LIGHT WITHIN 2 SECONDS AFTER IGNITION "ON".

LIGHT "ON"

- FAULTY RELAY.

LIGHT "OFF"

CKT 465 OPEN, SHORTED TO GROUND, OR FAULTY ECM.

LIGHT "OFF"

REPAIR OPEN CKT 450.

LIGHT "OFF"

REPAIR OPEN IN CKT 340.

NO

- DISCONNECT FUEL PUMP RELAY.
- USING THE FUSED JUMPER WIRE, CONNECT CKT 120 TO 12 VOLTS. DOES PUMP RUN?

YES

FAULTY RELAY.

NO

OPEN CKT 120, FAULTY IN-TANK PUMP OR FAULTY PUMP GROUND.

YES

- CLEAR CODES.
- START AND RUN ENGINE FOR 30 SECONDS OR UNTIL CODE 54 SETS. DOES CODE SET?

YES

- AT THE ECM, BACK PROBE CKT 120 WITH A TEST LIGHT TO GROUND.
- IGNITION "OFF" FOR 10 SECONDS.
- NOTE LIGHT WITHIN 2 SECONDS AFTER IGNITION "ON".

LIGHT "ON"

FAULTY CONNECTION AT ECM OR FAULTY ECM.

LIGHT "OFF"

OPEN CKT 120 TO ECM.

NO

CODE 54 IS INTERMITTENT. REFER TO "INTERMITTENTS" IN SECTION "B".

NOTE: IF ORIGINAL COMPLAINT WAS "CRANKS BUT WILL NOT RUN" MAKE THE FOLLOWING ADDITIONAL CHECKS:

- ENGINE IDLING AT NORMAL OPERATING TEMPERATURE.
- OIL PRESSURE NORMAL.
- DISCONNECT FUEL PUMP RELAY.
- ENGINE SHOULD CONTINUE TO RUN.
- DOES IT?

YES

- RECONNECT FUEL PUMP RELAY.
- IGNITION "OFF".
- PROBE FUEL PUMP TEST TERMINAL WITH A TEST LIGHT TO GROUND.

LIGHT "OFF"

FUEL PUMP CIRCUIT OK

LIGHT "ON"

FAULTY OIL PRESSURE SWITCH

NO

FAULTY OIL PRESSURE SWITCH.

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CODE 51
CODE 52
CODE 53
5.0L (VIN F) & 5.7L (VIN 8)
"F" CARLINE (PORT)

CODE 51

MEM-CAL ERROR
(FAULTY OR INCORRECT MEM-CAL)

CHECK THAT ALL PINS ARE FULLY INSERTED IN THE SOCKET AND THAT MEM-CAL IS PROPERLY LATCHED. IF OK, REPLACE MEM/CAL, CLEAR MEMORY, AND RECHECK. IF CODE 51 REAPPEARS, REPLACE ECM.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

CODE 52

CALPAK ERROR
(FAULTY OR INCORRECT CALPAK)

CHECK THAT THE MEM-CAL IS FULLY SEATED AND LATCHED INTO THE MEM-CAL SOCKET. IF OK, REPLACE MEM-CAL, CLEAR MEMORY, AND RECHECK. IF CODE 52 REAPPEARS, REPLACE ECM.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

CODE 53

SYSTEM OVER VOLTAGE

THIS CODE INDICATES THERE IS A BASIC GENERATOR PROBLEM.

- CODE 53 WILL SET, IF VOLTAGE AT ECM IGNITION INPUT PIN IS GREATER THAN 16.9 VOLTS FOR 10 SECONDS.
- CHECK AND REPAIR CHARGING SYSTEM. REFER TO SECTION "6D".

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

SECTION B

SYMPTOMS

CONTENTS

IMPORTANT PRELIMINARY CHECKS

BEFORE STARTING

Before using this section you should have performed the "Diagnostic Circuit Check" and found out that:

1. The ECM and "Service Engine Soon" light are operating.
2. There are no diagnostic codes stored, or there is a diagnostic code but no "Service Engine Soon" light.

SYMPTOM

Verify the customer complaint, and locate the correct symptom in the table of contents. Check the items indicated under that symptom.

VISUAL/PHYSICAL CHECK

Several of the symptom procedures call for a Careful Visual/Physical Check. This check should include:

- ECM grounds for being clean and tight.
- Vacuum hoses for splits, kinks, and proper connections, as shown on "Vehicle Emission Control Information" label.
- Air leaks at throttle body mounting and intake manifold.
- Ignition wires for cracking, hardness, proper routing and carbon tracking.
- Wiring for proper connections, pinches and cuts.

<u>The importance of this step cannot be stressed too strongly - it can lead to correcting a problem without further checks and can save valuable time.</u>

INTERMITTENTS

(Page 1 of 2)

Definition: Problem may or may not turn "ON" the "Service Engine Soon" light or store a code.

DO NOT use the diagnostic code charts in "Engine Components/Wiring Diagrams/Diagnostic Charts" Section "6E3-A" for intermittent problems. The fault must be present to locate the problem. If a fault is intermittent, use of diagnostic code charts may result in replacement of good parts.

- Most intermittent problems are caused by faulty electrical connections or wiring. Perform careful visual/physical check as described at start of "Symptoms" Section "6E3-B." Check for:
  - Poor mating of the connector halves. or terminal not fully seated in the connector body (backed out).
  - Improperly formed or damaged terminal. All connector terminals in problem circuit should be carefully reformed or replaced to insure proper contact tension.
  - Poor terminal to wire connection. This requires removing the terminal from the connector body to check. Refer to "Introduction" in "Driveability and Emissions," Section "6E," "Wiring Harness Service."

- If a visual/physical check does not find the cause of the problem, the car can be driven with a voltmeter connected to a suspected circuit. A "Scan" tool can also be used for monitoring input signal to the ECM to help detect intermittent conditions. An abnormal voltage, or "Scan" reading, when the problem occurs, indicates the problem may be in that circuit. If the wiring and connectors check OK, and a diagnostic code was stored for a circuit having a sensor, except for Codes 43, 44 and 45, substitute a known good sensor and recheck.

- Loss of diagnostic code memory. To check, disconnect TPS and idle engine until "Service Engine Soon" light comes "ON." Code 22 should be stored, and kept in memory when ignition is turned "OFF." If not, the ECM is faulty.

- An intermittent "Service Engine Soon" light with no stored diagnostic code may be caused by:
  - Ignition coil shorted to ground and arcing at spark plug wires or plugs.
  - "Service Engine Soon" light wire to ECM shorted to ground (CKT 419).
  - Diagnostic "test" terminal wire to ECM, shorted to ground (CKT 451).
  - ECM grounds, refer to ECM wiring diagrams.

INTERMITTENTS

(Page 2 of 2)

Definition: Problem may or may not turn "ON" the "Service Engine Soon" light or store a code.

- Check for an electrical system interference caused by a defective relay, ECM driven solenoid, or switch. They can cause a sharp electrical surge. Normally, the problem will occur when the faulty component is operated.

- Check for improper installation of electrical options such as lights, 2 way radios, etc.

- EST wires should be routed away from spark plug wires, distributor wires, distributor housing, coil and generator. Wire from ECM to distributor (CKT 453) would have a good connection.

- Check for open diode across A/C compressor clutch, and for other open diodes (see wiring diagrams).

HARD START

Definition: Engine Cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms" Section "6E3-B."
- Make sure the driver is using the correct starting procedure.

SENSORS

- **CHECK:** Coolant Temperature Sensor using a "Scan" tool, compare coolant temperature with ambient temperature on cold engine.
  - If coolant temperature readings is 5 degrees greater than or less than ambient air temperature on a cold engine, check resistance in coolant sensor circuit or sensor itself. Compare CTS resistance value to "Diagnostic Aids" chart on Code 15 chart.

- **CHECK:** TPS for binding or a high TPS voltage with the throttle closed (should read between .36 volt and .96 volt.)

FUEL SYSTEM

- **CHECK:** Fuel pump relay operation - pump should turn "ON" for 2 seconds when ignition is turned "ON." Use CHART A-7.
- **CHECK:** Fuel pressure, use CHART A-7.
- **CHECK:** Contaminated fuel
- **CHECK:** Both injector fuses (visual inspect).
- **NOTE:** A faulty in-tank fuel pump check valve will allow the fuel in the lines to drain back to the tank after engine is stopped. To check for this condition, perform fuel system diagnosis CHART A-7.

IGNITION SYSTEM

- **CHECK:** For proper ignition voltage output with spark tester J 26792 or equivalent (ST-125).
- **CHECK:** Spark plugs. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary.
- **CHECK:** Moisture in distributor cap
- **CHECK:** Bare or shorted wires
- **CHECK:** Worn distributor shaft
- **CHECK:** Loose ignition coil ground
- **CHECK:** Pickup coil resistance and connections.

ADDITIONAL CHECKS

- **CHECK:** IAC Operation - use CHART C-2C.
- **CHECK:** Basic engine problem. Refer to ENGINE MECHANICAL DIAGNOSIS (SECTION 6A).

SURGES AND/OR CHUGGLES

Definition: Engine power variation under steady throttle or cruise. feels like the car speeds up and slows down with no change in the acceleration pedal.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms" Section "6E3-B."
- Be sure driver understands transmission torque converter clutch, and A/C compressor operation as explained in the owner's manual.

SENSORS

- **CHECK:** The Oxygen (O_2) sensor should respond quickly to different throttle position, if it does not, check the Oxygen (O_2) sensor for silicon contamination from fuel, or use of improper RTV sealant. The sensor may have a white, powdery coating and result in a high but false signal voltage (rich exhaust indication). The ECM will then reduce the amount of fuel delivered to the engine, causing a severe driveability problem.

FUEL SYSTEM

- **NOTE:** To determine if the condition is caused by a rich or lean system, the car should be driven at the speed of the complaint. Monitoring block learn will help identify problem.
  Lean - Block learn above 142. Refer to "Diagnostic Aids" on facing page of Code 44.
  Rich - Block learn below 118. Refer to "Diagnostic Aids" on facing page of Code 45.
- **CHECK:** Fuel pressure while condition exists. Use CHART A-7.
- **CHECK:** In-line fuel filter. Replace if dirty or plugged.

IGNITION SYSTEM

- **CHECK:** For proper ignition voltage output using spark tester (ST-125) J 26792 or equivalent.
- **CHECK:** Spark Plugs. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary. Also, check condition of distributor cap, rotor and spark plug wires.
- **CHECK:** Ignition timing. Refer to "Vehicle Emission Control Information" label.

ADDITIONAL CHECKS

- **CHECK:** Vacuum lines for kinks or leaks.
- **CHECK:** EGR - There should be no EGR at idle. Refer to CHART C-7.
- **CHECK:** Generator output voltage. Repair if less than 9 or more than 16 volts.

LACK OF POWER, SLUGGISH OR SPONGY

Definition: Engine delivers less than expected power. Little or no increase in speed when accelerator pedal is pushed down part way.

PRELIMINARY CHECKS

- Perform the careful visual/physical checks as described at start of "Symptoms" Section "6E3-B."
- Compare customer's car to similar unit. Make sure the customer has an actual problem.
- Remove air filter and check air filter for dirt, or for being plugged. Replace as necessary.

FUEL SYSTEM

- **CHECK:** Restricted fuel filter.
- **CHECK:** Fuel pressure, use CHART A-7.
- **CHECK:** Contaminated fuel.

IGNITION SYSTEM

- **CHECK:** Ignition timing. See "Vehicle Emission Control Information" label.
- **CHECK:** Spark advance for excessive retarded ignition timing. Refer to CHART C-5. Use "Scan" tool.
- **CHECK:** Secondary voltage using a shop oscilloscope or a spark tester J 26792 (ST-125), or equivalent, to check for a weak coil.

ADDITIONAL CHECKS

- **CHECK:** ECM grounds for being clean and tight. See ECM wiring diagrams.
- **CHECK:** EGR operation for being open or partly open all the time. Refer to CHART C-7.
- **CHECK:** Generator output voltage. Repair if less than 9 or more than 16 volts.
- **CHECK:** A/C operation. A/C clutch should cut out at Wide Open Throttle (WOT).
- **CHECK:** Exhaust system for possible restriction. Refer to CHART B-1.
  - Inspect exhaust system for damaged or collapsed pipes.
  - Inspect muffler for heat distress or possible internal failure.
  - For possible plugged catalytic converter by comparing exhaust system back pressure on each side at engine. Check back pressure by removing A.I.R. check valves near exhaust manifolds.

ENGINE MECHANICAL

- **CHECK:** Engine valve timing and compression.
- **CHECK:** Engine for correct or worn camshaft. Refer to ENGINE MECHANICAL DIAGNOSIS (SECTION 6A).

DETONATION/SPARK KNOCK

Definition: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening. Sounds like popcorn popping.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms" Section "6E3-B."
- Park/Neutral (P/N) Switch. Be sure "Scan" indicates drive with gear selector in drive or overdrive. Use CHART C-1A.
- If "Scan" tool readings are normal (see facing page of "Diagnostic Circuit Check") and there are no engine mechanical faults, fill fuel tank with a premium gasoline that has a minimum octane reading of 92 and revaluate vehicle performance.

COOLING SYSTEM

- Check for obvious overheating problems:
  - Low engine coolant
  - Loose water pump belt
  - Restricted air flow to radiator, or restricted water flow through radiator.
  - Inoperative electric cooling fan circuit, use CHART C-12.
  - Correct coolant solution should be a 50/50 mix of GM #1052753 anti-freeze coolant (or equivalent) and water.

FUEL SYSTEM

- **NOTE:** To determine if the condition is caused by a rich or lean system, the car should be driven at the speed of the complaint. Monitoring block learn will help identify problem.
  Lean - Block learn above 142. Refer to "Diagnostic Aids" on facing page of Code 44.
  Rich - Block learn below 118. Refer to "Diagnostic Aids" on facing page of Code 45.
- **CHECK:** Fuel pressure, use CHART A-7.

IGNITION SYSTEM

- **CHECK:** Ignition timing. See "Vehicle Emission Control Information" label.
- **CHECK:** ESC system for no retard, use CHART C-5.

ENGINE MECHANICAL

- **CHECK:** For excessive oil in the combustion chamber.
  - Valve oil seals for leaking.
- **CHECK:** Combustion chambers for excessive carbon build up. Remove carbon with top engine cleaner and follow instructions on can.
- **CHECK:** Combustion chamber pressure by performing a compression test. See ENGINE MECHANICAL DIAGNOSIS (SECTION 6A).
- **CHECK:** For incorrect basic engine parts such as cam, heads, pistons, etc.

ADDITIONAL CHECKS

- EGR system for not opening. Use CHART C-7.
- **CHECK:** TCC operation, TCC applying too soon. Use CHART C-8.
- **CHECK:** For correct MEM-CAL. (See Service Bulletins.)

HESITATION, SAG, STUMBLE

Definition: Momentary lack of response as the accelerator is pushed down. Can occur at all car speeds. Usually most severe when first trying to make the car move, as from a stop sigh. May cause engine to stall severe enough.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms" Section "6E3-B."

SENSORS

- **CHECK:** TPS - Check TPS for binding or sticking. Voltage should increase at a steady rate as throttle is moved toward Wide Open Throttle (WOT).
- **CHECK:** MAP sensor - use CHART C-1D.

FUEL SYSTEM

- **CHECK:** Fuel pressure, use CHART A-7.
- **CHECK:** Contaminated fuel.
- **CHECK:** Canister Purge System for proper operation. Use CHART C-3.
- **CHECK:** Fuel injectors. Perform injector balance test, use CHART C-2A.

IGNITION SYSTEM

- **CHECK:** Spark plugs for being fouled, or for there being faulty secondary wiring.
- **CHECK:** Ignition timing. Refer to "Vehicle Emission Control Information" label.
- **CHECK:** Ignition system ground, CKT 453.

ADDITIONAL CHECKS

- **CHECK:** For correct MEM-CAL. (See Service Bulletins.)
- **CHECK:** EGR operation, refer to CHART C-7.
- **CHECK:** Engine thermostat functioning correctly and proper heat range.
- **CHECK:** Generator output voltage. Repair if less than 9 or more than 16 volts.

CUTS OUT, MISSES
(Page 1 of 2)

Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases, not normally felt above 1500 rpm or 48 kph (30 mph). The exhaust has a steady spitting sound at idle or low speed.

PRELIMINARY CHECKS

- Perform the careful visual/physical checks as described at start of "Symptoms" Section "6E3-B."

IGNITION SYSTEM

- Check for missing cylinder by:
  1. Start engine, allow engine to stabilize then disconnect IAC motor. Remove one spark plug wire at a time, using insulated pliers.

     CAUTION: **Do Not perform this test for more than 2 minutes, as this test may cause damage to the catalytic converter.**

  2. If there is an rpm drop on all cylinders (equal to within 50 rpm), go to "Rough, Unstable, or Incorrect Idle, Stalling" symptom. Reconnect IAC valve.
  3. If there is no rpm drop on one or more cylinders, or excessive variation is drop, check for spark on the suspected cylinder(s) using a shop oscilloscope or with J 26792 (ST-125) spark tester or equivalent. If no spark, refer to ENGINE ELECTRICAL (SECTION 6D) for intermittent operation of miss. If there is a spark, remove spark plug(s) in these cylinders and check for:
     - Cracks
     - Wear
     - Improper Gap
     - Burned Electrodes
     - Heavy Deposits
- **CHECK:** Spark plug wires by connecting ohmmeter to ends of each wire in question. If meter reads over 30,000 ohms, replace wire(s).
- **CHECK:** Visually inspect distributor cap and rotor for moisture, dust, cracks, burns, etc. Spray cap and plug wires with fine water mist to check for shorts.

FUEL SYSTEM

- **CHECK:** Fuel system - Plugged fuel filter, low pressure. Use CHART A-7.
- **CHECK:** Contaminated fuel
- **CHECK:** Injector drivers. Disconnect all injector harness connectors. Connect J 34730-2 Injector Test Light or equivalent 6 volts test light between the harness terminal, of each injector connector and note light while cranking. If test light fails to blink at any connector, it is a faulty injector drive circuit harness, connector or terminal.
- **CHECK:** Perform the Injector Balance Test. Refer to CHART C-2A.

CUTS OUT, MISSES

(Page 2 of 2)

Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases, not normally felt above 1500 rpm or 48 kph (30 mph). The exhaust has a steady spitting sound at idle or low speed.

ENGINE MECHANICAL

- **CHECK:** Perform compression check on questionable cylinder(s) found above. If compression is low, repair as necessary. Refer to ENGINE MECHANICAL DIAGNOSIS (SECTION 6A).
- **CHECK:** Base engine. Remove rocker covers. Check for bent pushrods, worn rocker arms, broken valve springs, worn camshaft lobes and valve timing. Repair as necessary. See ENGINE MECHANICAL DIAGNOSIS (SECTION 6A).

ADDITIONAL CHECKS

- **CHECK:** For EMI interference. A missing condition can be caused by Electromagnetic Interference (EMI) on the reference circuit. EMI can usually be detected by monitoring engine rpm with a "Scan" tool. A sudden increase in rpm with little change in actual engine rpm change, indicates EMI is present. If the problem exists, check routing of secondary wires, check distributor ground circuit.
- **CHECK:** Intake and exhaust manifolds for casting flash.

ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING

Definition: Engine Cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms" Section "6E3-B."
- **CHECK:** For vacuum leaks
- **CHECK:** ECM grounds for being clean and tight. See ECM wiring diagrams.

FUEL SYSTEM

- **CHECK:** Monitoring block learn will help identify the cause of the problem. If the system is running lean (block learn greater than 142), refer to "Diagnostic Aids" on facing page of Code 44. If the system is running rich (block learn less than 118), refer to "Diagnostic Aids" on facing page of Code 45.
- **CHECK:** Incorrect minimum idle speed may be caused by foreign material accumulation in the throttle bore, on the throttle valve or on the throttle shaft.
- **CHECK:** Injector balance. Refer to CHART C-2A or use "Scan" tool.
- **CHECK:** Clean injectors.
- **CHECK:** For fuel in pressure regulator hose. If fuel is present, replace regulator assembly.
- **CHECK:** Evaporative Emission Control System (EECS), use CHART C-3.
- **CHECK:** The Oxygen (O_2) sensor should respond quickly to different throttle positions, if it does not, check the Oxygen (O_2) sensor for silicon contamination from fuel, or use for improper RTV sealant. The sensor will have a white, powdery coating, and will result in a high but false signal voltage (rich exhaust indication). The ECM will then reduce the amount of fuel delivered to the engine, causing a severe driveability problem.

IGNITION SYSTEM

- **CHECK:** Ignition system; wires, plugs, rotor, etc.

ENGINE MECHANICAL

- **CHECK:** Perform a cylinder compression check. See ENGINE MECHANICAL DIAGNOSIS (SECTION 6).

ADDITIONAL CHECKS

- **CHECK:** Throttle linkage for sticking or binding.
- **CHECK:** P/N switch circuit. See CHART C-1A, or use "Scan" tool and be sure tool indicates vehicle is in drive with gear selector in drive or overdrive.
- **CHECK:** IAC operation, use CHART C-2C.
- **CHECK:** EGR valve. There should be no EGR at idle.
- **CHECK:** A/C signal to ECM, "Scan" tool should indicate A/C is being requested when ever A/C is selected. If problem exists with A/C "ON," check A/C system operation CHART C-10.
- **CHECK:** Check A.I.R. system. There should be no A.I.R. to ports while in "Closed loop." Refer to CHART C-6.
- **CHECK:** PCV valve for proper operation by placing finger over inlet hole in valve end several times. Valve should snap back. If not, replace valve. See "Positive Crankcase ventilation (PCV)" Section "6E3-C13."
- **CHECK:** Generator output voltage. Repair if less than 9 or more than 16 volts.

POOR FUEL ECONOMY

Definition: Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, economy is noticeably lower than it was on this car at one time, as previously shown by an actual road test.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms" Section "6E3-B."
- Check owner's driving habits.
  - Is A/C "ON" full time (Defroster mode "ON")?
  - Are tires at correct pressure.
  - Are excessively heavy loads being carried?
  - Is acceleration too much, too often?
- Check air cleaner element (filter) for dirty or being plugged.
- Visually (physically) check: Vacuum hoses for splits, kinks, and proper connections as shown on "Vehicle Emission Control Information" label.

IGNITION SYSTEM

- **CHECK:** Ignition timing. Refer to "Vehicle Emission Control Information" label.
- **CHECK:** Spark plugs. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary.

COOLING SYSTEM

- **CHECK:** Engine coolant level.
- **CHECK:** Engine thermostat for faulty part (always open) or for wrong heat range. Refer to ENGINE COOLING (SECTION 6B).

ENGINE MECHANICAL

- **CHECK:** Compression. See ENGINE MECHANICAL DIAGNOSIS (SECTION 6A).

ADDITIONAL CHECKS

- **CHECK:** TCC operation. Use CHART C-8. A "Scan" tool should indicate an rpm drop, when the TCC is commanded "ON."
- **CHECK:** For exhaust system restriction. Use CHART B-1.
- **CHECK:** For proper calibration of speedometer.
- **CHECK:** Induction system and crankcase for air leaks.

EXCESSIVE EXHAUST EMISSIONS OR ODORS

Definition: Vehicle fails an emission test. Vehicle has excessive "rotten egg" smell. Excessive odors do not necessarily indicate excessive emissions.

PRELIMINARY CHECKS

- Perform "Diagnostic Circuit Check."
- IF EMISSION TEST shows excessive CO and HC check items which cause car to run RICH (Block Learn Memory (BLM) less than 118), refer to "Diagnostic Aids" on facing page of Code 45.
- If EMISSION TEST shows excessive NOx, check items which cause car to run lean or too hot.

COOLING SYSTEM

- If the "Scan" tool indicates a very high coolant temperature and the system is running lean:
  - CHECK: Engine coolant level
  - CHECK: Engine thermostat for faulty part (always open) or for wrong heat range. Refer to ENGINE COOLING (SECTION 6B).
  - CHECK: Cooling fan operation, uee CHART C-12.

FUEL SYSTEM

- If the system is running rich (block learn near 118), refer to "Diagnostic Aids" on facing page of Code 45.
- If the system is running lean (block learn near 142) refer to "Diagnostic Aids" on facing page of Code 44.
- **CHECK:** For properly installed fuel cap.
- **CHECK:** Fuel pressure. Use CHART A-7.
- **CHECK:** Injector balance test. Use CHART C-2A.
- **CHECK:** Canister for fuel loading. Use CHART C-3.

IGNITION SYSTEM

- **CHECK:** Ignition timing. Refer to "Vehicle Emission Control Information" label.
- **CHECK:** Spark plugs. plug wires, and ignition components. Refer to ENGINE ELECTRICAL (SECTION 6D).

ADDITIONAL CHECKS

- **CHECK:** For vacuum leaks.
- **CHECK:** EGR valve for not opening. Use CHART C-7.
- **CHECK:** For lead contamination for catalytic converter (look for the removal of fuel filler neck restrictor).
- **CHECK:** Carbon build-up. Remove carbon with top engine cleaner. Follow instructions on can.
- **CHECK:** PCV valve for being plugged, stuck or blocked PCV hose or fuel in the crankcase.
- **CHECK:** For correct MEM-CAL (see Service Bulletins).

DIESELING, RUN-ON

Definition: Engine continues to run after key is turned "OFF," but runs very roughly. If engine runs smoothly, check ignition switch and adjustment.

PRELIMINARY CHECKS

- Perform the careful visual checks as described at start of "Symptoms" Section "6E3-B."

FUEL SYSTEM

- **CHECK:** Injectors for leaking. Refer to "Fuel System Diagnosis" CHART A-7.

BACKFIRE

Definition: Fuel ignites its intake manifold, or in exhaust system, making loud popping noise.

PRELIMINARY CHECKS

- Perform the careful visual/physical checks as described at start of "Symptoms" Section "6E3-B."

IGNITION SYSTEM

- **CHECK:** Proper ignition coil output voltage with spark tester J 26792 or equivalent (ST-125).
- **CHECK:** Spark plugs. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary.
- **CHECK:** Spark plug wires for crossfire, also inspect distributor cap, spark plug wires, and proper routing of plug wires.
- **CHECK:** Ignition timing. Refer to "Vehicle Emission Control Information" label.
- **NOTE:** If an intermittent condition exists in the ignition system, see "Ignition System/EST" Section "6E3-C4" or ENGINE ELECTRICAL (SECTION 6D).

BASE ENGINE

- **CHECK:** Compression - Look for sticking or leaking valves.
- **CHECK:** Valve timing, refer to ENGINE MECHANICAL DIAGNOSIS (SECTION 6A).
- **CHECK:** Intake and exhaust manifold for casting flash.

FUEL SYSTEM

- **CHECK:** Perform fuel system diagnosis check, see CHART A-7.
- **CHECK:** Fuel Injectors. Perform injector balance test, refer to CHART C-2A.

ADDITIONAL CHECKS

- **CHECK:** EGR gasket for faulty or loose fit.
- **CHECK:** EGR operation for being open all the time. Refer to "Exhaust Gas Recirculation (EGR)" CHART C-7.
- **CHECK:** Air Injection Reaction (AIR) system, refer to CHART C-6.
- **CHECK:** Intake and exhaust manifold for casting flash.

CHART B-1

RESTRICTED EXHAUST SYSTEM CHECK
ALL ENGINES

Proper diagnosis for a restricted exhaust system is essential before any components are replaced. Either of the following procedures may be used for diagnosis, depending upon engine or tool used:

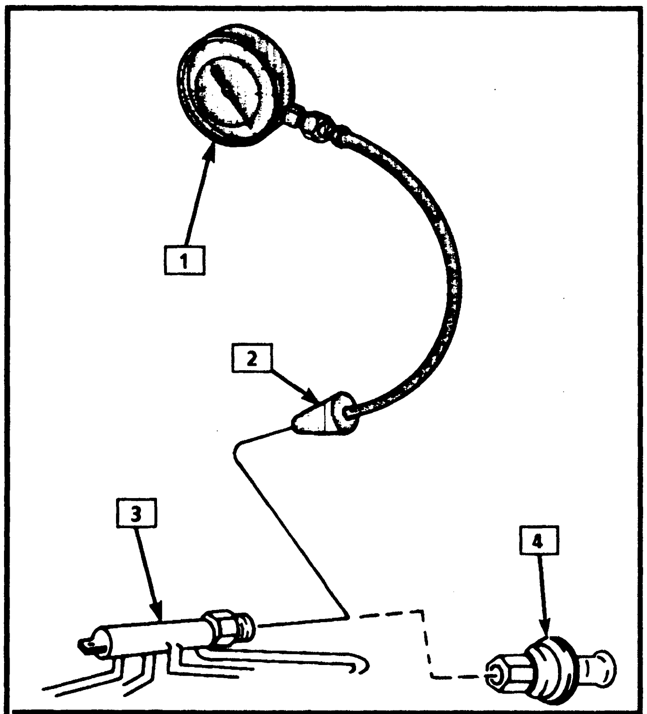
CHECK AT A. I. R. PIPE:

1. Remove the rubber hose at the exhaust manifold A.I.R. pipe check valve. Remove check valve.
2. Connect a fuel pump pressure gauge to a hose and nipple from a Propane Enrichment Device (J 26911) (see illustration).
3. Insert the nipple into the exhaust manifold A.I.R. pipe.

OR

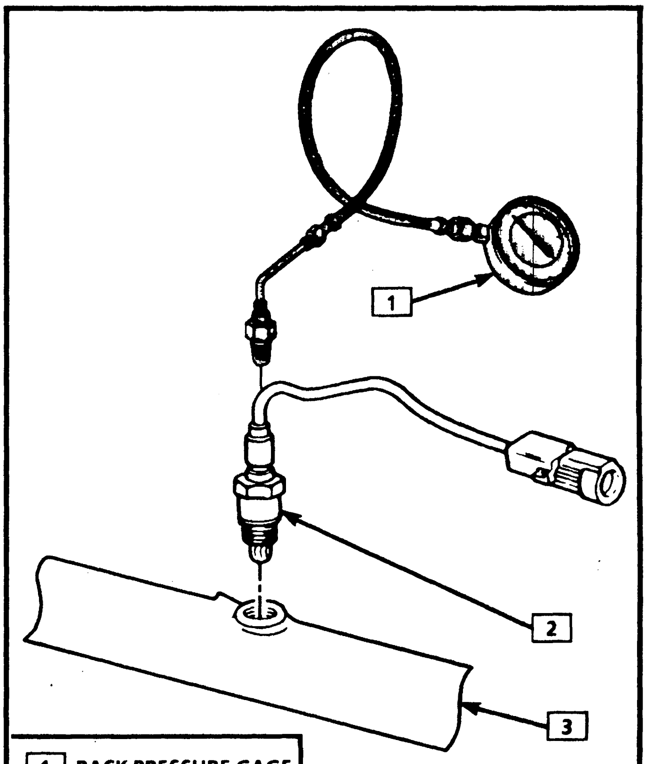
CHECK AT OXYGEN (O_2) SENSOR:

1. Carefully remove Oxygen (O_2) sensor.
2. Install Borroughs exhaust backpressure tester (BT 8515 or BT 8603) or equivalent in place of O_2 sensor (see illustration).
3. After completing test described below, be sure to coat threads of O_2 sensor with anti-seize compound P/N 5613695 or equivalent prior to re-installation.



1 GAGE
2 HOSE AND NIPPLE ADAPTER
3 A.I.R. PIPE (EXHAUST PORT)
4 CHECK VALVE

5-15-89
7S 3363-6E



1 BACK PRESSURE GAGE
2 OXYGEN (O_2) SENSOR
3 EXHAUST MANIFOLD

5-16-89
7S 3338-6E

DIAGNOSIS:

1. With the engine idling at normal operating temperature, observe the exhaust system backpressure reading on the gage. Reading should not exceed 8.6 kPa (1.25 psi).
2. Increase engine speed to 2000 rpm and observe gage. Reading should not exceed 20.7 kPa (3 psi).
3. If the backpressure at either speed exceeds specification, a restricted exhaust system is indicated.
4. Inspect the entire exhaust system for a collapsed pipe, heat distress, or possible internal muffler failure.
5. If there are no obvious reasons for the excessive backpressure, the catalytic converter is suspected to be restricted and should be replaced using current recommended procedures.

4-26-88
7S 3340-6E

ECM CONNECTOR "A"

PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR CAVITY	NORMAL VOLTAGES		CODES AFFECT	POSSIBLE SYMPTOMS FROM FAULTY CIRCUIT
				KEY "ON"	ENG RUN		
BA1							
BA2							
BA3							
BA4 MAP SENSOR 5 VOLT REFERENCE	474	GRY	MAP SENSOR "C"	5V	5V	33 34 ⑧	LACK OF POWER ROUGH IDLE SURGE
BA5 TPS 5 VOLT REFERENCE	416	GRY	TPS "C"	5V	5V	21 22 ⑧	HIGH IDLE
BA6 IGNITION FEED	439	PNK/BLK	ECM FUSE AND VATS MODULE "A1"	B+	B+	46 ⑩	NO SES LIGHT, ENGINE CRANKS BUT WILL NOT START, VATS INOPERATIVE
BA7							
BA8 SERIAL DATA	461	ORN	ALDL "E" AND "M"	③ 2.5	③ 2.5		NO SERIAL DATA "SCAN" TOOL WILL NOT WORK
BA9							
BA10							
BA11 FUEL PUMP RELAY DRIVE	465	DK GRN/WHT	FUEL PUMP RELAY "D"	④ B+ ②	④ B+	54 ⑩	LONG CRANKING TIME BEFORE ENGINE STARTS
BA12 ECM GROUND	450	BLK/WHT	ENGINE BLOCK	0	0		

① Varies from .60 to battery voltage, depending on position of drive wheels.
② Battery voltage for first two seconds
③ Varies
④ Battery voltage when fuel pump is running
⑤ Varies with temperature
⑥ Reads battery voltage in gear
⑦ Battery voltage where engine is cranking
⑧ Open circuit
⑨ Grounded circuit
⑩ Open/grounded circuit
* Less than .5 volt (500 mv)
⑪ Less than 1 volt

1-12-90
MS 9083-6E

ECM Symptom Chart (1 of 6)

ECM CONNECTOR "B"

PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR CAVITY	NORMAL VOLTAGES		CODES AFFECT	POSSIBLE SYMPTOMS FROM FAULTY CIRCUIT
				KEY "ON"	ENG RUN		
BB1 BATTERY FEED	340	ORN	FUEL PUMP RELAY "A" OPS "D"	B+	B+	54 ⑩	NO SES LIGHT ENGINE CRANKS BUT WILL NOT START
BB2							
BB3							
BB4							
BB5 TPS AND MAT SENSOR GROUND	452	BLK	MAT "A" TPS "A"	0	0	21 ⑧ 23 ⑧	HIGH IDLE
BB6 CTS AND MAP SENSOR GROUND	470	BLK	CTS "A" MAP SENSOR "A"	0	0	14 ⑧ 33 ⑧	ROUGH IDLE LACK OF PERFORMANCE EXHAUST ODOR
BB7							
BB8							
BB9 VEHICLE SPEED SENSOR (VSS) SIGNAL LOW	401	PPL	VEHICLE SPEED SENSOR (VSS) "B"	①	①	24 ⑩	NO VSS SIGNAL INOPERATIVE SPEEDOMETER INOPERATIVE CRUISE CONTROL
BB10 VEHICLE SPEED SENSOR (VSS) SIGNAL HIGH	400	YEL	VEHICLE SPEED SENSOR (VSS) "A"	①	①	24 ⑩	NO VSS SIGNAL INOPERATIVE SPEEDOMETER INOPERATIVE CRUISE CONTROL
BB11 ECM TO INSTRUMENT CLUSTER VSS	1019	GRY	I/P CLUSTER "C8"	①	①		INOPERATIVE SPEEDOMETER
BB12							

① Varies from .60 to battery voltage, depending on position of drive wheels.
② Battery voltage for first two seconds
③ Varies
④ Battery voltage when fuel pump is running
⑤ Varies with temperature
⑥ Reads battery voltage in gear
⑦ Battery voltage where engine is cranking
⑧ Open circuit
⑨ Grounded circuit
⑩ Open/grounded circuit
* Less than .5 volt (500 mv)
⑪ Less than 1 volt

1-12-90
MS 9084-6E

ECM Symptom Chart (2 of 6)

ECM CONNECTOR "C"

PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR CAVITY	NORMAL VOLTAGES		CODES AFFECT	POSSIBLE SYMPTOMS FROM FAULTY CIRCUIT
				KEY "ON"	ENG RUN		
BC1 VEHICLE SPEED SENSOR SIGNAL	381	RED	I/P CONNECTOR "P"				
BC2							
BC3							
BC4							
BC5							
BC6							
BC7 BYPASS	424	TAN/BLK	DISTRIBUTOR 4 PIN CONNECTOR "B"	0 *	5V	42 ⑩	LACK OF POWER (SET TIMING CONNECTOR)
BC8 ELECTRONIC SPARK TIMING (EST)	423	WHT	DISTRIBUTOR 4 PIN CONNECTOR "D"	0 *	1.3V	42 ⑩	LACK OF POWER DETONATION HARD START
BC9 A/C REQUEST SIGNAL	59	DK GRN	A/C COMPRESSOR CLUTCH "A" "OFF" "ON"	0 * B +	0 * B +		INOPERATIVE A/C INCORRECT IDLE
BC10							
BC11 INJECTOR DRIVER 1, 3, 5, 7	467	DK BLU	INJECTOR CONNECTOR "B"	B +	B +		ROUGH IDLE, ENGINE CRANKS BUT WILL NOT START LACK OF PERFORMANCE
BC12 INJECTOR DRIVER 2, 4, 6, 8	468	DK GRN	INJECTOR CONNECTOR "B"	B +	B +		ROUGH IDLE, ENGINE CRANKS BUT WILL NOT START LACK OF PERFORMANCE
BC13							
BC14							
BC15							
BC16 BATTERY FEED	340	ORN	FUEL PUMP RELAY "A" OPS "D"	B +	B +	54 ⑩	NO SES LIGHT ENGINE CRANKS BUT WILL NOT START

① Varies from .60 to battery voltage, depending on position of drive wheels.
② Battery voltage for first two seconds
③ Varies
④ Battery voltage when fuel pump is running
⑤ Varies with temperature
⑥ Reads battery voltage in gear
⑦ Battery voltage where engine is cranking
⑧ Open circuit
⑨ Grounded circuit
⑩ Open/grounded circuit
* Less than .5 volt (500 mv)
⑪ Less than 1 volt

1-12-90
MS 9085-6E

ECM Symptom Chart (3 of 6)

ECM CONNECTOR "D"

PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR CAVITY	NORMAL VOLTAGES		CODES AFFECT	POSSIBLE SYMPTOMS FROM FAULTY CIRCUIT
				KEY "ON"	ENG RUN		
BD1 ECM GROUND	450	BLK/WHT	ENGINE BLOCK	0	0		ENGINE CRANKS BUT WILL NOT START NO SES LIGHT
BD2							
BD3							
BD4							
BD5							
BD6 INJECTOR GROUND	450	BLK/WHT	ENGINE BLOCK	0	0	44 ⑧	ENGINE CRANKS BUT WILL NOT START IF CONNECTION AT ENGINE BLOCK IS FAULTY
BD7 INJECTOR GROUND	450	BLK/WHT	ENGINE BLOCK	0	0	44 ⑧	ENGINE CRANKS BUT WILL NOT START IF CONNECTION AT ENGINE BLOCK IS FAULTY
BD8 REFERENCE	430	PPL/WHT	DISTRIBUTOR 4 PIN TERMINAL "C"	0	1.3V		ENGINE CRANKS BUT WILL NOT START
BD9 REFERENCE GROUND	453	BLK/RED	DISTRIBUTOR 4 PIN TERMINAL "C"	0*	0*		LACK OF PERFORMANCE
BD10							
BD11							
BD12 SECONDARY COOLING FAN (FAN 2) REQUEST	731	GRY	SECONDARY FAN (FAN 2) RELAY "F" "ON" "OFF"	0 12V	0 12V		INOPERATIVE FAN 2 FAN 2 RUNS ALL THE TIME
BD13							
BD14 4th GEAR SWITCH	446	LT BLU	TCC CONNECTOR "B"	B +	B +		POOR FUEL ECONOMY
BD15							
BD16 PARK/NEUTRAL (P/N) SWITCH SIGNAL	434	ORN/BLK	PARK/NEUTRAL (P/N) SWITCH "B"	0 ⑥	0 ⑥	24 ⑩	POOR FUEL ECONOMY STALL INCORRECT IDLE

① Varies from .60 to battery voltage, depending on position of drive wheels.
② Battery voltage for first two seconds
③ Varies
④ Battery voltage when fuel pump is running
⑤ Varies with temperature
⑥ Reads battery voltage in gear
⑦ Battery voltage where engine is cranking
⑧ Open circuit
⑨ Grounded circuit
⑩ Open/grounded circuit
* Less than .5 volt (500 mv)
⑪ Less than 1 volt

1-12-90
MS 9086-6E

ECM Symptom Chart (4 of 6)

ECM CONNECTOR "E"

PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR CAVITY	NORMAL VOLTAGES		CODES AFFECT	POSSIBLE SYMPTOMS FROM FAULTY CIRCUIT
				KEY "ON"	ENG RUN		
GE1							
GE2							
GE3 IAC COIL "A" HIGH	441	LT BLU/WHT	IAC VALVE "A"	0 OR B +	0 OR B +		INCORRECT IDLE SURGE
GE4 IAC COIL "A" LOW	442	LT BLU/BLK	IAC VALVE "B"	0 OR B +	0 OR B +		INCORRECT IDLE SURGE
GE5 IAC COIL "B" HIGH	443	LT GRY/WHT	IAC VALVE "C"	0 OR B +	0 OR B +		INCORRECT IDLE SURGE
GE6 IAC COIL "B" LOW	444	LT GRY/BLK	IAC VALVE "D"	0 OR B +	0 OR B +		INCORRECT IDLE SURGE
GE7 SERVICE ENGINE SOON LIGHT	419	BRN/WHT	I/P PRINTED CIRCUIT CONNECTOR "C2"	0*	B +		NO SES LIGHT
GE8 PRIMARY COOLING FAN (FAN 1) CONTROL	335	DK GRN/WHT	PRIMARY FAN (FAN 1) RELAY "F" "ON" "OFF"	0 * B +	0 * B +		INOPERATIVE FAN 1 FAN 1 RUNS ALL THE TIME
GE9 EGR SOLENOID CONTROL	435	GRY	EGR SOLENOID "A"	B +	B +	32 ⑩	DETONATION, STALL, ROUGH IDLE POOR PERFORMANCE
GE10							
GE11							
GE12 DIAGNOSTIC "TEST" TERMINAL	451	WHT/BLK	ALDL CONNECTOR "B"	5V ②	5V ②		NO "SCAN" TOOL DATA WILL NOT FLASH CODE 12
GE13 FUEL PUMP SIGNAL (PPSW)	120	GRY	FUEL PUMP RELAY "A" OPS "'C"	0 ④	B +	54 ⑩	ENGINE CRANKS BUT WILL NOT START
GE14 OXYGEN (O_2) SENSOR SIGNAL	412	PPL	OXYGEN (O_2) SENSOR	.35 -.55	③ .1 - .9	13 ⑧ 44 ⑨	EXHAUST ODOR POOR PERFORMANCE
GE15 OXYGEN (O_2) SENSOR GROUND	413	TAN	ENGINE GROUND	0	0	13 ⑧ 44 ⑧	ROUGH IDLE, INCORRECT IDLE, LEAN EXHAUST POOR PERFORMANCE
GE16 CTS SIGNAL	410	YEL	CTS "B"	1.6V ⑤	1.6V ⑤	14 ⑨ 15 ⑧	EXHAUST ODOR, ROUGH IDLE LACK OF PERFORMANCE

① Varies from .60 to battery voltage, depending on position of drive wheels.
② Battery voltage for first two seconds
③ Varies
④ Battery voltage when fuel pump is running
⑤ Varies with temperature
⑥ Reads battery voltage in gear
⑦ Battery voltage where engine is cranking
⑧ Open circuit
⑨ Grounded circuit
⑩ Open/grounded circuit
* Less than .5 volt (500 mv)
⑪ Less than 1 volt

1-12-90
MS 9087-6E

ECM Symptom Chart (5 of 6)

ECM CONNECTOR "F"

PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR CAVITY	NORMAL VOLTAGES ⑥		CODES AFFECT.	POSSIBLE SYMPTOMS FROM FAULTY CIRCUIT
				KEY "ON"	ENG RUN		
GF1 M/T SHIFT LIGHT CONTROL	456	TAN/BLK	I/P PRINTED CIRCUIT CONN "C10"	0 ②	0		INOPERATIVE SHIFT LIGHT
GF2 A.I.R. PORT (SWITCH) SOLENOID CONTROL	436	BRN	A.I.R. E.A.S. SOLENOID "B"	B +	B +		INCORRECT IDLE ROUGH IDLE FAIL EMISSIONS TEST OVERHEAT CATALYTIC CONVERTER
GF3							
GF4 A.I.R. CONVERTER (DIVERT) SOLENOID CONTROL	429	BLK/PNK	A.I.R. E.A.C. SOLENOID "B"	B +	B +	44 ⑨	INCORRECT IDLE ROUGH IDLE BACKFIRE UPON DECELERATION
GF5							
GF6 A/T TCC CONTROL	422	TAN/BLK	TCC CONNECTOR "D"	B +	B +		POOR FUEL ECONOMY CHUGGLE
GF7 CANISTER PURGE SOLENOID CONTROL	423	DK GRN/ YEL	CANISTER PURGE SOLENOID "B"	0*	B +	45	FUEL ODOR ROUGH IDLE
GF8							
GF9 ESC KNOCK SENSOR SIGNAL	496	DK BLU	KNOCK SENSOR	9.2	9.3	43 ⑩	LACK OF PERFORMANCE
GF10 VATS (PASS-KEY) SIGNAL	229	DK BLU	VATS MODULE "A2"	2.5	2.5	46 ⑩	ENGINE CRANKS BUT WILL NOT START
GF11							
GF12							
GF13 TPS SIGNAL	417	DK BLU	TPS "B"	.54	.54	22 ⑩	LACK OF PERFORMANCE, ROUGH IDLE, MISS
GF14							
GF15 MAP SIGNAL	432	LT GRN	MAP SENSOR "B"	② 4.57	② .6-20	34 ⑩	LACK OF PERFORMANCE ROUGH IDLE SURGE
GF16 MAT SIGNAL	472	TAN	MAT SENSOR "B"	③	③	23 ⑧ 25 ⑨	POOR PERFORMANCE, HARD TO START

① Varies from .60 to battery voltage, depending on position of drive wheels.
② Battery voltage for first two seconds
③ Varies
④ Battery voltage when fuel pump is running
⑤ Varies with temperature
⑥ Reads battery voltage in gear
⑦ Battery voltage where engine is cranking
⑧ Open circuit
⑨ Grounded circuit
⑩ Open/grounded circuit
* Less than .5 volt (500 mv)
⑪ Less than 1 volt

1-12-90
MS 9088-6E

ECM Symptom Chart (6 of 6)

SECTION C
COMPONENT SYSTEMS

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts of system damage could result.

Section "C" provides information on the following:

- General description of components and systems.
- On-Vehicle service.
- Part names and group numbers.
- Diagnostic charts. These include a functional check of the system as well as diagnosis of any problem found in the functional check.

For locations of components, wiring diagrams, and ECM Terminal End View, refer to the front on the "A" section of the engine being diagnosed.

Following are the sub-section identification and the system covered:

DIAGNOSTIC CHARTS

The Diagnostic Charts for each system are found after the On-Vehicle service and parts information at the back of each section. Following are the charts found in this section.

SECTION C1

ELECTRONIC CONTROL MODULE (ECM) AND SENSORS

CONTENTS

GENERAL DESCRIPTION

ELECTRONIC CONTROL MODULE (ECM)

The Electronic Control Module (ECM) (Figure C1-1) is a compact microprocessor that is the control center of the fuel injection system. It constantly looks at the information from various sensors, and controls the systems that affect vehicle performance. The ECM performs the diagnostic function check of the system.

It can recognize operational problems, alert the driver through the "Service Engine Soon" light, and store a code or codes which identify the problem areas to aid the technician in making repairs. Refer to DRIVEABILITY AND EMISSIONS GENERAL INFORMATION (SECTION 6E) for more information on using the diagnostic function of the ECM.

For service, this ECM only consists of two parts: a Controller (the ECM without a MEM-CAL) and an assembly called a MEM-CAL. (This stands for "Memory and Calibration" Unit.)

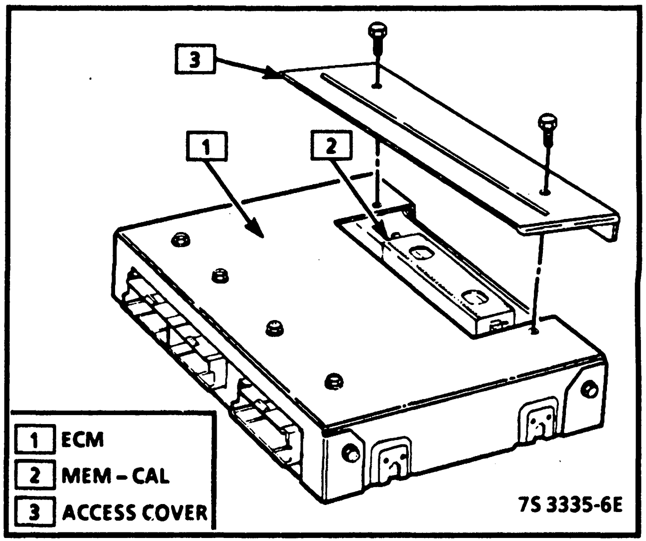


Figure C1-1 - Electronic Control Module (ECM)

MEM-CAL

This assembly contains both the functions of the PROM and CAL-PAK. Like the PROM, it contains the calibrations needed for a specific vehicle as well as the back-up fuel control circuitry required if the rest of the ECM becomes damaged or faulty.

ECM Function

The ECM contains a power supply which regulates the 12 volt vehicle supply input to 5, 8 and 12 volts, and these voltages are used for various internal and external functions.

The ECM supplies a buffered 5 or 12 volts to power various sensors or switches. This is done through resistances in the ECM which are so high in value that a test light will not light when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give an accurate reading because its resistance is too low. Therefore, the use of a 10 megohm input impedance digital voltmeter is necessary to assure accurate voltage readings.

The Input/Output (I/O) devices in the ECM include analog to digital converters, signal buffers, counters, and special drivers. The ECM controls output circuits such as the injectors, IAC, cooling fan relay, etc. by controlling the ground circuit through transistors or a device called a quad-driver in the ECM.

Memory

There are three types of memory storage within the ECM: ROM, RAM and PROM.

ROM

Read Only Memory (ROM) is a permanent memory that is physically soldered to the circuit boards within the ECM. The ROM contains the overall control algorithms. Once the ROM is programmed, it cannot be changed. The ROM memory is non-volatile, and does not need power to be retained.

RAM

Random Access Memory (RAM) is the microprocessor "scratch pad." The processor can write into, or read from this memory as needed. This memory is volatile and needs a constant supply of voltage to be retained. If the voltage is lost, the memory is lost and the ECM logs a code indicating this loss.

PROM

Programmable Read Only Memory (PROM) is the portion of the ECM that contains the different engine calibration information that is specific to year, model and emissions. The PROM is a non-volatile memory that is read only by the ECM.

The PROM is contained within the Memory Calibration (MEM-CAL) assembly and is removable from the ECM. The MEM-CAL should be retained with the vehicle following ECM replacement.

Integrator

The integrator is an ECM volatile memory register that will contain a number between 0 and 255. The neutral value for the integrator is 128; any deviation from this value indicates the integrator is changing the injector pulse width. The amount of pulse width change depends on how far the integrator value is from 128. The integrator changes the pulse width by varying the "Closed Loop" factor of the base pulse width equation. As the ECM monitors the Oxygen (O_2) sensor input, it is constantly varying the integrators value. The value is updated very quickly, therefore, the integrator only corrects for short term mixture trends. The correction of long term mixture trends is the function of the Block Learn.

Block Learn

The Block Learn is a matrix of cells arranged by RPM and MAP. Each cell of the block learn is a register like the integrator. As the engine operating conditions change, the ECM will switch from cell to cell to determine what "block learn" factor to use in the base pulse width equation.

While in any given block, the ECM also monitors the integrator. If the integrator is far enough from 128, the ECM will change the block learn value. Once the block learn value is changed, it should force the integrator back toward 128.

If the mixture is still not correct (as judged by the O_2), the integrator will continue to have a large deviation from the ideal 128. In this case, the blocklearn value will continue to change until the integrator becomes balanced.

Both the integrator and block learn have limits which will vary with each PROM or MEM-CAL. If the mixture is off enough so that block learn reaches the limit of its control and still cannot correct the condition, the integrator would also go to its limit of control in the same direction. If the mixture is still not corrected by both integrator and block learn at their extreme values, a Code 44 or Code 45 will likely result. Under the conditions of power enrichment, the ECM sets the integrator to 128 and freezes it there until power enrichment is no longer in effect. This is done so the "Closed Loop" factor and the block learn will not try to correct for the commanded richness of power enrichment.

SPEED DENSITY SYSTEM

The Port Fuel Injection (PFI) system is a speed and air density system. The system is based on "speed density" fuel management, let's define their basis of operation.

Three specific data sensors provide the ECM with the basic information for the fuel management portion of its operation. That is, three specific signals to the ECM establish the engine speed and air density factors.

Speed

The engine speed signal comes from the Distributor High Energy Ignition (HFI) module to the ECM on the crank reference high, CKT 430. The ECM uses this information to determine the "speed" or rpm factor for fuel and ignition management.

Density

Two sensors contribute to the density factor, the Manifold Air Temperature (MAT) and the Manifold Absolute Pressure (MAP) sensors.

The MAT sensor is a 2-wire sensor that measures the temperature of the air entering the intake manifold. The MAT sensor is a thermistor that changes its resistance as an inverse function of temperature. When the temperature is low, the resistance is high, and when the temperature is high, the resistance is low.

The Manifold Absolute Pressure (MAP) sensor is a 3-wire sensor that monitors the changes in intake manifold pressure which results from changes in engine loading. These pressure changes are supplied to the ECM in the form of analog electrical signals.

As intake manifold pressure increases, the air density in the intake manifold also increases, and additional fuel is required. The MAP sensor sends this pressure information to the ECM, and the ECM increases the amount of fuel injected, by increasing the injector pulse width. Conversely, as manifold pressure decreases, the amount of fuel is decreased.

Three inputs: MAP, MAT and rpm are the major determinants of the air/fuel mixture delivered by the fuel injection system.

The remaining sensors and switches provide electrical inputs to the ECM which are used for modification of the air/fuel mixture, as well as for other ECM control functions, such as Idle Air Control (IAC).

INFORMATION SENSORS

Coolant Temperature Sensor (CTS)

The Coolant Temperature Sensor (CTS) is a thermistor (a resistor which changes value based on temperature) mounted in the engine coolant stream. Low coolant temperature produces a high resistance (100,000 ohms at -40°C/-40°F), while high temperature causes low resistance (70 ohms at 130°C/266°F).

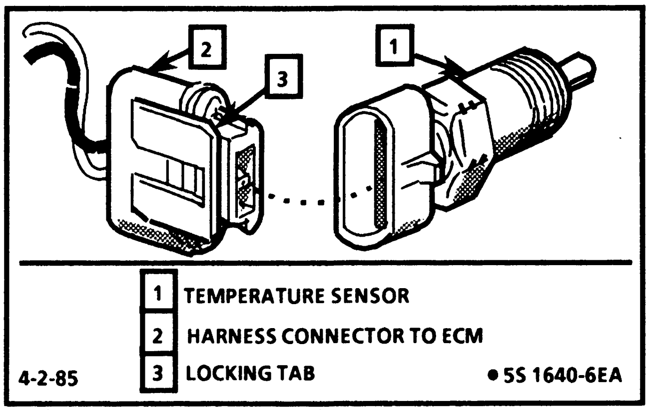


Figure C1-2 - Engine Coolant Temperature Sensor

The ECM supplies a 5 volt signal to the CTS through a resistor in the ECM and measures the voltage. The voltage will be high when the engine is cold, and low when the engine is hot. By measuring the voltage, the ECM knows the engine coolant temperature. Engine coolant temperature affects most systems the ECM controls.

A failure in the CTS circuit should set either a Code 14 or Code 15. Remember, these codes indicate a failure in the coolant temperature sensor circuit, so proper use of the chart will lead to either repairing a wiring problem or replacing the sensor to properly repair a problem.

Knock Sensor

The knock sensor is mounted in the lower right side of the engine block.

When abnormal engine vibrations (spark knock) are present the sensor produces a voltage signal, which is sent to the ESC module.

For further information, refer to "Electronic Spark Control (ESC) System" Section "6E3-C5."

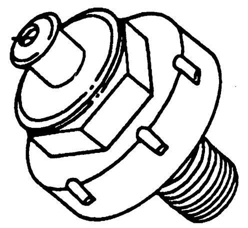
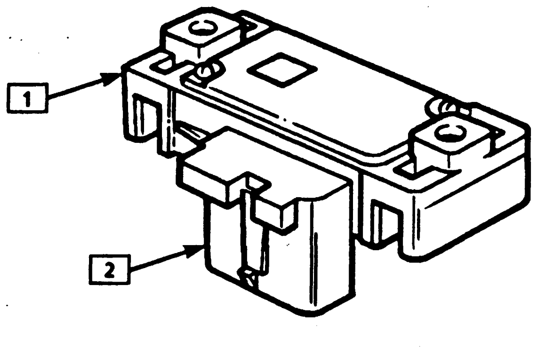


Figure C1-3 - Knock Sensor

Manifold Absolute Pressure (MAP) Sensor

The Manifold Absolute Pressure (MAP) sensor (Figure C1-4), is a pressure transducer that measures the changes in the intake manifold pressure. The pressure changes as a result of engine load and speed change, and the MAP sensor converts this to a voltage output.



1 SENSOR

2 ELECTRICAL CONNECTOR

*6S 2648-6E

Figure C1-4 - Manifold Absolute Pressure (MAP) Sensor

A closed throttle on engine coastdown would produce a relatively low MAP output voltage, while a wide-open throttle would produce a high MAP output voltage. This high output voltage is produced because the pressure inside the manifold is the same as outside the manifold, so you measure 100% of outside air pressure. Manifold Absolute Pressure (MAP) is the OPPOSITE of what you would measure on a vacuum gage.

When manifold pressure is high, vacuum is low. The MAP sensor is also used to measure barometric pressure under certain conditions, which allows the ECM to automatically adjust for different altitudes.

VACUUM

kPa	0	10	20	30	40	50	60	70	80	90	100
Hg	0	29	5.9	8.9	11.8	14.8	17.7	20.7	23.7	26.7	29.6
V	4.9	4.4	3.8	3.3	2.7	2.2	1.7	1.1	0.6	0.3	0.3

MAP

kPa	100	90	80	70	60	50	40	30	20	10	0
Hg	29.6	26.6	23.7	20.7	17.7	14.8	11.8	8.9	5.9	2.9	0
V	4.9	4.4	3.8	3.3	2.7	2.2	1.7	1.1	0.6	0.3	0.3

The ECM sends a 5 volt reference signal to the MAP sensor. As the manifold pressure changes, the electrical resistance of the MAP sensor also changes. By monitoring the sensor output voltage the ECM knows the manifold pressure. A higher pressure, low vacuum (high voltage) requires more fuel, while a lower pressure, higher vacuum (low voltage) requires less fuel. The ECM uses the MAP sensor to control fuel delivery and ignition timing.

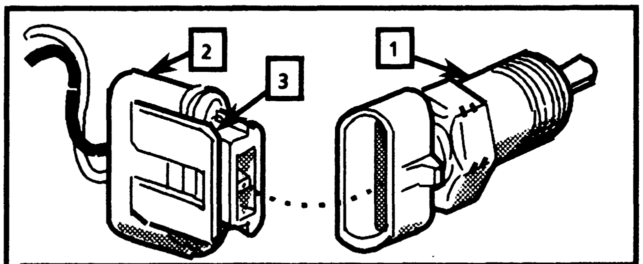
A failure in the MAP sensor circuit should set a Code 33 or Code 34.

Manifold Air Temperature (MAT) Sensor

The Manifold Air Temperature (MAT) sensor is a thermistor (a resistor which changes value based on temperature) is mounted in the throttle body extension. Low temperature produces a high resistance (100,000 ohms at -40°C/-40°F) while high temperature causes low resistance (70 ohms at 130°C/266°F).

The ECM supplies a 5 volt signal to the sensor through a resistor in the ECM and measures the voltage. The voltage will be high when the manifold air is cold, and low when the intake manifold air is hot. By measuring the voltage, the ECM knows the manifold air temperature.

A failure in the MAT sensor circuit should set either a Code 23 or Code 25.



1 TEMPERATURE SENSOR

2 HARNESS CONNECTOR TO ECM

4-2-85 3 LOCKING TAB •5S 1640-6EA

Figure C1-5 - Manifold Air Temperature (MAT) Sensor

Oxygen (O_2) Sensor

The Oxygen (O_2) sensor is essentially a small variable battery; it has the ability to produce a low voltage signal that feeds information on engine exhaust oxygen content to the ECM.

The Oxygen (O_2) sensor is constructed from a zirconia/platinum electrolytic element. Zirconia is an electrolyte that conducts electricity under certain chemical conditions. The element is made of a ceramic material. The element is an insulator when cold. At operating temperature, 315°C (600°F), the element becomes a semiconductor.

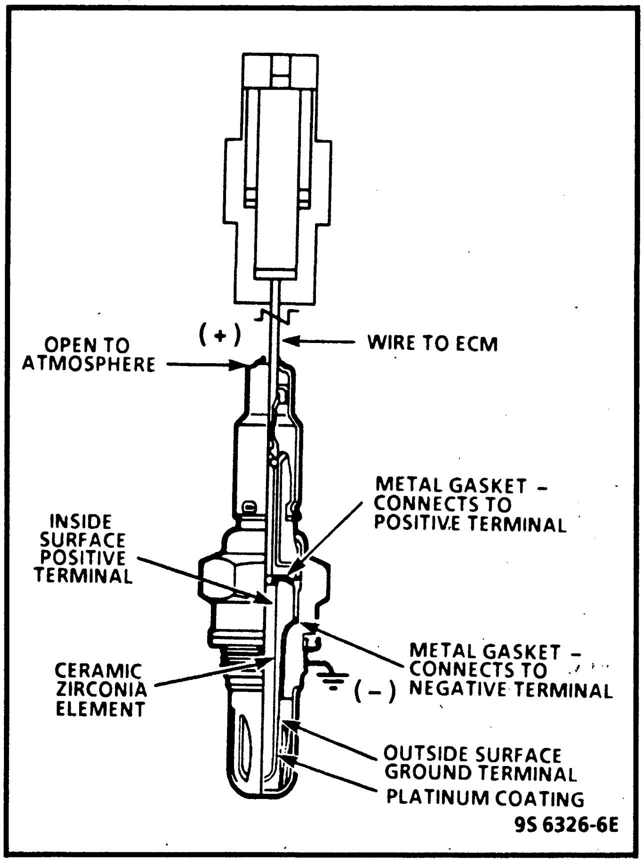


Figure C1-6 - Heated Oxygen (O_2) Sensor Cutaway View

A platinum coating on the outer surface of the element stimulatesfurther combustion of the exhaust gases right at the surface and this helps keep the element up to the desired temperature. The Oxygen (O_2) sensor has an inner cavitywhich is filled with atmospheric (reference) air. The atmosphere has approximately 21% oxygen in it. In the electrical circuit this inter cavity is the positive (+) terminal. The outer surface of the element is exposed to the exhaust gas stream. It is the negative (-) or ground terminal. Due to the electrolytic properties of the element the oxygen concentration differences between the reference air and exhaust gases produce small voltages (see Figure C1-7).

A rich exhaust (excessive fuel) has almost no oxygen. When there is a large difference in the amount of oxygen touching the inside and outside surfaces, there is more conduction, and the sensor puts out a voltage signal above 0.6 volt. With lean exhaust (excessive oxygen) there is about two percent oxygen in the exhaust. This is a smaller difference in oxygen from the outside surfaces which results in less conduction and a voltage signal below 0.3 volt. The voltages are monitored and used by the ECM to "fine tune" the air/fuel ratio to achieve the ideal mixture desired.

The ECM puts out a reference signal of 0.45 volt (See Figure C1-8). The reference signal serves two purposes.

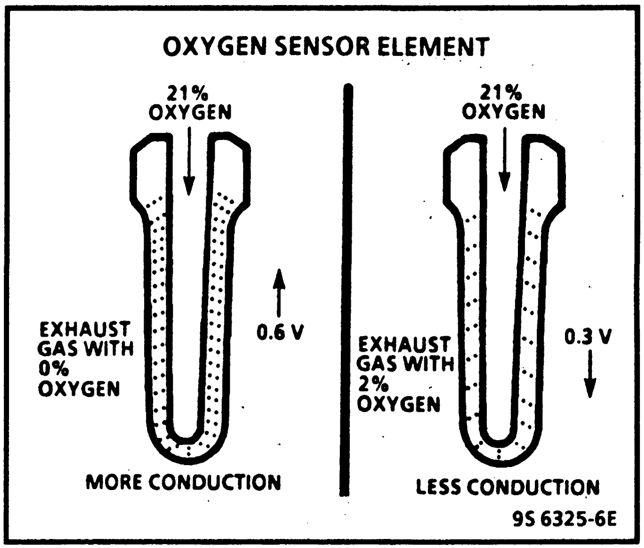


Figure C1-7 - Oxygen Sensor Element

The first is to run the engine when it is in "Open Loop" mode of operation. When the air/fuel ratio is correct, the ECM "sees" 0.45 volt. When the engine is operating with a rich air/fuel ratio there is a reduction of free oxygen in the exhaust stream and the O_2 voltage rises above the reference voltage. When the engine is run lean the voltage drops below the reference voltage due to excess oxygen in the exhaust stream. The oxygen sensor provides the feedback information for the "Closed Loop" operating mode of the fuel delivery system. The oxygen sensor indicates to the ECM what is happening in the exhaust. It doesnot cause things to happen. It is a type of gage: Low voltage output = lean mixture = high oxygen content in exhaust; high voltage output = rich mixture = low oxygen content in the exhaust.

An open Oxygen (O_2) sensor, should set a Code 13. A constant low voltage in the Oxygen (O_2) sensor circuit should set a Code 44. A constant high voltage in the circuit should set a Code 45. Code 44 or Code 45 could also be set as a result of fuel system problems. Refer to "Code Charts" for conditions that can cause a lean or rich system.

Throttle Position Sensor (TPS)

The Throttle Position Sensor (TPS) is a potentiometer connected to the throttle shaft on the throttle body (see Figure C1-9). It is a potentiometer with one end connected to 5 volts from the ECM and the other to ECM ground. A third wire is connected to the ECM to measure the voltage from the TPS. As the throttle valve angle is changed (accelerator pedal moved), the voltage output of the TPS also changes.

At a closed throttle position, the voltage output of the TPS is low (approximately .5 volt). As the throttle valve opens, the output increases so that, at Wide Open Throttle (WOT), the output voltage should be approximately 5 volts.

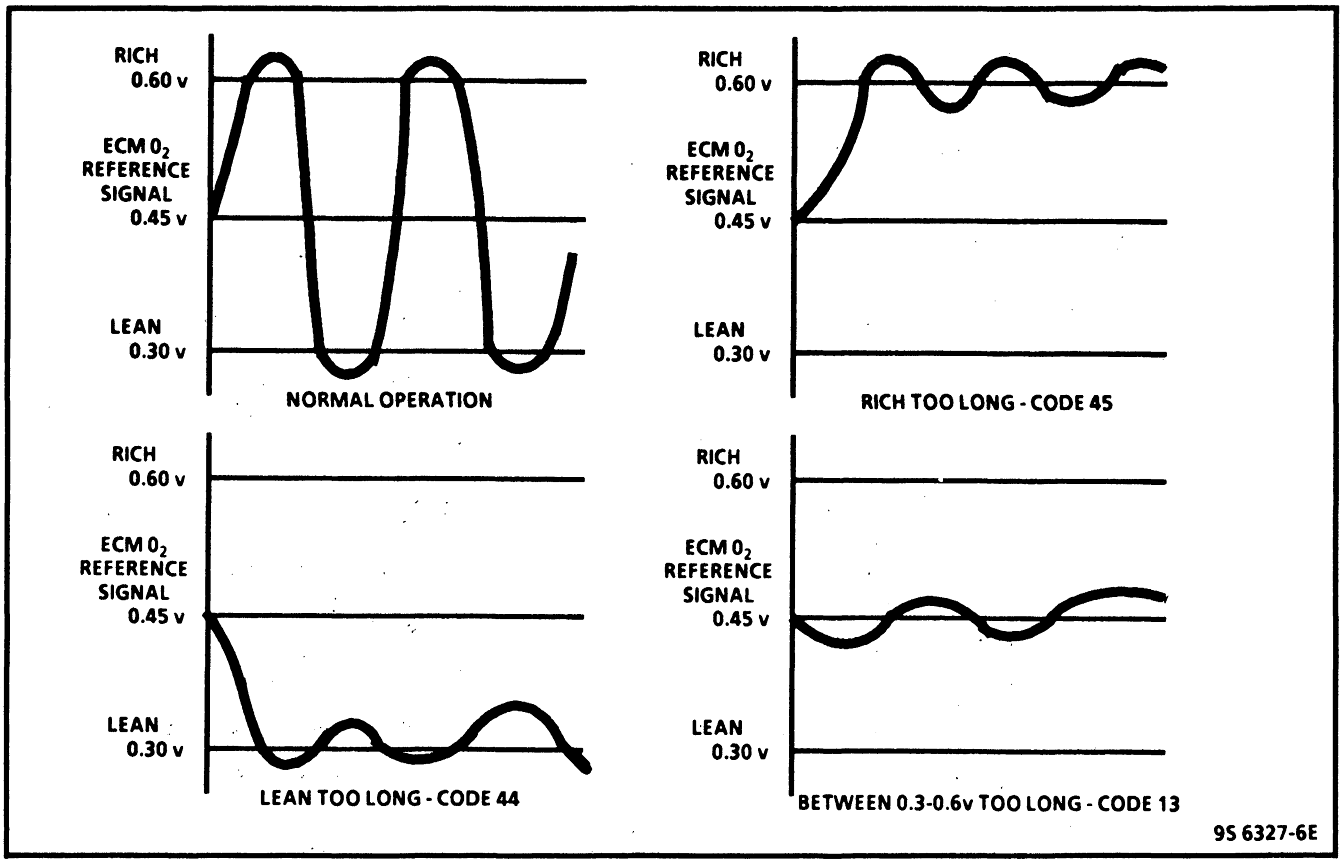


Figure C1-8 - Normal Voltage and Abnormal Trends

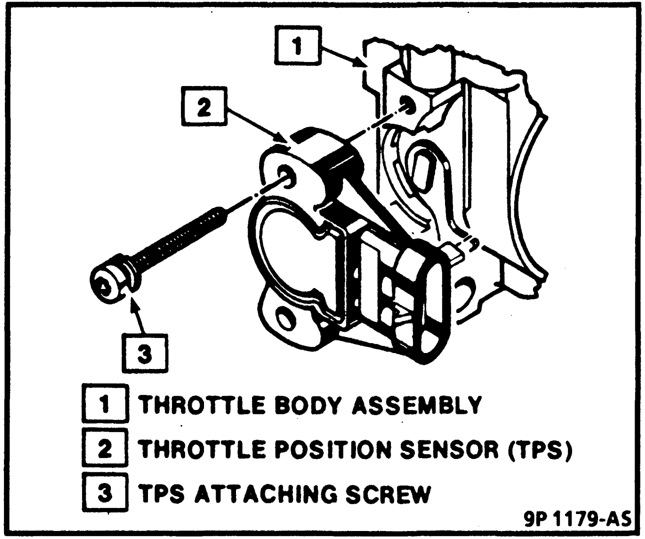


Figure C1-9 - Throttle Position Sensor (TPS)

By monitoring the output voltage from the TPS, the ECM can determine fuel delivery based on throttle valve angle (driver demand). A broken or loose TPS can cause intermittent bursts of fuel from the injector and an unstable idle, because the ECM thinks the throttle is moving.

If the TPS circuit is open, the ECM will set a trouble Code 22. If the TPS circuit is shorted, the ECM will think the vehicle is at WOT, and a trouble Code 21 will be set. A problem in any of the TPS circuits will set either a Code 21 or Code 22. Once a trouble code is set, the ECM will use an artificial default value for TPS, and some vehicle performance will return.

See "On-Vehicle Service" for replacement.

Vehicle Speed Sensor (VSS)

The Vehicle Speed Sensor (VSS), is a pulse counter type input that informs the ECM how fast the vehicle is being driven. The VSS system uses a Permanent Magnet (PM) generator, mounted at the output shaft of the transmission, to produce an AC voltage at a frequency proportional to the speed of the drive wheels. The ECM processes this signal and sends it to the L.C.D. speedometer cluster via serial data (CKT 437) to display miles per hour in the instrument panel. This sensor mainly controls the operation of the IAC and manual transmission shift light. Refer to "Code 24" or "Torque Converter Clutch System/and Manual Transmission Shift Light," Section "6E3-C8" for more information.

A/C Request Signal

This signal tells the ECM that the A/C selector switch is turned "ON," and that the pressure cycling switch and high pressure switch are closed. The ECM uses this information to adjust the idle speed when the air conditioning is working.

If this signal is not available to the ECM, idle may be rough, especially when the A/C compressor cycles. The voltage at ECM terminal "BC9" should equal battery voltage when A/C is requested and the pressure switches are closed.

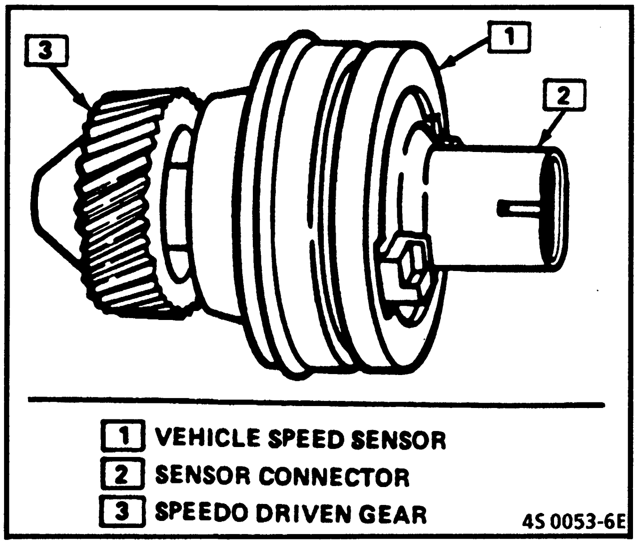


Figure C1-10 - Vehicle Speed Sensor (VSS)

Park/Neutral (P/N) Switch (Auto Only)

The Park/Neutral (P/N) switch indicates to the ECM when the transmission is in park or neutral or drive. This information is used for the TCC and the IAC valve operation.

Important

- Vehicle should not be driven with Park/Neutral (P/N) switch disconnected, as idle quality will be affected and a possible false Code 24 (VSS) may be set.

  Refer to ELECTRICAL DIAGNOSIS (SECTION 8A) for more information on the P/N switch, which is part of the neutral/start and backup light switch assembly. Refer to CHART C-1A for P/N switch check.

Reference Signal

The Distributor High Energy Ignition (HEI) module sends a signal to the ECM to tell it both engine rpm and crankshaft position. Refer to "Ignition System/EST," Section "6E3-C4" for further information.

Vehicle Anti-theft System (VATS) (PASS key) Signal

The VATS (PASS key) system is designed to disable vehicle operation if the incorrect key or starting procedure is used. The VATS "PASS key" decoder module sends a signal to the ECM, on CKT 229, if the correct key is being used. If the proper signal does not reach the ECM, the ECM will not pulse the fuel injectors "ON" and thus not allow the vehicle to start.

Code 46 will set if the proper signal is not being received by the ECM when the ignition is turned "ON."

DIAGNOSIS

To read the codes, use a "Scan" tool or ground the diagnostic "test" terminal with the engine not running and the ignition "ON." The "Service Engine Soon" light will flash Code 12 three times and then flash each code stored in memory three times. All codes stored in memory would have been read when Code 12 was flashed again. No new codes can be stored when in the Diagnostics Mode (diagnostics lead grounded). This eliminates confusion while the system is being worked on.

To clear the codes from memory:

- Ignition "OFF"
- Disconnect battery keep alive power connector, located near the battery, for 30 seconds.

Since the ECM can have a failure which may affect only one circuit, following the diagnostic procedures in this section will determine which circuit has a problem and where it is.

If a diagnostic chart indicates that the ECM connections or ECM is the cause of a problem,and the ECM is replaced, but does not correct the problem, one of the following may be the reason:

- <u>There is a problem with the ECM terminal connections</u> - The diagnostic chart will say ECM connections or ECM. The terminals may have to be removed from the connector in order to check them properly.
- <u>The ECM or MEM-CAL is not correct for the application</u> - The incorrect components may cause a malfunction and may or may not set a code.
- <u>The problem is intermittent</u> - This means that the problem is not present at the time the system is being checked. In this case, refer to "Symptoms" Section "6E3-B" portion of the manual and make a careful visual/physical inspection of all portions of the system involved.
- <u>Shorted solenoid, relay coil, or harness</u> - Solenoids and relays are turned "ON" and "OFF" by the ECM, using internal electronic switches called "drivers." Each driver is part of a group of four called "quad-drivers."

  A shorted solenoid, relay coil, or harness will not damage the ECM, but will cause the circuit and controlled component to be inoperative. When the circuit fault is not present or has been repaired, the "quad-drivers" will again operate in a normal manner due to it's fault protected design. If a fault has been repaired in a circuit controlled by a "quad-driver," the original ECM should be reinstalled and the circuit checked for proper operation. ECM replacement will not be necessary if the repaired circuit or component now operates correctly.

J 34636 or BT 8405 testers or equivalent provide a fast, accurate means of checking for a shorted coil or a short to battery voltage.

- The MEM-CAL may be faulty - Although these rarely fail, it operates as part of the ECM. Therefore, it could be the cause of the problem. Substitute a known good MEM-CAL.
- The replacement ECM may be faulty - After the ECM is replaced, the system should be rechecked for proper operation. If the diagnostic chart again indicates the ECM is the problem, substitute a known good ECM. Although this is a rare condition, it could happen.

ECM

A faulty ECM will be determined in the diagnostic charts, or by a Code 55.

MEM-CAL

An incorrect or faulty MEM-CAL, which is part of the ECM, may set a Code 41 or Code 51. Also, make sure MEM-CAL is fully seated and latched in the socket.

ECM INPUTS

All of the sensors and input switches can be diagnosed by the use of a "Scan" tool. Following is a short description of how the sensors and switches can be diagnosed by the use of a "Scan" tool. The "Scan" tool can also be used to compare the values for a normal running engine with the engine you're diagnosing.

Coolant Temperature Sensor (CTS)

A "Scan" tool displays engine coolant temperature in degrees Centigrade and Farenheit. After engine is started, the temperature should rise steadily to about 90°C (194°F) then stabilize when thermostat opens. Ifthe engine has not been run for several hours (overnight), the CTS and MAT temperatures should read close to each other. A fault in the coolant temperature sensor circuit should set a Code 14 or Code 15. The code charts also contain a chart to check for Coolant Temperature Sensor (CTS) resistance values relative to temperature.

MAP Sensor

A "Scan" tool reads manifold absolute pressure and will display either volts or kPa of pressure.

Key "ON," engine stopped (no vacuum), MAP will read high voltage or pressure, while at idle (high vacuum), MAP will read low voltage or pressure. Likewise, on acceleration, MAP will read high and on deceleration will read low voltage.

A failure in the MAP sensor, or circuit should result in a Code 33 or Code 34

MAT Sensor

A "Scan" tool displays temperature of the air entering the engine and should read close to ambient air temperature when engine is cold, and rise as underhood temperature increases. If the engine has not been run for several hours (overnight) the MATsensor temperature and CTS should read close to each other. A failure in the MAT sensor circuit should set a Code 23 or Code 25. The code charts also contain a chart to check for sensor resistance values relative to temperature.

Oxygen (O_2) Sensor

The "Scan" tool has several positions that will indicate the state of the exhaust gases, oxygen sensor voltage, integrator, and block learn. Refer to GENERAL INFORMATION (SECTION 6E) for "Scan" tool position information.

Normal "Scan" tool voltage varies between 100 mv to 999 mv (.1 and 1.0 volt) while in "Closed Loop." Code 13 sets in one minute if voltage remains between .35 and .55 volt, but the system will go open loop in about 15 seconds. The ECM counts each time the voltage crosses the 0.45 volt reference signal. These "cross counts" are indicated on a "Scan" tool.

Disconnecting the Oxygen (O_2) sensor and grounding the lead from the ECM will simulate a lean exhaust condition (low voltage signal).

Applying voltage to the ECM through a digital voltmeter on the 20 volt scale will simulate a rich exhaust condition (high voltage signal).

The ECM self-diagnostic circuit looks for trends in oxygen sensor voltage. If a trend is detected, the "Service Engine Soon" light comes "ON."

A rich exhaust trend causes the sensor voltage to stay above 0.6 volt for too long. This sets Code 45.

Lean exhaust causes voltage to stay below 0.3 volt for too long. This sets Code 44. If voltage stays between 0.3 volt and 0.6 volt for too long, the ECM sets Code 13. This indicates an open oxygen sensor circuit.

Response Time

Not only is it necessary for the Oxygen (O_2) sensor to produce a voltage signal for rich or lean exhaust, it is also important to respond quickly to changes. The ECM senses the response times. If the Oxygen (O_2) sensor responses slowly the customer may complain of poor fuel economy, rough idle or lack of performance. It may also set false ECM codes because the ECM uses Oxygen (O_2) sensor voltages for system checks.

OXYGEN (O_2) SENSOR CONTAMINANTS

Carbon

Black carbon or soot deposits result from over-rich mixtures. However, carbon does not harm a sensor. Deposits can be burned off in the engine by running it at least part throttle for two minutes.

Silica

Certain RTV silicone gasket materials give off vapors that contaminate the oxygen sensor. The sand-like particles from the RTV silica embed in the molecules of the sensor element and plug up the surface. This results in "lazy" Oxygen (O_2) sensor response and engine control. The sensor will also have a whitish appearance.

There is also a possibility of silica contamination caused by silicone in the fuel. Careless fuel handling practices with the transport containers can result in unacceptable concentrations of silicone in the fuel at the pump.

There is also a possibility of silica contamination caused by silicon in lubricants used to install vacuum hoses on fittings.

Lead

Lead glazes sensors. It can be introduced when regular, or leaded fuel, is burned. Fuel containing large amounts of methanol will also result in lead contamination.

The methanol dissolves the terne coat of the fuel tank, introduces lead into the fuel system, and into the exhaust after combustion. It is difficult to detect lead contamination by visual inspection.

Other Substances

Oil deposits will ultimately prevent sensor operation. The sensor will have a dark brown appearance. Causes of high oil consumption should be checked. The additives in ethylene glycol can also affect sensor performance.

This produces a whitish appearance. If antifreeze enters the exhaust system, you will likely encounter other, more obvious, symptoms of cooling system trouble.

Multiple Failures

If you encounter multiple or repeat Oxygen (O_2) sensor failures on the same car, consider contamination.

Leaded fuel, silica contamination from uncured, low-grade (unapproved) RTV sealant, and high oil consumption are possible.

A problem in the Oxygen (O_2) sensor circuit or fuel system should set a Code 13 (open circuit), Code 44 (lean indication), Code 45 (rich indication). Refer to applicable chart if any of these codes were stored in memory.

Throttle Position Sensor (TPS)

A "Scan" tool displays throttle position in volts. The value should read less than .96 volt with throttle closed and ignition "ON," or at idle. Voltage should increase at a steady rate as throttle is moved toward WOT (about 4.6 volts).

The ECM has the ability to Auto-Zero the TPS voltage if it is between .36 volt and .96 volt. This means that any voltage between .36 volt and .96 volt will be determined by the ECM to be 0% throttle. Some "Scan" tools have the ability to read the throttle angle, and should read 0% when the throttle is closed. A failure in the TPS or TPS circuit should set a Code 21 or Code 22.

Vehicle Speed Sensor (VSS)

A "Scan" tool reading should closely match with speedometer reading with drive wheels turning. A failure in the VSS circuit should set a Code 24.

A/C Request Signal

"Scan" tool should indicate A/C "ON," when A/C is requested and the pressure cycling switch and high pressure switch are closed.

Knock Signal

A "Scan" tool will indicate when the ESC module signals the ECM that knock is present. For further information, refer to "ESC System" Section "6E3-C5."

Reference Signal

A "Scan" tool will read this signal and is displayed in rpm. For more information, refer to "Ignition System/EST" Section "6E3-C4."

Vehicle Anti-Theft System (VATS) (PASS key) Signal

A "Scan" tool will not directly read this signal, but it will display Code 46 if the signal is not present.

ON-VEHICLE SERVICE

ELECTRONIC CONTROL MODULE (ECM)

Service of the ECM should, normally, consist of either replacement of the ECM or a MEM-CAL change.

If the diagnostic procedures call for the ECM to be replaced, the engine calibrator (MEM-CAL) and ECM should be checked first to see if they are the correct parts. If they are, remove the MEM-CAL from the faulty ECM and install it in the new service ECM. THE SERVICE ECM WILL NOT CONTAIN A MEM-CAL. Trouble Code 51 indicates the MEM-CAL is installed improperly or has malfunctioned. When Code 51 is obtained, check the MEM-CAL installation for bent pins or pins not fully seated in the socket. If it is installed correctly and Code 51 still shows, replace the MEM-CAL.

Important

- When replacing the production ECM with a service ECM (controller), it is important to transfer the Broadcast Code and production ECM number to the service ECM label. Please do not record on ECM cover. This will allow positive identification of ECM parts throughout the service life of the vehicle.

Important

- To prevent internal ECM damage, the ignition must be "OFF," when disconnecting or reconnecting power to ECM (for example, battery cable, ECM pigtail, ECM fuse, jumper cables, etc.).

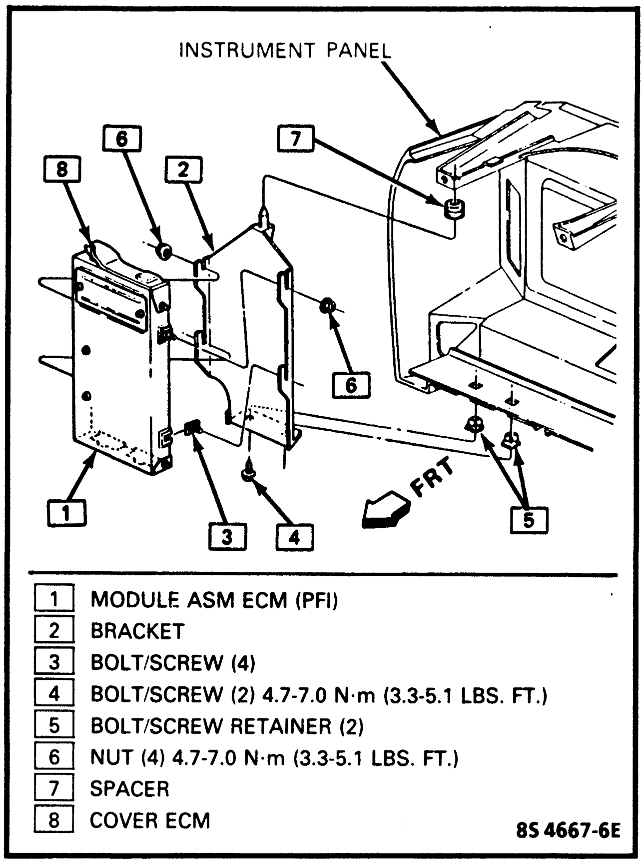


Figure C1-11 - ECM Removal

NOTICE: To prevent possible Electrostatic Discharge damage to the ECM, Do Not touch the connector pins or soldered components on the circuit board.

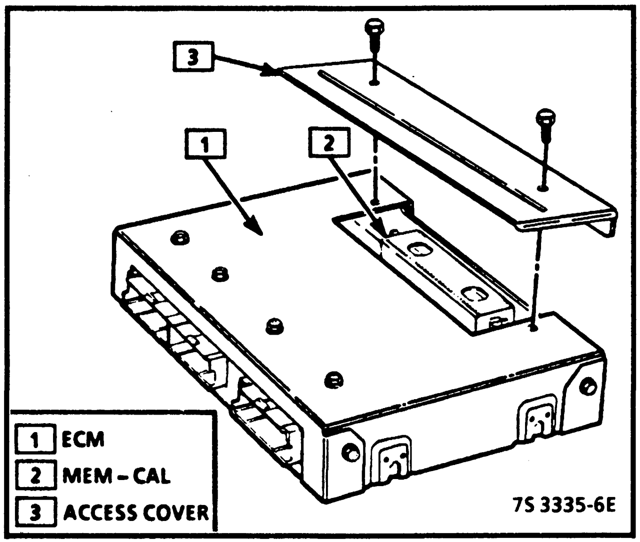


Figure C1-12 - ECM

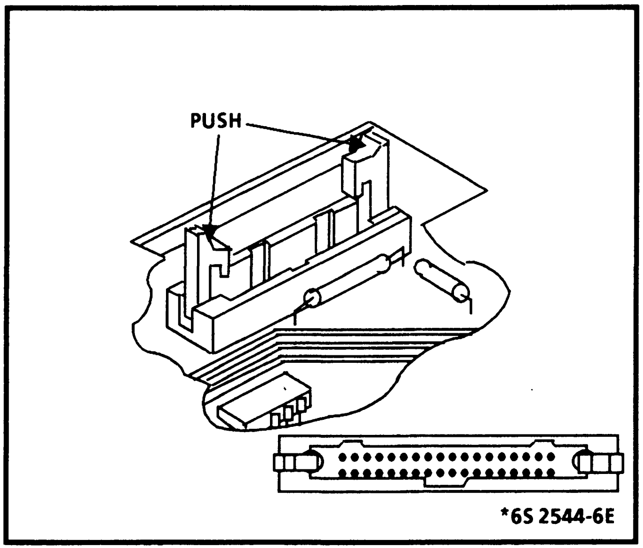


Figure C1-13 - Mem/Cal Unit Socket

ECM OR MEM-CAL REPLACEMENT

Remove or Disconnect

1. Negative battery cable
2. Right hand hush panel
3. Connectors from ECM
4. ECM mounting hardware
5. ECM from passenger compartment
6. ECM access cover
7. MEM-CAL removal

Important

- Replacement ECM is supplied without a MEM-CAL, so care should be used when removing it from the defective ECM because it will be reused in the new ECM.

NOTICE: To prevent possible Electrostatic Discharge damage to the PROM, CAL-PAK, or MEM-CAL, Do Not touch the component leads, and Do Not remove integrated circuit from carrier.

Using two fingers, push both retaining clips back away from the MEM-CAL. At the same time, grasp it at both ends and lift it up out of the socket. Do not remove the cover of the MEM-CAL. Use of unapproved MEM-CAL removal methods may cause damage to the MEM-CAL or socket.

Inspect

- For alignment notches of the MEM-CAL and carefully set it aside. Do not open the MEM-CAL.

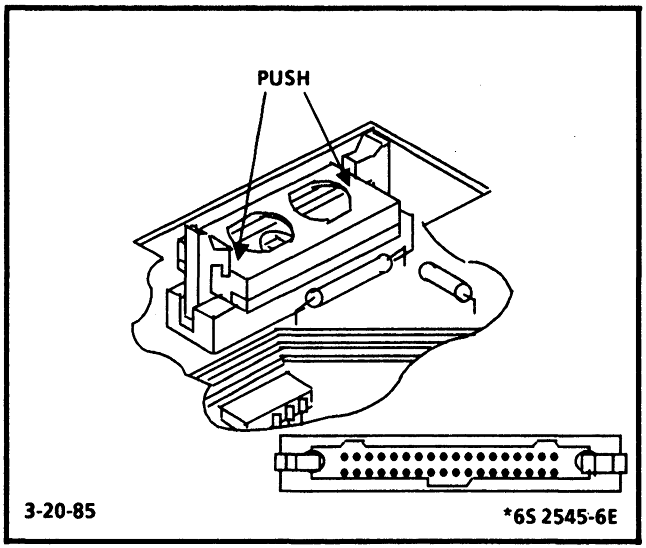


Figure C1-14 - Mem/Cal Unit Installation

IF ECM IS BEING REPLACED:

NOTICE: To prevent possible Electrostatic Discharge damage to the ECM, Do Not touch the connector pins or soldered components on the circuit board.

Remove or Disconnect

1. New ECM from its packaging and check the service number to make sure it is the same as the defective ECM.
2. Access Cover.

NOTICE: To prevent possible Electrostatic Discharge damage to the PROM, CAL-PAK, or MEM-CAL, Do Not touch the component leads, and Do Not remove integrated circuit from carrier.

Install or Connect

Figure C1-18

1. MEM-CAL in MEM-CAL socket

Important

- Press only on the ends of the MEM-CAL. Small notches in the MEM-CAL must be aligned with the small notches in the MEM-CAL socket. Press on the ends of the MEM-CAL until the retaining clips snap into the ends of the MEM-CAL. Do not press on the middle of the MEM-CAL, only on the ends.

2. Access cover on ECM
3. ECM in passenger compartment
4. ECM mounting hardware
5. Connectors to ECM
6. Right side hush panel
7. Negative battery cable

Functional Check

1. Turn ignition "ON."
2. Enter diagnostics.
   A. Allow Code 12 to flash four times to verify no other codes are present. This indicates the MEM-CAL is installed properly and the ECM is functioning.
   B. If trouble Code 51 occurs, or if the "Service Engine Soon" light is "ON" constantly with no codes, the MEM-CAL is not fully seated or is defective.
      - If not fully seated, press firmly on the ends of the MEM-CAL.
      - If it is necessary to remove the MEM-CAL, follow the previous removal instructions.

COOLANT TEMPERATURE SENSOR (CTS)

NOTICE: Care must be taken when handling Coolant Temperature Sensor (CTS). Damage to coolant sensor will affect proper operation of the fuel injection system.

Remove or Disconnect

1. Relieve coolant pressure
2. Negative battery cable
3. Air inlet duct
4. CTS electrical connector
5. Carefully back out CTS

Install or Connect

1. Coat threads (only) with sealer P/N 1052080 or equivalent.
2. Coolant Temperature Sensor (CTS) in engine

Tighten

- CTS to 30 N·m (22 lb. ft.)

3. CTS electrical connector
4. Air inlet duct
5. Negative battery cable
6. Refill lost coolant

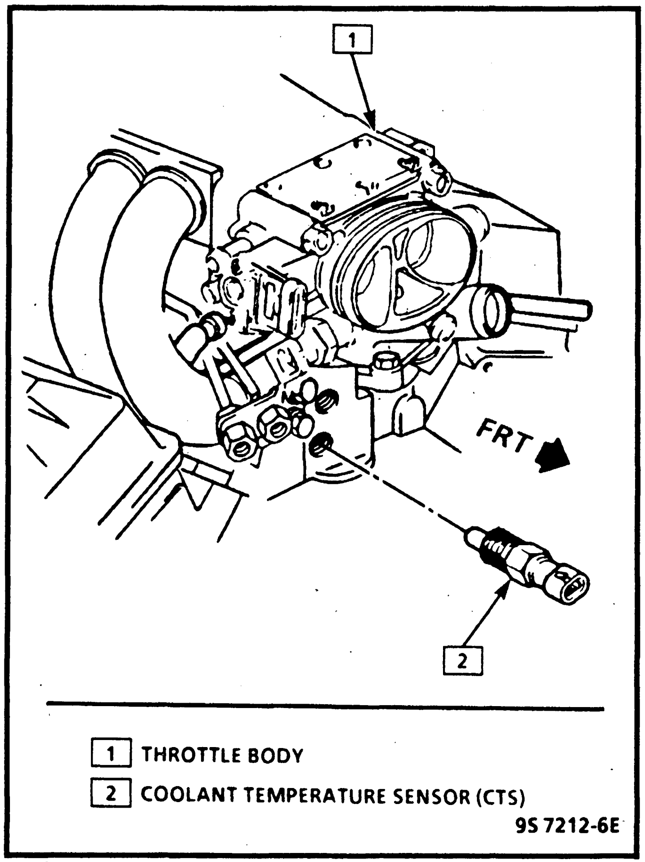


Figure C1-15 - Coolant Temperature Sensor (CTS)

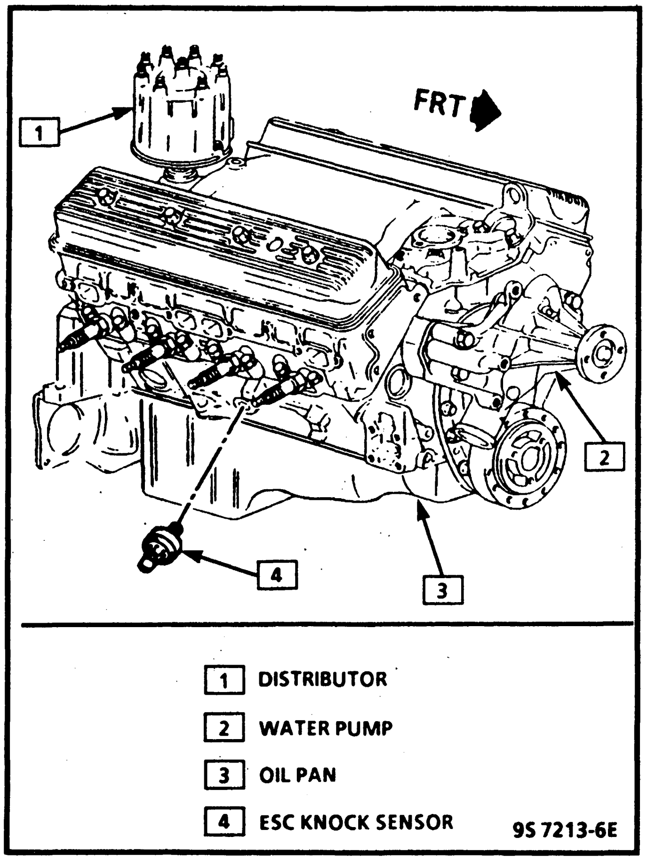


Figure C1-16 - ESC Knock Sensor

KNOCK SENSOR

Remove or Disconnect

1. Negative battery cable
2. Raise car
3. ESC wiring harness connector from ESC sensor
4. ESC knock sensor from engine block

Install or Connect

1. ESC knock sensor into engine block

NOTICE: Do not apply thread sealant to sensor threads. Sensor is coated at factory and applying additional sealant will affect the sensors ability to detect detonation.

Tighten

- ESC knock sensor to 19 N·m (14 lb. ft.)

2. ESC wiring harness connector to the ESC sensor.
3. Lower car
4. Negative battery cable

MANIFOLD AIR TEMPERATURE (MAT) SENSOR

NOTICE: Care must be taken when handling the Manifold Air Temperature (MAT) sensor. Damage to the Manifold Air Temperature (MAT) sensor will affect proper operation of the fuel injection system.

NOTICE: Care must be taken when removing intake manifold plenum, from intake runners. Damage by prying with a screwdriver or prybar on machined aluminum surfaces could affect engine performance.

Remove or Disconnect

1. Negative battery cable
2. Air inlet duct
3. Intake manifold plenum to runner bolts/screws (8)
4. Carefully pull up intake plenum from intake manifold runners to access mat sensor
5. Electrical jumper harness connector
6. Carefully backout MAT sensor from bottom of plenum (intake manifold plenum can be lifted to remove MAT sensor without removal of the plenum.)

Clean

NOTICE: Use care in cleaning old gasket material from machined aluminum surfaces sharp tools may damage sealing surfaces.
Gasket sealing surfaces.

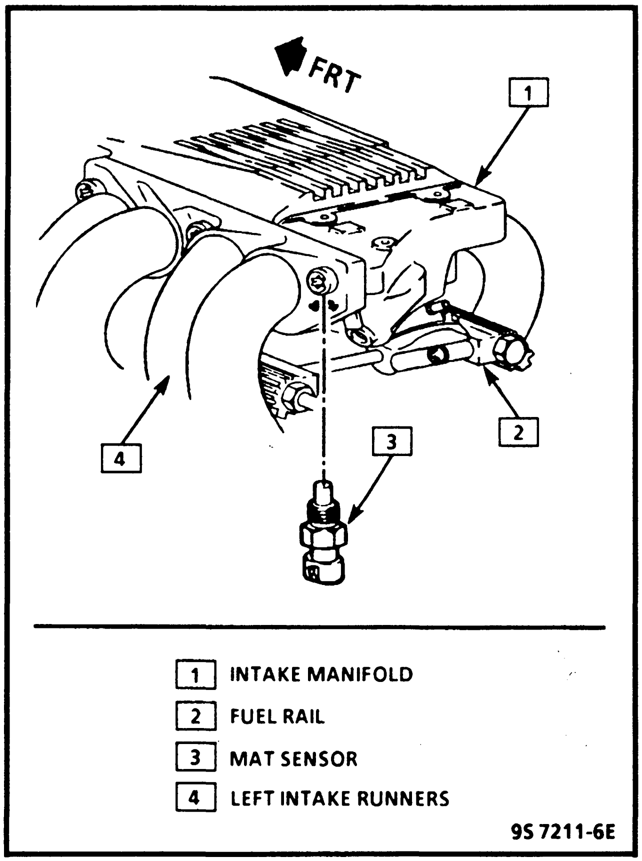


Figure C1-17 - MAT Sensor Removal

Install or Connect

1. MAT sensor

Tighten

- MAT sensor to 12.2 N·m (9 lb. in.)

2. Electrical jumper harness connector
3. Position plenum and new gaskets on intake runners.
4. Intake manifold plenum to runners bolts/screws (8).

Tighten

- Runner to plenum screws to 34 N·m (25 lb. ft.). (Start in center and work outward.)

5. Air inlet duct
6. Negative battery cable

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

Remove or Disconnect

1. Negative battery cable
2. Vacuum hose
3. Electrical connector
4. Hold down bolts (2)

Install or Connect

1. MAP sensor and attaching bolts (2)

Tighten

- MAP sensor bolts to 10 N·m (90 lb. in.)

2. Vacuum hose
3. MAP sensor
4. Negative battery cable

OXYGEN (O_2) SENSOR

NOTICE: The Oxygen (O_2) sensor uses a permanently attached pigtail and connector. This pigtail should not be removed from the Oxygen (O_2) sensor. Damage or removal of the pigtail or connector could affect proper operation of the Oxygen (O_2) sensor.

Important

- Take care when handling the Oxygen (O_2) sensor. The in-line electrical connector and louvered end must be kept free of grease, dirt, or other contaminants. Also, avoid using cleaning solvents of any type. Do not drop or roughly handle the Oxygen (O_2) sensor.

Remove or Disconnect

- The Oxygen (O_2) sensor may be difficult to remove when engine temperature is below 48°C (120°F). Excessive force may damage threads in exhaust manifold or exhaust pipe.

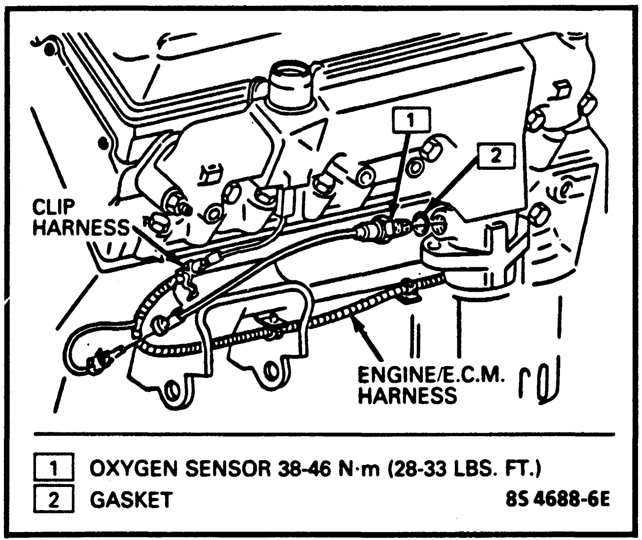


Figure C1-18 - Oxygen (O_2) Sensor

Oxygen Sensor:

1. Negative battery cable
2. Electrical connector
3. Carefully back out Oxygen (O_2) sensor

Install or Connect

Important

- A special anti-seize compound is used on the Oxygen (O_2) sensor threads. The compound consists of a liquid graphite and glass beads. The graphite will burn away, but the glass beads will remain, making the sensor easier to remove.
  New, or service, Oxygen (O_2) sensors will already have the compound applied to the threads. If a sensor is removed from an engine, and if for any reason it is to be reinstalled, the threads must have anti-seize compound applied before reinstallation.

1. Coat threads of Oxygen (O_2) sensor with anti-seize compound P/N 5613695, or equivalent.

Tighten

2. Oxygen (O_2) sensor to 42 N·m (31 lb. ft.)
3. Electrical connector
4. Negative battery cable

THROTTLE POSITION SENSOR (TPS)

Remove or Disconnect

1. Electrical connector.
2. Two TPS attaching screws, lockwashers and retainers.
3. Throttle Position Sensor (TPS)

Install or Connect

1. With throttle valve in the normal closed idle position, install Throttle Position Sensor (TPS) on throttle body assembly, making sure TPS pickup lever lines up with tang on throttle actuator lever. (See Figure C1-19.)
2. Retainers and two TPS screws.

Tighten

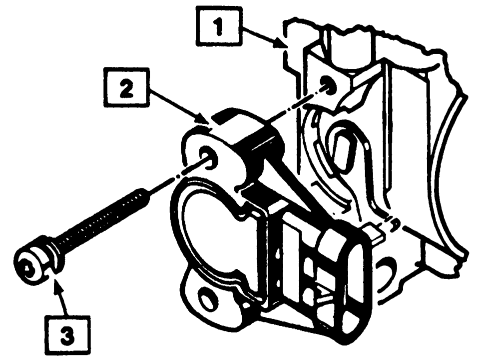
- TPS attaching screws using a #25 Torx Bit to 2.0 N·m (18 lb. in.)

PARK/NEUTRAL (P/N) SWITCH

See ELECTRICAL DIAGNOSIS (SECTION 8A) for location of Park/Neutral (P/N) switch. "On-Vehicle" service and adjustment procedures are also listed there.

VEHICLE SPEED SENSOR

For "On-Vehicle" service procedures of the vehicle speed sensor, refer to "Torque Converter Clutch (TCC) System and Manual Transmission Shift Light," Section "6E3-C8."



1 THROTTLE BODY ASSEMBLY
2 THROTTLE POSITION SENSOR (TPS)
3 TPS ATTACHING SCREW

9P 1179-AS

Figure C1-19 - Throttle Position Sensor (TPS) Service

PARTS INFORMATION

PART NAME	GROUP
Controller, ECM	3.670
Memory Calibration Unit, Mem-Cal	3.670
Sensor, Coolant Temp	3.682
Sensor, Exhaust Oxygen	3.682
Sensor, Manifold Air Temp. (MAT)	3.682
Manifold Air Pressure (MAP)	3.682
Sensor, Throttle Position: Part of Sensor Kit, Throttle Position	3.440
Sensor, Vehicle Speed	3.682
Sensor, Manifold Absolute Pressure (MAP)	3.682
Sensor, ESC Knock	2.383
Jumper, Manifold Air Temp. (MAT)	3.682

TORQUE SPECIFICATIONS

Sensor, Coolant Temp. (CTS)	30 N·m (22 lb. ft.)
Sensor, ESC Knock	19 N·m (14 lb. ft.)
Sensor, Manifold Air Temperature (MAT)	12.2 N·m (108 lb. in.)
Sensor, Manifold Absolute Pressure (MAP)	10.2 N·m (90 lb. in.)
Sensor, Oxygen	42 N·m (31 lb. ft.)
Sensor, Throttle Position (TPS)	2.0 N·m (18 lb. in.)

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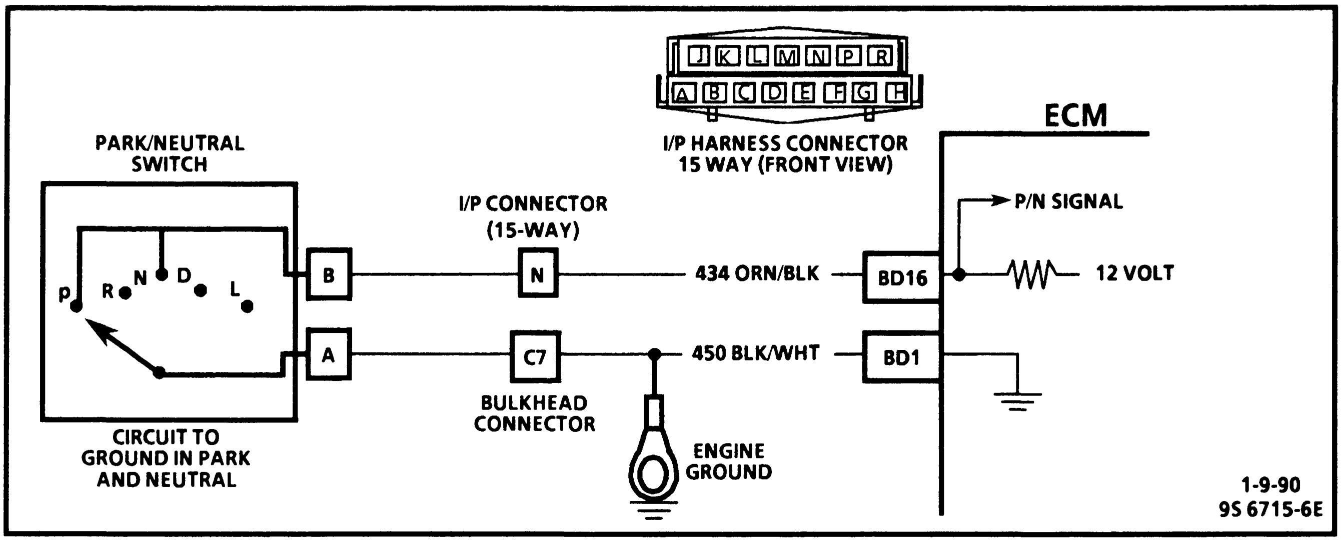


CHART C-1

PARK/NEUTRAL (P/N) SWITCH DIAGNOSIS
(AUTO TRANSMISSION ONLY)
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

The Park/Neutral (P/N) switch contacts are a part of the neutral start switch, and are closed to ground in park or neutral and open in drive ranges.

The ECM supplies ignition voltage, through a current limiting resistor, to CKT 434 and senses a closed switch, when the voltage on CKT 434 drops to less than one volt.

The ECM uses the P/N signal as one of the inputs to control:

Idle Air Control (IAC)
Vehicle Speed Sensor (VSS) diagnostics
Exhaust Gas Recirculation (EGR)

If CKT 434 indicates P/N (grounded), while in drive range, the EGR would be inoperative, resulting in possible detonation.

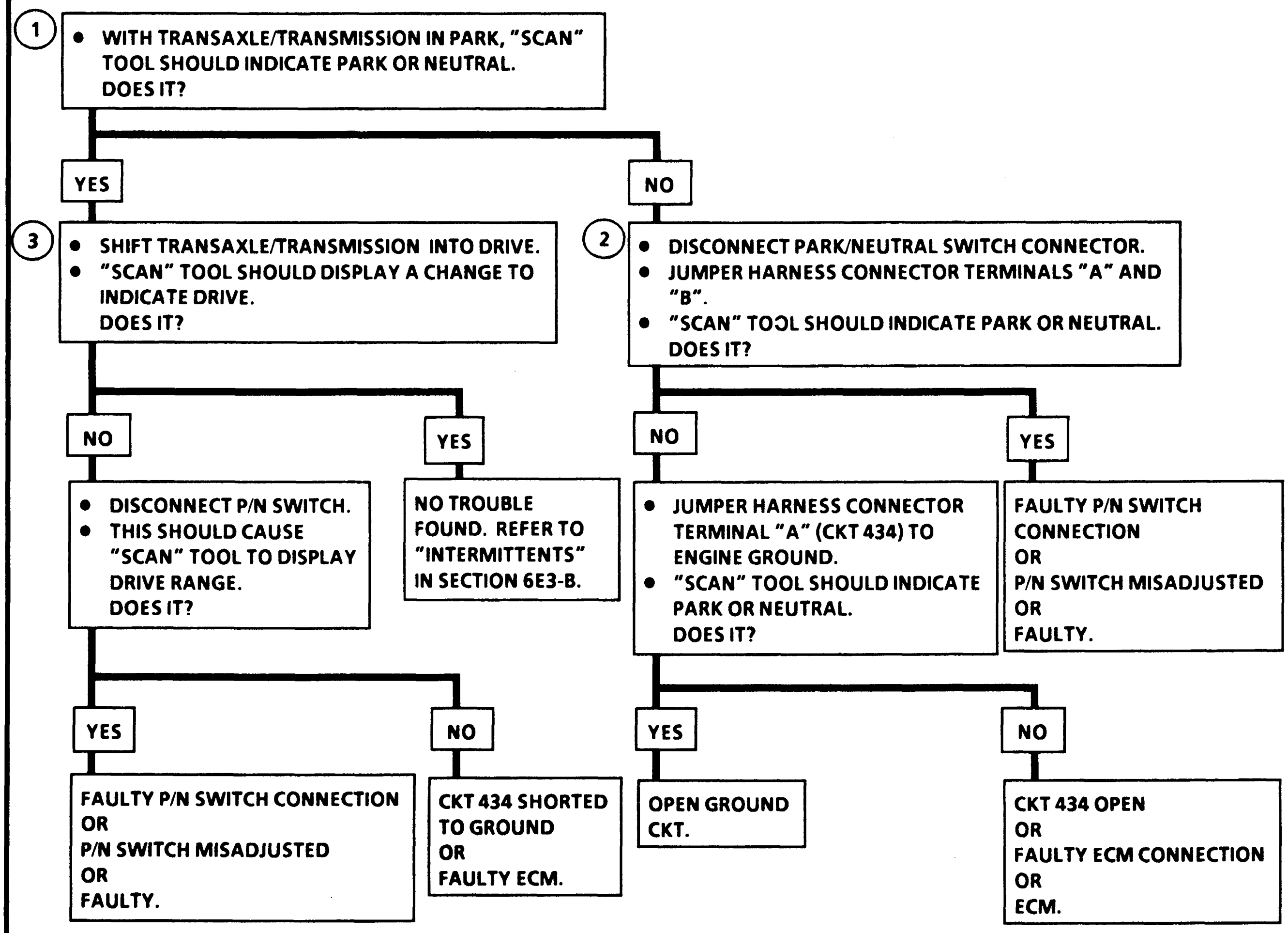
If CKT 434 always indicates drive (open), a drop in the idle speed may exist when the gear selector is moved into drive range.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Checks for a closed switch to ground in park position. Different makes of "Scan" tools will read P/N differently. Refer to "Operators Manual" for type of display used for a specific tool.
2. Checks for an open switch in drive range.
3. Make sure "Scan" tool indicates drive, even while wiggling shifter to test for an intermittent or misadjusted switch in drive range.

CHART C-1

PARK/NEUTRAL (P/N) SWITCH DIAGNOSIS
(AUTO TRANSMISSION ONLY)
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



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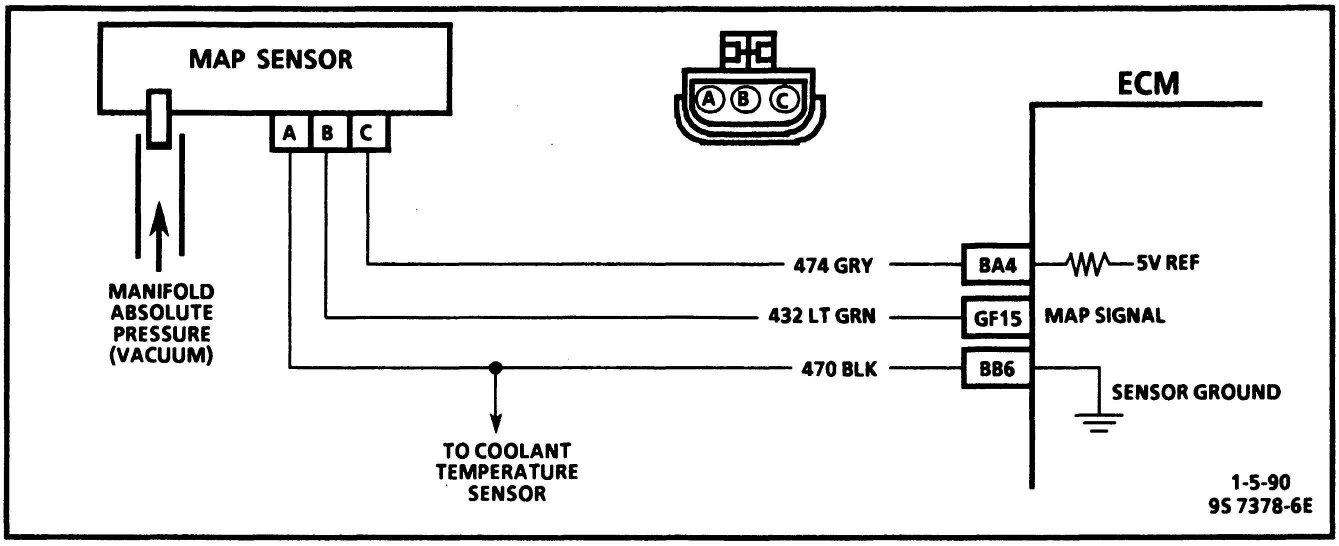

CHART C-1D

MAP OUTPUT CHECK

5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

The Manifold Absolute Pressure (MAP) sensor measures the changes in the intake manifold pressure which result from engine load (intake manifold vacuum) and rpm changes: and converts theses into a voltage output. The ECM sends a 5 volt reference voltage to the MAP sensor. As the manifold pressure changed, the output voltage of the sensor also changes. By monitoring the sensor output voltage, the ECM knows the manifold pressure. A lower pressure (low voltage will be about 1 - 2 volts at idle. While higher pressure (high voltage) output voltage will be about 4 - 4.8 at Wide Open Throttle (WOT). The MAP sensor is also used, under certain conditions, to measure barometric pressure, allowing the ECM to make adjustments for different altitudes. The ECM used the MAP sensor to control fuel delivery and ignition timing.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

Important

- Be sure to use the same Diagnostic Test Equipment for all measurements.

1. When comparing "Scan" readings to a known good vehicle, it is important to compare vehicles that use a MAP sensor having the same color insert or having the same "Hot Stamped" number.
2. Applying 34 kPa (10" Hg) vacuum to the MAP sensor should cause the voltage to be 1.5 to 2.1 volts less than the voltage at Step 1. Upon applying vacuum to the sensor, the change in voltage should be instantaneous. A slow voltage change indicates a faulty sensor.
3. Check vacuum hose to sensor for leaking or restriction. Be sure that no other vacuum devices are connected to the MAP hose.

NOTE: Make sure electrical connector remains securely fastened.

4. Disconnect sensor from bracket and twist sensor by hand (only) to check for intermittent connection. Output changes greater than .10 volt indicates a bad sensor.

CHART C-1D

MAP OUTPUT CHECK
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

①
- IGNITION "ON," ENGINE "OFF."
- "SCAN" TOOL SHOULD INDICATE A MAP SENSOR VOLTAGE.
- COMPARE THIS READING WITH THE READING OF A KNOWN GOOD VEHICLE. SEE FACING PAGE TEST DESCRIPTION, STEP 1.
- VOLTAGE READING SHOULD BE THE SAME, ± .4 VOLT.
  IS IT?

YES

②
- DISCONNECT VACUUM HOSE AT MAP SENSOR AND PLUG HOSE.
- CONNECT A HAND VACUUM PUMP TO MAP SENSOR.
- START ENGINE.
- APPLY 34 kPa (10" Hg) OF VACUUM AND NOTE VOLTAGE CHANGE.
  VOLTAGE CHANGE SHOULD BE 1.5 - 2.1 VOLTS LESS THAN STEP 1.
  IS IT?

NO

REPLACE SENSOR.

YES

③ NO TROUBLE FOUND. CHECK SENSOR HOSE FOR LEAKAGE OR RESTRICTION. BE SURE THIS HOSE SUPPLIES VACUUM TO MAP SENSOR ONLY.

NO

④ CHECK SENSOR CONNECTION. IF OK, REPLACE SENSOR.

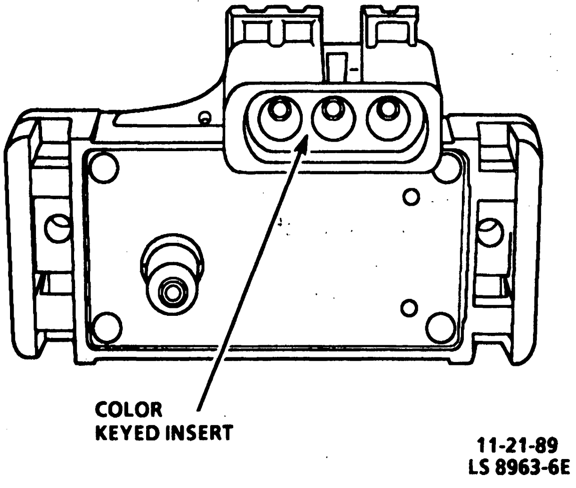

Figure 1 - Color Key Insert

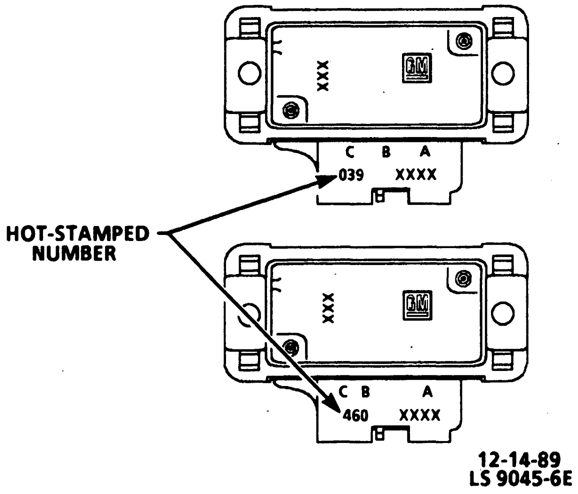

Figure 2 - Hot-Stamped

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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SECTION C2

FUEL METERING SYSTEM

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The function of the fuel metering system is to deliver the correct amount of fuel to the engine under all operating conditions. Fuel is delivered to the engine by individual fuel injectors mounted in the intake manifold near each cylinder.

The main control sensor is the Oxygen (O_2) sensor, located in the exhaust manifold. The O_2 sensor tells the Electronic Control Module (ECM) how much oxygen is in the exhaust gas. The ECM changes the air/fuel ratio to the engine by controlling the fuel injectors. The best mixture to minimize exhaust emissions is 14.7 to 1, which allows the catalytic converter to operate the most efficiently. Because of the constant measuring and adjusting of the air/fuel ratio, the fuel injection system is called a "Closed Loop" system (shown in Figure C2-1).

MODES OF OPERATION

The ECM looks at voltages from several sensors to determine how much fuel to give the engine. The fuel is delivered under one of several conditions, called "modes." All the modes are controlled by the ECM and are described below.

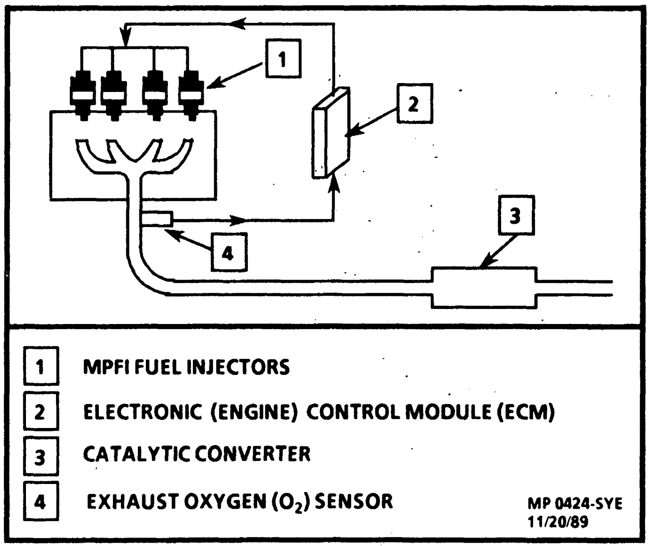


Figure C2-1 - "Closed Loop" System

Starting Mode

When the ignition switch is turned to the "ON" position (before engaging starter), the ECM turns "ON" the fuel pump relay for two seconds and the fuel pump builds up pressure. The ECM then checks the Coolant Temperature Sensor (CTS) and Throttle Position Sensor (TPS), and determines the proper air/fuel ratio for starting.

This ranges from 1.5:1 at -36°C (-33°F) to 14.7:1 at 94°C (201°F) running temperature. The ECM controls the amount of fuel delivered in the starting mode by changing how long the injectors are turned "ON" and "OFF." This is done by "pulsing" the injectors for very short times.

Clear Flood Mode

If the engine floods, it can be cleared by pushing the accelerator pedal down all the way. The ECM then pulses the injectors at an air/fuel ratio of 20:1. The ECM holds this injector rate as long as the throttle stays wide open, and the engine rpm is below 600. If the throttle position becomes less than 80%, the ECM returns to the starting mode.

Run Mode

The run mode has two conditions called "Open Loop" and "Closed Loop."

When the engine is first started, and rpm is above 400 rpm, the system goes into "Open Loop" operation. The ECM ignores the signal from the Oxygen (O_2) sensor, and calculates the air/fuel ratio based on inputs from the Coolant Temperature Sensor (CTS) and Manifold Absolute Pressure (MAP) sensor.

The system stays in "Open Loop" until the following conditions are met:

1. The Oxygen (O_2) sensor has varying voltage output, showing that it is hot enough to operate properly. (This depends on temperature.)
2. The Coolant Temperature Sensor (CTS) is above a specified temperature about 40°C (104°F).
3. A specific amount of time has elapsed after starting the engine.

Specific values for the above conditions exist for each different engine, and are stored in the Memory Calibration (MEM-CAL). When these values are reached, the system goes into "Closed Loop" operation.

In "Closed Loop," the ECM calculates the air/fuel ratio (injector on-time) based on the signal from various sensors, but mainly the O_2 sensor. This allows the air/fuel ratio to stay very close to 14.7:1 .

Acceleration Mode

When the driver pushes on the accelerator pedal, airflow into the cylinders increases rapidly, while fuel flow tends to lag behind. To prevent possible hesitation, the ECM increases the pulse width to the injectors to provide extra fuel during acceleration. The amount of fuel required is based on throttle position, manifold air pressure and engine speed.

Deceleration Mode

When the driver releases the accelerator pedal, air flow into the engine is reduced. The corresponding changes in throttle position and manifold air pressure are relayed to the ECM, which reduces the injector pulse width to reduce fuel flow. If the deceleration is very rapid, or for long periods (such as long closed throttle coast-down), the ECM shuts "OFF" fuel completely to protect the catalytic converter.

Battery Voltage Correction Mode

When battery voltage is low, the ECM compensates for the weak spark delivered by the distributor by:

- Increasing the amount of fuel delivered;
- Increasing the idle rpm; and
- Increasing ignition dwell time

FUEL METERING SYSTEM COMPONENTS

The fuel metering system (Figure C2-2) is made up of the following parts:

- Fuel supply components (fuel tank, pump, lines)
- Fuel pump electrical circuit
- Fuel rail assembly, including:
  - Fuel injectors
  - Pressure regulator assembly
- Throttle body assembly, including:
  - Idle Air Control (IAC) Valve
  - Throttle Position Sensor (TPS)

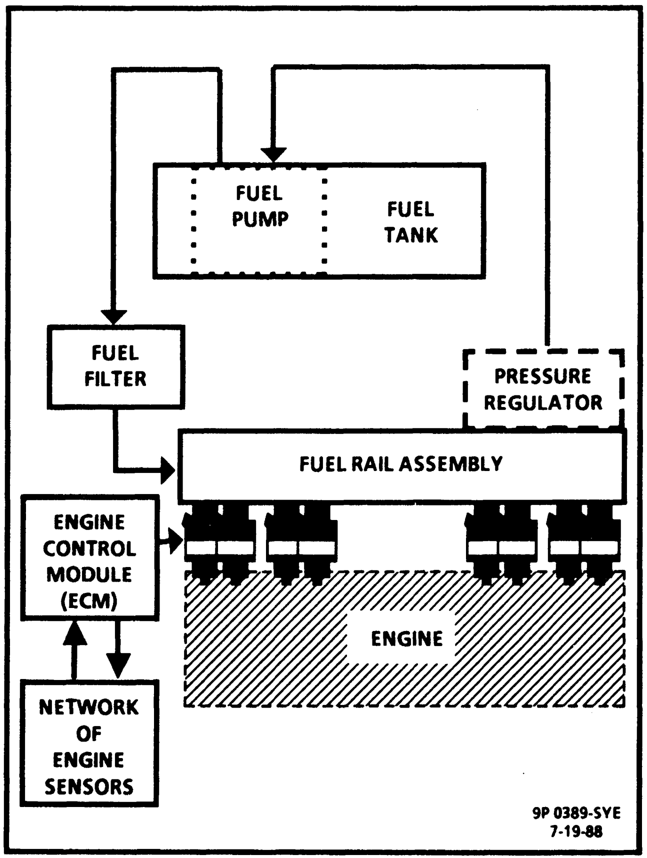


Figure C2-2 - Fuel Metering System

FUEL SUPPLY COMPONENTS

The fuel supply is stored in the fuel tank. An electric fuel pump, located in the fuel tank with the gage sending unit, pumps fuel through an in-line fuelfilter to the fuel rail assembly. The pump is designed to provide fuel at a pressure greater than is needed by the injectors. The pressure regulator, part of the fuel rail assembly, keeps fuel available to the injectors at a regulated pressure. Unused fuel is returned to the fuel tank by a separate line. For further information see ENGINE FUEL (SECTION 6C) for replacement procedures covering the fuel tank, fuel pump, in-line filter and fuel lines.

FUEL PUMP ELECTRICAL CIRCUIT

When the ignition switch is turned to the "ON" position (before engaging starter), the ECM turns the fuel pump relay "ON" for two seconds, causing the fuel pump to pressurize the fuel system. If the ECM does not receive ignition reference pulses (engine cranking or running) within two seconds, it shuts "OFF" the fuel pump relay, causing the fuel pump to stop.

As a backup system to the fuel pump relay, the fuel pump also can be turned on by the oil pressure sensor/switch. The oil pressure sender has two internal circuits. One operates the oil pressure indicator or gage in the instrument cluster, and the other is a normally open switch which closes when oil pressure reaches about 28 kPa (4 psi). If the fuel pump relay fails, a Code 54 is set in the ECM, and the oil pressure sensor/switch runs the fuel pump.

An inoperative fuel pump relay can result in long cranking times, particularly if the engine is cold. The oil pressure sensor/switch turns "ON" the fuel pump as soon as oil pressure reaches about 28 kPa (4 psi).

FUEL RAIL ASSEMBLY

The fuel rail assembly (Figure C2-3) is mounted to the engine intake manifold, and performs several functions. It positions the injectors in the intake manifold, distributes fuel evenly to the injectors, and integrates the fuel pressure regulator into the fuel metering system. Fuel flow within the rail can be seen in Figure C2-4.

Fuel Injector

An MPFI injector assembly is a solenoid-operated device, controlled by the ECM, that meters pressurized fuel to a single engine cylinder (Figures C2-5, 6). The ECM energizes the injector solenoid, which opens a ball valve, allowing fuel to flow past the ball valve, and through a recessed flow director plate.

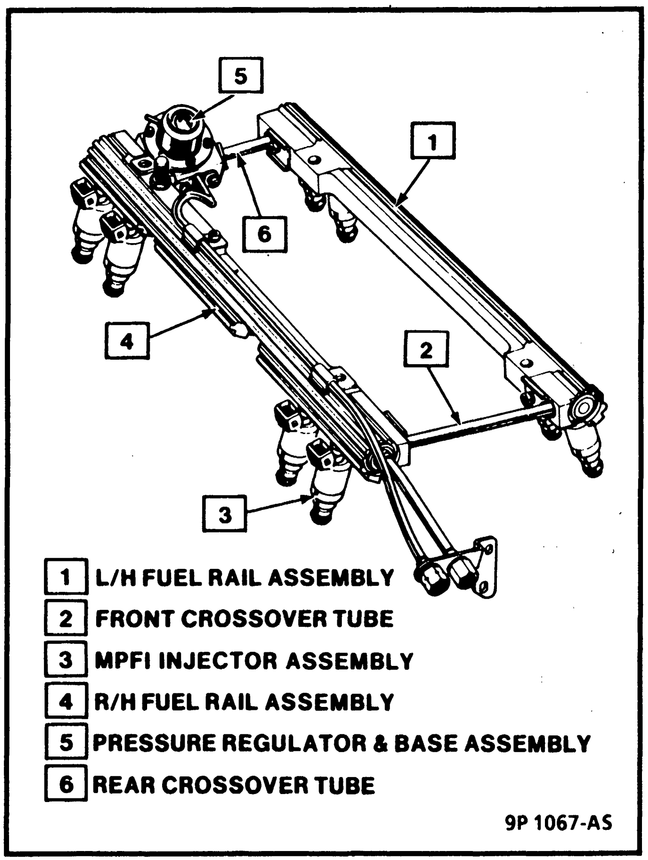


Figure C2-3 - Fuel Rail Assembly

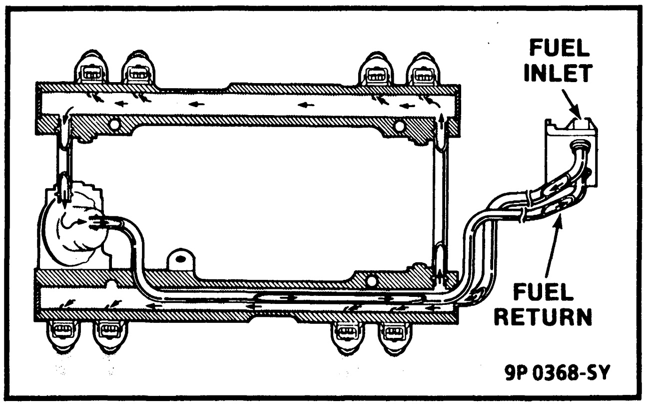


Figure C2-4 - Fuel Rail Flow Diagram

The director plate has six machined holes that control the fuel flow, generating a conical spray pattern of finely atomized fuel at the injector tip. Fuel is directed at the intake valve, causing it to become further atomized and vaporized before entering the combustion chamber.

An injector that is stuck partly open would cause loss of pressure after engine shut down. Consequently, long cranking times would be noticed on some engines. Dieseling could also occur, because some fuel could be delivered to the engine after the ignition is turned "OFF."

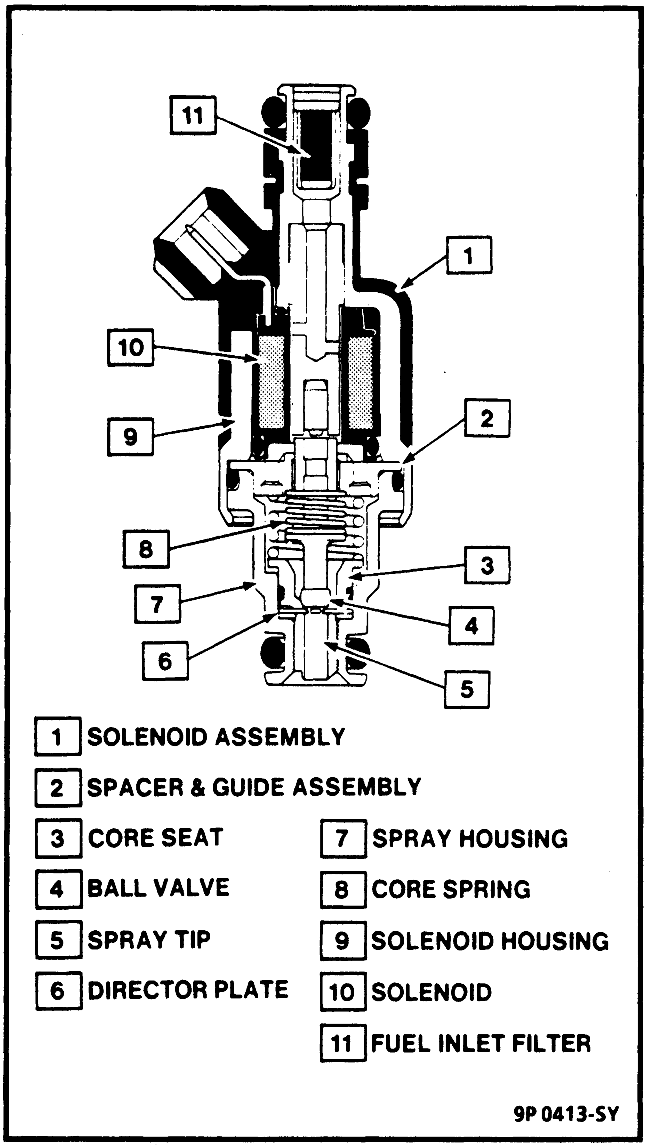


Figure C2-5 - MPFI Injector Assembly Cross-Sectional View

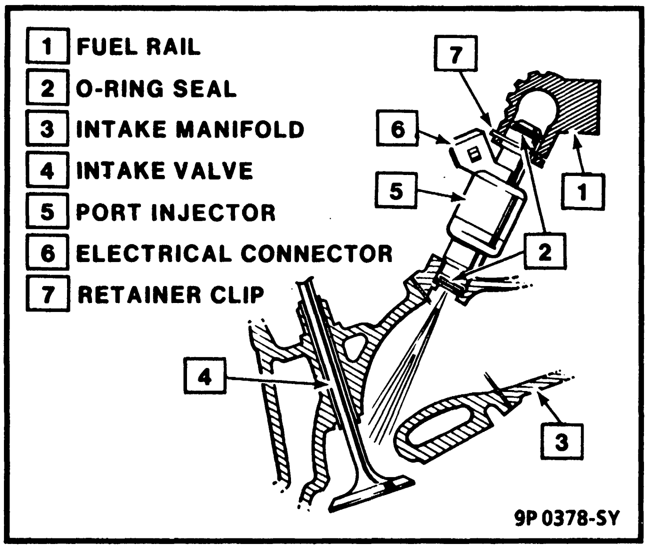


Figure C2-6 - Injector Orientation

Pressure Regulator Assembly

The pressure regulator is a diaphragm-operated relief valve with fuel pump pressure on one side, and regulator spring pressure and intake manifold vacuum on the other (Figure C2-7). The regulator's function is to maintain a constant pressure differential across the injectors at all times. The pressure regulator compensates for engine load by increasing fuel pressure as engine vacuum drops.

With the ignition "ON" and engine "OFF" (zero vacuum), fuel pressure at the pressure test connection should be 284-325 kPa (41-47 psi). If the pressure is too low, poor performance could result. If the pressure is too high, excessive odor and a Code 45 may result. CHART A-7 has information on diagnosing fuel pressure conditions.

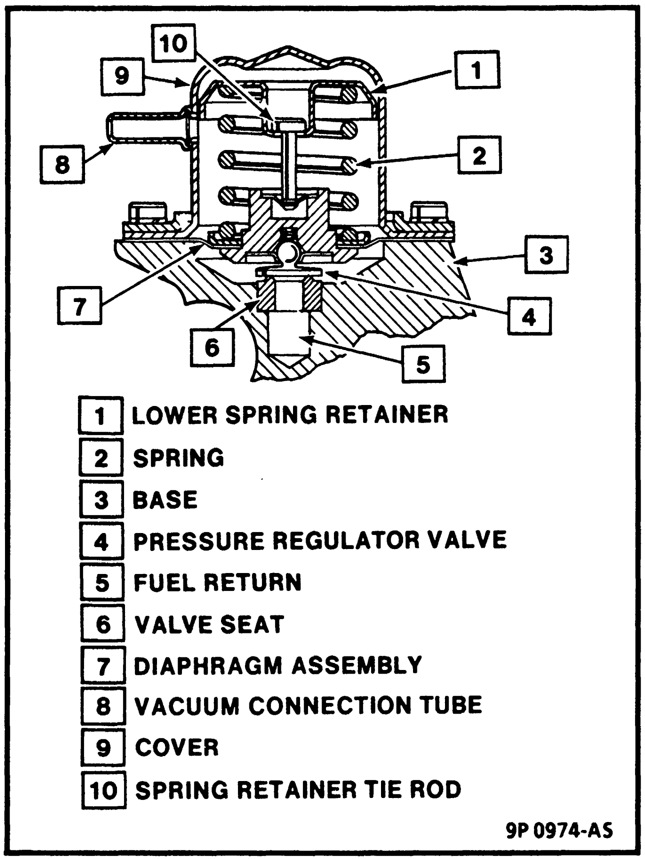


Figure C2-7 - Pressure Regulator Assembly

THROTTLE BODY ASSEMBLY

The throttle body assembly is attached to the intake manifold air plenum, and is used to control air flow into the engine, thereby controlling engine output (Figure C2-8). The throttle valves within the throttle body are opened by the driver through the accelerator controls. During engine idle, the throttle valves are almost closed, and air flow control is handled by the Idle Air Control (IAC) valve, described below. To prevent throttle valve icing during cool weather operation, engine coolant is directed through the coolant cavity, on the bottom of the throttle body.

The throttle body also provides the location for mounting the Throttle Position Sensor (TPS) and for sensing changes in engine vacuum due to throttle valve position.

Vacuum ports are located at, above, or below the throttle valve to generate vacuum signals needed by various components.

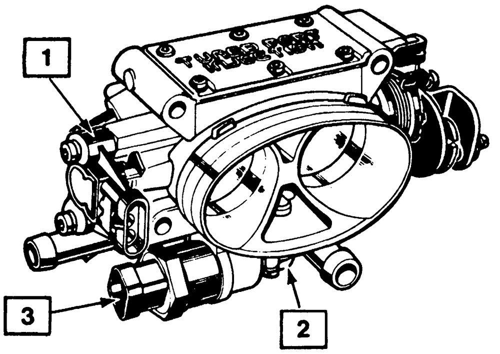


Figure C2-8 - Throttle Body Assembly

Idle Air Control (IAC) Valve

The purpose of the IAC valve assembly (shown in Figure C2-9) is to control engine idle speed, while preventing stalls due to changes in engine load.

The IAC valve, mounted in the throttle body, controls bypass air around the throttle valves (Figure C2-10). By moving a conical valve known as a pintle, IN, towards the seat (to decrease air flow); or OUT, away from the seat (to increase air flow), a controlled amount of air moves around the throttle valve. If rpm is too low, more air is bypassed around the throttle valve to increase it. If rpm is too high, less air is bypassed around the throttle valve to decrease it.

The ECM moves the IAC valve in small steps, called "counts." These can be measured by "Scan" tool test equipment, which plugs into the ALDL connector.

During idle, the proper position of the IAC valve is calculated by the ECM, based on battery voltage, coolant temperature, engine load, and engine rpm. If the rpm drops below specification and the throttle valve is closed, the ECM senses a near stall condition and calculates a new valve position to prevent stalling.

- Engine idle speed is a function of total airflow into the engine based on IAC valve pintle position + PCV flow + throttle valve opening + calibrated vacuum loss through accessories.

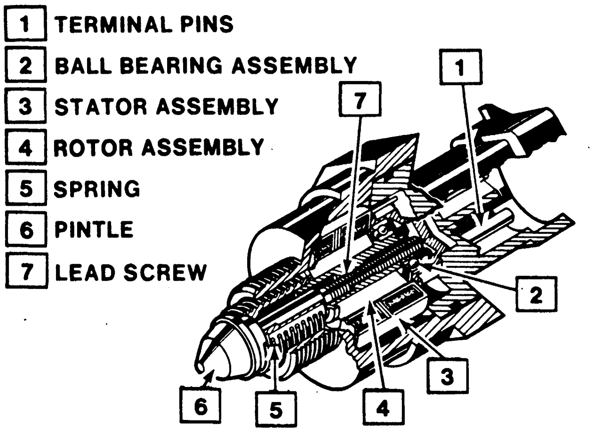


Figure C2-9 - Idle Air Control (IAC) Valve Assembly

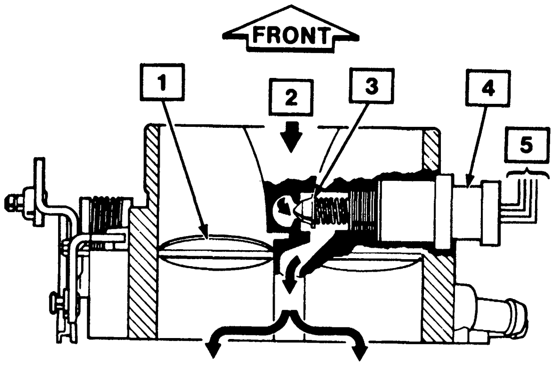


Figure C2-10 - IAC Valve Air Flow Diagram

- "Controlled" idle speed is programmed into the ECM, which determines the correct IAC valve pintle position to maintain the desired idle speed for all engine operating conditions and loads.
- The minimum idle air rate is set at the factory with a stop screw. This setting allows enough air flow by the throttle valves to cause the IAC valve pintle to be positioned a calibrated number of steps (counts), from the seat, during "controlled" idle operation.

- If the IAC valve is disconnected and reconnected with the engine running, the idle speed may be wrong. In this case, the IAC valve can be reset by doing the following: depress accelerator pedal slightly, start and run engine for five seconds, then turn ignition "OFF" for ten seconds.

Throttle Position Sensor (TPS)

The TPS is mounted on the side of the throttle body opposite the throttle lever. It senses the throttle valve angle and relays that information to the ECM. Knowledge of throttle angle is needed by the ECM to generate the required injector control signals (pulses). Refer to "Electronic Control Module (ECM) and Sensors," Section "6E3-C1."

DIAGNOSIS

FUEL PUMP RELAY

The fuel pump relay is mounted in the engine compartment, next to the power brake booster. See "On-Vehicle Service" for the locator view. For diagnosis of the fuel pump relay circuit, refer to the Code 54 Chart.

OIL PRESSURE SENSOR/SWITCH

The oil pressure sensor/switch is threaded into the engine block, above the oil filter. See "On-Vehicle Service" for the locator view. For diagnosis of the fuel pump relay circuit, refer to the Code 54 Chart.

FUEL METERING SYSTEM

Always start with the "Diagnostic Circuit Check" in Section "6E3-A". This will reduce diagnosis time, and prevent unnecessary parts replacement. The diagnosis of the "Fuel Metering System" is covered in CHART A-3, "Engine Cranks but Won't Run," and CHART A-7, "Fuel System Diagnosis." These charts cover the diagnosis of the injectors, pressure regulator, and the fuel pump.

If a malfunction occurs in the fuel metering system, it usually results in either a rich or lean exhaust condition. This condition is sensed by the O_2 sensor and causes the ECM to change the fuel calculation (injector pulse width). The change made to the fuel calculation is indicated by a change in the integrator and block learn values, which can be monitored by a "Scan" tool. A short term change to the fuel calculation is indicated by the integrator value, while a long term change is indicated by the block learn value. Average integrator and block learn values are around 128, but vary slightly from engine to engine.

Important

- When using a "Scan" tool to observe integrator and block learn values, remember that if the system is in control, no action is required unless a driveability symptom is present. Listed below are examples of lean and rich conditions with the system in control and out of control.
- A momentary *lean* condition (system is *in* control) will appear on "Scan" tool as:
  - Integrator value above 128 (adding fuel)
  - Block learn value around 128
- A long term *lean* condition (system is *in* control) will appear on "Scan" tool as:
  - Integrator value around 128
  - Block learn value above 128 (added fuel)
- A long term *lean* condition (system is *out of control)* will appear on "Scan" tool as:
  - Integrator value well above 128 (adding fuel)
  - Block learn value well above 128 (added fuel)

If both the integrator and block learn values are fixed well above 128, see Code 44, for items which can cause a lean system.

- A momentary *rich* condition (system is *in* control) will appear on "Scan" tool as:
  - Integrator value less than 128 (reducing fuel)
  - Block learn value around 128
- A long term *rich* condition (system is *in* control) will appear on "Scan" tool as:
  - Integrator value around 128
  - Block learn value less than 128 (reduced fuel)
- A long term *rich* condition (system is *out of control)* will appear on "Scan" tool as:
  - Integrator value much less than 128 (reducing fuel)
  - Block learn value much less than 128 (reduced fuel)

If the integrator and block learn values are fixed well below 128, see Code 45, for items which can cause the system to run rich. If a driveability symptom exists, refer to the particular symptom in Section "B" for additional items to check.

ON-VEHICLE SERVICE

FUEL PUMP RELAY
Figure C2-11

The fuel pump relay is mounted in the engine compartment, next to the power brake booster.

Remove or Disconnect

1. Fuel pump relay electrical connector
2. Fuel pump relay

Install or Connect

- Reverse removal procedure.

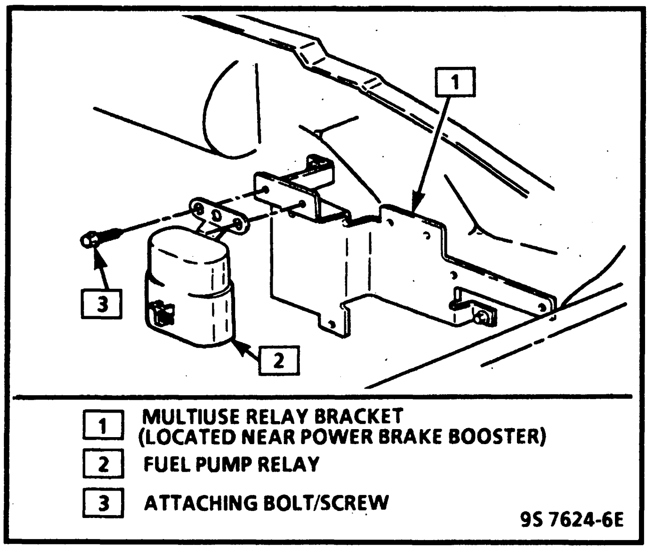


Figure C2-11 - Fuel Pump Relay

OIL PRESSURE SENSOR/SWITCH
Figure C2-12

The oil pressure sensor/switch is threaded into the engine block, above the oil filter.

Remove or Disconnect

1. Electrical connector.
2. Oil pressure sensor/switch.

Install or Connect

- Reverse removal procedure.

PORT FUEL INJECTION COMPONENTS

CAUTION:
- **To reduce the risk of fire and personal injury, relieve the fuel system pressure before servicing fuel system components.**
- **After relieving system pressure, a small amount of fuel may be released when servicing fuel lines or connections. To reduce the chance of personal injury, cover fuel line fittings with a shop towel before disconnecting, to catch any fuel that may leak out. Place the towel in an approved container when disconnect is completed.**

FUEL PRESSURE RELIEF PROCEDURE

Tool Required:
J 34730-1 Fuel Pressure Gage

1. Disconnect negative battery terminal to avoid possible fuel discharge if an accidental attempt is made to start the engine.

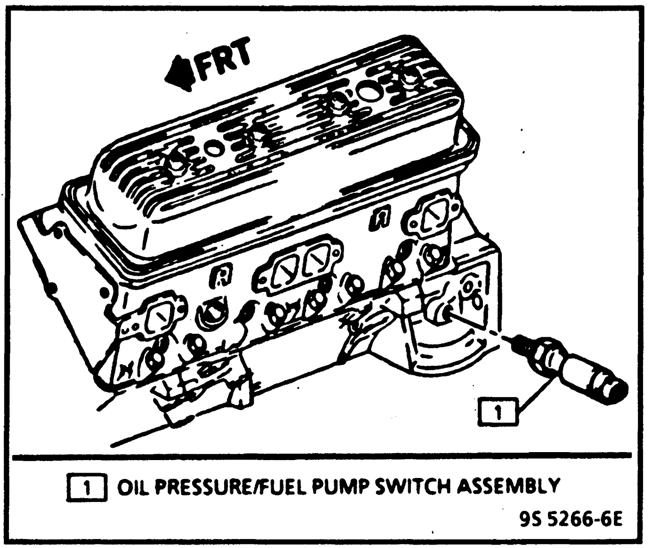


Figure C2-12 - Oil Pressure Sensor/Switch

2. Loosen fuel filler cap to relieve tank vapor pressure.
3. Connect gage J 34730-1 to fuel pressure valve. Wrap a shop towel around fitting while connecting gage to avoid spillage.
4. Install bleed hose into an approved container and open valve to bleed system pressure. Fuel connections are now safe for servicing.
5. Drain any fuel remaining in gage into an approved container.

INTAKE PLENUM/RUNNERS
Figure C2-13

Remove or Disconnect

1. Negative battery terminal.
2. Partially drain cooling system to coolant hoses at throttle body to be removed.
3. Throttle, T.V. (transmission control), and cruise control cables.
4. Cable retaining bracket.
5. Air intake duct.
6. Vacuum hoses at throttle body.
7. Coolant hoses.
8. Electrical connectors from TPS and IAC valve.
9. Throttle body bolts.
10. Throttle body assembly.
11. Electrical connectors from injectors, left/right electrical harness attaching nuts and harnesses.
12. Power brake vacuum hose at plenum.
13. Runner to plenum bolt attaching MAP sensor.
14. MAP sensor and vacuum hoses at plenum.
15. Remaining runner to plenum bolts.
16. Lift plenum and disconnect MAT sensor electrical connector.
17. Plenum and gaskets. Discard gaskets.
    - Refer to "Electronic Control Module (ECM) and Sensors," Section "6E3-C1" for MAT sensor replacement.

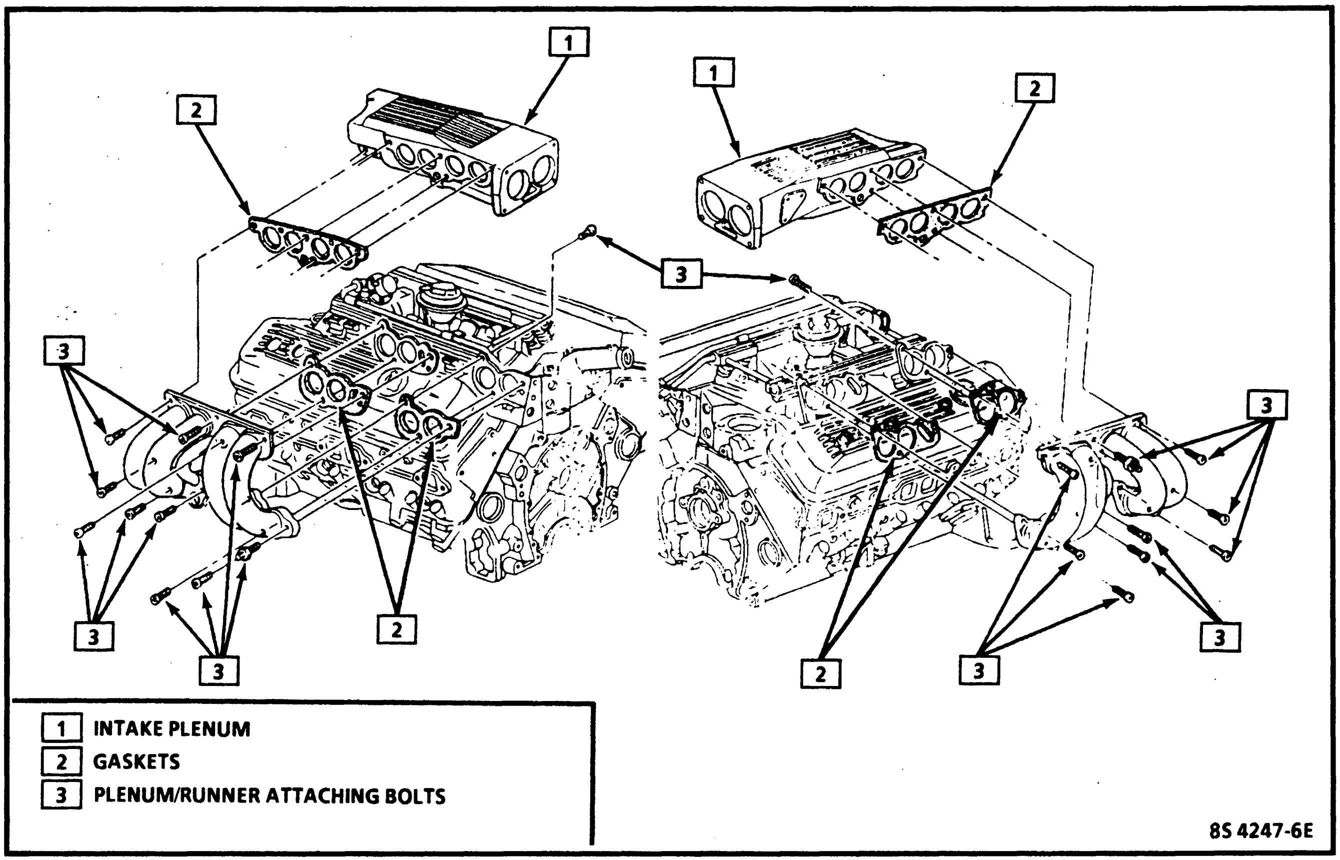


Figure C2-13 - Intake Plenum / Runners

18. Left side runner to manifold bolts
19. PCV valve and hose
20. Right side runner to manifold bolts
21. EGR solenoid
22. Left and right side manifold to runner bolts
23. Left and right side runners and gaskets. Discard gaskets.

NOTICE: Use care in cleaning old gasket material from machined aluminum surfaces. Sharp tools may damage sealing surfaces.

Clean

- Gasket sealing surfaces

Install or Connect

1. New gaskets on runners and intake manifold
2. Left and right side runners
3. Left and right side manifold to runner bolts

Tighten

- Manifold to runner bolts to 34 N·m (25 lb. ft.)

4. EGR solenoid
5. Right and left hand runner to manifold bolts
   - Finger tighten only
6. Support plenum above runners, connect MAT sensor electrical connector, then lower plenum into position.
   - Start a few bolts to hold plenum in position
7. Vacuum hoses and MAP sensor
8. Remaining runner to plenum bolts

Tighten

- All bolts to 34 N·m (25 lb.ft.)*
  - * Start in center of plenum/manifold and work outward.

9. PCV valve and hose
10. Power brake vacuum hose to fitting on plenum
11. Left/right injector electrical harnesses, attaching nuts, and electrical connectors to injectors.
12. Throttle body with new gasket
13. Throttle body attaching bolts

Tighten

- Throttle body attaching bolts to 24 N·m (18 lb. ft.)

14. Electrical connectors to TPS and IAC valve
15. Coolant hoses
16. Vacuum hoses
17. Air intake duct
18. Throttle cable bracket
19. Throttle, T.V., and cruise control cables
20. Refill radiator
21. Negative battery terminal

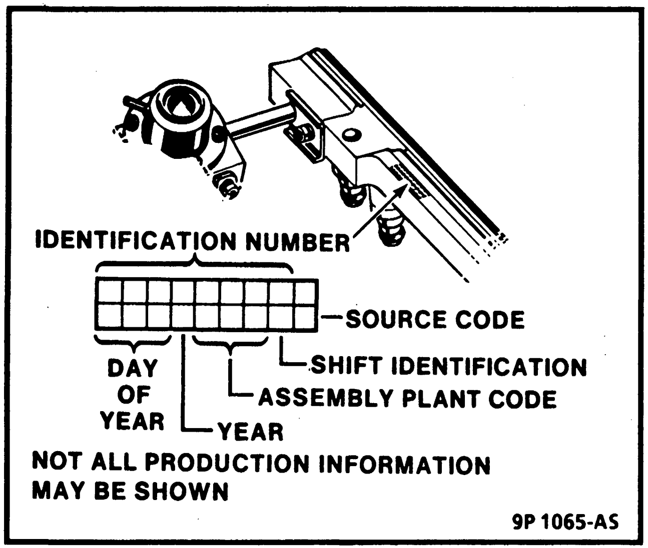


Figure C2-14 - Fuel Rail Assembly Identification

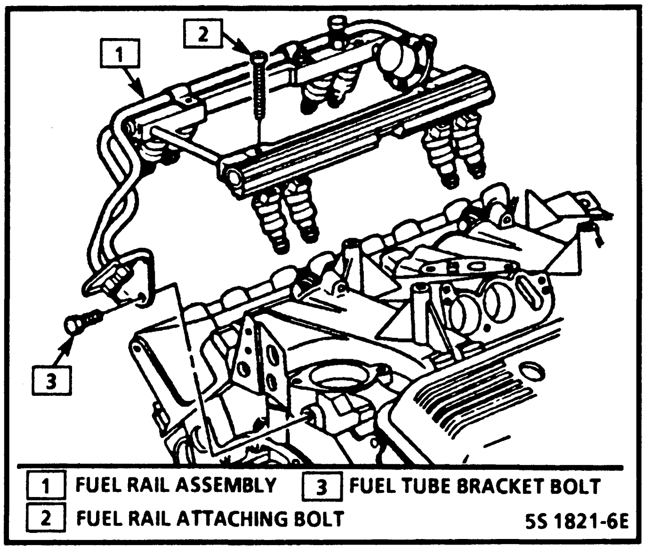


Figure C2-15 - Fuel Rail Removal and Installation

FUEL RAIL ASSEMBLY
Figures 13, 14, 15, 16

An eight digit identification number is stamped on the fuel rail assembly, as shown in Figure C2-14. Refer to this model identification number if servicing or part replacement is required.

Names of component parts will be found on the numbered list that accompanies the disassembled view (Figure C2-16).

NOTICE:
- Use care in removing the fuel rail assembly, to prevent damage to the injector electrical connector terminals and the injector spray tips. When removed, support the rail to avoid damaging its components.
- Prevent dirt and other contaminants from entering open lines and passages. Fittings should be capped, and holes plugged, during servicing.

Clean

- Before removal, the fuel rail assembly may be cleaned with a spray type engine cleaner, GM X-30A or equivalent, following package instructions. Do Not soak fuel rails in liquid cleaning solvent.

Remove or Disconnect

Figures C2-13, 15

1. Negative battery terminal
2. Relieve fuel system pressure. (Refer to "Fuel Pressure Relief Procedure.")
3. Intake plenum and runners
4. Fuel feed and return lines
    - Use a back-up wrench to support fuel rail tube fittings.
5. Fuel line O-rings (1, 2), and discard.
6. Fuel tube bracket bolt.
7. Vacuum line at pressure regulator.
8. Injector electrical connectors.
9. Fuel rail attaching bolts.
10. Fuel rail assembly.

Disassemble

Figure C2-16

- Injector O-ring seal (86) from spray tip end of each injector. Discard seals.

Assemble

- Lubricate new injector O-ring seals (86), and install on spray tip end of each injector.

Install or Connect

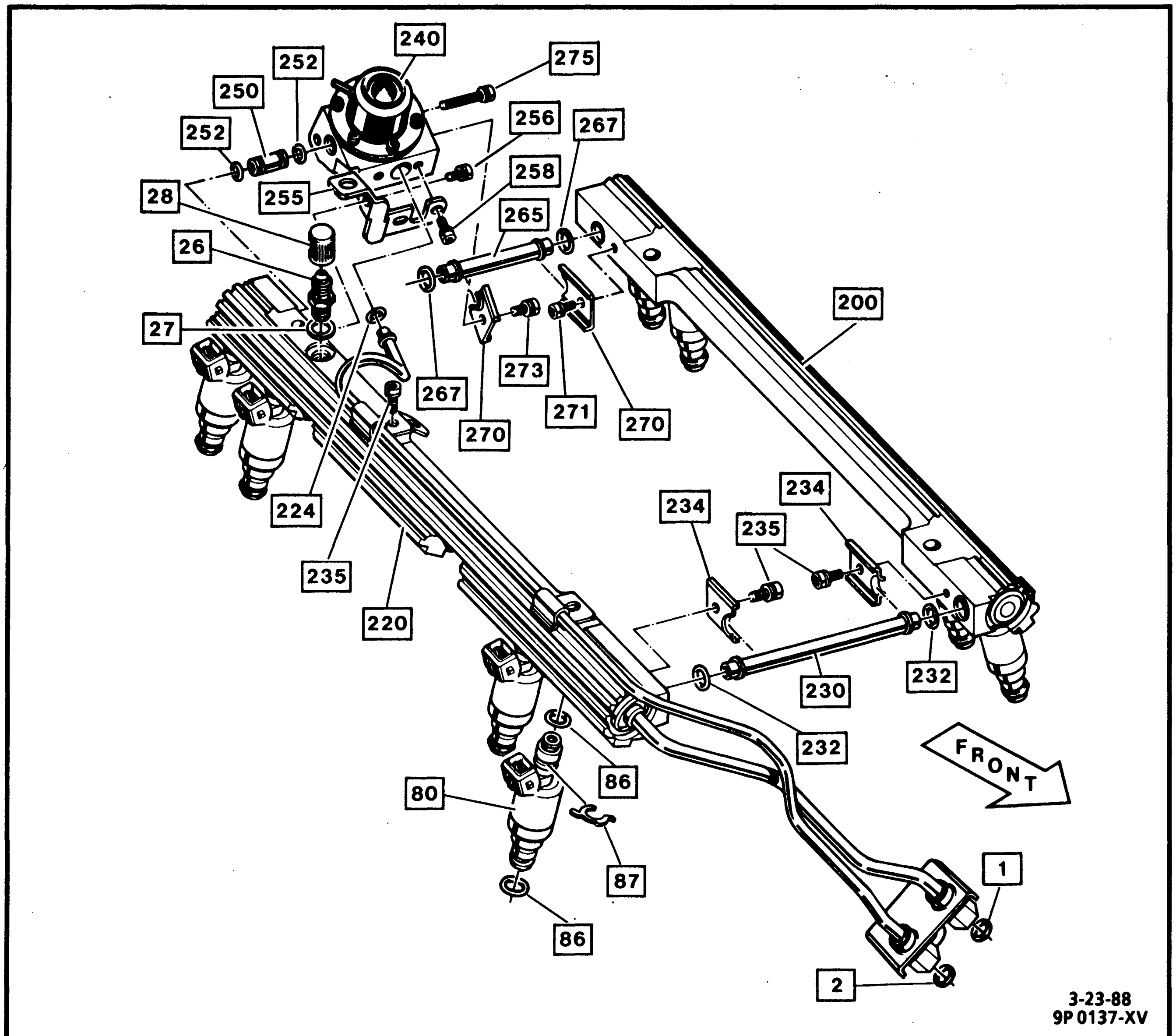
Figures C2-13, 15

1. Fuel rail assembly in intake manifold
2. Fuel rail attaching bolts, and fuel tube bracket bolt.

Tighten

- Fuel rail attaching bolts to 20 N·m (15 lb. ft.)
- Fuel tube bracket bolt to 34 N·m (25 lb. ft.)

3. Injector electrical connectors
    - Rotate injector(s) as required to avoid stretching wire harness.
4. Vacuum line to pressure regulator
5. New O-rings (1, 2) on fuel feed and return lines
6. Fuel lines



1	O-RING - FUEL INLET LINE
2	O-RING - FUEL RETURN LINE
26	FUEL PRESSURE CONNECTION ASSEMBLY
27	SEAL - FUEL PRESSURE CONNECTION
28	CAP - FUEL PRESSURE CONNECTION
80	MPFI INJECTOR ASSEMBLY
86	SEAL - O-RING - INJECTOR
87	CLIP - INJECTOR RETAINER
200	FUEL RAIL AND PLUG ASSEMBLY (LH)
220	FUEL RAIL AND TUBE ASSEMBLY (RH)
224	SEAL - O-RING - FUEL OUTLET TUBE
230	TUBE - FRONT CROSSOVER
232	SEAL - O-RING - FRONT CROSSOVER TUBE
234	RETAINER - CROSSOVER TUBE
235	SCREW ASSEMBLY - RETAINER ATTACHING
240	PRESSURE REGULATOR AND BASE ASSEMBLY
250	CONNECTOR - BASE TO RAIL
252	SEAL - O-RING - CONNECTOR
255	BRACKET - PRESSURE REGULATOR AND BASE ASSEMBLY
256	SCREW ASSEMBLY - BRACKET TO RAIL ATTACHING
258	SCREW ASSEMBLY - BRACKET TO BASE ATTACHING
265	TUBE - REAR CROSSOVER
267	SEAL - O-RING - CROSSOVER TUBE
270	RETAINER - REAR CROSSOVER TUBE
271	SCREW ASSEMBLY - RETAINER TO LH RAIL
273	SCREW ASSEMBLY - RETAINER TO BASE
275	SCREW ASSEMBLY - BASE TO RH RAIL

Figure C2-16 - Fuel Rail Assembly

Tighten

- Fuel line nuts to 27 N·m (20 lb. ft.)
- Use a back-up wrench to support fuel rail tube fittings.

Inspect

A. Temporarily connect negative battery terminal.
B. Turn ignition switch to the "ON" position for two seconds, then turn to the "OFF" position for ten seconds. Again turn the "ON" position, and check for fuel leaks.
C. Disconnect negative battery terminal

7. Intake plenum and runners
8. Tighten fuel filler cap
9. Negative battery terminal

FUEL PRESSURE CONNECTION ASSEMBLY
Figure C2-17

Clean

- Area around fuel pressure connection with GM X-30A or equivalent.

Remove or Disconnect

1. Negative battery terminal
2. Relieve fuel system pressure. (Refer to "Fuel Pressure Relief Procedure").
3. Fuel pressure connection (26) and seal (27).

Install or Connect

1. New seal (27) on fuel pressure connection (26).
2. Fuel pressure connection in fuel rail.

Tighten

- Fuel pressure connection to 13 N·m (115 lb. in.)

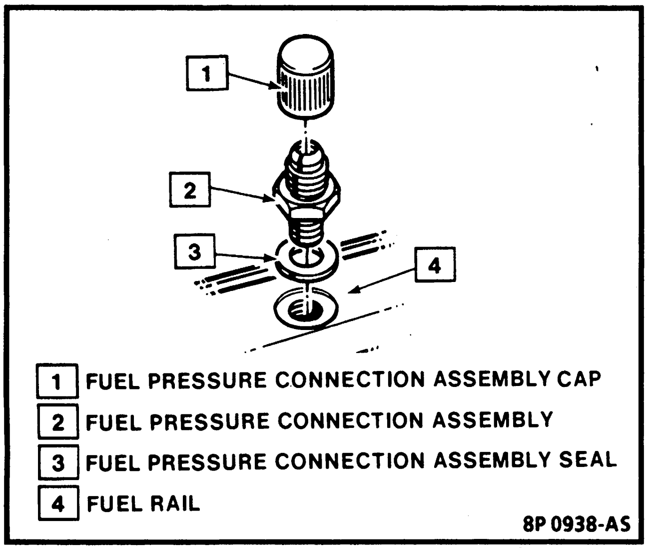


Figure C2-17 - Fuel Pressure Connection

3. Tighten fuel filler cap.
4. Negative battery terminal.

Inspect

- Turn ignition switch to the "ON" position for two seconds, then turn to the "OFF" position for ten seconds. Again turn the "ON" position, and check for fuel leaks.

FUEL INJECTORS

NOTICE: Use care in removing injectors to prevent damage to the electrical connector pins on the injector and the nozzle. The fuel injector is serviced as a complete assembly only. Since it is an electrical component, do not immerse it in any cleaner.

Remove or Disconnect

Figures C2-13, 15

1. Negative battery terminal
2. Relieve fuel system pressure. (Refer to "Fuel Pressure Relief Procedure").
3. Intake plenum and runners
4. Fuel rail assembly

Disassemble

Figure C2-18

1. Rotate injector retainer clip (87) to release position.
2. MPFI injector assembly (80)
3. Injector O-ring seals (86) from both ends of injector, and discard.
4. Injector retainer clip (87)

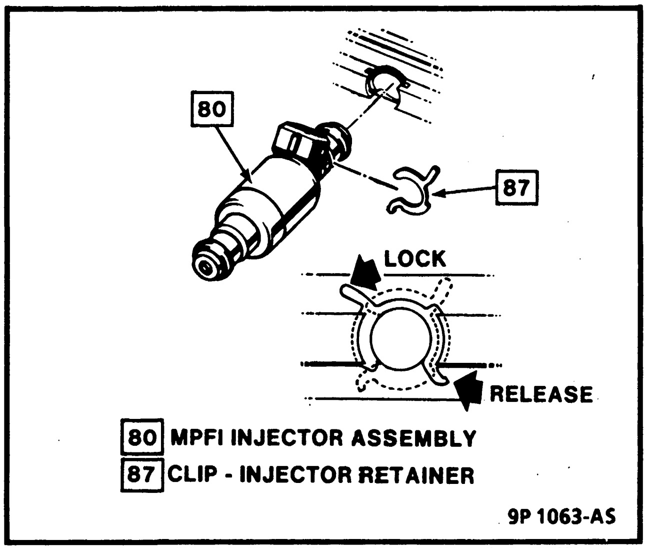


Figure C2-18 - MPFI Injector and Retainer Clip

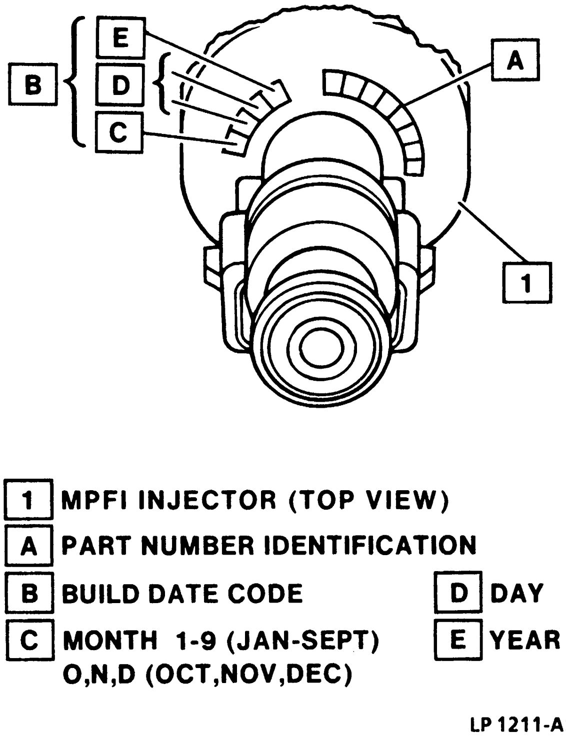


Figure C2-19 - Injector Part Number Location

Important

Figure C2-19

- There are two injector part numbers used in production for the 5.0L V8 engine, and two different part numbers for the 5.7L V8 engine. Do Not intermix injectors with different part numbers, as this will result in engine roughness and excessive emissions.
- When ordering individual replacement fuel injectors, be sure to order the identical part number that is inscribed on the old injector. If a complete set of injectors is being replaced, either part number specified for that engine application may be used.

Assemble

Figure C2-18

1. Lubricate new injector O-ring seals (86) with engine oil, and install on injector.
2. New retainer clip (87) onto injector
3. MPFI injector assembly (80) into fuel rail injector socket, with electrical connector facing outward.
4. Rotate injector retainer clip (87) to locking position.

Install or Connect

Figures C2-13, 15

1. Fuel rail assembly

Inspect

   A. Temporarily connect negative battery terminal.
   B. Turn ignition switch to the "ON" position for two seconds, then turn to the "OFF" position for ten seconds. Again turn the "ON" position, and check for fuel leaks.
   C. Disconnect negative battery terminal.

2. Intake plenum and runners
3. Tighten fuel filler cap
4. Negative battery terminal

PRESSURE REGULATOR ASSEMBLY

Important

- The pressure regulator and base are serviced as a complete assembly only. Do not attempt to remove regulator cover.

Remove or Disconnect

Figures C2-13, 15

1. Negative battery terminal
2. Relieve fuel system pressure. (Refer to "Fuel Pressure Relief Procedure.")
3. Intake plenum and runners
4. Fuel rail assembly

Disassemble

Figure C2-16

1. Rear crossover retainer to regulator base attaching screw (273) and retainer (270).
2. Rear crossover tube (265) and O-ring (267) from regulator base.
   - Discard O-ring
3. Pressure regulator bracket screws (256), (258) and bracket (255).
4. Pressure regulator base to rail screw (275).
5. Pressure regulator and base assembly (240):
   - Separate regulator base from fuel rail, then disconnect from fuel outlet tube.
6. Fuel outlet tube O-ring (224), and discard
7. Base to rail connector (250)
8. O-rings (252) from base to rail connector (250)

Assemble

1. Lubricate and install new base to rail connector O-rings (252).
2. Base to rail connector (250) in regulator base.

3. Lubricate new outlet tube O-ring (224), and install on end of tube.
4. Pressure regulator and base assembly (240):
   - Connect regulator base to fuel outlet tube, then to fuel rail.
5. Base to rail screw (275)
   - Finger tighten only
6. Pressure regulator bracket (255) with attaching screws (256), (258).
   - Finger tighten only
7. Lubricate new rear crossover tube O-ring (267), and install on end of tube.
8. Rear crossover tube (265) to regulator base.
9. Crossover tube retainer (270) with attaching screw (273).
   - Finger tighten only

Tighten

- All attaching screws to 5.0 N·m (44 lb. in.)

Install or Connect

Figures C2-13, 15

1. Fuel rail assembly

Inspect

A. Temporarily connect negative battery terminal.

B. Turn ignition switch to the "ON" position for two seconds, then turn to the "OFF" position for ten seconds. Again turn the "ON" position, and check for fuel leaks.

C. Disconnect negative battery terminal.

2. Intake plenum and runners
3. Tighten fuel filler cap
4. Negative battery terminal

THROTTLE BODY ASSEMBLY

The throttle body assembly repair procedures cover component replacement with the unit on the vehicle. However, throttle body replacement requires that the complete unit be removed from the engine.

An eight digit part identification number is stamped on the bottom of the throttle body casting next to the coolant cover (Figure C2-20). Refer to this number if servicing, or part replacement is required. For identification of parts during repair, refer to the disassembled view (Figure C2-22).

Clean

- The throttle bore and valve deposits may be cleaned on-vehicle, using carburetor cleaner and a parts cleaning brush. Do Not use a cleaner that contains methyl ethyl ketone, an extremely strong solvent, and not necessary for this type of deposit.

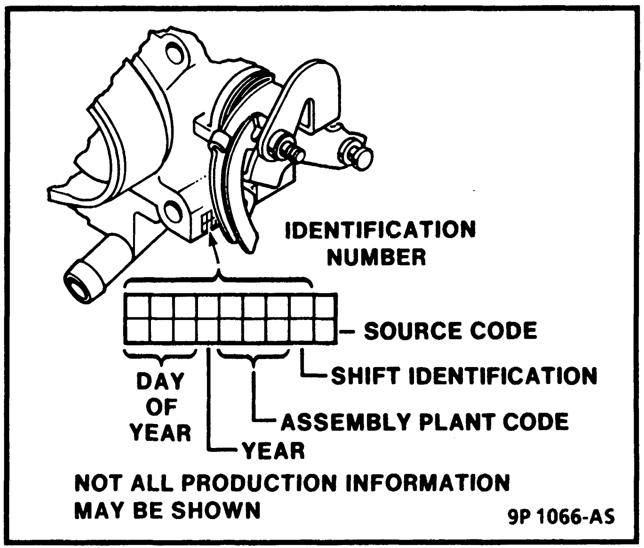
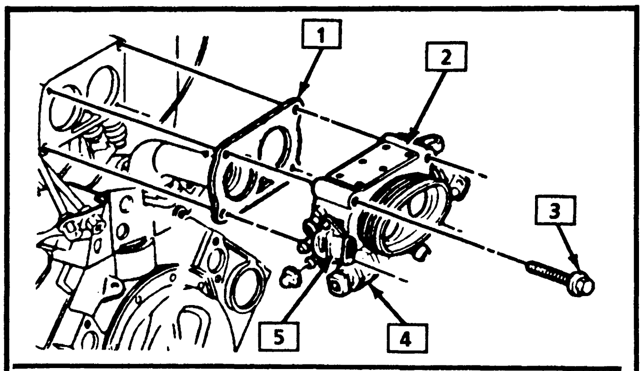


Figure C2-20 - Throttle Body Identification



1 GASKET
2 THROTTLE BODY ASSEMBLY
3 BOLT
4 IDLE AIR CONTROL (IAC) VALVE
5 THROTTLE POSITION SENSOR (TPS) 5S 1822-6E

Figure C2-21 - Throttle Body Removal

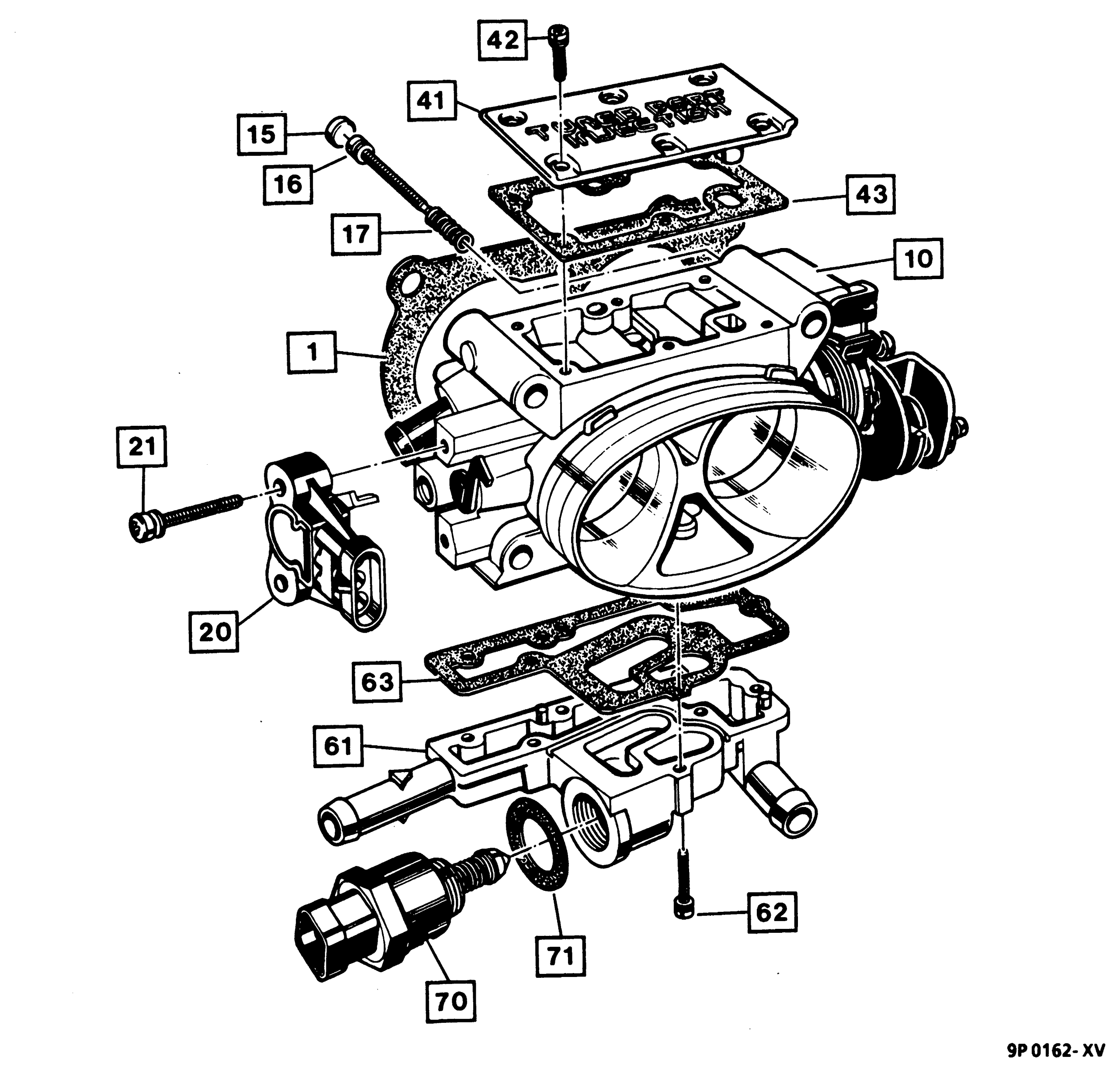
- The throttle body metal parts may be cleaned following disassembly, in a cold immersion-type cleaner such as GM X-55 or equivalent.

NOTICE: The TPS and IAC valve should NOT come in contact with solvent or cleaner, as they may be damaged.

Remove or Disconnect

Figure C2-21

1. Negative battery terminal
2. Partially drain cooling system to allow hoses at throttle body to be removed.
3. Air intake duct
4. Electrical connectors from TPS and IAC valve
5. Vacuum lines
6. Coolant hoses from throttle body
7. Throttle, T.V. (transmission control), and cruise control cables.



1	GASKET - FLANGE	41	COVER - CLEAN AIR
10	THROTTLE BODY ASSEMBLY	42	SCREW ASSEMBLY - CLEAN AIR COVER ATTACHING
15	PLUG - IDLE STOP SCREW	43	GASKET - CLEAN AIR COVER
16	SCREW ASSEMBLY - IDLE STOP	61	IACV/COOLANT COVER ASSEMBLY
17	SPRING - IDLE STOP SCREW ASSEMBLY	62	SCREW ASSEMBLY - IACV COVER ASSEMBLY TO THROTTLE BODY
20	SENSOR - THROTTLE POSITION (TPS)	63	GASKET - IACV/COOLANT COVER TO THROTTLE BODY
21	SCREW ASSEMBLY - TPS ATTACHING	70	VALVE ASSEMBLY - IDLE AIR CONTROL (IAC)
22	RETAINER - TPS ATTACHING SCREW	71	GASKET - IAC VALVE ASSEMBLY

Figure C2-22 - Throttle Body Assembly

8. Throttle body attaching bolts (4).
9. Throttle body assembly and flange gasket.
   - Discard gasket.

Clean

NOTICE: Use care in cleaning old gasket material from machined aluminum surfaces. Sharp tools may damage sealing surfaces.

- Gasket sealing surfaces

Install or connect

Figure C2-21

1. Throttle body assembly with new flange gasket.
2. Throttle body attaching bolts.

Tighten

- Throttle body attaching bolts to 24 N·m (18 lb. ft.)

3. Throttle, T.V., and cruise control cables.

Important

- Make sure throttle and cruise control cables do not hold throttle open. Refer to ENGINE FUEL (SECTION 6C) for additional information on accelerator controls.

4. Coolant hoses to throttle body
5. Vacuum lines
6. Electrical connectors to TPS and IAC valve
7. Air intake duct
8. Refill radiator
9. Negative battery terminal

Inspect

- With the engine "OFF," check to see that the accelerator pedal is free.
  - Depress pedal to the floor and release.

10. Reset IAC valve pintle position:
    a. Depress accelerator pedal slightly.
    b. Start and run engine for five seconds.
    c. Turn ignition "OFF" for ten seconds.
    d. Restart engine and check for proper idle operation.

THROTTLE POSITION SENSOR (TPS)

Figure C2-23

Remove or Disconnect

1. Electrical connector
2. TPS attaching screws (21)
3. Throttle Position Sensor (TPS) (20)

NOTICE: The TPS is an electrical component and must not be soaked in any liquid cleaner or solvent, as damage may result.

Install or Connect

1. With throttle valve in the closed position, install the throttle position sensor (20) on the throttle body assembly, making sure TPS lever lines up with the TPS drive lever on the throttle shaft.
2. TPS attaching screws (21)

Tighten

- TPS attaching screws to 2.0 N·m (18 lb. in.)

3. Electrical connector

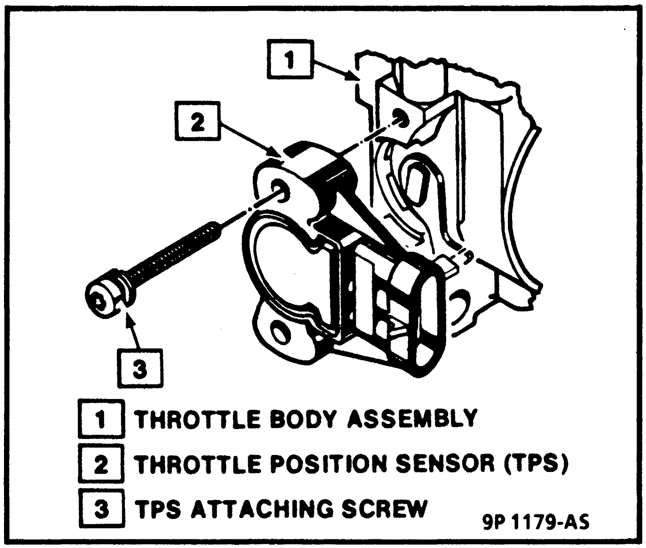


Figure C2-23 - Throttle Position Sensor

IDLE AIR CONTROL (IAC) VALVE

Figure C2-24

Remove or Disconnect

1. Electrical connector.
2. IAC valve assembly (70) and gasket (71).
   - Discard gasket

NOTICE: On IAC valves that have been in service: Do Not push or pull on the IAC valve pintle. The force required to move the pintle may damage the threads on the worm drive.
Also, Do Not soak IAC valve in any liquid cleaner or solvent, as damage may result.

Clean and Inspect

- Both original and replacement IAC valves have a special factory applied thread locking compound applied to the screw threads. If the valve removed from the throttle body is being reinstalled, Do Not remove the thread locking compound that may be on the threads.
- Clean IAC valve gasket sealing surface, pintle valve seat and air passage.

- Use carburetor cleaner to remove carbon deposits. Do Not use a cleaner that contains methyl ethyl ketone, an extremely strong solvent, and not necessary for this type of deposit.
- Shiny spots on the pintle or seat are normal, and do not indicate misalignment or a bent pintle shaft.
- If air passage has heavy deposits, remove throttle body for complete cleaning.

Important

- If installing a new IAC valve, be sure to replace with an identical part. IAC valve pintle shape and diameter are designed for the specific application.

Measure (If Installing a New IAC Valve)

- Distance between tip of IAC valve pintle and mounting surface.
  - If greater than 28 mm, use finger pressure to slowly retract the pintle. The force required to retract the pintle of a *new* valve will not cause damage to the valve.

Install or Connect

1. IAC valve assembly (70) with new gasket (71).

Tighten

- IAC valve to 18 N·m (13 lb. ft.)
- Use a socket or box wrench on valve hex

2. Electrical connector
3. Reset IAC valve pintle position:
   a. Depress accelerator pedal slightly.
   b. Start and run engine for five seconds.
   c. Turn ignition "OFF" for ten seconds.
   d. Restart engine and check for proper idle operation.

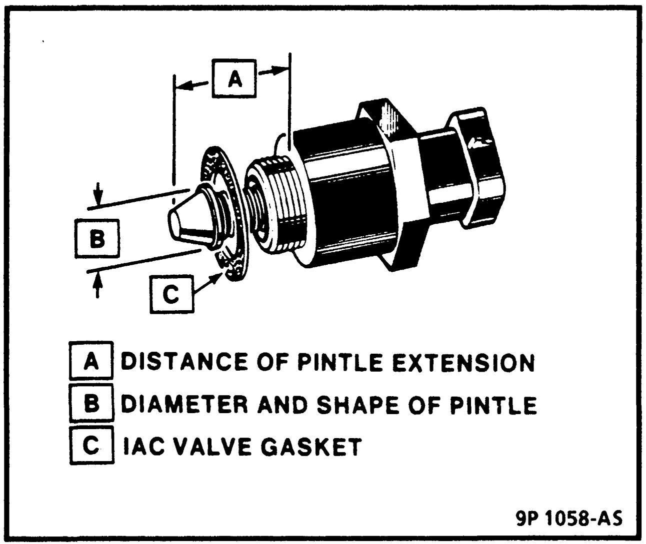


Figure C2-24 - Idle Air Control Valve Assembly

IDLE AIR CONTROL VALVE/COOLANT COVER ASSEMBLY

Figure C2-21

Remove or Disconnect

- Throttle body from intake plenum. (Refer to "Throttle Body Assembly.")

Disassemble

Figure C2-25

1. IAC valve assembly (70) and gasket (71)
   - Discard gasket
2. IAC valve cover assembly screws (62)
3. Cover assembly (61) and gasket (63)
   - Discard gasket

Clean and Inspect

- Clean gasket sealing surface.
- Inspect gasket sealing surface for corrosion or damage that would cause a coolant leak. Replace cover assembly or throttle body if necessary.

Assemble

Figures C2-24, 25

1. New cover gasket (63)
2. Cover assembly (61)

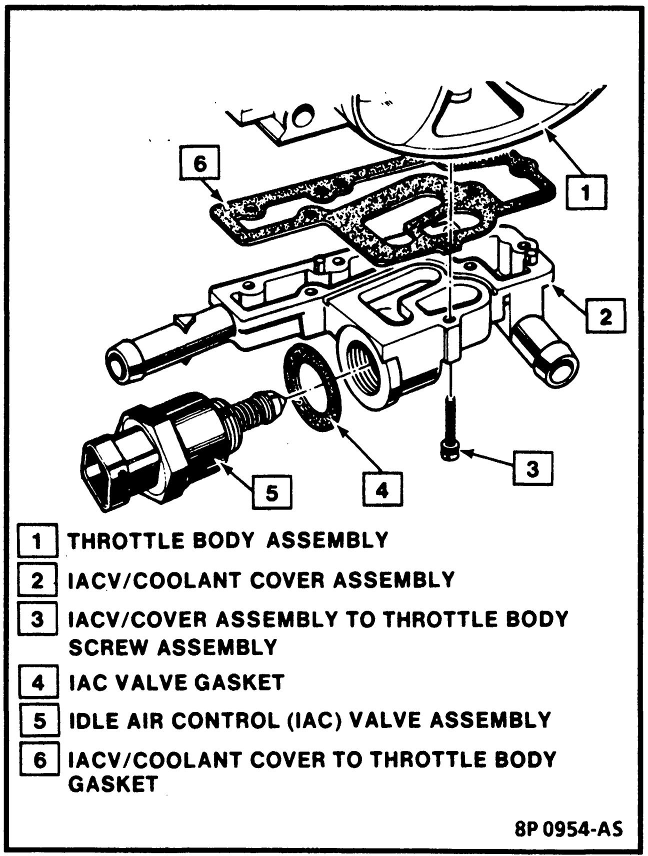


Figure C2-25 - Idle Air Control/Coolant Cover Assembly

3. Cover screws (62)

Tighten

- IAC valve cover screws to 3.0 N·m (27.0 lb. in.)

Measure (If Installing a New IAC Valve)

Figure C2-24

- Distance between tip of IAC valve pintle and mounting surface.
  - If greater than 28 mm, use finger pressure to slowly retract the pintle. The force required to retract the pintle of a *new* valve will not cause damage to the valve.

4. IAC valve assembly (70) with new gasket (71)

Tighten

- IAC valve to 18 N·m (13 lb. ft.)
- Use a socket or box wrench on valve hex

Install and Connect

Figure C2-21

- Throttle body to intake plenum. (Refer to "Throttle Body Assembly.")

CLEAN AIR COVER AND GASKET
Figure C2-22

Remove or Disconnect

1. Clean air cover attaching screws (42).
2. Clean air cover (41) and gasket (43).
   - Discard gasket

Clean

- Gasket sealing surfaces

Install or Connect

1. New clean air cover gasket (43) on throttle body
2. Clean air cover (41)
3. Clean air cover attaching screws (42)

Tighten

- Clean air cover attaching screws to 3.4 N·m (30 lb. in.)

PARTS INFORMATION

PART NAME	GROUP
Relay, Fuel Pump	3.900
Seals, Fuel Feed/Return Pipes (O-rings)	3.163
Rail Kit, Fuel	3.330
Injector Kit, Fuel	3.300
Regulator Kit, Pressure	3.330
Sensor Kit, Throttle Position	3.339
Valve Kit, Idle Air Control	3.338
Gasket Kit (Throttle Body)	3.336
Throttle Body Kit	3.335

TORQUE SPECIFICATIONS

Manifold to Runner Bolts	34.0 N·m (25 lb. ft.)
Runner to Manifold Bolts	34.0 N·m(25 lb. ft.)
Power Brake Vacuum Fitting	12.2 N·m (108 lb. in)
Fuel Line Nuts	27.0 N·m (20 lb. ft.)
Fuel Tube Bracket Bolt	34.0 N·m (25 lb. ft.)
Fuel Rail Attaching Bolts	20.0 N·m (15 lb. ft.)
Fuel Pressure Connection	13.0 N·m (115 lb. in.)
Pressure Regulator Base to Rail	5.0 N·m (44 lb. in.)
Pressure Regulator Bracket	5.0 N·m (44 lb. in.)
Crossover Tube Retainer Attach	5.0 N·m (44 lb. in)
Outlet Tube to R/H Rail Retainer	5.0 N·m (44 lb. in.)
Throttle Body Attach. Bolts	24.0 N·m (18 lb. ft.)
Throttle Position Sensor	2.0 N·m (18 lb. in.)
Idle Air Control Valve	18.0 N·m (13 lb. ft.)
IACV/Coolant Cover Assembly	3.0 N·m (27 lb. in.)
Clean Air Cover Attaching	3.4 N·m (30 lb. in.)

CHART C-2A

INJECTOR BALANCE TEST

The injector balance tester is a tool used to turn the injector on for a precise amount of time, thus spraying a measured amount of fuel into the manifold. This causes a drop in fuel rail pressure that we can record and compare between each injector. All injectors should have the same amount of pressure drop (± 10 kpa). Any injector with a pressure drop that is 10 kpa (or more) greater or less than the average drop of the other injectors should be considered faulty and replaced.

STEP 1

Engine "cool down" period (10 minutes) is necessary to avoid irregular readings due to "Hot Soak" fuel boiling. With ignition "OFF" connect fuel gauge J 347301 or equivalent to fuel pressure tap. Wrap a shop towel around fitting while connecting gage to avoid fuel spillage.

Disconnect harness connectors at all injectors, and connect injector tester J 34730-3, or equivalent, to one injector. Follow manufacturers instructions for use of adaptor harness. Ignition must be "OFF" at least 10 seconds to complete ECM shutdown cycle. Fuel pump should run about 2 seconds after ignition is turned "ON". At this point, insert clear tubing attached to vent valve into a suitable container and bleed air from gauge and hose to insure accurate gauge operation. Repeat this step until all air is bled from gauge.

STEP 2

Turn ignition "OFF" for 10 seconds and then "ON" again to get fuel pressure to its maximum. Record this initial pressure reading. Energize tester one time and note pressure drop at its lowest point (Disregard any slight pressure increase after drop hits low point). By subtracting this second pressure reading from the initial pressure, we have the actual amount of injector pressure drop.

STEP 3

Repeat Step 2 on each injector and compare the amount of drop. Usually, good injectors will have virtually the same drop. Retest any injector that has a pressure difference of 10 kPa, either more or less than the average of the other injectors on the engine. Replace any injector that also fails the retest. If the pressure drop of all injectors is within 10 kPa of this average, the injectors appear to be flowing properly. Reconnect them and review "Symptoms", Section "B".

NOTE: ***The entire test should <u>not</u> be repeated more than once without running the engine to prevent flooding. (This includes any retest on faulty injectors).***

NOTE: If injectors are suspected of being dirty, they should be cleaned using an approved tool and procedure prior to performing this test. The fuel pressure test in Section "A", Chart A-7, should be completed prior to this test.

CHART C-2A

INJECTOR BALANCE TEST 5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Step 1. If engine is at operating temperature, allow a 10 minute "cool down" period then connect fuel pressure gauge and injector tester.

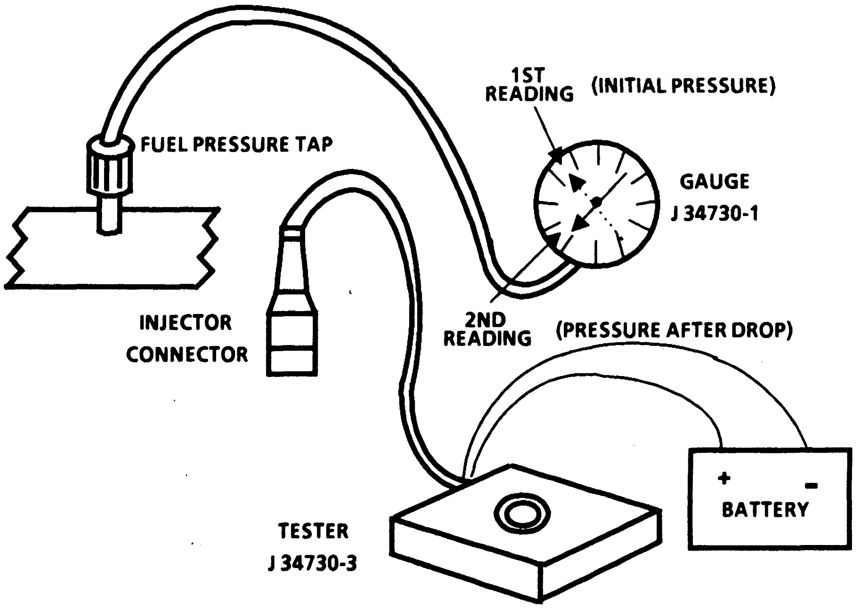
1. Ignition "OFF."
2. Connect fuel pressure gauge and injector tester.
3. Ignition "ON."
4. Bleed off air in gauge. Repeat until all air is bled from gauge.

Step 2. Run test:

1. Ignition "OFF" for 10 seconds.
2. Ignition "ON". Record gauge pressure. (Pressure must hold steady, if not see the Fuel System diagnosis, Chart A-7, in Section "A").
3. Turn injector on, by depressing button on injector tester, and note pressure at the instant the gauge needle stops.

Step 3.

1. Repeat step 2 on all injectors and record pressure drop on each. Retest injectors that appear faulty (Any injectors that have a 10 kPa difference, either more or less, in pressure from the average). If no problem is found, review "Symptoms" Section "B".



EXAMPLE

CYLINDER	1	2	3	4	5	6
1ST READING	225	225	225	225	225	225
2ND READING	100	100	100	90	100	115
AMOUNT OF DROP	125	125	125	135	125	110
	OK			FAULTY, RICH (TOO MUCH) (FUEL DROP)		FAULTY, LEAN (TOO LITTLE) (FUEL DROP)

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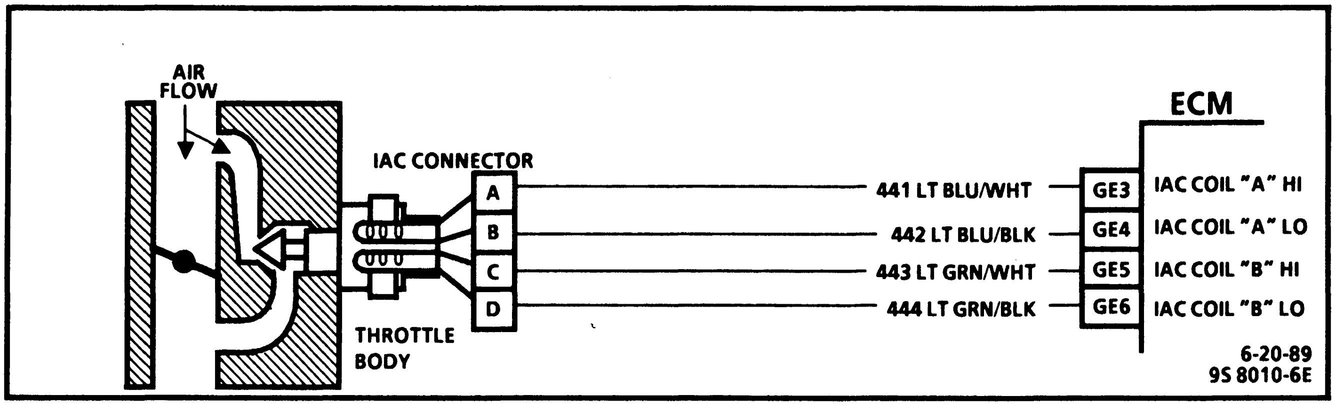


CHART C-2C

IDLE AIR CONTROL (IAC) SYSTEM CHECK
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

The ECM controls idle rpm with the IAC valve. To increase idle rpm, the ECM moves the IAC valve out, allowing more air to bypass the throttle plate. To decrease rpm, it moves the IAC valve in, reducing air flow bypassing the throttle plate. A "Scan" tool will read the ECM commands to the IAC valve in counts. The higher the counts, the more air allowed (higher idle). The lower the counts, the less air allowed (lower idle).

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. The IAC tester is used to extend and retract the IAC valve. Valve movement is verified by an engine speed change. If no change in engine speed occurs, the valve can be retested when removed from the throttle body.
2. This step checks the quality of the IAC movement in Step 1. Between 700 rpm and about 1500 rpm, the engine speed should change smoothly with each flash of the tester light in both extend and retract. If the IAC valve is retracted beyond the control range (about 1500 rpm), it may take many flashes in the extend position before engine speed will begin to drop. This is normal on certain engines, fully extending IAC may cause engine stall. This may be normal.
3. Steps 1 and 2 verified proper IAC valve operation while this step checks IAC circuits. Each lamp on the node light should flash red and green while the IAC valve is cycled. While the sequence of color is not important if either light is "OFF" or does not flash red and green, check the circuits for faults, beginning with poor terminal contacts.

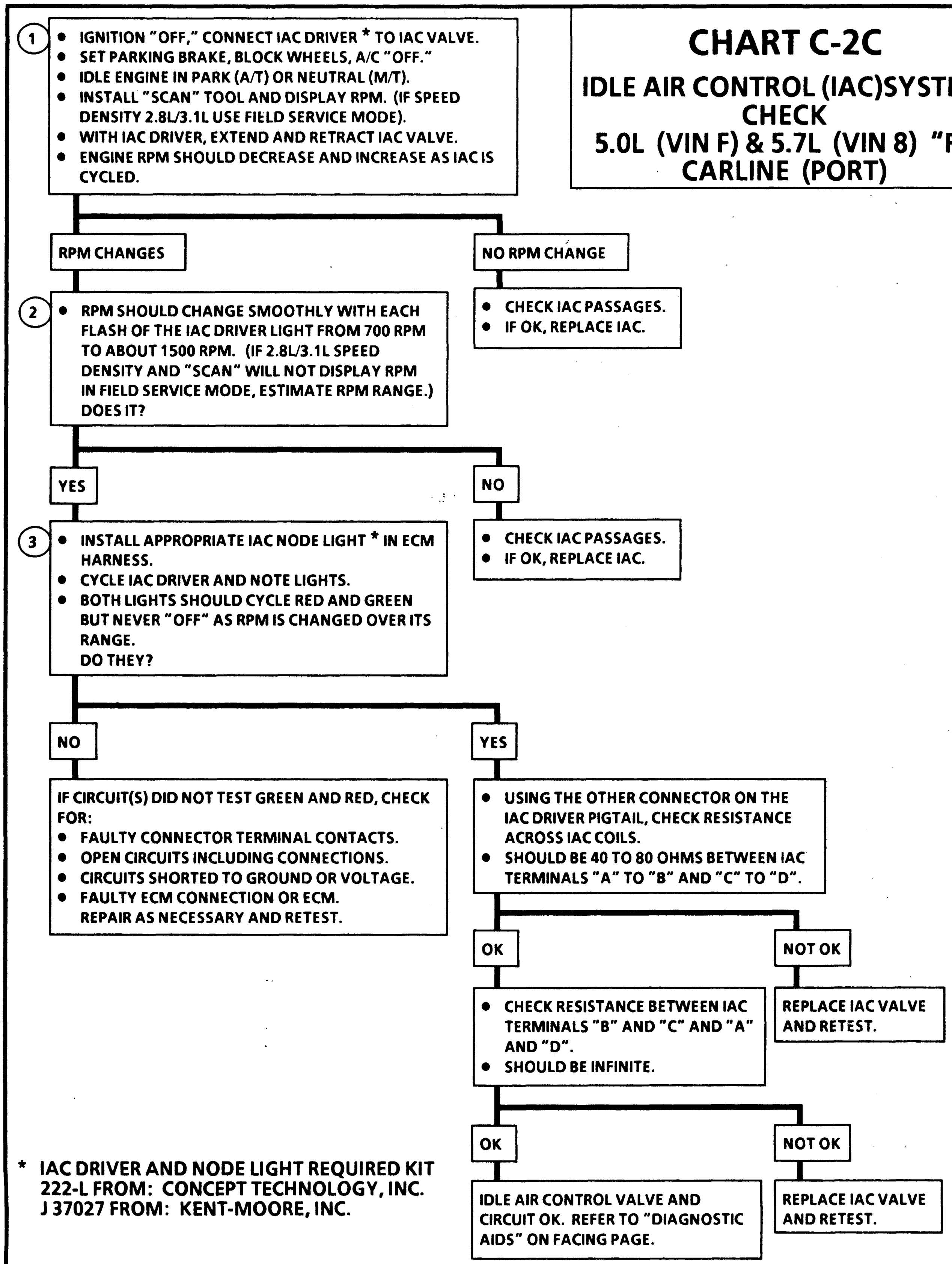
Diagnostic Aids:

A slow, unstable, or fast idle may be caused by a non-IAC system problem that cannot be overcome by the IAC valve. Out of control range IAC "Scan" tool counts will be above 60 if idle is too low, and zero counts if idle is too high. The following checks should be made to repair a non-IAC system problem.

- Vacuum Leak (High Idle)
  If idle is too high, stop the engine. Fully extend (low) IAC with tester. Start engine. If Idle speed is above 800 rpm, locate and correct vacuum leak including PCV system. Also check for binding of throttle blade or linkage.
- System too lean (High Air/Fuel Ratio)
  Idle speed may be too high or too low. Engine speed may vary up and down and disconnecting IAC does not help. Code 44 may be set. "Scan" O_2 voltage will be less than 300 mv (.3 volts.) Check for low regulated fuel pressure, water in the fuel or a restricted injector.
- System too rich (Low Air/Fuel Ratio)
  The idle speed will be too low. "Scan" tool IAC counts will usually be above 80. System is obviously rich and may exhibit black smoke exhaust.
  "Scan" tool O_2 voltage will be fixed above 800 mV (.8 volt). Check for high fuel pressure, leaking or sticking injector. Silicone contaminated O_2 sensor will "Scan" an O_2 voltage slow to respond.
- Throttle Body
  Remove IAC and inspect bore for foreign material.
- PCV Valve
  An incorrect or faulty PCV valve may result in an incorrect idle speed.
- Refer to "Rough, Unstable, Incorrect Idle or Stalling" in "Symptoms", Section "6E3-B".
- If intermittent poor driveability or idle symptoms are resolved by disconnecting the IAC, carefully recheck connections, valve terminal resistance, or replace IAC.

CHART C-2C

IDLE AIR CONTROL (IAC)SYSTEM CHECK 5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



①
- IGNITION "OFF," CONNECT IAC DRIVER * TO IAC VALVE.
- SET PARKING BRAKE, BLOCK WHEELS, A/C "OFF."
- IDLE ENGINE IN PARK (A/T) OR NEUTRAL (M/T).
- INSTALL "SCAN" TOOL AND DISPLAY RPM. (IF SPEED DENSITY 2.8L/3.1L USE FIELD SERVICE MODE).
- WITH IAC DRIVER, EXTEND AND RETRACT IAC VALVE.
- ENGINE RPM SHOULD DECREASE AND INCREASE AS IAC IS CYCLED.

RPM CHANGES

②
- RPM SHOULD CHANGE SMOOTHLY WITH EACH FLASH OF THE IAC DRIVER LIGHT FROM 700 RPM TO ABOUT 1500 RPM. (IF 2.8L/3.1L SPEED DENSITY AND "SCAN" WILL NOT DISPLAY RPM IN FIELD SERVICE MODE, ESTIMATE RPM RANGE.) DOES IT?

YES

③
- INSTALL APPROPRIATE IAC NODE LIGHT * IN ECM HARNESS.
- CYCLE IAC DRIVER AND NOTE LIGHTS.
- BOTH LIGHTS SHOULD CYCLE RED AND GREEN BUT NEVER "OFF" AS RPM IS CHANGED OVER ITS RANGE.

  DO THEY?

NO

IF CIRCUIT(S) DID NOT TEST GREEN AND RED, CHECK FOR:
- FAULTY CONNECTOR TERMINAL CONTACTS.
- OPEN CIRCUITS INCLUDING CONNECTIONS.
- CIRCUITS SHORTED TO GROUND OR VOLTAGE.
- FAULTY ECM CONNECTION OR ECM.

  REPAIR AS NECESSARY AND RETEST.

YES

- USING THE OTHER CONNECTOR ON THE IAC DRIVER PIGTAIL, CHECK RESISTANCE ACROSS IAC COILS.
- SHOULD BE 40 TO 80 OHMS BETWEEN IAC TERMINALS "A" TO "B" AND "C" TO "D".

OK

- CHECK RESISTANCE BETWEEN IAC TERMINALS "B" AND "C" AND "A" AND "D".
- SHOULD BE INFINITE.

OK

IDLE AIR CONTROL VALVE AND CIRCUIT OK. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

NOT OK

REPLACE IAC VALVE AND RETEST.

NOT OK

REPLACE IAC VALVE AND RETEST.

NO

- CHECK IAC PASSAGES.
- IF OK, REPLACE IAC.

NO RPM CHANGE

- CHECK IAC PASSAGES.
- IF OK, REPLACE IAC.

* IAC DRIVER AND NODE LIGHT REQUIRED KIT
222-L FROM: CONCEPT TECHNOLOGY, INC.
J 37027 FROM: KENT-MOORE, INC.

CLEAR CODES, CONFIRM "CLOSED LOOP" OPERATION, NO "SERVICE ENGINE SOON" LIGHT, PERFORM IAC RESET PROCEDURE PER APPLICABLE SERVICE MANUAL AND VERIFY CONTROLLED IDLE SPEED IS CORRECT.

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SECTION C3

EVAPORATIVE EMISSION CONTROL SYSTEM (EECS)

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The Evaporative Emission Control System (EECS) used on all vehicles is the charcoal canister storage method. This method transfers fuel vapor from the fuel tank to an activated carbon (charcoal) storage device (canister) to hold the vapors when the vehicle is not operating. When the engine is running, the fuel vapor is purged from the carbon element by intake air flow and consumed in the normal combustion process.

FUEL VAPOR CANISTER

Gasoline vapors from the fuel tank flow into the tube labeled tank. Any liquid fuel goes into a reservoir in the bottom of the fuel vapor canister to protect the integrity of the carbon bed above (Figure C3-1). These vapors are absorbed into the carbon. The fuel vapor canister is purged when the engine is running above idle speed. Ambient air is allowed into the fuel vapor canister through the air tube in the top. The air mixes with the vapor and the mixture is drawn into the intake manifold.

EVAPORATIVE EMISSION SYSTEM

The fuel vapor canister is equipped with a normally closed solenoid to control canister purge. The ECM operates the canister purge solenoid which controls vacuum to the purge valve in the charcoal canister. Under cold engine or idle conditions, the canister purge solenoid is turned "OFF" by the ECM, which closes the canister purge solenoid and blocks vacuum to the canister purge valve.

The ECM turns "ON" the canister purge solenoid and allows purge when:

- Above a specified road speed
- Engine is warm
- After the engine has been running a specified time
- Above a specified throttle opening

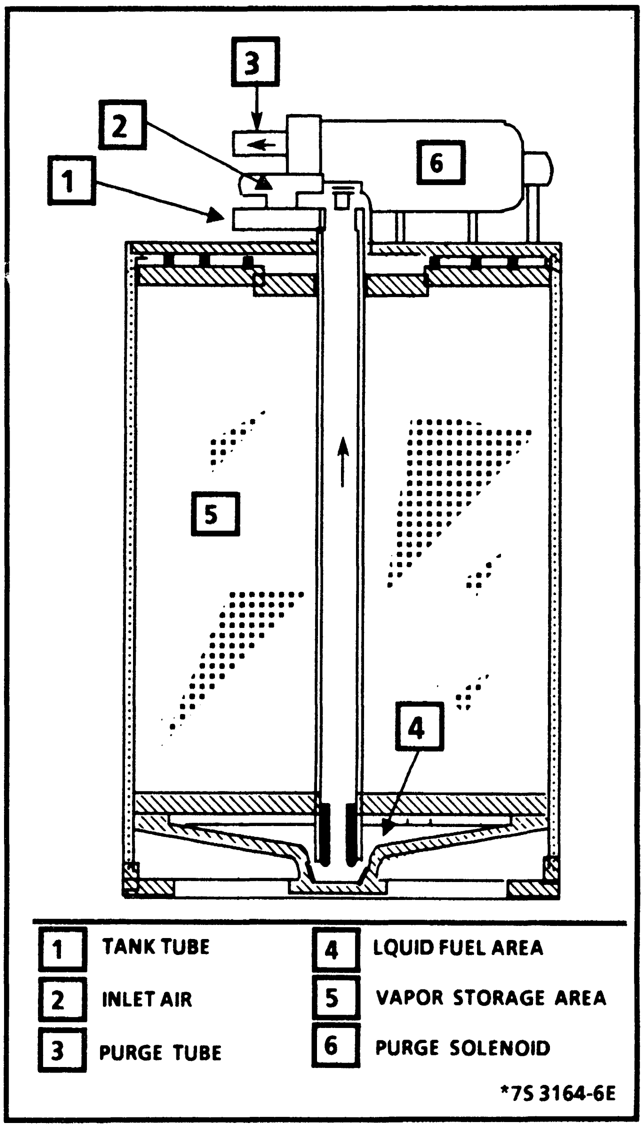
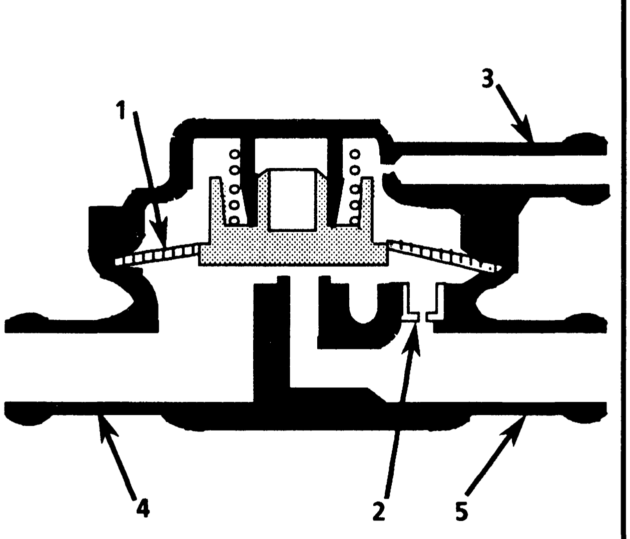


Figure C3-1 - Inverted Function Fuel Vapor Canister - With Encapsulated Canister Purge Solenoid

This is an ECM feedback system that increases purge until the ECM senses a rich condition from the Oxygen (O_2) sensor. The purge is then regulated until the ECM no longer receives a rich signal from the oxygen sensor. This system uses a tank pressure control valve to control the flow of vapors from the fuel tank to the canister.

FUEL TANK PRESSURE CONTROL VALVE

The fuel tank pressure control valve, a combination roll-over, integral pressure and vacuum relief valve. When vapor pressure in the tank exceeds 5 kPa (1" Hg) the valve opens and allows vapors to vent to the fuel vapor canister and then be purged. When the tank pressure drops below the opening point of the valve it will close, keeping vapors in the fuel tank. The valve provides vacuum relief to protect against vacuum build up in the fuel tank and roll-over protection to prevent liquid fuel from entering the fuel vapor canister during normal driving maneuvers.



1 DIAPHRAGM
2 VENT RESTRICTION
3 CONTROL VACUUM TUBE
4 TUBE TO FUEL TANK
5 TUBE TO CANISTER

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Figure C3-2 Fuel Tank Pressure Control Valve

RESULTS OF INCORRECT OPERATION

Poor idle, stalling and poor driveability can be caused by:

- Inoperative canister purge solenoid
- Damaged fuel vapor canister
- Hoses split, cracked and, or not connected to the proper tubes.

Evidence of fuel loss or fuel vapor odor can be caused by:

- Liquid fuel leaking from fuel lines.
- Cracked or damaged fuel vapor canister
- Disconnected, misrouted, kinked, deteriorated or damaged vapor hoses, or control hoses.

DIAGNOSIS

CANISTER PURGE SOLENOID

The canister purge solenoid operation is covered in CHART C-3 at the end of this section.

VISUAL CHECK OF FUEL VAPOR CANISTER

Cracked or damaged, replace fuel vapor canister.

FUNCTIONAL TEST

Fuel Vapor Canister Purge Valve

Apply a short length of hose to the lower tube of purge valve, and attempt to blow through it. Little or no air should pass into the canister. (A small amount of air will pass if the fuel vapor canister has a constant purge hole).

With hand vacuum pump, apply vacuum 51 kPa (15" Hg) through the control valve tube (upper tube). The diaphragm should hold vacuum for at least 20 seconds, if not the canister must be replaced. If the diaphragm holds vacuum, again try to blow through the hose connected to the lower tube while vacuum is still being applied. An increased flow of air should be observed, if not the fuel vapor canister must be replaced.

Fuel Tank Pressure Control Valve

With a hand vacuum pump apply vacuum 51 kPa (15" Hg) to the control vacuum tube. The diaphragm should hold vacuum for at least 20 seconds. If it does not hold vacuum the diaphragm is leaking and the valve must be replaced.

With the vacuum still applied to the control vacuum tube, apply a short hose to the valve's tank tube side, blow into the tube. You should feel the air pass through the valve. If the air does not pass through, the valve should be replaced.

ON-VEHICLE SERVICE

FUEL VAPOR CANISTER

Remove or Disconnect

1. Hoses from fuel vapor canister. Mark hoses to install on new fuel vapor canister.
2. Fuel vapor canister

Install or Connect

1. Fuel vapor canister as removed.

Tighten

- Screw, fuel vapor canister to 5.8 N·m (51 lb. in.)

2. Hoses. Make sure connections are correct.

CANISTER PURGE SOLENOID

Remove or Disconnect

1. Negative battery cable
2. Electrical connector and hoses from solenoid
3. Solenoid from canister

Install or Connect

1. Solenoid to canister
2. Electrical connector and hoses on solenoid
3. Negative battery cable

FUEL VAPOR CANISTER HOSES

Refer to "Vehicle Emission Control Information" label for routing of fuel vapor canister hoses.

PARTS INFORMATION

PART NAME	GROUP
Canister, Fuel Vapor	3.130
Solenoid, Fuel Vapor Canister Purge	3.140
Valve, Fuel Tank Pressure Control	3.140
Tube, Fuel Vapor Canister	3.145
Harness, Fuel Vapor Canister	3.145
Hose, (1/4) cut as required	8.962
Hose, (3/8) cut as required	8.962
Bracket, Fuel Vapor Canister	3.130
Clip, Fuel Vapor Pipe	3.162

TORQUE SPECIFICATIONS

Bolt/Screw, Fuel VPR CNSTR HARN Clip	5.8 N·m (51 lb. in.)
Bolt/Screw, Fuel VPR FRT Pipe Clip	6 N·m (53 lb. in.)
Bolt/Screw, Fuel Feed Pipe Clip	5.8 N·m (51 lb. in.)
Nut, Fuel RTN Pipe Clip	5.8 N·m (51 lb. in.)
Bolt/Screw, Fuel VPR CNSTR	6 N·m (53 lb. in.)

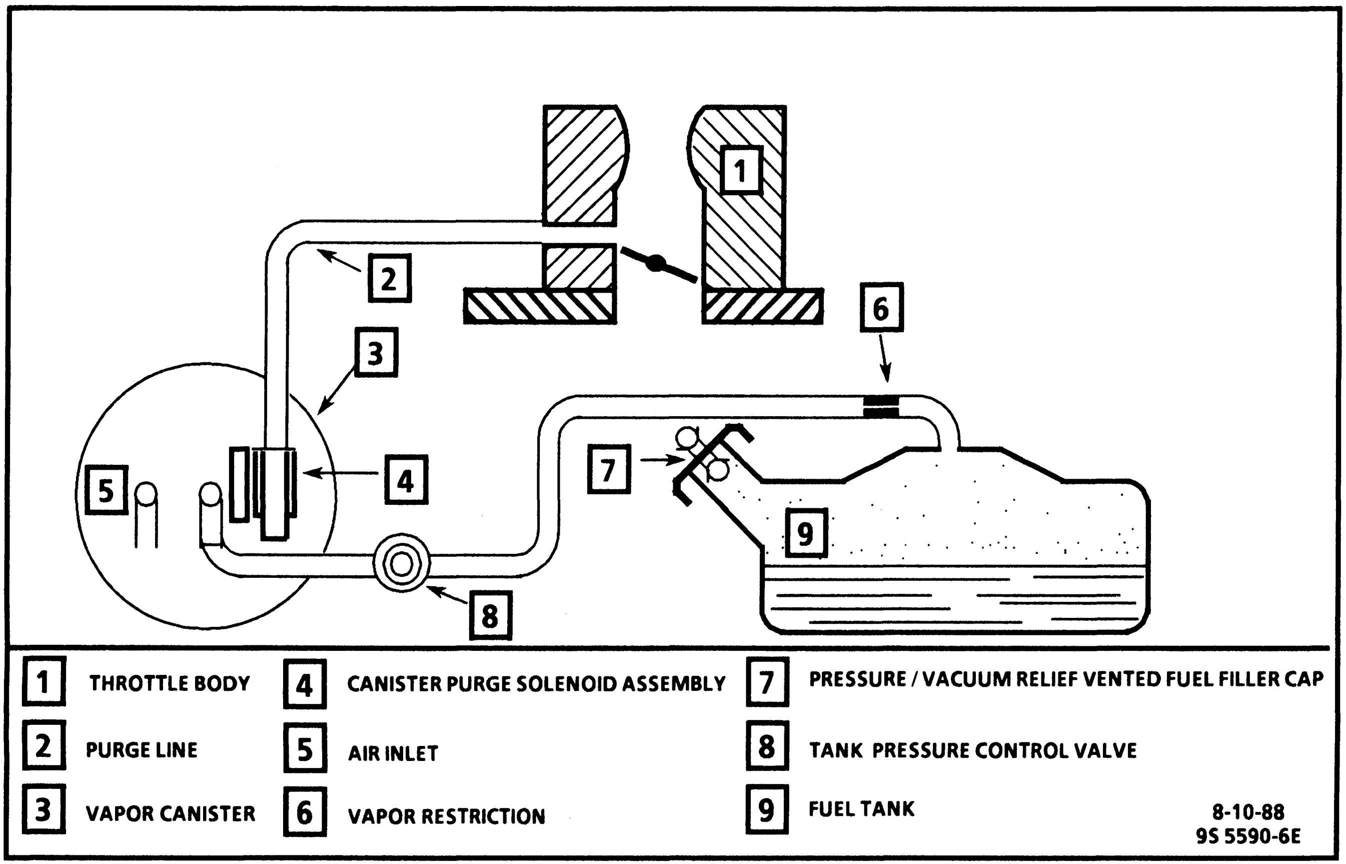


Figure C3-2 - Evaporative Emissions Control System Schematic

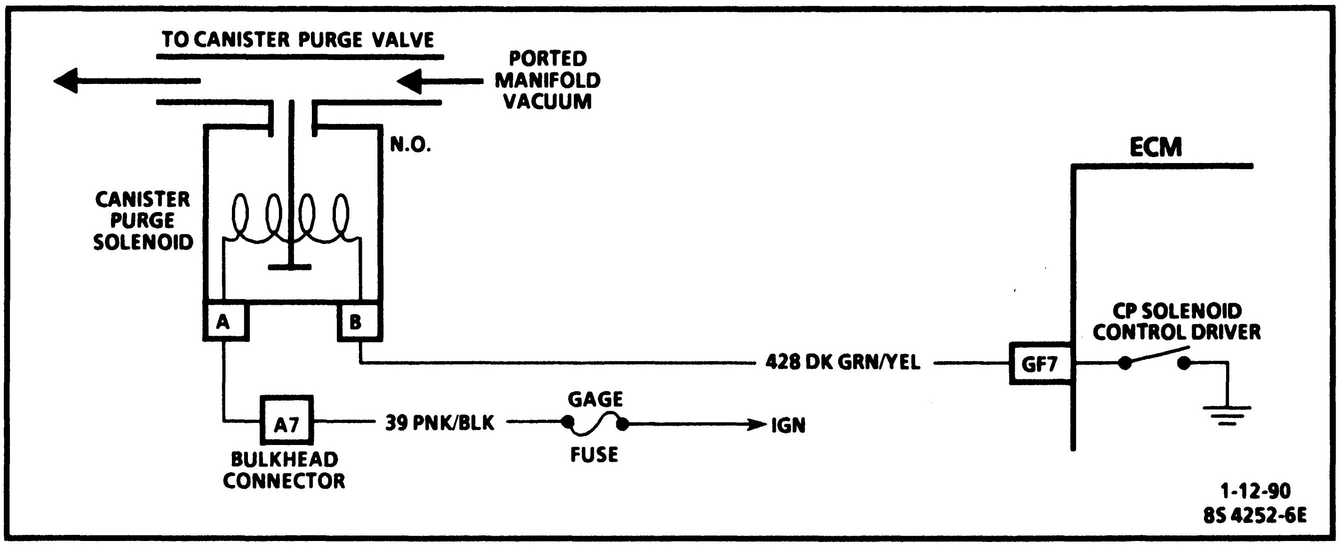


CHART C-3

CANISTER PURGE SOLENOID CHECK
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

Canister purge is controlled by a solenoid that allows ported manifold vacuum to purge the fuel vapor canister when de-energized. The ECM supplies a ground to energize the solenoid (purge "ON").

If the diagnostic "test" terminal is grounded, with the engine stopped, or the following conditions are met with the engine running, the canister purge solenoid will be energized (purge "ON").

- Engine run time after start more than 1 minute.
- Coolant temperature above 75°C (167°F)
- Vehicle Speed Sensor (VSS) above 15 mph
- Throttle Position Sensor (TPS) is above idle

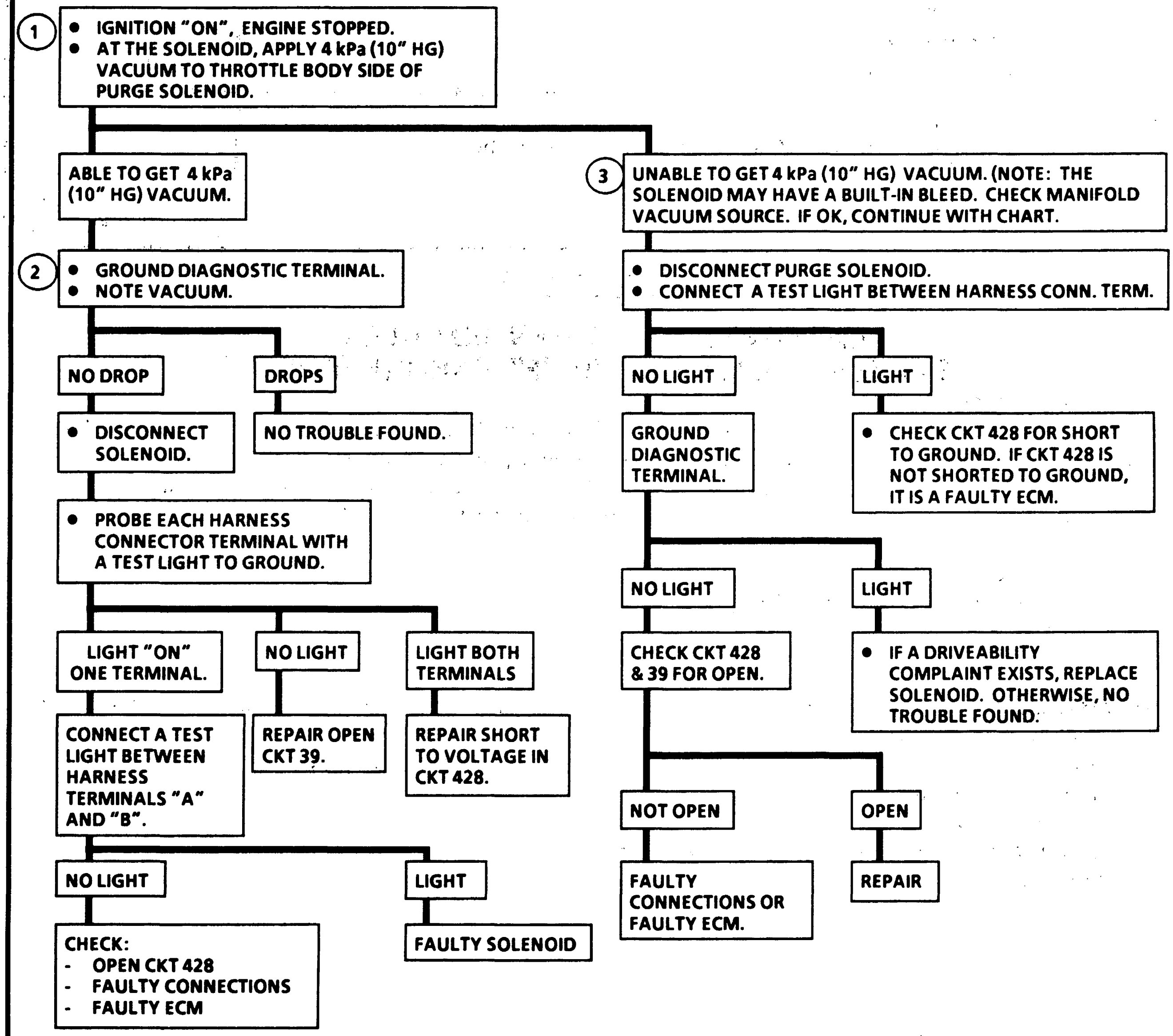
Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. The external vacuum source must be applied to the canister purge solenoid at the canister.
2. Grounding the diagnostic "test" terminal will energize the canister purge solenoid and allow vacuum to pass.
3. Some canister purge solenoids may have a large enough bleed built into them to appear to be operating incorrectly.

CHART C-3

CANISTER PURGE SOLENOID CHECK

5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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SECTION C4

IGNITION SYSTEM/EST

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The High Energy Ignition (HEI) system controls fuel combustion by providing a spark to ignite the compressed air/fuel mixture at the correct time. To provide improved engine performance, fuel economy, and control of exhaust emissions, the ECM controls distributor spark advance (timing) with the Electronic Spark Timing (EST) system.

Only the Electronic Spark Timing (EST) system will be described here. Additional information on the HEI system is found in ENGINE ELECTRICAL (SECTION 6D).

To properly control ignition/combustion timing the ECM needs to know:

- Crankshaft position
- Engine speed (rpm)
- Engine Load (manifold pressure or vacuum).
- Engine temperature

OPERATION

The EST system consists of the distributor module, ECM, and connecting wires. The connector terminals are lettered as shown in CHART C-4.

These circuits perform the following functions:

- Reference (CKT 430) - This provides the ECM with rpm and crankshaft position information. If the wire becomes open or grounded the engine will not run, because the ECM will not operate the injectors. If the engine cranks but will not run, Refer to CHART A-3.
- Distributor ground (CKT 453) - This wire is grounded in the distributor and provides a reference ground from the ignition module to the ECM for use by the ECM to compare with reference high voltage. If it is open, it may cause poor performance.
- Bypass (CKT 424) - At about 400 rpm, the ECM applies 5 volts to this circuit to switch spark timing control from the HEI module to the ECM. The wire goes through a connector between the 4 wire connector and the ECM. This wire is disconnected to set base timing.

An open or grounded bypass circuit will set a Code 42 and the engine will run at base timing, plus a small amount of advance built into the HEI module.

- EST (CKT 423) - This circuit triggers the HEI module after the engine is started and no Code 42 detected. The ECM does not know what the actual timing is, but it does know when it gets the reference signal. It then advances or retards the spark from that point. Therefore, if the base timing is set incorrectly, the entire spark curve will be incorrect.

RESULTS OF INCORRECT OPERATION

An open or ground in the EST, or bypass, circuit will set a Code 42 and cause the engine to run on the HEI module timing. This will cause reduced performance and poor fuel economy.

The ECM uses information from the MAP and coolant temperature sensors in addition to rpm to calculate spark advance as follows:

- Cold engine = More spark advance.
- Engine under minimum load based on rpm and low amount of air flow - More spark advance.
- Hot engine = Less spark advance.
- Engine under heavy load based on rpm and high amount of air flow - Less spark advance.

DIAGNOSIS

The description, operation, and repair procedures of the HEI system are found in ENGINE ELECTRICAL (SECTION 6D) of this manual. For an Ignition System/EST check, refer to CHART C-4 at the end of this section.

CODE 12

Code 12 is used during the "Diagnostic Circuit Check" procedure to test the code display ability of the ECM. This code indicates that the ECM is not receiving the engine rpm (REFERENCE) signal. This occurs with the ignition key "ON," and the engine not running.

The "Reference" signal also triggers the fuel injection system. Without the "Reference" signal the engine cannot run. This signal can be checked by using a "Scan" tool which will help determine the cause of an engine that cranks but will not start.

ON-VEHICLE SERVICE

SETTING TIMING

The initial base timing is set by disconnecting the timing connector. Then set the timing to the specification shown on Vehicle Emission Control Information label. This will cause Code 42 to be stored in the memory of the ECM. The memory must be cleared after setting timing.

How Code 42 Is Determined

When the system is running on the HEI module, that is, no voltage on the bypass line, the HEI module grounds the EST signal. The ECM expects to see no voltage on the EST line during this condition. If it sees a voltage, it sets Code 42 and will not go into the EST mode. When the rpm for EST is reached, (about 400 rpm), the ECM applies 5 volts to the bypass line and the EST should no longer be grounded in the HEI module, so the EST voltage should be varying. If the bypass line is open or grounded, the HEI module will not switch to EST mode, so the EST voltage will be low and Code 42 will be set.

Refer to ENGINE ELECTRICAL (SECTION 6D) for On-Vehicle service.

PARTS INFORMATION

PART NAME	GROUP
Coil, Distr	2.170
Controller, ECM (Remanufactured)	3.670
Distributor	2.361
Module, Distr	2.383

TORQUE SPECIFICATIONS

Distributor Hold-Down	34 N·m (25 lb. ft.)
Coil Mounting Bolts/Screws	1.5 N·m (13 lb. in.)
Ignition Module Bolts/Screws	2.0 N·m (18 lb. in.)

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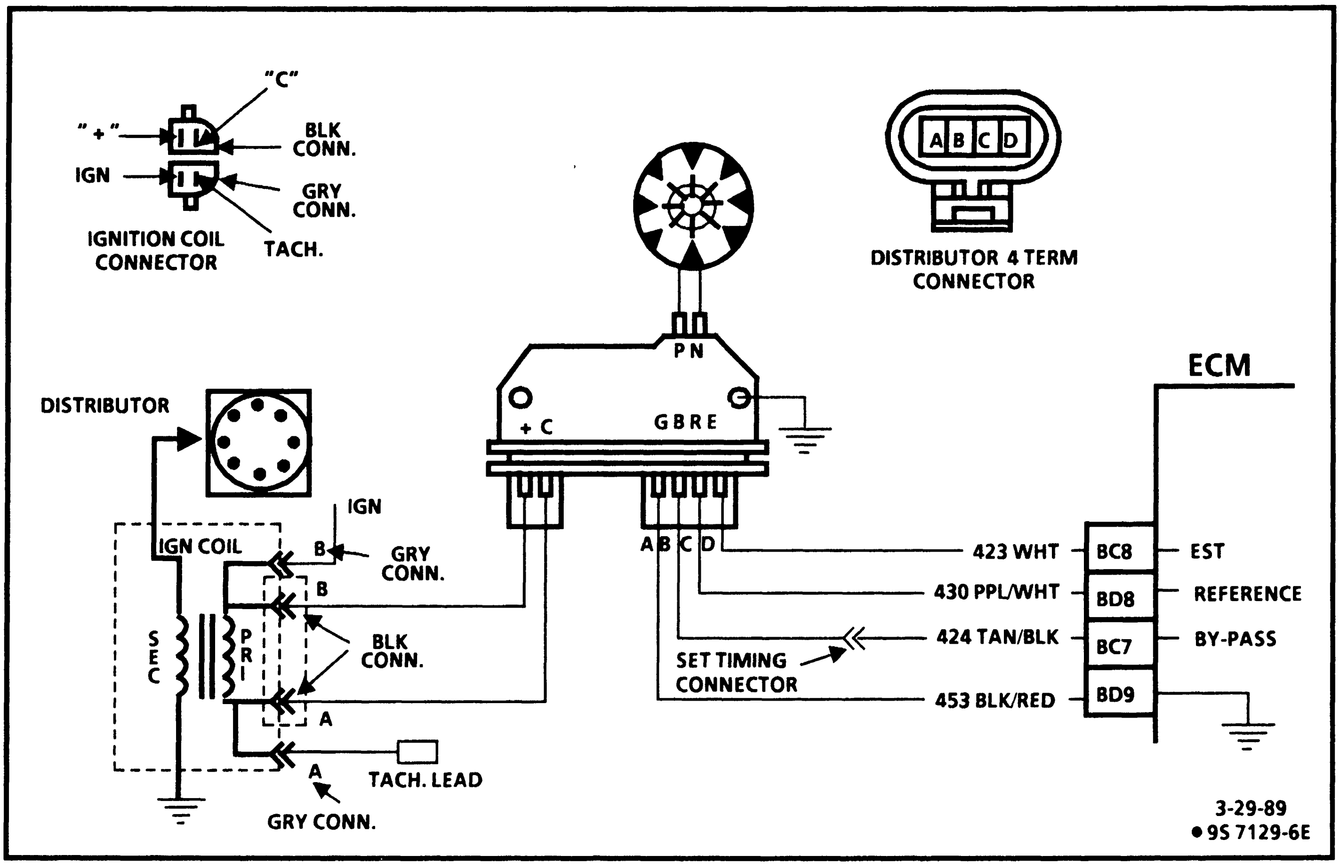

CHART C-4

IGNITION SYSTEM CHECK
(REMOTE COIL/SEALED MODULE CONNECTOR DISTRIBUTOR)
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Two wires are checked, to ensure that an open is not present in a spark plug wire.

1A. If spark occurs with EST connector disconnected, pick-up coil output is too low for EST operation.

2. A spark indicates the problem must be the distributor cap or rotor.
3. Normally, there should be battery voltage at the "C" and "+" terminals. Low voltage would indicate an open or a high resistance circuit from the distributor to the coil or ignition switch. If "C" terminal voltage was low, but "+" terminal voltage is 10 volts or more, circuit from "C" terminal to ignition coil or ignition coil primary winding is open.
4. Checks for a shorted module or grounded circuit from the ignition coil to the module. The distributor module should be turned "OFF," so normal voltage should be about 12 volts.

   If the module is turned "ON," the voltage would be low, but above 1 volt. This could cause the ignition coil to fail from excessive heat.

   With an open ignition coil primary winding, a small amount of voltage will leak through the module from the "Batt" to the tach terminal.
5. Applying a voltage (1.5 to 8 volts) to module terminal "P" should turn the module ON" and the tach terminal voltage should drop to about 7-9 volts. This test will determine whether the module or coil is faulty or if the pick-up coil is not generating the proper signal to turn the module "ON". This test can be performed by using a DC battery with a rating of 1.5 to 8 volts. The use of the test light is mainly to allow the "P" terminal to be probed more easily. Some digital multi-meters can also be used to trigger the module by selecting ohms, usually the diode position. In this position the meter may have a voltage across it's terminals which can be used to trigger the module. The voltage in the ohm's position can be checked by using a second meter or by checking the manufacturer's specification of the tool being used.
6. This should turn "OFF" the module and cause a spark. If no spark occurs, the fault is most likely in the ignition coil, because most module problems would have been found before this point in the procedure. A module tester could determine which is at fault.

CHART C-4
IGNITION SYSTEM CHECK
(REMOTE COIL/SEALED MODULE CONNECTOR DISTRIBUTOR)
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

①
- Perform Diagnostic Circuit Check before proceeding with this test. (If a tachometer is connected to the Tach term., disconnect it before proceeding with the test).
- Check spark at plug with spark tester J-26792 or equivalent (ST-125) while cranking (if no spark on one wire, check a second wire) A few sparks and then nothing is considered no spark.

- **No Spark**
  - (1A) Disconnect 4 term. distributor connector and check for spark.
    - **No spark**
      - ② Check for spark at coil wire with tester while cranking. (Leave spark tester connected to coil wire for Steps 3-6).
        - **No Spark**
          - ③ Disconnect distributor 2 term. "C / + " connector. Ignition switch "on", Engine stopped. Check volts at " + " and "C" term's. of dist. harn. conn.
            - **Both term's. 10 volts or more**
              - ④ Reconnect dist. 2 term. conn. With ign. "ON", check voltage from tach. term. to gnd. (term. may be taped back in harness).
                - **Over10 volts**
                  - Connect test light from tach. term. to ground. Crank engine and observe light.
                    - **Light on steady**
                      - ⑤ Disconnect distributor 4 term. connector. Remove dist. cap. Disconnect pick-up coil connector from module. Connect voltmeter from tach. term. to ground. Ignition on. Insulate a test light probe to 1/4" from tip and note voltage, as test light is momentarily connected from a voltage source (1.5 to 8V) to module term. "P". (Fig. 1).
                        - **Voltage drops**
                          - ⑥ Check for spark from coil wire with spark tester as test light is removed from module term.
                            - **No Spark**
                              - If no module tester (J24642) is available; Replace ign. coil and repeat Step 5.
                                - **No Spark**
                                  - Ign. coil removed is OK, reinstall coil and check coil wire from dist. cap. if OK, replace dist. module.
                                - **Spark**
                                  - System OK
                              - If module tester (J24642) is available: test module
                                - **OK**
                                  - Check coil wire from cap to coil. If OK, replace coil.
                                - **Not OK**
                                  - Replace module
                            - **Spark**
                              - Is rotating pole piece still magnetized?
                                - **Yes**
                                  - Check pick-up coil or conns. (Coil resistance should be 500-1500 ohms and not grounded).
                                - **No**
                                  - Replace pole piece and shaft assy.
                        - **No drop in voltage**
                          - Check module ground. If OK, replace module.
                    - **Light blinks**
                      - Replace ignition coil and recheck for spark with spark tester. If still no spark, re-install original coil and replace dist. module..
                - **Under 1 volt**
                  - Repair open tach. lead or conn and repeat test #4.
                - **1 to 10 volts**
                  - Replace module and check for spark from coil as in Step 6.
                    - **Spark**
                      - System OK
                    - **No Spark**
                      - Replace ign. coil, it too is faulty
            - **Both term's. under 10 volts**
              - Repair wire from module " + " term. to "B" term. of black Ign. coil connector or primary ckt. to ign. sw.
            - **Under 10 volts "C" term. only**
              - Check for open or gnd. in ckt. from "C" term. to ign. coil. If Ckt. is OK, fault is. ign. coil or conn..
        - **Spark**
          - Inspect cap for water, cracks, etc. If OK, replace rotor.
    - **Spark**
      - Replace pick-up coil
- **Spark**
  - Check fuel, spark plugs, etc. See section "B" symptoms.

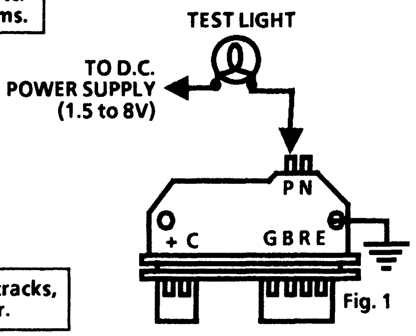

Fig. 1

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SECTION C5

ELECTRONIC SPARK CONTROL (ESC) SYSTEM

CONTENTS

GENERAL DESCRIPTION

PURPOSE

Varying octane levels in today's gasoline can cause detonation in high performance engines. Detonation is sometimes called spark knock.

To control spark knock, an Electronic Spark Control (ESC) system is used. This system is designed to retard spark timing up to 20°, if necessary, to reduce spark knock in the engine. This allows the engine to use maximum spark advance to improve driveability and fuel economy.

OPERATION

The ESC system has one major component:

- ESC knock sensor

The ESC knock sensor detects abnormal vibration (spark knocking) in the engine. The knock sensor is mounted in the engine block near the cylinders. The sensor produces an A/C output voltage which increases with the severity of the knock. This signal voltage inputs to the ECM. The ECM then adjusts the Electronic Spark Timing (EST) to reduce spark knocking.

DIAGNOSIS

The "Scan" tool will have two positions to check for diagnosing this circuit. Knock signal is used to monitor the input signal from the knock sensor. This position should display "yes" to indicate knock is being detected. Knock retard is the indication of how much the ECM is retarding the spark.

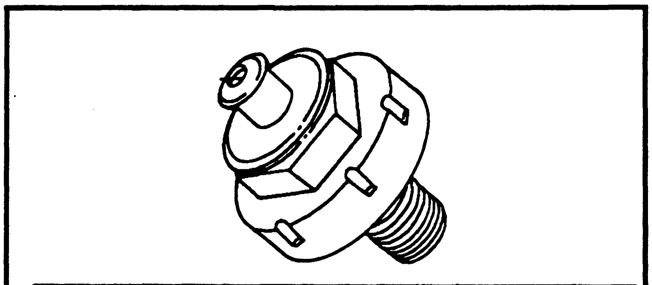
Code 43 is designed to diagnose the knock sensor and wiring, so problems encountered with this circuit should set the code. However, if no Code 43 was set but the ESC system is suspected because detonation was the customers complaint, refer to CHART C-5.

ON-VEHICLE SERVICE

ESC KNOCK SENSOR

Remove or Disconnect

1. Negative battery cable
2. Raise car
3. ESC sensor shield
4. ESC wiring harness connector from ESC sensor
5. ESC sensor from engine block


ESC KNOCK SENSOR

3S 0023-6E

Figure C5-1 - ESC Sensor

Install or Connect

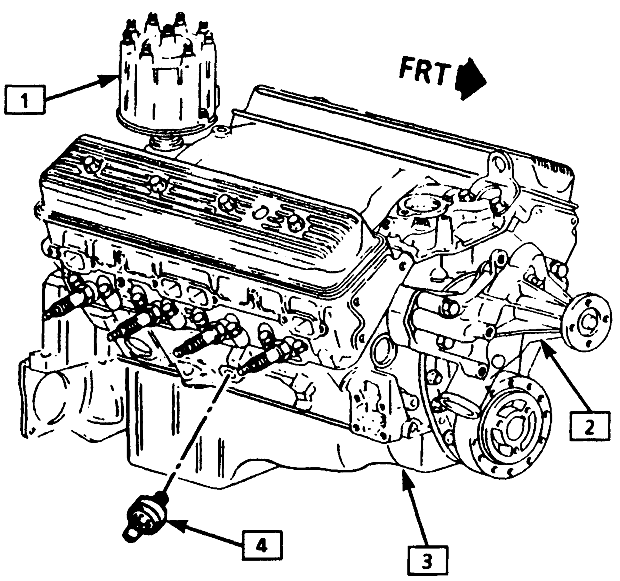
1. ESC sensor into engine block. Be sure threads are clean.

NOTICE: Do not apply thread sealant to sensor threads. Sensor is coated at factory and applying additional sealant will affect the sensors ability to detect detonation.

Tighten

- To 19 N·m (14 lb. ft.)

2. ESC sensor shield
3. ESC wiring harness connector to the ESC sensor
4. Lower car
5. Negative battery cable



1 DISTRIBUTOR
2 WATER PUMP
3 OIL PAN
4 ESC KNOCK SENSOR

9S 7213-6E

Figure C5-2 - Knock Sensor Location

MEM-CAL

Refer to "ECM and Sensors" Section "6E3-C1", for replacement procedure.

PARTS INFORMATION

PART NAME	GROUP
Sensor, ESC Knock	2.383

TORQUE SPECIFICATIONS

Sensor, ESC Knock	19 N·m (14 lb. ft.)

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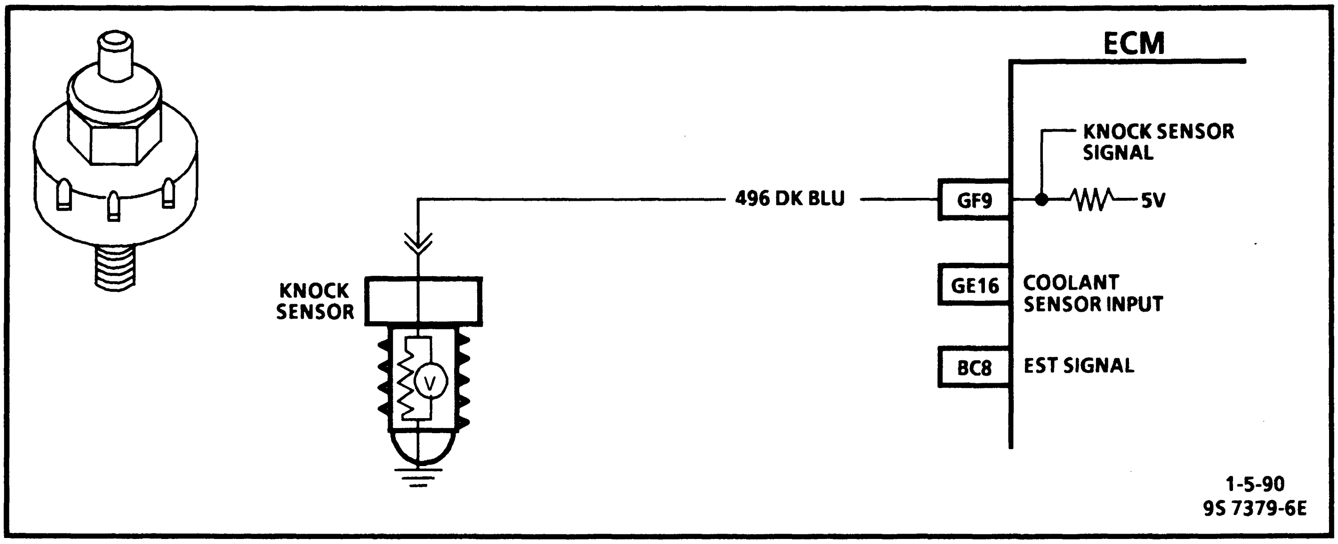


CHART C-5

ELECTRONIC SPARK CONTROL (ESC) 5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

The knock sensor is used to detect engine detonation and the ECM will retard the electronic spark timing based on the signal being received. The circuitry within the knock sensor causes the ECM's 5 volts to be pulled down so that under a no knock condition, CKT 496 would measure about 2.5 volts. The knock sensor produces an A/C signal which rides on the 2.5 volt DC voltage. The amplitude and frequency are dependent upon the knock level.

The MEM-CAL used with this engine, contains the functions which were part of remotely mounted ESC modules used on other GM vehicles. The ESC portion of the MEM-CAL then sends a signal to other parts of the ECM which adjusts the spark timing to retard the spark and reduce the detonation.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

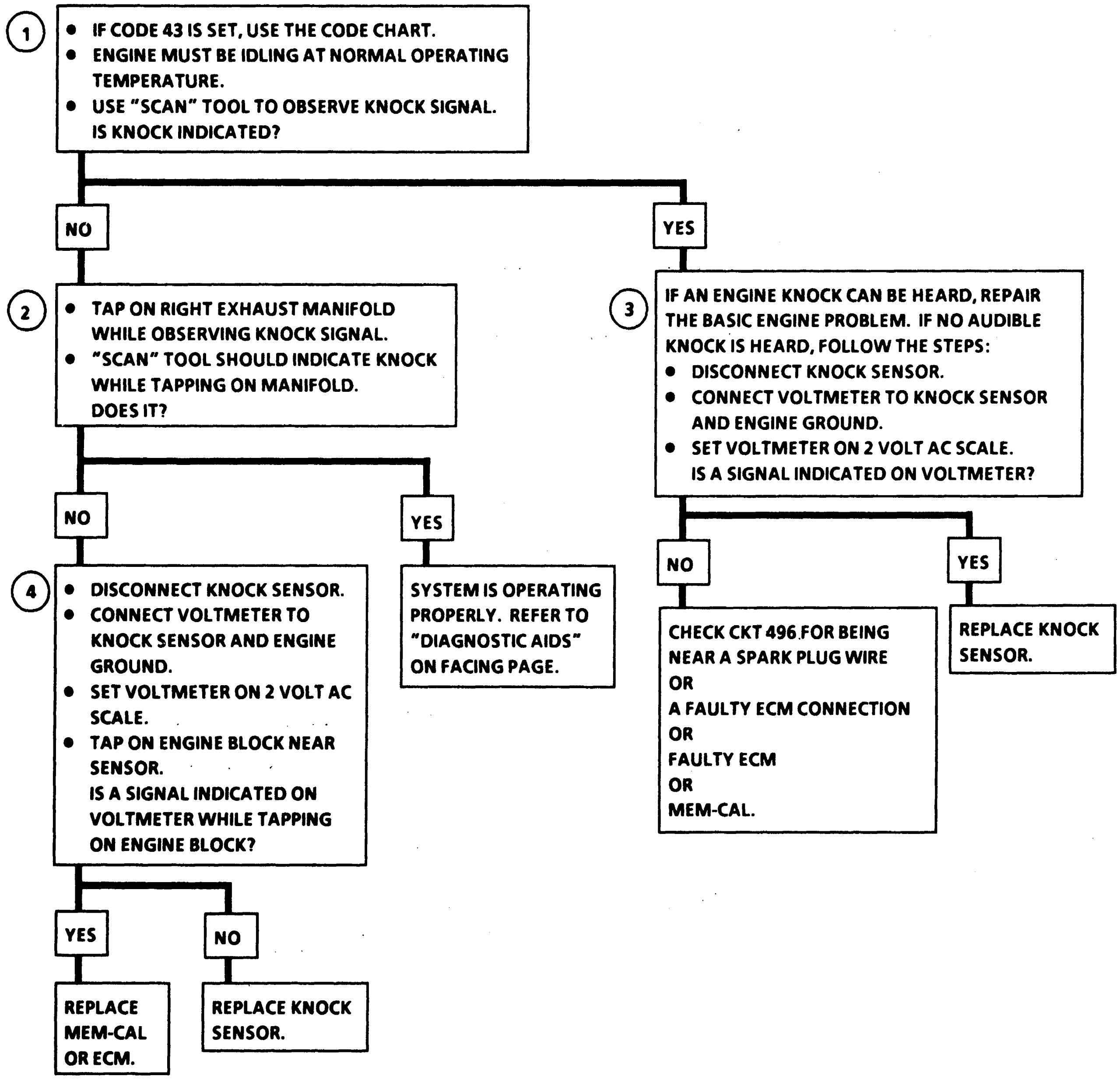
1. With engine idling, there should not be a knock signal present at the ECM because detonation is not likely under a no load condition.
2. Tapping on the engine should simulate a knock signal to determine if the sensor is capable of detecting detonation. If no knock is detected, try tapping on engine block closer to sensor before replacing sensor.
3. If the engine has an internal problem which is creating a knock, the knock sensor may be responding to the internal failure.
4. This test determines if the knock sensor is faulty or if the ESC portion of the MEM-CAL is faulty. If it is determined that the MEM-CAL is faulty, be sure that it is properly installed and latched into place. If not properly installed, repair and retest.

Diagnostic Aids:

While observing knock signal on the "Scan" tool, there should be an indication that knock is present when detonation can be heard. Detonation is most likely to occur under high engine load conditions.

CHART C-5

ELECTRONIC SPARK CONTROL (ESC) 5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



CLEAR CODES, DISCONNECT "SCAN" TOOL FROM ALDL, START ENGINE AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT

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SECTION C6

AIR INJECTION REACTION (A.I.R.) SYSTEM

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The A.I.R. system helps reduce Hydrocarbon (HC), Carbon Monoxide (CO), and Oxides of Nitrogen (NO_x) exhaust emissions. It also heats up the catalytic converter quickly on engine start-up so conversion of exhaust gases can occur sooner.

A dual bed converter is used. It consists of a three way catalyst (which controls all three emissions) in series with a two way catalyst (which controls only HC and CO) both are in one housing. A pipe between the two converters allows air to be injected into the second (two way) converter to increase its efficiency to further control HC and CO.

As shown in (Figure C6-1), air can be directed to:

- Atmosphere
- Exhaust ports;
  OR
- Catalytic converter

OPERATION

The system (Figure C6-1) includes:

- An A.I.R. Pump - The A.I.R. pump is driven by a belt on the front of the engine and supplies the air to the system. Intake air passes through a centrifugal filter fan at the front of the pump; where foreign materials are separated from the air by centrifugal force.
- A Control Valve (PEDES) - The A.I.R. control valve directs the flow of air from the A.I.R. pump to the atmosphere, exhaust ports or catalytic converter. Two electrical solenoids control the Pressure operated Electric Divert/Electric Switching (PEDES) valves, which are in the cohntrol valve. The ECM provides the ground to complete the circuit and energize the solenoids.
- Check Valves - The check valves prevent back flow of exhaust into the pump in the event of an exhaust backfire or pump drive belt failure.
- Necessary Plumbing

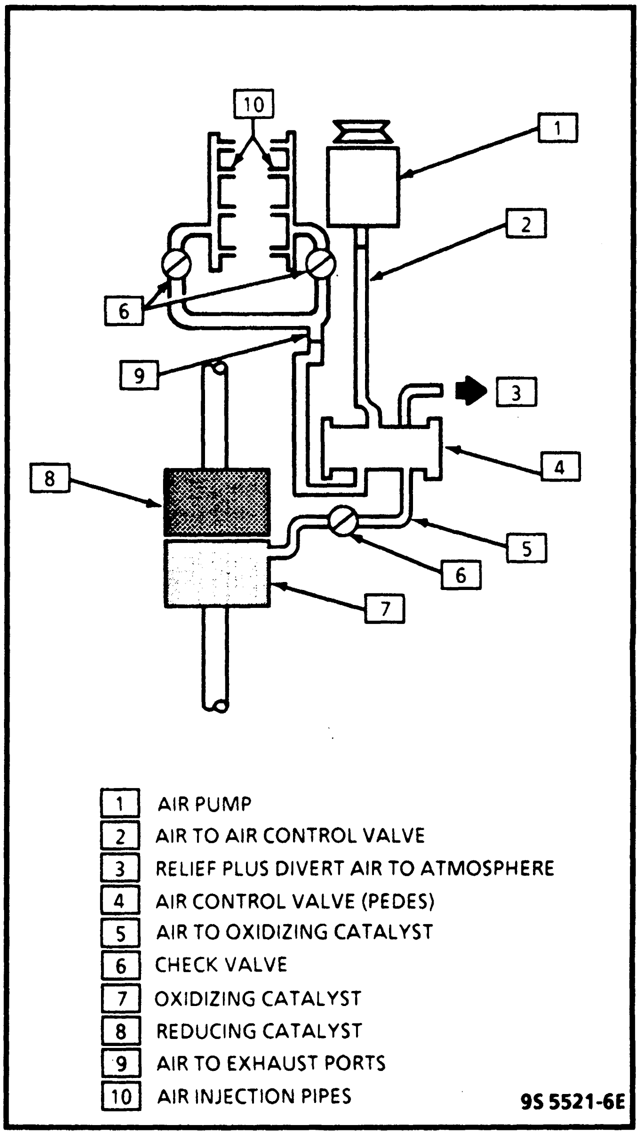

Figure C6-1 - A.I.R. System Operation

A.I.R. CONTROL VALVE (PEDES)

Air from the A.I.R. pump enters the body of the control valve and builds pressure against the port valve. The port solenoid controls the port valve which performs a switching operation by directing air flow

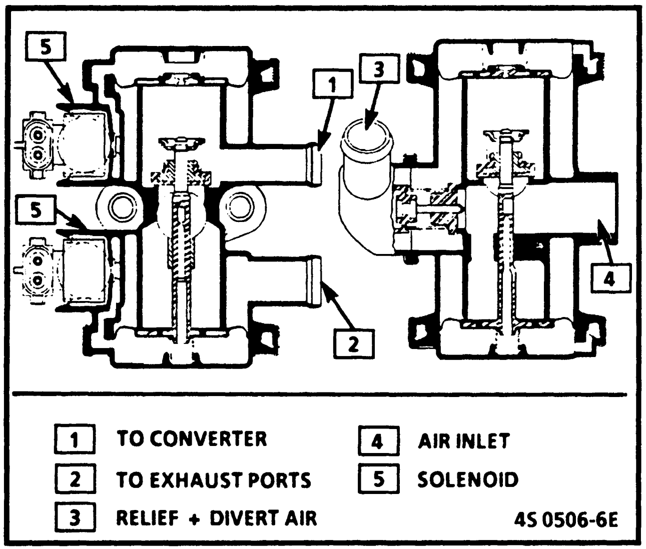

Figure C6-2 - A.I.R. Control Pedes Valve

from the A.I.R. pump to the exhaust ports (solenoid energized) or the converter valve (solenoid energized). The converter solenoid controls the converter valve which directs air to the catalytic coverter (solenoid energized) or diverts air to the atmosphere (solenoid de-energized).

Air enters the body of the valve from the pump. Air pressure builds against the control valve and for:

- Cold Mode - The port solenoid is energized which in turn opens the port valve and allows flow to the exhaust ports.
- Warm Mode - The port solenoid is de-energized and the converter solenoid energized which closes the port valve and keeps the converter valve seated, thus forcing flow past the converter valve and to the converter.
- Divert Mode - Both solenoids are de-energized which opens the converter valve, allowing air to take the path of least resistance, i.e., out the divert/relief tube to atmosphere.

Air is diverted to the atmosphere under the following conditions:

- Rich operation.
- When the ECM recognizes a problem and sets a trouble code.
- During deceleration.
- During high rpm operation when air pressure is greater than the setting for the internal relief valve.

RESULTS OF INCORRECT OPERATION

If no air (oxygen) flow enters the exhaust stream at the exhaust ports, HC and CO emission levels will be too high.

Air flowing to the exhaust ports at all times could increase temperature of the catalytic converter.

Air flowing at all times to the catalytic converter may cause converter overheating during rich operation.

Mechanical failures in the valves could cause the air to flow incorrectly to the exhaust ports or the converter.

DIAGNOSIS

The diagnosis of the A.I.R. system is covered in CHART C-6 at the end of this section.

OPERATIONAL CHECKS

A.I.R. Pump

The A.I.R. pump is a positive displacement vane type which is permanently lubricated and requires no periodic maintenance.

Accelerate engine to approximately 1500 rpm's and observe air flow from hose(s). If air flow increases as engine is accelerated, pump is operating satisfactorily. If air flow does not increase or is not present, proceed as follows:

Inspect

1. For proper drive belt tension.
2. For a leaky pressure relief valve. Air may be heard leaking with the A.I.R.pump running.

NOTICE: If the engine or underhood compartment is to be cleaned with steam or high-pressure detergent, the centrifugal filter fan should be masked off to prevent liquids from entering the pump.

Important

- The A.I.R. system is not completely noiseless. Under normal conditions, noise rises in pitch as engine speed increases. To determine if excessive noise is the fault of the air injection reactor system, operate the engine with the A.I.R.pump drive belt removed. If excessive noise does not exist with the belt removed proceed as follows:

Inspect

3. For a seized A.I.R. pump.
4. Hoses, tubes and all connections for leaks and proper routing.
5. For air flow from control valve.
6. A.I.R. injection pump for proper mounting and bolt torque.
7. If no irregularities exist and the A.I.R. pump noise is still excessive, remove and replace pump.

NOTICE: Do not oil the pump as damage may result.

Hoses and Pipes

Inspect

1. Hose or pipe for deterioration or holes.
2. All hoses or pipe connections, and clamp tightness.
3. Hose or pipe routing. Interference may cause wear.
4. If a leak is suspected on the pressure side of the system or if a hose or pipe has been disconnected on the pressure side, the connections should be checked for leaks with a soapy water solution. With the pump running, bubbles will form if a leak exists.

Check Valve

Inspect

1. A check valve should be inspected whenever the hose is disconnected from a check valve or whenever check valve failure is suspected. (A pump that had become inoperative and had shown indications of having exhaust gases in the pump would indicate check valve failure).
2. Blow through the check valve (toward the cylinder head) then attempt to suck back through the check valve. Flow should only be in one direction (toward the exhaust manifold). Replace valve which does not operate properly.

ON-VEHICLE SERVICE

A.I.R. PUMP

Remove or Disconnect

1. Hold pump pulley from turning by compressing drive belt, then loosen pump pulley bolts.
2. Drive belt and pulley.
3. Hoses, vacuum and electrical connections from A.I.R. control valve.
4. A.I.R. pump mounting bolts, and pump assembly (See Figure C6-3).

Install or Connect

1. A.I.R. pump assembly and tighten mounting bolts.
2. Spacer and pump pulley against centrifugal filter fan.
3. Pump pulley bolts

Tighten

- Pump pulley bolts (tighten equally) to 26 N·m (19 lb. ft.)

4. Check system for proper operation, refer to "Air Management Check - Control Pedes Valve," CHART C-6.

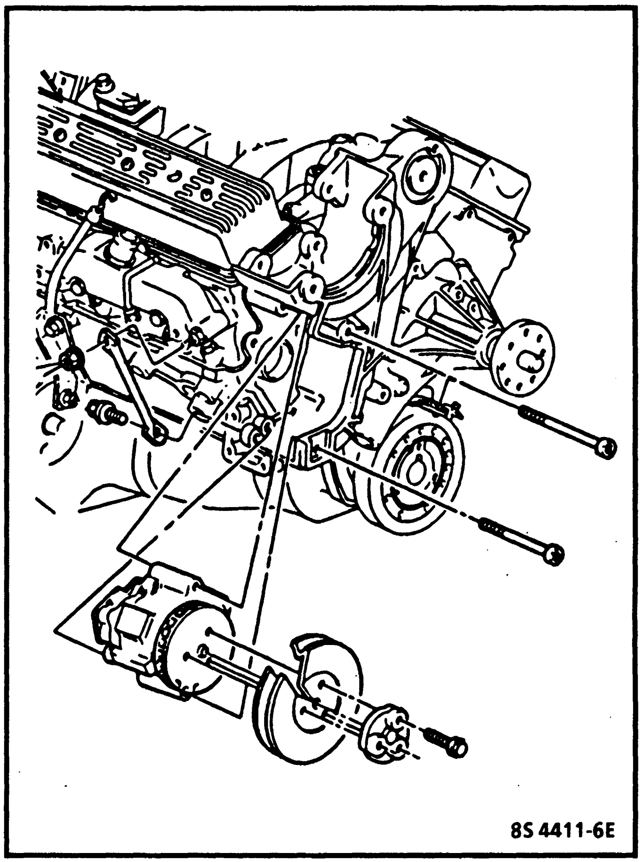
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Figure C6-3 - A.I.R Pump Service

A.I.R. CONTROL (PEDES) VALVE

Remove or Disconnect

1. Battery ground cable
2. Adapter bolts (see Figure C6-4)
3. Air outlet hoses from control valve
4. Splash guard/cover
5. Electrical connectors and vacuum hoses from valve.
6. Control valve

Install or Connect

1. Control valve
2. Electrical connectors
3. Splash guard/cover
4. Air hoses to valve
5. Adapter bolts
6. Battery ground cable
7. Check system operation, refer to "Air Management Check - Control Pedes Valve," CHART C-6.

A.I.R. CHECK VALVE

Remove or Disconnect

1. Release clamp and disconnect air hoses from check valve.
2. Unscrew check valve from air injection pipe.

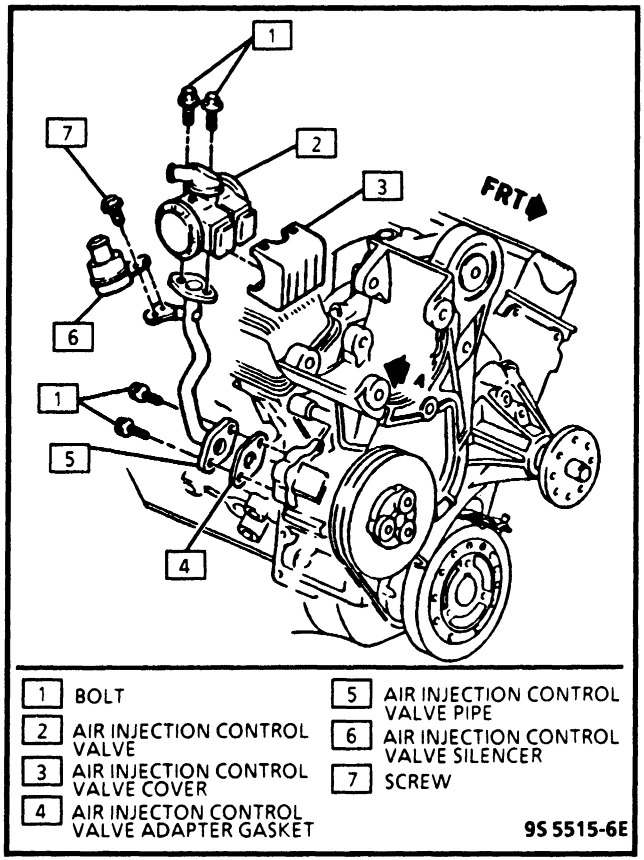

Figure C6-4 - PEDES Valve Service

Install or Connect

1. Screw check valve onto air injection pipe.

Tighten

- Check valve to 23 N·m (17 lb. ft.)

2. Position air hoses on check valve and secure with clamp.

PARTS INFORMATION

PART NAME	GROUP
Elbow, INV FLO Tube (45 deg) (5/16)	8.963
Bolt, Air Inj PumpPul	3.655
Pully, Air Inj Pump	3.650
Spacer, Air Inj Pump Pul	3.650
Bracket, Air Inj Pump	3.655
STUD, Inj PumpBRKT	3.655
Brace, Air Inj Pump	3.655
Gasket, Air Inj Cont VLV Pipe	3.665
Pump, Air Inj	3.660
Fan, Air Inj Pump Fltr	3.675
Pipe, Air Inj Cont VLV	3.650
Pipe, Air Inj Eng CHK VLV	3.675
Clamp, Worm Gr (11/16 to 15/16)	8.948
Hose, (5/8) Cut as required	8.962
Valve, Air Inj ENG CHK	3.670
Hose, Air Inj ENG CHK VLV	N.S
Connector, Air Inj ENG CHK VLV	3.675
Clamp, CTLTC CONV Air Inj Pipe (exh apr)	3.680
Clamp, CTLTC CONV Air Inj Pipe (at conn)	3.680
Hose, (7.9 mm x 3050 mm)	8.962
Clamp, Worm Gr (1/2 to 13/16) SSt	8.948
Tubing, (5/16 O.D.)	8.964
Hose, CTLTC Conv AIR INJ CHK VLV	3.675
Cover, Air INJ CONT VLV	3.670
Valve,Air INJ CONT VLV	3.670
Hose, Air INJ ENG CHK VLV (Tee to Air Cont VLV)	3.675
Hose, Air INJ ENG CHK VLV - RH	3.675
Hose, Air INJ ENG CHK VLV (Tee to Pipe)	3.675
Clamp, Worm Gr (15.7 to 31.8) SST	8.948
Clamp, (.31 to .75) 2N CHR (1.166)	8.948
Pipe, CTLTC CONV AIR INJ (VLV to CONV)	3.675
Clamp, CTLTC CONV AIR INJ Pipe (Exh Lwr)	3.680
Hose, Air INJ CONT VLV Sil	3.675
Silencer, Air INJ CONT VLV	3.672

TORQUE SPECIFICATIONS

Check Valve	23 N·m (17 lb. ft.)
Pump Pully Bolts	26 N·m (19 lb. ft.)
Bracket to Air INJ Pum Asm Bolt/Screw	49 N·m (36 lb. ft.)
Bracket to Cyl Head (ENG) Bolt/Screw	33 N·m (24 lb. ft.)

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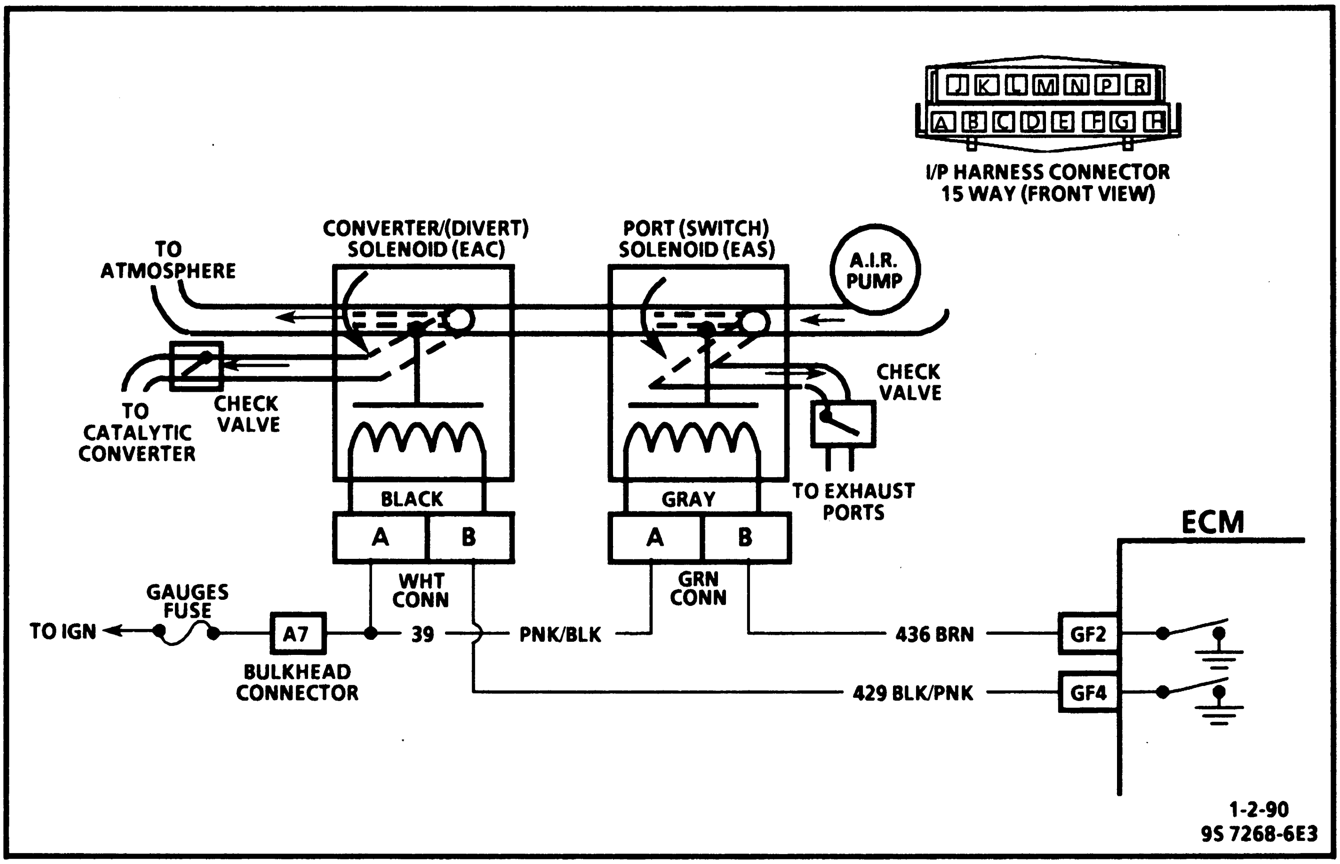


CHART C-6

AIR MANAGEMENT CHECK - CONTROL PEDES VALVE
(PRESSURE OPERATED ELECTRIC DIVERT/ELECTRIC SWITCHING)
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

Air management is controlled by a pressure operated port valve and a converter valve, each with an ECM controlled solenoid. When the solenoid is grounded by the ECM, A.I.R. pump pressure will activate the valve and allow pump air to be directed as follows:

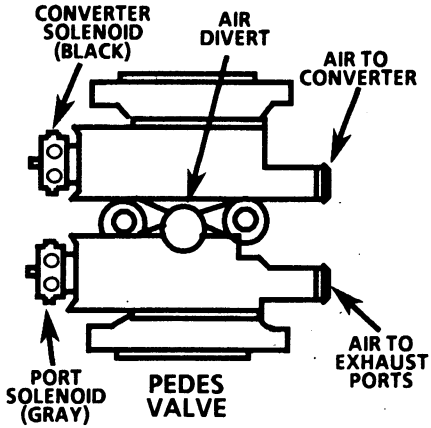
- Cold Mode - The port (switch) solenoid is energized which in turn opens the port valve and allows flow to the exhaust ports.
- Warm Mode - The port (switch) solenoid is de-energized and the converter (divert) solenoid energized which closes the port valve and keeps the converter valve seated, thus forcing flow past the converter valve and to the catalytic converter.
- Divert Mode - Both solenoids are de-energized, which opens the converter valve, allowing air to take the path of least resistance, i.e., out the divert/relief tube to atmosphere.

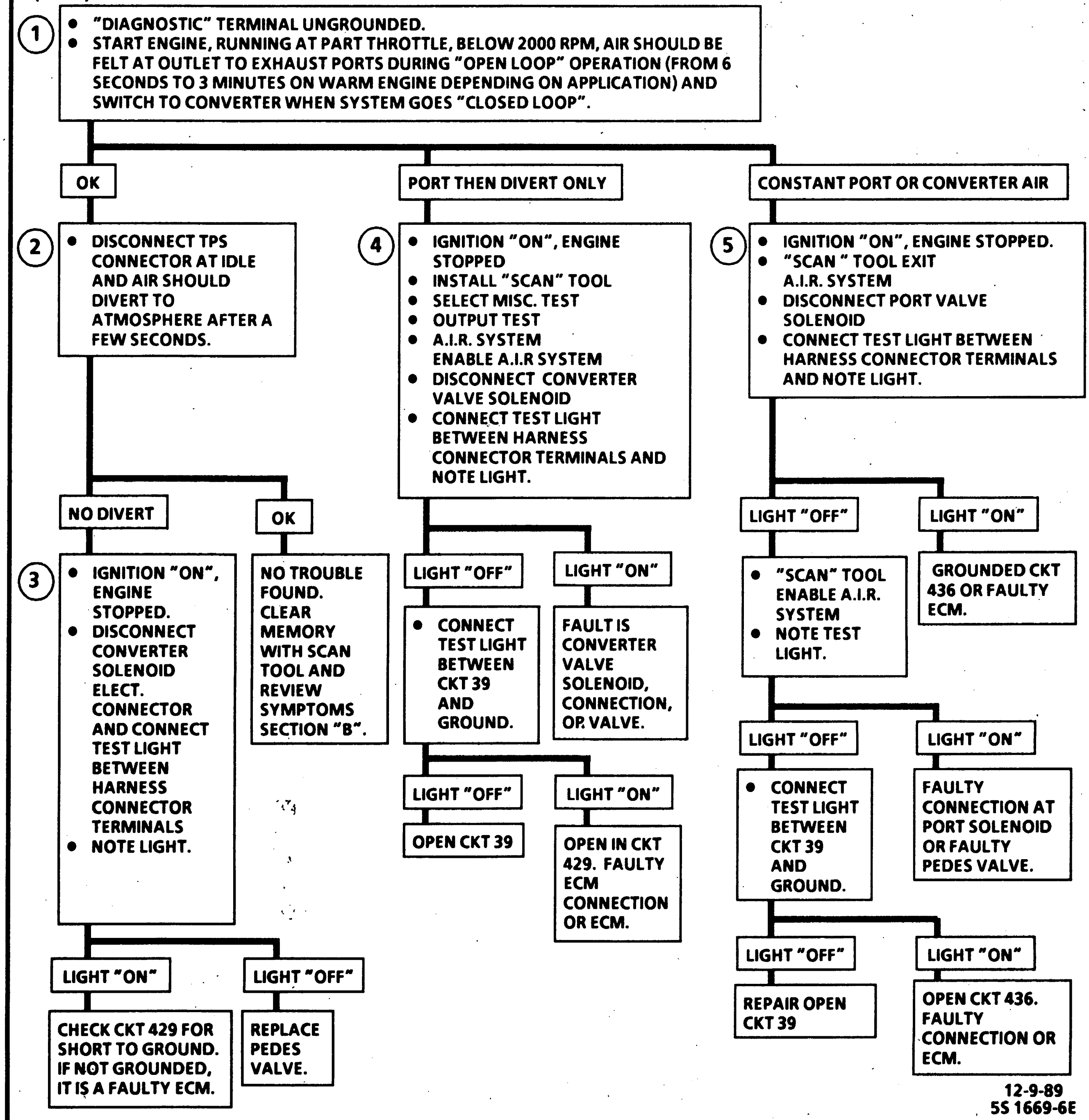
Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. This is a system functional check. Air is directed to ports during "Open Loop" and all engines start in "Open Loop" even on a warm engine. Since the air to the ports may be very short, prepare to observe port air prior to engine start up. This can be done by squeezing a hose.
2. This should normally set a Code 22. When any code is set, the ECM opens the ground to the converter solenoid and allows air to divert. This checks for ECM response to a fault. A ground in the control valve circuit to the ECM would prevent divert action.
3. This checks for a grounded circuit to the ECM. Test light "OFF" is normal and would indicate the circuit is not grounded.
4. Checks for an open in the solenoid control circuits. Grounding the diagnostic "test" terminal should ground both solenoid circuits. Normally, the test light should be "ON," which indicates the problem is not in the ECM or wiring but at the solenoid connections or the control valve itself.
5. Checks for a grounded port (switch) solenoid circuit. Test light "OFF" would indicate the circuit is normal and fault is in the control valve.

CHART C-6

AIR MANAGEMENT CHECK-CONTROL PEDES VALVE
(PRESSURE OPERATED ELECTRIC DIVERT/ ELECTRIC SWITCHING)
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)





①
- "DIAGNOSTIC" TERMINAL UNGROUNDED.
- START ENGINE, RUNNING AT PART THROTTLE, BELOW 2000 RPM, AIR SHOULD BE FELT AT OUTLET TO EXHAUST PORTS DURING "OPEN LOOP" OPERATION (FROM 6 SECONDS TO 3 MINUTES ON WARM ENGINE DEPENDING ON APPLICATION) AND SWITCH TO CONVERTER WHEN SYSTEM GOES "CLOSED LOOP".

OK

②
- DISCONNECT TPS CONNECTOR AT IDLE AND AIR SHOULD DIVERT TO ATMOSPHERE AFTER A FEW SECONDS.

NO DIVERT

③
- IGNITION "ON", ENGINE STOPPED.
- DISCONNECT CONVERTER SOLENOID ELECT. CONNECTOR AND CONNECT TEST LIGHT BETWEEN HARNESS CONNECTOR TERMINALS
- NOTE LIGHT.

LIGHT "ON"

CHECK CKT 429 FOR SHORT TO GROUND. IF NOT GROUNDED, IT IS A FAULTY ECM.

LIGHT "OFF"

REPLACE PEDES VALVE.

OK

NO TROUBLE FOUND. CLEAR MEMORY WITH SCAN TOOL AND REVIEW SYMPTOMS SECTION "B".

PORT THEN DIVERT ONLY

④
- IGNITION "ON", ENGINE STOPPED
- INSTALL "SCAN" TOOL
- SELECT MISC. TEST
- OUTPUT TEST
- A.I.R. SYSTEM ENABLE A.I.R SYSTEM
- DISCONNECT CONVERTER VALVE SOLENOID
- CONNECT TEST LIGHT BETWEEN HARNESS CONNECTOR TERMINALS AND NOTE LIGHT.

LIGHT "OFF"

- CONNECT TEST LIGHT BETWEEN CKT 39 AND GROUND.

LIGHT "OFF"

OPEN CKT 39

LIGHT "ON"

OPEN IN CKT 429. FAULTY ECM CONNECTION OR ECM.

LIGHT "ON"

FAULT IS CONVERTER VALVE SOLENOID, CONNECTION, OR VALVE.

CONSTANT PORT OR CONVERTER AIR

⑤
- IGNITION "ON", ENGINE STOPPED.
- "SCAN " TOOL EXIT A.I.R. SYSTEM
- DISCONNECT PORT VALVE SOLENOID
- CONNECT TEST LIGHT BETWEEN HARNESS CONNECTOR TERMINALS AND NOTE LIGHT.

LIGHT "OFF"

- "SCAN" TOOL ENABLE A.I.R. SYSTEM
- NOTE TEST LIGHT.

LIGHT "OFF"

- CONNECT TEST LIGHT BETWEEN CKT 39 AND GROUND.

LIGHT "OFF"

REPAIR OPEN CKT 39

LIGHT "ON"

OPEN CKT 436. FAULTY CONNECTION OR ECM.

LIGHT "ON"

FAULTY CONNECTION AT PORT SOLENOID OR FAULTY PEDES VALVE.

LIGHT "ON"

GROUNDED CKT 436 OR FAULTY ECM.

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SECTION C7

EXHAUST GAS RECIRCULATION (EGR) SYSTEM

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The Exhaust Gas Recirculation (EGR) system is used to lower NO_x (Oxides of Nitrogen) emission levels caused by high combustion temperature. It does this by decreasing combustion temperature.

The main element of the system is the EGR valve operated by vacuum and mounted on the intake manifold.

The EGR valve allows small amounts of exhaust gas back into the combustion chamber as shown in Figure C7-1.

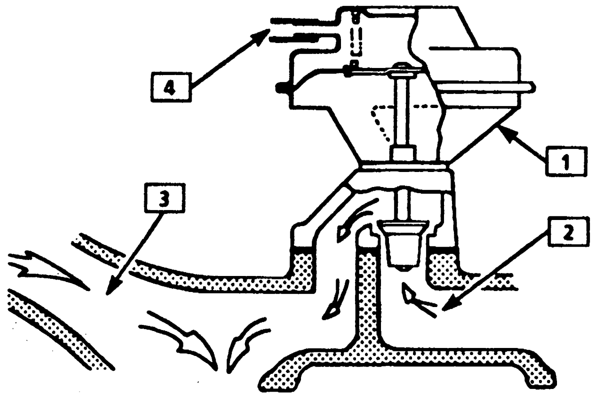
OPERATION

The EGR valve is opened by ported manifold vacuum to let exhaust gas flow into the intake manifold. The exhaust gas then moves with the air/fuel mixture into the combustion chamber. If too much exhaust gas enters, combustion will not occur. For this reason, very little exhaust gas is allowed to pass through the EGR valve, especially at idle. The EGR valve is usually open during warm engine operation and when the vehicle is above idle speed.

The amount of exhaust gas recirculated is controlled by variations in vacuum and the EGR vacuum control solenoid.

EGR CONTROL

The EGR vacuum control has a vacuum solenoid that uses "Pulse Width Modulation" (PWM). This means the ECM turns the solenoid "ON" and "OFF" many times a second and varies the amount of "ON" time ("pulse width") to vary the amount of ported manifold vacuum applied to the EGR valve.



1 EGR VALVE
2 EXHAUST GAS
3 INTAKE AIR
4 EGR VACUUM PORT
4S 0001-6E

Figure C7-1 - Exhaust Gas Recirculation

Grounding the ALDL diagnostic "test" terminal, with the ignition "ON" and the engine not running, will energize the solenoid.

NEGATIVE BACKPRESSURE EGR VALVE

The EGR valve on this engine is called a negative backpressure valve. It varies the amount of exhaust gas flow into the manifold depending on manifold vacuum and variations in exhaust backpressure.

The diaphragm on this EGR valve (shown in Figure C7-2) has an internal vacuum bleed hole which is held closed by a small spring when there is no exhaust backpressure. The amount of vacuum to the valve is controlled by the ECM controlling a solenoid.

Engine vacuum opens the EGR valve against the pressure of a large spring. When manifold vacuum combines with negative exhaust backpressure, the vacuum bleed hole opens and the EGR valve closes.

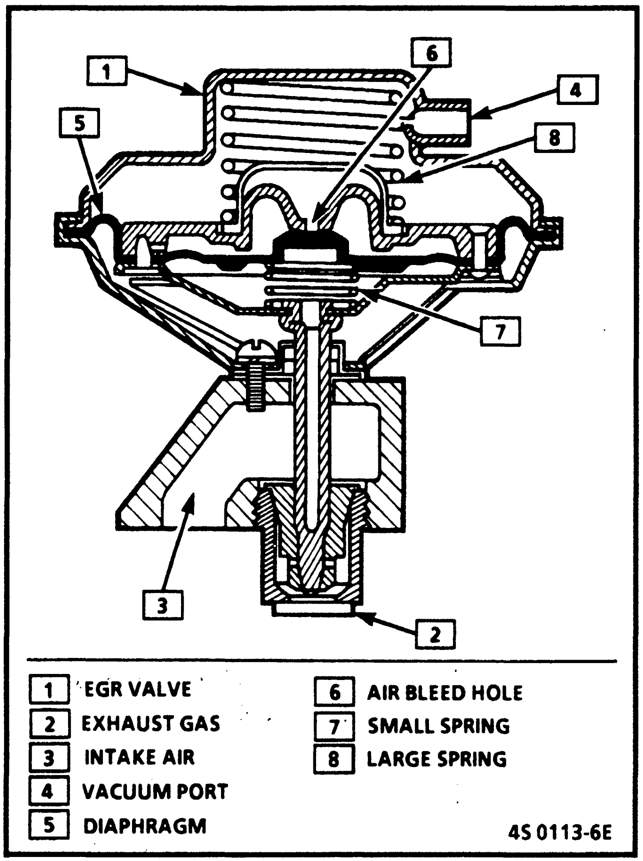


Figure C7-2 - Negative Backpressure EGR Valve

EGR VALVE IDENTIFICATION

- Negative backpressure EGR valves will have an "N" stamped on the top side of the valve after the part number (Figure C7-3).
- Positive backpressure EGR valves will have a "P" stamped on the top side of the valve, after the part number.
- Port EGR valves have no identification stamped after the part number.

When replacing an EGR valve, always check for correct part number in the parts catalog or supplemental bulletin.

RESULTS OF INCORRECT OPERATION

Too much EGR flow dilutes the fresh intake air/fuel mixture, causing the engine to run roughly or stall. With too much EGR flow at idle, cruise, or cold operation, any of the following conditions may happen:

- Engine stops after cold start
- Engine stops at idle after deceleration
- Car surges during cruise
- Rough idle

If the EGR valve should stay open all of the time, the engine may not idle.

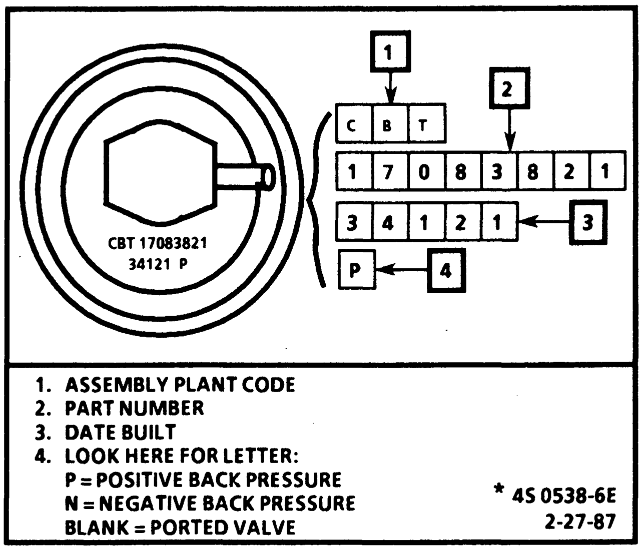


Figure C7-3 - EGR Valve Identification

Too little or no EGR flow allows combustion temperatures to get too high during acceleration and load conditions. This could cause:

- Spark knock (detonation)
- Engine overheating
- Emission test failure

DIAGNOSIS

Diagnosis of the EGR system is covered in CHART C-7 at the end of this section, if Code 32 was not set.

ON-VEHICLE SERVICE

EGR VALVE

Remove or Disconnect

1. Plenum (See "Plenum R&R," Section "C-2")
2. Vacuum line
3. Retaining bolts
4. EGR valve

NOTICE: Do not wash EGR valve in solvents or degreaser. Permanent damage to valve diaphragm may result. Also, sand blasting of the valve is not recommended since this can affect the operation of the valve.

EGR Manifold Passage

Inspect

- If EGR passages in the inlet manifold indicate excessive build-up of deposits, the passages should be cleaned. Care should be taken to ensure that all loose particles are completely removed to prevent them from clogging the EGR valve or from being ingested into the engine.

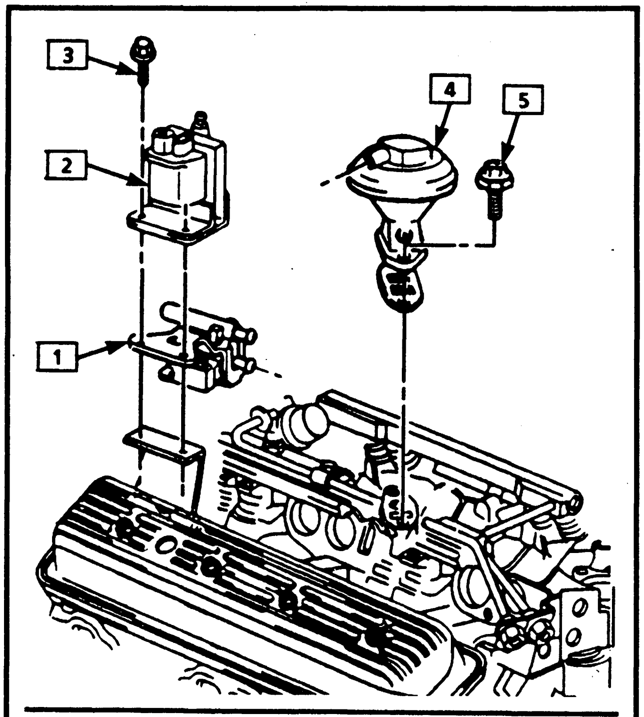


Figure C7-4 - EGR and Solenoid Service

Clean

1. With a wire wheel, buff the exhaust deposits from the mounting surface and around the valve.
2. Look for exhaust deposits in the valve outlet. Remove deposit build-up with a screwdriver.
3. Clean mounting surfaces of intake manifold and valve assembly.

Install or Connect

1. Reinstall valve or replacement EGR valve on intake manifold using new gasket.

Tighten

- Bolts to 22 N·m (16 lb. ft.)

2. Vacuum line to valve
3. Plenum

EGR CONTROL SOLENOID

Remove or Disconnect

1. Negative battery cable
2. Electrical connector at solenoid
3. Vacuum hoses
4. Nut and solenoid

Install or Connect

1. Solenoid and bracket

Tighten

- Nut to 24 N·m (17 lb. ft.).

2. Vacuum hoses
3. Electrical connector
4. Negative battery cable

PARTS INFORMATION

PARTS NAME	GROUP
Control, EGR Vacuum	3.670
Gasket, EGR Valve	3.680
Valve, EGR	3.670
Gasket, EGR Valve	3.680
Harness, EGR Valve	3.675
Solenoid, EGR Cont LVL RLY	3.670

TORQUE SPECIFICATIONS

EGR Valve Bolt to Intake Manifold	22 N·m (16 lb. ft.)
Solenoid and Bracket, Nut to	24 N·m (17 lb. ft.)

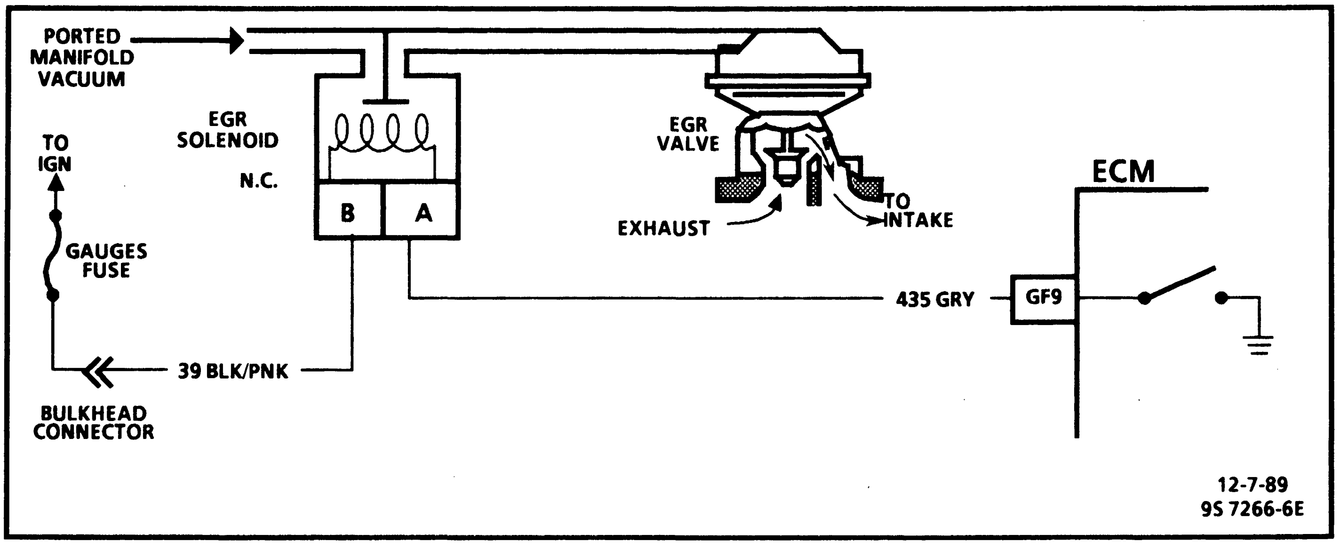


CHART C-7

EXHAUST GAS RECIRCULATION (EGR) CHECK
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

The Exhaust Gas Recirculation (EGR) valve is controlled by, a normally open, Pulse Width Modulated (PWM) solenoid. The ECM turns the solenoid "OFF" to allow vacuum to pass to the EGR and turns the solenoid "ON" to prohibit EGR operation. When EGR is commanded, the solenoid is turned "ON" and "OFF" many times a second (duty cycle).

The duty cycle is calculated by the ECM based on information from the CTS, MAT, TPS and MAP sensors. Also, engine rpm's and the P/N switch input affect EGR. There should be no EGR when in park or neutral, TPS below a calibrated value or TPS indicating WOT.

With the ignition "ON" and engine "OFF," the EGR solenoid is de-energized. The solenoid, however, should be energized if the diagnostic "test" terminal is grounded with the ignition "ON" and engine "OFF."

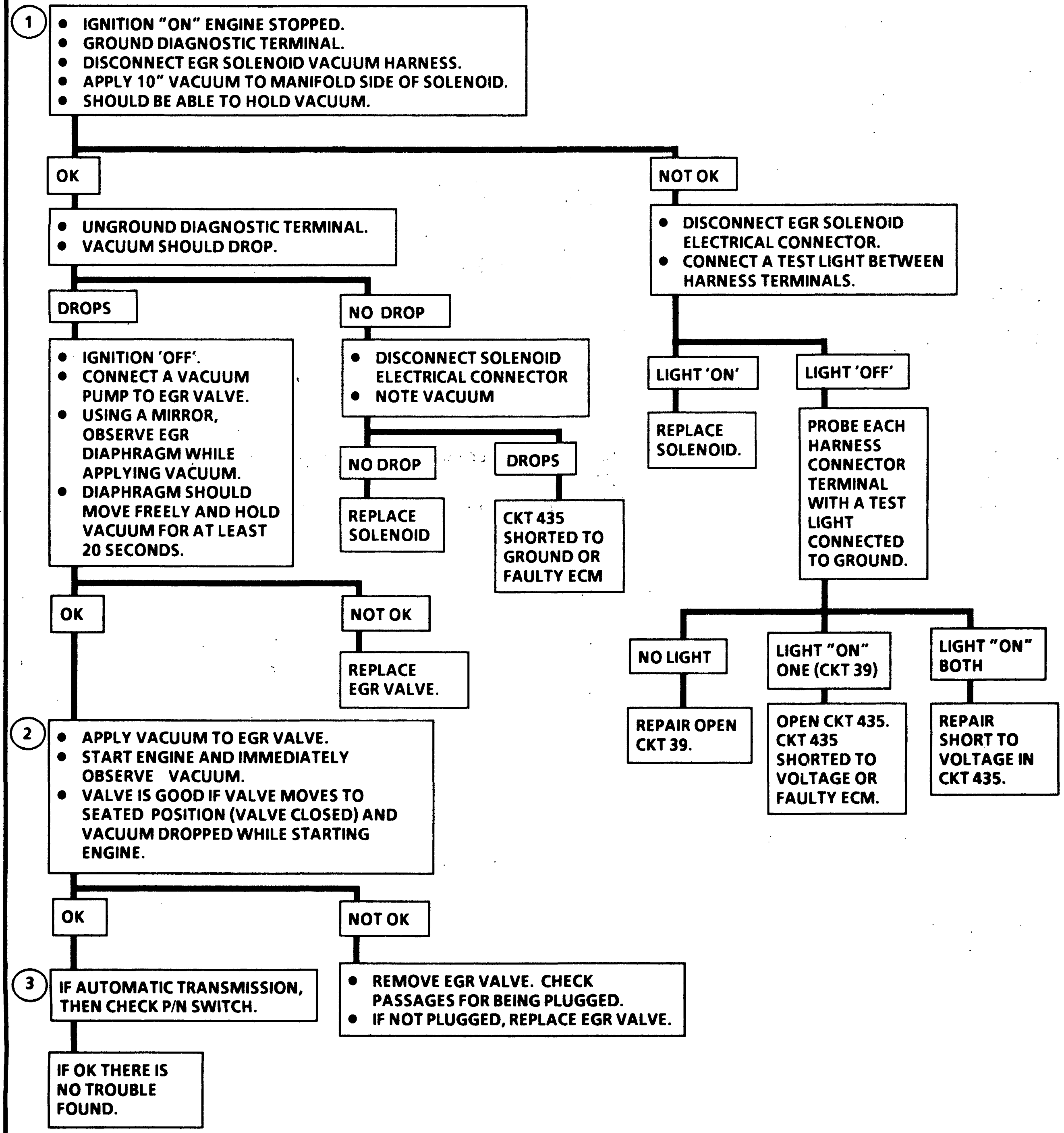
Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. This will test the solenoid value to determine if it is capable of closing off the manifold vacuum from the EGR valve. The vacuum may bleed off slowly but this should not be considered a fault.
2. As soon as back pressure is available at the EGR valve, the bleed portion in the valve should open and cause the valve to go to its heated position.
3. The EGR will be inoperative if the P/N switch is misadjusted or faulty. Use "Scan" tool and check P/N switch. Refer to CHART C-1.

CHART C-7

EXHAUST GAS RECIRCULATION (EGR) CHECK
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

BEFORE USING THIS CHART, CHECK FOR PORTED VACUUM TO EGR SOLENOID, ALSO CHECK HOSES FOR LEAKS OR RESTRICTIONS. SHOULD BE AT LEAST 7" HG VACUUM AT 2000 RPM. THIS CHART ASSUMES THERE IS NO CODE 32.



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CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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SECTION C8

TORQUE CONVERTER CLUTCH (TCC) SYSTEM AND MANUAL TRANSMISSION SHIFT LIGHT

CONTENTS

GENERAL DESCRIPTION

PURPOSE

The Torque Converter Clutch (TCC) system uses a solenoid operated valve in the automatic transmission to couple the engine flywheel to the output shaft of the transmission through the torque converter. This reduces the slippage losses in the converter, which increases fuel economy. The upshift light is used to provide a display which indicates the optimum fuel economy point for up-shifting the manual transmission based on engine speed and load.

OPERATION

For the Torque Converter Clutch (TCC) to apply, two conditions must be met:

- Internal transmission fluid pressure must be correct. For information on internal transmission operation, refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SECTION 7A). This section will cover only the electrical operation of the TCC system.
- The ECM grounds a switch internally to turn "ON" a TCC solenoid in the transmission. This moves a check ball, which will allow the torque converter clutch to apply, if the hydraulic pressure is correct, as described above.

The ECM controls the TCC apply solenoid by looking at several sensors:

- Vehicle Speed Sensor (VSS) - Speed must be above a certain value before the clutch can apply.
- Coolant Temperature Sensor (CTS) - Engine must be warmed up before the Torque Converter Clutch (TCC) can apply about 65°C (149°F).
- Throttle Position Sensor (TPS) - After the torque converter clutch applies, the ECM uses the information from the TPS to release the clutch when the car is accelerating or decelerating at a certain rate.
- The brake switch is also part of the TCC circuit as it will remove battery voltage to the TCC solenoid when the brake pedal is depressed.
- Gear Select Switch - The 4th gear switch is used to send a signal to the ECM when the transmission is in 4th gear. The ECM uses this information to vary the conditions under which the clutch applies or releases in fourth gear only. However, the transmission does not have to be in fourth gear in order for the ECM to turn the torque converter clutch "ON".

If the Torque Converter Clutch (TCC) is applied at all times, the engine will stall immediately, just as in a manual transmission with the clutch applied.

If the torque converter clutch does not apply, fuel economy may be lower than expected. If the vehicle speed sensor fails, the TCC will not apply. If the 4th gear switch does not operate, the TCC may not apply at the right time.

The upshift display is a lamp on the instrument panel. The ECM provides a path to ground by activating the driver and turns the lamp "ON."

RESULTS OF INCORRECT OPERATION

If the torque converter clutch is applied at all times, the engine will stall immediately, just as in a manual transmission with the clutch applied.

If the torque converter clutch does not apply, fuel economy may be lower than expected. If the Vehicle Speed Sensor (VSS) fails, the torque converter clutch will not apply.

The transmission Torque Converter Clutch (TCC) system has different operating characteristics than an automatic transmission without TCC. If the driver complains of a "chuggle" or "surge" condition, the car should be road tested and compared to a similar car to see if a real problem exists. Another TCC complaint may be a downshift felt when going up a grade, especially with cruise control.

This may be clutch disengagement rather than a downshift, due to thechange in TPS to maintain cruising speed. The "Owner's Manual" section on "Transmission Shift Light Diagnosis" should be reviewed with the driver.

DIAGNOSIS

The diagnosis of the TCC system is covered in CHART C-8A. If the ECM detects a problem in the VSS system, a Code 24 should set. In this case, see Code 24 CHART.

The upshift light circuit can be checked using CHART C-8C.

ON-VEHICLE SERVICE

- Refer to LIGHTING SYSTEMS AND HORNS (SECTION 8B), if the upshift light bulb needs replacement.
- Refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SECTION 7A).
- Refer to ELECTRICAL DIAGNOSIS (SECTION 8A) and "VSS Service Procedures," Figure "C8-1."

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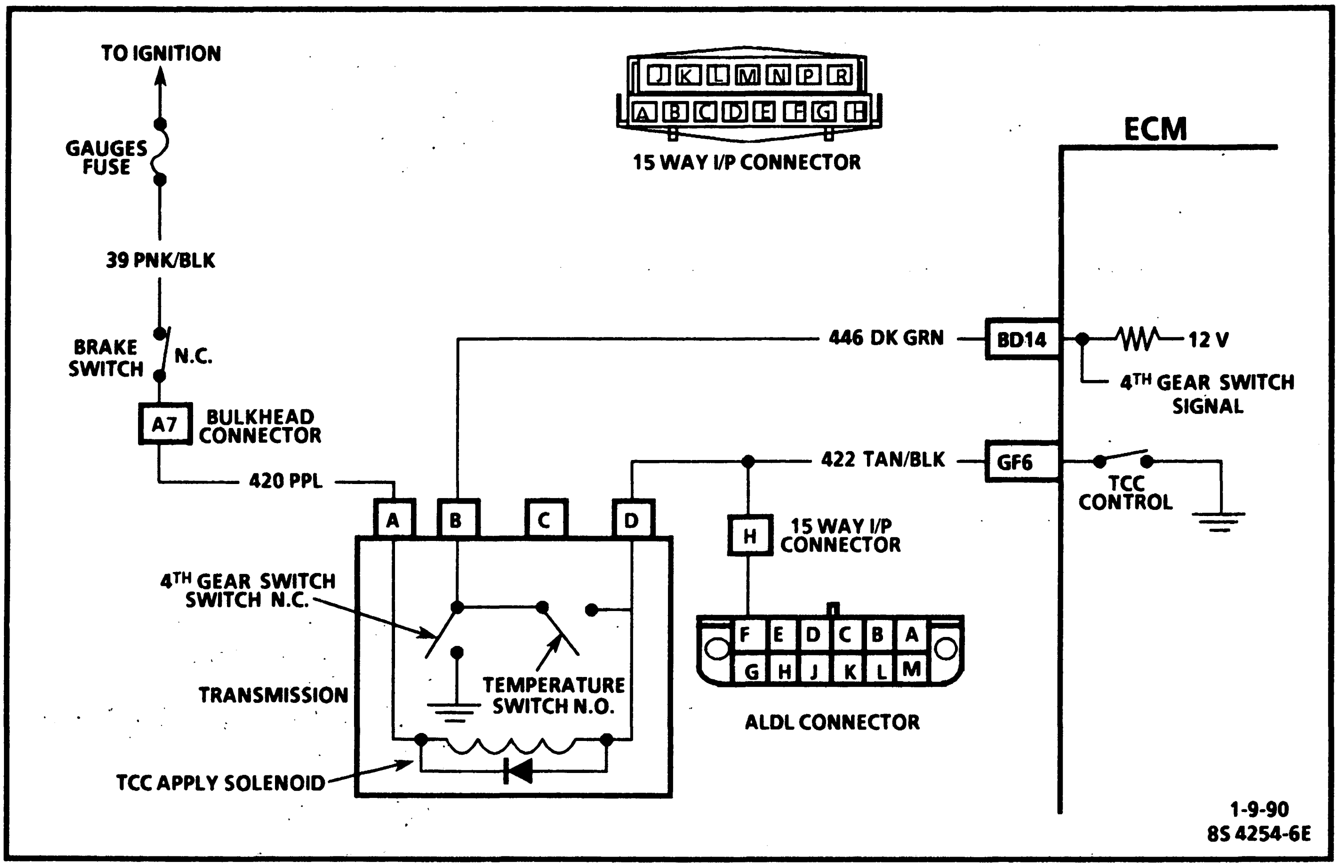


CHART C-8

(Page 1 of 3)

TORQUE CONVERTER CLUTCH (TCC) SYSTEM 5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

The purpose of the automatic transmission Torque Converter Clutch (TCC) feature is to eliminate the power loss of the torque converter stage when the vehicle is in a cruise condition. This allows the convenience of the automatic transmission and the fuel economy of a manual transmission. The heart of the system is a solenoid, located inside the automatic transmission, which is controlled by the ECM.

When the solenoid coil is activated ("ON"), the Torque Converter Clutch (TCC) is applied which results in 100% mechanical coupling from the engine to transmission. When the transmission solenoid is deactivated, the Torque Converter Clutch (TCC) is released, which allows the torque converter to operate in the conventional manner (fluid coupling between engine and transmission).

The ECM turns "ON" the TCC when coolant temperature is above 65°C (149°F), TPS not changing, and vehicle speed above a specified value.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. When a test light is connected from ALDL terminal "F" to ground, a test light "ON" indicates battery voltage is OK and the TCC solenoid is disengaged.
2. When the diagnostic terminal is grounded, the ECM should energize the TCC solenoid and the test light should go out.

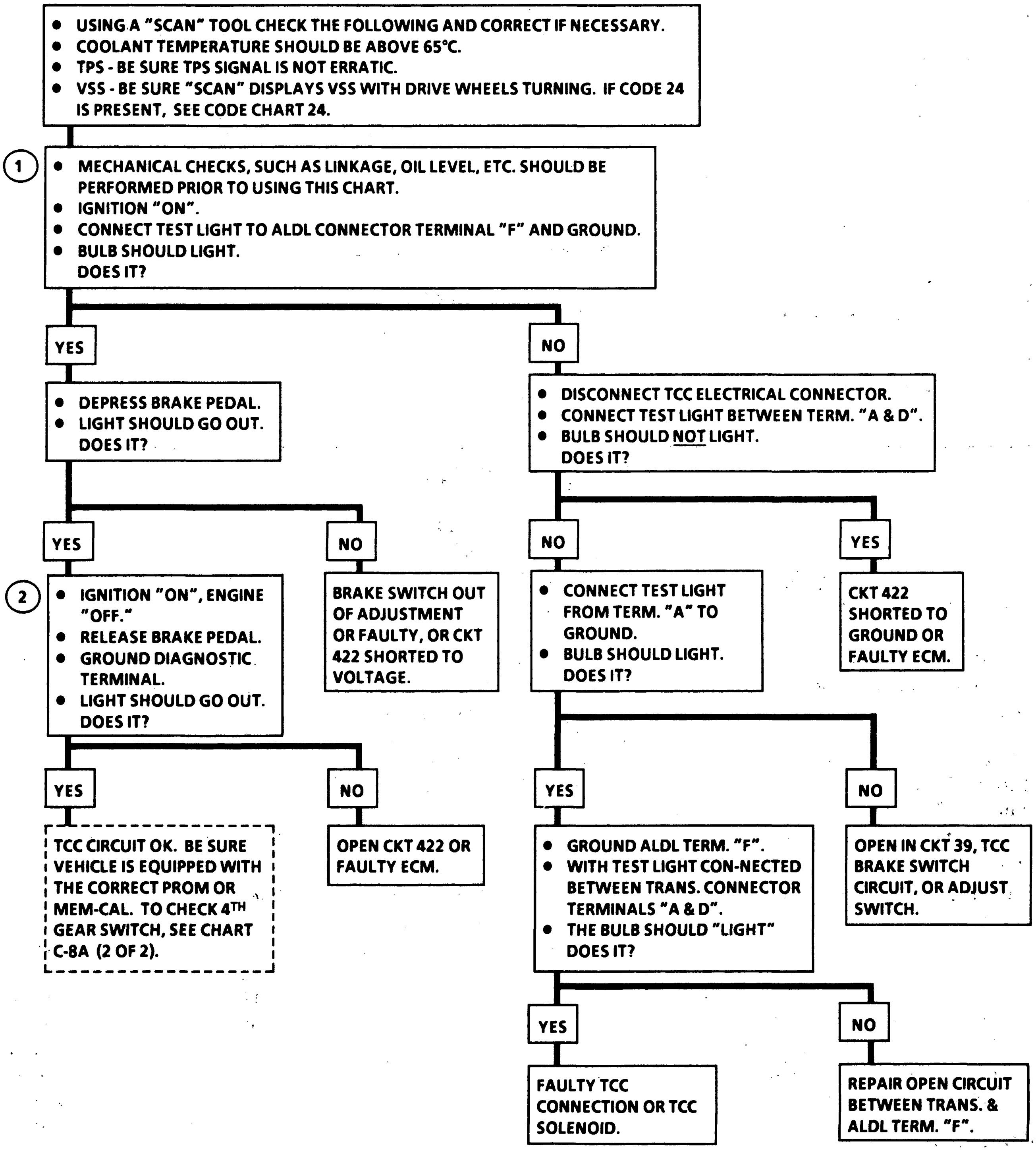
Diagnostic Aids:

A "Scan" tool only indicates when the ECM has turned "ON" the TCC driver (grounded CKT 422) but this does not confirm that the TCC has engaged. To determine if TCC is functioning properly, engine rpm should decrease when the "Scan" indicates the TCC driver has turned "ON". To determine if the 4th gear switch is functioning properly, perform the checks in CHART C-8 (Page 2 of 3) for 5.0L (VIN F) or (Page 3 of 3) for 5.7L (VIN 8). The switches will not prevent TCC from functioning but will affect TCC lock and unlock points. If the 4th gear switch circuit is always open/close depending on which TCC system is used, may engage as soon as sufficient oil pressure is reached.

CHART C-8

(Page 1 of 3)

TORQUE CONVERTER CLUTCH (TCC) SYSTEM
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



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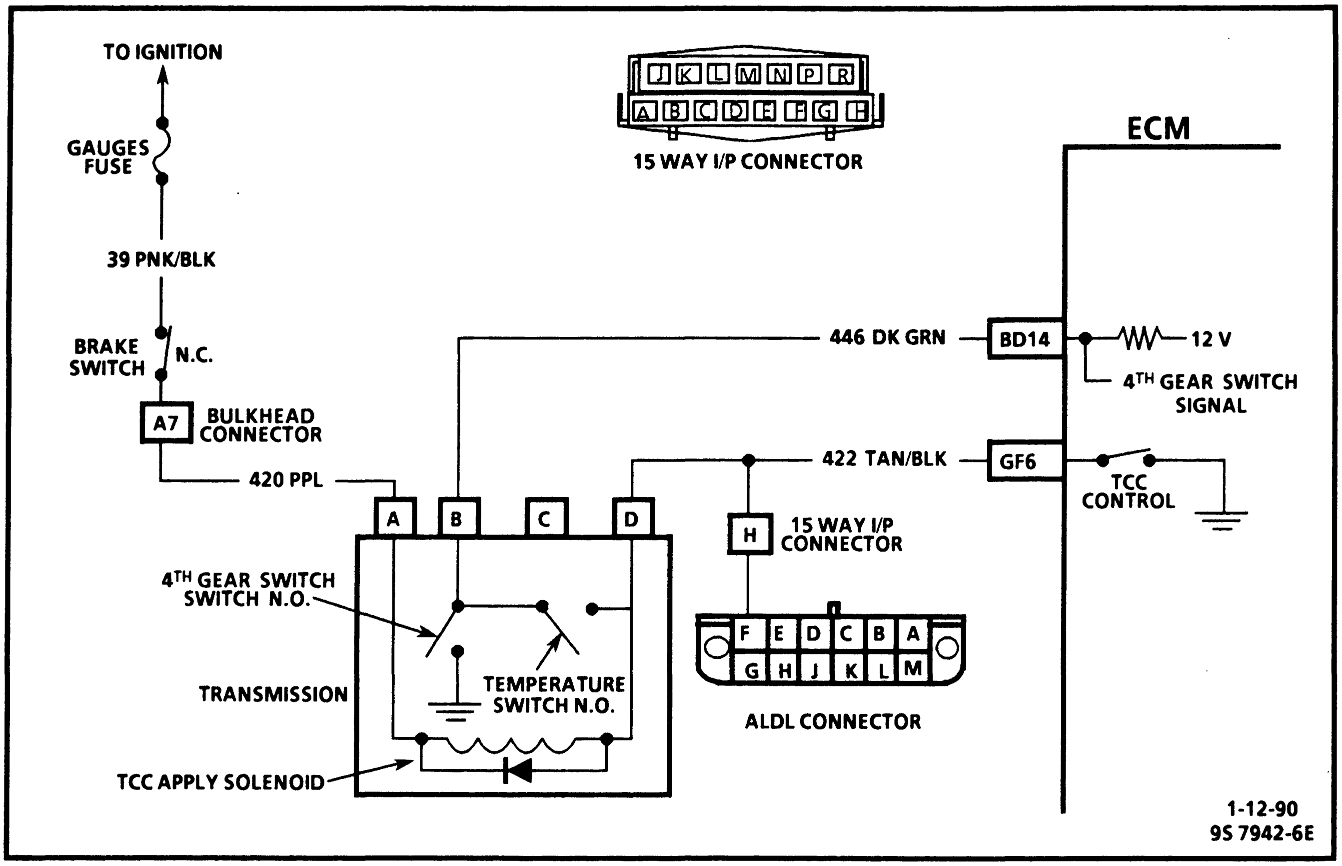


CHART C-8

(Page 2 of 3)

TORQUE CONVERTER CLUTCH (TCC) SYSTEM

(4th GEAR SWITCH DIAGNOSIS)

5.0L (VIN F) "F" CARLINE (PORT)

Circuit Description:

A 4th gear switch (mounted in the transmission) is normally open and closes when the transmission shifts into 4th gear, and this switch is used by the ECM to modify TCC lock and unlock points, when in a 4-3 downshift maneuver. Temperature switch is normally open. Transmission must be in 4th gear, for the temperature switch to apply TCC to cool transmission fluid. Temperature switch lock at 155°C ± 3.8°C (279°F ± 7°F) and unlock at 143°C ± 5°C (259°F ± 9°F).

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Unless the switch is stuck closed or CKT 446 is shorted to ground. The "Scan" should display "NO," indicating the transmission is not in 4th gear. The 4th gear switch should only be closed while in 4th gear.
2. Checks the operation of the 4th gear switch. When the transmission shifts into 4th gear the switch should close and the "Scan" tool should display "YES."
3. Disconnecting the TCC connector simulates an open switch to determine if CKT 446 is shorted to ground or the problem is in the transmission.
4. This step determines if the ECM and wiring are OK. Grounding CKT 446 should cause the "Scan" tool to display "YES" indicating the transmission is in 4th gear.

Diagnostic Aids:

A road test may be necessary to verify the customer complaint. If the "Scan" tool indicates TCC is turning "ON" and "OFF" erratically, check the state of the 4th gear switch to be sure it is not changing states under a steady throttle position. If the switch is changing states, check connections and wire routing carefully. Also, if the 4th gear switch is always open the TCC may engage as soon as sufficient oil pressure is reached.

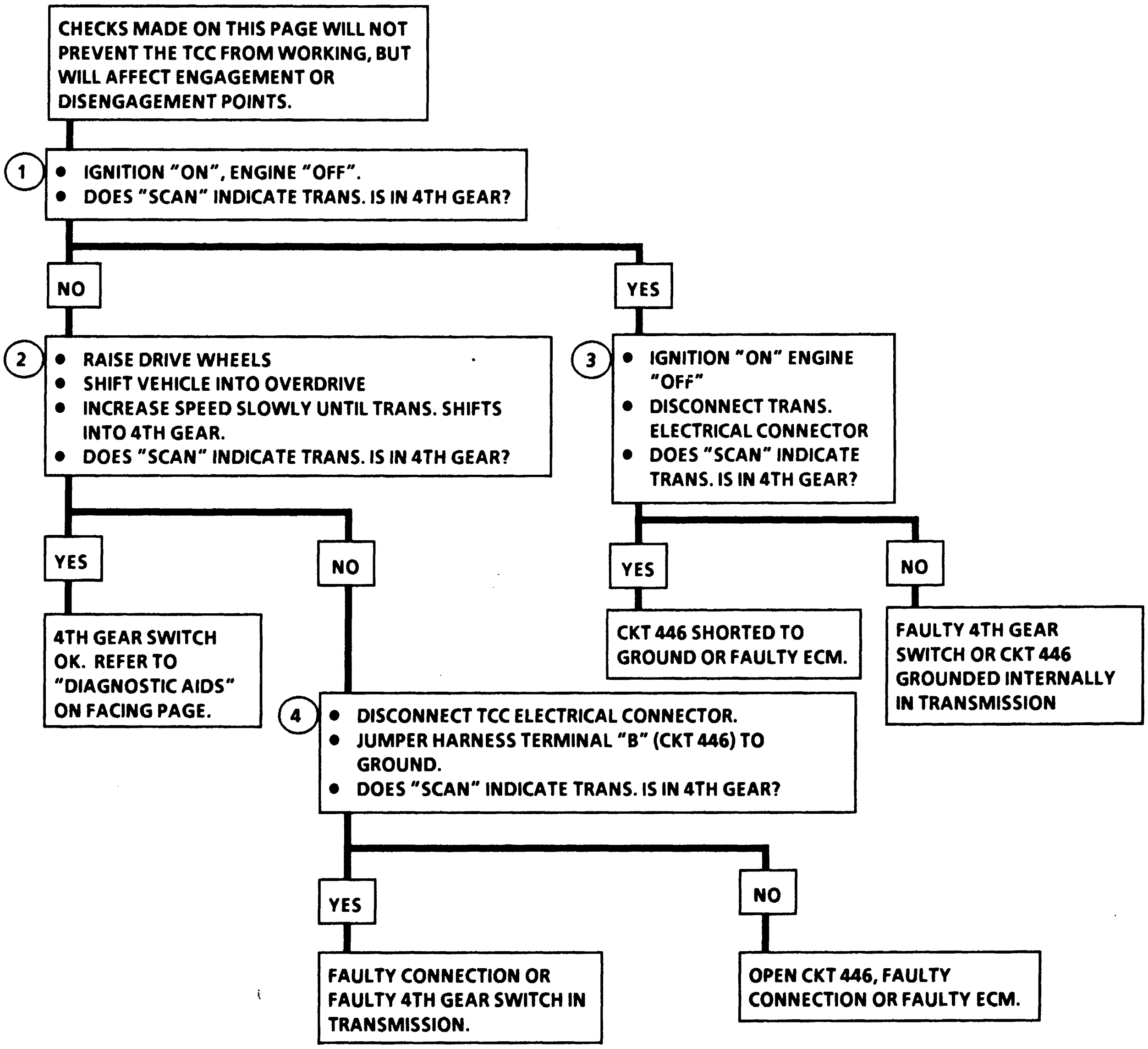
CHART C-8

(Page 2 of 3)

TORQUE CONVERTER CLUTCH (TCC) SYSTEM

(4th GEAR SWITCH DIAGNOSIS)

5.0L (VIN F) "F" CARLINE (PORT)



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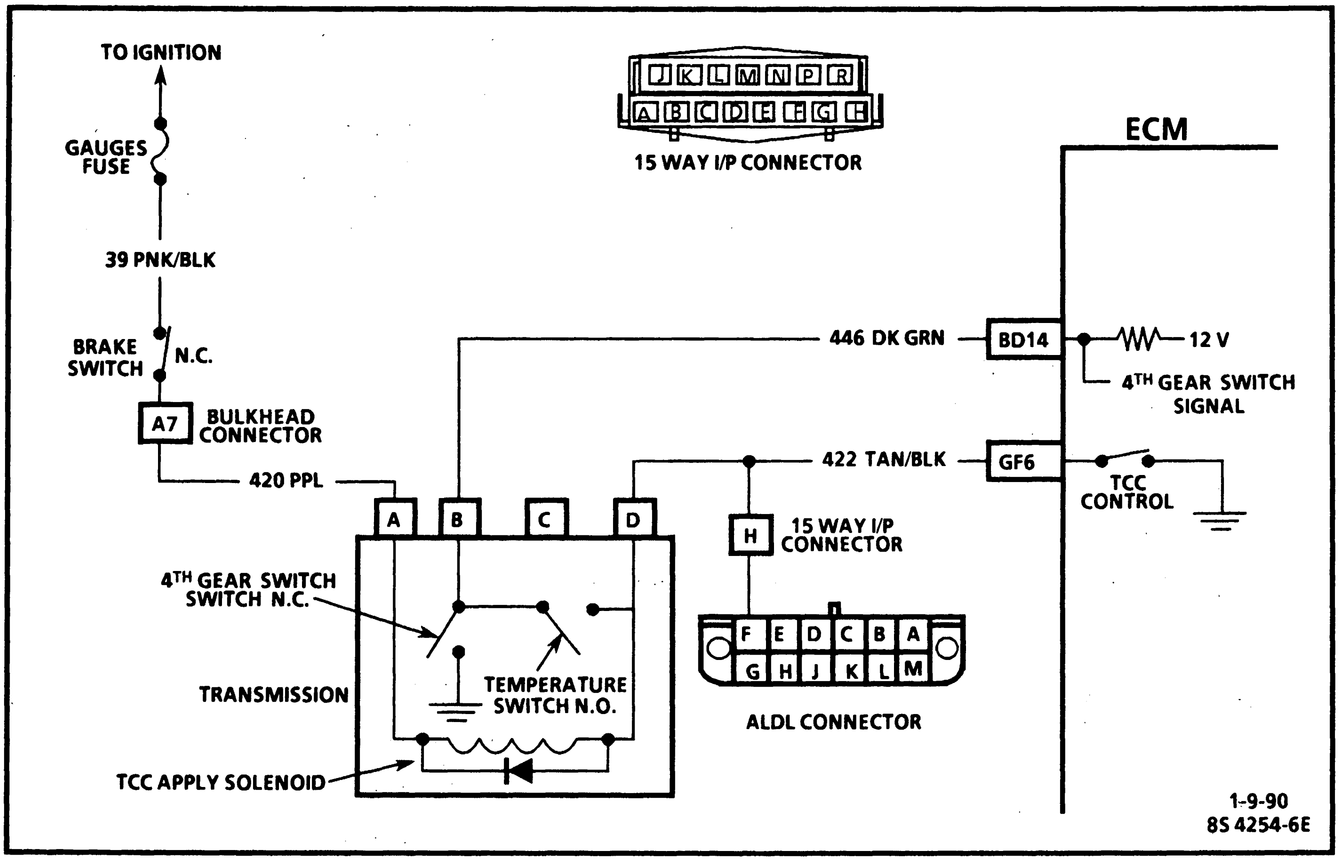


CHART C-8

(Page 3 of 3)

TORQUE CONVERTER CLUTCH (TCC) SYSTEM

(4th GEAR SWITCH DIAGNOSIS)

5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

A 4th gear switch (mounted in the transmission) is normally closed and opens when the transmission shifts into 4th gear, and this switch is used by the ECM to modify TCC lock and unlock points, when in a 4-3 downshift maneuver. Temperature switch is normally open. Transmission must be in 4th gear, for the temperature switch to apply TCC to cool transmission fluid. Temperature switch lock at 155°C ± 3.8°C (279°F ± 7°F) and unlock at 143°C ± 5°C (259°F ± 9°F).

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. Unless the switch is stuck open or CKT 446 is open, the "Scan" tool should display "NO," indicating the transmission is not in 4th gear. The 4th gear switch should only be open while in 4th gear.
2. This step determines if the ECM and wiring are OK. Grounding CKT 446 should cause the "Scan" tool to display "NO" indicating the transmission is not in 4th gear.
3. Checks the operation of the 4th gear switch. When the transmission shifts into 4th gear the switch should close and the "Scan" tool should display "YES."
4. Disconnecting the TCC connector simulates an open switch to determine if CKT 446 is shorted to ground or the problem is in the transmission.

Diagnostic Aids:

A road test may be necessary to verify the customer complaint. If the "Scan" tool indicates TCC is turning "ON" and "OFF" erratically, check the state of the 4th gear switch to be sure it is not changing states under a steady throttle position. If the switch is changing states, check connections and wire routing carefully. Also, if the 4th gear switch is always open the TCC may engage as soon as sufficient oil pressure is reached.

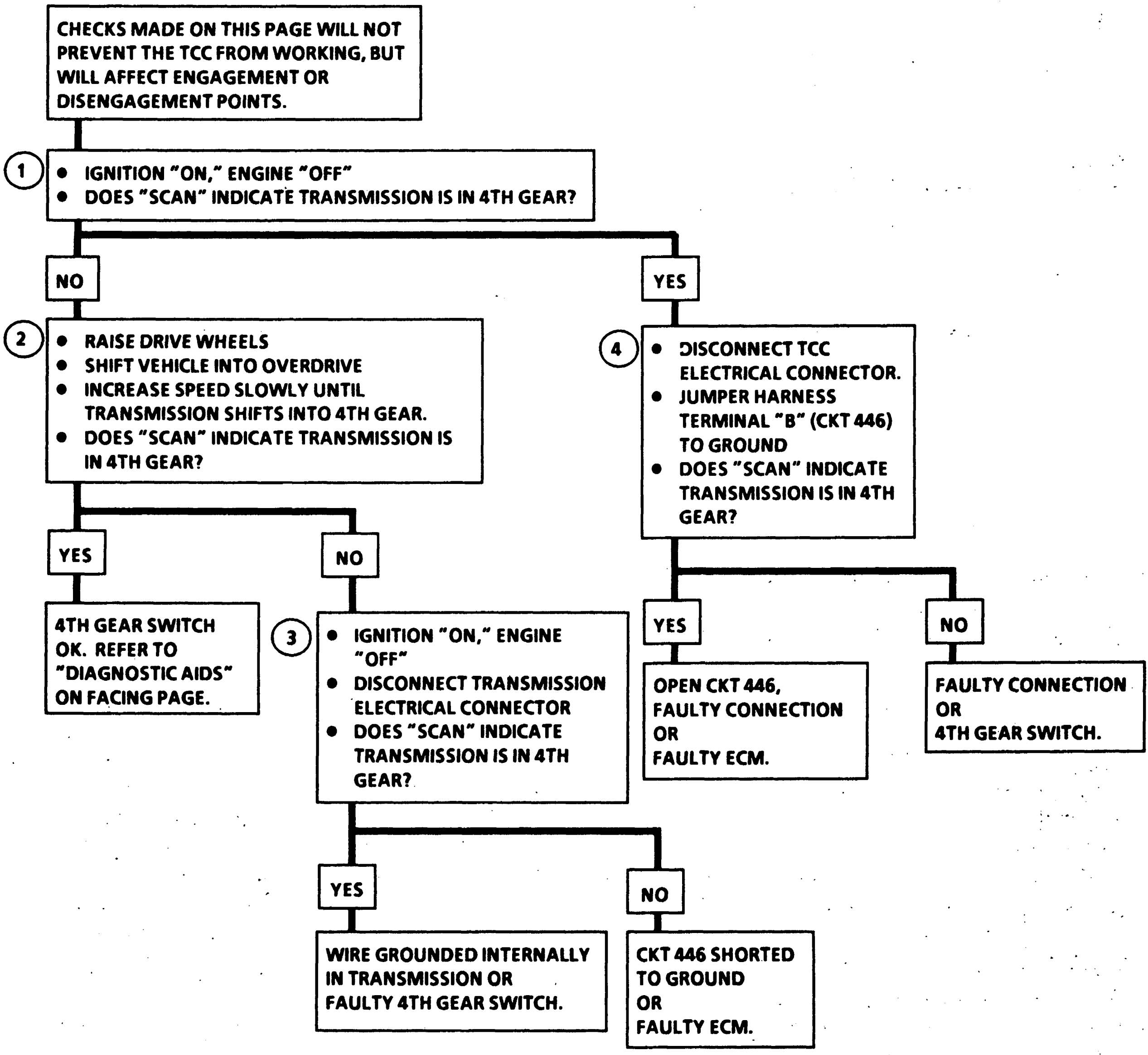
CHART C-8

(Page 3 of 3)

TORQUE CONVERTER CLUTCH (TCC) SYSTEM

(4th GEAR SWITCH DIAGNOSIS)

5.7L (VIN 8) "F" CARLINE (PORT)



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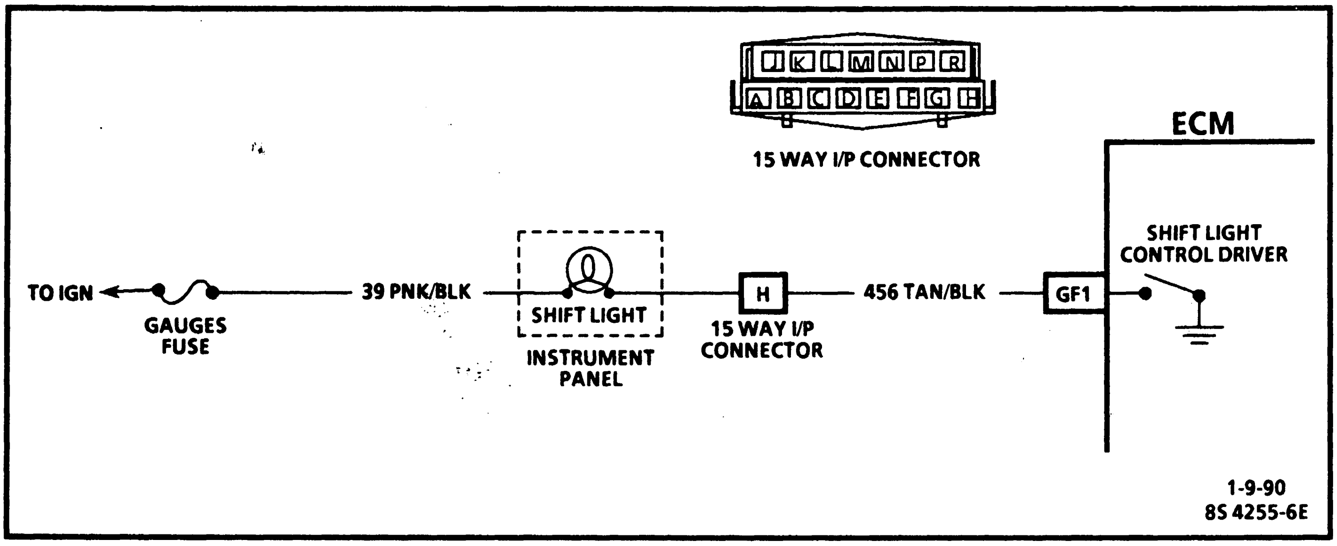


CHART C-8C

MANUAL TRANSMISSION SHIFT LIGHT DIAGNOSIS
5.0L (VIN F) "F" CARLINE (PORT)

Circuit Description:

The shift light lamp display is in the instrument panel. The purpose of the shift light is to provide a display, to the driver, which indicates the best transmission shift point for maximum fuel economy based on engine speed and load. The light is controlled by the ECM and is turned "ON" by grounding CKT 456.

The ECM uses information from the following inputs to control the shift light:

- Coolant Temperature Sensor (CTS)
- Throttle Position Sensor (TPS)
- Vehicle Speed Sensor (VSS)
- rpm

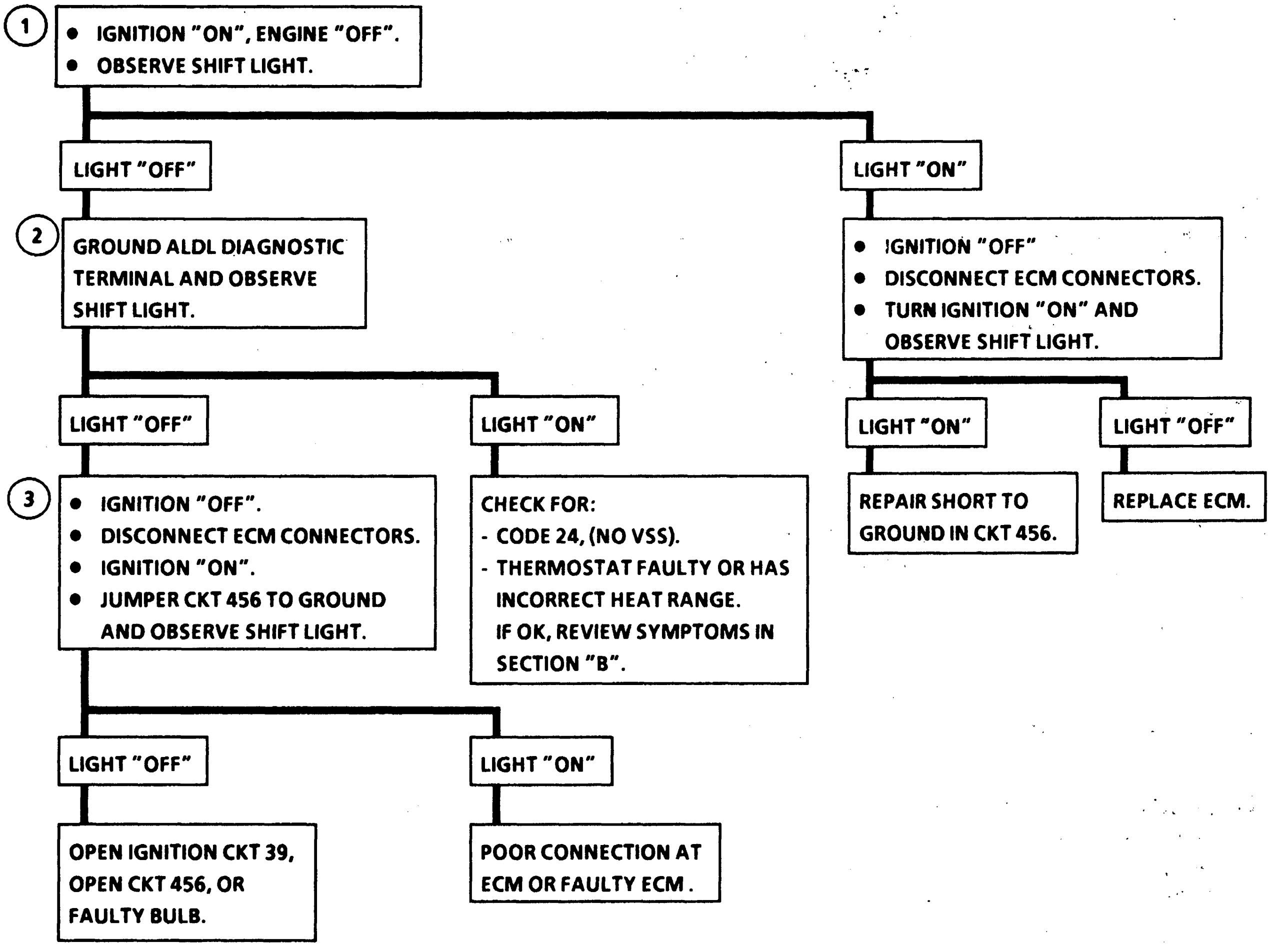
The ECM uses the measured rpm and the vehicle speed to calculate what gear the vehicle is in. It's this calculation that determines when the shift light should be turned "ON."

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. This should not turn "ON" the shift light. If the light is "ON," there is a short to ground in CKT 456 wiring or a fault in the ECM.
2. When the diagnostic terminal is grounded, the ECM should ground CKT 456 and the shift light should come "ON."
3. This checks the shift light circuit up to the ECM connector. If the shift light illuminates, then the ECM connector is faulty or the ECM does not have the ability to ground the circuit.

CHART C-8C

MANUAL TRANSMISSION SHIFT LIGHT DIAGNOSIS
5.0L (VIN F) "F" CARLINE (PORT)



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SECTION C12

ELECTRIC COOLING FAN

CONTENTS

GENERAL DESCRIPTION

The fan is used for engine and A/C condenser cooling but the fan only operates under certain conditions.

OPERATION

The electric cooling fan on this engine is controlled by the ECM. The ECM will ground the cooling fan relay, which turns "ON" the fan, when the following conditions are met.

- Coolant temperature sensor signal indicating a temperature greater than 106°C (222°F).
- A/C head pressure greater than 233 psi and vehicle speed less than 40 mph.
- When the cooling fan is turned "ON," it will stay "ON" for a minimum time of 15 seconds.

DIAGNOSIS

The following charts will diagnose the ECM controlled cooling fan.

Refer to ELECTRICAL DIAGNOSIS (SECTION 8A) to diagnose the secondary cooling fan.

ON-VEHICLE SERVICE

Cooling system component replacement can be found in COOLING AND RADIATOR (SECTION 6B).

PARTS INFORMATION

PART NAME	GROUP
Fan, Engine	1.055
Motor, Fan	1.055
Relay, Engine Fan	1.055
Bracket, Eng Cooling Fan	1.055
Retainer, Eng Cooling Fan Rly (Push in)	1.276
Bolts, Hex/ConWa (18x1.25 x 25) 9.8 Por	8.900

TORQUE SPECIFICATIONS

Bolts/Screws, Eng Coooling Fan	6.3 N·m (56 lb. in.)
Bolts/Screws, Eng Cooling Fan Relay Bracket	9.5 N·m (84 lb. in.)

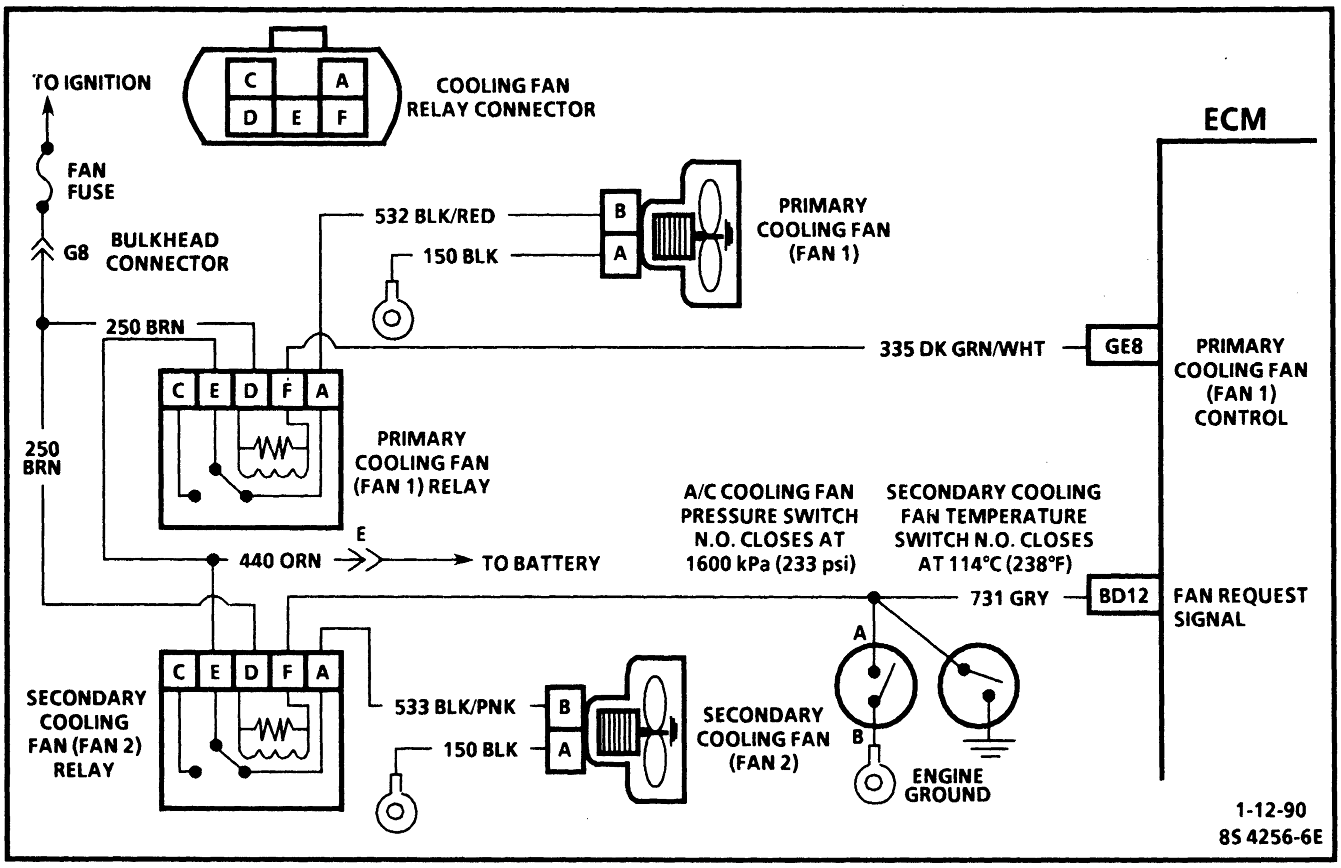


CHART C-12

(Page 1 of 2

ELECTRIC COOLING FAN
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

- The primary cooling fan is totally controlled by the ECM based on inputs from the coolant sensor and fan control switch. The fan should run, if coolant temperature is greater than 106°C (223°F).
- Battery voltage is supplied to the fan relay on terminal "E" and ignition voltage to terminal "D".
- Grounding CKT 335 (relay terminal "F") will energize the relay and supply battery voltage to the fan motor. Once the fan relay is energized by the ECM, it will remain "ON" for a minimum of 15 seconds.
- The ECM will remove the ground to CKT 335, if vehicle speed is over 40 mph, unless the engine is overheating.
- The A/C cooling fan pressure switch, mounted in the A/C high pressure line, will close when head pressure exceeds 1600 kPa (233 psi) and this input causes the ECM to ground CKT 335.
- If a Code 14 or 15 sets, or if the ECM is operating in the fuel back-up mode, the ECM will turn "ON" the cooling fan.

Diagnostic Aids:

If the owner complained of an overheating problem, it must be determined if the complaint was due to an actual boil over or the hot light or temperature gage indicated overheating.

If the gage or light indicates overheating, but no boilover is detected, the gage circuit should be checked. The gage accuracy can also be checked by comparing the coolant sensor reading using a "Scan" tool and comparing its reading with the gage reading.

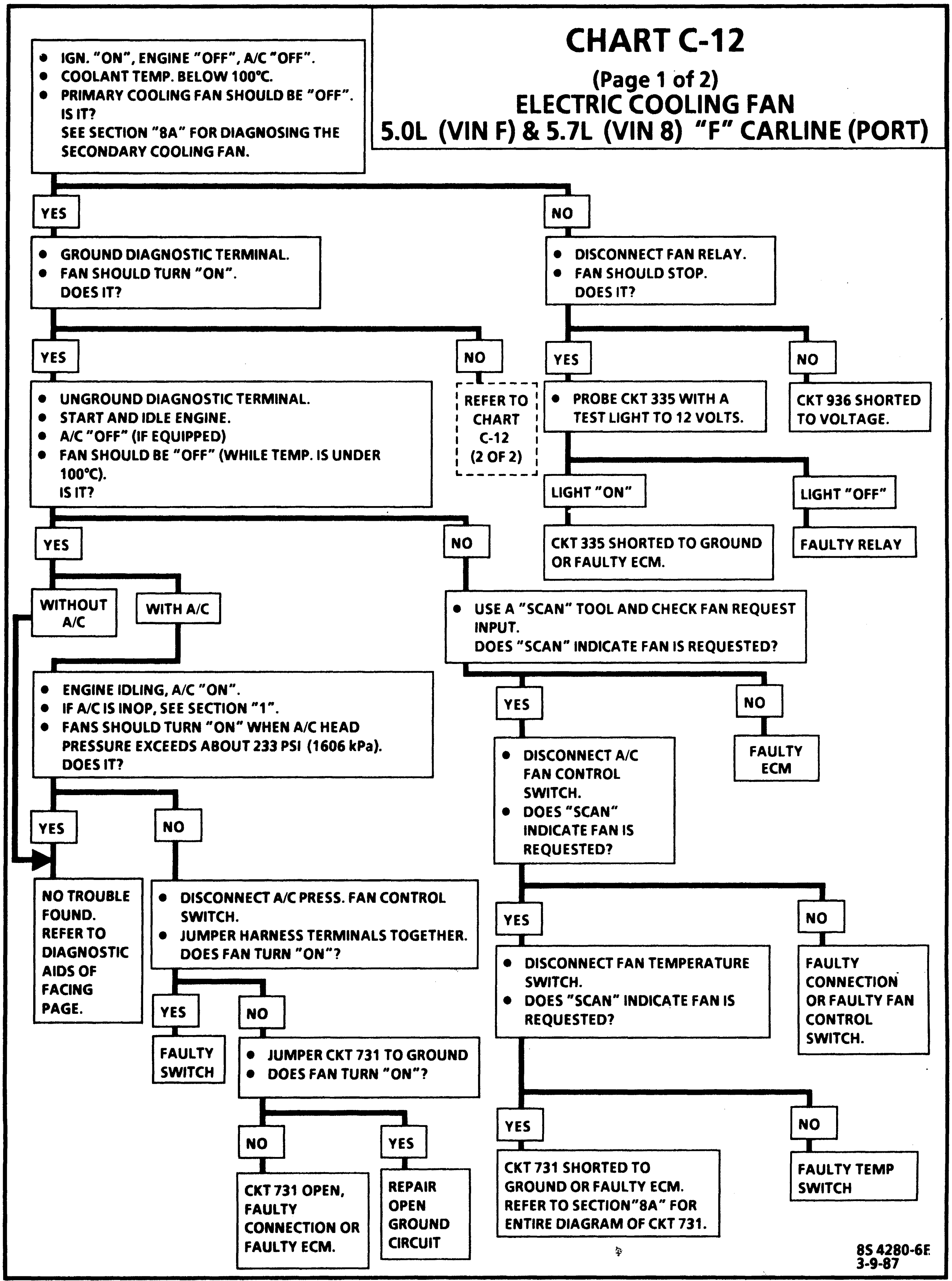
If the engine is actually overheating and the gage indicates overheating, but the cooling fan is not coming "ON", the coolant sensor has probably shifted out of calibration and should be replaced.

If the engine is overheating, and the cooling fan is "ON", the cooling system should be checked.

CHART C-12

(Page 1 of 2)

ELECTRIC COOLING FAN
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



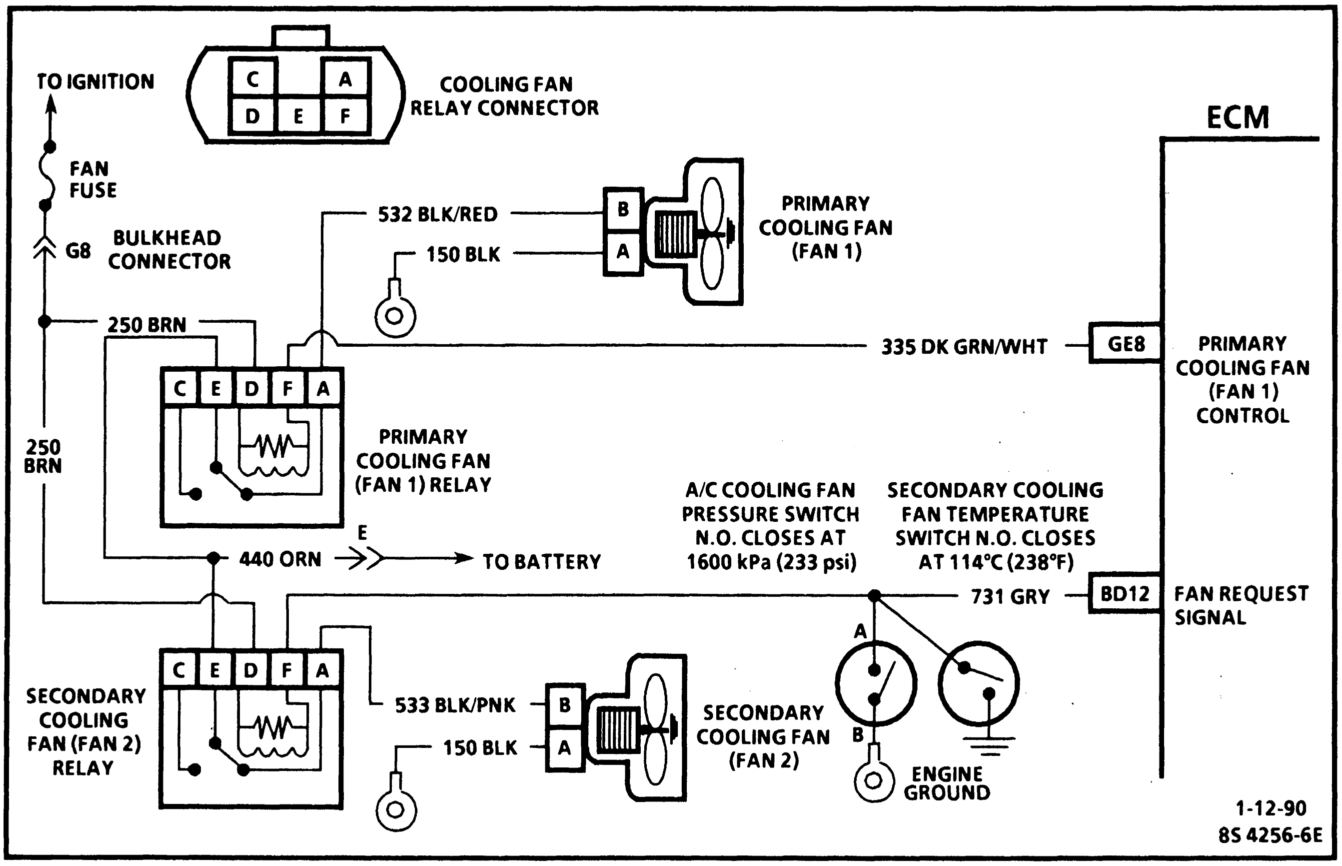


CHART C-12

(Page 2 of 2)

ELECTRIC COOLING FAN

5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)

Circuit Description:

- The primary cooling fan is totally controlled by the ECM based on inputs from the coolant sensor and fan control switch. The fan should run, if coolant temperature is greater than 106°C (223°F).
- Battery voltage is supplied to the fan relay on terminal "E" and ignition voltage to terminal "D".
- Grounding CKT 335 (relay terminal "F") will energize the relay and supply battery voltage to the fan motor. Once the fan relay is energized by the ECM, it will remain "ON" for a minimum of 15 seconds.
- The ECM will remove the ground to CKT 335, if vehicle speed is over 40 mph, unless the engine is overheating.
- The A/C cooling fan switch, mounted in the A/C high pressure line, will close when head pressure exceeds 1600 kPa (233 psi) and this input causes the ECM to ground CKT 335.
- If a Code 14 or 15 sets, or if the ECM is operating in the fuel back-up mode, the ECM will turn "ON" the cooling fan.

Diagnostic Aids:

If the owner complained of an overheating problem, it must be determined if the complaint was due to an actual boil over or the hot light or temperature gage indicated overheating.

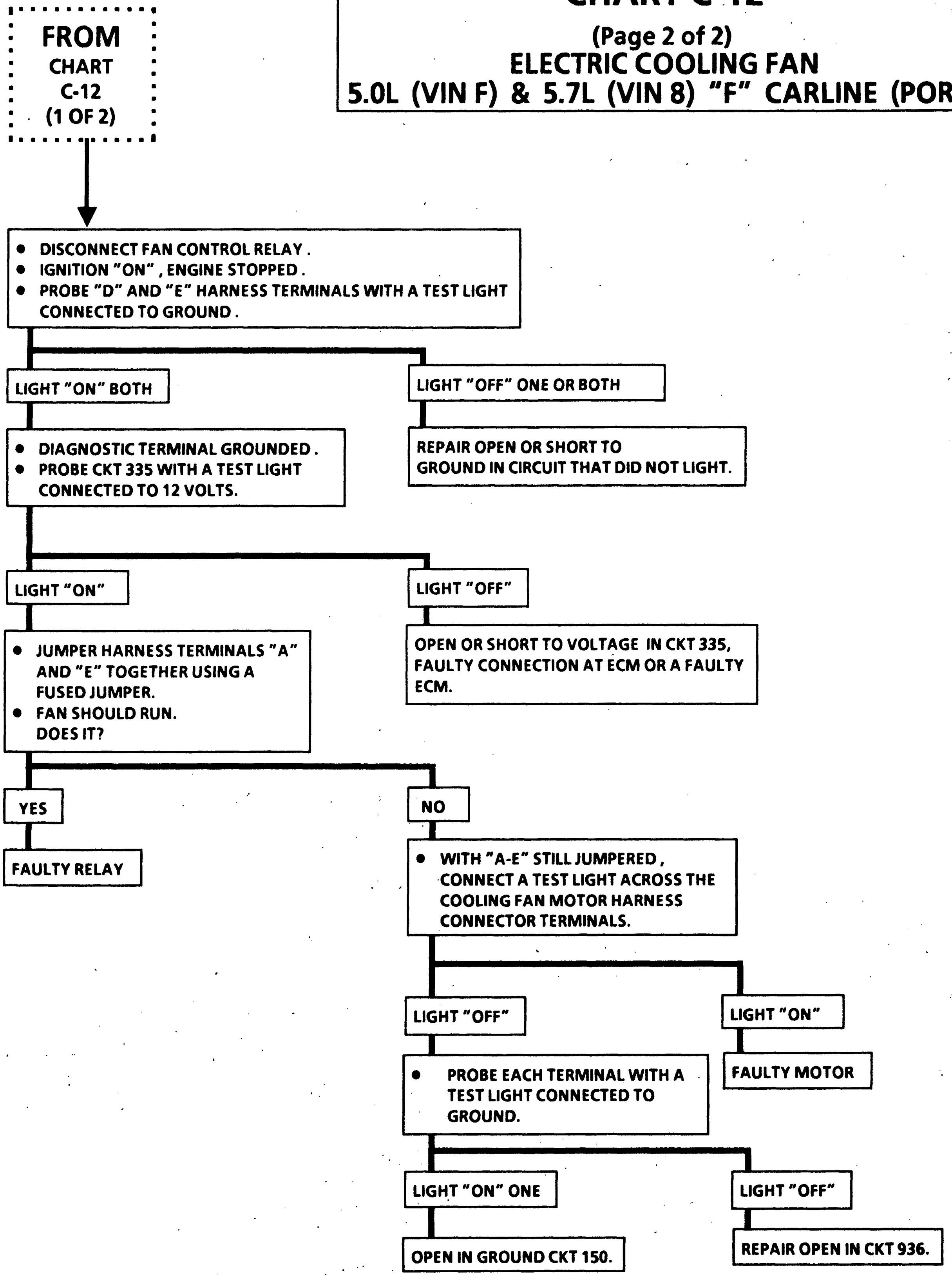
If the gage or light indicates overheating, but no boilover is detected, the gage circuit should be checked. The gage accuracy can also be checked by comparing the coolant sensor reading using a "Scan" tool and comparing its reading with the gage reading.

If the engine is actually overheating and the gage indicates overheating, but the cooling fan is not coming "ON", the coolant sensor has probably shifted out of calibration and should be replaced.

If the engine is overheating, and the cooling fan is "ON", the cooling system should be checked.

CHART C-12

(Page 2 of 2)
ELECTRIC COOLING FAN
5.0L (VIN F) & 5.7L (VIN 8) "F" CARLINE (PORT)



FROM CHART C-12 (1 OF 2)

- DISCONNECT FAN CONTROL RELAY.
- IGNITION "ON", ENGINE STOPPED.
- PROBE "D" AND "E" HARNESS TERMINALS WITH A TEST LIGHT CONNECTED TO GROUND.

LIGHT "ON" BOTH

- DIAGNOSTIC TERMINAL GROUNDED.
- PROBE CKT 335 WITH A TEST LIGHT CONNECTED TO 12 VOLTS.

LIGHT "ON"

- JUMPER HARNESS TERMINALS "A" AND "E" TOGETHER USING A FUSED JUMPER.
- FAN SHOULD RUN. DOES IT?

YES

FAULTY RELAY

NO

- WITH "A-E" STILL JUMPERED, CONNECT A TEST LIGHT ACROSS THE COOLING FAN MOTOR HARNESS CONNECTOR TERMINALS.

LIGHT "OFF"

- PROBE EACH TERMINAL WITH A TEST LIGHT CONNECTED TO GROUND.

LIGHT "ON" ONE

OPEN IN GROUND CKT 150.

LIGHT "OFF"

REPAIR OPEN IN CKT 936.

LIGHT "ON"

FAULTY MOTOR

LIGHT "OFF"

OPEN OR SHORT TO VOLTAGE IN CKT 335, FAULTY CONNECTION AT ECM OR A FAULTY ECM.

LIGHT "OFF" ONE OR BOTH

REPAIR OPEN OR SHORT TO GROUND IN CIRCUIT THAT DID NOT LIGHT.

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SECTION C13

POSITIVE CRANKCASE VENTILATION (PCV)

CONTENTS

GENERAL DESCRIPTION

A Positive Crankcase Ventilation (PCV) system is used to provide more complete scavenging of crankcase vapors. Fresh air from the air cleaner is supplied to the crankcase, mixed with blow-by gases and then passed through a Positive Crankcase Ventilation (PCV) valve into the intake manifold, see (Figure C13-1).

Operation

The primary control is through the PCV valve, see (Figure C13-2) which meters the flow at a rate depending on manifold vacuum.

To maintain idle quality, the PCV valve restricts the flow when intake manifold vacuum is high. If abnormal operating conditions arise, the system is designed to allow excessive amounts of blow-by gases to back flow through the crankcase vent tube into the engine air inlet to be consumed by normal combustion.

RESULTS OF INCORRECT OPERATION

A plugged valve or hose may cause:
- Rough idle
- Stalling or slow idle speed
- Oil leaks
- Sludge in engine

A leaking valve or hose would cause:
- Rough idle
- Stalling
- High idle speed

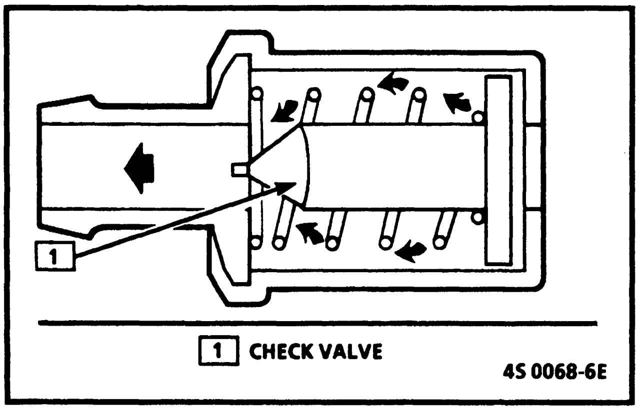

Figure C13-1 - PCV Flow

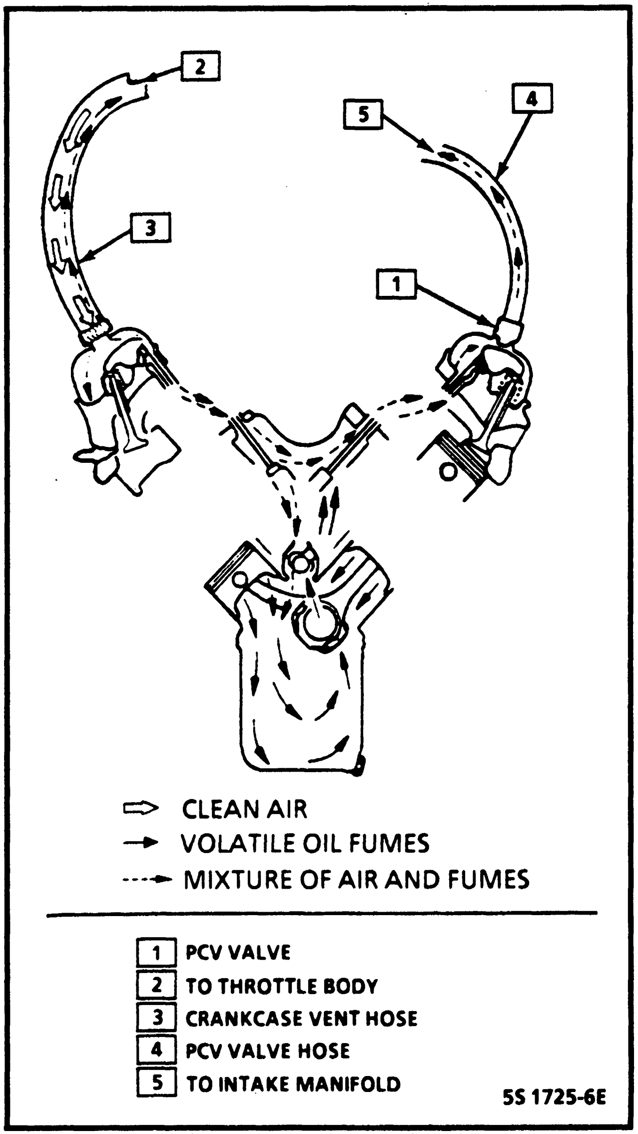

Figure C13-1 - PCV Flow

DIAGNOSIS

FUNCTIONAL CHECK OF PCV VALVE

If an engine is idling rough, check for a clogged PCV valve or plugged hose. Replace as required. Use the following procedure:

1. Remove PCV valve from rocker arm cover.
2. Run the engine at idle.

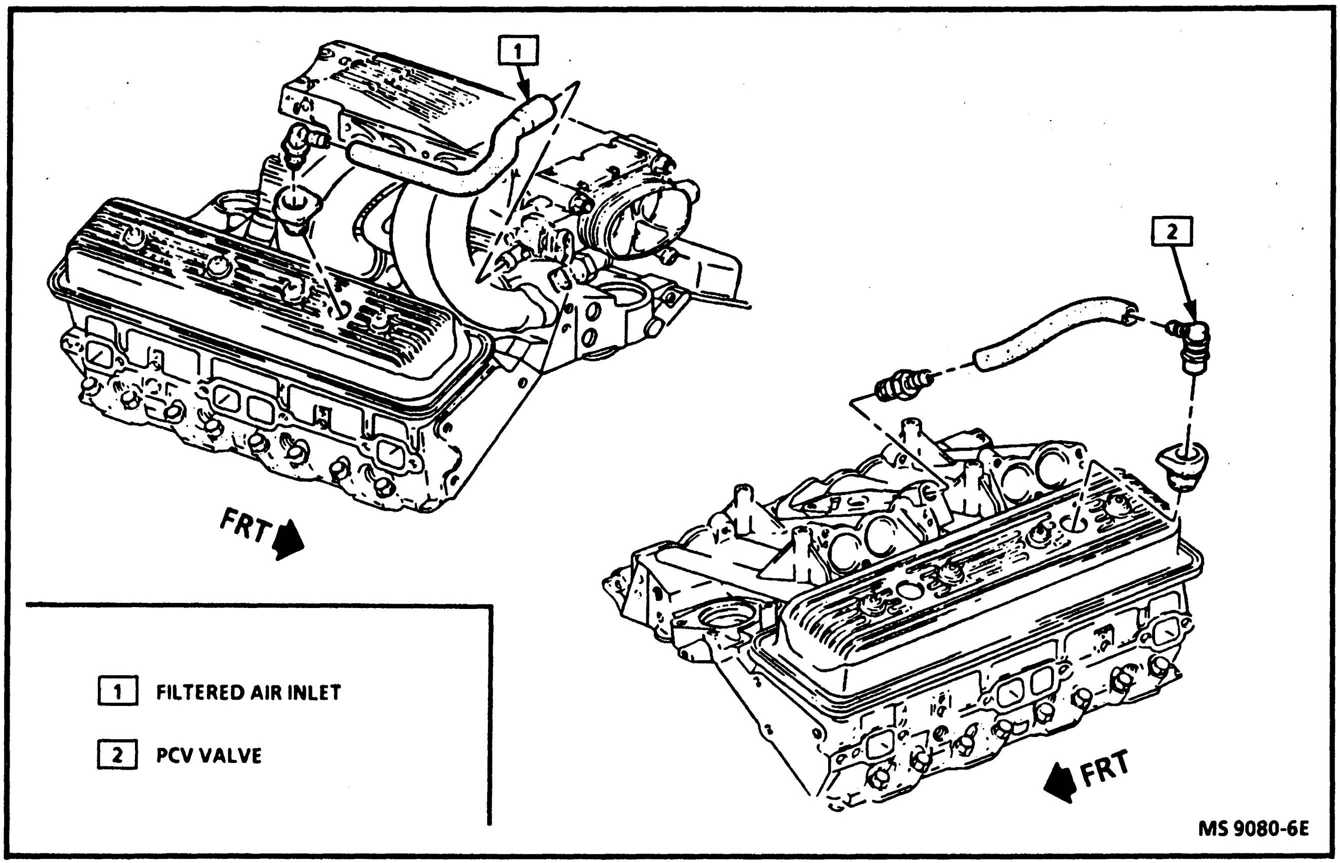

Figure C13-3 - Positive Crankcase Ventilation System 5.0L & 5.7L

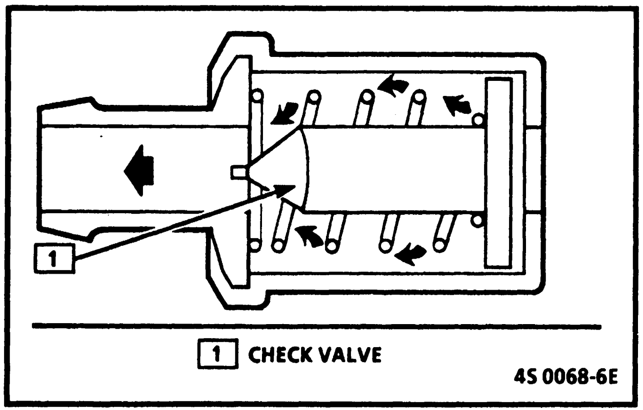

Figure C13-2 - PCV Valve Cross Section

3. Place your thumb over end of PCV valve to check for vacuum. If there is no vacuum at PCV valve, check for plugged hoses or manifold port, or PCV valve. Replace plugged or deteriorated hoses.
4. Turn "OFF" the engine and remove PCV valve. Shake valve and listen for the rattle of check needle inside the valve. If valve does not rattle, replace valve.

With this system, any blow-by in excess of the system capacity (from a badly-worn engine, sustained heavy load, etc.) is exhausted into the air cleaner and is drawn into the engine.

Proper operation of the PCV system is dependent upon a sealed engine. If oil sludging or dilution is noted, and the PCV system is not functioning properly, check engine for possible cause and correct to ensure that system will function as intended.

FUNCTIONAL CHECK OF PCV VALVE

1. Check PCV Valve for correct application.
2. Engine at normal operating temperature.
3. Block off PCV system fresh air intake passage.
4. Remove engine oil dipstick and install a vacuum gage on dipstick tube.
5. Run engine at 1500 rpm for 30 seconds then read vacuum gage while at 1500 rpm.

If a vacuum is present the PCV system is functioning properly.

No vacuum indicates the engine may not be sealed and/or is drawing in outside air. Check valve cover, oil pan gasket for leaks.

If the vacuum gage registers a pressure or the vacuum gage is pushed out of the dipstick tube, check for the correct PCV valve, a plugged hose, or excessive engine blow-by.

With this system, any blow-by in excess of the system capacity (from a badly-worn engine, sustained heavy load, etc.) is exhausted into the intake manifold and is drawn into the engine.

ON-VEHICLE SERVICE

An engine which is operated without any crankcase ventilation can be damaged. Therefore, it is important to replace the PCV valve at intervals shown in MAINTENANCE AND LUBRICATION (SECTION OB).

Periodically, inspect the hoses and clamps and replace any showing signs of deterioration.

PARTS INFORMATION

PART NAME	GROUP
Air Cleaner	3.402
Breather, A/C and Sil	3.410
Hose, C/Case Vent Vlv	1.762
Tube, C/Case Vent	1.762
Valve Asm, C/Case Vent	1.745

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SECTION C14

AIR INDUCTION SYSTEM

CONTENTS

GENERAL DESCRIPTION

AIR INDUCTION SYSTEM

Air induction system draws outside air in past the forward mounted air cleaner. The air cleaner assembly is remotely mounted. (See Figure C14-1). The air then enters the engine by flowing through inter air intake duct to throttle body into the plenum. The air is then directed into the plenum intake runners, through the cylinder heads and into the cylinder.

ON-VEHICLE SERVICE

AIR FILTER ELEMENT

↔ Remove or Disconnect

1. Spring clips from air cleaner cover
2. Inspect air filter element for dust, dirt, water and clean or replace if required. Refer to MAINTENANCE AND LUBRICATION (SECTION 0B).

→← Install or Connect

1. Air filter element
2. Spring clips to air cleaner cover

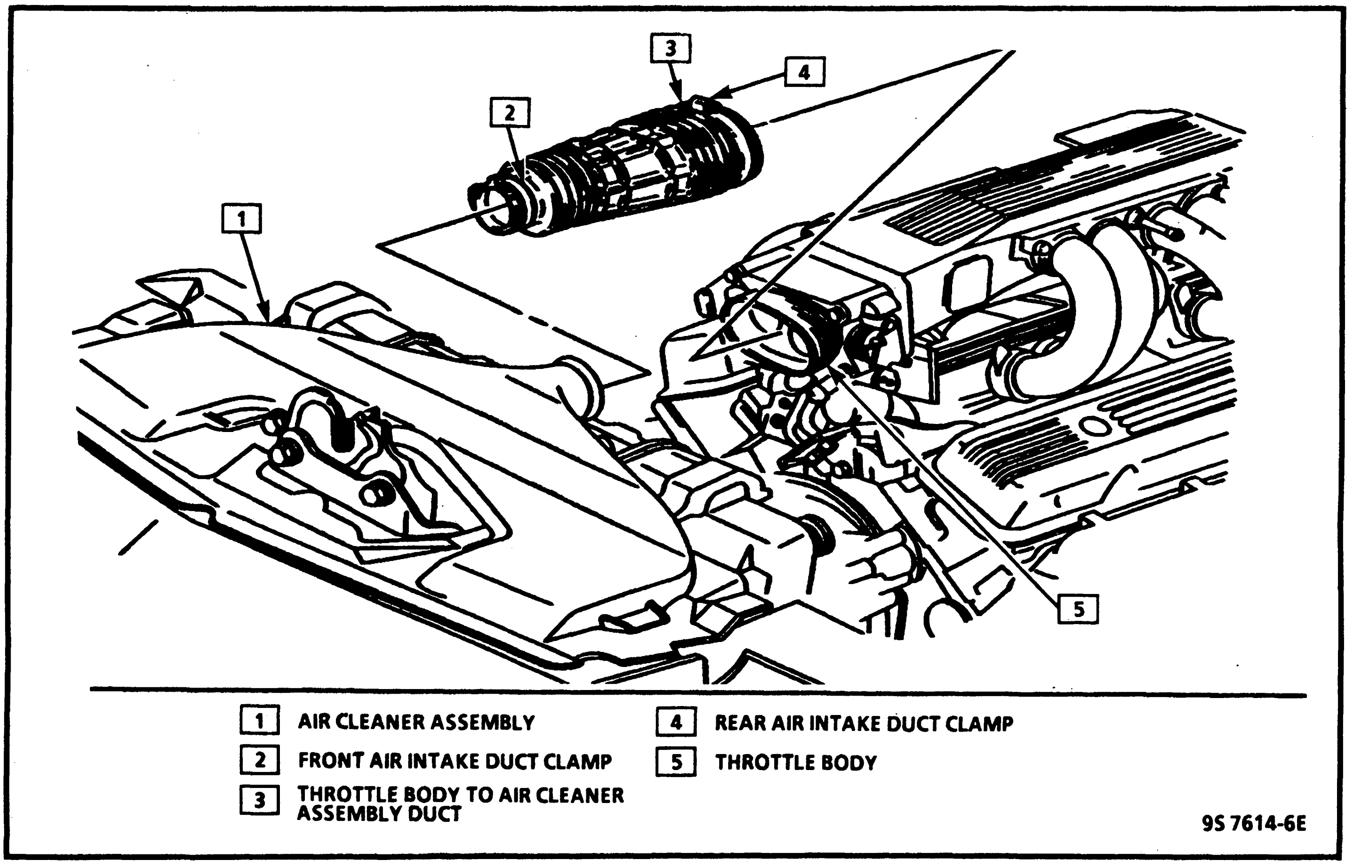


Figure C14-1 - Air Induction System

AIR CLEANER ASSEMBLY

Remove or Disconnect

1. Retainers from air cleaner assembly
2. Clamp from air intake duct front
3. Air cleaner assembly from upper radiator support.

Install or Connect

1. Position air cleaner assembly to upper radiator support (See Figure C14-1), push in retainers to tighten.

   #### Tighten

   - Front Clamp Assembly to 3 N·m (27 lb. in.)
2. Clamp and position air intake duct to air cleaner assembly and tighten.

PARTS INFORMATION

PART NAME	GROUP
Air Cleaner Element	3.410
Air Cleaner, Assembly	3.402
Clamp air intake duct front	3.417
Clamp air intake duct rear	3.407
Duct, Throttle body to air cleaner assembly	3.417
Retainers	1.269

TORQUE SPECIFICATIONS

Clamp Assembly. Front and Rear Intake Duct	3 N·m (27 lb. in.)

SECTION 6F

EXHAUST SYSTEM

NOTICE: All new GM vehicles are certified by the United States Environmental Protection Agency as conforming to the requirements of the regulations for the control of air pollution from new motor vehicles. This certification is contingent on certain adjustments being set to factory standards, thus, these adjustment points either have been permanently sealed and/or made inaccessible to prevent indiscriminate adjustment in the field. For this reason, the factory procedure for temporarily removing plugs, caps, etc., for the purpose of servicing the product must be strictly followed and, where practical, returned to the original intent of the design.

NOTICE: Exhaust system components must have enough clearance from the underbody to prevent overheating of the floor pan and possible damage to the passenger compartment, insulation and trim materials.

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 6F-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

NOTICE: When inspecting or replacing exhaust system components, make sure there is adequate clearance from all points on the underbody to prevent overheating of the floorpan and possible damage to the passenger compartment insulation and trim materials.

Periodic maintenance of the exhaust systemis not required. If the vehicle is raised for other service, it it advisable to check the condition of the complete exhaust system.

Check complete exhaust system, nearby body areas and rear compartment lid for broken, damaged, missing or mispositioned parts, open seams, holes, loose connections or other deterioration that could permit exhaust fumes to seep into the rear compartment or passenger compartment. Dust or water in the rear compartment may indicate a problem in one of these areas. Any faulty areas should be corrected immediately. To help ensure continued integrity, the exhaust system pipe rearward of the muffler must be replaced whenever a new muffler is installed.

EXHAUST CROSSOVER PIPE

The crossover pipe to exhaust pipe connection is a flex joint type, eliminating the need for gaskets.

MUFFLER

The mufflers are a tri-flow design. Some muffler installations have a slot in the inlet and/or outlet pipe. The slot indexes to a key (tab) welded on the exhaust and/or tailpipe to help maintain alignment.

HANGERS

Important

- Be sure to properly install the exhaust system supports. Improperly installed supports can cause annoying vibrations that can be difficult to diagnose.

Two types of hangers are used to support the exhaust system. One type is a conventional rubber strap and the second type is a rubber block. The rubber block type provides a rigid hanger along with a feature that continues to support the exhaust system if a rubber insulator block is broken.

CLAMPS AND WELDED CONNECTIONS

Figure 1

CAUTION: Coat slip joints with exhaust system sealer before assembly to prevent exhaust from entering the vehicle and causing personal injury.

Clamps and welds are used for connection of exhaust system slip joints. When servicing a welded connection it should be cut and the new connection clamped when installing replacement parts.

Three types of clamps are used for connecting exhaust system slip joints: guillotine, saddle/U-bolt and single nut compression.

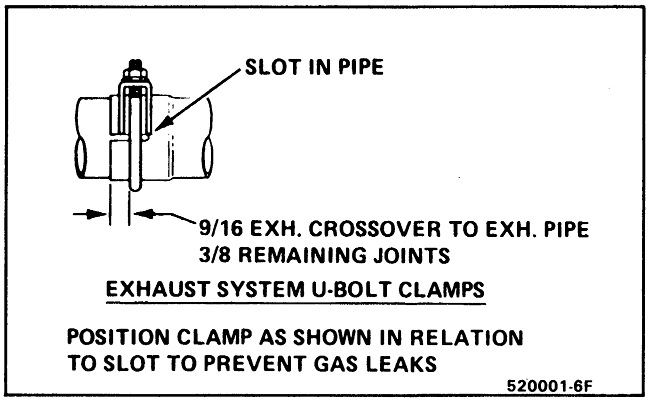


Figure 1 - Installing Exhaust System Clamp

CATALYTIC CONVERTER

Figure 2

CAUTION: Prolonged operation with a misfiring or flooded engine may cause the converter to overheat. This could cause possible personal injury and damage either to the catalyst or to the operating vehicle.

NOTICE: When jacking or lifting vehicle from frame side rails, be certain the lift pads do not contact catalytic converter or damage to converter may result.

NOTICE: The catalytic converter requires the use of unleaded fuel only, or damage to the catalyst may result.

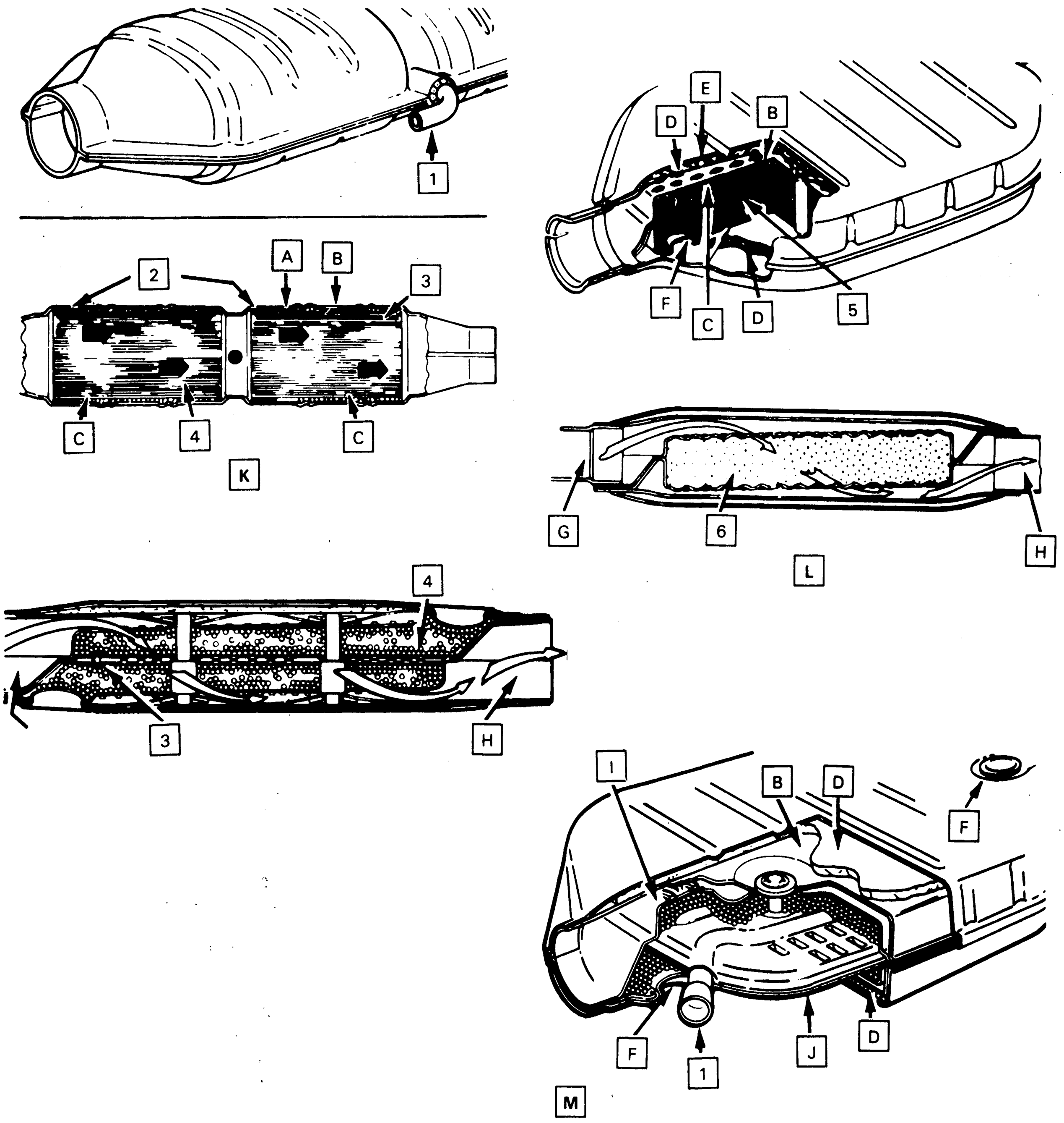
The catalytic converter is an emission control device added to the exhaust system to reduce pollutants from the exhaust gas stream.

A dual bed monolith catalytic converter, single bed pellet and dual bed pellet, are used in combination with two different types of catalysts: oxidation catalyst and three-way (reduction/oxidation) catalyst.

The catalysts have coatings that contain platinum and palladium. The oxidation catalyst lowers the levels of hydrocarbons (HC) and carbon monoxide (CO). The three-way catalyst lowers the level of oxides of nitrogen (NO) as well as HC and CO.

DIAGNOSIS

CONDITION	POSSIBLE CAUSE	CORRECTION
Leaking Exhaust Gases	1. Leaks at pipe joints.	1. Tighten U-bolt nuts at leaking joints to specifications.
	2. Damaged or improperly installed seals or packing.	2. Replace seals or packing as necessary.
	3. Loose exhaust pipe heat tube extension connections.	3. Replace seals or packing as necessary. Tighten stud nuts or bolts to specifications.
	4. Burned or rusted-out exhaust pipe heat tube extensions.	4. Replace heat tube extensions as necessary.
Exhaust Noises	1. Leaks at manifold or pipe connections.	1. Tighten clamps at leaking connections to specifications. Replace gasket or packing as necessary.
	2. Burned or blown-out muffler.	2. Replace muffler assembly.



A	METAL MESH	H	OUTLET	1	AIR INLET
B	SHELL	I	RETAINER	2	SEAL
C	BED	J	AIR PLENUM	3	OXIDATION CATALYST
D	INSULATION	K	DUAL BED MONOLITH	4	THREE-WAY CATALYST
E	OUTER WRAP	L	SINGLE BED PELLET	5	CATALYST
F	FILL PLUG	M	DUAL BED PELLET	6	CATALYST PELLET COMPOUND
G	INLET				

KC0002-6F-F-RP

Figure 2 - Converter Types

	3. Burned or rusted-out exhaust pipe.	3. Replace exhaust pipe.
	4. Leaking exhaust pipe at manifold flange.	4. Tighten attaching bolts and nuts to specifications.
	5. Cracked or broken exhaust manifold.	5. Replace manifold.
	6. Leak between manifold and cylinder head.	6. Tighten manifold-to-cylinder head stud nuts or bolts to specifications.
Loss of Engine Power and/or Internal Rattles in muffler.	Dislodged turning tubes and/or baffles in the muffler, converter, or exhaust pipe.	Replace muffler, converter, or exhaust pipe.

TESTING FOR RESTRICTED EXHAUST

Refer to DRIVEABILITY AND EMISSIONS — FUEL INJECTION (TBI) (SEC. 6E2) or DRIVEABILITY AND EMISSIONS — FUEL INJECTION (PORT) (SEC. 6E3) to test for a restricted exhaust or other driveability and emissions related problems.

ON-VEHICLE SERVICE

The exhaust system is a single MIG welded assembly. Exhaust system service includes replacement of the following items:

- Crossover pipe.
- Catalytic converter.
- Intermediate pipe.
- Muffler and tailpipe assembly.
- Heat shields.

CROSSOVER PIPE

Figures 3 through 5

On the single converter system the crossover pipe can be removed from the converter and manifold. On the dual converter system the crossover pipe can be removed from the manifold, but not from the converters. The crossover pipe and both converters must be replaced as a complete assembly.

Single Converter System

↔ Remove or Disconnect

1. Hose (18) at the switching valve (19).
2. Air injection pipe hold-down bracket nut.
- Raise vehicle and suitably support. Refer to GENERAL INFORMATION (SEC. 0A).
3. Nuts (13).

4. Crossover pipe (14) from the exhaust manifold (10).
- Lower exhaust assembly.
5. Seal (11) from the crossover pipe (14).
6. Clamp (20) holding the air injection pipe (15) to the crossover pipe (14).
7. Clamp (23) from the crossover pipe (14) at the converter (21).
8. Crossover pipe (14).

→← Install or Connect

NOTICE: See "Notice" on page 6F-1 of this section.

1. Crossover pipe (14).
2. Clamp (23) to the crossover pipe (14) at the converter (21).

Tighten

- Clamp nut to 60 N·m (44 lb. ft.).

3. Clamp (20) holding the air injection pipe (15) to the crossover pipe (14).
- Raise exhaust assembly.
4. Crossover pipe (14) and seal (11) to the exhaust manifold (10).
5. Nuts (13).

Tighten

- Nuts (13) to 20 N·m (15 lb. ft.).
- Lower vehicle.

6. Air injection pipe hold-down bracket nut.

Tighten

- Nut to 25 N·m (18 lb. ft.).

7. Hose (18) to the switching valve (19).

Dual Converter System

←→ Remove or Disconnect

- Raise vehicle and suitably support. Refer to GENERAL INFORMATION (SEC. 0A).
1. Clamp nuts (16).
2. Clamp (17).

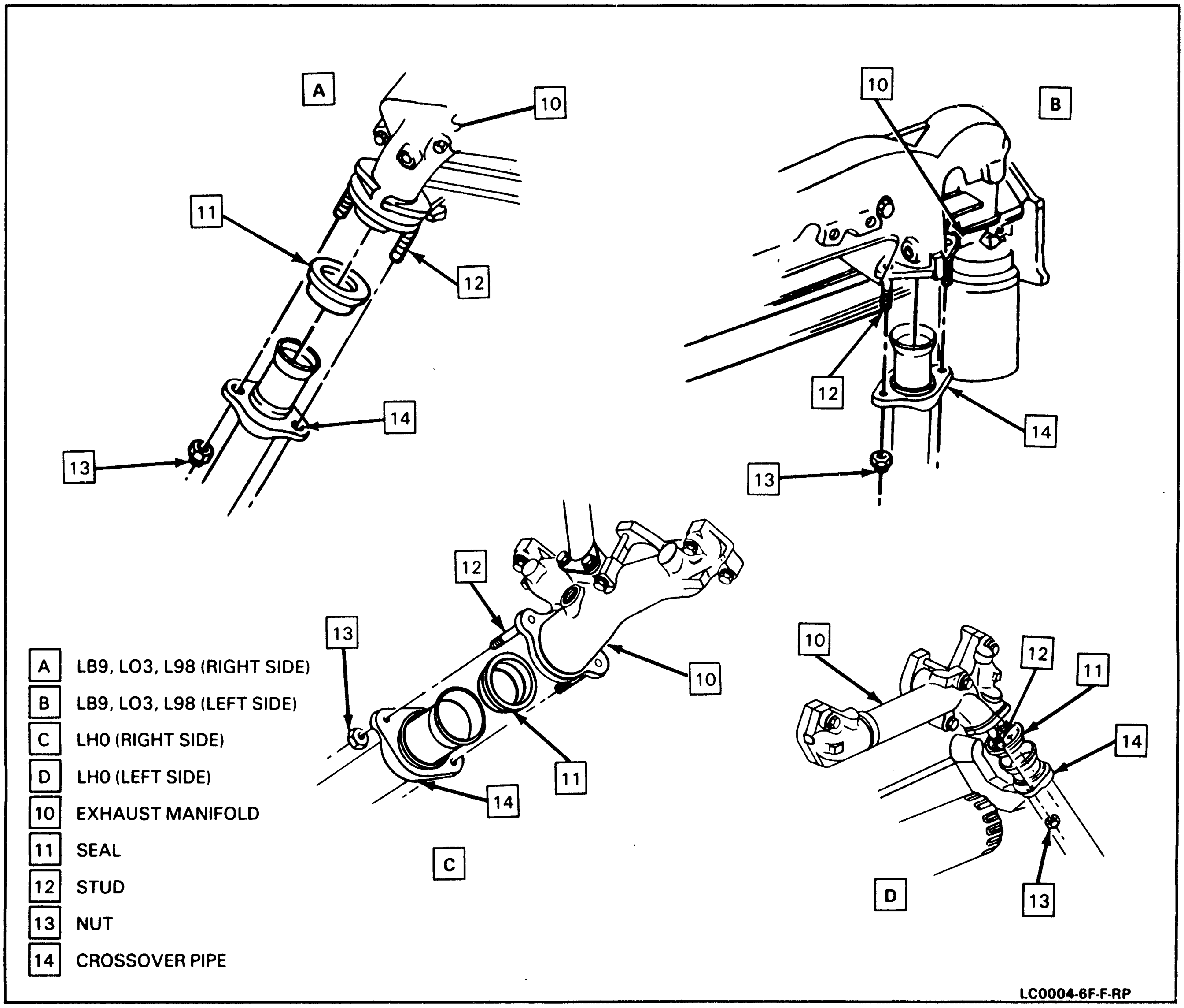
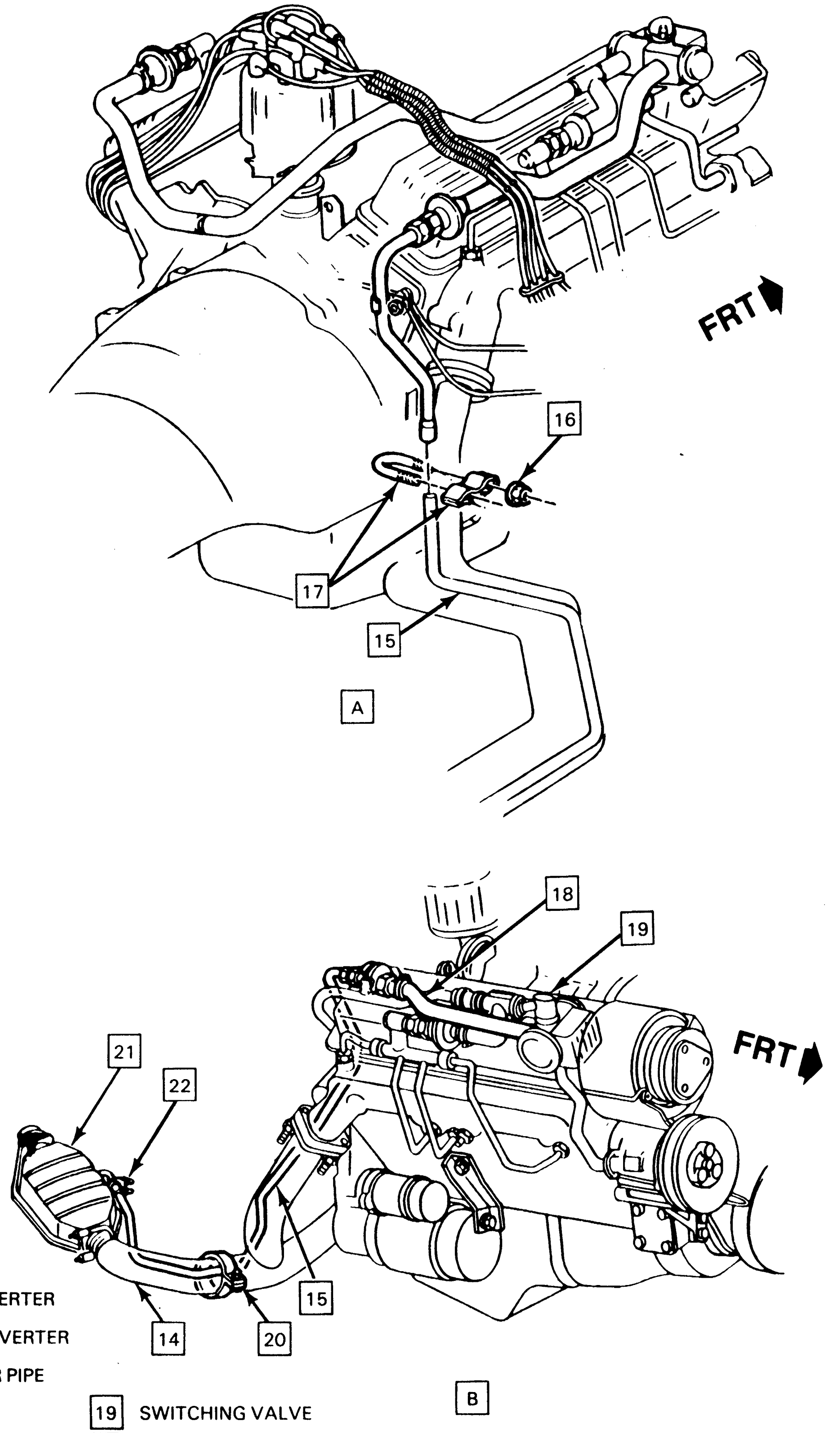


Figure 3 - Manifold Attachments



A	DUAL CONVERTER	19	SWITCHING VALVE
B	SINGLE CONVERTER	20	CLAMP
14	CROSSOVER PIPE	21	CONVERTER
15	PIPE	22	CLAMP
16	NUT		
17	CLAMP		
18	HOSE		

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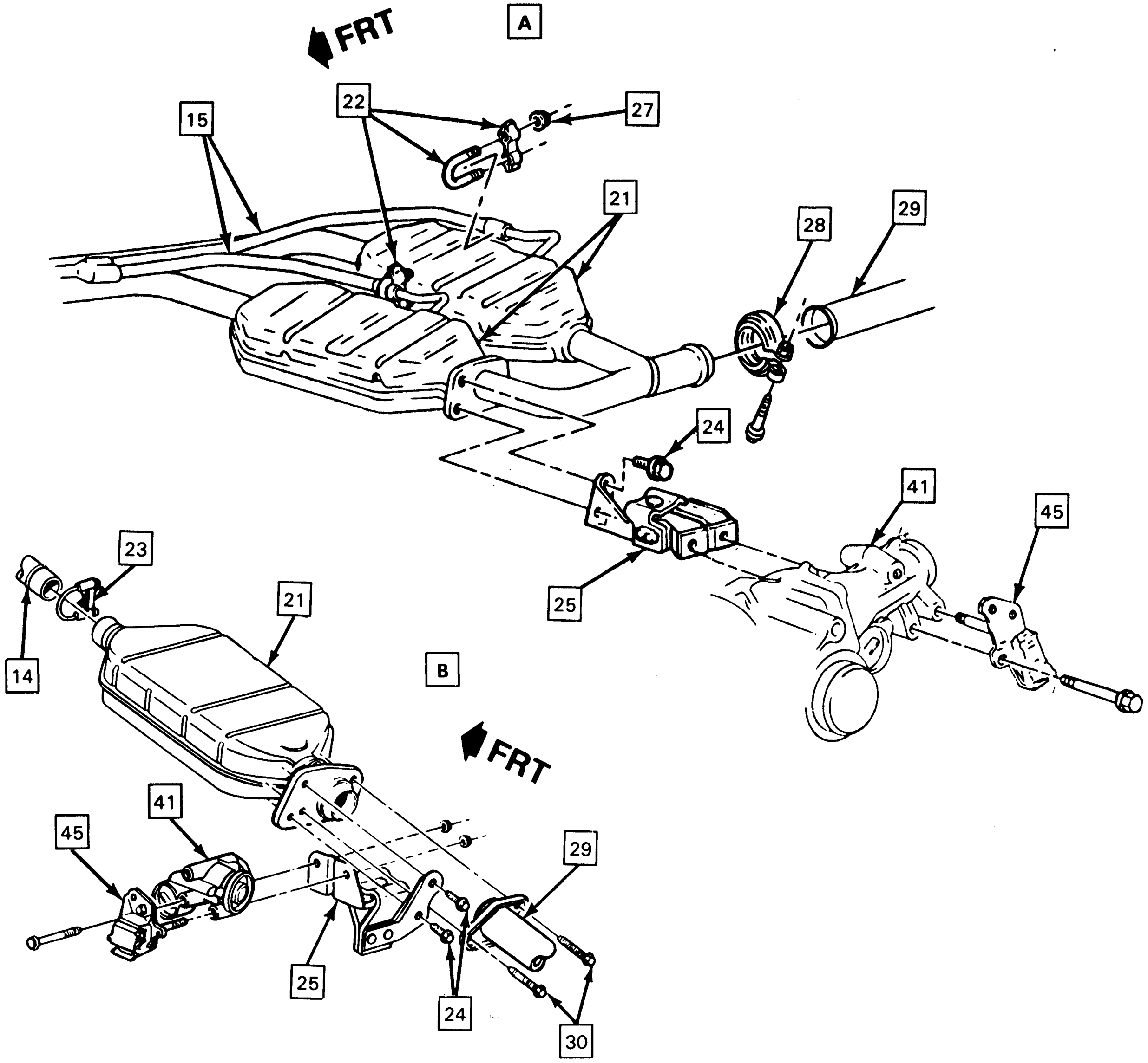
Figure 4 - Air Injection System Attachments



A	DUAL CONVERTER
B	SINGLE CONVERTER
14	CROSSOVER PIPE
15	PIPE
21	CONVERTER
22	CLAMP
23	CLAMP
24	HANGER BOLT
25	HANGER
27	NUT
28	CLAMP
29	INTERMEDIATE PIPE
30	BOLTS
41	TRANSMISSION
45	INNER BRACKET

Figure 5 - Catalytic Converter Attachments

3. Nuts (13).
4. Crossover pipe (14) from the exhaust manifold (10).
- Lower the exhaust assembly.
5. Seal (11) from the crossover pipe (14).
6. Clamp (28) from the intermediate pipe (29).
7. Hanger bolts (24).
8. Nuts (27) from the clamps (22).
9. Clamps (22) from the air injection pipe (15).
10. Air injection pipe (15) from the exhaust system.
11. Crossover pipe (14) and converters (21).

Install or Connect

NOTICE: See "Notice" on page 6F-1 of this section for steps 4 through 6, 9 and 11.

1. Crossover pipe (14) and converters (21).
2. Air injection pipe (15) to the exhaust system.
3. Clamps (22) to the air injection pipe (15).
4. Nuts (27) to the clamps (22).

   Tighten

   - Nuts (27) to 8.8 N·m (78 lb. in.).
5. Hanger bolts (24).

   Tighten

   - Hanger bolts (24) to 50 N·m (37 lb. ft.).
6. Clamp (28) to the intermediate pipe (29).

   Tighten

   - Clamp nuts on the LH0 and LO3 engines to 38 N·m (28 lb. ft.).
   - Clamp nuts on the LB9 and L98 engine to 60 N·m (44 lb. ft.).
7. Seal (11) to the crossover pipe (14).
- Raise the exhaust assembly.
8. Crossover pipe (14) to the exhaust manifold (10).
9. Nuts (13).

   Tighten

   - Nuts (13) to 20 N·m (15 lb. ft.).
10. Clamp (17).
11. Clamp nut (16).

   Tighten

   - Clamp nuts (16) to 8.8 N·m (78 lb. in.).

CATALYTIC CONVERTER

Figures 5 and 6

On the single converter system, the catalytic converter can be removed without removing the crossover pipe. On the dual converter system, the catalytic converter is removed as an assembly with the crossover pipe. Refer to "Crossover Pipe" in this section.

Remove or Disconnect

- Raise vehicle and suitably support. Refer to GENERAL INFORMATION (SEC. 0A).
1. Bolts (30) at intermediate pipe (29).
2. Intermediate pipe (29) from the converter (21).
3. Clamp (23) at the crossover pipe (14).
4. Air injection pipe clamp (22) from converter (21).
5. Hanger bolts (24).
6. Catalytic converter (21).

Install or Connect

NOTICE: See "Notice" on page 6F-1 of this section for steps 2 through 4 and 6.

1. Catalytic converter (21).
2. Hanger bolts (24).

   Tighten

   - Bolts (24) to 50 N·m (37 lb. ft.).
3. Air injection pipe clamp (22).

   Tighten

   - Nuts to 8.8 N·m 78 lb. in.).
4. Clamp (23) at the crossover pipe (14).

   Tighten

   - Nuts to 60 N·m (44 lb. ft.).
5. Intermediate pipe (29) to the converter (21).
6. Bolts (30) at intermediate pipe (29).

   Tighten

   - Bolts (30) to 20 N·m (15 lb. ft.).
- Lower the vehicle.

INTERMEDIATE PIPE

Figures 5 through 7

Remove or Disconnect

- Raise vehicle and suitably support. Refer to GENERAL INFORMATION (SEC. 0A).
1. Bolts (30) or clamp (28) from the intermediate pipe (29) at the converter (21).
- Lower the exhaust assembly.
2. Clamp (31) from muffler (32).
3. Nut (33) to the hanger on the intermediate pipe (29) for the V6 engine.
4. Hanger from hanger bracket (34).
5. Intermediate pipe (29).

Install or Connect

NOTICE: See "Notice" on page 6F-1 of this section.

1. Intermediate pipe (29) to muffler (32).

- Insert 37 mm (1.5 inches).

2. Hanger to hanger bracket (34).
3. Nut (33) to the hanger on the intermediate pipe (29) for the V6 engine.

Tighten

- Nut (33) to 22 N·m (16 lb. ft.).

4. Clamp (31) at muffler (32).

Tighten

- Clamp nut on V8 to 26 N·m (19 lb. ft.).
- Clamp nut on V6 to 38 N·m (28 lb. ft.).

- Raise the exhaust assembly.

5. Bolts (30) or clamp (28) to intermediate pipe (29) at the converter (21).

Tighten

- Bolts (30) to 20 N·m (15 lb. ft.).
- Clamp nuts on the LH0 and LO3 engines to 38 N·m (28 lb. ft.).
- Clamp nuts on the LB9 and L98 engines to 10 N·m (89 lb. in.).

- Lower the vehicle.

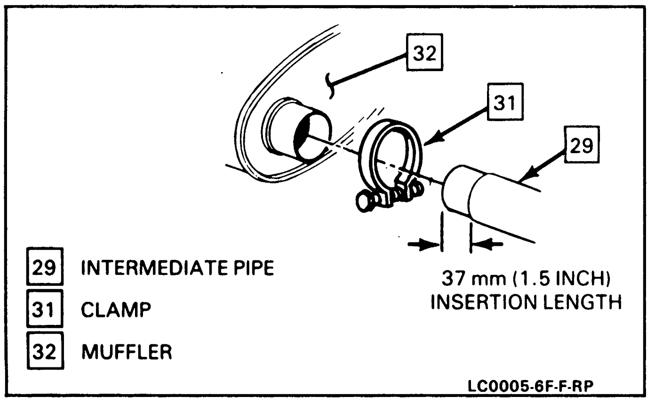


Figure 6 - Intermediate Pipe at Muffler

MUFFLER AND TAILPIPE ASSEMBLY

Figures 6 and 8

Remove or Disconnect

- Raise vehicle and suitably support. Refer to GENERAL INFORMATION (SEC. 0A).

1. Clamp (31) at muffler (32).
2. Hanger bolts (36).
3. Muffler (32) and tailpipes.

Install or Connect

NOTICE: See "Notice" on page 6F-1 of this section for steps 2 and 3.

1. Muffler (32) and tailpipes.
2. Hanger bolt (36).

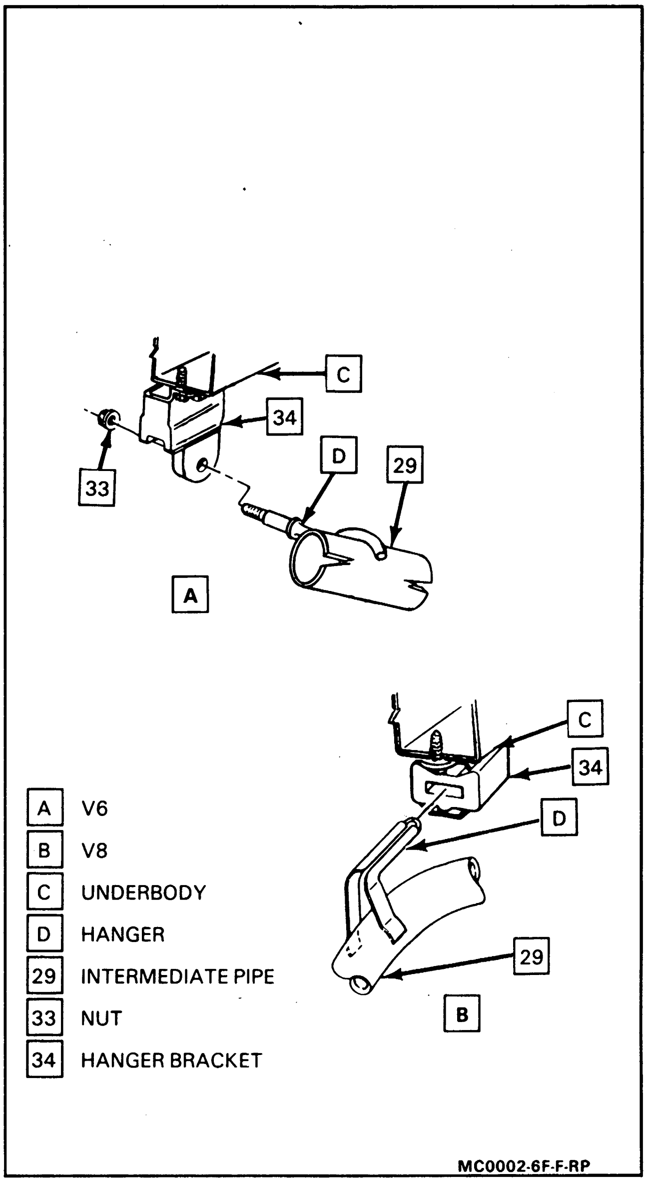


Figure 7 - Intermediate Pipe Hanger

Tighten

- Bolt (36) to 10 N·m (89 lb. in.).

3. Clamp (31) at muffler (32).

Tighten

- Clamp nut on V8 to 26 N·m (19 lb. ft.).
- Clamp nut on V6 to 38 N·m (28 lb. ft.).

- Lower vehicle.

HEAT SHIELDS

Heat shields are installed between the exhaust system components and the underbody of the vehicle.

Remove or Disconnect

- Raise vehicle and suitably support. Refer to GENERAL INFORMATION (SEC. 0A).

1. Screws.
2. Heat shield.

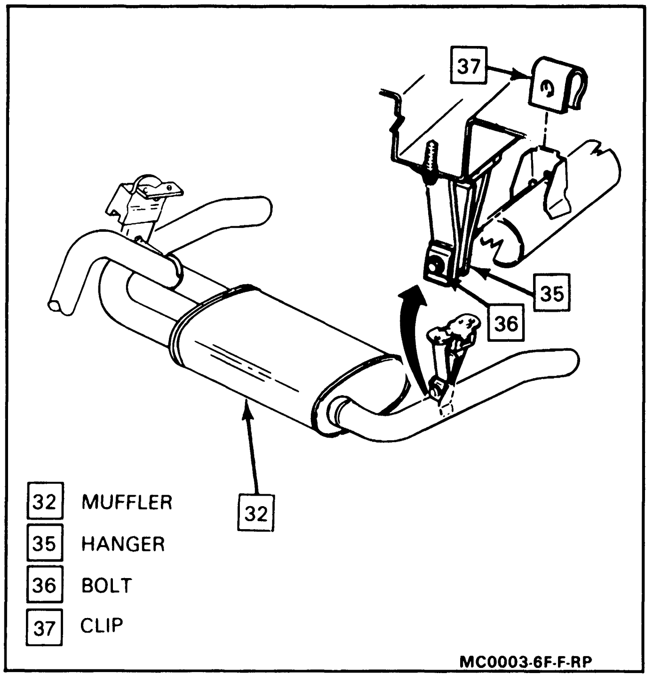


Figure 8 - Muffler Hanger

Install or Connect

1. Heat shield.

NOTICE: See "Notice" on page 6F-1 of this section.

2. Screws.

Tighten

- Screws to 2 N·m (18 lb. in.).

- Lower vehicle.

COMPLETE EXHAUST SYSTEM REPLACEMENT

Remove or Disconnect

1. Muffler and tailpipe assembly. Refer to "Muffler and Tailpipe Assembly" in this section.
2. Intermediate pipe. Refer to "Intermediate Pipe" in this section.
3. Catalytic converter. Refer to "Catalytic Converter" in this section.
4. Crossover pipe. Refer to "Crossover Pipe" in this section.

Install or Connect

1. Crossover pipe. Refer to "Crossover Pipe" in this section.
2. Catalytic converter. Refer to "Catalytic Converter" in this section.
3. Intermediate pipe. Refer to "Intermediate Pipe" in this section.
4. Muffler and tailpipe assembly. Refer to "Muffler and Tailpipe Assembly" in this section.

EXHAUST-TO-BODY CLEARANCE

For exhaust-to-body clearance specifications, refer to Figures 9 through 12.

Z	UNDERBODY
Y	CROSSMEMBER
X	FRONT CROSSMEMBER-UPPER
W	SPARE TIRE WELL PINCH FLANGE
14	CROSSOVER PIPE
21	CONVERTER
29	INTERMEDIATE PIPE
32	MUFFLER
37	CATALYTIC CONVERTER HEAT SHIELD
38	EXHAUST PIPE RIGHT REAR SHIELD
39	TAILPIPE
40	OIL PAN
41	TRANSMISSION
42	SOLENOID

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Figure 9 - Exhaust-to-Body Clearance (LB9/L98)-Legend

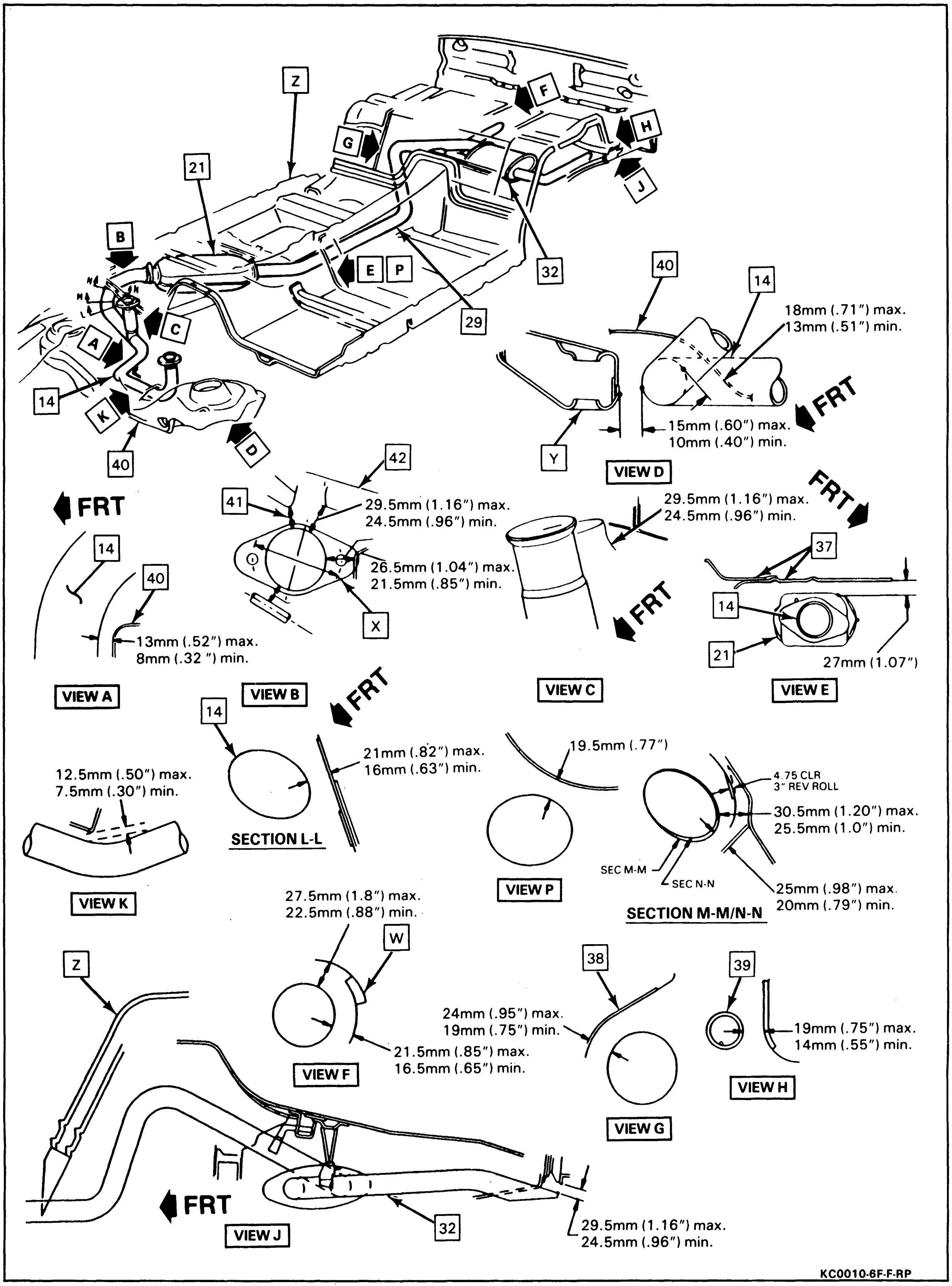


Figure 10 - Exhaust-to-Body Clearance (LB9/L98)

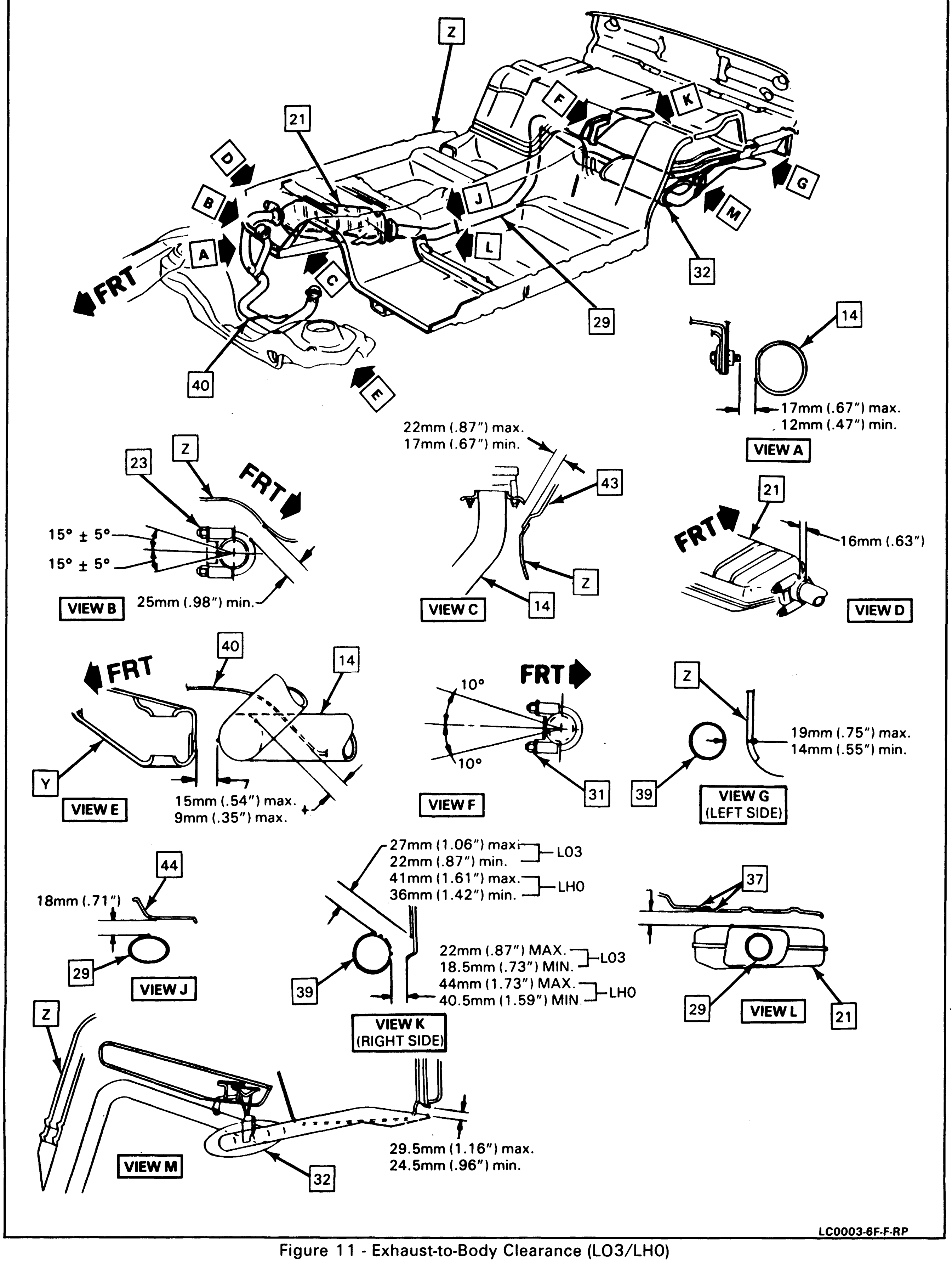


Figure 11 - Exhaust-to-Body Clearance (LO3/LHO)

Z	UNDERBODY
Y	FRONT FRAME
14	CROSSOVER PIPE
21	CONVERTER
23	CLAMP
29	INTERMEDIATE PIPE
31	CLAMP
32	MUFFLER
37	CATALYTIC CONVERTER HEAT SHIELD
39	TAILPIPE
40	OIL PAN
43	DASH PANEL
44	EXHAUST PIPE HEAT SHIELD

KC3013-6F-F-RP

Figure 12 - Exhaust-to-Body Clearance (LO3/LHO)-
Legend

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Crossover Pipe-to-Converter Clamp Nut	60 N·m (44 lb. ft.)
Crossover Pipe-to-Exhaust Manifold Bolt	20 N·m (15 lb. ft.)
Air Injection Pipe Hold-down Bracket Nut	25 N·m (18 lb. ft.)
Air Injection Pipe-to-Crossover Pipe Clamp Nut	8.8 N·m (78 lb. in.)
Converter Hanger Bolt	50 N·m (37 lb. ft.)
Intermediate Pipe-to-Converter Assembly Clamp Nut	
LHO/LO3	38 N·m (28 lb. ft.)
LB9/L98	10 N·m (89 lb. in.)
Air Injection Pipe Clamp Nut	8.8 N·m (78 lb. in.)
Intermediate Pipe-to-Converter Bolt	20 N·m (15 lb. ft.)
Intermediate Pipe Hanger-to-Hanger Bracket Nut	22 N·m (16 lb. ft.)
Intermediate Pipe-to-Muffler Clamp Nut	
V8	26 N·m (19 lb. ft.)
V6	38 N·m (28 lb. ft.)
Muffler-to-Hanger Bolt	10 N·m (89 lb. in.)
Heat Shield Screw	2 N·m (18 lb. in.)

SECTION 7

AUTOMATIC AND MANUAL TRANSMISSION GENERAL INFORMATION

CONTENTS

DESCRIPTION OF SECTION 7

SECTION 7A - TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE

This section contains information on transmission identification, fluid level checking procedures and specific information for servicing some components while the transmission is in the vehicle. This section also contains procedures for the removal and installation of the transmission from the vehicle.

SECTION HYDRA-MATIC 4L60 - AUTOMATIC TRANSMISSION DIAGNOSIS

This section contains information that will assist in the diagnosis of transmission operating conditions while the unit is in the vehicle. The diagnosis information covered is: road test procedures, shift speed charts, pressure check procedures, diagnosis charts, fluid flow diagrams, electrical wiring diagrams, fluid passage identification and torque converter clutch diagnosis.

SECTION HYDRA-MATIC 4L60 - AUTOMATIC TRANSMISSION UNIT REPAIR

This section contains the disassembly, inspection, overhaul and assembly procedures for the mechanical components in the transmission. Also included is information on the gaging of certain components, proper use of special tools, and torque specifications required for assembly.

SECTION 7B - MANUAL TRANSMISSION

This section contains information on transmission identification, fluid level checking procedures and specific information for servicing some components while the transmission is in the vehicle. This section also contains procedures for the removal and installation of the transmission from the vehicle. Under "Unit Repair," the disassembly, inspection, overhaul and assembly procedures for the mechanical components in the transmission are covered. Also included is information on the gaging of certain components, proper use of special tools, and torque specifications required for assembly.

SECTION 7C - CLUTCH

This section contains clutch diagnosis, on vehicle service of the hydraulic system, pressure plate/clutch disc removal and installation procedures, torque specification and special tools required.

SECTION 7A

TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 7A-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL INFORMATION

TRANSMISSION IDENTIFICATION

Figures 1 and 2

The Hydra-Matic 4L60 transmission was formerly designated the THM 700-R4 transmission.

All automatic transmissions have a metal identification nameplate attached to the case exterior or a stamped identification number on the pan rail. The location of this identification is shown in Figure 1. The information will assist in the servicing and determination of replacement parts when ordered through a GM parts catalog.

Additional transmission identification is provided on the service parts identification label as shown in Figure 2. This label contains information on the regular production options (RPO) as well as standard and mandatory options. This label is affixed to the inside of each vehicle at the assembly plant. Refer to GENERAL INFORMATION (SEC. 0A) for label location and additional information.

TRANSMISSION DEFINITIONS

The following definitions are being provided to establish a common language and assist the user in describing transmission related conditions. Some of

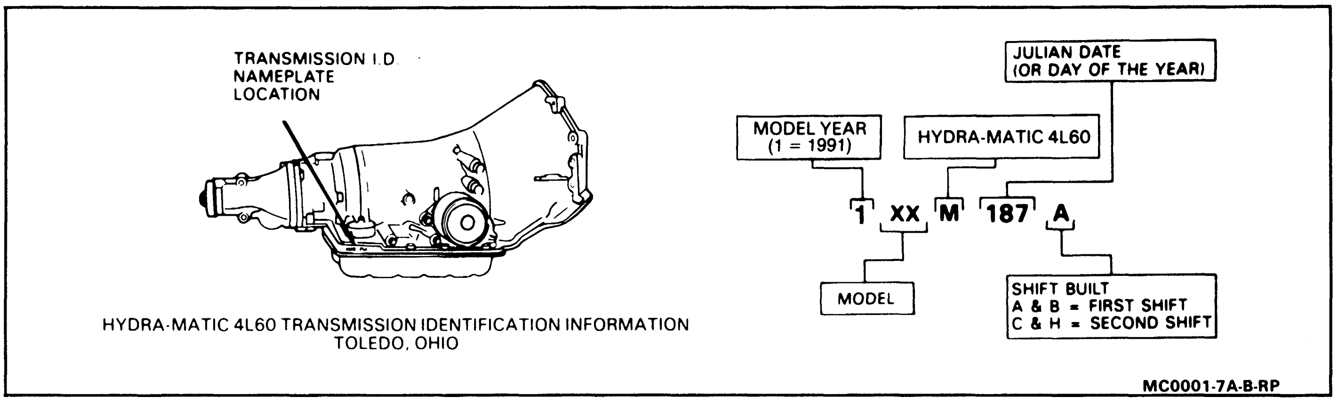
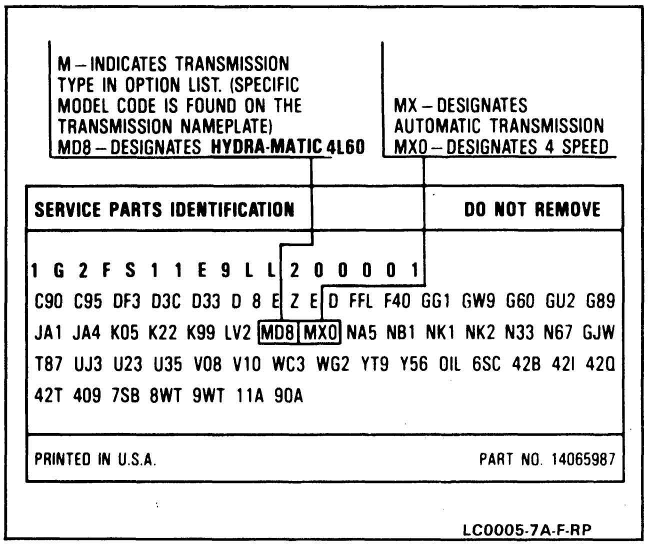


Figure 1 - Transmission Identification Information


M – INDICATES TRANSMISSION TYPE IN OPTION LIST. (SPECIFIC MODEL CODE IS FOUND ON THE TRANSMISSION NAMEPLATE)
MD8 – DESIGNATES HYDRA-MATIC 4L60

MX – DESIGNATES AUTOMATIC TRANSMISSION
MXO – DESIGNATES 4 SPEED

SERVICE PARTS IDENTIFICATION **DO NOT REMOVE**

1 G 2 F S 1 1 E 9 L L 2 0 0 0 0 1
C90 C95 DF3 D3C D33 D 8 E Z E D FFL F40 GG1 GW9 G60 GU2 G89
JA1 JA4 K05 K22 K99 LV2 MD8 MXO NA5 NB1 NK1 NK2 N33 N67 GJW
T87 UJ3 U23 U35 V08 V10 WC3 WG2 YT9 Y56 OIL 6SC 42B 42I 42Q
42T 409 7SB 8WT 9WT 11A 90A

PRINTED IN U.S.A. PART NO. 14065987

Figure 2 - Service Parts Identification Label

these terms or conditions are used in the transmission diagnosis section of this service manual.

Throttle Positions

Minimum throttle - the least amount of throttle opening required for an upshift.

Light throttle - approximately 1/4 of accelerator pedal travel.

Medium throttle - approximately 1/2 of accelerator pedal travel.

Heavy throttle - approximately 3/4 of the accelerator pedal travel.

Wide open throttle - full travel of the accelerator pedal.

Full throttle detent downshift - a quick application of the accelerator pedal to its full travel, forcing a downshift.

Zero throttle coastdown - a full release of the accelerator pedal while the vehicle is in motion in the drive range.

Engine braking - a condition where the engine is used to slow the vehicle by manually downshifting during a zero throttle coastdown.

Shift Conditions

Bump - a sudden and forceful application of a clutch or band.

Chuggle - a bucking or jerking condition that may be engine related. May be most noticeable when the converter clutch is engaged. Similar to the feel of towing a trailer.

Delayed - a condition where a shift is expected but does not occur for a period of time. Samples of this condition could be described as clutch or band engagement that does not occur as quickly as expected during a part throttle or wide open throttle application of the accelerator or when manually downshifting to a lower range. Also defined as "late" or "extended."

Double bump -two sudden and forceful applications of a clutch or band. Also defined as "double feel."

Early - a condition where the shift occurs before the vehicle has reached a proper speed and tends to labor the engine after the upshift.

End bump - a firmer feel at the end of a shift as compared to the feel at the start of the shift. Also defined as "end feel" or "slip bump."

Firm - a noticeable quick application of a clutch or band that is considered normal with a medium to heavy throttle shift. Should not be confused with "harsh" or "rough."

Flare -a quick increase in engine rpm accompanied with a momentary loss of torque. This most generally occurs during a shift. Also defined as "slipping."

Harsh - a more noticeable application of a clutch or band or as compared to "firm." This condition is considered undesirable at any throttle position. Also defined as "rough."

Hunting - a repeating quick series of upshifts and downshifts that causes a noticeable change in engine rpm. An example could be described as a 4-3-4 shift pattern. Also defined as "busyness."

Initial feel - a distinct firmer feel at the start of a shift as compared to the finish of the shift.

Late - a shift that occurs when the engine is at a higher than normal rpm for a given amount of throttle.

Shudder - a repeating jerking sensation similar to "chuggle" but more severe and rapid in nature. This condition may be most noticeable during certain ranges of vehicle speed. May also be used to define the condition after converter clutch engagement.

Slipping - a noticeable increase in engine rpm without a vehicle speed increase. A slip usually occurs during or after initial clutch or band engagement.

Soft - a slow, almost unnoticeable clutch application with very little shift feel.

Surge - a repeating engine related feeling of acceleration and deceleration that is less intense than "chuggle."

Tie-up - a condition where two opposing clutches are attempting to apply at the same time causing the engine to labor with a noticeable loss of engine rpm.

Noise Conditions

Gear noise - a whine, most noticeable in first gear and reverse that is related to vehicle speed. A gear noise condition may become less noticeable or go away after an upshift.

Pump noise - a high pitch whine that increases in intensity with engine rpm. This condition may also be noticeable in the "PARK" and "NEUTRAL" operating ranges with the vehicle stationary.

PRELIMINARY CHECKING PROCEDURE

Transmission performance may be influenced by one or a combination of the following items. These items should be checked and corrected if necessary, before attempting transmission diagnosis.

- High or low fluid level.
- Engine performance. Refer to ENGINE GENERAL INFORMATION AND MECHANICAL DIAGNOSIS (SEC. 6) and DRIVEABILITY AND EMISSIONS - GENERAL INFORMATION (SEC. 6E).
- Throttle Valve (TV) cable setting.
- Manual linkage adjustment.
- Internal fluid leaks. Refer to AUTOMATIC TRANSMISSION DIAGNOSIS (SEC. HYDRA-MATIC 4L60).
- Electrical system. Refer to ENGINE ELECTRICAL (SEC. 6D) and ELECTRICAL DIAGNOSIS (SEC. 8A).
- Transmission or other mechanical component. Refer to AUTOMATIC TRANSMISSION DIAGNOSIS (SEC. HYDRA-MATIC 4L60).

NOISE AND VIBRATION ANALYSIS

A noise or vibration that is noticeable when the vehicle is in motion, may not be the result of the transmission.

If noise or vibration is noticeable in "PARK" and "NEUTRAL" with engine at idle, but is less noticeable as rpm increases, the cause may be from poor engine performance.

Inspect

- Tires for:
  - Uneven wear.
  - Imbalance.
  - Mixed sizes.
  - Mixed radial and bias ply.
  - Refer to TIRES AND WHEELS (SEC. 3E).
- Suspension components for:
  - Alignment and wear.
  - Loose fasteners.
  - Refer to FRONT SUSPENSION (SEC. 3C).
- Engine and transmission mounts for:
  - Damage.
  - Loose bolts.
- Transmission case mounting holes for:
  - Missing bolts, nuts, studs.
  - Stripped threads.
  - Cracks.
- Flywheel for:
  - Missing or loose bolts.
  - Cracks.
  - Imbalance.
- Torque converter for:
  - Missing or loose bolts or lug nuts.
  - Missing or loose balance weights.
  - Imbalance.

TRANSMISSION FLUID INFORMATION

Checking fluid level, color and condition at regular intervals will provide early diagnosis information about the transmission. This information may then be used to correct a condition that, if not detected early, could result in major transmission repairs.

When adding or changing fluid, use only DEXRON®II, or equivalent. Refer to MAINTENANCE AND LUBRICATION (SEC. 0B) for maintenance information and servicing intervals.

> **NOTICE:** Do not overfill. Overfilling will cause foaming, loss of fluid and possible damage to the transmission.

- Fluid level should be checked when it reaches normal operating temperatures of 82°-93°C (180°-200°F). This temperature is reached after approximately 24 km (15 miles) of highway driving.
- Fluid color will be red, when new.

Important

When new, automatic transmission fluid is red in color. The red dye is added so the assembly plant can identify it as transmission fluid and distinguish it from engine oil or anti-freeze. The red dye, which is not an indicator of fluid quality, is not permanent. As the vehicle is driven the transmission fluid will begin to look darker in color. The color may eventually appear light brown.

- Inaccurate fluid level readings will result if the fluid is checked immediately after the vehicle has been operated:

  - In high ambient temperatures above 32°C (90°F).
  - At sustained high speeds.
  - In heavy city traffic during hot weather.
  - As a towing vehicle.

TRANSMISSION FLUID CHECKING PROCEDURE

Figure 3

NOTICE: The automatic transmission fluid level must be checked with the vehicle at normal operating temperature, 82° to 93°C (180° to 200°F). Temperature will greatly affect transmission fluid level. If the vehicle is not at normal operating temperature and the proper checking procedures are not followed, the results could be a false reading on the fluid level indicator and an incorrect adjustment of the fluid level. Incorrect fluid level may cause poor transmission performance and possible damage.

1. Start engine and operate vehicle for a minimum of 24 km (15 miles) or until a normal operating temperature is reached.
2. Park vehicle on level ground.
3. Move gear selector to "PARK."
4. Apply parking brake and block wheels.
5. Let vehicle idle for 3 minutes with accessories off.
6. Check fluid level, color and condition.

GENERAL SERVICE PROCEDURES

PARTS CLEANING, INSPECTION AND REPLACEMENT

- Use appropriate safety equipment such as:
  - Safety glasses.
  - Safety shoes.
  - Gloves.
- Keep work areas and tools clean.
- Clean transmission exterior before removing parts.
- Do not use wipe cloths or rags.
- Do not use solvents on:
  - Rubber seals.
  - Plastic/Teflon® thrust washers or spacers.
- Blow out all passages with compressed air.
- Clean out small passages with fine wire.
- Handle parts carefully to prevent damage.

NOTICE: Do not use any type of grease to retain parts during assembly of this unit. Greases other than the recommended assembly lube will change transmission fluid characteristics and cause undesirable shift conditions and/or filter clogging. The assembly of some components will require use of an assembly lube. It is recommended that Transjel™, or equivalent be used during assembly.

- Lubricate all internal parts with Transjel™, or equivalent, during assembly.
- When installing screws, bolts or studs into aluminum, always dip the threads in Transjel™, or equivalent.
- Always use a torque wrench for proper tightening.
- Recondition damaged or stripped aluminum threads with thread inserts.
- Replace all gaskets and O-ring seals.
  - Do not use gasket cement or sealers.
- Replace Teflon® and rubber lip seals only when necessary and install using the appropriate seal installer and sizer.

Inspect

- Manual linkage for:
  - Wear at pivoting points.
  - Bent or broken links and rods.
- All seals, gaskets, O-ring seals and mating surfaces for:
  - Nicks.
  - Cuts.
  - Damage.
- Snap rings for:
  - Expansion or compression.
  - Distortion.
  - Nicks.
  - Proper ring to groove fit.
- Bearings and thrust surfaces for:
  - Wear.
  - Scoring.
  - Pitting.

FLYWHEEL/TORQUE CONVERTER VIBRATION TEST PROCEDURE

NOTICE: Some engine/transmission combinations cannot be balanced in this manner due to limited clearances between the torque converter bolts and the engine. Be sure bolts do not bottom out in lug nuts or the torque converter cover could be dented and cause internal damage.

Remove or Disconnect

- Start engine.
- With engine at idle speed and the transmission in "PARK" or "NEUTRAL," observe vibration.
- Shut off engine.

1. Converter cover bolts (840).
2. Flywheel to torque converter attaching bolts (842).

- Rotate torque converter 120 degrees (1/3 turn).

Install or Connect

NOTICE: See "Notice" on page 7A-1 of this section for steps 1 and 2.

1. Flywheel to torque converter attaching bolts (842).

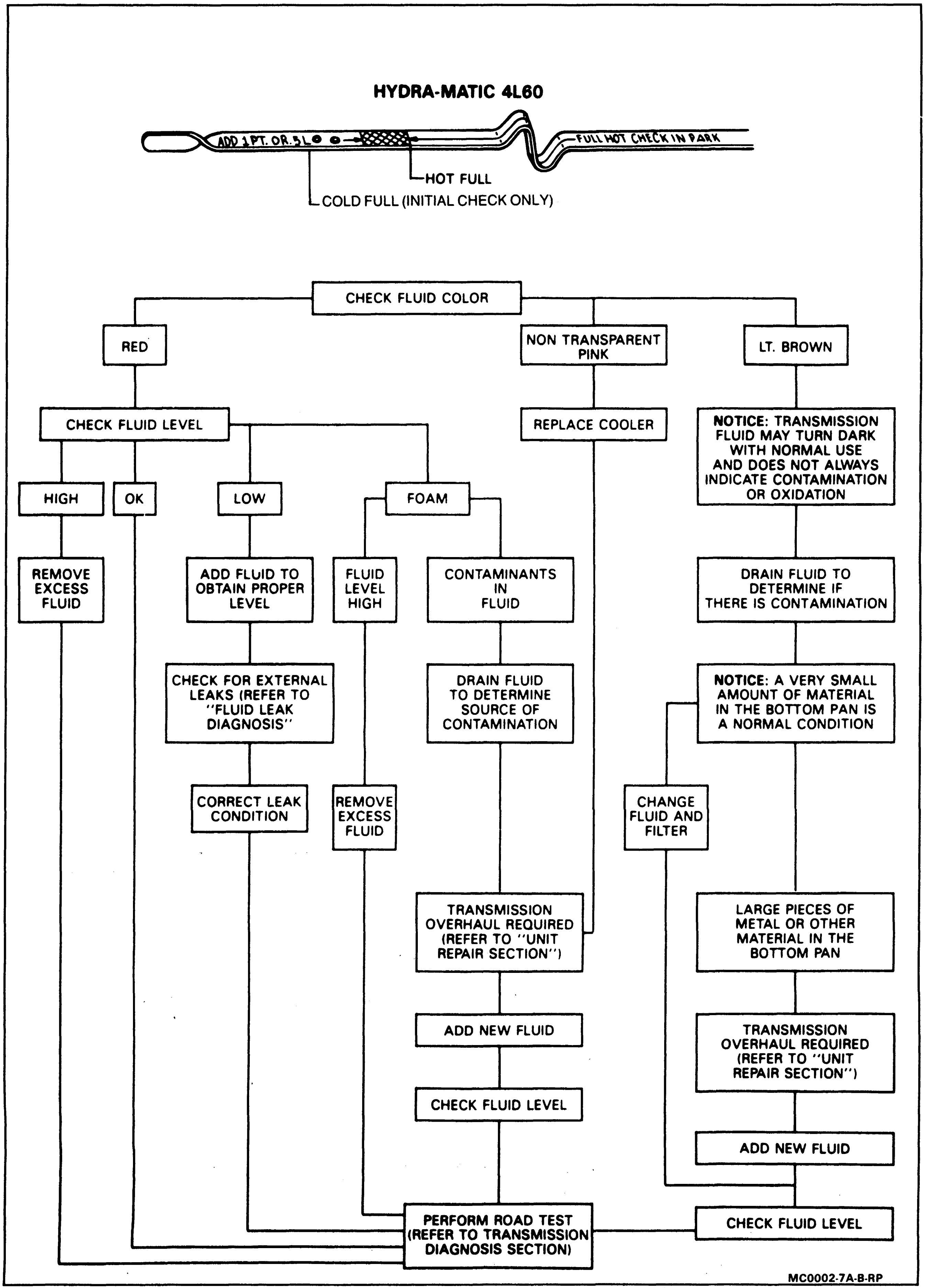


Figure 3 - Checking Fluid Color, Level and Condition

Tighten

- Bolts (842) to 63 N·m (46 lb. ft.).

2. Converter cover bolts (840).

Tighten

- Bolts (840) to 10 N·m (89 lb. in.).

- Start engine and check for vibration.
  - If vibration still exists, repeat this procedure until the best possible balance is obtained.

FLUID LEAK DIAGNOSIS

Figure 4

The cause of most external leaks generally can be located and repaired with the transmission in the vehicle.

Methods for Locating Leak

General Method

1. Verify that the leak is transmission fluid.
2. Thoroughly clean the suspected leak area.
3. Operate the vehicle for about 24 km (15 miles) or until normal operating temperatures are reached.
4. Park the vehicle over clean paper or cardboard.
5. Shut off engine and look for fluid spots on paper.
6. Make necessary repairs.

Powder Method

1. Thoroughly clean the suspected leak area with solvent.
2. Apply an aerosol type powder (foot powder) to the suspected leak area.
3. Operate the vehicle for about 24 km (15 miles) or until normal operating temperatures are reached.
4. Shut off engine.
5. Inspect suspected leak area and trace the leak path through the powder to find the source.
6. Make necessary repairs.

Dye and Black Light Method

A fluid dye and black light kit is available from various tool manufacturers.

1. Follow the manufacturer's recommendations for the amount of dye to be used.
2. Detect the leak with the black light.
3. Make necessary repairs.

Repairing the Leak

Once the leak has been pinpointed and traced back to its source, the cause of the leak must be determined for it to be repaired properly. For example, if a gasket is replaced, but the sealing flange is bent, the new gasket will not repair the leak. The bent flange must be repaired also. The following conditions may cause a leak. Before attempting to repair a leak, these conditions should be checked and corrected if necessary.

Gaskets

Inspect

- Fluid level/pressure is too high.
- Plugged vent or drain-back holes.
- Improperly tightened fasteners, dirty or damaged threads.
- Warped flanges or sealing surface.
- Scratches, burrs or other damage to the sealing surface.
- Damaged or worn gasket.
- Cracking or porosity of the component.
- Improper sealant used, where applicable.
- Incorrect gasket.

Seals

Inspect

- Fluid level/pressure is too high.
- Plugged vent or drain-back holes.
- Damaged seal bore.
- Damaged or worn seal.
- Improper installation.
- Cracks in component.
- Scratched, nicked or damaged, manual or output shaft surface.
- Loose or worn bearing causing excess seal wear.

Possible Points of Fluid Leaks

Transmission Oil Pan

Inspect

- Incorrectly tightened attaching bolts.
- Improperly installed or damaged gasket.
- Damaged oil pan.
- Incorrect gasket.

Case Leak

Inspect

- Damaged or missing filler tube seal.
- Mislocated filler tube bracket.
- Missing, damaged, or improperly installed TV cable seal.
- Damaged or missing governor cover and O-ring seals.
- Damaged speedometer driven gear/speed sensor seal.
- Damaged manual shaft seal.
- Loose or damaged oil cooler connector fittings.
- Worn or damaged propeller shaft oil seal.
- Loose parking pawl shaft cup plug, if equipped.
- Loose governor pressure pipe plug.
- Loose line pressure pipe plug.

- Porous casting.

Leak at Converter End

Inspect

- Converter seal damaged.
  - Seal lip cut. Check converter hub for damage.
  - Bushing moved forward and damaged.
  - Garter spring missing from seal.
- Converter leak in weld area.
- Porous casting of the case or pump.

Leak at Vent Pipe or Filler Tube

Inspect

- Over-filled system.
- Water or coolant in fluid. Fluid will appear milky.
- Case porous.
- Incorrect fluid level indicator.
- Plugged vent.
- Plugged drain-back holes.
- Mispositioned oil pump to case gasket, if equipped.

Case Porosity Repair

1. Clean the leak area with solvent and air dry.

   CAUTION: Epoxy cement may cause skin irritations and eye damage. Read and follow all information on the container label as provided by the manufacturer.

2. Mix a sufficient amount of epoxy cement GM 1052533, or equivalent, following the manufacturer's recommendations.
3. While the transmission case is hot, apply epoxy cement with a clean, dry soldering acid brush.
4. Allow the epoxy cement to cure for three hours before starting the engine.
5. Repeat fluid leak diagnosis procedures to determine that the leak has been corrected.

TORQUE CONVERTER CLUTCH ELECTRICAL CONTROLS

The torque converter clutch (TCC) system uses controls that are internal as well as external to the transmission. For internal control components of the TCC system, refer to AUTOMATIC TRANSMISSION DIAGNOSIS (SEC. HYDRA-MATIC 4L60) for wiring diagrams and switch locations.

The external control components of the TCC system include:

Brake release switch -to avoid stalling the engine when braking, the converter clutch is released any time the brakes are applied.

Electronic control module -receives input signals and grounds TCC solenoid to apply clutch when proper operating conditions are met.

Throttle position sensor -sends throttle position information to electronic control module.

Vacuum sensor -sends engine vacuum (load) information to electronic control module.

Vehicle speed sensor -sends vehicle speed information to electronic control module.

Coolant temperature sensor - sends engine coolant temperature information to electronic control module.

TORQUE CONVERTER CLUTCH DIAGNOSIS

To properly diagnose the torque converter clutch (TCC) system, perform all electrical testing first and then the hydraulic testing. Refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (TB1) (SEC. 6E2) or DRIVEABILITY AND EMISSIONS - FUEL INJECTION (PORT) (SEC. 6E3) for additional torque converter clutch information.

ON-VEHICLE SERVICE

SHIFT CONTROL CABLE

Figure 5

Remove or Disconnect

1. Negative (-) battery cable.
- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).
2. Transmission shift cable bracket screws (801), shift cable nut (802) and shift lever nut (803).
- Lower vehicle.
3. Console. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
4. Shift control cable (806) at the control lever and base.
5. Shift control cable (806) from the floor.

Install or Connect

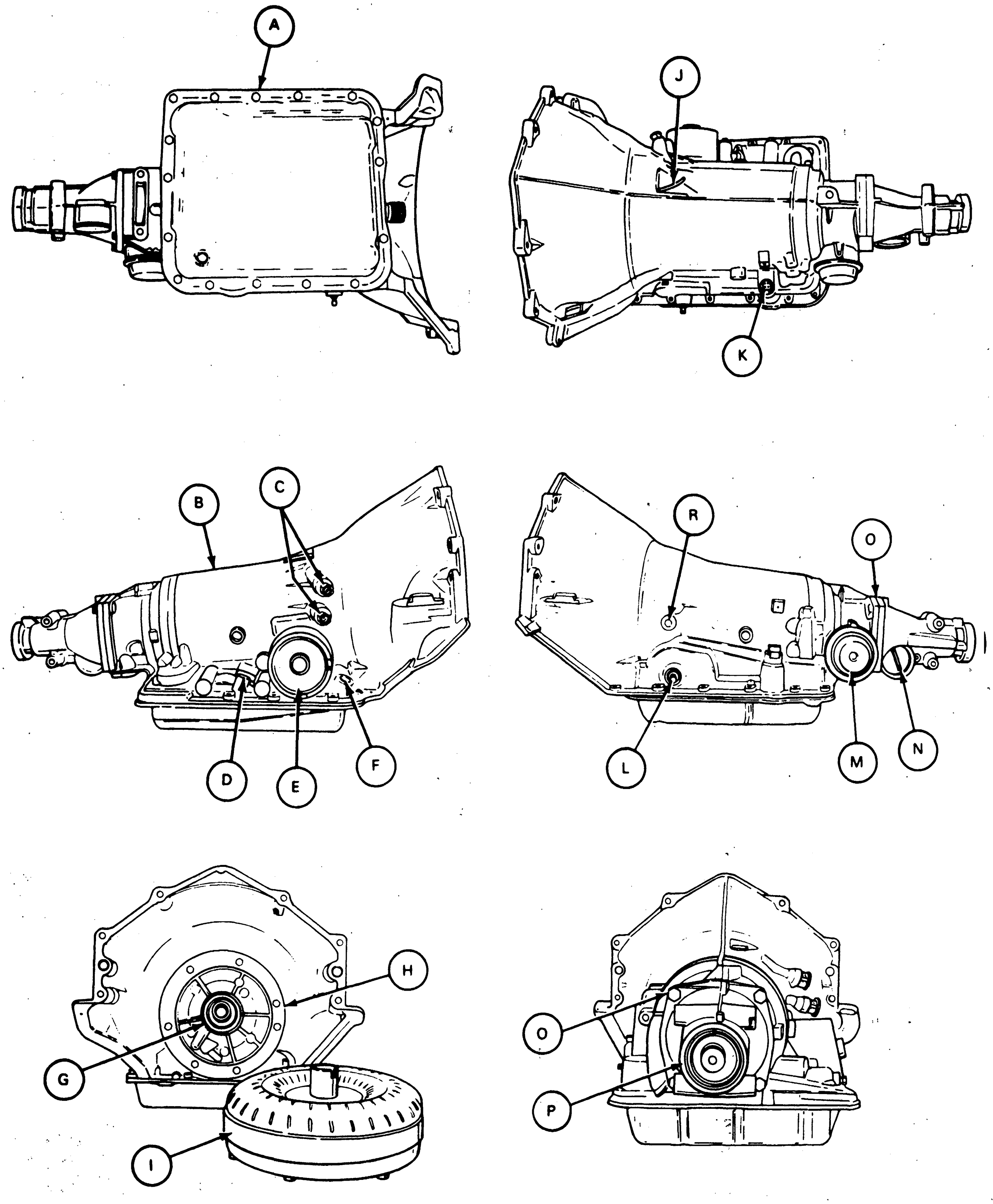
1. Shift control cable (806) to the floor.
2. Shift control cable (806) at base and the shift lever.
3. Console. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
- Place control lever in "NEUTRAL."
- Raise vehicle.

NOTICE: See "Notice" on page 7A-1 of this section.

4. Shift lever nut (803), shift cable nut (802) and shift cable bracket screws (801).

Adjust

- Shift control cable (806).
  - Loosen cable attachment at shift lever.



A BOTTOM PAN GASKET
B CASE
C COOLER CONNECTORS & PIPE PLUGS
D T.V. CABLE SEAL
E SERVO COVER SEAL
F OIL FILL TUBE SEAL
G OIL PUMP SEAL ASSEMBLY
H OIL PUMP TO CASE SEAL
I CONVERTER
J VENT
K ELECTRICAL CONNECTOR SEAL
L MANUAL SHAFT SEAL
M GOVERNOR COVER SEAL
N SPEEDO SEAL
O EXTENSION TO CASE SEAL
P EXTENSION OIL SEAL ASSEMBLY
R LINE PRESSURE TAP

MC0008-7A-B-RP

Figure 4 - Fluid Leak Diagnosis

- Rotate shift lever clockwise to "PARK" detent and then back to "NEUTRAL."

Tighten

- Shift cable nut (802) to 15 N·m (11 lb. ft.).
- Lever must be held out of "PARK" when tightening shift cable nut (802).
- Shift cable bracket screws (801) to 24 N·m (18 lb. ft.).
- Lower vehicle.
- Check cable adjustment by rotating control lever through the detents.

5. Negative (-) battery cable.

FLOORSHIFT CONTROL

Figure 6

Remove or Disconnect

1. Negative (-) battery cable.
2. Console. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
3. Shift control cable (806) at the shift control lever and base.
4. Park-neutral-backup lamp switch.
5. Floorshift control bolts (808).

Install or Connect

NOTICE: See "Notice" on page 7A-1 of this section.

1. Floorshift control bolts (808).

   Tighten

   - Bolts (808) to 5 N·m (44 lb. in.).
2. Park-neutral-backup lamp switch. Refer to "Park-Neutral-Backup Lamp Switch" in this section.
3. Shift control cable (806) at the base and the shift control lever.

   Adjust

   - Shift control cable (806). Refer to "Shift Control Cable" in this section.
4. Console. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
5. Negative (-) battery cable.

PARK/LOCK CONTROL CABLE

Figure 7

Remove or Disconnect

1. Negative (-) battery cable.

- Place transmission shift control lever in "PARK."
- Turn ignition key to "RUN" position.
  - Do not attempt to proceed to step 2 with key in any other position.

2. Park/lock cable (812) from inhibitor by slipping a screwdriver blade into the slot provided in the engine control switch inhibitor and depressing the cable latch.

- Push cable connector lock button (815) at the shifter base to the "UP" position.

3. Snap park/lock cable (812) from the park/lock lever pin.
4. Cable connector latches by depressing and removing from shifter base.
5. Cable clips (813).

Install or Connect

1. Snap park/lock cable (812) into shifter base, make sure that the cable lock button (815) is in the "UP" position and the shift lever is in the "PARK" position.
2. Snap park/lock cable (812) into inhibitor housing, make sure that the ignition key is in the "RUN" position.
   - Do not attempt to insert cable with key in any other position.

- Turn ignition key to "LOCK" position.

3. Snap park/lock cable (812) end onto shifter park/lock lever pin.

- Push cable connector hose forward to remove slack.
- With no load applied to the connector hose, snap cable connector lock button (815) down.

4. Cable clips (813).
5. Negative (-) battery cable.

Inspect

- Functional operation.
  1. With the shift lever in "PARK" and the key in "LOCK" position, make sure that you cannot move the shift lever to another position. Ignition key should be removable from column.
  2. With the key in "RUN" and the shift lever in "NEUTRAL," make sure that you cannot turn the key to "LOCK."
  3. If the above conditions are met, the system is properly adjusted. Proceed to step 5.
  4. If the above conditions are not met, put cable connector lock back to the "UP" position and readjust as indicated above, then push cable connector lock button down and recheck operation.
  5. If key cannot be removed in "PARK" position, snap connector lock button to "UP" position and move cable connector nose rearward until key can be removed from ignition.
  6. Snap lock button down.
  7. Reinstall cable into clips to provide correct routing.

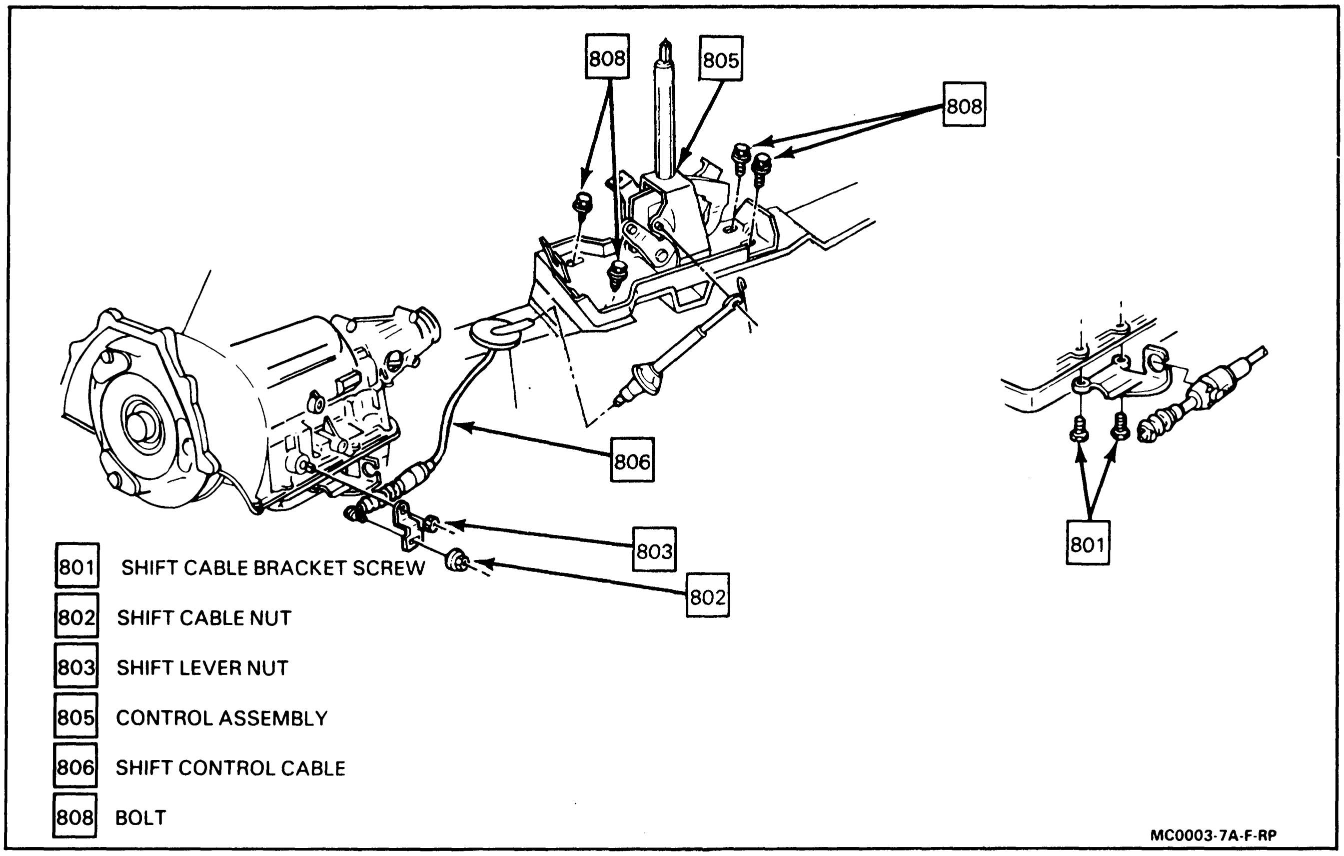


Figure 5 - Shift Control Cable Assembly

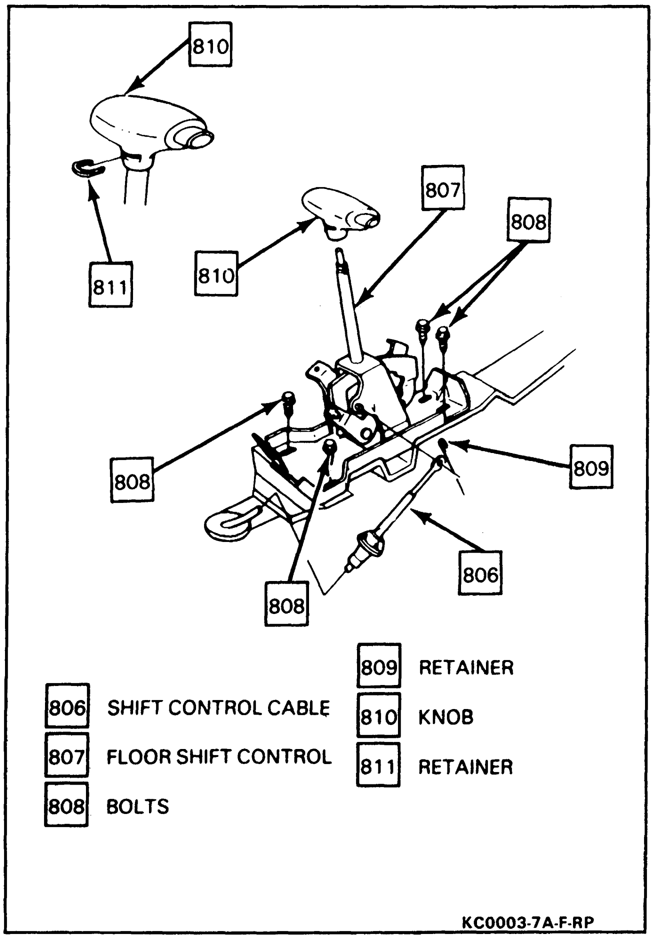


Figure 6 - Floorshift Control

PARK-NEUTRAL-BACKUP LAMP SWITCH

Figure 8

Remove or Disconnect

1. Negative (-) battery cable.
2. Console. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
3. Mounting bolts (819).
4. Switch (817).

Switch Adjustment Using Old Switch

Install or Connect

- Place shift control lever in "NEUTRAL."

1. Carrier tang (818) on switch (817) with tang slot (824) on shift control.
2. Mounting bolts (819) to case, loosely.

- Rotate switch (817) to align service adjustment hole with carrier tang hole.

3. Gage pin (820) 2.34 mm (3/32 inch) into service adjustment hole and rotate switch (817) until gage pin (820) drops to a depth of 15 mm (19/32 inch).

Tighten

- Mounting bolts (819) to 2 N·m (18 lb. in.).

4. Console. Refer to INSTRUMENT PANEL , CLUSTER AND CONSOLE (SEC. 8C).
5. Negative (-) battery cable.

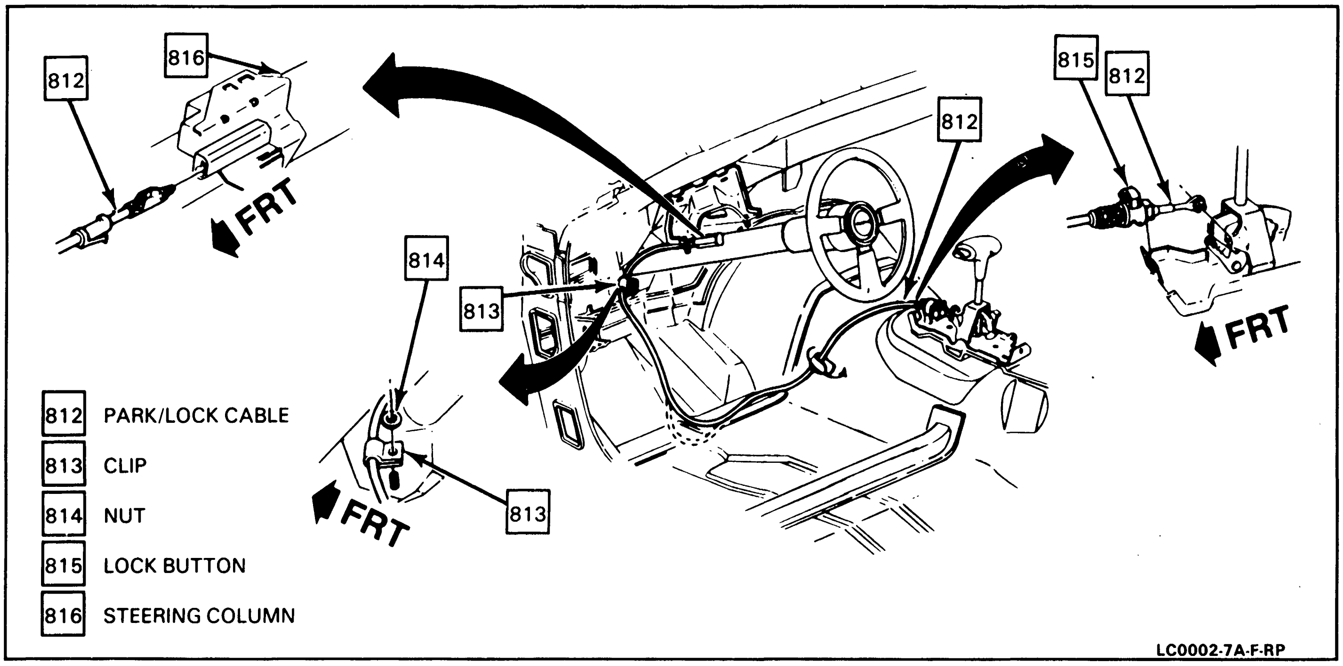


Figure 7 - Park/Lock Control Cable

Important

- After switch adjustment, verify that engine will only start in "PARK" or "NEUTRAL." If engine will start in any other position readjust the switch.

Switch Adjustment Using New Switch

Install or Connect

- Place shift control lever in "NEUTRAL."

1. Carrier tang (818) located on switch (817) into slot on shifter.
2. Mounting bolts (819).

   Tighten

   - Bolts (819) to 2 N·m (18 lb. in.).

   Important

   - If bolt holes do not align with shift control verify shift lever is in "NEUTRAL" position. Do not rotate switch. Switch is pinned in the "NEUTRAL" position. If switch has been rotated and the pin is broken the switch can be adjusted using the "Switch Adjustment Using Old Switch" procedure.

3. Console. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
4. Negative (-) battery cable.

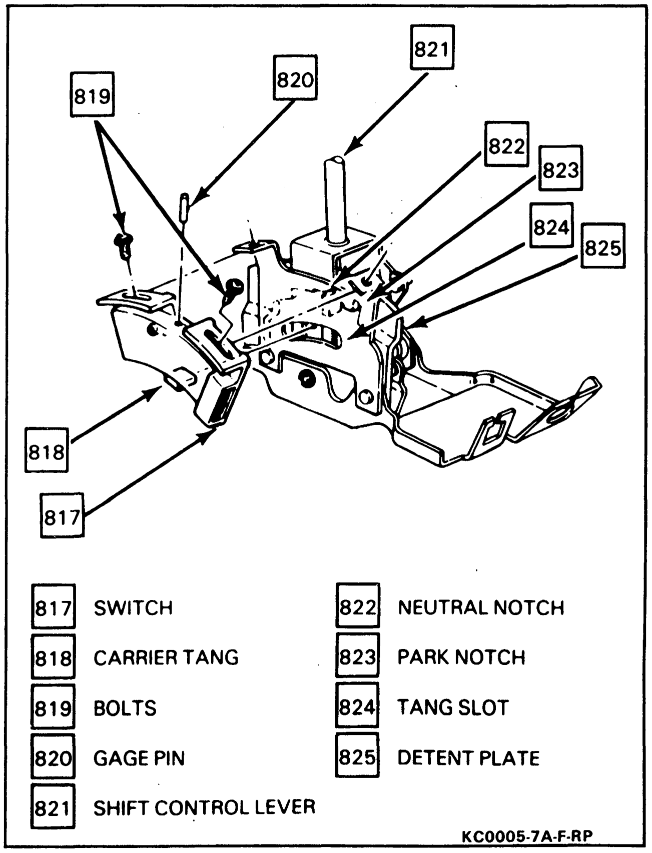


Figure 8 - Park-Neutral-Backup Lamp Switch

TV CABLE SYSTEM

Figures 9 through 12

The TV cable used on the Hydra-Matic 4L60 transmission controls line pressure, shift points, shift feel, part throttle downshifts and detent downshifts. The TV cable operates the throttle valve lever and bracket assembly in the control valve.

The throttle valve lever and bracket assembly serves two basic functions:

- To transfer the throttle lever movement to the TV plunger in the control valve assembly. This causes TV pressure and line pressure to increase according to engine throttle opening and controls part throttle and detent downshifts

- To prevent the transmission from operating at low (idle) pressures, if the TV cable should be broken or disconnected.
  - If the cable is properly connected, the TV lifter rod will remain in its normal position, holding the TV exhaust check ball off its seat.
  - If the cable is broken, disconnected or out of adjustment, the TV lifter rod will drop down to allow the TV exhaust check ball to seat.

Inspect

- With the transmission pan removed, pull down on the TV exhaust valve lifter rod and the spring should return the rod to its normal up position.
  - If the throttle valve lever and bracket assembly or lifter rod binds or sticks so that the TV lifter rod cannot lift the exhaust check ball off its seat, high line pressures and delayed upshifts will result.
  - The TV lifter rod will not function properly if bent.

TV CABLE SYSTEM DIAGNOSIS

CAUTION: To avoid possible personal injury and/or damage to the vehicle, the vehicle parking brake must be applied at all times during all diagnosis procedures.

Inspect

- The following conditions possibly are caused by the TV cable system:
  - Delayed or harsh upshifts.
  - Early and slipping upshifts.
  - High or low line pressure.
  - No upshifts.
  - Chatter on takeoff.
  - 1-2 shift at full throttle only.
  - No full throttle or part throttle detent downshifts.
  - Intermittent second gear starts.
- The above conditions can be caused by a TV cable that is:
  - Improperly set.
  - Kinked or binding.
  - Disconnected.
  - Broken.
  - Wrong part.

Make sure that the engine fuel, electrical and mechanical systems are performing properly before attempting transmission diagnosis. Transmission performance can be affected by a problem existing in another system.

Do not attempt to correct a condition by changing the TV cable setting from its proper adjustment. Apparent improvement as a result of changing the setting indicates that further diagnosis is required to identify the real cause of the condition (such as engine performance or control valve).

Line Pressure Checks

1. Install oil pressure gage.
2. Install engine tachometer.
3. Warm up engine to normal operating temperature.
4. Run engine at 1000 rpm.
5. Make certain parking brake is applied.
6. Place gear selector in "PARK" and note oil pressure.
7. Place gear selector in "DRIVE." Oil pressure should be equal to or not more than 69 kPa (10 psi) higher than in "PARK."
8. Increase engine speed to 1400 rpm. If oil pressure does not increase, set TV cable. Refer to "TV Cable Setting" in this section.

Inspect

- TV cable for kinked, binding, disconnected or broken condition.
- TV cable for correct part number.

Checking Line Pressure Regulation

Inspect

1. Oil pressure gage while manually pulling out the full length of the TV cable. Oil pressure should increase as cable is pulled out.
   - Do not increase the engine's throttle opening while performing this test.
   - If oil pressure does not increase, refer to "Inspection of TV System Parts" in this section.
2. Oil pressure gage as the TV cable is returned to its original position. Oil pressure should decrease smoothly as cable is returned.
   - If oil pressure does not decrease smoothly refer to "Inspection of TV System Parts" in this section.

Checking Lifter and Check Ball "Fail-Safe" System

- Run engine.

1. Disconnect TV cable at throttle linkage.
2. Read the oil pressure gage.
   - The line pressure should increase to the maximum. If line pressure does not increase, refer to "Inspection of TV System Parts" in this section.
3. Stop engine for at least 30 seconds before continuing.
4. Connect TV cable at the throttle linkage.
5. Set the TV cable as described in "TV Cable Setting" in this section.
6. Repeat line pressure checks in "PARK" and "DRIVE" as described in "Line Pressure Checks" in this section.

  - If TV system does not come out of the "fail-safe" mode (pressure remains high) refer to "Inspection of TV System Parts" in this section.

Inspection of TV System Parts

Inspect

- Throttle lever and bracket assembly. Make certain:
  - TV exhaust lifter rod is not distorted and not binding in the control valve assembly or spacer plate.
  - TV exhaust check ball moves up and down as the lifter does.
  - Lifter spring holds the lifter rod up against the bottom of the control valve assembly.
  - TV plunger does not stick at any position of travel.
- Replace or clean parts as necessary.

TV CABLE ASSEMBLY

Figures 9 through 12

Remove or Disconnect

1. Air cleaner.

NOTICE: Do not pry on plastic cable terminal to disconnect cable from throttle lever (831). Prying on cable terminal may cause breakage of terminal or kinking of TV cable (826). Pull cable toward the front of the vehicle.

2. Cable terminal from throttle lever (831) at throttle body.
3. Cable assembly from bracket (830) by compressing locking tangs.
4. Routing clips or straps, if used.

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

5. Bolt (827) and washer securing TV cable (826) to transmission.
6. Seal (828) from transmission case hole.
7. TV cable (826) from transmission link (829).

Install or Connect

1. New seal (828) into transmission case hole.

NOTICE: See "Notice" on page 7A-1 of this section.

2. Transmission end of TV cable (826) to the transmission link (829) and to transmission case with bolt (827) and washer.

Tighten

- Bolt (827) to 10 N·m (89 lb. in).

- Lower vehicle.

3. TV cable routing clips or straps.
4. Pass cable through engine bracket (830) and engage locking tangs of cable on engine bracket (830).
5. Cable terminal to throttle lever (831) at throttle body.

Adjust

- TV cable (826) as described in "TV Cable Setting" in this section.

6. Air cleaner.

TV CABLE SETTING

Figures 11 and 12

Setting of the TV cable must be done by rotating the throttle lever at the carburetor or throttle body. Do not use the accelerator pedal to rotate the throttle lever.

1. Stop engine.
2. Depress and hold down metal reset tab (832) at engine end of TV cable.
3. Move slider (834) until it stops against the fitting (833).
4. Release reset tab (832).
5. Rotate the throttle lever (831) to its "full travel position".
6. The slider (834) must move (ratchet) toward the lever when the lever is rotated to its "full travel position."

Inspect

- Check that cable moves freely. The cable may appear to function properly with the engine stopped and cold. Recheck after the engine is hot.
- Road test the vehicle.

CHANGING FLUID AND FILTER

Figures 13 and 14

Remove or Disconnect

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. OA).
- Place drain pan under transmission oil pan (73).

1. Oil pan screws (74) from the front and sides only.

- Loosen rear oil pan screws (74) approximately four turns.

NOTICE: When removing oil pan screws use caution in order not to damage the transmission case or oil pan sealing sufaces.

- Lightly tap transmission oil pan (73) with a rubber mallet or pry to allow fluid to drain.

Inspect

- Fluid color and condition. Refer to Figure 3.

2. Remaining oil pan screws (74), transmission oil pan (73) and gasket (72).

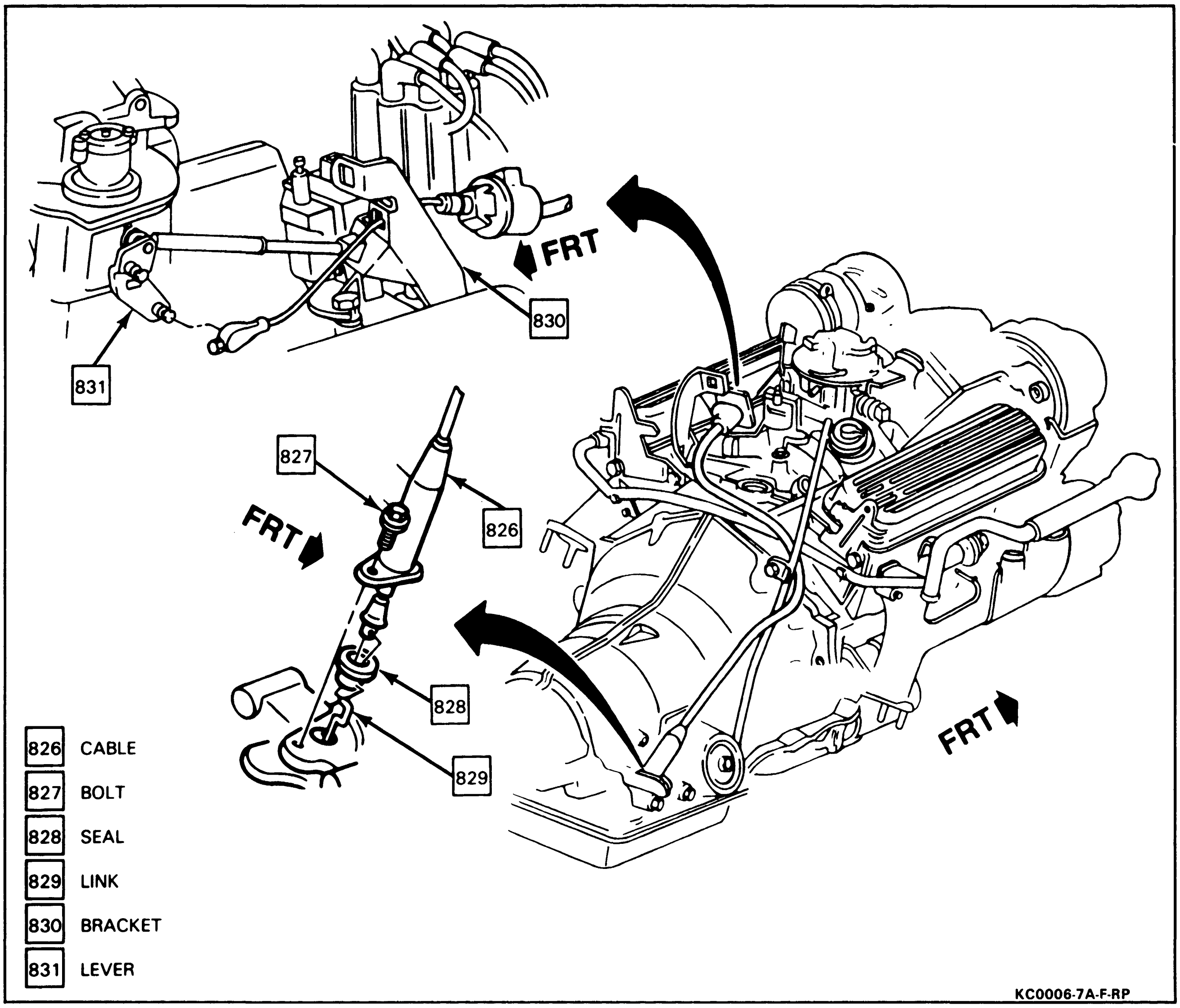


Figure 9 - TV Cable VIN E

3. Oil filter assembly (71) and filter seal (70).
   - Filter seal (70) may be stuck in the case.

Clean

- Transmission case and oil pan gasket surfaces with solvent and air dry. All traces of gasket material must be removed.

Install or Connect

- Coat filter seal (70) with a small amount of Transjel™, or equivalent.

1. New filter seal (70) to the filter assembly (71).
2. Filter assembly (71) and filter seal (70) into the case.

NOTICE: See "Notice" on page 7A-1 of this section.

3. New oil pan gasket (72), transmission oil pan (73) and oil pan screws (74).

NOTICE: Oil pan screw and washer assembly must not be reused if the conical washer is reversed. Failure to replace the screw and washer assembly may result in improper fastening of system components.

Tighten

- Screws (74) to 16 N·m (12 lb. ft.).
- Lower vehicle.
- Fill transmission fluid to proper level.
- Check "COLD" fluid level reading for initial fill only. Refer to "Transmission Fluid Checking Procedure" in this section.
  - Do not overfill.

Inspect

- Oil pan gasket (72) for leaks.

OIL COOLER FLUSHING PROCEDURE

Figures 15 and 16

Tools Required:

J 35944 "Sludge Buster" Oil Cooler and Line Flusher

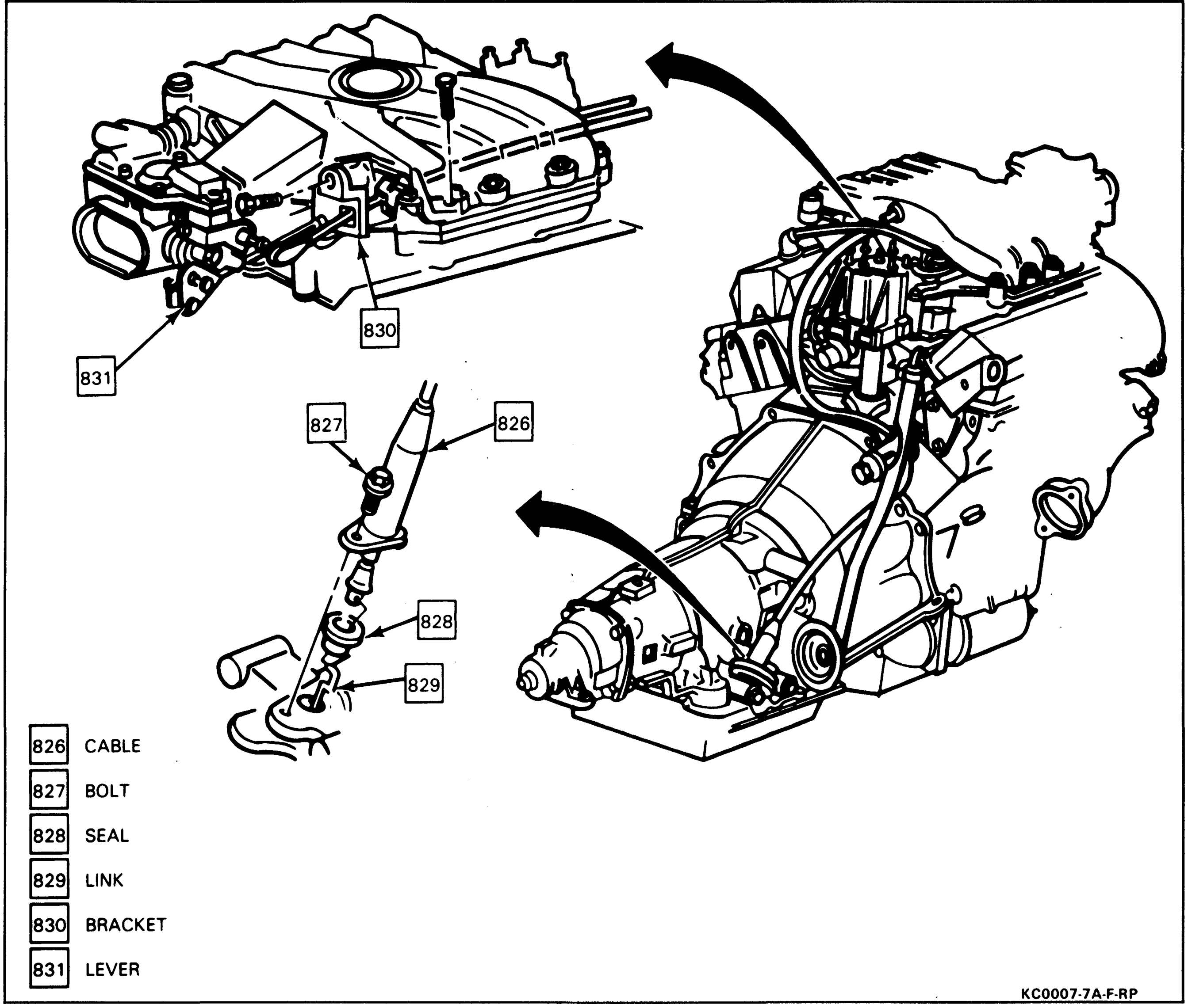


Figure 10 - TV Cable VIN T

J 35944-20 Cooler Flushing Fluid

NOTICE: The oil cooler flushing procedure must be performed whenever a transmission is removed for service to remove existing oil which may be contaminated and to prevent contamination of new oil. The flushing procedure must be performed after installation of the overhauled or replacement assembly.

NOTICE: Flushing tool is designed for use with only J 35944-20 flushing fluid. Use of any other fluid can result in damage to the tool, cooler components, or improper flushing of the cooler.

1. Remove fill cap on J 35944 and fill with 0.6 liters (20-21 ounces) of J 35944-20.
   - Do not overfill tool.
   - Follow manufacturer's suggested procedures for handling the fluid.
2. Replace cap on J 35944 and pressurize to 550-700 kPa (80-100 psi).

NOTICE: Shop air supply must be equipped with a water/oil filter and pressure should not exceed 825 kPa (120 psi). Failure to use a water/oil filter can allow residual moisture to cause corrosion of components. Excessive air pressure can cause damage to components.

3. Install J 35944 to the undercarriage of the vehicle with the hook provided and attach the hose from the flushing tool to the oil cooler pipe that attaches to the **top** fitting at the transmission end of the oil cooler.
4. Install discharge hose to the oil cooler pipe that attaches to the **bottom** fitting at the transmission end of the oil cooler. Clip opposite end of discharge hose to the oil drain container.
5. With the water valve on the tool in the "OFF" position attach the water supply to J 35944.
6. Turn water supply on at the faucet.
7. Flush the transmission fluid by opening the water valve on the tool to the "ON" position for about 10 seconds.
   - If water does not flow through the cooler (the system is completely plugged), do not complete the flushing procedure. Turn water off immediately and inspect the oil

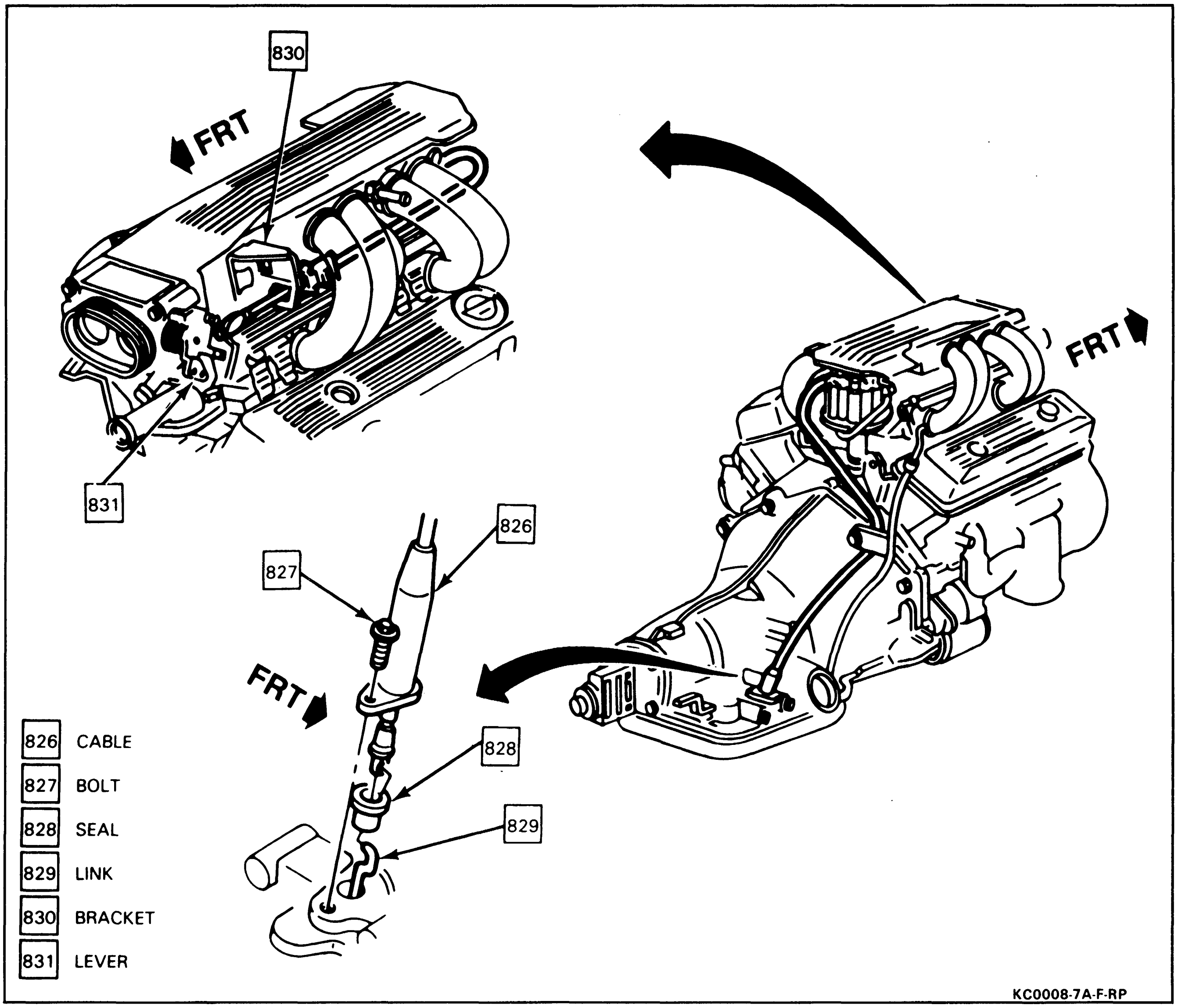


Figure 11 - TV Cable VIN F and 8

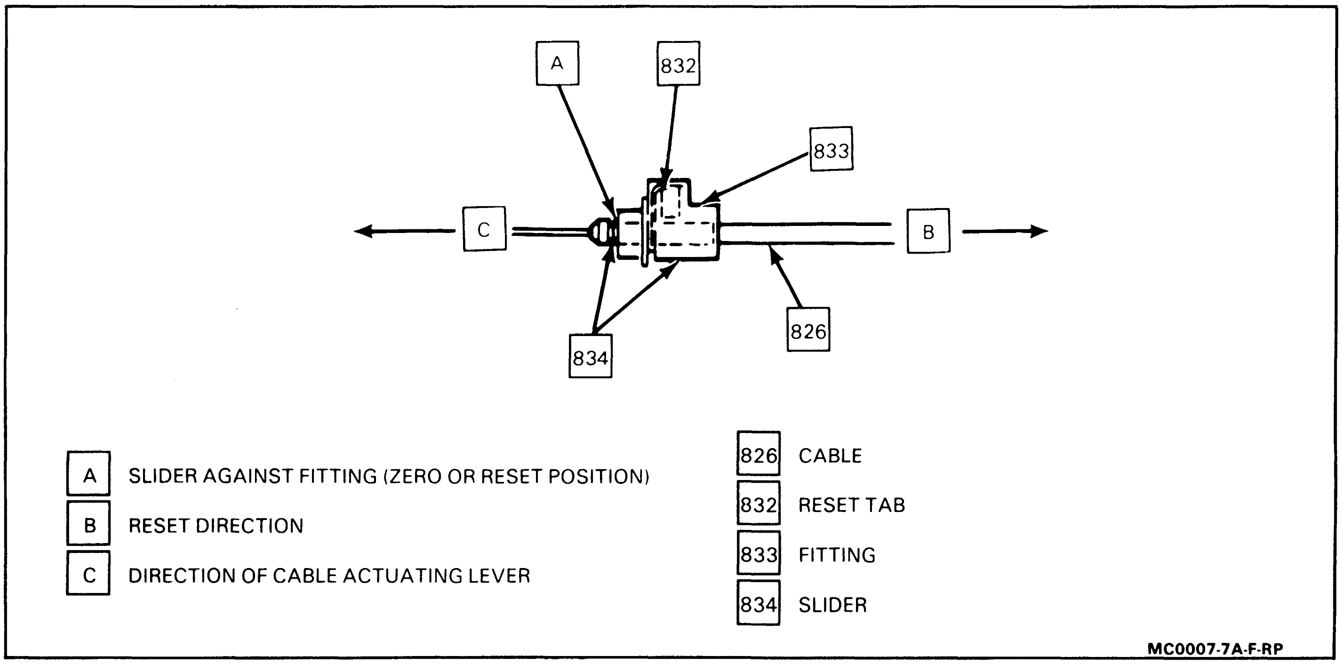
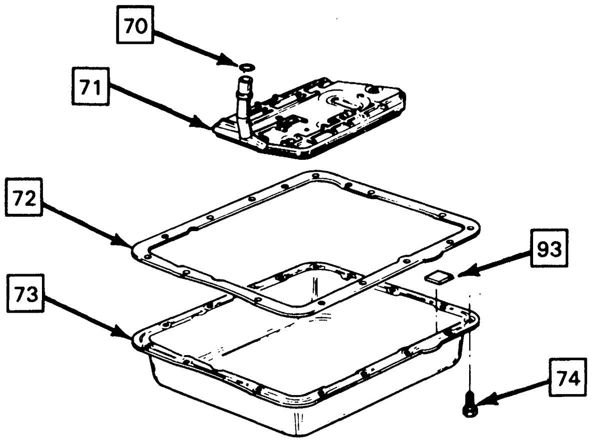


Figure 12 - Setting TV Cable (Part Rotated 90 Degrees)



70	SEAL, FILTER
71	FILTER ASSEMBLY, TRANSMISSION OIL
72	GASKET, TRANSMISSION OIL PAN
73	PAN, TRANSMISSION OIL
74	SCREW, SPEC. HEX WASHER HEAD (PAN)
93	MAGNET, CHIP COLLECTOR

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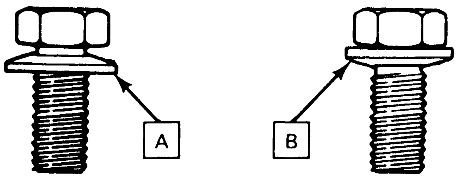
Figure 13 - Oil Pan and Filter



A	SCREW AND CONICAL WASHER ASSEMBLY IS REUSABLE
B	SCREW AND CONICAL WASHER ASSEMBLY IS NOT REUSABLE

LC0004-7A-B-RP

Figure 14 - Oil Pan Screw and Conical Washer Assembly

cooler and pipes for restriction. Replace cooler and/or pipes as required.

8. Turn water valve on tool to the "OFF" position and clip the discharge hose to a 5 gallon pail. Cover the pail with a shop cloth to prevent splash.
9. Turn the water valve on the tool to the "ON" position and depress the trigger to mix flushing fluid into the water flow.
   - Use a bale clip to hold the trigger down.
10. Flush oil cooler with water and fluid for two minutes.
    - Every 15-20 seconds during this flushing procedure attach air supply to the air valve on J 35944 and leave in place for 3-5 seconds to create a surging action for complete cleaning.
11. Release the trigger and turn the water valve on the tool to the "OFF" position.
12. Disconnect both hoses from the oil cooler pipes.
13. Install J 35944 to the oil cooler pipe that attaches to the **bottom** fitting of the oil cooler.
14. Connect the discharge hose to the oil cooler pipe that attaches to the **top** fitting of the oil cooler.
    - Reversing hoses will create a backflush.
15. Repeat steps 9 and 10.
16. Release the trigger and allow water only to rinse the oil cooler for one minute.
17. Turn the water valve on the tool to the "OFF" position and turn water supply off at the faucet.
18. Attach air supply to the air valve on J 35944 and dry the system out with dry compressed air for at least two minutes, Be sure that no moisture can be seen leaving the hose.
    - Use an air chuck clip, if available, to secure air chuck onto the air valve for ease of operation.
19. Remove J 35944 and discharge hose from oil cooler/pipes.
20. Connect the oil cooler feed pipe to the transmission.
    - The feed pipe is the pipe attached to the **bottom** connection at the transmission end of the system.
21. Attach discharge hose to the oil cooler return pipe.
    - The return pipe is the pipe attached to the **top** connection at the transmission end of the system.
22. Attach opposite end of discharge hose to the oil drain container.
23. Fill transmission with fluid.
24. Start engine and run for 30 seconds to remove any residual moisture from the cooler.

Inspect

- Fluid flow through cooler feed lines during the 30 second running period. A minimum of 1.8 liters (2 quarts) of fluid should flow during this time.
- If fluid flow is insufficient, check the flow by disconnecting the feed line at the cooler and observe the flow with the engine running at idle.
- Insufficient Flow: Inspect the transmission for causes.
- Sufficient Flow: Inspect cooler pipes and fittings and repeat cooler flushing procedure. If the flow through the cooler is still insufficient after second flushing procedure, replace the cooler.

25. Disconnect discharge hose.
26. Connect oil cooler return pipe to fitting.

Adjust

- Transmission fluid level

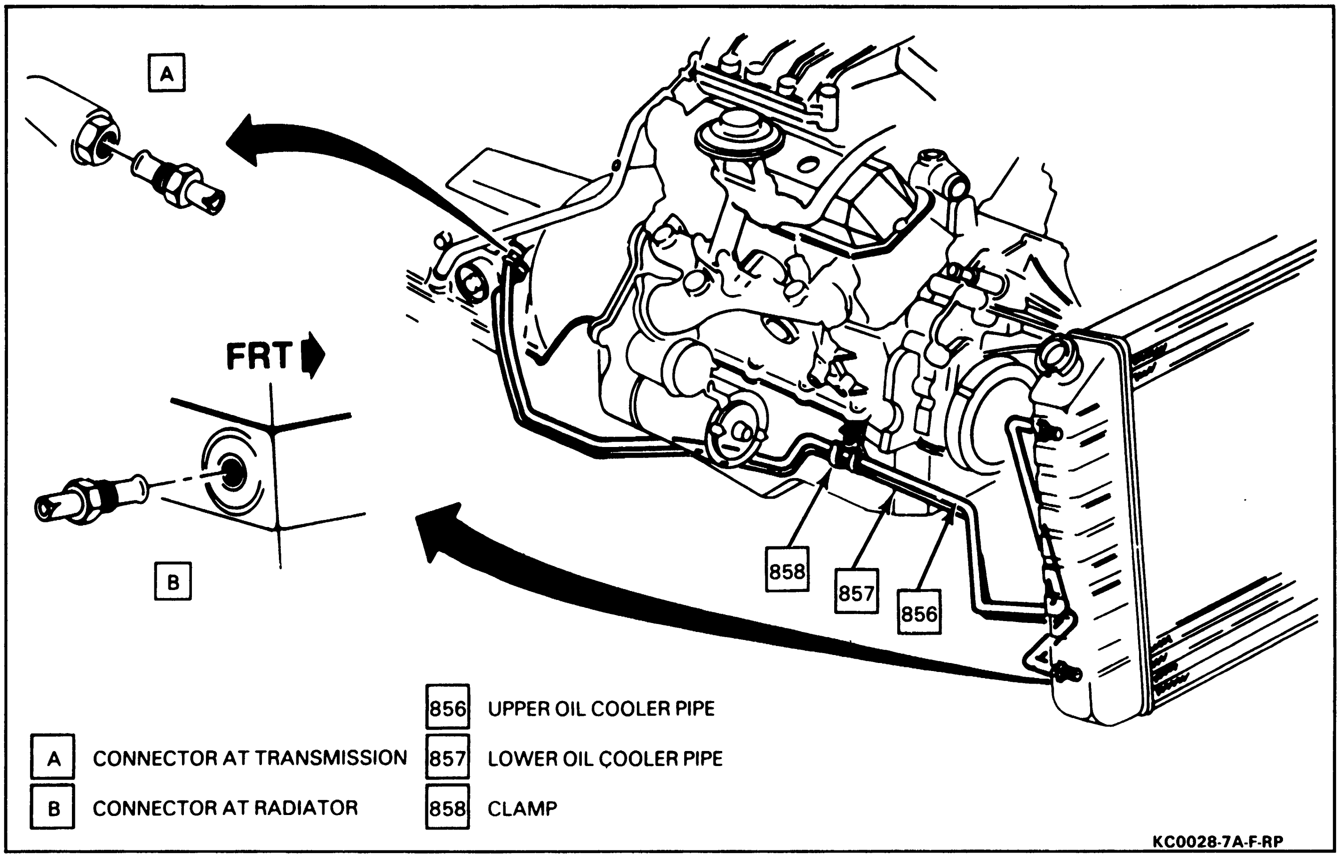


Figure 15 - Oil Cooler Pipes VIN T

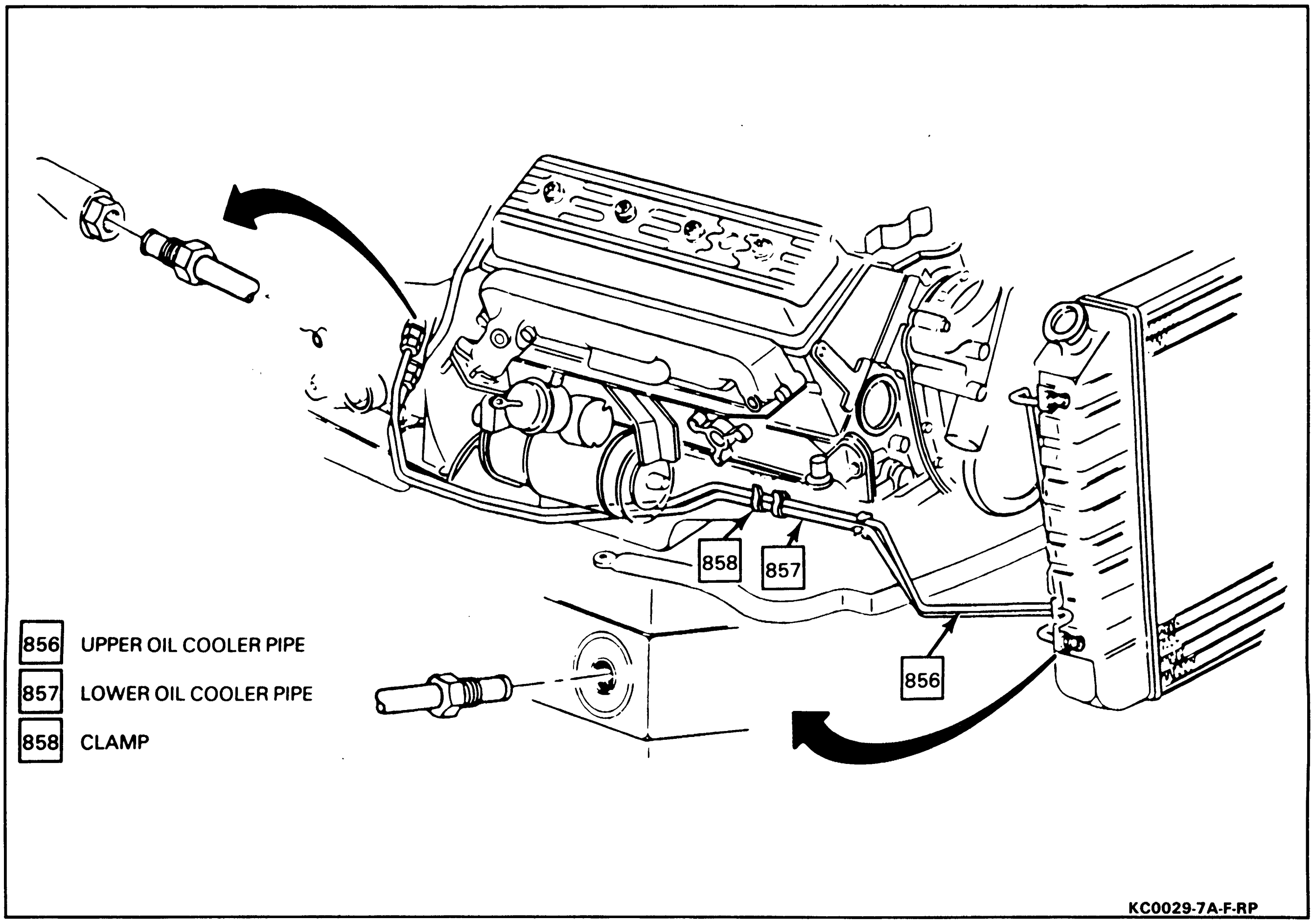


Figure 16 - Oil Cooler Pipes VIN E, F and 8

SERVICEABLE COMPONENTS

OIL PAN SCREWS INSPECTION

Figure 14

Inspect

- Oil pan screws whenever removed from oil pan.

  NOTICE: The oil pan screw and washer assembly must not be reused if the conical washer is reversed. Failure to replace the screw and washer assembly may result in improper fastening of system components.

SERVO ASSEMBLY

Figures 17 and 18

Remove or Disconnect

Tool Required:

J 29714-A Servo Cover Compressor

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Torque arm. Refer to REAR SUSPENSION (SEC. 3D).
2. Propeller shaft. Refer to PROPELLER SHAFT (SEC. 4A).
3. Exhaust hanger.
   - Support transmission.
4. Transmission support and transmission mount.

- Lower transmission.

5. Two transmission oil pan screws from below the servo cover.

- Install J 29714-A on the oil pan and reinstall oil pan screws.
- Depress 2-4 servo cover (15) and remove servo cover retaining ring (13).

6. J 29714-A.
7. 2-4 servo cover (15) and O-ring seal (14), using pliers.
   - Seal (14) might remain in the case.
8. Servo assembly (16 through 31).

Inspect

- Servo assembly. Refer to AUTOMATIC TRANSMISSION UNIT REPAIR (SEC. HYDRA-MATIC 4L60) for disassembly and inspection procedures.

Install or Connect

NOTICE: See "Notice" on page 7A-1 of this section.

1. Servo assembly (16 through 31).
2. New O-ring seal (14) and 2-4 servo cover (15).
3. J 29714-A on oil pan rail.

- Depress 2-4 servo cover (15).

4. Servo cover retaining ring (13).

- Remove J 29714-A.

5. Remaining oil pan screws.

Tighten

- Screws to 16 N·m (12 lb. ft.).

- Raise transmission.

6. Transmission support and transmission mount.

Tighten

- Transmission support bolts to 54 N·m (40 lb. ft.).
- Transmission mount to transmission support nut to 47 N·m (35 lb. ft.).
- Mount transmission bolts to 54 N·m (40 lb. ft.).

- Remove transmission supporting tool.

7. Exhaust hanger.
8. Propeller shaft. Refer to PROPELLER SHAFT (SEC. 4A).
9. Torque arm. Refer to REAR SUSPENSION (SEC. 3D).

- Lower vehicle.

Adjust

- Transmission fluid level.

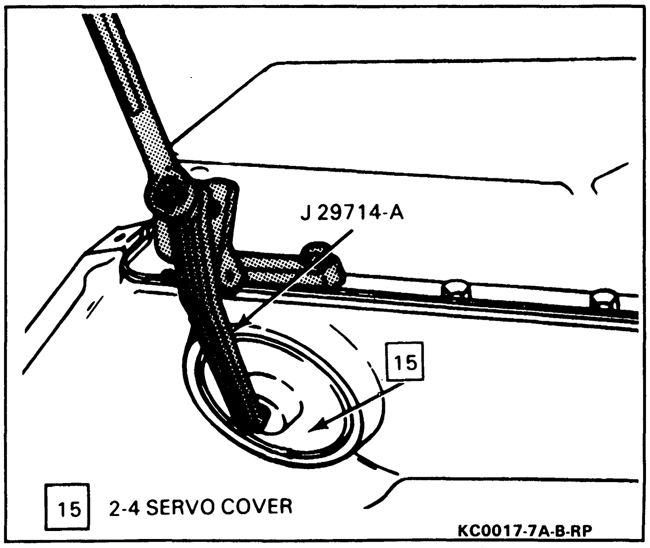


Figure 17 - Removing 2-4 Servo Cover

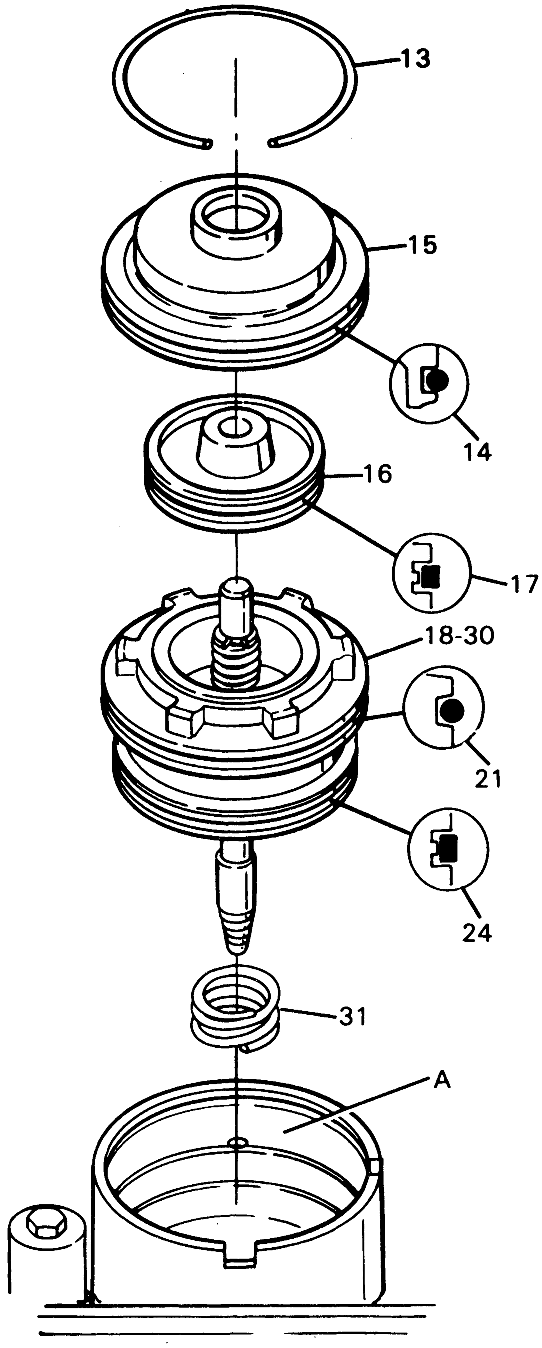
VEHICLE SPEED SENSOR

Figure 19

Remove or Disconnect

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. OA).

1. Electrical connector from vehicle speed sensor (99).
2. Retaining bolt (100).
3. Vehicle speed sens



ILL. NO.	DESCRIPTION
A	CASE SERVO BORE
13	RING, SERVO COVER RETAINING
14	SEAL, "O" RING (2-4 SERVO COVER)
15	COVER, 2-4 SERVO
16	PISTON, 4TH APPLY
17	RING, OIL SEAL (4TH APPLY PISTON) (OUTER)
18-30	2ND APPLY PISTON ASSEMBLY
21	SEAL, "O" RING
24	RING, OIL SEAL (2ND APPLY PISTON) (OUTER)
31	SPRING, SERVO RETURN

JH0057-700R4

Figure 18 - 2-4 Servo Assembly Removal

Inspect

- O-ring seal (42) and transmission case. Replace O-ring seal (42), if necessary.

Install or Connect

1. Vehicle speed sensor (99) to speedometer driven gear (44) and then to transmission.
2. Electrical connector to vehicle speed sensor (99).
3. Retaining bolt (100).

NOTICE: The speedometer driven gear and vehicle speed sensor must be fully seated in the transmission before the retaining bolt is tightened or damage to the speedometer driven gear will result.

Tighten

- Retaining bolt (100) to 10 N·m (89 lb. in.).

- Lower vehicle.

SPEEDOMETER DRIVE GEAR

Figure 20

Remove or Disconnect

1. Vehicle speed sensor and speedometer driven gear as described in "Vehicle Speed Sensor" in this section.
2. Torque arm. Refer to REAR SUSPENSION (SEC. 3D).
3. Propeller shaft. Refer to PROPELLER SHAFT (SEC. 4A).
4. Exhaust hanger.
5. Case extension to case bolts (37).
6. Case extension (36).
7. Speedometer drive gear (689) and retaining clip (688).
8. Output shaft sleeve (690) and seal (691), if equipped.

Inspect

- Speedometer drive gear. Refer to AUTOMATIC TRANSMISSION UNIT REPAIR (SEC. HYDRA-MATIC 4L60) for disassembly and inspection procedures.

Install or Connect

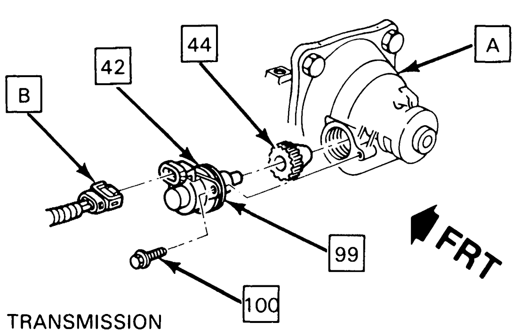
1. Speedometer drive gear (689) and retaining clip (688).
2. Shaft sleeve (690) and seal (691), if removed.
3. Case extension (36) and case extension to case bolts (37).

Tighten

- Bolts (37) to 35 N·m (26 lb. ft.).

4. Exhaust hanger.
5. Propeller shaft. Refer to PROPELLER SHAFT (SEC. 4A).

6. Torque arm. Refer to REAR SUSPENSION (SEC. 3D).
7. Vehicle speed sensor and speedometer driven gear as described in "Vehicle Speed Sensor" in this section.



A	TRANSMISSION
B	ELECTRICAL CONNECTOR
42	O-RING SEAL
44	SPEEDOMETER DRIVEN GEAR
99	VEHICLE SPEED SENSOR
100	RETAINING BOLT

MC0004-7A-F-RP

Figure 19 - Vehicle Speed Sensor and Speedometer Driven Gear

GOVERNOR

Figure 21

Remove or Disconnect

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

1. Governor cover (46).
   - Tap around the governor cover flange with a punch to remove.
   - Do not damage the governor cover.
2. Governor assembly (45).

Inspect

- Governor assembly. Refer to AUTOMATIC TRANSMISSION UNIT REPAIR (SEC. HYDRA-MATIC 4L60) for inspection and disassembly procedures.

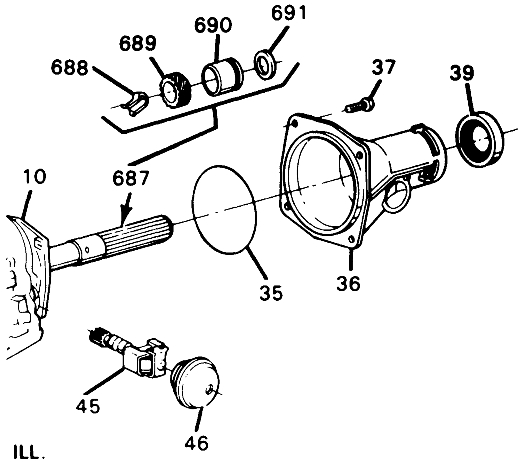
Install or Connect

1. Governor assembly (45) into the governor bore.
2. Governor cover (46).
   - Apply sealant, such as Loctite Cup Plug Sealant II, or equivalent, to cover flange before installing the governor cover (46).

- Lower vehicle.

Adjust

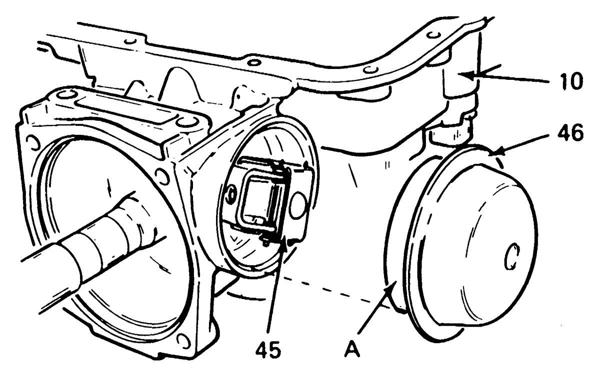
- Transmission fluid level.



ILL. NO.	DESCRIPTION	
10	CASE, TRANSMISSION	
35	SEAL, CASE EXTENSION TO CASE	
36	EXTENSION, CASE	
37	BOLT, CASE EXTENSION TO CASE	
39	SEAL ASSEMBLY, CASE EXTENSION OIL	
40	RETAINER, SPEEDO DRIVEN GEAR FITTING	
45	GOVERNOR ASSEMBLY	
46	COVER, GOVERNOR	
687	SHAFT, OUTPUT	
688	CLIP, SPEEDO DRIVE GEAR	
689	GEAR, SPEEDO DRIVE	
690	SLEEVE, OUTPUT SHAFT	NOT USED ON ALL MODELS
691	SEAL, OUTPUT SHAFT	

MC0006-7A-F-RP

Figure 20 - Speedometer Drive Gear



A	APPLY SEALANT ON THIS FLANGE BEFORE INSTALLATION
10	CASE, TRANSMISSION
45	GOVERNOR ASSEMBLY
46	COVER, GOVERNOR

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Figure 21 - Gov

FILLER TUBE

Figure 22

Remove or Disconnect

1. Fluid level indicator (837).
- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).
2. Bolt (835) retaining filler tube (836) to transmission.
- Loosen filler tube (836) from transmission.
- Lower vehicle.
3. Filler tube (836) and seal (901) from the vehicle by pulling out from the top.

Install or Connect

1. Filler tube (836) through the top of the vehicle.
- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).
2. Filler tube seal (901) into the transmission case hole.
3. Filler tube (836) to transmission.

NOTICE: See "Notice" on page 7A-1 of this section.

4. Filler tube bracket-to-transmission bolt (835).

Tighten

- Bolt (835) on V8 to 47 N·m (35 lb. ft.).
- Bolt (835) on V6 to 75 N·m (55 lb. ft.).
- Lower vehicle.
5. Fluid level indicator (837).

PRESSURE REGULATOR VALVE

Figure 23

Remove or Disconnect

1. Transmission oil pan. Refer to "Changing Fluid and Filter" in this section.
- Compress pressure regulator valve assembly with a small screwdriver.
2. Snap ring (224).
- Slowly release spring tension.
3. Pressure regulator valve assembly (218 through 223).

Inspect

- Pressure regulator valve assembly. Refer to AUTOMATIC TRANSMISSION UNIT REPAIR (SEC. HYDRA-MATIC 4L60) for inspection and disassembly procedures.

Install or Connect

1. Pressure regulator valve (218) into pump cover bore.
2. Pressure regulator spring (219).

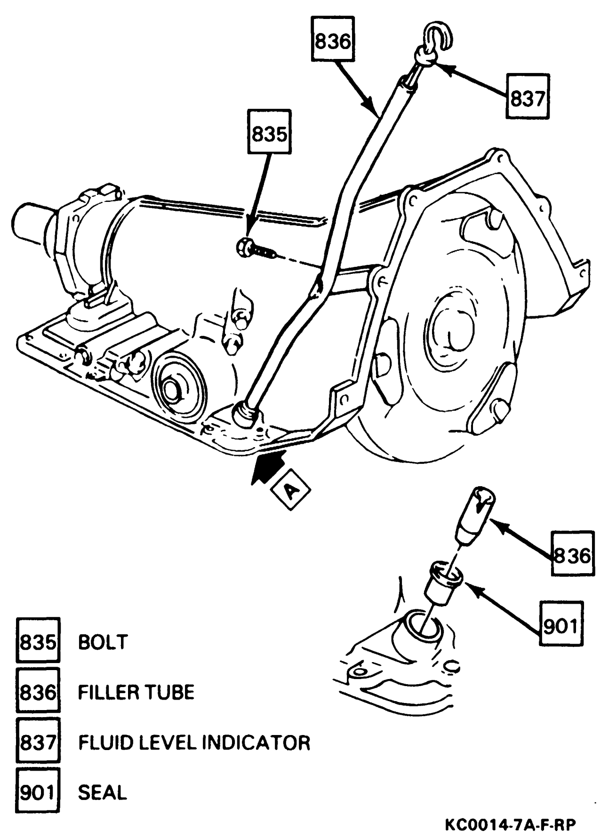

Figure 22 - Typical Filler Tube and Indicator

3. Reverse boost valve (220) into bushing/sleeve (221).
   - Small end first. Retain with Transjel™, or equivalent.
4. Reverse boost valve bushing/sleeve (221) into pump cover bore.
5. TV boost valve (222) into TV boost valve bushing (223).
   - Long land of the valve into the large hole of the bushing. Retain with Transjel™, or equivalent.
6. TV boost valve bushing (223) into pump cover bore.
7. Snap ring (224).
8. Transmission oil pan. Refer to "Changing Fluid and Filter" in this section.

ACCUMULATOR ASSEMBLY

Figure 24

Remove or Disconnect

1. Transmission oil pan and filter. Refer to "Changing Fluid and Filter" in this section.
2. Bolts (63) attaching accumulator cover and pin assembly (62) to valve body.
3. The 1-2 accumulator cover and pin assembly (62).
4. The 1-2 accumulator piston (61), oil seal ring (60), and spring

217	COVER, PUMP
218	VALVE, PRESSURE REGULATOR
219	SPRING, PRESSURE REGULATOR VALVE
220	VALVE, REVERSE BOOST
221	BUSHING/SLEEVE, REVERSE BOOST VALVE
222	VALVE, TV BOOST
223	BUSHING, TV BOOST VALVE
224	RING, SNAP PRESSURE REGULATOR CASE

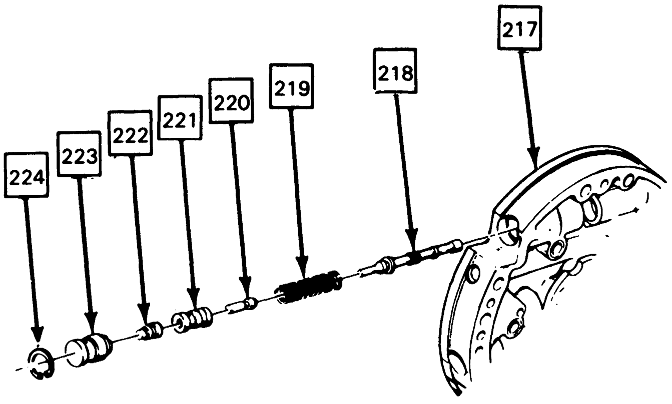

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Figure 23 - Pressure Regulator Assembly

5. Spacer plate (56) and gaskets (88 and 89).
6. The 3-4 accumulator spring (54) and oil seal ring (53).
7. The 3-4 accumulator piston (52) and piston pin (77).

Inspect

- Accumulator assembly. Refer to AUTOMATIC TRANSMISSION UNIT REPAIR (SEC. HYDRA-MATIC 4L60) for disassembly and inspection procedures.

Install or Connect

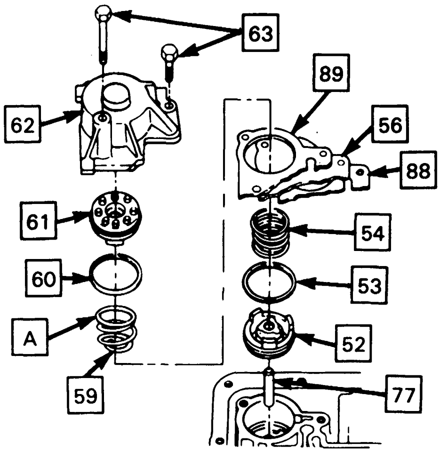
1. Piston pin (77) and 3-4 accumulator piston (52).
2. Oil seal ring (53) and the 3-4 accumulator piston spring (54).
3. Spacer plate (56) and gaskets (88 and 89).
4. Spring (59), oil seal ring (60), and 1-2 accumulator piston (61).
5. The 1-2 accumulator cover and pin assembly (62).
6. Bolts (63) attaching cover to valve body.
7. Transmission oil pan and filter. Refer to "Changing Fluid and Filter" in this section.

AUXILIARY VALVE BODY

Figure 25

Remove or Disconnect

1. Negative battery cable.
2. Transmission oil pan and filter. Refer to "Changing Fluid and Filter" in this section.
3. Tube clamp (97) and valve tube (96).
4. Bolts (374, 375 and 376), auxiliary accumulator valve body assembly (377) and check ball.



A	LARGE END INSTALLED IN PISTON
52	PISTON, 3-4 ACCUMULATOR
53	RING, OIL SEAL (3-4 ACCUMULATOR PISTON)
54	SPRING, 3-4 ACCUMULATOR
56	PLATE, VALVE BODY SPACER
59	SPRING, 1-2 ACCUMULATOR
60	RING, OIL SEAL (1-2 ACCUMULATOR)
61	PISTON, 1-2 ACCUMULATOR
62	COVER & PIN ASSEMBLY, 1-2 ACCUMULATOR
63	BOLT, ACCUMULATOR COVER
77	PIN, ACCUMULATOR PISTON
88	GASKET, SPACER PLATE TO CASE
89	GASKET, SPACER PLATE TO VALVE BODY

LC0006-7A-B-RP

Figure 24 - Accumulator Assembly

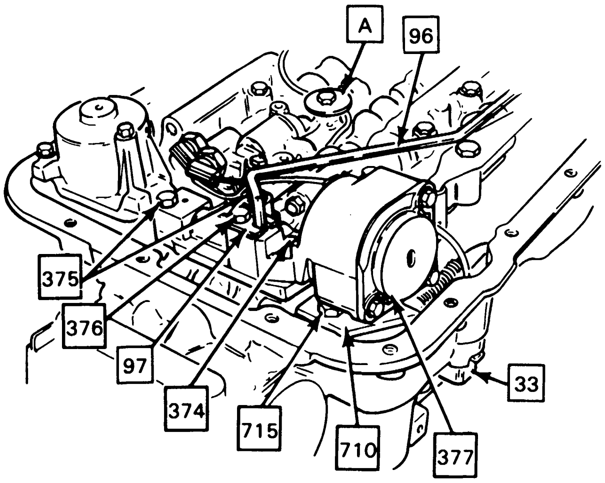
Inspect

- Auxiliary accumulator valve body assembly. Refer to AUTOMATIC TRANSMISSION UNIT REPAIR (SEC. HYDRA-MATIC 4L60) for disassembly an

Install or Connect

NOTICE: See "Notice" on page 7A-1 of this section.

1. Check ball in auxiliary accumulator valve body assembly (377).
   - If necessary, use Transjel™, or equivalent, to hold in place.
2. Auxiliary accumulator valve body assembly (377).
3. Bolts (374, 375 and 376).
4. Valve tube (96).
5. Tube clamp (97).
6. Transmission oil pan and filter. Refer to "Changing Fluid and Filter" in this section.
7. Negative battery cable.



A	WASHER, WIRE RETAINING
33	CONNECTOR, ELECTRICAL
96	TUBE, AUXILIARY ACCUMULATOR VALVE
97	CLAMP
374	BOLT, SPECIAL HEX HEAD (M6 X 1 X 16)
375	BOLT, HEX HEAD (M6 X 1 X 35)
376	BOLT, HEX HEAD (M6 X 1 X 45)
377	AUXILIARY ACCUM. VALVE BODY ASM.
710	BRACKET, PARKING LOCK
715	BOLT, PARKING LOCK BRACKET

LC0007-7A-B-RP

Figure 25 - Removing Auxiliary Valve Body Assembly

CONTROL VALVE ASSEMBLY

Figures 24 and 26 through 31

Remove or Disconnect

1. Negative (-) battery cable.
2. TV cable at throttle lever.
3. Transmission oil pan and filter. Refer to "Changing Fluid and Filter" in this section.
4. Electrical connector. Refer to AUTOMATIC TRANSMISSION DIAGNOSIS (SEC. HYDRA-MATIC 4L60) for specific model applications.
5. Solenoid bolts (51), solenoid assembly (50), O-ring seal (49) and wiring harness.
6. Accumulator cover bolts (63), 1-2 accumulator cover and pin assembly (62).
7. 1-2 accumulator piston (61), oil seal ring (60) and 1-2 accumulator spring (59).
8. Manual valve link (705).
9. Bolt and manual detent spring assembly (709).
10. Electrical wire clips and tube clamps.
11. Auxiliary valve tube (96).
12. Wiring harness, retaining washer filter, filter retainer clips.
13. Bolts (69), TV lever and bracket assembly (65).
14. TV link (64).
15. Control valve assembly (67).
16. Bolts (374, 375 and 376), auxiliary valve body (377), and check ball (55 B).
17. Spacer plate (56) and spacer plate gaskets (88 and 89).
18. Check balls (55A, 55C and 91).
    - The large copper flash colored ball is # 10 check ball (91).
19. 3-4 accumulator spring (54), seal ring (53) and piston (52).

Clean

- Valve body components.

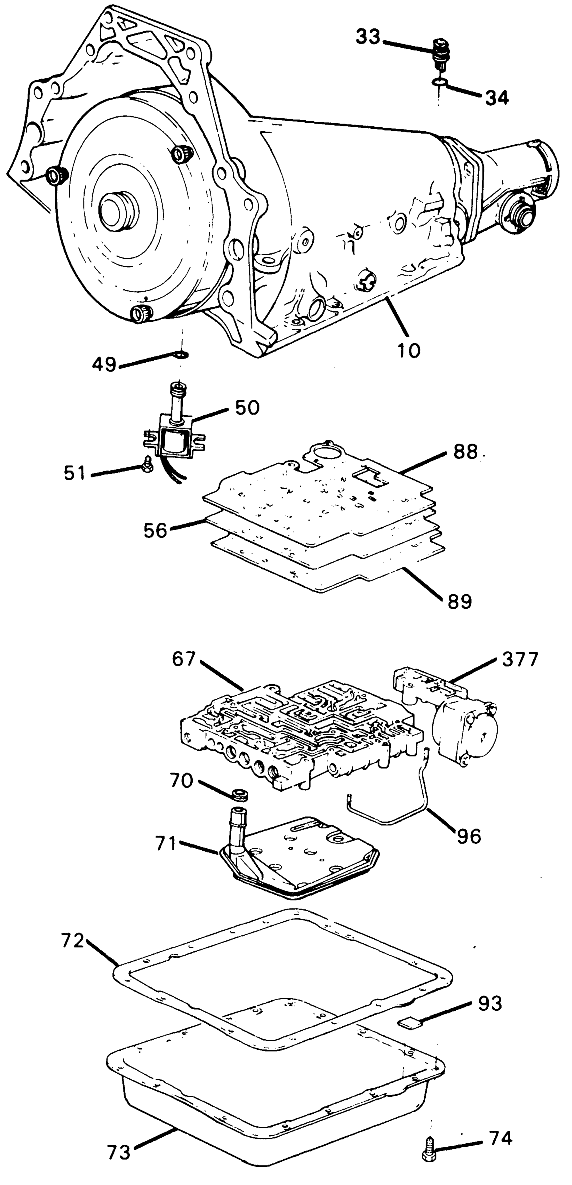
Inspect

- Control valve assembly. Refer to AUTOMATIC TRANSMISSION UNIT REPAIR (SEC. HYDRA-MATIC 4L60) for disassembly and inspection procedures.

Install or Connect

NOTICE: See "Notice" on page 7A-1 of this section.

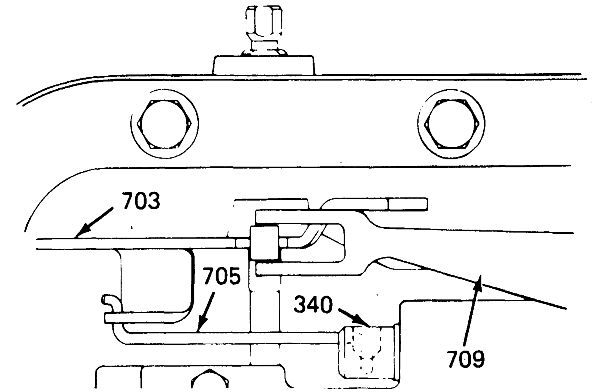
1. 3-4 accumulator spring (54), seal ring (53) and piston (52).
2. Check balls (55A, 55C and 91) into the valve body.
3. Check ball (55B) into auxiliary valve body.
4. Auxiliary valve body (377) and bolts (374, 375 and 376).



ILL. NO.	DESCRIPTION
10	CASE, TRANSMISSION
33	CONNECTOR, ELECTRICAL
34	SEAL, "O" RING (ELECTRICAL CONNECTION)
49	SEAL, "O" RING (SOLENOID)
50	SOLENOID ASSEMBLY
51	BOLT, HEX WASHER HEAD (SOLENOID)
56	PLATE, VALVE BODY SPACER
67	VALVE ASSEMBLY, CONTROL BODY
70	SEAL, FILTER
71	FILTER ASSEMBLY, TRANSMISSION OIL
72	GASKET, TRANSMISSION OIL PAN
73	PAN, TRANSMISSION OIL
74	SCREW, SPEC. HEX WASHER HEAD (PAN)
88	GASKET, SPACER PLATE TO CASE
89	GASKET, SPACER PLATE TO VALVE BODY
93	MAGNET, CHIP COLLECTOR
96	TUBE, AUXILIARY ACCUMULATOR VALVE
377	AUXILIARY ACCUMULATOR VALVE BODY ASSEMBLY

KH0204-700R4

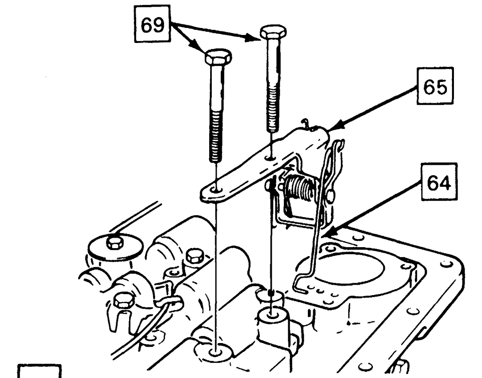
Figure 26 - Transmission Case and Attaching Parts



340	MANUAL VALVE
703	INNER DETENT LEVER
705	MANUAL VALVE LINK
709	MANUAL DETENT SPRING ASSEMBLY

JH0066-700R4

Figure 27 - Manual Detent Spring Assembly



64	LINK, THROTTLE LEVER TO CABLE
65	LEVER & BRACKET ASSEMBLY, THROTTLE
69	BOLTS, VALVE BODY

LC0009-7A-B-RP

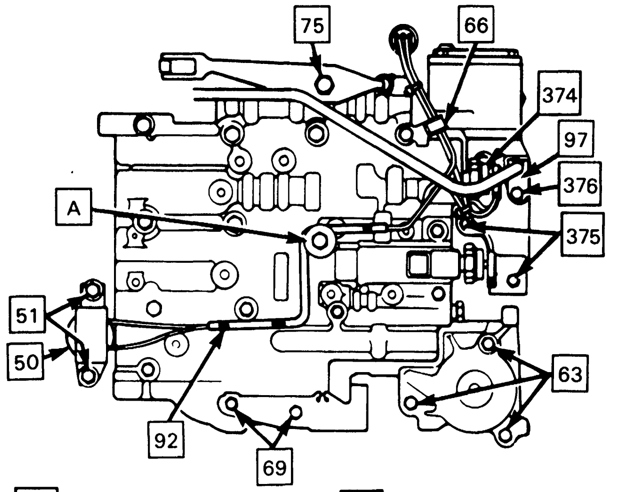
Figure 28 - TV Lever and Bracket Assembly

5. TV lever and bracket assembly (65), TV link (64) and valve body bolts (69).

Tighten

- Bolts (69) to 11 N·m (97 lb. in.).

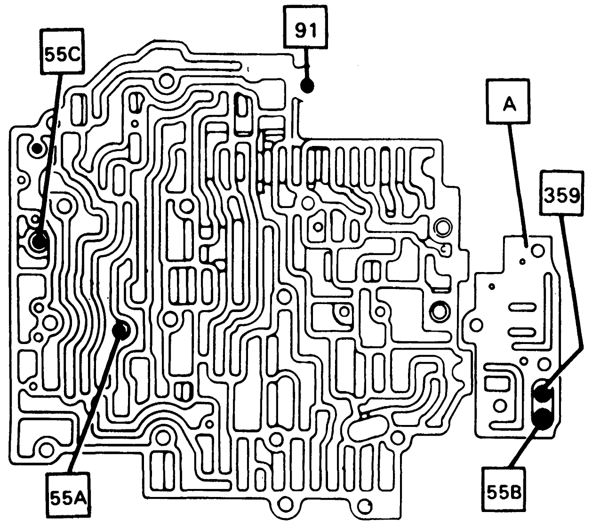
6. Control valve assembly (67), spacer plate (56), spacer plate gaskets (88 and 89).
7. Wiring harness, retainer washer and filter retainer clips.
8. Auxiliary valve tube.
9. Electrical wire clips and tube clamps.
10. Manual detent spring assembly (709), manual valve link (705) and bolt.
11. 1-2 accumulator piston (61), seal ring (60), and spring (59).
12. Accumulator cover and pin assembly (62) and accumulator cover bolts (63).
13. Solenoid assembly (50), O-ring seal (49), solenoid bolts (51) and wiring harness.
14. Electrical connections.
15. Transmission oil filter and oil pan. Refer to "Changing Fluid and Filter" in this section.



A	WASHER WIRE RETAINER
50	SOLENOID ASSEMBLY
51	BOLT, HEX WASHER HEAD (SOLENOID)
63	BOLT, ACCUMULATOR COVER
66	CLIP, ELECTRICAL WIRE
69	BOLT, VALVE BODY
75	BOLT, MANUAL DETENT SPRING
92	CONDUIT, SOLENOID WIRE
97	CLAMP
374	BOLT, SPEC. HEX WASHER HEAD (M6 X 1 X 16)
375	BOLT, HEX HEAD (M6 X 1 X 35)
376	BOLT, HEX HEAD (M6 X 1 X 45)

LC0010-7A-B-RP

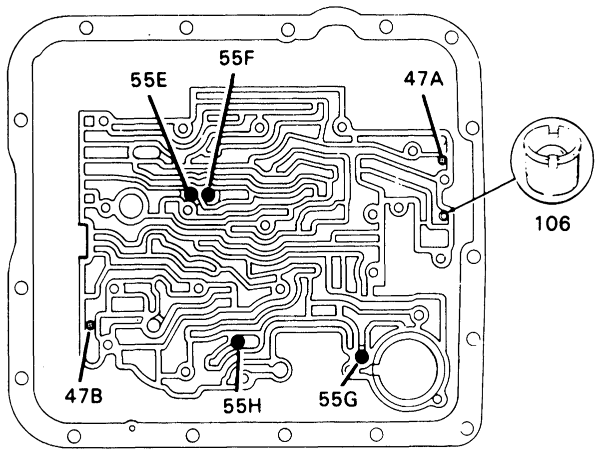
Figure 29 - Valve Body Bolt Locations



A	AUXILIARY VALVE BODY
55A	#2 CHECK BALL (3RD CLUTCH ACCUM.)
55B	#12 CHECK BALL (FORWARD CLUTCH)
55C	#6 CHECK BALL (DRIVE 3)
91	#10 CHECK BALL (T.V. EXHAUST) (COPPER FLASH)
359	CUP PLUG — ORIFICE

LC0011-7A-B-RP

Figure 30 - Valve Body Checkballs



ILL. NO.	DESCRIPTION
47A	GOVERNOR FILTER LOCATION
47B	CONVERTER CLUTCH FILTER LOCATION
55E	#4 CHECK BALL (3-4 CLUTCH/3-2 EX.)
55F	#8 CHECK BALL (2ND/1-2)
55G	#1 CHECK BALL (4TH ACCUMULATOR)
55H	#3 CHECK BALL (PART THROTTLE/DRIVE 3)
106	RETAINER & BALL ASM. (DOUBLE ORIFICE)

JH0069-700R4-R1

Figure 31 - Case Check Balls and Filter

16. TV cable to throttle lever.
17. Negative (-) battery cable.
18. Set TV cable.

Adjust

- Shift linkage.

REAR OIL SEAL

Remove or Disconnect

1. Propeller shaft. Refer to PROPELLER SHAFT (SEC. 4A).
2. Lip oil seal. Pry seal out with a suitable tool.

Install or Connect

Tool Required:

J 21426 Output Shaft Sleeve and Case Extension Oil Seal Installer

1. New lip oil seal. Tap into place with J 21426.
2. Propeller shaft. Refer to PROPELLER SHAFT (SEC. 4A).

Adjust

- Transmission fluid level.

OIL COOLER PIPES

Figures 15 and 16

If replacement of transmission oil cooler pipes is required, use only do tubing meeting GM specification 123 M or equivalent. Tubing should be double flared.

NOTICE: Allow sufficient clearance to cooler pipes to prevent damage or wear which may cause fluid loss.

Remove or Disconnect

1. Connectors at transmission.
2. Connectors at radiator.
3. Engine clamp (858).
4. Oil cooler pipes.

Install or Connect

NOTICE: See "Notice" on page 7A-1 of this section for steps 3 and 4.

1. Engine clamp (858).
2. Oil cooler pipes to engine clamp (858).
3. Connectors at radiator.

   Tighten

   - Nuts to 27 N·m (20 lb. ft.).
4. Connectors at transmission.

   Tighten

   - Nuts to 22 N·m (16 lb. ft.).

TRANSMISSION ASSEMBLY REMOVAL AND INSTALLATION

Figures 32 through 36

A pressure test should be performed before transmission removal to aid in diagnosis.

NOTICE: Transmission oil cooler flushing must be performed when a transmission is removed for service. The flushing procedure should be performed after the installation of the overhauled or replacement assembly. Failure to flush the system may cause damage to the system and its components.

Remove or Disconnect

Tool Required:

J 21366 Converter Holding Strap

1. Negative (-) battery cable.
2. Air cleaner, if necessary.
3. TV cable at throttle lever.
4. Transmission fluid level indicator, bolt retaining filler tube to transmission and filler tube.
- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. OA).
5. Torque arm. Refer to REAR SUSPENSION (SEC. 3D).
6. Propeller shaft. Refer to PROPELLER SHAFT (SEC. 4A) for removal.
7. Shift linkage at the transmission.
8. Electrical leads at the transmission and any clips that retain leads to the transmission case.
9. Bolts (840) and converter cover (839).
- Mark position of flywheel to converter to aid in reassembly.
10. Converter-to-flywheel bolts (842).
11. Catalytic converter support bracket.
12. Transmission mount to support nut (852).
13. Transmission support to frame bolts (854) and insulators (845) if used.
    - Support and raise transmission slightly using a transmission jack.
    - Slide transmission support (850) rearward.
- Lower transmission to gain access to the oil cooler pipes and TV cable attachments.
14. Oil cooler pipes.
    - Cap all openings.
15. TV cable.
- Support engine with a suitable tool.
16. Transmission to engine bolts (843).
- Attach J 21366 to converter assembly (1).
17. Transmission assembly, being careful not to damage any cables, pipes or linkage.

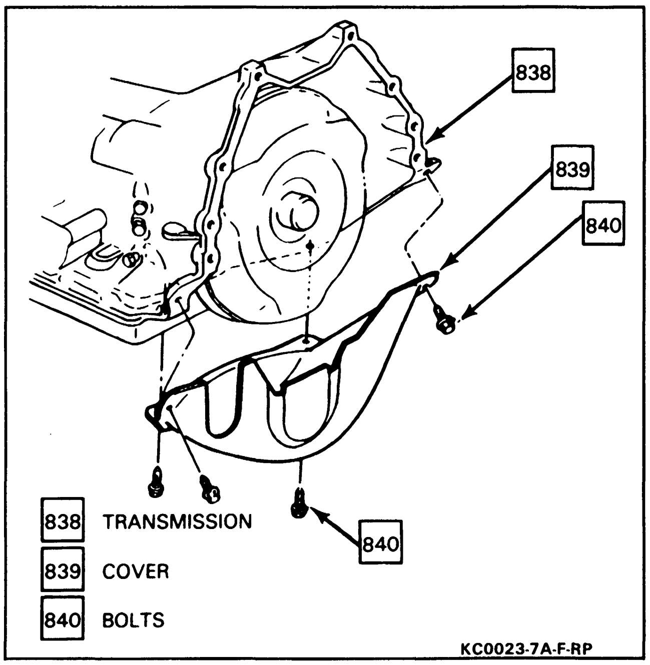


Figure 32 - Converter Cover

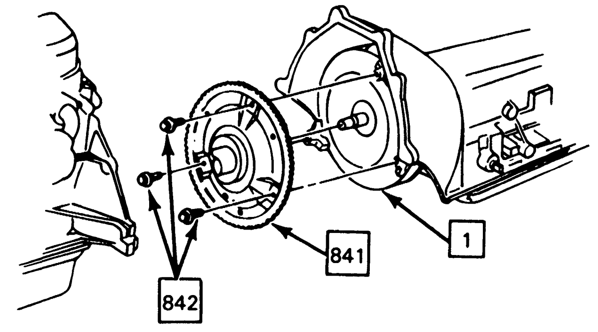
Install or Connect

NOTICE: See "Notice" on page 7A-1 of this section.

- Raise transmission into place.
- Remove J 21366.
1. Transmission to engine bolts (843).

   Tighten

   - Bolts (843) to 47 N·m (35 lb. ft.).
2. Oil cooler pipes.
3. TV cable.
4. Transmission supp



1	CONVERTER ASSEMBLY
841	FLYWHEEL
842	BOLT

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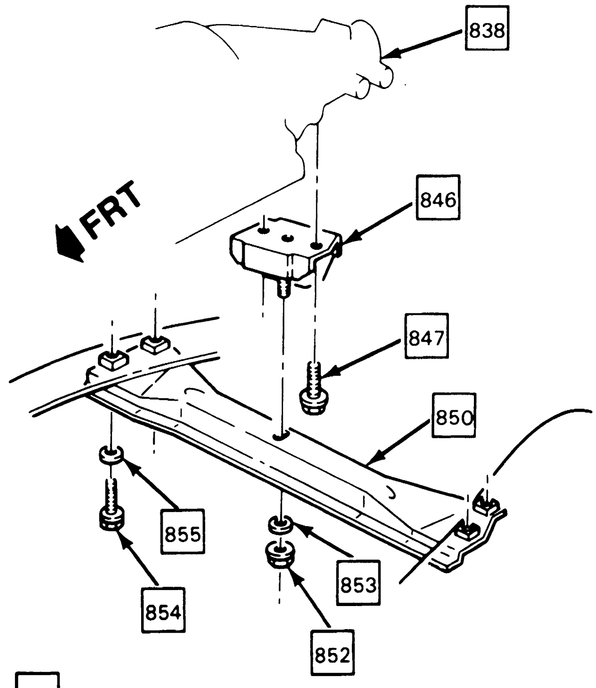
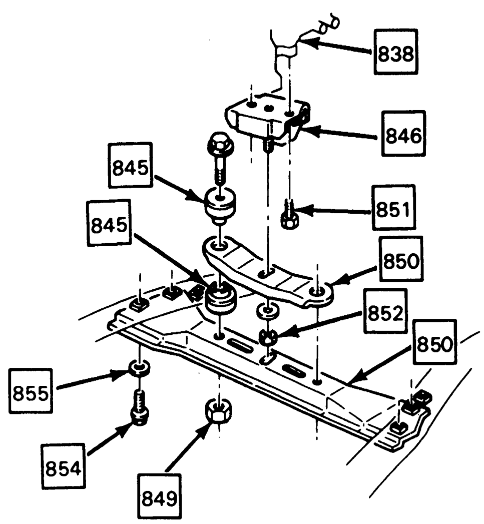
Figure 33 - Converter to Flywheel



838	TRANSMISSION
846	TRANSMISSION MOUNT ASSEMBLY
847	BOLT
850	TRANSMISSION SUPPORT
852	NUT
853	WASHER
854	BOLT
855	WASHER

KC0027-7A-F-RP

Figure 34 - Transmission Mounting LB9, L98 and LO3



838	TRANSMISSION
845	INSULATOR
846	TRANSMISSION MOUNT ASSEMBLY
849	NUT
850	TRANSMISSION SUPPORT
851	BOLT
852	NUT
854	BOLT
855	WASHER

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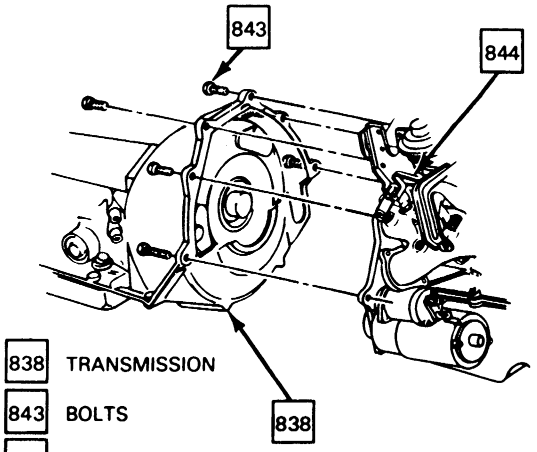
Figure 35 - Transmission Mounting LHO



838	TRANSMISSION
843	BOLTS
844	ENGINE

KC0025-7A-F-RP

Figure 36 -

Tighten

- Bolts (854) to 54 N·m (40 lb. ft.).

5. Transmission support to transmission mount nut (852).

Tighten

- Nut (852) to 47 N·m (35 lb. ft.).

- Remove transmission jack.

6. Converter to flywheel bolts (842).
   - Observe marks made during disassembly and align in original position.
   - Make sure weld nuts on the converter are flush with the flywheel (841).
   - Test converter for freedom of rotation.
   - Finger tighten the three bolts (842), then tighten to specification.

   Tighten

   - Bolts (842) to 63 N·m (46 lb. ft.).
   - Retighten the first bolt which was tightened to specification.
7. Catalytic converter support bracket.
8. Converter cover (839) and bolts (840).

Tighten

- Bolts (840) to 10 N·m (89 lb. in.).

9. Shift linkage.
10. Electrical leads and retaining clips.
11. Propeller shaft. Refer to PROPELLER SHAFT (SEC. 4A).
12. Torque arm. Refer to REAR SUSPENSION (SEC. 3D).

- Lower vehicle.

13. Fluid filler tube and new seal.
14. Bolt retaining filler tube to transmission.

Tighten

- Bolt on V8 to 47 N·m (35 lb. ft.).
- Bolt on V6 to 75 N·m (55 lb. ft.).

15. Fluid level indicator.
16. TV cable at throttle lever.
17. Air cleaner, if necessary.
18. Negative (-) battery cable.

Clean

NOTICE: Transmission oil cooler flushing must be performed when a transmission is removed for service. The flushing procedure should be performed after the installation of the overhauled or replacement assembly. Failure to flush the system may cause damage to the system and its components.

- Transmission oil cooler and oil cooler pipes. Refer to "Oil Cooler Flushing Procedure" in this section.

Adjust

- Shift linkage.
- Set TV cable.
- Transmission fluid level.

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Shift Cable Nut	15 N·m (11 lb. ft.)
Floorshift Control Bolt	5 N·m (44 lb. in.)
Park-Neutral-Backup Lamp Switch Mounting Bolt	2 N·m (18 lb. in.)
Cable Bracket Screw	24 N·m (18 lb. in.)
Transmission Support to Frame Bolt	54 N·m (40 lb. ft.)
Transmission Mount to Transmission Support Nut	47 N·m (35 lb. ft.)
Transmission Mount to Transmission Bolt	54 N·m (40 lb. ft.)
Filler Tube to Transmission Case Bolt - V8	47 N·m (35 lb. ft.)
Filler Tube to Transmission Case Bolt - V6	75 N·m (55 lb. ft.)
Valve Body Bolt	11 N·m (97 lb. in.)
Transmission to Engine Bolt	47 N·m (35 lb. ft.)
Converter to Flywheel Bolt	63 N·m (46 lb. ft.)
Auxiliary Valve Body Bolt	11 N·m (97 lb. in.)
Converter Cover Bolt	10 N·m (89 lb. in.)
Oil Cooler Connector at Transmission	22 N·m (16 lb. ft.)
Oil Cooler Connector at Radiator	27 N·m (20 lb. ft.)
TV Cable to Transmission Bolt	10 N·m (89 lb. in.)
Case Extension Bolt	35 N·m (26 lb. ft.)
Oil Pan Screw	16 N·m (12 lb. ft.)
Vehicle Speed Sensor-to-Transmission Bolt	10 N·m (89 lb. in.)

SPEEDOMETER GEAR CHART

TIRE SIZE	AXLE RATIO	DRIVEN GEAR		DRIVE GEAR	
		COLOR	TEETH	COLOR	TEETH
P215/65R15 P235/55R16 P245/50ZR16	2.73	RED RED BLUE	37 37 38	RED	17
P215/65R15 P245/50ZR16	3.23	BROWN DARK GREY	39 44	GREY RED	15 17

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SPECIAL TOOLS

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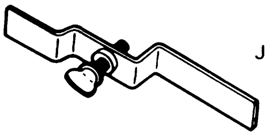
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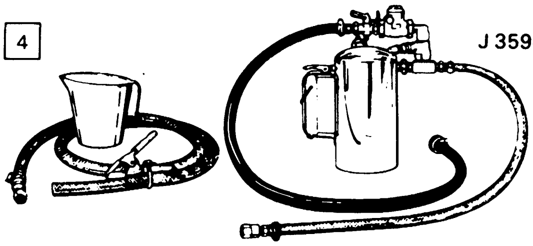
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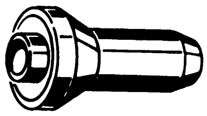
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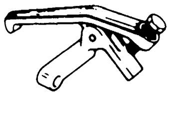
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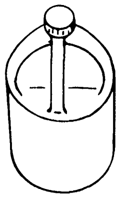
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1	CONVERTER HOLDING STRAP
2	OUTPUT SHAFT SLEEVE AND CASE EXTENSION OIL SEAL INSTALLER
3	SERVO COVER COMPRESSOR
4	"SLUDGE BUSTER" OIL COOLER AND LINE FLUSHER
5	COOLER FLUSHING FLUID

SECTION/HYDRA-MATIC 4L60

AUTOMATIC TRANSMISSION DIAGNOSIS

RPO MD8

CONTENTS

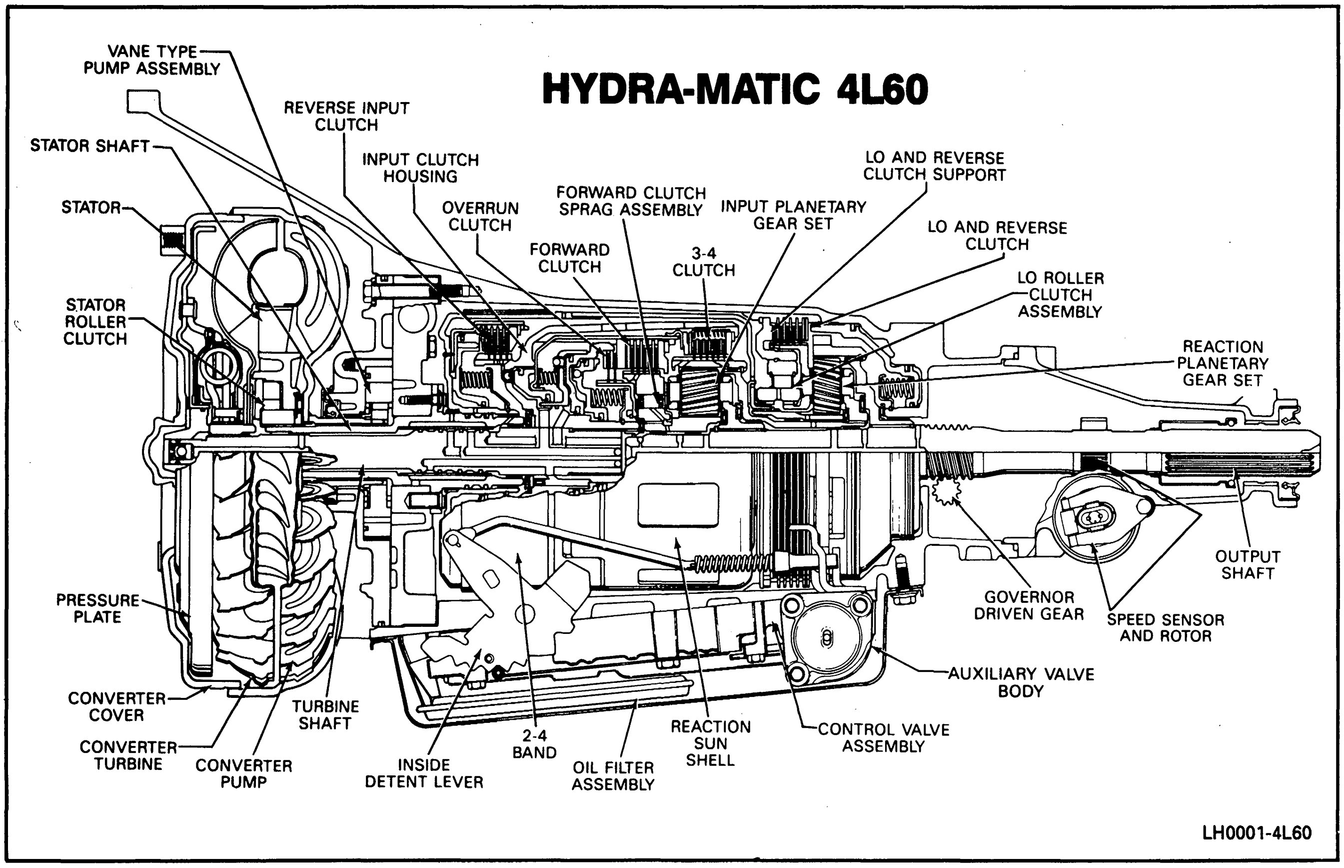

Figure 1 HYDRA-MATIC 4L60 Transmission

GENERAL DESCRIPTION

Figure 1

The HYDRA-MATIC 4L60 is a fully automatic transmission for rear wheel drive vehicles which provides four forward gear ranges and a reverse.

The major components of this transmission are:

- Torque Converter Clutch Asm.
- Vane Type Pump
- 2-4 Band Asm.
- Five Multiple Disc Clutches
- Two Planetary Gear Sets
- One Sprag Clutch
- One Roller Clutch
- Valve Body Asm.

The oil pressure and shift points are controlled by throttle opening via a throttle valve cable. (See Section 7A1 for T.V. cable information).

The transmission can be operated in any one of the following seven modes:

P — Park position prevents the vehicle from rolling either forward or backward. (For safety reasons the parking brake should be used in addition to the park position).

R — Reverse allows the vehicle to be operated in a rearward direction.

N — Neutral allows the engine to be started and operated without driving the vehicle. If necessary this position may be selected if the engine must be restarted with the vehicle moving.

Ⓓ — Overdrive is used for all normal driving conditions. It provides four gear ratios plus converter clutch operation. Downshifts are available for safe passing by depressing the accelerator.

D — Drive position is used for city traffic, hilly terrain, and trailer towing. It provides three gear ranges. Again, downshifts are available by depressing the accelerator.

2 — Manual second is used to provide acceleration and engine braking. This range may be selected at any vehicle speed.

1 — Manual Lo is used to provide maximum engine braking. This range may also be selected at any vehicle speed.

DIAGNOSIS INFORMATION

ROAD TEST PROCEDURE

- Perform the road test following the sequence given
- Mph (km/h) shift points will vary with actual throttle position and driver habits
- Not all possible throttle positions and corresponding mph shift point information have been provided.
- Compare the results of the test with shift speed chart information. Use these results with the diagnosis information contained in this Automatic Transmission Diagnosis Section to evaluate the transmission.
- This test should only be performed when traffic and road conditions permit
- Observe all traffic safety regulations

Drive and Reverse Engagement Shift Check

1. Start engine
2. Depress brake pedal
3. Move gear selector:
    - "Park" (P) to "Reverse" (R)
    - "Reverse" (R) to "Neutral" (N) to "Drive" (D)
    - Drive and/or Reverse engagement, may take from 1-2 seconds at normal operating temperatures (180°-200°F/80°-90°C). Engagement should not be harsh.

Upshifts and Torque Converter Clutch (TCC) Apply

Figure 2

With gear selector in "Overdrive" Ⓓ

1. Accelerate using a steady increasing throttle pressure
2. Note the shift speed point gear engagements for:
    - 2nd gear
    - 3rd gear
    - Overdrive
3. Note the speed shift point for TCC apply. This should occur while in third gear or overdrive. If the apply is not noticed, refer to the Torque Converter Clutch Diagnosis information contained in this section of the Service Manual.

Important

The torque converter clutch will not engage if engine coolant has not reached a minimum operating temperature of approximately 54°C (130°F).

Part Throttle Downshift

At vehicle speeds of 40-55 mph (64-88 km/h) quickly depress the accelerator to a half open position and observe:

- TCC release
- Transmission downshift to 3rd gear immediately

Full Throttle (Detent) Downshift

At vehicle speeds of 48-55 mph (77-88 km/h) quickly depress the accelerator to a wide open position and observe:

- TCC release
- Transmission downshift to 2nd gear immediately

Manual Downshift

1. At vehicle speeds of 40-55 mph (64 to 88 km/h) release the accelerator pedal while moving the gear selector to "Third" (D) gear and observe:
    - TCC release
    - Transmission downshift to 3rd gear should be immediate
    - Engine should slow vehicle down
2. Move gear selector to "Overdrive" Ⓓ and accelerate to 40-45 mph (64-72 km/h). Release the accelerator pedal while moving the gear selector to "Second" (2) gear and observe

1991 HYDRA-MATIC 4L60 SHIFT SPEED CHART

MODEL	1-2 MIN THROTTLE	2-3 MIN THROTTLE	3-4 MIN THROTTLE	1-2 W.O.T.	4-3 COAST DOWN	3-2 COAST DOWN	2-1 COAST DOWN
BBM	13-18	26-33	40-52	31-46	25-30	14-25	9-11
CAM, CBM, KAM	14-17	22-29	46-52	31-43	37-48	15-24	11-14
CCM, CFM, KBM, WBM	12-17	21-26	42-48	33-46	37-47	14-24	12-14
CHM, CJM, KCM, RAM, WCM	15-18	23-30	49+	29-41	34-45	15-21	10-13
FBM	15-17	24-30	39-45	37-51	28-35	16-24	10-12
FTM	12-15	21-26	39-48	28-41	31-39	13-22	10-12
FUM	13-15	23-25	38-46	25-41	25-31	14-21	9-11
FZM	13-17	24-32	44-52	36-46	34-39	10-19	10-12
LAM, LBM, LCM, LDM, LFM	10-13	20-24	38-43	25-34	29-40	14-22	8-10
MJM, MNM, WAM	13-17	22-29	46-52	28-39	34-44	14-22	10-12
MSM	11-13	20-23	41-46	22-36	26-37	11-19	7-9
SAM	12-14	18-24	47-53	24-37	37-47	10-18	9-12
SHM, TLM	14-17	24-31	49+	30-42	37-48	19-26	11-13

NOTES:
1. ALL SPEEDS INDICATED ARE IN MILES PER HOUR. CONVERSION TO km/h = MPH x 1.609.
2. SHIFT POINTS WILL VARY SLIGHTLY DUE TO ENGINE LOADS AND VEHICLE OPTIONS.
3. SPEEDS LISTED WITH + EXCEED 65 MPH.
4. SPEEDS ARE BASED ON TPS OF 10 TO 20. USE A SCAN TOOL TO MEASURE CORRECT TPS.

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Figure 2 Shift Speed Chart

- TCC release
- Downshift to second gear should be immediate
- Engine should slow vehicle down

3. Move gear selector to "Overdrive" Ⓓ and accelerate to 25 mph (40 km/h). Release the accelerator pedal while moving the gear selector to "First" (1) gear and observe:
   - TCC release
   - Transmission downshift to 1st gear should be immediate
   - Engine should slow vehicle down

Coastdown Downshift

1. With the gear selector in "Overdrive" Ⓓ accelerate to 4th gear and TCC apply.
2. Release the accelerator pedal and lightly apply the brakes to observe:
   - TCC release
   - Shift points for downshifts

Manual Gear Range Selection

Manual Third (D)

1. With vehicle stopped, place gear selector in "Third" (D) and accelerate to observe:
   - The first to second gear shift point
   - The second to third gear shift point

Manual Second (2)

1. With vehicle stopped, place gear selector in "Second" (2) and accelerate to observe:
   - The first to second gear shift point
2. Accelerate to 25 mph (40 km/h) and observe:
   - That a second to third gear shift does not occur
   - That TCC does not engage

Manual First (1)

1. With vehicle stopped, place gear selector in "First" (1) and accelerate to 15 mph (24 km/h) and observe:
   - That no upshift occurs
   - That TCC does not engage

Reverse

1. With vehicle stopped, place gear selector in "Reverse" (R) and slowly accelerate to observe reverse gear operation.

TORQUE CONVERTER CLUTCH (TCC) DIAGNOSIS

The Torque Converter Clutch is applied by fluid pressure which is controlled by a solenoid located inside the Automatic Transmission assembly. The solenoid is energized by completing an electrical circuit through a combination of switches and sensors.

Functional Check Procedure

Inspect

1. Install a tachometer or scan tool.
2. Drive the vehicle until proper transmission operating temperature is reached.
3. Drive the vehicle at 50-55 mph (80-88 km/h) with light throttle (road load).
4. Maintaining throttle, lightly touch the brake pedal and check for release of the TCC and a slight increase in engine rpm.
5. Release the brake, slowly accelerate and check for a re-apply of the TCC and a slight decrease in engine rpm.

To properly diagnose the Torque Converter Clutch (TCC) system, perform all electrical testing first and then test the hydraulic system.

- For diagnosis of electrical or emission control related components of the TCC, refer to the specific vehicle section in Section 6E2-C8, Driveability and Emissions.
- For diagnosis of TCC hydraulic controls, refer to the Fluid Flow and Circuit Description, and Wiring Diagrams provided in this section.
- Section 8A, Electrical Diagnosis, shows vehicle wiring diagrams if additional information is necessary.

NOTICE: Use only high impedence type ohmmeters for electrical testing on the TCC circuit. If another type of ohmmeter is used, damage to the TCC solenoid may occur.

NOTICE: Do not bench test the TCC solenoid using an automotive type battery. Accidentally crossed wires will damage the internal diode of the solenoid.

- A completed circuit does not indicate that the solenoid will actually apply.

LINE PRESSURE CHECK

Figure 3

The next step in diagnosing the Automatic Transmission is to do a line pressure check. This is a valuable tool in diagnosis since line pressure controls the hydraulic functions of the transmission.

Refer to figure 3 for the Line Pressure Check Procedure and line pressure chart.

TORQUE CONVERTER EVALUATION

The torque converter should be replaced under any of the following conditions:

- External leaks in the hub weld area
- Converter hub is scored or damaged.
- Converter pilot is broken, damaged or fits poorly into crankshaft.
- Steel particles are found after flushing the cooler and cooler lines.
- Pump is damaged or steel particles are found in the converter.
- Vehicle has TCC shudder and/or no TCC apply. Replace only after all hydraulic and electrical diagnoses has been made. (Converter clutch material may be glazed.)
- Converter has an imbalance which cannot be corrected. (Refer to Converter Vibration Test Procedure in the Transmission Unit Repair Section.)
- Converter is contaminated with engine coolant containing antifreeze.
- Internal failure of stator roller clutch
- Excess end play
- Heavy clutch debris due to overheating (blue converter)
- Steel particles or clutch lining material found in fluid filter or on magnet when no internal parts in unit are worn or damaged — indicates that lining material came from converter.

Noise

Torque converter whine is usually noticed when the vehicle is stopped and the transmission is in "Drive" or "Reverse". The noise will increase when engine rpm is increased. The noise will stop when the vehicle is moving or when the torque converter clutch is applied because both halves of the converter are turning at the same speed.

Perform a stall test to make sure the noise is actually coming from the converter:

1. Place foot on brake.
2. Put gear selector in "Drive".

3. Depress accelerator to approximately 1200 rpm for no more than six seconds.

NOTICE: If the accelerator is depressed for more than six seconds, damage to the transmission may occur.

A torque converter noise will increase under this load.

! Imporant

- This noise should not be confused with pump whine noise which is usually noticeable in "Park", "Neutral" and all other gear ranges. Pump whine will vary with pressure ranges.

Torque Converter Stator

The torque converter stator roller clutch can malfunction in two different ways. It can either remain locked up at all times or freewheel in both directions.

If the stator is freewheeling at all times, the vehicle tends to have poor acceleration from the standstill. The car may act normal at speeds above 30-35 mph (50-55 km/h). If poor acceleration is noted, it should first be determined that the exhaust system is not blocked, the engine timing is correct, and the transmission is in "First" (1) gear when starting out.

If the engine accelerates freely to high rpm in "Neutral" (N), it can be assumed that the engine and exhaust system are normal. Checking for poor performance in "Drive" (D) and "Reverse" (R) will help determine if the stator is freewheeling at all times.

If the stator is locked up at all times, performance from a standstill appears normal. Engine rpm and acceleration is restricted or limited, however, at high speeds. The engine may overheat with this condition. Visual examination of the converter may reveal a blue color from overheating.

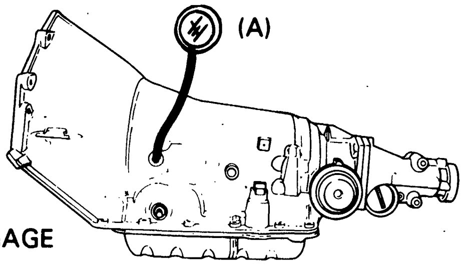
If the torque converter has been removed from the vehicle, the stator roller clutch can be checked by inserting a finger into the splined inner race of the roller clutch and trying to turn the race in both directions. The inner race should turn freely clockwise, but not turn or be very difficult to turn counterclockwise.

The Torque Converter Should Not Be Replaced If:

- The oil has an odor, is discolored, and there is no evidence of metal or clutch facing particles.
- The threads in one or more of the converter bolt holes are damaged.
  - Correct with thread insert. (Refer to Section 6A.)
- Transmission failure did not display evidence of damaged or worn internal parts, steel particles or clutch plate lining material in unit and inside the fluid filter.
- Vehicle has been exposed to high mileage (only). The exception may be where the torque converter clutch dampener plate lining has seen excess wear by vehicles operated in heavy and/or constant traffic, such as taxi, delivery or police use.

LINE PRESSURE CHECK PROCEDURE

- CHECK TRANSMISSION FLUID LEVEL
- CHECK AND ADJUST T.V. CABLE
- CHECK OUTSIDE MANUAL LINKAGE AND CORRECT
- CHECK ENGINE TUNE
- INSTALL PRESSURE GAGE
- CONNECT TACHOMETER TO ENGINE
- CHECK PRESSURE AS FOLLOWS:



(A) ATTACH PRESSURE GAGE

Minimum T.V. Line Pressure Check
Set the T.V. cable to specification; and with the brakes applied, take the line pressure readings in the ranges and at the engine r.p.m. indicated in the chart below.

Full T.V. Line Pressure Check
Full T.V. line pressure readings are obtained by tying or holding the T.V. cable to the full extent of its travel; and with the brakes applied, take the line pressure readings in the ranges and at the engine r.p.m. indicated in the chart below.

***NOTICE** Total running time for this combination not to exceed 2 minutes.

CAUTION Brakes must be applied at all times.

1991 HYDRA-MATIC 4L60 TRANSMISSION PRESSURES

RANGE	MODEL	NORMAL PRESSURE AT MINIMUM T.V.		NORMAL PRESSURE AT FULL T.V.	
		kPa	PSI	kPa	PSI
PARK, NEUTRAL, OVERDRIVE & MANUAL 3RD @ 1000 RPM	BBM	483-622	70-90	866-1146	125-166
	CAM, CBM, KAM, MJM, MNM, WAM	451-515	65-75	851-1063	123-154
	CCM, CFM, KBM, WBM	451-515	65-75	947-1185	137-172
	CHM, CJM, KCM, RAM, WCM	451-515	65-75	914-1149	133-167
	FBM	451-515	65-75	918-1146	133-166
	FTM, FUM, FZM	451-515	65-75	1073-1354	155-196
	LAM, LBM, LCM, LDM, LFM	451-515	65-75	899-1134	130-164
	MSM	483-622	70-90	797-1079	116-157
	SAM	451-515	65-75	845-1068	123-155
	SHM, TLM	451-515	65-75	969-1231	141-179
REVERSE @ 1000 RPM	BBM	793-1023	115-148	1424-1883	206-273
	CAM, CBM, KAM, MJM, MNM, WAM	742-847	108-123	1400-1747	203-253
	CCM, CFM, KBM, WBM	742-847	108-123	1556-1948	226-283
	CHM, CJM, KCM, RAM, WCM	742-847	108-123	1503-1889	218-274
	FBM	580-662	84-96	1180-1472	171-214
	FTM, FUM, FZM	742-847	108-123	1763-2225	256-323
	LAM, LBM, LCM, LDM, LFM	741-845	107-123	1474-1860	214-270
	MSM	793-1023	115-148	1311-1773	190-257
	SAM	580-662	84-96	1085-1372	157-199
	SHM, TLM	742-847	108-123	1593-2023	231-293
MANUAL 2ND & MANUAL LO @ 1000 RPM	CAM, CBM, CCM, CFM, CHM, CJM, FBM, FTM, FUM, FZM, KAM, KBM, KCM, MJM, MNM, RAM, SAM, SHM, TLM, WAM, WBM, WCM	1127-1286	163-186	1127-1286	163-186
	BBM, MSM	1205-1554	175-226	1205-1554	175-226
	LAM, LBM, LCM, LDM, LFM	1191-1359	173-197	1191-1359	173-197

Line pressure is basically controlled by pump output and the pressure regulator valve. In addition, line pressure is boosted in Reverse, Second and Lo by the reverse boost valve.

Also, in the Neutral, Drive, Intermediate and Reverse positions of the selector lever, the line pressure should increase with throttle opening because of the T.V. system. The pressure is controlled by the T.V. cable, the throttle lever and bracket assembly and the T.V. link, as well as the control valve assembly.

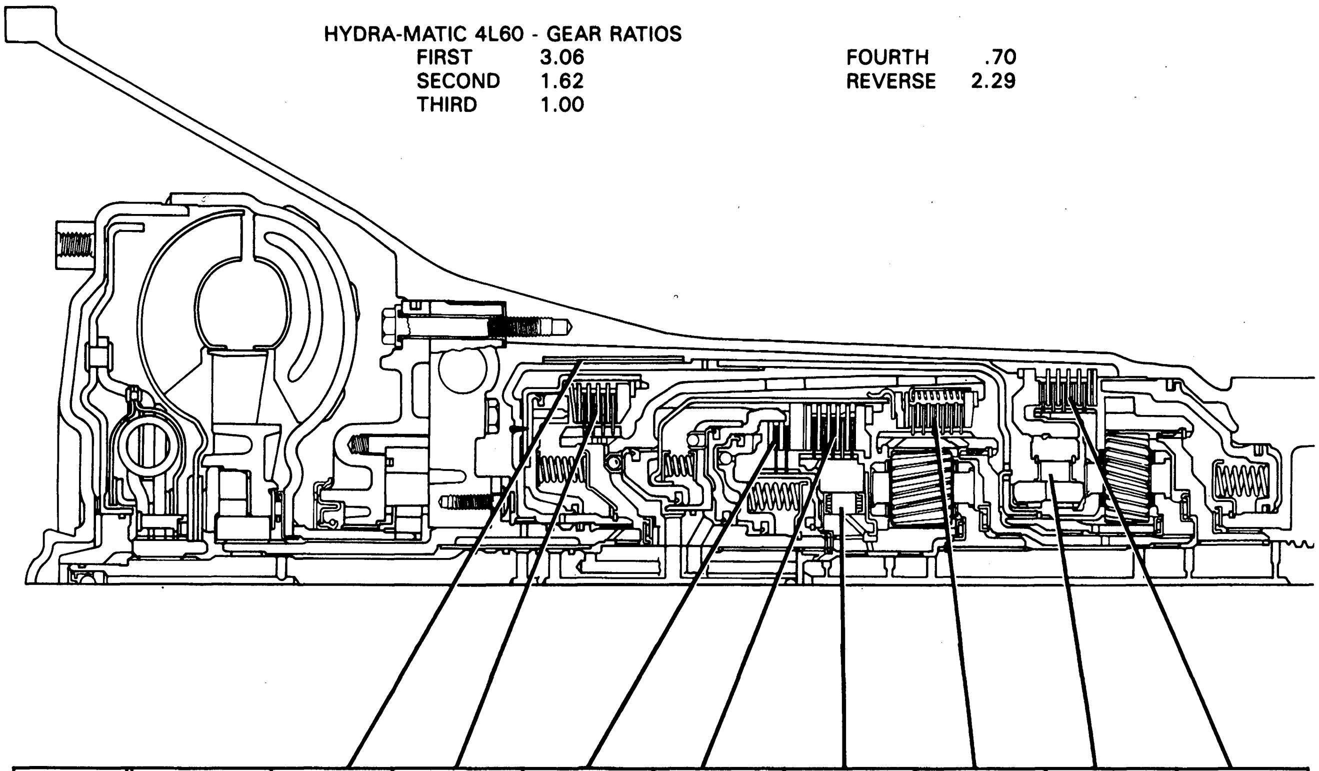
The main line pressure tap plug is located on the left side of the transmission above the outside manual lever.

MH0003-4L60-R3

Figure 3 Line Pressure Check Procedure

HYDRA-MATIC 4L60 - GEAR RATIOS

FIRST	3.06	FOURTH	.70
SECOND	1.62	REVERSE	2.29
THIRD	1.00		



RANGE	GEAR	2-4 BAND	REVERSE INPUT CLUTCH	OVERRUN CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO-ROLLER CLUTCH	LO-REV. CLUTCH
P-N									
D	1st				APPLIED	HOLDING		HOLDING	
	2nd	APPLIED			APPLIED	HOLDING			
	3rd				APPLIED	HOLDING	APPLIED		
	4th	APPLIED			APPLIED		APPLIED		
D	1st			APPLIED	APPLIED	HOLDING		HOLDING	
	2nd	APPLIED		APPLIED	APPLIED	HOLDING			
	3rd			APPLIED	APPLIED	HOLDING	APPLIED		
2	1st			APPLIED	APPLIED	HOLDING		HOLDING	
	2nd	APPLIED		APPLIED	APPLIED	HOLDING			
1	1st			APPLIED	APPLIED	HOLDING		HOLDING	APPLIED
R	REVERSE		APPLIED						APPLIED

LH0004-4L60

Figure 4 Clutch Application Chart

CONDITION	INSPECT COMPONENT	FOR CAUSE
OIL PRESSURE HIGH OR LOW (Verify With Gage—Refer To Line Pressure Check Procedure)	• Oil Pump Assembly (7)	— Pressure regulator valve (218) stuck. — Pressure regulator valve spring (219) damaged. — Rotor guide (213) omitted or misassembled. — Rotor (214) cracked or broken. — T.V. boost valve (222), reverse boost valve (220) or sleeve (221) stuck, damaged or incorrectly assembled. — Orifice hole in pressure regulator valve (218) plugged. — Sticking slide (206) or excessive rotor clearance. — Pressure relief ball (231) not seated or damaged. — Porosity in pump cover or body. — Wrong pump cover. — Pump faces not flat. — Excessive rotor clearance.
	• Oil Filter (71)	— Intake pipe restricted by casting flash. — Cracks in filter body or intake pipe. — "O" ring seal (70) missing, cut or damaged. — Wrong grease used on rebuild.
	• T.V. Exhaust Ball (91)	— Stuck or damaged.
	• Throttle Lever & Bracket Assembly (65)	— Misassembled, binding or damaged.
	• Throttle Link (64)	— Misassembled, binding or damaged.
	• Valve Body (67)	— Manual valve (340) scored or damaged. — Spacer plate (56) or gaskets (88 & 89) incorrect, misassembled or damaged. — Face not flat. — Throttle valve (326) sticking. — T.V. limit valve (332) sticking. — Modulated downshift valve (301) stuck. — Line bias valve (336) stuck. — 2-3 Shift valve (316) stuck. — Checkballs omitted or misassembled.
	• Case (10)	— Case to valve body face not flat.
HIGH OR LOW SHIFT POINTS	• T.V. Cable	— Binding or not correctly adjusted.
	• T.V. Exhaust Ball (91)	— Stuck or damaged.
	• Throttle Lever & Bracket Assembly (65)	— Misassembled, binding or damaged.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60 UNIT REPAIR SECTION

LH0005-4L60-R1

Figure 5 Diagnosis Chart A

CONDITION	INSPECT COMPONENT	FOR CAUSE
HIGH OR LOW SHIFT POINTS (Continued)	• Oil Pump Assembly (7)	– Stuck pressure regulator valve (218) or T.V. boost valve (222). – Sticking pump slide (206).
	• Valve Body Assembly (67)	– Sticking throttle valve (326) or plunger (324). – Modulated T.V. up or down valves (301 & 303) sticking. – T.V. limit valve (332) sticking. – Spacer plate (56) or gaskets (88 & 89) misassembled, damaged or incorrect. – Line bias valve (336) sticking.
	• Case (10)	– Porous or damaged valve body pad. – Governor filter (47A) restricted or damaged. – 2-4 Servo Assembly (13-31) a. 2-4 accumulator porosity. b. Damaged servo piston seals. c. Apply pin damaged or improper length. – 2-4 Band Assembly (602) a. Burned. b. Anchor pin not engaged.
1ST GEAR RANGE ONLY – NO UPSHIFT	• Governor Assembly (45)	– Governor valve (107) sticking. – Governor driven gear (83) loose or damaged: a. Wear on bottom of gear indicates pin is not pressed in deep enough. b. Wear of corner of gear indicates pin is missing. c. Wear resembles an apple core if wrong gear is used, or there is a burr on the output shaft. d. Wear on one side of gear indicates output shaft snap ring is missing or the governor has seized in the bore. – Governor driven gear retaining pin (82) missing. – Nicks or burrs on output shaft (687). – Nicks or burrs on governor sleeve (106) or case bore. – Governor support pin in case too long or short. – Governor weights (108 & 109) or springs (110 & 111) missing, binding or damaged.
	• Valve Body (67)	– 1-2 Shift valve (322) sticking. – Spacer plate (56) or gaskets (88 & 89) mispositioned or damaged.
	• Case (10)	– Case to valve body face not flat or damaged. – Governor filter (47A) restricted or damaged.

ALL ILLUSTRATION NUMBERS REFERENCE HYDRA-MATIC 4L60 UNIT REPAIR SECTION LH0006-4L60

Figure 6 Diagnosis Chart B

CONDITION	INSPECT COMPONENT	FOR CAUSE
1ST GEAR RANGE ONLY — NO UPSHIFTS (Continued)	• 2-4 Servo Assembly (13-31)	– Restricted or blocked apply passages in case. – Nicks or burrs on servo pin (29) or pin bore in case. – 4th Servo piston (16) in backwards.
	• 2-4 Band Assembly (602)	– 2-4 Band (602) worn or damaged. – Band anchor pin not engaged.
SLIPS IN 1ST GEAR	• Forward Clutch Assembly	– Clutch plates (649) worn. – Porosity or damage in forward clutch piston (630). – Forward clutch piston inner and outer seals (629) missing, cut or damaged. – Input housing to forward clutch housing "O" ring seal (622) missing, cut or damaged. – Damaged forward clutch housing (628). – Forward clutch housing retainer and ball assembly (627) not sealing or damaged.
	• Forward Clutch Accumulator	– Piston seal (369) missing, cut or damaged. – Piston (367) out of its bore. – Porosity in the piston or auxiliary valve body (377). – Stuck abuse valve (360).
	• Oil Pump (7)	– Auxiliary accumulator valve tube (96) leaks, not seated in pump cover or missing.
	• Input Housing & Shaft Assembly (621)	– Turbine shaft seals (619) missing, cut or damaged.
	• Valve Body (67)	– 1-2 Accumulator valve (333) stuck. – Face not flat, damaged lands or interconnected passages. – Spacer plate (56) or gaskets (88 & 89) incorrect, mispositioned or damaged.
	• T.V. Cable	– Binding or broken.
	• Low Roller Clutch (678)	– Damage to lugs or inner ramps. – Rollers not free moving. – Inadequate spring tension – Damage to inner splines. – Lube passage plugged.
	• Torque Converter (1)	– Stator roller clutch not holding.

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LH0007-4L60-R1

Figure 7 Diagnosis Chart C

CONDITION	INSPECT COMPONENT	FOR CAUSE
SLIPS IN 1ST GEAR (Continued)	• 1-2 Accumulator Assembly (59-63)	– Porosity in piston (61) or 1-2 accumulator cover and pin assembly (62). – Damaged ring grooves on piston. – Piston seal (60) missing, cut or damaged. – Valve body to spacer plate gasket (89) at 1-2 Accumulator cover, missing or damaged. – Leak between piston and pin. – Broken 1-2 accumulator spring (59).
	• Oil Pressure	– (See Causes of High or Low Oil Pressure.)
	• 2-4 Servo Assembly (13-31)	– 4th Servo piston (16) in backwards.
1-2 SHIFT SPEED – HIGH OR LOW	• T.V. Cable	– Binding or broken. – Not correctly adjusted.
	• Governor Assembly (45)	– (See 1st Gear Range Only – No Upshift.)
	• Throttle Lever & Bracket Assembly (65)	– Misassembled, binding or damaged. – T.V. link missing, binding or damaged.
	• Valve Body (67)	– T.V. exhaust checkball (91) stuck. – T.V. plunger (324) sticking. – Face not flat.
	• Oil Pump Assembly (71) or Case (10)	– Face not flat.
SLIPPING OR ROUGH 1-2 SHIFT	• Throttle Lever & Bracket Assembly (65)	– Incorrectly installed or damaged. – T.V. cable broken or binding.
	• Valve Body Assembly (67)	– Throttle valve (326) sticking. – 1-2 Shift valve train (317-322) stuck. – Gaskets (88 & 89) or spacer plate (56) incorrect, mispositioned or damaged. – Line bias valve (336) stuck. – 1-2 Accumulator valve (333) stuck. – T.V. limit valve (332) stuck. – Face not flat.
	• 2-4 Servo Assembly (13-31)	– Apply pin (29) too long or too short. – 2nd servo apply piston seal missing, cut or damaged. – Restricted or missing oil passages. – Servo bore in case damaged.
	• 2nd Accumulator (59-63)	– Porosity in 1-2 accumulator housing (62) or piston (61). – Piston seal or groove damaged. – Nicks or burrs in 1-2 accumulator housing. – Missing or restricted oil passage.

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LH0008-4L60

Figure 8 Diagnosis Chart D

CONDITION	INSPECT COMPONENT	FOR CAUSE
SLIPPING OR ROUGH 1-2 SHIFT (Continued)	• 2-4 Band (602)	– Worn or mispositioned.
	• Oil Pump Assembly (7) or Case (10)	– Faces not flat.
NO 2-3 SHIFT OR 2-3 SHIFT SLIPPING, ROUGH OR HUNTING	• Converter (1)	– Internal damage.
	• Governor Assembly (45)	– Valve (107) stuck. – Drive gear retaining pin (82) missing or loose. – Governor weights (108 & 109) binding. – Governor driven gear (83) damaged. – Governor support pin in case too long or too short.
	• Oil Pump (7)	– Stator shaft (216) sleeve scored or off location.
	• Valve Body (67)	– 2-3 Valve train (313-316) stuck. – Accumulator valve (333) stuck. – Spacer plate (56) or gaskets (88 & 89) incorrect, mispositioned or damaged. – Throttle valve (326) stuck. – T.V. limit valve (332) stuck.
	• Input Housing Assembly (621)	– Clutch plates worn [3-4 (654) or forward (649)]. – Excessive clutch plate travel. – Cut or damaged piston seals [3-4 (624) or forward (629)]. – Porosity in input clutch housing (621) or piston (623). – 3-4 Piston checkball (620) stuck, damaged or not sealing. – Restricted apply passages. – Forward clutch piston retainer and ball assembly (627) not seating. – Sealing balls loose or missing.
	• Case (10)	– 3rd Accumulator retainer and ball assembly (80) not seating.
	• 2-4 Servo Assembly (13-31)	– 2nd Apply piston seals (23 & 24) missing, cut or damaged.
NO 3-4 SHIFT/SLIPPING OR ROUGH 3-4 SHIFT	• Governor (45)	– Governor weights (108 & 109) binding. – Governor valve (107) stuck. – Governor driven gear retaining pin (82) missing or loose. – Governor driven gear (83) damaged. – Governor support pin in case too long or too short.

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LH0009-4L60

Figure 9 Diagnosis Chart E

CONDITION	INSPECT COMPONENT	FOR CAUSE
NO 3-4 SHIFT/SLIPPING OR ROUGH 3-4 SHIFT (Continued)	• Oil Pump Assembly (7)	Faces not flat. – Pump cover retainer and ball assembly omitted or damaged.
	• Valve Body Assembly (67)	– Valves stuck. • 2-3 Shift valve (313-316) train. • Accumulator valve (333). • Throttle valve (326). • T.V. limit valve (332). • 1-2 Shift valve train (317-322). • 3-2 Control valve (339). – Manual valve link (64) bent or damaged. – Spacer plate (56) or gaskets (88 & 89) incorrect, mispositioned or damaged.
	• 2-4 Servo Assembly (13-31)	– Incorrect band apply pin (29). – Missing or damaged servo seals (14 & 17). – Porosity in pistons, cover or case. – Damaged piston seal grooves. – Plugged or missing orifice cup plug (86).
	• Case (10)	– 3rd Accumulator retainer and ball assembly (80) leaking. – Porosity in 3-4 accumulator piston (52) or bore. – 3-4 Accumulator piston seal (53) or seal grooves damaged. – Plugged or missing orifice cup plug (81). – Restricted oil passage.
	• Input Housing Assembly (621)	– Refer to Slipping 2-3 Shift.
	• 2-4 Band Assembly (602)	– Worn or misassembled.
NO REVERSE OR SLIPS IN REVERSE	• Input Housing Assembly (621)	– 3-4 Apply ring (625) stuck in applied position. – Forward clutch not releasing. – Turbine shaft seals (619) missing, cut or damaged.
	• Manual Valve Link (705)	– Disconnected.
	• Oil Pump Assembly (7)	– Retainer and ball assembly missing or damaged. – Stator shaft seal rings (233) or ring grooves damaged. – Stator shaft sleeve scored or damaged. – Reverse boost valve (220) stuck, damaged or misassembled. – Cup plug missing. – Restricted oil passage. – Faces not flat. – Converter clutch valve (227) stuck.

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LH0010-4L60

Figure 10 Diagnosis Chart F

CONDITION	INSPECT COMPONENT	FOR CAUSE
NO REVERSE OR SLIPS IN REVERSE (Continued)	• Valve Body Assembly (67)	– 2-3 Shift valve (316) stuck. – Manual linkage (64) not adjusted. – Spacer plate (56) and gaskets (88 & 89) incorrect, mispositioned or damaged.
	• Reverse Input Clutch Assembly (605)	– Clutch plate (612) worn. – Reverse input housing and drum assembly (605) cracked at weld. – Clutch plate retaining ring out of groove. – Return spring assembly retaining ring (610) out of groove. – Seals (608) cut or damaged. – Restricted apply passage. – Porosity in piston (607). – Belleville plate (611) installed incorrectly. – Excessive clutch plate travel.
	• Auxiliary Valve Body (377)	– Lo overrun valve (364) stuck. – Orificed cup plug (359) restricted, missing or damaged.
	• Lo And Reverse Clutch	– Clutch plates (682) worn. – Porosity in piston (695). – Seals (696) damaged. – Return spring assembly retaining ring (693) mispositioned. – Restricted apply passage.
NO PART THROTTLE OR DELAYED DOWNSHIFTS	• T.V. Cable	– Loose or incorrectly installed.
	• T.V. Bracket Assembly (65)	– Bent.
	• 2-4 Servo Assembly (13-31)	– Servo cover retaining ring (13) omitted or misassembled. – 4th Apply piston (16) damaged or misassembled. – Servo inner housing (22) damaged or misassembled.
	• Governor Assembly (45)	– Governor weights (108 & 109) binding. – Governor valve (107) stuck.
	• Valve Body Assembly (67)	– Valves stuck. • Throttle valve (326) • 3-2 Control valve (339) • T.V. modulated downshift (301) – 4-3 Sequence valve body channel blocked.

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LH0011-4L60-R1

Figure 11 Diagnosis Chart G

CONDITION	INSPECT COMPONENT	FOR CAUSE
NO OVERRUN BRAKING – MANUAL 3-2-1	• External Linkage	– Not adjusted properly.
	• Valve Body Assembly (67)	– Valves stuck. • 4-3 Sequence valve (329) • Throttle valve (326) – Checkball #3 mispositioned. – Spacer plate (56) and gaskets (88 & 89) incorrect, damaged or mispositioned.
	• Input Clutch Assembly (621)	– Turbine shaft oil passages plugged or not drilled. – Turbine shaft seal rings (619) damaged. – Turbine shaft sealing balls loose or missing. – Porosity in forward (630) or overrun clutch piston (632). – Overrun piston seals (631) cut or damaged. – Overrun piston checkball (633) not sealing.
NO CONVERTER CLUTCH APPLY	• Electrical	– 12 Volts not supplied to transmission. – Outside electrical connector damaged. – Inside electrical connector, wiring harness or solenoid damaged. – Electrical short (pinched solenoid wire). – Solenoid not grounded. – Incorrect or damaged pressure switches. – Temperature switch damaged.
	• Converter (1)	– Internal damage.
	• Oil Pump Assembly (7)	– Converter clutch valve (227) stuck or assembled backwards. – Converter clutch valve retaining ring (225) mispositioned. – Pump to case gasket (9) mispositioned. – Orifice cup plug (240) restricted or damaged. – Solenoid "O" ring seal (49) cut or damaged. – High or uneven bolt torque (pump body to cover).
	• Input Housing and Shaft (621)	– Turbine shaft "O" ring seal (618) cut or damaged. – Turbine shaft retainer and ball assembly (617) restricted or damaged.
	• Valve Body Assembly (67)	– TCC shift valve stuck. – TCC apply valve stuck. – Solenoid o-ring leaking.
	• Solenoid Screen (47B)	– Blocked.

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LH0012-4L60-R1

Figure 12 Diagnosis Chart H

CONDITION	INSPECT COMPONENT	FOR CAUSE
CONVERTER SHUDDER	• Torque Converter Assembly (1)	– Internal damage.
	• Oil Pump Assembly (7)	– Converter clutch valve (227) stuck. – Restricted oil passage.
	• Oil Filter (71)	– Crack in filter body. – Flash restricting filter neck. – "O" ring seal (70) cut or damaged.
	• Miscellaneous	– Low oil pressure. – Engine not tuned properly.
	• Input Housing and Shaft Assembly (621)	– Turbine shaft "O" ring (618) cut or damaged. – Turbine shaft retainer and ball assembly (617) restricted or damaged.
NO CONVERTER CLUTCH RELEASE	• Solenoid	– External ground. – Clogged exhaust orifice.
	• Converter (1)	– Internal damage.
	• Valve Body Assembly (67)	– Converter clutch apply valve stuck in apply position.
	• Oil Pump Assembly (7)	– Converter clutch valve (227) stuck.
	• ECM	– External ground.
DRIVES IN NEUTRAL	• Forward Clutch	– Not releasing.
	• Manual Valve Link (705)	– Disconnected.
	• Case (10)	– Face not flat. – Internal leakage.
2ND GEAR START (DRIVE RANGE)	• Governor Assembly (45)	– Valve (107) stuck. – Governor support pin too long or missing.
	• Forward Clutch Sprag Assembly (642)	– Sprag assembly installed backwards.
NO PARK	• Parking Linkage (701-715)	– Actuator rod assembly (701) bent or damaged. – Actuator rod spring binding or improperly crimped. – Actuator rod not attached to inside detent lever (703). – Parking lock bracket (710) damaged or not torqued properly.

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LH0013-4L60-R1

Figure 13 Diagnosis Chart I

CONDITION	INSPECT COMPONENT	FOR CAUSE
NO PARK (Continued)	• Parking Linkage (Cont.)	— Inside detent lever (703) not torqued properly. — Detent roller and spring assembly (709) mispositioned or not torqued properly. — Parking pawl (711) binding or damaged.
RATCHETING NOISE	• Parking Pawl (711)	— Parking pawl return spring (714) weak, damaged or misassembled.
OIL OUT THE VENT	• Oil Pump (7)	— Chamfer in pump body rotor pocket too large.
	• Valve Body (67)	— T.V. limit valve (332) stuck.
	• Miscellaneous	— Fluid level - overfilled.
VIBRATION IN REVERSE AND WHINING NOISE IN PARK	• Oil Pump (7)	— Broken vane rings (212).
NO DRIVE IN ALL RANGES	• Torque Converter (1)	— Converter to flex plate bolts missing.
NO DRIVE IN DRIVE RANGE	• Torque Converter (1)	— Stator roller clutch not holding. — Converter not bolted to flex plate.
FRONT OIL LEAK	• Torque Converter (1)	— Welded seam leaking. — Damaged converter hub.
	• Torque Converter Seal (2)	— Damaged seal assembly. — Missing garter spring.
DELAY IN DRIVE AND REVERSE	• Torque Converter (1)	— Converter drainback.

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LH0014-4L60-R1

Figure 14 Diagnosis Chart J

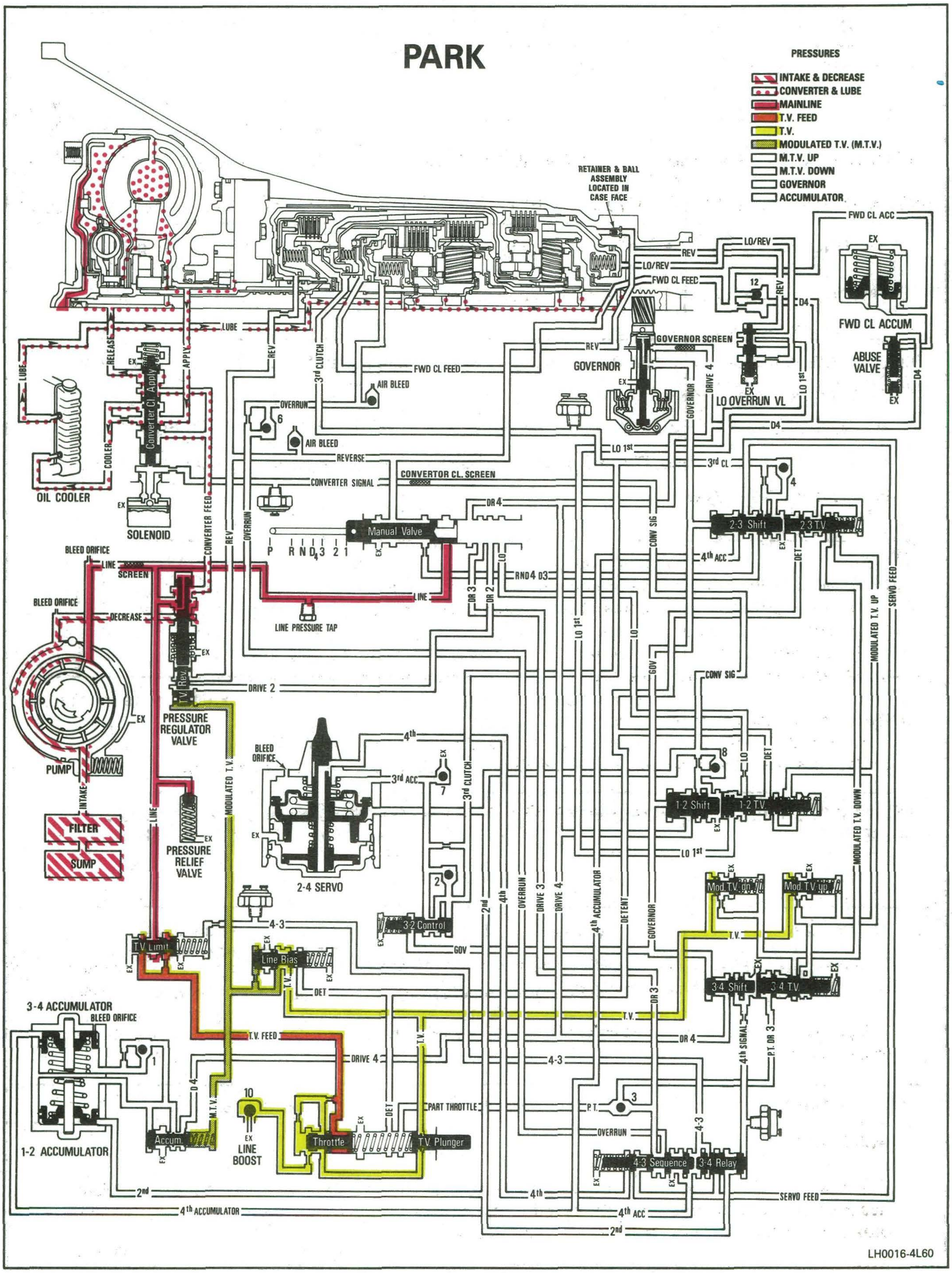


Figure 15 Park — Engine Running

PARK—ENGINE RUNNING

CONVERTER CLUTCH – RELEASED **3-4 CLUTCH – RELEASED** **2-4 BAND – RELEASED**

REVERSE INPUT CLUTCH – RELEASED **LO AND REVERSE CLUTCH – RELEASED** **OVERRUN CLUTCH – RELEASED**

FORWARD CLUTCH – RELEASED **LO ROLLER CLUTCH – NOT HOLDING** **FORWARD SPRAG CLUTCH – NOT HOLDING**

With the selector lever in the Park (P) position, oil from the pump is directed to the following:

1. Pressure Regulator Valve
2. Release Side of the Converter and the Lubrication System
3. Decrease Side of the Pump Slide
4. Manual Valve
5. T.V. System (Limit Valve, Throttle Valve, Line Bias Valve, M.T.V. Up Valve and M.T.V. Down Valve)
6. Pressure Relief Valve
7. Line Pressure Tap

Oil flows from the pump to the pressure regulator valve which regulates the pump pressure. When the pump output exceeds the demand of line pressure, oil from the pressure regulator valve is directed to the converter clutch apply valve. The converter clutch apply valve directs oil to the release side of the converter clutch. Converter return oil is directed to the transmission cooler by the converter clutch apply valve. Oil from the cooler is directed to the transmission lubrication system.

Oil is also directed from the pressure regulator valve to the pump slide to decrease pump output in relation to the combined pressure of M.T.V. oil and regulator valve spring force. Line pressure acts on the pressure relief valve which will exhaust any oil above 2,240 to 2,520 kPa (320 to 360 psi).

Line pressure at the manual valve is available for use in other drive ranges.

Line pressure at the T.V. limit valve is limited to 620 kPa (90 psi). This limited pressure is directed to the throttle valve where it is regulated to a variable pressure called throttle valve (T.V.) pressure. T.V. pressure increases with carburetor opening and is directed to the line bias, M.T.V. up and M.T.V. down valves.

At the line bias valve, T.V. pressure is modulated to M.T.V. pressure. M.T.V. pressure helps to control line pressure at the pressure regulator valve and accumulator pressure at the accumulator valve.

T.V. pressure at the M.T.V. up valve and M.T.V. down valve is available for use when accelerating in other ranges.

SUMMARY

The converter is filled from the release side; all clutches and the band are released. The manual linkage has the parking pawl engaged in the reaction internal gear lugs. At idle, there is not sufficient T.V. pressure to open the M.T.V. up or M.T.V. down valves.

LH0017-4L60

Figure 16 Park — Engine Running

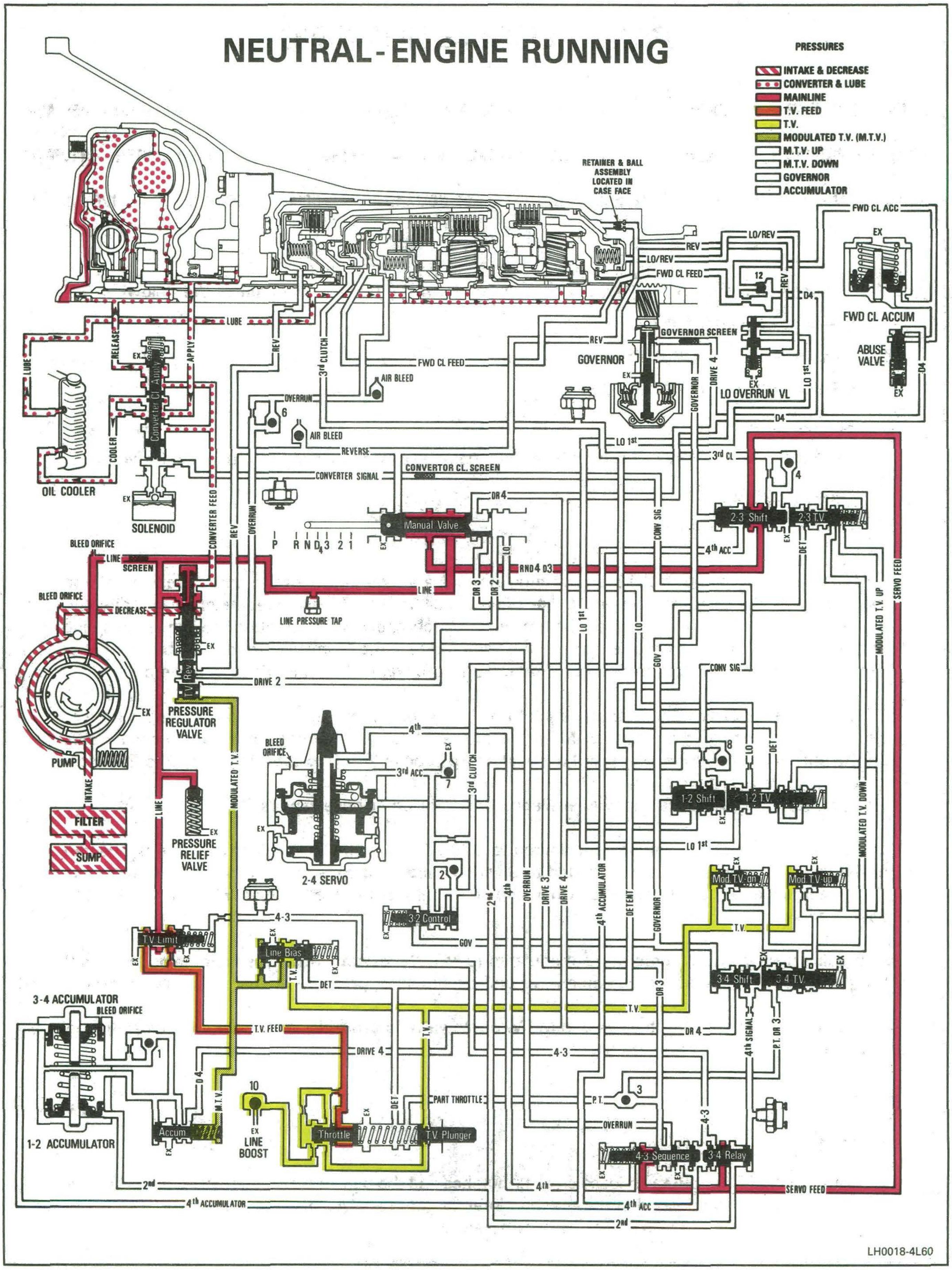


Figure 17 Neutral — Engine Running

NEUTRAL—ENGINE RUNNING

CONVERTER CLUTCH – RELEASED
3-4 CLUTCH – RELEASED
2-4 BAND – RELEASED
REVERSE INPUT CLUTCH – RELEASED
LO AND REVERSE CLUTCH – RELEASED
OVERRUN CLUTCH – RELEASED
FORWARD CLUTCH – RELEASED
LO ROLLER CLUTCH – NOT HOLDING
FORWARD SPRAG CLUTCH – NOT HOLDING

When the selector lever is moved to the Neutral (N) position, the line pressure is directed to the same areas as in Park, except in Neutral (N) the manual valve directs oil into the Reverse, Neutral, Drive 4, Drive 3 (RND4D3) oil is directed to the 2-3 shift valve which directs RND4D3 oil to the 3-4 relay valve through the servo feed passage. Oil at these valves is available for use in other ranges.

SUMMARY

The converter is filled from the release side; all clutches and the band are released. At idle, there is not sufficient T.V. pressure to open the M.T.V. up or M.T.V. down valves.

LH0019-4L60

Figure 18 Neutral — Engine Running

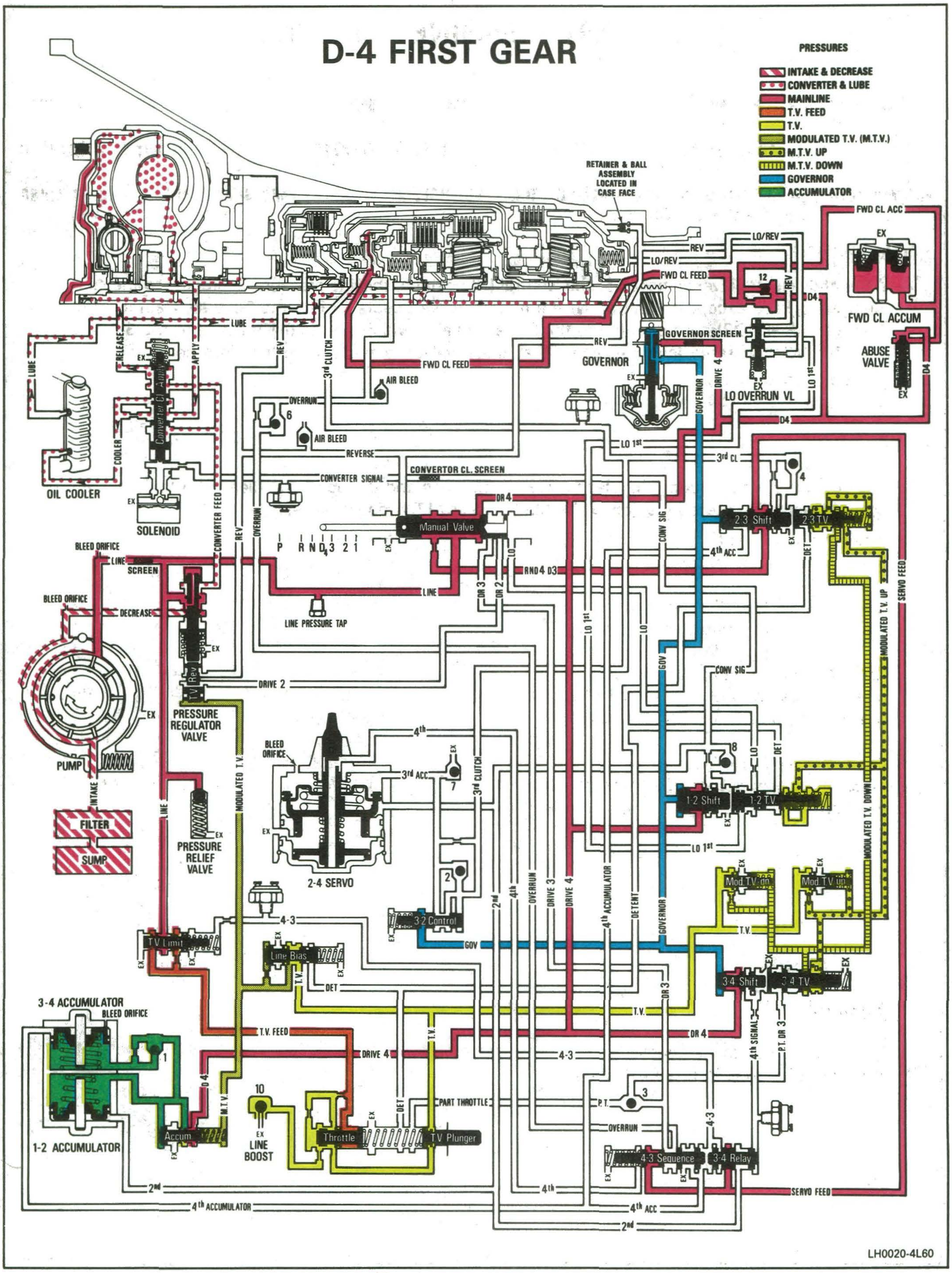


Figure 19 D4 — First Gear

D-4—FIRST GEAR

FORWARD CLUTCH – APPLIED **LO ROLLER CLUTCH – HOLDING** **FORWARD SPRAG CLUTCH – HOLDING**

When the selector lever is moved to the Drive (D) position, the manual valve is repositioned to allow line pressure to enter the Drive 4 (D4) passage. Drive 4 oil then flows to the following:

1. Forward Clutch Accumulator, Forward Clutch and Abuse Valve
2. Governor Valve
3. 1-2 Shift Valve
4. Accumulator Valve
5. 3-4 Shift Valve

BASIC CONTROL

Drive 4 oil is directed to the forward clutch accumulator where the #12 checkball seats, routing forward clutch feed through an orifice. This combines with the forward clutch accumulator to cushion the forward clutch apply.

During "Rock Cycle" conditions (stuck in mud or snow and "Rocking" out), an abuse valve routes D4 oil to forward clutch feed oil to quicken the apply of the forward clutch.

Drive 4 oil is directed to the 1-2 and 3-4 shift valves. Drive 4 oil is directed to the accumulator valve and is regulated to a pressure called accumulator pressure; this pressure is directed to the 1-2 and 3-4 accumulator pistons to act as a cushion for the band apply in second gear and overdrive.

Drive 4 oil is orificed into the governor passage, and is regulated to a variable pressure called governor pressure. Governor pressure increases with vehicle speed and acts against the 1-2, 2-3, 3-4, and the 3-2 control valve springs.

In first gear, there could be sufficient throttle valve plunger travel to increase T.V. pressure enough to open the M.T.V. up and the M.T.V. down valves. In first gear, M.T.V. up exerts pressure against governor pressure at the 1-2, 2-3, and 3-4 valves. M.T.V. down pressure is stopped by a land at the 2-3 and 3-4 throttle valves.

SUMMARY

The converter clutch is released, the forward sprag clutch is holding, the forward clutch is applied; the transmission is in Drive (D) Range — First Gear.

LHOO21-4L60

Figure 20 D4 — First Gear

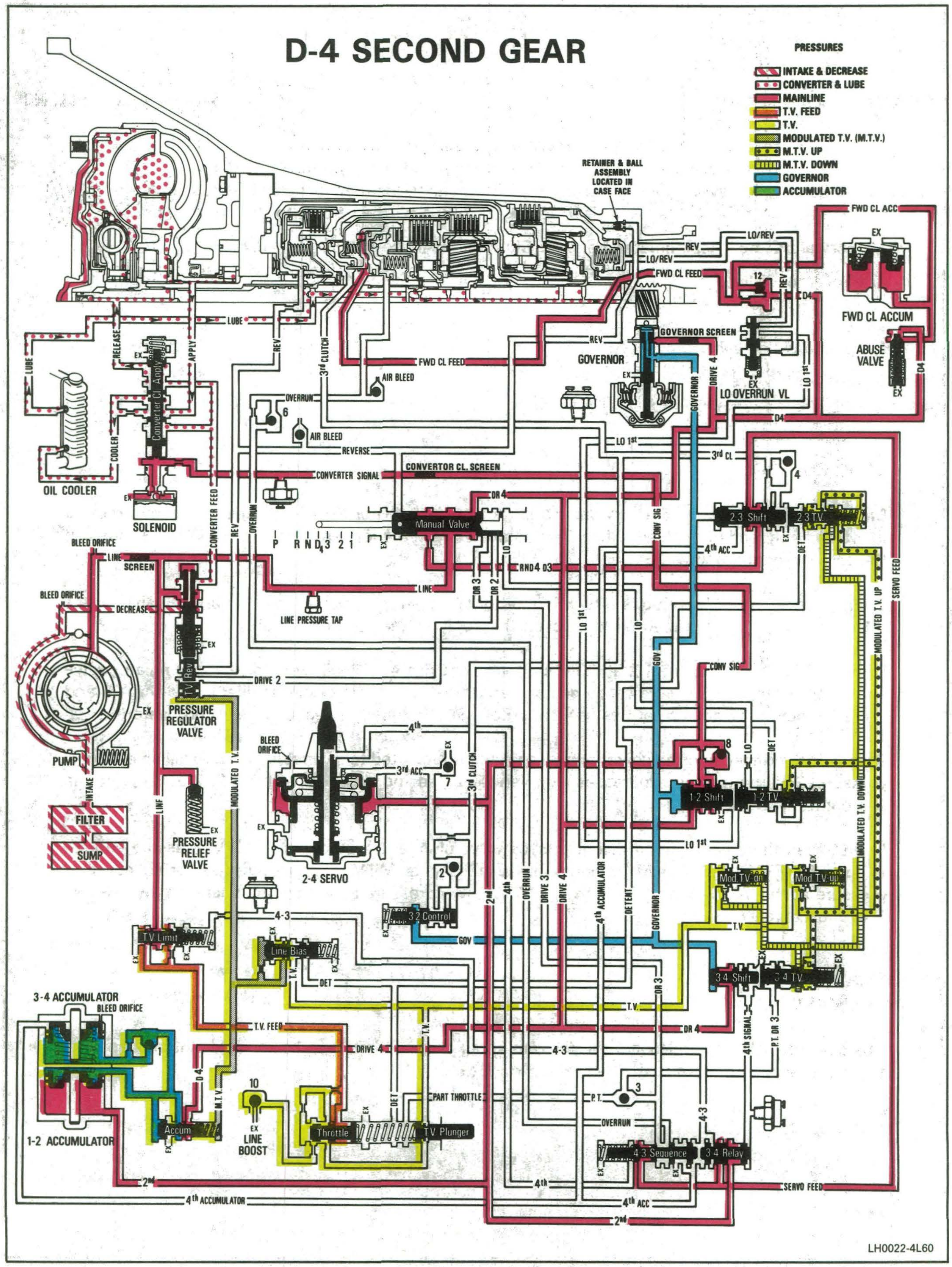


Figure 21 D4 — Second Gear

D-4—SECOND GEAR

2-4 BAND – APPLIED **FORWARD SPRAG CLUTCH – HOLDING** **FORWARD CLUTCH – APPLIED**

As both vehicle speed and governor pressure increase, the force of the governor oil acting on the 1-2 shift valve overcomes the pressure of M.T.V. up oil and the force of the 1-2 throttle valve spring. This allows the 1-2 shift valve to open and Drive 4 (D4) oil to enter the second (2nd) oil passage. This oil is called second (2nd) oil. Second oil from the 1-2 shift valve is directed to the following:

1. 1-2 Shift Checkball (8)
2. 2-4 Servo
3. 1-2 Accumulator Piston
4. Solenoid Assembly (Converter Clutch)
5. 3-4 Relay Valve

BASIC CONTROL

Second oil from the 1-2 shift valve will seat the 1-2 shift checkball (8) forcing 2nd oil through an orifice. Second oil is then directed to the 2-4 servo to apply the 2-4 band. At the same time, 2nd oil moves the 1-2 accumulator piston against accumulator pressure and the accumulator spring to maintain a controlled build-up of pressure on the servo during the 1-2 shift for a smooth band apply. 2nd oil at the 3-4 relay valve is available for use in other ranges.

Second oil is rerouted into converter clutch signal oil above the 1-2 shift valve. Converter signal oil exhausts at this solenoid until a signal is received from the vehicles E.C.M.

SUMMARY

The converter clutch is released, the 2-4 band is applied, the forward clutch is applied, and the forward sprag clutch is holding; the transmission is in Drive (D) Range — Second Gear.

LH0023-4L60

Figure 22 D4 — Second Gear

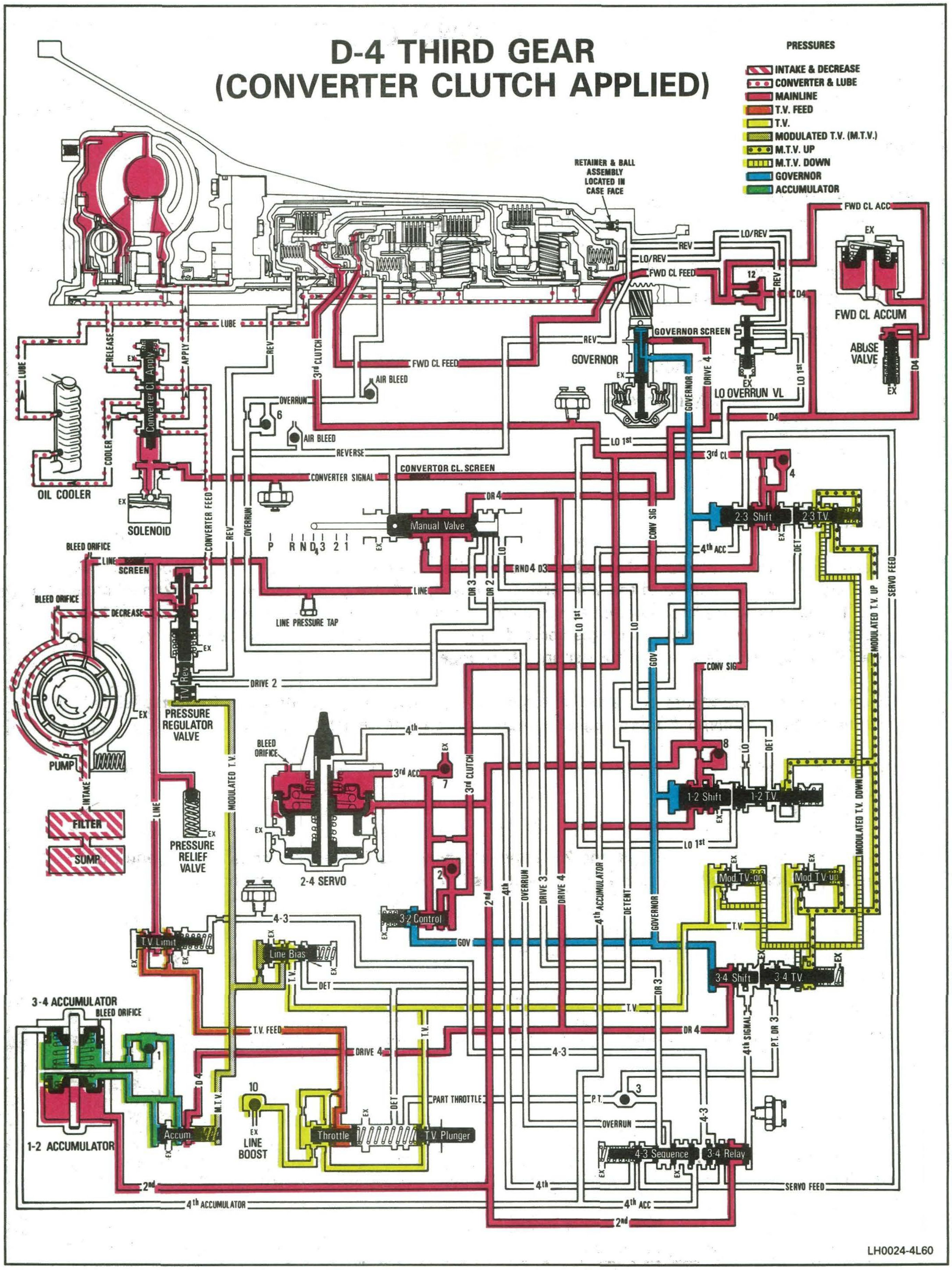


Figure 23 D4 — Third Gear — Converter Clutch Applied

D-4—THIRD GEAR

(Converter Clutch Applied)

CONVERTER CLUTCH – APPLIED

FORWARD CLUTCH – APPLIED

FORWARD SPRAG CLUTCH – HOLDING

3-4 CLUTCH – APPLIED

As both vehicle speed and governor pressure increase, the force of governor oil acting on the 2-3 shift valve overcomes the force of the 2-3 T.V. spring and M.T.V. up oil. This allows the 2-3 shift valve to open and allows RND4D3 oil to enter the 3rd clutch passage.

Third clutch oil from the 2-3 shift valve is directed to the following:

1. 3-2 Exhaust Checkball (4)
2. 3-4 Clutch Piston
3. Third Clutch Accumulator Checkball (2)
4. Third Accumulator Exhaust Checkball (7)
5. 2-4 Servo (Release Side)
6. 3-2 Control Valve

BASIC CONTROL

Third clutch oil from the 2-3 shift valve flows past the 3-2 exhaust checkball (4), to the 3-4 clutch piston. At the same time, third clutch oil is directed past the third clutch accumulator checkball (2), seats the third accumulator exhaust check ball (7), and then into the release side of the 2-4 servo. This third clutch accumulator pressure combined with the servo cushion spring, moves the second apply piston, in the 2-4 servo, against second oil and acts as an accumulator for a smooth 2-4 band release and 3-4 clutch apply.

Third clutch oil is present at the 3-2 control valve in preparation of a third gear to second gear shift.

Once the solenoid receives a signal from the vehicles controls and solenoid is on, converter clutch signal oil will shift the converter clutch apply valve, and redirect converter feed oil into the apply passage. The apply oil flows between the stator shaft and converter hub to charge the converter with oil and push the converter pressure plate against the converter cover, causing a mechanical link between the engine and the turbine shaft. The rate of apply is controlled by the orifice checkball capsule in the end of the turbine shaft.

At the same time the converter clutch apply valve will direct converter feed oil through an orifice to the transmission cooler. Cooler oil is directed to the transmission lubrication system.

SUMMARY

The converter clutch is applied*, the forward clutch is applied, the forward sprag clutch is holding, the 3-4 clutch is applied and the 2-4 band is released; the transmission is in Drive (D) Range — Third Gear (direct drive).

*The converter clutch may or may not be applied, depending on shift calibration and solenoid operation.

LH0025-4L60

Figure 24 D4 — Third Gear — Converter Clutch Appl

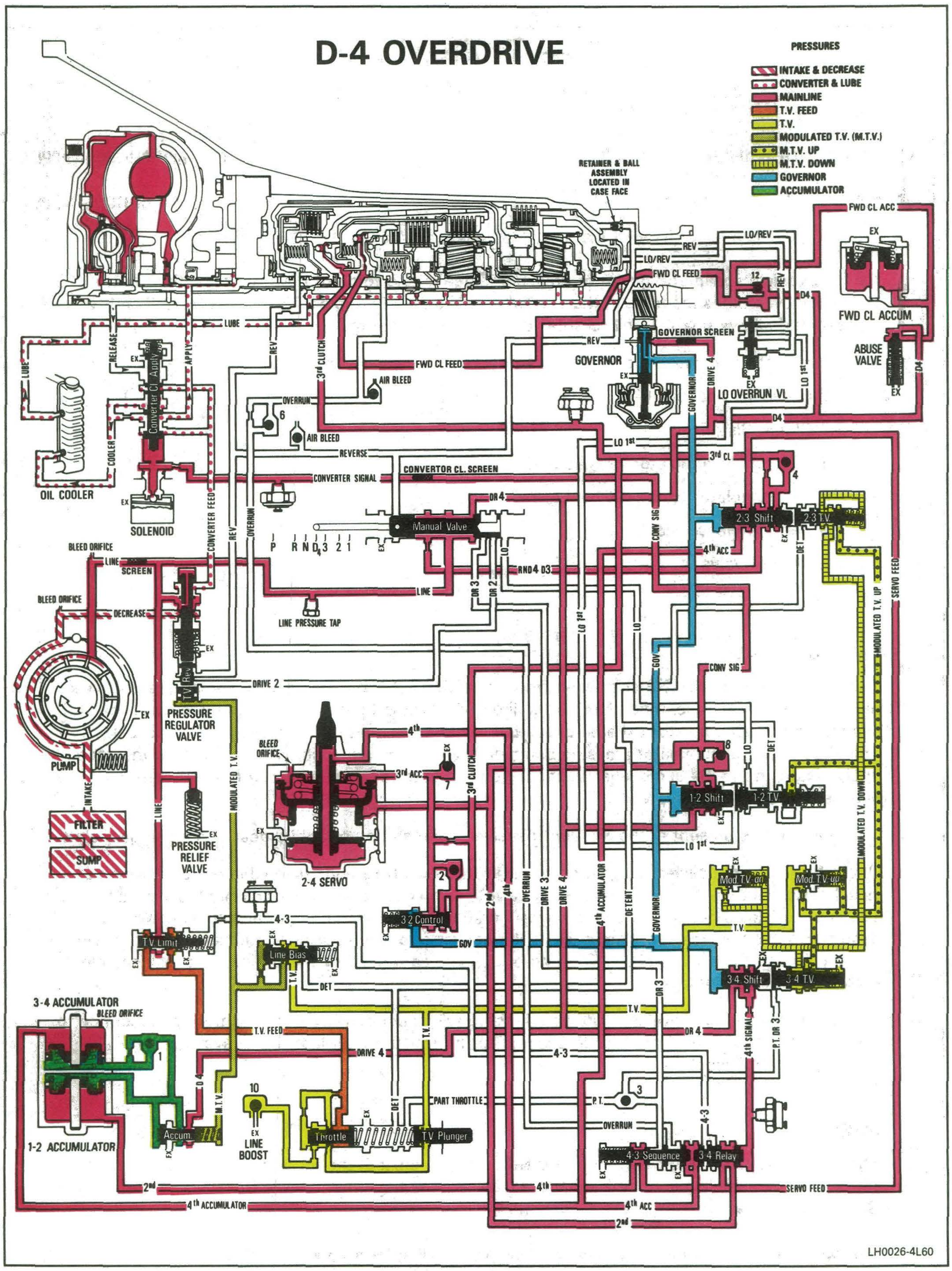


Figure 25 D4 — Overdrive

D-4—OVERDRIVE

CONVERTER CLUTCH – APPLIED
FORWARD CLUTCH – APPLIED
3-4 CLUTCH – APPLIED
2-4 BAND – APPLIED
FORWARD SPRAG CLUTCH – NOT HOLDING

As both vehicle speed and governor pressure increase, the force of governor oil acting on the 3-4 shift valve overcomes the force of the 3-4 T.V. spring and M.T.V. up oil. This opens the 3-4 shift valve sending Drive 4 (D4) into the fourth signal passage. Fourth signal oil will overcome the 4-3 sequence valve spring and open the 3-4 relay and the 4-3 sequence valves, allowing second oil to enter the servo feed passage.

Servo feed oil is directed to the following:

1. 2-3 Shift Valve
    a. Which directs oil to the:
        1) 3-4 Accumulator
        2) 4-3 Sequence Valve
2. 4-3 Sequence Valve
    a. Which directs oil to the:
        1) 4th Apply Piston (in the 2-4 servo)

BASIC CONTROL

Servo feed oil passes through the 4-3 sequence valve and becomes fourth oil. Fourth oil then enters the 2-4 servo, applies pressure on the fourth apply piston, and applies the 2-4 band.

SUMMARY

The converter clutch*, 2-4 band, forward clutch, the 3-4 clutch are applied, and the forward sprag clutch is overrunning; the transmission is in Drive (D) Range — Overdrive.

*The converter clutch may or may not be applied, depending on solenoid operation.

LH0027-4L60

Figure 26 D4 — Overdrive

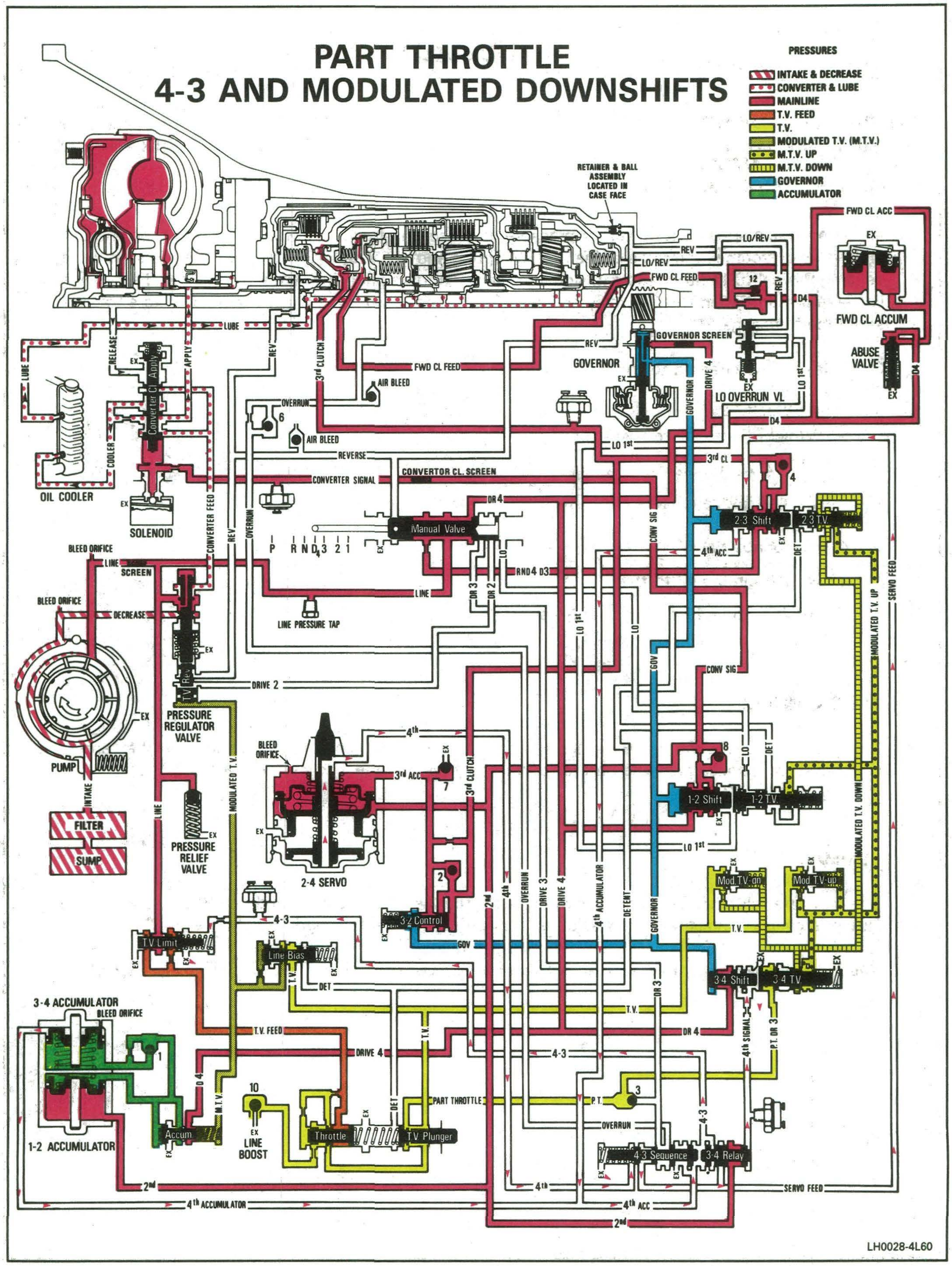


Figure 27 Part Throttle 4-3 and Modulated Downshifts

PART THROTTLE 4-3 AND MODULATED DOWNSHIFTS

(Valves In Third Gear Position)

CONVERTER CLUTCH – APPLIED*
FORWARD SPRAG CLUTCH – HOLDING

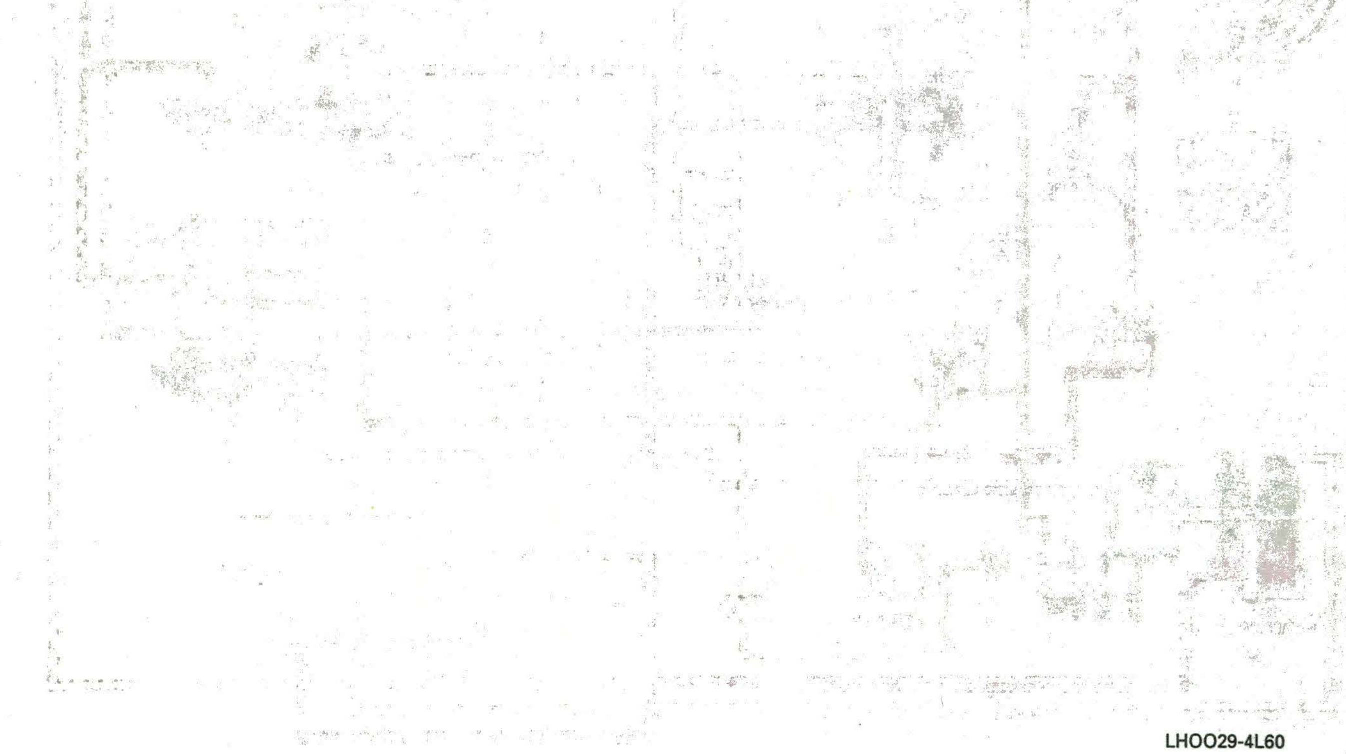
FORWARD CLUTCH – APPLIED
3-4 CLUTCH – APPLIED

A part throttle 4-3 downshift can be accomplished by depressing the accelerator pedal far enough to move the throttle valve (T.V.) plunger to allow the T.V. oil to enter the part throttle (P.T.) passage. This oil, called part throttle (P.T.) oil, is then routed to the 3-4 throttle valve.

Part throttle oil and the 3-4 throttle valve spring force will close the 3-4 shift valve against governor pressure, shutting off D4 oil to the fourth signal passage. Fourth accumulator oil will push the 3-4 relay valve closed and hold the 4-3 sequence valve open while it exhausts at an orifice at the T.V. limit valve. Fourth oil will pass through the 4-3 sequence valve to the servo feed passage to the 2-3 shift valve to the fourth accumulator passage. When fourth accumulator pressure is low enough, the 4-3 sequence valve spring will close the 4-3 sequence valve and the remaining fourth and fourth accumulator oil will exhaust at the 4-3 sequence valve.

A type of part throttle downshift can be accomplished in some ranges (4-3, and 3-2, shifts) by depressing the accelerator pedal far enough to raise M.T.V. down pressure. This pressure when combined with the throttle valve spring pressure can overcome governor pressure and cause a modulated downshift.

*The converter clutch will be released for the 4-3 downshift and may or may not be reapplied depending on shift calibration and solenoid operation.



LHOO29-4L60

Figure 28 Part Throttle 4-3 and Modulated Downshifts

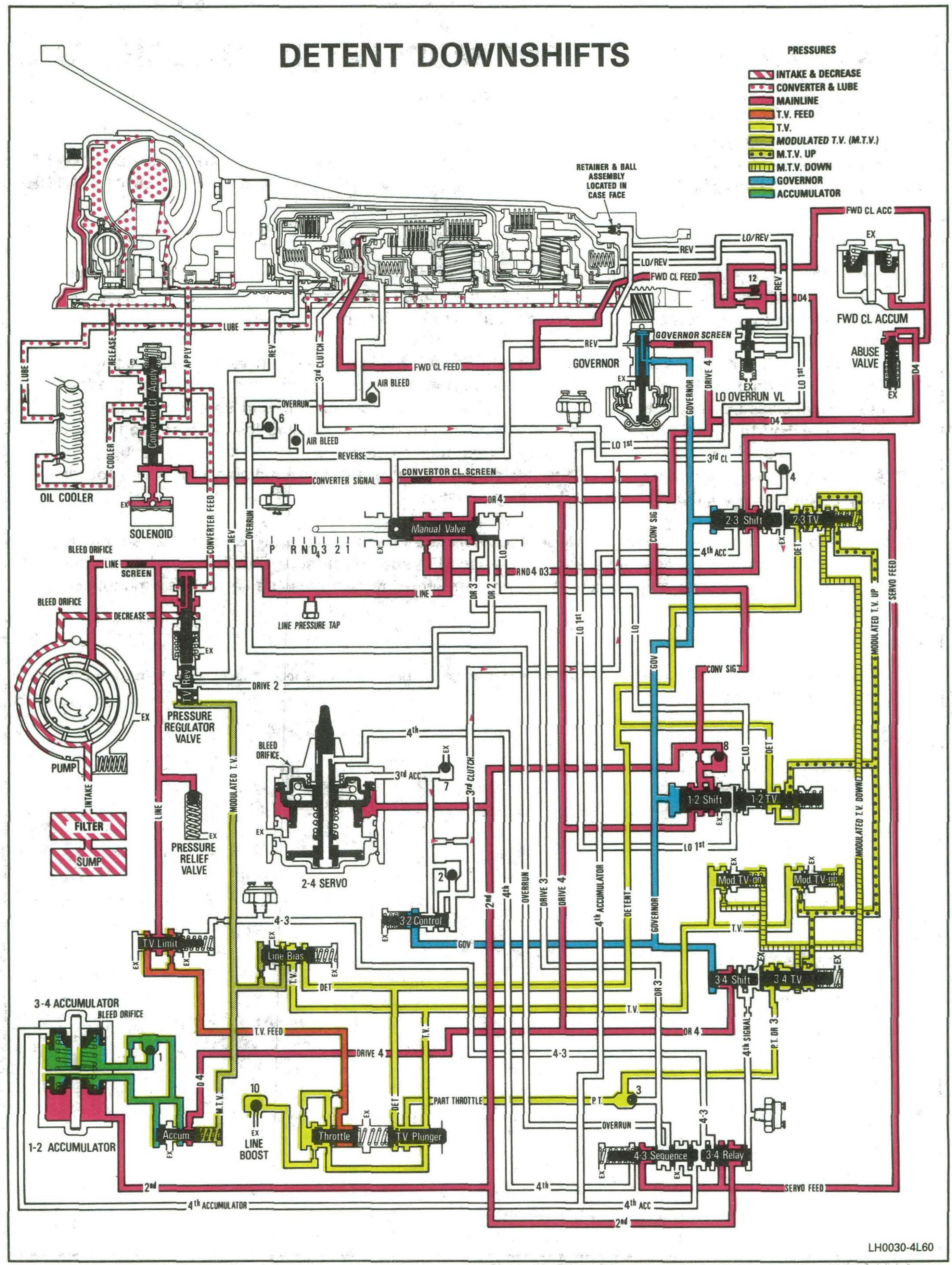


Figure 29 Detent Downshifts

DETENT DOWNSHIFTS

(Valves In Second Gear Position)

CONVERTER CLUTCH – RELEASED

2-4 BAND – APPLIED

FORWARD CLUTCH – APPLIED

FORWARD SPRAG CLUTCH – HOLDING

While operating at speeds below approximately 60 mph (96 km/h), a forced or detent 3-2 downshift is possible by depressing the accelerator pedal fully. This will position the throttle valve (T.V.) plunger to allow T.V. oil to enter the detent passage. This oil, called detent oil, is then routed to the following:

1. Line Bias Valve
2. 2-3 Throttle Valve
3. 1-2 Throttle Valve
4. Converter Clutch Throttle Valve (Non E.C.M. Controlled Vehicles Only)

Detent oil from the T.V. plunger flows to the line bias valve to boost modulated T.V. (M.T.V.) pressure. M.T.V. oil acting on the T.V. boost valve will boost line pressure approximately 70 kPa (10 psi).

The E.C.M. will discontinue the signal provided to the solenoid to release the converter clutch.

Detent oil from the T.V. plunger flows to the 2-3 throttle valve. Detent and M.T.V. down oil, acting on separate areas of the 2-3 throttle valve, will close the 2-3 shift valve against governor oil and allow 3rd clutch and 3rd accumulator oil to pass through an orifice and exhaust at the 2-3 shift valve.

At vehicle speeds above approximately 50 mph (80 km/h), governor oil acting on the 3-2 control valve will close it. Now the exhausting 3rd clutch accumulator oil from the intermediate servo will seat the 3rd clutch accumulator checkball (2) and flow through another orifice controlling the intermediate band apply for a smooth 3-2 shift at high speed.

A detent 2-1 downshift can be accomplished at speeds below approximately 30 mph (48 km/h), because detent oil pressure and the 1-2 spring force acting on the 1-2 throttle valve will close the 1-2 shift valve, shifting the transmission to first gear.

LH0031-4L60

Figure 30 Detent Downshifts

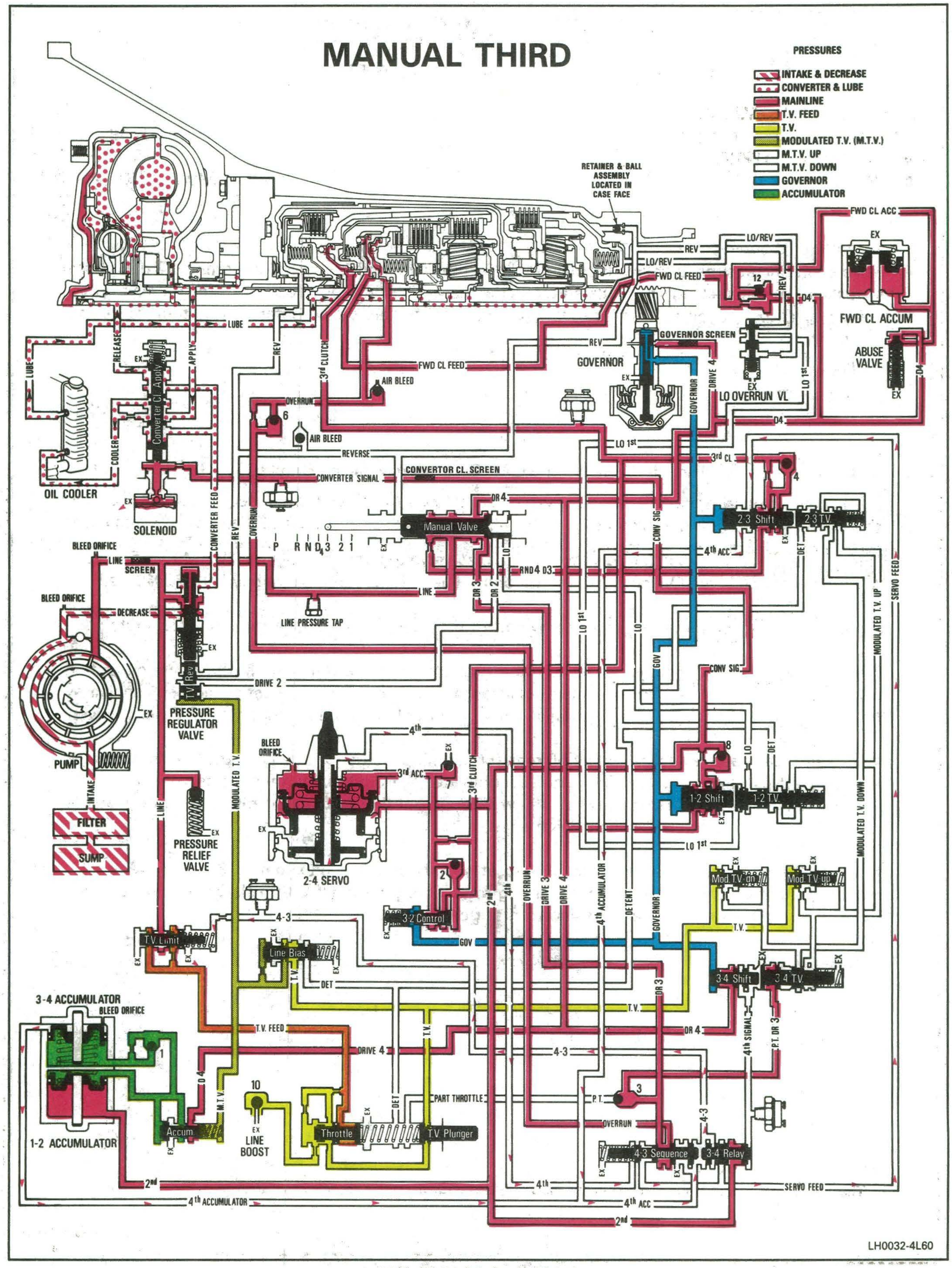


Figure 31 Manual Third

MANUAL THIRD

CONVERTER CLUTCH – RELEASED*

OVERRUN CLUTCH – APPLIED

FORWARD CLUTCH – APPLIED

3-4 CLUTCH – APPLIED

A forced 4-3 downshift can be accomplished by moving the selector lever from Drive (D) Range to Third (3rd) Gear. When the selector lever is moved to the Third (3rd) Gear position, D3 oil from the manual valve is directed to the following:

1. 4-3 Sequence Valve
2. Part Throttle and Drive 3 (D3) Checkball (3)
3. 3-4 Shift Valve

D3 oil will close the 3-4 shift valve and allow the 4th signal oil to exhaust.

D3 oil combined with the 4-3 sequence valve spring force will close the 4-3 sequence valve to allow the fourth and fourth accumulator oil to exhaust and release the band. D3 oil then flows into the overrun clutch passage where it applies the overrun clutch to keep the forward sprag clutch from overrunning when engine braking is needed.

The forward and 3-4 clutches are applied. The 2-4 band is released. The transmission is in Manual Third, direct drive. The overrun clutch is applied to allow engine braking.

In manual 3rd, the converter is shown released, and there is no M.T.V. up or M.T.V. down pressure. This is assuming the throttle is released. If the throttle is opened sufficiently, the E.C.M. could signal the solenoid to apply the converter clutch and the M.T.V. up and M.T.V. down valves could open.

**The converter clutch may or may not be applied, depending on shift calibration and solenoid operation.*

LH0033-4L60

Figure 32 Manual Third

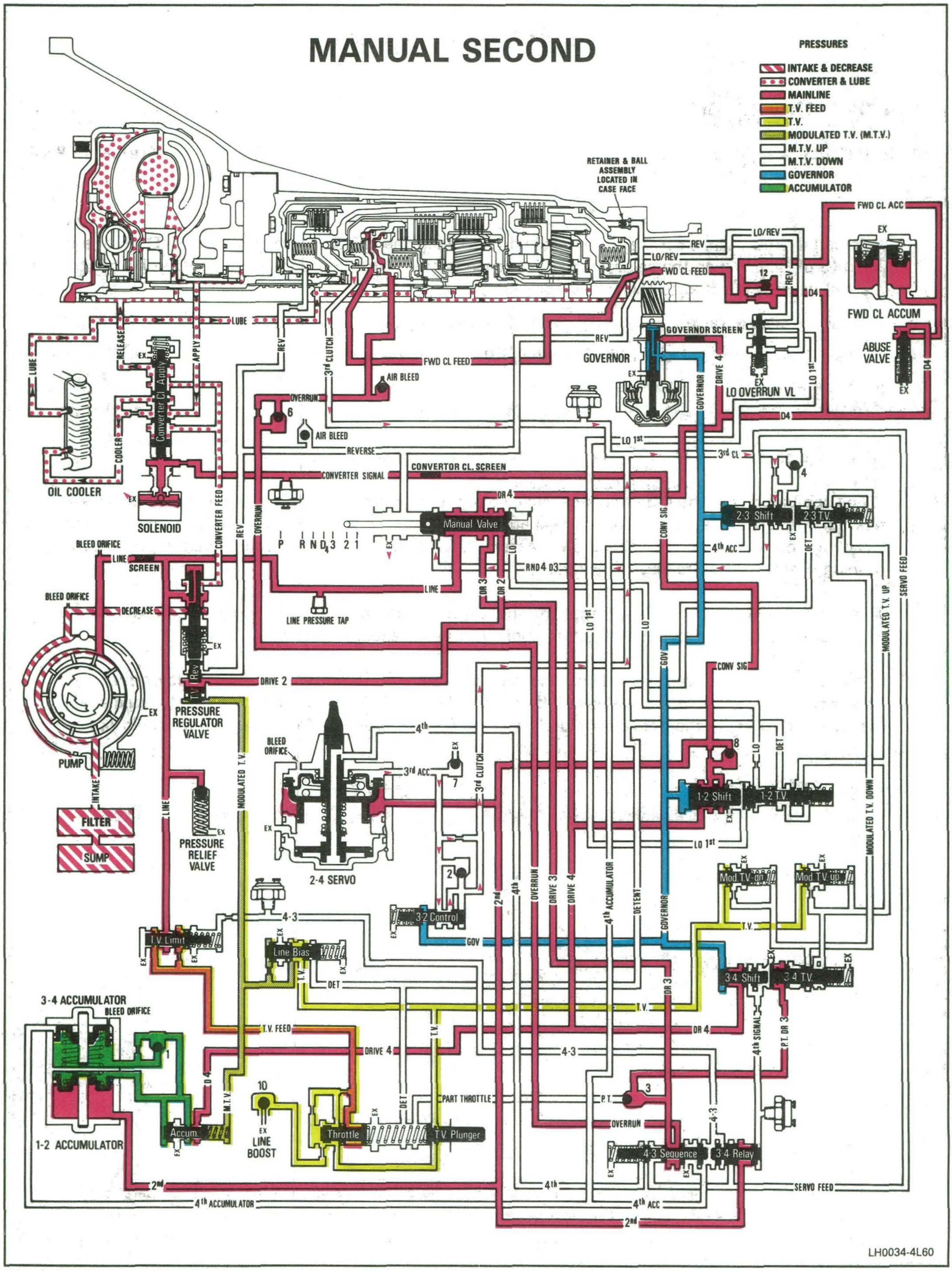


Figure 33 Manual Second

MANUAL SECOND

CONVERTER CLUTCH – RELEASED*

2-4 BAND – APPLIED

OVERRUN CLUTCH – APPLIED

FORWARD CLUTCH – APPLIED

A forced 3-2 downshift can be accomplished by moving the selector lever from Third (3rd) Gear to Second (2nd) Gear position.

When the selector lever is moved to the Second (2nd) Gear position, RND4D3, 3rd clutch, and 3rd accumulator oil will exhaust at the manual valve. With no pressure to apply the 3-4 clutch, or release the 2-4 band, the transmission will shift to second gear.

The manual valve will also direct line pressure into the D2 passage. Drive 2 (D2) oil will act on the reverse boost valve to boost line pressure to 1206 kPa (175 psi) which is required to prevent the 2-4 band and forward clutch from slipping.

SUMMARY

The forward clutch and 2-4 band are applied. The transmission is in second gear. Also, the overrun clutch is still applied to allow engine braking when needed.

*The converter clutch may or may not be applied, depending on shift calibration and solenoid operation.

LH0035-4L60

Figure 34 Manual Second

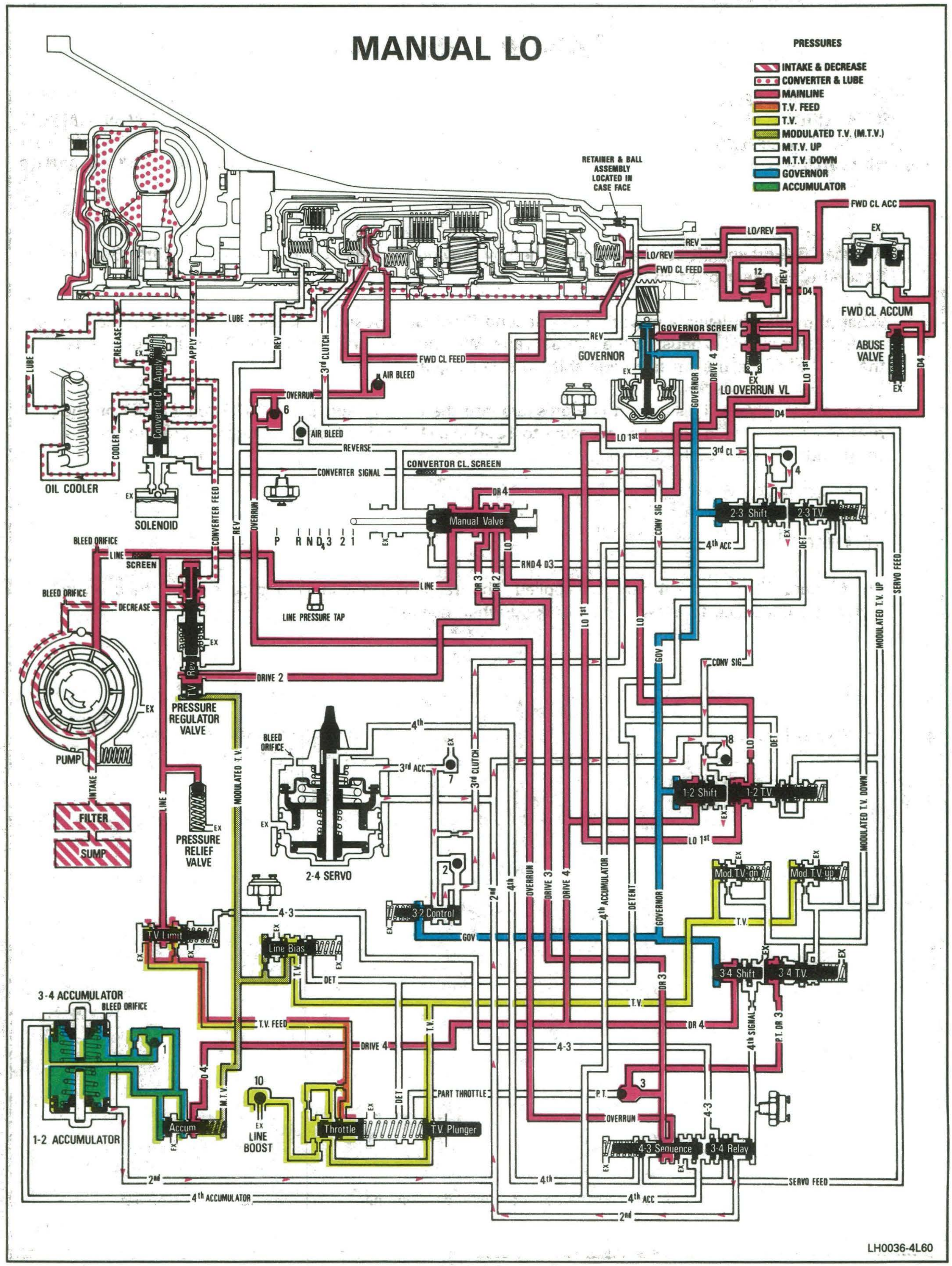


Figure 35 Manual Lo

MANUAL LO

CONVERTER CLUTCH – RELEASED

OVERRUN CLUTCH – APPLIED

FORWARD CLUTCH – APPLIED

LO ROLLER CLUTCH – APPLIED

Maximum downhill braking can be obtained at speeds below 30 mph (48 km/h) with the selector in Lo (1st) range. Lo/1st oil pressure, which is 1206 kPa (175 psi), is the same as second (2nd) oil pressure because second (D2) oil is still present.

Lo oil from the manual valve is directed to the following:

1. 1-2 Shift Valve Train
2. Lo and Reverse Clutch
3. Lo Overrun Valve

Lo oil at the 1-2 T.V. valve combined with the 1-2 throttle valve spring force will close the 1-2 shift valve at speeds approximately 35 mph (56 km/h) or below. This allows 2nd oil to exhaust, releasing the 2-4 band, and lo oil to apply the lo and reverse clutch.

Lo/1st oil coming off the 1-2 T.V. valve is directed toward the lo overrun valve that regulates lo/reverse oil. This smoothes the 2-1 manual downshift for maximum engine braking.

SUMMARY

The forward clutch is applied. The lo and reverse, and the overrun clutch are applied to allow engine braking. The 2-4 band is released, the transmission is in Lo Range — First Gear.

LH0037-4L60

Figure 36 Manual Lo

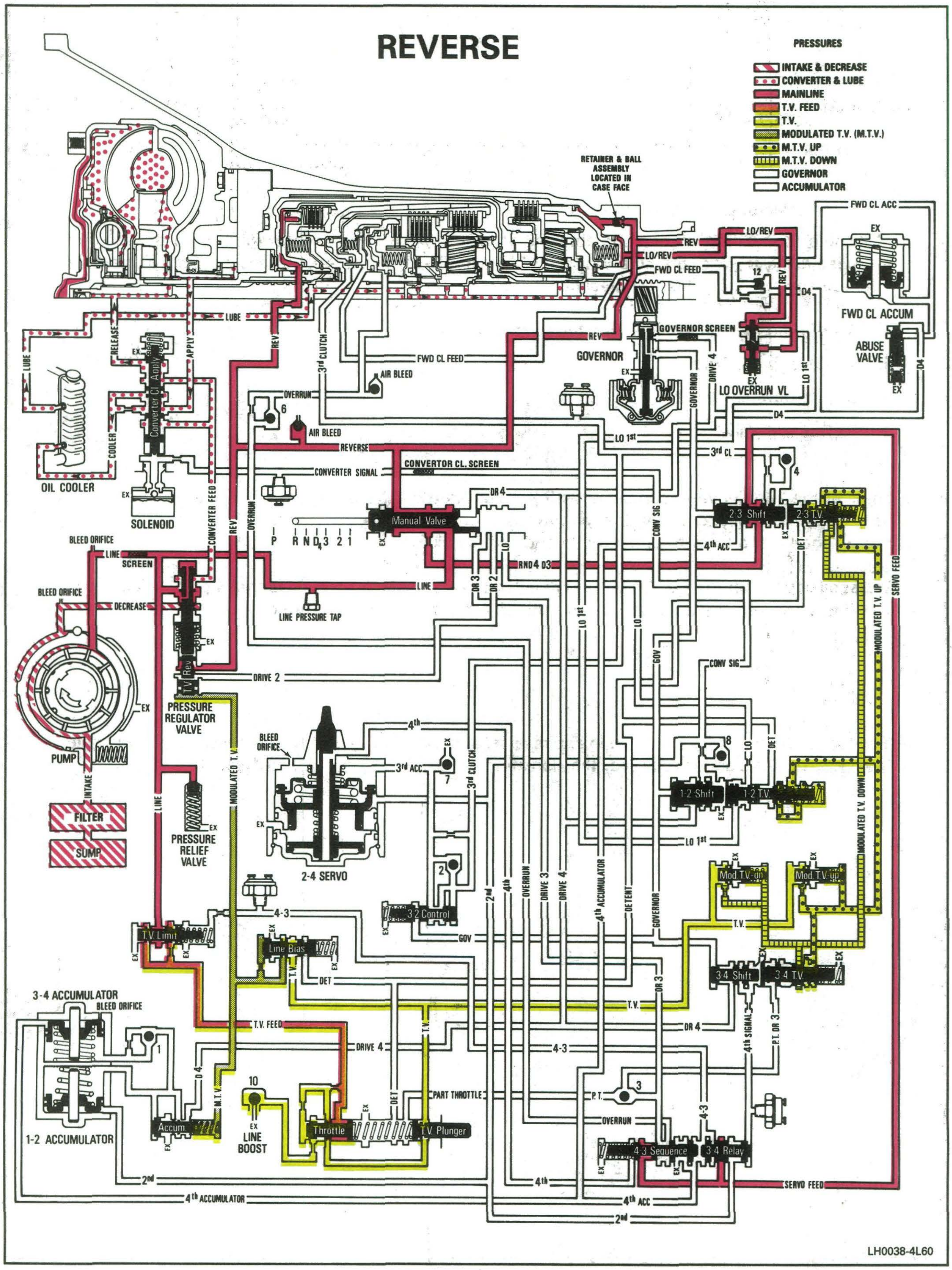


Figure 37 Reverse

REVERSE

REVERSE INPUT CLUTCH – APPLIED

LO AND REVERSE CLUTCH – APPLIED

When the selector lever is moved to the Reverse (R) position, the manual valve is repositioned to allow line pressure to enter the reverse passage which directs oil to the following:

1. Lo and Reverse Clutch
2. Reverse Input Clutch
3. Reverse Boost Valve
4. Lo Overrun Valve

Reverse oil is orificed at the retainer and ball assembly, and regulated at the lo overrun valve to apply the lo and reverse clutch.

Reverse oil is orificed into the reverse input clutch and orificed out of the reverse input piston for a smooth apply of the reverse input clutch during the shift.

Reverse oil acting on the reverse boost valve in the pressure regulator will boost line pressure to approximately 670 kPa (100 psi). M.T.V. oil from the line bias valve acting on the T.V. boost valve, in the pressure regulator, will further boost line pressure from 670 kPa (100 psi) at idle to 1690 kPa (245 psi) at full throttle.

SUMMARY

The reverse input clutch is applied. The lo and reverse clutch is applied. The transmission is in Reverse (R).

LH0039-4L60

Figure 38 Reverse

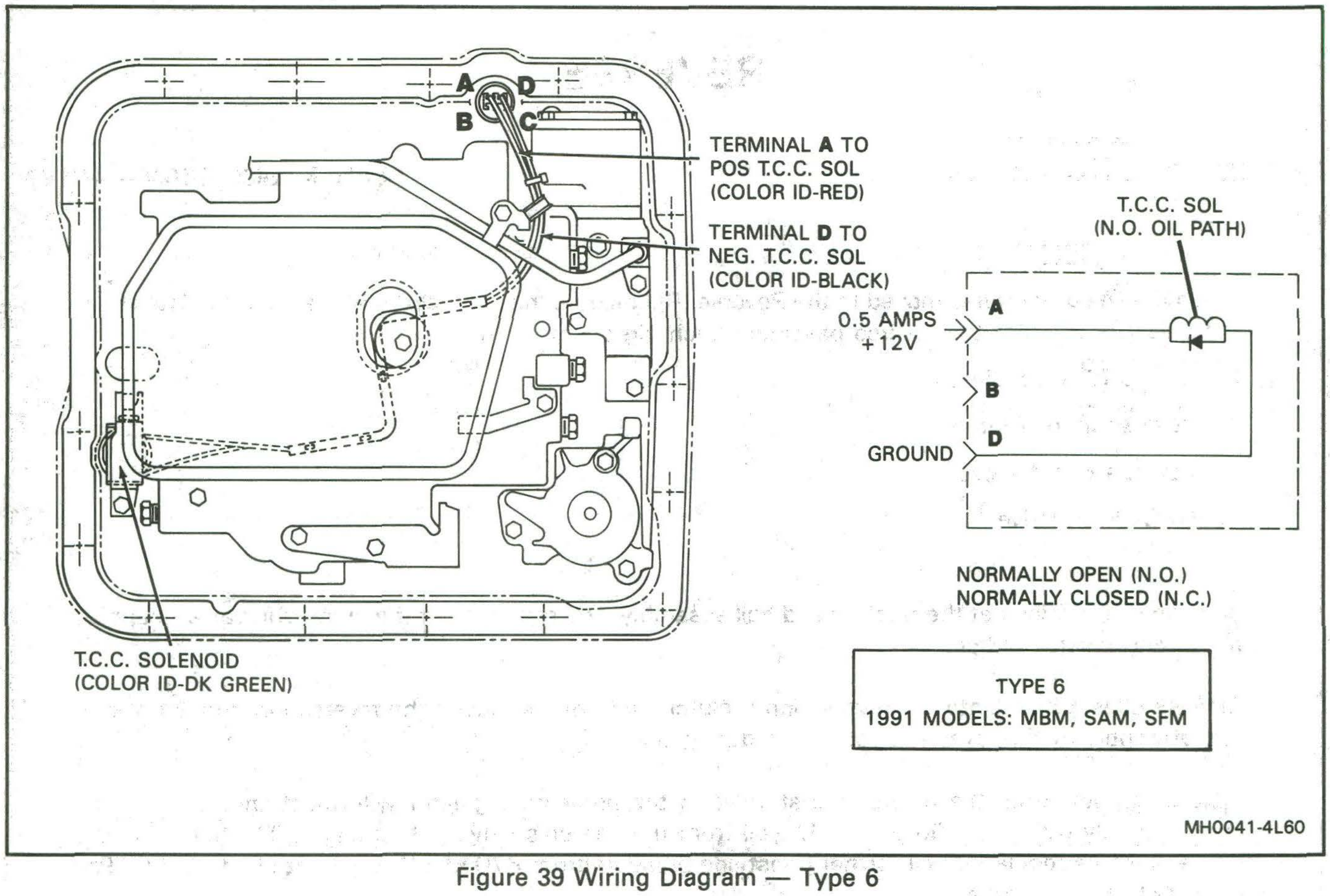


Figure 39 Wiring Diagram — Type 6

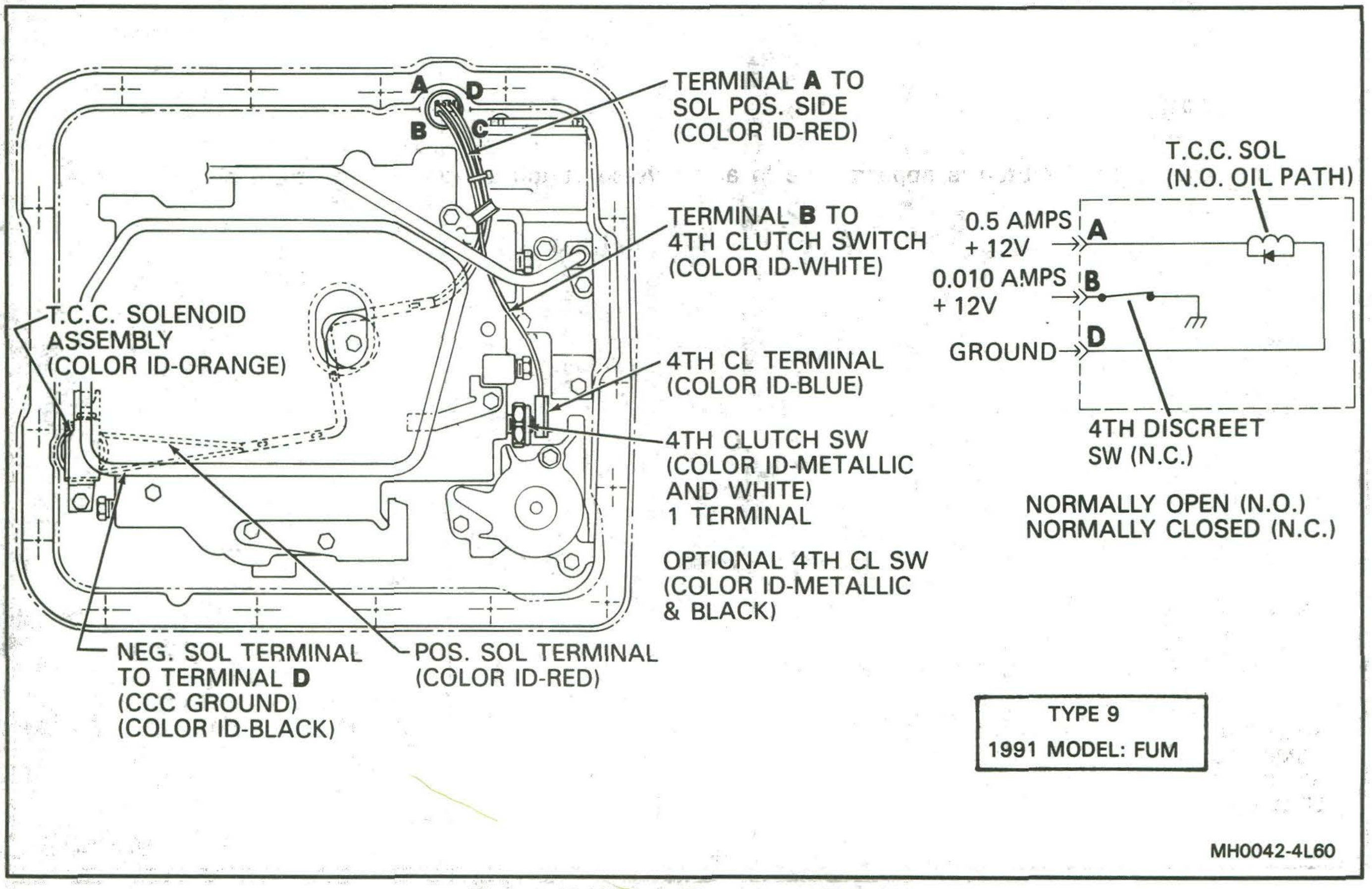
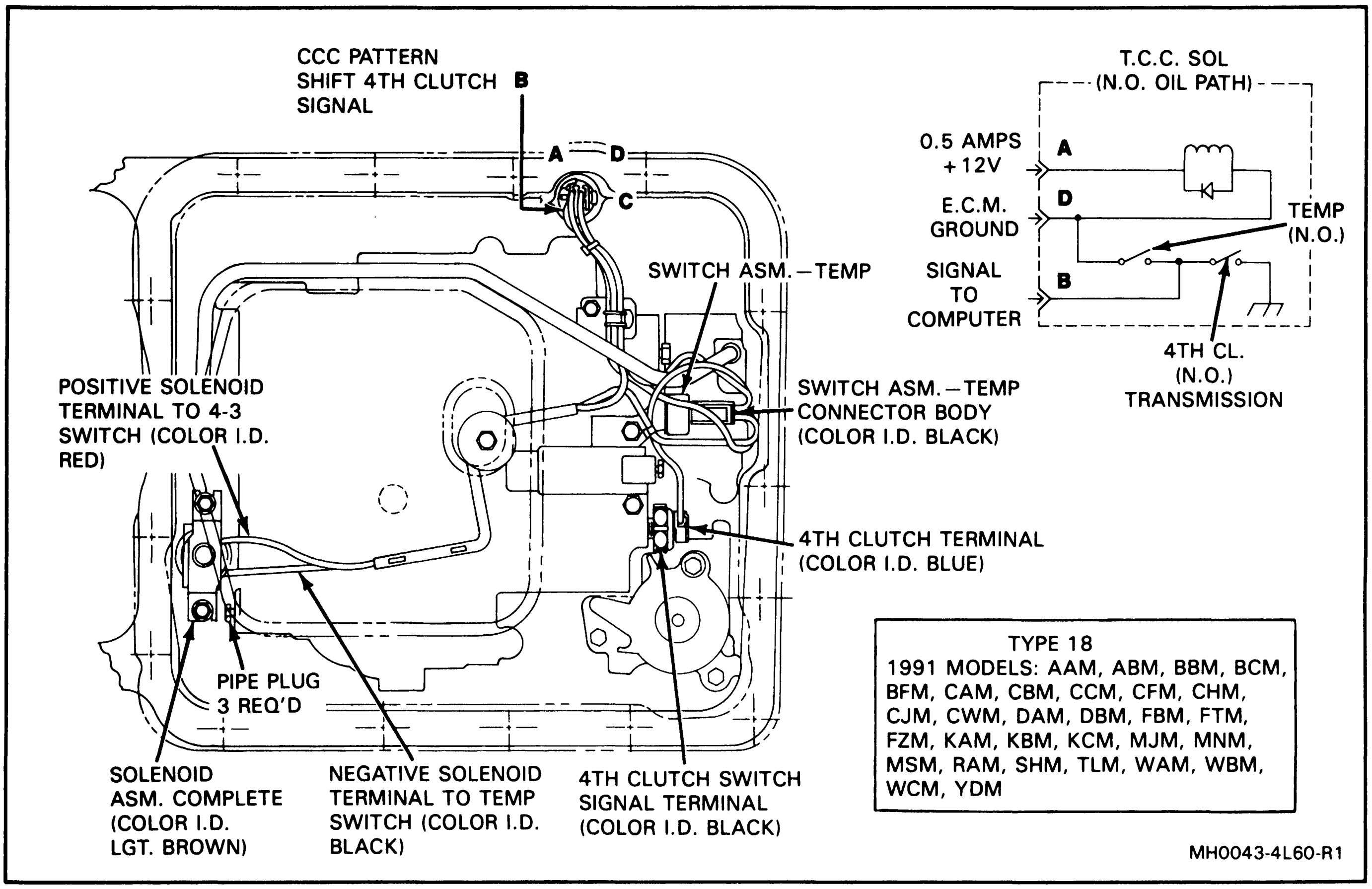
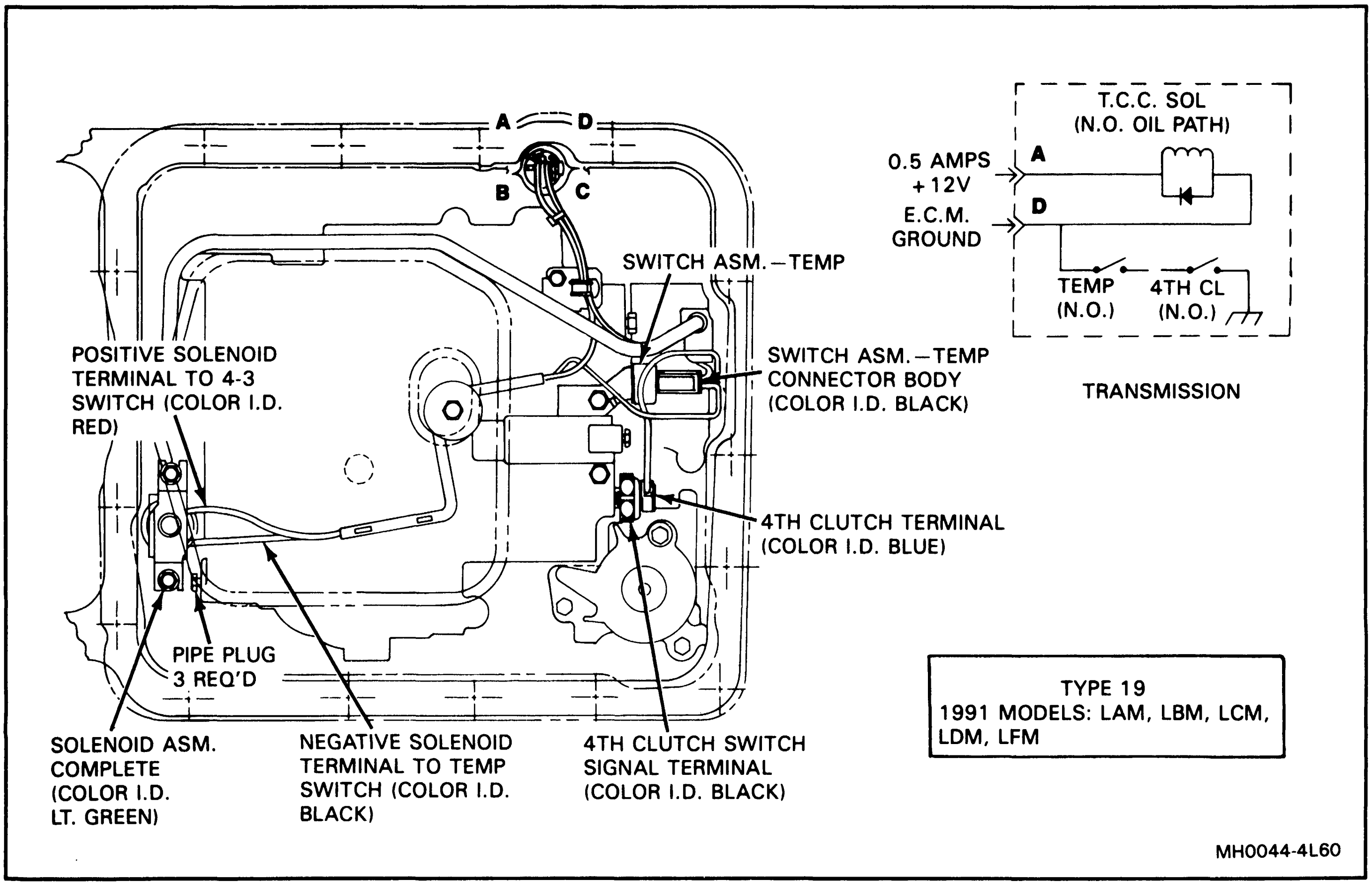


Figure 40 Wiring Diagram — Type 9



TYPE 18
1991 MODELS: AAM, ABM, BBM, BCM, BFM, CAM, CBM, CCM, CFM, CHM, CJM, CWM, DAM, DBM, FBM, FTM, FZM, KAM, KBM, KCM, MJM, MNM, MSM, RAM, SHM, TLM, WAM, WBM, WCM, YDM

Figure 41 Wiring Diagram — Type 18



TYPE 19
1991 MODELS: LAM, LBM, LCM, LDM, LFM

Figure 42 Wiring Diagram — Type 19

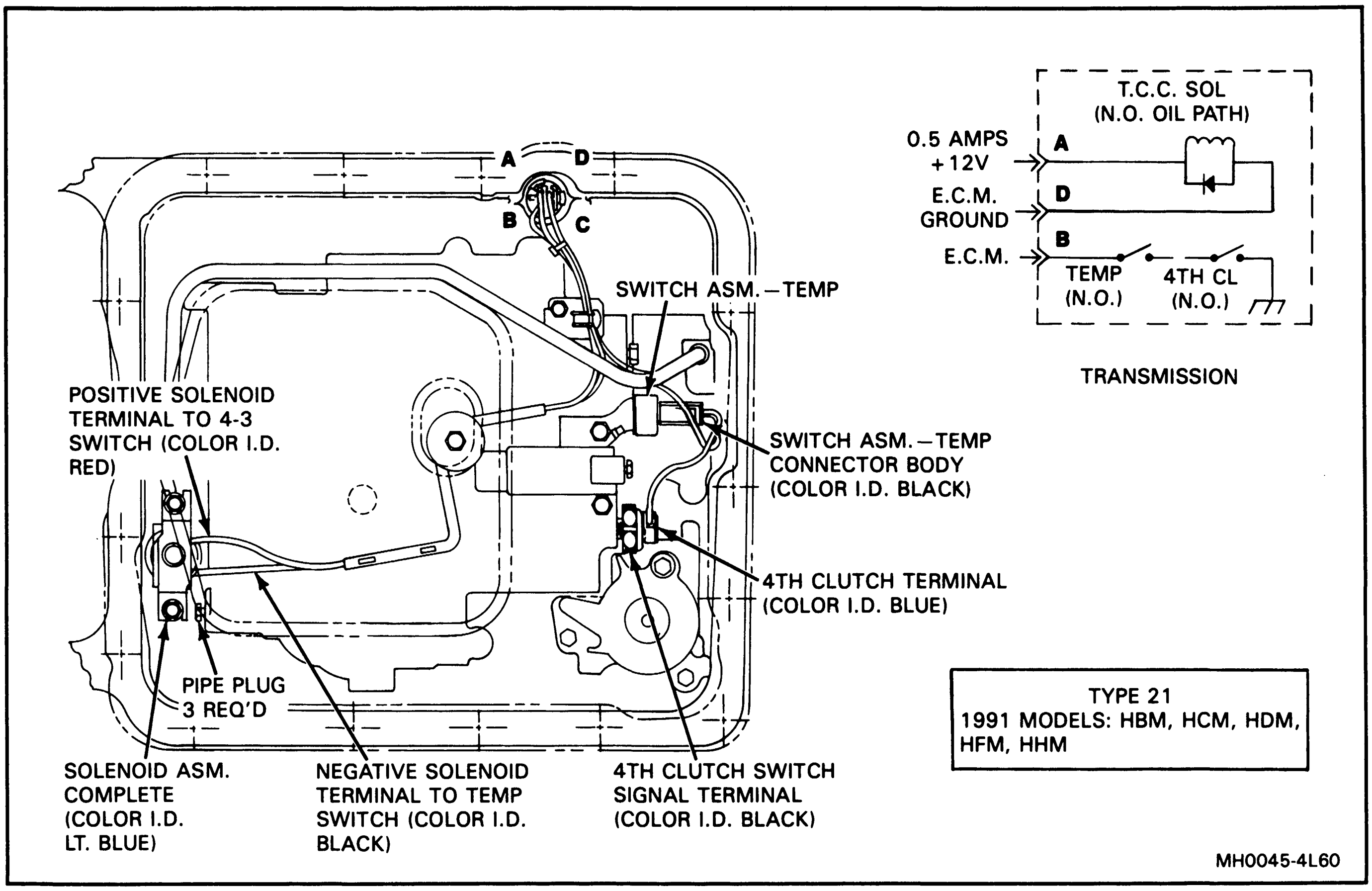
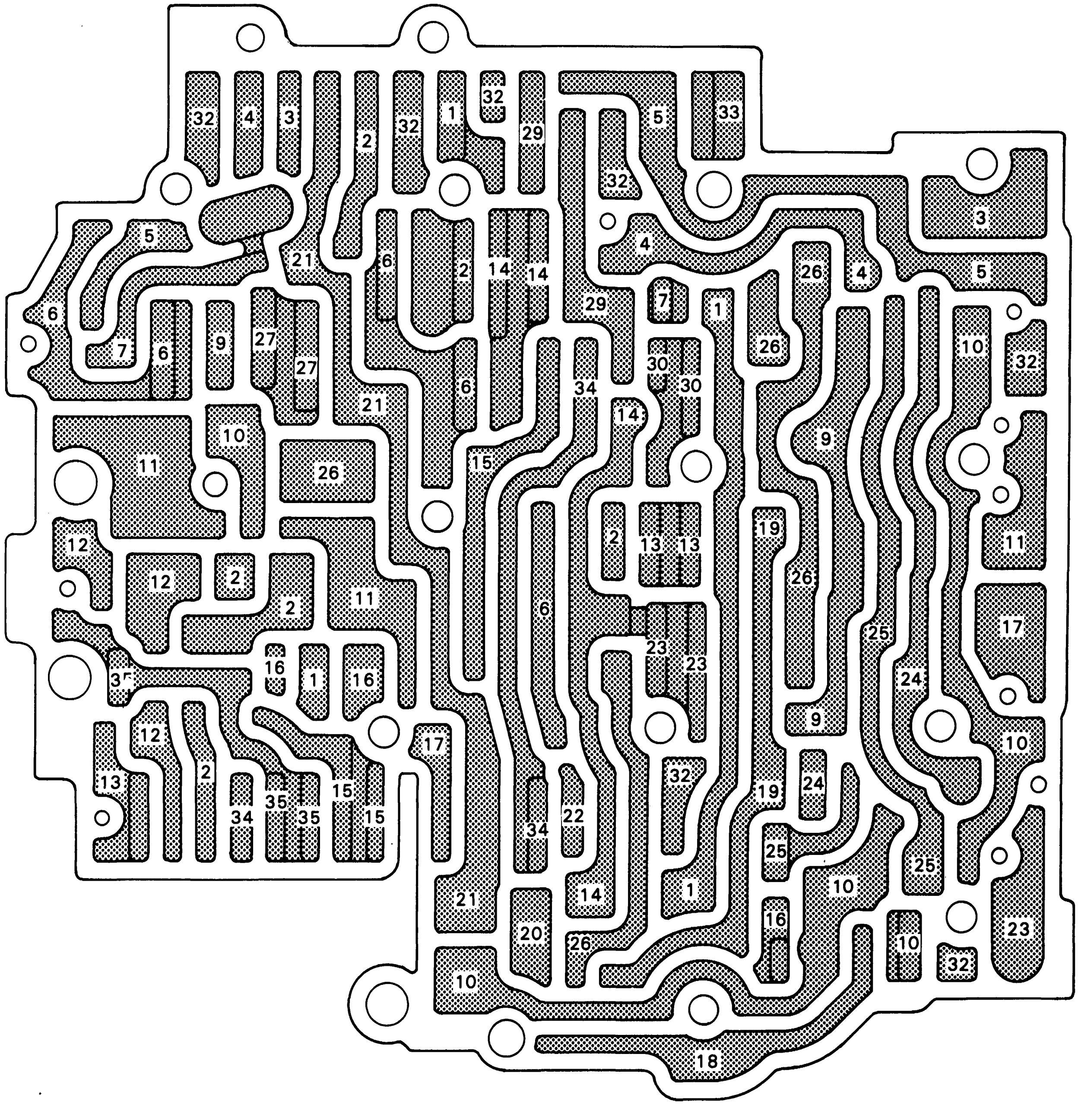


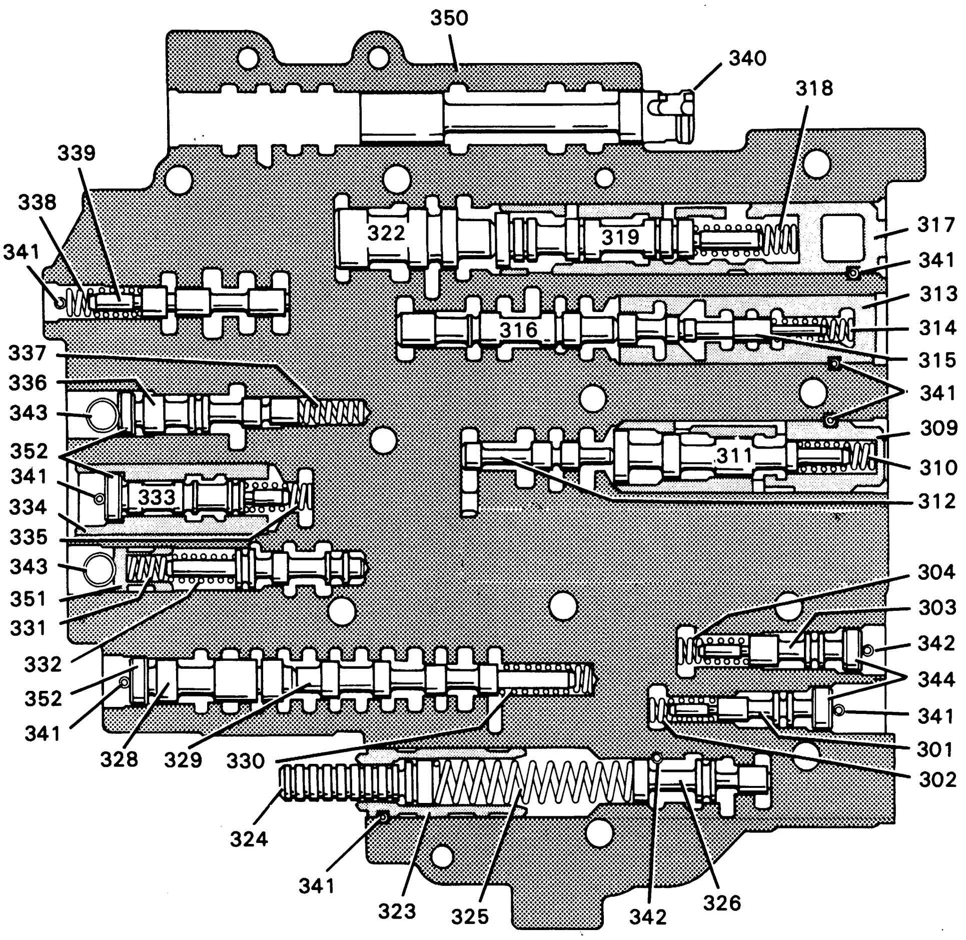
Figure 43 Wiring Diagram — Type 21



ILL. NO.	DESCRIPTION	ILL. NO.	DESCRIPTION	ILL. NO.	DESCRIPTION
1	LINE	16	T.V.F.	31	IDENTIFICATION
2	D4	17	OVERRUN CLUTCH	32	VOID
3	D2	18	T.V. EX.	33	EXHAUST
4	LO	19	D3/PART THROTTLE	34	SF
5	REVERSE	20	PART THROTTLE	35	4-3
6	GOVERNOR	21	D3	42	D4 ABUSE
7	LO - 1ST FEED	22	4TH CLUTCH	43	3RD FEED
9	3RD ACCUMULATOR	23	C.C. SIG.	44	3-2 HIGH SPEED
10	T.V.	24	MOD. UP	45	2ND FEED
11	M.T.V.	25	MOD. DOWN	46	3RD CL. EXHAUST
12	ACCUMULATOR	26	DETENT	47	4TH FEED
13	4TH SIGNAL	27	3-4 CLUTCH	48	1-2 ACCUMULATOR
14	2ND CLUTCH	29	RND4-3		
15	3-4 ACCUMULATOR	30	3RD CLUTCH		

LH0046-4L60

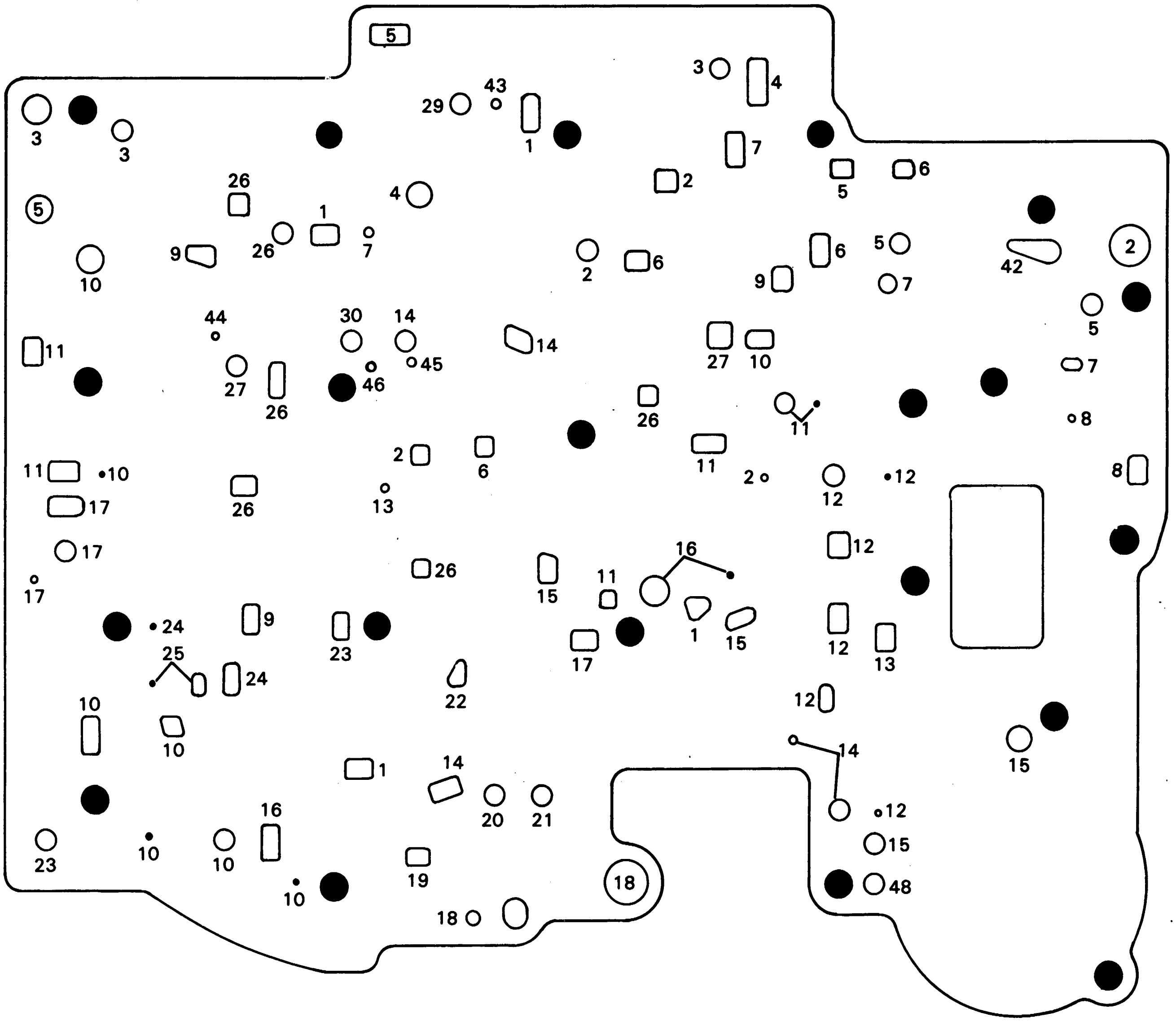
Figure 44 Valve Body Passages



ILL. NO.	DESCRIPTION
301	VALVE, T.V. MODULATOR DOWNSHIFT
302	SPRING, T.V. MODULATOR DOWNSHIFT VALVE
303	VALVE, T.V. MODULATOR UPSHIFT
304	SPRING, T.V. MODULATOR UPSHIFT VALVE
309	SLEEVE, 3-4 THROTTLE VALVE
310	SPRING, 3-4 THROTTLE VALVE
311	VALVE, 3-4 THROTTLE
312	VALVE, 3-4 SHIFT
313	SLEEVE, 2-3 THROTTLE VALVE
314	SPRING, 2-3 THROTTLE VALVE
315	VALVE, 2-3 THROTTLE
316	VALVE, 2-3 SHIFT
317	SLEEVE, 1-2 THROTTLE VALVE
318	SPRING, 1-2 THROTTLE VALVE
319	VALVE, 1-2 THROTTLE
322	VALVE, 1-2 SHIFT
323	SLEEVE, THROTTLE VALVE PLUNGER
324	PLUNGER, THROTTLE VALVE
325	SPRING, THROTTLE VALVE
326	VALVE, THROTTLE
328	VALVE, 3-4 RELAY
329	VALVE, 4-3 SEQUENCE
330	SPRING, 4-3 SEQUENCE VALVE
331	SPRING, T.V. LIMIT VALVE
332	VALVE, T.V. LIMIT
333	VALVE, 1-2 ACCUMULATOR
334	SLEEVE, 1-2 ACCUMULATOR VALVE
335	SPRING, 1-2 ACCUMULATOR VALVE
336	VALVE, LINE BIAS
337	SPRING, LINE BIAS VALVE
338	SPRING, 3-2 CONTROL
339	VALVE, 3-2 CONTROL
340	VALVE, MANUAL
341	PIN, COILED SPRING
342	PIN, COILED SPRING
343	RETAINER, SPRING (SLEEVE)
344	PLUG, VALVE BORE
350	BODY, CONTROL VALVE
351	PLUG, T.V. LIMIT
352	PLUG, VALVE BORE (12.5 - O.D.)

LH0047-4L60

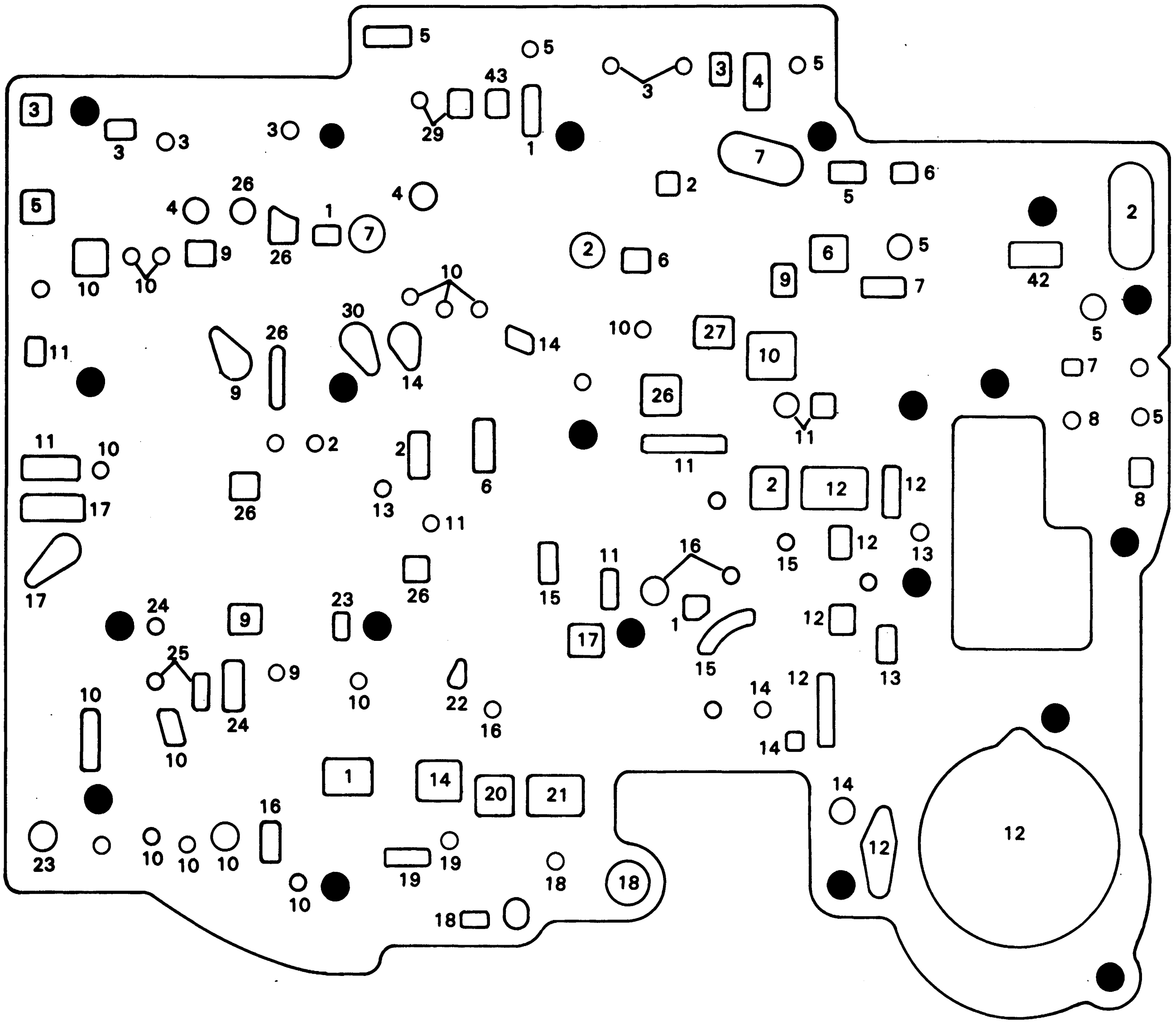
Figure 45 Valve Trains



ILL. NO.	DESCRIPTION
1	LINE
2	D4
3	D2
4	LO
5	REVERSE
6	GOVERNOR
7	LO - 1ST FEED
8	LO/REVERSE
9	3RD ACCUMULATOR
10	T.V.
11	M.T.V.
12	ACCUMULATOR
13	4TH SIGNAL
14	2ND CLUTCH
15	3-4 ACCUMULATOR
16	T.V.F.
17	OVERRUN CLUTCH
18	T.V. EX.
19	D3/PART THROTTLE
20	PART THROTTLE
21	D3
22	4TH CLUTCH
23	C.C. SIG.
24	MOD. UP
25	MOD. DOWN
26	DETENT
27	3-4 CLUTCH
29	RND4-3
30	3RD CLUTCH
31	IDENTIFICATION
42	D4 ABUSE
43	3RD FEED
44	3-2 HIGH SPEED
45	2ND FEED
46	3RD CL. EXHAUST
47	4TH FEED
48	1-2 ACCUMULATOR

LH0048-4L60

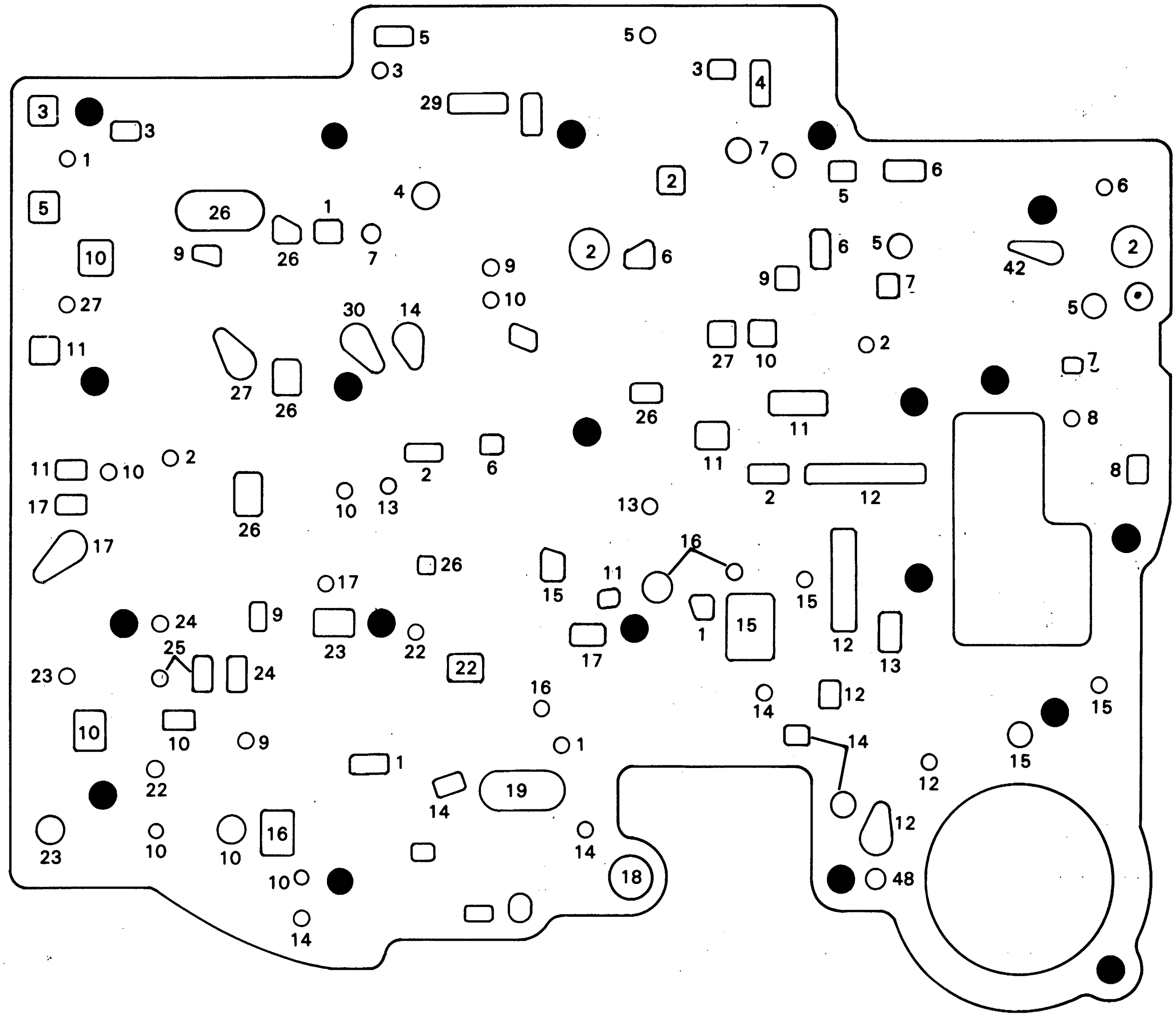
Figure 46 Typical Spacer Plate



ILL. NO.	DESCRIPTION
1	LINE
2	D4
3	D2
4	LO
5	REVERSE
6	GOVERNOR
7	LO - 1ST FEED
8	LO/REVERSE
9	3RD ACCUMULATOR
10	T.V.
11	M.T.V.
12	ACCUMULATOR
13	4TH SIGNAL
14	2ND CLUTCH
15	3-4 ACCUMULATOR
16	T.V.F.
17	OVERRUN CLUTCH
18	T.V. EX.
19	D3/PART THROTTLE
20	PART THROTTLE
21	D3
22	4TH CLUTCH
23	C.C. SIG.
24	MOD. UP
25	MOD. DOWN
26	DETENT
27	3-4 CLUTCH
29	RND4-3
30	3RD CLUTCH
31	IDENTIFICATION
42	D4 ABUSE
43	3RD FEED
44	3-2 HIGH SPEED
45	2ND FEED
46	3RD CL. EXHAUST
47	4TH FEED
48	1-2 ACCUMULATOR

LH0049-4L60

Figure 47 Spacer Plate to Valve Body Gasket



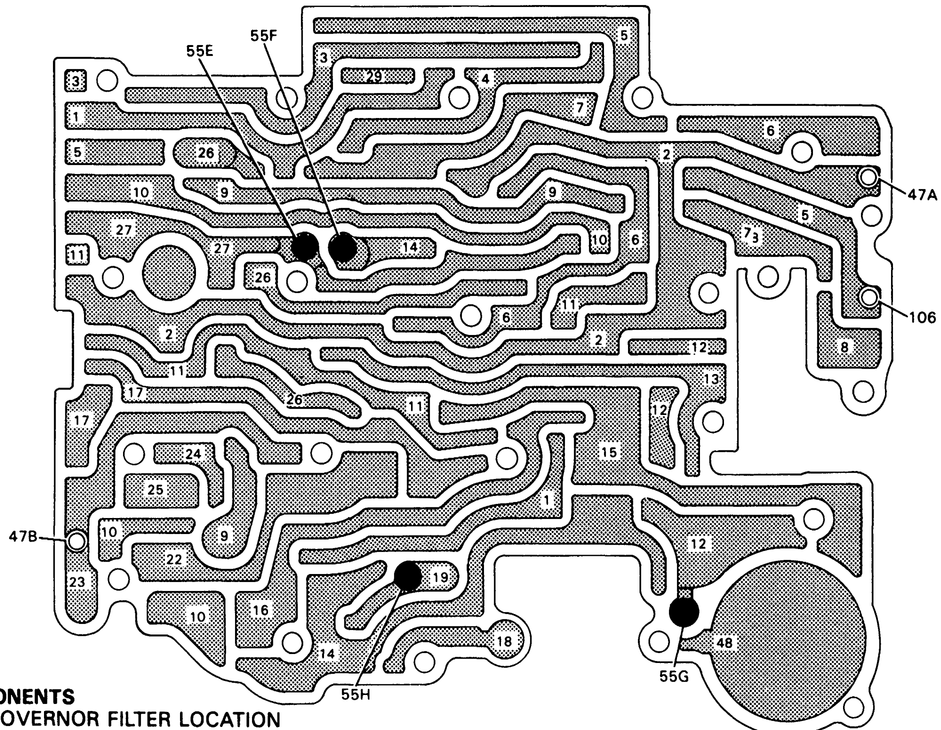
ILL. NO.	DESCRIPTION	ILL. NO.	DESCRIPTION	ILL. NO.	DESCRIPTION
1	LINE	14	2ND CLUTCH	27	3-4 CLUTCH
2	D4	15	3-4 ACCUMULATOR	29	RND4-3
3	D2	16	T.V.F.	30	3RD CLUTCH
4	LO	17	OVERRUN CLUTCH	31	IDENTIFICATION
5	REVERSE	18	T.V. EX.	42	D4 ABUSE
6	GOVERNOR	19	D3/PART THROTTLE	43	3RD FEED
7	LO - 1ST FEED	20	PART THROTTLE	44	3-2 HIGH SPEED
8	LO/REVERSE	21	D3	45	2ND FEED
9	3RD ACCUMULATOR	22	4TH CLUTCH	46	3RD CL. EXHAUST
10	T.V.	23	C.C. SIG.	47	4TH FEED
11	M.T.V.	24	MOD. UP	48	1-2 ACCUMULATOR
12	ACCUMULATOR	25	MOD. DOWN		
13	4TH SIGNAL	26	DETENT		

LH0050-4L60

Figure 48 Spacer Plate to Case Gasket

PASSAGES

1	LINE
2	D4
3	D2
4	LO
5	REVERSE
6	GOVERNOR
7	LO - 1ST FEED
8	LO/REVERSE
9	3RD ACCUMULATOR
10	T.V.
11	M.T.V.
12	ACCUMULATOR (4TH)
13	4TH SIGNAL
14	2ND CLUTCH
15	3-4 ACCUMULATOR
16	T.V.F.
17	OVERRUN CLUTCH
18	T.V. EX.
19	D3/PART THROTTLE
20	PART THROTTLE
21	D3
22	4TH CLUTCH
23	C.C. SIG.
24	MOD. UP
25	MOD. DOWN
26	DETENT
27	3-4 CLUTCH (3-2 EX)
29	RND4-3
42	D4 ABUSE
43	3RD FEED
44	3-2 HIGH SPEED
45	2ND FEED
46	3RD CL. EXHAUST
47	4TH FEED
48	1-2 ACCUMULATOR

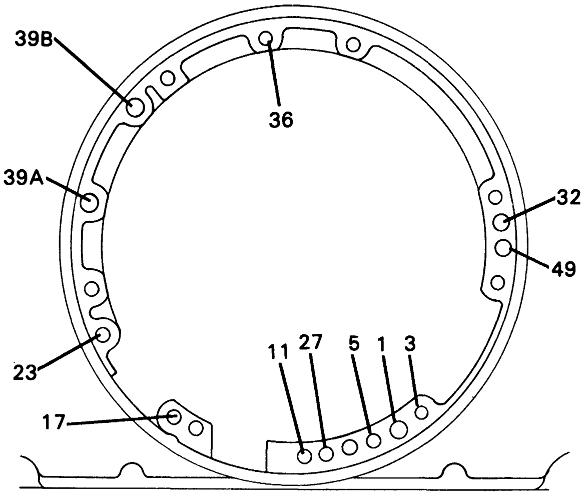


COMPONENTS

47A	GOVERNOR FILTER LOCATION
47B	CONVERTER CLUTCH FILTER LOCATION
55E	#4 CHECK BALL (3-4 CLUTCH/3-2 EX.)
55F	#8 CHECK BALL (2ND/1-2)
55G	#1 CHECK BALL (4TH ACCUMULATOR)
55H	#3 CHECK BALL (PART THROTTLE/DRIVE 3)
106	RETAINER & BALL ASM. (DOUBLE-ORIFICE)

LH0051-4L60

Figure 49 Case Passages and Checkball Locations

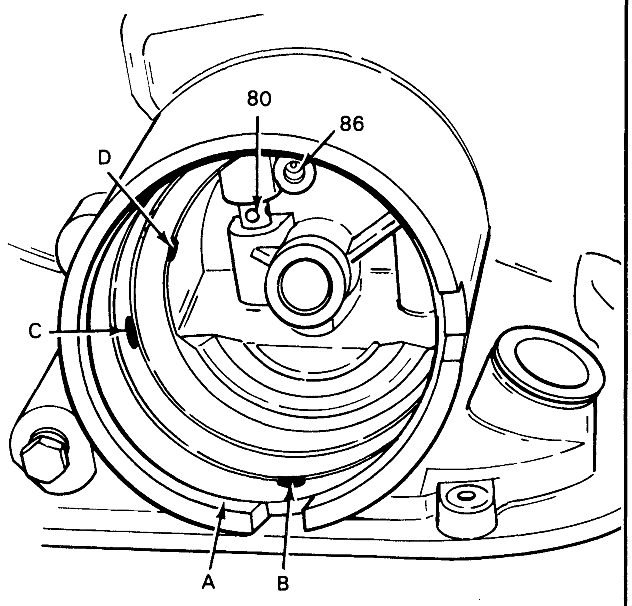


CASE OIL PASSAGES

1	LINE
3	DR-2
5	REVERSE
11	M.T.V.
17	O.R. CLUTCH
23	CONV. CL. SIG.
27	3-4 CLUTCH
32	VOID
36	VENT
39(a)	LUBE TO COOLER
39(b)	LUBE FROM COOLER
49	PRESSURE TAP

LH0052-4L60

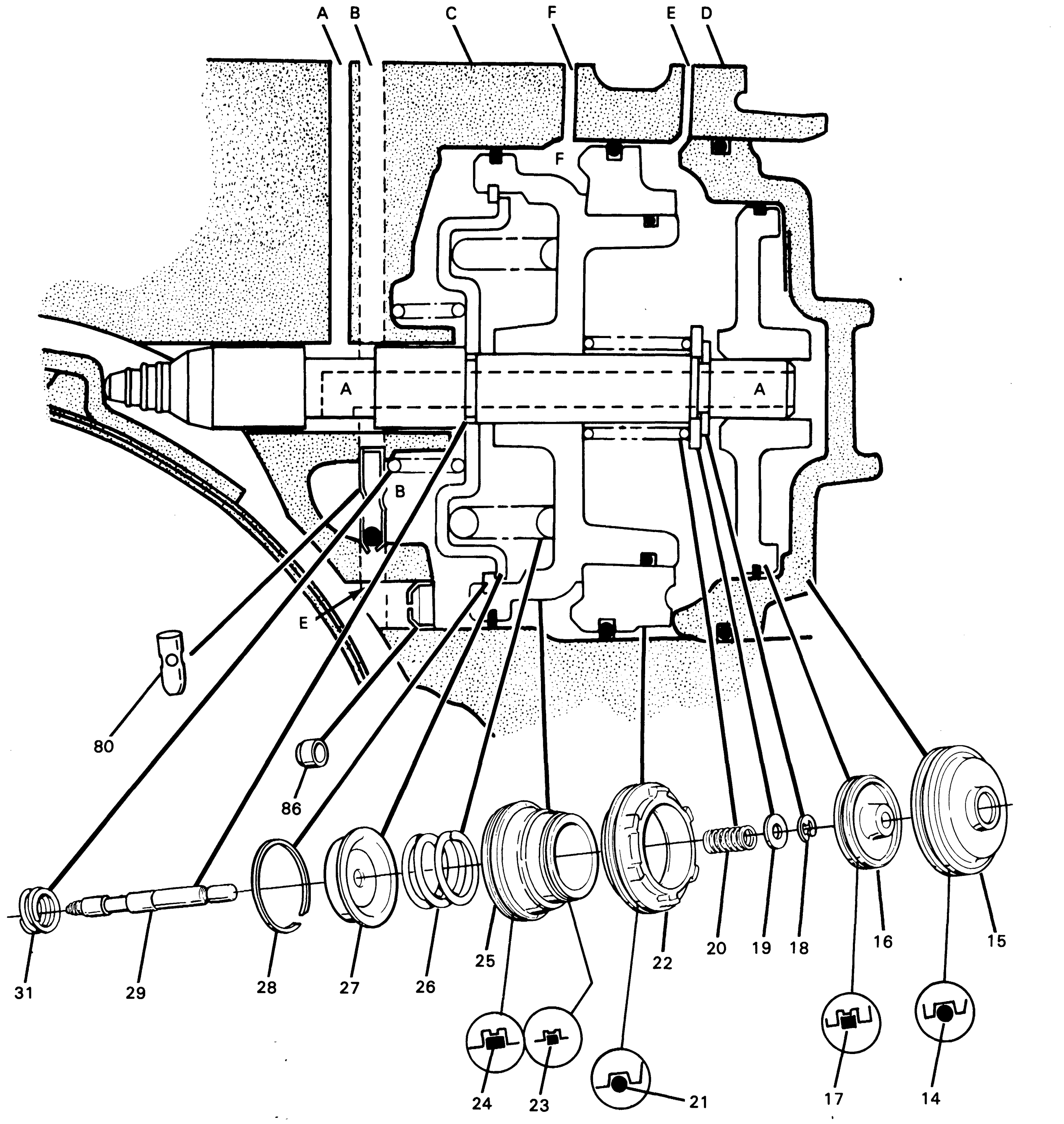
Figure 50 Pump to Case Passages



A	2-4 SERVO BORE
B	SERVO EXHAUST HOLE
C	2ND & 4TH BAND APPLY PASSAGE
D	3RD ACCUM. PRESSURE TAP PASSAGE
80	RETAINER & BALL ASSEMBLY, 3RD ACCUM.
86	PLUG, CASE SERVO

LH0053-4L60

Figure 51 Servo Passages



A 4TH OIL
B 3RD ACCUMULATOR OIL
C VALVE BODY FACE
D OIL PAN FLANGE
E EXHAUST
F 2ND OIL
14 SEAL, "O" RING (2-4 SERVO COVER)
15 COVER, 2-4 SERVO
16 PISTON, 4TH APPLY
17 RING, OIL SEAL (4TH APPLY PISTON) (OUTER)
18 RING, RETAINER (APPLY PIN)
19 WASHER, SERVO APPLY PIN
20 SPRING, SERVO APPLY PIN
21 SEAL, "O" RING
22 HOUSING, SERVO PISTON (INNER)
23 RING, OIL SEAL (2ND APPLY PISTON) (INNER)
24 RING, OIL SEAL (2ND APPLY PISTON) (OUTER)
25 PISTON, 2ND APPLY
26 SPRING, SERVO CUSHION
27 RETAINER, SERVO CUSHION SPRING
28 RING, RETAINER (2ND APPLY PISTON)
29 PIN, 2ND APPLY PISTON
31 SPRING, SERVO RETURN
80 RETAINER & BALL ASSEMBLY, 3RD ACCUM.
86 PLUG, CASE SERVO

LH0054-4L60

Figure 52 Servo Assembly

1	LINE
3	D2
5	REVERSE
11	MODULATED T.V.
17	OVERRUN CLUTCH
23	CONVERTER CLUTCH SIGNAL
23(a)	CONVERTER CLUTCH SIGNAL (ORIFICE CUP PLUG)
27	3-4 CLUTCH
32	VOID
33	EXHAUST
33(a)	EXHAUST (T.C.C. RELEASE)
33(b)	EXHAUST (PRESS. REG.)
36	VENT
37	DECREASE
37(a)	DECREASE AIR BLEED (ORIFICE CUP PLUG)
38	SEAL DRAIN
39	LUBE
39(a)	LUBE TO COOLER
39(b)	LUBE FROM COOLER
40	CONVERTER CLUTCH RELEASE
41	CONVERTER CLUTCH FEED
41(a)	CONVERTER CLUTCH FEED TO COOLER (ORIFICE CUP PLUG)

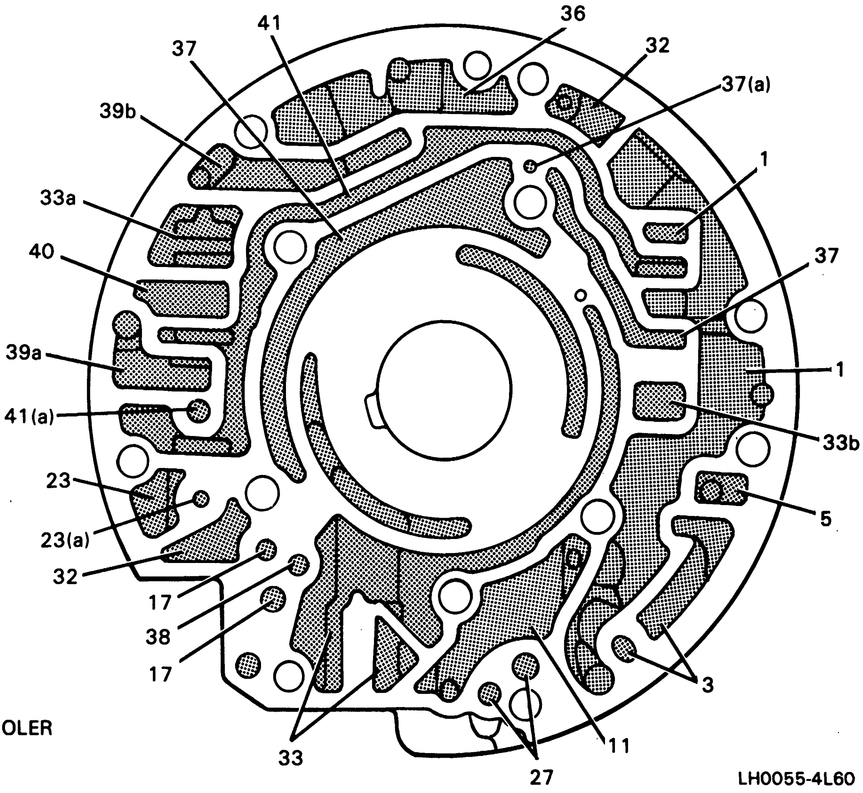


Figure 53 Pump Cover Passages

1	LINE
3	D2
5	REVERSE
11	MODULATED T.V.
17	OVERRUN CLUTCH
23	CONVERTER CLUTCH SIGNAL
27	3-4 CLUTCH
32	VOID
33	EXHAUST
33(a)	EXHAUST (T.C.C. RELEASE)
33(b)	EXHAUST (PRESS. REG.)
36	VENT
37	DECREASE
38	SEAL DRAIN
39	LUBE
39(a)	LUBE TO COOLER
39(b)	LUBE FROM COOLER
40	CONVERTER CLUTCH RELEASE
41	CONVERTER CLUTCH FEED

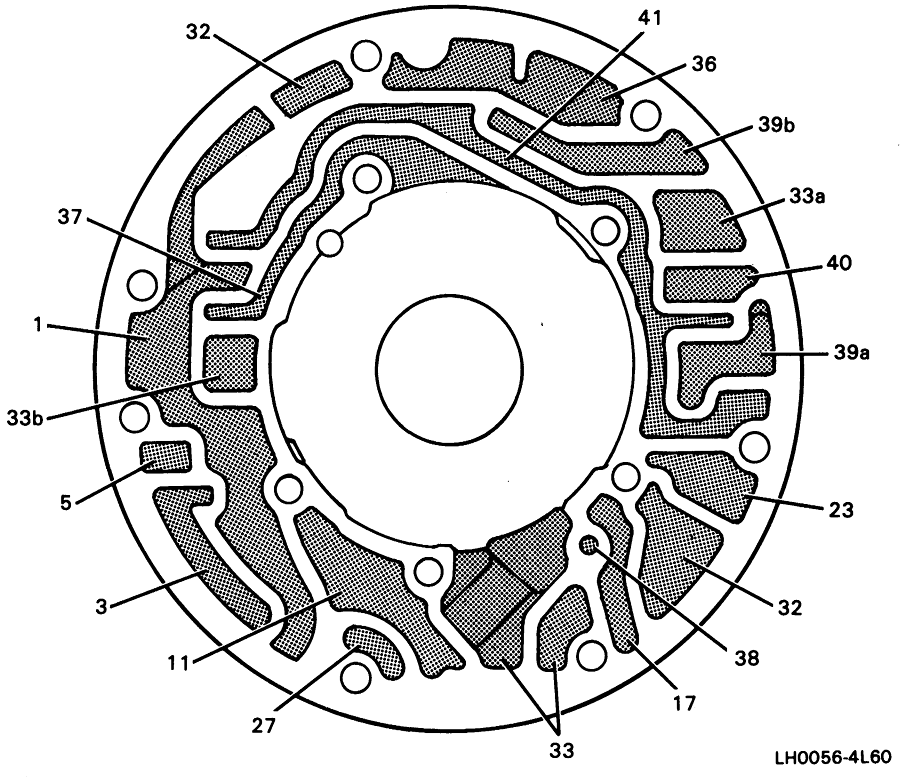


Figure 54 Pump Body Passages

SECTION/HYDRA-MATIC 4L60

AUTOMATIC TRANSMISSION UNIT REPAIR

RPO MD8

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

***Designates significant product changes since the publication of the 1990 Service Manual.**

TRANSMISSION DISASSEMBLY

General Service Information

Figure 1

Tool Required:

J 8763-02 Holding Fixture and Base

NOTICE: It is not recommended to use air powered tools to disassemble or assemble transmissions/transaxles. Improper bolt torques can contribute to transmission repair conditions and this information, vital to diagnosis, can only be detected when using hand tools.

- Teflon Oil Seal Rings
  If any seal rings are damaged, cut, or do not rotate freely in their groove be certain to check the ring groove for debris, burrs, or damage.
- Thrust Washer Surfaces
  The thrust washer and thrust bearing surfaces may appear to be polished. This is a normal condition and should not be considered damage.

Clean

- Thoroughly clean the exterior of the transmission.

Remove or Disconnect

- Torque Converter (1).

Install or Connect

1. J 8763-02 onto the transmission case.
2. Holding fixture into the base.

Remove or Disconnect

- Drain the transmission fluid out case extension by rotating transmission so bell housing is up.

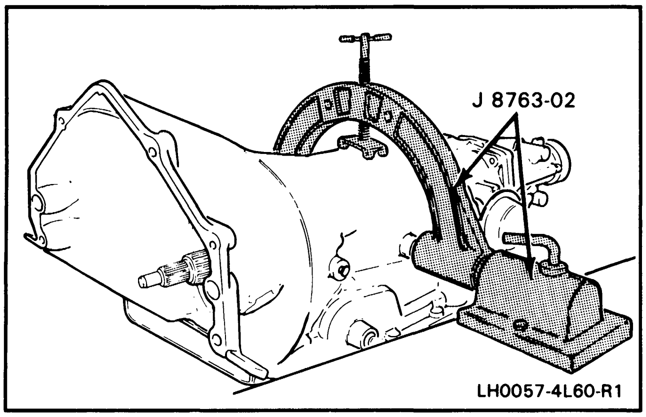


Figure 1 Holding Fixture

2-4 Servo Assembly

Figures 2 and 3

Tool Required:

J 29714 Servo Cover Compressor

Remove or Disconnect

1. Install J 29714.
2. Servo cover retaining ring (13).
3. Servo cover and O-ring seal (14 and 15).
4. 2-4 servo assembly (16-31).

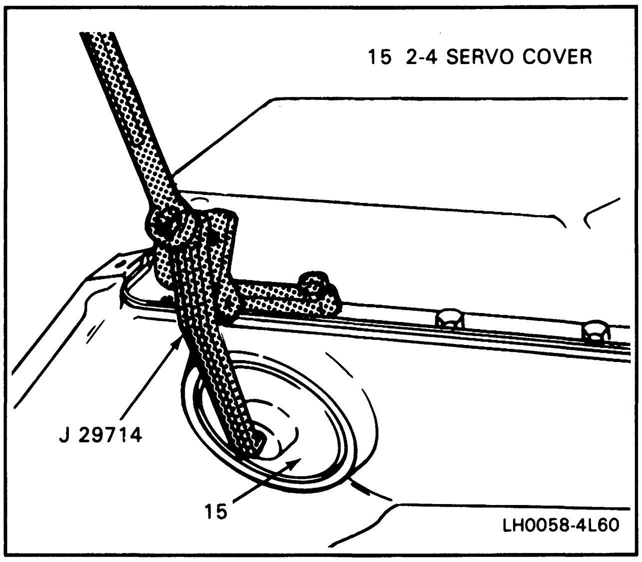


Figure 2 Servo Cover Removal

Servo Pin Length

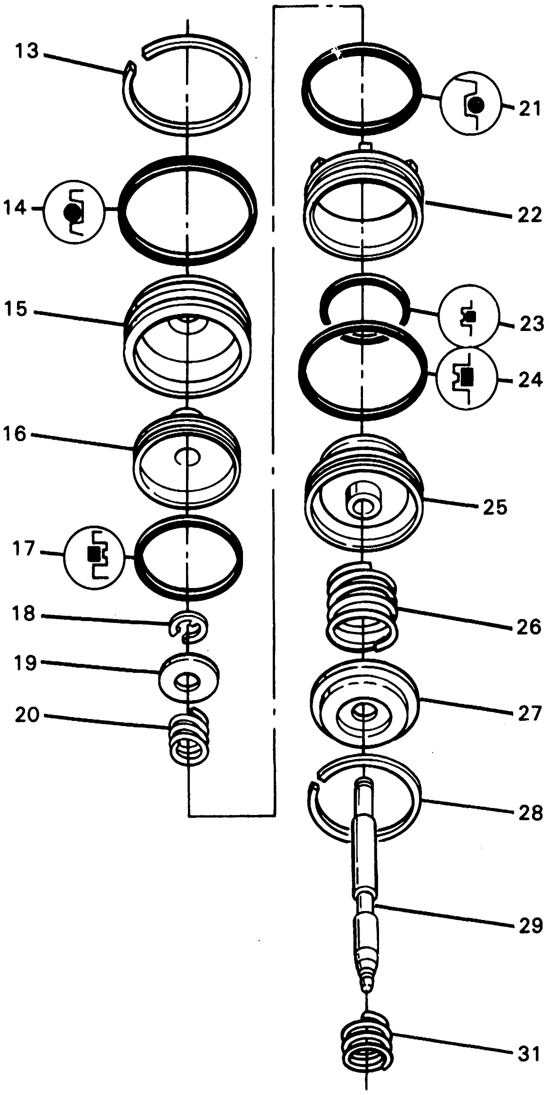
Figures 3, 4 and 5

Tools Required:

J 33037 Band Apply Pin Tool

J 22269-01 Piston Compressor

As a diagnostic aid, the servo pin length should now be checked. If the pin length is too short or too long, be certain to inspect the 2-4 band and reverse input drum for damage or wear when disassembled.



ILL. NO.	DESCRIPTION
13	RING, SERVO COVER RETAINING
14	SEAL, "O" RING (2-4 SERVO COVER)
15	COVER, 2-4 SERVO
16	PISTON, 4TH APPLY
17	RING, OIL SEAL (4TH APPLY PISTON) (OUTER)
18	RING, RETAINER (APPLY PIN)
19	WASHER, SERVO APPLY PIN
20	SPRING, SERVO APPLY PIN
21	SEAL, "O" RING
22	HOUSING, SERVO PISTON (INNER)
23	RING, OIL SEAL (2ND APPLY PISTON) (INNER)
24	RING, OIL SEAL (2ND APPLY PISTON) (OUTER)
25	PISTON, 2ND APPLY
26	SPRING, SERVO CUSHION
27	RETAINER, SERVO CUSHION SPRING
28	RING, RETAINER (2ND APPLY PISTON)
29	PIN, 2ND APPLY PISTON
31	SPRING, SERVO RETURN

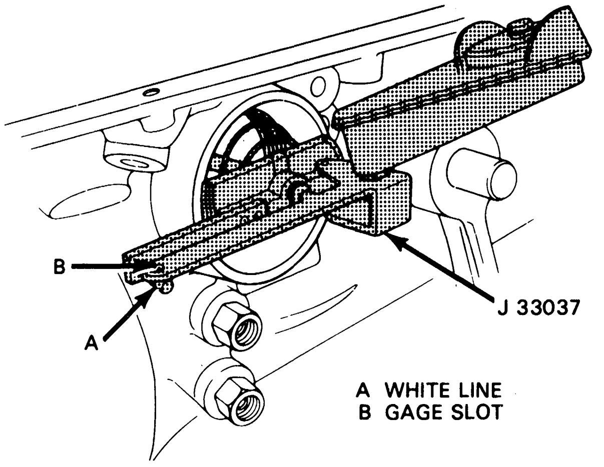
LH0059-4L60

Figure 3 Servo Assembly

Measure

Figure 4

1. Install J 33037 as shown with apply pin (29).
2. Install servo cover retaining ring (13) to secure tool.
3. Apply 11 N·m (98 lb.-in.) torque.
4. If white line "A" appears in gage slot "B" pin length is correct.
5. Use pin selection chart to determine correct pin length if new pin is needed.



PIN IS PRESET AT FACTORY AND MUST NOT BE READJUSTED

2-4 SERVO PIN SELECTION

PIN LENGTH		PIN I.D.
mm	INCH	
66.37 - 66.67	2.61 - 2.62	2 RINGS
67.74 - 68.04	2.67 - 2.68	3 RINGS
69.11 - 69.41	2.72 - 2.73	WIDE BAND

LH0060-4L60

Figure 4 Servo Pin Length

Remove or Disconnect

Figures 3 and 5

1. 4th apply piston (16)
2. Servo return spring (31)
3. Servo pin retainer ring (18), washer (19), and apply pin spring (20)
4. 2nd apply piston pin (29)
5. Install J 22269-01.
6. Retainer ring (28)
7. Cushion spring retainer (27) and cushion spring (26)

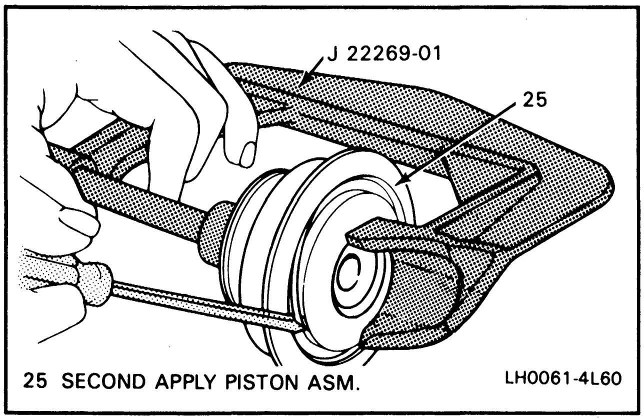


Figure 5 Second Servo Piston Retaining Ring Removal

Governor and Extension

Figures 6 and 7

Tool Required:

J 38417 Speed Sensor Remover and Installer

Remove or Disconnect

Figures 6 and 7

1. Governor cover (46)
   - Tap around the cover flange with a punch to remove.

Important

   - Do not damage the governor cover.

2. Governor assembly (45)
   Mechanical Speedometer:
3. Bolt and washer assembly (41) and retainer (40)
4. Speedometer driven gear assembly (43), speedo driven gear(44) and o-ring seal (42)
   Internal Transmission Speed Sensor (I.T.S.S.)
5. Speed sensor retaining bolt (100)
6. Speed sensor assembly (99) and o-ring seal (42) with J 38417
7. Case extension bolts (37) and case extension (36) Extension seal ring (35)
8. Output shaft sleeve (690) and output shaft o-ring seal (691)
   - Not all models use an output shaft sleeve and seal.

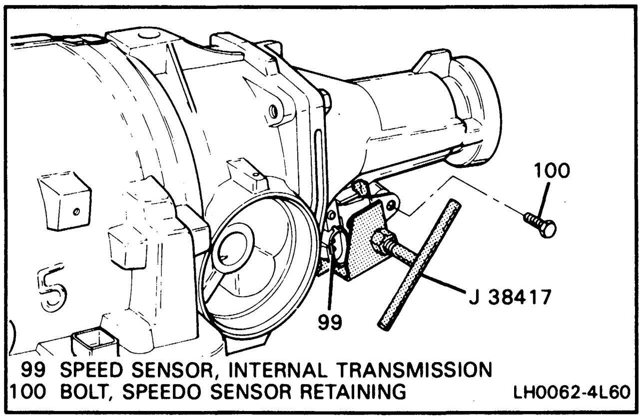
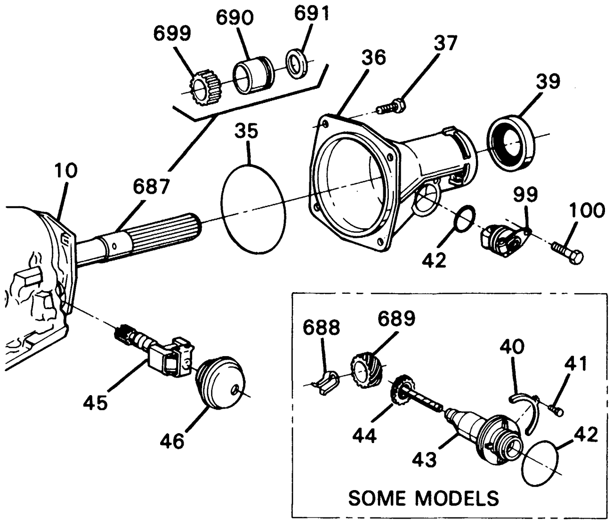


Figure 6 Speed Sensor Removal



ILL. NO.	DESCRIPTION
10	CASE, TRANSMISSION
35	SEAL, CASE EXTENSION TO CASE
36	EXTENSION, CASE
37	BOLT, CASE EXTENSION TO CASE
39	SEAL ASSEMBLY, CASE EXTENSION OIL
40	RETAINER, SPEEDO DRIVEN GEAR FITTING
41	BOLT & WASHER ASSEMBLY
42	SEAL, O-RING (SPEEDO FITTING TO CASE EXTENSION)
43	FITTING ASSEMBLY, SPEEDO DRIVEN GEAR
44	GEAR, SPEEDO DRIVEN
45	GOVERNOR ASSEMBLY
46	COVER, GOVERNOR
99	SPEED SENSOR, INTERNAL TRANSMISSION
100	BOLT, SPEEDO SENSOR RETAINING
687	SHAFT, OUTPUT
688	CLIP, SPEEDO DRIVE GEAR
689	GEAR, SPEEDO DRIVE
690	SLEEVE, OUTPUT SHAFT NOT USED ON
691	SEAL, OUTPUT SHAFT ALL MODELS
699	ROTOR, INTERNAL TRANSMISSION SPEED SENSOR

LH0063-4L60-R1

Figure 7 Extension and Associated Parts

Remove or Disconnect

Figure 7

Models with Mechanical Speedometer

1. Speedometer drive gear (689) and clip (688)
   - Use care not to damage the speedo gear.
   - Push tab of retaining clip and tap speedometer gear off the output shaft.

Pan And Filter Assembly

Figure 8

Clean

- Exposed ends of bottom pan screws and spray with penetrating oil

Remove or Disconnect

1. Screws (74), oil pan (73), and gasket (72)
2. Oil filter (71) and filter seal (70)
   - Filter seal may be stuck in the pump.

   Inspect

   - Filter (71), open filter by prying the metal crimping away from the top of the filter (black) and pull apart. The filter may contain evidence for root cause diagnosis.
     - clutch material
     - bronze slivers indicating bushing wear
     - steel particles
3. Outside electrical connector (33) and o-ring seal (34)

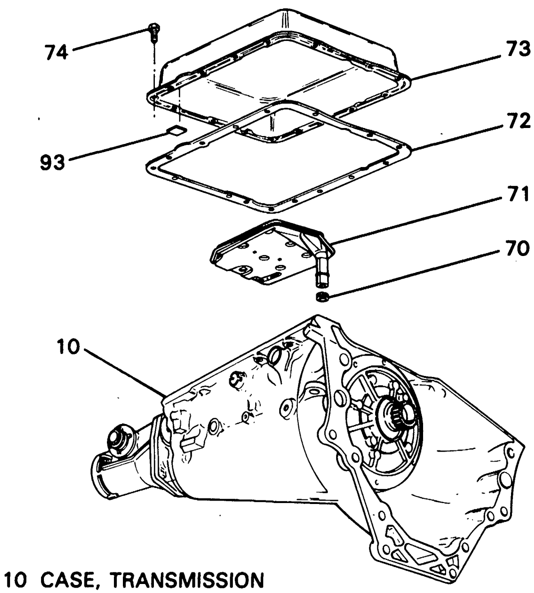
Valve Body And Wiring Harness

Figures 9 through 16

Remove or Disconnect

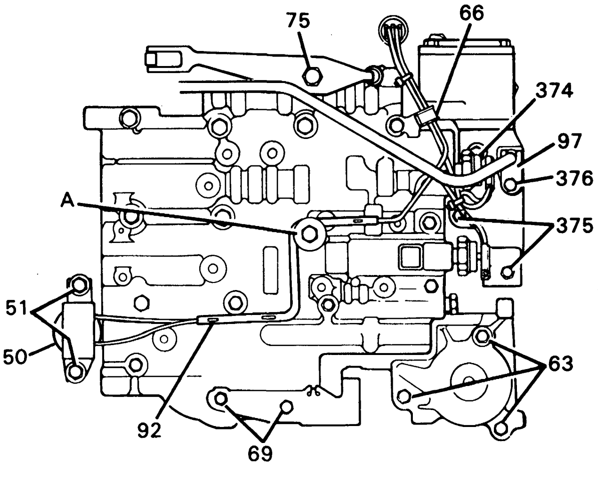
Figures 9 and 10

1. Electrical connections from switches
   - Refer to wiring diagrams in the Diagnosis Section for specific model applications.
2. Solenoid bolts (51) and solenoid assembly (50) with o-ring seal (49) and wiring harness
3. Accumulator cover bolts (63) and 1-2 accumulator cover and pin assembly (62)
4. 1-2 accumulator piston (61) and seal (60)
5. Spring (59)



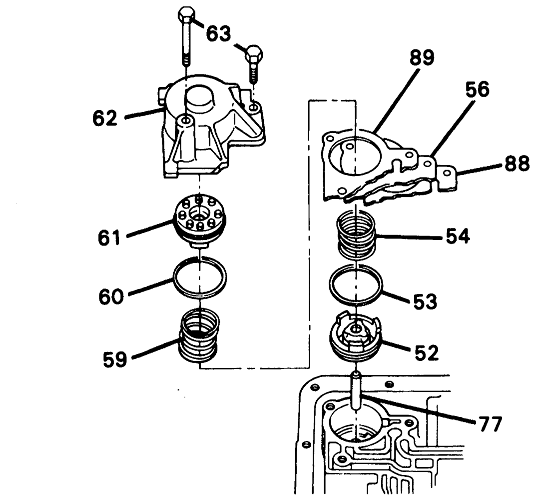
10 CASE, TRANSMISSION
70 SEAL, FILTER
71 FILTER ASSEMBLY, TRANSMISSION OIL
72 GASKET, TRANSMISSION OIL PAN
73 PAN, TRANSMISSION OIL
74 SCREW, SPEC. HEX WASHER HEAD (PAN)
93 MAGNET, CHIP COLLECTOR

Figure 8 Pan, Filter & Seal Remove



A WASHER WIRE RETAINER
50 SOLENOID ASSEMBLY
51 BOLT, HEX WASHER HEAD (SOLENOID)
63 BOLT, ACCUMULATOR COVER
66 CLIP, ELECTRICAL WIRE
69 BOLT, VALVE BODY
75 BOLT, MANUAL DETENT SPRING
92 CONDUIT, SOLENOID WIRE
97 CLAMP, AUXILIARY TUBE
374 BOLT, SPEC. HEX WASHER HEAD (M6 X 1 X 18)
375 BOLT, HEX HEAD (M6 X 1 X 35)
376 BOLT, HEX HEAD (M6 X 1 X 45)

Figure 9 Valve Body Bolt Locations



52 PISTON, 3-4 ACCUMULATOR
53 RING, OIL SEAL (3-4 ACCUMULATOR PISTON)
54 SPRING, 3-4 ACCUMULATOR
56 PLATE, VALVE BODY SPACER
59 SPRING, 1-2 ACCUMULATOR
60 RING, OIL SEAL (1-2 ACCUM. PISTON)
61 PISTON, 1-2 ACCUMULATOR
62 COVER & PIN ASSEMBLY, 1-2 ACCUM.
63 BOLT, ACCUMULATOR COVER
77 PIN, ACCUMULATOR PISTON
88 GASKET, SPACER PLATE TO CASE
89 GASKET, SPACER PLATE TO VALVE BODY

LH0066-4L60

Figure 10 Accumulator Assembly

Remove or Disconnect

Figures 9, 11, 12 and 13

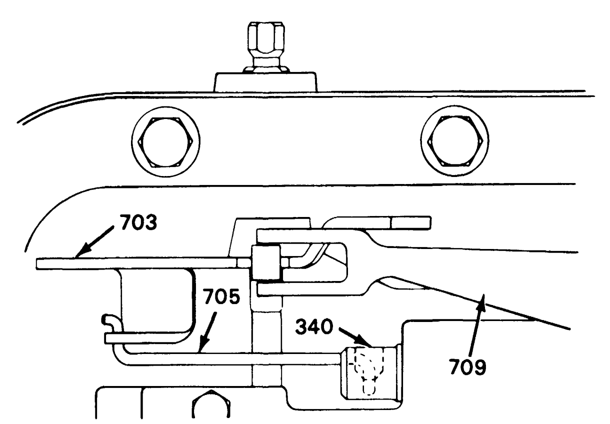
1. Bolt (75) and manual detent spring assembly (709)
2. Electrical wire clips (66)
3. Auxiliary tube clamps (97) and auxiliary accumulator valve tube (96)
4. Wiring harness retaining washer (A)
5. Bolts (69) and T.V. lever and bracket assembly (65)
6. T.V. link (64)

Remove or Disconnect

Figures 11 and 13 through 16

1. Remaining valve body bolts (69)
2. Manual valve link (705)
3. Control valve assembly (67)
4. Bolts (374-375), auxiliary valve body (377), and checkball (55B)

5. Spacer plate (56) and spacer plate gaskets (88 and 89)
6. Checkballs (55A, 55C and 91) spring (54), piston (52), seal (53) and pin
   - Three checkballs are located under the valve body: one is in the auxiliary valve body and four are located in the case. The large copper flash colored ball is #10 checkball (91).



340 VALVE, MANUAL
703 LEVER, DETENT (INNER)
705 LINK, MANUAL VALVE
709 SPRING ASSEMBLY, MANUAL DETENT

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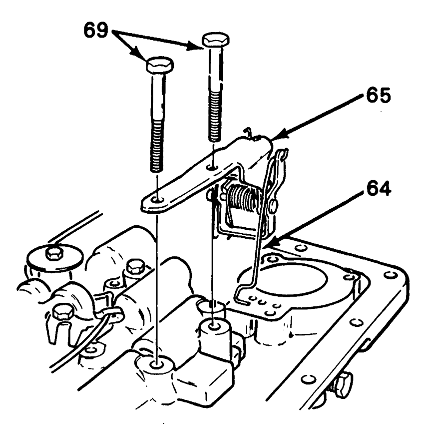
Figure 11 Manual Valve Link



64 LINK, THROTTLE LEVER TO CABLE
65 LEVER & BRACKET ASSEMBLY, THROTTLE
69 BOLTS, CONTROL VALVE ASSEMBLY

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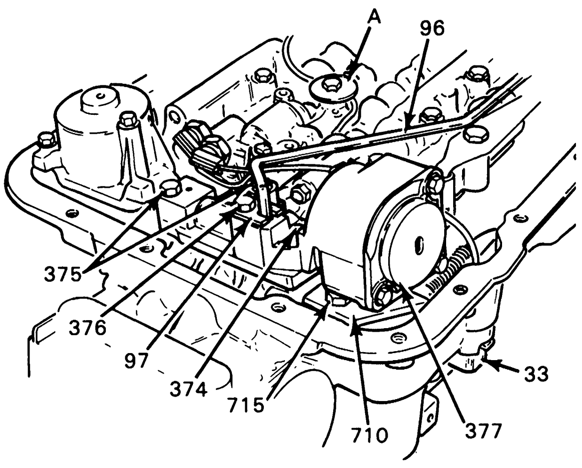
Figure 12 T.V. Lever and Bracket



ILL. NO.	DESCRIPTION
A	WASHER, WIRE RETAINING
33	CONNECTOR, ELECTRICAL
96	TUBE, AUXILIARY ACCUMULATOR VALVE
97	CLAMP, AUXILIARY TUBE
374	BOLT, SPECIAL HEX HEAD (M6 X 1 X 16)
375	BOLT, HEX HEAD (M6 X 1 X 35)
376	BOLT, HEX HEAD (M6 X 1 X 45)
377	AUXILIARY ACCUM. VALVE BODY ASM.
710	BRACKET, PARKING LOCK
715	BOLT, PARKING LOCK BRACKET

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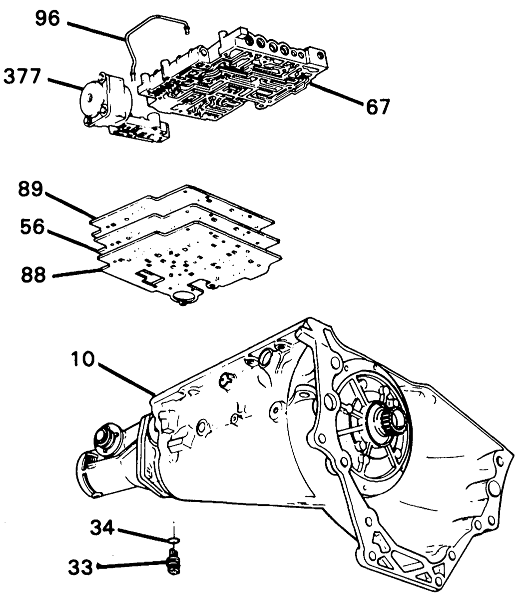
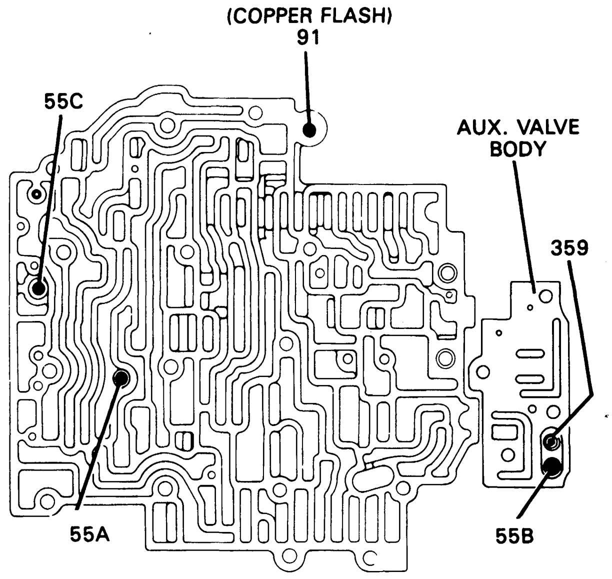
Figure 13 Removing Auxiliary Valve Body Assembly



10	CASE, TRANSMISSION
33	CONNECTOR, ELECTRICAL
34	SEAL, "O" RING (ELECTRICAL CONNECTION)
56	PLATE, VALVE BODY SPACER
67	VALVE ASSEMBLY, CONTROL BODY
88	GASKET, SPACER PLATE TO CASE
89	GASKET, SPACER PLATE TO VALVE BODY
96	TUBE, AUXILIARY ACCUMULATOR VALVE
377	AUXILIARY ACCUMULATOR VALVE BODY ASSEMBLY

LH0070-4L60

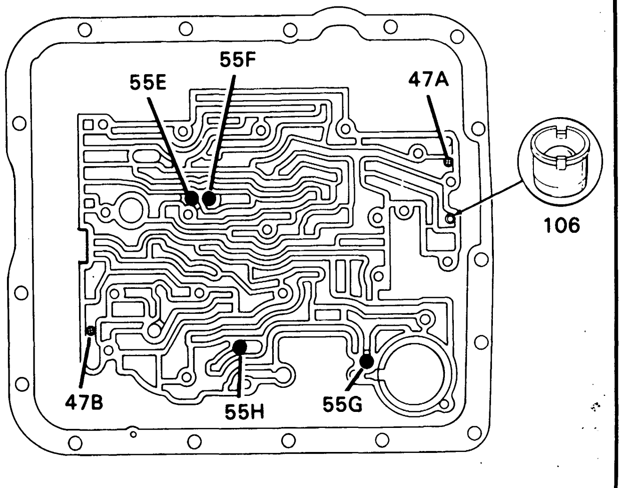
Figure 14 Control Valve, Auxiliary Valve Body, Spacer Plate and Gaskets



55A	#2 CHECKBALL (3RD CLUTCH ACCUM.)
55B	#12 CHECKBALL (FORWARD CLUTCH)
55C	#6 CHECKBALL (DRIVE 3)
91	#10 CHECKBALL (T.V. EXHAUST)
359	CUP PLUG – ORIFICE

LH0071-4L60

Figure 15 Valve Body Checkballs



ILL. NO.	DESCRIPTION
47A	GOVERNOR FILTER LOCATION
47B	CONVERTER CLUTCH FILTER LOCATION
55E	#4 CHECK BALL (3-4 CLUTCH/3-2 EX.)
55F	#8 CHECK BALL (2ND/1-2)
55G	#1 CHECK BALL (4TH ACCUMULATOR)
55H	#3 CHECK BALL (PART THROTTLE/DRIVE 3)
106	RETAINER & BALL ASM. (DOUBLE ORIFICE)

LH0072-4L60

Figure 16 Case Checkballs and Filters

Transmission End Play Check

Figures 17 and 18

Tools Required:

J 24773-A Oil Pump Remover
J 25022-A End Play Adaptor (245 mm)
J 34725 End Play Adaptor (298 mm)
J 25025-7A Post
Dial indicator

As a diagnostic aid, transmission end play should be checked prior to removing the internal parts. If the end play is not within specifications, you should watch for possible worn or misassembled parts during disassembly.

Measure

1. Remove an oil pump bolt (5) and install a 278 mm (11 in.) bolt and locknut or J 25025-7A.
2. Install J 25022-A or J 34725 as shown.
3. Install J 24773-A as shown.
4. Install dial indicator.
   - Set to zero.
   - Pull up on J 24773-A.
   - End play should be .13-.92 mm (.005-.036").

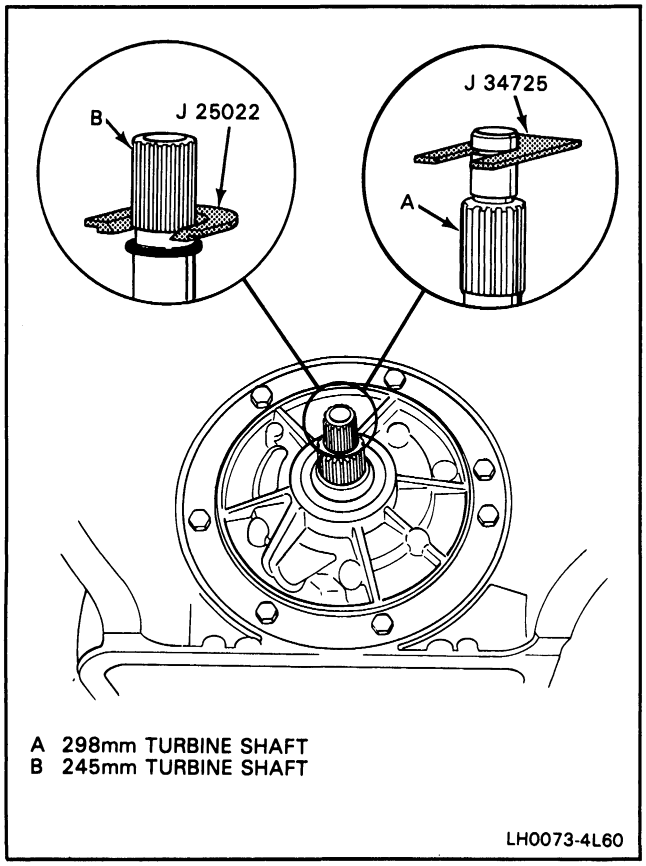


Figure 17 End Play Tool

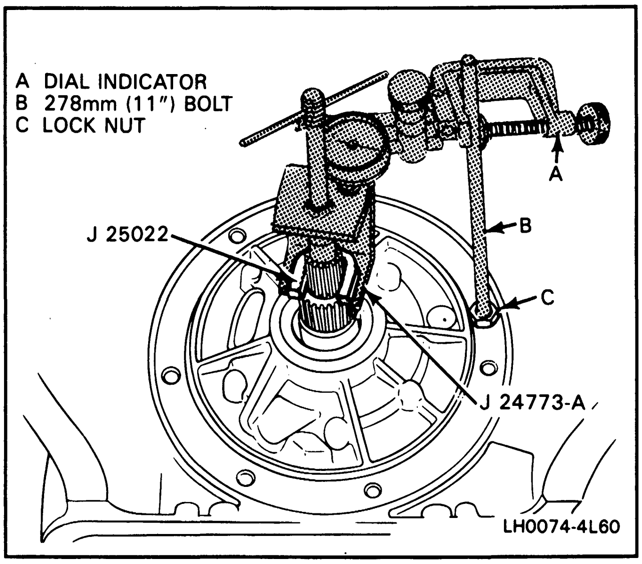


Figure 18 End Play Check

Oil Pump Assembly

Figures 19 and 20

Tool Required:

J 24773-A Oil Pump Remover

Remove or Disconnect

1. O-ring seal (618)
2. All oil pump bolts (5) and o-rings (6)
3. Oil pump assembly (7) with J 24773-A
4. Oil pump to case seal (8) and gasket (9)
5. Reverse input clutch to oil pump thrust washer (601)

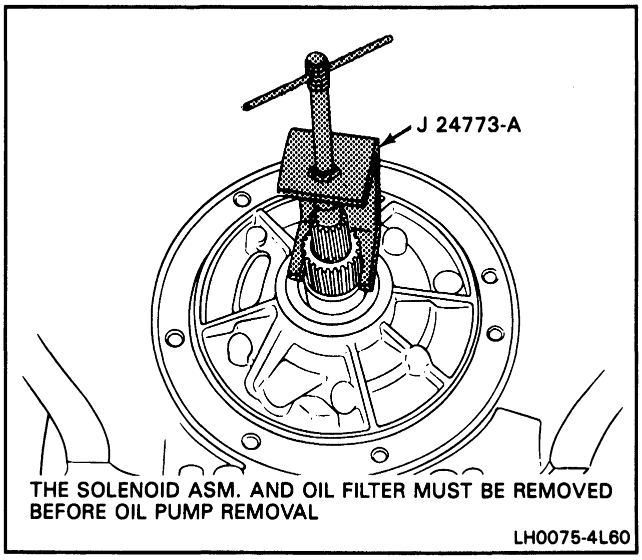
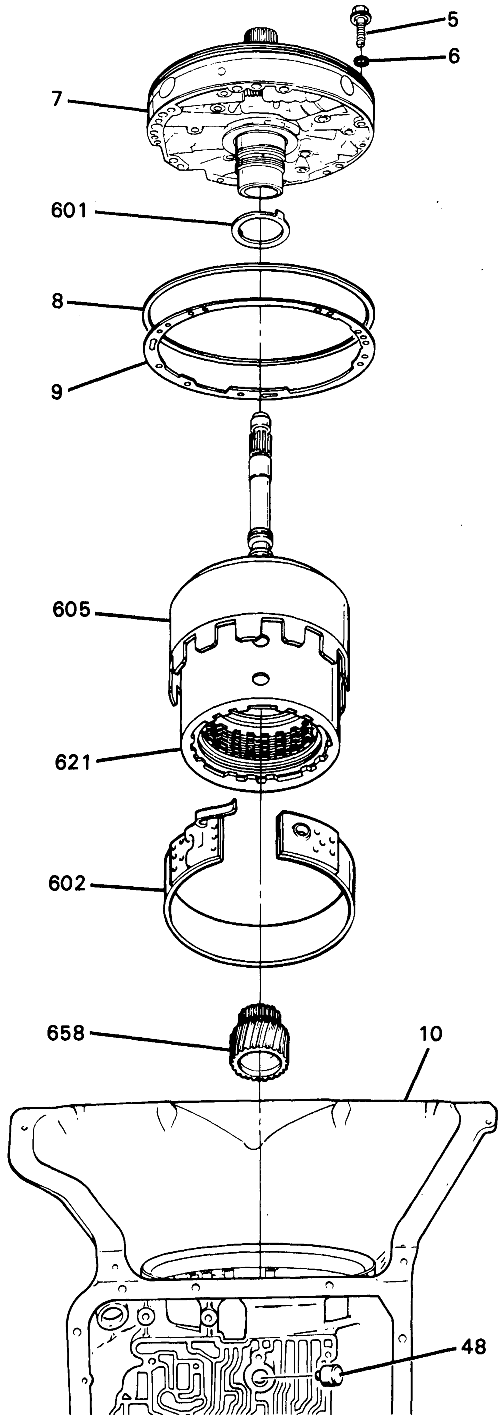


Figure 19 Oil Pump Removal



ILL. NO.	DESCRIPTION
5	BOLT, PUMP TO CASE
6	O-RING, PUMP TO CASE BOLT
7	PUMP ASSEMBLY, OIL
8	SEAL, OIL (PUMP TO CASE)
9	GASKET, PUMP COVER TO CASE
10	CASE, TRANSMISSION
48	PIN, BAND ANCHOR
601	WASHER, THRUST (PUMP TO DRUM)
602	BAND ASSEMBLY, 2-4
605	HOUSING & DRUM ASM., REVERSE INPUT CLUTCH
621	HOUSING & SHAFT ASSEMBLY, INPUT
658	GEAR, INPUT SUN

LH0076-4L60

Figure 20 Input Clutch Removal

2-4 Band, Reverse Input Clutch, Input Clutch And Input Gear Set

Figures 20 through 22

Tools Required:

J 29837 Output Shaft Support Fixture
J 34627 Snap Ring Pliers

Remove or Disconnect

Figures 20 and 22

1. Reverse input clutch (605) and input clutch (62) together
   - Grasp the turbine shaft and lift
2. Band assembly pin (48)
3. The 2-4 band assembly (602)
4. Input sun gear (658)

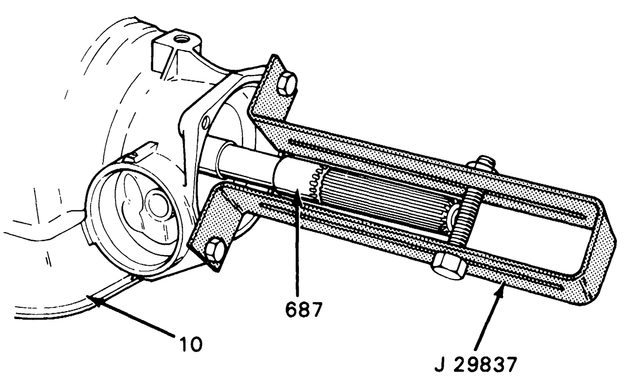
Install or Connect

Figures 21 and 22

- J 29837 as shown

Important

- Output shaft (687) may fall free when retaining ring (661) is removed if J 29837 is not used.



10	CASE, TRANSMISSION
687	SHAFT, OUTPUT

LH0077-4L60

Figure 21 Output Shaft Support Fixture

Remove or Disconnect

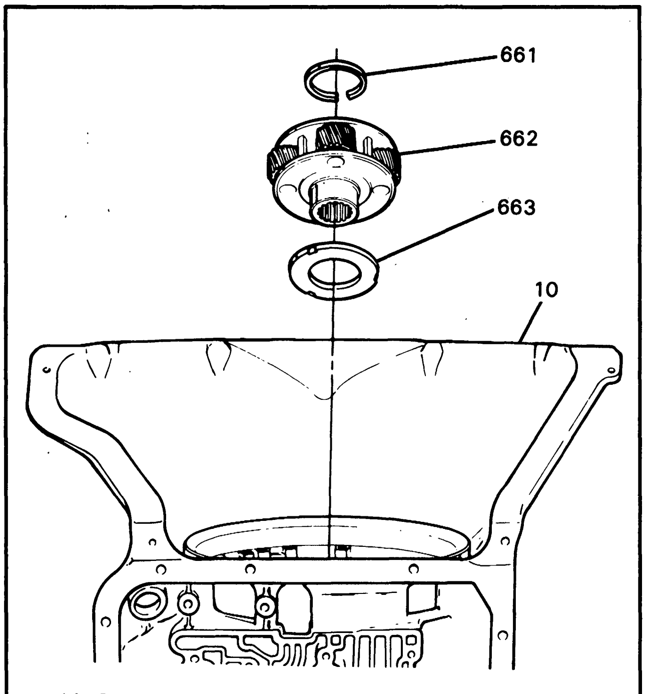
Figure 22

1. Retaining ring (661) with J 34627. Do not overexpand the ring.
2. Input carrier assembly (662)
3. J 29837 and output shaft (687)

Important

- The manufacturer assembles the output shaft and reaction internal gear with adhesive for ease of assembly. If these parts have not become separated during use, the output shaft will come out later along with the reaction internal gear.

4. Thrust bearing assembly (663)



10 CASE, TRANSMISSION
661 RET., OUTPUT SHAFT TO INPUT CARRIER
662 CARRIER ASSEMBLY, INPUT (COMPLETE)
663 BEARING ASSEMBLY, THRUST (INPUT CARRIER TO REACTION SHAFT)

LH0078-4L60

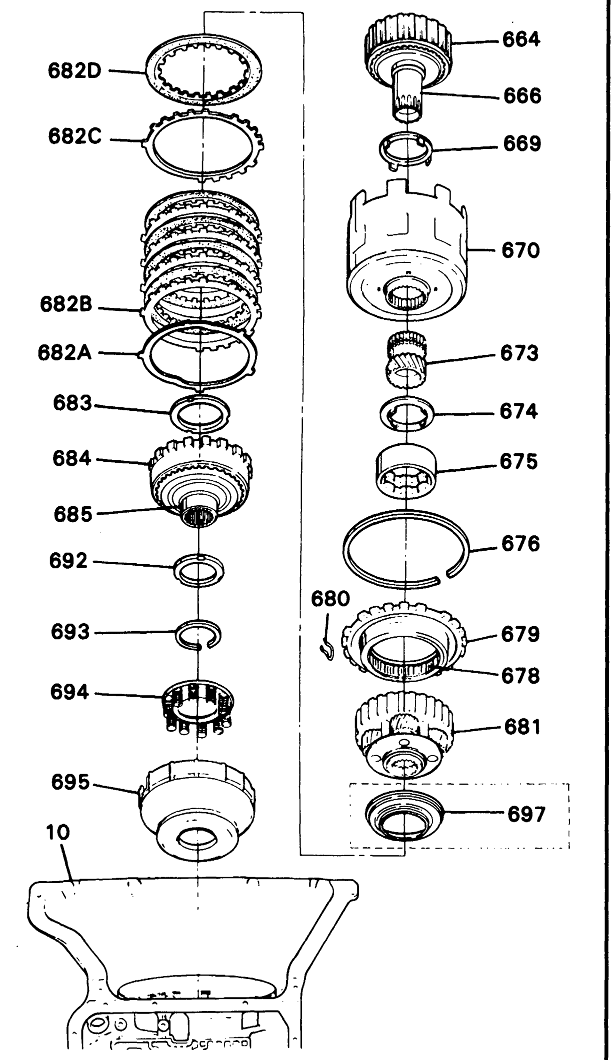
Figure 22 Input Carrier Removal

Reaction Gear Set

Figure 23

Remove or Disconnect

1. Input internal gear (664) and reaction carrier (666)
2. Reaction sun shell (670) and thrust washer (669)
3. Reaction sun shell to inner race thrust washer (674)
4. Lo and reverse support to case retainer ring (676)
5. Lo and reverse clutch support retainer spring (680)
6. Reaction sun gear (673)
7. Lo and reverse inner race (675), roller assembly (678), support assembly (679), and reaction carrier assembly (681)
8. Lo and reverse clutch plates (682)
9. Reaction internal gear (684) and thrust bearing assembly (683)
10. Reaction gear support to case bearing (692)



ILL. NO.	DESCRIPTION
10	CASE, TRANSMISSION
664	GEAR, INPUT INTERNAL
666	SHAFT, REACTION CARRIER
669	WASHER, THRUST (REACTION SHAFT/SHELL)
670	SHELL, REACTION SUN
673	GEAR, REACTION SUN
674	WASHER, THRUST (RACE/REACTION SHELL)
675	RACE, LO & REVERSE ROLLER CLUTCH
676	RING, LO & REVERSE SUPPORT TO CASE RETAINER
678	CLUTCH ASM., LO & REVERSE ROLLER
679	SUPPORT ASM., LO & REVERSE CLUTCH
680	SPRING, TRANSMISSION (LO & REVERSE CLUTCH SUPPORT RETAINER)
681	CARRIER ASSEMBLY, REACTION
682A	PLATE, LO & REVERSE CLUTCH (WAVED)
682B	PLATE, LO & REVERSE CL. (SELECTIVE)
682C	PLATE ASM., LO & REVERSE CLUTCH (FIBER)
682D	PLATE, LO & REVERSE CLUTCH (FLAT STEEL)
683	BEARING ASSEMBLY, THRUST (REACTION CARRIER/SUPPORT)
684	GEAR, INTERNAL REACTION
685	SUPPORT, INTERNAL REACTION GEAR
692	BRG., REACTION GEAR SUPPORT TO CASE
693	RING, LO & REVERSE CLUTCH RETAINER
694	SPRING ASM., LO & REVERSE CLUTCH
695	PISTON, LO & REVERSE CLUTCH
697	DEFLECTOR, OIL (HIGH OUTPUT MODELS ONLY)

LH0079-4L60

Figure 23 Reaction Gear Set Removal

Lo And Reverse Clutch Parts

Figures 24, 25 and 27

Tools Required:

J 34627 Snap Ring Remover/Installer

J 23327 Clutch Spring Compressor

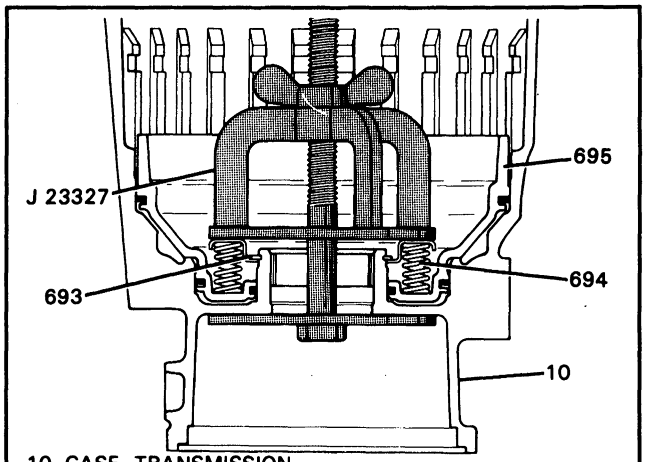
Remove or Disconnect

1. Bolts (715) and parking lock bracket (710)

Important

- Due to interference, the parking pawl may have to be removed before removing or installing the low and reverse piston.

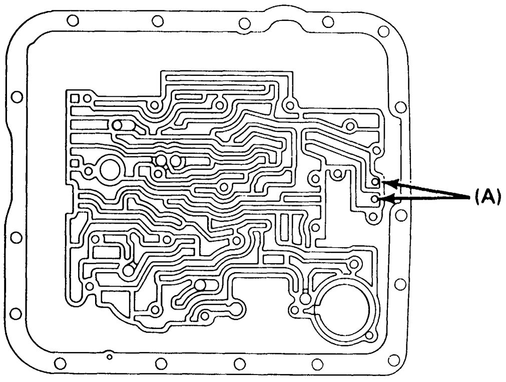
2. Parking pawl shaft plug (713) with a #4 screw extractor
3. Parking pawl pivot shaft (712) with a magnet
4. Parking pawl (711) and return spring (714)
5. Install tool J 23327.
6. Lo and reverse clutch retainer ring (693) with J 34627
7. Lo and reverse clutch spring assembly (694)
8. Lo and reverse clutch piston (695)
   - Apply air pressure in the case apply passage.



ILL. NO.	DESCRIPTION
10	CASE, TRANSMISSION
693	RING, LO & REVERSE CLUTCH RETAINER
694	SPRING ASSEMBLY, LO & REVERSE CLUTCH
695	PISTON, LO & REVERSE CLUTCH

LH0080-4L60

Figure 24 Lo and Reverse Snap Ring Removal



(A) APPLY AIR PRESSURE HERE TO REMOVE LO & REVERSE PISTON FROM THE CASE

LH0081-4L60

Figure 25 Lo and Reverse Piston Removal

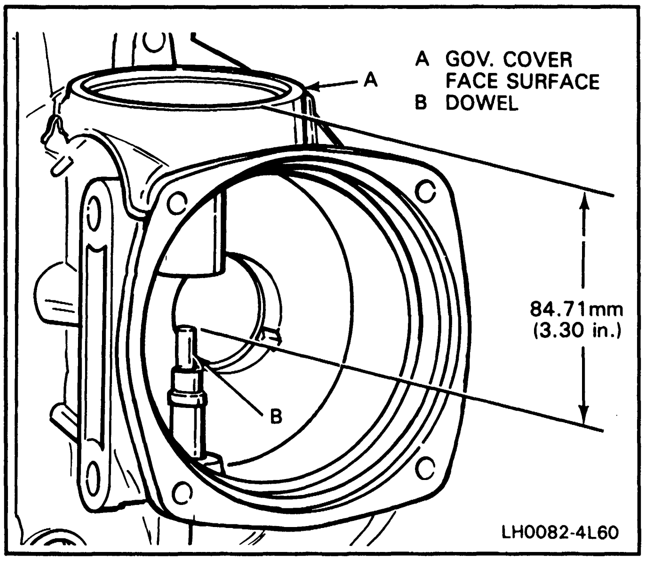


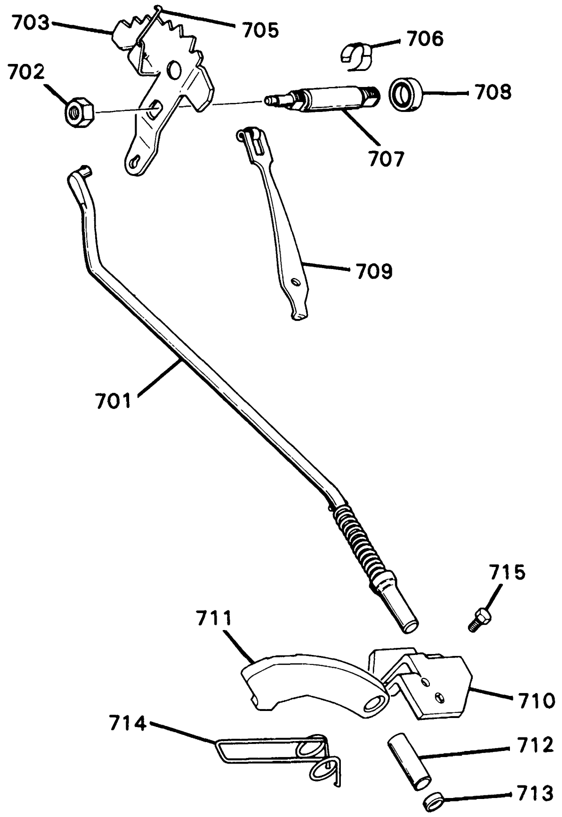
Figure 26 Governor Bore Pin Location

Inner Manual Linkage

Figure 27

Remove or Disconnect

1. Inside manual shaft nut (702)
2. Manual shaft (707) and manual shaft retainer (706)
3. Parking lock actuator assembly (701) and inside detent level (703)



701	ACTUATOR ASSEMBLY, PARKING LOCK
702	NUT, HEX HEAD
703	LEVER, INSIDE DETENT
705	LINK, MANUAL VALVE
706	RETAINER, MANUAL SHAFT
707	SHAFT, MANUAL
708	SEAL, MANUAL SHAFT
709	MANUAL DETENT ROLLER & SPRING ASM.
710	BRACKET, PARKING LOCK
711	PAWL, PARKING BRAKE
712	SHAFT, PARKING BRAKE PAWL
713	PLUG, STEEL CUP
714	SPRING, PARKING PAWL RETURN
715	BOLT, PARKING LOCK BRACKET

LH0083-4L60

Figure 27 Parking Linkage

Manual Shaft Seal Replacement

Figure 28

Remove or Disconnect

- Manual shaft seal (708)
  - Pry out with a screwdriver.

Install or Connect

- New manual shaft seal (708)
  - Tap into place using a 14 mm socket.

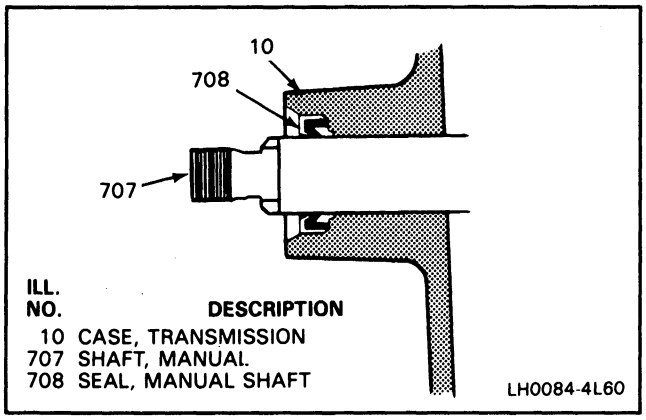


Figure 28 Manual Shaft Seal

Inspect

Figure 27

- Actuator rod (701) for damage
- Inside detent lever (703) for damage or cracks
- Manual shaft (707) for damage or burrs
- Manual detent spring assembly (709) for roller freeness or damage

Install or Connect

Figure 27

- Parking lock actuator (701) onto inside detent lever (703)
- Manual shaft (707) into case (10) and inside detent lever (703)
- Inside manual shaft nut (702) onto manual shaft (707)

  Tighten

  - Torque to 31 N·m (23 lb. ft.)
- Manual shaft retainer (706) onto manual shaft (707)

COMPONENT REPAIR AND TRANSMISSION REASSEMBLY

The assembly of some components will require use of an assembly lube. It is recommended that TRANSJEL™ J 36850 or equivalent be used during assembly.

> **NOTICE:** Do not use any type of grease to retain parts during assembly of this unit. Greases other than the recommended assembly lube will change transmission/transaxle fluid characteristics and cause undesirable shift conditions and/or filter clogging.

Case Assembly

Clean

- Thoroughly with solvent
- Air dry
  - Do not wipe with cloth.

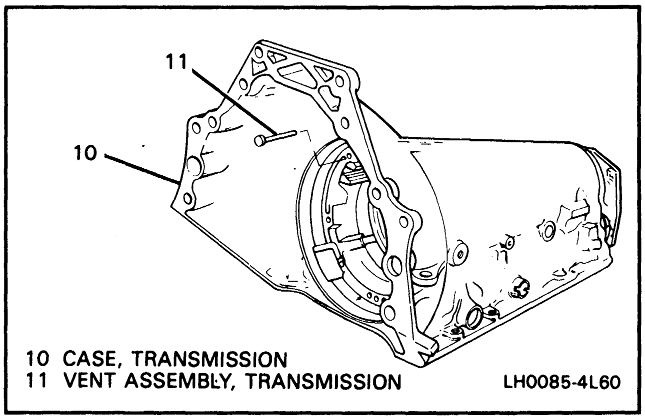


Figure 29 Case Vent Assembly

Case

Figures 26, 29, 30 and 31

Inspect

- Case (10) exterior for cracks or porosity
- Case to valve body face for damage, interconnected oil passages and flatness
  - Face flatness can be checked by inspecting the spacer plate to case gasket for proper land impressions.
- Vent assembly (11) for damage
- Air check all oil passages.
  - See diagnosis section for oil passage identification.
- 2-4 servo bore for:
  - Damage, porosity, or burrs
  - Any sharp edges (i.e. — oil passages, slots for retaining ring removal — remove if found)
- Orifice cup plug (86) in servo bore for debris or damage
- Third accumulator bore for:
  - Porosity, damage, or burrs
  - Pin damage (77)
  - Orifice cup plug (81) damaged or plugged
- Speedometer bore for:
  - Damage
  - Sharp edges
  - Porosity
- All bolt holes for thread damage
  - Heli-coil to repair
- Cooler connectors (12) for:
  - Damage
  - Proper torque 38 N·m (28 lb. ft.)

- Case interior for:
    - Damaged ring grooves or casting flash
    - Clutch plate lugs worn or damaged
    - Bushing (767) scored, worn, or damaged (see Bushing Replacement)
    - Governor support pin installation depth (Incorrect installation depth will cause governor driven gear damage and shift problems.)

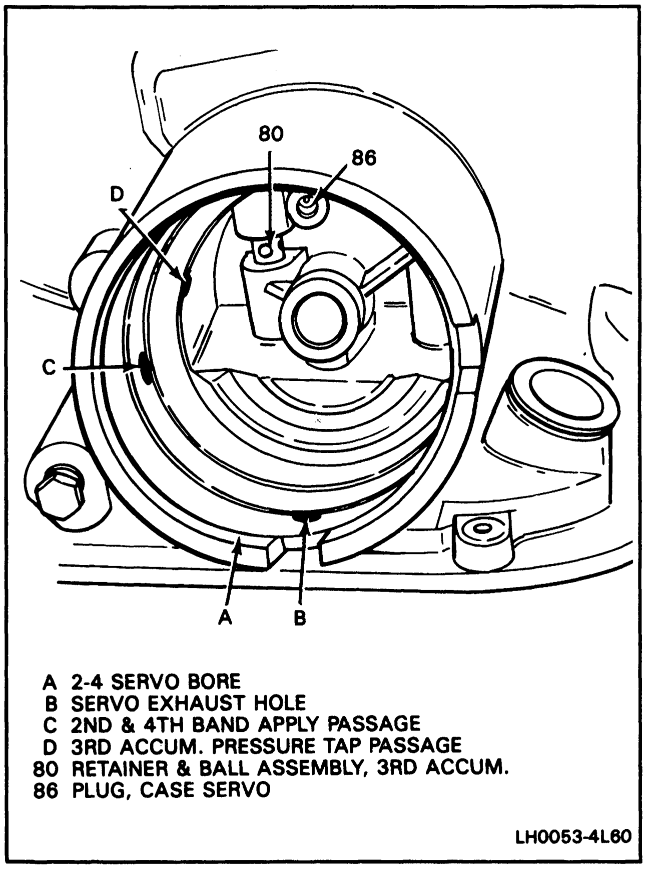


Figure 30 2-4 Servo Bore

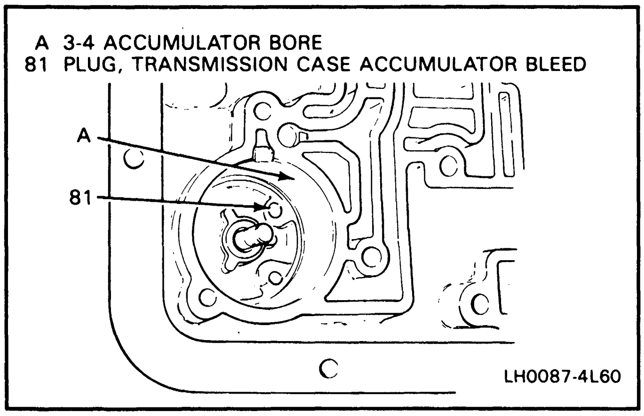


Figure 31 Third Accumulator Bore

Third Accumulator Retainer and Ball Assembly

Figure 32

Inspect

- Ball for:
    - Presence
    - Sticking or leaking
- Retainer for:
    - Presence
    - Loose
    - Incorrect seating
    - Restricted feed slots

Retainer and Ball Assembly Leak Check Procedure

Figure 32

1. Install the servo assembly (16-31) into the servo bore.
2. Install the servo cover (15) and retainer (13).
3. Pour a suitable solvent into the accumulator bore.

Inspect

- Watch for leakage inside the case.
- If leakage is observed, replace the third accumulator retainer and ball assembly.

Replacement Procedure — Third Accumulator Retainer and Ball Assembly

Figures 32 and 33

Tools Required:

6.3 mm (#4) Screw Extractor
9.5 mm (3/8 in.) diameter metal rod

Remove or Disconnect

- Third accumulator retainer and ball assembly (80)
    - Use 6.3 mm (#4) screw extractor.

Install or Connect

Figures 32 and 33

- A new third accumulator retainer and ball assembly
    - Oil feed slots in the retainer must line up with oil passage in the servo bore. To be certain of correct installation depth, scribe a mark at 42.0 mm (1.653") on the 9.5 mm (3/8 in.) diameter metal rod. Use it to seat the third accumulator and ball assembly as shown. When the scribed line is flush with the case face, installation depth is correct.

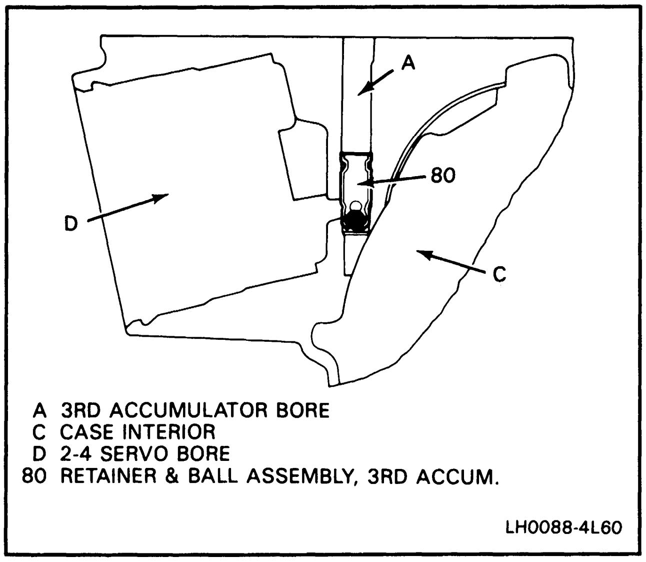


Figure 32 Leak Check — 3rd Accumulator

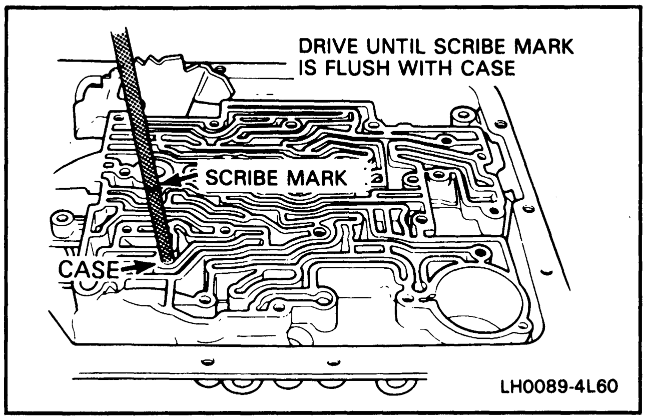


Figure 33 Third Accumulator Retainer and Ball Asm.— Installation

Lo and Reverse Clutch Piston

Figures 34 and 35

Tools Required:

J 34627 Snap Ring Remover/Installer
J 23327 Clutch Spring Compressor

Inspect

Figure 34

- Lo and reverse piston (695) for:
  - Porosity or damage
  - Ring groove damage
- Piston seals (696) for nicks or cuts
- Spring assembly (694) for damage
- Retainer ring (693) overstressed

Install or Connect

Figure 35

1. Piston seals (696) onto the piston (695)
   - Lubricate with TRANSJEL™ J 36850 or equivalent.
2. Piston (695) into the case
   - Index the piston with the notch in the bottom of the case.
3. Spring assembly (694) onto the piston
   - Flat side of the retainer upward.
4. J 23327 over the spring assembly
   - Compress the spring assembly past the ring groove in the case hub.
5. Retainer ring (693) into the case hub ring groove with J 34627

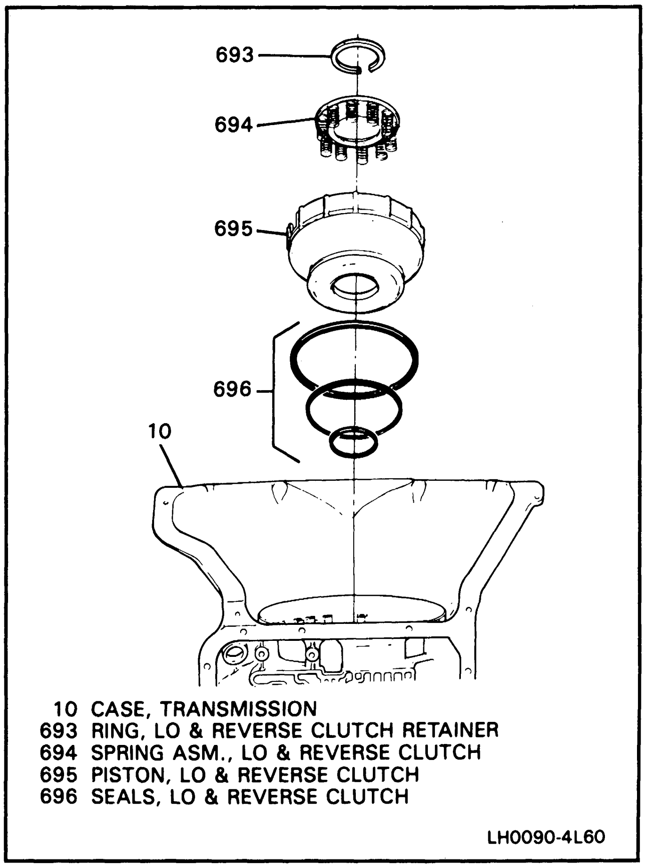
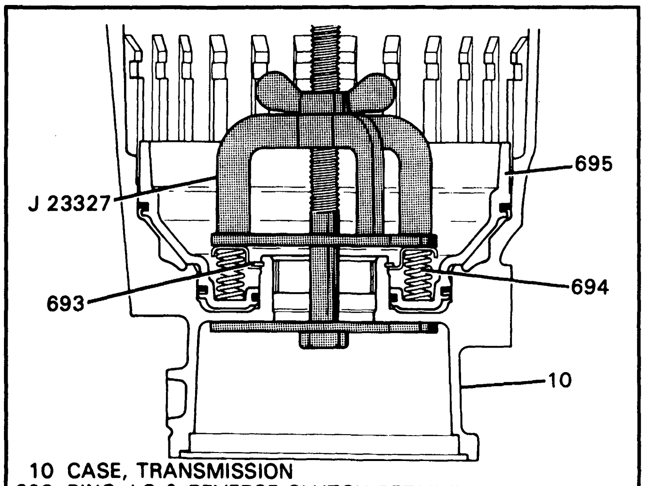


Figure 34 Lo and Reverse Piston



10 CASE, TRANSMISSION
693 RING, LO & REVERSE CLUTCH RETAINER
694 SPRING ASSEMBLY, LO & REVERSE CLUTCH
695 PISTON, LO & REVERSE CLUTCH
LH0080-4L60

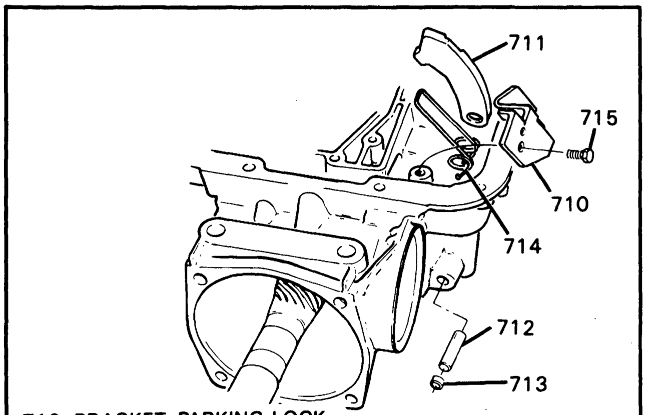
Figure 35 Installing Lo and Reverse Snap Ring

Parking Pawl

Figure 36

Inspect

- Parking pawl (711) for cracks, burrs, or damage
- Parking pawl return spring (714) for distortion or damage
- Parking pawl pivot shaft (712) for damage and freeness of fit with the parking pawl



710 BRACKET, PARKING LOCK
711 PAWL, PARKING BRAKE
712 SHAFT, PARKING BRAKE PAWL
713 PLUG, STEEL CUP
714 SPRING, PARKING PAWL RETURN
715 BOLT, PARKING LOCK BRACKET
LH0092-4L60

Figure 36 Parking Pawl Installation

Install or Connect

Figure 36

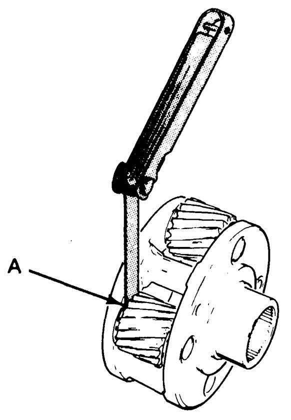
1. Parking pawl (711) and parking pawl return spring (714) into the case
2. Parking pawl pivot shaft (712) into the parking pawl (711) and the case
   - Check for proper operation.
3. Retaining plug (713) into the case
   - Coat the plug with Loctite® sealant or equivalent and install it with a hammer and punch.

Reaction Internal Gear and Carrier Assembly

Figures 37, 38 and 39

Inspect

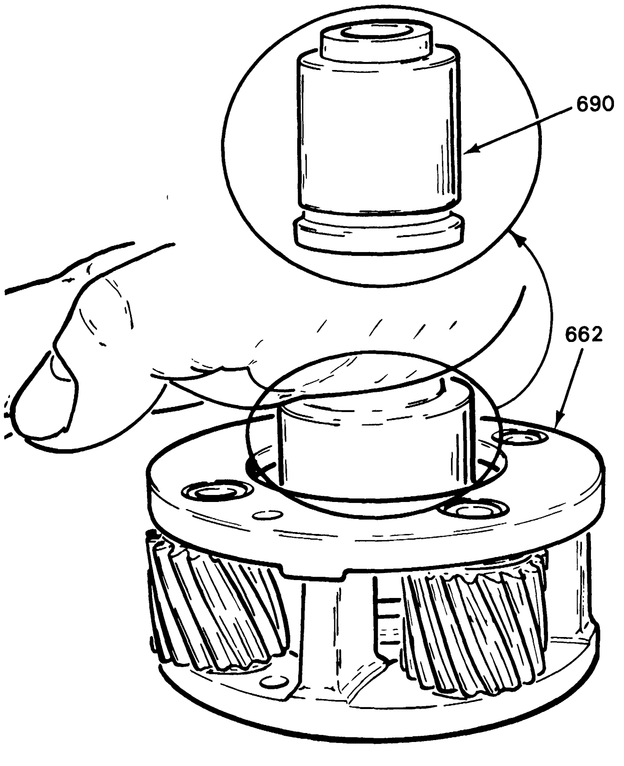
- Reaction internal gear (684) and support (685) for:
  - Proper assembly
  - Stripped splines
  - Cracks
  - Teeth or lug damage
  - Thrust bearing assemblies (683 and 692) for damage
- Lo and reverse clutch plates (682) for:
  - Composition material wear, heat damage, or delamination
  - Heat damage or surface finish damage to steel plates
- Reaction carrier assembly (681) for:
  - Pinion gear damage
  - Excessive pinion washer wear
  - End play exceeding .61 mm (.024″)
  - Proper pinion staking
  - Keystoned pinion gears (pinions must turn freely)
  - Damaged or worn thrust bearing
  - To check the captive thrust bearing in the carrier for wear, place a bushing or an output shaft sleeve on the bearing race (do not contact the pinion gears) and turn it with the palm of your hand. Any imperfections will be felt through the bushing.



A PINION GEAR END PLAY –
.20mm/.60mm (.008"/.024")

LH0093-4L60

Figure 37 Pinion End Play Check



662 CARRIER ASSEMBLY, INPUT – COMPLETE
690 SLEEVE, OUTPUT SHAFT

LH0094-4L60

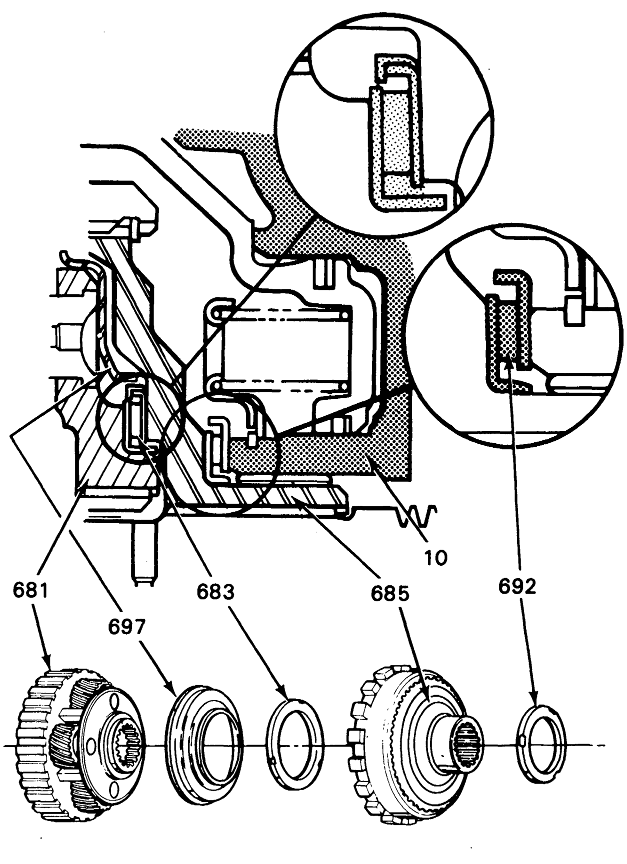
Figure 38 Captive Thrust Bearing Check

Reaction Internal Gear and Support

Figure 44

Install or Connect

1. Reaction gear support to case bearing (692) onto the case hub as shown
   - Outside bearing race goes toward case hub.
   - Retain with TRANSJEL™ J 36850 or equivalent.
2. Reaction internal gear and support (684 and 685) onto the bearing as shown
3. Reaction carrier to support thrust bearing assembly (683) onto the support (685)
   - Outer bearing race goes toward the support
4. Reaction carrier (681) onto the thrust bearing



10 CASE, TRANSMISSION
681 CARRIER ASSEMBLY, REACTION
683 BEARING ASSEMBLY, THRUST (REACTION CARRIER/SUPPORT)
685 SUPPORT, INTERNAL REACTION GEAR
692 BRG., REACTION GEAR SUPPORT TO CASE
697 DEFLECTOR, OIL (HIGH OUTPUT MODELS ONLY)

LH0095-4L60

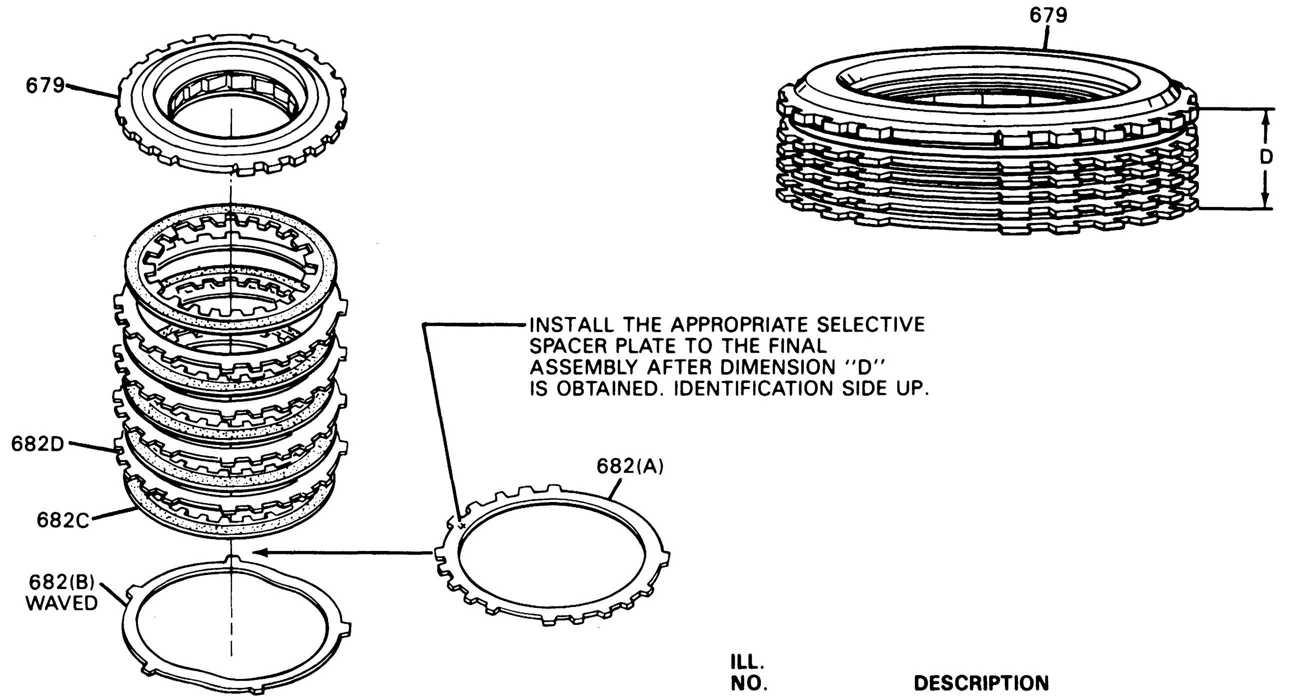
Figure 39 Reaction Internal Gear and Carrier Bearing Locations

Lo and Reverse Clutch Spacer Plate Selection

Figures 40 through 43

Tools Required:

Scale
Straight edge



ILL. NO.	DESCRIPTION
679	SUPPORT ASSEMBLY, LO & REVERSE CLUTCH
682	PLATE ASSEMBLY, LO & REVERSE CLUTCH
682(A)	SPACER PLATE, LO & REVERSE CL. (SELECTIVE)
682(B)	WAVE PLATE, LO & REVERSE CLUTCH

Figure 40 Measuring For Spacer Plate Selection

Measure

Figures 40, 41 and 42

1. To measure for proper selective spacer plate, stack the lo and reverse assembly on a flat surface in the following order:
   - One waved plate (682B)
   - Five composition and four steel plates (682), starting with one composition plate and alternating with steel
   - Lo and reverse clutch support (679)
2. Apply an evenly distributed load to the top of the lo and reverse support assembly (679). Light pressure (approximately 22 N or 55 lbs.) on the lo and reverse support assembly (679) will provide the correct dimension for measurement.

   NOTICE: Excessive pressure will start to flatten the wave plate resulting in an inaccurate measurement.
3. Measure the height of the clutch pack from the work surface to the top of the lo and reverse clutch support (dimension D).
4. Use dimension D to select the proper thickness of the selective spacer plate for assembly.
5. Install the proper selective spacer plate between the wave plate and the first composition clutch plate with the identification side up.
6. The overall height for dimension D with the selective spacer plate included should be 30.515 — 31.401 mm (1.20-1.24").

LO & REVERSE CLUTCH

	QTY.	THICKNESS
PLATE—WAVED	1	2.43mm (.096")
PLATE—SELECTIVE	1	SEE FIG. 42
PLATE—COMP. FACED	5	2.25mm (.088")
PLATE—FLAT STEEL	4	1.77mm (.069")

LH0096-4L60

Figure 41 Lo and Reverse Clutch Plate Chart

LO & REVERSE CLUTCH SPACER PLATE SELECTION CHART

IF GAGE DIMENSIONS 'D' IS		USE THIS SELECTIVE PLATE		
FROM	TO	IDENTIFICATION	PLATE THICKNESS	
29.559mm (1.164")	28.844mm (1.136")	NONE	1.671mm (.066")	1.842mm (.073")
28.844mm (1.136")	28.129mm (1.107")	4	2.386mm (.094")	2.557mm (.101")
28.129mm (1.107")	27.414mm (1.079")	5	3.101mm (.122")	3.272mm (.129")

LH0098-4L60

Figure 42 Lo and Reverse Spacer Plate Selection Chart

Install or Connect

Figures 41 and 43

1. Waved plate (682A)
2. Correct selective spacer plate (682B), from selection procedure
3. Lo and reverse clutch plates (682) into case lugs
   - Start with a composition plate and alternate with steel.
   - Index with the splines of the reaction carrier and the case as shown.

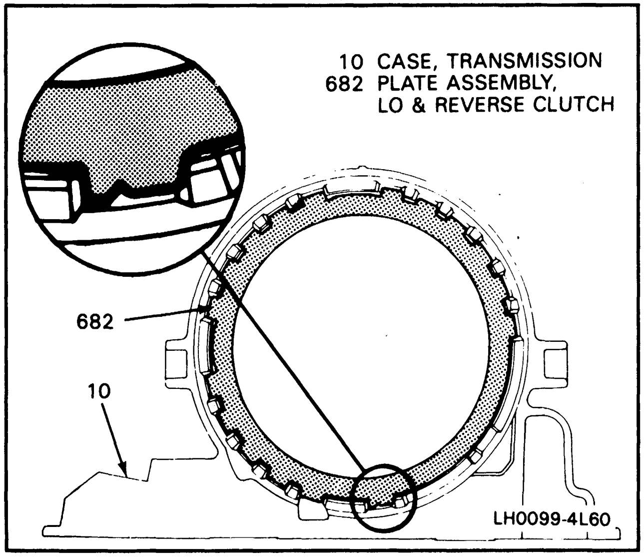


Figure 43 Lo and Reverse Clutch Plates Properly Installed

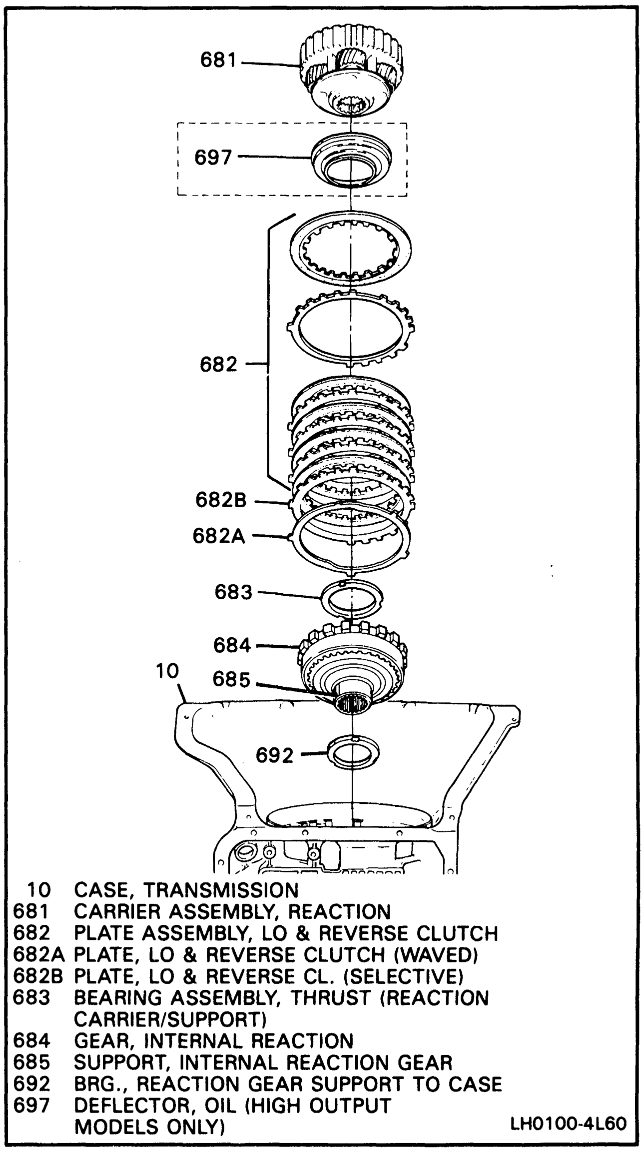


Figure 44 Reaction Internal Gear and Carrier Assembly Installation

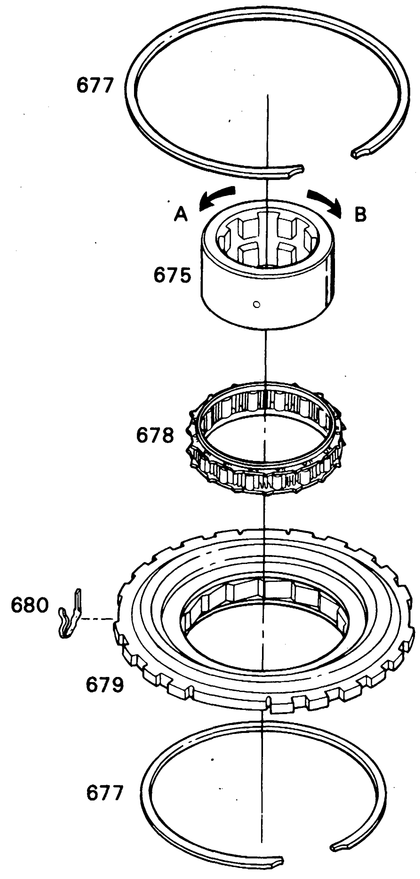
Lo and Reverse Clutch Support Assembly

Figures 45, 46 and 47

Remove or Disconnect

Figure 45

1. Inner race (675) from the support assembly
2. One retainer ring (677)
3. Roller clutch assembly (678)



A LOCKED UP
B FREE WHEELS
675 RACE, LO & REVERSE ROLLER CLUTCH
677 RING, LO & REVERSE RETAINER (ROLLER ASSEMBLY/CAM)
678 CLUTCH ASSEMBLY, LO & REVERSE ROLLER
679 SUPPORT ASSEMBLY, LO & REVERSE CLUTCH
680 SPRING, TRANSMISSION LO & REVERSE CLUTCH SUPPORT RETAINER

LH0101-4L60

Figure 45 Lo and Reverse Clutch Support Assembly

Inspect

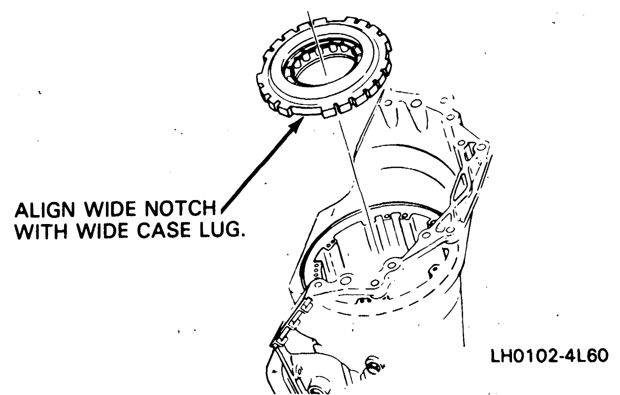
Figure 45

- Inner race (675) for damage and surface finish.
- Roller clutch assembly (678) for:
  - Damaged rollers
  - Broken springs
- Cam for:
  - Loose cam
  - Surface finish
- Support assembly for:
  - Cracks or damaged lugs

Install or Connect

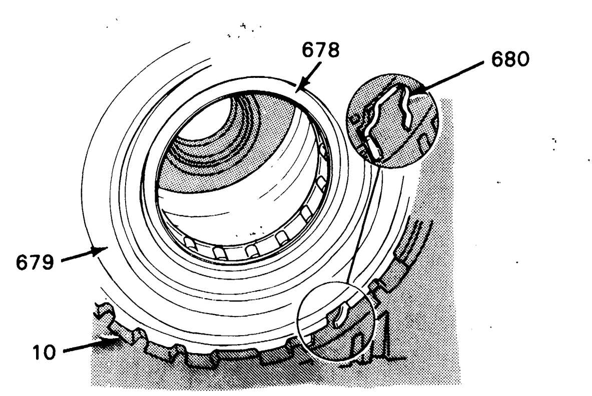
Figures 45, 46 and 47

1. Roller clutch assembly (678) into the cam and support assembly (679)
2. Support and roller assembly into the case with the hub down
3. Inner race (675) into the roller assembly
   - Turn inner race (675) while inserting.
     - Push down for full engagement.
     - Bottom tangs will be flush with carrier hub when properly installed.
     - Check for proper operation by rotating the inner race as shown in Figure 45.
4. Support retainer spring (680) into the case
   - Insert between the case lug and the one open notch in the support.



LH0102-4L60

Figure 46 Lo and Reverse Support and Roller Asm. Installation



10 CASE, TRANSMISSION
678 CLUTCH ASSEMBLY, LO & REVERSE ROLLER
679 SUPPORT ASM., LO & REVERSE CLUTCH
680 SPRING, TRANSMISSION (LO & REVERSE CLUTCH SUPPORT RETAINER)

LH0103-4L60

Figure 47 Support Spring — Installed

Reaction Sun Gear and Shell

Figure 48

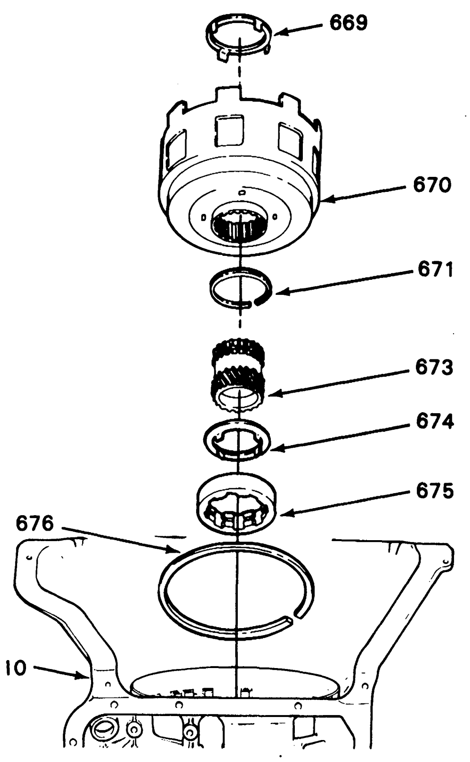
Inspect

- Reaction sun gear (673) for:
  - Nicked, scored, or worn bushing (See Bushing Replacement)
  - Damaged spline or teeth
  - Loose or weak retaining ring (do not remove this ring, except to replace it.)
- Reaction sun shell (670) for:
  - Stripped or worn splines
  - Broken hub
  - Bent tangs
- Lo and reverse inner race to reaction sun gear shell thrust washer (674) for wear or damage
- Reaction shaft to reaction sun gear shell bronze thrust washer (669) for wear or damage

Install or Connect

Figure 48

1. Reaction sun gear retainer ring (671) onto the reaction sun gear, if previously removed
2. Reaction sun gear (673) into the reaction carrier
   - Index the teeth with the pinion gears.
3. Thrust washer (674) onto the lo and reverse support inner race
   - Index the four locating ears into the inner race.
4. Reaction sun gear shell (670) onto the reaction sun gear
5. Bronze thrust washer (669) onto the reaction sun gear shell
   - Index tangs into the shell.



10 CASE, TRANSMISSION
669 WASHER, THRUST (REACTION SHAFT/SHELL)
670 SHELL, REACTION SUN
671 RING, REACTION SUN GEAR RETAINER
673 GEAR, REACTION SUN
674 WASHER, THRUST (RACE/REACTION SHELL)
675 RACE, LO & REVERSE ROLLER CLUTCH
676 RING, LO & REVERSE SUPPORT TO CASE RETAINER

LH0105-4L60

Figure 48 Reaction Sun Gear and Shell Installation

Input Internal Gear and Reaction Shaft

Figures 49 and 50

Remove or Disconnect

Figure 49

1. Retainer ring (668) from input internal gear (664)
2. Reaction carrier shaft (666) from the input internal gear

Inspect

Figures 49 and 50

- Reaction carrier shaft (666) for:
  - Scored, damaged, or worn bushings (see Bushing Replacement)
  - Cracked shaft
  - Damaged spline or gear teeth
  - Under cut around the shaft from interference with the sun gear

- Input internal gear (664) for:
  - Cracks
  - Damaged spline or gear teeth
- Input carrier to reaction shaft thrust bearing (663) for wear or damage
- Output shaft (687) for:
  - Plugged or restricted lube passages
  - Damaged splines or ring groove
  - Damaged governor drive gear teeth
  - Burrs or damage to the front of the shaft at seal area. (Polish with crocus cloth if necessary)
  - Burrs or damage to bearing journals

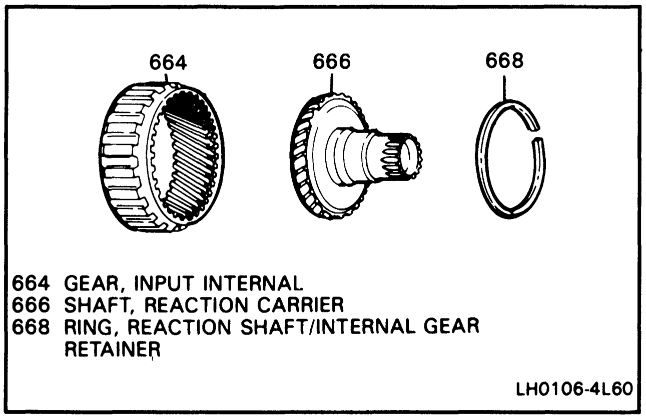


Figure 49 Input Internal Gear and Reaction Shaft

Internal Transmission Speed Sensor Rotor

Figure 50

Tools Required:

J 21427-01 Speedometer Gear Puller Adapter
J 8433 Speedometer Gear Puller
J 36352-6 "C" Washer
J 36352-4 Rotor Installer
Mechanical press

Inspect

Figure 50

- Speed sensor rotor on output shaft for tooth damage

Important

- If rotor is damaged, replace it. Do not reuse a rotor that has been removed.

Remove or Disconnect

Figure 50

- Install J 21427 with J 8433 and remove rotor.

Install or Connect

Figure 50

1. Place new rotor over output shaft.
2. Place J 36352-4 in groove on output shaft.
3. Place J 36352-6 on shaft and press to make contact with J 36352-4.

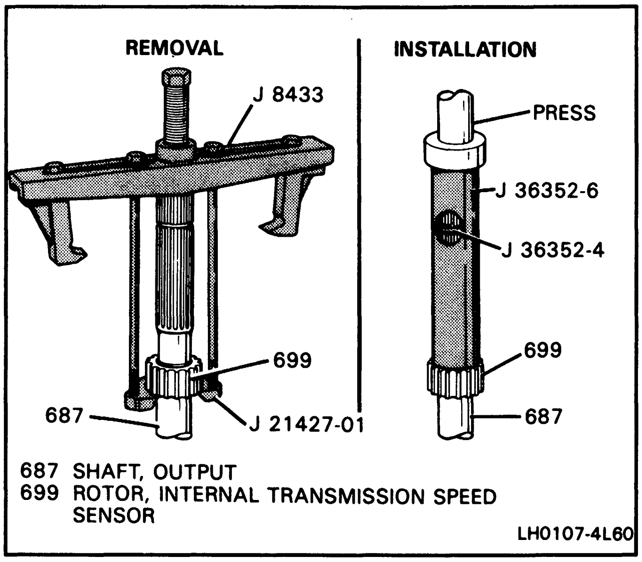


Figure 50 Internal Transmission Speed Sensor Rotor

Input Internal Gear and Output Shaft

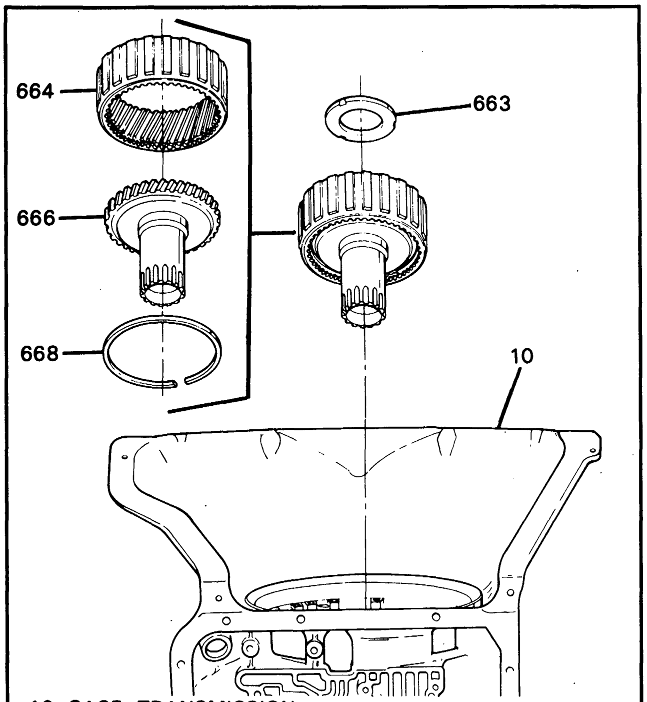
Figures 51 and 52

Tool Required:

J 29837 Output Shaft Support Fixture

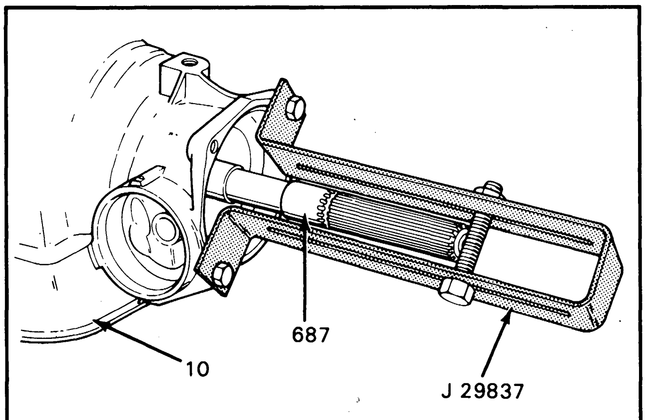
Install or Connect

1. Reaction shaft (666) into the input internal gear (664)
2. Retainer ring (668) into the input internal gear
3. Input internal gear and shaft assembly into the sun gear shell
   - Index the shaft spline into the reaction carrier.
4. Thrust bearing (663) onto the reaction carrier shaft.
   - Outer race goes toward the reaction carrier shaft.
5. Output shaft (687) into the transmission
   - Index the splines with the mating parts.
6. J 29837 onto the case
   - Position upwards as far as possible to support the output shaft.



10 CASE, TRANSMISSION
663 BEARING ASSEMBLY, THRUST (INPUT CARRIER TO REACTION SHAFT)
664 GEAR, INPUT INTERNAL
666 SHAFT, REACTION CARRIER
668 RING, REACTION SHAFT/INTERNAL GEAR RETAINER
LH0108-4L60

Figure 51 Input Internal Gear Installation



10 CASE, TRANSMISSION
687 SHAFT, OUTPUT
LH0077-4L60

Figure 52 Output Shaft — Installation

Input Carrier and Sun Gear

Figure 53

Tool Required:

J 34627 Snap Ring Pliers

Inspect

- Input carrier assembly (662) for:
  - Pinion gear damage
  - Excessive pinion washer wear — end play should be .20-.61 mm (.008-.024")
  - Proper pin stake
  - Keystoned pinion gears (pinion gears must rotate freely)
  - Damaged or worn thrust bearing
    - To check the captive thrust bearing in the carrier for wear, place a bushing or an output shaft sleeve on the bearing race (do not contact the pinion gears) and turn it with the palm of your hand. Any imperfections will be felt through the bushing.
- Input sun gear (658) for:
  - Bushing damage or wear (see Bushing Replacement Procedure)
  - Cracks
  - Damaged spline or gear teeth

Install or Connect

Figure 53

1. Input carrier assembly (662) onto the output shaft
2. Retainer ring (661) into the output shaft ring groove
   - Use care not to overexpand the ring during installation.
   - Do not reuse the old retainer ring if it has been overexpanded.
3. Remove J 29837.
4. Input sun gear (658) into the input carrier
   - Rotate the sun gear teeth into the pinion gear teeth

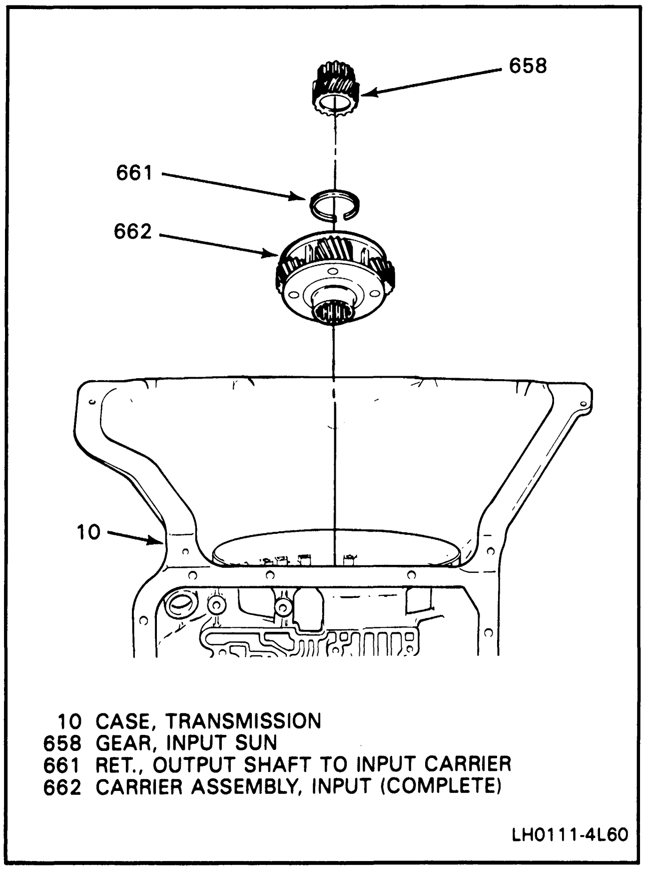


Figure 53 Input Carrier and Sun Gear — Installation

Input Clutch Assembly

Figures 54 through 58

Tools Required:

J 23456 Clutch Spring Compressor Press

J 23327-1 Clutch Spring Compressor

J 25018-A Clutch Spring Compressor Adaptor

Remove or Disconnect

Figures 54 and 56

- Reverse input clutch assembly (605) from the input clutch assembly (621)
- Oil pump to selective washer thrust bearing (615)
- Selective washer (616)

Disassemble

Figures 55 and 56

Place the input clutch assembly (621) on the bench with the turbine shaft through the bench hole.

1. The 3-4 clutch plate retainer ring (656) and the backing plate (655)
2. The 3-4 clutch plates (654)
3. Five 3-4 clutch boost spring assemblies (600)
4. The 3-4 clutch apply plate (653)
5. The 3-4 clutch ring retainer plate (652)
6. Forward clutch backing plate retainer ring (651) and backing plate (650)
7. Forward clutch sprag assembly (638-648)

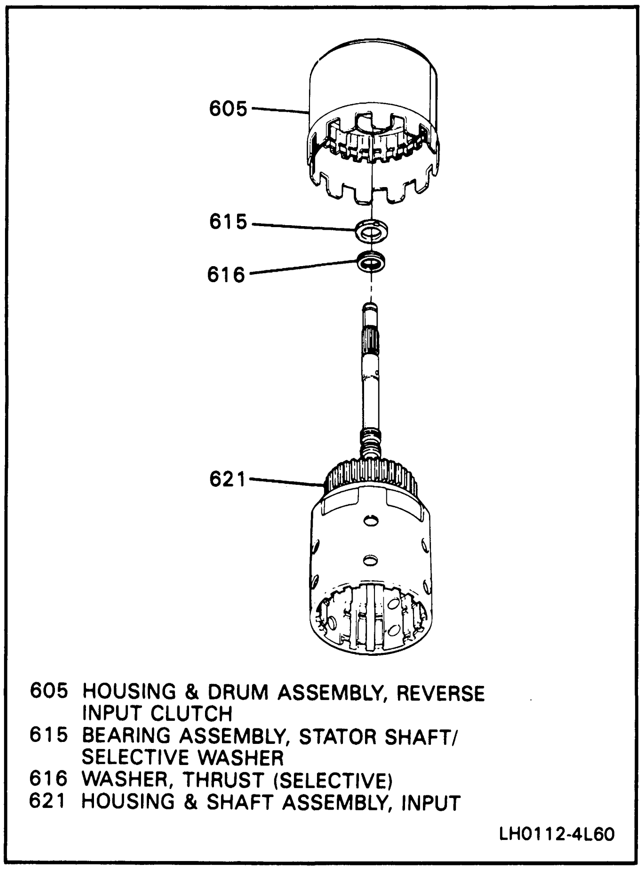


Figure 54 Reverse Input and Input Clutches

Disassemble

Figure 56

1. Input sun gear bearing assembly (637)
2. Input housing to output shaft lip seal (636).
3. Forward clutch plates (649)
4. Forward wave plate (648)
5. Forward clutch apply plate (646)
6. Overrun clutch plates (645)

Disassemble

Figure 55

1. Install J 23456 and J 23327-1 with J 25018-A.
    - Compress overrun clutch spring assembly (634).
2. Overrun clutch retainer ring (635).

3. Overrun clutch spring assembly (634).
4. Overrun clutch piston (632)
    - Inner and outer lip seals (631)
5. Forward clutch piston assembly (630)
    - Inner and outer lip seals (629)
6. Forward clutch housing (628)
7. The 3-4 clutch spring assembly (626)
8. The 3-4 clutch apply ring (625) and piston (623)
    - Inner and outer lip seals (624) from piston
9. Forward clutch to input housing O-ring seal (622)
10. Four turbine shaft oil seal rings (619)

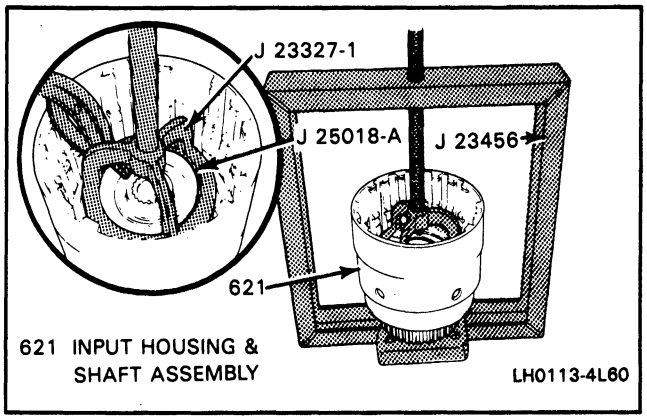


Figure 55 Overrun Clutch Retainer Ring — Removal

Inspect

Figures 57 and 58

- Input housing for porosity or damage
- Input housing and shaft assembly (621) for:
    - Spline wear or damage
    - Three turbine shaft check balls
        - The balls must **not** be loose or leaking.
        - The open hole is the lube oil passage which feeds the output shaft.
- Presence of orificed cup plug (698)
- Cracks at lube holes
- Four turbine shaft oil seal ring grooves for damage or burrs
    - Seals must fit freely into the ring grooves.
- Check valve retainer and ball assembly (617) for:
    - Damage
    - The ball must move freely in the retainer.
    - The retainer must be tight in the turbine shaft.
- Feed passages for:
    - Obstructions — blow air through passages

Check Valve Retainer and Ball Assembly — Replacement Procedures

Figures 56 through 67

Tools Required:

6.3 mm (#4) Screw extractor
9.5 mm (3/8 in.) diameter metal rod
6.35 mm (1/4 in.) diameter rod or drift hammer
J 23456 Clutch Spring Compressor Press
J 23327-1 Clutch Spring Compressor
J 25018-A Clutch Spring Compressor Adaptor
J 29882 Overrun Clutch Inner Seal Protector
J 29883 Forward Clutch Inner Seal Protector

Remove or Disconnect

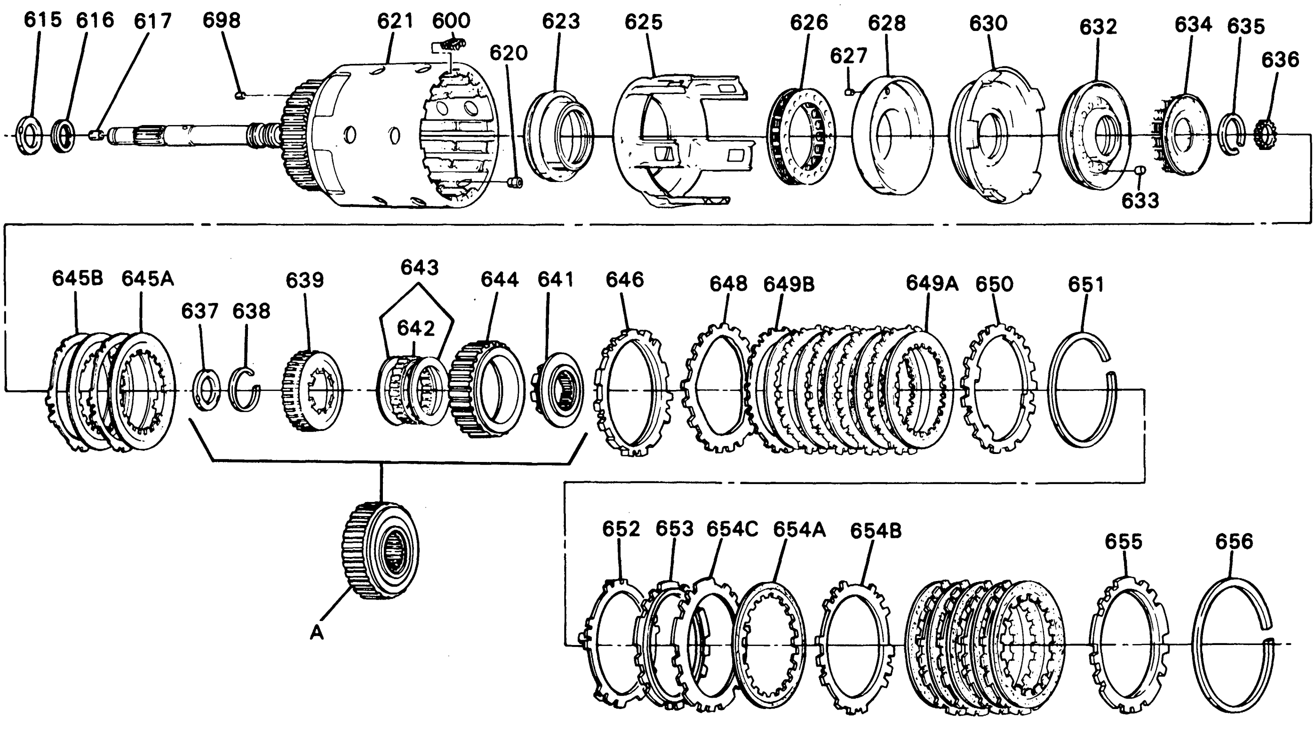
Figure 58

1. Straighten the tangs of the retainer and remove the ball.
2. Check valve retainer.
    - Use 6.3 mm (#4) Screw extractor.

Install or Connect

Figure 58

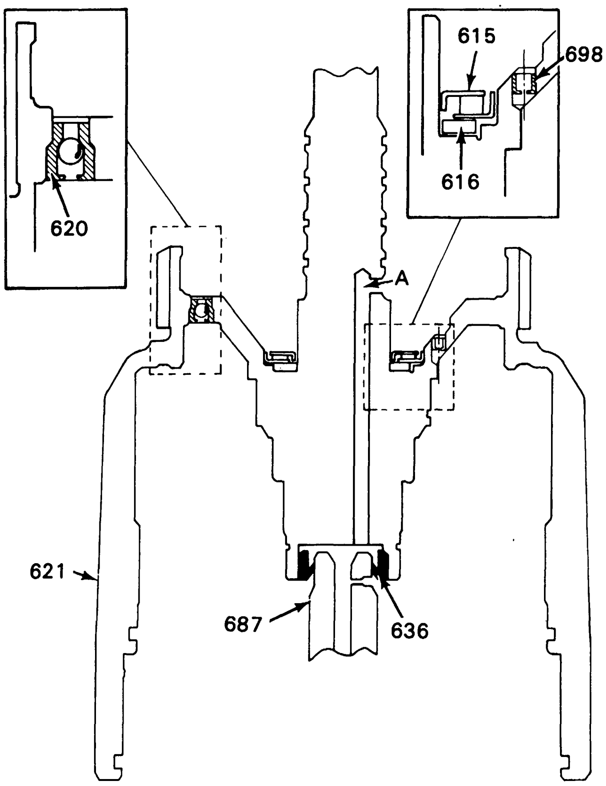
- New check valve retainer and ball assembly (617)
    - Use the 9.5 mm (3/8 in.) metal rod.
    - Seat the retainer 3.0 mm (1/8 in.) below top surface of the turbine shaft.
    - Be certain the ball is loose.



ILL. NO.	DESCRIPTION
600	SPRING ASM., 3-4 CLUTCH BOOST (5)
615	BEARING ASSEMBLY, STATOR SHAFT/ SELECTIVE WASHER
616	WASHER, THRUST (SELECTIVE)
617	RETAINER & BALL ASSEMBLY, CHECK VALVE
620	RETAINER & CHECK BALL ASSEMBLY
621	HOUSING & SHAFT ASSEMBLY, INPUT
623	PISTON, 3RD & 4TH CLUTCH
625	RING, 3RD & 4TH CLUTCH APPLY
626	SPRING ASSEMBLY, 3RD & 4TH CLUTCH
627	RETAINER & BALL ASSEMBLY, FORWARD CLUTCH HOUSING
628	HOUSING, FORWARD CLUTCH
630	PISTON, FORWARD CLUTCH
632	PISTON, OVERRUN CLUTCH
633	BALL, OVERRUN CLUTCH
634	SPRING ASSEMBLY, OVERRUN CLUTCH
635	SNAP RING, OVERRUN CLUTCH SPRING RETAINER
636	SEAL, INPUT HOUSING TO OUTPUT SHAFT
645A	PLATE ASSEMBLY, OVERRUN CLUTCH (FIBER)
645B	PLATE, OVERRUN CLUTCH (STEEL)
A	FORWARD CLUTCH SPRAG ASSEMBLY
637	BEARING ASSEMBLY, INPUT SUN GEAR
638	SNAP RING, OVERRUN CL. HUB RET.
639	HUB, OVERRUN CLUTCH
641	RETAINER & RACE ASSEMBLY, SPRAG
642	FORWARD SPRAG ASSEMBLY
643	RETAINER RINGS, SPRAG ASSEMBLY
644	RACE, FORWARD CLUTCH (OUTER)
646	PLATE, FORWARD CLUTCH APPLY
648	PLATE, FORWARD CLUTCH (WAVED)
649A	PLATE ASSEMBLY, FORWARD CLUTCH (FIBER)
649B	PLATE, FORWARD CLUTCH (STEEL)
650	PLATE, FORWARD CLUTCH BACKING (SEL.)
651	RING, FORWARD CLUTCH BACKING PLATE RETAINER
652	PLATE, 3RD & 4TH CLUTCH RING RETAINER
653	PLATE, 3RD & 4TH CLUTCH APPLY (STEPPED)
654A	PLATE ASSEMBLY, 3RD & 4TH CLUTCH (FIBER)
654B	PLATE, 3RD & 4TH CLUTCH (FLAT STEEL)
654C	PLATE, 3RD & 4TH CLUTCH (STEEL)
655	PLATE, 3RD & 4TH CLUTCH BACKING (SELECTIVE)
656	RING, 3RD & 4TH CLUTCH BACKING PLATE RETAINER
698	PLUG, ORIFICED CUP

LH0114-4L60

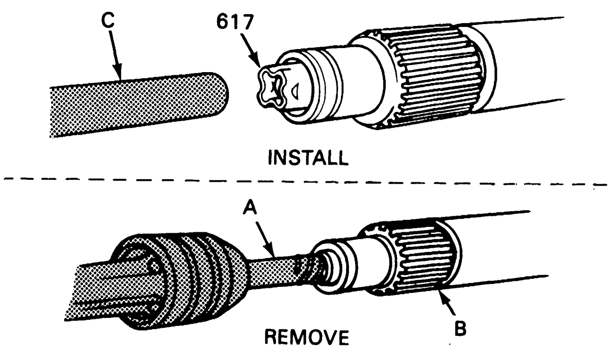
Figure 56 Input Clutch Assembly



A LUBE PASSAGE
615 BEARING ASSEMBLY, STATOR SHAFT/ SELECTIVE WASHER
616 WASHER, THRUST (SELECTIVE)
620 RETAINER & CHECK BALL ASSEMBLY
621 HOUSING & SHAFT ASSEMBLY, INPUT
636 SEAL, INPUT HOUSING TO OUTPUT SHAFT
687 SHAFT, OUTPUT
698 PLUG, ORIFICED CUP

LH0115-4L60

Figure 57 Input Housing Check Valve Ball



A #4 EASY OUT
B TURBINE SHAFT
C 9.5mm (3/8") METAL ROD
617 CHECK VALVE RETAINER & BALL ASSEMBLY

LH0116-4L60

Figure 58 Retainer and Ball Assembly — Replacement

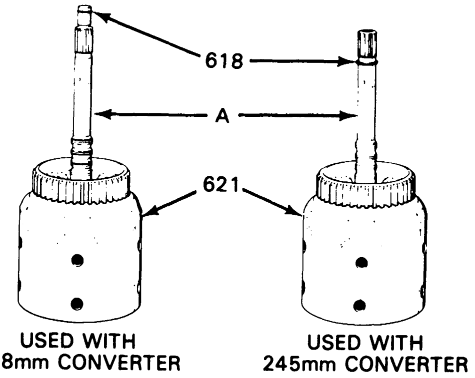
Inspect

Figures 57 and 59

- Turbine shaft O-ring seal (618) for:
  - Damage
  - Nicks or cuts
- Input housing check valve ball (620):
  - The ball must move freely.
  - Leak check the ball with solvent.

Important

- If the 3-4 clutch plates are burned or worn and a cause is not found during diagnosis or disassembly, replacement of the retainer and check ball assembly may be required (Figure 58).



A SHAFT, TURBINE
618 SEAL, "O" RING (TURBINE SHAFT/ SELECTIVE WASHER)
621 HOUSING & SHAFT ASSEMBLY, INPUT

LH0117-4L60

Figure 59 Views of the Input Housing

Remove or Disconnect

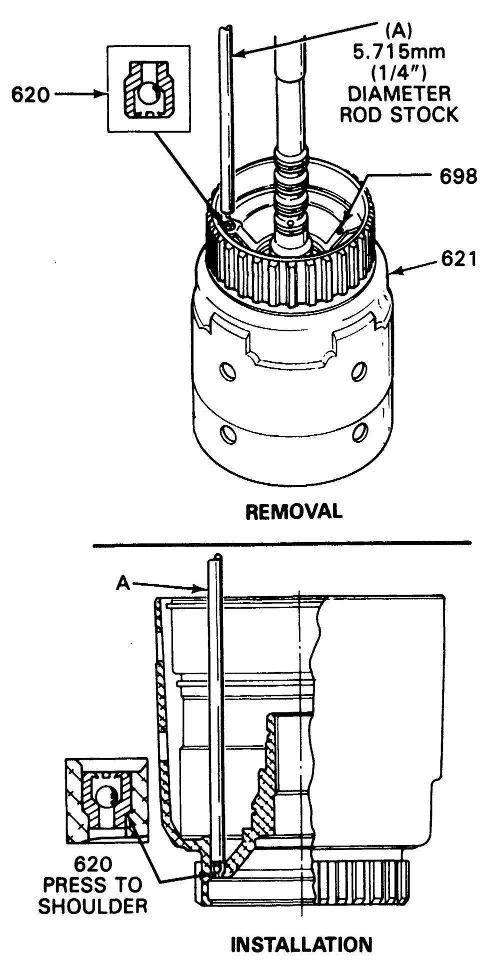
Figure 60

- Tap out retainer and ball assembly.

Install or Connect

Figures 58 and 60

- Using same tools, tap in retainer and ball assembly until shoulder is seated in housing.



A ROD STOCK/DRIFT, 5.715mm (1/4") DIA.
620 RETAINER & CHECK BALL ASSEMBLY
621 HOUSING & SHAFT ASSEMBLY, INPUT
698 PLUG, ORIFICED CUP

LH0118-4L60

Figure 60 Retainer and Check Ball Removal/Installation

Inspect

Figure 56

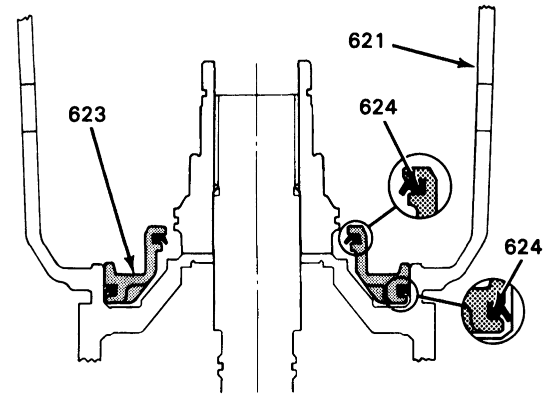
- The 3-4 clutch piston (623) for damage or porosity
- The 3-4 clutch apply ring (625) for:
  - Bent tangs
- The 3-4 clutch spring assembly (626) for damage or distortion
- The 3-4 clutch boost spring assemblies (600) for damage or distortion

Assemble

Figure 61

Position the input housing and shaft assembly on the bench with the turbine shaft through a bench hole.

1. Inner and outer 3-4 clutch lip seals (624) on the 3-4 clutch piston
   - Seal lips must face away from the piston hub.
   - Lubricate the seals with TRANSJEL™ J 36850 or equivalent.
2. The 3-4 clutch piston (623) into the input housing as shown
   - Use care not to damage the seals.



621 HOUSING & SHAFT ASSEMBLY, INPUT
623 PISTON, 3RD & 4TH CLUTCH
624 SEALS, 3RD & 4TH CL. (INNER & OUTER)

LH0119-4L60

Figure 61 Input Housing and 3-4 Piston

Inspect

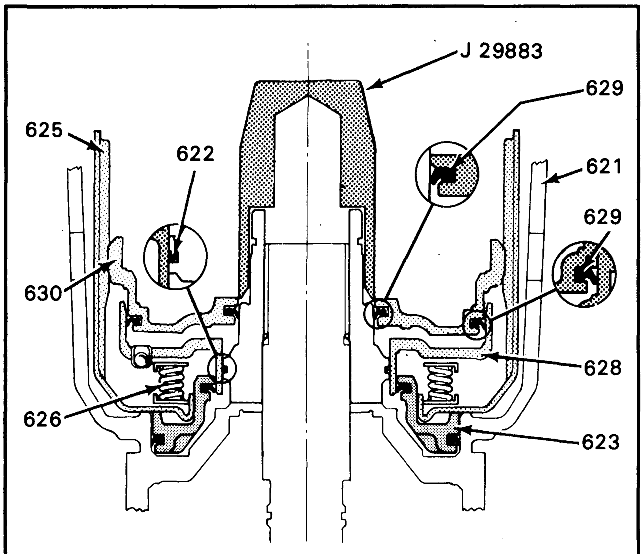
Figures 62 and 63

- Forward clutch housing (628) for:
  - Proper check ball operation
  - Damage or distortion
  - Burrs in seal areas
  - Cracks
- Forward clutch piston (630) and overrun clutch piston (632) for:
  - Porosity or damage
  - Ring groove damage
  - Apply leg damage
- Overrun spring assembly (634) for damage or distortion
- Input housing to output shaft lip seal (636) for damage or wear

Assemble

Figures 62 and 63

1. Forward clutch housing to input clutch housing O-ring seal (622) as shown
   - Lubricate with TRANSJEL™ J 36850 or equivalent.

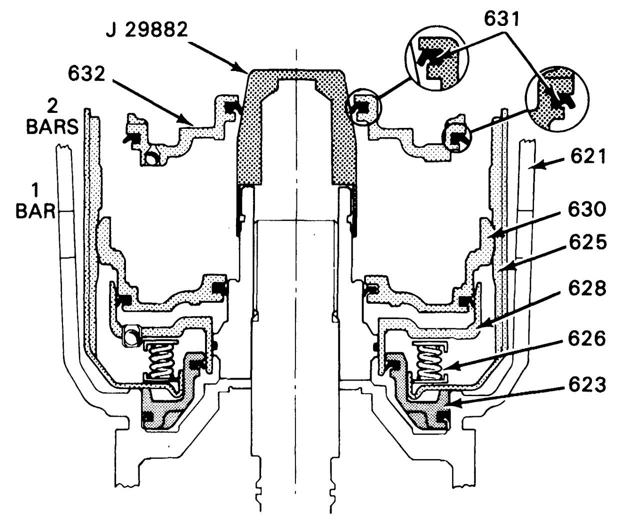


621	HOUSING & SHAFT ASSEMBLY, INPUT
622	SEAL, "O" RING INPUT TO FORWARD HSG.
623	PISTON, 3RD & 4TH CLUTCH
625	RING, 3RD & 4TH CLUTCH APPLY
626	SPRING ASSEMBLY, 3RD & 4TH CLUTCH
628	HOUSING, FORWARD CLUTCH
629	SEALS, FORWARD CLUTCH (INNER & OUTER)
630	PISTON, FORWARD CLUTCH

LH0120-4L60

Figure 62 Forward Clutch and 3-4 Apply Ring -- Installed

2. Inner and outer seals (629) on forward clutch piston
   - Seal lips must face away from the piston tangs as shown.
   - Lubricate with TRANSJEL™ J 36850 or equivalent.
3. Forward clutch piston (630) into the forward clutch housing
   - Use care not to damage the outer lip seal.
4. The 3-4 clutch spring assembly (626) onto the 3-4 clutch apply ring
5. Forward clutch assembly onto the 3-4 clutch spring assembly
   - The forward clutch piston apply legs must be indexed with the 3-4 clutch apply ring legs.
6. J 29883 on the input housing as shown
7. Apply ring and forward clutch assembly into the input housing as shown.
   - Hold the assembly by the apply ring legs during installation.
   - Do not let the forward clutch piston separate from the housing.
   - Firmly seat the assembly.



621	HOUSING & SHAFT ASSEMBLY, INPUT
623	PISTON, 3RD & 4TH CLUTCH
625	RING, 3RD & 4TH CLUTCH APPLY
626	SPRING ASSEMBLY, 3RD & 4TH CLUTCH
628	HOUSING, FORWARD CLUTCH
630	PISTON, FORWARD CLUTCH
631	SEAL, OVERRUN CLUTCH (INNER & OUTER)
632	PISTON, OVERRUN CLUTCH

LH0121-4L60

Figure 63 Overrun Piston — Installed

8. J 29882 on the input housing as shown
9. Overrun clutch piston (632)
   - Hub facing upward as shown.
   - If all parts are properly seated to this point, the overrun piston hub will be approximately 4.7 mm (3/16 in.) below the snap ring groove in the input housing hub.

Assemble

Figures 64 and 65

1. Overrun clutch spring assembly (634) onto the overrun clutch piston
   - Locate the springs on the piston tabs.
2. J 23456 and J 23327-1 with J 25018-A onto the overrun spring assembly
   - Compress springs (Do not over-compress).
3. Retainer snap ring (635) into the snap ring groove
4. Input housing to output shaft lip seal (636)

Inspect

- Overrun clutch plates (645) for:
  - Composition plate damaged tangs, delamination, or excessive wear
  - Steel plate damaged tangs, wear, or heat damage

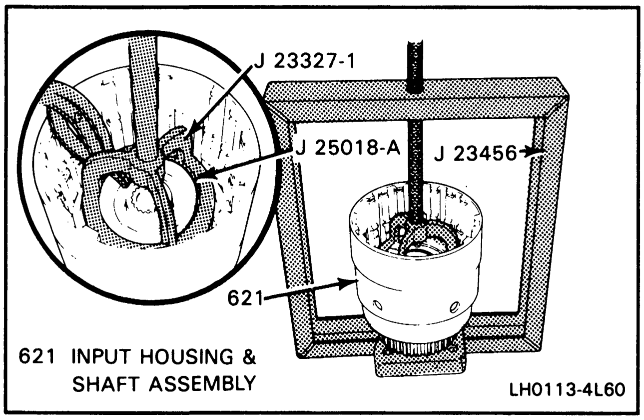


Figure 64 Overrun Clutch Retaining Ring — Installed

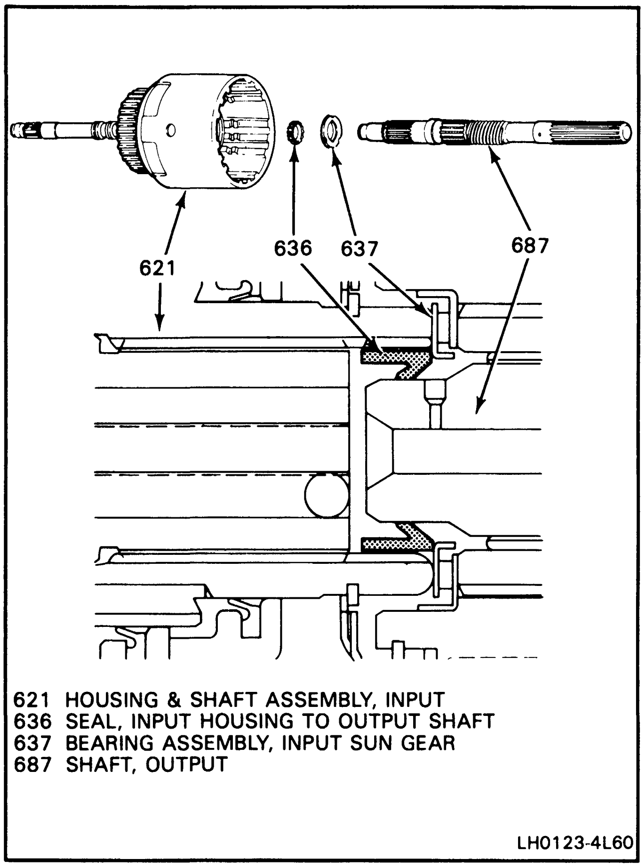


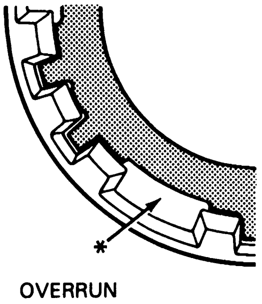
Figure 65 Input Hsg. to Output Shaft Lip Seal

- Input sun gear bearing assembly (637) for:
  - Wear
  - Flatness
  - Damaged

Assemble

Figures 66 and 67

1. Overrun clutch plates (645) into the input housing.
   - Overrun clutch plates are the smallest of the three sets of plates in the input housing.
   - Index the plates as shown starting with a steel plate and alternate with composition.
2. Thrust bearing assembly (637) onto the input clutch hub
   - The inside race must face the input housing hub.
   - Retain with TRANSJEL™ J 36850 or equivalent.
3. Align the tangs on the two composition overrun clutch plates.



*ALIGN WIDE NOTCHES TO CASE LUGS

OVERRUN CLUTCH

MODEL	FLAT STEEL		COMP. FACED	
	NO.	THICKNESS	NO.	THICKNESS
ALL MODELS	2	2.34 mm (.091")	2	2.03 mm (.079")

LH0124-4L60

Figure 66 Overrun Clutch Plate Chart

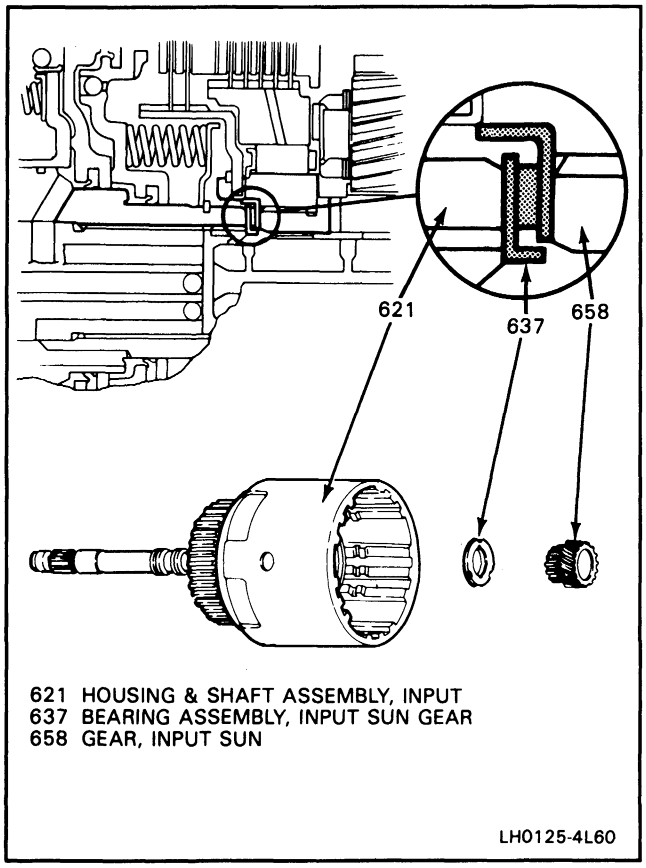


Figure 67 Input Sun Gear Thrust Bearing

Forward Clutch Sprag Assembly

Figures 68 through 75

Disassemble

Figure 68

1. Forward sprag outer race (644)
2. Overrun clutch hub retaining snap ring (638) and clutch hub (639)
3. Forward clutch retainer and race assembly (641)

Inspect

- Forward clutch sprag assembly (642) for:
  - Wear or damage
  - Weak or broken springs
  - Damaged or missing retainer caps (brass)
- Overrun clutch hub (639) for:
  - Spline damage
  - Plugged lubrication holes
  - Damaged tangs
  - Cracks
- Forward clutch retainer and race assembly (641) for:
  - Spline damage
  - Ring groove damage
  - Surface finish damage
  - Loose retainer
- Forward sprag outer race (644) for:
  - Spline damage
  - Surface finish damage
  - Plugged lubrication holes

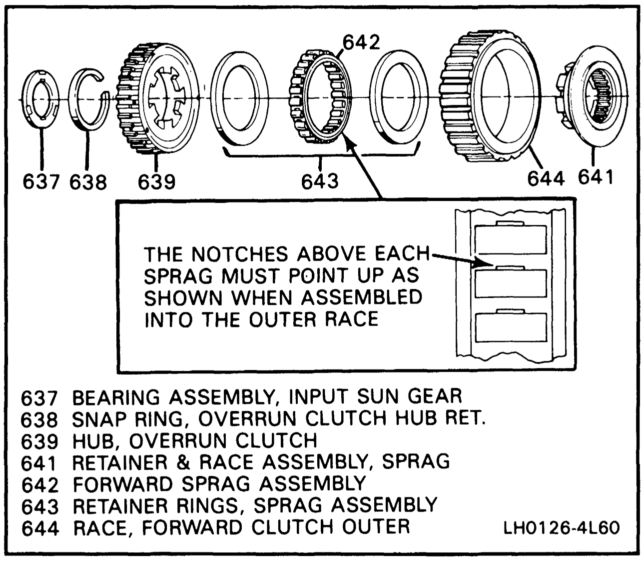


Figure 68 Forward Clutch Sprag Assembly

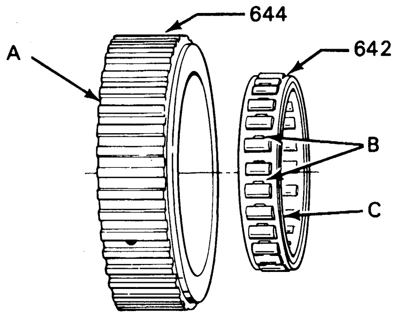
Assemble

Figures 69, 70 and 71

1. Forward clutch sprag assembly (642) into the outer race
   - To correctly install, the notches in the sprag cage must face upward as shown.
2. One sprag retainer ring (643) onto the race and retainer assembly
   - The flange on the retainer ring must face away from the retainer.
3. Race and retainer assembly into the sprag assembly
   - To assemble, hold the outer race in your left hand with your fingers supporting the sprag at the recessed side of the outer race.
   - Insert the race and retainer assembly by pushing in and turning to the left.
4. The remaining retainer ring onto the sprag assembly
5. Overrun clutch hub (639)
6. Overrun clutch hub retaining snap ring (638) into the snap ring groove of the race and retainer assembly
7. Test the assembly for proper operation as shown (Figure 71).

Important

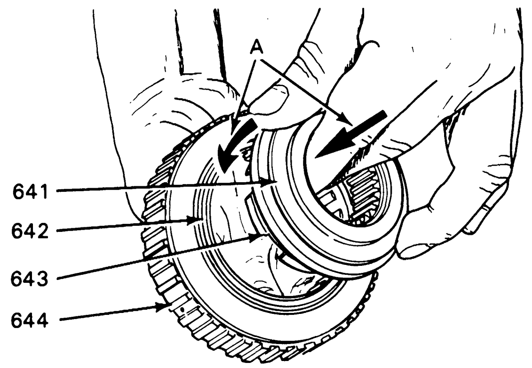
- If the assembly operates backwards, you have installed the sprag backwards. Reassemble correctly.



A RECESSED FACE
B NOTCHES POINT UPWARD AS SHOWN
C LIPPED EDGE
642 FORWARD SPRAG ASSEMBLY
644 RACE, FORWARD CLUTCH (OUTER)

LH0127-4L60

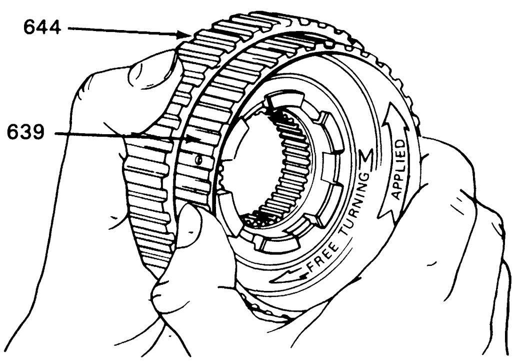
Figure 69 Sprag Assembly Procedure



A PUSH IN AND TURN COUNTERCLOCKWISE TO INSTALL
641 RETAINER & RACE ASSEMBLY, SPRAG
642 FORWARD SPRAG ASSEMBLY
643 RETAINER RINGS, SPRAG ASSEMBLY
644 RACE, FORWARD CLUTCH (OUTER)

LH0128-4L60

Figure 70 Sprag Race and Retainer Assembly Procedure



THE OVERRUN CLUTCH HUB MUST TURN CLOCKWISE, BUT NOT COUNTERCLOCKWISE

639 HUB, OVERRUN CLUTCH
644 RACE, FORWARD CLUTCH (OUTER)

LH0129-4L60

Figure 71 Sprag Operation Check

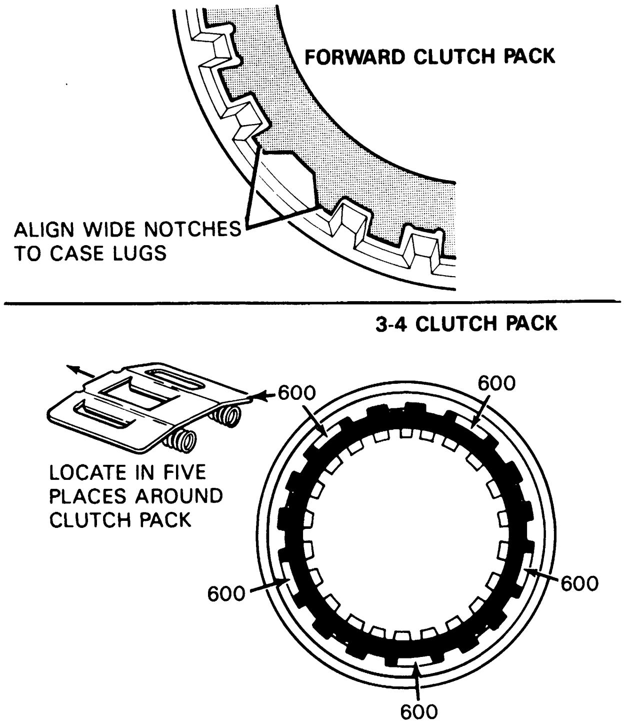
Assemble

- Forward clutch sprag assembly into the input clutch housing
  - Index the overrun clutch hub into the overrun clutch plates.

Inspect

Figures 72 and 73

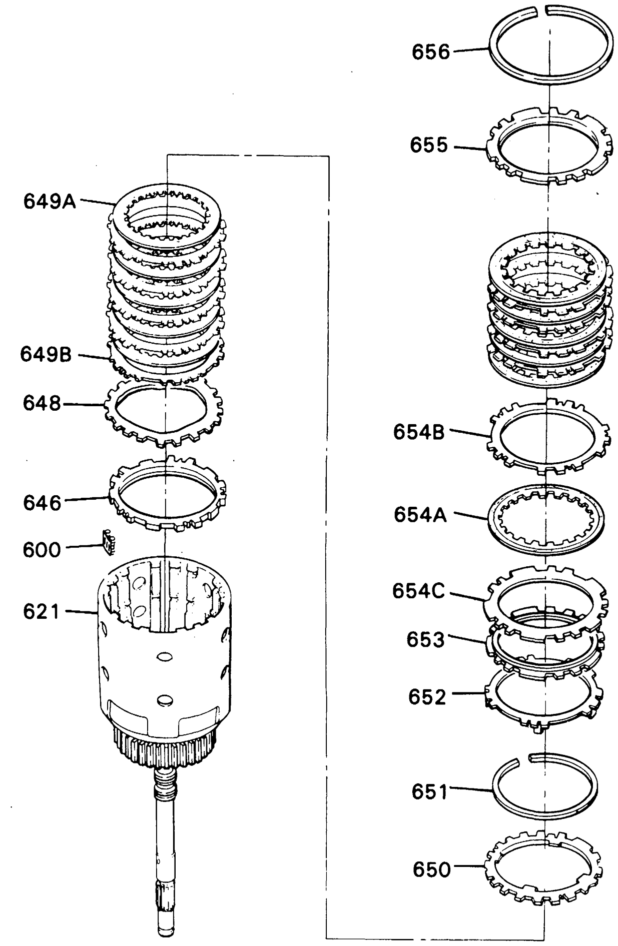
- Forward (649) and 3-4 clutch plates (654) for:
  - Composition plate damaged tangs, delamination, or wear
  - Steel plate damaged tangs, wear, or heat damage
- Forward (650) and 3-4 clutch backing plates (655) for:
  - Flatness
  - Surface finish damage
  - Burrs or nicks
- Forward clutch apply plate (646) and spacer plate (647) for:
  - Flatness
  - Surface finish damage
  - Burrs or nicks



600 SPRING ASM., BOOST 3-4 CLUTCH

LH0130-4L60

Figure 72 Forward and 3-4 Clutch Plates — Installed



ILL. NO.	DESCRIPTION
600	SPRING ASSEMBLY, 3-4 CLUTCH BOOST (5)
621	HOUSING & SHAFT ASSEMBLY, INPUT
646	PLATE, FORWARD CLUTCH APPLY
648	PLATE, FORWARD CLUTCH (WAVED)
649A	PLATE ASSEMBLY, FORWARD CLUTCH (FIBER)
649B	PLATE, FORWARD CLUTCH (STEEL)
650	PLATE, FORWARD CLUTCH BACKING (SELECTIVE)
651	RING, FORWARD CLUTCH BACKING PLATE RETAINER
652	PLATE, 3RD & 4TH CLUTCH RING RETAINER
653	PLATE, 3RD & 4TH CLUTCH APPLY (STEPPED)
654A	PLATE ASSEMBLY, 3RD & 4TH CLUTCH (FIBER)
654B	PLATE, 3RD & 4TH CLUTCH (STEEL)
654C	PLATE, 3RD & 4TH CLUTCH (STEEL)
655	PLATE, 3RD & 4TH CLUTCH BACKING (SELECTIVE)
656	RING, 3RD & 4TH CLUTCH BACKING PLATE RETAINER

LH0131-4L60

Figure 73 Input Housing with Forward and 3-4 Clutch Plates

- The 3-4 clutch apply plate (653) for:
  - Flatness
  - Surface finish damage
- The 3-4 clutch ring retainer plate (652) for:
  - Bent tangs
  - Flatness

Assemble

Figures 72 through 75

1. Forward clutch apply plate (646) into the input clutch housing
   - Index as shown.
2. Waved steel forward clutch plate (648) into the input clutch housing
   - Index as shown.
3. The remaining forward clutch plates (649) into the input clutch housing
   - Start with a steel plate and alternate with composition.
4. Forward clutch selective backing plate (650)
5. Forward clutch retaining ring (651)

Forward Clutch Piston Travel Check

Figure 75

Measure

1. With the overrun clutch and forward clutch fully assembled in the Input Housing, check the end clearance between the backing plate (650) and the retaining ring (651) with two feeler gages.
2. Proper forward clutch backing plate travel should be .75-1.60 mm (.030-.063").
3. Select the proper backing plate from the chart to obtain the correct clearance.

FORWARD CLUTCH INFORMATION CHART

PLATE TYPE	THICK-NESS	QUANTITY REQUIRED ALL MODELS
APPLY PLATE	6.44mm (2.51")	1
WAVED STEEL CLUTCH PLATE	2.03mm (.079")	1
FLAT STEEL CLUTCH PLATE	2.29mm (.090")	5
COMPOSITION FACED CLUTCH PLATE	1.78mm (.070")	5
BACKING PLATE	SELEC-TIVE	1

LH0132-4L60

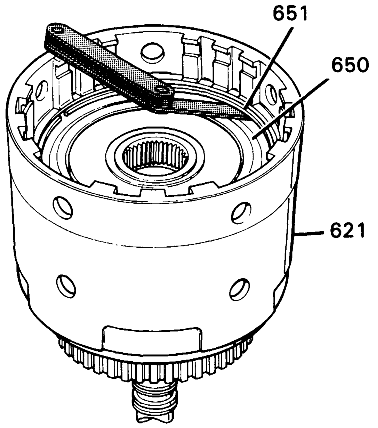
Figure 74 Forward Clutch Plate Chart

FORWARD CLUTCH
BACKING PLATE SELECTION

ALL MODELS

BACKING PLATE TRAVEL = .75mm - 1.60mm (.030" - .063")

PLATE THICKNESS	IDENTIFICATION
6.97mm - 7.07mm (.274" - .278")	A
6.38mm - 6.48mm (.250" - .255")	B
5.79mm - 5.89mm (.227" - .232")	C
5.20mm - 5.30mm (.205" - .208")	D
4.61mm - 4.71mm (.180" - 185")	E



621 HOUSING & SHAFT ASSEMBLY, INPUT
650 PLATE, FORWARD CLUTCH BACKING
651 RING, FORWARD CLUTCH BACKING PLATE RETAINER

LH0133-4L60

Figure 75 Forward Clutch Backing Plate Travel

3-4 Clutch Assembly

Figures 76 and 80

Assemble

1. The 3-4 ring retainer plate (652)
   - Index each leg into the apply ring legs.
2. The 3-4 clutch apply plate (653)
3. The 3-4 clutch plates (654)
   - Start with steel and alternate with composition as shown in (Figure 80).
   - First steel plate has the same spline configuration as apply plate.
4. The 3-4 boost springs (600)

3-4 CLUTCH
INFORMATION CHART

PLATE TYPE	THICK-NESS	QUANTITY REQUIRED	
		*A-MODELS	*B-MODELS
STEPPED APPLY PLATE	3.30mm (.130")	1	1
†FLAT STEEL CLUTCH PLATES	1.78mm (.070")	1	1
FLAT STEEL CLUTCH PLATE	1.78mm (.070")	6	5
COMPOSITION FACED CLUTCH PLATES	2.03mm (0.79")	5	6
BACKING PLATE	SELEC-TIVE	1	1

*A-MODELS	FBM, MBM, SAM
*B-MODELS	ALL OTHERS

†SAME SPLINE CONFIGURATION AS APPLY PLATE

LH0134-4L60

Figure 76 3-4 Clutch Plate Chart

5. The 3-4 clutch backing plate (655) and retainer ring (656)
   - Chamfered side up

3-4 Clutch Piston Travel Check

Figure 77

Measure

- Check the end clearance between the backing plate (655) and the first composition plate with a feeler gage.
- Select the proper backing plate from the chart to obtain the correct clearance for model you are working on.

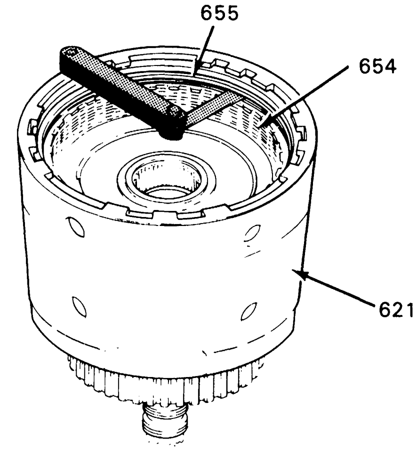
Clutch Air Check

Figure 78

Air check the 3-4, forward, and overrun clutches by applying air pressure at the feed holes in the turbine shaft. (When the overrun clutch is checked, the air will blow by the forward clutch piston lip seals and exit out the forward clutch feed hole in the turbine shaft.)

3-4 BACKING PLATE SELECTION

MODEL	BACKING PLATE TRAVEL	*BACKING PLATE	
		Use Backing Plate Which Gives Correct Travel	
		DIM.	I.D.
FBM, MBM, SAM	2.42mm - 1.61mm (.095" - .063")	6.58mm-6.38mm (.259"-.251")	5
		5.75mm-5.55mm (.226"-.218")	6
ALL OTHERS	2.40mm - 1.52mm (.094" - .060")	4.92mm-4.72mm (.194"-.186")	7
		4.09mm-3.89mm (.161"-.153")	8



621 HOUSING & SHAFT ASSEMBLY, INPUT
654 PLATE ASSEMBLY, 3RD & 4TH CLUTCH
655 PLATE, 3RD & 4TH CLUTCH BACKING

LH0135-4L60

Figure 77 3-4 Backing Plate Selection Chart

Turbine Shaft Seals

Figure 79

Tools Required:

J 36418-1 Seal Installer
J 36418-2A Seal Sizer

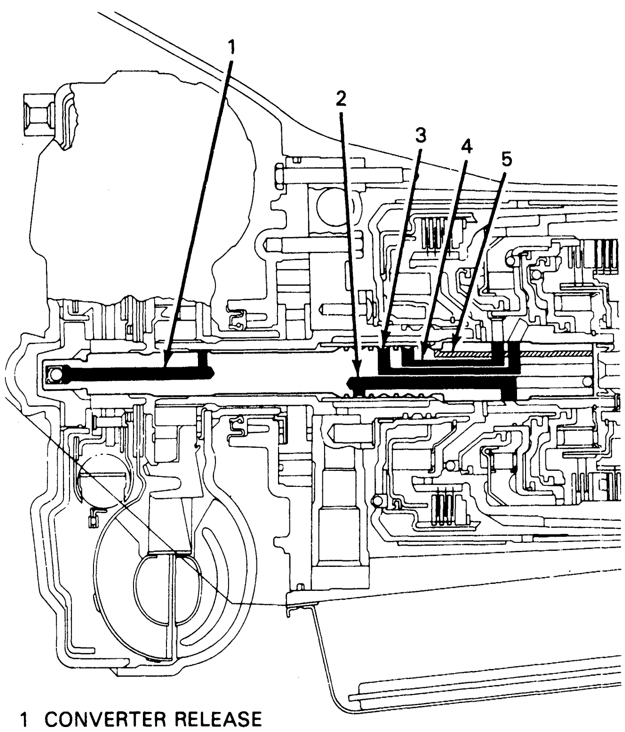
Assemble

1. Install four turbine shaft oil seal rings (619) using J-36418-1.

Adjust

- Adjust screw to obtain proper height.

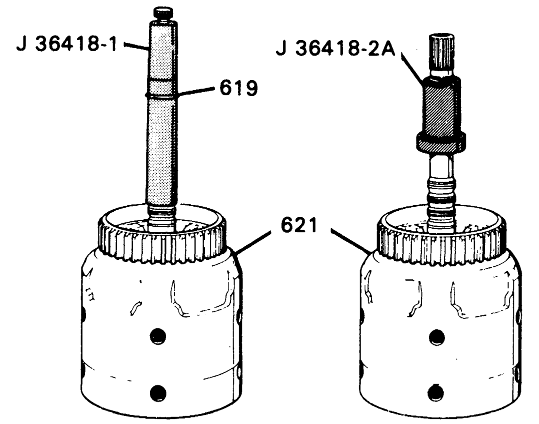
2. Use J 36418-2A to size the seals after installation.



1 CONVERTER RELEASE
2 OVERRUN CLUTCH
3 FORWARD CLUTCH
4 3-4 CLUTCH
5 LUBE

LH0136-4L60

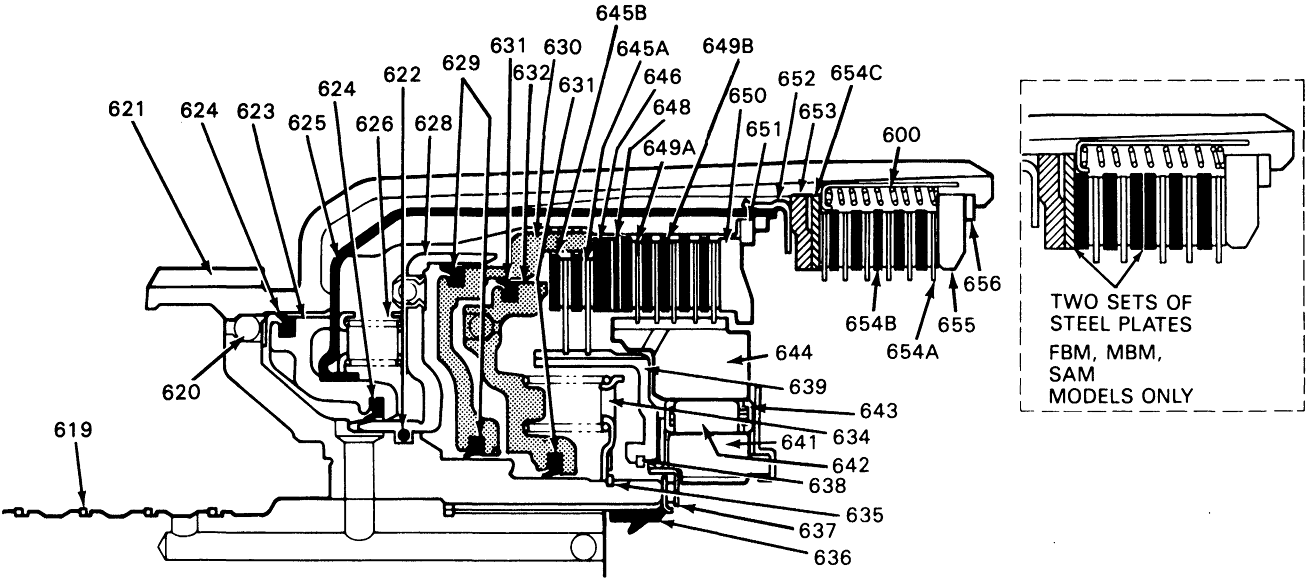
Figure 78 Turbine Shaft Fluid Passages



619 RING, OIL SEAL (TURBINE SHAFT)
621 HOUSING & SHAFT ASSEMBLY, INPUT

LH0137-4L60

Figure 79 Turbine Shaft Oil Seal Rings



600	SPRING ASM., BOOST 3-4 CLUTCH
619	RING, OIL SEAL (TURBINE SHAFT)
620	RETAINER & CHECK BALL ASSEMBLY
621	HOUSING & SHAFT ASSEMBLY, INPUT
622	SEAL, "O" RING INPUT TO FORWARD HSG.
623	PISTON, 3RD & 4TH CLUTCH
624	SEAL, 3RD & 4TH CL. (INNER & OUTER)
625	RING, 3RD & 4TH CLUTCH APPLY
626	SPRING ASSEMBLY, 3RD & 4TH CLUTCH
628	HOUSING, FORWARD CLUTCH
629	SEAL, FORWARD CLUTCH (INNER & OUTER)
630	PISTON, FORWARD CLUTCH
631	SEAL, OVERRUN CLUTCH (INNER & OUTER)
632	PISTON, OVERRUN CLUTCH
634	SPRING ASSEMBLY, OVERRUN CLUTCH
635	SNAP RING, OVERRUN CLUTCH SPRING RETAINER
636	SEAL, INPUT HOUSING TO OUTPUT SHAFT
637	BEARING ASSEMBLY, INPUT SUN GEAR
638	SNAP RING, OVERRUN CL. HUB RETAINING
639	HUB, OVERRUN CLUTCH
641	RETAINER & RACE ASSEMBLY, SPRAG
642	FORWARD SPRAG ASSEMBLY
643	RETAINER RINGS, SPRAG ASSEMBLY
644	RACE, FORWARD CLUTCH (OUTER)
645A	PLATE ASSEMBLY, OVERRUN CLUTCH (FIBER)
645B	PLATE, OVERRUN CLUTCH (STEEL)
646	PLATE, FORWARD CLUTCH APPLY
648	PLATE, FORWARD CLUTCH (WAVED)
649A	PLATE ASSEMBLY, FORWARD CLUTCH (FIBER)
649B	PLATE, FORWARD CLUTCH (STEEL)
650	PLATE, FORWARD CLUTCH BACKING (SEL.)
651	RING, FORWARD CLUTCH BACKING PLATE RETAINER
652	PLATE, 3RD & 4TH CLUTCH RING RETAINER
653	PLATE, 3RD & 4TH CL. APPLY (STEPPED)
654A	PLATE ASSEMBLY, 3RD & 4TH CLUTCH (FIBER)
654B	PLATE, 3RD & 4TH CLUTCH (STEEL)
654C	PLATE, 3RD & 4TH CLUTCH (STEEL)
655	PLATE, 3RD & 4TH CLUTCH BACKING (SELECTIVE)
656	RING, 3RD & 4TH CLUTCH BACKING PLATE RETAINER

LH0138-4L60

Figure 80 Input Clutch Assembly

Reverse Input Clutch Assembly

Figures 81 through 86

Tools Required:

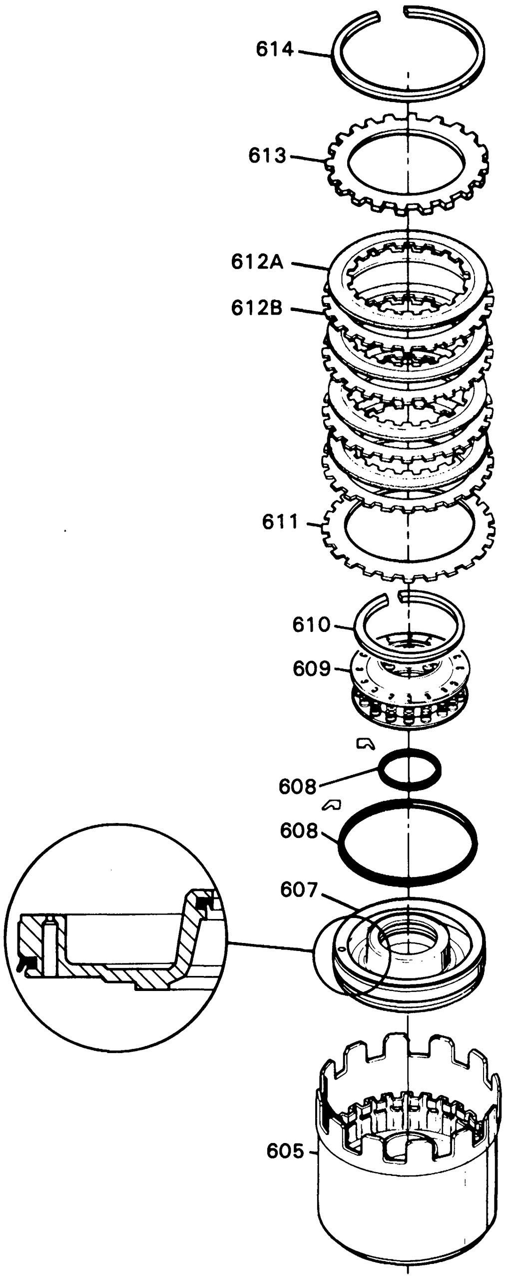
J 23327-1 Clutch Spring Compressor

J 25018-A Clutch Spring Compressor Adaptor

Disassemble

Figures 81 and 82

1. Retaining ring (614) from reverse input housing
2. Backing plate (613)
3. Clutch plates (612) and Belleville steel plate (611)
4. Install J 23327-1 and J 25018-A.
   - Compress the spring assembly.
5. Spring assembly retainer ring (610) and spring assembly (609)
6. Reverse input clutch piston (607)
   - Inner and outer lip seals (608)



ILL. NO.	DESCRIPTION
605	HOUSING & DRUM ASSEMBLY, REVERSE INPUT CLUTCH
607	PISTON ASM., REVERSE INPUT CLUTCH
608	SEALS, REVERSE INPUT CLUTCH (INNER & OUTER)
609	SPRING ASM., REVERSE INPUT CLUTCH
610	RING, REVERSE INPUT CLUTCH SPRING RETAINER
611	PLATE, REVERSE INPUT CL. (BELLEVILLE)
612A	PLATE ASM., REVERSE INPUT CLUTCH (FIBER)
612B	PLATE, REVERSE INPUT CLUTCH (STEEL)
613	PLATE, REVERSE INPUT CLUTCH BACKING
614	RING, REVERSE INPUT CL. RETAINING

LH0139-4L60

Figure 81 Reverse Input Clutch Assembly

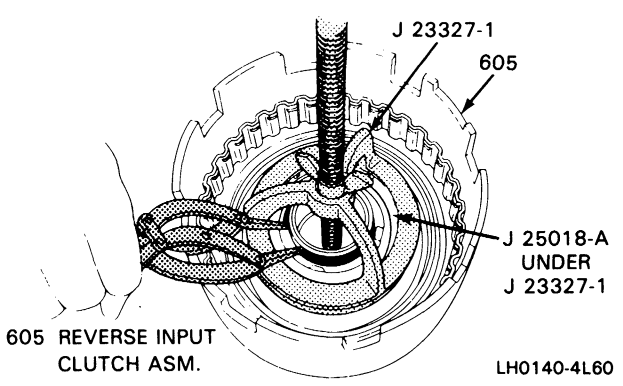
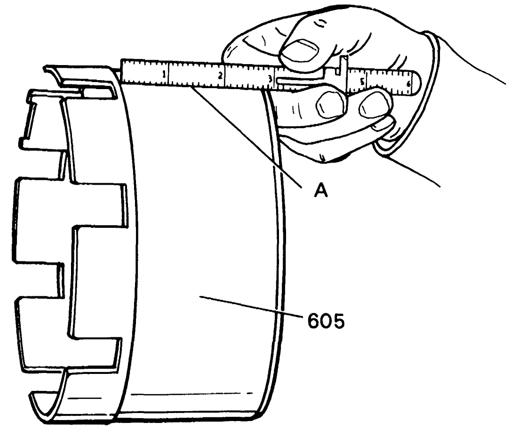


Figure 82 Reverse Input Retainer Ring — Removal

Inspect

Figures 81 and 83

- Backing plate (613) for:
  - Damage
  - Distortion or flatness
  - Burrs or surface finish damage
- Clutch Plates (612) for:
  - Composition plate tang damage, delamination, or wear
  - Steel plate tang damage, wear, or heat damage
- Spring assembly (609) for distortion or damage
- Piston (607) for:
  - Damage or porosity
  - Ring groove damage
- Housing and drum assembly (605) for:
  - Damaged or worn bushings (603 and 606)
  - Surface on the hub and outer housing
  - Leak at the weld



A CHECK FOR DISHING AT THIS POINT
605 HOUSING & DRUM ASSEMBLY, REVERSE INPUT CLUTCH

LH0141-4L60

Figure 83 Check Reverse Input Housing For Dishing

Assemble

Figures 81, 82, 84, 85, and 86

1. Inner and outer seals (608) on the piston
   - Lips must face away from the hub as shown.
   - Lubricate with transmission fluid.
2. Piston (607) into the housing and drum assembly
   - Use an 8 mm feeler gage to position the lip seals.
   - Use care not to damage the seals.
3. Spring assembly (609)
   - Large opening in the assembly goes towards the piston.
4. Install J 23327-1 and J 25018-A.
   - Compress the spring assembly
   - Install the retainer ring (610).
5. Belleville steel clutch plate (611)
6. Clutch plates (612). (4 steel and 4 composition plates required)
   - Start with a steel and alternate with composition.

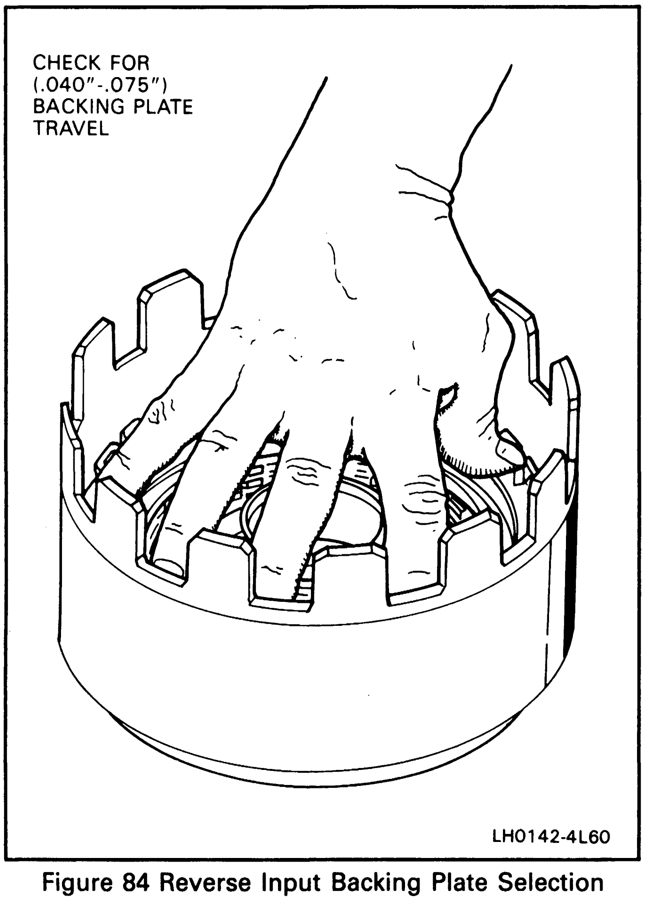


Figure 84 Reverse Input Backing Plate Selection

7. Backing plate (613)
   - Chamfered side up
8. Retaining ring (614)

Reverse Input Clutch Backing Plate Selection

Figures 84, 85 and 86

Measure

1. With the reverse input clutch fully assembled, apply an evenly distributed load to the clutch pack in the direction shown in Figure 1. Medium pressure (approximately 89 N or 20 lbs.) on the backing plate applied by hand on five evenly distributed points will obtain the backing plate travel for measurement.

   NOTICE: Excessive pressure will distort the Belleville plate resulting in an inaccurate measurement.
2. Using a feeler gage, measure between the snap ring and the backing plate. Backing plate travel should be 1.02 - 1.94 mm (.040 - .076").
3. Select the proper backing plate to obtain the specified travel.

REVERSE INPUT CLUTCH

	NO.	THICKNESS
BELLEVILLE PLATE	1	2.311mm (.091") 2.210mm (.087")
FLAT STEEL CLUTCH PLATE	4	2.045mm (.081") 1.892mm (.075")
COMPOSITION FACED CLUTCH PLATE	4	1.880mm (.074") 1.730mm (.068")
BACKING PLATE	1	SELECTIVE

LH0143-4L60

Figure 85 Reverse Input Clutch Plate Chart

REVERSE INPUT CLUTCH BACKING PLATE SELECTION

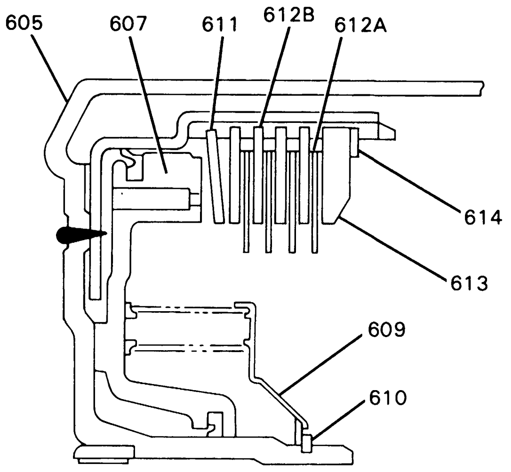
ALL MODELS

BACKING PLATE TRAVEL = 1.02mm - 1.94mm (0.40" - .076")

PLATE THICKNESS	IDENTIFICATION
7.60mm - 7.45mm (.299" - .293")	5
6.94mm - 6.79mm (.273" - .267")	6
6.28mm - 6.13mm (.247" - .241")	7
5.62mm - 5.47mm (.221" - .215")	8

LH0144-4L60

Figure 86 Reverse Input Backing Plate Selection Chart



605	HOUSING & DRUM ASSEMBLY, REVERSE INPUT CLUTCH
607	PISTON ASM., REVERSE INPUT CLUTCH
609	SPRING ASM., REVERSE INPUT CLUTCH
610	RING, REVERSE INPUT CLUTCH SPRING RETAINER
611	PLATE, REVERSE INPUT CL. (BELLEVILLE)
612A	PLATE ASM., REVERSE INPUT CLUTCH (FIBER)
612B	PLATE, REVERSE INPUT CLUTCH (STEEL)
613	PLATE, REVERSE INPUT CLUTCH BACKING
614	RING, REVERSE INPUT CL. RETAINING

LH0145-4L60

Figure 87 Reverse Input Clutch

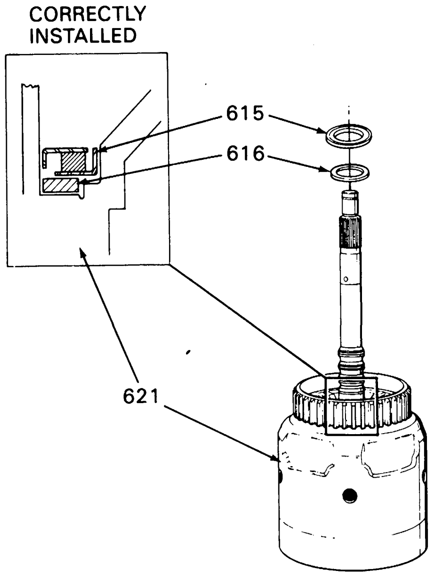
Reverse Input and Input Clutches

Figures 88, 89 and 90

Assemble

Figures 88 and 89

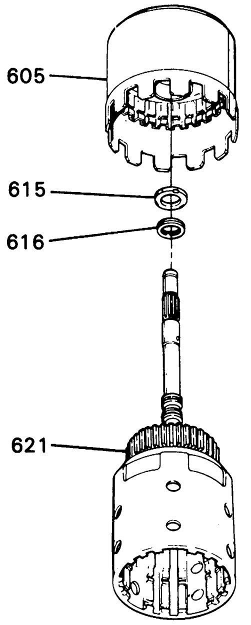
1. Selective thrust washer (616) onto the input housing
2. Bearing assembly (615)
   - Inside (black race) goes toward the oil pump.
3. Reverse input clutch assembly (605) onto the input clutch assembly
   - Index the reverse input clutch plates with the input clutch hub.
   - Make certain all clutch plates are fully engaged.



ILL. NO.	DESCRIPTION
615	BEARING ASSEMBLY, STATOR SHAFT/ SELECTIVE WASHER
616	WASHER, THRUST (SELECTIVE)
621	HOUSING & SHAFT ASSEMBLY, INPUT

LH0146-4L60

Figure 88 Thrust Bearing and Selective Washer Location



605	HOUSING & DRUM ASSEMBLY, REVERSE INPUT CLUTCH
615	BEARING ASSEMBLY, STATOR SHAFT/ SELECTIVE WASHER
616	WASHER, THRUST (SELECTIVE)
621	HOUSING & SHAFT ASSEMBLY, INPUT

LH0112-4L60

Figure 89 Reverse Input and Input Clutches

Assemble

Figure 90

- Reverse input and input clutch assembly into the transmission case
  - Index the 3-4 clutch plates with the input internal gear.
  - Make sure all clutch plates are fully engaged.
  - When properly assembled, the reverse input clutch housing will be located just below the case oil pump face.

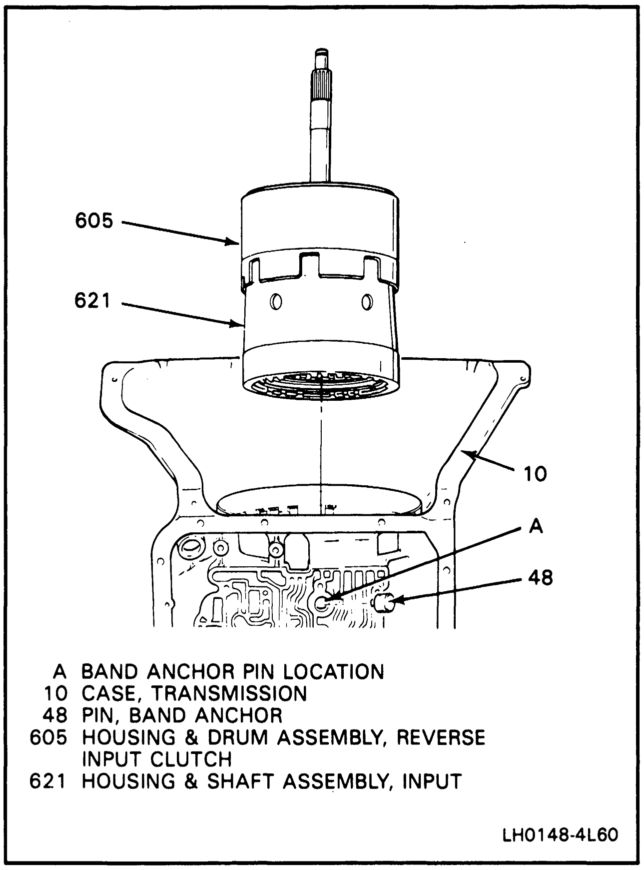


Figure 90 Installing Input Clutch

2-4 Band Assembly

Figures 90 and 91

Inspect

- 2-4 band assembly (602) for damage or wear

Assemble

Figures 90 and 91

1. Align the band anchor pin end with the case pin hole.
2. Band anchor pin (48) into the case.
   - Index the pin into the 2-4 band.

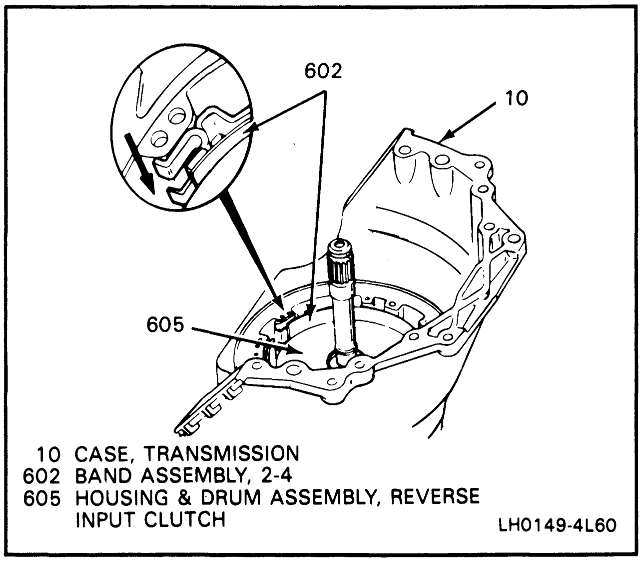


Figure 91 2-4 Band Assembly — Installed

Oil Pump Assembly

Figures 92 and 94

Remove or Disconnect

1. Thrust washer (601)
2. Pump cover to case gasket (9)
3. Pump to case oil seal (8)
4. Pump cover bolts (236)
5. Pump cover (217) from pump body (203)

Oil Pump Body

Figure 94

Disassemble

1. Pump slide spring (209)

CAUTION: Spring is under very high pressure. Place covering over spring to prevent possible injury.

- Compress with needle nose pliers.
- Pull straight out.

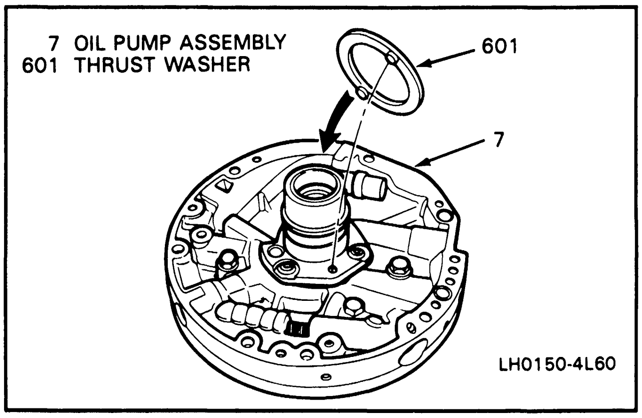


Figure 92 Oil Pump Thrust Washer Location

2. From the pump pocket
   - Pump guide rings (212)
   - Pump vanes (215)
   - Pump rotor (214)
   - Pump guide (213)
   - Slide (206)
   - Slide seal (211)
   - Seal support (210)
   - Pivot slide pin (208) and spring (207)
   - Slide seal ring (204) and slide back up seal (205)
3. Retainer (94), oil seal assembly (2)
   - Pry out with a screwdriver.

Oil Pump Cover

Figures 93, 94 and 97

Tool Required:

One inch micrometer

Disassemble

Figures 94 and 97

1. Converter clutch apply valve train
   - Compress converter clutch apply valve spring (228) with a screwdriver.
   - Remove retaining ring (225).
   - Slowly release the spring tension.
   - Stop valve (226), converter clutch apply valve (227), and two converter clutch valve springs.
2. Pressure relief ball (231)
   - Ball is under strong spring pressure.
   - Cover the ball with a cloth when removed.
3. Pressure regulator assembly (218-224)
   - Follow the same procedure used to remove the converter clutch valve.

Inspect

Figure 94

- Pressure regulator valve assembly (218-224) and converter clutch apply valve assembly (225-229) for:
  - Chips, burrs, distortion, plugged oil passage, and free movement in bore
  - Remove burrs with lapping compound.
- Pressure relief assembly (230-232) for damage or distortion
- Pump cover (217) and pump body (203) for:
  - Worn or damaged bushings (see Bushing Replacement Procedure)
  - Foreign material or debris
  - Porosity
  - Scored or irregular mating faces
  - Cross channel leaks
  - Ring groove damage
- Rotor (214) and slide (206) for cracks
- Oil seal assembly for damage or wear

Clean

- Wash and air dry all parts.

Important

- Do not wipe dry with a cloth.

OIL PUMP ROTOR SELECTION CHART

THICKNESS (mm)	THICKNESS (in.)
17.948 - 17.961	0.7066 - 0.7071
17.961 - 17.974	0.7071 - 0.7076
17.974 - 17.987	0.7076 - 0.7081
17.987 - 18.000	0.7081 - 0.7086
18.000 - 18.013	0.7086 - 0.7091

OIL PUMP SLIDE SELECTION CHART

THICKNESS (mm)	THICKNESS (in.)
17.948 - 17.961	0.7066 - 0.7071
17.961 - 17.974	0.7071 - 0.7076
17.974 - 17.987	0.7076 - 0.7081
17.987 - 18.000	0.7081 - 0.7086
18.000 - 18.013	0.7086 - 0.7091

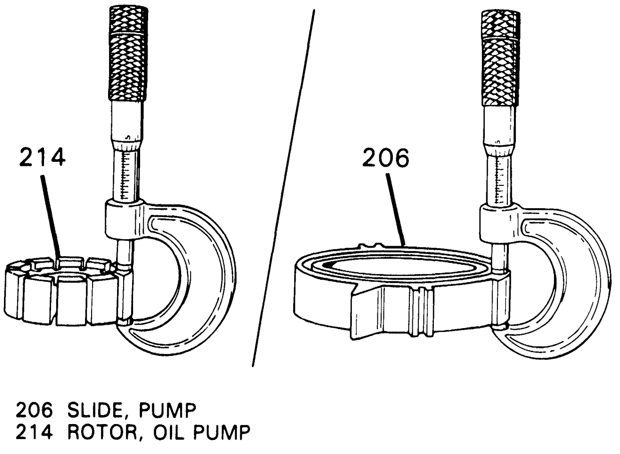
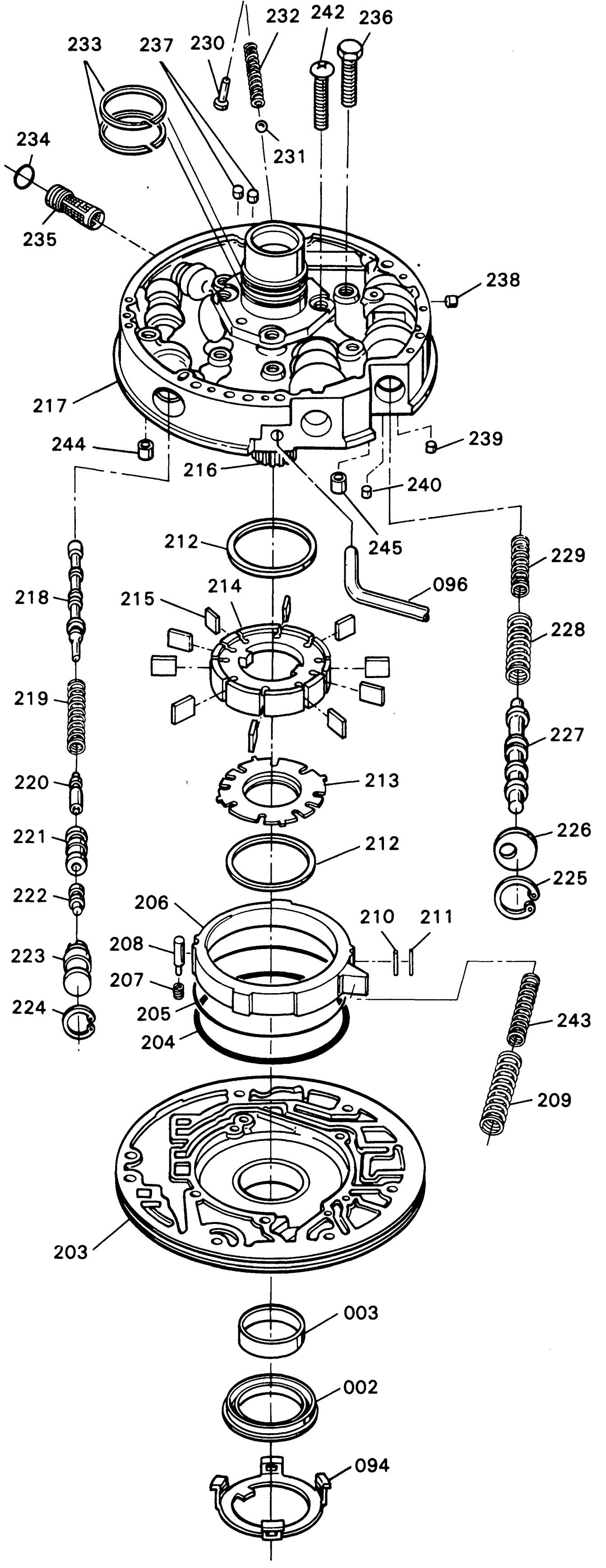


Figure 93 Oil Pump Rotor and Slide Selection



ILL. NO.	DESCRIPTION
002	SEAL ASSEMBLY, OIL
003	BUSHING, PUMP BODY
094	RETAINER, FRONT HELIX SEAL
096	TUBE, AUXILIARY ACCUMULATOR VALVE
203	BODY, PUMP
204	RING, OIL SEAL (SLIDE TO WEAR PLATE)
205	SEAL, "O" RING (SLIDE SEAL BACK-UP)
206	SLIDE, PUMP
207	SPRING, PIVOT PIN
208	PIN, PIVOT SLIDE
209	SPRING, PUMP SLIDE (OUTER)
210	SUPPORT, PUMP SLIDE SEAL
211	SEAL, PUMP SLIDE
212	RING, PUMP VANE
213	GUIDE, ROTOR
214	ROTOR, OIL PUMP
215	VANE, PUMP
216	SHAFT, STATOR
217	COVER, PUMP
218	VALVE, PRESSURE REGULATOR
219	SPRING, PRESSURE REGULATOR VALVE
220	VALVE, REVERSE BOOST
221	SLEEVE, REVERSE BOOST VALVE
222	VALVE, T.V. BOOST
223	BUSHING, T.V. BOOST
224	RING, OIL PUMP REVERSE BOOST VALVE RETAINING
225	RING, OIL PUMP CONVERTER CLUTCH VALVE RETAINING
226	VALVE, STOP
227	VALVE, CONVERTER CLUTCH
228	SPRING, CONVERTER CLUTCH VALVE (OUTER)
229	SPRING, CONVERTER CLUTCH VALVE (INNER)
230	RIVET, PRESSURE RELIEF BOLT
231	BALL, PRESSURE RELIEF
232	SPRING, PRESSURE RELIEF
233	RING, OIL SEAL (STATOR SHAFT)
234	SEAL, OIL PUMP COVER SCREEN
235	SCREEN, OIL PUMP COVER
236	BOLT, M8 x 1.25 x 40 (COVER TO BODY)
237	PLUG, OIL PUMP AIR BLEED
238	PLUG, OIL PUMP COVER
239	PLUG, OIL PUMP COOLER FEED
240	PLUG, OIL PUMP CONVERTER CLUTCH SIGNAL
242	SCREW, STATOR SHAFT (M6 x 1 x 16.0)
243	SPRING, PUMP SLIDE (INNER)
244	RETAINER & BALL ASSEMBLY, (REVERSE CLUTCH)
245	RETAINER & BALL ASSEMBLY, (OVERRUN CLUTCH)

LH0152-4L60

Figure 94 Oil Pump Assembly

Measure

Figure 93

- Oil pump rotor (214) thickness
- Oil pump slide (206) thickness

Important

- Measurement of rotor/slide must be made on undamaged surfaces. Select similar size replacements. Lightly hone both sides of replacement rotor or slide to remove any nicks or burrs.

Oil Pump Body

Figures 94, 95 and 96

Tool Required:

Assemble

J 25016 Seal Installer

1. O-ring seal (205) and oil seal ring (204) into the groove on the back side of the slide
   - Retain with TRANSJEL™ J 36850 or equivalent.
2. Pivot pin spring (207) and pivot pin (208) into the pump body
3. Slide (206)
   - Index the notch in the slide with the pivot pin.
   - The oil seal ring must face downward into the pump pocket.
4. Slide seal (211) and support (210)
5. Vane guide ring (212)
6. Rotor guide (213) onto the rotor
   - Retain with TRANSJEL™ J 36850 or equivalent.
7. Rotor (214)
   - With guide toward the pump pocket
8. Vanes (215)
9. Vane guide ring (212)
10. Pump slide spring (209)
11. Oil seal assembly (2), retainer (94)
    - Use J 25016.

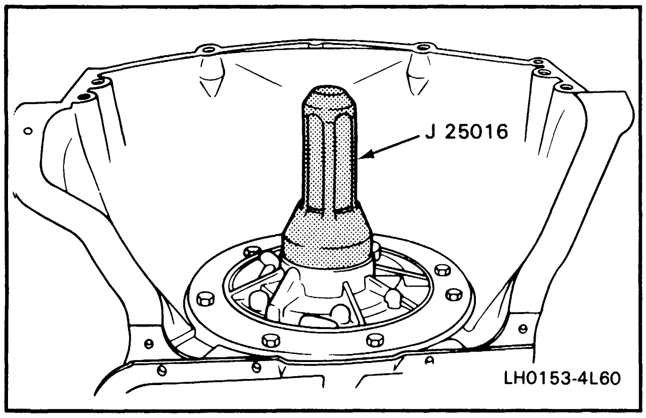


Figure 95 Oil Pump Seal

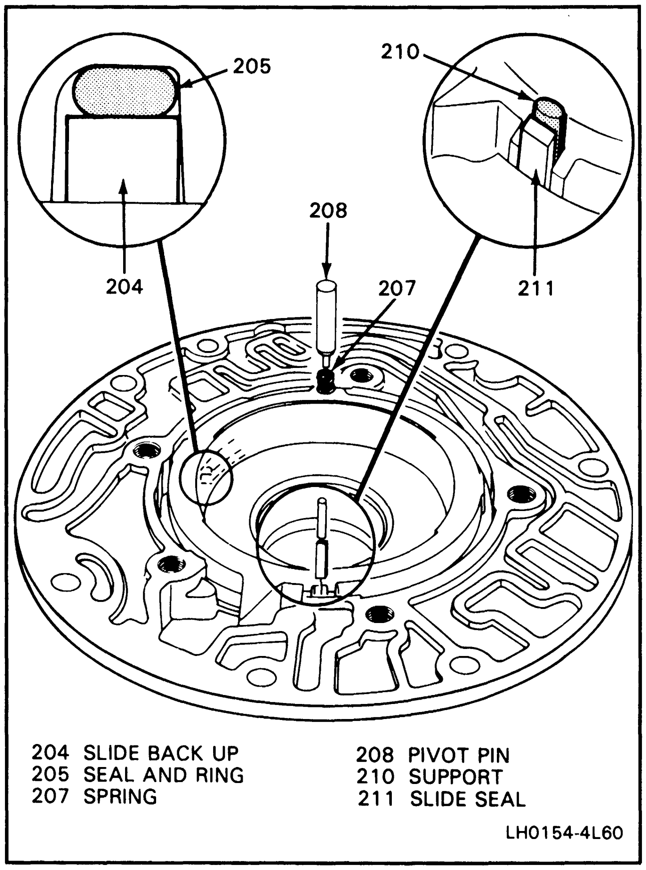


Figure 96 Slide Back Up and Slide Seal

Oil Pump Cover

Figure 94

Assemble

1. Pressure relief ball (231), spring (232) and rivet (230)
2. Inner (229) and outer (228) converter clutch valve springs into the converter clutch valve bore
3. Converter clutch valve (227)
4. Stop valve (226)
5. Retaining ring (225)
6. Pressure regulator valve (218) into the pressure regulator bore
7. Pressure regulator valve spring (219)

8. T.V boost valve (222) onto the T.V. bushing
   - Long land of the valve into the large hole of the bushing
   - Retain with TRANSJEL™ J 36850 or equivalent.
9. Reverse boost valve (220) into the reverse boost valve sleeve
   - Small end of the valve first
   - Retain with TRANSJEL™ J 36850 or equivalent.
10. Reverse boost valve sleeve (221) into the pressure regulator bore
11. T.V. boost valve sleeve (223) into the pressure regulator bore
12. Retainer ring (224)

Oil Pump Cover and Body

Figures 94 and 98 through 101

Tools Required:

J 21368 Oil Pump Body and Cover Alignment Band

J 25025-1 Alignment Pins

Assemble

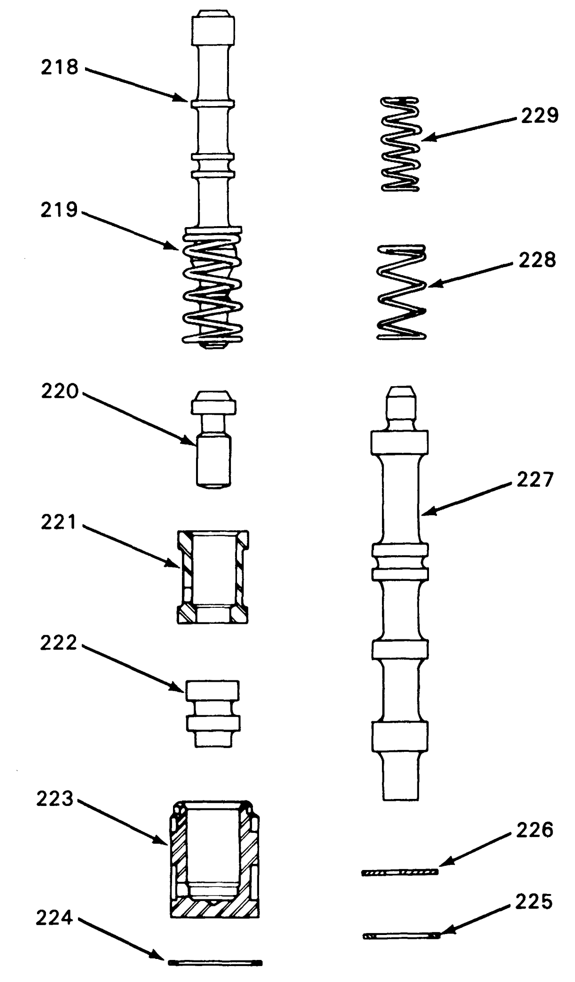
Figures 94, 98, 99 and 100

1. Oil pump cover (217) onto oil pump body
   - Stator shaft through a bench hole
2. Pump cover bolts (236)
   - Leave finger tight.
3. Align pump cover and pump body with J 21368.
   - Place a screwdriver through a bolt hole and into a hole in the bench.

Tighten

- Torque attaching bolts to 22 N·m (16 lb. ft.)

4. Pump to case gasket (9) onto case
   - Retain with TRANSJEL™ J 36850 or equivalent.
5. Oil seal rings (233), if removed previously, onto the pump cover hub
   - Retain with TRANSJEL™ J 36850 or equivalent.
6. Pump to case oil seal (8)
   - Do not twist the seal.
   - Lubricate with TRANSJEL™ J 36850 or equivalent.
7. Thrust washer (601)



ILL. NO.	DESCRIPTION
218	VALVE, PRESSURE REGULATOR
219	SPRING, PRESSURE REGULATOR VALVE
220	VALVE, REVERSE BOOST
221	SLEEVE, REVERSE BOOST VALVE
222	VALVE, T.V. BOOST
223	BUSHING, T.V. BOOST
224	RING, OIL PUMP REVERSE BOOST VALVE RETAINING
225	RING, OIL PUMP CONVERTER CLUTCH VALVE RETAINING
226	VALVE, STOP
227	VALVE, CONVERTER CLUTCH
228	SPRING, CONVERTER CLUTCH VALVE (OUTER)
229	SPRING, CONVERTER CLUTCH VALVE (INNER)

LH0155-4L60

Figure 97 Pressure Regulator and Converter Clutch Apply Valve Trains

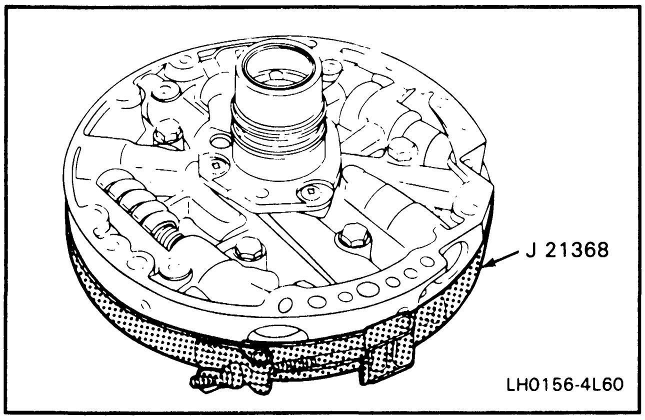


Figure 98 Oil Pump Alignment Band

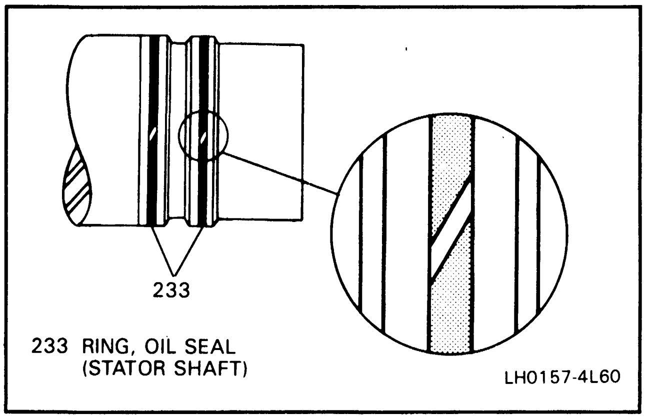


Figure 99 Oil Pump Hub Seal Rings

Install or Connect

Figure 101

1. J 25025-1 into the case as shown
2. Oil pump assembly into the case
    - Align all holes properly.
3. Bolts and O-rings (5 and 6)

Tighten

- Torque to 22 N·m (16 lb. ft.)

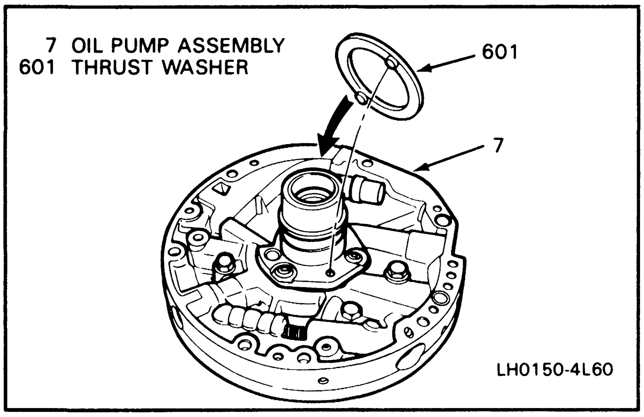


Figure 100 Oil Pump Thrust Washer

Important

- Rotate the transmission to a horizontal position. If the transmission is assembled properly the turbine shaft should turn by hand. If not identify and correct the misassembly now.

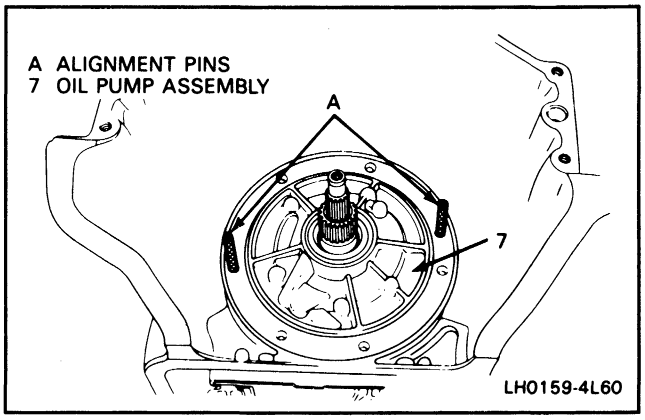


Figure 101 Oil Pump and Case

Transmission End Play Check

Figures 102 through 106 and 109, 110 and 111

Tools Required:

J 24773-A End Play Checking Fixture

J 25022 End Play Checking Fixture Adaptor (245 mm)

J 34725 End Play Checking Fixture Adaptor (298 mm)

J 25025-7A Post or 278 mm (11 in.) Bolt and Nut

Dial indicator

Measure

Figures 102 through 105

1. Remove an oil pump to case bolt and install a 278 mm (11 in.) bolt and lock nut or J 25025-7A.
2. Install J 25022-A or J 34725 as shown.
3. Install J 24773-A as shown.
4. Install a dial indicator.
    - Set to zero.
5. Pull up on J 24773-A.
    - End play should be 0.13 - 0.92 mm (.005" - .036").

The selective washer which controls end play is located between the input housing and the thrust bearing on the oil pump hub. If more or less end play is required, select the proper washer from the chart and install. If dial indicator shows no end play, the selective washer and thrust bearing have been misassembled.

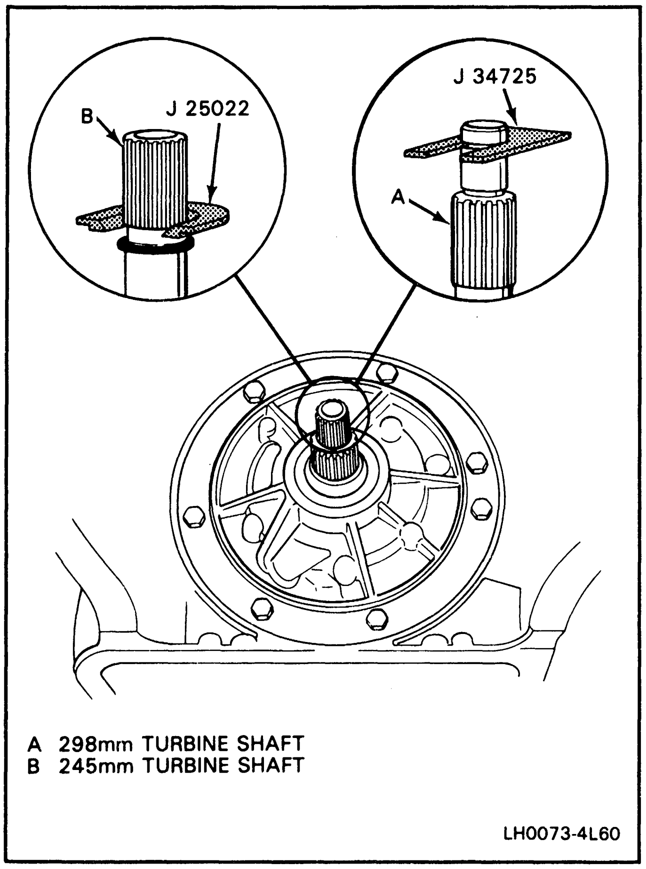


Figure 102 End Play Tool

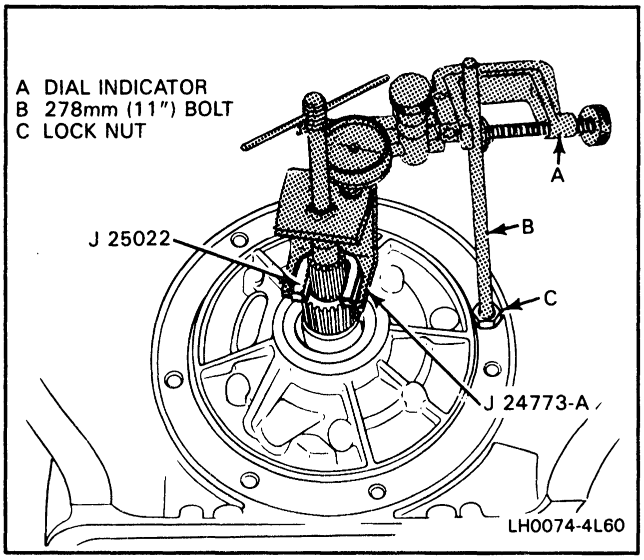


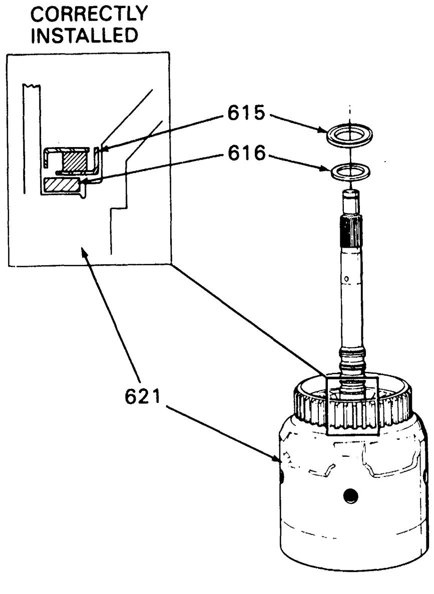
Figure 103 J 25022-A Installed

TRANSMISSION END PLAY WASHER SELECTION CHART

WASHER THICKNESS		I.D.
1.87 - 1.97 mm	(.074" - .078")	67
2.04 - 2.14 mm	(.080" - .084")	68
2.21 - 2.31 mm	(.087" - .091")	69
2.38 - 2.48 mm	(.094" - .098")	70
2.55 - 2.65 mm	(.100" - .104")	71
2.72 - 2.82 mm	(.107" - .111")	72
2.89 - 2.99 mm	(.113" - .118")	73
3.06 - 3.16 mm	(.120" - .124")	74

LH0162-4L60

Figure 104 End Play Chart



ILL. NO.	DESCRIPTION
615	BEARING ASSEMBLY, STATOR SHAFT/ SELECTIVE WASHER
616	WASHER, THRUST (SELECTIVE)
621	HOUSING & SHAFT ASSEMBLY, INPUT

LH0146-4L60

Figure 105 Selective Washer and Thrust Bearing Properly Installed

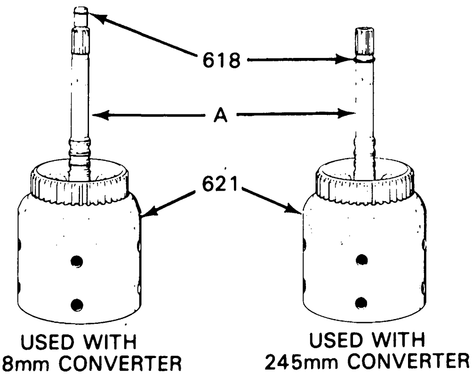
Assemble

Figure 106

- O-ring seal (618) into the groove in the end of the turbine shaft.

Important

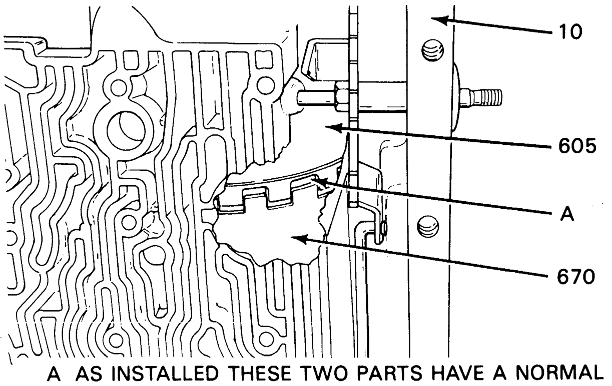
- There should be clearance between the reverse input clutch and the reaction sun gear shell. This clearance can be observed at the point shown in Figure 108. **Do not** try to shim the internal parts because of this clearance (Figure 107).



A SHAFT, TURBINE
618 SEAL, "O" RING (TURBINE SHAFT/ SELECTIVE WASHER)
621 HOUSING & SHAFT ASSEMBLY, INPUT

LH0117-4L60

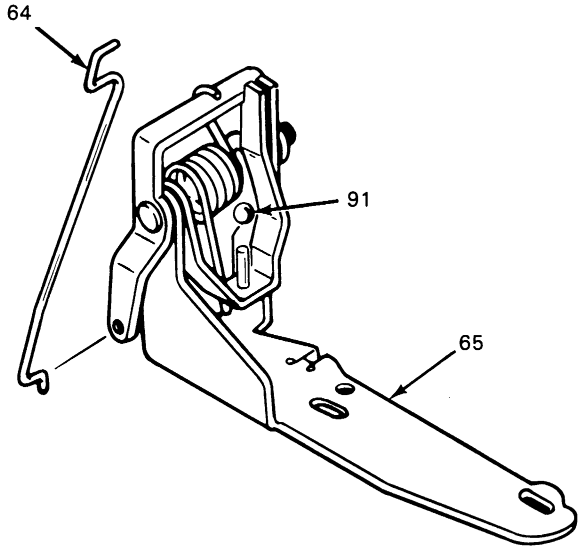
Figure 106 Turbine Shaft O-Ring Seal



A AS INSTALLED THESE TWO PARTS HAVE A NORMAL END CLEARANCE OF APPROX. 3.8MM (.150 IN.)
10 CASE, TRANSMISSION
605 HOUSING & DRUM ASSEMBLY, REVERSE INPUT CLUTCH
670 SHELL, REACTION SUN

LH0165-4L60

Figure 107 Clearance Between Reverse Input Clutch and the Sun Gear Shell



64 THROTTLE LINK
65 LEVER AND BRACKET ASSEMBLY, THROTTLE
91 BALL, CARBON STEEL – T.V. EXHAUST (LOCATED IN VALVE BODY)

LH0166-4L60

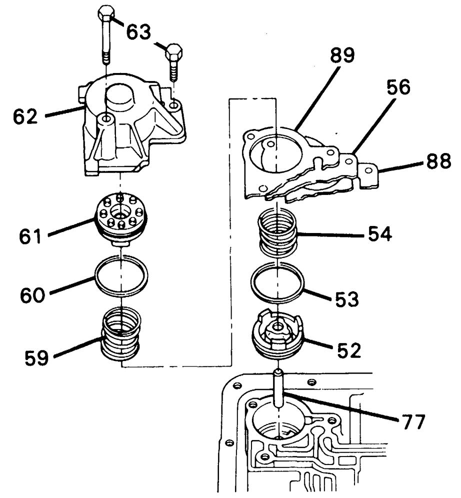
Figure 108 Throttle Lever and Bracket Assembly

Inspect

Figures 109, 110 and 111

- The 1-2 accumulator cover and pin assembly (62) for:
  - Porosity or damage
  - Scored piston wall
  - Plugged oil passage
- 1-2 accumulator piston (61) and the 3-4 accumulator piston (52) for:
  - Porosity
  - Ring groove damage
  - Pin hole damage

- 1-2 accumulator spring (59) and 3-4 accumulator spring (54) for distortion or damage
- Spacer plate (56) and gaskets (88 and 89) for damage
- Checkballs (55) for damage
- T.V. link (64) for damage
- Manual detent spring (709) for damage
- Oil filter (71) for:
  - Cut or damaged filter seal (70)
  - Cracks in the neck or body
  - Casting flash in the neck
- Solenoid assembly (50) for:
  - Damage
  - Cut or pinched wires
  - Damaged connectors
  - Cut or damaged O-ring (49)



52 PISTON, 3-4 ACCUMULATOR
53 RING, OIL SEAL (3-4 ACCUMULATOR PISTON)
54 SPRING, 3-4 ACCUMULATOR
56 PLATE, VALVE BODY SPACER
59 SPRING, 1-2 ACCUMULATOR
60 RING, OIL SEAL (1-2 ACCUM. PISTON)
61 PISTON, 1-2 ACCUMULATOR
62 COVER & PIN ASSEMBLY, 1-2 ACCUM.
63 BOLT, ACCUMULATOR COVER
77 PIN, ACCUMULATOR PISTON
88 GASKET, SPACER PLATE TO CASE
89 GASKET, SPACER PLATE TO VALVE BODY

LH0066-4L60

Figure 109 Accumulator Assembly

Valve Body and Associated Parts

NOTICE: The use of a honing stone, fine sandpaper or crocus cloth is not recommended for servicing stuck valves. All valve lands have sharply machined corners that are necessary for "cleaning" the bore. If these corners are rounded, foreign material could wedge between the valve and bore causing the valve to stick.

If it is found necessary to clean a valve, "micro fine" lapping compound 900 grit or finer should be used.

Too much "lapping" of a valve will cause excessive clearances and increase the chance of a valve not operating.

Figures 109 and 111

Tool Required:

J 25025-5 Guide Pins

1991 MODELS	1-2 ACCUMULATOR SPRING COLOR	3-4 ACCUMULATOR SPRING COLOR
CHM, CJM, KCM, RAM, WCM	ORANGE, LT. GREEN, WHITE OR PLAIN	VIOLET
CAM, CBM, KAM, MJM, MNM, WAM	ORANGE, LT. GREEN, WHITE OR PLAIN	DK. GREEN
CCM, CFM, FTM, KBM, LAM, LBM, LCM, LDM, LFM, WBM	ORANGE, LT. GREEN, WHITE OR PLAIN	RED
FUM	YELLOW	YELLOW
HCM, MBM, SAM, SFM	YELLOW	RED
SHM, TLM	DK. GREEN	LT. BLUE
FZM	YELLOW	VIOLET
HBM, HFM, HHM	DK. GREEN	YELLOW
FBM, HDM	DK. GREEN	RED
AAM, ABM	ORANGE, LT. GREEN, WHITE OR PLAIN	ORANGE, LT. GREEN, WHITE OR PLAIN
YDM	YELLOW	ORANGE, LT. GREEN, WHITE OR PLAIN
MSM	ORANGE, LT. GREEN, WHITE OR PLAIN	YELLOW
BBM, BCM, BFM, CWM	DK. GREEN	ORANGE, LT. GREEN, WHITE OR PLAIN

MH0168-4L60

Figure 110 1-2 and 3-4 Accumulator Spring Chart

Install or Connect

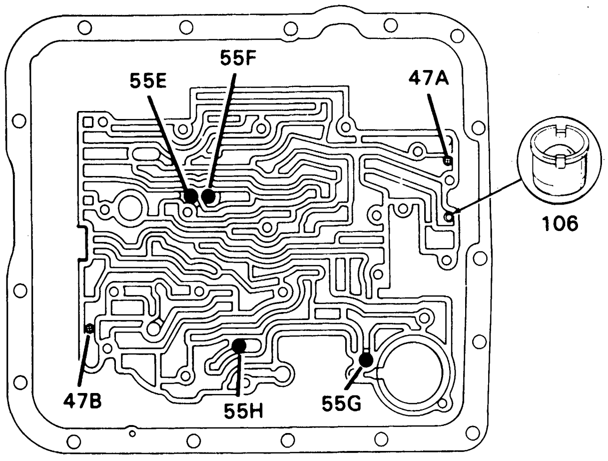
Figure 109

1. The 3-4 accumulator pin (77) into the case
2. The 3-4 accumulator piston seal (53) onto the 3-4 accumulator piston
3. The 3-4 accumulator piston (52) onto the pin
   - The end with three legs must face the valve body.
4. The 3-4 accumulator piston spring (54)

Install or Connect

Figure 111

1. Governor and converter clutch oil screens (47)



ILL. NO.	DESCRIPTION
47A	GOVERNOR FILTER LOCATION
47B	CONVERTER CLUTCH FILTER LOCATION
55E	#4 CHECK BALL (3-4 CLUTCH/3-2 EX.)
55F	#8 CHECK BALL (2ND/1-2)
55G	#1 CHECK BALL (4TH ACCUMULATOR)
55H	#3 CHECK BALL (PART THROTTLE/DRIVE 3)
106	RETAINER & BALL ASM. (DOUBLE ORIFICE)

LH0072-4L60

Figure 111 Case Checkballs and Oil Screens — Location

2. Four checkballs (55) into the case as shown
   - Retain with TRANSJEL ™ J 36850 or equivalent.
3. J 25025-5 into the case
4. Spacer plate to case gasket (88)
   - Gasket identified by a "C"
5. Spacer plate (56)
6. Valve body to spacer plate gasket (89)
   - Gasket identified by a "V"

Control Valve Assembly

Figures 112, 113 and 115

Clean

- Control valve assembly (67) thoroughly in clean solvent
  - Move the valves with a pick or small screwdriver to dislodge any dirt or debris that may have accumulated
  - Air dry.

Disassemble

Figure 112

Position as shown on a clean surface.

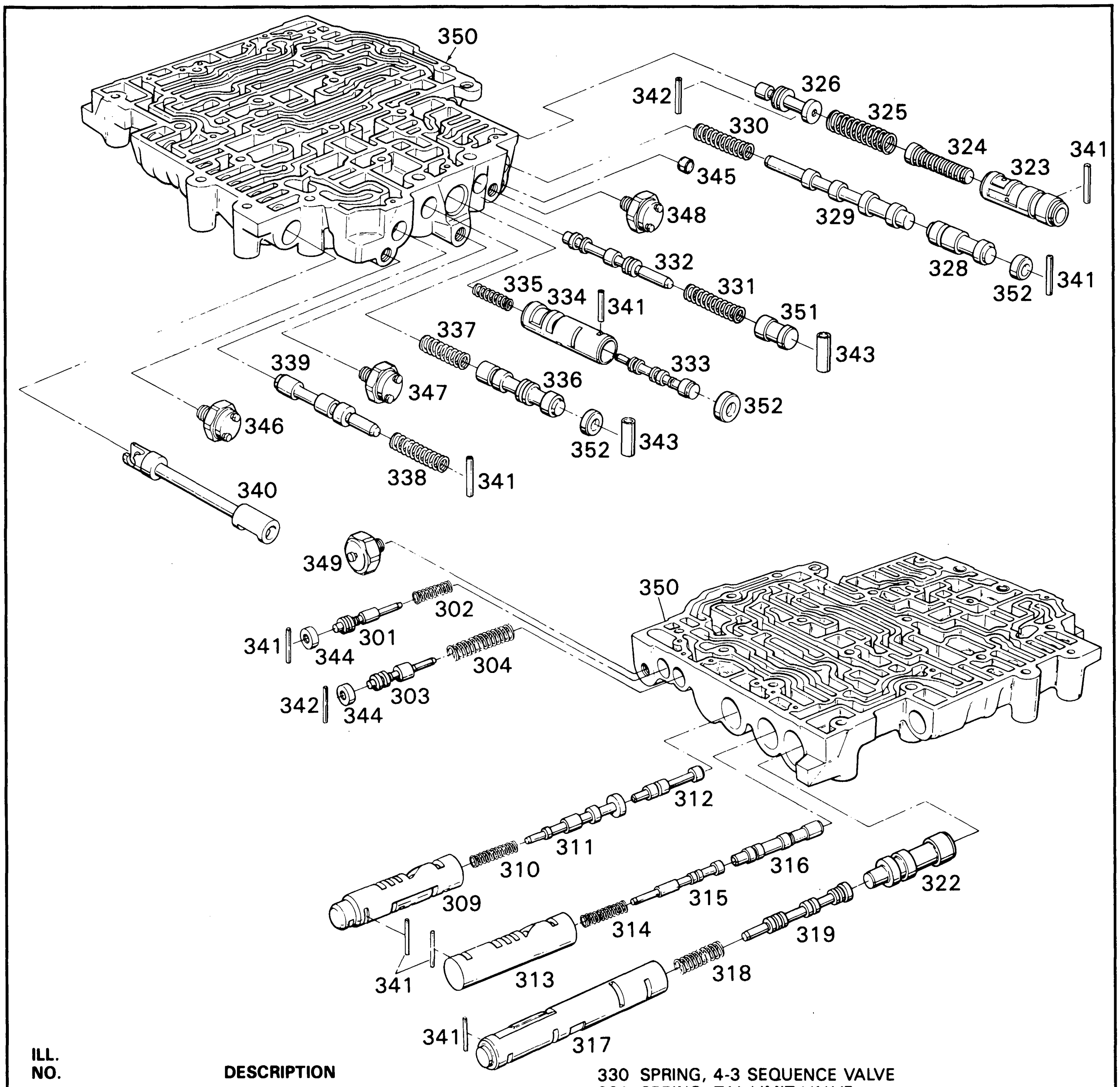
- Valve trains beginning with the upper left hand corner

  Important

  - Some valves are under pressure — cover the bores while removing the roll pins.
  - Valves, springs and bushings must be laid out on a clean surface in the exact sequence they are removed.
- Blind hole roll pins with a modified drill bit
- Pressure switches

Clean

- All valves, springs, bushings and control valve body in clean solvent
- Dry using compressed air.



ILL. NO.	DESCRIPTION
301	VALVE, T.V. MODULATOR DOWNSHIFT
302	SPRING, T.V. MODULATOR DOWNSHIFT VALVE
303	VALVE, T.V. MODULATOR UPSHIFT
304	SPRING, T.V. MODULATOR UPSHIFT VALVE
309	SLEEVE, 3-4 THROTTLE VALVE
310	SPRING, 3-4 THROTTLE VALVE
311	VALVE, 3-4 THROTTLE
312	VALVE, 3-4 SHIFT
313	SLEEVE, 2-3 THROTTLE VALVE
314	SPRING, 2-3 THROTTLE VALVE
315	VALVE, 2-3 THROTTLE
316	VALVE, 2-3 SHIFT
317	SLEEVE, 1-2 THROTTLE VALVE
318	SPRING, 1-2 THROTTLE VALVE
319	VALVE, 1-2 THROTTLE
322	VALVE, 1-2 SHIFT
323	SLEEVE, THROTTLE VALVE PLUNGER
324	PLUNGER, THROTTLE VALVE
325	SPRING, THROTTLE VALVE
326	VALVE, THROTTLE
328	VALVE, 3-4 RELAY
329	VALVE, 4-3 SEQUENCE
330	SPRING, 4-3 SEQUENCE VALVE
331	SPRING, T.V. LIMIT VALVE
332	VALVE, T.V. LIMIT
333	VALVE, 1-2 ACCUMULATOR
334	SLEEVE, 1-2 ACCUMULATOR VALVE
335	SPRING, 1-2 ACCUMULATOR VALVE
336	VALVE, LINE BIAS
337	SPRING, LINE BIAS VALVE
338	SPRING, 3-2 CONTROL
339	VALVE, 3-2 CONTROL
340	VALVE, MANUAL
341	PIN, COILED SPRING
342	PIN, COILED SPRING
343	RETAINER, SPRING (SLEEVE)
344	PLUG, VALVE BORE
345	PLUG, CUP (.33 DIA.)
346	SWITCH ASM., PRESSURE (3RD CLUTCH)
347	SWITCH ASM., PRESSURE (4-3 PULSE)
348	SWITCH ASM., PRESSURE (4TH CLUTCH)
349	SWITCH ASM., PRESSURE (T.C.C. SIGNAL)
350	BODY, CONTROL VALVE
351	PLUG, T.V. LIMIT
352	PLUG, VALVE BORE (12.5 - O.D.)

LH0170-4L60-R1

Figure 112 Control Valve Assembly

Inspect

- All valves and bushings for:
  - Porosity
  - Scoring
  - Nicks
  - Scratches
- Springs for damaged or distorted coils
- Valve body casting for:
  - Porosity
  - Cracks
  - Interconnected oil passages
  - Damaged machined surfaces

Assemble

Figure 112

- Control valve assembly (67) exactly as shown.
  - Notice the position of the valve lands and bushing passages.

Install or Connect

Figures 113 and 115

1. Three checkballs (55A), (55C), and (91) into the valve body assembly. Checkball (91) is the larger copper colored ball.
   - Retain with TRANSJEL ™ J 36850 or equivalent.
2. Valve body assembly (67)
   - Connect the manual valve link (705) to the inside detent lever (703).

Auxiliary Accumulator Valve Body Assembly

Figures 108, 109, 114, 117, 118 and 119

Tools Required:

#3 Screw Extractor
9.5 mm (3/8 in.) rod

Clean

Figure 114

- Auxiliary valve assembly (377) thoroughly in clean solvent
  - Move the valves with a pick or small screwdriver to dislodge any dirt or debris that may have accumulated.
  - Air dry.

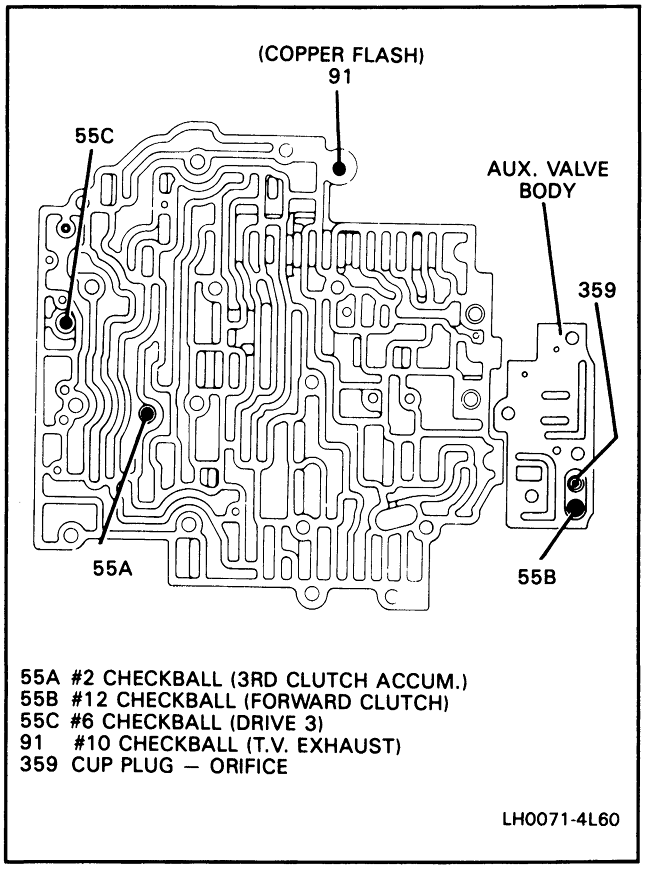


Figure 113 Valve Body Checkball Locations

Disassemble

Figure 114

1. (3) Bolts (373)
2. Cover (371) and accumulator piston spring (370)

Important

- Cover (371) is under spring pressure.

3. Piston (367)
4. Piston oil seal ring (53)

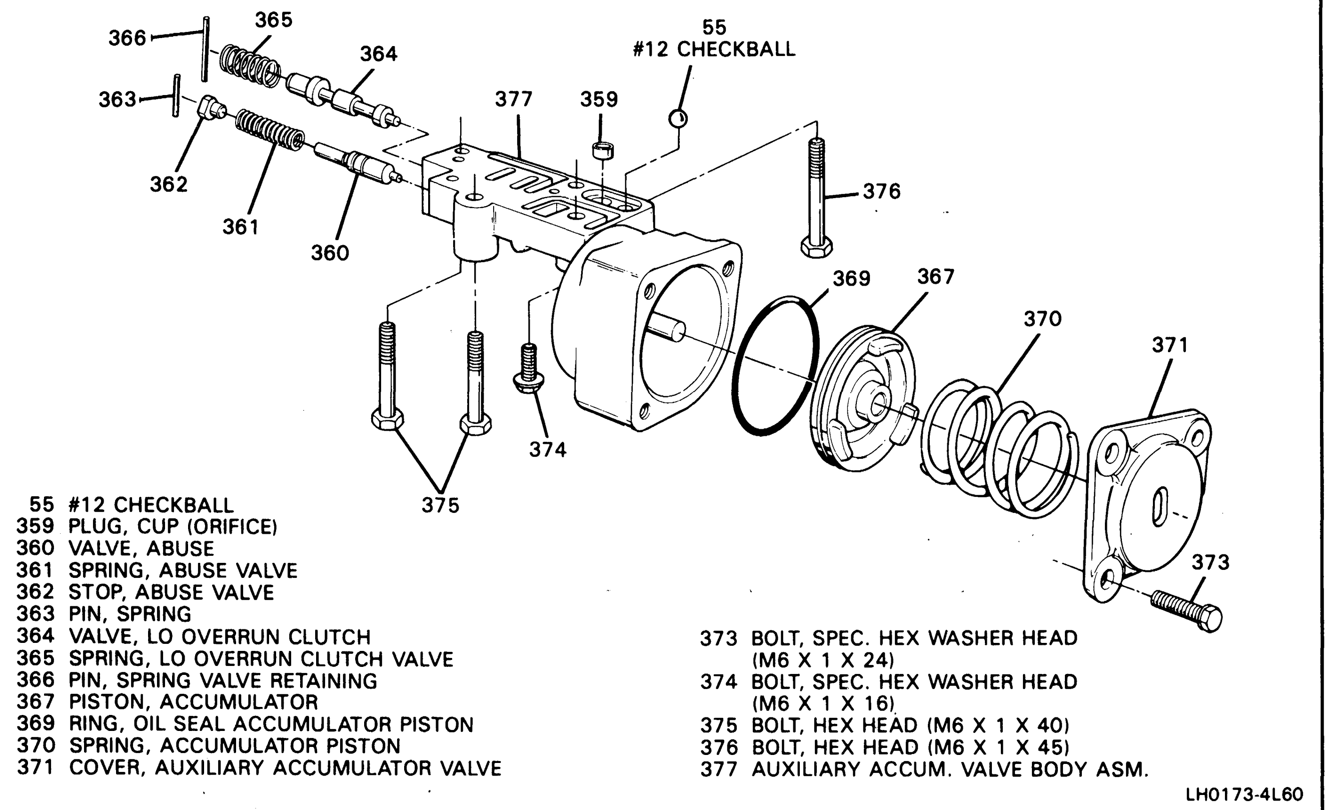
Disassemble

Figure 114

Position the auxiliary accumulator valve body on a clean surface. Remove valve trains beginning with the lower left hand corner. NOTE: valves are under pressure-cover bores while removing the roll pin.

Important

- Valves and springs must be laid out on a clean surface in the exact sequence as they are removed.



55	#12 CHECKBALL
359	PLUG, CUP (ORIFICE)
360	VALVE, ABUSE
361	SPRING, ABUSE VALVE
362	STOP, ABUSE VALVE
363	PIN, SPRING
364	VALVE, LO OVERRUN CLUTCH
365	SPRING, LO OVERRUN CLUTCH VALVE
366	PIN, SPRING VALVE RETAINING
367	PISTON, ACCUMULATOR
369	RING, OIL SEAL ACCUMULATOR PISTON
370	SPRING, ACCUMULATOR PISTON
371	COVER, AUXILIARY ACCUMULATOR VALVE
373	BOLT, SPEC. HEX WASHER HEAD (M6 X 1 X 24)
374	BOLT, SPEC. HEX WASHER HEAD (M6 X 1 X 16)
375	BOLT, HEX HEAD (M6 X 1 X 40)
376	BOLT, HEX HEAD (M6 X 1 X 45)
377	AUXILIARY ACCUM. VALVE BODY ASM.

Figure 114 Auxiliary Valve Body Assembly

Clean

- All valves and springs in clean solvent
- Air dry.

Inspect

- Piston (367) for:
  - Cracks
  - Porosity
  - Damage
- Valves for:
  - Scoring
  - Nicks
  - Scratches
- Springs for damaged or distorted coils
- Auxiliary valve body (377) for:
  - Porosity
  - Damaged machined surfaces
- Orifice cup plug (359).
  - Replace only if damaged

Remove or Disconnect

- Orifice cup plug (359). Use modified #3 screw extractor.

Install or Connect

- Orifice cup plug (359). Use 9.5 mm (3/8 in.) rod.
  - Seat flush

Assemble

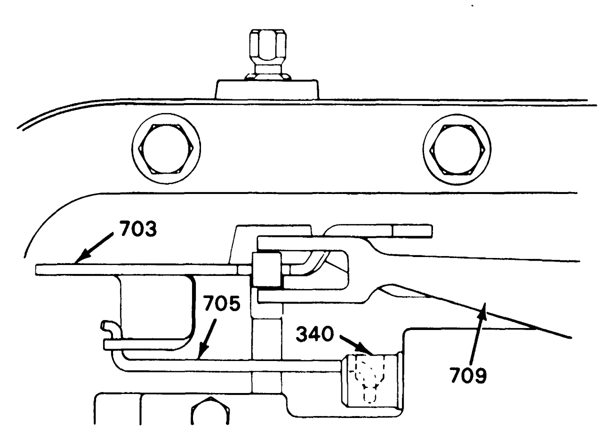
Figure 114

- Auxiliary accumulator valve train exactly as shown. Notice the valve lands.

Assemble

Figure 114

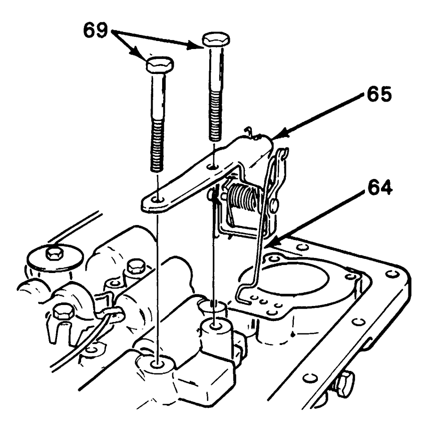
1. Piston oil seal ring (369) onto piston (367)
   - Lubricate with TRANSJEL™ J 36850 or equivalent.
2. Piston (367)
3. Accumulator spring (370)
4. Cover (371) and (3) bolts (373)



340 VALVE, MANUAL
703 LEVER, DETENT (INNER)
705 LINK, MANUAL VALVE
709 SPRING ASSEMBLY, MANUAL DETENT

LH0067-4L60

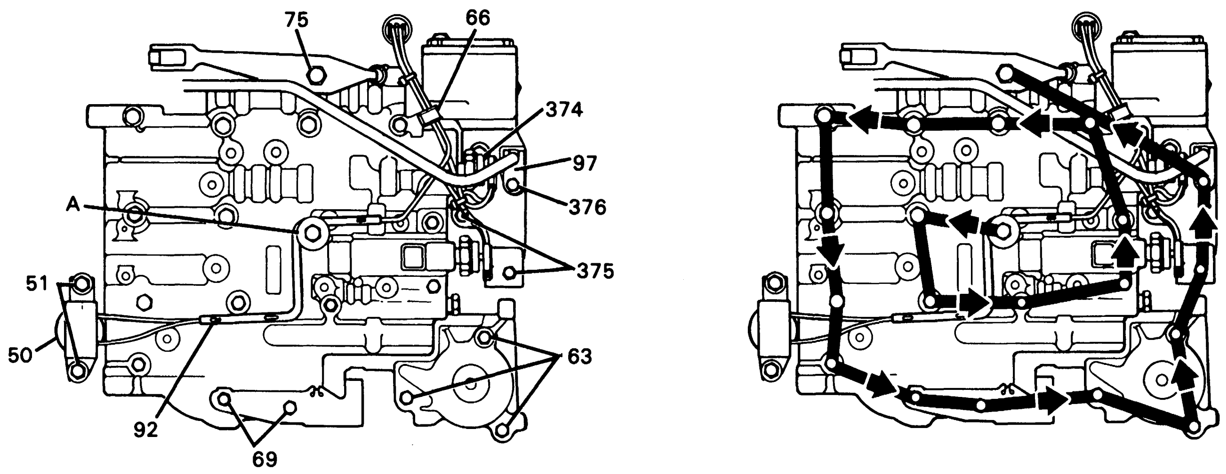
Figure 115 Manual Valve Link



64 LINK, THROTTLE LEVER TO CABLE
65 LEVER & BRACKET ASSEMBLY, THROTTLE
69 BOLTS, CONTROL VALVE ASSEMBLY

LH0068-4L60

Figure 116 T.V. Lever and Bracket



A WASHER WIRE RETAINER
50 SOLENOID ASSEMBLY
51 BOLT, HEX WASHER HEAD (SOLENOID)
63 BOLT, ACCUMULATOR COVER
66 CLIP, ELECTRICAL WIRE
69 BOLT, VALVE BODY
75 BOLT, MANUAL DETENT SPRING
92 CONDUIT, SOLENOID WIRE
97 CLAMP, AUXILIARY TUBE
374 BOLT, SPEC. HEX WASHER HEAD (M6 X 1 X 18)
375 BOLT, HEX HEAD (M6 X 1 X 35)
376 BOLT, HEX HEAD (M6 X 1 X 45)

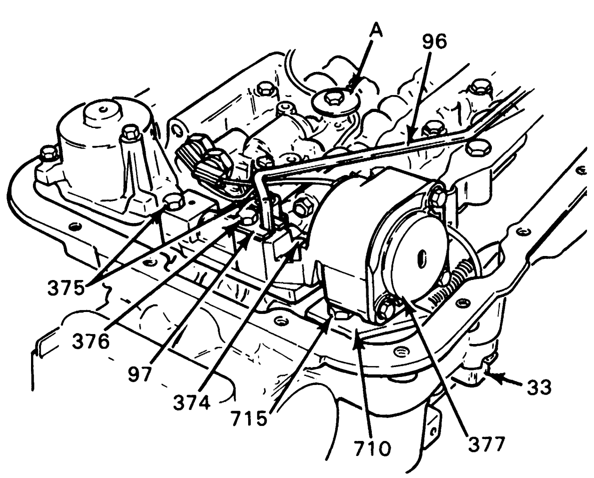
MH0211-4L60

Figure 117 Valve Body Bolt Locations

Install or Connect

Figures 114, 117 and 118

1. Check ball (55B) into auxiliary accumulator valve body (377) as shown in Figure 114.
   - Do not block orifice cup plug.
   - Retain with TRANSJEL ™ J 36850 or equivalent.
2. Auxiliary valve body (377)
3. Bolts (374) and (375) finger tight
4. Auxiliary accumulator valve tube (96)
5. Bolt (376) with tube clamp (97) finger tight



ILL. NO.	DESCRIPTION
A	WASHER, WIRE RETAINING
33	CONNECTOR, ELECTRICAL
96	TUBE, AUXILIARY ACCUMULATOR VALVE
97	CLAMP, AUXILIARY TUBE
374	BOLT, SPECIAL HEX HEAD (M6 X 1 X 16)
375	BOLT, HEX HEAD (M6 X 1 X 35)
376	BOLT, HEX HEAD (M6 X 1 X 45)
377	AUXILIARY ACCUM. VALVE BODY ASM.
710	BRACKET, PARKING LOCK
715	BOLT, PARKING LOCK BRACKET

LH0069-4L60

Figure 118 Outside Electrical Connector

Inspect

Figure 108

- Throttle lever and bracket assembly (65) for:
  - Sticking, binding or damage
- Make sure it operates freely.
- Replace if necessary.

Install or Connect

Figures 116, 117 and 118

1. T.V. link (64) onto the T.V. lever and bracket as shown
2. T.V. lever and bracket assembly (65) onto the valve body as shown
   - Attach with two valve body to case bolts (69).
3. Wire harness clips (66), manual spring assembly (68), wire retaining washer, and all remaining valve body to case bolts (69)

   NOTICE: Torque valve body bolts in a spiral pattern starting from the center. If bolts are torqued at random, valve bores may be distorted and inhibit valve operation.

   Tighten

   - Torque to 11 N·m (98 lb. in.)
4. O-ring seal (34) onto the electrical connector (33).
   - Lubricate with TRANSJEL ™ J 36850 or equivalent.
5. Electrical connector (33) into the case
6. O-ring seal (49) on the solenoid assembly (50)
7. Solenoid assembly (50) into the case
   - Attach with two solenoid bolts (51).

   Tighten

   - Torque to 11 N·m (98 lb. in.)

To correctly route and hook up the wires, see the wiring diagrams in the 700-R4 diagnosis section.

The wire connectors are color coded to correspond to the information in the wiring diagram. On switches which take two connectors, the terminals are reversible. It will be necessary to identify and use the wiring diagram chart which corresponds to the model you are working on. (See the Diagnosis Section for the wiring diagrams.)

Install or Connect

Figures 109, 116 and 117

1. Parking bracket (710)

   Tighten

   - Torque to 22 N·m (16 lb. ft.)
2. The 1-2 accumulator piston seal (60) onto the 1-2 accumulator piston (61)

3. The 1-2 accumulator piston (61) into the 1-2 accumulator cover and pin assembly (62)
   - The three legs on the piston must face up toward the case when installed.
4. The 1-2 accumulator spring (59) onto the piston
5. The 1-2 accumulator cover and pin assembly (62) onto the case

Tighten

- Torque to 11 N·m (98 lb. in.)

Install or Connect

Figure 119

1. Filter seal (70) onto the oil filter
   - Lubricate with TRANSJEL ™ J 36850 or equivalent.
2. Oil filter (71)
3. Oil pan gasket (72)
4. Chip magnet (93) onto oil pan (73)
5. Oil pan (73) and bolts (74)

Tighten

- Torque to 16 N·m (12 lb. ft.)

2-4 Servo Assembly

Figures 120 through 125

Tools Required:

J 33037 Band Apply Pin Tool
Vernier calipers
Scale
J 22269-01 Piston Compressor
J 29714 Servo Cover Compressor

Measure

Figure 120

1. Install J 33037 as shown with apply pin (29).
2. Install servo cover retaining ring (13) to secure tool.
3. Apply 11 N·m (98 lb. in.) torque.
4. If white line "A" appears in the gage slot "B", pin length is correct.
5. Use pin selection chart to determine the correct pin length if new pin is needed.

Inspect

- Pistons for:
  - Porosity or damage
  - Ring groove damage

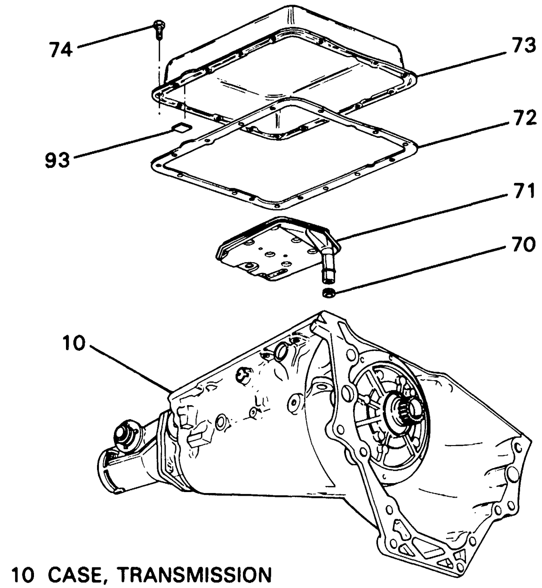
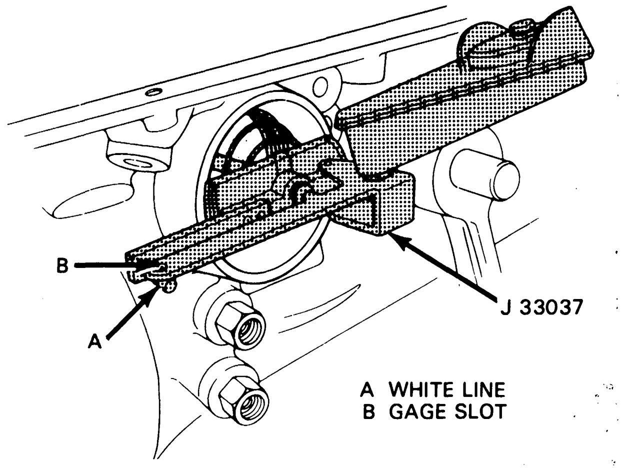


Figure 119 Case, Pan and Filter Assembly



PIN IS PRESET AT FACTORY AND MUST NOT BE READJUSTED

2-4 SERVO PIN SELECTION

PIN LENGTH mm	PIN LENGTH INCH	PIN I.D.
66.37 - 66.67	2.61 - 2.62	2 RINGS
67.74 - 68.04	2.67 - 2.68	3 RINGS
69.11 - 69.41	2.72 - 2.73	WIDE BAND

LH0060-4L60

Figure 120 Servo Pin Length

- Cover (15) for porosity or damage
- Seals for:
  - Nicks or cuts
  - Freeness in the seal groove
- Springs for distortion
- Pin for wear or burrs

Important

- Check servo bore in the case for any wear which may cut the servo seals.

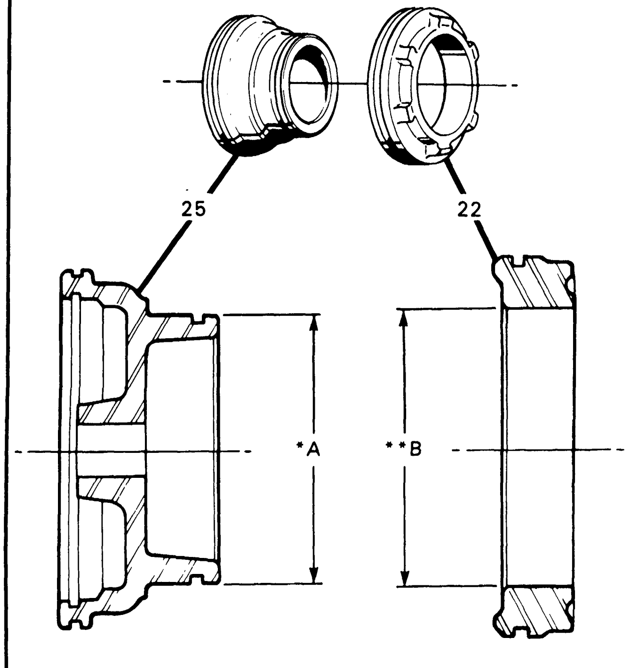
Measure

Figure 121

1. Measure piston (25) dimension *A.
2. Measure housing (22) dimension **B.
3. Check model application.

2ND APPLY PISTON & HOUSING APPLICATION

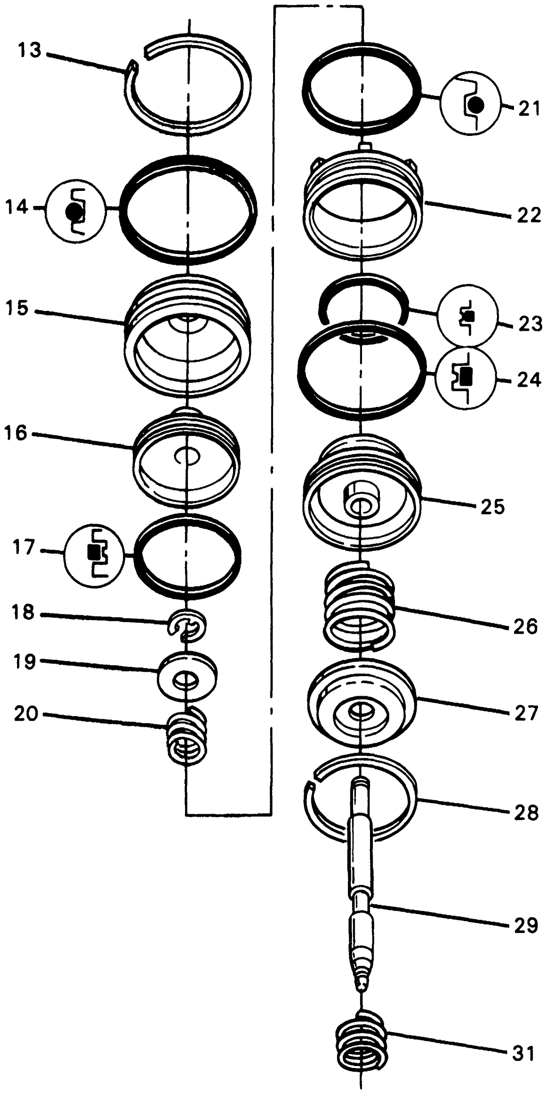
MODEL	PISTON DIMENSION *A	HOUSING DIMENSION **B
YDM	44.64 mm (1.78")	45.54 mm (1.79")
CHM, CJM, DBM, FUM, FZM, HBM, HFM, HHM, KCM, LAM, LBM, LCM, LDM, LFM, RAM, WCM	57.85 mm (2.28")	58.74 mm (2.31")
BAM, BPM, CAM, CBM, CCM, CFM, FBM, FTM, HCM, HDM, KAM, KBM, MBM, MJM, MNM, MSM, SAM, SHM, TLM, WAM, WBM	63.10 mm (2.48")	64.00 mm (2.52")



22 HOUSING, SERVO PISTON (INNER)
25 PISTON, 2ND APPLY

LH0180-4L60

Figure 121 2nd Apply Piston and Housing Measurement



ILL. NO.	DESCRIPTION
13	RING, SERVO COVER RETAINING
14	SEAL, "O" RING (2-4 SERVO COVER)
15	COVER, 2-4 SERVO
16	PISTON, 4TH APPLY
17	RING, OIL SEAL (4TH APPLY PISTON) (OUTER)
18	RING, RETAINER (APPLY PIN)
19	WASHER, SERVO APPLY PIN
20	SPRING, SERVO APPLY PIN
21	SEAL, "O" RING
22	HOUSING, SERVO PISTON (INNER)
23	RING, OIL SEAL (2ND APPLY PISTON) (INNER)
24	RING, OIL SEAL (2ND APPLY PISTON) (OUTER)
25	PISTON, 2ND APPLY
26	SPRING, SERVO CUSHION
27	RETAINER, SERVO CUSHION SPRING
28	RING, RETAINER (2ND APPLY PISTON)
29	PIN, 2ND APPLY PISTON
31	SPRING, SERVO RETURN

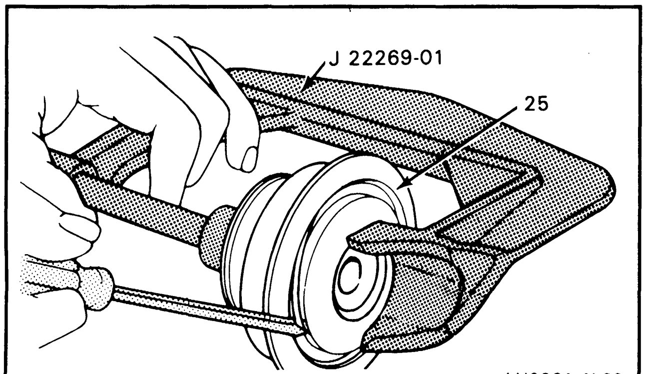
LH0059-4L60

Figure 122 2-4 Servo Assembly

Assemble

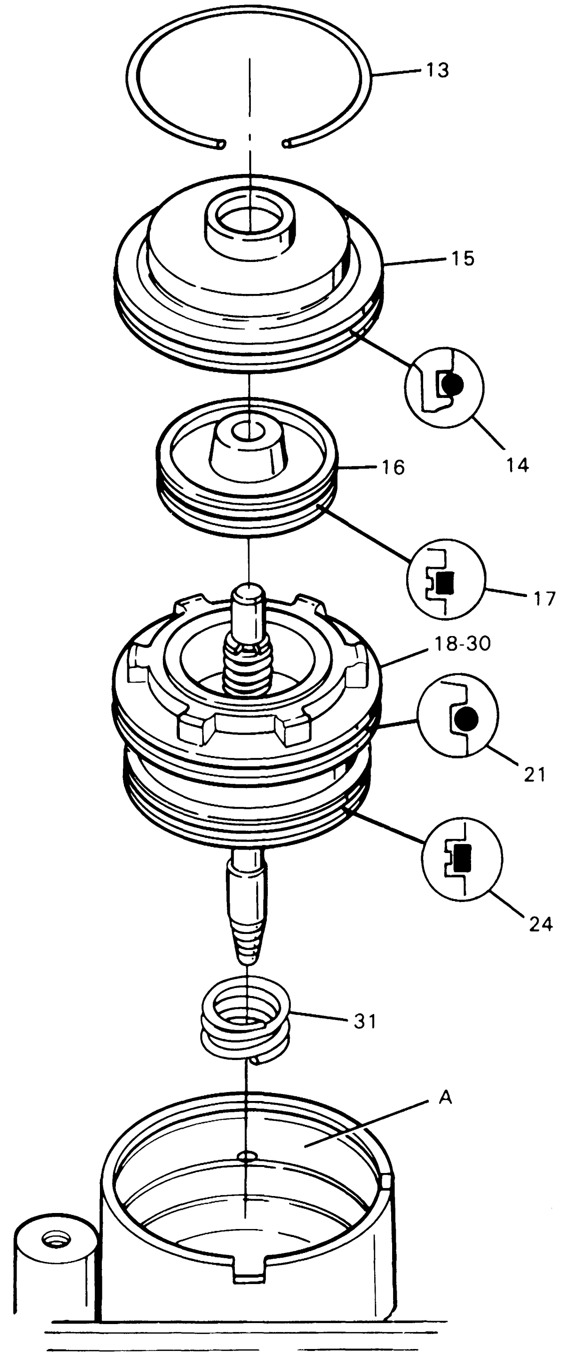
Figures 122 through 125

1. Cushion spring (26) into the 2nd apply piston (25).
2. Cushion spring retainer (27) on the cushion spring.
3. Install J 22269-01.
   - Compress the retainer past the snap ring groove in the 2nd apply piston.
   - Install the retainer ring (28).
4. The 2nd apply piston (25) onto the apply pin (29)
   - Retainer goes toward the shoulder of the pin.
5. Servo apply pin spring (20) on the pin
6. Servo apply pin washer (19) and retaining clip (18)
7. Inner (23) and outer (24) seals on the 2nd apply piston
   - Retain with TRANSJEL ™ J 36850 or equivalent.
8. O-ring seal (21) on servo piston housing
9. Servo piston inner housing (22) on the 2nd apply piston
10. Seal ring (17) onto the 4th apply piston
11. The 4th apply piston (16) onto the apply pin
12. Return spring (31) on the pin
13. Servo piston assembly into the servo bore
14. O-ring seal (14) on the servo cover
    - Lubricate the seal with TRANSJEL™ J 36850 or equivalent.
15. Servo cover (15) into the servo bore
16. Install J 29714.
    - Compress the servo cover.
    - Install the retainer ring (13).



25 SECOND APPLY PISTON ASM. LH0061-4L60

Figure 123 2nd Servo Piston — Assembly



A CASE SERVO BORE
13 RING, SERVO COVER RETAINING
14 SEAL, "O" RING (2-4 SERVO COVER)
15 COVER, 2-4 SERVO
16 PISTON, 4TH APPLY
17 RING, OIL SEAL (4TH APPLY PISTON) (OUTER)
18-30 2ND APPLY PISTON ASSEMBLY
21 SEAL, "O" RING
24 RING, OIL SEAL (2ND APPLY PISTON) (OUTER)
31 SPRING, SERVO RETURN

LH0183-4L60

Figure 124 2-4 Servo Bore

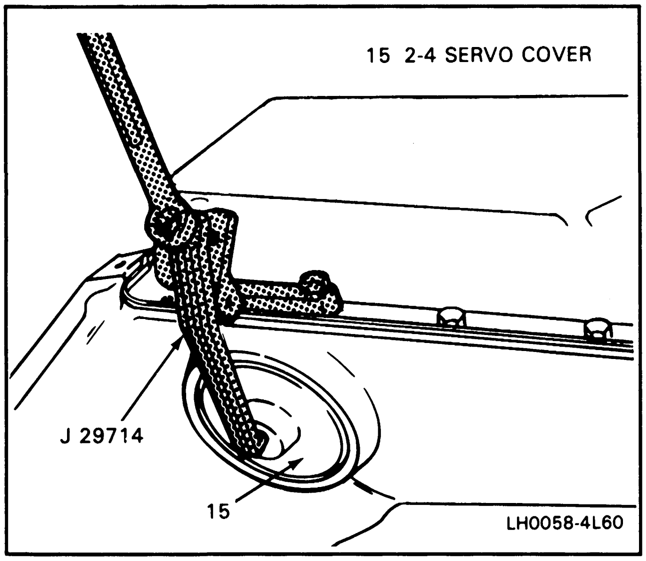


Figure 125 Servo Cover — Installed

Governor Assembly

Figures 126 and 127

Inspect

Figure 126

- Valve for free operation
- Weights for free operation
- Springs - missing or distorted
- Sleeve for nicks, burrs, scores or delamination
- Driven gear for damage

Disassemble

DO NOT DISASSEMBLE EXCEPT FOR CLEANING OR PART REPLACEMENT.

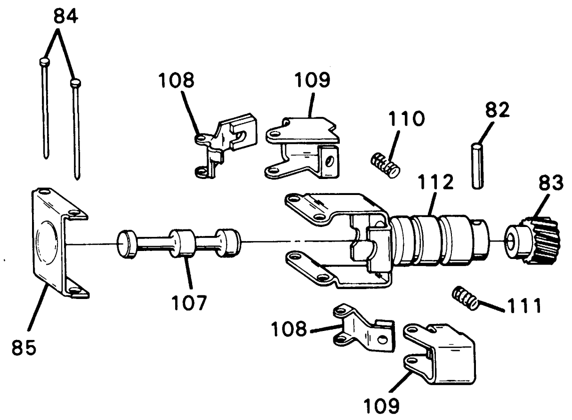
1. Cut off one end of each governor weight pin.
2. Pins (84)
3. Weights
4. Valve
5. Driven gear (83)
   - Drive out the retainer pin (82) with a small punch.
   - Support the governor assembly sleeve on plates installed in the exhaust slots. Push out the gear with an arbor press and a long punch.

Clean

- Wash all parts in solvent.
- Air dry and blow out passages.

Assemble

1. Install a new governor driven gear.
   - Support the governor or plates through the exhaust slots.
   - Press gear (83) into the sleeve until seated.
   - Drill a new retaining pin hole in the sleeve ninety degrees from the existing hole. Use a 3.1 mm (1/8 in.) drill.
   - Install retainer pin (82) and stake.
2. Valve into the sleeve
3. Weights, springs, and thrust cap onto the governor assembly
4. Retaining pins (84) into the thrust cap (85) and governor assembly
5. Stake the retaining pins (84).
6. Check for free operation of the valve and weights.



GOVERNOR ASSEMBLY

82	PIN, GOVERNOR GEAR RETAINER
83	GEAR, GOVERNOR DRIVEN
84	PIN, GOVERNOR WEIGHT
85	CAP, GOVERNOR THRUST
107	VALVE, GOVERNOR
108	WEIGHT, GOVERNOR SECONDARY
109	WEIGHT, GOVERNOR PRIMARY
110	SPRING, GOVERNOR WEIGHT PRIMARY
111	SPRING, GOVERNOR WEIGHT SECONDARY
112	SLEEVE & CARRIER ASSEMBLY

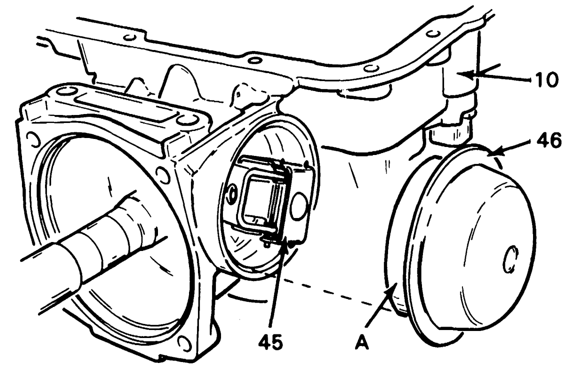
LH0185-4L60

Figure 126 Governor Assembly

Install or Connect

Figures 126 and 127

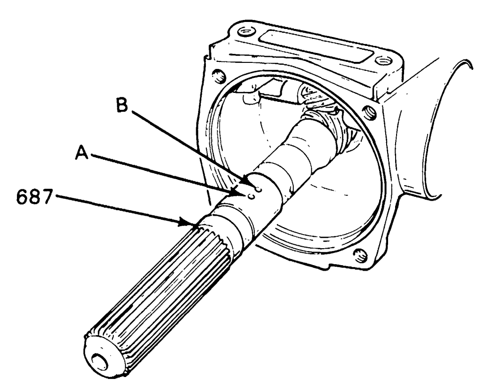
1. Governor assembly (45) into the governor bore
2. Governor cover (46)
   - Apply sealant, such as Loctite cup plug sealant #11 or equivalent, to cover flange before installation.



A APPLY SEALANT ON THIS FLANGE BEFORE INSTALLATION
10 CASE, TRANSMISSION
45 GOVERNOR, ASSEMBLY
46 COVER, GOVERNOR

LH0186-4L60

Figure 127 Governor Cover



A SPEEDO CLIP HOLE FOR CORVETTE ONLY
B SPEEDO CLIP HOLE FOR ALL OTHER VEHICLES
687 SHAFT, OUTPUT

LH0187-4L60

Figure 128 Speedometer Clip Holes

Mechanical Speedometer

Figures 128 and 133

Tools Required:

J 23103 or J 25016 Seal Installer
J 21426 Seal Installer

Install or Connect

1. Speedometer drive gear (689) and clip (688)
   - If the output shaft has two speedometer locating holes, use the hole nearest the yoke spline for Corvette vehicles only.
2. O-ring seal (691) on the output shaft sleeve
3. Output shaft sleeve (690) on the output shaft
   - Use J 25016 or J 23103.
   - Do not push the sleeve past the machined surface on the output shaft.
4. Seal ring (35) on the case extension
5. Case extension (36) and bolts (37) or, stud (100) and nut (98)
   - Position extension so the speedometer bore is on the governor side of the case.

Tighten

- Torque to 35 N·m (26 lb. ft.)

6. Remove case extension oil seal (39)
   - Pry out with a screwdriver.
   - Install new seal with J 21426.
7. Speedometer driven gear (44) and assembly (43) or speed sensor (99)
8. Retainer (40) bolt and washer (41)
9. Outside electrical connector, manual lever and nut

Torque Converter Assembly

Figure 136

Tool Required:

J 35138 Torque Converter End Play Checking Tool

Inspect

The torque converter assembly must be replaced for any of the following conditions:

- Evidence of damage to the pump assembly
- Metal particles are found after flushing the cooler and cooler lines.
- External leaks in hub weld area
- Converter pilot is broken, damaged or poor fit into crankshaft.
- Converter hub is scored or damaged.
- Internal damage to stator
- Contamination from engine coolant
- Excess end play

Measure

Figure 136

- Install J 35138 and measure end play.
  - 0 - .5 mm (.000-.020") for 245 mm torque converters
  - 0 - .6 mm (.000-.024") for 298 mm torque converters

The Torque Converter should not be replaced

If:

- The fluid has an odor, discoloration or no evidence of metal or clutch plate material.
  - Drain out as much fluid as possible
  - Replace the oil filter and pan gasket
  - Fill to proper level (Refer to Section 7A)
- The converter bolt hole threads are damaged.
  - Correct with thread insert (Refer to Section 6A).

Important

- Flushing the torque converter is not recommended.

Install or Connect

1. Torque converter
2. J 21366 converter holding strap
3. Remove transmission from holding fixture

687 SHAFT, OUTPUT
688 CLIP, SPEEDO DRIVE GEAR
689 GEAR, SPEEDO DRIVE

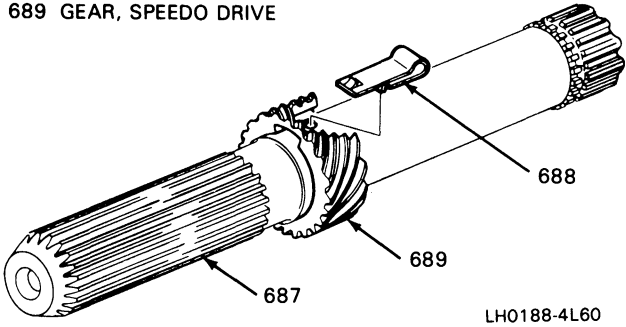
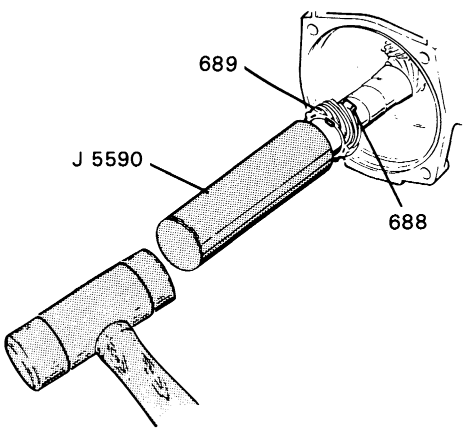
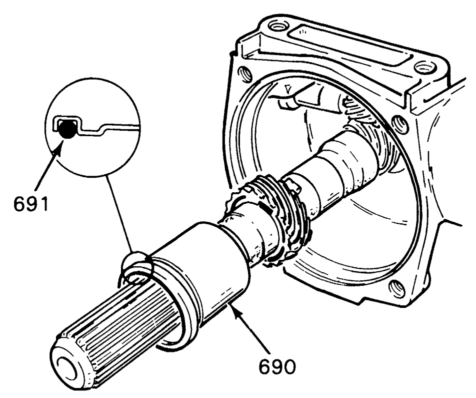


Figure 129 Speedometer Gear



688 CLIP, SPEEDO DRIVE GEAR
689 GEAR, SPEEDO DRIVE

Figure 130 Speedometer Gear — Installation



690 SLEEVE, OUTPUT SHAFT
691 SEAL, OUTPUT SHAFT

Figure 131 Output Shaft Sleeve and Seal

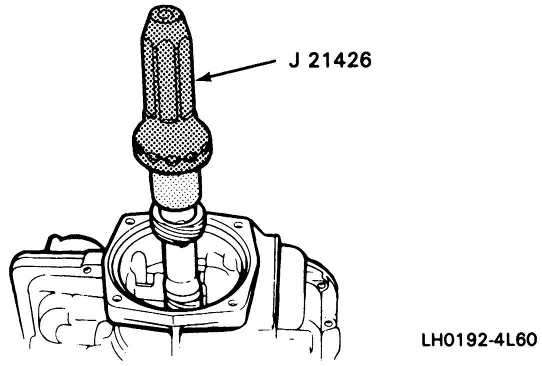
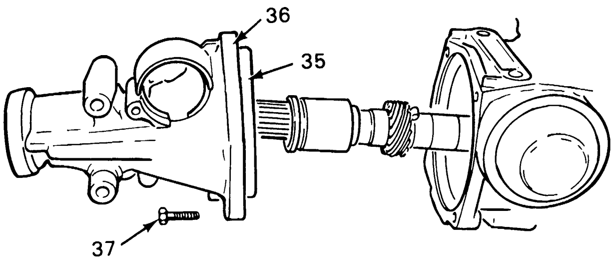
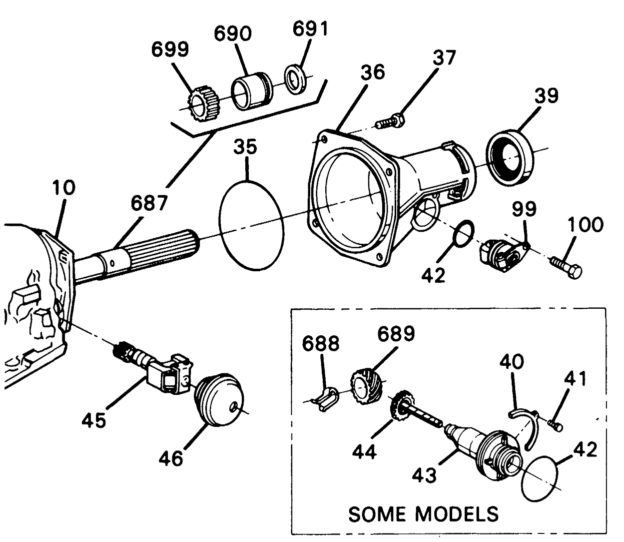


Figure 132 Output Shaft Sleeve — Installation



35 SEAL, CASE EXTENSION TO CASE
36 EXTENSION, CASE
37 BOLTS, CASE EXTENSION

Figure 133 Case Extension and Seal



ILL. NO.	DESCRIPTION
10	CASE, TRANSMISSION
35	SEAL, CASE EXTENSION TO CASE
36	EXTENSION, CASE
37	BOLT, CASE EXTENSION TO CASE
39	SEAL ASSEMBLY, CASE EXTENSION OIL
40	RETAINER, SPEEDO DRIVEN GEAR FITTING
41	BOLT & WASHER ASSEMBLY
42	SEAL, O-RING (SPEEDO FITTING TO CASE EXTENSION)
43	FITTING ASSEMBLY, SPEEDO DRIVEN GEAR
44	GEAR, SPEEDO DRIVEN
45	GOVERNOR ASSEMBLY
46	COVER, GOVERNOR
99	SPEED SENSOR, INTERNAL TRANSMISSION
100	BOLT, SPEEDO SENSOR RETAINING
687	SHAFT, OUTPUT
688	CLIP, SPEEDO DRIVE GEAR
689	GEAR, SPEEDO DRIVE
690	SLEEVE, OUTPUT SHAFT NOT USED ON
691	SEAL, OUTPUT SHAFT ALL MODELS
699	ROTOR, INTERNAL TRANSMISSION SPEED SENSOR

LH0063-4L60-R1

Figure 134 Case Extension and Associated Parts

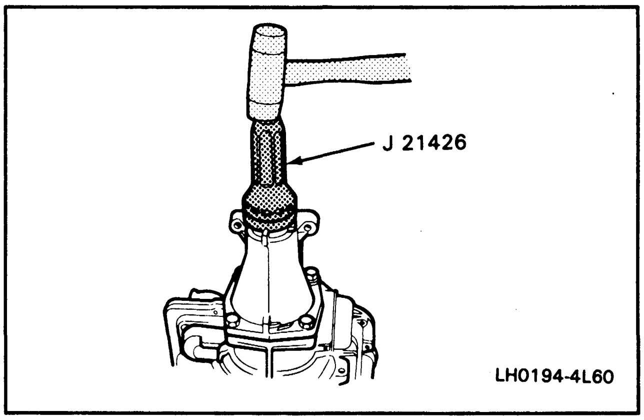


Figure 135 Case Extension Oil Seal Assembly

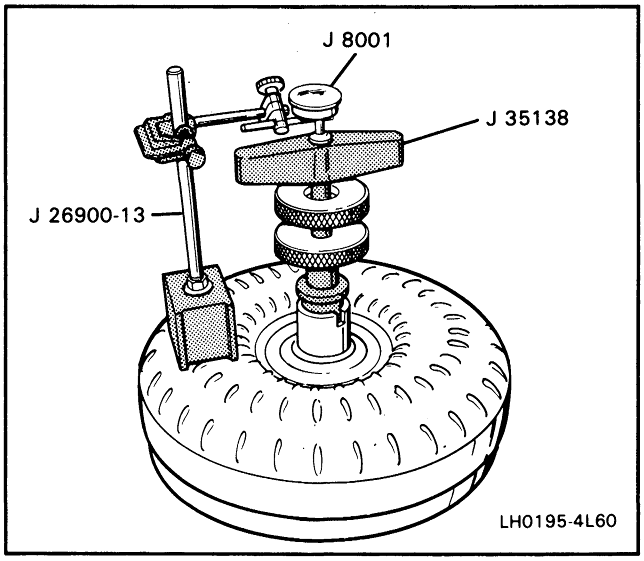


Figure 136 Checking Torque Converter End Play

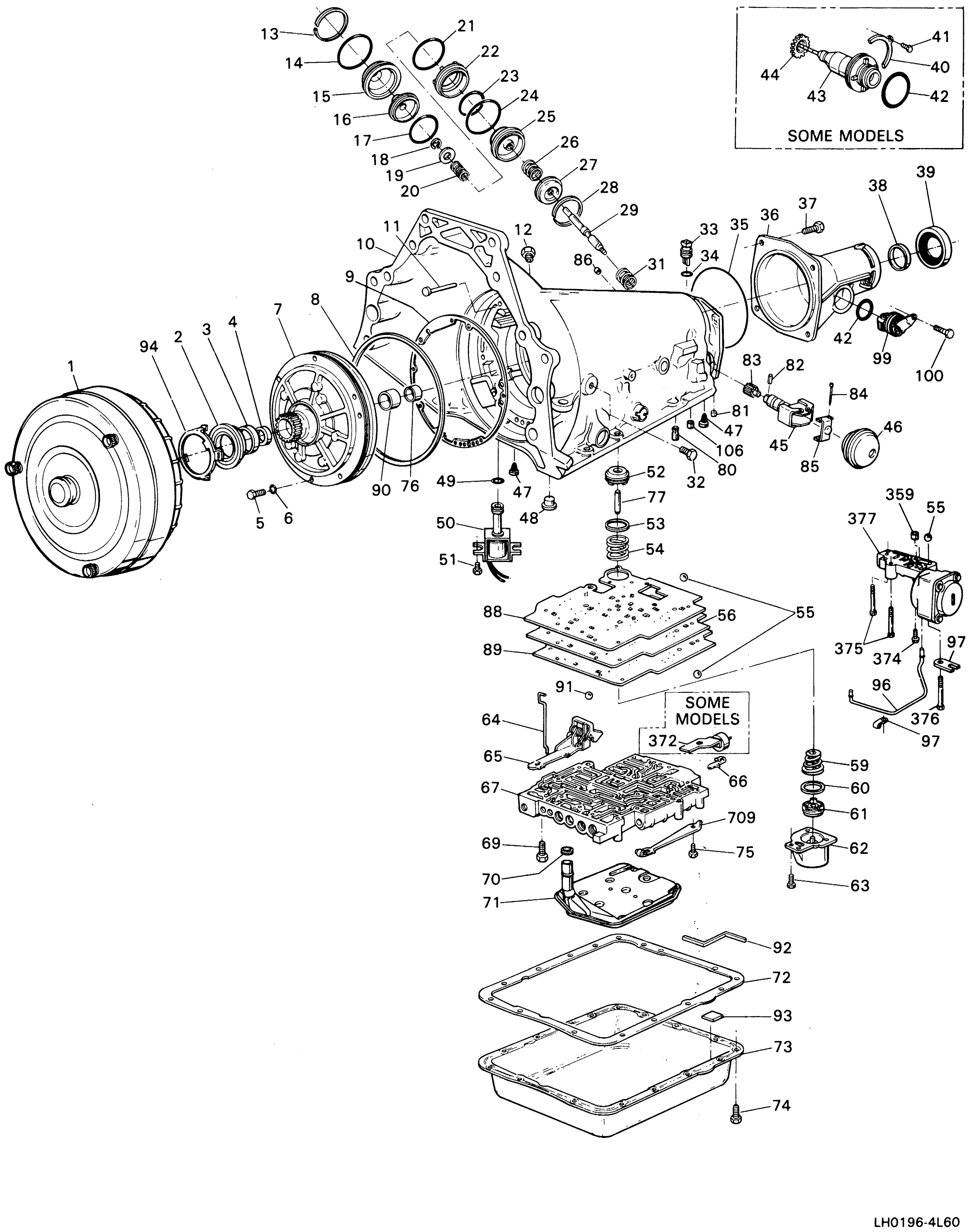


Figure 137 Case and External Parts

ILL. NO.	DESCRIPTION
1	CONVERTER ASSEMBLY
2	SEAL ASSEMBLY, OIL
3	BUSHING, OIL PUMP BODY
4	BUSHING, STATOR SHAFT (FRONT)
5	BOLT, PUMP TO CASE
6	O-RING, PUMP TO CASE BOLT
7	PUMP ASSEMBLY, OIL
8	SEAL, OIL (PUMP TO CASE)
9	GASKET, PUMP COVER TO CASE
10	CASE, TRANSMISSION
11	VENT ASSEMBLY, TRANSMISSION
12	CONNECTOR, OIL COOLER PIPE
13	RING, SERVO COVER RETAINING
14	SEAL, "O" RING (2-4 SERVO COVER)
15	COVER, 2-4 SERVO
16	PISTON, 4TH APPLY
17	RING, OIL SEAL (4TH APPLY PISTON) (OUTER)
18	RING, RETAINER (APPLY PIN)
19	WASHER, SERVO APPLY PIN
20	SPRING, SERVO APPLY PIN
21	SEAL, "O" RING
22	HOUSING, SERVO PISTON (INNER)
23	RING, OIL SEAL (2ND APPLY PISTON) (INNER)
24	RING, OIL SEAL (2ND APPLY PISTON) (OUTER)
25	PISTON, 2ND APPLY
26	SPRING, SERVO CUSHION
27	RETAINER, SERVO CUSHION SPRING
28	RING, RETAINER (2ND APPLY PISTON)
29	PIN, 2ND APPLY PISTON
31	SPRING, SERVO RETURN
32	PLUG, PRESSURE
33	CONNECTOR, ELECTRICAL
34	SEAL, "O" RING (ELECTRICAL CONNECTION)
35	SEAL, CASE EXTENSION TO CASE
36	EXTENSION, CASE
37	BOLT, CASE EXTENSION TO CASE
38	BUSHING, CASE EXTENSION
39	SEAL ASSEMBLY, CASE EXTENSION OIL
40	RETAINER, SPEEDO DRIVEN GEAR FITTING
41	BOLT & WASHER ASSEMBLY
42	SEAL, "O" RING (SPEEDO FITTING TO CASE EXTENSION)
43	FITTING ASSEMBLY, SPEEDO DRIVEN GEAR
44	GEAR, SPEEDO DRIVEN
45	GOVERNOR ASSEMBLY
46	COVER, GOVERNOR
47	SCREEN, TRANSMISSION OIL PRESSURE (CONVERTER & GOVERNOR)
48	PIN, BAND ANCHOR
49	SEAL, "O" RING (SOLENOID)
50	SOLENOID ASSEMBLY
51	BOLT, HEX WASHER HEAD (SOLENOID)
52	PISTON, 3-4 ACCUMULATOR
53	RING, OIL SEAL (3-4 ACCUMULATOR PISTON)
54	SPRING, 3-4 ACCUMULATOR
55	BALL, .25 DIAMETER
56	PLATE, VALVE BODY SPACER
59	SPRING, 1-2 ACCUMULATOR
60	RING, OIL SEAL (1-2 ACCUMULATOR PISTON)
61	PISTON, 1-2 ACCUMULATOR
62	COVER & PIN ASSEMBLY, 1-2 ACCUM.
63	BOLT, ACCUMULATOR COVER
64	LINK, THROTTLE LEVER TO CABLE
65	LEVER & BRACKET ASSEMBLY, THROTTLE
66	CLIP, ELECTRICAL WIRE
67	VALVE ASSEMBLY, CONTROL BODY
69	BOLT, VALVE BODY
70	SEAL, FILTER
71	FILTER ASSEMBLY, TRANSMISSION OIL
72	GASKET, TRANSMISSION OIL PAN
73	PAN, TRANSMISSION OIL
74	SCREW, SPEC. HEX WASHER HEAD (PAN)
75	BOLT, MANUAL DETENT SPRING
76	BUSHING, CASE
77	PIN, ACCUMULATOR PISTON
80	RETAINER & BALL ASSEMBLY, 3RD ACCUMULATOR
81	PLUG, TRANSMISSION CASE (ACCUMULATOR BLEED)
82	PIN, GOVERNOR GEAR RETAINER
83	GEAR, GOVERNOR DRIVEN
84	PIN, GOVERNOR WEIGHT
85	CAP, GOVERNOR THRUST
86	PLUG, CASE SERVO
88	GASKET, SPACER PLATE TO CASE
89	GASKET, SPACER PLATE TO VALVE BODY
90	BUSHING, STATOR SHAFT (REAR)
91	BALL, CARBON STEEL (T.V. EXHAUST)
92	CONDUIT, SOLENOID WIRE
93	MAGNET, CHIP COLLECTOR
94	RETAINER, FRONT HELIX SEAL
96	TUBE, AUXILIARY ACCUMULATOR VALVE
97	CLAMP, TUBE
99	SPEED SENSOR, INTERNAL TRANSMISSION
100	BOLT, SPEEDO SENSOR RETAINING
106	RETAINER & BALL ASM. (DOUBLE ORIFICE)
359	PLUG, CUP (ORIFICE)
372	SWITCH, TEMPERATURE (SOME MODELS)
374	BOLT, SPECIAL HEX HEAD (M6 X 1 X 16)
375	BOLT, HEX HEAD (M6 X 1 X 35)
376	BOLT, HEX HEAD (M6 X 1 X 45)
377	AUXILIARY ACCUMULATOR VALVE BODY ASSEMBLY
709	SPRING ASSEMBLY, MANUAL DETENT

LH0197-4L60

Figure 138 Case and External Parts — Legend

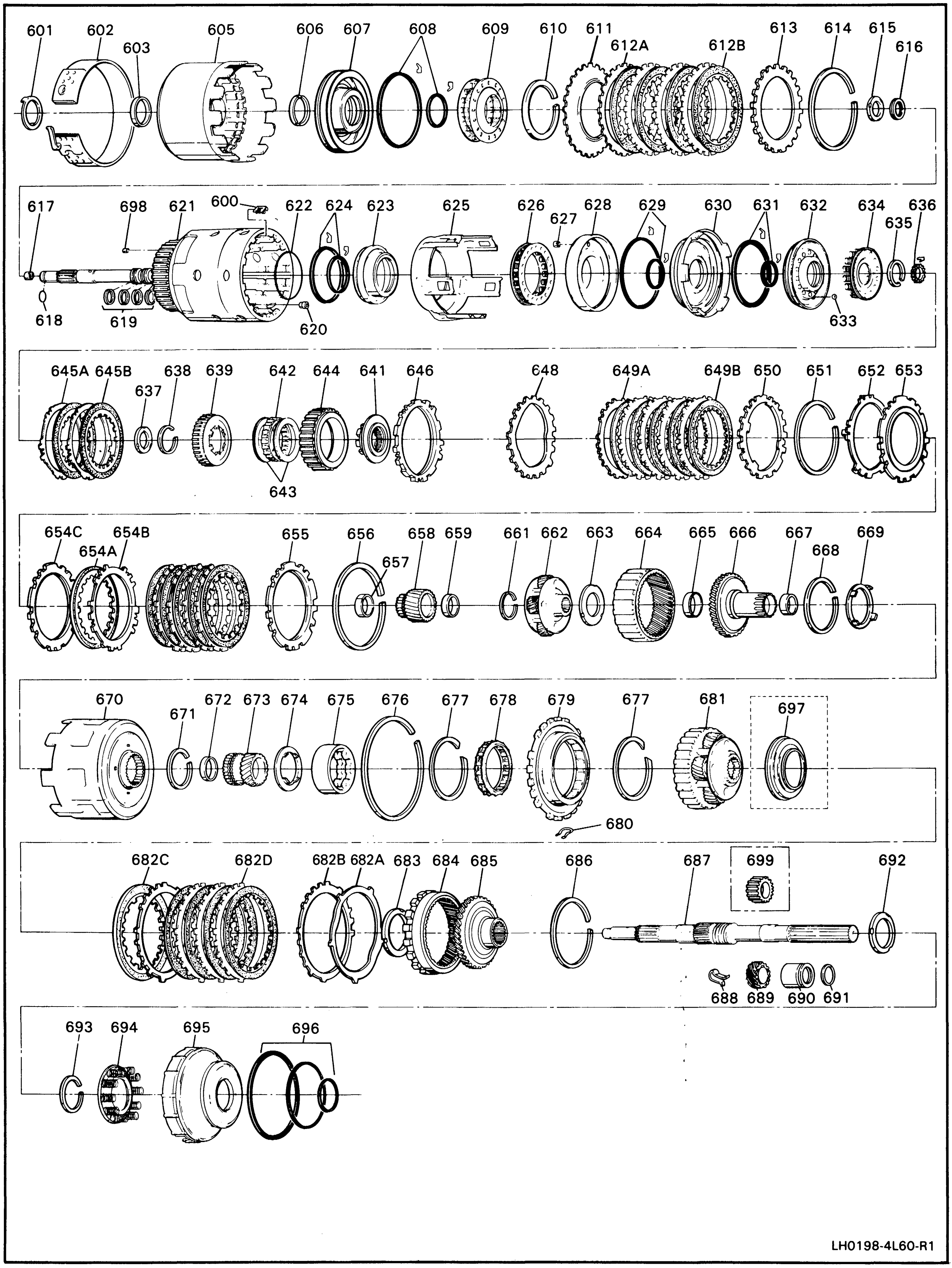


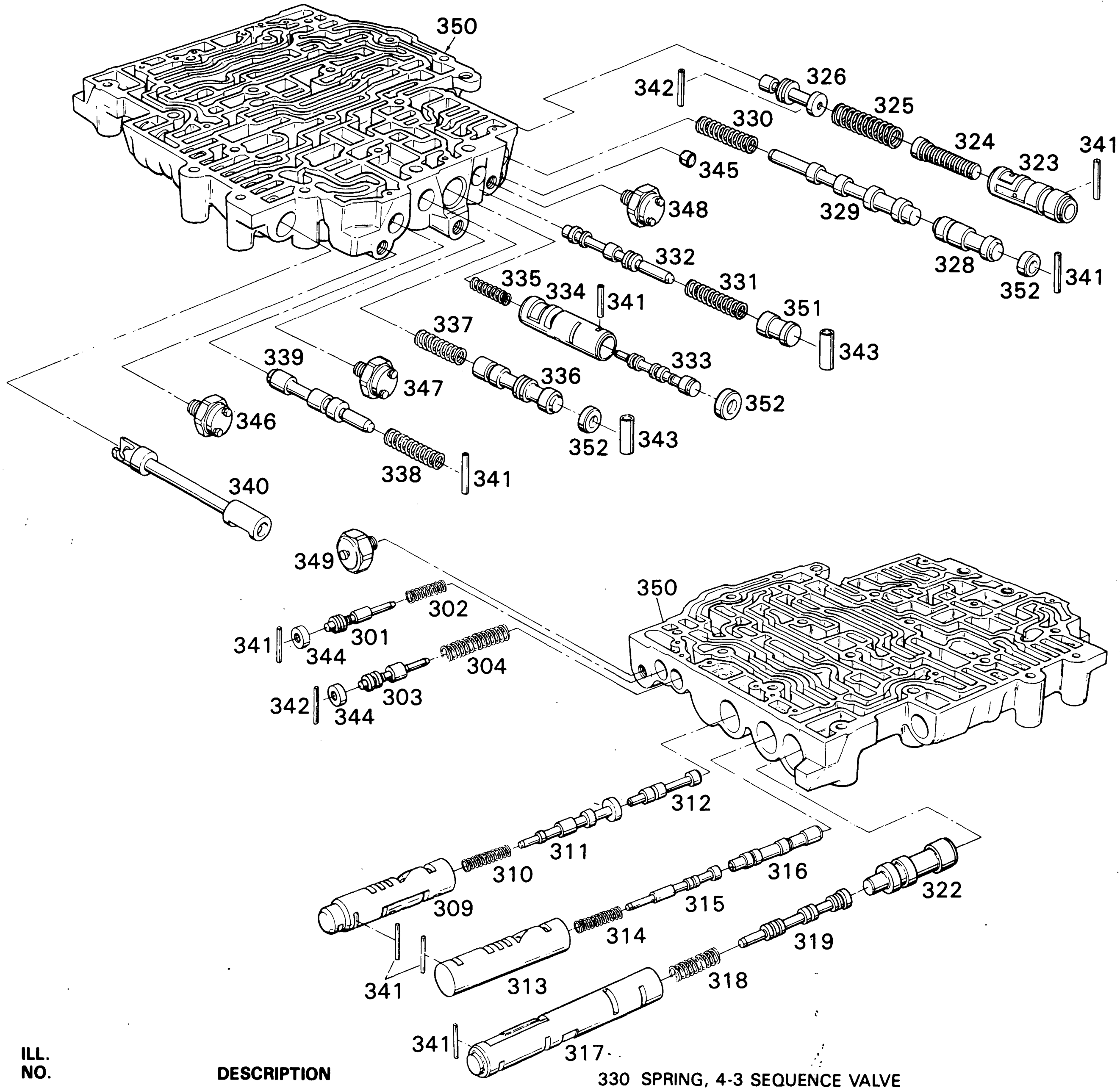
Figure 139 Transmission Internal Parts

ILL. NO.	DESCRIPTION
600	SPRING ASM., 3-4 CLUTCH BOOST (5)
601	WASHER, THRUST (PUMP TO DRUM)
602	BAND ASSEMBLY, 2-4
603	BUSHING, REVERSE INPUT CL. (FRONT)
605	HOUSING & DRUM ASSEMBLY, REVERSE INPUT CLUTCH
606	BUSHING, REVERSE INPUT CLUTCH (REAR)
607	PISTON ASM., REVERSE INPUT CLUTCH
608	SEALS, REVERSE INPUT CLUTCH (INNER & OUTER)
609	SPRING ASM., REVERSE INPUT CLUTCH
610	RING, REVERSE INPUT CLUTCH SPRING RETAINER
611	PLATE, REVERSE INPUT CLUTCH (BELLEVILLE)
612A	PLATE ASM., REVERSE INPUT CLUTCH (FIBER)
612B	PLATE, REVERSE INPUT CLUTCH (STEEL)
613	PLATE, REVERSE INPUT CLUTCH BACKING (SELECTIVE)
614	RING, REVERSE INPUT CL. RETAINING
615	BEARING ASSEMBLY, STATOR SHAFT/ SELECTIVE WASHER
616	WASHER, THRUST (SELECTIVE)
617	RETAINER & BALL ASM., CHECK VALVE
618	SEAL, "O" RING (TURBINE SHAFT/ SELECTIVE WASHER)
619	RING, OIL SEAL (SOLID)
620	RETAINER & CHECK BALL ASSEMBLY
621	HOUSING & SHAFT ASSEMBLY, INPUT
622	SEAL, "O" RING INPUT TO FORWARD HSG.
623	PISTON, 3RD & 4TH CLUTCH
624	SEAL, 3RD & 4TH CL. (INNER & OUTER)
625	RING, 3RD & 4TH CLUTCH APPLY
626	SPRING ASSEMBLY, 3RD & 4TH CLUTCH
627	RETAINER & BALL ASSEMBLY, FORWARD CLUTCH HOUSING
628	HOUSING, FORWARD CLUTCH
629	SEAL, FORWARD CLUTCH (INNER & OUTER)
630	PISTON, FORWARD CLUTCH
631	SEAL, OVERRUN CLUTCH (INNER & OUTER)
632	PISTON, OVERRUN CLUTCH
633	BALL, OVERRUN CLUTCH
634	SPRING ASSEMBLY, OVERRUN CLUTCH
635	SNAP RING, OVERRUN CLUTCH SPRING RETAINER
636	SEAL, INPUT HOUSING TO OUTPUT SHAFT
637	BEARING ASSEMBLY, INPUT SUN GEAR
638	SNAP RING, OVERRUN CL. HUB RETAINING
639	HUB, OVERRUN CLUTCH
641	RETAINER & RACE ASSEMBLY, SPRAG
642	FORWARD SPRAG ASSEMBLY
643	RETAINER RINGS, SPRAG ASSEMBLY
644	RACE, FORWARD CLUTCH (OUTER)
645A	PLATE ASSEMBLY, OVERRUN CLUTCH (FIBER)
645B	PLATE, OVERRUN CLUTCH (STEEL)
646	PLATE, FORWARD CLUTCH APPLY
648	PLATE, FORWARD CLUTCH (WAVED)
649A	PLATE ASSEMBLY, FORWARD CLUTCH (FIBER)
649B	PLATE, FORWARD CLUTCH (STEEL)
650	PLATE, FORWARD CLUTCH BACKING (SEL.)
651	RING, FORWARD CLUTCH BACKING PLATE RETAINER
652	PLATE, 3RD & 4TH CLUTCH RING RETAINER
653	PLATE, 3RD & 4TH CLUTCH APPLY (STEPPED)

ILL. NO.	DESCRIPTION
654A	PLATE ASSEMBLY, 3RD & 4TH CLUTCH (FIBER)
654B	PLATE, 3RD & 4TH CLUTCH (STEEL)
654C	PLATE, 3RD & 4TH CLUTCH (STEEL)
655	PLATE, 3RD & 4TH CLUTCH BACKING (SEL.)
656	RING, 3RD & 4TH CLUTCH BACKING PLATE RETAINER
657	BUSHING, INPUT SUN GEAR (FRONT)
658	GEAR, INPUT SUN
659	BUSHING, INPUT SUN GEAR (REAR)
661	RET., OUTPUT SHAFT TO INPUT CARRIER
662	CARRIER ASSEMBLY, INPUT (COMPLETE)
663	BEARING ASSEMBLY, THRUST (INPUT CARRIER TO REACTION SHAFT)
664	GEAR, INPUT INTERNAL
665	BUSHING, REACTION CARRIER SHAFT (FRONT)
666	SHAFT, REACTION CARRIER
667	BUSHING, REACTION CARRIER SHAFT (REAR)
668	RING, REACTION SHAFT/INTERNAL GEAR RETAINER
669	WASHER, THRUST (REACTION SHAFT/ SHELL)
670	SHELL, REACTION SUN
671	RING, REACTION SUN GEAR RETAINER
672	BUSHING, REACTION SUN
673	GEAR, REACTION SUN
674	WASHER, THRUST (RACE/REACTION SHELL)
675	RACE, LO & REVERSE ROLLER CLUTCH
676	RING, LO & REVERSE SUPPORT TO CASE RETAINER
677	RING, LO & REVERSE RETAINER (ROLLER ASSEMBLY/CAM)
678	CLUTCH ASSEMBLY, LO & REVERSE ROLLER
679	SUPPORT ASM., LO & REVERSE CLUTCH
680	SPRING, TRANSMISSION (LO & REVERSE CLUTCH SUPPORT RETAINER)
681	CARRIER ASSEMBLY, REACTION
682A	PLATE, LO & REVERSE CLUTCH (WAVED)
682B	PLATE, SPACER LO & REVERSE CLUTCH (SELECTIVE)
682C	PLATE ASSEMBLY, LO & REVERSE CLUTCH (FIBER)
682D	PLATE, LO & REVERSE CLUTCH (STEEL)
683	BEARING ASSEMBLY, THRUST (REACTION CARRIER/SUPPORT)
684	GEAR, INTERNAL REACTION
685	SUPPORT, INTERNAL REACTION GEAR
686	RING, REACTION GEAR/SUPPORT RETAINER
687	SHAFT, OUTPUT
688	CLIP, SPEEDO DRIVE GEAR
689	GEAR, SPEEDO DRIVE
690	SLEEVE, OUTPUT SHAFT
691	SEAL, OUTPUT SHAFT
692	BRG., REACTION GEAR SUPPORT TO CASE
693	RING, LO & REVERSE CLUTCH RETAINER
694	SPRING ASSEMBLY, LO & REVERSE CLUTCH
695	PISTON, LO & REVERSE CLUTCH
696	SEAL, TRANSMISSION (LO & REVERSE CLUTCH – OUTER, CENTER, INNER)
697	DEFLECTOR, OIL (HIGH OUTPUT MODELS ONLY)
698	PLUG, ORIFICED CUP
699	ROTOR, INTERNAL TRANSMISSION SPEED SENSOR

LH0199-4L60

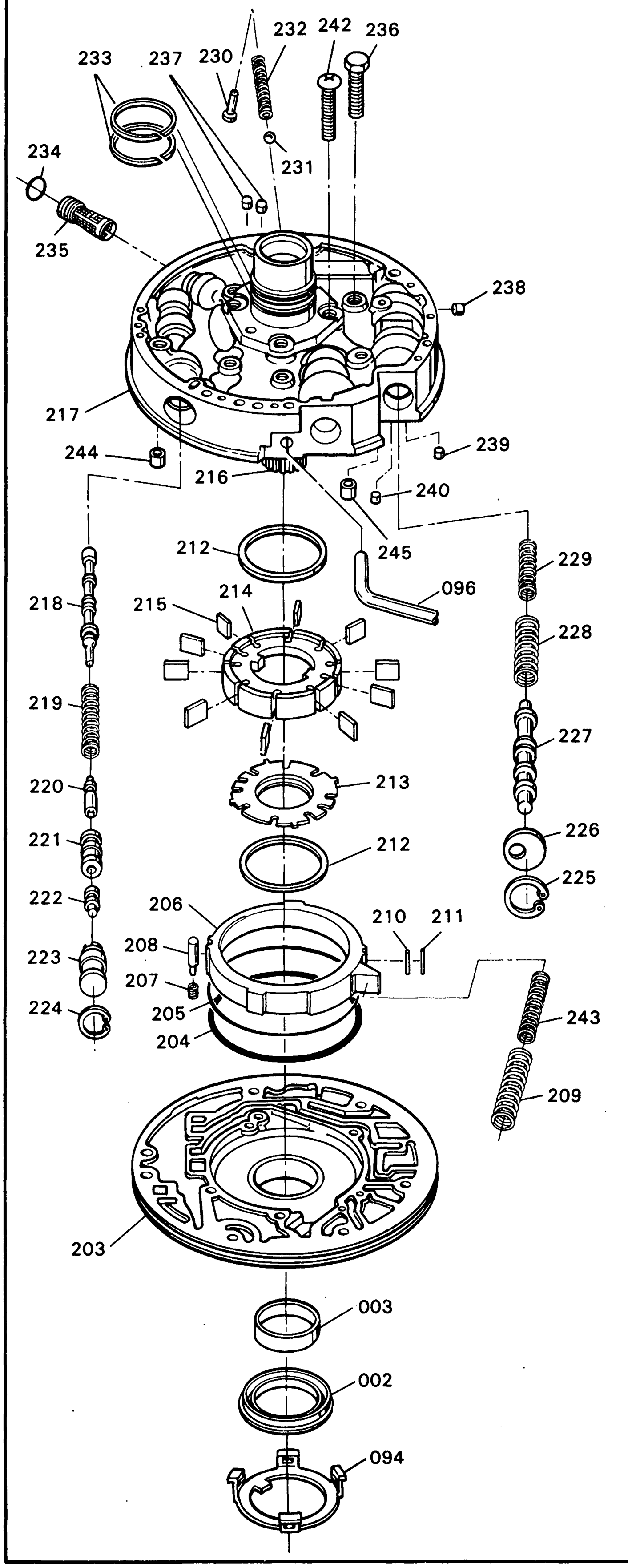
Figure 140 Transmission Internal Parts— Legend



ILL. NO.	DESCRIPTION
301	VALVE, T.V. MODULATOR DOWNSHIFT
302	SPRING, T.V. MODULATOR DOWNSHIFT VALVE
303	VALVE, T.V. MODULATOR UPSHIFT
304	SPRING, T.V. MODULATOR UPSHIFT VALVE
309	SLEEVE, 3-4 THROTTLE VALVE
310	SPRING, 3-4 THROTTLE VALVE
311	VALVE, 3-4 THROTTLE
312	VALVE, 3-4 SHIFT
313	SLEEVE, 2-3 THROTTLE VALVE
314	SPRING, 2-3 THROTTLE VALVE
315	VALVE, 2-3 THROTTLE
316	VALVE, 2-3 SHIFT
317	SLEEVE, 1-2 THROTTLE VALVE
318	SPRING, 1-2 THROTTLE VALVE
319	VALVE, 1-2 THROTTLE
322	VALVE, 1-2 SHIFT
323	SLEEVE, THROTTLE VALVE PLUNGER
324	PLUNGER, THROTTLE VALVE
325	SPRING, THROTTLE VALVE
326	VALVE, THROTTLE
328	VALVE, 3-4 RELAY
329	VALVE, 4-3 SEQUENCE
330	SPRING, 4-3 SEQUENCE VALVE
331	SPRING, T.V. LIMIT VALVE
332	VALVE, T.V. LIMIT
333	VALVE, 1-2 ACCUMULATOR
334	SLEEVE, 1-2 ACCUMULATOR VALVE
335	SPRING, 1-2 ACCUMULATOR VALVE
336	VALVE, LINE BIAS
337	SPRING, LINE BIAS VALVE
338	SPRING, 3-2 CONTROL
339	VALVE, 3-2 CONTROL
340	VALVE, MANUAL
341	PIN, COILED SPRING
342	PIN, COILED SPRING
343	RETAINER, SPRING (SLEEVE)
344	PLUG, VALVE BORE
345	PLUG, CUP (.33 DIA.)
346	SWITCH ASM., PRESSURE (3RD CLUTCH)
347	SWITCH ASM., PRESSURE (4-3 PULSE)
348	SWITCH ASM., PRESSURE (4TH CLUTCH)
349	SWITCH ASM., PRESSURE (T.C.C. SIGNAL)
350	BODY, CONTROL VALVE
351	PLUG, T.V. LIMIT
352	PLUG, VALVE BORE (12.5 - O.D.)

LH0170-4L60-R1

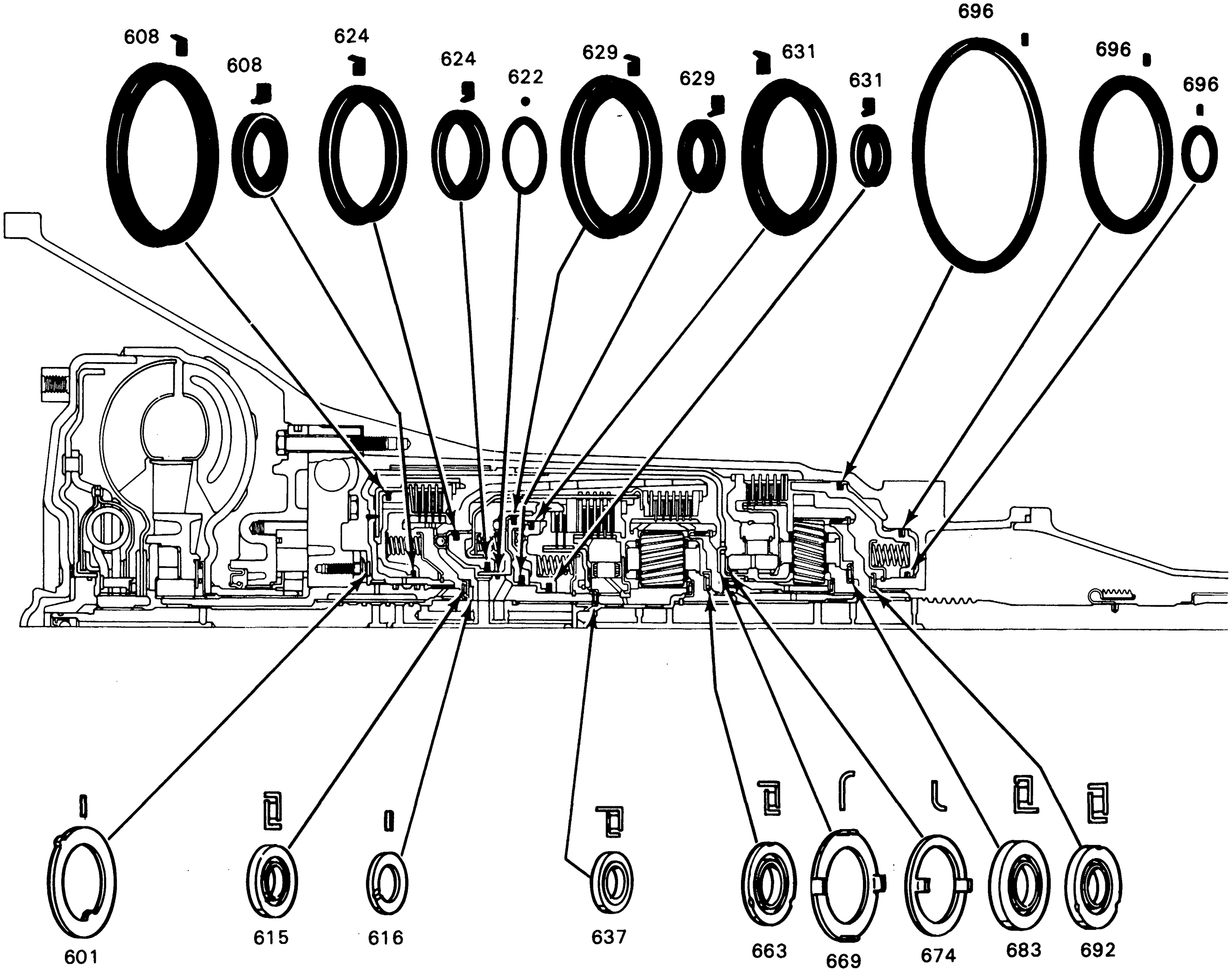
Figure 141 Control Valve Assembly



ILL. NO.	DESCRIPTION
002	SEAL ASSEMBLY, OIL
003	BUSHING, PUMP BODY
094	RETAINER, FRONT HELIX SEAL
096	TUBE, AUXILIARY ACCUMULATOR VALVE
203	BODY, PUMP
204	RING, OIL SEAL (SLIDE TO WEAR PLATE)
205	SEAL, "O" RING (SLIDE SEAL BACK-UP)
206	SLIDE, PUMP
207	SPRING, PIVOT PIN
208	PIN, PIVOT SLIDE
209	SPRING, PUMP SLIDE (OUTER)
210	SUPPORT, PUMP SLIDE SEAL
211	SEAL, PUMP SLIDE
212	RING, PUMP VANE
213	GUIDE, ROTOR
214	ROTOR, OIL PUMP
215	VANE, PUMP
216	SHAFT, STATOR
217	COVER, PUMP
218	VALVE, PRESSURE REGULATOR
219	SPRING, PRESSURE REGULATOR VALVE
220	VALVE, REVERSE BOOST
221	SLEEVE, REVERSE BOOST VALVE
222	VALVE, T.V. BOOST
223	BUSHING, T.V. BOOST
224	RING, OIL PUMP REVERSE BOOST VALVE RETAINING
225	RING, OIL PUMP CONVERTER CLUTCH VALVE RETAINING
226	VALVE, STOP
227	VALVE, CONVERTER CLUTCH
228	SPRING, CONVERTER CLUTCH VALVE (OUTER)
229	SPRING, CONVERTER CLUTCH VALVE (INNER)
230	RIVET, PRESSURE RELIEF BOLT
231	BALL, PRESSURE RELIEF
232	SPRING, PRESSURE RELIEF
233	RING, OIL SEAL (STATOR SHAFT)
234	SEAL, OIL PUMP COVER SCREEN
235	SCREEN, OIL PUMP COVER
236	BOLT, M8 x 1.25 x 40 (COVER TO BODY)
237	PLUG, OIL PUMP AIR BLEED
238	PLUG, OIL PUMP COVER
239	PLUG, OIL PUMP COOLER FEED
240	PLUG, OIL PUMP CONVERTER CLUTCH SIGNAL
242	SCREW, STATOR SHAFT (M6 x 1 x 16.0)
243	SPRING, PUMP SLIDE (INNER)
244	RETAINER & BALL ASSEMBLY, (REVERSE CLUTCH)
245	RETAINER & BALL ASSEMBLY, (OVERRUN CLUTCH)

LH0152-4L60

Figure 142 Oil Pump Assembly

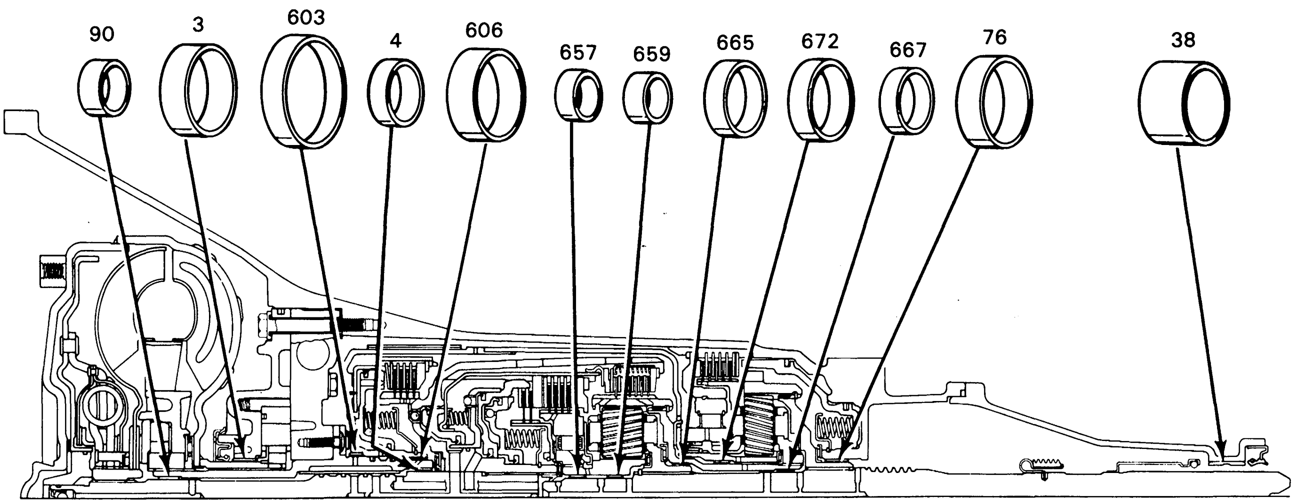


ILL. NO.	DESCRIPTION
601	WASHER, THRUST (PUMP TO DRUM)
608	SEALS, REVERSE INPUT CLUTCH (INNER & OUTER)
615	BEARING ASSEMBLY, STATOR SHAFT/ SELECTIVE WASHER
616	WASHER, THRUST (SELECTIVE)
622	SEAL, "O" RING INPUT TO FORWARD HSG.
624	SEAL, 3RD & 4TH CL. (INNER & OUTER)
629	SEAL, FORWARD CLUTCH (INNER & OUTER)
631	SEAL, OVERRUN CLUTCH (INNER & OUTER)
637	BEARING ASSEMBLY, INPUT SUN GEAR

ILL. NO.	DESCRIPTION
663	BEARING ASSEMBLY, THRUST (INPUT CARRIER TO REACTION SHAFT)
669	WASHER, THRUST (REACTION SHAFT/ SHELL)
674	WASHER, THRUST (RACE/REACTION SHELL)
683	BEARING ASSEMBLY, THRUST (REACTION CARRIER/SUPPORT)
692	BRG., REACTION GEAR SUPPORT TO CASE
696	SEAL, TRANSMISSION (LO & REVERSE CLUTCH — OUTER, CENTER, INNER)

LH0203-4L60

Figure 143 Seal and Bearing Locations



ILL. NO.	DESCRIPTION
3	BUSHING, OIL PUMP BODY
4	BUSHING, STATOR SHAFT (REAR)
38	BUSHING, CASE EXTENSION
76	BUSHING, CASE
90	BUSHING, STATOR SHAFT (FRONT)
603	BUSHING, REVERSE INPUT CLUTCH (FRONT)
606	BUSHING, REVERSE INPUT CLUTCH (REAR)

ILL. NO.	DESCRIPTION
657	BUSHING, INPUT SUN GEAR (FRONT)
659	BUSHING, INPUT SUN GEAR (REAR)
665	BUSHING, REACTION SHAFT (FRONT)
667	BUSHING, REACTION SHAFT (REAR)
672	BUSHING, REACTION SUN GEAR

TORQUE SPECIFICATIONS

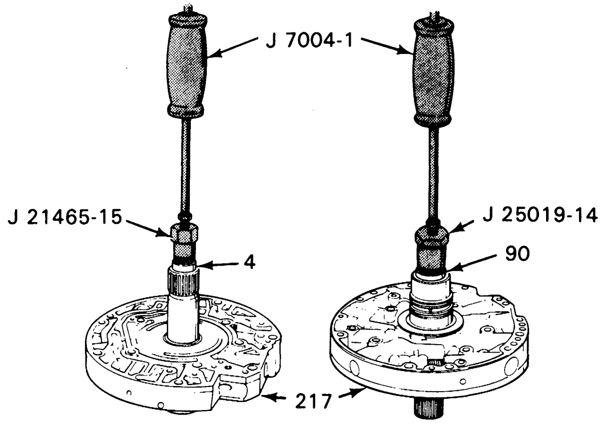
LOCATION	QTY.	SIZE	TORQUE	LOCATION	QTY.	SIZE	TORQUE
ACCUMULATOR COVER TO CASE	2	M6 1.0 x 35.0	11 N·m (8 LB.-FT.)	PARK BRAKE BRACKET TO CASE	2	M8 1.25 x 20.0	22 N·m (18 LB.-FT.)
ACCUMULATOR COVER TO CASE	1	M6 1.0 x 65.0	11 N·m (8 LB.-FT.)	PUMP COVER TO BODY	5	M8 1.25 x 40.0	22 N·m (18 LB.-FT.)
DETENT SPRING TO VALVE BODY	1	M8 1.75 x 20.0	22 N·m (18 LB.-FT.)	PUMP ASSY. TO CASE	7	M8 1.25 x 60.0	22 N·m (18 LB.-FT.)
VALVE BODY TO CASE	15	M6 1.0 x 50.0	11 N·m (8 LB.-FT.)	CASE EXTENSION TO CASE	4	M10 1.50 x 30.0	34 N·m (26 LB.-FT.)
OIL PASSAGE COVER TO AUX. VALVE BODY	3	M6 1.0 x 16.0	11 N·m (8 LB.-FT.)	MANUAL SHAFT TO INSIDE DET. LEVER	1	M10 1.50 NUT	31 N·m (23 LB.-FT.)
SOLENOID ASSY. TO PUMP	2	M6 1.0 x 12.0	11 N·m (8 LB.-FT.)	PRESSURE PLUGS	1-4	⅛ - 27	11 N·m (8 LB.-FT.)
TRANSMISSION OIL PAN TO CASE	16	M8 1.25 x 19.3	11 N·m (8 LB.-FT.)	CONNECTOR COOLER PIPE	2	¼ - 18	38 N·m (28 LB.-FT.)
PRESSURE SWITCHES	1-3	⅛ - 27	11 N·m (8 LB.-FT.)				
AUXILIARY VALVE BODY TO CASE	1	M6 1.0 x 18	11 N·m (8 LB-FT.)				
AUXILIARY VALVE BODY TO CASE	1	M6 1.0 x 35	11 N·m (8 LB.-FT.)				
AUXILIARY VALVE BODY TO CASE	1	M6 1.0 x 45	11 N·m (8 LB.-FT.)				

LH0204-4L60-R1

Figure 144 Torque Specifications and Bushing Locations

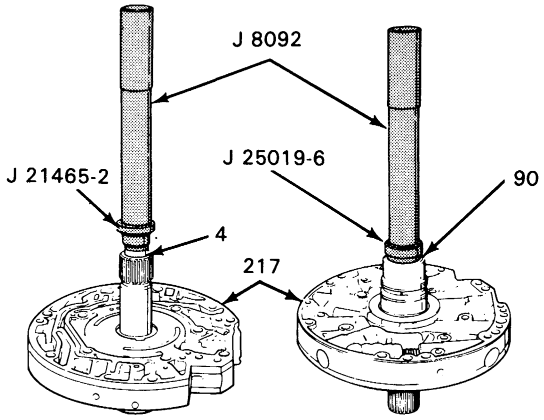
BUSHING REPLACEMENT PROCEDURE
PROTECT PARTS WITH WOOD BLOCKS OR CLOTH AS NECESSARY

REMOVE AS SHOWN



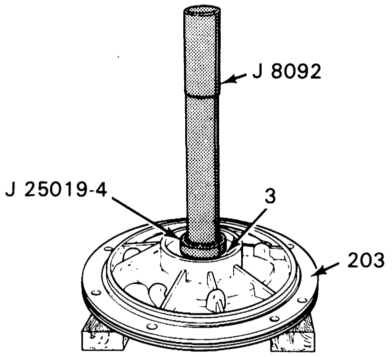
4 BUSHING, STATOR SHAFT – FRONT
90 BUSHING, STATOR SHAFT – REAR
217 COVER, PUMP

INSTALL AS SHOWN



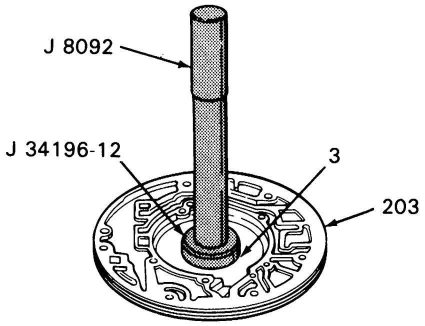
4 BUSHING, STATOR SHAFT – FRONT
90 BUSHING, STATOR SHAFT – REAR
217 COVER, PUMP

REMOVE AS SHOWN



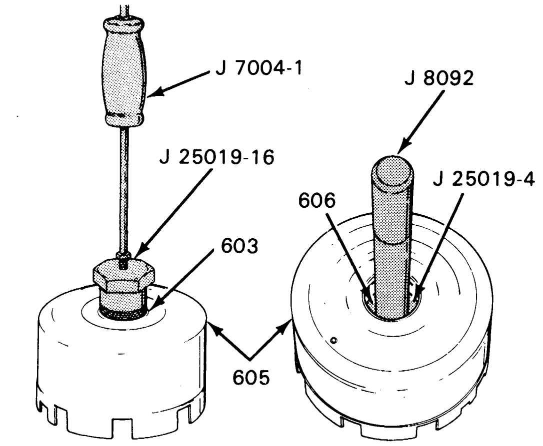
3 BUSHING, OIL PUMP BODY
203 BODY, PUMP

INSTALL AS SHOWN



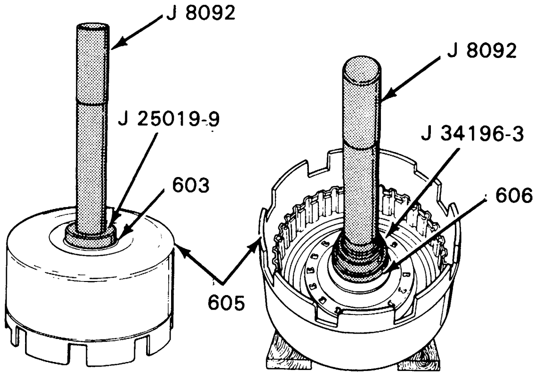
3 BUSHING, OIL PUMP BODY
203 BODY, PUMP

REMOVE AS SHOWN



603 BUSHING, REVERSE INPUT CLUTCH – FRONT
605 HOUSING & DRUM ASM., REVERSE INPUT CLUTCH
606 BUSHING, REVERSE INPUT CLUTCH – REAR

INSTALL AS SHOWN

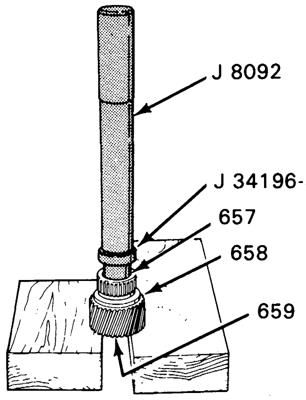
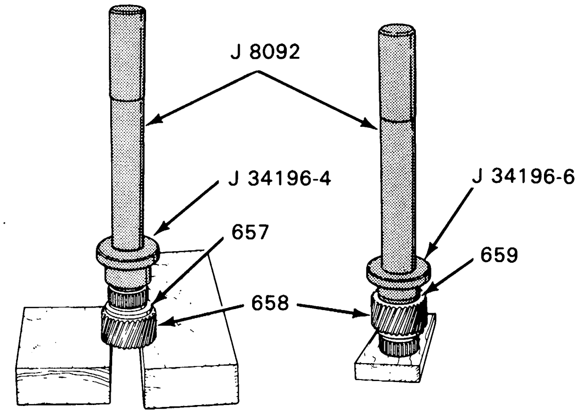
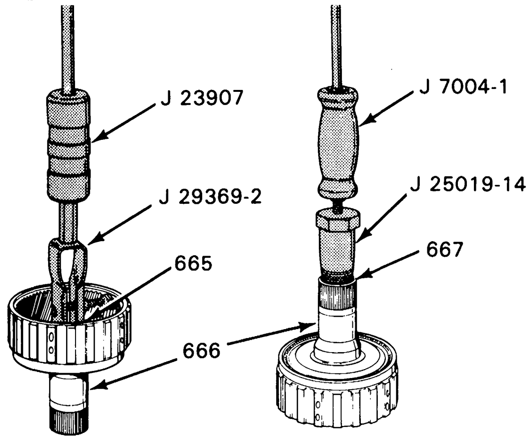
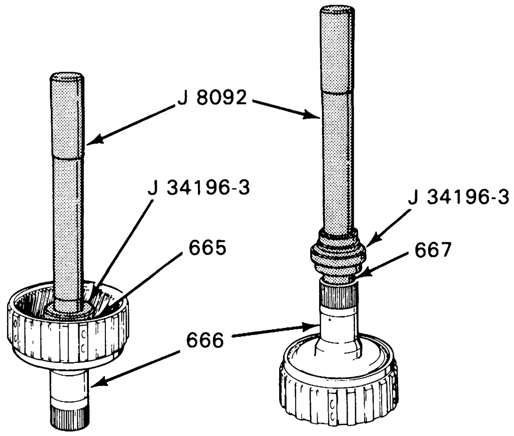
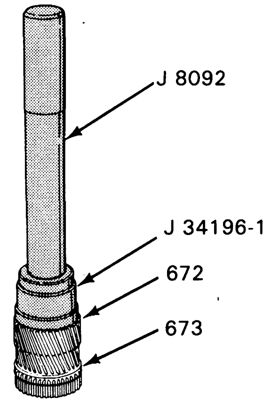
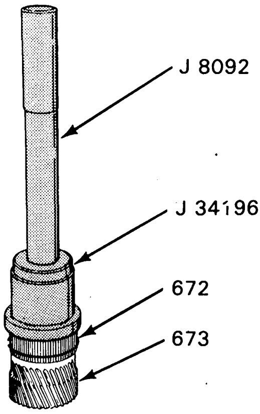


603 BUSHING, REVERSE INPUT CLUTCH – FRONT
605 HOUSING & DRUM ASM., REVERSE INPUT CLUTCH
606 BUSHING, REVERSE INPUT CLUTCH – REAR

LH0205-4L60

Figure 145 Bushing Replacement Procedure

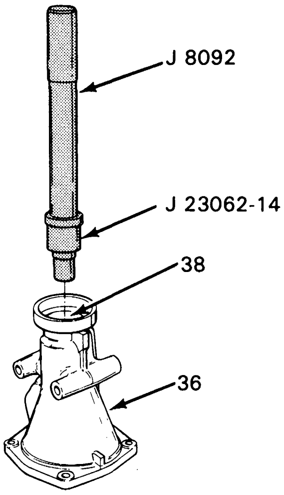
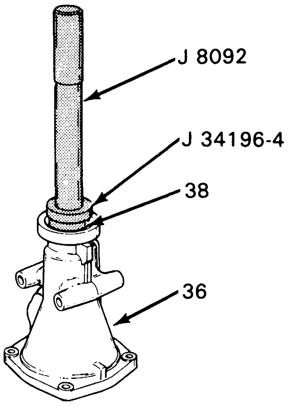
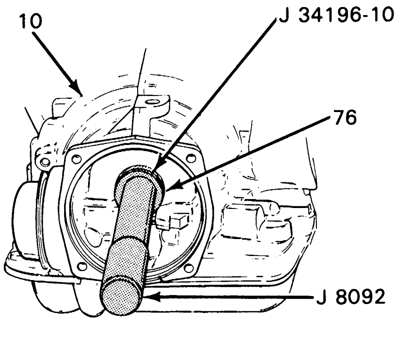
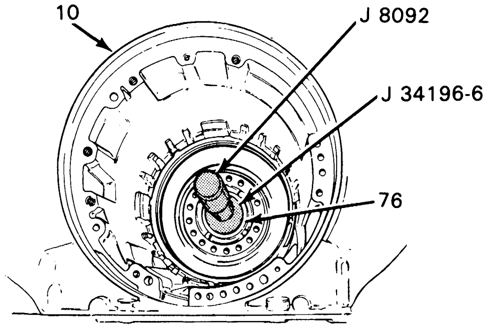
BUSHING REPLACEMENT PROCEDURE
PROTECT PARTS WITH WOOD BLOCKS OR CLOTH AS NECESSARY

REMOVE AS SHOWN	INSTALL AS SHOWN
 657 BUSHING, INPUT SUN GEAR – FRONT 658 GEAR, INPUT SUN 659 BUSHING, INPUT SUN GEAR – REAR	 657 BUSHING, INPUT SUN GEAR – FRONT 658 GEAR, INPUT SUN 659 BUSHING, INPUT SUN GEAR – REAR
 665 BUSHING, REACTION CARRIER SHAFT – FRONT 666 SHAFT, REACTION CARRIER 667 BUSHING, REACTION CARRIER SHAFT – REAR	 665 BUSHING, REACTION CARRIER SHAFT – FRONT 666 SHAFT, REACTION CARRIER 667 BUSHING, REACTION CARRIER SHAFT – REAR
 672 BUSHING, REACTION SUN 673 GEAR, REACTION SUN	 672 BUSHING, REACTION SUN 673 GEAR, REACTION SUN

LH0206-4L60

Figure 146 Bushing Replacement Procedure

BUSHING REPLACEMENT PROCEDURE
PROTECT PARTS WITH WOOD BLOCKS OR CLOTH AS NECESSARY

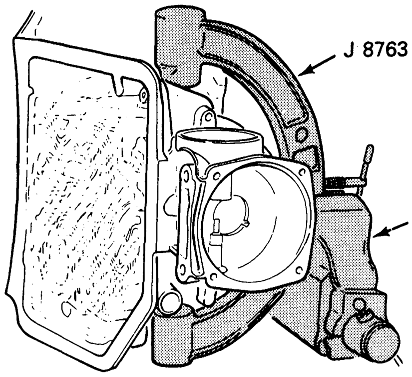
REMOVE AS SHOWN	INSTALL AS SHOWN
 36 EXTENSION, CASE 38 BUSHING, CASE EXTENSION	 36 EXTENSION, CASE 38 BUSHING, CASE EXTENSION
 10 CASE, TRANSMISSION 76 BUSHING, CASE	 10 CASE, TRANSMISSION 76 BUSHING, CASE

LH0207-4L60

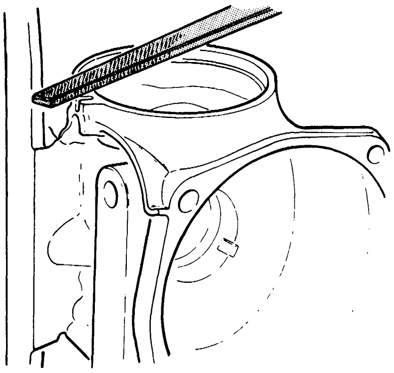
Figure 147 Bushing Replacement Procedure

GOVERNOR BORE REPAIR PROCEDURE

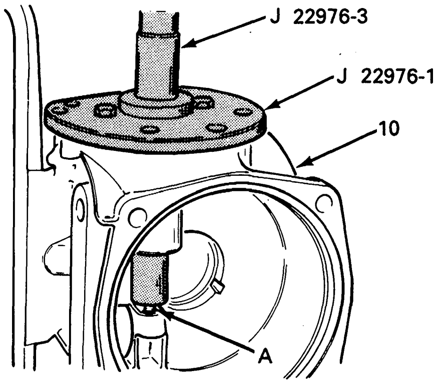
FOLLOW STEPS 1-6 TO REPAIR THE GOVERNOR BORE



STEP 1 Install holding fixture J 8763 and mount in vise.

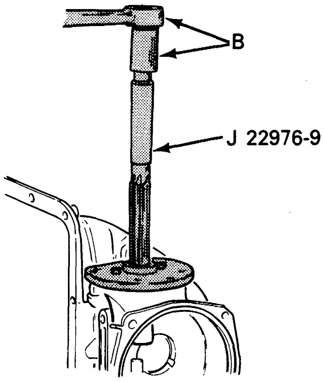


STEP 2 Remove (file) any excess material from the governor face.



A PIN, GOVERNOR SUPPORT
10 CASE, TRANSMISSION

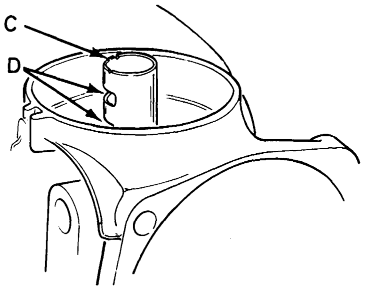
STEP 3 Install J 22976-3 and J 22976-1. Torque bolts to 13 N·m (10 ft.-lbs.). Make sure J 22976-3 rotates freely and then remove it.



B RATCHET & SOCKET

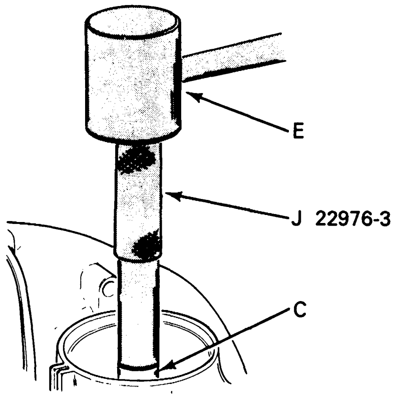
STEP 4 Ream the governor bore as follows:

- Oil J 22976-9, J 22976-1 and the governor bore with transmission fluid.
- After each ten revolutions, remove the reamer and dip in transmission fluid to clean.
- After the reamer reaches the end of the bore and bottoms on the governor support pin, rotate the reamer ten additional revolutions.
- Remove the reamer. Be certain to rotate during removal to prevent scoring the bore.
- Remove the tools and thorougly clean the case.



C BUSHING
D SLOTS

STEP 5 Align the slots in the bushing with the slots in the governor bore.



C BUSHING
E BRASS HAMMER

STEP 6 Install the bushing until the slots in the bushing align with the feed holes in the governor bore.

LH0208-4L60

Figure 148 Governor Bore Repair Procedure

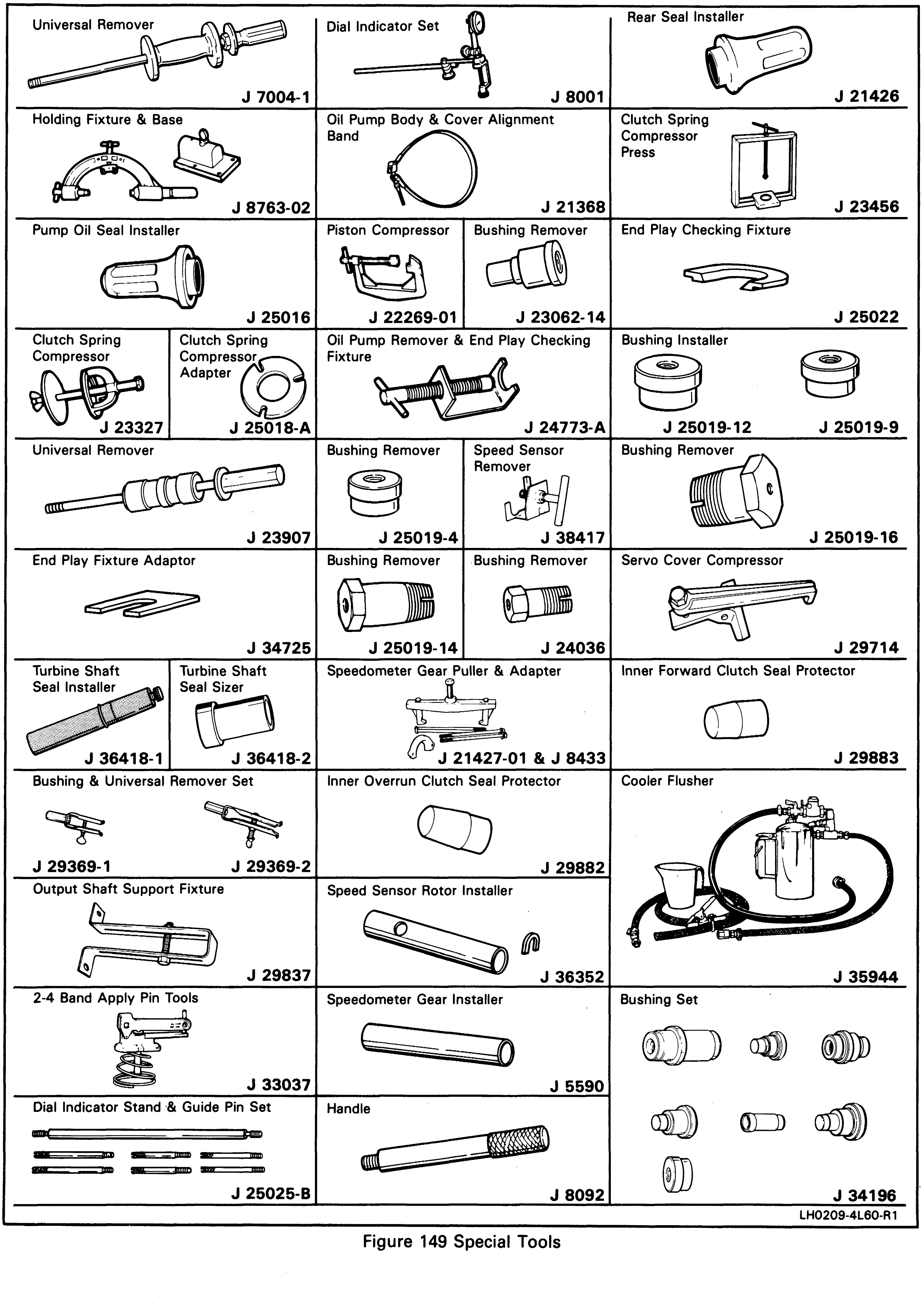


Figure 149 Special Tools

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SECTION 7B

MANUAL TRANSMISSION

RPO M39, MK6, AND MB1

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology:"**NOTICE:** See "Notice" on page 7B-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

The MB1 transmission is the only manual transmission available for the V6 engine. The M39 and MK6 transmissions are available for the V8 engine.

Manual transmissions are identified by the number of forward gears and the measured distance between centerlines of the mainshaft and the countergear.

The 5-speed 77 mm transmission is a fully synchronized unit with blocker ring synchronizers and a sliding mesh reverse gear. First and second gears have three-piece synchronizer rings, consisting of steel inner and outer cones and a tapered metal ring that is lined on both sides with friction material similar to automatic transmission friction plates. The cones are independent of the gears and can be replaced separately. Third and fourth gear blocker rings are more conventional in appearance, but are also lined with friction material. The fifth gear blocker ring is brass.

NOTICE: No lubricant other than Dexron® II number 1051855 or equivalent should be used in this transmission. Other lubricants or additives may damage the blocker ring friction material or its adhesive.

The mainshaft and the countershaft are supported on tapered roller bearings and must be shimmed for proper end play. First through fourth speed mainshaft gears ride on caged roller bearings. An aluminum transmission case houses the various gears and bearings. The gearshift lever assembly is mounted on top of the extension housing. The shift mechanism does not require adjustment and can be serviced independently of the transmission.

DIAGNOSIS

For diagnosis of the 5-speed 77 mm transmission, refer to the diagnosis chart.

CONDITION	POSSIBLE CAUSE	CORRECTION
Transmission Shifts Hard	1. Incorrect clutch travel.	1. Refer to CLUTCH (SEC. 7C).
	2. Misaligned clutch	2. Check alignment and adjust

CONDITION	POSSIBLE CAUSE	CORRECTION
	housing bore to crankshaft pilot.	as necessary.
	3. Binding shift rail.	3. Check for mispositioned selector arm roll pin, loose cover bolts, worn shift rail bores, worn shift rail, distorted oil seal, or extension housing not aligned with case. Repair as necessary.
	4. Internal bind in transmission caused by shift forks, selector plates, or synchronizer assemblies.	4. Remove, disassemble and inspect transmission. Replace worn or damaged components as necessary.
	5. Incorrect lubricant.	5. Drain and refill transmission.
Gear Clash When Shifting from One Gear to Another	1. Incorrect clutch travel.	1. Refer to CLUTCH (SEC. 7C).
	2. Low lubricant level or incorrect lubricant.	2. Drain and refill transmission. If lubricant level was low, check for leaks and repair as necessary.
	3. Worn or damaged gearshift components, or synchronizer assemblies.	3. Remove, disassemble and inspect transmission. Replace worn or damaged components as necessary.
Noisy Transmission	1. Low lubricant level or incorrect lubricant.	1. Drain and refill transmission. If lubricant level was low, check for leaks and repair as necessary.
	2. Loose clutch housing-to-engine, or transmission-to-clutch, housing bolts.	2. Check and correct bolt torque as necessary.
	3. Misaligned clutch housing bore to crankshaft pilot.	3. Check alignment and adjust as necessary.
	4. Worn or damaged gearshift mechanism, transmission gears, or bearing components.	4. Remove, disassemble and inspect transmission. Replace worn or damaged components as necessary.
Jumps Out of Gear	1. Worn offset lever plastic insert or loose lever.	1. Remove gearshift lever and check for loose offset lever or worn insert. Repair or replace as necessary.
	2. Worn or damaged gearshift mechanism, shift forks, selector plates, interlock plate, selector arm,	2. Remove, disassemble and inspect transmission cover assembly. Replace worn or damaged components as necessary.

CONDITION	POSSIBLE CAUSE	CORRECTION
	shift rail, springs or shift cover. 3. Worn or tapered gear teeth, worn or damaged synchronizer assemblies, excessive end play caused by worn thrust washers or output shaft gears.	 3. Remove, disassemble and inspect transmission. Replace worn or damaged components as necessary.
Will Not Shift into One Gear	1. Worn, damaged, or incorrectly assembled gearshift selector plates, interlock plate, or selector arm. 2. Damaged or worn synchronizer sleeves or hubs.	1. Remove, disassemble, and inspect transmission cover assembly. Repair or replace components as necessary. 2. Remove, disassemble, and inspect transmission. Replace worn or damaged components.
Locked in One Gear, Cannot Be Shifted Out	1. Worn or broken shift rail(s), bent or damaged shifter fork. 2. Worn gearshift lever, incorrectly assembled or broken shift mechanism in cover, worn or damaged gear train components.	1. Inspect and replace worn or damaged parts. 2. Disassemble transmission. Replace damaged parts or assemble correctly.

ON-VEHICLE SERVICE

SHIFT CONTROL ASSEMBLY

Remove or Disconnect

1. Console. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
2. Shift control assembly boot screws.
3. Shift control assembly boot.
4. Shift control assembly bolts.
5. Shift control assembly.

NOTICE: The upper lever is no longer threaded to the lower lever. The levers are bonded together. Separation of the levers will damage the shifter, requiring replacement of the shifter assembly.

Install or Connect

NOTICE: See "Notice" on page 7B-1 of this section.

Clean

- Sealant from extension housing.
- Sealant from shift control assembly, if reinstalling.
- Apply a continuous 3mm (1/8-inch) bead of RTV Sealant GM part number 1052751, or equivalent to extension housing sealing surface.

1. Shift control assembly.
2. Shift control assembly bolts.

Tighten

- Bolts to 17 N·m (13 lb ft.).

3. Shift control assembly boot.
4. Shift control assembly boot screws.

Tighten

- Screws to 6 N·m (53 lb. in.).

5. Console. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).

TRANSMISSION MOUNT

Figure 1

Remove or Disconnect

1. Negative (-) battery cable.

- Raise the vehicle and suitably support. Refer to GENERAL INFORMATION (SEC. 0A).

2. Transmission mount-to-support nut(s).
- Support the transmission with a jack.
3. Support-to-rail bolts.
- Raise the transmission.
4. Support.
5. Mount-to-transmission bolts.
6. Transmission mount.
7. Shims, if equipped.

Install or Connect

NOTICE: See "Notice" on page 7B-1 of this section for steps 3, 5 and 6.

1. Shims, if equipped.
2. Transmission mount.
3. Mount-to-transmission bolts.

Tighten

- Bolts to 54 N·m (40 lb. ft.).

- Lower the transmission.
4. Support.
5. Support-to-rail bolts.

Tighten

- Bolts to 54 N·m (40 lb. ft.).

- Remove the transmission jack.
6. Transmission mount-to-support nut(s).

Tighten

- Nuts to 47 N·m (35 lb. ft.).

- Lower the vehicle.
7. Negative (-) battery cable.

TRANSMISSION

Figures 2 and3

Tool Required:
J 34162-A Holding Fixture

Remove or Disconnect

1. Negative battery cable.
2. Shift control lever knob.
- Raise the vehicle and suitably support. Refer to GENERAL INFORMATION (SEC. 0A).
- Drain transmission.
3. Propeller shaft. Refer to PROPELLER SHAFT (SEC. 4A).
- Support left side of rear axle with an adjustable lifting device. See Figure 2.

NOTICE: Rear axle must be supported on the left side only or damage to brake lines could result.

4. Torque arm rear attaching bolts.
5. Front torque arm outer bracket and torque arm.
6. Speed sensor connector.
7. Backup lamp wiring harness connector.
8. Catalytic converter hanger nuts and bolt.

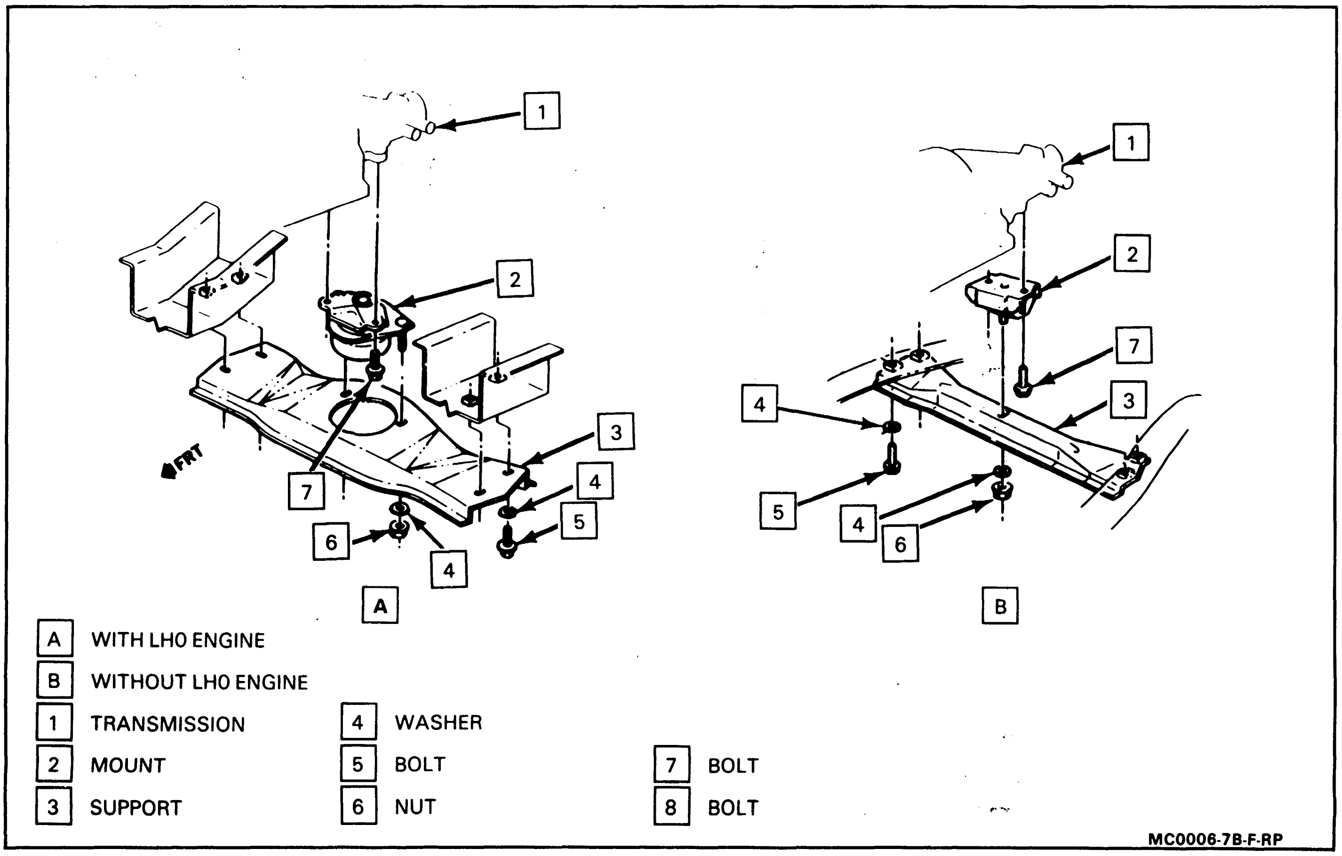


Figure 1 - Transmission Mount

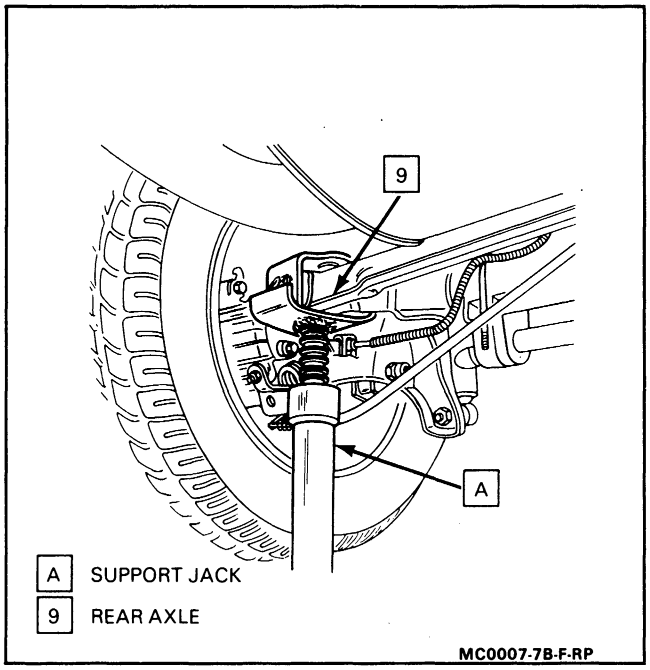


Figure 2 - Rear Axle Support - Left Side

9. Catalytic converter hanger.
- Support the engine with a suitable jackstand.
10. Transmission mount nuts at the support.
11. Support bolts.
12. Support.

- Lower transmission, with aid of a helper, enough to reach shift control assembly.
13. Shift control assembly bolts.
14. Shift control assembly from extension housing.
15. Transmission-to-flywheel housing bolts.
16. Transmission, with the aid of a helper.
- Place transmission in J 34162-A.

Important

- Inspection of clutch components should be made after transmission removal. If the clutch requires repair, refer to CLUTCH (SEC. 7C) before transmission is reinstalled.
- If replacing the transmission, the original shift control assembly must be reattached before returning the transmission. The replacement tranmission will have an attached shift control assembly that must be removed before installation to the vehicle.

Install or Connect

NOTICE: See "Notice" on page 7B-1 of this section.

Clean

- Sealant from extension housing.
- Sealant from shift control assembly.
- Apply a continuous 3mm (1/8-inch) bead of RTV sealant GM part number 1052751, or equivalent, to extension housing sealing surface.

1. Transmission, with aid of helper.
2. Transmission-to-flywheel housing bolts.

Tighten

- Bolts to 75 N·m (55 lb. ft.).
3. Shift control assembly to extension housing.
4. Shift control assembly bolts.

Tighten

- Four bolts to 17 N·m (13 lb. ft.).
5. Support.
6. Support bolts.

Tighten

- Bolts to 54 N·m (40 lb. ft.).
7. Transmission mount nuts to the support.

Tighten

- Nuts to 47 N·m (35 lb. ft.).
8. Catalytic converter hanger.
9. Catalytic converter hanger nuts and bolt.

Tighten

- Nuts to 40 N·m (35 lb. ft.).

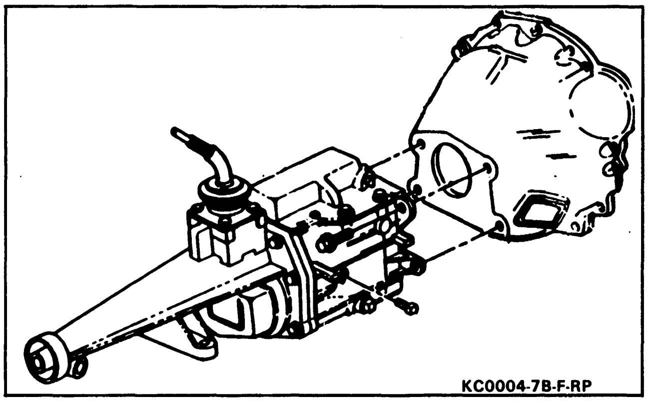


Figure 3 - Transmission to Engine Attachment

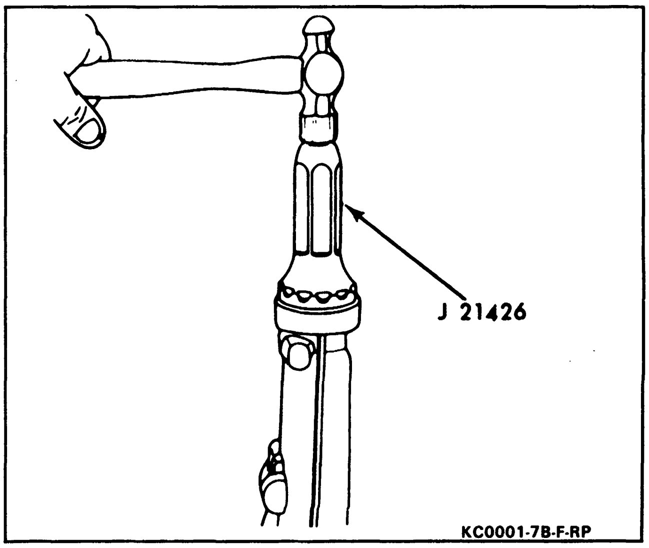
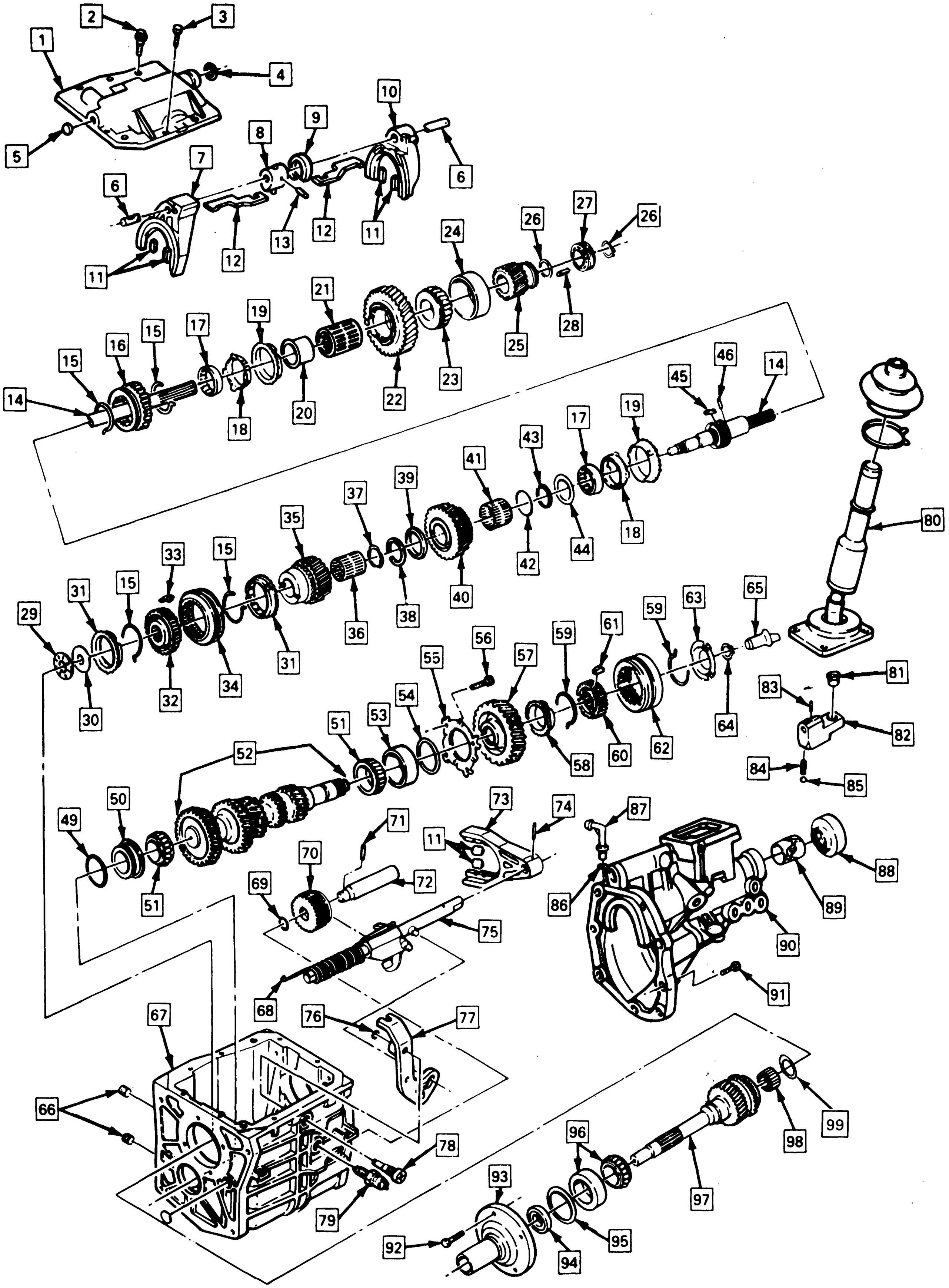


Figure 4 - Installing Extension Housing Oil Seal



MC0001-7B-F-RP

Figure 5 - 5-Speed 77 mm Transmission

1. COVER, TRANSMISSION
2. BOLT, ALIGNMENT DOWEL
3. BOLT
4. SEAL, O-RING
5. PLUG, SHIFT RAIL
6. RAIL, SHIFT
7. FORK, 3RD AND 4TH SHIFT
8. ARM, SELECTOR
9. PLATE, GEAR SELECT INTERLOCK
10. FORK, 1ST AND 2ND SHIFT
11. INSERT, SHIFT FORK
12. PLATE, SHIFT FORK
13. PIN, ROLL - SELECTOR ARM
14. SHAFT, MAIN WITH 1ST AND 2ND SYNCHRONIZER HUB
15. SPRING, SYNCHRONIZER
16. GEAR, REVERSE SLIDING
17. CONE, INNER - 1ST AND 2ND SYNCHRONIZER
18. CONE, OUTER - 1ST AND 2ND SYNCHRONIZER
19. RING, BLOCKER - 1ST AND 2ND SYNCHRONIZER
20. SLEEVE, 1ST GEAR BEARING
21. BEARING, 1ST GEAR
22. GEAR, 1ST SPEED
23. BEARING, MAINSHAFT REAR
24. RACE, MAINSHAFT REAR BEARING
25. GEAR, 5TH SPEED DRIVEN
26. RING, SNAP
27. GEAR, SPEEDOMETER DRIVE
28. CLIP, SPEEDOMETER DRIVE GEAR
29. BEARING, MAIN DRIVE-GEAR THRUST
30. RACE, MAIN DRIVE GEAR THRUST BEARING
31. RING, BLOCKER - 3RD AND 4TH SYNCHRONIZER
32. HUB, 3RD AND 4TH SYNCHRONIZER
33. KEY, SYNCHRONIZER
34. SLEEVE, 3RD AND 4TH SYNCHRONIZER
35. GEAR, 3RD SPEED
36. BEARING, 3RD GEAR
37. SPACER, 3RD GEAR BEARING
38. RING, SNAP 2ND GEAR THRUST WASHER
39. WASHER, THRUST - 2ND GEAR
40. GEAR, 2ND SPEED
41. BEARING, 2ND GEAR
42. SPACER, 2ND GEAR BEARING
43. RING, SPIRAL RETAINING - 2ND SYNCHRONIZER
44. WASHER, THRUST - 2ND SYNCHRONIZER
45. KEY, 1ST-2ND SYNCHRONIZER
46. PIN, LOCATING - 1ST SPEED BEARING SLEEVE
49. O-RING, BEARING RACE
50. RACE, FRONT COUNTERSHAFT BEARING
51. BEARING, COUNTERSHAFT
52. GEAR CLUSTER, COUNTERSHAFT
53. RACE, REAR COUNTERSHAFT
54. SHIM, COUNTERSHAFT BEARING ADJUSTMENT
55. RETAINER, COUNTERSHAFT
56. BOLT, COUNTERSHAFT RETAINER
57. GEAR, 5TH SPEED DRIVE
58. RING, BLOCKER - 5TH SYNCHRONIZER
59. SPRING, 5TH SYNCHRONIZER
60. HUB, 5TH SYNCHRONIZER
61. KEY, 5TH SYNCHRONIZER
62. SLEEVE, 5TH SYNCHRONIZER
63. RETAINER, 5TH SYNCHRONIZER
64. RING, SNAP - 5TH SYNCHRONIZER RETAINER
65. FUNNEL, TRANSMISSION OILING
66. PLUG, FILL AND DRAIN
67. CASE, TRANSMISSION
68. SPRING, REVERSE LOCK
69. O-RING, REVERSE IDLER
70. GEAR, REVERSE IDLER
71. PIN, ROLL - REVERSE IDLER
72. SHAFT, REVERSE IDLER
73. FORK, 5TH SHIFT
74. PIN, ROLL - SHIFT FORK
75. RAIL, 5TH AND REVERSE SHIFT
76. CLIP, SPRING – 5TH AND REVERSE LEVER
77. LEVER, 5TH AND REVERSE SHIFT
78. BOLT, 5TH AND REVERSE SHIFT LEVER PIVOT
79. SWITCH, REVERSE LAMP
80. CONTROL, TRANSMISSION SHIFT LEVER AND HOUSING
81. SLEEVE, SHIFT LEVER DAMPER
82. LEVER, OFFSET SHIFT
83. PIN, ROLL - OFFSET LEVER
84. SPRING, DETENT
85. BALL, DETENT
86. O-RING, EXTENSION HOUSING VENT
87. VENT, EXTENSION HOUSING
88. SEAL, EXTENSION HOUSING REAR OIL
89. BUSHING, EXTENSION HOUSING
90. HOUSING, EXTENSION
91. BOLT, EXTENSION HOUSING
92. BOLT, DRIVE GEAR BEARING RETAINER
93. RETAINER, DRIVE GEAR BEARING
94. SEAL, DRIVE GEAR BEARING RETAINER OIL
95. SHIM, MAINSHAFT BEARING ADJUSTMENT
96. RACE, MAIN DRIVE GEAR FRONT BEARING
97. GEAR, MAIN DRIVE
98. BEARINGS, ROLLER – MAIN DRIVE GEAR PILOT
99. SPACER

MC0002-7B-F-RP

Figure 6 - 5-Speed 77 mm Transmission - Legend

10. Backup lamp wiring harness connector.
11. Speed sensor connector.
- Position torque arm and loosely install rear torque arm bolts.
12. Front torque arm bracket.

Tighten

- Nuts to 27 N·m (20 lb. ft.).

Tighten

- Rear torque arm nuts to 133 N·m (98 lb. ft.). • Remove support from rear axle.

13. Propeller shaft. Refer to PROPELLER SHAFT (SEC. 4A).
- Refill the transmission with Dexron® II GM Part Number 1051855, or equivalent.
- Lower the vehicle.
14. Shift control lever knob.
15. Negative battery cable.

EXTENSION HOUSING OIL SEAL

Figure 4

Remove or Disconnect

1. Propeller shaft. Refer to PROPELLER SHAFT (SEC. 4A).
2. Seal, using a screwdriver.

Install or Connect

Tool Required:

J 21426 Extension Housing Seal Installer

1. New seal, using J 21426.
- Lubricate inside diameter of seal with transmission fluid.
2. Propeller shaft. Refer to PROPELLER SHAFT (SEC. 4A).

Inspect

- Transmission oil level.

SPEED SENSOR

Remove or Disconnect

1. Negative (-) battery cable.
- Raise and suitably support the vehicle. Refer to GENERAL INFORMATION (SEC. 0A).
2. Speed sensor electrical connector.
3. Retaining bolt.
4. Speed sensor with the speedometer driven gear.

Inspect

- Inspect O-ring seal and transmission case. Replace O-ring seal, if necessary.

Install or Connect

NOTICE: See "Notice" on page 7B-1 of this secton.

1. Speed sensor with the speedometer driven gear.
2. Retaining bolt.

NOTICE: The speedometer driven gear and vehicle speed sensor must be fully seated in the transmission before the retaining bolt is tightened or damage to the speedometer driven gear will result.

Tighten

- Bolt to 10 N·m (89 lb. in.).

3. Speed sensor electrical connector.
- Lower the vehicle.
4. Negative (-) battery cable.

CHECKING FLUID LEVEL

- Raise the vehicle and suitably support. Refer to GENERAL INFORMATION (SEC. 0A).

Clean

- All dirt and oil from around the fill plug.
  - The fill plug is located on the right side of the transmission.

Remove or Disconnect

- Fill plug.
- The fluid level should be even with the bottom of the fill plug hole.

Install or Connect

- Use only Dexron® II number 1051855, or equivalent.

NOTICE: See "Notice" on page 7B-1 of this section.

- Fill plug.

Tighten

- Fill plug to 27 N·m (20 lb. ft.).

- Lower the vehicle.

UNIT REPAIR

TRANSMISSION - DISASSEMBLY

Figures 5 through 22

Clean

- Exterior of the transmission assembly thoroughly with appropriate solvent.

Disassemble

Tools Required:

J 37359 Countershaft Bearing Remover

J 22912-01 Bearing and Gear Puller

- Remove drain bolt on transmission case and drain lubricant.

NOTICE: Removal of offset lever in position other than neutral (centered) may result in driving the roll pin into the detent plate without releasing lever, making further disassembly extremely difficult.

- Position offset lever in neutral gate (centered).

1. Roll pin attaching offset lever to shift rail (Figure 7).
2. Extension housing-to-transmission case bolts.

NOTICE: Do not attempt to remove the offset lever while the extension housing is still bolted in place. The lever has a positioning lug engaged in the housing detent plate, which prevents moving the lever far enough for removal.

3. Housing and offset lever as an assembly (Figure 8).
4. Detent ball and spring from offset lever (Figure 9).
5. Roll pin from extension housing or offset lever.
6. Oiling funnel from rear of countershaft (Figure 10).
7. Bolts attaching transmission cover and shift fork assembly to case.
   - Two of the transmission cover attaching bolts are alignment-type dowel bolts. Note the location of these bolts for assembly reference.
8. Cover (Figure 11).

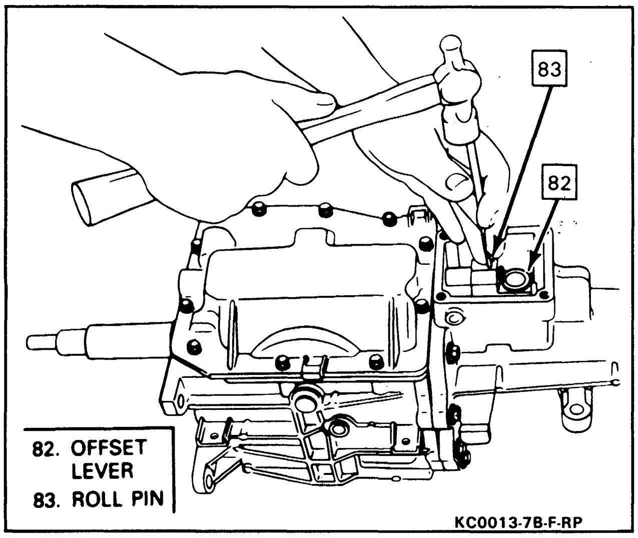


Figure 7 - Offset Lever

9. Reverse lever spring clip, pivot bolt and shift lever (Figure 12).
10. Backup lamp switch.
11. Fifth gear synchronizer snap ring and retainer from rear of countershaft (Figure 13).
12. Unhook reverse lock spring from front of transmission case (Figure 14).

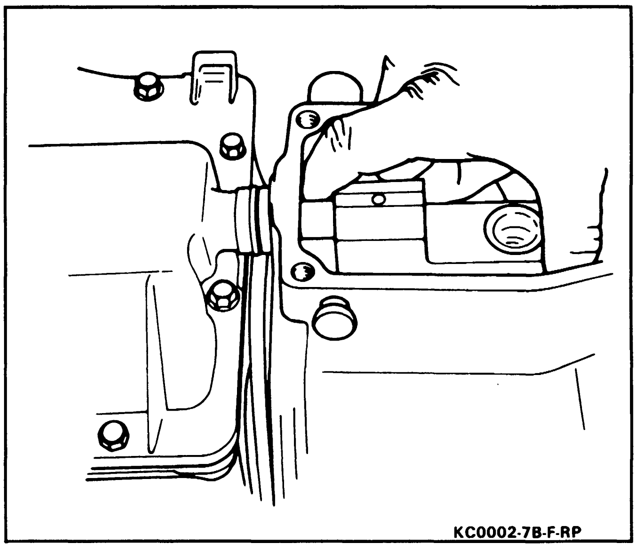


Figure 8 - Extension Housing to Transmission Case

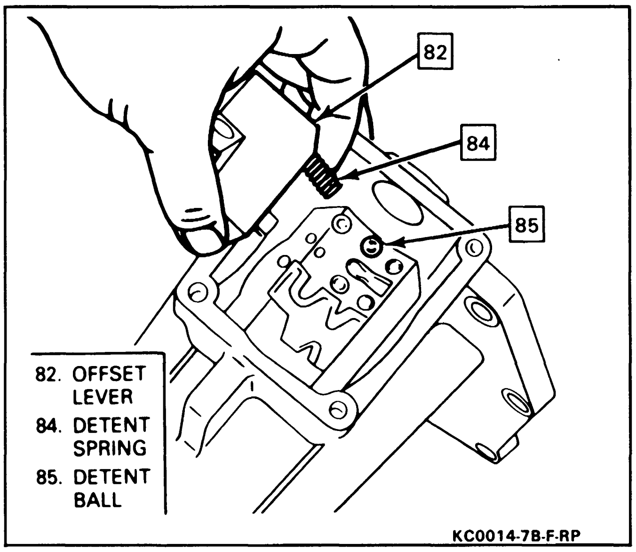


Figure 9 - Detent and Offset Lever

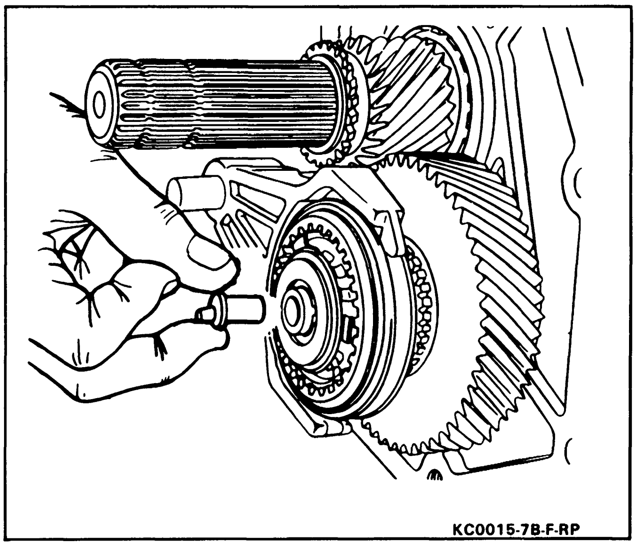


Figure 10 - Oiling Funnel

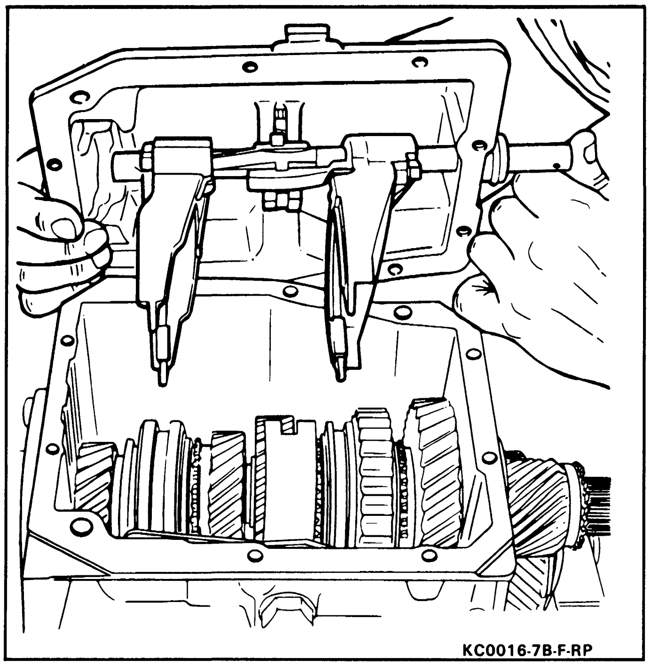


Figure 11 - Transmission Cover

13. Fifth gear, synchronizer, shift fork and shift rail as an assembly. If necessary, rotate rail to disengage from reverse lever assembly (Figure 15).
14. Circlip, speedometer gear and retaining clip.
15. Snap ring from fifth speed driven gear (Figure 16).
16. Front bearing retainer bolts.
17. Front bearing retainer.
18. Front bearing race and end play shims from front bearing retainer (Figure 17).
19. Rotate drive gear until flat surface faces countershaft and remove drive gear from the transmission case.
    - Be careful not to drop the 15 roller bearings, thrust bearing, or race from the rear of drive gear (Figure 18).
20. Fourth gear blocker ring from third/fourth synchronizer.
21. Mainshaft rear bearing race.
    - If the race sticks, it is probably misaligned in the case bore. To free the race, work the shaft back and fourth in the case.
- Tilt mainshaft upward and remove assembly from transmission case (Figure 19).
22. Reverse fork assembly from transmission case.
23. Countershaft retainer and shims (Figure 20).
24. Roll pin from forward end of reverse idler shaft.
25. Remove reverse idler shaft, rubber O-ring and gear from the transmission case (Figure 21).
26. Rear countershaft bearing race.
27. Countershaft bearing using appropriate pullers (Figure 22).
- Move countershaft assembly rearward, tilt countershaft upward and remove from case.
28. Rear countershaft bearing from shaft using J 37359 with J 22912-01.

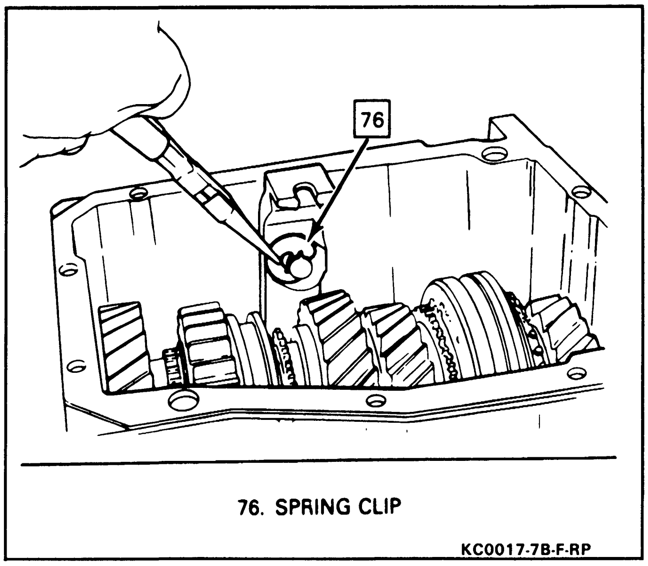


Figure 12 - Reverse Lever Spring Clip

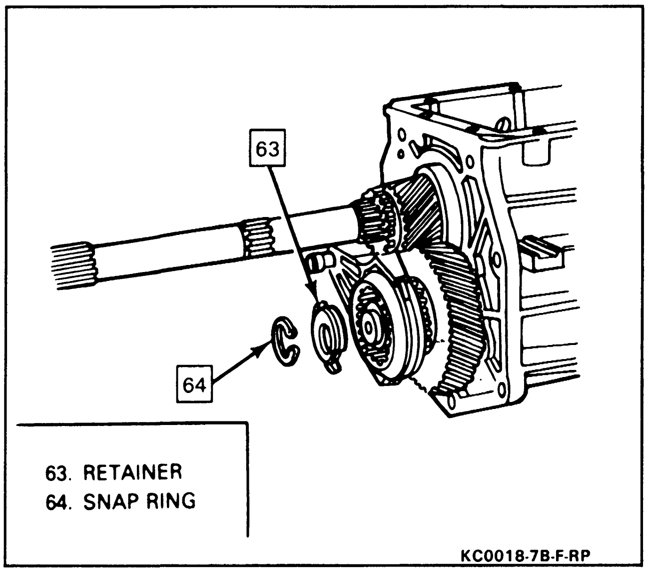


Figure 13 - Fifth Gear Synchronizer Retainer

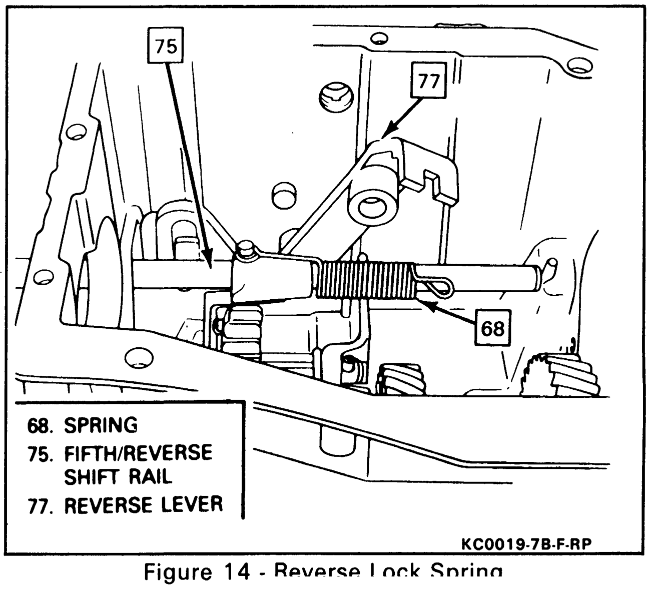


Figure 14 - Reverse Lock Spring

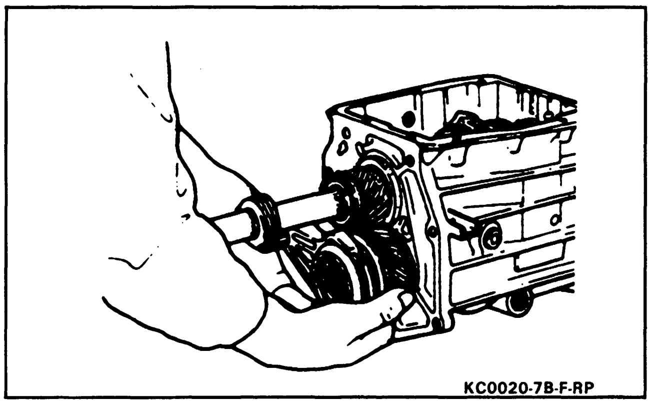


Figure 15 - Fifth Gear Synchronizer

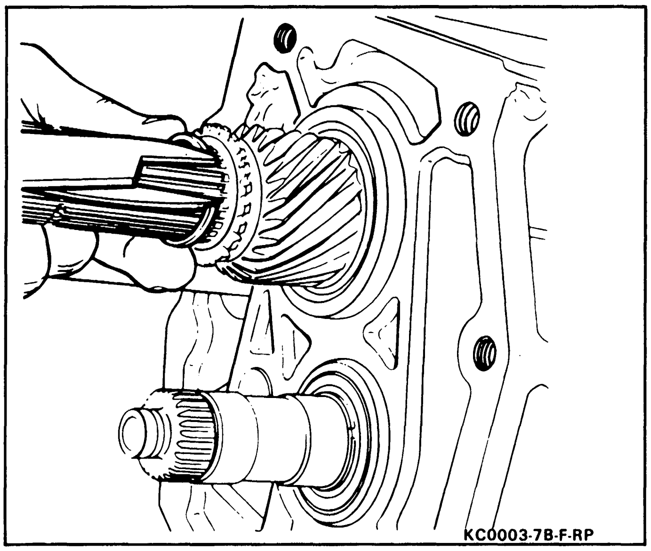


Figure 16 - Fifth Gear Snap Ring

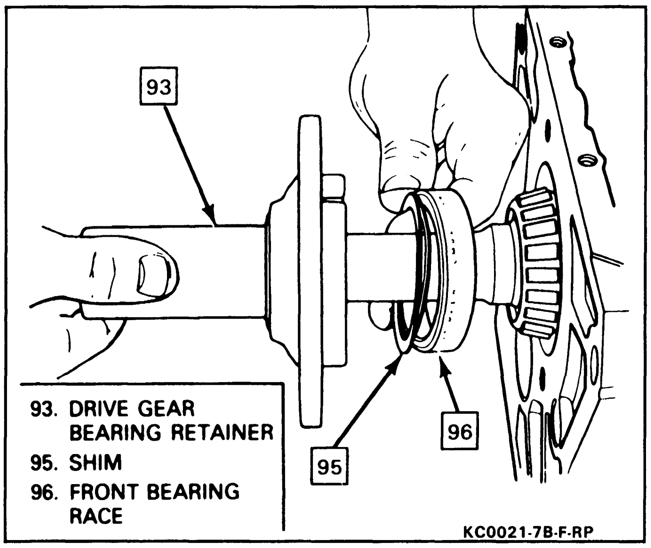


Figure 17 - Bearing Retainer and Shims

MAINSHAFT - DISASSEMBLY

Figures 23 through 25

Disassemble

Tool Required:

J 22912-01 Bearing and Gear Puller

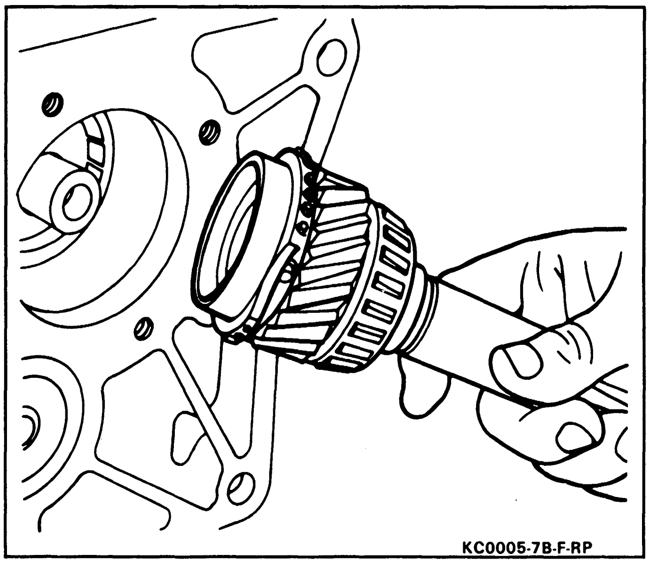


Figure 18 - Drive Gear

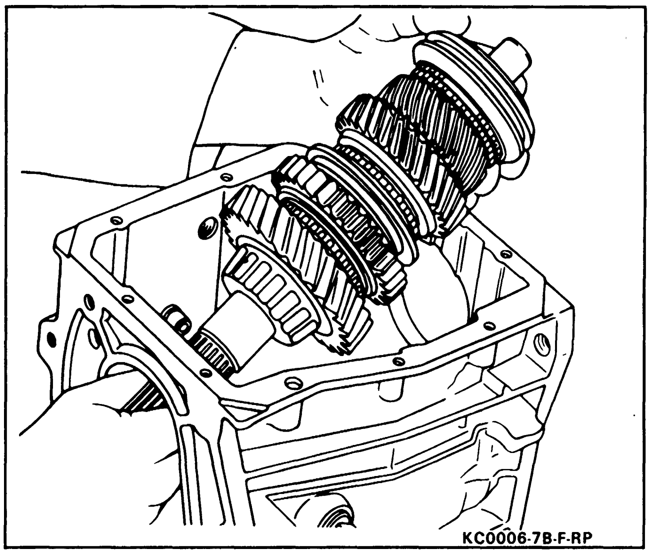


Figure 19 - Mainshaft

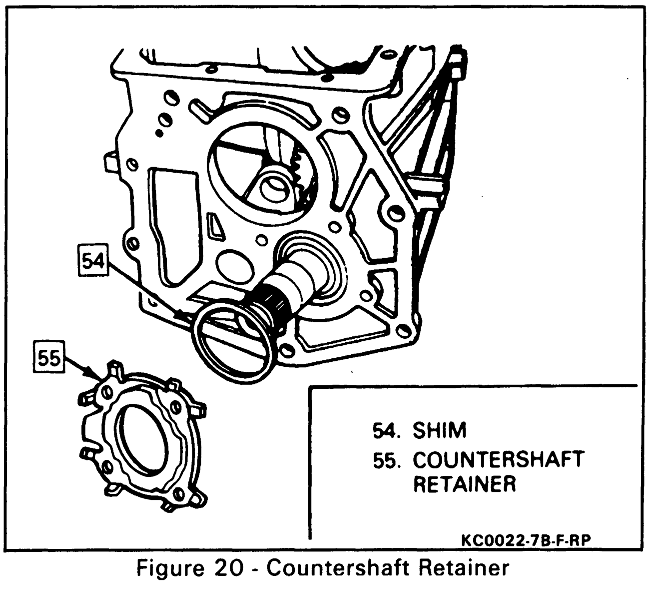


Figure 20 - Countershaft Retainer

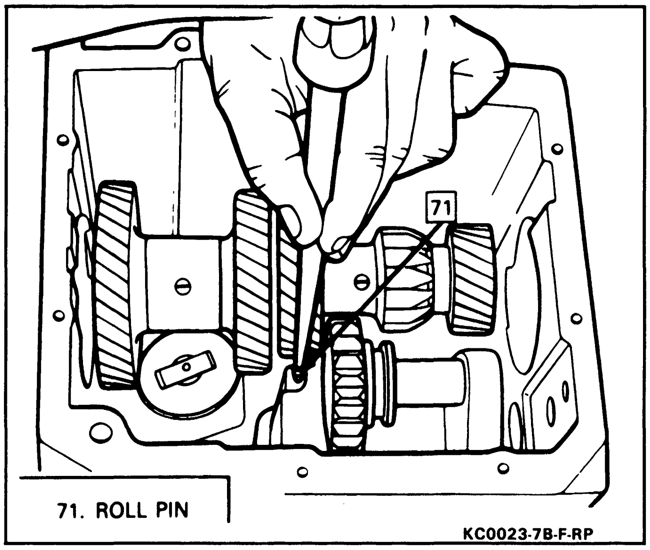


Figure 21 - Removing Reverse Idler Shaft Roll Pin

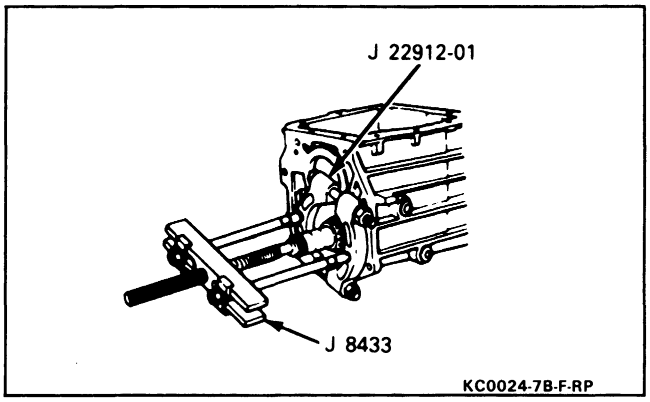


Figure 22 - Removing Countershaft Bearing

1. Thrust bearing and race from front end of mainshaft.
- Scribe reference mark on third-fourth synchronizer hub and sleeve for reassembly.
2. Third-fourth synchronizer, third blocker ring, sleeve, hub and third gear as an assembly from mainshaft, using J 22912-01 and press.
3. Needle bearing assembly and spacer.
4. Second gear snap ring and thrust washer.
5. Second gear, spacer and needle bearing.
6. Spiral snap ring.
7. Thrust washer.
8. Three-piece second gear blocker ring assembly.
- Scribe reference mark on first-second synchronizer hub and sleeve for reassembly.
9. First/second synchronizer spring and keys from first-reverse sliding gear.
10. Sleeve from mainshaft hub.

NOTICE: Do not attempt to remove the first-second-reverse hub from mainshaft. The hub and shaft are permanently assembled and machined as a matched set.

11. Fifth gear, using J 22912-01 and press.
12. Mainshaft rear bearing assembly.
13. First gear.
14. Needle bearing and sleeve.
15. Locating pin.
16. Three-piece first gear blocker ring assembly.

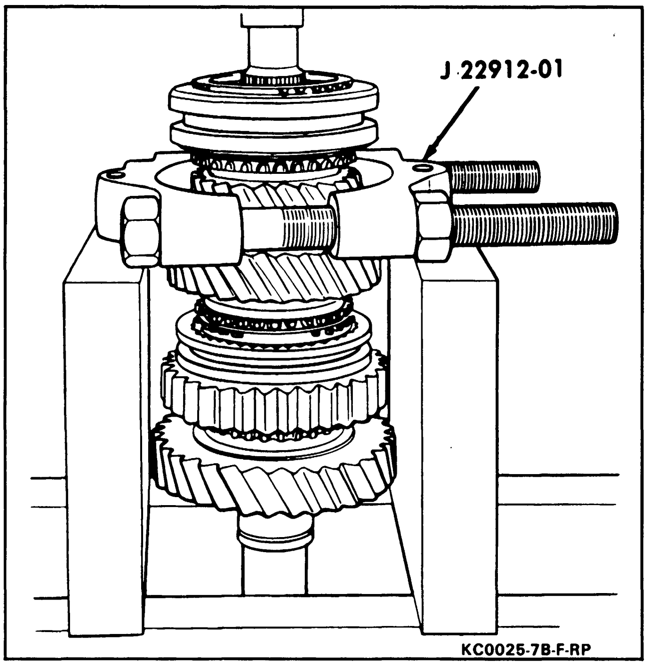


Figure 23 - Removing Third-Fourth Synchronizer

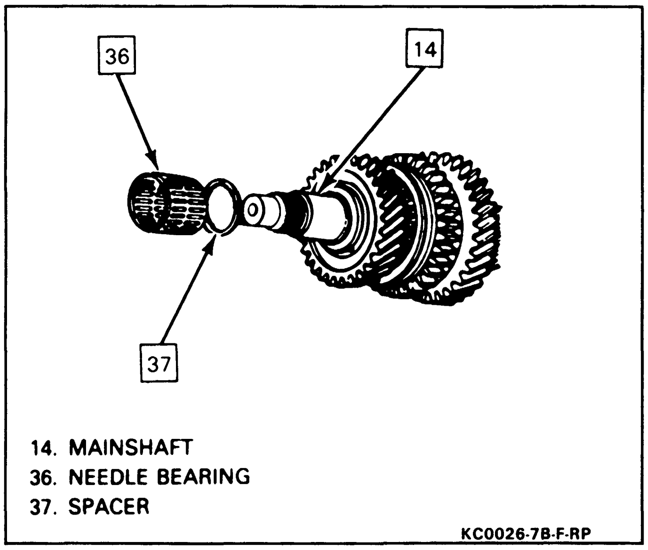


Figure 24 - Needle Bearing and Spacer

DRIVE GEAR - DISASSEMBLY

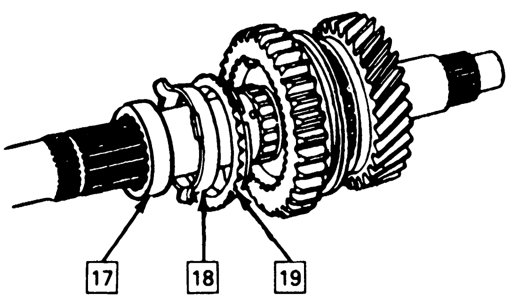
Figures 26 and 27

Disassemble

Tool Required:

J 22912-01 Bearing and Gear Puller

1. Bearing race.
2. Thrust bearing.
3. Roller bearings from cavity of drive gear.
4. Remove bearing from drive gear using J 22912-01 and a press.



17. INNER CONE
18. OUTER CONE
19. BLOCKER RING

Figure 25 - Three-Piece Blocker Ring

Clean

- Parts in appropriate solvent.

Inspect

- Gear teeth and shaft pilot for wear.

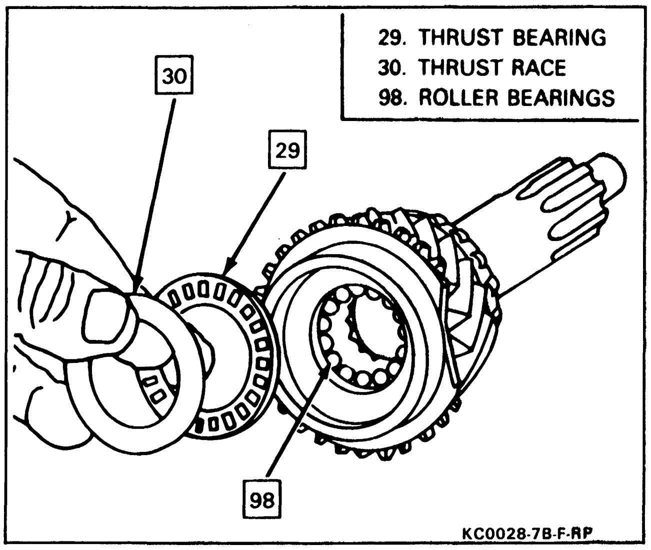


Figure 26 - Drive Gear Bearings

CLEANING AND INSPECTION

Transmission Case

Clean

1. Transmission case thoroughly inside and outside with appropriate solvent.
2. Magnetic disk at the bottom of the transmission case.

Inspect

1. Case for cracks.
2. Front and rear faces of the transmission case for burrs, and if present, dress them off with a fine mill file.

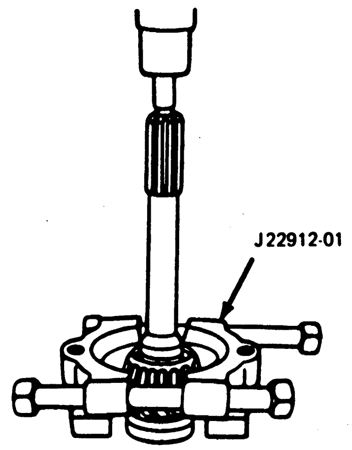


Figure 27 - Removing Drive Gear Bearing

Bearing Rollers and Spacers

Inspect

- Drive gear bearing rollers.
- Reverse idler shaft.
- Spacers.

Gears

Inspect

- Drive gear bearing rollers for chips, cracks, or excessive wear and replace if necessary.
- Clutch sleeves to insure that they slide freely on their hubs.

Front and Rear Bearings

Clean

- Front and rear bearings thoroughly with appropriate solvent.

  NOTICE: Do not allow the bearings to spin. Turn them slowly by hand. Spinning bearings may damage the race and rollers.

- Blow out bearings with compressed air.
- Lubricate bearings with transmission lubricant.

Inspect

- Bearings for roughness by slowly turning race by hand.

Synchronizer Blocker Rings

Figure 28

First/second synchronizer outer cone and third/fourth blocker ring are lined with friction material and cannot be checked visually for wear. Replacement is necessary when gap between blocker teeth and adjacent clutch teeth is significantly less than specified. Fifth gear blocker ring is brass and can be checked visually for wear and damage.

NOTICE: Make certain the blocker rings are correctly identified before assembly. First/second synchronizer blocker ring does not have friction material. The third/fourth synchronizer blocker ring has friction material. Assembling one in place of the other will result in serious damage to the transmission.

Inspect

- Fifth gear blocker ring for wear and damage.

Third/Fourth Blocker Rings

Figure 28

Assemble

1. Third gear blocker ring to third gear with twisting motion to fully seat.
2. Fourth gear blocker ring to main drive gear with twisting motion to fully seat.

Measure

- Gap between vertical faces of blocker teeth and clutch teeth. Nominal gap is 0.88-1.50 mm (0. 035-0.059 inch) for new blocker rings (Figure 28).

First/Second Blocker Rings

Figure 28

Assemble

1. Three-piece first gear blocker ring assembly, using a twisting motion to fully seat.
2. Three-piece first gear blocker ring assembly, with needle bearing and bearing sleeve, to first gear.
3. Three-piece second gear blocker ring assembly, using a twisting motion to fully seat.
4. Three-piece second gear blocker ring assembly, with thrust washer, to second gear.

Measure

- Gap between vertical faces of blocker teeth and clutch teeth. Nominal gap is 0.81-1.40 mm (0. 032-0.055 inch) for new blocker ring assemblies (Figure 28).

SYNCHRONIZER KEYS AND SPRINGS

Figures 29 through 31

NOTICE: The synchronizer hubs and sliding sleeves are a selected assembly and should be kept together as originally assembled, but the keys and springs may be replaced if worn or broken.

Remove or Disconnect

- Keys and springs.
  - If relation of hub and sleeve are not already marked, mark for assembly purposes.
  - Push the sliding sleeve from the hub. The keys will fall free and the springs may be easily removed.

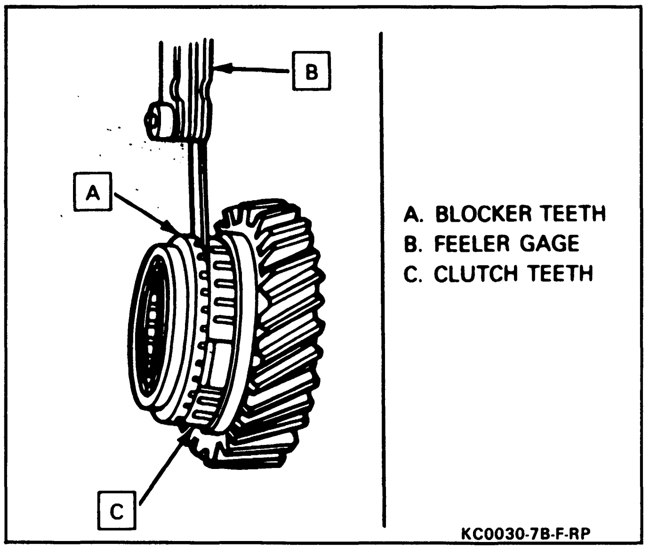


Figure 28 - Measuring Blocker Ring Wear

Install or Connect

- Keys and springs.
  - Place a blocker ring on side of the hub and sleeve and install keys and retain with a spring.
  - Place a blocker ring on opposite side of the hub and sleeve and install remaining spring.

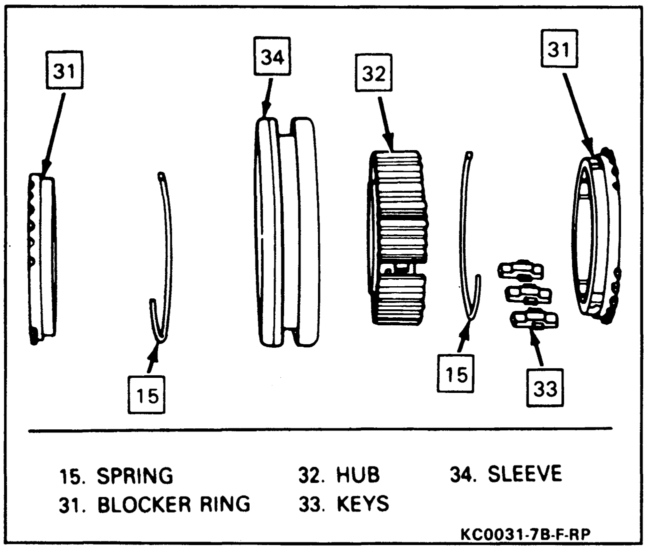


Figure 29 - Third-Fourth Synchronizer Assembly

EXTENSION HOUSING OIL SEAL

Figure 4

Remove or Disconnect

- Oil seal out of extension housing, using a screwdriver or small chisel.

Install or Connect

Tool Required:

J 21426 Extension Housing Seal Installer

- New oil seal into extension housing using J 21426.
- Lubricate inside diameter of seal with transmission lu

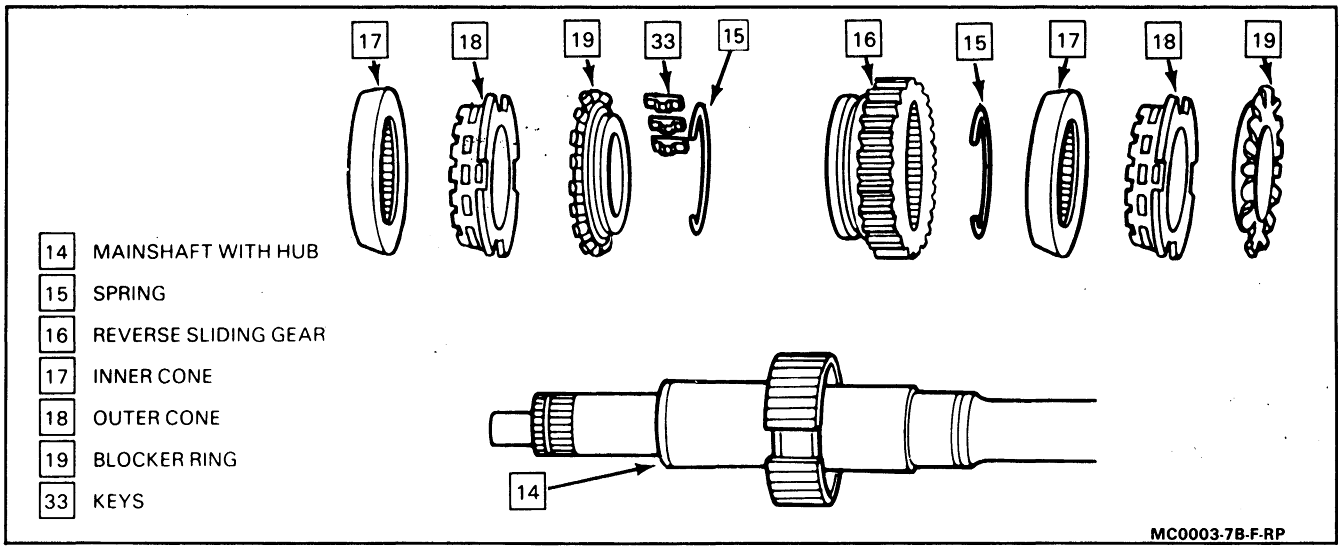


Figure 30 - First-Second Synchronizer Assembly

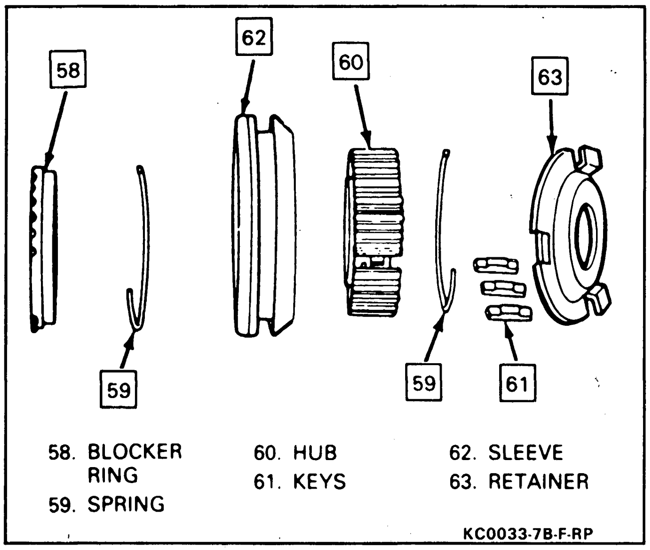


Figure 31 - Fifth Gear Synchronizer Assembly

EXTENSION HOUSING BUSHING

Figures 4 and 32

Remove or Disconnect

Tools Required:

J 8092 Universal Driver Handle

J 23062-14 Extension Housing Bushing Remover and Installer

1. Oil seal out of extension housing, using a screwdriver or small chisel.
2. Bushing out of housing, using J 8092 with J 23062-14.

Install or Connect

Tools Required:

J 8092 Universal Driver Handle

J 23062-14 Extension Housing Bushing Remover and Installer

J 21426 Extension Housing Seal Installer

1. Bushing in housing, using J 8092 with J 23062-14.
2. New oil seal into extension housing using J 21426.

- Lubricate inside diameter of seal with transmission lubricant.

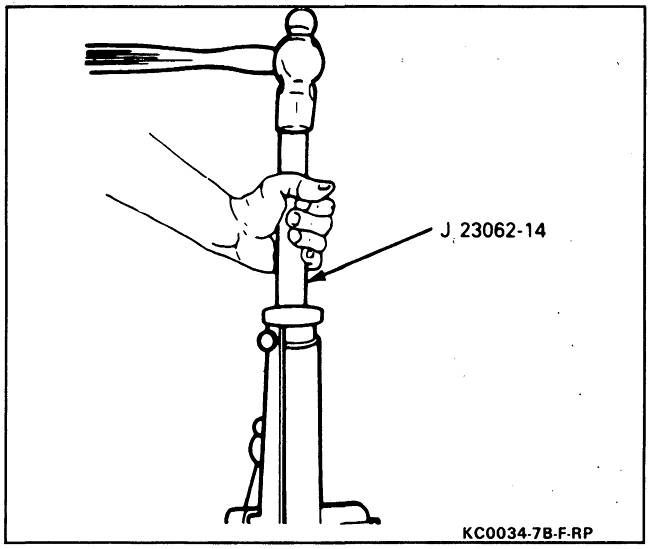


Figure 32 - Installing Extension Housing Bushing

DRIVE GEAR BEARING RETAINER OIL SEAL

Figure 33

Remove or Disconnect

- Oil seal, using a screwdriver or small chisel.

Install or Connect

Tool Required:

J 37375 Drive Gear Bearing Retainer Seal Installer

- New seal into retainer using J 37375 until it bottoms in bore.
- Lubricate inside diameter of seal with transmission lubricant

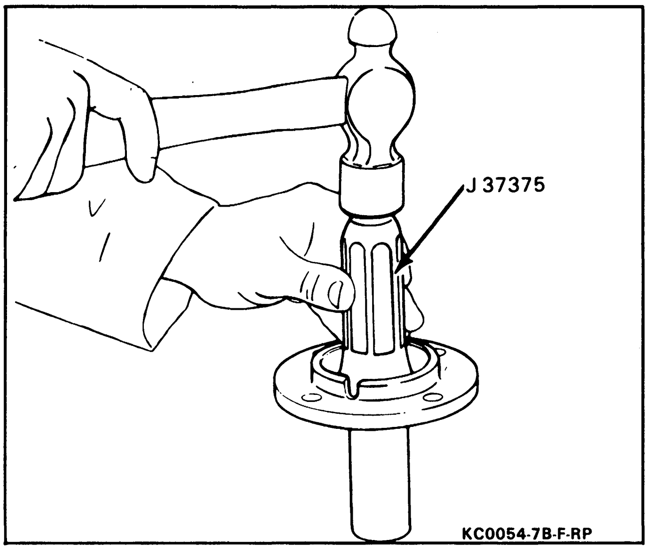


Figure 33 - Installing Bearing Retainer Oil Seal

TRANSMISSION COVER

Figures 34 and 35

Disassemble

- Place selector arm plates and shift rail in neutral position (centered).
- Rotate shift rail until selector arm disengages from selector arm plates and roll pin is accessible.

1. Selector arm roll pin using a pin punch and hammer (Figure 35).
2. Shift rail, shift forks, selector arms plates, selector arm, interlock plate and roll pin.
3. Transmission cover to extension housing O-ring seal using a screwdriver.
4. Nylon inserts and selector arm plates from shift forks.
    - Note position of inserts and plates for assembly reference.

Assemble

1. Nylon inserts and selector arm plates in shift forks.

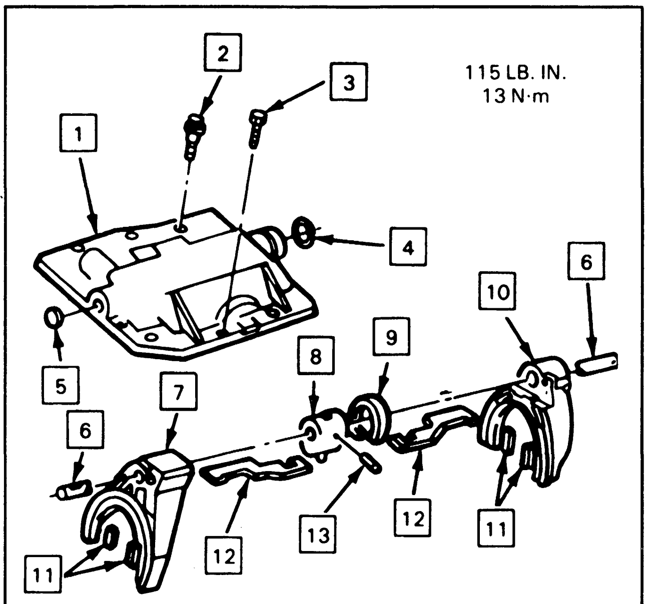
- If removed, coat edges of shift rail plug with sealer number 1052624, or equivalent, before installing.
- Coat shift rail and rail bores with transmission lubricant.

2. Shift rail in cover until flush with inside edge of cover.
3. Place first-second shift fork in cover with fork offset facing rear of cover and push shift rail through fork.
    - The first-second shift fork is the larger of the two forks.
4. Selector arm and C-shaped interlock plate in cover and insert shift rail through arm.
    - Widest part of interlock plate must face away from cover, and selector arm roll pin hole must face downward and toward rear of cover.
5. Third-fourth shift fork in cover with fork offset facing rear of cover.
    - Third-fourth shift fork selector arm plate must be under first-second shift fork selector arm plate.
6. Shift rail through third-fourth shift fork and into front bore in cover.

- Rotate shift rail until selector arm plate at forward end of rail faces away from, but is parallel to cover.
- Align roll pin holes in selector arm and shift rail and install roll pin.
    - Roll pin must be flush with surface of selector arm to prevent pin from contacting selector arm plates during shifts.

7. New transmission cover to extension housing O-ring seal.

- Coat O-ring seal with transmission lubricant.



1. TRANSMISSION COVER
2. ALIGNMENT BOLT
3. BOLT
4. O-RING SEAL
5. SHIFT RAIL PLUG
6. SHIFT RAIL
7. 3RD/4TH SHIFT FORK
8. SELECTOR ARM
9. INTERLOCK PLATE
10. 1ST/2ND SHIFT FORK
11. INSERT
12. SHIFT FORK PLATE
13. ROLL PIN

MC0005-7B-F-RP

Figure 34 - Transmission Cover

FRONT COUNTERSHAFT BEARING

Figures 36 through 39

Remove or Disconnect

Tools Required:

J 37358-1, -2 Bearing Race Receiver and Case Support

J 22912-01 Bearing and Gear Puller

J 37359 Countershaft Bearing Remover

J 8092 Un

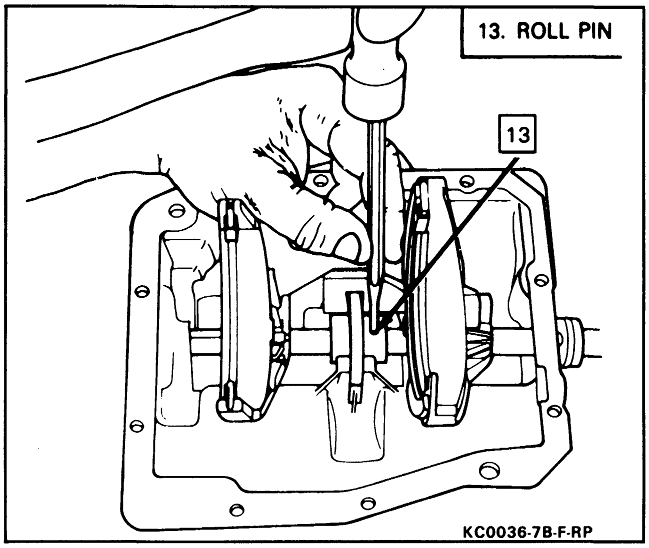


Figure 35 - Removing Selector Arm Roll Pin

NOTICE: Failure to support the case properly will result in permanent distortion of the case during bearing race removal.

1. Countershaft front bearing race and O-ring from the transmission case, using J 37358-1 with J 37358-2 and a press.
   - Remove the front countershaft bearing race only if it is worn or damaged.
2. Countershaft front bearing from the countershaft, using J 22912-01 with J 37359, J 8092 and a press.

Install or Connect

Tools Required:

J 37357 Countershaft Bearing and Race Remover and Installer

J 22912-01 Bearing and Gear Puller

J 8092 Universal Driver Handle

1. Countershaft front bearing onto the countershaft, using J 37357 with J 22912-01, J 8092 and a press.
2. New O-ring onto the countershaft front bearing race.
   - Lubricate the O-ring.
3. Countershaft front bearing race into the case, using J 37357 with J 8092 and a press.
   - Lightly tap the race into its bore until the O-ring is compressed.
   - Use a press to install the race until its shoulder rests on the inside of the case.

DRIVE GEAR - ASSEMBLY

Assemble

Tools Required:

J 22912-01 Bearing and Gear Puller

J 6133-01 Installer

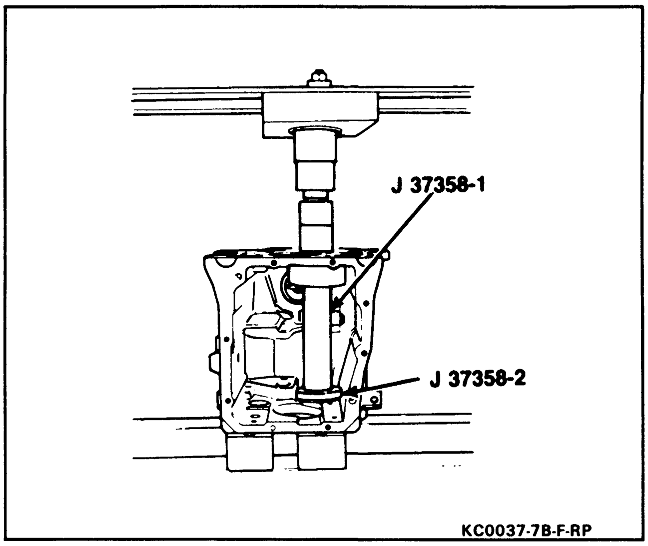


Figure 36 - Removing Bearing Race from Case

1. Bearing onto the drive gear, using J 22912-01 with J 6133-01 and a press.
   - Coat roller bearings and drive gear bearing bore with lightweight grease.
2. Roller bearings into the bore of the drive gear.
3. Thrust bearing and race into the drive gear.

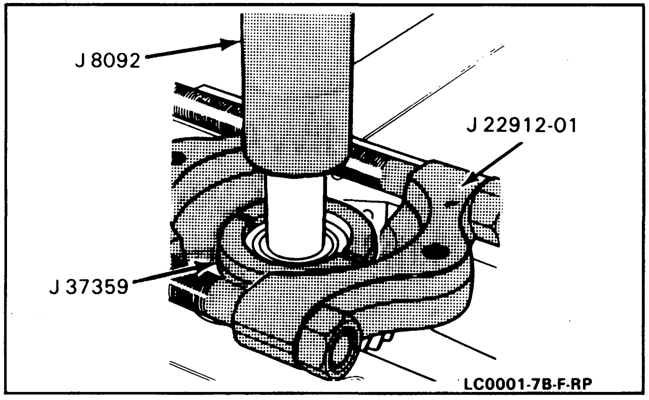


Figure 37 - Removing Bearing from Countershaft

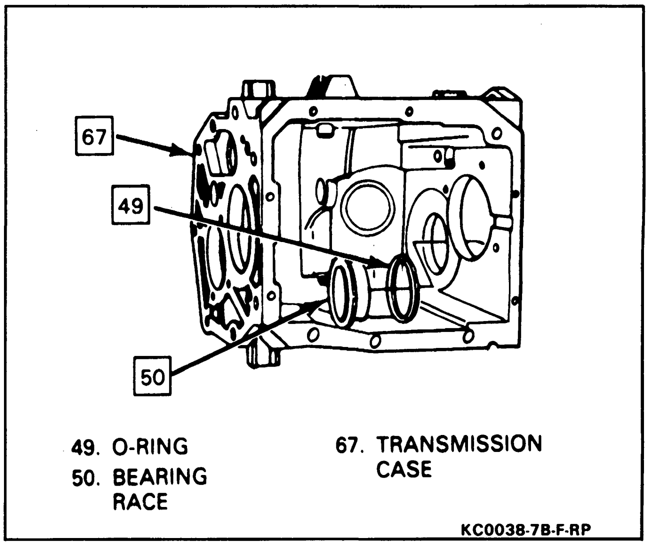


Figure 38 - Front Countershaft Bearing Assembly

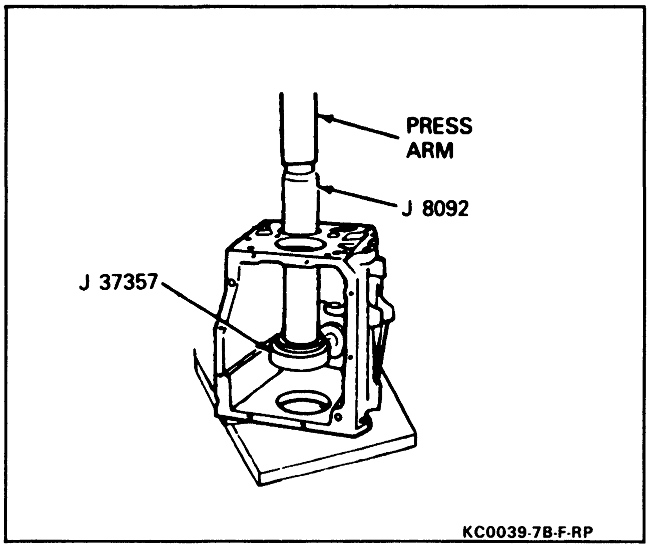


Figure 39 - Installing Bearing Race to Case

MAINSHAFT - ASSEMBLY

Figures 23, 24, 25 and 40

Assemble

Tools Required:

J 25234 Front and Rear Bearing Installer
J 37360 Spiral Snap Ring Installer
J 37372 Synchronizer and Gear Installer

NOTICE: If replacing first/second or third/fourth synchronizer blocker rings, soak new blocker ring assemblies for 10 minutes in Dexron® II or equivalent before assembly on mainshaft.

- Coat mainshaft and gear bores with transmission lubricant.

1. First-second synchronizer sleeve on mainshaft hub aligning marks made at disassembly.

NOTICE: Use care in synchronizer spring placement. If synchronizer is assembled with improper spring replacement, hard shifting will result.

2. First-second synchronizer keys and springs.
    - Engage tang end of each spring in same synchronizer key, but position open end of springs opposite of each other.
3. Three-piece first gear blocker ring assembly.
4. Locating pin into mainshaft.
5. Sleeve and bearing onto mainshaft, aligning notch in sleeve with locating pin.
6. First gear, aligning slots in first gear with tabs on blocker ring assembly.
7. Rear mainshaft bearing with taper facing rear of shaft.

- Lubricate fifth gear splines with petroleum jelly.

NOTICE: Carefully align the mainshaft and gear splines. If splines are improperly aligned, damage could occur when the gear is pressed onto the mainshaft.

8. Fifth gear onto mainshaft, using J 25234 and a press.
9. Fifth gear snap ring.
10. Three-piece second gear blocker ring assembly and thrust washer.
11. Spiral snap ring, using J 37360.
12. Second gear spacer, needle bearing and gear, aligning slots in second gear with tabs on blocker ring assembly.
13. Second gear thrust washer and snap ring.
14. Third gear spacer and needle bearing assembly.
    - Make sure the bearing spacer is not trapped between the gear face and snap ring. The spacer runs inside the gear bore.
15. Third-fourth synchronizer, third blocker ring , sleeve, hub and third gear as an assembly, using J 37372 and a press.
16. Thrust bearing and race to front end of mainshaft.

Important

- Before pressing components together, make sure the synchronizer hub faces the short end of the mainshaft. Hold third gear against the synchronizer to maintain blocker ring alignment with keys.

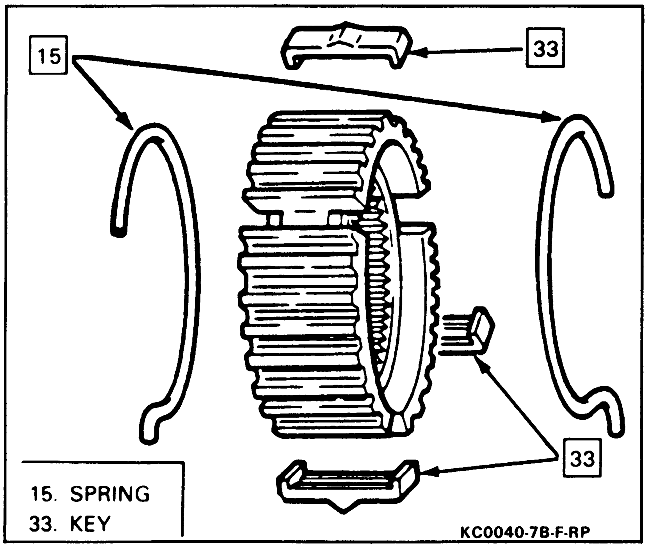


Figure 40 - Synchronizer Springs

TRANSMISSION - ASSEMBLY

Figures 5 through 22 and 41 through 43

Assemble

Tools Required:

J 37357 Countershaft Bearing and Race Remover and Installer
J 8092 Universal Driver Handle
J 37372 Synchronizer and Gear Installer
J 8001 Dial Indicator

NOTICE: See "Notice" on page 7B-1 of this section for steps 8, 20, 25, 27 and 31 through 33.

1. Front countershaft bearing onto countershaft using J 37357 with J 8092 and a press.
2. Countershaft in case.
3. Rear countershaft bearing to countershaft using J 37372 and a press (Figure 41).

NOTICE: Failure to properly support the countershaft may result in permanent distortion of the case during installation.

- Support the countershaft with J 37357.

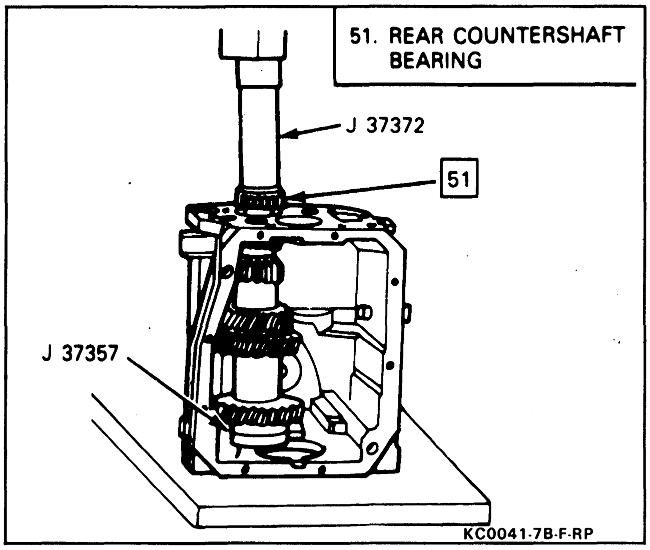


Figure 41 - Installing Rear Countershaft Bearing

4. Rear countershaft bearing race.
5. Rubber O-ring and reverse idler gear in case with shift lever groove facing rear of case.
6. Reverse idler shaft from rear of case.
7. Roll pin in idler shaft.
8. Countershaft retainer (without shims) to transmission housing.

Tighten

- Countershaft retainer bolts to 20 N·m (15 lb. ft.).

Measure

- Countershaft end play using dial indicator J 8001.

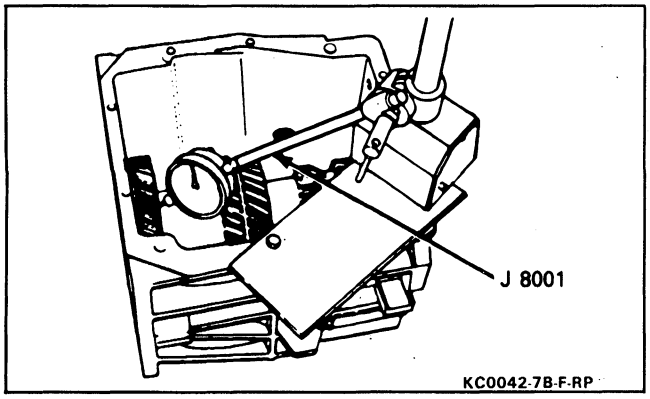


Figure 42 - Measuring Countershaft End Play

  - Remove retainer and install shim(s) as necessary to provide proper end play. Zero end play with no preload is ideal, but up to 0.10 mm (0.004 inch) end play is allowable. Do not preload bearing with shim(s) larger than original end play measurement. Refer to "Specifications" in this section.
- Reinstall retainer and bolts.

Tighten

  - Bolts to 20 N·m (15 lb. ft.).
- Bend tabs over the four attaching bolts.

9. Reverse shift fork in case.
10. Assembled mainshaft in transmission case.
11. Rear mainshaft bearing race in case.
12. Drive gear in case (make sure rollers, thrust bearing and washer are in place), and engage in third-fourth synchronizer sleeve and blocker ring.
13. Front bearing race in front bearing retainer.
    - Do not install shims in front bearing retainer at this time.
- Temporarily install front bearing retainer.

14. Fifth gear on countershaft.
    - Slide shift rail/fifth gear shift fork assembly into case. As shift rail enters case, align reverse shift fork and slide rail through fork. Position lever return spring in case with long end of spring to rear, and slide rail through spring (Figure 14).
15. Blocker ring and fifth gear synchronizer in fifth gear shift fork.

- Slide fork rail assembly and synchronizer into position.

16. Fifth gear synchronizer retainer and snap ring (Figure 13).
17. Oiling funnel into rear of countershaft (Figure 10).
18. Fifth/reverse shift lever in case.
19. Lever return spring to front of case.
    - Make sure reverse shift fork pin and fifth gear shift rail pin are engaged with shift lever.
20. Fifth gear/reverse lever pivot bolts and retaining clip.
    - Coat pivot bolt threads with pipe thread sealant number 1052080, or equivalent.

Tighten

  - Pivot bolt to 27 N·m (20 lb. ft.).

21. Backup lamp switch.
    - Coat threads with pipe thread sealant number 1052080, or equivalent.
22. Speedometer gear and retaining clip.
23. Circlip.

- Apply 3 mm (1/8-inch) bead of RTV Sealant number 1052751, or equivalent, to transmission cover assembly.

- Make sure all synchronizers are in the neutral position and that the shift forks in the cover are in the neutral (center) position.
- Lower cover onto case while aligning shift forks and synchronizer sleeves.

24. Cover and install two dowel bolts.
25. Remaining cover bolts.

Tighten

  - Cover bolts to 13 N·m (115 lb. in.).

- Apply 3 mm (1/8-inch) bead of RTV Sealant number 1052751, or equivalent, to extension housing mating surface.
- Coat detent spring with petroleum jelly and insert in offset lever.
- Lubricate detent plate and install detent ball in neutral position on plate.
- Position offset lever in extension housing with spring over detent ball. Slide lever and extension into position as an assembly.

26. Extension housing vent.

- Press downward on offset lever to compress detent spring and push lever and housing into position.

27. Extension housing bolts.
    - Apply pipe thread sealant number 1052080, or equivalent, to threads of bolts.

Tighten

  - Extension housing bolts to 30 N·m (22 lb. ft.).

28. Roll pin in offset lever and shift rail.
29. Damper sleeve in offset lever.

- Turn transmission case on end, and mount a dial indicator on extension housing with indicator on the end of mainshaft (Figure 43).

Measure

  - Mainshaft end play.
    - Rotate mainshaft and zero dial indicator. Pull upward on mainshaft until end play is removed and record reading.
    - Ideal mainshaft end play is zero with plus or minus 0.02 mm (0.001 inch) allowable.
    - To set preload, select a shim pack equal to the dial indicator reading recorded.

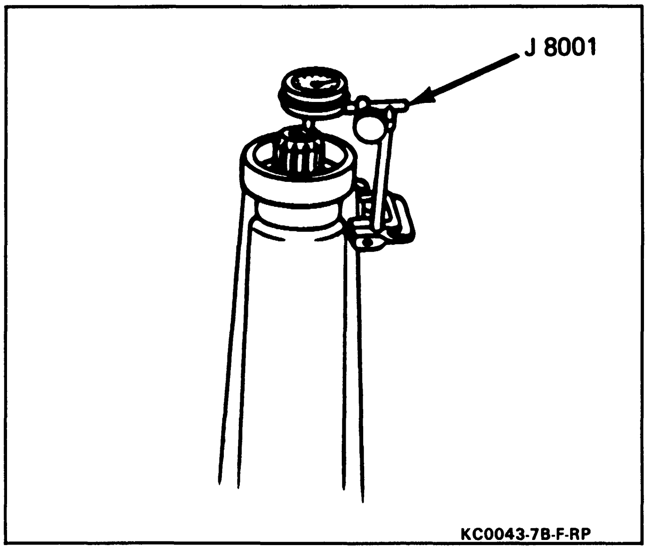


Figure 43 - Measuring Mainshaft End Play

- Remove front bearing retainer and front bearing race.
- Install necessary shims and reinstall bearing race. Refer to "Specifications" in this section.
- Apply a 3 mm diameter (1/8-inch) bead of RTV sealant, number 1052751 or equivalent, on case mating surface of front bearing retainer.

30. Bearing retainer.

- Apply pipe thread sealant number 1052080, or equivalent, to the threads of the retainer bolts.

31. Retainer bolts.

Tighten

  - Retainer bolts to 20 N·m (15 lb. ft.).

- Apply pipe thread sealant number 1052080, or equivalent, to the threads of the drain and fill plugs.

32. Drain plug.

Tighten

  - Drain plug to 27 N·m (20 lb. ft.).

- Fill the transmission to its proper level with Dexron® II number 1051855, or equivalent.

33. Fill plug.

Tighten

  - Fill plug to 27 N·m (20 lb. ft.).

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Catalytic Converter-to-Transmission Nut and Bolt	40 N·m (30 lb. ft.)
Transmission-to-Flywheel Housing Bolt	75 N·m (55 lb. ft.)
Extension Housing Bolt	30 N·m (22 lb. ft.)
Transmission Cover-to-Case Bolt	13 N·m (115 lb. in.)
Front Bearing Retainer Bolt	20 N·m (15 lb. ft.)
Countershaft Retainer Bolt	20 N·m (15 lb. ft.)
Reverse Pivot Bolt	27 N·m (20 lb. ft.)
Fill Plug	27 N·m (20 lb. ft.)
Drain Plug	27 N·m (20 lb. ft.)
Support-to-Rail Bolt	54 N·m (40 lb. ft.)
Transmission Mount-to-Transmission Bolt	54 N·m (40 lb. ft.)
Transmission Mount-to-Support Nut	47 N·m (35 lb. ft.)
Transmission Mount-to-Support Bolt	54 N·m (40 lb. ft.)
Speed Sensor Retainer Bolt	10 N·m (89 lb. in)
Shift Control Assembly Boot Screw	6 N·m (53 lb. in)
Shift Control Assembly Bolt	17 N·m (13 lb. ft.)
Vehicle Speed Sensor Retainer Bolt	10 N·m (89 lb. in.)

LUBRICATION SPECIFICATIONS

Lubricant Capacity (approximate)	2.8 Liters (2.96 quarts)
Lubricant Recommended	Dexron® II part number 1051855, or equivalent

SPEEDOMETER GEAR CHART

SPEEDOMETER GEAR CHART

TIRE SIZE	AXLE RATIO	TRANSMISSION	DRIVE GEAR		DRIVEN GEAR	
			COLOR	TEETH	COLOR	TEETH
P215/65R15 P235/55R16 P245/50ZR16	3.08	M39	RED	9	GREY	22
P215/65R15	3.42	MB1	PURPLE	7	WHITE	19
P245/50ZR16		MK6				

MC0004-7B-F-RP

SHIM SPECIFICATIONS

Input/Mainshaft		**Countershaft**	
Thickness (inches)	**GM P/N**	**Thickness (inches)**	**GM P/N**
0.012	14050783	0.1005	10117781
0.014	14050780	0.102	10117782
0.016	14050781	0.1035	10117783
0.018	14050782	0.105	10117784
0.020	14050784	0.1065	10117785
0.022	14050786	0.108	10117786
0.023	14050787	0.1095	10117787
0.024	14069868	0.111	10117788
0.025	14069869	0.1125	10117789
0.026	14069870	0.114	10117790
0.027	14069871	0.1155	10117791
0.028	14069872	0.117	10117792
0.029	14069873	0.1185	10117793
0.030	14069874	0.120	10117794
0.031	14069875	0.1215	10117795
0.032	14069876	0.123	10117796
0.033	14069877	0.1245	10117797
0.034	14069878	0.126	10117798
0.035	14069879	0.1275	10117799
0.036	14050785	0.129	10117800
0.037	14069880	0.1305	10117801
0.038	14069881	0.132	10117802
0.039	14069882	0.1335	10117803
0.040	14069883	0.135	10117804
0.041	14069884	0.1365	10117805
0.042	14069885	0.138	10117806
0.043	14069886	0.1395	10117807
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		0.147	10117812
		0.1485	10117813
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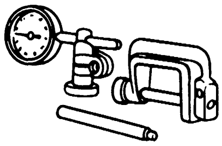
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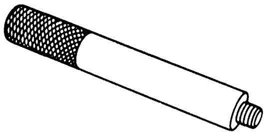
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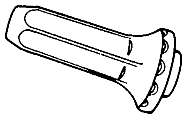
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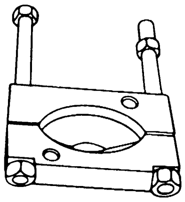
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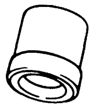
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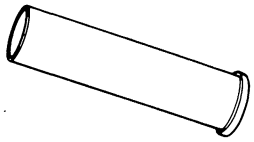
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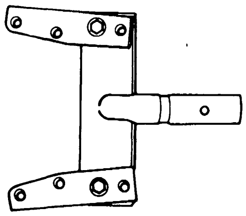
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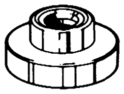
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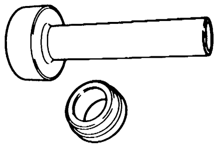
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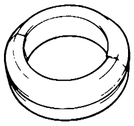
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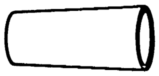
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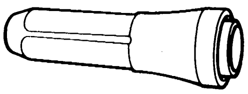
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1	DIAL INDICATOR
2	UNIVERSAL DRIVER HANDLE
3	EXTENSION HOUSING SEAL INSTALLER
4	BEARING AND GEAR PULLER
5	EXTENSION HOUSING BUSHING REMOVER AND INSTALLER
6	FRONT AND REAR BEARING INSTALLER
7	HOLDING FIXTURE
8	INSTALLER
9	COUNTERSHAFT BEARING AND RACE REMOVER AND INSTALLER
10	BEARING RACE RECEIVER AND CASE SUPPORT
11	COUNTERSHAFT BEARING REMOVER
12	SPIRAL SNAP RING INSTALLER
13	SYNCHRONIZER AND GEAR INSTALLER
14	DRIVE GEAR BEARING RETAINER SEAL INSTALLER

SECTION 7C
CLUTCH

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 7C-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

PRINCIPLE COMPONENTS

Driving Members

Figures 1 and 2

The driving members consist of two flat surfaces machined to a smooth finish: the rear face of the engine flywheel, and the pressure plate assembly, bolted to the flywheel.

Driven Member

The driven member is the clutch disc with a splined hub. The clutch disc is free to slide lengthwise along the splines of the input shaft, and drives the input shaft through these splines.

The driving and driven members are held in contact by spring pressure. This pressure is exerted by a diaphragm spring in the clutch cover and plate assembly.

Operating Members (Hydraulic Clutch)

Figures 3 and 4

A hydraulic clutch operating mechanism is used. The mechanism consists of a remote fluid reservoir, clutch master cylinder and actuator. The remote reservoir is mounted to a bracket which bolts to the power brake booster. The clutch master cylinder is mounted on the cowl panel and the actuator is mounted on the clutch housing. The clutch master cylinder is operated directly by the clutch pedal.

When the clutch pedal is pressed down, hydraulic fluid under pressure from the clutch master cylinder flows into the actuator. The actuator piston engages the clutch fork which moves the release bearing into contact with the diaphragm spring fingers to disengage the clutch.

The hydraulic clutch system locates the clutch pedal height and provides automatic clutch adjustment. No adjustment of clutch linkage or pedal position is required.

Hydraulic Clutch Fluid

When adding fluid to or refilling the system after service operations use GM Delco Supreme No. 11 brake fluid or an equivalent fluid that meets DOT 3 specifications.

> **NOTICE:** Do not use silicon, mineral or paraffin based oil in the clutch hydraulic system. These fluids will damage the rubber parts in the cylinders.

Pilot Bearing

The clutch pilot bearing is an oil-impregnated bearing pressed into the crankshaft. This bearing requires attention when the clutch is removed from the vehicle. It should be cleaned and inspected for excessive wear or damag

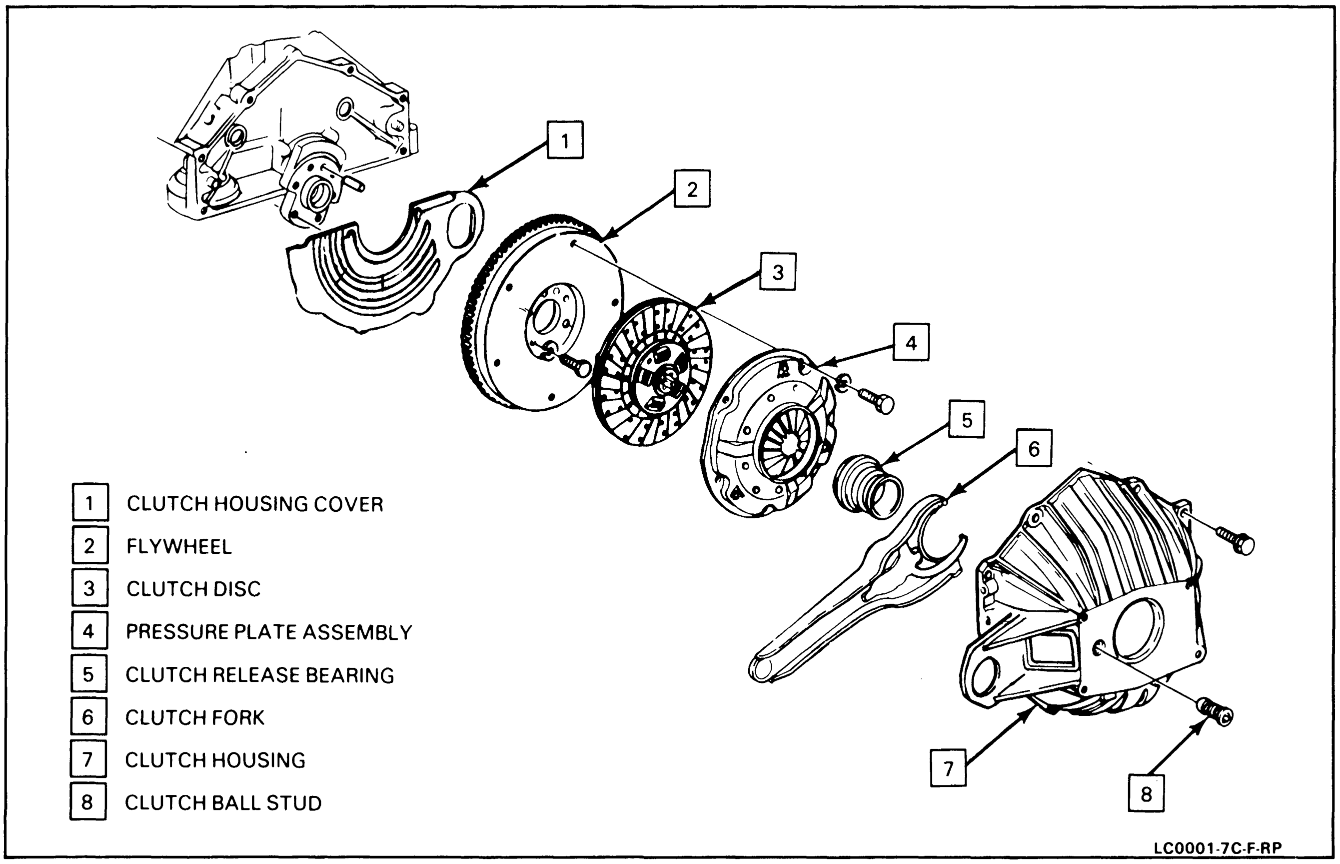


Figure 1 - Clutch Components

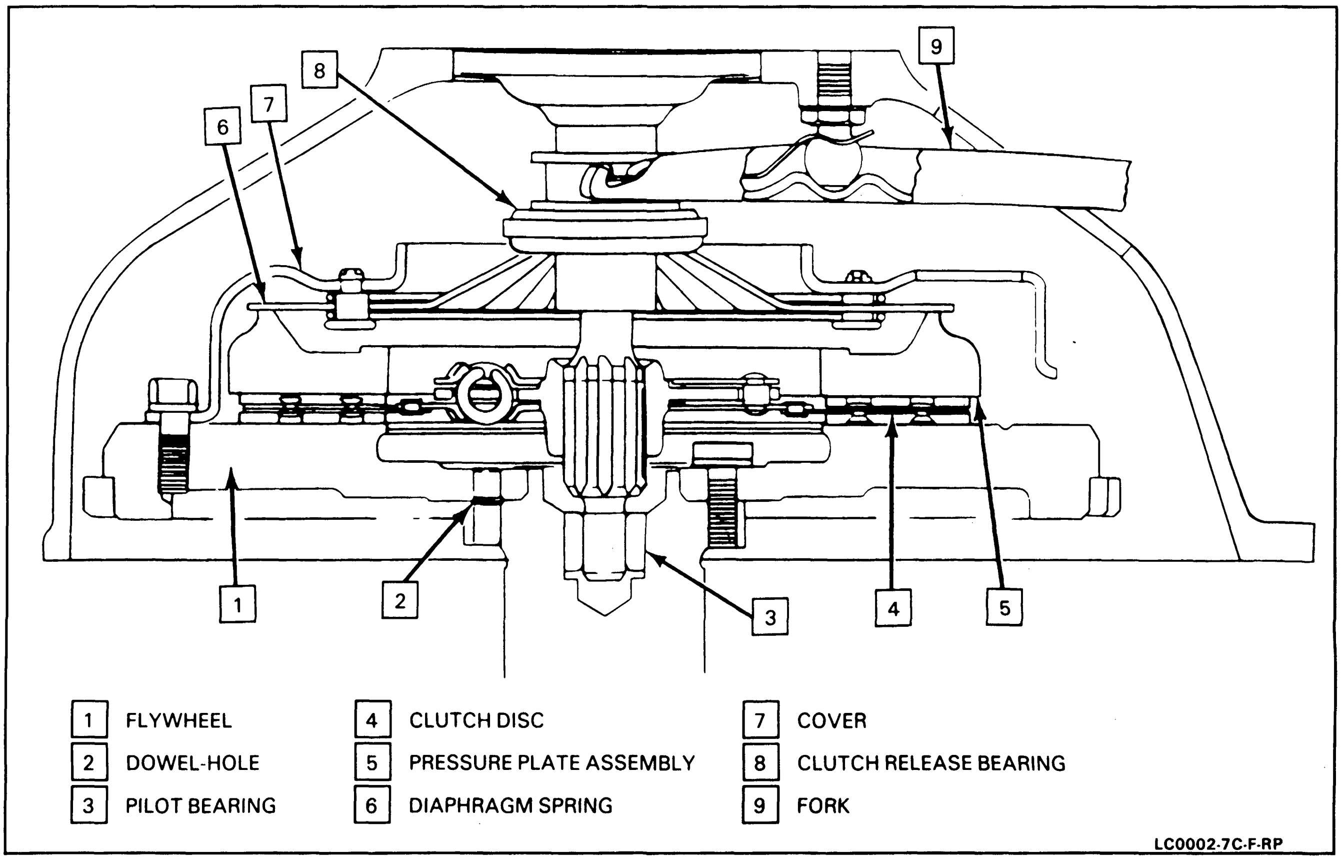
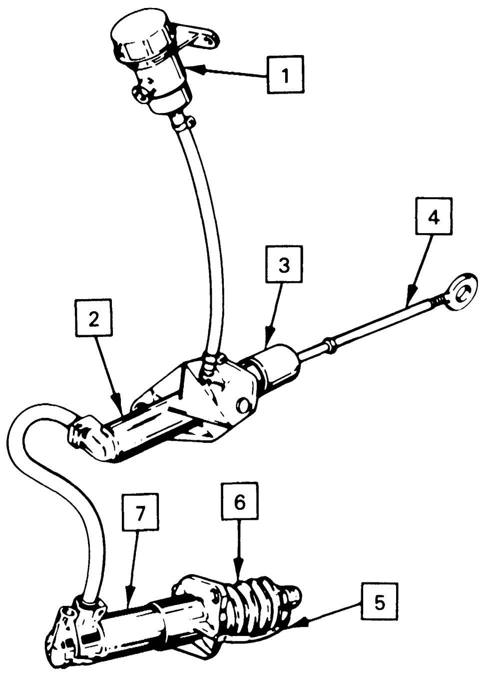


Figure 2 - Clutch Assembly Cross-Section



1 FLUID RESERVOIR
2 CLUTCH MASTER CYLINDER
3 BOOT
4 CLUTCH MASTER CYLINDER INPUT ROD
5 SHIPPING STRAP
6 BOOT
7 ACTUATOR

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Figure 3 - Clutch Hydraulic System

DIAGNOSIS

PRELIMINARY CHECKS

Before attempting to repair the clutch, transmission or related hydraulic components for any reason other than an obvious failure, the problem and probable cause should be identified. A large percentage of clutch and manual transmission problems show up as shifting difficulties, such as high shift effort, gear clash and grinding, or transmission blockout. When any of these problems occur, a careful analysis of these difficulties should be performed before removing the clutch or transmission for repairs. Refer to the clutch diagnosis chart for conditions, causes and corrections.

Before removal of the clutch hydraulic system, verify the malfunction by removing the clutch housing cover and measure the travel of the clutch actuator output rod. With the clutch pedal pushed fully to the floor, the actuator output rod should extend a minimum of 11 mm (0.43 inch) against the fork. Do not replace the hydraulic system if pushrod travel exceeds this distance.

- If the actuator does not meet the travel requirements, check the reservoir fluid level.
  - The actuator must be in place when checking the fluid level.
  - The proper level is indicated by a step on the reservoir. Fill to the specified level with GM Delco Supreme No. 11 brake fluid or an equivalent fluid that meets DOT 3 specifications.
  - Do not overfill. The upper portion of the reservoir must accept fluid that is displaced from the actuator as the clutch wears.

NOTICE: Carefully clean the top and sides of the reservoir before opening to prevent contamination of the system with dirt, water or other foreign material. Remove the reservoir diaphragm before adding fluid. Carefully replace the diaphragm, cover gasket and cover after filling.

If the reservoir requires any fluid, check the hydraulic system components for leakage. Remove the rubber boots from the cylinder and check for leakage past the pistons. A slight wetting of the surfaces is acceptable. Replace the system if excessive leakage is evident.

CLUTCH SPIN DOWN

1. Run the engine at a normal idle with the transmission in neutral and the clutch engaged.
2. Disengage the clutch, wait five seconds and shift the transmission into reverse.
3. If a grinding noise is heard, refer to "Clutch Diagnosis" in this section.

CLUTCH DIAGNOSIS

Condition	Probable Cause	Correction
Fails to Release (Pedal pressed to floor, shift lever does not move freely in and out of reverse gear)	1. Faulty pilot bearing.	1. Replace bearing.
	2. Faulty clutch disc.	2. Replace clutch disc.
	3. Fork off of ball stud or ball stud loose.	3. Install properly and lightly lubricate fingers at release bearing and ball stud.
	4. Clutch disc hub binding on clutch gear spline.	4. Repair or replace clutch gear and/or clutch disc.

Condition	Probable Cause	Correction
	5. Clutch disc warped or bent.	5. Replace clutch disc. Runout should not exceed 0.5 mm (0.20 inch).
	6. Air in hydraulic system.	6. Bleed hydraulic system clutch disc.
	7. Pedal assembly misaligned to the cowl.	7. Loosen pedal assembly mounting bolts and realign pedal assembly.
Slipping	1. Oil-soaked clutch disc.	1. Install new clutch disc. and correct leak at its source.
	2. Worn facing or facing torn from clutch disc.	2. Replace clutch disc.
	3. Warped pressure plate assembly or flywheel.	3. Replace pressure plate assembly or flywheel.
	4. Weak diaphragm spring.	4. Replace pressure plate assembly.
	5. Clutch disc not seated in.	5. Make 30 to 40 normal starts. Do not overheat.
	6. Clutch disc overheated.	6. Allow to cool.
Grabbing (Chattering)	1. Oil on facing. Burned or glazed facings.	1. Install new clutch disc and correct leak.
	2. Worn splines on clutch gear.	2. Replace transmission clutch gear.
	3. Warped pressure plate assembly or flywheel.	3. Replace pressure plate assembly or flywheel.
	4. Burned or smeared resin on flywheel or pressure plate assembly.	4. Sand off if superficial. Replace burned or heat checked parts.
Release Bearing Noise with Clutch Fully Engaged	1. Release bearing binding on transmission bearing retainer.	1. Clean, lubricate, check for burrs, nicks, and other wear.
	2. Fork improperly installed.	2. Install properly.
Noisy	1. Worn release bearing.	1. Replace bearing.
	2. Fork off of the ball stud (heavy clicking).	2. Install properly and lubricate fork fingers and bearing.
	3. Pilot bearing loose in crankshaft.	3. Replace pilot bearing.
Pedal Stays on Floor When Disengaged	1. Bind in release bearing.	1. Lubricate and free-up release bearing.
	2. Master cylinder rod fell off pedal.	2. Install correctly.

Condition	Probable Cause	Correction
Excessive Pedal Pressure	1. Linkage needs lubrication.	1. Lubricate.
	2. Pressure plate assembly release fingers binding.	2. Free and lubricate.
	3. Linkage misaligned.	3. Align linkage.
	4. Release bearing sleeve binding on transmission bearing retainer.	4. Free and lubricate.
	5. Sticking linkage, master cylinder or actuator.	5. Clean or replace as needed.
Rapid Clutch Disc Wear	1. Scored flywheel or pressure plate assembly.	1. Grind or replace.
	2. Driver rides the clutch (rests left foot on clutch while driving).	2. Instruct driver.
	3. Driver races engine and slips clutch excessively during starting.	3. Instruct driver.
	4. Driver holds vehicle on hill by slipping clutch.	4. Instruct driver.
	5. Weak pressure plate assembly springs.	5. Rebuild or replace pressure plate assembly.

ON-VEHICLE SERVICE

CLUTCH HYDRAULIC SYSTEM

Figure 4

Remove or Disconnect

1. Negative (-) battery cable.
2. Sound insulator.
3. Brake vacuum booster pushrod from the brake pedal.
   - Remove the retainer and washer.

NOTICE: Disconnect the clutch master cylinder input rod before removing the actuator. If not disconnected, permanent damage to the actuator will occur if the clutch pedal is depressed while the actuator is disconnected.

4. Clutch master cylinder input rod from the clutch pedal.
   - Use a sharp knife to cut the bushing retaining tabs.
5. Clutch master cylinder-to-cowl nuts.
6. Brake vacuum booster-to-cowl nuts.
7. Clutch fluid reservoir screws.
8. Clutch fluid reservoir from the bracket.
   - Pull the brake vacuum booster forward to gain access to the clutch master cylinder.
9. Clutch master cylinder with U-bolt from the cowl.

- Raise the vehicle.

10. Actuator heat shield bolts.
11. Actuator heat shield.
12. Actuator.

- Lower the vehicle.

13. Clutch hydraulic system (clutch master cylinder and actuator) from the engine compartment.

Install or Connect

NOTICE: See "Notice" on page 7C-1 of this section.

- Position the hydraulic clutch master cylinder at the cowl and lower the actuator down to the clutch housing area.

1. Clutch master cylinder with U-bolt to the cowl.
2. Brake vacuum booster to the cowl.

3. Clutch master cylinder-to-cowl nuts.

Tighten

- Nuts to 13 N·m (115 lb. in.).

4. Brake vacuum booster-to-cowl nuts.

Tighten

- Nuts to 21 N·m (15 lb. ft.).

5. Brake vacuum booster pushrod to the brake pedal.
   - Install the retainer and washer.
6. New bushing to the clutch pedal.
   - Install the bushing with the flat side toward the pedal.
7. Clutch master cylinder input rod to the clutch pedal.
8. Sound insulator.
9. Clutch fluid reservoir to the bracket.
10. Clutch fluid reservoir screws.

Tighten

- Screws to 6 N·m (53 lb. in.).

- Raise the vehicle.

11. Actuator.
12. Actuator heat shield.
13. Actuator heat shield bolts.

Tighten

- Bolts to 21 N·m (15 lb. ft.).

- Lower the vehicle.

14. Negative (-) battery cable.

BLEEDING HYDRAULIC SYSTEM

Figure 3

The process of removing air from the line and cylinders is known as "bleeding" and is necessary any time the level of fluid in the reservoir has been allowed to fall so low that air has been drawn into the master cylinder.

NOTICE: Never, under any circumstances, use fluid which has been bled from a system to fill the reservoir as it may be aerated, have too much moisture content and possibly be contaminated.

1. Clean dirt and grease from the cap to ensure no foreign substances enter the system.
2. Remove cap and diaphragm and fill reservoir to the top with approved brake fluid only. (Brake fluid must be certified to DOT 3 specifications).
3. Fully loosen bleed screw which is in the actuator body next to the inlet connection.
4. Fluid will now begin to move from the clutch master cylinder down the tube to the actuator.
   - For efficient gravity fill, the reservoir must be kept full at all times.
5. At this point bubbles will appear at the bleed screw outlet. This means that air is being expelled. When the actuator is full, a steady stream of fluid will come from the actuator outlet. At this point, tighten bleed screw to a torque of 2 N·m (18 lb. in.).
6. Assemble diaphragm and cap to the reservoir. Fluid in reservoir should be level with the step.
7. Exert a light load (approximately 89N (20 lb.)) to the actuator piston by pushing the clutch fork toward the actuator and loosening the bleed screw. Maintain a constant light load. Fluid and any air that is left will be expelled through the bleed port. Tighten the bleed screw when a steady flow of fluid and no air is being expelled.
8. Renew fluid level in the reservoir and assemble the diaphragm and cap. If necessary, repeat steps 7 and 8.
9. Exert a light load to the clutch fork as in step 7. Do not open bleed screw. The piston in the actuator will move slowly down the bore. Repeat 2-3 times. Fluid movement will force any air left in the system into the reservoir.
10. The hydraulic system should now be fully bled and should release the clutch. Check the vehicle by starting, pushing clutch pedal to the floor and selecting reverse gear. The gears should not grate. If they do, the hydraulic system could still contain air. If this is the case, repeat the bleed procedure.
11. Check actuator output rod travel to insure a minimum travel of 14.5 mm (0.57 inch) for V8 and 11 mm (0.43 inch) for V6.

MASTER CYLINDER

Figures 3 and 4

Remove or Disconnect

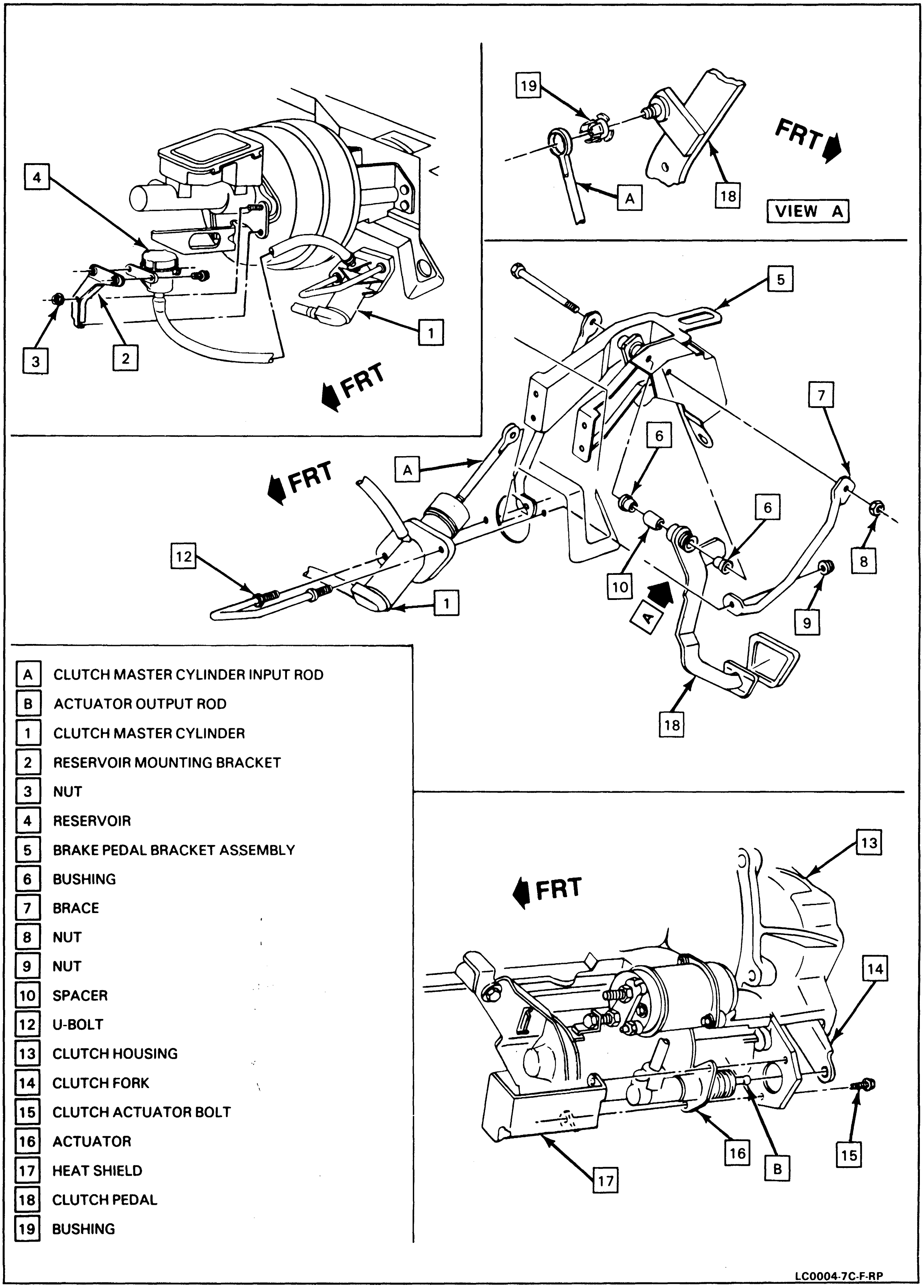
1. Negative (-) battery cable.
2. Sound insulator.
3. Brake vacuum booster pushrod from the brake pedal. Refer to GENERAL BRAKES (SEC. 5).
   - Remove the retainer and washer.
4. Clutch master cylinder input rod from the pedal.
   - Use a sharp knife to cut the bushing retaining tabs.
5. Clutch master cylinder-to-cowl nuts.
6. Brake vacuum booster-to-cowl nuts.
7. Hose clamp.
8. Clutch fluid reservoir hose.
   - Catch the hydraulic fluid from the reservoir in a container.

- Pull the brake vacuum booster forward to gain access to the clutch master cylinder.

9. Clutch master cylinder with U-bolt from the cowl.

- Lower the master cylinder down to the clutch housing area.
- Raise the vehicle.

10. High-pressure hose.



A	CLUTCH MASTER CYLINDER INPUT ROD
B	ACTUATOR OUTPUT ROD
1	CLUTCH MASTER CYLINDER
2	RESERVOIR MOUNTING BRACKET
3	NUT
4	RESERVOIR
5	BRAKE PEDAL BRACKET ASSEMBLY
6	BUSHING
7	BRACE
8	NUT
9	NUT
10	SPACER
12	U-BOLT
13	CLUTCH HOUSING
14	CLUTCH FORK
15	CLUTCH ACTUATOR BOLT
16	ACTUATOR
17	HEAT SHIELD
18	CLUTCH PEDAL
19	BUSHING

Figure 4 - Hydraulic System Components

11. Clutch master cylinder.

Install or Connect

NOTICE: See "Notice" on page 7C-1 of this section.

1. High-pressure hose.
- Place the clutch master cylinder up near the brake vacuum booster.
- Lower the vehicle.
2. Clutch master cylinder to the cowl with the U-bolt.
3. New bushing to the pedal.
    - Install the flat end of the bushing toward the pedal.
4. Clutch master cylinder input rod to the pedal.
    - Install the retainer and washer.
5. Brake vacuum booster to the cowl.
6. Clutch fluid reservoir hose.
7. Hose clamp.
8. Clutch master cylinder-to-cowl nuts.

Tighten

- Nuts 13 N·m (115 lb. in.).

9. Brake vacuum booster-to-cowl nuts.

Tighten

- Nuts to 21 N·m (15 lb. ft.).

10. Sound insulator.
11. Brake vacuum pushrod to the brake pedal. Refer to GENERAL BRAKES (SEC. 5).
- Fill and bleed the hydraulic system. Refer to "Bleeding Hydraulic System" in this section.
12. Negative (-) battery cable.

ACTUATOR

Figures 3 and 4

Remove or Disconnect

1. Negative (-) battery cable.
2. Sound insulator panel.

NOTICE: Disconnect the clutch master cylinder input rod before removing the actuator. If not disconnected, permanent damage to the actuator wil occur if the clutch pedal is depressed while the actuator is disconnected.

3. Clutch master cylinder input rod from the clutch pedal.
    - Use a sharp knife to cut the bushing retaining tabs.
- Raise the vehicle.
4. Pressure hose.
    - Catch the hydraulic fluid in a container.
5. Clutch actuator bolts.
6. Actuator heat shield.
7. Actuator.

Install or Connect

1. Actuator.
2. Actuator heat shield.

NOTICE: See "Notice on page 7C-1 of this section.

3. Clutch actuator bolts.

Tighten

- Bolts to 21 N·m (15 lb. ft.).

4. Pressure hose.
- Lower the vehicle.
5. New bushing to the clutch pedal.
    - Install the flat side of the bushing toward the clutch pedal.
6. Clutch master cylinder input rod to the clutch pedal.
- Bleed the hydraulic system. Refer to "Bleeding Hydraulic System" in this section.
7. Sound insulator panel.
8. Negative (-) battery cable.

CLUTCH PEDAL ASSEMBLY

Figure 4

Remove or Disconnect

1. Negative (-) battery cable.
2. Sound insulator.
3. Cruise control switch at the clutch pedal, if equipped.
4. Clutch master cylinder input rod.
    - Use a sharp knife to cut the bushing retaining tabs.
5. Nut from the clutch pedal pivot bolt.
    - Pull the bolt out far enough to remove the pedal.
6. Clutch pedal assembly.

Clean

- Bushings with a clean cloth. Do not clean the bushings with cleaning solvent.

Install or Connect

- Lubricate the clutch pedal pivot bushing and moving parts.
1. Clutch pedal assembly.
    - Push the clutch pedal pivot bolt back in.

NOTICE: See "Notice" on page 7C-1 of this section.

2. Clutch pedal pivot bolt nut.

Tighten

- Nut to 35 N·m (26 lb. ft.).

3. New bushing to the clutch pedal.
    - Install the flat side of the bushing toward the clutch pedal.
4. Clutch master cylinder input rod to the clutch pedal.
5. Cruise control switch at the clutch pedal, if equipped.
6. Sound insulator.
7. Negative (-) battery cable.

CLUTCH START SWITCH

Remove or Disconnect

1. Negative battery cable.
2. Trim plate fasteners.
3. Console trim plate.
4. Clutch start switch connector and bolt.
5. Clutch start switch.

Install or Connect

NOTICE: See "Notice" on page 7C-1 of this section.

1. Clutch start switch.
2. Clutch start switch connector and bolt.

Tighten

- Bolt to 2.2 N·m (19 lb. in.).

3. Console trim plate.
4. Trim plate fasteners.
5. Negative battery cable.

CLUTCH COVER AND PLATE ASSEMBLY, DISC, FORK AND RELEASE BEARING

Figures 1 through 5

Remove or Disconnect

Tool Required:

J 33169 Clutch Alignment Arbor (V6) or
J 5824-01 Clutch Alignment Arbor (V8)

1. Transmission, Refer to MANUAL TRANSMISSION (SEC 7B).
2. Actuator and heat shield bolts.
3. Heat shield.
4. Actuator.
5. Clutch housing cover.
6. Clutch housing bolts.
7. Clutch housing.
8. Clutch release bearing.
9. Clutch fork with spring.
    - Slide the clutch fork from the ball stud and dust boot.

- Install J 33169 (V6), or J 5824-01 (V8) to support the clutch assembly during removal.
- Look for the mark or the white painted letter on the clutch housing, and the "X" mark on the flywheel. If the marks are not visible, place matchmarks on the flywheel and clutch cover.

10. Clutch cover-to-flywheel bolts.
    - Loosen the bolts evenly, one turn at a time until spring pressure is released.
11. Clutch cover pressure and plate assembly clutch disc.

Inspect

- Flywheel for cracks, heat checking, or other defects. Replace or repair as required. Refer to 3.1 LITER V6 (SEC. 6A2) or V8 ENGINES (SEC. 6A3).
- Clutch disc, pressure plate assembly and flywheel face for oil, grease, or metal contamination, and for burned spots. Replace as necessary.
- Pilot bearing for excessive wear or damage. Replace if necessary. Refer to "Pilot Bearing" in this section.

Clean

- Pilot bearing. Lubricate the pilot bearing sparingly with machine oil.

Install or Connect

Tool Required:

J 33169 Clutch Alignment Arbor (V6) or
J 5824-01 Clutch Alignment Arbor (V8)

NOTICE: See "Notice" on page 7C-1 of this section.

1. Clutch disc clutch cover and pressure plate assembly to the flywheel, using J 33169 (V6) or J 5824-01 (V8).
    - The clutch disc is installed with the damper springs toward the transmission. The flywheel side is marked.
    - Align the matchmark on the clutch cover and plate assembly with the matchmark on the flywheel.
2. Clutch cover and pressure plate assembly-to-flywheel bolts.

Tighten

- Alternate bolts, one turn at a time to avoid distorting the clutch assembly.
- Bolts to 21 N·m (15 lb. ft.) V6.
- Bolts to 40 N·m (30 lb. ft.) V8.

- Remove J 33169 or J 5824-01.
- Lubricate the clutch fork ball socket and fingers at the release bearing using wheel bearing lubricant number 1051344, or equivalent.

NOTICE: If replacing the fork, install the correct part number. The V6 and V8 forks appear very similar. Installing the wrong fork may destroy the actuator.

3. Clutch fork with retaining spring onto the ball stud.
    - Replace the ball stud if worn or damaged.

- Lubricate the recess inside the release bearing collar and the clutch fork groove using wheel bearing lubricant number 1051344, or equivalent.

- Retaining spring tangs must be installed to the rear of the shoulder on the ball stud.

4. Dust boot onto the clutch fork.
5. Release bearing onto the clutch fork.
   - Clutch fork fingers and the retaining spring tabs must be installed in the release bearing groove.
6. Clutch housing.
7. Clutch housing bolts.

Tighten

- Bolts to 47 N·m (35 lb. ft.) V6.
- Bolts to 95 N·m (70 lb. ft.) V8.

8. Clutch housing cover.

Tighten

- Bolts to 6 N·m (53 lb. in.).

9. Transmission. Refer to MANUAL TRANSMISSION (SEC. 7B).
10. Actuator.
11. Heat shield.
12. Actuator and heat shield bolts.

Tighten

- Bolts to 21 N·m (15 lb. ft.).

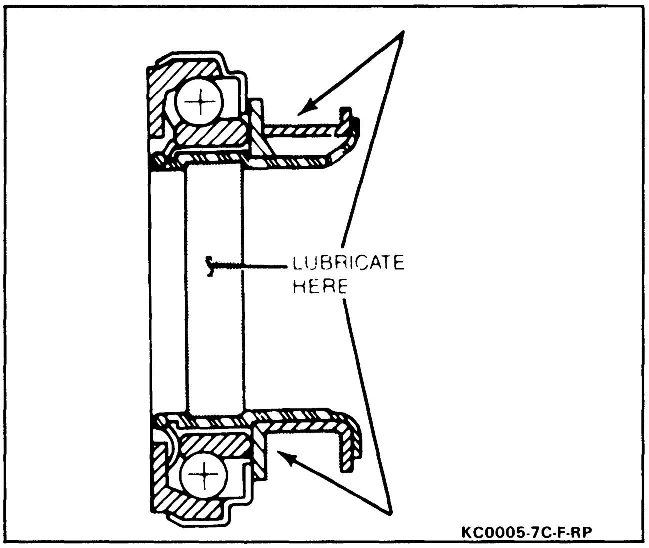


Figure 5 - Release Bearing Lubrication Areas

FLYWHEEL

Figures 1 and 2

Remove or Disconnect

1. Driven plate assembly. Refer to "Clutch Cover and Plate Assembly, Disc, Fork and Release Bearing" in this section.
2. Flywheel-to-crankshaft bolts.
3. Flywheel.

Install or Connect

1. Flywheel.

   NOTICE: See "Notice" on page 7C-1 of this section.

2. Flywheel-to-crankshaft bolts.

Tighten

- Bolts to 70 N·m (52 lb. ft.) V6.
- Bolts to 100 N·m (74 lb. ft.) V8.

3. Driven plate assembly. Refer to "Clutch Cover and Plate Assembly, Disc, Fork and Release Bearing" in this section.

PILOT BEARING

Tool Required:

J 23907 Clutch Pilot Bearing Remover

Remove or Disconnect

1. Driven plate assembly. Refer to "Clutch Cover and Plate Assembly, Disc, Fork and Release Bearing" in this section.
2. Pilot bearing from the crankshaft using J 23907.

Install or Connect

1. Pilot bearing into the crankshaft.
   - Use a bearing driver that contacts the outer race only.
   - Lubricate the pilot bearing sparingly with machine oil.
2. Driven plate assembly. Refer to "Clutch Cover and Plate Assembly, Disc, Fork and Release Bearing" in this section.

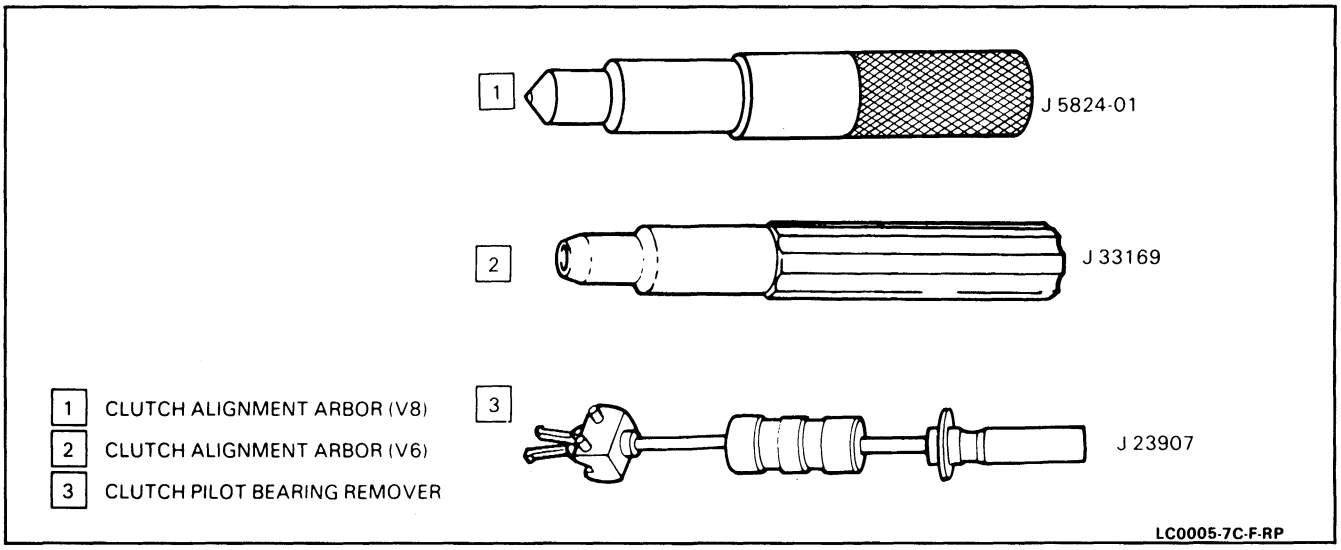
SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Clutch Fluid Reservoir-to-Mounting Bracket Screw	6 N·m (53 lb. in.)
Clutch Master Cylinder-to-Cowl Nut	13 N·m (115 lb. in.)
Brake Vacuum Booster-to-Cowl Nut	21 N·m (15 lb. ft.)
Actuator-to-Clutch Housing Bolt	21 N·m (15 lb. ft.)
Clutch Pedal-to-Mounting Bracket Nut	35 N·m (26 lb. ft.)
Clutch Cover and Pressure Plate Assembly-to-Flywheel Bolt	
V6	21 N·m (15 lb. ft.)
V8	40 N·m (30 lb. ft.)
Flywheel-to-Crankshaft Bolt	
V6	70 N·m (52 lb. ft.)
V8	100 N·m (74 lb. ft.)

Clutch Housing-to-Engine Bolt	
V6	47 N·m (35 lb. ft.)
V8	95 N·m 70 lb. ft.)
Clutch Housing Cover Bolt	6 N·m (53 lb. in.)
Bleed Screw	2 N·m (18 lb. in.)
Clutch Start Switch Bolt	2.2 N·m (19 lb. in.)

SPECIAL TOOLS



SECTION 8A

ELECTRICAL DIAGNOSIS

1991 CAMARO

INDEX

INDEX

DIAGNOSTIC INFORMATION

This manual contains the following kinds of diagnostic information:

- Electrical Schematics
- Component Location Lists
- Harness Connector Faces
- Troubleshooting Hints
- System Checks
- System Diagnoses
- Circuit Operation Descriptions
- Harness Routing Views
- Input Tests (with built-in self-diagnostic system)

Using these elements together will make electrical troubleshooting faster and easier. Each element is described below.

The **Electrical Schematic** should always be your starting point in using this Electrical Troubleshooting Manual. The schematic shows the electrical current paths when a circuit is operating properly. It is essential to understand how a circuit *should* work before trying to figure out why it doesn't.

The **Component Location List** helps you find where the parts of a circuit are in a vehicle. A brief statement of the location is given and also a reference to a drawing that shows the component and its connecting wires. These **Component Location Views** are in cell 201.

The **Harness Connector Faces** show the cavity or terminal locations in all the multi-pin connectors shown in the schematic. Together with the wire colors and terminals given in the schematic, they help you locate test points. The drawings show the connector faces you see after the harness connector has been disconnected from a component. When more than one connector is connected to a component the connectors are all shown together.

The **Troubleshooting Hints** offer short-cuts or checks to help you determine the cause of a complaint. They are not intended to be a rigid procedure for solving an electrical situation. Rather, Troubleshooting Hints represent a common-sense approach, based on an understanding of the circuit.

The **System Check** gives a summary of how the circuit should be operated and what should happen. This is especially important when you are working on a new system. This information is generally supplied in table form. In the first column the various control settings are listed, and in the second column the proper operation of the circuit is described. The System Check will help you identify symptoms that will lead you to diagnose the complaint and confirm the system after repair.

The **System Diagnosis** provides a procedure to follow that will locate a faulty condition in a circuit. If your own knowledge of the system and the Troubleshooting Hints have not produced a quick fix, follow the System Diagnosis. All procedures are based on symptoms that lead to Test Tables. An example of a commonly used type of table is given in Figure 1 (facing page) with an explanation of each of its parts. These tables will assist you in locating the condition quickly.

The **Circuit Operation** will help you to understand the circuit. It describes the components and how the circuit works.

Harness Routing Views are found in cell 203. These views show routing of the major wiring harnesses and the in-line connectors between the major harnesses. These views will make trouble-shooting easier when you are not sure about harness routi

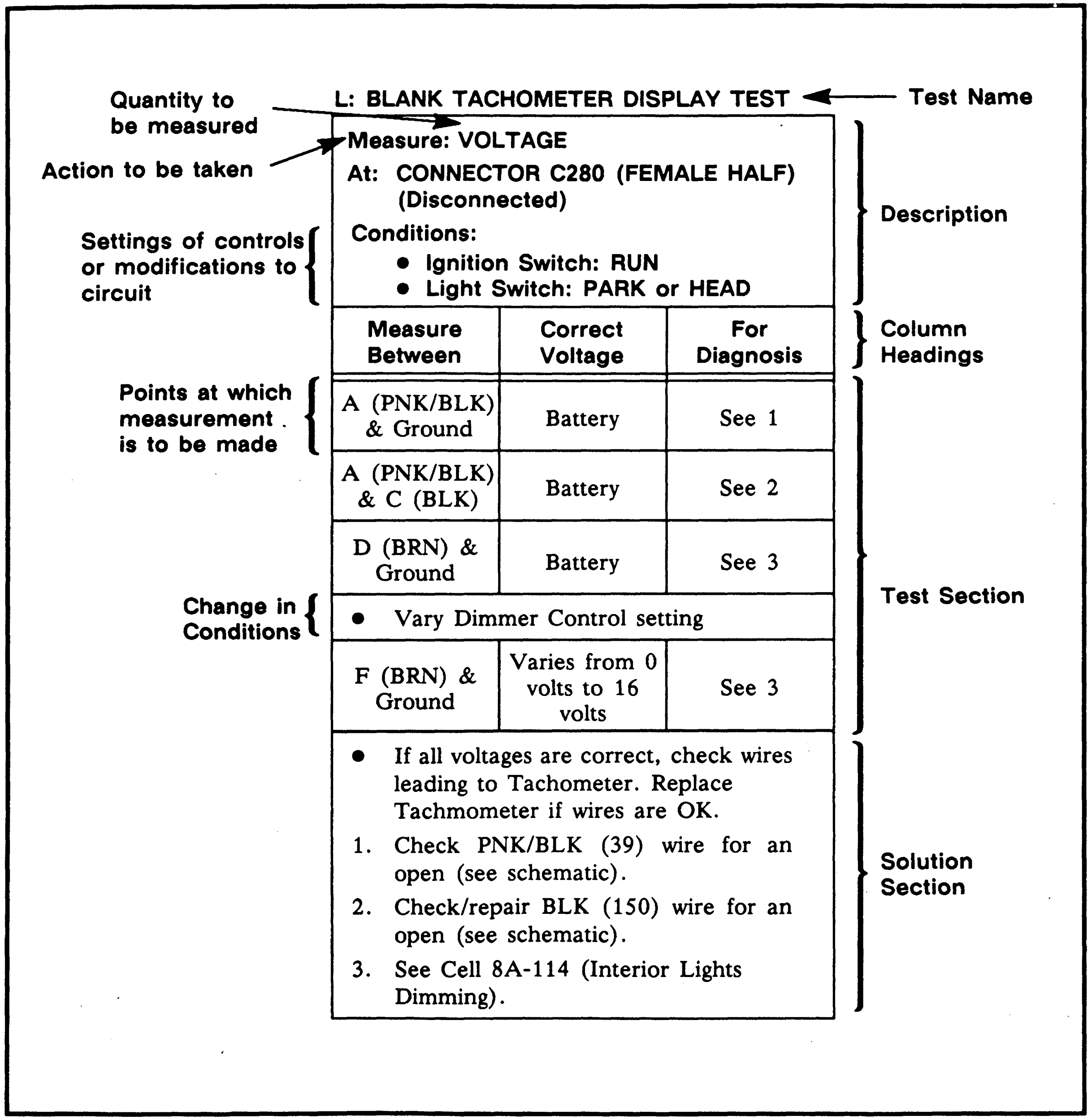
If the system you are troubleshooting has a built-in self-diagnostic system, the **Input Test** sections permit you to use the Body Computer (BCM) to troubleshoot circuits that interface with the BCM, ECM and IPC. The step-by-step test procedures in cells 300 (ECM Input Tests), 301 (BCM Input Tests), and 302 (Instrument Panel Input Tests) should be used after a circuit problem is isolated by using the System Diagnosis. The System Diagnosis procedures direct you to the proper Diagnostic Test procedure.

PAGE NUMBER

This section is organized into cells with most cells containing a circuit schematic and the text for that circuit. This makes the section easy to use, since the page number for a schematic will normally stay the same year after year, and it will also be the same in all the GM publications about that circuit. For example, the Cruise Control schematics will always be the first pages of cell 34 (pages 34-0, 34-1). The other information for Cruise Control follows them on pages 34-2, 34-3, etc.

Some cells may have more than one circuit schematic, such as Power Distribution, Interior Lights, and Air Conditioning. The circuit schematic you want can be located by using the index, or by a quick look through the related cell.

All the engine circuits for a particular engine VIN type are in the same cell. This makes the cell easy to use, since schematics for other cars are not in your way. The instrument panel schematics are organized similarly. If you are working on a car with a Digital Cluster, only the schematics that apply to that car's Digital Cluster will be in the cell you use. Information on the Indicators (Standard) and Gages Clusters will be in other cells.



L: BLANK TACHOMETER DISPLAY TEST

Measure: VOLTAGE

At: CONNECTOR C280 (FEMALE HALF) (Disconnected)

Conditions:

- **Ignition Switch: RUN**
- **Light Switch: PARK or HEAD**

Measure Between	**Correct Voltage**	**For Diagnosis**
A (PNK/BLK) & Ground	Battery	See 1
A (PNK/BLK) & C (BLK)	Battery	See 2
D (BRN) & Ground	Battery	See 3
• Vary Dimmer Control setting		
F (BRN) & Ground	Varies from 0 volts to 16 volts	See 3

- If all voltages are correct, check wires leading to Tachometer. Replace Tachmometer if wires are OK.

1. Check PNK/BLK (39) wire for an open (see schematic).
2. Check/repair BLK (150) wire for an open (see schematic).
3. See Cell 8A-114 (Interior Lights Dimming).

Figure 1 - Typical Test Table

SCHEMATICS

These schematics break the entire electrical system down into individual circuits. You are not distracted by wiring which is not part of the circuit you're working on.

It is important to realize that no attempt is made on the schematic to represent components and wiring as they physically appear on the car. For example, a 4-foot length of wire is treated no differently in a schematic from one which is only a few inches long. The number of cavities for each connector is listed in the Component Location List rather than illustrated. Similarly, switches and other components are shown as simply as possible, with regard to function only.

The following example shows how to read a Horn schematic, see Figure 2. Locate the Horn schematic using the Index. The circuit schematic will look somewhat like the one to the right. The schematic is read from top to bottom.

Voltage is applied to the Horn Relay at all times. When the relay coil is grounded by closing the Horn Switch, the relay contacts close. When the relay contacts are closed, both the LH and RH Horns are energized.

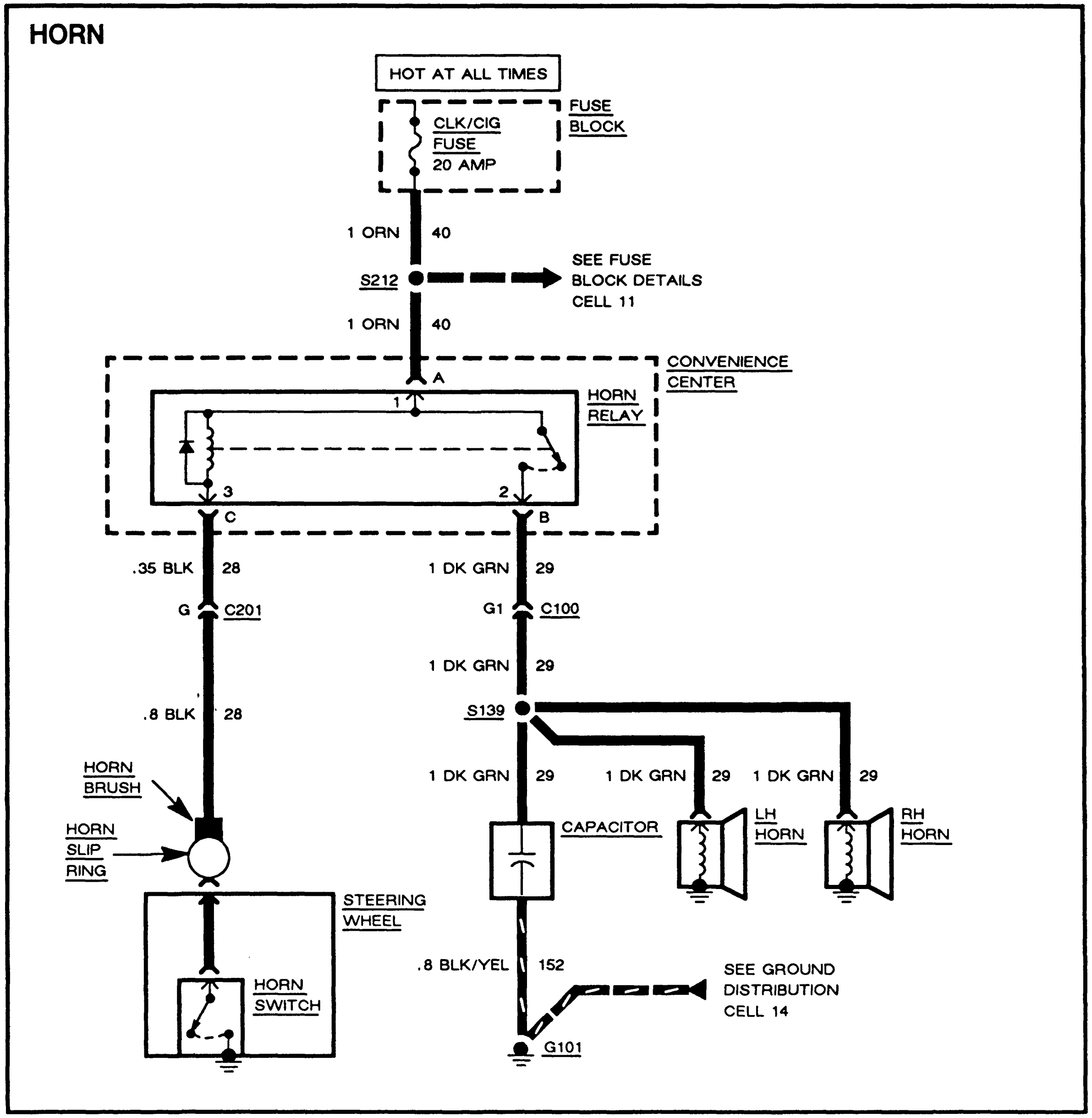


Figure 2 - Typical Horn Schematic

INTRODUCTION

COMPONENT LOCATIONS

When you are ready to locate the schematic components on the car, use the Component Location List, see Figure 3.

Listed in the left hand column are the components shown on the schematic. Next to the Convenience Center is the location, "Under LH side of I/P." Reference to LH and RH is made as though the troubleshooter was sitting in the driver's seat. On the same line, in the far right column, is a page-figure reference. In this case, you are directed to Figure A on page 201-6.

When connectors are listed, the number of cavities is provided. This represents the total number of cavities in the connector, regardless of how many are actually used. This information is provided to help you identify connectors on the car.

Grounds are listed next in the table. The location description for G101 reads, "LH front of engine compartment, behind headlights panel." You are directed to page 201-8, Figure D.

Nearly every component, connector, ground, grommet, or splice shown on a schematic can be pin-pointed visually by using the Component Location Views' figures.

COMPONENT LOCATION — Page-Figure

COMPONENTS

Convenience Center	Under LH side of I/P	201-6-A
Fuse Block	Under LH side of I/P	201-6-A
Horn Brush/Slip Ring	Under steering wheel	201-5-E
Horn Switch	Under steering wheel	201-5-E

CONNECTORS

C100 (46 cavities)	LH side of dash	201-5-B
C201 (11 cavities)	Under LH side of I/P, near C100	201-5-F

GROUNDS

G101	LH front of engine compartment, behind headlights panel	201-88-D

SPLICES

S139	Front lights harness, behind LH front light panel	201-8-C
S212	I/P harness, behind I/P, above steering column	201-6-B

Figure 3 – Typical Entries in The Component Location List

HARNESS CONNECTOR FACES

The connectors, see Figure 4, are labeled with the component they are connected to, or the connector number from the schematic where they appear, connection system identification, and their color. The connector is a Push-to-Seat type unless Pull-to-Seat is stated. The identifying number is for reference only; it is not the connector part number. For in-line connectors, the half shown is usually the Socket Half. If both views are shown, the other half is the Pin Half.

If you need to backprobe a connector while it is on the component, the order of the terminals must be mentally reversed. The wire color is a help in this situation. If there is more than one wire of the same color, you may need to locate a test point from its terminal number. A useful trick is to imagine that you are probing a terminal from behind the page you are looking at. Then mentally locate that terminal with respect to the keyway or other reference mark.

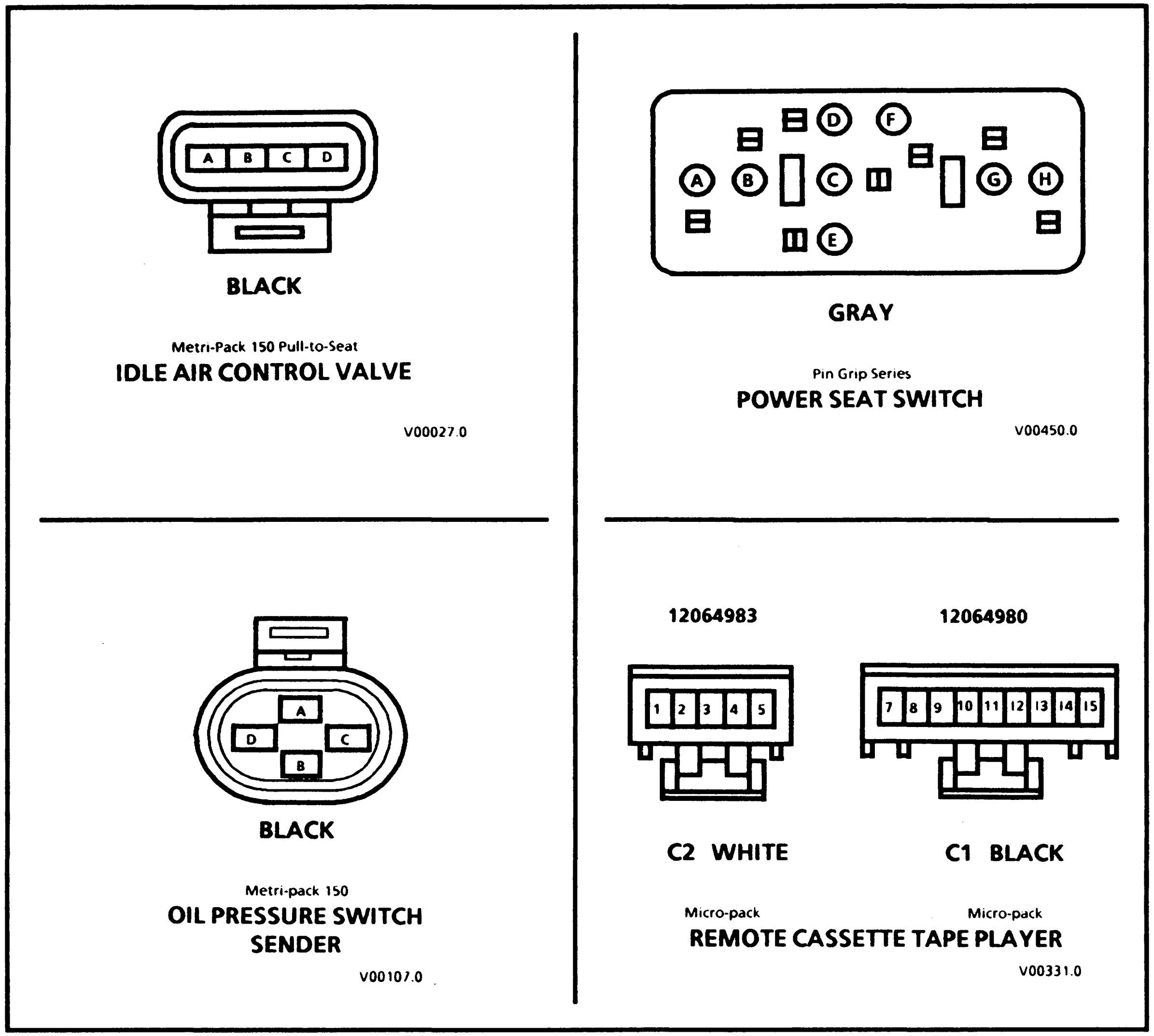


Figure 4 - Typical Harness Connector Faces

OTHER INFORMATION

Body Part Names

Refer to Figure 5 for correct body part names.

VIN References

If schematics for more than one variation of an engine type – V6, for example – are shown, then the schematics will be labeled with VIN designations to distinguish the variations.

Service Parts Identification Label

To aid service and parts personnel in identifying options and parts originally installed, a Service Parts Identification Label has been placed in the car. See the General Information Section 0A of the Chassis Service Manual for the location of the label and the definition of the option codes.

Abbreviations

A/C - Air Conditioning

BCM - Body Computer Module

ECM - Electronic Control Module or Engine Control Module

I/P - Instrument Panel

RH - Right Hand, as seen from driver's seat

LH - Left Hand

Not Used - The connector cavity has no function.

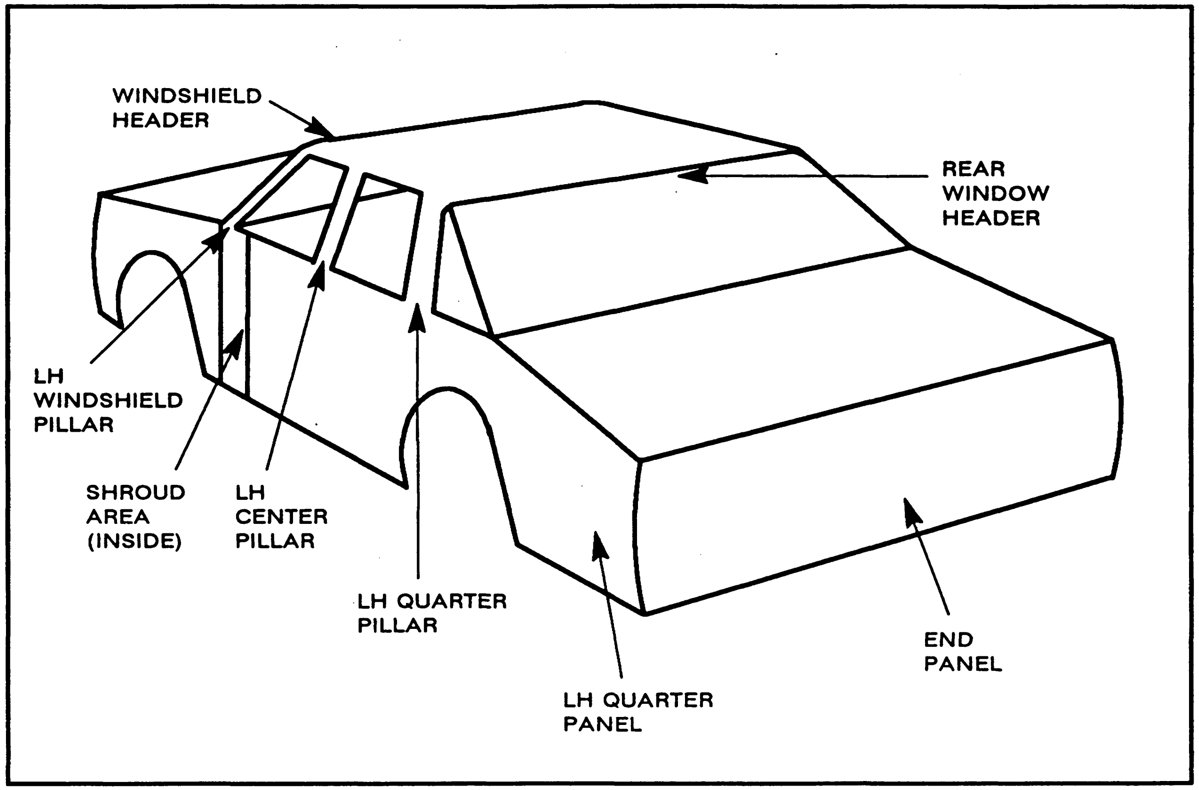


Figure 5 - Body Part Names

POWER DISTRIBUTION

The Power Distribution schematic shows the wiring from the Battery and Generator to the Starter Solenoid, Fuse Block, Ignition Switch and Light Switch. The first component after a Fusible Link is also shown. In certain instances, the first component after a Fuse Block fuse and Light Switch is also shown.

The Power Distribution schematic refers to Fuse Block Details and Light Switch Details schematics. By using these three (3) schematics, power distribution wiring can be followed from the Battery and Generator to the first component after a Fusible Link, Fuse and Light Switch. The ability to follow the power distribution wiring to the first component in each circuit is extremely helpful in locating short circuits which cause fusible links and fuses to open.

Figure 6 is a sample Power Distribution schematic. It shows how voltage is applied from the positive Battery terminal to the various circuits on the car. For example, Battery voltage is applied to the Starter Solenoid, Fusible Link D, the RED wire and connector C100 to Fuse 1 and Fuse 2 in the Fuse Block and the Light Switch in the LH Pod. These fuses are said to be "Hot At All Times", since Battery voltage is always applied to them.

Notice that Battery voltage is also applied to Fusible Link F and the RED wire to the Coolant Fan Relay.

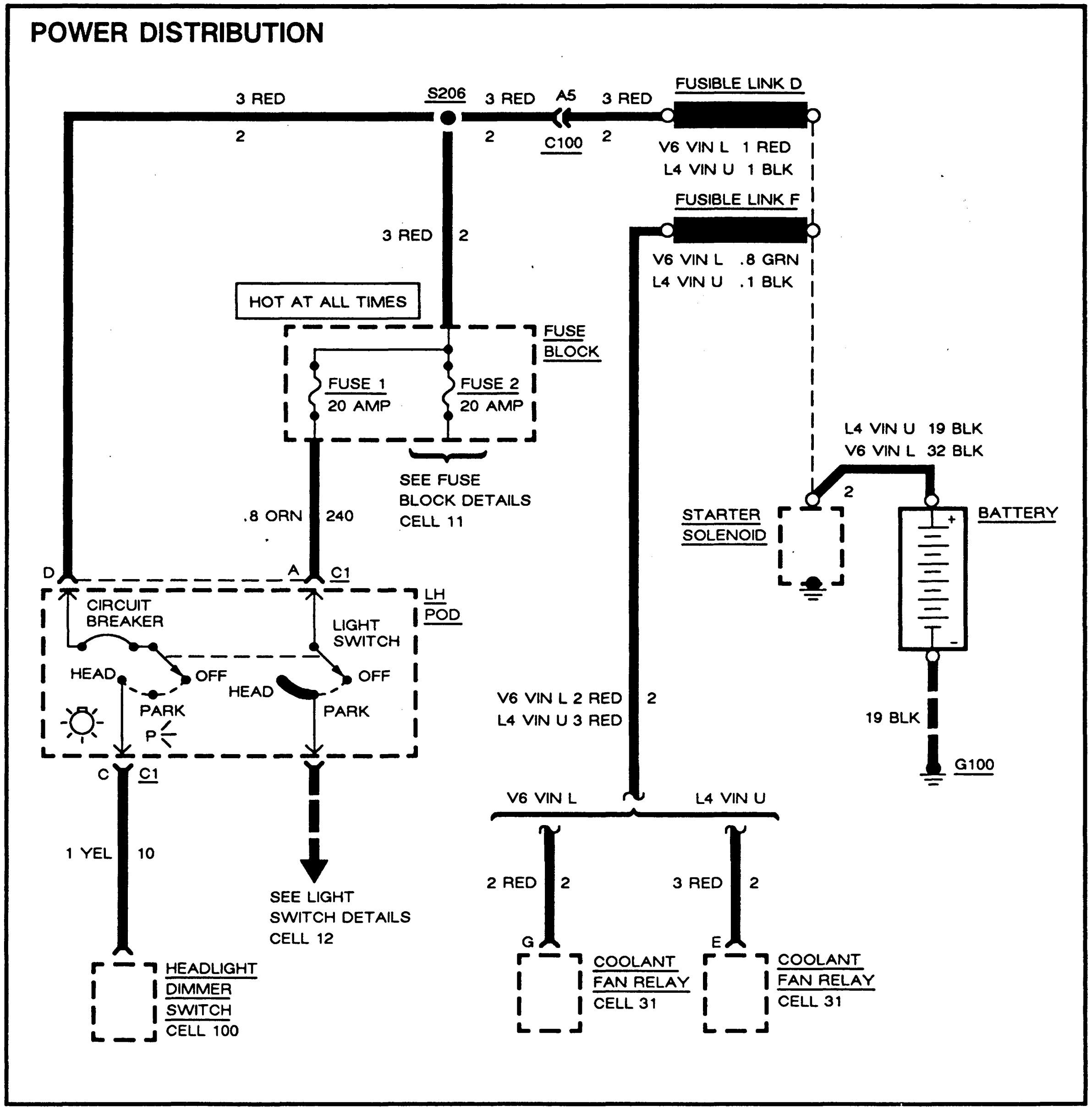


Figure 6 - Typical Power Distribution Schematic

FUSE BLOCK DETAILS

The Fuse Block Details schematic shows all the wiring between a fuse and the components connected to the output of the fuse, see Figure 7. In certain instances where space permits, this detail is shown on the Power Distribution schematic. The Fuse Block Details schematic is extremely helpful in locating a short circuit that causes a fuse to open.

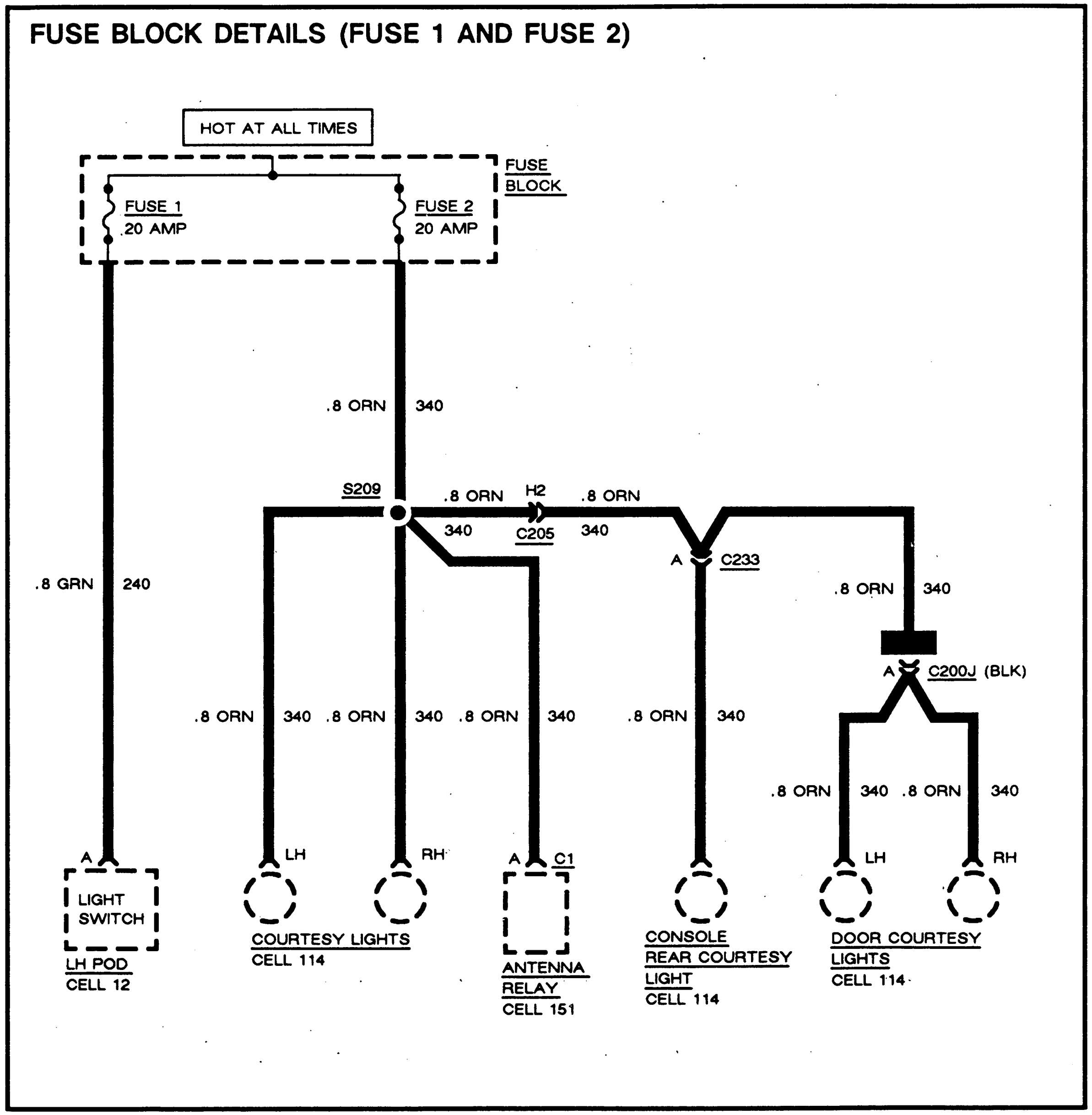


Figure 7 - Typical Fuse Block Details Schematic

LIGHT SWITCH DETAILS

The Light Switch Details schematic shows the wiring between the Light Switch and the components connected to the output of the Light Switch, see Figure 8. In certain instances where space permits, some of this detail may be shown on the Power Distribution schematic. The Light Switch Details schematic helps you understand the many wires that come from the Light Switch.

This schematic is also helpful in locating a short circuit that causes the fuse ahead of the Light Switch to open.

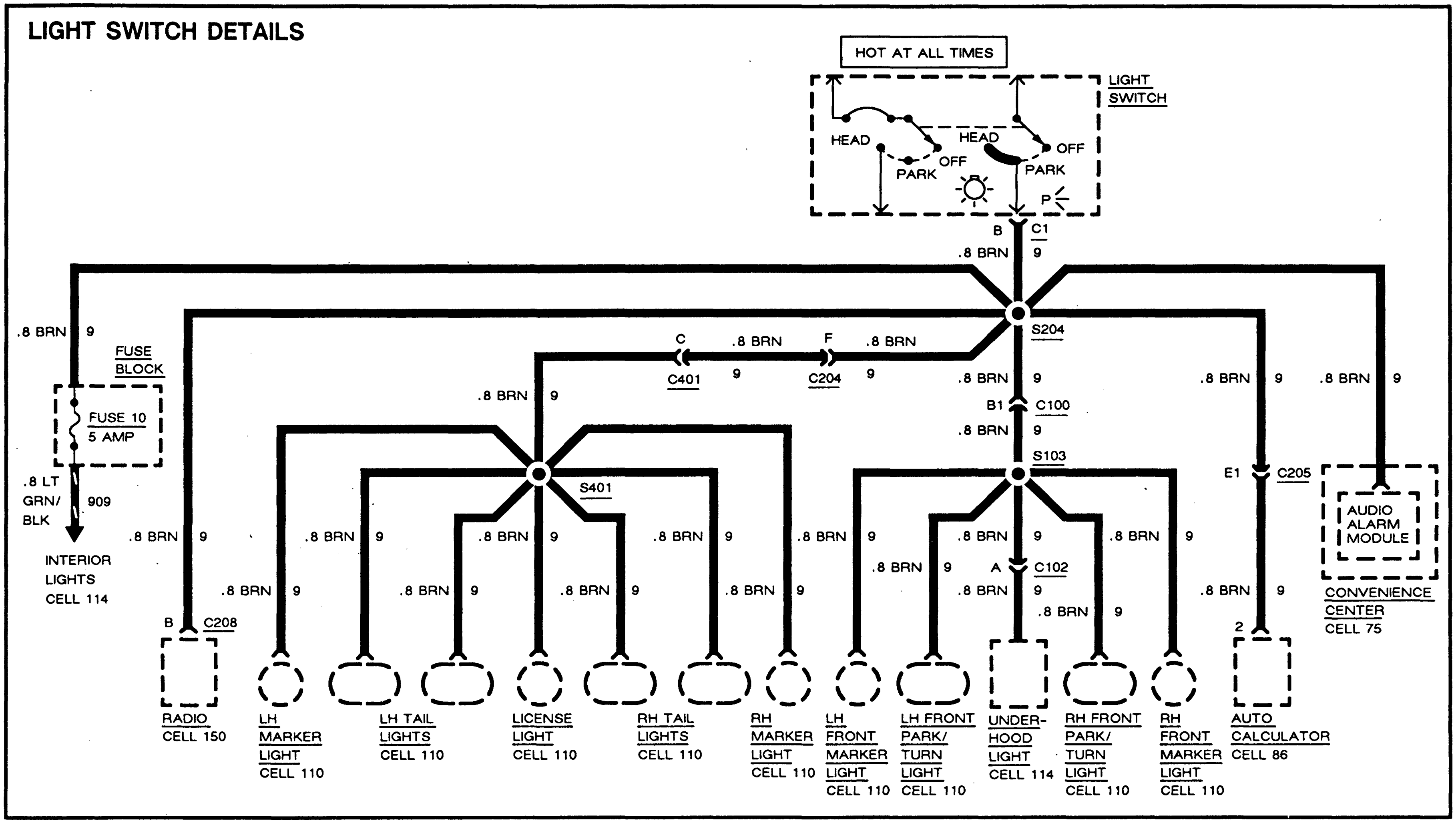


Figure 8 - Typical Light Switch Details Schematic

GROUND DISTRIBUTION

Figure 9 is a sample Ground Distribution schematic for the Headlights. It shows exactly which components share each ground. This information can often be a time-saver when troubleshooting ground circuits.

For example, if both Headlights and the Park/Turn Light on one side are all out, you could suspect an open in their common ground wire or the ground connection itself. On the other hand, if one of the lights works, you know that the ground and the wire up to the splice are good. You have learned this just by inspecting the schematic and knowing the vehicle's symptoms. No actual work on the lighting system was needed.

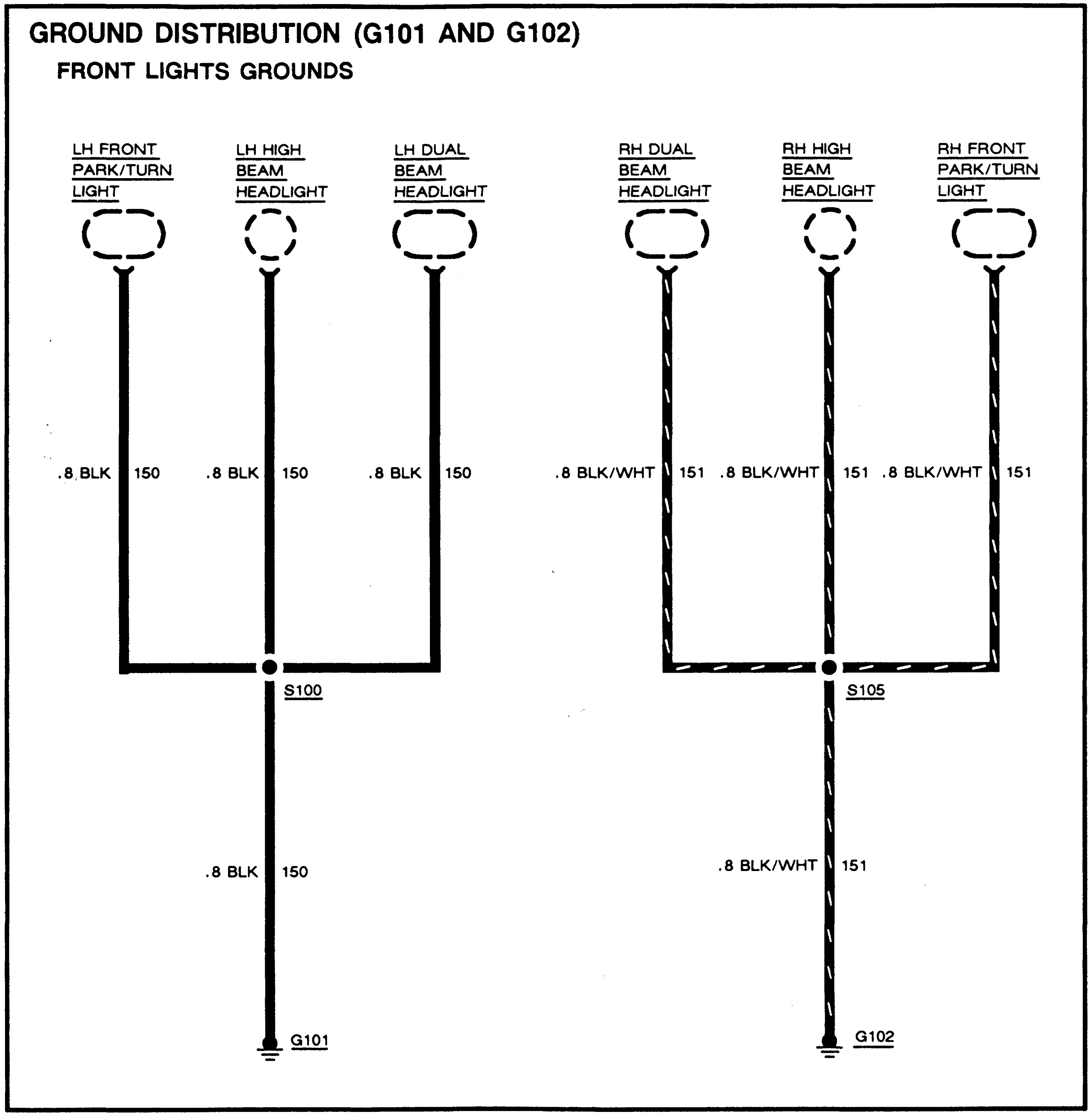
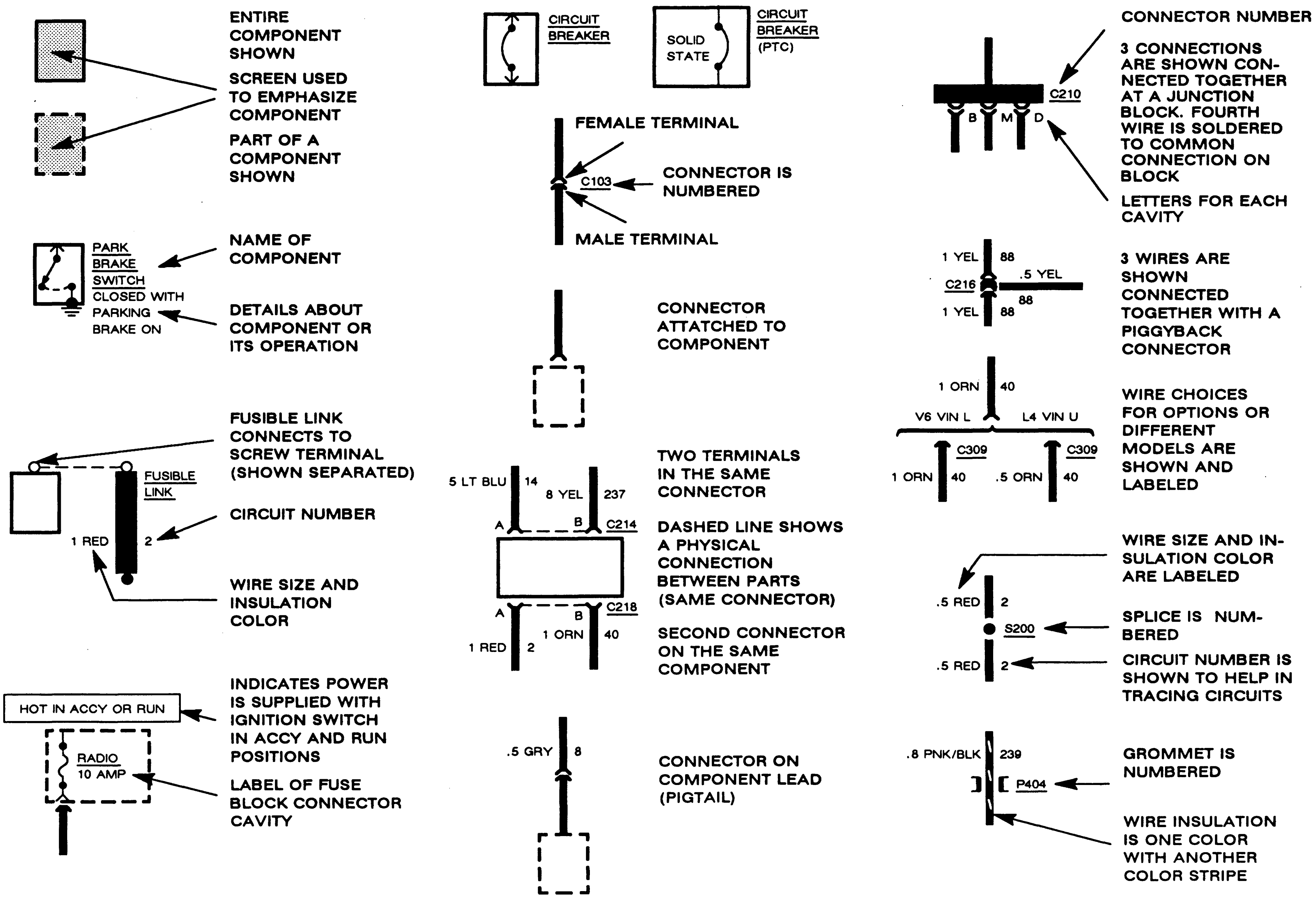


Figure 9 - Typical Ground Distribution Schematic

SYMBOLS



ENTIRE COMPONENT SHOWN

SCREEN USED TO EMPHASIZE COMPONENT

PART OF A COMPONENT SHOWN

NAME OF COMPONENT

DETAILS ABOUT COMPONENT OR ITS OPERATION

FUSIBLE LINK CONNECTS TO SCREW TERMINAL (SHOWN SEPARATED)

CIRCUIT NUMBER

WIRE SIZE AND INSULATION COLOR

INDICATES POWER IS SUPPLIED WITH IGNITION SWITCH IN ACCY AND RUN POSITIONS

LABEL OF FUSE BLOCK CONNECTOR CAVITY

FEMALE TERMINAL

CONNECTOR IS NUMBERED

MALE TERMINAL

CONNECTOR ATTATCHED TO COMPONENT

TWO TERMINALS IN THE SAME CONNECTOR

DASHED LINE SHOWS A PHYSICAL CONNECTION BETWEEN PARTS (SAME CONNECTOR)

SECOND CONNECTOR ON THE SAME COMPONENT

CONNECTOR ON COMPONENT LEAD (PIGTAIL)

CONNECTOR NUMBER

3 CONNECTIONS ARE SHOWN CONNECTED TOGETHER AT A JUNCTION BLOCK. FOURTH WIRE IS SOLDERED TO COMMON CONNECTION ON BLOCK

LETTERS FOR EACH CAVITY

3 WIRES ARE SHOWN CONNECTED TOGETHER WITH A PIGGYBACK CONNECTOR

WIRE CHOICES FOR OPTIONS OR DIFFERENT MODELS ARE SHOWN AND LABELED

WIRE SIZE AND INSULATION COLOR ARE LABELED

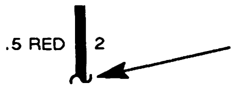
SPLICE IS NUMBERED

CIRCUIT NUMBER IS SHOWN TO HELP IN TRACING CIRCUITS

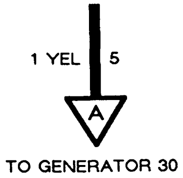
GROMMET IS NUMBERED

WIRE INSULATION IS ONE COLOR WITH ANOTHER COLOR STRIPE

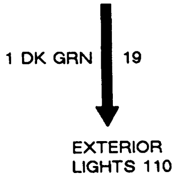
SYMBOLS



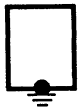
A WAVY LINE MEANS A WIRE IS TO BE CONTINUED



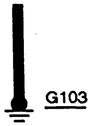
A CURRENT PATH IS CONTINUED AS LABELED. ARROW SHOWS THE DIRECTION OF CURRENT FLOW AND IS REPEATED WHERE CURRENT PATH CONTINUES



A WIRE WHICH CONNECTS TO ANOTHER CIRCUIT. THE WIRE IS SHOWN AGAIN IN THAT CIRCUIT. ARROW SHOWS DIRECTION OF CURRENT FLOW

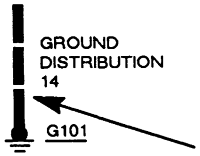


COMPONENT CASE IS DIRECTLY ATTACHED TO METAL PART OF CAR (GROUNDED)



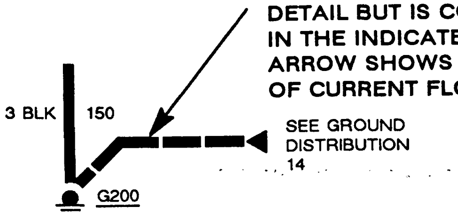
WIRE IS ATTACHED TO METAL PART OF CAR (GROUNDED)

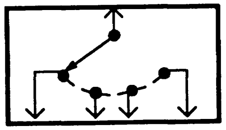
GROUND IS NUMBERED



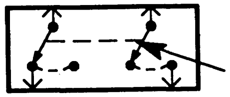
WIRE IS INDIRECTLY CONNECTED TO GROUND

BROKEN WIRE INDICATES THAT CIRCUITRY IS NOT SHOWN IN COMPLETE DETAIL BUT IS COMPLETE IN THE INDICATED CELL. ARROW SHOWS DIRECTION OF CURRENT FLOW



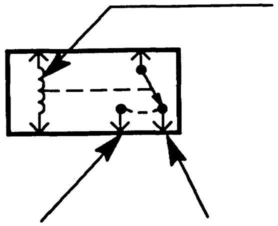


MULTI-POSITION SWITCH



SWITCH CONTACTS THAT MOVE TOGETHER

DASHED LINE SHOWS A MECHANICAL CONNECTION BETWEEN SWITCH CONTACTS



RELAY COIL

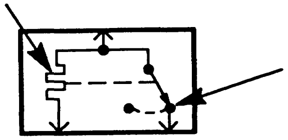
RELAY SHOWN WITH NO CURRENT FLOWING THROUGH COIL

WHEN CURRENT FLOWS THROUGH COIL, CONTACT MOVES TO NORMALLY OPEN POSITION

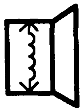
NORMALLY OPEN CONTACT

NORMALLY CLOSED CONTACT

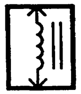
HEATING ELEMENT



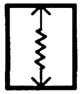
HEAT ACTUATED CONTACT



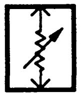
HORN OR SPEAKER



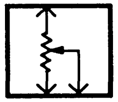
SOLENOID OR COIL



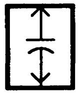
RESISTOR



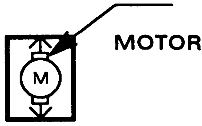
VARIABLE RESISTOR



POTENTIOMETER

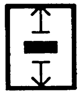


CAPACITOR



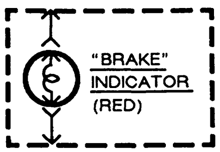
BRUSH

MOTOR



CRYSTAL

SYMBOLS

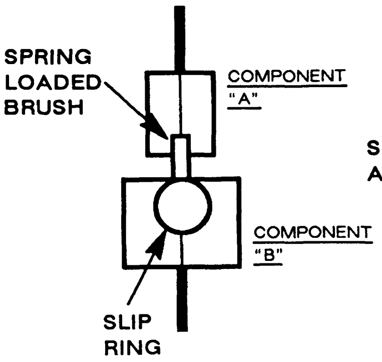


INDICATOR WHICH DISPLAYS THE LIGHTED WORD "BRAKE"

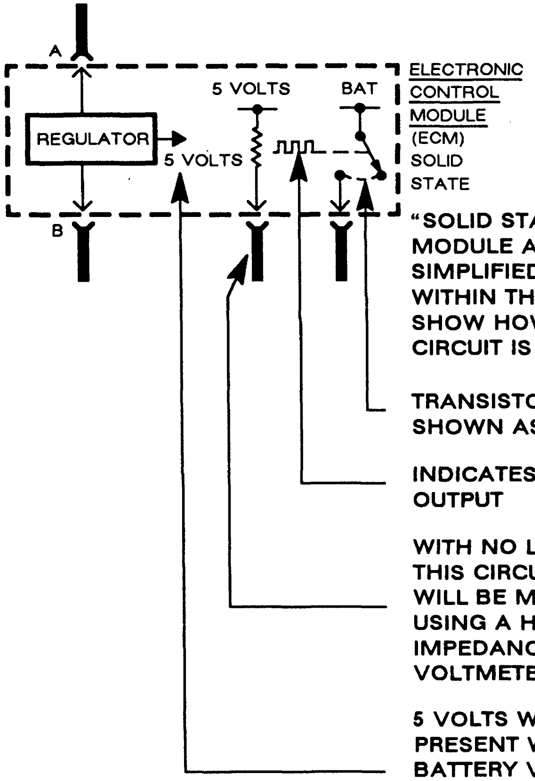
LIGHT EMITTING DIODE

PHOTO SENSITIVE TRANSISTOR

DIODE CURRENT FLOWS ONLY IN DIRECTION OF ARROW



SLIP RING ASSEMBLY



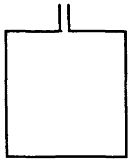
"SOLID STATE" IDENTIFIES MODULE AS ELECTRONIC. SIMPLIFIED COMPONENTS WITHIN THE MODULE SHOW HOW EACH CIRCUIT IS COMPLETED

TRANSISTOR SHOWN AS SWITCH

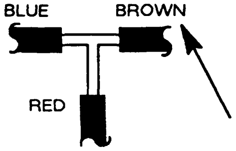
INDICATES PULSING OUTPUT

WITH NO LOAD ON THIS CIRCUIT, 5 VOLTS WILL BE MEASURED USING A HIGH IMPEDANCE DIGITAL VOLTMETER

5 VOLTS WILL BE PRESENT WHEN BATTERY VOLTAGE IS APPLIED BETWEEN TERMINALS "A" AND "B"



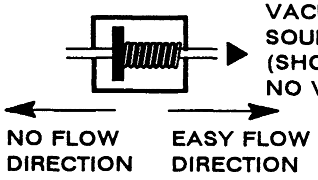
VACUUM TANK



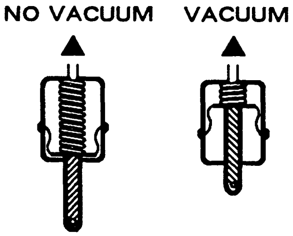
VACUUM JUNCTION

HOSE COLOR

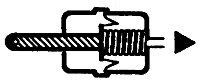
VACUUM CHECK VALVE



VACUUM SOURCE (SHOWN WITH NO VACUUM)

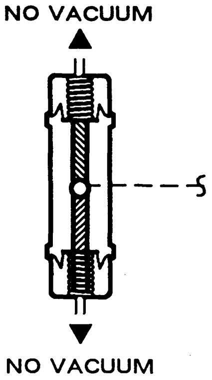


VACUUM ACTUATOR (SINGLE DIAPHRAGM, TWO POSITION)



PARTIAL VACUUM

VACUUM ACTUATOR (SERVO, MULTIPLE POSITION)



VACUUM ACTUATOR (DOUBLE DIAPHRAGM, THREE POSITIONS)

SYMBOLS

SOLID STATE SYMBOLS

A group of special symbols is used to represent electronic circuits used in solid state modules. These symbols are greatly simplified versions of the actual circuits. They can be very useful for troubleshooting purposes if properly used. It is important to remember that these symbols apply only to modules with all connectors in place and supply voltages on.

OUTPUTS

The Solid State Switch (Figures 1 and 2) is used to turn on a circuit outside the module. When the switch closes, the voltage or ground shown will be applied to the connected circuit. Additional information about what makes the switch close is often provided. The voltage controlled by the switch may be measured just as if it were a mechanical switch.

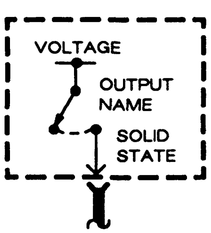


Figure 1

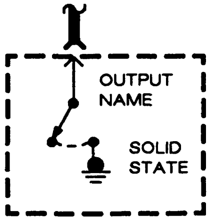


Figure 2

These symbols (Figures 3 and 4) are similar to the Solid State Switch. The pulses represent the rate at which the switch is turned on and off.

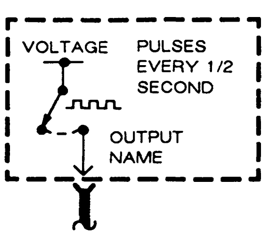


Figure 3

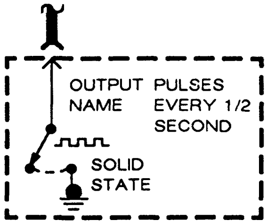
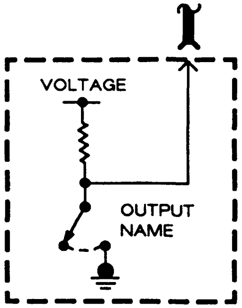


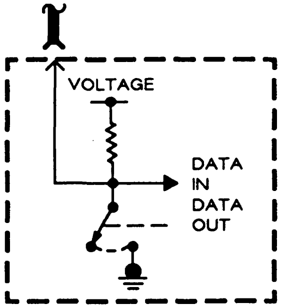
Figure 4

These two symbols (Figures 5 and 6) are special versions of the Solid State Switch. They represent serial data inputs and outputs. Serial data consits of coded groups of voltage pulses transmitted at high speed. These pulses cannot usually be measured with a Digital Voltmeter. There are cases however where procedures in System Diagnosis may describe such measurements. A Scan tool can often read and display this data.



DATA OUTPUT

Figure 5



DATA INPUT AND OUTPUT

Figure 6

INPUTS

These symbols (Figures 7 and 8) represent the equivalent circuit at the input terminals of electronic modules. You should not attempt to measure the resistance of these terminals unless instructed to do so by a service procedure. These inputs can be used to check wiring to electronic modules as shown under Troubleshooting Tests (Cell 4).

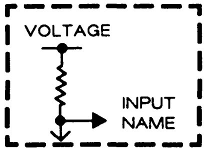


Figure 7

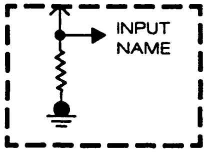


Figure 8

TROUBLESHOOTING PROCEDURES

ELECTROSTATIC DISCHARGE (ESD) SENSITIVE DEVICES

All ESD sensitive components contain Solid State circuits. The following information applies to all ESD sensitive devices. The ESD symbol (Figure 1) is used on schematics (Figure 2) to indicate which components are ESD sensitive.

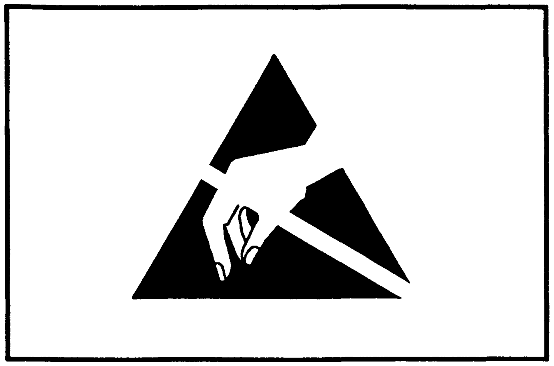


Figure 1 - Electrostatic Discharge (ESD) Sensitive Device Symbol

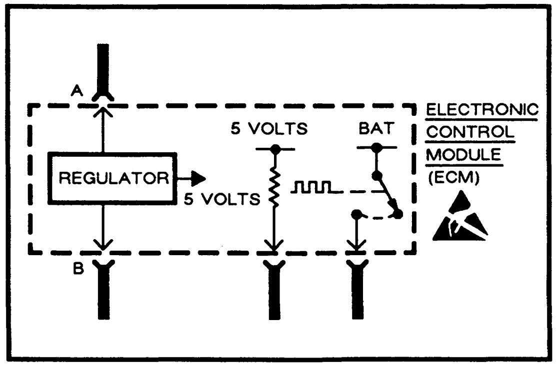


Figure 2 - Component (on Schematic) Indicated as ESD Sensitive

HANDLING PROCEDURES

When handling an electronic part that is ESD sensitive (see Figure 1), the service technician should follow these guidelines to reduce any possible electrostatic charge build-up on the service technician's body and the electronic part in the dealership:

1. Always touch a known good ground before handling the part. This should be repeated while handling the part and more frequently after sliding across the seat, sitting down from a standing position or walking a distance.
2. Avoid touching electrical terminals of the part, unless so instructed by a written diagnostic procedure.
3. Do not open package of a new part until it is time to install the part.
4. Before removing the part from its package, ground the package to a known good ground on the car.

MEASURING PROCEDURES

1. Solid State circuits in electronic devices are shown greatly simplified.
2. Due to the simplification of the electronic devices on the schematics, resistance measurements could be misleading or could lead to electrostatic discharge.
3. Only measure the resistance at the terminals of these devices when instructed by a written diagnostic procedure.
4. When using a voltmeter, be sure to connect the ground lead first.

JUMP STARTING IN CASE OF EMERGENCY WITH AUXILIARY (BOOSTER) BATTERY

Refer to Section 6D1, Battery, for jump starting procedures.

TROUBLESHOOTING PROCEDURES

The following four-step troubleshooting procedure is recommended.

Step 1: Check the problem

Perform a System Check to be sure you understand what's wrong. Don't waste time fixing part of the problem! Do not begin disassembly or testing until you have narrowed down the possible causes.

If the system you are troubleshooting has a built-in self-diagnostic system, enter diagnostics and check for trouble codes. Refer to the appropriate section of the Service Manual.

Step 2: Read the Electrical Schematic

Study the schematic. Read the Circuit Operation text if you do not understand how the circuit *should* work. Check circuits that share wiring with the problem circuit. The names of circuits that share the same fuse, ground, switch, etc., are included on each electrical schematic. (Shared circuits are also shown on Power Distribution, Ground Distribution, Fuse Block Details, and Light Switch Details pages.) Try to operate the shared circuits. If these circuits work, then the shared wiring is OK. The cause must be within the wiring used only by the problem circuit. If several circuits fail at the same time, chances are the power (fuse) or ground circuit is faulty.

Step 3: Find the Cause and Repair

- Narrow down the possible causes.
- Use the Troubleshooting Hints.
- Make the necessary measurements as given in the System Diagnosis.

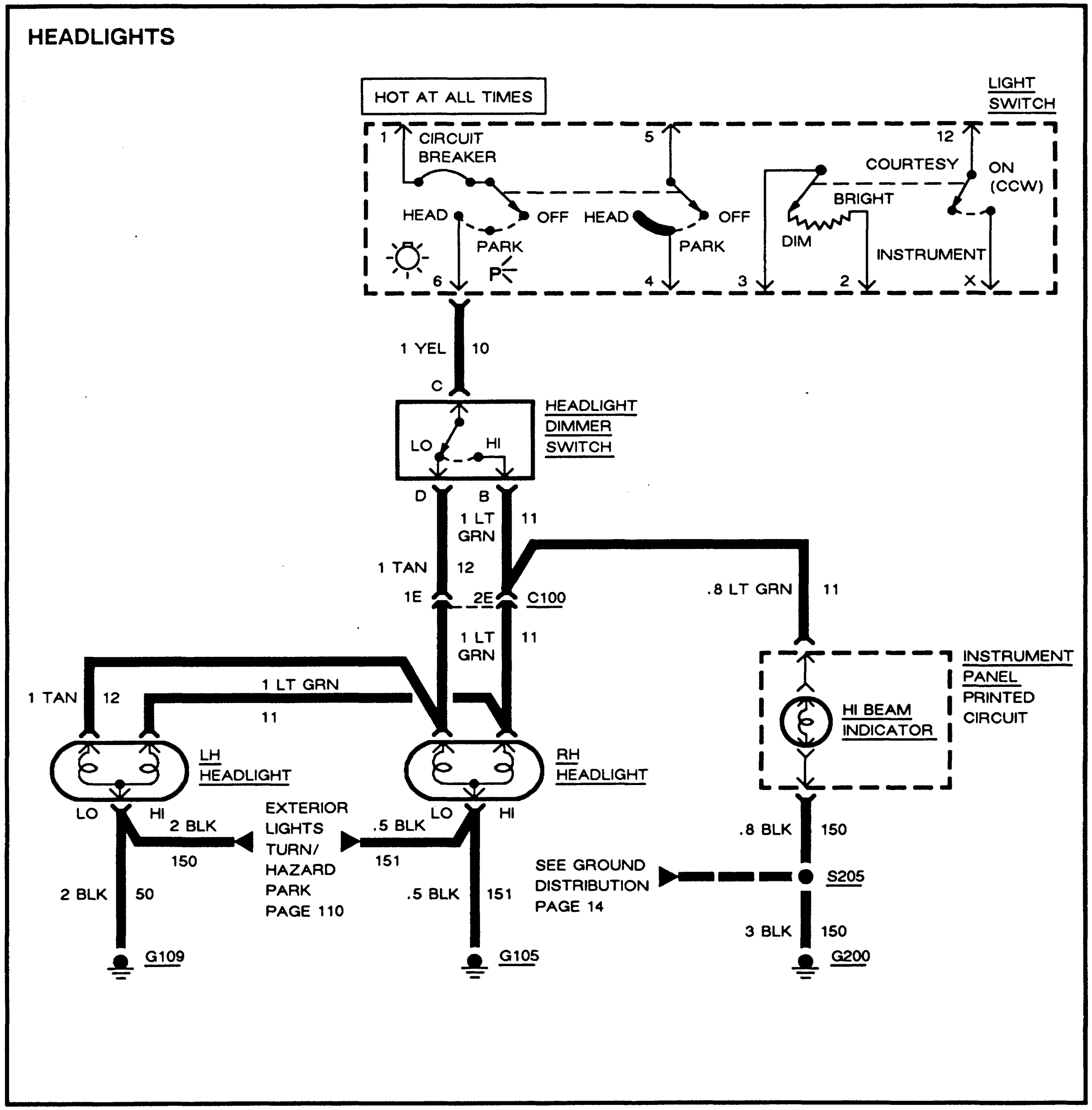


Figure 3 - Typical Headlights Schematic

- Before you replace a component, check power, signal, and ground wires at the component harness connector. If these are OK, the component must be bad.

Step 4: Test the Repair

Repeat the System Check to be sure you have fixed the whole problem.

Example

A customer brings in a car and says that the high beams do not work.

Step 1: Perform a System Check on the Headlights Circuit. You may discover that both low beams operate. In HI, you may notice that the High Beam Indicator comes on, but neither high beam operates.

Step 2: Read the Headlights electrical schematic, see Figure 3. This is the step that will save you time and labor. Remember, it is essential to understand how a circuit *should* work, before trying to figure out why it doesn't.

After you understand how the circuit should operate, read the schematic again, this time keeping in mind what you have learned by operating the circuit.

Since both low beams work, you know that the Light Switch, the YEL wire, the Lo contacts of the Headlight Dimmer Switch, terminal 1E of C100, the TAN wires, and grounds G105 and G109 are all good.

Furthermore, since you saw that the High Beam Indicator came on when the Headlight Dimmer Switch was moved to HI, you know that the Hi contacts of the dimmer switch and the LT GRN wire between the dimmer switch and C100 are good.

At this point, you could test for voltage at the RH Headlight with the dimmer switch in HI. However, it is extremely unlikely that the high beam filaments have burned out in *both* headlights, or that *both* headlight connections are bad. The cause must be a bad connection at C100, or a break in the LT GRN wire between C100 and the RH Headlight.

You have quickly narrowed the possible causes down to one specific area, and have *done* absolutely *no* work on the car itself.

Step 3: Find the cause and repair it. Using the Component Location List and the corresponding figure, you can quickly find C100 and the LT GRN wire, locate the exact trouble point, and make the repair.

Step 4: Check the repair by performing a system check on the Headlights circuit. This, of course, means making sure that both high beams, both low beams, and the High Beam Indicator are all working.

Now suppose that the symptoms were different. You may have operated the Headlights and found that the low beams were working, but neither the high beams nor the High Beam Indicator were working. Looking at the schematic, you might conclude that it is unlikely that both high beam filaments and the High Beam Indicator have all burned out at once. The cause is probably the dimmer switch or its connector.

Electrical troubleshooting requires the use of common electrical test equipment.

TEST LIGHT/VOLTMETER

Use a test light to check for voltage. A Test Light (J34142-B or equivalent) is made up of a 12-Volt light bulb with a pair of leads attached. After grounding one lead, touch the other lead to various points along the circuit where voltage should be present. When the bulb goes on, there is voltage at the point being tested.

A voltmeter can be used instead of a test light. While a test light shows whether or not voltage is present, a voltmeter indicates how much voltage is present.

An increasing number of circuits include solid state control modules. One example is the Electronic Control Module (ECM). Voltages in these circuits should be tested only with a 10-megohm or higher impedance digital voltmeter or multimeter (J34029-A or equivalent). Never use a test light on circuits that contain solid state components, since damage to these components may result.

When testing for voltage or continuity at a connection, you do not have to separate the two halves of the connector. Unless you are testing a "weather-pack" connector, you should probe the connector from the back. Always check both sides of the connector. An accumulation of dirt and corrosion between contact surfaces is sometimes a cause of electrical problems.

CONNECTOR TEST ADAPTERS

A connector Adapter Kit is available (J35616) for making tests and measurements at separated connectors. This kit contains an assortment of probes which mate with many of the types of connectors you will see. avoid using paper clips and other substitutes since they can damage terminals and cause incorrect measurements.

SELF-POWERED TEST LIGHT

Use a self-powered test light (J21008-A or equivalent) to check for continuity. This tool is made up of a light bulb, battery, and two leads. If the leads are touched together, the bulb will light.

A self-powered test light is used only on an unpowered circuit. First disconnect the car's battery, or remove the fuse which feeds the circuit you're working on. Select two specific points along the circuit through which there should be continuity. Connect one lead of the self-powered test light to each point. If there is continuity, the test light's circuit will be completed and the bulb will light.

Never use a self-powered test light on circuits that contain solid state components, since damage to these components may result.

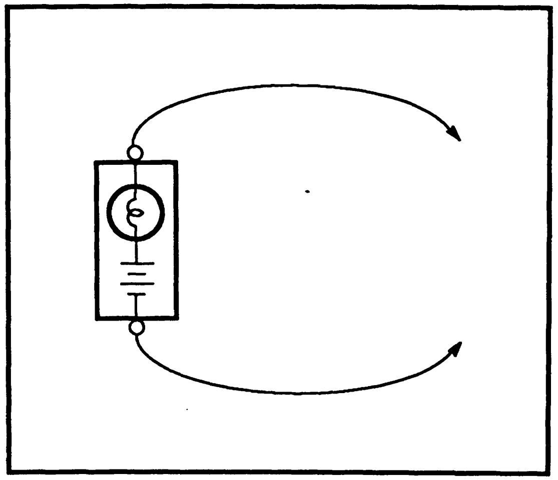


Figure 4 - Self-Powered Test Light

OHMMETER

An ohmmeter can be used instead of a self-powered test light. The ohmmeter shows how much resistance there is between two points along a circuit. Low resistance means good continuity.

Circuits which include any solid state control modules, such as the Electronic Control Module (ECM) should be tested only with a 10-megohm or higher impedance digital multimeter (J34029-A or equivalent).

When measuring resistance with a digital multimeter, the vehicle battery should be disconnected. This will prevent incorrect readings.

Diodes and solid state components in a circuit can cause an ohmmeter to give a false reading. To find out if a component is affecting a measurement, take a reading once, reverse the leads and take a second reading.

If the readings differ, the solid state component is affecting the measurement.

FUSED JUMPER WIRE

A fused jumper is available (J36169 or equivalent) with small clamp connectors providing adaptation to most connectors without damage. This fused jumper wire is supplied with a 20 amp fuse which may not be suitable for some circuits. Do not use a fuse with a higher rating than the fuse that protects the circuit being tested.

NOTICE: Do not use fused jumper wire in any instance to substitute for inputs or outputs at the ECM (Electronic Control Module), BCM (Body Control Module), or any microprocessor device.

SHORT FINDER

Short Finders are available (J8681-A or equivalent) to locate hidden shorts to ground. The short finder creates a pulsing magnetic field in the shorted circuit and shows you the location of the short through body trim or sheet metal.

FUSE TESTER

A simple tester that indicates a blown fuse is available (J34764 or equivalent). To check a fuse the tester is applied directly to the fuse in the fuse block. Two probes contact the fuse. The probes are either placed into the slots of a flat fuse or to the metal ends of a glass fuse. With power on, a red LED in the tester lights if the fuse is open. The handle of the tester is a tool for removing either type of fuse.

TROUBLESHOOTING TESTS

TESTING FOR VOLTAGE

1. Connect one lead of a test light to a known good ground. If you are using a voltmeter, be sure it is the voltmeter's negative lead that you have connected to ground.
2. Connect the other lead of the test light or voltmeter to a selected test point (connector or terminal).
3. If the test light glows, there is voltage present. If you are using a voltmeter, note the voltage reading. It should be within one volt of measured battery voltage. A loss of more than one volt indicates a problem.

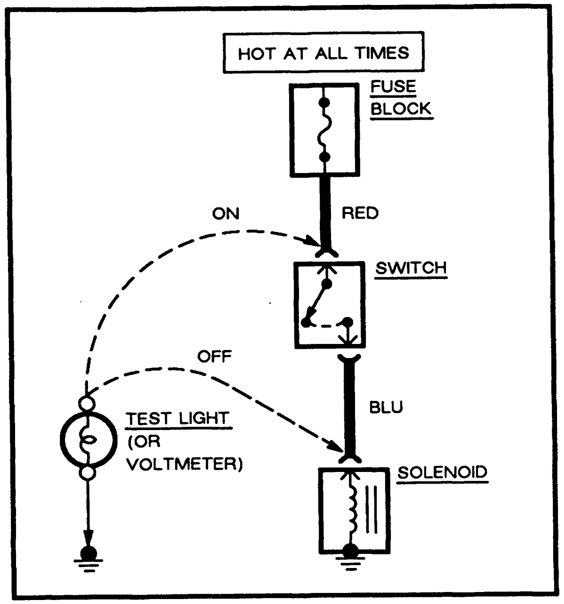


Figure 5 - Voltage Check

4. A quick test of wire continuity can often be made using the input voltages of solid state modules. (See Figure 6.)

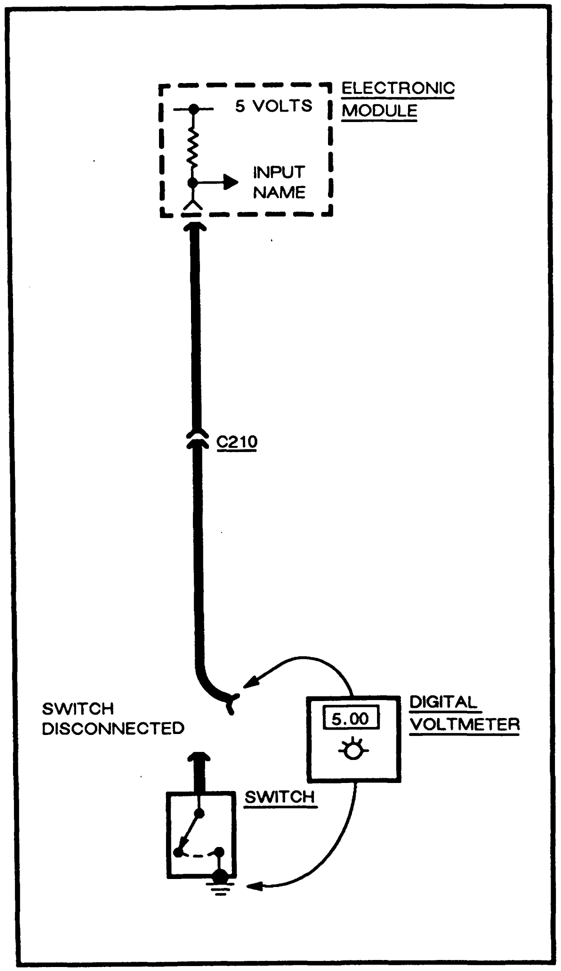


Figure 6

If the continuity of the wire is good, 5 volts will be found at the switch connector. This test can be performed only with a Digital Voltmeter. Analog meters or a Test Lamp *will not work*.

The figure below illustrates the same point with another type of input.

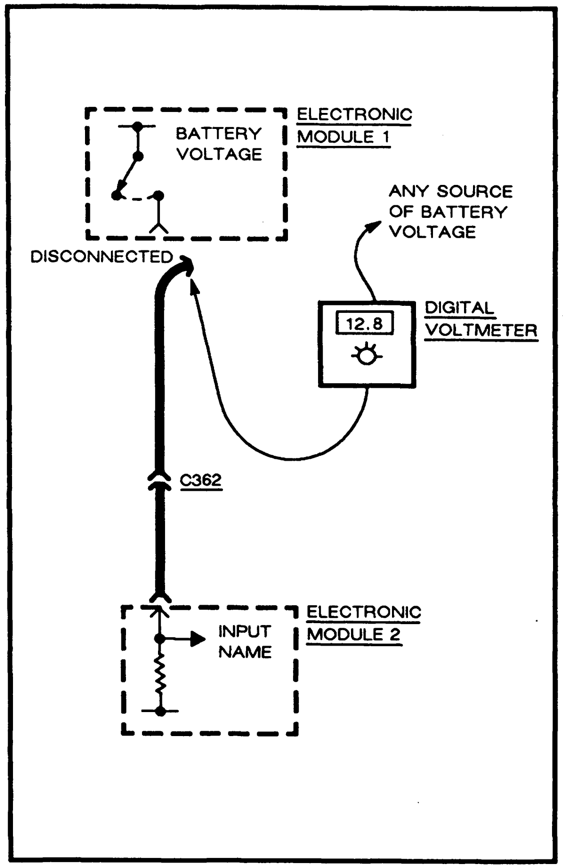


Figure 7

If the continuity of the wire is good, battery voltage will be found between the connector and a source of battery voltage. Again, use only a Digital Voltmeter for this test.

TROUBLESHOOTING TESTS

TESTING FOR CONTINUITY

1. Disconnect the car battery.
2. Connect one lead of a self-powered test light or ohmmeter to one end of the part of the circuit you wish to test.
3. Connect the other lead to the other end of the circuit.
4. If the self-powered test light glows, there is continuity. If you are using an ohmmeter, low or no resistance means good continuity.

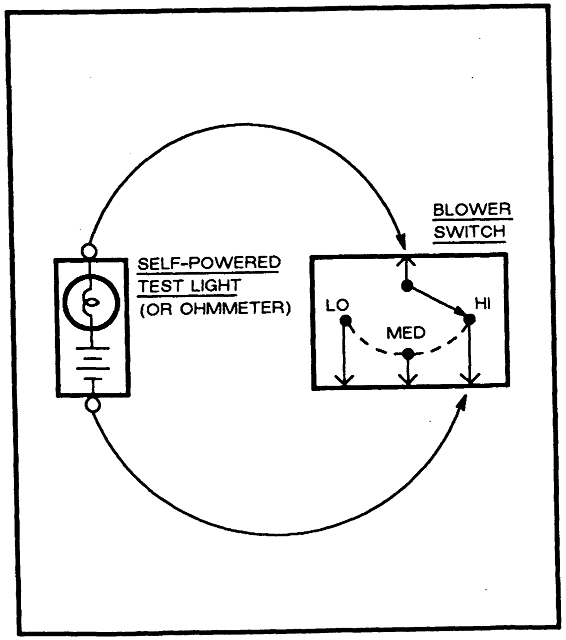


Figure 8 - Continuity Check through a Switch

TESTING FOR VOLTAGE DROP

This test checks for voltage being lost along a wire, or through a connection or switch.

1. Connect the positive lead of a voltmeter to the end of the wire (or to one side of the connection or switch) which is closer to the Battery.
2. Connect the negative lead to the other end of the wire (or the other side of the connection or switch).
3. Operate the circuit.
4. The voltmeter will show the difference in voltage between the two points.

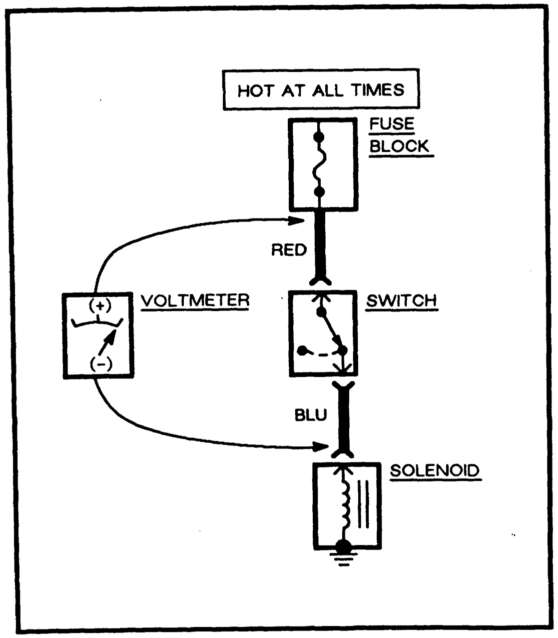


Figure 9 - Voltage Drop Test

TESTING FOR SHORT TO GROUND

With a Test Light or Voltmeter

1. Remove the blown fuse and disconnect the load.
2. Connect a test light or voltmeter across the fuse terminals (be sure that the fuse is powered).
3. Beginning near the fuse block, wiggle the harness from side to side. Continue this at convenient points (about 6 inches apart) while watching the test light or voltmeter.
4. When the test light glows, or the voltmeter registers, there is a short to ground in the wiring near that point.

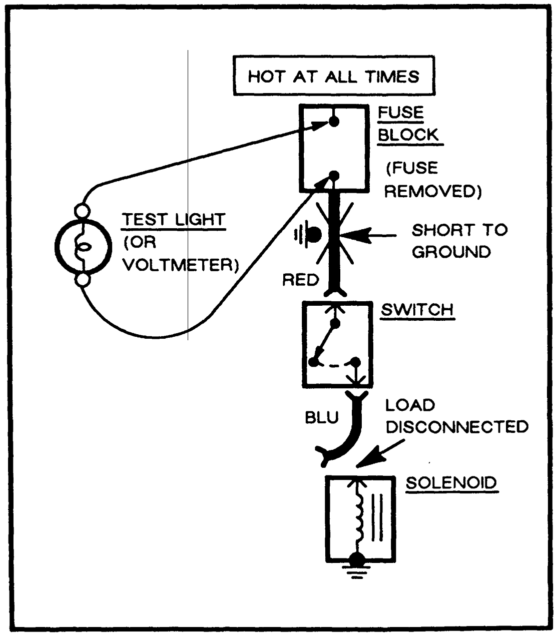


Figure 10 - Testing for Short With Test Light or Voltmeter

With a Self-Powered Test Light or Ohmmeter

1. Remove the blown fuse and disconnect the battery and load.
2. Connect one lead of a self-powered test light or ohmmeter to the fuse terminal on the loadside.
3. Connect the other lead to a known good ground.
4. Beginning near the fuse block, wiggle the harness from side to side. Continue this at convenient points (about 6 inches apart) while watching the self-powered test light or ohmmeter.
5. When the self-powered test light glows, or the ohmmeter registers, there is a short to ground in the wiring near that point.

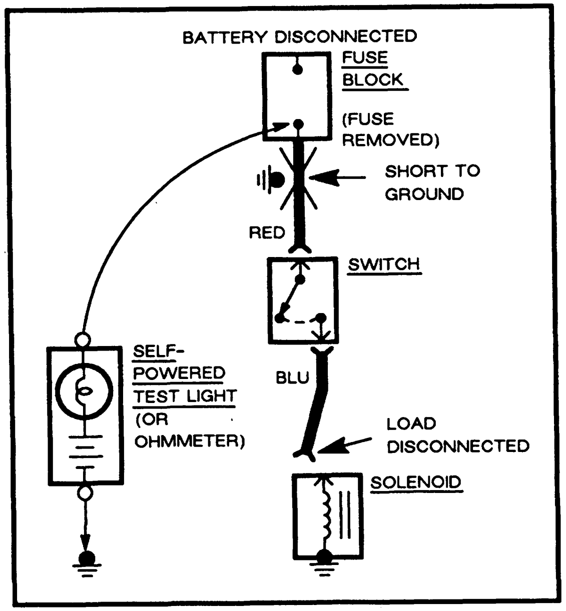


Figure 11 - Testing For Short With Self-Powered Test Light or Ohmmeter

With a Short Finder

1. Remove the blown fuse, leaving the battery connected.
2. Connect the short finder across the fuse terminals.
3. Close all switches in series with the circuit you are troubleshooting.
4. Operate the short finder. The short finder will pulse current to the short. This creates a pulsing magnetic field surrounding the circuit wiring between the fuse block and the short.
5. Beginning at the fuse block, slowly move the short finder meter along the circuit wiring. The meter will show current pulses through sheet metal and body trim. As long as the meter is between the fuse block and the short, the needle will move with each current pulse. When you have moved the meter past the point of the short, the needle will stop moving. Examine the wiring in that area for the short to ground.

Fuses Powering Several Loads

1. Find the schematic in Fuse Block Details (Cell 11) for the fuse that has blown.
2. Open the first connector or switch leading from the fuse to each load.
3. Replace the fuse.
    - If the fuse blows, the short is in the wiring leading to the first connector or switch. Use a test light, meter, or short finder as described above.
    - If the fuse does not blow, go to the next step.
4. Close each connector or switch until the fuse blows to find which circuit the short is in. Connect test lamp, meter, or short finder a the connector to the suspect circuit (disconnected) rather than at the fuse terminals.

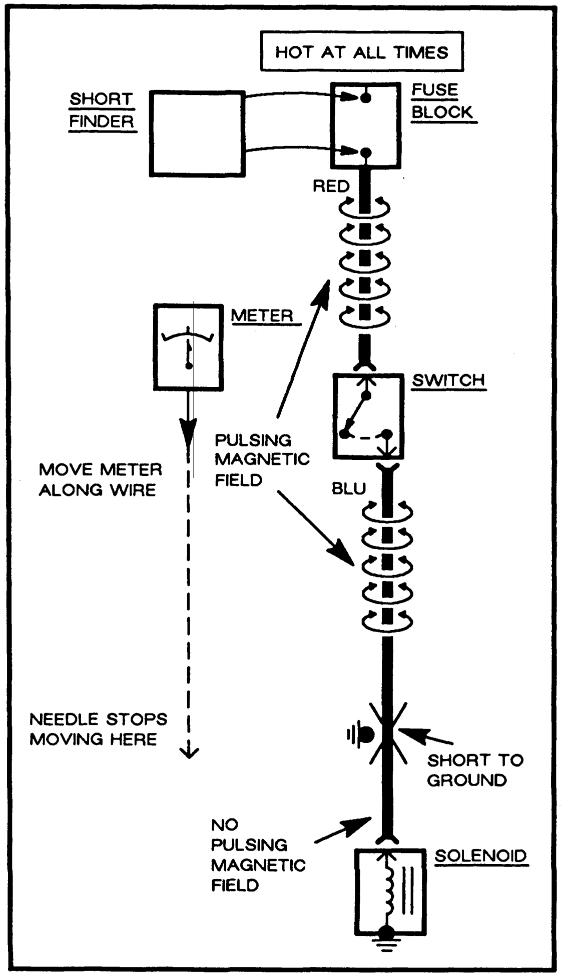


Figure 12 - Finding Short With Short Finder

TESTING FOR CURRENT

To test for current the meter must be connected in series in the circuit. Current measurements always involve a component being removed or disconnected from the circuit. The circuit current flows through the meter, which displays the current in amps or milliamps. The meter should have a rating higher than the expected current.

NOTICE: Never use a meter set on a current scale to measure voltage. Severe damage to the meter, the circuit or both will result.

Two commonly used locations for taking current measurements are at a fuse and at the battery.

To measure current in a Windshield Wiper Motor, for instance, the meter should be connected across the fuse terminals, after removing the fuse. The meter can be inserted in any circuit where a single circuit can be temporarily opened to make the measurement. A second example, measuring at a fusible link, is illustrated in Figure 14.

The meter should be connected between the screw terminal and the fusible link ring tongue terminal, after disconnecting the link

A special use of current measurement is the case of a car whose battery goes dead with no explanation. Normally current flow from the battery with the key "off" should be less than 50 milliamps. By disconnecting the positive battery cable and connecting your current meter between the positive cable and positive battery terminal you can measure this current. If the current is greater than 50 milliamps it will be necessary to check every fuse and fusible link as described above. Any circuits that have high current flow should be investigated.

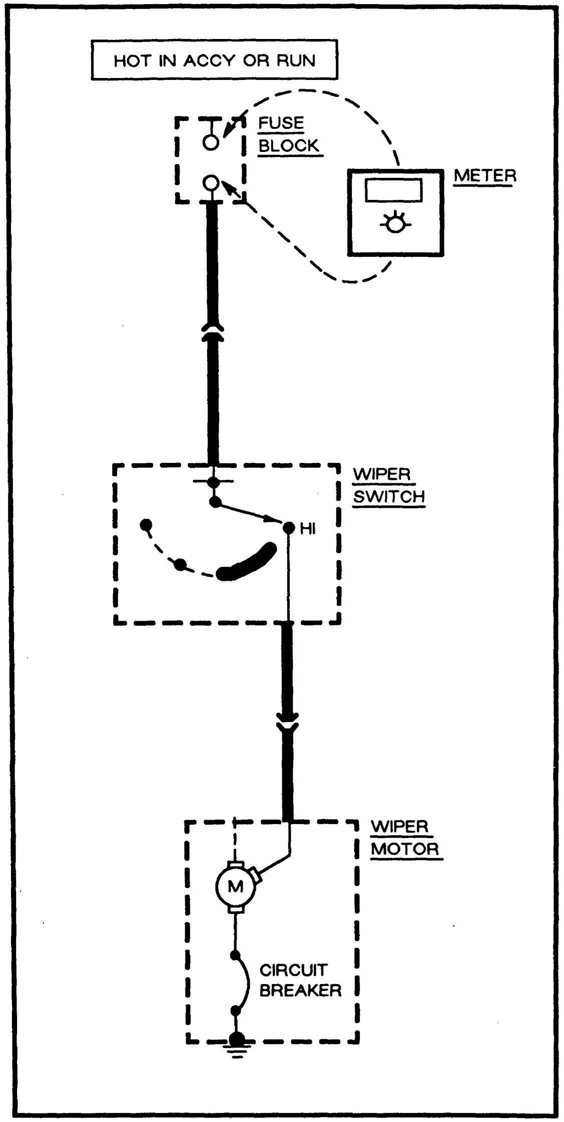


Figure 13

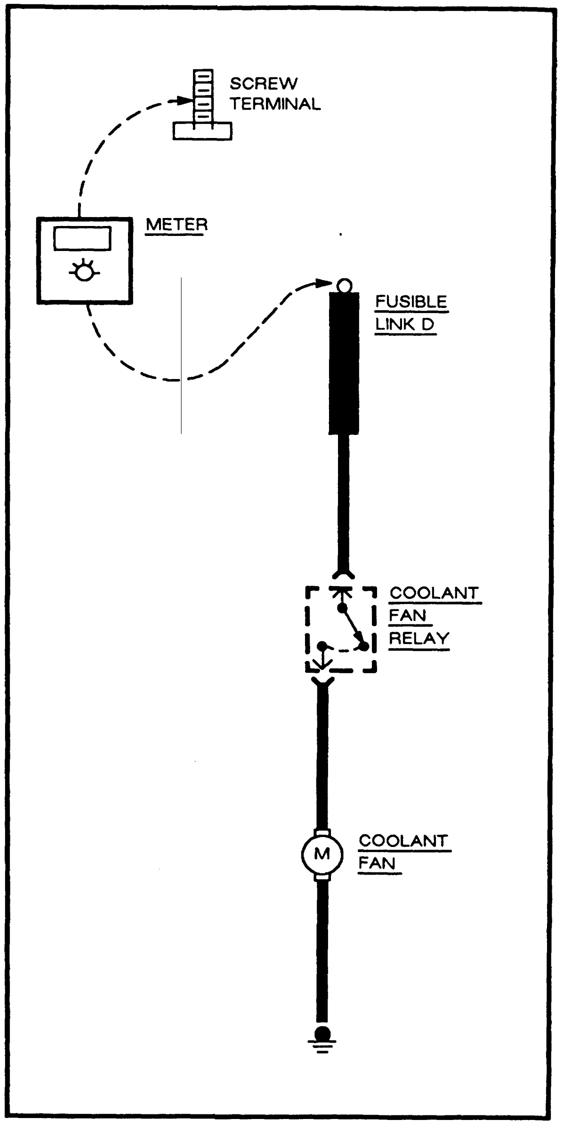


Figure 14

REPAIR PROCEDURES

ELECTRICAL REPAIRS

This section provides instruction in the following repairs:

- Circuit Protection
- Typical Electrical Repairs
- Splicing Copper Wire
- Splicing Twisted/Shielded Cable
- Repairing Connectors (Except Weather Pack®)
- Repairing Weather Pack® (Environmental) Connectors

Note: After any electrical repair is made, always test the circuit by operating the devices in the circuit. This confirms not only that the repair is correct, but also that the cause of the complaint was correctly identified.

CIRCUIT PROTECTION

All electrical circuits are protected against excessive loads which might occur because of shorts or overloads in the wiring system. Such protection is provided by a fuse, circuit breaker, or fusible link. A short circuit may cause a fuse to blow or a circuit breaker to open.

Fuses

The most common method of automotive wiring circuit protection is the fuse. Whenever there is an excessive amount of current flowing through a circuit the fusible element will melt and create an open or incomplete circuit (see Figure 1). Fuses are a "one time" protection device and must be replaced each time the circuit is overloaded.

Auto-fuses, Mini Fuses and Maxi Fuses are color coded. The standardized color identification and ratings are shown in Figure 2.

For service replacement, non-color coded fuses of the same respective current rating can be used. The current rating of each fuse is molded into its head.

To determine whether or not a fuse is blown, remove the suspect fuse and examine the element in the fuse for a break. (see Figure 1). If the element is broken, replace the fuse with one of equal current rating.

There are, however, additional specific circuits with in-line fuses. In-line fuses are located within the individual wiring harness.

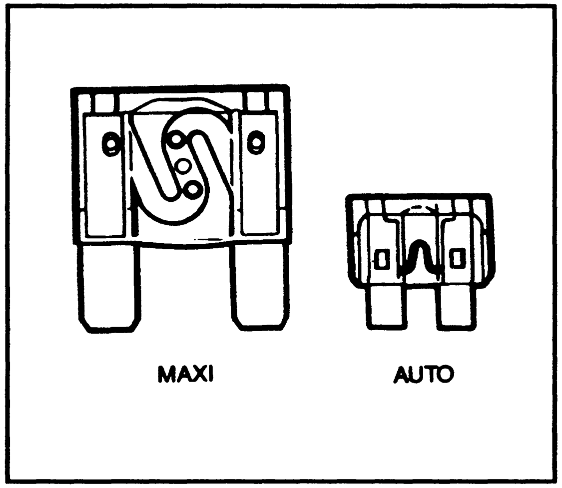


Figure 1 - Sample Fuses

CURRENT RATING AMPERES	COLOR
AUTO-FUSES, MINI FUSES	
3	VIOLET
5	TAN
7.5	BROWN
10	RED
15	BLUE
20	YELLOW
25	WHITE
30	GREEN
MAXI FUSES	
20	YELLOW
30	LIGHT GREEN
40	ORANGE
60	BLUE

Fuse 2- Fuse Rating and Color

Circuit Breakers

A circuit breaker is a protective device designed to open the circuit when a current load is in excess of rated breaker capacity. If there is a short or other type of overload condition in the circuit, the excessive current will open the circuit between the circuit breaker terminals.

Two types of Circuit Breaker are used. The first is identified simply as a Circuit Breaker in Section 8A. This type will open when excessive current passes through it for a period of time. It will close again after a few seconds. If the cause of the high current is still present it will open again. It will continue to cycle open and closed until the condition causing the high current is removed.

REPAIR PROCEDURES

The second type of Circuit Breaker is identified in section 8A as a Positive Temperature Coefficient (PTC) Circuit Breaker. This type increases its resistance greatly when excessive current passes through it. The excessive current heats the PTC device. As the device heats, its resistance increases thus the name, "Positive Temperature Coefficient". Eventually the resistance gets so high that the circuit is effectively open. Unlike the ordinary Circuit Breaker the PTC unit will not reset until the circuit is opened, removing voltage from its terminals. Once voltage is removed, the Circuit Breaker will re-close within a second or two.

Fusible Links

In addition to circuit breakers and fuses, some circuits use fusible links to protect the wiring. Like fuses, fusible links are "one time" protection devices that will melt and create an open circuit (see Figure 3).

Not all fusible link open circuits can be detected by observation. Always inspect that there is battery voltage past the fusible link to verify continuity.

Fusible links are used instead of a fuse in wiring circuits that are not normally fused, such as the ignition circuit. The fusible link is a smaller gage than the cable it is designed to protect. Links are marked on the insulation with wire-gage size because the heavy insulation makes the link appear to be a heavier gage than it actually is. The same wire size fusible link must be used when replacing a blown fusible link.

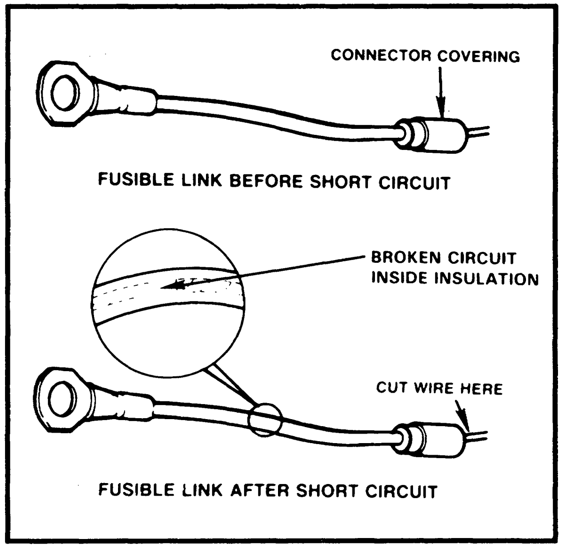


Figure 3 - Good and Damaged Fusible Links

Fusible links are available with two types of insulation: Hypalon® and Silicone/GXL (SIL/GXL). Service fusible links made with SIL/GXL may be used to replace either Hypalon® or SIL/GXL fusible links. Service fusible links made with Hypalon® may only be used to replace Hypalon® fusible links. To determine the fusible link type, nick the insulation of the blown fusible link with a knife. SIL/GXL will have a white inner core under the outer color. Hypalon® insulation is one color. Service fusible links are available in many lengths. Choose the shortest length that is suitable. If the fusible link is to be cut from a spool, NEVER make it longer than 228 mm (9 in).

NOTICE: Fusible links cut longer than 228 mm (9 in) will not provide sufficient overload protection.

To replace a damaged fusible link, cut it off beyond the splice. Replace with a repair link. When connecting the repair link, strip wire and use staking-type pliers to crimp the splice securely in two places (see Figure 4). For more details on splicing procedures see Splicing Copper Wire. Use Crimp and Seal splices whenever possible.

To replace a damaged fusible link which feeds two harness wires, cut them both off beyond the splice. Use two repair links, one spliced to each harness wire (see Figure 5).

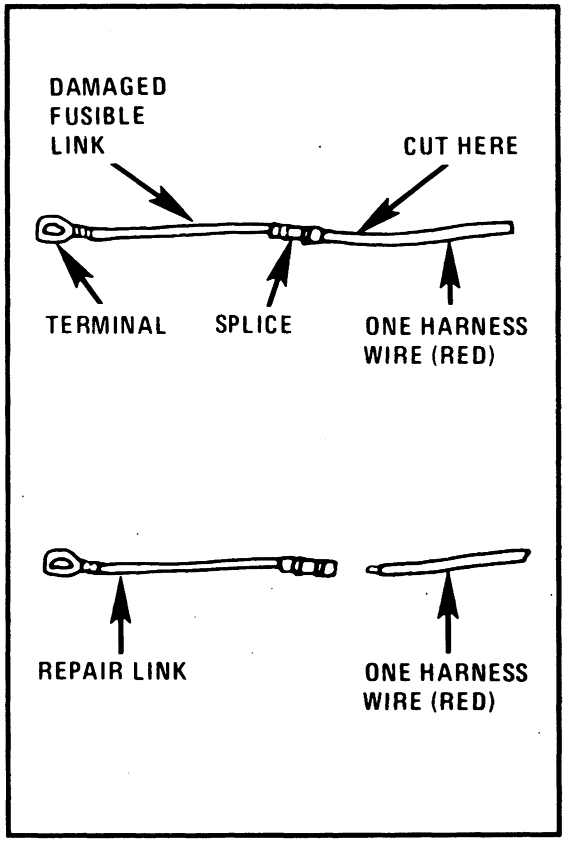


Figure 4 - Single Wire Feed Fusible Link

REPAIR PROCEDURES

TYPICAL ELECTRICAL REPAIRS

An open circuit is an incomplete circuit. Power cannot reach the load or reach ground. If a circuit is open, active components do not energize. A short circuit is an unwanted connection between one part of the circuit and either ground or another part of the circuit. A short circuit causes a fuse to blow or a circuit breaker to open.

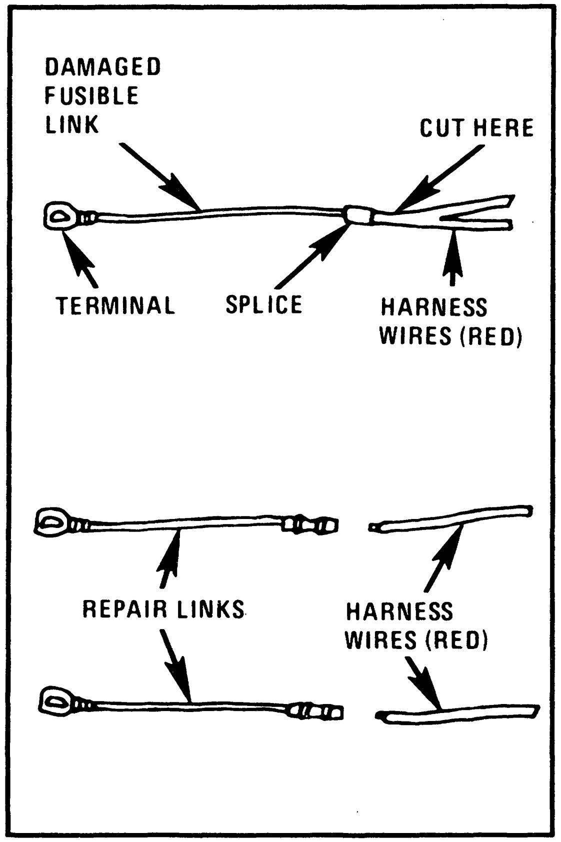


Figure 5 - Double Wire Feed Fusible Link

Short Circuits Caused by Damaged Wire Insulation

- Locate the damaged wire.
- Find and correct the cause of the wire insulation damage.
- For minor damage, tape over the wire. If damage is more extensive, replace the faulty segment of the wire. (Refer to the splicing instructions for copper or shielded cable for the correct procedure.)

SPLICING COPPER WIRE USING SPLICE CLIPS

Spice Clips are included in the J38125 Terminal Repair Kit. The Splice Clip is a general purpose wire repair device . It may not be acceptable for applications having special requirements such as moisture sealing. Refer to the appropriate Service Manual Section to determined if there are any special requirements.

Step One: Open the Harness

If the harness is taped, remove the tape. To avoid wire insulation damage, use a sewing "seam ripper" to cut open the harness (available from sewing supply stores). If the harness has a black plastic conduit, simply pull out the desired wire.

Step Two: Cut the Wire

Begin by cutting as little wire off the harness as possible. You may need the extra length of wire later if you decide to cut more wire off to change the location of a splice. You may have to adjust splice locations to make certain that each splice is at least 40mm (1½ in) away from other splices, harness branches, or connectors. This will help prevent moisture from bridging adjacent splices and causing damage.

Step Three: Strip the Insulation

When replacing wire, use wire of equal or greater size than the original. The wire's insulation must have the same or higher temperature rating.

The following table (see Figure 6) shows the commercial (AWG) wire sizes that can be used to replace each of the metric wire sizes. Each AWG size shown is equal to, or larger than, the equivalent metric wire size.

METRIC WIRE SIZES	AWG SIZES
.22	24
.35	22
.5	20
.8	18
1.0	16
2.0	14
3.0	12
5.0	10
8.0	8
13.0	6
19.0	4
32.0	2
50.0	1/0

Figure 6 - Wire Size Conversion Table

To find the correct wire size either find the wire on the schemtaic page and convert or use an AWG gage.

The type of wire insulation must also be carefully selected. For areas not subject to high temperatures such as the passenger compartment, instrument panel or cargo compartment, a general purpose insulation may be used. The most common general purpose insulation is Polyvinyl Chloride (PVC). PVC may be used where temperatures do not exceed 80°C (176°F).

For applications where higher temperatures are expected, such as the engine compartment, a cross linked polyethylene insulated wire should be used. Insulex (TM) is one such type; it can withstand temperatures up to 148°C (300°F). Cross linked polyethylene wire may be used to replace PVC, but not the other way around. Cross linked polyethelene wire is not resistant to fuel or fuel vapors and should not be used to replace wire on the fuel tank unit or throttle body injector connector for example. Fusible links and Oxygen sensor leads should not be replaced with cross linked polyethylene. See the AC Delco Wire and Cable Catalog number 16A-100 for information about ordering wire and cable.

Select the correct size opening in the wire stripper or work down from the largest size if you're not sure of wire size. Strip an equal amount of insulation on both pieces of wire. Inspect both pieces for nicks or cut strands; repeat the strip if needed.

Step Four: Crimp the Wires

Select the proper clip to secure the splice. To determine the proper clip size crimp tool and anvil for the wire being spliced, follow the directions included in the J38125 Terminal Repair Kit. (On most crimpers your choice is limited to either a small or large anvil.) Overlap the two stripped wire ends and hold them between your thumb and forefinger as shown in Figure 7. Then, center the splice clip under the stripped wires and hold it in place.

- Open the crimping tool to its full width and rest one handle on a firm flat surface.
- Center the back of the splice clip on the proper anvil and close the crimping tool to the point where the former touches the wings of the clip.
- Make sure that the clip and wires are still in the correct position. Then, apply steady pressure until the crimping tool closes (see Figure 8).

Before crimping the ends of the clip, be sure that:

- The wires extend beyond the clip in each direction.
- No strands of wire are cut loose.
- No insulation is caught under the clip.

Crimp the splice again, once on each end. Do not let the crimping tool extend beyond the edge of the clip or you may damage or nick the wires (see Figure 9).

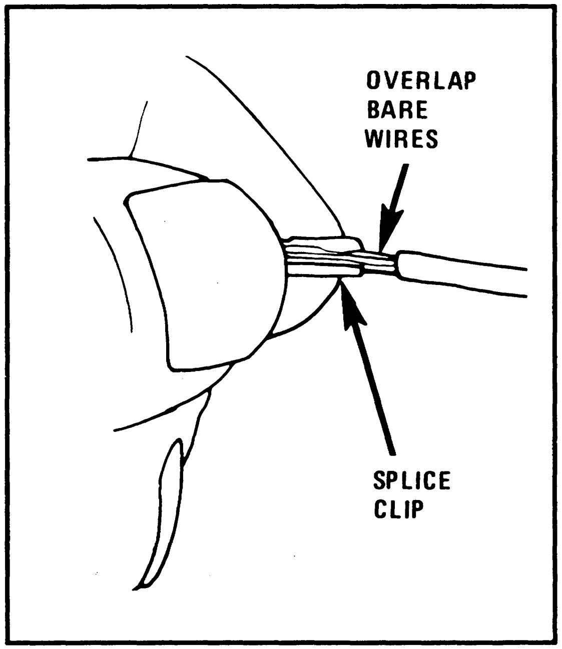


Figure 7 - Centering the Splice Clip

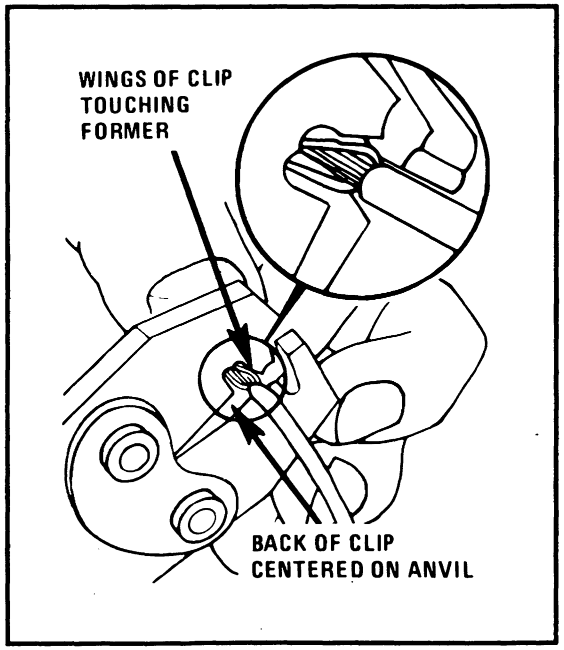


Figure 8 - Crimping the Splice Clip

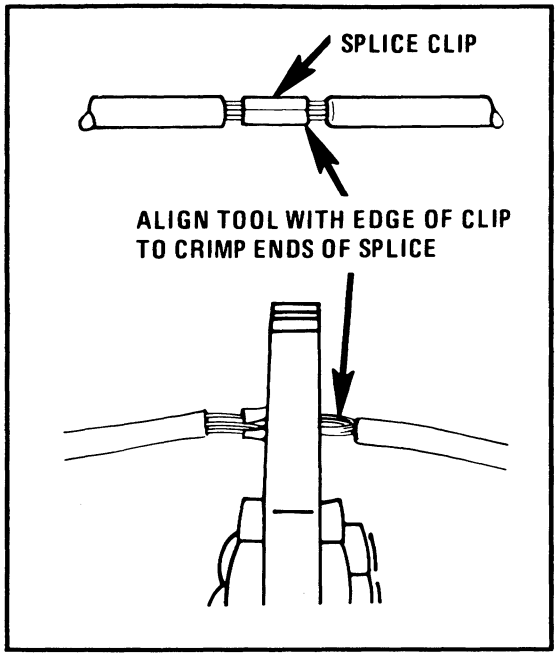


Figure 9 - Completing the Crimp

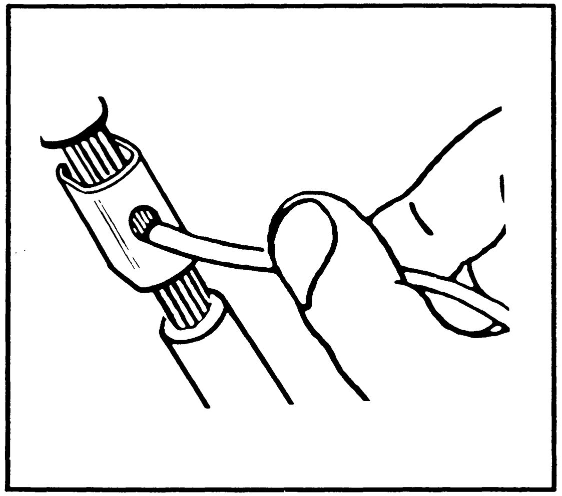


Figure 10 - Applying the Solder

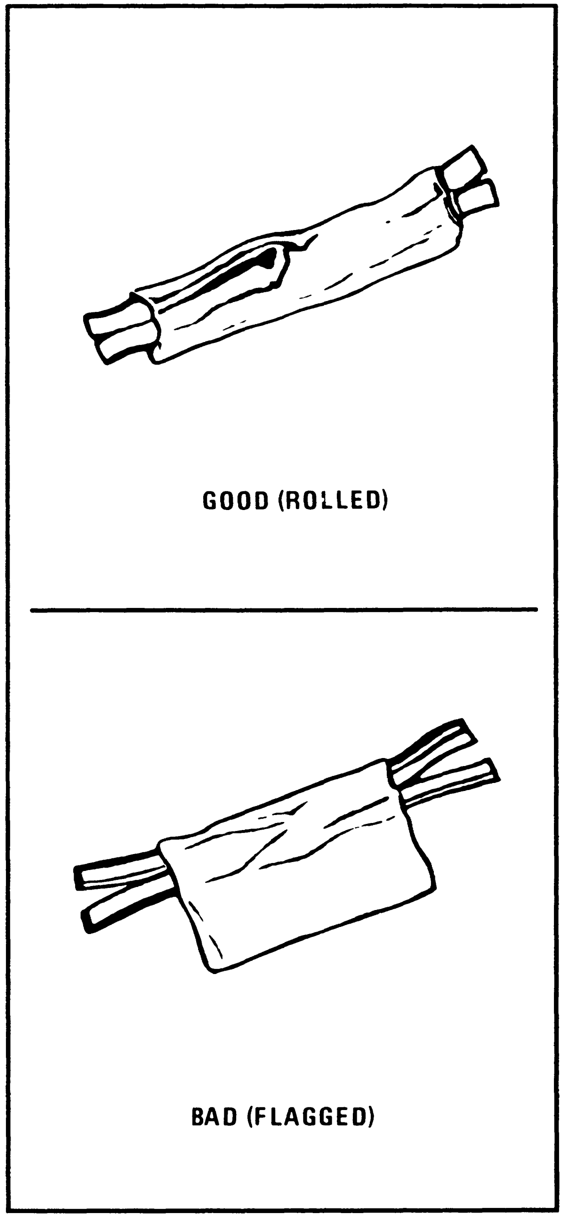


Figure 11 - Proper First Taping

Step Five: Solder

Apply 60/40 rosin core solder to the opening in the back of the clip (see Figure 10). Follow the manufacturer's instructions for the solder equipment you are using.

Step Six: Tape the Splice

Use splicing tape or duct tape when taping splices, do not use standard electrical tape. Center and roll the splicing tape. The tape should cover the entire splice. Roll on enough tape to duplicate the thickness of the insulation on the existing wires. Do not flag the tape. Flagged tape may not provide enough insulation, and the flagged ends will tangle with the other wires in the harness (see Figure 11).

If the wire does not belong in a conduit or other harness covering, tape the wire again. Use a winding motion to cover the first piece of tape (see Figure 12).

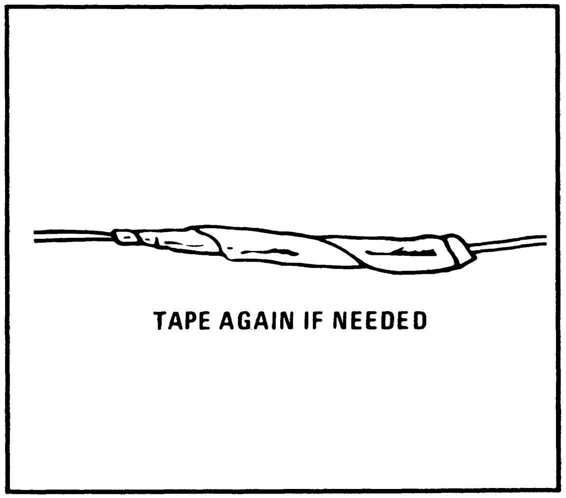


Figure 12 - Proper Second Taping

SPLICING COPPER WIRE USING CRIMP AND SEAL SPLICE SLEEVES

Crimp and Seal splice sleeves maybe used on all types of insulation except tefzel and coaxial to form a one to one splice. They are to be used where there are special requirements such as moisture sealing. Refer to the appropriate section of the Service Manual to determine if the Crimp and Seal is necessary. Crimp and Seal splice sleeves are included in the J38125 terminal Repair Kit.

Step One: Open the Harness

If the harness is taped, remove the tape. To avoid wire insulation damage, use a sewing "seam ripper" to cut open the harness (available from sewing supply stores). The crimp and seal splice sleeves may be used on all types of insulation except tefzel and coaxial and may only be used to form a one to one splice.

Step Two: Cut the Wire

Begin by cutting as little wire off the harness as possible. You may need the extra length of wire later if you decide to cut more wire to change the location of a splice. You may have to adjust splice locations to make certain that each splice is at least 40mm (1.5 in) away from other splices, harness branches, or connectors. This will help prevent moisture from bridging adjasent splices and causing damage.

Step Three: Strip the Insulation

If it is necessary to add a length of wire to the existing harness, be certain to use the same size as the original wire (see table Figure 6).

To find the correct wire size either find the wire on the schematic and convert the metric size to the equivalent AWG size or use an AWG wire gage. If unsure about the wire size, begin with the largest opening in your wire stripper and work down until you get a clean strip of the insulation. Strip approximately 7.5mm (5/16 in) of insulation from each wire to be spliced. Be careful to avoid nicking or cutting any of the wires. Check the stripped wire for nicks or cut strands. If the wire is damaged, repeat this procedure after removing the damaged section.

Step Four: Select and Position the Splice Sleeve

Select the proper splice sleeve according to wire size. The splice sleeves and tool nests are color coded (see following chart).

CRIMP AND SEAL SPLICE SLEEVE CHART

Color splice sleeve	Crimp tool nest color	Wire gage AWG/(metric)
Salmon (yellowish-pink)	Red	20, 18/ (0.5, 0.8)
Blue	Blue	16, 14/ (1.0, 2.0)
Yellow	Yellow	12, 10/ (3.0, 5.0)

Using the J38125-8 splice crimp tool (see Figure 13), position the splice sleeve in the proper color nest of the hand crimp tool. Place the splice sleeve in the nest so that the crimp falls midway between the end of the barrel and the stop.

The sleeve has a stop in the middle of the barrel to prevent the wire from going further (see figure 14). Close the hand crimper handles slightly to hold the splice sleeve firmly in the proper nest.

Step Five: Insert Wires into Splice Sleeve and Crimp

Insert the wire into the splice sleeve until it hits the barrel stop and close the handles of the J38125-8 crimper tightly until the crimper handles open when released (see Figure 14).The crimper handles will not open until the proper amount of pressure is applied to the splice sleeve. Repeat steps 4 and 5 for opposite end of the splice.

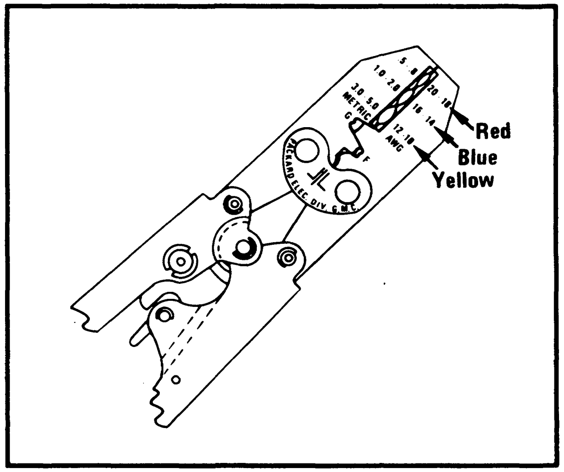
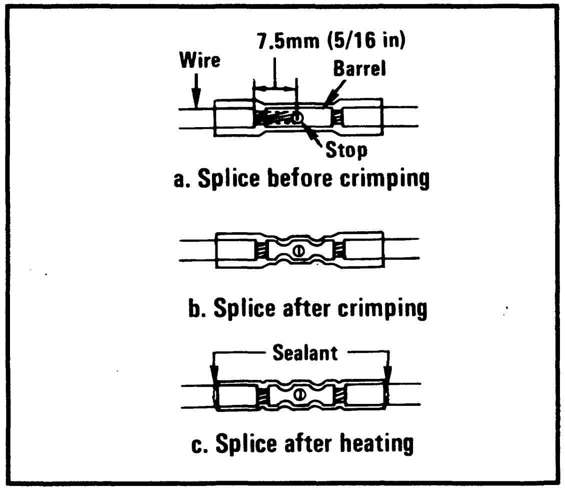


Figure 13 - Hand Crimp Tool



a. Splice before crimping

b. Splice after crimping

c. Splice after heating

Figure 14 - Seal Splice Sequence

Step Six: Shrink the Insulation around the Splice

Using a the heat touch, apply heat where the barrel is crimped. Apply heat where the barrel is crimped.

Gradually move the heat barrel to the open end of the tubing, shrinking the tubing completely as the heat is moved along the insulation. A small amount of sealant will come out of the end of the tubing when sufficient shrinking is achieved (see Figure 14).

SPLICING TWISTED/SHIELDED CABLE

Twisted/shielded cable is sometimes used to protect wiring from electrical noise (stray signals). Two-conductor cable of this construction is used between the ECM and the distributor and other applications where low level, sensitive signals must be carried. See Figure 15 for a breakdown of twisted/shielded cable construction.

Step One: Remove Outer Jacket

Remove the outer jacket and discard it. Be careful to avoid cutting into the drain wire or the mylar tape.

Step Two: Unwrap the Tape

Unwrap the aluminum/mylar tape, but do not remove it. The tape will be used to rewrap the twisted conductors after the splices have been made.

Step Three: Prepare the Splice

Untwist the conductors. Then, prepare the splice by following the splicing instructions for copper wire presented earlier. Remember to stagger splices to avoid shorts (see Figure 16).

Step Four: Re-Assemble the Cable

After you have spliced and taped each wire, rewrap the conductors with the mylar tape. Be careful to avoid wrapping the drain wire in the tape.

Next, splice the drain wire following the splicing instructions for copper wire. Then, wrap the drain wire around the conductors and mylar tape (see Figure 17).

Step Five: Tape the Cable

Tape over the entire cable using a winding motion (see Figure 18). This tape will replace the section of the jacket you removed to make the repair.

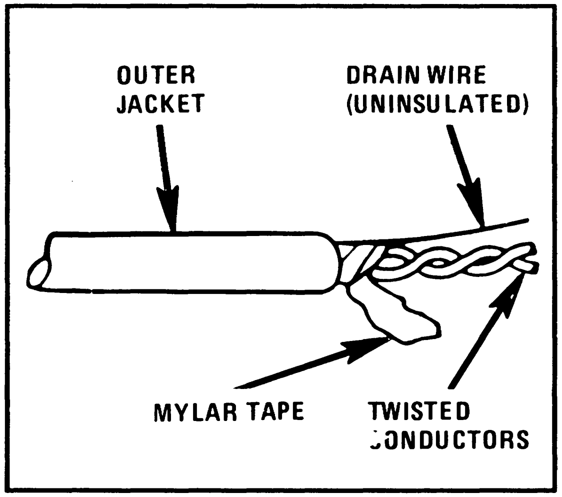


Figure 15 - Twisted/Shielded Cable

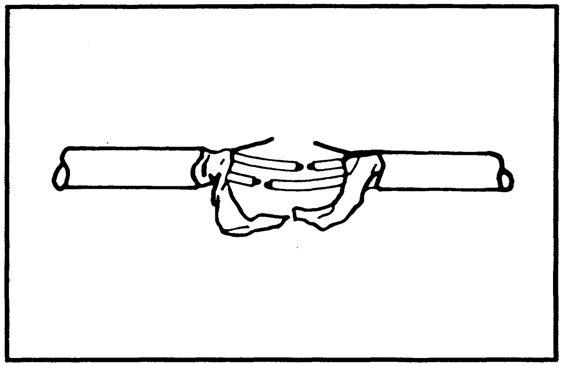


Figure 16 - The Untwisted Conductors

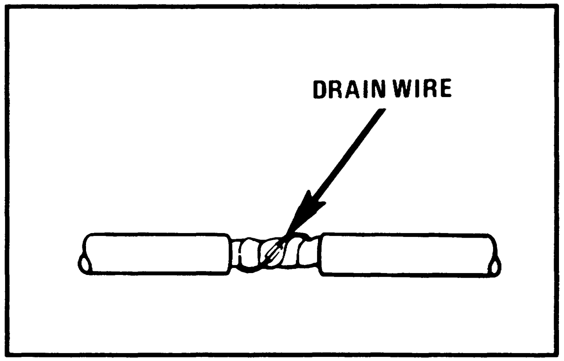


Figure 17 - The Reassembled Cable

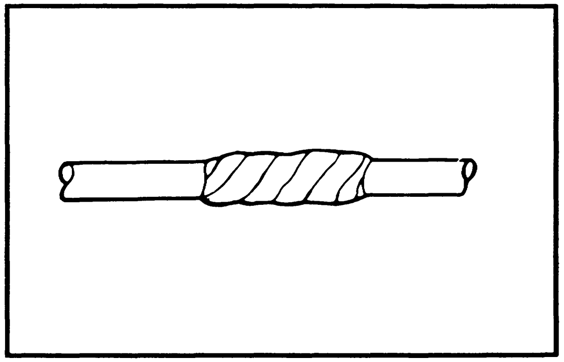


Figure 18 - Proper Taping

REPAIRING CONNECTORS

- The following general repair procedures can be used to repair most types of connectors. The repair procedures are divided into two general groups, Push-to-Seat and Pull-to-Seat.
- See connector views (8A-202) to determine which type of connector you have.
- Use the Pick(s) or Tool(s) that apply to your terminal.
- The Terminal Repair Kit (J38125) contains further information.

Push-to-Seat

Follow the steps below to repair Push-to-Seat connectors, see Figure 19. The steps are illustrated with typical connectors. Your connector may differ, but the repair steps are similar. Some connectors do not require all the steps shown. Skip those that don't apply.

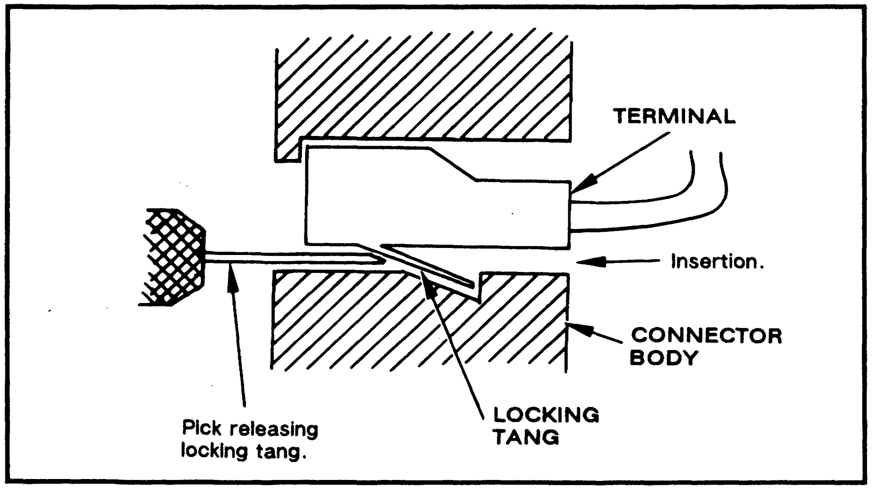


Figure 19 - Typical Push-to-Seat Connector

Remove Terminal Position Assurance (TPA) device, Connector Position Assurance (CPA) device and/or secondary lock.

1. Separate connector halves. See Figures 20 through 24.

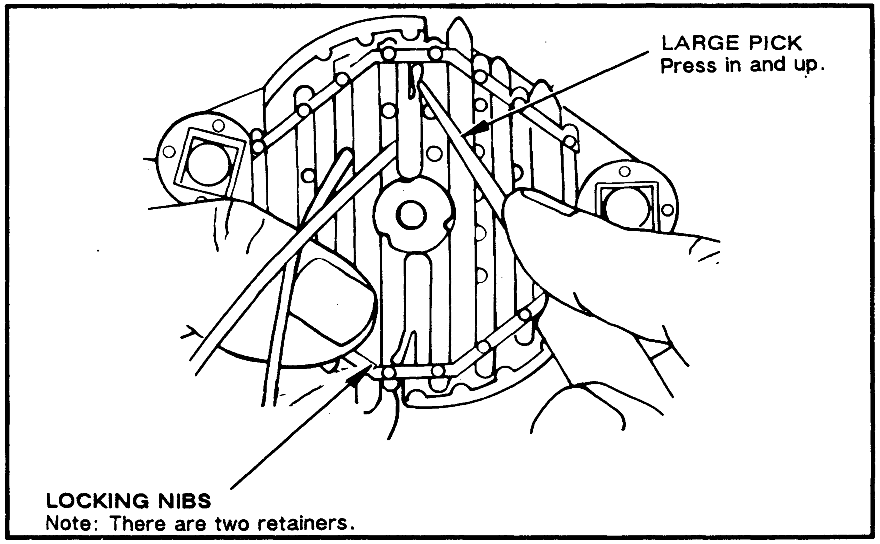


Figure 20

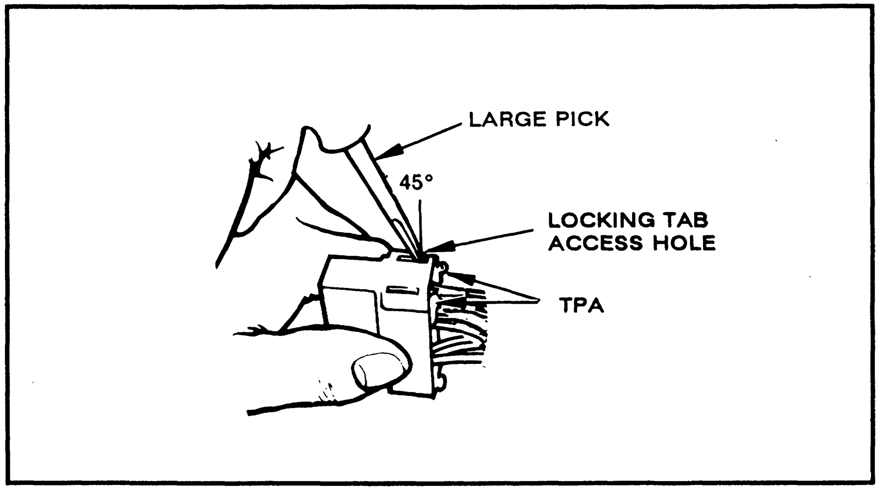


Figure 21

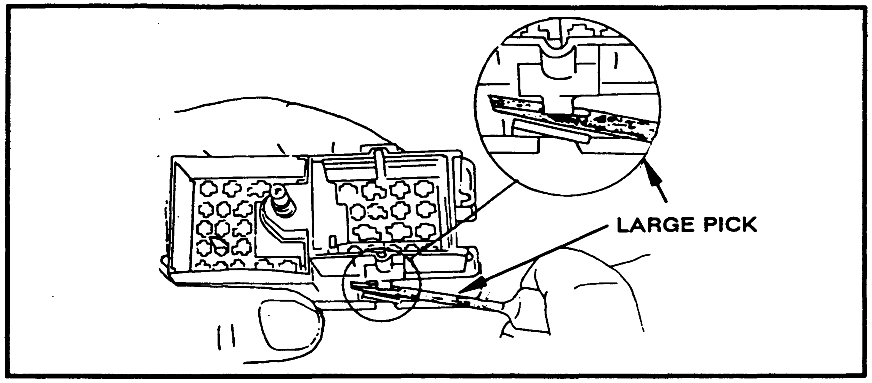


Figure 22

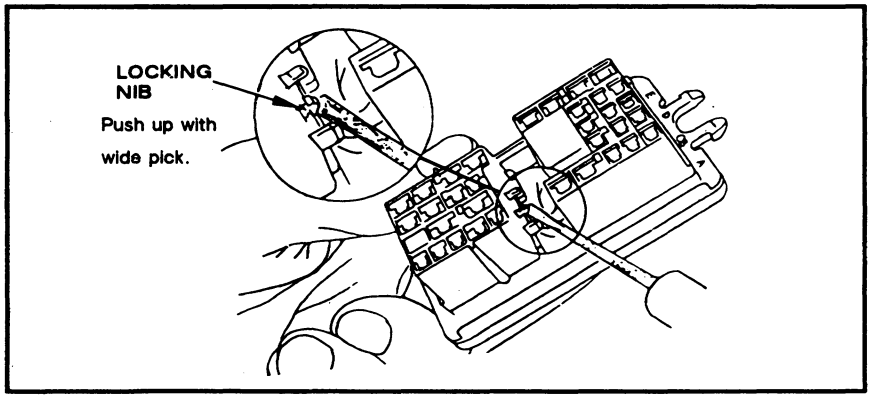


Figure 23

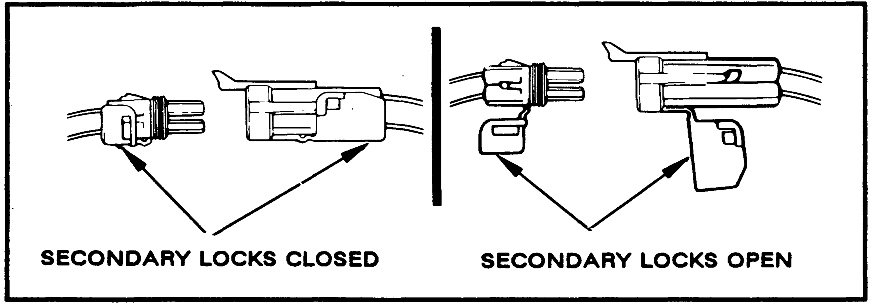


Figure 24

2. Release terminal using proper pick or removal tool. Gently pull cable and terminal out the back of the connector. See Figures 25 through 29.

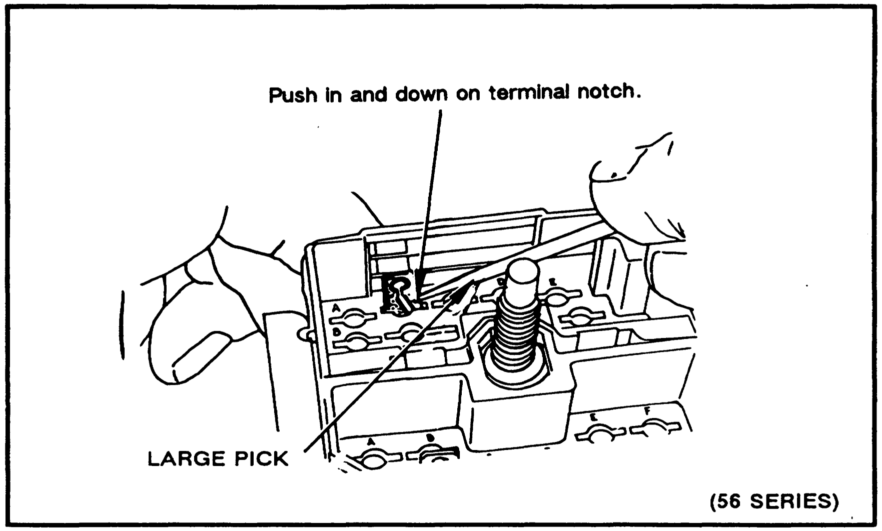


Figure 25

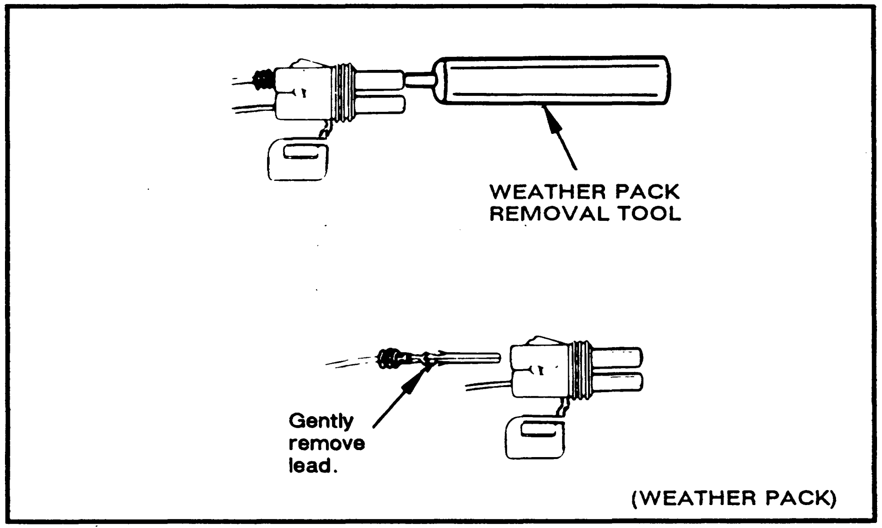


Figure 26

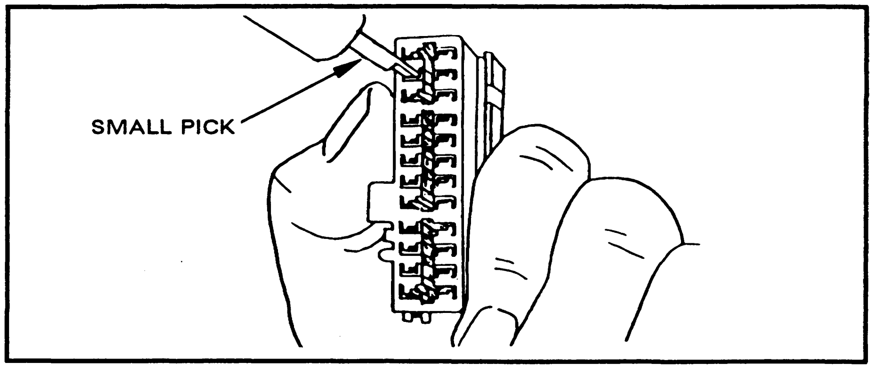


Figure 27

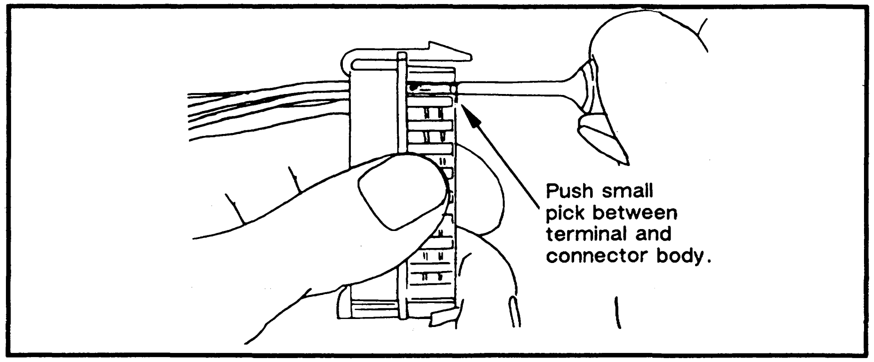


Figure 28

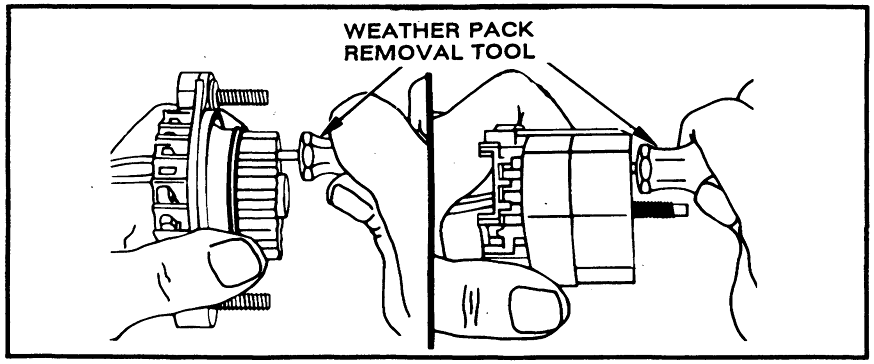


Figure 29

3. If terminal is to be re-used, re-form locking tang, see Figures 30 through 34.

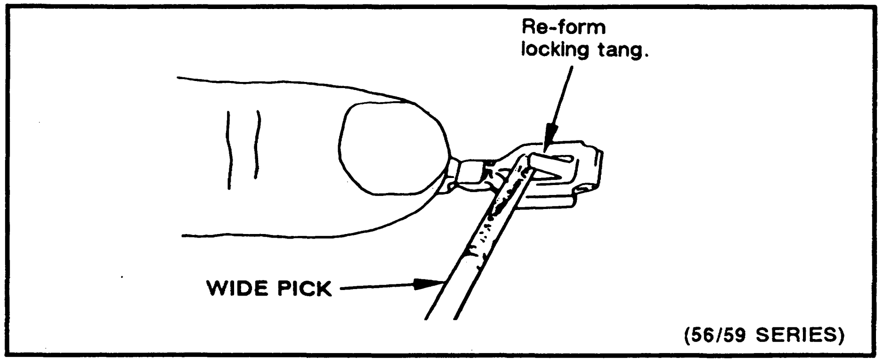


Figure 30

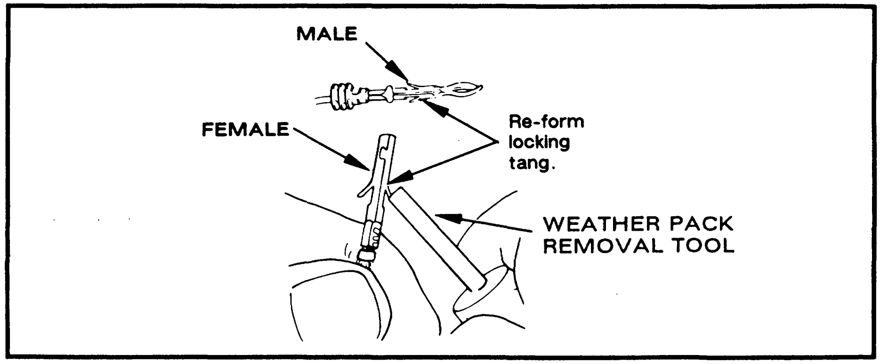


Figure 31

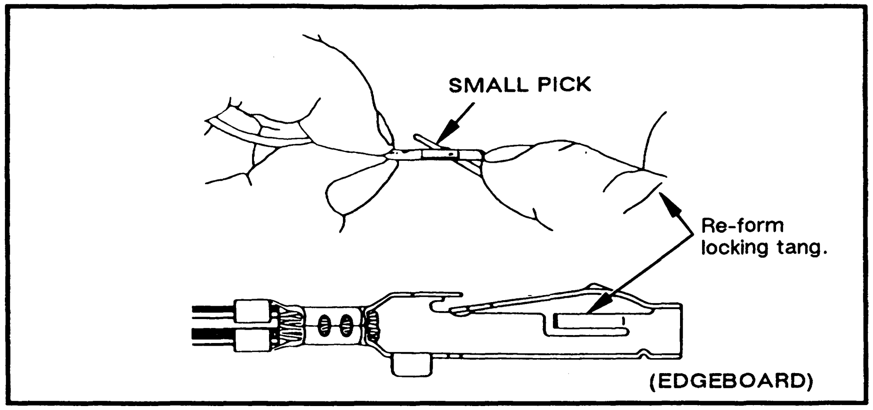


Figure 32

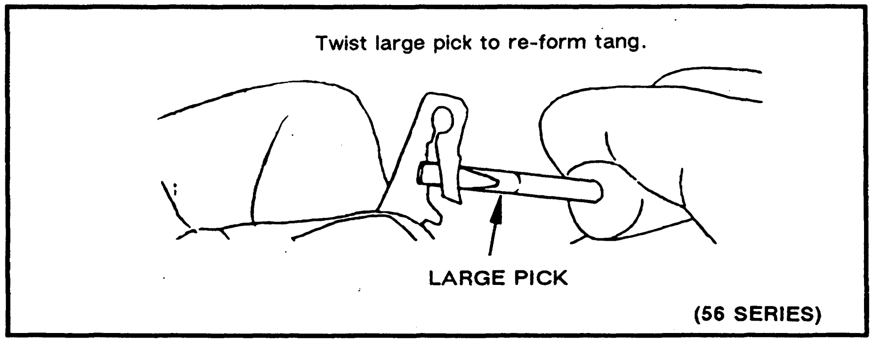


Figure 33

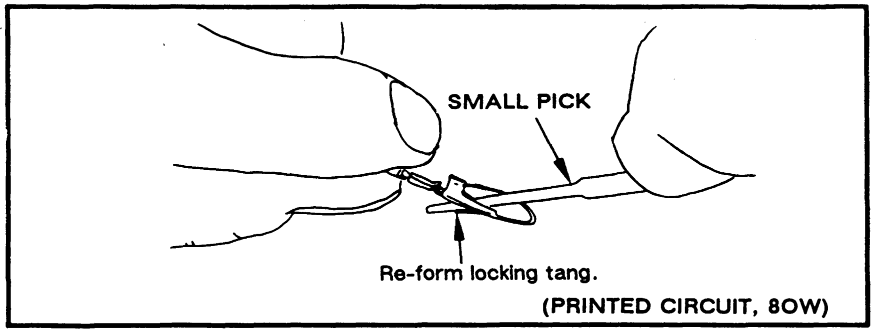


Figure 34

4. Make repair.

- Using a new terminal:

  A. Slip cable seal away from terminal (if equipped with seal).

  B. Cut wire as close to terminal as possible.

  C. Slip a new cable seal onto wire (if equipped with seal).

  D. Strip 5mm (3/16 in.) of insulation from wire.

  E. Crimp a new terminal to wire.

  F. Solder with rosin core solder.

  G. Slide cable seal toward terminal (if equipped with seal).

  H. Crimp cable seal and insulation (if equipped with seal).

  I. Apply grease to connectors outside the passenger compartment where the connector originally was equipped with grease.

- To re-use a terminal or lead assembly, see Splicing Copper Wire. Be sure to keep cable seal (if equipped) on the terminal side of splice.

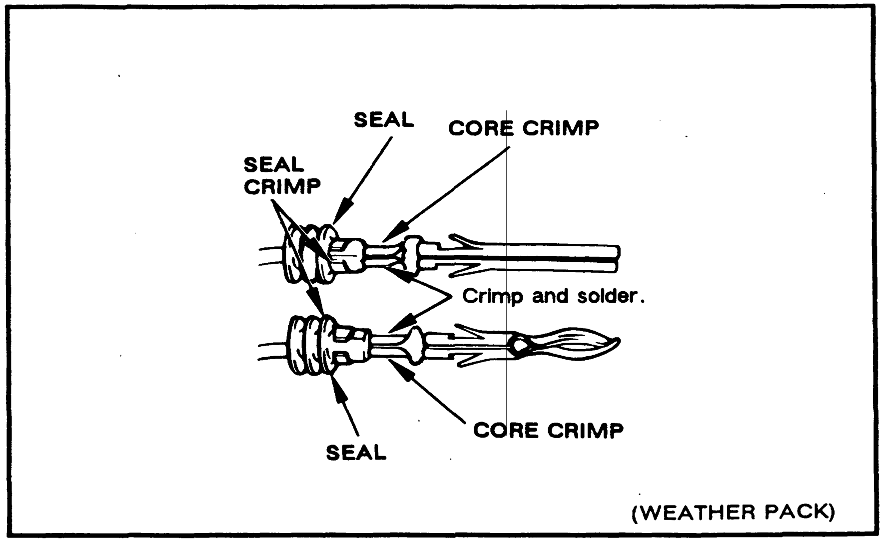


Figure 35

5. Insert lead from the back until it catches.
6. Install TPA's, CPA's and /or secondary locks, if equipped. See figures 36 through 38.

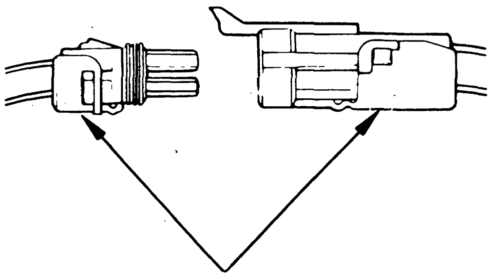


Figure 36

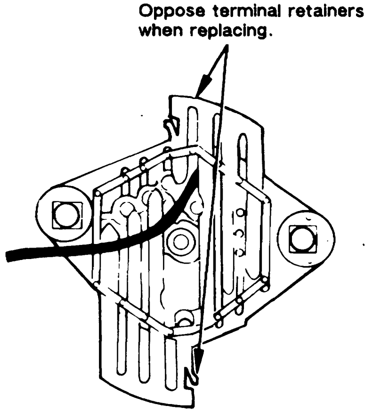


Figure 37

Pull-to-Seat

Follow the steps below to repair Pull-to-Seat connectors, see Figure 38. The steps are illustrated with typical connectors. Your connector may differ, but the repair steps are similar. Some connectors do not require all the steps shown. Skip those that don't apply.

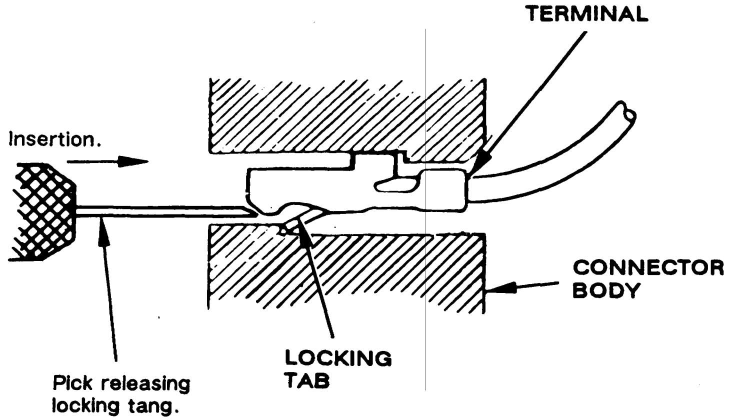


Figure 38 - Typical Pull-to-Seat Connector

REPAIR PROCEDURES

1. Separate connector halves. Remove terminal using proper pick or removal tool, see Figures 39 through 40.
   - A. Pull on lead gently.
   - B. Insert pick from front of connector into canal
   - C. Pry tab up with tool.
   - D. Push lead to remove.

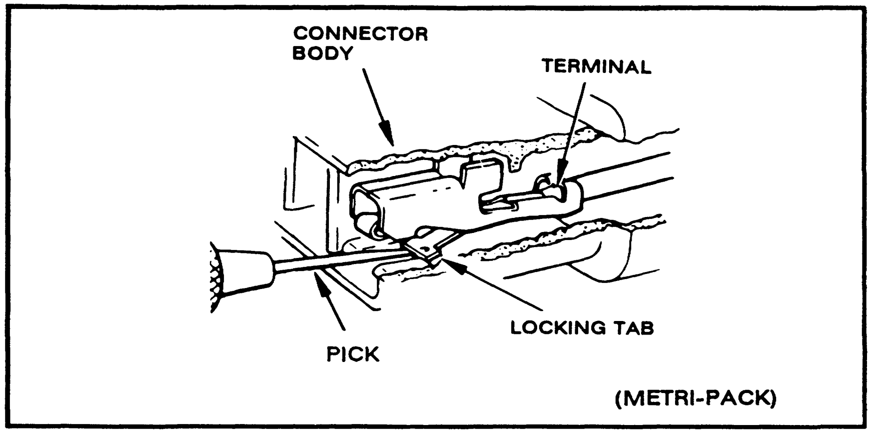


Figure 39

2. If terminal is to be re-used, re-form locking tang.

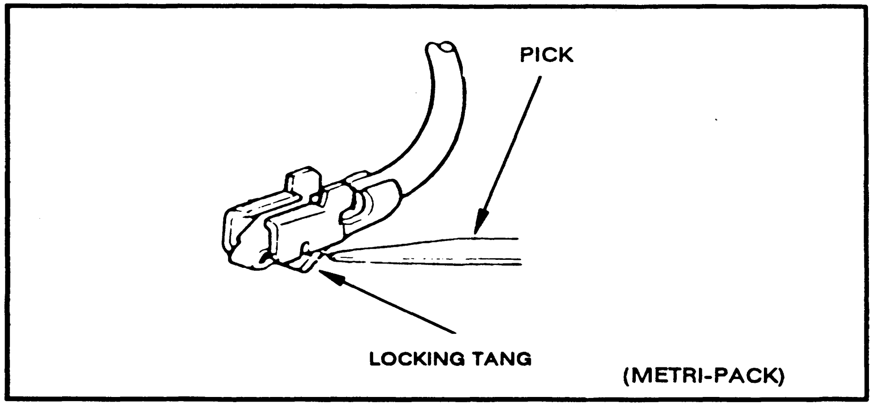


Figure 40

3. Make repair.
   - A. Pull terminal wire out of connector body.
   - B. Cut wire as close to terminal as possible.
   - C. Strip 5mm. (3/16 in.) of insulation from wire, see Figure 41.

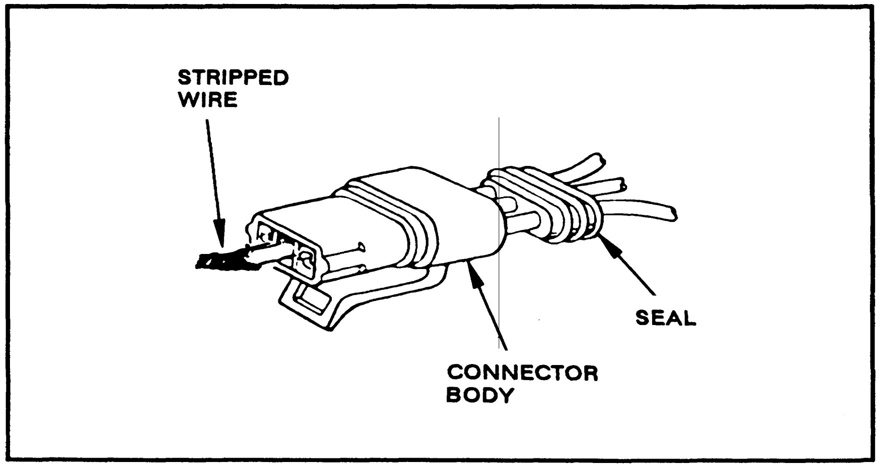


Figure 41

   - D. Crimp new terminal to wire.
   - E. Solder with rosin core solder.
   - F. Carefully pull on wire to draw terminal into connector body until it locks.

REPAIR PROCEDURES

WIRING REPAIR - SIR SYSTEM

Special wiring repair procedures have been developed for use on the Supplemental Inflatable Restraint (SIR) system due to the sensitive nature of the circuitry. These instructions are to be followed whenever servicing the SIR system wiring.

TERMINAL REPAIR KIT J-38125

Essential tool kit J-38125 contains special "sealed splices" for use in repairing SIR system wiring. A special crimping tool, heat torch, and instruction manual for these splices are also included.

Two critical features of the sealed splices are a special heat shrink sleeve with sealing adhesive to produce an environmentally sealed splice and a cross hatched (Knurled) core crimp to provide necessary contact integrity for the sensitive, low energy circuits.

Tool kit J-38125 also serves as a generic terminal repair kit. The kit contains a large sampling of common GM electrical terminals and the correct tools to apply them to wires and remove them from connectors. The terminals in the kit are not to be used to replace damaged SIR system terminals unless otherwise indicated by the terminal package. Specifically the DERM/resistor terminal repair assembly pack, is included in the J-38125 for SIR use.

SIR CONNECTOR (PLASTIC BODY) AND TERMINAL (METAL PIN) REPAIR

If any connector or terminal in the SIR wire harness (except pigtails) is damaged, the component should be repaired using one of the connector repair assembly packs. These kits include an instruction sheet and the sealed splices which will be necessary to splice the new wires, connector, and terminals to the harness. Crimping tool J-38125-8 (the tool which is color keyed to match the spices) from terminal repair kit J-38125 must be used to apply these splices.

The terminals in the SIR system are made of a special metal to provide necessary contact integrity for the sensitive low energy circuits. These terminals are only available in the connector repair assembly packs and not other terminals should be substituted.

If individual terminals are damaged on the DERM or resistor module, they should be repaired using the DERM/resistor terminal repair assembly pack. If individual terminals are damaged on any other SIR connection, the entire connection should be replace using the appropriate connector Repair Assembly Pack.

SIR WIRE PIGTAIL REPAIR

If the wiring pigtail (wire attached directly to the device, not by a connector (Sensor, Coil Assembly, or Inflator Module) is damaged the entire component (with pigtail) should be replaced. Absolutely no wire, connector, or terminal repair is to be attempted on the Dual Sensor, the Forward Discriminating Sensor, the Inflator Module, or the SIR Coil Assembly.

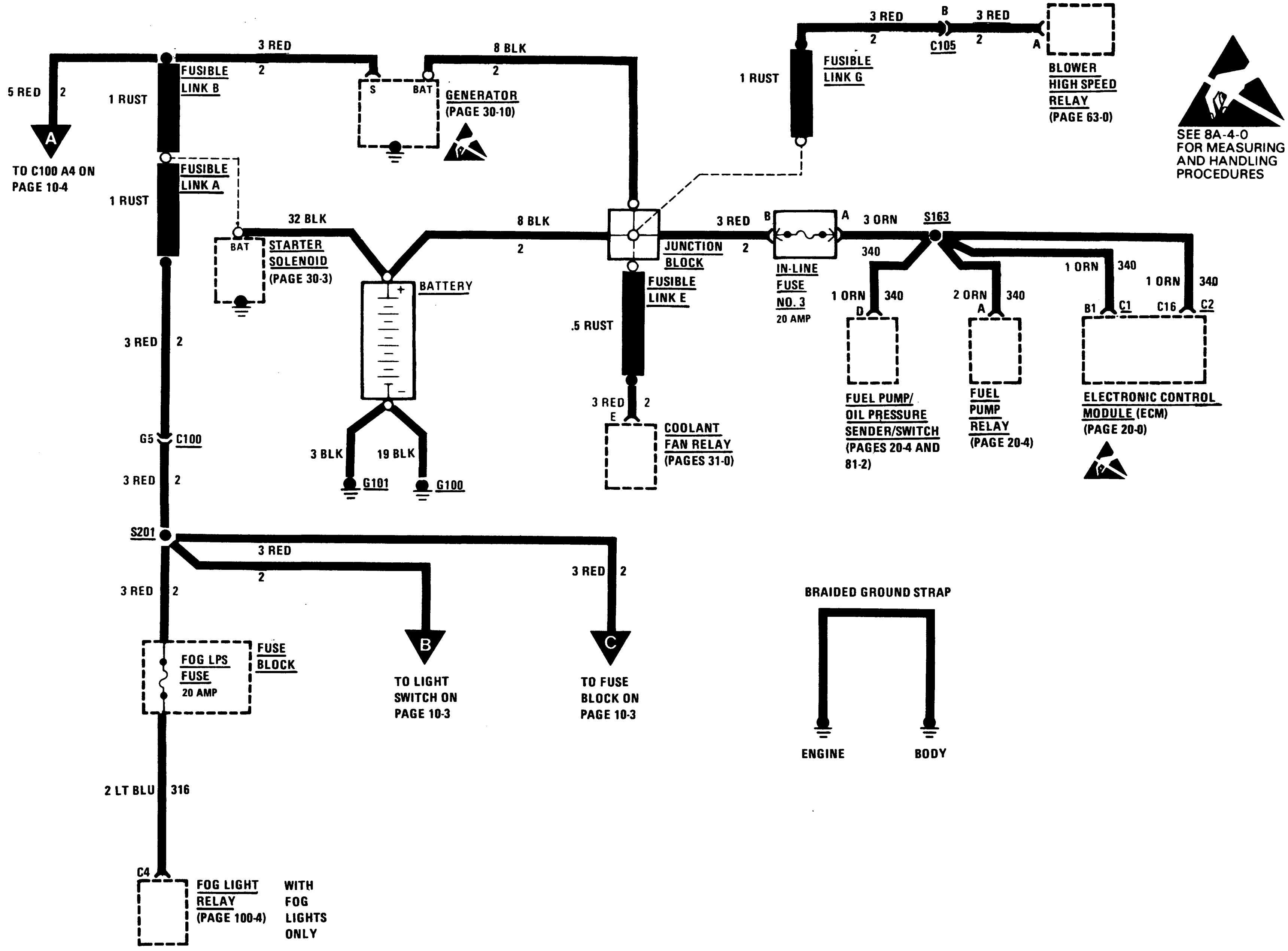
SIR WIRE REPAIR

If any wire except the pigtail is damaged, the wire should be repaired by splicing in a new section of wire of the same gauge size (.5, .8, 1.0, etc.). The sealed splices and crimping tool from terminal repair kit J-38125 must be used for these splices, Carefully follow the wiring repair procedures or the instructions included in the kit, for proper sealed application.

SIR SYSTEM WIRE SPLICE REPAIR

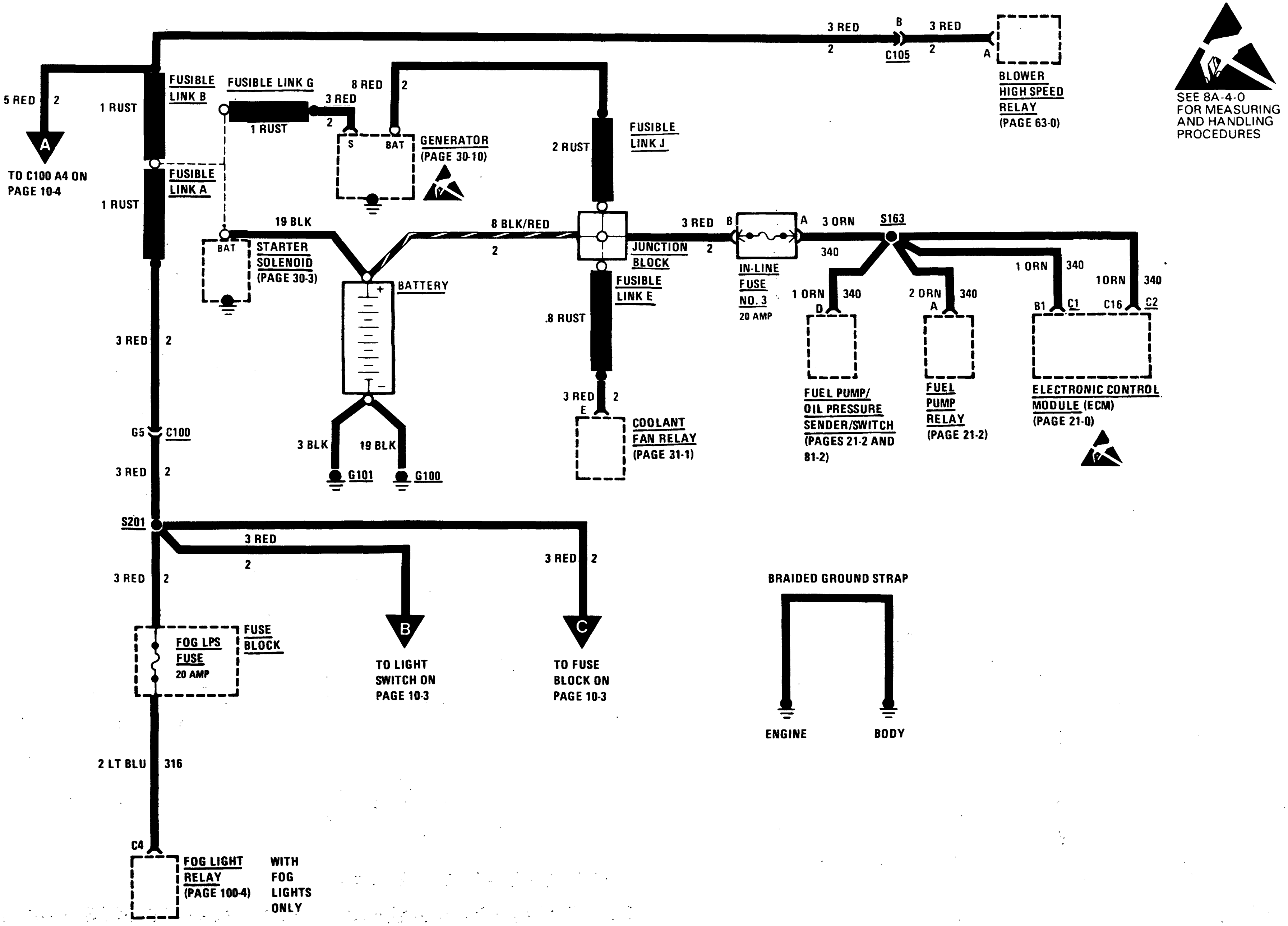
If any of the original equipment splices (S201, etc., three wires or more) in the SIR system wiring are damaged they should be repaired by applying a new splice (not sealed) from terminals kit J-38125. Carefully follow the instructions included in the kit for proper splice clip application. Cloth duct tape may be substituted for splice tape if necessary.

POWER DISTRIBUTION: V6 VIN T



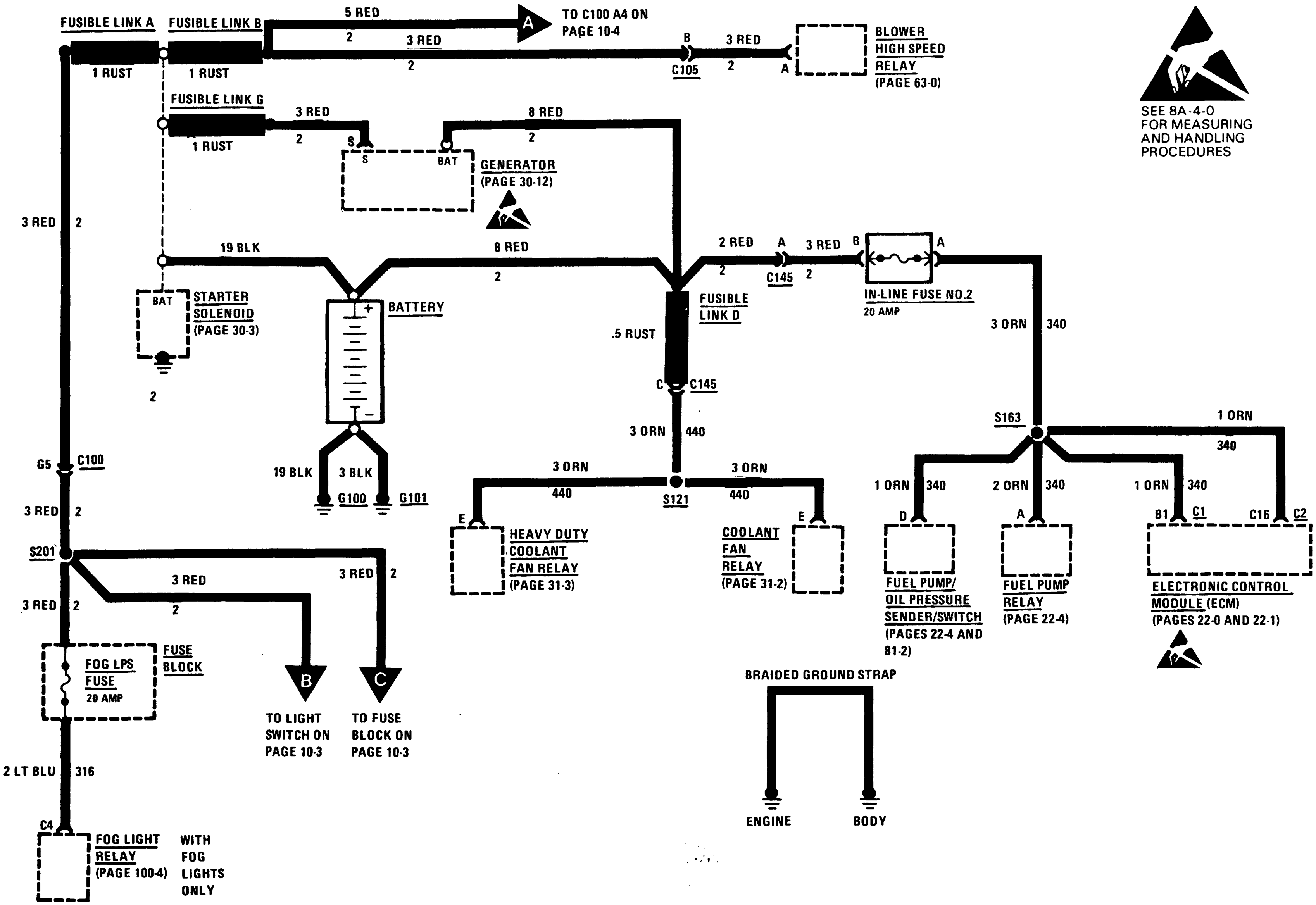
SEE 8A-4-0 FOR MEASURING AND HANDLING PROCEDURES

POWER DISTRIBUTION: V8 VIN E

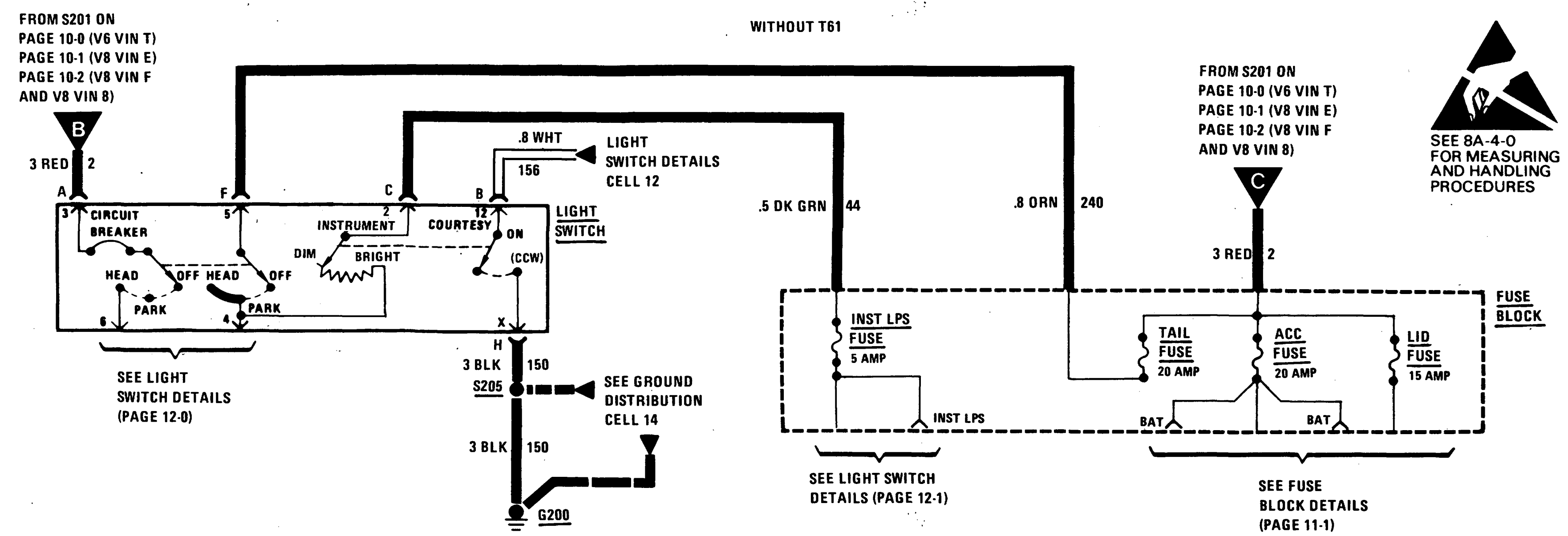


SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES

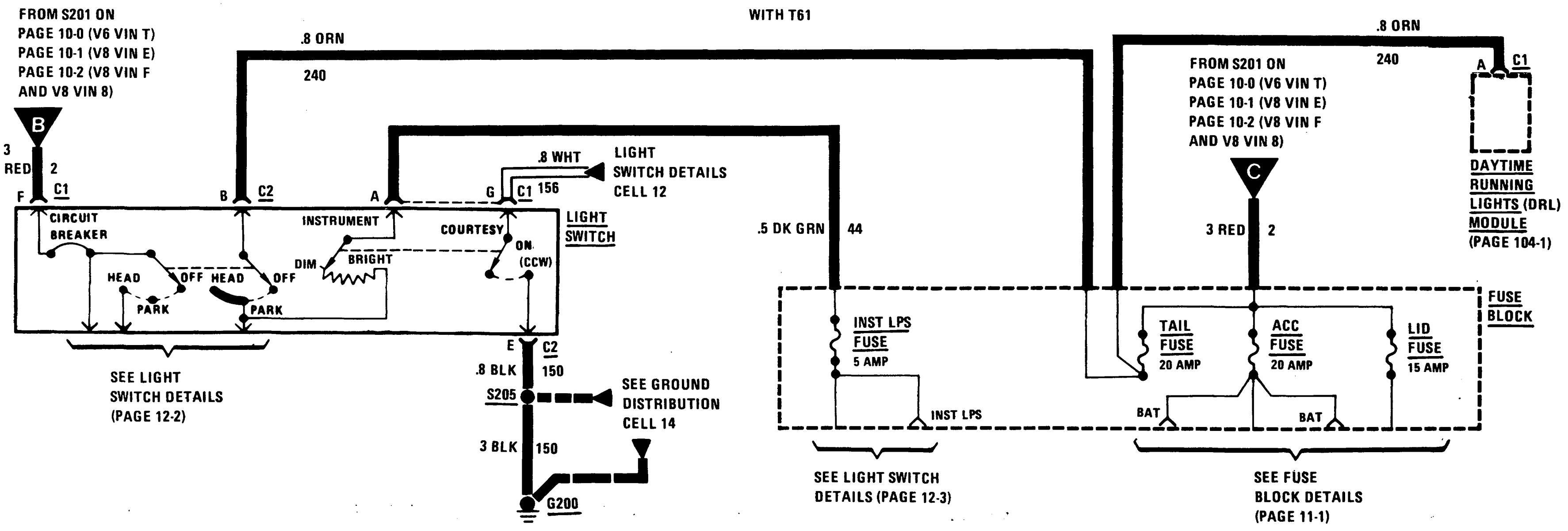
POWER DISTRIBUTION: V8 VIN F AND V8 VIN 8



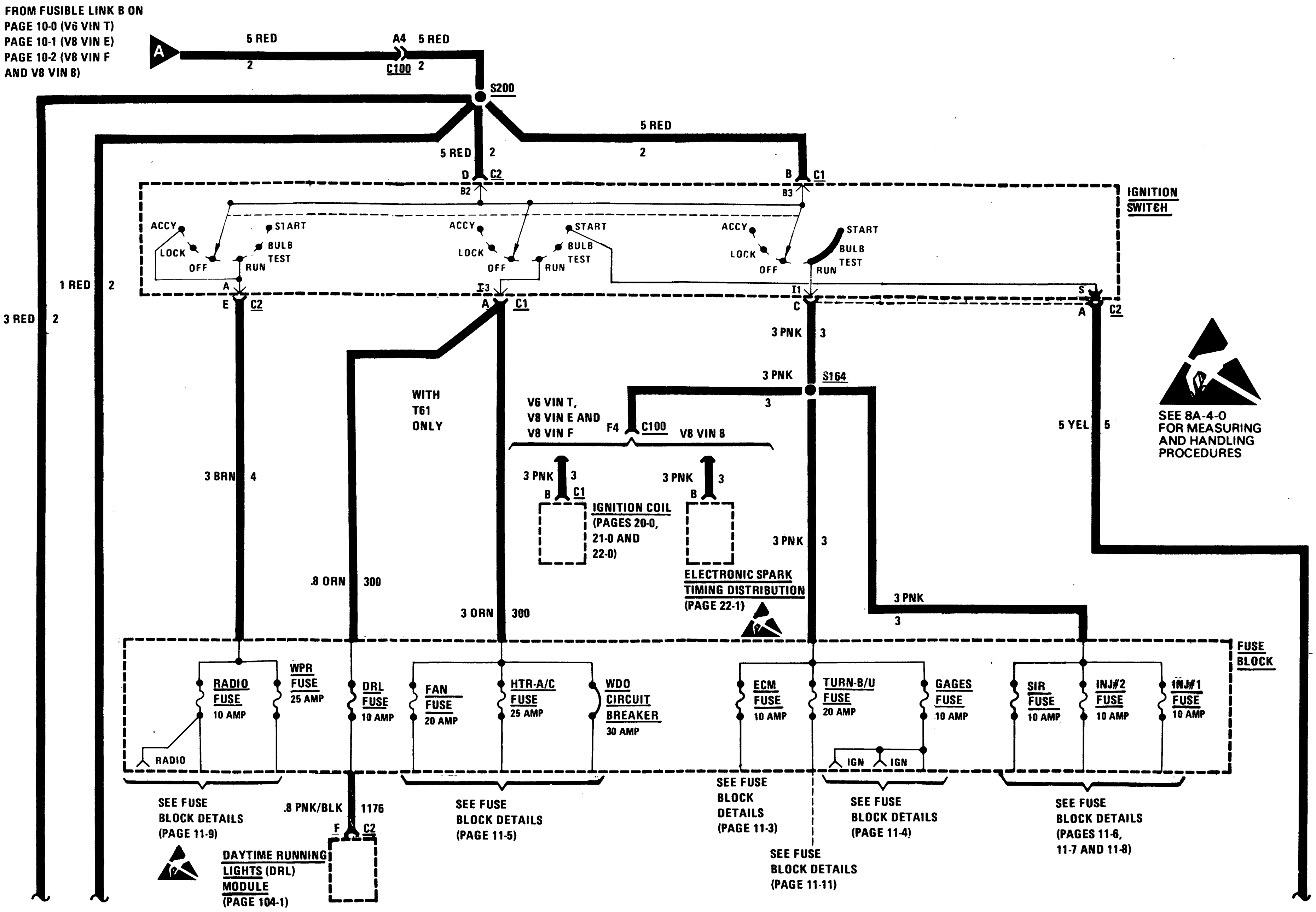
WITHOUT T61

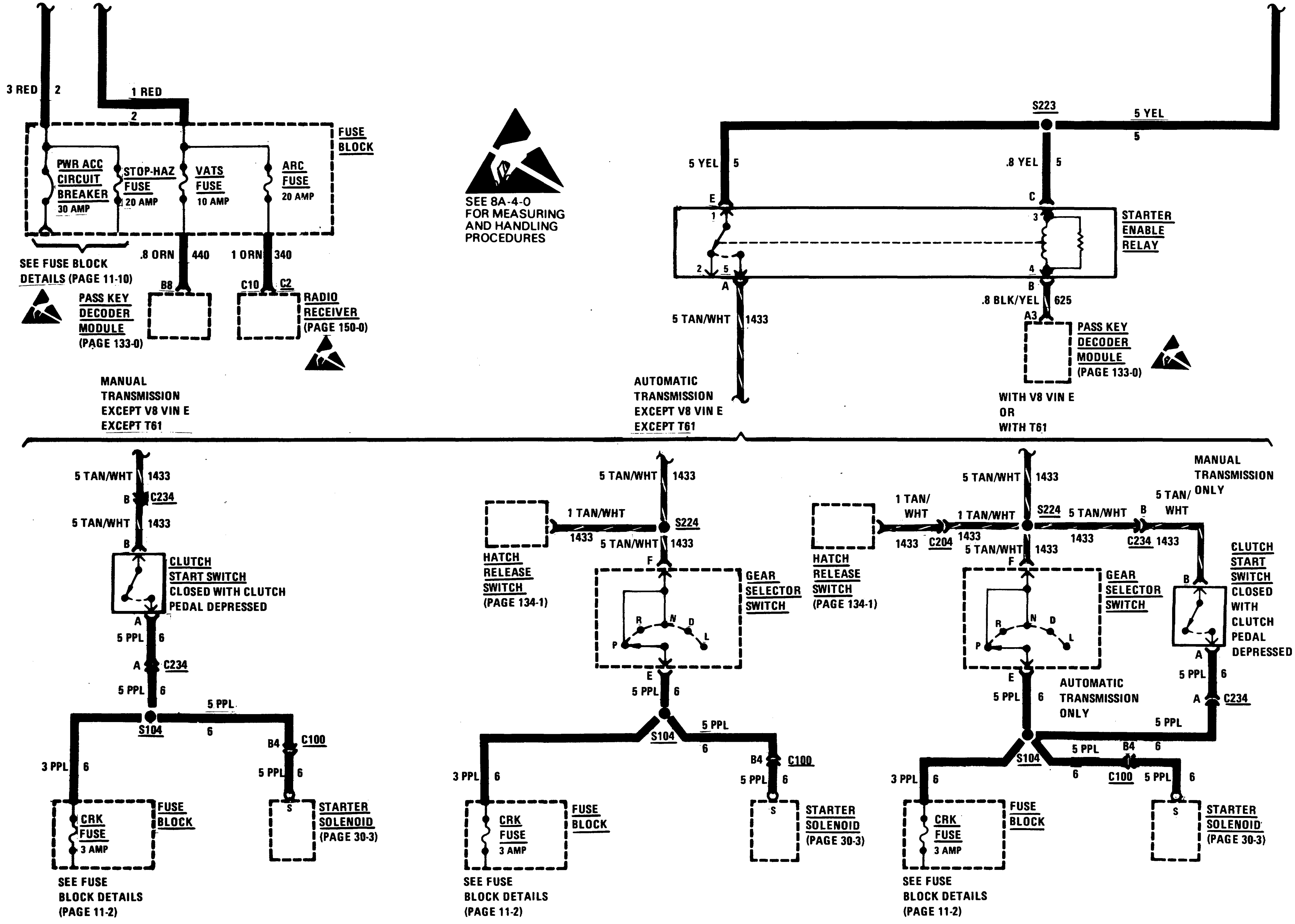


WITH T61



POWER DISTRIBUTION




3 RED
2
1 RED
2
FUSE BLOCK
PWR ACC CIRCUIT BREAKER 30 AMP
STOP-HAZ FUSE 20 AMP
VATS FUSE 10 AMP
ARC FUSE 20 AMP
SEE FUSE BLOCK DETAILS (PAGE 11-10)
.8 ORN
440
1 ORN
340
B8
C10
C2
PASS KEY DECODER MODULE (PAGE 133-0)
RADIO RECEIVER (PAGE 150-0)
SEE 8A-4-0 FOR MEASURING AND HANDLING PROCEDURES
S223
5 YEL
5
5 YEL
5
.8 YEL
5
E
C
1
3
2
5
4
STARTER ENABLE RELAY
A
B
.8 BLK/YEL
625
A3
5 TAN/WHT
1433
PASS KEY DECODER MODULE (PAGE 133-0)
MANUAL TRANSMISSION EXCEPT V8 VIN E EXCEPT T61
AUTOMATIC TRANSMISSION EXCEPT V8 VIN E EXCEPT T61
WITH V8 VIN E OR WITH T61
5 TAN/WHT
1433
B
C234
5 TAN/WHT
1433
B
CLUTCH START SWITCH CLOSED WITH CLUTCH PEDAL DEPRESSED
A
5 PPL
6
A
C234
5 PPL
6
5 PPL
S104
6
B4
C100
3 PPL
6
5 PPL
6
CRK FUSE 3 AMP
FUSE BLOCK
S
STARTER SOLENOID (PAGE 30-3)
SEE FUSE BLOCK DETAILS (PAGE 11-2)
5 TAN/WHT
1433
1 TAN/WHT
1433
S224
5 TAN/WHT
1433
HATCH RELEASE SWITCH (PAGE 134-1)
F
GEAR SELECTOR SWITCH
R
N
D
P
L
E
5 PPL
6
S104
5 PPL
6
B4
C100
3 PPL
6
5 PPL
6
CRK FUSE 3 AMP
FUSE BLOCK
S
STARTER SOLENOID (PAGE 30-3)
SEE FUSE BLOCK DETAILS (PAGE 11-2)
5 TAN/WHT
1433
MANUAL TRANSMISSION ONLY
1 TAN/ WHT
1 TAN/WHT
1433
S224
5 TAN/WHT
B
5 TAN/ WHT
1433
C204
1433
C234
1433
5 TAN/WHT
1433
HATCH RELEASE SWITCH (PAGE 134-1)
F
GEAR SELECTOR SWITCH
R
N
D
P
L
E
CLUTCH START SWITCH CLOSED WITH CLUTCH PEDAL DEPRESSED
B
A
5 PPL
6
A
C234
AUTOMATIC TRANSMISSION ONLY
5 PPL
6
5 PPL
S104
5 PPL
6
B4
6
C100
5 PPL
6
3 PPL
6
CRK FUSE 3 AMP
FUSE BLOCK
S
STARTER SOLENOID (PAGE 30-3)
SEE FUSE BLOCK DETAILS (PAGE 11-2)

CIRCUIT OPERATION

Electrical power for the car is provided by the Generator when the engine is running. The schematic diagram shows how each circuit gets its power. For more detail about the Generator and connections to the Battery and Starter, see the Charging System section.

The car's Power Distribution System consists of Fusible Links, Fuses, Circuit Breakers, the Light Switch and the Ignition Switch. Fusible Links are short pieces of wire several sizes smaller than the circuit wire to which they supply power. They are covered with special high-temperature insulation. When conducting a dangerously high current, they will melt and stop current. They are designed to protect the car's electrical system from electrical shorts that are not protected by the Circuit Breakers and Fuses.

The Ignition Switch has six positions, five of which have detents. The BULB TEST position is after the RUN position and just before the START position. BULB TEST does not have a detent. As shown in the schematic, circuits which are supplied from the Ignition Switch are HOT for different switch positions. Schematics show their fuses supplied from headings such as HOT IN RUN. The heading corresponds to the Ignition Switch position from which power is available.

COMPONENT LOCATION

		Page-Figure
Blower High Speed Relay	RH rear of engine compartment, on A/C module	201-11-A
Clutch Start Switch	Below I/P, on clutch pedal bracket	201-16-C
Coolant Fan Relay	LH front of dash, on relay bracket	
Daytime Running Lights (DRL) Module	Behind LH side of I/P	201-12-A
Electronic Control Module (ECM) (Except VIN E)	Behind RH side of I/P	201-15-B
Electronic Control Module (ECM) (VIN E)	Behind RH side of I/P	201-15-C
Electronic Spark Timing (EST) Distributor (VIN F)(VIN 8)	Top rear of engine	201- 7-A
Fog Light Relay	Behind LH side of I/P, near Fuse Block	201-13-A
Fuel Pump Relay	LH front of dash, on relay bracket	
Fuel Pump/Oil Pressure Sender/ Switch (VIN E)	Lower LH rear of engine	201- 5-A
Fuel Pump/Oil Pressure Sender/ Switch (VIN F)(VIN 8)	Lower LH side of engine	201- 7-B
Fuel Pump/Oil Pressure Sender/ Switch (VIN T)	Lower LH side of engine	201- 0-A
Fuse Block	Behind LH side of I/P	201-13-A
Fusible Link A (VIN E)	Lower RH side of engine, at Starter Solenoid	201- 6-C
Fusible Link A (VIN F)(VIN 8)	Lower RH side of engine, at Starter Solenoid	201- 9-C
Fusible Link A (VIN T)	Lower RH side of engine, at Starter Solenoid	201- 2-B
Fusible Link B (VIN E)	Lower RH side of engine, at Starter Solenoid	201- 6-C
Fusible Link B (VIN F)(VIN 8)	Lower RH side of engine, at Starter Solenoid	201- 9-C
Fusible Link B (VIN T)	Lower RH side of engine, at Starter Solenoid	201- 2-B
Fusible Link D	RH front of engine compartment, near battery	201- 9-A
Fusible Link E (VIN E)	RH front of engine compartment, at Junction Block	201- 3-A
Fusible Link E (VIN T)	RH front of engine compartment, at Junction Block	201- 2-A
Fusible Link G (VIN E)	Lower RH side of engine, at Starter Solenoid	201- 6-C
Fusible Link G (VIN F)(VIN 8)	Lower RH side of engine, at Starter Solenoid	201- 9-C
Fusible Link G (VIN T)	RH front of engine compartment, at Junction Block	201- 2-A
Fusible Link J	RH front of engine compartment, at Junction Block	201- 3-A

COMPONENT LOCATION

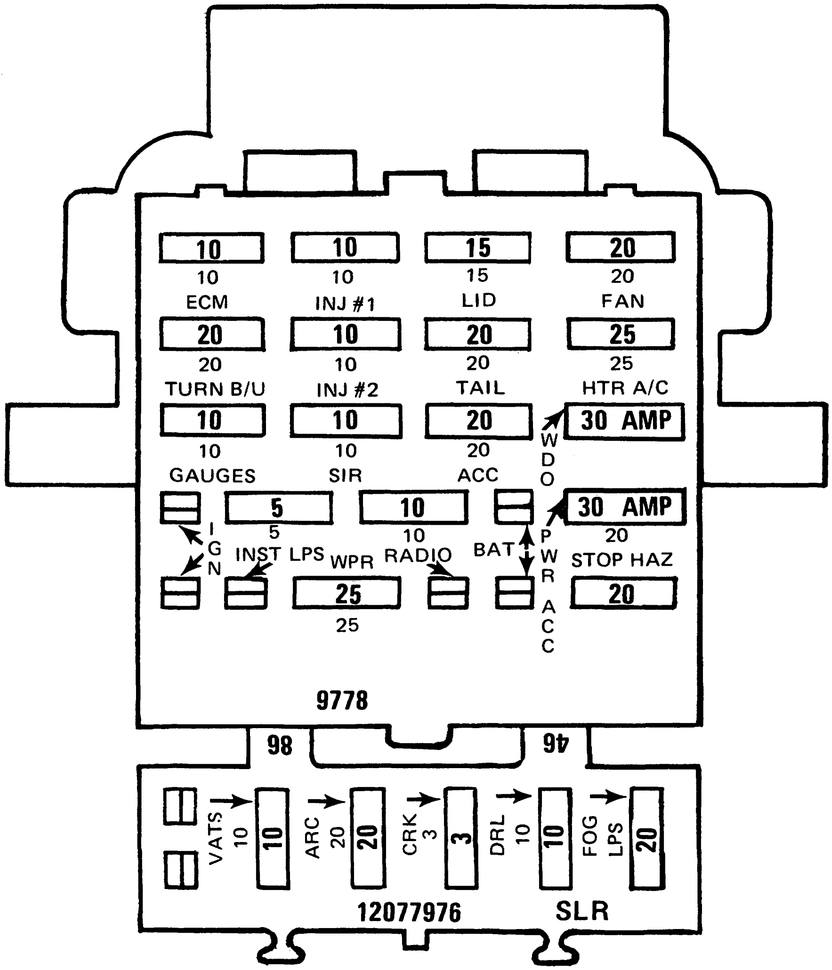
		Page-Figure
Gear Selector Switch	In console, at gear selector	201-17-F
Generator (VIN E)	Top LH front of engine	201- 5-A
Generator (VIN F)(VIN 8)	LH front of engine	201- 8-A
Generator (VIN T)	Top RH side of engine	201- 2-A
Heavy Duty Coolant Fan Relay	LH front of dash, on relay bracket	
Ignition Coil (VIN E)	Top rear of engine	201- 4-A
Ignition Coil (VIN F)	Top RH rear of engine	201- 8-B
Ignition Coil (VIN T)	RH rear of engine	201- 1-A
Ignition Switch	At base of steering column, below I/P	201-14-A
In-Line Fuse No. 2	RH front of engine compartment, near battery	201- 9-E
In-Line Fuse No. 3 (VIN E)	RH inner fender panel, by battery	201- 3-A
In-Line Fuse No. 3 (VIN T)	RH inner fender panel, by battery	201- 2-A
Junction Block (VIN E)	RH side of radiator support bracket	201- 3-A
Junction Block (VIN T)	RH side of radiator support bracket	201- 2-A
PASS Key Decoder Module	Behind RH side of I/P	201-15-A
Starter Enable Relay	Below LH side of I/P, on kick panel	201-16-A
Starter Solenoid (VIN E)	Lower RH side of engine	201- 6-C
Starter Solenoid (VIN F)(VIN 8)	Lower RH side of engine	201- 9-C
Starter Solenoid (VIN T)	Lower RH side of engine	201- 2-B
C100 (42 cavities)	LH front of dash, below relay bracket	201-12-A
C105 (4 cavities) VIN E)	RH rear of engine compartment	201- 4-B
C105 (4 cavities) (VIN F)(VIN 8)	RH rear of engine compartment	
C105 (4 cavities) (VIN T)	RH rear of engine compartment	201- 1-C
C145 (3 cavities)	RH front of engine compartment, near battery	201- 9-A
C204 (1 cavity)	Behind center of I/P	201-12-A
C234 (2 cavities)	Below LH side of I/P, near shroud	201-16-C
G100 (Except VIN T)	Lower RH front of engine	201- 5-B
G100 (VIN T)	Lower LH front of engine	201- 0-C
G101 (Except VIN T)	RH inner fender panel, near battery	201- 9-A
G101 (VIN T)	LH inner fender panel, near battery	201- 3-C
G200	Behind LH side of I/P, on Convenience Center bracket	201-14-C
S104	I/P harness, behind LH side of I/P	201-12-A
S121	Engine harness, LH rear of engine compartment.	201- 8-A
S163 (VIN E)	Engine harness, RH rear of engine compartment	201- 4-B

COMPONENT LOCATION

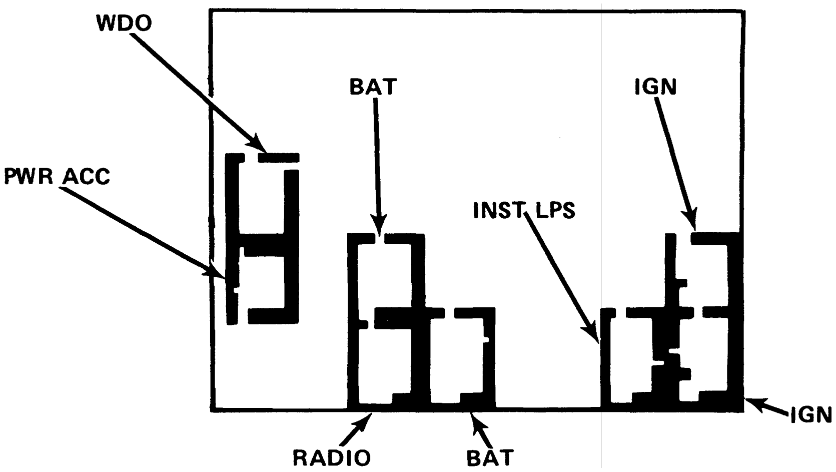
		Page-Figure
S163 (VIN F)(VIN 8)	Engine harness, LH rear of engine compartment.	201- 8-A
S163 (VIN T)	Engine harness, lower RH rear of engine compartment	201- 1-C
S164	I/P harness, behind LH side of I/P	201-14-A
S200	I/P harness, above steering column.	201-13-A
S201	I/P harness, behind LH side of I/P	201-12-A
S205	I/P harness, behind instrument cluster.	201-12-A
S223	I/P harness, behind LH side of I/P	201-12-A
S224	I/P harness, behind LH side of I/P, near Fuse Block.	201-12-A

BLANK

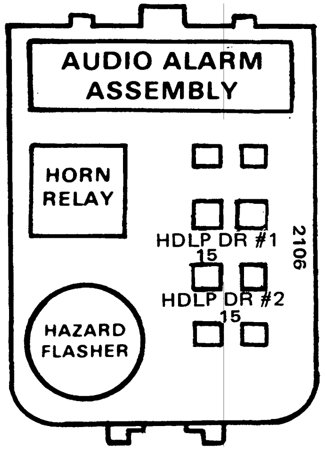
FUSE BLOCK DETAILS



FRONT VIEW OF FUSE BLOCK

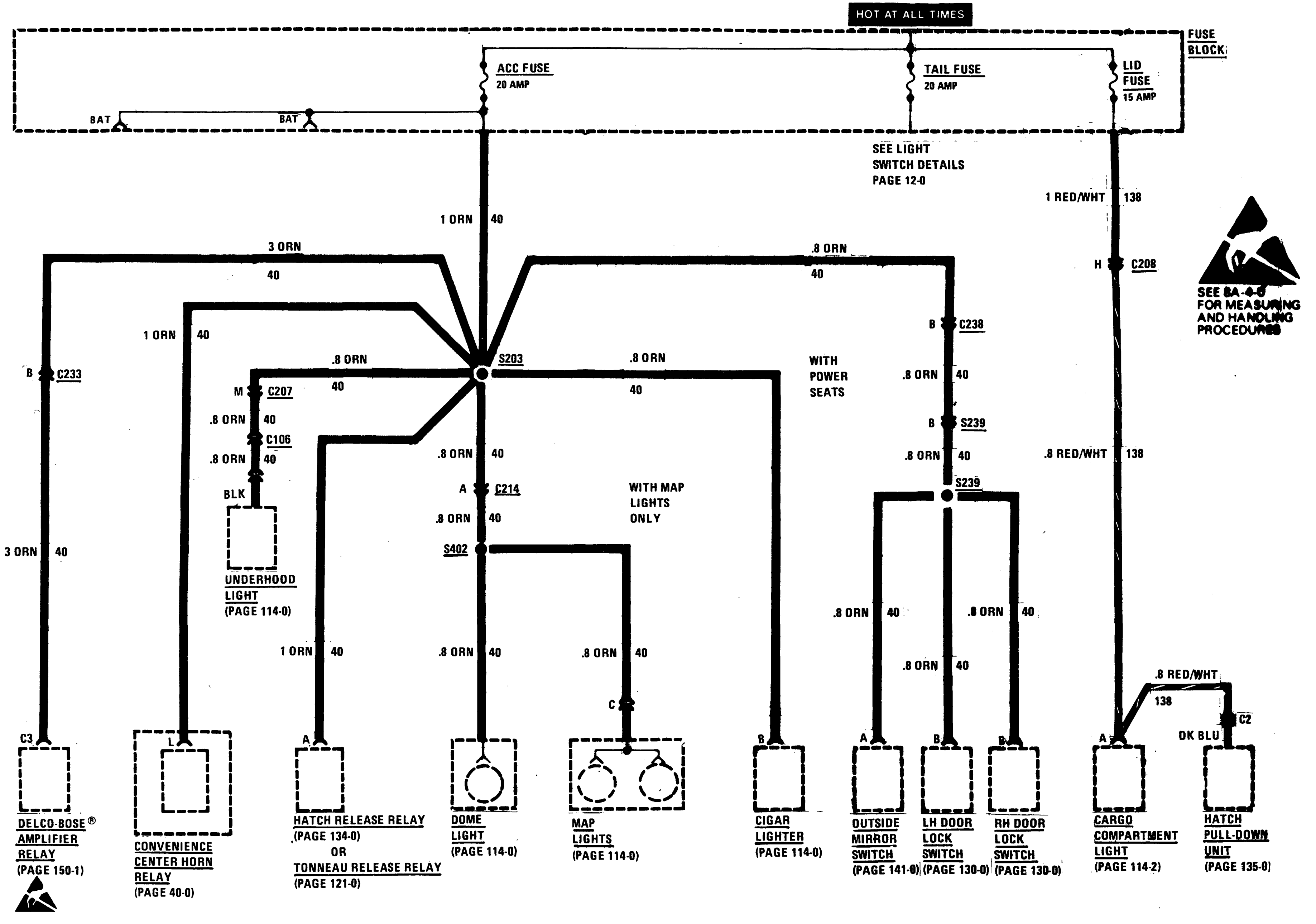


REAR VIEW OF FUSE BLOCK
Cavity and Connector Locations



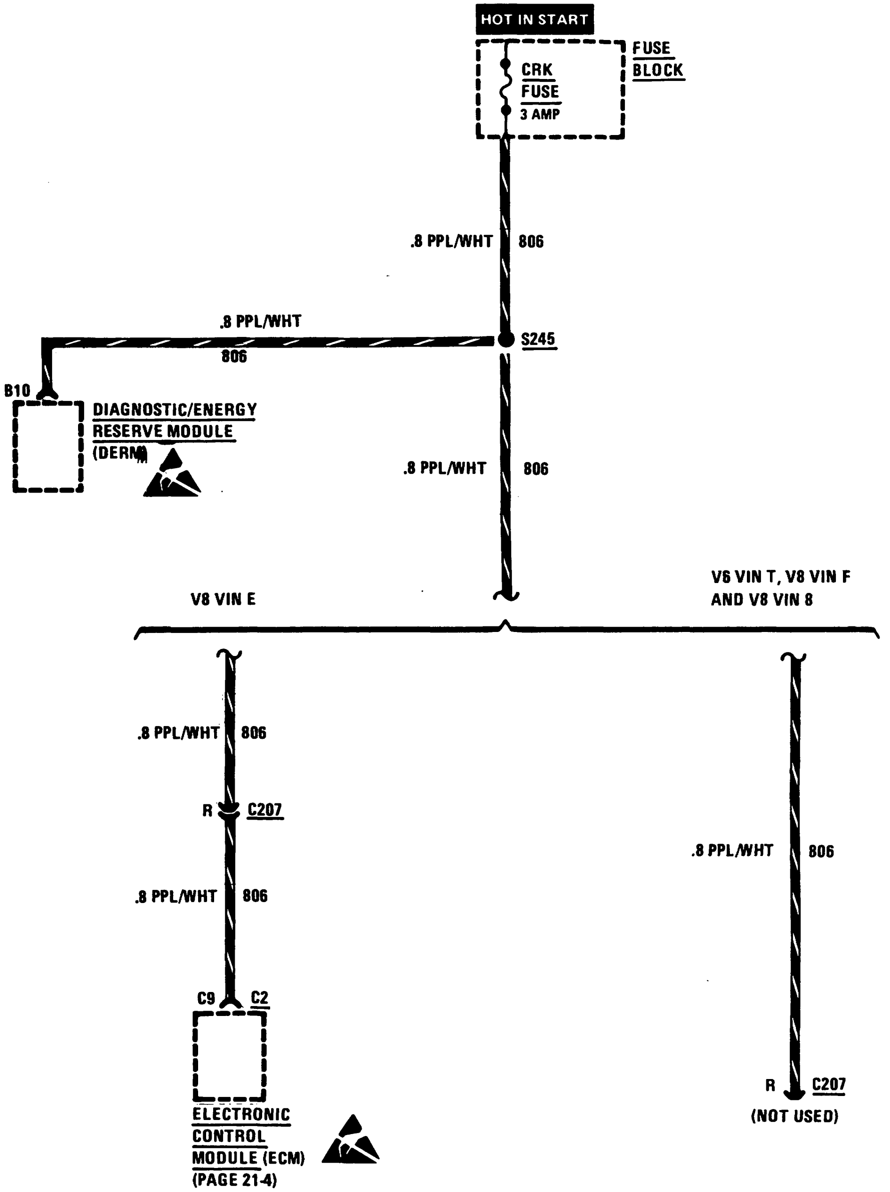
CONVENIENCE CENTER

FUSE BLOCK DETAILS: ACC FUSE, LID FUSE AND TAIL FUSE



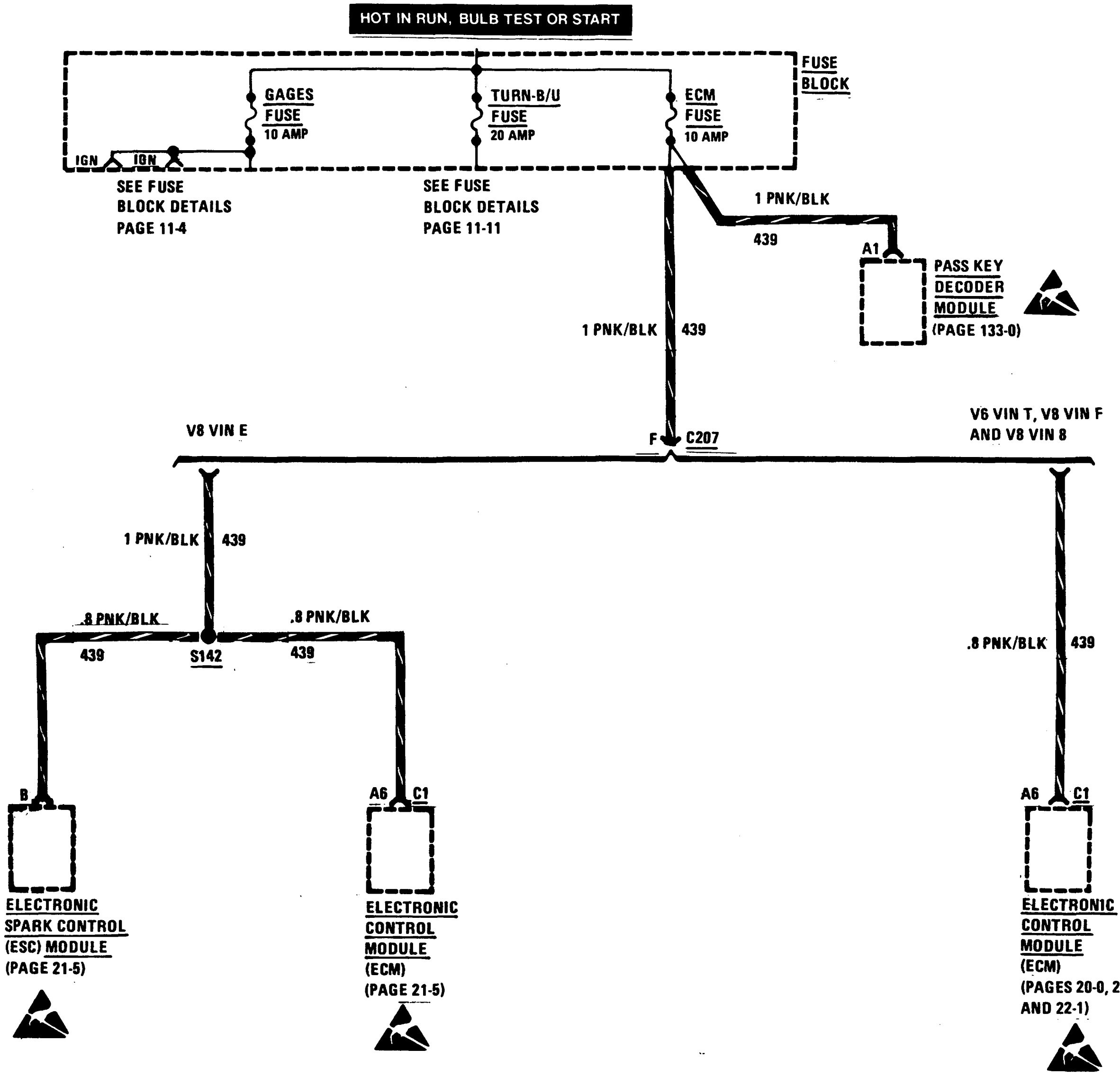
SEE 8A-4-0 FOR MEASURING AND HANDLING PROCEDURES

FUSE BLOCK DETAILS: CRK FUSE



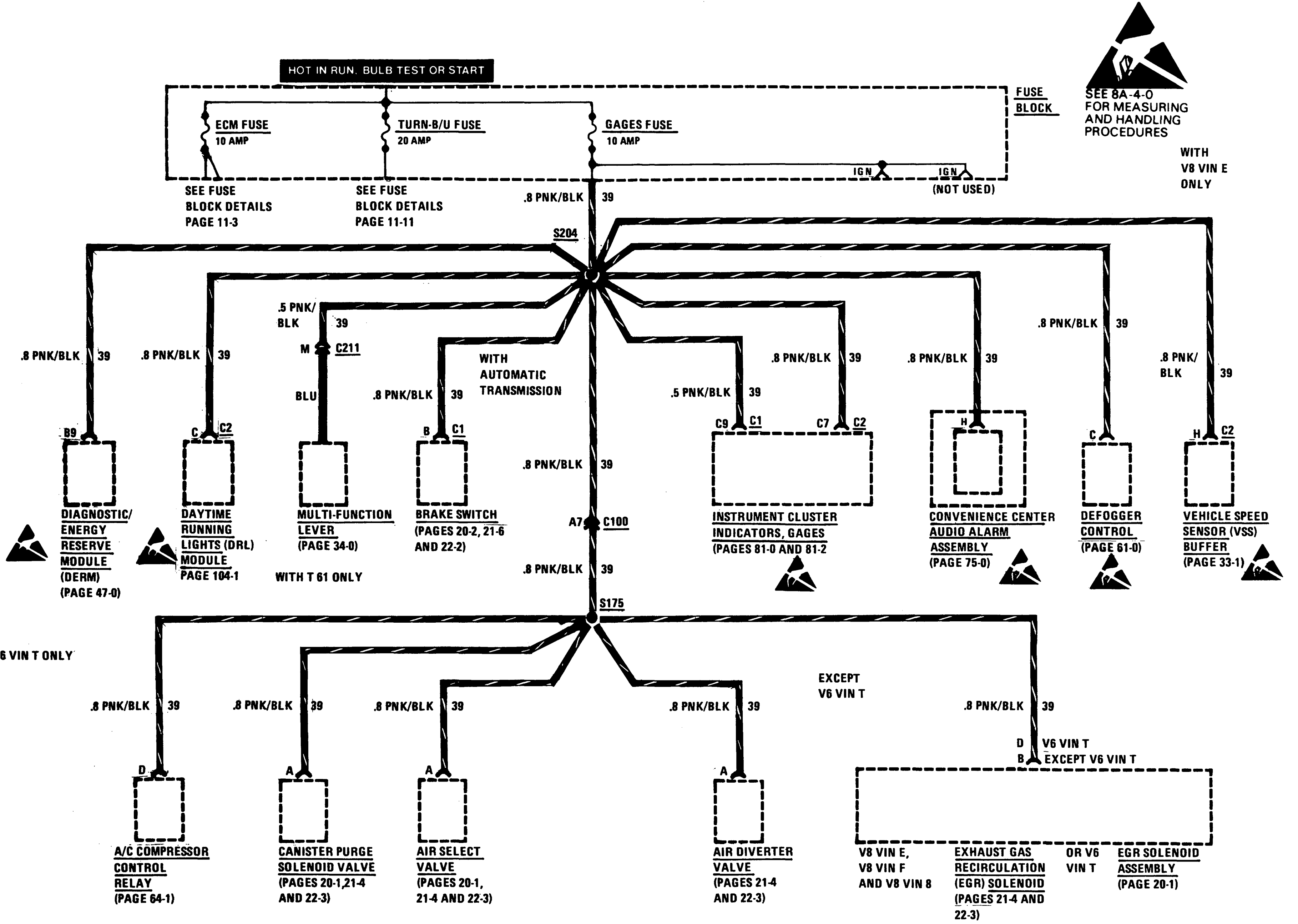
SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES

FUSE BLOCK DETAILS: ECM FUSE

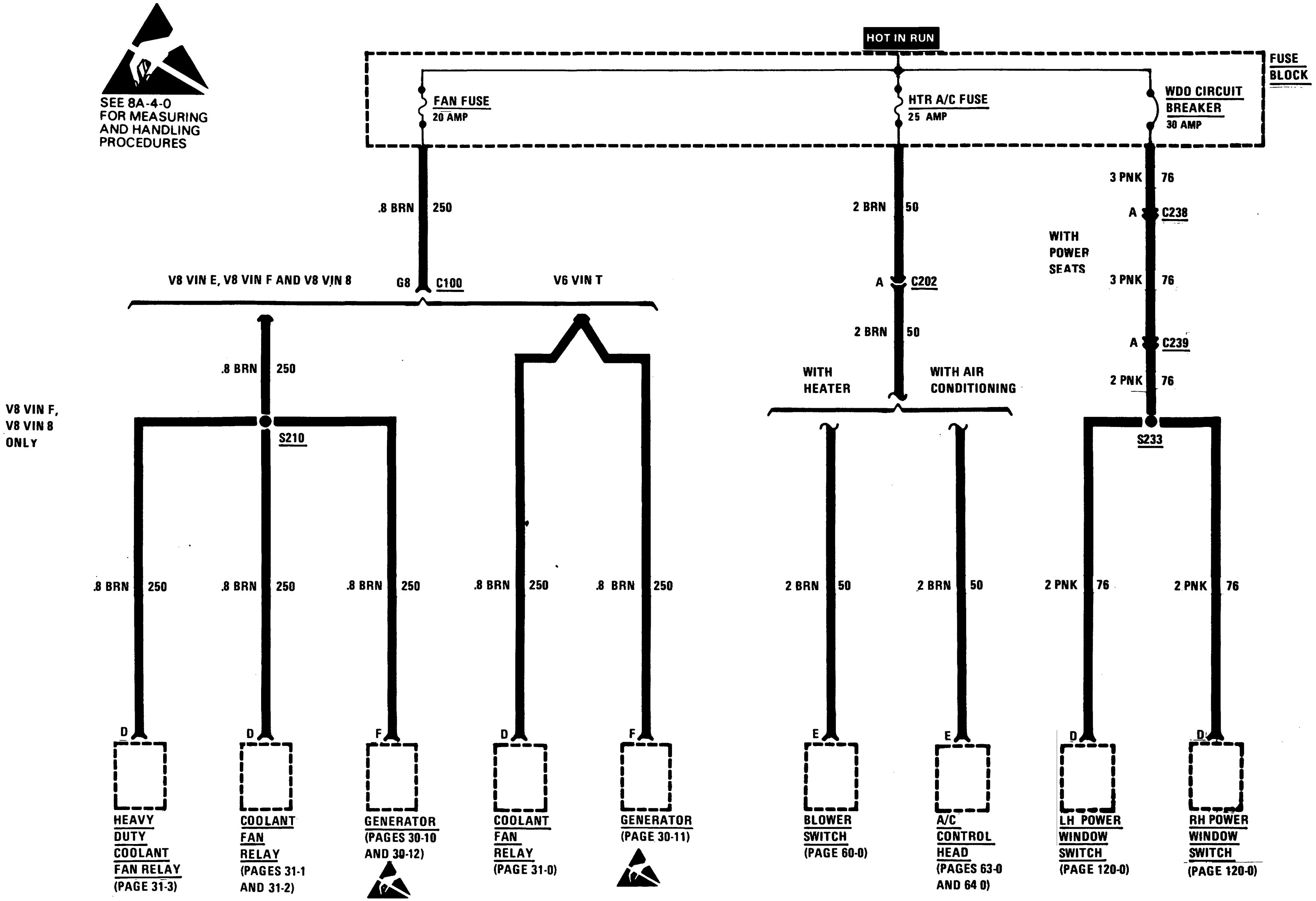


SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES

FUSE BLOCK DETAILS: GAGES FUSE

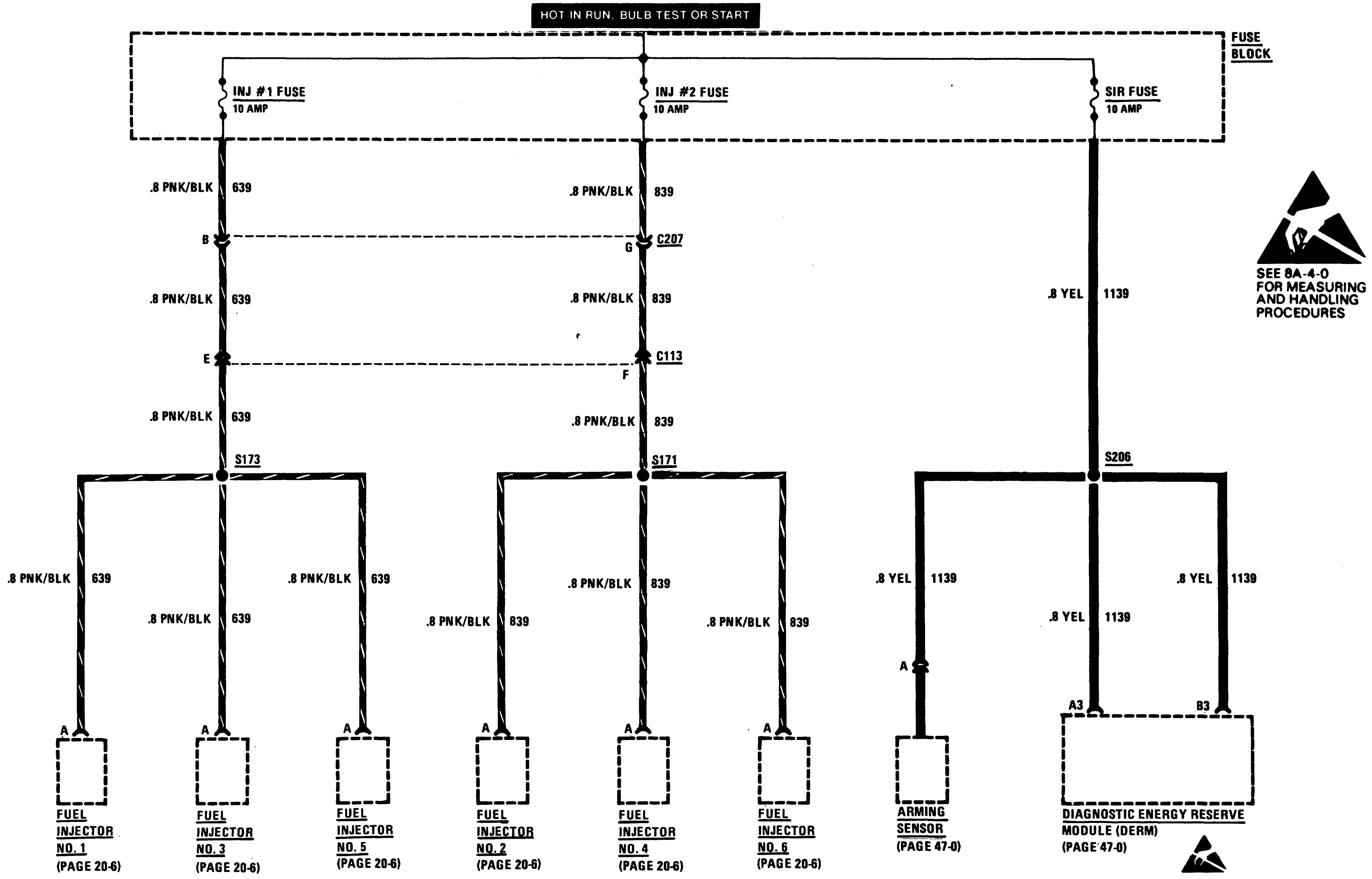


FUSE BLOCK DETAILS: FAN FUSE, HTR A/C FUSE AND WDO CIRCUIT BREAKER



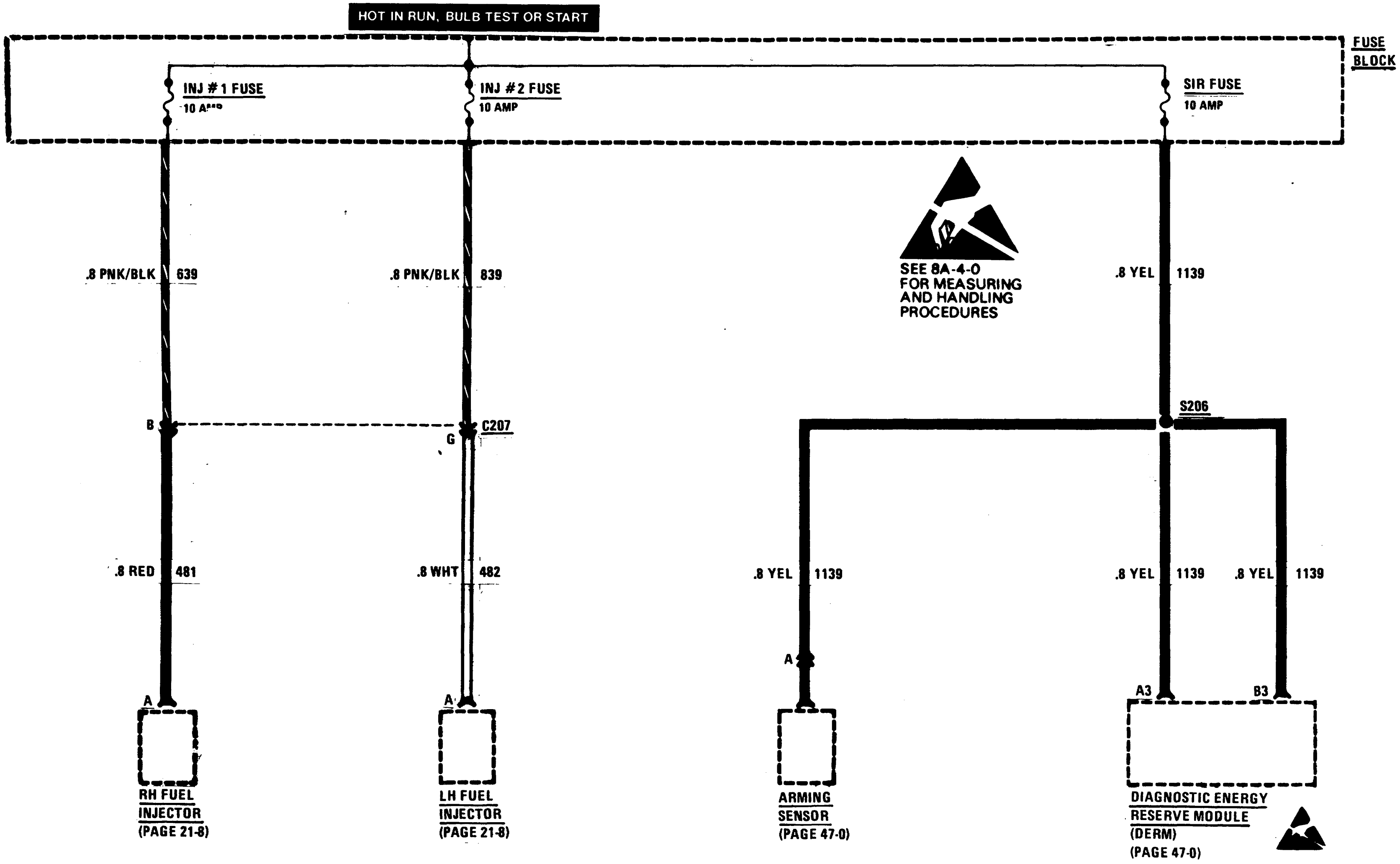
FUSE BLOCK DETAILS: INJ#1 FUSE, INJ#2 FUSE AND SIR FUSE

V6 VIN T



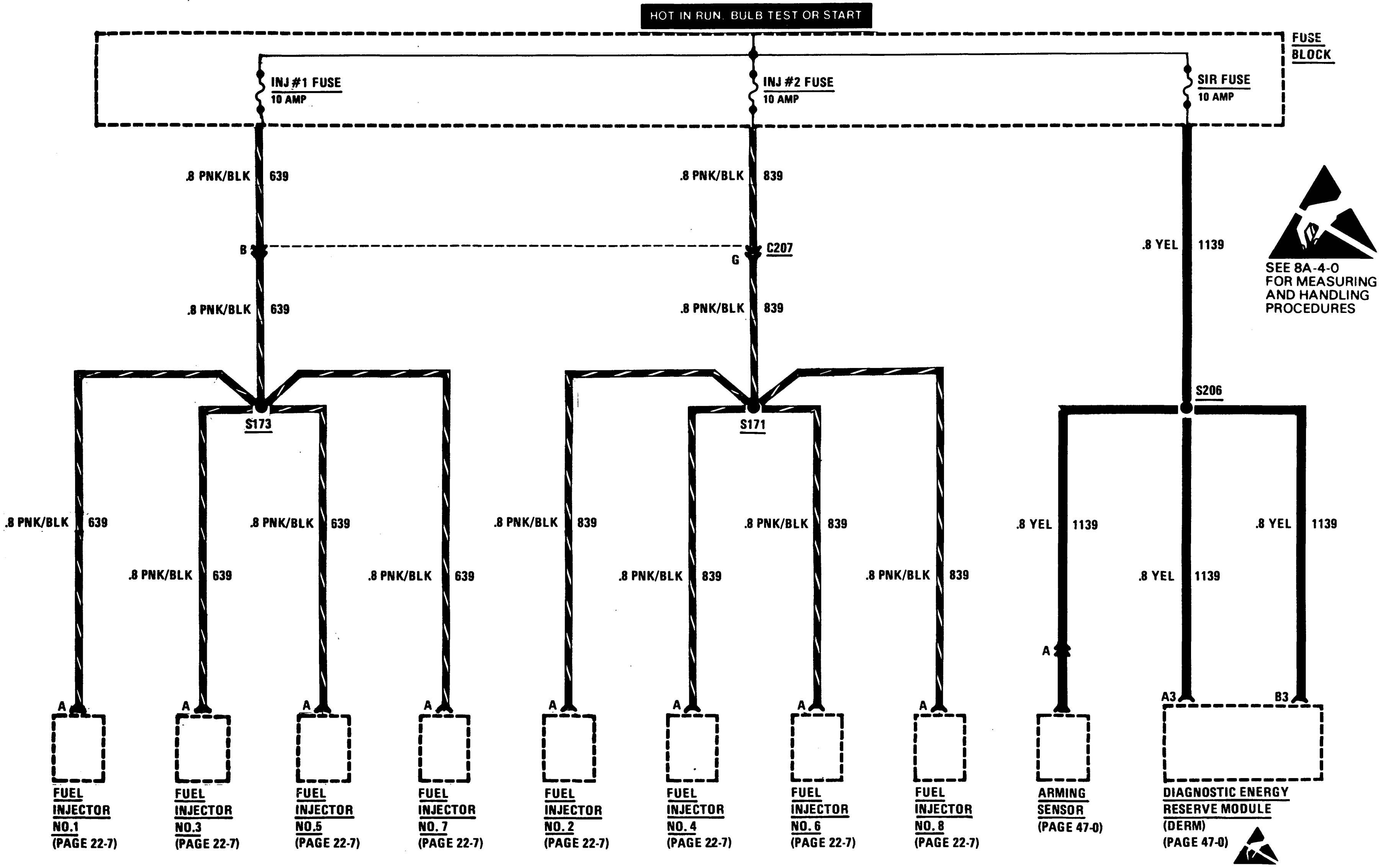
FUSE BLOCK DETAILS: INJ#1 FUSE, INJ#2 FUSE AND SIR FUSE

V8 VIN E



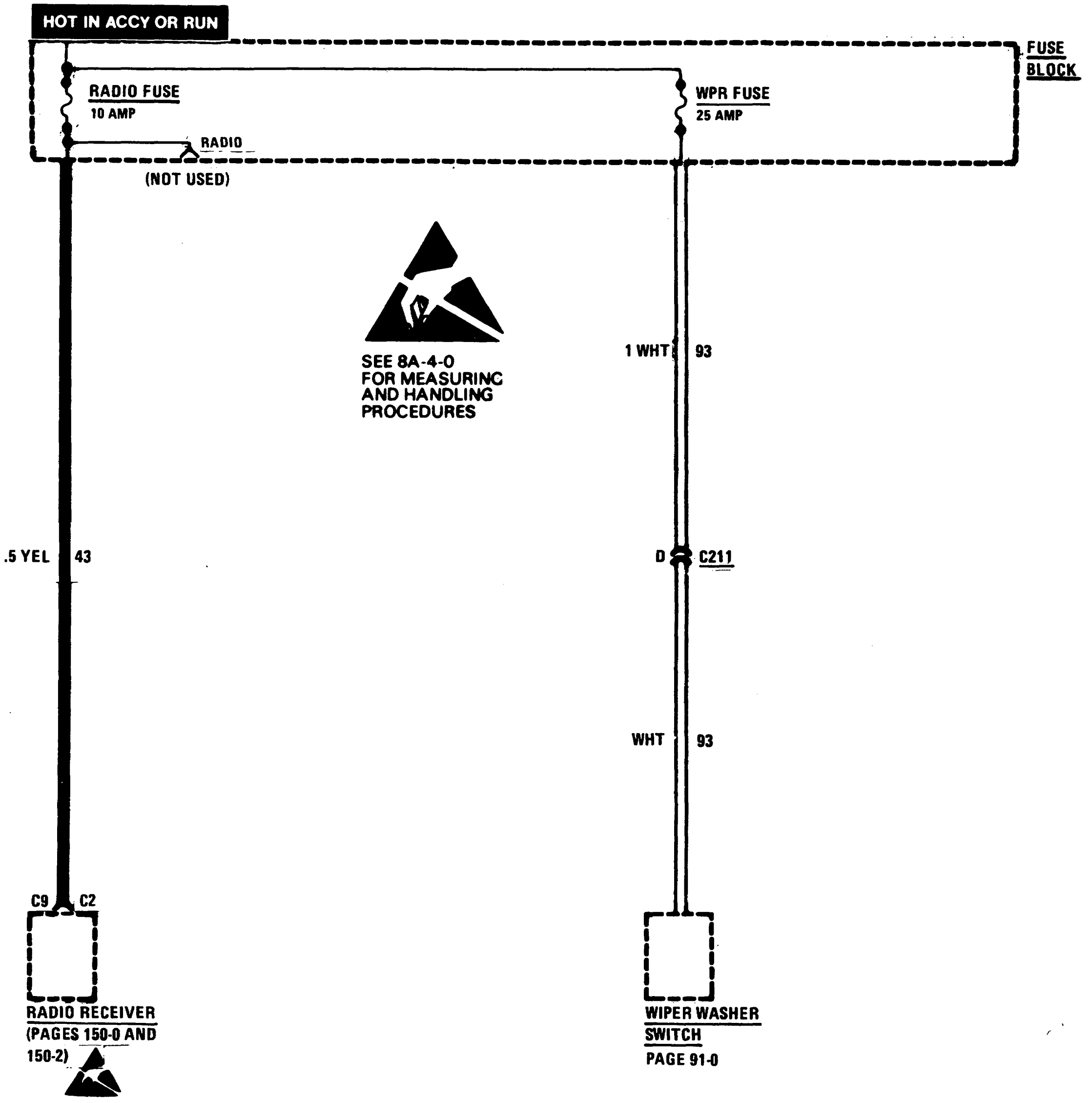
FUSE BLOCK DETAILS: INJ#1 FUSE, INJ#2 FUSE AND SIR FUSE

V8 VIN F AND V8 VIN 8

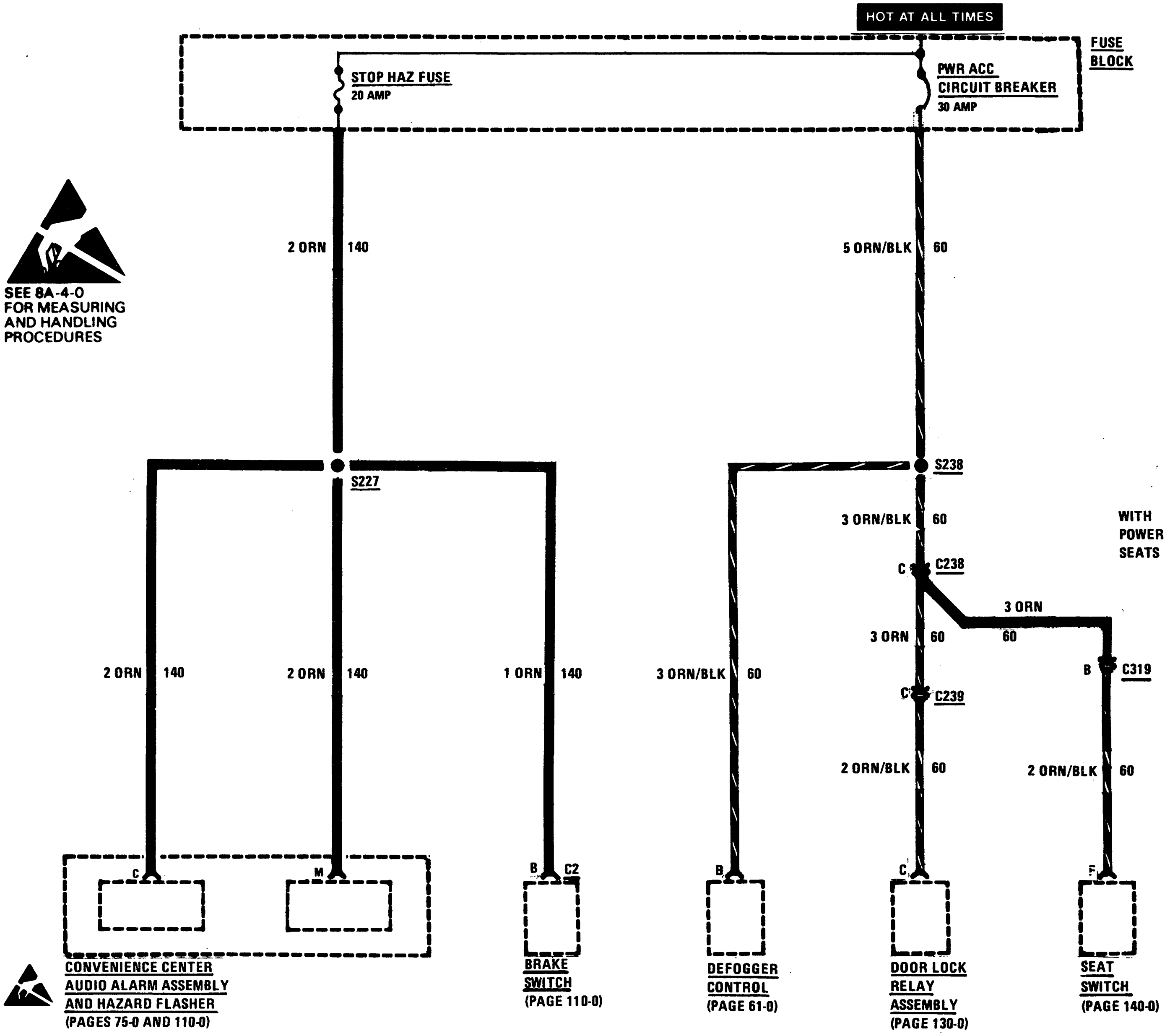


SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES

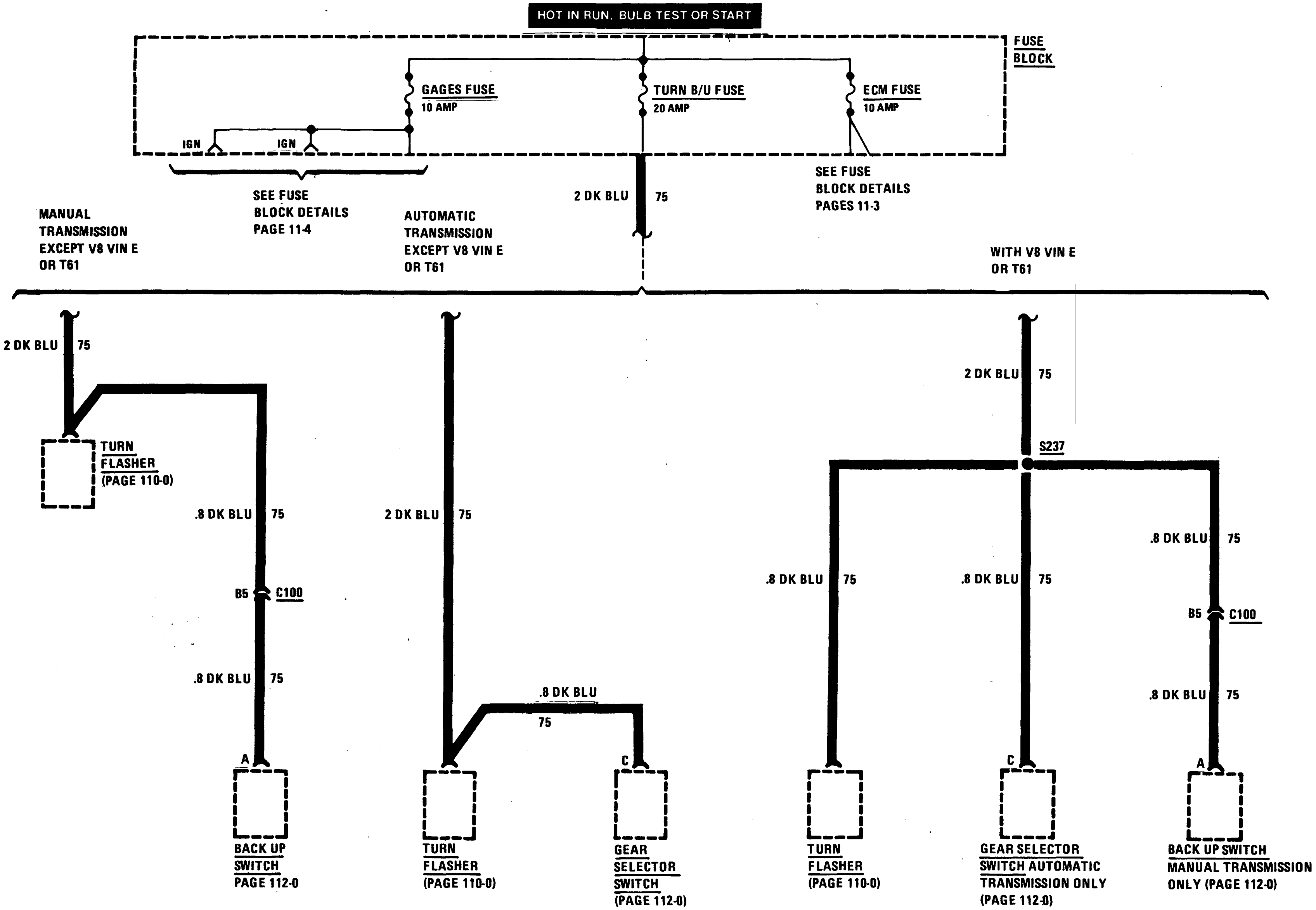
FUSE BLOCK DETAILS: RADIO FUSE AND WPR FUSE



FUSE BLOCK DETAILS: PWR ACC CIRCUIT BREAKER AND STOP HAZ FUSE

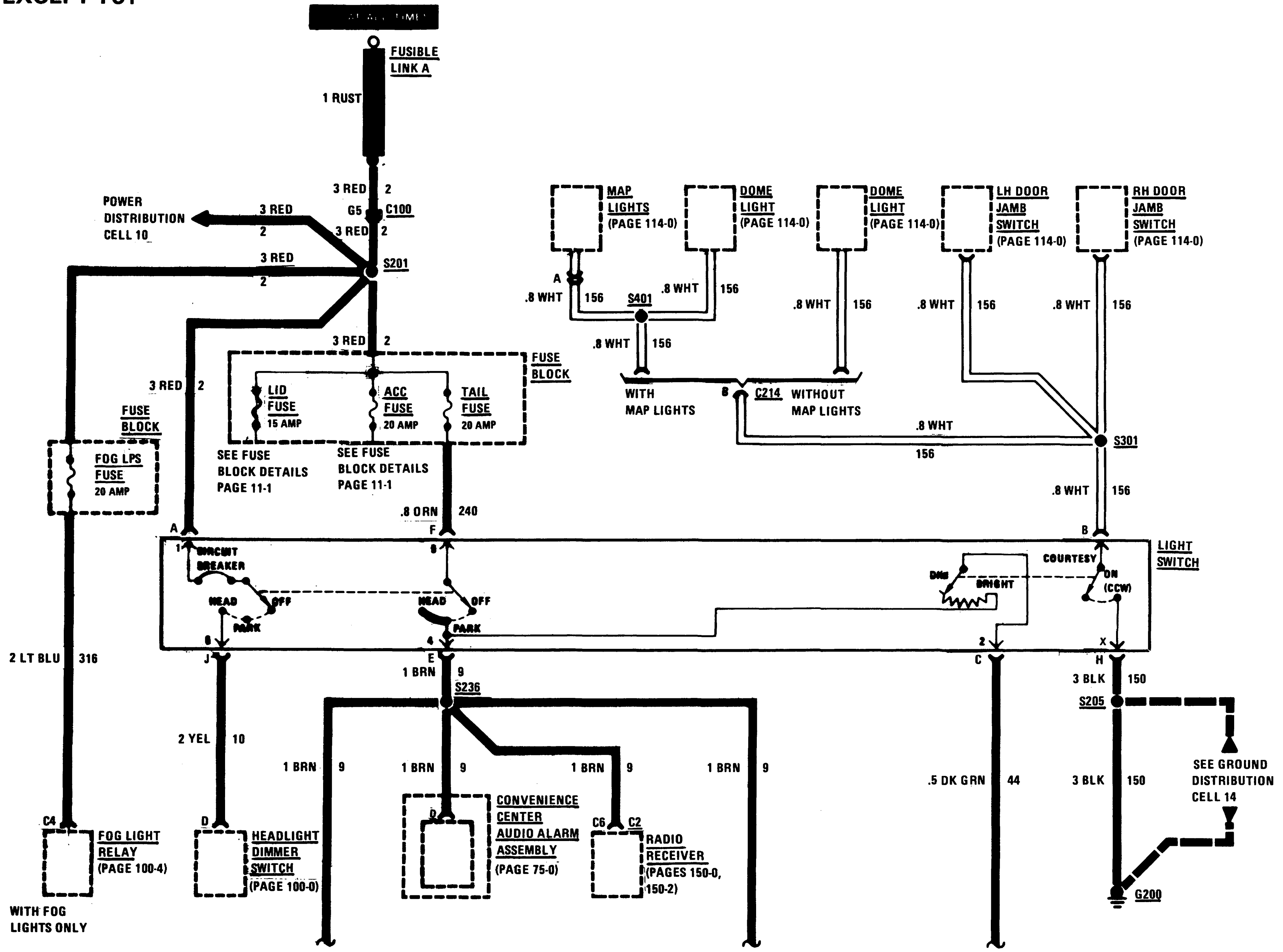


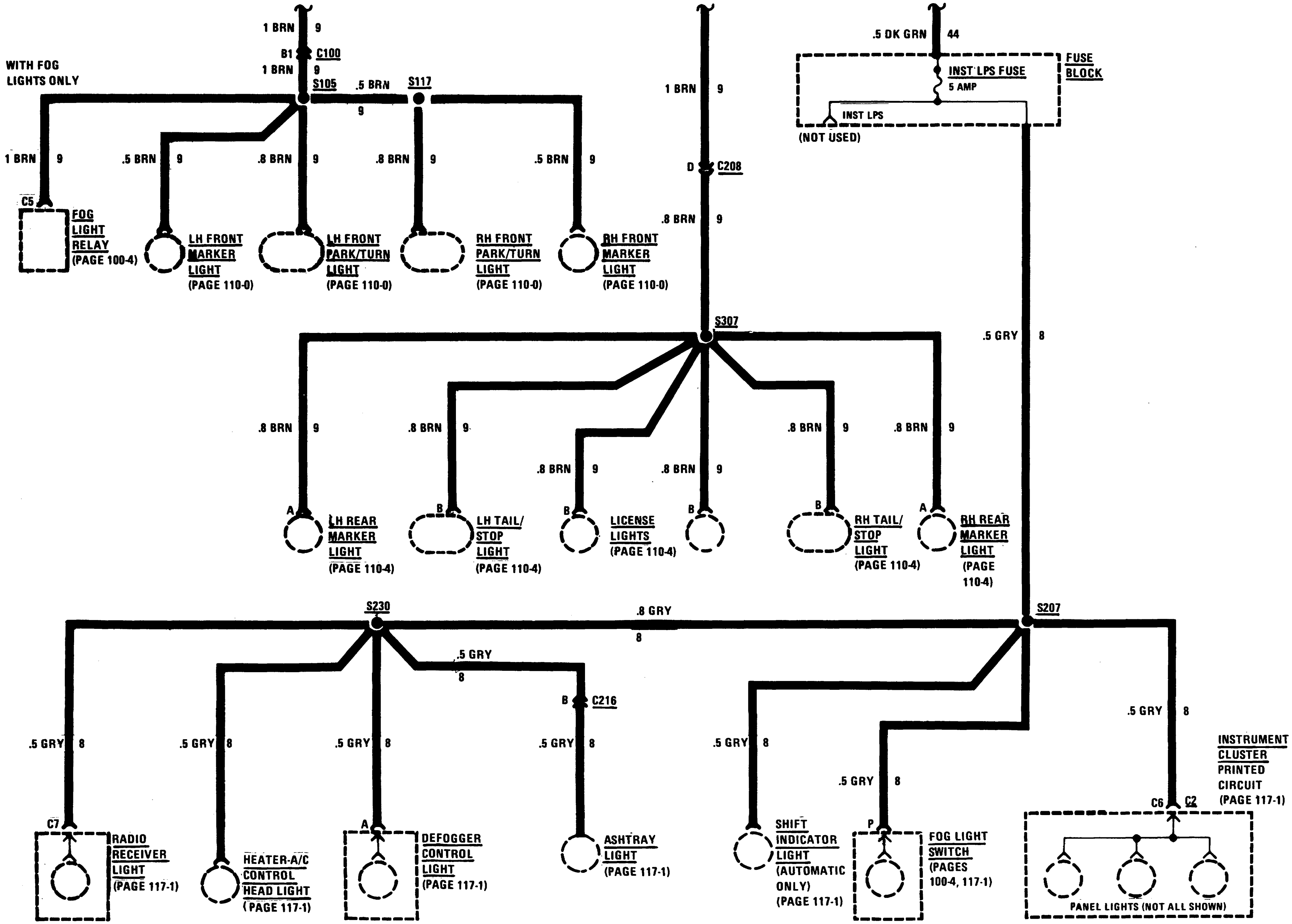
FUSE BLOCK DETAILS: TURN B/U FUSE



LIGHT SWITCH DETAILS

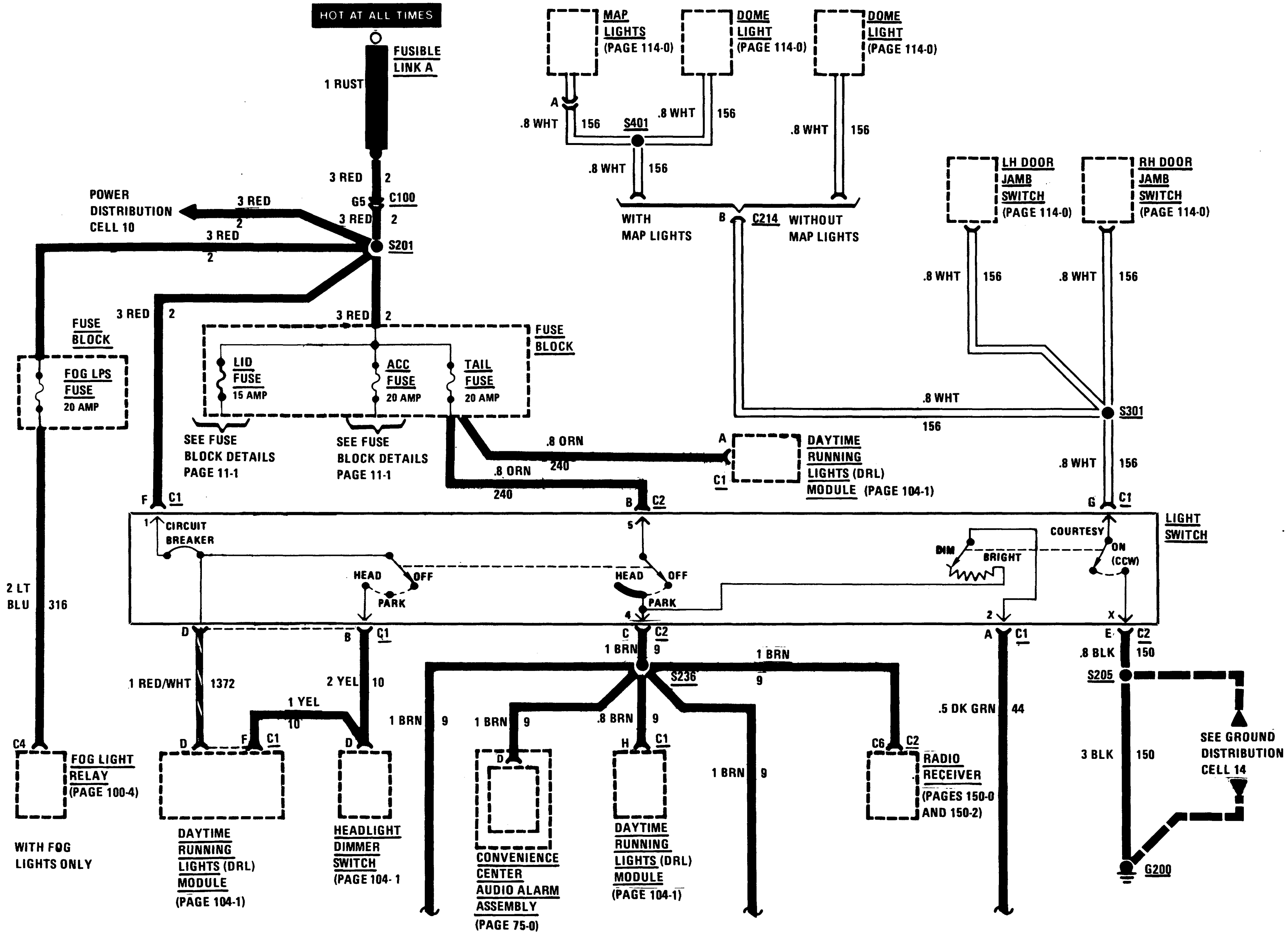
EXCEPT T61

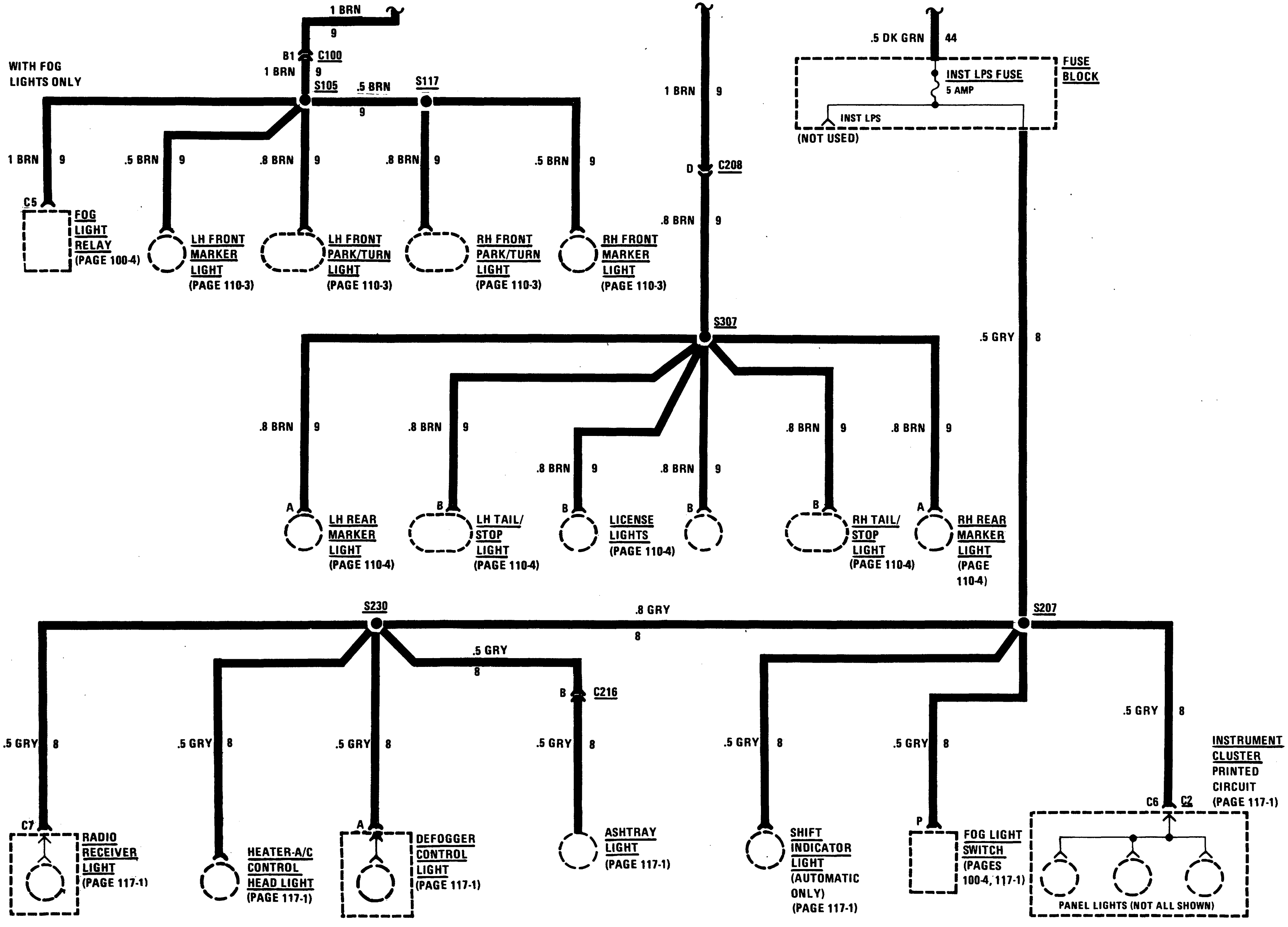



WITH FOG LIGHTS ONLY
1 BRN 9
B1 C100
1 BRN 9
S105
.5 BRN 9
S117
1 BRN 9
.5 BRN 9
.8 BRN 9
.8 BRN 9
.5 BRN 9
C5
FOG LIGHT RELAY (PAGE 100-4)
LH FRONT MARKER LIGHT (PAGE 110-0)
LH FRONT PARK/TURN LIGHT (PAGE 110-0)
RH FRONT PARK/TURN LIGHT (PAGE 110-0)
RH FRONT MARKER LIGHT (PAGE 110-0)
1 BRN 9
D C208
.8 BRN 9
S307
.8 BRN 9
.8 BRN 9
.8 BRN 9
.8 BRN 9
.8 BRN 9
.8 BRN 9
A
B
B
B
B
A
LH REAR MARKER LIGHT (PAGE 110-4)
LH TAIL/STOP LIGHT (PAGE 110-4)
LICENSE LIGHTS (PAGE 110-4)
RH TAIL/STOP LIGHT (PAGE 110-4)
RH REAR MARKER LIGHT (PAGE 110-4)
.5 DK GRN 44
INST LPS FUSE 5 AMP
FUSE BLOCK
INST LPS
(NOT USED)
.5 GRY 8
S207
.8 GRY 8
S230
.5 GRY 8
B C216
.5 GRY 8
.5 GRY 8
.5 GRY 8
.5 GRY 8
.5 GRY 8
.5 GRY 8
.5 GRY 8
C7
A
P
C6 C2
RADIO RECEIVER LIGHT (PAGE 117-1)
HEATER-A/C CONTROL HEAD LIGHT (PAGE 117-1)
DEFOGGER CONTROL LIGHT (PAGE 117-1)
ASHTRAY LIGHT (PAGE 117-1)
SHIFT INDICATOR LIGHT (AUTOMATIC ONLY) (PAGE 117-1)
FOG LIGHT SWITCH (PAGES 100-4, 117-1)
INSTRUMENT CLUSTER PRINTED CIRCUIT (PAGE 117-1)
PANEL LIGHTS (NOT ALL SHOWN)

LIGHT SWITCH DETAILS

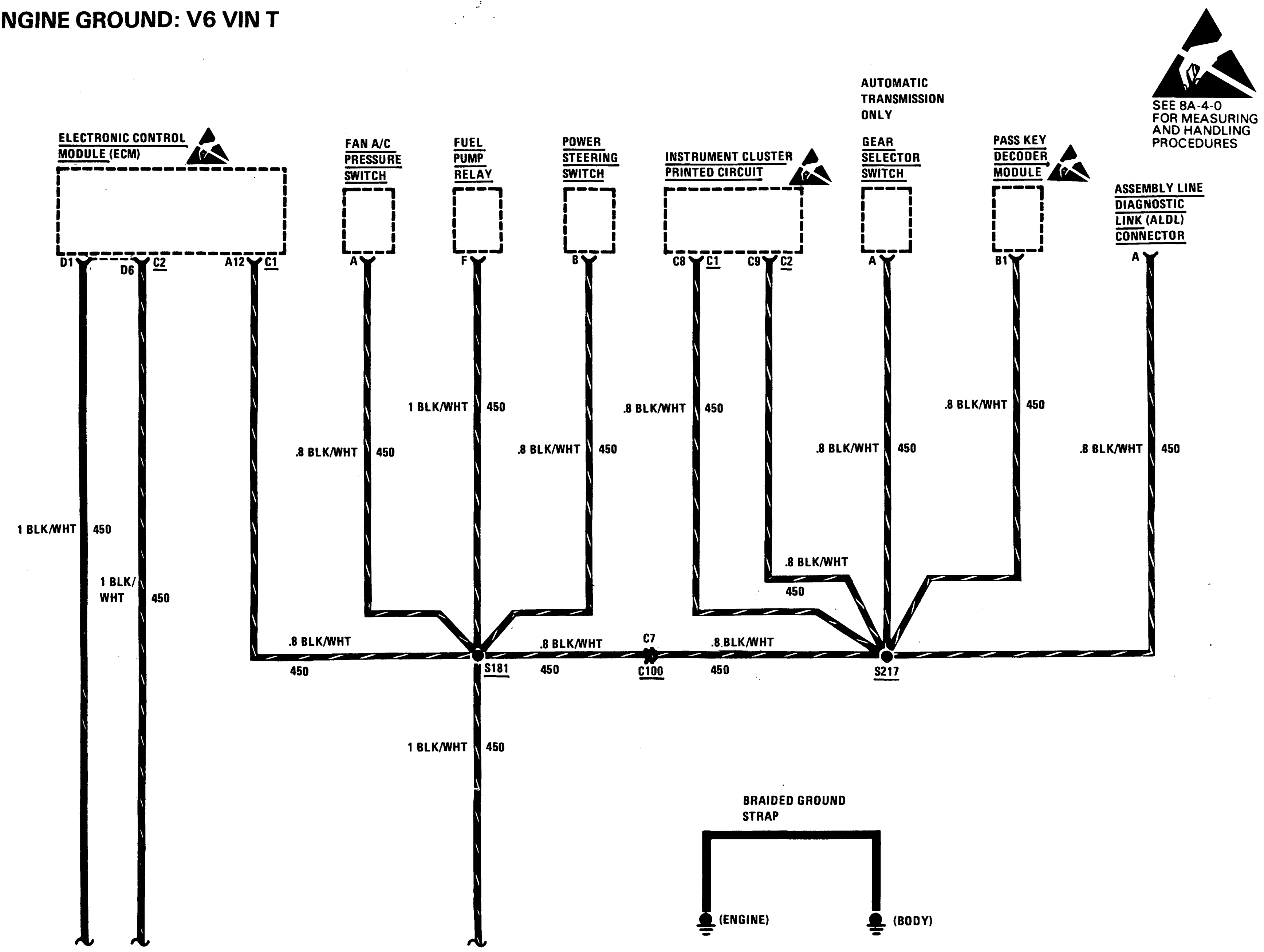
WITH T61

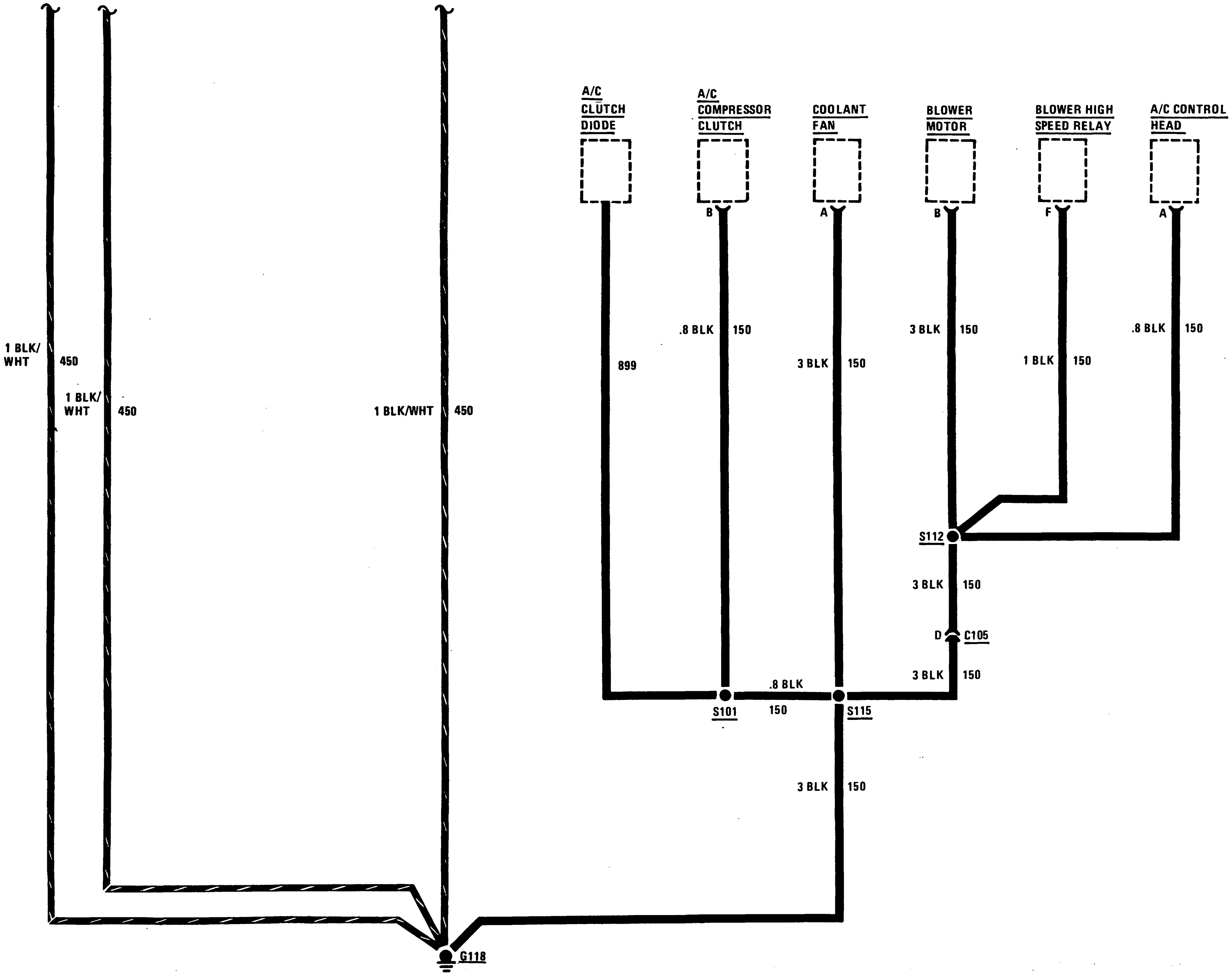



1 BRN
9
B1
C100
1 BRN
9
S105
.5 BRN
9
S117
WITH FOG LIGHTS ONLY
1 BRN 9
.5 BRN 9
.8 BRN 9
.8 BRN 9
.5 BRN 9
C5
FOG LIGHT RELAY (PAGE 100-4)
LH FRONT MARKER LIGHT (PAGE 110-3)
LH FRONT PARK/TURN LIGHT (PAGE 110-3)
RH FRONT PARK/TURN LIGHT (PAGE 110-3)
RH FRONT MARKER LIGHT (PAGE 110-3)
1 BRN 9
D
C208
.8 BRN 9
S307
.5 DK GRN 44
INST LPS FUSE 5 AMP
FUSE BLOCK
INST LPS
(NOT USED)
.5 GRY 8
.8 BRN 9
.8 BRN 9
.8 BRN 9
.8 BRN 9
.8 BRN 9
.8 BRN 9
A
B
B
B
B
A
LH REAR MARKER LIGHT (PAGE 110-4)
LH TAIL/ STOP LIGHT (PAGE 110-4)
LICENSE LIGHTS (PAGE 110-4)
RH TAIL/ STOP LIGHT (PAGE 110-4)
RH REAR MARKER LIGHT (PAGE 110-4)
S230
.8 GRY
8
S207
.5 GRY
8
B
C216
.5 GRY 8
.5 GRY 8
.5 GRY 8
.5 GRY 8
.5 GRY 8
.5 GRY 8
.5 GRY 8
C7
A
P
C6
C2
RADIO RECEIVER LIGHT (PAGE 117-1)
HEATER-A/C CONTROL HEAD LIGHT (PAGE 117-1)
DEFOGGER CONTROL LIGHT (PAGE 117-1)
ASHTRAY LIGHT (PAGE 117-1)
SHIFT INDICATOR LIGHT (AUTOMATIC ONLY) (PAGE 117-1)
FOG LIGHT SWITCH (PAGES 100-4, 117-1)
INSTRUMENT CLUSTER PRINTED CIRCUIT (PAGE 117-1)
PANEL LIGHTS (NOT ALL SHOWN)

GROUND DISTRIBUTION: G118

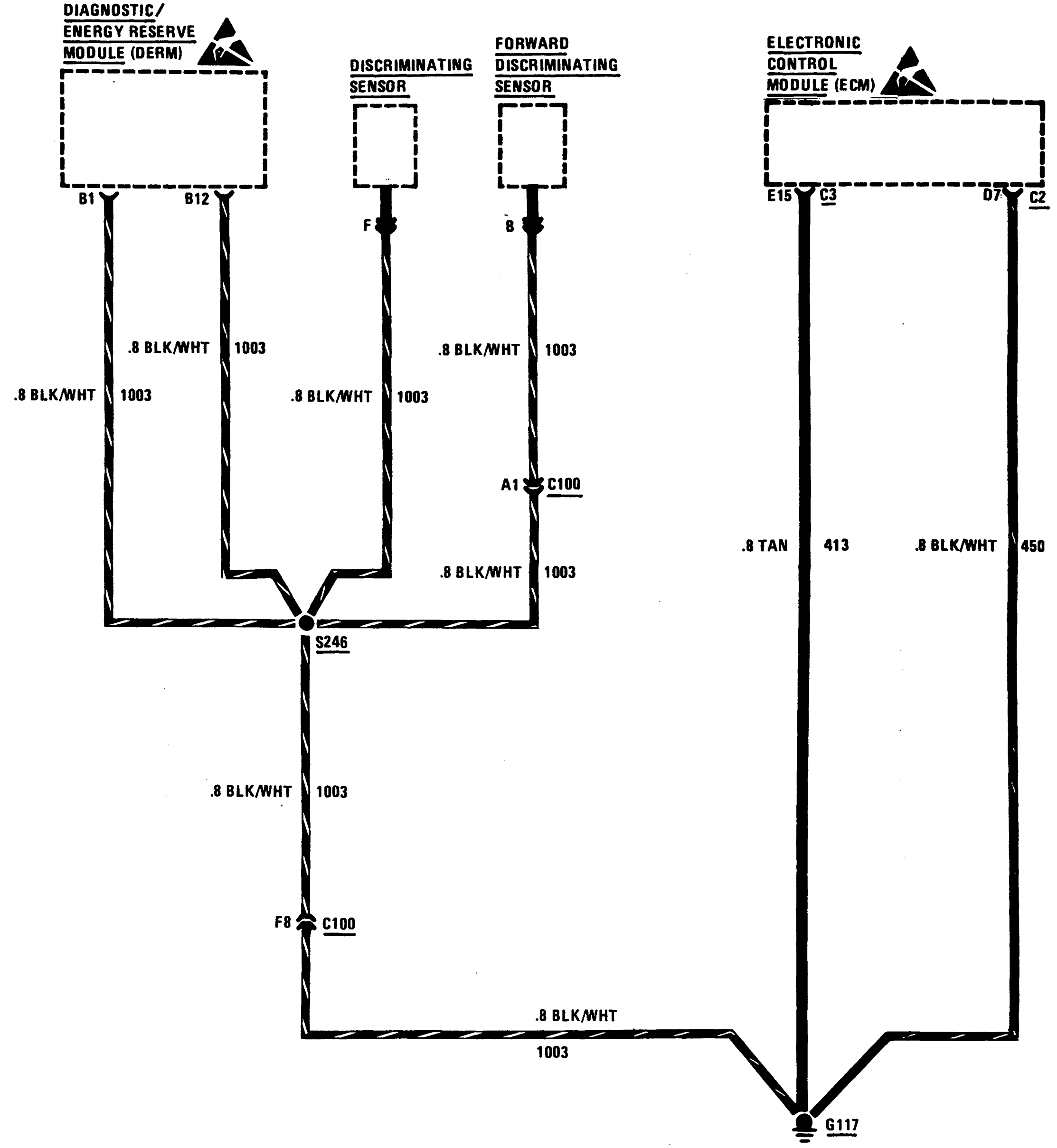
ENGINE GROUND: V6 VIN T




A/C
CLUTCH
DIODE
A/C
COMPRESSOR
CLUTCH
COOLANT
FAN
BLOWER
MOTOR
BLOWER HIGH
SPEED RELAY
A/C CONTROL
HEAD
B
A
B
F
A
899
.8 BLK
150
3 BLK
150
3 BLK
150
3 BLK
150
1 BLK
150
.8 BLK
150
1 BLK/
WHT
450
1 BLK/
WHT
450
1 BLK/WHT
450
S112
3 BLK
150
D
C105
3 BLK
150
.8 BLK
150
S101
S115
3 BLK
150
G118

GROUND DISTRIBUTION: G117

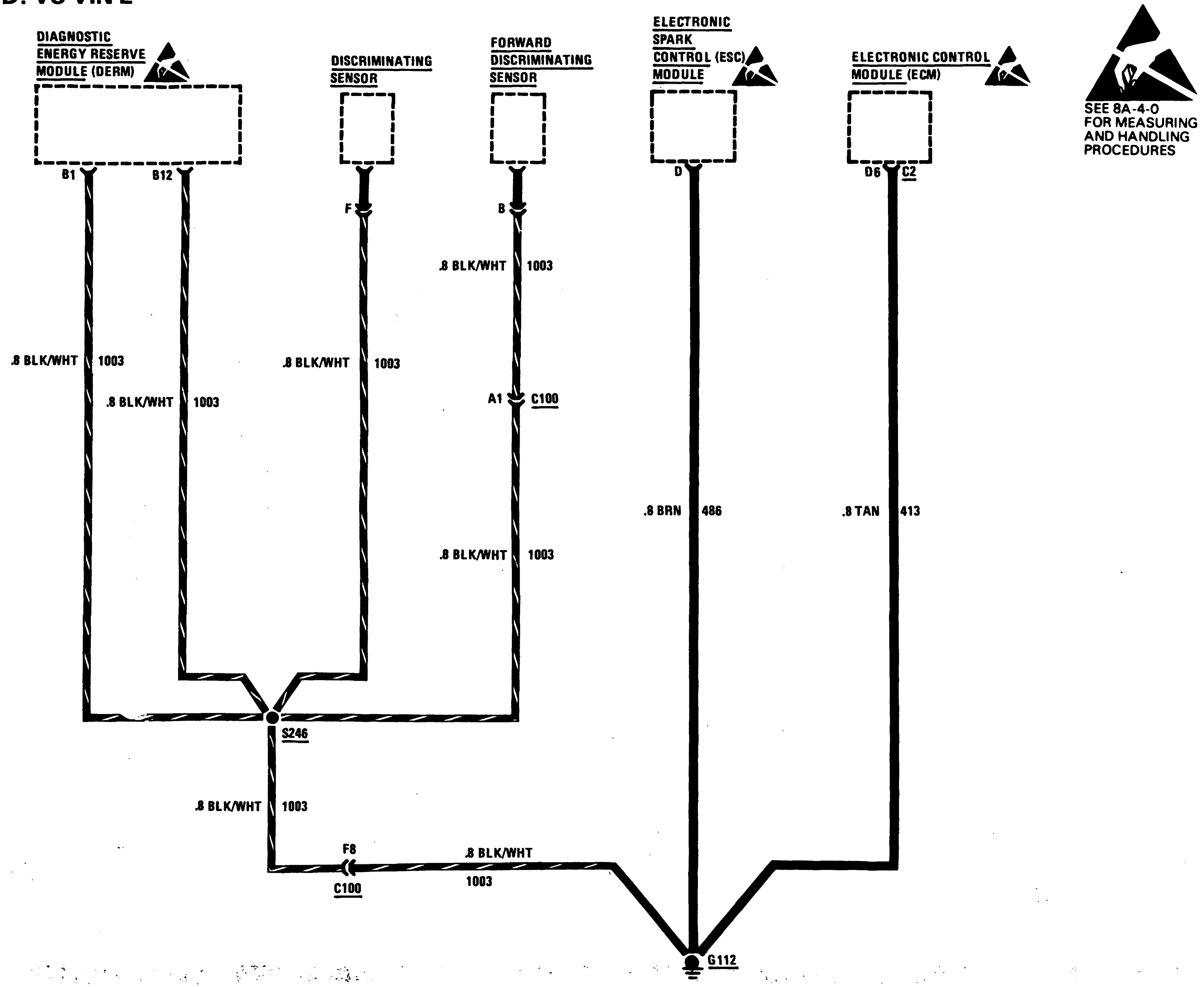
ENGINE GROUND: V6 VIN T



SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES

GROUND DISTRIBUTION: G112

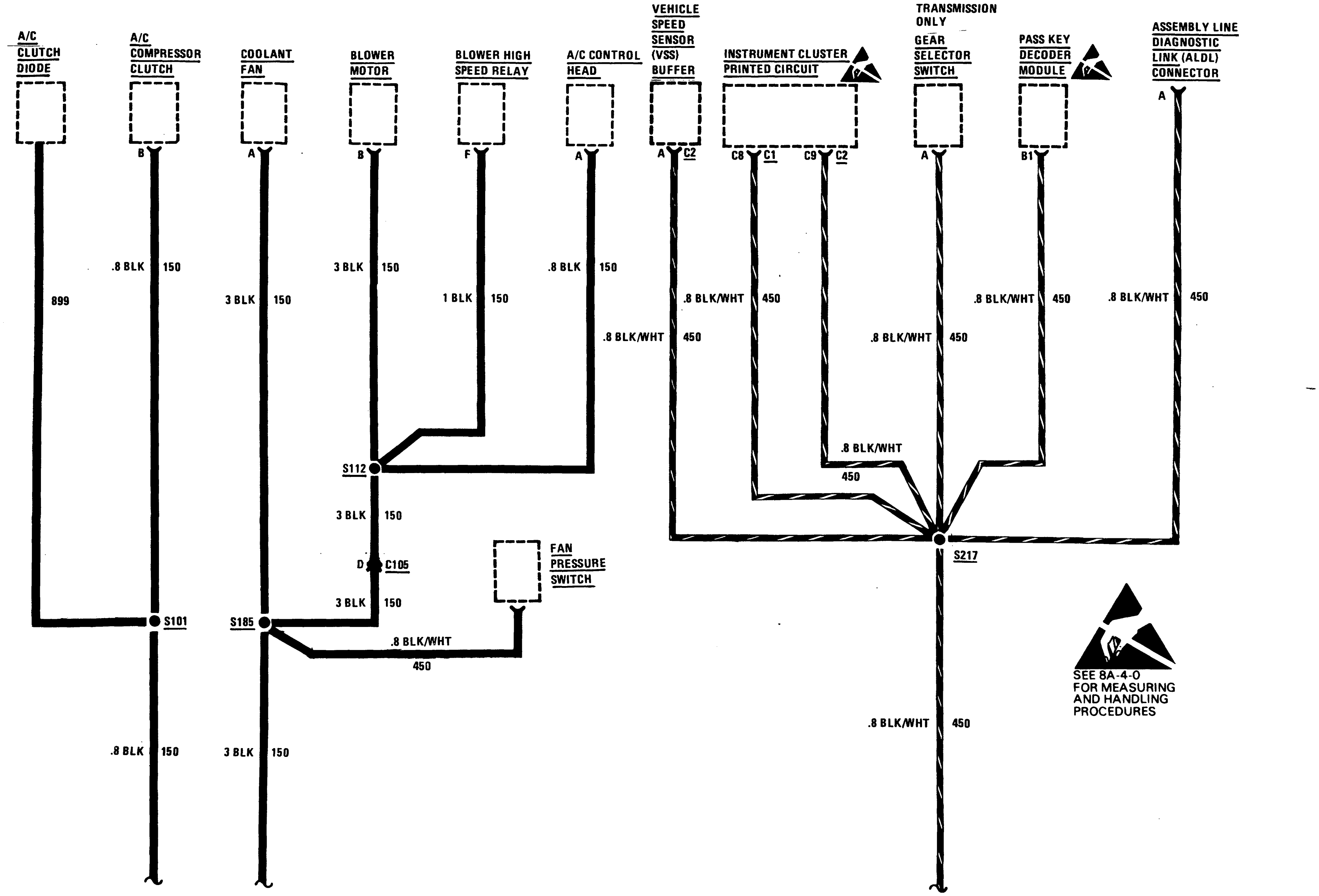
ENGINE GROUND: V8 VIN E



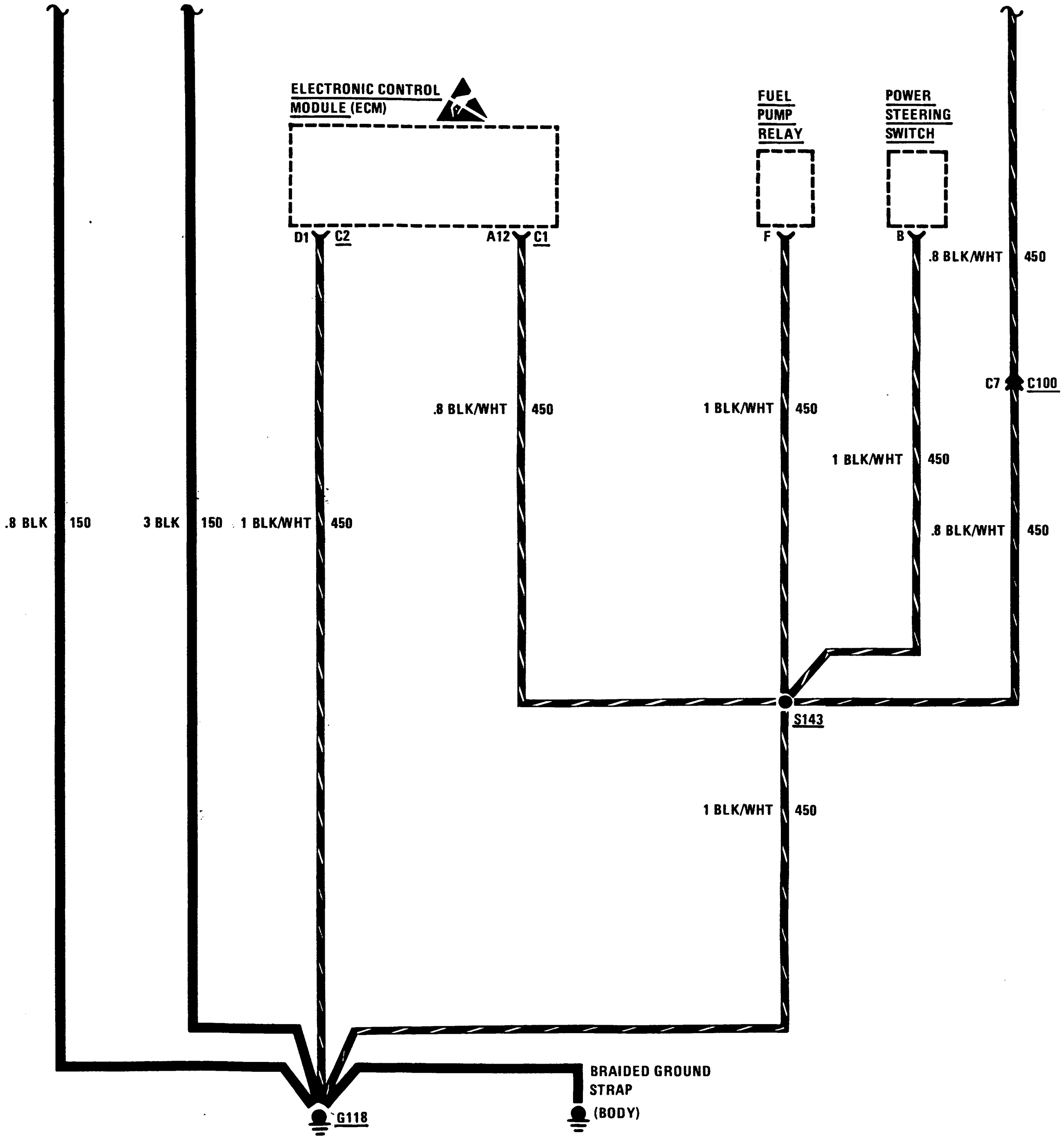
SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES

GROUND DISTRIBUTION: G118

ENGINE GROUND: V8 VIN E

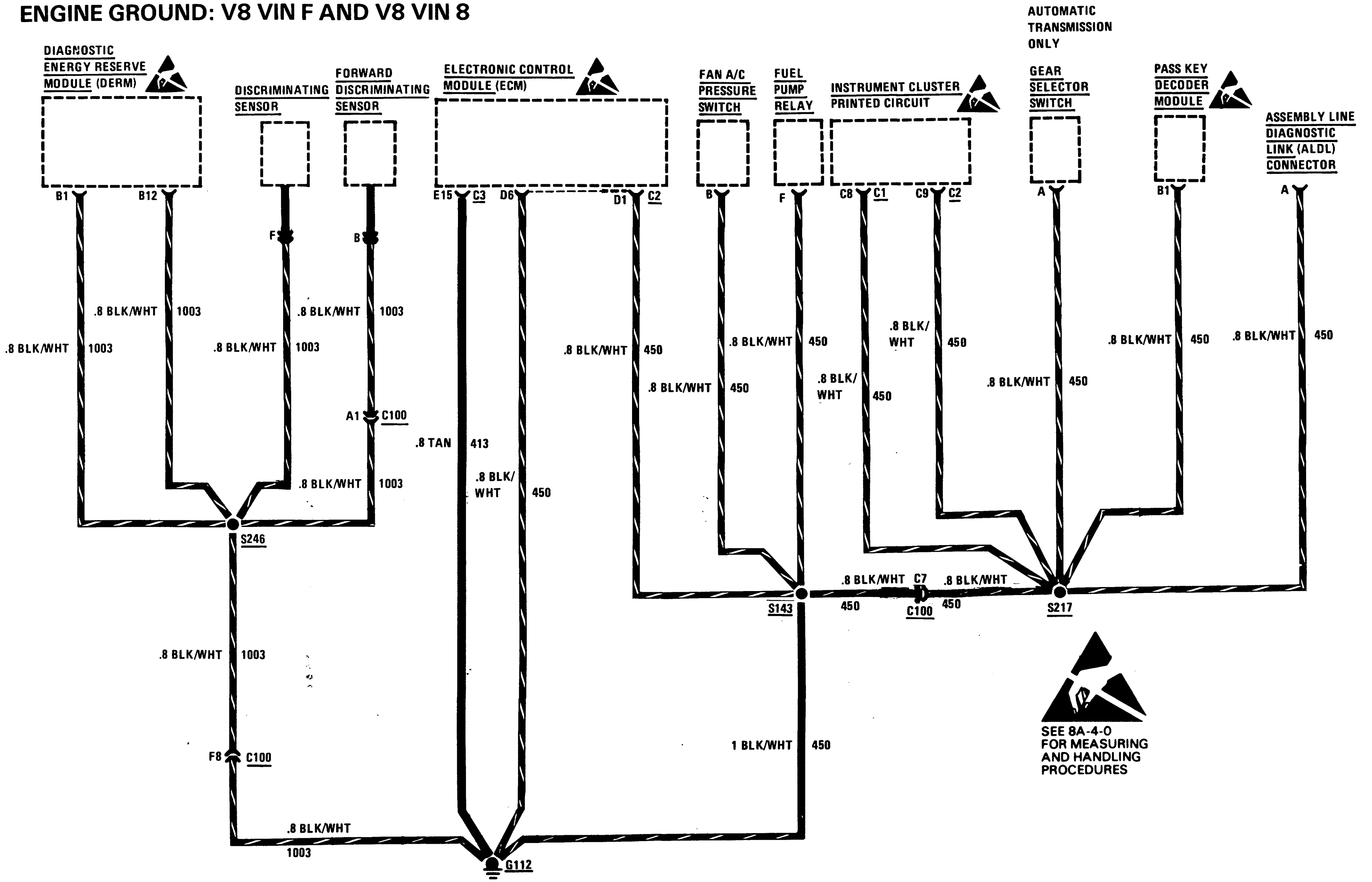


SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES


ELECTRONIC CONTROL MODULE (ECM)
D1
C2
A12
C1
FUEL PUMP RELAY
F
POWER STEERING SWITCH
B
.8 BLK/WHT
450
C7
C100
.8 BLK
150
3 BLK
150
1 BLK/WHT
450
.8 BLK/WHT
450
1 BLK/WHT
450
1 BLK/WHT
450
.8 BLK/WHT
450
S143
1 BLK/WHT
450
BRAIDED GROUND STRAP
(BODY)
G118

GROUND DISTRIBUTION: G112

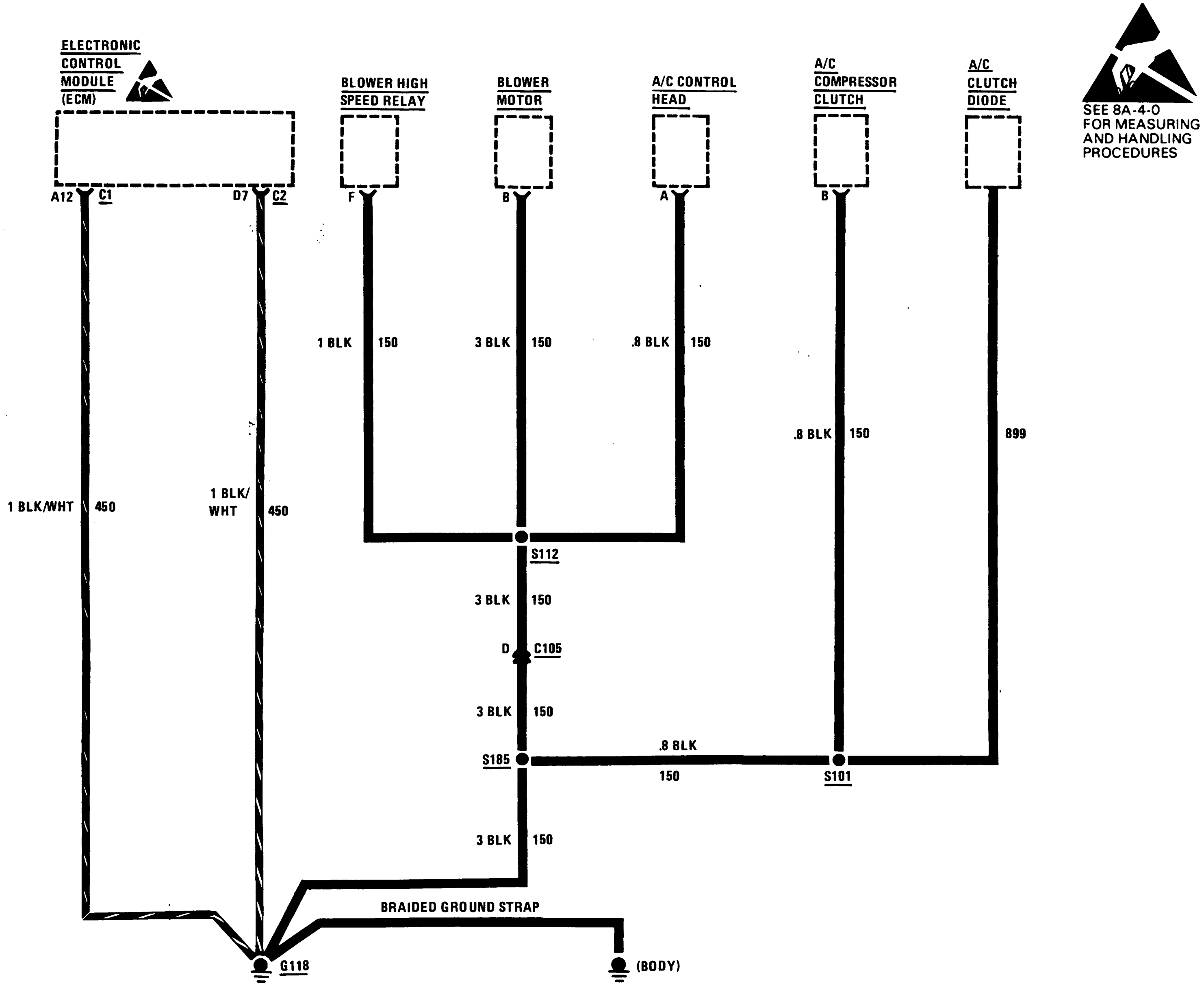
ENGINE GROUND: V8 VIN F AND V8 VIN 8



SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES

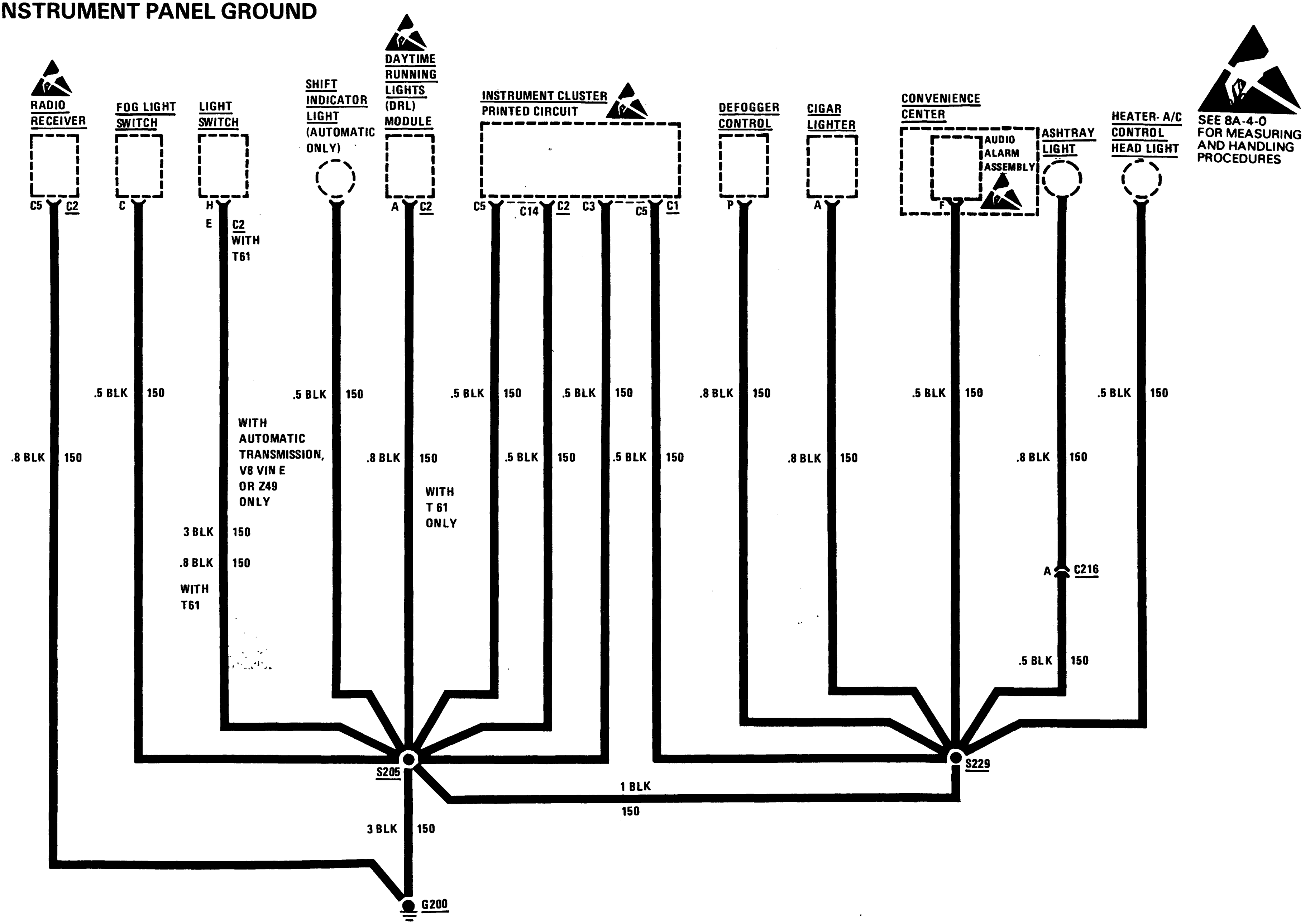
GROUND DISTRIBUTION: G118

ENGINE GROUND: V8 VIN F AND V8 VIN 8



GROUND DISTRIBUTION: G200

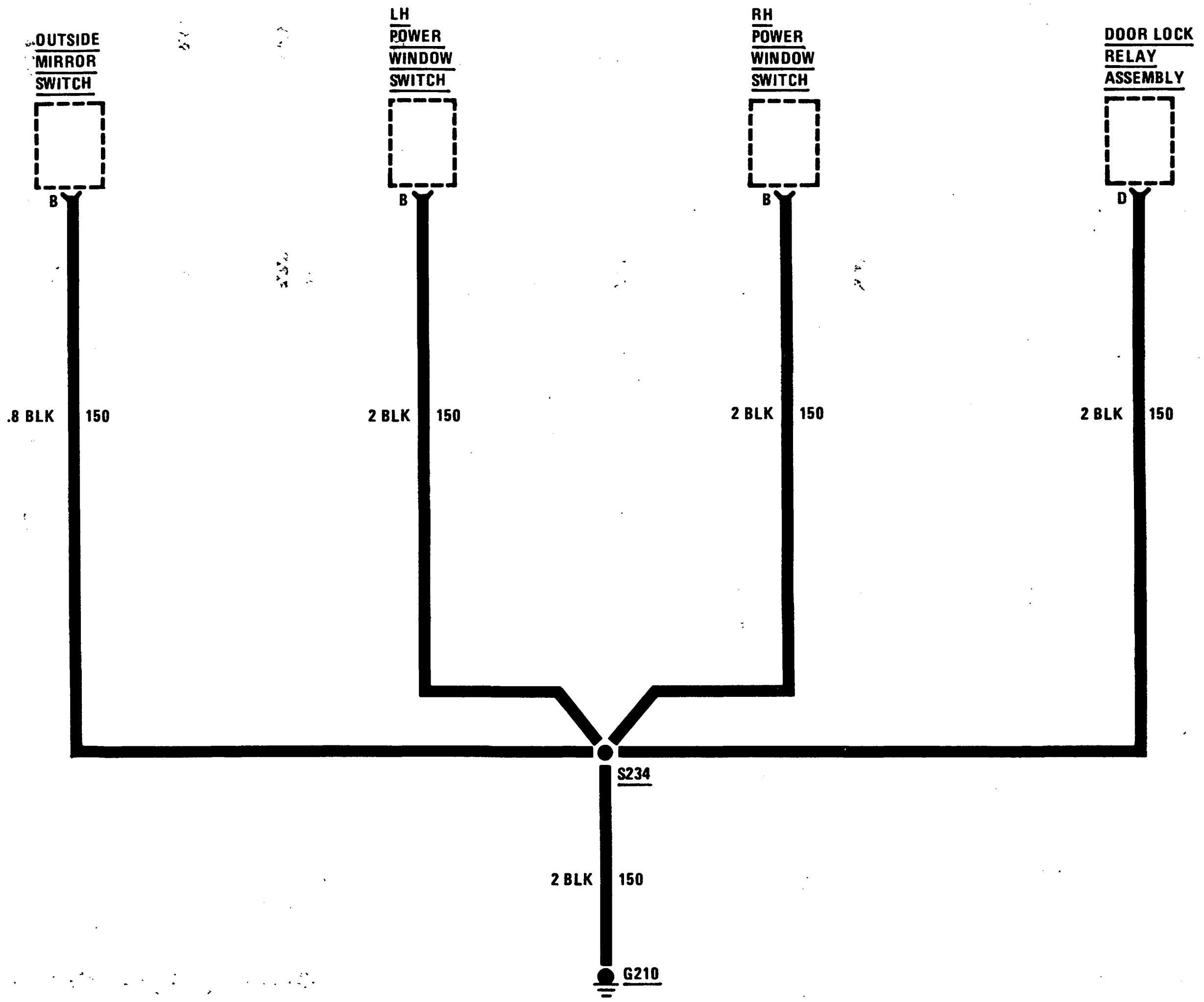
INSTRUMENT PANEL GROUND



SEE 8A-4-0 FOR MEASURING AND HANDLING PROCEDURES

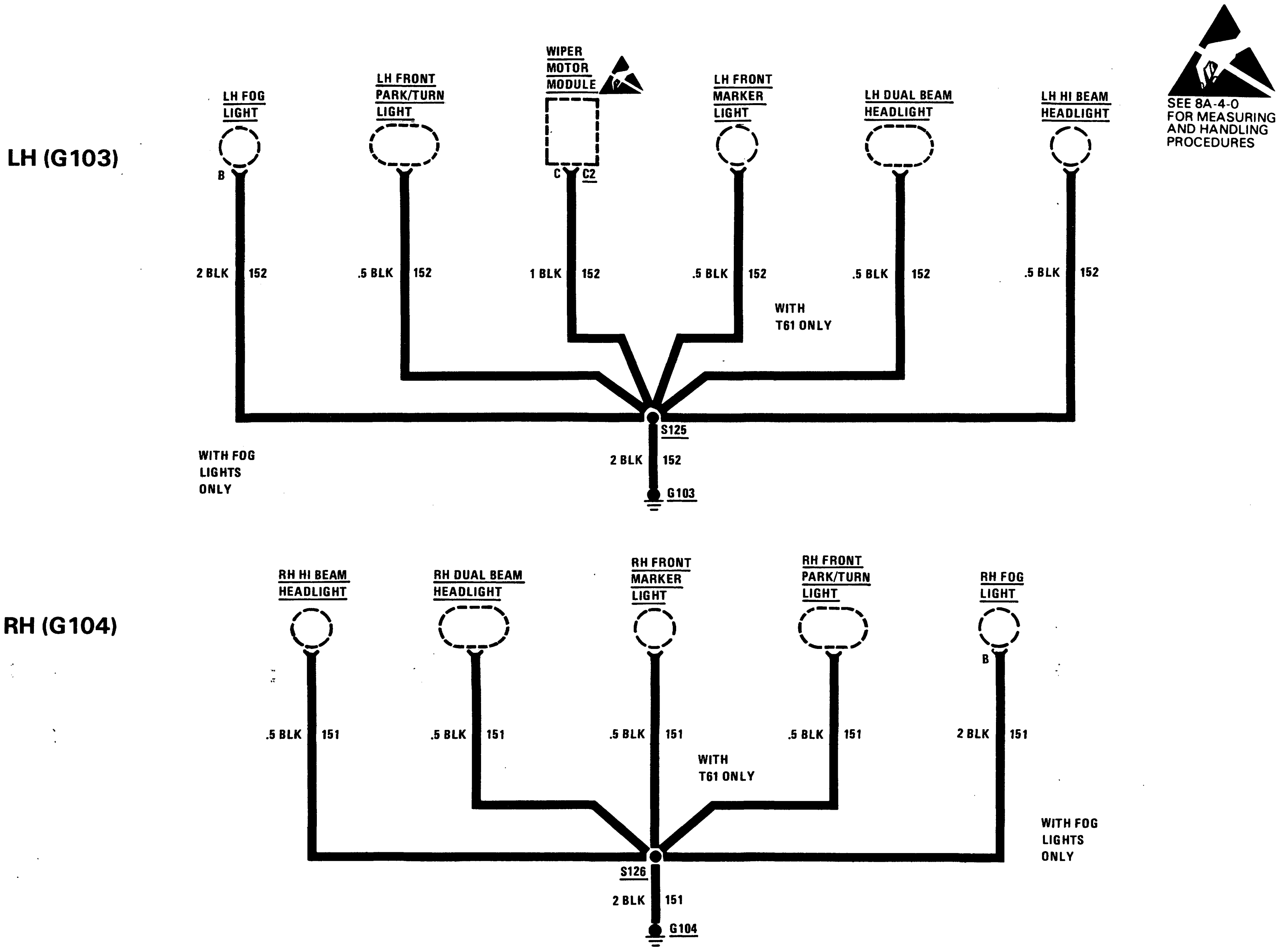
GROUND DISTRIBUTION: G210

CROSS CAR GROUND



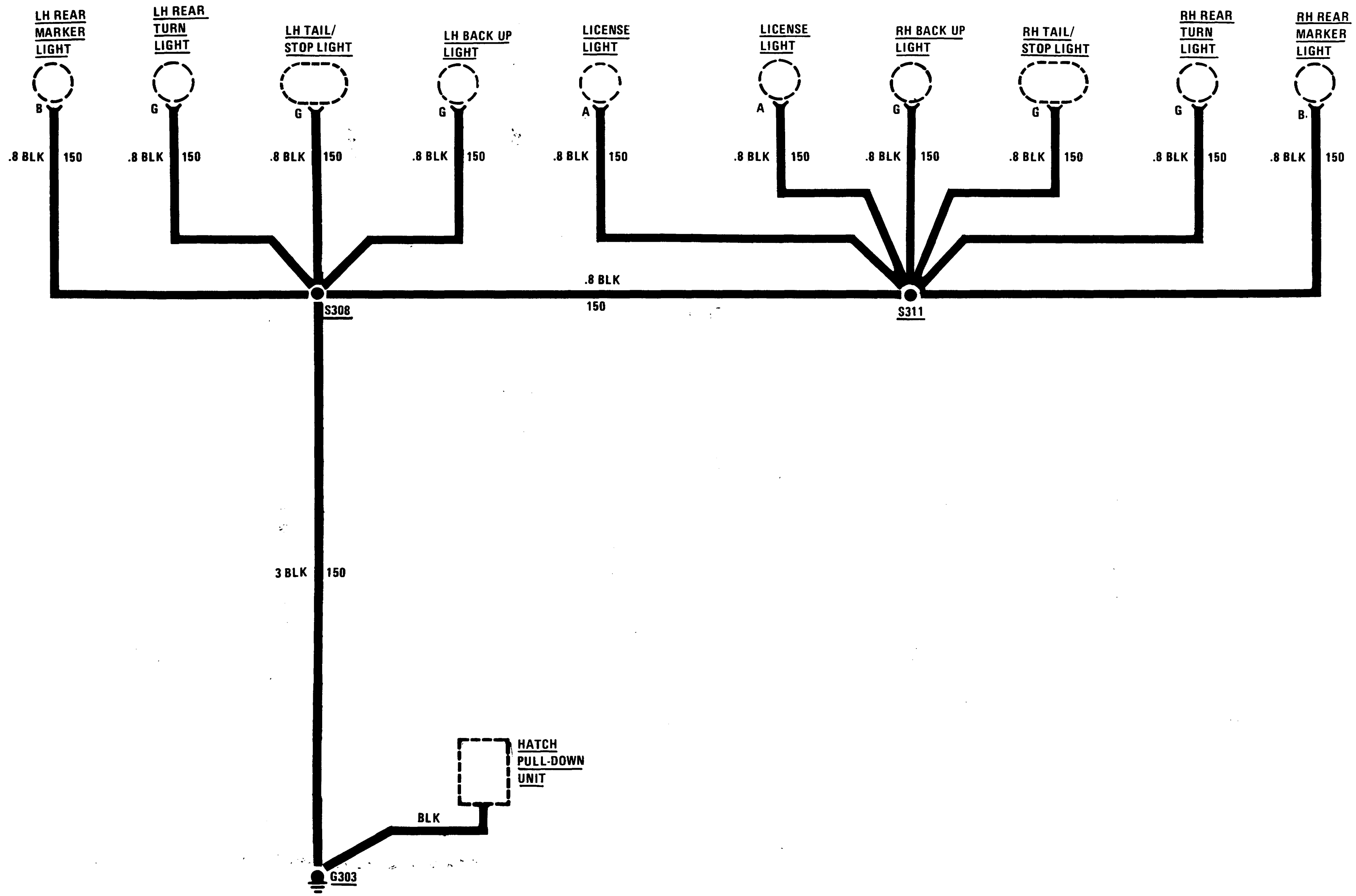
GROUND DISTRIBUTION: G103 AND G104

LIGHTS GROUNDS: FRONT



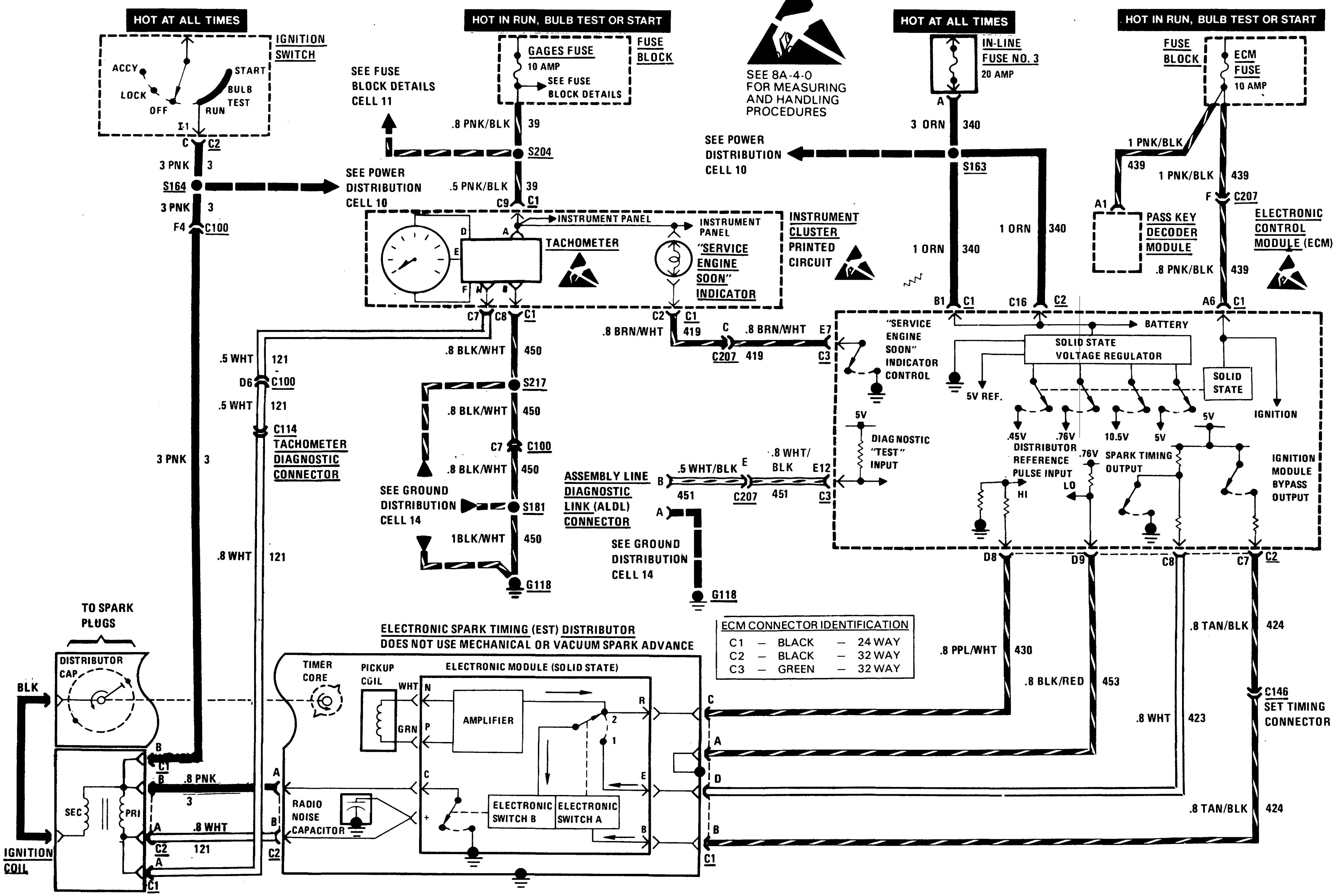
GROUND DISTRIBUTION: G303

LIGHTS GROUNDS: REAR



MULTI-PORT FUEL INJECTION: V6 VIN T

IGNITION, SERVICE ENGINE SOON INDICATOR, AND TACHOMETER



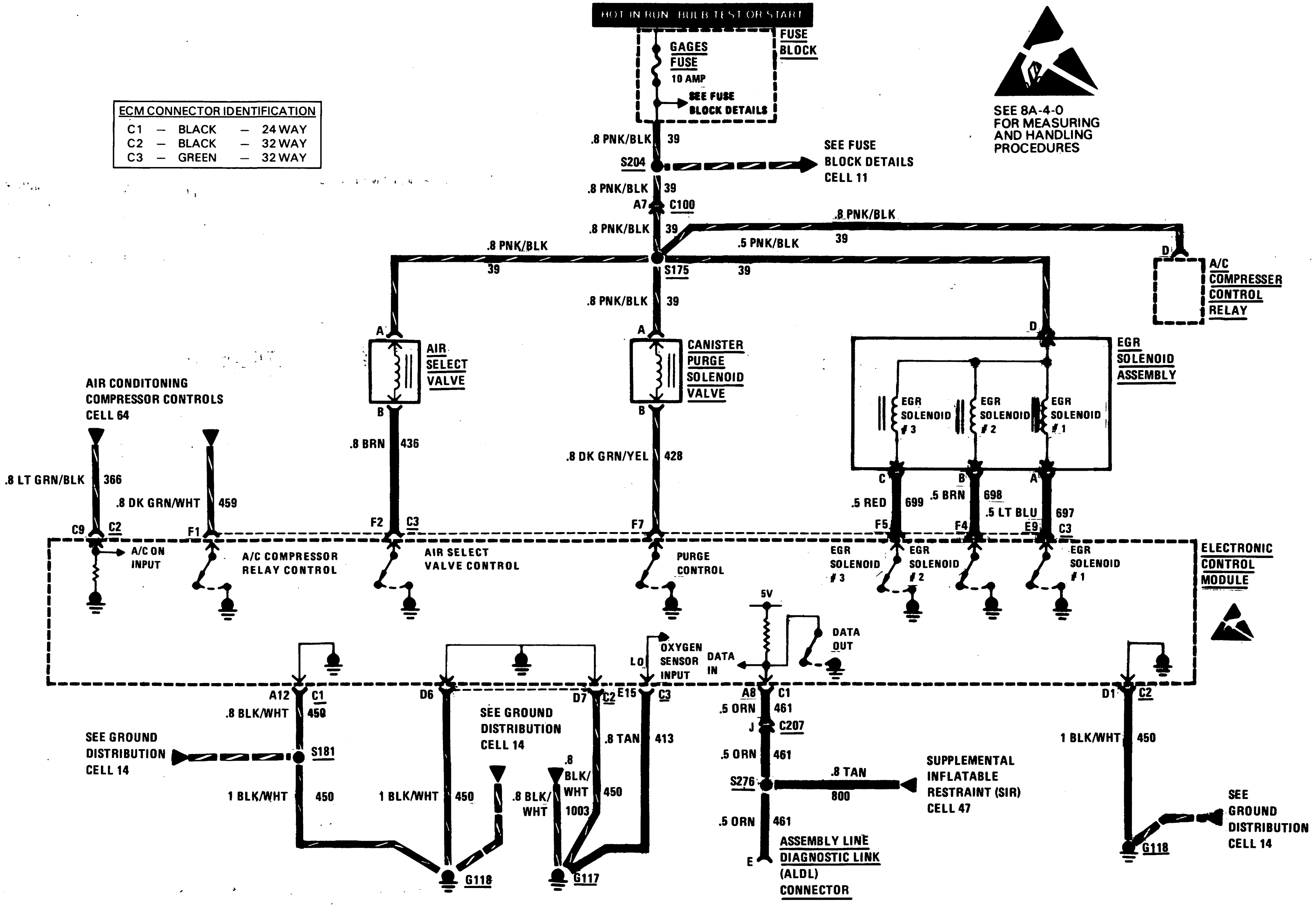
ECM CONNECTOR IDENTIFICATION

C1	—	BLACK	—	24 WAY
C2	—	BLACK	—	32 WAY
C3	—	GREEN	—	32 WAY

MULTI-PORT FUEL INJECTION: V6 VIN T

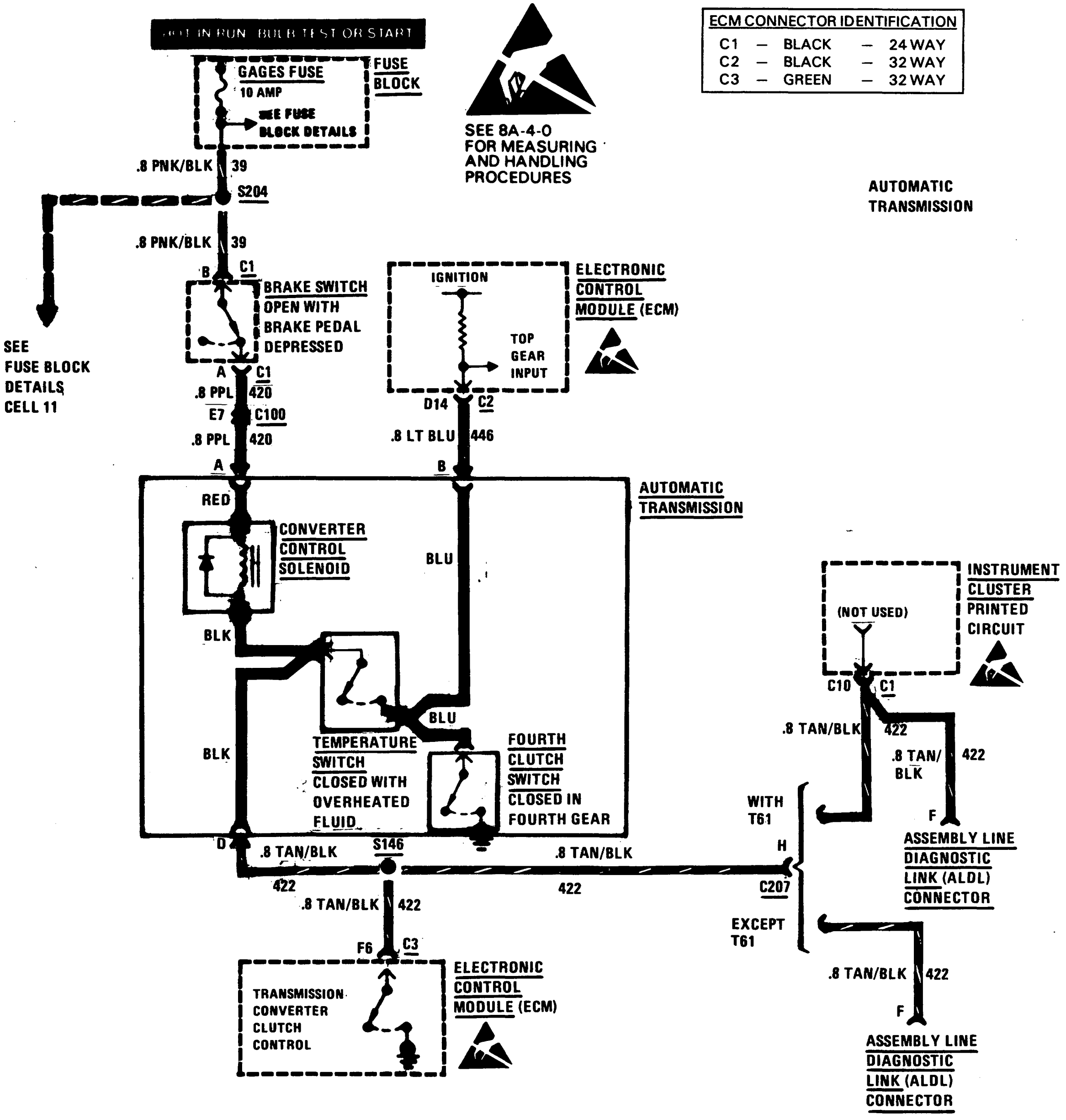
EMISSION CONTROLS AND DATA LINK

ECM CONNECTOR IDENTIFICATION			
C1	BLACK	–	24 WAY
C2	BLACK	–	32 WAY
C3	GREEN	–	32 WAY

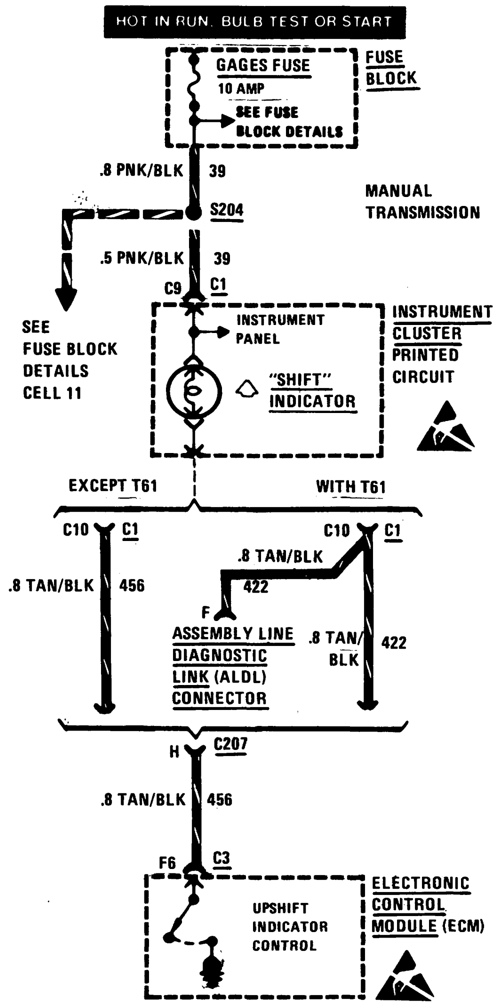


MULTI-PORT FUEL INJECTION: V6 VIN T

TRANSMISSION CONVERTER CLUTCH AND UPSHIFT INDICATOR



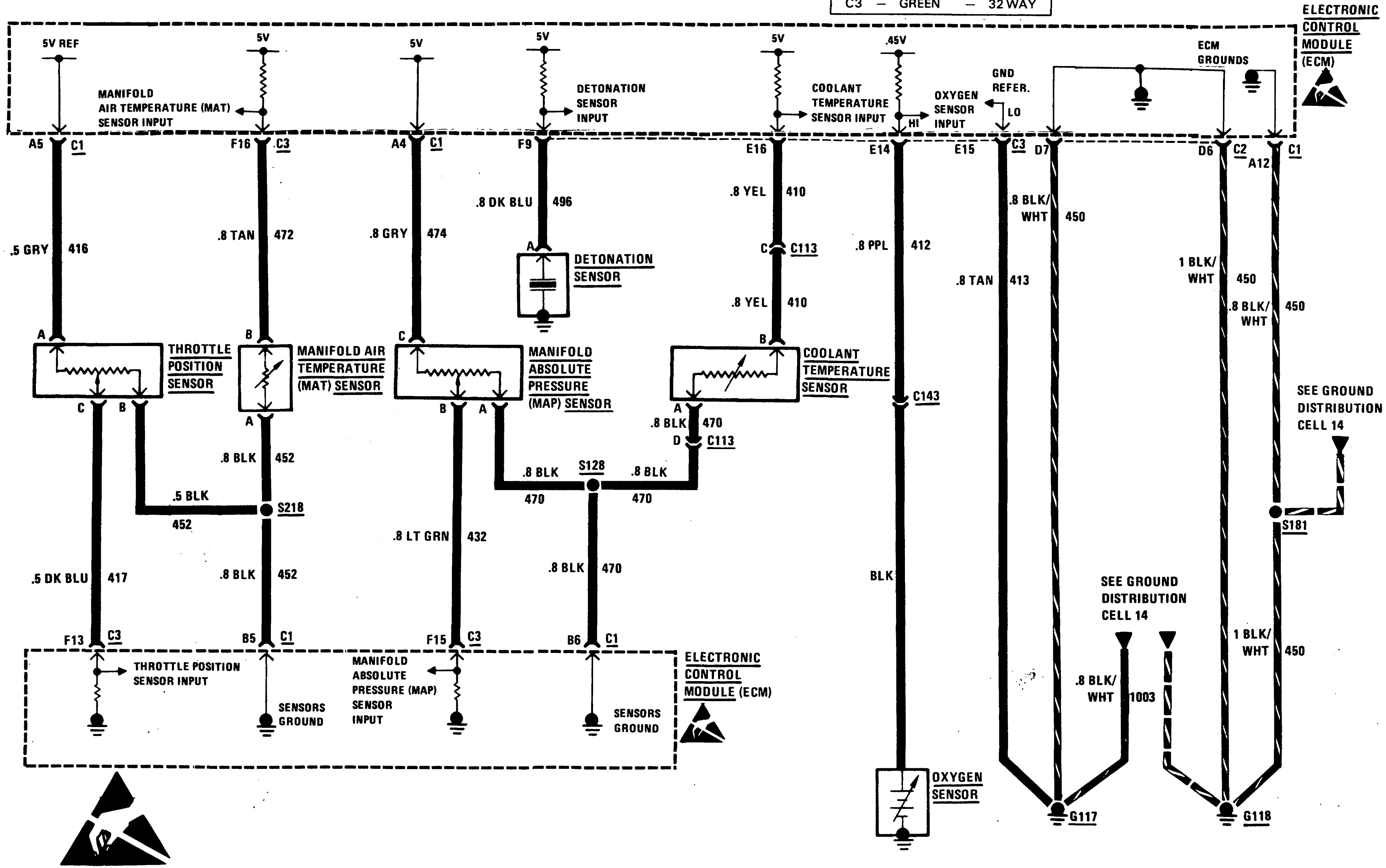
ECM CONNECTOR IDENTIFICATION					
C1	—	BLACK	—	24 WAY	
C2	—	BLACK	—	32 WAY	
C3	—	GREEN	—	32 WAY	



MULTI-PORT FUEL INJECTION: V6 VIN T

ENGINE DATA SENSORS

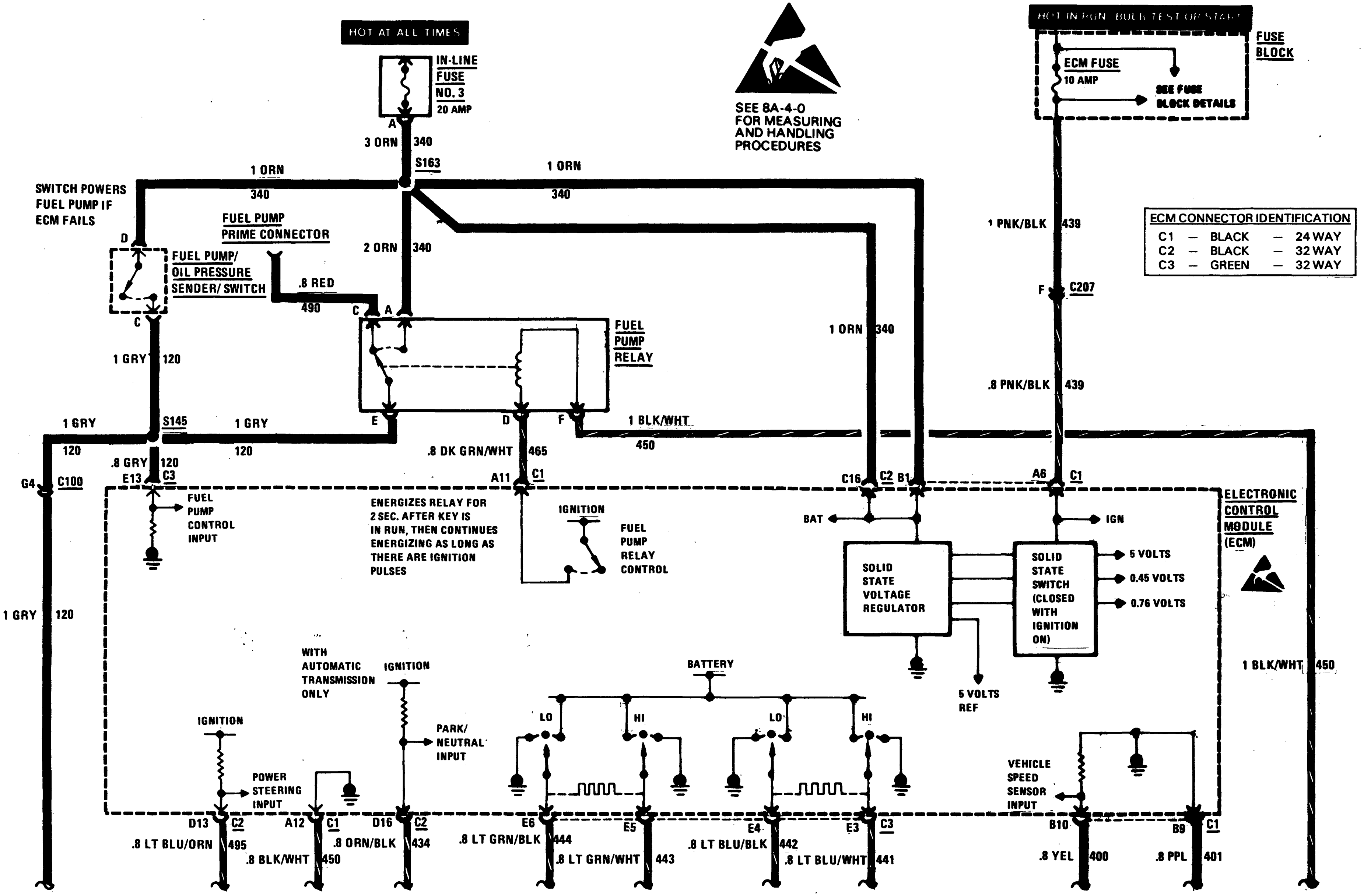
ECM CONNECTOR IDENTIFICATION				
C1	–	BLACK	–	24 WAY
C2	–	BLACK	–	32 WAY
C3	–	GREEN	–	32 WAY



SEE 8A-4-0 FOR MEASURING AND HANDLING PROCEDURES

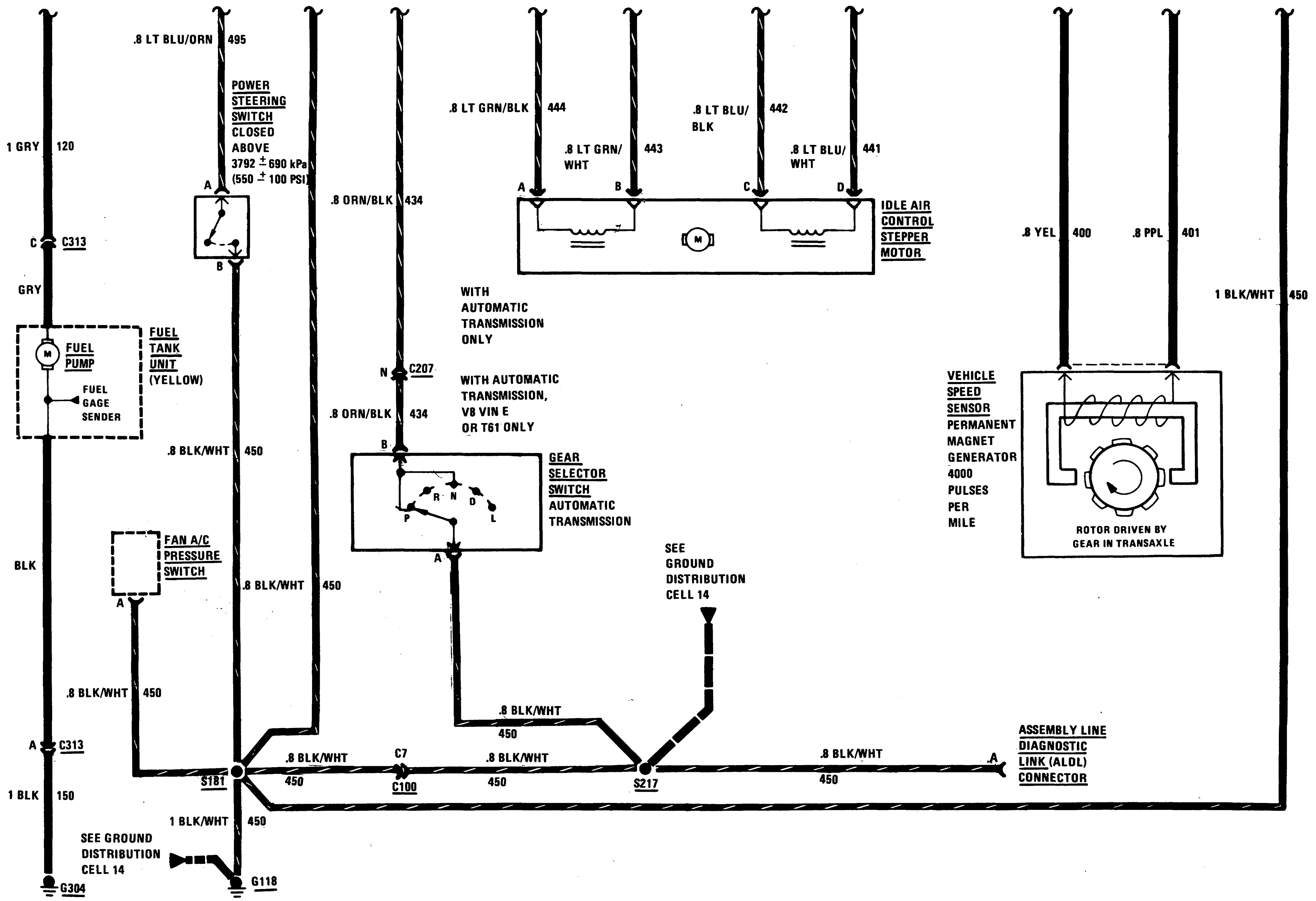
MULTI-PORT FUEL INJECTION: V6 VIN T

IDLE SPEED CONTROL, FUEL CONTROL AND VEHICLE DATA SENSORS



ECM CONNECTOR IDENTIFICATION

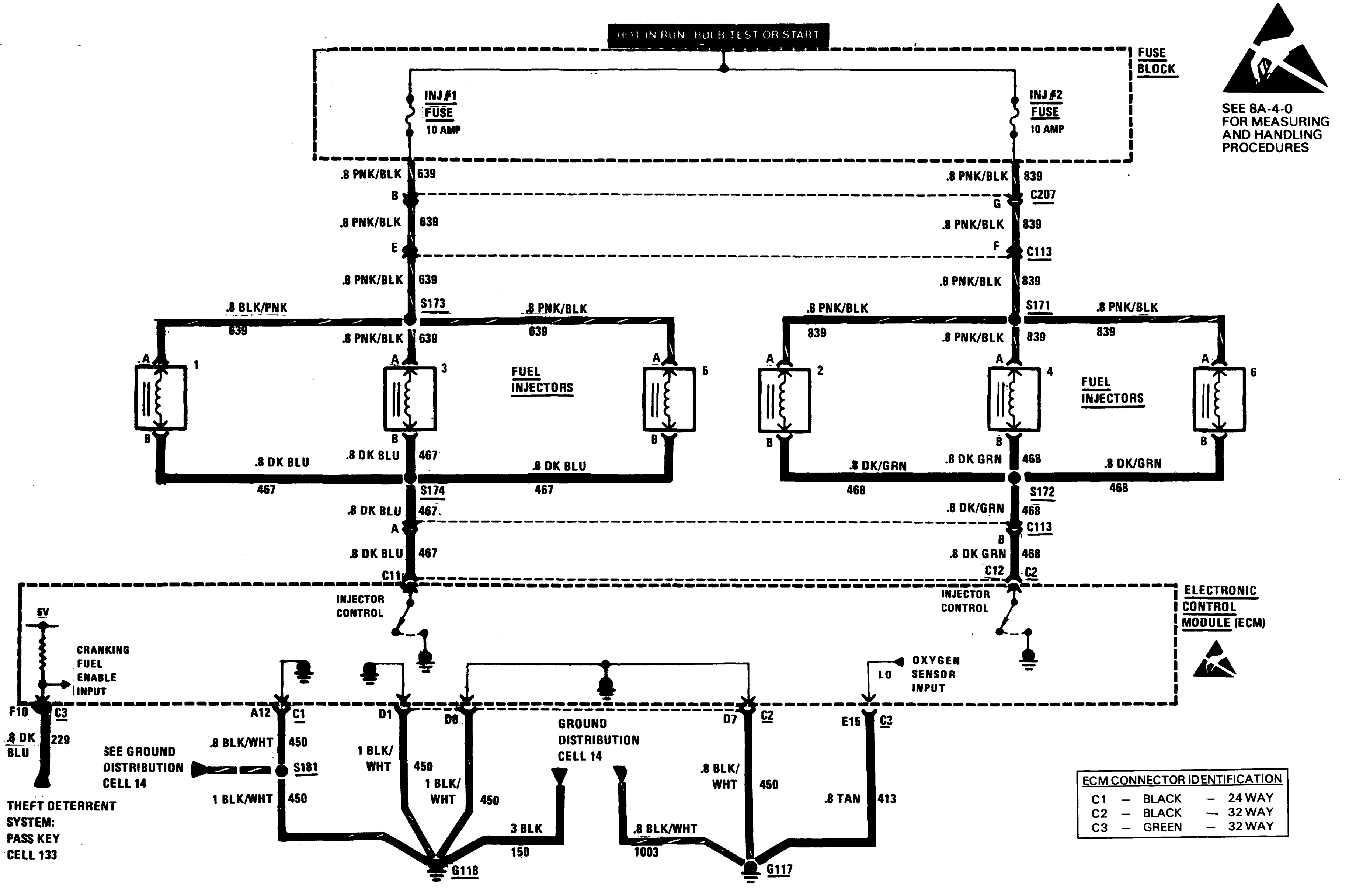
C1	—	BLACK	—	24 WAY
C2	—	BLACK	—	32 WAY
C3	—	GREEN	—	32 WAY


1 GRY
120
C
C313
GRY
FUEL PUMP
FUEL GAGE SENDER
FUEL TANK UNIT (YELLOW)
BLK
A
C313
1 BLK
150
G304
.8 LT BLU/ORN
495
POWER STEERING SWITCH CLOSED ABOVE 3792 ± 690 kPa (550 ± 100 PSI)
A
B
.8 BLK/WHT
450
FAN A/C PRESSURE SWITCH
A
.8 BLK/WHT
450
.8 BLK/WHT
450
S181
1 BLK/WHT
450
SEE GROUND DISTRIBUTION CELL 14
G118
.8 ORN/BLK
434
WITH AUTOMATIC TRANSMISSION ONLY
N
C207
.8 ORN/BLK
434
WITH AUTOMATIC TRANSMISSION, V8 VIN E OR T61 ONLY
B
GEAR SELECTOR SWITCH AUTOMATIC TRANSMISSION
R
N
D
P
L
A
.8 BLK/WHT
450
.8 BLK/WHT
450
C7
C100
.8 BLK/WHT
450
S217
SEE GROUND DISTRIBUTION CELL 14
.8 LT GRN/BLK
444
.8 LT GRN/ WHT
443
.8 LT BLU/ BLK
442
.8 LT BLU/ WHT
441
A
B
C
D
M
IDLE AIR CONTROL STEPPER MOTOR
.8 BLK/WHT
450
A
ASSEMBLY LINE DIAGNOSTIC LINK (ALDL) CONNECTOR
.8 YEL
400
.8 PPL
401
VEHICLE SPEED SENSOR PERMANENT MAGNET GENERATOR 4000 PULSES PER MILE
ROTOR DRIVEN BY GEAR IN TRANSAXLE
1 BLK/WHT
450

MULTI-PORT FUEL INJECTION: V6 VIN T

FUEL INJECTORS

SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES



ECM CONNECTOR IDENTIFICATION				
C1	—	BLACK	—	24 WAY
C2	—	BLACK	—	32 WAY
C3	—	GREEN	—	32 WAY

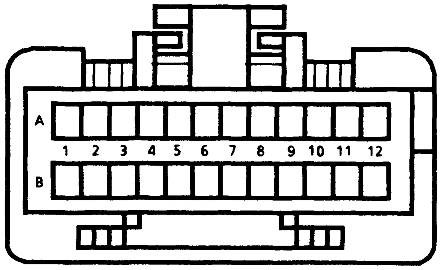
COMPONENT LOCATION

		Page-Figure
A/C Compressor Control Relay	LH front of dash, on relay bracket	
AIR Select Valve (VIN T)	Lower RH side of engine	201- 2-C
Assembly Line Diagnostic Link (ALDL) Connector	Under LH side of I/P, on Fuse Block	201-13-A
Brake Switch	Behind LH side of I/P, top of brake pedal support	201-13-C
Canister Purge Solenoid Valve (VIN T)	RH front corner of engine compartment	201- 2-A
Coolant Temperature Sensor (VIN T)	Top front of engine, under intake plenum	
Detonation Sensor (VIN T)	Lower RH side of engine, near Starter Solenoid	201- 2-B
EGR Solenoid Assembly	Top RH rear of engine	201- 1-A
Electronic Control Module (ECM) (Except VIN E)	Behind RH side of I/P	201-15-B
Electronic Spark Timing (EST) Distributor (VIN T)	Top rear of engine	201- 1-A
Fan A/C Pressure Switch (VIN T)	Lower RH rear corner of engine compartment, on A/C line	201- 2-A
Fuel Injectors (VIN T)	Top of engine, at each intake port	
Fuel Pump Prime Connector (VIN T)	LH rear corner of engine compartment	
Fuel Pump Relay	LH front of dash, on relay bracket	
Fuel Pump/Oil Pressure Sender/ Switch (VIN T)	Lower LH side of engine	201- 0-A
Fuel Tank Unit	Top of fuel tank	
Fuse Block	Behind LH side of I/P	201-13-A
Gear Selector Switch	In console, at gear selector	201-17-F
Idle Air Control Stepper Motor (VIN T)	Top of engine, on rear of throttle body	201- 1-B
Ignition Coil (VIN T)	RH rear of engine	201- 1-A
Ignition Switch	At base of steering column, below I/P	201-14-A
In-Line Fuse No. 3 (VIN T)	RH inner fender panel, by battery	201- 2-A
Manifold Absolute Pressure (MAP) Sensor (VIN T)	On RH front of dash	201- 1-C
Manifold Air Temperature (MAT) Sensor (VIN T)	Front of engine compartment, on air intake duct	201- 2-A
Oxygen Sensor (VIN T)	RH rear of engine compartment	201- 0-B
PASS Key Decoder Module	Behind RH side of I/P	201-15-A
Power Steering Switch (VIN T)	LH front of engine compartment	201- 3-B

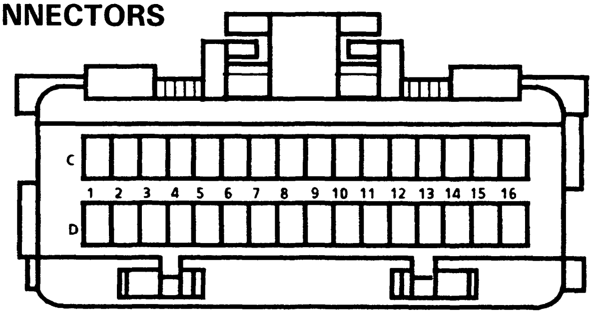
COMPONENT LOCATION		Page-Figure
Throttle Position Sensor (VIN T)	Top front of engine, on throttle body	201- 1-B
Vehicle Speed Sensor	LH side of transmission	201-12-B
C100 (42 cavities)	LH front of dash, below relay bracket	201-12-A
C113 (6 cavities)	Top front of engine, behind A/C compressor	201- 0-A
C114 (1 cavity) (VIN T)	RH rear of engine, near Electronic Spark Timing (EST) Distributor	201- 1-A
C143 (1 cavity) (VIN T)	RH rear of engine compartment, near exhaust manifold	201- 0-B
C146 (1 cavity)	RH rear of engine compartment	
C207 (15 cavities)	Behind RH side of I/P	201-15-A
C313 (3 cavities)	Below car, forward of fuel tank	201-18-E
G117 (VIN T)	Rear of LH cylinder head	201- 1-A
G118 (VIN T)	Rear of RH cylinder head	201- 1-A
G304	Under driver's seat, on floor rail	201-16-A
S128 (VIN T)	Engine harness, RH rear of engine compartment	201- 1-A
S145 (VIN T)	Engine harness, LH rear corner of engine compartment	201- 3-B
S146 (Except VIN E)	Engine harness, behind RH side of I/P, near Electronic Control Module (ECM)	201-15-B
S163 (VIN T)	Engine harness, lower RH rear of engine compartment	201- 1-C
S164	I/P harness, behind LH side of I/P	201-14-A
S171 (VIN T)	Injector harness, top of engine	201- 0-A
S172 (VIN T)	Injector harness, top rear of engine	201- 0-A
S173 (VIN T)	Injector harness, top of engine	201- 0-A
S174 (VIN T)	Injector harness, top of engine	201- 0-A
S175 (VIN T)	Engine harness, RH rear of engine	201- 1-A
S181	Engine harness, RH rear of engine	201- 1-A
S204	I/P harness, behind LH side of instrument cluster	201-13-A
S217	I/P harness, behind RH side of instrument cluster	201-12-A
S218 (VIN T)	Engine harness, lower RH rear of engine compartment	201- 1-C
S276	I/P harness, near Fuse Block	201-13-A

MULTI-PORT FUEL INJECTION: V6 VIN T

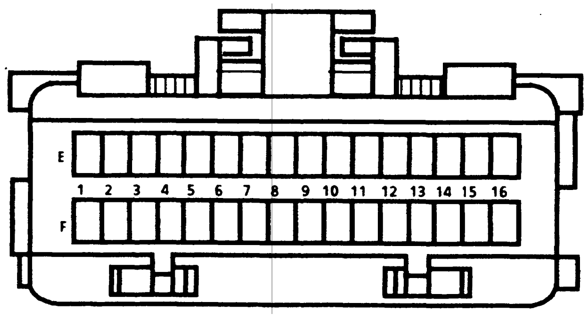
ELECTRONIC CONTROL MODULE CONNECTORS



C1 BLACK



C2 BLACK



C3 GREEN

Cavity	Wire Color	Circuit Number	Circuit Function
A1	—	—	(NOT USED)
A2	—	—	(NOT USED)
A3	—	—	(NOT USED)
A4	GRY	474	5V TO MANIFOLD ABSOLUTE PRESSURE SENSOR
A5	GRY	416	5V TO THROTTLE POSITION SENSOR
A6	PNK/BLK	439	IGNITION
A7	—	—	(NOT USED)
A8	ORN	461	DATA LINE
A9	—	—	(NOT USED)
A10	—	—	(NOT USED)
A11	DK GRN/WHT	465	FUEL PUMP RELAY CONTROL
A12	BLK/WHT	450	GROUND
B1	ORN	340	BATTERY
B2	—	—	(NOT USED)
B3	—	—	(NOT USED)
B4	—	—	(NOT USED)
B5	BLK	452	THROTTLE POSITION SENSOR AND MANIFOLD AIR TEMPERATURE SENSOR GROUND
B6	BLK	470	MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR AND COOLANT TEMPERATURE SENSOR GROUND
B7	—	—	(NOT USED)
B8	—	—	(NOT USED)
B9	PPL	401	VEHICLE SPEED SENSOR GROUND
B10	YEL	400	VEHICLE SPEED SENSOR INPUT
B11	GRY	1019	VEHICLE SPEED OUTPUT 4000 PPM)
B12	—	—	(NOT USED)

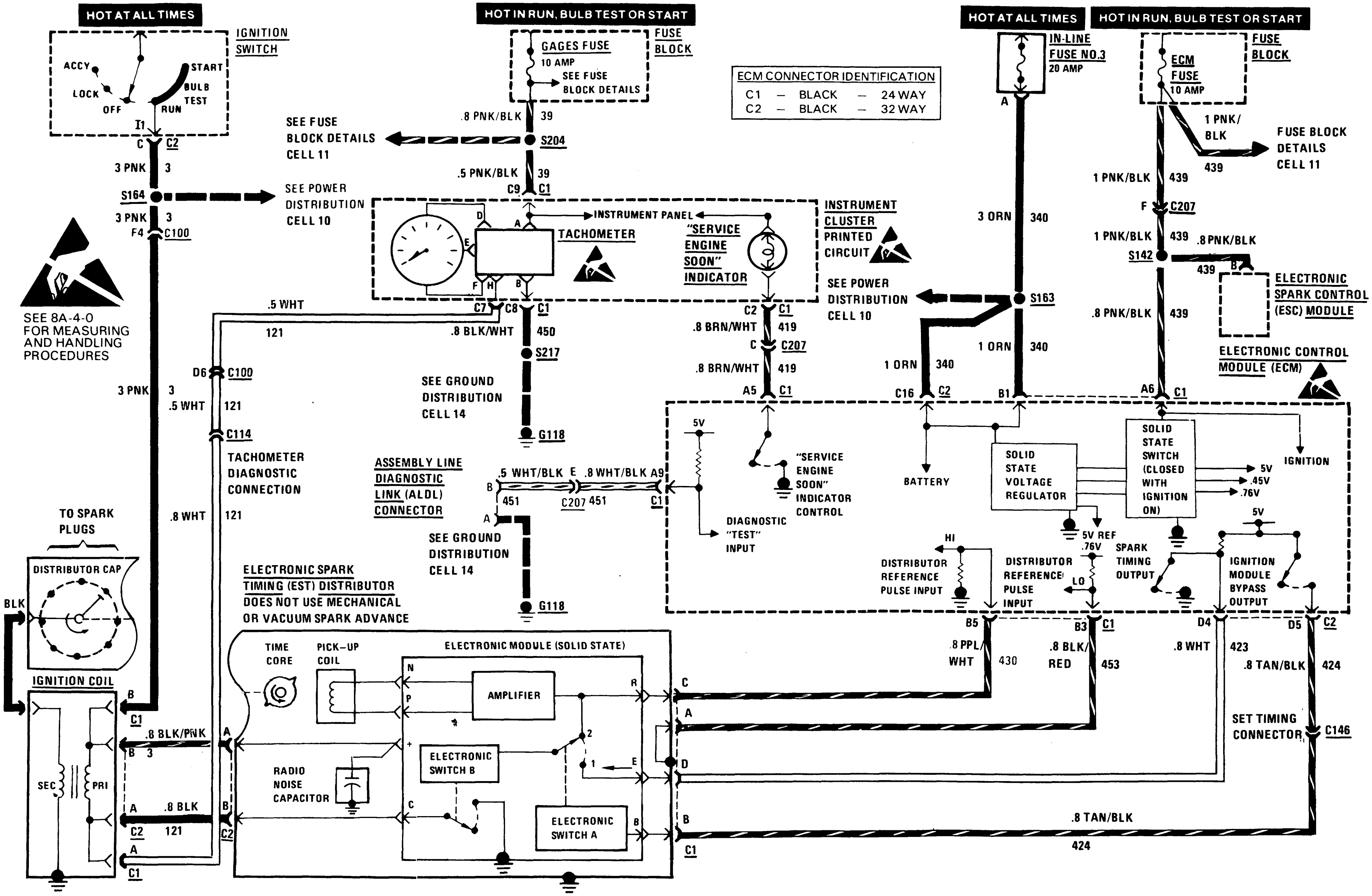
Cavity	Wire Color	Circuit Number	Circuit Function
C1	RED	381	VEHICLE SPEED OUTPUT 2000 PPM
C2	—	—	(NOT USED)
C3	—	—	(NOT USED)
C4	—	—	(NOT USED)
C5	—	—	(NOT USED)
C6	—	—	(NOT USED)
C7	TAN/BLK	424	IGNITION MODULE BYPASS OUTPUT
C8	WHT	423	SPARK TIMING OUTPUT
C9	LT GRN/BLK	366	A/C ON INPUT
C10	—	—	(NOT USED)
C11	DK BLU	467	FUEL INJECTOR CONTROL
C12	DK GRN	468	FUEL INJECTOR CONTROL
C13	—	—	(NOT USED)
C14	—	—	(NOT USED)
C15	—	—	(NOT USED)
C16	ORN	340	BATTERY
D1	BLK/WHT	450	GROUND
D2	—	—	(NOT USED)
D3	—	—	(NOT USED)
D4	—	—	(NOT USED)
D5	—	—	(NOT USED)
D6	BLK/WHT	450	GROUND
D7	BLK/WHT	450	GROUND
D8	PPL/WHT	430	DISTRIBUTOR REFERENCE PULSE INPUT HI
D9	BLK/RED	453	DISTRIBUTOR REFERENCE PULSE INPUT LO
D10	—	—	(NOT USED)

Cavity	Wire Color	Circuit Number	Circuit Function
D11	–	–	(NOT USED)
D12	DK BLU	732	A/C PRESSURE FAN SWITCH INPUT
D13	LT BLU/ORN	495	POWER STEERING PRESSURE INPUT
D14	LT BLU	446 (AUTO)	TOP GEAR (FOURTH CLUTCH INPUT)
D15	–	–	(NOT USED)
D16	ORN/BLK	434 (AUTO)	PARK/NEUTRAL INPUT
E1	–	–	(NOT USED)
E2	–	–	(NOT USED)
E3	LT BLU/WHT	441	IDLE AIR CONTROL A HI
E4	LT BLU/BLK	442	IDLE AIR CONTROL A LO
E5	LT GRN/WHT	443	IDLE AIR CONTROL B HI
E6	LT GRN/BLK	444	IDLE AIR CONTROL B LO
E7	BRN/WHT	419	SERVICE ENGINE SOON INDICATOR CONTROL
E8	DK GRN/WHT	335	COOLANT FAN CONTROL
E9	LT BLU	697	EGR SOLENOID NO. 1 CONTROL
E10	–	–	(NOT USED)
E11	–	–	(NOT USED)
E12	WHT/BLK	451	DIAGNOSTIC "TEST" INPUT
E13	GRY	120	FUEL PUMP CONTROL UNIT
E14	PPL	412	OXYGEN SENSOR INPUT HI
E15	TAN	413	OXYGEN SENSOR INPUT LO
E16	YEL	410	COOLANT TEMPERATURE SENSOR INPUT
F1	DK GRN/WHT	459	A/C COMPRESSOR CONTROL RELAY
F2	BRN	436	AIR SELECT VALVE CONTROL
F3	–	–	(NOT USED)
F4	BRN	698	EGR SOLENOID NO. 2 CONTROL
F5	RED	699	EGR SOLENOID NO. 3 CONTROL
F6	TAN/BLK	422 (AUTO)	TRANSMISSION CONVERTER CLUTCH (TCC) CONTROL
	TAN/BLK	456 (MAN)	UPSHIFT INDICATOR CONTROL
F7	DK GRN/YEL	428	CANISTER PURGE SOLENOID CONTROL
F8	–	–	(NOT USED)
F9	DK BLU	496	DETONATION SENSOR INPUT
F10	DK BLU	229	PASS KEY CRANK FUEL ENABLE INPUT
F11	–	–	(NOT USED)
F12	–	–	(NOT USED)
F13	DK BLU	417	THROTTLE POSITION SENSOR INPUT
F14	–	–	(NOT USED)
F15	LT GRN	432	MANIFOLD ABSOLUTE PRESSURE SENSOR INPUT
F16	TAN	472	MANIFOLD AIR TEMPERATURE SENSOR INPUT

BLANK

THROTTLE BODY INJECTION: V8 VIN E

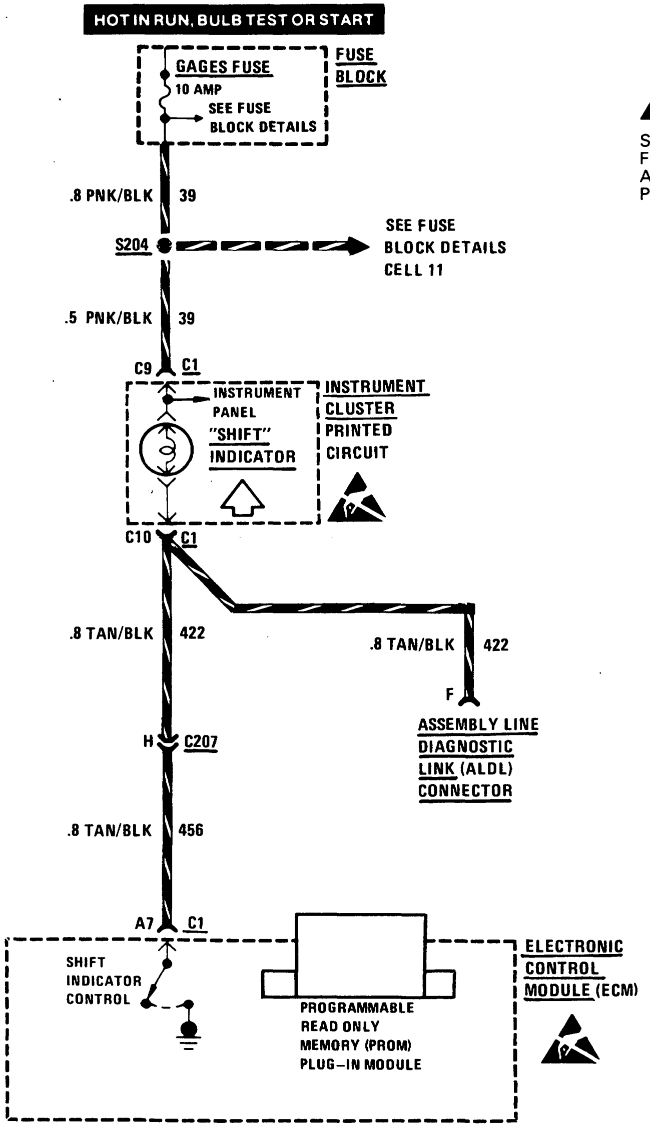
IGNITION, SERVICE ENGINE SOON INDICATOR, AND TACHOMETER



UPSHIFT INDICATOR

MANUAL TRANSMISSION ONLY

SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES



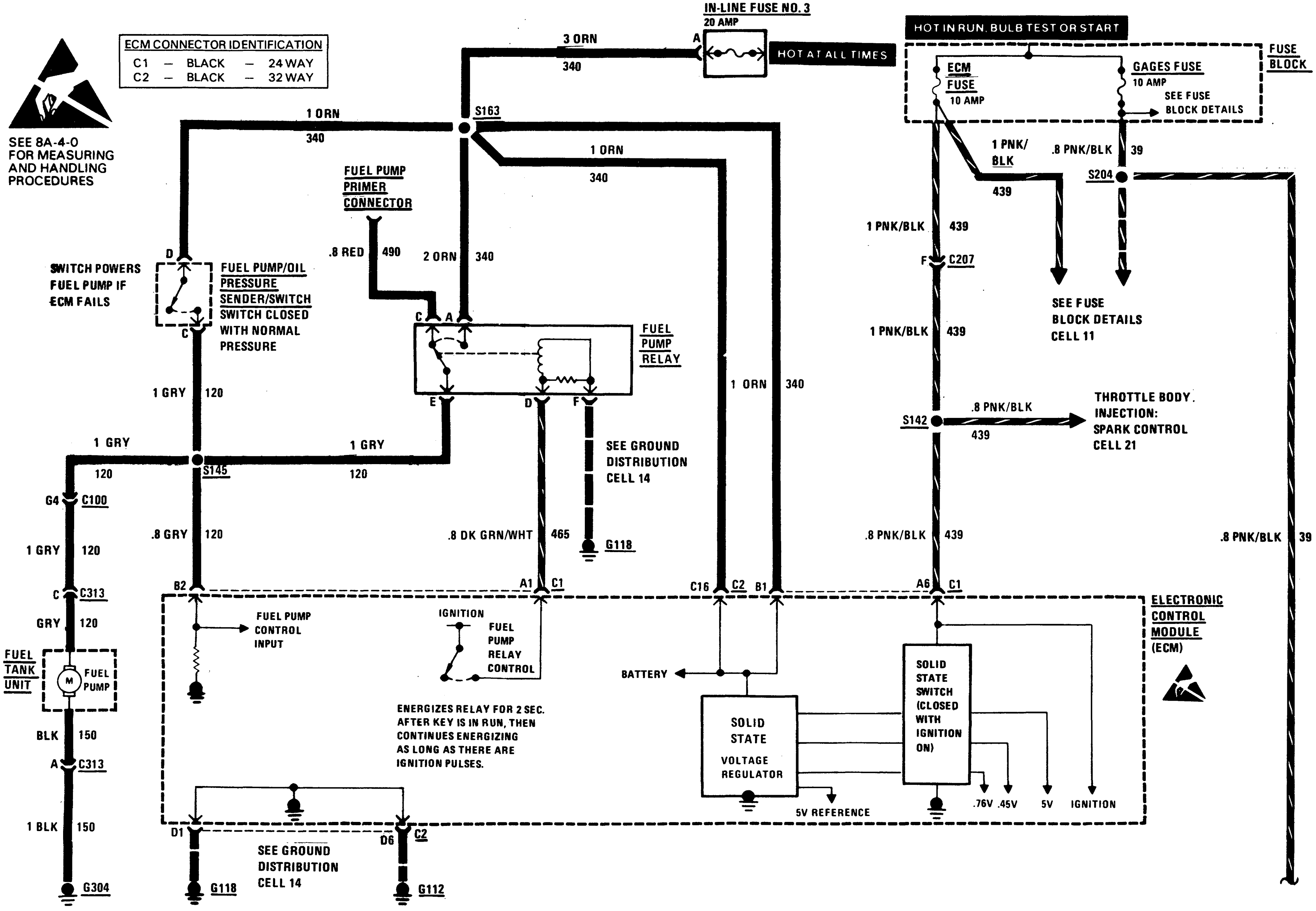
ECM CONNECTOR IDENTIFICATION				
C1	–	BLACK	–	24 WAY
C2	–	BLACK	–	32 WAY

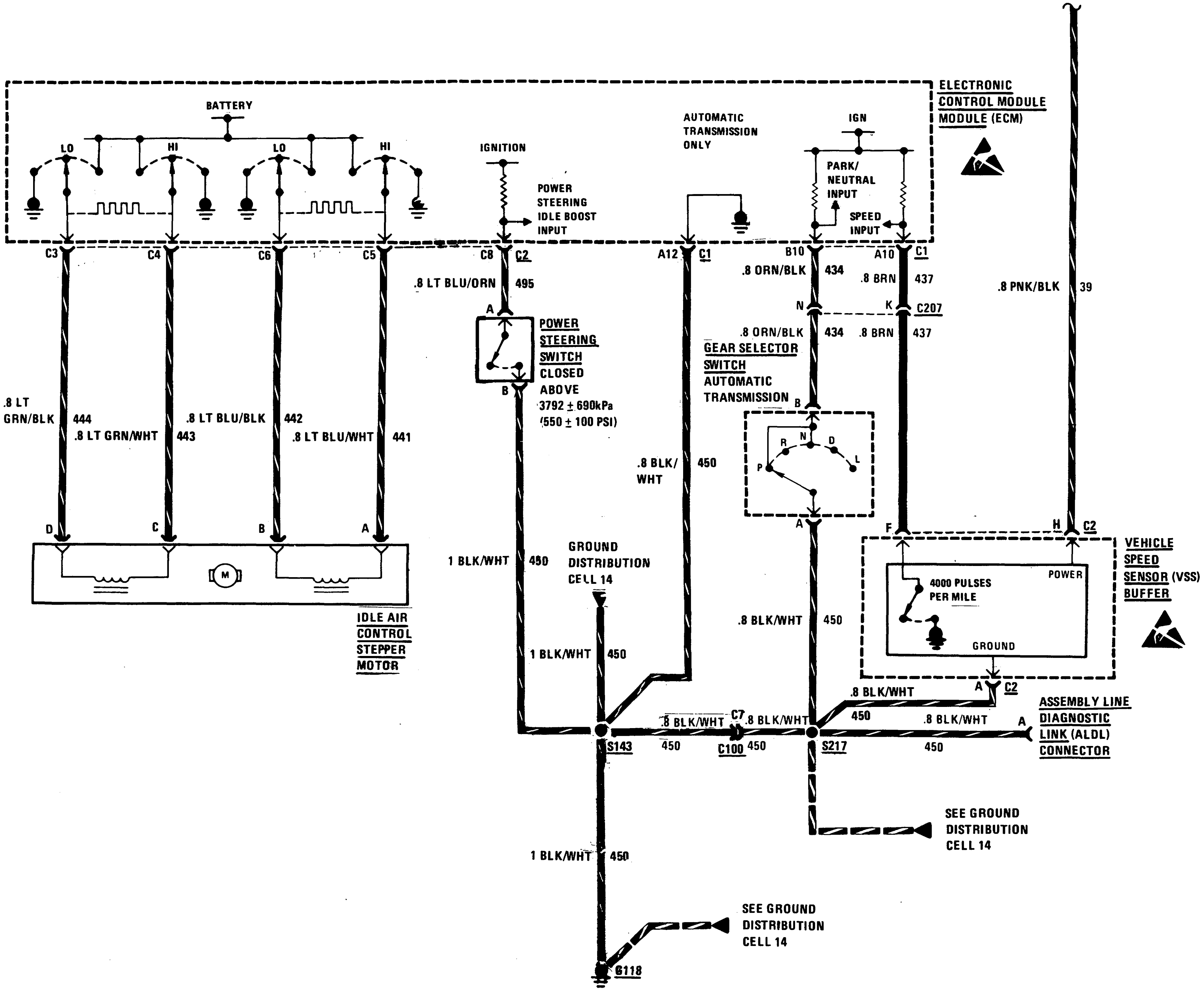
THROTTLE BODY INJECTION: V8 VIN E

IDLE SPEED CONTROL, FUEL CONTROL, AND VEHICLE DATA SENSORS

ECM CONNECTOR IDENTIFICATION				
C1	—	BLACK	—	24 WAY
C2	—	BLACK	—	32 WAY

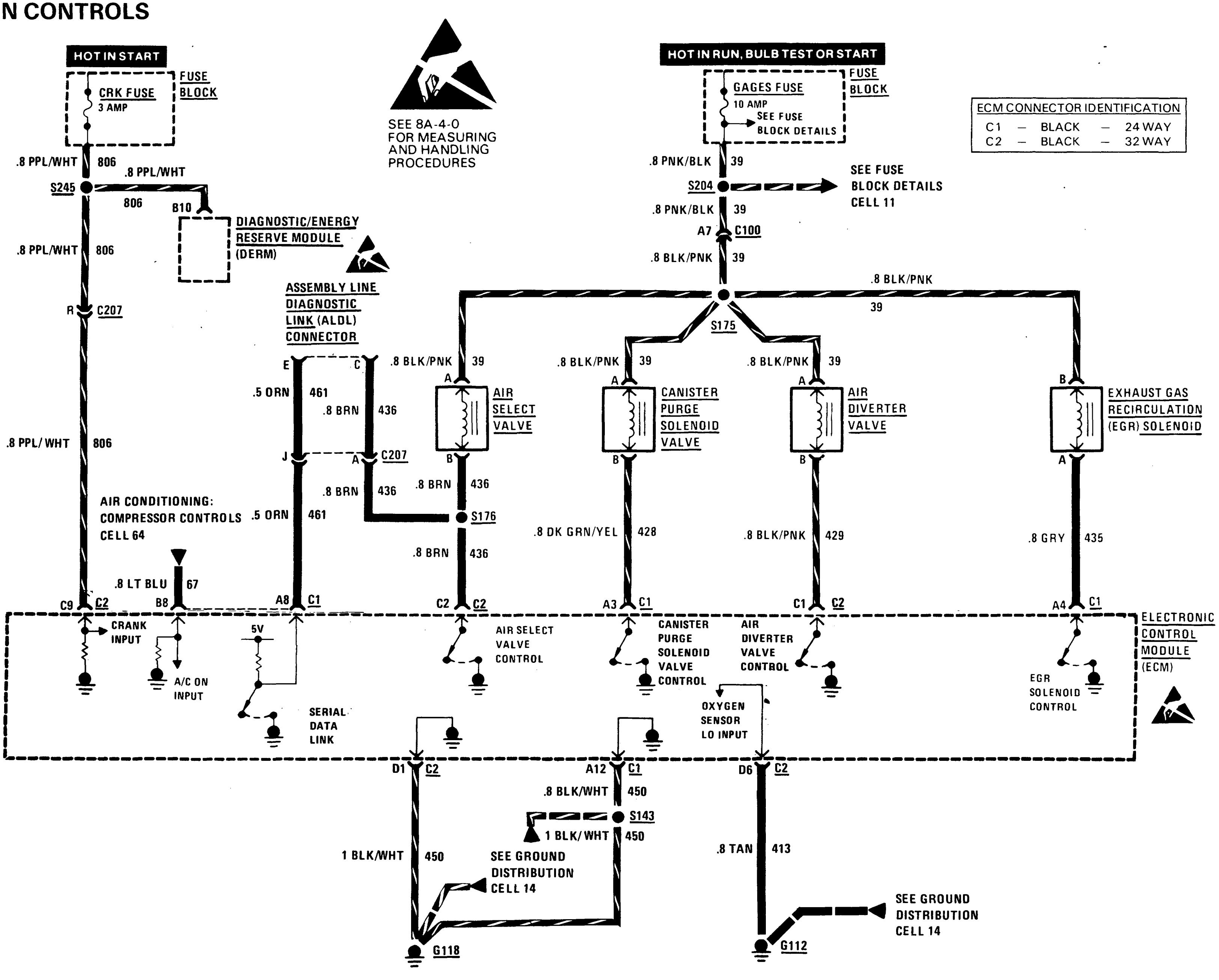
SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES




ELECTRONIC CONTROL MODULE MODULE (ECM)
BATTERY
LO
HI
LO
HI
IGNITION
POWER STEERING IDLE BOOST INPUT
AUTOMATIC TRANSMISSION ONLY
IGN
PARK/ NEUTRAL INPUT
SPEED INPUT
C3
C4
C6
C5
C8
C2
A12
C1
B10
A10
C1
.8 LT BLU/ORN 495
.8 ORN/BLK 434
.8 BRN 437
.8 PNK/BLK 39
N
K
C207
.8 ORN/BLK 434
.8 BRN 437
A
POWER STEERING SWITCH CLOSED ABOVE 3792 ± 690kPa (550 ± 100 PSI)
B
GEAR SELECTOR SWITCH AUTOMATIC TRANSMISSION
B
P
R
N
D
L
A
.8 LT GRN/BLK 444
.8 LT GRN/WHT 443
.8 LT BLU/BLK 442
.8 LT BLU/WHT 441
.8 BLK/ WHT 450
D
C
B
A
M
IDLE AIR CONTROL STEPPER MOTOR
1 BLK/WHT 450
GROUND DISTRIBUTION CELL 14
1 BLK/WHT 450
.8 BLK/WHT 450
F
H
C2
VEHICLE SPEED SENSOR (VSS) BUFFER
4000 PULSES PER MILE
POWER
GROUND
A
C2
.8 BLK/WHT 450
.8 BLK/WHT
C7
.8 BLK/WHT
.8 BLK/WHT
A
ASSEMBLY LINE DIAGNOSTIC LINK (ALDL) CONNECTOR
S143
450
C100 450
S217
450
SEE GROUND DISTRIBUTION CELL 14
1 BLK/WHT 450
SEE GROUND DISTRIBUTION CELL 14
G118

THROTTLE BODY INJECTION: V8 VIN E

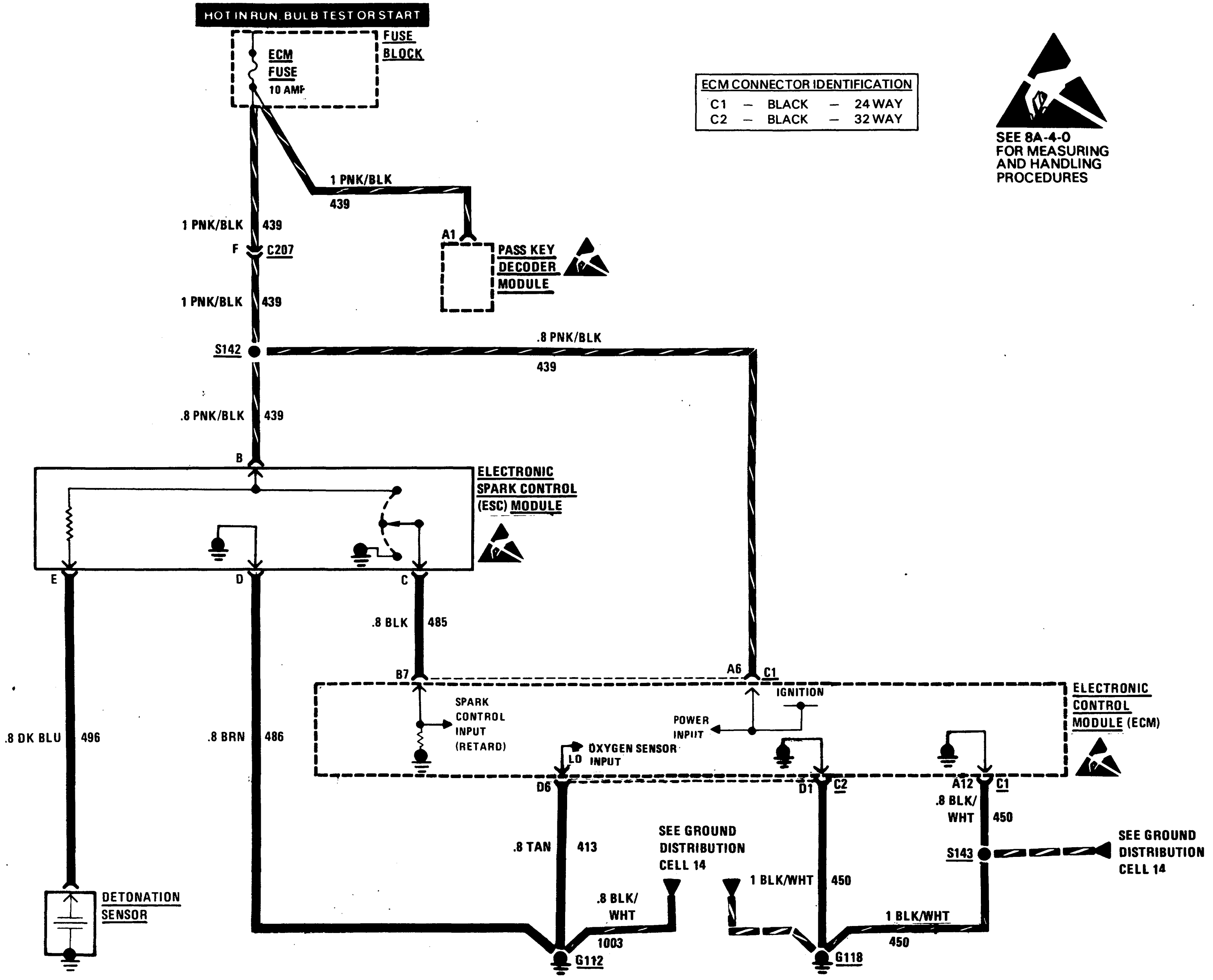
EMISSION CONTROLS



ECM CONNECTOR IDENTIFICATION				
C1	—	BLACK	—	24 WAY
C2	—	BLACK	—	32 WAY

THROTTLE BODY INJECTION: V8 VIN E

SPARK CONTROL



ECM CONNECTOR IDENTIFICATION				
C1	–	BLACK	–	24 WAY
C2	–	BLACK	–	32 WAY

SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES

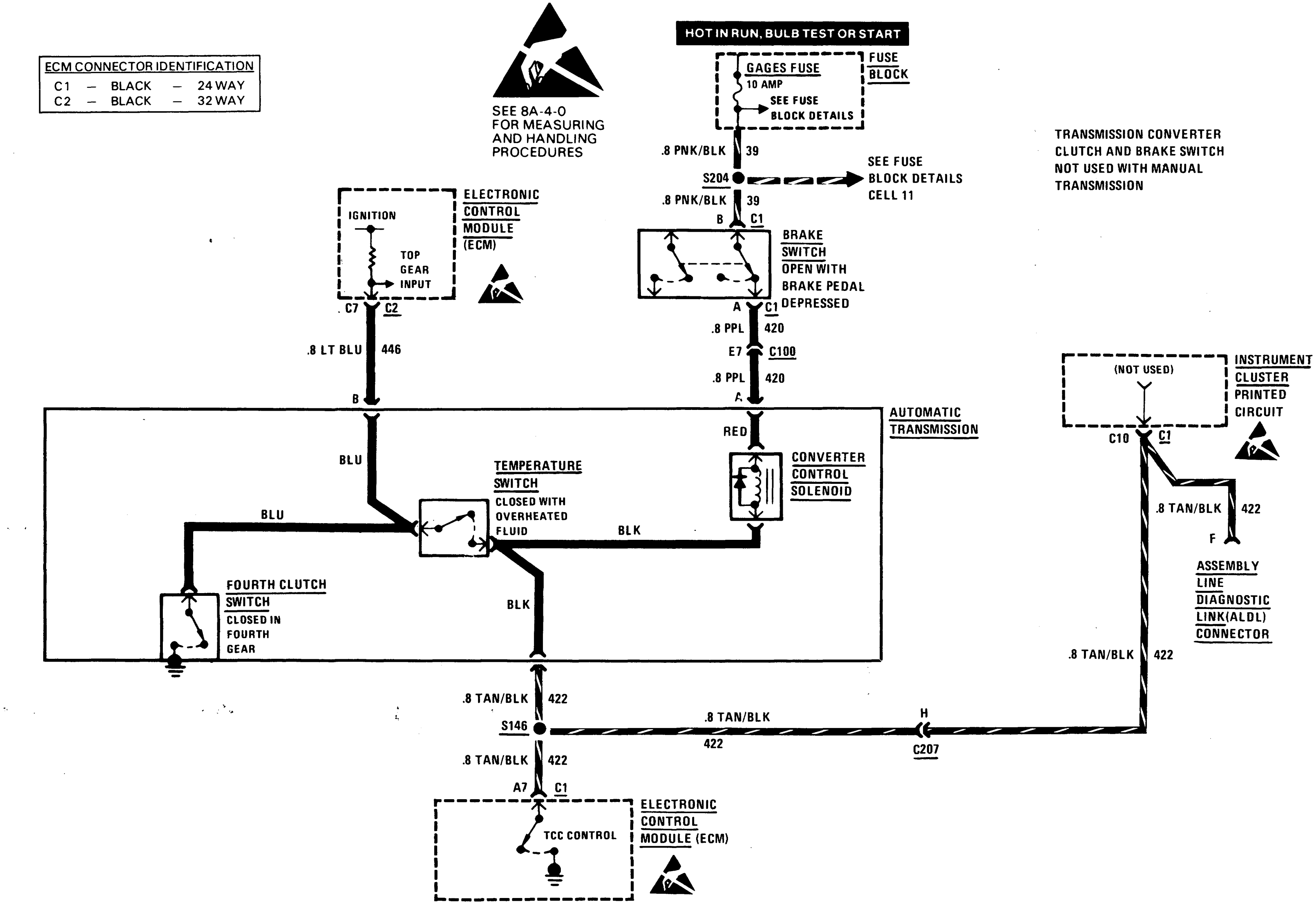
THROTTLE BODY INJECTION: V8 VIN E

TRANSMISSION CONVERTER CLUTCH

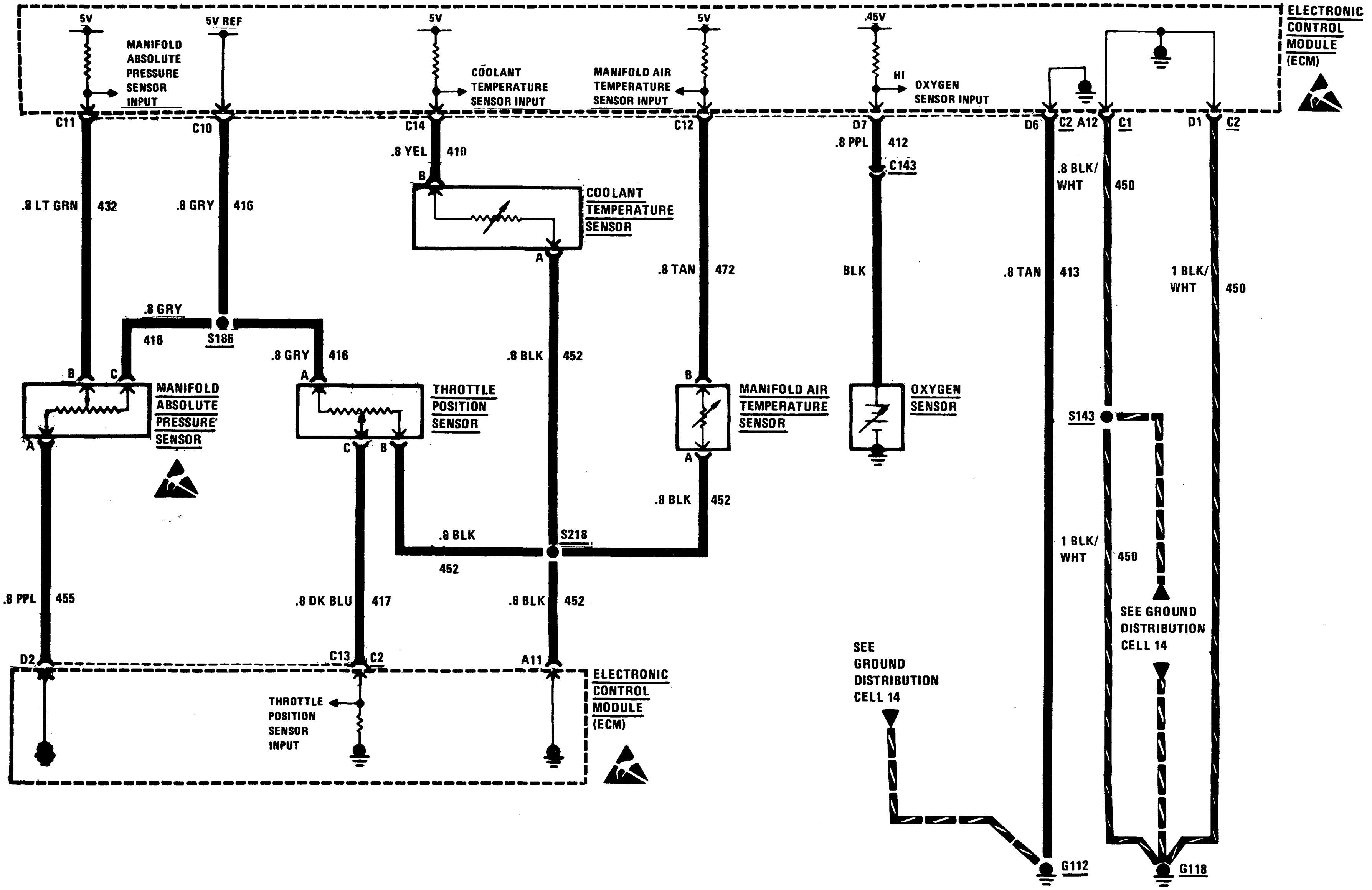
ECM CONNECTOR IDENTIFICATION				
C1	—	BLACK	—	24 WAY
C2	—	BLACK	—	32 WAY

SEE 8A-4-0 FOR MEASURING AND HANDLING PROCEDURES

TRANSMISSION CONVERTER CLUTCH AND BRAKE SWITCH NOT USED WITH MANUAL TRANSMISSION

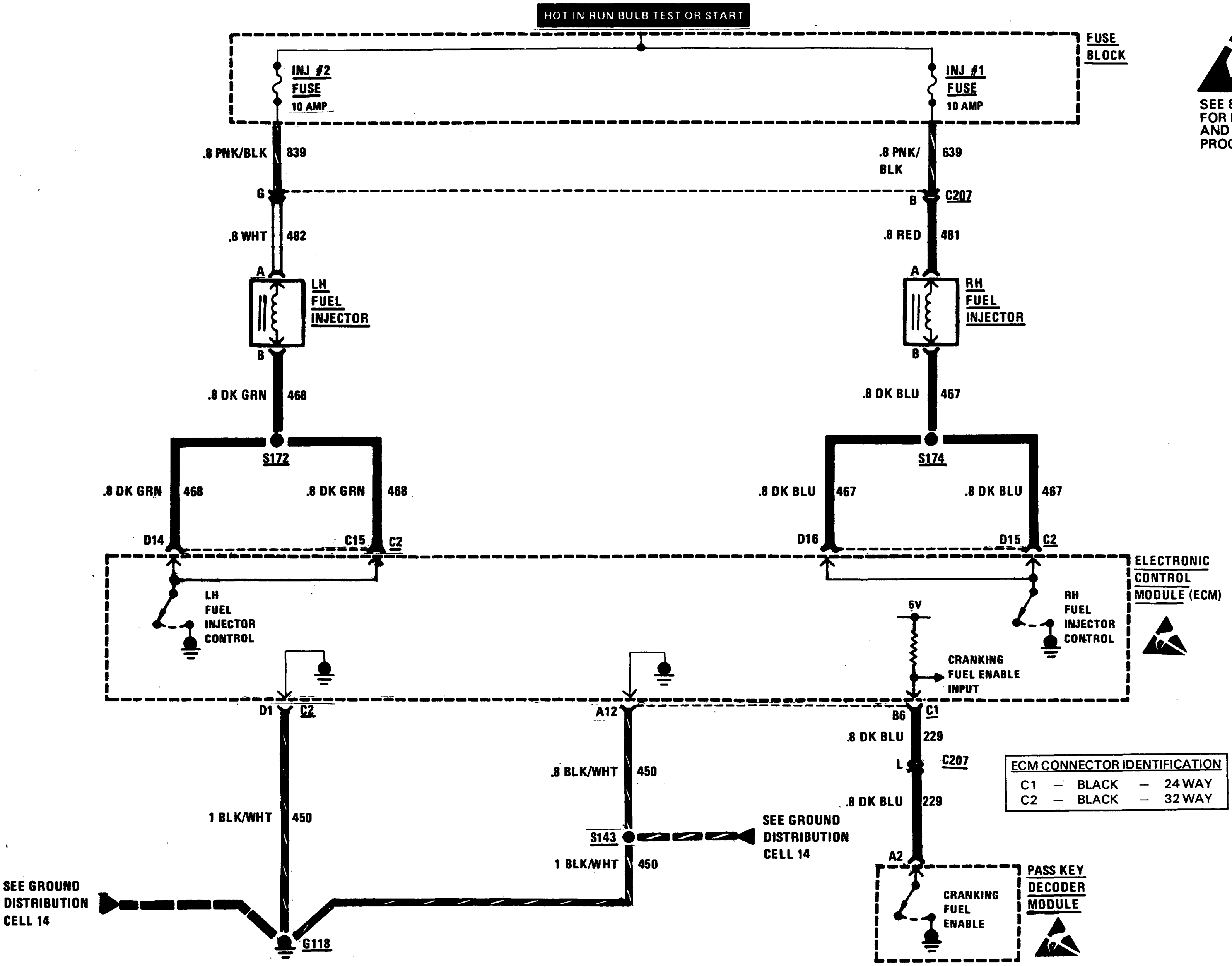


THROTTLE BODY INJECTION: V8 VIN E



THROTTLE BODY INJECTION: V8 VIN E

FUEL INJECTORS



ECM CONNECTOR IDENTIFICATION				
C1	–	BLACK	–	24 WAY
C2	–	BLACK	–	32 WAY

SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES

COMPONENT LOCATION

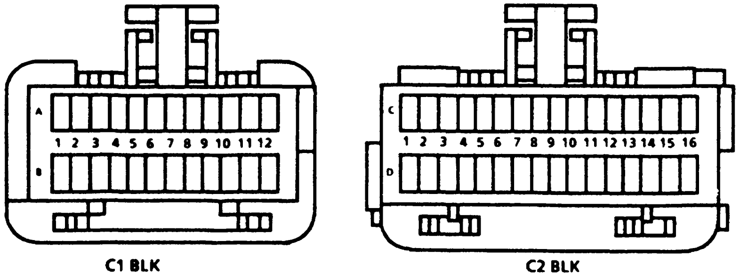
		Page-Figure
AIR Diverter Valve (VIN E)	RH front of engine	201- 3-A
AIR Select Valve (VIN E)	RH front of engine	201- 3-A
Assembly Line Diagnostic Link (ALDL) Connector	Under LH side of I/P, on Fuse Block	201-13-A
Brake Switch	Behind LH side of I/P, top of brake pedal support	201-13-C
Canister Purge Solenoid Valve (VIN E)	LH front of engine compartment	201- 5-A
Coolant Temperature Sensor (VIN E)	Top RH front of engine, behind A/C Compressor	201- 4-C
Detonation Sensor (VIN E)	Lower RH side of engine, near Starter Solenoid	201- 6-C
Diagnostic/Energy Reserve Module (DERM)	Behind RH side of I/P	201-15-A
Electronic Control Module (ECM) (VIN E)	Behind RH side of I/P	201-15-C
Electronic Spark Control (ESC) Module	LH front of dash	
Electronic Spark Timing (EST) Distributor (VIN E)	Top rear of engine	201- 4-A
Exhaust Gas Recirculation (EGR) Solenoid (VIN E)	Top RH rear of engine	201- 3-A
Fuel Injectors (VIN E)	Top of engine, on throttle body	201- 3-A
Fuel Pump Prime Connector (VIN E)	RH rear of engine compartment	201- 4-B
Fuel Pump Relay	LH front of dash, on relay bracket	
Fuel Pump/Oil Pressure Sender/Switch (VIN E)	Lower LH rear of engine	EI8201-G5-A
Fuel Tank Unit	Top of fuel tank	
Fuse Block	Behind LH side of I/P	201-13-A
Gear Selector Switch	In console, at gear selector	201-17-F
Idle Air Control Stepper Motor (VIN E)	Top of engine, on rear of throttle body	201- 3-A
Ignition Coil (VIN E)	Top rear of engine	201- 4-A
Ignition Switch	At base of steering column, below I/P	201-14-A
In-Line Fuse No. 3 (VIN E)	RH inner fender panel, by battery	201- 3-A
Manifold Absolute Pressure (MAP) Sensor (VIN E)	On RH front of dash	201- 4-B

COMPONENT LOCATION

		Page-Figure
Manifold Air Tmperature (MAT) Sensor (VIN E)	Top rear of engine, on air intake shroud	201- 5-C
Oxygen Sensor (VIN E)	Lower LH side of engine, on exhaust manifold.	201- 5-A
PASS Key Decoder Module	Behind RH side of I/P	201-15-A
Power Seering Switch (VIN E)	LH front of engine compartment	201- 5-A
Throttle Position Sensor (VIN E)	Top of engine, on throttle body	201- 3-A
Vehicle Speed Sensor (VSS) Buffer	Behind RH side of I/P	201-18-B
C100 (42 cavities)	LH front of dash, below relay bracket	201-12-A
C114 (1 cavity) (VIN E)	Top rear of engine, near Ignition Coil	201- 4-A
C143 (1 cavity) (VIN E)	Lower LH side of engine, near exhaust manifold.	201- 5-A
C146 (1 cavity)	RH rear of engine compartment	
C207 (15 cavities)	Behind RH side of I/P	201-15-A
C313 (3 cavities)	Below car, forward of fuel tank	201-18-E
G112 (VIN E)	Rear of LH cylinder head	201- 4-A
G118 (VIN E)	Rear of RH cylinder head	201- 4-A
G304	Under driver's seat, on floor rail	201-16-A
S142	Engine harness, behind RH side of I/P	201-15-C
S143 (VIN E)	Engine harness, LH rear of engine compartment.	201- 5-A
S145 (VIN E)	Engine harness, LH rear of engine compartment.	201- 5-A
S146 (VIN E)	Engine harness, behind RH side of I/P, near Electronic Control Module (ECM)	201-15-C
S163 (VIN E)	Engine harness, RH rear of engine compartment	201- 4-B
S164	I/P harness, behind LH side of I/P	201-14-A
S172 (VIN E)	Engine harness, RH rear of engine compartment	201- 4-B
S174 (VIN E)	Engine harness, RH rear of engine compartment	201- 4-B
S175 (VIN E)	Engine harness, behind top RH side of engine	201- 3-A
S176	Engine harness, behind RH side of I/P	201-15-C
S186	Engine harness, RH rear of engine compartment	201- 4-B
S204	I/P harness, behind LH side of instrument cluster	201-13-A
S217	I/P harness, behind RH side of instrument cluster	201-12-A
S218 (VIN E)	Engine harness, behind top RH side of engine	201- 3-A
S245	I/P harness, behind center of I/P	201-12-A

THROTTLE BODY INJECTION: V8 VIN E

ELECTRONIC CONTROL MODULE CONNECTORS

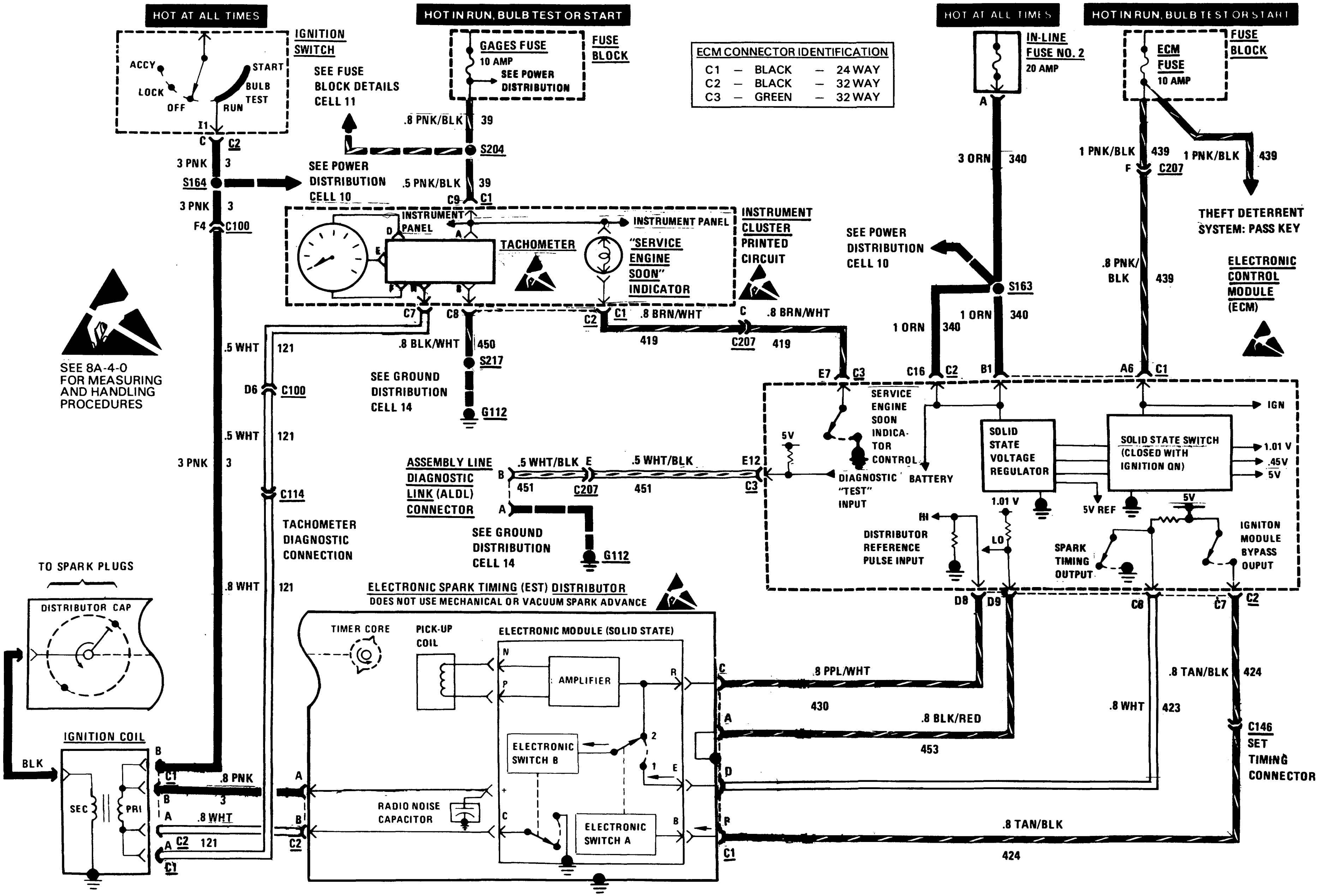


ELECTRONIC CONTROL MODULE (ECM)

CAVITY	WIRE COLOR	CIRCUIT NUMBER	CIRCUIT FUNCTION
A1	DK GRN/WHT	465	FUEL PUMP RELAY CONTROL
A2	–	–	(NOT USED)
A3	DK GRN/YEL	428	CANISTER PURGE SOLENOID VALVE CONTROL
A4	GRY	435	EXHAUST GAS RECIRCULATION SOLENOID CONTROL
A5	BRN/WHT	419	"SERVICE ENGINE SOON" INDICATOR CONTROL
A6	PNK/BLK	439	IGNITION
A7	TAN/BLK	422 (AUTO) 456 (MAN)	TCC CONTROL (AUTO) SHIFT INDICATOR CONTROL (MAN)
A8	ORN	461	SERIAL DATA LINK
A9	WHT/BLK	451	DIAGNOSTIC "TEST" INPUT
A10	BRN	437	SPEED INPUT
A11	BLK	452	SENSOR GROUND
A12	BLK/WHT	450	GROUND
B1	ORN	340	BATTERY
B2	GRY	120	FUEL PUMP CONTROL INPUT
B3	BLK/RED	453	DISTRIBUTOR REFERENCE PULSE INPUT: LO
B4	–	–	(NOT USED)
B5	PPL/WHT	430	DISTRIBUTOR REFERENCE PULSE INPUT: HI
B6	DK BLU	229	THEFT DETERRENT INPUT
B7	BLK	485	ELECTRONIC SPARK CONTROL INPUT (RETARD)
B8	LT BLU	67	A/C ON INPUT
B9	–	–	(NOT USED)
B10	ORN/BLK	434	PARK/NEUTRAL INPUT
B11	–	–	(NOT USED)
B12	–	–	(NOT USED)
C1	BLK/PNK	429	AIR DIVERTER VALVE CONTROL
C2	BRN	436	AIR SELECT VALVE CONTROL
C3	LT GRN/BLK	444	IDLE AIR CONTROL B LO
C4	LT GRN/WHT	443	IDLE AIR CONTROL B HI
C5	LT BLU/WHT	441	IDLE AIR CONTROL A HI
C6	LT BLU/BLK	442	IDLE AIR CONTROL A LO
C7	LT BLU	446	TOP GEAR INPUT
C8	LT BLU/ORN	495	POWER STEERING INPUT
C9	PPL/WHT	806	CRANK INPUT
C10	YEL	410	COOLANT TEMPERATURE SENSOR INPUT
C11	LT GRN	432	MANIFOLD ABSOLUTE PRESSURE SENSOR INPUT
C12	TAN	472	MANIFOLD AIR TEMPERATURE SENSOR INPUT
C13	DK BLU	417	THROTTLE POSITION SENSOR INPUT
C14	GRY	416	5 VOLT REFERENCE
C15	DK GRN	468	LH FUEL INJECTOR CONTROL
C16	ORN	340	BATTERY
D1	BLK/WHT	450	GROUND
D2	PPL	455	SENSOR GROUND
D3	–	–	(NOT USED)
D4	WHT	423	SPARK TIMING OUTPUT
D5	TAN/BLK	424	IGNITION MODULE BYPASS OUTPUT
D6	TAN	413	OXYGEN SENSOR INPUT: LO
D7	PPL	412	OXYGEN SENSOR INPUT: HI
D8	–	–	(NOT USED)
D9	–	–	(NOT USED)
D10	–	–	(NOT USED)
D11	–	–	(NOT USED)
D12	–	–	(NOT USED)
D13	–	–	(NOT USED)
D14	DK GRN	468	LH FUEL INJECTOR CONTROL
D15	DK BLU	467	RH FUEL INJECTOR CONTROL
D16	DK BLU	467	RH FUEL INJECTOR CONTROL

TUNED PORT INJECTION: V8 VIN F

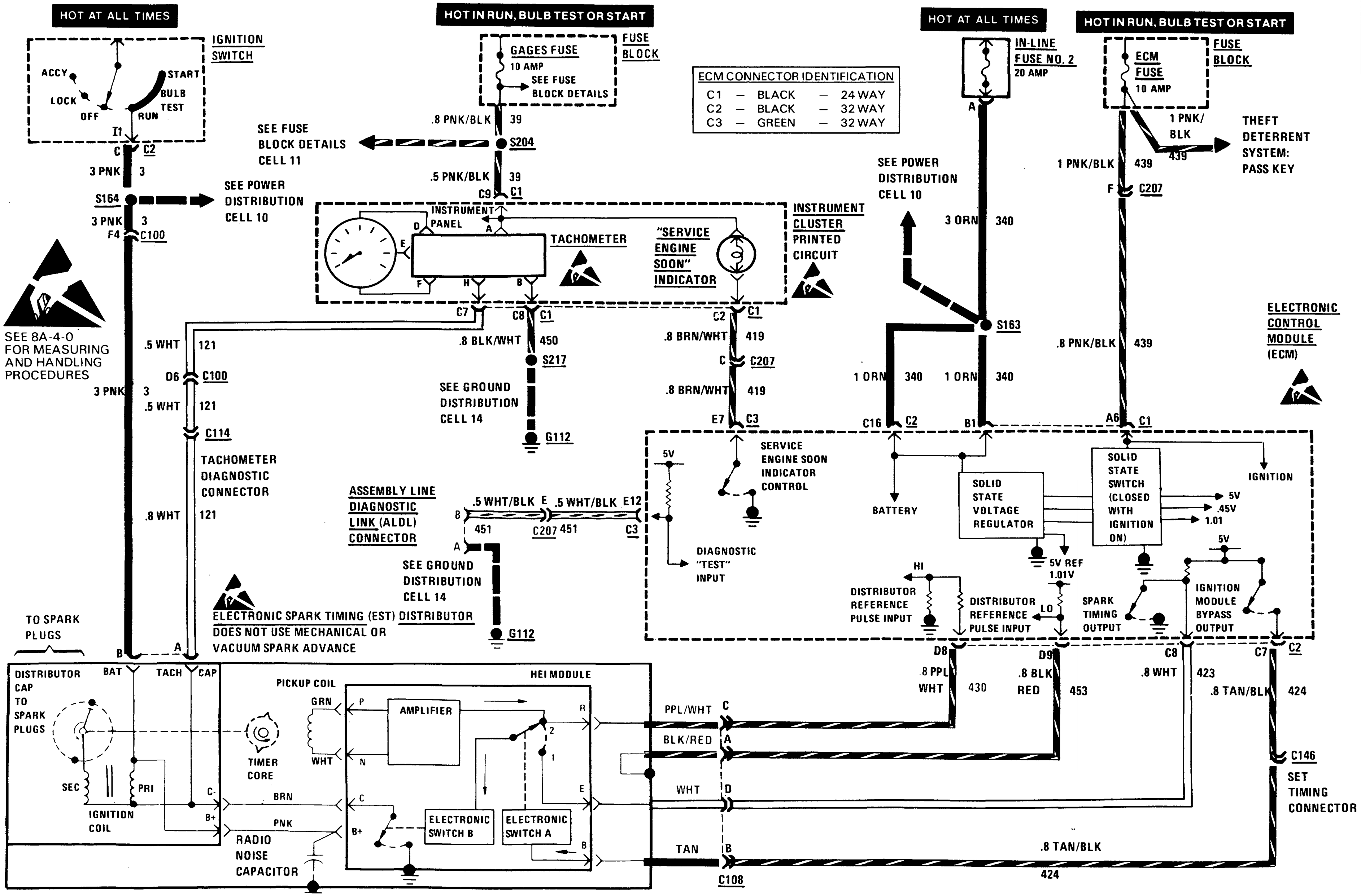
IGNITION, SERVICE ENGINE SOON INDICATOR. AND TACHOMETER



ECM CONNECTOR IDENTIFICATION			
C1	BLACK	—	24 WAY
C2	BLACK	—	32 WAY
C3	GREEN	—	32 WAY

MULTI-PORT FUEL INJECTION: V8 VIN 8

IGNITION, SERVICE ENGINE SOON INDICATOR, AND TACHOMETER

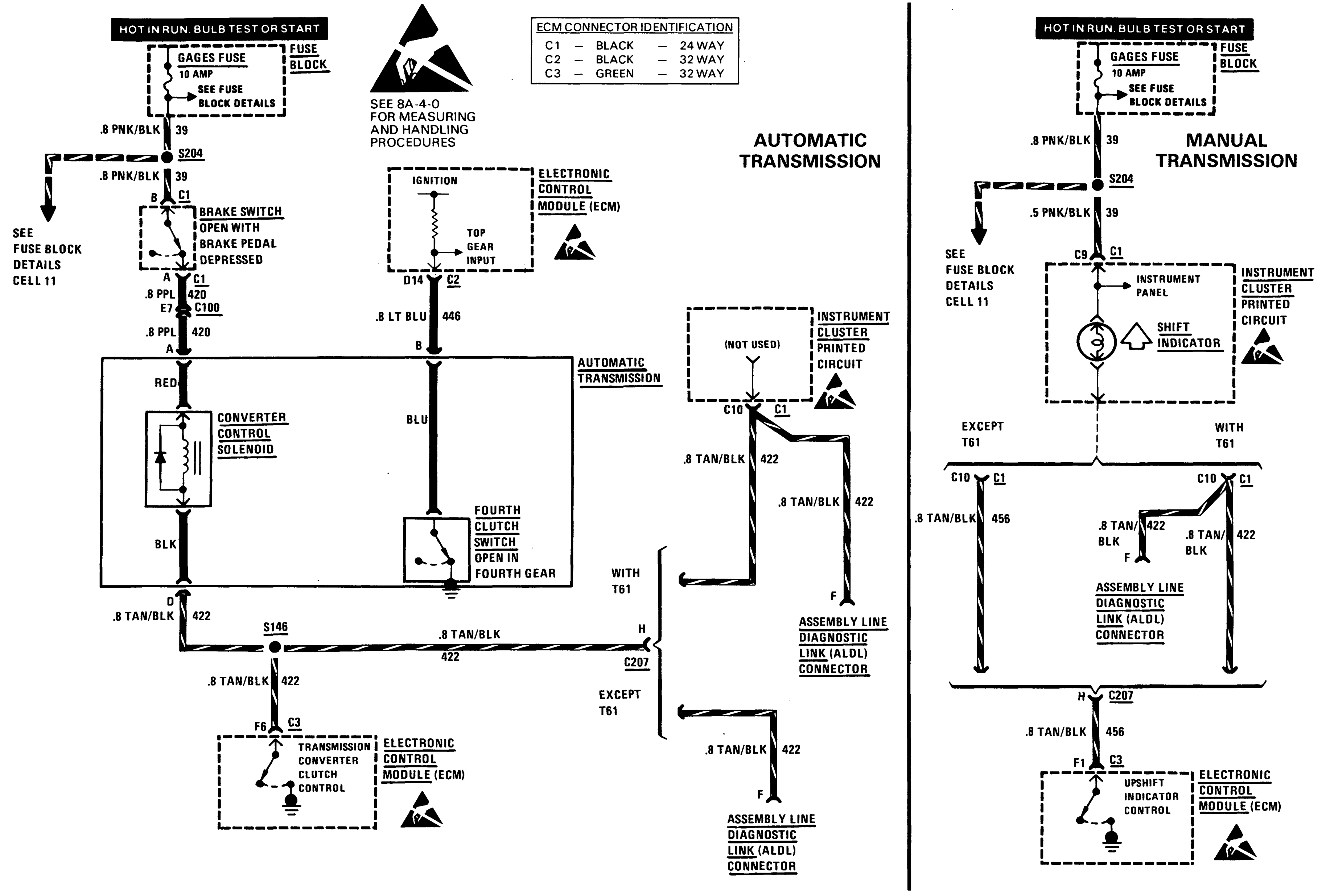


ECM CONNECTOR IDENTIFICATION

C1	—	BLACK	—	24 WAY	
C2	—	BLACK	—	32 WAY	
C3	—	GREEN	—	32 WAY	

TUNED PORT INJECTION (V8 VIN F) AND MULTI-PORT FUEL INJECTION (V8 VIN 8)

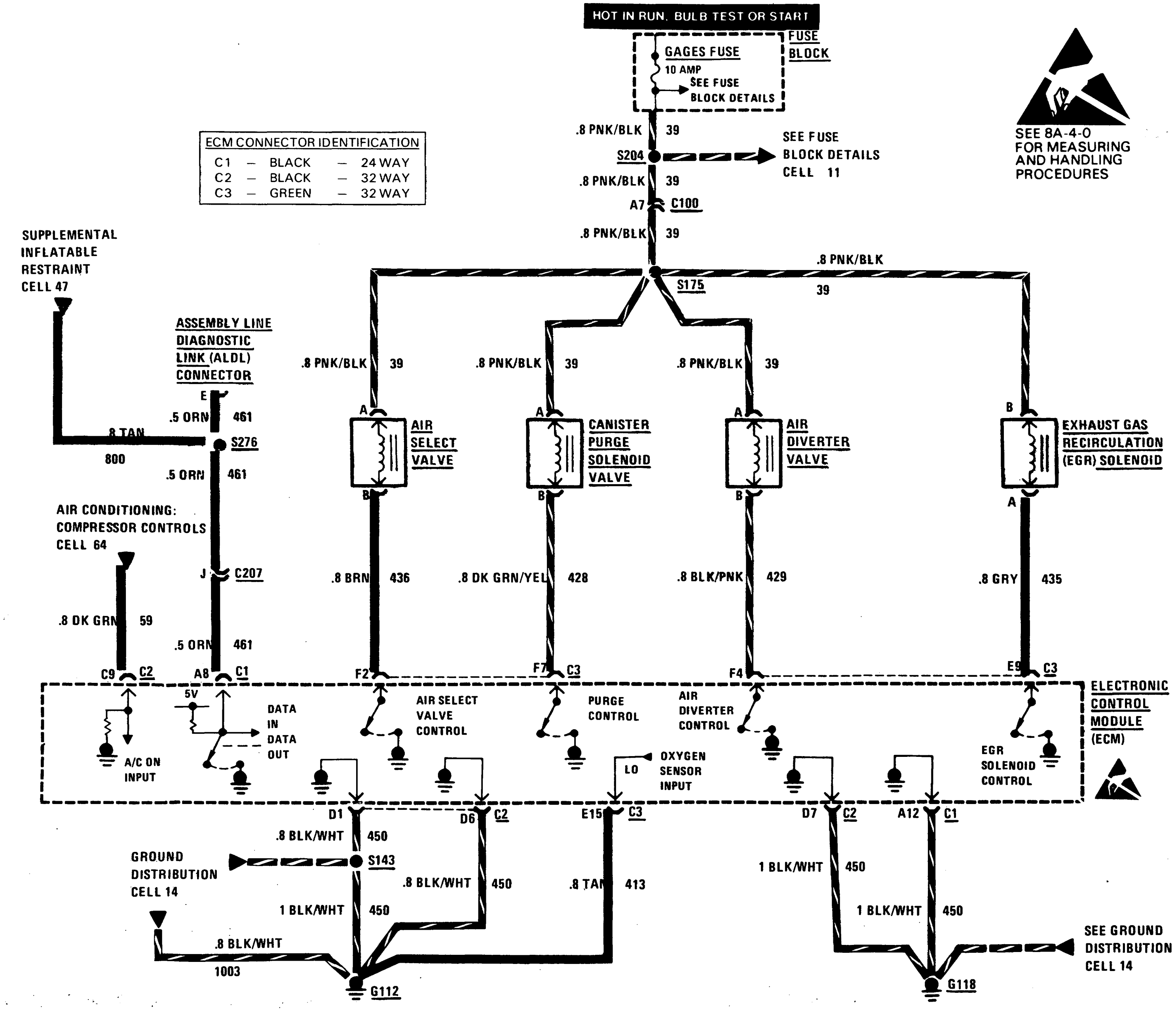
TRANSMISSION CONVERTER CLUTCH AND UPSHIFT INDICATOR



ECM CONNECTOR IDENTIFICATION				
C1	–	BLACK	–	24 WAY
C2	–	BLACK	–	32 WAY
C3	–	GREEN	–	32 WAY

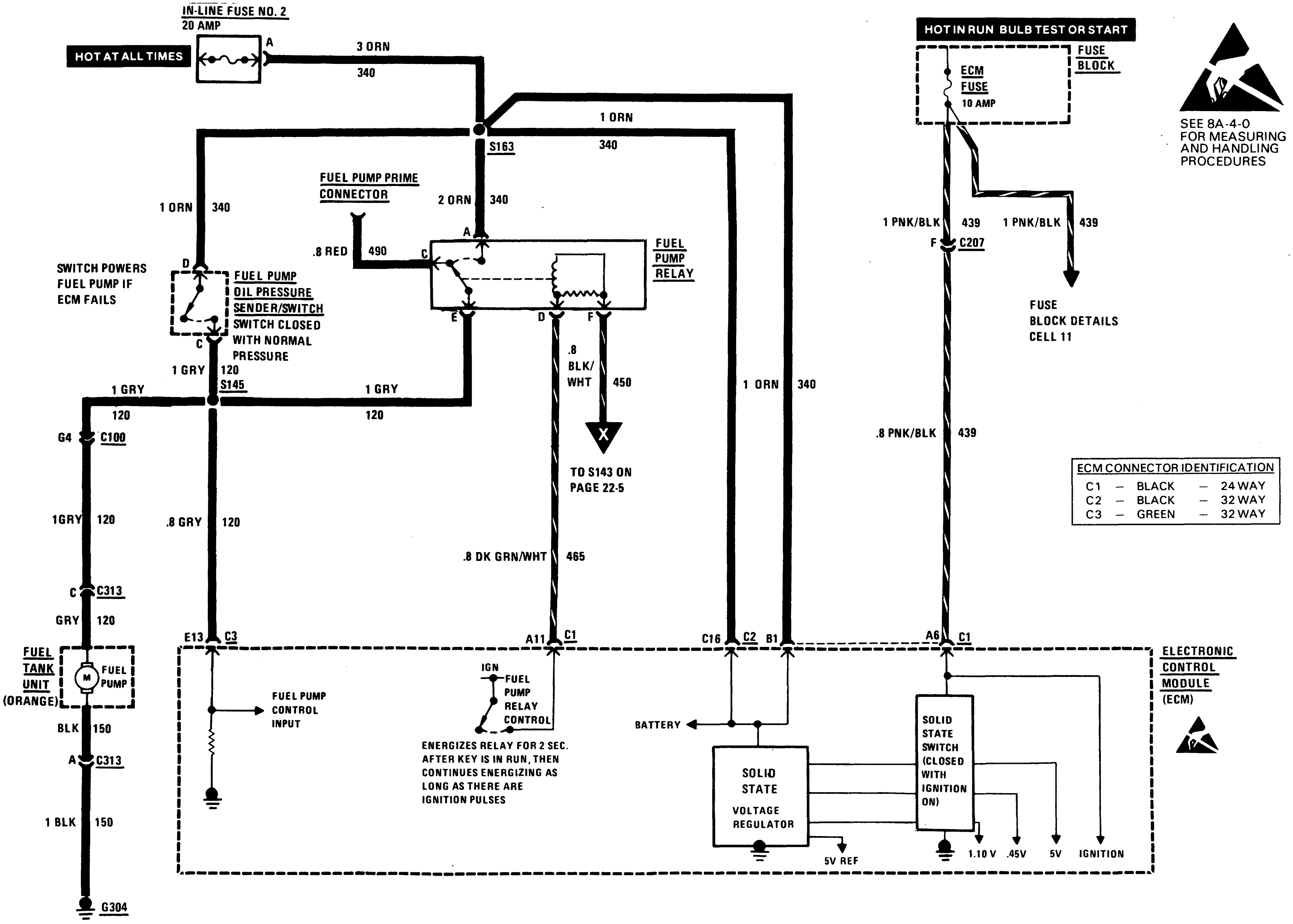
TUNED PORT INJECTION (V8 VIN F) AND MULTI-PORT FUEL INJECTION (V8 VIN 8)

EMISSION CONTROLS



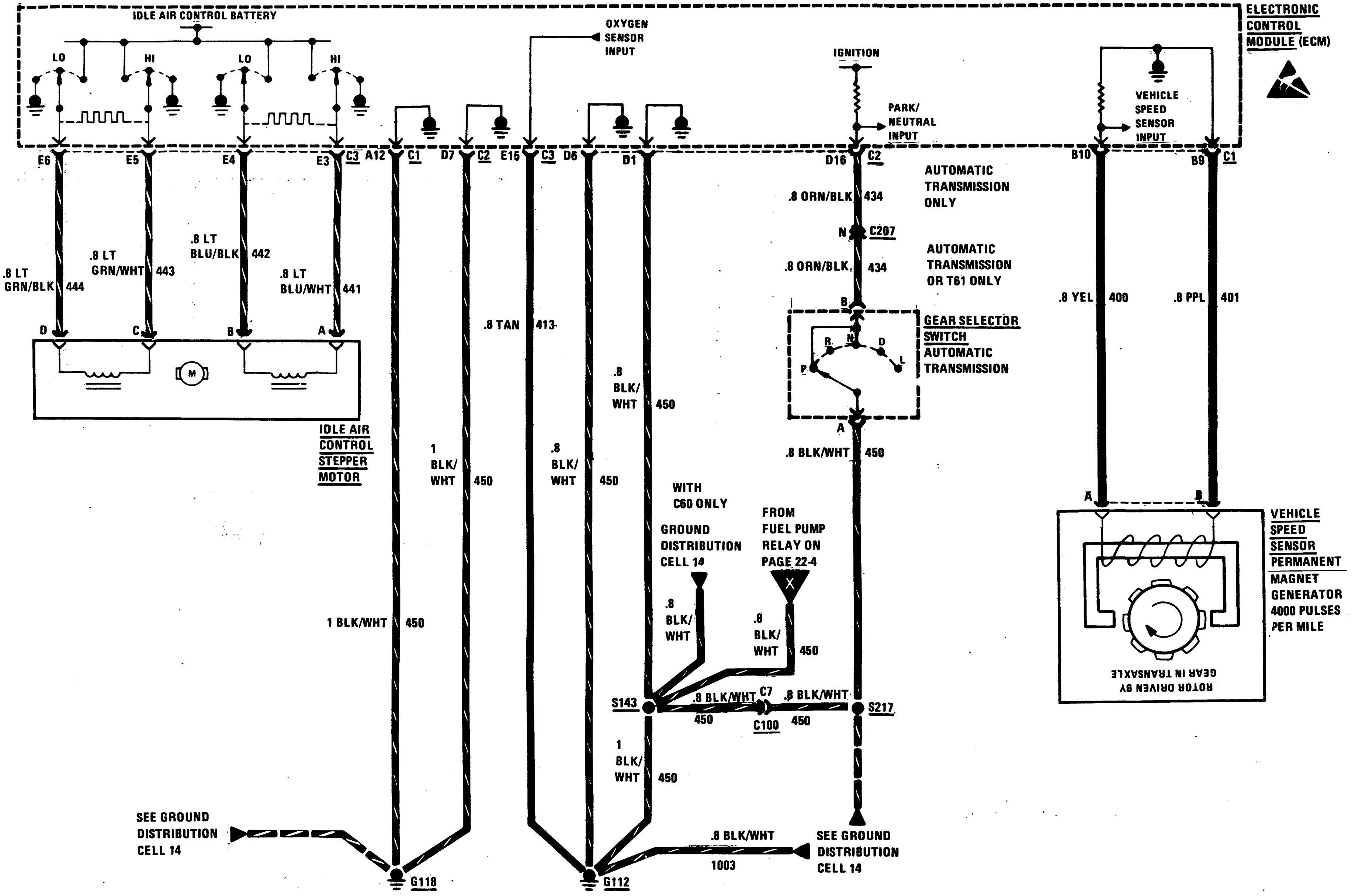
TUNED PORT INJECTION (V8 VIN F) AND MULTI-PORT FUEL INJECTION (V8 VIN 8)

IDLE SPEED CONTROL, FUEL CONTROL, AND VEHICLE DATA SENSORS



SEE 8A-4-0 FOR MEASURING AND HANDLING PROCEDURES

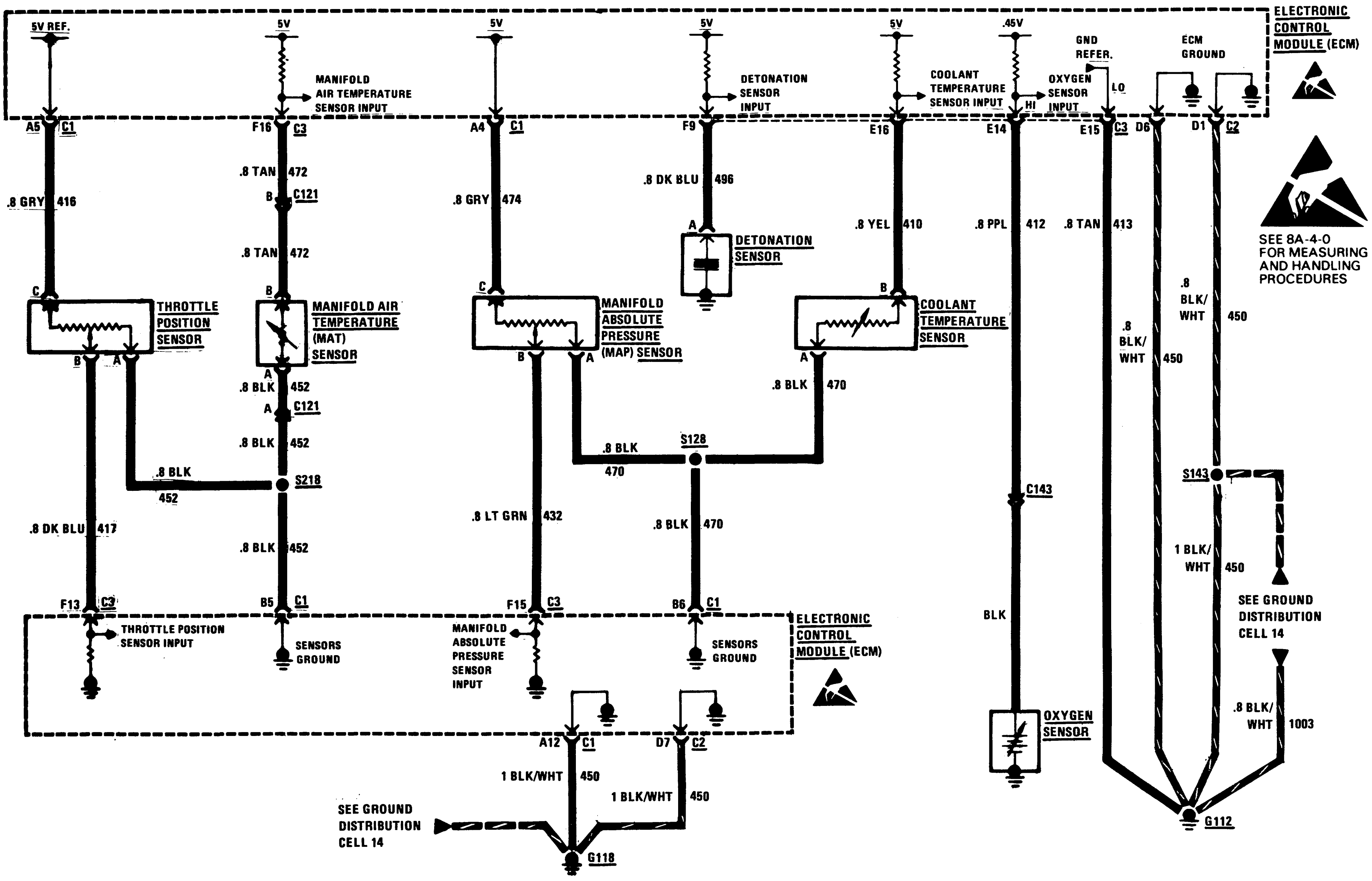
ECM CONNECTOR IDENTIFICATION				
C1	–	BLACK	–	24 WAY
C2	–	BLACK	–	32 WAY
C3	–	GREEN	–	32 WAY


IDLE AIR CONTROL BATTERY
LO
HI
LO
HI
OXYGEN SENSOR INPUT
IGNITION
PARK/ NEUTRAL INPUT
VEHICLE SPEED SENSOR INPUT
ELECTRONIC CONTROL MODULE (ECM)
E6
E5
E4
E3
C3
A12
C1
D7
C2
E15
C3
D6
D1
D16
C2
B10
B9
C1
AUTOMATIC TRANSMISSION ONLY
.8 ORN/BLK 434
N C207
AUTOMATIC TRANSMISSION OR T61 ONLY
.8 ORN/BLK 434
.8 LT GRN/BLK 444
.8 LT GRN/WHT 443
.8 LT BLU/BLK 442
.8 LT BLU/WHT 441
.8 TAN 413
.8 BLK/ WHT 450
.8 YEL 400
.8 PPL 401
D
C
B
A
M
IDLE AIR CONTROL STEPPER MOTOR
B
R
N
D
L
P
GEAR SELECTOR SWITCH AUTOMATIC TRANSMISSION
A
.8 BLK/WHT 450
1 BLK/ WHT 450
.8 BLK/ WHT 450
WITH C60 ONLY
GROUND DISTRIBUTION CELL 14
FROM FUEL PUMP RELAY ON PAGE 22-4
X
.8 BLK/ WHT
.8 BLK/ WHT 450
A
B
VEHICLE SPEED SENSOR PERMANENT MAGNET GENERATOR 4000 PULSES PER MILE
ROTOR DRIVEN BY GEAR IN TRANSAXLE
1 BLK/WHT 450
S143
.8 BLK/WHT 450
C7
C100
.8 BLK/WHT 450
S217
1 BLK/ WHT 450
SEE GROUND DISTRIBUTION CELL 14
G118
G112
.8 BLK/WHT 1003
SEE GROUND DISTRIBUTION CELL 14

TUNED PORT INJECTION (V8 VIN F) AND MULTI-PORT FUEL INJECTION (V8 VIN 8)

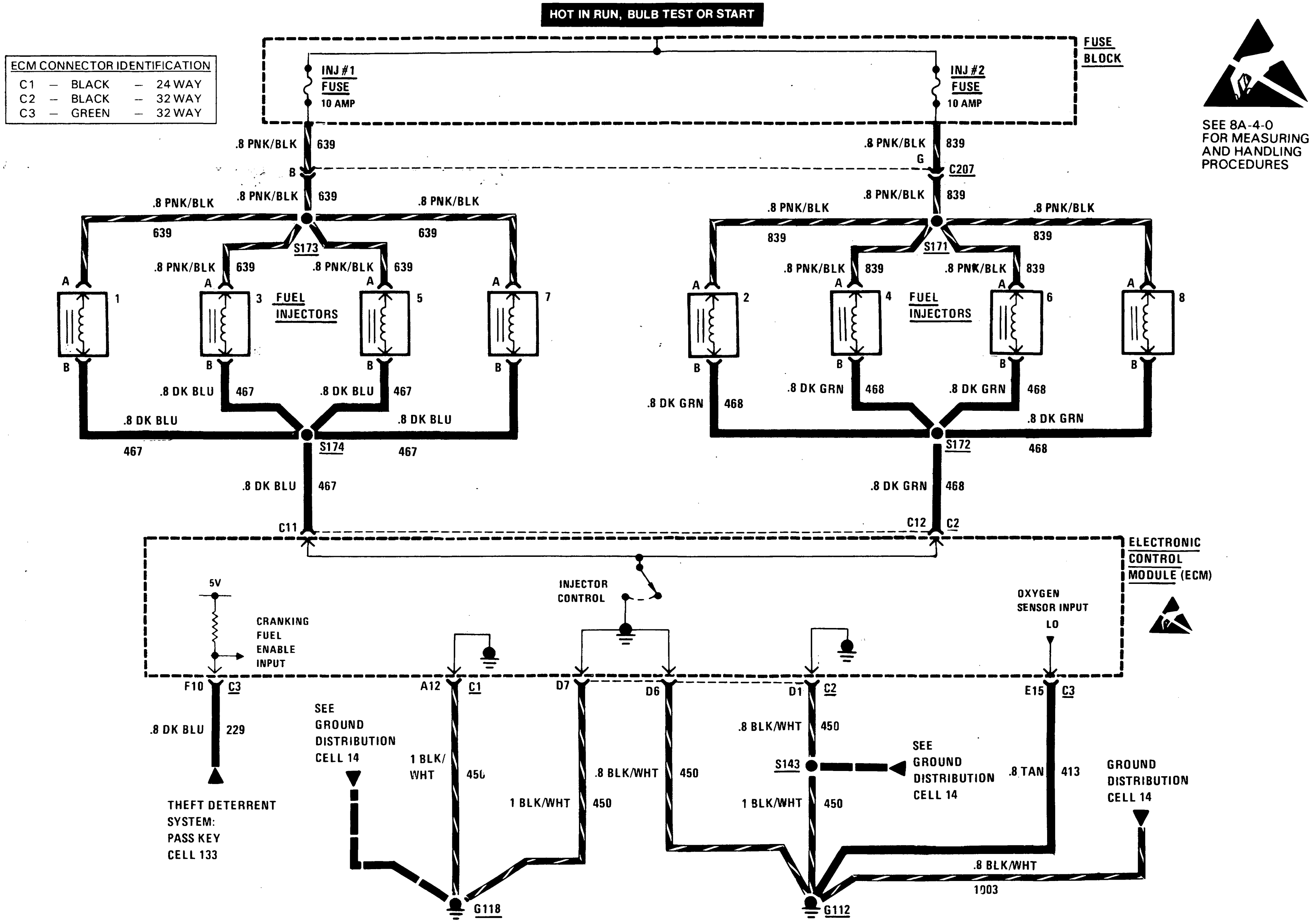
ENGINE DATA SENSORS

ECM CONNECTOR IDENTIFICATION				
C1	—	BLACK	—	24 WAY
C2	—	BLACK	—	32 WAY
C3	—	GREEN	—	32 WAY



TUNED PORT INJECTION (V8 VIN F) AND MULTI-PORT FUEL INJECTION (V8 VIN 8)

FUEL INJECTORS



ECM CONNECTOR IDENTIFICATION					
C1	–	BLACK	–	24 WAY	
C2	–	BLACK	–	32 WAY	
C3	–	GREEN	–	32 WAY	

SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES

COMPONENT LOCATION

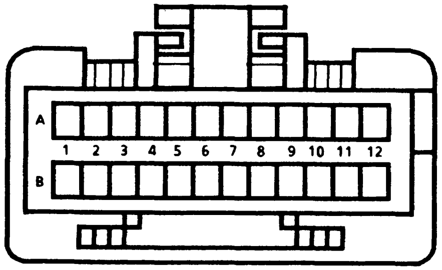
		Page-Figure
AIR Diverter Valve (VIN F)(VIN 8)	RH front of engine	201- 6-A
AIR Select Valve (VIN F)(VIN 8)	RH front of engine	201- 6-A
Assembly Line Diagnostic Link (ALDL) Connector	Under LH side of I/P, on Fuse Block	201-13-A
Brake Switch	Behind LH side of I/P, top of brake pedal support	201-13-C
Canister Purge Solenoid Valve (VIN F)(VIN 8)	LH front of engine compartment	201- 8-A
Coolant Temperature Sensor (VIN F)(VIN 8)	Top RH side of engine	201- 8-C
Detonation Sensor (VIN F)(VIN 8)	Lower RH side of engine, near Starter Solenoid	201- 9-C
Electronic Control Module (ECM) (Except VIN E)	Behind RH side of I/P	201-15-B
Electronic Spark Timing (EST) Distributor (VIN F)(VIN 8)	Top rear of engine	201- 7-A
Exhaust Gas Recirculation (EGR) Solenoid (VIN F)(VIN 8)	Top RH rear of engine	201- 9-D
Fuel Injectors (VIN F)(VIN 8)	Top of engine	201- 6-A
Fuel Pump Prime Connector (VIN F)(VIN 8)	RH rear corner of engine compartment	
Fuel Pump Relay	LH front of dash, on relay bracket	
Fuel Pump/Oil Pressure Sender/ Switch (VIN F)(VIN 8)	Lower LH side of engine	201- 7-B
Fuel Tank Unit	Top of fuel tank	
Fuse Block	Behind LH side of I/P	201-13-A
Gear Selector Switch	In console, at gear selector	201-17-F
Idle Air Control Stepper Motor (VIN F)(VIN 8)	Top RH side of engine	201- 8-C
Ignition Coil (VIN F)	Top RH rear of engine	201- 8-B
Ignition Switch	At base of steering column, below I/P	201-14-A
In-Line Fuse No. 2	RH front of engine compartment, near battery	201- 9-E
Manifold Absolute Pressure (MAP) Sensor (VIN F)(VIN 8)	RH rear of engine	201- 9-B
Manifold Air Temperature (MAT) Sensor (VIN F)(VIN 8)	Top rear of engine, on air intake shroud	
Oxygen Sensor (VIN F)(VIN 8)	LH side of engine, in exhaust manifold	201- 7-C

COMPONENT LOCATION

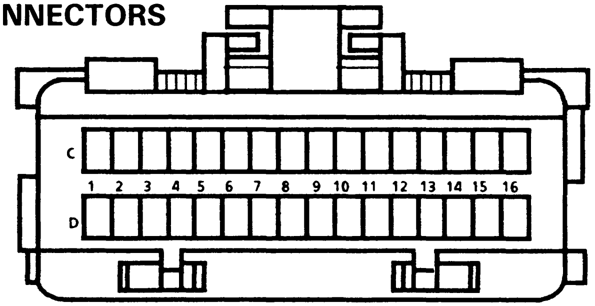
		Page-Figure
Throttle Position Sensor (VIN F)(VIN 8)	Top RH side of engine	201- 8-C
Vehicle Speed Sensor	LH side of transmission	201-12-B
C100 (42 cavities)	LH front of dash, below relay bracket	201-12-A
C108 (4 cavities)	Top rear of engine, near Electronic Spark Timing (EST) Distributor	
C114 (1 cavity) (VIN F)(VIN 8)	Top rear of engine, near Ignition Coil	201- 8-B
C121 (2 cavities)	Top rear of engine	201- 7-A
C143 (1 cavity) (VIN F)(VIN 8)	Lower LH side of engine	201- 7-C
C146 (1 cavity)	RH rear of engine compartment	
C207 (15 cavities)	Behind RH side of I/P	201-15-A
C313 (3 cavities)	Below car, forward of fuel tank	201-18-E
G112 (VIN F)(VIN 8)	Rear of LH cylinder head	201- 7-A
G118 (VIN F)(VIN 8)	Rear of RH cylinder head	201- 7-A
G304	Under driver's seat, on floor rail	201-16-A
S128 (VIN F)(VIN 8)	Engine harness, RH rear of engine compartment	201- 6-A
S143 (VIN F)(VIN 8)	Engine harness, RH rear of engine compartment	201- 7-A
S145 (VIN F)(VIN 8)	Engine harness, LH rear of engine compartment.	201- 8-A
S146 (Except VIN E)	Engine harness, behind RH side of I/P, near Electronic Control Module (ECM)	201-15-B
S163 (VIN F)(VIN 8)	Engine harness, LH rear of engine compartment.	201- 8-A
S164	I/P harness, behind LH side of I/P	201-14-A
S171 (VIN F)(VIN 8)	Engine harness, RH rear of engine	201- 7-A
S172 (VIN F)(VIN 8)	Engine harness, RH rear of engine	201- 7-A
S173 (VIN F)(VIN 8	Engine harness, top rear of engine	201- 7-A
S174 (VIN F)(VIN 8)	Engine harness, top rear of engine	201- 7-A
S175 (VIN F)(VIN 8)	Engine harness, behind RH rear of engine	201- 7-A
S204	I/P harness, behind LH side of instrument cluster	201-13-A
S217	I/P harness, behind RH side of instrument cluster	201-12-A
S218 (VIN F)(VIN 8)	Engine harness, behind RH rear of engine	201- 7-A
S276	I/P harness, near Fuse Block	201-13-A

TUNED PORT INJECTION (V8 VIN F) AND MULTI-PORT FUEL INJECTION (V8 VIN 8)

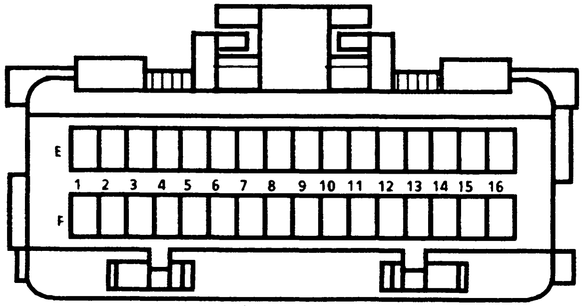
ELECTRONIC CONTROL MODULE CONNECTORS



C1 BLACK



C2 BLACK



C3 GREEN

Cavity	Wire Color	Circuit Number	Circuit Function
A1	–	–	(NOT USED)
A2	–	–	(NOT USED)
A3	–	–	(NOT USED)
A4	GRY	474	5V TO MANIFOLD ABSOLUTE PRESSURE SENSOR
A5	GRY	416	5V TO THROTTLE POSITION SENSOR
A6	PNK/BLK	439	IGNITION
A7	–	–	(NOT USED)
A8	ORN	461	DATA LINE
A9	–	–	(NOT USED)
A10	–	–	(NOT USED)
A11	DK GRN/WHT	465	FUEL PUMP RELAY CONTROL
A12	BLK/WHT	450	GROUND
B1	ORN	340	BATTERY
B2	–	–	(NOT USED)
B3	–	–	(NOT USED)
B4	–	–	(NOT USED)
B5	BLK	452	THROTTLE POSITION SENSOR AND MANIFOLD AIR TEMPERAURE SENSOR GROUND
B6	BLK	470	MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR AND COOLANT TEMPERATURE SENSOR GROUND
B7	–	–	(NOT USED)
B8	–	–	(NOT USED)
B9	PPL	401	VEHICLE SPEED SENSOR GROUND
B10	YEL	400	VEHICLE SPEED SENSOR INPUT
B11	GRY	1019	VEHICLE SPEED OUTPUT 4000 PPM)
B12	–	–	(NOT USED)

Cavity	Wire Color	Circuit Number	Circuit Function
	Socket Half		
C1	RED	381	VEHICLE SPEED OUTPUT 2000 PPM
C2	–	–	(NOT USED)
C3	–	–	(NOT USED)
C4	–	–	(NOT USED)
C5	–	–	(NOT USED)
C6	–	–	(NOT USED)
C7	TAN/BLK	424	IGNITION MODULE BYPASS OUTPUT
C8	WHT	423	SPARK TIMING OUTPUT
C9	DK GRN	59	A/C ON INPUT
C10	–	–	(NOT USED)
C11	DK BLU	467	FUEL INJECTOR CONTROL
C12	DK GRN	468	FUEL INJECTOR CONTROL
C13	–	–	(NOT USED)
C14	–	–	(NOT USED)
C15	–	–	(NOT USED)
C16	ORN	340	BATTERY
D1	BLK/WHT	450	GROUND
D2	–	–	(NOT USED)
D3	–	–	(NOT USED)
D4	–	–	(NOT USED)
D5	–	–	(NOT USED)
D6	BLK/WHT	450	GROUND
D7	BLK/WHT	450	GROUND
D8	PPL/WHT	430	DISTRIBUTOR REFERENCE PULSE INPUT HI
D9	BLK/RED	453	DISTRIBUTOR REFERENCE PULSE INPUT LO
D10	–	–	(NOT USED)

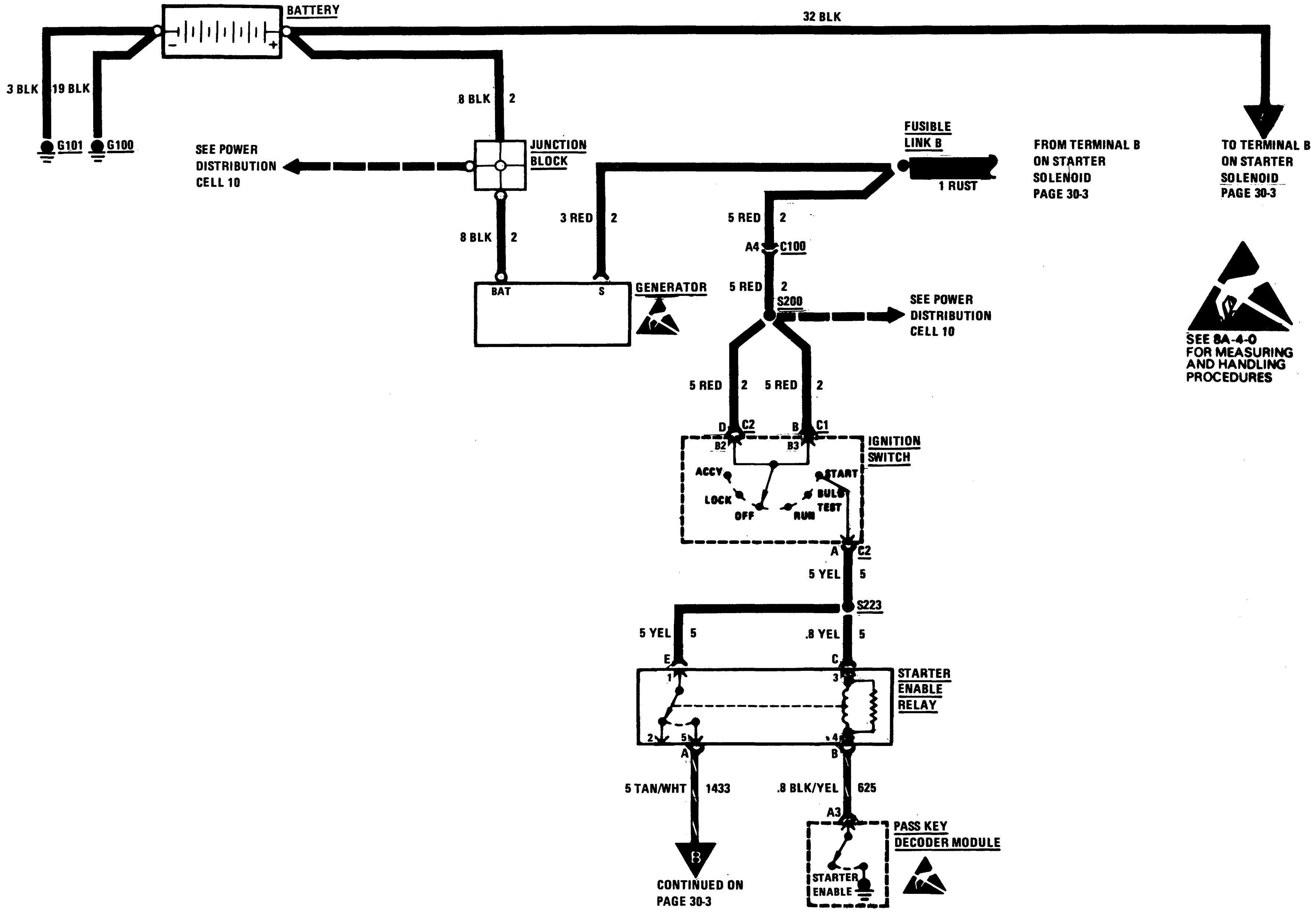
TUNED PORT INJECTION (V8 VIN F) AND MULTI-PORT FUEL INJECTION (V8 VIN 8)

ELECTRONIC CONTROL MODULE CONNECTORS

Cavity	Wire Color	Circuit Number	Circuit Function
D11	–	–	(NOT USED)
D12	GRY	731	A/C PRESSURE FAN SWITCH INPUT
D13	–	–	(NOT USED)
D14	LT BLU	446 (AUTO)	TOP GEAR (FOURTH CLUTCH INPUT)
D15	–	–	(NOT USED)
D16	ORN/BLK	434 (AUTO)	PARK/NEUTRAL INPUT
E1	–	–	(NOT USED)
E2	–	–	(NOT USED)
E3	LT BLU/WHT	441	IDLE AIR CONTROL A HI
E4	LT BLU/BLK	442	IDLE AIR CONTROL A LO
E5	LT GRN/WHT	443	IDLE AIR CONTROL B HI
E6	LT GRN/BLK	444	IDLE AIR CONTROL B LO
E7	BRN/WHT	419	SERVICE ENGINE SOON INDICATOR CONTROL
E8	DK GRN/WHT	335	COOLANT FAN CONTROL
E9	GRY	435	EGR SOLENOID CONTROL
E10	–	–	(NOT USED)
E11	–	–	(NOT USED)
E12	WHT/BLK	451	DIAGNOSTIC "TEST" INPUT
E13	GRY	120	FUEL PUMP CONTROL UNIT
E14	PPL	412	OXYGEN SENSOR INPUT HI
E15	TAN	413	OXYGEN SENSOR INPUT LO
E16	YEL	410	COOLANT TEMPERATURE SENSOR INPUT
F1	TAN/BLK	456 (MAN)	UPSHIFT INDICATOR CONTROL
F2	BRN	436	AIR SELECT VALVE CONTROL
F3	–	–	(NOT USED)
F4	BLK/PNK	429	AIR DIVERTER VALVE CONTROL
F5	–	–	(NOT USED)
F6	TAN/BLK	422 (AUTO)	TRANSMISSION CONVERTER CLUTCH (TCC) CONTROL
F7	DK GRN/YEL	428	CANISTER PURGE SOLENOID CONTROL
F8	–	–	(NOT USED)
F9	DK BLU	496	DETONATION SENSOR INPUT
F10	DK BLU	229	PASS KEY CRANK FUEL ENABLE INPUT
F11	–	–	(NOT USED)
F12	–	–	(NOT USED)
F13	DK BLU	417	THROTTLE POSITION SENSOR INPUT
F14	–	–	(NOT USED)
F15	LT GRN	432	MANIFOLD ABSOLUTE PRESSURE SENSOR INPUT
F16	TAN	472	MANIFOLD AIR TEMPERATURE SENSOR INPUT

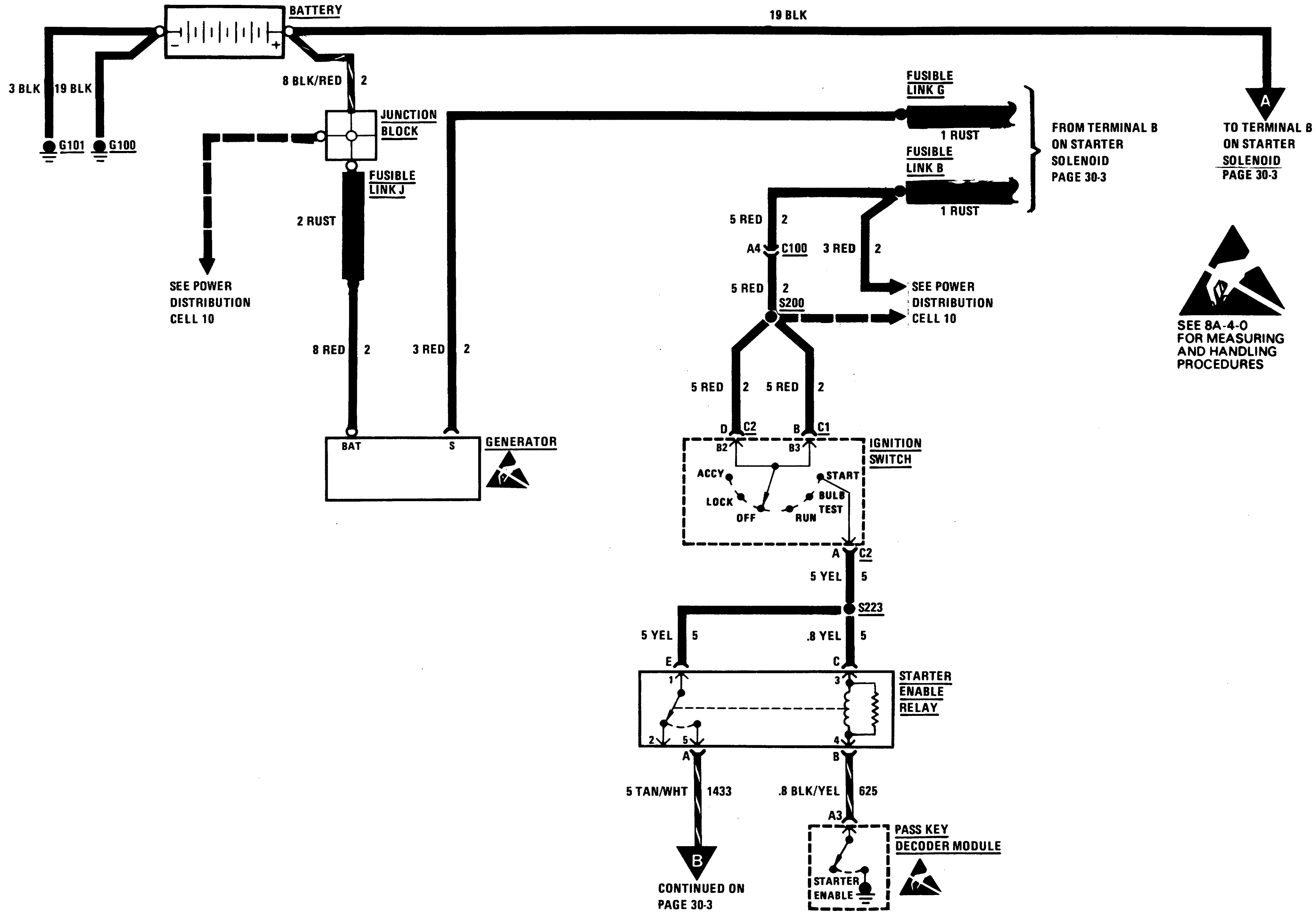
STARTER AND CHARGING SYSTEM: V6 VIN T

STARTER



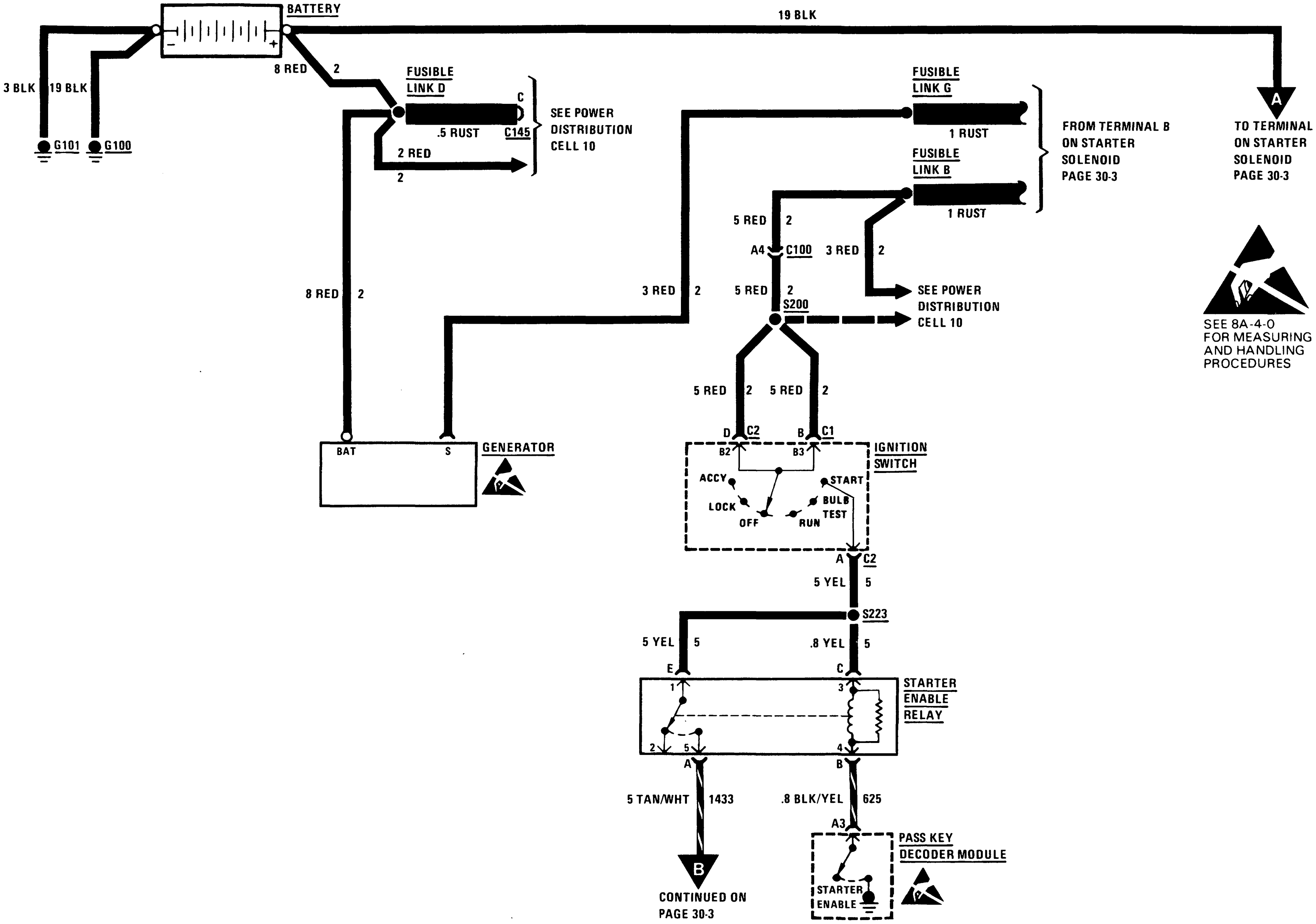
STARTER AND CHARGING SYSTEM: V8 VIN E

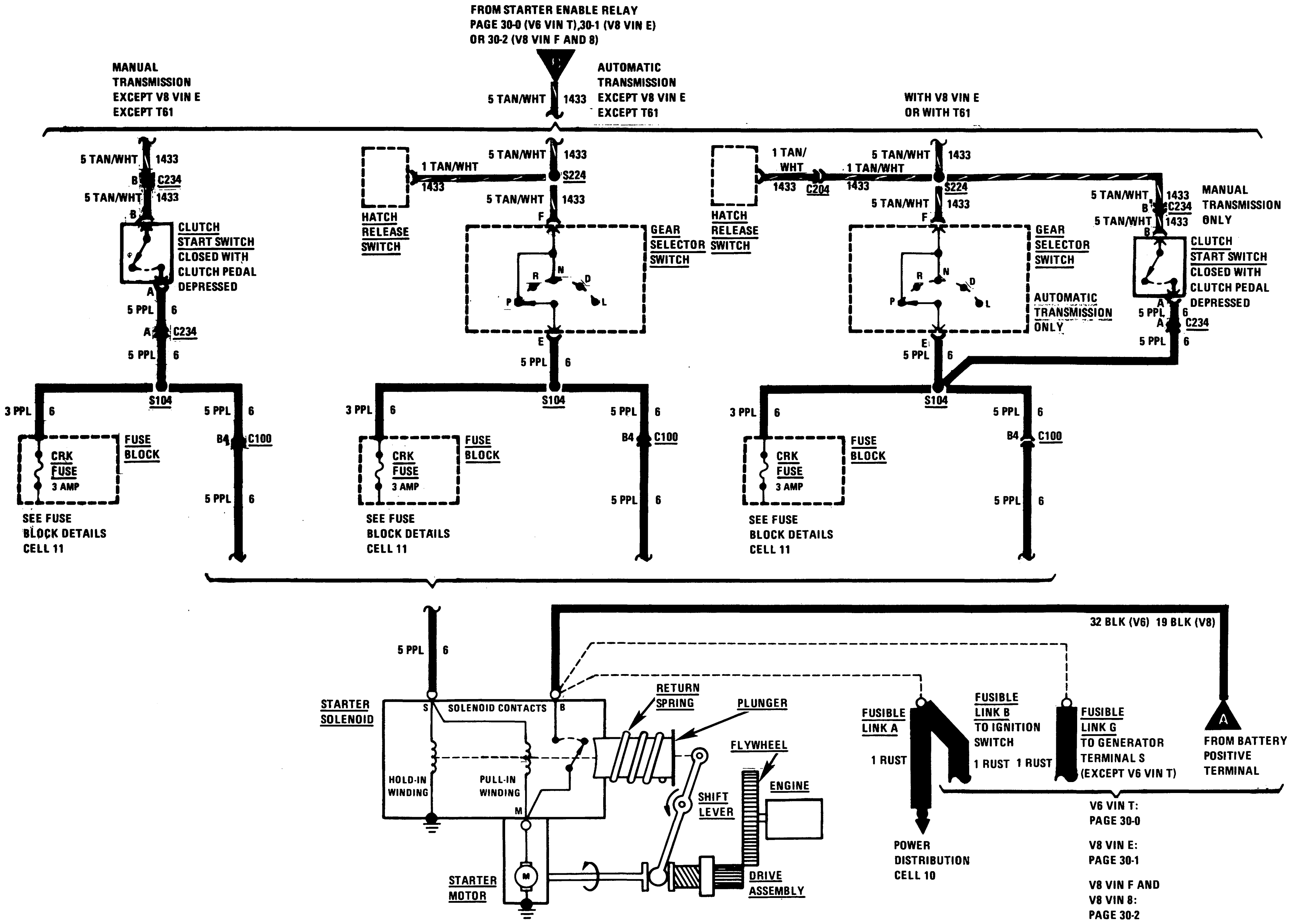
STARTER



STARTER AND CHARGING SYSTEM: V8 VIN F AND V8 VIN 8

STARTER




FROM STARTER ENABLE RELAY
PAGE 30-0 (V6 VIN T),30-1 (V8 VIN E)
OR 30-2 (V8 VIN F AND 8)
B
MANUAL
TRANSMISSION
EXCEPT V8 VIN E
EXCEPT T61
AUTOMATIC
TRANSMISSION
EXCEPT V8 VIN E
EXCEPT T61
WITH V8 VIN E
OR WITH T61
5 TAN/WHT
1433
B
C234
CLUTCH
START SWITCH
CLOSED WITH
CLUTCH PEDAL
DEPRESSED
A
5 PPL
6
S104
3 PPL
B4
C100
FUSE
BLOCK
CRK
FUSE
3 AMP
SEE FUSE
BLOCK DETAILS
CELL 11
1 TAN/WHT
S224
HATCH
RELEASE
SWITCH
F
GEAR
SELECTOR
SWITCH
R
N
D
P
L
E
1 TAN/
WHT
C204
AUTOMATIC
TRANSMISSION
ONLY
MANUAL
TRANSMISSION
ONLY
32 BLK (V6) 19 BLK (V8)
STARTER
SOLENOID
S
SOLENOID CONTACTS
B
RETURN
SPRING
PLUNGER
FLYWHEEL
ENGINE
HOLD-IN
WINDING
PULL-IN
WINDING
M
SHIFT
LEVER
STARTER
MOTOR
DRIVE
ASSEMBLY
FUSIBLE
LINK A
1 RUST
FUSIBLE
LINK B
TO IGNITION
SWITCH
1 RUST
FUSIBLE
LINK G
TO GENERATOR
TERMINAL S
(EXCEPT V6 VIN T)
A
FROM BATTERY
POSITIVE
TERMINAL
POWER
DISTRIBUTION
CELL 10
V6 VIN T:
PAGE 30-0
V8 VIN E:
PAGE 30-1
V8 VIN F AND
V8 VIN 8:
PAGE 30-2

TROUBLESHOOTING HINTS

STARTER

- **Try the following checks before doing the System Diagnosis.**

1. Check the hydrometer eye that is built into the vehicle Battery before troubleshooting the Starter System.

— Green eye — Battery is charged.

— Dark eye — Battery is discharged. Recharge Battery.

— Clear or yellow eye — Battery fluid is low. Replace Battery.

2. Check that Starter Solenoid terminals S and B and battery connections are clean and tight.
3. Check that grounds G100 and G101 are clean and tight.

- **Go to System Diagnosis for diagnostic tests.**

SYSTEM DIAGNOSIS

STARTER

- **Do the following checks to choose the proper diagnostic tests.**

PASS KEY OR STARTER SYSTEM

A "No Crank" condition may be caused by either the PASS Key System or the Battery/Starter System. To locate the cause of the condition, follow these procedures.

1. Check whether ECM code 46 (except V8 VIN E) or 53 (V8 VIN E)is set or displayed.

— If code 46 (except V8 VIN E) or 53 (V8 VIN E) is present, proceed to Section 8A-133 for PASS Key System Diagnosis.

— If code 46 (except V8 VIN E) or 53 (V8 VIN E) is not present, go to step 2.

COMPONENT LOCATION

		Page-Figure
Clutch Start Switch	Below I/P, on clutch pedal bracket	201-16-C
Fuse Block	Behind LH side of I/P	201-13-A
Fusible Link A (VIN E)	Lower RH side of engine, at Starter Solenoid	201- 6-C
Fusible Link A (VIN F)(VIN 8)	Lower RH side of engine, at Starter Solenoid	201- 9-C
Fusible Link A (VIN T)	Lower RH side of engine, at Starter Solenoid	201- 2-B
Fusible Link B (VIN E)	Lower RH side of engine, at Starter Solenoid	201- 6-C
Fusible Link B (VIN F)(VIN 8)	Lower RH side of engine, at Starter Solenoid	201- 9-C
Fusible Link B (VIN T)	Lower RH side of engine, at Starter Solenoid	201- 2-B
Fusible Link D	RH front of engine compartment, near battery	201- 9-A
Fusible Link G (VIN E)	Lower RH side of engine, at Starter Solenoid	201- 6-C
Fusible Link G (VIN F)(VIN 8)	Lower RH side of engine, at Starter Solenoid	201- 9-C
Fusible Link J	RH front of engine compartment, at Junction Block	201- 3-A
Gear Selector Switch	In console, at gear selector	201-17-F
Generator (VIN E)	Top LH front of engine	201- 5-A
Generator (VIN F)(VIN 8)	LH front of engine	201- 8-A
Generator (VIN T)	Top RH side of engine	201- 2-A
Ignition Switch	At base of steering column, below I/P	201-14-A
Junction Block (VIN E)	RH side of radiator support bracket	201- 3-A
Junction Block (VIN T)	RH side of radiator support bracket	201- 2-A
PASS Key Decoder Module	Behind RH side of I/P	201-15-A
Starter Enable Relay	Below LH side of I/P, on kick panel	201-16-A
Starter Solenoid (VIN E)	Lower RH side of engine	201- 6-C
Starter Solenoid (VIN F)(VIN 8)	Lower RH side of engine	201- 9-C
Starter Solenoid (VIN T)	Lower RH side of engine	201- 2-B
C100 (42 cavities)	LH front of dash, below relay bracket	201-12-A
C204 (1 cavity)	Behind center of I/P	201-12-A
C234 (2 cavities)	Below LH side of I/P, near shroud	201-16-C
G100 (Except VIN T)	Lower RH front of engine	201- 5-B
G100 (VIN T)	Lower LH front of engine	201- 0-C
G101 (Except VIN T)	RH inner fender panel, near battery	201- 9-A
G101 (VIN T)	LH inner fender panel, near battery	201- 3-C
S104	I/P harness, behind LH side of I/P	201-12-A
S200	I/P harness, above steering column	201-13-A
S223	I/P harness, behind LH side of I/P	201-12-A
S224	I/P harness, behind LH side of I/P, near Fuse Block	201-12-A

(Continued from previous page)

2. Go to the Starter Enable Relay that is behind the LH side of the I/P, on the kick panel (See Component Location Views). Backprobe terminal B of the relay (BLK/YEL wire) with a voltmeter to ground. Leave the connector on the relay.
3. Turn the Ignition Switch to START.

—If there is battery voltage at terminal B in START, go to Section 8A-133 for PASS Key System Diagnosis.

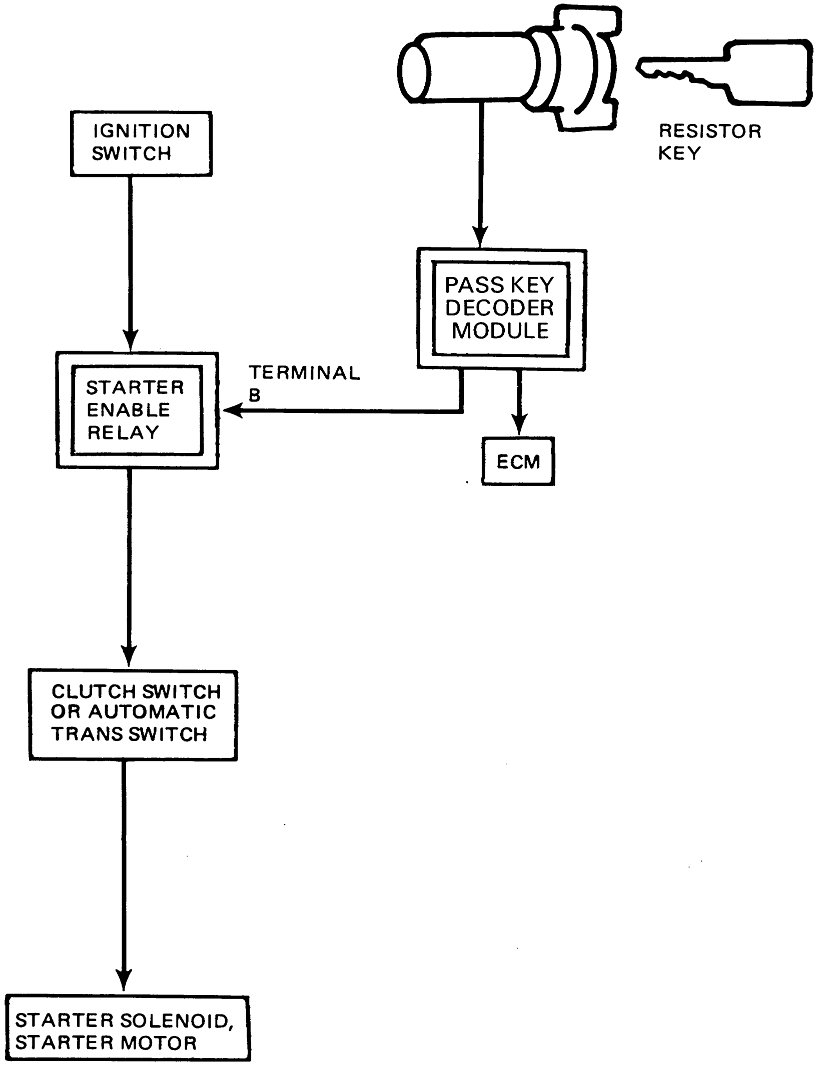
— If terminal B has 0-1.5 volts in START, continue with diagnosis on the following pages. The condition exists in the Ignition Switch or Starter System.

- **Diagnostic steps for the symptoms listed in the following table are listed after the table.**

SYMPTOM TABLE

A. Engine does not crank and the Starter Solenoid does not click.

B. The Starter Solenoid clicks, engine does not crank or cranks slowly.



A: ENGINE DOES NOT CRANK AND THE STARTER SOLENOID DOES NOT CLICK (TABLE 1)

Measure: VOLTAGE
At: STARTER SOLENOID
Conditions:

- **Ignition Switch: START**
- **Gear Selector Switch: PARK (Automatic Transmission)**
- **Clutch Depressed (Manual Transmission)**

Measure Between	Correct Voltage	For Diagnosis
S (PPL) & Ground	Battery	See 1
S (PPL) & Starter Motor mounting bolts	Battery	See 2

- If the voltages are correct, replace the Starter Solenoid. Refer to Section 6D.

1. Go to Table 2 (Automatic Transmission) or Table 3 (Manual Transmission).
2. Clean Starter Motor mounting bolts and Starter Motor to create a good ground to engine block. Scrape away any excess paint, rust or dirt.

A: ENGINE DOES NOT CRANK AND THE STARTER SOLENOID DOES NOT CLICK (TABLE 2 - AUTOMATIC TRANSMISSION)

Measure: VOLTAGE
At: GEAR SELECTOR SWITCH CONNECTOR (Disconnected)
Condition:

- **Ignition Switch: START**

Measure Between	Correct Voltage	For Diagnosis
F (TAN/WHT) & Ground	Battery	See 1

- If the voltage is correct, go to Table 4.

1. Reconnect connector and go to Table 6.

A: ENGINE DOES NOT CRANK AND THE STARTER SOLENOID DOES NOT CLICK (TABLE 3 - MANUAL TRANSMISSION)

Measure: VOLTAGE
At: CLUTCH START SWITCH CONNECTOR (Disconnected)
Condition:

- **Ignition Switch: START**

Measure Between	Correct Voltage	For Diagnosis
B (TAN/WHT) & Ground	Battery	See 1

- If the voltage is correct, go to Table 5.

1. Reconnect connector and go to Table 6.

A: ENGINE DOES NOT CRANK AND THE STARTER SOLENOID DOES NOT CLICK (TABLE 4 - AUTOMATIC TRANSMISSION)

Connect: FUSED JUMPER
At: GEAR SELECTOR SWITCH CONNECTOR (Disconnected)
Condition:

- **Ignition Switch: START**

Jumper Between	Correct Result	For Diagnosis
F (TAN/WHT) & E (PPL)	Engine cranks	See 1

- If the engine cranks, replace the Gear Selector Switch. (Check the Gear Selector Switch adjustment before replacing the switch).

1. Check/repair the PPL (6) wire for an open (see schematic).

A: ENGINE DOES NOT CRANK AND THE STARTER SOLENOID DOES NOT CLICK (TABLE 5 - MANUAL TRANSMISSION)

Connect: FUSED JUMPER
At: CLUTCH START SWITCH CONNECTOR (Disconnected)
Conditions:

- **Transmission: NEUTRAL**
- **Ignition Switch: START**

Jumper Between	Correct Result	For Diagnosis
B (TAN/WHT) & A (PPL)	Engine cranks	See 1

(Continued on next page)

(Continued from previous page)

- If the engine cranks, check/replace the Clutch Start Switch.

1. Check/repair the PPL (6) wire for an open (see schematic).

A: ENGINE DOES NOT CRANK AND THE STARTER SOLENOID DOES NOT CLICK (TABLE 6)

Measure: VOLTAGE
At: IGNITION SWITCH CONNECTORS C1 & C2 (Connected)

Measure Between	Correct Voltage	For Diagnosis
C1-B (RED) & Ground	Battery	See 1
C2-D (RED) & Ground	Battery	See 1
• Ignition Switch: START		
C2-A (YEL) & Ground	Battery	See 2

- If all voltages are correct, go to Table 7.

1. Check the RED (2) wire(s) and Fusible Link B (see schematic).
2. Replace the Ignition Switch.

A: ENGINE DOES NOT CRANK AND THE STARTER SOLENOID DOES NOT CLICK (TABLE 7)

Connect: FUSED JUMPER
At: STARTER ENABLE RELAY CONNECTOR (Connected)
Conditions:
- **Ignition Switch: START**
- **Gear Selector Switch: PARK (Automatic Transmission)**
- **Clutch Depressed (Manual Transmission)**

Jumper Between	Correct Result	For Diagnosis
B (BLK/YEL) & Ground	Engine cranks	See 1

- If the result is correct, check the BLK/YEL (625) wire for an open (see schematic). Refer to Section 8A-133 for Pass-Key Diagnostic Procedures if BLK/YEL wire is OK.

1. Go to Table 8.

A: ENGINE DOES NOT CRANK AND THE STARTER SOLENOID DOES NOT CLICK (TABLE 8)

Measure: VOLTAGE
At: STARTER ENABLE RELAY CONNECTOR (Disconnected)
Condition:
- **Ignition Switch: START**

Measure Between	Correct Voltage	For Diagnosis
E (YEL) & Ground	Battery	See 1
C (YEL) & Ground	Battery	See 1

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- If all the voltages are correct, go to Table 9.

1. Check/repair YEL (5) wire for an open (see schematic).

A: ENGINE DOES NOT CRANK AND THE STARTER SOLENOID DOES NOT CLICK (TABLE 9)

Connect: FUSED JUMPER
At: STARTER ENABLE RELAY CONNECTOR (Disconnected)
Conditions:
- **Ignition Switch: START**
- **Gear Selector Switch: PARK (Automatic Transmission)**
- **Clutch Depressed (Manual Transmission)**

Jumper Between	Correct Result	For Diagnosis
E (YEL) & A (TAN/WHT)	Engine cranks	See 1

- If the result is correct, replace the Starter Enable Relay.

1. Check/repair TAN/WHT (1433) wire for an open (see schematic).

Note: The following tests are designed for engines and batteries at normal ambient temperatures and assume that there are no engine symptoms which could cause a no start condition. To use the tests under other conditions could result in misdiagnosis.

B: THE STARTER SOLENOID CLICKS, ENGINE DOES NOT CRANK OR CRANKS SLOWLY (TABLE 1)

Measure: VOLTAGE
At: BATTERY TERMINALS
Conditions:

- **Battery: FULLY CHARGED**
- **INJ #1 Fuse removed**
- **INJ #2 Fuse removed**
- **Ignition Switch: START**
- **Engine being cranked**

Measure Between	Correct Voltage	For Diagnosis
Positive & Negative Battery Terminals	Greater than 9.5 volts	See 1

- If the voltage is correct, proceed to Table 2.

1. Refer to Section 6D for Battery Load Test. Remove Starter Assembly for repairs if the Battery is OK.

B: THE STARTER SOLENOID CLICKS, ENGINE DOES NOT CRANK OR CRANKS SLOWLY (TABLE 2)

Measure: VOLTAGE
At: BATTERY CABLES
Conditions:

- **Battery: FULLY CHARGED**
- **INJ #1 Fuse removed**
- **INJ #2 Fuse removed**
- **Ignition Switch: START**
- **Engine being cranked**

Measure Between	Correct Voltage	For Diagnosis
Negative Battery Terminal & Engine Block	Less than .5 volts	See 1
Positive Battery Terminal & Starter Solenoid, Terminal B	Less than .5 volts	See 2

- If both voltages are correct, remove the Starter Assembly for repairs. Refer to Section 6D.

1. Replace the Negative Battery Cable.
2. Replace the Positive Battery Cable.

CIRCUIT OPERATION

STARTER

When the Ignition Switch is moved to the START position, battery voltage is applied to the Starter Solenoid S terminal from the Starter Enable Relay and the Gear Selector Switch (Automatic Transmission) or the Clutch Start Switch (Manual Transmission). Both the Hold-In and Pull-In solenoid windings are energized. The circuit through the Pull-In Windings is complete to ground through the Starter Motor. The magnetic fields created by the parallel circuits of the Hold-In Windings and the Pull-In Windings work together to pull in the Starter Solenoid Plunger. The Plunger moves the Shift Lever which causes the Drive Assembly to engage the Flywheel ring gear on the engine.

When the Plunger is fully pulled-in, the solenoid switch contacts close. The closing of the solenoid switch simultaneously controls two actions. Full battery voltage is applied to the Starter Motor through the battery cable, and it cranks the engine. At the same time, battery voltage is applied to the motor terminal side of the Pull-In Winding. With battery voltage on both sides of the Pull-In Winding there is no current flow through the winding and it no longer generates a magnetic field. The magnetic field of the Hold-In Winding is sufficient to hold the plunger in while the engine is cranking.

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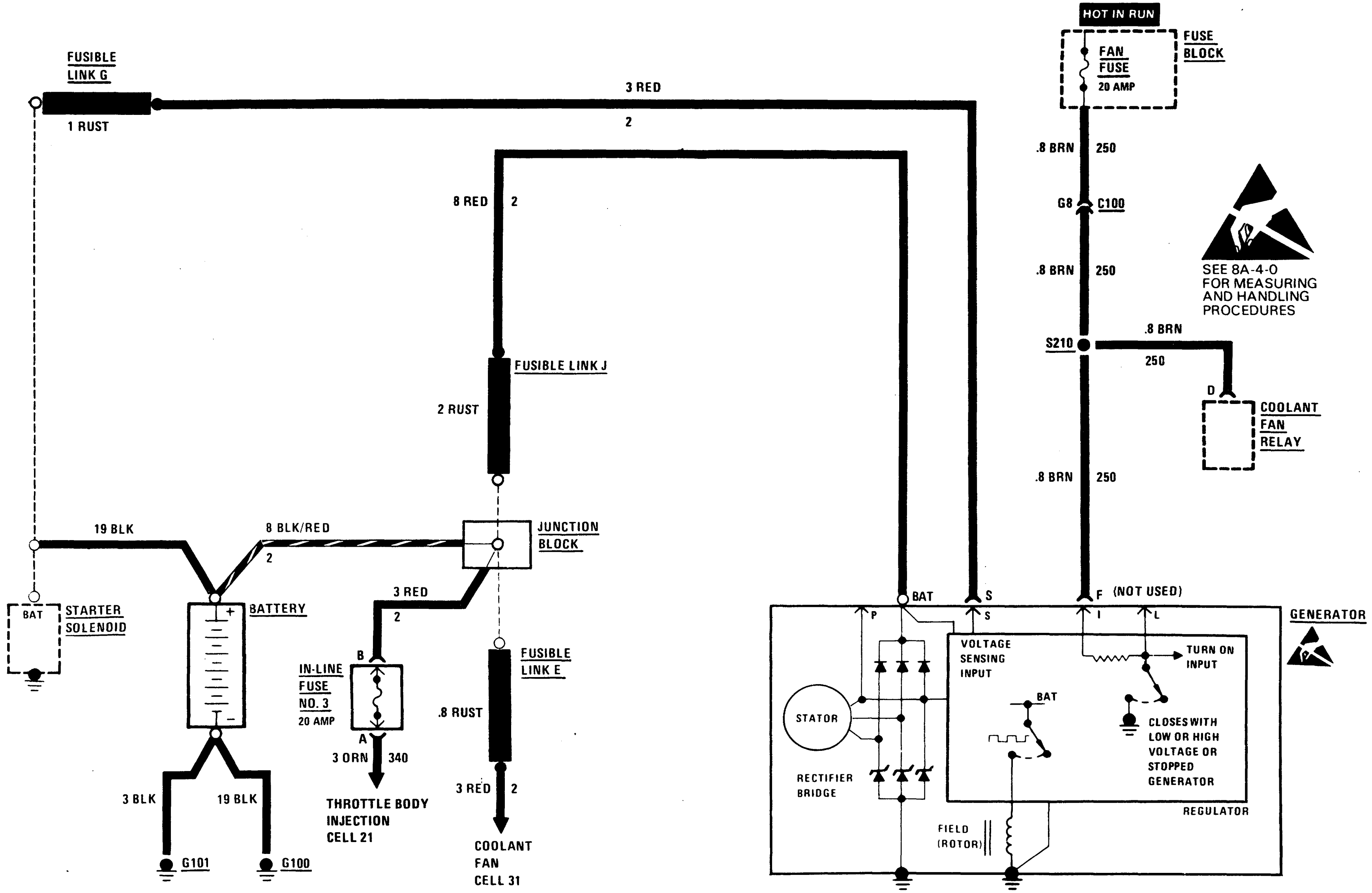
When the Ignition Switch is released from the START position, battery voltage is removed from the Starter Solenoid S terminal and the junction of the two windings. Current now flows through the solenoid switch to the motor terminal and through the Pull-In and Hold-In Windings in series. The magnetic fields oppose each other and can no longer hold in the Plunger. The Return Spring causes the Drive Assembly to disengage and at the same time opens the solenoid switch contacts. As soon as the contacts open, all electrical circuits in the Starter Motor are turned off.

STARTER AND CHARGING SYSTEM: V8 VIN E

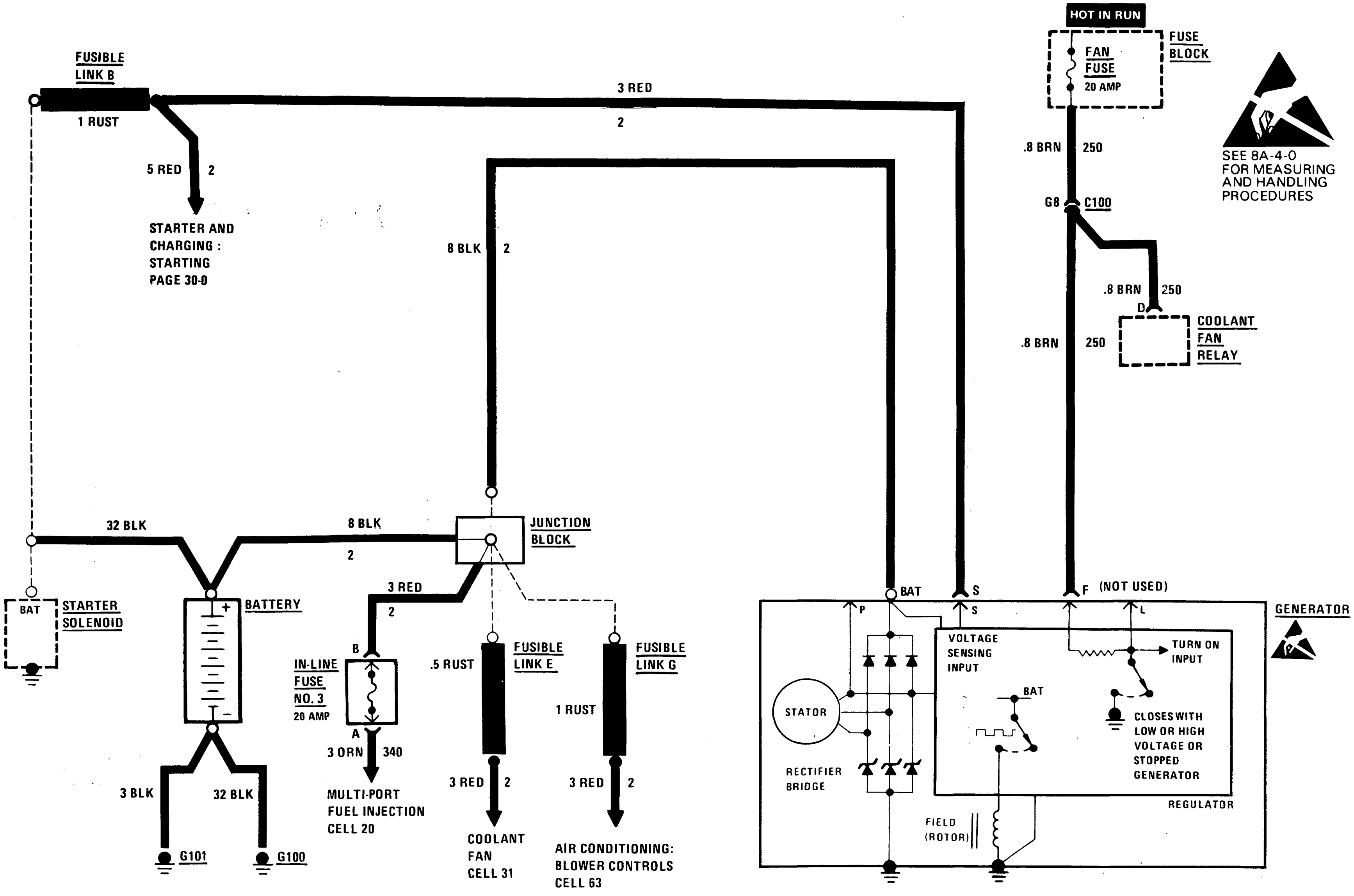
CHARGING



SEE 8A-4-0 FOR MEASURING AND HANDLING PROCEDURES

STARTER AND CHARGING SYSTEM: V6 VIN T

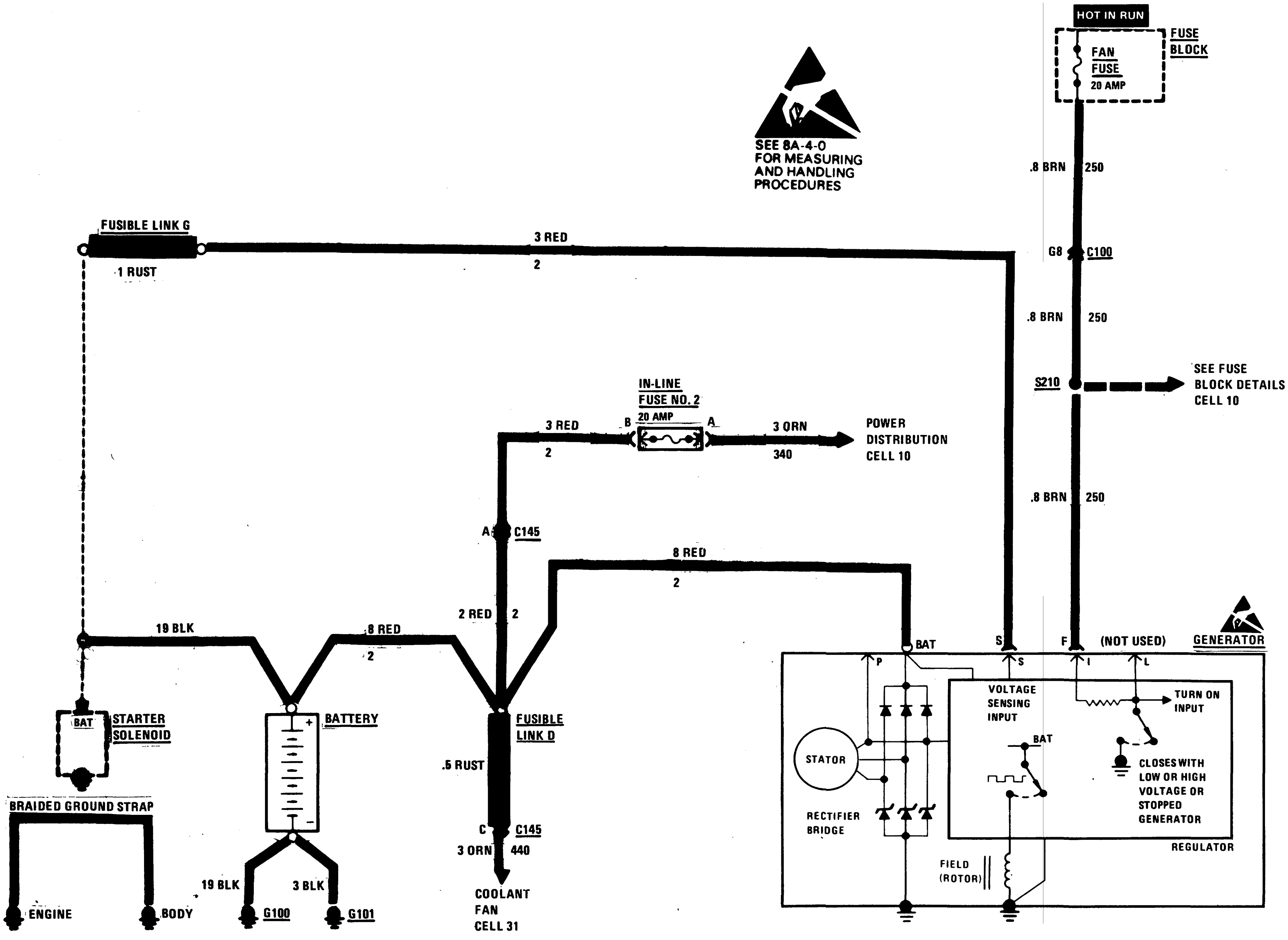
CHARGING



SEE 8A-4-0 FOR MEASURING AND HANDLING PROCEDURES

STARTER AND CHARGING SYSTEM: V6 VIN F AND V8 VIN 8

CHARGING



TROUBLESHOOTING HINTS

CHARGING

- **Try the following checks before doing the System Diagnosis.**

1. Check the hydrometer eye that is built into the vehicle Battery before troubleshooting the Charging System.

— Green eye — Battery is charged.

— Dark eye — Battery is discharged. Recharge Battery.

— Clear or Yellow eye — Battery fluid is low. Replace Battery.

2. Check Generator belt.
3. Check that Starter Solenoid, terminal B, and battery connections are clean and tight.
4. Check that Generator connector is tight and that the Generator battery terminal is clean and tight.
5. Check vehicle voltmeter (if equipped) to assure accurate voltage readings.
6. Check the FAN Fuse.

- **Diagnostic steps for the symptoms listed in the following table are listed after the table.**

SYMPTOM TABLE

A: Battery is undercharged or overcharged.

COMPONENT LOCATION

		Page-Figure
Coolant Fan Relay	LH front of dash, on relay bracket	
Fuse Block	Behind LH side of I/P	201-13-A
Fusible Link B (VIN T)	Lower RH side of engine, at Starter Solenoid	201- 2-B
Fusible Link D	RH front of engine compartment, near battery	201- 9-A
Fusible Link E (VIN E)	RH front of engine compartment, at Junction Block	201- 3-A
Fusible Link E (VIN T)	RH front of engine compartment, at Junction Block	201- 2-A
Fusible Link G (VIN E)	Lower RH side of engine, at Starter Solenoid	201- 6-C
Fusible Link G (VIN F)(VIN 8)	Lower RH side of engine, at Starter Solenoid	201- 9-C
Fusible Link G (VIN T)	RH front of engine compartment, at Junction Block	201- 2-A
Fusible Link J	RH front of engine compartment, at Junction Block	201- 3-A
Generator (VIN E)	Top LH front of engine	201- 5-A
Generator (VIN F)(VIN 8)	LH front of engine	201- 8-A
Generator (VIN T)	Top RH side of engine	201- 2-A
In-Line Fuse No. 2	RH front of engine compartment, near battery	201- 9-E
In-Line Fuse No. 3 (VIN E)	RH inner fender panel, by battery	201- 3-A
In-Line Fuse No. 3 (VIN T)	RH inner fender panel, by battery	201- 2-A
Junction Block (VIN E)	RH side of radiator support bracket	201- 3-A
Junction Block (VIN T)	RH side of radiator support bracket	201- 2-A
Starter Solenoid (VIN E)	Lower RH side of engine	201- 6-C
Starter Solenoid (VIN F)(VIN 8)	Lower RH side of engine	201- 9-C
Starter Solenoid (VIN T)	Lower RH side of engine	201- 2-B
C100 (42 cavities)	LH front of dash, below relay bracket	201-12-A
C145 (3 cavities)	RH front of engine compartment, near battery	201- 9-A
G100 (Except VIN T)	Lower RH front of engine	201- 5-B
G100 (VIN T)	Lower LH front of engine	201- 0-C
G101 (Except VIN T)	RH inner fender panel, near battery	201- 9-A
G101 (VIN T)	LH inner fender panel, near battery	201- 3-C
S210 (VIN E)	Engine harness, lower LH side of engine compartment	201- 5-A
S210 (VIN F)(VIN 8)	Engine harness, LH rear of engine compartment	201- 8-A

A: BATTERY IS UNDERCHARGED OR OVERCHARGED (TABLE 1)

Measure: VOLTAGE
At: GENERATOR CONNECTOR (Disconnected) and GENERATOR BATTERY TERMINAL
Condition:
- **Ignition Switch: RUN**

Measure Between	Correct Voltage	For Diagnosis
F & Ground (see schematic)	Battery	See 1
Battery Terminal & Ground	Battery	See 2

- If all voltages are correct, reconnect connector and go to Table 2.

1. Check/repair (250) wire and FAN Fuse for opens (see schematic).
2. Check/repair wiring to Positive Battery Terminal for an open (see schematic).

A: BATTERY IS UNDERCHARGED OR OVERCHARGED (TABLE 2)

Measure: VOLTAGE
At: GENERATOR
Conditions:
- **All Accessories Turned Off**
- **Engine Running At Fast Idle**

Measure Between	Correct Voltage	For Diagnosis
Battery Terminal & Ground	Less than 16 volts	See 1

- If voltage is correct, perform a Generator Load Test. Refer to Section D6. Perform a Battery Load Test if Generator is good. Refer to Section 6D.

1. Repair/replace Generator. Refer to Section 6D.

CIRCUIT OPERATION

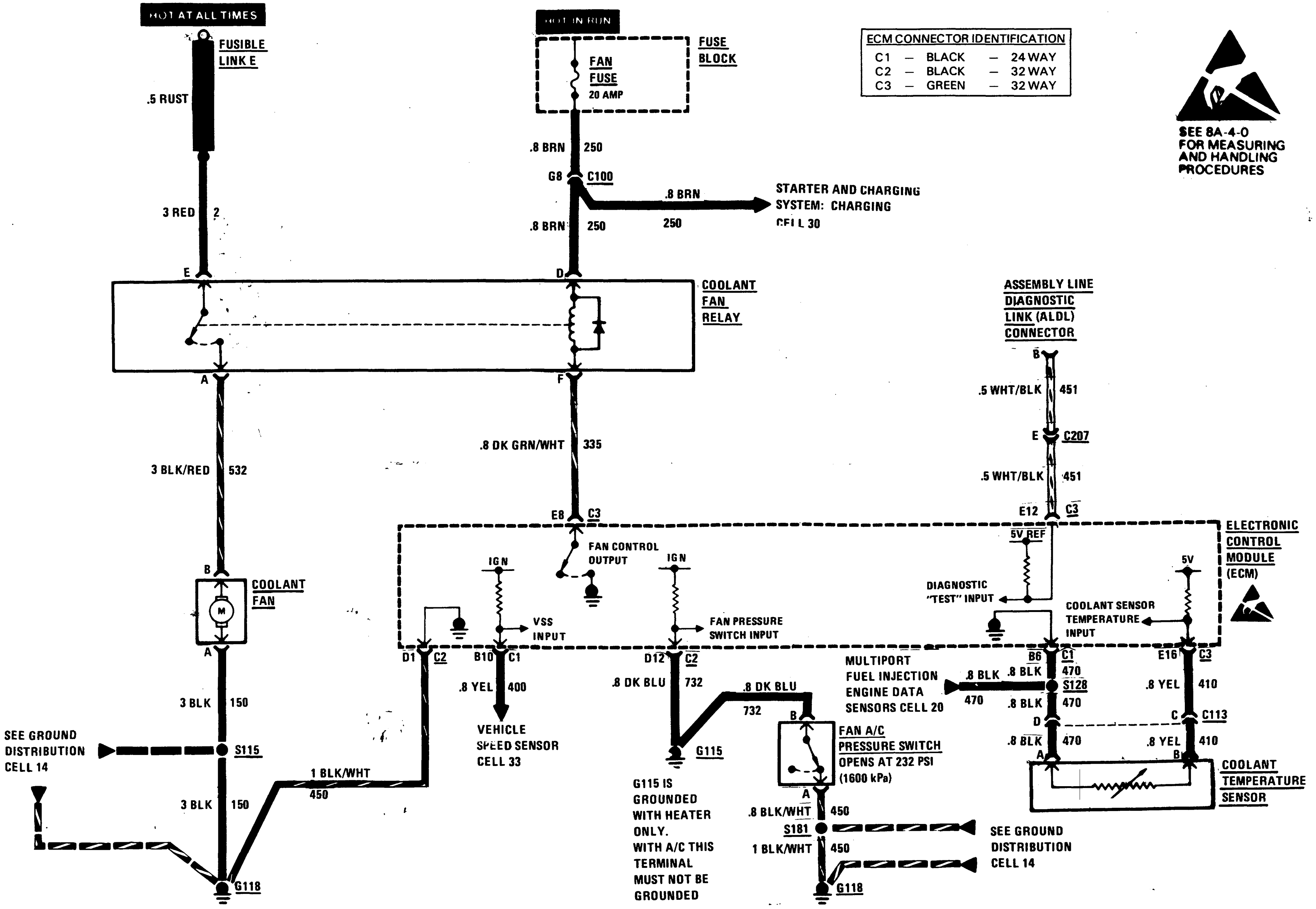
CHARGING

The Generator provides voltage to operate the car's electrical system and to charge its Battery. A magnetic field is created when current flows through the Rotor. This field rotates as the Rotor is driven by the engine, creating an AC voltage in the Stator windings. The AC voltage is converted to DC by the Rectifier Bridge and is supplied to the electrical system at the battery terminal.

The Generator's Regulator uses digital techniques to supply the Rotor current and thereby control the output voltage. The Rotor current is proportional to the width of the electrical pulses supplied by the Regulator. When the Ignition Switch is placed in RUN, voltage is supplied to terminal F via the 250 wire turning on the Regulator. Narrow width pulses are supplied to the Rotor, creating a weak magnetic field. When the engine is started, the Regulator senses Generator rotation by detecting AC voltage at the Stator through an internal wire. Once the engine is running, the Regulator monitors the battery voltage at terminal S via the 2 wire and varies the required field current by controlling the pulse width. This regulates the Generator output voltage for proper Battery charging and electrical system operation.

BLANK

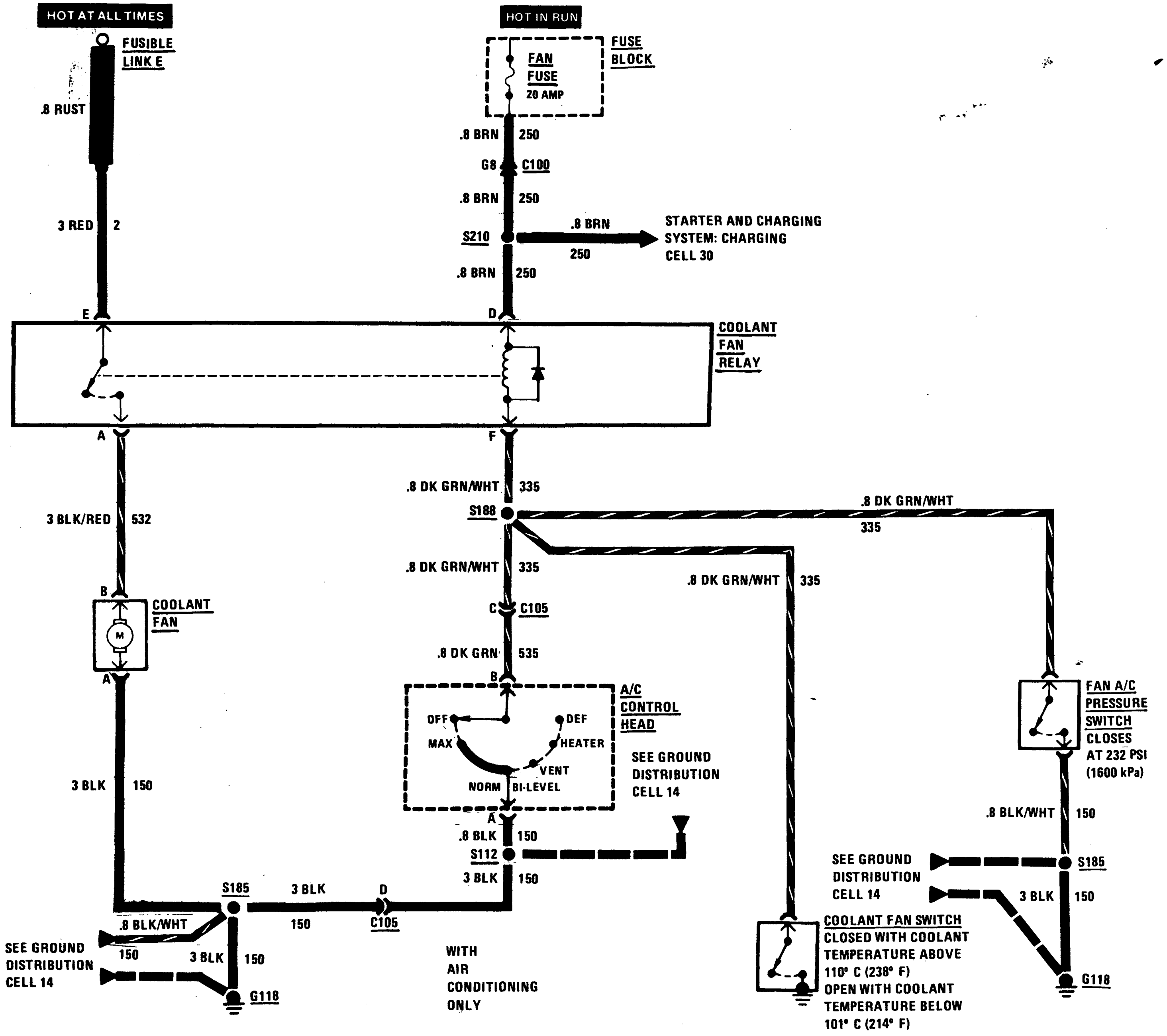
COOLANT FAN: V6 VIN T



ECM CONNECTOR IDENTIFICATION				
C1	–	BLACK	–	24 WAY
C2	–	BLACK	–	32 WAY
C3	–	GREEN	–	32 WAY

SEE 8A-4-0 FOR MEASURING AND HANDLING PROCEDURES

COOLANT FAN: V8 VIN E



COOLANT FAN: V8 VIN F AND V8 VIN 8

ECM CONNECTOR IDENTIFICATION				
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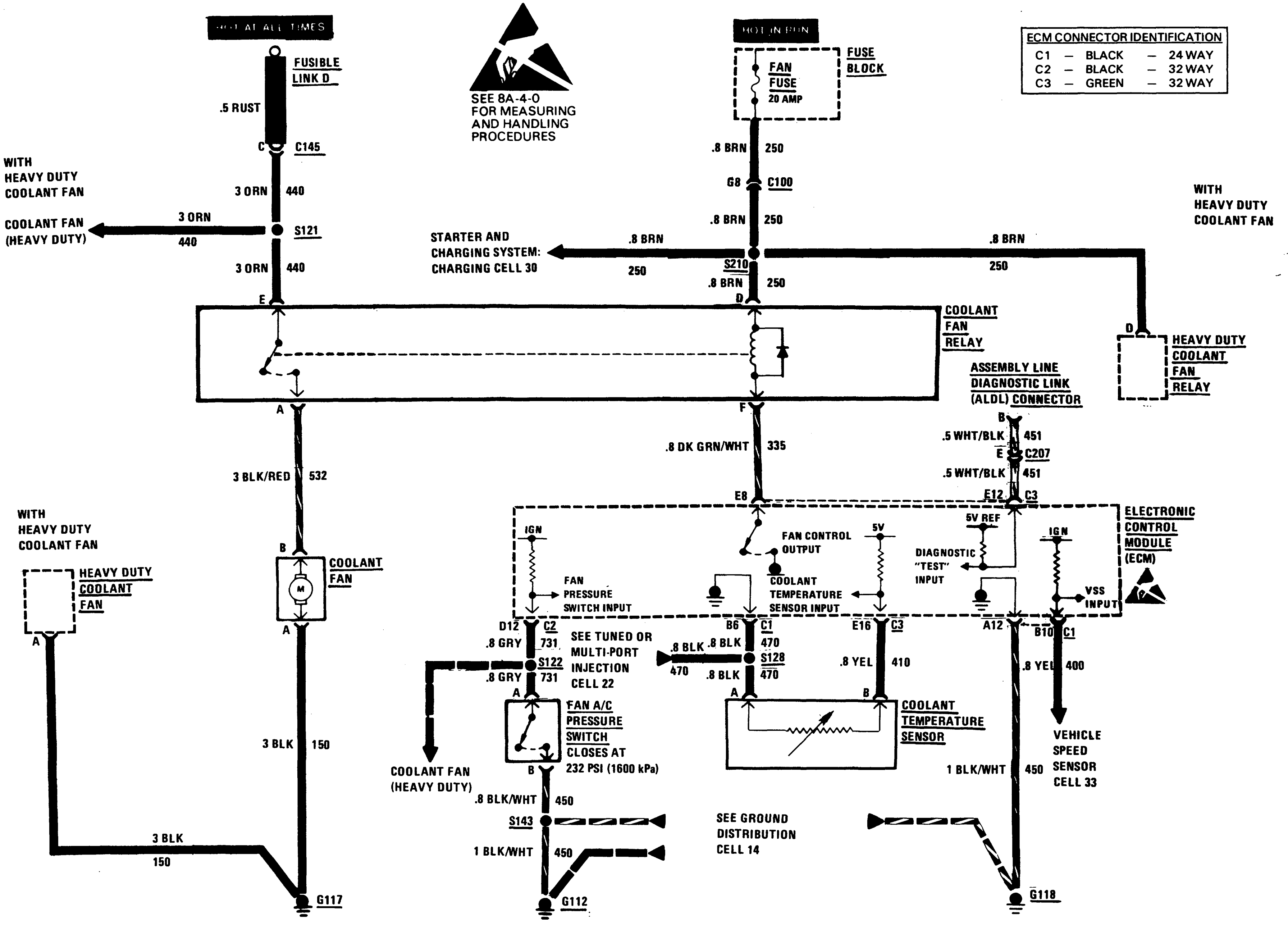
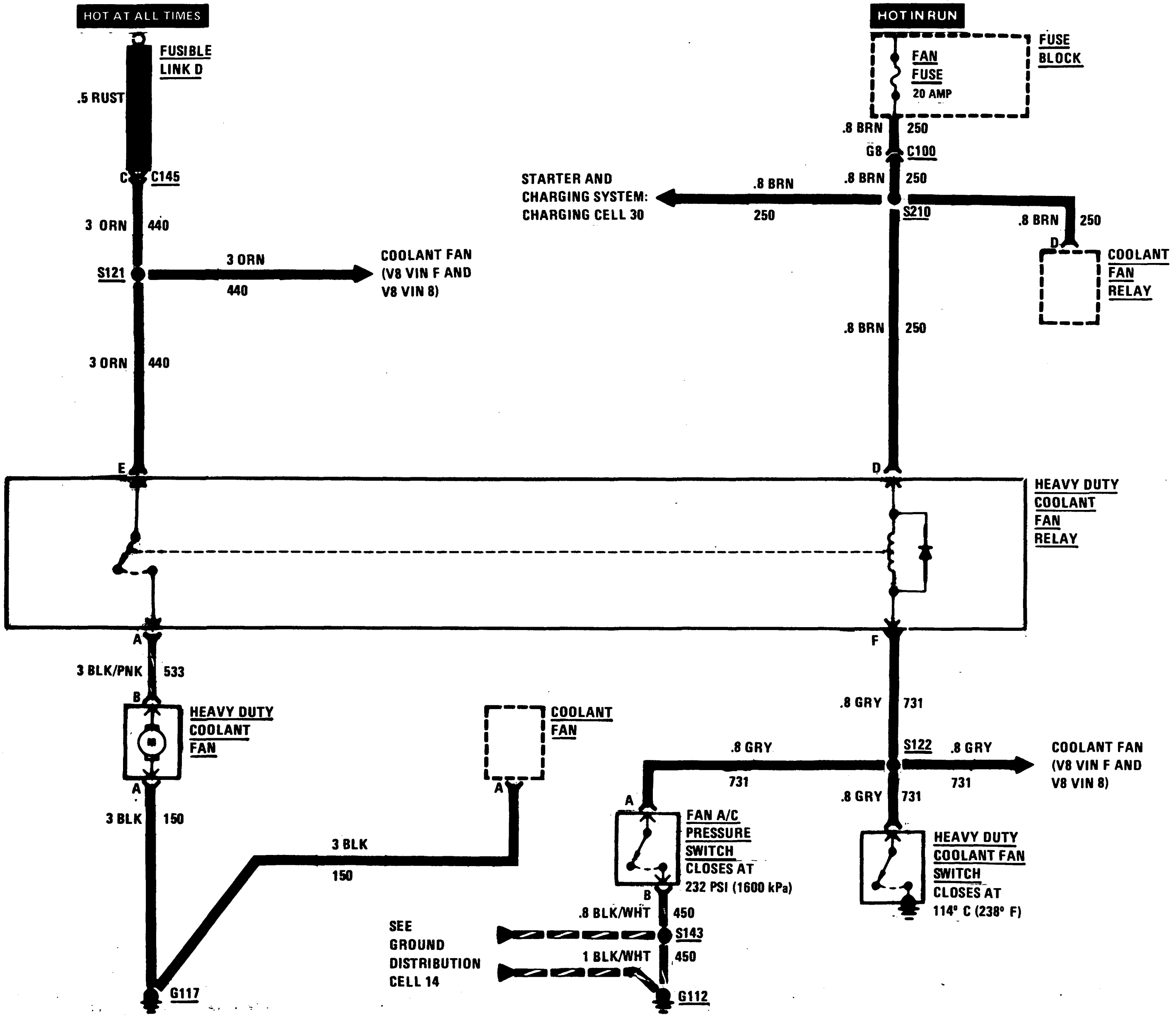
C2	–	BLACK	–	32 WAY
C3	–	GREEN	–	32 WAY



COOLANT FAN: V8 VIN F AND V8 VIN 8

HEAVY DUTY COOLANT FAN



COOLANT FAN

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Check.**

1. Check the FAN Fuse if the Coolant Fan does not run.
2. Check that grounds G118 (V6 VIN T and V8 VIN E) or G112, G117 and G118 (V8 VIN F and V8 VIN 8) are clean and tight.
3. Check the Fusible Link (see schematic).
4. If the Coolant Fan runs with the Ignition Switch OFF, replace the Coolant Fan Relay.
5. Check ECM for codes (V6 VIN T, V8 VIN F and V8 VIN 8).

- **Go to System Check for a guide to normal operation.**
- **Go to System Diagnosis for diagnostic tests.**

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation.**

SYSTEM CHECK TABLE

ACTION	NORMAL RESULT
With the engine cold and idling, turn the A/C Selector to NORM (if equipped with A/C)	VIN E: Coolant Fan turns on VIN T, VIN F & VIN 8: Coolant Fan (and Heavy Duty Coolant Fan-if equipped) turns on when A/C Control Head Pressure exceeds 232 psi (1600 kPa)

(Continued on next page)

COMPONENT LOCATION

		Page-Figure
Assembly Line Diagnostic Link (ALDL) Connector	Under LH side of I/P, on Fuse Block	201-13-A
Coolant Fan Relay	LH front of dash, on relay bracket	
Coolant Fan Switch	Lower RH rear of engine	201- 3-A
Coolant Temperature Sensor (VIN F)(VIN 8)	Top RH side of engine	201- 8-C
Coolant Temperature Sensor (VIN T)	Top front of engine, under intake plenum	
Electronic Control Module (ECM) (Except VIN E)	Behind RH side of I/P	201-15-B
Electronic Control Module (ECM) (VIN E)	Behind RH side of I/P	201-15-C
Fan A/C Pressure Switch (Except VIN T)	RH side of engine compartment	201- 6-B
Fan A/C Pressure Switch (VIN T)	Lower RH rear corner of engine compartment, on A/C line	201- 2-A
Fuse Block	Behind LH side of I/P	201-13-A
Fusible Link D	RH front of engine compartment, near battery	201- 9-A
Fusible Link E (VIN E)	RH front of engine compartment, at Junction Block	201- 3-A
Fusible Link E (VIN T)	RH front of engine compartment, at Junction Block	201- 2-A
Heavy Duty Coolant Fan Relay	LH front of dash, on relay bracket	
Heavy Duty Coolant Fan Switch	RH rear of engine, above starter	201- 9-C
C100 (42 cavities)	LH front of dash, below relay bracket	201-12-A
C105 (4 cavities) (VIN E)	RH rear of engine compartment	201- 4-B
C113 (6 cavities)	Top front of engine, behind A/C compressor	201- 0-A
C145 (3 cavities)	RH front of engine compartment, near battery	201- 9-A
C207 (15 cavities)	Behind RH side of I/P	201-15-A
G112 (VIN F)(VIN 8)	Rear of LH cylinder head	201- 7-A
G115	RH rear of engine compartment	201- 1-A
G117 (VIN F)(VIN 8)	RH rear of radiator bracket	201- 9-E
G118 (VIN E)	Rear of RH cylinder head	201- 4-A
G118 (VIN F)(VIN 8)	Rear of RH cylinder head	201- 7-A
G118 (VIN T)	Rear of RH cylinder head	201- 1-A
S112	A/C harness, RH rear of engine compartment	201-11-A
S115	Engine harness, above RH rear corner of engine	201- 1-A

(Continued from previous page)

With the engine coolant below operating temperature, move the A/C Selector to OFF	VIN E: Coolant Fan turn off VIN T, VIN F & VIN 8: Coolant Fan (and Heavy Duty Coolant Fan-if equipped) continues to run for approximately one minute and then turns off if the A/C Control Head Pressure falls below 232 psi (1600 kPa)
With the engine warm, run the engine at a fast idle for several minutes	Coolant Fan (and Heavy Duty Coolant Fan-if equipped) turns on before the Coolant Temperature Gage needle indicates hot
Turn the Ignition Switch to off	Coolant Fan (and Heavy Duty Coolant Fan-if equipped) turns off

- **Refer to System Diagnosis when a result is not normal.**

SYSTEM DIAGNOSIS

V6 VIN T

- **Do the tests listed for your symptom in the Symptom Table below.**
- **Tests follow the Symptom Table.**

COMPONENT LOCATION

		Page-Figure
S121	Engine harness, LH rear of engine compartment.	201- 8-A
S122	Engine harness, RH side of engine compartment	
S128 (VIN F)(VIN 8)	Engine harness, RH rear of engine compartment	201- 6-A
S128 (VIN T)	Engine harness, RH rear of engine compartment	201- 1-A
S143 (VIN F)(VIN 8)	Engine harness, RH rear of engine compartment	201- 7-A
S181	Engine harness, RH rear of engine	201- 1-A
S185 (VIN E)	Engine harness, RH rear of engine compartment	201- 4-B
S188	Engine harness, behind top RH side of engine	201- 4-B
S210 (VIN E)	Engine harness, lower LH side of engine compartment	201- 5-A
S210 (VIN F)(VIN 8)	Engine harness, LH rear of engine compartment.	201- 8-A

COOLANT FAN

V6 VIN T

- **If any diagnostic codes are present refer to section 6E2.**

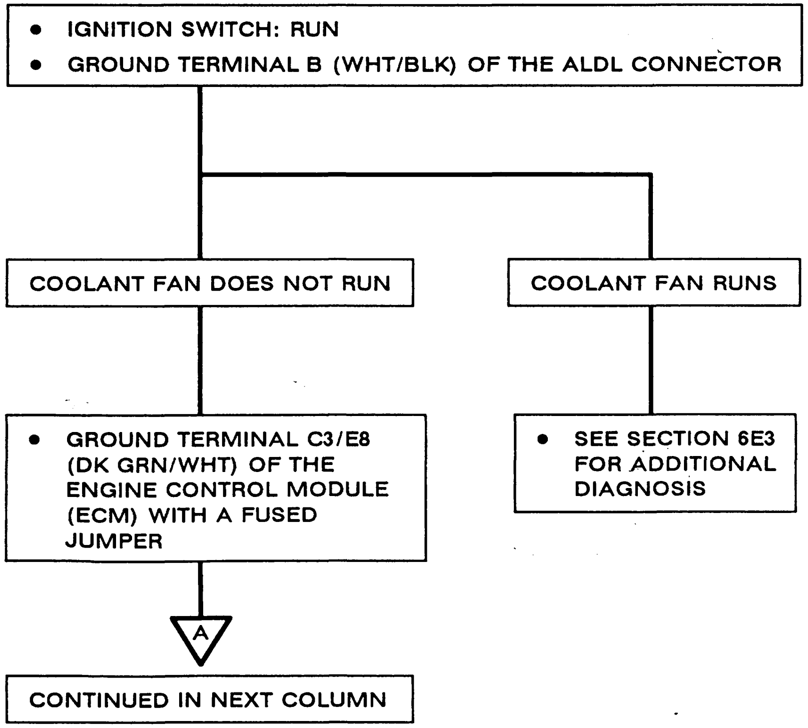
SYMPTOM TABLE

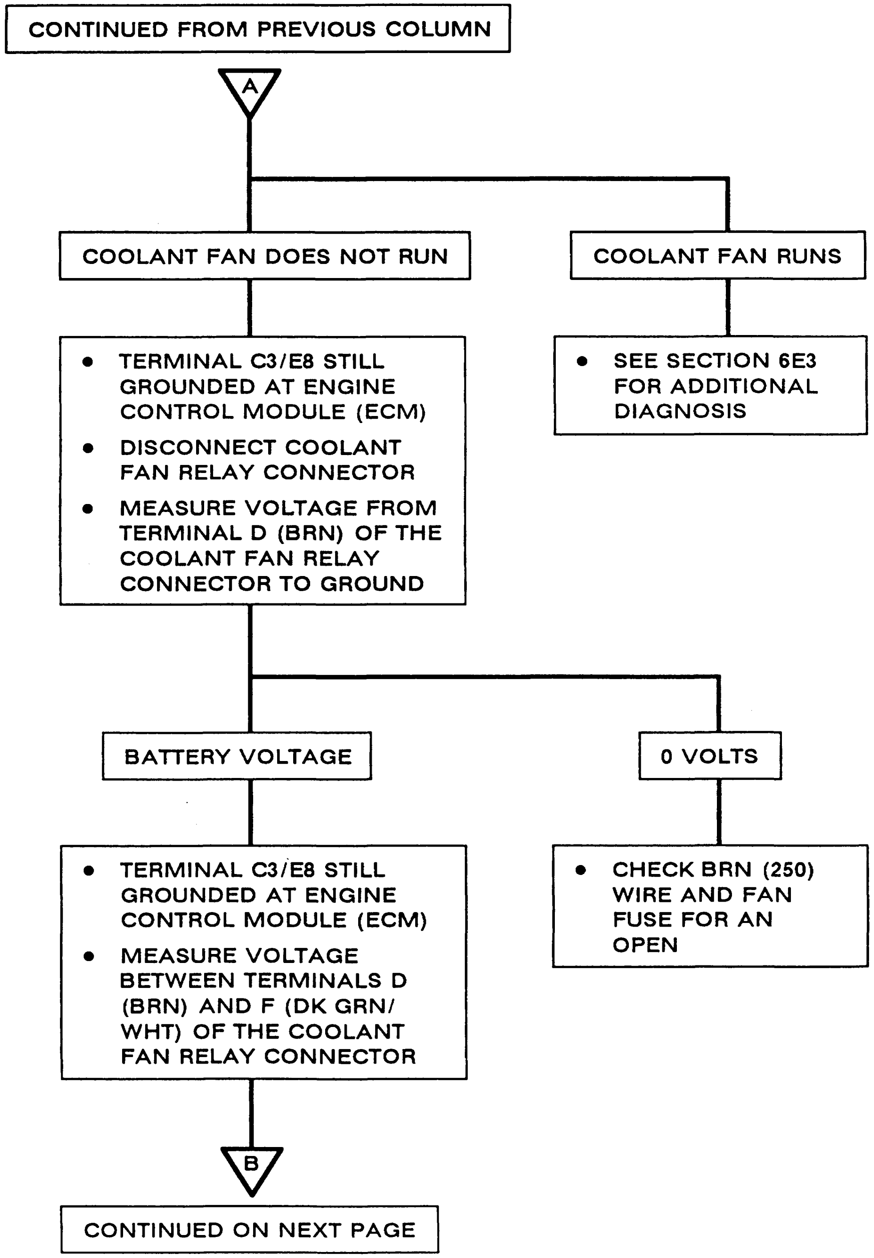
A: Coolant Fan does not turn on

B: Coolant Fan does not turn off with engine coolant cool, A/C Mode Selector OFF, and Ignition Switch in RUN

C: Coolant Fan does not turn on with A/C Mode Selector ON and head pressure above 1600 kPa (232 PSI), but does turn on with engine hot.

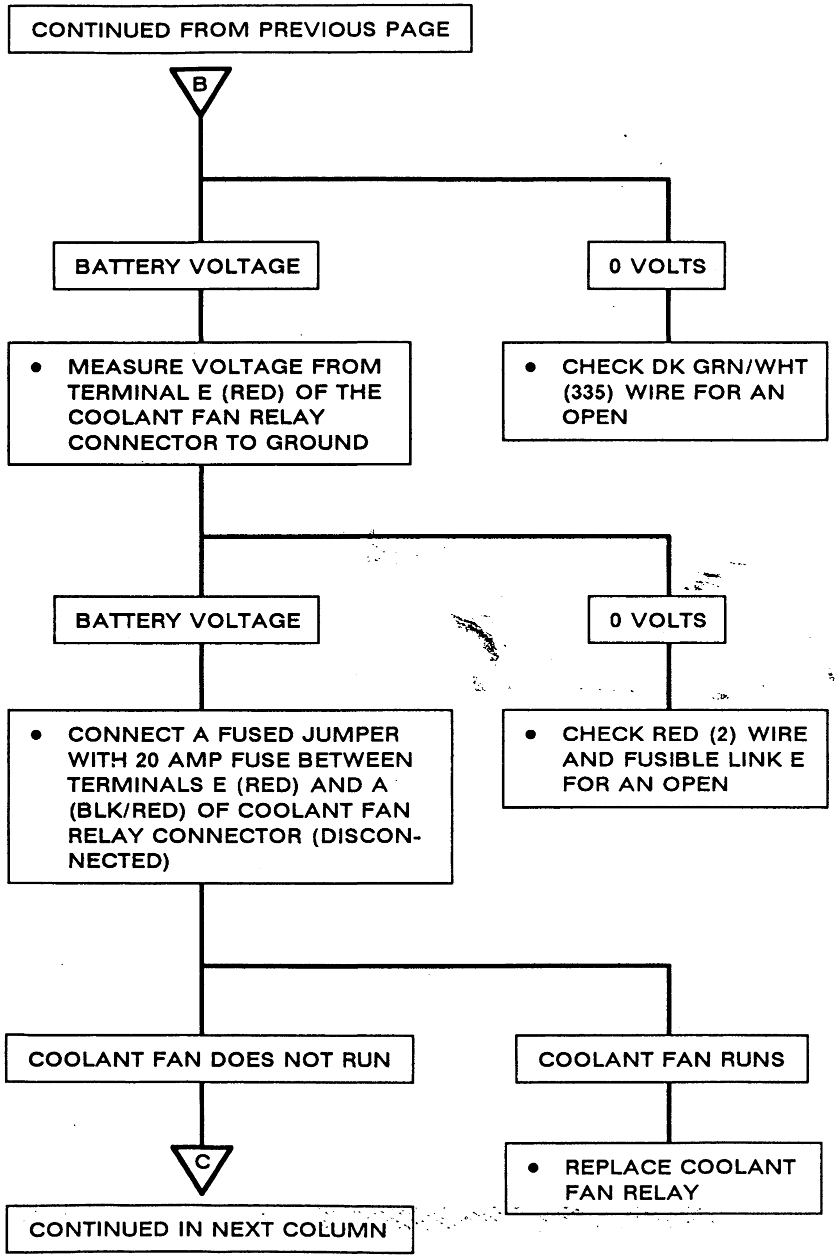
A: COOLANT FAN DOES NOT TURN ON

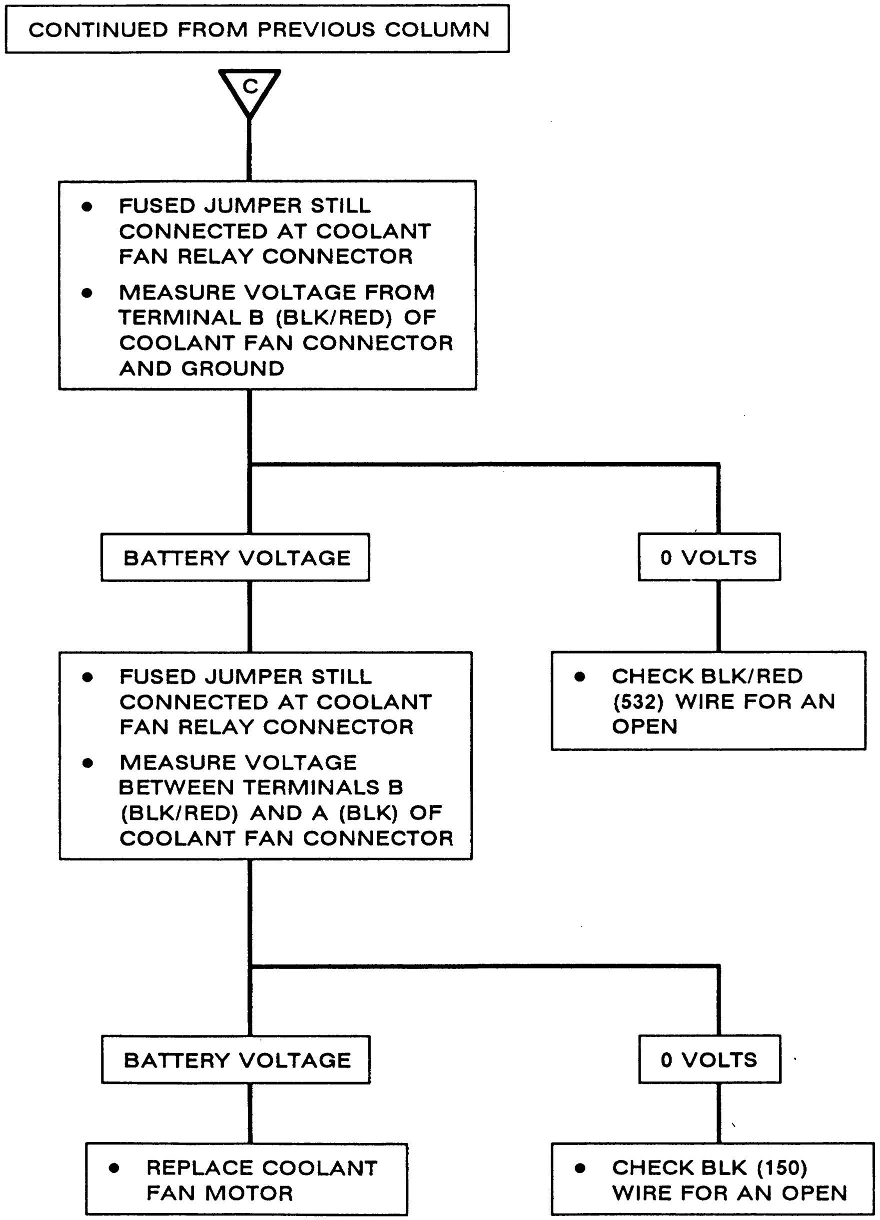




COOLANT FAN

V6 VIN T

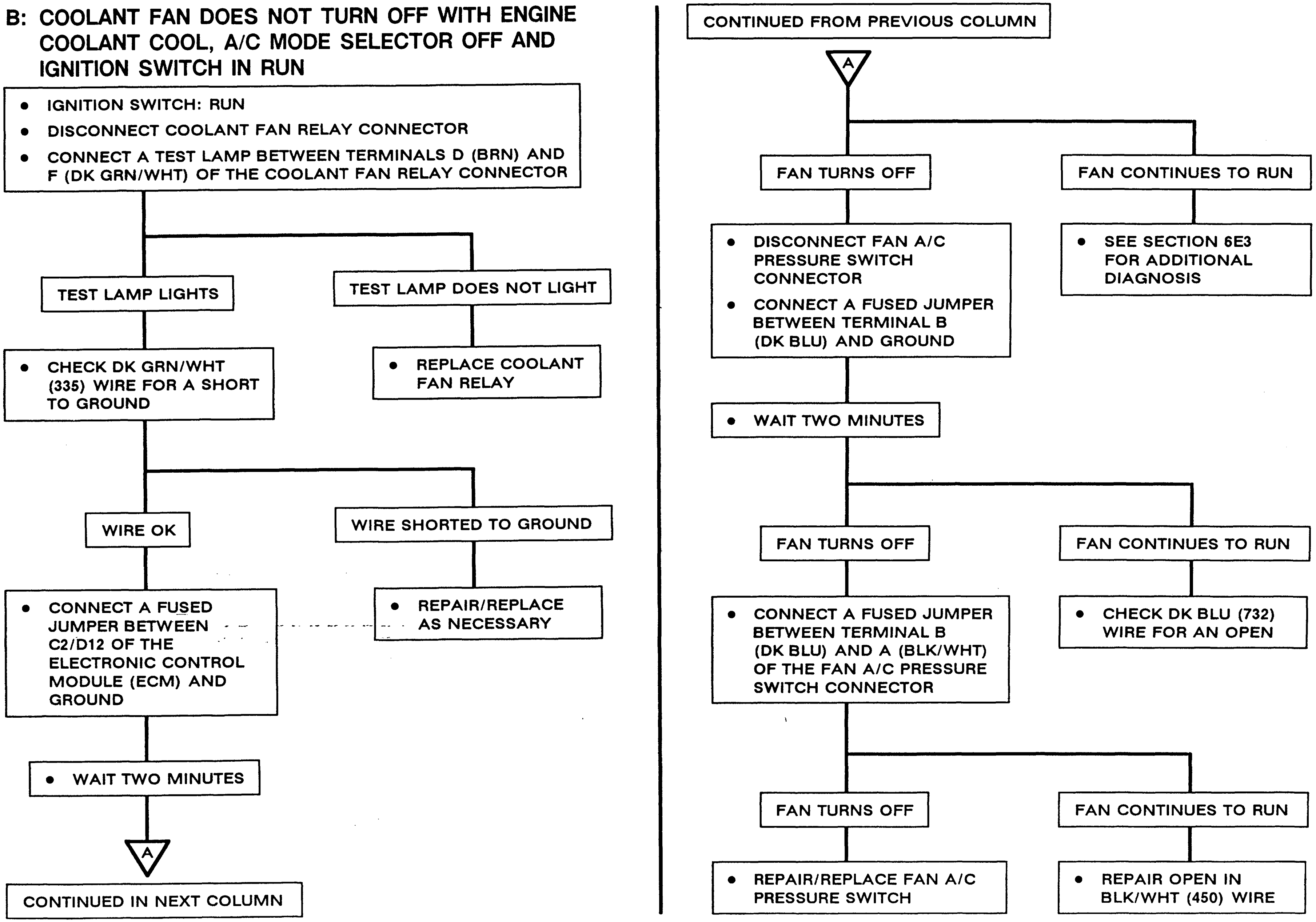




COOLANT FAN

V6 VIN T

B: COOLANT FAN DOES NOT TURN OFF WITH ENGINE COOLANT COOL, A/C MODE SELECTOR OFF AND IGNITION SWITCH IN RUN



COOLANT FAN

V6 VIN T

C: COOLANT FAN DOES NOT TURN ON WITH A/C MODE SELECTOR ON, AND HEAD PRESSURE ABOVE 1600 kPa (232 psi), BUT DOES RUN WITH ENGINE HOT

- IGNITION SWITCH: RUN
- A/C MODE SELECTOR: MAX
- DISCONNECT FAN A/C PRESSURE SWITCH CONNECTOR
- MEASURE VOLTAGE BETWEEN TERMINAL B (DK BLU) OF THE FAN A/C PRESSURE SWITCH CONNECTOR AND GROUND

BATTERY

- SEE SECTION 6E3 FOR ADDITIONAL DIAGNOSIS

0 VOLTS

- CHECK DK BLU (732) FOR A SHORT TO GROUND

SYSTEM DIAGNOSIS
V8 VIN E

- **Do the tests listed for your symptom in the symptom table below.**
- **Tests follow the Symptom Table.**

SYMPTOM TABLE

SYMPTOM	FOR DIAGNOSIS
Coolant Fan does not run at all	Do Test A
Coolant Fan does not run with high engine temperature	Do Test A
Coolant Fan does not run with A/C on	Do Test B
Coolant Fan will not turn off	Do Test C

A: COOLANT FAN OPEN TEST (TABLE 1)

Connect: VOLTMETER
At: COOLANT FAN RELAY CONNECTOR
(Disconnected)
Condition:
• Ignition Switch: RUN

Connect Between	Correct Voltage	For Diagnosis
E (RED) & Ground	Battery	See 1
D (BRN) & Ground	Battery	See 2

- If results are correct go to Test A (Table 2).

1. Check Fusible Link E and the RED (2) wire for an open.
2. Check the FAN Fuse and the BRN (250) wire for an open.

A: COOLANT FAN OPEN TEST (TABLE 2)

Connect: FUSED JUMPER (20 AMP)
At: COOLANT FAN RELAY CONNECTOR
(Disconnected)

Connect Between	Correct Result	For Diagnosis
E (RED) & A (BLK/RED)	Coolant Fan runs	See 1

- If the result is correct go to Test A (Table 4).

1. Leave fused jumper in place and go to Test A (Table 3).

A: COOLANT FAN OPEN TEST (TABLE 3)

Connect: VOLTMETER
At: COOLANT FAN CONNECTOR
(Disconnected)
Condition:
• Fused Jumper in place from table 2

Connect Between	Correct Voltage	For Diagnosis
B (BLK/RED) & Ground	Battery	See 1
B (BLK/RED) & A (BLK)	Battery	See 2

- If results are correct repair/replace the Coolant Fan.

1. Check the BLK/RED (532) wire for an open.
2. Check the BLK (150) wire for an open.

A: COOLANT FAN OPEN TEST (TABLE 4)

1. Reconnect the Coolant Fan Relay. Connect a fused jumper from the Coolant Fan Switch connector to ground.

- If the Coolant Fan runs check/replace the Coolant Fan Switch.
  Fan Switch.
- If the Coolant Fan does not run check the DK GRN/WHT (335) wires for an open. If the wires are OK check/replace the Coolant Fan Relay.

B: COOLANT FAN A/C OPEN

Connect: FUSED JUMPER
At: A/C CONTROL HEAD CONNECTOR
(Disconnected)
Condition:
• Ignition Switch: RUN

Connect Between	Correct Result	For Diagnosis
B (DK GRN) & Ground	Coolant Fan runs	See 1
B (DK GRN) & A (BLK)	Coolant Fan runs	See 2

- If all results are correct repair/replace the A/C Control Head.

1. Check the DK GRN/WHT (335) and DK GRN (535) wires for an open.
2. Check the BLK (150) wire for an open.

COOLANT FAN

V8 VIN E

C: COOLANT FAN DOES NOT TURN OFF

1. If the Coolant Fan runs with the Ignition in OFF, replace the Coolant Fan Relay.
2. With the Ignition in RUN and the A/C OFF, disconnect the Coolant Fan Switch.

- **If the Coolant Fan turns off check/replace the Coolant Fan Switch**
- **If the Coolant Fan continues to run, check the DK GRN/WHT (335) and DK GRN (535) wires and the A/C Control Head for a short to ground.**

SYSTEM DIAGNOSIS

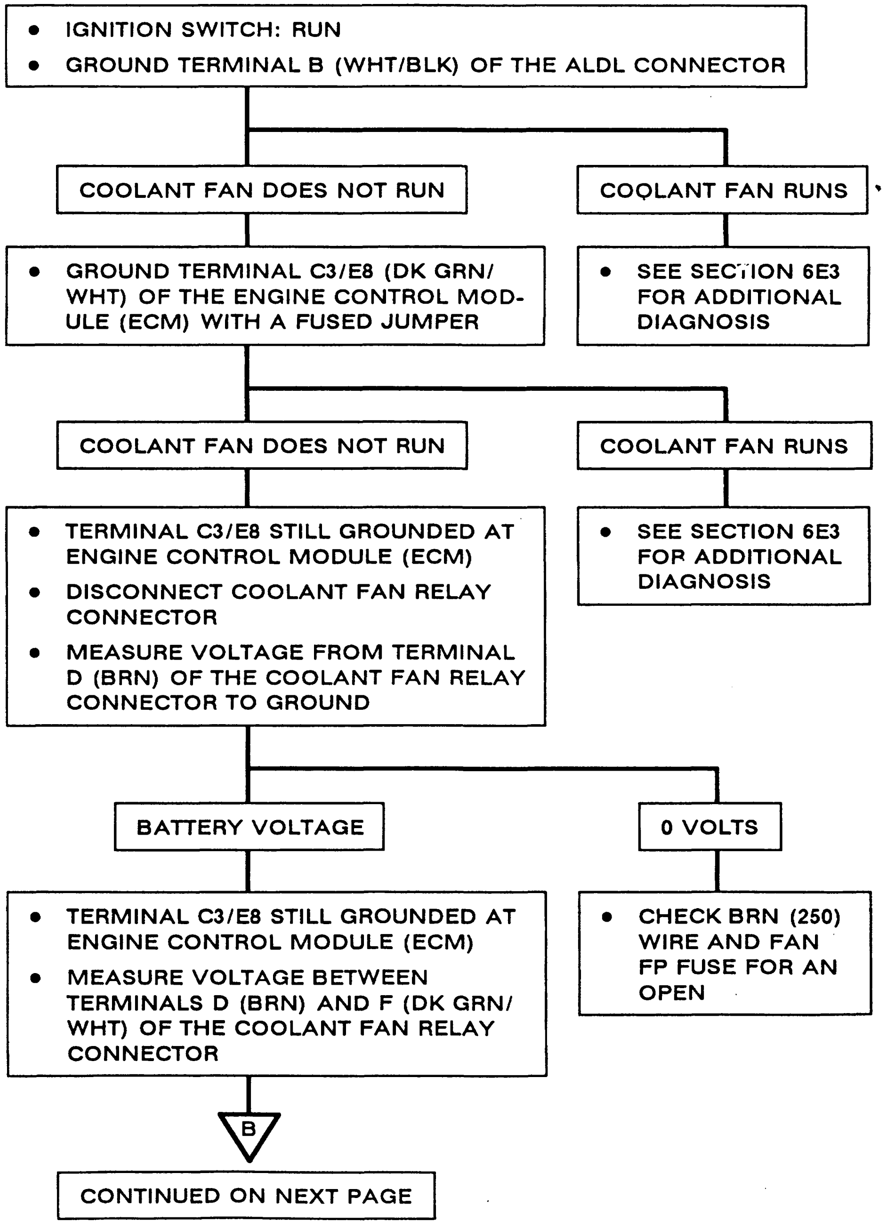
V8 VIN F AND V8 VIN 8

- **Diagnostic steps for the symptoms listed in the following table are listed after the table.**
- **If any diagnostic codes are present, refer to Section 6E3.**

SYMPTOM TABLE

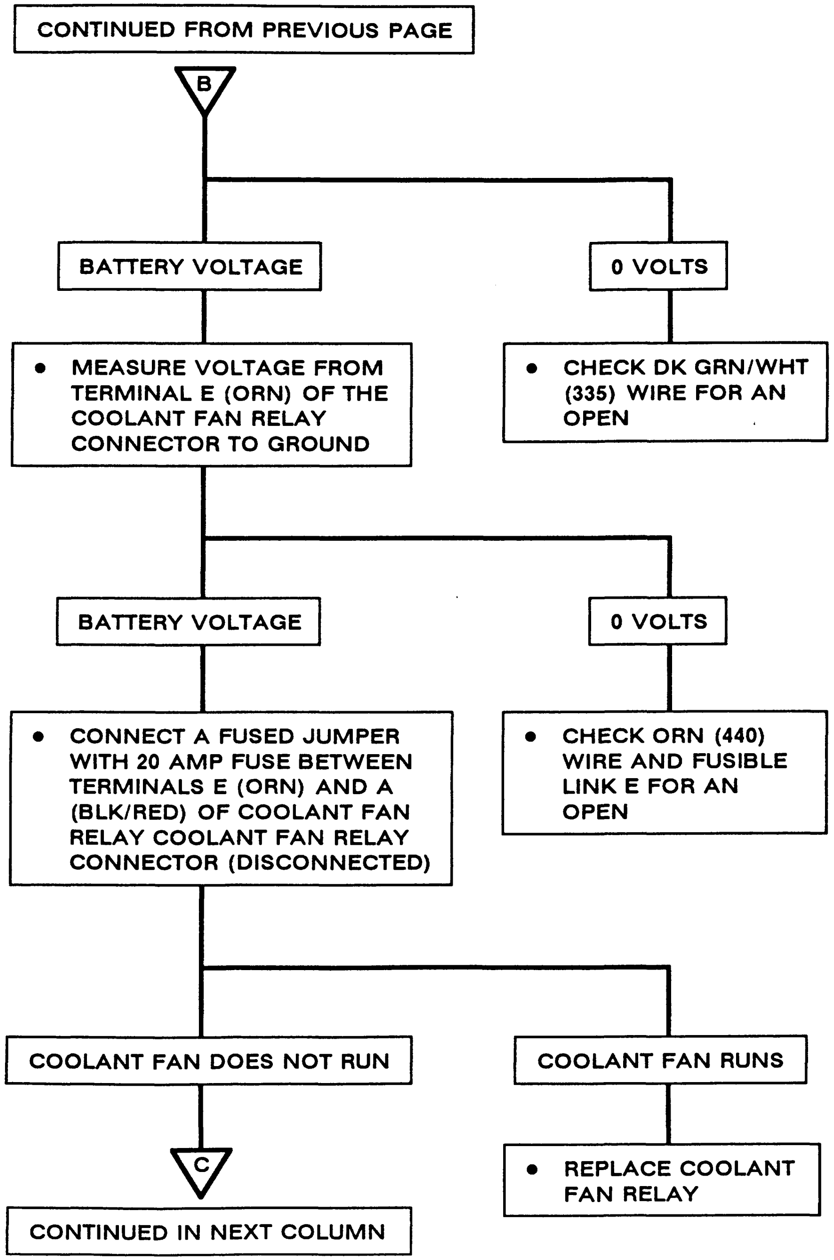
A:	Coolant Fan does not turn on
B:	Coolant Fan does not turn off with engine coolant cool, A/C Mode Selector OFF and Ignition Switch in RUN
C:	Coolant Fan does not turn on with A/C Mode Selector ON and head pressure above 1600 kPa (232 psi), but does run with engine hot
D:	Only the Auxiliary Coolant Fan does not turn on

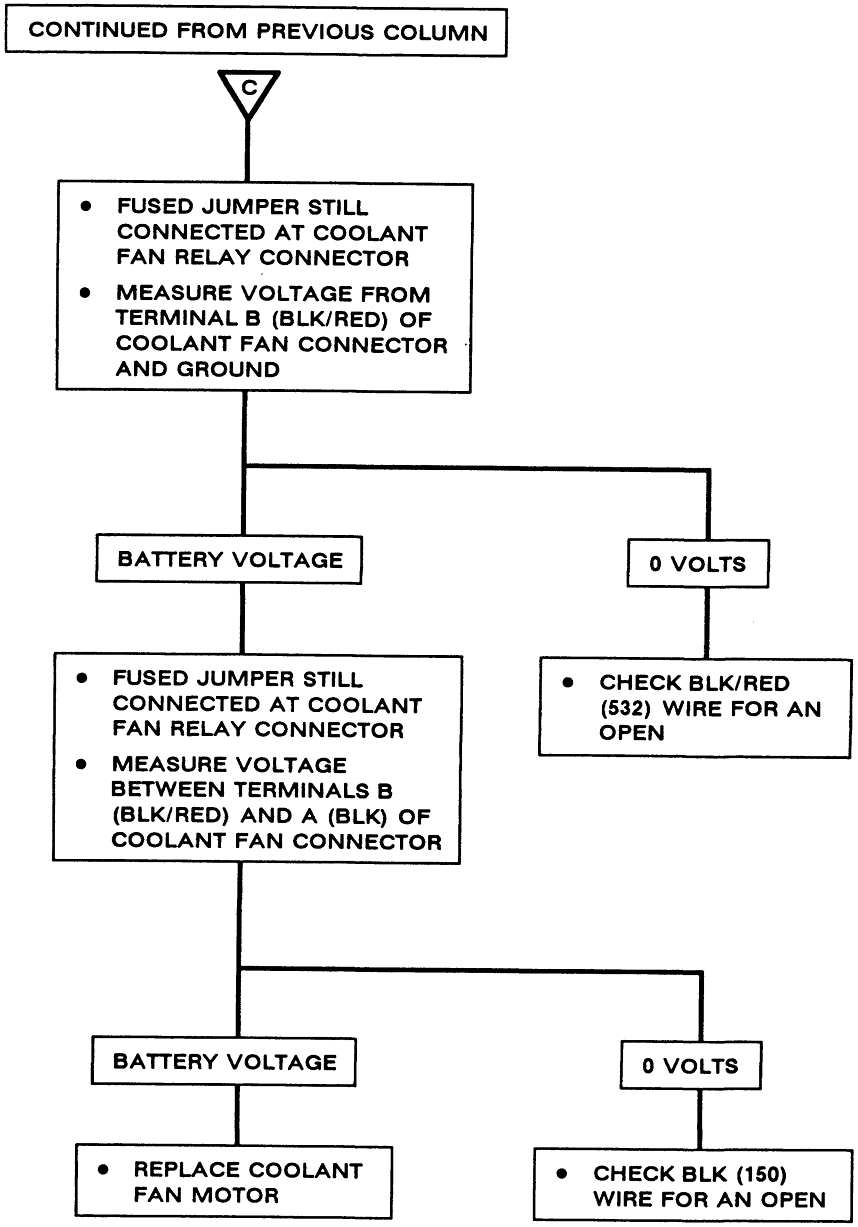
A: COOLANT FAN DOES NOT TURN ON



COOLANT FAN

V8 VIN F AND V8 VIN 8

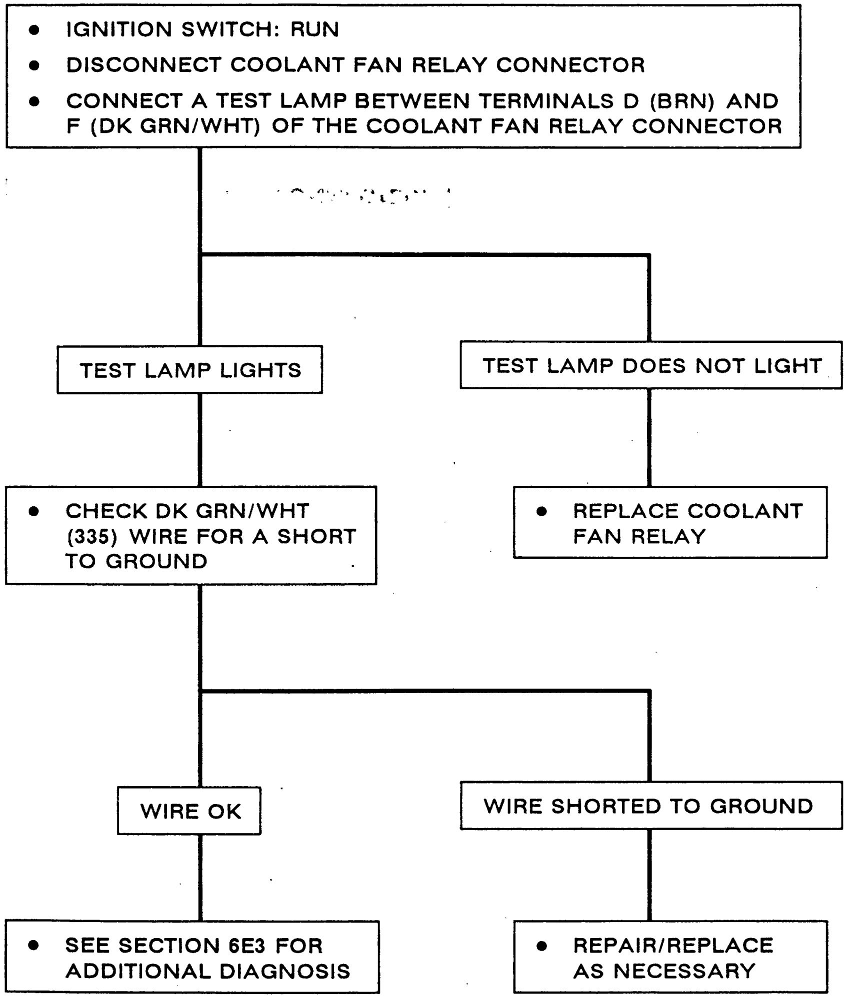




COOLANT FAN

V8 VIN F AND V8 VIN 8

B: COOLANT FAN DOES NOT TURN OFF WITH ENGINE COOLANT COOL, A/C MODE SELECTOR OFF AND IGNITION SWITCH IN RUN



- IGNITION SWITCH: RUN
- DISCONNECT COOLANT FAN RELAY CONNECTOR
- CONNECT A TEST LAMP BETWEEN TERMINALS D (BRN) AND F (DK GRN/WHT) OF THE COOLANT FAN RELAY CONNECTOR

TEST LAMP LIGHTS

- CHECK DK GRN/WHT (335) WIRE FOR A SHORT TO GROUND

WIRE OK

- SEE SECTION 6E3 FOR ADDITIONAL DIAGNOSIS

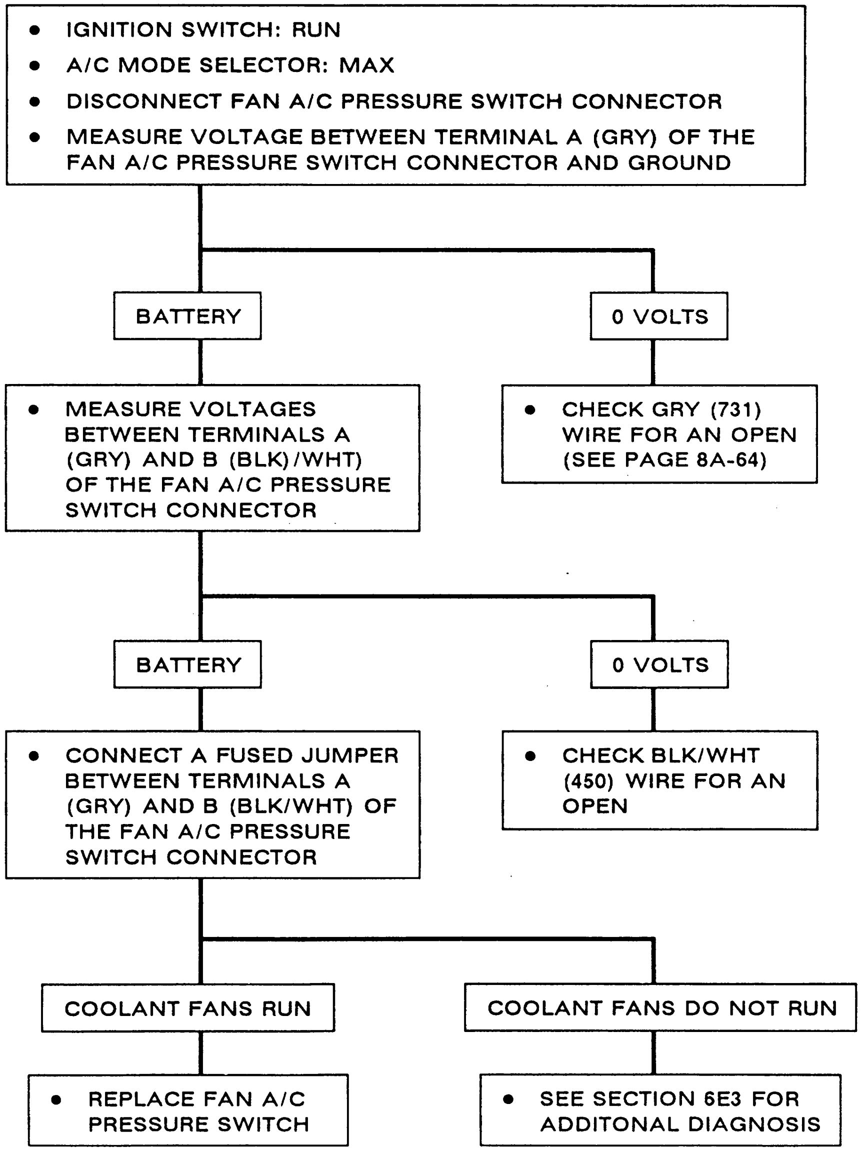
WIRE SHORTED TO GROUND

- REPAIR/REPLACE AS NECESSARY

TEST LAMP DOES NOT LIGHT

- REPLACE COOLANT FAN RELAY

C: COOLANT FAN DOES NOT TURN ON WITH A/C MODE SELECTOR ON, AND HEAD PRESSURE ABOVE 1600 kPa (232 psi), BUT DOES RUN WITH ENGINE HOT



- IGNITION SWITCH: RUN
- A/C MODE SELECTOR: MAX
- DISCONNECT FAN A/C PRESSURE SWITCH CONNECTOR
- MEASURE VOLTAGE BETWEEN TERMINAL A (GRY) OF THE FAN A/C PRESSURE SWITCH CONNECTOR AND GROUND

BATTERY

- MEASURE VOLTAGES BETWEEN TERMINALS A (GRY) AND B (BLK)/WHT) OF THE FAN A/C PRESSURE SWITCH CONNECTOR

BATTERY

- CONNECT A FUSED JUMPER BETWEEN TERMINALS A (GRY) AND B (BLK/WHT) OF THE FAN A/C PRESSURE SWITCH CONNECTOR

COOLANT FANS RUN

- REPLACE FAN A/C PRESSURE SWITCH

COOLANT FANS DO NOT RUN

- SEE SECTION 6E3 FOR ADDITONAL DIAGNOSIS

0 VOLTS

- CHECK BLK/WHT (450) WIRE FOR AN OPEN

0 VOLTS

- CHECK GRY (731) WIRE FOR AN OPEN (SEE PAGE 8A-64)

D: HEAVY DUTY COOLANT FAN OPEN TEST (TABLE 1)

Connect: VOLTMETER
At: HEAVY DUTY COOLANT FAN RELAY CONNECTOR (Disconnected)
Condition:
- **Ignition Switch: RUN**

Connect Between	Correct Voltage	For Diagnosis
E (ORN) & Ground	Battery	See 1
D (BRN) & Ground	Battery	See 2

- If results are correct go to Test D (Table 2).

1. Check Fusible Link D and the ORN (440) wire for an open.
2. Check the FAN Fuse and the BRN (250) wire for an open.

D: HEAVY DUTY COOLANT FAN OPEN TEST (TABLE 2)

Connect: FUSED JUMPER (20 AMP)
At: HEAVY DUTY COOLANT RELAY CONNECTOR (Disconnected)

Connect Between	Correct Result	For Diagnosis
E (ORN) & A (BLK/PNK)	Heavy Duty Coolant Fan runs	See 1

- If result is correct go to Test D (Table 4).

1. Leave fused jumper in place and go to Test D (Table 3).

D: HEAVY DUTY COOLANT FAN OPEN TEST (TABLE 3)

Connect: VOLTMETER
At: HEAVY DUTY COOLANT FAN CONNECTOR (Disconnected)
Condition:
- **Fused Jumper in place from table 2**

Connect Between	Correct Voltage	For Diagnosis
B (BLK/PNK) & Ground	Battery	See 1
B (BLK/PNK) & A (BLK)	Battery	See 2

- If results are correct repair/replace the Heavy Duty Coolant Fan

1. Check the BLK/PNK (533) wire for an open.
2. Check the BLK (150) wire for an open.

D: HEAVY DUTY COOLANT FAN OPEN TEST (TABLE 4)

1. Reconnect the Heavy Duty Coolant Fan Relay. Connect a fused jumper from the Heavy Duty Cooant Fan Switch connector to ground.

- If the Heavy Duty Coolant Fan runs check/replace the Coolant Fan Switch.
- If the Heavy Duty Coolant Fan does not run checkthe GRY (731) wire for an open. If the wire is OK check/replace the Coolant Fan Relay.

CIRCUIT OPERATION

V6 VIN T, V8 VIN F and V8 VIN 8

The Coolant Fan is controlled by the Electronic Control Module (ECM). When the ECM grounds the 335 circuit, the Coolant Fan Relay is energized and battery voltage is applied to the Coolant Fan. The ECM will ground the Coolant Fan Relay when the Coolant Temperature Sensor indicates the coolant temperature is greater than 106 °C (222 °F) or when the A/C Control Head pressure is greater than 232 psi (1600 kPa) and the vehicle speed is less than 40 mph.

The Heavy Duty Coolant Fan (V8 VIN F and V8 VIN 8) is controlled by the Fan A/C Pressure Switch and the Heavy Duty Coolant Fan Switch. If one of these switches closes, the Heavy Duty Coolant Fan Relay is energized and the Heavy Duty Coolant Fan is turned on. When a switch is closed, terminal D12 of ECM connector C2 is grounded. This tells the ECM that the Heavy Duty Coolant Fan should be on.

V8 VIN E

The Coolant Fan is activated by the Coolant Fan Switch. The switch closes when the coolant temperature is over 110 °C (238 °F), completing a path to ground through the Coolant Fan Relay windings. The relay contacts then close and voltage is applied to the Coolant Fan. When the coolant temperature drops to 101 °C (214 °F), the switch opens and the Coolant Fan stops.

In A/C equipped vehicles, the A/C Control Head completes a path to ground for the Coolant Fan Relay when the Air Conditioning is on. Voltage is then applied to the Coolant Fan.

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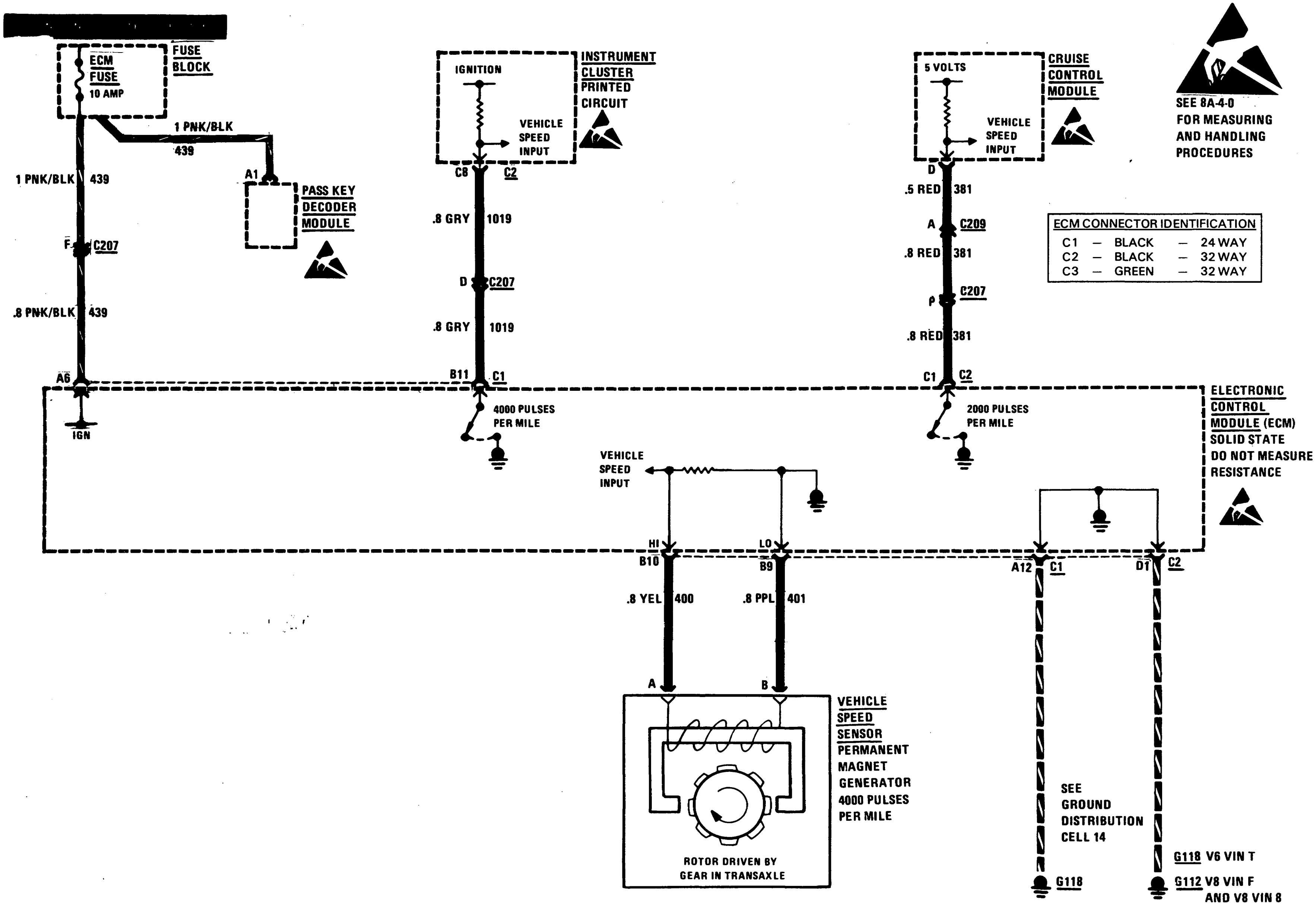
VEHICLE SPEED SENSOR: PERMANENT MAGNET GENERATOR

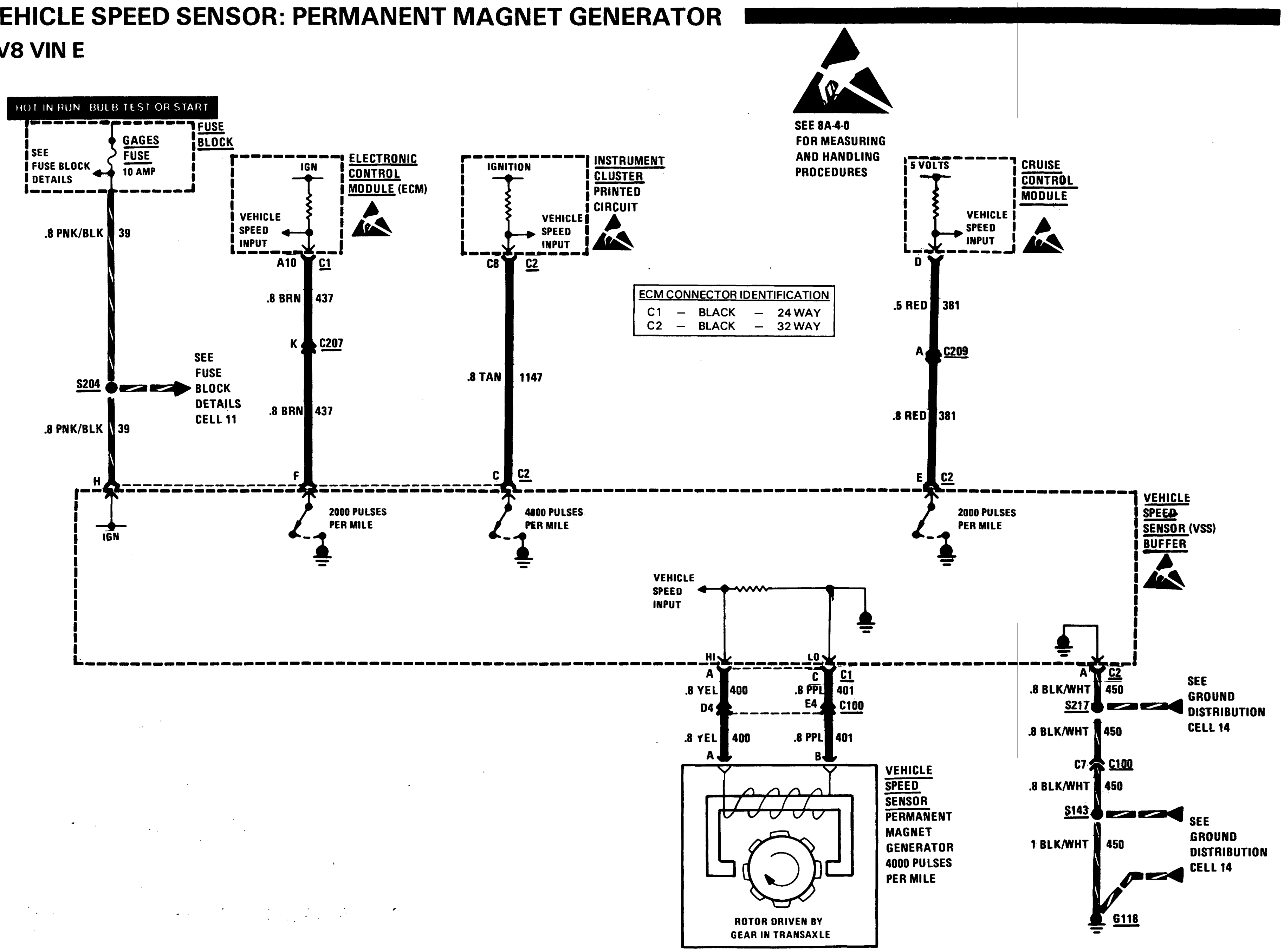
V6 VIN T, V8 VIN F AND V8 VIN 8



ECM CONNECTOR IDENTIFICATION				
C1	—	BLACK	—	24 WAY
C2	—	BLACK	—	32 WAY
C3	—	GREEN	—	32 WAY

VEHICLE SPEED SENSOR: PERMANENT MAGNET GENERATOR

V8 VIN E



ECM CONNECTOR IDENTIFICATION				
C1	—	BLACK	—	24 WAY
C2	—	BLACK	—	32 WAY

VEHICLE SPEED SENSOR: PERMANENT MAGNET GENERATOR

TROUBLESHOOTING HINTS

- **Try the following check before doing the System Diagnosis.**

V6 VIN T, V8 VIN F and V8 VIN 8

1. Check the ECM Fuse by visual inspection.
2. Check that grounds G118 and G112 (V8 VIN F AND V8 VIN 8) are clean and tight.

V8 VIN E

1. Check the GAGES Fuse by starting the engine and observing that the gages operate.
2. Check that G118 is clean and tight.

- **Go to System Diagnosis for diagnostic tests.**

SYSTEM DIAGNOSIS

V6 VIN T, V8 VIN F and V8 VIN 8

- **Do the tests listed for your symptom in the Symptom Table below.**
- **Test follow the Symptom Table.**

SYMPTOM TABLE

SYMPTOM	FOR DIAGNOSIS
ECM Code 24 is set, but Speedometer is OK	See Section 6E3
Speedometer does not operate properly and ECM Code 24 is set	Do Test A
Speedometer does not operate properly, but ECM Code 24 is not set	Do Test B
Cruise Control does not operate properly, but ECM Code 24 is not set	Do Test B

COMPONENT LOCATION

		Page-Figure
Cruise Control Module	Behind RH side of I/P	
Electronic Control Module (ECM) (Except VIN E)	Behind RH side of I/P	201-15-B
Electronic Control Module (ECM) (VIN E)	Behind RH side of I/P	201-15-C
Fuse Block	Behind LH side of I/P	201-13-A
PASS Key Decoder Module	Behind RH side of I/P	201-15-A
Vehicle Speed Sensor	LH side of transmission	201-12-B
Vehicle Speed Sensor (VSS) Buffer	Behind RH side of I/P	201-18-B
C100 (42 cavities)	LH front of dash, below relay bracket	201-12-A
C207 (15 cavities)	Behind RH side of I/P	201-15-A
C209 (4 cavities)	Behind RH side of I/P	201-15-A
G112 (VIN F)(VIN 8)	Rear of LH cylinder head	201- 7-A
G118 (VIN E)	Rear of RH cylinder head	201- 4-A
G118 (VIN F)(VIN 8)	Rear of RH cylinder head	201- 7-A
G118 (VIN T)	Rear of RH cylinder head	201- 1-A
S143 (VIN E)	Engine harness, LH rear of engine compartment.	201- 5-A
S204	I/P harness, behind LH side of instrument cluster	201-13-A
S217	I/P harness, behind RH side of instrument cluster	201-12-A

A: VEHICLE SPEED SENSOR TEST

Measure: VOLTAGE
At: ELECTRONIC CONTROL MODULE (ECM) CONNECTOR C2 (Connected)
Conditions:

- **Ignition Switch: RUN**
- **Shift Control Lever: NEUTRAL**
- **Raise car off the ground and turn the drive wheels by hand, while making measurements**

Measure Between	Correct Voltage	For Diagnosis
B10 (YEL) & B9 (PPL)	1 to 5 volts AC	See 1

- If voltage is correct, replace Electronic Control Module (ECM).

1. Check YEL (400) and PPL (401) wires for an open (see schematic). If wires are good, replace Vehicle Speed Sensor.

B: ELECTRONIC CONTROL MODULE (ECM) TEST (TABLE 1)

Measure: VOLTAGE
At: ELECTRONIC CONTROL MODULE (ECM) CONNECTOR (Disconnected)
Condition:
- **Ignition Switch: RUN**

Measure Between	Correct Voltage	For Diagnosis
C1/B11 (GRY) & Ground (see schematic)	Battery	See 1
C2/C1 (RED) & Ground (see schematic)	5 volts	See 2

- If voltages are correct, go to Table 2.

1. Check GRY (1019) wire for an open to Instrument Cluster. If wire is OK, replace Instrument Cluster.
2. Check RED (381) wire for an open to Cruise Control Module. If wire is OK, replace Cruise Control Module.

B: ELECTRONIC CONTROL MODULE (ECM) TEST (TABLE 2)

Measure: VOLTAGE
At: ELECTRONIC CONTROL MODULE CONNECTOR (Connected)
Conditions:
- **Ignition Switch: RUN**
- **Shift Control Lever: NEUTRAL**
- **Raise car off the ground and turn the drive wheels by hand while making measurements**

Measure Between	Correct Voltage	For Diagnosis
C1/B11 (GRY) & Ground (see schematic)	Varying from less than 1 volt to more than 4 volts	See 1
C2/C1 (RED) & Ground (see schematic)	Varying from less than 1 volt to more than 2.5 volts	See 1

- If voltage at C1/B11 is correct and Speedometer is inoperative, replace Instrument Cluster.
- If voltage at C2/C1 is correct and Cruise Control is inoperative, replace Cruise Control Module.

1. Replace Electronic Control Module (ECM).

SYSTEM DIAGNOSIS

V8 VIN E

- **Do the tests listed for your symptom in the Symptom Table below.**
- **Tests follow the Symptom Table.**

SYMPTOM TABLE

SYMPTOM	FOR DIAGNOSIS
ECM Code 24 is set Speedometer operates properly	See Section 6E for diagnosis
Speedometer does not operate properly and ECM Code 24 is set	Do Test A
Speedometer does not operate properly, ECM Code 24 is not set	Do Test B
Cruise Control does not operate properly, ECM Code 24 is not set	Do Test B
Speedometer and/or Odometer(s) are inaccurate	Do Test C
Odometer(s) are inoperative or inaccurate	Do Test D

VEHICLE SPEED SENSOR: PERMANENT MAGNET GENERATOR

A: VEHICLE SPEED SENSOR BUFFER TEST (TABLE 1)

Measure: VOLTAGE
At: VEHICLE SPEED SENSOR BUFFER CONNECTOR C2 (Disconnected)
Condition:
- **Ignition Switch: RUN**

Measure Between	Correct Voltage	For Diagnosis
H (PNK/BLK) & Ground	Battery	See 1
H (PNK/BLK) & A (BLK/WHT)	Battery	See 2

- If voltages are correct, go to Table 2.

1. Check PNK/BLK (39) wire for an open (see schematic).
2. Check BLK/WHT (450) wire for an open (see schematic). Check that G118 is clean and ground.

A: VEHICLE SPEED SENSOR BUFFER TEST (TABLE 2)

Measure: VOLTAGE
At: VEHICLE SPEED SENSOR BUFFER CONNECTOR C1 (Disconnected)
Conditions:
- **Ignition Switch: RUN**
- **Gear Selector: NEUTRAL**
- **Turn drive wheels by hand while making measurements**

Measure Between	Correct AC Voltage	For Diagnosis
A (YEL) & C (PPL)	Between 1 and 5 volts AC	See 1

- If voltages are correct, replace Vehicle Speed Sensor Buffer.

1. Check YEL (400) and PPL (401) wires (see schematic). If both wires are OK, replace Vehicle Speed Sensor.

B: VEHICLE SPEED SENSOR BUFFER OUTPUT TEST (TABLE 1)

Measure: VOLTAGE
At: VEHICLE SPEED SENSOR BUFFER CONNECTOR C2 (Disconnected)
Conditions:
- **Ignition Switch: RUN**
- **Cruise Switch: ON**

Measure Between	Correct Voltage	For Diagnosis
C (TAN) & Ground	Battery	See 1
F (BRN) & Ground	Battery	See 2
• Cruise Control: CONNECTED		
E (RED) & Ground	5 Volts or greater	See 3

- If voltages are correct, go to Table 2.

1. Check TAN (1147) wire for an open. See Section 81 for further diagnosis.
2. Check BRN (437) wire for an open. If OK, replace ECM.
3. Check RED (381) wire for an open (see schematic). Check that C209 is properly mated. If OK, replace Cruise Control Module.

B: VEHICLE SPEED SENSOR BUFFER OUTPUT TEST (TABLE 2)

Measure: VOLTAGE
At: VEHICLE SPEED SENSOR BUFFER CONNECTOR C2 (Connected)
Conditions:
- **Cruise Control: ON**
- **Ignition Switch: RUN**
- **Gear Selector: NEUTRAL**
- **Turn drive wheels by hand while making measurements**

Measure Between	Correct Voltage	For Diagnosis
C (TAN) & Ground	Varying from less than 1 volt to more than 4 volts	See 1
E (RED) & Ground	Varying from less than 1 volt to more than 2.5 volts	See 1
F (BRN) & Ground	Varying from less than 1 volt to more than 4 volts	See 1

- If voltages are correct, replace the inoperative component.
- If voltages are correct and Cruise Control Module is inoperative, replace it.
- If voltages are correct and Speedometer or Odometer is inoperative, go to Test C.

1. Replace Vehicle Speed Sensor Buffer.

C: SPEEDOMETER IS INACCURATE

1. Plug in scan tool to ALDL Connector at lower left of I/P near steering column. With scan tool on and set to proper mode (RPM/ Speed), operate vehicle at constant speeds. Observe the speedometer and scan tool display.

- If they are in agreement ± 2 mph, the Speedometer is good. Check for correct tire size and inflation, and axle ratio gear calibration (see Section 7A). If all are correct, replace the VSS Buffer.
- If scan tool and speedometer are not in agreement ± 2 mph, go to Step 2.

2. Remove I/P Cluster. See Section 8C for Cluster Removal. Connect I/P tester J-33431 to circuit board on underside of I/P Cluster using 3 terminal edge board connector J-33431-9. With the tester plugged in and set to ON, 54 mph, and 60 Hz, the Speedometer should read 54 mph ± 2 mph.

- If the Speedometer does not indicate properly, the Speedometer is to be sent to an approved A/C Repair Center for repair.
- If the Speedometer operates properly, replace the VSS Buffer.

D: ODOMETER(S) DO NOT OPERATE CORRECTLY

1. Remove the I/P Cluster. See Section 8C for Cluster Removal. Disassemble the cluster and remove the small Odometer connectors from the Speedometer circuit board. Connect I/P tester J-33431-3. Plug in the I/P tester and set it to ON, 54 mph, and 60 Hz. With the Odometer test switch held down, the Odometer should turn and change the mileage shown, about 1.8 mile per minute.

- If the Odometer does not turn, replace the stepper motor (see Section 8C).
- If the Odometer turns about 2.9 miles per minute, a metric Odometer could have been installed. Check to see that the correct Odometer assembly was installed (see Section 8C).

CIRCUIT OPERATION

V6 VIN T, V8 VIN F AND V8 VIN 8

The Vehicle Speed Sensor generates a signal that indicates the speed of the vehicle. The signal produced is a sine wave, which is processed into a square wave by the Electronic Control Module (ECM), to supply inputs to the Cruise Control Module and the Speedometer.

The Vehicle Speed Sensor is mounted in the transmission. A magnet rotates near a coil, producing voltage pulses in the coil. The frequency of the AC voltage coming from this coil depends on the vehicle speed. As the speed increases, so does the number of voltage pulses per second.

The ECM takes the pulses from the sensor through the PPL and YEL wires and uses them to close two Solid State output switches. Each output terminal is switched to ground at a rate that is proportional to the speed of the car. The Speedometer is switched at the same frequency that the ECM generates, 4000 pulses per mile. The Cruise Control Module uses a lower frequency, 2000 pulses per mile. This output switch is operated by a circuit after it has divided the sensor frequency by two.

V8 VIN E

The Vehicle Speed Sensor (VSS) generates a signal that indicates the speed of the vehicle. This signal is processed by the Solid State Vehicle Speed Sensor Buffer to supply inputs to the Electronic Control Module (ECM), the Speedometer and the Cruise Control Module (if equipped).

(Continued on next page)

VEHICLE SPEED SENSOR: PERMANENT MAGNET GENERATOR

(Continued from previous page)

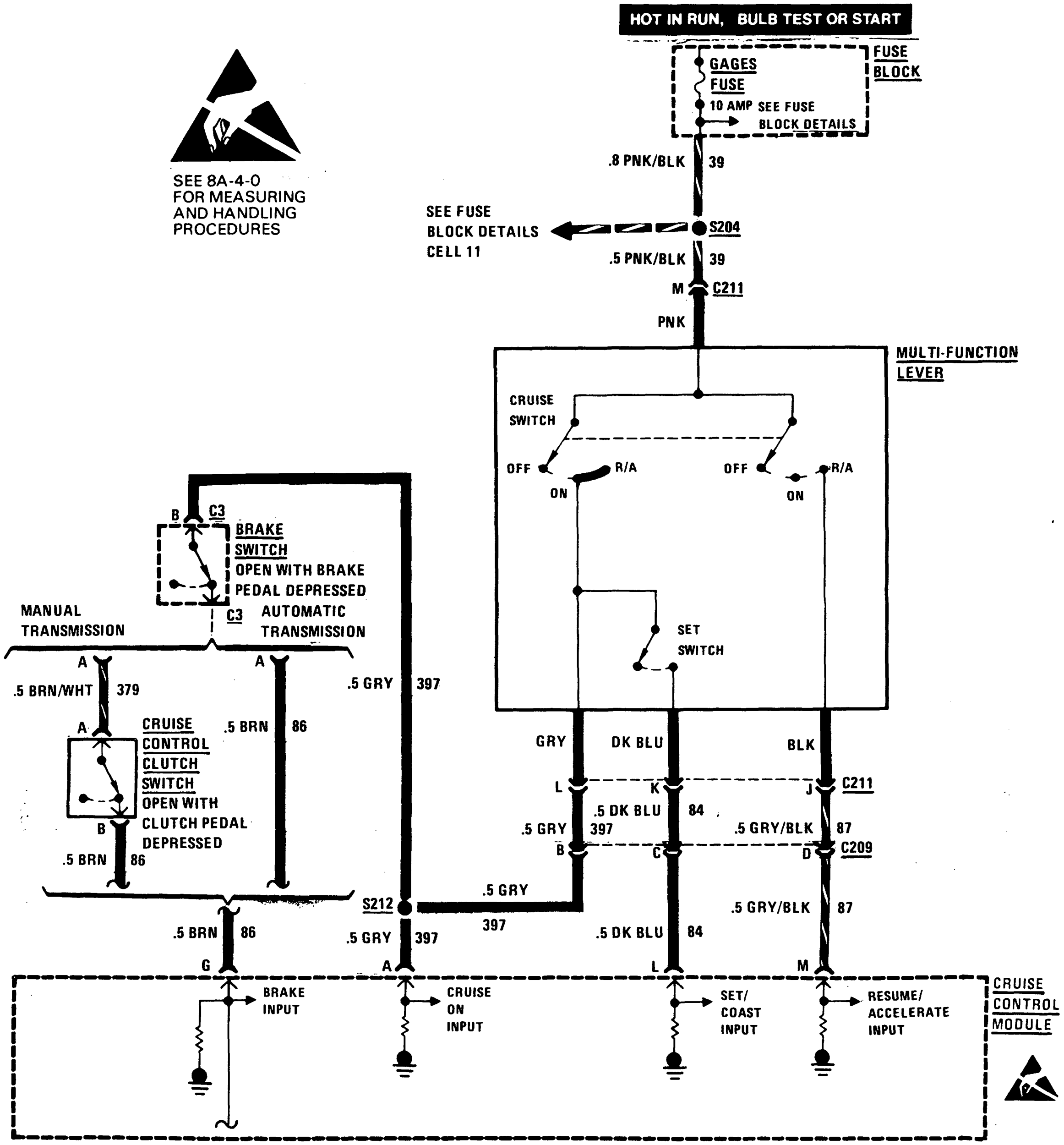
The Vehicle Speed Sensor is mounted in the transmission. A magnet rotates near a coil, producing voltage pulses in the coil. The frequency coming from this coil depends on the vehicle speed. As the speed increases, so does the number of voltage pulses per second.

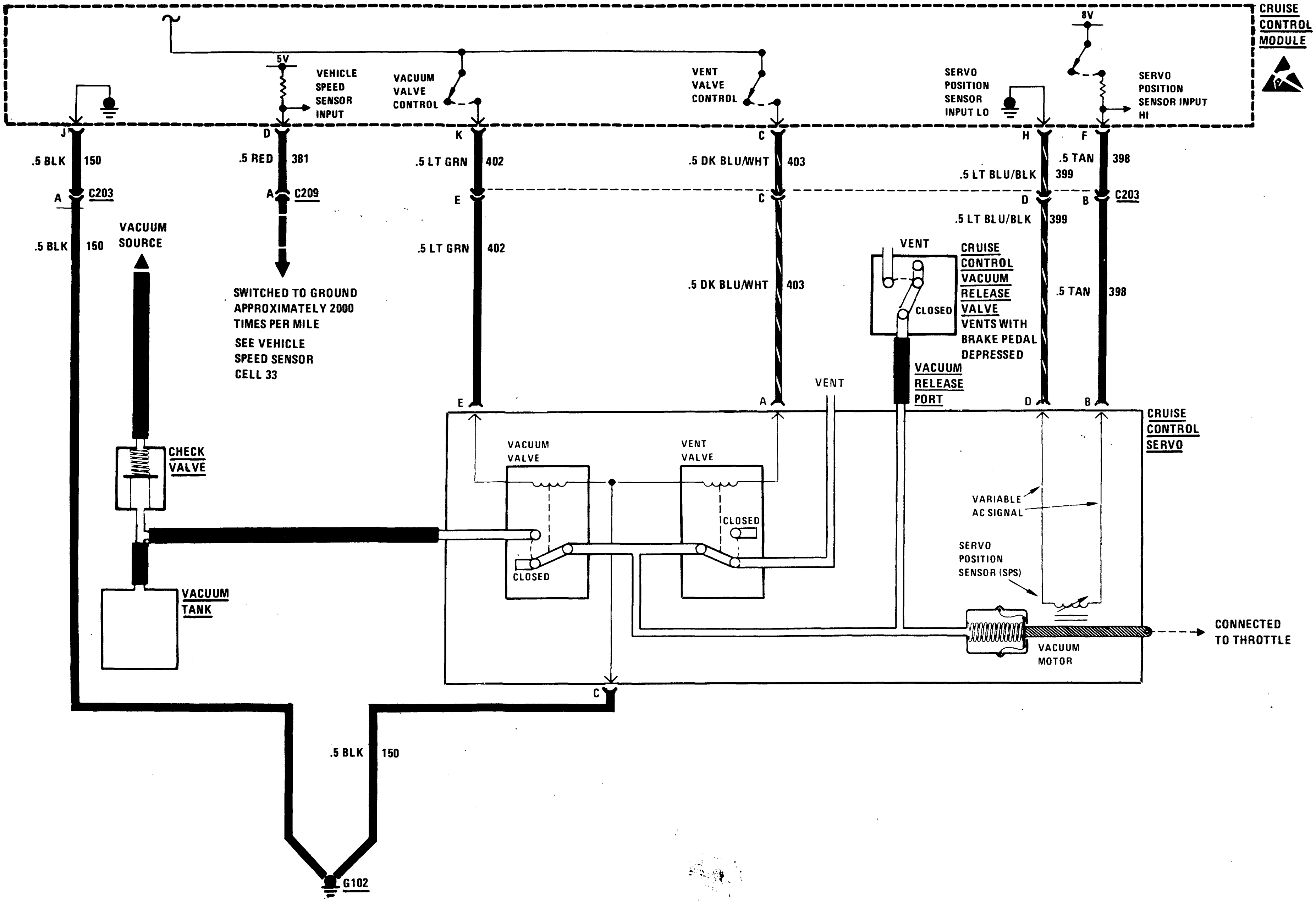
The Vehicle Speed Sensor Buffer takes the voltage pulses from the Sensor and uses them to close three Solid State output switches. Each output terminal is switched to ground at a rate that is proportional to the speed of the car. The Sensor generates 4,000 pulses per mile (ppm). The Speedometer is switched at a frequency of 4,000 ppm. The ECM and the Cruise Control use a lower frequency, 2,000 ppm.

The output switches in the Vehicle Speed Sensor Buffer are Solid State switches, not mechanical ones. Self-powered test lamps or ohmmeters should not be used to test them. Do not measure the resistance at the output of the buffer.

BLANK

SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES




CRUISE CONTROL MODULE
5V
VEHICLE SPEED SENSOR INPUT
VACUUM VALVE CONTROL
VENT VALVE CONTROL
8V
SERVO POSITION SENSOR INPUT LO
SERVO POSITION SENSOR INPUT HI
J
D
K
C
H
F
.5 BLK
150
.5 RED
381
.5 LT GRN
402
.5 DK BLU/WHT
403
.5 LT BLU/BLK
399
.5 TAN
398
A
C203
A
C209
E
C
D
B
C203
VACUUM SOURCE
SWITCHED TO GROUND APPROXIMATELY 2000 TIMES PER MILE
SEE VEHICLE SPEED SENSOR CELL 33
VENT
CRUISE CONTROL VACUUM RELEASE VALVE
VENTS WITH BRAKE PEDAL DEPRESSED
CLOSED
VACUUM RELEASE PORT
VENT
E
A
D
B
CRUISE CONTROL SERVO
CHECK VALVE
VACUUM VALVE
VENT VALVE
CLOSED
CLOSED
VARIABLE AC SIGNAL
SERVO POSITION SENSOR (SPS)
VACUUM TANK
VACUUM MOTOR
CONNECTED TO THROTTLE
C
.5 BLK
150
G102

CRUISE CONTROL

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Check.**

1. Check all Vacuum Hoses for leaks, kinks, and restrictions. Also check Cruise Control Servo linkage. Refer to Section 9 for Vacuum Hose routing and Servo linkage adjustments.
2. If the system works except for the Tap-Up and Tap-Down functions replace the Cruise Control Module.

- **Go to System Check for a guide to normal operation.**
- **Go to System Diagnosis for diagnostic tests.**

SYSTEM CHECK (ROAD TEST)

- **Use the System Check Table as a guide to normal operation.**

COMPONENT LOCATION

		Page-Figure
Brake Switch	Behind LH side of I/P, top of brake pedal support	201-13-C
Check Valve	Center front of dash	201- 9-F
Cruise Control Clutch Switch	Behind LH side of I/P, on clutch pedal bracket	201-13-C
Cruise Control Module	Behind RH side of I/P	
Cruise Control Servo	LH front corner of engine compartment	201- 9-F
Cruise Control Vacuum Release Valve	Behind LH side of I/P, on brake pedal support bracket	201-13-C
Fuse Block	Behind LH side of I/P	201-13-A
Multi-Function Lever	Top LH side of steering column	
Vacuum Tank	LH front corner of engine compartment	201- 9-F
C203 (6 cavities)	Behind LH side of I/P, above brake pedal	201-14-B
C209 (4 cavities)	Behind RH side of I/P	201-15-A
C211 (11 cavities)	Behind I/P, lower RH side of steering column	201-14-A
G102	LH rear corner of engine compartment	201- 9-F
S204	I/P harness, behind LH side of instrument cluster	201-13-A
S212	Cruise control jumper harness, behind LH side of I/P	201-14-B

SYSTEM CHECK TABLE

ACTION	NORMAL RESULT
Drive car faster than 25 mph Turn Cruise Switch ON Depress Set button at the end of the Multi-Function Lever	Car should maintain speed
Hold Set button in, take foot off accelerator	Car should coast to a slower speed
Release Set button	Cruise Control should engage and hold a slower speed, if the new speed remains above 25 mph
Slide Cruise Switch to R/A and hold it there	Car should accelerate
Release Cruise Switch back to ON	Car should hold new faster speed
Tap brake pedal	Car should coast slower (Cruise disengages)
Slide Cruise Control Switch momentarily to R/A	Car should accelerate to former set speed

(Continued on facing page)

(Continued from facing page)

While cruising, accelerate, then remove foot from accelerator	Car should coast back to set speed
While cruising, tap Cruise Switch to R/A	Car speed should increase 1 mph for each tap, up to ten taps, then system may have to be reset to a new speed
While cruising, tap Set button	Car speed should decrease 1 mph for each tap, until 25 mph is reached, then Cruise Control will not operate
Slide Cruise Switch to OFF	Cruise Control turns off

- **Refer to System Diagnosis when a result is not normal.**

SYSTEM DIAGNOSIS

- **Use the Isolation Test below to choose the proper diagnostic tests.**
- **Tests follow the Isolation Test.**
- **Note: Do not press both the SET and R/A Switches at the same time while the engine is running. If the Quick Checker displays a short light, release the switches immediately. Shorts can damage the Quick Checker.**

ISOLATION TEST

Connect: QUICK CHECKER (J-34185, SPECMO QC-3 OR EQUIVALENT) or VOLT-OHMMETER
At: CRUISE CONTROL MODULE CONNECTOR (Disconnected)
Conditions:

- **Ignition Switch: RUN**
- **Test with quick Checker (J-34185 or equivalent) or Digital Meter**

Check	Condition	With Quick Checker, Correct Response	Without Quick Checker, Using a Digital Meter			For Different Result, Do Test:
			Meter Range	Connector Terminals	Correct Result	
1	Cruise Switch OFF	—	200 ohms	J & Ground	0 ohms	B
		All Lights Off	20 VDC	A & J	0 volts	A
			20 VDC	M & J	0 volts	
2	Cruise Switch ON	ON/OFF Light On	20 VDC	A & J	Battery voltage	B
		BRK Light On	20 VDC	G & J	Battery voltage	C
		VENT Light On	200 ohms	C & J	30 to 55 ohms	D
		VAC Light On	200 ohms	K & J	30 to 55 ohms	E
		SPS Light On	200 ohms	F & H	15 to 25 ohms	F
		RA Light Off	20 VDC	M & J	0 volts	A
		SC Light Off	20 VDC	L & J	0 volts	A

(Continued on next page)

(Continued from previous page)

Check	Condition	With Quick Checker, Correct Response	Without Quick Checker, Using a Digital Meter			For Different Result, Do Test
			Meter Range	Connector Terminals	Correct Result	
3	Cruise Switch ON Set Switch pressed	SC Light On	20 VDC	L & J	Battery voltage	G
		VAC & SHORT Lights Off	200 ohms	K & J	30 to 55 ohms	H
4	Cruise Switch in R/A	ON/OFF Light ON	20 VDC	A & J	Battery voltage	A
		RA Light On	20 VDC	M & J	Battery voltage	I
		VENT & SHORT Lights Off	200 ohms	C & J	30 to 55 ohms	J
5	Cruise Switch ON, drive wheels turned by hand	VSS Light flashes On and Off	20 VDC	A & D	Pulses between approximately battery voltage and less than 7 volts	K, L
6	Run engine for one minute, then turn it off. With Ignition Switch in RUN and holding Cruise Switch in R/A, press Set Switch, wait for Servo to pull in, and release Set Switch.	Vacuum holds the servo all the way in	Connect fused jumpers from C to M and from K to L before operating switches		Vacuum holds the servo all the way in	M
7	Quick Checker not connected		200 ohms	F & J	Over range	N
8	Quick Checker not connected	—	200 ohms	F &C	Open circuit (infinite resistance)	O
9	Quick Checker not connected	—	200 ohms	F & K	Open circuit (infinite resistance)	
10	Quick Checker not connected	—	200 ohms	H & C	Open circuit (infinite resistance)	
11	Quick Checker not connected	—	200 ohms	H & K	Open circuit (infinite resistance)	

- If all results are correct, replace Cruise Control Module and check for normal operation.

A: CRUISE SWITCH SHORT TEST

Check for shorts to voltage in the wires to terminals G (BRN), A (GRY), M (GRY/BLK) and L (DK BLU) of the Cruise Control Module (see schematic).

- If wires are good, replace the Multi-Function Lever.

B: POWER CIRCUIT OPEN TEST

1. Check GAGES Fuse.
2. Check that terminal J (BLK) of the Cruise Control Module is grounded.
3. Disconnect C211 and check for battery voltage at terminal M (PNK/BLK) of the harness half with Ignition in RUN (see schematic).

- If battery voltage is missing, check/repair PNK/BLK (39) wire.

4. Check continuity between terminals M and L of the pin half of connector C211 with the Cruise Switch ON.

- If the Switch is open, replace the Multi-Function Lever.

5. Check for an open in GRY (397) wire between terminal L of connector C211 and terminal A of the module connector.

C: BRAKE CIRCUIT OPEN TEST

1. Check for an open Brake Switch or Cruise Control Clutch Switch (see schematic).
2. Check for an open in the GRY (397) wire, BRN (86) wire or BRN/WHT (397) wire (see schematic).

D: VENT CIRCUIT OPEN TEST

- If you measured less than 30 ohms, perform Test J. Otherwise, remove the connector from the Cruise Control Servo. Measure the resistance between terminals A and C of the Servo.
- If it is greater than 55 ohms, replace the Servo.
- If it is less than 55 ohms, check for an open DK BLU/WHT (403) wire between terminal C of the Cruise Control Module and terminal A of the Cruise Control Servo. Check that terminal C (BLK) of the Servo connector is grounded (see schematic).

E: VAC CIRCUIT OPEN TEST

- If you measured less than 30 ohms, perform Test H. Otherwise, remove the connector from the Cruise Control Servo. Measure the resistance between terminals E and C of the Servo.
- If it is more than 55 ohms, replace the Servo.
- If it is less than 55 ohms, check for an open in the LT GRN (402) wire between terminal K of the Cruise Control Module and terminal E of the Cruise Control Servo. Check that terminal C (BLK) of the Servo Connector is grounded (see schematic).

F: SPS CIRCUIT OPEN TEST

- If you measured less than 30 ohms, perform Test N. Otherwise, remove the connector from the Cruise Control Servo. Measure the resistance between terminals B and D of the Servo.
- If it is more than 25 ohms, replace the Servo.
- If it is less than 25 ohms, check for an open in the LT BLU/BLK (399) wire between terminal H of the Cruise Control Module and terminal D of the Cruise Control Servo. Check for an open in the TAN (398) wire between terminal F of the Module and terminal B of the Servo.

G: SC CIRCUIT OPEN TEST

Disconnect C211 and check the switch continuity between terminals L and K of the pin half with the Set Switch pressed.

- If the switch is open, replace the Multi-Function Lever.
- If the switch is not open, check for an open in the DK BLU (84) wire between terminal K of connector C211 and terminal L of the Module.

H: VAC CIRCUIT SHORT TEST

Remove the connector from the Cruise Control Servo and measure resistance between terminals E (LT GRN) and C (BLK) of the Cruise Control Servo.

- If it is less than 30 ohms, replace the Servo.
- If it is 30 ohms or more, check for a short to ground in the LT GRN (402) wire from terminal K of the Cruise Control Module to terminal E of the Cruise Control Servo.

TEST I: R/A CIRCUIT OPEN

Disconnect C211 and check switch continuity between terminals M and J of the pin half with the Cruise Switch in R/A.

- If the switch is not open, check for an open in the GRY/BLK (87) wire between terminal J of connector C211 and terminal M of the Module.
- If the switch is open, replace the Multi-Function Lever.

J: VENT CIRCUIT SHORT TEST

Remove the connector from the Cruise Control Servo and measure resistance between terminals A and C of the Servo.

- If it is less than 30 ohms, replace the Servo.
- If it is 30 ohms or more, check for a short to ground in the DK BLU/WHT (403) wire from terminal C of the Cruise Control Module to terminal A of the Cruise Control Servo.

TEST K: VSS CIRCUIT OPEN

If the VSS light does not come on, or the voltage between terminals A (GRY) and D (BRN) of the Cruise Control Module remains less than 7 volts, check for an open in the RED (381) wire with the Vehicle Speed Sensor signal. Refer to Section 8A-33-0 for details and diagnosis of the Vehicle Speed Sensor.

TEST L: VSS CIRCUIT SHORT

If the VSS light does not go off or Battery voltage remains between terminals A (GRY) and D (RED) of the Cruise Control Module, check for a short to ground on the RED (381) wire with the Vehicle Speed Sensor signal. Refer to Section 8A-33-0 for details and diagnosis of the Vehicle Speed Sensor.

M: VACUUM SYSTEM TEST

1. Check for a blocked or leaking vacuum source.
2. If the vacuum source is good, plug the Vacuum Release Port and repeat Test 6 of the Isolation Test.

- If the vacuum now holds the throttle open, repair or replace the Cruise Control Vacuum Release Valve or the hose to it.
- If the test still fails, replace the Cruise Control Servo.

N: SPS CIRCUIT SHORT TEST

Disconnect the Cruise Control Servo connector and repeat Test 7 of the Isolation Test.

- If the resistance is now over range, replace the Cruise Control Servo.
- If the resistance is still low, find and repair the short in the wire from terminal F (TAN) of the Cruise Control Module to terminal B of the Cruise Control Servo.

TEST O: SERVO TEST

Disconnect the Cruise Control Servo and repeat tests 8, 9, 10 and 11 on the Cruise Control Servo (male side).

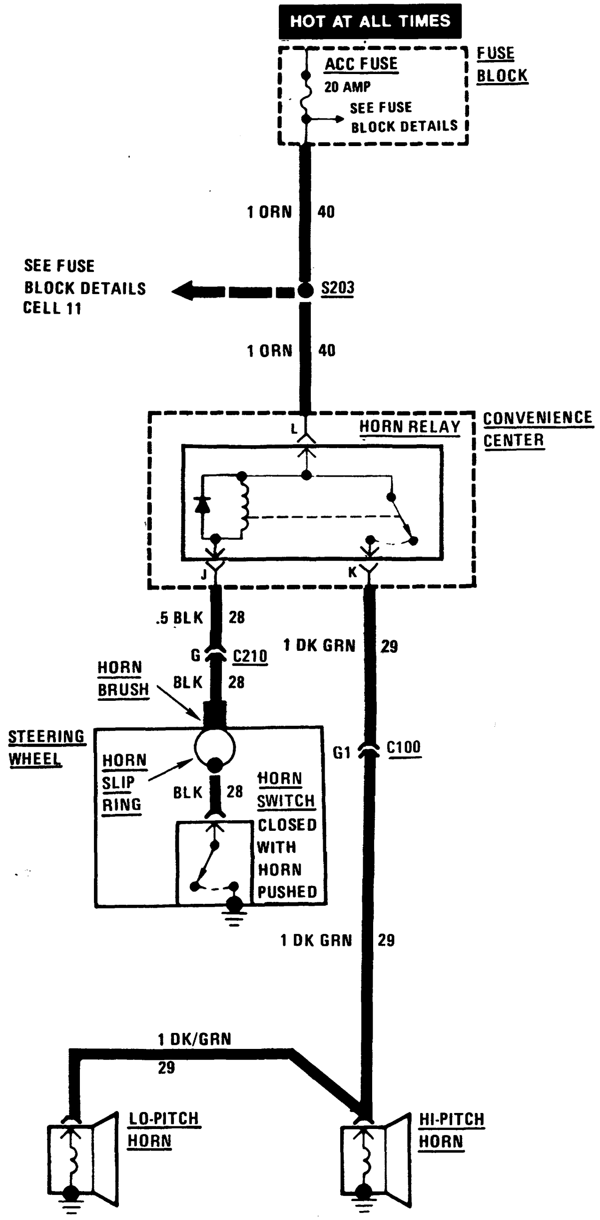
- If the circuit is now open (infinite resistance), check Cruise Control Servo connector and Cruise Control Module connector for corrosion between terminals. Repair shorted wires if connectors are OK.
- If the resistance is still low, check Cruise Control Servo terminals for corrosion between terminals. Replace Servo if terminals are OK.

CIRCUIT OPERATION

The Cruise Control System operates a mechanical linkage to the throttle by means of Vacuum Motor. The motor is a diaphragm. The diaphragm moves when vacuum is applied to only one of its surfaces. A solenoid operated valve connects the Vacuum Motor to a Vacuum Tank. Another solenoid valve vents the vacuum to reduce the suction. The Cruise Control Module controls the Vacuum Motor and the throttle by pulsing these solenoid valves on and off.

One input to the Module is the vehicle speed. This input comes from the Vehicle Speed Sensor. If the actual speed signal is different from the speed that was set into and remembered by the Module, the Module generates pulses to change the vacuum and return the vehicle to the set speed. The Vehicle Speed Sensor is mounted on the transmission. Other inputs to the Module come from the Cruise Switch and the Set Switch. A disengage input to the Module comes from a switch above the brake pedal (and a switch above the clutch pedal with manual transmission). An independent vacuum shut-down of the Cruise Control comes from the Cruise Control Vacuum Release Valve above the brake pedal.

The two inputs of the Cruise Control Module operate the coils of the Vacuum Valve and the Vent Valve. Both valves are located in the Cruise Control Servo. These valves move the throttle by means of the Vacuum Motor. The Servo Position Sensor coil senses the position and motion of the Vacuum Motor. It feeds this information back to the Module to provide smooth acceleration while the vehicle is in Cruise Control.


HOT AT ALL TIMES
ACC FUSE
20 AMP
SEE FUSE
BLOCK DETAILS
FUSE
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1 ORN
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SEE FUSE
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STEERING
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RING
BLK
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HORN
SWITCH
CLOSED
WITH
HORN
PUSHED
G1
C100
1 DK GRN
29
1 DK/GRN
29
LO-PITCH
HORN
HI-PITCH
HORN

HORNS

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Diagnosis.**

1. Check ACC Fuse by operating Cigar Lighter.
2. If only one Horn sounds, check DK GRN (29) wire to inoperative Horn for an open.

- **Go to System Diagnosis for diagnostic tests.**

SYSTEM DIAGNOSIS

- **Diagnostic steps for the symptoms listed in the following table are listed after the table.**

SYMPTOM TABLE

A: Horn(s) sounds continuously.
B: Horn(s) does not sound.

A: HORN(S) SOUNDS CONTINUOUSLY

Connect: TEST LAMP
At: HORN RELAY CONNECTOR (Disconnected)

Connect Between	Correct Result	For Diagnosis
L (ORN) & J (BLK)	Lamp does not light	See 1

- If the lamp does not light replace the Horn Relay.

1. Check BLK (28) wire and Horn Switch for shorts to ground (see schematic).

COMPONENT LOCATION

		Page-Figure
Convenience Center	Behind I/P, to right of steering column	201-12-A
Fuse Block	Behind LH side of I/P	201-13-A
Horn Brush	Below steering wheel	
Horn Slip Ring	Top of steering column, below steering wheel	
Horn Switch	Below steering wheel	
C100 (42 cavities)	LH front of dash, below relay bracket	201-12-A
C210 (11 cavities)	Behind I/P, lower RH side of steering column	201-14-A
S203	I/P harness, behind LH side of instrument cluster	201-12-A

B: HORN(S) DOES NOT SOUND

Connect: TEST LAMP
At: HORN RELAY CONNECTOR (Disconnected)

Connect Between	Correct Result	For Diagnosis
L (ORN) & Ground	Lamp lights	See 1
• Horn Switch: ON		
L (ORN) & J (BLK)	Lamp lights	See 2

- If all test results are good, check Horns and the DK GRN (29) wire for opens, then replace the Horn Relay if wire and Horns are OK.

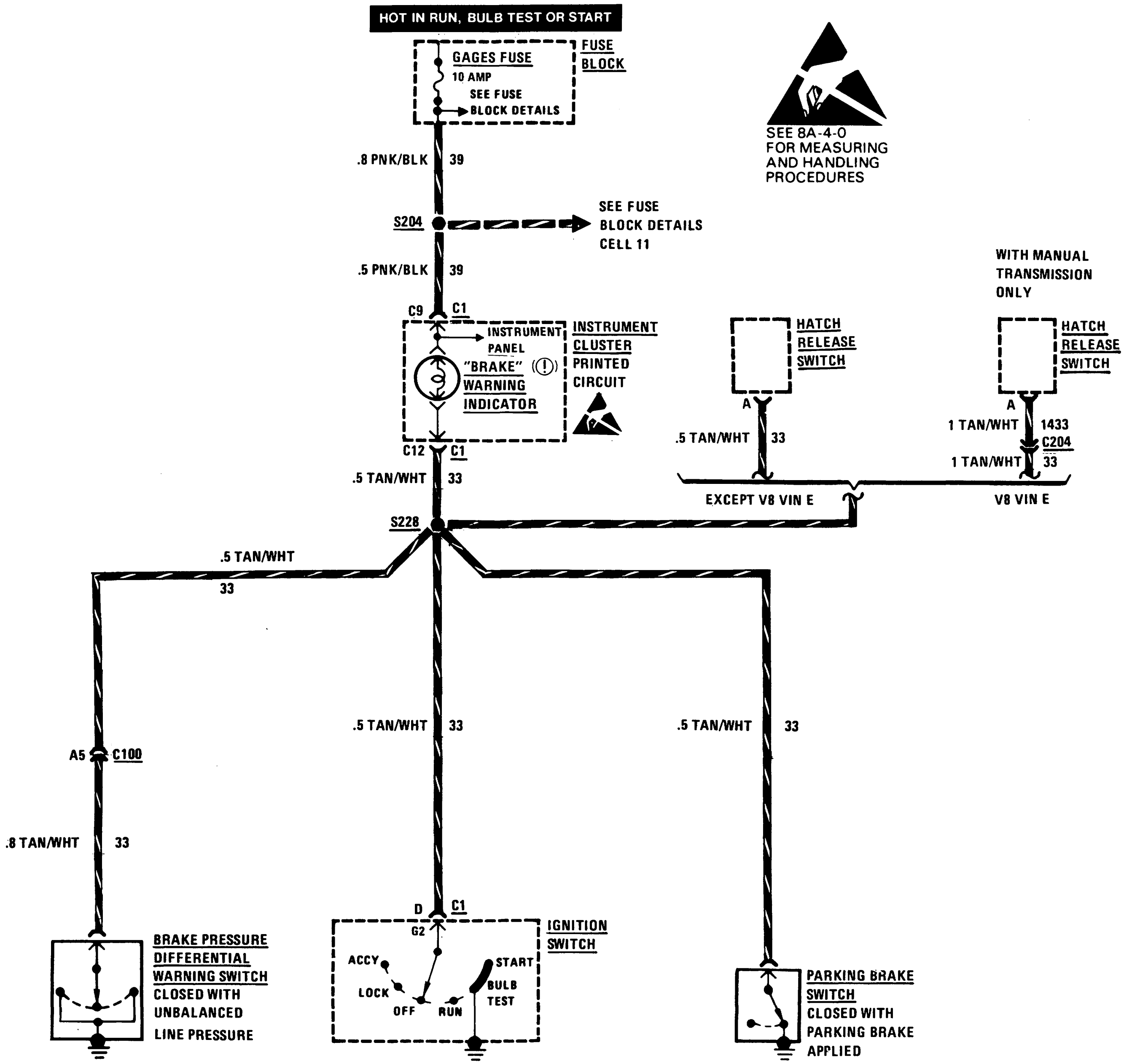
1. Check ORN (40) wire for an open.
2. Check BLK (28) wire and Horn Switch for opens.

CIRCUIT OPERATION

When the Horn Switch is depressed, one side of the Horn Relay coil is grounded. The relay is energized. Its contacts close and battery voltage is applied to the Horns.

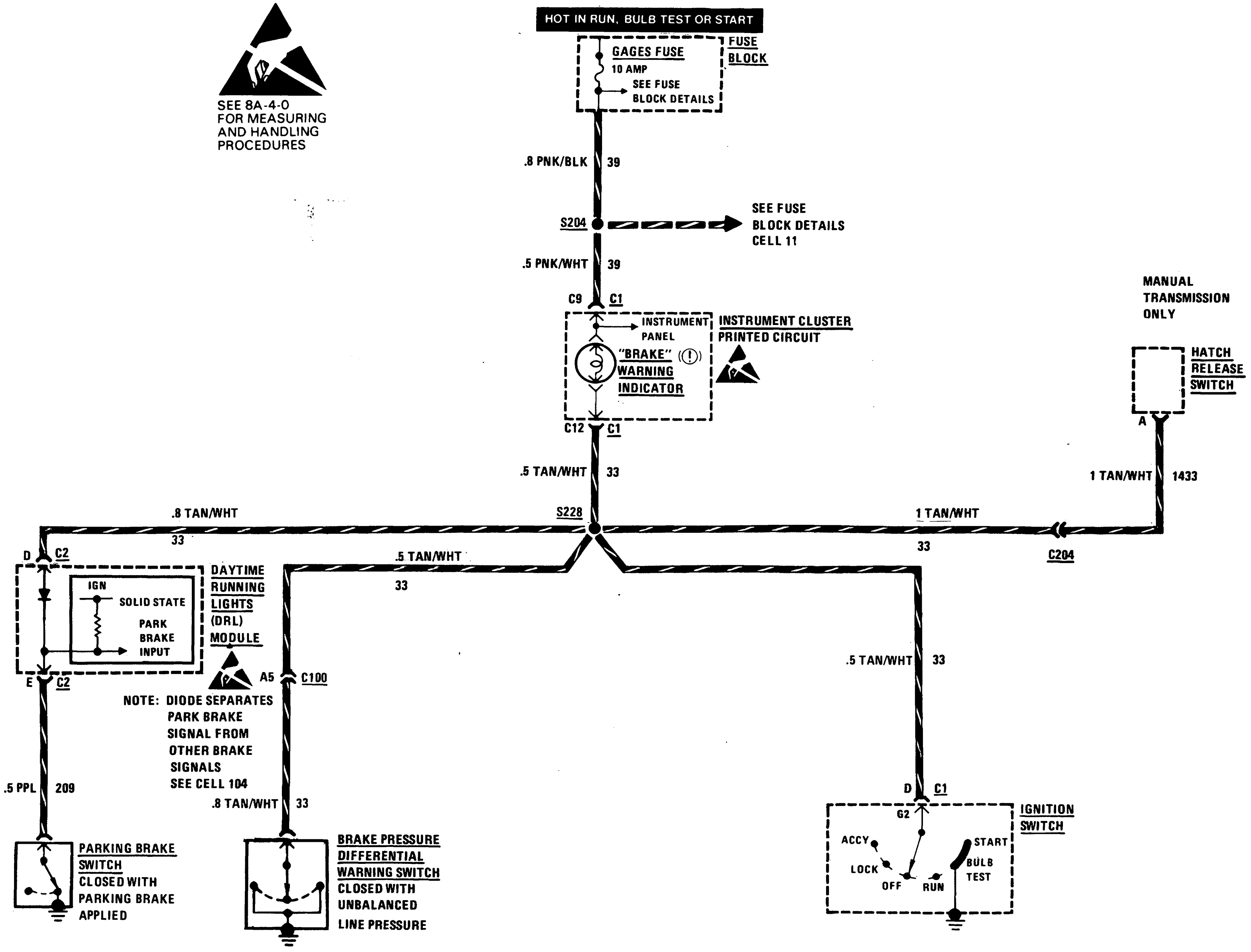
BRAKE WARNING SYSTEM

EXCEPT T61



BRAKE WARNING SYSTEM

WITH T61



BRAKE WARNING SYSTEM

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Check.**

1. Check GAGES Fuse by observing other Instrument Cluster Indicators.
2. If BRAKE Warning Indicator does not light at all, check the bulb and the Instrument Cluster (see Section 81).
3. If the brakes do not function properly or a leak is detected, refer to Section 5.
4. Check that brake fluid reservoir is filled.

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation.**
- **Refer to System Diagnosis for a list of symptoms and diagnostic steps.**

COMPONENT LOCATION

		Page-Figure
Brake Pressure Differential Warning Switch	LH side of engine compartment, below master cylinder	201-10-B
Daytime Running Lights (DRL) Module	Behind LH side of I/P	201-12-A
Fuse Block	Behind LH side of I/P	201-13-A
Ignition Switch	At base of steering column, below I/P	201-14-A
Parking Brake Switch	In console, at base of parking brake lever	201-17-D
C100 (42 cavities)	LH front of dash, below relay bracket	201-12-A
C204 (1 cavity)	Behind center of I/P	201-12-A
S204	I/P harness, behind LH side of instrument cluster	201-13-A
S228	I/P harness, behind LH side of I/P	201-12-A

SYSTEM CHECK TABLE

ACTION	NORMAL RESULT
With the Parking Brake released, turn the Ignition Switch slowly past the RUN position to BULB TEST	BRAKE Warning Indicator lights
Release the Ignition Switch to the RUN position	BRAKE Warning Indicator does not light
With the Ignition Switch in RUN, apply the Parking Brake	BRAKE Warning Indicator lights
Release the Parking Brake	BRAKE Warning Indictor does not light

- **Refer to System Diagnosis when a result is not normal.**

SYSTEM DIAGNOSIS

- **Diagnostic steps for the symptoms listed in the following table are listed after the table.**

SYMPTOM TABLE

A: BRAKE Indicator remains on with the Ignition Switch in RUN and the park brake off

B: BRAKE Indicator lights with the park brake applied, but does not light when there is a brake hydraulic failure.

C: BRAKE Indicator does not light at all

D: BRAKE Indicator lights will the Ignition Switch in BULB TEST, but does not light when the park brake is applied

E: BRAKE Indicator lights with the park brake applied, but does not light when the Ignition Switch is in BULB TEST

A: BRAKE INDICATOR REMAINS ON WITH THE IGNITION SWITCH IN RUN AND THE PARK BRAKE OFF (TABLE 1)

Disconnect: CONNECTOR
At: BRAKE PRESSURE DIFFERENTIAL WARNING SWITCH
Conditions:
- **Ignition Switch: RUN**
- **Park Brake: OFF**

Disconnect	Correct Result	For Diagnosis
Brake Pressure Differential Warning Switch connector	BRAKE Warning Indicator does not light	See 1

- If the result is correct, refer to Section 5 to test the Brake Hydraulic System. Replace the Brake Pressure Differential Warning Switch if the Brake Hydraulic System is OK.

A: BRAKE INDICATOR REMAINS ON WITH THE IGNITION SWITCH IN RUN AND THE PARK BRAKE OFF (TABLE 2)

Disconnect: CONNECTOR
At: PARKING BRAKE SWITCH
Conditions:
- **Ignition Switch: RUN**
- **Park Brake: OFF**

Disconnect	Correct Result	For Diagnosis
Parking Brake Switch connector	BRAKE Warning Indicator does not light	See 1

- If the result is correct, check/replace the Parking Brake Switch.

1. Without Daytime Running Lights: Check the Ignition Switch for a short to ground in the RUN position. If Ignition Switch is good, check TAN/WHT (33 and 1433) wires for a short to ground.

   With Daytime Running Lights: Check the PPL (209) wire between the Parking Brake Switch and the DRL Module for a short to ground. If the wire is good, go to Table 3.

A: BRAKE INDICATOR REMAINS ON WITH THE IGNITION SWITCH IN RUN AND THE PARK BRAKE OFF (TABLE 3)

Disconnect: CONNECTOR
At: DAYTIME RUNNING LIGHTS MODULE
Condition:
- **Ignition Switch: RUN**

Disconnect	Correct Result	For Diagnosis
Daytime Running Lights (DRL) Module connector C2	BRAKE Warning Indicator does not light	See 1

- If the result is correct, replace the Daytime Running Lights Module.

1. Check the Ignition Switch for a short to ground in the RUN position. If the Ignition Switch is good, check the TAN/WHT (33 and 1433) wires for a short to ground.

B: BRAKE INDICATOR LIGHTS WITH THE PARK BRAKE APPLIED, BUT DOES NOT LIGHT WHEN THERE IS A HYDRAULIC FAILURE

Connect: FUSED JUMPER
At: BRAKE PRESSURE DIFFERENTIAL WARNING SWITCH CONNECTOR
Conditions:
- Ignition Switch: RUN
- Park Brake: OFF

Connect Between	Correct Result	For Diagnosis
Brake Pressure Differential Warning Switch Connector & Ground	BRAKE Warning Indicator lights	See 1

- If the result is correct, check/replace the Brake Pressure Differential Warning Switch.

1. Check TAN/WHT (33) wire for an open.

C: BRAKE INDICATOR DOES NOT LIGHT AT ALL

Connect: FUSED JUMPER
At: CONNECTOR C100 (Connected)
Condition:
- Ignition Switch: RUN

Connect Between	Correct Result	For Diagnosis
A5 (TAN/ WHT) & Ground	BRAKE Warning Indicator lights	See 1

- If the result is correct, go to Tables D and E.

1. Check Indicator bulb, TAN/WHT (33) wire(s) and the Instrument Cluster Printed Circuit for an open.

D: BRAKE INDICATOR LIGHTS WITH THE IGNITION SWITCH IN BULB TEST, BUT DOES NOT LIGHT WHEN THE PARK BRAKE IS APPLIED (TABLE 1)

Connect: FUSED JUMPER
At: PARKING BRAKE SWITCH CONNECTOR
Condition:
- Ignition Switch: RUN

Connect Between	Correct Result	For Diagnosis
Park Brake Switch Connector & Ground	BRAKE Warning Indicator lights	See 1

- If the result is correct check/replace the Parking Brake Switch.

1. Without Daytime Running Lights: Check the TAN/WHT (33) wire for an open.
2. With Daytime Running Lights: Check the TAN/WHT (33) wire between the Parking Brake Switch and the DRL Module for an open. If the wire is good, go to Table 2.

D: BRAKE INDICATOR LIGHTS WITH THE IGNITION SWITCH IN BULB TEST, BUT DOES NOT LIGHT WHEN THE PARK BRAKE IS APPLIED (TABLE 2)

Connect: FUSED JUMPER
At: DAYTIME RUNNING LIGHTS MODULE CONNECTOR C2 (Disconnected)
Condition:
- Ignition Switch: RUN

Connect Between	Correct Result	For Diagnosis
C2/D (TAN/ WHT) & Ground	BRAKE Warning Indicator Lights	See 1

- If the result is correct replace the Daytime Running Lights Module.

1. Check the TAN/WHT (33) wire for an open.

E: BRAKE INDICATOR LIGHTS WITH THE PARK BRAKE APPLIED, BUT DOES NOT LIGHT WHEN THE IGNITION SWITCH IS IN BULB TEST

Connect: FUSE JUMPER
At: IGNITION SWITCH CONNECTOR C1 (Connected)
Conditions:

- **Ignition Switch: RUN**
- **Park Brake: OFF**

Connect Between	Correct Result	For Diagnosis
C1/D (TAN/ WHT) & Ground	BRAKE Warning Indicator lights	See 1

- If the result is correct, check/replace the Ignition Switch.

1. Check/repair TAN/WHT (33) wire for an open.

CIRCUIT OPERATION

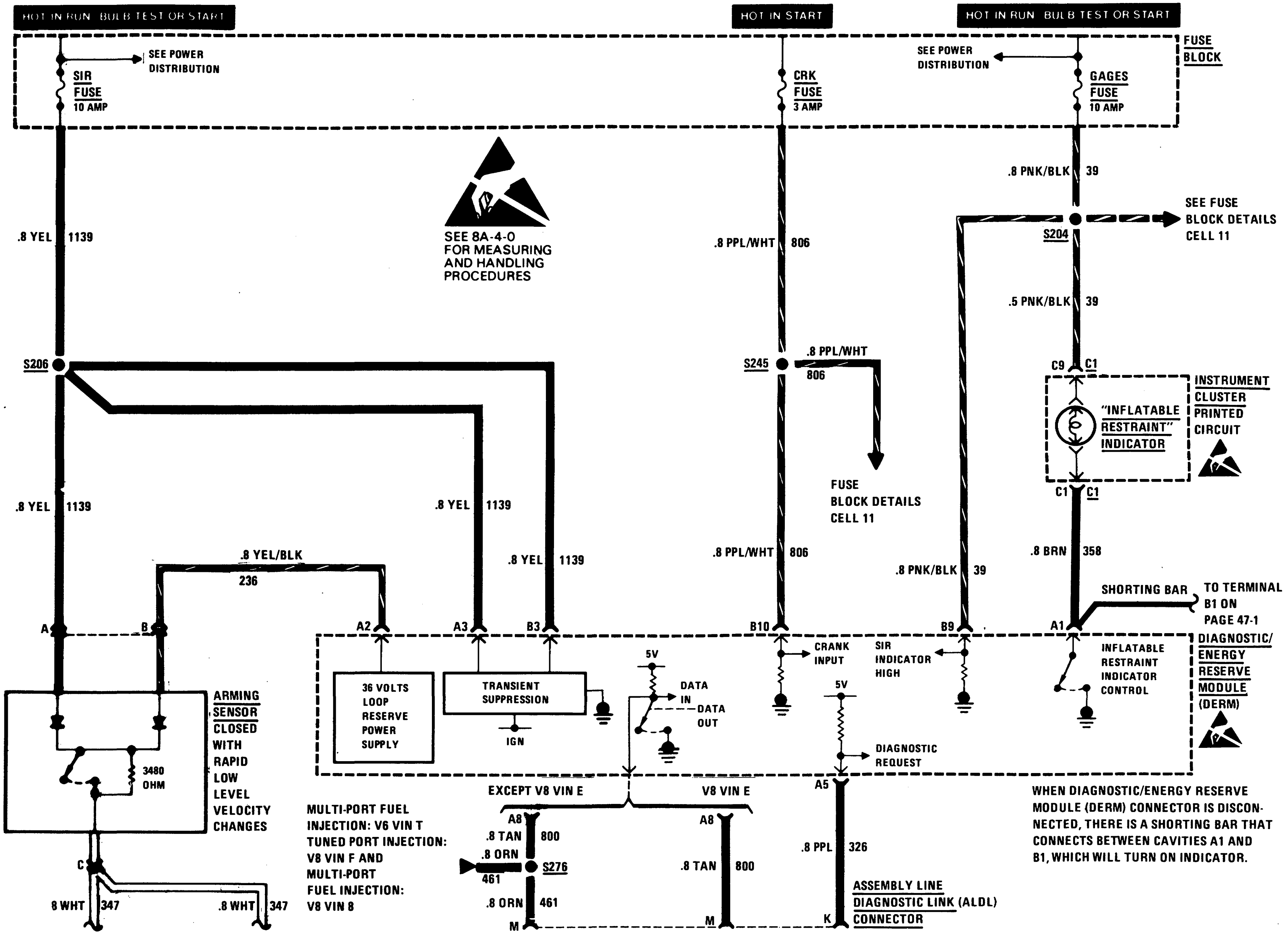
Battery voltage is applied to the BRAKE Warning Indicator when the Ignition Switch is in RUN, BULB TEST or START. Three switches are connected to the BRAKE Warning Indicator. When any one of these switches closes, ground is provided and the Indicator lights.

The Ignition Switch provides a ground when it is in the BULB TEST and START positions. The BRAKE Warning Indicator lights.

The Parking Brake Switch provides a ground when the park brake is applied. The BRAKE Warning Indicator lights to alert the driver.

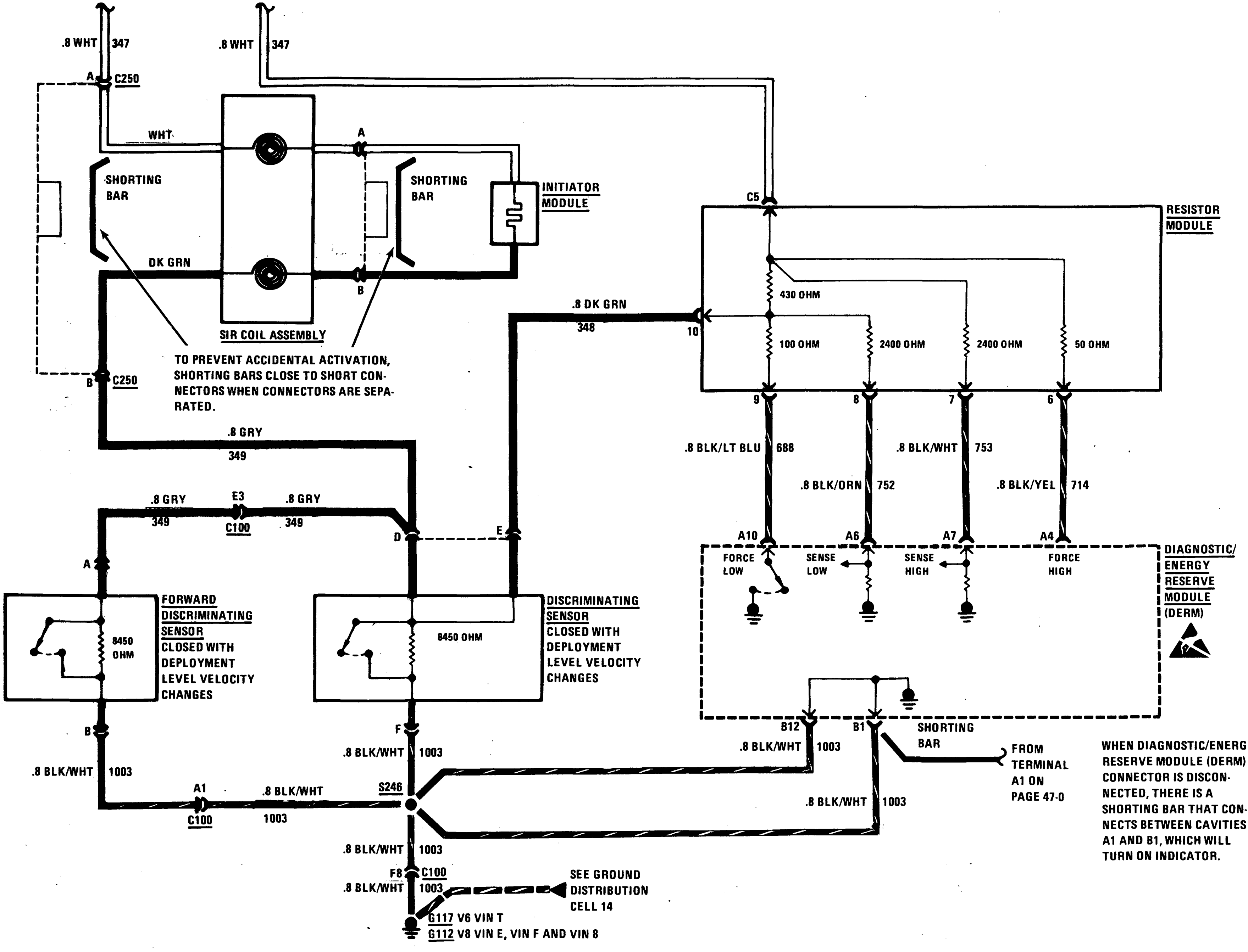
The Brake Pressure Differential Warning Switch closes to light the BRAKE Warning Indicator when there is low brake fluid in one of the two hydraulic brake systems. This could be caused by a leak in one of the brake lines. The switch is reset to an open condition when brake pressure is equalized. This can only be accomplished after the faulty system has been repaired.

SUPPLEMENTAL INFLATABLE RESTRAINT (SIR): AJ3



MULTI-PORT FUEL INJECTION: V6 VIN T
TUNED PORT INJECTION: V8 VIN F AND
MULTI-PORT FUEL INJECTION: V8 VIN 8

WHEN DIAGNOSTIC/ENERGY RESERVE MODULE (DERM) CONNECTOR IS DISCONNECTED, THERE IS A SHORTING BAR THAT CONNECTS BETWEEN CAVITIES A1 AND B1, WHICH WILL TURN ON INDICATOR.



TO PREVENT ACCIDENTAL ACTIVATION, SHORTING BARS CLOSE TO SHORT CONNECTORS WHEN CONNECTORS ARE SEPARATED.

WHEN DIAGNOSTIC/ENERGY RESERVE MODULE (DERM) CONNECTOR IS DISCONNECTED, THERE IS A SHORTING BAR THAT CONNECTS BETWEEN CAVITIES A1 AND B1, WHICH WILL TURN ON INDICATOR.

SUPPLEMENTAL INFLATABLE RESTRAINT (SIR): AJ3

- **For diagnostic procedures refer to Section 9J of the Service Manual.**

COMPONENT LOCATION

		Page-Figure
Arming Sensor	Under console, to rear of gear selector bracket	201-16-A
Assembly Line Diagnostic Link (ALDL) Connector	Under LH side of I/P, on Fuse Block	201-13-A
Diagnostic/Energy Reserve Module (DERM)	Behind RH side of I/P	201-15-A
Discriminating Sensor	Under front of console	201-16-A
Forward Discriminating Sensor	Front of engine compartment, on radiator support	201-11-E
Fuse Block	Behind LH side of I/P	201-13-A
Resistor Module	Below LH side of I/P	
C100 (42 cavities)	LH front of dash, below relay bracket	201-12-A
C250 (2 cavities)	Below LH side of I/P, near steering column	201-14-A
G112 (VIN E)	Rear of LH cylinder head	201- 4-A
G112 (VIN F)(VIN 8)	Rear of LH cylinder head	201- 7-A
G117 (VIN T)	Rear of LH cylinder head	201- 1-A
S204	I/P harness, behind LH side of instrument cluster	201-13-A
S206	I/P harness, behind center of I/P	201-15-A
S245	I/P harness, behind center of I/P	201-12-A
S246	I/P harness, behind center of I/P	201-12-A
S276	I/P harness, near Fuse Block	201-13-A

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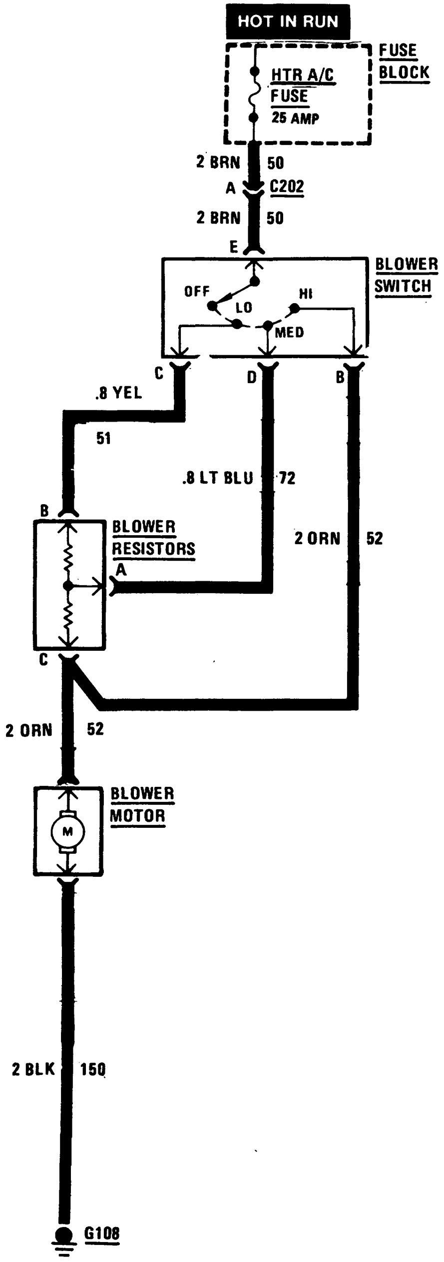
HOT IN RUN
FUSE BLOCK
HTR A/C FUSE
25 AMP
2 BRN
50
A
C202
2 BRN
50
E
BLOWER SWITCH
OFF
LO
HI
MED
C
D
B
.8 YEL
51
.8 LT BLU
72
2 ORN
52
B
BLOWER RESISTORS
A
C
2 ORN
52
BLOWER MOTOR
M
2 BLK
150
G108

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Check.**

1. If Blower Motor does not operate at all, check HTR A/C Fuse.
2. Check that ground G108 is clean and tight.
3. If Blower Motor does not turn off, install a new Blower Switch.

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation.**
- **Refer to System Diagnosis for a list of symptoms and diagnostic steps.**

SYSTEM CHECK TABLE

ACTION	NORMAL RESULT
With Ignition Switch in RUN, set Blower Switch to OFF	Blower Motor does not operate
Set Blower Switch to LO	Blower Motor operates at low speed
Set Blower Switch to MED	Blower Motor operates faster at medium speed
Set Blower Switch to HI	Blower Motor operates faster at high speed

- **Refer to System Diagnosis when a result is not normal.**

COMPONENT LOCATION

		Page-Figure
Blower Motor	RH front of dash	201-11-B
Blower Resistors (without A/C)	RH front of dash, on heater module	201-11-B
Fuse Block	Behind LH side of I/P	201-13-A
C202 (1 cavity)	Behind center of I/P, near A/C Control Head	201-17-E
G108	RH front of dash, left of Blower Motor	201-11-B

SYSTEM DIAGNOSIS

- **Do the tests listed for your symptom in the Symptom Table below.**
- **Tests follow the Symptom Table.**

SYMPTOM TABLE

SYMPTOM	FOR DIAGNOSIS
Blower Motor operates with Blower Switch in OFF	Do Test D
Blower Motor does not operate at all	Do Test C: Blower Motor Test Do Test A: Blower Switch Test
Blower Motor does not operate in HI, but operates in LO and/or MED	Do Test A: Blower Switch Test Check (ORN) 52 wire for an open (see schematic)
Blower Motor does not operate in LO and/or MED, but operates in HI	Do Test A: Blower Switch Test Do Test B: Blower Resistors Test

- **If your symptom does not appear in the Symptom Table, perform all of the tests.**

A: BLOWER SWITCH TEST

Measure: VOLTAGE
At: BLOWER SWITCH CONNECTOR
(Connected)
Condition:
• Ignition Switch: RUN

Measure Between	Correct Voltage	For Diagnosis
E (BRN) & Ground	Battery	See 1
• Blower Switch: LO		
C (YEL) & Ground	Battery	See 2
• Blower Switch: MED		
D (LT BLU) & Ground	Battery	See 2
• Blower Switch: HI		
B (ORN) & Ground	Battery	See 2

- If all voltages are correct, go to Symptom Table.

1. Check BRN (50) wire for an open (see schematic).
2. Replace Blower Switch.

B: BLOWER RESISTORS TEST

Measure: VOLTAGE
At: BLOWER RESISTORS CONNECTOR (Disconnected)
Conditions:
- **Ignition Switch: RUN**
- **Blower Switch: LO**

Measure Between	Correct Voltage	For Diagnosis
B (YEL) & Ground	Battery	See 1
• Blower Switch: MED		
A (LT BLU) & Ground	Battery	See 2

- If all the results are correct, replace the Blower Resistors.

1. Check YEL (51) wire for an open (see schematic).
2. Check LT BLU (72) wire for an open (see schematic).

C: BLOWER MOTOR TEST

Measure: VOLTAGE
At: BLOWER MOTOR CONNECTOR (Disconnected)
Conditions:
- **Ignition Switch: RUN**
- **Blower Switch: HI**

Measure Between	Correct Voltage	For Diagnosis
ORN wire & Ground	Battery	See 1
ORN wire & BLK wire	Battery	See 2

- If all the voltages are correct, replace Blower Motor.

1. Go to Test A: Blower Switch Test. If Blower Switch is OK, check/repair ORN (52) wire for an open (see schematic).
2. Check/repair BLK (150) wire for an open (see schematic).

D: BLOWER MOTOR DOES NOT TURN OFF

1. Disconnect the Blower Switch connector.
- If the Blower Motor stops, replace the Blower Switch.
- If the Blower Motor continues to run, go to step 2.

2. Disconnect the Blower Resistors connector.
- If the Blower Motor stops check the YEL (51) and LT BLU (72) wires for a short to battery.
- If the Blower Motor continues to run check the ORN (52) wires for a short to battery.

CIRCUIT OPERATION

The Blower Motor delivers air to the interior of the vehicle. Its speed is controlled by the Blower Switch and the Blower Resistors. When the Ignition Switch is in RUN, battery voltage is applied to the Blower Switch. With the Blower Switch in LO, voltage is applied across both Blower Resistors and the Blower Motor: the Blower Motor runs at its slowest speed. With the Blower Switch in MED, one of the Blower Resistors is bypassed and the Blower Motor runs faster. When the Blower Switch is set to HI, battery voltage is applied directly to the Blower Motor and the motor runs at its fastest speed.

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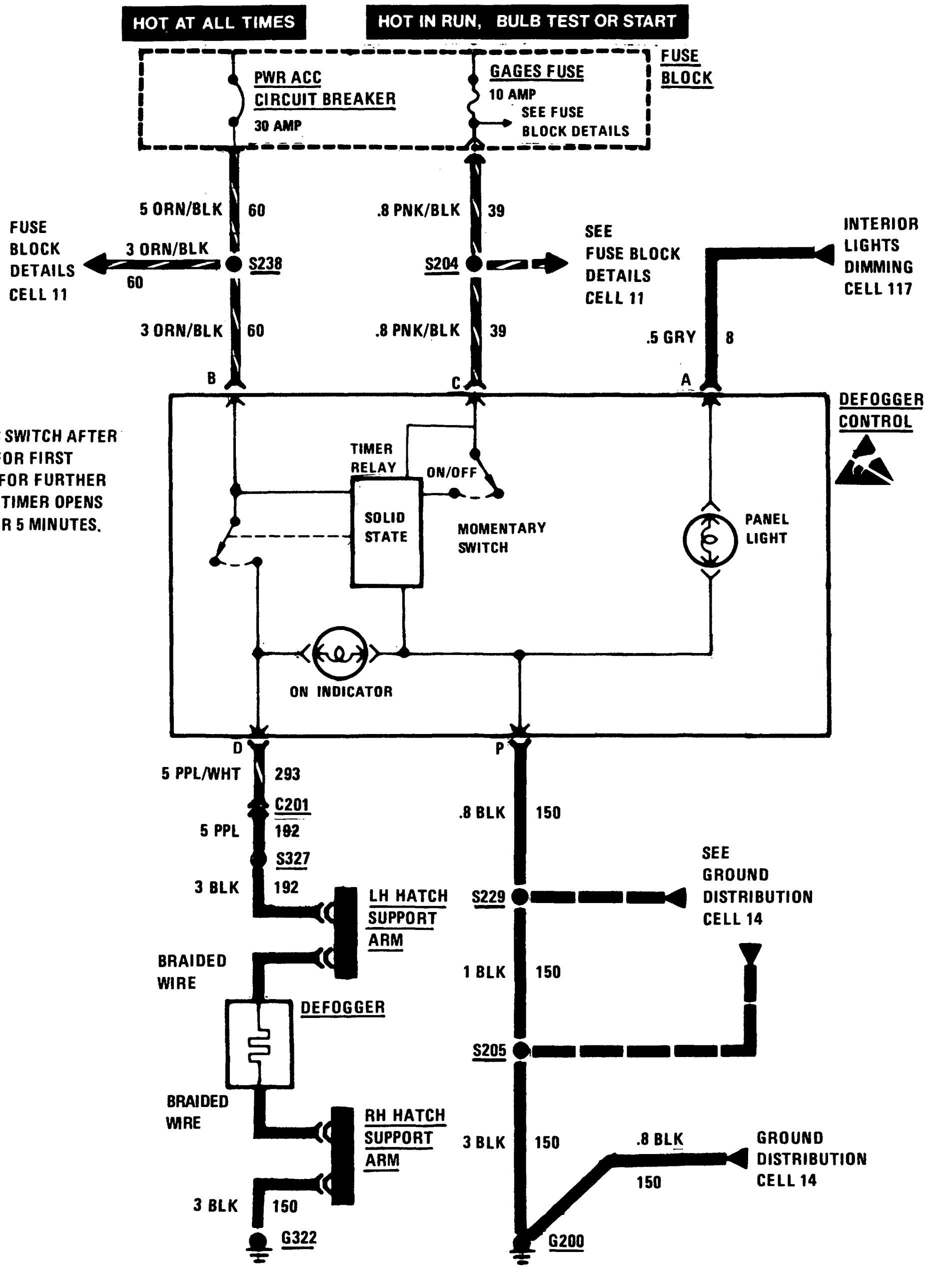
DEFOGGER



TIMER OPENS SWITCH AFTER 10 MINUTES FOR FIRST OPERATION. FOR FURTHER OPERATIONS TIMER OPENS SWITCH AFTER 5 MINUTES.

SEE 8A-4-0 FOR MEASURING AND HANDLING PROCEDURES

DEFOGGER

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Check.**

1. Check GAGES Fuse by observing the BRAKE Warning Indicator, with Ignition Switch in RUN, and the Park Brake applied.
2. Check PWR ACC Circuit Breaker by operating Power Seat or Power Door Locks (if equipped).
3. Check that the connections at both LH and RH Hatch Support Arms and grounds G322 and G200 are clean and tight.
4. If one or more of the grid lines do not heat, refer to Body Service (Section 10-2) for repair procedures.
5. If the symptom involves only the time interval that the Defogger operates, replace Defogger Control.

- **Go to System Check for a guide to normal operation.**
- **Go to System Diagnosis for diagnostic tests.**

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation. Refer to the diagnosis given if other results occur. (Table must be used in the order shown.)**
- **Tests follow in System Diagnosis.**

COMPONENT LOCATION

		Page-Figure
Fuse Block	Behind LH side of I/P	201-13-A
C201 (1 cavity)	LH shroud, near upper access hole	201-12-A
G200	Behind LH side of I/P, on Convenience Center bracket	201-14-C
G322	On body, near RH hatch support arm	201-19-D
S204	I/P harness, behind LH side of instrument cluster	201-13-A
S205	I/P harness, behind instrument cluster	201-12-A
S229	I/P harness, above Convenience Center	201-12-A
S238	I/P harness, behind LH side of I/P	201-12-A

SYSTEM CHECK TABLE

ACTION	NORMAL RESULT	FOR DIAGNOSIS
1. Turn the Ignition Switch to RUN and depress Defogger Switch	The Switch button returns to the rest position and the ON Indicator, in the center of the Defogger Control, lights.	Do Test A: Defogger Control Input Voltage Test.
	Defogger grid warms to remove fog from the rear window.	Do Test B: Defogger Test.
	ON Indicator and Defogger turn off after approximately 10 minutes.	Replace Defogger Control.
2. Depress Defogger Switch again	ON Indicator and Defogger turn on. After approximately 5 minutes, they turn off again.	Replace Defogger Control.
3. Depress Defogger Switch and immediately press switch again	ON Indicator and Defogger turn on, and then turn off.	Do Test A: Defogger Control Input Voltage Test.
4. Put Light Switch in HEAD or PARK	Defogger Control Panel Light is on.	Do Test C: Defogger Control Panel Light Test.

- **If all the results are normal, the system is OK.**

SYSTEM DIAGNOSIS

- **Do the tests below when directed by the System Check.**

(Continued on next page)

(Continued from previous page)

A: DEFOGGER CONTROL INPUT VOLTAGE TEST (TABLE 1)

Measure: VOLTAGE
At: DEFOGGER CONTROL CONNECTOR (Disconnected)
Condition:

- **Ignition Switch: RUN**

Measure Between	Correct Voltage	For Diagnosis
C (PNK/BLK) & Ground	Battery	See 1
C (PNK/BLK) & P (BLK)	Battery	See 2
B (ORN/BLK) & Ground	Battery	See 3

- If all voltages are correct, go to Table 2.

1. Check PNK/BLK (39) wire for an open. If wire is OK, check GAGES Fuse.
2. Check the BLK (150) wire for an open. Check that connections at ground G200 are clean and tight (see schematic).
3. Check ORN/BLK (60) wire for an open. If wire is OK, check PWR ACC Circuit Breaker.

A: DEFOGGER CONTROL INPUT VOLTAGE TEST (TABLE 2)

Measure: VOLTAGE
At: DEFOGGER CONTROL CONNECTOR (Connected)
Conditions:

- **Ignition Switch: RUN**
- **Defogger Switch: ON**

Measure Between	Correct Voltage	For Diagnosis
D (PPL/WHT) & Ground	Battery	See 1

- If voltage is correct, check that the connections at LH and RH Hatch Support Arms and ground G322 are clean and tight (see schematic). Check BLK (150) wire for an open.

1. Replace Defogger Control.

B: DEFOGGER TEST

With the Ignition Switch in RUN and the Defogger Switch pressed ON, connect one lead of a test lamp to ground. From inside the car, lightly touch the other lead to each grid line and slowly move it along the length of the grid. The brilliance of the test lamp bulb should increase as the test lamp is moved from left (passenger's side) to right (driver's side).

- If test lamp does not light along any of the grid lines, check PPL/WHT (293) wire to Defogger Control for an open. If OK, do Test A.
- If test lamp bulb shows full brilliance at both ends of the grid, check BLK (150) wire for an open to ground (see schematic).
- If test lamp suddenly lights as it is moved along the grid, a break in the continuity of the grid line exists. Refer to the GM Body Service Manual for grid line repair procedures.

C: DEFOGGER CONTROL PANEL LIGHT TEST

Measure: VOLTAGE
At: DEFOGGER CONTROL CONNECTOR (Disconnected)
Conditions:

- **Ignition Switch: RUN**
- **Headlight Switch: PARK**

Measure Between	Correct Voltage	For Diagnosis
A (GRY) & Ground	Battery	See 1
A (GRY) & P (BLK)	Battery	See 2

- If all voltages are correct, repair/replace Panel Light in Defogger Control.

1. Check GRY (8) wire for an open (see schematic). If the wire is OK, check the INST Fuse.
2. Check BLK (150) wire for an open. If wire is OK, check that ground G200 is clean and tight (see schematic).

DEFOGGER

CIRCUIT OPERATION

With the Ignition Switch in RUN, voltage is applied to the Defogger Control. When the Defogger Control Switch is moved to the ON position, voltage is applied to the Defogger Timer-Relay. The contact closes, providing voltage to the ON Indicator and Defogger. The rear window will become warm to remove condensation from the surface of the window.

The contact in the Defogger Control will stay closed until the Defogger Control Switch is turned off, or the timer cycle is completed.

The first time the Defogger Control Switch is pushed in, the Timer-Relay will allow the Defogger to operate 10 minutes. Thereafter, each time the Defogger Control Switch is pushed in, the Timer-Relay will allow the Defogger to operate for a maximum of 5 minutes. The Timer-Relay will reset to 10 minutes when the Ignition Switch is turned OFF and then back to the RUN position, or when the Defogger Control is turned off manually.

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation. All of the checks can be performed without the use of tools or disassembly of components.**
- **Even though one or more checks may not give the normal result, complete the entire System Check to reveal all symptoms which may exist.**

SYSTEM CHECK TABLE

Air Conditioning: C60
Engine warm and running at idle.
Temperature outside car at 60°F (16°C) or higher

SET A/C CONTROLS	EXPECTED RESULT	REFER TO SECTION:
OFF Fan LO	Blower is not running	8A-63 Blower Controls
Move Temperature Lever repeatedly back and forth	Temperature Door hits stop in each direction	8A-65 Air Delivery
HEATER (Temperature Lever at COLD)	Blower runs at low speed	8A-63 Blower Controls
	Air at outside temperature flows from floor outlets	8A-65 Air Delivery
	Slight air flow at windshield outlets	8A-65 Air Delivery
Move Fan Switch through M1, M2 to HI	Increased air flow at each step	8A-63 Blower Controls
Move Temperature Lever to HOT	Air flow becomes warm	8A-65 Air Delivery
DEF	Warm air flows from windshield outlets	8A-65 Air Delivery
	Compressor turns on and may cycle ON and OFF	8A-64 Compressor Controls
	Engine's speed may increase	6E Driveability and Emissions
VENT	Outside air flows from Instrument Panel outlets Compressor remains OFF	8A-65 Air Delivery

(System Check Table continued on facing page)

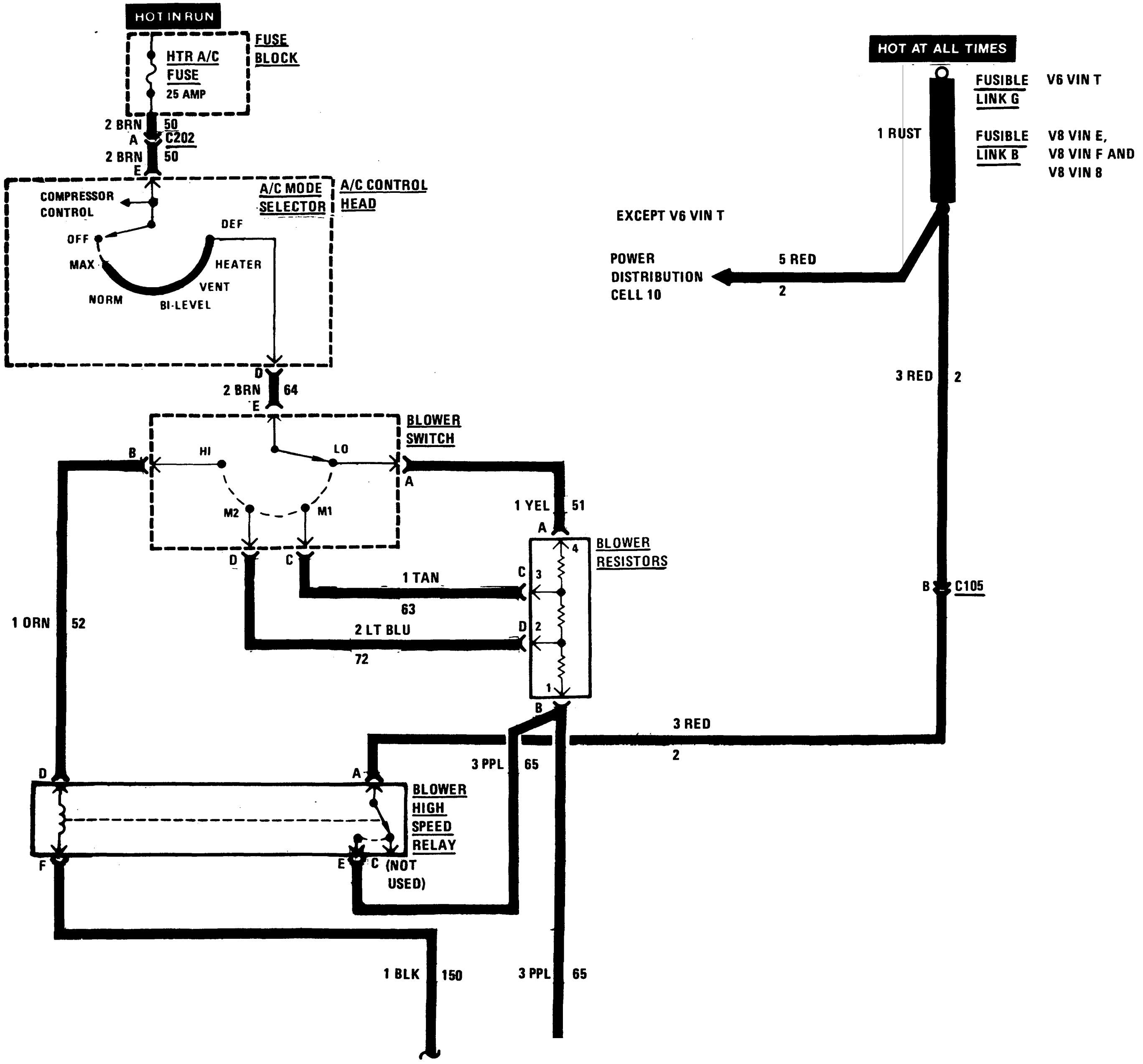
(System Check Table continued from facing page)

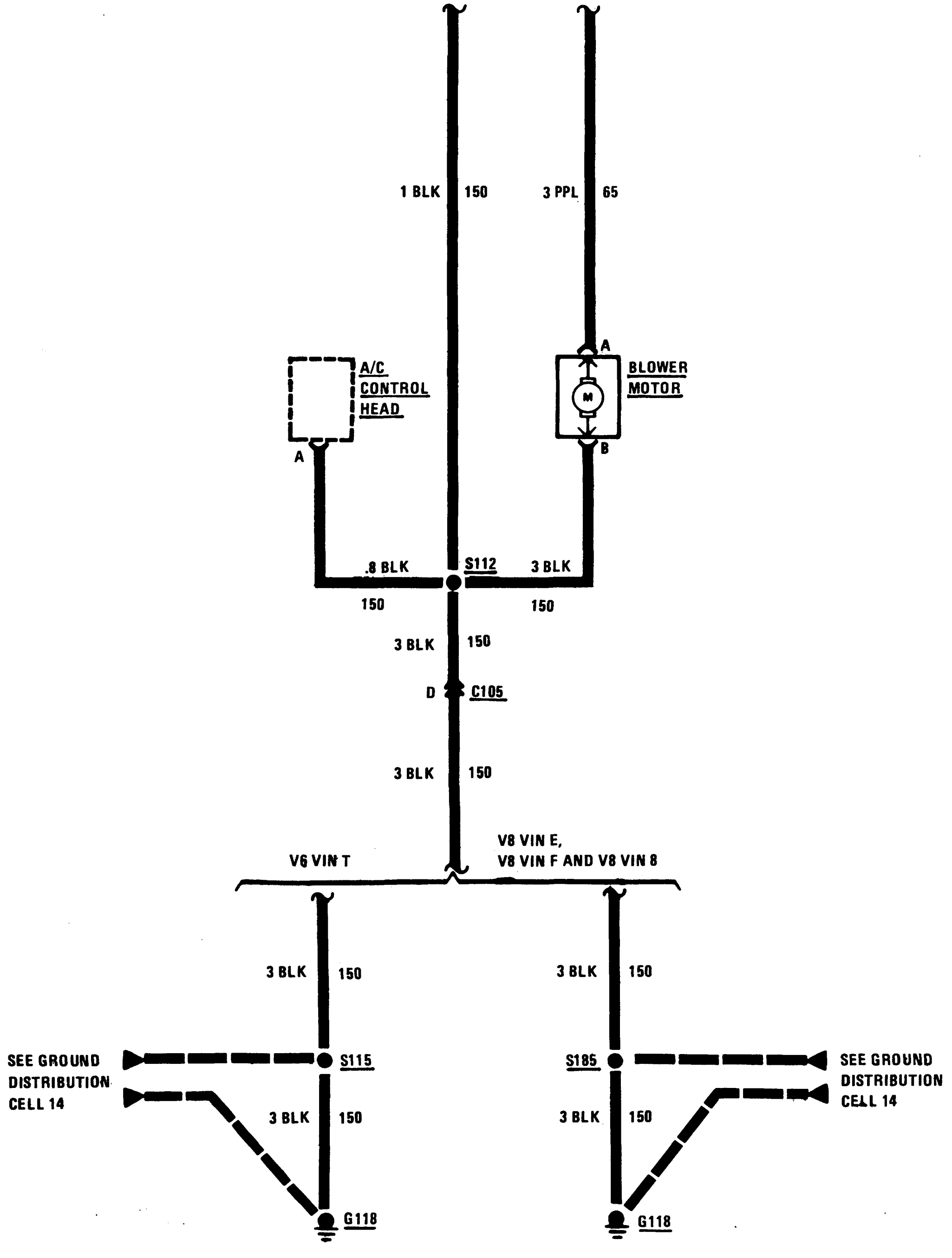
SET A/C CONTROLS	EXPECTED RESULT	REFER TO SECTION:
BI-LEVEL Set Temperature Lever to COLD	Air flows from Instrument Panel and floor outlets	8A-65 Air Delivery
	Compressor turns ON	8A-64 Compressor Controls
	Engine cooling fan may run	8A-31 Coolant Fans
	Air flow becomes cold	8A-64 Compressor Controls
NORMAL	Air flows from Instrument Panel outlets	8A-65 Air Delivery
	Compressor continues to run	8A-64 Compressor Controls
MAX	Blower noise increases as outside air door closes	8A-65 Air Delivery
Rotate steering wheel to stop	Engine maintains normal idle speed	6E Driveability and Emissions.
OFF	Blower and Compressor turn OFF	8A-63 Blower Controls 8A-64 Compressor Controls

- **If all of the above steps can be completed as described, C60 Air Conditioning and Heating System is operating normally.**

AIR CONDITIONING: BLOWER CONTROLS

C60, MANUAL




1 BLK
150
3 PPL
65
A/C CONTROL HEAD
A
BLOWER MOTOR
M
A
B
.8 BLK
150
S112
3 BLK
150
3 BLK
150
D
C105
3 BLK
150
V6 VIN T
V8 VIN E, V8 VIN F AND V8 VIN 8
3 BLK
150
3 BLK
150
SEE GROUND DISTRIBUTION CELL 14
S115
S185
SEE GROUND DISTRIBUTION CELL 14
3 BLK
150
3 BLK
150
G118
G118

AIR CONDITIONING: BLOWER CONTROLS
C60, MANUAL

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Check.**

1. Check HTR A/C Fuse by visual inspection.
2. Check that ground G118 is clean and tight.
3. Check that Blower Motor connectors and Blower High Speed Relay are mated correctly and firmly seated.

- **Go to the A/C System Check in Section 8A-62 for a guide to normal operation and diagnostic references.**
- **Go to System Diagnosis for diagnostic tests.**

SYSTEM DIAGNOSIS

- **Do the tests listed for your symptom in the Symptom Table below.**
- **Tests follow the Symptom Table.**

SYMPTOM TABLE

SYMPTOM	DO TEST
Blower runs all the time (Ignition Switch: OFF)	Replace Blower High Speed Relay
Blower runs all the time (Ignition Switch: ON)	B: Blower High Speed Relay Test E: A/C Mode Selector Test
Blower will not run in any mode	A: Blower Motor Test E: A/C Mode Selector Test
No low speed operation	C: Blower Resistors Test D: Blower Switch Test
No high speed operation	B: Blower High Speed Relay Test D: Blower Switch Test
High speed operation only	B: Blower High Speed Relay Test D: Blower Switch Test
Blower runs in low speed at M1 or M2	D: Blower Switch Test

- **If your symptom does not appear in the Symptom Table, do all of the tests.**

COMPONENT LOCATION

		Page-Figure
Blower High Speed Relay	RH rear of engine compartment, on A/C module	201-11-A
Blower Motor	RH front of dash	201-11-B
Blower Resistors (with A/C)	RH front of dash, on A/C module	201-11-A
Fuse Block	Behind LH side of I/P	201-13-A
Fusible Link B (VIN E)	Lower RH side of engine, at Starter Solenoid	201- 6-C
Fusible Link B (VIN F)(VIN 8)	Lower RH side of engine, at Starter Solenoid	201- 9-C
Fusible Link G (VIN T)	RH front of engine compartment, at Junction Block	201- 2-A
C105 (4 cavities) (VIN E)	RH rear of engine compartment	201- 4-B
C105 (4 cavities) (VIN F)(VIN 8)	RH rear of engine compartment	
C105 (4 cavities) (VIN T)	RH rear of engine compartment	201- 1-C
C202 (1 cavity)	Behind center of I/P, near A/C Control Head	201-17-E
G118 (VIN E)	Rear of RH cylinder head	201- 4-A
G118 (VIN F)(VIN 8)	Rear of RH cylinder head	201- 7-A
G118 (VIN T)	Rear of RH cylinder head	201- 1-A
S112	A/C harness, RH rear of engine compartment	201-11-A
S115	Engine harness, above RH rear corner of engine	201- 1-A
S185 (VIN E)	Engine harness, RH rear of engine compartment	201- 4-B
S185 (VIN F)(VIN 8)	Engine harness, top RH rear of engine	201- 6-A

A: BLOWER MOTOR TEST

Measure: VOLTAGE
At: BLOWER MOTOR CONNECTOR (Disconnected)
Conditions:

- **Ignition Switch: RUN**
- **A/C Mode: VENT**
- **Blower Switch: HI**

Measure Between	Correct Voltage	For Diagnosis
A (PPL) & Ground	Battery	See 1

(Continued on facing page)

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A (PPL) & B (BLK)	Battery	See 2

- If voltages are correct but Blower does not run, install a new Blower Motor.

1. Check PPL (65) wire for an open. If wire is good, do Tests B and D.
2. Check BLK (150) wire for an open and that ground G118 is clean and tight (see schematic).

B: BLOWER HIGH SPEED RELAY TEST (TABLE 1)

Measure: VOLTAGE
At: BLOWER HIGH SPEED RELAY CONNECTOR (Disconnected)
Conditions:
- **Ignition Switch: RUN**
- **A/C Mode: VENT**
- **Blower Switch: HI**

Measure Between	Correct Voltage	For Diagnosis
A (RED) & Ground	Battery	See 1
D (ORN) & Ground	Battery	See 2

- If voltages are correct, proceed to Table 2.

1. Check RED (2) wire for an open back to Fusible Link B or Fusible Link G.
2. Check ORN (52) wire for an open. If wire is good, do Test D.

B: BLOWER HIGH SPEED RELAY TEST (TABLE 2)

Measure: RESISTANCE
At: BLOWER HIGH SPEED RELAY CONNECTOR (Disconnected)
Conditions:
- **Ignition Switch: OFF**
- **Negative Battery Terminal: DISCONNECTED**

Measure Between	Correct Resistance	For Diagnosis
F (BLK) & Ground	0 ohms	See 1
E (PPL) & Ground	Less than 3 ohms	See 2

- If voltages in Table 1 and resistances in Table 2 are correct but Blower High Speed Relay does not operate, replace Blower High Speed Relay.

1. Check BLK (150) wire for an open.
2. Check PPL (65) wire for an open. If wire is good, recheck measurements made in Test A.

C: BLOWER RESISTORS TEST

Measure: RESISTANCE
At: BLOWER RESISTORS (Disconnected)
Condition:
- **Ignition Switch: OFF**

Measure Between	Correct Resistance	For Diagnosis
A & C	1.5 ± 1 ohm	See 1
C & D	0.7 ± .5 ohm	See 1
D & B	0.2 ± .1 ohm	See 1

- If resistances are correct, Blower Resistors are operating normally. Return to Symptom Table.

1. Install new Blower Resistors.

D: BLOWER SWITCH TEST (TABLE 1)

Measure: VOLTAGE
At: BLOWER RESISTORS CONNECTOR (Disconnected)
Conditions:
- **Ignition Switch: RUN**
- **A/C Mode: VENT**
- **Blower Switch: LO**

Measure Between	Correct Voltage	For Diagnosis
A (YEL) & Ground	Battery	See 1
C (TAN) & Ground	0 volts	See 2
• Blower Switch: M1		
C (TAN) & Ground	Battery	See 3
D (LT BLU) & Ground	0 volts	See 2
• Blower Switch: M2		
D (LT BLU) & Ground	Battery	See 4

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- If no voltage is present at any of the terminals, check BRN (64) wire for an open. If wire is good, do Test E.
- If all voltages are correct, go to Table 2.

1. Check YEL (51) wire for an open.
2. Replace Blower Switch.
3. Check TAN (63) wire for an open.
4. Check LT BLU (72) wire for an open.

D: BLOWER SWITCH TEST (TABLE 2)

Measure: VOLTAGE
At: BLOWER HIGH SPEED RELAY CONNECTOR (Disconnected)
Conditions:
- **Ignition Switch:** RUN
- **A/C Mode:** VENT
- **Blower Switch:** M2

Measure Between	Correct Voltage	For Diagnosis
D (ORN) & Ground	0 volts	See 1
• Blower Switch: HI		
D (ORN) & Ground	Battery	See 2

- If voltages are correct, Blower Switch is operating normally. Return to Symptom Table.

1. If voltage is present, check ORN (52) wire for a wire to wire short to voltage. If wire is good, replace Blower Switch.
2. Check ORN (52) wire for an open. If wire is good, replace Blower Switch.

E: A/C MODE SELECTOR TEST

Measure: VOLTAGE
At: A/C CONTROL HEAD CONNECTOR (Connected)
Conditions:
- **Ignition Switch:** RUN
- **A/C Mode:** OFF

Measure Between	Correct Voltage	For Diagnosis
E (BRN) & Ground	Battery	See 1
D (BRN) & Ground	0 volts	See 2
• A/C Mode in all positions except OFF		
D (BRN) & Ground	Battery	See 3

- If all voltages are correct, A/C Mode Selector is operating normally. Return to Symptom Table.

1. Check BRN (50) wire for an open back to HTR A/C Fuse.
2. Replace A/C Control Head.
3. If battery voltage is present at terminal E but is not present at terminal D, replace A/C Control Head.

CIRCUIT OPERATION

The Blower Motor speed is controlled by the Blower Switch in the A/C Control Head. With the switch in the LO position, all of the Blower Resistors are in the circuit with the motor so that it runs slowly. In the M1 and M2 positions, the Blower Switch bypasses some of the resistors, increasing the motor speed.

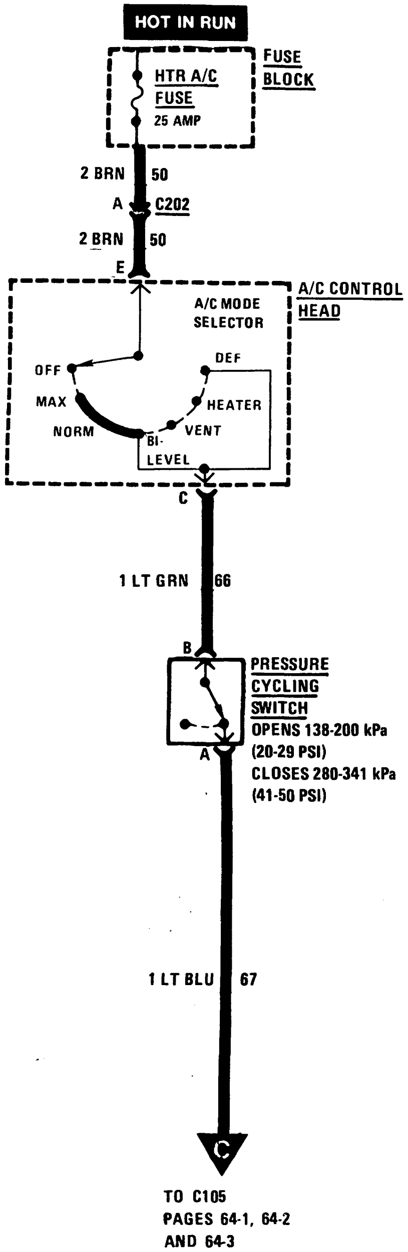
In High Speed operation the Blower Motor is fed through the contact of the Blower High Speed Relay. When the Blower Switch is in the HI position, battery voltage is supplied through the ORN wire to the coil of the Blower High Speed Relay. The relay is energized and its contacts supply battery voltage directly to the Blower Motor from Fusible Link B or Fusible Link G. The Blower Motor now runs at maximum speed.

When the Mode Selector is in the OFF position, no voltage is applied to the Blower Switch and Motor so the Blower does not run. In all other positions, the Blower will operate as described.

BLANK

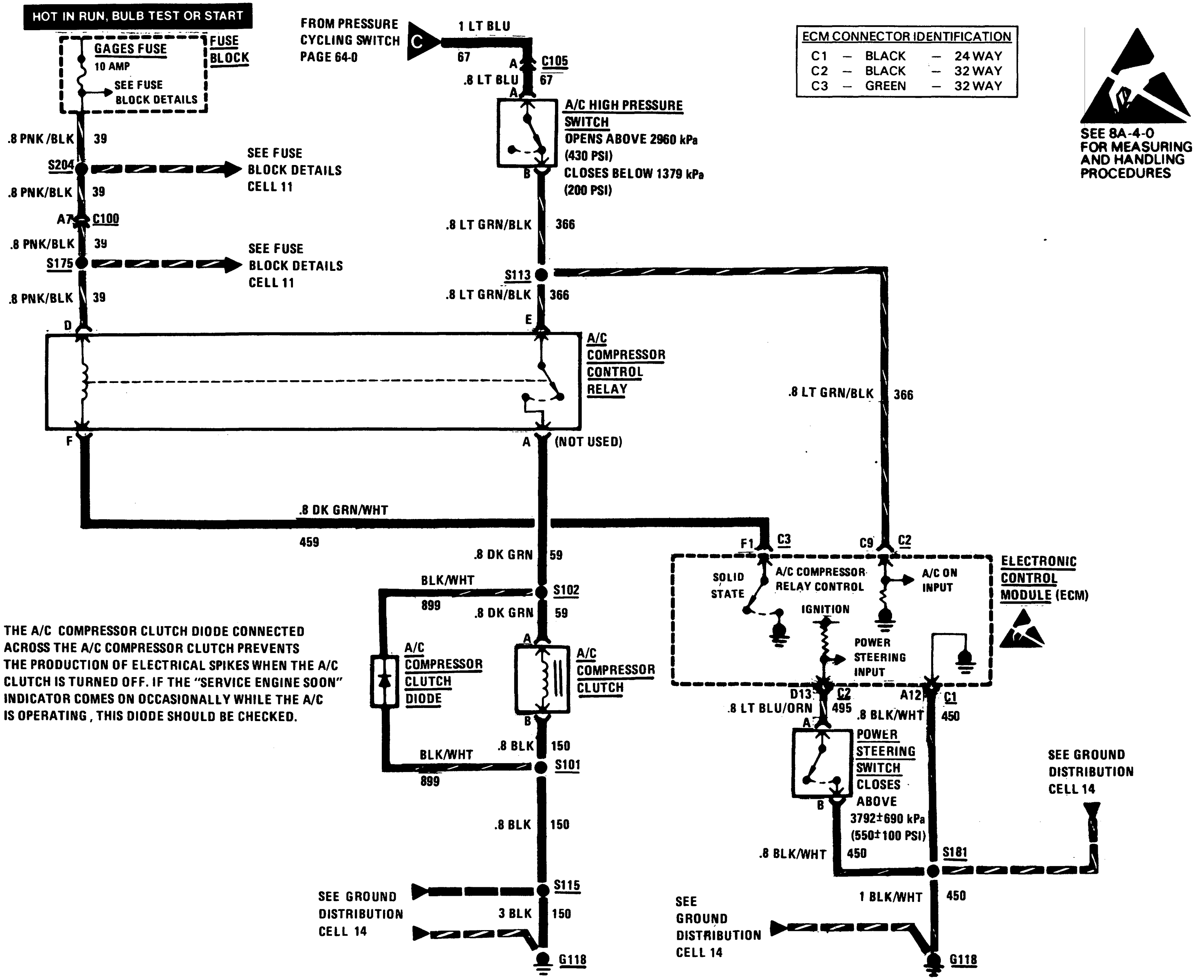
AIR CONDITIONING: COMPRESSOR CONTROLS

C60, MANUAL



AIR CONDITIONING: COMPRESSOR CONTROLS, V6 VIN T

C60, MANUAL



ECM CONNECTOR IDENTIFICATION				
C1	–	BLACK	–	24 WAY
C2	–	BLACK	–	32 WAY
C3	–	GREEN	–	32 WAY

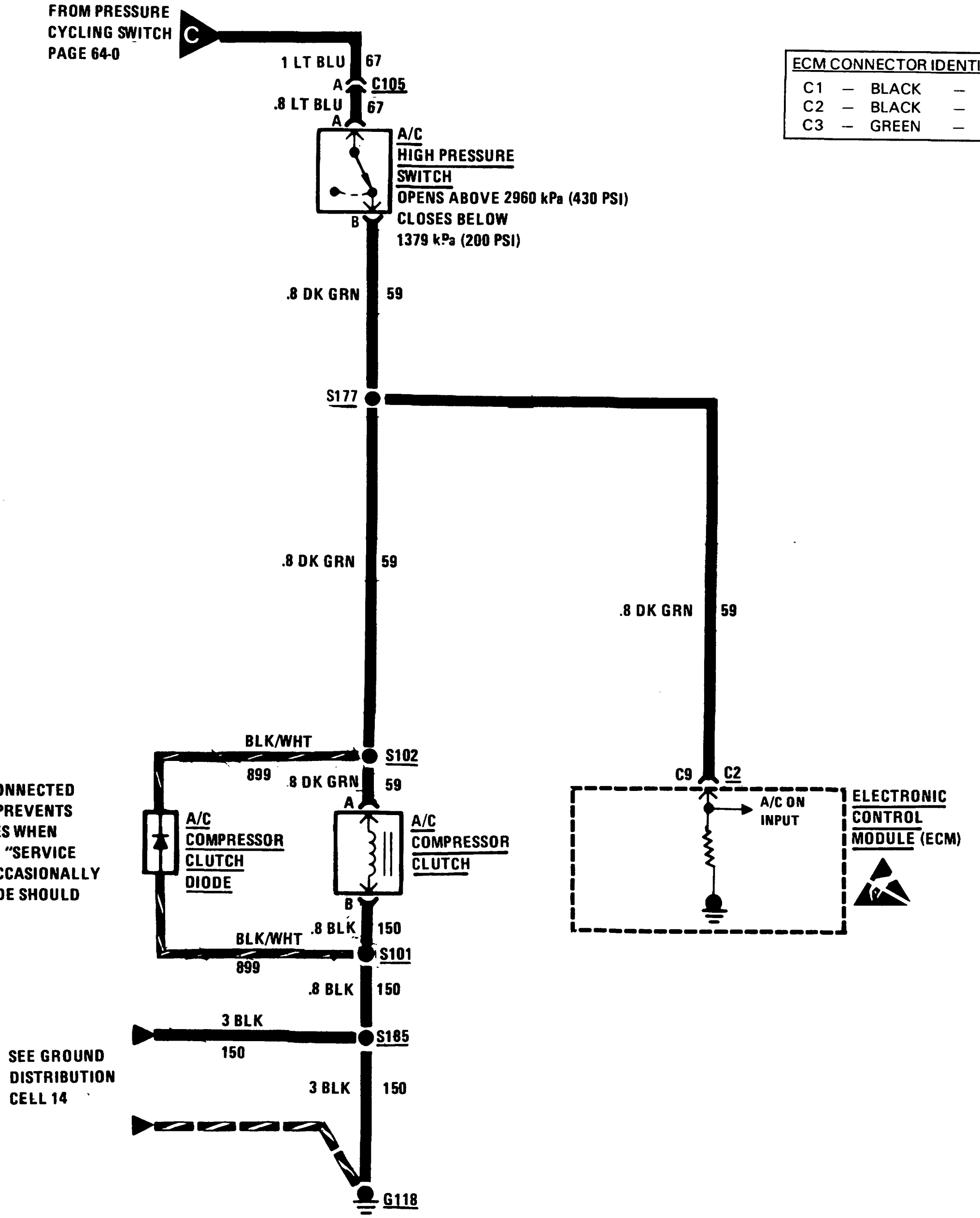
THE A/C COMPRESSOR CLUTCH DIODE CONNECTED ACROSS THE A/C COMPRESSOR CLUTCH PREVENTS THE PRODUCTION OF ELECTRICAL SPIKES WHEN THE A/C CLUTCH IS TURNED OFF. IF THE "SERVICE ENGINE SOON" INDICATOR COMES ON OCCASIONALLY WHILE THE A/C IS OPERATING, THIS DIODE SHOULD BE CHECKED.

AIR CONDITIONING: COMPRESSOR CONTROLS, V8 VIN F AND V8 VIN 8

C60, MANUAL

ECM CONNECTOR IDENTIFICATION				
C1	—	BLACK	—	24 WAY
C2	—	BLACK	—	32 WAY
C3	—	GREEN	—	32 WAY

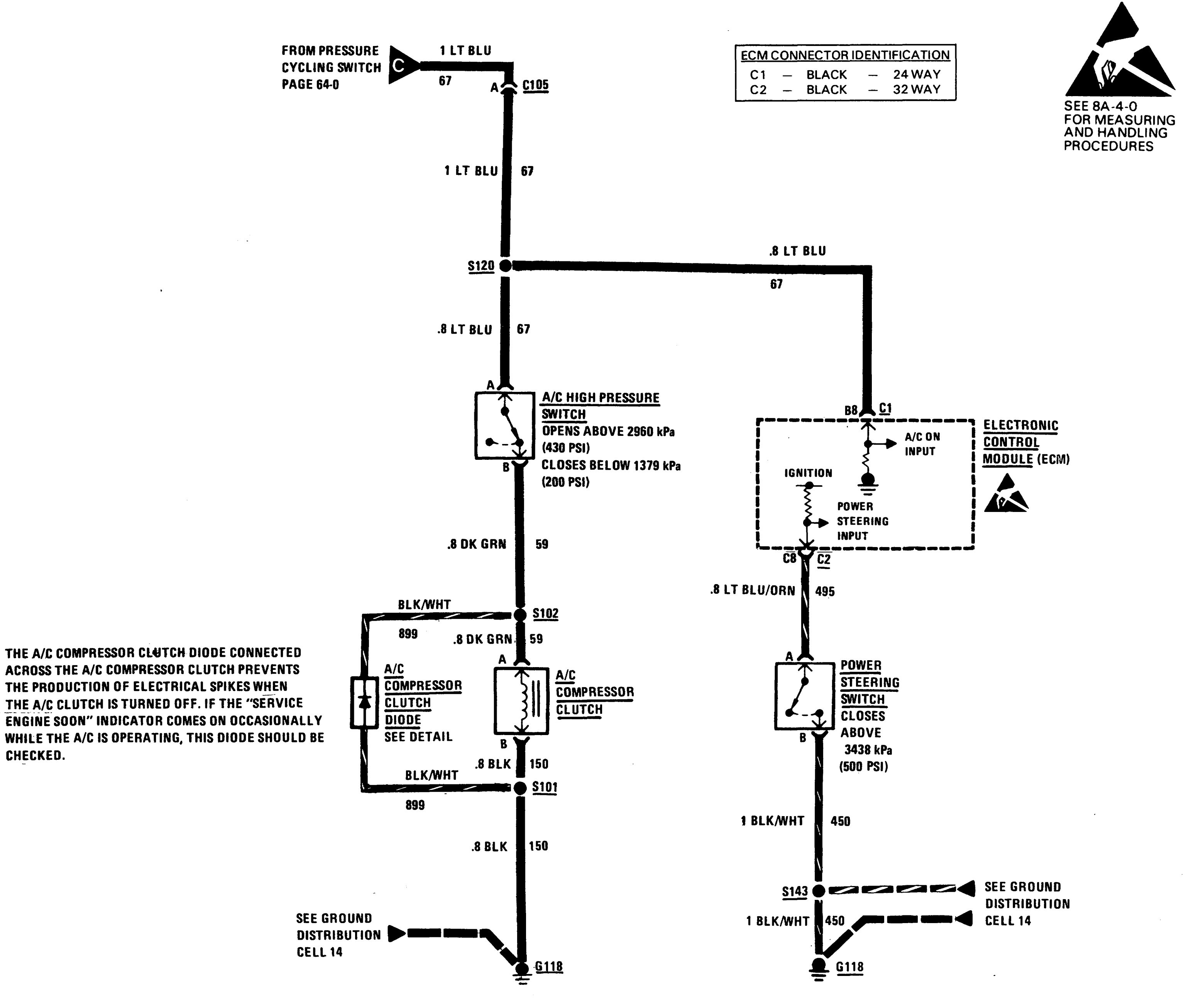
SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES



THE A/C COMPRESSOR CLUTCH DIODE CONNECTED ACROSS THE A/C COMPRESSOR CLUTCH PREVENTS THE PRODUCTION OF ELECTRICAL SPIKES WHEN THE A/C CLUTCH IS TURNED OFF. IF THE "SERVICE ENGINE SOON" INDICATOR COMES ON OCCASIONALLY WHILE THE A/C IS OPERATING, THIS DIODE SHOULD BE CHECKED.

AIR CONDITIONING: COMPRESSOR CONTROLS, V8 VIN E

C60, MANUAL



ECM CONNECTOR IDENTIFICATION				
C1	–	BLACK	–	24 WAY
C2	–	BLACK	–	32 WAY

SEE 8A-4-0 FOR MEASURING AND HANDLING PROCEDURES

THE A/C COMPRESSOR CLUTCH DIODE CONNECTED ACROSS THE A/C COMPRESSOR CLUTCH PREVENTS THE PRODUCTION OF ELECTRICAL SPIKES WHEN THE A/C CLUTCH IS TURNED OFF. IF THE "SERVICE ENGINE SOON" INDICATOR COMES ON OCCASIONALLY WHILE THE A/C IS OPERATING, THIS DIODE SHOULD BE CHECKED.

AIR CONDITIONING: COMPRESSOR CONTROLS

C60, MANUAL

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Check.**

1. Check HTR A/C Fuse.
2. Check that A/C Compressor Clutch connector is firmly seated.
3. Check that grounds are clean and tight.

- **Complete the A/C System Check in Section 8A-62 as a guide to normal operation of the entire A/C System and for references to diagnostic tests.**
- **Go to System Diagnosis for diagnostic tests.**

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation.**

SYSTEM CHECK TABLE

ACTION	EXPECTED RESULT
1. Turn Ignition Switch to RUN and start engine. Move A/C Mode Selector to OFF then to MAX.	A click can be heard when clutch engages
2. Move A/C Mode Selector between OFF and MAX several times	Verify that clutch engages in MAX position Clutch plate movement can be seen on front of compressor pulley If clutch does not engage, proceed to step 4 If clutch operates as expected, continue to step 3

COMPONENT LOCATION

		Page-Figure
A/C Compressor Clutch (Except VIN T)	Top RH front of engine	201-11-C
A/C Compressor Clutch (VIN T)	Upper LH front of engine	201- 0-A
A/C Compressor Clutch Diode (Except VIN T)	Taped inside harness, near A/C Compressor Clutch	201-11-C
A/C Compressor Clutch Diode (VIN T)	Taped inside harness, near A/C Compressor Clutch	201- 0-A
A/C Compressor Control Relay	LH front of dash, on relay bracket	
A/C High Pressure Switch (Except VIN T)	RH front of engine, behind A/C compressor	201-11-C
A/C High Pressure Switch (VIN T)	LH front of engine, behind A/C compressor	201- 0-A
Electronic Control Module (ECM) (Except VIN E)	Behind RH side of I/P	201-15-B
Electronic Control Module (ECM) (VIN E)	Behind RH side of I/P	201-15-C
Fuse Block	Behind LH side of I/P	201-13-A
Power Steering Switch (VIN E)	LH front of engine compartment	201- 5-A
Power Steering Switch (VIN T)	LH front of engine compartment	201- 3-B
Pressure Cycling Switch	RH rear of engine compartment, on accumulator	201-11-A
C100 (42 cavities)	LH front of dash, below relay bracket	201-12-A
C105 (4 cavities) (VIN E)	RH rear of engine compartment	201- 4-B
C105 (4 cavities) (VIN F)(VIN 8)	RH rear of engine compartment	
C105 (4 cavities) (VIN T)	RH rear of engine compartment	201- 1-C
C202 (1 cavity)	Behind center of I/P, near A/C Control Head	201-17-E
G118 (VIN E)	Rear of RH cylinder head	201- 4-A
G118 (VIN F)(VIN 8)	Rear of RH cylinder head	201- 7-A
G118 (VIN T)	Rear of RH cylinder head	201- 1-A
S101 (Except VIN T)	Engine harness, RH front of engine, near A/C Compressor Clutch	201-11-C
S101 (VIN T)	Engine harness, LH front of engine, near A/C Compressor Clutch	201- 0-A
S102 (Except VIN T)	Engine harness, RH front of engine, near A/C Compressor Clutch	201-11-C

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AIR CONDITIONING: COMPRESSOR CONTROLS

C60, MANUAL

(Continued from previous page)

3. Put A/C Mode Selector in MAX to engage clutch	Check that air from coolant fan can move feely through condensor Feel the input (cool) and output (warm) pipes to the compressor. If there is not a wide temperature difference after the compressor has run for several seconds see Section 1B for refrigerant and compressor diagnosis
4. Turn off ignition. Check refrigerant charge according to procedures in Section 1B	If refrigerant charge is low, follow procedures in Section 1B for refrigerant diagnosis If refrigerant charge is normal, isolate conditions using the procedures which follow is System Diagnosis

SYSTEM DIAGNOSIS

V6 VIN T

- **Use the Isolation Tests below to choose the proper diagnosis tests.**
- **Tests follow the Isolation Tests.**

COMPONENT LOCATION

		Page-Figure
S102 (VIN T)	Engine harness, LH front of engine, near A/C Compressor Clutch	201- 0-A
S113	Engine harness, above RH rear corner of engine	201- 1-A
S115	Engine harness, above RH rear corner of engine	201- 1-A
S120	Engine harness, RH rear of engine compartment	201- 4-B
S143 (VIN E)	Engine harness, LH rear of engine compartment.	201- 5-A
S175 (VIN T)	Engine harness, RH rear of engine	201- 1-A
S177	Engine harness, RH rear of engine	201- 6-A
S181	Engine harness, RH rear of engine	201- 1-A
S185 (VIN F)(VIN 8)	Engine harness, top RH rear of engine	201- 6-A
S204	I/P harness, behind LH side of instrument cluster	201-13-A

ISOLATION TEST (TABLE 1)

Measure: VOLTAGE
At: A/C COMPRESSOR CONTROL RELAY (Disconnected)
Conditions:

- **Ignition Switch: RUN (Engine need not be running)**
- **A/C Mode Selector: NORM**
- **Temperature Outside Car: Above 60 °F (16 °C)**

Measure Between	Correct Voltage	For Diagnosis
D (PNK/BLK) & Ground	Battery	Check GAGES Fuse and (39) wires for an open
E (LT GRN/ BLK) & Ground	Battery	Check LT GRN/BLK (366) wire for an open. If wire is good, do Test C

- If voltages are correct, leave A/C Compressor Control Relay disconnected and go to Table 2.

ISOLATION TEST (TABLE 2)

Connect: FUSED JUMPER
At: A/C COMPRESSOR CONTROL RELAY (Disconnected)
Conditions:

- **Ignition Switch: RUN (Engine need not be running)**
- **A/C Mode Selector: NORM**
- **Temperature Outside Car: Above 60 °F (16 °C)**

Jumper Between	Correct Result	For Diagnosis
E (LT GRN/ BLK) & A (DK GRN)	Clutch engages	Do Test B

- If result is correct, do Test A.

A: ECM COMPRESSOR CONTROL TEST (TABLE 1)

Measure: VOLTAGE
At: ELECTRONIC CONTROL MODULE (ECM) (Disconnected)
Conditions:

- Ignition Switch: RUN (Engine not running)
- A/C Mode Selector: NORM
- A/C Compressor Control Relay: CONNECTED
- Temperature Outside Car: Above 60 °F (16 °C)

Measure Between	Correct Voltage	For Diagnosis
C2/C9 (LT GRN/BLK) & Ground	Battery	See 1
C3/F1 (DK GRN/WHT) & Ground	Battery	See 2

- If voltages are correct, go to Table 2.

1. Check for an open in LT GRN/BLK (366) wire.
2. Check for an open in DK GRN/WHT (459) wire. If wire is good, replace A/C Compressor Control Relay.

A: ECM COMPRESSOR CONTROL TEST (TABLE 2)

Measure: RESISTANCE
At: ECM CONNECTOR (Disconnected)
Conditions:

- Ignition Switch: OFF
- Negative Battery Terminal (Disconnected)

Measure Between	Correct Resistance	For Diagnosis
D13 on Conn C2 (LT BLU/ ORN) & Ground	Open Circuit	See 1

- If resistance is correct proceed to Table 3.

1. Check that Power Steering Switch is open. If switch is closed, replace it (see Section 3 for replacement procedures). Check LT BLU/ORN (495) wire for a short to ground.

A: ECM COMPRESSOR CONTROL TEST (TABLE 3)

Connect: FUSED JUMPER
At: ELECTRONIC CONTROL MODULE (ECM) (Disconnected)
Conditions:

- Ignition Switch: RUN (Engine not running)
- A/C Mode Selector: NORM
- Temperaure Outside Car: Above 60 °F (16 °C)

Jumper Between	Correct Result	For Diagnosis
C3/F1 (DK GRN/WHT) & Ground	A/C Compressor Control Relay operates and A/C Clutch engages	See 1

- If result is correct but A/C System does not operate under normal conditions, condition is due to ECM. Refer to Section 6E for ECM diagnostics.

1. Replace A/C Compressor Control Relay.

B: A/C COMPRESSOR CLUTCH TEST

Measure: VOLTAGE
At: A/C COMPRESSOR CLUTCH (Disconnected)
Conditions:
- **Ignition Switch: RUN (Engine not running)**
- **A/C Mode Selector: NORM**
- **Temperature Outside Car: Above 60 °F (16 °C)**

Measure Between	Correct Voltage	For Diagnosis
A (DK GRN) & Ground	Battery	See 1
A (DK GRN) & B (BLK)	Battery	See 2

- If voltages are correct but clutch does not engage, replace A/C Compressor Clutch.

1. Check for an open in DK GRN (59) wire.
2. Check for an open in BLK (150) wire.

C: A/C COMPRESSOR FUNCTION CONTROL TEST

Measure: VOLTAGE
At: A/C CONTROL HEAD
Conditions:
- **Ignition Switch: RUN (Engine need not be running)**
- **A/C Mode Selector: NORM**
- **Temperature Outside Car: Above 60 °F (16 °C)**

Measure Between	Correct Voltage	For Diagnosis
E (BRN) & Ground	Battery	See 1
C (LT GRN) & Ground	Battery	See 2

- If voltages are correct, go to C1.

1. Check for open HTR A/C Fuse or open BRN (50) wire.
2. Replace A/C Control Head.

TEST C1

Measure the voltage at terminal E of the A/C Compressor Control Relay with a fused jumper connected across the terminals of the A/C Pressure Cycling Switch connector (disconnected).

- If battery voltage is not present, go to Test C2.
- If battery voltage is present, refer to Section 1B to check for normal refrigerant charge. If refrigerant charge is normal, replace Pressure Cycling Switch.

TEST C2

Measure the voltage at terminal E of the A/C Compressor Control Relay with a fused jumper connected across the terminals of the A/C High Pressure Cut-Out Switch connector (disconnected).

- If battery voltage is present, replace A/C High Pressure Cut-Out Switch.
- If battery voltage is not present, check the wiring between the switches back to the A/C Control Head (see schematic).

SYSTEM DIAGNOSIS

V8 VIN F, V8 VIN 8 AND V8 VIN E

- **Use the Isolation Tests below to choose the proper diagnostic tests.**
- **Test follow the Isolation Tests.**

ISOLATION TEST (TABLE 1)

Measure: VOLTAGE
At: PRESSURE CYCLING SWITCH CONNECTOR (Disconnected)
Conditions:
- **Ignition Switch: RUN (Engine need not be running)**
- **A/C Mode Selector: NORM**
- **Temperature Outside Car: Above 60 °F (16 °C)**

Measure Between	Correct Voltage	For Diagnosis
B (LT GRN) & Ground	Battery	Do Test B

- If voltage is correct, leave Pressure Cycling Switch disconnected and go to Table 2.

AIR CONDITIONING: COMPRESSOR CONTROLS

C60, MANUAL

ISOLATION TEST (TABLE 2)

Connect: FUSED JUMPER
At: PRESSURE CYCLING SWITCH CONNECTOR (Disconnected)
Conditions:

- Ignition Switch: RUN (Engine need not be running)
- A/C Mode Selector: NORM
- Temperature Outside Car: Above 60°F (16°C)

Jumper Between	Correct Result	For Diagnosis
B (LT GRN) & A (LT BLU)	Clutch engages	Do Test A

- If result is correct but A/C Compressor Clutch does not engage under normal operation conditions, refer to Section 1B for procedure to check refrigerant pressure. If refrigerant pressure is normal, replace Pressure Cycling Switch.

A: A/C COMPRESSOR CLUTCH TEST

Measure: VOLTAGE
At: A/C COMPRESSOR CLUTCH (Disconnected)
Conditions:

- Ignition Switch: RUN (Engine not running)
- A/C Mode Selector: NORM
- Temperature Outside Car: Above 60°F (16°C)

Measure Between	Correct Voltage	For Diagnosis
A (DK GRN) & Ground	Battery	See 1
A (DK GRN) & B (BLK)	Battery	See 2

- If voltages are correct but clutch does not engage, replace A/C Compressor Clutch.

1. Check that A/C High Pressure Switch is closed (see schematic). If it is open, replace it. Check LT BLU (67) and DK GRN (59) wires for opens.
2. Check BLK (150) wire for an open. Check that G118 is clean and tight.

B: A/C COMPRESSOR FUNCTION CONTROL TEST

Measure: VOLTAGE
At: A/C CONTROL HEAD
Conditions:

- Ignition Switch: RUN
- A/C Mode Selector: NORM
- Temperature Outside Car: Above 60°F (16°C)

Measure Between	Correct Voltage	For Diagnosis
E (BRN) & Ground	Battery	See 1
C (LT GRN) & Ground	Battery	See 2

- If voltages are correct, check for an open in LT GRN (66) wire.

1. Check for opens in HTR A/C Fuse or BRN (50) wire.
2. Replace A/C Control Head.

CIRCUIT OPERATION

The compressor for the air conditioning system is belt-driven by the engine through the A/C Compressor Clutch. The clutch allows the compressor to be disengaged when air conditioning is not required, or to remove the air conditioning load from the engine when needed.

Operation of the compressor depends upon the particular A/C mode selected by the driver. When the A/C Mode Selector Switch is in MAX, NORM, BI-LEVEL or DEF, battery voltage is applied through the HTR A/C Fuse and A/C Fuse and A/C Control Head Selector Switch to the remaining circuits.

AIR CONDITIONING: COMPRESSOR CONTROLS

C60, MANUAL

(Continued from previous page)

V6 VIN T

For vehicles equipped with the V6 VIN T engine, the path to the A/C Compressor Control Relay is through the Pressure Cycling Switch and the A/C High Pressure Switch, which are both normally closed. The Pressure Cycling Switch opens when refrigerant pressure drops to a point near the level where the evaporator may begin to ice. It closes again when additional cooling is required. This action causes the compressor to cycle on and off. The A/C High Pressure Switch opens when refrigerant pressure is too high for normal operation.

The A/C Compressor Control Relay is operated by the Electronic Control Module (ECM). When the ECM receives the A/C On signal to terminal C9, it grounds terminal F1, energizing the relay. When the relay is energized, voltage is applied to the A/C Compressor Clutch through the contact of the relay. If the ECM determines that engine load should be reduced, such as during full throttle, the A/C Compressor Control Relay is de-energized. This removes voltage from the A/C Compressor Clutch thus removing the A/C load from the engine.

The Power Steering Switch closes under heavy steering loads to signal the ECM to increase the engine idle speed.

V8 VIN F and V8 VIN 8, V8 VIN E

Voltage from the A/C Control Head is applied to the A/C Compressor Clutch through the Pressure Cycling Switch and the A/C High Pressure Switch. The Pressure Cycling Switch is normally closed, but opens when refrigerant pressure drops below 200 kPa (29 psi). It closes again when refrigerant pressure rises enough that additional cooling is required. This action causes the A/C Compressor to cycle on and off, so that the evaporator temperature does not drop low enough to cause icing. The A/C High Pressure Switch opens if refrigerant pressure rises enough that overheating of the engine may result.

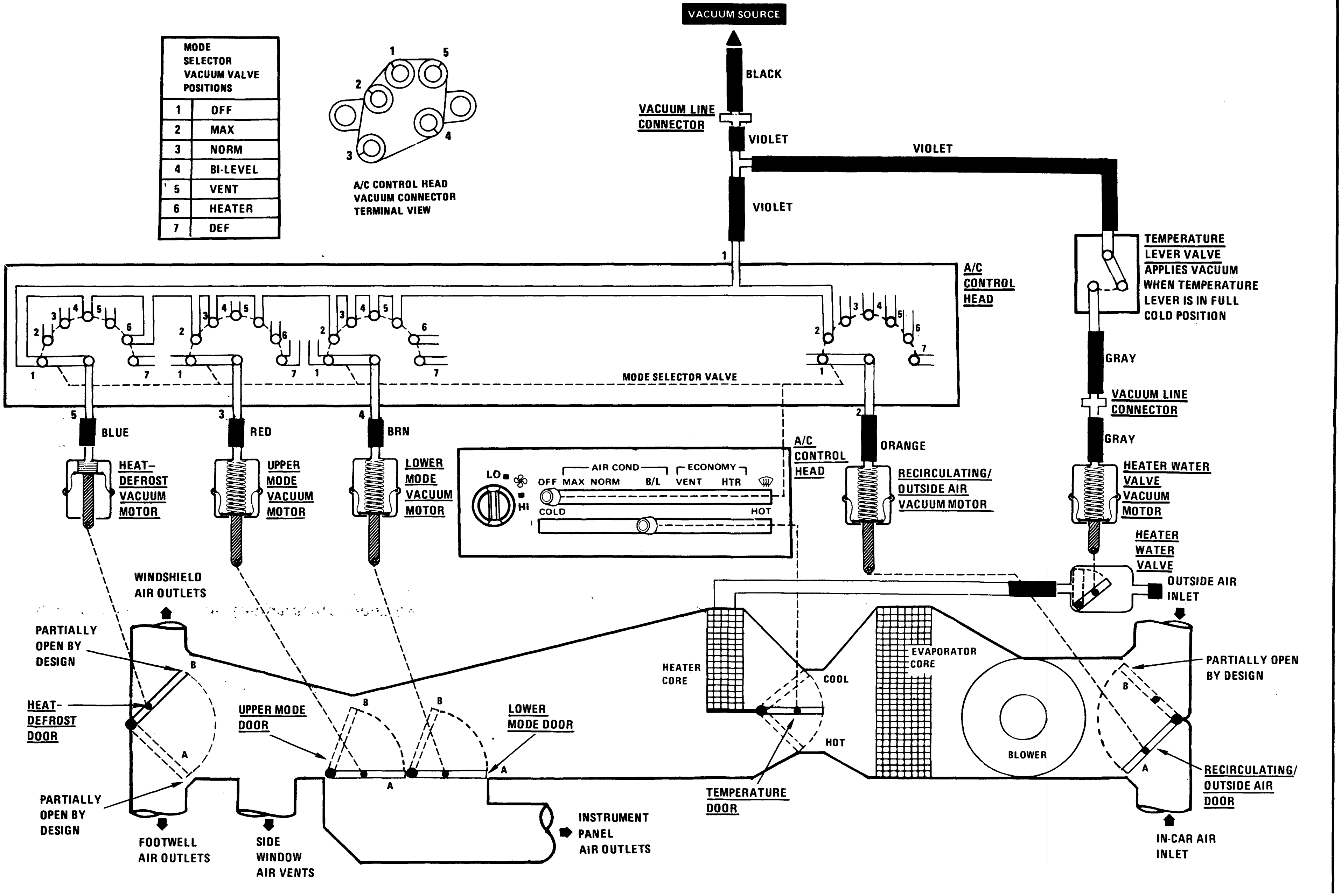
When voltage is applied to the A/C Compressor Clutch, it is also applied to the ECM at terminal B8 on connector C1 (V8 VIN E) or terminal C9 connector C2 (V8 VIN F and V8 VIN 8).

On vehicles equipped with the V8 VIN E engine there is a second input to the ECM for maintaining normal idle speed from the Power Steering Switch. The ECM will maintain or increase engine idle speed when the Power Steering Switch is closed.

AIR CONDITIONING: AIR DELIVERY

C60, MANUAL

MODE SELECTOR VACUUM VALVE POSITIONS	
1	OFF
2	MAX
3	NORM
4	BI-LEVEL
5	VENT
6	HEATER
7	DEF



AIR CONDITIONING: AIR DELIVERY

C60, MANUAL

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Diagnosis.**

1. Check for manifold vacuum to the Vacuum Tank at the BLACK hose from the engine and at the VIOLET hose to the A/C Control Head.
2. Check operation of Temperature Door by moving the Temperature Lever rapidly back and forth several times. Listen for the door to strike the stop at each end of its travel. If the sound indicates that the door is not fully closing or opening, check the mechanical linkage between the door and the Temperature Lever.

- **Go to the A/C System Check in Section 8A-62 for a guide to normal operation and diagnostic references for the entire A/C System.**
- **Go to System Diagnosis to isolate air delivery conditions.**

SYSTEM DIAGNOSIS

If air flow does not come from the proper outlets under one or more operating modes, check the operation of the valves using the following chart.

COMPONENT LOCATION

		Page-Figure
Heat-Defrost Vacuum Motor	LH side of plenum	201-17-E
Heater Water Valve Vacuum Motor	RH rear of engine compartment, near accumulator	201-11-A
Lower Mode Vacuum Motor	Lower LH side of plenum	201-17-E
Recirculating/Outside Air Vacuum Motor	Behind RH side of I/P, on rear of air intake assembly	201-17-E
Temperature Lever Valve	Mounted on LH side of A/C control head	
Upper Mode Vacuum Motor	Upper LH side of plenum	201-17-E
Vacuum Line Connector	Behind center of I/P, near A/C control head	201-17-E

AIR DOOR POSITION CHART

Mode Selector	Heat-Defrost Door	Upper Mode Door	Lower Mode Door	Recirculating/ Outside Air Door
OFF	B	A	A	A
MAX	A	B	B	B
NORM	A	B	B	A
BI-LEVEL	B	A	B	A
VENT	A	B	B	A
HEATER	B	A	A	A
DEF	A	A	A	A

The Heater Water Valve is closed only when Temperature Lever is in the full COLD position.

CIRCUIT OPERATION

The air doors and vents in the Air Conditioning System are operated by mechanical and vacuum controls. There are no electrical circuits. The functions of the air doors and the Evaporator Core are described below.

Heater Water Valve

The Heater Water Valve is operated by the Heater Water Valve Vacuum Motor. Vacuum is applied to the motor only when the Temperature Lever is in the full COLD position. The valve closes, blocking the flow of hot water to the Heater Core.

When the Temperature Lever is not in COLD, vacuum is removed from the motor. The valve opens and hot water flows to the Heater Core.

Temperature Door

The Temperature Door is controlled by the Temperature Lever in the A/C Control Head. With the lever in COLD, the door is in the COOL position. This prevents air from blowing across the Heater Core. With the lever in any other position, some or all of the air blows across the Heater Core.

(Continued on next page)

AIR CONDITIONING: AIR DELIVERY

C60, MANUAL

(Continued from previous page)

Evaporator Core

All air passing through the A/C Module moves across the Evaporator Core. When the compressor is on, the core cools and removes moisture from the air.

Air Doors

The Recirculating/Outside Air Door, Heat-Defrost Door, Upper Mode Door, and Lower Mode Door are moved according to the position of the Mode Selector. The Mode Selector contains vacuum valves or switches. These valves apply and remove vacuum ot vacuum motors that move the air doors.

The Recirculating/Outside Air Vacuum Motor has vacuum applied to it when the Mode Selector is in the MAX position. In every other position, the motor bellows are expanded, moving the Recirculating/Outside Air Door to position A. This opens the Outside Air Inlet and lets outside air into the A/C module.

When the Mode Selector is moved to MAX, a vacuum is applied to the Recirculating/Outside Air Vacuum Motor. The bellows are drawn in and the door is moved to position B. Air from inside the car is pulled into the A/C module.

The Upper Mode Door is controlled by the Upper Mode Vacuum Motor. The Lower Mode Door is controlled by the Lower Mode Vacuum Motor. With the Mode Selector in MAX, NORMAL or VENT, vacuum is applied to both motors. Each bellow contracts and the Upper Mode Door and the Lower Mode Door are pulled to position B. Air flows to the Instrument Cluster Air Outlets.

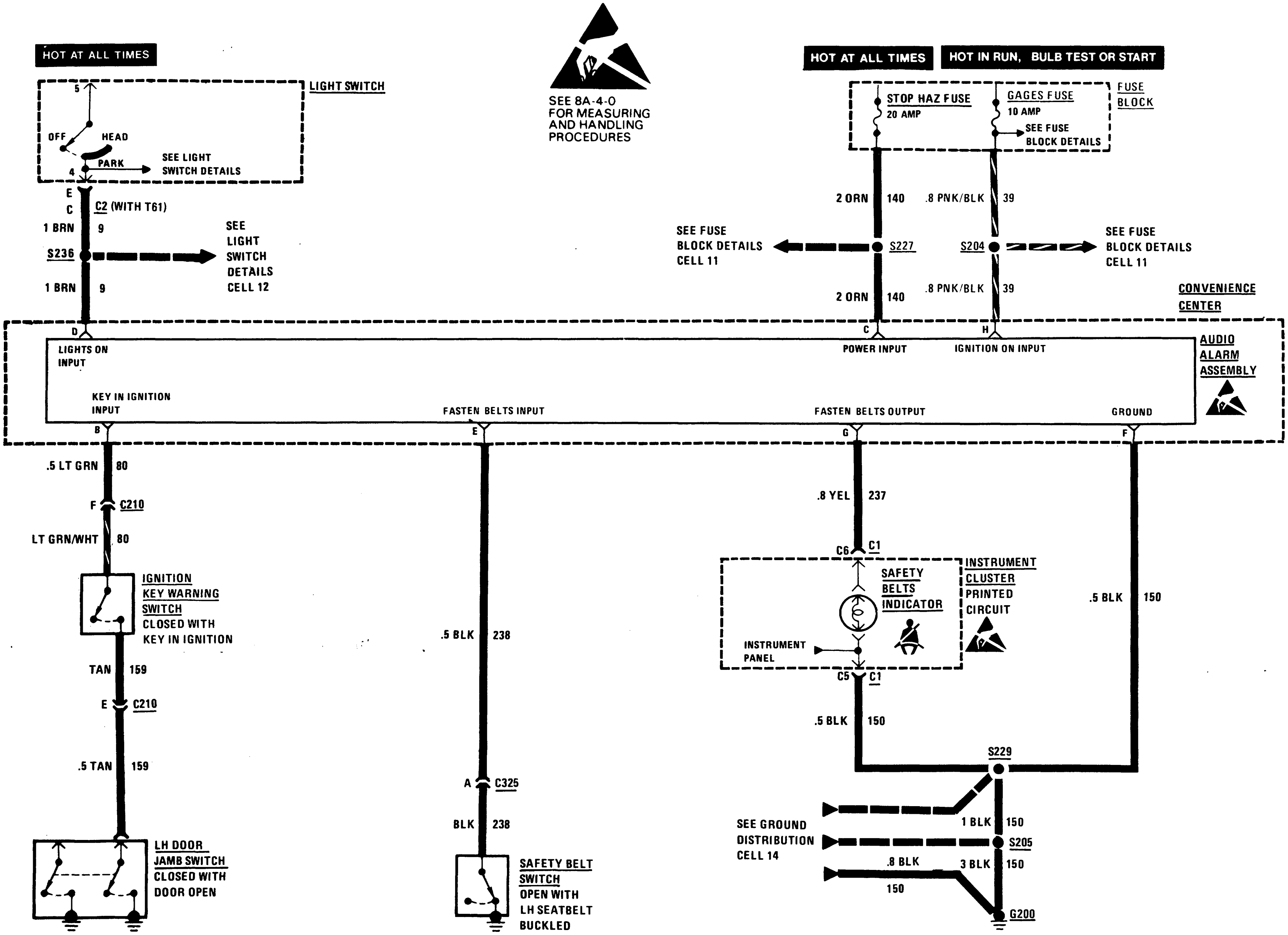
When the Mode Selector is moved to BI-LEVEL, vacuum is only applied to the Lower Mode Vacuum Motor. The Upper mode Door remains in position A and the Lower Mode Door is pulled to position B. Part of the air flows to the Instrument Panel Air Outlets. The rest of the air flows to the Footwell Air Outlets and Side Window Air Vents.

The Heat-Defrost Door is controlled by the Heat-Defrost Vacuum Motor. With the Mode Selector in OFF, BI-LEVEL or HEATER, vacuum is applied to the motor. The bellows contract and the Heat-Defrost Door is pulled to position B. Air flows out the Footwell Air Outlets. A small amount of air is directed to the windshield.

With the Mode Selector in MAX, NORM, VENT or DEF, the Heat-Defrost Vacuum Motor is vented. The bellows extends and the Heat-Defrost Door moves to position A. Air passes out to the Windshield Air Outlets. A small amount of air is directed to the Footwell Air Outlets.

BLANK

WARNINGS AND ALARMS: TONE



WARNINGS AND ALARMS: TONE

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Check.**

1. Check GAGES Fuse by operating Rear Defogger and observing indicator light.
2. Check the STOP HAZ Fuse by observing the Stop Lights.
3. Check that ground G200 is clean and tight.
4. If the Safety Belts Chime Reminder and SAFETY BELTS Indicator operate continuously, replace Audio Alarm Assembly.

- **Go to System Check for a guide to normal operation.**
- **Go to System Diagnosis for diagnostic tests.**

COMPONENT LOCATION

		Page-Figure
Convenience Center	Behind I/P, to right of steering column	201-12-A
Fuse Block	Behind LH side of I/P	201-13-A
Ignition Key Warning Switch	In upper portion of steering column	
Safety Belt Switch	In driver's safety belt buckle	
C210 (11 cavities)	Behind I/P, lower RH side of steering column	201-14-A
C325 (1 cavity)	Under driver's seat	201-16-A
G200	Behind LH side of I/P, on Convenience Center bracket	201-14-C
S204	I/P harness, behind LH side of instrument cluster	201-13-A
S205	I/P harness, behind instrument cluster	201-12-A
S227	I/P harness, near RH side of Convenience Center	201-12-A
S229	I/P harness, above Convenience Center	201-12-A
S236	I/P harness, behind LH side of I/P	201-12-A

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation.**

SYSTEM CHECK TABLE

ACTION	NORMAL RESULT
Sit in driver's seat and close driver's door	Safety Belts alarm sounds
Turn Ignition Switch to RUN	SAFETY BELTS Indicator lights in the Instrument Cluster
Do not buckle seatbelt	Alarm stops and indicator shuts off after 4 to 8 seconds
Repeat above, but buckle seatbelt	No alarm sounds, but indicator comes on for 4 to 8 seconds
With Ignition Switch in ACCY, LOCK or OFF, and the key still in the ignition, open LH front door	Key In Ignition alarm sounds
Remove key from ignition	Alarm stops
With key removed from ignition, turn Light Switch to PARK	Lights-On alarm sounds
Turn Light Switch OFF	Alarm stops

- **Refer to System Diagnosis when a result is not normal.**

SYSTEM DIAGNOSIS

- **Do the tests listed for your symptom in the Symptom Table below.**
- **Tests follow the Symptom Table.**

SYMPTOM TABLE

SYMPTOM	DO TEST
None of the alarms operate	A: Audio Alarm Assembly Test
Only Key In Ignition alarm does not operate	B: Key In Ignition Input Test
Key In Ignition alarm operates when it should not	B: Key In Ignition Input Test
Safety Belts alarm does not operate	C: Safety Belts Input Test

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WARNINGS AND ALARMS: TONE

(Continued from previous page)

Safety Belts alarm operates when seatbelt is buckled	C: Safety Belts Input Test
SAFETY BELTS Indicator does not operate, but Safety Belts alarm operates	D: SAFETY BELTS Indicator Test
SAFETY BELTS Indicator is always on, but the alarm operates properly	D: SAFETY BELTS Indicator Test
Only Lights-On alarm does not operate	E: Lights-On Input Test
Only the Lights-On alarm operates when it should not	E: Lights-On Input Test

A: AUDIO ALARM ASSEMBLY TEST

Connect: TEST LAMP
At: CONVENIENCE CENTER
Condition:

- Audio Alarm Assembly (Disconnected)

Measure Between	Correct Result	For Diagnosis
C (ORN) & Ground	Lamp lights	See 1
C (ORN) & F (BLK)	Lamp lights	See 2

- If all the results are correct and the chime functions are not working, replace Audio Alarm Assembly.

1. Check ORN (140) wire.
2. Check BLK (150) wire.

B: KEY IN IGNITION INPUT TEST

Connect: TEST LAMP
At: CONVENIENCE CENTER
Conditions:

- Audio Alarm Assembly (Disconnected)
- Ignition Switch: ACCY, LOCK or OFF (Key In)
- LH Door: OPEN

Connect Between	Correct Result	For Diagnosis
C (ORN) & B (LT GRN)	Lamp lights	See 1
• Ignition Switch: ACCY, LOCK or OFF (Key In) • LH Front Door: CLOSED		
C (ORN) & B (LT GRN)	Lamp does not light	See 2
• Ignition Switch: KEY OUT • LH Door: OPEN		
C (ORN) & B (LT GRN)	Lamp does not light	See 3

- If all of the test lamp results are correct, replace Audio Alarm Assembly.

1. Check/repair Ignition Key Warning Switch, LH Door Jamb Switch, LT GRN (80) and TAN (159) wires for opens (see schematic).
2. Check/repair LH Door Jamb Switch and TAN (159) wire for shorts to ground (see schematic).
3. Check/repair LT GRN (80) wire for a short to ground. Replace Ignition Key Warning Switch, if LT GRN wire is OK.

C: SAFETY BELTS INPUT TEST

Measure: VOLTAGE
At: CONVENIENCE CENTER
Conditions:

- LH Front Safety Belt: UNBUCKLED
- Audio Alarm Assembly (Disconnected)
- Ignition Switch: RUN

Connect Between	Correct Voltage	For Diagnosis
H (PNK/BLK) & Ground	Battery	See 1
H (PNK/BLK) & E (BLK)	Battery	See 2
• LH Front Safety Belt: BUCKLED		
H (PNK/BLK) & E (BLK)	0 volts	See 3

- If above voltages are correct, replace Audio Alarm Assembly.

1. Check PNK/BLK (39) wire for an open.
2. Check Safety Belt Switch and BLK (238) wire for an open (see schematic).
3. Check BLK (238) wire for a short to ground. If wire is OK, replace Safety Belt Switch.

D: SAFETY BELTS INDICATOR TEST

Connect: FUSED JUMPER
At: CONVENIENCE CENTER
Condition:

- Audio Alarm Assembly (Disconnected)

Connect Between	Correct Result	For Diagnosis
C (ORN) & G (YEL)	SAFETY BELTS Indicator lights	See 1

(Continued on facing page)

(Continued from facing page)

Remove Jumper	SAFETY BELTS Indicator does not light	See 2

- If indicator response was correct, replace Audio Alarm Assembly.

1. Check/repair bulb, YEL (237), BLK (150) wires and Instrument Cluster (Printed Circuit) for an open.
2. Check Instrument Cluster (Printed Circuit) for a short to Battery.

E: LIGHTS-ON INPUT TEST

Measure: VOLTAGE
At: CONVENIENCE CENTER
Conditions:

- **Audio Alarm Assembly (Disconnected)**
- **Ignition Switch: RUN**

Measure Between	Correct Voltage	For Diagnosis
D (BRN) & Ground	0 Volts	See 1
• Light Switch: PARK or HEAD		
D (BRN) & Ground	Battery	See 1

- If both voltages are correct, replace Audio Alarm Assembly.

1. Check/repair BRN wire. See Section 8A-117, Interior Lights: Instrument Panel Lights for further diagnosis.

CIRCUIT OPERATION

The Warnings and Alarms System sounds a tone to bring attention to one or more of several conditions. These conditions are: 1) the lights are on and the Ignition Switch is not in RUN, BULB TEST or START: 2) the ignition key is in the Ignition Switch when the driver's door is open; and 3) the safety belt is unbuckled when the Ignition Switch is in RUN, BULB TEST or START. Voltage is applied at all times through the STOP HAZ Fuse to terminal C, to power the Solid State Audio Alarm Assembly.

IGNITION KEY WARNING

Voltage is applied to the Audio Alarm Assembly by the STOP HAZ Fuse. Whenever the key is in the Ignition Switch and the Ignition Switch is in LOCK, OFF or ACCY, with the driver's door open, terminal B of the module is grounded. This sounds the alarm.

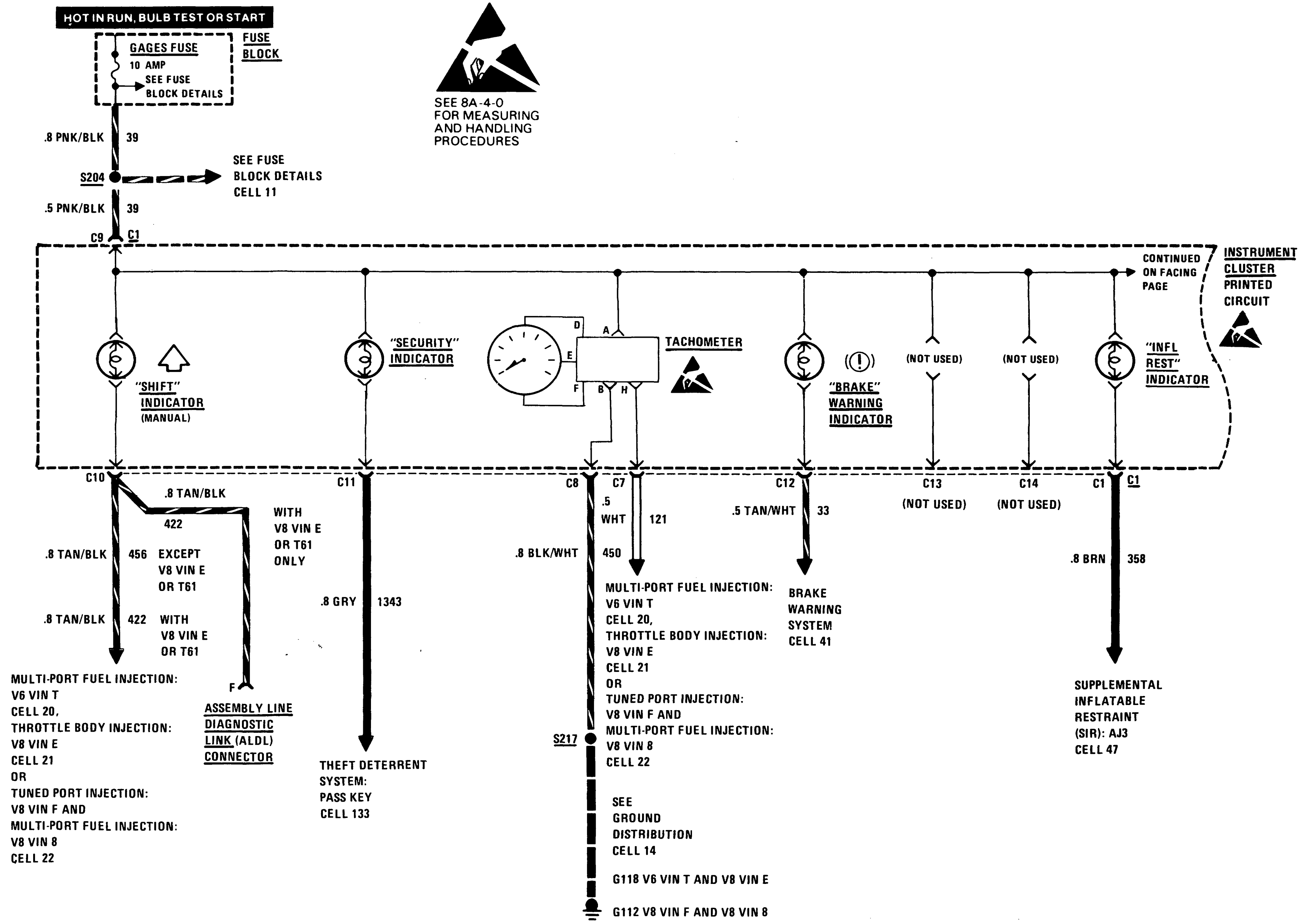
SAFETY BELT WARNING

With the Ignition Switch in RUN, BULB TEST or START, voltage is applied through the GAGES Fuse to the Audio Alarm Assembly. With the driver's safety belt unbuckled, terminal E of the module is grounded through the Seatbelt Switch. The SAFETY BELTS Indicator always goes on for about 5 seconds, when the Ignition Switch is set to RUN, BULB TEST or START. The Safety Belts Alarm, however, only sounds if the safty belt is unbuckled and the Ignition Switch is in RUN, BULB TEST or START.

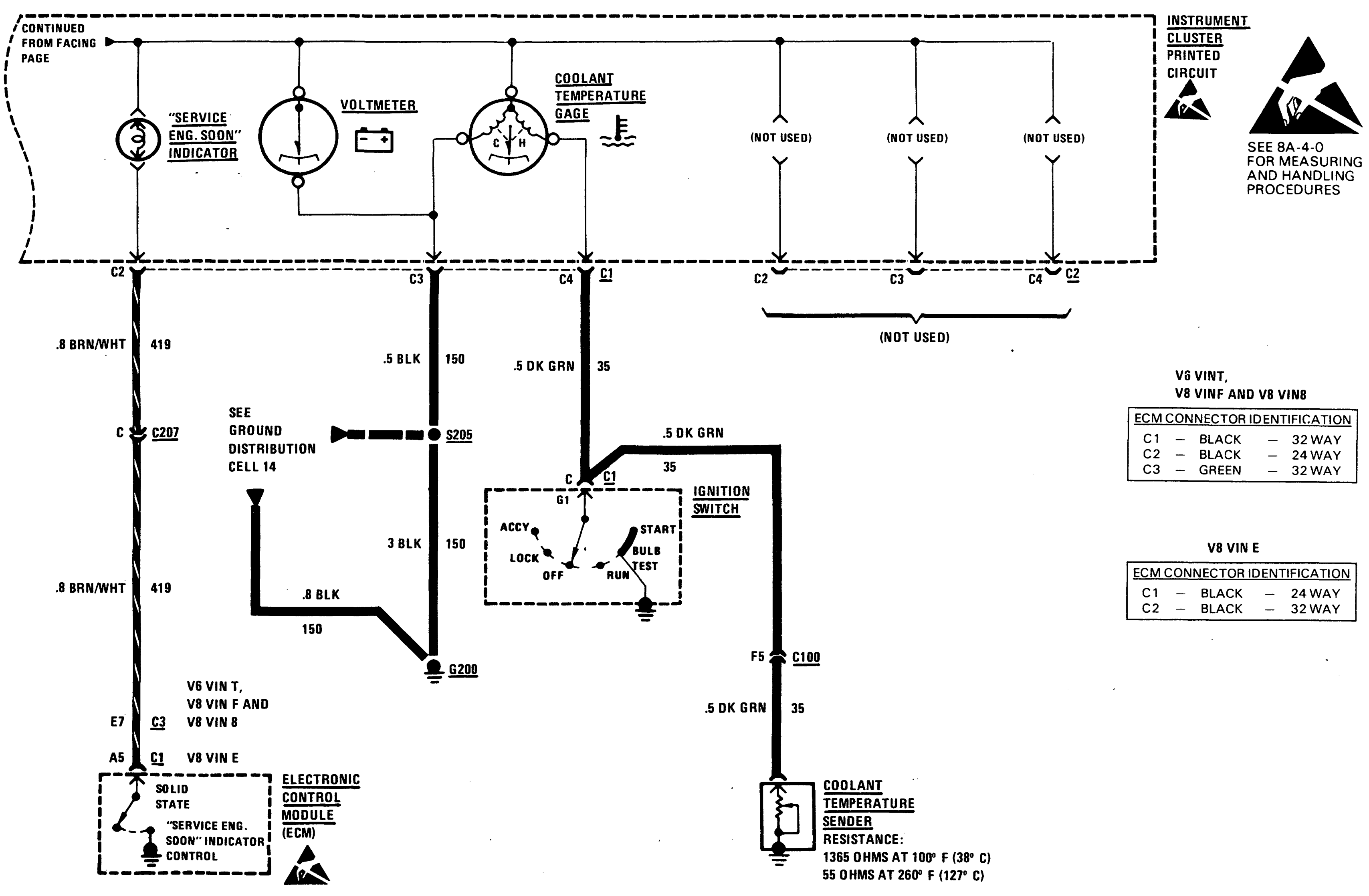
LIGHTS-ON WARNING

When the Light Switch is in HEAD or PARK, voltage is applied to the Audio Alarm Assembly at the Lights-On Input. When the Ignition Switch is in RUN, BULB TEST or START, voltage is applied to the GAGES Fuse and the Audio Alarm Assembly Power Input. If voltage is applied only to the Lights-On Input, and not to the Power Input, the alarm will sound. The voltage at the Power Input through the GAGES Fuse cancels the alarm.

INSTRUMENT PANEL: GAGES CLUSTER



INSTRUMENT PANEL: GAGES CLUSTER



RESISTANCE:
1365 OHMS AT 100° F (38° C)
55 OHMS AT 260° F (127° C)

SEE 8A-4-0 FOR MEASURING AND HANDLING PROCEDURES

V6 VINT,
V8 VINF AND V8 VIN8

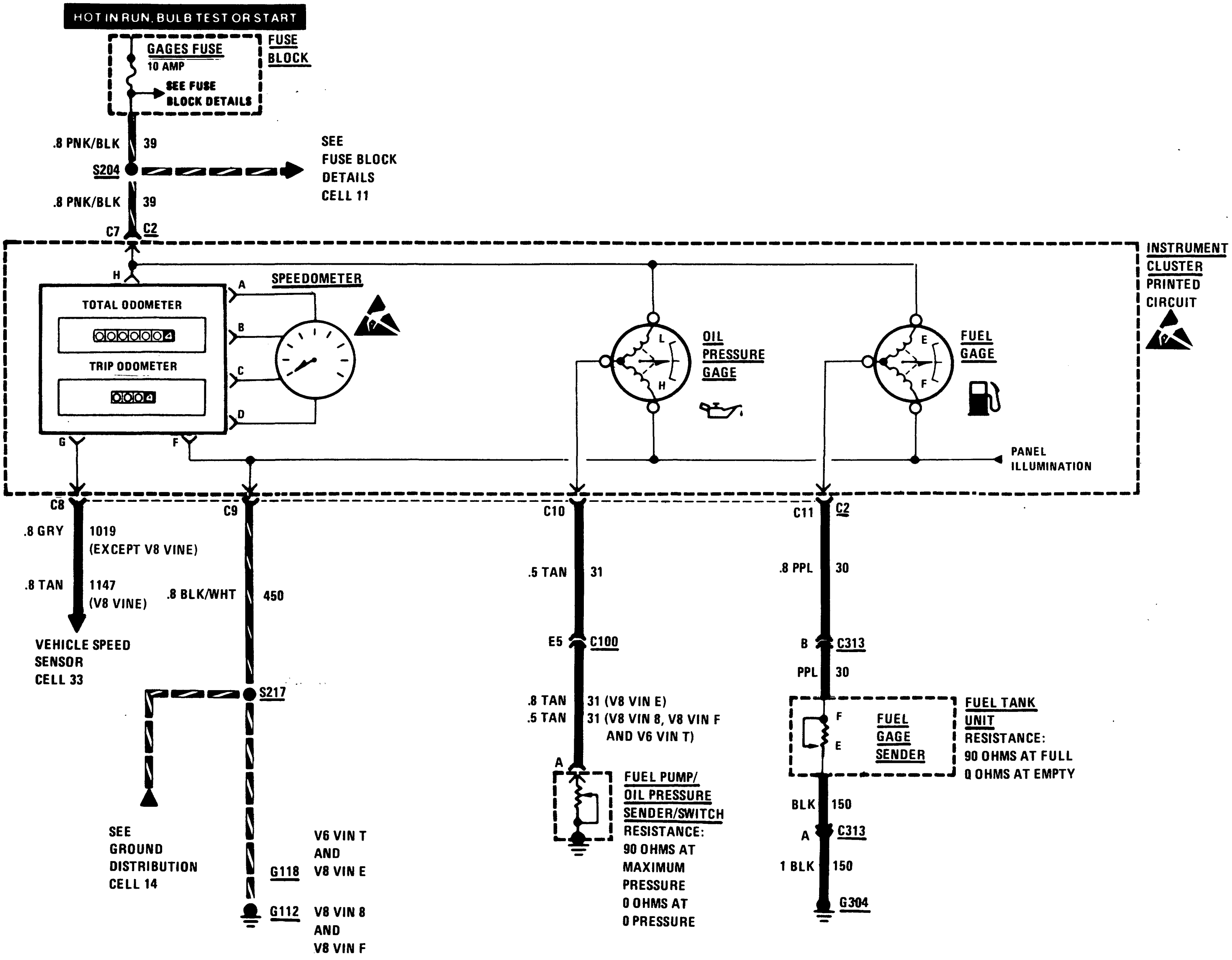
ECM CONNECTOR IDENTIFICATION				
C1	–	BLACK	–	32 WAY
C2	–	BLACK	–	24 WAY
C3	–	GREEN	–	32 WAY

V8 VIN E

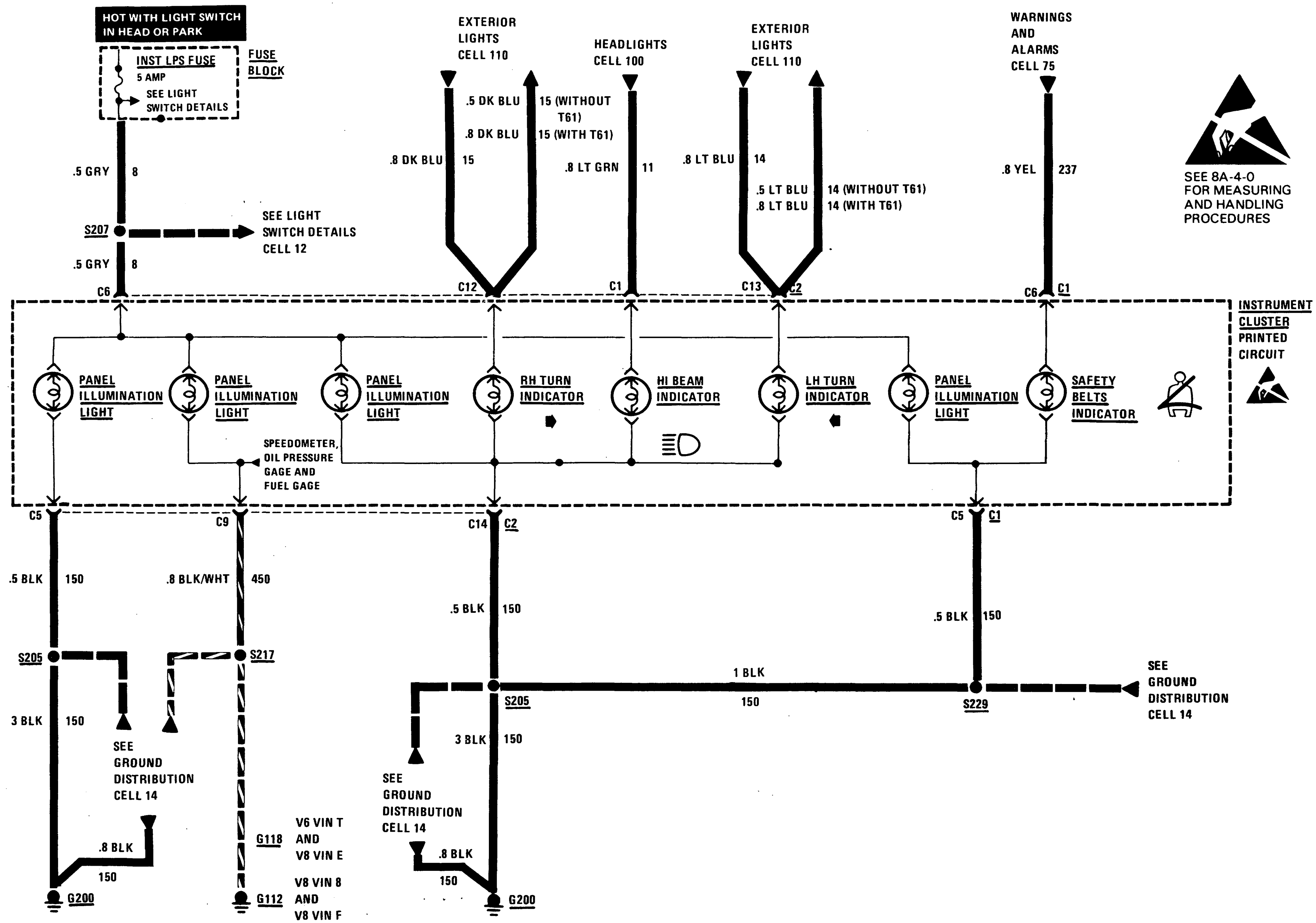
ECM CONNECTOR IDENTIFICATION				
C1	–	BLACK	–	24 WAY
C2	–	BLACK	–	32 WAY

INSTRUMENT PANEL: GAGES CLUSTER

SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES

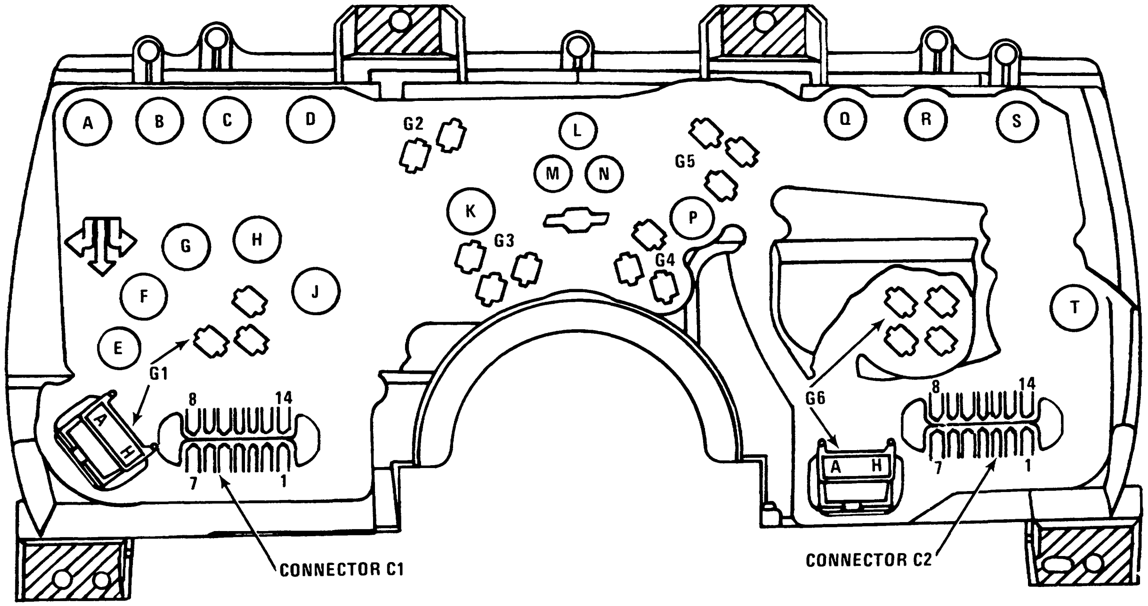


INSTRUMENT PANEL: GAGES CLUSTER



INSTRUMENT PANEL: GAGES CLUSTER

CLUSTER REAR VIEW



BULB LOCATIONS

A	Not Used
B	Not Used
C	INFL REST Indicator
D	SERVICE ENG. SOON Indicator
E	Illumination
F	Safety Belts Indicator
G	BRAKE Warning Indicator
H	SECURITY Indicator
J	SHIFT Indicator
K	Illumination
L	Hi Beam Indicator
M	RH Turn Indicator
N	LH Turn Indicator
P	Illumination
Q	Not Used
R	Not Used
S	Not Used
T	Illumination

GAGE LOCATIONS

G1	Tachometer
G2	Voltmeter
G3	Coolant Temperature Gage
G4	Fuel Gage
G5	Oil Pressure Gage
G6	Speedometer

CONNECTOR C1

1	INFL REST Indicator
2	SERVICE ENG. SOON Indicator
3	Ground
4	Coolant Temperature Gage Sender
5	Ground
6	Safety Belts Indicator
7	Tachometer Sender
8	Ground
9	Ignition
10	SHIFT Indicator
11	SECURITY Indicator
12	BRAKE Warning Indicator
13	Not Used
14	Not Used

CONNECTOR C2

1	Hi Beam Indicator
2	Not Used
3	Not Used
4	Not Used
5	Ground
6	Panel Illumination
7	Ignition
8	Speedometer Input
9	Ground
10	Oil Pressure Gage Sender
11	Fuel Gage Sender
12	RH Turn Indicator
13	LH Turn Indicator
14	Ground

INSTRUMENT PANEL: GAGES CLUSTER

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Check.**

1. If none of the gages operate, check GAGES Fuse.
2. Check indicator bulbs.
3. If none of the Panel Illumination Lights work, check the INST LPS Fuse.
4. If more than one indicator or gage is out, check wire(s) common to all affected circuits and inspect the Instrument Cluster Printed Circuit for cracks or flaws.
5. Check that grounds G200, G112 and G118 are clean and tight.

- **Go to System Check for a guide to normal operation.**
- **Go to System Diagnosis for diagnostic tests.**

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation. Refer to the diagnosis given if other results occur.**
- **Tests follow in System Diagnosis.**

COMPONENT LOCATION

		Page-Figure
Assembly Line Diagnostic Link (ALDL) Connector	Under LH side of I/P, on Fuse Block	201-13-A
Coolant Temperature Sender (VIN E)	LH side of engine, below valve cover	201- 5-A
Coolant Temperature Sender (VIN F)(VIN 8)	LH side of engine, below valve cover	201- 7-B
Coolant Temperature Sender (VIN T)	Top LH front of engine	201- 0-A
Electronic Control Module (ECM) (Except VIN E)	Behind RH side of I/P	201-15-B
Electronic Control Module (ECM) (VIN E)	Behind RH side of I/P	201-15-C
Fuel Pump/Oil Pressure Sender/ Switch (VIN E)	Lower LH rear of engine	201- 5-A
Fuel Pump/Oil Pressure Sender/ Switch (VIN F)(VIN 8)	Lower LH side of engine	201- 7-B
Fuel Pump/Oil Pressure Sender/ Switch (VIN T)	Lower LH side of engine	201- 0-A
Fuel Tank Unit	Top of fuel tank	
Fuse Block	Behind LH side of I/P	201-13-A
Ignition Switch	At base of steering column, below I/P	201-14-A
C100 (42 cavities)	LH front of dash, below relay bracket	201-12-A
C207 (15 cavities)	Behind RH side of I/P	201-15-A
C313 (3 cavities)	Below car, forward of fuel tank	201-18-E
G112 (VIN F)(VIN 8)	Rear of LH cylinder head	201- 7-A
G118 (VIN E)	Rear of RH cylinder head	201- 4-A
G118 (VIN T)	Rear of RH cylinder head	201- 1-A
G200	Behind LH side of I/P, on Convenience Center bracket	201-14-C
G304	Under driver's seat, on floor rail	201-16-A
S204	I/P harness, behind LH side of instrument cluster	201-13-A
S205	I/P harness, behind instrument cluster	201-12-A
S207	I/P harness, above Fuse Block	201-12-A
S217	I/P harness, behind RH side of instrument cluster	201-12-A
S229	I/P harness, above Convenience Center	201-12-A

SYSTEM CHECK TABLE

ACTION	NORMAL RESULT	FOR DIAGNOSIS
Turn Ignition Switch to RUN	SERVICE ENG. SOON Indicator is on	See Section 6E of the Service Manual
	Safety Belts Indicator will come on for 4 to 5 seconds	See Warnings and Alarms (see Index)
	The Audio Alarm will sound if the driver's seatbelt is unbuckled	See Symptom Table
	Fuel Gage shows current fuel level	
With Ignition Switch in RUN, operate first the RH Turn Signal then the LH Turn Signal	RH and LH Turn Indicators flash	See Exterior lights, Section 8A-110
With Ignition Switch in RUN, turn the Hi Beam Headlights on	Hi Beam Indicator is on	See Headlights and Fog Lights, Section 8A-100
With Ignition Switch in RUN, apply the Parking Brake	BRAKE Warning Indicator is on	See Brake Warning System, Section 8A-41
With Ignition Switch in RUN, turn the Head or Park Lights on and adjust the dimmer control	Instrument Cluster illumination varies with dimmer control	See Interior Lights Dimming, Section 8A-117
Start engine and let idle	Coolant Temperature Gage moves upward while cranking and then indicates current coolant temperature	Do Test F
	Oil Pressure Gage indicates current oil pressure	Do Test E
	Tachometer indicates engine rpm	Do Test D
	Voltmeter indicates charging system voltage	Do Test G
	BRAKE Warning Indicator lights while cranking	See Brake Warning System, Section 8A-41

- **If all results are normal, the system is OK.**

SYSTEM DIAGNOSIS

- **Do the tests listed for your symptom in the Symptom Table below, or when directed by the System Check.**
- **Tests follow the Symptom Table.**

SYMPTOM TABLE

SYMPTOM	FOR DIAGNOSIS
Fuel Gage reads E when there is fuel in the tank	Do Test A (also see Test J, terminal C11)
Fuel Gage is inacccurate	Do Test B (also see Test J, terminal C11)
Fuel Gage always indicates F or beyond	Do Test C (also see Test J, terminal C11)
Tachometer does not operate	Do Test D (also see Test I, terminal C7)
Oil Pressure Gage is inaccurate	Do Test E (also see Test J, terminal C10)
Coolant Temperature Gage does not read hot with the Ignition Switch in START or BULB TEST.	Check DK GRN (35) wire and Ignition Switch for an open (see schematic) Repair/replace as necessary
Coolant Temperature Gage is inaccurate	Do Test F (also see Test I, terminal C4)
Voltmeter is inaccurate	Do Test G

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Speedometer is inaccurate or inoperative	See Vehicle Speed Sensor Section 8A-33
One or both Odometers do not operate, but Speedometer operates accurately	Replace the Speedometer Assembly (see Section 8C)
Hi Beam Indicator does not operate properly	See Headlights, Section 8A-100 (also see Test J, terminal C1)
Safety Belts Indicator and alarm do not operate properly	See Warnings and Alarms, Section 8A-75
BRAKE Warning Indicator does not work properly	See Brake Warning System, Section 8A-41 (also see Test I, terminal C12)
SERVICE ENG. SOON Indicator is always on	See Section 6E of the Service Manual
SERVICE ENG. SOON Indicator does not come on with the Ignition Switch in RUN (engine not running)	See Section 6E of the Service Manual
SHIFT Indicator does not work properly	Do Test H
SECURITY Indicator is on	See Theft Deterrent PASS Key, Section 8A-133
Turn Indicators do not operate properly	See Exterior Lights, Section 8A-110 (also see Test J, terminals C12 and C13)

- **If all results are normal, the system is OK.**

A: FUEL GAGE SHORT TEST

Disconnect the Fuel Tank Unit connector C313. Turn the Ignition Switch to RUN (allow 1 minute for Fuel Gage to respond).

- If Fuel Gage now indicates full, replace the Fuel Gage Sender.
- If Fuel Gage still indicates empty, check/repair PPL or PNK (30) wires for shorts to ground, the Instrument Cluster Printed Circuit for flaws and the gages connections. Replace the Fuel Gage if PPL and PNK (30) wires, Printed Circuit and gage connections are OK (see Section 8C).

B: FUEL GAGE SENDER TEST

Disconnect connector C313 and connect one red lead of tester J-33431 to terminal B (PPL) and the other to terminal A (BLK) of the Instrument Panel harness half of C313. Set the resistance dials of the tester to 0 ohms and then to 90 ohms. The Fuel Gage should read E and then F. Allow 1 minute for Fuel Gage to respond.

- If the gage responds correctly, replace the Fuel Gage Sender and its wires.
- If the gage does not respond correctly, check BLK (150) wire and PPL (30) wire to the Instrument Cluster for faulty wiring. Also, inspect the Printed Circuit for proper mating of the connectors. Replace the Fuel Gage if the wire and Printed Circuit are good.

C: FUEL GAGE OPEN TEST

Connect: FUSED JUMPER
At: FUEL TANK UNIT CONNECTOR (C313 INSTRUMENT PANEL HALF) (Disconnected)
Condition:
- **Ignition Switch: RUN**

Jumper Between	Correct Result	For Diagnosis
B (PPL) & Ground	Fuel Gage reads E	See 1
B (PPL) & A (BLK)	Fuel Gage reads E	See 2

- If the Fuel Gage indicates correctly both times, repair/replace the Fuel Gage Sender.

1. Check/repair PPL (30) wires for opens. Check Printed Circuit for flaws and Fuel Gage for clean and tight connections. Replace Fuel Gage if the above checks are OK.
2. Check/repair BLK (150) wire.

D: TACHOMETER TEST

Measure: VOLTAGE
At: INSTRUMENT CLUSTER CONNECTORS (Disconnected)
Condition:
- **Ignition Switch: RUN**

Measure Between	Correct Voltage	For Diagnosis
C1/C9 (PNK/BLK) & Ground	Battery	See 1

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C1/C9 (PNK/BLK) & C1/C8 (BLK/WHT)	Battery	See 2
C1/C7 (WHT) & Ground	Greater than 10 volts	See 3
• If above voltages are correct, replace the Tachometer. 1. Check PNK/BLK (39) wire for an open. 2. Check BLK/WHT (450) wire for an open to ground. 3. Check WHT (121) wire for an open. If wire is OK, see Section 6D for further diagnosis.		

E: OIL PRESSURE GAGE TEST

1. Disconnect the Oil Pressure Sender. Place the Ignition Switch in RUN.

- If the Oil Pressure Gage reads high, go to step 2.
- If the Oil Pressure Gage does not read high, check TAN (31) wire for a short to ground, the Instrument Cluster Printed Circuit for cracks or flaws and gage connections at back of cluster. Repair/replace the Oil Pressure Gage if above checks are OK.

2. Jumper TAN (31) wire to ground at the Oil Pressure Sender.

- If the Oil Pressure Gage reads low, repair/replace the Oil Pressure Sender.
- If the Oil Pressure Gage does not read low, check TAN (31) wire for an open, the Instrument Cluster Printed Circuit for cracks or flaws and gage connections at back of cluster. Repair/replace the Oil Pressure Gage if the above checks are OK (see Section 8C).

F: COOLANT TEMPERATURE GAGE TEST

1. Disconnect the Coolant Temperature Sender connector and connect one red lead of tester J-33431 to the DK GRN (35) wire and the other to a known good ground. Set the resistance dials of the tester to 55 ohms. Put the Ignition Switch in RUN and observe the Coolant Temperature Gage. Allow 1 minute for the Coolant Temperature Gage to respond.

- If the gage reads 260 °F (hot), go to step 2.
- If the gage does not read hot, check the DK GRN (35) wire, Printed Circuit and gage connections for high resistance or an open. If all check OK, replace the Coolant Temperature Gage (see Section 8C).

2. Set the resistance dials to 1365 ohms. Allow 1 minute for Coolant Temperature Gage to respond.

- If the gage reads 100 °F (cold), replace the Coolant Temperature Sender.
- If the gage does not read cold, check the DK GRN (35) wire, Ignition Switch and Printed Circuit for a short to ground. Check PNK/BLK (39) wire for an open (see schematic). If all check OK, replace the Coolant Temperature Gage (see Section 8C).

G: VOLTMETER TEST

With Ignition Switch in RUN, connect a voltmeter between the positive and negative terminals of the Battery.

- If the voltage reading on the test voltmeter is approximately the same as the car's voltmeter reading, the car's voltmeter is OK.
- If the voltage reading on the test voltmeter is not close to the car's voltmeter reading, check the Instrument Cluster Printed Circuit for cracks or flaws and gage connections at back of cluster. If above checks are OK, repair/replace the voltmeter.

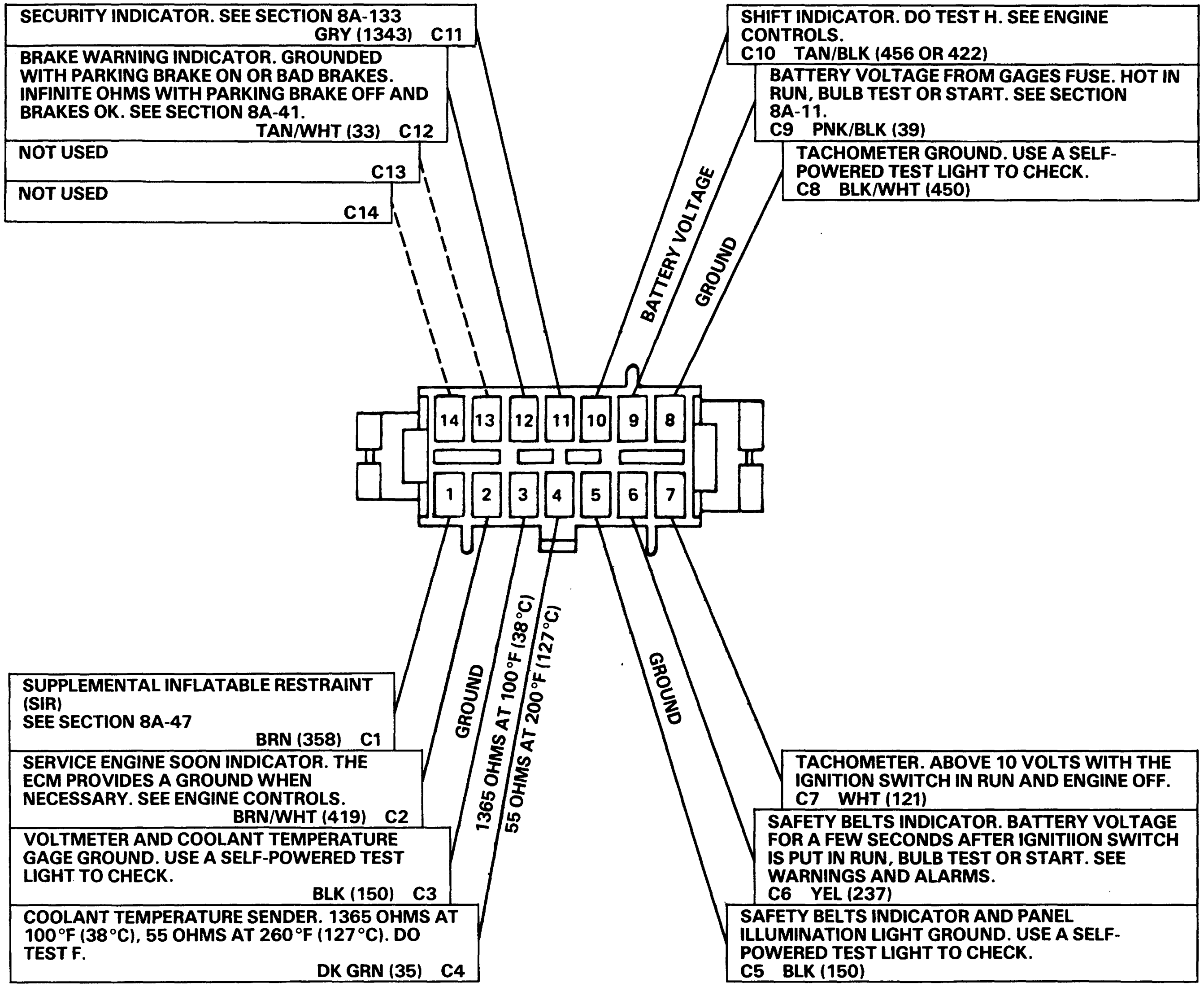
H: SHIFT INDICATOR WIRE TEST

Disconnect ECM connector (C3 - V6 VIN T, V8 VIN F and V8 VIN 8) or (C1 - V8 VIN E). Put the Ignition Switch in RUN and measure the voltage at terminal C3/F6 (V6 VIN T), C3/F1 (V8 VIN F or V8 VIN 8) or C1/A7 (V8 VIN E). See Section 8A-20, 21 and 22.

- If battery voltage is present, see Section 6E for ECM diagnosis.
- If battery voltage is not present, check the TAN/BLK (456 or 422) wire for an open.

I: CONNECTOR C1 PINOUT TEST

- IGNITION SWITCH IN RUN EXCEPT FOR RESISTANCE MEASUREMENTS
- MEASURE ALL RESISTANCES TO GROUND WITH THE NEGATIVE BATTERY TERMINAL DISCONNECTED
- MEASURE TO GROUND UNLESS ANOTHER TERMINAL IS GIVEN
- CLUSTER CONNECTOR C1 AS SEEN FROM THE DRIVER'S SEAT WITH THE INSTRUMENT CLUSTER REMOVED
- CONNECTOR C1 IS ON THE RIGHT SIDE
- IF THE CORRECT VOLTAGE OR RESISTANCE IS FOUND AT THE TERMINALS AND THE CLUSTER FUNCTION THAT USES THOSE TERMINALS DOES NOT OPERATE, CHECK BULBS, PRINTED CIRCUIT AND GAGE CONNECTIONS. IF OK, REPLACE GAGE AT FAULT (SEE SECTION 8C)
- IF THE CORRECT VOLTAGE OR RESISTANCE IS NOT FOUND AT A TERMINAL, DO THE TEST GIVEN OR GO TO THE PAGE REFERRED



SECURITY INDICATOR. SEE SECTION 8A-133
GRY (1343) C11

BRAKE WARNING INDICATOR. GROUNDED WITH PARKING BRAKE ON OR BAD BRAKES. INFINITE OHMS WITH PARKING BRAKE OFF AND BRAKES OK. SEE SECTION 8A-41.
TAN/WHT (33) C12

NOT USED
C13

NOT USED
C14

SHIFT INDICATOR. DO TEST H. SEE ENGINE CONTROLS.
C10 TAN/BLK (456 OR 422)

BATTERY VOLTAGE FROM GAGES FUSE. HOT IN RUN, BULB TEST OR START. SEE SECTION 8A-11.
C9 PNK/BLK (39)

TACHOMETER GROUND. USE A SELF-POWERED TEST LIGHT TO CHECK.
C8 BLK/WHT (450)

SUPPLEMENTAL INFLATABLE RESTRAINT (SIR)
SEE SECTION 8A-47
BRN (358) C1

SERVICE ENGINE SOON INDICATOR. THE ECM PROVIDES A GROUND WHEN NECESSARY. SEE ENGINE CONTROLS.
BRN/WHT (419) C2

VOLTMETER AND COOLANT TEMPERATURE GAGE GROUND. USE A SELF-POWERED TEST LIGHT TO CHECK.
BLK (150) C3

COOLANT TEMPERATURE SENDER. 1365 OHMS AT 100°F (38°C), 55 OHMS AT 260°F (127°C). DO TEST F.
DK GRN (35) C4

TACHOMETER. ABOVE 10 VOLTS WITH THE IGNITION SWITCH IN RUN AND ENGINE OFF.
C7 WHT (121)

SAFETY BELTS INDICATOR. BATTERY VOLTAGE FOR A FEW SECONDS AFTER IGNITIION SWITCH IS PUT IN RUN, BULB TEST OR START. SEE WARNINGS AND ALARMS.
C6 YEL (237)

SAFETY BELTS INDICATOR AND PANEL ILLUMINATION LIGHT GROUND. USE A SELF-POWERED TEST LIGHT TO CHECK.
C5 BLK (150)

J: CONNECTOR C2 PINOUT TEST

- IGNITION SWITCH IN RUN EXCEPT FOR RESISTANCE MEASUREMENTS
- MEASURE ALL RESISTANCES TO GROUND WITH THE NEGATIVE BATTERY CABLE DISCONNECTED
- MEASURE TO GROUND UNLESS ANOTHER TERMINAL IS GIVEN
- CLUSTER CONNECTOR C2 AS SEEN FROM THE DRIVER'S SEAT WITH THE INSTRUMENT CLUSTER REMOVED
- CONNECTOR C2 IS ON THE LEFT SIDE
- IF THE CORRECT VOLTAGE OR RESISTANCE IS FOUND AT THE TERMINALS AND THE CLUSTER FUNCTION THAT USES THOSE TERMINALS DOES NOT OPERATE, CHECK BULBS, PRINTED CIRCUIT AND GAGE CONNECTIONS. IF OK, REPLACE GAGE AT FAULT (SEE SECTION 8C)
- IF THE CORRECT VOLTAGE OR RESISTANCE IS NOT FOUND AT A TERMINAL, DO THE TEST GIVEN OR GO TO THE PAGE REFERRED

FUEL GAGE SENDER. RESISTANCE VARIES FROM 0 OHMS AT EMPTY TO 90 OHMS AT FULL. DO TEST A, B, OR C.
PPL (30) C11

RH TURN INDICATOR. FLASHING BATTERY VOLTAGE WITH RH TURN SIGNAL ON. SEE SECTION 8A-110.
DK BLU (15) C12

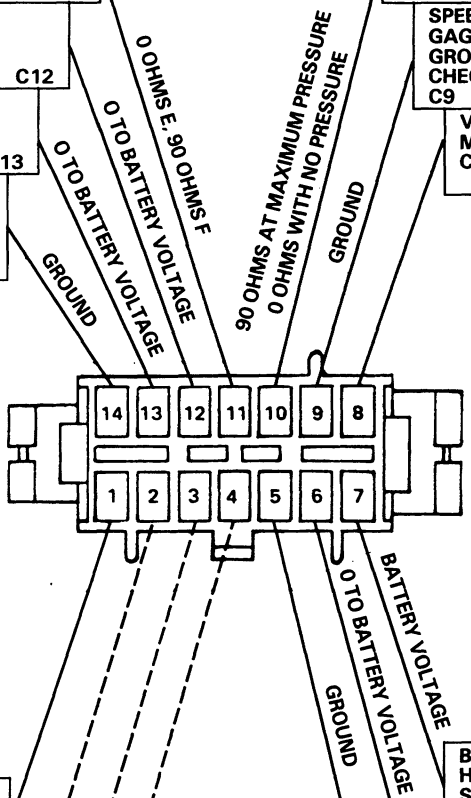
LH TURN INDICATOR. FLASHING BATTERY VOLTAGE WITH LH TURN SIGNAL ON. SEE SECTION 8A-110.
LT BLU (14) C13

PANEL ILLUMINATION LIGHT, RH TURN INDICATOR, HI BEAM INDICATOR AND LH TURN INDICATOR GROUND. USE A SELF-POWERED TEST LIGHT TO CHECK.
BLK (150) C14

FUEL PUMP/OIL PRESSURE SENDER/SWITCH. 90 OHMS AT MAXIMUM PRESSURE. 0 OHMS WITH NO PRESSURE.
C10 TAN (31)

SPEEDOMETER, OIL PRESSURE GAGE, FUEL GAGE AND PANEL ILLUMINATION LIGHT GROUND. USE A SELF-POWERED TEST LIGHT TO CHECK.
C9 BLK/WHT (450)

VEHICLE SPEED INPUT. 4000 PULSES PER MILE. SEE SECTION 8A-33.
C8 GRY (1019) (EXCEPT V8 VIN E)
TAN (1147)(V8 VIN E)



HI BEAM INDICATOR. BATTERY VOLTAGE WITH HI BEAM HEADLIGHTS ON. SEE HEADLIGHTS, SECTION 8A-100.
LT GRN (11) C1

NOT USED
C2

NOT USED
C3

NOT USED
C4

BATTERY VOLTAGE FROM GAGES FUSE. HOT IN RUN, AND START. SEE SECTION 8A-117.
C7 PNK/BLK (39)

CLUSTER ILLUMINATION. VARIABLE VOLTAGE WHEN LIGHTS ARE ON AND DIMMER RHEOSTAT IS ADJUSTED. SEE SECTION 8A-117.
C6 GRY (8)

PANEL ILLUMINATION LIGHT GROUND. USE A SELF-POWERED TEST LIGHT TO CHECK.
C5 BLK (150)

CIRCUIT OPERATION

See the circuit referred to for the complete operation of an indicator and the other components that work with it. Only the indicators that do not appear in other schematics are described in this section.

With the Ignition Switch in RUN, BULB TEST or START, voltage is available through the GAGES Fuse to all of the indicators in the circuit.

Fuel Gage

The pointer of the Fuel Gage is moved by the magnetic field of two coils. The coils are at right angles to each other. Battery voltage is applied to the E coil and the circuit divides at the opposite end of this coil. The other path grounds through the variable resistor of the Fuel Gage Sender.

When the tank is low, the resistance of the sender is low (0 ohms). A large flow of current passes through the E coil and the Fuel Gage Sender resistor. This moves the pointer toward E on the scale. When the tank is full, the sender's resistance is high (90 ohms). More current flows through the F coil, moving the pointer toward F on the scale.

With two coils operating the pointer, the gage is not affected by changes in the voltage of the system.

Oil Pressure Gage

The engine's oil pressure is displayed by the Oil Pressure Gage. The pointer of the gage is moved by two coils, and its operation is similar to that of the Fuel Gage.

The Oil Pressure Sender is connected to the junction of the two coils. It has low resistance when the oil pressure is low, and 90 ohms resistance when the oil pressure is high. This changing resistance changes the current flow through the coils. The magnetic fields of the coils move the pointer from L to H.

Coolant Temperature Gage

The Coolant Temperature Gage is also operated by two coils. Battery voltage is applied to both coils. One is grounded directly and the other is grounded through the Coolant Temperature Sender. This has 55 ohms resistance at 260°F (hot coolant) and its resistance increases at lower temperatures. Resistance is approximately 1365 ohms at 100°F. This causes the current flow through the sender and one coil to increase as the coolant temperature increases. This moves the pointer.

Voltmeter

The Voltmeter measures the electrical system's voltage with the Ignition Switch in RUN, BULB TEST or START. With the engine stopped, the Voltmeter indicates the Battery's condition. With the engine running, the Voltmeter indicates Charging System operation.

Tachometer

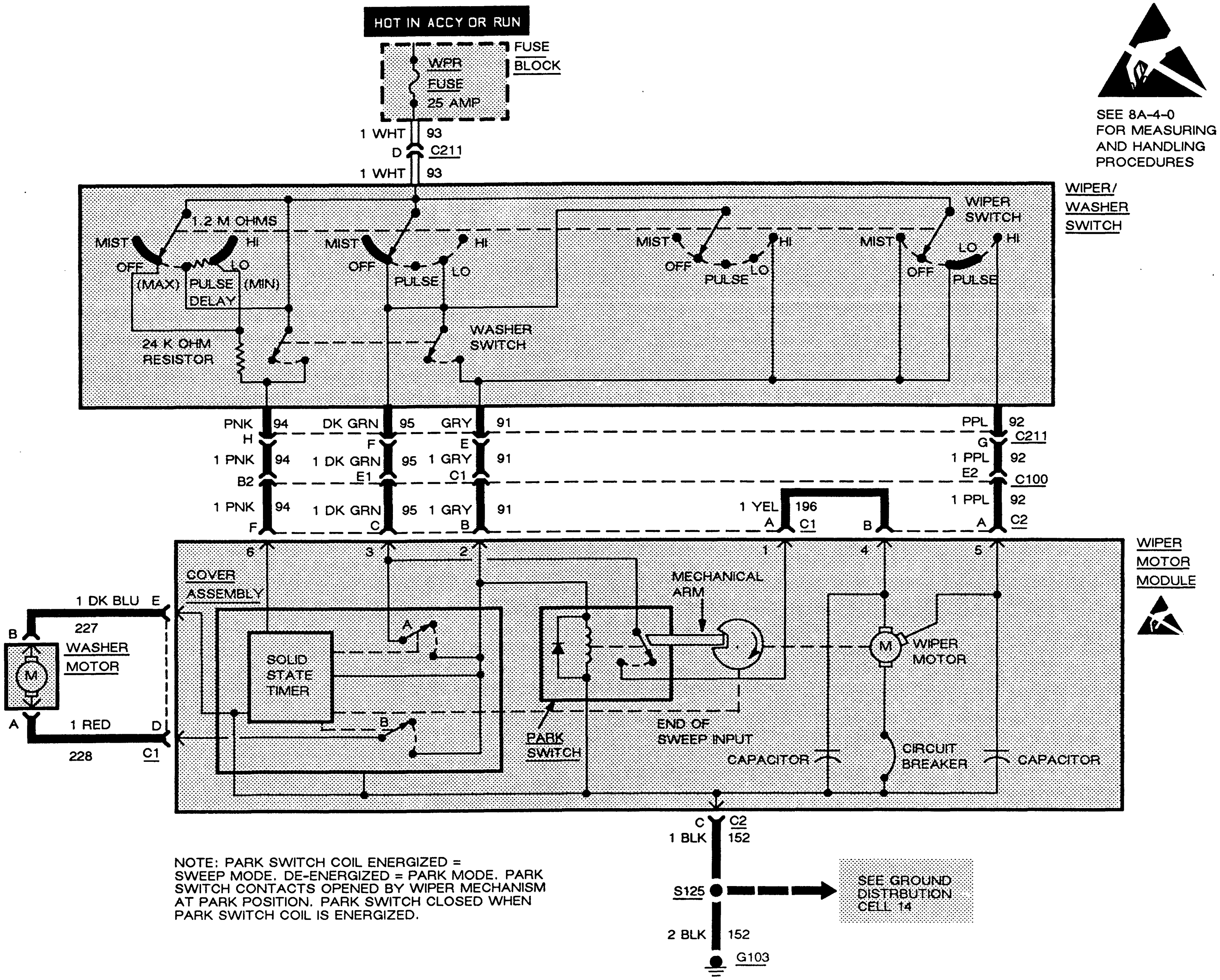
The Tachometer displays engine speed in rpms. Voltage pulses are taken from the Ignition System and sent to the Tachometer. Solid State circuits process these pulses into a signal that drives the pointer of the meter. The Tachometer responds to the frequency of the voltage pulses. These pulses increase with engine speed. The Tachometer Filter rounds off the pulses and removes spikes.

Shift Indicator

In vehicles equipped with Manual Transmission, an indicator lights when the car should be shifted to the next higher gear for better fuel economy. Battery voltage is applied to one side of the bulb. The other side of the bulb is switched to ground by the ECM, which uses engine data such as rpm, vehicle speed, and intake vacuum to compute an efficient shift point.

WIPER/WASHER: PULSE, CD4

SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES



NOTE: PARK SWITCH COIL ENERGIZED = SWEEP MODE. DE-ENERGIZED = PARK MODE. PARK SWITCH CONTACTS OPENED BY WIPER MECHANISM AT PARK POSITION. PARK SWITCH CLOSED WHEN PARK SWITCH COIL IS ENERGIZED.

WIPER/WASHER: PULSE, CD4

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Diagnosis.**

1. Check the WPR Fuse by visual inspection.
2. Check that Wiper/Washer Switch connector and Wiper/Washer Motor Module connectors are mated correctly.
3. If the Washer does not operate, check that:
   - — The Washer reservoir is filled.
   - — The hoses are not pinched or kinked.
   - — The hoses are correctly attached.
   - — The nozzles are not clogged.
4. If Wipers cycle in and out of PARK position in HI and do not operate in LO, MIST or PULSE, check YEL (196) wire for an open (see schematic).
5. If the Wiper Motor runs but the wiper blades do not, check the wiper linkage at the wiper crank arm.

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation.**
- **Refer to System Diagnosis for a list of symptoms and diagnostic steps.**

COMPONENT LOCATION

		Page-Figure
Fuse Block	Behind LH side of I/P	201-13-A
Washer Motor	LH side of engine compartment, in washer fluid reservoir	201-10-C
Wiper Motor Module	Mounted to LH front of dash	201-11-D
C100 (42 cavities)	LH front of dash, below relay bracket	201-12-A
C211 (11 cavities)	Behind I/P, lower RH side of steering column	201-14-A
G103	Behind LH headlights	201-10-A
S125	Front lights harness, behind LH headlights	201-10-A

WIPER/WASHER: PULSE, CD4

ACTION	NORMAL OPERATION
Ignition in ACCY or RUN, press Washer Switch ON for less than one second	Washer sprays windshield for approximately $2^1/_2$ seconds Wipers run at low speed and continue to run at low speed until the Washer Button is released After button is released, Wipers run for approximately six seconds and then return to park
Turn Wiper Switch to PULSE (Delay Mode)	Wipers make one complete stroke, then pause for 0 to 25 seconds before making the next stroke The wait time is adjusted by turning the Wiper Switch through the delay range
With the Wiper Switch in PULSE, hold the Washer Switch on for one or two seconds	Washer sprays windshield as long as Washer Button is held ON Pulse function is overridden and the Wipers run at low speed during spray period After the Washer stops, the Wipers continue to run for six seconds Wipers return to Pulse operation
With the Wiper Switch in HI, hold Washer Switch for one or two seconds	Same operation at low speed wash except that the Wipers run at high speed
Turn Wiper Switch to LO	Wipers run continuously at low speed
Turn Wiper Switch to HI	Wipers run continuously at high speed
Turn Wiper Switch to OFF	Wipers return to PARK position at low speed
Move Wiper Switch to MIST	Wipers make one complete stroke and then PARK

SYSTEM DIAGNOSIS

- **Do the tests listed for your symptom in the Symptom Table below.**
- **Tests follow the Symptom Table.**

SYMPTOM TABLE

SYMPTOM	DO TEST
Wipers do not operate in any mode	A: Wiper/Washer Switch Voltage Test B: Wiper Motor Module Input Voltage Test E: Wiper Motor Module Current Draw Test
Wipers run at low speed only (no HI speed)	B: Wiper Motor Module Input Voltage Test
Wipers cycle in and out of park in HI	B: Wiper Motor Module Input Voltage Test C: Wiper Motor Module Resistance Test
Wipers cycle in and out of PARK in OFF and operate in LO	Replace Park Switch Refer to Section 8E
Wipers will not shut off	B: Wiper Motor Module Input Voltage Test
No delay in PULSE Mode or PULSE mode does not operate correctly	B: Wiper Motor Module Input Voltage Test D: Wiper/Washer Pulse Control Resistance Test
Wipers operate very slowly or intermittently	E: Wiper Motor Module Current Draw Test
Wipers do not PARK	F: Mechanical Inspection
Washer will not operate or runs continuously	B: Wiper Motor Module Input Voltage Test G: Washer Motor Voltage Test
Wipers stay in delay during wash cycle	Replace cover assembly Refer to Section 8E

A: WIPER/WASHER SWITCH VOLTAGE TEST

Measure: VOLTAGE

AT: WIPER/WASHER SWITCH CONNECTOR C211 (Disconnected)

Condition:

- **Ignition Switch: ACCY**

Measure Between	Correct Voltage	For Diagnosis
D (WHT) & Ground	Battery	See 1

- If the voltage is correct, return to Symptom Table.

1. Check WPR Fuse and WHT (93) wire for an open.

B: WIPER MOTOR MODULE INPUT VOLTAGE TEST

Measure: VOLTAGE

At: WINDSHIELD WIPER MOTOR MODULE CONNECTORS C1 & C2 (Disconnected)

Conditions:

- **Ignition Switch: ACCY**
- **Wiper Switch: OFF**

Connect Between	Correct Voltage	For Diagnosis
C2/A (PPL) & Ground	0 volts	See 1
C1/B (GRY) & Ground	0 volts	See 1

(Continued on next page)

WIPER/WASHER: PULSE, CD4

(Continued from previous page)

C1/C (DK GRN) & Ground	Battery	See 2
C1/F (PNK) & Ground	Battery	See 2
• Wiper Switch: MIST		
C2/A (PPL) & Ground	0 volts	See 1
C1/B (GRY) & Ground	Battery	See 2
C1/C (DK GRN) & Ground	Battery	See 2
C1/F (PNK) & Ground	Battery	See 2
• Wiper Switch: PULSE		
C2/A (PPL) & Ground	0 volts	See 1
C1/B (GRY) & Ground	Battery	See 2
C1/C (DK GRN) & Ground	0 volts	See 1
C1/F (PNK) & Ground	Battery	See 2
• Wiper Switch: LO		
C2/A (PPL) & Ground	0 volts	See 1
C1/B (GRY) & Ground	Battery	See 2
C1/C (DK GRN) & Ground	Battery	See 2
C1/F (PNK) & Ground	Battery	See 2
• Wiper Switch: HI		
C2/A (PPL) & Ground	Battery	See 2
C1/B (GRY) & Ground	0 volts	See 1
C1/C (DK GRN) & Ground	0 volts	See 1
C1/F (PNK) & Ground	Battery	See 2
• Wiper Switch: OFF & Washer Switch ON		
C2/A (PPL) & Ground	0 volts	See 1
C1/B (GRY) & Ground	Battery	See 2
C1/C (DK GRN) & Ground	Battery	See 2
C1/F (PNK) & Ground	Battery	See 2

(Continued in next column)

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- If all measurements are correct and the Wiper Motor is on all the time, replace the Cover Assembly. Refer to Section 8E. Otherwise return to the Symptom Table.

1. Check associated wiring for a short to voltage. If wiring is good, replace the Wiper/Washer Switch. Refer to Section 3F4.
2. Check associated wiring to the Wiper/Washer Switch for an open or short to ground. If wiring is good, replace the Wiper/Washer Switch. Refer to Section 3F4.

C: WIPER MOTOR MODULE RESISTANCE TEST

Measure: RESISTANCE

AT: WIPER MOTOR ASSEMBLY CONNECTORS C1 & C2 (Disconnected)

Conditions:

- **Ignition Switch: OFF**
- **Wiper Switch: HI**

Measure Between	Correct Resistance	For Diagnosis
C1/C (DK GRN) & C1/B (GRY)	Less than 0.5 ohms	See 1

- Wiper Switch: OFF, PULSE

Measure Between	Correct Resistance	For Diagnosis
C1/C (DK GRN) & C1/B (GRY)	Infinite	See 1
C1/A (YEL) & C2/B (YEL)	Less than 0.5 ohms	See 2
C1/A (YEL) & Ground	Infinite ohms	See 3

- If all measurements are correct, check for proper operation of the Park Switch Latch Arm and the Drive Pawl.

1. Check DK GRN (95) and GRY (91) wires for a short to ground, to each other or opens. If wires are OK, replace Wiper Switch Assembly.
2. Check YEL (196) wire for an open.
3. Check YEL (196) wire for a short to ground.

D: WIPER/WASHER PULSE CONTROL RESISTANCE TEST

Measure: RESISTANCE

AT: WIPER MOTOR ASSEMBLY CONNECTORS C1 (Disconnected)

Conditions:

- **Ignition Switch: OFF**
- **Negative Battery Terminal DISCONNECTED**
- **Wiper Switch: LO**

Measure Between	Correct Resistance	For Diagnosis
B (GRY) & F (PNK)	Approximately 24 K ohms	See 1

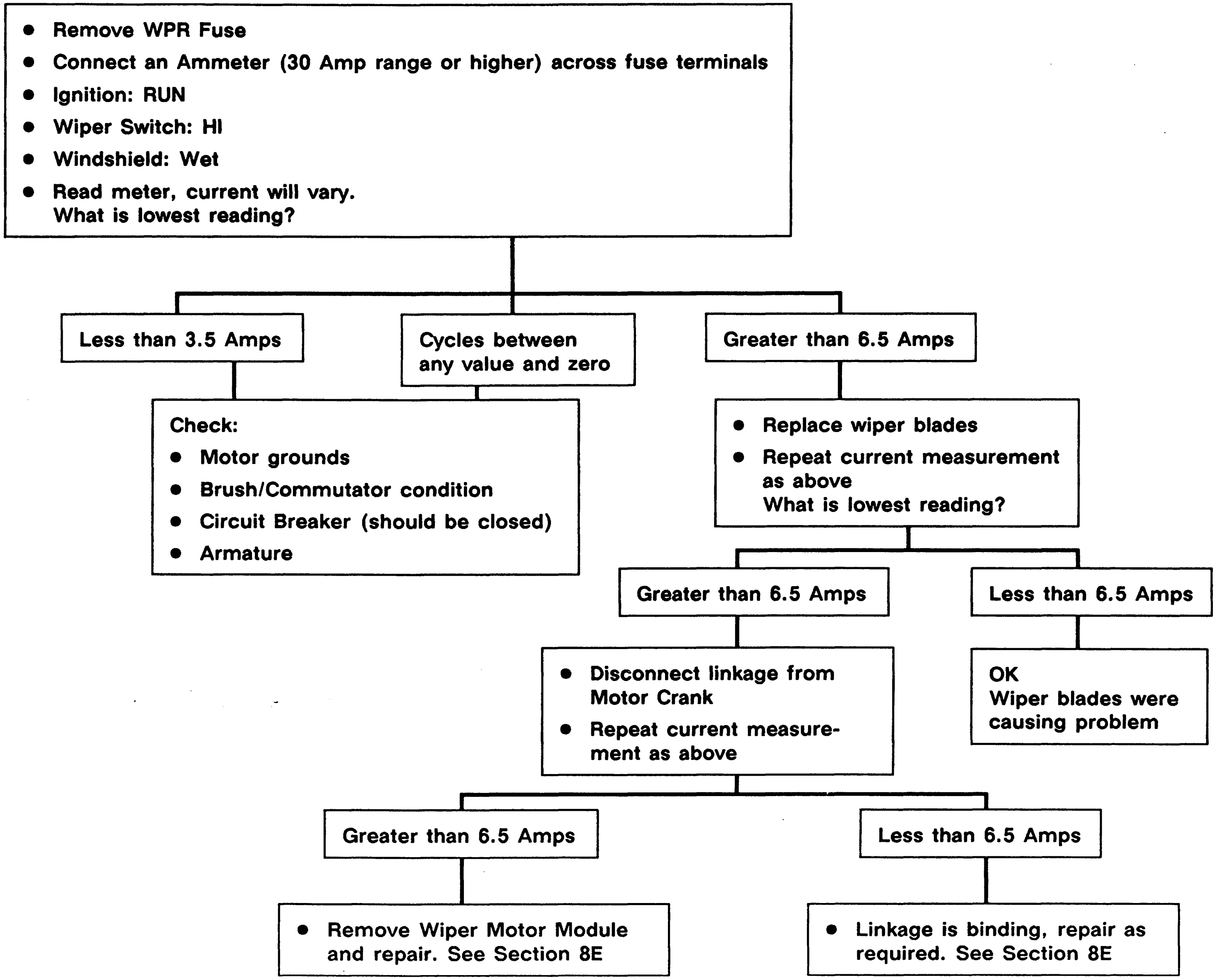
- Move Wiper Switch through delay range to the maximum delay position

Measure Between	Correct Resistance	For Diagnosis
B (GRY) & F (PNK)	Resistance increases to approximately 1.2 megohms	See 1

- If both resistances are correct, but the pulse mode does not operate, replace Cover Assembly. See Section 8E for replacement procedures.

1. Check PNK (94) and GRY (91) wires for an open. If wires are OK, replace Wiper Switch Assembly.

E: WIPER MOTOR MODULE CURRENT DRAW TEST



F: MECHANICAL INSPECTION

1. Remove Wiper Motor Cover.
2. Reconnect motor without cover.
3. Turn Wiper Switch to LO.
4. Observe spring loaded Latch Arm and Drive Pawl which rotates with big gear.
5. Turn Wiper Switch to OFF.
   Does Latch Arm spring out and catch Drive Pawl to shift to Park? (See 8E for view).

- If Latch Arm doesn't spring out, replace the Park Switch (See 8E).
- If Latch Arm does spring out, check for a bent Pawl or Shaft endplay. See 8E for repair procedures.

G: WASHER MOTOR VOLTAGE TEST

Measure: VOLTAGE

AT: WASHER MOTOR CONNECTOR (Disconnected)

Conditions:

- **Ignition Switch: ACCY**
- **Washer Switch: ON (hold)**

Measure Between	**Correct Voltage**	**For Diagnosis**
A (RED) & B (DK BLU)	Battery	See 1
• Washer Switch: OFF		
A (RED) & B (DK BLU)	0 volts	See 2
• If the voltage is correct, replace Washer Motor. See Section 8E for removal and replacement procedures.		

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1. Check RED (228) and DK BLU (227) wires for an open. If wires are OK, check terminal control between Park Switch and Cover Assembly. If contact is good, replace Cover Assembly.
2. Check RED (228) for a short to Battery. If wire is OK, replace Cover Assembly.

CIRCUIT OPERATION

In addition to the features of a conventional (non-pulse) wiper system (low and high speed), the pulse-type Windshield Wiper/Washer System includes an operating mode in which the Wipers make single strokes with an adjustable time interval between strokes. The time interval is controlled by a Solid State Timer in the Wiper Motor Assembly. The duration of the delay interval is determined by the delay rheostat in the Wiper Switch Assembly.

The Wiper Motor is protected by a Circuit Breaker. If the Wipers are blocked (by snow or ice for example) the Circuit Breaker will open the circuit. The Circuit Breaker resets automatically when it cools.

Pulse Operation

With the Wiper/Washer Switch in PULSE, battery voltage is applied to the Wiper Motor Assembly at terminal B of connector C1 through the GRY wire. Voltage is also applied to terminal F through the PNK wire and the pulse delay resistor in the Wiper Switch Assembly. The battery voltage at terminal B energizes the Park Switch Coil which closes its contacts. In response to the voltage at terminal F, the Solid State Timer momentarily closes contact A on the Cover Assembly which applies battery voltage at terminal B to the contacts of the Park Switch, starting the Wiper Motor.

A mechanical arm (end of sweep input) operates contacts on the Cover Assembly, which cause contact A to open when the Wipers have completed their sweep. Since the Park Switch Coil remains energized, the Wipers do not park but remain just above the park position until the Cover Assembly closes contact A again to start another sweep.

The length of delay time between sweeps is controlled by the variable Pulse Delay resistor. The delay is adjustable from 0 to 25 seconds.

Low Speed

With the Wiper Switch in LO, battery voltage is applied at the Wiper Motor Assembly connector C1, terminals B and C through the DK GRN and GRY wires. The Park Switch Coil is again energized and battery voltage is applied to the Park Switch contacts and the Wiper Motor, which runs continuously.

High Speed

With the Wiper Switch in the HI position, battery voltage is applied directly to the Wiper Motor, at terminal A, without passing through the Park Switch contacts. Terminal A is connected to a separate Wiper Motor brush for high speed operation. The Park Switch coil remains energized in the HI position because of the voltage that is present at the low speed Wiper Motor brush when voltage is applied to the high speed brush. The current path from the low speed brush to the Park Switch coil is completed through the Wiper/Washer Switch.

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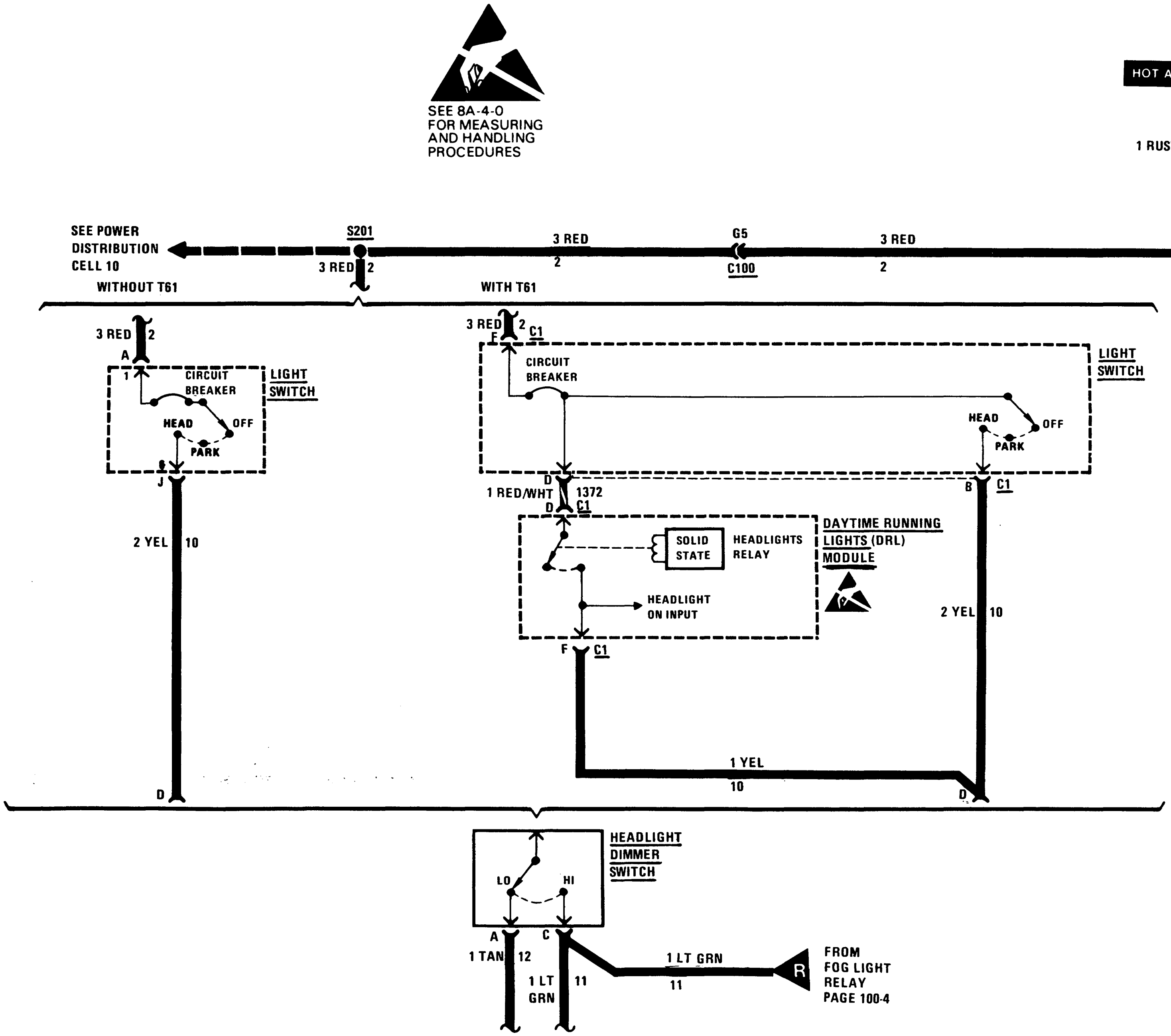
An open in this circuit will cause the wipers to be inoperative in LO and cycle in and out of park in HI.

Washer

When the Washer Switch is held ON, battery voltage is applied to the Cover Assembly through the PNK and GRY wires. The Park Switch Coil is energized by the battery voltage at terminal B of connector C1. The Cover Assembly turns on the Washer and Wiper Motors by closing contacts A and B. The Cover Assembly turns the Wiper Motor off approximately six seconds after it interrupts power to the Washer Motor. If the Wipers had been in PULSE, LO or HI, they would return to that operation after the wash cycle.

BLANK

HEADLIGHTS


SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES
HOT AT ALL TIMES
FUSIBLE
LINK A
1 RUST
SEE POWER
DISTRIBUTION
CELL 10
S201
3 RED
2
3 RED
2
G5
C100
3 RED
2
WITHOUT T61
WITH T61
3 RED
2
A
1
CIRCUIT
BREAKER
LIGHT
SWITCH
HEAD
OFF
PARK
J
2 YEL
10
D
3 RED
2
C1
F
CIRCUIT
BREAKER
LIGHT
SWITCH
HEAD
OFF
PARK
D
1 RED/WHT
1372
D
C1
B
C1
SOLID
STATE
HEADLIGHTS
RELAY
DAYTIME RUNNING
LIGHTS (DRL)
MODULE
HEADLIGHT
ON INPUT
F
C1
2 YEL
10
1 YEL
10
D
HEADLIGHT
DIMMER
SWITCH
LO
HI
A
C
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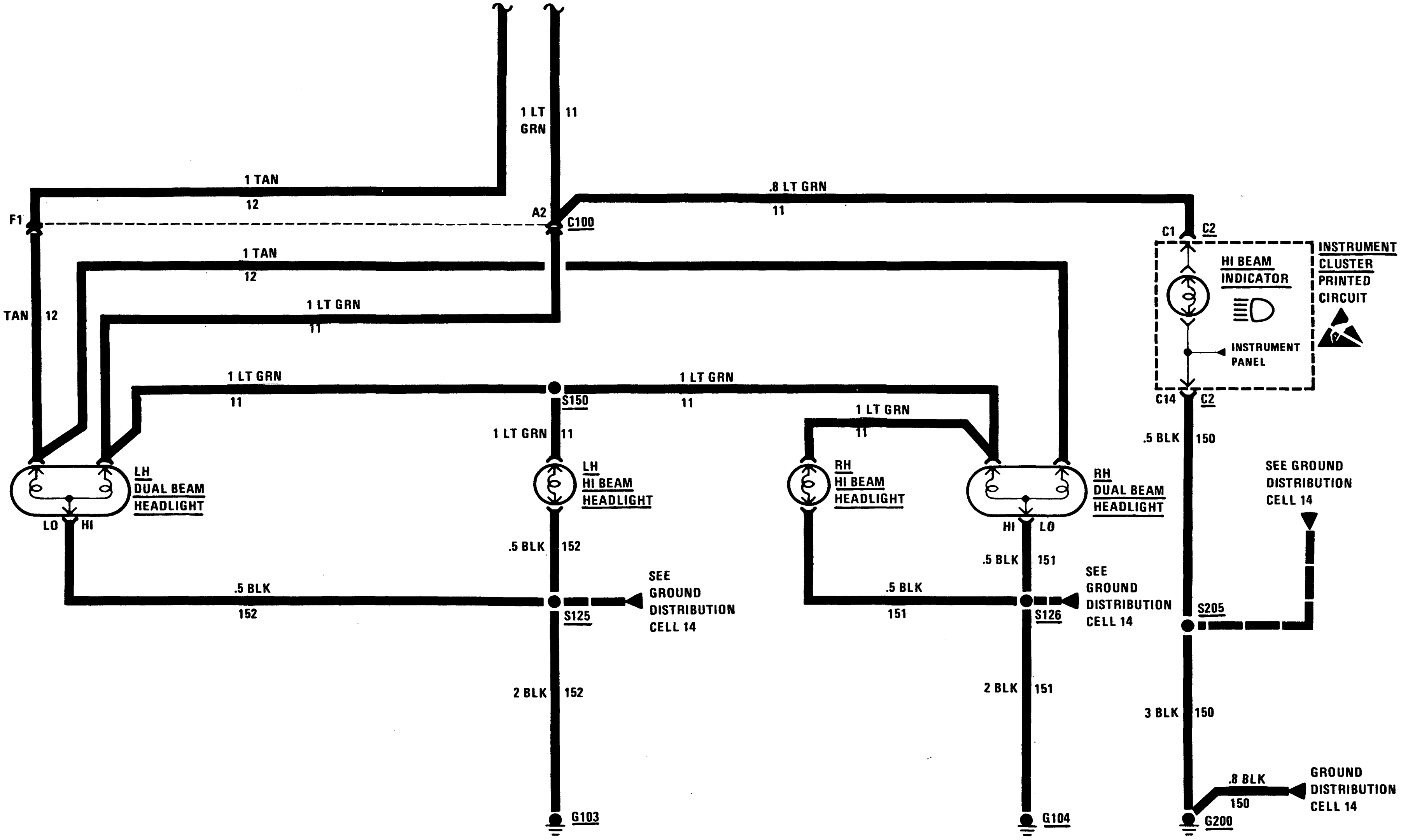
12
1 LT
GRN
11
1 LT GRN
11
R
FROM
FOG LIGHT
RELAY
PAGE 100-4


1 LT GRN
11
1 TAN
12
.8 LT GRN
11
F1
A2
C100
C1
C2
INSTRUMENT CLUSTER PRINTED CIRCUIT
HI BEAM INDICATOR
INSTRUMENT PANEL
1 TAN
12
1 TAN
12
1 LT GRN
11
1 LT GRN
11
1 LT GRN
11
S150
1 LT GRN
11
1 LT GRN
11
C14
C2
.5 BLK
150
LH DUAL BEAM HEADLIGHT
LO
HI
LH HI BEAM HEADLIGHT
RH HI BEAM HEADLIGHT
RH DUAL BEAM HEADLIGHT
HI
LO
SEE GROUND DISTRIBUTION CELL 14
.5 BLK
152
.5 BLK
152
S125
SEE GROUND DISTRIBUTION CELL 14
.5 BLK
151
.5 BLK
151
S126
SEE GROUND DISTRIBUTION CELL 14
S205
2 BLK
152
2 BLK
151
3 BLK
150
.8 BLK
150
GROUND DISTRIBUTION CELL 14
G103
G104
G200

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Diagnosis.**

1. If Headlights on one side are dimly lit, check the ground on that side.
2. If Hi Beams do not light, but the Hi Beam Indicator lights, check LT GRN (11) wire for an open.
3. If one Headlight doesn't work, check the connections, Headlight, and wires to the Headlight.

- **Go to System Diagnosis for diagnostic test.**

SYSTEM DIAGNOSIS

- **If your symptom is not listed in the following table or in the Troubleshooting Hints, do Test A.**
- **Do the tests listed for your symptom in the Symptom Table below.**
- **Tests follow the Symptom Table.**

SYMPTOM TABLE

A. All Headlights are inoperative or intermittent.
B. Lo Beams on both sides are inoperative or Hi Beams and Hi Beam Indicator are inoperative.
C. Headlights do not turn off.

COMPONENT LOCATION

		Page-Figure
Daytime Running Lights (DRL) Module	Behind LH side of I/P	201-12-A
Fusible Link A (VIN E)	Lower RH side of engine, at Starter Solenoid	201- 6-C
Fusible Link A (VIN F)(VIN 8)	Lower RH side of engine, at Starter Solenoid	201- 9-C
Fusible Link A (VIN T)	Lower RH side of engine, at Starter Solenoid	201- 2-B
Headlight Dimmer Switch	At base of steering column	201-14-A
C100 (42 cavities)	LH front of dash, below relay bracket	201-12-A
G103	Behind LH headlights	201-10-A
G104	Behind RH headlights	201-10-A
G200	Behind LH side of I/P, on Convenience Center bracket	201-14-C
S125	Front lights harness, behind LH headlights	201-10-A
S126	Front lights harness, behind RH headlights	201-10-A
S150	Front lights harness, behind LH headlights	201-10-A
S201	I/P harness, behind LH side of I/P	201-12-A
S205	I/P harness, behind instrument cluster	201-12-A

A: ALL HEADLIGHTS ARE INOPERATIVE OR INTERMITTENT (WITHOUT T61) (TABLE 1)

Connect: TEST LAMP
At: LIGHT SWITCH CONNECTOR (Connected)
Condition:

- **Light Switch: HEAD**

Connect Between	Correct Result	For Diagnosis of Incorrect Results
A (RED) & Ground	Lamp lights	See 1
J (YEL) & Ground	Lamp lights	See 2

- If both results are correct, go to Test B.

1. Check Fusible Link A and RED (2) wire for an open.
2. Go to Table 2.

A: ALL HEADLIGHTS ARE INOPERATIVE OR INTERMITTENT (WITHOUT T61) (TABLE 2)

Connect: FUSED JUMPER
At: LIGHT SWITCH CONNECTOR (Connected)
Conditions:

- **Put a 15 amp fuse in the fused jumper**
- **Dimmer Switch: LO**

Connect Between	Correct Result	For Diagnosis of Incorrect Results
A (RED) & J (YEL)	Headlights light	See 1
• Dimmer Switch: HI		
A (RED) & J (YEL)	Hi Beams light	See 1

(Continued on next page)

(Continued from previous page)

- If results are correct, replace Light Switch.

1. Check for an open or short to ground in wiring to Headlights.

A: ALL HEADLIGHTS ARE INOPERATIVE OR INTERMITTENT (WITH T61) (TABLE 1)

Connect: TEST LAMP
At: LIGHT SWITCH CONNECTOR (Connected)
Condition:
- **Light Switch: HEAD**

Connect Between	Correct Result	For Diagnosis of Incorrect Results
C1/F (RED) & Ground	Lamp lights	See 1
C1/B (YEL) & Ground	Lamp lights	See 2

- If both results are correct, go to Test B.

1. Check Fusible Link A and RED (2) wire for an open.
2. Go to Table 2.

A: ALL HEADLIGHTS ARE INOPERATIVE OR INTERMITTENT (WITH T61) (TABLE 2)

Connect: FUSED JUMPER
At: LIGHT SWITCH CONNECTOR (Connected)
Conditions:
- **Put a 15 amp fuse in the fused jumper**
- **Dimmer Switch: LO**

(Continued in next column)

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Connect Between	Correct Result	For Diagnosis of Incorrect Results
C1/F (RED) & C1/B (YEL)	Headlights light	See 1
• Dimmer Switch: HI		
C1/F (RED) & C1/B (YEL)	Hi Beams light	See 1

- If results are correct, replace Light Switch.

1. Check for short to ground in wiring to Headlights.

B: LO BEAMS ON BOTH SIDES ARE INOPERATIVE OR HI BEAMS AND HI BEAM INDICATOR ARE INOPERATIVE

Connect: TEST LAMP
At: DIMMER SWITCH CONNECTOR (Connected)
Conditions:
- **Light Switch: HEAD**
- **Dimmer Switch: LO**

Connect Between	Correct Result	For Diagnosis of Incorrect Results
D (YEL) & Ground	Lamp lights	See 1
A (TAN) & Ground	Lamp lights	See 2
• Dimmer Switch: HI		
C (LT GRN) & Ground	Lamp lights	See 2

(Continued in next column)

(Continued from previous column)

- If all results are correct, check wiring to lights for opens.

1. Check YEL (10) wire for an open.
2. Replace Dimmer Switch.

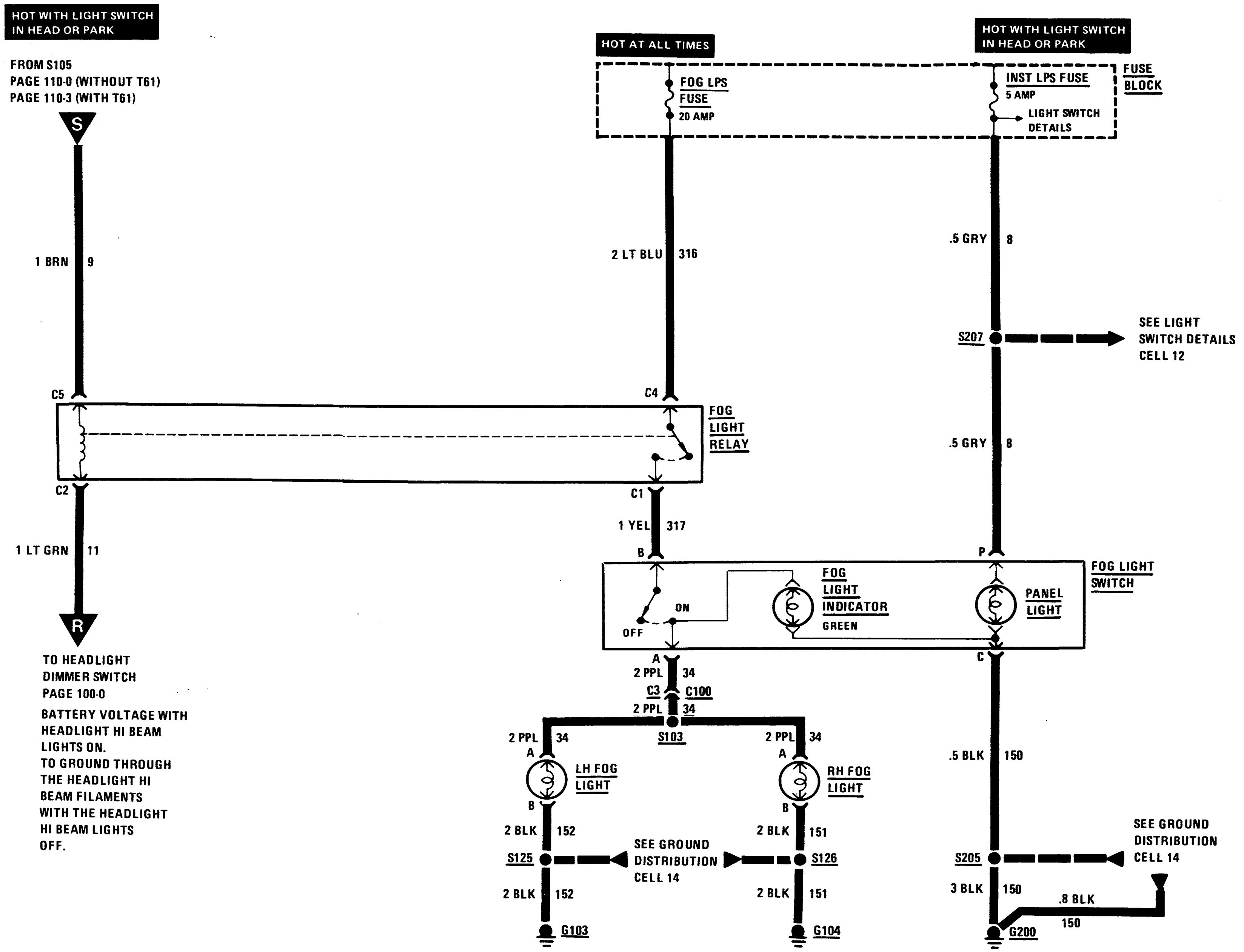
C: HEADLIGHTS DO NOT TURN OFF

1. If the vehicle is equipped with the T61 option, disconnect the Daytime Running Lights (DRL) Module C1 connector.
   - If the headlights go off see section 8A-104 for diagnosis.
   - If the headlights remain on, leave the DRL module disconnected and go to step 2.
2. Disconnect the Light Switch connector (without T61) or the C1 Light Switch connector (with T61).
   - If the headlights go off, check that the wires are inserted into the proper connector cavities. If the connector is wired correctly, replace the Light Switch.
   - If the headlights do not go off, check for a short to battery.

CIRCUIT OPERATION

Voltage is applied to the Light Switch at all times. The Light Switch includes a self-resetting circuit breaker. The circuit breaker opens when the Headlight circuit draws too much current. When the circuit breaker opens, it interrupts the current flow. With no current flow, the circuit breaker cools off and resets automatically. When the Light Switch is in HEAD, the Dimmer Switch directs voltage to either the Lo Beams or the Hi Beams. The Hi Beam Indicator also receives voltage along with the Hi Beams.

FOG LIGHTS: T96



FOG LIGHTS: T96

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Check.**

1. If one Fog Light doesn't work, check the connections, Fog Light, and wiring to the Fog Light (see schematic).
2. If Fog Light Indicator does not light but Fog Lights work, replace Fog Light Switch.
3. If Fog Lights turn on when Park Lights are off and don't go off when Hi Beams are on, replace Fog Light Relay.

- **Go to System Check for a guide to normal operation.**
- **Go to System Diagnosis for diagnostic test.**

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation.**
- **Refer to System Diagnosis for a list of symptoms and diagnostic steps.**

SYSTEM CHECK TABLE

ACTION	NORMAL RESULT
With Light Switch OFF, turn Fog Light Switch ON	Fog Lights do not light
Turn Light Switch to PARK	Fog Lights and Fog Light Indicator light
Turn Light Switch to HEAD and Dimmer Switch to HI	Fog Lights go off

- **Refer to System Diagnosis when a result is not normal.**

COMPONENT LOCATION

		Page-Figure
Fog Light Relay	Behind LH side of I/P, near Fuse Block	201-13-A
Fuse Block	Behind LH side of I/P	201-13-A
C100 (42 cavities)	LH front of dash, below relay bracket	201-12-A
G103	Behind LH headlights	201-10-A
G104	Behind RH headlights	201-10-A
G200	Behind LH side of I/P, on Convenience Center bracket	201-14-C
S103	Front lights harness, behind LH headlights	201-11-E
S125	Front lights harness, behind LH headlights	201-10-A
S126	Front lights harness, behind RH headlights	201-10-A
S205	I/P harness, behind instrument cluster	201-12-A
S207	I/P harness, above Fuse Block	201-12-A

SYSTEM DIAGNOSIS

- **Diagnostic steps for the symptoms listed in the following table are listed after the table.**

SYMPTOM TABLE

A. Fog Lights and Fog Light Indicator are inoperative (Headlights and Park Lights work properly)

B. Fog Lights are inoperative; Fog Light Indicator works

FOG LIGHTS: T96

A: FOG LIGHTS AND FOG LIGHT INDICATOR ARE INOPERATIVE (TABLE 1)

Connect: TEST LAMP
At: FOG LIGHT RELAY CONNECTOR (Disconnected)
Condition:
- **Light Switch: PARK**

Connect Between	Correct Result	For Diagnosis
C5 (BRN) & Ground	Lamp lights	See 1
C4 (LT BLU) & Ground	Lamp lights	See 2
C4 (LT BLU) & C2 (LT GRN)	Lamp lights	See 3

- If all results are correct, go to Table 2.

1. Check BRN (9) wire for an open.
2. Check FOG LPS Fuse and the LT BLU (316) wire for an open.
3. Check LT BRN (11) wire for an open.

A: FOG LIGHTS AND FOG LIGHT INDICATOR ARE INOPERATIVE (TABLE 2)

Connect: FUSED JUMPER
At: FOG LIGHT RELAY CONNECTOR (Disconnected)
Condition:
- **Fog Light Switch: ON**

Connect Between	Correct Result	For Diagnosis
C4 (LT BLU) & C1 (YEL)	Fog Lights light	See 1

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- If Fog Lights light, replace Fog Light Relay.

1. Check Fog Light Switch and YEL (317) wire for an open (see schematic).

B: FOG LIGHTS ARE INOPERATIVE, FOG LIGHT INDICATOR WORKS

Connect: TEST LAMP
At: FOG LIGHT SWITCH CONNECTOR (Connected)
Conditions:
- **Light Switch: PARK**
- **Fog Light Switch: ON**

Connect Between	Correct Result	For Diagnosis
A (PPL) & Ground	Lamp lights	See 1

- If test lamp lights, check PPL (34) wire for an open.

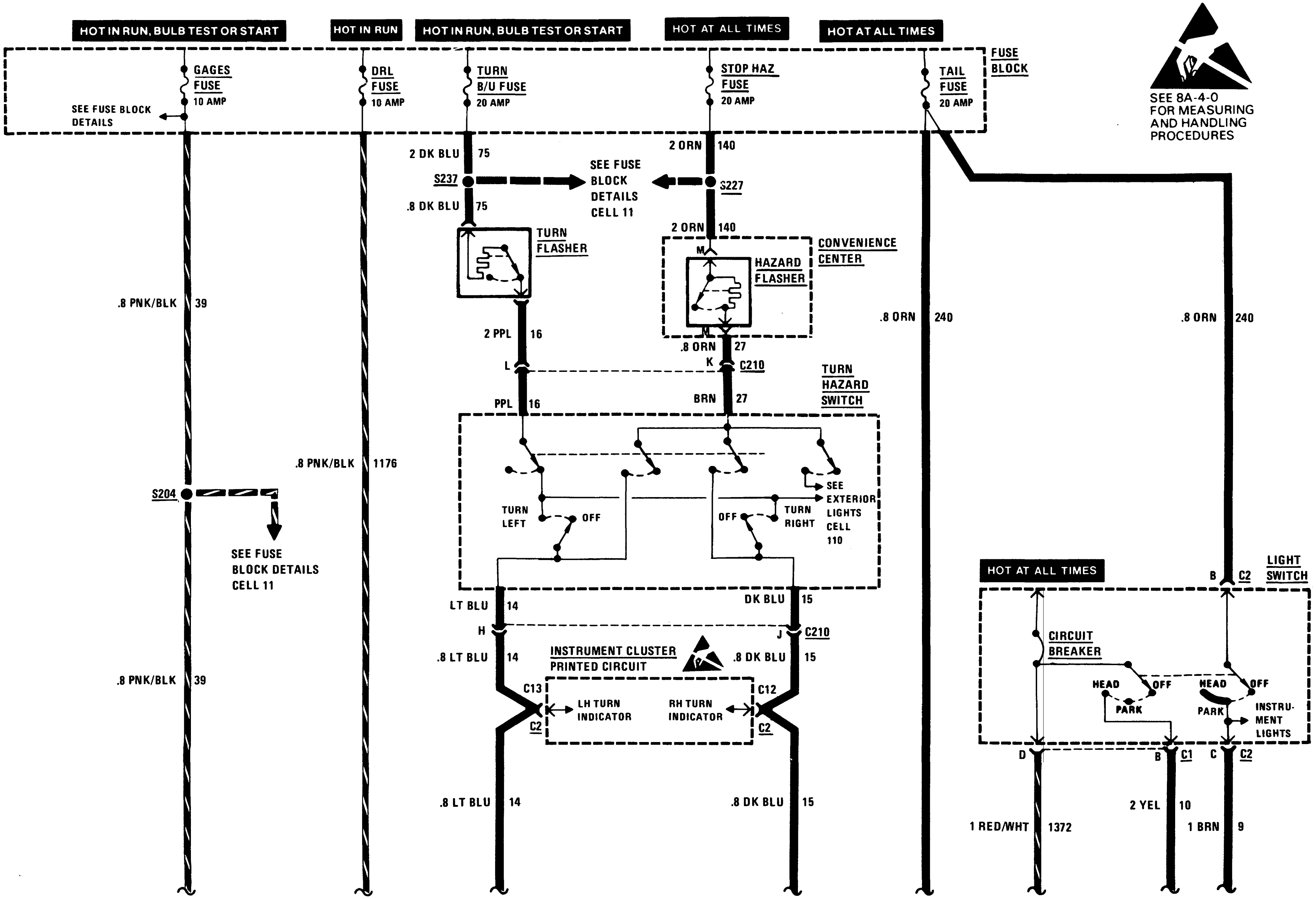
1. Replace Fog Light Switch.

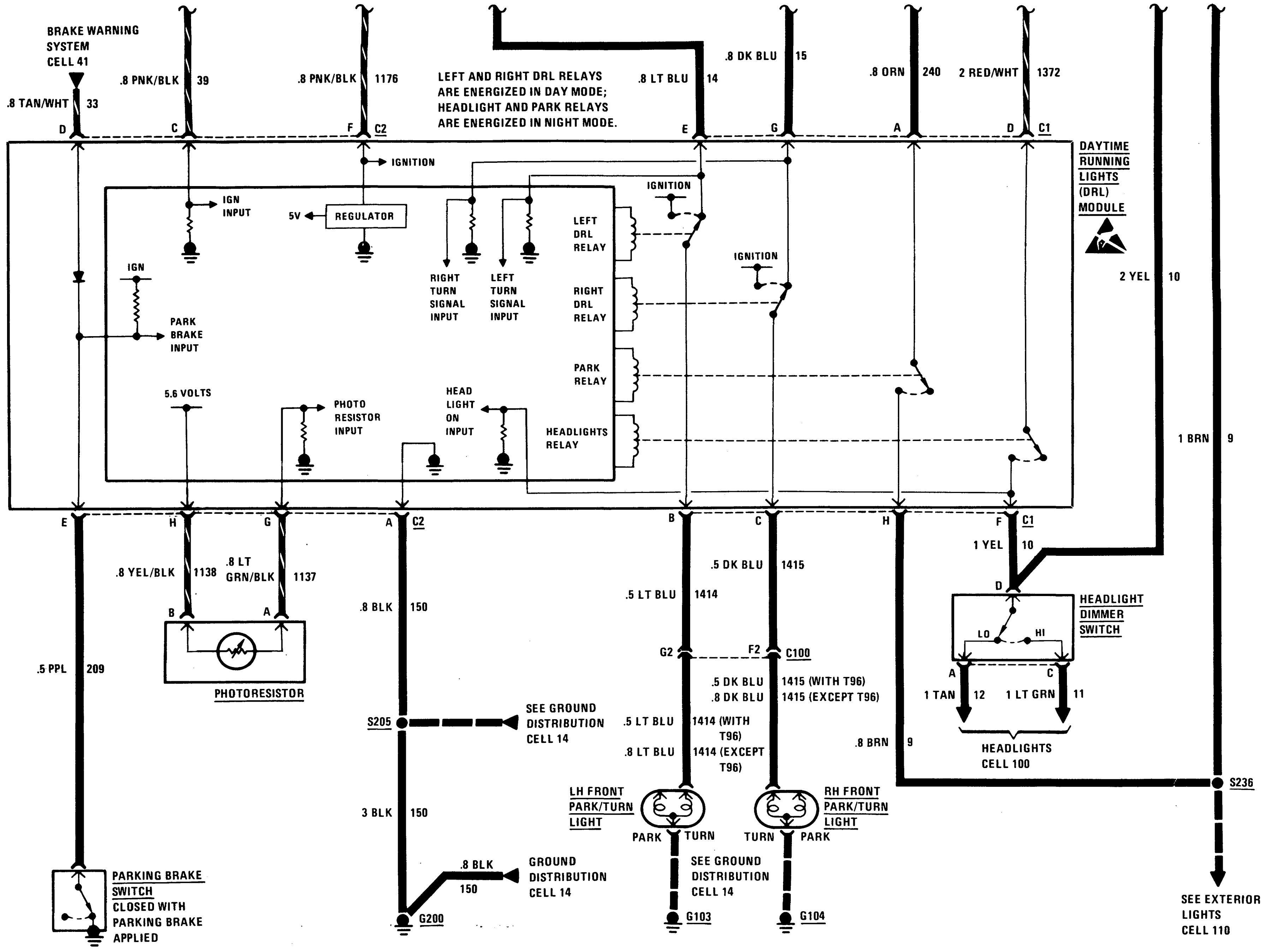
CIRCUIT OPERATION

Voltage is applied to terminal C4 of the Fog Light Relay at all times. With the Light Switch in PARK or HEAD, voltage is applied to terminal C5 of the relay. If the Hi Beam Headlights are not on, the relay coil is grounded through the Hi Beam Headlights. The relay energizes and applies voltage to the Fog Light Switch. With the Fog Light Switch ON, voltage is applied to the Fog Lights and Fog Light Indicator. With the Hi Beams on, battery voltage is applied to both sides of relay coil. The relay de-energizes and turns off the Fog Lights.

BLANK

DAYTIME RUNNING LIGHTS (DRL): T61




BRAKE WARNING SYSTEM CELL 41
.8 TAN/WHT 33
.8 PNK/BLK 39
.8 PNK/BLK 1176
LEFT AND RIGHT DRL RELAYS ARE ENERGIZED IN DAY MODE; HEADLIGHT AND PARK RELAYS ARE ENERGIZED IN NIGHT MODE.
.8 LT BLU 14
.8 DK BLU 15
.8 ORN 240
2 RED/WHT 1372
D
C
F C2
E
G
A
D C1
IGNITION
IGN INPUT
5V
REGULATOR
IGNITION
LEFT DRL RELAY
IGNITION
RIGHT TURN SIGNAL INPUT
LEFT TURN SIGNAL INPUT
RIGHT DRL RELAY
IGN
PARK BRAKE INPUT
PARK RELAY
5.6 VOLTS
PHOTO RESISTOR INPUT
HEAD LIGHT ON INPUT
HEADLIGHTS RELAY
DAYTIME RUNNING LIGHTS (DRL) MODULE
2 YEL 10
1 BRN 9
E
H
G
A C2
B
C
H
F C1
.8 YEL/BLK 1138
.8 LT GRN/BLK 1137
.8 BLK 150
.5 DK BLU 1415
.5 LT BLU 1414
1 YEL 10
B
A
PHOTORESISTOR
D
HEADLIGHT DIMMER SWITCH
LO
HI
.5 PPL 209
G2
F2 C100
.5 DK BLU 1415 (WITH T96)
.8 DK BLU 1415 (EXCEPT T96)
A
C
1 TAN 12
1 LT GRN 11
S205
SEE GROUND DISTRIBUTION CELL 14
.5 LT BLU 1414 (WITH T96)
.8 LT BLU 1414 (EXCEPT T96)
.8 BRN 9
HEADLIGHTS CELL 100
S236
LH FRONT PARK/TURN LIGHT
RH FRONT PARK/TURN LIGHT
PARK
TURN
TURN
PARK
3 BLK 150
.8 BLK 150
GROUND DISTRIBUTION CELL 14
SEE GROUND DISTRIBUTION CELL 14
PARKING BRAKE SWITCH CLOSED WITH PARKING BRAKE APPLIED
G200
G103
G104
SEE EXTERIOR LIGHTS CELL 110

DAYTIME RUNNING LIGHTS (DRL): T61

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Check.**

1. Check the TAIL Fuse by turning on the Park Lights with the Light Switch.
2. Check the GAGES Fuse by operating the Rear Defogger and observing the Indicator.
3. Check the DRL Fuse by visual inspection.
4. Check the TURN B/U Fuse by observing if the Back Up Lights work.
5. If the BRAKE Indicator is lit with the Ignition Switch in RUN and the Park Brake released, see Brake Warning System (Section 8A-41) for diagnosis.
6. If the Night Mode of the Daytime Running Lights (DRL) Module is activated in bright light, check that the Photoresistor is not obstructed (by dirt or lint, for example).

- **Go to System Check for a guide to normal operation.**
- **Go to System Diagnosis for diagnostic tests.**

SYSTEM CHECK

Note 1: The following tests assume that the Headlights and Exterior Lights operate using the Light Switch.

Note 2: Indoor lighting may not be sufficient to activate the Day Mode. When checking Day Mode operation, always shine a trouble light on the Photoresistor. Do not use a fluorescent light.

COMPONENT LOCATION

		Page-Figure
Convenience Center	Behind I/P, to right of steering column	201-12-A
Daytime Running Lights (DRL) Module	Behind LH side of I/P	201-12-A
Fuse Block	Behind LH side of I/P	201-13-A
Headlight Dimmer Switch	At base of steering column	201-14-A
Parking Brake Switch	In console, at base of parking brake lever	201-17-D
Photoresistor	RH side of I/P	201-15-A
Turn Flasher	Behind LH side of I/P, clipped to Fuse Block bracket	201-13-A
Turn-Hazard Switch	Top of steering column	
C100 (42 cavities)	LH front of dash, below relay bracket	201-12-A
C210 (11 cavities)	Behind I/P, lower RH side of steering column	201-14-A
G103	Behind LH headlights	201-10-A
G104	Behind RH headlights	201-10-A
G200	Behind LH side of I/P, on Convenience Center bracket	201-14-C
S204	I/P harness, behind LH side of instrument cluster	201-13-A
S205	I/P harness, behind instrument cluster	201-12-A
S227	I/P harness, near RH side of Convenience Center	201-12-A
S236	I/P harness, behind LH side of I/P	201-12-A
S237	I/P harness, behind LH side of I/P, near Fuse Block	201-13-A

SYSTEM CHECK TABLE

ACTION	NORMAL RESULT
With the Ignition Switch in RUN and the Park Brake released, cover the Photoresistor and wait 20 seconds	Headlights, Marker, Park and Tail Lights light
Crank the engine	Headlights go off while cranking. Marker, Park and Tail Lights stay lit while cranking.
Uncover the Photoresistor and expose it to bright light with a trouble light. Wait approximately 45 seconds.	Marker, Park, Tail Lights and Headlights turn off. LH and RH Front Turn Lights are on (steady - not flashing).
Apply the Park Brake	No change
Turn the Ignition Switch to OFF	Turn Lights go off

With the Ignition Switch in the OFF position apply the Parking Brake. Turn the Ignition Switch to RUN.	Headlights and all Exterior Lights stay off
Release the Park Brake (continue to expose the Photoresistor to light)	LH and RH Front Turn Lights come on (steady - not flashing)
Move the Turn Signal Switch to the left turn and right turn positions (continue to expose the Photoresistor to light)	LH and RH Turn Lights flash normally. Opposite Turn Light stays on steady
Turn on the Headlights using the Light Switch	Headlights, Marker, Park and Tail Lights light. LH and RH Turn Lights go off.

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- **Refer to System Diagnosis when a result is not normal.**

SYSTEM DIAGNOSIS

If the Daytime Running Lights System or the Turn Signals do not operate properly, perform the Daytime Running Lights Module Test.

NOTE: The following tests assume that Headlights and Exterior Lights operate using the Light Switch.

DAYTIME RUNNING LIGHTS (DRL) MODULE TEST (TABLE 1)

Measure: VOLTAGE
At: DAYTIME RUNNING LIGHTS (DRL) MODULE CONNECTORS C1 AND C2 (Disconnected)
Conditions:

- **Ignition Switch: RUN**
- **Light Switch: OFF**
- **Park Brake: RELEASED**

Measure Between	Correct Measurement	For Diagnosis
C2/C (PNK/BLK) & Ground	Battery	Check/repair PNK/BLK (39) wire for an open or short to ground
C2/F (PNK/BLK) & Ground	Battery	Check/repair PNK/BLK (1176) wire for an open or short to ground
C2/D (TAN/WHT) & Ground	Battery	See Brake Warning System, Section 8A-41
C2/F (PNK/BLK) & C2/A (BLK)	Battery	Check/repair BLK (150) wire for an open
C2/F (PNK/BLK) & C2/E (PPL)	0 Volts	See Brake Warning System, Section 8A-41
C1/A (ORN) & Ground	Battery	Check/repair ORN (240) wire for an open
C1/D (RED/WHT) & Ground	Battery	Check/repair RED/WHT (1372) wire and the Light Switch for an open or short to ground
• Park Brake: APPLIED		
C2/F (PNK/BLK) & C2/E (PPL)	Battery	See Brake Warning System, Section 8A-41
• Light Switch: HEAD		

C1/H (BRN) & Ground	Battery	Check/repair BRN (9) wire for an open between splice (see schematic) and the Daytime Running Lights (DRL) Module
C1/F (YEL) & Ground	Battery	Check/repair YEL (10) wire for an open
• Turn Hazard Switch: LEFT		
C1/E (LT BLU) & Ground	Battery	Check/repair LT BLU (14) wire and Turn Hazard Switch for an open or short to ground
• Turn Hazard Switch: RIGHT		
C1/G (DK BLU) & Ground	Battery	Check/repair DK BLU (15) wire and Turn Hazard Switch for an open or short to ground
• Measure resistance while exposing the Photoresistor to bright light with a trouble light then covering it with cardboard		
C2/G (LT GRN/BLK) & C2/H (YEL/BLK)	Varies from 1K Ohm (Bright Light) To 100K Ohms (Covered)	Reconnect Daytime Running Lights (DRL) Module and go to Table 2

- **If all measurements are correct go to Table 3.**

DAYTIME RUNNING LIGHTS (DRL) MODULE TEST (TABLE 2)

Measure: VOLTAGE
At: PHOTORESISTOR CONNECTOR (Disconnected)
Condition:
- **Ignition Switch: RUN**

Measure Between	Correct Voltage	For Diagnosis
B (YEL/BLK) & Ground	5.6 Volts	See 1
B (YEL/BLK) & A (LT GRN/BLK)	5.6 Volts	See 2

- If all voltages are correct, replace the Photoresistor.

1. Check/repair YEL/BLK (1138) wire for an open or short to ground. If OK, replace DRL Module.
2. Check/repair LT GRN/BLK (1137) wire for an open. If OK, replace DRL Module.

DAYTIME RUNNING LIGHTS MODULE TEST (TABLE 3)

Connect: FUSED JUMPER
At: DAYTIME RUNNING LIGHTS MODULE CONNECTOR C1
Conditions:
- **Ignition Switch: RUN**
- **Turn Hazard Switch: LEFT**

Connect Between	Correct Result	For Diagnosis
C1/E (LT BLU) & C1/B (LT BLU)	LH Front Turn Light flashes	See 1
• Turn Hazard Switch: RIGHT		
C1/G (DK BLU) & C1/C (DK BLU)	RH Front Turn Light flashes	See 2

- If all results are correct, replace the Daytime Running Lights Module.

1. Check LH Front Turn bulb; if OK, repair LT BLU (1414) wire.
2. Check RH Front Turn bulb; if OK, repair DK BLU (1415) wire.

CIRCUIT OPERATION

The Daytime Running Lights (DRL) Module is designed to automatically turn on certain lights depending on outside light conditions. The DRL Module operates in two modes, the day mode and the night mode. In the day mode the Front Turn Lights are lit. In the night mode the Headlights, and Front Marker and Tail Lights are turned on.

When the DRL Module is in the Day Mode the Left and Right DRL Relay are energized, allowing voltage to be applied to the LH and RH Front Turn Lights through the DRL Relay's contacts. If the driver operates the Turn Signal Switch to signal a turn, the DRL Module will sense battery voltage being applied at either the right or left turn signal input. The DRL Module will then de-energize the appropiate DRL Relay, allowing the turn signal to flash.

When the Photoresistor senses darkness the DRL Module's Headlights Relay and Park Relay are energized, allowing voltage to be applied to the Headlights and Exterior Lights. If the engine should stall when the DRL Module is in the night mode, the DRL Module will turn off the Headlights and leave the Marker, Park and Tail Lights on while the engine is being cranked.

PHOTORESISTOR

The Photoresistor is a light sensitive variable resistor. Its resistance decreases as outside light intensity increases. The DRL Module measures the voltage drop across the Photoresistor and determines whether the DRL Module should operate in the day mode or the night modes.

PARK BRAKE INPUT

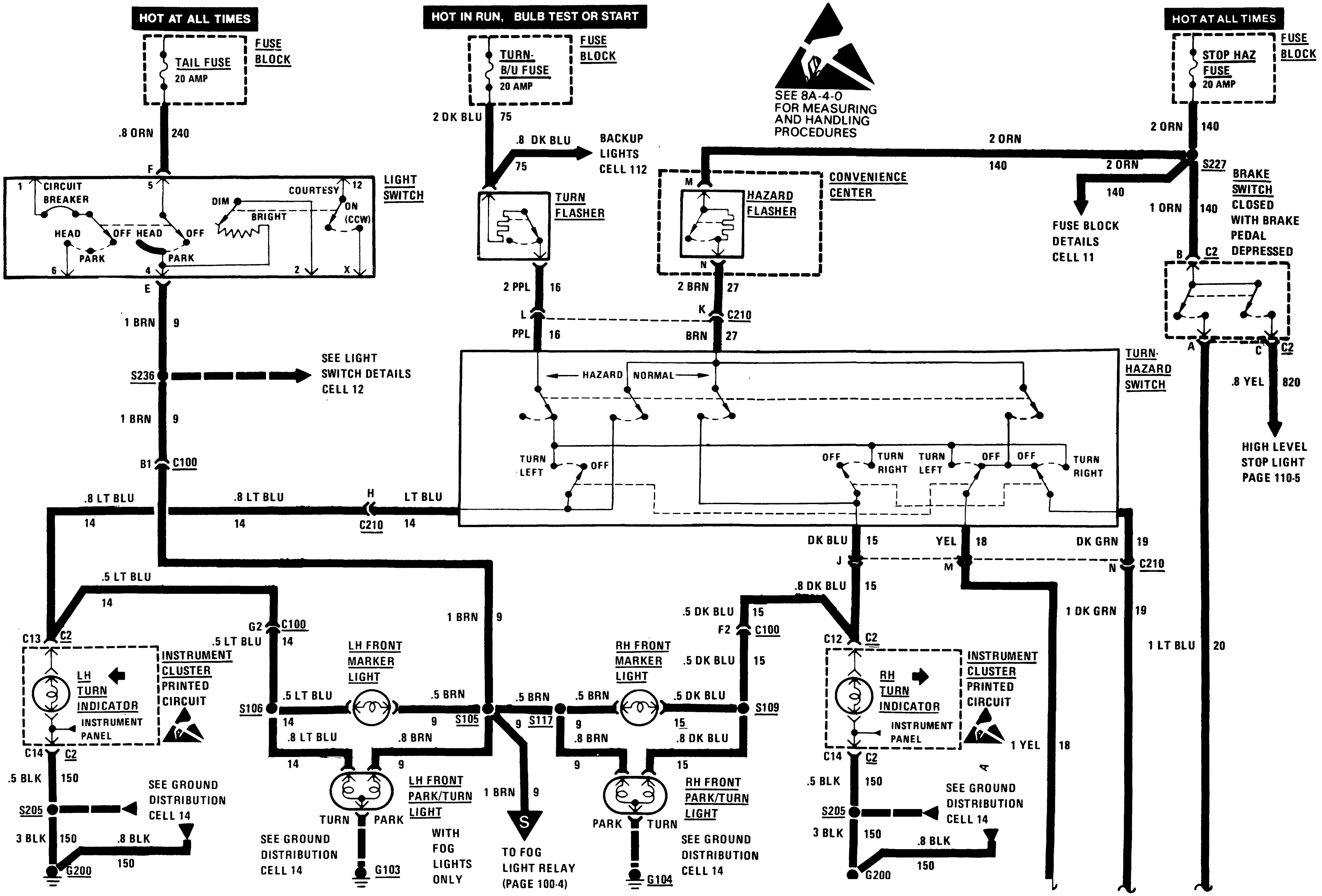
If the Park Brake is applied before the Ignition Switch is turned to RUN, the DRL Module will not turn on any lights. This allows the operator to start the car and keep all lights off as long as the Park Brake remains applied. Once the lights come on they will stay on. To turn them off, the Ignition must be turned off to reset the feature. This feature is intended for use during service or while parked at a drive-in theater, etc. If the Light Switch is in the PARK or HEAD position, the park brake will have no effect on the Headlights and Exterior Lights operation.

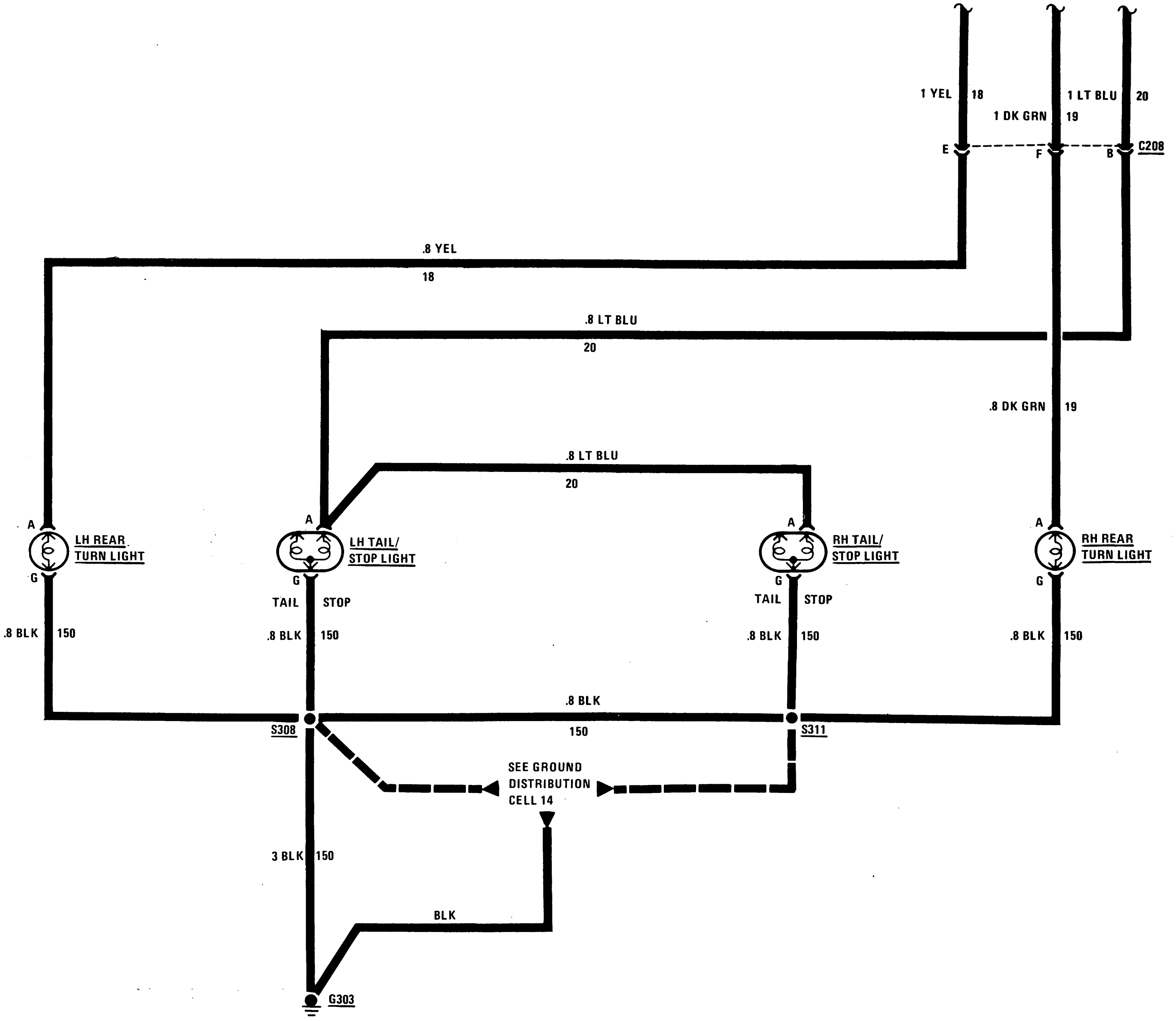
HEADLIGHTS ON INPUT

When the Headlights are turned on using the Light Switch the DRL Module will sense battery voltage being applied at the Headlights on input (terminal F) and the DRL system will be overridden. If the DRL Module is in the day mode the LH and RH Front Turn Lights will be turned off by the DRL Module.

EXTERIOR LIGHTS: TURN/STOP/HAZARD/FRONT PARK/FRONT MARKER

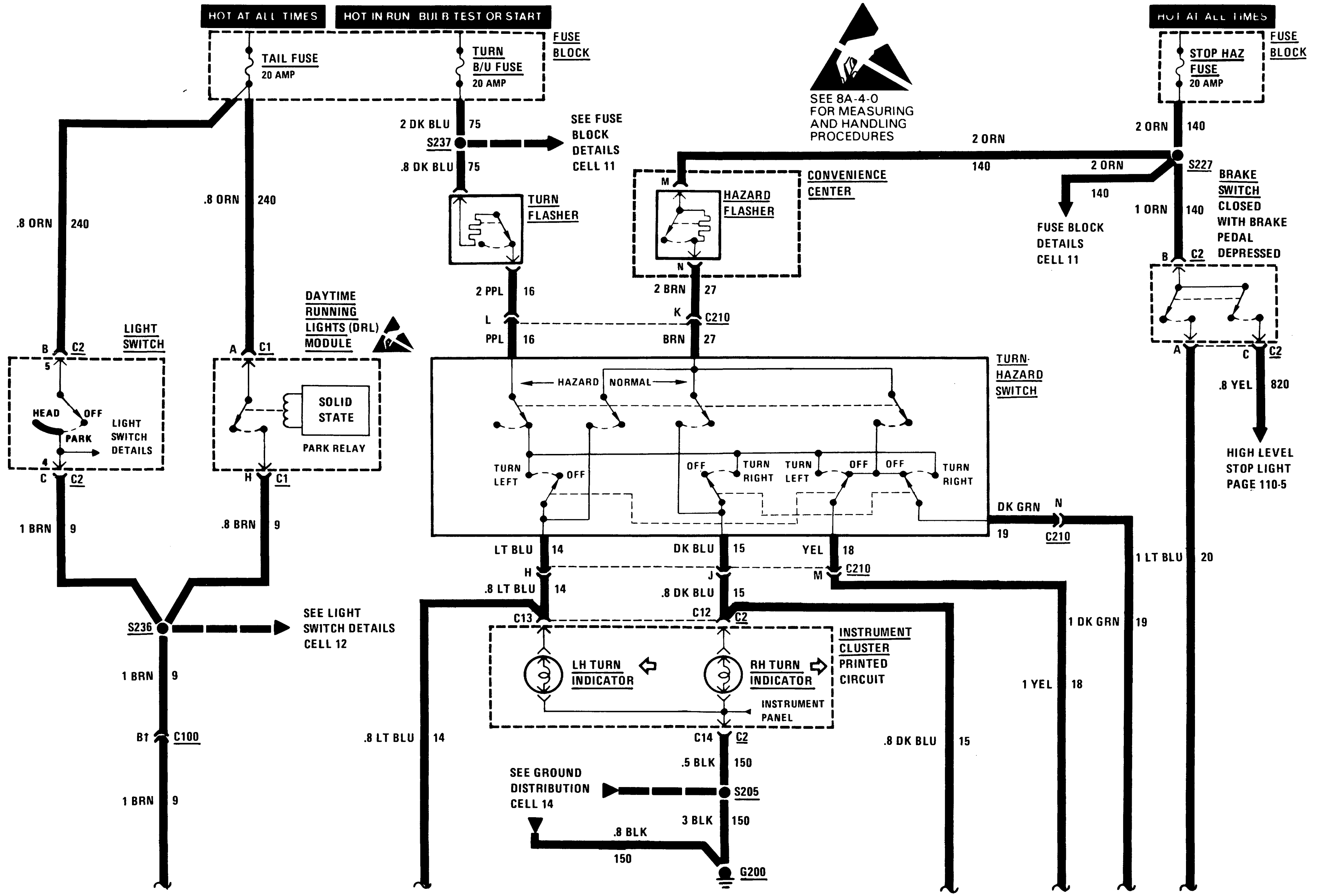
WITHOUT T61

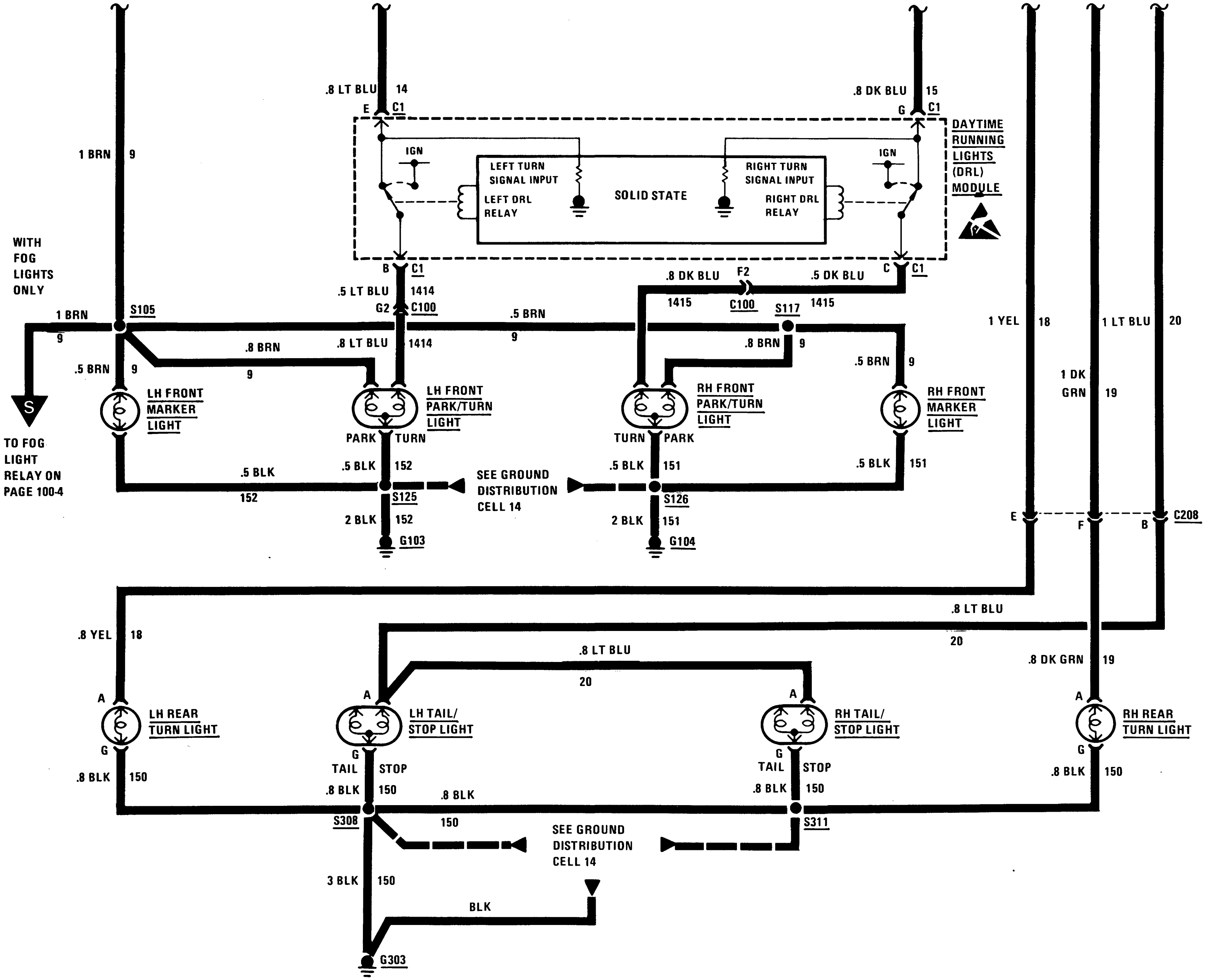



1 YEL
18
1 DK GRN
19
1 LT BLU
20
E
F
B
C208
.8 YEL
18
.8 LT BLU
20
.8 DK GRN
19
.8 LT BLU
20
A
LH REAR
TURN LIGHT
G
A
LH TAIL/
STOP LIGHT
G
TAIL
STOP
A
RH TAIL/
STOP LIGHT
G
TAIL
STOP
A
RH REAR
TURN LIGHT
G
.8 BLK
150
.8 BLK
150
.8 BLK
150
.8 BLK
150
.8 BLK
150
S308
S311
SEE GROUND
DISTRIBUTION
CELL 14
3 BLK
150
BLK
G303

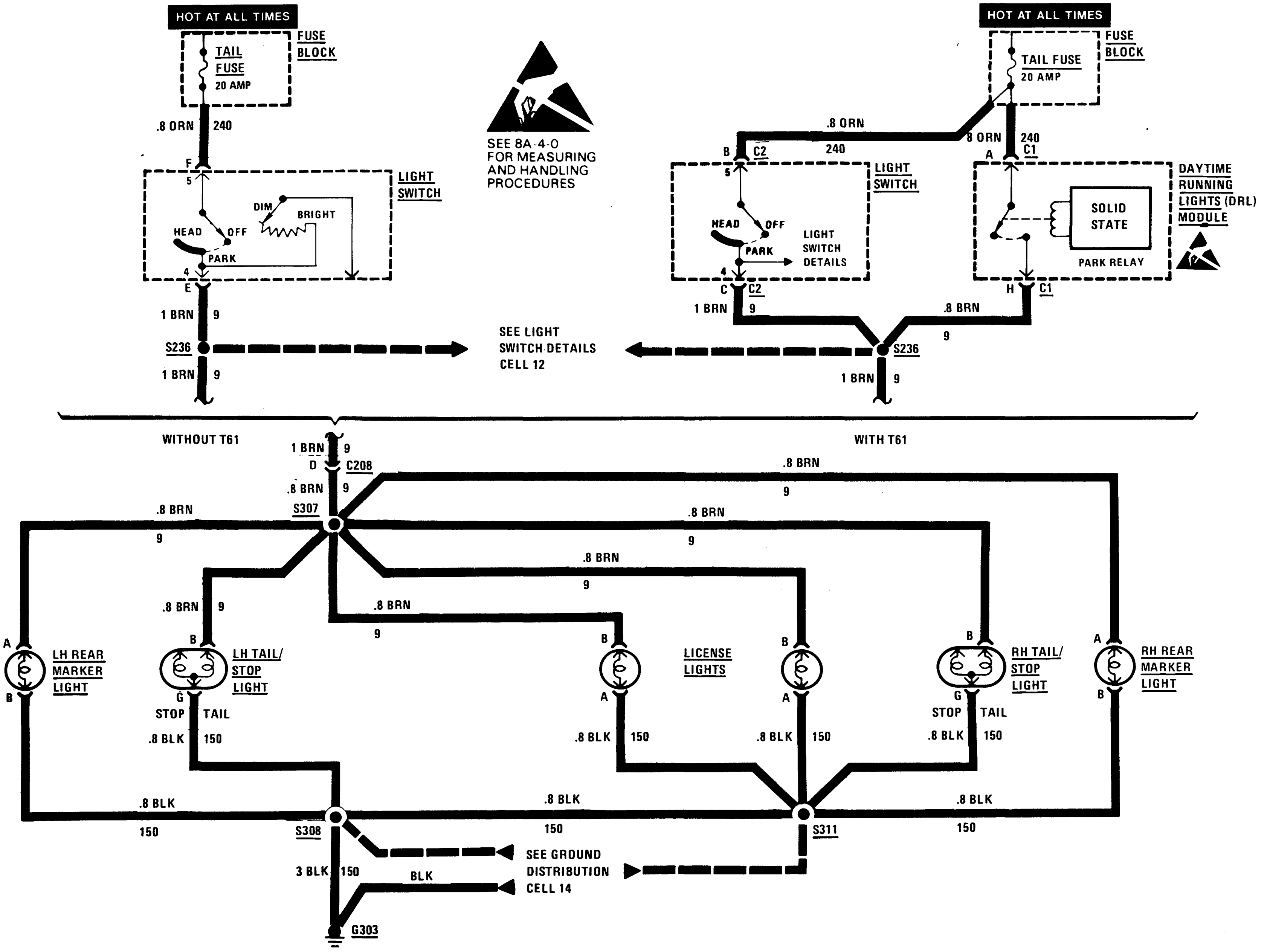
EXTERIOR LIGHTS: TURN/STOP/HAZARD/FRONT PARK/FRONT MARKER

WITH T61

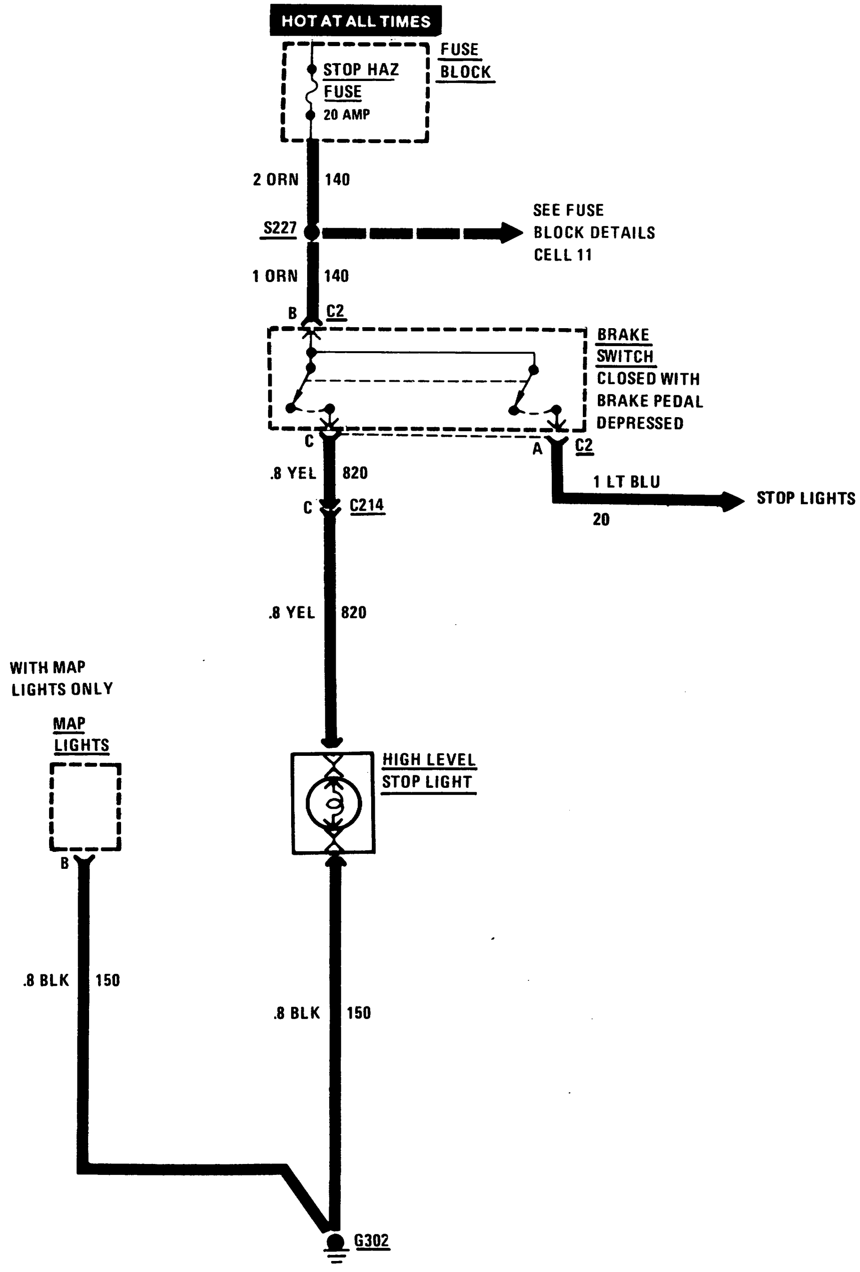



.8 LT BLU 14
E C1
.8 DK BLU 15
G C1
DAYTIME RUNNING LIGHTS (DRL) MODULE
IGN
LEFT TURN SIGNAL INPUT
LEFT DRL RELAY
SOLID STATE
RIGHT TURN SIGNAL INPUT
RIGHT DRL RELAY
IGN
1 BRN 9
B C1
C C1
.5 LT BLU 1414
G2 C100
.8 DK BLU 1415
F2 C100
.5 DK BLU 1415
WITH FOG LIGHTS ONLY
1 BRN 9
S105
.5 BRN 9
S117
.8 BRN 9
.8 LT BLU 1414
.8 BRN 9
.5 BRN 9
.5 BRN 9
S
TO FOG LIGHT RELAY ON PAGE 100-4
LH FRONT MARKER LIGHT
LH FRONT PARK/TURN LIGHT
PARK TURN
RH FRONT PARK/TURN LIGHT
TURN PARK
RH FRONT MARKER LIGHT
.5 BLK 152
.5 BLK 152
S125
SEE GROUND DISTRIBUTION CELL 14
.5 BLK 151
S126
.5 BLK 151
2 BLK 152
G103
2 BLK 151
G104
1 YEL 18
1 LT BLU 20
1 DK GRN 19
E F B C208
.8 YEL 18
.8 LT BLU 20
.8 LT BLU 20
.8 DK GRN 19
A
LH REAR TURN LIGHT
G
A
LH TAIL/ STOP LIGHT
G
TAIL STOP
A
RH TAIL/ STOP LIGHT
G
TAIL STOP
A
RH REAR TURN LIGHT
G
.8 BLK 150
.8 BLK 150
.8 BLK 150
.8 BLK 150
.8 BLK 150
S308
S311
SEE GROUND DISTRIBUTION CELL 14
3 BLK 150
BLK
G303

EXTERIOR LIGHTS: TAIL/REAR MARKER/LICENSE



EXTERIOR LIGHTS: HIGH LEVEL STOP LIGHT



EXTERIOR LIGHTS

TROUBLESHOOTING HINTS

Note: This section does not address conditions with the operation of the Daytime Running Lights. If the exterior lights work with the Light Switch, but do not operate automatically, see section 8A-104.

- **Try the following checks before doing the System Diagnosis.**

TURN LIGHTS

1. Check the Turn Flasher and PPL (16) wire for an open.
2. If only some of the Turn Lights work but all Hazard Lights work, replace the Turn-Hazard Switch.
3. If the Left Turn or Right Turn lights flash slowly or turn on other lights, check the ground wires and check that G103, G104 and G303 are clean and tight.
4. If the Turn Lights stay on (do not flash) in both LEFT TURN and RIGHT TURN, replace the Turn Flasher.
5. If only one light does not light, check bulb, socket and related wiring (see schematic).
6. If the Front Turn Lights on vehicles equipped with Daytime Running Lights (T61), do not operate in the daytime (Light Switch in OFF) but operate correctly at night (Light Switch in HEAD), see section 8A-104.

STOP LIGHTS

1. Check the STOP HAZ Fuse by operating Hazard Lights.
2. If no Stop Lights work, check the Brake Switch and ORN (140) wire for continuity (see schematic).

(Continued on next page)

COMPONENT LOCATION

		Page-Figure
Brake Switch	Behind LH side of I/P, top of brake pedal support	201-13-C
Convenience Center	Behind I/P, to right of steering column	201-12-A
Daytime Running Lights (DRL) Module	Behind LH side of I/P	201-12-A
Fuse Block	Behind LH side of I/P	201-13-A
Turn Flasher	Behind LH side of I/P, clipped to Fuse Block bracket	201-13-A
Turn-Hazard Switch	Top of steering column	
C100 (42 cavities)	LH front of dash, below relay bracket	201-12-A
C208 (8 cavities)	Near LH rear quarter panel	201-19-C
C210 (11 cavities)	Behind I/P, lower RH side of steering column	201-14-A
C214 (4 cavities)	LH shroud, near center access hole	201-18-D
G103	Behind LH headlights	201-10-A
G104	Behind RH headlights	201-10-A
G200	Behind LH side of I/P, on Convenience Center bracket	201-14-C
G302	Under headliner, near dome light	201-18-D
G303	Center of rear end panel, in cargo compartment	201-19-A
S105	Front lights harness, behind LH headlights	201-10-A
S106	Front lights harness, base of LH wheelhouse	201-10-A
S109	Front lights harness, behind RH headlights	201-10-A
S117	Front lights harness, behind RH headlights	201-10-A
S125	Front lights harness, behind LH headlights	201-10-A
S126	Front lights harness, behind RH headlights	201-10-A
S205	I/P harness, behind instrument cluster	201-12-A
S227	I/P harness, near RH side of Convenience Center	201-12-A
S236	I/P harness, behind LH side of I/P	201-12-A
S237	I/P harness, behind LH side of I/P, near Fuse Block	201-13-A
S307	Rear lights harness, in LH rear corner of cargo compartment	201-19-C
S308	Rear lights harness, near LH turn signal	201-19-B
S311	Rear lights harness, near RH turn signal	201-19-B

(Continued from previous page)

3. If the Stop Lights do not turn off, adjust/replace the Brake Switch as necessary.
4. If only one light does not light, check bulb, socket and related wiring (see schematic).

HAZARD LIGHTS

1. Check the STOP HAZ Fuse by operating the Stop Lights.
2. If only some Hazard Lights work but all of the Turn Lights work, replace the Turn-Hazard Switch.
3. If Hazard Lights do not turn off, replace the Turn-Hazard Switch.
4. If Hazard Lights stay on (do not flash), replace Hazard Flasher.

PARK/MARKER/TAIL/LICENSE LIGHT

1. If none of the Park, Marker or Tail Lights work, check TAIL Fuse, Light Switch, ORN (240) and BRN (9) wires for continuity (see schematic).
2. If Front Marker and Park Lights do not work, check connection at C100 and related wiring (see schematic).
3. If the Park, Marker and License lights do not turn off, disconnect the Daytime Running Lights (DRL) Module connector C1 (with T61). If the lights turn off replace the DRL Module. If the lights remain on, or without T61, disconnect the Light Switch. If the lights remain on, check for a short to battery in the BRN (9) wire.

- **Go to System Diagnosis for diagnostic tests.**

SYSTEM DIAGNOSIS

- **Do the tests listed for your symptom in the Symptom Table below.**
- **Tests follow the Symptom Table.**

SYMPTOM TABLE

SYMPTOM	FOR DIAGNOSIS
Turn Lights do not work, but Hazard Lights do	Do Test A: Turn Lights Test
Hazard Lights do not operate, but the Stop Lights do	Do Test B: Hazard Lights Test
Stop Lights do not work, but the Turn Signals do	Do Test C: Stop Lights Test
Stop Lights, on one or both sides, do not work	Do Test C: Stop Lights Test

A: TURN LIGHTS TEST

Connect: TEST LAMP
At: CONNECTOR C210 (Connected)
Condition:
- **Ignition Switch: RUN**

Connect Between	Correct Result	For Diagnosis
L (PPL) & Ground	Lamp lights	See 1

- If the test lamp lights, replace the Turn-Hazard Switch.

1. Check the Turn Flasher and PPL (16) wire for an open.

B: HAZARD LIGHTS TEST (TABLE 1)

Connect: FUSED JUMPER
At: HAZARD FLASHER CONNECTOR (Disconnected)
Condition:
- **Hazard Switch: HAZARD**

Jumper Between	Correct Result	For Diagnosis
M ORN (140) & N BRN (27)	All Turn Lights turn on	See 1

- If result is correct, replace Hazard Flasher.

1. Go to Table 2.

B: HAZARD LIGHTS TEST (TABLE 2)

Measure: VOLTAGE
At: Connector C210 (Disconnected)
Condition:
- **Hazard Flasher: Connected**

Measure Between	Correct Voltage	For Diagnosis
K (BRN) & Ground	Battery	See 1

- If voltage is correct, replace the Turn-Hazard Switch.

1. Check ORN (140) and BRN (27) wires for opens.

C: STOP LIGHTS TEST (TABLE 1)

Connect: TEST LAMP
At: CONNECTOR C208 (Disconnected)
Condition:
- **Brake Pedal: DEPRESSED**

Connect Between	Correct Result	For Diagnosis
B (LT BLU) & Ground	Lamp lights	See 1

- If the results are correct, check bulbs, sockets and related wiring for opens.

1. Check the Brake Switch, LT BLU (20) and ORN (140) wires for continuity. Repair/replace as necessary.

C: STOP LIGHTS TEST (TABLE 2)

Connect: TEST LAMP
At: HIGH LEVEL STOP LIGHT CONNECTOR (Connected)
Condition:
- **Brake Pedal: DEPRESSED**

Connect Between	Correct Result	For Diagnosis
(YEL) & (BLK)	Lamp lights	See 1

- If voltage is correct, check bulbs, sockets and related wiring for opens.

1. Check the Brake Switch, YEL (820), ORN (140) and BLK (150) wires for continuity. Repair/replace as necessary.

CIRCUIT OPERATION

TURN LIGHTS

With the Ignition Switch in RUN, BULB TEST or START, voltage is applied through the TURN B/U Fuse and Turn Flasher to the normally closed contact of the Hazard Switch in the Turn-Hazard Switch.

With the Turn-Hazard Switch in the TURN LEFT position, voltage is applied to both the LH Turn Indicator and the LH Front Park/Turn Light (LT BLU wires). Voltage is also applied to the LH Rear Turn Light (YEL wire).

On vehicles with Daytime Running Lights, voltage is applied to connector C1, pin E, of the DRL Module. The module controls the LH Front Turn Light. See section 8A-104 for operation of the DRL Module.

The turn lights go on immediately. They begin to flash when the current flow heats up the timing element in the Turn Flasher and it repeatedly opens and closes the circuit.

The voltage applied to the LH Front Park/Turn Light will also be applied to the LH Front Marker Light (without T61). If the light switch is in the OFF position, the LH Front Marker Light will find a path to ground through S105 and the many lights connected in parallel to ground. These lights provide low resistance paths to ground. The Marker Light will flash with the Turn Lights. The lights used for the ground path will not flash, however, since the voltage drop across the Marker Light is much higher than that across the other lights.

When the Light Switch is in either PARK or HEAD, voltage is applied through the TAIL Fuse, Light Switch, and S105 to the Marker and Park Lights. If the Turn-Hazard Switch is in TURN LEFT, the LH Front Marker Light will have voltage at both connections and will go out. When the Turn Flasher stops voltage to the Turn Light, the Marker Light will be grounded through the Turn Light and will go on. In this way, the LH Front Marker Light will flash on when the LH Front Park/Turn Light goes off, and off when the Turn Light goes on.

With Daytime Running Lights (T61) the Front Marker Lights do not flash with the Turn Lights. Only the Turn Lights will flash with the Turn-Hazard Switch in TURN LEFT.

With the Turn-Hazard switch in TURN RIGHT, voltage is applied to the RH Lights in a similar way.

STOP LIGHTS

Voltage is applied at all times through the STOP HAZ Fuse to the Brake Switch. When the brake pedal is depressed, the contacts in the Brake Switch close. Voltage is applied to the LH and RH Tail/Stop Lights and the High Level Stop Light. The Stop Lights go on.

EXTERIOR LIGHTS

HAZARD LIGHT

Voltage is applied at all times through the STOP HAZ Fuse and the Hazard Flasher to the normally open contact of the hazard switch in the Turn-Hazard Switch. With the hazard switch in HAZARD, voltage is applied to both Front and Rear Turn Lights. All of the Turn Lights and both Turn Indicators flash on and off.

The Front Marker Lights flash in HAZARD just as they did in TURN RIGHT and TURN LEFT (without T61). If the Light Switch is in OFF, they flash on when the Hazard Lights are on. If the Light Switch is in either PARK or HEAD, they flash on when the Hazard Lights are off, and off when the Hazard Lights are on.

With Daytime Running Lights (T61) the Front Marker Lights do not flash with the Turn Lights. Only the Turn Lights will flash with the Turn-Hazard Switch in HAZARD.

In HAZARD, the turn circuit is always open, and the Hazard Flasher controls the lights.

Front Marker Lights (Without T61)

The Front Marker Lights can be lit by the Park Lights or the Turn Lights. Neither of the two wires to each of the marker bulbs is a ground wire.

With the Park Lights on, battery voltage is supplied through the BRN wires to both Marker Lights. The path to ground for the marker bulbs is through the Turn Lights. The small Marker Light bulbs light up, but not the larger turn bulbs.

When the Turn Lights are on, but not the Park Lights, battery voltage is applied through the LT BLU wires to the Marker Lights. They glow since they are grounded through the entire Park Light system. As before, the small marker bulbs light up, but not all the parking bulbs.

If both the Park Lights and a set of Turn lights are on at the same time, the marker bulb for that side will not light up. With battery voltage on both sides of a bulb, it will not glow. When the Turn Lights flash off, however, the marker bulb on that side will come on since it is now grounded through the Turn Lights. This circuit makes the turn and marker bulbs flash out of step with each other when the Park Lights are on.

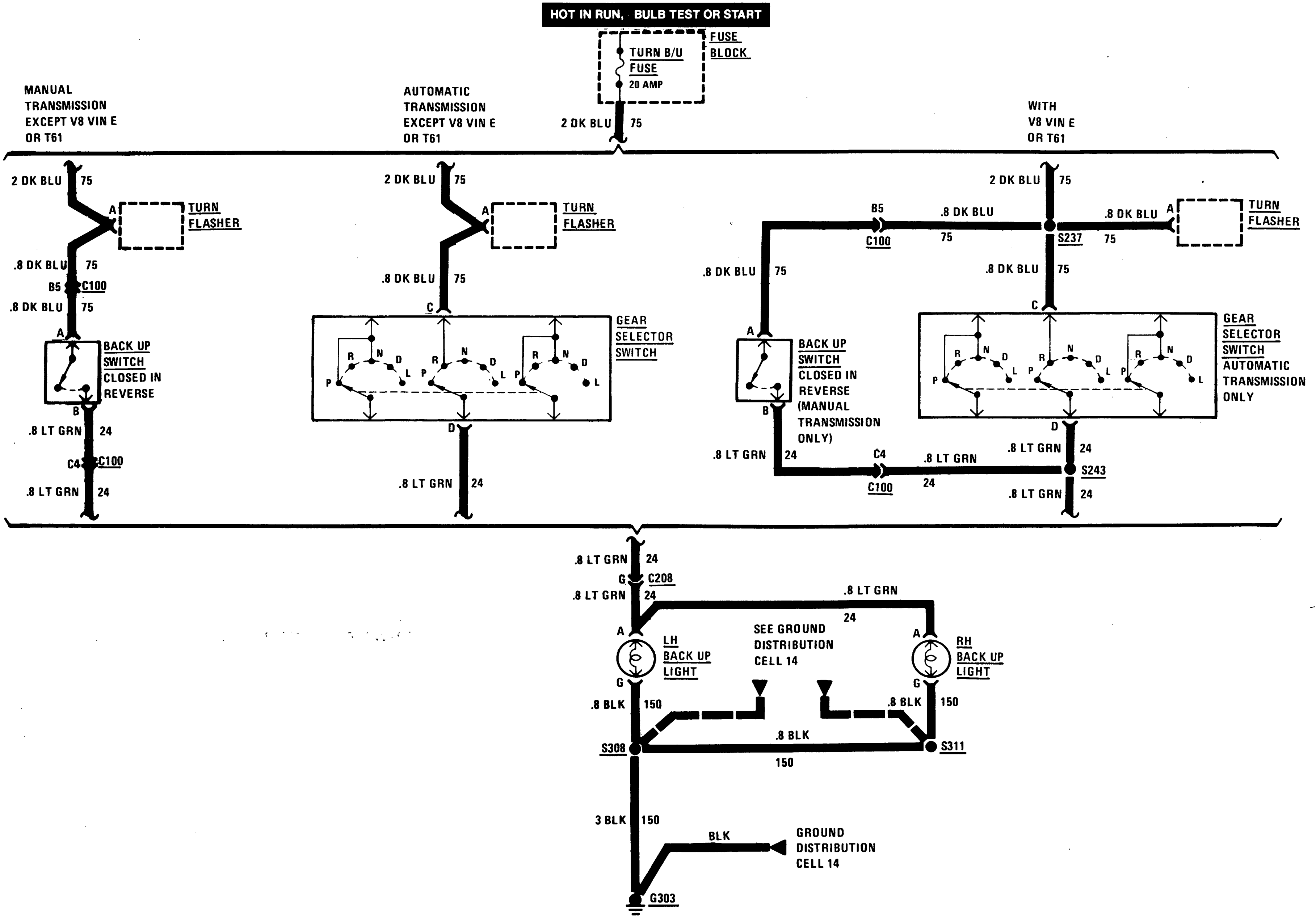
Front Marker Lights (With T61)

The Front Marker Lights can be lit by putting the Light Switch in PARK or HEAD. Voltage is provided through the BRN wires to each Front Marker Light. The ground path for the Marker Lights is to G103 (LH) or G104 (RH). The Marker Lights will not flash when the turn signal is on, they will have a steady glow.

License, Tail, or Rear Marker Lights

Voltage is applied through the TAIL Fuse to the Light Switch at all times. With the Light Switch in PARK or HEAD, voltage is applied through the fuse and the Light Switch to all of the lights in this circuit.

BACK UP LIGHTS



BACK UP LIGHTS

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Check.**

1. Check TURN B/U Fuse by operating Turn Signals.
2. If only one Back Up Light does not operate, check bulb, socket and related wiring.
3. If Back Up Lights go on and off in the wrong gear, adjust Gear Selector Switch (automatic transmission) or Back Up Switch (manual transmission).

- **Go to System Check for a guide to normal operation.**
- **Go to System Diagnosis for diagnostic tests.**

COMPONENT LOCATION

		Page-Figure
Back Up Switch	LH side of transmission	201-12-C
Fuse Block	Behind LH side of I/P	201-13-A
Gear Selector Switch	In console, at gear selector	201-17-F
Turn Flasher	Behind LH side of I/P, clipped to Fuse Block bracket	201-13-A
C100 (42 cavities)	LH front of dash, below relay bracket	201-12-A
C208 (8 cavities)	Near LH rear quarter panel	201-19-C
G303	Center of rear end panel, in cargo compartment	201-19-A
S237	I/P harness, behind LH side of I/P, near Fuse Block	201-13-A
S243	I/P harness, behind LH side of I/P	201-12-A
S308	Rear lights harness, near LH turn signal	201-19-B
S311	Rear lights harness, near RH turn signal	201-19-B

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation.**
- **Refer to System Diagnosis for a list of symptoms and diagnostic steps.**

SYSTEM CHECK TABLE

ACTION	NORMAL RESULT
Put Ignition Switch in RUN and Gear Shift Lever in P (PARK) or N (NEUTRAL)	Back Up Lights are off
Put Gear Shift Lever in R (REVERSE)	Back Up Lights turn on
Put Gear Shift Lever in N (NEUTRAL)	Back Up Lights go out

- **Refer to System Diagnosis when a result is not normal.**

SYSTEM DIAGNOSIS

- **Diagnostic steps for the symptoms listed in the following table are listed after the table.**

SYMPTOM TABLE

A: Back Up Lights do not operate
B: Back Up Lights light in PARK and/or NEUTRAL

A: BACK UP LIGHTS DO NOT OPERATE

Connect: TEST LAMP
At: GEAR SELECTOR SWITCH CONNECTOR or BACK UP SWITCH CONNECTOR (Disconnected)
Condition:
- **Ignition Switch: RUN**

Connect Between	Correct Result	For Diagnosis of Incorrect Results
DK BLU wire & Ground (see schematic)	Lamp lights	See 1
DK BLU wire & LT GRN wire (see schematic)	Lamp lights	See 2

(Continued on next page)

BACK UP LIGHTS

(Continued from previous page)

- If the results are correct, adjust/replace suspect Switch.

1. Check TURN B/U Fuse and DK BLU (75) wire for an open.
2. Check LT GRN (24) sockets and BLK (150) wires for an open.

B: BACK UP LIGHTS LIGHT IN PARK AND/OR NEUTRAL

Disconnect the connector from Gear Selector Switch/Back Up Switch.

- If Back Up Lights go out, adjust/replace Gear Selector Switch/Back Up Switch.
- If Back Up Lights do not go out, check for a short to voltage in LT GRN (24) wire.

CIRCUIT OPERATION

With the Ignition Switch in RUN, BULB TEST or START, voltage is applied through the TURN B/U Fuse to the Gear Selector Switch (automatic transmission) or to the Back Up Switch (manual transmission). Whenever the Gear Selector Lever is shifted to REVERSE, the Gear Selector Switch or Back Up Switch closes and voltage is applied to the Back Up Switch.

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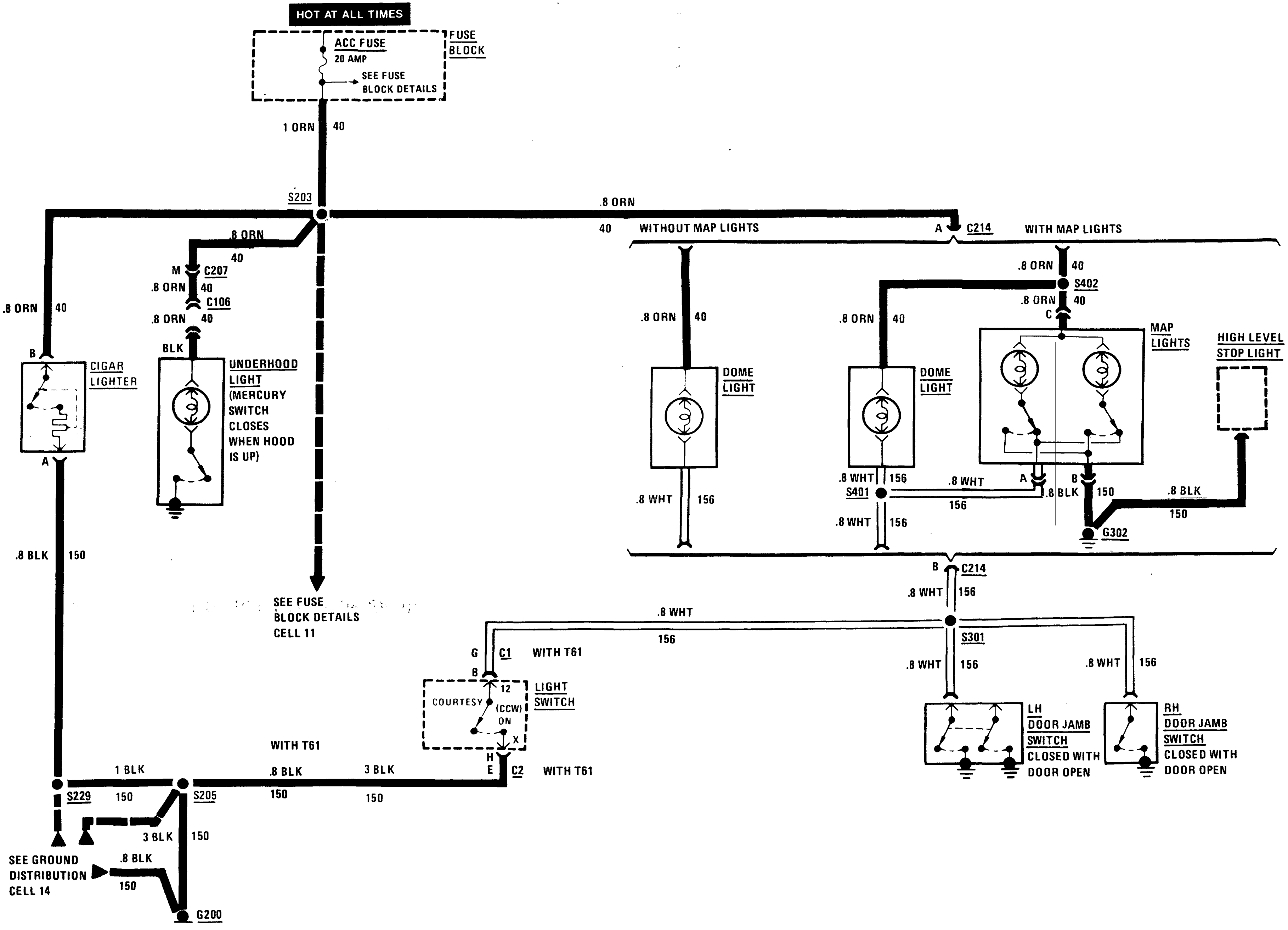
INTERIOR LIGHTS: CIGAR LIGHTER, UNDERHOOD LIGHT AND MAP/DOME



INTERIOR LIGHTS: CIGAR LIGHTER, UNDERHOOD LIGHT AND MAP/DOME

TROUBLESHOOTING HINTS

- **Try the following checks.**

1. Check the ACC Fuse and wire to S203 by operating the Horns.
2. If only the Dome or Map Lights do not operate, check the connection at C214 and related wiring for an open (see schematic).
3. If the Dome Lights do not turn off, check the Light Switch, LH and RH Door Jamb Switches and WHT (156) wire for a short to ground. Repair/replace as necessary.
4. If only the Cigar Lighter does not work, check ORN (40) and BLK (150) wires for opens. Replace the Cigar Lighter if the wires are OK.
5. If only one light does not light, check bulb, socket and related wiring (see schematic).

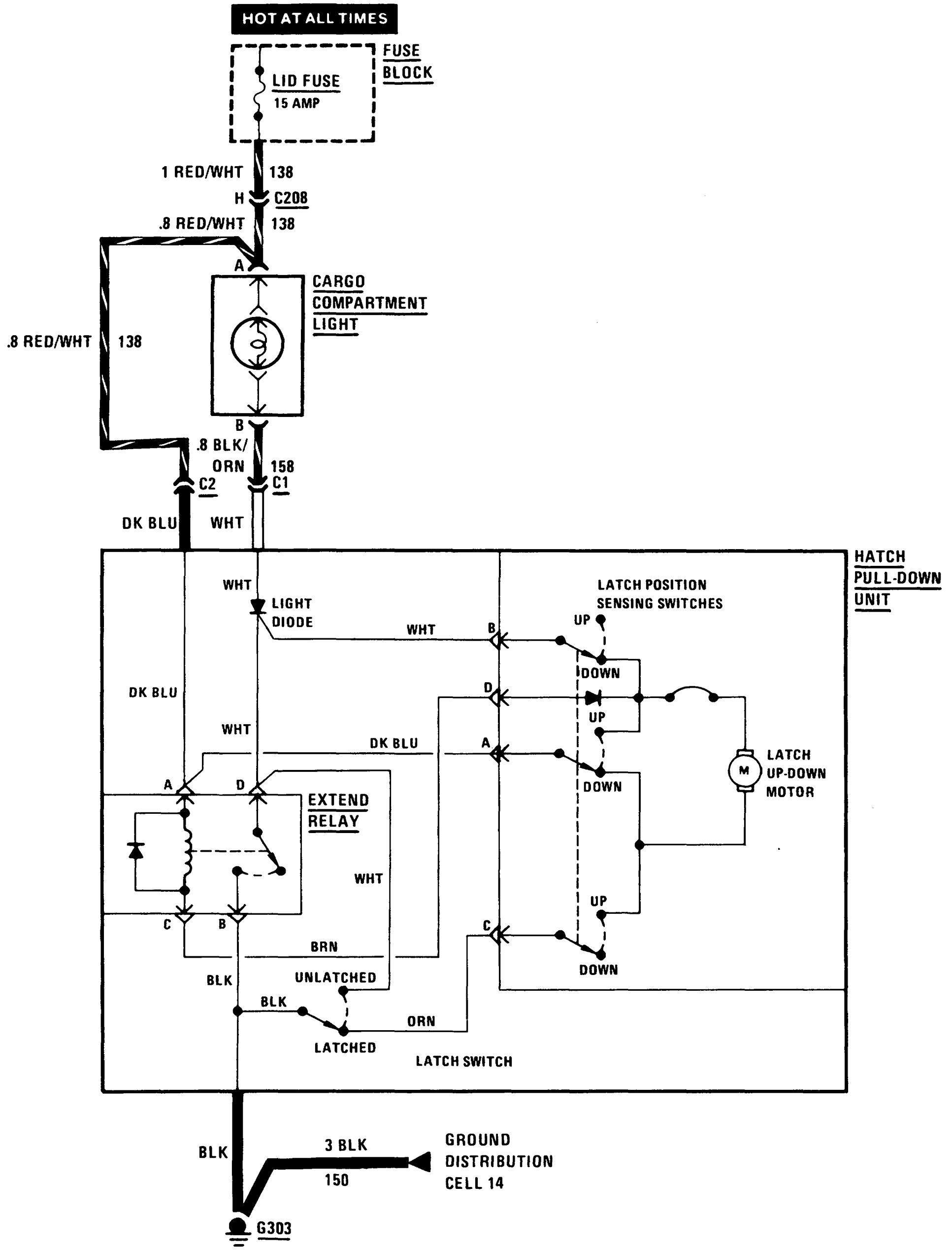
CIRCUIT OPERATION

Voltage is applied at all times through the ACC Fuse to the components in the circuit. The Cigar Lighter, Underhood Light and the Map Lights each use separate switches. The Dome Light and Map Lights can be operated by providing a ground through the Light Switch to G200 or through any Door Jamb Switch to ground.

COMPONENT LOCATION

		Page-Figure
Fuse Block	Behind LH side of I/P	201-13-A
C106 (1 cavity)	RH rear of engine compartment	201- 1-C
C207 (15 cavities)	Behind RH side of I/P	201-15-A
C214 (4 cavities)	LH shroud, near center access hole	201-18-D
G200	Behind LH side of I/P, on Convenience Center bracket	201-14-C
G302	Under headliner, near dome light	201-18-D
S203	I/P harness, behind LH side of instrument cluster	201-12-A
S205	I/P harness, behind instrument cluster	201-12-A
S229	I/P harness, above Convenience Center	201-12-A
S301	I/P harness, behind LH side of I/P	201-12-A
S401	Dome lamp harness, under headliner	201-18-D
S402	Dome lamp harness, under headliner	201-18-D

INTERIOR LIGHTS: CARGO COMPARTMENT



INTERIOR LIGHTS: CARGO COMPARTMENT

TROUBLESHOOTING HINTS

- **Try the folowing checks before doing the System Check.**

1. Check the LID Fuse by visual inspection.
2. Check the bulb by visual inspection.
3. Check that all connectors are firmly seated.
4. If the Hatch Pull-Down Unit does not function correctly, repair/replace it before repairing the Cargo Compartment Light (see Section 8A-135).

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation.**
- **Refer to System Diagnosis for diagnostic steps.**

SYSTEM CHECK TABLE

ACTION	NORMAL RESULT
Open the hatch	The Cargo Light turns on and remains on
Close the hatch	The Cargo Light turns off

SYSTEM DIAGNOSIS

Do the test indicated below if the Cargo Compartment Light does not function correctly.

- If the Cargo Compartment Light does not light, do Test 1.
- If the Cargo Compartment Light does not turn off, do Test 2.

COMPONENT LOCATION

		Page-Figure
Fuse Block	Behind LH side of I/P	201-13-A
Hatch Pull-Down Unit	Center of rear end panel, in cargo compartment	201-19-A
C208 (8 cavities)	Near LH rear quarter panel	201-19-C
G303	Center of rear end panel, in cargo compartment	201-19-A

TEST 1

Measure: VOLTAGE
At: CARGO COMPARTMENT LIGHT
(Disconnected)
Condition:
• Hatch: OPEN

Measure Between	Corect Voltage	For Diagnosis
RED/WHT & Ground	Battery	See 1
RED/WHT & BLK/ORN	Battery	See 2

- If all voltages are correct repair/replace the Cargo Compartment Light.

1. Check RED/WHT (138) wire and LID Fuse for an open.
2. Check BLK/ORN (158) wire for an open. If OK, repair/replace the Hatch Pull-Down Unit.

TEST 2

Disconnect the BLK/ORN (158) wire from the Hatch Pull-Down Unit.

1. If the light remains on, check the BLK/ORN wire for a short to ground.
2. If the light turns off, repair/replace the Hatch Pull-Down Unit.

CIRCUIT OPERATION

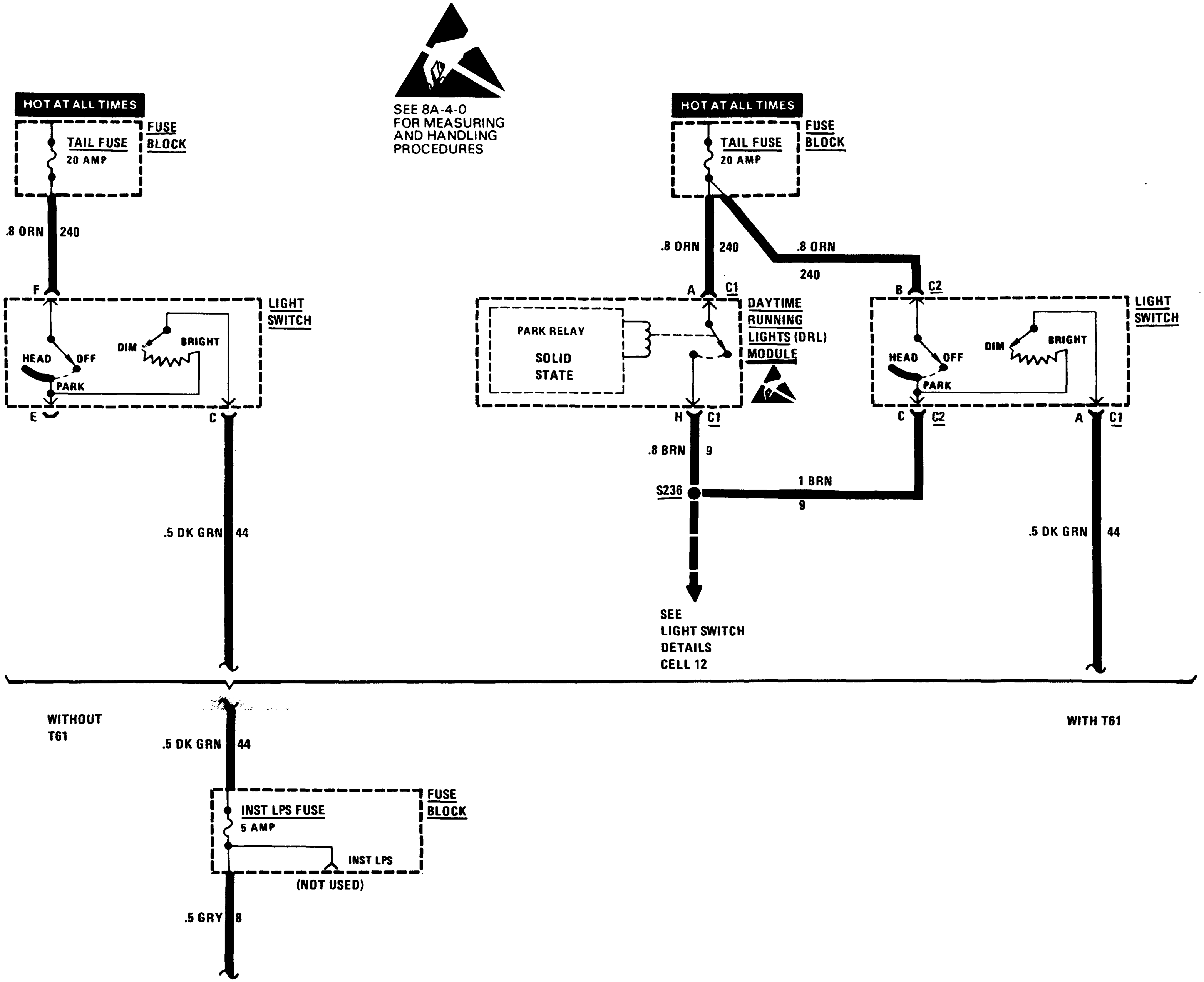
Battery voltage is applied at all times from the LID Fuse to the Cargo Compartment Light. The light is controlled by the Hatch Pull-Down Unit switching the ground on or off.

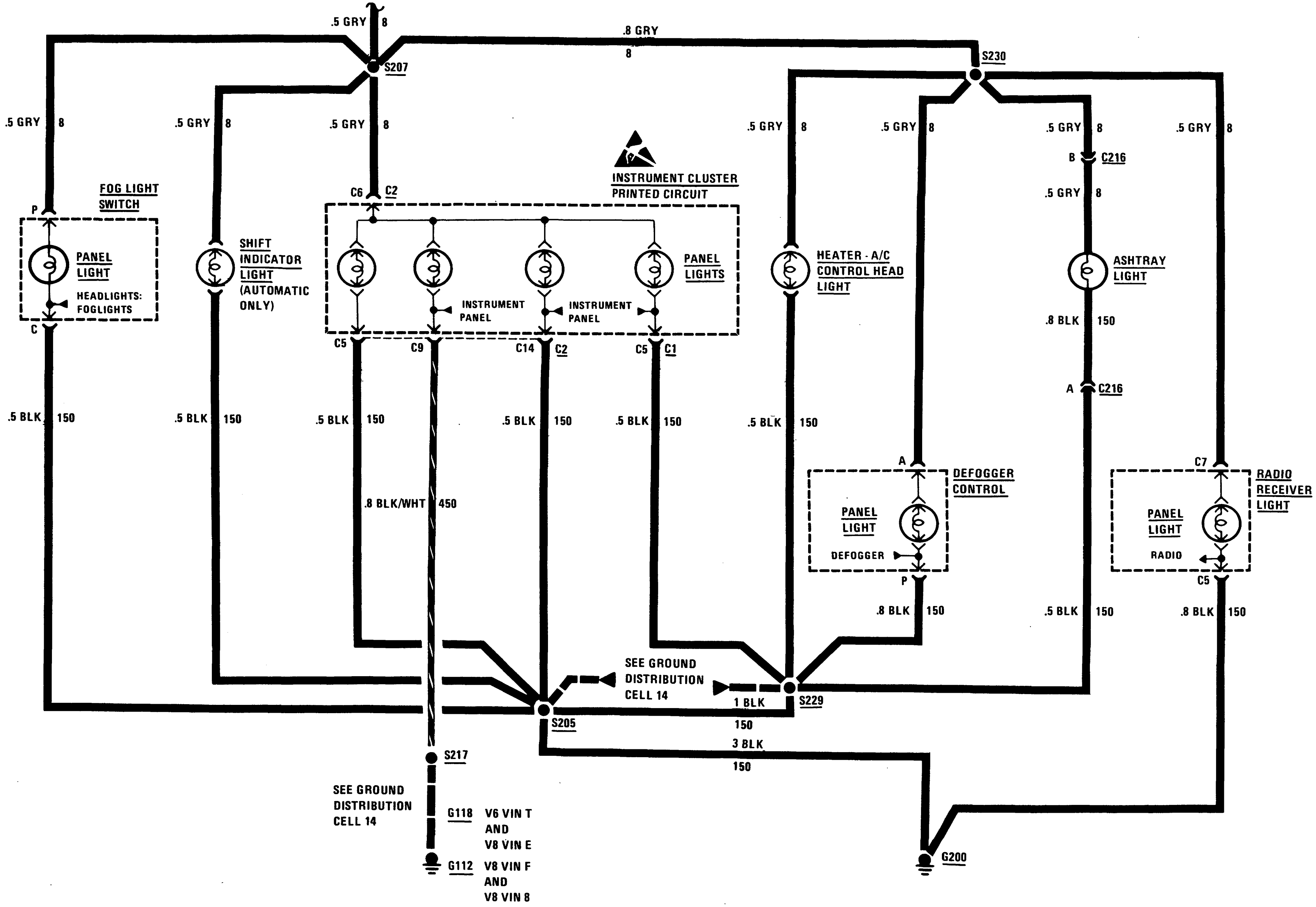
When the hatch is opened, the pull-down unit Latch Switch moves to the "unlatched" position. The Latch Switch completes the ground for the Cargo Light and it turns on.

When the hatch is pushed down the Latch Switch moves to the "latched" position, the ground path is opened and the Cargo Light turns off.

The Light Diode prevents the hatch from inadvertently opening if the wire from the Cargo Light were to short to ground.

INTERIOR LIGHTS DIMMING




.5 GRY 8
S207
.8 GRY 8
S230
.5 GRY 8
.5 GRY 8
.5 GRY 8
.5 GRY 8
.5 GRY 8
.5 GRY 8
.5 GRY 8
INSTRUMENT CLUSTER PRINTED CIRCUIT
FOG LIGHT SWITCH
P
PANEL LIGHT
HEADLIGHTS: FOGLIGHTS
C
SHIFT INDICATOR LIGHT (AUTOMATIC ONLY)
C6 C2
INSTRUMENT PANEL
INSTRUMENT PANEL
PANEL LIGHTS
C5
C9
C14 C2
C5 C1
HEATER - A/C CONTROL HEAD LIGHT
B C216
.5 GRY 8
ASHTRAY LIGHT
.8 BLK 150
A C216
.5 BLK 150
.5 BLK 150
.5 BLK 150
.5 BLK 150
.5 BLK 150
.5 BLK 150
.8 BLK/WHT 450
A
DEFOGGER CONTROL
PANEL LIGHT
DEFOGGER
P
C7
RADIO RECEIVER LIGHT
PANEL LIGHT
RADIO
C5
.8 BLK 150
.5 BLK 150
.8 BLK 150
SEE GROUND DISTRIBUTION CELL 14
1 BLK 150
S229
S205
3 BLK 150
S217
SEE GROUND DISTRIBUTION CELL 14
G118 V6 VIN T AND V8 VIN E
G112 V8 VIN F AND V8 VIN 8
G200

INTERIOR LIGHTS DIMMING

TROUBLESHOOTING HINTS

- **Note: This section does not address conditions with the operation of the Daytime Running Lights. If the Interior lights work with the Light Switch, but do not operate automatically, see Section 8A-104.**

1. If no Interior Lights work:

- Check TAIL Fuse, ORN (240) wire and Light Switch by observing the Park Lights (see schematic).
- Check INST LPS Fuse.

2. If a group of Interior Lights does not come on, check the wires to the suspect lights (see schematic).
3. If a single Interior Light does not come on, check the bulb socket and related wires.
4. If Dimmer Switch will not vary the brilliance of Interior Lights, replace Light Switch.
5. If Interior Lights will not turn off, replace Light Switch.

SYSTEM DIAGNOSIS

- **Do the tests below if the Interior Lights do not operate properly.**

COMPONENT LOCATION

		Page-Figure
Daytime Running Lights (DRL) Module	Behind LH side of I/P	201-12-A
Fuse Block	Behind LH side of I/P	201-13-A
C216 (2 cavities)	Behind center of I/P, near ashtray	201-12-A
G112 (VIN F)(VIN 8)	Rear of LH cylinder head	201- 7-A
G118 (VIN E)	Rear of RH cylinder head	201- 4-A
G118 (VIN T)	Rear of RH cylinder head	201- 1-A
G200	Behind LH side of I/P, on Convenience Center bracket	201-14-C
S205	I/P harness, behind instrument cluster	201-12-A
S207	I/P harness, above Fuse Block	201-12-A
S217	I/P harness, behind RH side of instrument cluster	201-12-A
S229	I/P harness, above Convenience Center	201-12-A
S230	I/P harness, behind RH side of instrument cluster	201-12-A
S236	I/P harness, behind LH side of I/P	201-12-A

LIGHT SWITCH TEST

Connect: TEST LAMP
At: LIGHT SWITCH CONNECTOR (Connected)
Conditions:
- **Light Switch: PARK**
- **Dimmer Switch: BRIGHT**

Connect Between	Correct Result	For Diagnosis Of Incorrect Results
C (Without T61) or C1/A (With T61) (DK GRN) & Ground	Lamp lights	See 1

- If above results are correct, check DK GRN (44) wire, INST LPS Fuse and GRY (8) wire for opens (see schematic).

1. Replace the Light Switch.

CIRCUIT OPERATION

Voltage is applied at all times through the TAIL Fuse to the Light Switch. With the Light Switch in the PARK or HEAD position, voltage is applied through the INST LPS Fuse to the individual lights.

A rheostat inside the Light Switch controls the brightness of the lights. When the Dimmer Switch is turned, the resistance of the rheostat either increases or decreases, thus increasing or decreasing the brightness of the Interior Lights.

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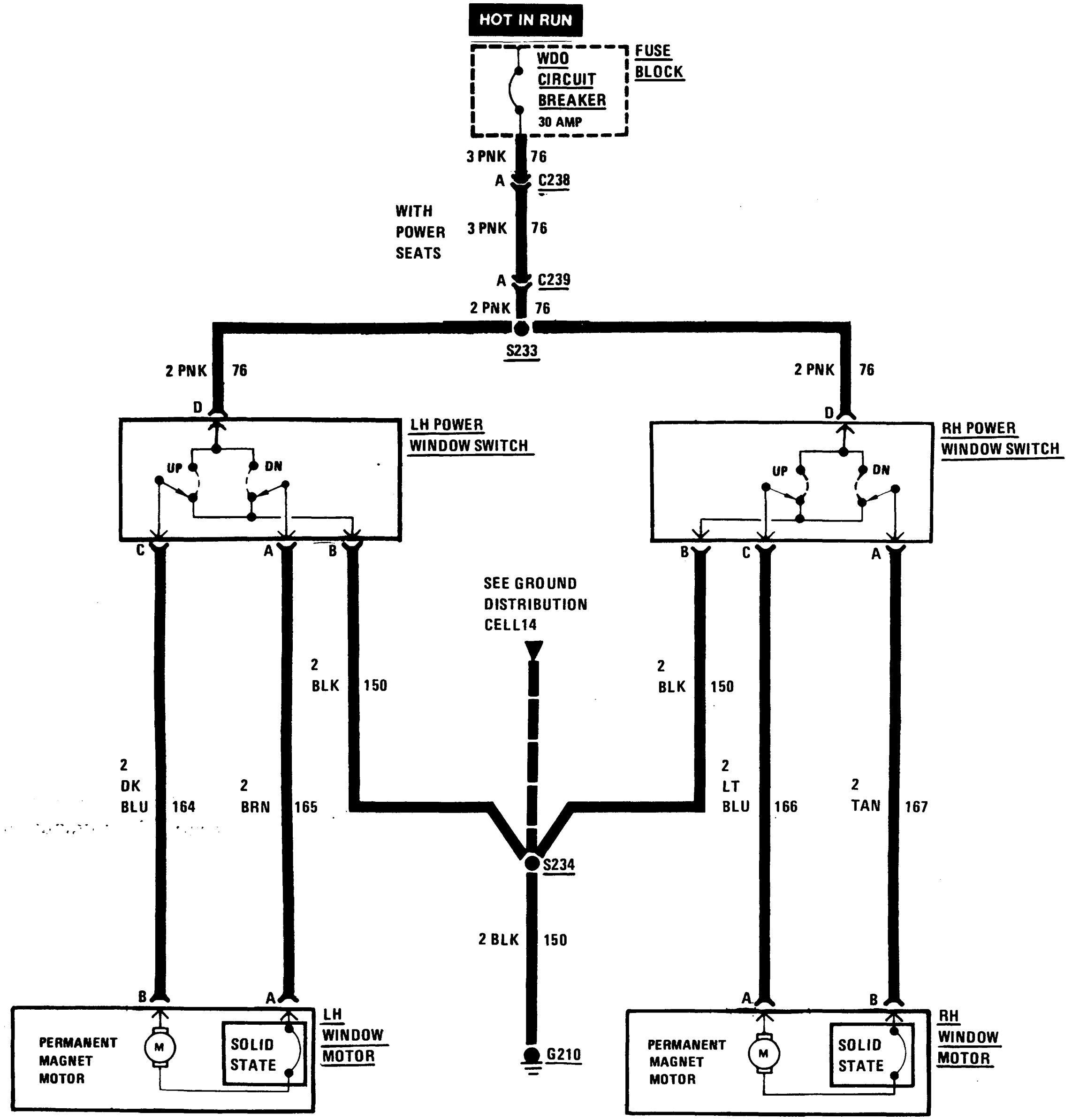
POWER WINDOWS



EACH MOTOR CONTAINS
A CIRCUIT BREAKER
(PTC). IT RESETS ONLY
AFTER VOLTAGE IS
REMOVED FROM THE MOTOR

POWER WINDOWS

TROUBLESHOOTING HINTS

- **Try the following check before doing the System Check.**

1. If both Power Windows do not operate, check the WDO Circuit Breaker.
2. If both Power Windows do not operate, check that G210 is clean and tight. If equipped, G210 may be checked by operating the Power Door Locks or Power Outside Mirrors.

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation.**
- **Refer to System Diagnosis for a list of symptoms and diagnostic steps.**

SYSTEM CHECK TABLE

ACTION	NORMAL RESULT
With the Ignition Switch in RUN, operate each window from the individual Window Switches	Each window operates quietly and smoothly, with no sticking

- **Refer to System Diagnosis when a result is not normal.**

COMPONENT LOCATION

		Page-Figure
Fuse Block	Behind LH side of I/P	201-13-A
LH Window Motor	In front of LH door, behind panel	201-18-A
RH Window Motor	In RH door, behind panels	201-18-A
C238 (4 cavities)	LH shroud, ahead of center access hole	201-17-A
C239 (4 cavities)	LH shroud, near center access hole	201-17-A
G210	Under rear of console	201-17-C
S233	Crosscar harness, in console below trim plate	201-17-C
S234	Crosscar harness, below console	201-17-C

SYSTEM DIAGNOSIS

- **Do the tests below if one or both Power Windows do not operate.**

A: WINDOW POWER AND GROUND TEST

Connect: TEST LAMP
At: SUSPECT POWER WINDOW SWITCH CONNECTOR (Connected)
Condition:
- **Ignition Switch: RUN**

Connect Between	Correct Result	For Diagnosis Of Incorrect Results
D (PNK) & Ground	Lamp lights	See 1
D (PNK) & B (BLK)	Lamp lights	See 2

- If all of the above results are correct, go to Test B: Power Window Switch Test.

1. Check PNK (76) wire for an open (see schematic).
2. Check BLK (150) wire for an open (see schematic).

B: POWER WINDOW SWITCH TEST

Connect: TEST LAMP
At: POWER WINDOW SWITCH CONNECTOR (Connected)
Conditions:
- **Ignition Switch: RUN**
- **Operate Associated Switch Up and Down**

Connect Between	Correct Result	For Diagnosis Of Incorrect Results
• For RH Power Window Switch measurements		
A (TAN) & C (LT BLU)	Lamp lights	See 1
• For LH Power Window Switch measurements		
A (BRN) & C (DK BLU)	Lamp lights	See 1

- If above result is correct, go to Test C: Window Motor Test.

1. Replace Power Window Switch.

C: WINDOW MOTOR TEST

Connect: TEST LAMP
At: WINDOW MOTOR CONNECTOR
(Disconnected)
Conditions:

- **Ignition Switch: RUN**
- **Operate Associated Switch Up and Down**

Connect Between	**Correct Result**	**For Diagnosis Of Incorrect Results**
• For RH Power Window Motor measurements		
A (LT BLU) & B (TAN)	Lamp lights	See 1
• For LH Power Window Motor measurements		
B (DK BLU) & A (BRN)	Lamp lights	See 2

- If above result is correct, replace Window Motor.

1. Check LT BLU (166) and TAN (167) wires for an open.
2. Check DK BLU (164) and BRN (165) wires for opens.

CIRCUIT OPERATION

The Power Windows are driven by reversible permanent magnet motors. Each motor is controlled by a switch with two sets of contacts that are normally closed to ground. With the Power Window Switch in the UP position, one set of contacts is closed, applying battery voltage to the Power Window Motor. The remaining set of contacts remains closed, providing a path to ground and completing the circuit. With the Power Window Switch in the DN position, the functions of the switches are reversed and the motor runs in the opposite direction.

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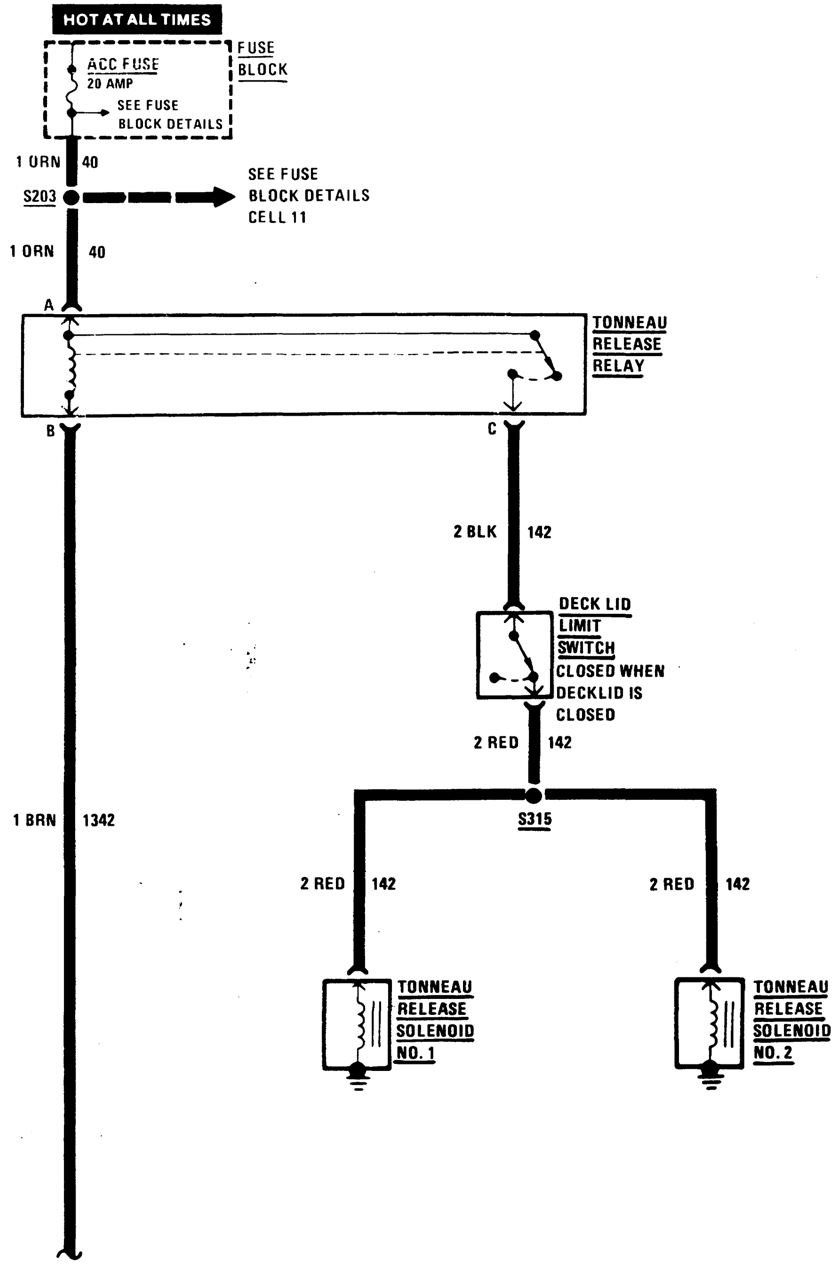
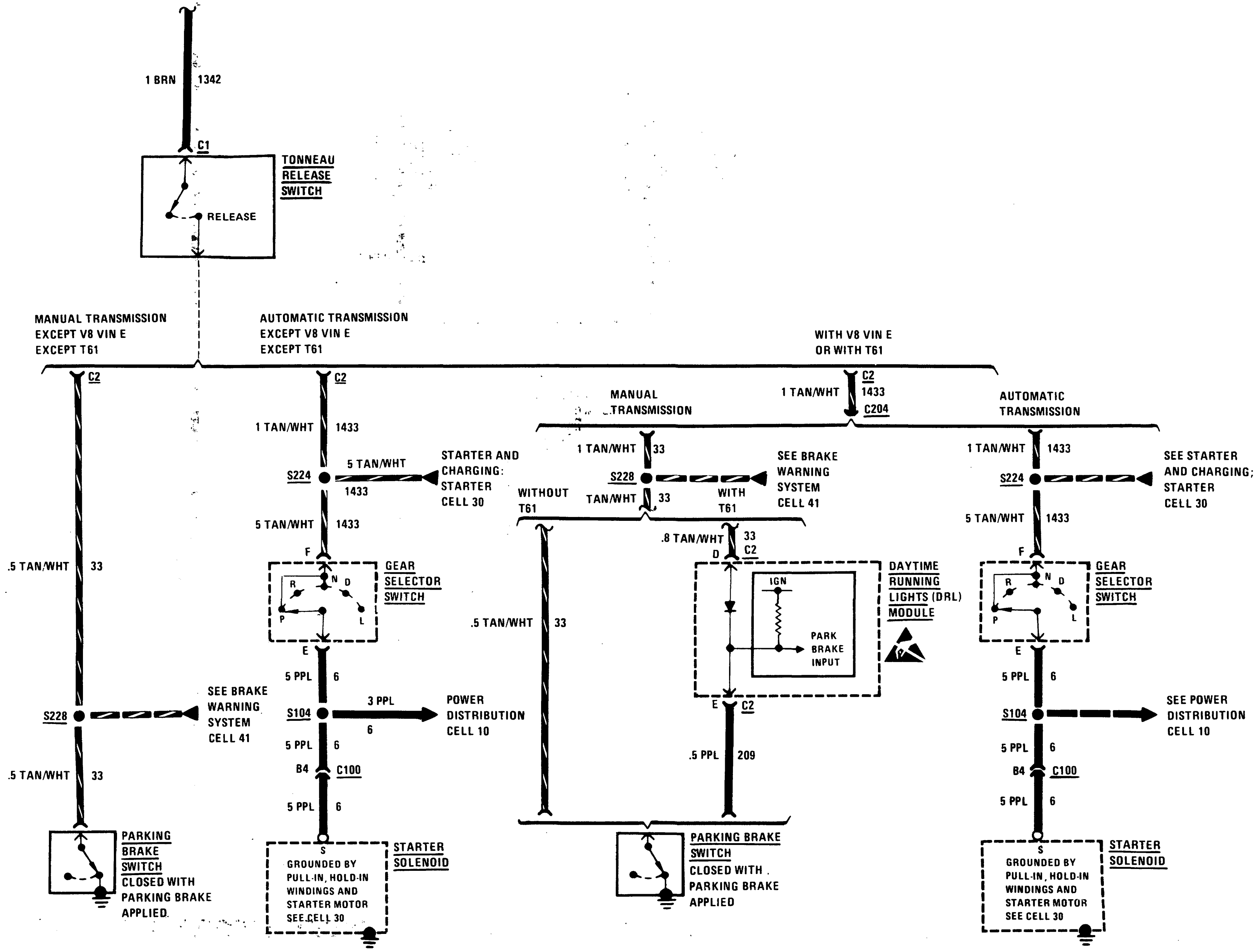
CONVERTIBLE TONNEAU RELEASE



SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES


1 BRN
1342
C1
TONNEAU RELEASE SWITCH
RELEASE
MANUAL TRANSMISSION EXCEPT V8 VIN E EXCEPT T61
AUTOMATIC TRANSMISSION EXCEPT V8 VIN E EXCEPT T61
WITH V8 VIN E OR WITH T61
C2
1 TAN/WHT
1433
C204
MANUAL TRANSMISSION
AUTOMATIC TRANSMISSION
.5 TAN/WHT
33
S228
SEE BRAKE WARNING SYSTEM CELL 41
PARKING BRAKE SWITCH
CLOSED WITH PARKING BRAKE APPLIED.
S224
5 TAN/WHT
STARTER AND CHARGING: STARTER CELL 30
F
GEAR SELECTOR SWITCH
R
N
D
P
L
E
5 PPL
6
S104
3 PPL
POWER DISTRIBUTION CELL 10
B4
C100
S
STARTER SOLENOID
GROUNDED BY PULL-IN, HOLD-IN WINDINGS AND STARTER MOTOR SEE CELL 30
WITHOUT T61
WITH T61
TAN/WHT
.8 TAN/WHT
D
DAYTIME RUNNING LIGHTS (DRL) MODULE
IGN
PARK BRAKE INPUT
.5 PPL
209
PARKING BRAKE SWITCH
CLOSED WITH . PARKING BRAKE APPLIED
SEE STARTER AND CHARGING; STARTER CELL 30
SEE POWER DISTRIBUTION CELL 10

CONVERTIBLE TONNEAU RELEASE

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Diagnosis.**

1. Check for proper operation of the Brake Warning System (manual transmission) or the Starting System (automatic transmission). Repair any conditions in those systems before attempting to diagnose conditions in the Hatch Release circuit.
2. Check the ACC Fuse by operating the horn.

- **Go to System Check for a guide to normal operation.**
- **Go to System Diagnosis for diagnostic tests.**

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation.**

SYSTEM CHECK TABLE

ACTION	NORMAL RESULT
Press Tonneau Release Switch button with the Deck lid closed and the Parking Brake applied (manual transmission) or the Gear Selector Switch in P or N (automatic transmission)	Tonneau releases and opens freely

SYSTEM DIAGNOSIS

- **Do the tests indicated below if the Tonneau Release does not operate properly.**

COMPONENT LOCATION

		Page-Figure
Daytime Running Lights (DRL) Module	Behind LH side of I/P	201-12-A
Deck Lid Limit Switch	Center rear of end panel, in cargo compartment	
Fuse Block	Behind LH side of I/P	201-13-A
Gear Selector Switch	In console, at gear selector	201-17-F
Parking Brake Switch	In console, at base of parking brake lever	201-17-D
Starter Solenoid (VIN E)	Lower RH side of engine	201- 6-C
Starter Solenoid (VIN F)(VIN 8)	Lower RH side of engine	201- 9-C
Starter Solenoid (VIN T)	Lower RH side of engine	201- 2-B
Tonneau Release Relay	RH side of console, behind gear selector	201-17-D
Tonneau Release Solenoid No.1	Below tonneau cover	
Tonneau Release Solenoid No.2	Below tonneau cover	
C100 (42 cavities)	LH front of dash, below relay bracket	201-12-A
C204 (1 cavity)	Behind center of I/P	201-12-A
S104	I/P harness, behind LH side of I/P	201-12-A
S203	I/P harness, behind LH side of instrument cluster	201-12-A
S224	I/P harness, behind LH side of I/P, near Fuse Block	201-12-A
S228	I/P harness, behind LH side of I/P	201-12-A

TEST 1

Measure: VOLTAGE
At: TONNEAU RELEASE SWITCH CONNECTOR (Disconnected)
Conditions:

- **Parking Brake (manual transmission): APPLIED**
- **Gear Selector Switch (automatic transmission): P or N**

Measure Between	Correct Voltage	For Diagnosis
C1 (BRN) & Ground	Battery	See 1
C1 (BRN) & C2 (TAN/WHT)	Battery	See 2
• Parking Brake: RELEASED • Gear Selector Switch: D or R		
C1 (BRN) & C2 (TAN/WHT)	Approximately 0	See 3

(Continued in next column)

(Continued from previous column)

- If all voltages are correct, reconnect switch and go to Test 2.

1. Reconnect switch and go to Test 2.
2. Repair open in TAN/WHT (33 or 1433) wire.
3. Repair short to ground in TAN/WHT (33 or 1433) wire.

CONVERTIBLE TONNEAU RELEASE

TEST 2

Measure: VOLTAGE
At: TONNEAU RELEASE RELAY CONNECTOR (Disconnected)
Conditions:
- Parking Brake (manual transmission): APPLIED
- Gear Selector Switch (automatic transmission): P or N

Measure Between	Correct Voltage	For Diagnosis
A (ORN) & Ground	Battery	See 1
• Tonneau Release Switch: RELEASE (hold closed)		
A (ORN) & B (BRN)	Battery	See 2

- If all voltages are correct reconnect relay and go to Test 3.

1. Check ORN (40) wire for an open.
2. Check BRN (1342) wire for an open. If wire and connectors are OK, replace the Tonneau Release Switch.

TEST 3

Measure: VOLTAGE
At: DECK LID LIMIT SWITCH CONNECTOR (Disconnected)
Conditions:
- Parking Brake (manual transmission): APPLIED
- Gear Selector Switch (automatic transmission): P or N
- Tonneau Release Switch: RELEASE (hold closed)

Measure Between	Correct Voltage	For Diagnosis
Power feed (BLK) & Ground	Battery	See 1

- If voltage is correct, go to Test 4.

1. Check BLK (142) wire for an open. If wire and connectors are OK, replace the Tonneau Release Relay.

TEST 4

Measure: VOLTAGE
At: EACH TONNEAU RELEASE SOLENOID CONNECTOR (Disconnected)
Conditions:
- Deck Lid: CLOSED
- Parking Brake (manual transmission): APPLIED
- Gear Selector Switch (automatic transmission): P or N
- Tonneau Release Switch: RELEASE (hold closed)

Measure Between	Correct Voltage	For Diagnosis
RED & Ground	Battery	See 1

- If voltage is correct, repair/replace the Tonneau Release Solenoid.

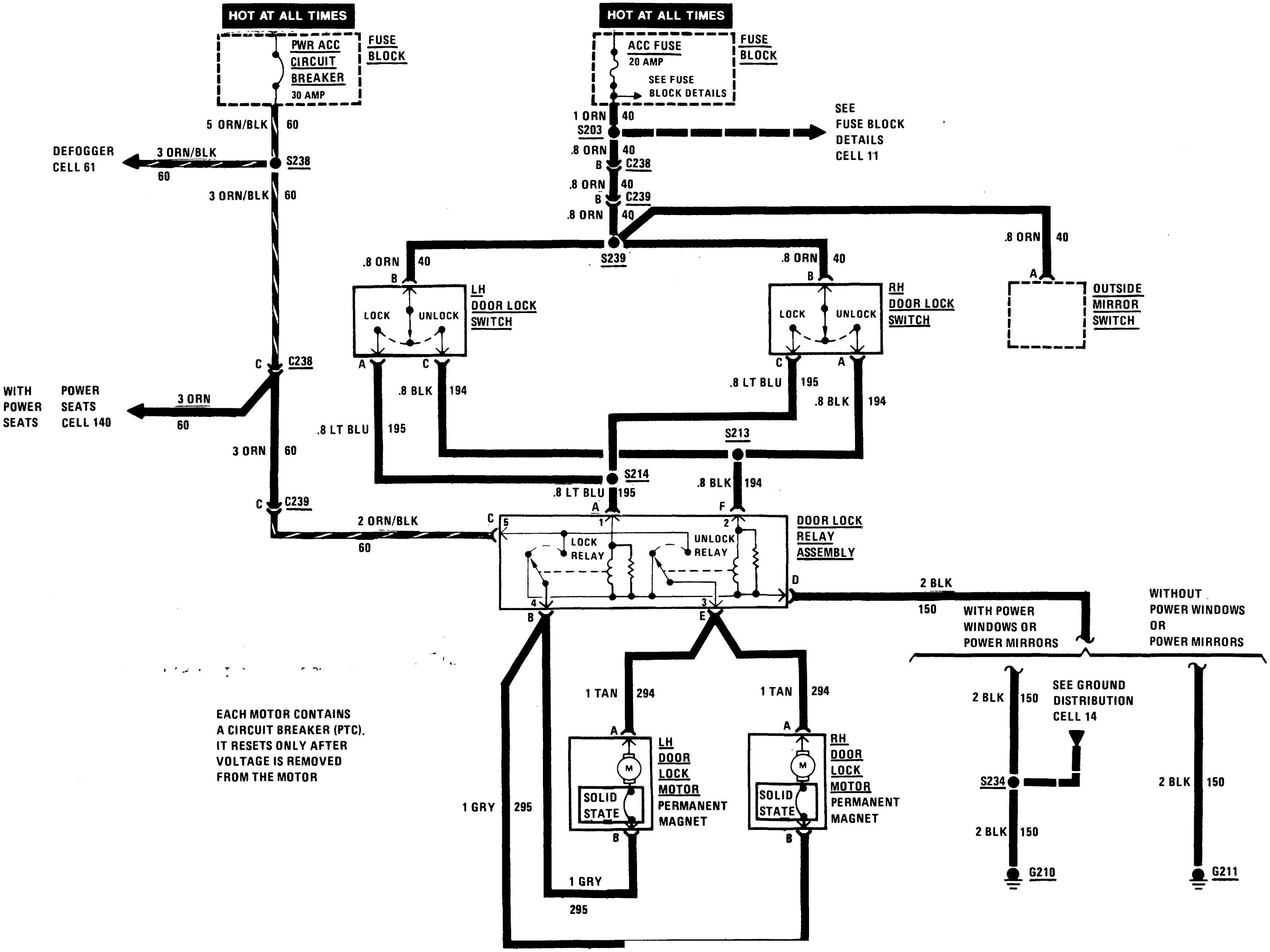
1. Check RED (142) wire for an open. If wire and connectors are OK, replace the Deck Lid Limit Switch.

CIRCUIT OPERATION

Voltage is applied at all times from the ACC Fuse to the Tonneau Release Relay. The relay is controlled by the Tonneau Release Switch grounding the relay coil. The Parking Brake must be applied, on vehicles with manual transmissions, to ground the relay coil. Vehicles with automatic transmissions use the starter, solenoid and motor to complete the ground.

When the relay is energized, voltage is applied to the Deck Lid Limit Switch. When the Deck Lid is closed, voltage is applied to the Tonneau Release Solenoids. The solenoids operate the latches and the Tonneau panel opens.

POWER DOOR LOCKS



EACH MOTOR CONTAINS
A CIRCUIT BREAKER (PTC).
IT RESETS ONLY AFTER
VOLTAGE IS REMOVED
FROM THE MOTOR

POWER DOOR LOCKS

TROUBLESHOOTING HINTS

1. Check the PWR ACC Circuit Breaker by operating the Defogger.
2. Check ACC Fuse by operating the Horn.
3. Check that G210 or G211 is clean and tight. If equipped, G210 may be checked by operating the Power Windows or Power Outside Mirrors.
4. If one or more of the door lock motors does not operate properly but the other door locks do function normally, check the wiring to the motors. If the wiring is correct, replace that motor.

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation.**
- **Refer to System Diagnosis for a list of symptoms and diagnostic steps.**

COMPONENT LOCATION

		Page-Figure
Door Lock Relay Assembly	LH shroud, near door grommet	201-17-B
Fuse Block	Behind LH side of I/P	201-13-A
LH Door Lock Motor	In LH door, behind panels	201-18-A
RH Door Lock Motor	In RH door, behind panels	201-18-A
C238 (4 cavities)	LH shroud, ahead of center access hole	201-17-A
C239 (4 cavities)	LH shroud, near center access hole	201-17-A
G210	Under rear of console	201-17-C
G211	Under driver's seat	201-16-A
S203	I/P harness, behind LH side of instrument cluster	201-12-A
S213	Crosscar harness, near LH shroud	201-17-B
S214	LH front door harness, near door jamb conduit	201-18-A
S234	Crosscar harness, below console	201-17-C
S238	I/P harness, behind LH side of I/P	201-12-A
S239	Crosscar harness, near LH shroud	201-17-B

SYSTEM CHECK TABLE

ACTION	NORMAL RESULT
Operate LH Door Lock Switch	All doors lock and unlock
Operate the RH Door Lock Switch	All the doors lock and unlock
With all the doors closed and locked, operate the inside door handle to try to open each door	The doors will not open
Open the LH door and move the LH Door Lock Switch to the LOCK position, close the door, and try to open each door from the outside	The doors will not open

- **Refer to System Diagnosis when a result is not normal.**

SYSTEM DIAGNOSIS

- **Do the tests listed for your symptom in the Symptom Table below.**
- **Tests follow the Symptom Table.**

SYMPTOM TABLE

SYMPTOM	DO TEST
Only some doors lock and unlock	A: Door Lock Motor Test on suspect Door Lock Motor
The Power Door Locks do not operate from one Door Lock Switch	B: Door Lock Switch Test on suspect Door Lock Switch
The Power Door Locks do not operate from any Door Lock Switch	C: Door Lock Relay Test B: Door Lock Switch Test

A: DOOR LOCK MOTOR TEST

Measure: VOLTAGE
At: SUSPECT DOOR LOCK MOTOR CONNECTOR (Disconnected)
Condition:
- **LH Door Lock Switch: UNLOCK and hold**

Measure Between	Correct Voltage	For Diagnosis
A (TAN) & Ground	Battery	See 1
A (TAN) & B (GRY)	Battery	See 2

- If voltages are correct, replace the suspect Door Lock Motor.

1. Check TAN (294) wire for an open (see schematic).
2. Check GRY (295) wire for an open (see schematic).

B: DOOR LOCK SWITCH TEST

Measure: VOLTAGE
At: DOOR LOCK SWITCH CONNECTOR (Connected)

Measure Between	Correct Voltage	For Diagnosis
B (ORN) & Ground	Battery	See 1
• Door Lock Switch: LOCK and hold		
LT BLU & Ground (see schematic)	Battery	See 2
• Door Lock Switch: UNLOCK and hold		
BLK & Ground (see schematic)	Battery	See 2

- If all voltages are correct, check the LT BLU (195) wire and BLK (194) wires for an open (see schematic).

1. Check the ACC Fuse. Check the ORN (40) wire for an open (see schematic).
2. Replace the suspect Door Lock Switch.

C: DOOR LOCK RELAY TEST (TABLE 1)

Measure: VOLTAGE
At: DOOR LOCK RELAY CONNECTOR (Disconnected)

Measure Between	Correct Result	For Diagnosis
C (ORN/BLK) & Ground	Test Lamp lights	See 1

- If the result is correct, proceed to Table 2.

1. Check the PWR ACC Circuit Breaker and the ORN/BLK and ORN (60) wires for an open (see schematic).

C: DOOR LOCK RELAY TEST (TABLE 2)

Connect: TEST LAMP
At: DOOR LOCK RELAY CONNECTOR (Connected)
Condition:
- **Door Lock Switch: LOCK and hold**

Connect Between	Correct Result	For Diagnosis
A (LT BLU) & Ground	Test Lamp lights	See 1
B (GRY) & Ground	Test Lamp lights	See 3
B (GRY) & E (TAN)	Test Lamp lights	See 3
• Move the Door Lock Switch to UNLOCK and hold		
F (BLK) & Ground	Test Lamp lights	See 2
E (TAN) & Ground	Test Lamp lights	See 3
B (GRY) & E (TAN)	Test Lamp lights	See 3

- If all the results are correct, check the TAN (294) and GRY (295) wires for opens (see schematic). If the wires are OK, do Test A.

1. Check the LT BLU (195) wire for an open (see schematic). If the wire is good, do Test B.
2. Check the BLK (194) wire for an open (see schematic). If wire is good, do Test B.
3. Replace the Door Lock Relay.

POWER DOOR LOCKS

CIRCUIT OPERATION

When a Door Lock Switch is activated in the Power Door Lock System, all of the doors will lock or unlock in unison. Each lock can also be operated manually from the locking post. The locks are operated by reversible motors that receive voltage from two relays in the Door Lock Relay Assembly. These relays operate to turn the motors on by applying a voltage to one of the terminals and a ground to the other terminal.

When either Door Lock Switch is moved to the LOCK position, it completes the circuit to the coil of the Door Lock Relay Assembly. The lock relay is energized. The contact for the lock relay closes and is connected to battery voltage through the ORN/BLK and ORN wires which is the high current from feed for driving the motors.

Voltage is then applied to the GRY wires and the Door Lock Motors, which are grounded by the TAN wires from the other terminal of the motor through the contact for the Unlock Relay. The motor in each door runs to operate the door locks. When the Door Lock Switch is released, the Lock Relay contact returns to ground and the motors turn off.

A similar action occurs with the Unlock Relay when it is energized by either of the Door Lock Switches closing to the UNLOCK position. Now the TAN wires to the motors carry battery voltage and the GRY wires are grounded. The polarity of the voltage to the motors is reversed. The motors run in the opposite direction to unlock the doors.

The Door Lock Switches are usually closed for just a moment. If they are held closed a circuit breaker in each motor will open to protect against damage. The circuit breakers close automatically when they cool down.

THEFT DETERRENT SYSTEM: PASS KEY

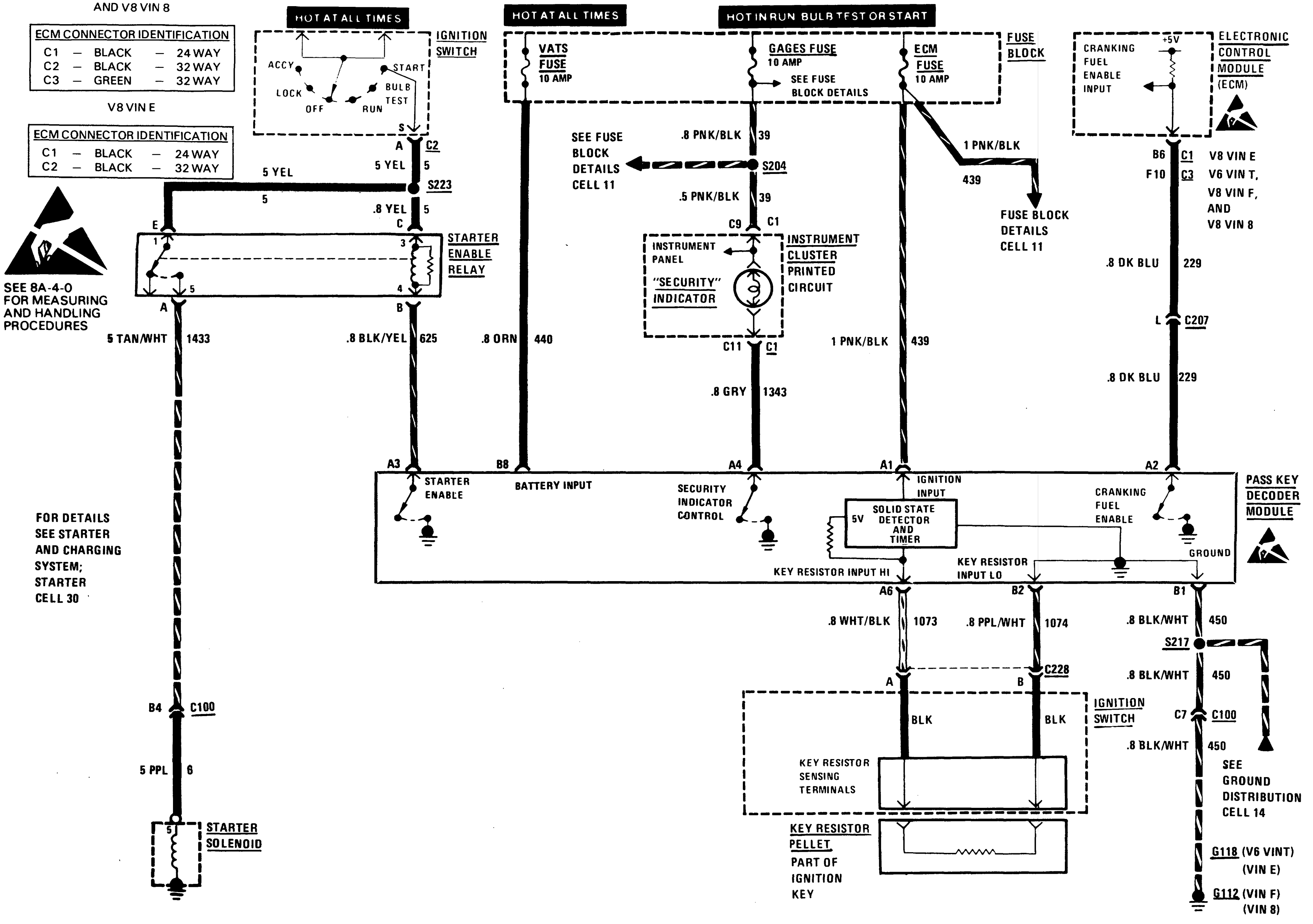
V6 VIN T, V8 VIN F
AND V8 VIN 8

ECM CONNECTOR IDENTIFICATION		
C1	BLACK	24 WAY
C2	BLACK	32 WAY
C3	GREEN	32 WAY

V8 VIN E

ECM CONNECTOR IDENTIFICATION		
C1	BLACK	24 WAY
C2	BLACK	32 WAY

SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES



THEFT DETERRENT SYSTEM: PASS KEY

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Check.**

1. Check the key pellet sensing contacts in the Ignition Lock Cylinder by looking into the key opening. If the contacts are damaged, replace the Lock Cylinder.
2. Check the VATS Fuse by visual inspection.
3. Check all of the owner's ignition keys using the J35628 Interrogator or equivalent. If the Key Code window shows "E," or reading is erratic, replace the owner's key.
4. Check the Security Indicator bulb.
5. Check the ECM Fuse and the GAGES Fuse by visual inspection.

Note: When the PASS Key Decoder Module is replaced, the new module will store the key resistance value the first time the car is started. The Security Indicator will remain on for this first ignition cycle, and not turn off until the Ignition Switch is turned to OFF.

- **Go to System Check for a guide to normal operation.**
- **Go to System Diagnosis for diagnostic tests.**

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation.**
- **Refer to System Diagnosis for a list of symptoms and diagnostic steps.**

COMPONENT LOCATION

		Page-Figure
Electronic Control Module (ECM) (Except VIN E)	Behind RH side of I/P	201-15-B
Electronic Control Module (ECM) (VIN E)	Behind RH side of I/P	201-15-C
Fuse Block	Behind LH side of I/P	201-13-A
Ignition Switch	At base of steering column, below I/P	201-14-A
PASS Key Decoder Module	Behind RH side of I/P	201-15-A
Starter Enable Relay	Below LH side of I/P, on kick panel	201-16-A
Starter Solenoid (VIN E)	Lower RH side of engine	201- 6-C
Starter Solenoid (VIN F)(VIN 8)	Lower RH side of engine	201- 9-C
Starter Solenoid (VIN T)	Lower RH side of engine	201- 2-B
C100 (42 cavities)	LH front of dash, below relay bracket	201-12-A
C207 (15 cavities)	Behind RH side of I/P	201-15-A
C228 (2 cavities)	Below LH side of I/P, near steering column	201-14-A
G112 (VIN F)(VIN 8)	Rear of LH cylinder head	201- 7-A
G118 (VIN E)	Rear of RH cylinder head	201- 4-A
G118 (VIN T)	Rear of RH cylinder head	201- 1-A
S204	I/P harness, behind LH side of instrument cluster	201-13-A
S217	I/P harness, behind RH side of instrument cluster	201-12-A
S223	I/P harness, behind LH side of I/P	201-12-A

SYSTEM CHECK TABLE

Put the Ignition Switch in RUN	Security Indicator lights for approximately 2 seconds and then goes out
Turn Ignition Switch to START	If engine starts, proceed to next step If engine does not start, proceed to System Diagnosis

(Continued on next page)

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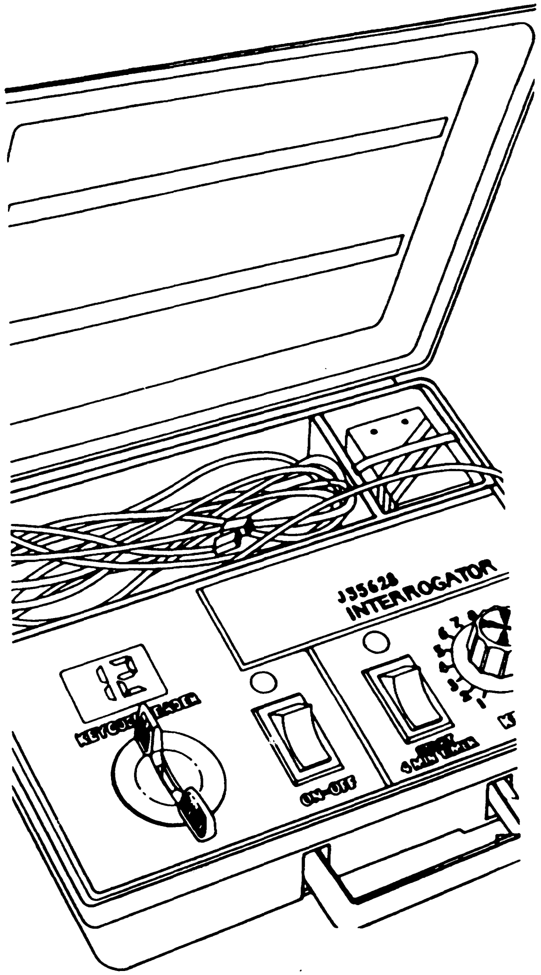
Do the following to check that PASS Key will detect the use of an incorrect key: Shut off engine. Remove hush panel under steering column and disconnect C228 (Two-cavity connector at base of steering column). Connect the J35628 Interrogator (or equivalent) between both halves of C228. Set the Key Code Selector on the J35628 Interrogator to an incorrect resistance value (any code but the one noted in step 3 of Troubleshooting Hints).	
Attempt to start engine	Engine should not crank and the Security Indicator will stay on, indicating an incorrect key code If engine cranks, go the Symptom Table in System Diagnosis
Disconnect the J35628 Interrogator Reconnect C228 and attempt to start engine again (must be done within two minutes of first attempt)	Engine should not crank If engine cranks, replace PASS Key Decoder Module
Turn Ignition Switch to OFF Wait four minutes and turn Ignition Switch to START	Engine starts normally
Replace hush panel	

- **Refer to System Diagnosis when a result is not normal.**

SYSTEM DIAGNOSIS

Use the following table to determine the procedure to use.



J 35628 INTERROGATOR. SEE KEY DUPLICATION PROCEDURE.

SYMPTOM TABLE

SYMPTOM	TEST
No crank: Security Indicator did not come on during System Check and code 46 or 53 is present	B: PASS Key Decoder Module Test
No crank: Security Indicator stays on and code 46 or 53 is present	A: Lock Cylinder and Harness Test B: PASS Key Decoder Module Test
No crank: Security Indicator operates normally	C: Starter Enable Relay Test
Crank but not start: Security Indicator operates normally and code 46 or 53 is present	D: ECM Enable Test (V8) See Section 6E (V6)
Security Indicator does not light but engine starts	E: Security Indicator open Test
Security Indicator stays on with Ignition Switch in RUN but engine starts	F: PASS Key Decoder Module Programming Test
Security Indicator stays on at all times	Check GRY 1343 wire for a short to ground. If OK, replace PASS Key Decoder Module.
Engine cranks when an incorrect resistance is inserted during the System Check	Check the Starter Enable Relay for shorted contacts and the BLK/YEL (625) wire for a short to ground. If OK, replace the PASS Key Decoder Module.

A: LOCK CYLINDER AND HARNESS TEST

1. Remove the hush panel under the steering column. Disconnect the two-cavity connector in the wire leading into the steering column. Connect the male and female parts to the mating connectors on the pigtails from the J35628 Interrogator or equivalent.
2. Insert the customer's ignition key into the ignition lock cylinder.
3. Press the On-Off switch on the J35628 Interrogator to the ON position.

   The window above the Key Code Reader indicates the electrical code for the key (1 to 15) or "E" error.

   Rotate the ignition lock cylinder while the key is inserted to insure that the correct code is read in all positions.

- If code is correct in all positions, proceed to step 4.
- If the code shows "E" or is erratic in some positions, obtain a spare key or make a replacement key (See Key Duplication Procedure). Read the code again while rotating the ignition lock cylinder with the spare/replacement key. A correct code in all positions indicates that the original key was defective. An incorrect code indicates a defective lock cylinder. See section 3B5 for lock cylinder replacement procedures.

4. Set the Key Code Selector on the J35628 Interrogator to the same electrical code determined in step 3. Turn the Ignition Switch to START.

- If the SECURITY Indicator remains on and the engine starts, turn the Ignition Switch to OFF and repeat step 4. If the indicator is still on replace the PASS Key Decoder Module.
- If engine starts, and the Security Indicator goes out, reconnect vehicle wiring and check that the two-cavity connector at the base of the steering column mates correctly.
- If engine does not start, go to Test B, Decoder Module Test.

B: PASS KEY DECODER MODULE TEST (TABLE 1)

Measure: VOLTAGE
At: PASS KEY DECODER MODULE CONNECTOR (Disconnected)
Condition:
- **Ignition Switch: RUN**

Measure Between	Correct Voltage	For Diagnosis
A1 (PNK/BLK) & Ground	Battery	See 1
B8 (ORN) & Ground	Battery	See 2
A1 (PNK/BLK) & B1 (BLK/WHT)	Battery	See 3

(Continued on next page)

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A2 (DK BLU) & B1 (BLK/ WHT)	5 Volts	See 4
• Ignition Switch: START		
A3 (BLK/ YEL) & Ground	Battery	See 5

- If voltages are correct, go to Table 2.

1. Check the PNK/BLK (439) wire and ECM Fuse for an open.
2. Check the ORN (440) wire and VATS Fuse for an open.
3. Check the BLK/WHT (450) wire for an open.
4. Check the DK BLU (229) wire for an open. If wire is good, replace ECM.
5. Check BLK/YEL (625) wire for an open. If wire is good, do Test C.

B: PASS KEY DECODER MODULE TEST (TABLE 2)

Measure: RESISTANCE
At: PASS KEY DECODER MODULE CONNECTOR (Disconnected)
Conditions:
- **Negative Battery Terminal (Disconnected)**
- **Key Not In Ignition Switch**

Measure Between	Correct Resistance	For Diagnosis
A6 (WHT/ BLK) & B2 (PPL/WHT)	Open circuit	See 1
• Key in Ignition		
A6 (WHT/ BLK) & B2 (PPL/WHT)	380 to 12.3K ohms	See 2

- If resistance is correct but engine will not crank, replace the PASS Key Decoder Module.

Note: When the PASS Key Decoder Module is replaced, the new module will store the key resistance value the first time the car is started. The Security Indicator will remain on for this first ignition cycle, and not turn off until the Ignition Switch is turned to OFF.

1. Check WHT/BLK (1073) and PPL/WHT (1074) wires for shorts to ground or between the two wires.
2. Check WHT/BLK (1073) and PPL/WHT (1074) wires for an open.

C: STARTER ENABLE RELAY TEST

Measure: VOLTAGE
At: STARTER ENABLE RELAY CONNECTOR (Disconnected)
Condition:
- **Ignition Switch: START**

Measure Between	Correct Voltage	For Diagnosis
E (YEL) & Ground	Battery	See 1
C (YEL) & Ground	Battery	See 1

- If voltages are correct, go to C2.

1. Check YEL (5) wire for an open. If wire is good but voltage is not present, go to 8A-30 for diagnosis of Starter and Charging circuits.

C2. Connect a fused jumper between terminals E (YEL) wire and A (TAN/WHT) wire of the Starter Enable Relay Connector. Turn Ignition Switch to START.

- If engine cranks proceed to C3.
- If engine does not crank, go to page 30-0 for diagnosis of Starter and Charging circuits.

C3. Reconnect the Starter Enable Relay and connect a fused jumper from terminal A3 (BLK/YEL) wire of the PASS Key Decoder Module to ground. Turn Ignition Switch to START.

- If engine cranks, replace the PASS Key Decoder Module.
- If engine does not crank, check the BLK/YEL (625) wire for an open. If wire is OK, replace the Starter Enable Relay.

D: ECM ENABLE SIGNAL TEST (TABLE 1)

Measure: VOLTAGE
At: ELECTRONIC CONTROL MODULE (ECM) CONNETORS C1 (V8 VIN E) or C3 (V6 VIN T, V8 VIN F, V8 VIN 9) (Connected)
Condition:
- **Ignition Switch: RUN**

Measure Between	Correct Voltage	For Diagnosis
C1/B6 or C3/ F10 (DK BLU) & Ground	2-3 Volts	See 1

- If the voltage is correct but the car will not start, the PASS Key Module is OK. See Diagnostic Circuit check Section 6E.

1. Go to Table 2.

D: ECM ENABLE SIGNAL TEST (TABLE 2)

Measure: VOLTAGE
At: ELECTRONIC CONTROL MODULE (ECM) CONNECTORS C1 (V8 VIN E) or C3 (V6 VIN T, V8 VIN 8, V8 VIN F) (Connected)
Conditions:
- **VATS Fuse: REMOVED**
- **Ignition Switch: RUN**

Measure Between	Correct Voltage	For Diagnosis
C1/B6 or C3/ F10 (DK BLU) & Ground	5 Volts	See 1

- If voltage is correct, check DK BLU (229) wire for an open. Check PASS Key Decoder Module connector terminals. They should be clean and tight. If OK, replace PASS Key Decoder Module.

1. Check DK BLU (229) wire and PASS Key Decoder Module for a short to ground. If both are good, check for good contact between the Electronic Control Module (ECM) and its connectors. If contact is good, replace the Electronic Control Module (ECM).

E: SECURITY INDICATOR OPEN TEST

Measure: VOLTAGE
At: PASS KEY DECODER MODULE CONNECTOR (Disconnected)
Condition:
- **Ignition Switch: RUN**

Measure Between	Correct Voltage	For Diagnosis
A4 (GRY) & Ground	Battery	See 1

- If voltage is correct replace PASS Key Decoder Module.

1. Check the GRY (1343) wire for an open. If OK, replace the Instrument Cluster (see section 8C).

F: PASS KEY DECODER MODULE PROGRAMMING TEST

1. Check that connector C228 is connected clean and tight. With Ignition Switch in OFF, disconnect connector C228. Turn the Ignition Switch to RUN and measure the voltage between terminal A (WHT/BLK) and a known good ground.

- If approximately 5 volts is measured, go to step 2.
- If 5 volts is not measured, check the WHT/BLK (1073) wire for an open or short to ground. If OK, replace the PASS Key DecoderModule.

2. Measure the voltage between connector C228 terminals B and A.

- If approximately 5 volts is measured, go to Test A.
- If approximately 5 volts is not measured, check the PPL/WHT (1074) wire for an open. If OK, replace the PASS Key Decoder Module.

KEY DUPLICATION PROCEDURE

Key Replacement (Spare Key Available)

The J35628 Interrogator or equivalent must be used to determine the proper electrical code of the key.

1. Insert the customer's spare ignition key into the Key Code Reader on the J35628 Interrogator.
2. Press the On-Off switch to ON.
3. A number from 1 to 15, designating the electrical code of the key, will appear in the window.
4. Cut a new key which has the electrical code determined from the J35628 Interrogator.
5. Start the engine using the new key to insure that the key is correct both mechanically and electrically.

Key Replacement (No Spare Key Available)

1. If the Ignition Key is lost and there is no spare key, determine the mechanical code from the code on the ignition key lock cylinder. The code may also be determined from the dealer invoice for the car, or from the Chevrolet Zone Office.
2. Cut a new key to this mechanical code. This key becomes a test key and is used to operate the Ignition Switch for the remaining steps. The resistance of this key does not matter for the remaining steps.
3. Remove the hush panel under the steering column and disconnect C228 (two-cavity connector leading into the steering column).
4. Insert the male half of the connector into the female pigtail connector from the J35628 Interrogator.
5. Set the Key Code Selector on the Interrogator (J35628 or equivalent) to "1".
6. Attempt to start engine using the key made in step 2.

- If engine starts, the Key Code Selector is set to the correct electrical code. Cut a new key having this electrical code. The new key will be the customer's replacement key.

(Continued on next page)

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- If engine does not start, turn Ignition Switch to OFF, then turn the Key Code Selector to the next higher position. Wait four minutes and attempt to start the engine using the new electrical code. (Use the 4-minute Timer on the J35628 Interrogator to indicate the 4-minute interval. Start the Timer by depressing the "Start" rocker switch. The red indicator will turn off at the end of a 4-minute interval.) Repeat this step until the engine starts. Cut a new key with the electrical code which allowed the vehicle to start.

CIRCUIT OPERATION

Resistor sensing contacts are located in the Ignition Key Lock Cylinder. These contact the Key Resistor Pellet on the key when it is inserted. When the lock is rotated, battery voltage is applied through the ECM Fuse to the PASS Key Decoder Module. The Pellet resistance is then compared against the resistance value stored in the Module.

If the Key Resistance Pellet is the proper resistance, terminal A3 is grounded, energizing the Starter Enable Relay. At the same time, a signal is applied at terminal A2 to enable the Electronic Control Module (ECM). When this signal is received by the Electronic Control Module (ECM), it allows fuel injector pulses to begin.

If the Key Resistor Pellet is the wrong value, the PASS Key Decoder Module will shut down for 2 to 4 minutes. During this interval there will be no output at terminals A3 or A2.

If the Ignition Switch is turned on again during this interval, the Timer will begin over again and the PASS Key Decoder Module will remain shut down for another 2 to 4 minutes. The PASS Key Decoder Module will continue this process even if a key with the correct pellet is used to turn the ignition back on. The Timer is restarted by the ignition voltage at terminal A1 when Ignition Switch is turned to RUN.

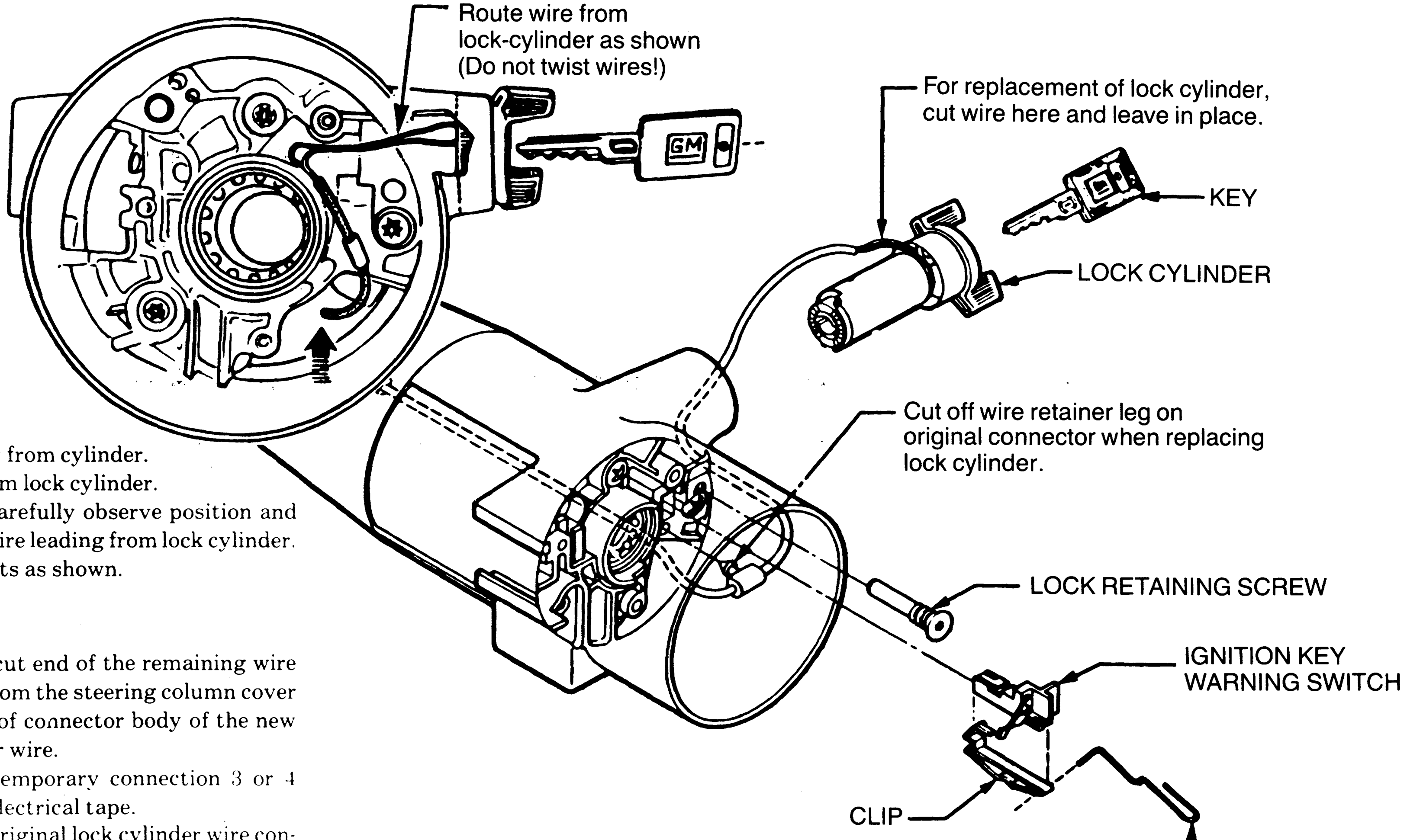
Once the Timer has completed its 2 to 4 minute cycle with the ignition off, the PASS Key Decoder Module and Timer are reset. A key having the correct code can then be used to start the engine.

The Security Indicator is controlled directly by the PASS Key Decoder Module. If the PASS Key Decoder Module is actively preventing the vehicle from starting, this indicator will be grounded by the PASS Key Decoder Module with the ignition in RUN, BULB TEST or START. When the Ignition Switch is first placed in RUN, BULB TEST or START, the Indicator lights for about 2 seconds as a bulb check.

NOTE:
In the event that the PASS Key Decoder Module must be replaced, there is no special procedure necessary to program the new PASS Key Decoder Module to the resistance in the existing ignition key. The new PASS Key Decoder Module will automatically program itself to the existing ignition key resistance on the first ignition cycle.

If the wiring to the Key Resistance Pellet is defective and a new module is installed, the engine will start but the Indicator will stay on until Ignition Switch is turned off. Use this as a check for proper module installation. After the module has programmed itself, defective wiring to the resistance pellet will be treated as an incorrect resistance code and the engine will not start.

REMOVE AND INSTALL IGNITION LOCK AND KEY WARNING BUZZER



Route wire from lock-cylinder as shown (Do not twist wires!)

For replacement of lock cylinder, cut wire here and leave in place.

Cut off wire retainer leg on original connector when replacing lock cylinder.

Use paper clip when removing ignition key warning switch.

REMOVE

1. Remove key from cylinder.
2. Cut wire from lock cylinder.
3. NOTE — Carefully observe position and routing of wire leading from lock cylinder.
4. Remove parts as shown.

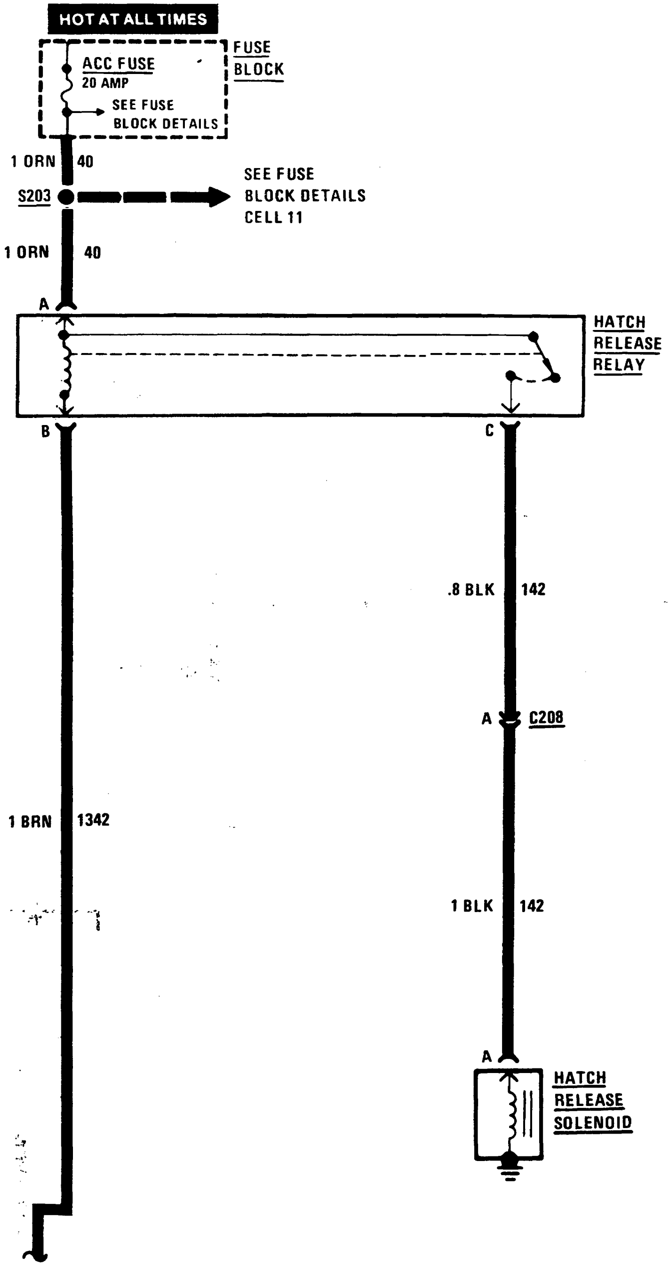
INSTALL

1. Attach the cut end of the remaining wire extending from the steering column cover to the back of connector body of the new lock cylinder wire.
2. Wrap this temporary connection 3 or 4 times with electrical tape.
3. Pull on the original lock cylinder wire connector at the bottom of the steering column and carefully feed the new wire through the lock cover opening and down through the steering column.
4. Route wire as it originally was and insert wire retaining grommet.

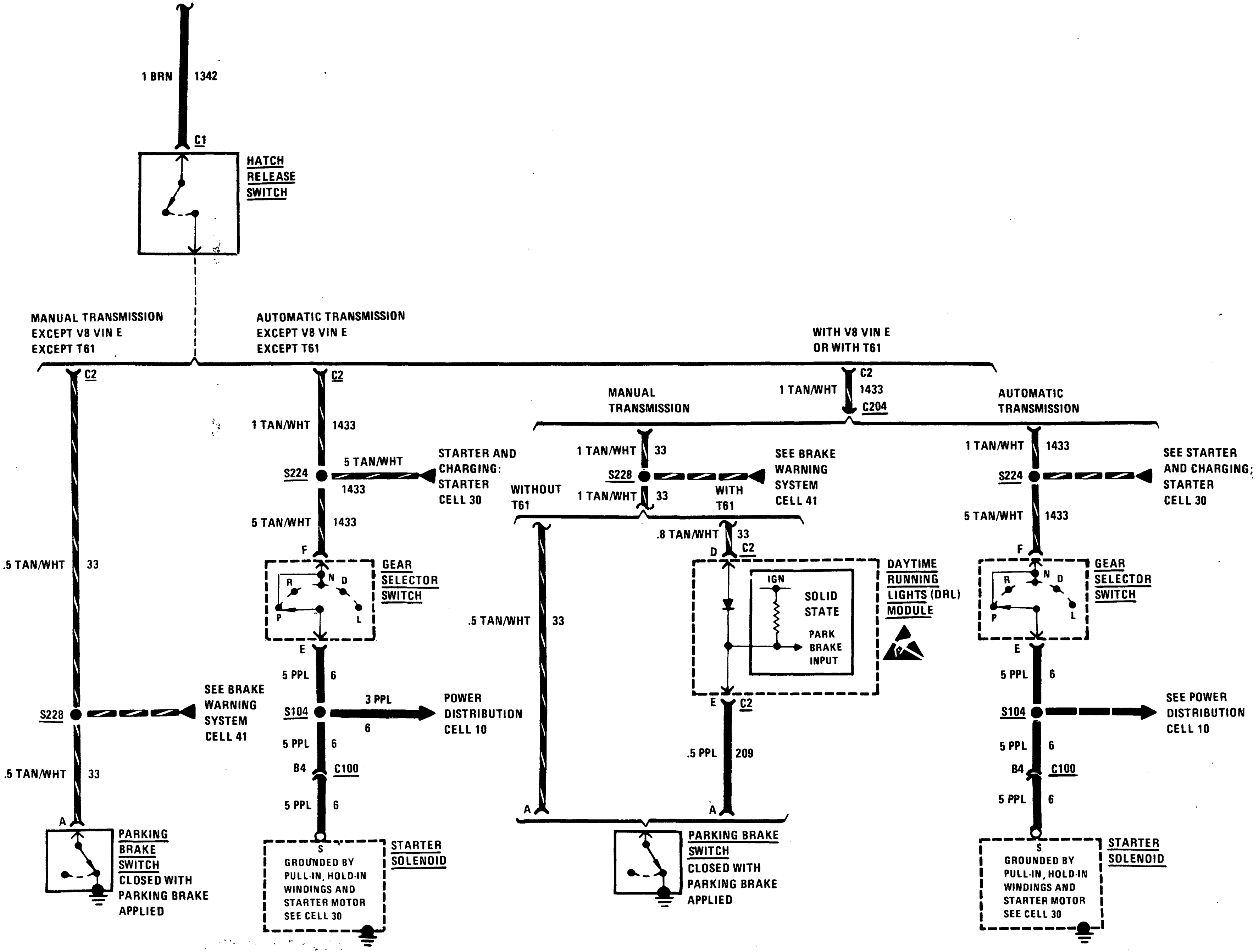
LOST KEYS

1. Follow steps 2 and 3 under REMOVE.
2. Rotate lock cylinder 90° CCW and read key number.
3. Reinstall lock cylinder and route attached wire as shown.

HATCH RELEASE



SEE 8A-4-0
FOR MEASURING
AND HANDLING
PROCEDURES


1 BRN
1342
C1
HATCH RELEASE SWITCH
MANUAL TRANSMISSION EXCEPT V8 VIN E EXCEPT T61
AUTOMATIC TRANSMISSION EXCEPT V8 VIN E EXCEPT T61
WITH V8 VIN E OR WITH T61
C2
.5 TAN/WHT
33
S228
SEE BRAKE WARNING SYSTEM CELL 41
.5 TAN/WHT
33
A
PARKING BRAKE SWITCH CLOSED WITH PARKING BRAKE APPLIED
C2
1 TAN/WHT
1433
S224
5 TAN/WHT
1433
STARTER AND CHARGING: STARTER CELL 30
5 TAN/WHT
1433
F
GEAR SELECTOR SWITCH
R
N
D
P
L
E
5 PPL
6
S104
3 PPL
6
POWER DISTRIBUTION CELL 10
5 PPL
6
B4
C100
5 PPL
6
S
GROUNDED BY PULL-IN, HOLD-IN WINDINGS AND STARTER MOTOR SEE CELL 30
STARTER SOLENOID
1 TAN/WHT
C2
1433
C204
MANUAL TRANSMISSION
AUTOMATIC TRANSMISSION
1 TAN/WHT
33
S228
SEE BRAKE WARNING SYSTEM CELL 41
WITHOUT T61
1 TAN/WHT
33
WITH T61
.5 TAN/WHT
33
.8 TAN/WHT
33
D
C2
DAYTIME RUNNING LIGHTS (DRL) MODULE
IGN
SOLID STATE
PARK BRAKE INPUT
E
C2
.5 PPL
209
A
A
PARKING BRAKE SWITCH CLOSED WITH PARKING BRAKE APPLIED
1 TAN/WHT
1433
S224
SEE STARTER AND CHARGING; STARTER CELL 30
5 TAN/WHT
1433
F
GEAR SELECTOR SWITCH
R
N
D
P
L
E
5 PPL
6
S104
SEE POWER DISTRIBUTION CELL 10
5 PPL
6
B4
C100
5 PPL
6
S
GROUNDED BY PULL-IN, HOLD-IN WINDINGS AND STARTER MOTOR SEE CELL 30
STARTER SOLENOID

HATCH RELEASE

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Diagnosis**

1. Check for proper operation of the Brake Warning System (manual transmission) or the Starting System (automatic transmission). Repair any conditions in those systems before attempting to diagnose conditions in the Hatch Release circuit.
2. Check the ACC Fuse by operating the horn.
3. Check that the Hatch Release Solenoid case ground is clean and tight.

- **Go to System Check for a guide to normal operation.**
- **Go to System Diagnosis for diagnostic tests.**

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation.**

SYSTEM CHECK TABLE

ACTION	NORMAL RESULT
Press Hatch Release Switch button with the Parking Brake applied (manual transmission) or the Gear Selector Switch in P or N (automatic transmission)	Hatch Lid releases and opens freely

SYSTEM DIAGNOSIS

- **Do the tests indicated below if the Hatch release does not operate properly.**

COMPONENT LOCATION

		Page-Figure
Daytime Running Lights (DRL) Module	Behind LH side of I/P	201-12-A
Fuse Block	Behind LH side of I/P	201-13-A
Gear Selector Switch	In console, at gear selector	201-17-F
Hatch Release Relay	RH side of console, behind gear selector	201-17-D
Hatch Release Solenoid	Center of end panel, in cargo compartment	201-19-A
Parking Brake Switch	In console, at base of parking brake lever	201-17-D
Starter Solenoid (VIN E)	Lower RH side of engine	201- 6-C
Starter Solenoid (VIN F)(VIN 8)	Lower RH side of engine	201- 9-C
Starter Solenoid (VIN T)	Lower RH side of engine	201- 2-B
C100 (42 cavities)	LH front of dash, below relay backet	201-12-A
C204 (1 cavity)	Behind center of I/P	201-12-A
C208 (8 cavities)	Near LH rear quarter panel	201-19-C
S104	I/P harness, behind LH side of I/P	201-12-A
S203	I/P harness, behind LH side of instrument cluster	201-12-A
S224	I/P harness, behind LH side of I/P, near Fuse Block	201-12-A
S228	I/P harness, behind LH side of I/P	201-12-A

TEST 1

Measure: VOLTAGE
At: HATCH RELEASE SWITCH CONNECTORS (Disconnected)
Conditions:

- **Parking Brake (manual transmission): APPLIED**
- **Gear Selector Switch (automatic transmission): P or N**

Measure Between	Correct Voltage	For Diagnosis
C1 (BRN) & Ground	Battery	See 1
C1 (BRN) & C2 (TAN/WHT)	Battery	See 2

(Continued in next column)

(continued from previous column)

- Parking Brake: RELEASED
- Gear Selector Switch: D or R

C1 (BRN) & C2 (TAN/WHT)	Approximately 0	See 3

- If all voltages are correct, reconnect switch and go to Test 2.

1. Reconnect switch and go to Test 2.
2. Repair open in TAN/WHT (33 or 1433) wire.
3. Repair short to ground in TAN/WHT (33 or 1433) wire.

TEST 2

Measure: VOLTAGE
At: HATCH RELEASE RELAY CONNECTOR (Disconnected)
Conditions:

- **Parking Brake (manual transmission): APPLIED**
- **Gear Selector Switch (automatic transmission): P or N**

Measure Between	Correct Voltage	For Diagnosis
A (ORN) & Ground	Battery	See 1
• Hatch Release Switch: RELEASE (hold)		
A (ORN) & B (BRN)	Battery	See 2

- If all voltages are correct, reconnect relay and go to Test 3.

1. Check ORN (40) wire for an open.
2. Check BRN (1342) wire for an open. If wire and connectors are OK, replace the Hatch Release Switch.

TEST 3

Measure: VOLTAGE
At: HATCH RELEASE SOLENOID CONNECTOR (Disconnected)
Conditions:

- **Parking Brake (manual transmission): APPLIED**
- **Gear Selector Switch (automatic transmission): P or N**
- **Hatch Release Switch: RELEASE (hold)**

Measure Between	Correct Voltage	For Diagnosis
BLK & Ground	Battery	See 1

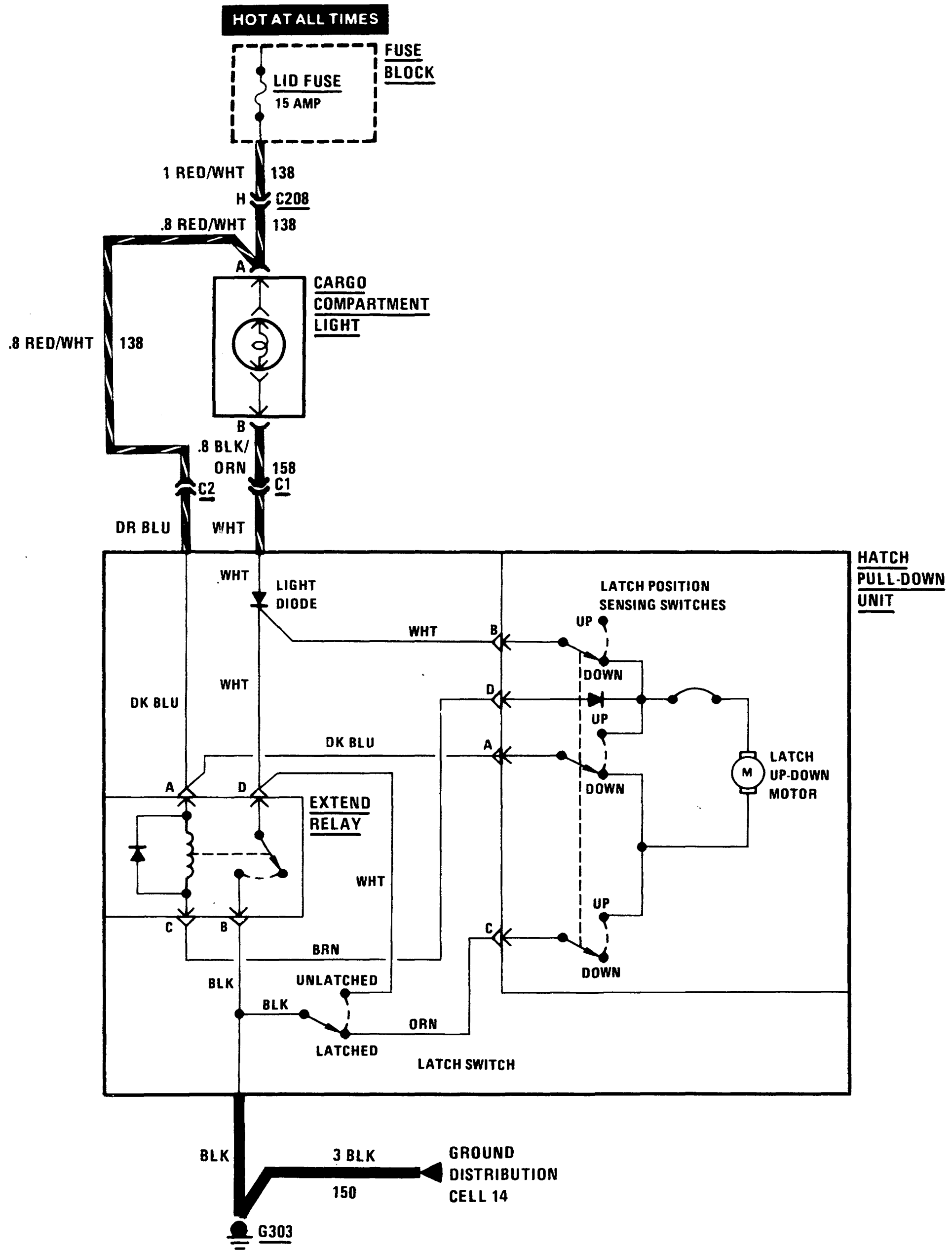
- If voltage is correct, repair/replace the Hatch Release solenoid.

1. Check 142 (BLK) wire for an open. If wire and connectors are OK, replace the Hatch Release Relay.

CIRCUIT OPERATION

Voltage is applied at all times from the ACC Fuse to the Hatch Release Relay. The relay is controlled by the Hatch Release Switch grounding the relay coil. On vehicles with manual transmissions, the Parking Brake must be applied to ground the relay coil. Vehicles with automatic transmissions use the starter motor to complete the ground. When the relay is energized, voltage is applied to the Hatch Release Solenoid. The solenoid operates the latch and the hatch opens.

HATCH PULL-DOWN



HATCH PULL-DOWN

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Check.**

1. Check the LID Fuse by visual inspection.
2. Check that the Hatch Pull-Down Unit is properly grounded.
3. Check that all connectors are firmly seated.

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation.**
- **Refer to System Diagnosis for diagnostic steps.**

SYSTEM CHECK TABLE

ACTION	NORMAL RESULT
Open the Hatch	The hatch should open freely and the pull-down latch should fully extend
Lower the hatch until it latches the striker	The latch retracts pulling the hatch closed **Caution:** to avoid injury keep fingers and clothing away from edge of hatch while it is closing.

SYSTEM DIAGNOSIS

- **Do the test below if the Hatch Pull-Down Unit does not operate.**

COMPONENT LOCATION

		Page-Figure
Fuse Block	Behind LH side of I/P	201-13-A
Hatch Pull-Down Unit	Center of rear end panel, in cargo compartment	201-19-A
C208 (8 cavities)	Near LH rear quarter panel	201-19-C
G303	Center of rear end panel, in cargo compartment	201-19-A

Measure: VOLTAGE
At: HATCH PULL-DOWN UNIT CONNECTOR (Disconnected)

Measure Between	Correct Voltage	For Diagnosis
RED/WHT & Ground	Battery	See 1

- If voltage is correct but Hatch Pull-Down Unit does not operate, check that unit is properly grounded. If ground is OK, repair/replace unit.

1. Check RED/WHT (138) wire and LID Fuse for an open.

CIRCUIT OPERATION

Battery voltage is applied at all times from the LID Fuse to the Hatch Pull-Down Unit. The Latch Up-Down Motor is protected by a self resetting circuit breaker. The unit is grounded by the BLK wire at G303. The unit also controls the Cargo Light. See Interior Lights: Cargo Compartment (Cell 114) for details.

HATCH PULL-DOWN

Extend Sequence

The motor receives battery voltage through the RED/WHT wire and the BLU wire to the center Latch Position Sensing Switch in the "down" position. When the hatch is released, with either the key or the release solenoid, the Latch Switch moves to the "unlatched" position. The Latch Switch provides a ground path through the top position sensing switch and the WHT wire for the motor. The latch extends. The Extend Relay coil is energized through the BRN wire to the top position sensing switch and through the WHT wire in the same manner as the motor. If the hatch was closed into the latch before the latch was fully extended, the Extend Relay continues the extending operation so that the pull-down operation will occur correctly.

When the latch is fully extended the Latch Position Sensing Switches move to the "up" position and the motor stops.

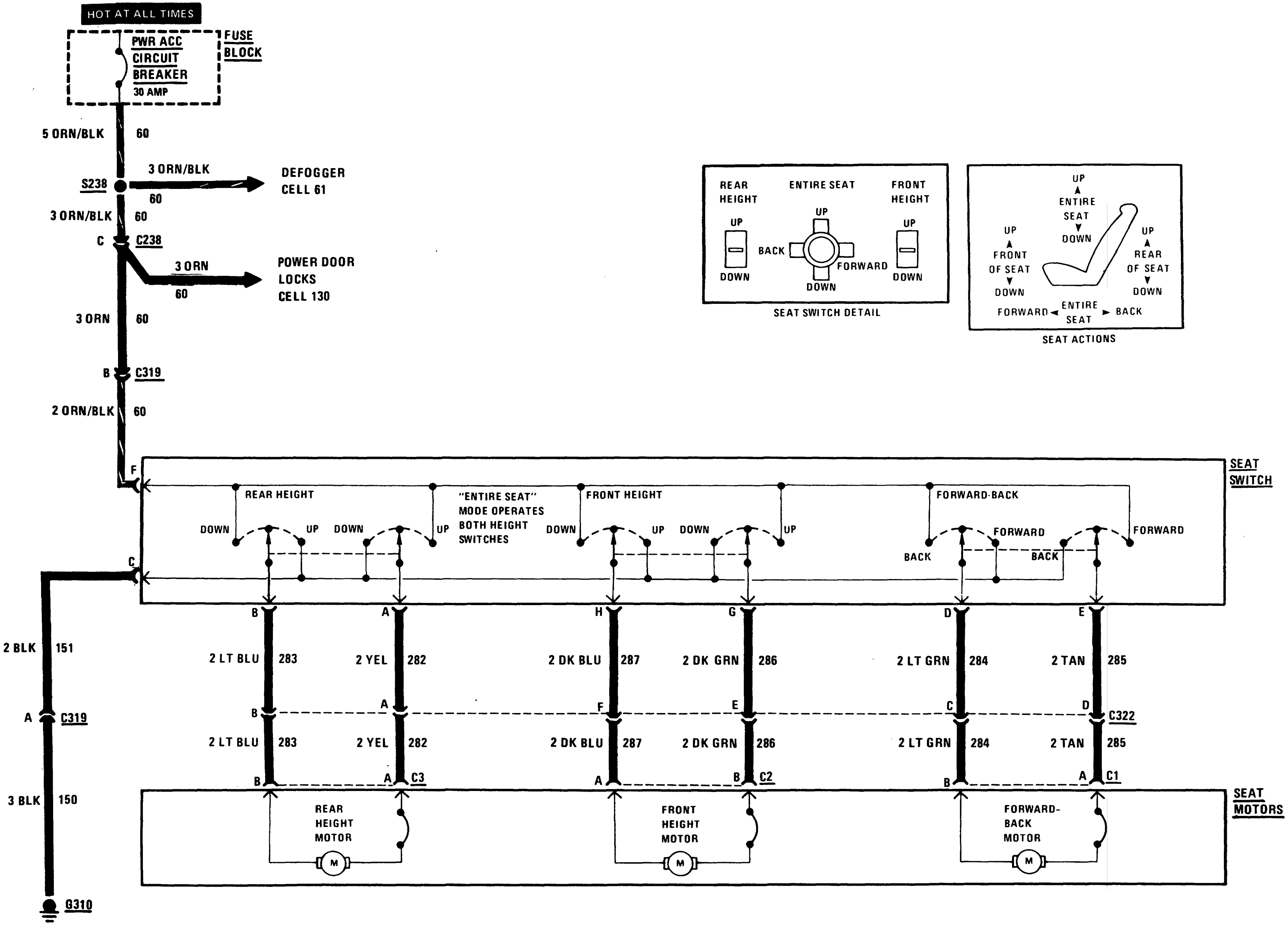
The Light Diode in the Hatch Pull-Down Unit prevents the latch from accidentally extending if the BLK/ORN wire was shorted to ground.

Pull-Down Sequence

When the hatch is manually pushed down into the latch, the Latch Switch moves to the "latched" position. With the Latch Position Sensing Switches already in the "up" position, the Latch Up-Down Motor is grounded through the lower position sensing switch the ORN wire and the Latch Switch, in the "latched" position, to ground. The pull-down operation starts. When the hatch reaches the fully closed position the Latch Position Sensing Switches move to the "down" position and the motor stops.

BLANK

POWER SEATS: THREE MOTOR



POWER SEATS: THREE MOTOR

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Check.**

1. If none of the Seat functions operate, check PWR ACC Circuit Breaker.
2. If Rear or Front Height does not function, but Entire Seat moves up and down, replace Seat Switch.
3. If the Rear and Front Height function properly, but Entire Seat does not move up and down, replace Seat Switch.

- **Go to System Check for a guide to normal operation.**
- **Go to System Diagnosis for diagnostic tests.**

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation.**

SYSTEM CHECK TABLE

ACTION	NORMAL RESULT
Move Rear Height Switch UP and DOWN	Rear of seat moves up and down
Move Front Height Switch UP and DOWN	Front of seat moves up and down
Move Entire Seat Switch UP and DOWN	Entire seat moves up and down
Move Entire Seat Switch FORWARD and BACK	Entire seat moves forward and back

- **Refer to System Diagnosis when a result is not normal.**

COMPONENT LOCATION

		Page-Figure
Fuse Block	Behind LH side of I/P	201-13-A
Seat Motors	Under LH front seat	
C238 (4 cavities)	LH shroud, ahead of center access hole	201-17-A
C319 (2 cavities)	Under LH front seat	201-16-B
C322 (6 cavities)	Under LH front seat	
G310	Under driver's seat	201-16-B
S238	I/P harness, behind LH side of I/P	201-12-A

SYSTEM DIAGNOSIS

- **Do the tests listed for your symptom in the Symptom Table below.**
- **Tests follow the Symptom Table.**

SYMPTOM TABLE

SYMPTOM	FOR DIAGNOSIS
None of the seat functions work	Do Test A
Some, but not all, seat functions work	Do Test B

A: INPUT TEST

Connect: TEST LAMP
At: SEAT SWITCH CONNECTOR (Connected)

Connect Between	Correct Result	For Diagnosis
F (ORN/BLK) & Ground	Lamp lights	See 1
F (ORN/BLK) & C (BLK)	Lamp lights	See 2

- If lamp lights in both tests, check C322, then replace Seat Switch.

1. Check PWR ACC Circuit Breaker and ORN and ORN/BLK (60) wires for an open (see schematic).
2. Check G310 and BLK (151) and BLK (150) wires for an open (see schematic).

B: SWITCH TEST

Connect: TEST LAMP At: SEAT SWITCH CONNECTOR (Connected) Condition: • Entire Seat Switch: FORWARD & BACK		
Connect Between	**Correct Result**	**For Diagnosis**
D (LT GRN) & E (TAN)	Lamp lights	See 1
• Rear Height Switch: UP & DOWN		
B (LT BLU) & A (YEL)	Lamp lights	See 1
Front Height Switch: UP & DOWN		
H (DK BLU) & G (DK GRN)	Lamp lights	See 1
• If lamp lights in all tests, test wires leading to appropriate motor for an open. Replace motor if wires are OK (see schematic). 1. Replace Seat Switch.		

CIRCUIT OPERATION

There are three reversible motors that operate the Power Seats. Two separate motors are used to position the front and rear height of a seat. When the Entire Seat Switch is pushed to the UP or DOWN position, both motors operate to move the front and back height of a seat at the same time.

The Forward-Back Motor is operated by the Entire Seat Switch. When held in the FORWARD position, battery voltage is applied to the switch contacts, the TAN wire, and the Forward-Back Motor. The motor is grounded through the LT GRN wire and the switch contacts to G310. The motor runs to drive the seat forward until the switch is released.

In the BACK position, the LT GRN wire receives battery voltage and the TAN wire is grounded. This reversed polarity causes the motor to run in the opposite direction to drive the seat backward until the switch is released.

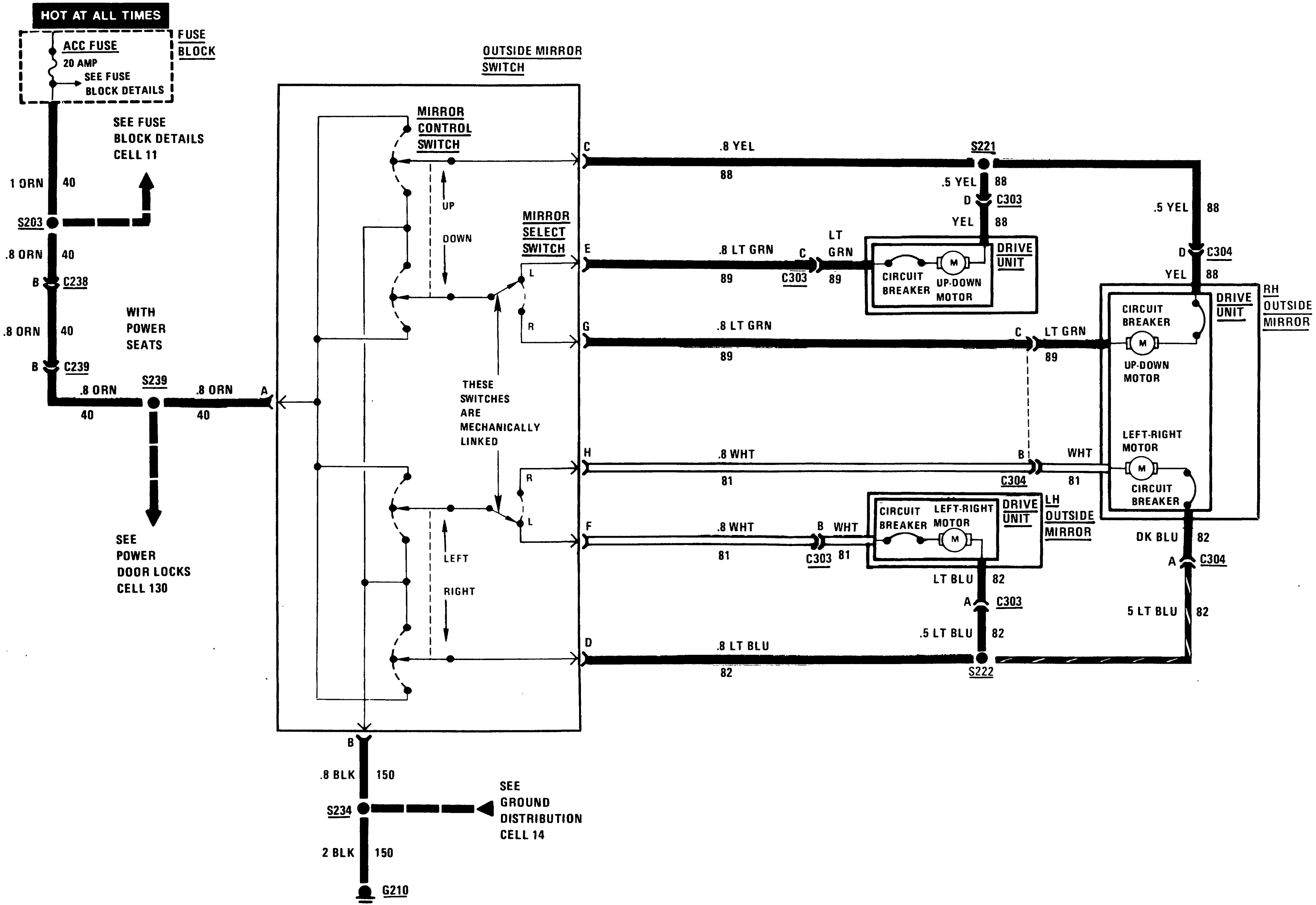
To raise the entire seat, the Entire Seat Switch is held in the UP position. This applies battery voltage to both the YEL and DK GRN wires, and both the Front Height and Rear Height Motors. The LT BLU and DK BLU wires are grounded through the contacts of the Front Height Switch and the Rear Height Switch. Both motors run to drive the entire seat up. A similar action occurs to move the entire seat down.

To raise the front height of the seat independently, hold the Front Height Switch in the UP position. This applies battery voltage to the Front Height Motor through the Front Height Switch contacts and DK GRN wire. The motor is grounded through the DK BLU wire and the contacts of the Front Height Switch to G310. The motor runs until the switch is released. To lower the front height of the seat, hold the Front Height Switch in the DOWN position. This action now grounds the DK GRN wire and applies battery voltage to the DK BLU wire. This reverses the polarity of the motor and causes the motor to run in the opposite direction to lower the seat. The Rear Height Motor operates similarly to adjust the rear height of the seat.

Each motor contains a self-resetting circuit breaker to protect it from overload. It will reset as the motor circuit cools off.

BLANK

POWER MIRRORS



POWER MIRRORS

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Check.**

1. Check the ACC Fuse by check for operation of the Horn.
2. Check that ground G210 is clean and tight. If equipped, G210 may be checked by operating the Power Door Locks or the Power Windows.

- **Go to System Check for a guide to normal operation.**
- **Go to System Diagnosis for diagnostic tests.**

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation.**
- **Refer to System Diagnosis for a list of symptoms and diagnostic steps.**

SYSTEM CHECK TABLE

ACTION	NORMAL RESULT
Put Mirror Select Switch in L position, operate Mirror Control Switch in UP and DOWN positions	LH Outside Mirror moves smoothly up and down
Operate Mirror Control Switch in the LEFT and RIGHT positions	LH Outside Mirror moves smoothly to the left and right
Put Mirror Select Switch in R position, operate Mirror Control Switch in UP and DOWN positions	RH Outside Mirror moves smoothly up and down
Operate Mirror Control Switch in the LEFT and RIGHT positions	RH Outside Mirror moves smoothly to the left and right

- **Refer to System Diagnosis when a result is not normal.**

COMPONENT LOCATION

		Page-Figure
Fuse Block	Behind LH side of I/P	201-13-A
C238 (4 cavities)	LH shroud, ahead of center access hole	201-17-A
C239 (4 cavities)	LH shroud, near center access hole	201-17-A
C303 (4 cavities)	Top front of LH door, behind panel	201-18-A
C304 (4 cavities)	Top front of RH door, behind panel	201-18-A
G210	Under rear of console	201-17-C
S203	I/P harness, behind LH side of instrument cluster	201-12-A
S221	Crosscar harness, near LH center access hole	201-17-B
S222	Crosscar harness, near LH center access hole	201-17-B
S234	Crosscar harness, below console	201-17-C
S239	Crosscar harness, near LH shroud	201-17-B

SYSTEM DIAGNOSIS

- **Diagnostic steps for the symptoms listed in the following table are listed after the table.**

SYMPTOM TABLE

A. Both mirrors do not operate in any mode.
B. LH mirror does not operate in one or more modes.
C. RH mirror does not operate in one or more modes.

A: BOTH MIRRORS DO NOT OPERATE IN ANY MODE

Measure: VOLTAGE
At: OUTSIDE MIRROR SWITCH CONNECTOR (Disconnected)

Measure Between	Correct Voltage	For Diagnosis
A (ORN) & Ground	Battery	See 1
A (ORN) & B (BLK)	Battery	See 2

- If all voltages are correct, replace the Outside Mirror Switch.

1. Check/repair ORN (40) wire.
2. Check/repair BLK (150) wire.

B: LH MIRROR DOES NOT OPERATE IN ONE OR MORE MODES

Measure: VOLTAGE
At: OUTSIDE MIRROR SWITCH CONNECTOR (Connected)
Conditions:
- **Mirror Select Switch: L**
- **Mirror Control Switch: Hold UP or DOWN**

Measure Between	Correct Voltage	For Diagnosis
C (YEL) & E (LT GRN)	Battery	See 1
• Mirror Control Switch: LEFT or RIGHT position (HOLD)		
D (LT BLU) & F (WHT)	Battery	See 1

- If all voltages are correct, replace LH Outside Mirror Drive Unit after checking C303 and YEL (88), LT GRN (89), WHT (81) and LT BLU (82) wires. Refer to Section 5A of the Body Service Manual for replacement procedures.

1. Replace Outside Mirror Switch.

C: RH MIRROR DOES NOT OPERATE IN ONE OR MORE MODES

Measure: VOLTAGE
At: OUTSIDE MIRROR SWITCH CONNECTOR (Connected)
Conditions:
- **Mirror Select Switch: R**
- **Mirror Control Switch: Hold UP or DOWN**

Measure Between	Correct Voltage	For Diagnosis
C (YEL) & G (LT GRN)	Battery	See 1
• Mirror Control Switch: LEFT or RIGHT position (HOLD)		
D (LT BLU) & H (WHT)	Battery	See 1

- If all voltages are correct, replace RH Outside Mirror Drive Unit after checking C304 and YEL (88), LT GRN (89), LT BLU (82), and WHT (81) wires. Refer to Section 5A of the Body Service Manual for replacement procedures.

1. Replace Outside Mirror Switch.

CIRCUIT OPERATION

The Power Mirrors are adjusted from the interior of the car by moving the Outside Mirror Switch in the desired direction.

Each Outside Mirror has two reversible motors, one to adjust the mirror view up and down, the other to adjust the mirror view right and left. The driver operates either an Up-Down Switch or Left-Right Switch to control the polarity of the voltage to the motors. The Mirror Select Switch directs these control voltages to either the RH or LH Outside Mirror.

With the switches in the positions shown in the schematic, the LH Outside Mirror is moved. When the Up-Down Switch is moved UP, battery voltage from the ORN wire is applied through the LH contacts of the Mirror Select Switch to the YEL wire at terminal C and to the Up-Down Motor in the LH Outside Mirror. The LH Outside Mirror Up-Down Motor has a path to ground through the LT GRN wire at terminal E through the Up-Down Switch and the BLK wire. The LH motor runs and turns the mirror up.

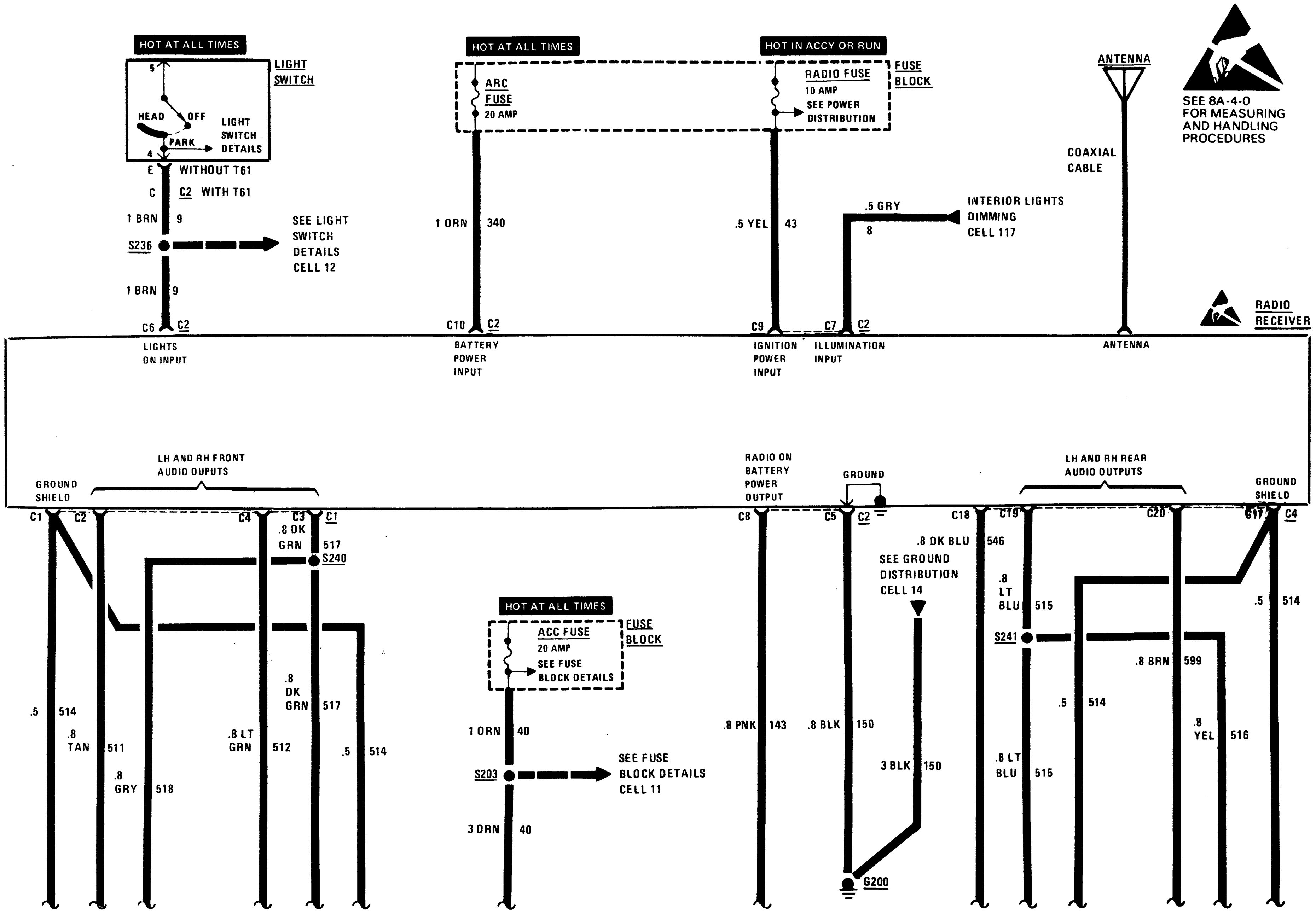
When the Up-Down Switch is pushed to the DOWN position, the LH motor receives voltage; however, the polarity is reversed. The YEL wire is now grounded and voltage is applied to the motor through the LT GRN wire. The motor should run in the opposite direction.

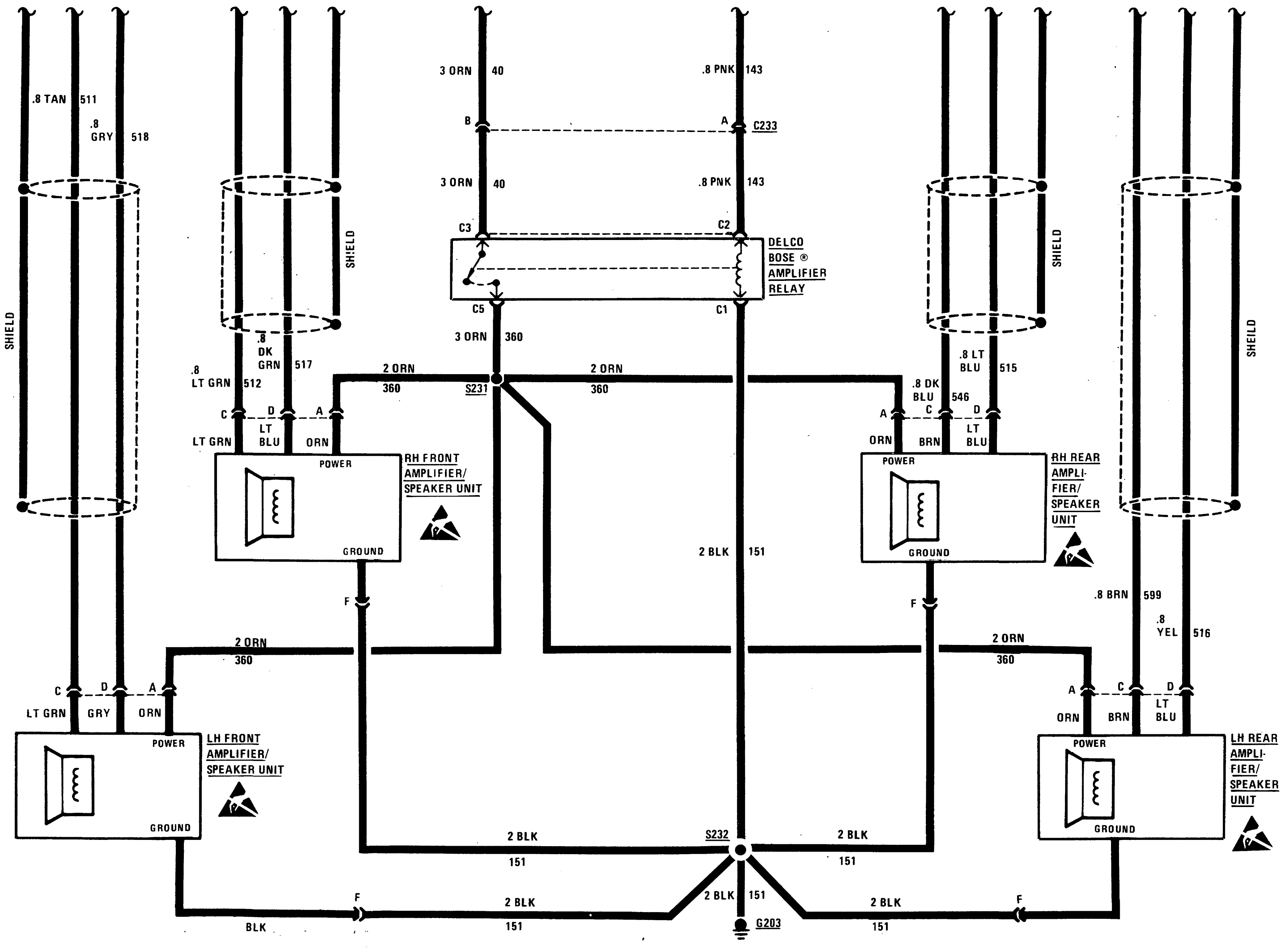
The LH Left-Right Motor operates similarly. When the Left-Right Switch is moved to the LEFT position, battery voltage from the ORN wire is applied through the LH contacts of the Mirror Select Switch to the WHT wire at terminal F and the Left-Right Motor in the LH Outside Mirror. The LH Outside Mirror is grounded through the LT BLU wire at terminal D, the Left-Right Switch and BLK wire. The LH motor runs and turns the mirror to the left.

If the Left-Right Switch is pushed to the RIGHT position, the same motor receives voltage. However, the polarity is reversed, with the WHT wire grounded and voltage now applied to the motor through the LT BLU wire. The motor should run in the opposite direction.

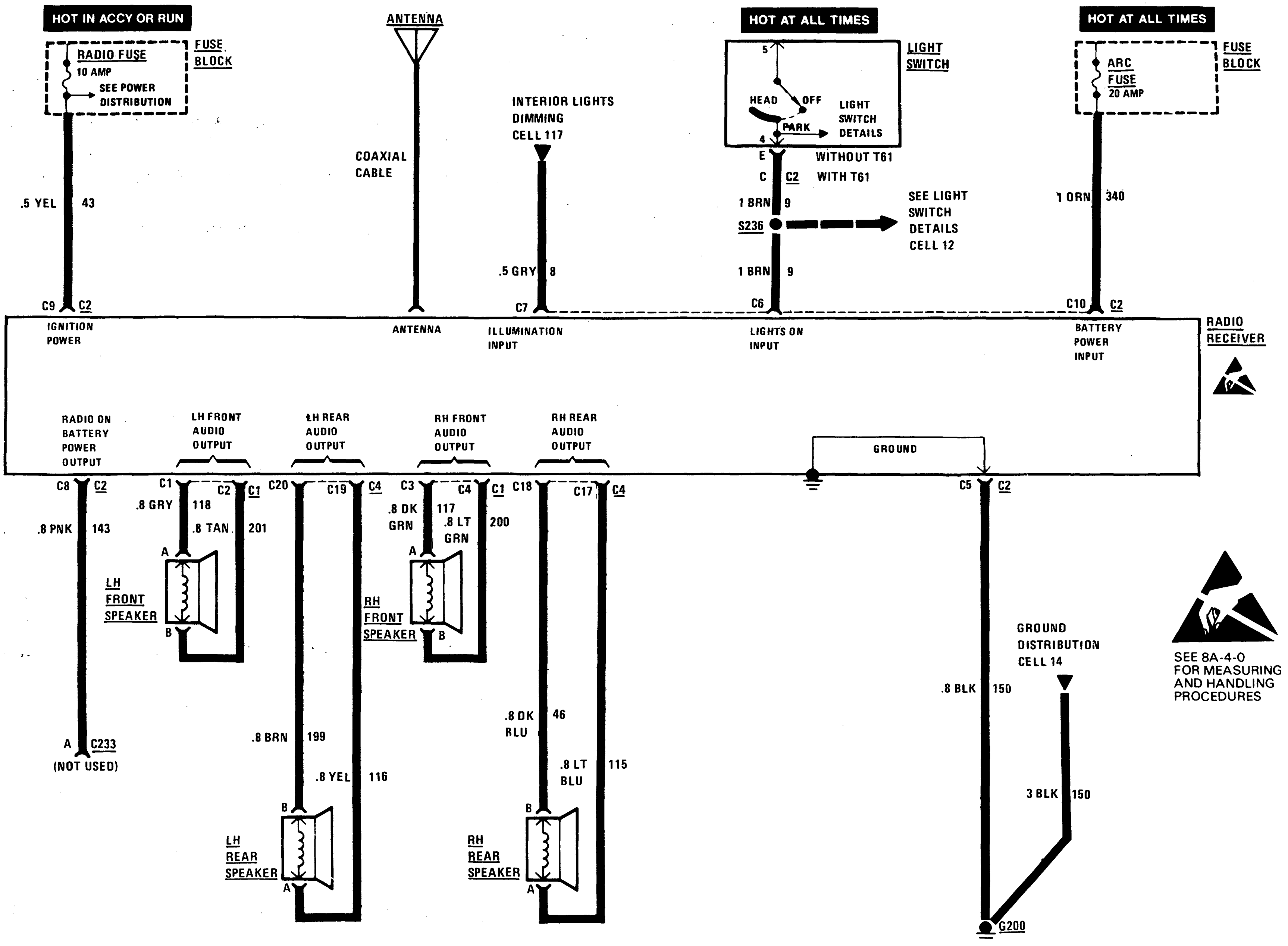
The RH Outside Mirror works the same way as the LH Outside Mirror when the Mirror Select Switch is moved to the R position and the Up-Down and Left-Right Switches are operated.

RADIO: DELCO-BOSE® AMPLIFIED SPEAKER SYSTEM




.8 TAN 511
.8 GRY 518
SHIELD
.8 LT GRN 512
.8 DK GRN 517
SHIELD
3 ORN 40
.8 PNK 143
B
A
C233
3 ORN 40
.8 PNK 143
C3
C2
DELCO BOSE ® AMPLIFIER RELAY
C5
C1
3 ORN 360
2 ORN 360
S231
2 ORN 360
SHIELD
.8 LT BLU 515
.8 DK BLU 546
SHIELD
C D A
LT GRN
LT BLU
ORN
POWER
RH FRONT AMPLIFIER/ SPEAKER UNIT
GROUND
A C D
ORN
BRN
LT BLU
POWER
RH REAR AMPLI-FIER/ SPEAKER UNIT
GROUND
2 BLK 151
F
F
.8 BRN 599
.8 YEL 516
2 ORN 360
2 ORN 360
C D A
LT GRN
GRY
ORN
POWER
LH FRONT AMPLIFIER/ SPEAKER UNIT
GROUND
A C D
ORN
BRN
LT BLU
POWER
LH REAR AMPLI-FIER/ SPEAKER UNIT
GROUND
2 BLK 151
S232
2 BLK 151
F
F
BLK
2 BLK 151
2 BLK 151
2 BLK 151
G203

RADIO (UM6)(UM7)(UU8)(UX1)(U1C)



SEE 8A-4-0 FOR MEASURING AND HANDLING PROCEDURES

TROUBLESHOOTING HINTS

- **Try the following checks before doing the System Check.**

1. Check the RADIO Fuse.
2. Chec the ARC Fuse.
3. Check that the Antenna connector and coaxial cable are properly connected.
4. Adjusting the Radio controls will change the operation of the sound system. Consult the Delco Sound Service Guide for information regarding the operation of these controls.
5. Before troubleshooting a suspect speaker, check all connections to that speaker.
6. For proper noise diagnosis, take the car outside where signals are strong. Close the hood, and keep away from metal buildings or sources of radio interference.
7. Ignition noise on FM may indicate a possible defective Ignition system.
8. Coated screws or bolts can cause a poor ground condition and increase radio noise. Scrape ground screws or bolts clean of any paint or varnish.
9. Check ground G200 and ground G203 (if applicable).

- **Go to System Check for a guide to normal operation.**
- **Go to System Diagnosis for diagnostic tests.**

SYSTEM CHECK

- **Use the System Check Table as a guide to normal operation.**
- **Refer to System Diagnosis for a list of symptoms and diagnostic steps.**
- **For noise problems, refer to System Diagnosis, Test I.**

COMPONENT LOCATION

		Page-Figure
Delco-Bose® Amplifier Relay	Behind RH side of I/P	201-15-A
Fuse Block	Behind LH side of I/P	201-13-A
C233 (2 cavities)	Behind center of I/P, taped to I/P harness	201-13-B
G200	Behind LH side of I/P, on Convenience Center bracket	201-14-C
G203	Behind LH side of I/P, on Convenience Center bracket	201-14-C
S203	I/P harness, behind LH side of instrument cluster	201-12-A
S231	Delco-Bose speaker harness, behind LH side of I/P	201-13-B
S232	Delco-Bose speaker harness, at RH door sill	201-18-C
S236	I/P harness, behind LH side of I/P	201-12-A
S240	Delco-Bose speaker harness, behind radio	201-13-B
S241	Delco-Bose speaker harness, behind radio	201-13-B

SYSTEM CHECK TABLE

ACTION	NORMAL RESULT
With Ignition Switch in RUN, turn the Radio on	The digital display comes on The Digital Clock operates Sound comes from all four speakers
Operate the Radio controls	Consult the Delco Sound Service Guide for information regarding the operation of the controls
Turn Headlight Switch to PARK	The panel light comes on The digital display dims (if equipped)

- **Refer to System Diagnosis when a result is not normal.**

SYSTEM DIAGNOSIS

- **Do the tests listed for your symptom in the Symptom Table below.**
- **Tests follow the Symptom Table.**
- **Tests apply to both Electronically Tuned Radio (ETR) and Delco BOSE ® Music System unless otherwise indicated.**

SYMPTOM TABLE

SYMPTOM	DO TEST
Radio does not appear to work (no display, no sound)	A: Radio Power Input Test
Clock (if equipped) does not operate	B: Clock Power Input Test
Panel Light does not come on	C: Panel Light Voltage Test
Display dimming function will not operate	D: Display Dimming Input Test
(Electronically Tuned Radio ETR) No sound or distorted sounds come from speaker	E: Speaker Test
(Delco/Bose® Music System) Radio appears to work (Display appears) but no sound comes from any speaker	F: Amplifier Relay Test
(Delco/Bose® Music System) No sound or distorted sound comes from a speaker unit	H: Amplifier/ Speaker Unit Test
Excessive noise comes from all speakers	I: Noise Diagnosis

A: RADIO POWER INPUT TEST

Measure: VOLTAGE
At: RADIO CONNECTOR C2 (Disconnected)
Condition:
- **Ignition Switch: RUN**

Measure Between	Correct Voltage	For Diagnosis
C9 (YEL) & Ground	Battery	See 1
C9 (YEL) & C5 (BLK)	Battery	See 2

- If voltages are correct, go to Test B.

1. Check YEL (43) wire for an open.
2. Check BLK (150) wire for an open to ground.

B: CLOCK POWER INPUT TEST

Measure: VOLTAGE
At: RADIO CONNECTOR C2 (Disconnected)

Measure Between	Correct Voltage	For Diagnosis
C10 (ORN) & Ground	Battery	See 1

- If the voltage is correct, remove Radio for service.

1. Check ORN (340) wire for an open (see schematic).

C: PANEL LIGHT VOLTAGE TEST

Measure: VOLTAGE
At: RADIO CONNECTOR C2 (Disconnected)
Conditions:
- **Light Switch: PARK**
- **Dimming Switch: HI**

Measure Between	Correct Voltage	For Diagnosis
C7 (GRY) & Ground	Battery	See 1

- If the voltage is correct, remove Radio for service.

1. Check GRY (8) wire for an open (see schematic).

D: DISPLAY DIMMING INPUT TEST

Measure: VOLTAGE
At: RADIO CONNECTOR C2 (Disconnected)
Condition:
- **Light Switch: PARK**

Measure Between	Correct Voltage	For Diagnosis
C6 (BRN) & Ground	Battery	See 1

- If voltage is correct, remove Radio for service.

1. Check BRN (9) wire for an open (see schematic).

E: SPEAKER TEST (TABLE 1)

Connect: ANALOG OHMMETER
At: SUSPECT SPEAKER (Disconnected)
Conditions:
- **Ohmmeter set on R X 1 scale**
- **Speaker Wires: DISCONNECTED**

Action	Correct Result	For Diagnosis
Connect Ohmmeter across Speaker terminals	Speaker "pops"	See 1

- If the result is correct, go to Table 2.

1. Replace the problem Speaker with a new one.

E: SPEAKER TEST (TABLE 2)

Measure: AC VOLTAGE
At: RADIO OUTPUT FOR SUSPECT SPEAKER
Conditions:
- **Ignition Switch: RUN**
- **Radio: ON (High Volume)**

Action	Correct Voltage	For Diagnosis
Connect voltmeter across outputs of suspect Speaker with Radio tuned to a strong signal	Varying around 1 volt AC	See 1

- If the voltage is correct, repair the wires between the Radio and the suspect speaker.

1. Remove Radio for service.

F: DELCO BOSE® AMPLIFIER RELAY TEST

Measure: VOLTAGE
At: DELCO BOSE® AMPLIFIER RELAY (Connected)
Conditions:
- **Ignition Switch: RUN**
- **Radio: ON**

Measure Between	Correct Voltage	For Diagnosis
C2 (PNK) & Ground	Battery	See 1
C2 (PNK) & C1 (BLK)	Battery	See 2
C3 (ORN & Ground	Battery	See 3
C5 (ORN) & Ground	Battery	See 4

- If all voltages are correct, check the ORN (360) wire for an open. If OK, perform Test G.

1. Check/repair PNK (143) wire.
2. Check/repair BLK (151) wire.
3. Check/repair ORN (40) wire.
4. Replace Delco Bose® Amplifier Relay.

G: ANTENNA TEST

Check for a tight connection of the coaxial cable at the Radio and at the Antenna.

Choose a test antenna that is designed for the Radio installed and connect it to the Radio. Make sure the test Antenna is grounded to the vehicle chassis and keep hands off the mast.

- If the reception improves, the problem exists in the Antenna or its lead-in cable. Refer to the Delco Sound Service Guide for Lead-In Cable diagnosis.
- If the reception is still poor, remove the Radio for service.

H: AMPLIFIER/SPEAKER UNIT TEST (TABLE 1)

Measure: VOLTAGE
At: SUSPECT AMPLIFIER/SPEAKER UNIT CONNECTOR (Disconnected)
Conditions:
- Ignition: RUN
- Radio: ON

Measure Between	Correct Voltage	For Diagnosis
A (ORN) & Ground	Battery	See 1
A (ORN) & F (BLK)	Battery	See 2

- If all voltages are correct, go to Table 2.

1. Check/repair ORN (360) wire.
2. Check/repair BLK (151) wire.

H: AMPLIFIER/SPEAKER UNIT TEST (TABLE 2)

Measure: AC VOLTAGE
At: SUSPECTED AMPLIFIER/SPEAKER UNIT CONNECTOR (Disconnected)
Conditions:
- Ignition Switch: RUN
- Radio: ON (Tuned to strong signal)
- Voltmeter: ON LOW AC VOLTS SCALE

Measure Between	Correct Voltage	For Diagnosis
Terminal C & Terminal D (see schematic)	Varying around 1 volt A/C	See 1

- If voltage is correct, remove speaker from enclosure and go to Table 4.

1. Go to Table 3.

H: AMPLIFIER/SPEAKER UNIT TEST (TABLE 3)

Measure: AC VOLTAGE
At: RADIO CONNECTOR (Connected)
Conditions:
- Ignition: RUN
- Radio: ON (Tuned to a strong signal)
- Voltmeter: ON LOW AC VOLTS SCALE

Measure Between	Correct Voltage	For Diagnosis
Radio output terminals of suspect Speaker	Varying around 1 volt AC	See 1

- If voltage is correct, check/repair the wires between the Radio and the suspect speaker.

1. Remove the Radio for repair.

H: AMPLIFIER/SPEAKER UNIT TEST (TABLE 4)

Connect: ANALOG OHMMETER
At: SUSPECT SPEAKER
Conditions:
- **Ohmmeter set on R x 1 scale**
- **Speaker removed from Amplifier/ Speaker unit enclosure**

Action	Correct Result	For Diagnosis
Connect Ohmmeter across speaker terminals	Speaker "pops"	See 1

- If the result is correct, the Amplifier/ Speaker Unit is OK. Check that connectors are clean and tight.

1. Replace the problem speaker with a new one.

I: NOISE DIAGNOSIS TEST

Unplug the Antenna at the back of the Radio.

- If the noise disappears, it was being picked up by the Antenna. Consult the Delco Sound Service Guide for Antenna noise diagnosis.

If the noise persists, it is coming in the Radio wiring. Refer to the following chart for a possible cause and corrective action.

For more detailed noise repair procedures consult the Delco Sound Service Guide. Service procedures are given for:

- Accessory noise
- CB antennas and noise
- Computer noise
- Shielding of wiring and components
- Locating vehicle noise.

NOISE SYMPTOM TABLE

SYMPTOM	POSSIBLE CAUSE	REPAIR ACTION
1. Harsh popping noise that changes with engine rpm.	Ignition noise	• Perform the steps under Ignition Noise p. 150-10.
2. High whine like a siren that changes with engine rpm	Generator noise	• Add filter package 1224205 to power and/or memory lead to the Radio. See Fig. 2, p. 150-9. • By-pass the Generator output with a 250 MFD 100 v capacitor. See Fig 3, p. 150-9. • Install a dedicated ground strap on the Radio. See Fig. 1, p. 150-9. • Run a direct wire from Battery to Generator. • Exchange the defective Radio with a good Radio. If noise disappears, send the defective Radio for repair. • Replace Generator.

(Continued on next page)

SYSTEM CHECK TABLE

SYMPTOM	POSSIBLE CAUSE	REPAIR ACTION
3. Noise occurs only when an accessory is on	Condition in that accessory	• Install filter package 1224205 in the power lead(s) to that accessory. See Fig. 2, p. 150-9. • Install a .5 MFD by-pass capacitor at the power lead to that accessory • Consult Delco Sound Service Guide
4. All stations weak, noisy (both AM and FM)	Defective Antenna or lead-in-wire	• Temporarily replace the Antenna with another one. Repair/replace the defective one if the Radio reception improves. Check at the Antenna coaxial cable, and the connector.
5. AM only weak, noisy	AM alignment	• Remove Radio for repair.
6. FM only weak, noisy	FM alignment	• Remove Radio for repair.
7. Noise present with engine not running	ECM	• Install filter package 1224205 in the power leads to the Electronic Control Module (ECM).
8.Noise that stops when Antenna is unplugged from back of Radio	Antenna noise	• Replace defective Antenna with a good Antenna. If noise disappears repair or replace the defective antenna. Check antenna ground, coaxial cable, braid and grounds at connectors. • If noise persists with replacement antenna, the problem must be repaired at the source of noise (Generator, Ignition System, accessory, etc). See Delco manual for noise "sniffing" procedures.

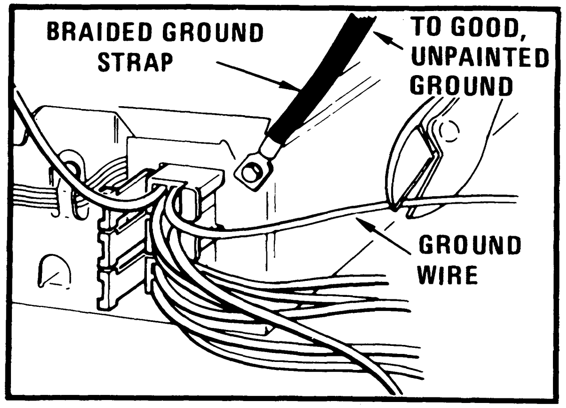


Figure 1. Cut the ground wire (see schematic) and run a braided ground strap from the case of the radio to a good unpainted body ground.

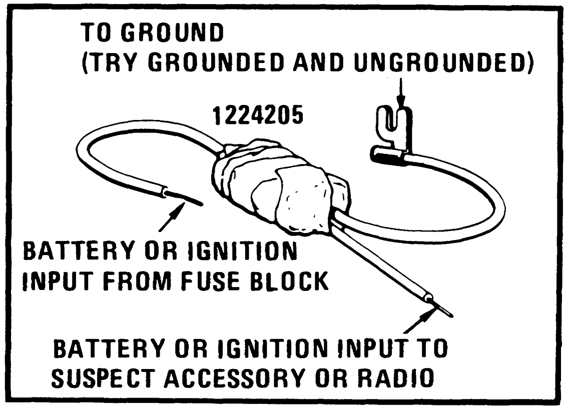


Figure 2. Install a 1224205 filter package.

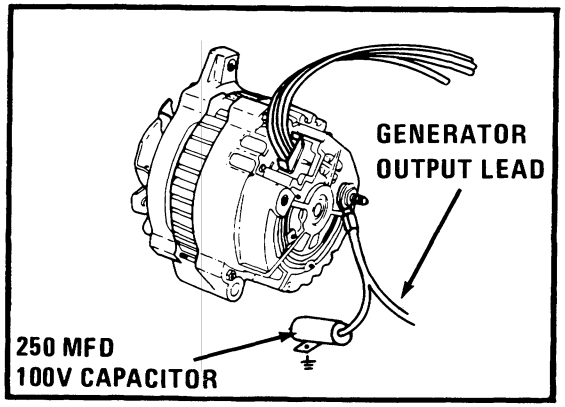


Figure 3. Install a 250 MFD 100V capacitor on the alternator output lead to ground.

IGNITION NOISE

Try the following fixes in the given order.

1. Check for loose or defective spark plug wire.
2. Check for defective spark plug.
3. Move all wiring away from the Ignition System and spark plug wires.
4. Reroute spark plug wires laying against anything that could possibly transmit noise to the Radio (car wiring or sensor leads that travel into the passenger compartment).
5. Check the ground from engine to firewall, install a braided ground if necessary.
6. Install a braided ground strap on the hood.
7. Check heater core ground, clean or install braided ground strap if necessary.
8. Check air conditioner accumulator ground, clean or install a braided ground strap if necessary.

CIRCUIT OPERATION

With the Ignition Switch in ACCY or RUN, voltage is applied through the RADIO Fuse to the ON-OFF Switch of the Radio.

When the Radio is turned on, voltage is applied to the Radio's solid-state circuitry and display.

Voltage is available at all times through the ARC Fuse to power the digital clock and memory related functions of the Radio to continue operation with the Radio off.

Delco-Bose® Music System

The Delco-Bose® Music System consists of Electronic Radio and four Amplifier/Speaker units. Each Amplifier/Speaker Unit has a speaker assembly, and an amplifier to power the speaker. The speakers have been carefully designed and positioned to utilize sound reflections from windows and other parts of the car interior. The result is balanced sound for every listening position in the car. This ends the need for a left and right balance control.

Power for the Radio is available through the RADIO Fuse with the Ignition Switch in ACCY or RUN. When the Radio is turned on, voltage is applied through the Radio to the Delco-Bose® Amplifier Relay. The Relay contact closes to power the Amplifier/Speaker Units.

The Radio receives voltage through four paths: 1) RADIO Fuse to the On-Off Switch from the YEL wire, 2) ARC Fuse which keeps the solid state clock,date, and Radio station memory circuits alive when the Ignition Switch is turned OFF (ORN wire), 3) an Instrument Panel lamp voltage controlled by Panel Interior Light Control to the Radio Panel Light (GRY wire), 4) a Digital Dimmming voltage from the Light Switch (BRN wire).

The Radio also applies battery voltage to the PNK wire to energize the Delco-Bose® Amplifier Relay (if equipped).

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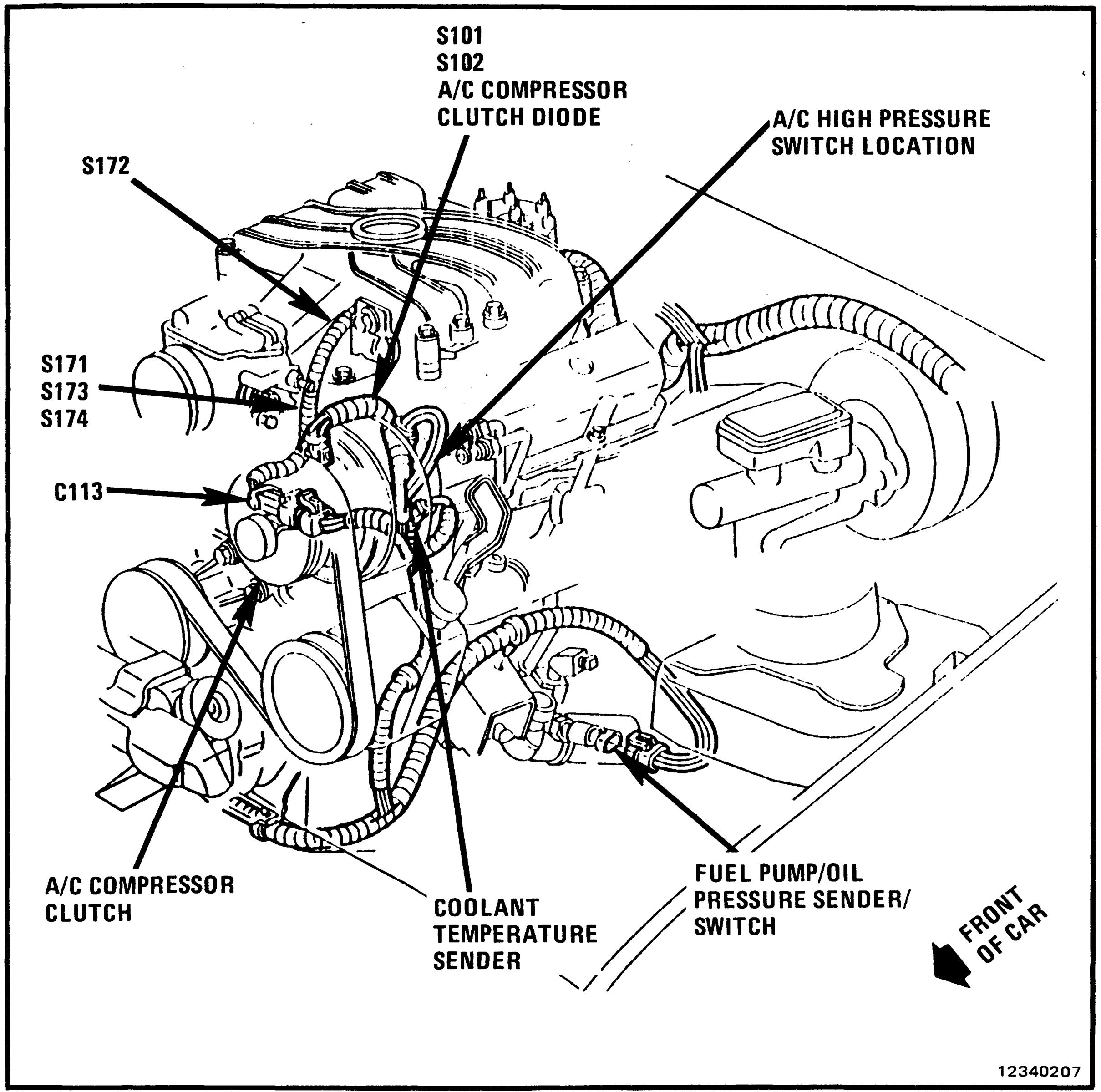


Figure A - LH Side Of VIN T Engine

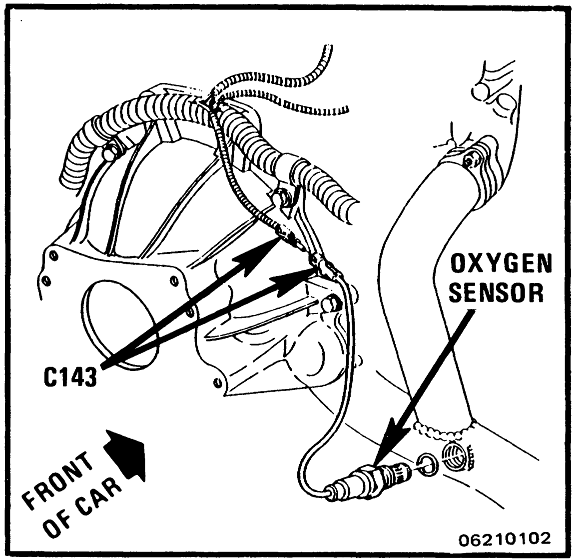


Figure B - RH Rear Of VIN T Engine

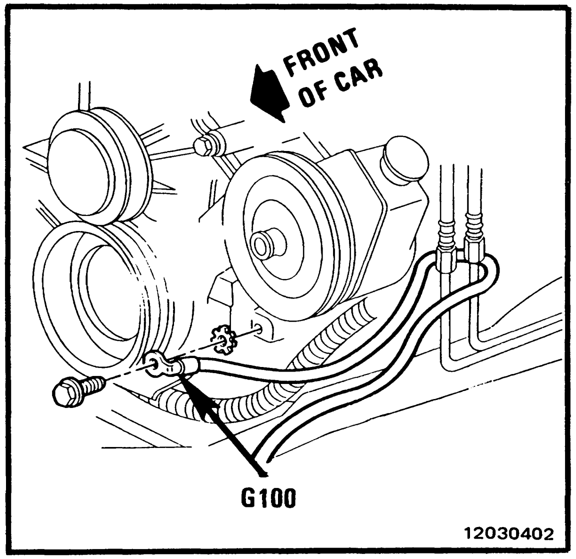


Figure C - Lower LH Front Of VIN T Engine

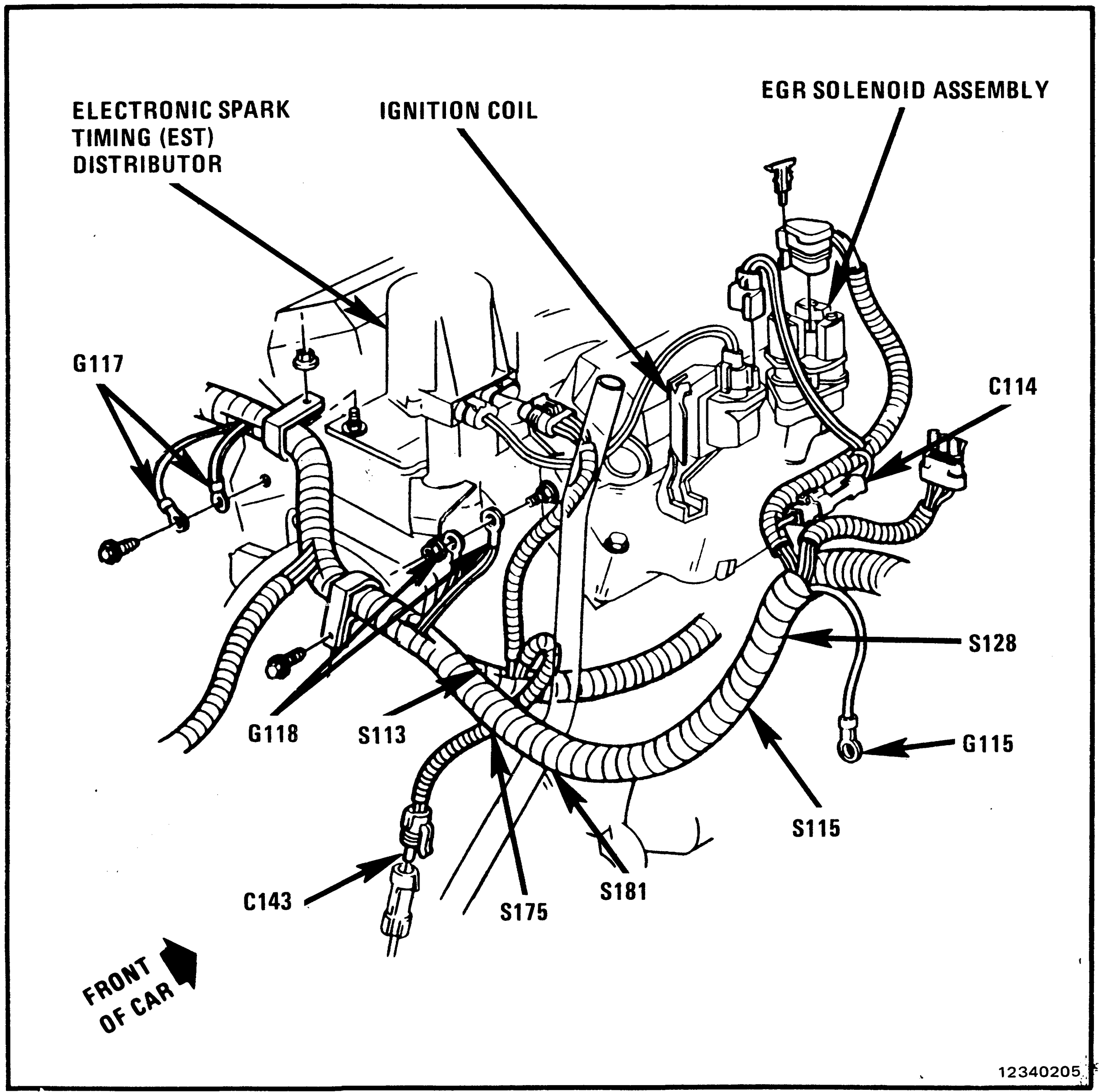


Figure A - Rear Of VIN T Engine

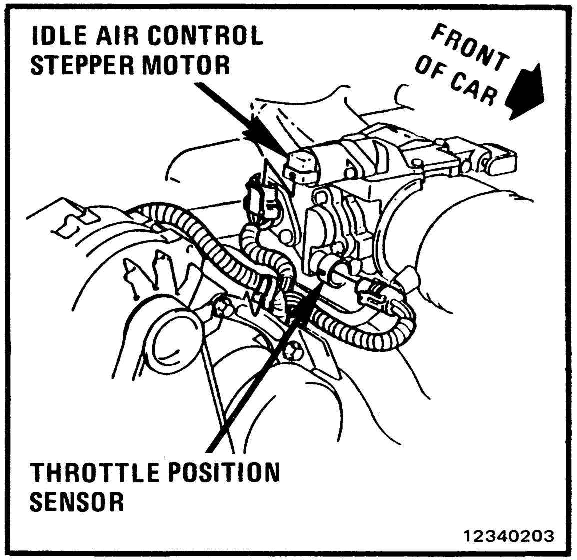


Figure B - Top Of VIN T Engine

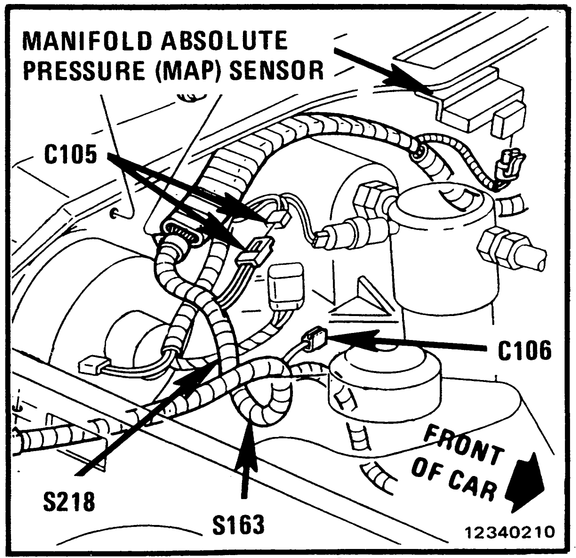


Figure C - RH Rear Of VIN T Engine

COMPONENT LOCATION VIEWS

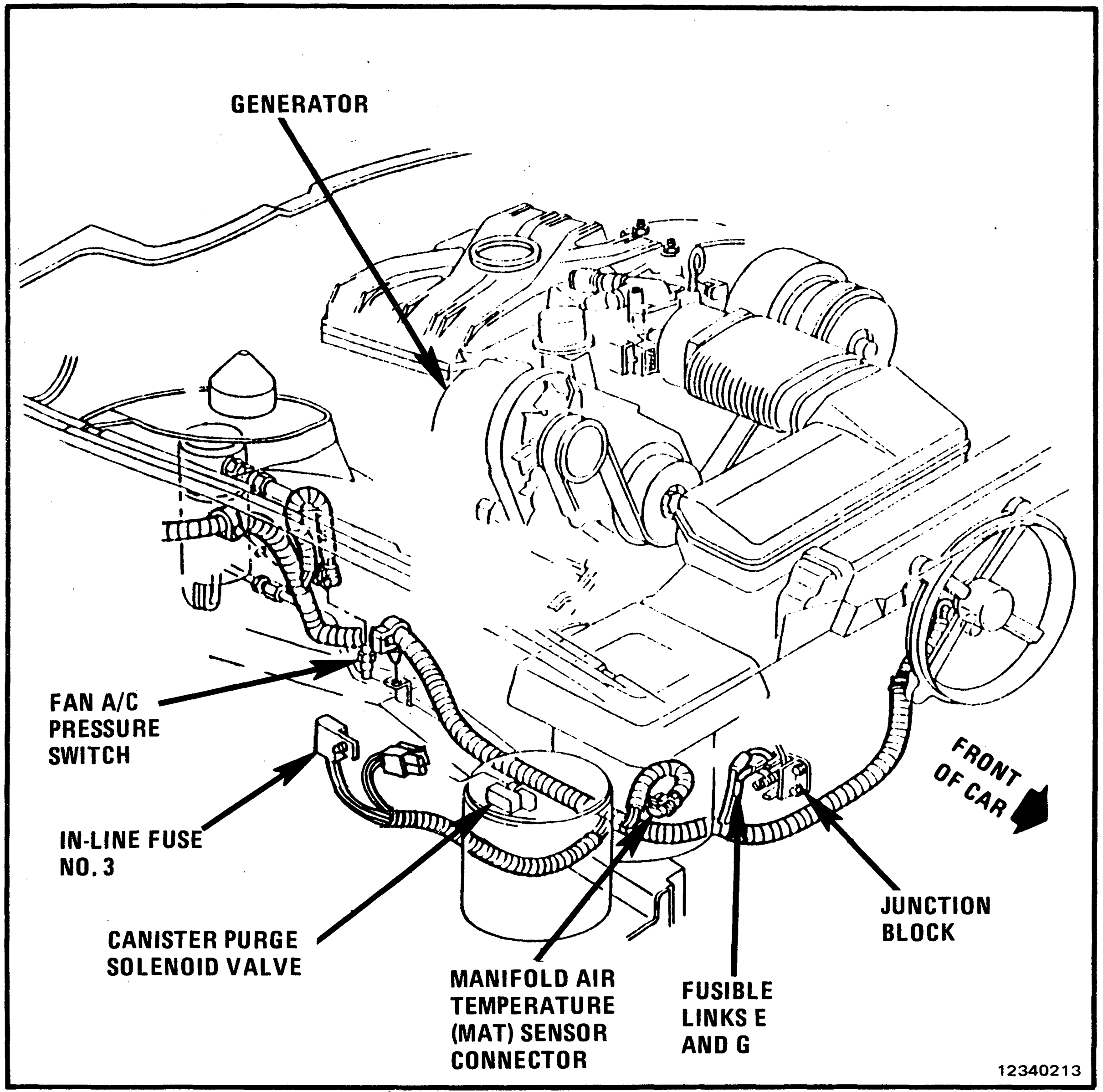


Figure A - RH Side Of VIN T Engine

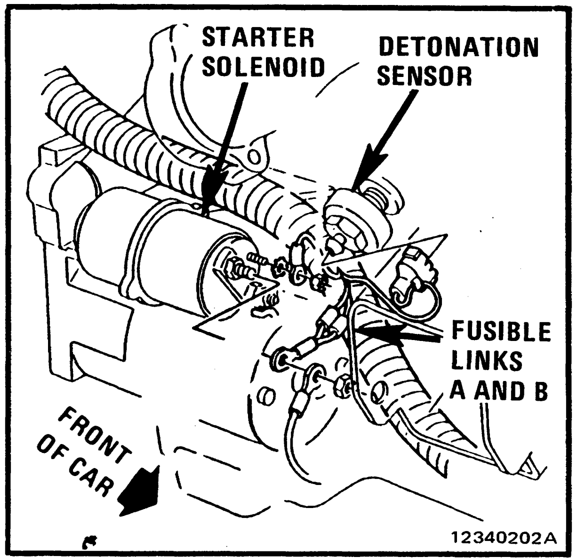


Figure B - Lower RH Side Of VIN T Engine

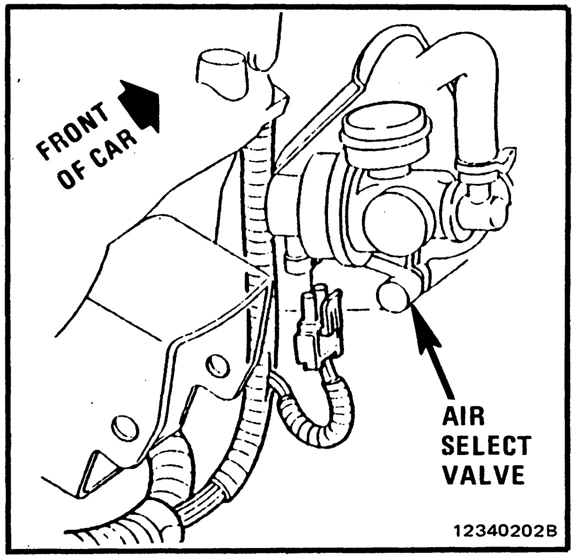


Figure C - Lower RH Side Of VIN T Engine

COMPONENT LOCATION VIEWS

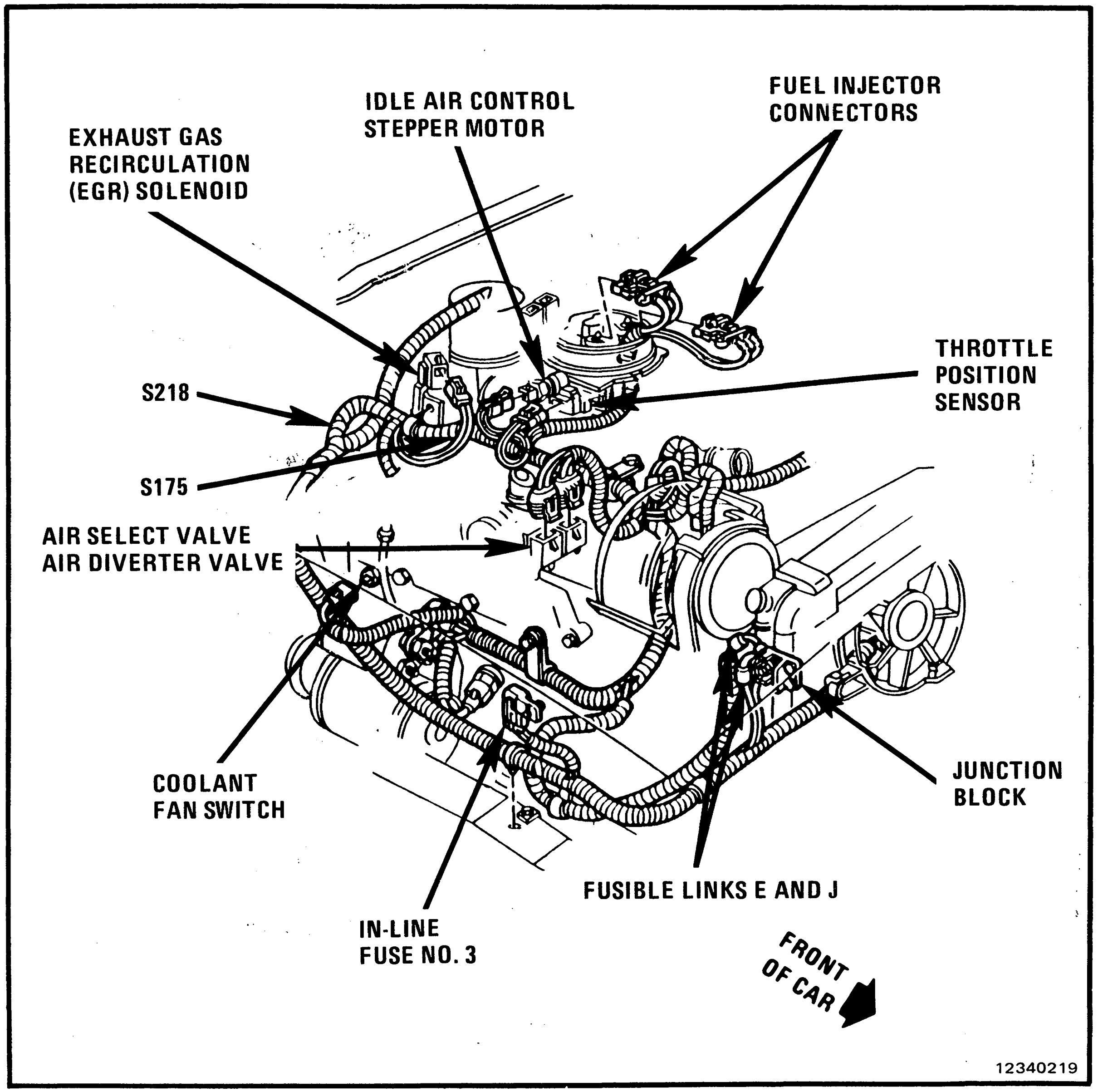


Figure A - RH Side Of VIN E Engine

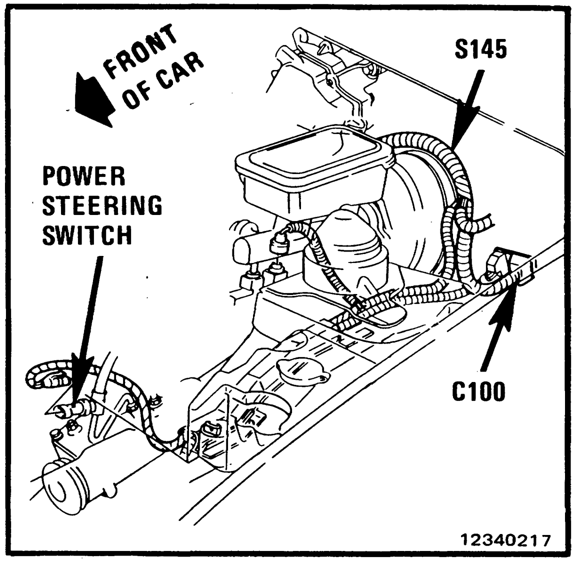


Figure B - LH Side Of VIN T Engine Compartment

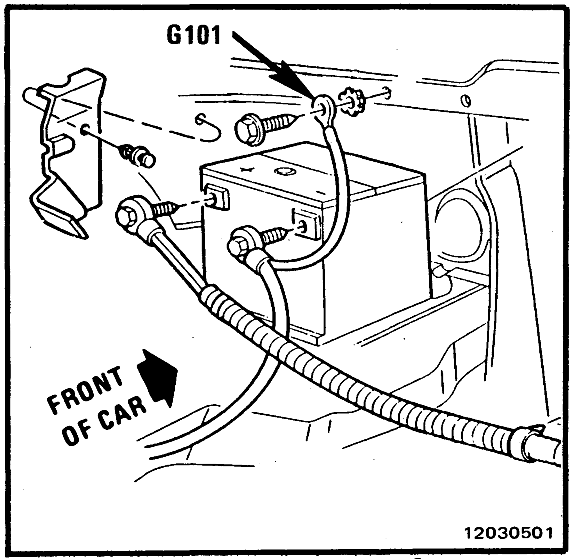


Figure C - LH Front Of VIN T Engine Compartment

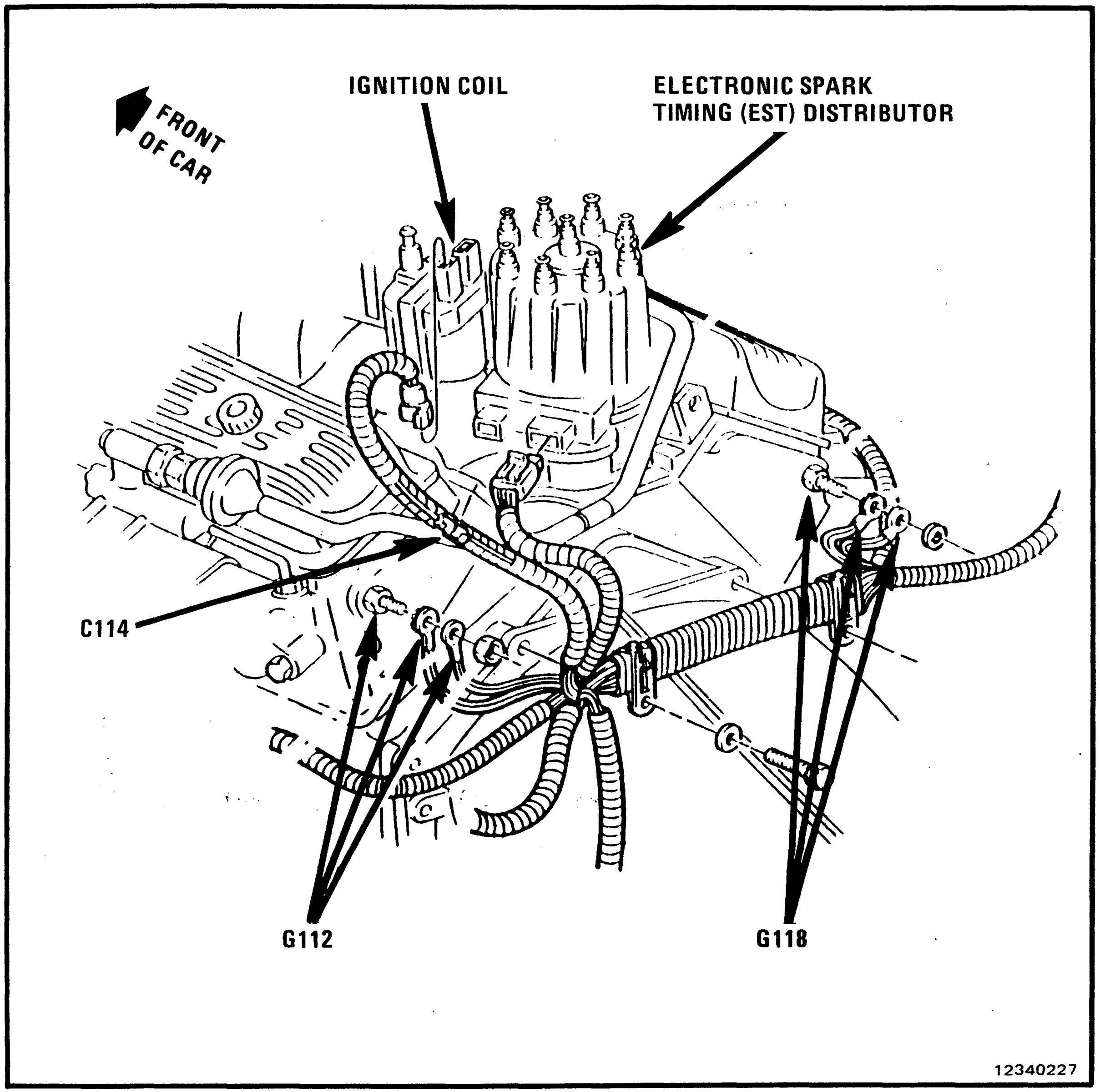


Figure A - Rear Of VIN E Engine

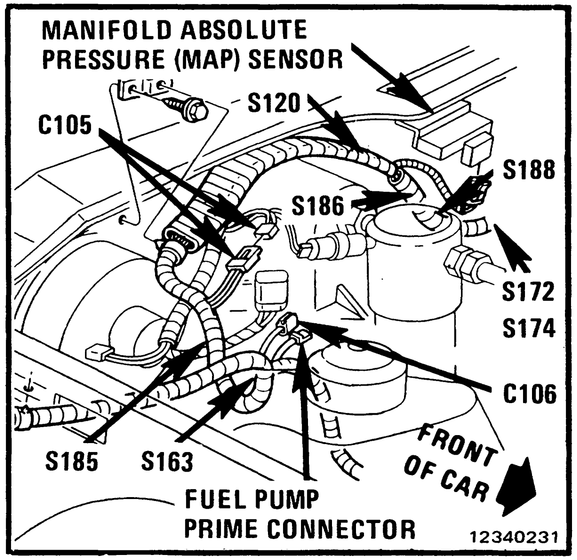


Figure B - RH Rear Of VIN E Engine

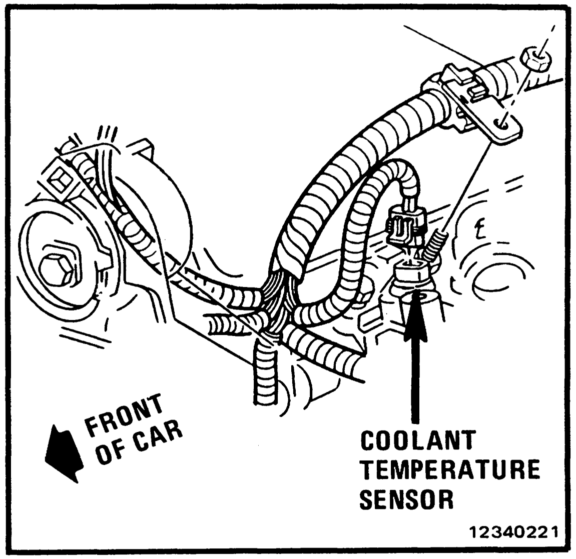


Figure C - Top Front Of VIN E Engine

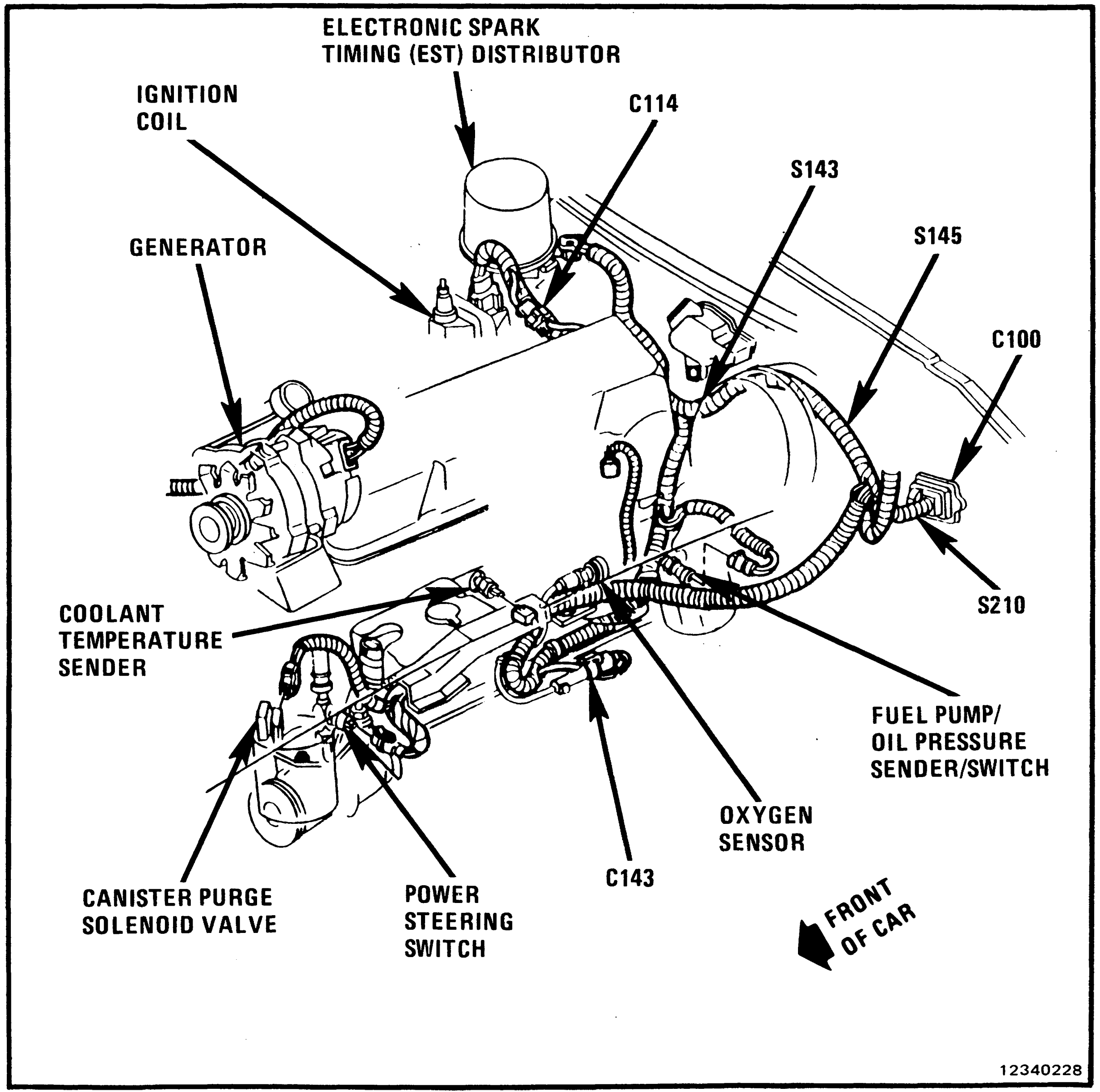


Figure A - LH Side Of VIN E Engine Compartment

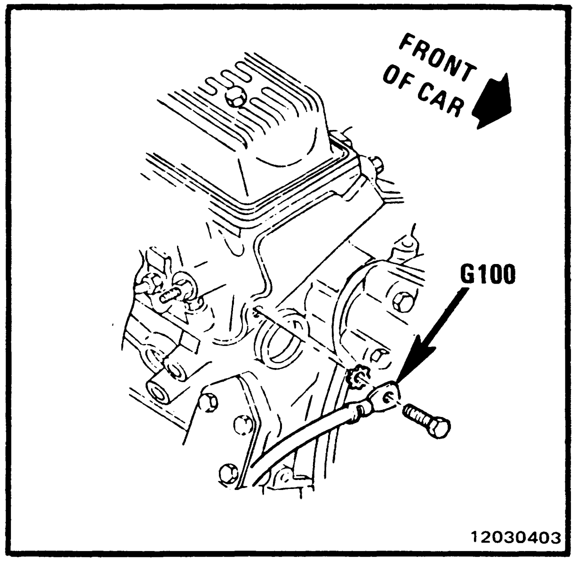


Figure B - RH Front Of VIN E Engine (VIN F and VIN 8 Similar)

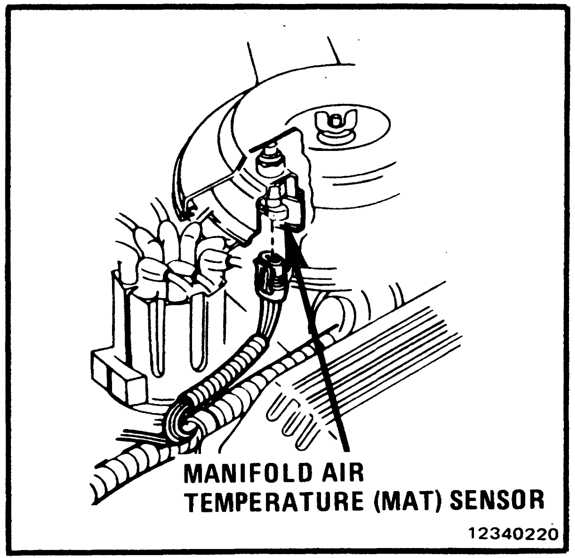


Figure C - Top Rear Of VIN E Engine

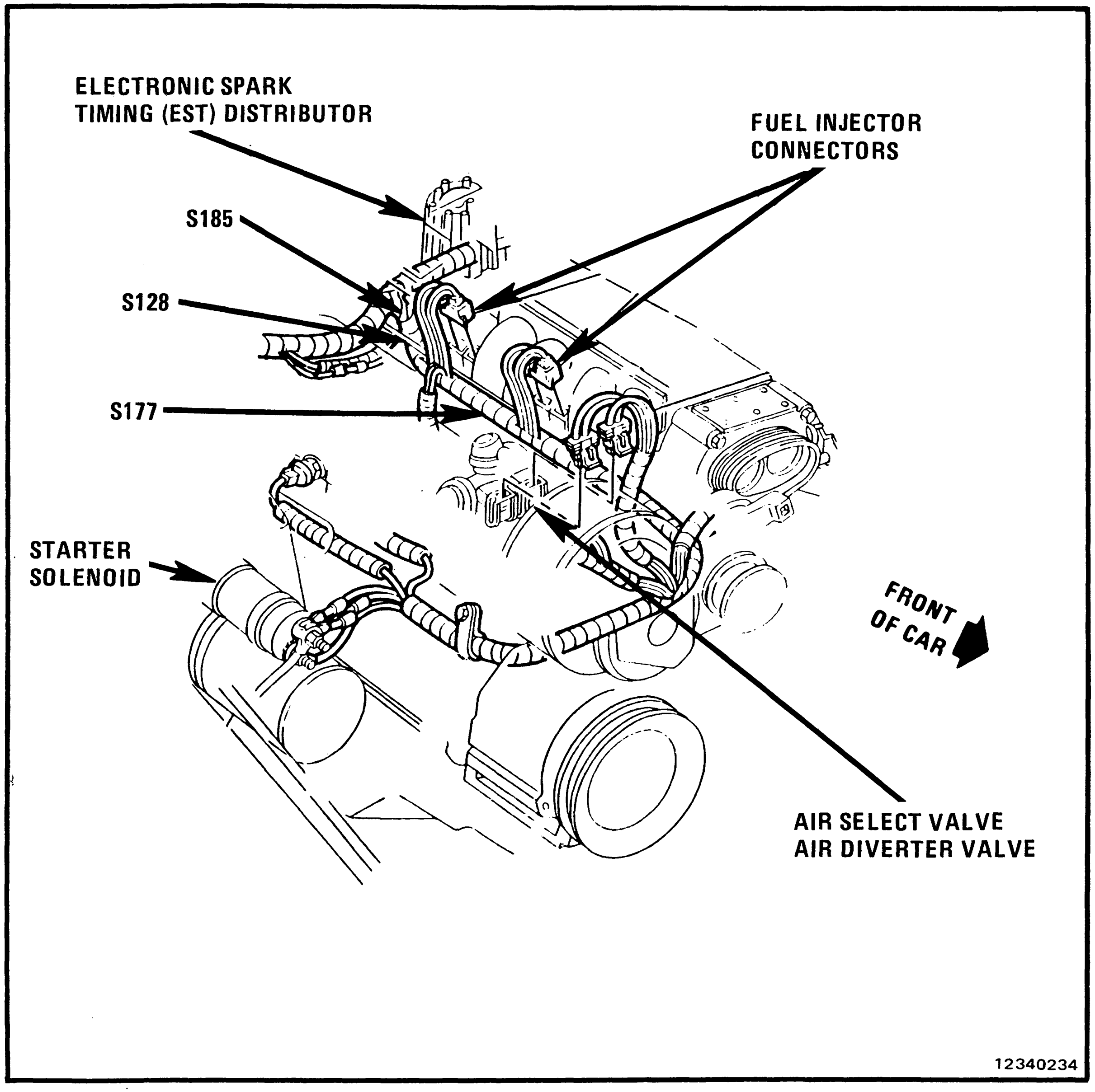


Figure A - RH Side Of VIN F Engine (VIN 8 Similar)

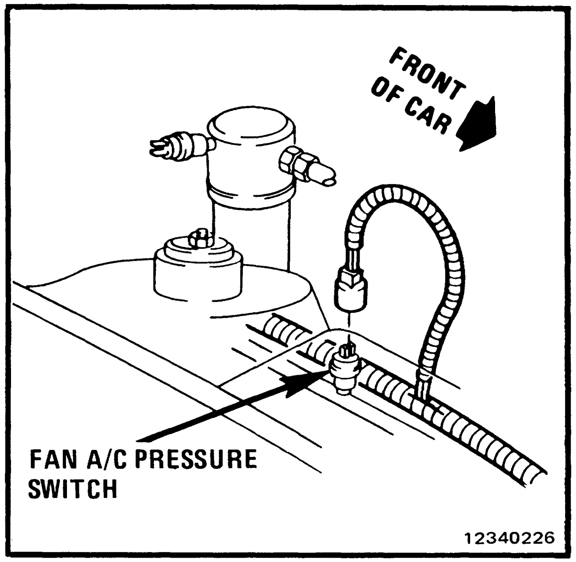


Figure B - RH Side Of VIN E Engine Compartment (VIN F and VIN 8 Similar)

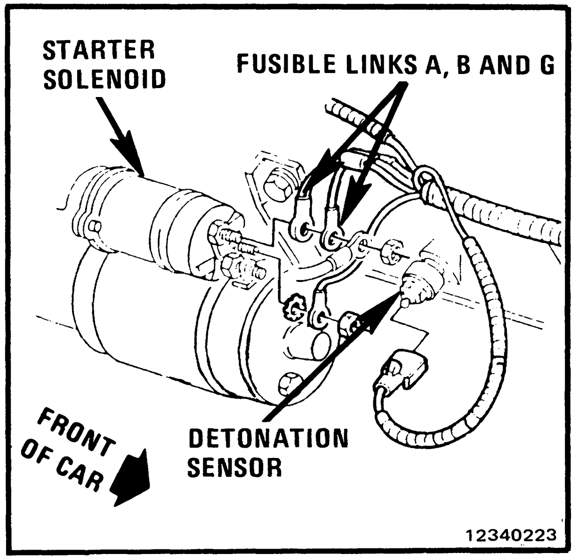


Figure C - RH Side Of VIN E Engine

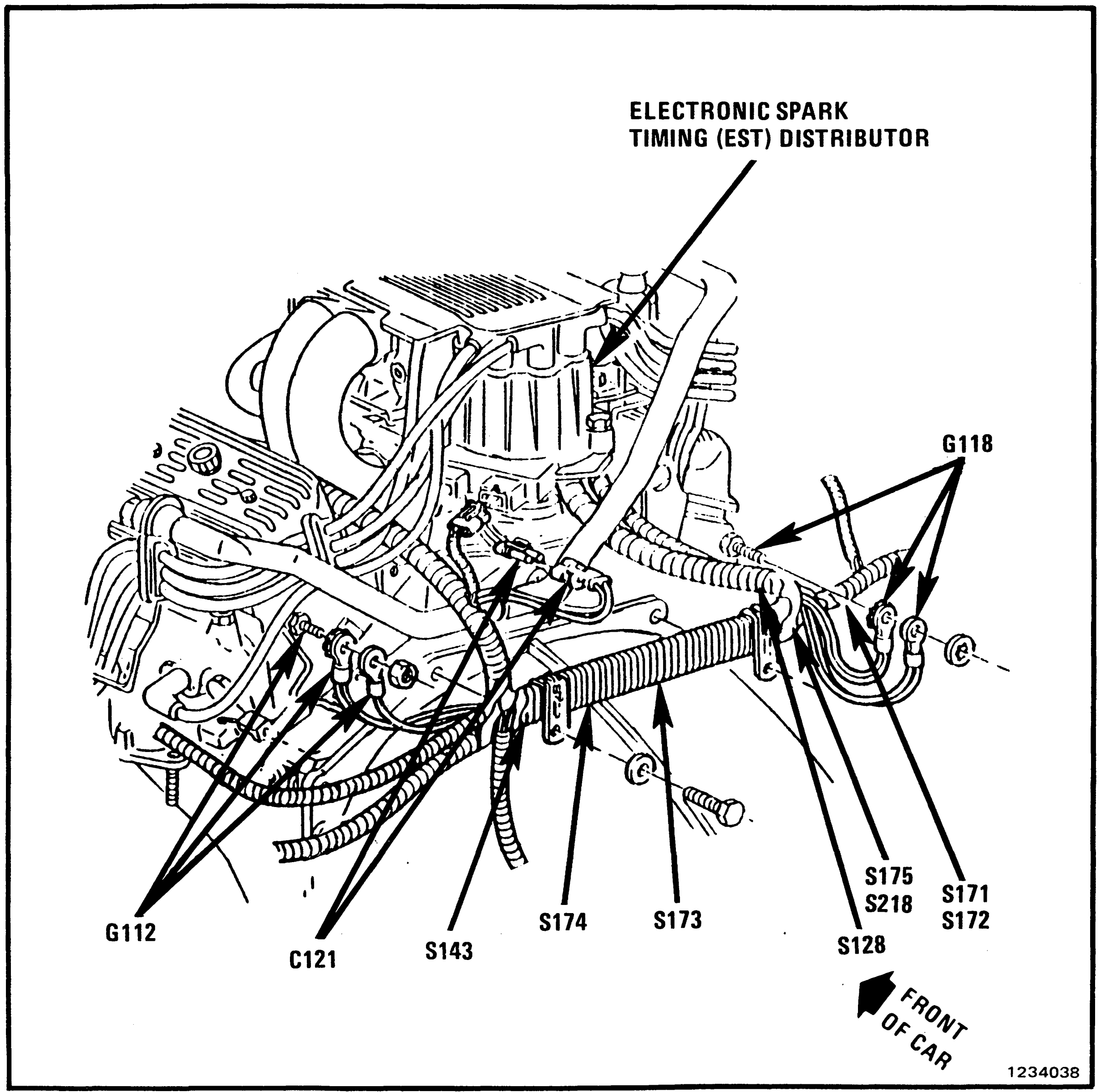


Figure A - Rear Of VIN F Engine (VIN 8 Similar)

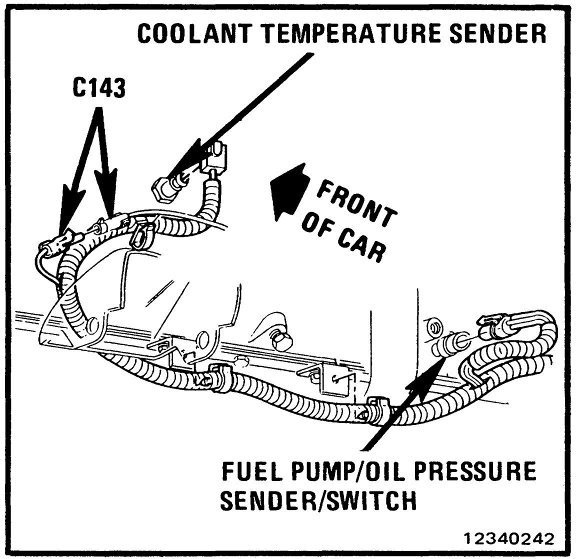


Figure B - Lower LH Side Of VIN F Engine (VIN 8 Similar)

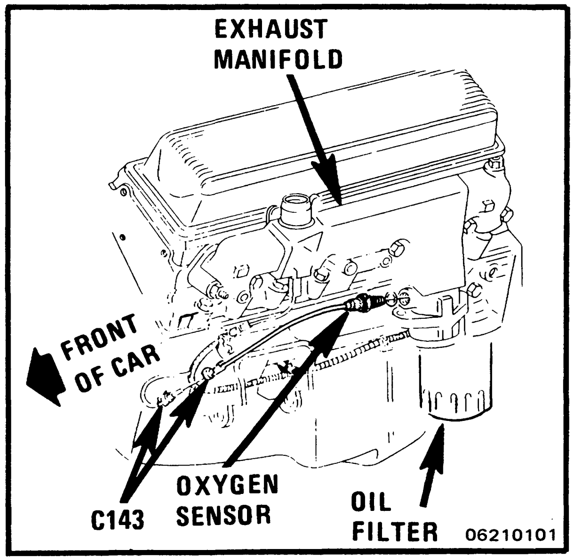


Figure C - LH Side Of VIN F Engine (VIN 8 Similar)

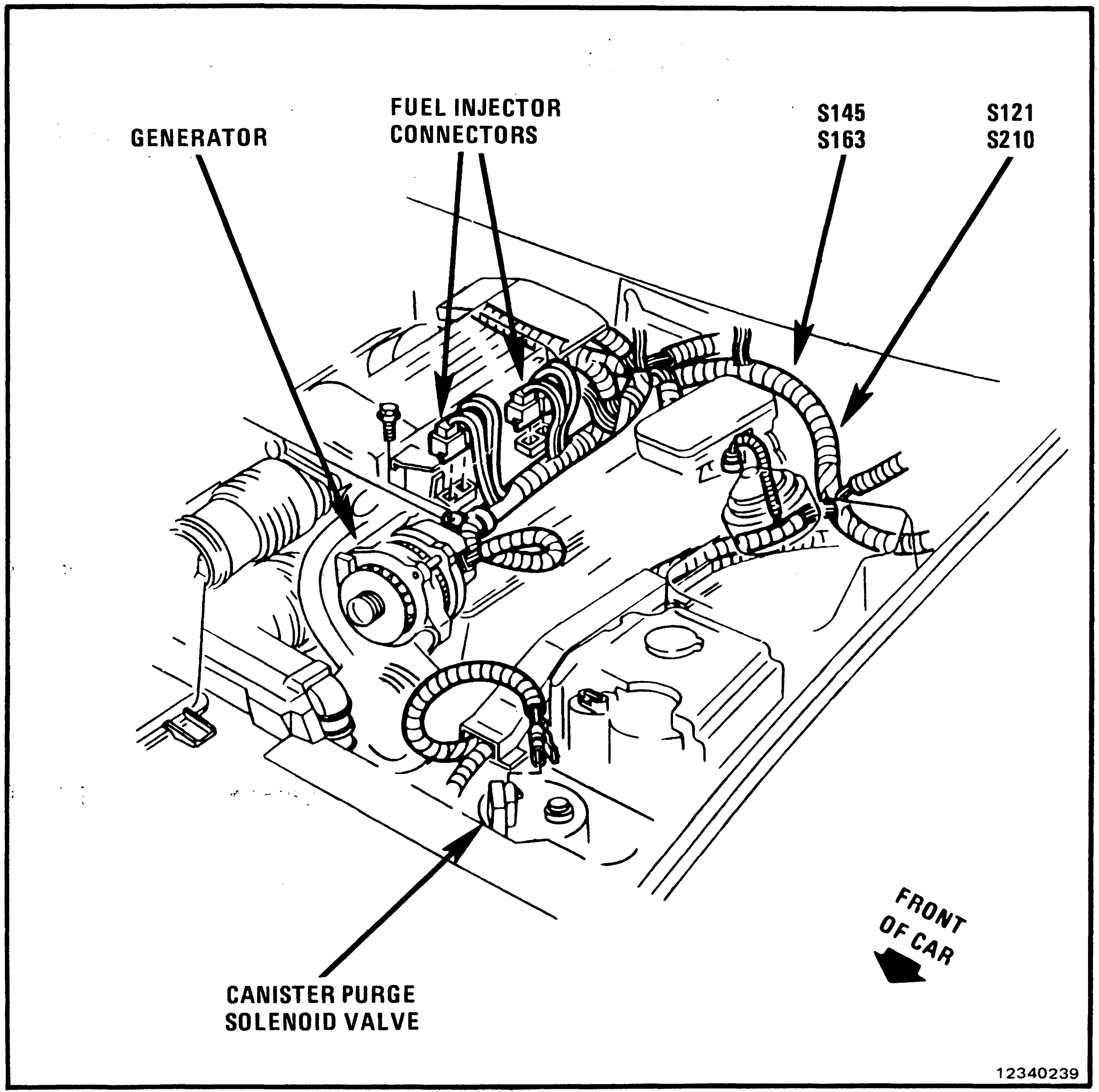


Figure A - LH Side Of VIN F Engine (VIN 8 Similar)

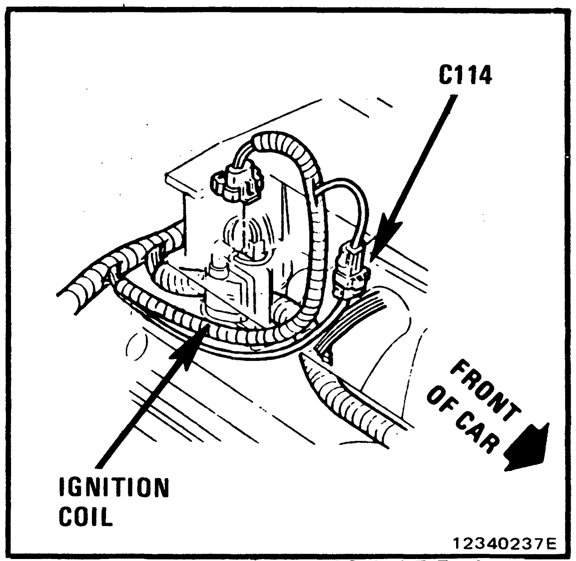


Figure B - Top RH Rear Of VIN F Engine (VIN 8 Similar)

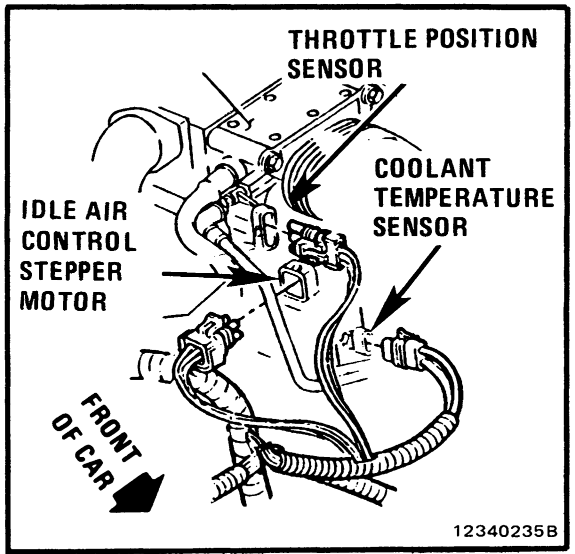


Figure C - Top Front Of VIN F Engine (VIN 8 Similar)

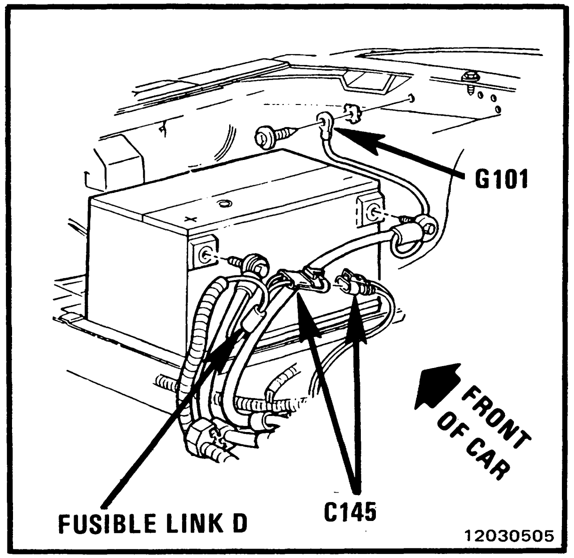


Figure A - RH Front Of VIN F Engine Compartment (VIN 8 And VIN E Similar)

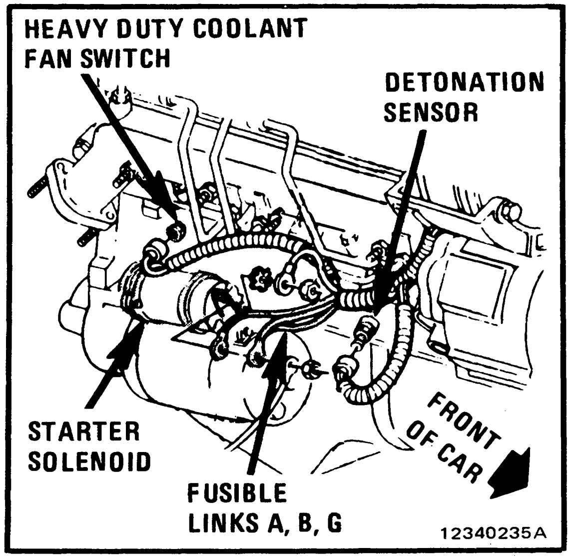


Figure C - RH Side Of VIN F Engine (VIN 8 Similar)

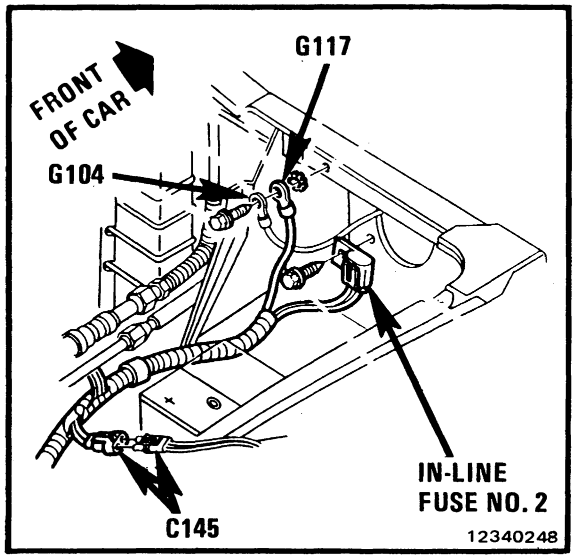


Figure E - RH Front Of VIN F Engine (VIN 8 Similar)

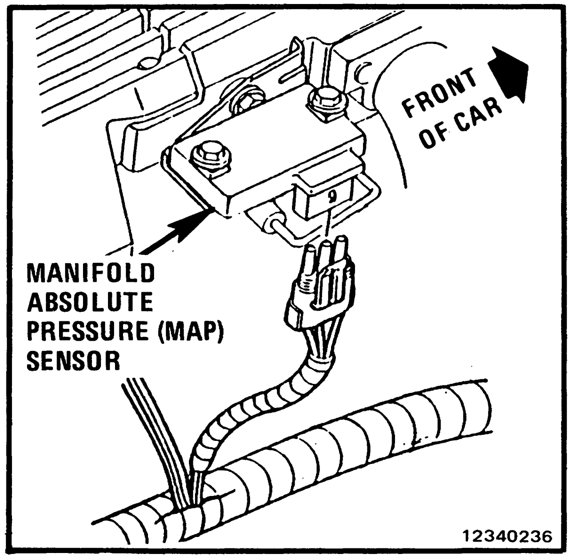


Figure B - RH Rear Of VIN F Engine (VIN 8 Similar)

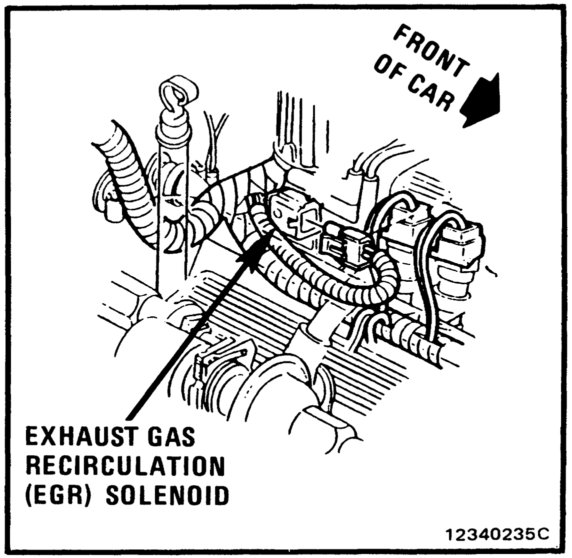


Figure D - Top RH Side Of VIN F Engine (VIN 8 Similar)

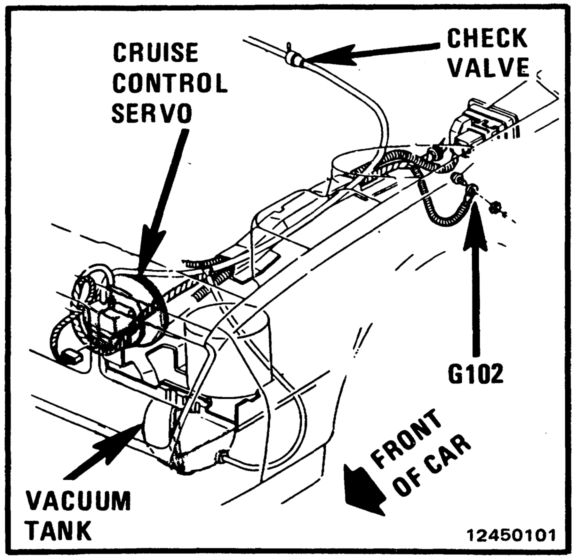


Figure F - LH Side Of Engine Compartment

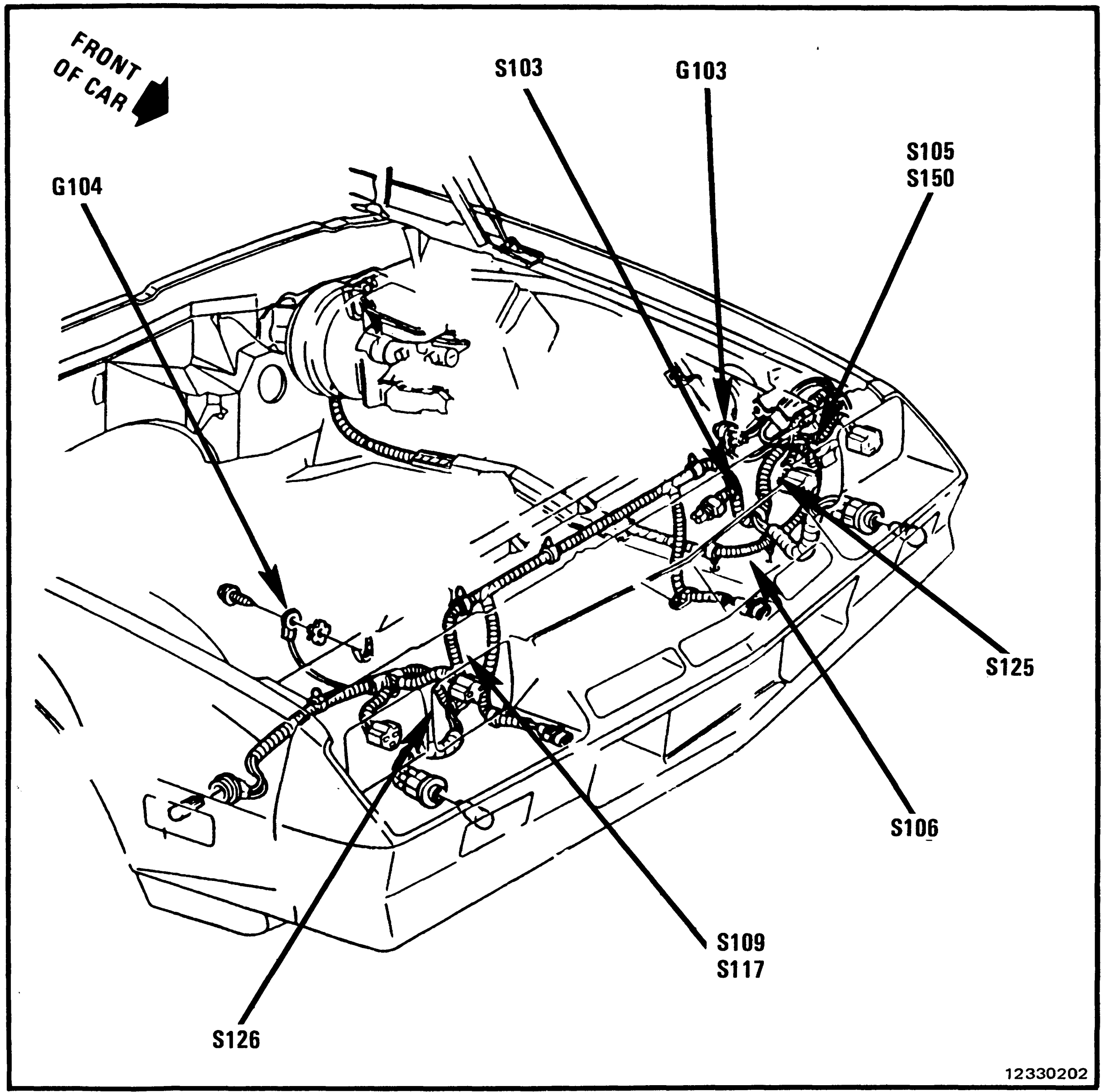


Figure A - Engine Compartment

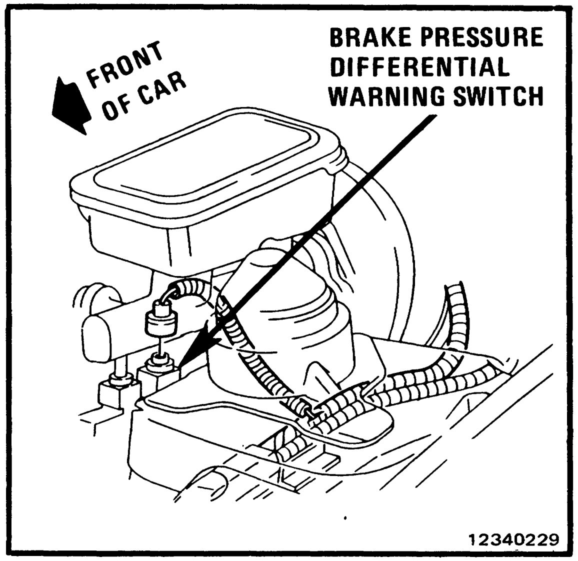


Figure B - LH Side Of Engine Compartment

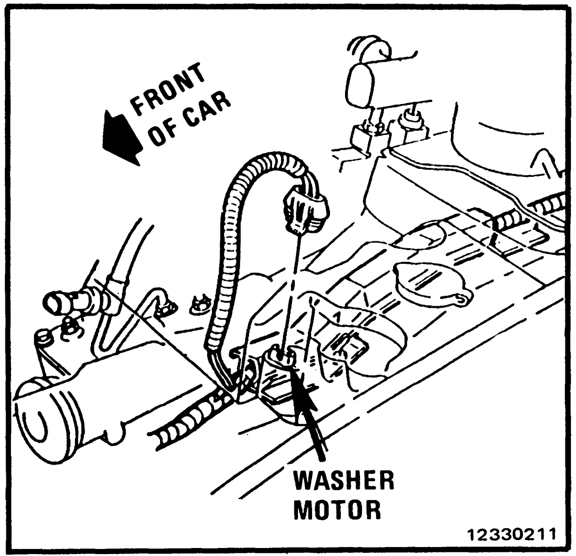


Figure C - LH Side Of Engine Compartment

COMPONENT LOCATION VIEWS

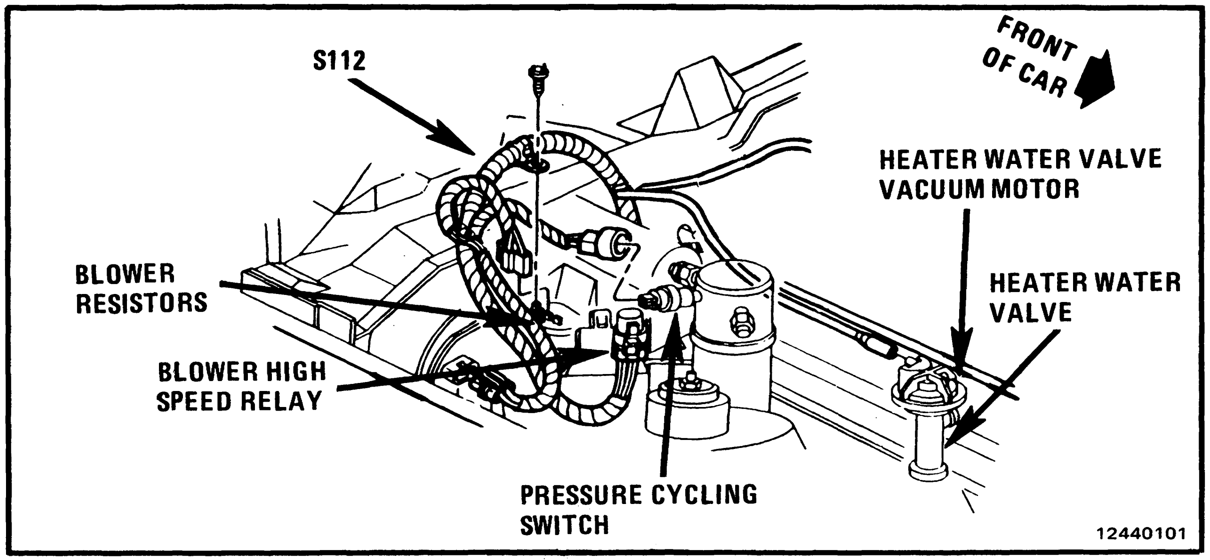


Figure A - RH Rear Of Engine Compartment (With A/C)

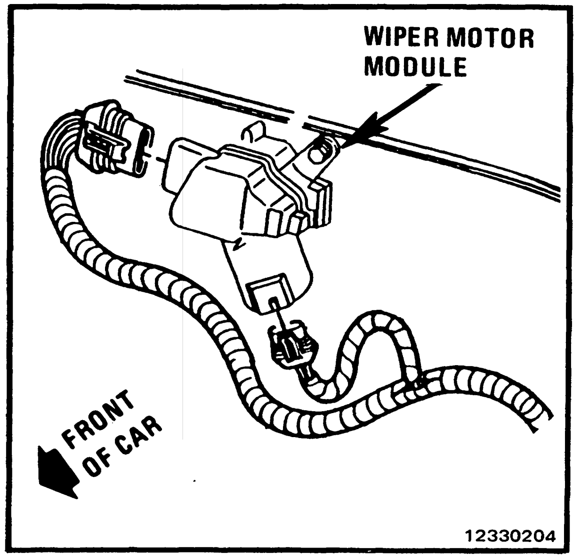


Figure D - LH Front Of Dash

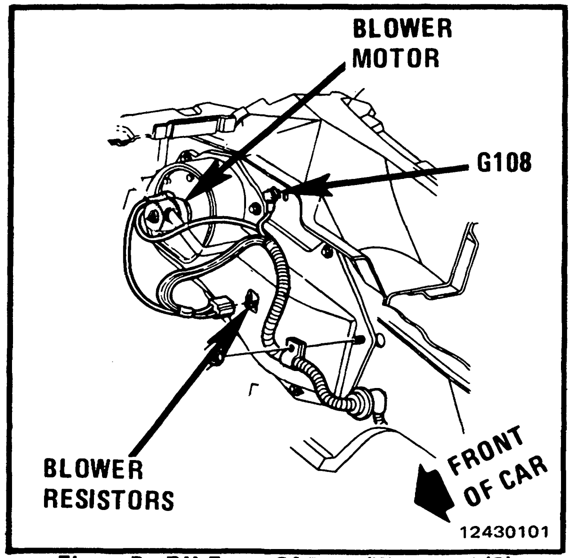


Figure B - RH Front Of Dash (Without A/C)

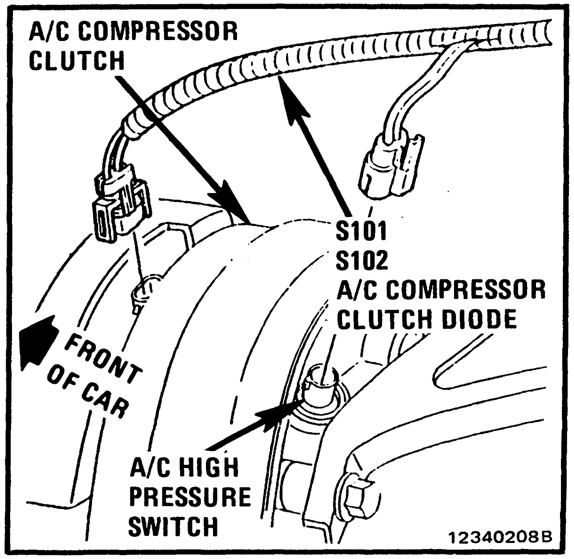


Figure C - Top RH Front Of VIN E Engine (VIN F and VIN 8 Similar)

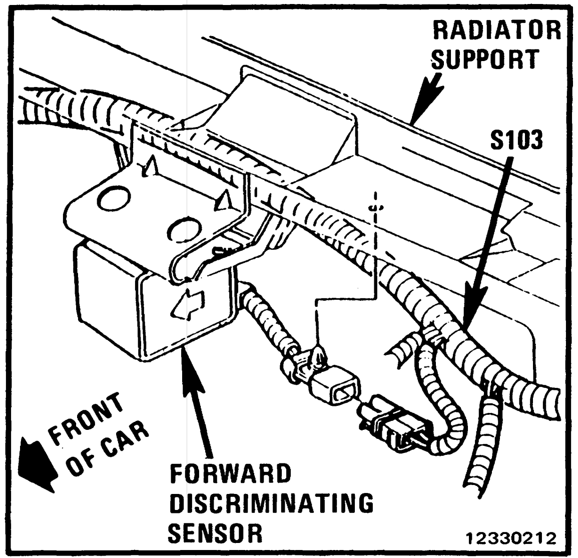


Figure E - Front Of Engine Compartment

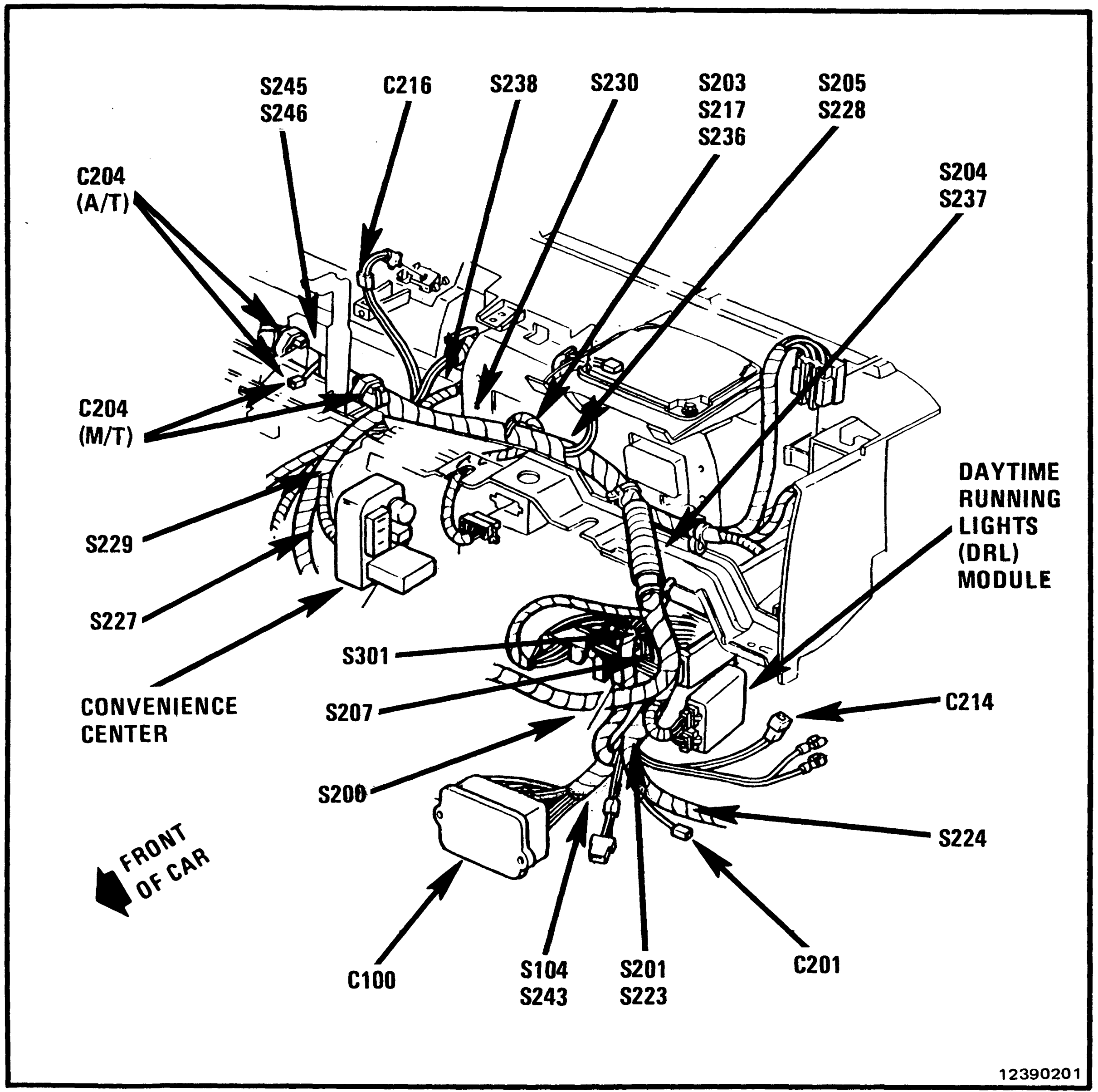


Figure A - Behind LH Side Of I/P

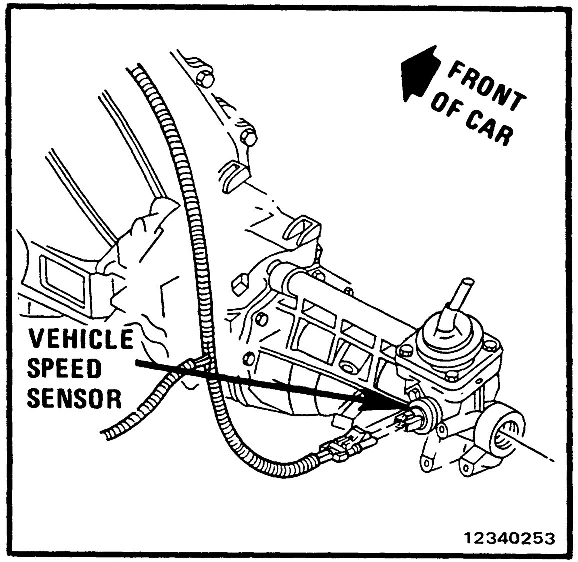


Figure B - LH Side Of Transmission

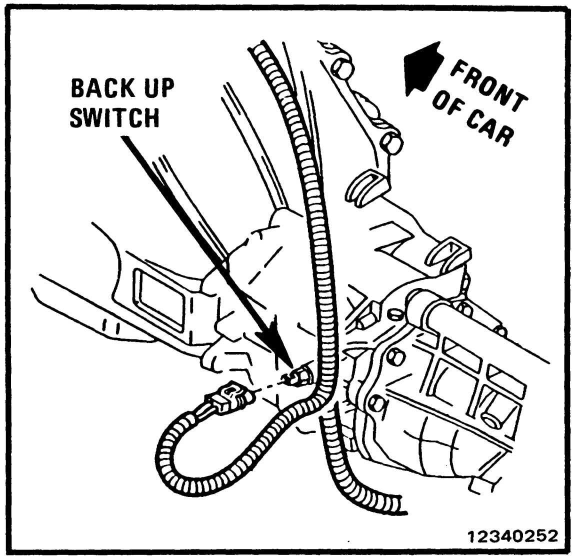


Figure C - LH Side Of Manual Transmission

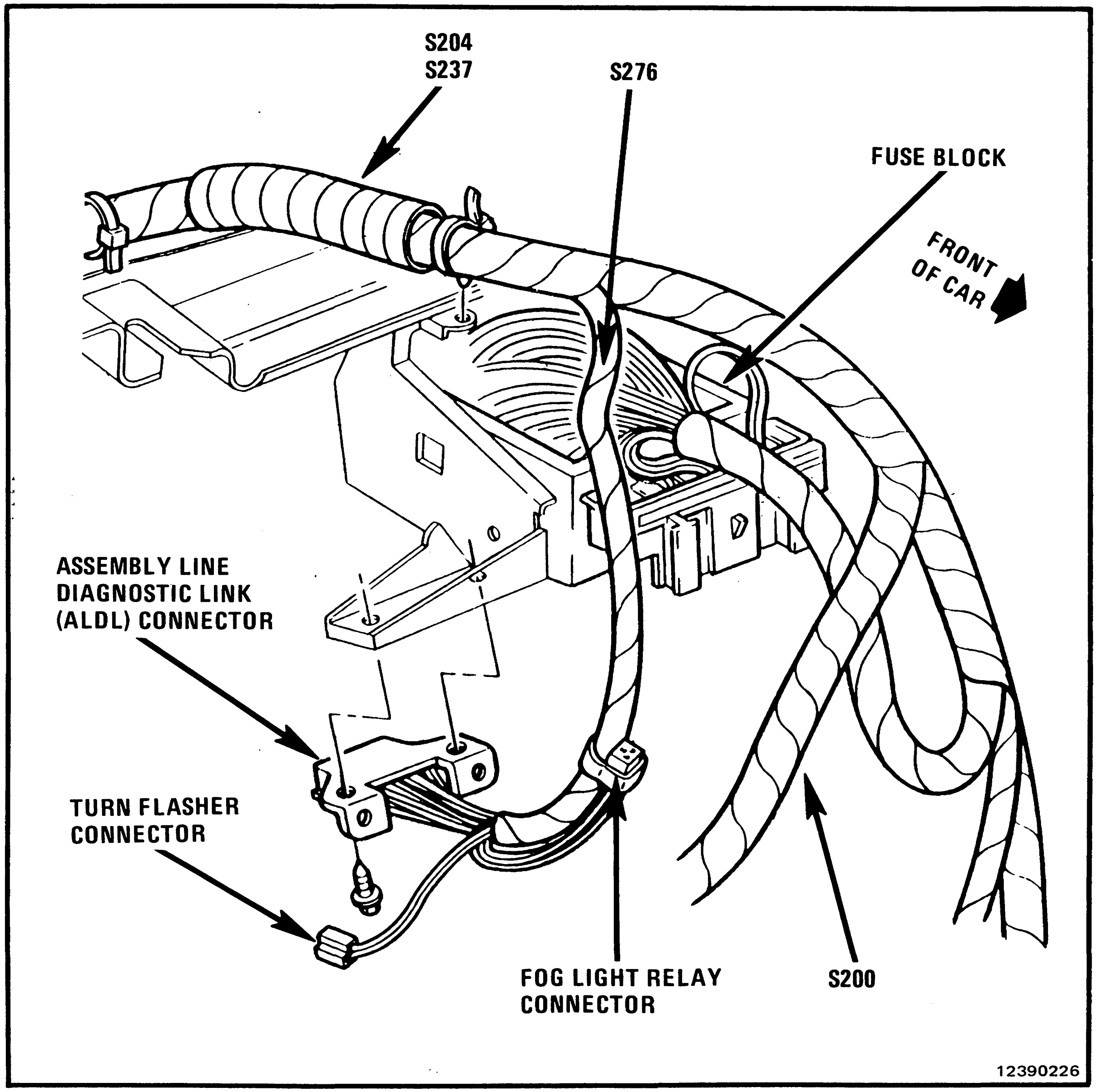


Figure A - Behind LH Side Of I/P

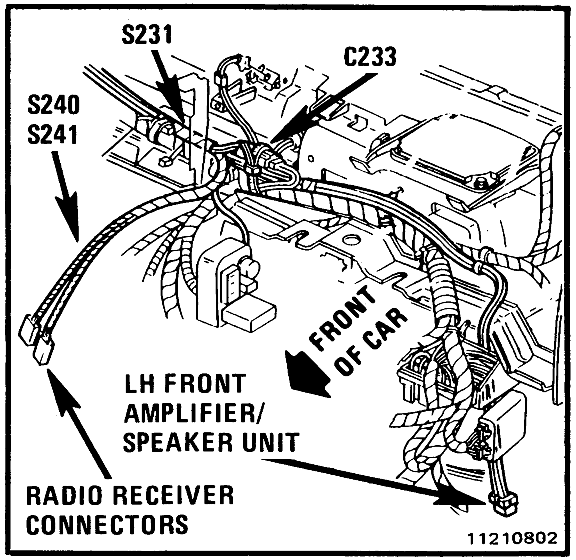


Figure B - Behind LH Side Of I/P

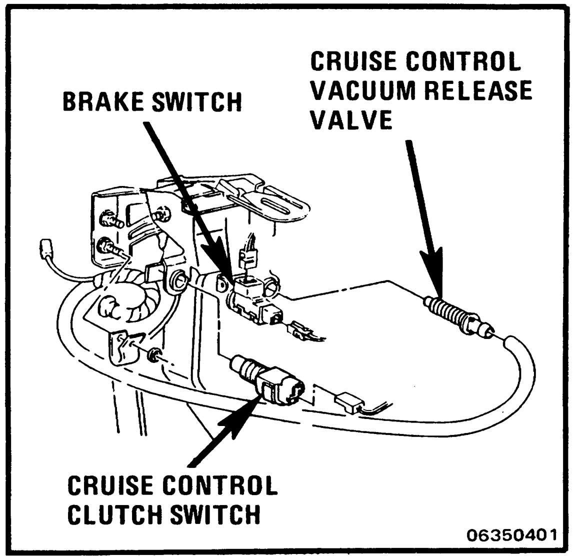


Figure C - Below LH Side Of I/P

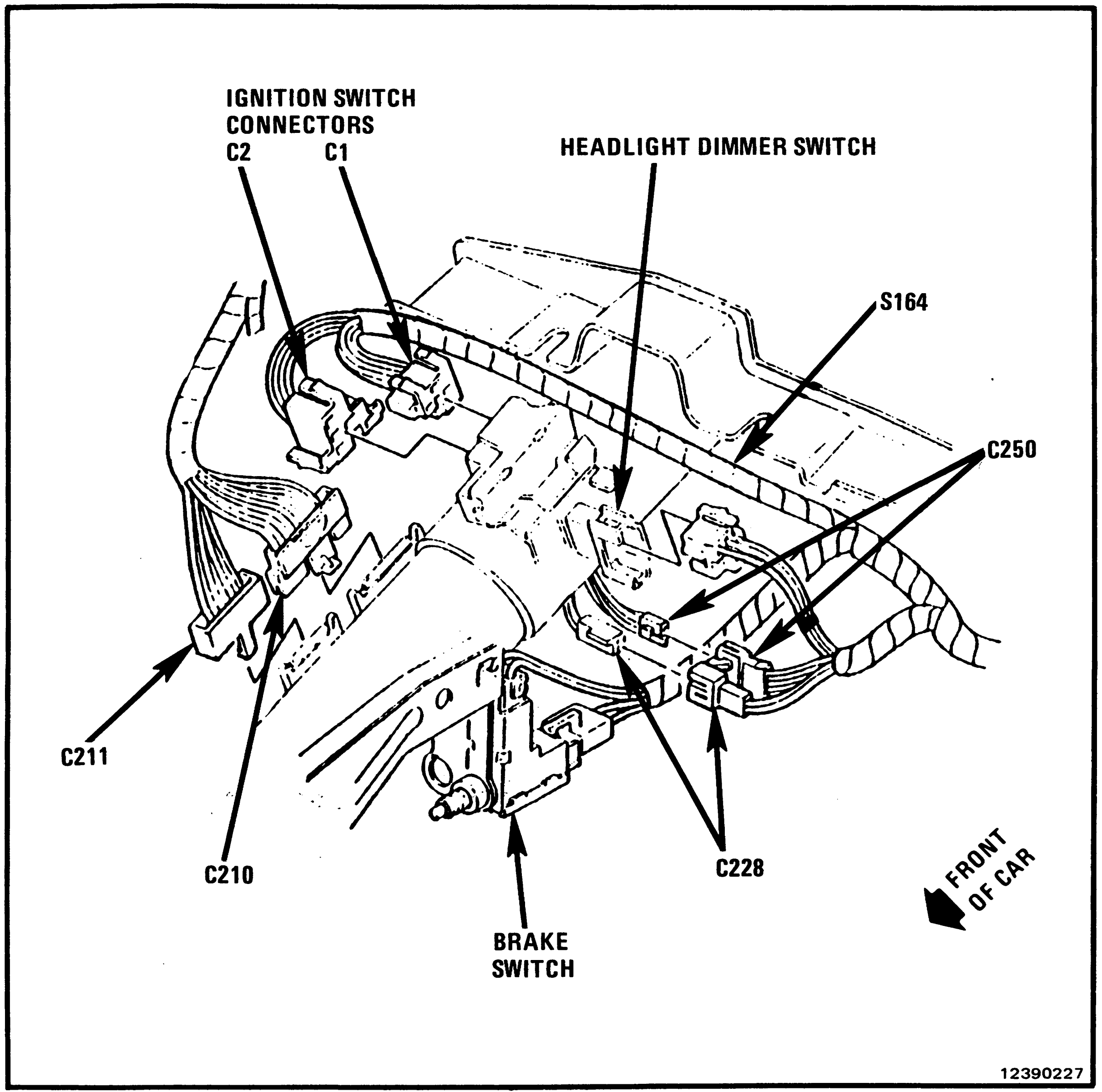


Figure A - Below LH Side Of I/P

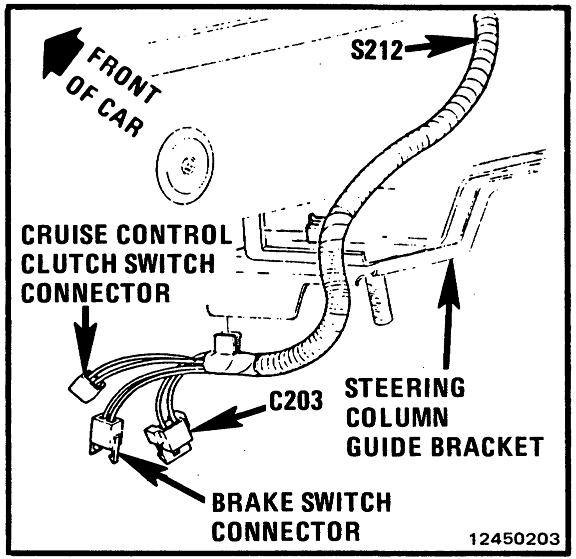


Figure B - Below LH Side Of I/P

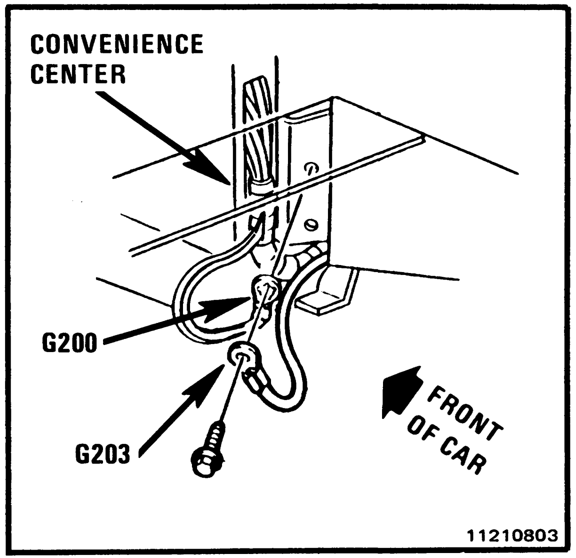


Figure C - Behind LH Side Of I/P

COMPONENT LOCATION VIEWS

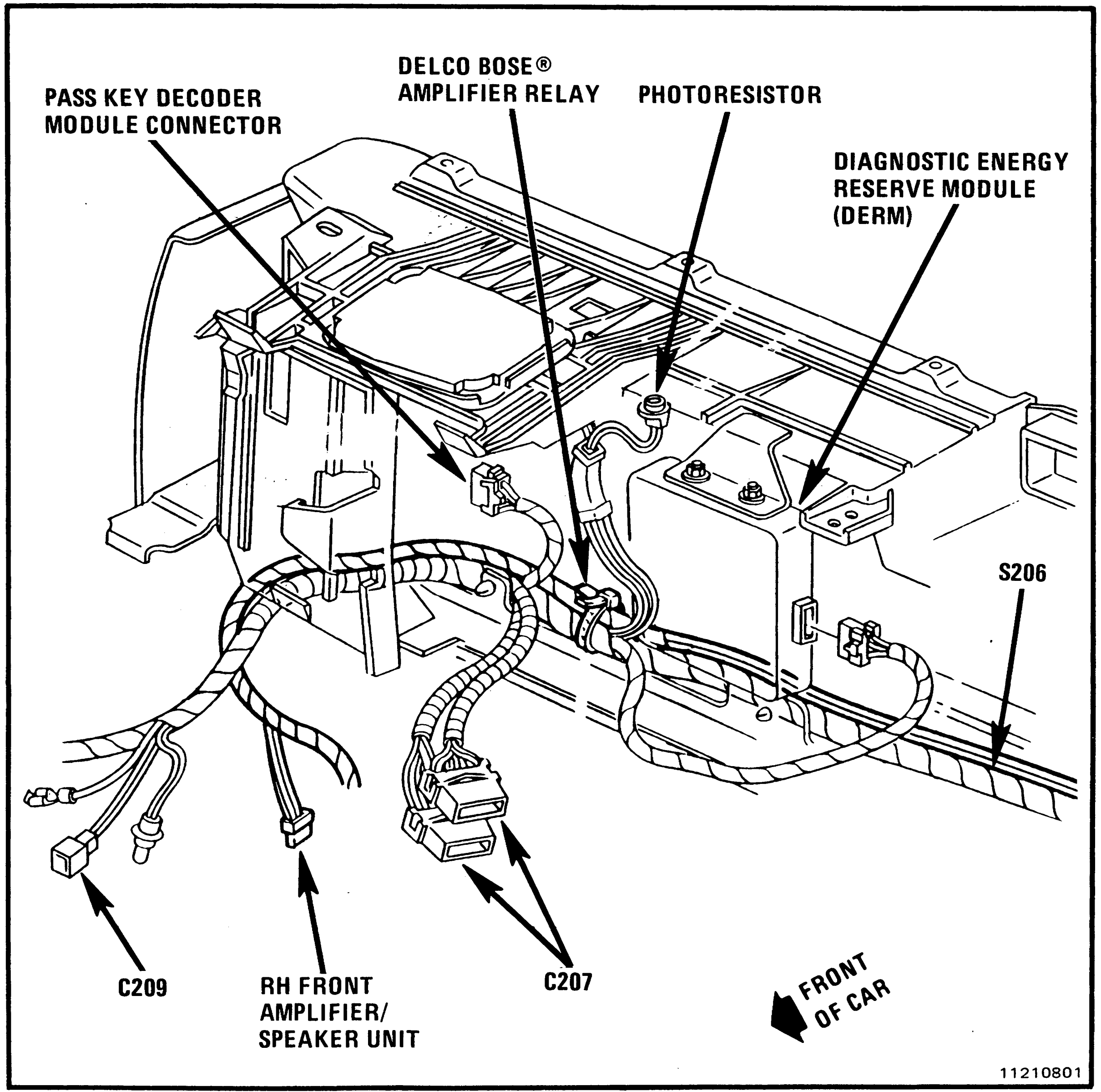


Figure A - Behind RH Side Of I/P

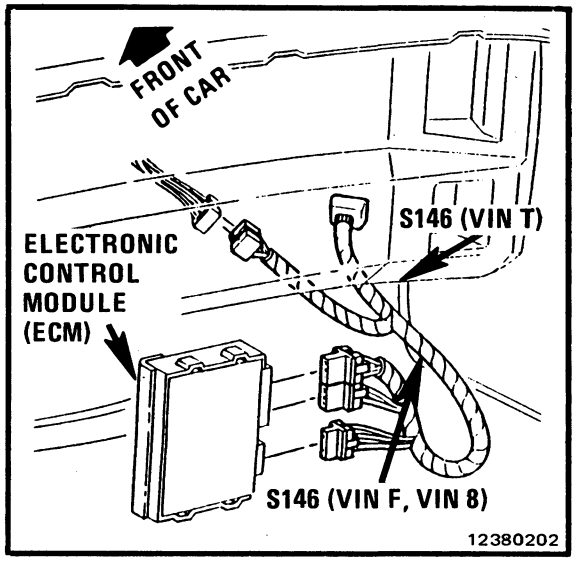


Figure B - Below RH Side Of I/P (Except VIN E)

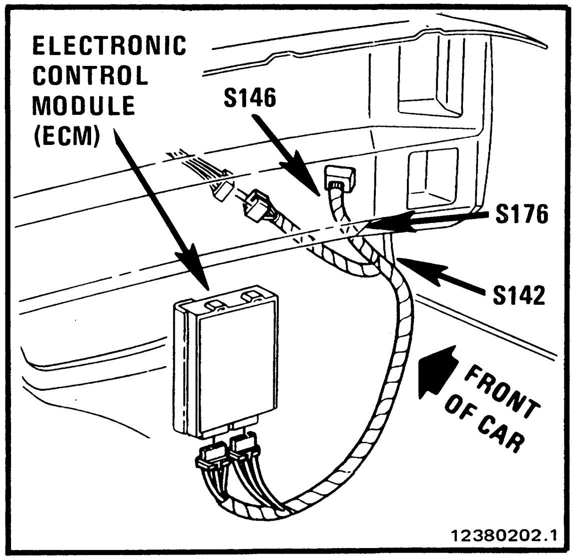


Figure C – Below RH Side Of I/P (VIN E)

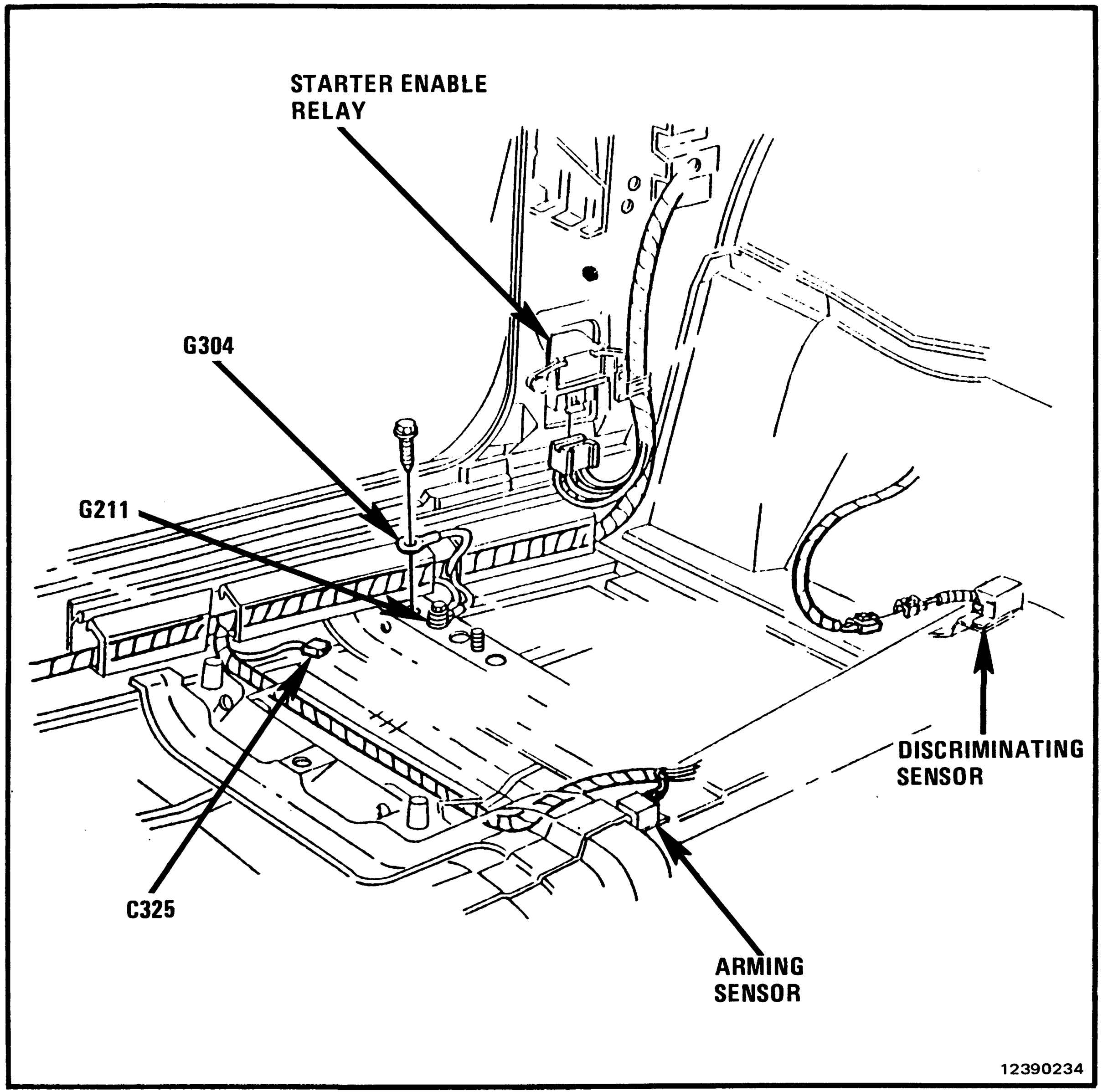


Figure A - Under Drivers Seat

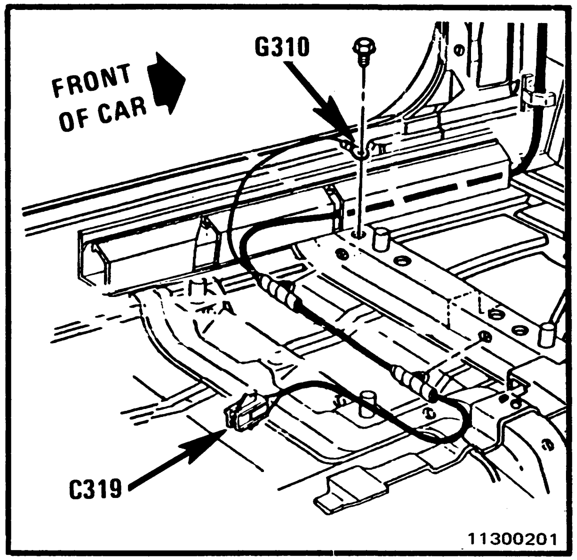


Figure B- Under Driver's Seat

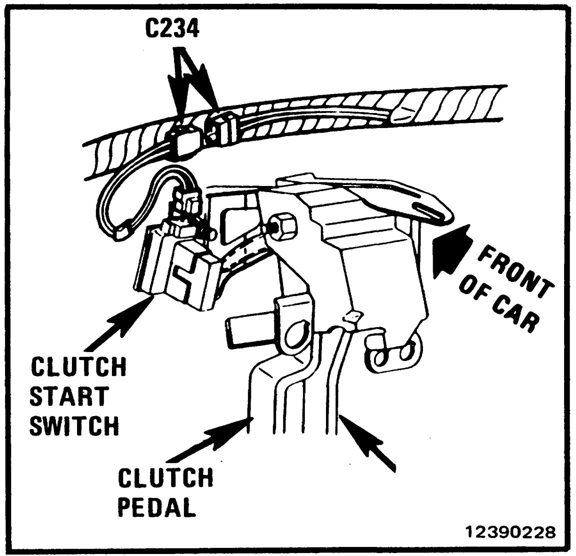


Figure C - Below LH Side Of I/P

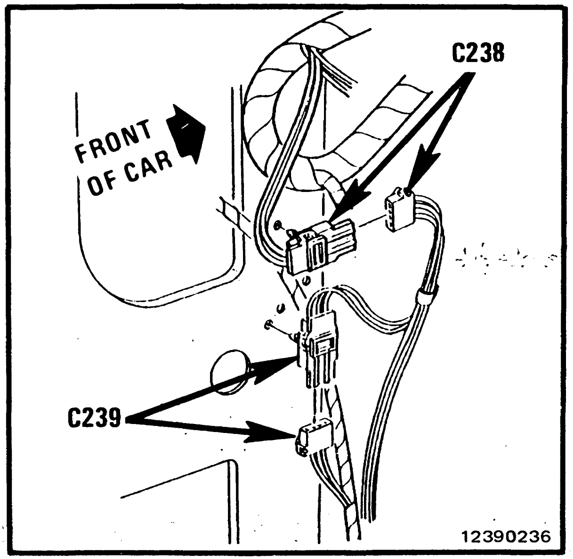


Figure A - LH Shroud

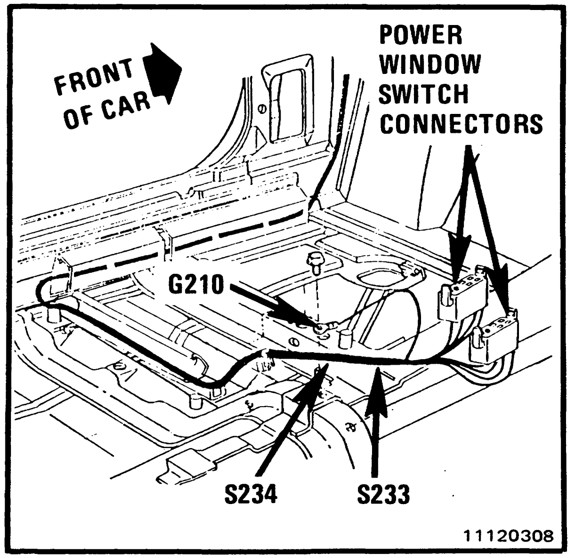


Figure C - Under Console

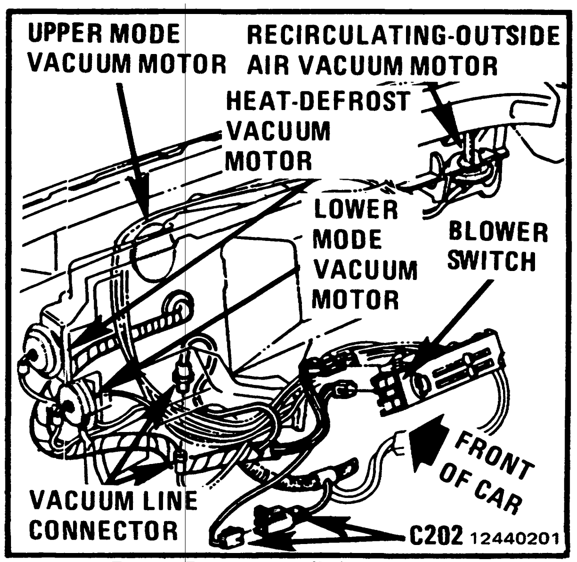


Figure E - Behind I/P (C60 Manual)

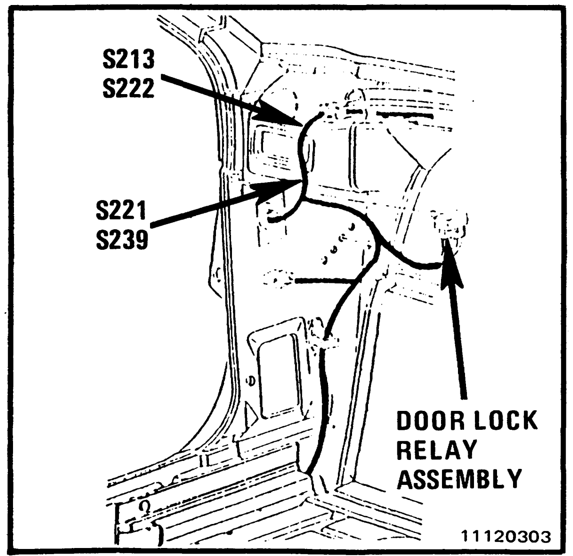


Figure B - LH Shroud

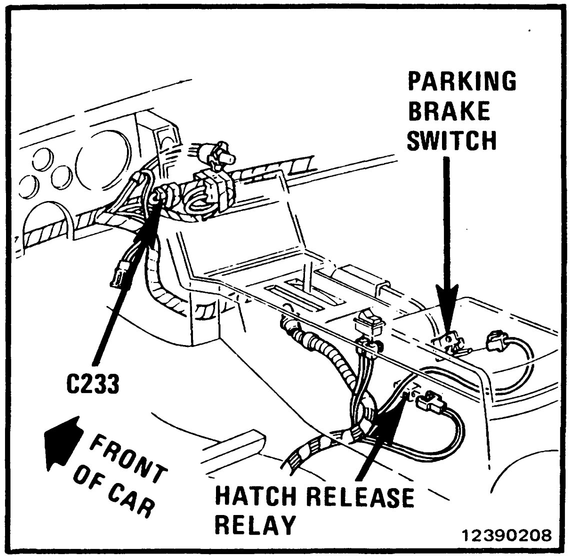


Figure D - Console

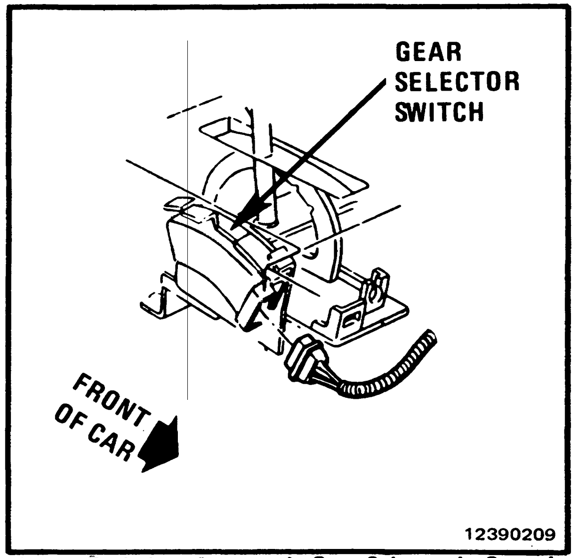


Figure F - Below Automatic Gear Selector in Console

COMPONENT LOCATION VIEWS

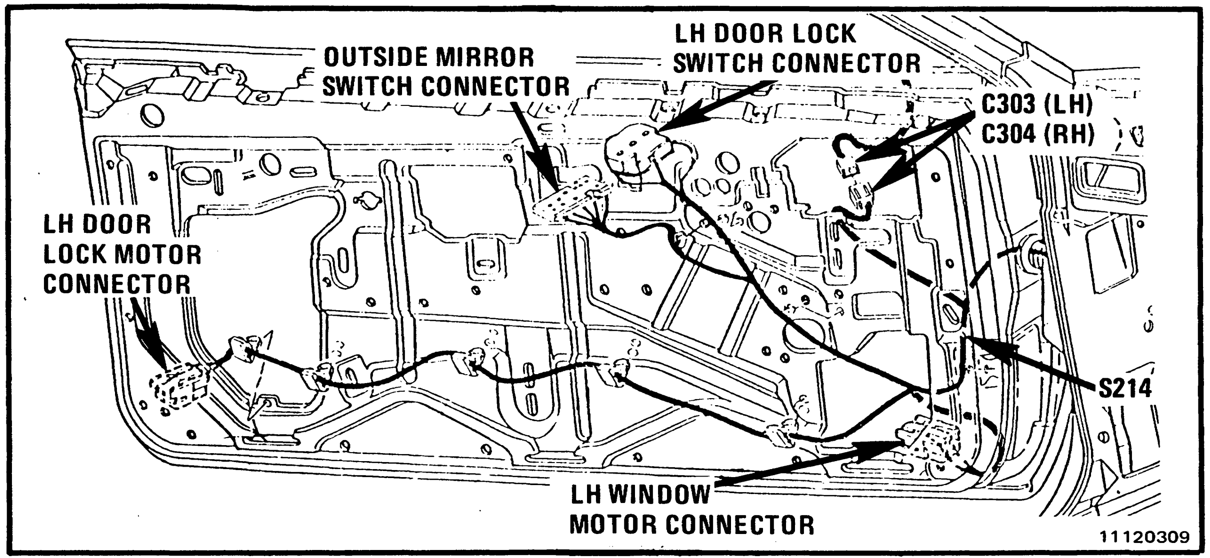


Figure A - LH Door (RH Similar)

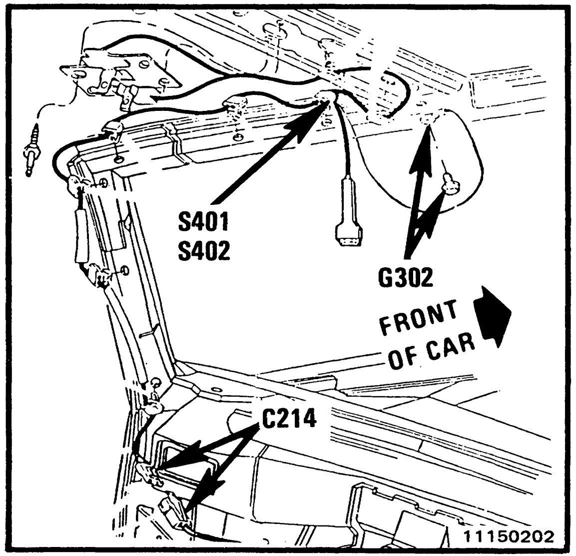


Figure D - LH Windshield Pillar

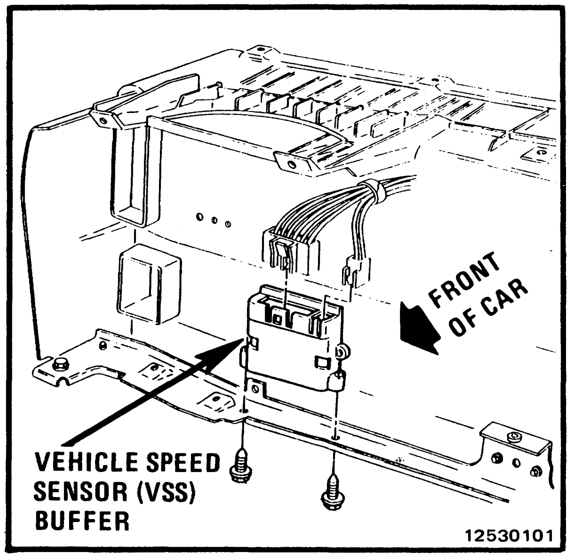


Figure B - Behind RH Side Of I/P

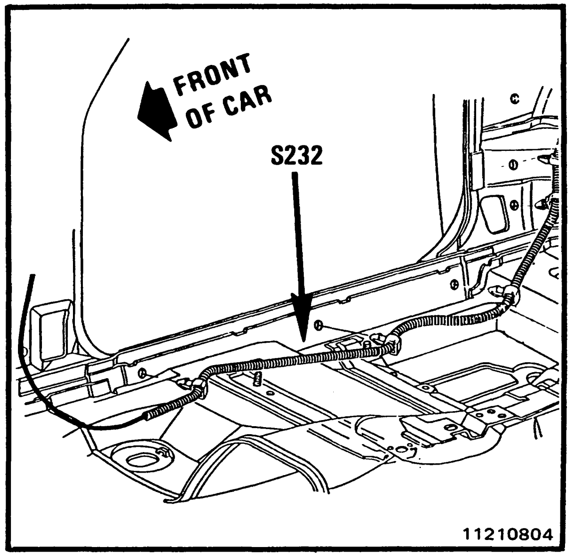


Figure C - RH Door Sill

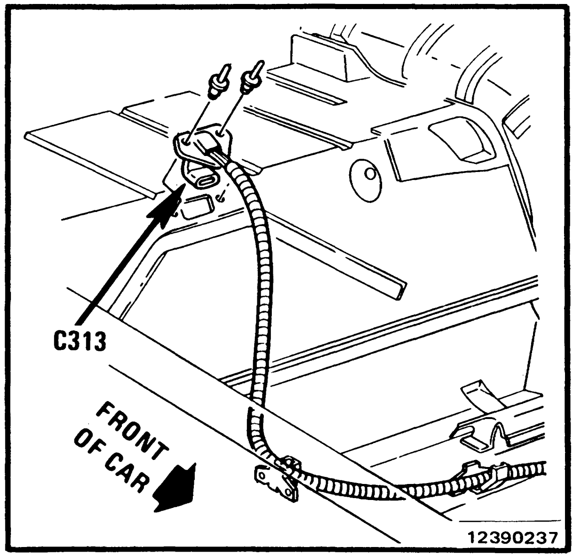


Figure E - Behind Rear Seat

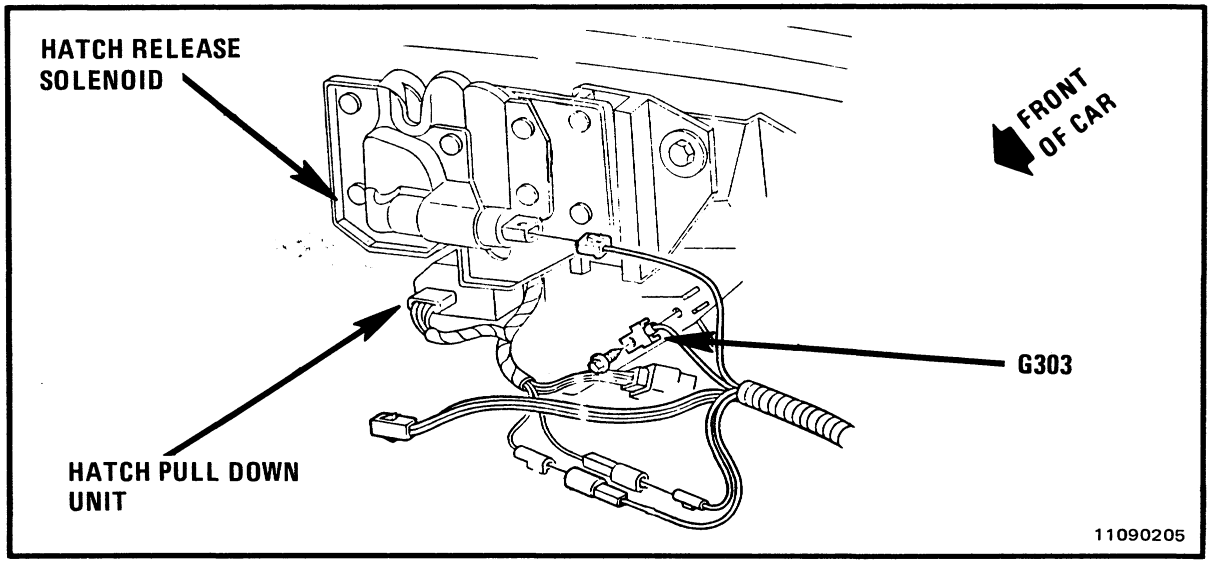


Figure A - Rear Of Luggage Compartment

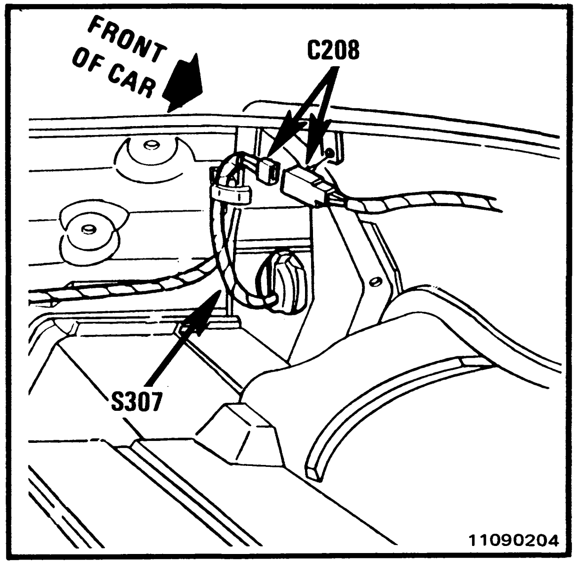


Figure C - LH Rear Of Luggage Compartment

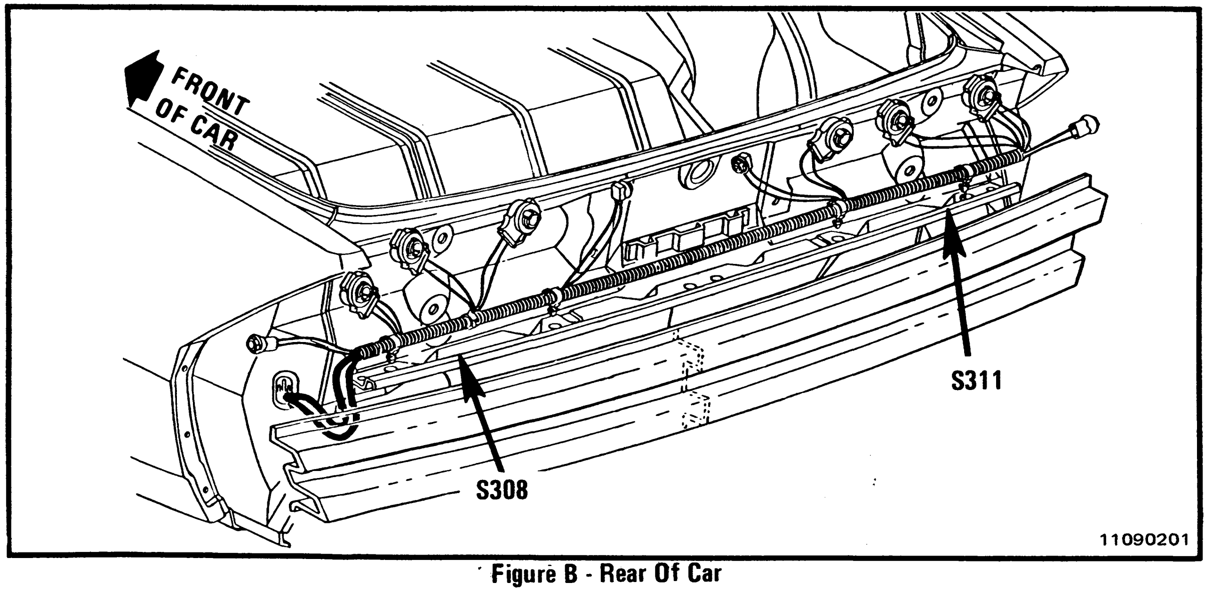


Figure B - Rear Of Car

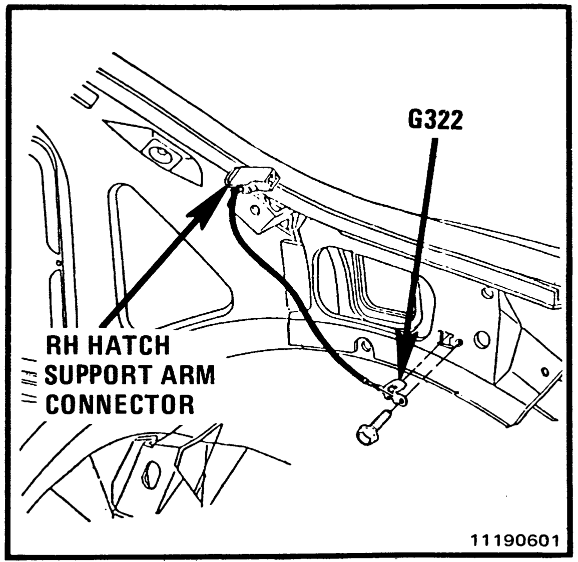
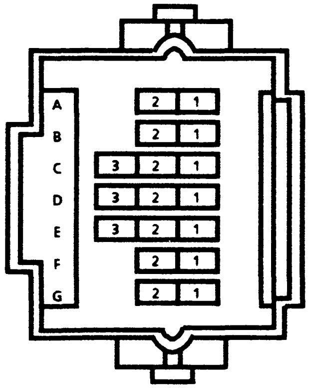


Figure D - RH Side Of Cargo Compartment

HARNESS CONNECTOR FACES
BULKHEAD CONNECTOR: C100



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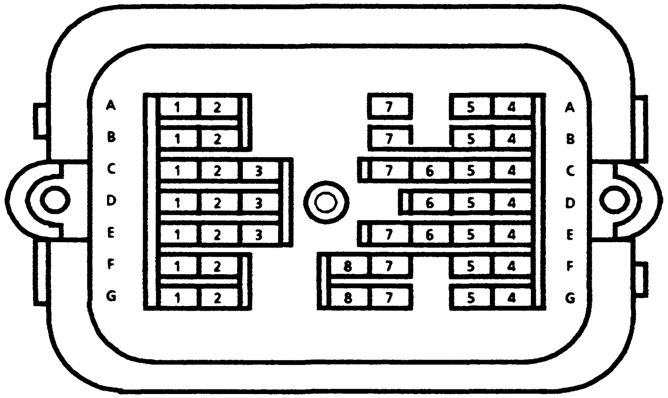
Metri-Pack Mixed

FRONT LIGHT HARNESS CONNECTOR
(REMOVED FROM C100)



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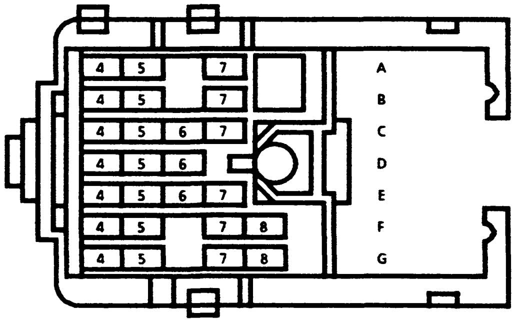
Metri-Pack Mixed

C100 TERMINAL VIEW
(AS MOUNTED ON COWL)



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Metri-Pack Mixed

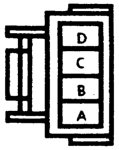
ENGINE HARNESS CONNECTOR
(REMOVED FROM C100)

V42000.0

HARNESS CONNECTOR FACES

CAVITY	WIRE COLOR		SCHEMATICS
	SOCKET HALF	PIN HALF	
A1	BLK/WHT	BLK/WHT	Supplemental Inflatable Restraint
A2	LT GRN	LT GRN	Headlights (High Beam)
A4	RED	RED	Power Distribution (Ignition Switch)
A5	TAN/WHT	TAN/WHT	Brake Warning System
A6	—	—	Not Used
A7	PNK/BLK	PNK/BLK	Engine: Emission Controls
B1	BRN	BRN	Exterior Lights (Front Park & Marker)
B2	PNK	PNK	Wiper/Washer
B4	PPL	PPL	Starter And Charging System: Starter
B5	DK BLU	DK BLU	Back-Up Lights (Manual Transmission)
B6	—	—	Not Used
B7	—	—	Not Used
C1	GRY	GRY	Wiper/Washer
C2	—	—	Not Used
C3	PPL	PPL	Headlights:Fog Lights
C4	LT GRN	LT GRN	Back-Up Lights (Manual Transmission)
C5	—	—	Not Used
C6	—	—	Not Used
C7	BLK/WHT	BLK/WHT	Engine
D1	—	—	Not Used
D2	—	—	Not Used
D3	—	—	Not Used
D4	—	—	Not Used (V6 VIN T)
	YEL	YEL	Vehicle Speed Sensor (V8 VIN E)
	—	—	Not Used (V8 VIN F And V8 VIN 8)
D5	—	—	Not Used
D6	WHT	WHT	Engine: Tachometer
E1	DK GRN	DK GRN	Wiper/Washer
E2	PPL	PPL	Wiper/Washer
E3	GRY	GRY	Supplemental Inflatable Restraint
E4	—	—	Not Used (V6 VIN T)
	PPL	PPL	Vehicle Speed Sensor (V8 VIN E)
	—	—	Not Used (V8 VIN F And V8 VIN F)
E5	TAN	TAN	Instrument Panel (Oil Pressure)
E6	—	—	Not Used
E7	PPL	PPL	Engine: Torque Converter Clutch
F1	TAN	TAN	Headlights (Low Beam)
F2	DK BLU	DK BLU	Exterior Lights: Turn
F4	PNK	PNK	Engine: Ignition
F5	DK GRN	DK GRN	Instrument Panel (Coolant Temperature)
F6	—	—	Not Used
F7	—	—	Not Used
F8	BLK/WHT	BLK/WHT	Supplemental Inflatable Restraint
G1	DK GRN	DK GRN	Horns
G2	LT BLU	LT BLU	Exterior Lights: Turn
G4	GRY	GRY	Engine: Fuel Control
G5	RED	RED	Power Distribution (Fuse Block)
G6	—	—	Not Used
G7	—	—	Not Used
G8	BRN	BRN	Starter And Charging System: Charging Coolant Fans (Coolant Fan Relay)

HARNESS CONNECTOR FACES



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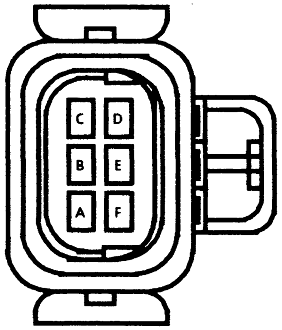
Metri-Pack 630
C105

V04011.0



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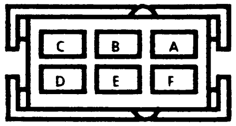
Metri-Pack 150
C113

V00721.0



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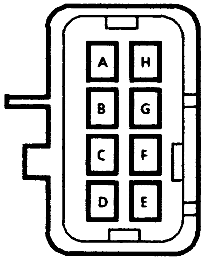
Metri-Pack 280
C203

V00453.0



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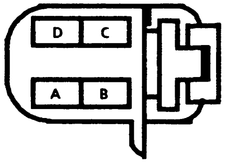
Metri-Pack 150
C208

V08000.0



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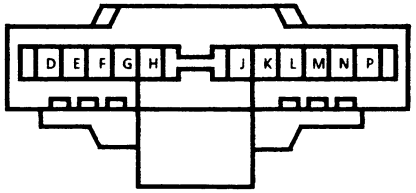
Metri-Pack 150
C209

V00724.0



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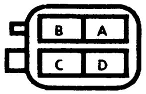
Pack Con I
C210

V11004.0

BLACK

Pack Con I
C211

V11003.0



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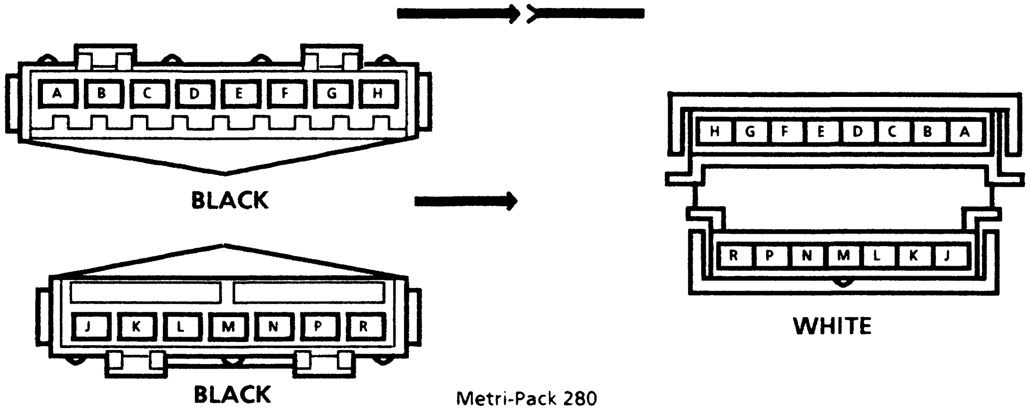
Metri-pack 150
C214

V04006.0

HARNESS CONNECTOR FACES



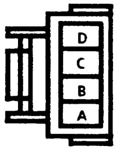
Metri-Pack 280

C207

CAVITY	WIRE COLOR	
	SOCKET HALF	PIN HALF
A	— (V6 VIN T) BRN (V8 VIN E) — (V8 VIN F) — (V8 VIN 8)	BRN
B	PNK/BLK (V6 VIN T) RED (V8 VIN E) PNK/BLK (V8 VIN F) PNK/BLK (V8 VIN 8)	PNK/BLK
C	BRN/WHT	BRN/WHT
D	GRY (V6 VIN T) — (V8 VIN E) GRY (V8 VIN F) GRY (V8 VIN 8)	GRY
E	WHT/BLK	WHT/BLK
F	PNK/BLK	PNK/BLK
G	PNK/BLK (V6 VIN T) WHT (V8 VIN E) PNK/BLK (V8 VIN F) PNK/BLK (V8 VIN 8)	PNK/BLK

CAVITY	WIRE COLOR	
	SOCKET HALF	PIN HALF
H	TAN/BLK	TAN/BLK
J	ORN	ORN
K	— (V6 VIN T) BRN (V8 VIN E) — (V8 VIN F) — (V8 VIN 8)	BRN
L	DK BLU	DK BLU
M	ORN	ORN
N	ORN/BLK	ORN/BLK
P	RED (V6 VIN T) — (V8 VIN E) RED (V8 VIN F) RED (V8 VIN 8)	RED
R	— (V6 VIN T) PPL/WHT (V8 VIN E) — (V8 VIN F) — (V8 VIN 8)	PPL/WHT

HARNESS CONNECTOR FACES



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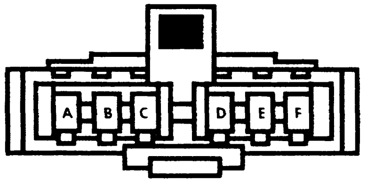
Metri-Pack 630
C238
V04011.0

C239, see C105

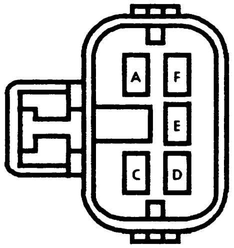
C303, see C214

C304, see C214



BLACK

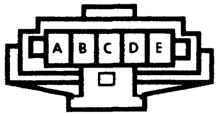
Pack Con II
C322
V06011.0



GRAY

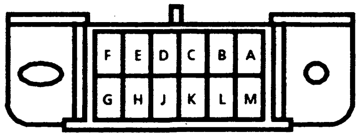
Metri-Pack Mixed Sealed
A/C COMPRESSOR CONTROL RELAY
V00488.0

AUXILIARY COOLANT FAN RELAY, see A/C COMPRESSOR CONTROL RELAY



BLACK
Pack Con H.D.

A/C CONTROL HEAD (WITH C60)
V00047.0

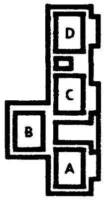


BLACK

Metri-Pack 280
ASSEMBLY LINE DIAGNOSTIC LINK (ALDL) CONNECTOR
V00287.1

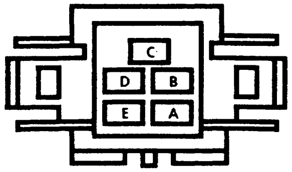
HARNESS CONNECTOR FACES

BLOWER HIGH SPEED RELAY, see A/C COMPRESSOR CONTROL RELAY



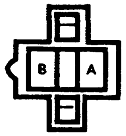
GRAY

56 Series
BLOWER RESISTORS
V00518.0

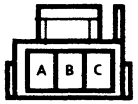


BLACK

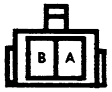
Metri-Pack 630
BLOWER SWITCH
V00215.0



56 Series
C1 WHITE



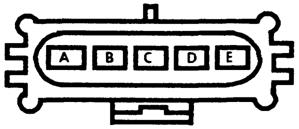
Metri-Pack Mixed
C2 BLACK



Metri-Pack 280
C3 BLUE

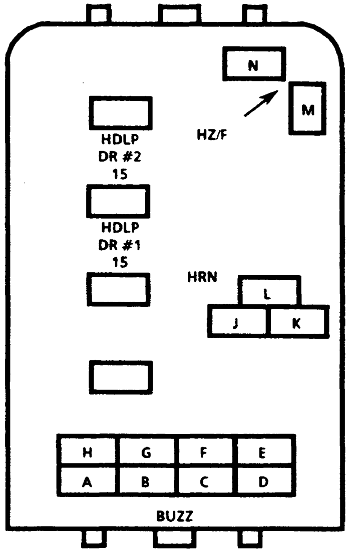
BRAKE SWITCH
V00029.0

COOLANT FAN RELAY, see A/C COMPRESSOR CONTROL RELAY



GRAY

Metri-PacK 280
CRUISE CONTROL SERVO
V00459.0



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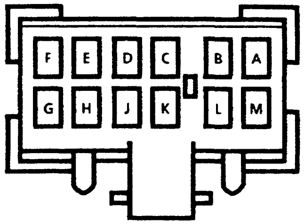
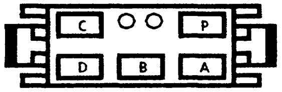
Metri-Pack 630
CONVENIENCE CENTER
V00744.0

HARNESS CONNECTOR FACES



WHITE
Printed Circuit (Edgeboard)
CRUISE CONTROL MODULE
V00286.0



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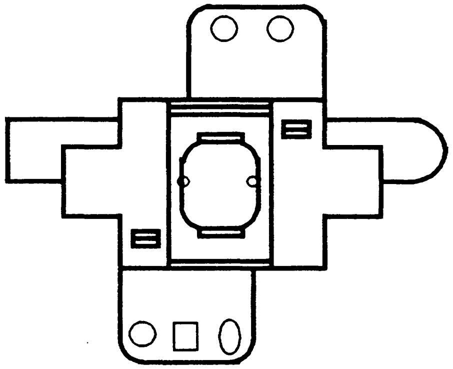
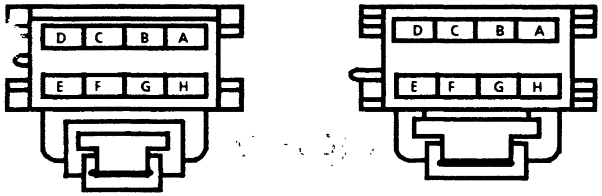
56 Series
DEFOGGER CONTROL
V00175.0



WHITE

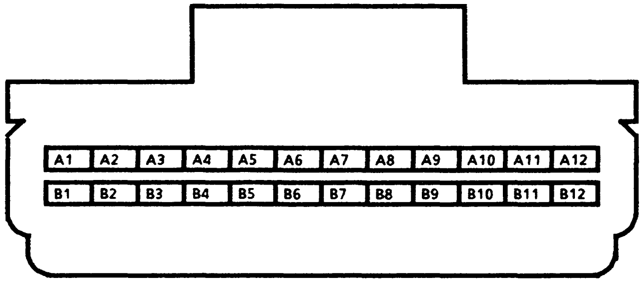
Non-Packard Assembly
DOME LIGHT
V00570.0



Metri-Pack 280
C1 BLACK

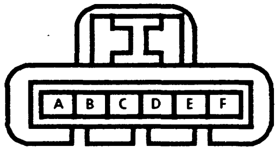
Metri-Pack 150
C2 BLUE

DAYTIME RUNNING LIGHTS (DRL) MODULE
V00673.0



YELLOW

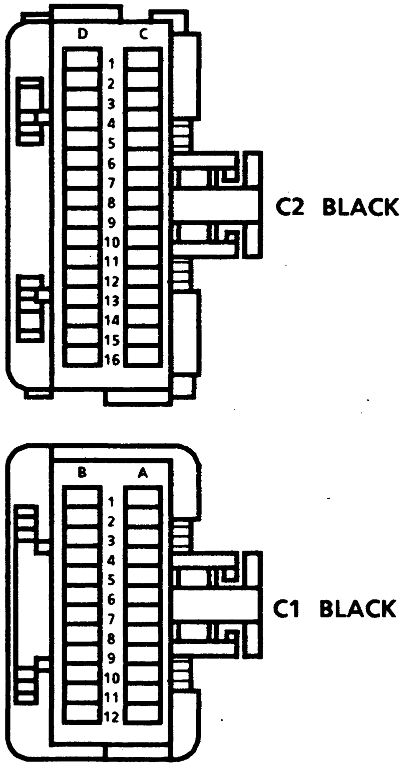
Micro-Pack
DIAGNOSTIC ENERGY RESERVE MODULE (DERM)
V00742.0



BLACK

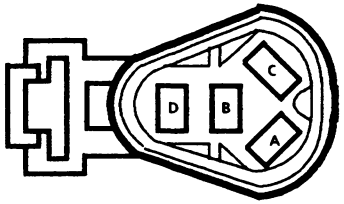
Metri-Pack Mixed
DOOR LOCK RELAY
V00191.0

HARNESS CONNECTOR FACES



Micro-Pack
ELECTRONIC CONTROL MODULE (ECM)
(V8 VIN E)

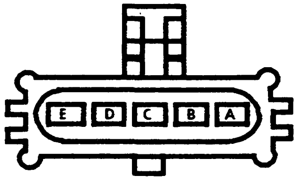
V00005.1



BLACK

Metri Pack 150
Pull-to-Seat
ERG-SOLENOID ASSEMBLY
(V6 VIN T)

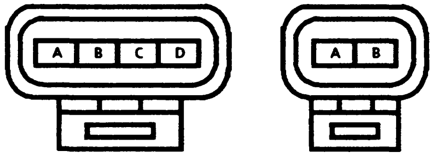
V00505.0



BLACK

Metri-Pack 280 Sealed
ELECTRONIC SPARK CONTROL MODULE

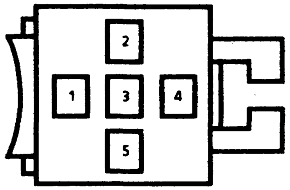
V00456.0



C1 BLACK **C2 BLACK**

Metri-Pack 150 Pull-to-Seat
ELECTRONIC SPARK
TIMING (EST) DISTRIBUTOR

V00328.0



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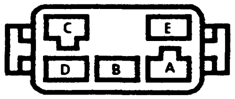
Metri-Pack 630
FOG LIGHT RELAY

V00463.0

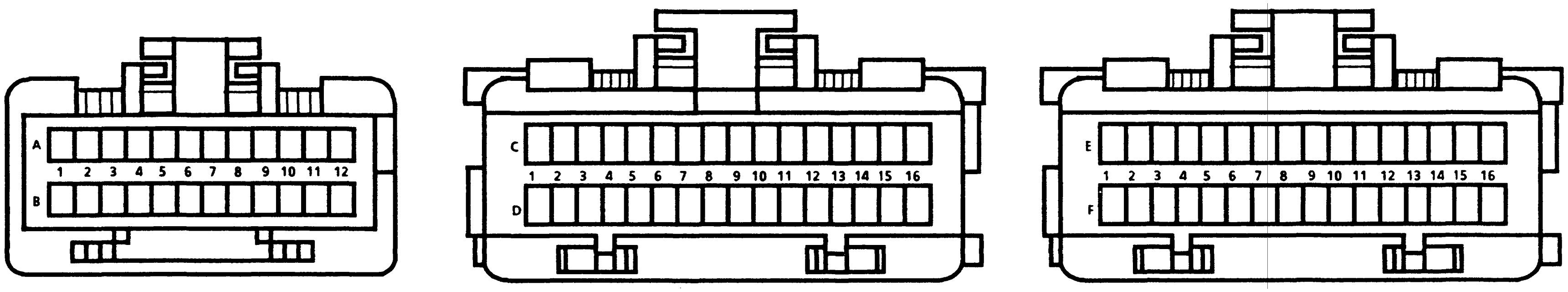


BLACK

56 Series
FOG LIGHT SWITCH

V00520.0

FRONT AMPLIFIER/SPEAKER UNIT (RH), see FRONT AMPLIFIER/SPEAKER UNIT (LH)



C1 BLACK

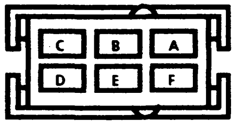
C2 BLACK

C3 GREEN

Micro-Pack

ELECTRONIC CONTROL MODULE (ECM)
(V6 VIN T, V8 VIN F AND V8 VIN 8)

V00482.0

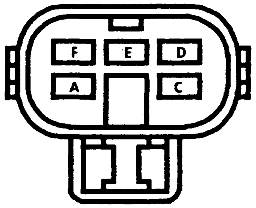


BLACK

Metri-Pack 280

FRONT AMPLIFIER/SPEAKER UNIT (LH)

V00453.0

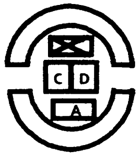


BLACK

Metri-Pack Mixed

FUEL PUMP RELAY

V00231.0

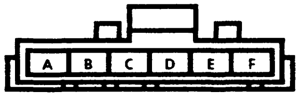


GRAY

Metri-Pack 150

FUEL PUMP/OIL PRESSURE SENDER/SWITCH

V00249.0

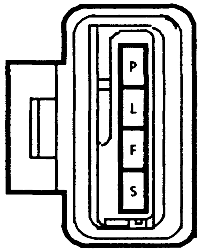


BLACK

Metri-Pack Mixed

GEAR SELECTOR SWITCH

V00541.1



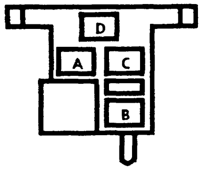
BLACK

Metri-Pack Mixed

GENERATOR

V00176.0

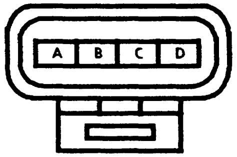
HARNESS CONNECTOR FACES



BLACK

56 Series
HEADLIGHT DIMMER SWITCH

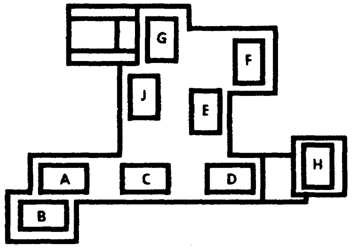
V00285.0



BLACK

Metri-Pack 150
Pull-to-Seat
IDLE AIR CONTROL STEPPER MOTOR (V6 VIN T)

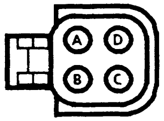
V00328.0



BLACK

56/59 Series
LIGHT SWITCH (WITHOUT DAYTIME RUNNING LIGHTS)

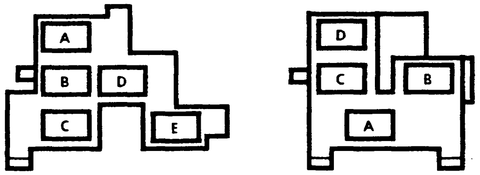
V00500.0



BLACK

Weather Pack
IDLE AIR CONTROL STEPPER MOTOR (V8 VIN E, V8 VIN F AND V8 VIN 8)

V00083.0

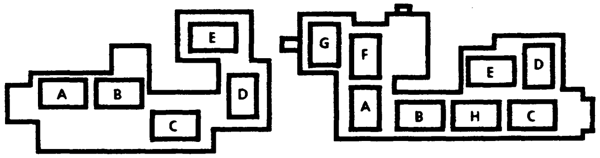


56 Series
C2 BLUE

56/59 Series
C1 BLACK

IGNITION SWITCH

V00032.0



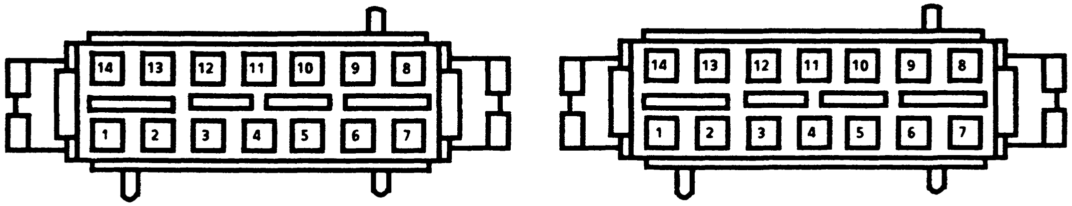
56/59 Series
C2 GRAY

56 Series
C1 WHITE

LIGHT SWITCH (WITH DAYTIME RUNNING LIGHTS)

V00745.0

HARNESS CONNECTOR FACES

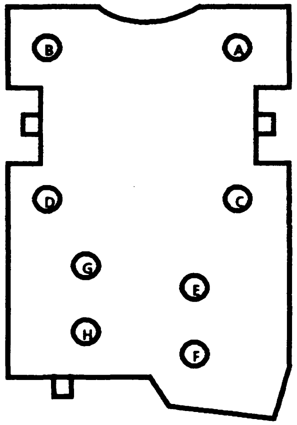


C1 BROWN

C2 GRAY

Printed Circuit (Bow)
INSTRUMENT PANEL

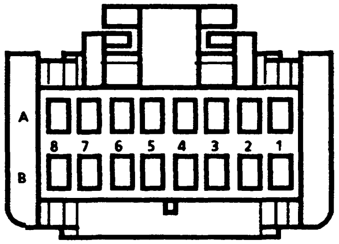
V00324.0



GRAY

Pin Grip Series
OUTSIDE MIRROR SWITCH

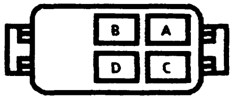
V00184.0



BLACK

Micro-pack
PASS KEY DECODER MODULE

V00117.0

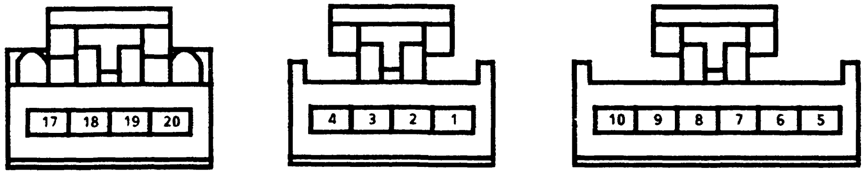


BLUE (RH)
WHITE (LH)
56 Series
POWER
WINDOW SWITCH

V00571.0

REAR AMPLIFIER/SPEAKER UNIT (LH),
see FRONT AMPLIFIER/SPEAKER UNIT (LH)

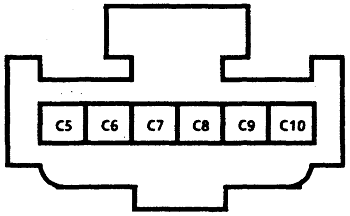
REAR AMPLIFIER /SPEAKER UNIT (RH),
see FRONT AMPLIFIER/ SPEAKER UNIT (LH)



BLUE **WHITE** **BLACK**

Micro-Pack
RADIO

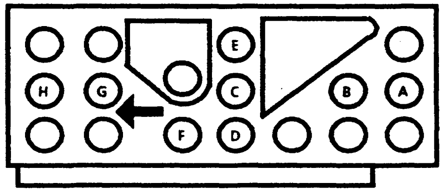
V00224.0



YELLOW

Micro-Pack
RESISTOR MODULE

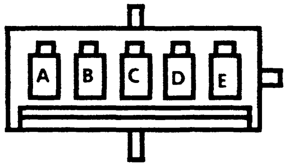
V00743.0



WHITE

Non-Packard Assembly
SEAT SWITCH

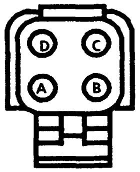
V00037.0



BLACK

Pack Con H.D.
STARTER ENABLE RELAY

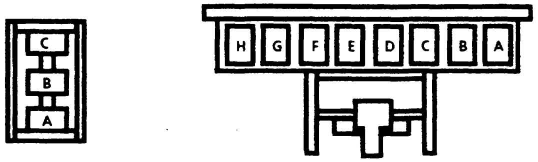
V00013.0



WHITE

Weather Pack
TRANSMISSION CONVERTER CLUTCH

V04017.0

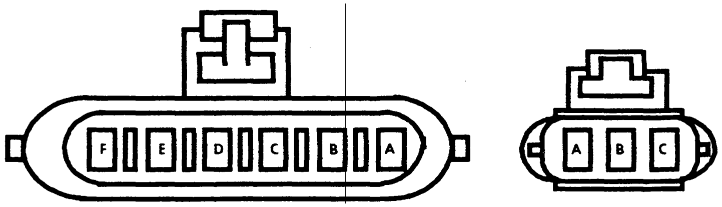


Printed Circuit (Fork)
C1 BLACK

Printed Circuit (Edgeboard)
C2 BLACK

VEHICLE SPEED SENSOR BUFFER
(DIGITAL CLUSTER)

V00325.0

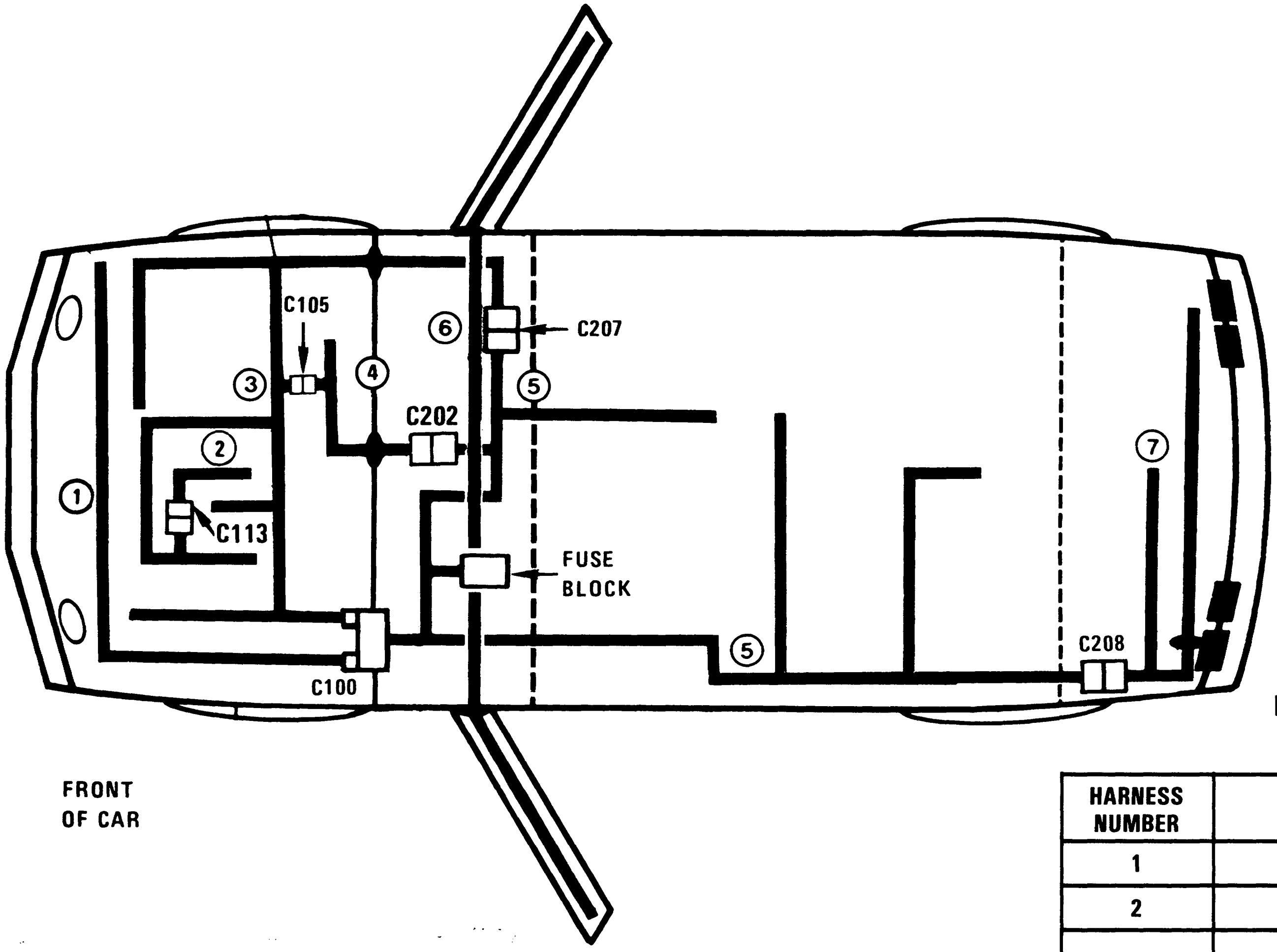


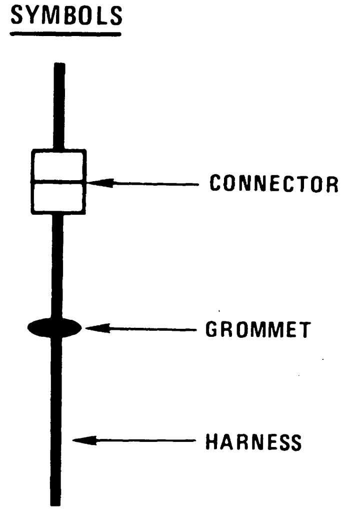
C1 BLACK **C2 BLACK**

Metri-Pack 280
WIPER MOTOR MODULE

V00409.0

HARNESS ROUTING VIEWS: V6 VIN T

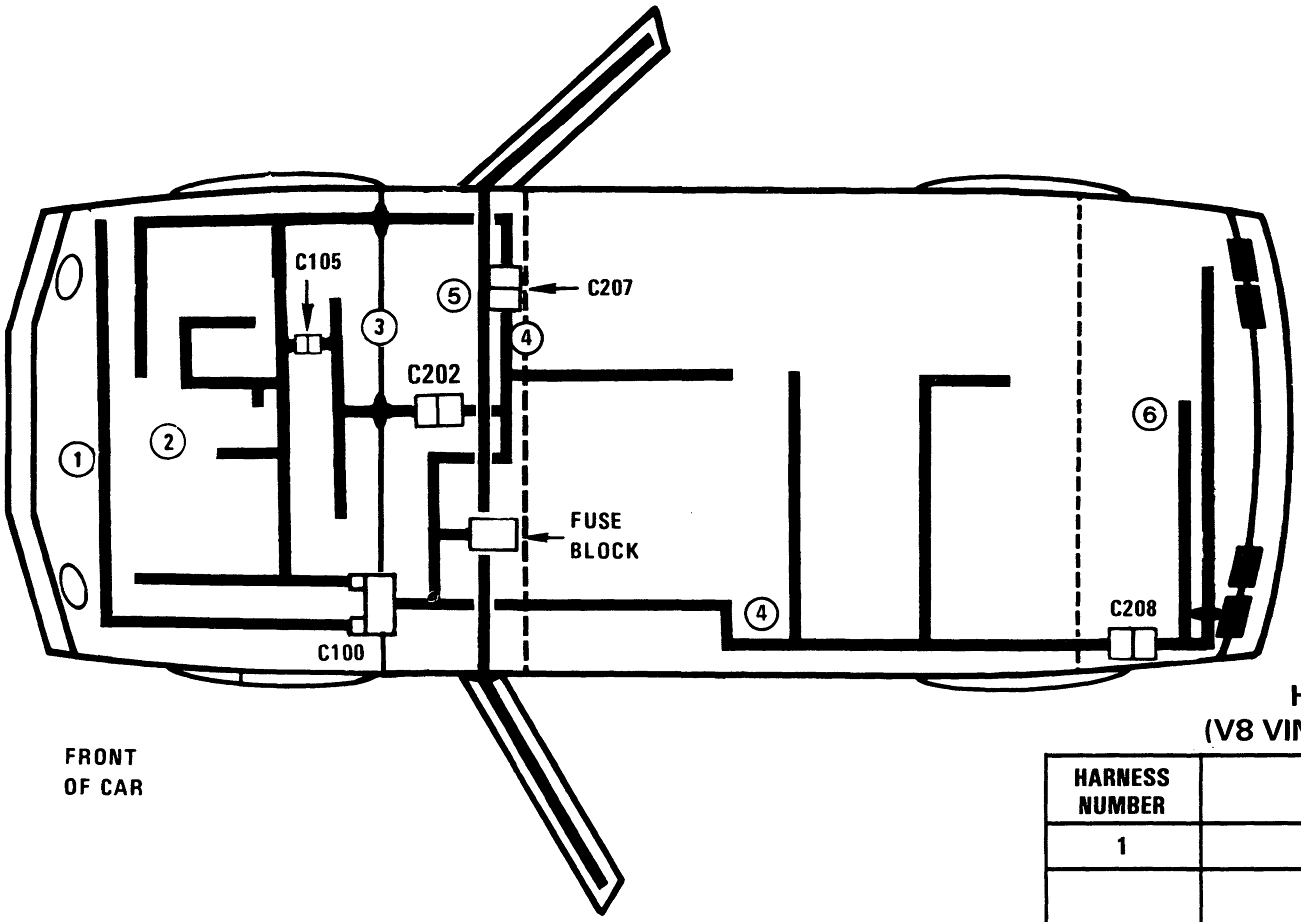


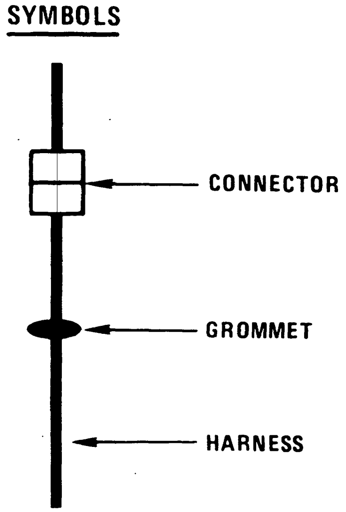


HARNESS CHART
(V6 VIN T)

HARNESS NUMBER	HARNESS NAME	PAGE-FIGURE
1	FRONT LIGHTS	201-10-A
2	INJECTOR	201-0-A
3	ENGINE	201-1-A 201-2-A
4	AIR CONDITIONING	201-11-A 201-17-E
5	INSTRUMENT PANEL	201-12-A 201-15-A
6	CROSS CAR	201-17-A 201-18-A
7	REAR LIGHTS	201-19-B

HARNESS ROUTING VIEWS: V8 VIN E, V8 VIN F, V8 VIN 8





HARNESS CHART
(V8 VIN E, V8 VIN F, V8 VIN 8)

HARNESS NUMBER	HARNESS NAME	PAGE-FIGURE
1	FRONT LIGHTS	201-10-A
2	ENGINE	(VIN E) 201-3-A 201-4-A (VIN F) (VIN 8) 201-7-A 201-8-A
3	AIR CONDITIONING	201-11-A 201-17-E
4	INSTRUMENT PANEL	201-12-A 201-15-A
5	CROSS CAR	201-17-A 201-18-A
6	REAR LIGHTS	201-19-B

SECTION 8B

LIGHTING SYSTEMS AND HORNS

CAUTION: The procedures in this section must be followed in the order listed to temporarily disable the Supplemental Inflatable Restraint (SIR) System and prevent false diagnostic codes from setting. Failure to follow this procedure could result in possible air bag deployment, personal injury, or unneeded SIR system repairs.

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 8B-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

HALOGEN BULBS

Some bulbs in this vehicle may contain halogen gas.

CAUTION: Halogen bulbs contain a gas under pressure. Handling a bulb improperly could cause it to shatter into flying glass fragments. To help avoid personal injury:

- Turn off the lamp switch and allow the bulb to cool before changing bulbs. Leave the switch off until bulb change is complete.
- Always wear eye protection when changing a halogen bulb.
- Handle the bulb only by its base. Avoid touching the glass.
- Do not drop or scratch the bulb. Keep moisture away.
- Place the used bulb in the new bulb's carton and dispose of it properly. Keep halogen bulbs out of the reach of children.

EXTERIOR LAMPS

The exterior lighting system includes the headlamps, fog lamps, front parking/turn signal lamps, rear tail/stop/turn signal lamps, backup lamps, license plate lamps, center high-mounted stoplamp, sidemarker lamps, and the underhood lamp. It also includes all associated wiring, control and related hardware for these lamps.

Backup Lamps

The backup lamps are located next to the rear license plate. They will come on when the transmission is shifted to "REVERSE." On vehicles with an automatic transmission, the backup lamps are activated by the neutral start switch. On vehicles with a manual transmission, they are activated by a separate backup lamp switch on the transmission. For more information, refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A).

Center High-Mounted Stoplamp

The center high-mounted stoplamp, on the top center of the compartment lid glass (for a convertible, in the center of the rear spoiler), will come on whenever the brake pedal is pushed down. The lamp is powered separately from the rear tail/stop/turn signal lamps through a separate circuit in the stoplamp switch. For more information, refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

Fog Lamps

The fog lamp switch is under the headlamp switch, to the left of the steering column. To use the fog lamps, first turn on the headlamps or parking lamps. Then, push the top of the fog lamp switch to turn on the fog lamps. Push the bottom part of the switch to turn off the fog lamps.

The fog lamps should not be used as a substitute for the headlamps.

Switching to high-beam headlamps will turn off the fog lamps. Switching back to low-beams will turn the fog lamps on again.

The fog lamps must be aimed for proper illumination of the road. Fog lamp aim should be checked when a new bulb is installed or if service or repairs in the front end area may have disturbed the fog lamp mountings.

Front Parking/Turn Signal Lamps

Pulling the instrument panel switch to the first stop will turn on the front parking lamps. When the ignition is on and the turn signal lever is moved, the appropriate front parking lamp flashes to signal a turn. Both lamps will flash when the hazard flashers are on.

If the ignition is turned off when the parking lamps are on, a warning tone will sound. For more information refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

Hazard Flasher

The hazard warning flasher is part of the turn signal circuit. Pushing in the button on the lower right side of the steering column will cause the front and rear turn signal lamps and the front sidemarker lamps to flash. Pull out the collar around the button to turn off the hazard flashers.

The hazard flashers will work with the ignition either off or on. When the hazard flashers are on, the turn signals do not work. The hazard flasher will still remain flashing if the brake pedal is depressed.

Headlamps

The headlamps are controlled by the switch on the instrument panel (to the left of the speedometer). They will come on whether or not the ignition is turned on. Pulling the switch all the way out turns on headlamps. Pushing the switch all the way in turns off the headlamps.

If the ignition is turned off and the headlamps are on, a warning tone will sound. For more information, refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

Headlamp low beam and high beam are controlled by the turn signal/multifunction lever on the left side of the steering column. When the headlamps are on, pull the lever toward the steering wheel until the switch clicks; the lamps will change from low-beam to high-beam, or from high beam to low beam. An indicator lamp on the center instrument cluster will come on when the high-beam headlamps are on.

The headlamps must be aimed for proper illumination of the road. Headlamp aim should be checked when a new headlamp bulb is installed or if service or repairs in the front end area may have disturbed the headlamps or their mountings. The headlamp bezels do not need to be removed to aim the headlamps.

Headlamp focus is set when the sealed-beam unit is made; no adjustment for focus is necessary or possible.

Some state and local laws specify requirements for headlamp aim; these laws must be followed.

License Plate Lamps

Lamps to the sides of the rear license plate will come on when the headlamps or parking lamps are on.

Rear Tail/Stop/Turn Signal Lamps

The rear tail/stop/turn signal lamps are part of the same lamp assembly. Pulling out the instrument panel switch to either stop turns on the taillamps When the brake pedal is pushed down, the lamps glow brighter to serve as stoplamps.

Moving the turn signal lever when the ignition is on causes the appropriate rear lamps to flash. If the brake pedal is held down and a turn is signalled, one side will flash and the other will stay on brightly.

All lamps will flash when the hazard flashers ar on, If the brake pedal is pushed while the hazard flashers are on, the lamps will continue flashing.

Sidemarker Lamps

The front and rear sidemarker lamps will com on when the headlamps or parking lamps are on. Bot front and rear sidemarker lamps also have reflectors they will shine when struck by light, whether or not th vehicle's lamps are on.

If the headlamps or parking lamps are off whe a turn is signalled, the front sidemarker lamp will flas in unison with the front turn signal lamp on the sam side. If the lamps are on when a turn is signalled, th front sidemarker lamp and front turn signal lamp flas alternately.

The rear sidemarker lamps are part of the rear tail/stop/turn signal lamp assemblies.

Turn Signals

The front turn signals are combined with the front parking lamps. The rear turn signals are part of the rear tail/stop/turn signal lamps. The turn signals work only when the ignition is on, and the hazard flashers are turned off.

The turn signals are controlled by the turn signal/ multifunction lever on the left side of the steering column. Moving the lever all the way up or down (past the detent) will turn on the turn signals. When the turn is completed, the lever will return to neutral and the turn signals will stop flashing.

For changing lanes or shallow turns where the steering wheel does not move far enough to cancel the signal, move the turn signal lever only to the first detent. When the lever is released, it will return to neutral and the turn signals will cancel.

Underhood Lamp

The underhood lamp will come on when the hood is raised.

Lamp Switch

Most exterior lamps are controlled by the switch on the instrument panel, to the left of the speedometer. Pulling the switch out to the first stop turns on the front parking lamps, the taillamps, the sidemarker lamps and the instrument panel lamps. Pulling the switch all the way out turns on all these lamps plus the headlamps. Pushing the switch all the way in turns off all lamps. For more information on the lamp switch and interior lamps, refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).

HORNS

The horns are mounted behind the front fascia on the driver's side. Pushing the pad in the center of the steering wheel sounds the horn by closing the horn relay (in the convenience center behind the instrument panel, to the right of the steering column). The horns use a solenoid-operated diaphragm to generate sound. For wiring and circuit information, refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

INTERIOR LAMPS

Dome and Reading Lamps

The dome lamp is on the roof between the front seats. It will come on when a door is opened, or when the inside lamps are turned on. To turn on the dome and inside lamp, rotate the instrument panel switch counterclockwise.

If so equipped, the reading lamps are part of the dome lamp assembly. Push the switch to turn a lamp on or off.

Cargo Lamp

The cargo lamp is in the rear of the compartment. The lamp will come on when the hatch is open and go off when the hatch is closed.

FORWARD DISCRIMINATING SENSOR

The forward discriminating sensor consists of a sensing element, normally open switch contacts and a diagnostic resistor. For explanation of the supplemental inflatable restraint components, refer to SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM INTRODUCTION (SEC. 9J).

ON-VEHICLE SERVICE

Wiring diagrams and other diagnosis information is given in ELECTRICAL DIAGNOSIS (SEC. 8A). Information on properly repairing wire harnesses connectors, etc., is also included in ELECTRICAL DIAGNOSIS (SEC. 8A).

Most lighting problems are caused by loose connectors, open or shorted wiring, burned-out bulbs, bad switches, inadequate ground or blown fuses. Many of these problems require only replacement of a defective part. When replacing a part that requires a special procedure (such as a lens and housing assembly sealed together), follow the instructions normally included in the replacement parts package.

When removing a part that requires special sealing items (such as sealing washers), be sure to reinstall those items when replacing the part. Also, if any body sealing items (grommets, etc.) are disturbed, be sure to repair them so the passenger compartment remains properly sealed.

EXTERIOR LAMPS

Backup Lamps

To replace a backup lamp bulb, refer to "Rear Tail/Stop/Turn Signal Lamps" in this section. For information on the backup lamp switch in the transmission, refer to TRANSMISSION GENERAL INFORMATION AND ON-VEHICLE SERVICE (SEC. 7A).

Center High-Mounted Stoplamp

Assembly or Bulb Replacement (Except Convertible)

Remove or Disconnect

1. Two screws from trim cover.
2. Trim cover.
3. Electrical connector.
4. Two screws from lamp assembly.
5. Lamp assembly from bracket.
6. Bulb from socket.

Install or Connect

1. Bulb into socket.
2. Lamp assembly to bracket.
3. Two screws to lamp assembly.
4. Electrical connector.
5. Trim cover.
6. Two screws to trim cover.

Assembly or Bulb Replacement (Convertible Only)

Remove or Disconnect

1. Two screws from lens.
2. Lamp assembly.
3. Electrical connector.
4. Screws from socket bar on back of assembly.
5. Socket bar.
6. Bulb from socket.

Install or Connect

1. Bulb into socket.
2. Socket bar.
3. Screws to socket bar.
4. Electrical connector.
5. Lamp assembly.
6. Two screws.

Fog Lamps

Figure 1

Assembly Replacement

Remove or Disconnect

1. Two screws (3) attaching lamp assembly (4) to front impact bar (1).
2. Connector (2) from lamp assembly (4).
3. Lamp assembly (4) from front impact bar (1).

Install or Connect

NOTICE: See "Notice" on page 8B-1 of this section.

1. Lamp assembly (4) onto front impact bar (1).
2. Connector (2) to lamp assembly (4).
3. Two screws (3) attaching lamp assembly (4) to front impact bar (1).

Tighten

- Screws (3) to 3 N•m (27 lb. in.).

Adjust

- Fog lamp aim. Refer to "Fog Lamp Aiming" in this section.

Bulb Replacement

Remove or Disconnect

1. Vertical adjusting screw.
- Fold lamp forward.
2. Connector (2) from lamp.
3. Bulb from lamp.

Install or Connect

1. Bulb into lamp.
2. Connector (2) to lamp.
- Raise lamp into position.
3. Vertical adjusting screw.

Adjust

- Fog lamp aim. Refer to "Fog Lamp Aiming" in this section.

Fog Lamp Aiming

Fog lamps are to be visually aimed in accordance with sections 6 and 7 of SAE Standard, Lighting Inspection Code - SAE J599, May 1981.

Prepare the vehicle for checking or setting aim as follows:

- Completely assemble all components on vehicle.
- Fuel load to be 1/2 tank or less.
  - Only other load in vehicle is the driver.
- Place vehicle on level surface.
- Close doors.
- Rock vehicle sideways to stabilize suspension.
- Turn on fog lamps.

Adjust

- Vertical aim using the vertical adjusting screw mounted on the top of the fog lamp assembly.
  - Within the following limits:
    - The top edge of the high intensity zone is to be 100 mm (4 inches) below the horizontal centerline of the fog lamp + 51 mm (2 inches) / - 64 mm (2.5 inches) on a screen located 7.6 m (25 feet) away from the front of the vehicle.

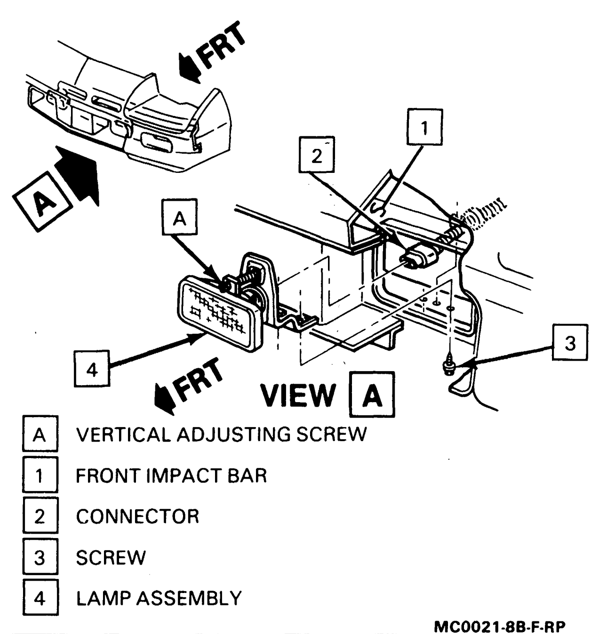


Figure 1 - Fog Lamp Assembly Mounting (Typical)

Front Parking/Turn Signal Lamps

Figure 2

Assembly Replacement

Remove or Disconnect

1. Socket from assembly.
2. Two nuts.
3. Front parking/turn signal lamp assembly.

Install or Connect

1. Front parking/turn signal lamp assembly.
2. Two nuts.
3. Socket into assembly.

Bulb Replacement

Remove or Disconnect

1. Socket from assembly.
2. Bulb from socket.

Install or Connect

1. Bulb into socket.
2. Socket into assembly.

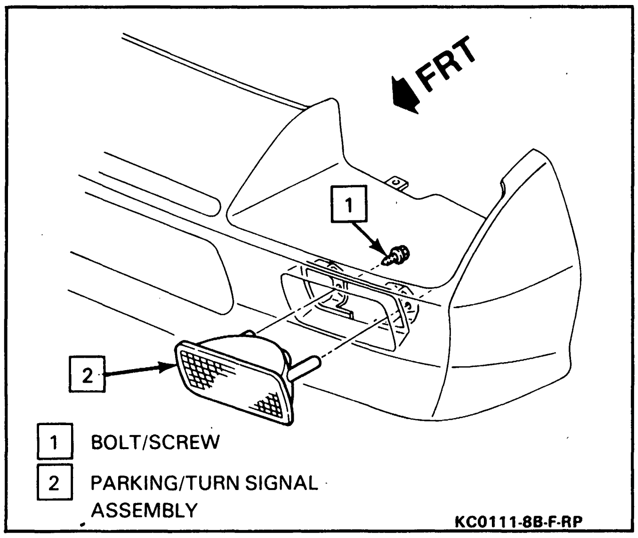


Figure 2 - Front Parking/Turn Signal Lamp Mounting

Hazard Flasher

The hazard flasher is in the convenience center, behind the instrument panel to the right of the steering column. To remove the flasher, remove sound insulator panel and lift flasher up and out.

Headlamps

Figure 3

Bulb (Capsule) Replacement

Remove or Disconnect

1. Four screws (8) attaching bezel (7) to capsule (1).
2. Spring (5) from bezel (7).
   - Loosen horizontal adjuster (3) and vertical adjuster (4).
3. Horizontal adjuster (3) and vertical adjuster (4) off bezel (7).
4. Bezel (7) from capsule (1).
5. Capsule (1).
6. Electrical connector from capsule (1).

Install or Connect

NOTICE: See "Notice" on page 8B-1 of this section.

1. Electrical connector to capsule (1).
2. Capsule (1).
3. Bezel (7) to capsule (1).
4. Horizontal adjuster (3) and vertical adjuster (4) onto bezel (7).
5. Spring (5) to bezel (7).
6. Four screws (8) attaching bezel (7) to capsule (1).

Adjust

- Headlamp aim. Refer to "Headlamp Aiming" in this section.

Headlamp Aiming

Horizontal aim corrected by an adjusting screw on the outer side of the headlamp assembly. Vertical aim is corrected by an adjusting screw in the top center of the assembly. When adjusting headlamp aiming, use aimer J 25300-B. All aimers should be used according to the manufacturer's instructions.

Tool Required:

J 25300-B Headlamp Aimer

Prepare vehicle for checking beam aim as follows:

- Completely assemble all components on vehicle.
- Fuel load to be 1/2 tank or less.
  - Only other load in the vehicle is the driver.
- Place vehicle on level surface within ± 0.76 mm (± 0.032 inch).
- Close doors.
- Rock vehicle sideways to stabilize the suspension.
- Open hood.

Install or Connect

- Headlamp aimer J 25300-B to headlamp.

Important

- Calibrate mechanical aimers in accordance with SAE Standard, Headlamp Aiming Device for Mechanically Aimable Sealed Beam Headlamp Units - SAE J602, October 1980 as follows:
  - Set master fixture to "0" U/D and "0" R/L.

  - Calibrate aimers on master fixture to read "O" U/D and R/L.

Headlamps are to be visually aimed in accordance with sections 1 through 5 of SAE Standard, Lighting Inspection Code - SAE J 599, May 1981.

Adjust

- Vertical aim using the vertical adjusting screw at the top of the bezel by turning screw clockwise.
  - Within the following limits:
    - 50.8 mm (2 inches) up to 63.5 mm (2.5 inches) down when measured on a screen located 7.6 m (25 feet) away from the front of the vehicle.
- Horizontal aim using the horizontal adjusting screw at the side of the bezel by turning screw clockwise.
  - Within the following limits:
    - 101.6 mm (4 inches) right to 101.6 mm (4 inches) left when measured on a screen located 7.6 m (25 feet) away from the front of the vehicle.

Important

  - Aim adjusting tools should be carefully selected since one full turn of an adjusting screw will move the aim approximately 88.6 mm (3.5 inches) when measured at 7.6 m (25 feet).

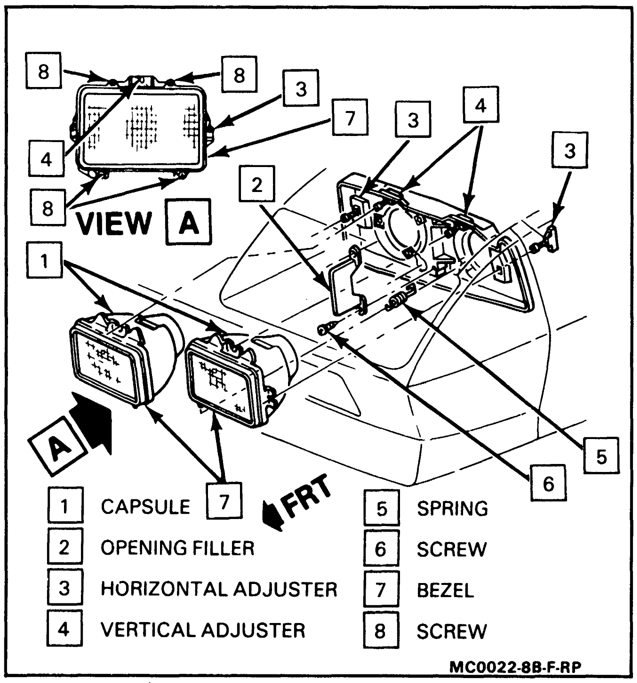


Figure 3 - Headlamp Mounting

License Plate Lamps

Figure 4

Assembly or Bulb Replacement

Remove or Disconnect

1. Screw at top of assembly.
2. License plate assembly by lifting up and out.
3. Socket from assembly.
4. Bulb from socket.

Install or Connect

1. Bulb into socket.
2. Socket into assembly.
3. License plate lamp assembly by putting tab on bottom into slot, then pushing top in.
4. Screw to top of assembly.

Rear Tail/Stop/Turn Signal Lamps

Figure 4

Remove or Disconnect

1. Two fasteners at ends of trim panel.
2. Two screws near hatch catch.
3. Trim panel.
4. Five wing nuts holding taillamp lens.
5. Taillamp lens.
6. Bulb from socket.

Install or Connect

1. Bulbs into socket.
2. Taillamp lens.
3. Wing nuts.

Adjust

- Taillamp lens for proper appearance before tightening wing nuts.

4. Trim panel.
5. Two screws near hatch catch.
6. Two fasteners.

Sidemarker Lamps

Figures 4 and 5

Assembly Replacement - Front

Remove or Disconnect

1. Socket from assembly.
2. Two retainers.
3. Side marker lamp assembly.

Install or Connect

1. Side marker lamp assembly.

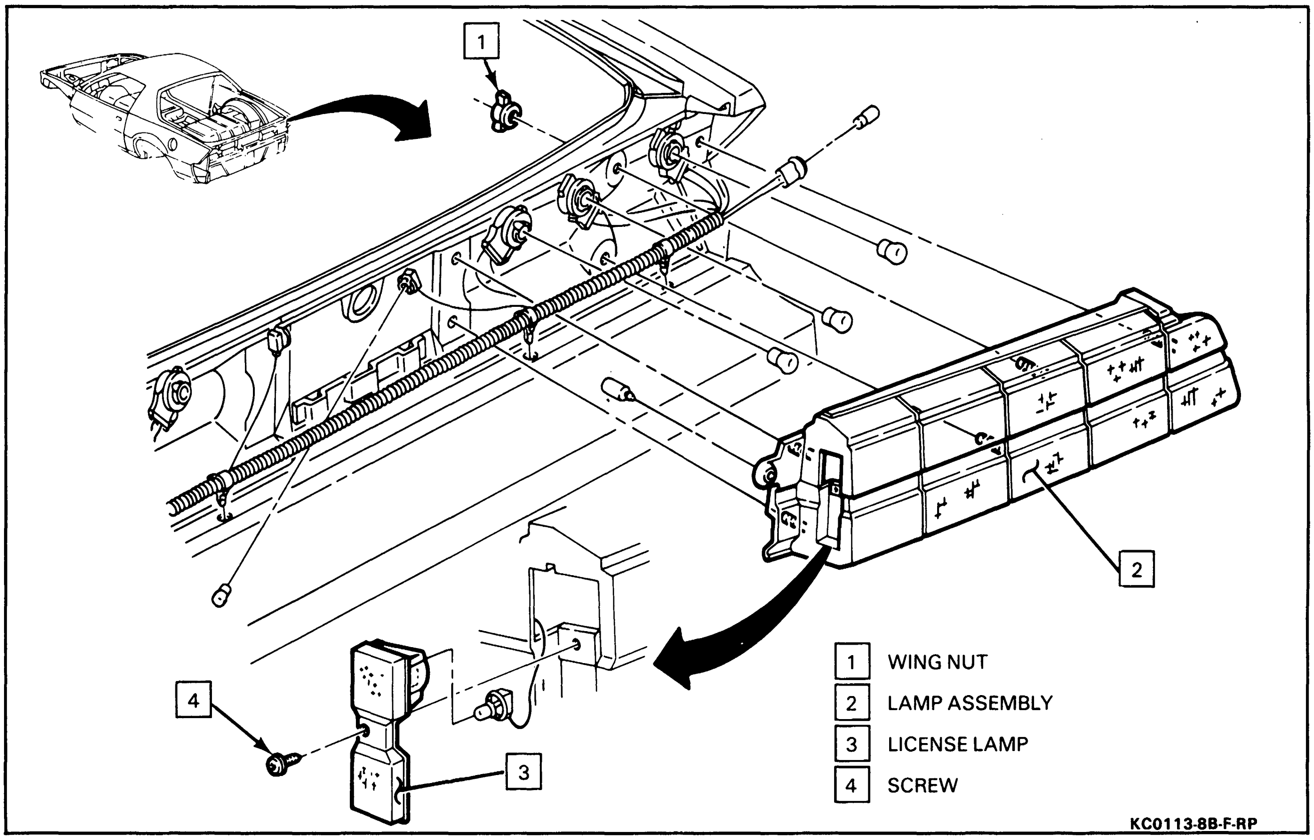


Figure 4 - Rear Lamps (Typical)

2. Two retainers.
3. Socket.

Bulb Replacement - Front

↔ Remove or Disconnect

1. Socket from assembly.
2. Bulb from socket.

→← Install or Connect

1. Bulb into socket.
2. Socket into assembly.

Assembly or Bulb Replacement - Rear

The rear sidemarker lamps are in the "wrap-around" part of the rear tail/stop/turn signal lamps. Refer to "Rear Tail/Stop/Turn Signal Lamps" in this section.

Turn Signal Flasher

The turn signal flasher is clipped to the fuse block mounting bracket behind the instrument panel to the left of the steering column. To remove the flasher, remove the sound insulator panel, disconnect electrical connector and remove flasher from clip.

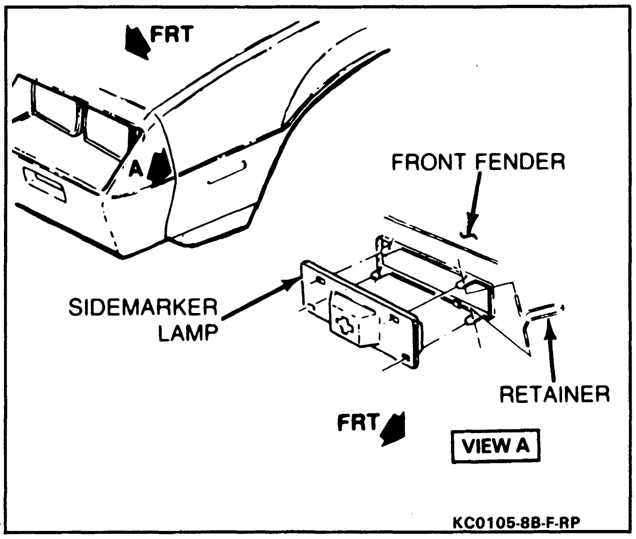


Figure 5 - Front Sidemarker Lamps

Underhood Lamp

Package Replacement

↔ Remove or Disconnect

1. Negative (-) battery cable.
2. Electrical connector.
3. Two screws.
4. Underhood lamp package.

Install or Connect

1. Underhood lamp package.
2. Two screws.
3. Electrical connector.
4. Negative (-) battery cable.

Bulb Replacement

Remove or Disconnect

- Bulb from socket.

Install or Connect

- Bulb into socket.

HORNS

Figure 6

If the horns do not blow, or blow constantly, follow the diagnostic procedures in ELECTRICAL DIAGNOSIS (SEC. 8A).

Poor Horn Tone

1. **Poor Horn Tone**- Tighten bolts in mounting area, or correct poor connections or ground.
2. **Low-Pitched Moan**- Sounds like "mooing." Caused by current too high. Adjust current. Refer to following procedure.
3. **Weak Tone**- Current too low. Correct poor connections or ground, or adjust current. Refer to following procedure.
4. **Weak, Strained Tone**- Remove foreign object in horn.
5. **Harsh Vibration**- Bend bracket so horn is not touching sheet metal.

Current Adjustment

Current draw for a horn while operating should be 4.5 to 5.5 amperes at 11.5 to 12.5 volts. High current (more than 20 amperes) indicates an overheated winding or shorted horn; replace the horn. A current reading of about 18 amperes means the contact points are not opening; adjust the horn current. Refer to adjustment procedure below.

No current reading indicates a broken connection, or an open circuit due to a broken lead or overheated horn. An overheated horn must be replaced. No current reading may also mean the contact points are open; adjust the horn. Refer to adjustment procedure below.

Adjust

1. Increase current – turn adjusting screw clockwise.
2. Decrease current – turn adjusting screw counterclockwise.
3. Current adjustments should be made 1/4 turn (90 degrees) at a time.

Horn Assembly

Remove or Disconnect

1. Bolt/screw.
2. Electrical connector.
3. Horn.

Install or Connect

1. Horn.
2. Electrical connector.
3. Bolt/screw.

Horn Relay

The horn relay is in the convenience center, behind the instrument panel to the right of the steering column. To remove the relay, remove left sound insulator panel and pull relay straight out.

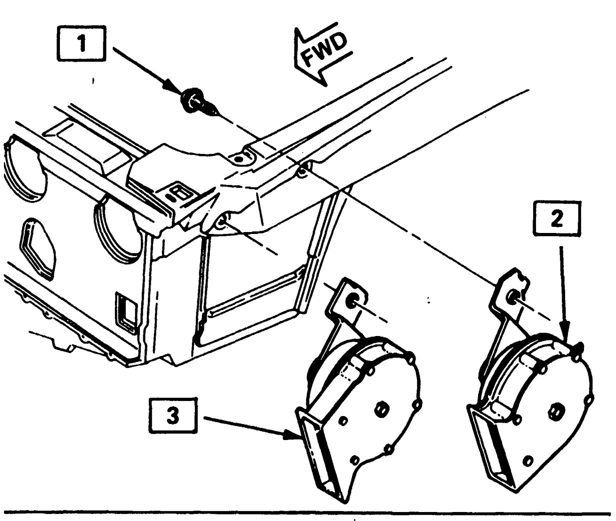


Figure 6 - Horns

FORWARD LAMP WIRING

For an illustration of forward lamp wiring, refer to Figure 7.

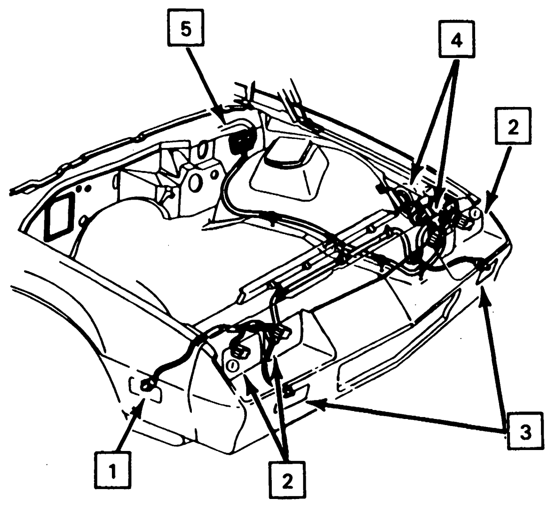
INTERIOR LAMPS

Dome and Reading Lamps

Assembly (and Reading Lamp Bulb) Replacement

Remove or Disconnect

1. Courtesy lamps fuse. Refer to ELECTRICAL DIAGNOSIS (SEC. 8A).



1 – SIDEMARKER LIGHT
2 – HEADLIGHT
3 – PARKING LIGHT
4 – HORNS
5 – ENGINE HARNESS

KC0107-8B-F-RP

Figure 7 - Forward Lamp Wiring

2. Lens by squeezing gently on the edge and pulling down.
3. Two clips by loosening slightly with small screwdriver, then pulling with pliers.
4. Assembly by lowering the rear and pulling backward to release the clip at the front.
5. Electrical connector.
6. Socket(s) if replacing bulb(s).
7. Bulb(s) if replacing.

Install or Connect

1. Bulb(s) if removed.
2. Socket(s) if replacing bulb.
3. Electrical connector.
4. Assembly, making sure clip on front goes over bracket.
5. Two clips by pushing into place.
6. Lens.
7. Fuse. Refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

Dome Lamp Bulb Replacement

Remove or Disconnect

1. Lens by squeezing gently on the edge and pulling down.
2. Bulb by pulling down.

Install or Connect

1. Bulb.
2. Lens by snapping into place.

Cargo Compartment Lamp

Assembly or Bulb Replacement

Remove or Disconnect

1. Lamp from rear end trim panel by using a flat bladed tool to pry up on left side of lamp.
2. Lens.
3. Electrical connections.
4. Bulbs (if replacing).

Install or Connect

1. Bulbs, if replacing.
2. Electrical connections.
3. Lens.
4. Lamp by inserting right side into trim panel and snapping left side into place.

DISABLING THE SIR SYSTEM

Remove or Disconnect

- Turn the steering wheel so that the vehicle wheels are pointing straight ahead.
- Turn the ignition switch to "LOCK."

1. SIR fuse from the fuse block.
2. Left side sound insulator. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
3. Connector position assurance (CPA) and yellow two-way SIR harness connector at the base of the steering colunm.

ENABLING THE SIR SYSTEM

Install or Connect

1. Yellow two-way SIR harness connector to base of steering column and connector position assurance (CPA).
2. Left side sound insulator. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
3. SIR fuse to fuse block.

- Turn the ignition switch to "RUN" and verify that the inflatable restraint indicator flashes 7 to 9 times and then turns off. If the indicator does not respond as stated, refer to SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM DIAGNOSIS (SEC. 9J-A).

FORWARD DISCRIMINATING SENSOR

Figure 8

For descriptions and diagnosis of the Supplemental Inflatable Restraint (SIR) System, refer to SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM INTRODUCTION (SEC. 9J) and SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM DIAGNOSIS (SEC. 9J-A). All sensors are specifically calibrated for each vehicle series and are keyed to the mounting brackets and the SIR wiring harness. Caution should be used to ensure proper location of the sensors to their mounting brackets. The keying of the sensors to their mounting brackets and wiring harness should never be modified in the field.

CAUTION: Be very careful when handling a sensor. Never strike or jar a sensor. If you do, it could cause deployment and result in personal injury or improper operation of the Supplemental Inflatable Restraint (SIR) System. All sensors and mounting bracket bolts must be carefully torqued to ensure proper operation. Never power up the SIR system when any sensor is not rigidly attached to the vehicle since the sensor is easily activated when not attached. This could result in immediate deployment and possible personal injury.

CAUTION: The following procedures must be followed in the order listed to temporarily disable the Supplemental Inflatable Restraint (SIR) System and prevent false diagnostic codes from setting. Failure to follow this procedure could result in possible air bag deployment, personal injury, or unneeded SIR system repairs.

Remove or Disconnect

CAUTION: See "Caution" on page 8B-1 of this section.

- Disable the SIR system. Refer to "Disabling the SIR System" in this section.

1. Fascia center support mounting bolts.
   - Pull the fascia center support forward to gain access to the forward discriminating sensor.
2. Connector position assurance (CPA) (5) and electrical connector (4) behind the radiator support (3).
3. Bolts (2).
4. Forward discriminating sensor (1).

CAUTION: Proper operation of the sensors and Supplemental Inflatable Restraint (SIR) System requires that any repairs to the vehicle structure return it to its original production configuration. Deployment (Current Code 51) or any visible damage to sensors and/or their mounting brackets requires replacement, not repair. Proper operation of the forward discriminating sensor requires the sensor and its bracket be rigidly attached to the vehicle structure and that the arrow on the sensor be pointing toward the front of the vehicle. Failure to observe these precautions can result in improper SIR system operation and possible lack of supplemental restraint protection for the driver during an accident impact.

Install or Connect

NOTICE: See "Notice" on page 8B-1 of this section.

1. Forward discriminating sensor (1) with arrow pointing to the front of the vehicle.
2. Bolts (2).

Tighten

- Bolts (2) to 2.8 N·m (25 lb. in.).

3. Electrical connector (4) and connector position assurance (5) behind the radiator support (3).
4. Fascia center support mounting bolts.

- Enable the SIR system. Refer to "Enabling the SIR System" in this section.

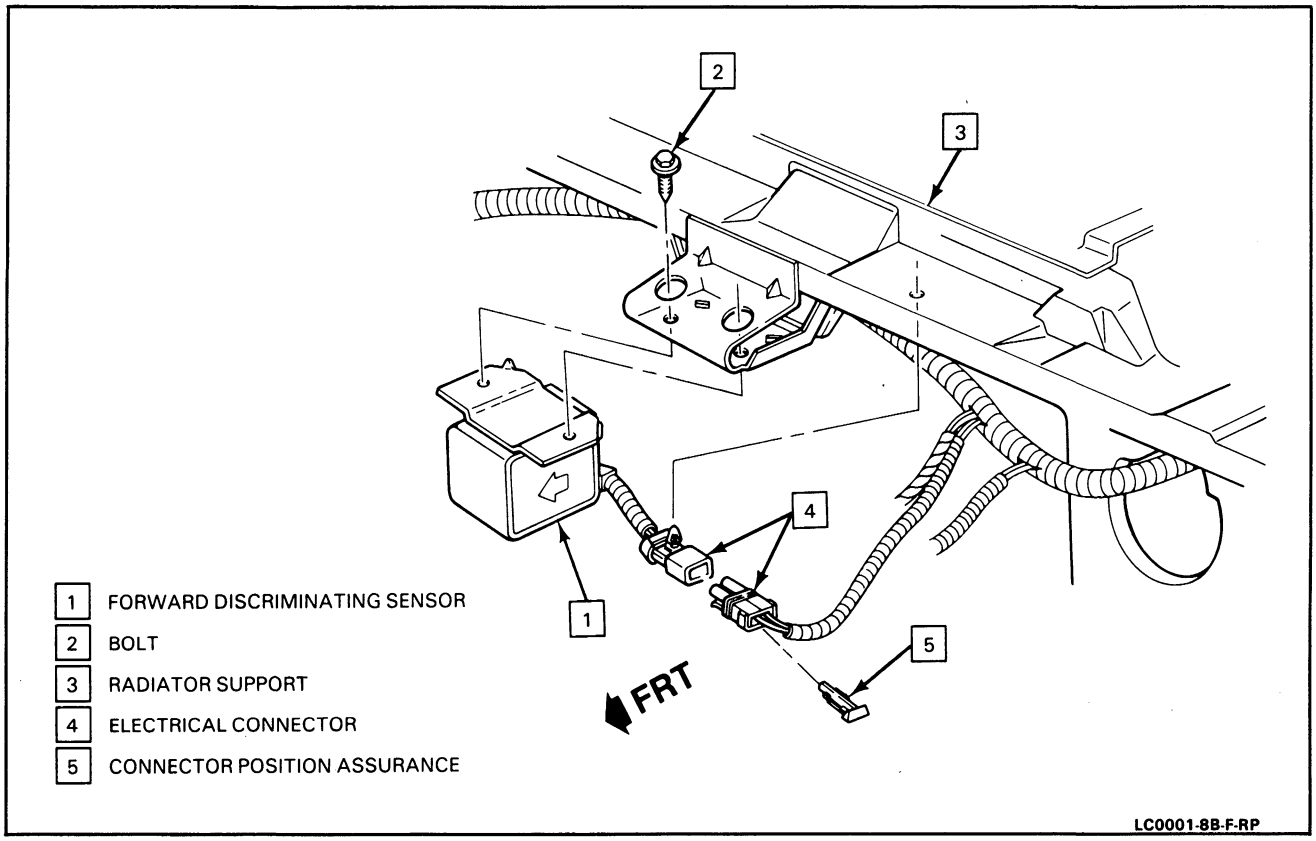


Figure 8 - Forward Discriminating Sensor

SPECIFICATIONS

REPLACEMENT LIGHT BULBS

EXTERIOR LAMPS	Trade No.
Backup Lamp	1156
Center High-Mounted Stoplamp	3156
Fog Lamp	885
Front Parking/Turn Signal Lamp	2057
Headlamp	
Inner (Halogen)	H4651
Outer (Halogen)	H4652
License Plate Lamp	194
Rear Tail/Stop/Turn Signal Lamp	2057
Sidemarker Lamp (Front and Rear)	194
Underhood Lamp	93

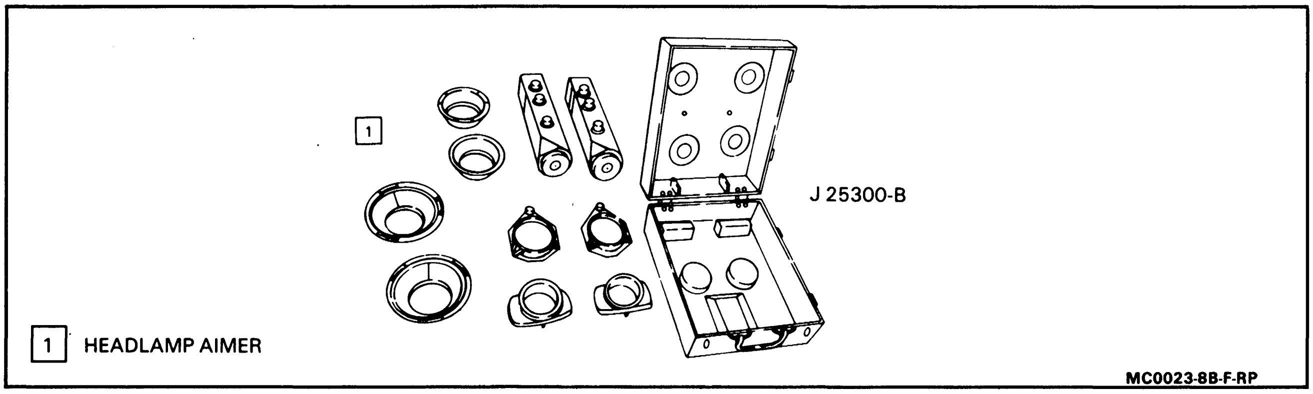
INTERIOR LAMPS	Trade No.
Air Conditioner/Heater Controls	194
Cargo Compartment	168
Dome Lamp	211-2
Gear Selector Indicator	194
Headlamp High-Beam Indicator	74
Indicator Lamps	
Brake System Warning	161
Charging System Warning	161
Vats II	161
Oil Pressure Warning	161
Safety Belt Reminder	161
Service Engine Soon Warning	161

Temperature Gage Warning	161
Instrument Cluster	194
Reading Lamp	192
Turn Signal Indicator	74
Automatic Transmission (PRNDL) Lamp	161
Rear Wiper/Washer Switch Lamp	168

FASTENER TORQUE SPECIFICATIONS

Forward Discriminating Sensor Bolt	2.8 N·m (25 lb. in.)
Fog Lamp-to-Impact Bar Screw	3 N·m (27 lb. in.)

SPECIAL TOOLS



SECTION 8C

INSTRUMENT PANEL, CLUSTER AND CONSOLE

CAUTION: The procedures in this section must be followed in the order listed to temporarily disable the supplemental inflatable restraint (SIR) system and prevent false diagnostic codes from setting. Failure to follow this procedure could result in possible air bag deployment, personal injury, or unneeded SIR system repairs.

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 8C-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

INSTRUMENT PANEL

The instrument panel and related parts form a rigid structure that encloses and supports many components on or near the passenger compartment side of the cowl. The top of the instrument panel is attached to the cowl next to the base of the windshield near both outboard ends by screws, and at the center by a support bracket. The bottom of the instrument panel is attached to a stamped metal tie bar that adds to the rigidity of the structure. Sound insulator panels are attached to the tie bar and the cowl at both sides of the front passenger compartment to conceal the components under the instrument panel and provide a finished appearance. The left sound insulator has an access panel that can be opened from the driver's seat to reach the swing-down fuse block for service. There are no sound insulators on vehicles equipped with Bose sound systems.

The steering column is clamped in place at the left side of the instrument panel. Below and to both sides of the column is a driver's knee bolster. An impact-absorbing pad covers the top of the instrument panel. Trim covers and trim plates accent the appearance of the exposed rear face of the instrument panel.

The heater or air conditioning module case is attached to the cowl. Air ducts connect the case outlets to floor outlets, windshield defroster outlets, side window defogger outlets and two high level outlets in the center of the instrument panel. A high level air outlet is provided at the left end of the instrument panel and two outlets are provided at the right end of the panel. The heater or air conditioning module and ducts are concealed within the instrument panel structure.

Beneath the instrument panel pad are two front radio speakers, one at each end of the instrument panel. Canadian vehicles have an ambient light sensor for the daytime running lamp system installed flush with the top surface of the instrument panel pad.

Many components are attached to the tie bar at the bottom of the instrument panel. The supplemental inflatable restraint (SIR) resistor is mounted to the tie bar to the left of the steering column. Just forward of the SIR resistor is the fuse block and its swing-down mounting bracket. Also attached to the bracket are the turn signal flasher unit, the left-hand courtesy lamp, the assembly line diagnostic link (ALDL) connector, and on Canadian vehicles, the daytime running lamp (DRL) module. Just to the right of the steering column is the convenience center with the hazard flasher unit, horn relay, audio alarm and fuses for the VATS II system and radio.

Components attached to the tie bar at the right side of the instrument panel include the electronic control module (ECM) and mounting bracket, the speed sensor buffer of the vehicle speed sensor system (VIN E L03 5.0L TBI V8 engine only), the relay for the optional radio power antenna and the diagnostic energy reserve module (DERM) of the supplemental inflatable restraint system. The ECM and the DERM are also supported by the forward top portion of the instrument panel.

The vehicle anti-theft system (VATS II) module is mounted to the forward face of the fan-shaped air distributor duct of the heater or air conditioning system, just below the right-hand defroster outlet. The optional cruise control module and bracket are attached to the extreme right end of the heater or air conditioning module rear case.

The instrument panel wiring harness and the optional cruise control wiring harness are installed within the instrument panel area.

INSTRUMENT CLUSTER

The instrument cluster is centered above the steering column in the instrument panel and is removable from the rear of the panel (toward the steering wheel). The cluster contains instruments that provide the driver with information on vehicle performance.

The headlamp switch and optional fog lamp switch are at the left side of the cluster and the optional rear window defogger switch is at the right side. In addition, a cigarette lighter is mounted at the right side of the cluster.

Gages in the instrument cluster include an oil pressure gage, a fuel gage, and engine coolant temperature gage and a voltmeter. A speedometer with an odometer and a trip odometer is included, as is a tachometer. The cluster also has indicator lamps for VATS II "SECURITY," "SERVICE ENG. SOON," the SIR system "INFL. REST." (inflatable restraint), the fasten seat belts symbol, the headlamp high beam symbol, the manual transmission "SHIFT" and turn signal directional indicator arrows, plus a "BRAKE" warning lamp.

Electric power is directed to the appropriate lamps and gages of the instrument cluster by a flexible printed circuit attached to the back of the instrument cluster case. Two multiple connectors join the printed circuit to the instrument panel wiring harness. The two multiple connectors and the snap-in bulb sockets help to hold the printed circuit to the back of the instrument cluster.

Separate electrical connectors feed the headlamp switch, cigarette lighter, and optional fog lamp and rear window defogger switches at the sides of the cluster.

CONSOLE

The center floor console fits over the tunnel in the floor of the vehicle and extends from under the center of the instrument panel to the rear seat area. The console consists of two major assemblies. The lower console forms the side and rear walls of the complete console structure, and the upper console forms the top of the structure.

The forward end of the console is joined to the center of the instrument panel at the tie bar. Mounted in the console below the instrument panel are the heater or air conditioning control assembly and the radio. Near the forward end, low on both sides of the lower console, are low-level floor outlets for heated air.

The upper console has an ashtray for front seat occupants, the transmission shift lever, the parking brake lever in a recess in the right side of the console, and switches for optional power windows, optional rear hatch release (coupes) or optional top cover release (convertible), if equipped. There is also a storage compartment in the top of the upper console. The storage compartment has a padded door that serves as a front seat center armrest. The rear face of the lower console has an ashtray for rear seat occupants.

The lower console encloses two sensors for the supplemental inflatable restraint (SIR) system. The SIR passenger compartment sensor is mounted to a bracket on the top of the floor tunnel, forward of the shift lever. The SIR arming sensor is mounted to a bracket on the top of the floor tunnel to the rear of the shift lever. The electrical connectors of the instrument panel harness for both sensors have secondary retainer locks to prevent unintentional disconnection.

There are two console trim plates. One covers the edges of the heater or air conditioning control assembly and the radio. The other covers the opening for the transmission shift lever and provides a mounting for the front seat ashtray.

INDIVIDUAL COMPONENT DETAILS

Speedometer

The electric speedometer does not have a speedometer cable. The source of speed information is a small permanent magnet alternating current generator called a vehicle speed sensor, mounted on the transmission. The shaft of the vehicle speed sensor fits into a pinion gear at the transmission output shaft in the same manner as the speedometer cable of a mechanical speedometer system. When the transmission output shaft rotates, the vehicle speed sensor shaft also rotates and turns the permanent magnet near a coil within the vehicle speed sensor. This generates an alternating current in the coil with a frequency that is proportional to the speed of the vehicle.

The alternating current from the vehicle speed sensor is sent to the vehicle speed sensor buffer (L03 VIN E engine) or to the electronic control module (ECM) (all other engines). The vehicle speed sensor buffer or the ECM modifies the current to a series of direct current pulses at a frequency proportional to the speed of the vehicle. These pulses form a vehicle speed signal that is transmitted to the speedometer. A speed signal also is transmitted to the cruise control module, if equipped, and to the ECM if the vehicle is equipped with the L03 VIN E engine.

At the speedometer, a solid state circuit uses the speed signal to regulate the distribution of current from the "GAGES" fuse in the fuse block to two electromagnetic coils at right angles to each other near the base of the speedometer pointer pivot. At the base of the speedometer pointer pivot is a magnet that is acted upon by the magnetic fields of the two coils. The relative strength of the two magnetic fields determines the position of the magnet and accordingly, the position of the speedometer pointer.

Pulses from the solid state circuit also are used to drive a small electric stepper motor. The stepper motor turns the numbered wheels of the odometer and the trip odometer. The numbered wheels are geared so when any one wheel completes a revolution, the next wheel to the left is turned one-tenth of a revolution. Every tenth of a revolution advances the displayed number by one unit. The trip odometer can be reset to zero at any time so the driver can record the distance traveled from any selected starting point.

When a speedometer is replaced, the law requires the odometer reading of the replacement unit to be set to register the same mileage as the prior odometer. If the same mileage cannot be set, the law requires that the replacement odometer be set to zero and a label be installed on the driver's door frame to show the previous odometer reading and the date of replacement.

Tachometer

Voltage pulses from the ignition primary circuit are transmitted through the tachometer terminal of the ignition distributor. These pulses are used by the tachometer to position the gage pointer to a setting corresponding to the engine speed in revolutions per minute (rpm). The tachometer is an electronic instrument and should be handled with appropriate electrostatic discharge (ESD) precautions.

NOTICE: Never attempt to check resistance across the tachometer terminals, or the tachometer may be damaged.

Voltmeter

The voltmeter is an instrument that shows the voltage of the vehicle electrical system and indicates the ability of the charging system to keep the battery charged. The voltmeter is wired in parallel with other circuits in the vehicle.

When the engine is running, the voltmeter indicates charging system voltage. If the engine is not running and the ignition switch is in the "RUN" or "START" position, the voltmeter will show battery voltage. The voltmeter can be used as a first step in diagnosing many electrical problems. Battery voltage drop can be seen while the engine is cranking. After the engine is running, generator output voltage is indicated.

It is normal for the voltmeter to read between 11 and 13 volts during extended idle or just after starting. As the electrical load is increased, or in stop-and-go driving, the pointer may rotate temporarily to the bottom of the scale. A voltmeter reading continuously below 11 volts or above 16 volts indicates an electrical system problem.

Oil Pressure Gage

The oil pressure gage indicates the pressure of the lubricating oil flow provided by the engine oil pump. The oil pressure gage sending unit is a variable resistor mounted to the engine block so it will sense the oil pressure in a main oil passage just downstream from the engine oil pump. When electric power is supplied to the gage, current flows through the gage to the resistor in the sending unit and then to ground at the engine block. The position of the oil pressure gage pointer is determined by the strength of the current flowing through the gage.

When oil pressure is low, the resistance of the sending unit also is low and current flow through the gage is high. This causes the gage indicator needle to show a low pressure reading. As oil pressure increases, the resistance of the sending unit resistor also increases and current flow through the gage is reduced. The oil pressure gage needle moves to indicate a higher pressure. Under normal conditions, the oil pressure reading should be between 138 and 414 kPa (20 and 60 psi). Engine oil pressure never should fall below a reading of 28 kPa (4 psi), even at idle.

Fuel Gage

The fuel gage sending unit is mounted on the top surface of the fuel tank. The fuel level sender itself consists of a float that rides on the surface of the fuel in the tank and a variable resistor controlled by the float arm. When electric power is supplied to the fuel gage, current flows through the gage to the variable resistor and then to ground. The position of the gage pointer is determined by the strength of the current flowing through the gage.

If the tank is full, the resistance of the variable resistor is high (90 ohms) and the current flow through the gage is at a minimum. This causes the pointer to indicate the "F" mark on the gage dial.

If the fuel level is low, the resistance of the variable resistor also is low and current flow through the gage is high. This causes the pointer to show a low fuel level reading. Intermediate fuel levels cause the pointer to indicate the corresponding position between "F" and "E."

Engine Coolant Temperature Gage

The coolant temperature sending unit is mounted to the engine at a point where it is exposed to the coolant being circulated through the engine cooling passages. The sending unit contains a temperature-sensitive variable resistor that senses and reacts to coolant temperature. Resistance decreases as temperature increases.

When electric power is supplied to the engine coolant temperature gage, a current flows through the gage to the variable resistor and then to ground at the engine. The position of the gage pointer is determined by the strength of the current flowing through the gage. When the engine coolant is cold, resistance is high, the current flow is low, and the pointer indicates a cold reading. As coolant temperature increases, the resistance of the sending unit resistor decreases and the pointer moves toward the center of the gage. Prolonged driving or idling in very hot weather may cause the pointer to move beyond this point. An overheat condition exists if the pointer goes into the red zone at the upper limit of the scale.

Dial calibrations go far above the normal boiling point of water - 100°C (212°F) - because the cooling system is pressurized. The increase in pressure also increases the boiling temperature of the coolant, permitting it to reach temperatures above that possible with a non-pressurized system without boiling. The higher operating temperature of the cooling system that results gives greater cooling efficiency and other benefits.

Rear Window Defogger

The switch for the optional rear window defogger is on the right side of the instrument cluster. The switch has two sources of electrical power - an always-hot wire from the power accessories ("PWR ACC") circuit breaker to feed the defogger grid, and a wire from the "GAGES" fuse to the momentary rocker switch that actuates the solid state electronic timer relay in the switch assembly.

When the rear window defogger rocker switch is momentarily pressed with the ignition switch in "RUN," the switch routes power from the "GAGES" fuse to the solid state electronic timer relay. The timer relay closes the circuit from the power accessories circuit breaker to the defogger grid resistance wires baked into the inside surface of the rear window. The first time after the ignition switch is turned from "OFF" to "RUN," or after the rear window defogger switch is turned "OFF" manually, the timer relay will hold the circuit closed for approximately ten minutes. Each time after that, the timer relay will hold the circuit closed for approximately five minutes.

From the timer relay, the circuit goes back to feed the left side of the defogger grid. After passing through the grid, where the high resistance of the grid wires creates heat to defog the glass, the circuit continues to ground at the body sheet metal near the right hatch support arm.

The circuit from the timer relay also includes a branch that illuminates the indicator in the center of the rocker switch to show that the rear window defogger is operating.

Daytime Running Lamps (Canadian Vehicles)

All Canadian vehicles are equipped with daytime running lamps. The daytime running lamp system includes a solid state module, a relay and a light sensor. The system lights the parking lamps and taillamps when the ignition switch is in the "RUN" position during daylight. The daytime running lamp system is designed so if the vehicle stalls, the parking lamps and taillamps will remain on when trying to restart the engine during daylight.

Rear Hatch Release

The switch for the optional rear hatch release in coupe models receives power from the accessory ("ACC") fuse in the fuse block. The circuit is routed through the coil of the hatch release relay on the right side of the console before reaching the switch.

The hatch release relay operates the automatic hatch release and pulldown assembly in the center of the rear end panel when the circuit through the hatch release switch is completed. The circuit from the hatch release switch continues to the gear selector switch at the gear selector in the console on vehicles with an automatic transmission, or to the parking brake switch at the parking brake in the console on vehicles with a manual transmission. As a result, the hatch release will not function unless the automatic transmssion gear selector is in "P" (Park) or "N" (Neutral), or unless the parking brake is applied on vehicles with a manual transmission.

Top Cover Release

The switch for the top cover release in convertible models operates in the same manner as the hatch release switch for coupe models with one exception. The circuit from the relay is connected to the tonneau release solenoid instead of the automatic hatch release and pulldown assembly of the coupe. Refer to "Rear Hatch Release" in this section.

Power Window Switches

The two center-off momentary rocker switches in the upper console for the optional power windows receive electrical power from the power window ("WDO") circuit breaker in the fuse block when the ignition switch is in the "RUN" position. When a rocker switch is pressed to the "UP" position, one set of switch contacts sends power through a wire to the reversible permanent magnet motor near the front of the corresponding door. A second set of switch contacts connects the other wire from the motor to a wire that is grounded to the tunnel sheet metal just ahead of the console stowage compartment. This causes the motor to run and crank the window up as long as the switch is pressed or until the window reaches its full up position.

Pressing the rocker switch to the "DOWN" position reverses the switch contact connections and causes current to flow to the motor in the opposite direction. As a result, the motor rotates in the opposite direction and cranks the window down as long as the switch is pressed or until the window reaches its full down position.

Heater or Air Conditioning Module and Ducts

Refer to HEATER SYSTEM (SEC. 1A) or MANUALLY CONTROLLED AIR CONDITIONING (SEC. 1B).

Radio, Front Speakers and Power Antenna

Refer to AUDIO SYSTEMS (SEC. 9A).

Supplemental Inflatable Restraint (SIR) System Components

For a description of the supplemental inflatable restraint (SIR) components within the instrument panel and console, refer to SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM (SEC. 9J).

VATS II System

For a description of the VATS II vehicle anti-theft system, refer to THEFT DETERRENT SYSTEMS (SEC. 9D).

Assembly Line Diagnostic Link (ALDL)

Refer to DRIVEABILITY AND EMISSIONS - GENERAL INFORMATION (SEC. 6E).

Electronic Control Module (ECM)

Refer to DRIVEABILITY AND EMISSIONS - GENERAL INFORMATION (SEC. 6E).

Cruise Control System

For information on components of the cruise control system that are within the instrument panel, refer to CRUISE CONTROL (SEC. 9B).

Headlamp Switch

Refer to LIGHTING SYSTEMS AND HORNS (SEC. 8B).

Fog Lamp Switch

Refer to LIGHTING SYSTEMS AND HORNS (SEC. 8B).

"INFL. REST." - Inflatable Restraint Indicator Lamp

The "INFL. REST." inflatable restraint indicator lamp will light to warn the driver of a potential supplemental inflatable restraint (SIR) system problem that could prevent the proper deployment of the air bag in an accident. When the ignition switch is first turned on, the lamp will flash a number of times to verify proper operation of the lamp circuit and the diagnostic/energy reserve module (DERM). The lamp also will flash SIR trouble codes to aid diagnosis when the designated assembly line diagnostic link (ALDL) is grounded with the ignition on. In addition, a Scan Tool can be used to read trouble codes remaining in the "history" memory of the DERM and to clear all "history" codes after repair. For additional information, including service precautions, refer to SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM (SEC. 9J).

"SERVICE ENG. SOON" Indicator Lamp

The "SERVICE ENG. SOON" indicator lamp in the instrument cluster will come on during engine starting to serve as a bulb and system check. It should go off after the engine starts unless a problem has been detected by the system.

The electronic control module (ECM) performs a continual self-diagnosis of certain control functions and causes the "SERVICE ENG. SOON" lamp to remain on when the engine is running if a problem is detected. The "SERVICE ENG. SOON" lamp may remain on for only ten seconds if the problem is an intermittent one. In any event, the ECM will store in memory a 2-digit or 3-digit trouble code if a problem is detected. When the assembly line diagnostic link (ALDL) test connection is grounded, the ECM will cause the "SERVICE ENG. SOON" lamp to flash the code for each trouble condition detected by self-diagnosis. The code or codes will aid further diagnosis and correction of the condition.

"SHIFT" Upshift Indicator Lamp

The manual transmission "Shift" upshift indicator lamp in the instrument cluster will illuminate to indicate the best transmission shift point, based on engine speed and load. The "SHIFT" lamp is controlled by the electronic control module (ECM) in response to engine rpm input (for engine speed), vehicle speed sensor (VSS) and throttle position sensor (TPS) inputs (for engine load), and coolant temperature input.

The ECM compares engine speed and vehicle speed inputs to determine what gear the manual transmission is in, and illuminates the "SHIFT" lamp when a shift to the next-higher gear would provide acceptable performance without overloading the engine. It is normal for the upshift indicator lamp to come on for a moment when downshifting to a lower gear if the accelerator pedal is not released completely. It also is normal for the lamp to flash on and off at times if the driver changes the position of the accelerator pedal while accelerating. The lamp should not light when driving in 5th gear or when the accelerator pedal is released.

Turn Indicator Lamps

The left or right turn indicator lamp will illuminate when the multifunction turn signal lever on the left side of the steering column is moved to signal a turn. The turn-hazard switch in the steering column receives an on-and-off flashing current from the "TURN-B/U" fuse in the fuse block and the turn signal flasher unit on the fuse block bracket when the ignition switch is in the "RUN," "START" or "BULB TEST" position. The turn-hazard switch routes the current to circuits that feed the left or right front park/turn lamp and marker lamp, left or right rear turn signal and tail/stop lamps when the multifunction turn signal lever is moved. The circuit to the left or right front park/turn lamp and marker lamp has a branch that feeds the appropriate turn indicator lamp in the instrument cluster, causing it to flash when the exterior lamps are indicating a turn.

When the hazard warning button on the right side of the steering column is pressed in, the left and right front park/turn lamps, front marker lamps, rear turn signal and tail/stop lamps all flash, and both turn signal indicator lamps in the instrument cluster flash. Power for the hazard warning system reaches the turn/hazard switch from the "STOP/HAZ" fuse in the fuse block and the hazard flasher in the convenience center. Power is supplied with the ignition switch in any position. When the hazard warning system is flashing, the turn signal circuits are inoperative.

"BRAKE" Warning Lamp

Refer to GENERAL BRAKES (SEC. 5).

VATS II "SECURITY" Indicator Lamp

Refer to THEFT DETERRENT SYSTEMS (SEC. 9D).

Fasten Safety Belts Warning Lamp

Refer to SAFETY BELTS (SEC. 10-10).

Headlamp High Beam Indicator Lamp

Refer to LIGHTING SYSTEMS AND HORNS (SEC. 8B).

DIAGNOSIS

For diagnosis of instrument panel, cluster and console electrical systems, including individual wire color information and applicable precautions for testing solid state electronic devices and systems, refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

ON-VEHICLE SERVICE

INSTRUMENT PANEL SOUND INSULATORS

Left Side Sound Insulator

Figure 1

Remove or Disconnect

1. Nut (4) from stud (5).
2. Insulator (2) from knee bolster.
   - Gently pry to disengage clips.
3. Insulator (2) from stud (5).

Install or Connect

NOTICE: See "Notice" on page 8C-1 of this section.

1. Insulator (2) onto stud (5).
2. Insulator (2) to knee bolster.
   - Align clips and push to engage.
3. Nut (4) to stud (5).

Tighten

- Nut (4) to 1.9 N·m (17 lb. in.).

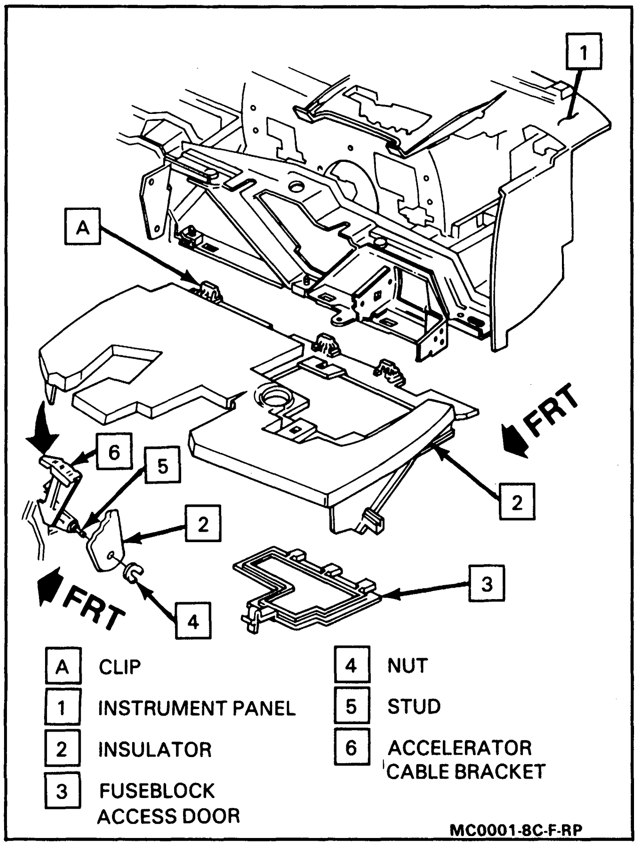


Figure 1 - Left Side Sound Insulator

Right Side Sound Insulator

Figure 2

Remove or Disconnect

1. Three screws (7) attaching insulator (8) to instrument panel (1).
2. Insulator (8) from instrument panel (1).

Install or Connect

NOTICE: See "Notice" on page 8C-1 of this section.

1. Insulator (8) to instrument panel (1).
   - Insulator (8) must be installed over A/C case stud.
2. Three screws (7) attaching insulator (8) to instrument panel (1).

Tighten

- Screws (7) to 1.5 N·m (13 lb. in.).

DRIVER KNEE BOLSTER AND DEFLECTOR

Figure 3

Remove or Disconnect

- Pry off caps using a flat bladed tool.

1. Screws (12) from knee bolster (10).
2. Knee bolster (10).

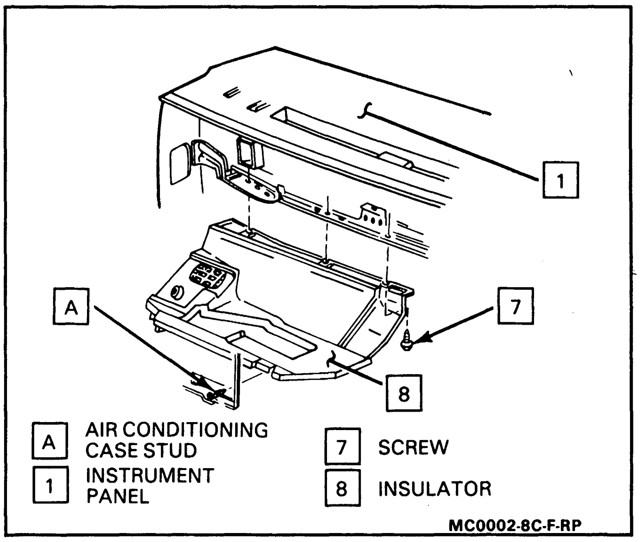


Figure 2 - Right Side Sound Insulator

3. Nuts (13).
4. Deflector (14).

Install or Connect

NOTICE: See "Notice" on page 8C-1 of this section.

1. Deflector (14).
2. Nuts (13).
3. Knee bolster (10).
4. Screws (12).

Tighten

- Screws (12) to 5.5 N·m (49 lb. in.).
- Snap caps over screws (12).

ELECTRONIC CONTROL MODULE (ECM)

For service information on the electronic control module, refer to DRIVEABILITY AND EMISSIONS - GENERAL INFORMATION (SEC. 6E).

CRUISE CONTROL MODULE

For service information on the cruise control module, refer to CRUISE CONTROL (SEC. 9B).

VEHICLE SPEED SENSOR BUFFER

For service information on the vehicle speed sensor buffer, refer to CRUISE CONTROL (SEC. 9B).

POWER ANTENNA RELAY

Figure 4

Remove or Disconnect

1. Negative battery cable.
2. Right side sound insulator. Refer to "Instrument Panel Sound Insulators" in this section.
3. Screw (16) from antenna relay (15).

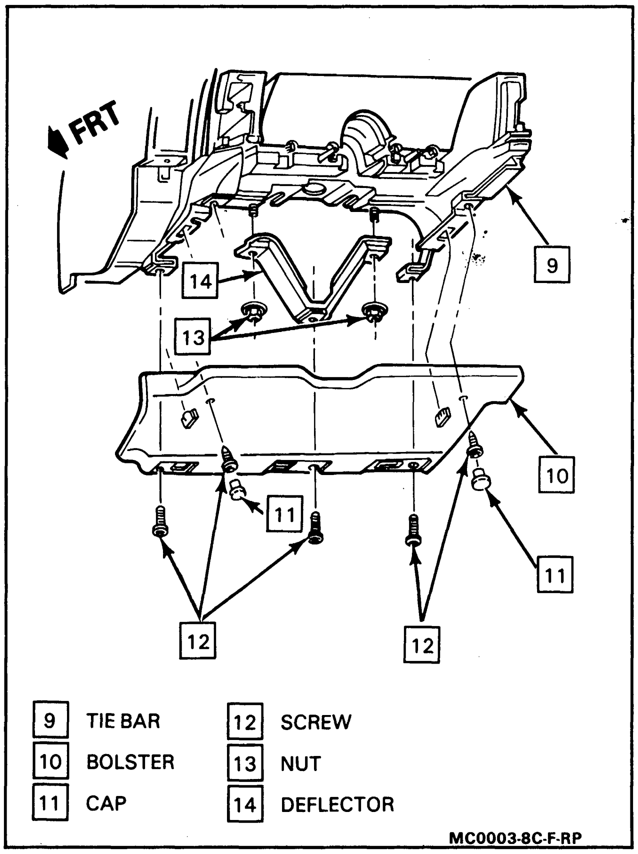


Figure 3 - Driver Knee Bolster and Deflector

4. Antenna relay (15).
5. Electrical connector from the antenna relay (15).

Install or Connect

NOTICE: See "Notice" on page 8C-1 of this section.

1. Electrical connector to the antenna relay (15).
2. Antenna relay (15).
3. Screw (16).

   #### Tighten

   - Screw (16) to 1.5 N·m (13 lb. in.).
4. Right side sound insulator. Refer to "Instrument Panel Sound Insulators" in this section.
5. Negative battery cable.

FUSE BLOCK

Figure 5

Remove or Disconnect

1. Negative battery cable.
2. Left side sound insulator. Refer to "Instrument Panel Sound Insulators" in this section.
3. Fuse block (18) from bracket (17) by sliding upward.
4. Electrical connectors from fuse block (18) only if necessary.

Install or Connect

1. Electrical connectors to fuse block (18) if removed.
2. Fuse block (18) by sliding into bracket (17).
3. Left side sound insulator. Refer to "Instrument Panel Sound Insulators" in this section.
4. Negative battery cable.

CONVENIENCE CENTER

Figure 6

Remove or Disconnect

1. Negative battery cable.
2. Left side sound insulator. Refer to "Instrument Panel Sound Insulators" in this section.
3. Bolts (19).
4. Convenience center (22).
5. Electrical connectors from convenience center (22) only if necessary.

Install or Connect

NOTICE: See "Notice" on page 8C-1 of this section.

1. Electrical connectors to convenience center (22) if removed.
2. Convenience center (22).
3. Bolts (19).

   #### Tighten

   - Bolts (19) to 1.5 N·m (13 lb. in.).
4. Left side sound insulator. Refer to "Instrument Panel Sound Insulators" in this section.
4. Negative battery cable.

INSTRUMENT PANEL CLUSTER TRIM PLATE

Figure 7

Remove or Disconnect

1. Negative battery cable.
2. Knee bolster. Refer to "Driver Knee Bolster and Deflector" in this section.
3. Headlamp switch knob.
4. Screws (24).
- Pull cluster trim plate (23) forward away from instrument panel.
5. Electrical connectors from the switches.
6. Switches and cigarette lighter, as necessary.
7. Cluster trim plate (23).

Install or Connect

NOTICE: See "Notice" on page 8C-1 of this section.

1. Cluster trim plate (23).

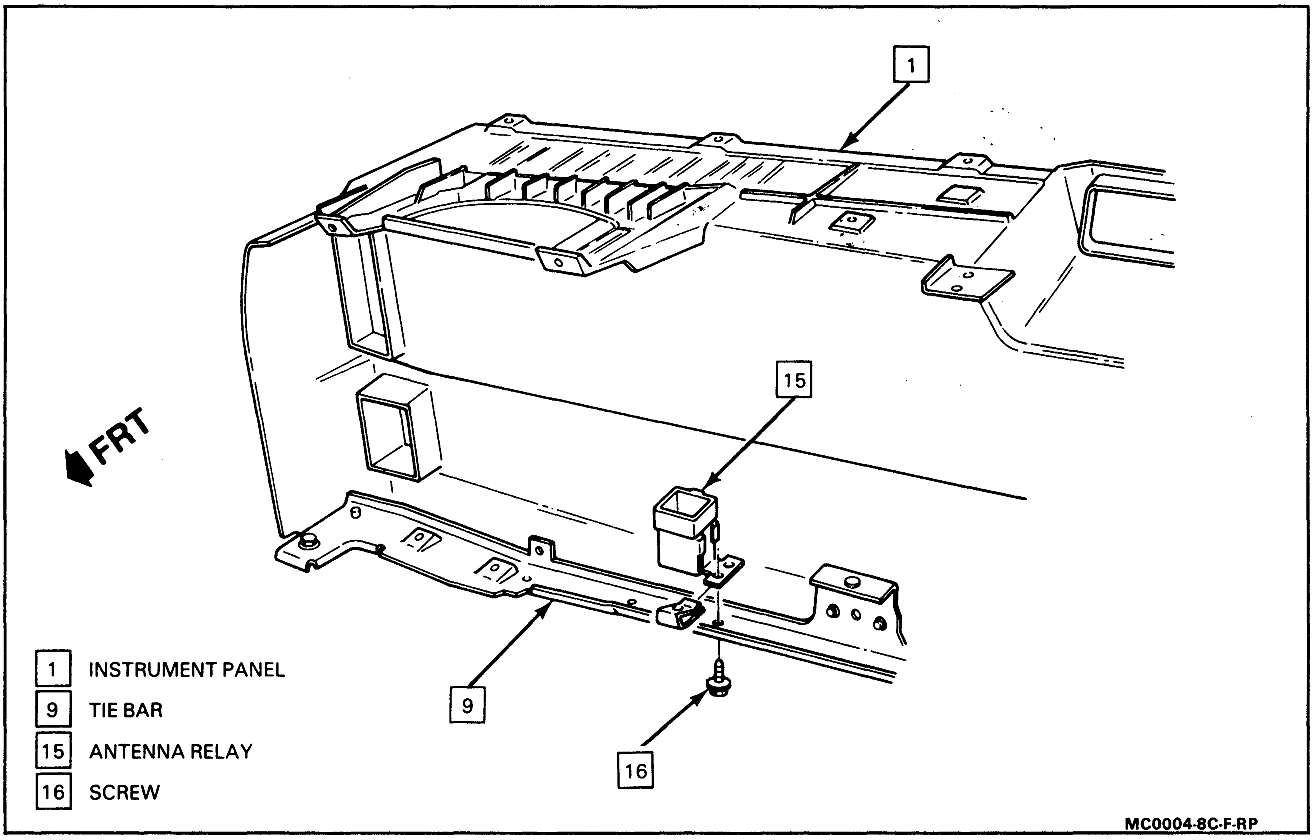


Figure 4 - Power Antenna Relay

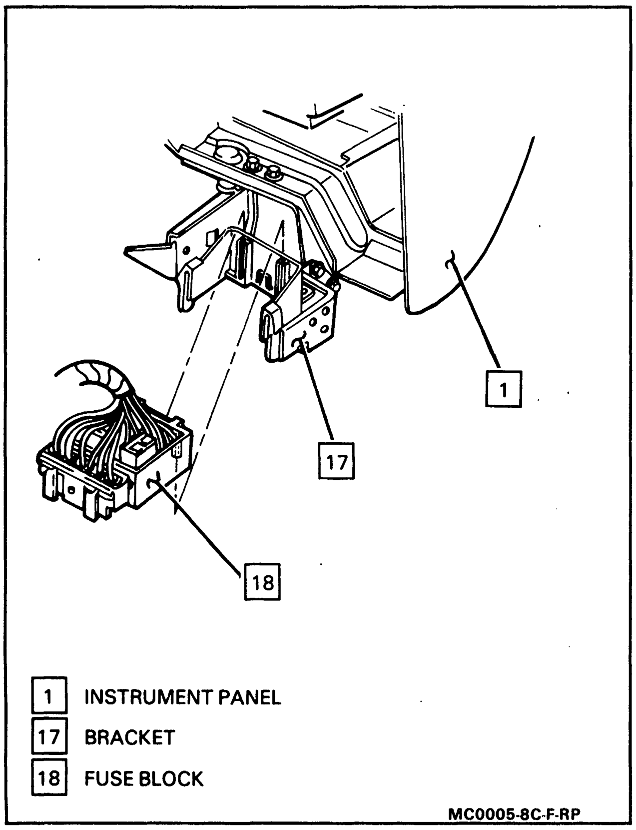


Figure 5 - Fuse Block

2. Switches and cigarette lighter, if removed.
3. Electrical connectors to the switches and install cluster trim plate (23).

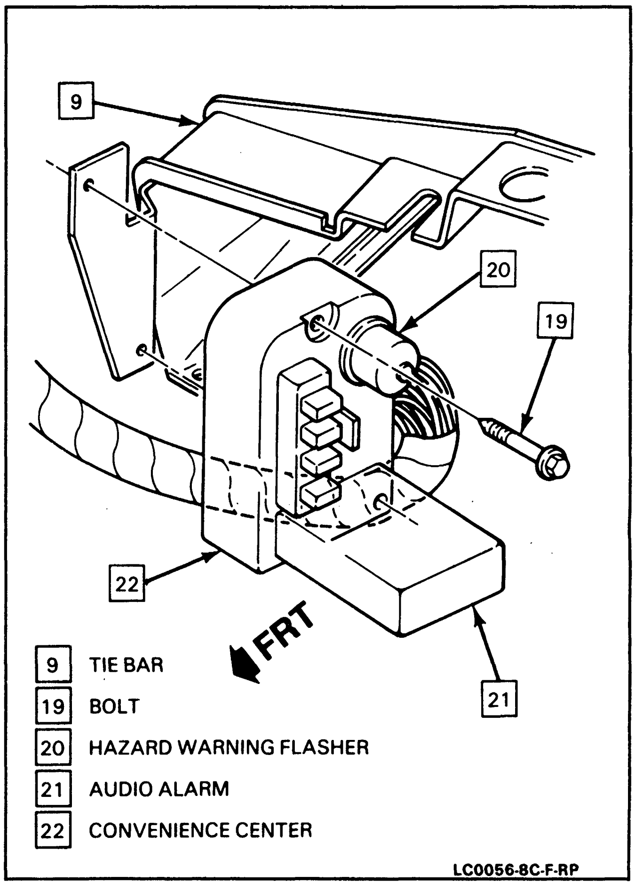


Figure 6 - Convenience Center

4. Screws (24).

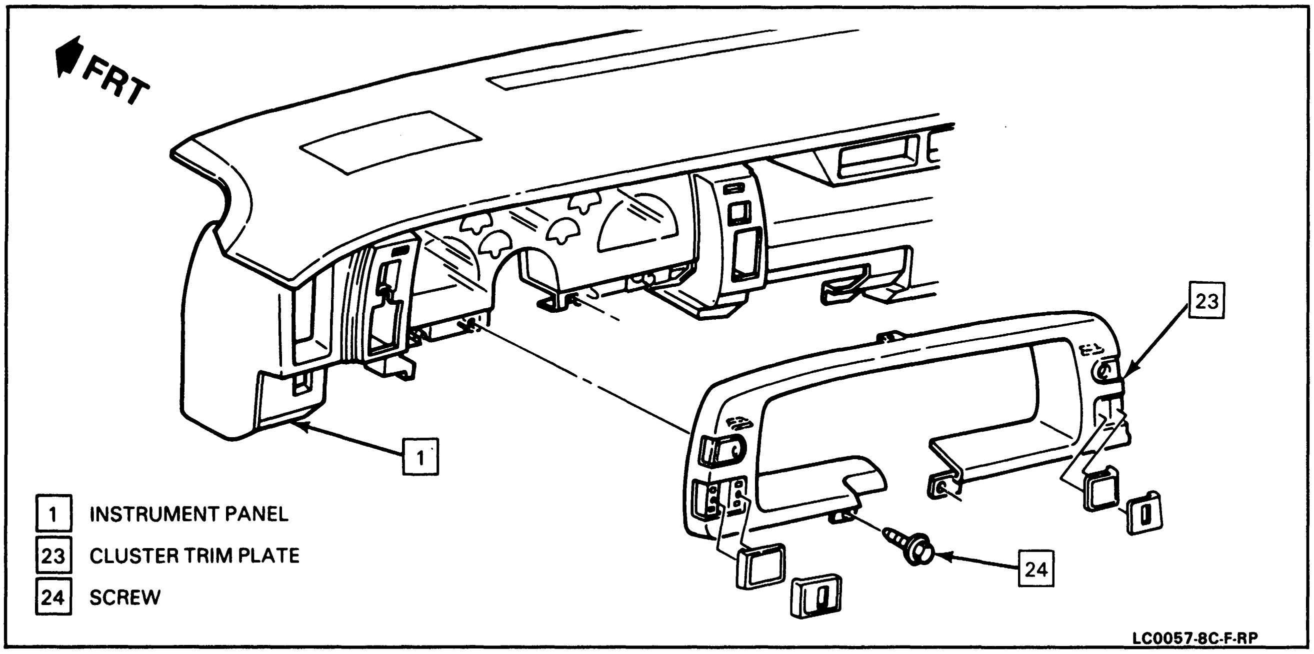


Figure 7 - Instrument Panel Cluster Trim Plate

Tighten

- Screws (24) to 1.7 N·m (15 lb. in.).

5. Headlamp switch knob.
6. Knee bolster. Refer to "Driver Knee Bolster and Deflector" in this section.
7. Negative battery cable.

HEADLAMP/PARKING LAMP SWITCH

Figure 8

Remove or Disconnect

1. Knee bolster. Refer to "Driver Knee Bolster and Deflector" in this section.
2. Switch knob (27) by depressing the release button on the switch (26) from underneath the instrument panel (1).
3. Cluster trim plate. Refer to "Instrument Panel Cluster Trim Plate" in this section.
4. Nut (28).
- Lower switch (26) out through the bottom of the instrument panel (1).
5. Electrical connector (25).
6. Headlamp/parking lamp switch (26).

Install or Connect

1. Headlamp/parking lamp switch (26).
2. Electrical connector (25).
- Raise switch (26) up through the bottom of the instrument panel (1).
3. Nut (28).
4. Cluster trim plate. Refer to "Instrument Panel Cluster Trim Plate" in this section.
5. Switch knob (27) by pushing into the switch (26).
6. Knee bolster. Refer to "Driver Knee Bolster and Deflector" in this section.

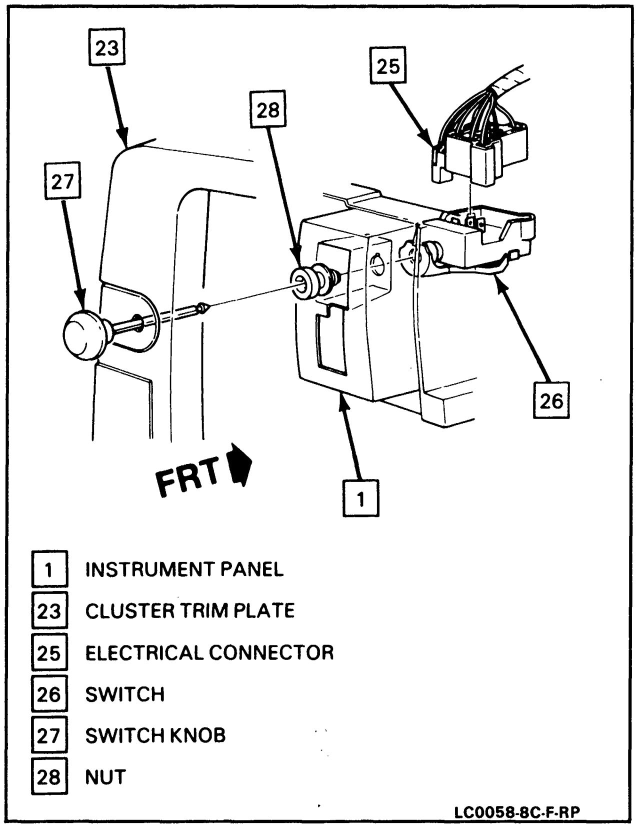


Figure 8 - Headlamp/Parking Lamp Switch

FOG LAMP SWITCH

Figure 9

Remove or Disconnect

1. Cluster trim plate. Refer to "Instrument Panel Cluster Trim Plate" in this section.

2. Screws (29) from fog lamp switch (30).
3. Fog lamp switch (30).

→← Install or Connect

1. Fog lamp switch (30).
2. Screws (29).
3. Cluster trim plate. Refer to "Instrument Panel Cluster Trim Plate" in this section.

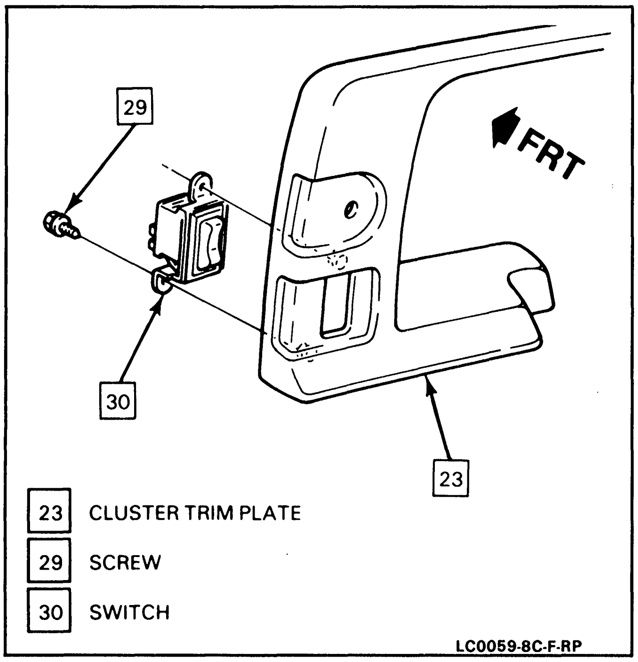


Figure 9 - Fog Lamp Switch

CIGARETTE LIGHTER ASSEMBLY

Figure 10

←→ Remove or Disconnect

1. Cluster trim plate. Refer to "Instrument Panel Cluster Trim Plate" in this section.
2. Element (33).
3. Housing (32) by unscrewing from the retainer (31).

→← Install or Connect

1. Housing (32) by fastening to the retainer (31).
2. Element (33).
3. Cluster trim plate. Refer to "Instrument Panel Cluster Trim Plate" in this section.

REAR DEFOGGER SWITCH

Figure 11

←→ Remove or Disconnect

1. Cluster trim plate. Refer to "Instrument Panel Cluster Trim Plate" in this section.
2. Screw (35) from defogger switch (34).
3. Defogger switch (34).

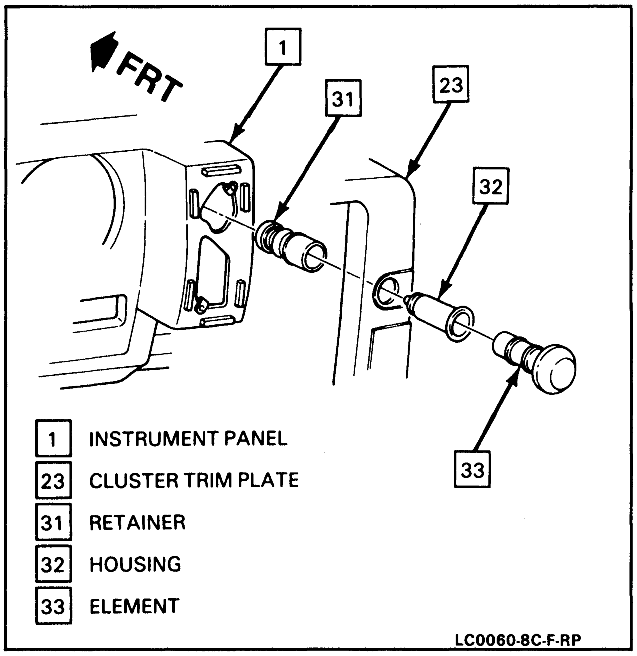


Figure 10 - Cigarette Lighter Assembly

→← Install or Connect

1. Defogger switch (34).
2. Screw (35).
3. Cluster trim plate. Refer to "Instrument Panel Cluster Trim Plate" in this section.

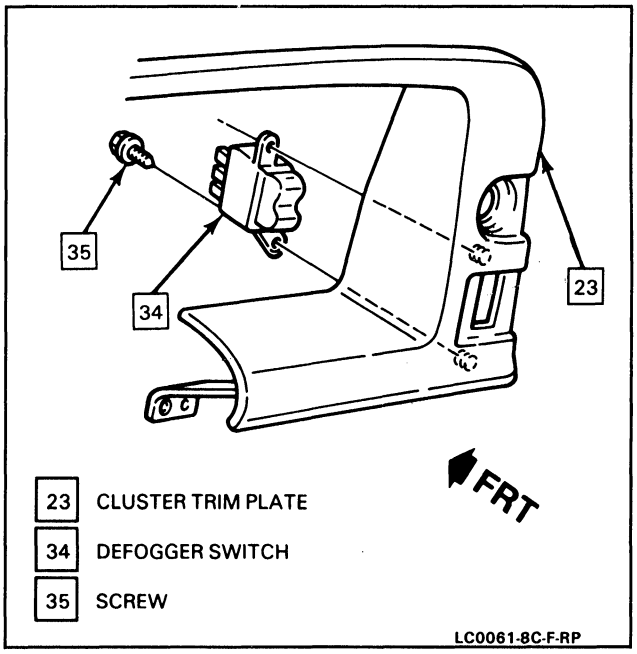


Figure 11 - Rear Defogger Switch

INSTRUMENT PANEL CLUSTER

Figure 12

←→ Remove or Disconnect

- Place ignition switch to "LOCK" position.

1. Cluster trim plate. Refer to "Instrument Panel Cluster Trim Plate" in this section.

2. Screws (37) from cluster (36).
3. Cluster (36).

Disassemble

1. Cluster lens attaching screws.
2. Cluster lens.

Assemble

1. Cluster lens.
2. Cluster lens attaching screws.

Install or Connect

1. Cluster (36) to instrument panel (1).
2. Screws (37).
3. Cluster trim plate. Refer to "Instrument Panel Cluster Trim Plate" in this section.

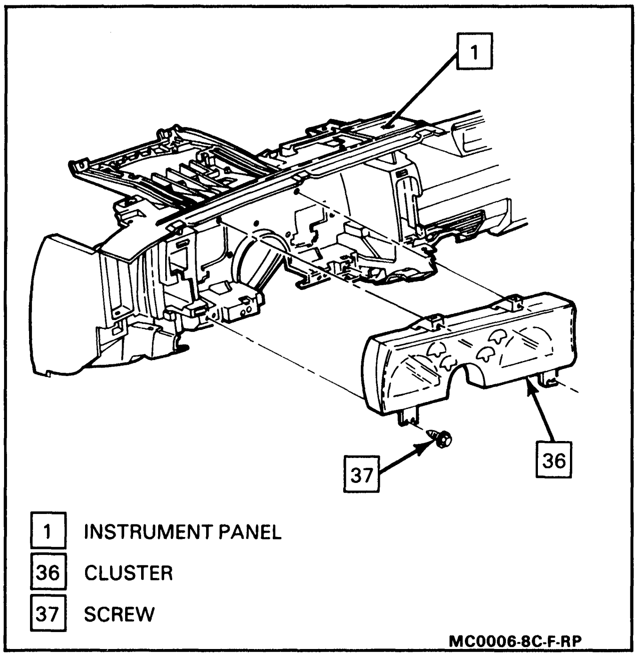


Figure 12 - Instrument Panel Cluster

CLUSTER INSTRUMENTS IDENTIFICATION

For identification of cluster components, refer to Figure 13.

INSTRUMENT PANEL PAD

Figure 14

Remove or Disconnect

1. Screws (56).
2. Daytime running lamp light sensor electrical connector, if equipped.
3. Instrument panel pad (55).

Install or Connect

1. Instrument panel pad (55).
2. Daytime running lamp light sensor electrical connector, if disconnected.
3. Screws (56).

DAYTIME RUNNING LAMP COMPONENTS (CANADIAN VEHICLES)

Daytime Running Lamp Module and Bracket

Figure 15

Remove or Disconnect

1. Negative battery cable.
2. Left side sound insulator. Refer to "Instrument Panel Sound Insulators" in this section.
3. Electrical connectors (59) from module (58).
4. Module (58) by sliding from mounting bracket (57).
5. Screw (60) and bracket (57), if necessary.

Install or Connect

1. Bracket (57) and screw (60), if removed.
2. Module (58) by sliding onto the mounting bracket (57).
3. Electrical connectors (59).
4. Left side sound insulator. Refer to "Instrument Panel Sound Insulators" in this section.
5. Negative battery cable.

Daytime Running Lamp Light Sensor

Figure 16

Remove or Disconnect

- Tape defroster duct closed.
- Pull assembly up from instrument panel pad enough to expose housing (63).
- Compress housing (63) to remove from instrument panel pad.

1. Grille (143) from housing (63) by inserting a screwdriver into slot and disengaging.
2. Sensor (62) from housing.

Install or Connect

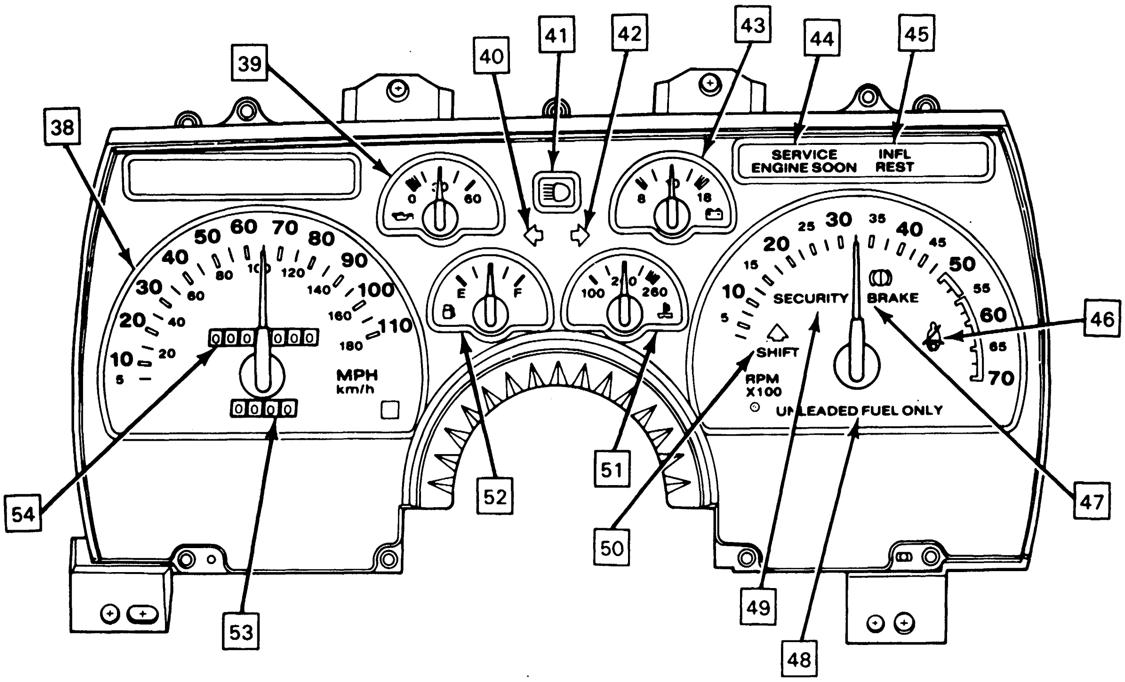
1. Sensor (62) into housing (63).
2. Grille (143) into housing (63) by snapping into place.

- Feed wires back into the instrument panel pad and press housing (63) into hole until seated.
- Remove tape from defroster duct.

SPEAKER

Remove or Disconnect

1. Instrument panel pad. Refer to "Instrument Panel Pad" in this section.
2. Speaker attaching screws.
3. Electrical connector from speaker.
4. Speaker.



38	SPEEDOMETER
39	OIL PRESSURE GAGE
40	LEFT HAND TURN SIGNAL INDICATOR
41	HEADLAMP HIGH BEAM INDICATOR
42	RIGHT HAND TURN SIGNAL INDICATOR
43	VOLTMETER
44	SERVICE ENGINE SOON LAMP
45	SUPPLEMENTAL INFLATABLE RESTRAINT WARNING LAMP
46	FASTEN SAFETY BELT WARNING LAMP
47	BRAKE WARNING LAMP
48	TACHOMETER
49	VATS II SECURITY LAMP
50	SHIFT INDICATOR
51	TEMPERATURE GAGE
52	FUEL GAGE
53	TRIP ODOMETER
54	ODOMETER

MC0012-8C-F-RP

Figure 13 - Cluster Instruments Identification

→← Install or Connect

1. Electrical connector to speaker.
2. Speaker.
3. Speaker attaching screws.
4. Instrument panel pad. Refer to "Instrument Panel Pad" in this section.

ASHTRAY

←→ Remove or Disconnect

- Ashtray by lifting up and out.

→← Install or Connect

- Ashtray by pressing in place.

CONSOLE TRIM PLATES

Figure 17

Front Console Trim Plate

←→ Remove or Disconnect

1. Knee bolster. Refer to "Driver Knee Bolster and Deflector" in this section.
2. Screws (65) from front trim plate (64).
3. Front trim plate (64).

→← Install or Connect

1. Front trim plate (64).
2. Screws (65).
3. Knee bolster. Refer to "Driver Knee Bolster and Deflector" in this section.

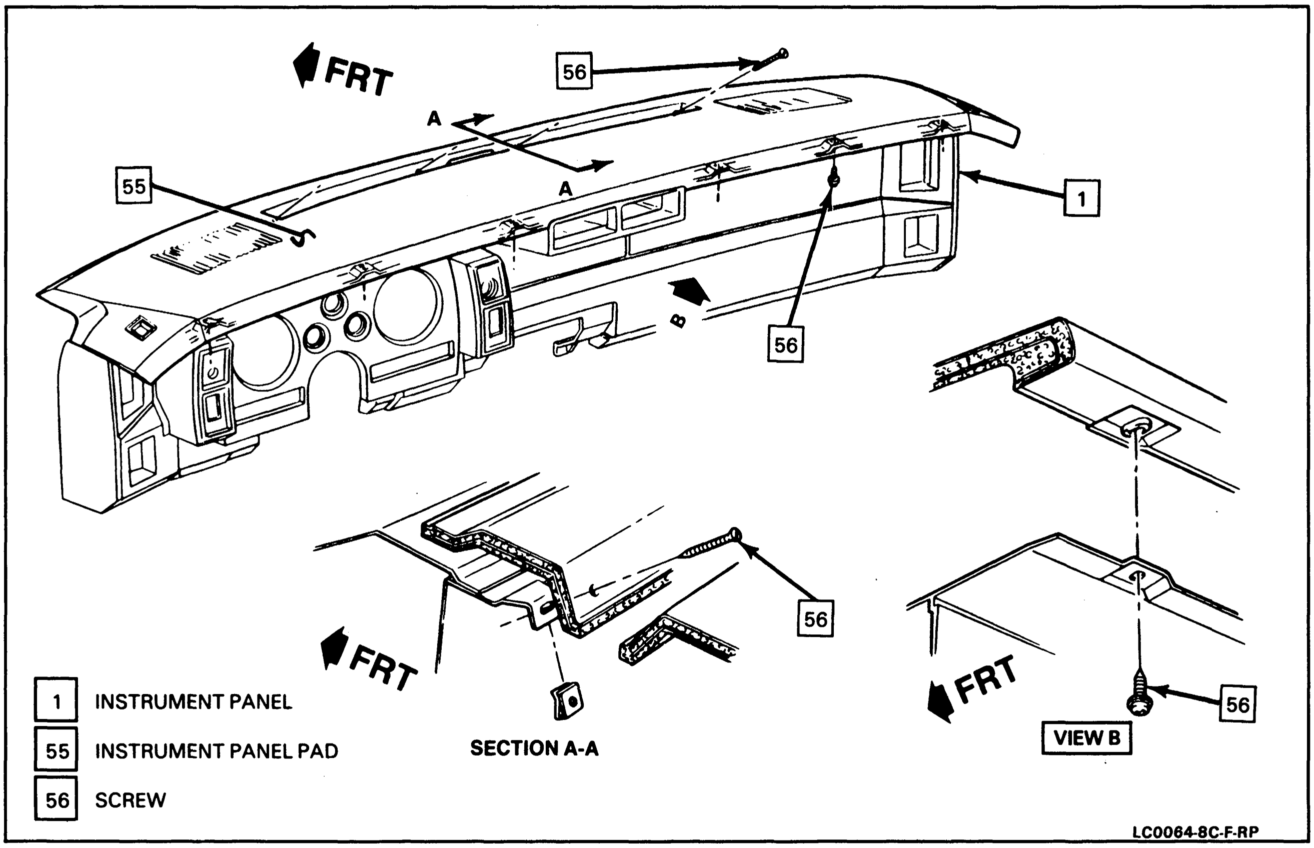


Figure 14 - Instrument Panel Pad

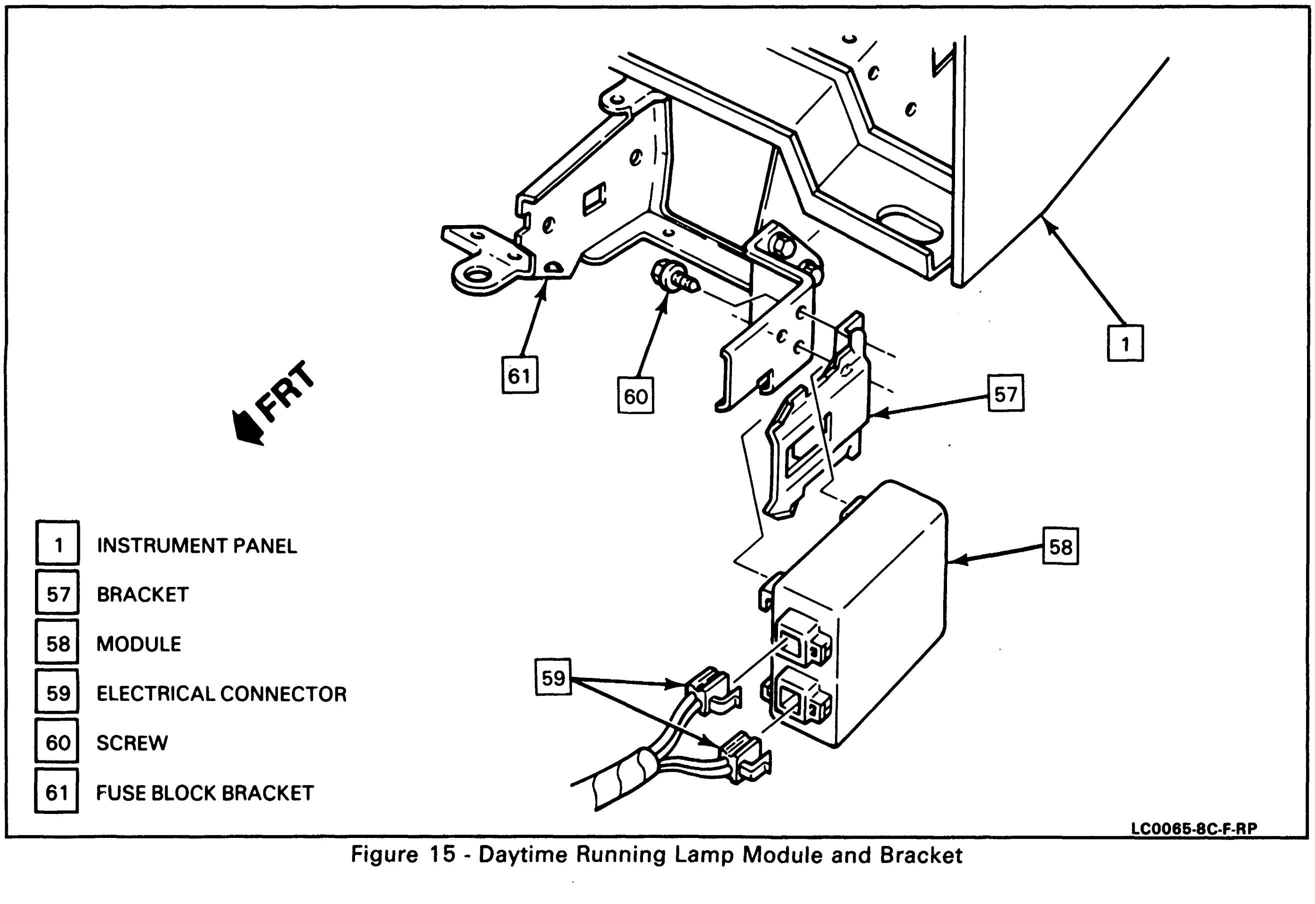


Figure 15 - Daytime Running Lamp Module and Bracket

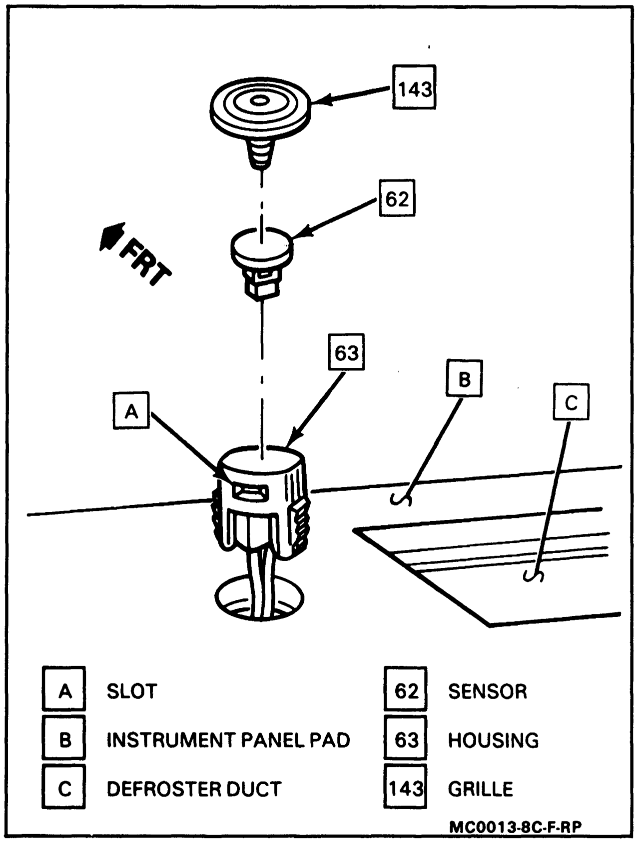


Figure 16 - Daytime Running Lamp Light Sensor

Shifter Console Trim Plate

Remove or Disconnect

1. Ashtray by lifting up and out.
2. Shifter handle, if necessary.
3. Screws (66) from shifter trim plate (67).
4. Shifter trim plate (67).

Install or Connect

1. Shifter trim plate (67).
2. Screws (66).
3. Shifter handle, if removed.
4. Ashtray by pressing in place.

HEATER OR AIR CONDITIONING CONTROL ASSEMBLY

Figure 18

Remove or Disconnect

1. Front trim plate. Refer to "Front Console Trim Plate" in this section.
2. Screws (72).
- Pull the control assembly (71) out far enough to reach the control cable ends and electrical connectors.
3. Blower switch connector.
4. Control assembly lamp bulb and socket.
5. Temperature control cable.

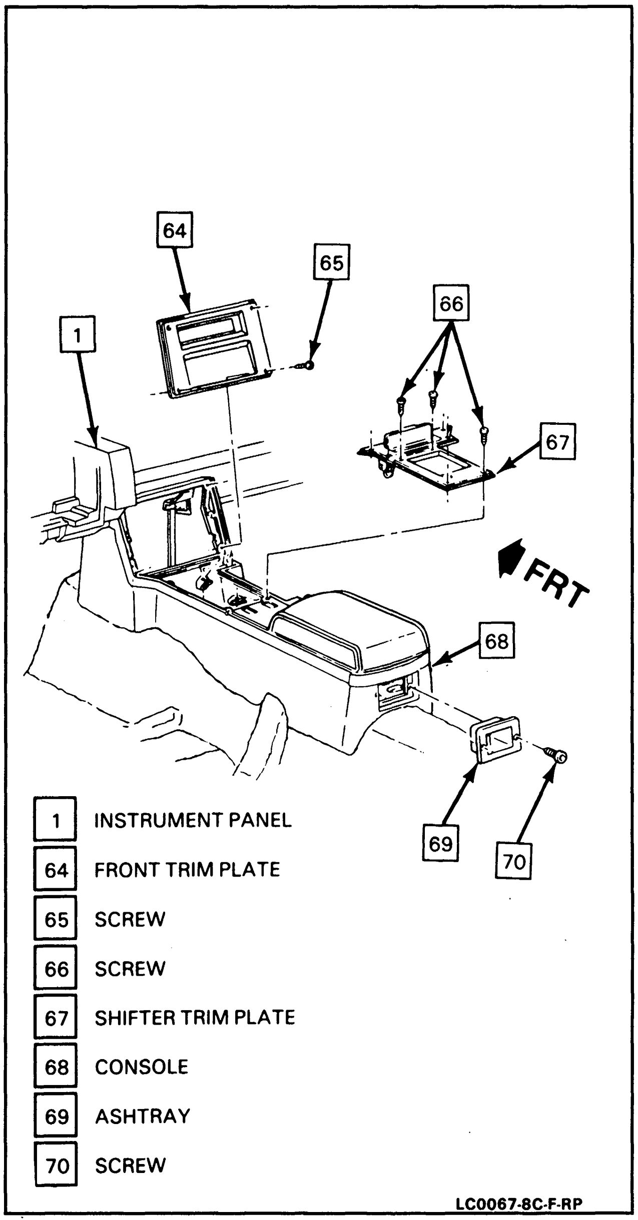


Figure 17 - Console Trim Plates

6. Control assembly (71).

Install or Connect

NOTICE: See "Notice" on page 8C-1 of this section.

1. Temperature control cable.
2. Control assembly lamp bulb and socket.
3. Blower switch connector.
4. Control assembly (71).
5. Screws (72).

Tighten

- Screws (72) to 1.4 N·m (12 lb. in.).

6. Front trim plate. Refer to "Front Console Trim Plate" in this section.

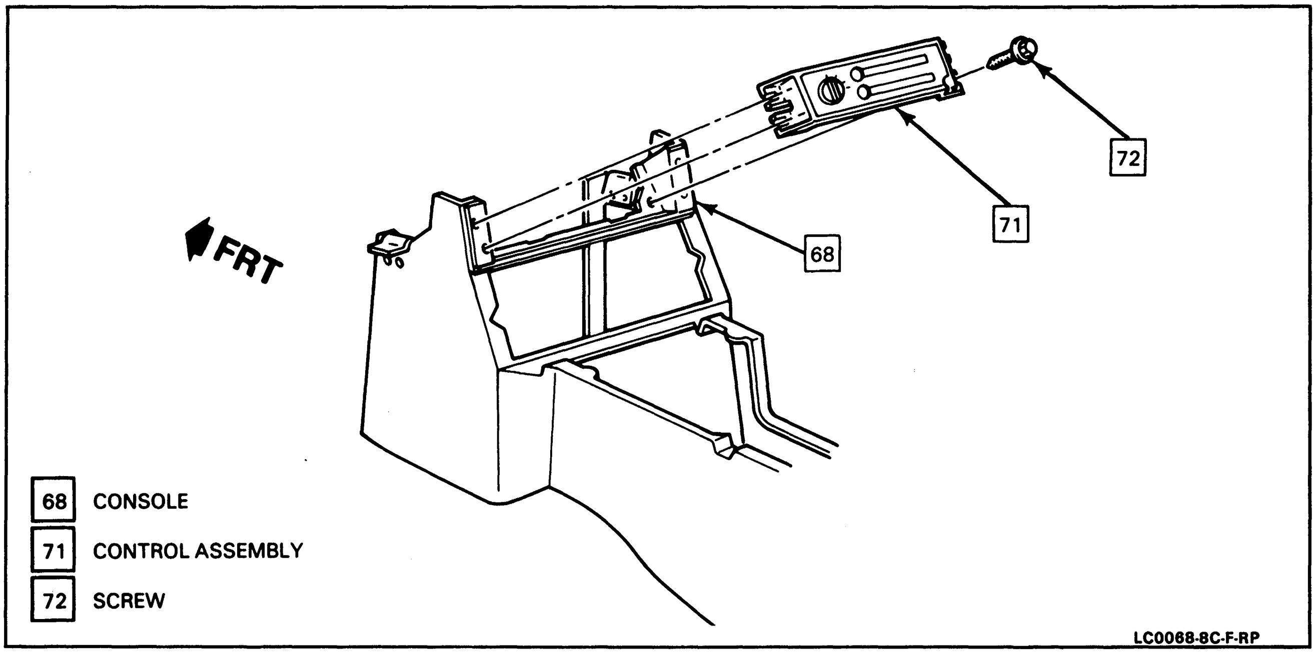


Figure 18 - Heater or Air Conditioning Control Assembly

RADIO

Figure 19

↔ Remove or Disconnect

1. Negative battery cable.
2. Front trim plate. Refer to "Front Console Trim Plate" in this section.
3. Screws (79).
- Pull radio (73) away from console (68) to access the electrical connectors and antenna lead.
4. Electrical connectors and antenna lead from radio (73).

→← Install or Connect

1. Electrical connectors and antenna lead to radio (73).
2. Radio (73) into the console (68).
3. Screws (79).
4. Front trim plate. Refer to "Front Console Trim Plate" in this section.
5. Negative battery cable.

CONSOLE MOUNTED SWITCHES

Figure 20

↔ Remove or Disconnect

1. Negative battery cable.
- Unsnap switches (80 or 81) from the console (68).
2. Electrical connectors from the switches (80 or 81).
3. Switches (80 or 81).

→← Install or Connect

1. Switches (80 or 81).
2. Electrical connectors to the switches (80 or 81).
- Snap switches (80 or 81) into the console (68).
3. Negative battery cable.

CONSOLE

Figure 21

↔ Remove or Disconnect

1. Negative battery cable.
2. Console trim plates. Refer to "Console Trim Plates" in this section.
3. Control assembly. Refer to "Heater or Air Conditioning Control Assembly" in this section.
4. Radio. Refer to "Radio" in this section.
5. Shifter handle and retainer, if necessary.
6. Parking brake handle grip.
7. Console mounted switches. Refer to "Console Mounted Switches" in this section.
8. Screws (82).
9. Floor upper console (84).
10. Screws (87).
11. Floor lower console (85).

→← Install or Connect

NOTICE: See "Notice" on page 8C-1 of this section.

1. Floor lower console (85).
2. Screws (87).

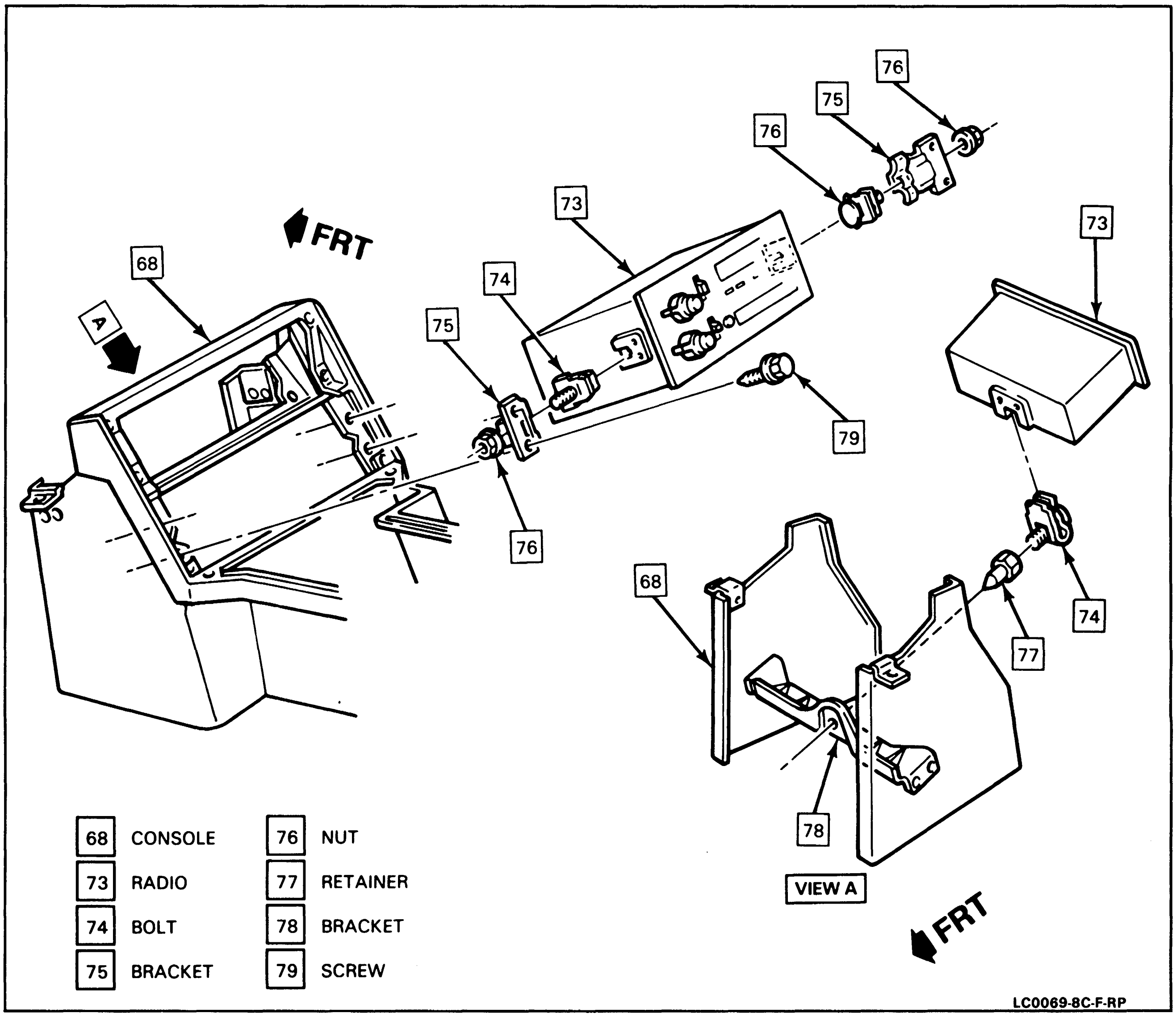


Figure 19 - Radio

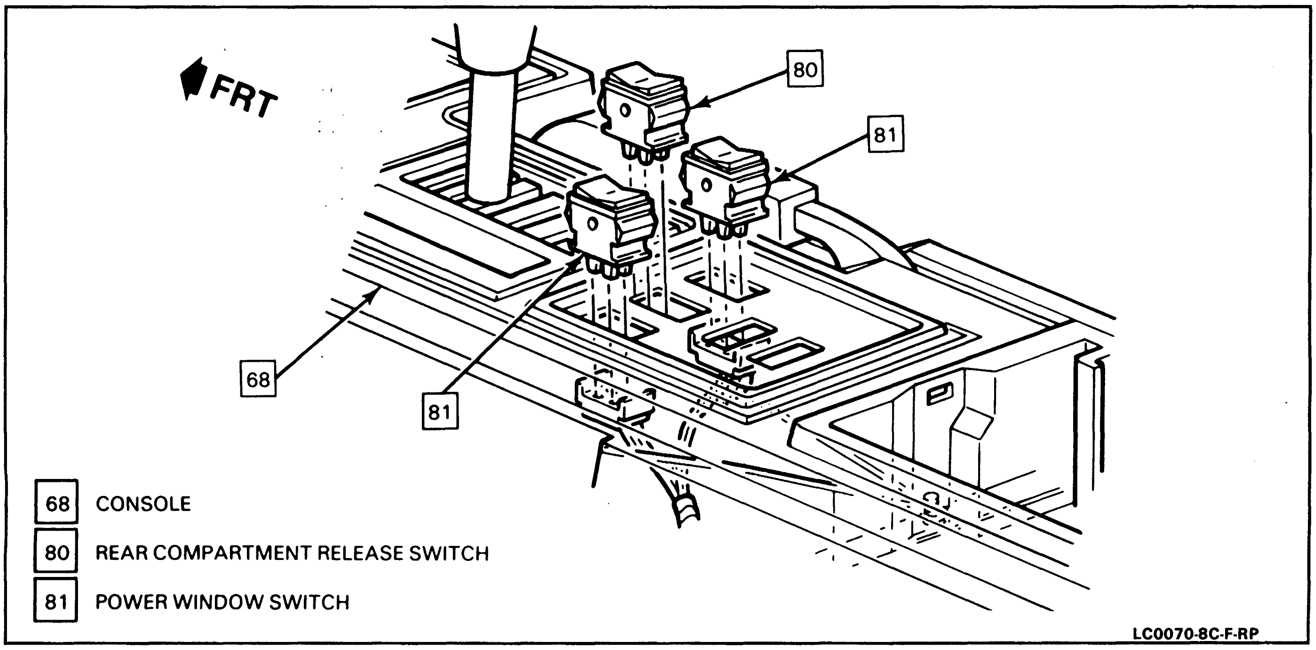


Figure 20 - Console Mounted Switches

Tighten

- Screws (87) to 2.6 N·m (23 lb. in.).

3. Floor upper console (84).
4. Screws (82).

Tighten

- Screws (82) to 1.9 N·m (17 lb. in.).

5. Console mounted switches. Refer to "Console Mounted Switches" in this section.
6. Parking brake handle grip.
7. Shifter handle and retainer, if removed.
8. Radio. Refer to "Radio" in this section.
9. Control assembly. Refer to "Heater or Air Conditioning Control Assembly" in this section.
10. Console trim plates. Refer to "Console Trim Plates" in this section.
11. Negative battery cable.

SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM COMPONENTS

For descriptions and diagnosis of the Supplemental Inflatable Restraint (SIR) System, refer to SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM (SEC. 9J) and SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM DIAGNOSIS (SEC. 9J-A). All sensors are specifically calibrated for each vehicle series and are keyed to the mounting brackets and the SIR wiring harness. Caution should be used to ensure proper location of the sensors to their mounting brackets. The keying of the sensors to their mounting brackets and wiring harness should never be modified in the field.

SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM SERVICING PRECAUTIONS

CAUTION: Proper operation of the sensors and supplemental inflatable restraint (SIR) system requires that any repairs to the vehicle structure return it to its original production configuration. Deployment (Current Code 51) or any visible damage to sensors and/or their mounting brackets requires replacement, not repair. Proper operation of a sensor also requires that the sensor and its bracket be rigidly attached to the vehicle structure. The arrow on the sensor must be pointing toward the front of the vehicle. Failure to observe these precautions can result in improper SIR system operation and possible lack of supplemental restraint protection for the driver during an accident impact.

CAUTION: Be very careful when handling a sensor. Never strike or jar a sensor. If you do, it could cause deployment and result in personal injury or improper operation of the supplemental inflatable restraint (SIR) system. All sensors and mounting bracket bolts must be carefully torqued to ensure proper operation. Never power up the SIR system when any sensor is not rigidly attached to the vehicle since the sensor is easily activated when not attached. This could result in immediate deployment and possible personal injury.

DISABLING THE SIR SYSTEM

Remove or Disconnect

- Turn the steering wheel so that the vehicle's wheels are pointing straight ahead.
- Turn the ignition switch to "LOCK."

1. SIR fuse from the fuse block.
2. Left side sound insulator. Refer to "Instrument Panel Sound Insulators" in this section.
3. Connector position assurance (CPA) and yellow two-way SIR harness electrical connector at the base of the steering column.

ENABLING THE SIR SYSTEM

Install or Connect

1. Yellow two-way SIR harness connector to base of steering column and connector position assurance (CPA).
2. Left side sound insulator. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
3. SIR fuse to the fuse block.

- Turn the ignition switch to "RUN" and verify that the inflatable restraint indicator flashes 7 to 9 times and then turns off. If the indicator does not respond as stated, refer to SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM DIAGNOSIS (SEC. 9J-A).

Diagnostic Energy Reserve Module (DERM)

Figures 22 and 23

CAUTION: Refer to "Supplemental Inflatable Restraint (SIR) System Servicing Precautions" in this section.

Remove or Disconnect

CAUTION: See "Caution" on page 8C-1 of this section.

- Disable the SIR system. Refer to "Disabling the SIR System" in this section.

1. Instrument panel pad. Refer to "Instrument Panel Pad" in this section.
2. Side window defogger duct and screws.

- Cut off an unused mounting screw tab (91) from the front edge of the instrument panel, just above the DERM module.

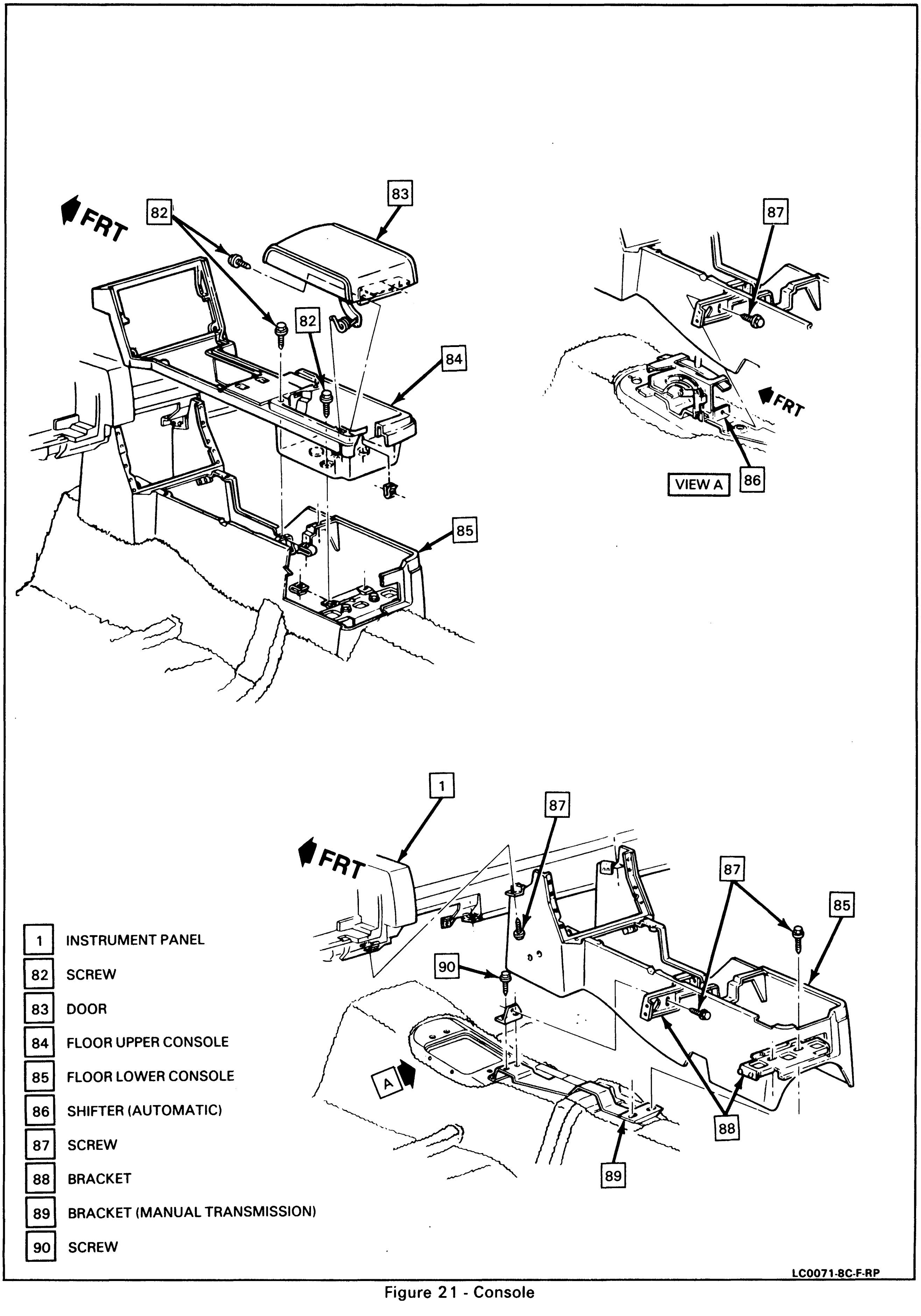


Figure 21 - Console

3. Screw (92).
4. DERM module (93).

- Unlatch orange lock and disconnect electrical connector.

Install or Connect

NOTICE: See "Notice" on page 8C-1 of this section.

1. Electrical connector and orange connector lock.
2. DERM module (93).
3. Screw (92).

Tighten

- Screws (92) to 2.2 N·m (19 lb. in.).

4. Side window defogger duct and screws.
5. Instrument panel pad. Refer to "Instrument Panel Pad" in this section.

- Enable the SIR system. Refer to "Enabling the SIR System" in this section.

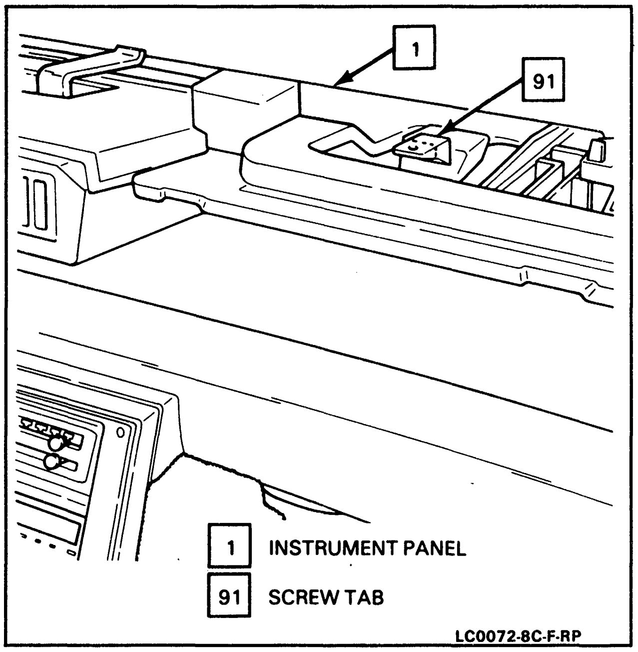


Figure 22 - Mounting Screw Tab

Resistor Module

Figure 24

CAUTION: Refer to "Supplemental Inflatable Restraint (SIR) System Servicing Precautions" in this section.

Remove or Disconnect

CAUTION: See "Caution" on page 8C-1 of this section.

- Disable the SIR system. Refer to "Disabling the SIR System" in this section.

1. Knee bolster. Refer to "Driver Knee Bolster and Deflector" in this section.
2. Resistor module (96) by unsnapping from the left side tie bar (95).
3. Connector position assurance (CPA) (97) and electrical connector.

Install or Connect

1. Electrical connector and connector position assurance (CPA) (97).
2. Resistor module (96) by snapping to the left side tie bar (95).
3. Knee bolster. Refer to "Driver Knee Bolster and Deflector" in this section.

- Enable the SIR system. Refer to "Enabling the SIR System" in this section.

Passenger Compartment Discriminating Sensor

Figure 25

All sensors are specifically calibrated for each vehicle series and are keyed to the mounting brackets and the SIR wiring harness. Caution should be used to ensure proper location of the sensors to their mounting brackets. The keying of the sensors to their mounting brackets and wiring harness should never be modified in the field.

CAUTION: Refer to "Supplemental Inflatable Restraint (SIR) System Servicing Precautions" in this section.

Remove or Disconnect

CAUTION: See "Caution" on page 8C-1 of this section.

- Disable the SIR system. Refer to "Disabling the SIR System" in this section.

1. Knee bolster. Refer to "Driver Knee Bolster and Deflector" in this section.
2. Console. Refer to "Console" in this section.
3. Heater air distribution duct and screws. Refer to "Floor Air Outlet Duct" in this section.
4. Connector position assurance (CPA) (100) and electrical connector (101).
5. Bolts (99).
6. Discriminating sensor (98).

Install or Connect

NOTICE: See "Notice" on page 8C-1 of this section.

1. Discriminating sensor (98) with arrow pointing toward the front of the vehicle.
2. Bolts (99).

Tighten

- Bolts (99) to 2.8 N·m (25 lb. in.).

3. Electrical connector (101) and connector position assurance (CPA) (100).
4. Heater air distribution duct and screws. Refer to "Floor Outlet Duct" in this section.
5. Console. Refer to "Console" in this section.
6. Knee bolster. Refer to "Driver Knee Bolster and Deflector" in this section.

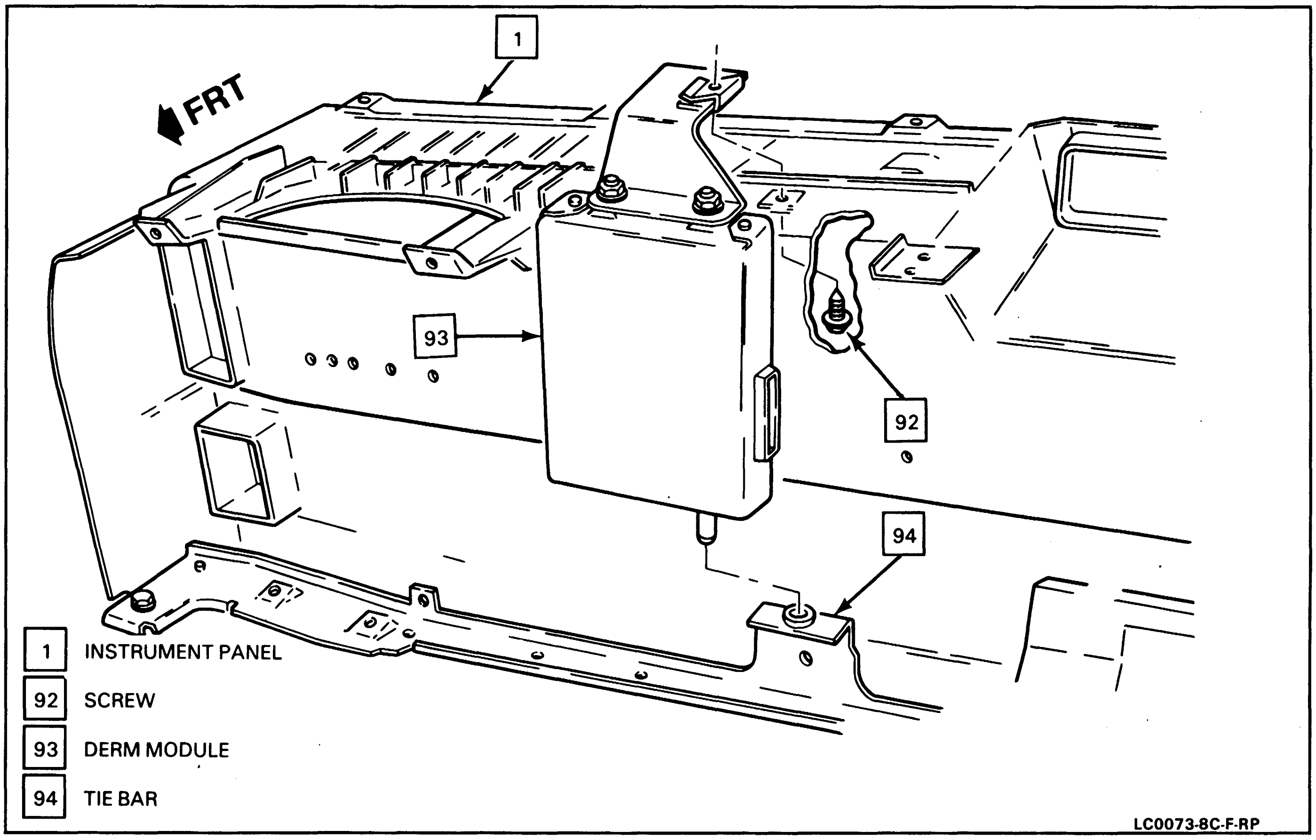


Figure 23 - Diagnostic Energy Reserve Module (DERM)

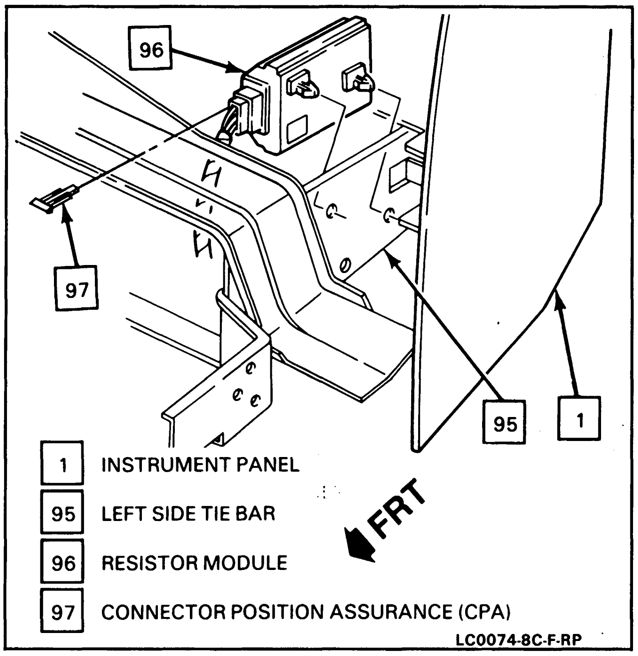


Figure 24 - Resistor Module

- Enable the SIR system. Refer to "Enabling the SIR System" in this section.

Arming Sensor

Figure 26

All sensors are specifically calibrated for each vehicle series and are keyed to the mounting brackets and the SIR wiring harness. Caution should be used to ensure proper location of the sensors to their mounting brackets. The keying of the sensors to their mounting brackets and wiring harness should never be modified in the field.

CAUTION: Refer to "Supplemental Inflatable Restraint (SIR) System Servicing Precautions" in this section.

↔ Remove or Disconnect

CAUTION: See "Caution" on page 8C-1 of this section.

- Disable the SIR system. Refer to "Disabling the SIR System" in this section.

1. Knee bolster. Refer to "Driver Knee Bolster and Deflector" in this section.
2. Upper console. Refer to "Console" in this section.
3. Connector position assurance (CPA) (103) and electrical connector (104).
4. Bolts (105).
5. Arming sensor (106).

→← Install or Connect

NOTICE: See "Notice" on page 8C-1 of this section.

1. Arming sensor (106).
2. Bolts (105).

Tighten

- Bolts (105) to 2.8 N·m (25 lb. in.).

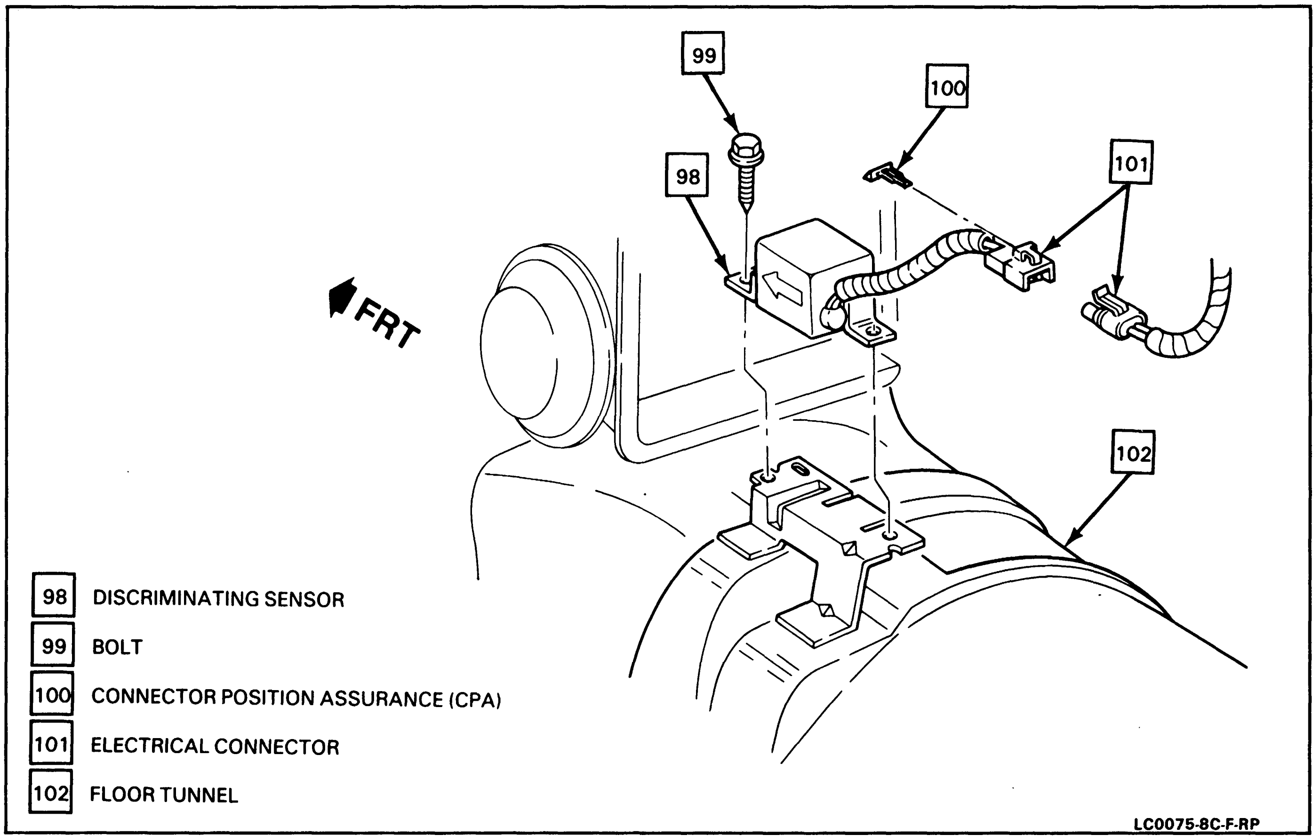


Figure 25 - Passenger Compartment Discriminating Sensor

3. Electrical connector (104) and connector position assurance (CPA) (103).
4. Upper console. Refer to "Console" in this section.
5. Knee bolster. Refer to "Driver Knee Bolster and Deflector" in this section.

- Enable the SIR system. Refer to "Enabling the SIR System" in this section.

NAMEPLATE

Figure 27

Remove or Disconnect

- Nameplate (108) by gently pulling the locking keys (110) out of the holes in the instrument panel (1).

Install or Connect

- Nameplate (108) by lining up the locating pins (109) on the nameplate (108) with the holes in the instrument panel (1). Push the nameplate (108) to engage the locking keys (110).

INSTRUMENT PANEL

Figure 28

Remove or Disconnect

1. Negative battery cable.
2. Console. Refer to "Console" in this section.
3. Instrument panel pad. Refer to "Instrument Panel Pad" in this section.
4. Instrument panel sound insulators. Refer to "Instrument Panel Sound Insulators" in this section.
5. Instrument panel knee bolster and bracket. Refer to "Driver Knee Bolster and Deflector" in this section.
6. Instrument panel cluster. Refer to "Instrument Panel Cluster" in this section.
7. Steering column retaining nuts.

- Lower steering column.

8. Upper and lower instrument panel to cowl screws.
9. Instrument panel electrical harness at cowl connector and under dash panel.
10. Instrument panel (1).

Install or Connect

1. Instrument panel (1).
2. Instrument panel electrical harness at cowl connector and under dash panel.
3. Upper and lower instrument panel to cowl screws.

- Raise steering column.

4. Steering column retaining nuts.
5. Instrument panel cluster. Refer to "Instrument Panel Cluster" in this section.
6. Instrument panel knee bolster and bracket. Refer to "Driver Knee Bolster and Deflector" in this section.

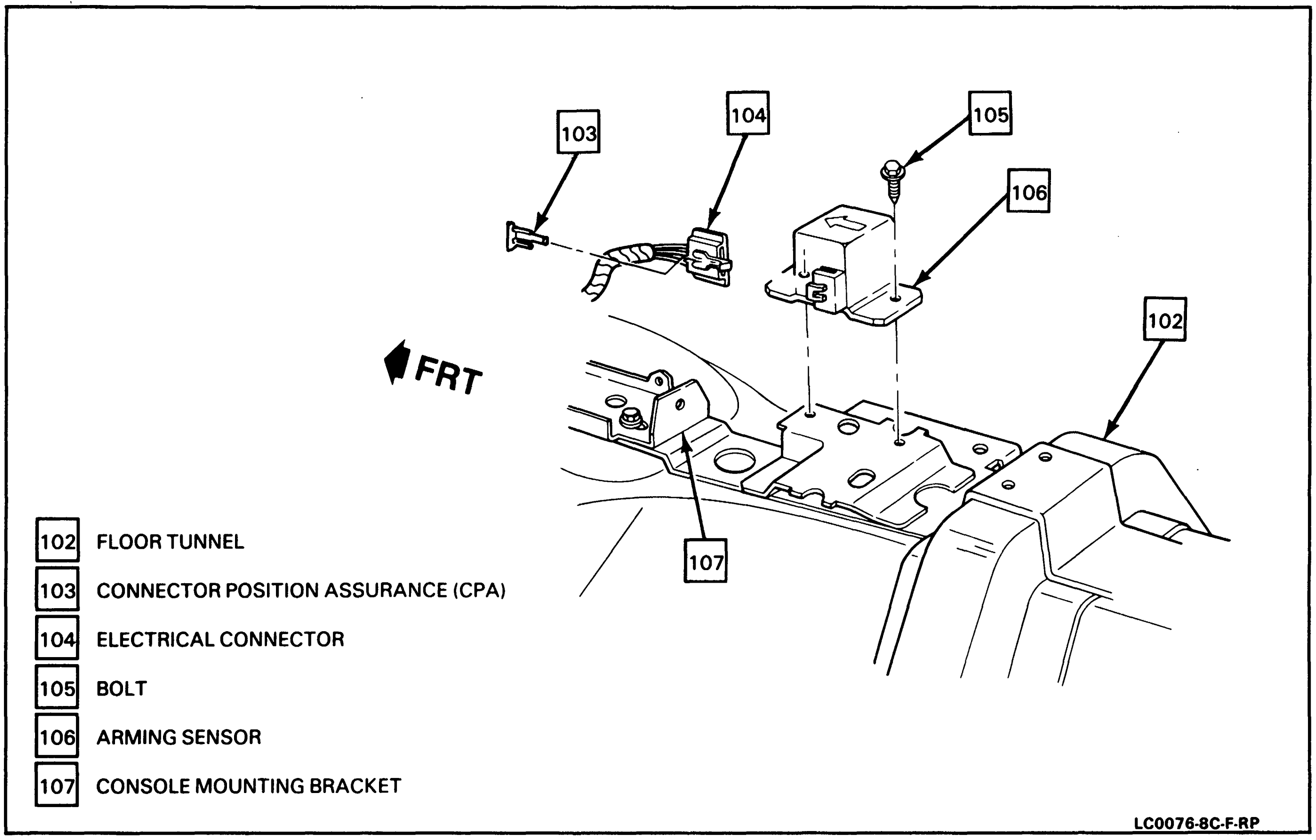


Figure 26 - Arming Sensor

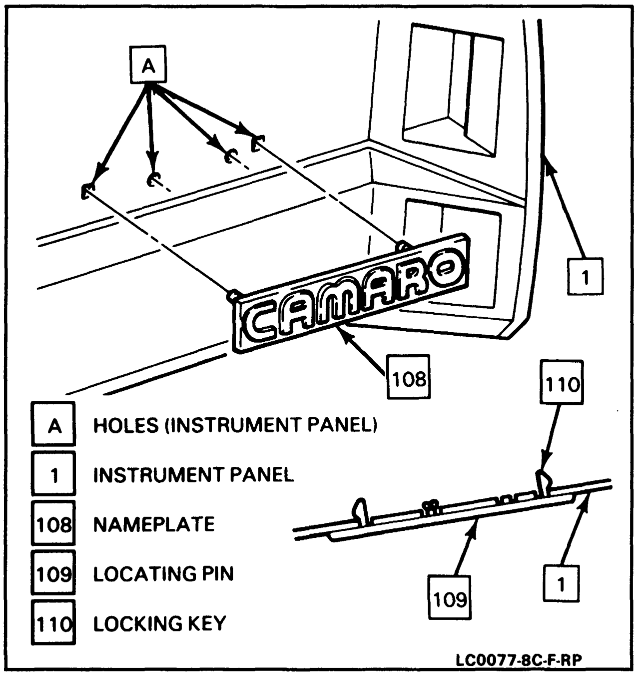


Figure 27 - Nameplate

7. Instrument panel sound insulators. Refer to "Instrument Panel Sound Insulators" in this section.
8. Instrument panel pad. Refer to "Instrument Panel Pad" in this section.
9. Console. Refer to "Console" in this section.
10. Negative battery cable.

FLOOR AIR OUTLET DUCT

Figure 29

↔ Remove or Disconnect

1. Console. Refer to "Console" in this section.
2. Screws (116) from floor air outlet duct (117).
3. Floor air outlet duct (117).

→← Install or Connect

NOTICE: See "Notice" on page 8C-1 of this section.

1. Floor air outlet duct (117).
2. Screws (116).

Tighten

- Screws (116) to 1.4 N·m (12 lb. in.).

3. Console. Refer to "Console" in this section.

INSTRUMENT PANEL DUCTS

Figures 30 through 32

Side Window Defroster Duct and Gasket

↔ Remove or Disconnect

1. Instrument panel pad. Refer to "Instrument Panel Pad" in this section.
2. Screws (128).

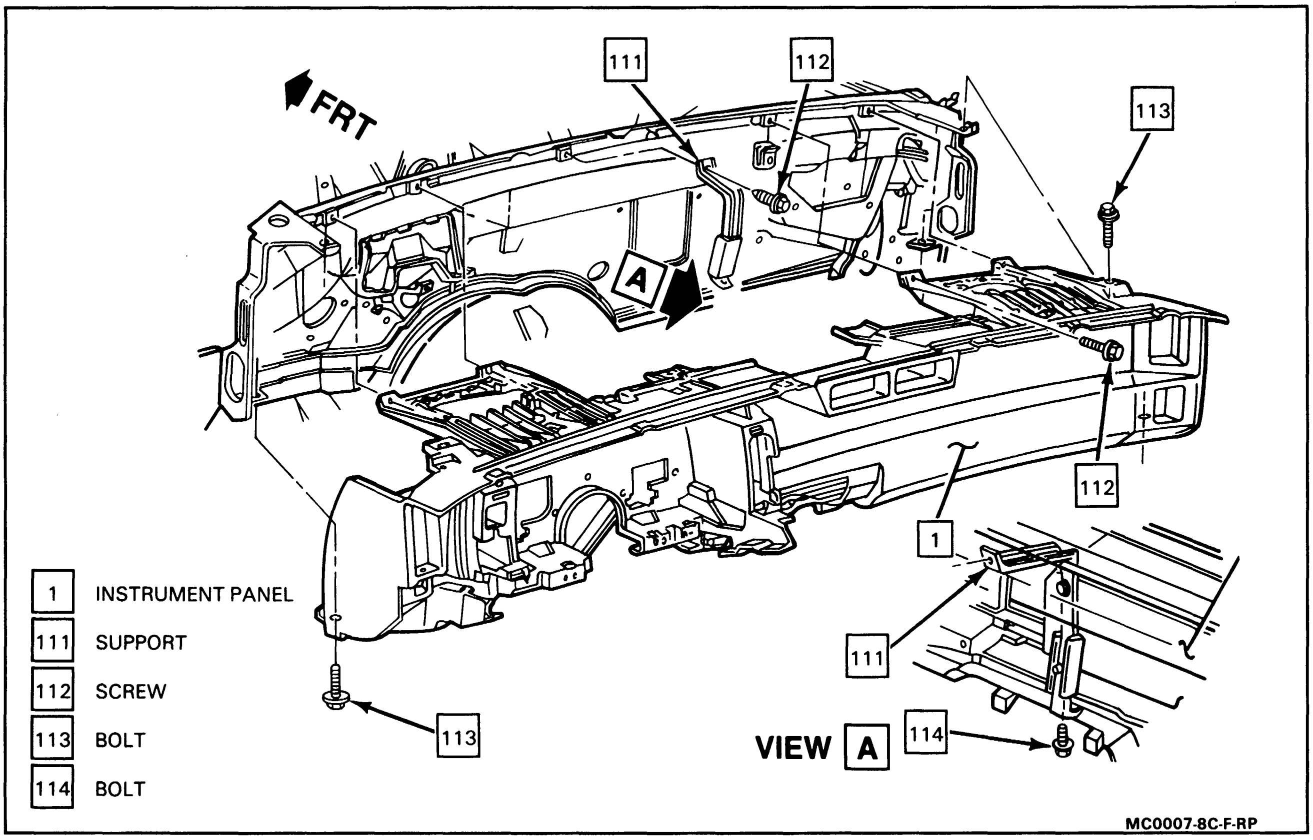


Figure 28 - Instrument Panel

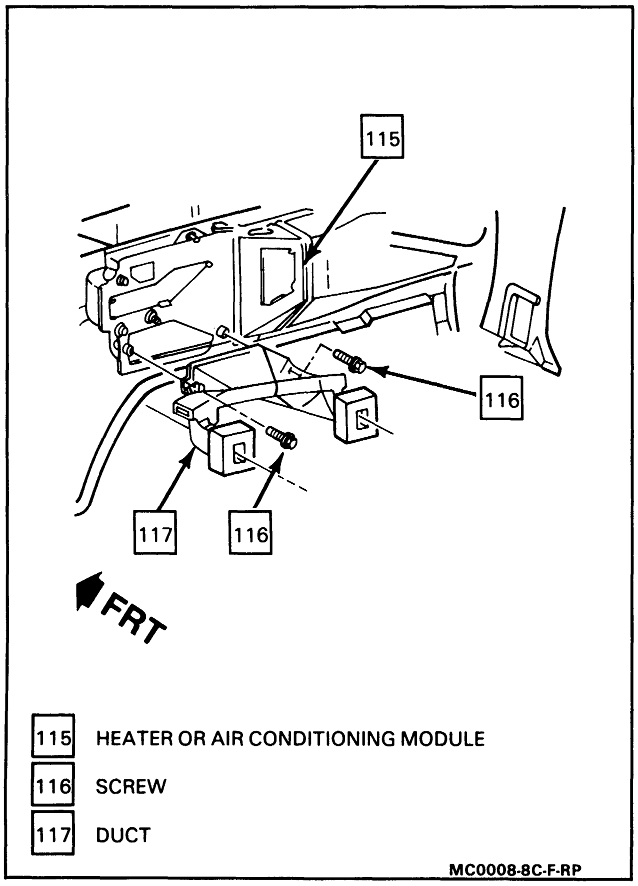


Figure 29 - Floor Air Outlet Duct

3. Defroster duct (122 or 123).
4. Duct gasket.

→← Install or Connect

1. Duct gasket.
2. Defroster duct (122 or 123).
3. Screws (128).
4. Instrument panel pad. Refer to "Instrument Panel Pad" in this section.

Air Distributor Duct

←→ Remove or Disconnect

1. Side window defroster duct. Refer to "Side Window Defroster Duct and Gasket" in this section.
2. Air outer ducts. Refer to "Outer Air Outlet Duct" in this section.
3. Air distributor duct mounting screws.
4. Air distributor duct (119).

→← Install or Connect

1. Air distributor duct (119).
2. Air distributor duct mounting screws.
3. Air outer ducts. Refer to "Outer Air Outlet Duct" in this section.
4. Side window defroster duct. Refer to "Side Window Defroster Duct and Gasket" in this section.

Center Air Outlet Duct and Gasket

Remove or Disconnect

1. Air distributor duct. Refer to "Air Distributor Duct" in this section.
2. Screws (127).
3. Center air outlet duct (120).
4. Air distributor duct seal (125).
5. Center air outlet seal (126).

Install or Connect

1. Center air outlet seal (126).
2. Air distributor duct seal (125).
3. Center air outlet duct (120).
4. Screws (127).
5. Air distributor duct. Refer to "Air Distributor Duct" in this section.

Outer Air Outlet Duct

Remove or Disconnect

1. Instrument panel. Refer to "Instrument Panel" in this section.
2. Screws (118).
3. Outer air outlet duct (121 or 124).

Install or Connect

1. Outer air outlet duct (121 or 124).
2. Screws (118).
3. Instrument panel. Refer to "Instrument Panel" in this section.

VATS II MODULE

For service information on the VATS module, refer to THEFT DETERRENT SYSTEMS (SEC. 9D).

INSTRUMENT PANEL INSULATORS (UPPER AND LOWER)

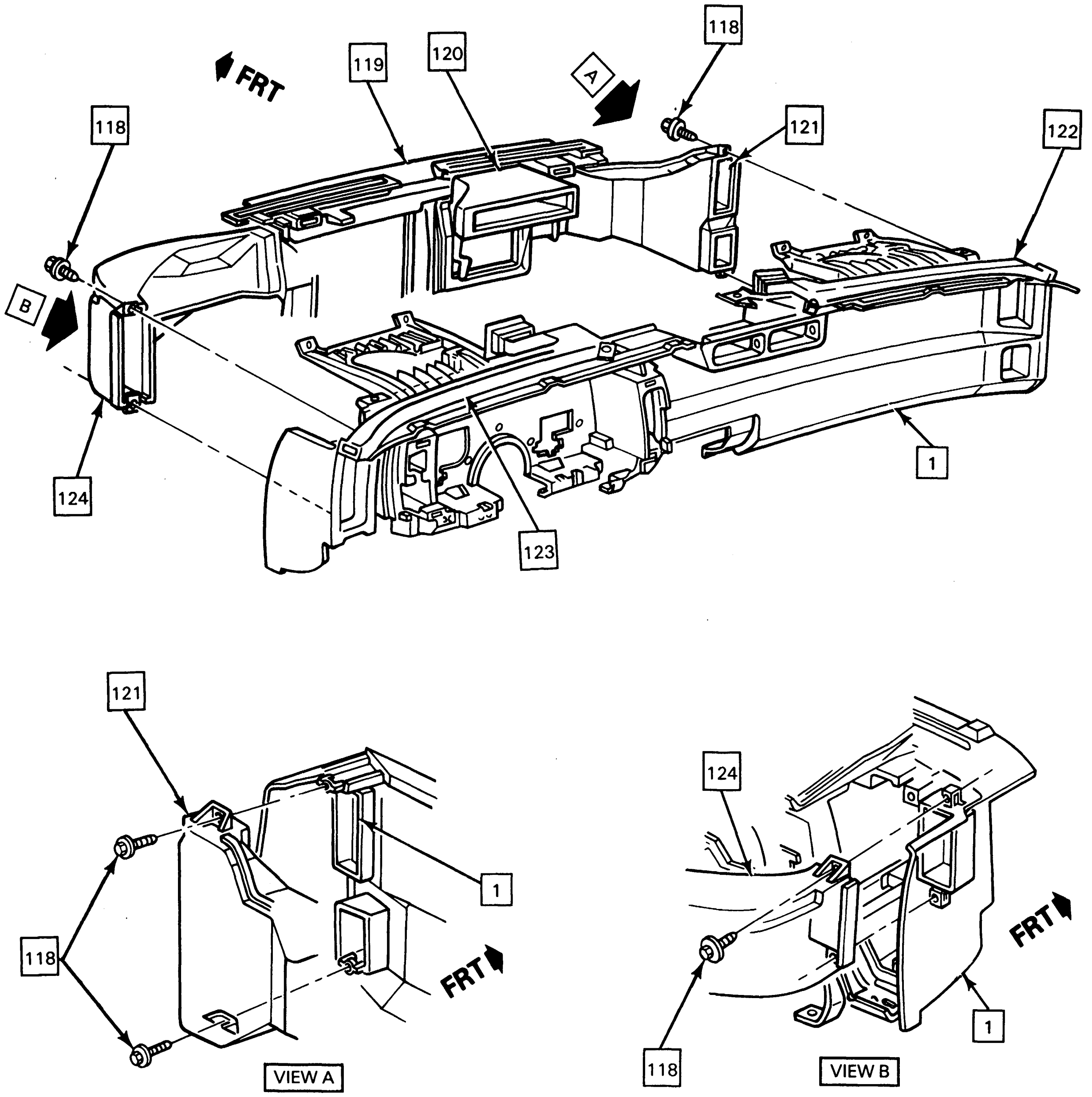
Figure 33

Remove or Disconnect

1. Instrument panel. Refer to "Instrument Panel" in this section.
2. Retainers (140).
3. Upper insulator (139), if necessary.
4. Lower insulator (141), if necessary.
   - Bend tab (142) to release lower insulator (141).

Install or Connect

1. Lower insulator (141), if necessary.
   - Bend tabs (142) to retain lower insulator (141).
2. Upper insulator (139), if necessary.
3. Retainers (140).
4. Instrument panel. Refer to "Instrument Panel" in this section.



1	INSTRUMENT PANEL	121	OUTER AIR OUTLET DUCT
118	SCREW	122	SIDE WINDOW DEFROSTER DUCT
119	CENTER AIR DISTRIBUTOR DUCT	123	SIDE WINDOW DEFROSTER DUCT
120	CENTER AIR OUTLET DUCT	124	OUTER AIR OUTLET DUCT

MC0009-8C-F-RP

Figure 30 - Air Conditioning or Heater, Ventilation and Defroster Ducts

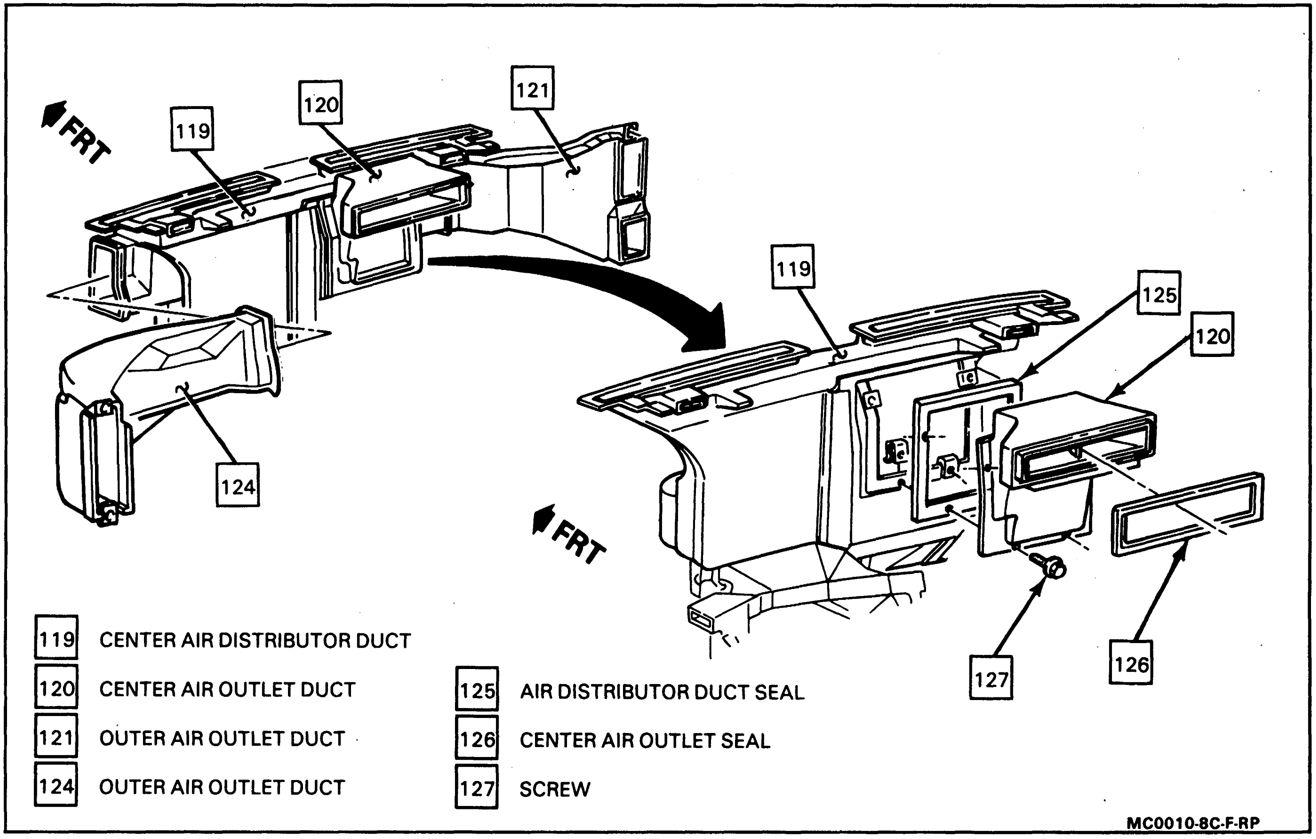


Figure 31 - Air Outlet Duct Mounting

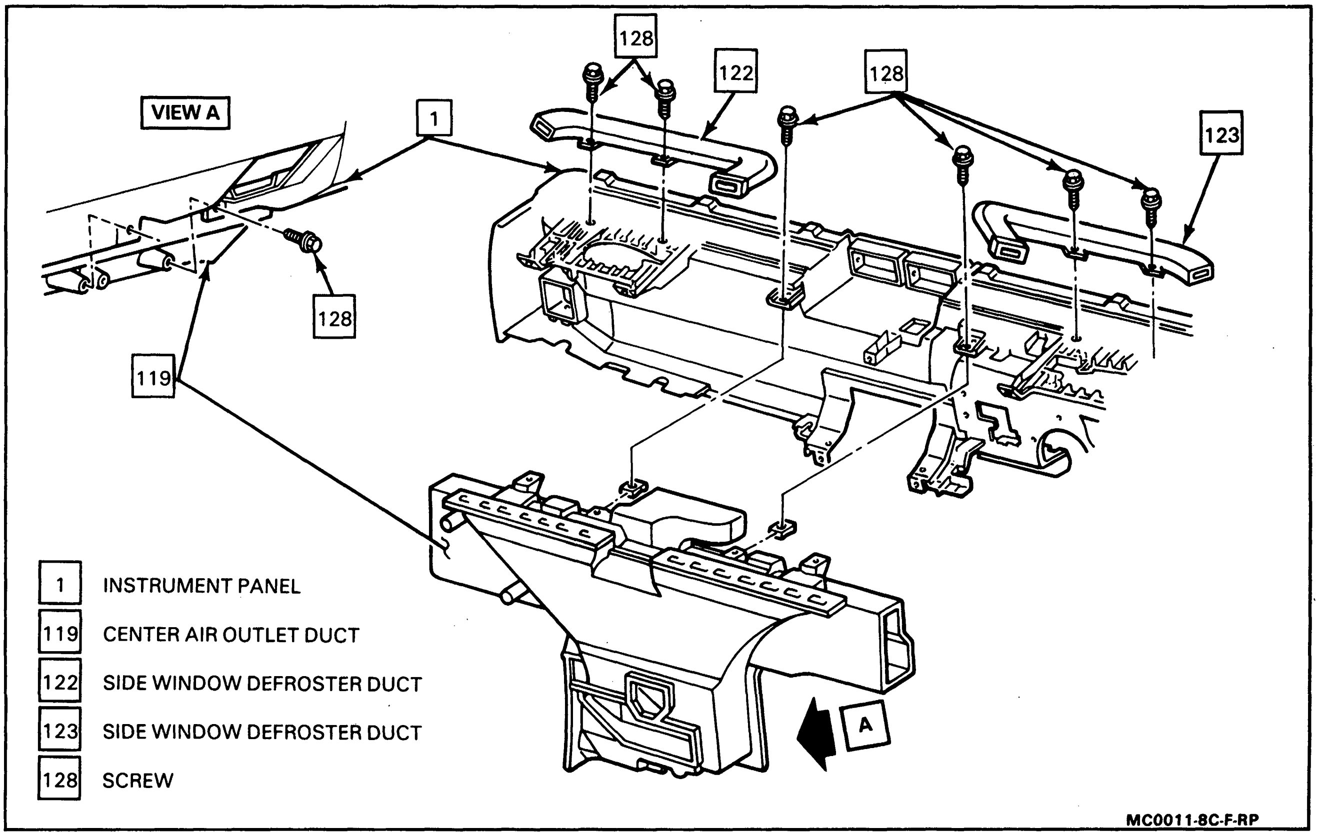


Figure 32 - Heater and Defroster Ducts

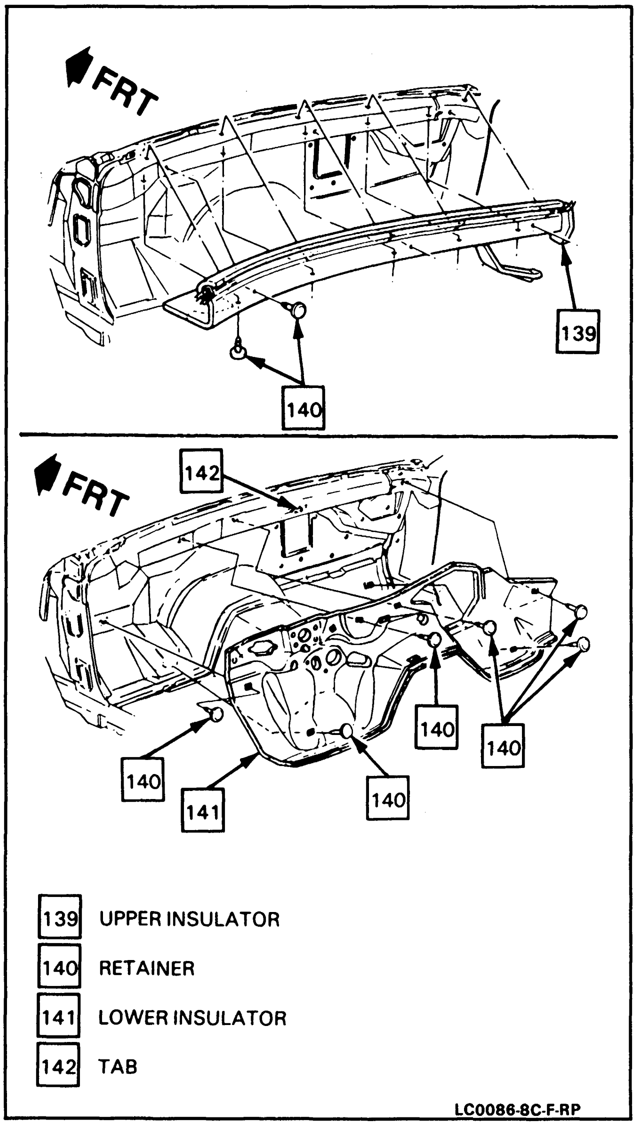


Figure 33 - Dash Insulators

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Instrument Panel Sound Insulator Nut	1.9 N·m (17 lb. in.)
Instrument Panel Sound Insulator Screw	1.5 N·m (13 lb. in.)
Driver Knee Bolster Screw	5.5 N·m (49 lb. in.)
Power Antenna Relay Screw	1.5 N·m (13 lb. in.)
Convenience Center Bolt	1.5 N·m (13 lb. in.)
Instrument Panel Cluster Trim Plate Screw	1.7 N·m (15 lb. in.)
Heater or Air Conditioning Control Assembly Screw	1.4 N·m (12 lb. in.)
Lower Console Screw	2.6 N·m (23 lb. in.)
Upper Console Screw	1.9 N·m (17 lb. in.)
Diagnostic Energy Reserve Module Screw	2.2 N·m (19 lb. in.)
Passenger Compartment Discriminating Sensor Bolt	2.8 N·m (25 lb. in.)
Arming Sensor Bolt	2.8 N·m (25 lb. in.)
Floor Air Outlet Duct Screw	1.4 N·m (12 lb. in.)

SECTION 8E

WINDSHIELD WIPER / WASHER SYSTEM

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 8E-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

The permanent magnet (PM) depressed park windshield wiper with remote washer pump system consists of a depressed park wiper motor and a remote washer pump mounted on the solvent containter.

An electronic printed circuit board attached in the wiper motor cover controls pulse timing and demand wash functions.

WIPER AND WASHER OPERATION

Pulse Wiper System

Electronic logic circuits on a pulse wiper system's printed circuit board establish all timing and washer commands. When the windshield washer switch paddle is pressed for less than one second, the washer sprays only during the wiper arm outwipe and pulsates operation for 2 1/2 seconds. Then the wiper dry wipes for nearly 6 seconds before shutting off.

If the windshield washer switch paddle is pressed for more than one second, a demand wash is performed for as long as the paddle is depressed. This wash action is followed by 6 seconds of dry wipes before shut-off. With the control switch in the "LO" or "HI" speed position, the respective brush circuit is completed to the 12-volt DC source and the wiper motor runs at that particular speed setting.

Moving the wiper switch to the "DELAY" mode operates the wiper motor intermittently and the delay can be varied by moving the switch back and forth in the "DELAY" mode. An instantaneous wipe can be obtained by moving the switch to the "MIST" position. If the switch is held in "MIST" continually, a continuous wiping action will be performed.

Fluidic Washer Nozzle

The system consists of a fluid container, pump, wiper motor, fluidic hoses and pipes, nozzle mounts, nozzles, wiper arm and blades.

The fluidic washer flow is controlled by a small plastic element designed into the washer nozzle. As water is forced through this insert, the design of the mechanism creates an oscillating power stream. This produces larger, more widely dispersed droplets, resulting in a more efficient cleaning action.

Wiper and Washer Control Switches

Figure 1

The wiper and washer control switches are part of the multi-function turn signal lever mounted on the left side of the steering column. For removal and replacement procedures, refer to STEERING WHEEL UPPER COLUMN ON-VEHICLE SERVICE - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4).

DIAGNOSIS

PRELIMINARY CHECKS

Figure 2

Perform the following checks before removing any parts from the vehicle.

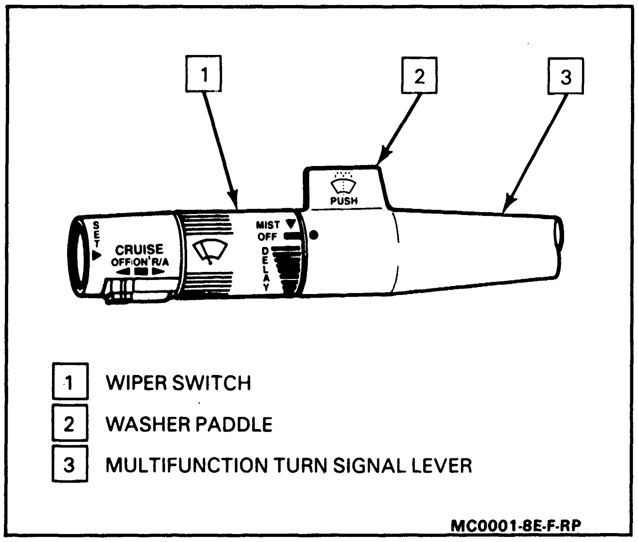


Figure 1 - Wiper and Washer Control Switches

Inspect

- Wiper and washer system operation (Figure 2).
- Wiper fuse.
- Wiper motor assembly-to-dash mounting for proper installation.
- All electrical connections for correct mating.
- Washer reservoir for adequate fluid level.
- Washer hoses to ensure they are not kinked, broken, disconnected and are not clogged.
- Washer nozzles are properly connected and not clogged.
- Transmission drive link at wiper motor crank arm if wiper motor runs but wiper blades do not.

If the wiper and washer system is not operating properly after performing the preliminary checks, refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

ON-VEHICLE SERVICE

WASHER PUMP REPLACEMENT

Figure 3

Remove or Disconnect

1. Electrical connector (7) from washer pump (6).
2. Two retainers (4) attaching solvent container (5) to right side inner wheelhouse panel.
    - Unscrew until retainers (4) can be removed.
3. Solvent container (5) from vehicle.
4. Pump hose (8) from washer pump (6).
    - Drain washer solvent into a clean drain pan.
5. Washer pump (6) from solvent container (5).

Install or Connect

NOTICE: See "Notice" on page 8E-1 of this section.

1. Washer pump (6) to solvent container (5).
    - Ensure washer pump (6) is fully seated on container gasket.
2. Pump hose (8) to washer pump (6).
3. Solvent container (5) into vehicle.

Important

- Route pump hose (8) as shown in Figure 3 to ensure that it does not become kinked or pinched.

4. Two retainers (4) attaching solvent container (5) to right side inner wheelhouse panel.

Tighten

- Retainers (4) until snug and solvent container (5) cannot be moved.

5. Electrical connector (7) to washer pump (6).

- Fill solvent container (5) with washer solvent. Use GM part number 1051515 or equivalent.

Important

- Fill solvent container (5) only 3/4 full in freezing weather.

WIPER MOTOR COVER REPLACEMENT

Figure 4

Remove or Disconnect

1. Electrical connector from cover (12).
2. Three screws (9) attaching cover (12) to motor (11).
3. Cover (12) from motor (11).

Install or Connect

NOTICE: See "Notice" on page 8E-1 of this section.

1. Cover (12) to motor (11).

Important

- Always install cover (12) with wiper in park position and drive pin in the open area of the cam. Refer to Figure 4.

2. Three screws (9) attaching cover (12) to motor (11).

Tighten

- Screws (9) to 2 N·m (18 lb. in.).

3. Electrical connector to cover (12).

WIPER MOTOR REPLACEMENT

Figure 5

Remove or Disconnect

1. Right hand wiper arm. Refer to "Wiper Arm" in this section.
2. Shroud vent grille. Refer to BODY FRONT END (SEC. 10-4).

		WASHER PADDLE POSITION		
		OFF	PADDLE HELD LESS THAN 1 SECOND	PADDLE HELD MORE THAN 1 SECOND
WIPER SWITCH POSITION	MIST	Wiper runs through a single cycle if wiper switch is moved to "MIST" momentarily. Wiper continues to run if switch is held in "MIST."	Not applicable.	Not applicable.
	OFF	Wiper and washer are off — blades are at park position.	Wiper starts, runs and washes in low speed. Fluid pulses approximately $2\frac{1}{2}$ seconds, followed by approximately 6 seconds of drying wipes. Wiper then returns to park and shuts off.	Wiper starts, runs and washes in low speed. Fluid flows as long as button is held, then approximately 6 seconds of drying wipes and wiper returns to park position and shuts off.
	DELAY	Wiper runs one low speed wipe. Blades stop at inner wipe position, next wipe is delayed for period of time of 0 to 25 seconds (depending upon rheostat setting), then cycle repeats.	Delay function is overridden and followed by wash and dry cycle above. Blades then return to inner wipe position and delay function resumes.	Delay function is overridden and followed by wash and dry cycle above. Blades then return to inner wipe position and delay function resumes.
	LO	Wiper runs in continuous low speed.	Wiper continues to run in low during wash cycle above, and remains in low speed after wash.	Wiper continues to run in low during wash cycle above, and remains in low speed after wash.
	HI	Wiper runs in continuous high speed.	Same as low speed wash above except motor running in high speed.	Same as low speed wash above except motor running in high speed.

MC0002-8E-F-RP

Figure 2 - Wiper and Washer Operation Chart

- Loosen (do not remove) screws (19).

3. Drive link (18) from crank arm (17).
4. Electrical connectors (14 and 16).
5. Three screws (15) attaching motor (11) to cowl extension panel.
6. Wiper motor (11).
   - Carefully guide crank arm (17) through hole.

Install or Connect

NOTICE: See "Notice" on page 8E-1 of this section.

1. Wiper motor (11).
   - Carefully guide crank arm (17) through hole.
2. Three screws (15) attaching motor (11) to cowl extension panel.

Tighten

- Screws (15) to 5 N·m (44 lb. in.).

3. Electrical connectors (14 and 16).
4. Drive link (18) to crank arm (17).

Tighten

- Screws (19) to 10.5 N·m (93 lb. in.).

5. Shroud vent grille. Refer to BODY FRONT END (SEC. 10-4).
6. Right hand wiper arm. Refer to "Wiper Arm" in this section.

WIPER TRANSMISSION

Figure 6

Remove or Disconnect

1. Right and left wiper arms. Refer to "Wiper Arm" in this section.
2. Shroud vent grille. Refer to BODY FRONT END (SEC. 10-4).

- Loosen (do not remove) screws (19) attaching drive link (18) to transmission (21).

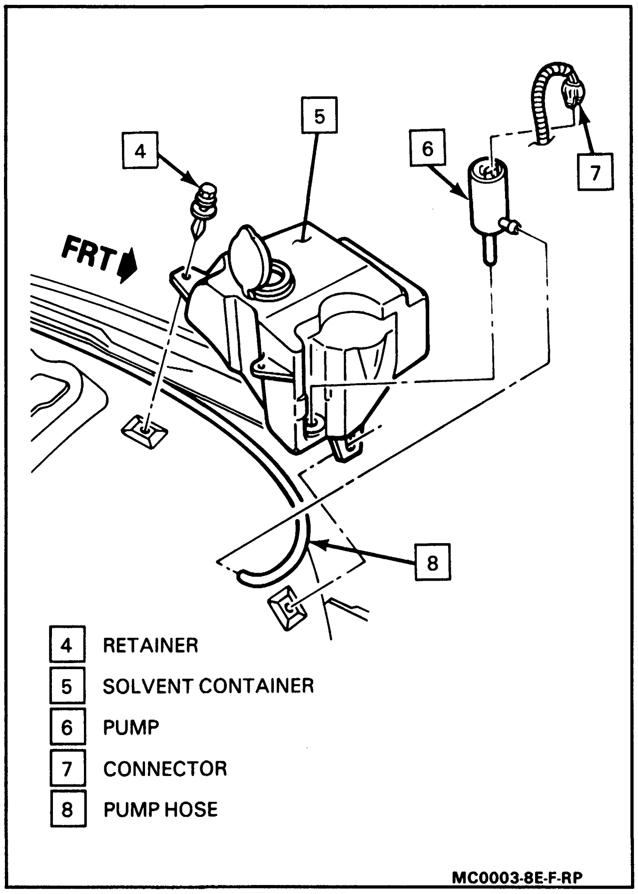


Figure 3 - Washer Pump and Solvent Container

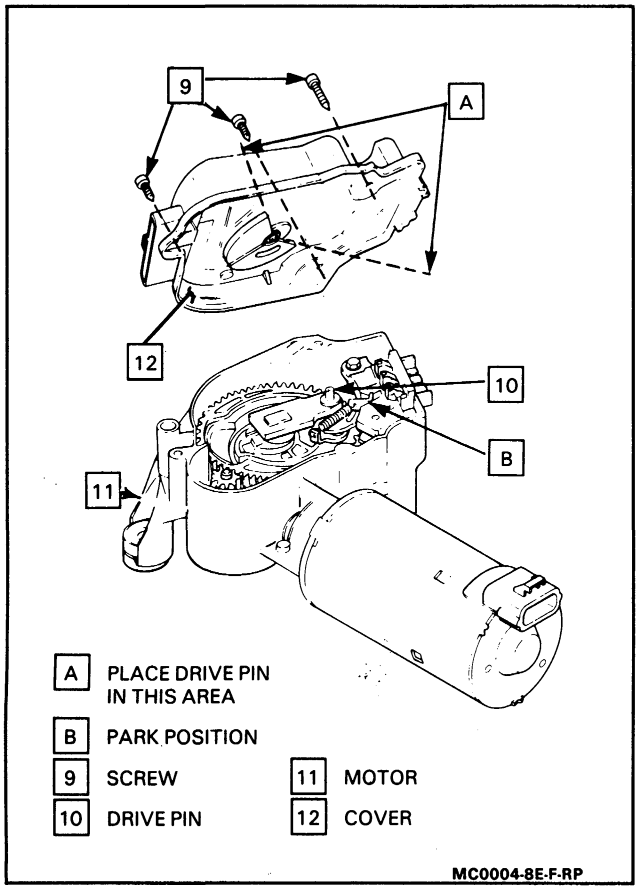


Figure 4 - Wiper Motor Cover

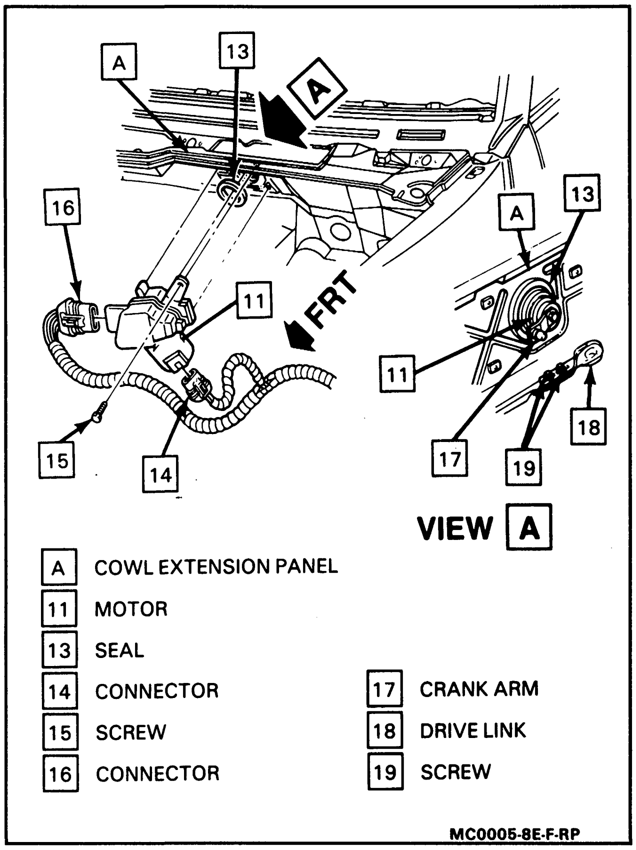


Figure 5 - Wiper Motor

3. Drive link (18) from crank arm (17).
4. Six screws (20) attaching transmission (21) to vehicle.
5. Transmission (21) from vehicle.
   - Collapse transmission (21) by rotating as shown in Figure 6.

Install or Connect

NOTICE: See "Notice" on page 8E-1 of this section.

- Open transmission (21) and align locator rib to approximate position of the cutout in the vehicle.
- Collapse transmission (21) by rotating as shown in Figure 6.

1. Transmission (21) to vehicle.
2. Six screws (20) attaching transmission (21) to vehicle.
   - Loosely install screws (20).
3. Drive link (18) to crank arm (17).

Tighten

- Screws (19) to 10.5 N·m (93 lb. in.).

- Align transmission (21).

Tighten

- Screws (20) to 7.3 N·m (65 lb. in.).

4. Shroud vent grille. Refer to BODY FRONT END (SEC. 10-4).

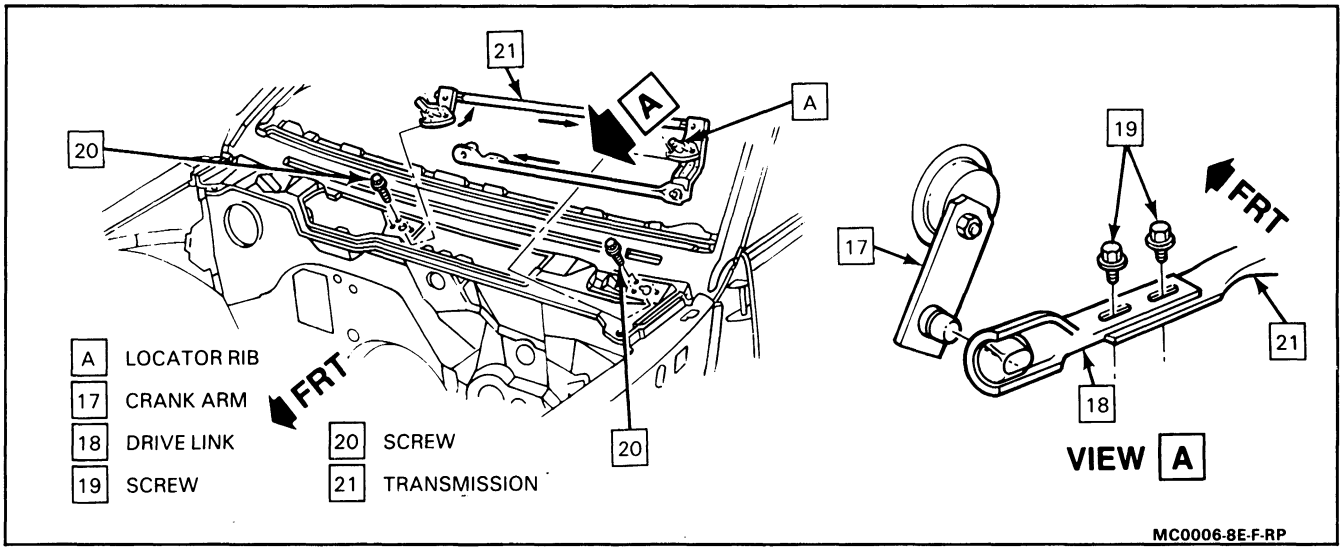


Figure 6 - Wiper Transmission

5. Right and left wiper arms. Refer to "Wiper Arm" in this section.

- Check wiper operation, wipe pattern and park position.
  - Adjust, if necessary. Refer to "Wiper Arm Adjustment" in this section.

WIPER ARM

Figures 7 and 8

↔ Remove or Disconnect

- Turn ignition switch "ON."
- Turn wiper control switch to "LO" and then turn ignition switch "OFF" when wiper arms are at the mid-wipe position.
- Lift wiper arm (22 or 23) from windshield and engage retaining latch (Figure 8).

1. Inner nozzle hose (24) from connector.
2. Wiper arm (22 or 23) from drive shaft (30 or 31).
3. Nozzle and hoses, if necessary. Refer to "Nozzle and Hose Replacement" in this section.

→← Install or Connect

1. Nozzle and hoses, if removed. Refer to "Nozzle and Hose Replacement" in this section.
2. Wiper arm (22 or 23) to drive shaft (30 or 31).
   - Align wiper arm (22 or 23) and push to fully seat on drive shaft (30 or 31).
   - Lift wiper arm (22 or 23), slightly to disengage the retaining latch.
   - Gently lower wiper arm (22 or 23) to windshield.
3. Inner nozzle hose (24) to connector.

- Turn ignition switch "ON" and wiper control switch "OFF" to return wiper arms to park position.
- Turn ignition switch "OFF."

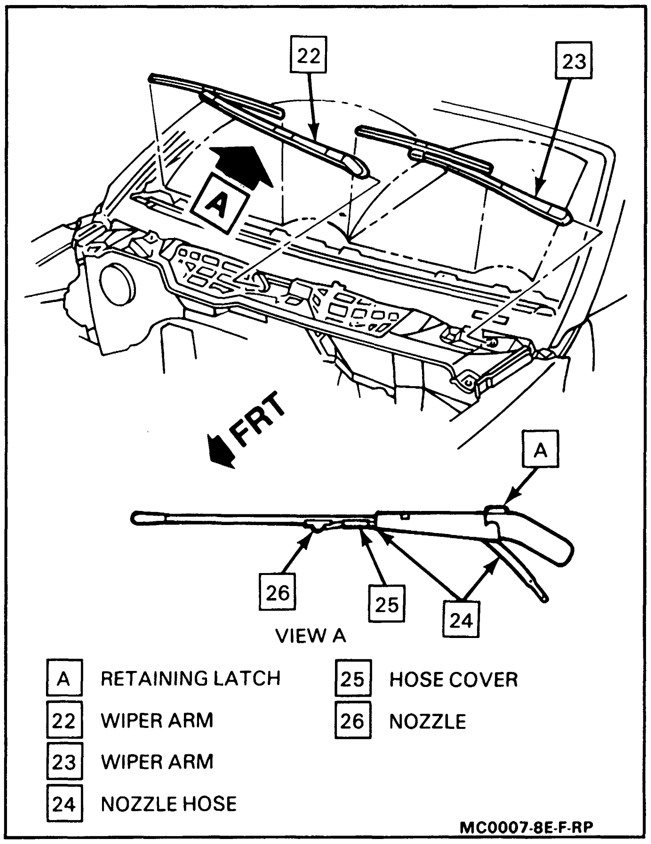


Figure 7 - Typical Fluidic Wiper Arm

WIPER ARM ADJUSTMENT

Figures 6 through 9

↔ Remove or Disconnect

1. Right hand wiper arm. Refer to "Wiper Arm" in this section.
2. Shroud vent grille. Refer to BODY FRONT END (SEC. 10-4).

- Loosen (do not remove) screws (19) attaching drive link (18) to transmission (21).
- Rotate wiper arm (23) to a position slightly below the park position.

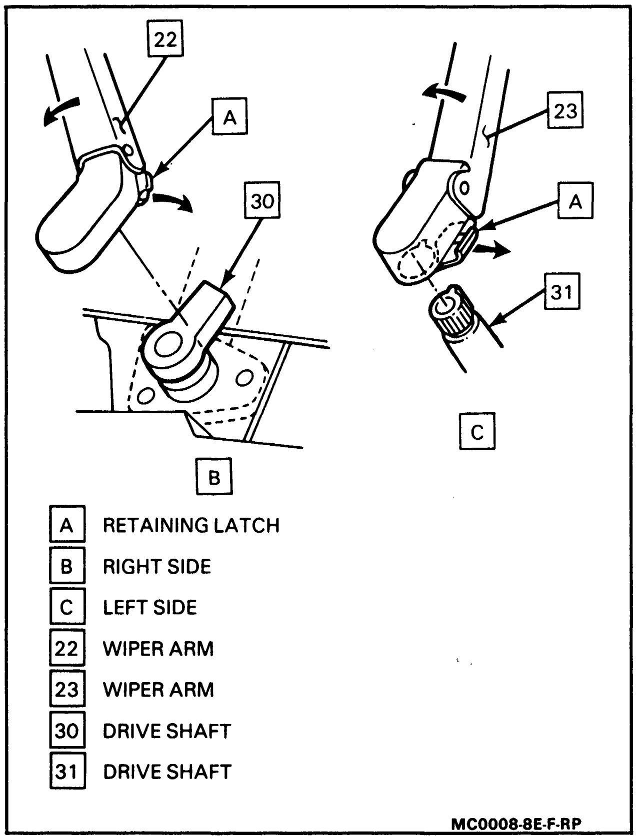


Figure 8 - Wiper Arm Replacement

Tighten

- Screws (19) to 10.5 N·m (93 lb. in.).

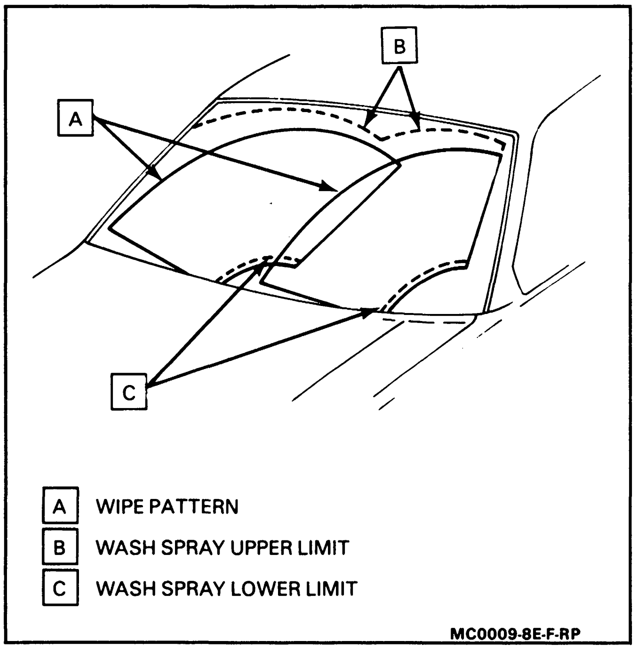


Figure 9 - Wiper and Washer Patterns

Install or Connect

1. Shroud vent grille. Refer to BODY FRONT END (SEC. 10-4).
- Position wiper arm (22) slightly below the blade stop.
2. Right hand wiper arm. Refer to "Wiper Arm" in this section.
- Lift wiper arms (22 and 23) over blade stops.

Inspect

- Wipe pattern and park position. Refer to Figure 9.
  - Correct park position and outwipe dimensions are determined with wiper operating in "LO" on wet glass.

WINDSHIELD WASHER SYSTEM

A correctly operating windshield wiper-washer system has a spray pattern that cleans 75% of the wipe pattern within ten wiper cycles. Refer to Figure 9.

Nozzle and Hose Replacement

Figure 7

Nozzles

If the nozzles become plugged, apply air pressure to clear them. If a nozzle remains plugged, the nozzle must be replaced.

Remove or Disconnect

1. Nozzle hose (24) from nozzle (26).
2. Nozzle (26) from wiper arm (22 or 23) by unsnapping.

Install or Connect

1. Nozzle (26) to wiper arm (22 or 23) by snapping into place.
2. Nozzle hose (24) to nozzle (26).

Inspect

- Spray pattern, refer to Figure 9.

Adjust

- Spray pattern, if necessary.
  - Move nozzle (26) on wiper arm (22 or 23).

Hoses

Figures 7 and 10

Remove or Disconnect

Important

- Before removing any hoses, take note of routing to ensure correct installation.

1. Right hand wiper arm. Refer to "Wiper Arm' in this section.
2. Shroud vent grille. Refer to BODY FRONT END (SEC. 10-4).
3. Hose (33) from connector (32).
   - Retain connector (32).
4. Connector (34) from hose (33), nozzle hose (24) and pump hose (8).

- Retain connector (34).

- Pull pump hose (8) through cowl extension panel.

5. Pump hose (8) from pump (6).
6. Pump hose (8).
7. Hose cover (25) from wiper arm (22 or 23) by unsnapping.
8. Nozzle hose (24) from nozzle (26).
9. Nozzle hose (24) from wiper arm (22 or 23).

Install or Connect

1. Nozzle hose (24) to wiper arm (22 or 23).
2. Nozzle hose (24) to nozzle (26).
3. Hose cover (25) to wiper arm (22 or 23) by snapping into place.
4. Pump hose (8).
5. Pump hose (8) to pump (6).

- Push pump hose (8) through cowl extension panel.

Important

- Make sure pump hose (8) is not kinked or pinched. For correct routing, refer to Figure 10.

6. Pump hose (8), nozzle hose (24) and hose (33) to connector (34).
7. Connector (32) to hose (33).
8. Shroud vent grille. Refer to BODY FRONT END (SEC. 10-4).
9. Right hand wiper arm. Refer to "Wiper Arm" in this section.

Inspect

- Spray pattern, refer to Figure 9.

Adjust

- Spray pattern, if necessary.
  - Move nozzle (26) on wiper arm (22 or 23).

WIPER BLADE AND INSERT

Figure 11

Blade

Remove or Disconnect

- Turn ignition switch "ON" and wiper control switch to "LO."
- When wiper arms (22 and 23) are at mid-wipe position, turn ignition switch "OFF."
- Disengage blade retainer using a small screwdriver.
- Blade (38) from wiper arm (22 or 23).

Install or Connect

- Blade (38) to wiper arm (22 or 23).
- Turn ignition switch "ON" and wiper control switch "OFF" to return wiper arms (22 and 23) to park position.
- Turn ignition switch "OFF."

Insert

Remove or Disconnect

- Turn ignition switch "ON" and wiper control switch to "LO."
- When wiper arms (22 and 23) are at mid-wipe position, turn ignition switch "OFF."
- Squeeze insert retainer together.
- Insert (37) from wiper arm (22 or 23).

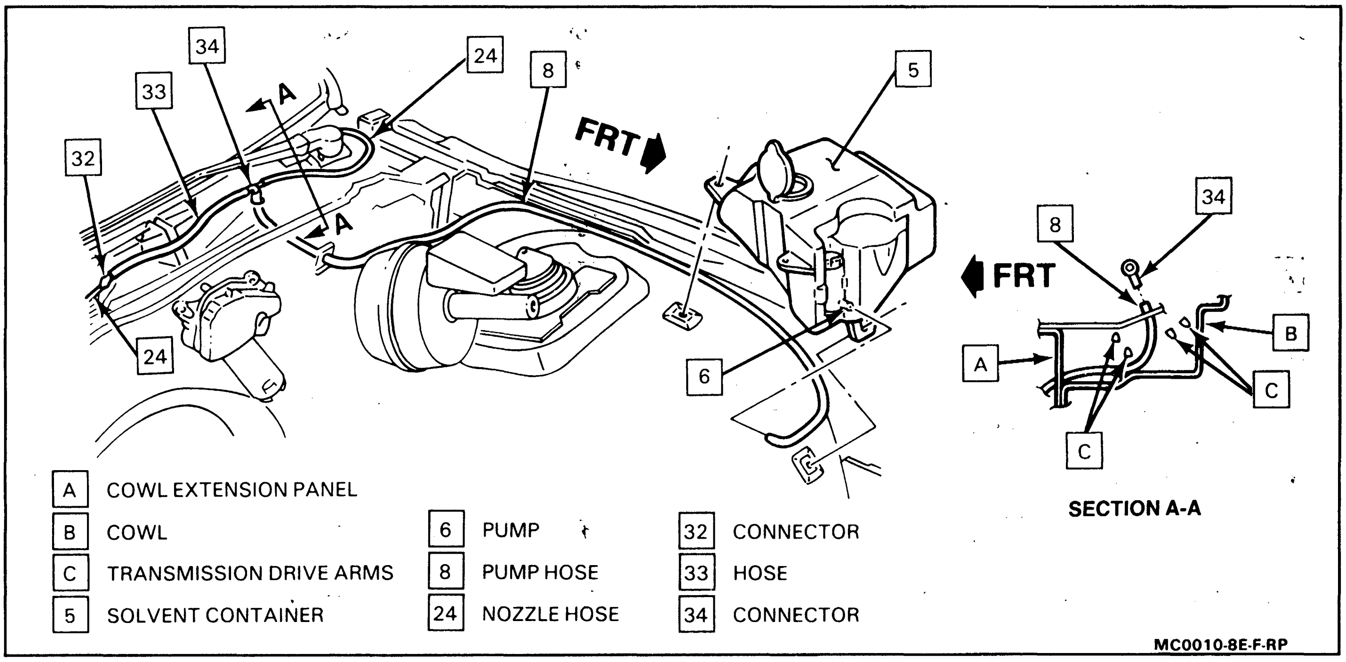


Figure 10 - Washer Hose Routing

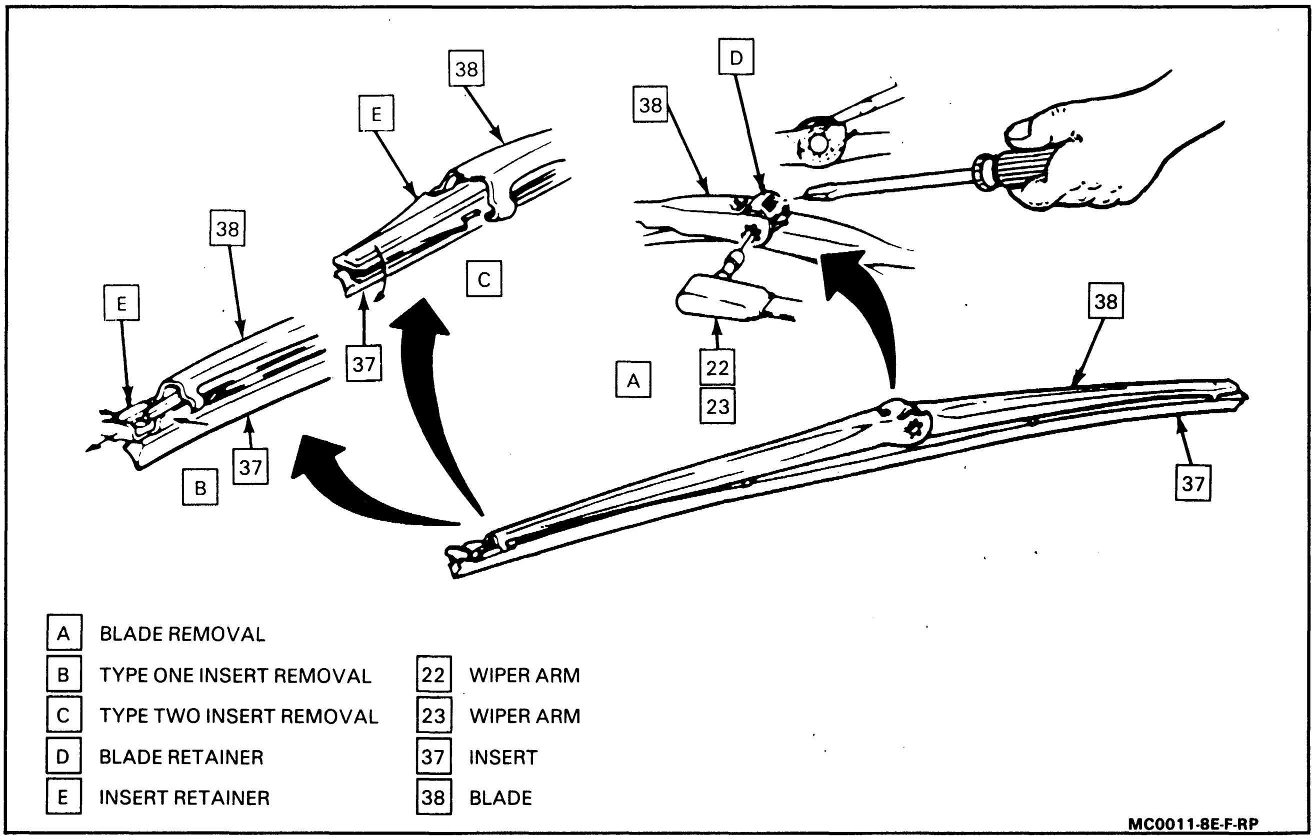


Figure 11 - Trico ® Wiper Blade and Insert

Install or Connect

- Insert (37) to wiper arm (22 or 23).
- Engage insert retainer.
- Turn ignition switch "ON" and wiper control switch "OFF" to return wiper arms (22 and 23) to park position.
- Turn ignition switch "OFF."

PARK SWITCH REPLACEMENT

Figure 12

Remove or Disconnect

- Turn ignition switch "ON" and wiper control switch "LO."
- When wiper arms are in mid-wipe position, turn ignition switch "OFF."

1. Wiper motor cover. Refer to "Wiper Motor Cover" in this section.
2. Screw (39).
3. Park switch assembly (40).

Install or Connect

NOTICE: See "Notice" on page 8E-1 of this section.

1. Park switch assembly (40).
2. Screw (39) until snug. Do not overtighten.
3. Wiper motor cover. Refer to "Wiper Motor Cover" in this section.

- Turn ignition switch "ON" and wiper control switch "OFF" to return wiper arms to park position.
- Turn ignition switch "OFF."

UNIT REPAIR

GEAR REPLACEMENT

Figures 12 through 15

A service replacement parts kit is required to perform the following procedure.

Remove or Disconnect

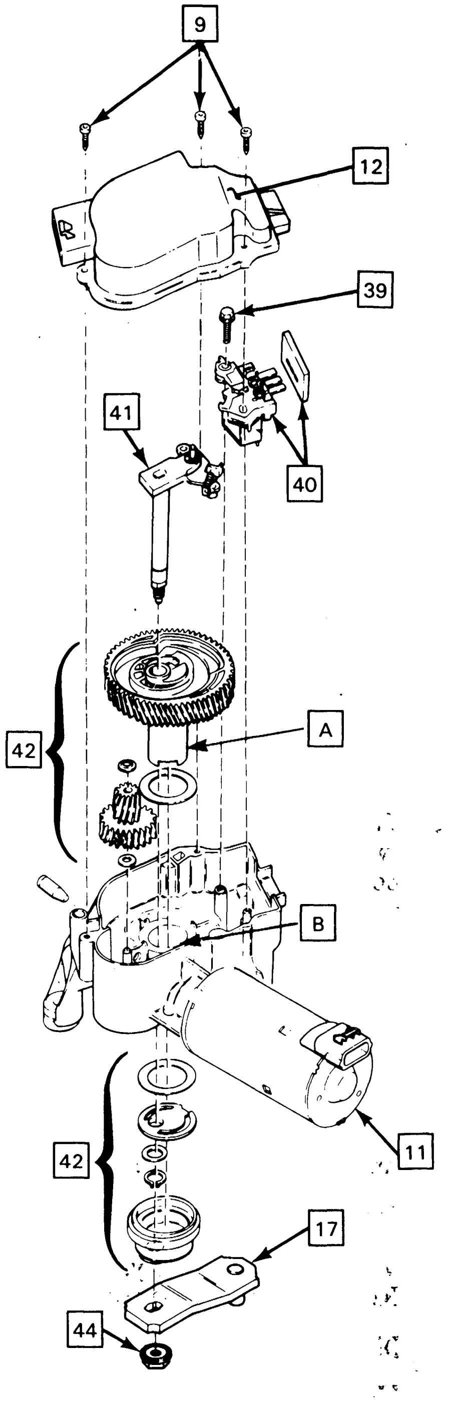
- Wiper motor assembly. Refer to "Wiper Motor Replacement" in this section.

Disassemble

Important

- Clamp crank arm in a vise before proceeding.

1. Crank arm retaining nut.
2. Crank arm.
3. Rubber seal cap.
4. Thrust collar or retaining ring. (Thrust collar is on original motor. Retaining ring to be used on service motor.)
5. Shim washers.
6. Shield.



A LUBRICATE SHAFT WITH SUPPLIED GREASE

B LUBRICATE BOTH BEARINGS WITH SUPPLIED GREASE

9 SCREW

11 MOTOR

12 COVER

17 CRANK ARM

39 SCREW

40 PARK SWITCH

41 DRIVE SHAFT ASSEMBLY

42 GEAR PACKAGE

44 NUT

MC0012-8E-F-RP

Figure 12 - Wiper Motor Assembly Components

7. Spacer washers.
8. Park switch assembly.
9. Large gear, moving latch arm out of the way.
10. Inner spacer washer.
11. Intermediate gear retainer.
12. Intermediate gear.
13. Drive plate and shaft assembly.

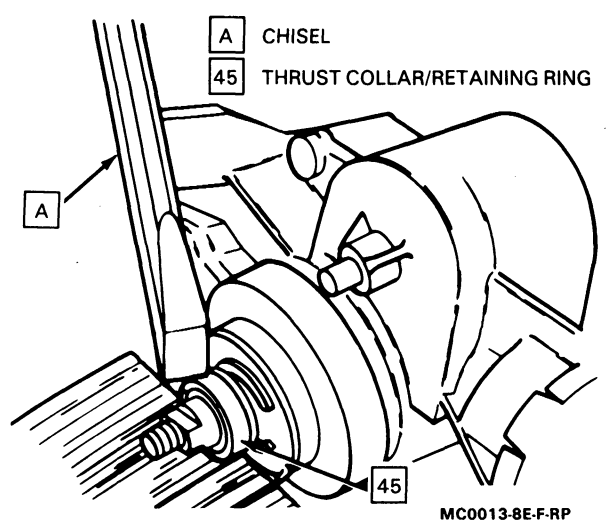
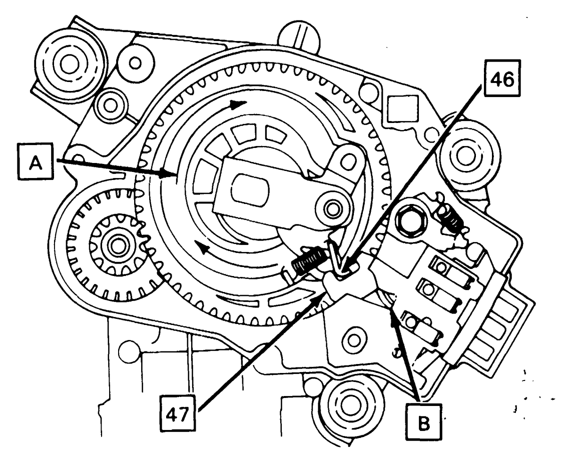


Figure 13 - Thrust Collar/Retaining Ring Removal



A ROTATION

B RELAY SLOT

46 DRIVE PAWL

47 LATCH ARM

MC0014-8E-F-RP

Figure 14 - Large Gear Removal

Assemble

1. Drive plate and shaft assembly into new large gear.

Important

- Move drive and lock pawls as required to allow their respective pins to fit in the gear pockets. Make sure drive plate is firmly against gear.

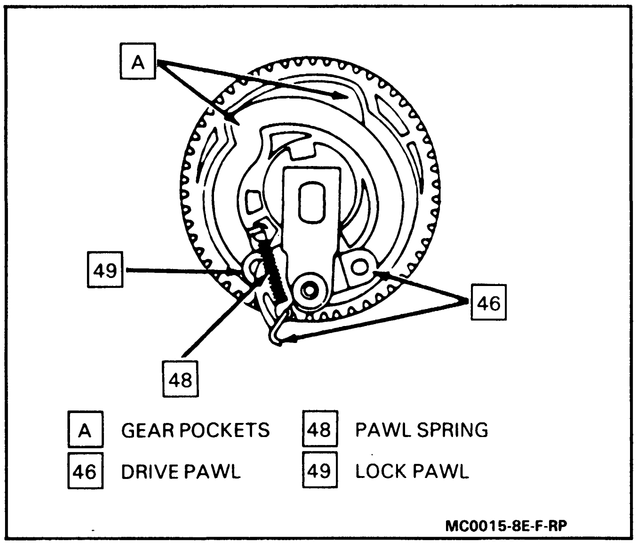


Figure 15 - Gear and Pawl Alignment

2. Intermediate gear.
3. New intermediate gear retainer.
4. Inner spacer washer onto large gear tube.

- Lubricate large gear shaft and gear shaft bearings in housing with grease supplied in service replacement parts kit.

5. Large gear.
6. Park switch assembly.
7. Spacer washer.
8. Shield.
9. Shim washers as required to obtain 0.03 to 0.25 mm (0.001 to 0.020 inch) end play.
10. Retaining ring in place of thrust collar on original motor.
11. Rubber seal cap.
12. Crank arm.
13. Crank arm retaining nut.

Tighten

- Crank arm retaining nut (in vise) to 42 N·m (31 lb. ft.).

Install or Connect

NOTICE: See "Notice" on page 8E-1 in this section.

- Wiper motor assembly. Refer to "Wiper Motor Replacement" in this section.

Inspect

- Check for proper motor operation.

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Wiper Motor Cover Screw	2 N·m (18 lb. in.)
Wiper Motor-to-Cowl Screw	5 N·m (44 lb. in.)
Transmission Drive Link-to-Crank Arm Screw	10.5 N·m (93 lb. in.)
Transmission-to-Body Screw	7.3 N·m (65 lb. in.)
Crank Arm Retaining Nut	42 N·m (31 lb. ft.)

SECTION 9A

AUDIO SYSTEMS

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "**NOTICE:** See "Notice" on page 9A-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

SPEAKERS

NOTICE: All Delco factory equipped sound systems have ungrounded speakers. Installing add-on tape players, CBs or other units that use the car speakers may damage sound system and impair operation of the added unit. Consult an authorized dealer in advance if considering additions.

NOTICE: All radios are the bridge audio type, using two wires to each speaker. It is very important when changing speakers or performing any radio work to avoid pinching the wires. A short circuit to ground from either wire will cause damage to the output circuit in the radio.

When installing a new radio, or when noise is a problem, ensure that radio suppression equipment is present and properly installed.

FM RECEPTION

Although FM is normally static free, reception can be limited by terrain, atmospheric conditions, station strength and distance from the transmitter. Buildings or other obstructions can cause momentary static, flutter or station swapping. If reception is poor, tuning to a stronger station will bring improvement.

STEREO SOUND

All factory equipped sound systems with an FM stereo radio will switch to stereo operation whenever an FM stereo broadcast is being received, and an indicator in the dial will light. Stereo operation means the radio is separating a stereo broadcast back into the original two channels, called "left" and "right." Stereo sound is noticeably more realistic to the ear.

FIXED MAST ANTENNA

The fixed mast antenna is designed to withstand most car washes without damage. It cannot be adjusted up or down. If the mast becomes slightly bent, you can straighten it by hand. The mast antenna can be replaced if severely bent. Mast antennas must be kept clean for good performance.

POWER ANTENNA

The optional power antenna is controlled by the radio. When the radio is on, the antenna will go up. When the radio is turned off either by the "ON/OFF" knob, power button or by turning the ignition switch to the "OFF" position, the antenna is designed to go down.

OPERATING INSTRUCTIONS

All 2000 series radios feature ETR (electronically tuned receiver) tuning, vacuum fluorescent display, AM-FM stereo, seek and scan tuning, and digital clock display.

When the radio is first turned on, the radio frequency will appear on the display for five seconds and then the display will return to the time display. To recall the radio frequency, push in the upper knob, while the radio is turned on, and the frequency will appear on the display for five seconds. When the ignition lock cylinder is in the "LOCK" or "OFF" position, the radio display is blank. To display the time when the ignition cylinder is in the "OFF" or "LOCK" position, push the upper knob and the time will display for five seconds and then the display will be blank.

ETR AM-FM STEREO (UM7)

Figure 1

Radio Operation

- **Upper Knob** - Rotate knob to turn radio on or off and to control volume. Press knob to recall station frequency when listening to the radio with ignition on or to display time of day with ignition off.
- **Balance Control** (located behind upper knob) - Turn to adjust left/right speaker balance.
- **Lower Knob** - Rotate knob to tune radio stations manually. Frequency will be displayed during tuning. Press knob to select AM or FM band alternately.
- **Front/Rear Speaker Control** (located behind lower knob) - Rotate control to adjust the sound between the front and rear speakers.
- **Bass and Treble Controls** - Slide treble control up to increase treble or down to decrease treble. Slide bass control up to increase bass or down to decrease bass.

Station Preset Buttons

The radio has four pushbuttons for presetting favorite stations.

1. Select the desired band (AM or FM), and tune to the desired station.
2. Press "SET" button. Within five seconds press one of the four station buttons. The radio will tune in the selected station whenever that station preset button is pressed.

Up to three additional stations on each band may be preset by "pairing" the pushbuttons.

1. Tune in the desired station.
2. Press "SET" and within five seconds press any two adjacent pushbuttons at the same time.

Seek and Scan

Press "SCAN" button to sample each station being received automatically. To stop "SCAN," press the "SCAN" button again or press the upper knob. The "SCAN" indicator lamp on the frequency dial will be lit during "SCAN" operation. Press the "SEEK" button to locate and retain the next listenable station on the band automatically. The FM stereo indicator will light when tuned to an FM station broadcasting in stereo.

Time Set

To set hour, press "SET" button. The "SET" indicator lamp on the dial will then light up and the radio frequency will be displayed. Then press the "SCAN" button, holding "SCAN" button in until correct hour appears.

To set minutes, press "SET" button. The "SET" indicator light will then light up and the radio frequency will be displayed. Then press "SEEK" button, holding "SEEK" button in until correct minute appears.

After pressing the "SET" button, the radio frequency will be displayed. The time of day will be displayed when pressing the "SCAN" or "SEEK" button.

ETR STEREO/CASSETTE (UN6)

Figure 2

Radio Operation

- **Upper Knob** - Rotate knob to control volume. Press knob to recall station frequency when

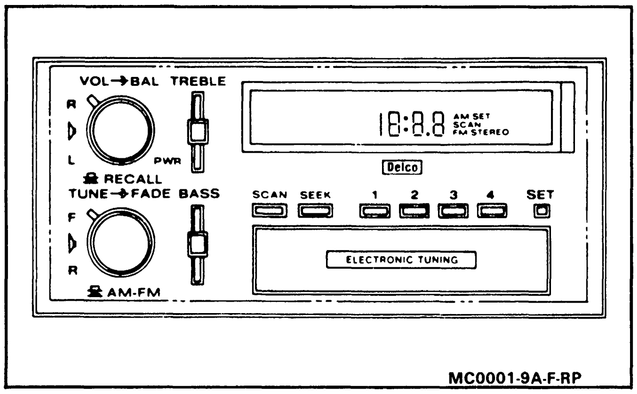


Figure 1 - UM7 Radio

listening to the radio with the ignition on, or to display time of day with ignition off.

Press knob to select the other side of the tape when the cassette is playing.

- **Balance Control** (located behind upper knob) - Turn to adjust left/right speaker balance.
- **Lower Knob** - Rotate knob to tune radio stations manually. Frequency will be displayed during tuning. Press knob to select AM or FM band alternately.
- **Front/Rear Speaker Control** (located behind lower knob) - Rotate control to adjust the sound between the front and rear speakers.
- **Bass and Treble Controls** - Slide treble control up to increase treble or down to decrease treble. Slide bass control up to increase bass or down to decrease bass.

Station Preset Buttons

The radio has four pushbuttons for presetting favorite stations.

1. Select the desired band (AM or FM) and tune to the desired station.
2. Press "SET" button. Within five seconds, press one of the four station preset buttons. The radio will tune in the selected station whenever that station preset button is pushed.

Up to three additional stations on each band may be preset by "pairing" the pushbuttons.

1. Tune in the desired station;
2. Press "SET," and within five seconds press any two adjacent pushbuttons at the same time.

Seek and Scan

Use the "SEEK" and "SCAN" buttons for automatic station tuning.

Press "SCAN" button to sample each station being received automatically. To stop "SCAN," press the "SCAN" button again or press the upper knob.

The "SCAN" indicator light on the frequency dial will be lit during "SCAN" operation. Press the "SEEK" button to locate and retain the next listenable station on the band automatically. The FM stereo indicator will light when tuned to an FM station broadcasting in stereo.

Time Set

To set hour, press "SET" button. The "SET" indicator lamp on the dial will then light up and the radio frequency will be displayed. Then press "SCAN" button, holding "SCAN" button in until the correct hour appears.

To set minutes, press "SET" button. The "SET" indicator lamp will then light up and the radio frequency will be displayed. Then press "SEEK" button, holding "SEEK" button in until correct minute appears.

After pressing the "SET" button, the radio frequency will be displayed. The time of day will be displayed when pressing the "SCAN" or "SEEK" button.

Tape Player Operation

Insert the cassette squarely through the door. This automatically switches the unit from radio to tape operation. If the sound is garbled or if there is no sound, eject the tape and reinsert it squarely.

To advance the tape, press the forward ("FWD") button. To listen to the earlier portion of the tape, press the reverse ("REV") button. To stop forward or reverse movement, press the opposite button lightly.

To listen to the next selection, slide the "SEARCH" button to the right and press the forward ("FWD") button. The radio will seek the next selection. To listen to the previous selection again, slide the "SEARCH" button to the right and press the reverse ("REV") button. The radio will repeat the previous selection.

The "ON" lamp, to the right of the search switch, will be on while the search function is engaged. When the left triangle indicator lamp is lit, the top side of the tape is playing. When the right triangle indicator lamp is lit, the bottom side of the tape is playing.

To play the other side of the tape before the present side has ended, press the upper left knob. When end-of-tape is reached in one direction, the unit will automatically play the other side of the tape. To remove the tape or listen to the radio, push the "EJECT" button. When the ignition is turned off, the tape is automatically ejected.

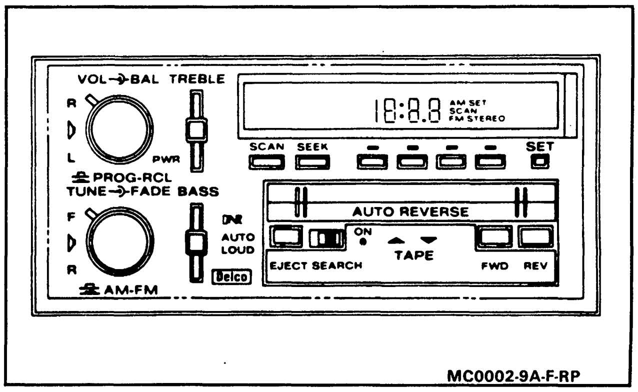


Figure 2 - UN6 Radio

DELCO-GM/BOSE MUSIC SYSTEM (UU8)

Figure 3

Radio Operation

- **Upper Knob** - Rotate knob to turn radio on or off and to control volume. To recall station frequency when listening to the radio, press knob, or, press to momentarily display time of day with the ignition off. Press knob to select the other side of the tape when the cassette is playing.
- **Lower Knob** - Rotate knob to tune radio stations manually. Frequency will be displayed during tuning. Press knob to alternately select AM or FM band.
- **Front/Rear Speaker Control** (located behind lower knob) - Rotate control to adjust the sound between the front and rear speakers. One of the things that makes the Delco-GM/Bose Music System unique is that the custom equalization of the car body interior has eliminated the need for a left/right balance control since proper left/right balance has been designed into the system.
- **Bass and Treble Controls** - Slide treble control up to increase treble or down to decrease treble. Slide bass control up to increase bass or down to decrease bass. The normal position for the bass and treble controls on the Delco-GM/Bose Music System is to be all the way "up." However, if you are receiving a weak stereo signal, high frequency noise may be heard. To reduce the high frequency emphasis, slide the treble control down.
- **Preset Station Buttons** - This radio has four buttons to select your favorite stations easily. Four AM and four FM stations may be selected.
- **To Set Preset Buttons:**

1. Tune in the desired station on the AM or FM band.
2. Push "SET" button.
3. Push one of the four buttons.

The radio will now tune to the selected station whenever the station button is pressed.

Up to three additional stations on each band may be preset by "pairing" the pushbuttons.

1. Tune in the desired station.
2. Press "SET," and within five seconds press any two adjacent pushbuttons at the same time. This station will return when the two buttons are pushed again.

- **Seek and Scan** - Use the "SEEK AND SCAN" buttons for automatic station tuning.

  Press "SCAN" button to sample each station being received automatically. To stop "SCAN," press "SCAN" button again.

  The "SCAN" indicator will be lit during "SCAN" operation.

  Press the "SEEK" button to locate and retain the next listenable station on the band automatically.

- **Time Set** - To set the hour, press "SET" button. The "SET" indicator will then light up on the display and the radio frequency will be displayed. Then, press "SCAN" button and hold in until the correct hour appears.

  To set the minutes, press "SET" button. The "SET" indicator will then light up on the display and the radio frequency will be displayed. Then press "SEEK" button and hold in until the correct minutes appear.

  NOTE: After pressing the "SET" button, the radio frequency will be displayed. The time of the day will be displayed when the "SCAN" or "SEEK" button is pressed.

Tape Player Operation

- **Tape Door** - Insert the tape squarely through the door. This automatically switches the unit from radio to tape operation.
- **Forward Button ("FWD")** - Press to advance tape. To stop forward motion, press the "REV" button lightly.
- **Reverse Button ("REV")** - Press to reverse direction. To stop reverse motion, press the "FWD" button lightly.
- **Tape Eject Button ("EJECT")** - Press to eject tape.

  For best results, 120 minute tapes are not recommended.

- **Reversing Sides** - Press the upper left knob (volume knob) to play the other side of the tape. When the end of tape is reached, it automatically reverses direction and plays the other side.
- **Tape Indicator Lamps (triangle shape)** - When lighted arrow located below the tape door points "up," the top side of the tape is being played. When the arrow points "down," the bottom side is being played.
- **Music Search Control ("SEARCH")** - To listen to the next selection, slide "SEARCH" control to the right and then advance to the beginning of the next selection and begin playing.

  To listen to the present selection again, slide "SEARCH" button to the right and then press the "REV" button. The tape will then reverse to the beginning of the present selection and begin playing.

  For the SEARCH function to work properly, there must be at least five blank seconds between selections.

  The "on" lamp will be lit while the search function is engaged.

- **Dynamic Noise Reduction Button (DNR®)** - Removes high frequency background hiss on AM, FM, FM stereo, and cassette tapes. Press button in to activate DNR. We suggest always leaving DNR on.

  Your cassette is equipped with Dolby®noise reduction. This reduces high frequency hiss on tapes. This feature is automatic.

- **Tape Equalization Button (CrO$_2$/M)** - Select the 70 μsec (chrome or metal) tape by pressing button in or 120 μsec (standard) by leaving button out.

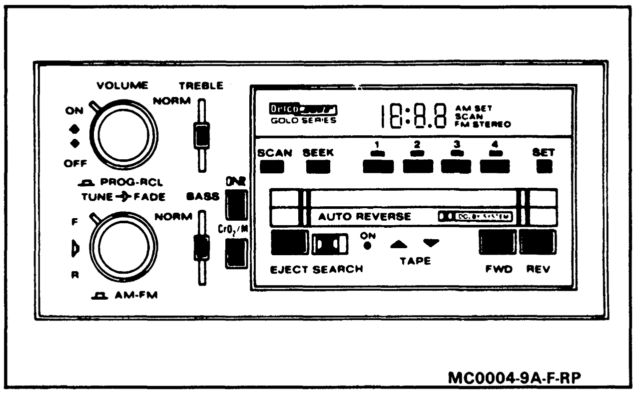


Figure 3 - UU8 Radio

ETR AM-FM STEREO/COMPACT DISC (U1C)

Figure 4

This advanced ETR has many conveniences. The graphic display provides information about time, station frequency, band (AM or FM), stereo, volume, speaker balance, and the compact disc. Lighting dims with other instruments to prevent glare at night.

Radio Operation

- **"POWER" Button** - Turns radio on and off. (It also goes on and off with ignition key).
- **"VOLUME" Button** - Adjusts volume up or down. (Press center of button to get a factory preset level).
- **AM-FM Button** - Press to get AM or FM (the lighted display shows your selection).
- **"SEEK"** - Press to go to next station and stay there; press again and it will find another station for you.
- **"SCAN"** - Press to hear each station for a few seconds; press again when you hear something you like and want to stay there.
- **"TUNE"** - This tunes only while button is held, then stops. It is not as easy as using "SEEK" or "SCAN" (watch the display).
- **Pushbuttons** - There are five of these in lower right corner. They help you return to favorite stations. (Note: The buttons have other uses when a disc is playing). To set the pushbuttons for up to ten favorite stations (5 AM and 5 FM), just:
  - Tune-in the station.
  - Push "SET" and within 5 seconds...
  - Push one of the five pushbuttons.
- **Clock Setting:**
  - Press "SET," and within 5 seconds...
  - Press and hold "SEEK" until clock shows correct hour.
  - Press and hold "SCAN" until clock shows correct minute.
- **"RCL" (Recall)** - Press this to switch between time and frequency on the display.
- **Stereo** is received by tuning to any FM station broadcasting in stereo ("ST" shows on the display).
- **Adjusting Tone** - Press top of "BASS" to increase bass, or bottom of "BASS" to decrease (pressing in center gives mid-range setting). Press "TREB" to increase treble, or bottom of "TREB" to decrease (pressing in center gives mid-range setting).
- **"BAL" (Balance)** - This is the way to balance the speakers:

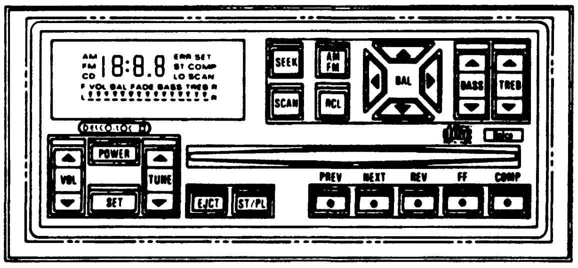
  Press top of "BAL" to increase sound in front speakers, or bottom of "BAL" to increase sound in rear speakers (pressing both at the same time balances the sound). Press right side of "BAL" to increase sound in right speakers, or left side of "BAL" to increase left (pressing both at same time balances the sound).

Compact Disc Player Operation

Press "Power" to turn radio on. Insert disc partway into slot, label side up (player pulls it in). Wait a few seconds and disc should play. If disc comes back out, check for...

  - Disc upside down.
  - Disc dirty, scratched or wet.
  - Too much moisture in air.
    - Wait about one hour and try again.
- **"RCL" (Recall)** - Press to see what track is playing...press again within 5 seconds to see how long it has been playing.
  - Track number also shows up when volume is changed or a new track starts to play.
- **"PREV" (Previous)** - Press to play track again.
  - If held or pressed more than once, disc returns to previous tracks.
- **"NEXT"** - Press when you want to hear the next track now (instead of waiting until present track is finished).
  - If held or pressed more than once, disc advances further.
- **"REV" (Reverse)** - Press and hold to rapidly return to a favorite passage; release to play the passage.
- **"FF" (Fast Forward)** - Press and hold to rapidly advance within a track; release to resume playing.
- **"COMP" (Compression)** - Pressing this makes soft passages louder.
- When finished with the disc player, you can:
  - Press **"POWER"** button or turn ignition key off (disc stays in player and starts at point where it ended when turned back on).
  - Press **"ST/PL" (Stop/Play)** -Disc stops and radio plays; press again to return to disc (continues playing at point where stopped).
  - Press **"EJCT"** - Disc ejects and radio plays (disc starts at track 1 when inserted again).
- Your disc may eject or mute temporarily on very rough roads, or when temperature is abnormally

hot or cold. "ERR" may appear on the lighted display. The unit will resume proper operation when normal conditions return.



MC0005-9A-F-RP

Figure 4 - U1C Radio

SETTING DELCO-LOC II ANTI-THEFT FEATURE

Figure 5

Delco-Loc II is a security feature which can be used or ignored. If ignored, the radio plays normally. If used, the radio will be unusable if stolen because it won't turn on.

The following instructions tell you how to enter a secret code into the radio. Then, if battery power is lost for any reason, the secret code must be entered again before the radio will turn on.

1. Write down any 6-digit number and keep in safe place.
2. Turn ignition to "ACC" or "RUN" position.
3. Press "PWR" button to turn radio off.
4. Press "PREV" and "FF" buttons together and hold until "---" shows on the display.

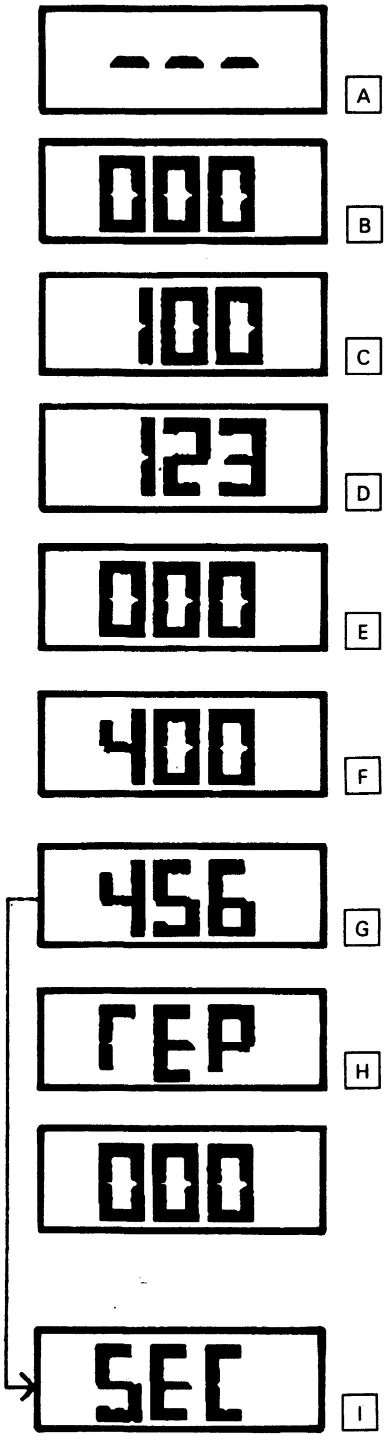
- Do not wait more than 15 seconds between each step.

5. Press "SET" and "000" appears on the display.
6. Press "SEEK" and hold until the first digit of your code appears.
7. Press "SCAN" and hold until the second and third digits appear.
8. Press "AM-FM" ("000" appears).
9. Press "SEEK" and hold until the fourth digit of code appears.
10. Press "SCAN" and hold until the fifth and sixth digits of code appear.
11. Press "AM-FM" ("rEP" appears for 5 seconds, then "000" appears).
12. Repeat steps 6 thru 11. "SEC" will then be seen on the display, meaning your radio is secured.

UNLOCKING SECURED RADIO AFTER POWER LOSS

Figure 6

When battery power is reapplied to a secured radio, the radio won't turn on and "LOC" appears on the display. Enter the secret customer or factory backup code as follows: (Do not pause more than 15 seconds between steps.)



A STEP 4
B STEP 5
C STEP 6
D STEP 7
E STEP 8
F STEP 9
G STEP 10
H STEP 11
I STEP 12

KC5552-9A-F-RP

Figure 5 - Anti-Theft Feature

1. Turn ignition to "ACC" or "RUN" position.
2. Press "SET" and "000" appears on the display.
3. Press "SEEK" and hold until the first digit of the secret code appears.
4. Press "SCAN" and hold until the second and third digits appear.
5. Press AM-FM and "000" appears on the display.
6. Press "SEEK" and hold until the fourth digit of your secret code appears.
7. Press "SCAN" and hold until the fifth and sixth digits of code appears.
8. Press "AM-FM" ("SEC" appears and radio can be turned on). Radio stays in secured mode. To remove the customer code and deactivate the security feature, the factory unlocking code must be entered again, repeating steps 2 through 8.

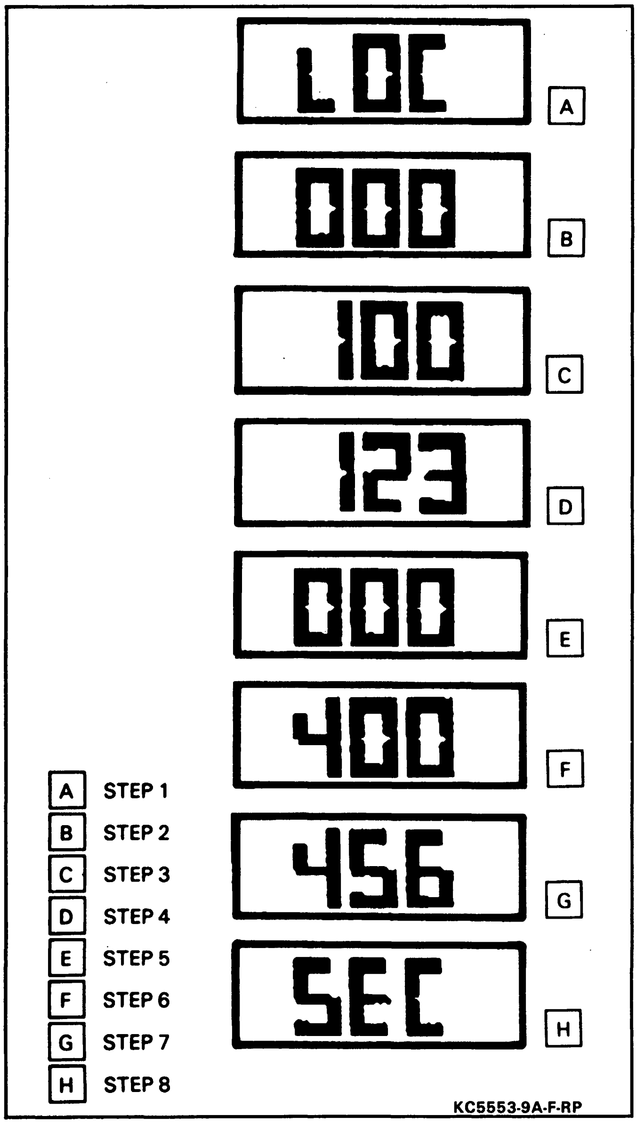


Figure 6 - Unlocking Secured Radio

DETERMINING FACTORY BACKUP UNLOCKING CODE FOR SECURED RADIO

If the security is activated and the radio is disconnected from battery power, the radio will display "LOC." The radio will not turn on until the correct unlocking code is entered. If the customer code is lost or unavailable, use the following procedures to determine the factory backup code. This procedure requires a tone dialing telephone.

1. Turn ignition to "ACC" or "RUN" position.
2. Press and hold "NEXT" and "REV" (presets 2 and 3). After five seconds, digits 1 through 3 of the radio identification number will be displayed. Write them down.
3. Press AM-FM. Digits 4 through 6 of the radio identification number will be displayed. Write them down.
4. Using a tone dialing telephone, call 1-800-537-5140 (U.S. and Canada) or (317) 451-8965.
5. When the computer advises, enter your dealer code or radio shop account number using the telephone keypad, then press "*."
6. When advised, enter the six-digit radio identification number obtained in steps 2 and 3, then press "*." The computer will respond with the unlocking code. Write it down.
7. To unlock the secured radio, refer to "Unlocking Secured Radio After Power Loss" in this section.

STEREO CASSETTE TAPE AND TAPE PLAYER CARE

Figure 7

Optimum performance can be maintained by cleaning the internal tape head, capstan, and pinch roller each 100 hours of operation. This can be done by inserting a nonabrasive cleaning cassette in place of the music tape.

> **NOTICE:** Do not use silicone spray lubricant for switch, plunger or tape head lubrication. No lubricants should be used since they cause the player to operate improperly, especially at extreme temperatures. Do not bring any magnetized tools near the tape head. If the head becomes magnetized, every cassette played will be degraded.

Store cassettes away from extreme heat or direct sunlight. Protect the open ends from dirt or damage; store them in their original cases or other protective cases. For best results, 120 minute tapes are not recommended.

When leaving the vehicle, cassettes may be left in the tape player. Tapes are either automatically ejected or internally protected.

COMPACT DISC CARE

Handle discs carefully. Store in protective case away from sun, heat, and dust. If surface is soiled, dampen a clean soft cloth in a solution of mild neutral detergent and wipe clean. Mini discs called "singles" (about 3 inches diameter) will not eject and should not be used.

POWER ANTENNA MAST CARE

The mast sections of the power antenna, when extended, are always exposed to every kind of

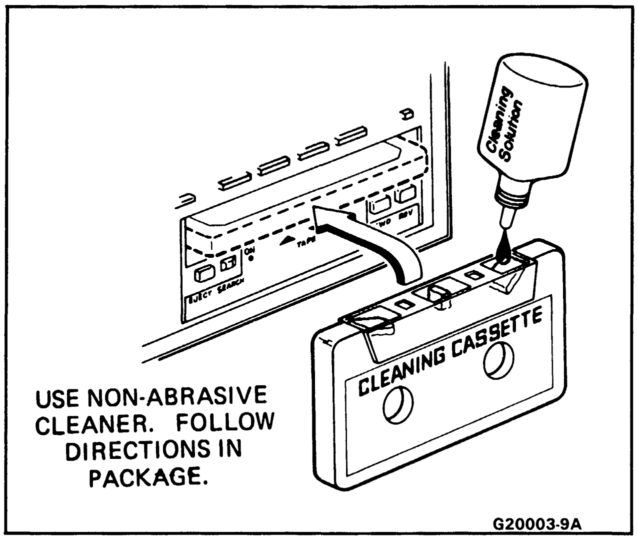


Figure 7 - Cleaning Cassette Player

environmental condition. Ice, dirt, and sand, mixed with rain, can be hard on the exterior surface of the mast sections and build up to form an unwanted and harmful residue, impairing the proper operation of the unit. It is essential that these deposits be removed periodically and that the mast sections be lubricated.

Clean Mast

1. Raise antenna to full mast position.
2. Dampen clean cloth with mineral spirits or equivalent solvent.
3. Wipe cloth over antenna mast sections removing any dirt.
4. Move antenna through one complete cycle (retract and extend).
5. Repeat steps 1 through 4 at least two more times.

Lubricate Mast

1. Raise antenna to full mast extension.
2. Dampen clean cloth with light oil such as 3-in-1 or equivalent.
3. Wipe cloth over antenna mast sections evenly distributing oil over mast section surfaces.
4. Move antenna through one complete cycle (extend and retract).
5. Dry the mast sections using a clean cloth. Any remaining light oil deposits can collect dirt.

DIAGNOSIS

RADIO

Radio problems are normally repaired at authorized warranty repair stations. Removing the set when a problem is reported, without any preliminary diagnosis, results in a large number of radios being "No Trouble Found" units received by the warranty repair stations. Often the trouble can be corrected without radio removal.

Static and Noise

Ground strap connections must be clean and tight, spark plug cables must be TVRS type and in good condition and resistance-type spark plugs used. Capacitors are used in the generator, heating/air conditioning system, and fuse panel to reduce noise entering the radio through the feed wires. If the car has a heater only, the capacitor is in the blower motor feed wire. If equipped with A/C, the blower motor has a built-in capacitor. Extra electrical equipment adds to the static if not properly grounded or if wiring was improperly routed.

Weak FM station reception will be affected by nearby buildings, car speed and direction. These "flutter" and "fading" conditions are characteristic of weak FM signals.

Popping Noise

Operating devices such as turn signals, pushing in cigar lighter, operating stoplamp, etc., may cause a popping noise on distant or weak AM signals.

Preliminary Diagnostics

The inconvenience of driving without a radio while the set is being serviced can often be avoided if the following quick checks are used to eliminate external radio system problems before removing the radio for repair.

1. Turn ignition to the accessory position and turn radio on.
2. On AM-FM radios, if the radio is dead on FM but the AM plays normally, the radio should be removed for repair.
   - The reverse of this condition does not necessarily call for radio removal.
3. On combination radio/tape units, if the radio operates properly but the tape player does not, the unit should be removed for repair. (The reverse of this condition does not necessarily call for radio/tape removal).

Always determine the exact nature of the radio problem as an aid to diagnosis. Knowing whether the condition is intermittent or constant, whether it occurs with engine off or running, and whether it occurs with vehicle parked or moving will help to pinpoint the problem. For further diagnostic information, refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

CASSETTE TAPE PLAYER

Figure 8

For diagnostic information, refer to Figure 8 in this section or to ELECTRICAL DIAGNOSIS (SEC. 8A).

SPEAKER

Refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

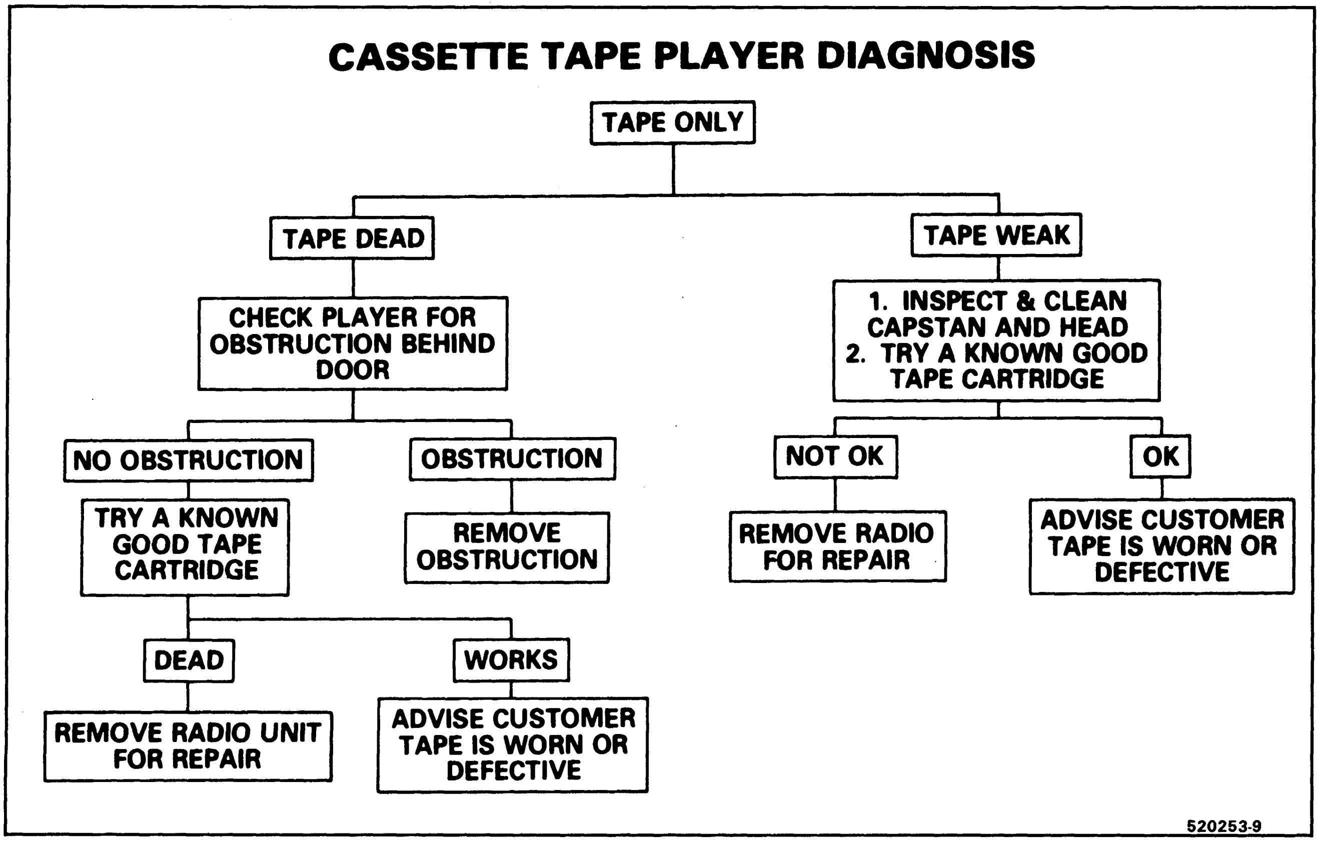


Figure 8 - Tape Player Diagnosis

ANTENNA

Figures 9 and 10

Testing For Good Ground of Antenna Mounting and Connections

Poor grounding of the power antenna, either at the antenna mounting or at any other connection in the antenna/lead-in system, can result in seriously reduced radio performance. A poor ground can be a reason for excess ignition noise in AM reception, or erratic audio.

1. Fully lower antenna.
2. Disconnect antenna motor electrical connector.
3. Remove escutcheon from fender.
4. Attach alligator clip to upper end of antenna to act as antenna. Leave other end of clip unattached.
5. Tune radio for weak AM station or signal which is dependent on clip, i.e., clip attached, station is present; clip removed, no station.
6. Remove clip.
7. Ground upper end of antenna to fender, preferably with knife blade, very short jumper wire, etc.
8. If radio station is not received, then the antenna grounds are good. If the station is still present or stronger, a poor ground or no ground connection is present in the system.

Possible Ground Loss Points

- Antenna upper mounting (screws loose, paint overspray, etc.).
- Coaxial connector at antenna loose or corroded. Remove to inspect inside the connector for corrosion.
- Coaxial connector at radio loose or corroded.
- Quick connect connector corroded.

Power Antenna Check

Figure 9

The power antenna can be checked using an ohmmeter, preferably digital.

With the ohmmeter probes fastened to each point as shown in Figure 9, wiggle the separate antenna sections and antenna housing case. The readings shown should always be obtained. If not, replace antenna or fix ground. Improperly grounded antennas are usually the cause of comments regarding poor reception or noise. To ensure a good ground, a braided group strap should be connected from the housing case to chassis ground. After checking and correcting the antenna, make sure lead-in connector(s) are dirt and corrosion free and are tightly fastened.

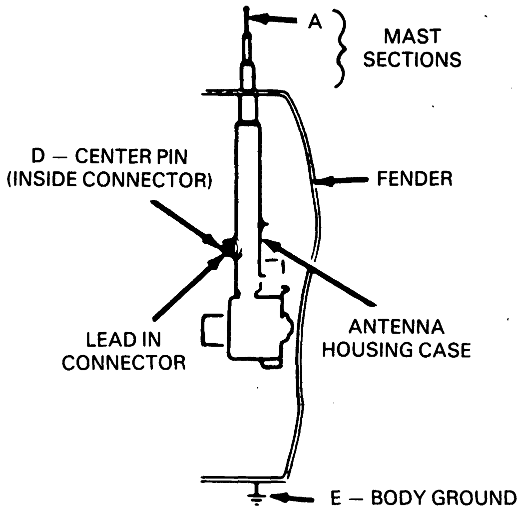
Moisture in Antenna Tube

Weak reception or fading may be caused by moisture in the support tube due to condensation or leakage through the insulation bushings. If trouble has been traced to moisture in the tube, the antenna must be removed, disassembled, and thoroughly cleaned. All moisture can be removed by blowing out with compressed air then pushing a clean dry cloth through the support tube as far as possible. Before assembling antenna, check drain holes in motor housing to be sure they are not obstructed.

Checking Lead-In Cables

Figure 10

Usually a broken center conductor of the lead-in cable will result in no AM and weak FM. In case of continued reception or noise comments, always check the lead-in with an ohmmeter. The chart and diagram in Figure 10 show readings which should be obtained. When checking resistance, cautiously wiggle the lead in tip and cable. If the readings shown in Figure 10 are not obtained, some portion of the lead-in is intermittent and the lead-in should be replaced.



OHMMETER PROBES AT POINTS:	RESISTANCE MEASURED IN OHMS
A AND D	LESS THAN 0.5
A AND E	INFINITE

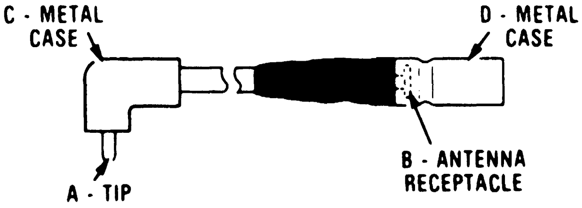
MC0006-9A-F-RP

Figure 9 - Three Section Antenna Diagnosis

Checking Fixed Antennas

Unplug antenna lead-in at back of radio and plug a test antenna into radio. Make sure the test antenna base is grounded to the vehicle chassis and keep hands off of the antenna. Refer to "Testing for Good Ground of Antenna Mounting and Connections" in this section. Check radio reception in an area away from electrical interferences. These include tall buildings, metal structures, power lines, fluorescent lighting, and power tools. Tune to high and low ends of the dial on both AM and FM, checking weak and strong station reception. If reception is acceptable, problem exists with antenna and/or its lead-in cable. If reception is still poor, refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

For further diagnosis of antennas, refer to ELECTRICAL DIAGNOSIS (SEC. 8A).



Ohmmeter probes at points;	Resistance measured in ohms
A and B	less than 0.5*
C and D	less than 0.5
A and D	infinite
C and B	infinite
A and C	infinite
B and D	infinite

*On some long lengths of lead-ins, such as power antennas, capacitance is added in the tip. This results in a resistance reading of approximately 100,000 ohms.

G35209-9-E

Figure 10 - Lead-In Cable Diagnosis

ON-VEHICLE SERVICE

RADIO RECEIVER

Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).

FRONT RADIO SPEAKER

Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).

REAR QUARTER RADIO SPEAKER

Refer to REAR QUARTERS (SEC. 10-6).

REAR COMPARTMENT RADIO SPEAKER

Refer to BODY REAR END (SEC. 10-7).

FRONT BOSE AMPLIFIER AND SPEAKER

Figure 11

↔ Remove or Disconnect

1. Negative (-) battery cable.
2. Shroud side finishing panel. Refer to BODY FRONT END (SEC. 10-4).
3. Electrical connections, by gently pulling apart connectors.
4. Screws from side finishing panel trim.
5. Side finishing panel trim from carpeted panel.
6. Carpet edge from panel, as needed, to gain access to screws, by gently pulling away with a soft bladed instrument.

7. Bose speaker cover screws.
8. Bose speaker cover from rear of panel.
9. Speaker wire.

NOTICE: Avoid pinching wires. A short circuit to ground from either wire will damage the output circuit in the radio.

10. Amplifier screws.
11. Amplifier.
12. Speaker screws.
13. Speaker.

Install or Connect

1. Speaker.
2. Speaker screws.
3. Amplifier.
4. Amplifier screws.
5. Speaker wire.
6. Bose speaker cover to rear of panel.
7. Bose speaker cover screws.
8. Carpet edges.
    - Apply 3M Carpet Adhesive or equivalent to edges and gently press to panel.
9. Side finishing panel trim to carpeted panel.
10. Screws to side finishing panel trim.
11. Electrical connections.
12. Shroud side finishing panel. Refer to BODY FRONT END (SEC. 10-4).
13. Negative (-) battery cable.

REAR BOSE AMPLIFIER TUNED ENCLOSURE

Figure 12

Remove or Disconnect

- Lift rear compartment load floor.

1. Negative (-) battery cable.
2. Bose speaker cover screws.
3. Bose speaker cover.
4. Electrical connectors.
5. Speaker wires.

NOTICE: Avoid pinching wires. A short circuit to ground from either wire will damage the output circuit in the radio.

6. Amplifier screws.
7. Amplifier.

Install or Connect

1. Amplifier.
2. Amplifier screws.
3. Speaker wire.
4. Electrical connectors.
5. Bose speaker cover.
6. Bose speaker cover screws.
7. Negative (-) battery cable.

HOOD SEAL RADIO SUPPRESSION EQUIPMENT

Figure 13

When installing a new radio, or when noise is a problem, ensure that radio suppression equipment is present and properly installed.

Remove or Disconnect

1. Bolt.
2. Ground clip from under hood seal.

Install or Connect

1. Ground clip to under hood seal.
2. Bolt.

HEATER BLOWER MOTOR RADIO SUPPRESSION EQUIPMENT

Figure 13

When installing a new radio, or when noise is a problem, ensure that radio suppression equipment is present and properly installed.

Remove or Disconnect

1. Bolt.
2. Radio suppression equipment capacitor by pulling electrical connectors from heater blower motor assembly.

Install or Connect

1. Radio suppression equipment capacitor by pushing electrical connectors onto heater blower motor assembly.
2. Bolt.

FIXED MAST ANTENNA

Figure 14

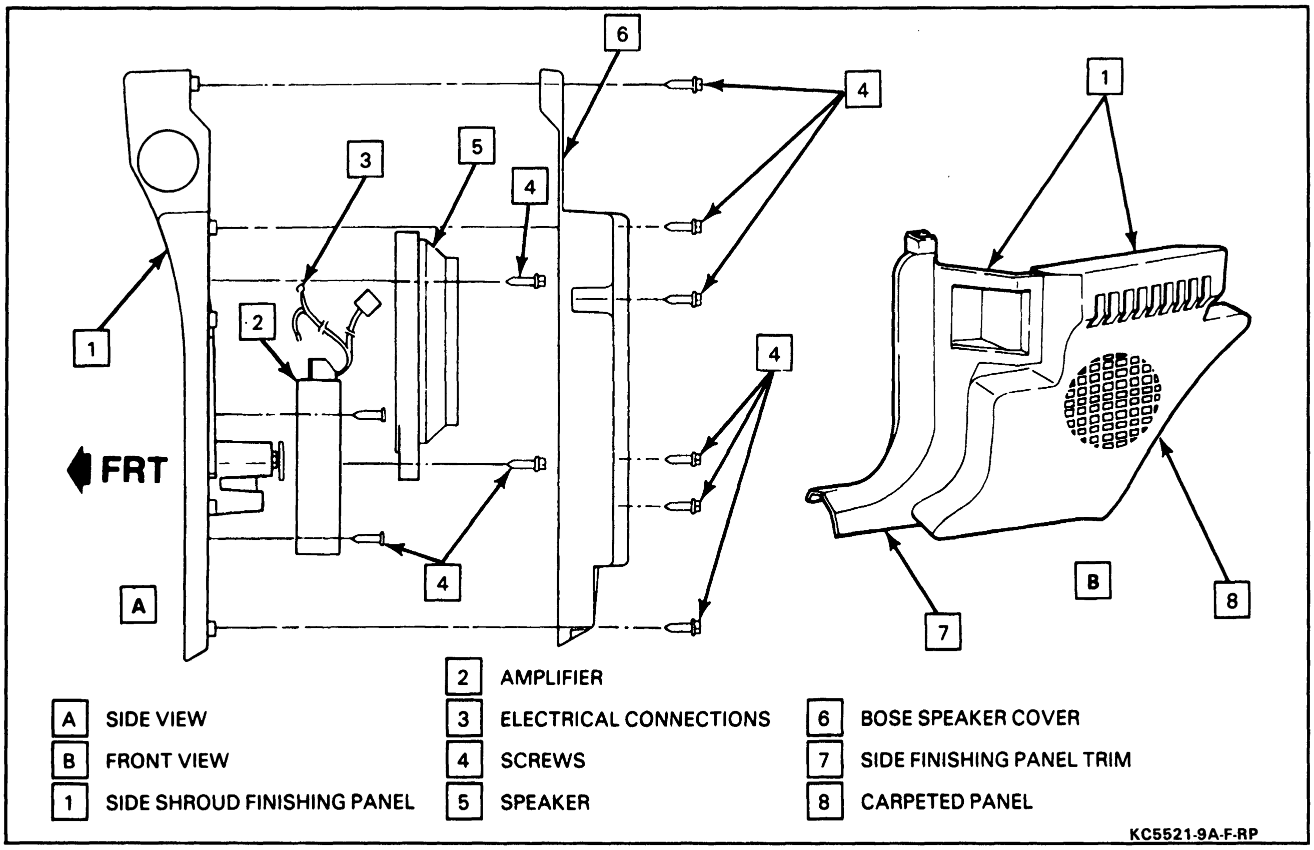
Remove or Disconnect

- Mask door edge with tape.

1. Negative (-) battery cable.
2. Right side lower instrument panel sound insulator.
3. Antenna connection from radio.

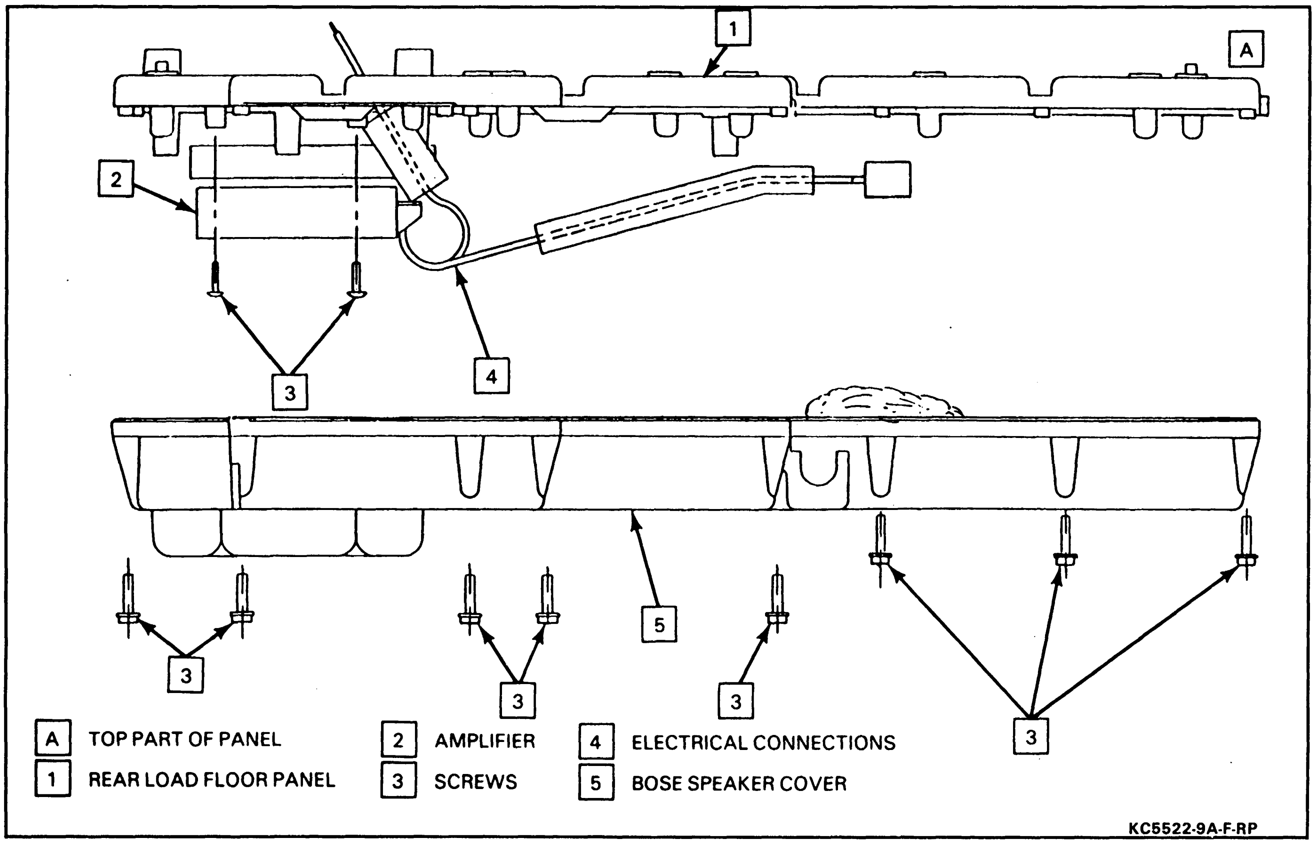
- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

4. Fender wheelhouse. Refer to FRONT END BODY PANELS (SEC. 2C).
5. Bezel and nut.
6. Antenna mast.
7. Mast assembly bracket screws.
8. Grommet from side shroud finishing panel bulkhead and carefully pull harness from vehicle interior.



A SIDE VIEW
B FRONT VIEW
1 SIDE SHROUD FINISHING PANEL
2 AMPLIFIER
3 ELECTRICAL CONNECTIONS
4 SCREWS
5 SPEAKER
6 BOSE SPEAKER COVER
7 SIDE FINISHING PANEL TRIM
8 CARPETED PANEL

Figure 11 - Front Bose Speaker Assembly



A TOP PART OF PANEL
1 REAR LOAD FLOOR PANEL
2 AMPLIFIER
3 SCREWS
4 ELECTRICAL CONNECTIONS
5 BOSE SPEAKER COVER

Figure 12 - Rear Bose Amplifier

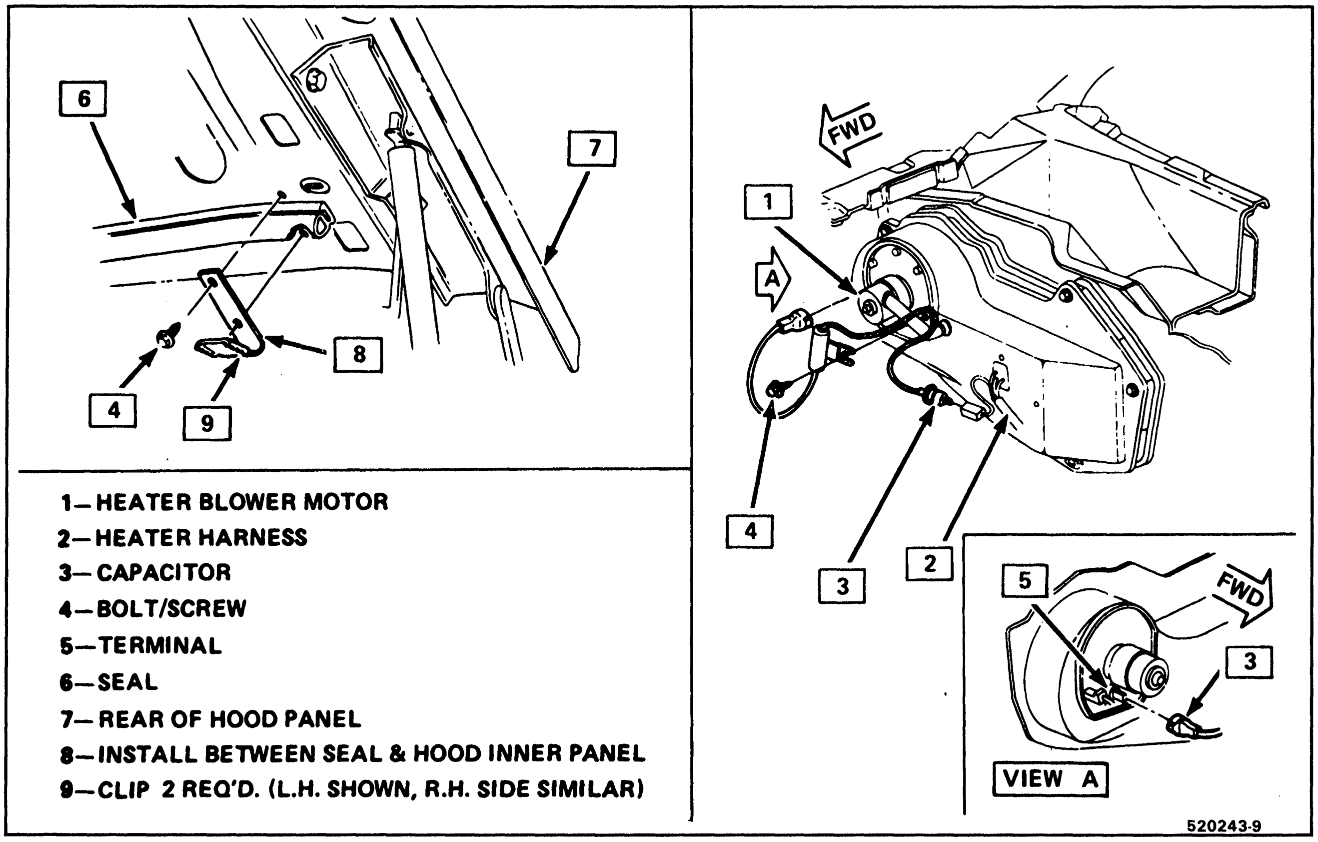


Figure 13 - Typical Radio Suppression Equipment

9. Body and cable assembly from fender well.

Install or Connect

NOTICE: See "Notice" on page 9A-1 of this section for steps 3 and 5.

1. Body and cable assembly to fender well.
2. Grommet to side shroud finishing panel bulkhead.
   - Carefully push harness through vehicle interior.
3. Mast assembly bracket screws.

Tighten

- Fender bracket screw to 1.9 N·m (17 lb. in).
- Body and cable assembly bracket screw to 3.8 N·m (34 lb. in.).

4. Antenna mast.
5. Bezel and nut.

Tighten

- Nut to 3.5 N·m (31 lb. in.).

6. Fender wheelhouse. Refer to FRONT END BODY PANELS (SEC. 2C).

- Lower vehicle.

7. Antenna connection firmly to radio.
8. Right side lower instrument panel and sound insulator.
9. Negative (-) battery cable.

- Remove tape from door edge.

POWER ANTENNA ASSEMBLY

Figures 14 and 15

Remove or Disconnect

Tool Required:

J 28742-A Terminal Remover

- Mask door edge with tape.

1. Negative (-) battery cable.
2. Right side lower instrument panel sound insulator.
3. Antenna connection from radio.

- Raise and suitably support vehicle. Refer to GENERAL INFORMATION (SEC. 0A).

4. Instrument panel harness from radio.
5. Power antenna wire from connector using J 28742-A.
6. Power antenna wire from power antenna relay by gently unplugging connectors.
7. Fender wheelhouse. Refer to FRONT END BODY PANELS (SEC. 2C).
8. Fender to body attaching bolts and nuts.
   - Block fender out.
9. Bezel and nut.
10. Antenna mast. Refer to "Power Antenna Mast Section" in this section.
11. Screws from motor assembly bracket.

12. Grommet from side shroud finishing panel bulkhead and carefully pull harness from vehicle interior.
13. Antenna assembly from fender well.

Install or Connect

NOTICE: See "Notice" on page 9A-1 of this section for steps 3, 5 and 6.

1. Antenna assembly to fender well.
2. Grommet to side shroud finishing panel bulkhead.
   - Carefully push harness through vehicle interior.
3. Screws to motor assembly bracket.

   Tighten

   - Fender bracket screws to 1.9 N·m (17 lb. in.).
   - Lower motor assembly bracket screw to 3.8 N·m (34 lb. in.).
4. Antenna mast. Refer to "Power Antenna Mast Section" in this section.
5. Bezel and nut.

   Tighten

   - Nut to 3.5 N·m (31 lb. in.).
6. Fender to body attaching nuts and bolts.

   Tighten

   - Nuts and bolts to required torque specifications. Refer to FRONT END BODY PANELS (SEC. 2C).
7. Fender wheelhouse. Refer to FRONT END BODY PANELS (SEC. 2C).
- Lower vehicle.
8. Power antenna wire to power antenna relay by gently plugging connectors together.
9. Power antenna wire to connector.
10. Instrument panel harness to radio.
11. Antenna connection firmly to radio.
12. Right side lower instrument panel sound insulator.
13. Negative (-) battery cable.
- Remove tape from door edge.

POWER ANTENNA MAST SECTION

Figures 16 and 17

The power antenna mast should not be disassembled except to replace damaged mast sections. A special assembly tool is included in the mast section replacement kit.

Remove or Disconnect

1. Mounting nut with appropriate tool, then remove mounting wedge.
2. Insulator stop using an 11-mm, thin wall, extra deep well, 12 point socket.
- Have a helper turn radio on (ignition key in "ACC" position). When finial is extended approximately 25.4 mm (1 inch), immediately disconnect power (either disconnect battery or unplug power lead from relay).
3. Finial using a wrench or suitable pliers on flats of finial. Keep the 100 rod assembly from turning by gripping rod with pliers padded with cloth or rubber to prevent damage to rod surface. Do not bend 100 rod.
- Using long nose pliers or fingers, remove the 200/300 tube assemblies from the antenna, sliding them over the 100 rod assembly.

Install or Connect

- Before assembling the new mast assemblies, lubricate the contactor.
- Slide the assembly tool over the contactor to compress its fingers (Figure 17). Slide the mast assemblies over the 100 rod and into the stationary tube, past the contactor fingers. Remove the assembly tool, then bottom the mast in the stationary tube. Make sure the threaded top of the 100 rod is above the top of the 200 tube.

1. Seal (if used), mounting wedge, mounting nut, insulator stop and finial in the reverse order of removal instructions.
2. Power.

UNIT REPAIR

POWER ANTENNA SYSTEM

Figures 18 through 24

As shown in Figure 18, a plastic housing consisting of two halves is attached to the mast and tube assembly. The housing contains the permanent magnet motor parts, limit switch assembly, drive gear and drive cable storage spool. Sealer is used between the two housing halves to prevent water entry and they are held together with five snap-on clips and four eyelets.

The motor armature is protected by an automatic reset type circuit breaker which is located on the limit switch assembly.

Raising and Lowering Mast

The mast sections are extended and retracted by a plastic drive cable attached to the top section of the mast. The other end of drive cable is attached directly to the drive gear with a metal hook. Refer to Figure 19.

Automatic shut off, when the mast reaches the full up or down position, is accomplished by the thrust of the armature tripping a reaction switch assembly.

The reaction switch assembly, as shown in Figure 19, consists of two snap action type switches. One shuts off the motor when the antenna is full up--the other when the antenna is down. Direction of armature thrust depends on direction of armature rotation.

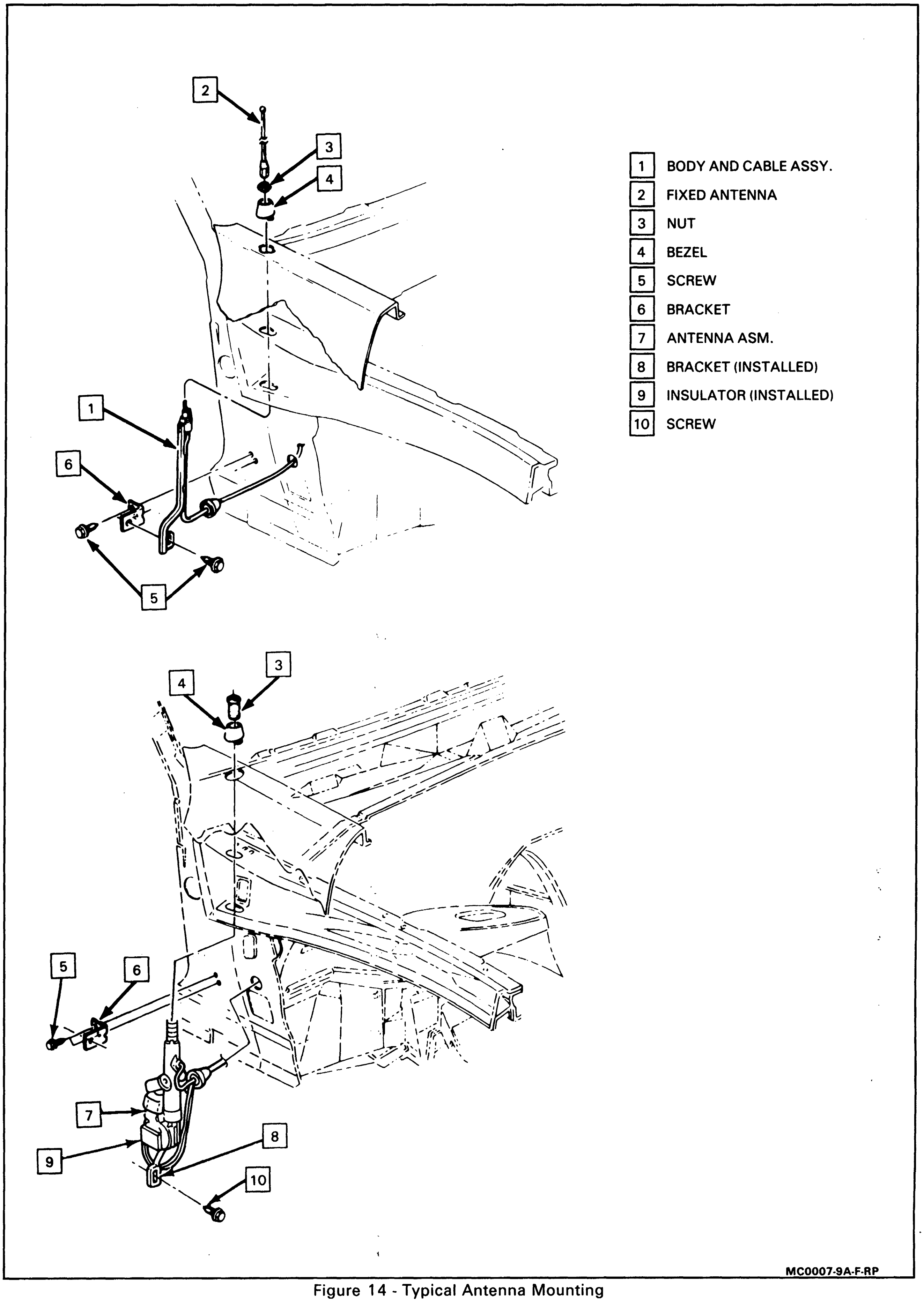


Figure 14 - Typical Antenna Mounting

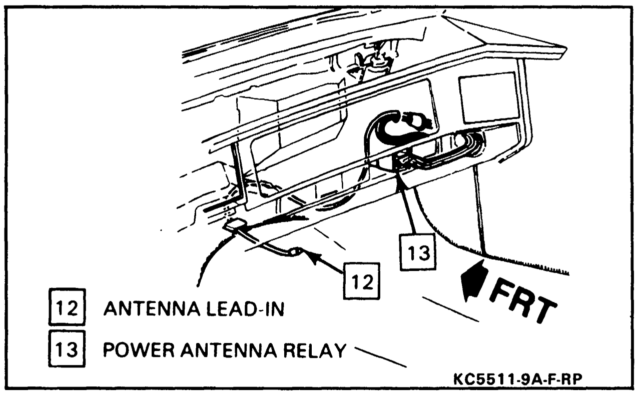


Figure 15 - Power Antenna Relay

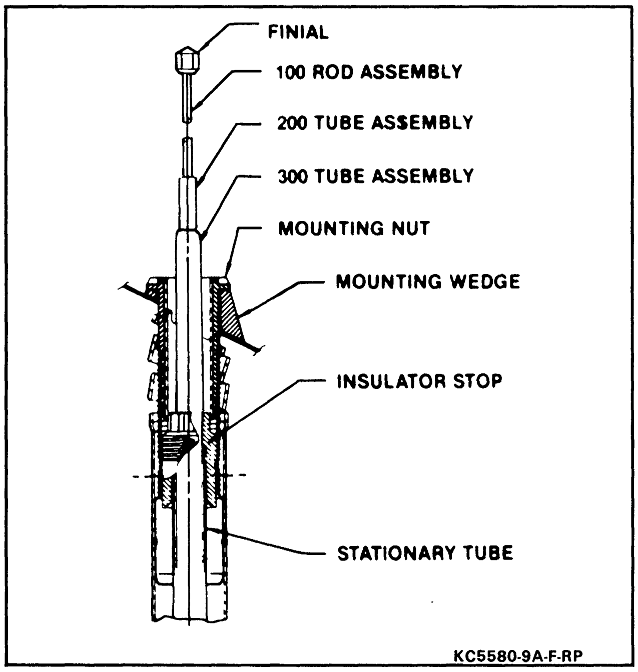


Figure 16 - Front Mounted Antenna

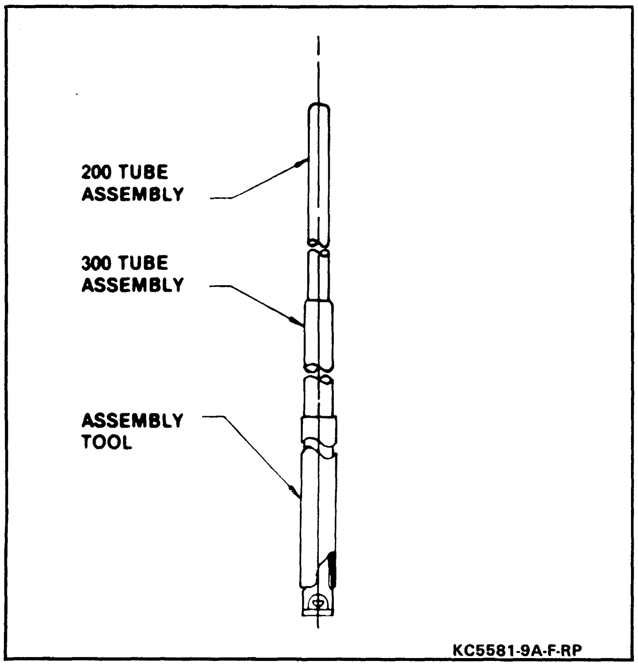


Figure 17 - Assembly Tube Installed

To understand how armature thrust actuates the reaction switches, think of the armature worm as threads on a bolt. Next, think of the drive gear teeth as threads on a nut that is held in a fixed position (i.e., when the mast reaches the full up or down positions and the gear stops turning).

The continuous rotation of the armature when the gear stops turning causes the armature worm to act like a bolt being screwed in or out of a nut held in a fixed position. This causes the armature to move fore and aft depending on rotation.

A spring-loaded thrust mechanism consisting of two blocks and a load spring is assembled on the armature shaft. The mechanism is held in a fixed location on the shaft by two retainers. Refer to Figure 20.

When the armature assembly is installed in the housing, the thrust mechanism fits into a cavity in the housing, as shown in Figure 21. The spring load between the two thrust blocks prevents the armature from thrusting fore and aft until the drive gear stops turning.

As explained previously, when the mast reaches the full up or down position the gear stops turning, the continuing rotation of the armature causes it to move fore and aft depending on rotation. As it moves fore or aft, it moves one of the thrust blocks toward the other compressing the load spring. After the thrust block has been moved a pre-determined distance, it triggers a limit switch to open the motor circuit. Refer to Figure 19 to identify which thrust block and limit switch controls motor shut off when the mast reaches the up or down position.

All "Slimline" antennas are automatic.

WIRING CIRCUITS

With the ignition switch "ON" and the radio turned "ON," the antenna motor automatically raises the mast to the full up position.

Turning the radio ignition switch off automatically causes the antenna motor to lower the mast to full down position.

POWER ANTENNA MOTOR DISASSEMBLY

Antenna Motor and Gear Housing Cover

Figures 22 and 23

Disassemble

1. Four eyelets.
2. Five retaining clips.
3. Housing cover by wedging a small screwdriver in provided slots.
4. Excess or loose sealer.

Assemble

1. Housing cover.
2. Bolts and nuts supplied with service kit.
3. Clips supplied with service kit.

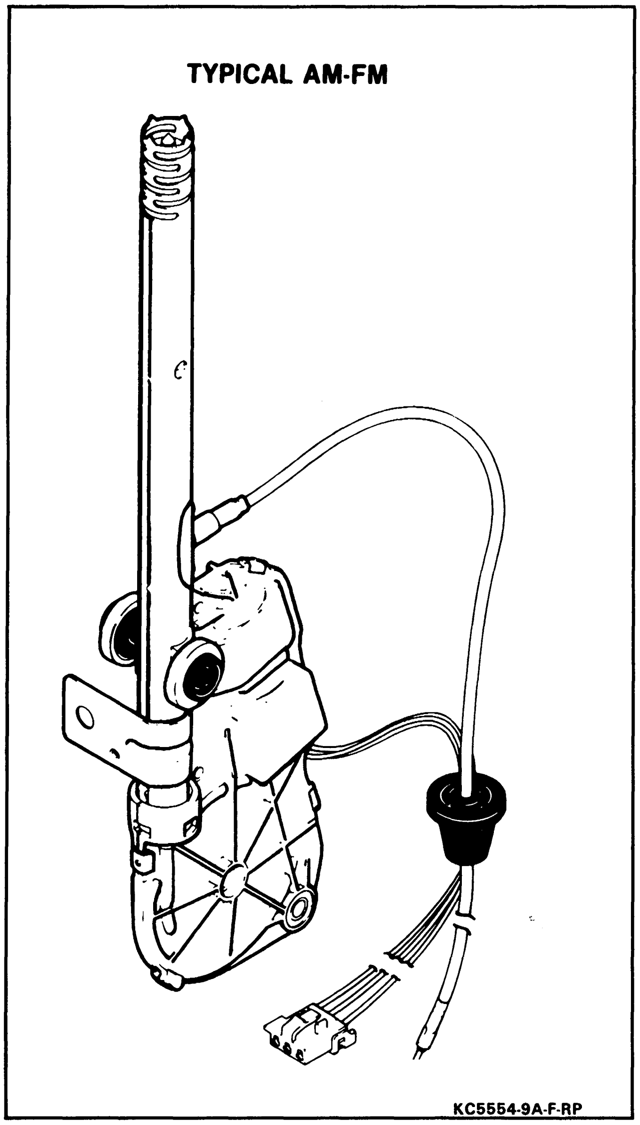


Figure 18 - Typical Power Antenna

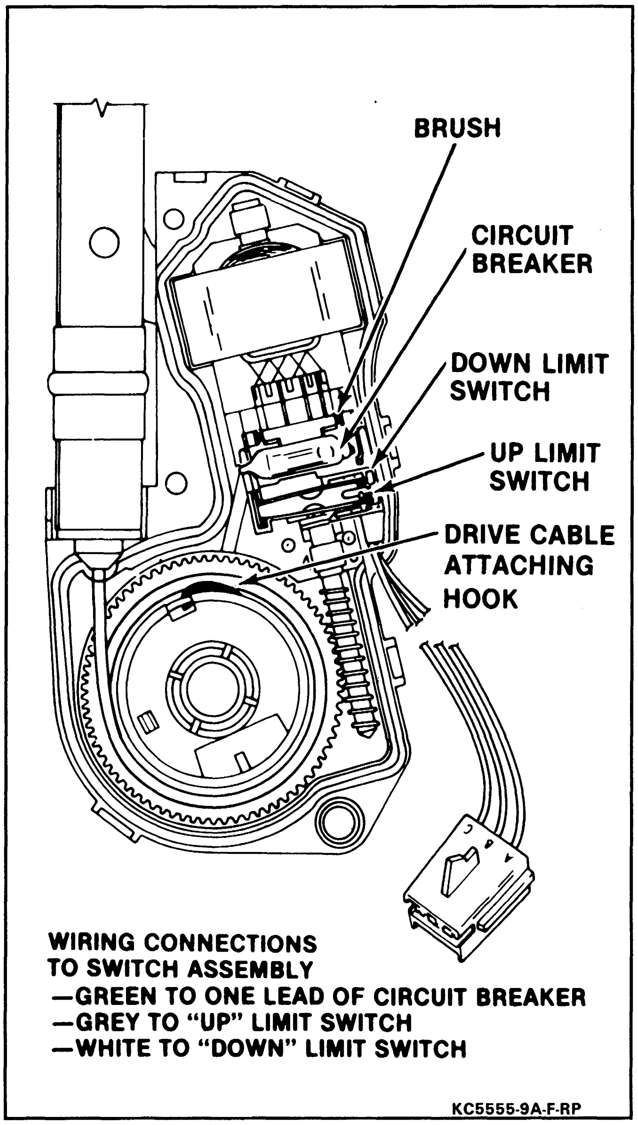


Figure 19 - Wiring Connections

4. Apply sealer (GE 162 or equivalent) around edge of housing cover and around the tube assembly.

Antenna and Tube Assembly

Figures 22 and 24

Disassemble

1. Housing cover. Refer to "Antenna Motor and Gear Housing Cover" in this section.
2. Separate antenna and tube assembly from housing.
3. Unwind and unhook cable from gear.

Assemble

1. Extend antenna until 254 mm (10 inches) of cable are exposed.
2. Hook cable into gear and route cable into spool.
3. Position antenna and tube assembly on housing so that the rubber drain pipe fits in the housing drain hole and the mounting ears are located in the housing slots.
4. Push excess cable into the tube assembly, as required, to keep the cable in the gear spool.
5. Housing cover. Refer to "Antenna Motor and Gear Housing Cover" in this section.

Limit Switch (Includes Motor Brushes, Circuit Breaker and Leads)

Figures 19 and 22

Disassemble

1. Housing cover. Refer to "Antenna Motor and Gear Housing Cover" in this section.
2. Antenna and tube assembly. Refer to "Antenna and Tube Assembly" in this section.
3. Limit switch.

Assemble

1. Limit switch.
2. Antenna and tube assembly. Refer to "Antenna and Tube Assembly" in this section.

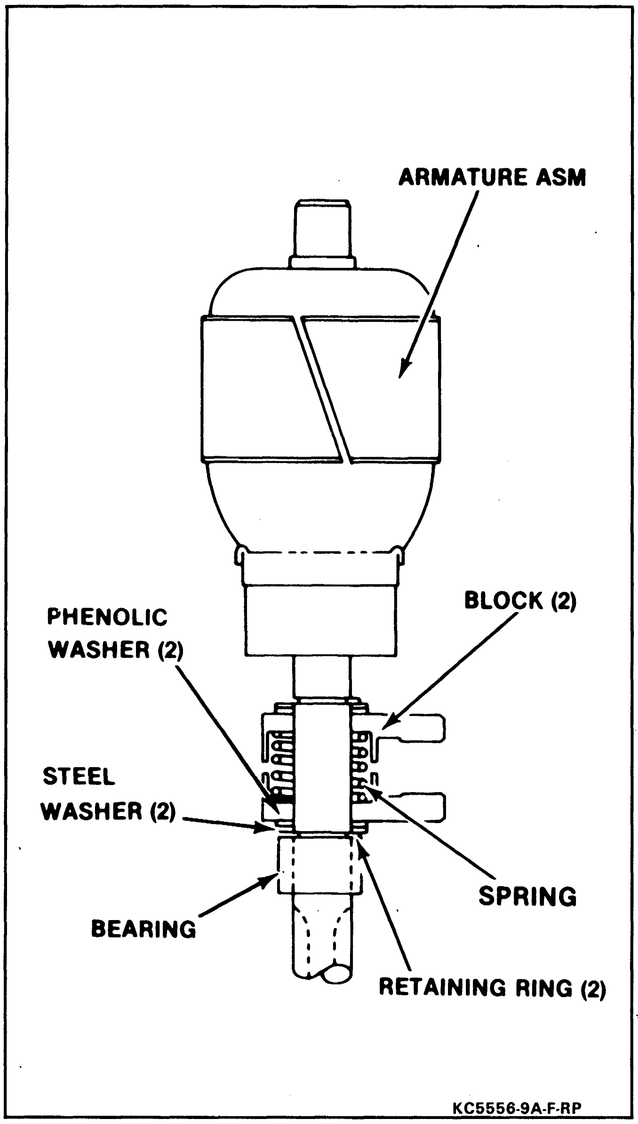


Figure 20 - Armature Assembly

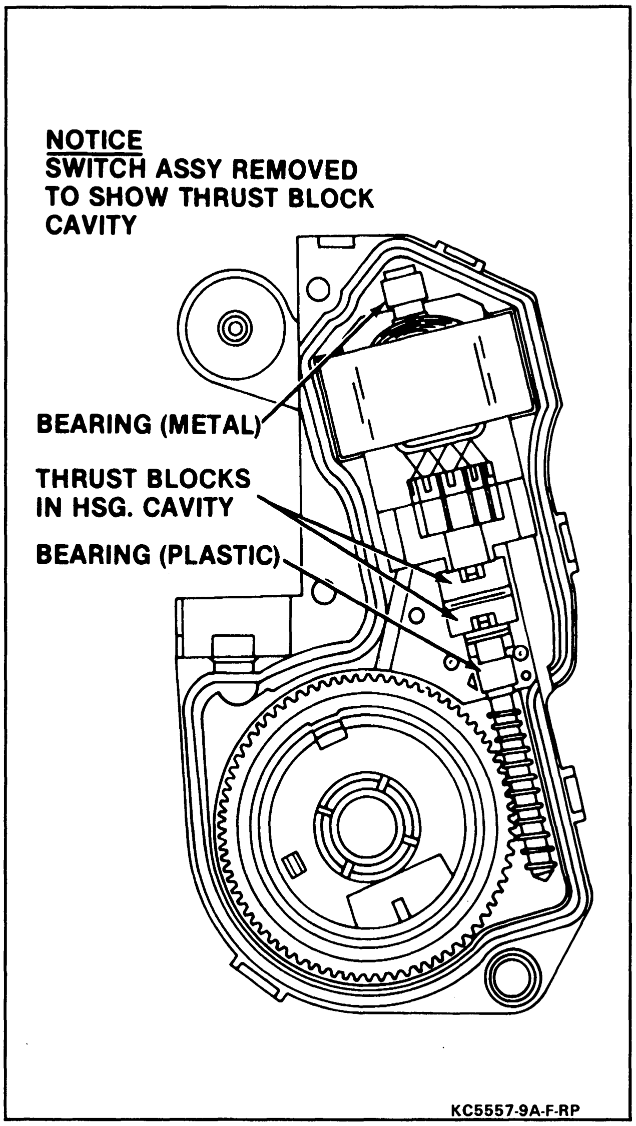


Figure 21 - Thrust Block Cavity

3. Housing cover. Refer to "Antenna Motor and Gear Housing Cover" in this section.

- Seal leads.

Armature and Field Assembly

Figures 20 and 22

Disassemble

1. Housing cover. Refer to "Antenna Motor and Gear Housing Cover" in this section.
2. Antenna and tube assembly. Refer to "Antenna and Tube Assembly" in this section.
3. Limit Switch.
4. Armature and field assembly from field end.

Clean

- Old lubricant out of housing.

Assemble

1. Armature and field assembly.
2. Limit switch.

- Lubricate worm and gear with lithium soap grease such as Sun Oil Prestige No. 2, or equivalent, and apply a drop of light oil to bearings.

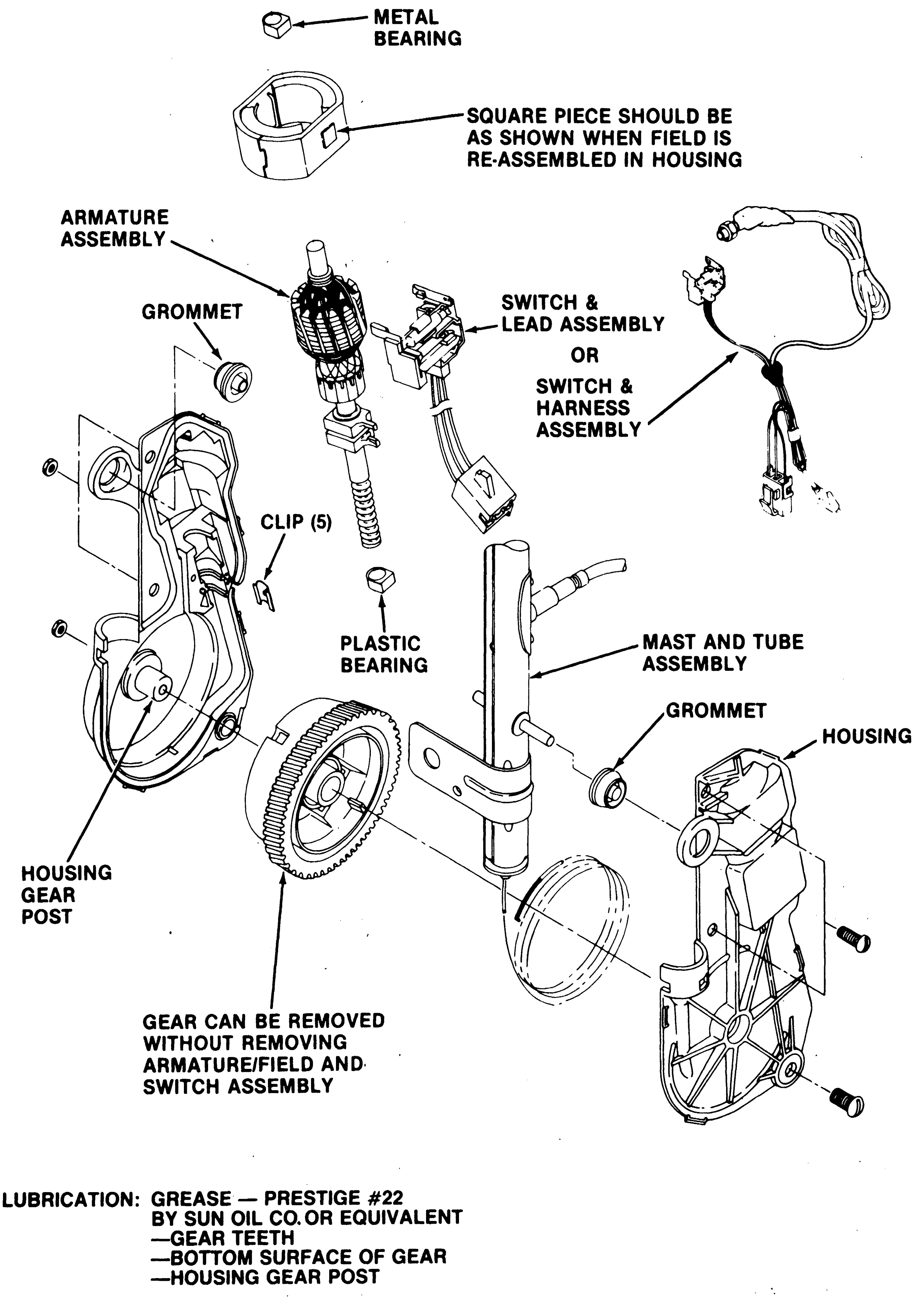
3. Antenna and tube assembly. Refer to "Antenna and Tube Assembly" in this section.
4. Housing Cover. Refer to "Antenna Motor and Gear Housing Cover" in this section.

Gear Assembly

Figure 22

Disassemble

1. Housing cover. Refer to "Antenna Motor and Gear Housing Cover" in this section.
2. Antenna and tube assembly. Refer to "Antenna and Tube Assembly" in this section.
3. Gear from housing post, using pliers if necessary.



LUBRICATION: GREASE — PRESTIGE #22
BY SUN OIL CO. OR EQUIVALENT
—GEAR TEETH
—BOTTOM SURFACE OF GEAR
—HOUSING GEAR POST

Figure 22 - Exploded Diagram

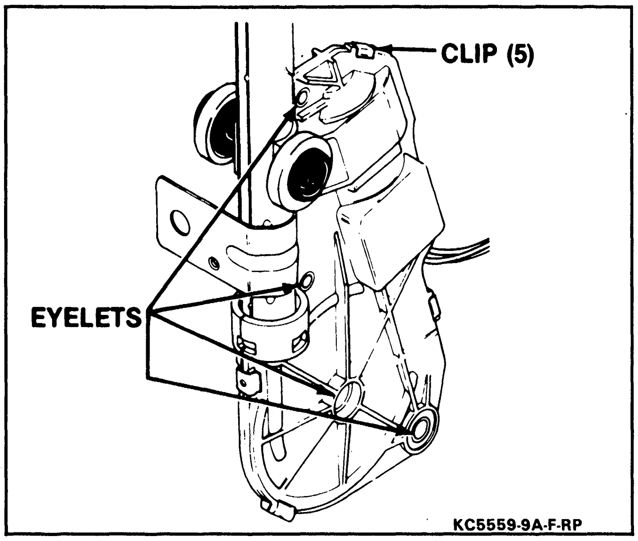


Figure 23 - Eyelets and Clips

Assemble

1. Gear on post.
2. Antenna and tube assembly. Refer to "Antenna and Tube Assembly" in this section.
3. Housing cover. Refer to "Antenna Motor and Gear Housing Cover" in this section.

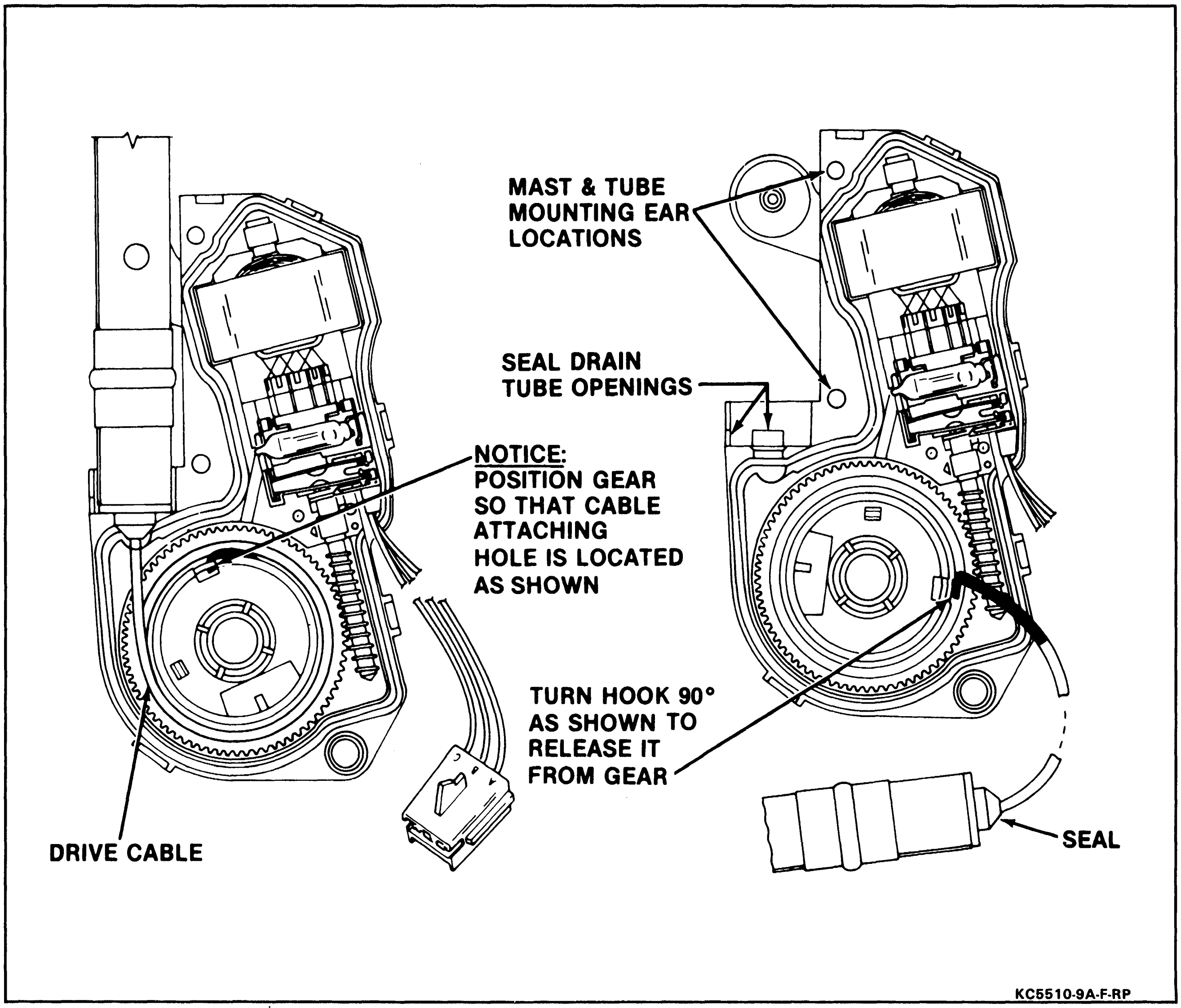


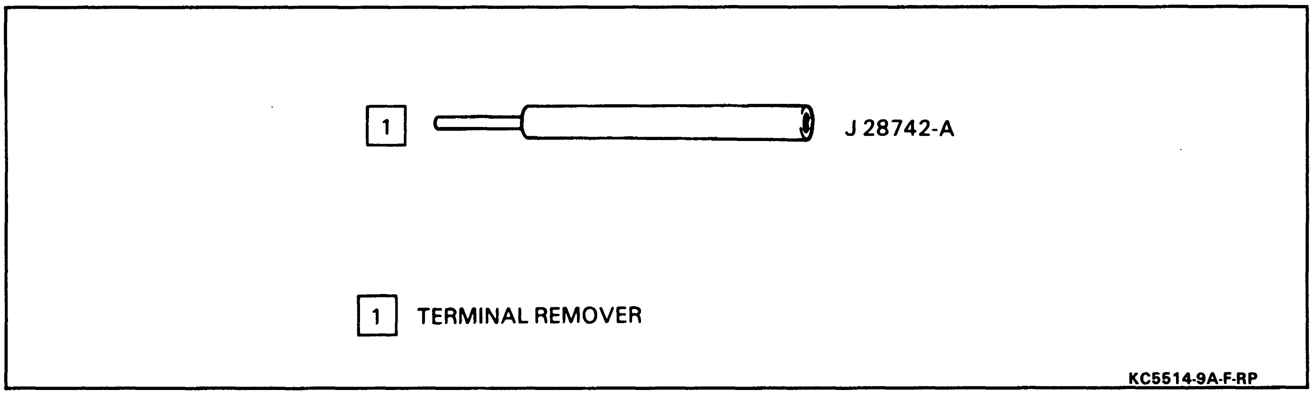
Figure 24 - Drive Cable and Hook

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Fender Bracket Screw	1.9 N·m (17 lb. in.)
Fixed Mast Antenna Body and Cable Assembly Bracket Screw	3.8 N·m (34 lb. in.)
Antenna Mast Nut	3.5 N·m (31 lb. in.)
Power Antenna Lower Motor Assembly Bracket Screw	3.8 N·m (34 lb. in.)

SPECIAL TOOLS



SECTION 9B

CRUISE CONTROL

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 9B-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

Cruise control is a speed control system that maintains a desired vehicle speed under normal driving conditions. However, steep grades up or down may cause variations in the selected speeds. The electronic cruise control system has the capability to cruise, coast, resume speed, accelerate, and "tap-up" and "tap-down."

The main parts of the cruise control system are the mode control switches, cruise control module, servo unit, speed sensor, buffer, vacuum supply, electrical and vacuum release switches, and electrical harness.

The cruise control system uses vacuum to operate a throttle servo unit. The servo unit maintains a desired vehicle speed by trapping vacuum in the servo unit at the proper servo position. The module monitors vehicle speed and servo position and operates the vacuum and vent valves in the servo to maintain desired speed. The module contains a low speed limit that will prevent system engagement below a minimum speed of about 40 km/h (25 mph). The operation of the module is regulated by mode control switches located in the end of the multifunction lever (Figure 1). To disengage the system, two release switches are provided. An electrical release switch mounted on the brake pedal bracket (brake and clutch pedal bracket on vehicles equipped with manual transmission) disengages the system electrically when the brake pedal (or clutch pedal) is depressed. A vacuum release valve mounted on the brake pedal bracket vents the trapped vacuum in the servo to atmosphere when the brake pedal is depressed, allowing the servo unit to quickly return the throttle to idle position.

OFF-ON-RESUME/ACCELERATE SWITCH

Figure 1

The "OFF-ON-R/A" switch has three positions. This switch turns the cruise control system "ON" and "OFF" and also returns cruise control operation to the last speed setting when momentarily moved toward the "R/A" position after braking. Do not hold the slider in the "R/A" position. Release it immediately. If the slider is held in the "R/A" position for more than one second, the system goes into the acceleration mode. To accelerate the vehicle, move the slider switch to the "R/A" position and hold it there until the vehicle reaches the desired speed. When the slider switch is released, the system will maintain the new cruise speed. In order to use the acceleration mode, the cruise "OFF-ON-R/A" switch must be in the "ON" position and the vehicle must be above the low speed limit of 40 km/h (25 mph).

The slide switch can also be used to "tap-up" vehicle speed. In order to do this the cruise must be engaged and operating. "Tapping-up" is done by quickly pressing the slide switch toward the "R/A" position and quickly releasing it, or "tapping" the lever. Do not hold the lever in the "R/A" position, or the system will go into the acceleration mode. "Tap-up" is a function in which cruise speed can be increased by 1.6 km/h (1 mph) increments (one tap = 1.6 km/h (1 mph) increase).

SET/COAST BUTTON SWITCH

Figure 1

The cruise control "SET/COAST" button switch (located in the end of the multifunction lever) has two positions - "NORMAL" and "DEPRESSED."

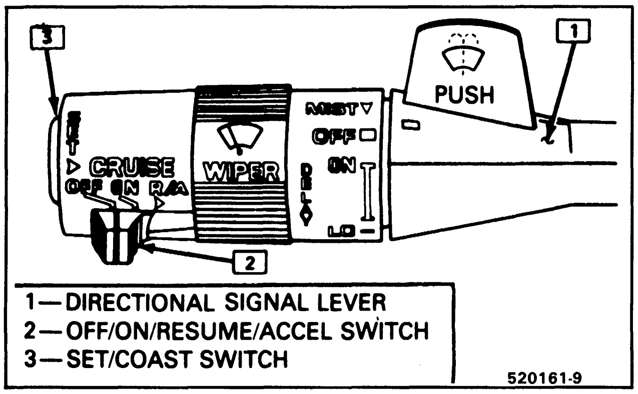


Figure 1 - Multifunction Lever

- **The Set Position** -With the button switch depressed and then released (vehicle speed must exceed the low speed limit point, and the "OFF-ON-R/A" switch must be in the "ON" position) the cruise speed will be set at the speed the vehicle was going when the button was released. Vehicle cruise speed will be within ± 1.6 km/h (1 mph) of the actual speed at engaged speed. The system will cruise until either the "OFF-ON-R/A" switch is moved to "OFF," the engine control switch is turned "OFF," and/or the "SET/COAST" button switch is pushed in fully and held. Pushing the brake pedal (or clutch pedal) disengages the cruise system but will not erase the speed setting.
- **The Coast Position** -With the button switch fully depressed, the driver can raise or lower vehicle speed. To increase speed, the driver can accelerate to a new speed, fully depress the switch and release the button. The module "forgets" the previously set speed. An increased control speed can be more easily set with the "OFF-ON-R/A" switch as previously described. To decrease cruise speed, the button switch is held in, disengaging the cruise system, which allows the throttle to return to the idle position. When the vehicle has slowed to the desired cruise speed, releasing the button switch will re-engage the system.
- **The "Tap-Down" Position** -To "tap down," the cruise must be engaged and operating. "Tapping-down" is done by quickly pressing and releasing the "SET/COAST" button switch, or "tapping" the button switch. Do not hold the button in the depressed position or the system will go into the coast mode. "Tap-down" is a function in which cruise speed can be decreased by 1.6 km/h (1 mph) by increments (one tap = 1.6 km/h (1 mph) increase). The accelerator may be depressed at any time to override the cruise system. Release of the accelerator will return the vehicle to the previously set cruise speed.

NOTICE: To keep the vehicle under control, and to prevent possible vehicle damage, the cruise control should not be used on slippery or winding roads or in traffic of heavy or varying volume. When traveling down a steeply graded hill, the cruise control should be disengaged by depressing the brake pedal lightly. The transmission can then be shifted into a lower gear range to help control vehicle speed.

CRUISE CONTROL MODULE

Figure 2

The module interprets the position of the servo, the position of the control switches and the output of the speed sensor. In response to these inputs, the module electrically signals the opening or closing of the vent and vacuum solenoid valves in the servo.

The module is mounted on the heater-vent-air conditioning module.

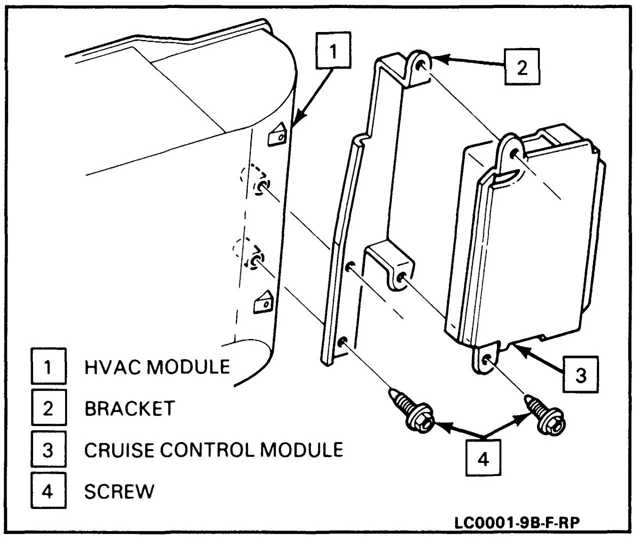


Figure 2 - Cruise Control Module

SERVO UNIT

Figure 3

The servo consists of a vacuum-operated diaphragm, a normally open solenoid valve to vent the diaphragm chamber to atmosphere, a normally closed solenoid valve to connect the diaphragm chamber to the vacuum source, and a variable inductance position sensor.

The servo has a steel core that moves within a coil. Its resulting variable inductance provides a continuous voltage servo position signal to the module. This voltage signal is constantly compared to the vehicle speed signal. This comparison determines if the cruise system has corrected the speed error or if additional changes are required.

The servo operates the throttle in response to signals from the cruise control module as follows.

- **Steady Cruise State** (level road) - Both vacuum and vent valves are closed or sealed. The servo has a constant vacuum on the diaphragm and places no requirements on the vacuum source, as vacuum is trapped in the diaphragm chamber.

- **Vehicle Losing Speed** (due to grades or driver increasing speed by using the acceleration or "tap-up" feature) - The module energizes the vacuum solenoid to open the vacuum valve to the vacuum source. This increases the vacuum level in the servo and increases the throttle opening. The vent remains closed.
- **Vehicle Gaining Speed** (due to grades or driver decreasing speed by using the coast or "tap-down" feature) - The module de-energizes the vent solenoid to open the vent valve to the atmosphere. which reduces vacuum in the servo and allows the throttle return spring to decrease the throttle opening. The vacuum valve remains closed.

When the cruise system is engaged and operating, without any interference from the driver via the mode control switches, no speed correction will be made until the vehicle varies approximately ± 0.8 km/h (1/2 mph) of set speed.

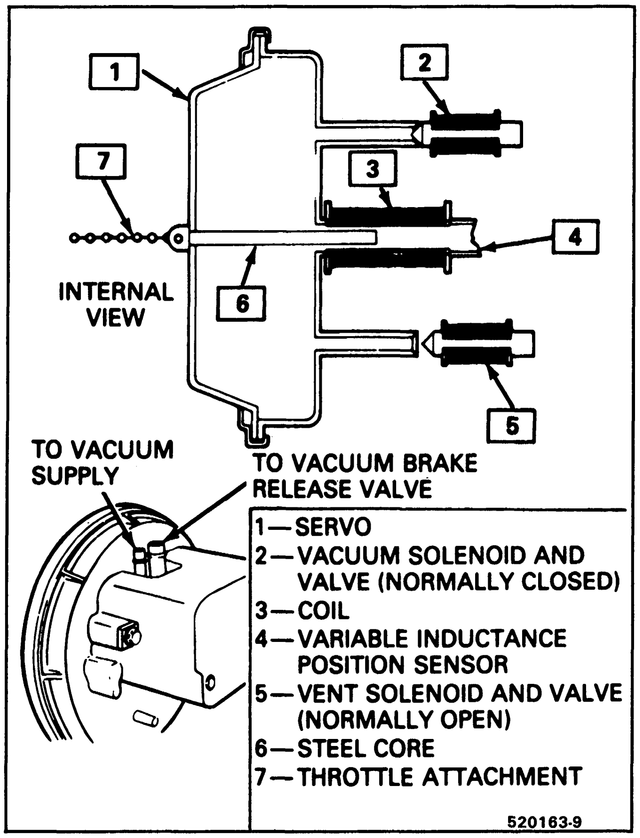


Figure 3 - Servo Unit

When the module senses an over or underspeed condition, it will pulse the opening of the vent or vacuum valve. The pulse will be repeated as required until the vehicle returns to the set speed. From any set speed, under normal road load conditions, the vacuum valve will remain in a completely open position when the vehicle speed has dropped 8 km/h (5 mph) below set speed. Likewise, when vehicle speed has exceeded 5 km/h (3 mph) over the set speed, such as down a steep grade, the vent will go into constant open position.

The servo will go into an open vent valve position under the following conditions:

- Brake (or clutch) pedal is depressed.
- An open or shorted variable inductance position sensor coil in the servo.
- A loss of electrical power to the system.
- The engine control switch is turned "OFF."

SPEED SENSORS

Vehicle Speed Sensor (VSS) Buffer

Figure 4

This device receives a signal from the vehicle speed sensor (permanent magnet generator) indicating the speed of the vehicle. This signal is then processed by the vehicle speed sensor buffer and supplied to the electronic control module (ECM), the cruise control module and the speedometer. The speed sensor buffer is used only on vehicles equipped with the L03 (VIN Code E) engines.

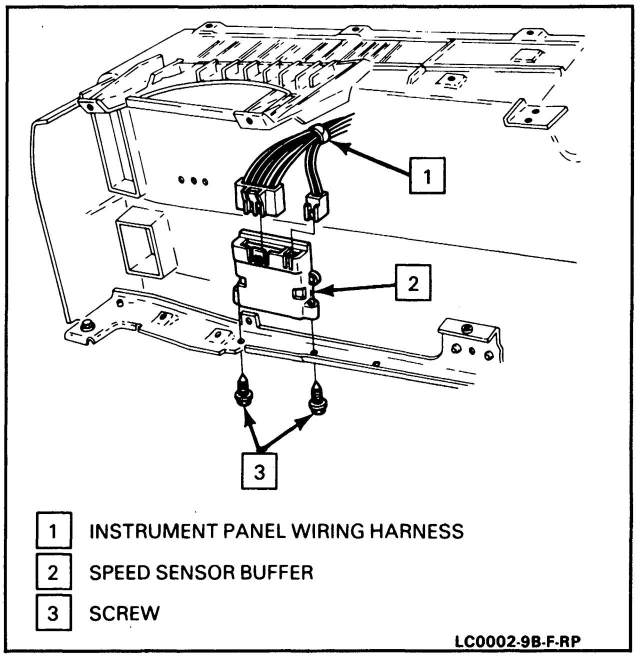


Figure 4 - Vehicle Speed Sensor Buffer

Vehicle Speed Sensor

Figure 5

Vehicle speed information is provided to the buffer, if equipped, or to the Electronic Control Module (ECM) by the vehicle speed sensor which is driven by the transmission. The output frequency of the vehicle speed sensor is sent to the buffer or to the ECM, which amplifies and conditions the signal to the cruise control module.

VACUUM SUPPLY

The vacuum to operate the cruise control servo can come from manifold vacuum connected straight to the servo, from manifold through a vacuum storage tank.

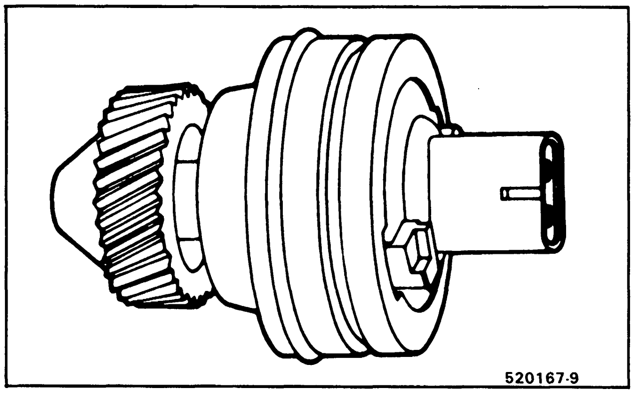


Figure 5 - Vehicle Speed Sensor

ELECTRICAL AND VACUUM RELEASE SWITCHES

Figure 6

These switches are used to disengage the cruise control system. An electrical release switch mounted on the brake pedal bracket (or clutch pedal bracket) disengages the system electrically when the brake (or clutch) pedal is depressed. This is done by interrupting the flow of current to the module. A vacuum release valve mounted on the brake pedal bracket vents the trapped vacuum in the servo to the atmosphere when the brake pedal is depressed allowing the servo unit to quickly return the throttle to idle position. This is done by routing separate vacuum hose directly to the servo from the normally closed vacuum switch. These two types of switches will also sometimes be combined with stoplamp switch, torque converter clutch switch, or other switches. For replacement and adjustment of these switches, refer to "Release Switches" in this section.

ELECTRICAL HARNESS

For specific wiring and connector locations, refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

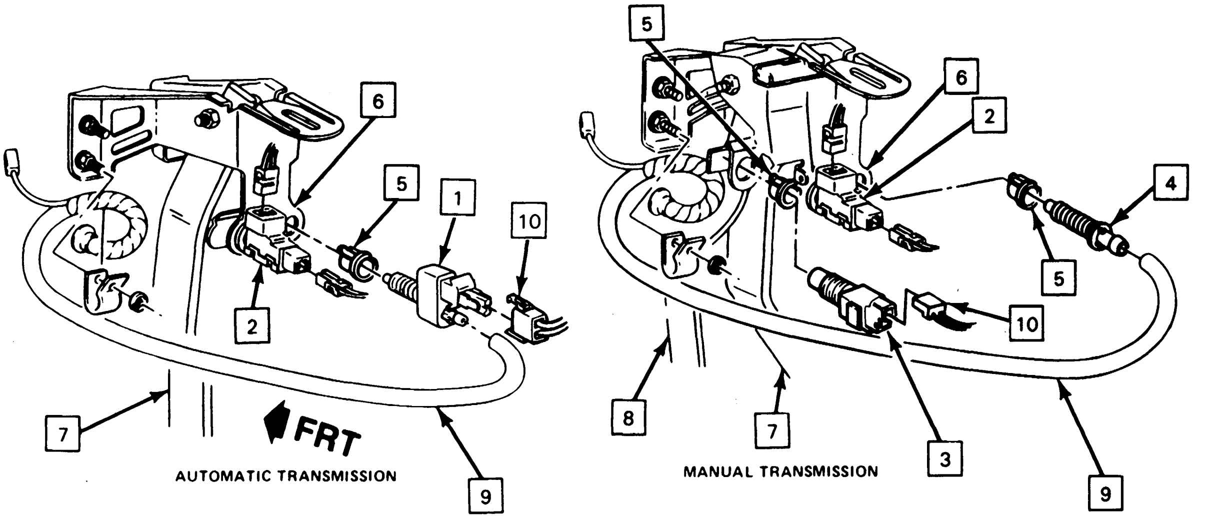
DIAGNOSIS

IMPROPER CRUISE CONTROL OPERATION

Improper operation can be caused by one or a combination of mechanical, electrical and vacuum problems. In resolving any cruise system operating problem, first make a visual inspection. Check the system to ensure there are no bare, broken, or disconnected wires or any pinched, damaged, or disconnected vacuum hoses. The servo and throttle linkage should operate freely and smoothly. The servo linkage should be adjusted.

Because any problem in this system is either vacuum, mechanical, or electrical, the technician should perform a few initial checks before turning to ELECTRICAL DIAGNOSIS (SEC. 8A). This can be done by first eliminating a vacuum or mechanical problem by starting the engine and using a finger to feel for source vacuum at the servo, and by visual inspection of the vacuum release valve, throttle linkage, vacuum hoses, and other components. If preliminary inspection reveals no solution and the system is inoperative, use the diagnostic information in ELECTRICAL DIAGNOSIS (SEC. 8A).

Several versions of cruise control testers are available. This quick check instrument is installed in



1	CRUISE CONTROL VACUUM RELEASE ASSEMBLY AND TCC SWITCH	5	RETAINER
2	STOP LAMP AND CRUISE CONTROL SWITCH	6	BRAKE PEDAL BRACKET
3	CLUTCH CRUISE CONTROL SWITCH	7	BRAKE PEDAL
4	VACUUM RELEASE VALVE	8	CLUTCH PEDAL
		9	VACUUM LINE
		10	I/P WIRING HARNESS

MC0001-9B-F-RP

Figure 6 - Release Switches and Valves

place of the controller and determines which part of the system has a problem. Instructions on the operation of the instrument should be provided by the manufacturer.

Cruise System Surges

- The servo and throttle linkages should operate freely and smoothly. Linkage should be adjusted.
- Check hose routing for pinches, leaks or restrictions.

Cruise Speed High or Low

- Check vacuum hoses for proper routing, restrictions or leaks. Adjust or replace as required.
- Check servo linkage for correct adjustment.
- If no system problem is noted, replace the cruise control module.

Excessive Cruise Speed Loss on Hills

- Check hoses for vacuum leaks.
- Determine if vacuum line check valve is functional.

Cruise Tap-Up and Tap-Down Inoperative

If all other functions of cruise control are working except "tap-up" and "tap-down," replace the cruise control module.

ELECTRIC BRAKE RELEASE SWITCH

On-Vehicle Check

1. Turn engine control/switch "ON."
2. Connect test light (or multimeter) to ground.
3. Probe brown wire at brake switch connector; lamp should light (12 volts on meter), indicating proper feed.
4. Check switch adjustment with probe still at brown wire depressing brake pedal - 3.5 - 12.5 mm (1/8 - 1/2 inch) should turn out lamp (no voltage on meter).
5. If lamp did not light in step 3, probe wire in adjacent connector cavity. If lamp lights (12 volts on meter), adjust or replace switch as necessary. If no light or less than 12 volts, wiring to switch is faulty.

Off-Vehicle Check

1. Use multimeter or self-powered test light.
2. With switch plunger extended, meter should read infinity (open circuit). Test light off.
3. With switch plunger fully depressed, meter should indicate continuity. Test light on.

ON-VEHICLE SERVICE

SERVO UNIT

Figures 7 through 9

Remove or Disconnect

1. Electrical connector and vacuum hoses.
2. Throttle actuating chain, cable or rod from servo unit.
3. Screws securing servo unit and servo unit solenoid valve assembly to mounting bracket and remove servo.

Install or Connect

NOTICE: See "Notice" on page 9B-1 of this section.

1. Servo unit to mounting bracket and secure with screws.

   Tighten

   - Screws to 1.4 N·m (12 lb. in.).
2. Rod or cable to servo unit.
3. Electrical connector and vacuum hoses.

Adjust

NOTICE: Do not stretch cable to make the pin fit into a hole. This will prevent engine from returning to idle.

- Cable to obtain minimum slack.
- With cable assembly installed on engine bracket and servo bracket, install cable end over stud on lever so stud engages slot in cable end.
- Assemble cable to lever stud with retainer and release lever.
- Pull servo end of cable toward servo without moving lever.
- If one of the six holes in the servo assembly tab aligns with cable pin, insert the pin and secure with retainer.
- If a tab hole does not align with the pin, move the cable away from the servo assembly until the next closest hole aligns with the pin. Insert and secure with retainer.

ENGAGEMENT SWITCH

The engagement switch cannot be serviced. The complete multifunction lever must be replaced as an assembly.

For removal and installation of the multifunction lever, refer to STEERING WHEEL UPPER COLUMN ON VEHICLE SERVICE — TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4).

SPEED SENSOR AND HARNESS

Refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

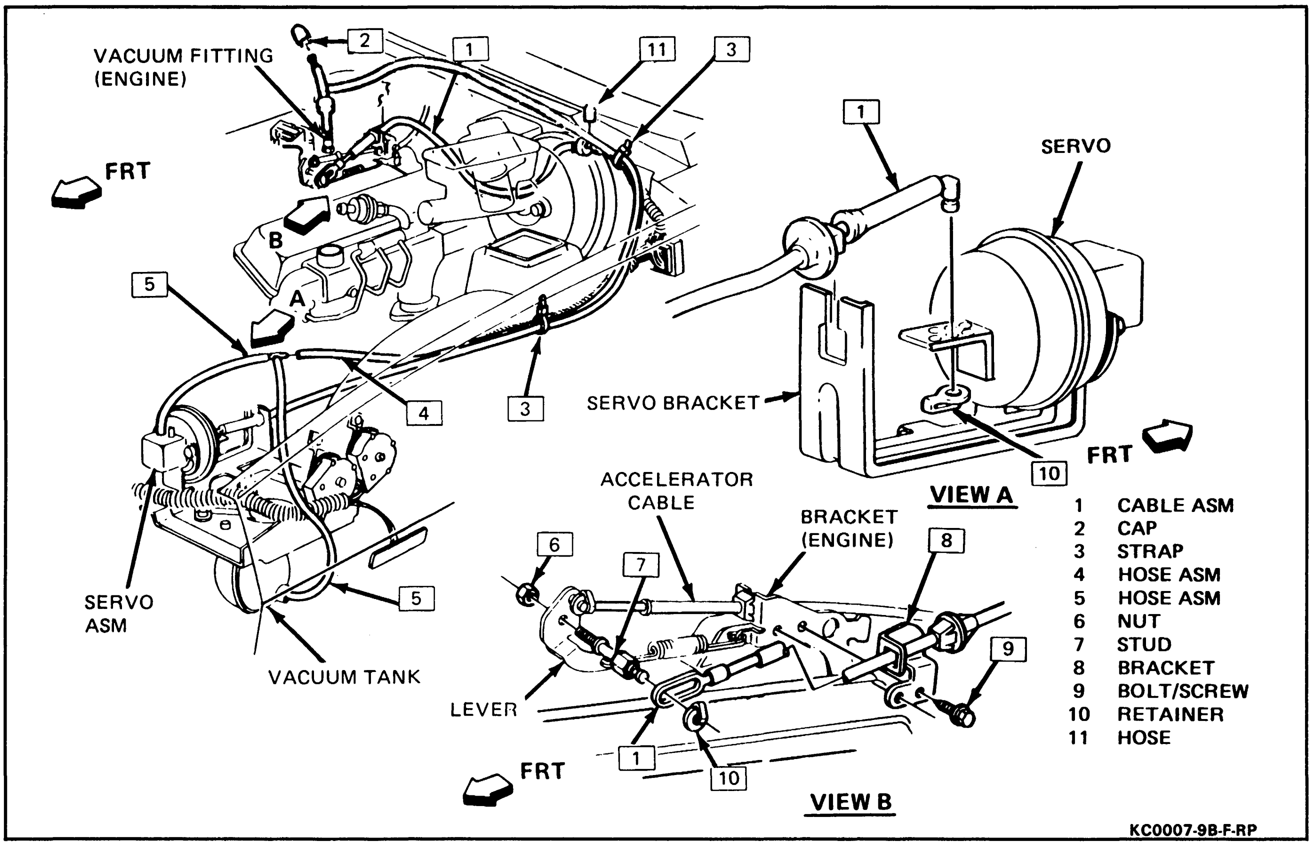


Figure 7 - Servo Mounting (L03)

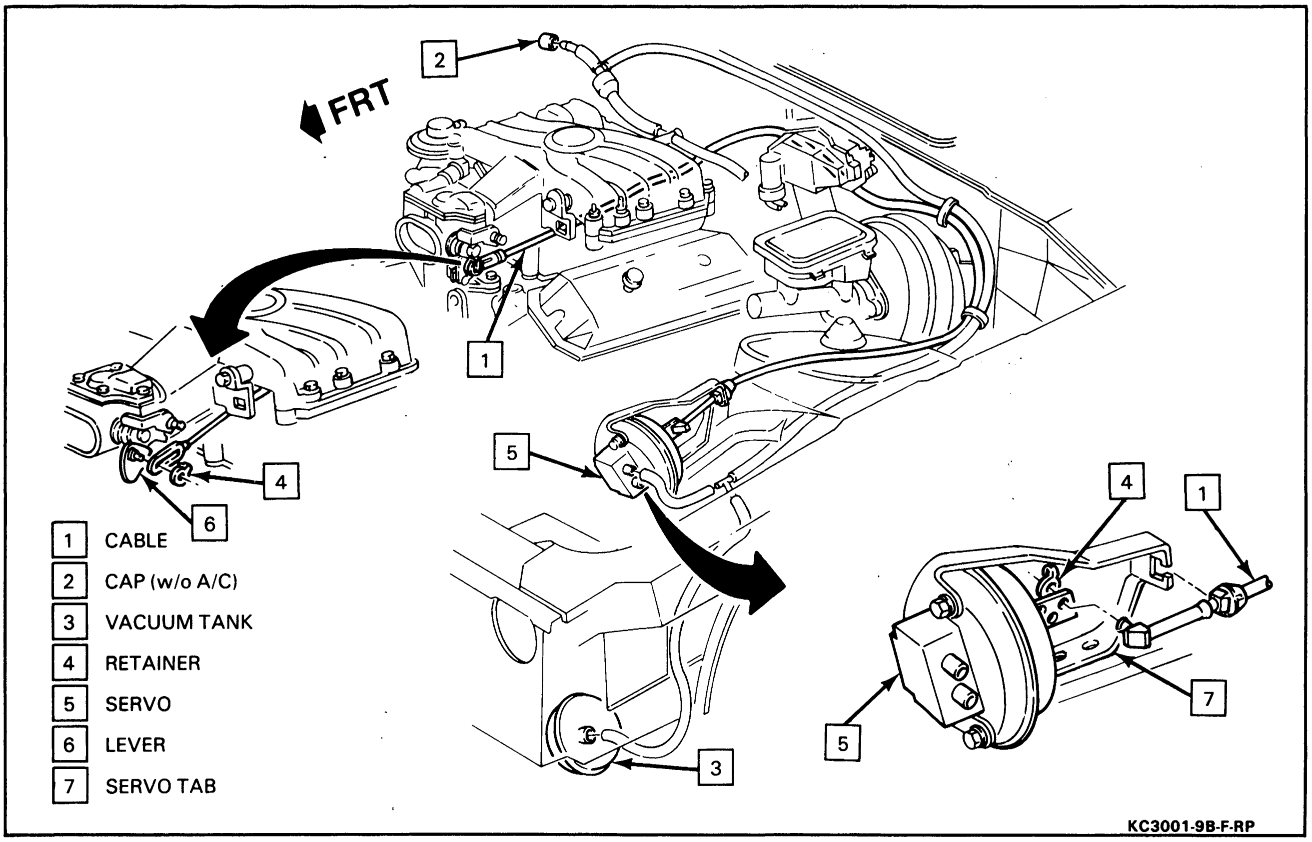


Figure 8 - Servo Mounting (LHO)

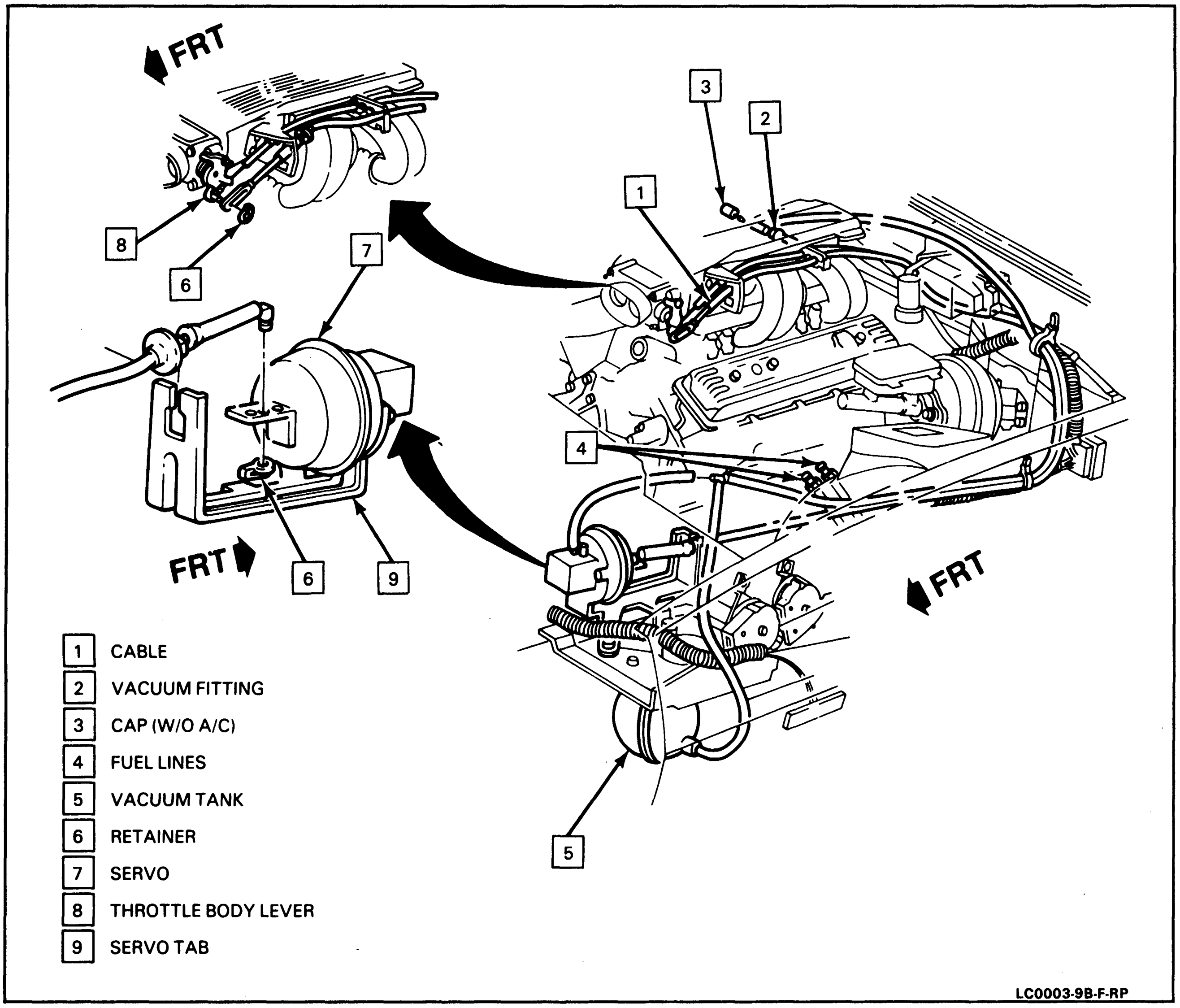


Figure 9 - Servo Mounting (LB9, L98)

CRUISE CONTROL MODULE

Figure 2

Remove or Disconnect

1. Negative battery cable.
2. Right side sound insulator and attaching screws.
3. Screws.
4. Cruise control module.
5. Electrical connector from the module.

Install or Connect

1. Electrical connector to the module.
2. Cruise control module.
3. Screws.
4. Right side sound insulator and attaching screws.
5. Negative battery cable.

VEHICLE SPEED SENSOR BUFFER

Figure 4

Remove or Disconnect

1. Negative battery cable.
2. Right side sound insulator and attaching screws.
3. Screws.
4. Buffer.
5. Electrical connectors from the buffer.

Install or Connect

1. Electrical connectors to the buffer.
2. Buffer.
3. Screws.
4. Right side sound insulator and attaching screws.
5. Negative battery cable.

RELEASE SWITCH/VALVE

Remove or Disconnect

1. Negative (-) battery cable.
2. Left-hand instrument panel sound insulator panel.
3. Stoplamp/cruise control release switch wire connectors.
4. Transmission convertor clutch switch wire connector (automatic transmission).
5. Vacuum line.
6. Switch/valve retainer.
7. Switch/valve retainers from bracket.

Install or Connect

1. Switch/valve on bracket, securing with retainer.
    - Switch/valve must be oriented correctly and inserted far enough into retainer to allow adjustment to correct position. "Clicks" can be heard as threaded portion is inserted into retainer.
2. Vacuum line.
3. Transmission convertor clutch switch wire connector (automatic transmission).
4. Stoplamp/cruise control release switch wire connectors.

Adjust

- Switch/valve.
    - Firmly pull pedal fully rearward against pedal stop until "click" sounds can no longer be heard. (If no "click" sounds were heard, then switch/valve was not inserted far enough into retainer). Switch/valve will be moved in retainer to adjust.
    - Release pedal, then repeat until no audible "click" sound can be heard.

5. Left-hand instrument panel sound insulator panel.
6. Negative (-) battery cable.

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Servo Unit-to-Mounting Bracket Screw.. 1.4 N·m (12 lb. in.)

SECTION 9D

THEFT DETERRENT SYSTEMS

CAUTION: On vehicles equipped with Supplemental Inflatable Restraints (SIR), refer to CAUTIONS in Section 9J-B under On-Vehicle Service before performing service on or around SIR components or SIR wiring. Failure to follow cautions could result in possible air bag deployment, personal injury or unneeded SIR system repairs.

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 9D-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

The Vehicle Anti-Theft System (VATS) is designed to prevent theft by disabling the engine unless a key with a specific electrical resistance value is used in the steering column ignition lock. The system components include: the ignition key, the ignition lock cylinder, the system module (controller), the starter enable relay, the engine control module (ECM), and the connecting wire harness.

SYSTEM OPERATION

The VATS system will prevent the engine from starting when the correct resistance is not sensed from the encoded pellet on the ignition key. Of the 15 resistance values available, only one will work with each VATS module. VATS prevents the engine from starting by isolating the starter enable relay and the engine control module (ECM) fuel enable input. If the ECM does not sense the correct square wave signal on the fuel enable input, it will not provide fuel to the engine.

If the wrong resistance value is sensed when the ignition switch is activated, the VATS module will not ground the starter enable relay circuit and will not output the fuel enable signal for approximately three minutes. This effectively prevents the engine from starting and discourages anyone from trying codes (resistance values) at random.

When the correct resistance value is sensed due to ignition switch activation, the VATS module will ground the starter enable relay circuit and output the fuel enable signal. This allows the engine to start normally.

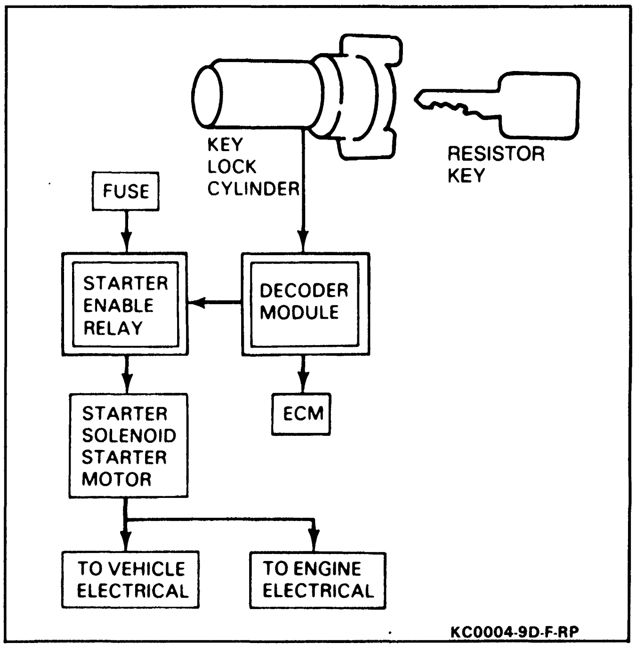


Figure 1 - Vehicle Anti-Theft System (VATS) Components

SYSTEM COMPONENTS

Figure 1

Ignition Key

The ignition key for VATS equipped vehicles is an assembly of a typical square head ignition key blank and a resistor pellet. The key blank and resistor pellet are not serviceable separately. There are 15 different ignition key assemblies, each with a different resistance value. The ignition key also has mechanical cuts similar to all regular ignition keys.

Steering Column Lock Cylinder

The steering column lock cylinder on VATS equipped vehicles contains a set of electrical contacts used to measure the resistance value in the ignition key pellet. The wire routing for the contacts inside the steering column is important. When servicing the lock cylinder set, be certain to maintain proper wire routing. See Figure 2. A two-way connector at the base of the steering column connects the contacts to the vehicle wiring harness. The connector is also used for diagnostic purposes. The steering column lock cylinder also performs all normal ignition switch lock functions. When replacing a VATS steering column lock cylinder, it will be necessary to make new keys which match the VATS module code as well as the mechanical cut of the new lock cylinder.

Vehicle Anti-Theft System (VATS) Module (Controller)

The Pass-Key® theft deterrent module (controller) contains the logic of the VATS system. The VATS module has inputs from the ignition circuit and the ignition key resistor. The module has outputs to the starter enable relay, the fuel enable relay, and instrument panel security lamp connector.

The ignition key input is used to turn the module on. When the module is turned on, it will read the ignition key resistor and control outputs accordingly. When the module is turned off, the ignition key resistor is not read and the starter enable relay and fuel enable output will not allow the engine to start. When the ignition is turned "OFF," the VATS module will draw about 0.1 milliamps from the battery.

The ignition key resistor inputs are used to determine if the correct key is being used to start the vehicle. If the resistance value of the ignition key matches the value stored in the VATS module, then the starter enable relay and fuel enable output will allow the vehicle to start. If the resistance value of the ignition key does not match the value stored in the VATS module, the starter enable relay and fuel enable output will not allow the vehicle to start.

The starter enable circuit controls the starter enable relay. When the VATS module senses the proper resistance at the ignition key, it grounds the starter enable circuit, which allows the engine to be cranked. If the VATS module does not sense the proper resistance at the ignition key, it will not ground the starter enable circuit.

The fuel enable circuit is an output from the VATS module and an input to the ECM. When the VATS module senses the proper resistance at the ignition key, it will output a square wave signal to the ECM. If the VATS module does not sense the proper resistance at the ignition key, it will not output the square wave signal to the ECM.

The security indicator lamp, located in the instrument panel cluster, is controlled directly by the Pass-Key® theft deterrent module (controller) through a grounding circuit. If the key resistance being compared to the stored resistance value in the module (controller) is matched, the indicator lamp will be grounded during a two-second "bulb test." If it is not matched, if the module has not been programmed, or on the first ignition cycle after a new module is programmed, the lamp will stay on until the ignition is turned off.

Starter Enable Relay

The starter enable relay is used to prevent the engine from cranking if the correct resistance is not sensed at the ignition key. It prevents the engine from cranking by not closing the circuit to the starter solenoid.

Engine Control Module (ECM)

The ECM reads the fuel enable circuit to determine if fuel injection should be allowed. If the fuel enable square wave signal is not present, the ECM will not allow fuel injection. If the square wave signal is present, the ECM will allow fuel injection and normal engine operation.

The ECM has some diagnostic features associated with the VATS fuel enable input, including trouble codes. Refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

DIAGNOSIS

For all diagnostic procedures on the VATS system, refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

ON-VEHICLE SERVICE

IGNITION KEY

Copying VATS Ignition Keys

Tool Required:

J 35628 VATS Interrogator

To copy a VATS ignition key, it is necessary to first determine which key code (resistance value) is needed. The ignition key being copied must be tested to determine the key code. The key may be tested by using J 35628. To operate J 35628, turn the cover switch "ON." Be sure the tool wiring connectors are disconnected, and insert the key into the tool lock cylinder. The key code reader will display the key code of the ignition key. Obtain a key blank matching this key code and cut it to match the original key.

Replacing Lost VATS Ignition Keys

Tool Required:

J 35628 VATS Interrogator

To replace lost VATS ignition keys it is necessary to determine the mechanical cut and the electrical (resistance value) code.

The mechanical cut can be determined from the key code on the ignition lock cylinder or from the original key "knock outs." If the mechanical cuts cannot be determined, the ignition lock cylinder must be replaced. Make a key with the correct mechanical cut to use while determining the proper electrical (VATS) key code.

To determine the proper electrical key code (resistance value) use J 35628 and the following procedure:

1. Connect J 35628 wiring to the VATS dash connector at the base of the steering column. Do not connect the steering column wiring.
2. Turn power switch "ON" and place key code switch to "1" and attempt to start engine with proper mechanically cut key. If engine starts, the key code is "1."
3. If engine does not start, press four minute timer.
4. When timer lamp goes out place key code switch to "2" and attempt to start engine. If engine starts, key code is "2."
5. Continue trying different key codes until proper key code is found.
6. Make a new key with the proper VATS code and mechanical cut.

STEERING COLUMN LOCK CYLINDER

Figure 2

To remove the steering column lock cylinder, refer to STEERING COLUMN UNIT REPAIR - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4-A).

Important

- The wire routing for the contacts inside the steering column is important. When servicing the lock cylinder (2) be certain to maintain proper wire routing (A); do not twist wires and keep wires away from sharp edges and potential pinch points. Reconnect to replacement lock cylinder (2). Refer to STEERING COLUMN UNIT REPAIR - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4-A).

VEHICLE ANTI-THEFT SYSTEM (VATS) MODULE (CONTROLLER)

Figure 3

If a VATS module is inoperative, it should be replaced with a new VATS module. It is not necessary to match the replacement module to the ignition key. The replacement module will "learn" the ignition key code (resistance value) the first time it is turned on. The ignition key code is stored permanently, so caution should be used to ensure that unwanted key codes are not learned.

Remove or Disconnect

1. Negative battery cable.
2. Instrument panel. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
3. VATS module mounting screws (7) from front, right side of the air distributor (8).
4. Module (6).

Install or Connect

NOTICE: See "Notice" on page 9D-1 of this section.

1. Module (6).
2. Module mounting screws (7).

   Tighten

   - Screws (7) to 1.5 N·m (13 lb. in.).
3. Instrument panel. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
4. Negative battery cable.

STARTER ENABLE RELAY

Figure 4

If the starter enable relay is determined to be inoperative, it should be replaced.

Remove or Disconnect

1. Negative battery cable.
2. Left side finishing panel. Refer to BODY FRONT END (SEC. 10-4).
3. Connector (12) from starter enable relay (10).
4. Relay mounting screw (11).
5. Starter enable relay (10).

Install or Connect

1. Starter enable relay (10).

   NOTICE: See "Notice" on page 9D-1 of this section.
2. Relay mounting screw (11).

   Tighten

   - Screw (11) to 1.8 N·m (16 lb. in.).
3. Connector (12) to starter enable relay (10).
4. Left side finishing panel. Refer to BODY FRONT END (SEC. 10-4).
5. Negative battery cable.

ENGINE CONTROL MODULE (ECM)

For information on the ECM, refer to DRIVEABILITY AND EMISSIONS - FUEL INJECTION (TBI) (SEC. 6E2) or DRIVEABILITY AND EMISSIONS - FUEL INJECTION (PORT) (SEC. 6E3).

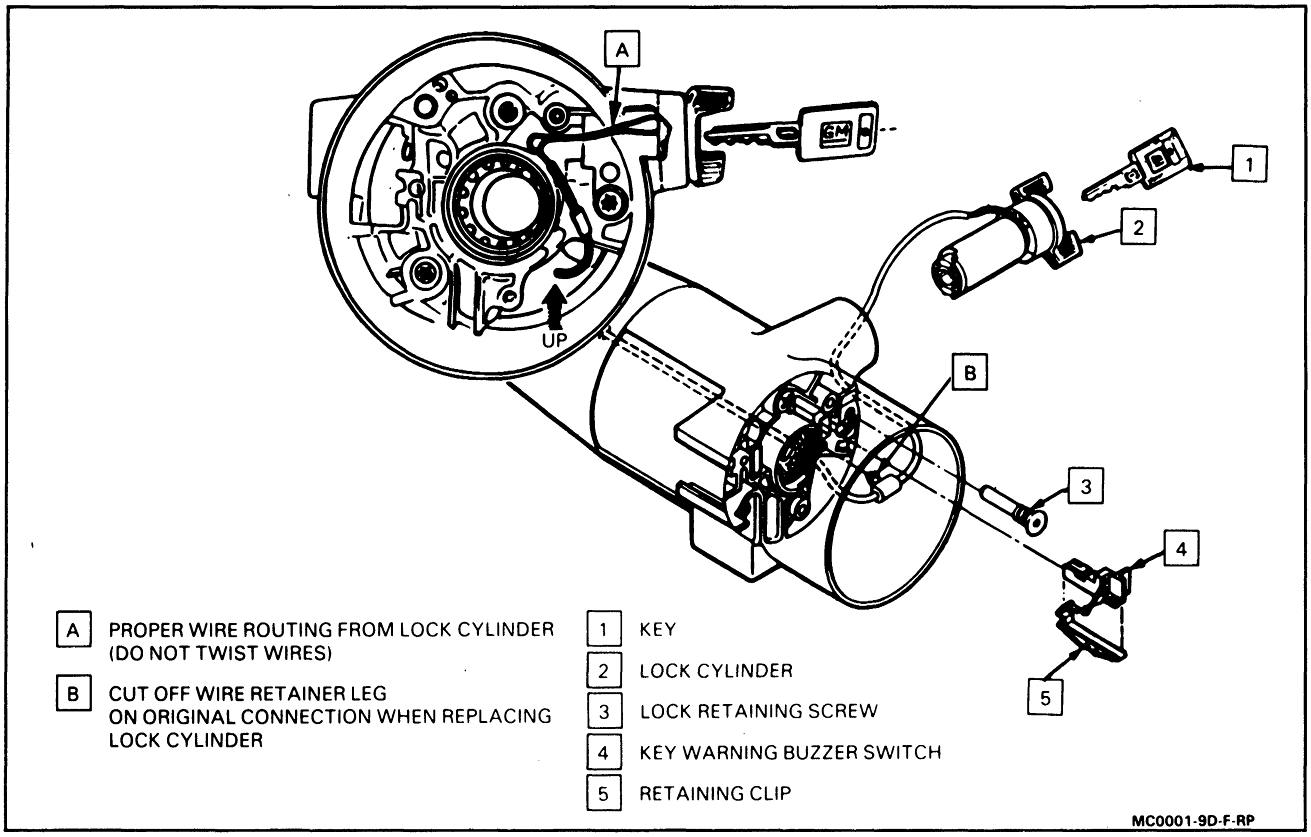


Figure 2 - Ignition Lock Cylinder Installation

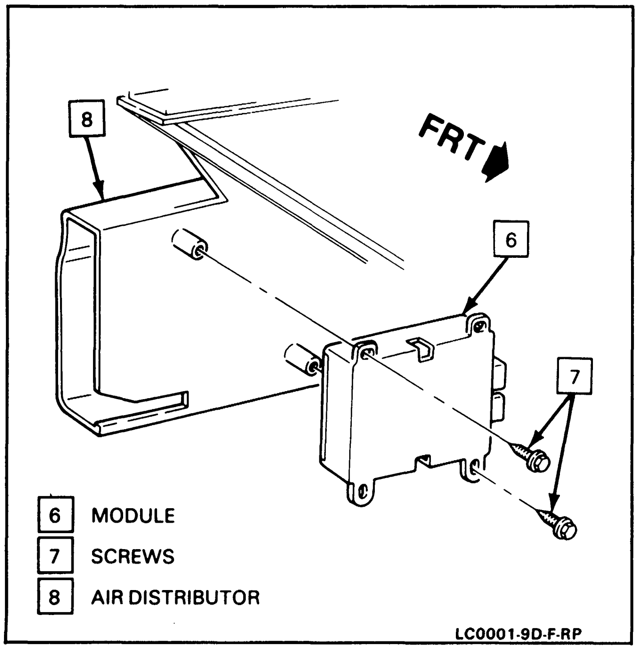


Figure 3 - Vehicle Anti-Theft System Module

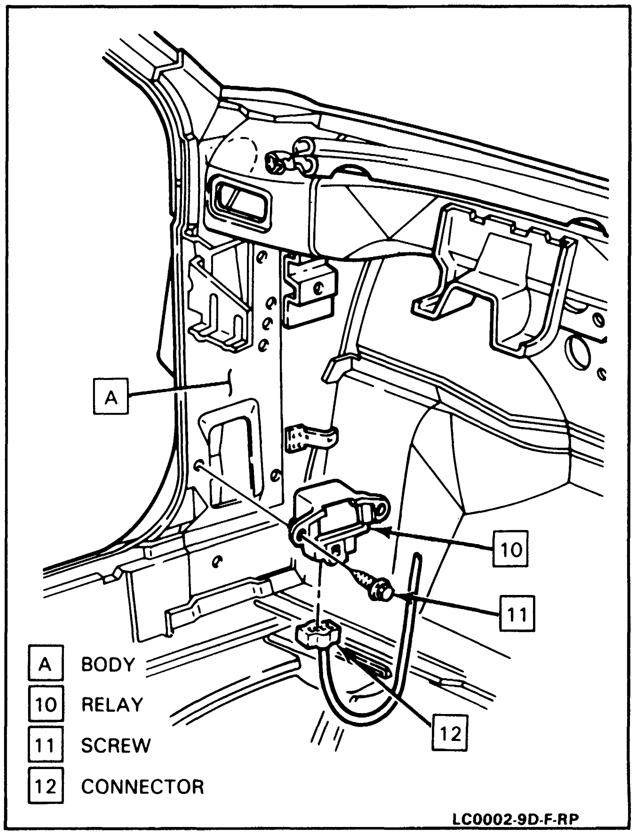


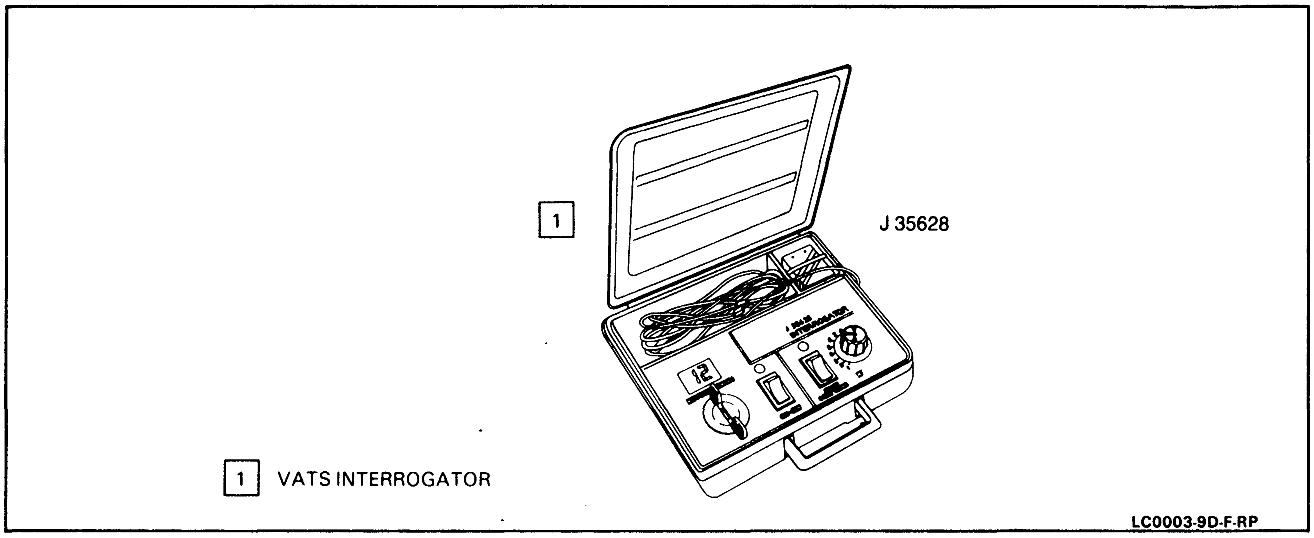
Figure 4 - Starter Enable Relay

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Module Mounting Screw	1.5 N·m (13 lb. in.)
Relay Mounting Screw	1.8 N·m (16 lb. in.)

SPECIAL TOOLS



SECTION 9E

ENGINE BLOCK HEATER

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 9E-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

GENERAL DESCRIPTION

The optional engine block heater is used to heat engine coolant, making it easier to start the engine in cold climates. The engine block heater is installed into the engine block at a water jacket plug location (Figures 1 and 2). An electric heater cord runs from the engine block heater to a convenient location on the vehicle.

ON-VEHICLE SERVICE

ENGINE BLOCK HEATER REPLACEMENT

Figures 1 through 3

Remove or Disconnect

CAUTION: Perform this operation when the engine is cool or personal injury may result.

- Drain the coolant from the engine block into an approved container.
- Raise the vehicle and suitably support. Refer to GENERAL INFORMATION (SEC. 0A).

1. Electrical connector (2) from engine block heater (1).
2. Engine block heater (1).
   - Turn the center screw counterclockwise as far as it will go.

   NOTICE: When removing the engine block heater from the engine block, be careful not to score the machined surface of the plug hole.

   - Tilt the engine block heater (1) so the yoke will come out of the engine block.
   - Pull the engine block heater (1) out of the plug hole.

- If removing the engine block heater (1) permanently, install a water jacket plug into the plug hole and replace coolant. For coolant replacement procedures, refer to COOLING AND RADIATOR (SEC. 6B).

Clean

- Plug hole.
  - Remove burrs, lubricant, paint and other rough spots.

Install or Connect

- Apply a coat of petroleum jelly or grease to the O-ring (3) and the walls of the plug hole.

NOTICE: The element on the engine block heater must not touch the engine block inner wall in the installed position or damage to the engine block and engine block heater could result.

1. Engine block heater (1) into plug hole.
   - Fit one end of the yoke into the block, then tilt the engine block heater (1) so the other end of the yoke can fit through the plug hole.
   - Line up the engine block heater (1) with the plug hole and push it straight into place.
   - Rotate engine block heater (1) clockwise as far as it will go, then back it off slightly so the heater element is clear of the engine block inner wall.
   - Turn the center screw so that the yoke presses against the engine block inner wall.

CAUTION: The heater cord must not touch the engine, hot pipes, manifold or any moving parts or damage to the vehicle and possible personal injury may result.

2. Electrical connector (2) to the engine block heater (1).

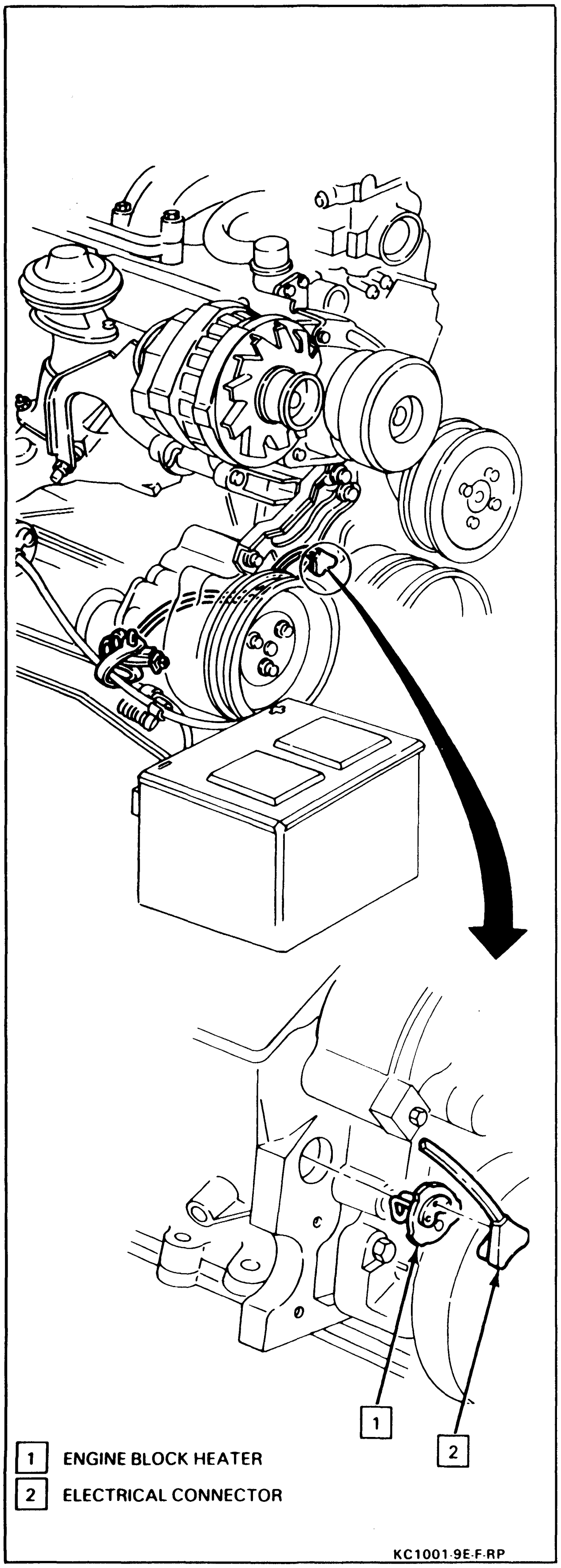


Figure 1 - V8 Engine Block Heater Location

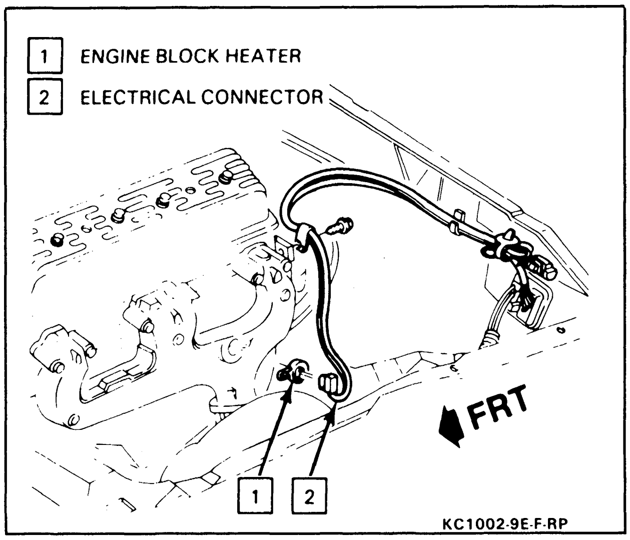


Figure 2 - V6 Engine Block Heater Location

- Replace coolant. Refer to COOLING AND RADIATOR (SEC. 6B).
- Lower vehicle.

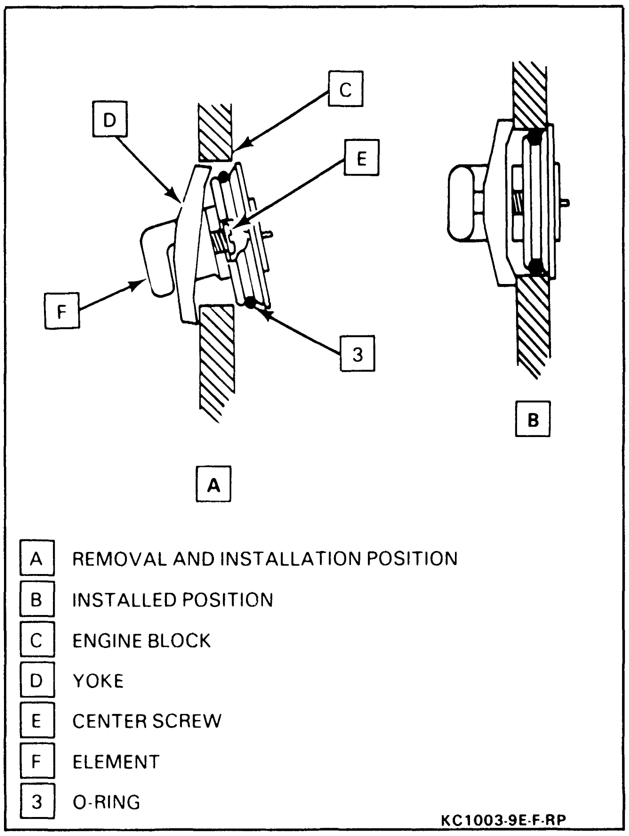


Figure 3 - Engine Block Heater

HEATER CORD REPLACEMENT

Figures 1 and 2

↔ Remove or Disconnect

- Note position and routing of heater cord for proper placement during installation.

1. Heater cord electrical connector (2) from engine block heater (1).
2. Clips and/or straps as required.
3. Heater cord from vehicle routing.

→← Install or Connect

CAUTION: Heater cord must not touch the engine, hot pipes, manifold or any moving parts, or damage to the vehicle and possible personal injury may result.

1. Heater cord to vehicle routing as noted during removal.
2. Clips and/or straps as required.
3. Heater cord electrical connector (2) to engine block heater (1).

SECTION 9J

SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM INTRODUCTION

CONTENTS

CAUTION: The procedures in this section must be followed in the order listed to temporarily disable the Supplemental Inflatable Restraint (SIR) System and prevent false diagnostic codes from setting. Failure to follow this procedure could result in possible air bag deployment, personal injury, or unneeded SIR system repairs.

SECTION 9J

SIR SYSTEM INTRODUCTION

INTRODUCTION

GENERAL DESCRIPTION

The Supplemental Inflatable Restraint (SIR) System supplements the normal restraint of the driver's seat belt by deploying an air bag from the center of the steering wheel during an accident. The air bag deploys when the vehicle is involved in a front end collision of sufficient force. To further absorb the energy of an accident there is a knee bolster located beneath the instrument panel in the driver's area. The steering column continues to be collapsible.

SYSTEM DESCRIPTION

ELECTRICAL SYSTEM

The main portions of the SIR system are the Deployment Loop and the Diagnostic Energy Reserve Module (DERM). The main function of the deployment loop is to supply current through the Inflator Module in the steering wheel which will cause deployment of the air bag in the event of an accident severe enough to warrant deployment.

The Arming Sensor, Coil Assembly, Inflator Module and Discriminating Sensors make up the deployment loop. The Arming Sensor switches power to the Inflator Module on the high side of the deployment loop. Either of the Discriminating Sensors can supply ground to the Inflator Module on the low side of the loop. The Inflator Module is only supplied sufficient current to deploy when the Arming Sensor and at least one of the two Discriminating Sensors close simultaneously.

The function of the Diagnostic Energy Reserve Module (DERM) is to supply the deployment loop with a 36 Volt Loop Reserve (36VLR) to assure sufficient energy to deploy the air bag for a few seconds after ignition voltage is lost in an accident. Deployment of the air bag can still take place without the DERM connected if adequate ignition voltage is present at the Arming Sensor.

Another function of the DERM is electrical system diagnostics. The DERM is utilized in conjunction with the resistors in the Arming Sensor, Discriminating Sensors and Resistor Module. These resistors make it possible for the DERM to detect circuit and component faults within the deployment loop. The DERM monitors the voltage drop across each component within the loop during normal non-deployment conditions. If the monitored voltages fall outside of expected limits, the DERM will indicate a fault through the storage of a malfunction code and the illumination of the "INFLATABLE RESTRAINT" indicator lamp.

COMPONENT DESCRIPTION

DERM:

The DERM (Diagnostic Energy Reserve Module) is designed to perform the following functions in the SIR system:

1) Energy Reserve; The DERM maintains a 36 Volt Loop Reserve (36VLR) energy supply to provide deployment energy for a few seconds when the vehicle voltage is low or if lost in a vehicle accident.
2) Malfunction Detection; The DERM performs diagnostic monitoring of SIR system, electrical components.
3) Malfunction Recording; The DERM provides SIR system fault code information through a scan tool or the "INFLATABLE RESTRAINT" indicator light.
4) Driver Notification; The DERM warns the vehicle driver of SIR system faults by controlling the "INFLATABLE RESTRAINT" indicator lamp.
5) Accident Recording; The DERM records the SIR system status during a vehicle accident.

The DERM is connected to the SIR harness by a 24 way connector. This harness connector utilizes a shorting bar across certain terminals in the contact area. This shorting bar connects the "INFLATABLE RESTRAINT" indicator input to ground when the DERM connector is disconnected. This will cause the "INFLATABLE RESTRAINT" indicator to come on steady whenever the ignition switch is at the RUN (BULB TEST) or START positions with the DERM disconnected.

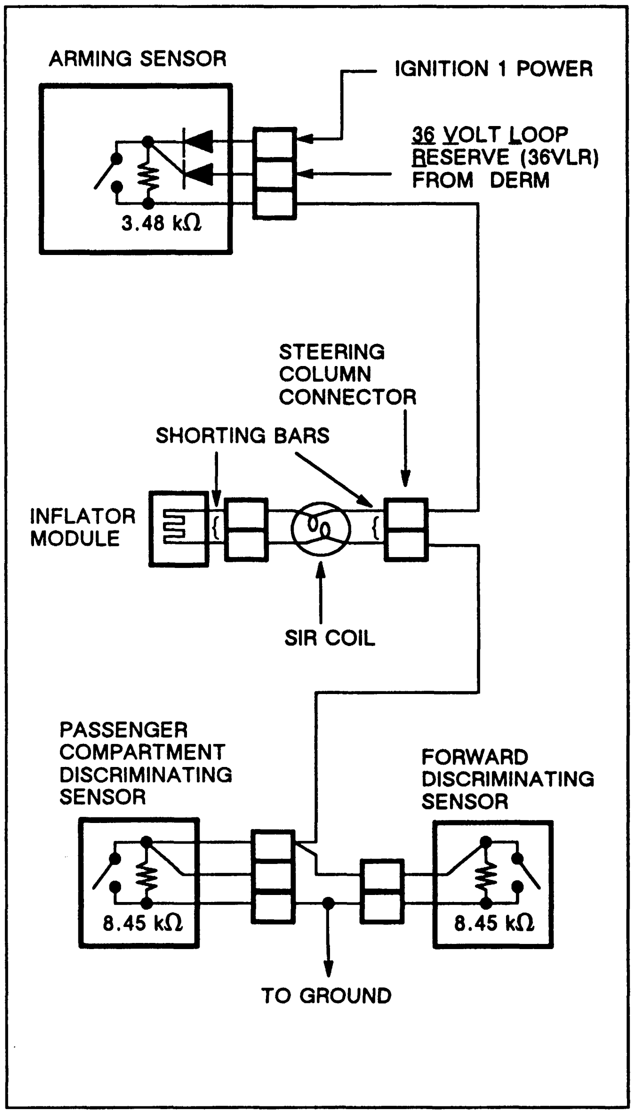


Figure 9J-A-1 Deployment Loop

"INFLATABLE RESTRAINT" INDICATOR:

Battery voltage is applied to the "INFLATABLE RESTRAINT" indicator lamp when the Ignition Switch is at the RUN (BULB TEST) or START positions. The DERM controls the lamp by providing ground with a lamp driver. The "INFLATABLE RESTRAINT" indicator lamp is used in the SIR system to do the following:

1) Verify lamp and DERM operation by flashing 7 to 9 times when the ignition switch is first turned on.
2) Warn the vehicle driver of SIR electrical system faults which could potentially affect the operation of the SIR system. These faults could result in non-deployment in case of an accident or deployment for conditions less severe than intended.
3) Provide diagnostic information by flashing the fault codes when the flash code diagnostic mode is enabled.

The "INFLATABLE RESTRAINT" indicator lamp is the key to driver notification of SIR system faults. Proper lamp operation is verified by the "SIR Diagnostic System Check" in this section.

ARMING SENSOR:

The Arming Sensor is a protective switch located in the power feed side (or high side) of the deployment loop. The Arming Sensor is calibrated to close at low level velocity changes (lower than the Discriminating Sensors). This assures that the Inflator Module is connected directly to the 36VLR output of the DERM or Ignition 1 voltage when either of the Discriminating Sensors closes.

The Arming Sensor consists of a sensing element, normally open switch contacts, a diagnostic resistor and two steering diodes. The sensing element closes the normally open switch contacts when the velocity of the vehicle changes at a rate indicating potential need for deployment.

The diagnostic resistor is connected in parallel with the normally open switch contacts and allows a small amount of current through the deployment loop during normal non-deployment conditions. This small current flow results in voltage drops across each component within the loop. The DERM monitors these voltage drops to detect circuit or component faults. The two steering diodes provide isolation between the 36VLR output of the DERM and Ignition 1 voltage.

DISCRIMINATING SENSORS:

There are two Discriminating Sensors in the SIR system. The Forward Discriminating Sensor is located in front of the radiator and the Passenger Compartment Discriminating Sensor is located in front of the console. The Discriminating Sensors are wired in parallel on the ground side (or low side) of the deployment loop. These sensors are calibrated to close with velocity changes which are severe enough to warrant deployment.

The Discriminating Sensors consist of a sensing element, normally open switch contacts and a diagnostic resistor. The sensing element closes the normally open switch contacts when the vehicle velocity changes are severe enough to warrant deployment.

A diagnostic resistor is connected in parallel with the normally open switch contacts within each of the Discriminating Sensors. These parallel resistors supply the ground path for the current passing through the deployment loop during normal non-deployment conditions. This small current flow results in voltage drops across each component within the loop. The DERM monitors these voltage drops to detect circuit or component faults.

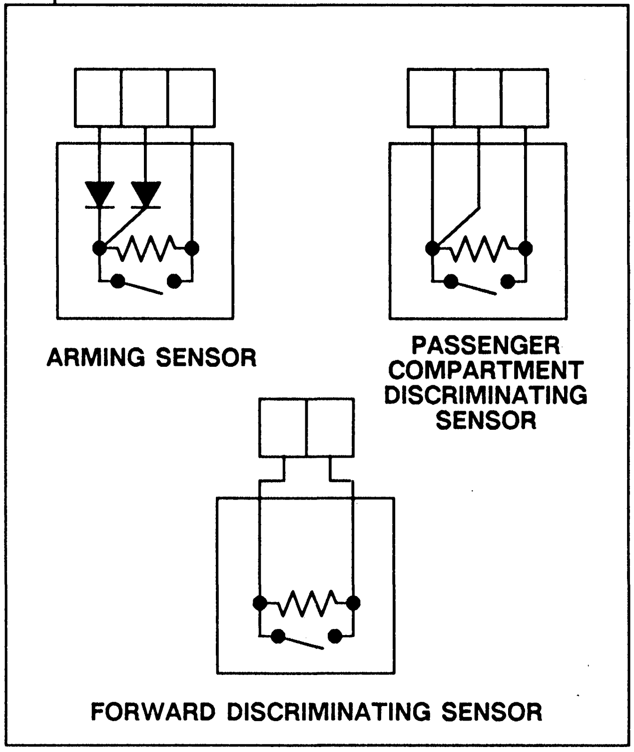


Figure 9J-2 Sensors

SIR COIL ASSEMBLY:

The SIR Coil Assembly consists of two current carrying coils. They are attached to the steering column and allow rotation of the steering wheel while maintaining continuous contact of the deployment loop through the Inflator Module.

There is a shorting bar on the lower steering column connector which connects the SIR Coil to the SIR harness. The shorting bar shorts the circuits to the main coil and Inflator Module when the lower steering column connector is disconnected. The circuit to the Inflator Module is shorted in this way to help prevent unwanted deployment of the air bag when servicing the steering column or other SIR components.

INFLATOR MODULE:

The Inflator Module is located on the steering wheel. The Inflator Module consists of: an inflatable bag, inflator and initiator (a canister of gas-generating material and initiating device). When the vehicle is in an accident of sufficient force to close the Arming Sensor and at least one of the Discriminating Sensors simultaneously, current is developed through the deployment loop. Current passing through the initiator thus ignites the material in the Inflator Module. The gas produced from this reaction rapidly inflates the air bag.

There is a shorting bar on the Inflator Module side of the upper steering column connector which connects the SIR Coil to the Inflator Module. The shorting bar shorts the Inflator Module circuit when the SIR Coil connector is disconnected. The circuit to the Inflator Module is shorted in this way to help prevent unwanted deployment of the air bag when servicing the Inflator Module or steering column.

RESISTOR MODULE:

The Resistor Module is inserted in the SIR harness between the Inflator Module and the DERM. The Resistor Module allows the DERM to monitor the deployment loop for faults and also allows the DERM to detect when a deployment has occurred.

The resistors in the Resistor Module are balanced with the resistors in the Arming and Discriminating Sensors to allow the DERM to monitor the voltage drops across the components of the deployment loop. Faults are detected during normal non-deployment conditions by monitoring these voltages.

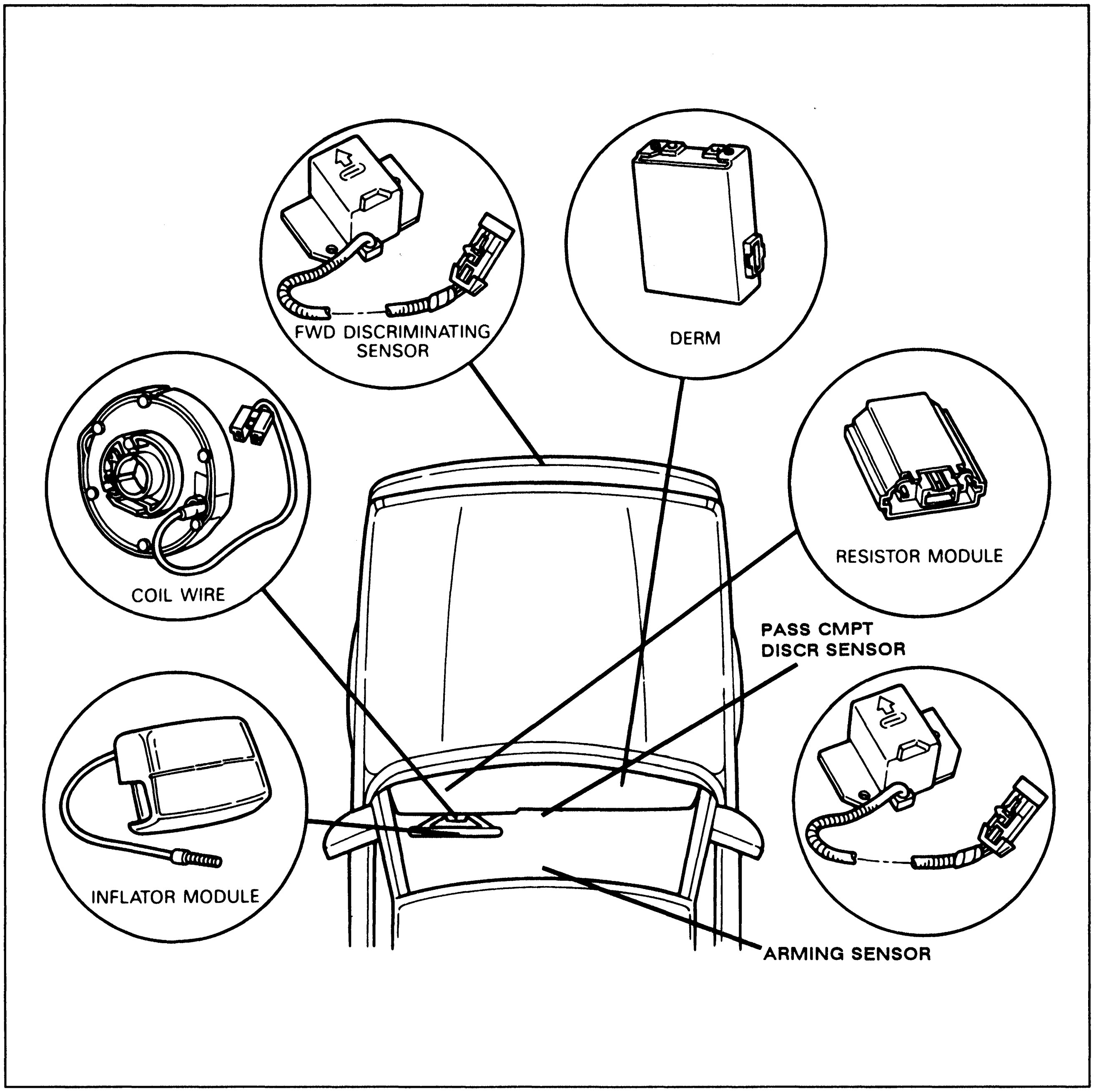


Figure 9J-3 SIR Component Location Guide

KNEE BOLSTER:

The knee bolster is used to absorb energy and control the driver's forward movement during a crash by limiting leg movement.

STEERING COLUMN:

The steering column is energy absorbing and is designed to compress in a front-end collision to lessen the chance of injury to the driver. A steering column reinforcement is also used for additional support.

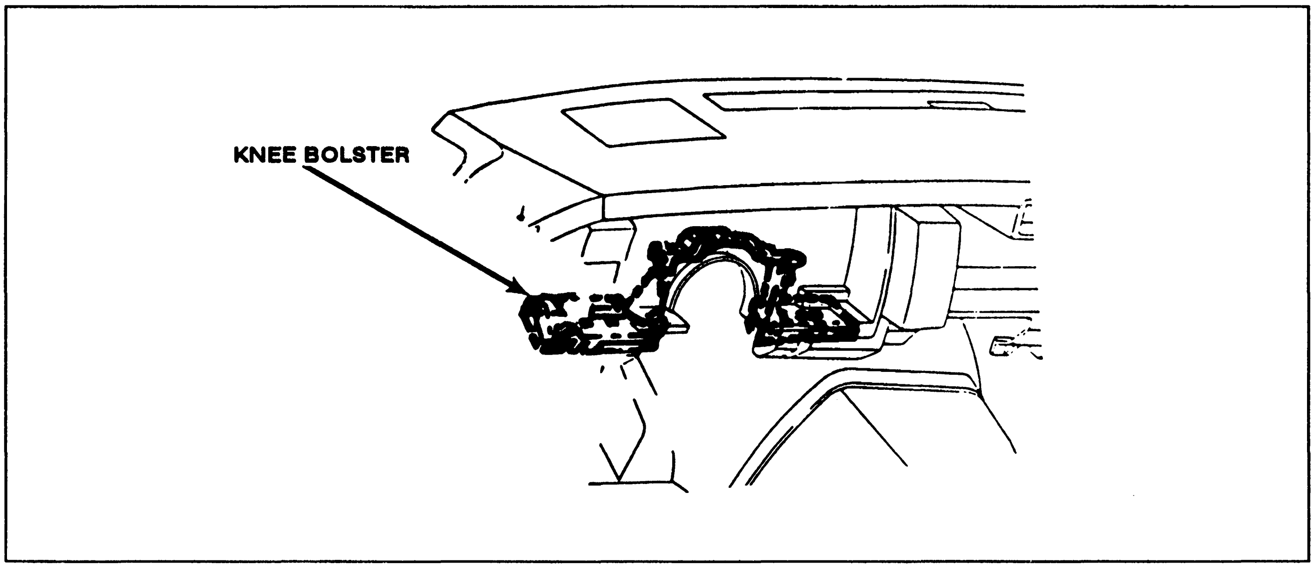


Figure 9J-4 Knee Bolster

DEFINITIONS

ALDL - Assembly Line Data Link.

ARMING SENSOR - A Sensor on the High side (or power side) of the deployment loop that is calibrated to supply voltage to the Inflator Module when the vehicle velocity changes are severe enough to warrant arming of the air bag.

"CONTINUOUS MONITORING" - Tests performed by the DERM on the SIR system every 100 milliseconds while Ignition 1 voltage is present at the DERM.

DATA LINK - A signal wire used for communications between multiple on-board computers or from an on-board computer to an off-board computer.

DEPLOY - To inflate the bag located in the trim cover of the steering wheel.

DEPLOYMENT LOOP - The circuit that supplies current to the Inflator Module in the steering wheel to deploy the air bag.

DERM - Diagnostic Energy Reserve Module which provides reserve energy to the deployment loop and diagnostic monitoring of all system components.

FORWARD DISCRIMINATING SENSOR - A Sensor on the ground side (or low side) of the deployment loop that is calibrated to ground the Inflator Module when the vehicle velocity changes are severe enough to warrant deployment of the air bag.

EEPROM - Electrically Erasable Programmable Read Only Memory.

FORCE HI - An output of the DERM which injects current into the steering column circuit during the "Steering Column Resistance" tests.

FORCE LOW - An input of the DERM which grounds the steering column circuit during the "Steering Column Resistance" tests.

INFLATOR MODULE - An assembly located in the steering wheel hub beneath the vinyl trim cover consisting of an inflatable bag and the Inflator.

NSSS - Neutral Start Safety Switch, switch to disable starter motor activation when the vehicle is not in Park or Neutral.

PASSENGER COMPARTMENT DISCRIMINATING SENSOR - A Sensor on the ground side (or low side) of the deployment loop that is calibrated to ground the Inflator Module when the vehicle velocity changes are severe enough to warrant deployment of the air bag.

RESISTOR MODULE - An assembly of resistors in the SIR harness between the DERM and steering wheel which allows the DERM to monitor the deployment loop for faults and detect when a vehicle accident has occurred.

SCAN TOOL - Tool used to read diagnostic information from the DERM via the ALDL connector.

SENSE HI - An input to the DERM on the high side of the deployment loop which the DERM monitors for fault detection.

SENSE LOW - An input to the DERM on the low side of the deployment loop which the DERM monitors for fault detection.

SIR - Supplemental Inflatable Restraint.

SIR COIL - A current carrying coil in the deployment loop that allows the rotation of the steering wheel while maintaining the continuous contact of the deployment loop through the Inflator Module.

WIRING HARNESS - The wires and connectors that electrically connect the components in the SIR system together.

"STEERING COLUMN RESISTANCE" - Inflator Module, SIR Coil and steering column wiring tests, which the DERM performs once each ignition cycle when no faults are detected during "Turn-on" or "Continuous Monitoring".

SYSTEM VOLTAGE - Voltage available at the battery at the time of the indicated voltage measurement. With the key on and engine not running, the system voltage will likely be between 12 and 12.5 volts. At idle the voltage may be 14 to 16 volts. The voltage could be as low as 10 volts during engine cranking.

"TURN-ON"- Tests which the DERM performs on the SIR system once during each ignition cycle immediately after Ignition 1 voltage is applied to the DERM.

36VLR - The 36 Volt Loop Reserve energy supply from the DERM which provides deployment power when vehicle voltage is low or is lost in an accident.

ON-VEHICLE SERVICE

SERVICE PRECAUTIONS

GENERAL SAFETY PROCEDURES

The DERM can maintain sufficient voltage to cause a deployment for up to 10 minutes after the Ignition Switch is turned off and the battery is disconnected. Many of the service procedures require disconnection of the Inflator Module from the deployment loop to avoid an accidental deployment. **The following procedure will disable the SIR system.**

Disabling the SIR System

Remove or Disconnect

- Turn the steering wheel so that the vehicle's wheels are pointing straight ahead.
- Turn the ignition switch to "LOCK."

1. SIR fuse from the fuse block.
2. Left sound insulator. Refer to INSTRUMENT PANEL CLUSTER AND CONSOLE (SEC. 8C).
3. Connector position assurance (CPA) and yellow two-way SIR harness connector at the base of the steering column.

When all service work is completed, the following procedure should be followed.

Enabling the SIR System

Install or Connect

1. Yellow two-way SIR harness connector to base of steering column and connector position assurance.
2. Left sound insulator. Refer to INSTRUMENT PANEL CLUSTER AND CONSOLE (SEC. 8C).
3. SIR fuse to the fuse block.

- Turn the ignition switch to "RUN" and verify that the inflatable restraint indicator flashes 7 to 9 times and then turns off. If the indicator does not respond as stated, refer to SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM DIAGNOSIS (SEC. 9J-A).

SENSORS

All sensors are specifically calibrated to each vehicle series and are keyed to the mounting brackets and the SIR wiring harness. Caution should be used to assure proper location of the sensors to their mounting brackets. **The keying of the sensors to their mounting brackets and wiring harness should never be modified in the field.** Refer to Section 8B for Forward Discriminating Sensor remove and replace procedures. Refer to Section 8C for the Arming Sensor or Passenger Compartment Discriminating Sensor remove and replace procedures.

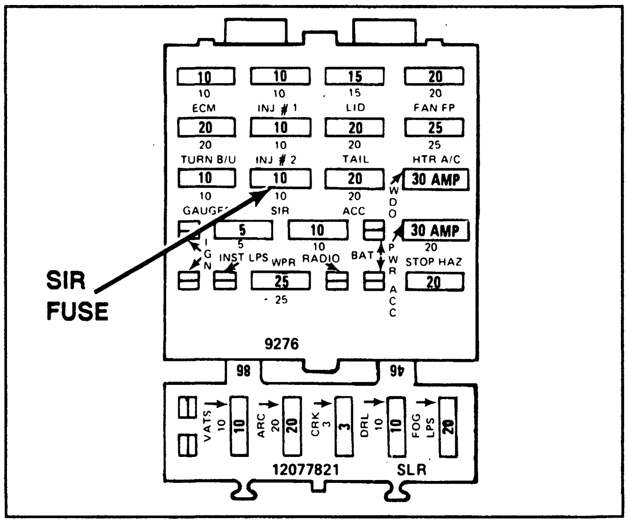


Figure 9J-5 Fuse Block

CAUTION: Be very careful when handling a sensor. Never strike or jar a sensor. If you do, it could cause deployment and result in personal injury or improper operation of the Supplemental Inflatable Restraint (SIR) System. All sensors and mounting bracket bolts must be carefully torqued to assure proper operation. Never power up the SIR system when any sensor is not rigidly attached to vehicle, since the sensor is easily activated when not attached and could result in deployment.

INFLATOR MODULE

LIVE (UNDEPLOYED) INFLATOR MODULES

Special care is necessary when handling and storing a live (undeployed) Inflator Module. The rapid gas generation produced during deployment of the air bag could cause the Inflator Module, or object in front of the Inflator Module, to be thrown through the air in the unlikely event of an accidental deployment.

CAUTION: When carrying a live Inflator Module, make sure the bag and trim cover are pointed away from you. In case of an accidental deployment, the bag will then deploy with minimal chance of injury. When placing a live Inflator Module on a bench or other surface, always face the bag and trim cover up, away from the surface. This is necessary so that a free space is provided to allow the air bag to expand in the unlikely event of accidental deployment. Otherwise, personal injury may result. Also, never carry the Inflator Module by the wires or connector on the underside of the module.

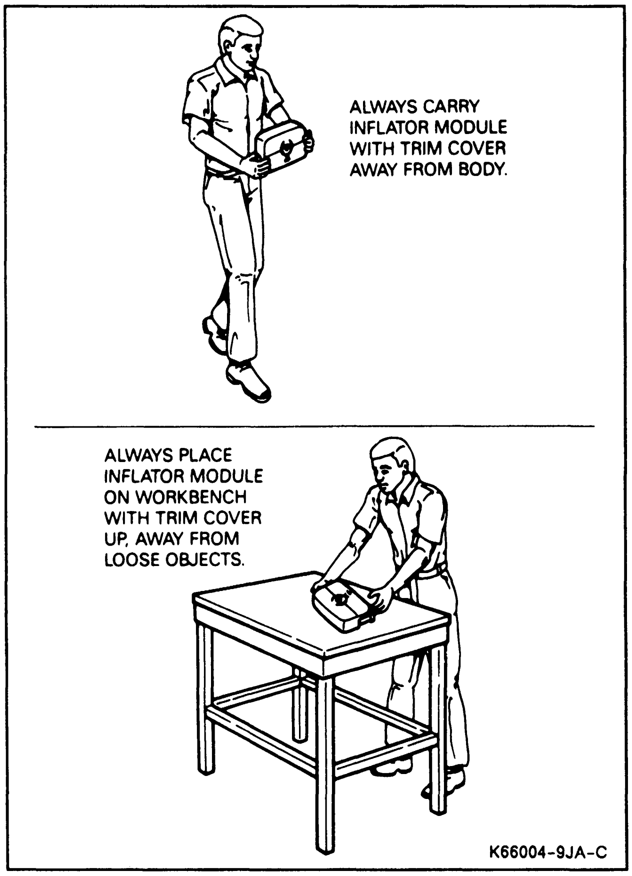


Figure 9J-6 Proper Live Inflator Module Handling

INFLATOR MODULE SHIPPING PROCEDURES FOR LIVE (UNDEPLOYED) INFLATOR MODULES

Chevrolet dealers should refer to the latest Chevrolet service bulletins for proper SIR inflator module shipping procedures.

INFLATOR MODULE SCRAPPING PROCEDURES

CAUTION: Failure to follow proper SIR inflator module disposal procedures can result in air bag deployment which may cause personal injury. Undeployed inflator modules must not be disposed of through normal refuse channels. The undeployed inflator module contains substances that can cause severe illness or personal injury if the sealed container is damaged during disposal. Disposal in any manner inconsistent with proper procedures may be a violation of federal, state and/or local laws.

Chevorlet dealers should refer to the latest Chevorlet Service bulletins for proper SIR Inflator Module disposal procedures. All others should contact a local Chevorlet dealership for proper SIR Inflator Module disposal procedures.

VEHICLE SCRAPPING PROCEDURES

Some vehicles equipped with SIR systems that have live (undeployed) Inflator Modules may have to be scrapped because they have completed their useful life or have been severely damaged in a nondeployment type accident. The following procedure should be followed when **scrapping a vehicle** with an undeployed module.

1. Turn ignition switch "OFF."
2. Disconnect the yellow 2-way connector at the base of the steering column.
3. Cut the *harness side* of the SIR wiring approximately 3 to 6 inches from the yellow 2-way connector.
4. Splice 2 wires at least 20 feet long to the wiring attached to the yellow 2-way that was cut from the SIR harness wiring in step 3.
5. Connect the yellow 2-way connector with 20 foot wires attached to yellow 2-way SIR connector at the base of the steering column .
6. Check that the Inflator Module is secured to the steering wheel.
7. Remove all loose objects from front seat.
8. Be sure no one is in the vehicle.
9. Stretch wires away from car to their full length.
10. To deploy air bag connect one wire to a 12 volt source and the other to ground.
11. Do not touch Inflator Module area for 20 minutes, due to heat generated during deployment.
12. Wear gloves and safety glasses if you handle the deployed air bag. Wash your hands with mild soap and water afterwards.

DEPLOYED INFLATOR MODULES

After an Inflator Module has been deployed, the surface of the air bag may contain a small amount of sodium hydroxide dust (a by-product of the reaction which takes place during deployment) combined with a white packing powder (used to ease deployment of the bag). The sodium hydroxide dust could be irritating to the skin if left on for an extended period of time.

CAUTION: Safety precautions must be observed when handling a deployed Inflator Module. After deployment, the air bag surface may contain deposits of sodium hydroxide dust, a by-product of the sodium azide reaction during deployment that is irritating to the skin. Always wear gloves and safety glasses when handling a deployed Inflator Module, and wash your hands with mild soap and water afterwards.

INSPECTIONS REQUIRED AFTER AN ACCIDENT

Important

All SIR system components, including harness and brackets, must be inspected after an accident. If any are damaged or bent, they must be replaced even if a deployment did not occur. Inspect steering column, (see Steering Column Unit Repair) and the knee bolster. Do not attempt to service the forward discriminating sensor, passenger compartment discriminating sensor, arming sensor, DERM, coil assembly or inflator module. Service is by replacement only with the crimp and seal splice sleeves contained within tool J-38125-A.

CAUTION: Proper operation of the sensors and Supplemental Inflatable Restraint (SIR) System requires that any repairs to the vehicle structure return it to its original production configuration. Deployment (Current Code 51) requires, at a minimum, replacement of the passenger compartment discriminating sensor, forward discriminating sensor, arming sensor and the inflator module. Any visible damage to the sensors and/or their respective mounting brackets requires replacement, whether a deployment occurred or not.

REMOVAL AND INSTALLATION PROCEDURES

Refer to the sections listed in the table below for component removal and replacement procedures.

ARMING SENSOR	Section 8C
DERM	Section 8C
DISCRIMINATING SENSORS:	
(FORWARD)	Section 8B
(PASSENGER COMPARTMENT)	Section 8C
INFLATOR MODULE	Section 3F4
"INFLATABLE RESTRAINT" INDICATOR LAMP	Section 8C
RESISTOR MODULE	Section 8C
SIR COIL	Section 3F4
SIR WIRING HARNESS	Section 9J

WIRING REPAIR

Special wiring repair procedures have been developed for use on the Supplemental Inflatable Restraint (SIR) system due to the sensitive nature of the circuitry. These instructions are to be followed whenever servicing the SIR system wiring.

TERMINAL REPAIR KIT J-38125-A

Essential tool kit J-38125-A contains special "sealed splices" for use in repairing SIR system wiring. A special crimping tool, heat torch, and instruction manual for these splices are also included.

Two critical features of the sealed splices are a special heat shrink sleeve with sealing adhesive to produce an environmentally sealed splice and a cross hatched (knurled) core crimp to provide necessary contact integrity for the sensitive, low energy circuits.

Tool kit J-38125-A also serves as a generic terminal repair kit. The kit contains a large sampling of common GM electrical terminals and the correct tools to apply them to wires and remove them from connectors. The terminals in the kit are not to be used to replace damaged SIR system terminals unless otherwise indicated by the terminal package. Specifically, the DERM/resistor terminal repair assembly pack, is included in J-38125-A for SIR use.

SIR-CONNECTOR (PLASTIC BODY AND TERMINAL METAL PIN) REPAIR

If any connector or terminal in the SIR wire harness (except pigtails) is damaged, the component should be repaired using one of the connector repair assembly packs. These kits include an instruction sheet and the sealed splices which will be necessary to splice the new wires, connector, and terminals to the harness. The crimping tool (the tool which is color keyed to match the splices) from terminal repair kit J-38125-A must be used to apply these splices.

The terminals in the SIR system are made of a special metal to provide necessary contact integrity for the sensitive low energy circuits. These terminals are only available in the connector repair assembly packs and no other terminal should be substituted.

If individual terminals are damaged on the DERM or resistor module, they should be repaired using the DERM/resistor terminal repair assembly pack. If individual terminals are damaged on any other SIR connection, the entire connection should be replaced using the appropriate Connector Repair Assembly Pack.

SIR WIRE PIGTAIL REPAIR

If the wiring pigtail (wire attached directly to the device, not by a connector [Sensor, Coil Assembly, or Inflator Module] is damaged, the entire component (with pigtail) should be replaced. Absolutely no wire, connector, or terminal repair is to be attempted on the Arming Sensor, Passenger Compartment Discriminating Sensor, the Forward Discriminating Sensor, the Inflator Module, or the SIR Coil Assembly.

SIR WIRE REPAIR

If any wire except the pigtail is damaged, the wire should be repaired by splicing in a new section of wire of the same gauge size (.5, .8, 1.0, etc.). The sealed splices and crimping tool from terminal repair kit J-38125-A must be used for these splices. Carefully follow the following wiring repair procedures or the instructions included in the kit, for proper sealed splice application.

Step One: Open the Harness

If the harness is taped, remove the tape. To avoid wire insulation damage use a sewing "seam ripper" to cut open the harness (available from sewing supply stores). The crimp and seal splice sleeves may be used on all types of insulation except tefzel and coaxial and may only be used to form a one to one splice.

Step Two: Cut the Wire

Begin by cutting as little wire off the harness as possible. You may need the extra length of wire later if you decide to cut more wire to change the location of a splice. You may have to adjust splice locations to make certain that each splice is at least 40 mm (1.5 in.) away from other splices, harness branches, or connectors.

Step Three: Strip the Insulation

If it is necessary to add a length of wire to the existing harness, be certain to use the same size as the original wire.

To find the correct wire size either find the wire on the schematic and convert the metric size to the equivalent AWG size or use an AWG wire gage. If unsure about the wire size, begin with the largest opening in your wire stripper and work down until you get a clean strip of the insulation. Strip approximately 7.5 mm (5/16 in.) of insulation from each wire to be spliced. Be careful to avoid nicking or cutting any of the wires. Check the stripped wire for nicks or cut strands. If the wire is damaged, repeat this procedure after removing the damaged section.

Step Four: Select and Position the Splice Sleeve

Select the proper splice sleeve according to wire size. The splice sleeves and tool nests are color coded (see following chart).

CRIMP AND SEAL SPLICE CHART

Color splice sleeve	Crimp tool nest color	Wire gage AWG/ (metric)
Salmon (yellowish-pink)	Red	20, 18/ (0.5, 0.8)
Blue	Blue	16, 14/ (1.0, 2.0)
Yellow	Yellow	12, 10/ (3.0, 5.0)

Using the J-38125-A splice crimp tool (see Figure 9J-7), position the splice sleeve in the proper color nest of the hand crimp tool. Place the splice sleeve in the nest so that the crimp falls midway between the end of the barrel and the stop.

The sleeve has a stop in the middle of the barrel to prevent the wire from going further (see Figure 9J-8). Close the hand crimper handles slightly to hold the splice sleeve firmly in the proper nest.

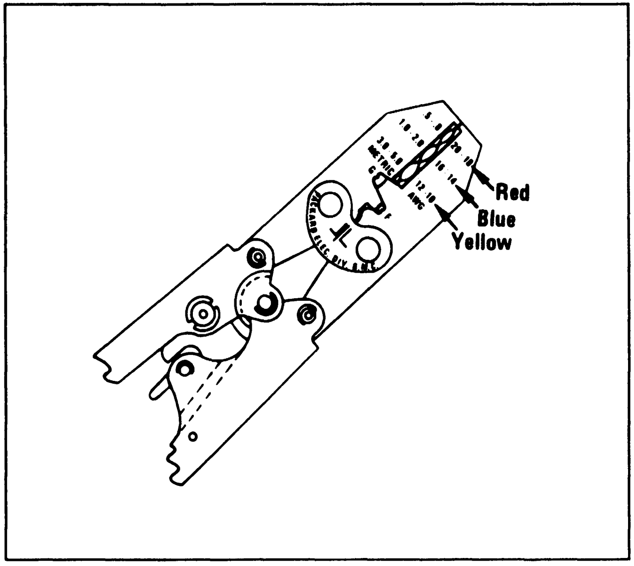


Figure 9J-7 Hand Crimp Tool

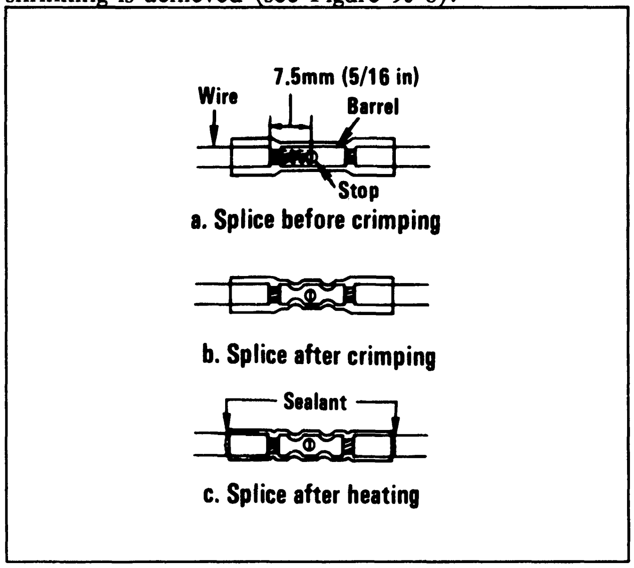
Step Five: Insert Wires Into Splice Sleeve and Crimp

Insert the wire into the splice sleeve until it hits the barrel stop and close the handles of the crimper tightly until the crimper handles open when released (see Figure 9J-8). The crimper handles will not open until the proper amount of pressure is applied to the splice sleeve. Repeat steps 4 and 5 for opposite end of the splice.

Step Six: Shrink the Insulation around the Splice

Using the heat torch apply heat where the barrel is crimped.

Gradually move the heat barrel to the open end of the tubing, shrinking the tubing completely as the heat is moved along the insulation. A small amount of sealant will come out of the end of the tubing when sufficient shrinking is achieved (see Figure 9J-8).



a. Splice before crimping

b. Splice after crimping

c. Splice after heating

Figure 9J-8 Seal Splice Sequence

SIR SYSTEM WIRE SPLICE REPAIR

If any of the original equipment splices (S201, etc., three wires or more) in the SIR system wiring are damaged they should be repaired by applying a new splice (not sealed) from terminal kit J-38125-A. Carefully follow the instructions included in the kit for proper splice clip application. Cloth duct tape may be substituted for splice tape if necessary.

ALTERNATIVE REPAIR METHODS

No alternative repair methods are available for the SIR system wiring and components.

SPECIAL TOOLS

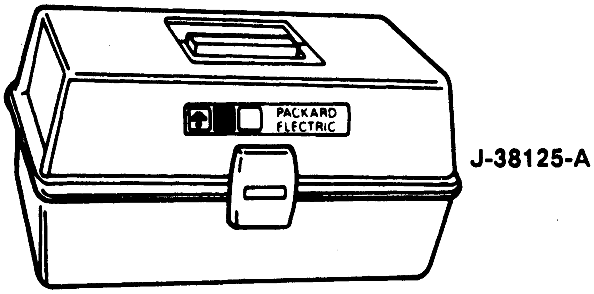


Figure 9J-9 SIR Required Tools

SECTION 9J-A

SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM DIAGNOSIS

CAUTION: The procedures in this section must be followed in the order listed to temporarily disable the Supplemental Inflatable Restraint (SIR) System and prevent false diagnostic codes from setting. Failure to follow this procedure could result in possible air bag deployment, personal injury, or unneeded SIR system repairs.

CONTENTS

HOW TO USE THIS SECTION

DIAGNOSTIC PROCEDURES

The diagnostic procedures used in this section are designed to aid in finding and repairing SIR problems. Outlined below are the steps to find and repair SIR problems quickly and effectively. **Not carefully following these procedures may result in extended diagnostic time, incorrect diagnosis and incorrect part replacements.**

1. PERFORM THE "SIR DIAGNOSTIC SYSTEM CHECK."

   The "SIR Diagnostic System Check" should always be the starting point of any SIR diagnostics. The "SIR Diagnostic System Check" checks for proper "INFLATABLE RESTRAINT" indicator operation and checks for SIR trouble codes using either "Flash Code" or "Scan Tool" methods, as preferred.

2. REFER TO THE PROPER DIAGNOSTIC CHART AS DIRECTED BY THE "SIR DIAGNOSTIC SYSTEM CHECK."

   The "SIR Diagnostic System Check" will lead you to the correct chart to diagnose any SIR problems. **Bypassing these procedures may result in extended diagnostic time, incorrect diagnosis and incorrect part replacements.**

3. REPEAT THE "SIR DIAGNOSTIC SYSTEM CHECK" AFTER ANY REPAIR OR DIAGNOSTIC PROCEDURES HAVE BEEN PERFORMED.

Performing the "SIR Diagnostic System Check" after all repair or diagnostic procedures will assure that the repair has been made correctly and that no other conditions exist.

TROUBLE CODES

The DERM maintains a history of all trouble codes that have been detected since the SIR codes were last cleared during service. The trouble codes are also stored according to class:

1) **Current Codes** - Faults that are presently being detected. Current codes are stored in RAM (Random Access Memory).
2) **History Codes** - All faults detected since the last time the EEPROM fault memory was cleared. History codes are stored in EEPROM.

How To Read Trouble Codes

Current codes can be read by using flash code or scan tool diagnostics. The presence of any history codes can be determined by using flash code diagnostics; however, the specific history code numbers can be read and cleared only by using scan tool diagnostics.

How To Clear History Codes

History codes can only be cleared by using a Scan Tool. If a scan tool is not available, inform the owner of the stored codes and suggest that the codes be cleared upon the next visit to a GM dealership.

Flash Code Diagnostics

Flash code diagnostics can only be used to read current codes and to determine if history codes are present. Flash code diagnostics cannot be used to clear codes or read history codes. Flash code diagnostics is enabled by grounding terminal K of the ALDL connector with the ignition switch "ON". Grounding terminal K of the ALDL connector pulls the "Diagnostic Request" input (terminal A5) of the DERM low and signals the DERM to enter the flash code diagnostic display mode.

The DERM displays the trouble codes by flashing the "INFLATABLE RESTRAINT" indicator with a lamp driver at the "SIR Indicator Low" output (terminal A1). Each code that is displayed will consist of a number of flashes which represents the tens or first digit, a 1/2 second pause, followed by a number of flashes which represents the ones or second digit of the code. Each code is flashed once before moving on to the next code. After all of the codes have been displayed, the entire code sequence will continually be repeated until ground is removed from terminal K of the ALDL connector.

Two special codes exist when reading in the flash code mode (Flash Code 12 and Flash Code 13). Code 12 will always be the first code displayed when the flash code mode is enabled. Code 12 is not an indication of a SIR fault, but an indication that the flash code mode has been enabled. If there are no current or history codes present the DERM will display code 12 until ground is removed from the ALDL connector at terminal K. Flash Code 13 will be displayed if there are history codes or if there are codes in history that are not current. To read the history codes a scan tool must be used.

Scan Tool Diagnostics

A Scan Tool can be used to read current and history codes and to clear all history codes after a repair is complete. The scan tool must be updated to communicate with the SIR system through a replaceable cartridge or a manufacturer's update before it can be used for SIR diagnostics. To use the scan tool, connect it to the ALDL connector and turn the ignition switch "ON." Follow the manufacturer's directions for communication with the SIR system. The scan tool reads serial data from the DERM "Data Link" output (terminal A8) to the ALDL connector (terminal M).

BASIC KNOWLEDGE REQUIRED

Before using this section of the Service Manual, there is some basic knowledge required. Without this knowledge, you will have trouble using the diagnostic procedures in this section. Use care to prevent harm or unwanted deployment. Read all cautions in the Service Manual and on warning labels attached to SIR components.

BASIC ELECTRICAL CIRCUITS

You should understand the basic theory of electricity including series and parallel circuits, and understand the voltage drops across series resistors. You should know the meaning of voltage (volts), current (amps), and resistance (ohms). You should understand what happens in a circuit with an open or a shorted wire. You should be able to read and understand a wiring diagram.

USE OF SPECIAL TOOLS

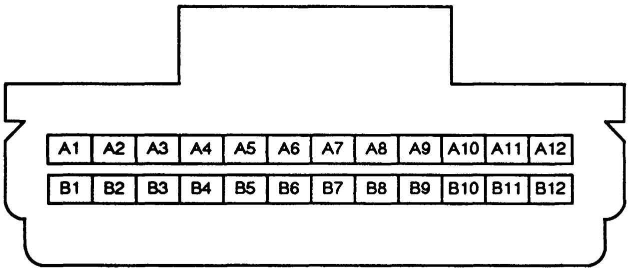
You should be familiar with the tools listed under the heading "SPECIAL TOOLS." You should be able to measure voltage, resistance, and current. You should be familiar with proper use of the Scan Tool and DVOM.

CAUTION: To avoid deployment when troubleshooting the SIR system, do not use electrical test equipment such as test lights, battery powered or A/C powered voltmeter, ohmmeter, etc., or any type of electrical equipment other than those specified in this manual. Instructions in this manual must be followed carefully, otherwise personal injury may result.

WIRING REPAIR

Wiring repair procedures are included in Sections 8A and 9J of the service manual. When repairing any wiring associated with the Iflatable Restraint system, ALWAYS USE THE "CRIMP AND SEAL SPLICE SLEEVES" CONTAINED WITHIN TOOL J38125-A.

SIR WIRING CONNECTOR FACE VIEWS

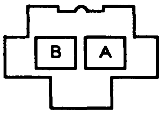


YELLOW

Micro-Pack

DERM

V00742.0

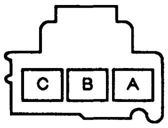


YELLOW

Metri-Pack

STEERING COLUMN CONNECTOR

V00750.0

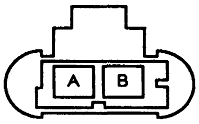


YELLOW

Metri-Pack

ARMING SENSOR

V00749.0

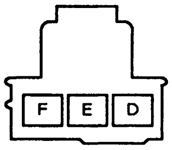


YELLOW

Metri-Pack

FORWARD DISCRIMINATING SENSOR

V00748.0

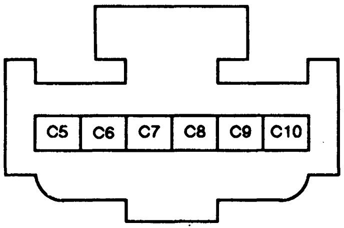


YELLOW

Metri-Pack

PASSENGER COMPARTMENT DISCRIMINATING SENSOR

V00751.0



YELLOW

Micro-Pack

RESISTOR MODULE

V00743.0

Figure 9J-A-7 SIR Connector Body Face Views

CAUTION:

To avoid deployment when troubleshooting the SIR system, do not use electrical test equipment such as test lights, battery powered or A/C powered voltmeter, ohmmeter, etc., or any type of electrical equipment other than those specified in this manual. Instructions in this manual must be followed carefully, otherwise personal injury may result.

SIR DIAGNOSTIC SYSTEM CHECK

The diagnostic procedures used in this section are designed to find and repair SIR problems. To get the best results, it is important to utilize the diagnostic charts and follow the sequence listed below.

A. PERFORM THE "SIR DIAGNOSTIC SYSTEM CHECK."

The "SIR Diagnostic System Check" should be the starting point of any SIR diagnostics. The "SIR Diagnostic System Check" checks for proper "INFLATABLE RESTRAINT" indicator operation and checks for SIR trouble codes.

B. REFER TO THE PROPER DIAGNOSTIC CHART AS DIRECTED BY THE "SIR DIAGNOSTIC SYSTEM CHECK."

The "SIR Diagnostic System Check" will lead you to the correct chart to diagnose any SIR problems. Bypassing these procedures may result in extended diagnostic time.

C. REPEAT THE "SIR DIAGNOSTIC SYSTEM CHECK" AFTER ANY REPAIR OR DIAGNOSTIC PROCEDURES HAVE BEEN PERFORMED.

Performing the "SIR Diagnostic System Check" after all repair or diagnostic procedures will assure that the repair has been made correctly and that no other conditions exist.

Description:

When the ignition switch is first turned "ON," system voltage is applied through the SIR FUSE to the DERM at the "Ignition 1" input and through GAGES FUSE to the DERM at the "SIR Indicator Low" and "SIR Indicator High" inputs. The DERM responds by blinking the "INFLATABLE RESTRAINT" indicator 7 to 9 times.

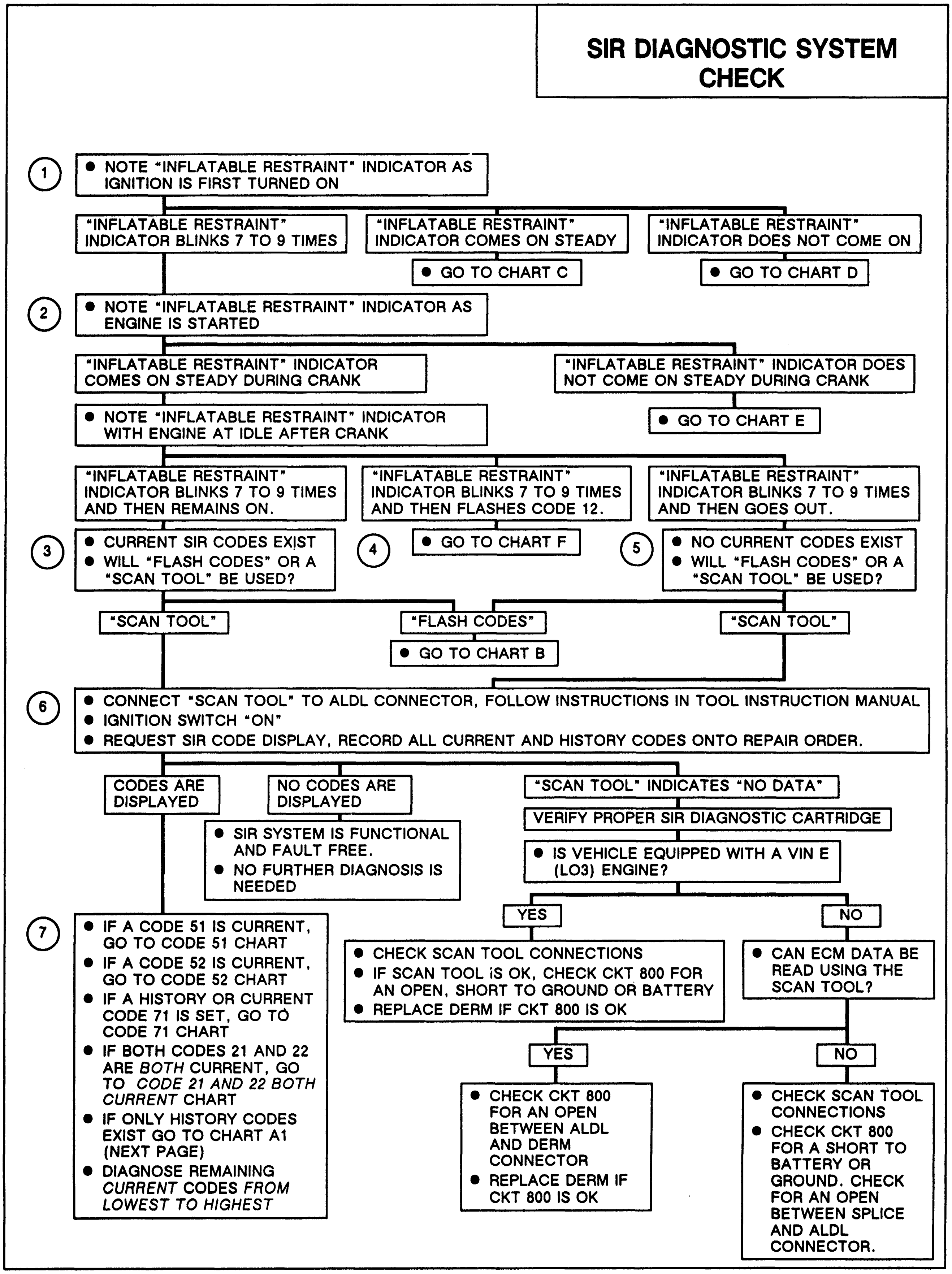
When the engine is being cranked system voltage is applied to the DERM at the "CRANK" input. The DERM grounds the lamp circuit until system voltage is removed from the "CRANK" input. This results in a steady "INFLATABLE RESTRAINT" indicator during cranking.

After cranking the DERM will again blink the "INFLATABLE RESTRAINT" indicator 7 to 9 times.

Notes on Fault Tree:

1) The "INFLATABLE RESTRAINT" indicator should blink 7 to 9 times as the ignition is just turned on. If the indicator does not respond use Chart C or D to diagnose the indicator malfunction.
2) As the engine is "Cranked" the "INFLATABLE RESTRAINT" indicator should remain on steady. If the indicator does not respond use Chart E to diagnose the malfunction.
3) The "INFLATABLE RESTRAINT" indicator has completed the "Bulb Check" and remains on indicating a current code has been detected. At this point a "Scan Tool" or the "INFLATABLE RESTRAINT" indicator can be used to diagnose the malfunction. For "Flash Code" diagnosis use Chart B.
4) After "Cranking" the engine the "INFLATABLE RESTRAINT" indicator should blink 7 to 9 times and then go out. If the indicator begins to flash a Code 12, there is a system fault. Use Chart F to diagnose the malfunction.
5) The "INFLATABLE RESTRAINT" indicator has completed the "Bulb Check" and is indicating no current codes exist.
6) Record all codes (both History and Current) onto the repair order. If there are no codes (History or Current) record this fact onto the repair order. No further diagnosis is required. If the scan tool indicates that no data is being received from the DERM, then the data link will require repair.
7) If multiple codes are displayed (History or Current). **The order that the codes are diagnosed is very important. Refer to the recommended charts.**

SIR DIAGNOSTIC SYSTEM CHECK



①
- NOTE "INFLATABLE RESTRAINT" INDICATOR AS IGNITION IS FIRST TURNED ON

"INFLATABLE RESTRAINT" INDICATOR BLINKS 7 TO 9 TIMES

"INFLATABLE RESTRAINT" INDICATOR COMES ON STEADY
- GO TO CHART C

"INFLATABLE RESTRAINT" INDICATOR DOES NOT COME ON
- GO TO CHART D

②
- NOTE "INFLATABLE RESTRAINT" INDICATOR AS ENGINE IS STARTED

"INFLATABLE RESTRAINT" INDICATOR COMES ON STEADY DURING CRANK
- NOTE "INFLATABLE RESTRAINT" INDICATOR WITH ENGINE AT IDLE AFTER CRANK

"INFLATABLE RESTRAINT" INDICATOR DOES NOT COME ON STEADY DURING CRANK
- GO TO CHART E

"INFLATABLE RESTRAINT" INDICATOR BLINKS 7 TO 9 TIMES AND THEN REMAINS ON.

③
- CURRENT SIR CODES EXIST
- WILL "FLASH CODES" OR A "SCAN TOOL" BE USED?

"INFLATABLE RESTRAINT" INDICATOR BLINKS 7 TO 9 TIMES AND THEN FLASHES CODE 12.

④
- GO TO CHART F

"INFLATABLE RESTRAINT" INDICATOR BLINKS 7 TO 9 TIMES AND THEN GOES OUT.

⑤
- NO CURRENT CODES EXIST
- WILL "FLASH CODES" OR A "SCAN TOOL" BE USED?

"SCAN TOOL"

"FLASH CODES"
- GO TO CHART B

"SCAN TOOL"

⑥
- CONNECT "SCAN TOOL" TO ALDL CONNECTOR, FOLLOW INSTRUCTIONS IN TOOL INSTRUCTION MANUAL
- IGNITION SWITCH "ON"
- REQUEST SIR CODE DISPLAY, RECORD ALL CURRENT AND HISTORY CODES ONTO REPAIR ORDER.

CODES ARE DISPLAYED

⑦
- IF A CODE 51 IS CURRENT, GO TO CODE 51 CHART
- IF A CODE 52 IS CURRENT, GO TO CODE 52 CHART
- IF A HISTORY OR CURRENT CODE 71 IS SET, GO TO CODE 71 CHART
- IF BOTH CODES 21 AND 22 ARE *BOTH* CURRENT, GO TO *CODE 21 AND 22 BOTH CURRENT* CHART
- IF ONLY HISTORY CODES EXIST GO TO CHART A1 (NEXT PAGE)
- DIAGNOSE REMAINING *CURRENT* CODES *FROM LOWEST TO HIGHEST*

NO CODES ARE DISPLAYED
- SIR SYSTEM IS FUNCTIONAL AND FAULT FREE.
- NO FURTHER DIAGNOSIS IS NEEDED

"SCAN TOOL" INDICATES "NO DATA"

VERIFY PROPER SIR DIAGNOSTIC CARTRIDGE

- IS VEHICLE EQUIPPED WITH A VIN E (LO3) ENGINE?

YES
- CHECK SCAN TOOL CONNECTIONS
- IF SCAN TOOL IS OK, CHECK CKT 800 FOR AN OPEN, SHORT TO GROUND OR BATTERY
- REPLACE DERM IF CKT 800 IS OK

NO
- CAN ECM DATA BE READ USING THE SCAN TOOL?

YES
- CHECK CKT 800 FOR AN OPEN BETWEEN ALDL AND DERM CONNECTOR
- REPLACE DERM IF CKT 800 IS OK

NO
- CHECK SCAN TOOL CONNECTIONS
- CHECK CKT 800 FOR A SHORT TO BATTERY OR GROUND. CHECK FOR AN OPEN BETWEEN SPLICE AND ALDL CONNECTOR.

Figure 9J-A-1 SIR Diagnostic System Check

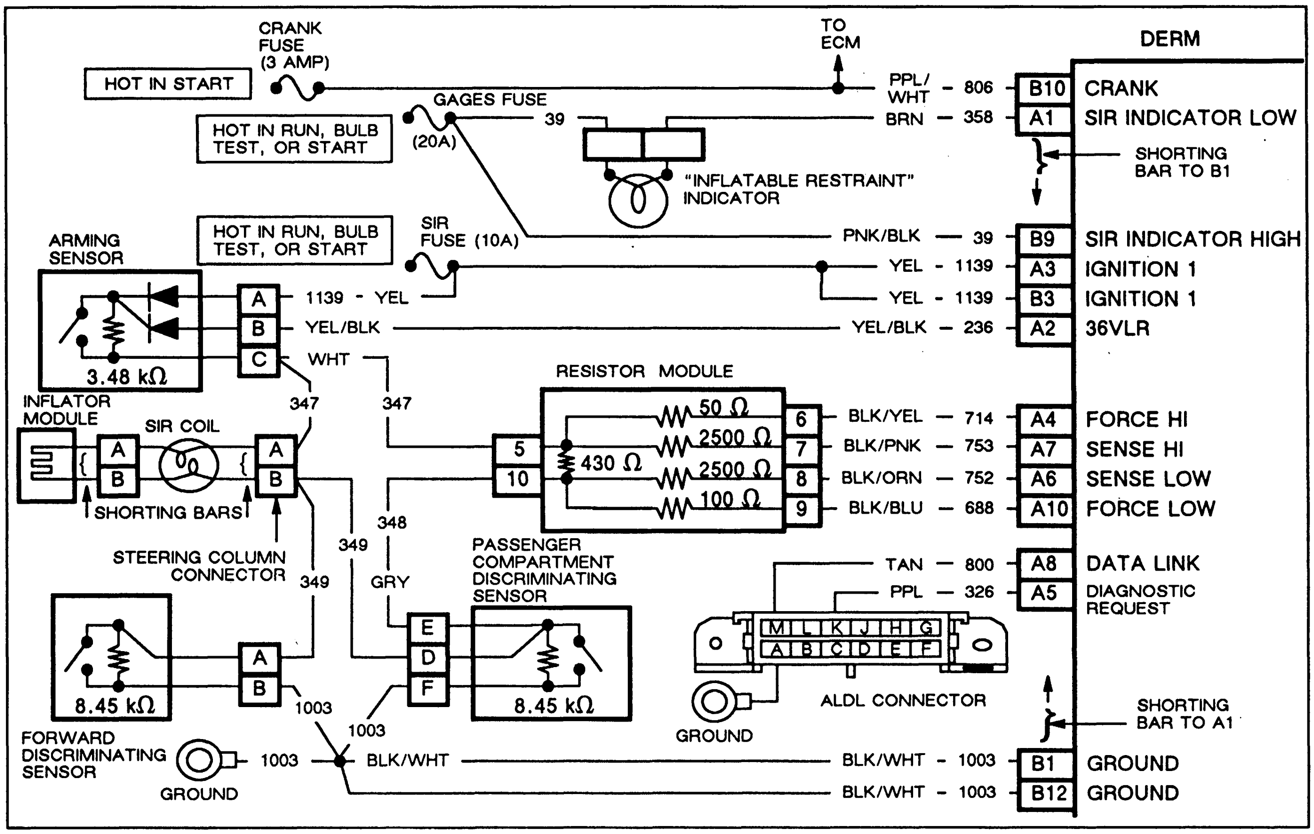


Figure 9J-A-2 SIR Circuit

CHART A1
"SCAN TOOL" HISTORY CODE DIAGNOSIS

Description:

When the Ignition Switch is first turned "ON" system voltage is applied through GAGES FUSE to "SIR Indicator High" (B9) and to the "INFLATABLE RESTRAINT" Indicator Lamp which is connected to "SIR Indicator Low" (A1). SIR FUSE also applies system voltage to the "Ignition 1" inputs (A3 and B3). The DERM responds by blinking the "INFLATABLE RESTRAINT" indicator 7 to 9 times.

When the engine is being cranked system voltage is applied to the DERM at the "CRANK" input. The DERM grounds the lamp circuit until system voltage is removed from the "CRANK" input. This results in a steady "INFLATABLE RESTRAINT" indicator during cranking.

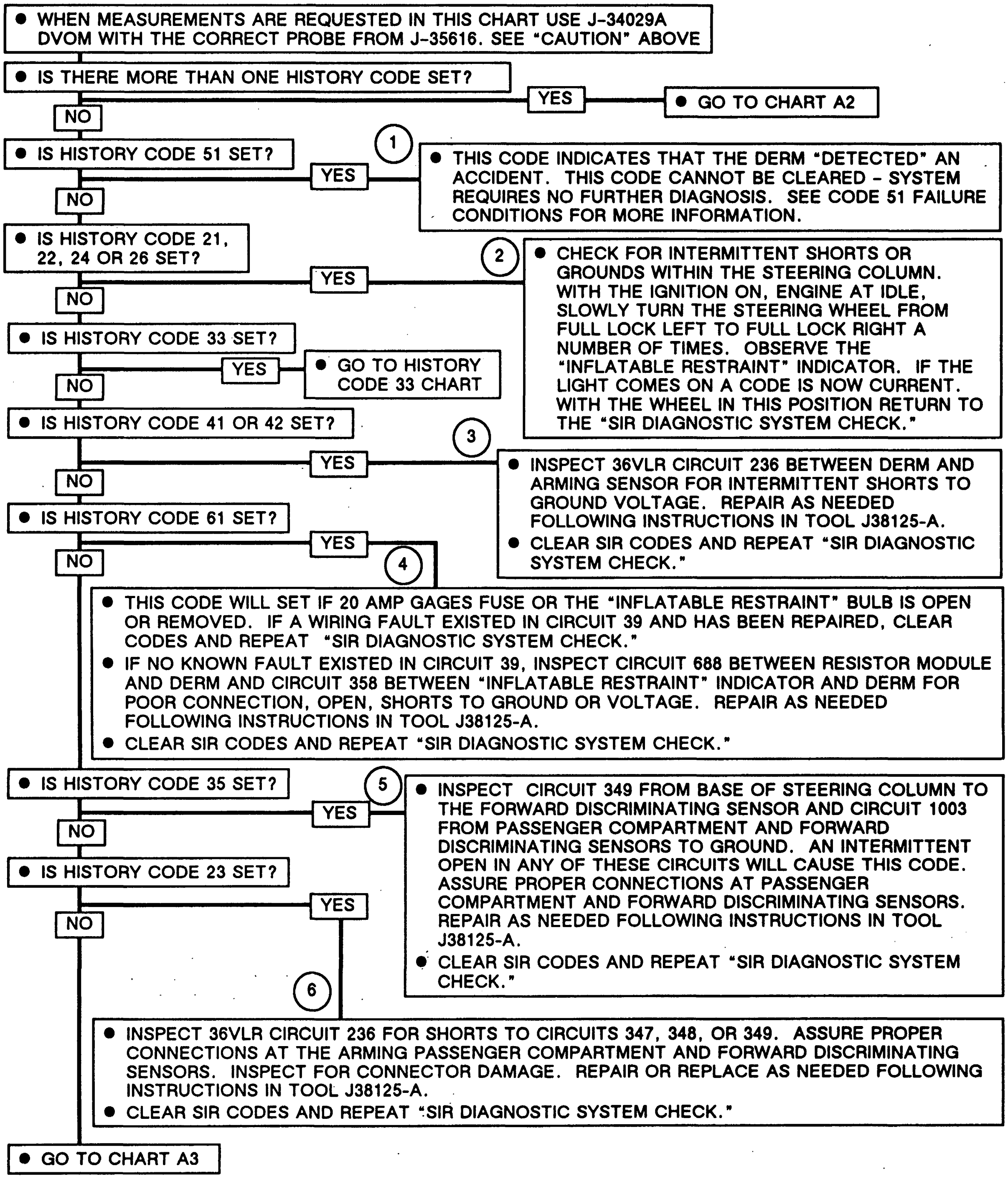
After cranking the DERM will again blink the "INFLATABLE RESTRAINT" indicator 7 to 9 times.

Notes on Fault Tree:

1) The DERM determines that the Arming Sensor is closed when system voltage or more is present at the "Sense Hi" input, and it determines that a Discriminating sensor in closed when it notes low voltage at the "Sense Low" input. There are some faults that may "look" like an accident to the DERM, and therefore record a code 51. History Code 51 therefore is not proof that the vehicle was in an accident.
2) Checks for intermittent electrical conditions within the steering column.
3) Checks for intermittent shorts in the 36VLR wiring (circuit 236).
4) Checks for misinstalled GAGES FUSE and "INFLATABLE RESTRAINT" Indicator bulb or uncleared code 61 after a completed wiring repair on circuit 39. Also checks for intermittent faults in circuits 688 and 358.
5) Checks for intermittent opens in the ground path of the deployment loop between the base of the steering column and both discriminating sensors (circuit 349-both branches).
6) Checks for intermittent wiring shorts between 36VLR circuit 236 and circuits 347, 348 and 349 of the SIR wiring harness.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CHART A1
"SCAN TOOL" HISTORY CODE DIAGNOSIS



- WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART USE J-34029A DVOM WITH THE CORRECT PROBE FROM J-35616. SEE "CAUTION" ABOVE
- IS THERE MORE THAN ONE HISTORY CODE SET?
- GO TO CHART A2
- IS HISTORY CODE 51 SET?
- ① THIS CODE INDICATES THAT THE DERM "DETECTED" AN ACCIDENT. THIS CODE CANNOT BE CLEARED - SYSTEM REQUIRES NO FURTHER DIAGNOSIS. SEE CODE 51 FAILURE CONDITIONS FOR MORE INFORMATION.
- IS HISTORY CODE 21, 22, 24 OR 26 SET?
- ② CHECK FOR INTERMITTENT SHORTS OR GROUNDS WITHIN THE STEERING COLUMN. WITH THE IGNITION ON, ENGINE AT IDLE, SLOWLY TURN THE STEERING WHEEL FROM FULL LOCK LEFT TO FULL LOCK RIGHT A NUMBER OF TIMES. OBSERVE THE "INFLATABLE RESTRAINT" INDICATOR. IF THE LIGHT COMES ON A CODE IS NOW CURRENT. WITH THE WHEEL IN THIS POSITION RETURN TO THE "SIR DIAGNOSTIC SYSTEM CHECK."
- IS HISTORY CODE 33 SET?
- GO TO HISTORY CODE 33 CHART
- IS HISTORY CODE 41 OR 42 SET?
- ③ INSPECT 36VLR CIRCUIT 236 BETWEEN DERM AND ARMING SENSOR FOR INTERMITTENT SHORTS TO GROUND VOLTAGE. REPAIR AS NEEDED FOLLOWING INSTRUCTIONS IN TOOL J38125-A.
- CLEAR SIR CODES AND REPEAT "SIR DIAGNOSTIC SYSTEM CHECK."
- IS HISTORY CODE 61 SET?
- ④ THIS CODE WILL SET IF 20 AMP GAGES FUSE OR THE "INFLATABLE RESTRAINT" BULB IS OPEN OR REMOVED. IF A WIRING FAULT EXISTED IN CIRCUIT 39 AND HAS BEEN REPAIRED, CLEAR CODES AND REPEAT "SIR DIAGNOSTIC SYSTEM CHECK."
- IF NO KNOWN FAULT EXISTED IN CIRCUIT 39, INSPECT CIRCUIT 688 BETWEEN RESISTOR MODULE AND DERM AND CIRCUIT 358 BETWEEN "INFLATABLE RESTRAINT" INDICATOR AND DERM FOR POOR CONNECTION, OPEN, SHORTS TO GROUND OR VOLTAGE. REPAIR AS NEEDED FOLLOWING INSTRUCTIONS IN TOOL J38125-A.
- CLEAR SIR CODES AND REPEAT "SIR DIAGNOSTIC SYSTEM CHECK."
- IS HISTORY CODE 35 SET?
- ⑤ INSPECT CIRCUIT 349 FROM BASE OF STEERING COLUMN TO THE FORWARD DISCRIMINATING SENSOR AND CIRCUIT 1003 FROM PASSENGER COMPARTMENT AND FORWARD DISCRIMINATING SENSORS TO GROUND. AN INTERMITTENT OPEN IN ANY OF THESE CIRCUITS WILL CAUSE THIS CODE. ASSURE PROPER CONNECTIONS AT PASSENGER COMPARTMENT AND FORWARD DISCRIMINATING SENSORS. REPAIR AS NEEDED FOLLOWING INSTRUCTIONS IN TOOL J38125-A.
- CLEAR SIR CODES AND REPEAT "SIR DIAGNOSTIC SYSTEM CHECK."
- IS HISTORY CODE 23 SET?
- ⑥ INSPECT 36VLR CIRCUIT 236 FOR SHORTS TO CIRCUITS 347, 348, OR 349. ASSURE PROPER CONNECTIONS AT THE ARMING PASSENGER COMPARTMENT AND FORWARD DISCRIMINATING SENSORS. INSPECT FOR CONNECTOR DAMAGE. REPAIR OR REPLACE AS NEEDED FOLLOWING INSTRUCTIONS IN TOOL J38125-A.
- CLEAR SIR CODES AND REPEAT "SIR DIAGNOSTIC SYSTEM CHECK."
- GO TO CHART A3

Figure 9J-A-3 Chart A1

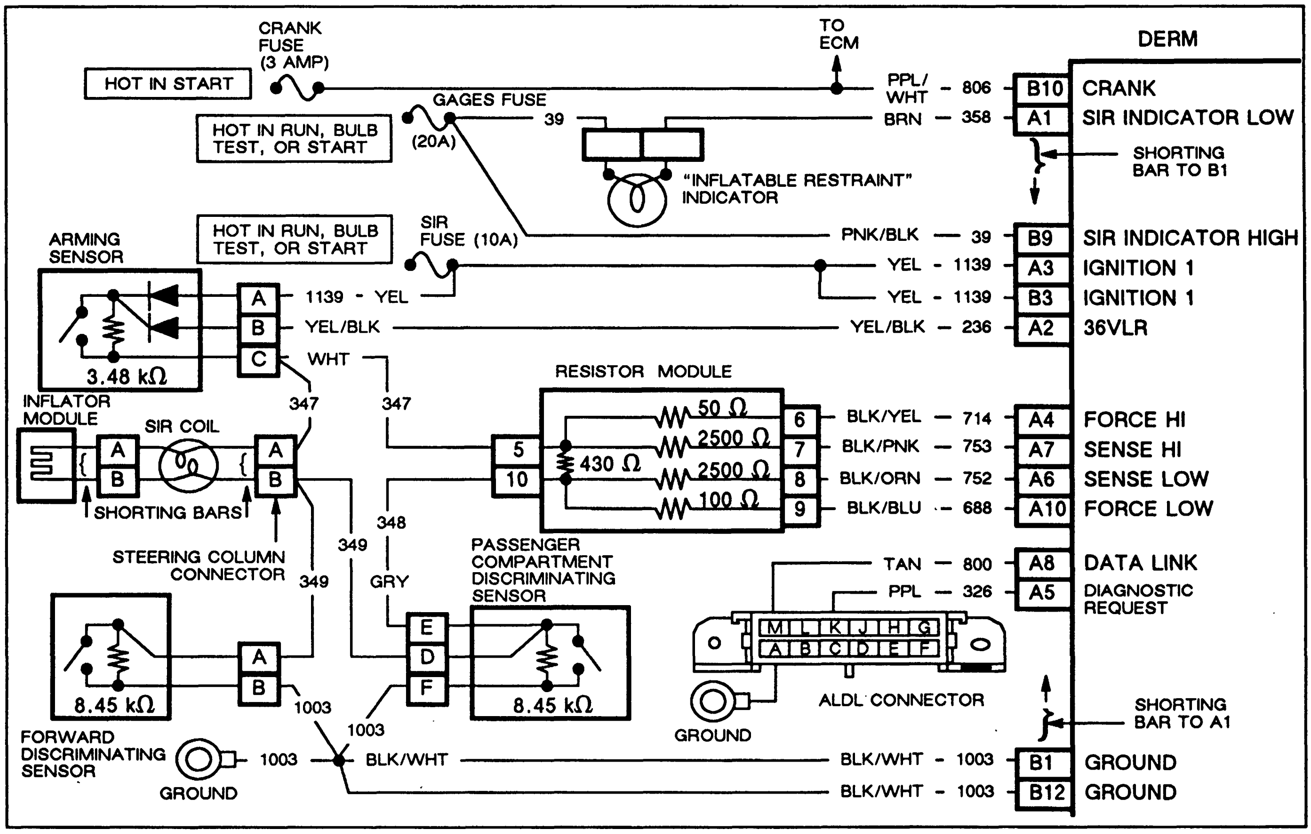


Figure 9J-A-4 SIR Circuit

CHART A2
“SCAN TOOL” HISTORY CODE DIAGNOSIS

Description:

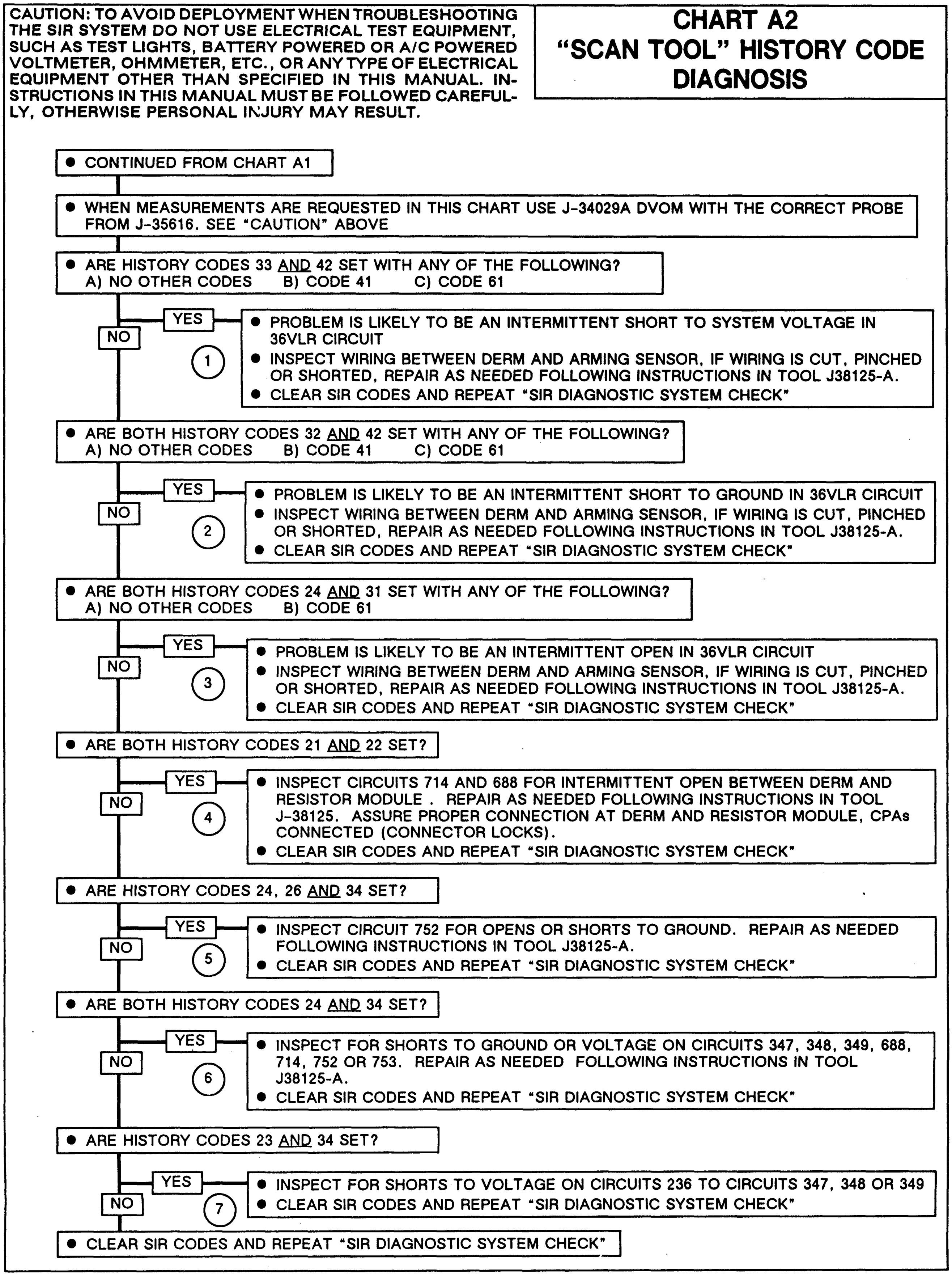
When the Ignition Switch is first turned “ON” system voltage is applied through GAGES FUSE to “SIR Indicator High” (B9) and to the “INFLATABLE RESTRAINT” Indicator Lamp which is connected to “SIR Indicator Low” (A1). SIR FUSE also applies system voltage to the “Ignition 1” inputs (A3 and B3). The DERM responds by blinking the “INFLATABLE RESTRAINT” indicator 7 to 9 times.

When the engine is being cranked system voltage is applied to the DERM at the “CRANK” input. The DERM grounds the lamp circuit until system voltage is removed from the “CRANK” input. This results in a steady “INFLATABLE RESTRAINT” indicator during cranking.

After cranking the DERM will again blink the “INFLATABLE RESTRAINT” indicator 7 to 9 times.

Notes on Fault Tree:

1) Checks for intermittent shorts to system voltage in the 36VLR wiring (circuit 236).
2) Checks for intermittent shorts to ground in the 36VLR wiring (circuit 236).
3) Checks for intermittent open in the 36VLR wiring (circuit 236).
4) Checks for intermittent open in the Force Hi and Force Low wiring (circuits 714 and 688).
5) Checks for intermittent opens or shorts to ground in the Sense Low wiring (circuit 752).
6) Checks for shorts to system voltage in the deployment loop (circuits 347 and 349) or in the diagnostic circuits (circuits 347, 348, 688, 714, 752 and 753).
7) Checks for shorts between circuit 236 and 347, 348, or 349.



CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CHART A2
"SCAN TOOL" HISTORY CODE DIAGNOSIS

- CONTINUED FROM CHART A1

- WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART USE J-34029A DVOM WITH THE CORRECT PROBE FROM J-35616. SEE "CAUTION" ABOVE

- ARE HISTORY CODES 33 AND 42 SET WITH ANY OF THE FOLLOWING?
  A) NO OTHER CODES B) CODE 41 C) CODE 61

YES ①

- PROBLEM IS LIKELY TO BE AN INTERMITTENT SHORT TO SYSTEM VOLTAGE IN 36VLR CIRCUIT
- INSPECT WIRING BETWEEN DERM AND ARMING SENSOR, IF WIRING IS CUT, PINCHED OR SHORTED, REPAIR AS NEEDED FOLLOWING INSTRUCTIONS IN TOOL J38125-A.
- CLEAR SIR CODES AND REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

NO

- ARE BOTH HISTORY CODES 32 AND 42 SET WITH ANY OF THE FOLLOWING?
  A) NO OTHER CODES B) CODE 41 C) CODE 61

YES ②

- PROBLEM IS LIKELY TO BE AN INTERMITTENT SHORT TO GROUND IN 36VLR CIRCUIT
- INSPECT WIRING BETWEEN DERM AND ARMING SENSOR, IF WIRING IS CUT, PINCHED OR SHORTED, REPAIR AS NEEDED FOLLOWING INSTRUCTIONS IN TOOL J38125-A.
- CLEAR SIR CODES AND REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

NO

- ARE BOTH HISTORY CODES 24 AND 31 SET WITH ANY OF THE FOLLOWING?
  A) NO OTHER CODES B) CODE 61

YES ③

- PROBLEM IS LIKELY TO BE AN INTERMITTENT OPEN IN 36VLR CIRCUIT
- INSPECT WIRING BETWEEN DERM AND ARMING SENSOR, IF WIRING IS CUT, PINCHED OR SHORTED, REPAIR AS NEEDED FOLLOWING INSTRUCTIONS IN TOOL J38125-A.
- CLEAR SIR CODES AND REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

NO

- ARE BOTH HISTORY CODES 21 AND 22 SET?

YES ④

- INSPECT CIRCUITS 714 AND 688 FOR INTERMITTENT OPEN BETWEEN DERM AND RESISTOR MODULE . REPAIR AS NEEDED FOLLOWING INSTRUCTIONS IN TOOL J-38125. ASSURE PROPER CONNECTION AT DERM AND RESISTOR MODULE, CPAs CONNECTED (CONNECTOR LOCKS).
- CLEAR SIR CODES AND REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

NO

- ARE HISTORY CODES 24, 26 AND 34 SET?

YES ⑤

- INSPECT CIRCUIT 752 FOR OPENS OR SHORTS TO GROUND. REPAIR AS NEEDED FOLLOWING INSTRUCTIONS IN TOOL J38125-A.
- CLEAR SIR CODES AND REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

NO

- ARE BOTH HISTORY CODES 24 AND 34 SET?

YES ⑥

- INSPECT FOR SHORTS TO GROUND OR VOLTAGE ON CIRCUITS 347, 348, 349, 688, 714, 752 OR 753. REPAIR AS NEEDED FOLLOWING INSTRUCTIONS IN TOOL J38125-A.
- CLEAR SIR CODES AND REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

NO

- ARE HISTORY CODES 23 AND 34 SET?

YES ⑦

- INSPECT FOR SHORTS TO VOLTAGE ON CIRCUITS 236 TO CIRCUITS 347, 348 OR 349
- CLEAR SIR CODES AND REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

NO

- CLEAR SIR CODES AND REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

Figure 9J-A-5 Chart A2

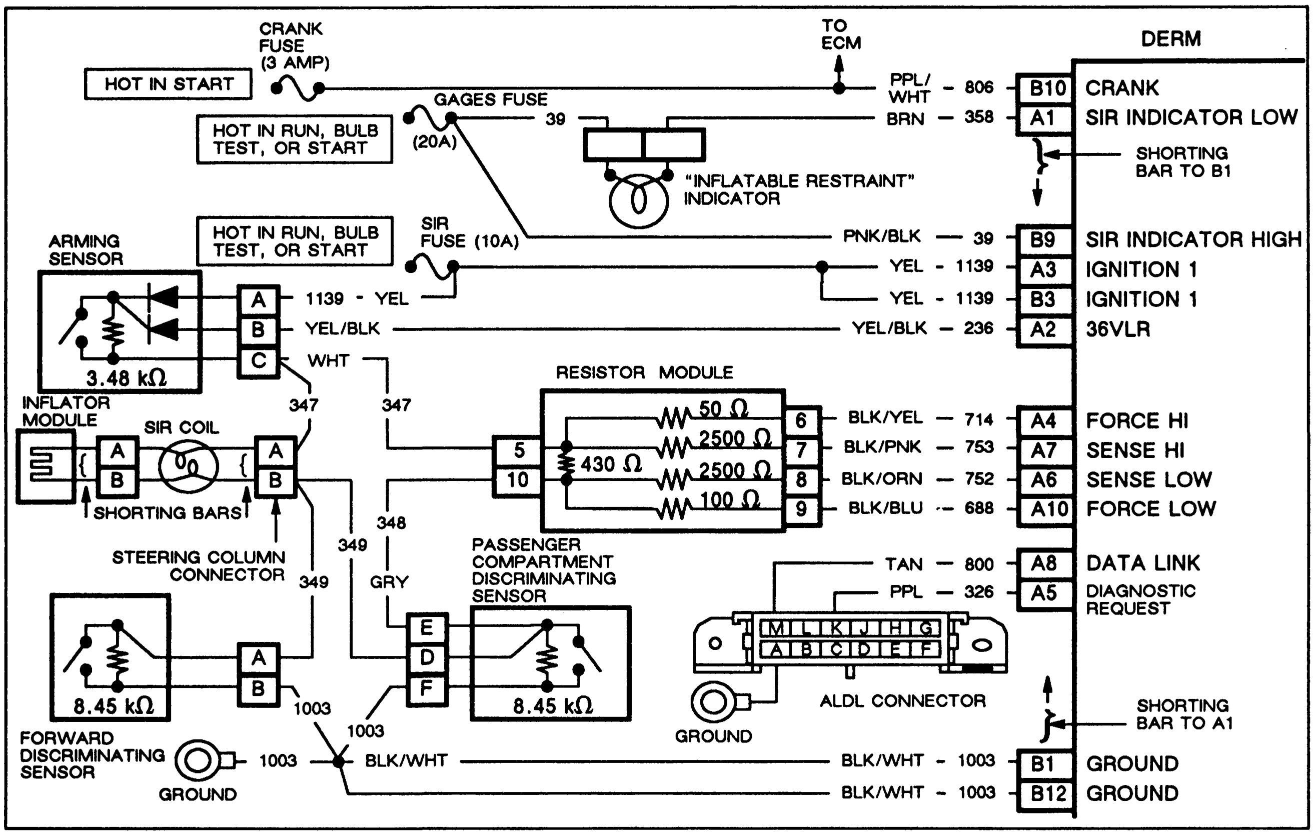


Figure 9J-A-6 SIR Circuit

CHART A3
"SCAN TOOL" HISTORY CODE DIAGNOSIS

Description:

When the Ignition Switch is first turned "ON" system voltage is applied through GAGES FUSE to "SIR Indicator High" (B9) and to the "INFLATABLE RESTRAINT" Indicator Lamp which is connected to "SIR Indicator Low" (A1). SIR FUSE also applies system voltage to the "Ignition 1" inputs (A3 and B3). The DERM responds by blinking the "INFLATABLE RESTRAINT" indicator 7 to 9 times.

When the engine is being cranked system voltage is applied to the DERM at the "CRANK" input. The DERM grounds the lamp circuit until system voltage is removed from the "CRANK" input. This results in a steady "INFLATABLE RESTRAINT" indicator during cranking.

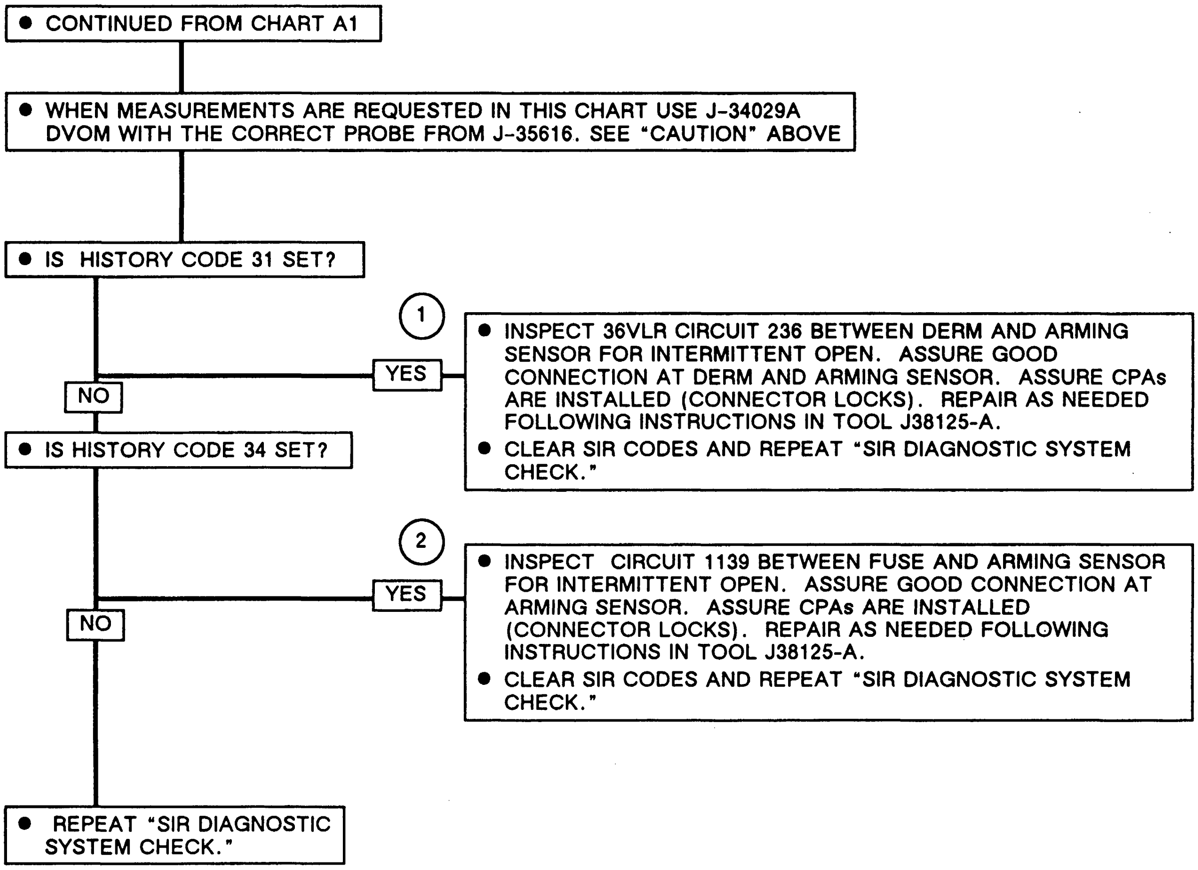
After cranking the DERM will again blink the "INFLATABLE RESTRAINT" indicator 7 to 9 times.

Notes on Fault Tree:

1) Checks for intermittent opens in the 36VLR wiring (circuit 236).
2) Checks for intermittent open between fuse 3 and the arming sensor (circuit 1139).

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CHART A3
"SCAN TOOL" HISTORY CODE DIAGNOSIS



- CONTINUED FROM CHART A1

- WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART USE J-34029A DVOM WITH THE CORRECT PROBE FROM J-35616. SEE "CAUTION" ABOVE

- IS HISTORY CODE 31 SET?

① YES:
- INSPECT 36VLR CIRCUIT 236 BETWEEN DERM AND ARMING SENSOR FOR INTERMITTENT OPEN. ASSURE GOOD CONNECTION AT DERM AND ARMING SENSOR. ASSURE CPAs ARE INSTALLED (CONNECTOR LOCKS). REPAIR AS NEEDED FOLLOWING INSTRUCTIONS IN TOOL J38125-A.
- CLEAR SIR CODES AND REPEAT "SIR DIAGNOSTIC SYSTEM CHECK."

NO:
- IS HISTORY CODE 34 SET?

② YES:
- INSPECT CIRCUIT 1139 BETWEEN FUSE AND ARMING SENSOR FOR INTERMITTENT OPEN. ASSURE GOOD CONNECTION AT ARMING SENSOR. ASSURE CPAs ARE INSTALLED (CONNECTOR LOCKS). REPAIR AS NEEDED FOLLOWING INSTRUCTIONS IN TOOL J38125-A.
- CLEAR SIR CODES AND REPEAT "SIR DIAGNOSTIC SYSTEM CHECK."

NO:
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK."

Figure 9J-A-7 Chart A3

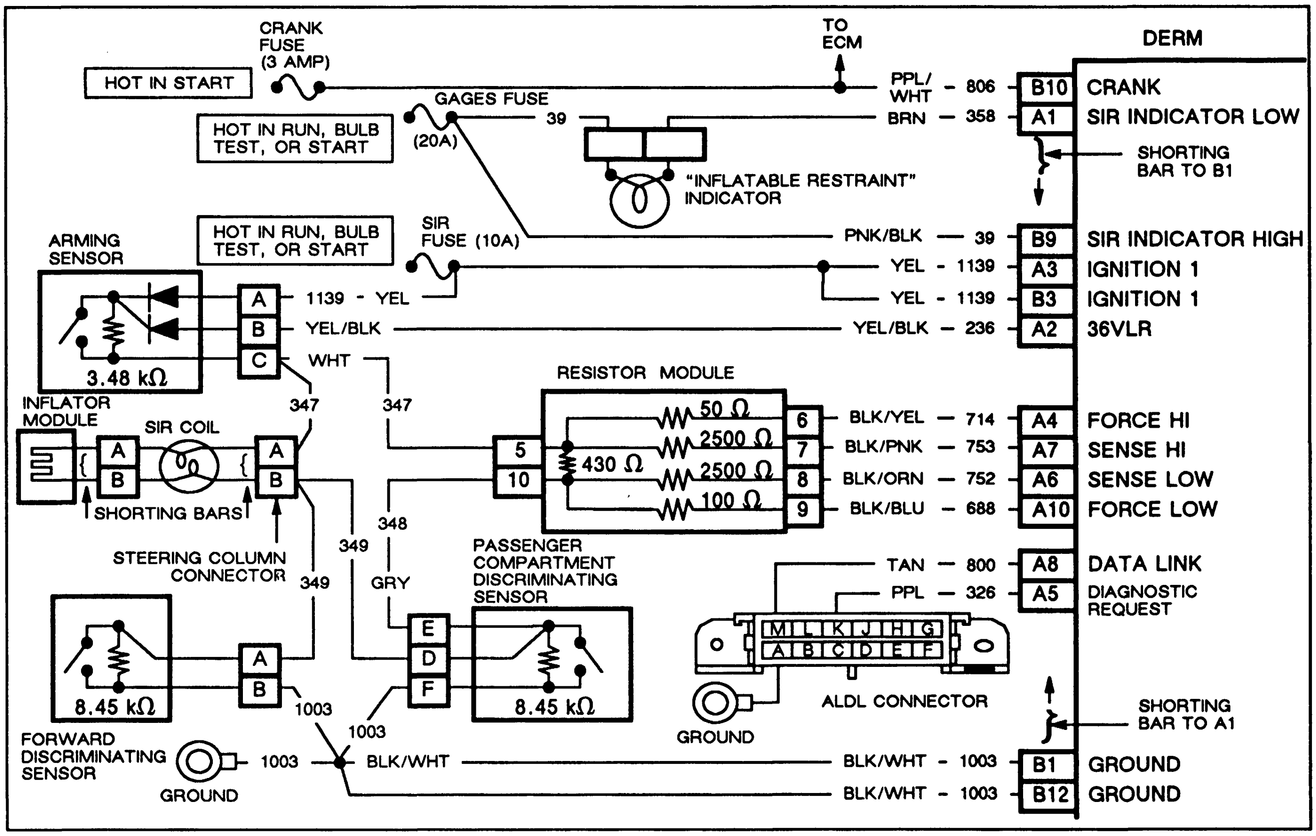


Figure 9J-A-8 SIR Circuit

CHART B
"FLASH CODE" DIAGNOSIS

Description:

When the Ignition Switch is first turned "ON" system voltage is applied through GAGES FUSE to "SIR Indicator High" (B9) and to the "INFLATABLE RESTRAINT" Indicator Lamp which is connected to "SIR Indicator Low" (A1). SIR FUSE also applies system voltage to the "Ignition 1" inputs (A3 and B3). The DERM responds by blinking the "INFLATABLE RESTRAINT" indicator 7 to 9 times.

When the engine is being cranked system voltage is applied to the DERM at the "CRANK" input. The DERM grounds the lamp circuit until system voltage is removed from the "CRANK" input. This results in a steady "INFLATABLE RESTRAINT" indicator during cranking.

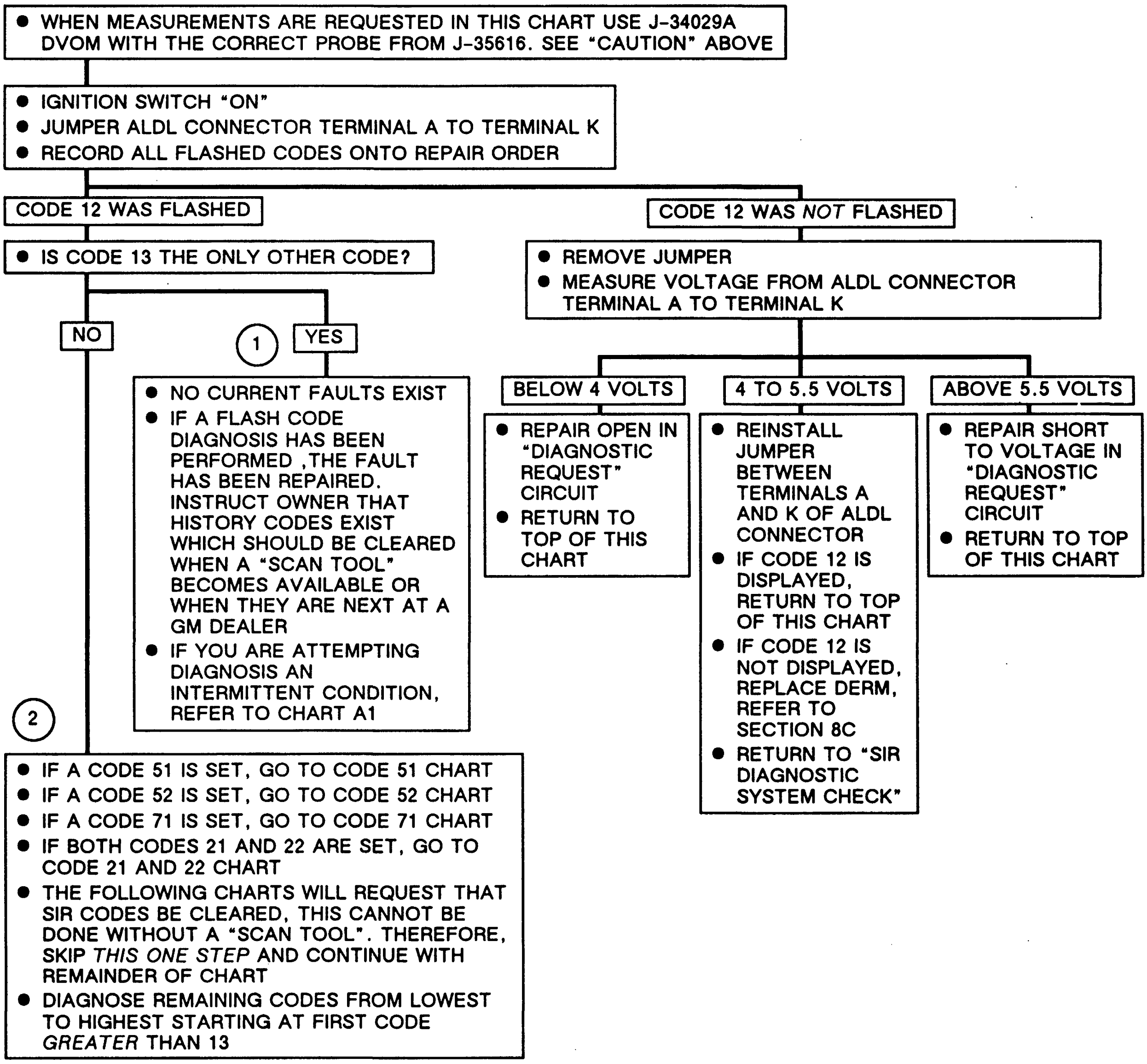
After cranking the DERM will again blink the "INFLATABLE RESTRAINT" indicator 7 to 9 times.

Notes on Fault Tree:

1) If flash codes have been used to diagnose and repair a fault, the code(s) diagnosed and repaired will still appear as history codes only. The only way to clear history codes is with a "scan tool."
2) Where diagnostic charts request the clearing of SIR codes, the step is to be skipped since codes cannot be cleared through flash code diagnostics.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CHART B
"FLASH CODE" DIAGNOSIS



- WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART USE J-34029A DVOM WITH THE CORRECT PROBE FROM J-35616. SEE "CAUTION" ABOVE

- IGNITION SWITCH "ON"
- JUMPER ALDL CONNECTOR TERMINAL A TO TERMINAL K
- RECORD ALL FLASHED CODES ONTO REPAIR ORDER

CODE 12 WAS FLASHED

- IS CODE 13 THE ONLY OTHER CODE?

NO

YES ①

- NO CURRENT FAULTS EXIST
- IF A FLASH CODE DIAGNOSIS HAS BEEN PERFORMED ,THE FAULT HAS BEEN REPAIRED. INSTRUCT OWNER THAT HISTORY CODES EXIST WHICH SHOULD BE CLEARED WHEN A "SCAN TOOL" BECOMES AVAILABLE OR WHEN THEY ARE NEXT AT A GM DEALER
- IF YOU ARE ATTEMPTING DIAGNOSIS AN INTERMITTENT CONDITION, REFER TO CHART A1

②

- IF A CODE 51 IS SET, GO TO CODE 51 CHART
- IF A CODE 52 IS SET, GO TO CODE 52 CHART
- IF A CODE 71 IS SET, GO TO CODE 71 CHART
- IF BOTH CODES 21 AND 22 ARE SET, GO TO CODE 21 AND 22 CHART
- THE FOLLOWING CHARTS WILL REQUEST THAT SIR CODES BE CLEARED, THIS CANNOT BE DONE WITHOUT A "SCAN TOOL". THEREFORE, SKIP *THIS ONE STEP* AND CONTINUE WITH REMAINDER OF CHART
- DIAGNOSE REMAINING CODES FROM LOWEST TO HIGHEST STARTING AT FIRST CODE *GREATER* THAN 13

CODE 12 WAS *NOT* FLASHED

- REMOVE JUMPER
- MEASURE VOLTAGE FROM ALDL CONNECTOR TERMINAL A TO TERMINAL K

BELOW 4 VOLTS

- REPAIR OPEN IN "DIAGNOSTIC REQUEST" CIRCUIT
- RETURN TO TOP OF THIS CHART

4 TO 5.5 VOLTS

- REINSTALL JUMPER BETWEEN TERMINALS A AND K OF ALDL CONNECTOR
- IF CODE 12 IS DISPLAYED, RETURN TO TOP OF THIS CHART
- IF CODE 12 IS NOT DISPLAYED, REPLACE DERM, REFER TO SECTION 8C
- RETURN TO "SIR DIAGNOSTIC SYSTEM CHECK"

ABOVE 5.5 VOLTS

- REPAIR SHORT TO VOLTAGE IN "DIAGNOSTIC REQUEST" CIRCUIT
- RETURN TO TOP OF THIS CHART

Figure 9J-A-9 Chart B

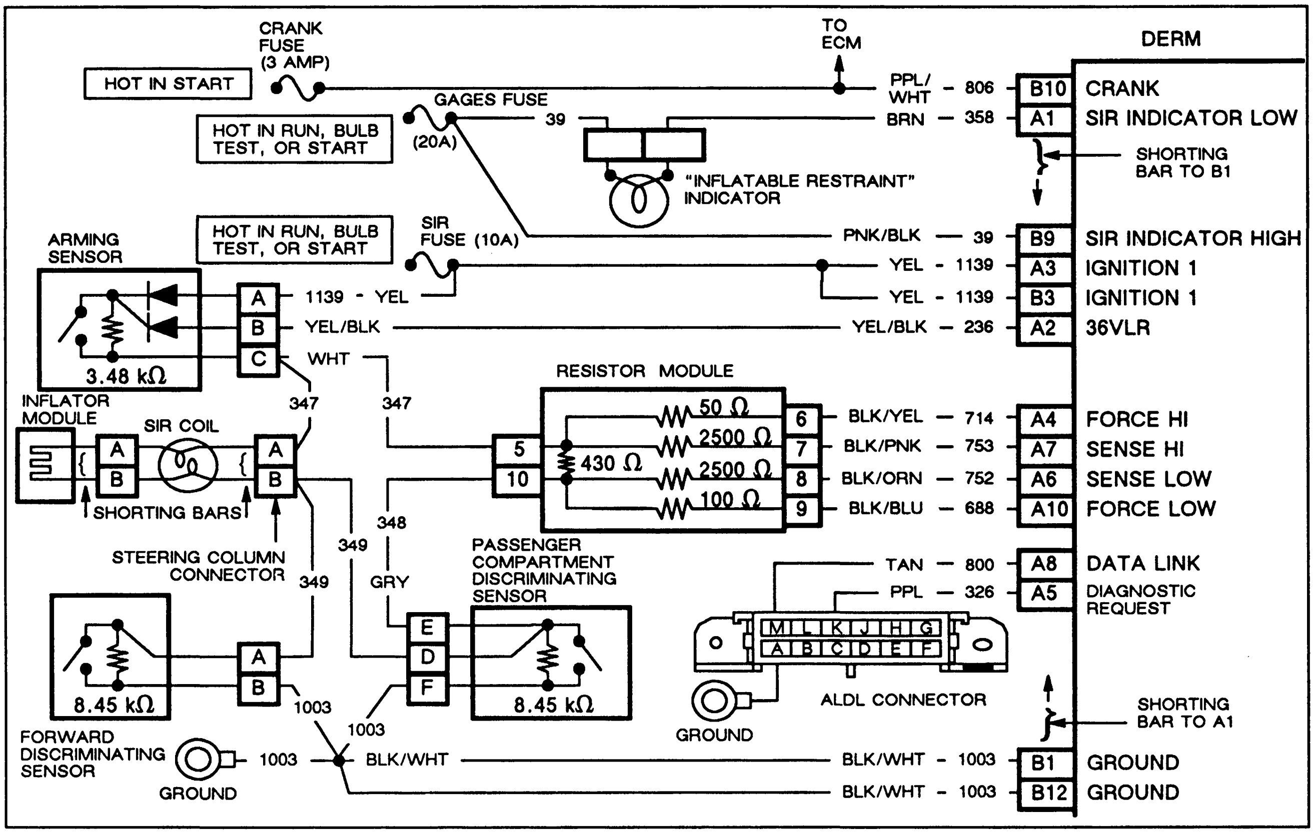


Figure 9J-A-10 SIR Circuit

CHART C

"INFLATABLE RESTRAINT" INDICATOR COMES ON STEADY

Description:

When the Ignition Switch is first turned "ON" system voltage is applied through the GAGES FUSE to "SIR Indicator High" (B9) and to the "INFLATABLE RESTRAINT" Indicator Lamp which is connected to "SIR Indicator Low" (A1). SIR FUSE also applies system voltage to the "Ignition 1" inputs (A3 and B3). The DERM responds by blinking the "INFLATABLE RESTRAINT" indicator 7 to 9 times.

The purpose of the Shorting Bar is to turn the "INFLATABLE RESTRAINT" Indicator Lamp ON should the DERM become disconnected.

When the engine is being cranked system voltage is applied to the DERM at the "CRANK" input. The DERM grounds the lamp circuit until system voltage is removed from the "CRANK" input. This results in a steady "INFLATABLE RESTRAINT" indicator during cranking.

After cranking the DERM will again blink the "INFLATABLE RESTRAINT" indicator 7 to 9 times.

Notes on Fault Tree:

1) An open SIR Fuse would result in a loss of Ignition 1 voltage at the DERM. The DERM will respond by grounding the lamp circuit ("SIR Indicator Low") whenever the Ignition Switch is "ON."

2) If the DERM and the SIR harness connector are disconnected the shorting bar between terminals A1 and B1 of the harness connector will ground the lamp circuit.

3) Checks for a short to ground in the "Ignition 1" circuits or the DERM.

4) Checks if there is a short to ground on the low side of the lamp circuit external of the DERM. The SIR Load Tool prevents the shorting bar in the DERM connector from grounding the lamp circuit.

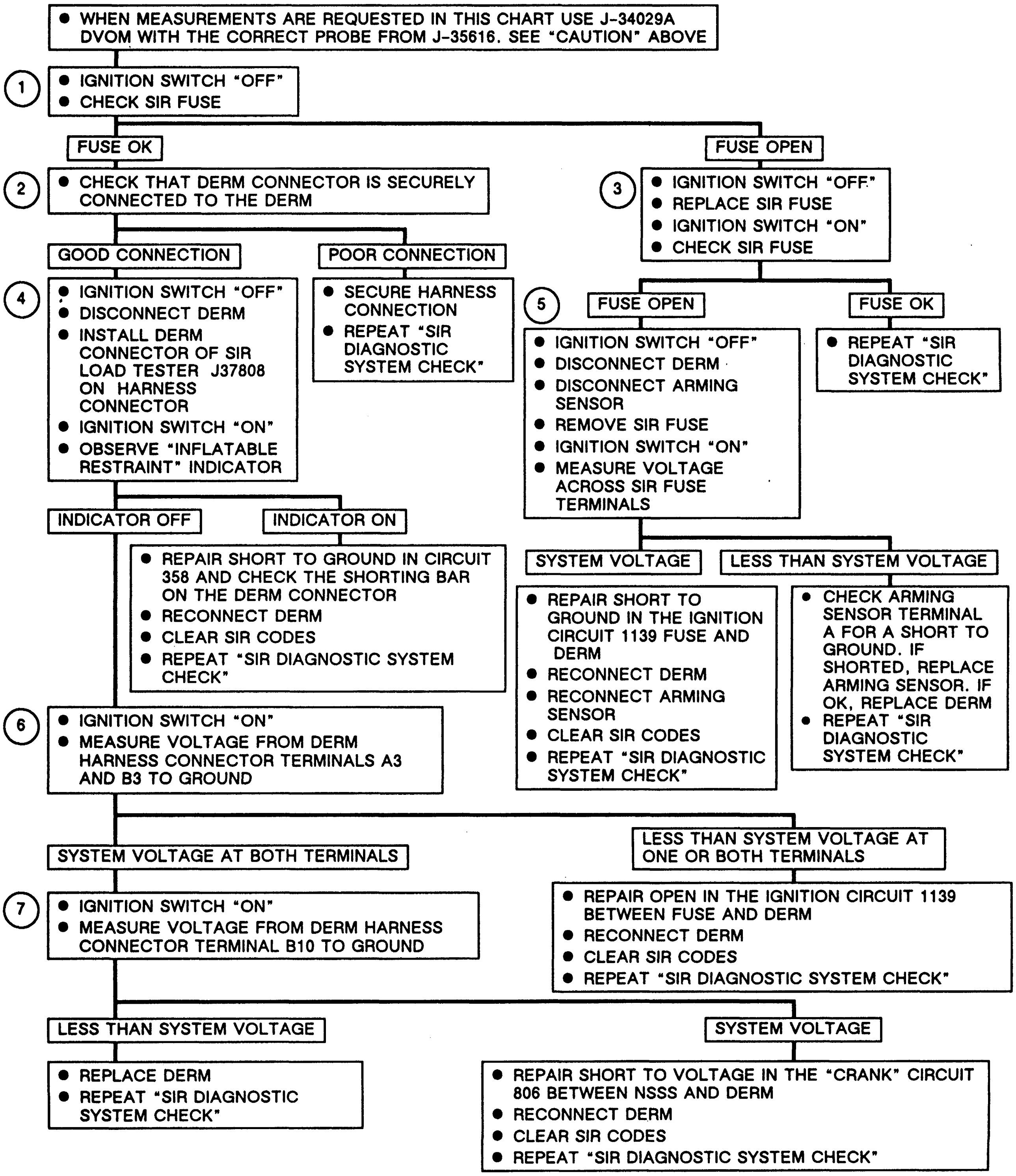
5) Checks if short to ground is in the DERM or the "Ignition 1" circuits.

6) Checks for Ignition 1 voltage at the DERM. If the "Ignition 1" circuits are open the DERM will ground the lamp circuit whenever the Ignition Switch is "ON" (if the "SIR Indicator High" circuit is good).

7) Checks for a short to system voltage in the "Crank" circuit.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CHART C
"INFLATABLE RESTRAINT" INDICATOR COMES ON STEADY



- WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART USE J-34029A DVOM WITH THE CORRECT PROBE FROM J-35616. SEE "CAUTION" ABOVE

①
- IGNITION SWITCH "OFF"
- CHECK SIR FUSE

FUSE OK

②
- CHECK THAT DERM CONNECTOR IS SECURELY CONNECTED TO THE DERM

GOOD CONNECTION

④
- IGNITION SWITCH "OFF"
- DISCONNECT DERM
- INSTALL DERM CONNECTOR OF SIR LOAD TESTER J37808 ON HARNESS CONNECTOR
- IGNITION SWITCH "ON"
- OBSERVE "INFLATABLE RESTRAINT" INDICATOR

INDICATOR OFF

⑥
- IGNITION SWITCH "ON"
- MEASURE VOLTAGE FROM DERM HARNESS CONNECTOR TERMINALS A3 AND B3 TO GROUND

SYSTEM VOLTAGE AT BOTH TERMINALS

⑦
- IGNITION SWITCH "ON"
- MEASURE VOLTAGE FROM DERM HARNESS CONNECTOR TERMINAL B10 TO GROUND

LESS THAN SYSTEM VOLTAGE

- REPLACE DERM
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

SYSTEM VOLTAGE

- REPAIR SHORT TO VOLTAGE IN THE "CRANK" CIRCUIT 806 BETWEEN NSSS AND DERM
- RECONNECT DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

LESS THAN SYSTEM VOLTAGE AT ONE OR BOTH TERMINALS

- REPAIR OPEN IN THE IGNITION CIRCUIT 1139 BETWEEN FUSE AND DERM
- RECONNECT DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

INDICATOR ON

- REPAIR SHORT TO GROUND IN CIRCUIT 358 AND CHECK THE SHORTING BAR ON THE DERM CONNECTOR
- RECONNECT DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

POOR CONNECTION

- SECURE HARNESS CONNECTION
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

FUSE OPEN

③
- IGNITION SWITCH "OFF"
- REPLACE SIR FUSE
- IGNITION SWITCH "ON"
- CHECK SIR FUSE

FUSE OPEN

⑤
- IGNITION SWITCH "OFF"
- DISCONNECT DERM
- DISCONNECT ARMING SENSOR
- REMOVE SIR FUSE
- IGNITION SWITCH "ON"
- MEASURE VOLTAGE ACROSS SIR FUSE TERMINALS

SYSTEM VOLTAGE

- REPAIR SHORT TO GROUND IN THE IGNITION CIRCUIT 1139 FUSE AND DERM
- RECONNECT DERM
- RECONNECT ARMING SENSOR
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

LESS THAN SYSTEM VOLTAGE

- CHECK ARMING SENSOR TERMINAL A FOR A SHORT TO GROUND. IF SHORTED, REPLACE ARMING SENSOR. IF OK, REPLACE DERM
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

FUSE OK

- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

Figure 9J-A-11 Chart C

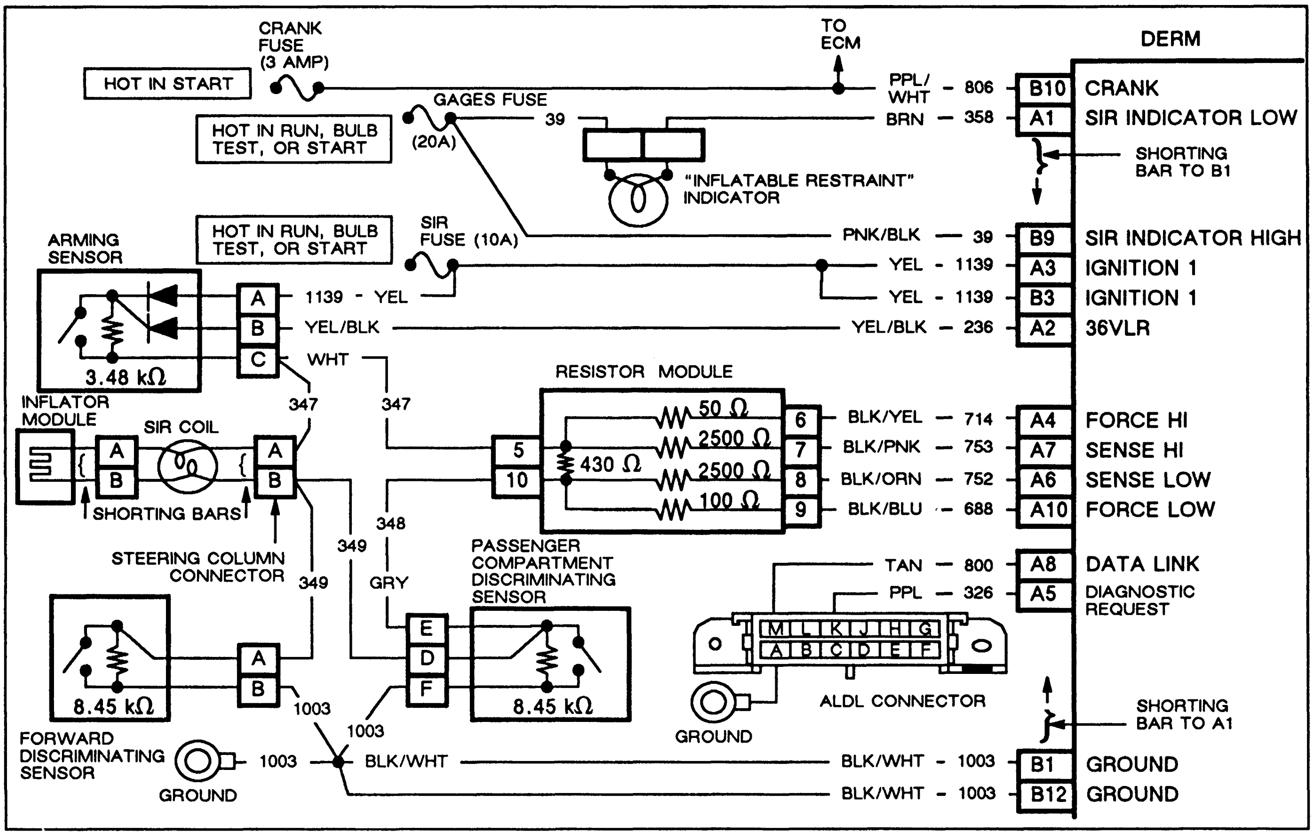


Figure 9J-A-12 SIR Circuit

CHART D

"INFLATABLE RESTRAINT" INDICATOR DOES NOT COME ON

Description:

When the Ignition Switch is first turned "ON" system voltage is applied through the SIR FUSE and GAGES FUSE to the DERM at the "SIR Indicator Low", "SIR Indicator High" and the "Ignition 1" inputs. The DERM responds by blinking the "INFLATABLE RESTRAINT" indicator 7 to 9 times with a lamp driver at the "SIR Indicator Low" input.

When the engine is being cranked system voltage is applied to the DERM at the "CRANK" input. The DERM grounds the lamp circuit until system voltage is removed from the "CRANK" input. This results in a steady "INFLATABLE RESTRAINT" indicator during cranking.

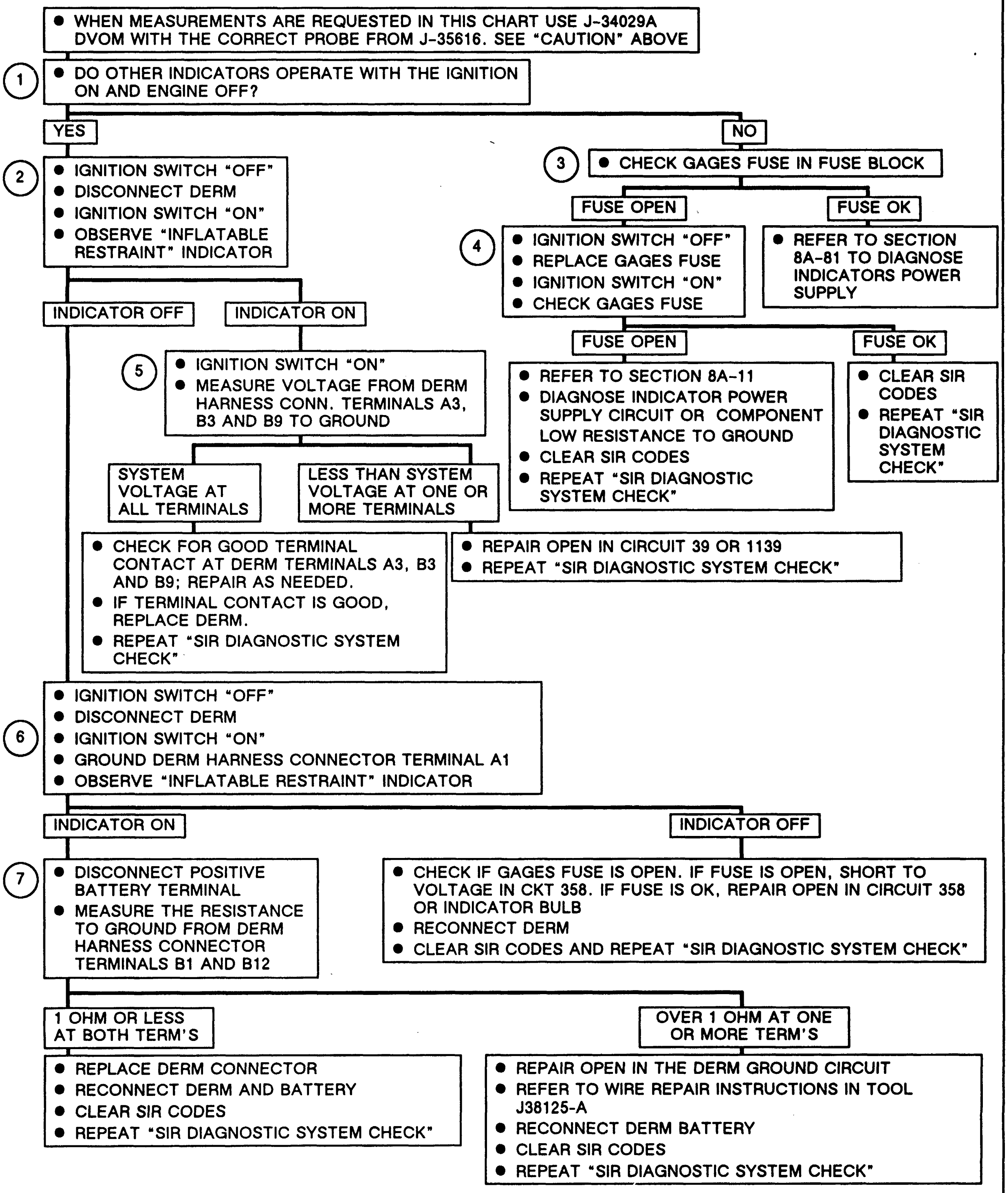
After cranking the DERM will again blink the "INFLATABLE RESTRAINT" indicator 7 to 9 times if the Ignition Switch is "ON."

Notes on Fault Tree:

1) Checks if high side (power side) of the lamp circuit is good. This circuit powers a number of indicators within the indicators cluster (such as the "Service Engine Soon" and "Oil" indicators). If these other indicators are operative, then the power supply to the "Inflatable Restraint" indicator is not suspect.
2) When the DERM is disconnected the shorting bar between terminals A1 and B1 of the DERM harness connector should ground the lamp circuit. If the indicator does not come on the ground circuits, Indicator circuit or the shorting bar are suspect. If the indicator comes on the DERM or the "SIR Indicator High" and the "Ignition 1" circuits are suspect.
3) Checks Fuse 16 which is in the high side (power side) of the lamp circuit.
4) Checks for a short to ground in Fuse 16 circuits.
5) Checks for system voltage at the "Ignition 1" and "SIR Indicator High" inputs at the DERM.
6) Checks if the lamp circuit external to the DERM is good.
7) Checks if the ground circuits to the DERM are good.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CHART D "INFLATABLE RESTRAINT" INDICATOR DOES NOT COME ON



- WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART USE J-34029A DVOM WITH THE CORRECT PROBE FROM J-35616. SEE "CAUTION" ABOVE

①
- DO OTHER INDICATORS OPERATE WITH THE IGNITION ON AND ENGINE OFF?

YES

②
- IGNITION SWITCH "OFF"
- DISCONNECT DERM
- IGNITION SWITCH "ON"
- OBSERVE "INFLATABLE RESTRAINT" INDICATOR

INDICATOR OFF

INDICATOR ON

⑤
- IGNITION SWITCH "ON"
- MEASURE VOLTAGE FROM DERM HARNESS CONN. TERMINALS A3, B3 AND B9 TO GROUND

SYSTEM VOLTAGE AT ALL TERMINALS

- CHECK FOR GOOD TERMINAL CONTACT AT DERM TERMINALS A3, B3 AND B9; REPAIR AS NEEDED.
- IF TERMINAL CONTACT IS GOOD, REPLACE DERM.
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

LESS THAN SYSTEM VOLTAGE AT ONE OR MORE TERMINALS

- REPAIR OPEN IN CIRCUIT 39 OR 1139
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

NO

③
- CHECK GAGES FUSE IN FUSE BLOCK

FUSE OPEN

④
- IGNITION SWITCH "OFF"
- REPLACE GAGES FUSE
- IGNITION SWITCH "ON"
- CHECK GAGES FUSE

FUSE OPEN

- REFER TO SECTION 8A-11
- DIAGNOSE INDICATOR POWER SUPPLY CIRCUIT OR COMPONENT LOW RESISTANCE TO GROUND
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

FUSE OK

- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

FUSE OK

- REFER TO SECTION 8A-81 TO DIAGNOSE INDICATORS POWER SUPPLY

⑥
- IGNITION SWITCH "OFF"
- DISCONNECT DERM
- IGNITION SWITCH "ON"
- GROUND DERM HARNESS CONNECTOR TERMINAL A1
- OBSERVE "INFLATABLE RESTRAINT" INDICATOR

INDICATOR ON

⑦
- DISCONNECT POSITIVE BATTERY TERMINAL
- MEASURE THE RESISTANCE TO GROUND FROM DERM HARNESS CONNECTOR TERMINALS B1 AND B12

1 OHM OR LESS AT BOTH TERM'S

- REPLACE DERM CONNECTOR
- RECONNECT DERM AND BATTERY
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

OVER 1 OHM AT ONE OR MORE TERM'S

- REPAIR OPEN IN THE DERM GROUND CIRCUIT
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT DERM BATTERY
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

INDICATOR OFF

- CHECK IF GAGES FUSE IS OPEN. IF FUSE IS OPEN, SHORT TO VOLTAGE IN CKT 358. IF FUSE IS OK, REPAIR OPEN IN CIRCUIT 358 OR INDICATOR BULB
- RECONNECT DERM
- CLEAR SIR CODES AND REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

Figure 9J-A-13 Chart D

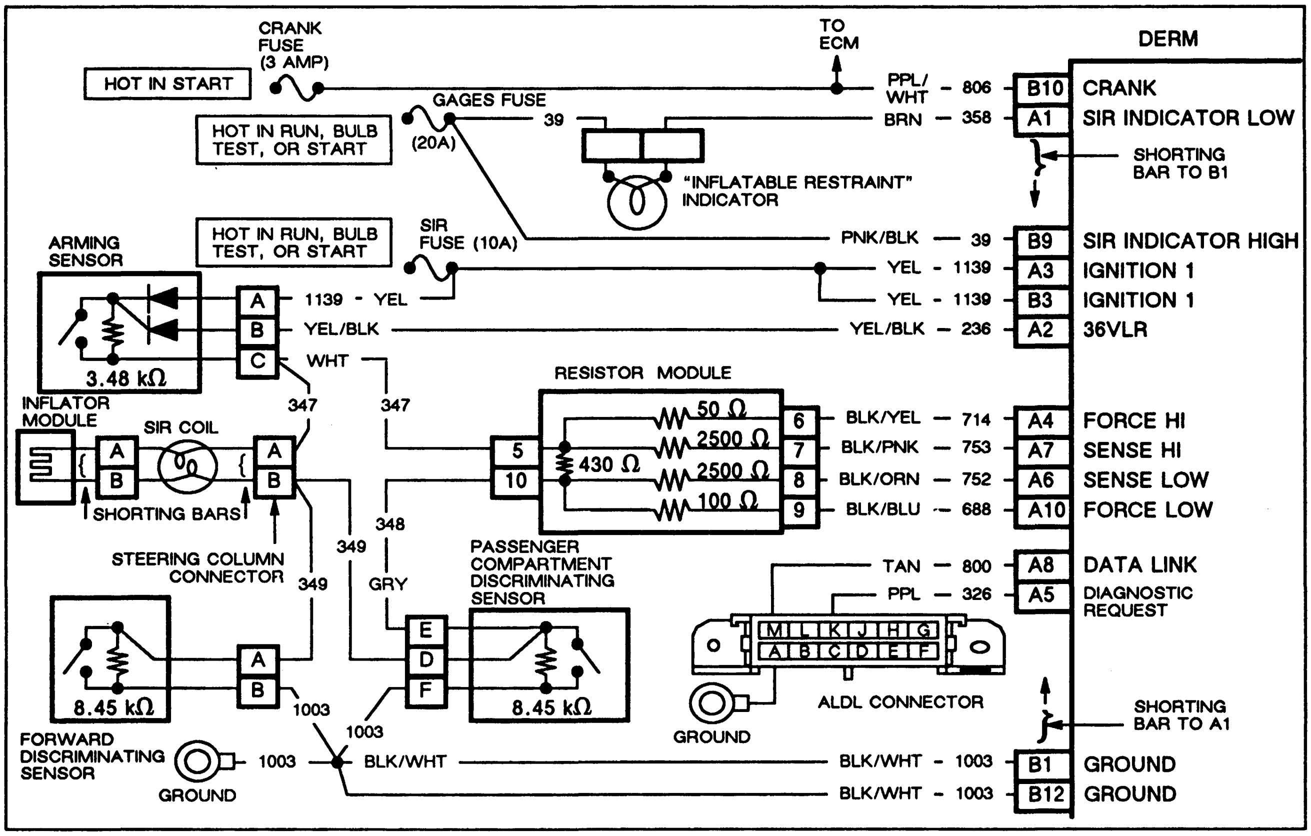


Figure 9J-A-14 SIR Circuit

CHART E

"INFLATABLE RESTRAINT" INDICATOR DOES NOT COME ON STEADY DURING CRANK

Description:

When the Ignition Switch is first turned "ON" system voltage is applied through GAGES FUSE to "SIR Indicator High" (B9) and to the "INFLATABLE RESTRAINT" Indicator Lamp which is connected to ("SIR Indicator Low"(A1). SIR FUSE also applies system voltage to the "Ignition 1" inputs (A3 and B3). The DERM responds by blinking the "INFLATABLE RESTRAINT" indicator 7 to 9 times.

When the engine is being cranked system voltage is applied to the DERM at the "CRANK" input. The DERM grounds the lamp circuit until system voltage is removed from the "CRANK" input. This results in a steady "INFLATABLE RESTRAINT" indicator during cranking.

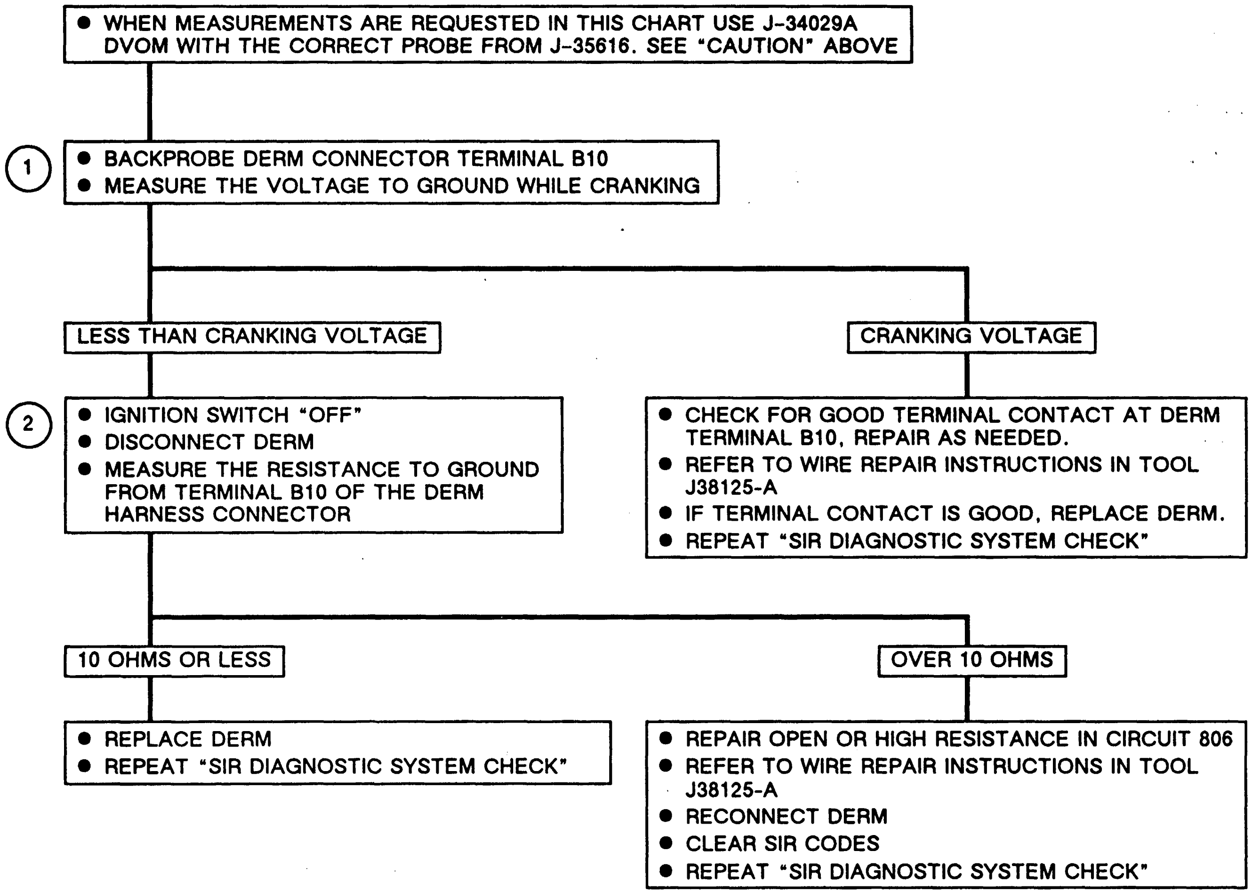
After cranking the DERM will again blink the "INFLATABLE RESTRAINT" indicator 7 to 9 times if the Ignition Switch is "ON."

Notes on Fault Tree:

1) Checks for system voltage at the "CRANK" input of the DERM during cranking.
2) Checks for the "CRANK" circuit for an open or high resistance.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CHART E
"INFLATABLE RESTRAINT" INDICATOR DOES NOT COME ON STEADY DURING CRANK



- WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART USE J-34029A DVOM WITH THE CORRECT PROBE FROM J-35616. SEE "CAUTION" ABOVE

①
- BACKPROBE DERM CONNECTOR TERMINAL B10
- MEASURE THE VOLTAGE TO GROUND WHILE CRANKING

LESS THAN CRANKING VOLTAGE

②
- IGNITION SWITCH "OFF"
- DISCONNECT DERM
- MEASURE THE RESISTANCE TO GROUND FROM TERMINAL B10 OF THE DERM HARNESS CONNECTOR

10 OHMS OR LESS

- REPLACE DERM
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

OVER 10 OHMS

- REPAIR OPEN OR HIGH RESISTANCE IN CIRCUIT 806
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

CRANKING VOLTAGE

- CHECK FOR GOOD TERMINAL CONTACT AT DERM TERMINAL B10, REPAIR AS NEEDED.
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- IF TERMINAL CONTACT IS GOOD, REPLACE DERM.
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

Figure 9J-A-15 Chart E

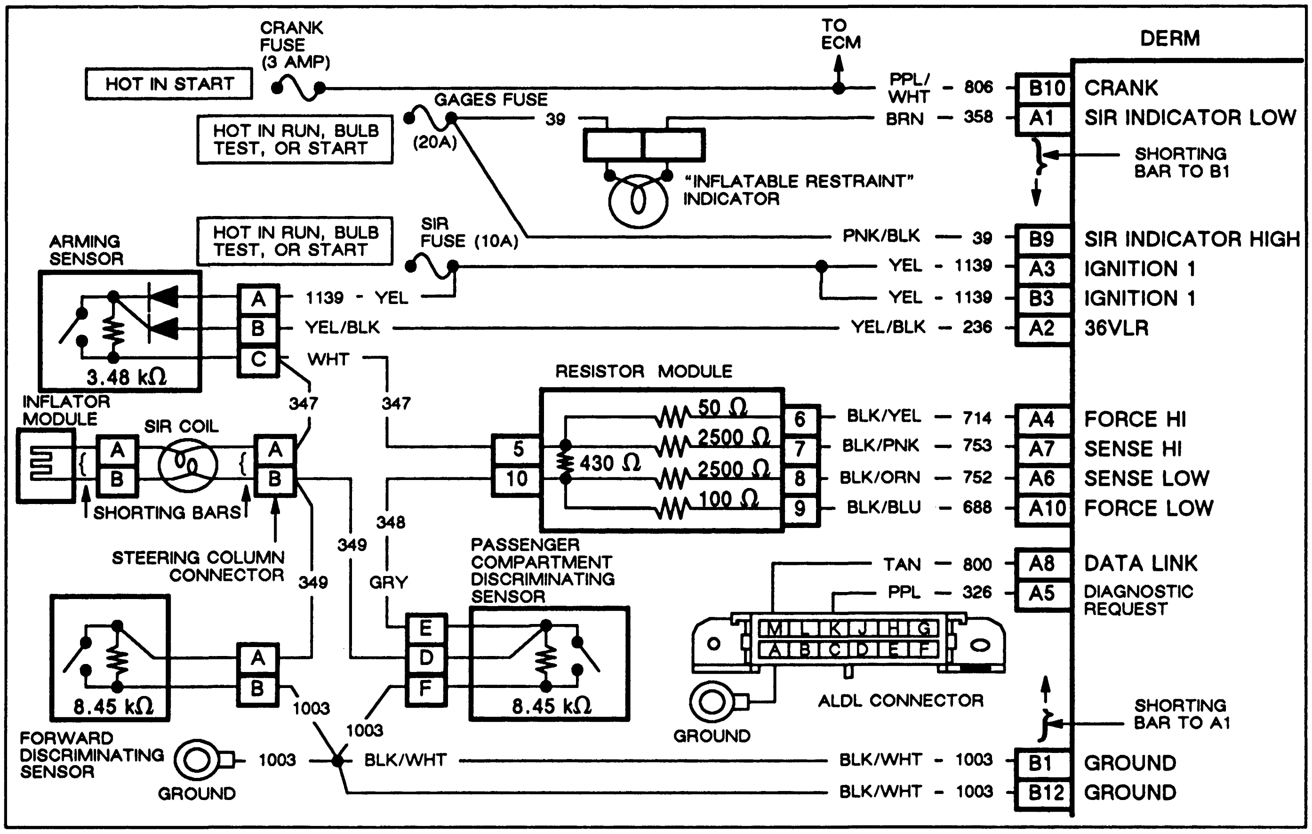


Figure 9J-A-16 SIR Circuit

CHART F

"INFLATABLE RESTRAINT" INDICATOR BLINKS 7 TO 9 TIMES AND THEN FLASHES CODE 12.

Description:

When the Ignition Switch is first turned "ON" system voltage is applied through GAGES FUSE to "SIR Indicator High" (B9) and to the "INFLATABLE RESTRAINT" Indicator Lamp which is connected to "SIR Indicator Low" (A1). SIR FUSE also applies system voltage to the "Ignition 1" inputs (A3 and B3). The DERM responds by blinking the "INFLATABLE RESTRAINT" indicator 7 to 9 times.

When the engine is being cranked system voltage is applied to the DERM at the "CRANK" input. The DERM grounds the lamp circuit until system voltage is removed from the "CRANK" input. This results in a steady "INFLATABLE RESTRAINT" indicator during cranking.

After cranking the DERM will again blink the "INFLATABLE RESTRAINT" indicator 7 to 9 times if the Ignition Switch is "ON."

Notes on Fault Tree:

1) Checks the "Diagnostic Request" circuit for voltage at the ALDL connector.
2) Checks if short to ground is in the "Diagnostic Request" circuit or the DERM.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CHART F
"INFLATABLE RESTRAINT" INDICATOR BLINKS 7 TO 9 TIMES AND THEN FLASHES CODE 12.

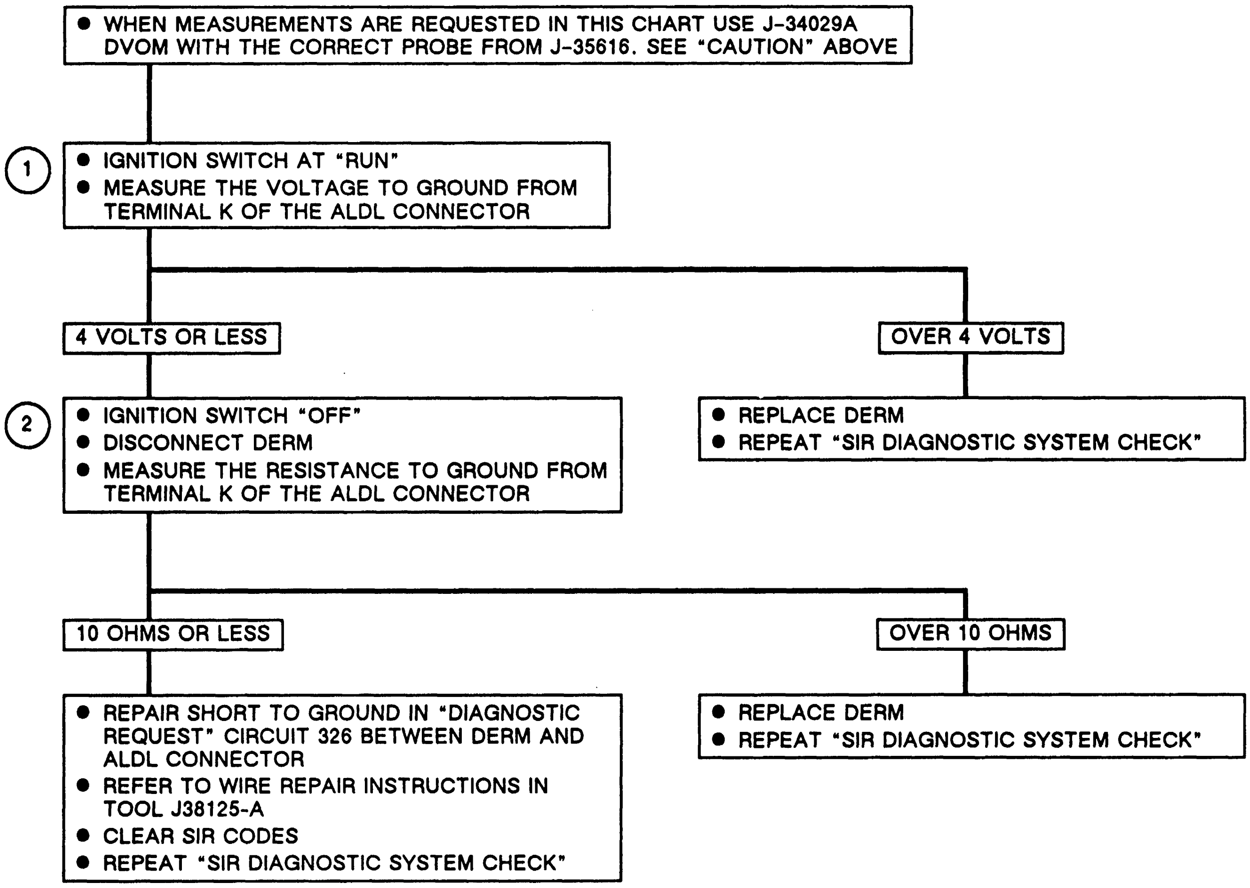


Figure 9J-A-17 Chart F

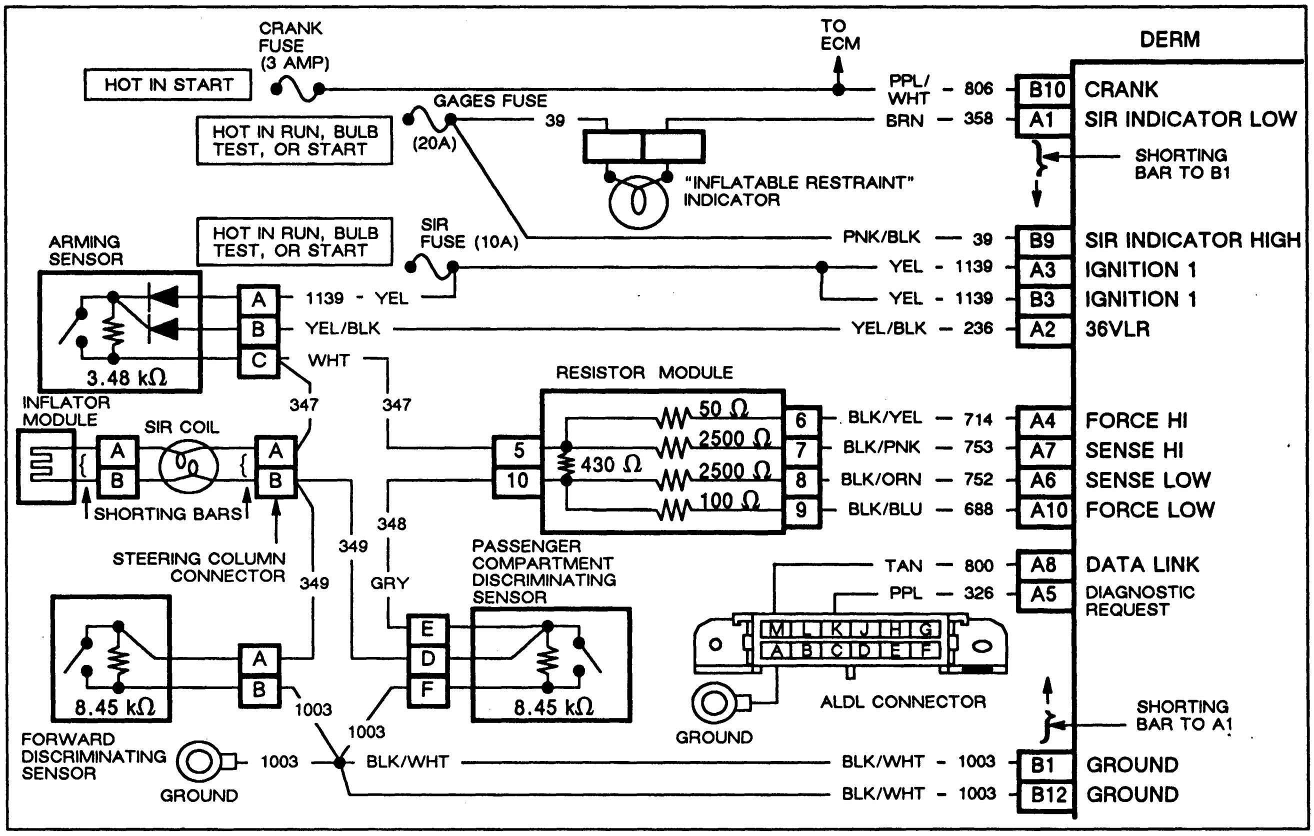


Figure 9J-A-18 SIR Circuit

CODE 21 (CHART 1)

STEERING COLUMN RESISTANCE TOO HIGH

Test Conditions:

Tested once each ignition cycle during the "Steering Column Resistance Test" if: 1) No faults are detected during "Turn-on"; 2) No faults are detected during "Continuous Monitoring" for 1 second; 3) No Crank signal present.

Failure Conditions:

Code 21 will set if the combined resistance of the Inflator Module, SIR Coil, harness wiring and connector terminal contact in the steering column is greater than a specified value.

Conditions To Clear:

Current Code 21 will be cleared each time the Ignition Switch is turned OFF.

Action Taken:

DERM turns ON the "INFLATABLE RESTRAINT" indicator lamp.

Description:

The DERM injects a current of 75 milliamperes through the steering column from the Force Hi output (terminal A4) to the Force Low input (terminal A10). By monitoring the voltage at the Sense Hi input (terminal A7) and the Sense Low input (terminal A6) the DERM calculates the combined resistance of the Inflator Module, SIR Coil, harness wiring (circuits 347, 348 and 349) and connector terminal contact in the steering column. Code 21 will set if the resistance is greater than a specified value or the 100 ohm resistors within the Resistor Module is shorted.

Notes on Fault Tree:

1) Checks if fault is in steering column. The SIR Load Tester simulates the resistance of good steering column wiring and components.
2) Determines if fault is in Inflator Module or in the SIR Coil. The SIR Load Tester simulates the resistance of a good Inflator Module.
3) Checks if 100 ohm resistor in the Resistor Module is shorted.
4) Checks the Resistor Module for internal shorts.
5) Checks the resistance of circuits between the Resistor Module and the DERM.
6) Checks for harness shorts between Force Hi and Sense Hi.
7) Checks for Sense Hi shorted to voltage.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CODE 21 (CHART 1)

STEERING COLUMN RESISTANCE TOO HIGH

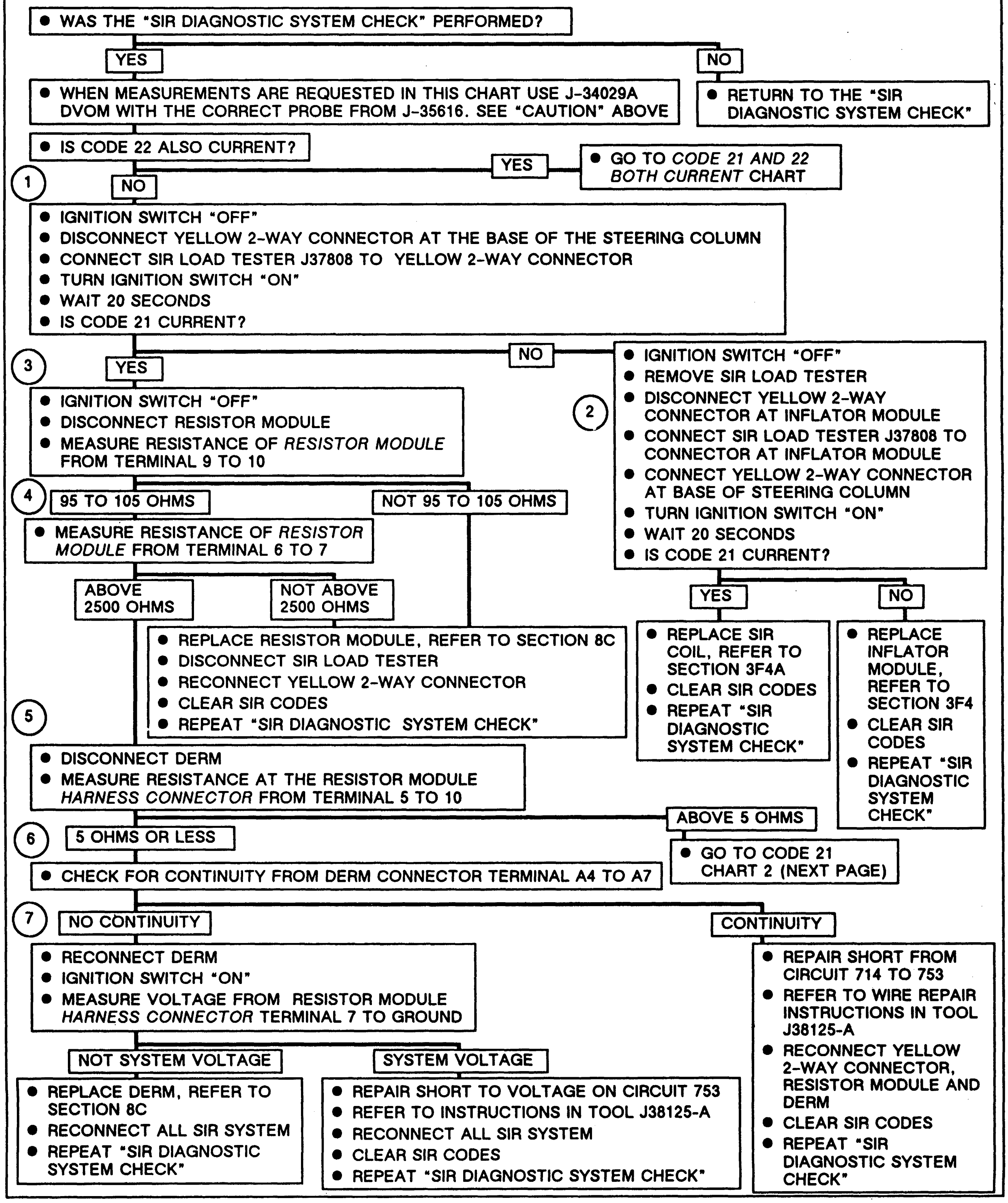


Figure 9J-A-19 Code 21 (Chart 1)

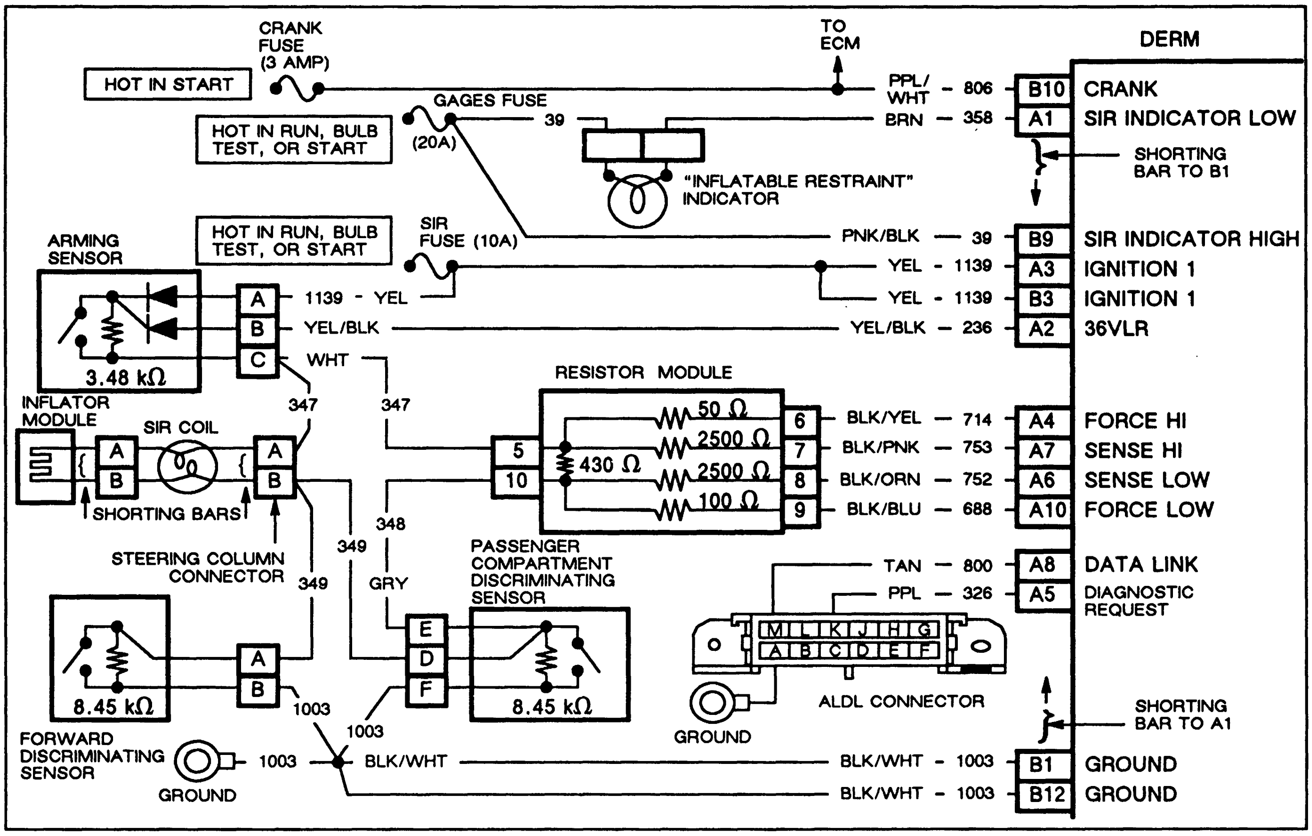


Figure 9J-A-20 SIR Circuit

CODE 21 (CHART 2)

STEERING COLUMN RESISTANCE TOO HIGH

Test Conditions:

Tested once each ignition cycle during the "Steering Column Resistance Test" if: 1) No faults are detected during "Turn-on"; 2) No faults are detected during "Continuous Monitoring" for 1 second; 3) No Crank signal present.

Failure Conditions:

Code 21 will set if the combined resistance of the Inflator Module, SIR Coil, harness wiring and connector terminal contact in the steering column is greater than a specified value.

Conditions To Clear:

Current Code 21 will be cleared each time the Ignition Switch is turned OFF.

Action Taken:

DERM turns ON the "INFLATABLE RESTRAINT" indicator lamp.

Description:

The DERM injects a current of 75 milliamperes through the steering column from the Force Hi output (terminal A4) to the Force Low input (terminal A10). By monitoring the voltage at the Sense Hi input (terminal A7) and the Sense Low input (terminal A6) the DERM calculates the combined resistance of the Inflator Module, SIR Coil, harness wiring (circuits 347, 348 and 349) and connector terminal contact in the steering column. Code 21 will set if the resistance is greater than a specified value or the 100 ohm resistors within the Resistor Module is shorted.

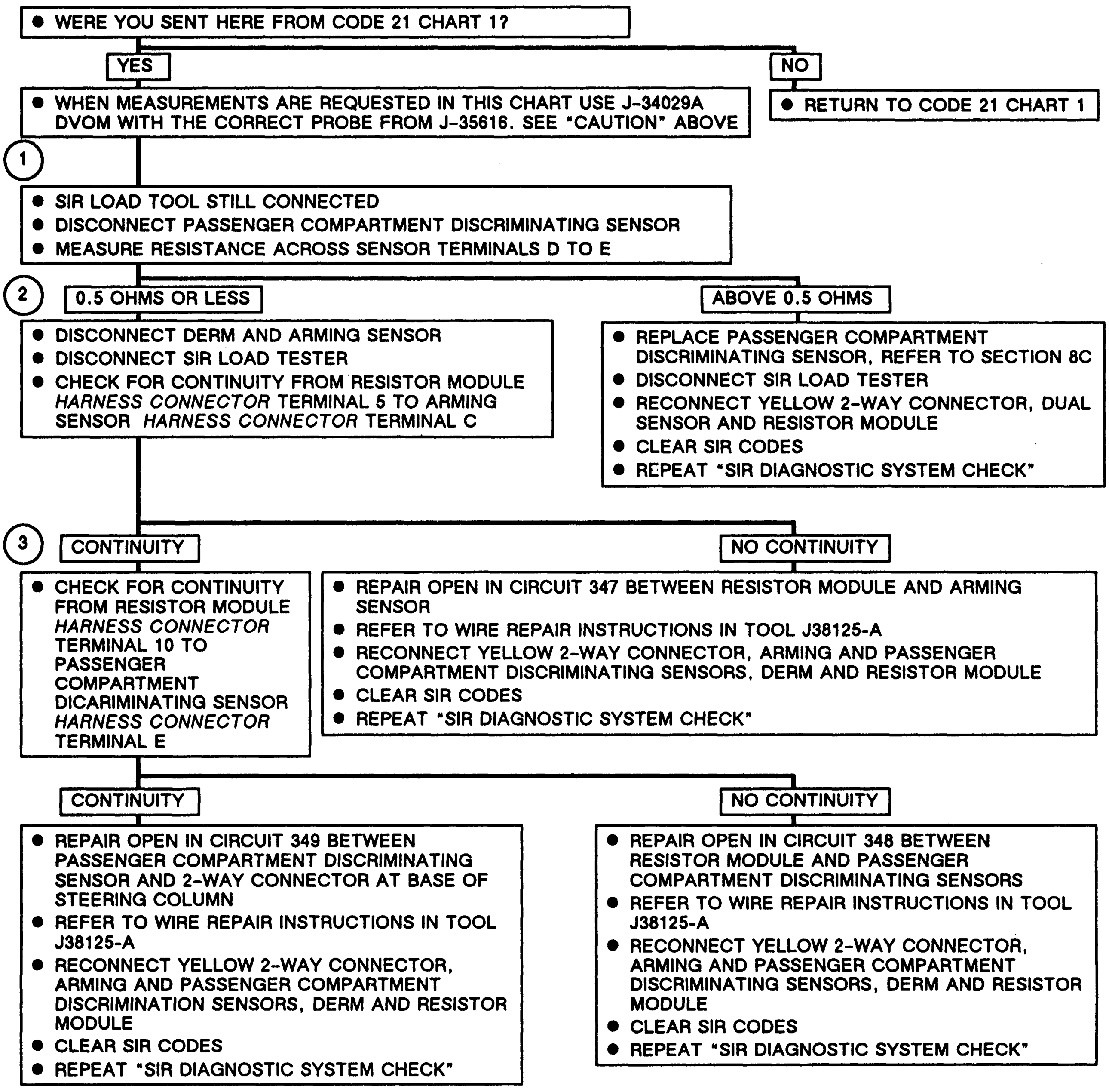
Notes on Fault Tree:

1) Checks for resistance in Passenger Compartment Discriminating Sensor Dual Sensor between terminals D and E.
2) Checks for an open in circuit 347 between the Resistor Module and the Arming Sensor.
3) Checks for an open in circuit 348 between the Resistor Module and the Passenger Compartment Discriminating Sensor.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CODE 21 (CHART 2)

STEERING COLUMN RESISTANCE TOO HIGH



- WERE YOU SENT HERE FROM CODE 21 CHART 1?

YES

- WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART USE J-34029A DVOM WITH THE CORRECT PROBE FROM J-35616. SEE "CAUTION" ABOVE

NO

- RETURN TO CODE 21 CHART 1

①

- SIR LOAD TOOL STILL CONNECTED
- DISCONNECT PASSENGER COMPARTMENT DISCRIMINATING SENSOR
- MEASURE RESISTANCE ACROSS SENSOR TERMINALS D TO E

② 0.5 OHMS OR LESS

- DISCONNECT DERM AND ARMING SENSOR
- DISCONNECT SIR LOAD TESTER
- CHECK FOR CONTINUITY FROM RESISTOR MODULE *HARNESS CONNECTOR* TERMINAL 5 TO ARMING SENSOR *HARNESS CONNECTOR* TERMINAL C

ABOVE 0.5 OHMS

- REPLACE PASSENGER COMPARTMENT DISCRIMINATING SENSOR, REFER TO SECTION 8C
- DISCONNECT SIR LOAD TESTER
- RECONNECT YELLOW 2-WAY CONNECTOR, DUAL SENSOR AND RESISTOR MODULE
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

③ CONTINUITY

- CHECK FOR CONTINUITY FROM RESISTOR MODULE *HARNESS CONNECTOR* TERMINAL 10 TO PASSENGER COMPARTMENT DICARIMINATING SENSOR *HARNESS CONNECTOR* TERMINAL E

NO CONTINUITY

- REPAIR OPEN IN CIRCUIT 347 BETWEEN RESISTOR MODULE AND ARMING SENSOR
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT YELLOW 2-WAY CONNECTOR, ARMING AND PASSENGER COMPARTMENT DISCRIMINATING SENSORS, DERM AND RESISTOR MODULE
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

CONTINUITY

- REPAIR OPEN IN CIRCUIT 349 BETWEEN PASSENGER COMPARTMENT DISCRIMINATING SENSOR AND 2-WAY CONNECTOR AT BASE OF STEERING COLUMN
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT YELLOW 2-WAY CONNECTOR, ARMING AND PASSENGER COMPARTMENT DISCRIMINATION SENSORS, DERM AND RESISTOR MODULE
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

NO CONTINUITY

- REPAIR OPEN IN CIRCUIT 348 BETWEEN RESISTOR MODULE AND PASSENGER COMPARTMENT DISCRIMINATING SENSORS
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT YELLOW 2-WAY CONNECTOR, ARMING AND PASSENGER COMPARTMENT DISCRIMINATING SENSORS, DERM AND RESISTOR MODULE
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

Figure 9J-A-21 Code 21 (Chart 2)

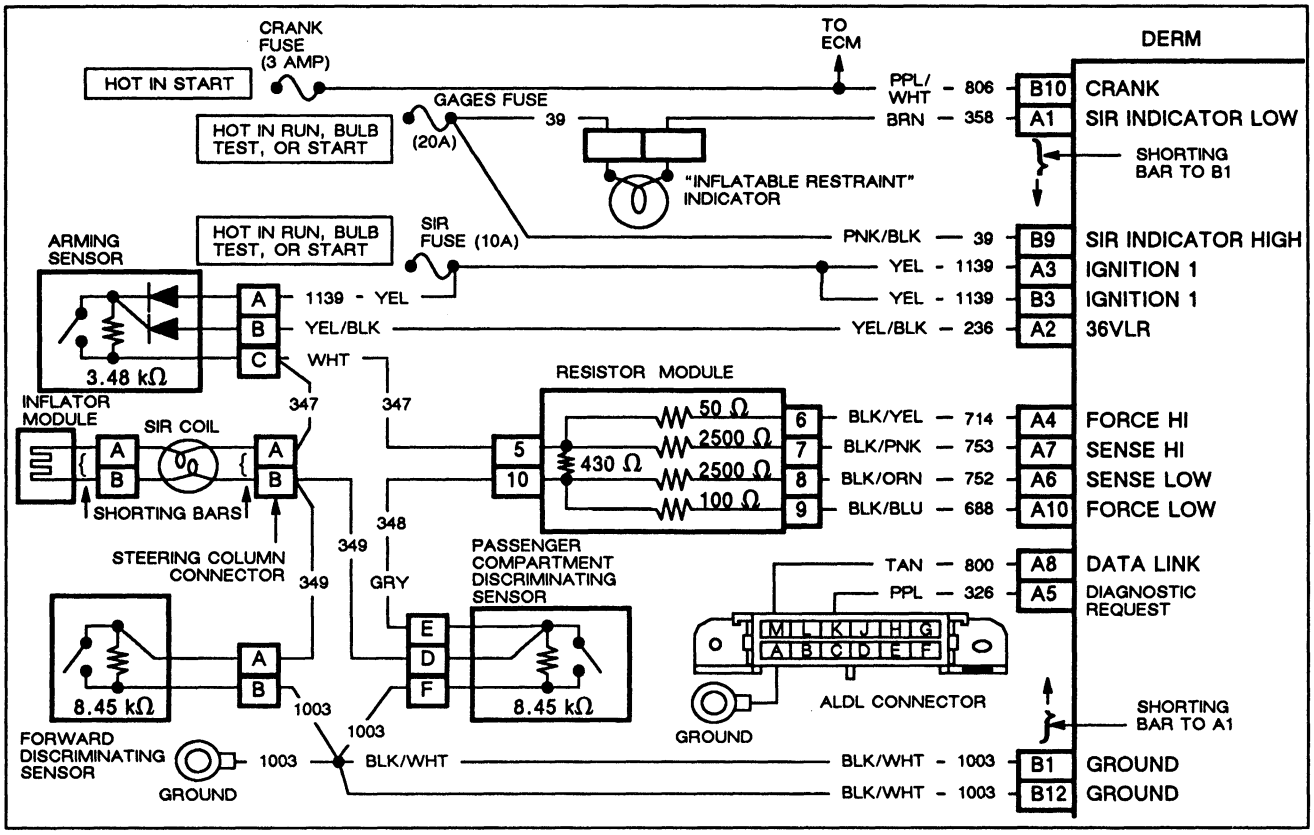


Figure 9J-A-22 SIR Circuit

CODE 22 (CHART 1)

STEERING COLUMN RESISTANCE TOO LOW

Test Conditions:

Tested once each ignition cycle during the "Steering Column Resistance Test" if: 1) No faults are detected during "Turn-on"; 2) No faults are detected during "Continuous Monitoring" for 1 second; 3) No Crank signal present.

Failure Conditions:

Code 22 will set if the combined resistance of the Inflator Module, SIR Coil, harness wiring and connector terminal contact in the steering column is less than a specified value.

Conditions To Clear:

Current Code 22 will be cleared each time the Ignition Switch is turned OFF.

Action Taken:

DERM turns on the "INFLATABLE RESTRAINT" indicator lamp.

Description:

The DERM injects a current of 75 milliamperes through the steering column from the Force Hi output (terminal A4) to the Force Low input (terminal A10). By monitoring the voltage at the Sense Hi input (terminal A7) and the Sense Low input (terminal A6) the DERM calculates the combined resistance of the Inflator Module, SIR Coil, harness wiring (circuits 347, 348 and 349) and connector terminal contact in the steering column. Code 22 will set if:

- The steering column resistance is less than a specified value.
- The 430 ohm resistor in the Resistor Module is shorted.
- The resistance of the 100 ohm resistor in the Resistor Module is too high.
- The high side of the deployment loop is shorted to the low side of the deployment loop.

Notes on Fault Tree:

1) Checks if fault is in steering column. The SIR Load Tester J37808 simulates the resistance of good steering column wiring and components.
2) Determines if fault is in Inflator Module or in the SIR Coil. The SIR Load Tester J37808 simulates the resistance of a good Inflator Module.
3) Determines if fault is on deployment loop side or DERM side of resistor module.
4) Checks for open in Sense Hi (circuit 753)
5) Checks for an open or shorted Resistor Module.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CURRENT CODE 22 (CHART 1)

STEERING COLUMN RESISTANCE TOO LOW

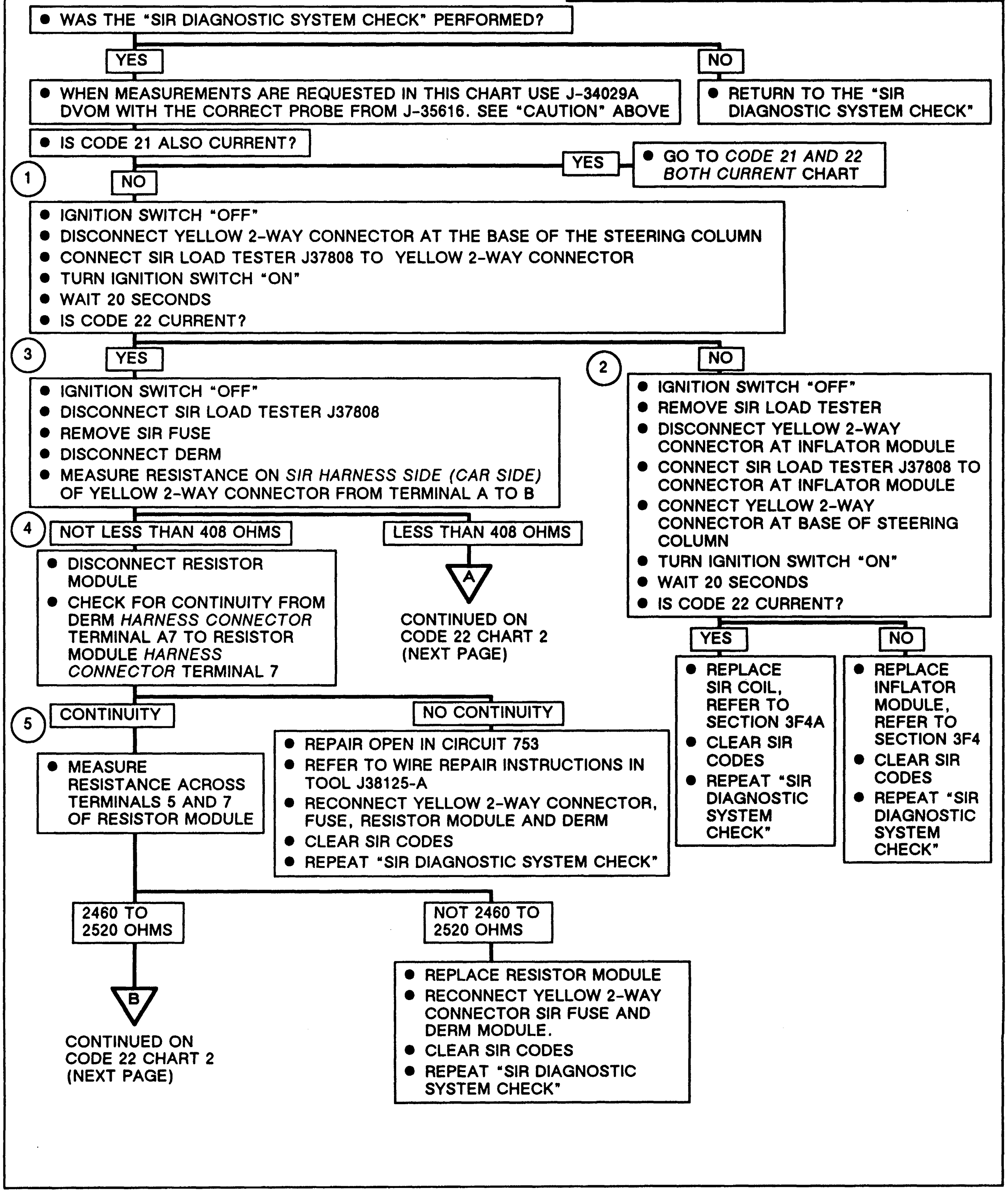


Figure 9J-A-23 Code 22 (Chart 1)

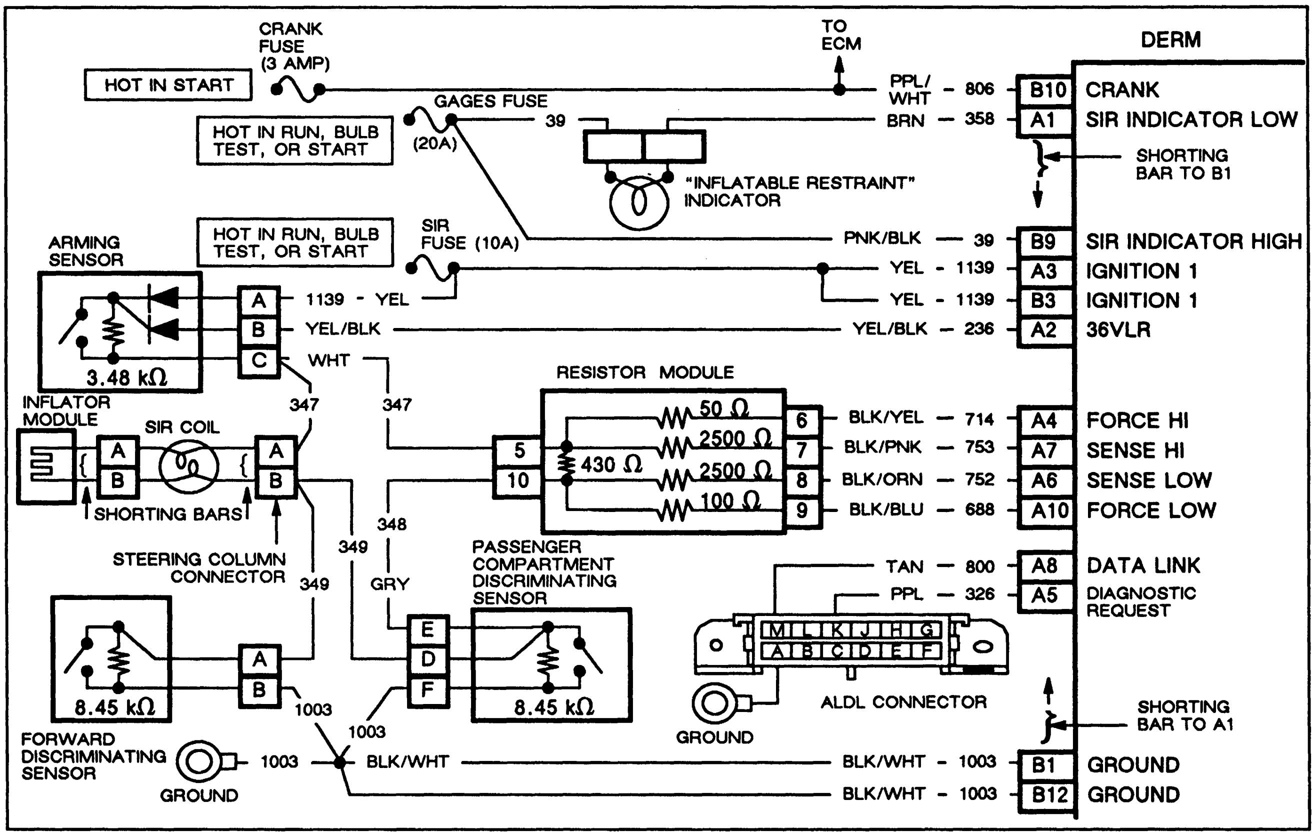


Figure 9J-A-24 SIR Circuit

CODE 22 (CHART 2)

STEERING COLUMN RESISTANCE TOO LOW

Test Conditions:

Tested once each ignition cycle during the "Steering Column Resistance Test" if: 1) No faults are detected during "Turn-on"; 2) No faults are detected during "Continuous Monitoring" for 1 second; 3) No Crank signal present.

Failure Conditions:

Code 22 will set if the combined resistance of the Inflator Module, SIR Coil, harness wiring and connector terminal contact in the steering column is less than a specified value ohms.

Conditions To Clear:

Current Code 22 will be cleared each time the Ignition Switch is turned OFF.

Action Taken:

DERM turns on the "INFLATABLE RESTRAINT" indicator lamp.

Description:

The DERM injects a current of 75 milliamperes through the steering column from the Force Hi output (terminal A4) to the Force Low input (terminal A10). By monitoring the voltage at the Sense Hi input (terminal A7) and the Sense Low input (terminal A6) the DERM calculates the combined resistance of the Inflator Module, SIR Coil, harness wiring (circuits 347, 348 and 349) and connector terminal contact in the steering column. Code 22 will set if:

- The steering column resistance is less than a specified value ohms.
- The 430 ohm resistor in the Resistor Module is shorted.
- The resistance of the 100 ohm resistor in the Resistor Module is too high.
- The high side of the deployment loop is shorted to the low side of the deployment loop.

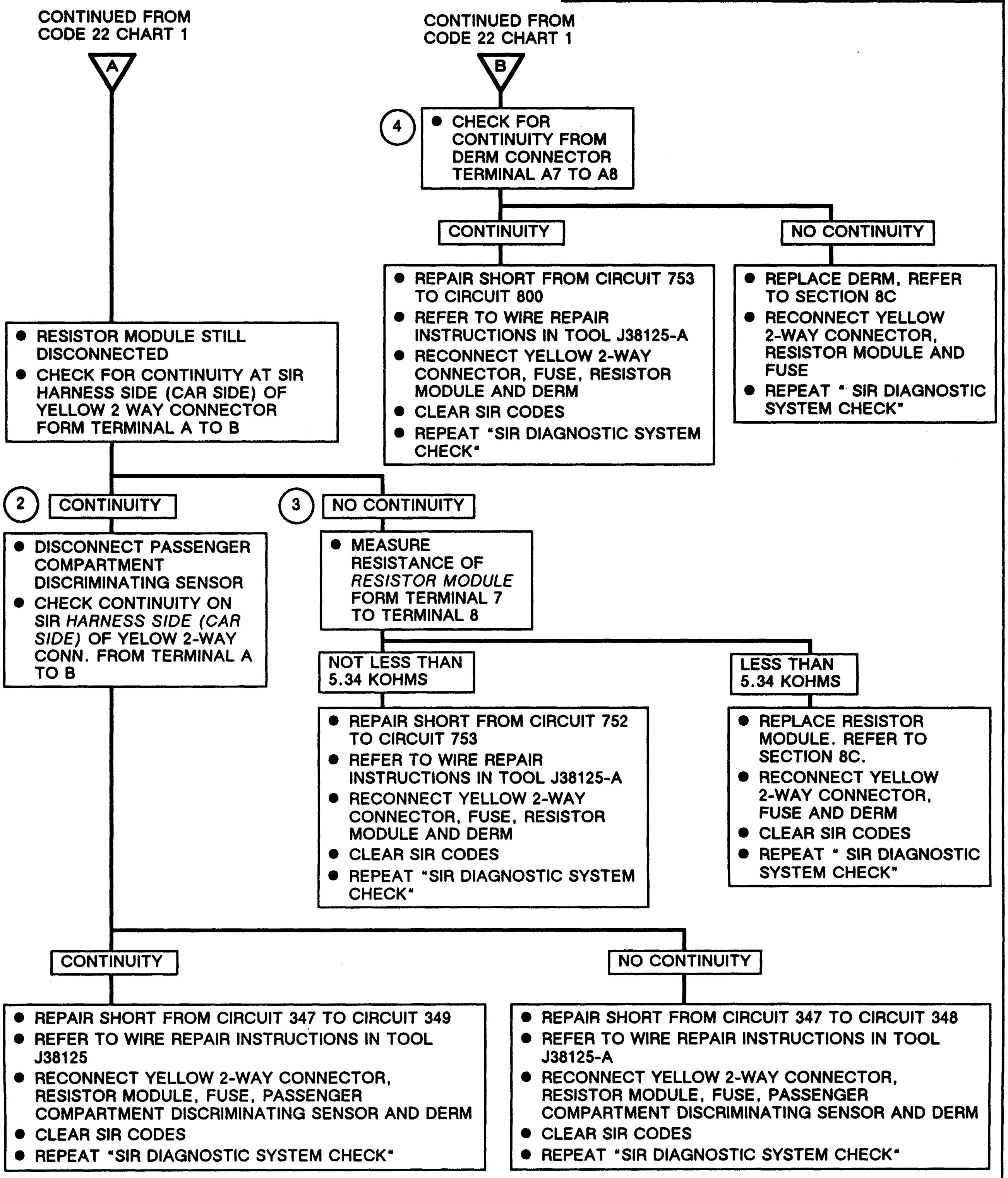
Notes on Fault Tree:

1) Determines if a short exists in wiring from resistor module to steering column or from resistor module to DERM.
2) Determines if short is with circuit 348 or circuit 349.
3) Determines if resistor module is defective or if Sense Hi wiring is shorted to Sense Low wiring.
4) Checks for short between Sense HI and Data line.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CODE 22 (CHART 2)

STEERING COLUMN RESISTANCE TOO LOW



CONTINUED FROM CODE 22 CHART 1

A

- RESISTOR MODULE STILL DISCONNECTED
- CHECK FOR CONTINUITY AT SIR HARNESS SIDE (CAR SIDE) OF YELLOW 2 WAY CONNECTOR FORM TERMINAL A TO B

② CONTINUITY

- DISCONNECT PASSENGER COMPARTMENT DISCRIMINATING SENSOR
- CHECK CONTINUITY ON SIR *HARNESS SIDE (CAR SIDE)* OF YELOW 2-WAY CONN. FROM TERMINAL A TO B

CONTINUITY

- REPAIR SHORT FROM CIRCUIT 347 TO CIRCUIT 349
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125
- RECONNECT YELLOW 2-WAY CONNECTOR, RESISTOR MODULE, FUSE, PASSENGER COMPARTMENT DISCRIMINATING SENSOR AND DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

NO CONTINUITY

- REPAIR SHORT FROM CIRCUIT 347 TO CIRCUIT 348
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT YELLOW 2-WAY CONNECTOR, RESISTOR MODULE, FUSE, PASSENGER COMPARTMENT DISCRIMINATING SENSOR AND DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

③ NO CONTINUITY

- MEASURE RESISTANCE OF *RESISTOR MODULE* FORM TERMINAL 7 TO TERMINAL 8

NOT LESS THAN 5.34 KOHMS

- REPAIR SHORT FROM CIRCUIT 752 TO CIRCUIT 753
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT YELLOW 2-WAY CONNECTOR, FUSE, RESISTOR MODULE AND DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

LESS THAN 5.34 KOHMS

- REPLACE RESISTOR MODULE. REFER TO SECTION 8C.
- RECONNECT YELLOW 2-WAY CONNECTOR, FUSE AND DERM
- CLEAR SIR CODES
- REPEAT " SIR DIAGNOSTIC SYSTEM CHECK"

CONTINUED FROM CODE 22 CHART 1

B

④

- CHECK FOR CONTINUITY FROM DERM CONNECTOR TERMINAL A7 TO A8

CONTINUITY

- REPAIR SHORT FROM CIRCUIT 753 TO CIRCUIT 800
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT YELLOW 2-WAY CONNECTOR, FUSE, RESISTOR MODULE AND DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

NO CONTINUITY

- REPLACE DERM, REFER TO SECTION 8C
- RECONNECT YELLOW 2-WAY CONNECTOR, RESISTOR MODULE AND FUSE
- REPEAT " SIR DIAGNOSTIC SYSTEM CHECK"

Figure 9J-A-25 Code 21 (Chart 2)

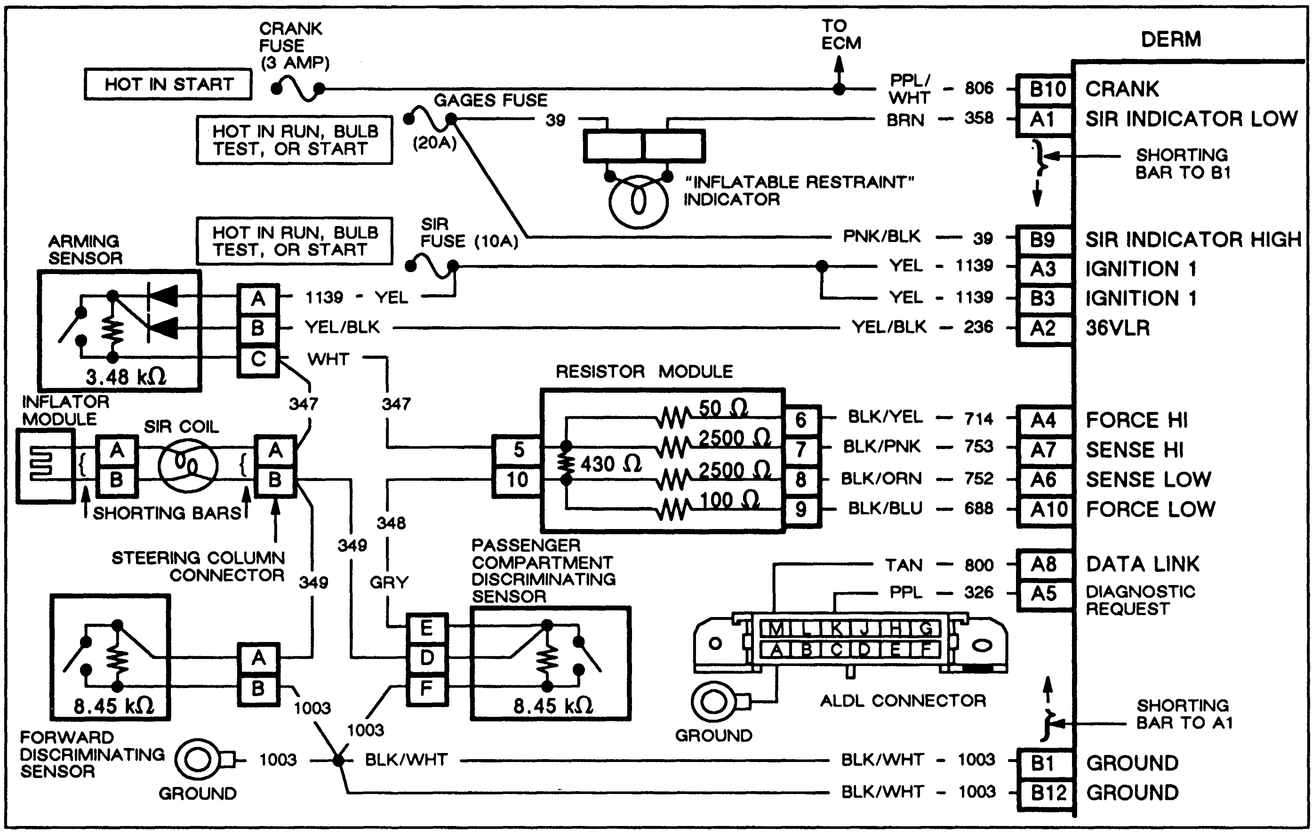


Figure 9J-A-26 SIR Circuit

CODE 21 AND 22 BOTH CURRENT

STEERING COLUMN RESISTANCE UNDETERMINED

Test Conditions:

Tested once each ignition cycle during the "Steering Column Resistance Test" if: 1) No faults are detected during "Turn-on"; 2) No faults are detected during "Continuous Monitoring" for 1 second; 3) No Crank signal present.

Failure Conditions:

Code 21 and 22 will set if the voltage at the Sense Low input (terminal A6) is less than 5 volts during the first portion of the steering column resistance test. This will occur when the Force Hi output (terminal A4) is open and results in an undetermined steering column resistance.

Conditions To Clear:

Current Code 21 and 22 will be cleared each time the Ignition Switch is turned OFF.

Action Taken:

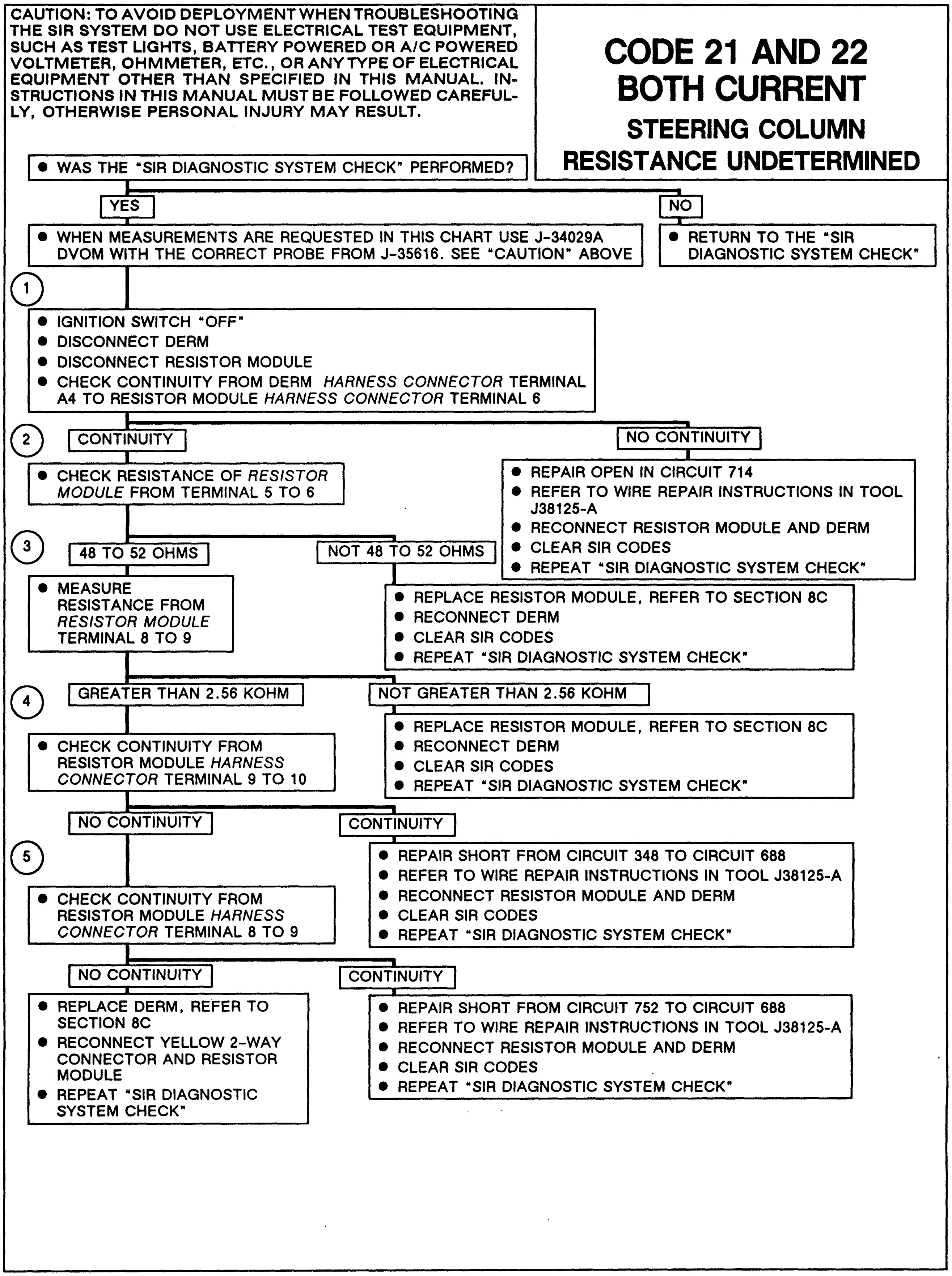
DERM turns on the "INFLATABLE RESTRAINT" indicator lamp.

Description:

The DERM injects a current of 75 milliamperes through the steering column from the Force Hi output (terminal A4) to the Force Low input (terminal A10). By monitoring the voltage at the Sense Hi input (terminal A7) and the Sense Low input (terminal A6) the DERM calculates the combined resistance of the Inflator Module, SIR Coil, harness wiring and connector terminal contact in the steering column. Codes 22 and 21 will set if the Force Hi output (terminal A4) is open.

Notes on Fault Tree:

1) Checks for open in Force Hi wiring.
2) Checks for open 50 ohm resistor in resistor module.
3) Checks for proper values in resistor module.
4) Checks for short in resistor module wiring harness.
5) Checks for short in resistor module wiring harness.



CODE 21 AND 22 BOTH CURRENT
STEERING COLUMN RESISTANCE UNDETERMINED

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

- WAS THE "SIR DIAGNOSTIC SYSTEM CHECK" PERFORMED?

YES

- WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART USE J-34029A DVOM WITH THE CORRECT PROBE FROM J-35616. SEE "CAUTION" ABOVE

NO

- RETURN TO THE "SIR DIAGNOSTIC SYSTEM CHECK"

①

- IGNITION SWITCH "OFF"
- DISCONNECT DERM
- DISCONNECT RESISTOR MODULE
- CHECK CONTINUITY FROM DERM *HARNESS CONNECTOR* TERMINAL A4 TO RESISTOR MODULE *HARNESS CONNECTOR* TERMINAL 6

②

CONTINUITY

- CHECK RESISTANCE OF *RESISTOR MODULE* FROM TERMINAL 5 TO 6

NO CONTINUITY

- REPAIR OPEN IN CIRCUIT 714
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT RESISTOR MODULE AND DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

③

48 TO 52 OHMS

- MEASURE RESISTANCE FROM *RESISTOR MODULE* TERMINAL 8 TO 9

NOT 48 TO 52 OHMS

- REPLACE RESISTOR MODULE, REFER TO SECTION 8C
- RECONNECT DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

④

GREATER THAN 2.56 KOHM

- CHECK CONTINUITY FROM RESISTOR MODULE *HARNESS CONNECTOR* TERMINAL 9 TO 10

NOT GREATER THAN 2.56 KOHM

- REPLACE RESISTOR MODULE, REFER TO SECTION 8C
- RECONNECT DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

NO CONTINUITY

⑤

- CHECK CONTINUITY FROM RESISTOR MODULE *HARNESS CONNECTOR* TERMINAL 8 TO 9

CONTINUITY

- REPAIR SHORT FROM CIRCUIT 348 TO CIRCUIT 688
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT RESISTOR MODULE AND DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

NO CONTINUITY

- REPLACE DERM, REFER TO SECTION 8C
- RECONNECT YELLOW 2-WAY CONNECTOR AND RESISTOR MODULE
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

CONTINUITY

- REPAIR SHORT FROM CIRCUIT 752 TO CIRCUIT 688
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT RESISTOR MODULE AND DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

Figure 9J-A-27 Code 21 and 22 Both Current

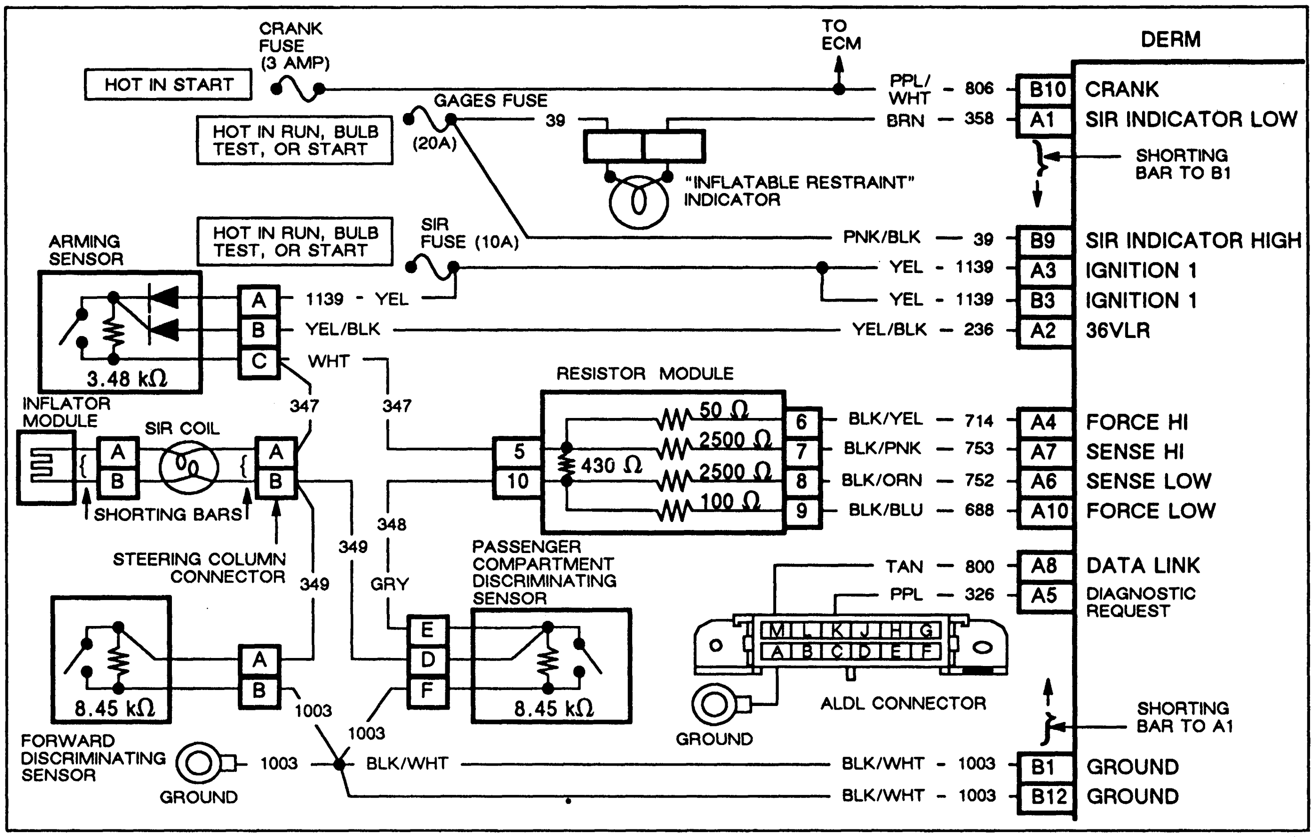


Figure 9J-A-28 SIR Circuit

CODE 23

STEERING COLUMN VOLTAGE TOO HIGH

Test Condition:

Tested every 100 milliseconds during "Continuous Monitoring."

Failure Conditions:

Code 23 will set if the voltage at the Sense Low input (terminal A6) is greater than 78% of 36VLR output voltage for 500 milliseconds.

Conditions To Clear:

Current Code 23 will clear if the voltage at the Sense Low input (terminal A6) is between 41% and 61% of 36VLR output voltage for 500 milliseconds (5 consecutive "Continuous Monitoring" cycles) after Code 23 has been set.

Action Taken:

DERM turns on the "INFLATABLE RESTRAINT" indicator lamp.

Description:

Code 23 is set when the voltage at the Sense Low input (terminal A6) is greater than 78% of 36VLR output voltage for 500 milliseconds during the "Continuous Monitoring" tests performed by the DERM. The "Continuous Monitoring" tests are performed by the DERM after the initial "Turn-on" tests are completed and are performed every 100 milliseconds while Ignition 1 voltage is present at the DERM. The "Continuous Monitoring" tests check the continuity of the deployment loop from the 36VLR output of the DERM through the Arming Sensor, Inflator Module and the Discriminating Sensors to ground. Code 23 indicates a shorted Arming Sensor, shorted harness, or open grounds on both Discriminating Sensors.

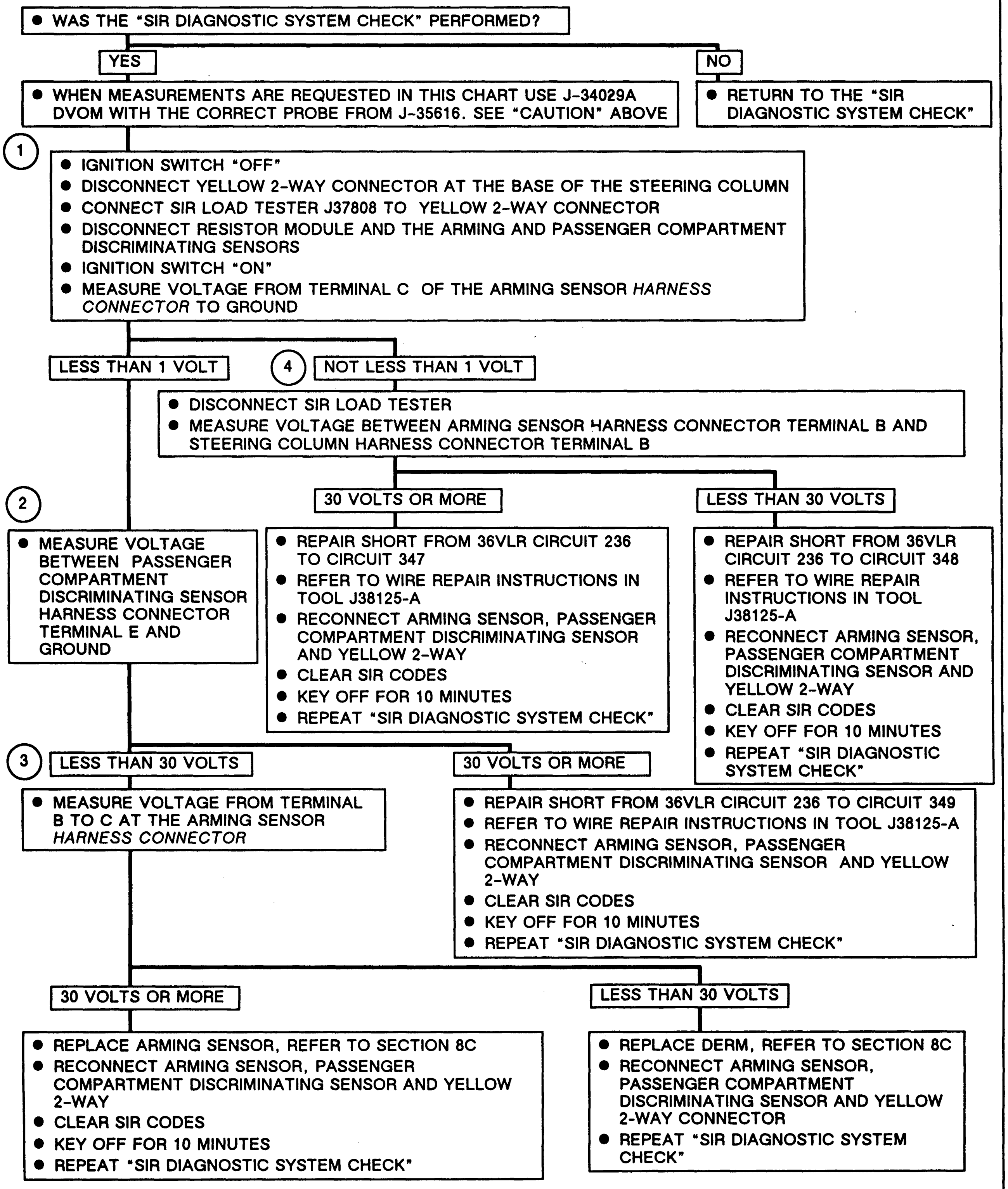
Notes on Fault Tree:

1) Checks the 36VLR circuit for a short to the high side of the steering column (circuit 347).
2) Checks if the ground circuits on both Discriminating Sensors are open.
3) Checks the 36VLR circuit for a short to the low side of the steering column (circuit 348).
4) Checks the 36VLR circuit for a short to the low side of the steering column (circuit 349).

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CODE 23

STEERING COLUMN VOLTAGE TOO HIGH



- WAS THE "SIR DIAGNOSTIC SYSTEM CHECK" PERFORMED?

YES

- WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART USE J-34029A DVOM WITH THE CORRECT PROBE FROM J-35616. SEE "CAUTION" ABOVE

NO

- RETURN TO THE "SIR DIAGNOSTIC SYSTEM CHECK"

①

- IGNITION SWITCH "OFF"
- DISCONNECT YELLOW 2-WAY CONNECTOR AT THE BASE OF THE STEERING COLUMN
- CONNECT SIR LOAD TESTER J37808 TO YELLOW 2-WAY CONNECTOR
- DISCONNECT RESISTOR MODULE AND THE ARMING AND PASSENGER COMPARTMENT DISCRIMINATING SENSORS
- IGNITION SWITCH "ON"
- MEASURE VOLTAGE FROM TERMINAL C OF THE ARMING SENSOR *HARNESS CONNECTOR* TO GROUND

LESS THAN 1 VOLT

②

- MEASURE VOLTAGE BETWEEN PASSENGER COMPARTMENT DISCRIMINATING SENSOR HARNESS CONNECTOR TERMINAL E AND GROUND

③ LESS THAN 30 VOLTS

- MEASURE VOLTAGE FROM TERMINAL B TO C AT THE ARMING SENSOR *HARNESS CONNECTOR*

30 VOLTS OR MORE

- REPLACE ARMING SENSOR, REFER TO SECTION 8C
- RECONNECT ARMING SENSOR, PASSENGER COMPARTMENT DISCRIMINATING SENSOR AND YELLOW 2-WAY
- CLEAR SIR CODES
- KEY OFF FOR 10 MINUTES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

LESS THAN 30 VOLTS

- REPLACE DERM, REFER TO SECTION 8C
- RECONNECT ARMING SENSOR, PASSENGER COMPARTMENT DISCRIMINATING SENSOR AND YELLOW 2-WAY CONNECTOR
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

30 VOLTS OR MORE

- REPAIR SHORT FROM 36VLR CIRCUIT 236 TO CIRCUIT 349
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT ARMING SENSOR, PASSENGER COMPARTMENT DISCRIMINATING SENSOR AND YELLOW 2-WAY
- CLEAR SIR CODES
- KEY OFF FOR 10 MINUTES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

④ NOT LESS THAN 1 VOLT

- DISCONNECT SIR LOAD TESTER
- MEASURE VOLTAGE BETWEEN ARMING SENSOR HARNESS CONNECTOR TERMINAL B AND STEERING COLUMN HARNESS CONNECTOR TERMINAL B

30 VOLTS OR MORE

- REPAIR SHORT FROM 36VLR CIRCUIT 236 TO CIRCUIT 347
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT ARMING SENSOR, PASSENGER COMPARTMENT DISCRIMINATING SENSOR AND YELLOW 2-WAY
- CLEAR SIR CODES
- KEY OFF FOR 10 MINUTES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

LESS THAN 30 VOLTS

- REPAIR SHORT FROM 36VLR CIRCUIT 236 TO CIRCUIT 348
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT ARMING SENSOR, PASSENGER COMPARTMENT DISCRIMINATING SENSOR AND YELLOW 2-WAY
- CLEAR SIR CODES
- KEY OFF FOR 10 MINUTES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

Figure 9J-A-29 Code 23

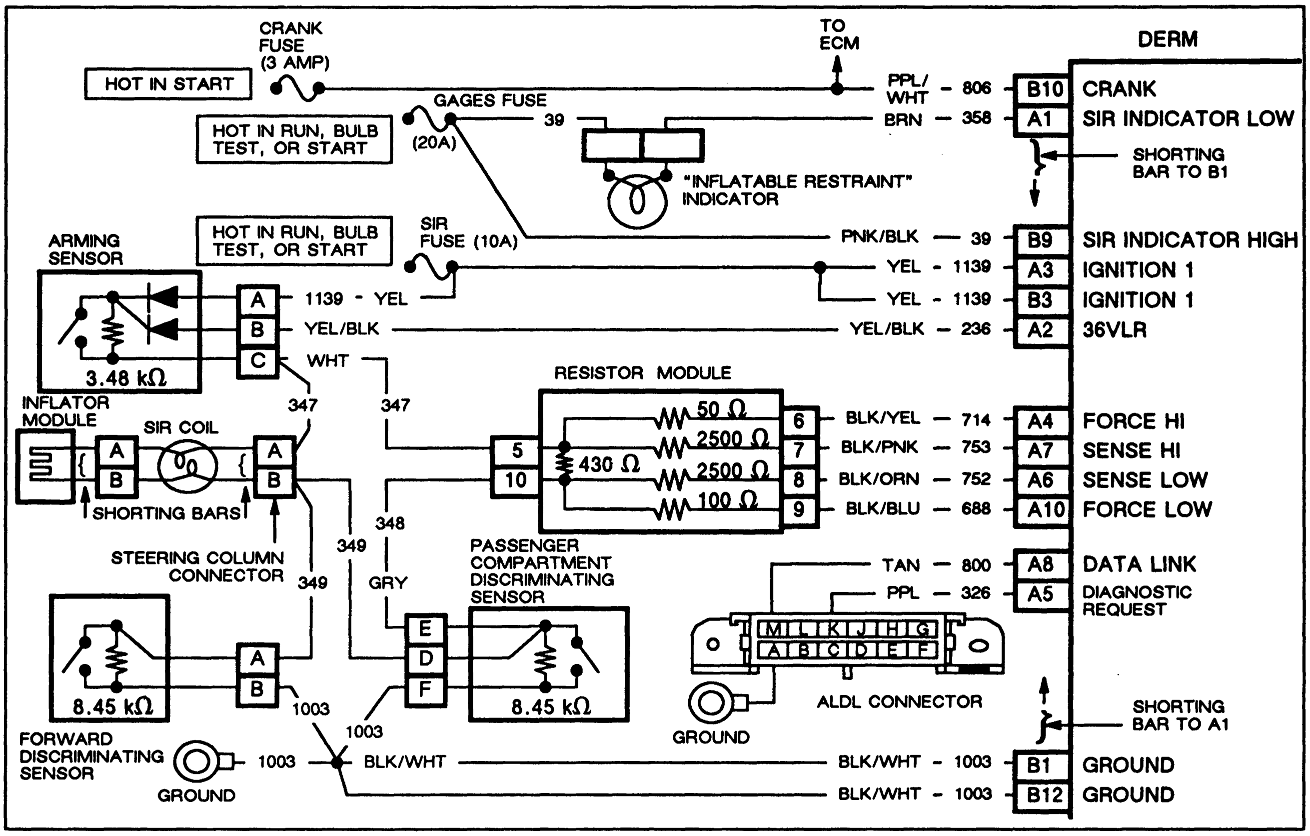


Figure 9J-A-30 SIR Circuit

CODE 24

STEERING COLUMN VOLTAGE TOO LOW

Test Condition:

Tested every 100 milliseconds during "Continuous Monitoring."

Failure Conditions:

Code 24 will set if the voltage at the Sense Low input (terminal A6) is between 0% and 41% of 36VLR output voltage for 500 milliseconds.

Conditions To Clear:

Code 24 will clear if the voltage at the Sense Low input (terminal A6) is between 41% and 61% of 36VLR output voltage for 500 milliseconds.

Action Taken:

DERM turns on the "INFLATABLE RESTRAINT" indicator lamp.

Description:

Code 24 is set when the voltage at the Sense Low input (terminal A6) is between 0% and 41% of 36VLR output voltage for 500 milliseconds during the "Continuous Monitoring" tests performed by the DERM. The "Continuous Monitoring" tests are performed by the DERM after the initial "Turn-on" tests are completed and are performed every 100 milliseconds while Ignition 1 voltage is present at the DERM. The "Continuous Monitoring" tests check the continuity of the deployment loop from the 36VLR output of the DERM through the Arming Sensor, Inflator Module and the Discriminating Sensors to ground. Code 24 will set if the Arming Sensor resistance is too high or open, the Discriminating Sensor resistance is too low or shorted, the "Force Hi," "Sense Hi," "Sense Low" or "Force Low" circuits are shorted to ground or system voltage, the high side of the deployment loop is shorted to the low side.

Notes on Fault Tree:

1) Determines if fault is short to voltage on circuit 349 or SIR coil.
2) Determines if fault is short to voltage on circuit 347.
3) Determines if fault is short to voltage on circuit 349 or if fault is defective SIR coil or Dual Sensor.
4) Determines if fault is short to voltage on circuit 348.
5) Determines if fault is short to voltage on circuit 714.
6) Determines if fault is short to voltage on circuit 752 or 688.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH TEST LIGHTS AS BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CODE 24

STEERING COLUMN VOLTAGE TOO LOW

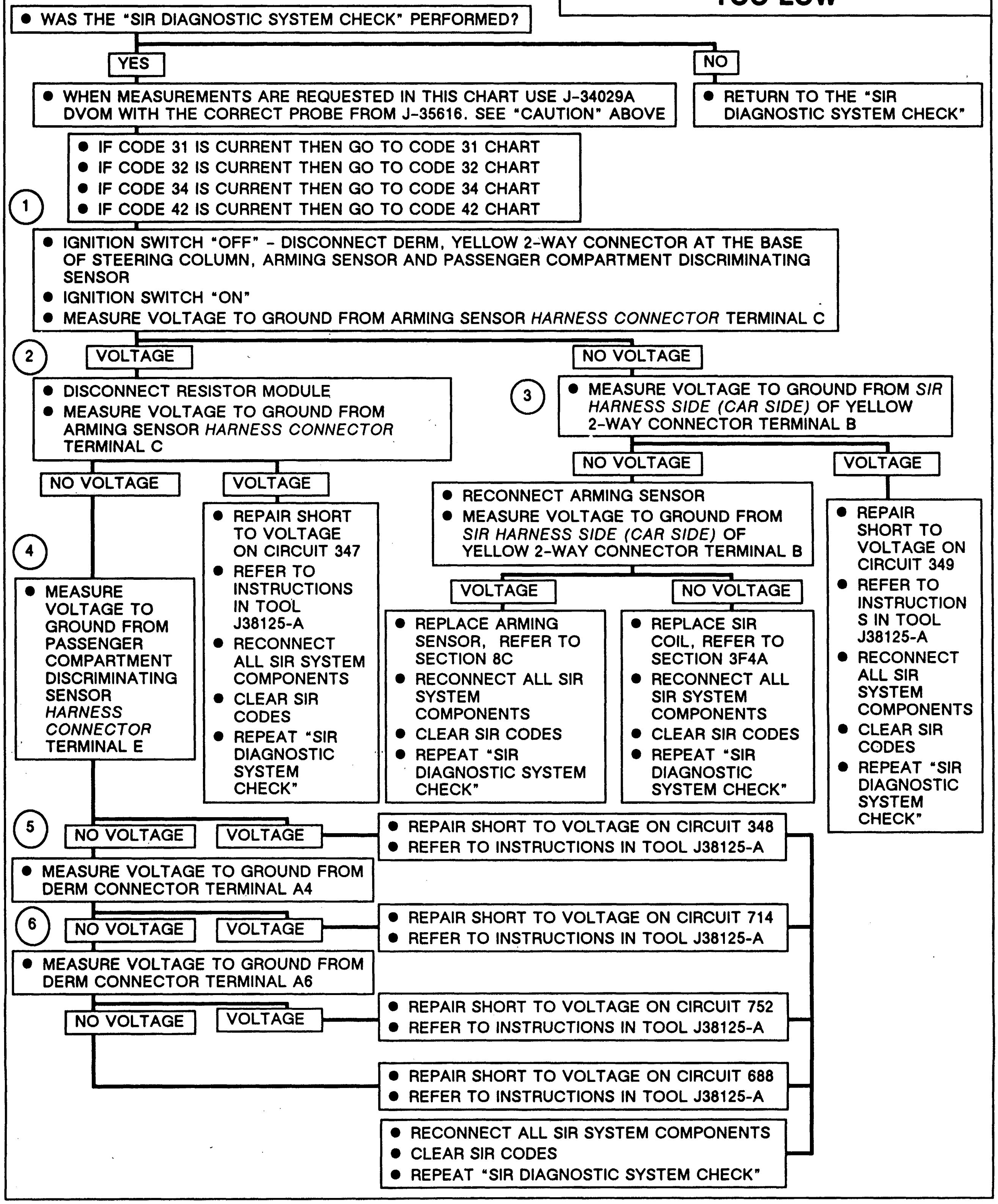


Figure 9J-A-31 Code 24

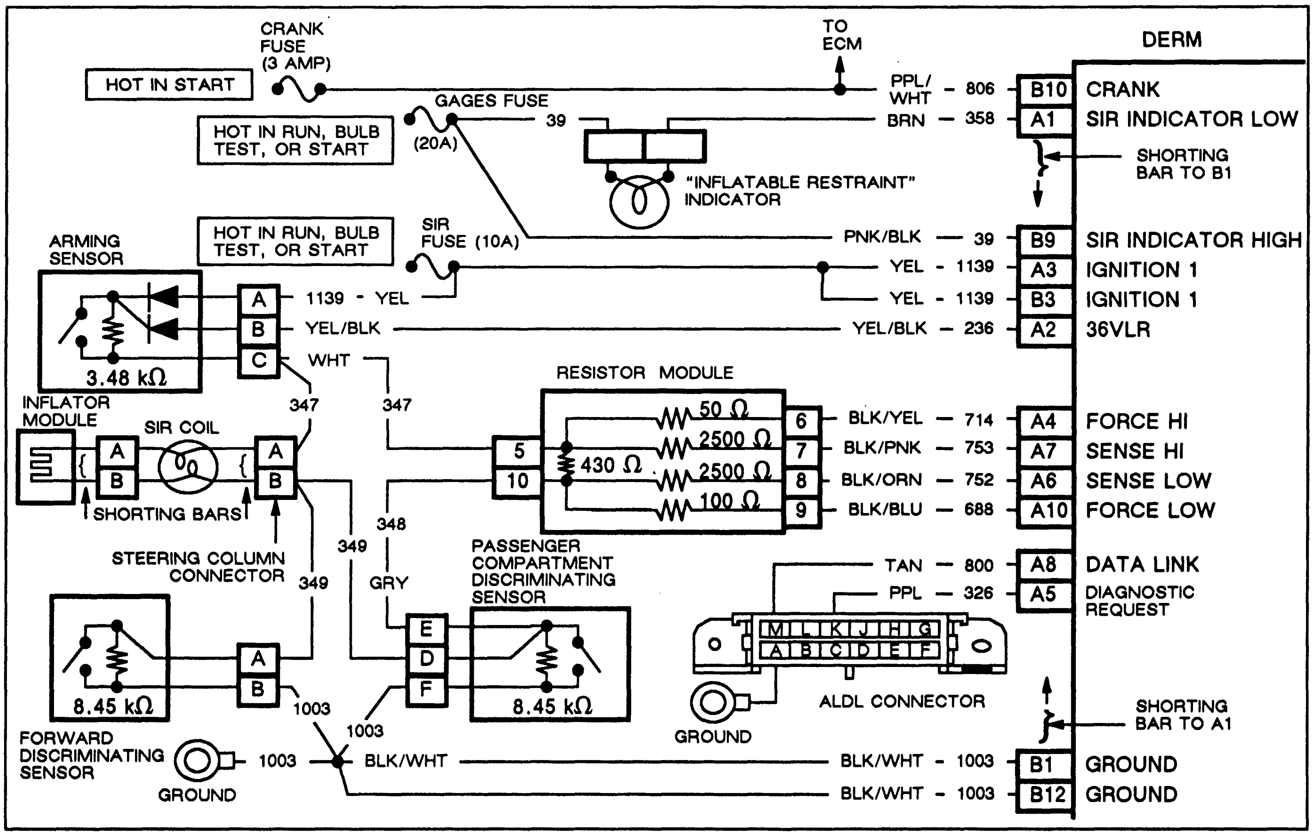


Figure 9J-A-32 SIR Circuit

CODE 25

SHORT TO BATTERY IN STEERING COLUMN

Test Conditions:

Tested once each ignition cycle during the "Steering Column Resistance Test" if: 1) No faults are detected during "Turn-on"; 2) No faults are detected during "Continuous Monitoring" for 1 second; 3) No Crank signal present.

Failure Conditions:

Code 25 will set if the voltage at the Sense Low Input (terminal A6) is equal to Ignition 1 voltage (± 2 volts) during the first portion of the Steering Column Resistance Test.

Conditions To Clear:

Current Code 25 will be cleared each time the Ignition Switch is turned OFF.

Action Taken:

DERM turns on the "INFLATABLE RESTRAINT" indicator lamp.

Description:

The DERM grounds the Force Low input (terminal A10) and then monitors the voltage at the Sense Low input (terminal A6). If the voltage is greater than 3 volts Code 25 will set. Code 25 is an indication of a short to system voltage in the steering column, Passenger Compartment Discriminating Sensor, Arming Sensor, or associated wiring. Additionally, this code can be set if the actual resistance of the 100 ohm resistor within the Resistor Module is too high or is open.

Notes on Fault Tree:

1) Determines if fault is short to voltage on circuit 349 or SIR coil.
2) Determines if fault is short to voltage on circuit 347.
3) Determines if fault is short to voltage on circuit 349 or if fault is defective SIR coil or Arming Sensor.
4) Determines if fault is short to voltage on circuit 348.
5) Determines if fault is short to voltage on circuit 714.
6) Determines if fault is short to voltage on circuit 752 or 688.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CODE 25

SHORT TO BATTERY IN STEERING COLUMN

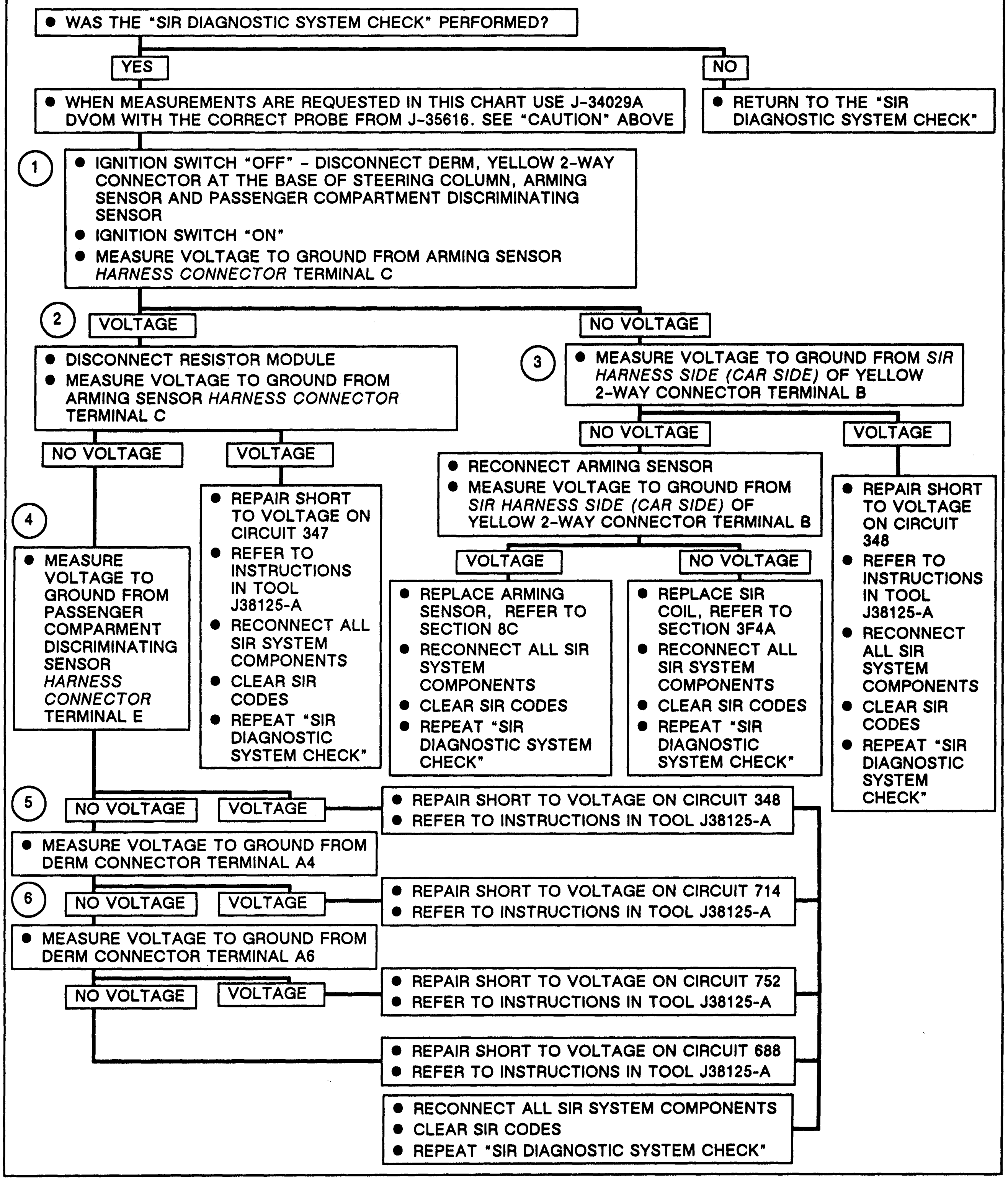


Figure 9J-A-33 Code 25

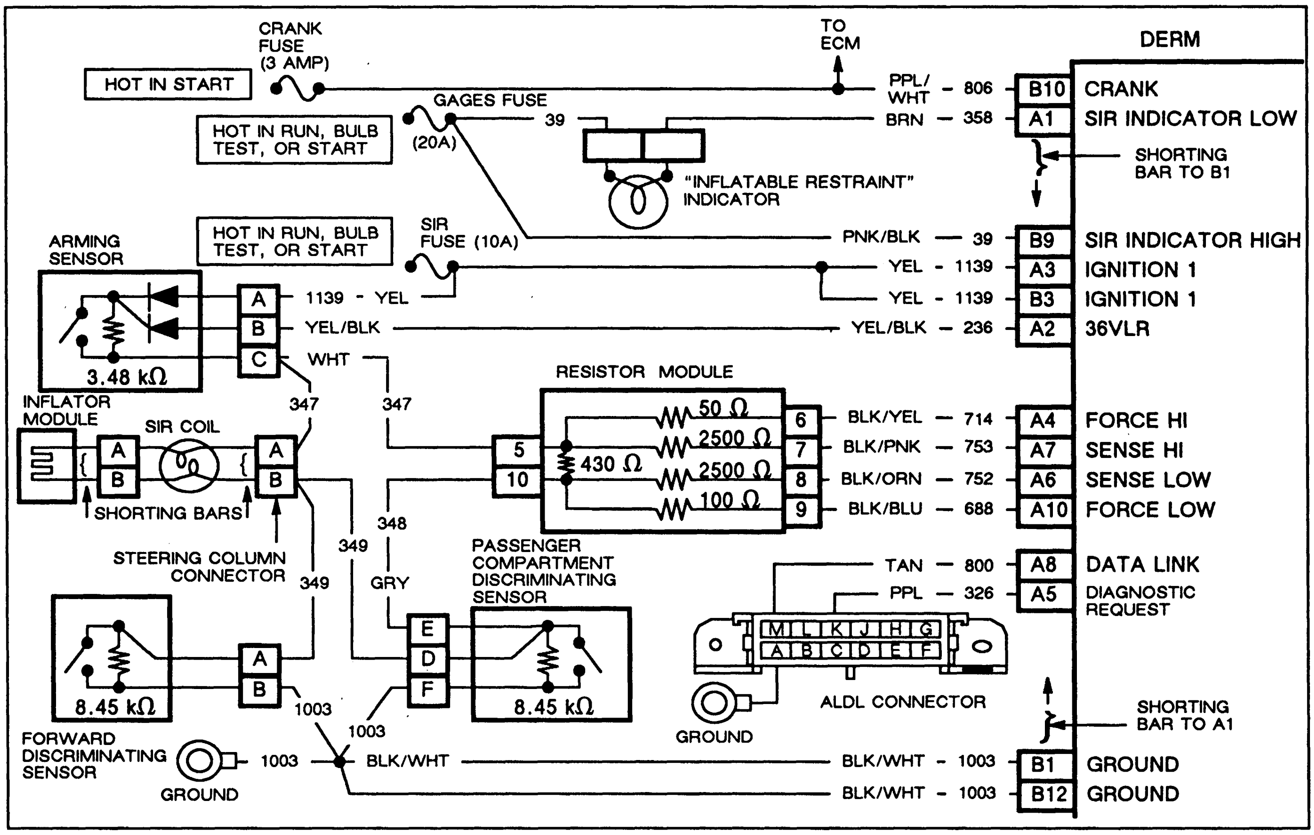


Figure 9J-A-34 SIR Circuit

CODE 26

OPEN IN STEERING COLUMN

Test Condition:

Tested every 100 milliseconds during "Continuous Monitoring".

Failure Conditions:

Code 26 will set if the voltage at the Sense Hi input (terminal A7) minus the voltage at the Sense Low input (terminal A6) is greater than 0.45 volts for 500 milliseconds.

Conditions To Clear:

Current Code 26 will clear if the voltage at the Sense Hi input (terminal A7) minus the voltage at the Sense Low input (terminal A6) is greater than 0 volts but less than 0.40 volts for 500 milliseconds after Code 26 has been set.

Action taken:

DERM turns on the "INFLATABLE RESTRAINT" indicator lamp.

Description:

If there is an open in the SIR Coil, Inflator Module or wiring in the steering column the resistance between the Sense Hi input (terminal A7) and the Sense Low input (terminal A6) increases. This increased resistance causes a larger voltage drop from the Sense Hi input to the Sense Low input, across the 430 ohm resistor in the Resistor Module. The increase in voltage between the Sense Hi input and the Sense Low input is sensed by the DERM during the "Continuous Monitoring" Tests and Code 26 is set.

Notes on Fault Tree:

1) Checks if fault is in the steering column. The SIR load tester J37808 simulates the resistance of good steering column wiring and components.
2) Checks if fault is in the Inflator Module or the SIR Coil.
3) Checks if fault is in resistor module.
4) Checks if fault is in Passenger Compartment Discriminating Sensor.
5) Checks fault is in circuit 347 or 348.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CODE 26

OPEN IN STEERING COLUMN

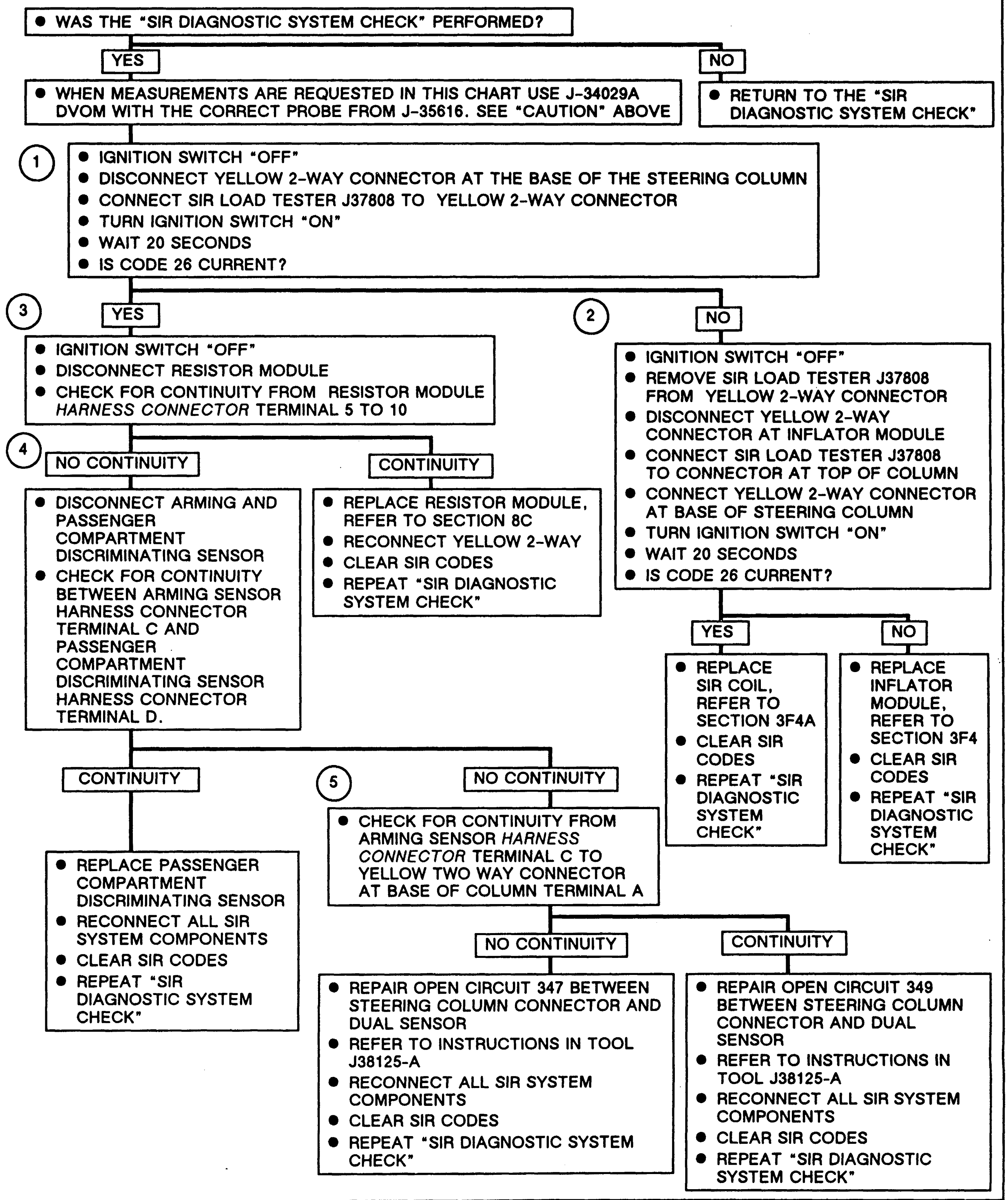


Figure 9J-A-35 Code 26

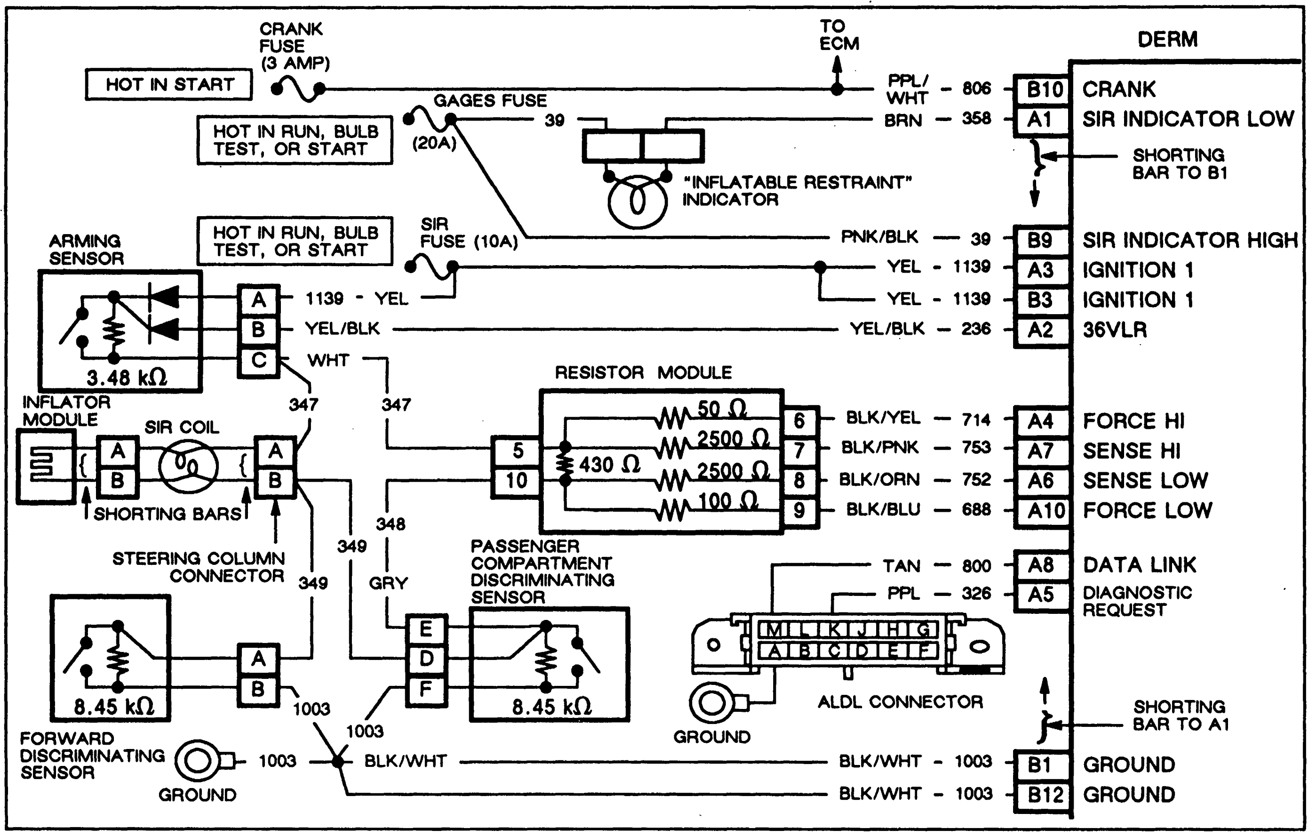


Figure 9J-A-36 SIR Circuit

CODE 31

OPEN 36VLR TO DEPLOYMENT LOOP

Test Condition:

Tested every 100 milliseconds during "Continuous Monitoring."

Failure Conditions:

Code 31 will set if: 1) The Voltage at the Sense Low input (terminal A6) is between 28% and 59% of Ignition 1 output voltage for 700 milliseconds; 2) Code 42 <u>is not</u> set.

Conditions To Clear:

Current Code 31 will clear if the voltage at the Sense Low input (terminal A6) is between 41% and 61% of 36VLR output voltage for 500 milliseconds.

Action taken:

DERM turns on the "INFLATABLE RESTRAINT" indicator lamp.

Description:

The voltage at the Sense Low input (terminal A6) is between 41% and 61% of 36VLR output voltage when 36VLR output of the DERM is functional. Should the circuit open between the 36VLR output and the Arming Sensor, Ignition 1 voltage will be supplying the deployment loop. The voltage at the Sense Low input (terminal A6) will decrease due to the decrease in the supply voltage and Code 31 will set after 700 milliseconds (if Code 42 is not set). Code 31 indicates an open in the wiring between the 36VLR output of the DERM and the Arming Sensor, an open diode in the Arming Sensor or a problen with Sense High or Sense Low circuits.

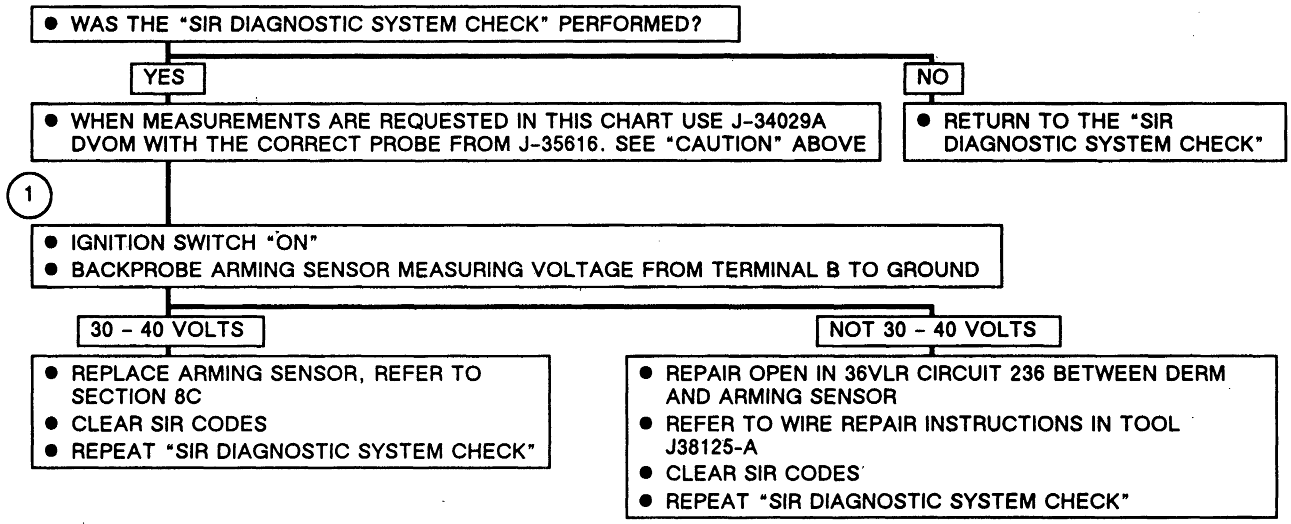
Notes on Fault Tree:

1) Checks if the fault is in the 36VLR Circuit between the DERM and the Arming Sensor or if the fault is in the Arming Sensor.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CODE 31

OPEN 36VLR TO DEPLOYMENT LOOP



- WAS THE "SIR DIAGNOSTIC SYSTEM CHECK" PERFORMED?

YES

- WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART USE J-34029A DVOM WITH THE CORRECT PROBE FROM J-35616. SEE "CAUTION" ABOVE

NO

- RETURN TO THE "SIR DIAGNOSTIC SYSTEM CHECK"

①

- IGNITION SWITCH "ON"
- BACKPROBE ARMING SENSOR MEASURING VOLTAGE FROM TERMINAL B TO GROUND

30 - 40 VOLTS

- REPLACE ARMING SENSOR, REFER TO SECTION 8C
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

NOT 30 - 40 VOLTS

- REPAIR OPEN IN 36VLR CIRCUIT 236 BETWEEN DERM AND ARMING SENSOR
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

Figure 9J-A-37 Code 31

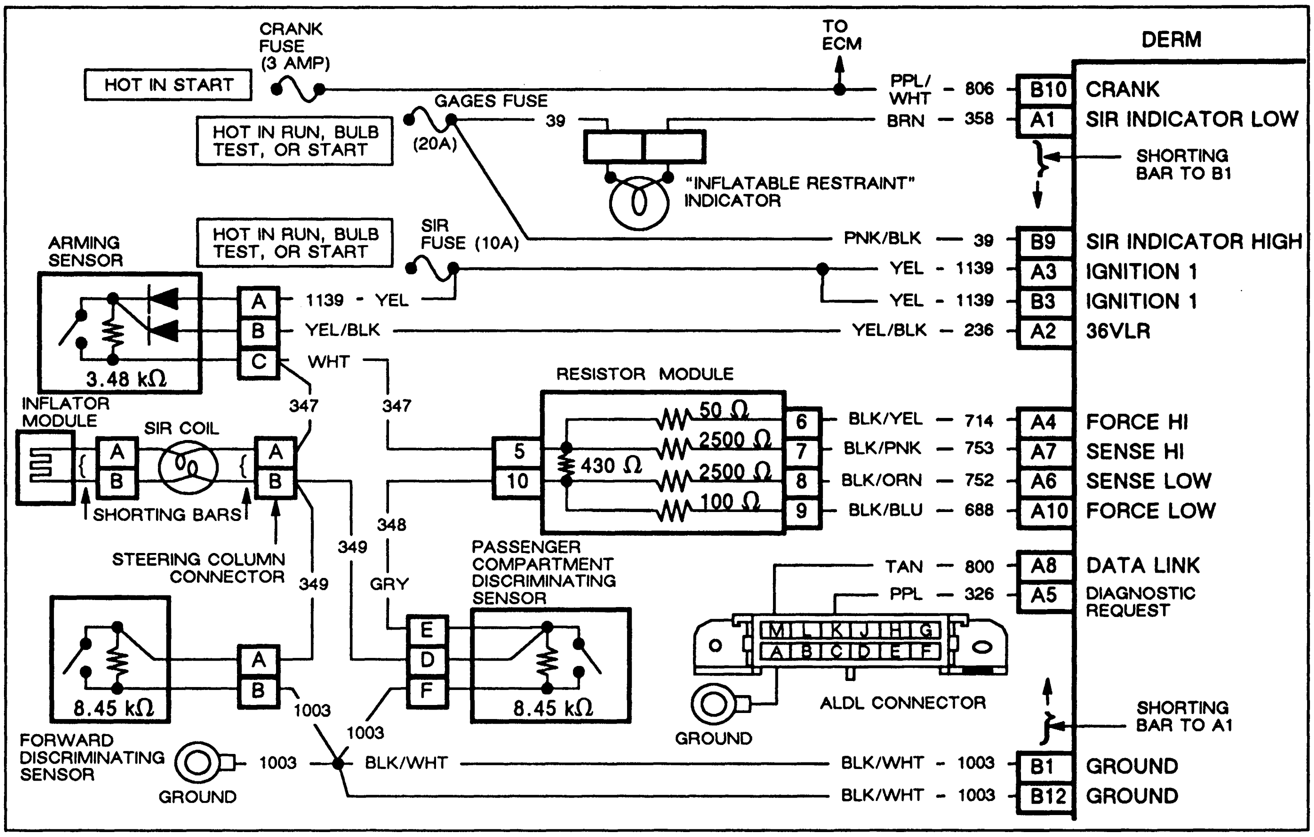


Figure 9J-A-38 SIR Circuit

CODE 32

GROUNDED 36VLR TO DEPLOYMENT LOOP

Test Condition:

Tested every 100 milliseconds during "Continuous Monitoring."

Failure Conditions:

Code 32 will set if: 1) The voltage at the Sense Low input (terminal A6) is between 28% and 59% of Ignition 1 output voltage for 700 milliseconds; 2) Code 42 is set.

Conditions To Clear:

Current Code 32 will clear if the voltage at the Sense Low input (terminal A6) is between 41% and 61% of 36VLR output voltage for 500 milliseconds.

Action taken:

DERM turns on the "INFLATABLE RESTRAINT" indicator lamp.

Description:

The voltage at the Sense Low input (terminal A6) is between 41% and 61% of 36VLR output voltage when 36VLR output of the DERM is charged. Should the circuit short to ground between the 36VLR output and the Arming Sensor, Ignition 1 voltage will be supplying the deployment loop. The voltage at the Sense Low input (terminal A6) will decrease due to the decrease in the supply voltage and Code 32 will set after 700 milliseconds. Code 32 indicates a short to ground in the wiring between the 36VLR output of the DERM and the Arming Sensor.

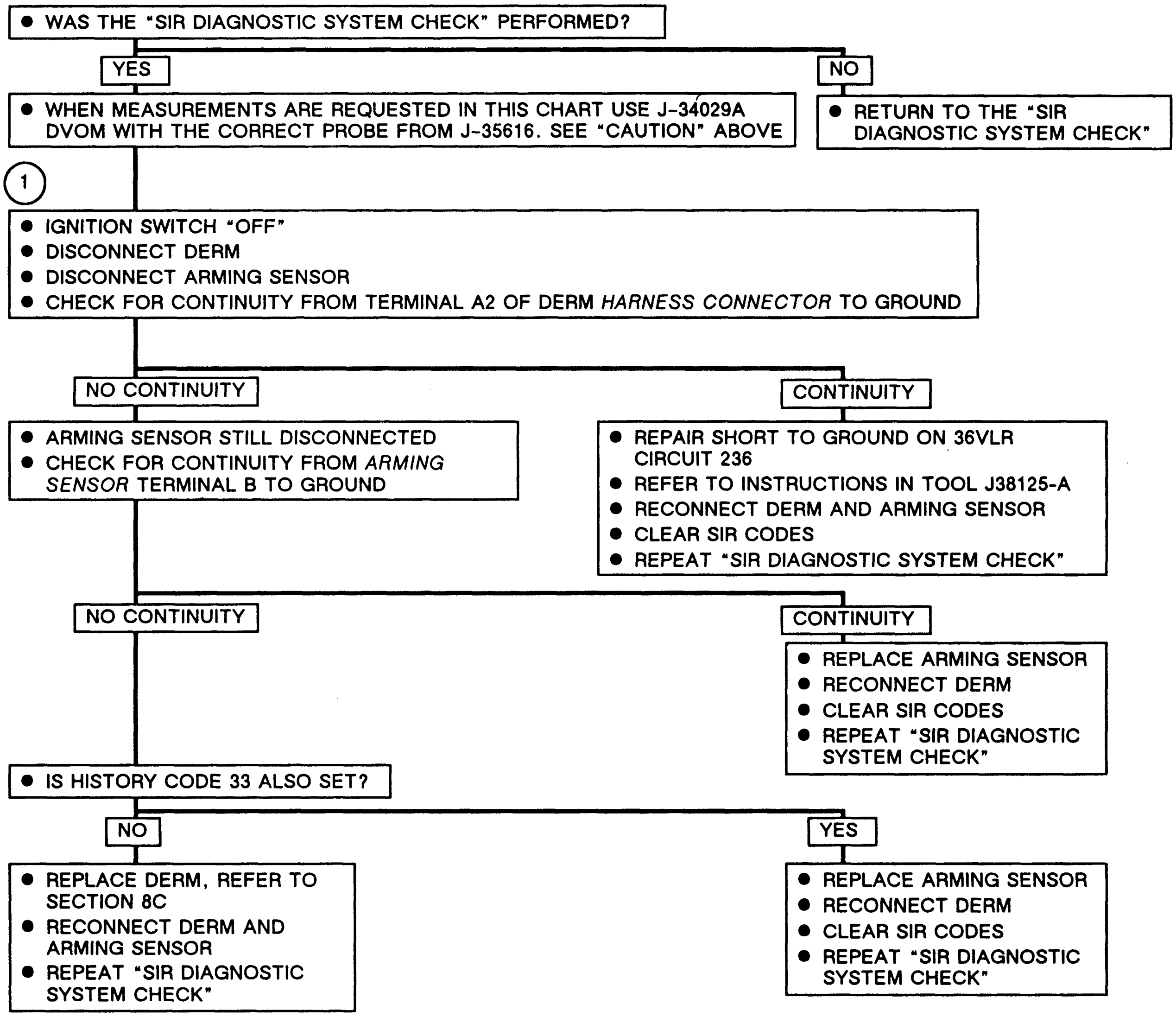
Notes on Fault Tree:

1) Checks for a short to ground in the 36 VLR circuit between the DERM and the Arming Sensor.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CODE 32

GROUNDED 36VLR TO DEPLOYMENT LOOP



- WAS THE "SIR DIAGNOSTIC SYSTEM CHECK" PERFORMED?

YES

- WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART USE J-34029A DVOM WITH THE CORRECT PROBE FROM J-35616. SEE "CAUTION" ABOVE

NO

- RETURN TO THE "SIR DIAGNOSTIC SYSTEM CHECK"

①

- IGNITION SWITCH "OFF"
- DISCONNECT DERM
- DISCONNECT ARMING SENSOR
- CHECK FOR CONTINUITY FROM TERMINAL A2 OF DERM *HARNESS CONNECTOR* TO GROUND

NO CONTINUITY

- ARMING SENSOR STILL DISCONNECTED
- CHECK FOR CONTINUITY FROM *ARMING SENSOR* TERMINAL B TO GROUND

CONTINUITY

- REPAIR SHORT TO GROUND ON 36VLR CIRCUIT 236
- REFER TO INSTRUCTIONS IN TOOL J38125-A
- RECONNECT DERM AND ARMING SENSOR
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

NO CONTINUITY

- IS HISTORY CODE 33 ALSO SET?

CONTINUITY

- REPLACE ARMING SENSOR
- RECONNECT DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

NO

- REPLACE DERM, REFER TO SECTION 8C
- RECONNECT DERM AND ARMING SENSOR
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

YES

- REPLACE ARMING SENSOR
- RECONNECT DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

Figure 9J-A-39 Code 32

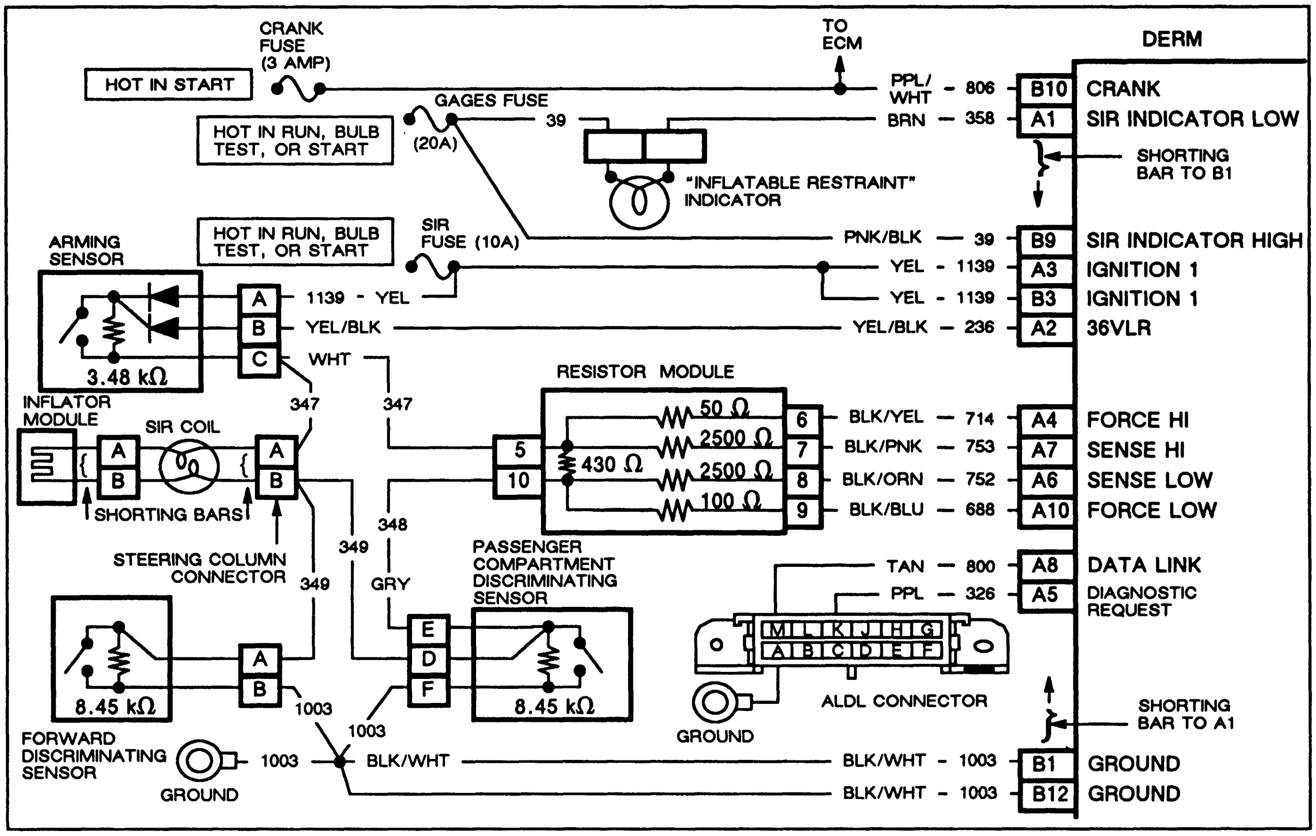


Figure 9J-A-40 SIR Circuit

HISTORY CODE 33

STEERING DIODE SHORTED IN ARMING SENSOR

Test Condition:

Tested once during each ignition cycle at "Turn-on."

Failure Conditions:

History Code 33 will set if the voltage at the 36VLR output of the DERM (terminal A2) is equal to the Ignition 1 voltage (±2 volts) within the first 500 milliseconds after the ignition is turned on, three ignition cycles in a row.

Conditions To Clear:

History Code 33 will remain as a History Code until codes are cleared with a scan tool.

Action taken:

DERM will <u>not</u> turn on "INFLATABLE RESTRAINT" indicator lamp.

Description:

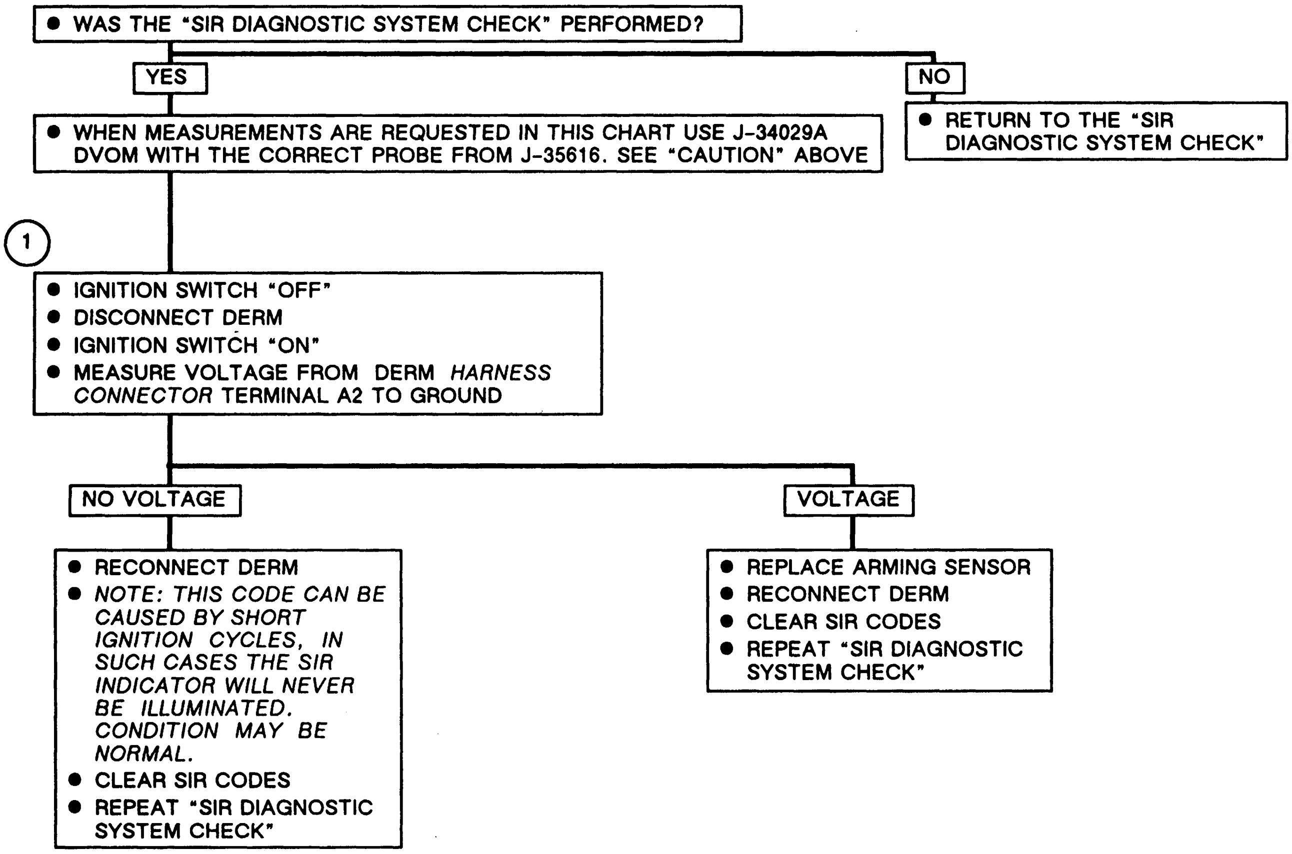
At "Turn-on" the DERM monitors the voltage at the 36VLR output (terminal A2) before this output begins to charge. If the diode in the Arming Sensor connected to Ignition 1 is shorted, Ignition 1 voltage will be present at the 36VLR output (terminal A2) as soon as the ignition is turned on. If the DERM detects this Ignition voltage (±2 volts) three ignition cycles in a row History Code 33 will be set.

Notes on Fault Tree:

1) Checks if diode on 36VLR circuit in the Arming Sensor is shorted.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

HISTORY
CODE 33
STEERING DIODE SHORTED IN ARMING SENSOR



- WAS THE "SIR DIAGNOSTIC SYSTEM CHECK" PERFORMED?

YES

- WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART USE J-34029A DVOM WITH THE CORRECT PROBE FROM J-35616. SEE "CAUTION" ABOVE

NO

- RETURN TO THE "SIR DIAGNOSTIC SYSTEM CHECK"

①

- IGNITION SWITCH "OFF"
- DISCONNECT DERM
- IGNITION SWITCH "ON"
- MEASURE VOLTAGE FROM DERM *HARNESS CONNECTOR* TERMINAL A2 TO GROUND

NO VOLTAGE

- RECONNECT DERM
- *NOTE: THIS CODE CAN BE CAUSED BY SHORT IGNITION CYCLES, IN SUCH CASES THE SIR INDICATOR WILL NEVER BE ILLUMINATED. CONDITION MAY BE NORMAL.*
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

VOLTAGE

- REPLACE ARMING SENSOR
- RECONNECT DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

Figure 9J-A-41 History Code 33

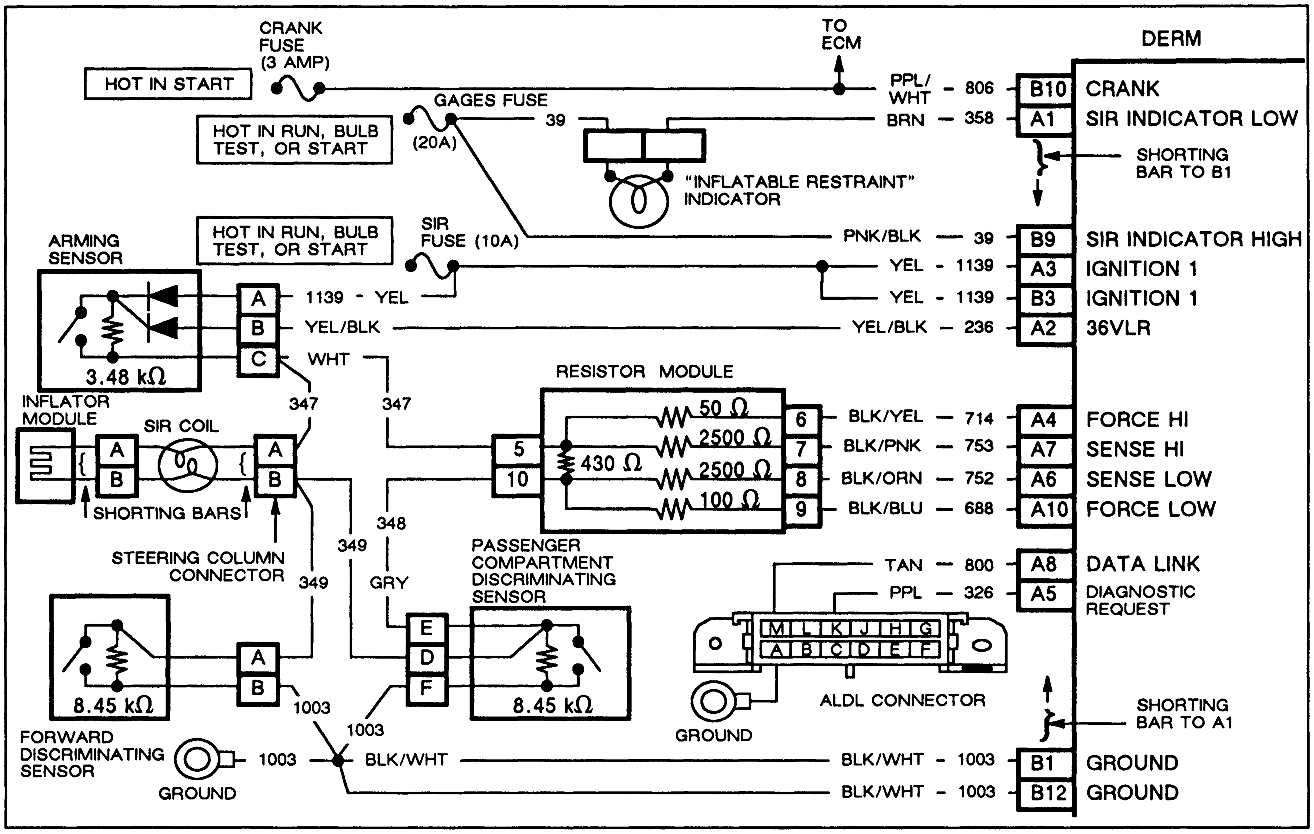


Figure 9J-A-42 SIR Circuit

CODE 34 CHART 1

OPEN IN IGNITION 1 FEED TO DEPLOYMENT LOOP

Test Condition:

Tested once during each ignition cycle at "Turn-on."

Failure Conditions:

Code 34 will set if the voltage at the Sense Low input (terminal A6) is less than 28% of Ignition 1 output voltage for 500 milliseconds and 36VLR is less than Ignition 1 output voltage at "Turn-on."

Conditions To Clear:

To clear code 34, the ignition must be off long enough to assure the 36VLR supply voltage has fully discharged. Once 36 VLR is discharged, the DERM will again check the failure conditions upon key on. If the failure conditions are not present (no failure indicated) then, and only then, will current code 34 be cleared.

Action taken:

DERM turns on the "INFLATABLE RESTRAINT" indicator lamp.

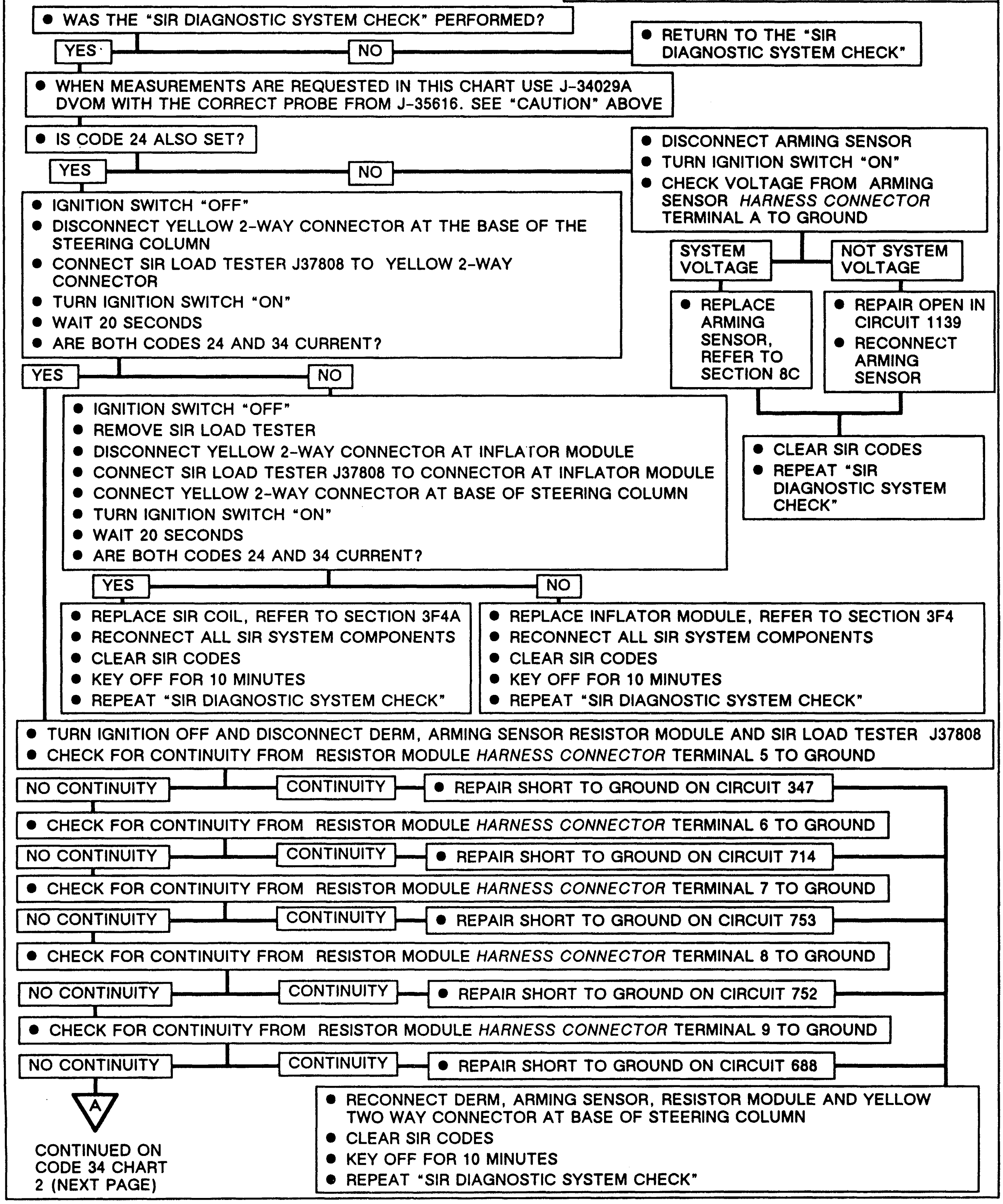
Description:

At "Turn-on" the DERM monitors the voltage at the Sense Low input (terminal A6) for 500 milliseconds. The DERM expects the voltage to be between 28% and 59% of Ignition 1 voltage before the 36VLR output is charged. If Ignition 1 circuit from the SIR fuse to the Arming Sensor is open or the Ignition 1 diode in the Arming Sensor is open the voltage at the Sense Low input (terminal A6) will be less than 4.6 volts and Code 34 will set.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CODE 34 (CHART 1)

OPEN IN IGNITION 1 FEED TO DEPLOYMENT LOOP



- WAS THE "SIR DIAGNOSTIC SYSTEM CHECK" PERFORMED?

YES / NO

- RETURN TO THE "SIR DIAGNOSTIC SYSTEM CHECK"

- WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART USE J-34029A DVOM WITH THE CORRECT PROBE FROM J-35616. SEE "CAUTION" ABOVE

- IS CODE 24 ALSO SET?

YES / NO

- DISCONNECT ARMING SENSOR
- TURN IGNITION SWITCH "ON"
- CHECK VOLTAGE FROM ARMING SENSOR *HARNESS CONNECTOR* TERMINAL A TO GROUND

SYSTEM VOLTAGE / NOT SYSTEM VOLTAGE

- REPLACE ARMING SENSOR, REFER TO SECTION 8C

- REPAIR OPEN IN CIRCUIT 1139
- RECONNECT ARMING SENSOR

- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

- IGNITION SWITCH "OFF"
- DISCONNECT YELLOW 2-WAY CONNECTOR AT THE BASE OF THE STEERING COLUMN
- CONNECT SIR LOAD TESTER J37808 TO YELLOW 2-WAY CONNECTOR
- TURN IGNITION SWITCH "ON"
- WAIT 20 SECONDS
- ARE BOTH CODES 24 AND 34 CURRENT?

YES / NO

- IGNITION SWITCH "OFF"
- REMOVE SIR LOAD TESTER
- DISCONNECT YELLOW 2-WAY CONNECTOR AT INFLATOR MODULE
- CONNECT SIR LOAD TESTER J37808 TO CONNECTOR AT INFLATOR MODULE
- CONNECT YELLOW 2-WAY CONNECTOR AT BASE OF STEERING COLUMN
- TURN IGNITION SWITCH "ON"
- WAIT 20 SECONDS
- ARE BOTH CODES 24 AND 34 CURRENT?

YES / NO

- REPLACE SIR COIL, REFER TO SECTION 3F4A
- RECONNECT ALL SIR SYSTEM COMPONENTS
- CLEAR SIR CODES
- KEY OFF FOR 10 MINUTES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

- REPLACE INFLATOR MODULE, REFER TO SECTION 3F4
- RECONNECT ALL SIR SYSTEM COMPONENTS
- CLEAR SIR CODES
- KEY OFF FOR 10 MINUTES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

- TURN IGNITION OFF AND DISCONNECT DERM, ARMING SENSOR RESISTOR MODULE AND SIR LOAD TESTER J37808
- CHECK FOR CONTINUITY FROM RESISTOR MODULE *HARNESS CONNECTOR* TERMINAL 5 TO GROUND

NO CONTINUITY / CONTINUITY

- REPAIR SHORT TO GROUND ON CIRCUIT 347

- CHECK FOR CONTINUITY FROM RESISTOR MODULE *HARNESS CONNECTOR* TERMINAL 6 TO GROUND

NO CONTINUITY / CONTINUITY

- REPAIR SHORT TO GROUND ON CIRCUIT 714

- CHECK FOR CONTINUITY FROM RESISTOR MODULE *HARNESS CONNECTOR* TERMINAL 7 TO GROUND

NO CONTINUITY / CONTINUITY

- REPAIR SHORT TO GROUND ON CIRCUIT 753

- CHECK FOR CONTINUITY FROM RESISTOR MODULE *HARNESS CONNECTOR* TERMINAL 8 TO GROUND

NO CONTINUITY / CONTINUITY

- REPAIR SHORT TO GROUND ON CIRCUIT 752

- CHECK FOR CONTINUITY FROM RESISTOR MODULE *HARNESS CONNECTOR* TERMINAL 9 TO GROUND

NO CONTINUITY / CONTINUITY

- REPAIR SHORT TO GROUND ON CIRCUIT 688

- RECONNECT DERM, ARMING SENSOR, RESISTOR MODULE AND YELLOW TWO WAY CONNECTOR AT BASE OF STEERING COLUMN
- CLEAR SIR CODES
- KEY OFF FOR 10 MINUTES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

CONTINUED ON CODE 34 CHART 2 (NEXT PAGE)

Figure 9J-A-43 Code 34 Chart 1

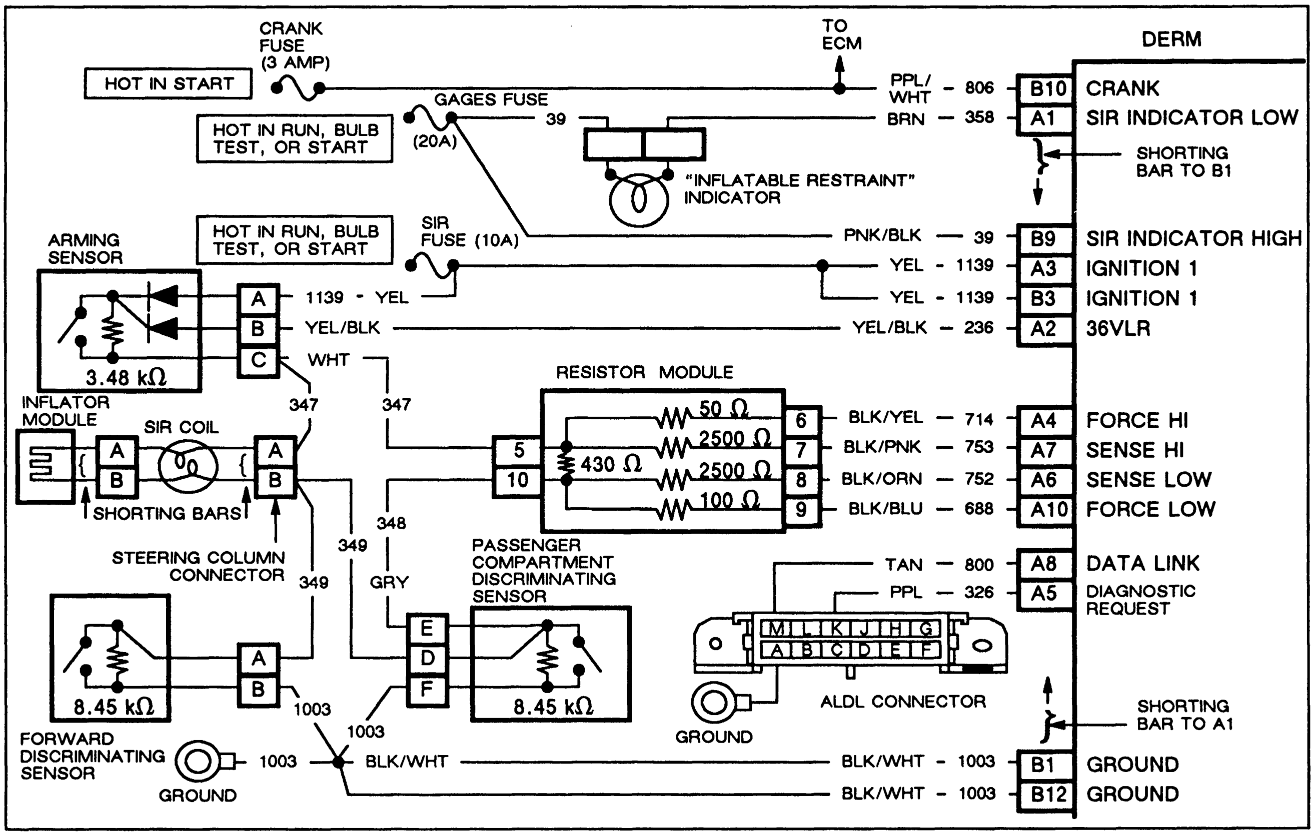


Figure 9J-A-44 SIR Circuit

CODE 34 CHART 2

OPEN IN IGNITION 1 FEED TO DEPLOYMENT LOOP

Test Condition:

Tested once during each ignition cycle at "Turn-on."

Failure Conditions:

Code 34 will set if the voltage at the Sense Low input (terminal A6) is less than 28% of Ignition 1 output voltage for 500 milliseconds and 36VLR is less than Ignition 1 output voltage at "Turn-on."

Conditions To Clear:

To clear code 34, the ignition must be off long enough to assure the 36VLR supply voltage has fully discharged. Once 36 VLR is discharged, the DERM will again check the failure conditions upon key on. If the failure conditions are not present (no failure indicated) then, and only then, will current code 34 be cleared.

Action taken:

DERM turns on the "INFLATABLE RESTRAINT" indicator lamp.

Description:

At "Turn-on" the DERM monitors the voltage at the Sense Low input (terminal A6) for 500 milliseconds. The DERM expects the voltage to be between 28% and 59% of Ignition 1 voltage before the 36VLR output is charged. If Ignition 1 circuit from the SIR fuse to the Arming Sensor is open or the Ignition 1 diode in the Arming Sensor is open the voltage at the Sense Low input (terminal A6) will be less than 4.6 volts and Code 34 will set.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CODE 34 (CHART 2)

STEERING COLUMN VOLTAGE TOO LOW

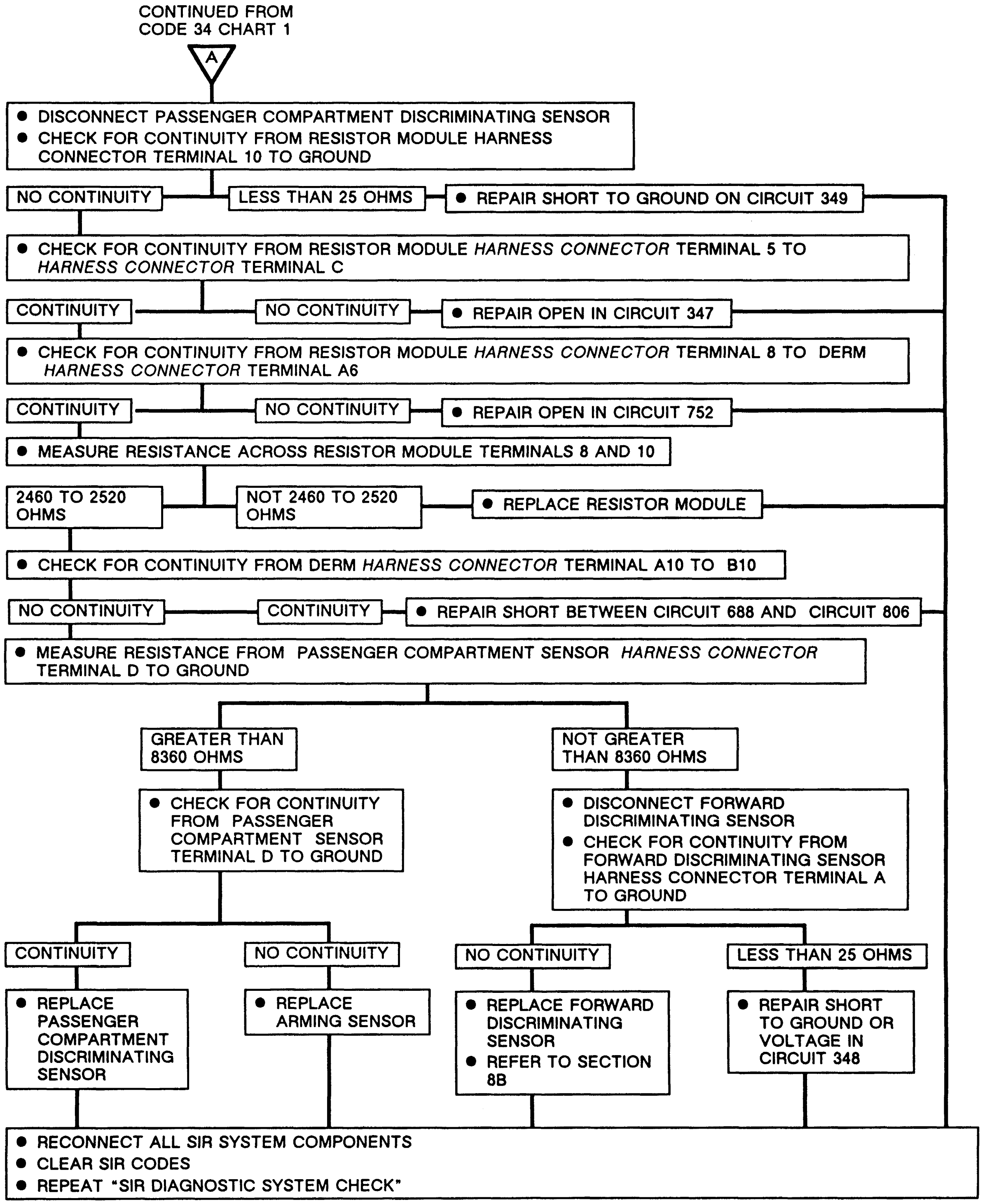


Figure 9J-A-45 Code 34 Chart 2

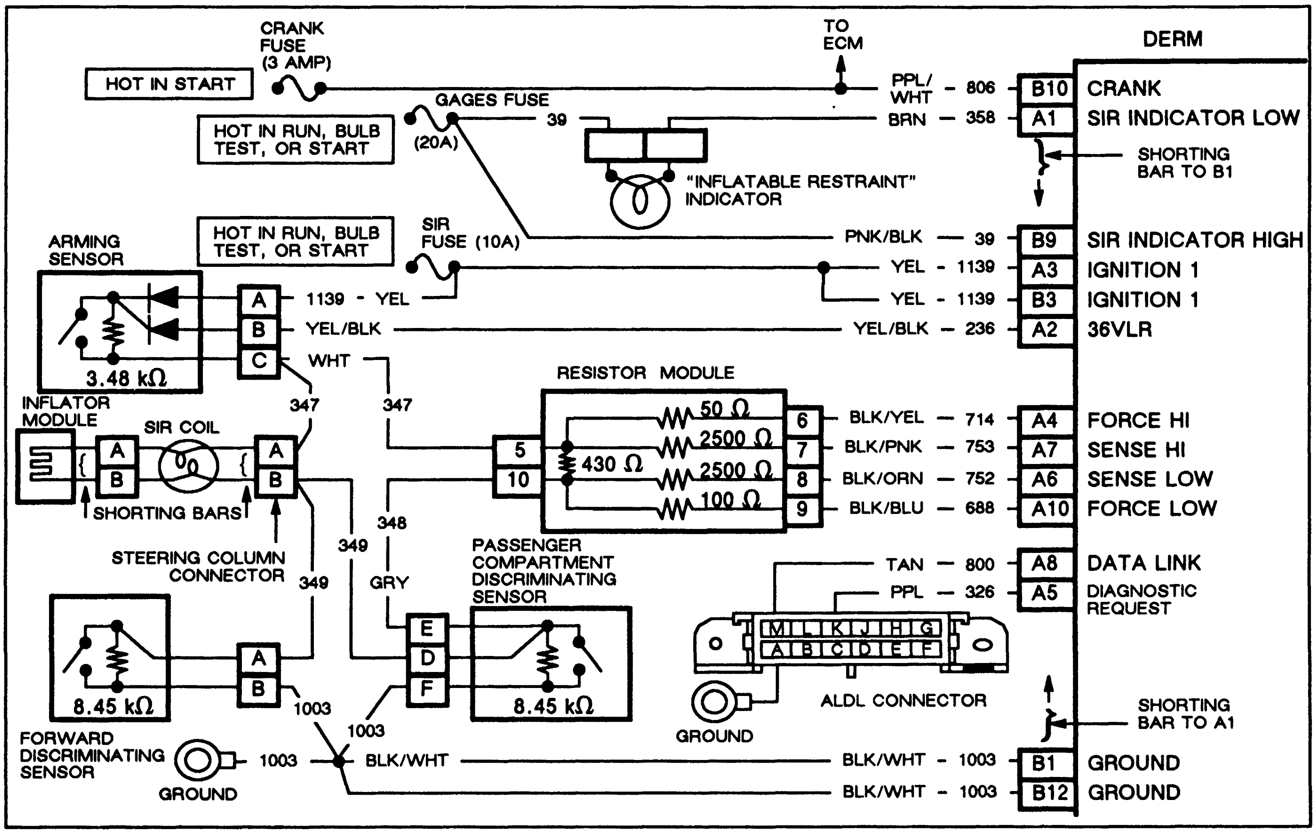


Figure 9J-A-46 SIR Circuit

CODE 35 CHART 1

DISCRIMINATING SENSOR OPEN

Test Condition:

Tested every 100 milliseconds during "Continuous Monitoring."

Failure Conditions:

Code 35 will set if the voltage at the Sense Low input (terminal A6) is between 61% and 78% of 36VLR output voltage for 500 milliseconds.

Conditions To Clear:

Current Code 35 will clear if the voltage at the Sense Low input (terminal A6) is between 41% and 61% of 36VLR output voltage for 500 milliseconds.

Action taken:

DERM turns on the "INFLATABLE RESTRAINT" indicator lamp.

Description:

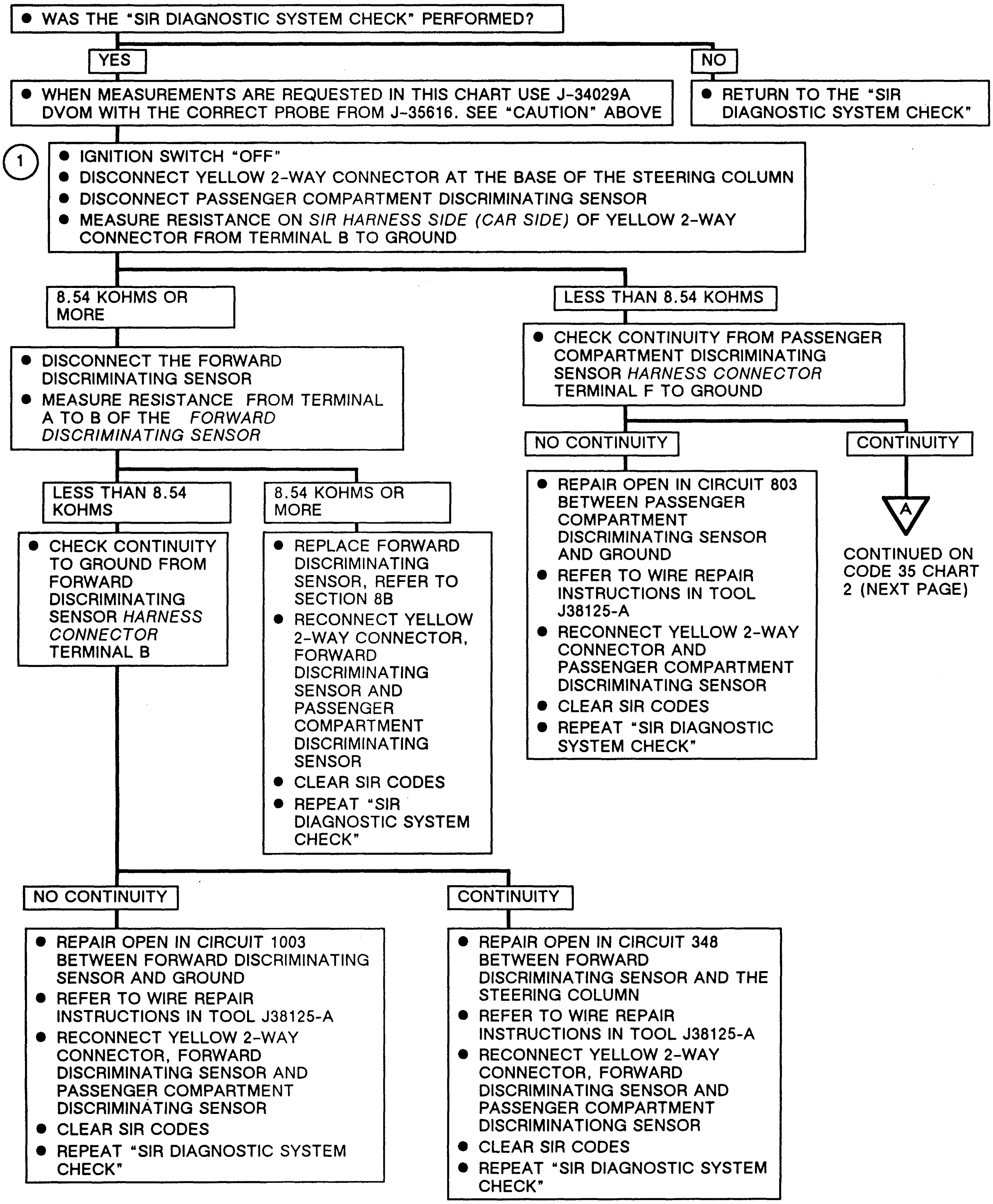
Code 35 is set when the voltage the Sense Low input (terminal A6) is between 61% and 78% of 36VLR output voltage for 500 milliseconds during the "Continuous Monitoring" tests performed by the DERM. The "Continuous Monitoring" tests are performed by the DERM after the initial "Turn-on" tests are completed and are performed every 100 milliseconds while Ignition 1 voltage is present at the DERM. If one of the Discriminating Sensors is open the voltage at the Sense Low input will increase due to the increase in the resistance of the Discriminating Sensor section of the deployment loop and Code 35 will set.

Notes on Fault Tree:

1) Checks the resistance of the Forward Discriminating Sensor.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CODE 35 (CHART 1)
DISCRIMINATING SENSOR OPEN



- WAS THE "SIR DIAGNOSTIC SYSTEM CHECK" PERFORMED?

NO

- RETURN TO THE "SIR DIAGNOSTIC SYSTEM CHECK"

YES

- WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART USE J-34029A DVOM WITH THE CORRECT PROBE FROM J-35616. SEE "CAUTION" ABOVE

①
- IGNITION SWITCH "OFF"
- DISCONNECT YELLOW 2-WAY CONNECTOR AT THE BASE OF THE STEERING COLUMN
- DISCONNECT PASSENGER COMPARTMENT DISCRIMINATING SENSOR
- MEASURE RESISTANCE ON *SIR HARNESS SIDE (CAR SIDE)* OF YELLOW 2-WAY CONNECTOR FROM TERMINAL B TO GROUND

LESS THAN 8.54 KOHMS

- CHECK CONTINUITY FROM PASSENGER COMPARTMENT DISCRIMINATING SENSOR *HARNESS CONNECTOR* TERMINAL F TO GROUND

NO CONTINUITY

- REPAIR OPEN IN CIRCUIT 803 BETWEEN PASSENGER COMPARTMENT DISCRIMINATING SENSOR AND GROUND
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT YELLOW 2-WAY CONNECTOR AND PASSENGER COMPARTMENT DISCRIMINATING SENSOR
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

CONTINUITY

A

CONTINUED ON CODE 35 CHART 2 (NEXT PAGE)

8.54 KOHMS OR MORE

- DISCONNECT THE FORWARD DISCRIMINATING SENSOR
- MEASURE RESISTANCE FROM TERMINAL A TO B OF THE *FORWARD DISCRIMINATING SENSOR*

8.54 KOHMS OR MORE

- REPLACE FORWARD DISCRIMINATING SENSOR, REFER TO SECTION 8B
- RECONNECT YELLOW 2-WAY CONNECTOR, FORWARD DISCRIMINATING SENSOR AND PASSENGER COMPARTMENT DISCRIMINATING SENSOR
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

LESS THAN 8.54 KOHMS

- CHECK CONTINUITY TO GROUND FROM FORWARD DISCRIMINATING SENSOR *HARNESS CONNECTOR* TERMINAL B

NO CONTINUITY

- REPAIR OPEN IN CIRCUIT 1003 BETWEEN FORWARD DISCRIMINATING SENSOR AND GROUND
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT YELLOW 2-WAY CONNECTOR, FORWARD DISCRIMINATING SENSOR AND PASSENGER COMPARTMENT DISCRIMINATING SENSOR
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

CONTINUITY

- REPAIR OPEN IN CIRCUIT 348 BETWEEN FORWARD DISCRIMINATING SENSOR AND THE STEERING COLUMN
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT YELLOW 2-WAY CONNECTOR, FORWARD DISCRIMINATING SENSOR AND PASSENGER COMPARTMENT DISCRIMINATIONG SENSOR
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

Figure 9J-A-47 Code 35

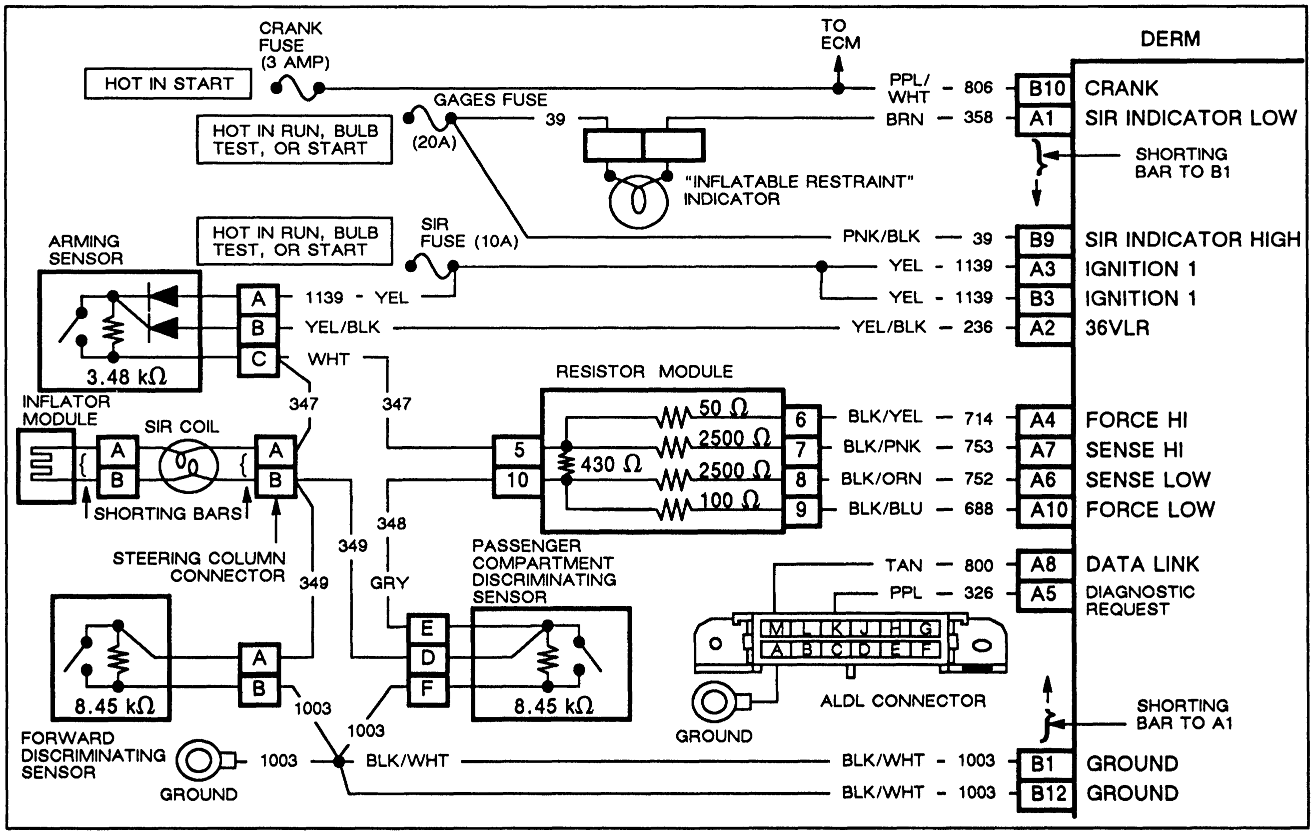


Figure 9J-A-48 SIR Circuit

CODE 35 CHART 2

DISCRIMINATING SENSOR OPEN

Test Condition:

Tested every 100 milliseconds during "Continuous Monitoring".

Failure Conditions:

Code 35 will set if the voltage at the Sense Low input (terminal A6) is between 61% and 78% of 36VLR output voltage for 500 milliseconds.

Conditions To Clear:

Current Code 35 will clear if the voltage at the Sense Low input (terminal A6) is between 41% and 61% of 36VLR output voltage for 500 milliseconds.

Action taken:

DERM turns on the "INFLATABLE RESTRAINT" indicator lamp.

Description:

Code 35 is set when the voltage the Sense Low input (terminal A6) is between 61% and 78% of 36VLR output voltage for 500 milliseconds during the "Continuous Monitoring" tests performed by the DERM. The "Continuous Monitoring" tests are performed by the DERM after the initial "Turn-on" tests are completed and are performed every 100 milliseconds while Ignition 1 voltage is present at the DERM. If one of the Discriminating Sensors is open the voltage at the Sense Low input will increase due to the increase in the resistance of the Discriminating Sensor section of the deployment loop and Code 35 will set.

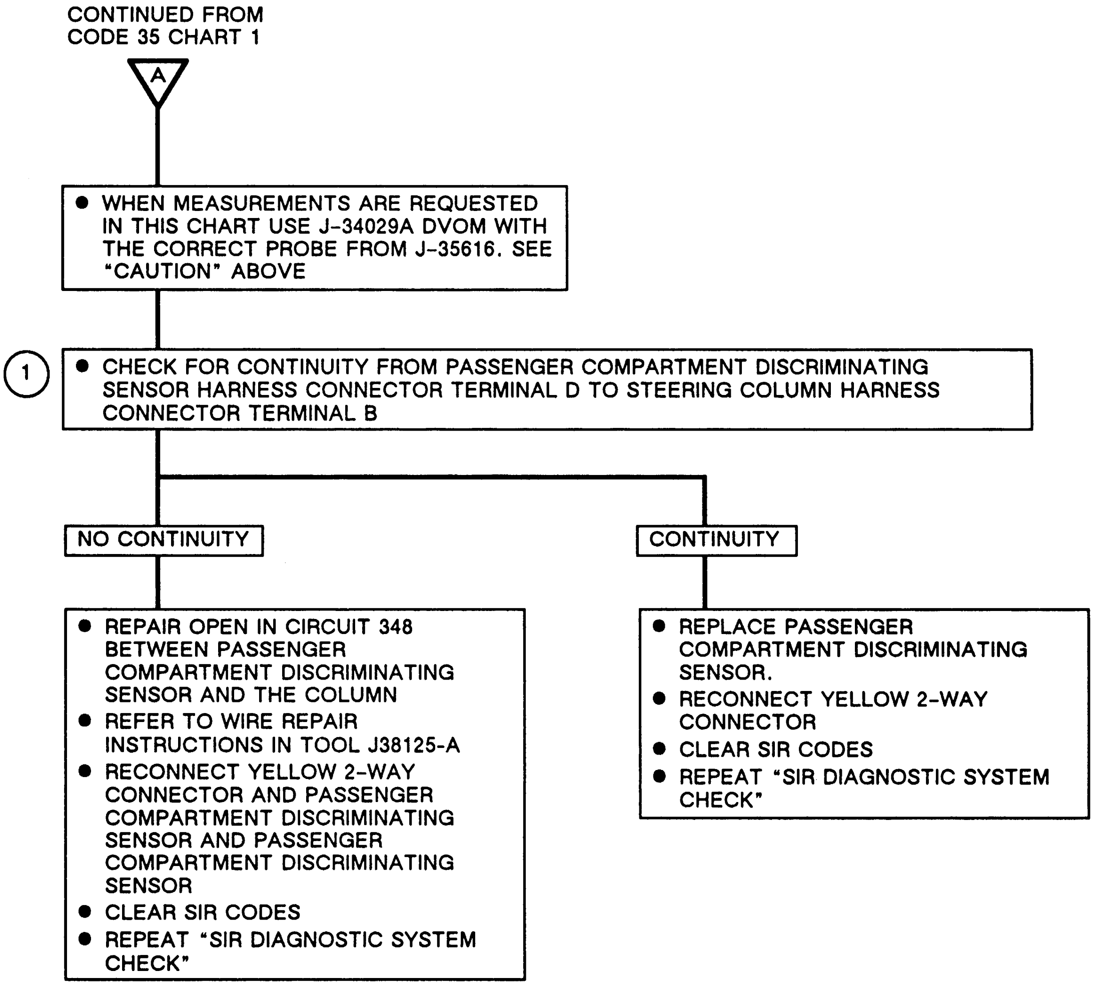
Notes on Fault Tree:

1) Checks for continuity in circuit 349.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CODE 35 (CHART 2)

DISCRIMINATING SENSOR OPEN



CONTINUED FROM CODE 35 CHART 1

- WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART USE J-34029A DVOM WITH THE CORRECT PROBE FROM J-35616. SEE "CAUTION" ABOVE

①
- CHECK FOR CONTINUITY FROM PASSENGER COMPARTMENT DISCRIMINATING SENSOR HARNESS CONNECTOR TERMINAL D TO STEERING COLUMN HARNESS CONNECTOR TERMINAL B

NO CONTINUITY

- REPAIR OPEN IN CIRCUIT 348 BETWEEN PASSENGER COMPARTMENT DISCRIMINATING SENSOR AND THE COLUMN
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT YELLOW 2-WAY CONNECTOR AND PASSENGER COMPARTMENT DISCRIMINATING SENSOR AND PASSENGER COMPARTMENT DISCRIMINATING SENSOR
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

CONTINUITY

- REPLACE PASSENGER COMPARTMENT DISCRIMINATING SENSOR.
- RECONNECT YELLOW 2-WAY CONNECTOR
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

Figure 9J-A- Code 35 Chart 2

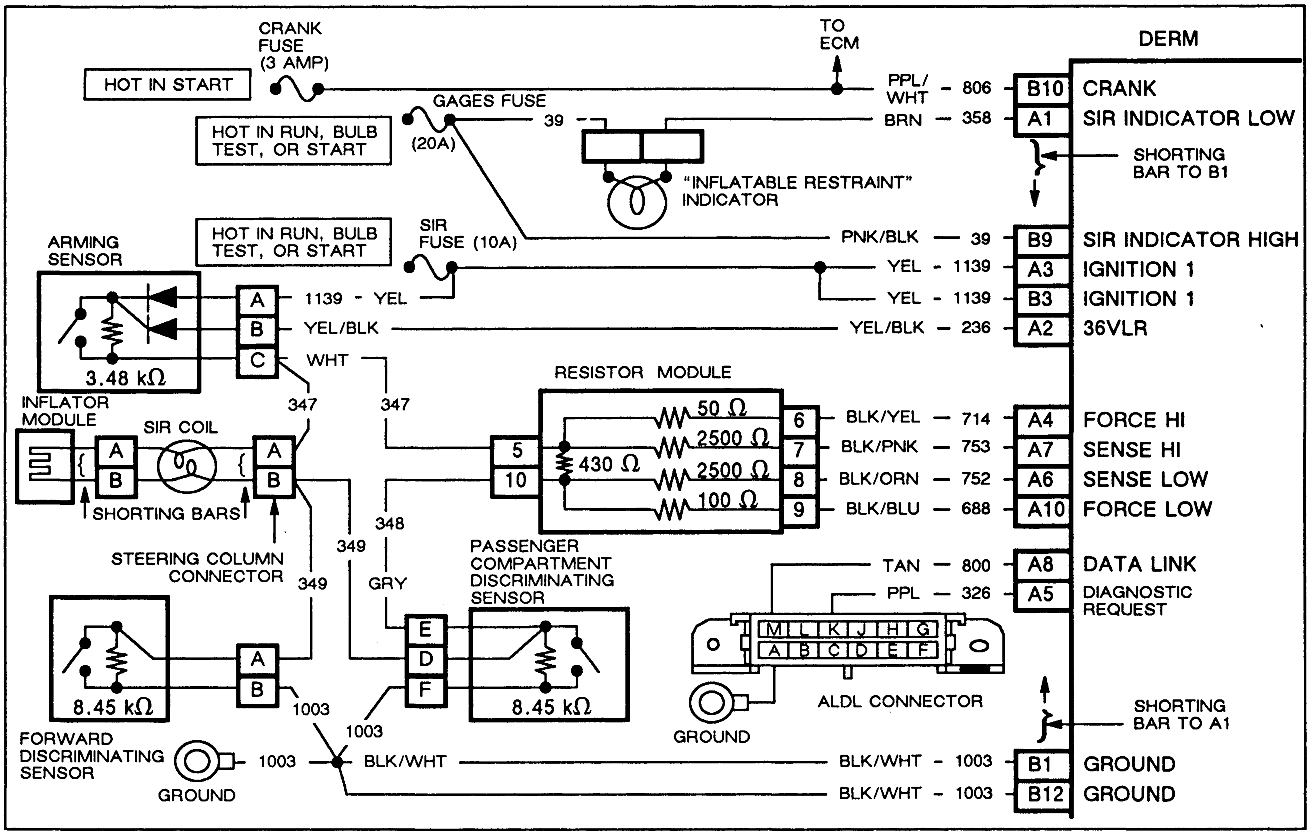


Figure 9J-A-49 SIR Circuit

CODE 41

ENERGY RESERVE VOLTAGE CHARGING FAILURE

Test Condition:

Tested once during each ignition cycle at "Turn-on".

Failure Conditions:

Code 41 will set if the 36VLR output of the DERM has not reached at least 28.4 volts within 7 seconds after Ignition 1 voltage is applied to the DERM.

Conditions To Clear:

Current Code 41 will be cleared each time the Ignition Switch is turned OFF.

Action taken:

DERM turns on the "INFLATABLE RESTRAINT" indicator lamp.

Description:

The DERM measures the deployment loop energy reserve voltage (36VLR) and checks that it has reached at least 28.4 volts within 7 seconds after Ignition 1 voltage is applied to the DERM. Code 41 indicates an internal fault in the DERM or a resistive short to ground in the 36VLR circuit to the Arming Sensor.

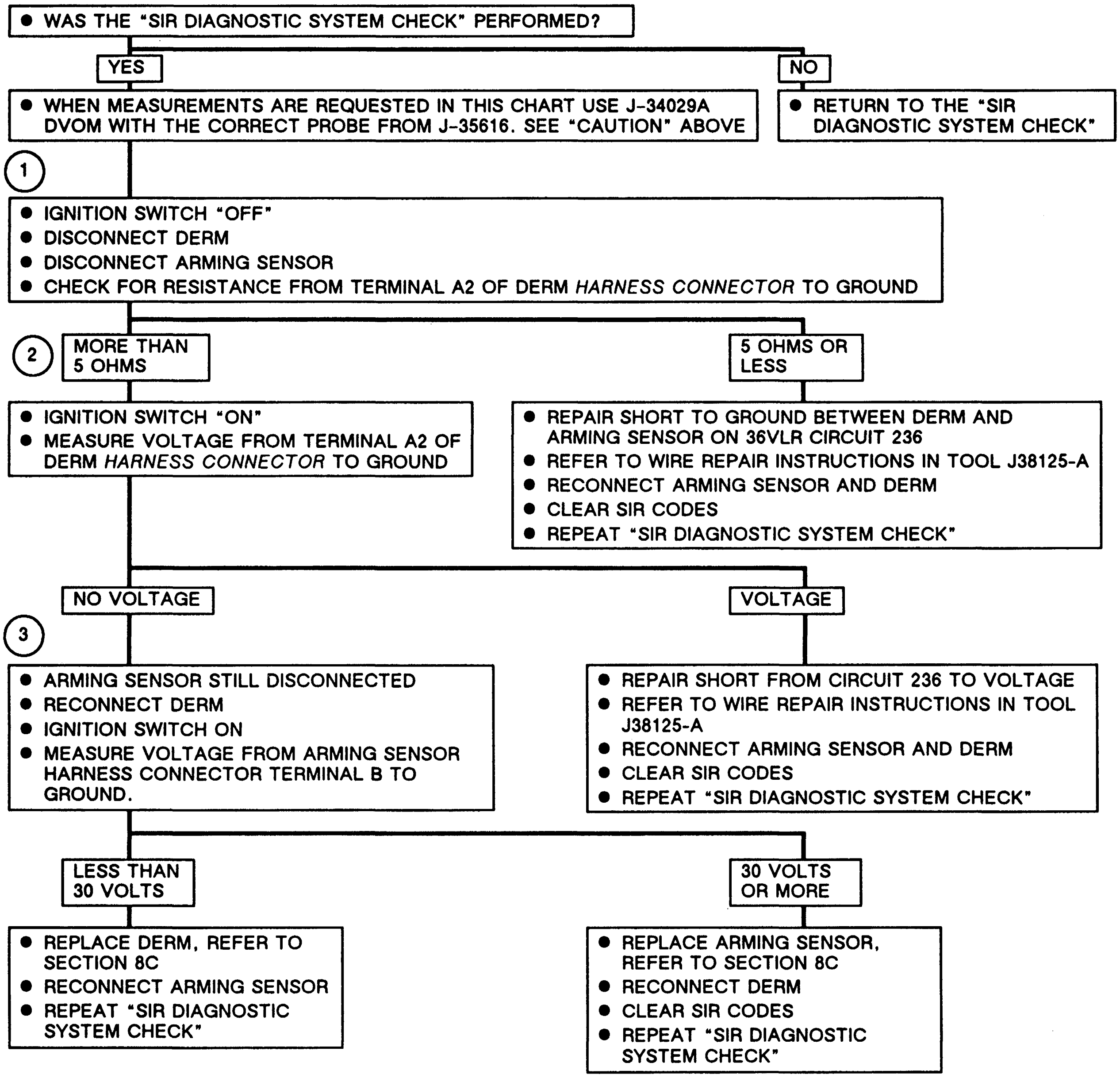
Notes on Fault Tree:

1) Checks for a resistive short to ground in the 36VLR circuit between the DERM and the Arming Sensor.
2) Checks for a short to system voltage on 36VLR circuit.
3) Checks for a open in the DERM or in circuit 236.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CODE 41

ENERGY RESERVE VOLTAGE CHARGING FAILURE



- WAS THE "SIR DIAGNOSTIC SYSTEM CHECK" PERFORMED?

YES

- WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART USE J-34029A DVOM WITH THE CORRECT PROBE FROM J-35616. SEE "CAUTION" ABOVE

NO

- RETURN TO THE "SIR DIAGNOSTIC SYSTEM CHECK"

①

- IGNITION SWITCH "OFF"
- DISCONNECT DERM
- DISCONNECT ARMING SENSOR
- CHECK FOR RESISTANCE FROM TERMINAL A2 OF DERM *HARNESS CONNECTOR* TO GROUND

② MORE THAN 5 OHMS

- IGNITION SWITCH "ON"
- MEASURE VOLTAGE FROM TERMINAL A2 OF DERM *HARNESS CONNECTOR* TO GROUND

5 OHMS OR LESS

- REPAIR SHORT TO GROUND BETWEEN DERM AND ARMING SENSOR ON 36VLR CIRCUIT 236
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT ARMING SENSOR AND DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

NO VOLTAGE

③

- ARMING SENSOR STILL DISCONNECTED
- RECONNECT DERM
- IGNITION SWITCH ON
- MEASURE VOLTAGE FROM ARMING SENSOR HARNESS CONNECTOR TERMINAL B TO GROUND.

VOLTAGE

- REPAIR SHORT FROM CIRCUIT 236 TO VOLTAGE
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT ARMING SENSOR AND DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

LESS THAN 30 VOLTS

- REPLACE DERM, REFER TO SECTION 8C
- RECONNECT ARMING SENSOR
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

30 VOLTS OR MORE

- REPLACE ARMING SENSOR, REFER TO SECTION 8C
- RECONNECT DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

Figure 9J-A-50 Code 41

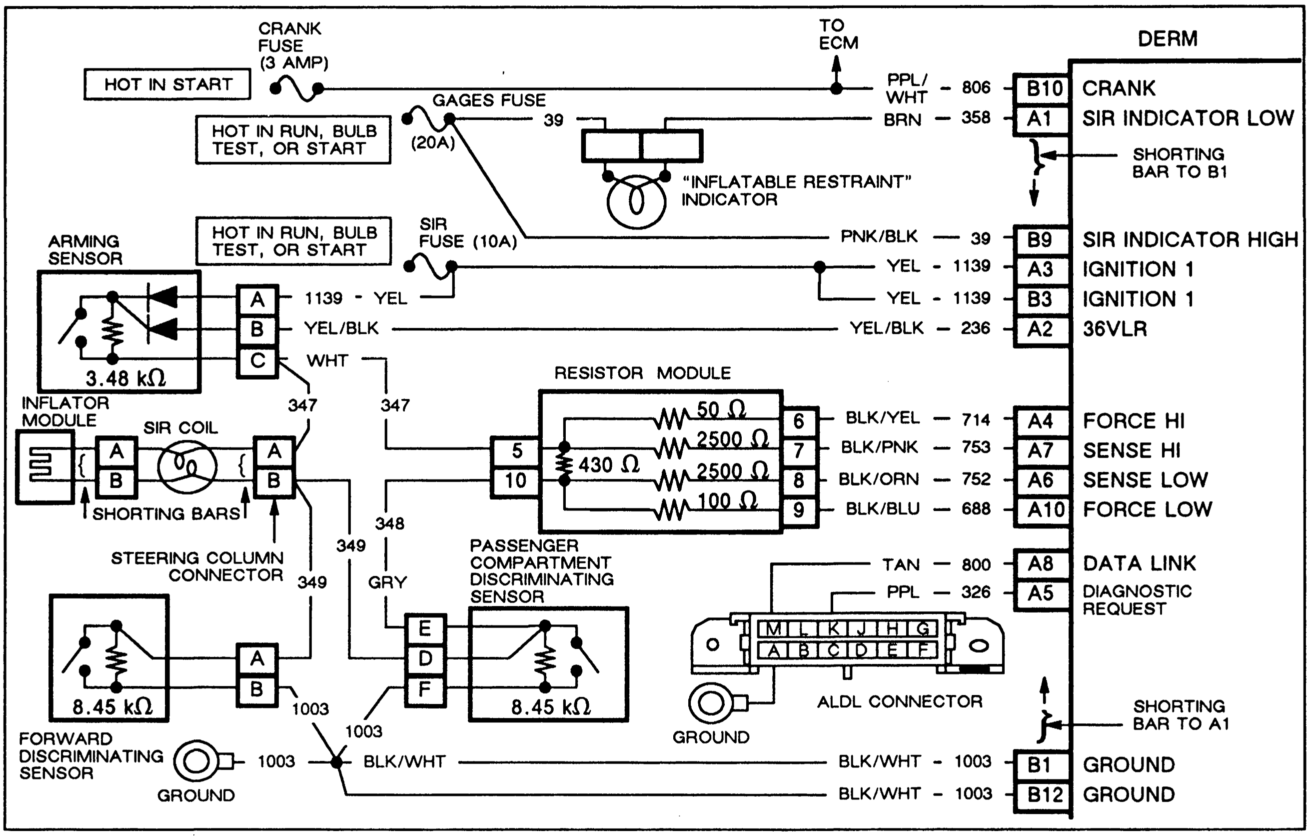


Figure 9J-A-50 SIR Circuit

CODE 42

ENERGY RESERVE VOLTAGE TOO LOW

Test Condition:

Tested every 100 milliseconds during "Continuous Monitoring."

Failure Conditions:

Code 42 will set if the deployment loop energy reserve voltage (36VLR) is less than 28.4 volts for 500 milliseconds.

Conditions To Clear:

Code 42 will clear if the deployment energy reserve voltage (36VLR) is greater than 28.4 volts for 500 milliseconds after Code 42 has set.

Action taken:

DERM turns on the "INFLATABLE RESTRAINT" indicator lamp.

Description:

The DERM measures the deployment loop energy reserve voltage (36VLR) and checks that it remains above 28.4 volts at all times after the initial charging of the reserve is completed (see Code 41). Code 42 indicates an internal fault in the DERM or a resistive short to ground in the 36VLR circuit to the Arming Sensor.

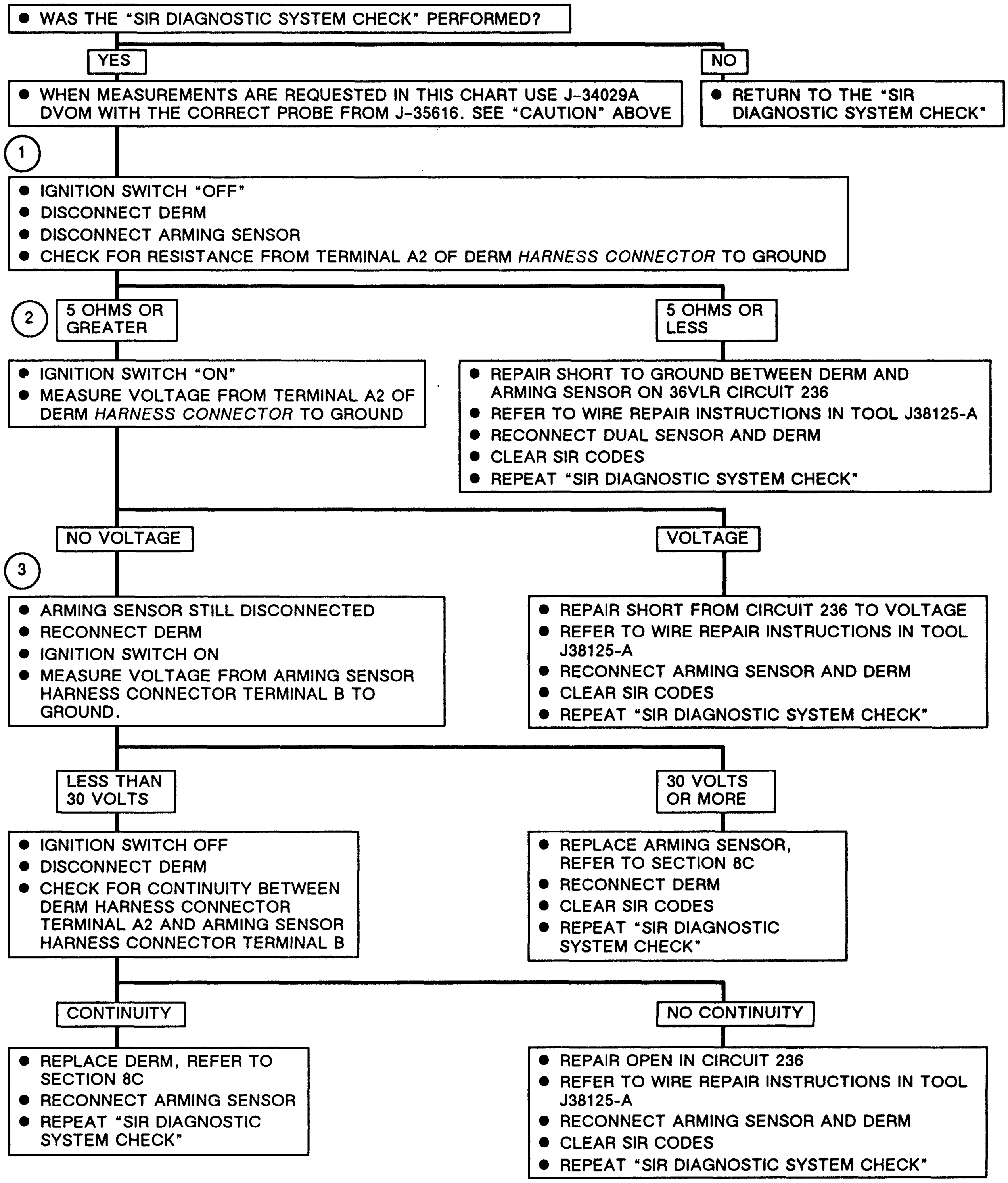
Notes on Fault Tree:

1) Checks for a resistive short to ground in the 36VLR circuit between the DERM and the Arming Sensor.
2) Checks for a short to system voltage on 36VLR circuit.
3) Checks for a open in the DERM or in circuit 236.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CODE 42

ENERGY RESERVE VOLTAGE TOO LOW



- WAS THE "SIR DIAGNOSTIC SYSTEM CHECK" PERFORMED?

YES

- WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART USE J-34029A DVOM WITH THE CORRECT PROBE FROM J-35616. SEE "CAUTION" ABOVE

NO

- RETURN TO THE "SIR DIAGNOSTIC SYSTEM CHECK"

①

- IGNITION SWITCH "OFF"
- DISCONNECT DERM
- DISCONNECT ARMING SENSOR
- CHECK FOR RESISTANCE FROM TERMINAL A2 OF DERM *HARNESS CONNECTOR* TO GROUND

② 5 OHMS OR GREATER

- IGNITION SWITCH "ON"
- MEASURE VOLTAGE FROM TERMINAL A2 OF DERM *HARNESS CONNECTOR* TO GROUND

5 OHMS OR LESS

- REPAIR SHORT TO GROUND BETWEEN DERM AND ARMING SENSOR ON 36VLR CIRCUIT 236
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT DUAL SENSOR AND DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

NO VOLTAGE

③

- ARMING SENSOR STILL DISCONNECTED
- RECONNECT DERM
- IGNITION SWITCH ON
- MEASURE VOLTAGE FROM ARMING SENSOR HARNESS CONNECTOR TERMINAL B TO GROUND.

VOLTAGE

- REPAIR SHORT FROM CIRCUIT 236 TO VOLTAGE
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT ARMING SENSOR AND DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

LESS THAN 30 VOLTS

- IGNITION SWITCH OFF
- DISCONNECT DERM
- CHECK FOR CONTINUITY BETWEEN DERM HARNESS CONNECTOR TERMINAL A2 AND ARMING SENSOR HARNESS CONNECTOR TERMINAL B

30 VOLTS OR MORE

- REPLACE ARMING SENSOR, REFER TO SECTION 8C
- RECONNECT DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

CONTINUITY

- REPLACE DERM, REFER TO SECTION 8C
- RECONNECT ARMING SENSOR
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

NO CONTINUITY

- REPAIR OPEN IN CIRCUIT 236
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT ARMING SENSOR AND DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

Figure 9J-A-52 Code 42

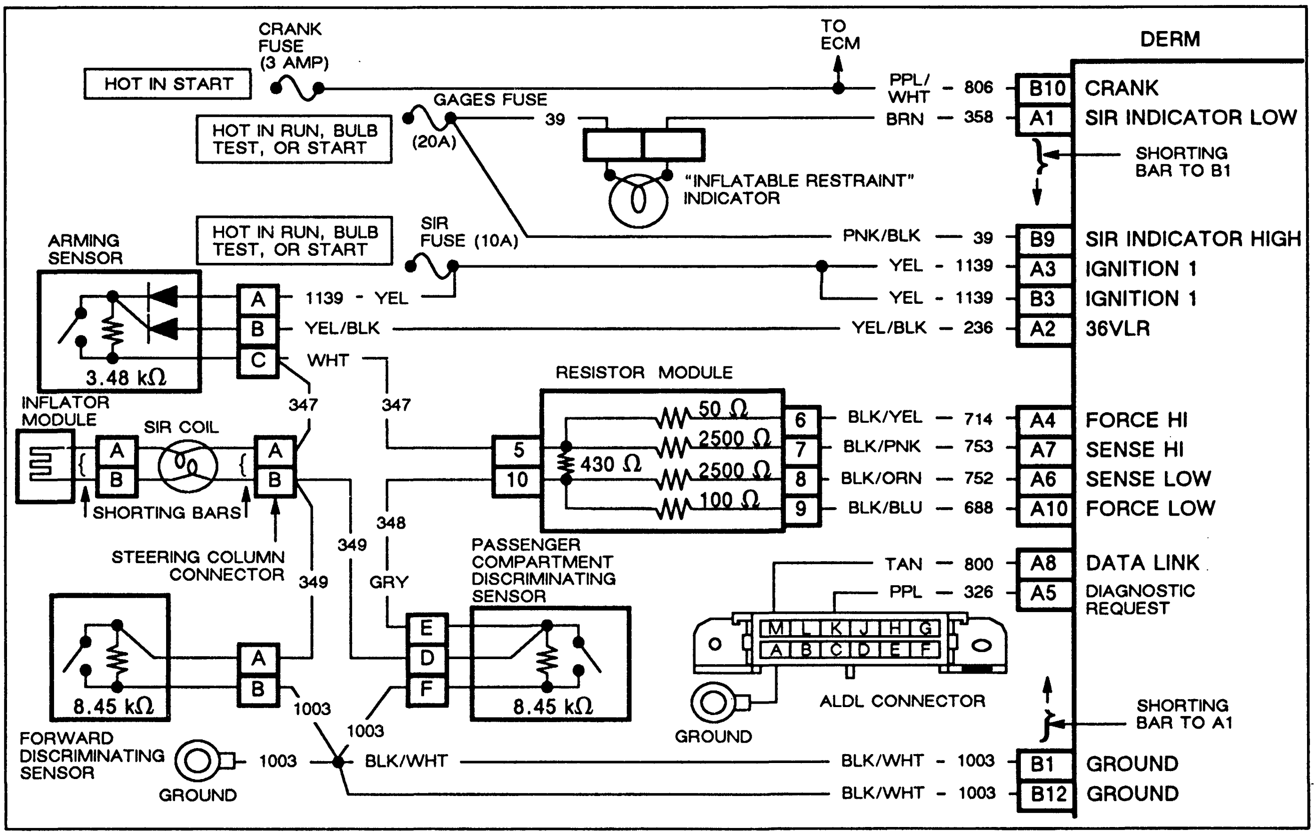


Figure 9J-A-51 SIR Circuit

CURRENT CODE 51

ACCIDENT DETECTED

Test Condition:

DERM energy reserve voltage OK.

Failure Conditions:

Current Code 51 will set if the DERM senses that both the Arming Sensor and at least one of the Discriminating Sensors are closed simultaneously.

Conditions To Clear:

Current Code 51 can be cleared using a scan tool clear codes command. *History Code 51 will remain in the DERM thereafter.*

Action taken:

DERM turns on the "INFLATABLE RESTRAINT" indicator until current Code 51 is cleared.

Description:

The DERM determines that the Arming Sensor is closed when system voltage or more is present at the "Sense Hi" input, and it determines that a Discriminating sensor in closed when it notes low voltage at the "Sense Low" input. There are some faults that may "look" like an accident to the DERM, and therefore record a code 51. History Code 51 therefore is not proof that the vehicle was in an accident.

Notes On Fault Tree:

1) Incorrect diagnosis will occur if the SIR Diagnostic System Check is not performed
2) If a Code 51 is current without signs of frontal impact and no deployment, then the code has set falsely and the DERM should be replaced.
3) *History Code 51 cannot be cleared* because the event of both the arming sensor and discriminating sensor being closed simultaneously is permanently stored in the EEPROM of the DERM.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CURRENT CODE 51

ACCIDENT DETECTED

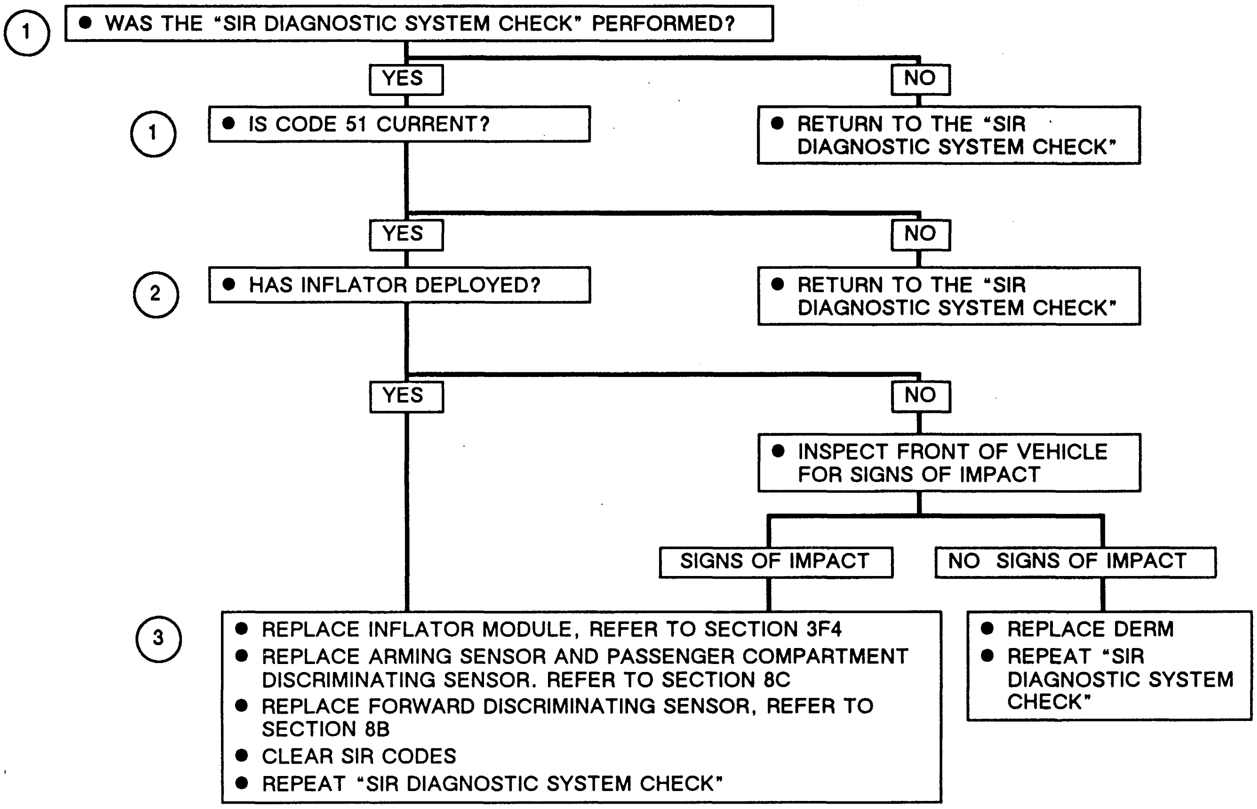


Figure 9J-A-52 Code 51

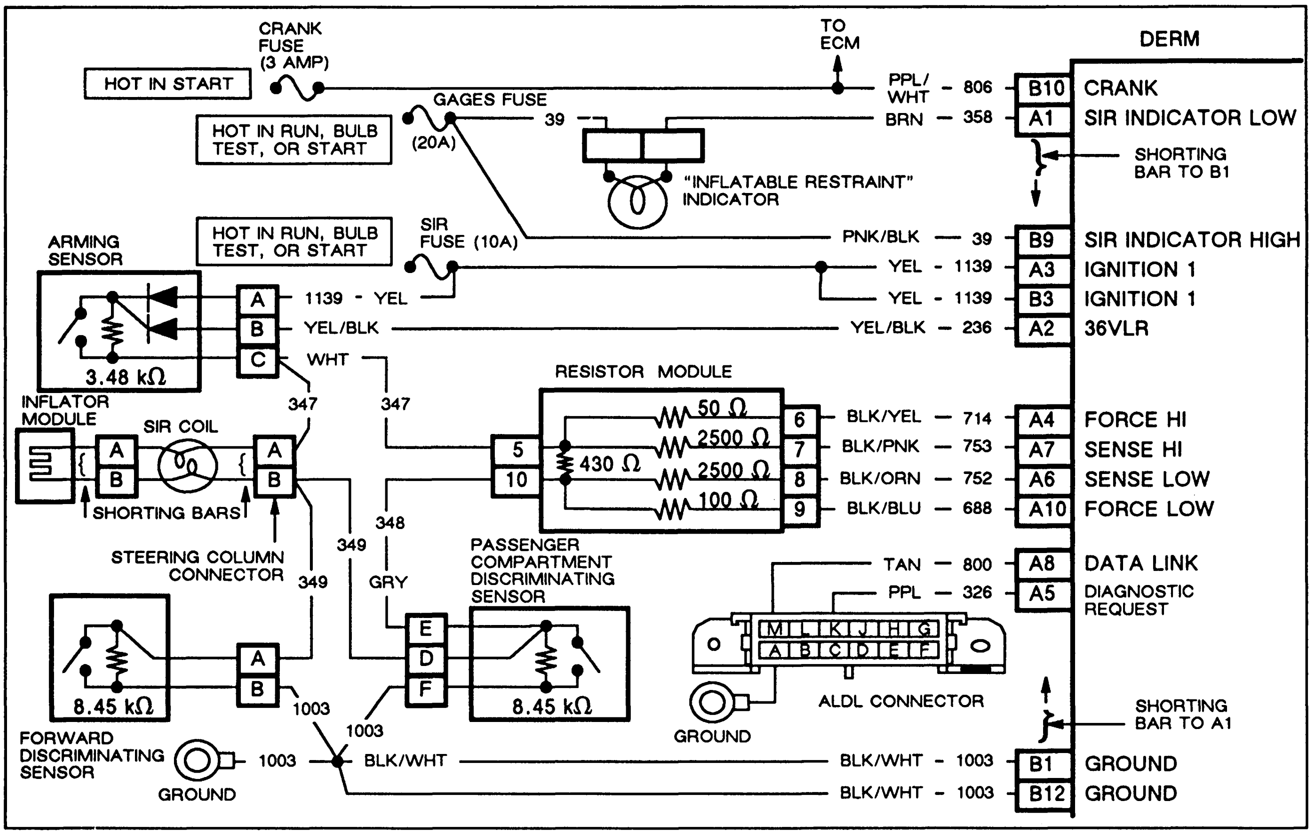


Figure 9J-A-53 SIR Circuit

CODE 52

EEPROM ACCIDENT DATA AREA FULL

Test Condition:

Tested every 100 milliseconds during "Continuous Monitoring."

Failure Conditions:

Code 52 will set when the EEPROM area reserved for accident data in the DERM is detected to be full during "Continuous Monitoring" for 100 milliseconds.

Conditions To Clear:

This code cannot be cleared.

Action taken:

"INFLATABLE RESTRAINT" indicator is turned on during all future Ignition cycles.

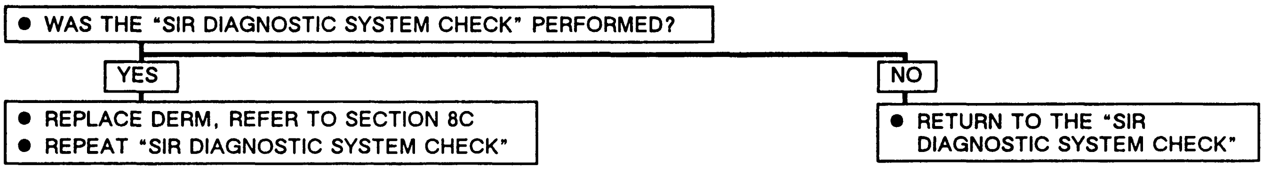
Description:

When there is a vehicle accident of sufficient magnitude to set Code 51, the DERM stores accident information in the EEPROM. Code 52 is set when the EEPROM has stored 4 simultaneously closed arming and discriminating sensor events (Code 51 settings).

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CODE 52

EEPROM ACCIDENT DATA AREA FULL



- WAS THE "SIR DIAGNOSTIC SYSTEM CHECK" PERFORMED?

YES:

- REPLACE DERM, REFER TO SECTION 8C
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

NO:

- RETURN TO THE "SIR DIAGNOSTIC SYSTEM CHECK"

Figure 9J-A-54 Code 52

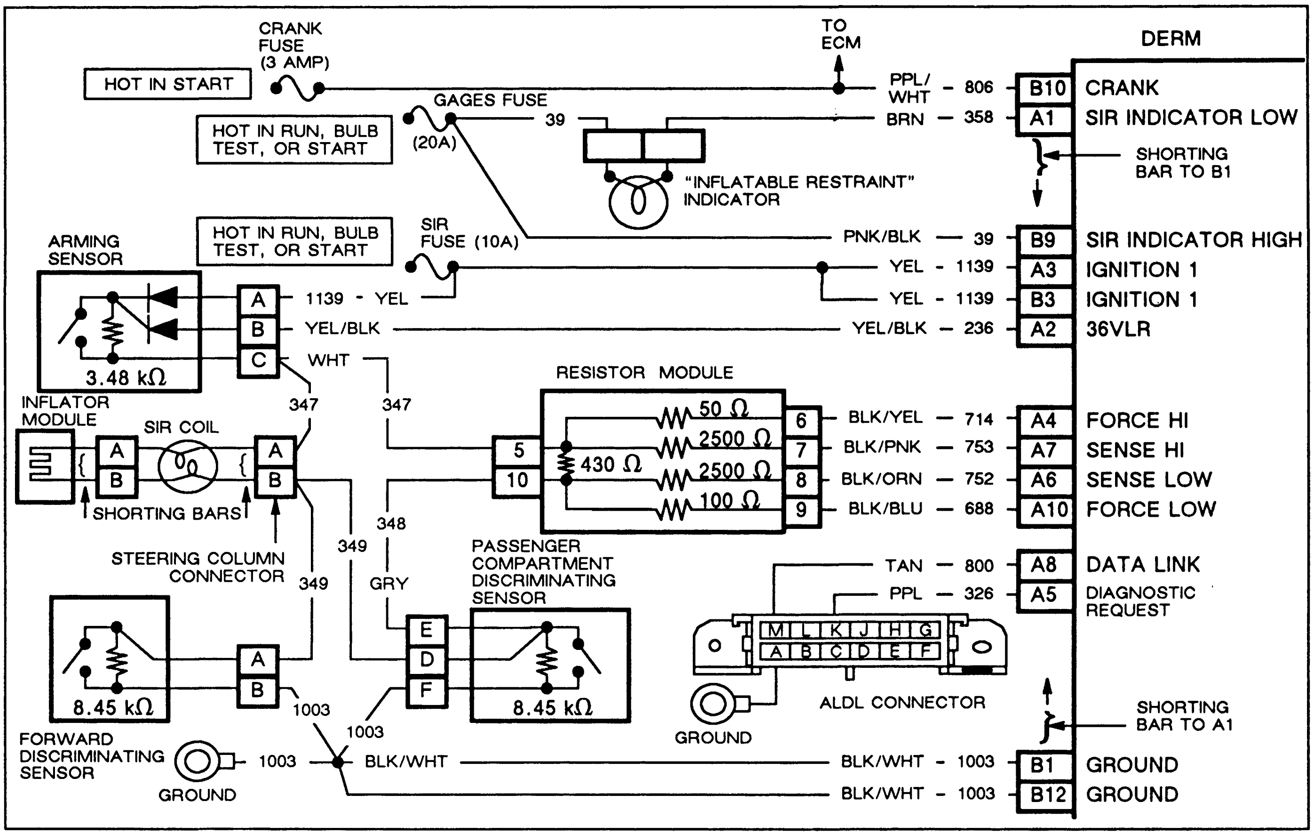


Figure 9J-A-55 SIR Circuit

CODE 61

FORCE LOW OR "INFLATABLE RESTRAINT" INDICATOR CIRCUIT FAILURE

Test Conditions:

Tested every 100 milliseconds during "Continuous Monitoring."

Failure Conditions:

Code 61 will set if: 1) Voltage at Sense Low input is greater than 8 volts; 2) Feedback from ground driver (QDM) does not agree with the commanded state for 500 milliseconds.

Conditions To Clear:

Current Code 61 will be cleared each time the Ignition Switch is turned OFF.

Action taken:

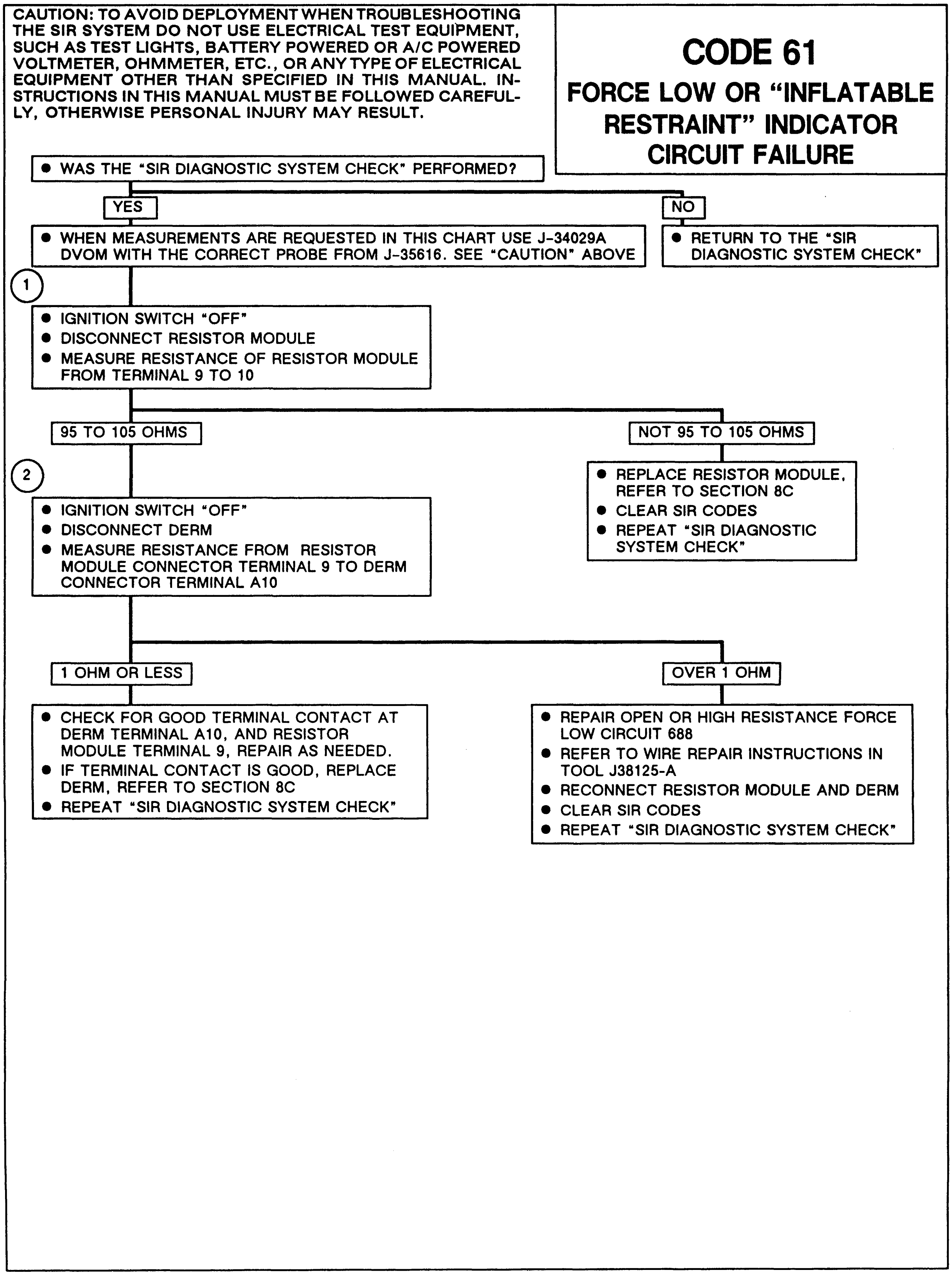
DERM attempts to turn on the "INFLATABLE RESTRAINT" indicator.

Description:

The DERM monitors the ground driver output by comparing the output state to the processor commanded state. Code 61 will set when the commanded state does not match the output state of the ground driver. A possible cause for a Code 61 an open or short to ground in the Forced Low circuit.

Notes on Fault Tree:

1) Checks for an open 100 ohm resistor in the Resistor Module.
2) Checks for an open between the Resistor Module and the DERM on the Force Low circuit.



CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CODE 61

FORCE LOW OR "INFLATABLE RESTRAINT" INDICATOR CIRCUIT FAILURE

- WAS THE "SIR DIAGNOSTIC SYSTEM CHECK" PERFORMED?

YES

- WHEN MEASUREMENTS ARE REQUESTED IN THIS CHART USE J-34029A DVOM WITH THE CORRECT PROBE FROM J-35616. SEE "CAUTION" ABOVE

NO

- RETURN TO THE "SIR DIAGNOSTIC SYSTEM CHECK"

①

- IGNITION SWITCH "OFF"
- DISCONNECT RESISTOR MODULE
- MEASURE RESISTANCE OF RESISTOR MODULE FROM TERMINAL 9 TO 10

95 TO 105 OHMS

②

- IGNITION SWITCH "OFF"
- DISCONNECT DERM
- MEASURE RESISTANCE FROM RESISTOR MODULE CONNECTOR TERMINAL 9 TO DERM CONNECTOR TERMINAL A10

NOT 95 TO 105 OHMS

- REPLACE RESISTOR MODULE, REFER TO SECTION 8C
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

1 OHM OR LESS

- CHECK FOR GOOD TERMINAL CONTACT AT DERM TERMINAL A10, AND RESISTOR MODULE TERMINAL 9, REPAIR AS NEEDED.
- IF TERMINAL CONTACT IS GOOD, REPLACE DERM, REFER TO SECTION 8C
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

OVER 1 OHM

- REPAIR OPEN OR HIGH RESISTANCE FORCE LOW CIRCUIT 688
- REFER TO WIRE REPAIR INSTRUCTIONS IN TOOL J38125-A
- RECONNECT RESISTOR MODULE AND DERM
- CLEAR SIR CODES
- REPEAT "SIR DIAGNOSTIC SYSTEM CHECK"

Figure 9J-A-56 Code 61

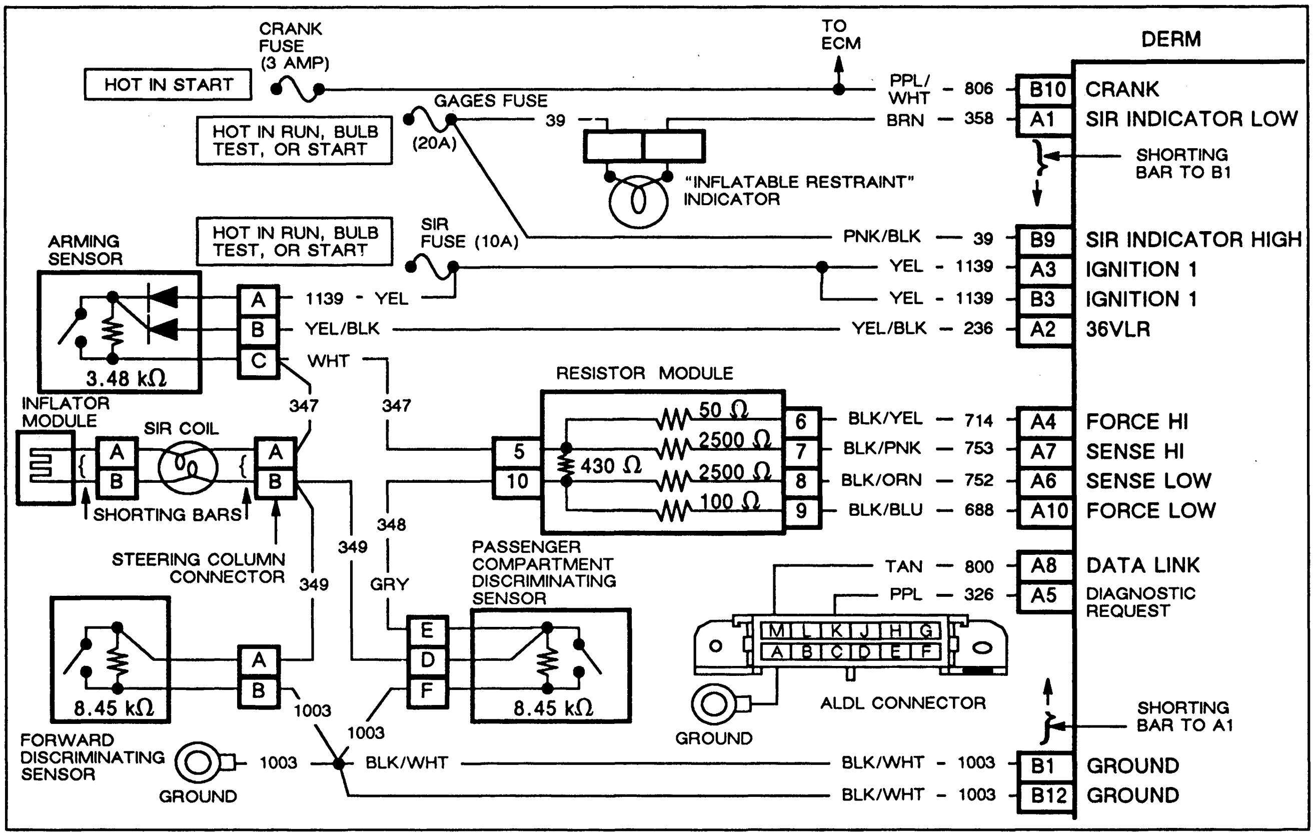


Figure 9J-A-57 SIR Circuit

CODE 71

INTERNAL DERM FAULT

Test Conditions:

Tested during "Turn-on" and every 100 milliseconds during "Continuous Monitoring."

Failure Conditions:

Code 71 is set when an internal DERM fault is detected during "Turn-on" or "Continuous Monitoring."

Conditions To Clear:

Current Code 71 will clear if no internal DERM faults are detected for 500 milliseconds.

Action taken:

DERM turns on the "INFLATABLE RESTRAINT" indicator.

Description:

Code 71 is an internal DERM fault and will set if any of the following conditions are detected: 1) DERM power supply reserve voltage charge or discharge time failure; 2) DERM power supply reserve voltage less than 13.0 volts or greater than 19.6 volts for 500 milliseconds; 3) DERM is unable to read from or write to EEPROM; 4)36VLR is greater than 44.0 volts for 500 milliseconds.

CAUTION: TO AVOID DEPLOYMENT WHEN TROUBLESHOOTING THE SIR SYSTEM DO NOT USE ELECTRICAL TEST EQUIPMENT, SUCH AS TEST LIGHTS, BATTERY POWERED OR A/C POWERED VOLTMETER, OHMMETER, ETC., OR ANY TYPE OF ELECTRICAL EQUIPMENT OTHER THAN SPECIFIED IN THIS MANUAL. INSTRUCTIONS IN THIS MANUAL MUST BE FOLLOWED CAREFULLY, OTHERWISE PERSONAL INJURY MAY RESULT.

CODE 71

INTERNAL DERM FAULT

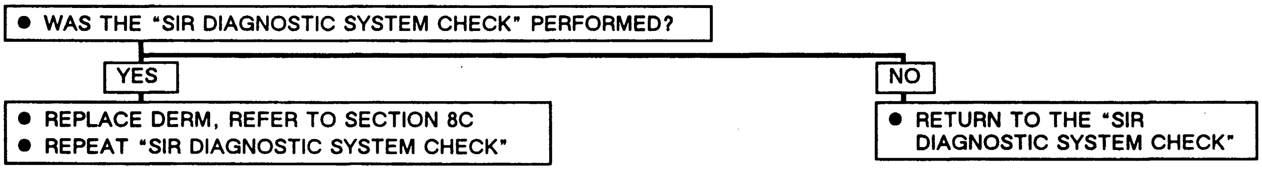
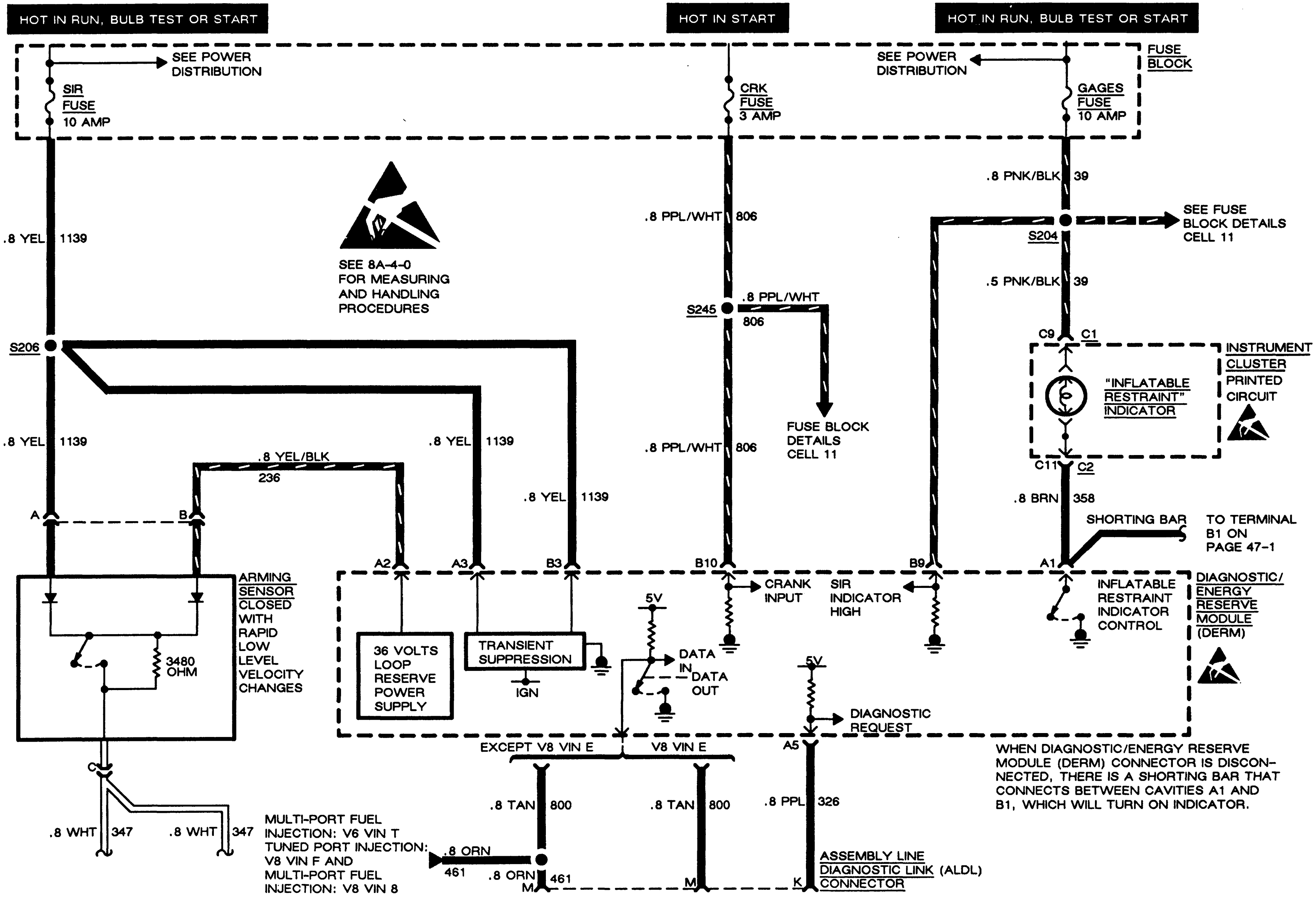
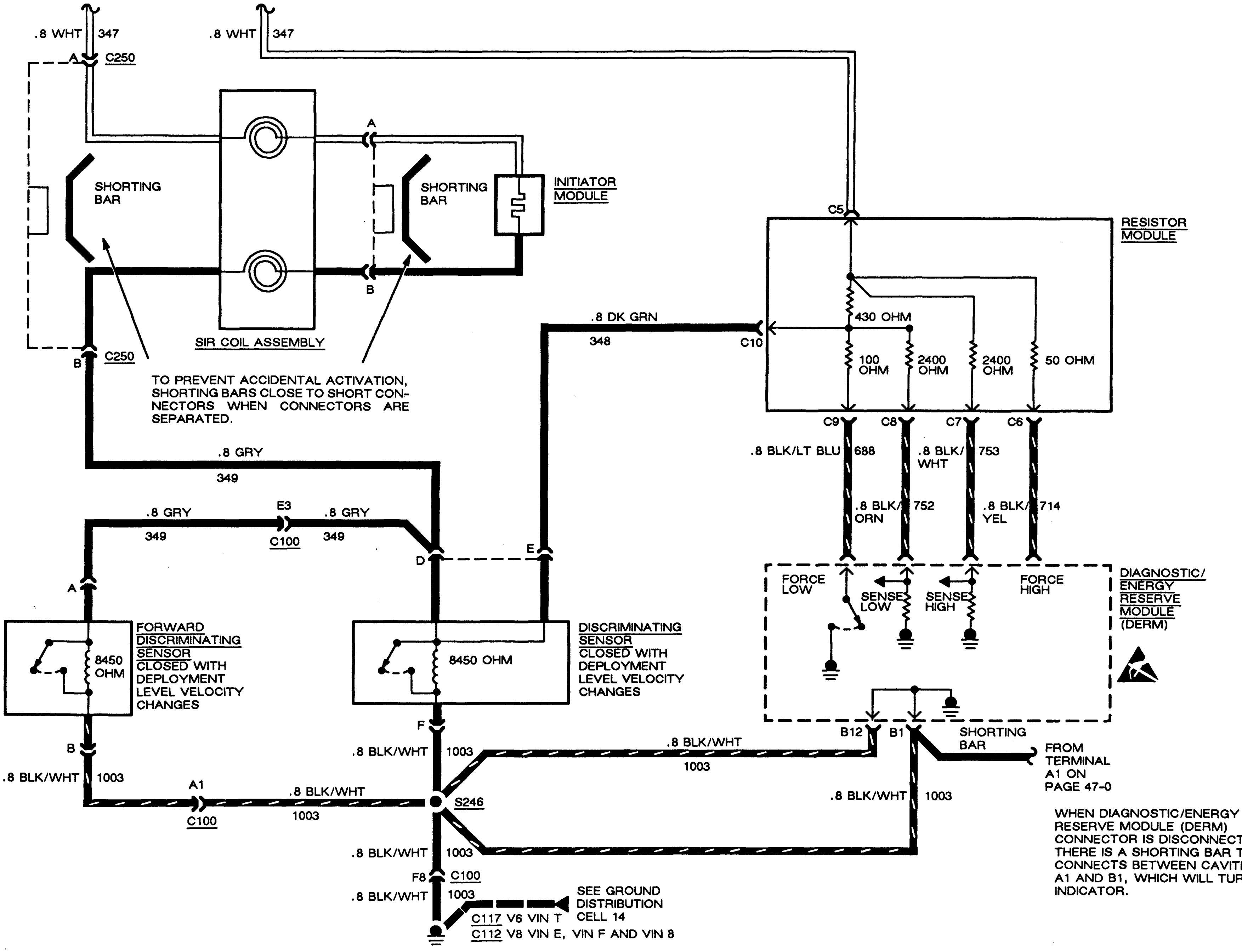


Figure 9J-A-58 Code 71

SUPPLEMENTAL INFLATABLE RESTRAINT (SIR): AJ3



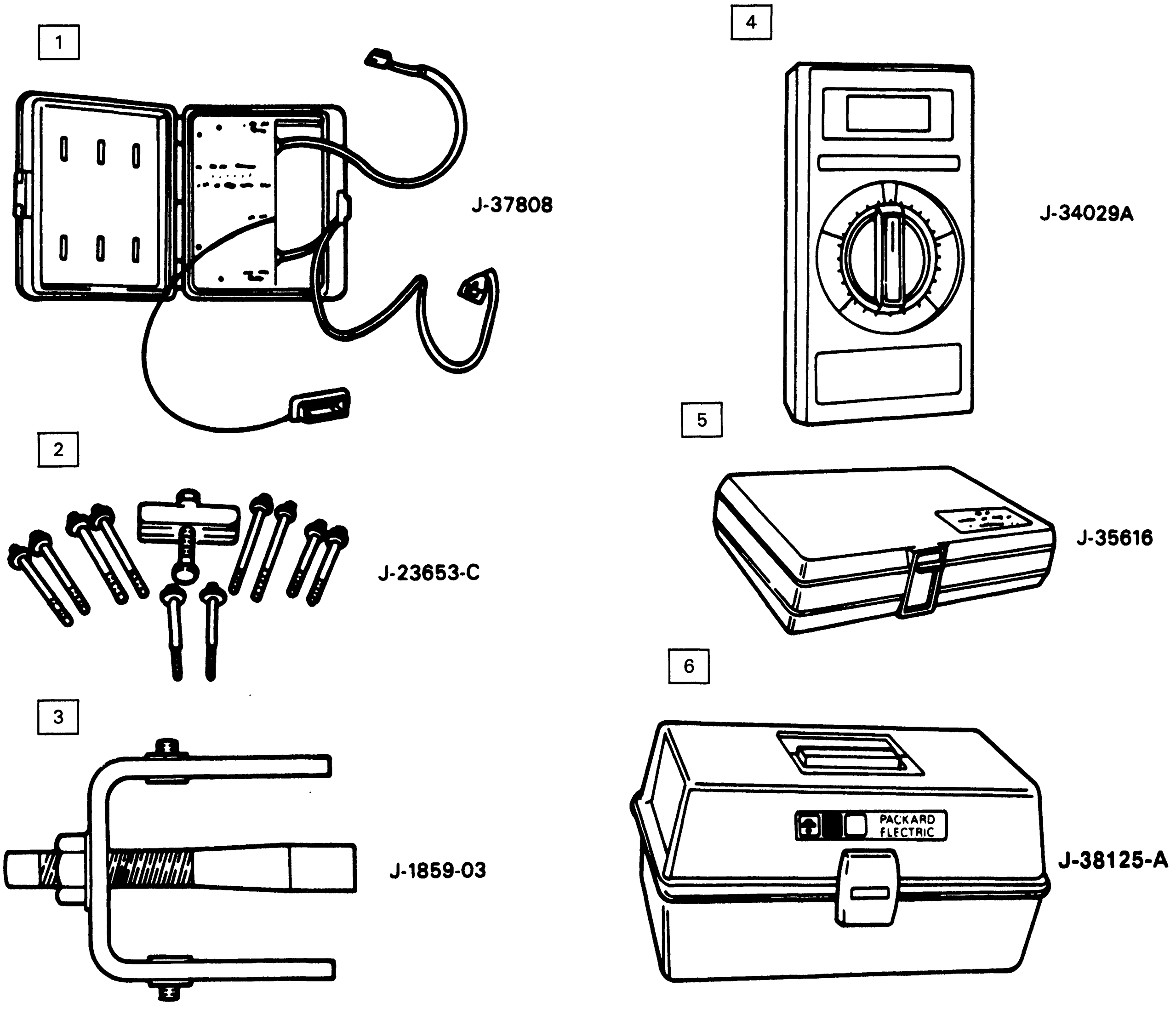
WHEN DIAGNOSTIC/ENERGY RESERVE MODULE (DERM) CONNECTOR IS DISCONNECTED, THERE IS A SHORTING BAR THAT CONNECTS BETWEEN CAVITIES A1 AND B1, WHICH WILL TURN ON INDICATOR.



TO PREVENT ACCIDENTAL ACTIVATION, SHORTING BARS CLOSE TO SHORT CONNECTORS WHEN CONNECTORS ARE SEPARATED.

WHEN DIAGNOSTIC/ENERGY RESERVE MODULE (DERM) CONNECTOR IS DISCONNECTED, THERE IS A SHORTING BAR THAT CONNECTS BETWEEN CAVITIES A1 AND B1, WHICH WILL TURN ON INDICATOR.

SPECIAL TOOLS



K66006-9JA-C

1 INFLATOR MODULE AND STEERING COLUMN REPLACEMENT LOAD

2 LOCK PLATE COMPRESSOR

3 STEERING WHEEL PULLER

4 DIGITAL MULTIMETER

5 TERMINAL TEST ADAPTER KIT

6 WIRE REPAIR KIT

SECTION 9J-B

SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM REMOVAL AND INSTALLATION PROCEDURES

CAUTION: The procedures in this section must be followed in the order listed to temporarily disable the Supplemental Inflatable Restraint (SIR) System and prevent false diagnostic codes from setting. Failure to follow this procedure could result in possible air bag deployment, personal injury, or unneeded SIR system repairs.

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 9J-B-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

ON-VEHICLE SERVICE

DISABLING THE SIR SYSTEM

Figure 1

↔ **Remove or Disconnect**

- Turn the steering wheel so that the vehicle wheels are pointing straight ahead.
- Turn the ignition switch to "LOCK."

1. SIR fuse from the fuse block.
2. Left side sound insulator. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
3. Connector position assurance (31) and yellow two-way SIR harness electrical connector at the base of the steering column.

ENABLING THE SIR SYSTEM

→← **Install or Connect**

1. Yellow two-way SIR harness electrical connector to base of steering column and connector position assurance (31).
2. Left side sound insulator. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
3. SIR fuse to the fuse block.

- Turn the ignition switch to "RUN" and verify that the inflatable restraint indicator flashes 7 to 9 times and then turns off. If the indicator does not respond as stated, refer to SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM DIAGNOSIS (SEC. 9J-A).

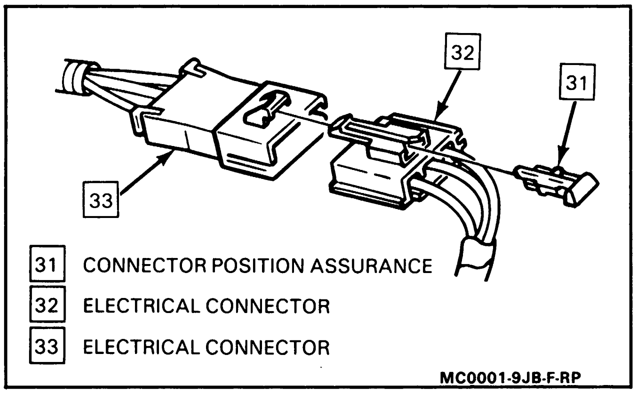


Figure 1 - Connector Position Assurance Removed

SUPPLEMENTAL INFLATABLE RESTRAINT COMPONENT LOCATION

For the location of various supplemental inflatable restraint components, refer to Figures 2 and 3.

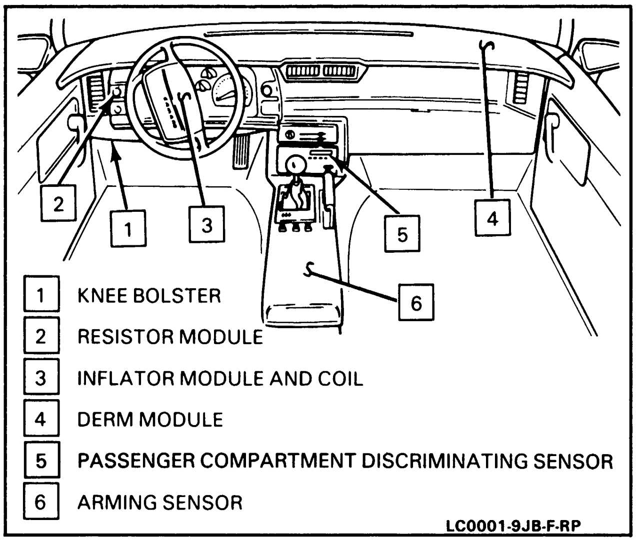


Figure 2 - Passenger Compartment SIR Component Location

SIR SYSTEM SERVICING PRECAUTIONS

CAUTION: Proper operation of the sensors and supplemental inflatable restraint (SIR) system requires that any repairs to the vehicle structure return it to its original production cofiguration. Deployment (current code 51) or any visible damage to sensors and/or their mounting brackets requires replacement, not repair. Proper operation of a sensor also requires that the sensor and its bracket be rigidly attached to the vehicle structure. The arrow on the sensor must be pointing toward the front of the vehicle. Failure to observe these precautions can result in improper SIR system operation and possible lack of supplemental restraint protection for the driver during an accident impact.

CAUTION: Be very careful when handling a sensor. Never strike or jar a sensor. If you do, it could cause deployment and result in personal injury or improper operation of the supplemental inflatable restraint (SIR) system. All sensors and mounting bracket bolts must be carefully torqued to ensure proper operation. Never power up the SIR system when any sensor is not rigidly attached to the vehicle, since the sensor is easily activated when not attached. This could result in immediate deployment and possible personal injury.

INSPECTIONS REQUIRED AFTER ACCIDENT

CAUTION: Refer to "SIR System Servicing Precautions" in this section.

Important

- Every SIR system component, harness or bracket must be inspected after an accident. If any are damaged or bent, they must be replaced even if a deployment did not occur. Inspect the steering column, knee bolster and bracket for damage. Do not attempt to repair either discriminating sensor, the arming sensor, the DERM, the coil assembly or the inflator module. Service is by replacement only. Any wiring harness damage should be repaired only with the crimp and seal splice contained with tool J 38125-A.

FORWARD DISCRIMINATING SENSOR

Figures 3 and 4

All sensors are specifically calibrated for each vehicle series and are keyed to the mounting brackets and the SIR wiring harness. Caution should be used to ensure proper location of the sensors to their mounting brackets. The keying of the sensors to their mounting brackets and wiring harness should never be modified in the field.

CAUTION: Refer to "SIR System Servicing Precautions" in this section.

Remove or Disconnect

CAUTION: See "Caution" on page 9J-B-1 of this section.

- Disable the SIR system. Refer to "Disabling the SIR System" in this section.

1. Fascia center support mounting bolts.

- Pull the fascia center support (8) forward to gain access to the forward discriminating sensor (7).

2. Connector position assurance (12) and electrical connectors (11 and 34) behind the radiator support (10).
3. Bolts (9).
4. Forward discriminating sensor (7).

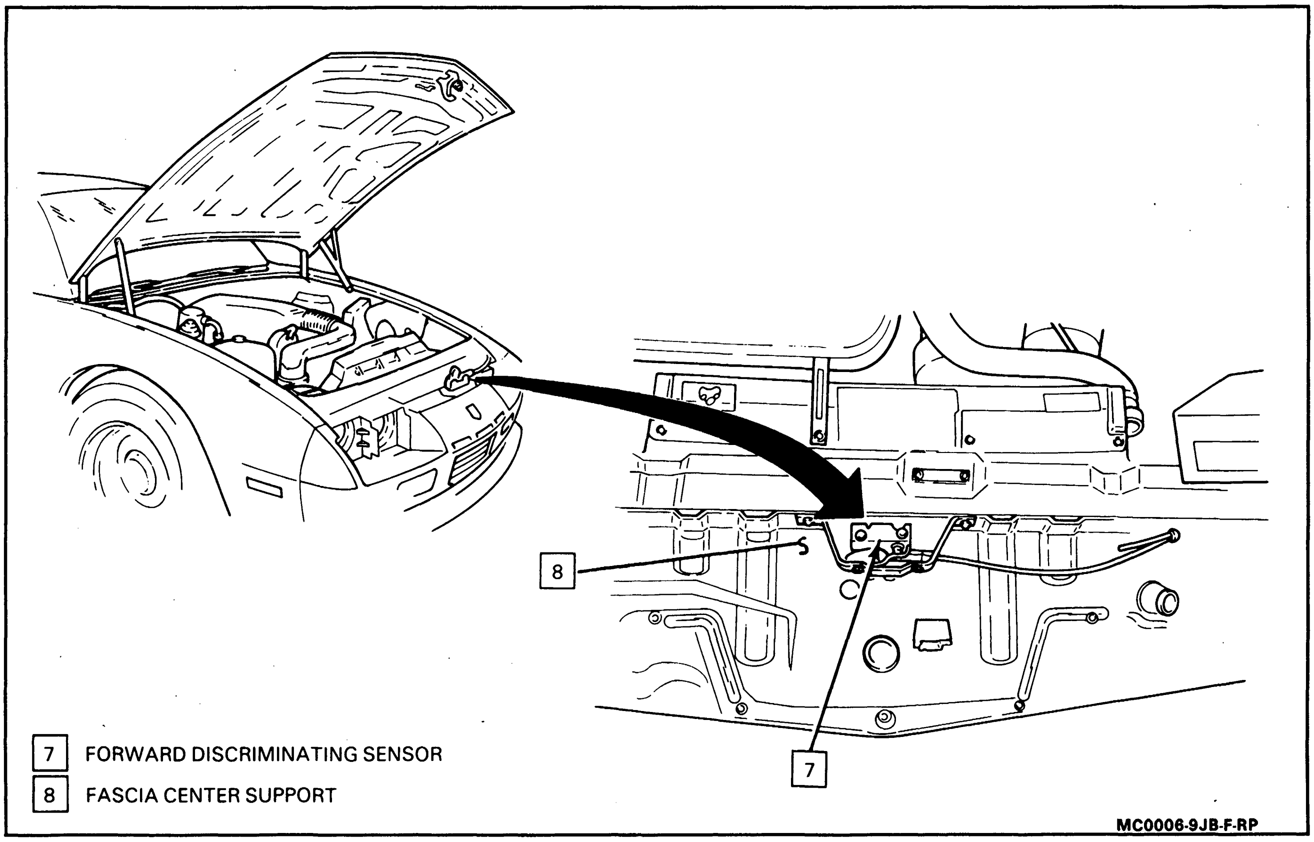


Figure 3 - Engine Compartment SIR Component Location

Install or Connect

NOTICE: See "Notice" on page 9J-B-1 of this section.

1. Forward discriminating sensor (7) with arrow pointing to the front of the vehicle.
2. Bolts (9).

Tighten

- Bolts (9) to 2.8 N·m (25 lb. in.).

3. Electrical connectors (11 and 34) and connector position assurance (12) behind the radiator support (10).
4. Fascia center support mounting bolts.

- Enable the SIR system. Refer to "Enabling the SIR System" in this section.

DIAGNOSTIC ENERGY RESERVE MODULE (DERM)

Figures 5 and 6

CAUTION: Refer to "SIR System Servicing Precautions" in this section.

Remove or Disconnect

CAUTION: See "Caution" on page 9J-B-1 of this section.

- Disable the SIR system. Refer to "Disabling the SIR System" in this section.

1. Instrument panel pad. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
2. Side window defogger duct and screws.

- Cut off an unused mounting screw tab (14) from the front edge of the instrument panel, just above the DERM module.

3. Screw (15).
4. DERM module (4).

- Unlatch orange connector lock and disconnect electrical connector.

Install or Connect

NOTICE: See "Notice" on page 9J-B-1 of this section.

1. Electrical connector and orange connector lock.
2. DERM module (4).
3. Screw (15).

Tighten

- Screw (15) to 2.2 N·m (19 lb. in.).

4. Side window defogger duct and screws.
5. Instrument panel pad. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).

- Enable the SIR system. Refer to "Enabling the SIR System" in this section.

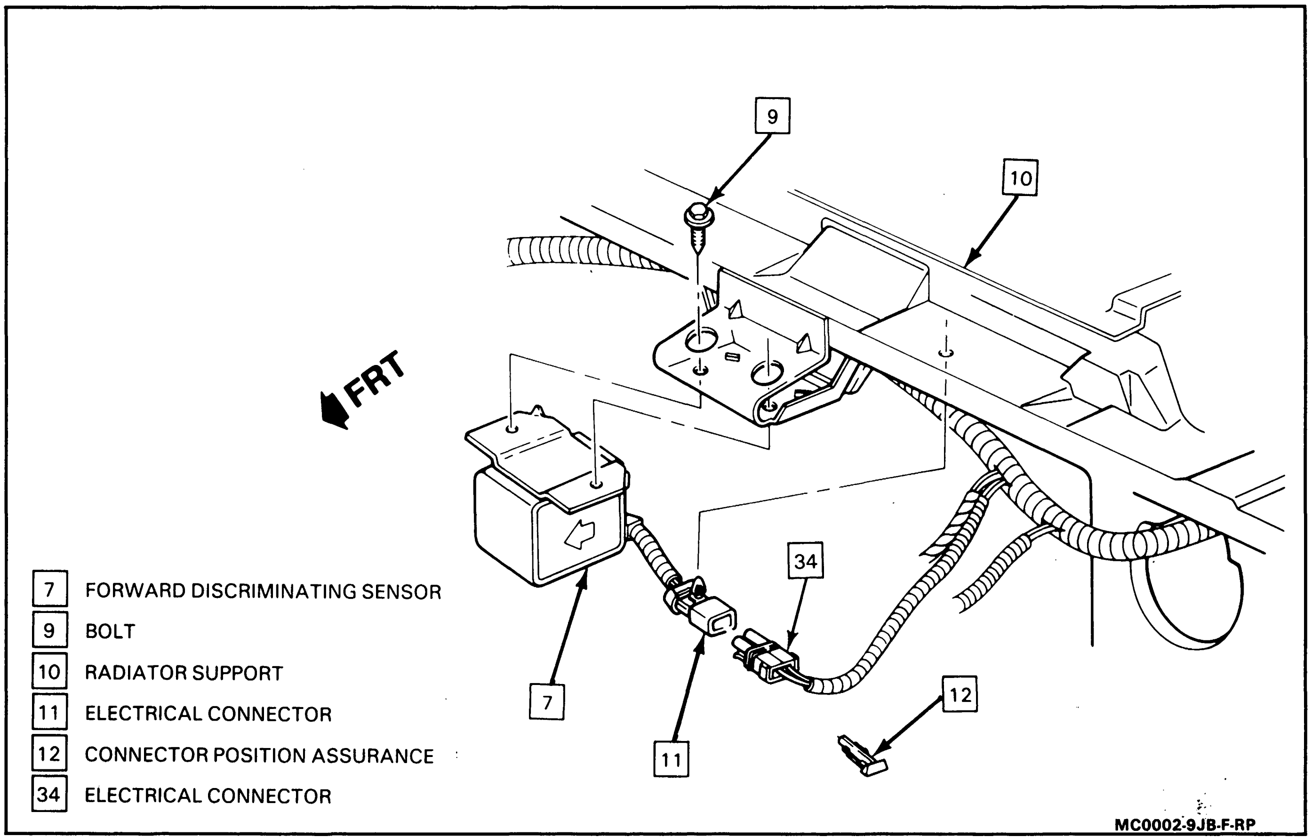


Figure 4 - Forward Discriminating Sensor

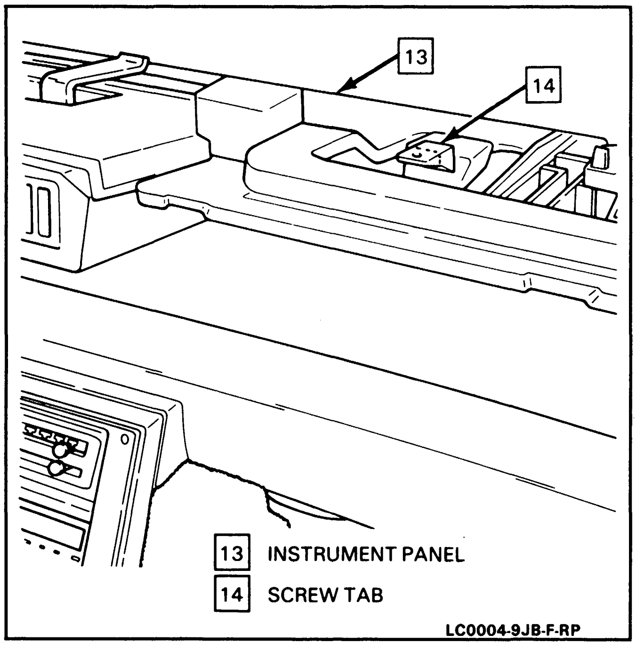


Figure 5 - Mounting Screw Tab

RESISTOR MODULE

Figure 7

CAUTION: Refer to "SIR System Servicing Precautions" in this section.

Remove or Disconnect

CAUTION: See "Caution" on page 9J-B-1 of this section.

- Disable the SIR system. Refer to "Disabling the SIR System" in this section.

1. Knee bolster. Refer to "Instrument Panel Knee Bolster and Bracket" in this section.
2. Resistor module (2) by unsnapping from the left side tie bar (17).
3. Connector position assurance (18) and electrical connector.

Install or Connect

1. Electrical connector and connector position assurance (18).
2. Resistor module (2) by snapping to the left side tie bar (17).
3. Knee bolster. Refer to "Instrument Panel Knee Bolster and Bracket" in this section.

- Enable the SIR system. Refer to "Enabling the SIR System" in this section.

PASSENGER COMPARTMENT DISCRIMINATING SENSOR

Figure 8

All sensors are specifically calibrated for each vehicle series and are keyed to the mounting brackets and the SIR wiring harness. Caution should be used to ensure proper location of the sensors to their mounting brackets. The keying of the sensors to their mounting brackets and wiring harness should never be modified in the field.

CAUTION: Refer to "SIR System Servicing Precautions" in this section.

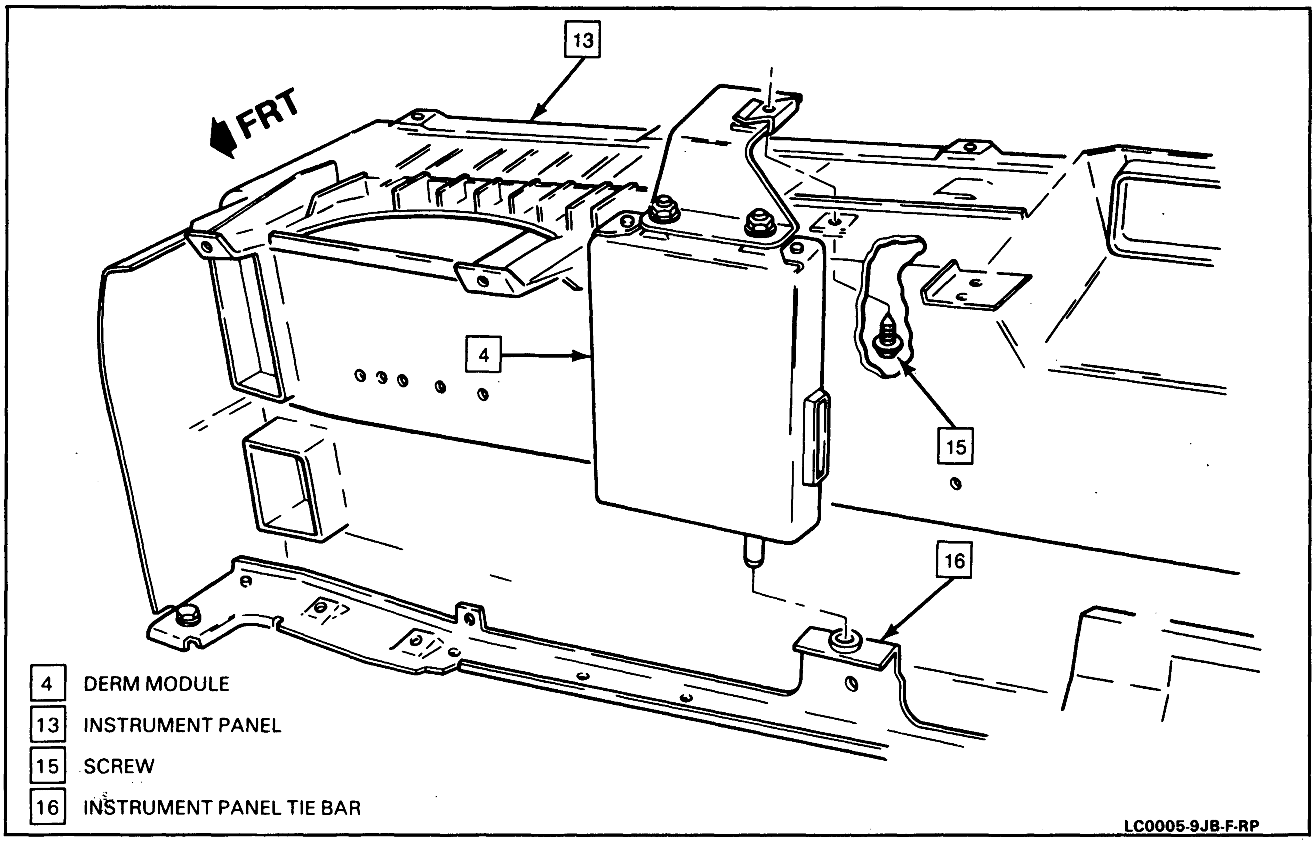


Figure 6 - Diagnostic Energy Reserve Module (DERM)

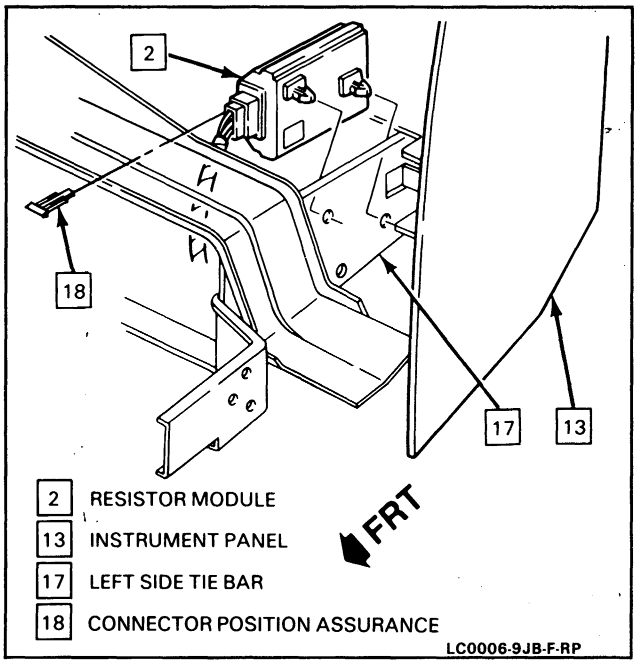


Figure 7 - Resistor Module

Remove or Disconnect

CAUTION: See "Caution" on page 9J-B-1 of this section.

- Disable the SIR system. Refer to "Disabling the SIR System" in this section.

1. Knee bolster. Refer to "Instrument Panel Knee Bolster and Bracket" in this section.
2. Console. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
3. Heater air distribution duct and screws.
4. Connector position assurance (20) and electrical connectors (21 and 35).
5. Bolts (19).
6. Passenger compartment discriminating sensor (5).

Install or Connect

NOTICE: See "Notice" on page 9J-B-1 of this section.

1. Passenger discriminating sensor (5) with arrow pointing toward the front of the vehicle.
2. Bolts (19).

Tighten

- Bolts (19) to 2.8 N·m (25 lb. in.).

3. Electrical connectors (21 and 35) and connector position assurance (20).
4. Heater air distribution duct and screws.
5. Console. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
6. Knee bolster. Refer to "Instrument Panel Knee Bolster and Bracket" in this section.

- Enable the SIR system. Refer to "Enabling the SIR System" in this section.

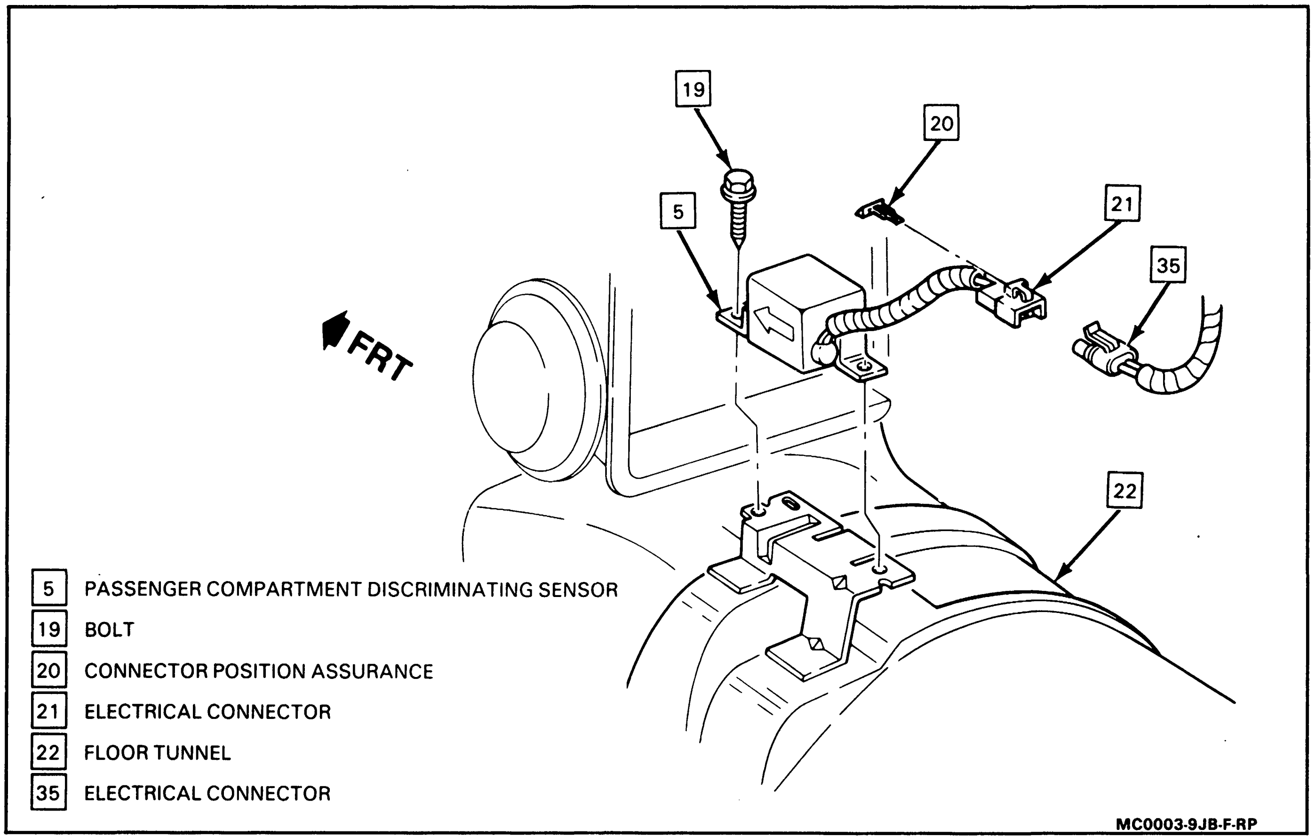


Figure 8 - Passenger Compartment Discriminating Sensor

ARMING SENSOR

Figure 9

All sensors are specifically calibrated for each vehicle series and are keyed to the mounting brackets and the SIR wiring harness. Caution should be used to ensure proper location of the sensors to their mounting brackets. The keying of the sensors to their mounting brackets and wiring harness should never be modified in the field.

CAUTION: Refer to "SIR System Servicing Precautions" in this section.

Remove or Disconnect

CAUTION: See "Caution" on page 9J-B-1 of this section.

- Disable the SIR system. Refer to "Disabling the SIR System" in this section.

1. Knee bolster. Refer to "Instrument Panel Knee Bolster and Bracket" in this section.
2. Upper console. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
3. Connector position assurance (23) and electrical connector (24).
4. Bolts (25).
5. Arming sensor (6).

Install or Connect

NOTICE: See "Notice" on page 9J-B-1 of this section.

1. Arming sensor (6).
2. Bolts (25).

Tighten

- Bolts (25) to 2.8 N·m (25 lb. in.).

3. Electrical connector (24) and connector position assurance (23).
4. Upper console. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
5. Knee bolster. Refer to "Instrument Panel Knee Bolster and Bracket" in this section.

- Enable the SIR system. Refer to "Enabling the SIR System" in this section.

INSTRUMENT PANEL KNEE BOLSTER AND BRACKET

Figure 10

Important

- The knee bolster should be replaced, not repaired, if there is any visible damage.

Remove or Disconnect

- Open screw covers (28).

1. Screws (29).
2. Knee bolster (1).
3. Nuts (30).
4. Bracket (27).

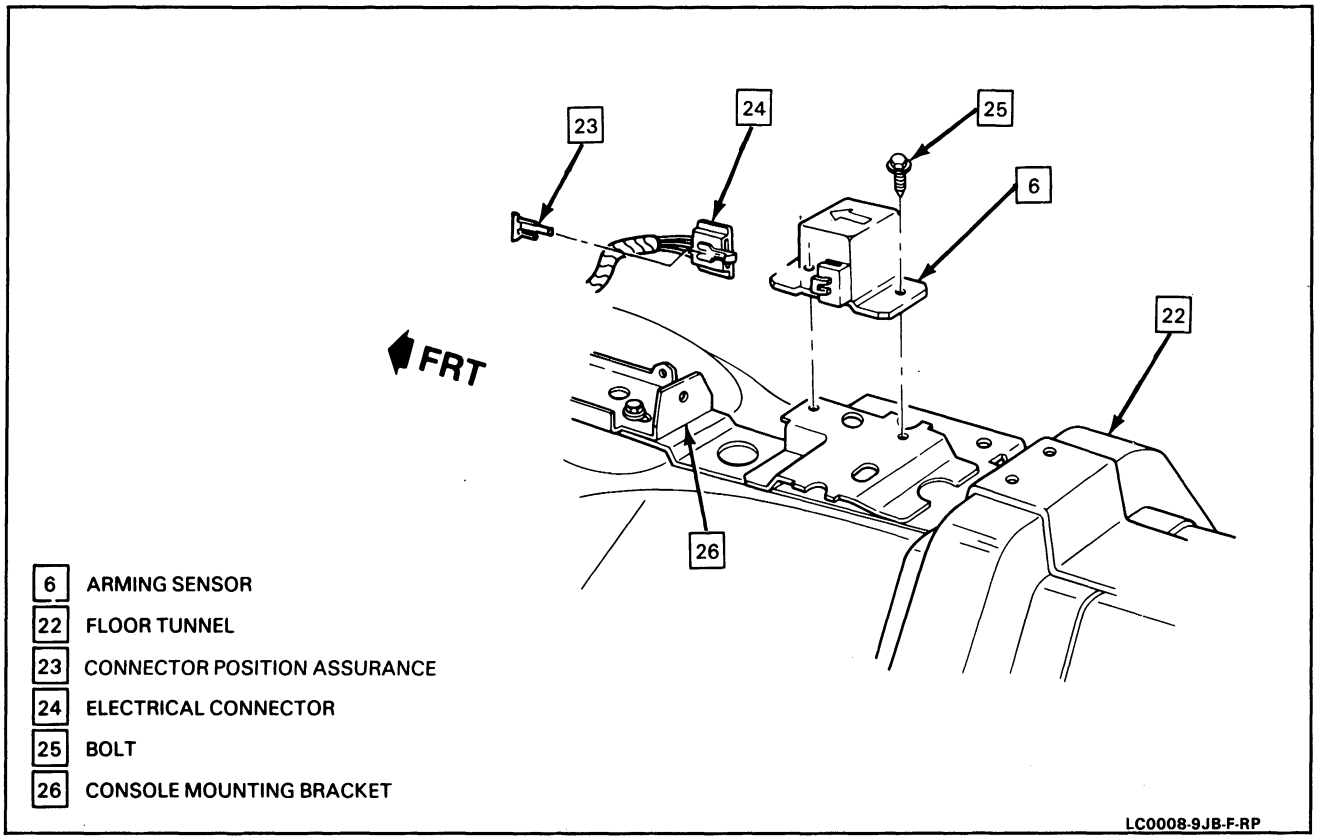


Figure 9 - Arming Sensor

Install or Connect

NOTICE: See "Notice" on page 9J-B-1 of this section.

1. Bracket (27).
2. Nuts (30).
3. Knee bolster (1).
4. Screws (29).

Tighten

- Screws (29) to 5.5 N·m (49 lb. in.).

- Close screw covers (28).

INFLATABLE RESTRAINT INDICATOR LAMP

For service information on the indicator lamp, refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).

INFLATOR MODULE, COIL ASSEMBLY AND CENTERING COIL ASSEMBLY

For service information on these components, refer to STEERING WHEEL UPPER COLUMN ON-VEHICLE SERVICE - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4).

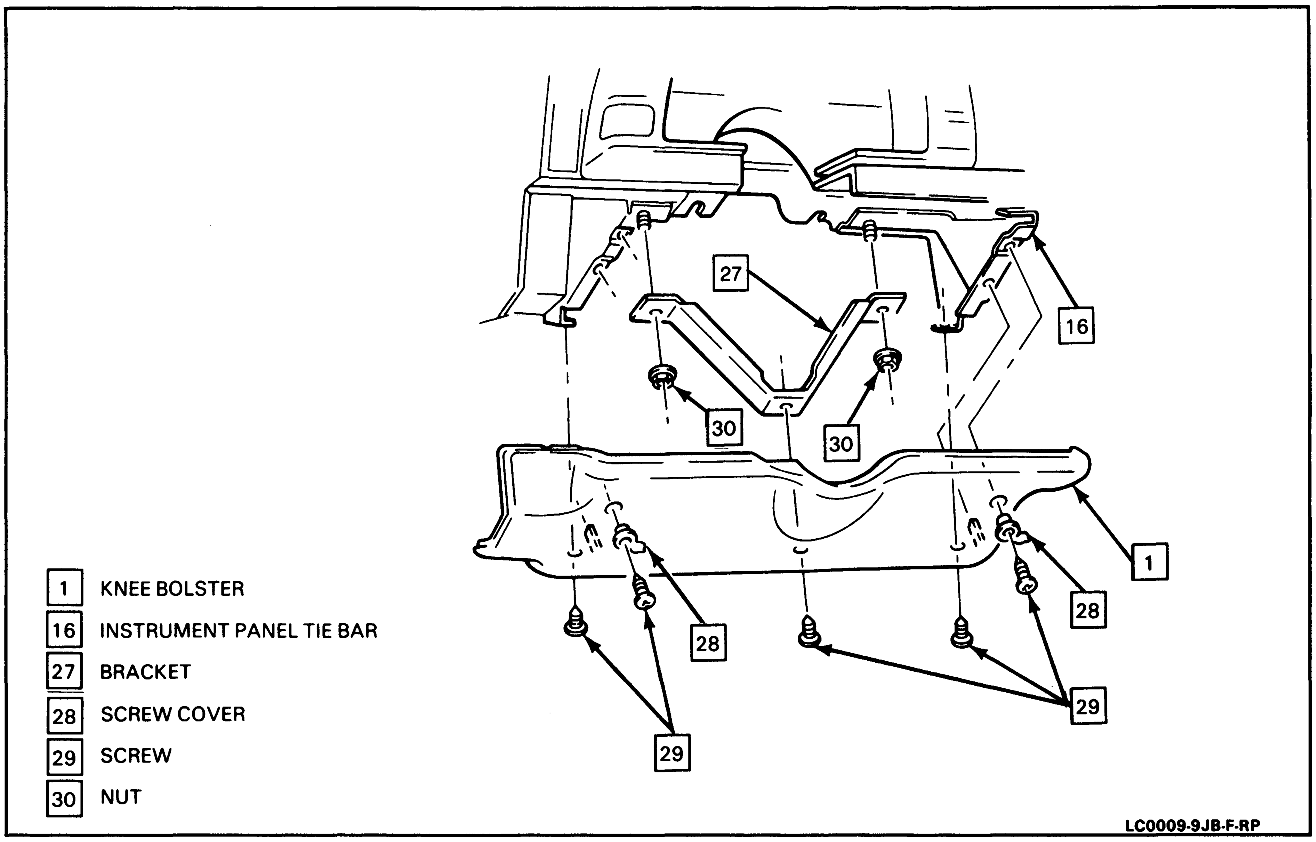


Figure 10 - Instrument Panel Knee Bolster and Bracket

SERVICE PARTS INFORMATION

PART NAME	SERVICE PARTS CATALOG REFERENCE NAME	SERVICE PARTS CATALOG GROUP
COMPONENTS		
DERM	Module Asm-Infl Rst Resv Engy	14.865
Forward Discriminating Sensor	Sensor Asm-Infl Rst F/End Sh Met.	14.865
Passenger Compartment Discriminating Sensor	Sensor Asm-Inf Rst Pass Compt	14.865
Arming Sensor	Sensor Asm-Inf Rst Arming	14.865
"Inflatable Restraint" Indicator Lamp		9.744 (Standard Parts Cat.)
Inflator Module	Module Asm-Infl Rst Resv Engy	14.865
Knee Bolster	Bolster Asm I/P Drvr Knee	10.235
Resistor Module	Module, Infl Rst Syst Resistor	14.865
SIR Coil Assembly	Coil, Infl Res	14.865
CONNECTOR ASSEMBLY PACKS:		
DERM		2.480
Forward Discriminating Sensor		2.530
Passenger Compartment Discriminating Sensor		2.530
Arming Sensor		2.530
Resistor Module		2.480
Steering Column		2.530
DERM/Resistor Module Terminal Repair		13.1

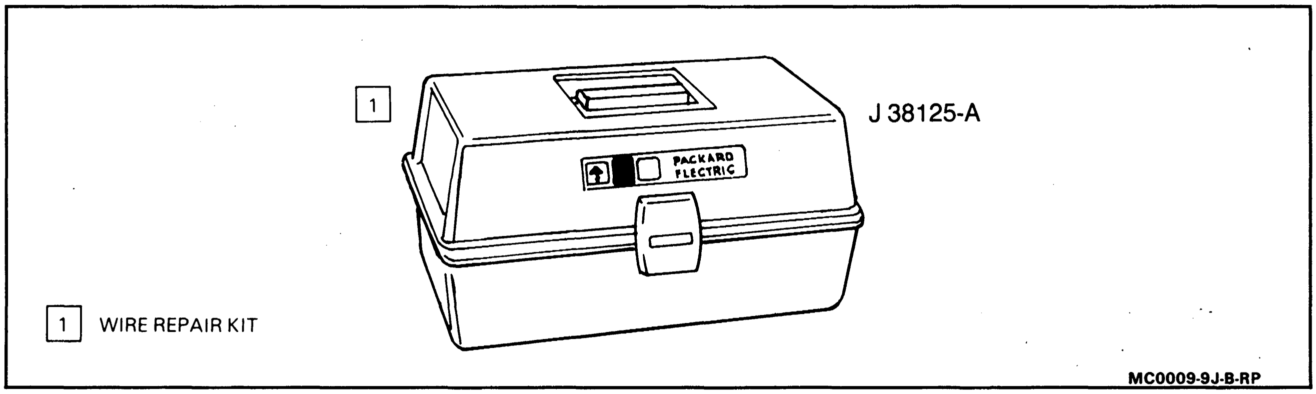
MC0005-9JB-F-RP

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Forward Discriminating Sensor Bolt	2.8 N·m (25 lb. in.)
Diagnostic Energy Reserve Module (DERM) Screw	2.2 N·m (19 lb. in.)
Passenger Compartment Discriminating Sensor Bolt	2.8 N·m (25 lb. in.)
Arming Sensor Bolt	2.8 N·m (25 lb. in.)
Knee Bolster Screw	5.5 N·m (49 lb. in.)

SPECIAL TOOLS



SECTION 10-1

GENERAL BODY SERVICE PROCEDURES

CAUTION: On vehicles equipped with Supplemental Inflatable Restraints (SIR), refer to CAUTIONS in Section 9J-B under On-Vehicle Service before performing service on or around SIR components or SIR wiring. Failure to follow cautions could result in possible air bag deployment, personal injury or unneeded SIR system repairs.

NOTICE: The anti-theft label found on some major sheet metal, engines, and transmissions must be masked prior to painting, rustproofing, undercoating, etc. The mask must be removed following the above operations. Failure to keep the label clean and readable may result in liability for violation of Federal Vehicle Theft Prevention Standard, and subject the vehicle owner to possible suspicion that the part was stolen.

CONTENTS

LOCK CYLINDER CODING

KEY IDENTIFICATION AND USAGE

Figure 1

The lock cylinder keyway is designed so that other model keys will not enter a current model lock cylinder. Two noninterchangeable keys are used.

- Square-headed key is used in the ignition lock.
- Oval-headed key is used in all other lock cylinders.

Key identification for the oval-headed key is obtained from the four character key code stamped on the knockout portion of the key head and an identification letter stamped on the key shank. After the code number has been recorded by the owner, the plugs should be knocked out of the key head. From these numbers, the lock combination can be determined by use of a code list which is available to owners of key cutting equipment from equipment suppliers. If the key code numbers are not available from records or from the knockout plug, the lock combination (tumbler numbers and position) can be determined by laying the key on the diagram. For information on the square-headed ignition key and lock cylinder,refer to THEFT DETERRENT SYSTEMS (SEC. 9D).

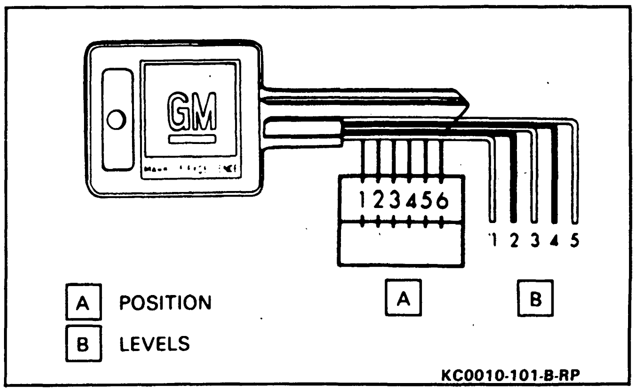


Figure 1 - Key Code Diagram

CUTTING KEYS

Figure 1

1. Determine special code from the code list or the key code diagram.

2. Cut a blank key to the proper level for each of six tumbler positions.
3. Check key operation in the lock cylinder.

REPLACEMENT LOCK CYLINDERS

Figure 2

Lock cylinders (3) are available from service parts warehouses. The new cylinder (3) has a locking bar staked in place. Tumblers (1) are also available and must be assembled into the cylinder (3).

ASSEMBLING AND CODING LOCK CYLINDERS

All Lock Cylinders Except Rear Stowage Compartment

Figures 2 through 4

Tumblers (1) for all locks are shaped exactly alike with the exception of the notch position on one side. As the key is inserted in the lock cylinder (3), tumblers (1) are lowered to the correct height so that notches on each tumbler (1) are at the same level. When the notches on all six tumblers (1) line up, the side bar (4) is pushed into the notches by two small springs. This allows the cylinder (3) to turn in its bore. Five types of tumblers (1) are used to make the various lock combinations. Each tumbler (1) is coded according to a number, one through five, stamped on its side.

Assemble

- Determine tumbler numbers and arrangement.
  - With the numerical key code, use the code list provided by the key cutting equipment supplier.
  - Without the numerical key code or without the code list, refer to Figure 1.
    - Lay the key on the key code diagram. Be sure the key is outlined by the diagram.
    - Start with position number one. Find and record the lowest level (tumbler number) that is visible. Repeat for each of the remaining five positions.

1. Tumblers in their proper slots in the order called for by the code (Figure 2).
   - Start with position number one, open end or lock cylinder head (2).
2. Tumblers by pulling side bar (4) out with fingers.
3. One tumbler spring (6) above each tumbler (1) (Figure 4).
4. Spring retainer (5) so that end prongs slide into the slots at each end of the cylinder (3).
   - Press the spring retainer (5) down (Figure 3).

- Insert key into lock cylinder (3) to check for proper installation.
  - Side bar (4) will drop down if tumblers (1) are installed properly. If incorrectly assembled, take apart and assemble correctly.

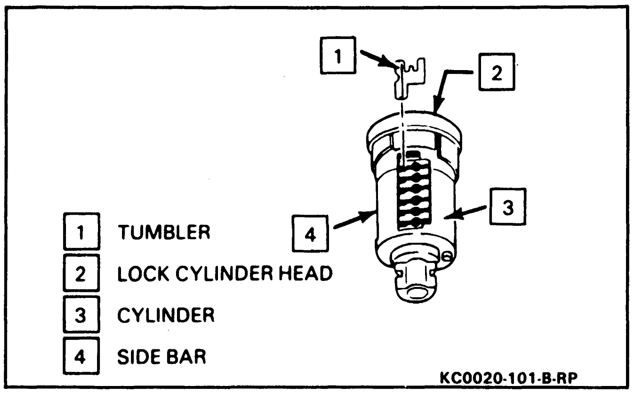


Figure 2 - Lock Cylinder Components

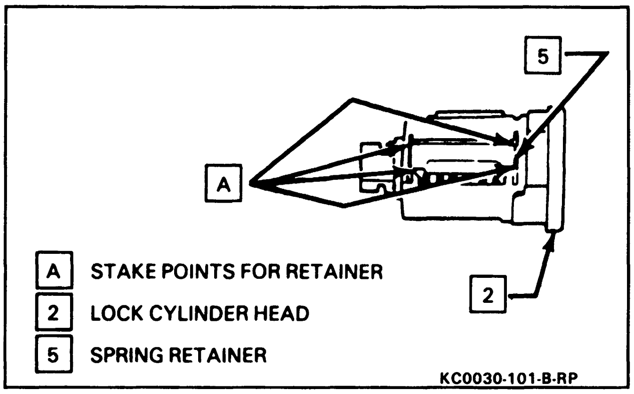


Figure 3 - Installing Spring Retainer

NOTICE: Use leather or wood at each vise jaw to prevent damage to the cylinder.

- Remove key and secure the cylinder (3) in a vise with the spring retainer (5) exposed.
- Stake the spring retainer (5) securely in place at each end. Use a suitable staking tool and stake cylinder metal over the retainer.
- Black lock cylinders should be lubricated with a light oil. All other lock cylinders should be lubricated with a general purpose silicone lubricant, GM part number 1052277 or equivalent.

Rear Stowage Compartment Lock Cylinder

Figures 4 and 5

A lock cylinder (3) with snap-in tumblers (1) is used for the rear stowage compartment lock. The lock cylinder has four or five tumbler positions. The number one or two position (closest to the cylinder head) is a brass retainer tumbler. The two through five positions or three through five positions are standard tumbler positions depending upon cylinder type. Therefore only the last three or four tumbler combinations are required.

Assemble

- Determine tumbler numbers and arrangement as previously described and install tumblers.
- After installation, tap the tumblers (1) flush with the cylinder (3).

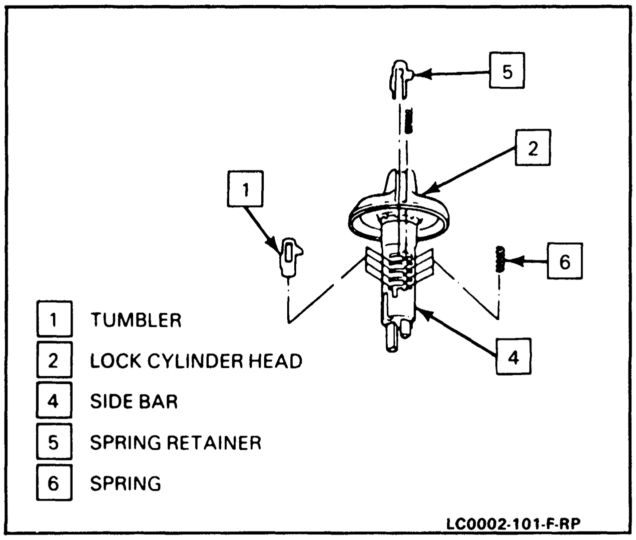


Figure 4 - Installing Tumblers

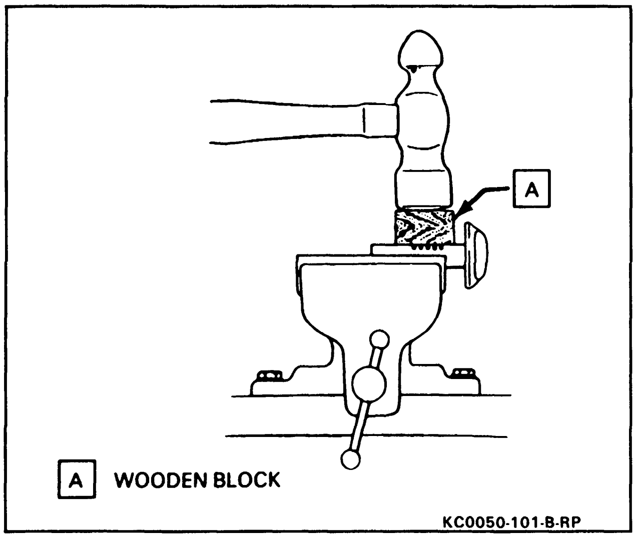


Figure 5 - Locking Tumblers in Place

ADHESIVE BODY SIDE MOLDINGS

The body side moldings are attached to the body panels with adhesive tape. To insure a good replacement of new or old moldings, the panel surface should be warm 21°C to 32°C (70°F to 90°F), clean and free of any wax or oily film. Methods are listed to attach loose molding ends, completely removed moldings, and replacement moldings.

MOLDING END LOOSE

1. Wash the affected area with soap and water and wipe dry. Wipe panel and adhesive side of the molding with a clean rag using oil-free naphtha or alcohol.
   - If the molding has pulled loose from the adhesive backing (tape remains on body panel), do not remove the tape from the body. Clean the back of the molding and the tape on the body with oil-free naphtha or alcohol and proceed with step 3.
2. If needed, apply a length of masking tape as a molding guide. A straightedge may also be used.
3. Apply adhesive to the back of the molding and press in place. If adhesive (GM part number 1052621 or equivalent) is used, apply constant pressure to the molding for 30 seconds or until a firm bond has been made.

MOLDING COMPLETELY REMOVED

Important

- Do not use this procedure if molding is dented or was pried from the body.

Figure 6

1. Wash affected panel area with soap and water. Wipe dry.
2. Remove all traces of adhesive from the body panel and back of molding using oil-free naphtha or alcohol.
3. Mark proper position of molding with a length of masking tape (Figure 6). Use adjacent moldings as a guide.
4. Warm body panel with a heat lamp or heat gun to 21°C (70°F).
5. Apply a double-coated foam tape (3M part number 06380 or equivalent) to the molding.
6. Align molding to the tape guideline on the body panel.
7. Peel backing from the end of the molding.
8. Press firmly into place while continuing to remove the backing.
9. Hand roll the molding to the body to ensure proper adhesion.

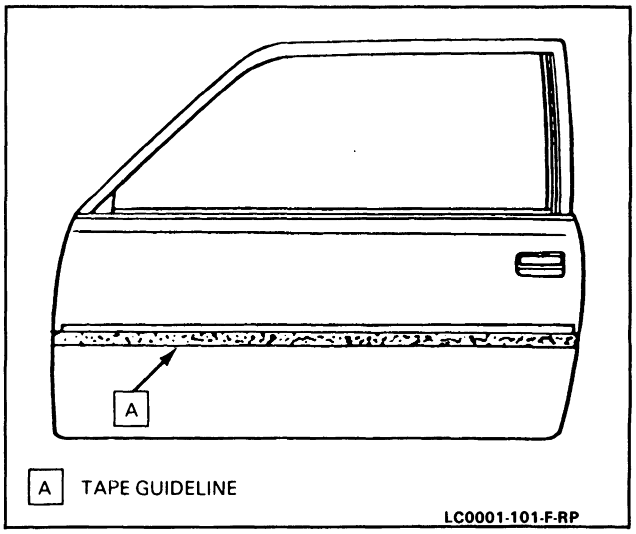


Figure 6 - Adhesive Body Side Molding Repair

MOLDING REPLACEMENT

1. Mark proper position of molding with a length of masking tape (Figure 6).

   Clean

   - Body panel using oil-free naphtha or alcohol.
2. Warm body panel with a heat lamp or heat gun to 21°C (70°F).

3. Peel backing from the front end of the molding.
    - Do not touch the adhesive backing.
4. Press molding to the body while continuing to remove the backing.
5. Hand roll the molding to the body to ensure proper adhesion.
6. Molding ends should not overlap door edge, door edge guard, lock cylinder or body openings.

Inspect

- Molding ends for bonding.
- Hand roll loose ends.

WATERLEAK DIAGNOSIS

GM vehicles are designed to operate under normal environmental conditions. The design criteria for sealing materials and components takes into consideration the sealing forces required to withstand the natural elements. These specifications do not, and cannot, take into consideration all artificial conditions such as may be encountered in some high pressure car washes.

The watertest procedure has been correlated to the natural elements and will determine the ability of a vehicle to perform under normal operating conditions (Figures 7 through 9).

Repairing body waterleaks is a problem of proper testing, diagnosis and repair through adjustment of misaligned components and/or application of proven repair materials. The first step in waterleak diagnosis is finding the conditions under which the leak occurs. For example, the leak is noticed only when parked on an inclined drive, or when water is in the spare tire compartment.

If the general leak area can be found, the exact entry point can be quickly isolated by use of a localized test such as a water hose or air hose. If the leak source is not obvious, a testing method using watertest equipment should be used (Figures 7 and 8). It may be necessary to remove some interior trim panels or components to locate and confirm repairs.

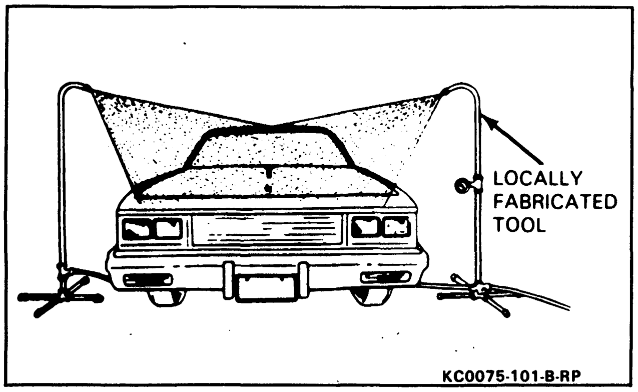


Figure 7 - Watertest Stands Positioned for Front End Watertest

The watertest stand must be constructed (Figure 9).

- Watertest stand specifications:
    - Volume of flow should be 14 liters (3.7 gallons) per minute.
    - Water pressure, measured at nozzle - 155 kPa (22 psi).
    - Windshield and front body pillar - approximately 30 degrees down, 45 degrees towards rear and aimed at corner of windshield (Figure 8).
    - Side - approximately 30 degrees down, 45 degrees towards rear and aimed at the center of the rear door or rear quarter.
    - Back window and rear compartment lid - approximately 30 degrees down, 30 degrees towards the front and aimed about 600 mm (24 inches) from the corner of the back window.
- If the specified water pressure of 155 kPa (22 psi) cannot be obtained because of a local situation, both test stands may be moved toward the body until the water spray overlap can be obtained (Figure 7).

LOCALIZED TESTING (SPOT TEST)

Localized testing may be made with either water or air. Begin the test at the base of the suspected area and continue up slowly until the leak is located.

Important

- Pinpoint the leak area before any repair is made. Random repair may only temporarily restrict water entry and make future diagnosis and repair more difficult.

Continue localized testing in the same general area to confirm that all leaks have been located.

WATER HOSE TEST

Figures 10 and 11

- Have a helper inside the car to detect the actual leak point.
- Use unrestricted water flow (no nozzle).
- Begin at the base of the suspected leak area and move upward slowly.

AIR HOSE TEST

Figures 12 and 13

1. Apply bubble solution (liquid soap) to the suspected area.
2. Apply air pressure with an air hose from inside the vehicle. Do not exceed 205 kPa (30 psi).
3. Observe for bubbles on the outside at the suspected leak area.

WATERLEAK REPAIR

To locate the exact leak point or to repair the leak, it may be necessary to remove some interior trim

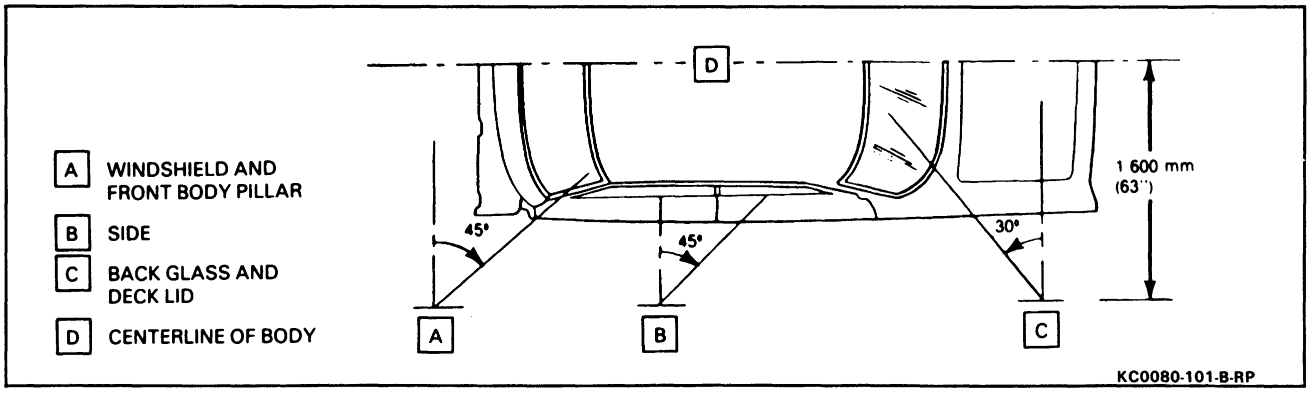


Figure 8 - Watertest Stand Specifications

panels or components. Waterleak repair is covered in the section covering the component. For example, for the repair procedure on stationary glass, refer to STATIONARY GLASS (SEC. 10-2).

After completion of any waterleak repair, the general area should be retested using the watertest stand. Do not use the air hose or water hose to test repaired areas as the repair material may dislodge under abnormal pressure.

Materials recommended for specific leak areas include:

- Urethane adhesive caulking kit (GM part number 9636067 or equivalent) for windshield, back glass and quarter glass repair.
- Brushable seam sealer which can be painted for metal joints.
- Bedding and glazing compound for ventilation ducts and drip moldings.
- Drip-check sealer for small cracks and pin holes.
- All around automobile body sealant (3M part number 8500 or equivalent) for large holes.
- Weatherstrip adhesive (3M part number 08011 or equivalent) for weatherstrips.
- Strip caulk for bolts, studs and screws.

WINDNOISE DIAGNOSIS AND REPAIR

Many of the waterleak diagnosis tests are also used for windnoise diagnosis.

1. Visual inspection.
   - Misaligned components
   - Loose fasteners
   - Torn weatherstrips
   - Broken weld joints
   - Sealer and/or adhesive skips
2. Tracing powder or chalk test.

Clean

- Weatherstrip and contact surfaces with solvent.

Apply powder or chalk in an unbroken line to the contact surface of weatherstrip around the perimeter of the trunk lid, door, door glass, hood, hatch gate or roof lift-off panels. Surrounding areas must be free of chalk or powder.

Close panel completely. Do not slam. This presses the weatherstrip firmly against the mating surfaces.

Inspect

- Applied line on the weatherstrip will be marred where contact is good. A corresponding imprint will be on the mating surfaces.
- Gaps or irregularities in the powder or chalk line indicate a poor seal.

3. Air pressure test.

Mask off both pressure relief valves. Turn on the vehicle's ventilation fan. Close all openings – windows, doors, etc. An abnormal amount of high pressure will build up in the vehicle and will escape through poor seals. With a stethoscope or length of heater hose, listen for escaping air along the door and window seals.

- A smoke or dusting powder test can be used in the same manner. The exact leak location can be seen as the smoke or powder travels through the bad seal.

4. Soap suds or bubble test.

Pressurize interior of vehicle. Apply soapy solution to potential leak areas outside the vehicle. Escaping air pinpoints leak area.

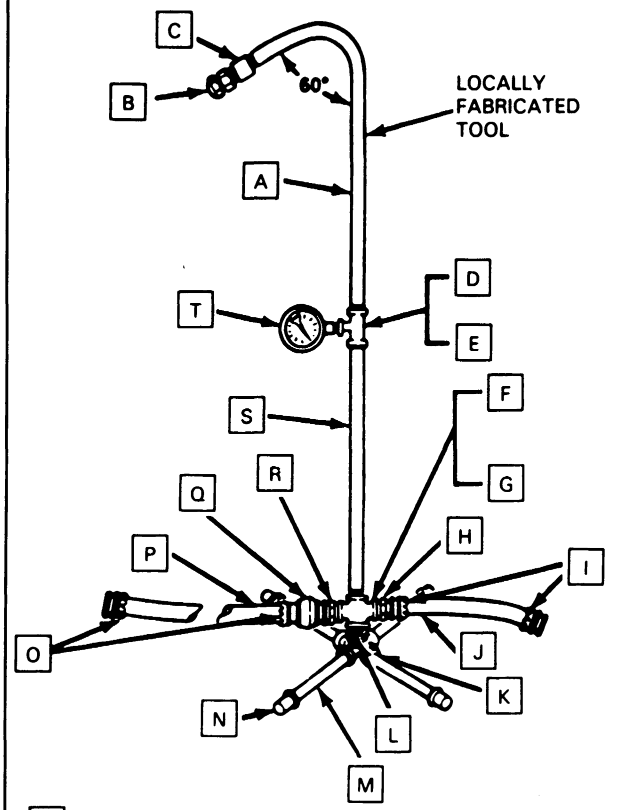
Air pressure from an air hose from inside the vehicle can be used instead of pressurizing the vehicle's interior. Do not exceed 205 kPa (30 psi) when using an airhose. (Figures 12 and 13).

5. External windnoise.

Road-test the vehicle to determine the source of noise.

- Wind roar is caused by outside air passing over an opening.
- Wind whistle is caused by inside air seeping through a bad seal or outside air passage over a protruding edge.
- Wind rush is outside air passing over the vehicle's body.

Tape various moldings and gaps until the noise is eliminated (Figure 14).



A	1/2" x 36" PIPE
B	FULL CONE SPRAY NOZZLE, NOZZLE HEIGHT - 1600 mm (63") FROM FLOOR.
C	1/2 " COUPLING
D	1/2" x 1/2" x 1/4" REDUCING TEE (RIGHT ONLY)
E	1/2" COUPLING (LEFT ONLY)
F	1/2" CROSS (RIGHT ONLY)
G	1/2" TEE (LEFT ONLY)
H	1/2" PIPE TO HOSE NIPPLE (RIGHT ONLY)
I	5/8" FEMALE HOSE COUPLING
J	2' INPUT HOSE (5/8" DIA.) RIGHT ONLY
K	1/2" CLOSE NIPPLE
L	1/2" CROSS WITH WELD-ON 1/2" CAP
M	1/2" x 12" NIPPLE
N	1/2" CAP
O	5/8" FEMALE HOSE COUPLING
P	12' CROSS HOSE (5/8" DIA.)
Q	HOSE QUICK CONNECT
R	1/2" PIPE TO HOSE NIPPLE
S	1/2" x 30" PIPE (STRAIGHT)
T	WATER PRESSURE GAGE (RIGHT SIDE)

KC0090-101-B-RP

Figure 9 - Watertest Stand Components

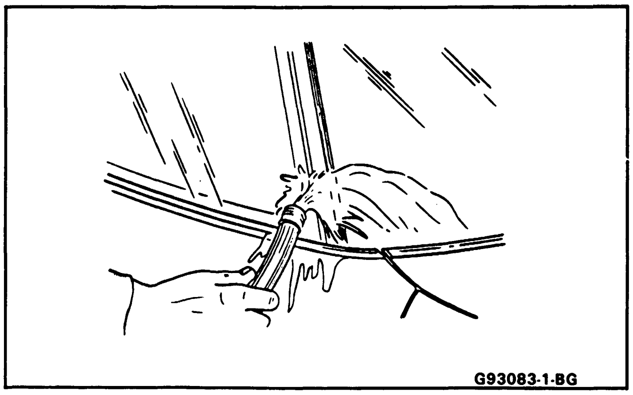


Figure 10 - Water Hose Test of Windshield Pillar

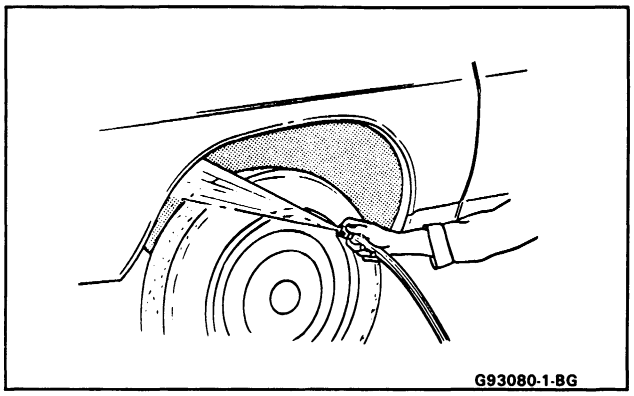


Figure 11 - Pressure Test of Wheelhouse

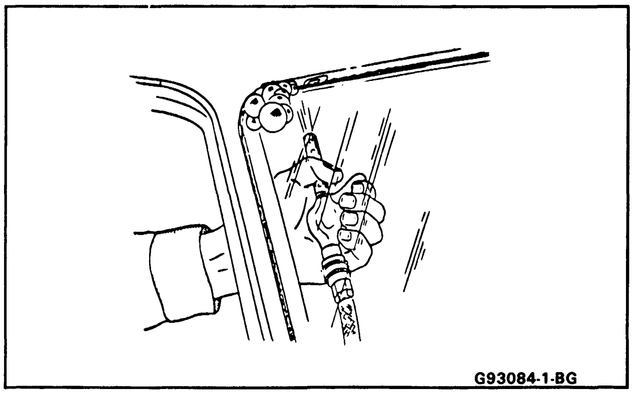


Figure 12 - Air Hose and Bubble Solution Test of Windshield Glass Sealant

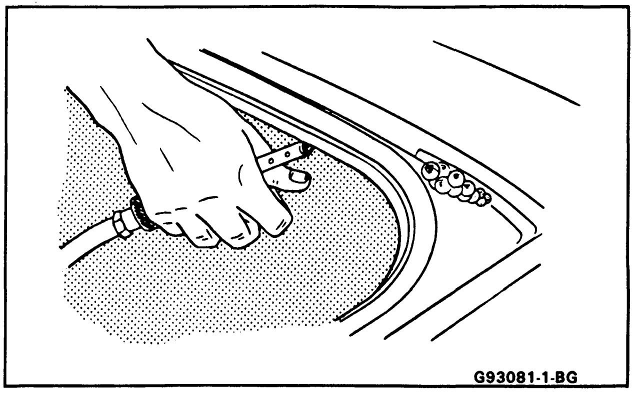


Figure 13 - Air Gun and Bubble Solution Test of Panel Joints

NOTICE: If masking the grille and headlamp bezel areas, care must be taken not to restrict airflow and cause vehicle overheating.

Windnoise leak repairs are very similar to waterleak repairs. The actual procedure depends on the type of seal being repaired.

Leaks around door opening weatherstrip do not always indicate a faulty weatherstrip. A door or door glass adjustment may resolve the condition. Refer to DOORS (SEC. 10-5).

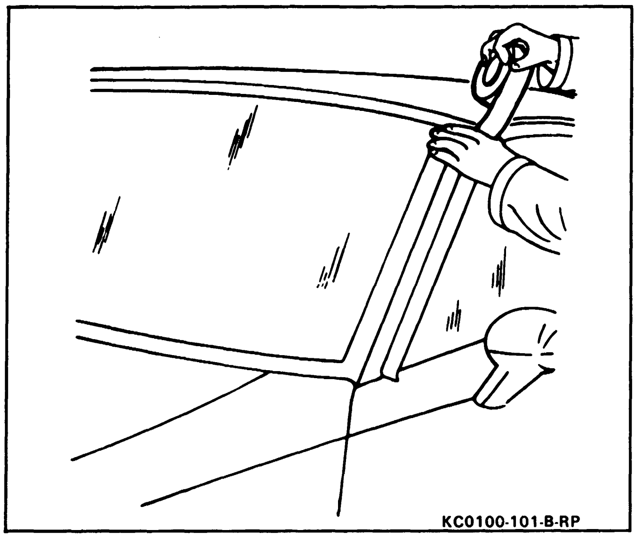


Figure 14 - Masking Tape Application to Identify Windnoise

ANTICORROSION TREATMENT

Anticorrosion materials are used on interior and exterior surfaces of metal panels providing rust resistance. These materials include metals such as one-sided and two-sided galvanized zincrometal and zinc-iron alloy steels. These treated metals are used on components such as fenders, doors, quarter panels, rocker panels, lids, floor pans, wheelhousings and other critical parts.

Metal conditioners and primers are used on interior and exterior surfaces along with protective waxes on interior surfaces in areas where moisture might accumulate. Sealers are applied along exposed joints and moisture-repelling asphaltic sound deadeners are applied inside the wheel wells, doors and on some underbody components. Figures 15 through 23 illustrate typical production and field usage of these materials.

Any procedure that disturbs these special treatments, such as panel replacement or collision damage repair operations, may leave the metal unprotected and result in corrosion. Proper recoating of these surfaces with service-type anticorrosion material is essential.

CORROSION REPAIR

Metal conditioners and primer coatings are applied to all metal panels at the time of vehicle manufacture. After repair and/or replacement parts are installed, all accessible bare metal surfaces must be treated with metal conditioner and reprimed using an

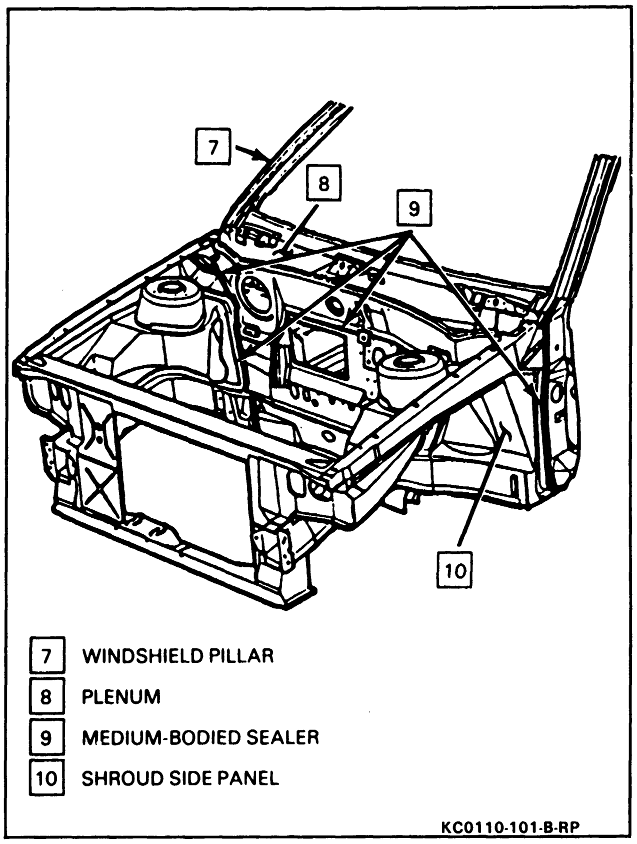


Figure 15 - Sealing Front End

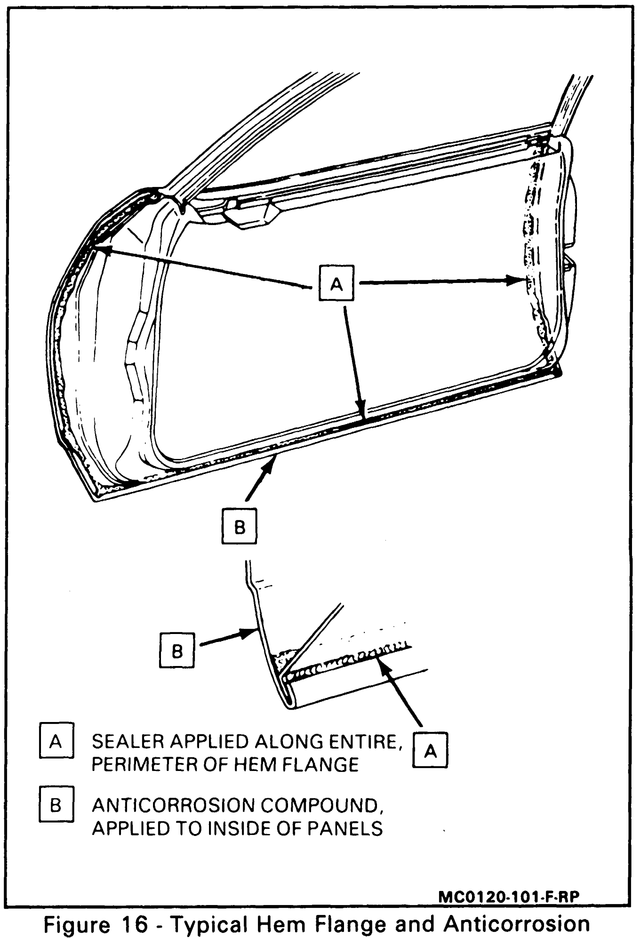


Figure 16 - Typical Hem Flange and Anticorrosion Treatment

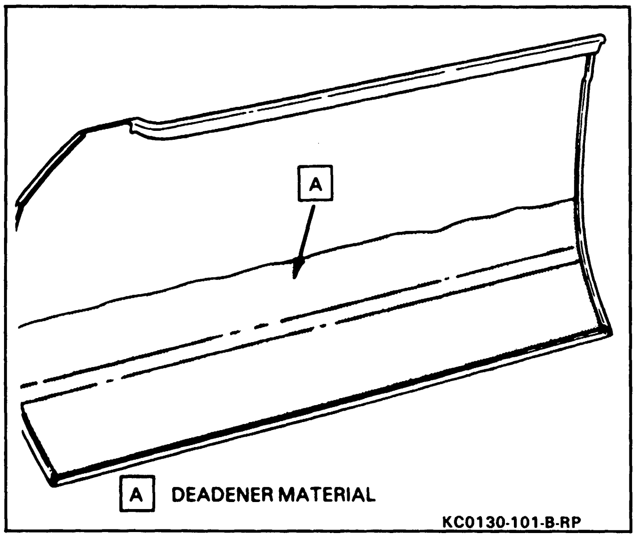


Figure 17 - Typical Application of Deadener Material to Inside of Door Outer Panel

acrylic chromate material. This operation is to be performed prior to the application of sealers, waxes, deadeners and antirust compounds.

Sealers are applied to specific joints during manufacture. These sealers are intended to prevent water and dust from entering the vehicle and are anticorrosion barriers. Sealers are applied to such areas as door and rear compartment lid hem flanges, wheelhouse, quarter outer panel, floor, cowl, roof and various other panel-to-panel attaching points. The originally sealed joints are obvious and any damage to these sealed locations should be corrected by resealing. Attaching points of new replacement panels should be resealed. Replacement lids and doors will also require sealing in the hem flange areas.

Flanged joints, overlap joints and seams should be sealed using a quality sealer of medium-bodied consistency. The sealer used must retain its flexible characteristics after curing and be paintable.

Open joints which require bridging of the sealer to close a gap should be sealed using a heavy-bodied caulking material. Follow the label directions for the material selected.

Color application may be required to restore repaired areas such as hood, fenders, doors, quarters, lid, roof, engine compartment, underbody and inner panels to original appearance. When this is necessary, conventional refinishing preparation, undercoat build-up and color application techniques should be followed.

CAUTION: When applying sound deadeners, due care and preventative measures must be exercised to prevent any materials from being sprayed into door and quarter panel mechanisms such as door locks, glass run channels, window regulators and safety belt retractors, as well as any moving or rotating mechanical or suspension parts on the underbody. After material application, be sure all body drain holes are open.

Deadener materials (spray-on type) are used on various metal panels to provide corrosion resistance and joint sealing. They control the general noise level inside the passenger area of the vehicle. When deadeners are disturbed because of damage, removed during repair operations, or a new replacement panel is installed, the deadener material must be replaced by a service equivalent material. The application pattern and location of deadener materials can be determined by observing the original production installation.

Anticorrosion compounds are light-bodied materials designed to penetrate between metal-to-metal surfaces, such as pinch-weld joints, hem flanges, and integral panel attaching points where metal surfaces are difficult to coat with conventional undercoating materials, and are inaccessible for painting. Material suited for this type application is GM part number 1052856 or equivalent.

Conventional undercoating is recommended to coat large areas such as replacement door and quarter outer panels, floor pan sections, lids, hoods, fenders, etc.

During undercoating operations, care should be taken to prevent the material from being sprayed into door and quarter panel hardware mechanisms such as door locks, glass run channels, window regulators and safety belt retractors. On the underbody, the material should **not** be applied to any moving or rotating part, energy absorbing bumper components or shock absorbers. After undercoating, make sure that all body drain holes are open.

The sequence of application steps for anticorrosion materials is as follows:

1. Clean and prepare metal.
2. Apply primer (acrylic chromate).
3. Apply sealers at all previously sealed joints.
4. Apply color in areas where color is required, such as hem flanges, exposed joints and underbody components.
5. Apply deadeners as indicated by original application pattern.
6. Apply anticorrosion compounds.
7. Apply underbody rustproofing material.

Cleaning of the interior and underbody panel surfaces is necessary when original galvanized or other anticorrosion materials have been burned off during welding or heating operations. Removal of the residue from burning will require additional care in such areas as interior surfaces of box-type construction and when configurations of the metal panels limit access to the interior surfaces. One or more of the following methods will remove the residue.

CAUTION: Approved safety glasses should be worn when performing this procedure to reduce the chance of personal injury.

- Where access is possible, scraping can be used. If a standard putty knife or scraper will not fit into the affected area, fabricate a small, flexible scraper from a narrow piece of sheet metal.
- A jet of compressed air will remove most residue and is effective in limited-access areas. Eye

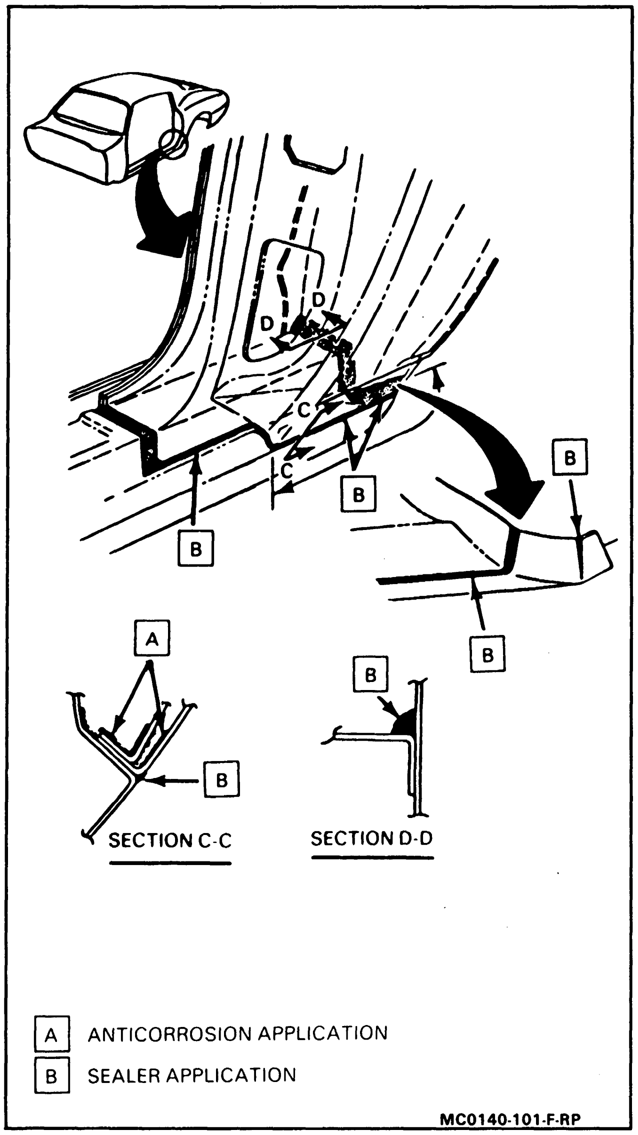


Figure 18 - Typical Sealer and Anticorrosion Compound Treatment

protection is absolutely necessary in an operation of this type.

- Sandblasting is effective and should be used when the equipment is available and access to the area is good. Sandblasting is an excellent method for cleanup and preparation of open joints, underbody components and hem flange areas.
- Wire brushing (power and by hand).
- When access is good, sandpaper and steel wool can be used.

PAINT CONDITIONS AND REPAIR

ANTI-CHIP COATING

An anti-chip coating is applied to specific lower areas of the body prior to the color coat application on some vehicles. The applied material can be detected through visual inspection. If the production-applied anti-chip coating requires replacement, a chip resistant air dry vinyl that is solvent borne and sprayable is available for field use.

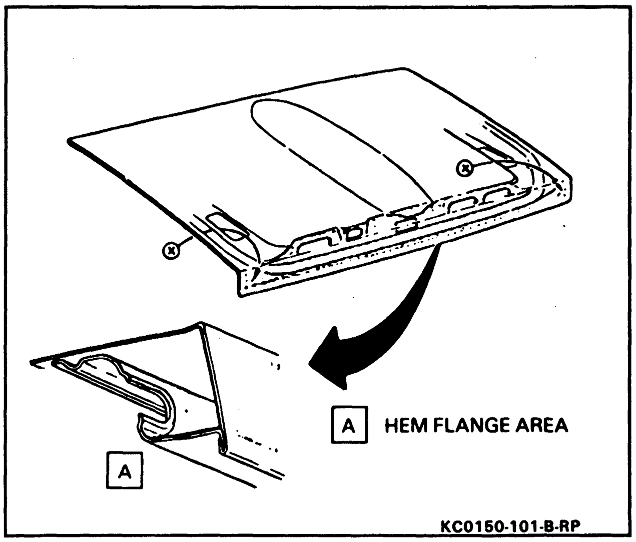


Figure 19 - Typical Anticorrosion Treatment Around Entire Perimeter of Rear Compartment Lid

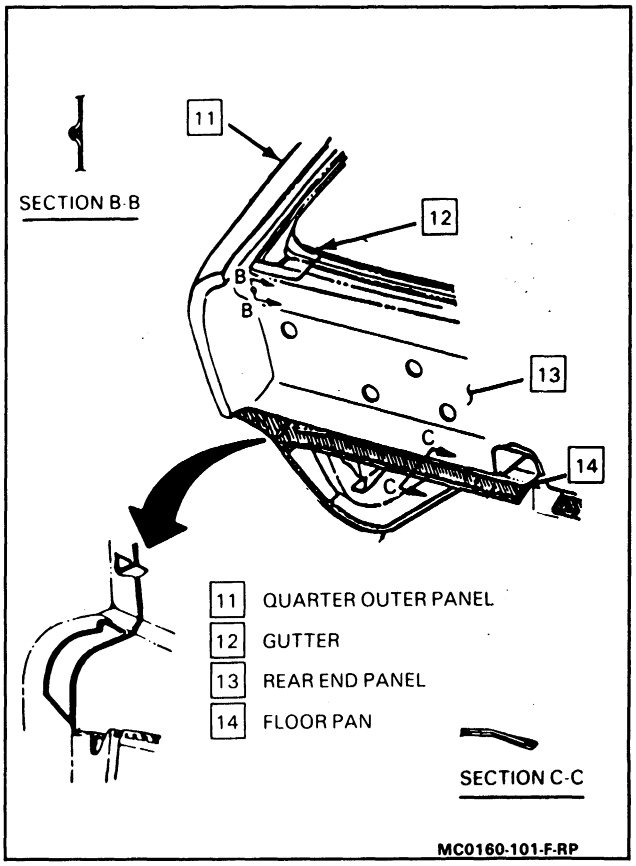


Figure 20 - Typical Joint Sealing, Rear End Area

Materials and equipment necessary for repair:

- Vinyl gravel guard.
- Sandpaper - number 80 grit.
- Portable heat lamp or heat gun.
- Extension cord.
- Clean shop towel.
- Conventional hand spray gun with pressure feed cup attached.
- Putty knife.

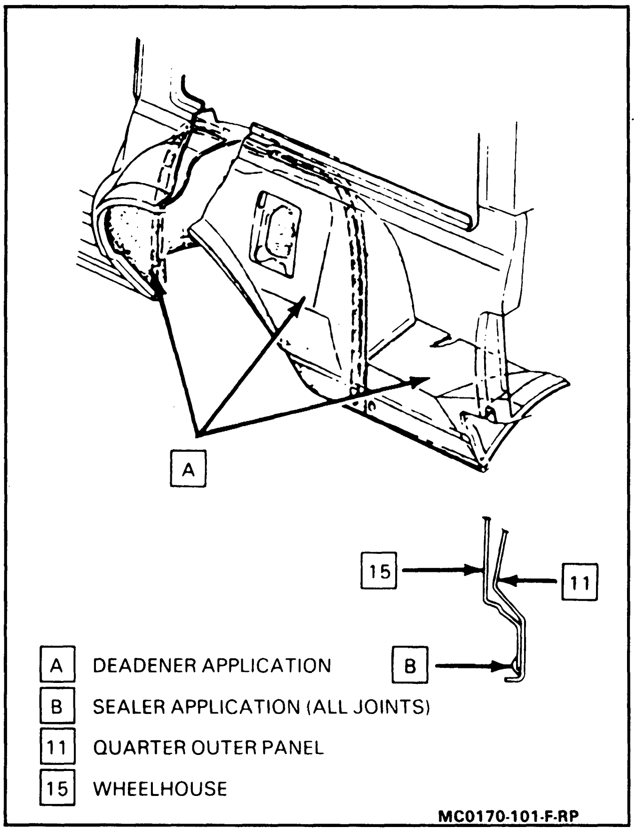


Figure 21 - Typical Deadener and Sealer Application, Wheelhouse and Floor Pan Extension Areas

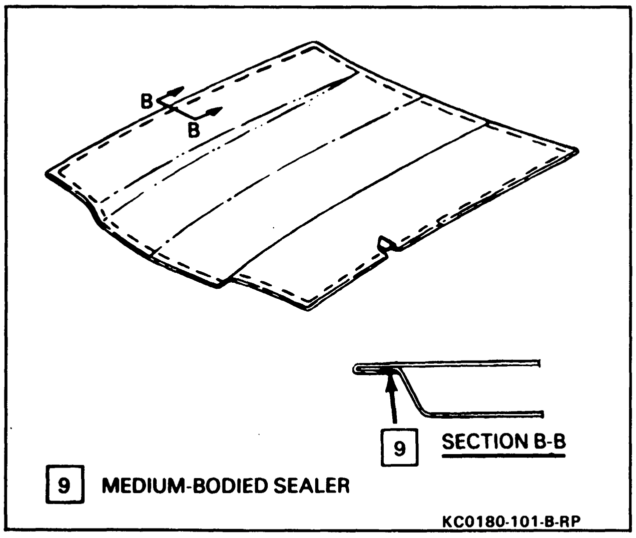


Figure 22 - Typical Anticorrosion Treatment Around Perimeter of Hood Outer-to-Inner Panel Flanges

FLEXIBLE EXTERIOR PLASTIC PARTS REPAIR (EXCEPT E/P AND TPO)

Figures 24 through 37

Soft plastic parts used for exterior or cosmetic application are compounded of resins that have flexible characteristics to absorb minor impact without sustaining damage. Typical examples include bumpers and front end fascia or side panels such as fenders. These parts are generally fabricated of thermosetting plastics, which when cured cannot be melted with the application of heat such as through hot air welding.

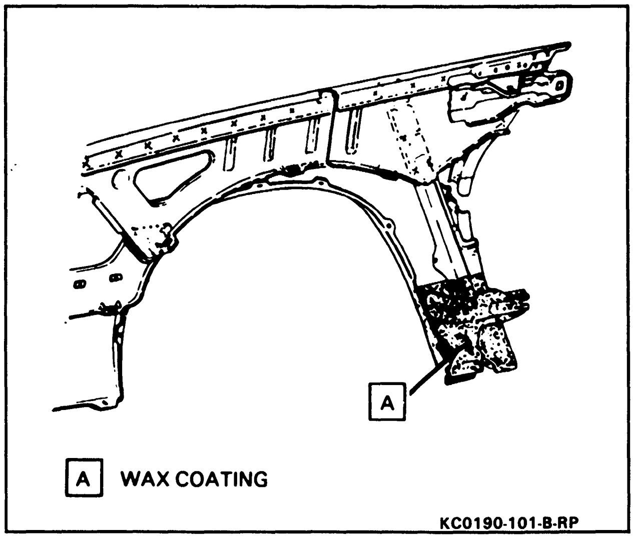


Figure 23 - Typical Fender Anticorrosion Compound Application

However, if the impact force is great enough to create damage, thermoset plastics can be successfully repaired with structural adhesives.

Briefly, the repair system amounts to a filling and, where necessary, a reinforcing operation. After curing, the patch is dressed to conform to the surrounding contour.

Following are typical damage conditions and respective repair procedures:

Gouge or Puncture Repair

1. Clean the repair area with a wax, grease and silicone-removing solvent applied with a water-dampened cloth. Wipe dry.
2. With a random orbit sander fitted with a number 180 grit disc, remove the paint film in and surrounding the area to be filled. The repair material should **not** overlap the painted surface (Figure 24).

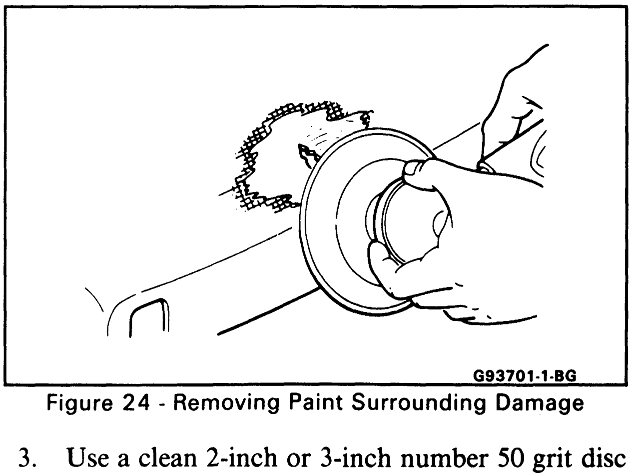


Figure 24 - Removing Paint Surrounding Damage

3. Use a clean 2-inch or 3-inch number 50 grit disc to enlarge the gouge or puncture in order to ensure removal of grease, oil or dirt from the area to be contacted by the repair material. This action should also create at least a 25 mm (1 inch) taper around the damage for extended contact between the repair material and substrate. Remove all

dust and loose particles from the repair area (Figure 25).

- An aluminum autobody repair tape can be used on the backside of a puncture to support the repair material (Figure 26).

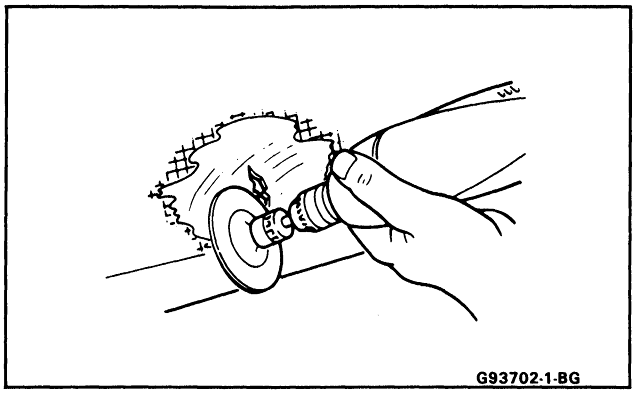


Figure 25 - Tapering Substrate Surrounding Damage

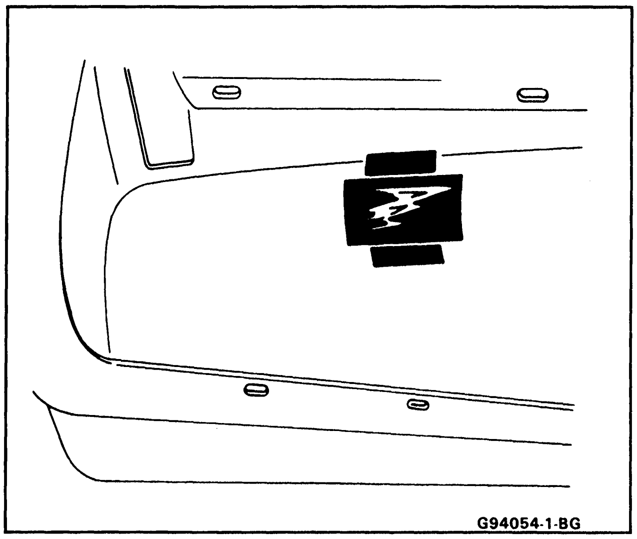


Figure 26 - Tape Support for Repair Material

4. On a clean, flat surface of nonporous material such as metal, glass or plastic, deposit equal length beads of each component of two-component flexible parts repair material (3M part number 05900 or equivalent). With a paddling motion, mix the two components until a uniform color and consistency is achieved (Figure 27).
5. Apply the mixed repair material with a squeegee or plastic spreader. Apply a light coat over the entire area. Continue applying to a level slightly above the surrounding contour. Allow the mixture to cure 20 to 30 minutes at 16°C to 27°C (60°F to 80°F). If low areas or pits remain, mix and spread additional repair material (Figure 28).
6. Establish the rough contour with a curved tooth body file. Follow by block sanding using number 220 sandpaper to establish accurate level and contour with the surrounding surface (Figures 29 and 30).
7. Fill sand scratches and pinholes with flexible parts putty (3M part number 05903 or equivalent). Allow to dry at least 15 minutes.

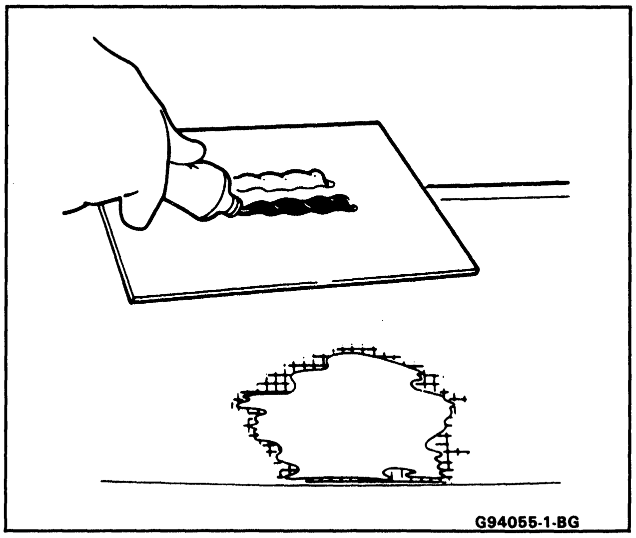


Figure 27 - Measuring Two-Component Repair Material

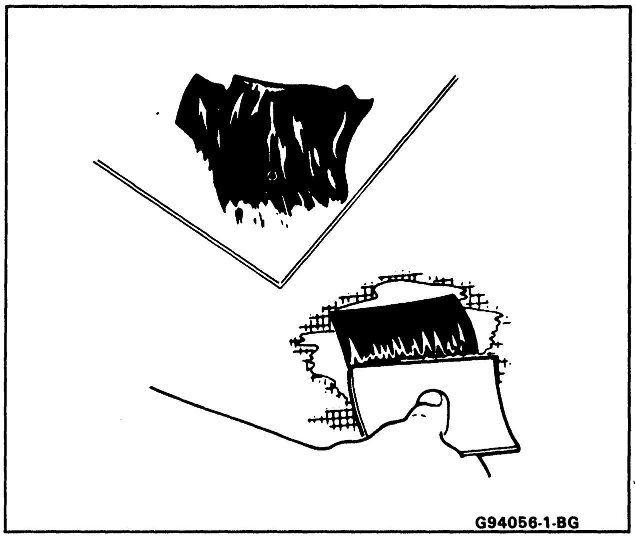


Figure 28 - Applying Mixed Repair Material

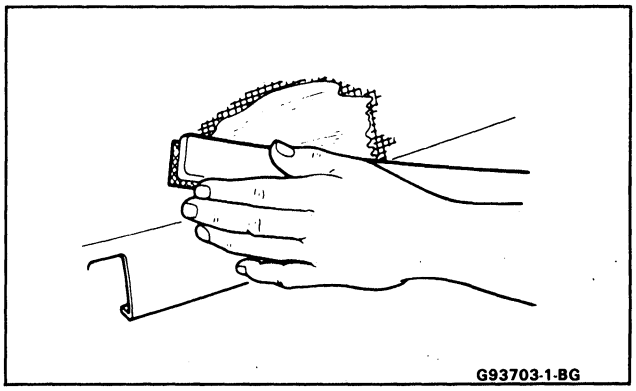


Figure 29 - Establishing Rough Contour with Body File

8. Finish sanding with number 320 sandpaper.

Structural Type Repair

When a piece of attaching surface of a part is cracked or broken away (Figure 31), structural strength may be restored as follows:

1. Align and secure the piece on the face side with body tape and clamp (Figure 32).

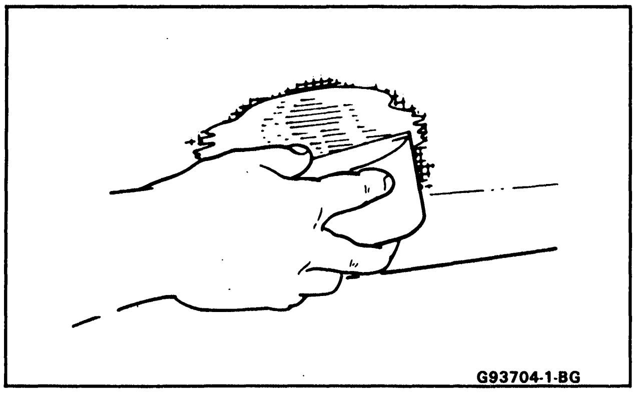


Figure 30 - Block Sanding for Accurate Contour

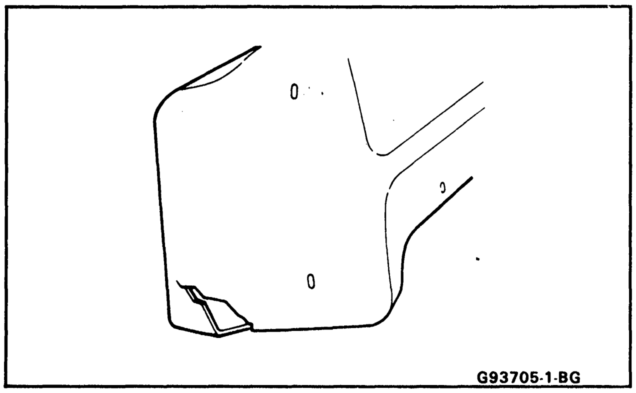


Figure 31 - Damaged Attaching Surface

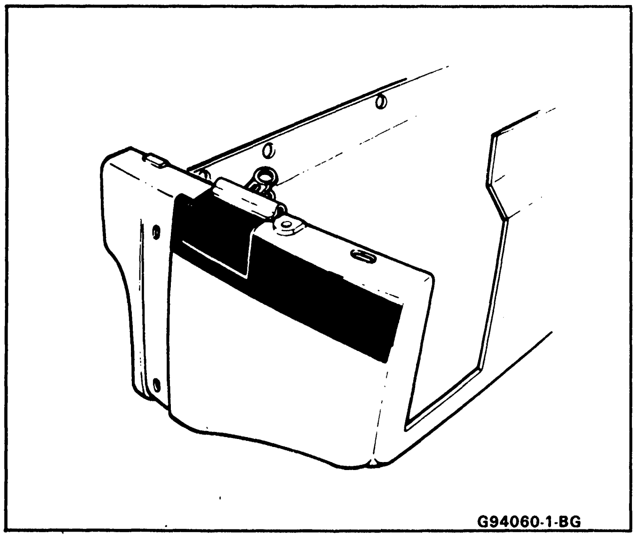


Figure 32 - Aligning Damage with Tape and Clamp

2. Clean the underside of the repair area with a wax, grease and silicone removing solvent applied with a water-dampened cloth. Wipe dry. Sand each side of the break with a number 50 grit disc (Figure 33).
3. Cut a piece of fiberglass cloth large enough to overlap the break by at least 38 mm (1-1/2 inches) (Figure 34).
4. On a clean, flat surface of nonporous material such as metal, glass or plastic, deposit equal length beads of each component of two-component flexible parts repair material (3M part number 05900 or equivalent). With a paddling motion, mix the two components until a uniform color and consistency is achieved (Figure 27). Apply a layer of the mixture approximately 3 mm (1/8 inch) thick on the backside of the part overlapping the break at least 38 mm (1-1/2 inches) (Figure 35).

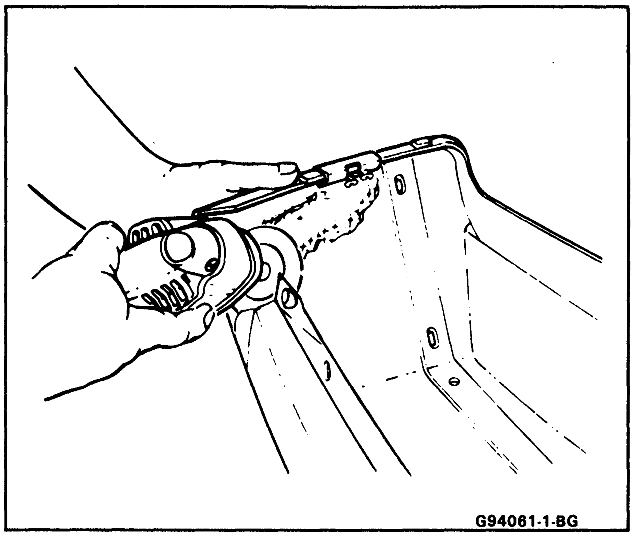


Figure 33 - Discing Backside of Damage

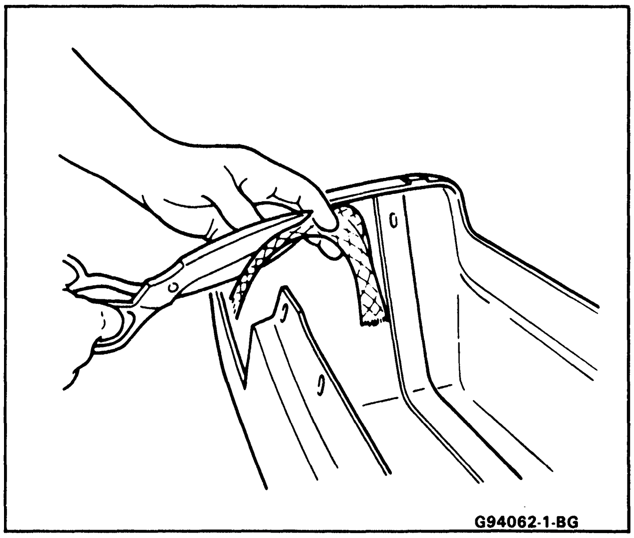


Figure 34 - Cutting Fiberglass Cloth to Size

5. Apply the precut fiberglass cloth to the adhesive and immediately cover the cloth with additional adhesive in sufficient quantity to fill the weave (Figures 36 and 37).
6. Allow 20 to 30 minutes cure time at 16°C to 27°C (60°F to 80°F). Trim excess repair material at the edge if necessary.
7. Repair the face side of the area following the procedure in "Gouge or Puncture Repair."

Paint Repair

The original factory applied paint finish on flexible exterior plastic parts is in most cases baked elastomeric enamel. For repair, either a lacquer or enamel system may be used; but **both** primer, when required, and color coats **must** have elastomeric or flexible properties.

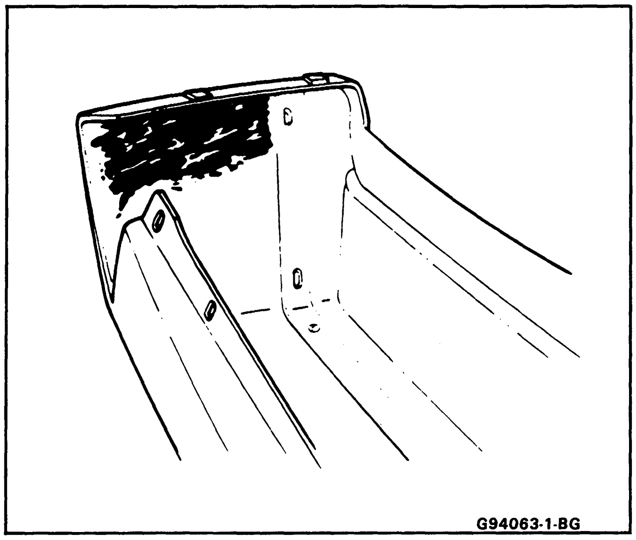


Figure 35 - Applying Repair Material - Backside of Damage

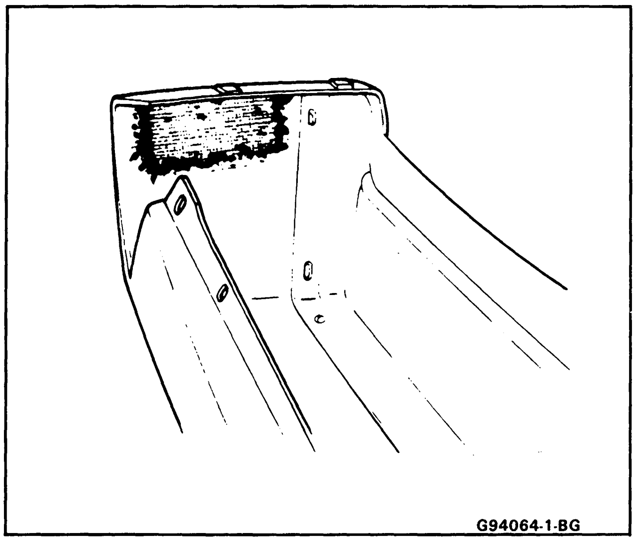


Figure 36 - Applying Fiberglass Cloth to Repair Material

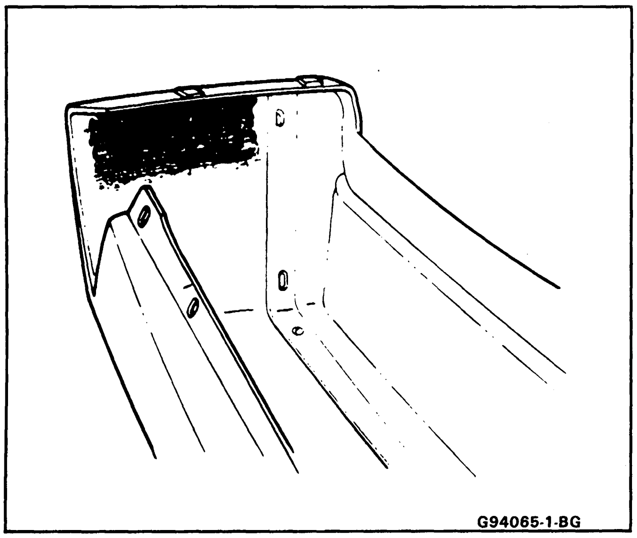


Figure 37 - Filling Fiberglass Cloth

There is a wide choice of flexible paint systems available for service use. Many require additives containing isocyanates. Be certain to follow all recommendations and warnings listed on the container labels for materials selected.

CAUTION: If the paint system selected specifies an additive containing isocyanates, it is mandatory that adequate respiratory protection be worn. An example of such protection is an air line respirator with a full hood or half mask. If not available, use a vapor/particulate respirator that the respirator supplier recommends as effective for isocyanate vapors and mists (unless local regulations prevail).

Color coat the entire component. Spot repair is not recommended.

1. Clean the entire part with a wax, grease and silicone-removing solvent applied with a water-dampened cloth. Wipe dry. (For color coat only operations, omit steps 2 and 3.)
2. Apply a double wet coat of flexible parts coating (3M part number 05905, or equivalent). Allow to flash 10 minutes, then apply a second coat. Allow to dry 45 minutes.
3. Featheredge the repair with number 320 sandpaper, blow off dust and tack.
4. Mix and apply four medium coats of flexible primer surfacer. Follow manufacturer's directions and cautions. Allow each coat to flash.

   Allow to dry at least one hour and block sand with number 400 sandpaper.
5. **Thoroughly** sand the entire part with number 400 sandpaper to remove **all** gloss. Clean entire part with solvent applied with a water-dampened cloth.
6. Mix a flexible topcoat system. Follow manufacturer's directions and cautions.
7. Apply a sufficient number of coats to achieve complete hiding and color match. The topcoat mixture will dry to the touch in about one hour.

ETHYLENE/PROPYLENE (E/P) AND THERMO PLASTIC OLEFIN (TPO) REPAIR

1. Clean the repair area with wax, grease and silicone removing solvent. Wipe dry.
2. Use a 2-inch or 3-inch number 50 grit disc to enlarge the damaged area.
3. With a random orbit sander fitted with a number 180 grit disc, sand the damaged area and remove the paint film from the surrounding area to be filled.
4. Prime the entire area with a polyolefin adhesion promoter (3M part number 05907 or equivalent) before filling with a flexible parts repair material (3M part number 05900 or equivalent).
5. Shape repair material with a curved body tooth file. Then block sand with number 220 grit disc and final featheredge with number 320 grit disc.

6. If low areas or pits remain, reapply polyolefin adhesion promoter. Mix and spread additional repair material.

Painting Flexible Parts - E/P and TPO

When painting flexible plastic exterior parts identified as E/P and TPO, a polypropylene primer **must be used.** Follow manufacturer's label instructions.

METAL REPLACEMENT PARTS FINISHING

Metal service replacement parts or assemblies are painted with a high-bake factory primer. For proper adhesion of color coats in service, the following refinishing steps are necessary.

1. Clean part with a wax and grease-removing solvent.
2. Scuff-sand panel lightly with wet or dry number 400 sandpaper and water. Avoid cut-throughs. Reclean part. Apply sealer to entire part.
3. If factory primer coat was cut through, apply metal conditioner to the exposed bare metal. Follow label directions.
4. Apply primer-surfacer to the entire part. Allow to dry thoroughly before sanding. Follow label directions for drying time.
5. Sand primer-surfacer using wet or dry number 400 sandpaper and water. Do not sand sealer.
6. Reclean part.
7. Apply color coats to parts.
8. Follow label directions for drying time before compounding.
9. Compound part by hand or with power equipment.
10. Nonsealing polish may be applied after rubout if desired. Waxes, however, should **not** be applied until the paint finish has aged at least two months.

Prior to replacing exterior body parts or assemblies, check the condition of paint on all covered or hidden interior surfaces. If rust scale is found in these areas, proceed as follows:

1. Remove rust with wire brush, abrasive or liquid rust removing agent. Follow label directions.
2. If necessary, wash with detergent, rinse and dry.
3. Apply a heavy coating of anticorrosion compound to all cleaned hidden surfaces before installing exterior body parts. Apply anticorrosion compound to all inner surfaces of exterior body parts being installed.

INTERIOR PLASTIC TRIM PARTS FINISHING

Paintable plastic interior trim components can be divided into three general types:

- Polypropylene Plastic
- Acrylonnitrile-Butadiene-Styrene (ABS) Plastic
- Vinyl Plastic

It is important for a painter to be able to identify each plastic in order to paint it satisfactorily. Painting of complete soft seat cushion and seatback trim cover assemblies of vinyl construction is not approved by the factory. Excluding the soft seat cushion and seatback trim cover assemblies, the plastic used most widely on the interior of bodies is polypropylene.

Painting Polypropylene Plastic Parts

The system for painting polypropylene parts involves the use of a special primer. Since polypropylene plastic is hard, it can be color coated after prime with conventional interior acrylic lacquer.

NOTICE: The service part must be primed with a coating of special polypropylene primer (part number 1052364) according to factory recommendations. The primer acts as a bonding agent between the plastic and acrylic lacquer. Failure to use the required primer as directed will result in color coat lifting and/or peeling problems.

1. Wash the part with a cleaning solvent that will not leave any greasy film. Follow label directions.
2. Apply a thin, wet coat of polypropylene primer according to label directions. Wetness of primer is determined by observing the gloss reflection of the spray application in adequate lighting. Be sure the primer application includes all edges. Allow the primer to flash dry one minute minimum and ten minutes maximum.
3. During the above flash time period (1 to 10 minutes), apply conventional interior acrylic lacquer color as required and allow to dry before installing part. Application of color during above flash time range promotes best adhesion of color coats.

Painting Rigid or Hard ABS Plastic Parts

Rigid or hard ABS plastic requires no primer. Conventional interior acrylic lacquers adhere satisfactorily to hard ABS plastics.

1. Wash part with a cleaning solvent to remove any dirt or grease.
2. Apply conventional interior acrylic lacquer color according to trim combination. See paint supplier color chart for trim and color code. Apply only enough color for proper hiding to avoid washout of the grain effect.
3. Allow to dry following label directions and then install part.

Painting Vinyl and Flexible (Soft) ABS Plastic Parts

The outer cover material of flexible instrument panel cover assemblies and many padded door trim assemblies are made of ABS plastic blended with PVC or vinyl. The soft cushion padding under ABS covers is urethane foam plastic.

The most widely used flexible vinyls (polyvinyl chloride) are coated fabrics as used in seat trim, some door trim assemblies, headlinings and sunshades. Most head restraints are covered with flexible vinyls. Examples of hard vinyls are door and front seatback assist handles, coat hooks and exterior molding inserts.

The paint system for vinyl and flexible ABS plastic involves the use of interior vinyl color and a clear vinyl top coat. No primer or primer-sealer is required.

1. Wash part with a vinyl cleaning and preparation solvent, to remove greasy film or silicone. Wipe off the cleaner while still wet with a clean, lint-free cloth.
2. As soon as the surface has been wiped dry, apply interior vinyl color in wet coats. Allow flash time between coats. Follow label directions. Use proper vinyl color as shown by interior trim code combination. Apply only enough color for proper hiding to avoid washout of the grain effect.
3. Before color flashes completely, apply two coats of clear vinyl top coat. Do not allow the first coat to dry before spraying on the second. Use top coat with appropriate gloss level to match adjacent similar components. The clear coat is necessary to control the gloss requirement and to prevent crocking (rubbing-off) of the color coat after drying.
4. Allow to dry according to label directions before installing part.

Availability of Colors for Painting Interior Plastic Parts

Interior colors are color keyed to trim code combination numbers located on the service parts identification label.

Conventional interior acrylic lacquer colors are designed for use only on hard trim parts, such as:

- Steel parts (primer and/or sealer required on new service parts).
- Hard ABS plastic (no primer necessary).
- Hard polypropylene plastic (special primer required).

Each major paint supplier provides an interior color chart which identifies the stock number, color name, gloss factor and trim code combination number for each conventional interior color.

Vinyl interior colors are designed for soft trim parts such as instrument panel cover assemblies, door trim assemblies and head restraints. These colors require a final top coat of clear vinyl. Instrument panel covers require a nonglare final top coat. Other trim parts require a degree of gloss to match similar adjacent parts. Use interior vinyl colors and clear vinyl finishes.

SECTION 10-2

STATIONARY GLASS

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 10-2-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

WINDSHIELD VINYL REVEAL MOLDING

VINYL REVEAL MOLDING REPLACEMENT

Figure 1

The reveal molding (1) is a vinyl trim that fills the cavity between the body and glass edge. The reveal molding (1) is hand pressed into place and is retained by urethane adhesive.

←→ Remove or Disconnect

- Carefully pry the end of the reveal molding (1) out about 75 mm (3 inches), using a screwdriver.
- Grasp with pliers and slowly pull the reveal molding (1) away from the body.

Inspect

- Reveal molding (1).
  - If the original reveal molding (1) cannot be reused (due to damage, cut short, etc.), discard it and replace it with a new service molding. Be sure to prefit the service molding by locating it on the body prior to actual installation.

→← Install or Connect

- To reuse the original reveal molding (1), trim off the last barb and prefit it in the cavity (Figure 1).

1. Clear primer from urethane kit (GM part number 9636067 or equivalent) to the lower surface of the reveal molding (1).
2. Urethane in the cavity between the body and the windshield.

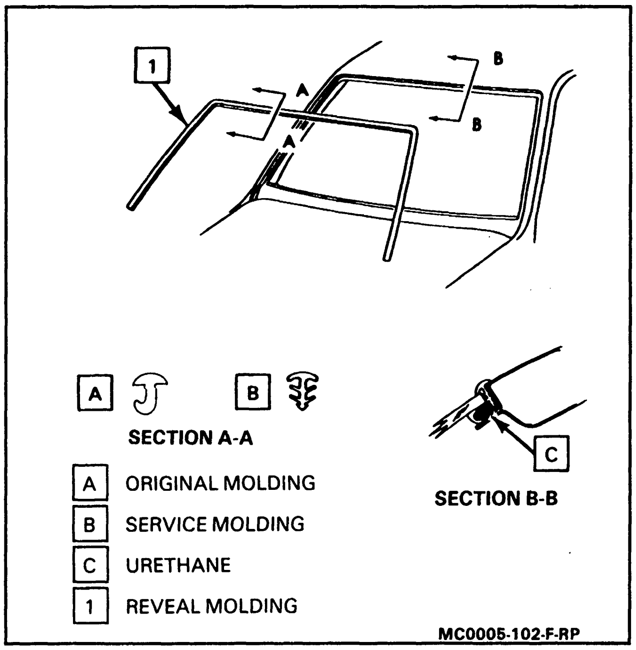


Figure 1 - Reveal Molding Installation

3. Reveal molding (1).
   - Start from the center and hand press the reveal molding (1) into place.
   - Tape can be applied to keep reveal molding (1) flush with the body.
   - Flood the reveal molding (1) with warm water to speed the setup of the adhesive.

STATIONARY GLASS

The windshield is installed from outside the body using self-curing urethane. To replace a window

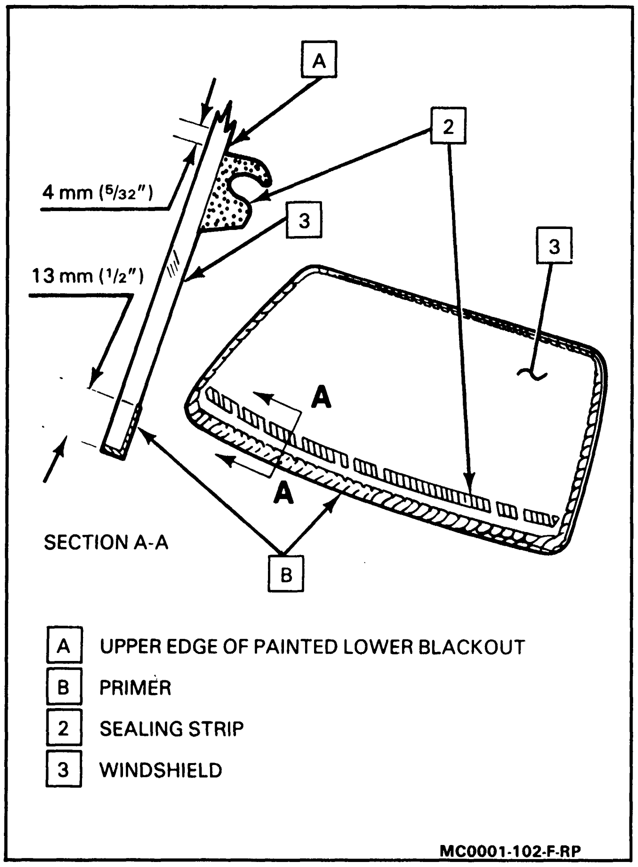


Figure 2 - Location of Sealing Strip and Primer

installed with urethane adhesive requires either partial or complete replacement of the adhesive. Partial replacement of material is known as the short method. Complete replacement of the material is known as the extended method.

Use short method where original adhesive left on the window opening pinch-weld flanges after glass removal can serve as a base for the new glass. Use this method with cracked or intact windshield removal. The amount of adhesive left in the window opening can be controlled during glass removal.

Use the extended method when the original adhesive left in the window opening after glass removal cannot serve as a base for the new glass. Use this method when metal work or paint repair in the opening is necessary. In these cases, the original material is removed and replaced with new material during window installation.

WINDSHIELD REMOVAL

The window removal method is the same for both the short and extended installation methods with one exception. Use more care with the short method during cutout to make certain that an even bead of adhesive remains on the window opening to serve as a base for the new glass.

CAUTION: Approved safety glasses and gloves should be worn when performing this procedure to reduce the chance of personal injury.

Remove or Disconnect

Tool Required:

J 24402-A Glass Sealant Remover Knife

- Place protective coverings around the area where glass is being removed.

1. Rearview mirror. Refer to "Rearview Mirror" in this section.
2. Windshield wiper arm assemblies and windshield wiper arm stop. Refer to WINDSHIELD WIPER-WASHER SYSTEM (SEC. 8E).
3. Shroud top vent grille. Refer to BODY FRONT END (SEC. 10-4).
4. Reveal molding. Refer to "Vinyl Reveal Molding Replacement" in this section.

- Using a commercial razor knife, make a preliminary cut into the urethane adhesive around the outside edge of the glass, staying as close to the edge of the glass as possible.
- Mask the area around window opening to protect painted surfaces and to aid in cleanup after installation.
  - Tape must not be on glass sealant surface.
- Cut out windshield using J 24402-A.
  - Keep the blade as close to the edge of the glass as possible.

5. Windshield.

Clean

- Glass opening of any loose material. If the glass is to be reinstalled, all urethane must be removed from the glass. Use an alcohol-dampened cloth.

GLASS INSTALLATION

Short Method

Figures 1 through 4

Install or Connect

CAUTION: Approved safety glasses and gloves should be worn when performing this procedure to reduce the chance of personal injury.

1. Lower right glass support.
2. Windshield (3) in the opening.
3. A piece of masking tape over each edge of the windshield (3) and adjacent body pillars.
   - Slit tape vertically at the edge of the glass. During installation, the tape on the windshield (3) can be aligned with the tape on the body to guide the windshield (3) into the desired position.

- Remove windshield (3).

Clean

- Surface of windshield (3) to which adhesive will be applied (around edge of inside surface) by wiping with a clean, alcohol dampened cloth.

- Allow to air dry.

4. Sealing strip (2) if replacing windshield (3).
   - Remove paper backing from rubber sealing strip (2) service part and position adjacent to painted lower blackout line.

CAUTION: When replacing the windshield, urethane adhesive GM part number 9636067 or equivalent must be used to maintain original installation integrity. Failure to use urethane adhesive will result in poor retention of the windshield, which may allow unrestrained occupants to be thrown from the vehicle resulting in personal injury.

5. Primer from urethane adhesive kit, GM part number 9636067 or equivalent, around the entire perimeter of the glass edge and 6 mm (1/4 inch) inboard on the inner surface. Allow the primer to dry five minutes.
   - Two primers are provided in urethane adhesive kit.
     - The clear primer is used on the glass prior to the black primer.
6. Urethane adhesive from kit.
   - With a household cartridge-type caulking gun and nozzle, apply a smooth continuous bead of urethane adhesive, 3 to 5 mm (1/8 to 3/16-inch) wide, around the edge of the glass where primed in the previous step.
   - The caulk tip cut for the short method should be used (Figure 3).

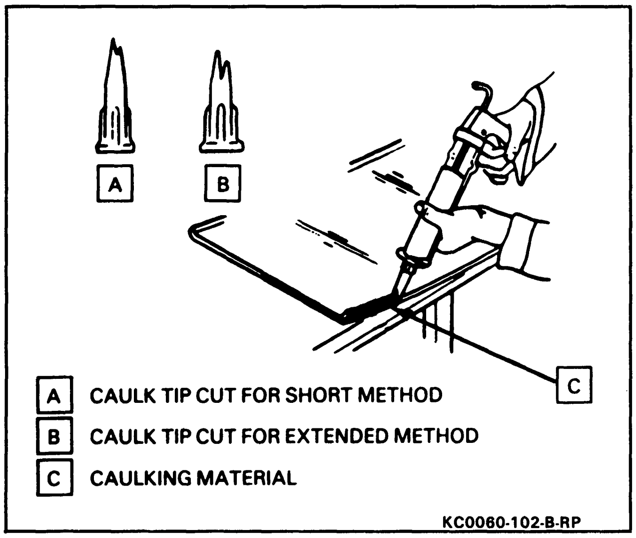


Figure 3 - Applying Urethane Adhesive Material

7. Windshield (3) into the window opening, with the aid of a helper.
   - The windshield (3) can be positioned without the aid of carrying devices. Carry the windshield (3) with one hand on the inside of the glass and one hand on the outside (Figure 4). Guide the windshield (3) along the rear edge of the front fender (10) to avoid smearing fresh adhesive on the instrument panel. At the window opening, put the windshield (3) in a horizontal position. While one person holds the windshield (3) in this position, the second person can reach one arm around the body pillar and support it while the other person assumes the same position.
8. Windshield (3) on the lower supports.
   - Center in the opening.
   - Use tape guides previously applied to place the windshield (3) in the proper position.

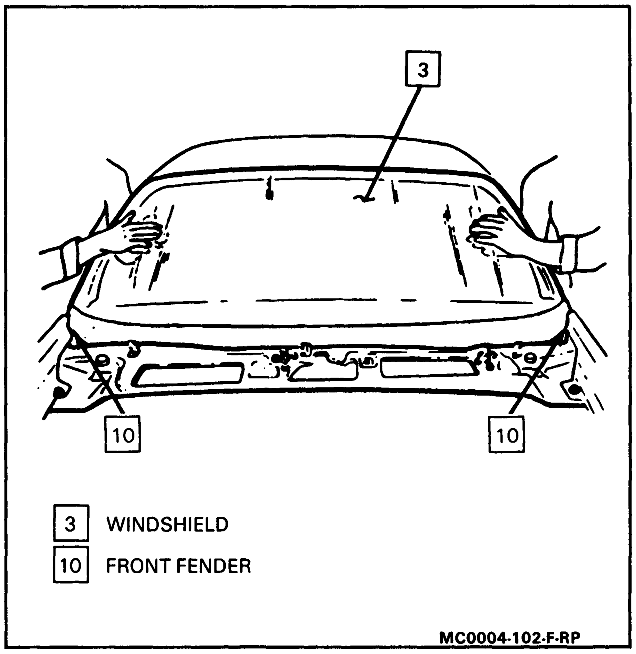


Figure 4 - Installing Windshield

   - The windshield (3) must be located properly within the window opening so that enough space is left between the windshield (3) and body opening to install the one-piece vinyl reveal molding.
- Press the glass firmly to wet-out and set adhesive. Use care to avoid excessive squeezeout that would cause an appearance problem.
- Using small disposable brush or flat, soft fiberglass tool, paddle material around the edge of the glass to ensure a watertight seal.
  - If necessary, paddle additional material to fill the voids in the seal.
- Watertest vehicle at once using soft spray.
  - Use warm or hot water if available.
  - Do not direct hard stream of water at fresh adhesive material.
  - Water applied on top of urethane adhesive, either during watertest or as a separate operation, will speed up the cure of the urethane.

Inspect

- For leaks. Paddle in extra adhesive at leak point, using a small disposable brush or flat, soft fiberglass tool.

9. Windshield reveal molding (1).

10. Shroud top vent grille. Refer to BODY FRONT END (SEC. 10-4).
11. Windshield wipers and blades. Refer to WINDSHIELD WIPER-WASHER SYSTEM (SEC. 8E).

NOTICE: See "Notice" on page 10-2-1 of this section.

12. Rearview mirror. Refer to "Rearview Mirror" in this section.

- On windshield installations, the vehicle must remain at normal room temperature for six hours to complete the proper cure of adhesive.

Extended Method

Figures 1 through 5

Use the extended installation method if prior service installation was made with butyl tape or if urethane material remaining in the window opening after window removal is damaged or must be removed to permit refinishing of window opening.

Spacers (4) are used to maintain correct windshield to pinch-weld flange dimensions. The spacers (4) are specific to certain styles and can be found in the service parts manual. Spacers (4) should be reused or replaced before installing the windshield (3).

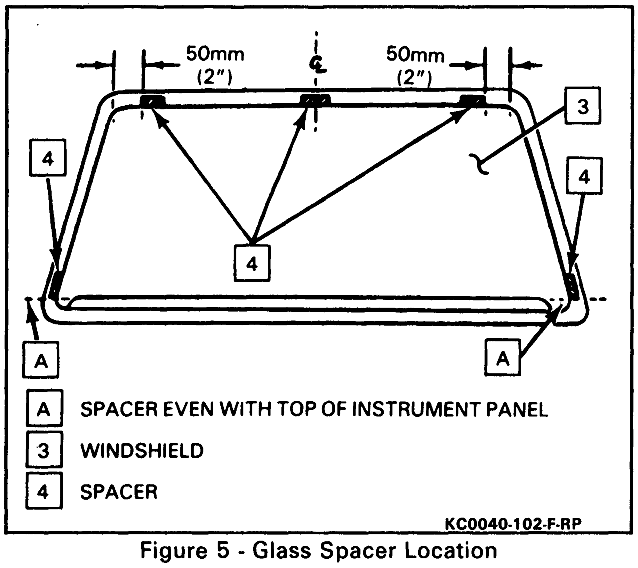


Figure 5 - Glass Spacer Location

Clean

- Window opening.
  - Using a sharp scraper or chisel, remove the old adhesive material from window opening.
  - On butyl tape installations or installations of unknown material, it will be necessary to remove all traces of the material.
  - On urethane installations, all traces of material need not be removed, but there should not be any mounds or loose pieces left.
- If refinishing or painting operations are required, or painted surface is exposed during removal of material, apply black primer from urethane adhesive kit, GM part number 9636067 or equivalent, to the exposed area.

Install or Connect

CAUTION: Approved safety glasses and gloves should be worn when performing this procedure to reduce the chance of personal injury.

1. Lower right glass support in its original position.
2. Windshield (3) in the opening for fit.
   - Carrying devices are not needed.
   - Guide the windshield (3) along the rear edge of the front fender (10).
   - Place window in vertical position and support it on lower glass supports. While one person holds the glass in position, the second person can reach one arm around the body pillar and support the glass while the other person assumes the same position.
   - With glass positioned in opening, check relationship of glass to pinch-weld flange around entire perimeter. The opening between glass and pinch-weld flange should be equal for installation of the vinyl reveal molding. The opening at the top of the windshield may be corrected by repositioning the lower glass supports.
3. A piece of masking tape over each edge of the windshield (3) and adjacent body pillars.
   - Slit tape vertically at the edge of the glass.
   - During installation, the tape on the windshield (3) can be aligned with the tape on the body to guide the windshield (3) into the desired position.
   - Remove the windshield (3) from the opening.
   - For the extended method, the caulk tip should be cut (Figure 3).

Clean

- Surface of glass to which bead of adhesive material will be applied (around edge of inside surface) by wiping with a clean, alcohol dampened cloth.
- Allow to air dry.

4. Sealing strip (2) if replacing windshield (3).
   - Remove paper backing from foam rubber sealing strip (2) service part and position adjacent to painted lower blackout line.

CAUTION: When replacing the windshield, urethane adhesive GM part number 9636067 or equivalent must be used to maintain original installation integrity. Failure to use urethane adhesive will result in poor retention of the windshield, which may allow unrestrained occupants to be thrown from the vehicle resulting in personal injury.

5. Primer from urethane adhesive kit, GM part number 9636067 or equivalent, around the entire perimeter of the glass edge and 6 mm (1/4 inch) inboard on inner surface. Allow the primer to dry for five minutes.
    - Two primers are provided in urethane adhesive kit.
    - Clear primer is used on the glass prior to the black primer.
6. Black primer to portion of the glass opening that required refinishing and painting operations, or any portion that was cleaned of former adhesive enough to expose the painted surface. Black primer is the bonding agent between the urethane adhesive and the vehicle body. Allow primer to dry for five minutes.
7. Urethane adhesive from kit.
    - The caulk tip cut for the extended method should be used (Figure 3).
    - With a household cartridge-type caulking gun and nozzle, carefully apply a smooth continuous bead of adhesive, 10 mm (3/8-inch) high by 5 mm (3/16-inch) wide, at base completely around the edge of the glass where primed in previous step. Make sure the bead of adhesive is tipped slightly inboard.
8. Windshield (3) into the window opening with the aid of a helper.
    - The windshield (3) can be positioned without the aid of carrying devices. Carry the windshield (3) with one hand on the outside (Figure 4). Guide the windshield (3) along the rear edge of the front fender (2) to avoid smearing fresh adhesive on the instrument panel. At the window opening, put the windshield (3) in the horizontal position, the second person can reach one arm around the body pillar and support it while the other person assumes the same position.
9. Windshield (3) on the lower supports.
    - Center in the opening.
    - Use tape guides previously applied to place the windshield (3) in the proper position.

- Press the glass firmly to wet-out and set adhesive.
    - Use care to avoid excessive squeezeout which would cause an appearance problem.
- Using a small disposable brush or flat, soft fiberglass tool, paddle material around the edge of the glass to ensure watertight seal.
    - If necessary, paddle additional material to fill the voids in the seal.
- Watertest vehicle at once using soft spray.
    - Use warm or hot water if available.
    - Do not direct hard stream of water at fresh adhesive material.
    - Water applied on top of urethane adhesive, either during watertest or as a separate operation, will speed up the cure of the urethane.

Inspect

- For leaks. Paddle in extra adhesive at leak points using a small disposable brush or flat, soft fiberglass tool.

10. Windshield reveal molding (1).
11. Shroud top vent grille. Refer to BODY FRONT END (SEC. 10-4).
12. Windshield wipers and blades. Refer to WINDSHIELD WIPER-WASHER SYSTEM (SEC. 8E).

NOTICE: See "Notice" on page 10-2-1 of this section.

13. Rearview mirror. Refer to "Rearview Mirror" in this section.

- On windshield installations, the vehicle must remain at normal room temperature for six hours to complete the proper cure of the adhesive.

WATERLEAK CORRECTION

Figure 6

Where accessible, waterleaks can be corrected without removing and reinstalling glass. This method applies only to urethane installed glass and the use of adhesive furnished in urethane adhesive kit, GM part number 9636067 or equivalent.

1. Remove reveal molding in the area of leak.
    - In some cases, it may become necessary to remove interior moldings to locate the source of the leak.
2. Mark location of the leak(s).
    - This operation should be performed while water is being applied to the leak area.
    - Carefully push outward on the glass in the area of the leak to determine the extent of the leak.
    - Mark the extent of the leak area.
3. Using a sharp knife, trim off uneven edge of adhesive at leak point and 75 to 100 mm (3 to 4 inches) on both sides of leak point or beyond limits of leak area.
4. Clean dirt or foreign material from leak area with water (outside body). Dry area with air hose.
5. Prime affected area with black primer supplied in kit.
    - Agitate primer prior to use.
    - Allow primer to dry five minutes.
6. Apply urethane adhesive from kit at leak point and 75 to 100 mm (3 to 4 inches) on both sides of leak point beyond the limits of the leak area.
7. Right after performing the previous step, use a flat stick or other suitable flat, soft fiberglass tool to work the adhesive material well into the leak point and into the joint of original material and body to obtain a watertight seal along the entire length of the material application.
8. Using warm or hot water, spray test to assure that leak has been corrected.

  - Do not run heavy stream of water directly on freshly applied adhesive.

9. If leak still exists, use a flat soft fiberglass tool and paddle additional adhesive material into leak point.
10. Replace all previously removed parts.

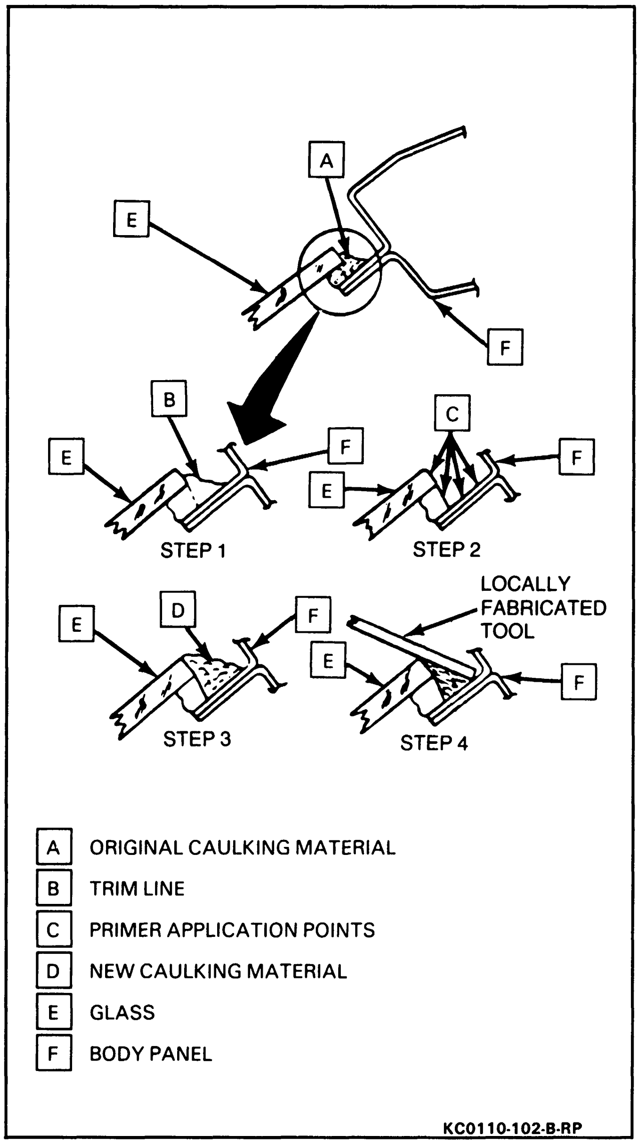


Figure 6 - Glass Adhesive Waterleak Correction

REARVIEW MIRROR

REARVIEW MIRROR SUPPORT

Figure 7

The rearview mirror is attached to a mirror support (5) that is secured to the windshield glass. This mirror support (5) is installed by the glass supplier using a plastic-polyvinyl butyral adhesive.

Service replacement windshield glass has the mirror support bonded to the glass assembly. To install a detached mirror support or install a new part, the following items are needed.

- GM part number 1052369, Loctite 312 Adhesive Kit, two component pack or equivalent
- Mirror support (5).
- Wax marking pencil or crayon.
- Rubbing alcohol.
- Clean paper towels.
- Fine grit emery cloth or sandpaper number 320 or number 360.
- Clean toothpick.

Measure

- Windshield (3) on outside to determine rearview mirror support position.
  - Mirror support (5) should be located at the center of the windshield (3), 689 mm (27-1/8 inches) from the base of the windshield (3) to the base of the mirror support (5).
  - Mark the support location with a small circle on the outside of the windshield (3) with wax pencil or crayon.
  - Make a larger diameter circle around the mirror support circle on the outside windshield surface (Figure 7).

Clean

- The area of the large circle on the inside windshield surface with paper towels and glass cleaning solution or glass polishing compound.
  - Rub until the area is completely clean and dry.
  - When dry, clean the area with an alcohol-saturated paper towel to remove any traces of cleaning solution or polishing compound.
- Sand bonding surface of new rearview mirror support (5) or factory installed mirror support with a piece of fine grit emery cloth or sandpaper, number 320 or number 360.
- If the original rearview mirror support (5) is to be reused, all traces of factory installed adhesive must be removed prior to installation.
- Wipe sanded mirror support with clean paper towel saturated with alcohol and allow to dry.

Install or Connect

1. Rearview mirror support (5) to windshield (3).
   - Follow directions on adhesive kit to prepare rearview mirror support (5) prior to installation on windshield (3).
   - Lightly apply adhesive accelerator to the bonding surfaces of the mirror support (5) and windshield (3).
   - Allow to dry completely.
   - Apply two drops of adhesive to the mirror support (5).
   - Use toothpick to evenly distribute the adhesive over the entire bonding surface of the mirror support (5).
   - Properly position the mirror support (5) to its premarked location, with rounded end pointed upward.

- Press the mirror support (5) against the windshield (3) for 30 to 60 seconds, exerting steady pressure against the windshield (3).
- After five minutes, remove excess adhesive with an alcohol-moistened paper towel or glass cleaning solution.

NOTICE: See "Notice" on page 10-2-1 of this section.

2. Mirror by sliding onto mirror support (5).

Tighten

- Attaching screw to 2 N·m (18 lb. in.).

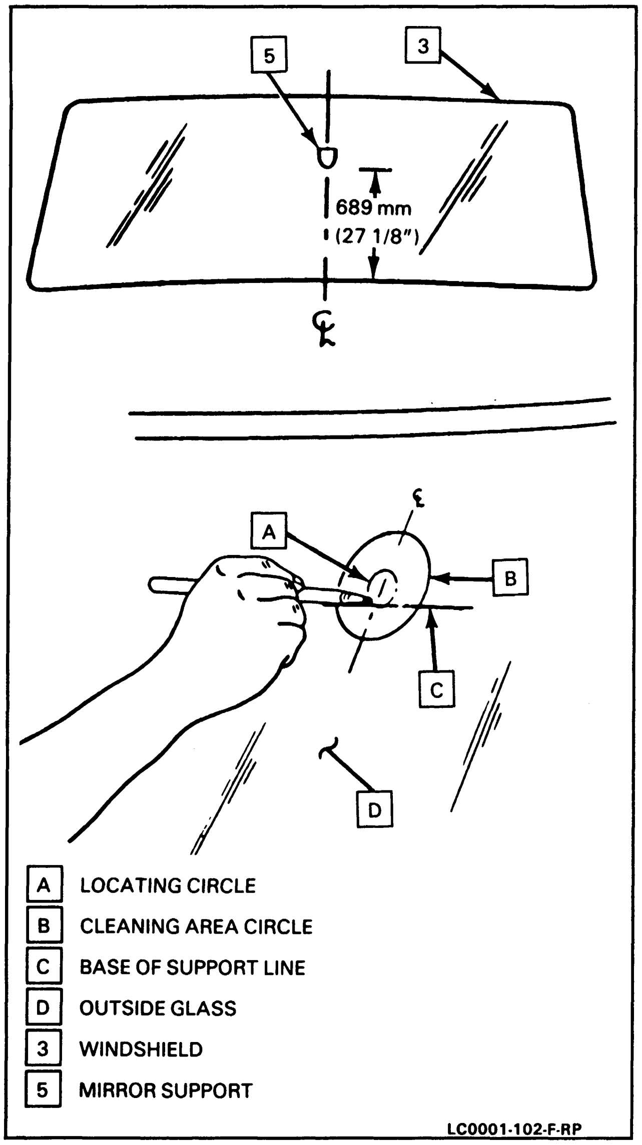


Figure 7 - Rearview Mirror Placement

DUAL READING LAMP MIRROR

Figure 8

The rearview tilt mirror is mounted to the windshield in the same location as the standard mirror. The mirror is equipped with dual reading lamps. It is powered from the vehicle electrical system and requires no batteries.

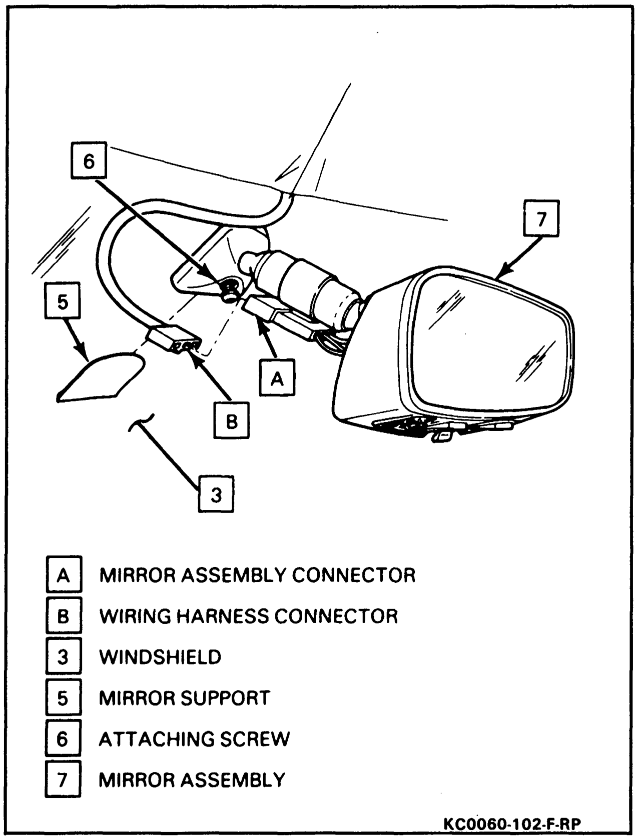


Figure 8 - Dual Reading Lamp Mirror

Remove or Disconnect

1. Mirror assembly connector from the body wiring connector.
2. Mirror assembly (7) from mirror support (5).
   - Loosen attaching screw (6).
   - Slide mirror assembly (7) from the mirror support (5).

Install or Connect

1. Mirror assembly connector to body wiring connector.

   NOTICE: See "Notice" on page 10-2-1 of this section.

2. Mirror assembly (7) to mirror support (5).
   - Make sure attaching screw (6) is loose on the mirror assembly.
   - Slide mirror assembly (7) onto the mirror support (5).

Tighten

- Attaching screw (6) to 2 N·m (18 lb. in.).

REAR WINDOW DEFOGGER

The optional rear window defogger system consists of a tinted glass that has a number of horizontal ceramic silver compound element lines and two vertical bus bars baked into the inside surface during the glass forming operation. The feed wire or terminal is soldered to the feed bus bar on the left side.

The ground wire or terminal is soldered to the ground bus bar on the right side.

The system operates on 12 volts. Under some conditions, heat from the glass may not be detected by finger touch. The length of time required to remove interior fog from the back glass will vary with such conditions as vehicle speed, outside glass temperature, atmospheric pressure and number of passengers.

This system uses an instrument panel mounted switch with an integral indicator lamp and will operate for five to ten minutes, automatically turning off through the use of a timer. The system can be turned off during this operating period by turning either the instrument panel mounted switch or engine control switch to "OFF."

TESTING GRID LINES

Figures 9 and 10

To locate inoperative grid lines, start the engine and turn on the rear window defogger system. Ground one voltmeter lead and lightly touch the other probe to each grid line. Figure 9 illustrates the pattern of test voltage to be expected with a properly functioning grid.

If the voltmeter shows full voltage at both ends of grid lines, check for loose ground wire contact to body metal.

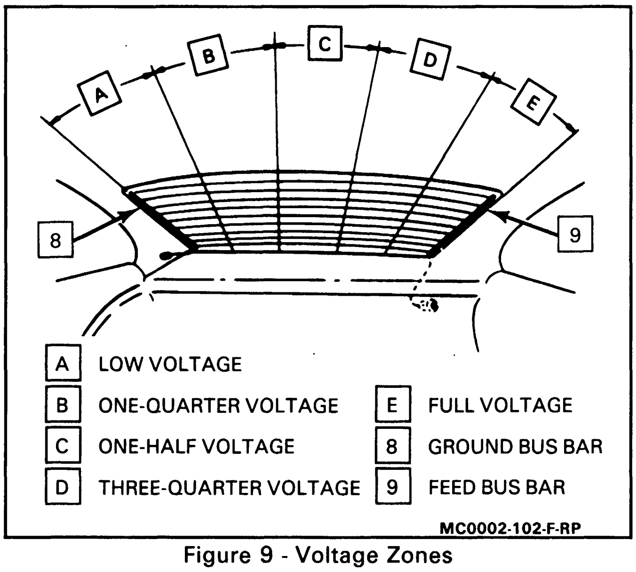


Figure 9 - Voltage Zones

The range of voltage zones may vary slightly from one glass to another. The voltage will decrease proportionately to the increased resistance in the grid line as the probe is moved from the feed bus bar (9) to the ground bus bar (8).

All grid lines must be tested in at least two places to eliminate the possibility of bridging a break. For best results, contact each grid line a few centimeters (inches) either side of the glass centerline. If an abnormal voltmeter reading is apparent on a specific grid line, place voltmeter probe on that grid at the feed bus bar (9) and move probe toward the ground bus bar (8) until the voltage is zero. This will indicate a break in the continuity of the grid line (Figure 10).

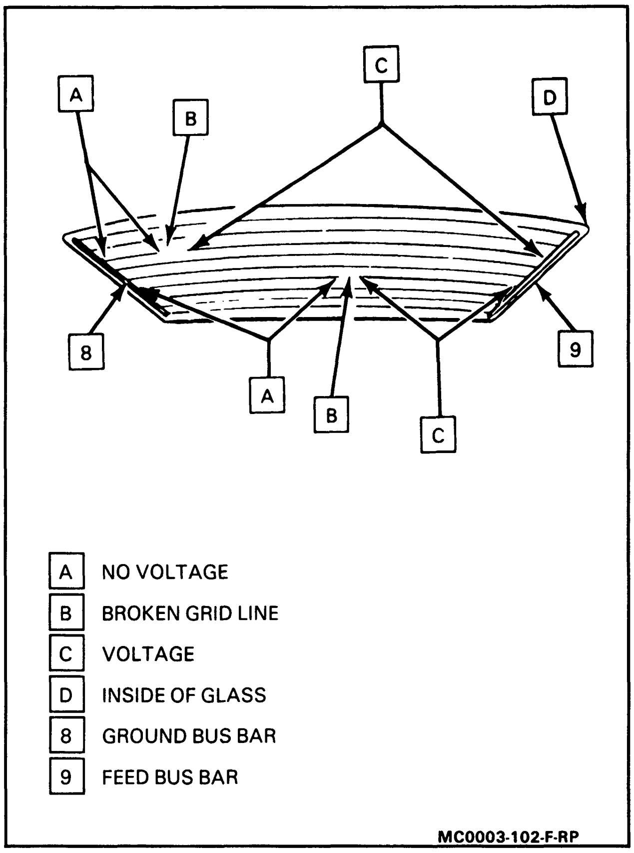


Figure 10 - Voltage with Broken Grid Lines

GRID LINE REPAIR

Figures 11 and 12

Remove or Disconnect

- Negative battery cable.

Inspect

- Rear window defogger grid lines.
- Mark grid line breaks on the outside of glass with a grease pencil.

Clean

- Grid line area to be repaired.
- Buff with fine steel wool and wipe clean using a cloth dampened with alcohol.
  - Buff and clean about 6 mm (1/4 inch) beyond each side of the break in the grid line.

Install or Connect

CAUTION: Approved safety glasses should be worn when performing this procedure to reduce the chance of personal injury.

1. Grid line repair decal or two strips of tape positioned above and below the repair area.
   - Repair decal or tape must be used to control the width of the repair area.

  - If a decal is used, be sure the die-cut metering slot is the same width as the grid line.
- Mix grid repair material according to manufacturer instructions.

2. Grid repair material at room temperature to the repair area using a small wood stick or spatula.

- Carefully remove the decal or tape.

NOTICE: The grid line repair material must be cured with heat. To avoid heat damage to the interior trim, protect the trim near the repair area where heat is to be applied.

- Apply heat to repair area for one to two minutes with a heat gun capable of reaching 260°C (500°F).
  - Hold heat gun nozzle 25 mm (1 inch) from surface.
  - A minimum temperature of 149°C (300°F) is required.

3. Negative battery cable.

Inspect

  - Grid line repair area.
    - If repair appears discolored, apply a coating of tincture of iodine to repair area using a pipe cleaner or fine brush.
    - Allow iodine to dry for about 30 seconds and carefully wipe off excess with lint-free cloth.
- Test rear defogger operation to verify grid line repair. Refer to "Testing Grid Lines" in this section.

NOTICE: At least 24 hours are required for complete curing of repair materials. The unit should not be physically disturbed until after that time, or the repair may not hold.

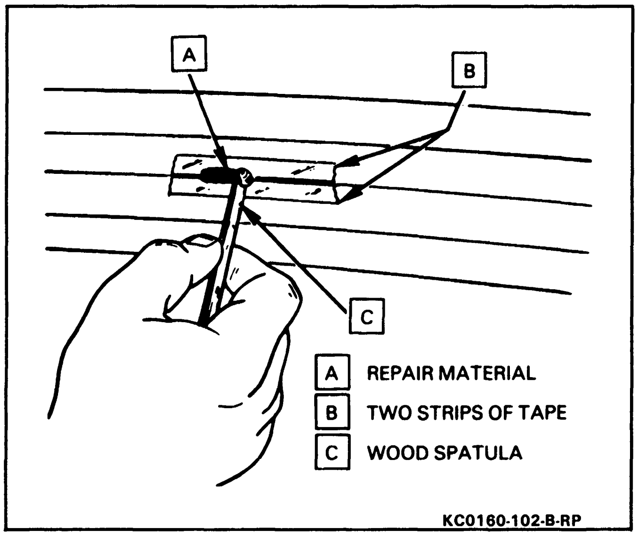


Figure 11 - Applying Repair Material to Broken Grid Line

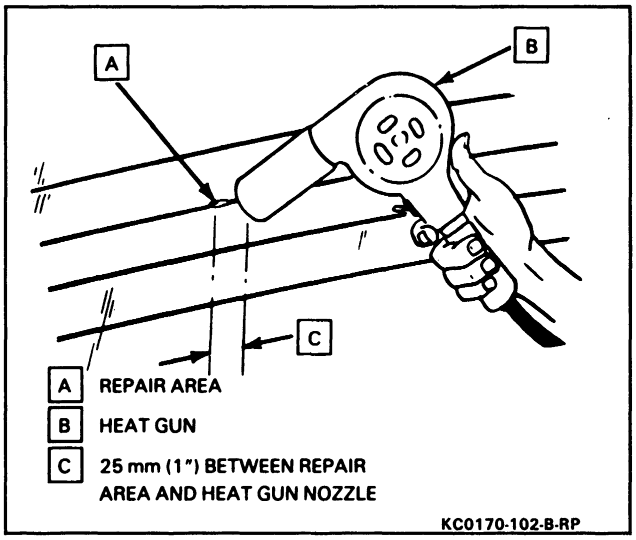


Figure 12 - Applying Heat to Grid Line Repair

BRAIDED LEAD WIRE REPAIR

Figures 10 and 13

CAUTION: Approved safety glasses should be worn when performing this procedure to reduce the chance of personal injury.

Clean

- Buff repair area with fine steel wool to remove the oxide coating formed during glass manufacture.

Install or Connect

1. Paste-type rosin flux in small quantities to the wire lead and bus bar repair area using a brush.
   - The soldering iron tip should be coated with solder beforehand.

NOTICE: To prevent burning the bus bar, the soldering iron tip temperature should be just enough to melt the solder and allow it to run freely. The iron should be in contact with the bus bar as short a time as possible.

2. Solder to the feed bus bar (9) or ground bus bar (8).
   - Draw the soldering iron tip across the fluxed area, thinly coating the bus bar with solder.
3. Small amount of flux to the underside of the lead wire braid.
   - Align the spots with fluxed and tinned spots on the feed bus bar (9) or ground bus bar (8).

- Coat the tip of the soldering iron with solder.

4. Solder to the underside of the lead wire braid.
   - Draw the iron across the fluxed spot, thinly coating the spot with solder.
5. Solder spot on the braid against the spot on the feed bus bar (9) or ground bus bar (8).
   - Apply heat to the top of the lead wire braid, causing the solder spots to melt and fuse together.

- The holding force should not be removed until the solder has solidified.
- Wipe off excess flux with solvent.

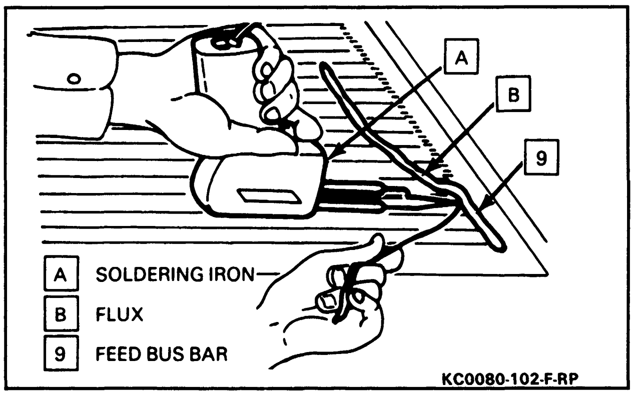


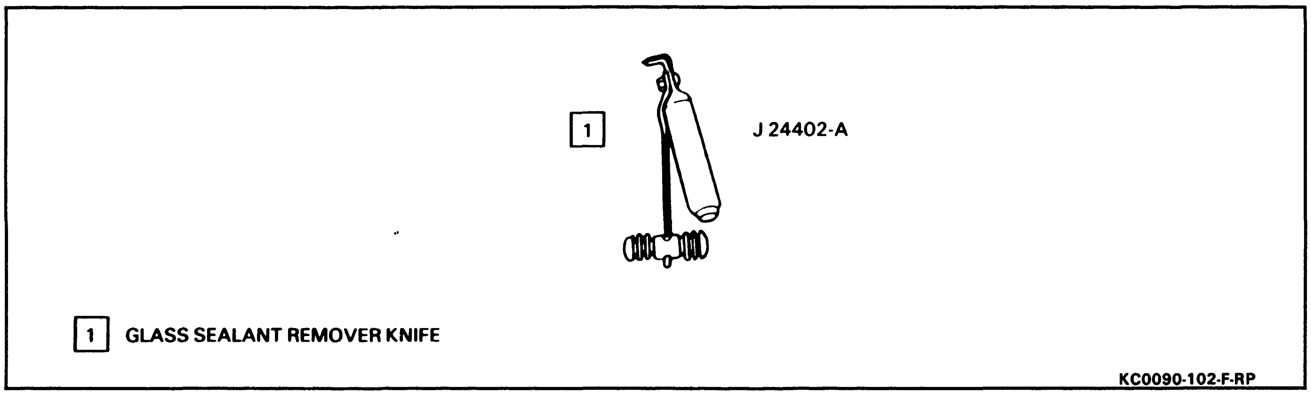
Figure 13 - Bus Bar Repair

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Mirror Attaching Screw .... 2 N·m (18 lb. in.)

SPECIAL TOOLS



SECTION 10-3

UNDERBODY

CONTENTS

GENERAL BODY CONSTRUCTION

Information in this section pertains to unitized body construction which incorporates integral front and rear frame side rails.

The front suspension lower control arms are supported by a crossmember. The crossmember is bolted to the body at six locations – three on each side of the engine front compartment lower rails. Mounting provisions for the front suspension system are shared by chassis components (suspension lower control arms and crossmember) and body components (engine compartment side panels). The suspension strut towers must be dimensionally correct in relation to the remainder of the underbody in order to maintain specified suspension strut and caster/camber angles.

Since the individual underbody components contribute directly to the overall strength of the body, proper welding techniques must be observed during service repair operations. The underbody components should be properly sealed and rustproofed whenever body repair operations destroy or damage the original sealing and rustproofing. When rustproofing critical underbody components, use a good quality air dry primer such as corrosion-resistant chromate or equivalent material. Combination type primer-surfacers are not recommended.

ALIGNMENT CHECKING

FRAME AND UNDERBODY

Figures 1 and 2

Use a tram gage to accurately measure underbody alignment. Make sure the tram gage set has a vertical pointer that can reach 914 mm (36 inches).

Two types of measurements can be made with a tram gage: direct point-to-point measurements and measurements calculated on a horizontal plane, or datum line, parallel to the underbody. To calculate measurements on a horizontal plane, the vertical pointers must be set as specified for each point to be measured.

Point-to-point measurements are generally taken only on engine compartment components and simply require the vertical pointers to be equally set. Dimensions-to-gage holes are measured to dead center of the holes and flush to the adjacent surface metal unless otherwise specified.

STEERING UNIT MOUNTING

Vehicles involved in accidents resulting in frame damage, major body or sheet metal damage, or where the steering column has been impacted, may also have a misaligned steering column.

For the procedure to check capsules on the steering column bracket assembly, refer to STEERING WHEEL UPPER COLUMN ON-VEHICLE SERVICE - TILT WITH SUPPLEMENTAL INFLATABLE RESTRAINT (SEC. 3F4).

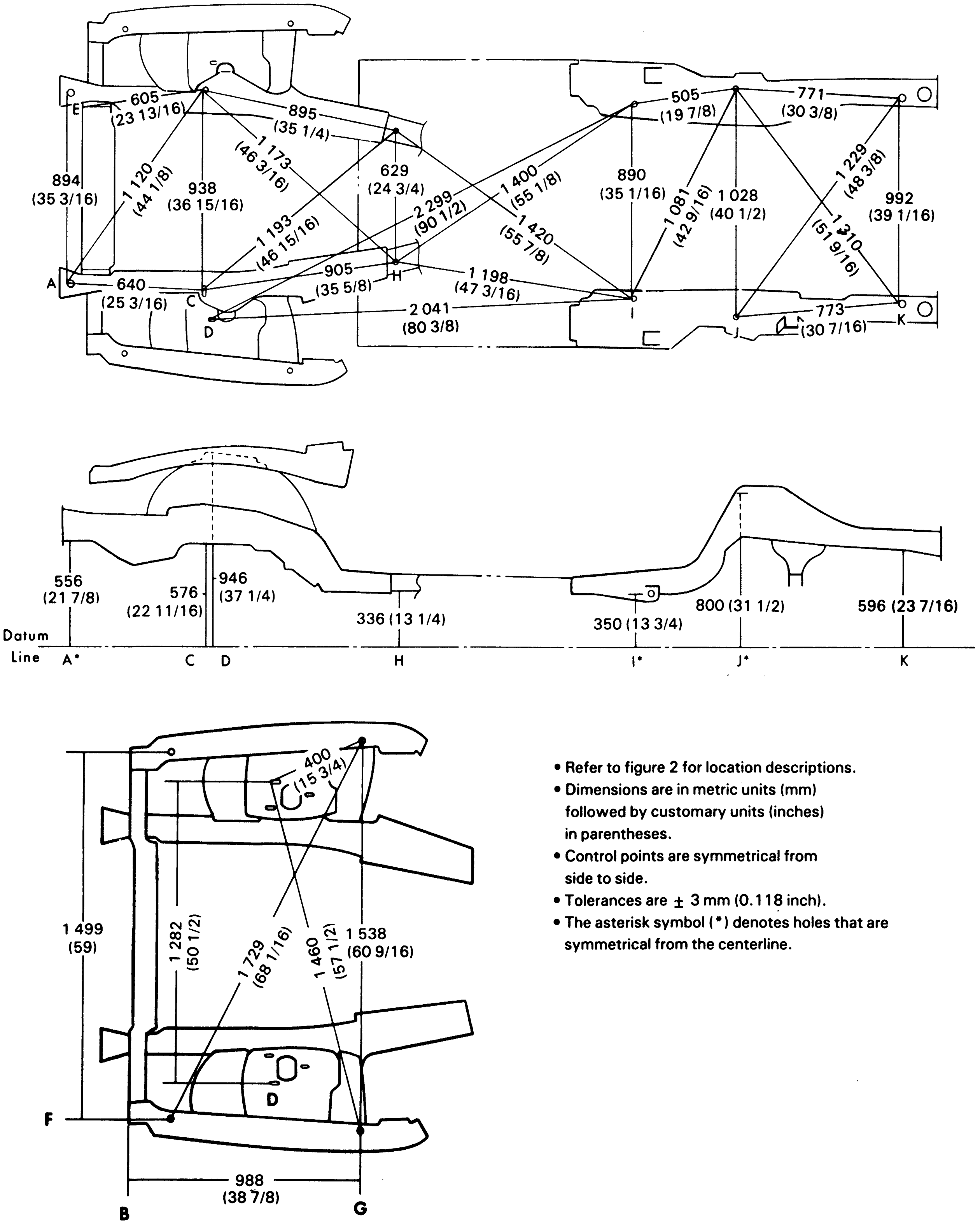
FLOOR PAN INSULATORS

CAUTION: All materials used for insulators must meet Vehicle Safety Standard No. 302 for flammability. Failure to do so could result in bodily injury and/or vehicle damage.

Floor pan insulators have been designed for the higher floor pan temperatures that result from the use of the catalytic converter in the exhaust system. When servicing a vehicle in the field, any insulators that may have been disturbed or removed must be reinstalled in the original sequence and location. If replacement of an insulator is necessary, the material specified for that particular location on the floor pan must be used.

When servicing or replacing interior insulators, the following instructions must be observed:

- Any insulator service repair or replacement should be the same thickness, size and location as the original installation in the vehicle.
- Insulators must be installed in the original position and sequence. Pieces should be butted together in order to avoid gapping or overlapping.
- If it is necessary to replace an insulator, the specified material must be used.
- Use the original part to determine the amount of replacement material required and as a template for cutting and fitting the new piece to the floor pan.
- When installing an insulator, do not enlarge cutouts or holes that are used for the attachment of interior components such as seats or safety belts.
- Cross body wiring harnesses for interior components such as power seats, lap belt warning lamp and alarm/buzzer or rear speakers must be routed over the floor pan insulators in the original location and clipped in place.



- Refer to figure 2 for location descriptions.
- Dimensions are in metric units (mm) followed by customary units (inches) in parentheses.
- Control points are symmetrical from side to side.
- Tolerances are ± 3 mm (0.118 inch).
- The asterisk symbol (*) denotes holes that are symmetrical from the centerline.

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Figure 1 - Underbody Horizontal and Vertical Dimensions

REF	HORIZONTAL	VERTICAL	LOCATION
A	Front edge of 24 mm (15/16 inch) hole	Lower surface of engine compartment rail	Engine compartment rail forward of lower tie bar
B	Leading edge of upper tie bar	None	Engine compartment bar, upper rail
C	Front edge of 16 mm (5/8 inch) gage hole (front edge center of slot on right side)	Lower surface of engine compartment rail at hole (slot on right side)	Engine compartment rail, forward of suspension pocket
D	Front edge of outboard strut mounting slot	Lower surfaces of strut tower at slot	Shock-strut tower
E	Leading edge of lower tie bar at corner	None	Engine compartment bar lower rail
F	Center of 9 mm (23/64 inch) hole in rail depression	None	Engine compartment upper side rail
G	Center of 9 mm (23/64 inch) hole in rail depression	None	Engine compartment upper side rail
H	Center of 16mm (5/8 inch) gage hole	Lower surface of reinforcement rear of rail at hole	Floor pan reinforcement behind engine compartment rail
I	Front edge of 18 mm (11/16 inch) gage hole	Lower surface of rail at hole	Rear longitudinal rail
J	Center of 16 mm (5/8 inch) hole	Lower surface of rail at hole	Shock mounting hole rear longitudinal rail
K	Front edge of 18 mm (11/16 inch) hole	Lower surface of rail at hole	Rear longitudinal rail, forward of 25 mm (1 inch) hole

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Figure 2 - Underbody Horizontal and Vertical Locations

- Spray-on deadeners and trim adhesives should not be applied to the top of the floor pan at the area directly over a catalytic converter or muffler.

FLOOR CARPETS

All floor carpets consist of a molded one-piece carpet over both front and rear floor pan areas.

↔ Remove or Disconnect

1. Front seats. Refer to SEATS (SEC. 10-9).
2. Front safety belts. Refer to SAFETY BELTS (SEC. 10-10).
3. Rear seat cushion and back. Refer to SEATS (SEC. 10-9).
4. Left and right shroud side trim finishing panels. Refer to BODY FRONT END (SEC. 10-4).
5. Outboard shoulder belt floor attachments. Refer to SAFETY BELTS (SEC. 10-10).
6. Sill plate. Refer to REAR QUARTERS (SEC. 10-6).
7. Quarter lower trim finishing panel. Refer to REAR QUARTERS (SEC. 10-6).
8. Console assembly. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
9. Carpet.

→← Install or Connect

1. Carpet.
2. Console assembly. Refer to INSTRUMENT PANEL, CLUSTER AND CONSOLE (SEC. 8C).
3. Quarter lower trim finishing panel. Refer to REAR QUARTERS (SEC. 10-6).
4. Sill plate. Refer to REAR QUARTERS (SEC. 10-6).
5. Outboard shoulder belt floor attachments. Refer to SAFETY BELTS (SEC. 10-10).
6. Left and right shroud side trim finishing panels. Refer to BODY FRONT END (SEC. 10-4).
7. Rear seat back and cushion. Refer to SEATS (SEC. 10-9).
8. Front safety belts. Refer to SAFETY BELTS (SEC. 10-10).
9. Front seats. Refer to SEATS (SEC. 10-9).

SECTION 10-4

BODY FRONT END

CAUTION: On vehicles equipped with Supplemental Inflatable Restraints (SIR), refer to CAUTIONS in Section 9J-B under On-Vehicle Service before performing service on or around SIR components or SIR wiring. Failure to follow cautions could result in possible air bag deployment, personal injury or unneeded SIR system repairs.

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 10-4-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value ust be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

FRONT END SEALING

All potential waterleak locations are sealed in production with high quality durable sealers. To reseal specific areas, a high quality medium-bodied sealer that will remain flexible after curing and can be painted should be used.

> **NOTICE:** The anti-theft label found on some major sheet metal, engines, and transmissions must be masked prior to painting, rustproofing, undercoating, etc. The mask must be removed following the above operations. Failure to keep the label clean and readable may result in liability for violation of Federal Vehicle Theft Prevention Standard, and subject the vehicle owner to possible suspicion that the part was stolen.

SHROUD VENT GRILLE

Figure 1

The body ventilation system on styles without air conditioning consists of a fresh air intake located at the front plenum chamber. Air enters the front plenum chamber through a shroud top vent grille (1). Air passes through the plenum chamber to an air outlet valve. When ventilation controls are operated, air enters past the air valves and into the body from the instrument panel and heater module outlets.

↔ Remove or Disconnect

1. Washer hose from the grille.
2. Right-hand wiper arm. Refer to WINDSHIELD WIPER-WASHER SYSTEM (SEC. 8E).
3. Self drilling screw (2).
4. Shroud top vent grille (1) by prying.

→← Install or Connect

1. Shroud top vent grille (1).
2. Washer hose into grille.
   - Align studs on screen to slots in panel.
3. Self drilling screw (2).
4. Right-hand wiper arm. Refer to WINDSHIELD WIPER-WASHER SYSTEM (SEC. 8E).

PLENUM CHAMBER WATER DEFLECTORS

Figure 2

Water entering the plenum chamber is drained through water deflectors (3). The water deflectors (3) are located within the plenum chamber to prevent water from entering the air inlets to the passenger compartment.

SHROUD SIDE TRIM FINISHING PANELS

Figures 3 through 5

The shroud side finishing panels are designed with an integral hinge pillar pinch-weld finishing lace. The left side has a cutout slot for the hood release cable handle. There is no need to remove the cable assembly when removing the trim finishing panel. The trim finishing panel is secured to the side shroud with self-tapping screws.

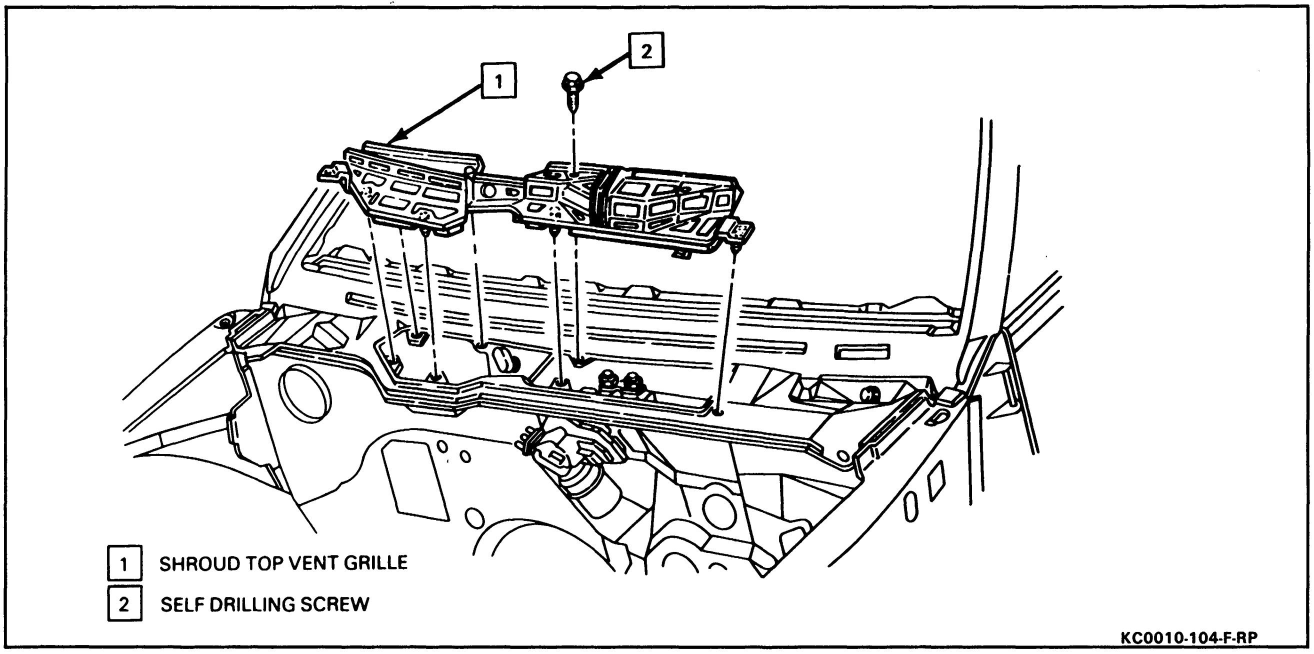


Figure 1 - Air Entrance into Plenum Chamber

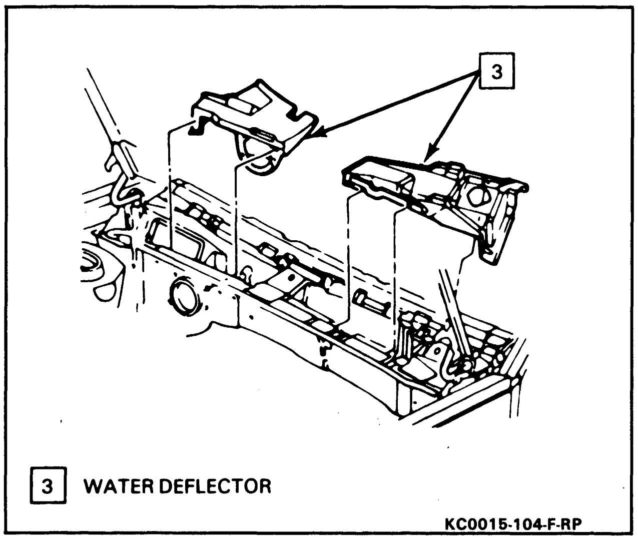


Figure 2 - Typical Internal Water Deflectors

←→ Remove or Disconnect

1. Shroud side trim finishing panel screws (5).
2. Hood release cable handle (6) from the slot on the left side by pulling down and rearward on the trim finishing panel (4).
3. Finishing panel (4) from windshield lower side garnish molding (7) by pulling rearward.
4. Speaker wiring harness connectors, if equipped.

→← Install or Connect

1. Speaker wiring harness connectors, if equipped.
2. Finishing panel (4) to the body hinge pillar lower panel.
3. Hood release cable handle (6) through access hole of left side finishing panel (4).
4. Upper rear flange of finishing panel (4) under garnish molding (7) by pushing.
5. Groove in lace portion of finishing panel (4) over the pinch-weld flange of the front body hinge pillar.
6. Screws (5).

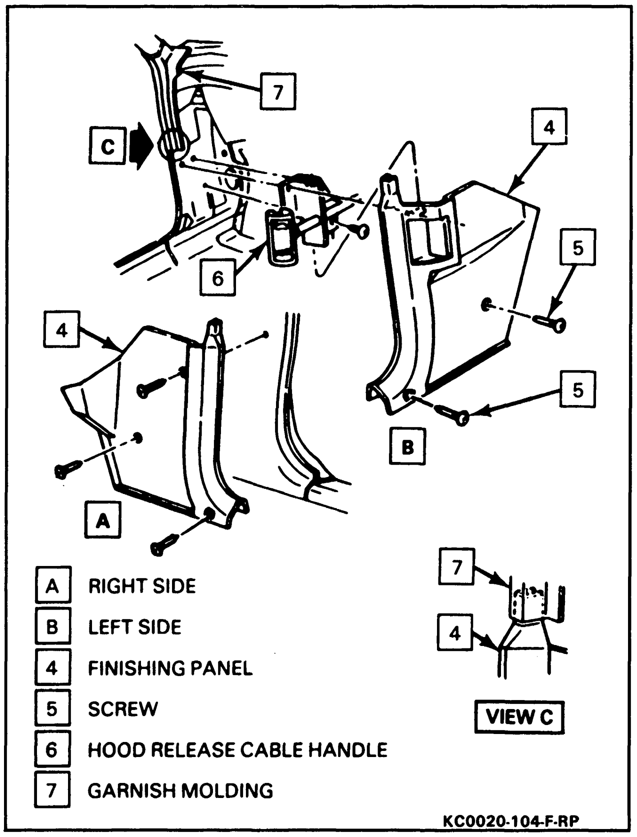


Figure 3 - Shroud Side Trim Finishing Panel

RADIO SPEAKERS

For information on the radio speakers, refer to AUDIO SYSTEMS (SEC. 9A).

FRONT DOOR JAMB SWITCH

Figures 6 and 7

Door jamb switch terminal assemblies consist of a plunger, plunger collar, threaded retainer and terminals. They are installed in the door hinge pillars. When the door of the vehicle is closed, the plunger is depressed which creates an open in the ground circuit. When the door is opened, the plunger is released and completes the circuit to ground.

When a new jamb switch is installed and the door is closed the first time, the plunger is forced into the sleeve and automatically adjusts the jamb switch for that particular door. If a jamb switch fails, it should not be readjusted by hand. A new jamb switch should be installed.

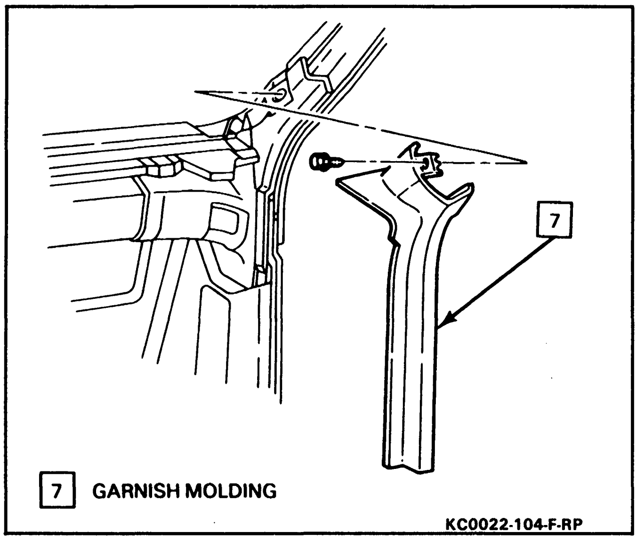


Figure 4 - Windshield Lower Side Garnish Molding

Remove or Disconnect

1. Door jamb switch (8 or 9).
2. Electrical connector (10).

Install or Connect

1. Electrical connector (10).

   NOTICE: See "Notice" on page 10-4-1 of this section.

2. Door jamb switch (8 or 9).

   Tighten

   - Door jamb switch (8 or 9) to 20 N·m (15 lb. ft.).

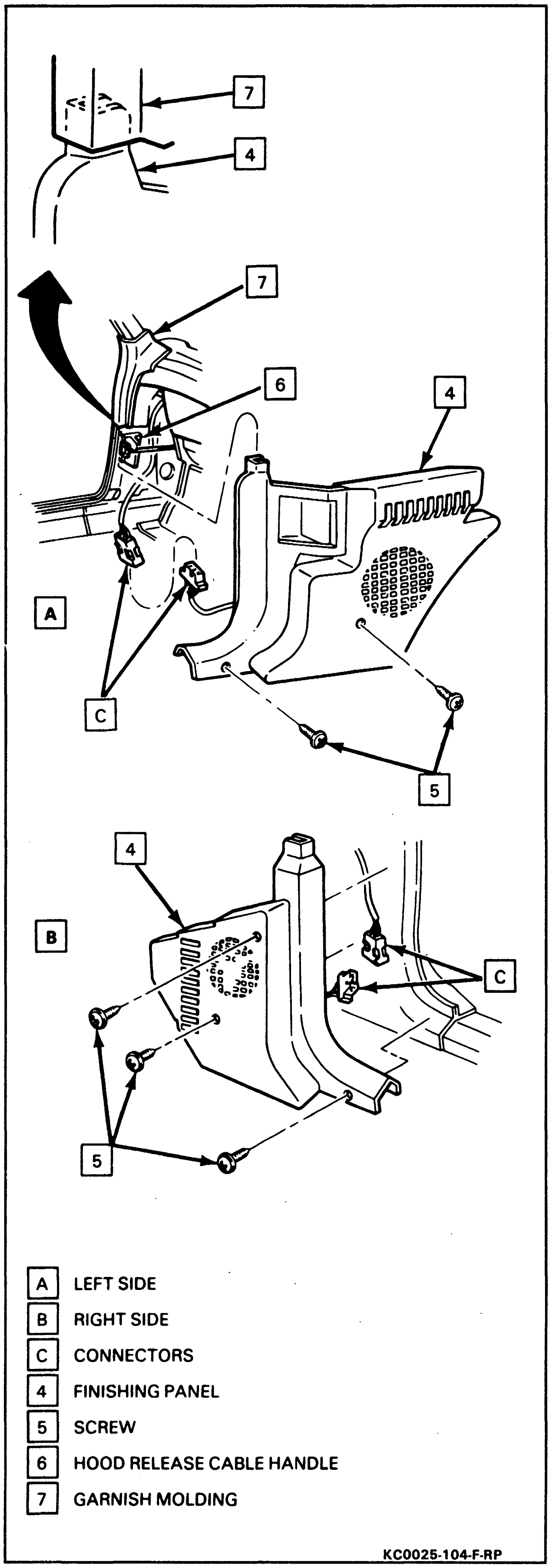


Figure 5 - Shroud Side Trim Finishing Panel with Bose Speaker System

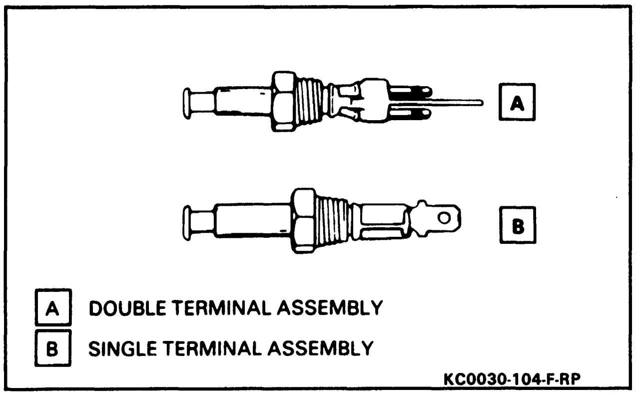


Figure 6 - Door Jamb Switches

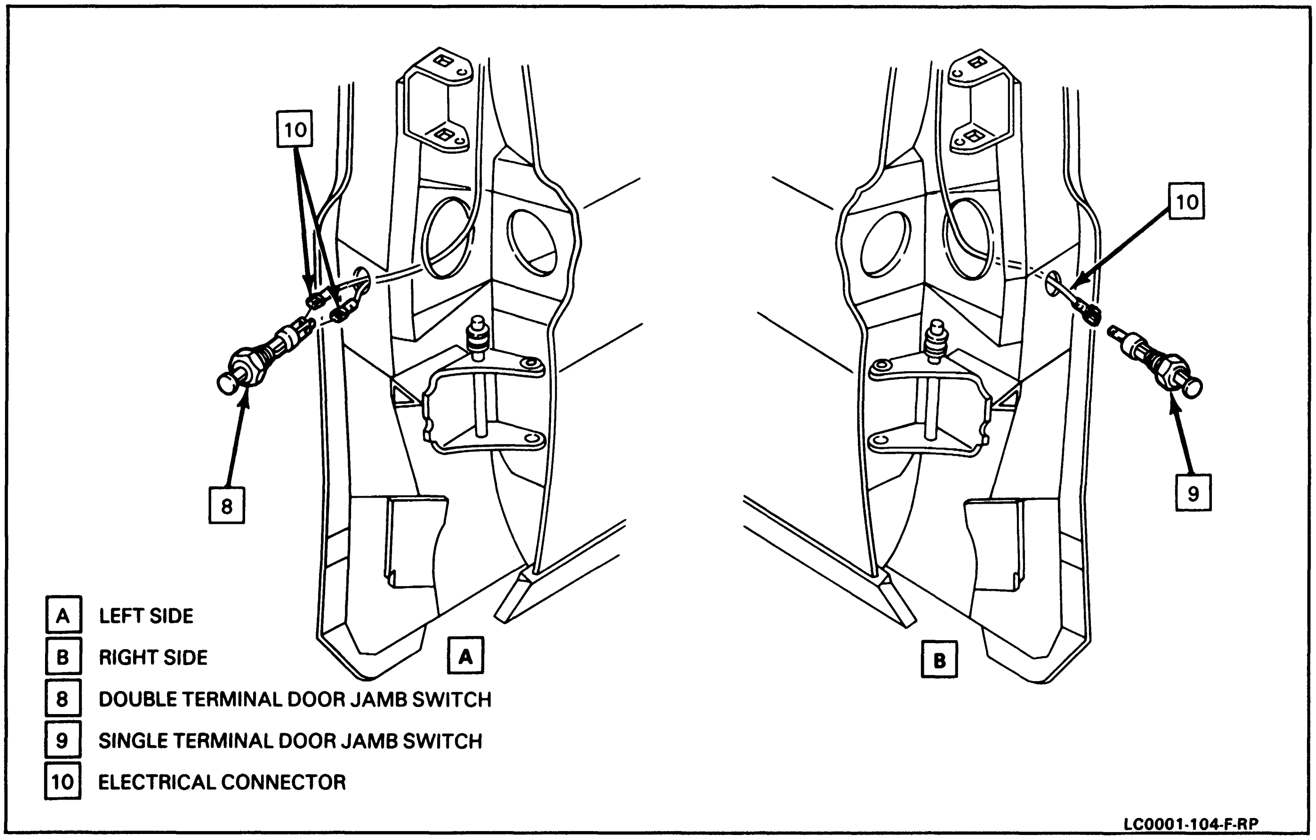


Figure 7 - Replacing Door Jamb Switches

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Door Jamb Switch .... 20 N·m (15 lb. ft.)

SECTION 10-5

DOORS

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 10-5-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

NOTICE: The anti-theft label found on some major glass, sheet metal, engines, and transmissions must be masked prior to painting, rustproofing, undercoating, etc. The mask **must** be removed following the above operations. Failure to keep the label clean and readable may result in liability for violation of Federal Vehicle Theft Prevention Standard, and subject the vehicle owner to possible suspicion that the part was stolen.

CONTENTS

GENERAL DESCRIPTION

This section contains the service operations necessary for the removal, installation, adjustment and sealing of door assemblies, hardware and trim.

THREAD LOCKING FASTENERS

All factory installed door hardware attaching screws contain an epoxy thread locking compound to ensure that the torque setting will be maintained.

Service replacement screws may not contain a thread locking compound. Such screws may be treated with GM part number 1052279, Loctite 75, or equivalent. The adhesive is placed on the fastener prior to installation. After the fastener is installed and tightened, the adhesive will cure, preventing the fastener from becoming loose.

DOOR HARDWARE LUBRICATION

For the proper door hardware lubricants, refer to MAINTENANCE AND LUBRICATION (SEC. 0B).

DOOR TRIM

INTERIOR

Door Trim Panel

Figure 1

Remove or Disconnect

Tool Required:

J 24595-C Door Trim Pad and Garnish Clip Remover

1. Remote handle mount panel. Refer to "Trim Pad Switch and Remote Handle Mount Panel" in this section.
2. Window regulator handle, if equipped. Refer to "Window Regulator Handle" in this section.
3. Door trim panel (1) using J 24595-C.
    - Push the door trim panel (1) outboard and upward to disengage it from the upper retaining clips.

Inspect

- Door trim panel retainers for damage. Make sure the retainers are installed securely into the door trim panel (1). Replace if necessary.

Install or Connect

1. New trim retainers into the door trim panel (1), if necessary.
    - Insert the retainer flange into the cutout attachment hole in the door trim panel (1).
    - Rotate the retainer until the flange is fully engaged.
2. Door trim panel (1).
    - Position the top of the door trim panel over the upper flange of the door inner panel.
    - Press down on the door trim panel (1) to engage the upper retaining clips.
    - Position the door trim panel (1) so that the trim retainers are aligned with the attaching holes in the panel.
    - Tap the door trim panel retainers into the holes with the palm of the hand or a clean rubber mallet.
3. Window regulator handle, if equipped. Refer to "Window Regulator Handle" in this section.
4. Remote handle mount panel. Refer to "Trim Pad Switch and Remote Handle Mount Panel" in this section.

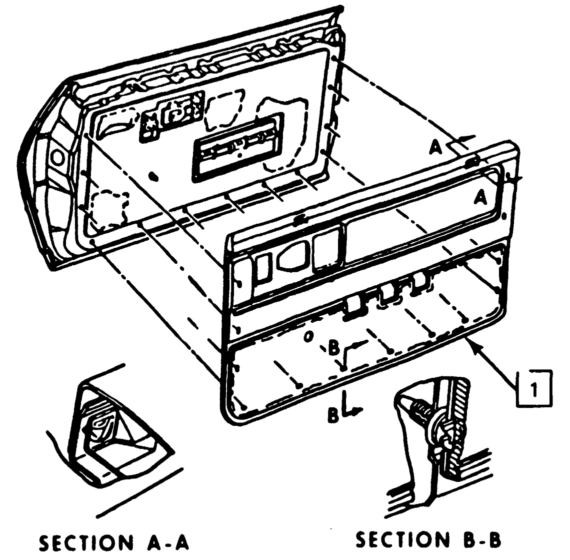


Figure 1 - Door Trim Panel

Armrest

Figure 2

Remove or Disconnect

1. Screws (3 and 4) retaining armrest (2) to the door trim panel, the armrest hanger plate, and the trim pad switch and remote handle mount panel (5).
2. Armrest (2) from the door trim panel and the trim pad switch and remote handle mount panel (5).

Install or Connect

1. Armrest (2) to the door trim panel and the trim pad switch and remote handle mount panel (5).

    NOTICE: See "Notice" on page 10-5-1 of this section.

2. Screws (3 and 4).

    #### Tighten

    - Screws (3 and 4) to 5 N·m (44 lb. in.).

Trim Pad Switch and Remote Handle Mount Panel

Figure 3

Remove or Disconnect

1. Armrest. Refer to "Armrest" in this section.
2. Inside lock rod knob. Refer to "Inside Lock Rod Knob" in this section.
3. Screws (6 and 87) retaining trim pad switch and remote handle mount panel (5) to door trim panel.
4. Electrical connector from the power door lock switch, if equipped.

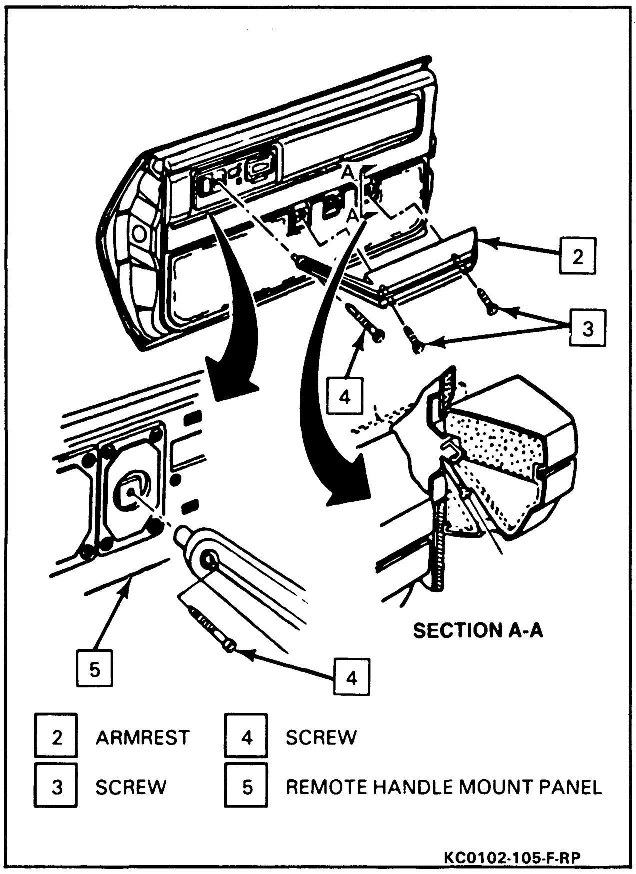


Figure 2 - Armrest

5. Remote mirror control, if equipped.
   - Remove retaining clip with the blade of a small screwdriver and pull the lever out of the trim plate from behind.
6. Electrical connector from the power mirror switch, if equipped.
7. Trim pad switch and remote handle mount panel (5) from the door trim panel.

Install or Connect

NOTICE: See "Notice" on page 10-5-1 of this section.

1. Trim pad switch and remote handle mount panel (5) to the door trim panel.
2. Electrical connector to the power mirror switch, if equipped.
3. Remote mirror control lever, if equipped.
   - Position lever into the trim plate from behind.
   - Insert the retaining clip into the trim plate and rotate the clip 90 degrees counterclockwise to secure.
4. Electrical connector to the power door lock switch, if equipped.
5. Screws (6 and 87) retaining the trim pad switch and remote handle mount panel (5) to the door trim panel.

Tighten

- Screws (6 and 87) to 2.5 N·m (22 lb. in.).

6. Inside lock rod knob. Refer to "Inside Lock Rod Knob" in this section.
7. Armrest. Refer to "Armrest" in this section.

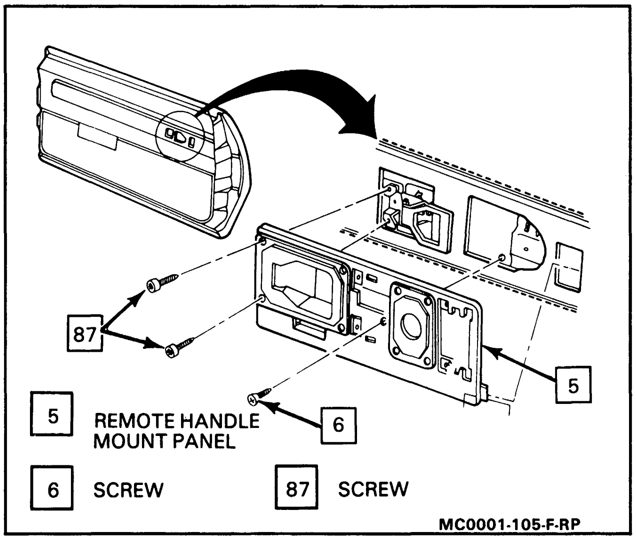


Figure 3 - Remote Handle Mount Panel

EXTERIOR

Door Molding

For information and procedures on replacing door exterior adhesive molding, refer to GENERAL BODY SERVICE PROCEDURES (SEC. 10-1).

Door Lower Molding

Figure 4

Remove or Disconnect

1. Door trim panel. Refer to "Door Trim Panel" in this section.
2. Water Deflector along the bottom of the door just enough to expose the door lower molding nuts (8 and 90).
3. Nuts (8 and 90) retaining the door lower molding (7) to the door.
4. Door lower molding (7).

Install or Connect

NOTICE: See "Notice" on page 10-5-1 of this section.

1. Door lower molding (7).
2. Nuts (8 and 90) retaining the door lower molding (7) to the door.

Tighten

- Nuts (8 and 90) to 3.4 N·m (30 lb. in.).

3. Area of water deflector previously detached.
4. Door trim panel. Refer to "Door Trim Panel" in this section.

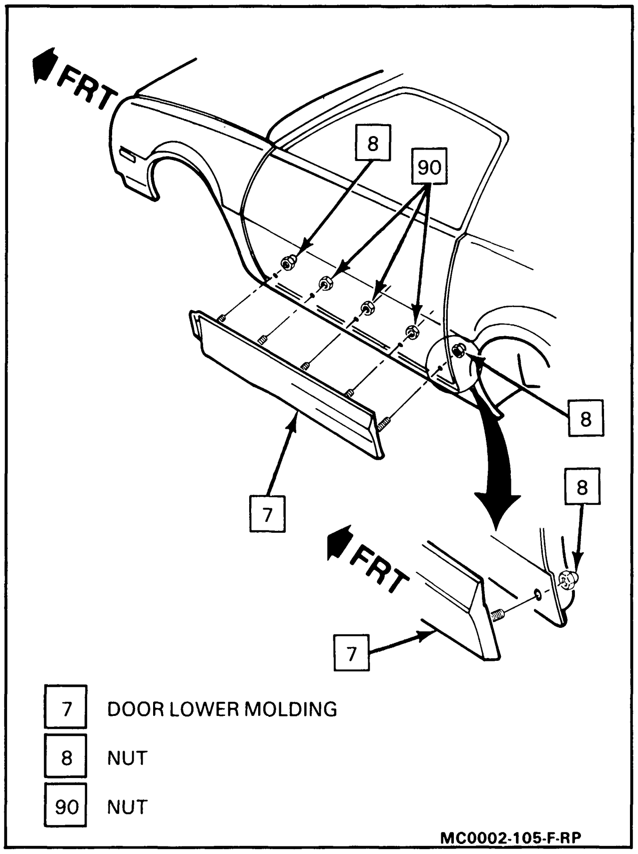


Figure 4 - Door Lower Molding

Decals

Remove or Disconnect

Tool Required:

J 25070 Heat Gun

- Decal.
  - Hold J 25070 at least 152 mm (6 inches) from the decal. Apply heat in an even and circular motion.
  - Peel off decal slowly.

Clean

- Area where the decal is to be applied using a clean, lint-free cloth saturated with high flash naphtha or isopropyl alcohol in a 50/50 mixture with water.
- Using a dry, clean, lint-free cloth, wipe dry the body surface of any film where the naphtha or alcohol was applied.

Install or Connect

- Decal.
  - Remove the protective backing from the decal by flicking the corner of the decal away from the backing paper with the ball of the thumb or finger.
  - Apply the decal to the body surface using a teflon-covered plastic squeegee to remove all air bubbles.

FRONT DOOR HARDWARE AND GLASS

WEATHERSTRIPS

Door Weatherstrips

Figures 5 and 6

Nylon fasteners are used to retain the door weatherstrips. The nylon fasteners are a component part of the weatherstrip. They secure the weatherstrip to the door by engaging piercings in the door panel. The serrations on the fastener also seal the piercings from water entry. Adhesive retains the weatherstrip at the belt line and down the door hinge pillar.

Remove or Disconnect

Tool Required:

J 21104-B Universal Weatherstrip Remover

1. Door trim panel. Refer to "Door Trim Panel" in this section.
2. Screws (11) from weatherstrip retainers (12).
3. Weatherstrip fasteners (9) using J 21104-B.

Inspect

- Weatherstrip fasteners (9) for damage. Replace as necessary.

NOTICE: To prevent damage to the weatherstrip during removal, apply an adhesive release agent such as 3M No. 08971, Kent No. 30125, or equivalent, to aid in breaking the adhesive.

4. Weatherstrip (10).
   - Break the adhesive bond between the door and the weatherstrip (10) using a flat-bladed tool.

Inspect

- Weatherstrip (10) for damage.
  - If the weatherstrip (10) will not hold a nylon fastener (9), remove the fastener (9) and secure the weatherstrip (10) using adhesive at the area where the fastener (9) was removed.
  - If more than two nylon fasteners (9) in a row will not remain attached to the weatherstrip (10), replace the weatherstrip (10).

Clean

- Old weatherstrip adhesive from the door.

Install or Connect

1. Nylon fasteners (9) to the weatherstrip (10).
2. Adhesive to weatherstrip (10) at belt line and door hinge pillar.

Important

- Weatherstrip (10) must be installed within 15 minutes of adhesive application to prevent the adhesive from skinning or drying out.

3. Weatherstrip (10).
   - Position the weatherstrip (10) to the door.
   - Tap the nylon fastener (9) into the door piercing using a hammer and a blunt caulking tool.
   - Apply weatherstrip adhesive at any point where additional retention or sealing is required.
4. Screws (11) to weatherstrip retainers (12).
5. Door trim panel. Refer to "Door Trim Panel" in this section.

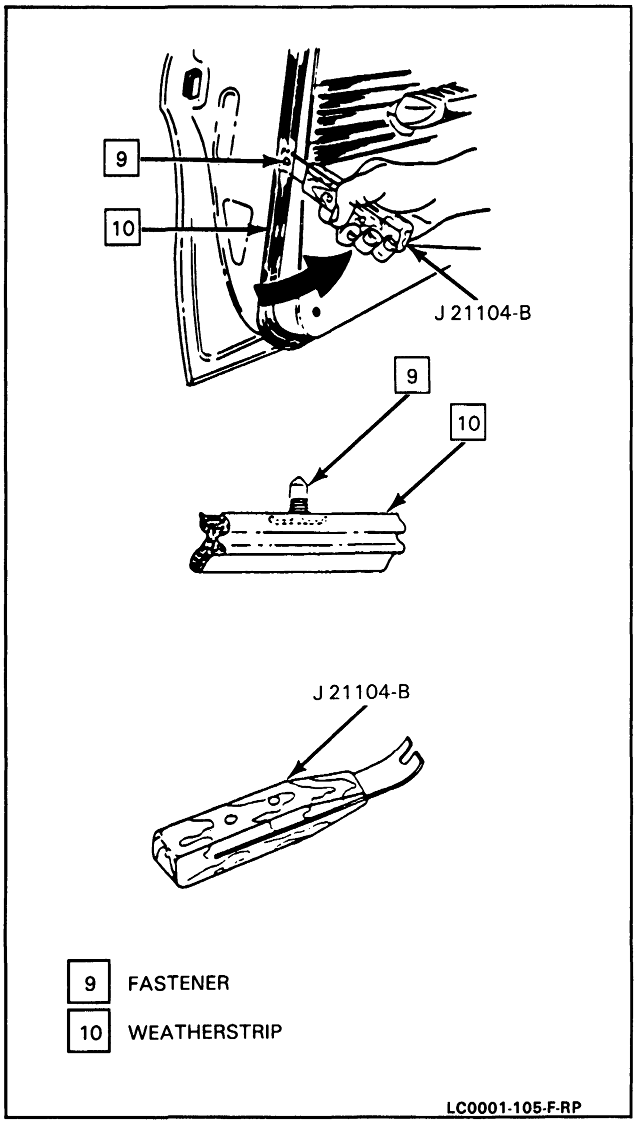


Figure 5 - Removing Weatherstrip

Roof Rail Weatherstrip and Retainer

Figure 7

The roof rail weatherstrip (13) is sealed to a weatherstrip retainer (14). The weatherstrip retainer

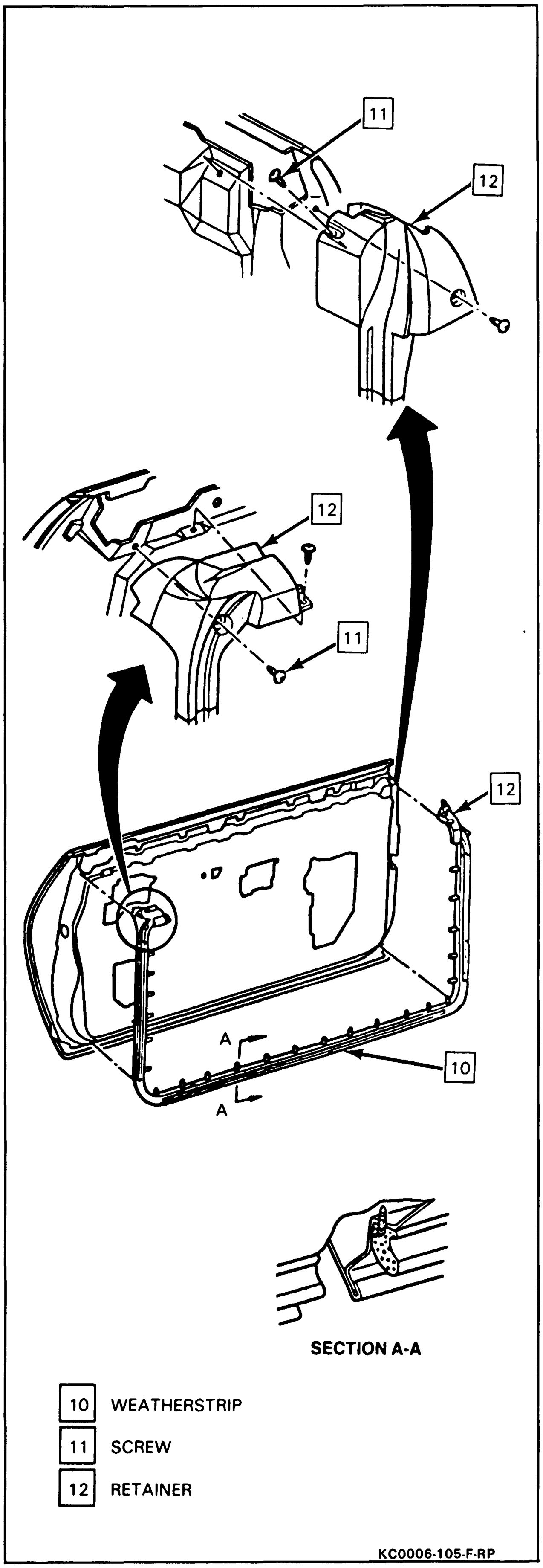


Figure 6 - Installing Weatherstrip

(14) is sealed to the body by a nitrile foam material bonded to the retainer (14). Plastic fasteners (15) retain the rear end of the roof rail weatherstrip (13) to the body.

Remove or Disconnect

Tool Required:

J 21104-B Universal Weatherstrip Remover

1. Plastic fasteners (15) at rear of roof rail weatherstrip (13) with J 21104-B.

NOTICE: To prevent damage to the roof rail weatherstrip during removal, apply an adhesive release agent such as 3M No. 08971, Kent No. 30125, or equivalent, to aid in breaking the adhesive bond.

2. Roof rail weatherstrip (13).
   - Beginning at the front body hinge pillar, carefully pull the roof rail weatherstrip (13) out of the retainer (14) while carefully breaking the sealer bond between the roof rail weatherstrip (13) and the retainer (14) with a flat-bladed tool.

- Mark the position of the retainer (14) on the rail or the pillar.

3. Screws attaching the retainer (14) to the side roof rail.
4. Retainer (14).

Clean

1. Excess sealer from weatherstrip retainer (14).

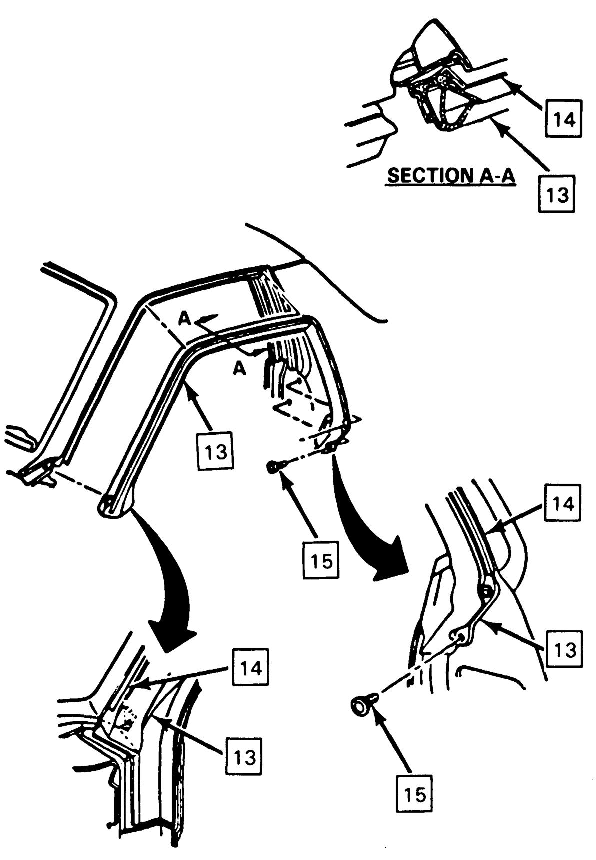
Install or Connect

- Apply a continuous bead of pumpable body caulking compound 100 mm (4 inches) rearward and 100 mm (4 inches) down from the front and rear upper corner of the retainer (14) and along the full length of the body lock pillar retainer.

1. Retainer (14).
2. Retainer attaching screws.

- Apply black weatherstrip adhesive to the outboard flange and outboard surface of the weatherstrip retainers (14).
- Apply black weatherstrip adhesive to the front and rear end details of the side roof rail weatherstrip (13).
- Position the front end of the roof rail weatherstrip (13) to the body.

3. Roof rail weatherstrip (13) to the retainer (14), outboard lip first then inboard lip, using a flat-bladed tool.
4. Plastic fastener (15) at rear end of roof rail weatherstrip (13).



13 ROOF RAIL WEATHERSTRIP
14 RETAINER
15 FASTENER

Figure 7 - Roof Rail Weatherstrip

PRESSURE RELIEF VALVE

Figure 8

Remove or Disconnect

1. Screw (16) retaining pressure relief valve (17) to lock pillar.
2. Pressure relief valve (17) by lifting up and forward to disengage tab of pressure relief valve (17) from lock pillar.

Install or Connect

1. Pressure relief valve (17) to body by placing tab on valve in opening in lock pillar.

NOTICE: See "Notice" on page 10-5-1 of this section.

2. Screw (16).

Tighten

- Screw (16) to 1.9 N·m (17 lb. in.).

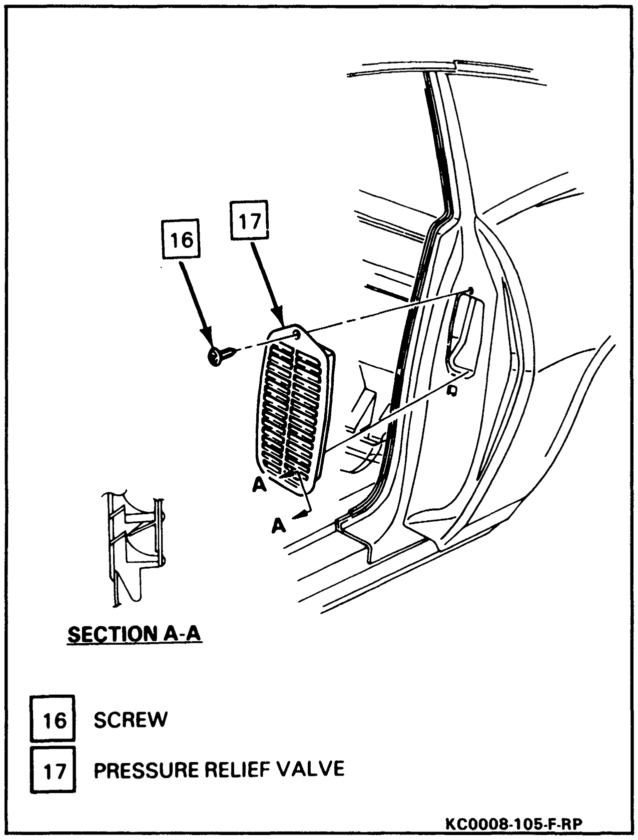


Figure 8 - Pressure Relief Valve

HANDLES

Window Regulator Handle

Figure 9

Remove or Disconnect

Tool Required:
J 9886-01 Door Handle Clip Remover

1. Spring clip (18) by pushing J 9886-01 between the window regulator handle (19) and the door trim panel.
2. Window regulator handle (19) from the window regulator spindle.
3. Bearing plate from window regulator spindle.

Install or Connect

1. Spring clip (18) onto the window regulator handle (19).
2. Bearing plate onto the window regulator spindle.
3. Window regulator handle (19) to window regulator spindle.

Inside Lock Rod Knob

Figure 10

Remove or Disconnect

- Inside lock rod knob (20).
    - Slide lock rod knob (20) forward.

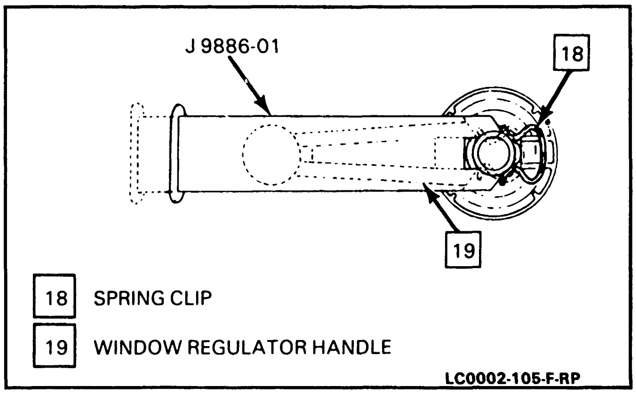


Figure 9 - Removing Window Regulator Handle

    - Insert a small flat-bladed tool behind the end of the lock rod knob (20) and pry it away from the rod.

Install or Connect

- Inside lock rod knob (20).
    - Insert end of the lock rod knob (20) through the hole in the trim pad switch and remote handle mount panel (5).
    - Slide the lock rod knob (20) rearward until the end of the rod engages the depression in the end of the lock rod knob (20).

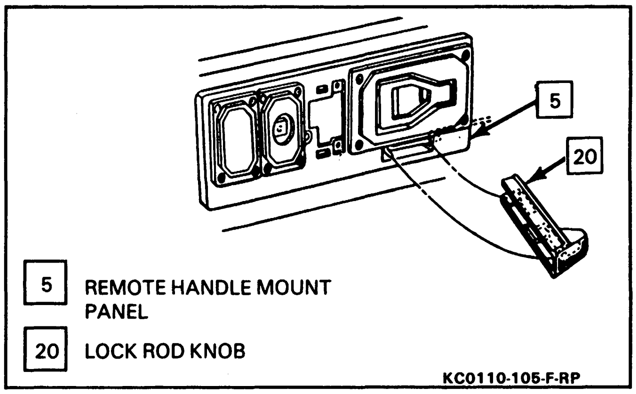


Figure 10 - Lock Rod Knob

Door Lock Inside Handle

Figure 11

Remove or Disconnect

1. Door trim panel. Refer to "Door Trim Panel" in this section.
2. Water deflector. Refer to "Water Deflector" in this section.
- Raise window all the way.
3. Connecting rod clip at inside handle (21).
4. Rod from the inside handle (21).
5. Center pin of attaching rivet (22) using a punch.
6. Rivet (22) using a 3/16-inch drill bit and a drill.
7. Inside handle (21) by sliding forward to disengage front retaining tab.

Install or Connect

1. Inside handle (21).
2. Inside handle rod to the inside handle (21).
3. Connecting rod clip.
4. Rivet (22) 3/16-inch x 5/16-inch USM part number SD62BS or equivalent.
5. Water deflector. Refer to "Water Deflector" in this section.
6. Door trim panel. Refer to "Door Trim Panel" in this section.

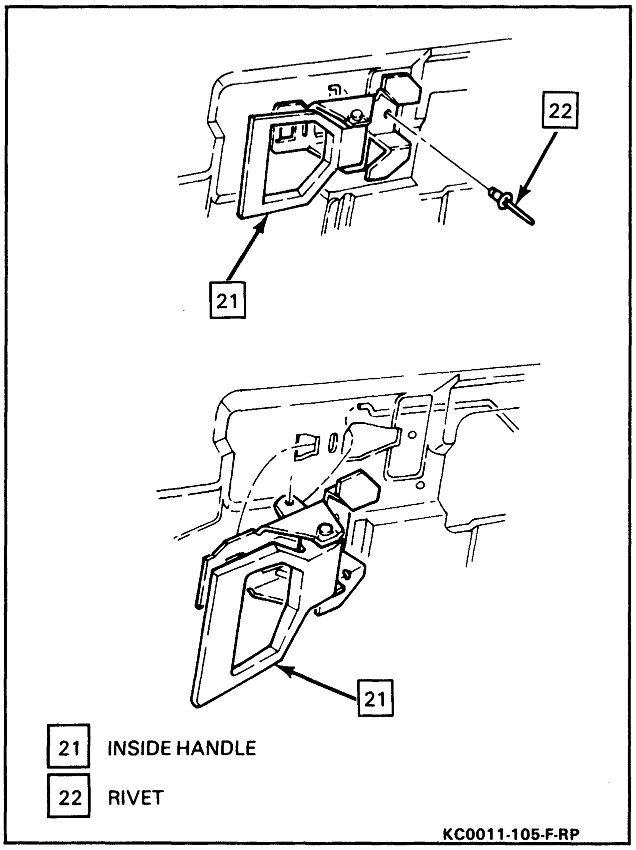


Figure 11 - Door Lock Inside Handle

Outside Handle

Figure 12

Remove or Disconnect

1. Door trim panel. Refer to "Door Trim Panel" in this section.
- Raise the window all the way.
2. Upper edge of the water deflector enough to expose rear access hole.
3. Outside handle (24) from the outside handle-to-lock rod (23) by disengaging the clip (91) from outside handle (24).
4. Nuts (26) from outside handle studs.
5. Outside handle (24).

Install or Connect

1. Outside handle (24).

NOTICE: See "Notice" on page 10-5-1 of this section.

2. Nuts (26) to the outside handle studs.

Tighten

- Nuts (26) to 7 N·m (62 lb. in.).

3. Outside handle (24) to the outside handle-to-lock rod (23) and clip (91).
4. Upper edge of water deflector.
5. Door trim panel. Refer to "Door Trim Panel" in this section.

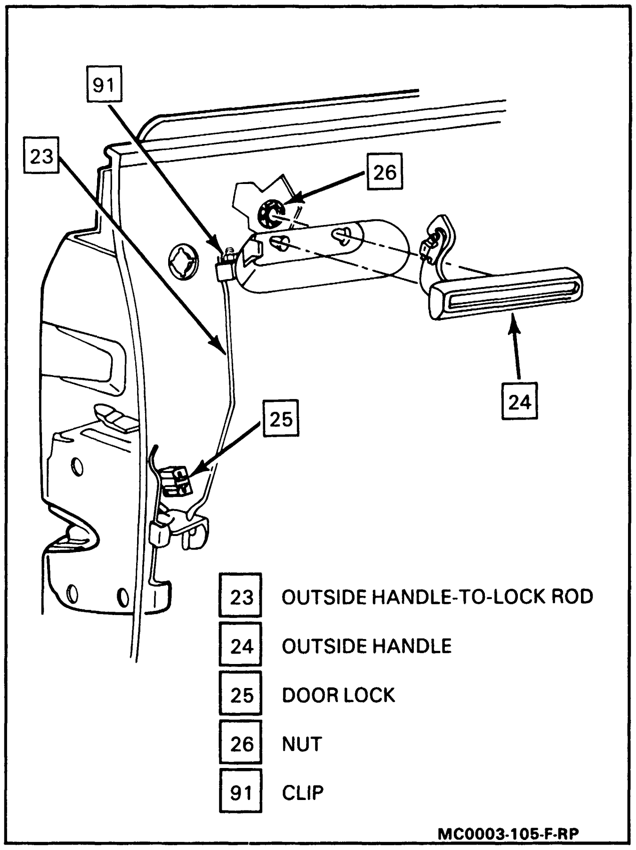


Figure 12 - Outside Handle

SWITCHES

Door Jamb Switch

For information on replacing the door jamb switches, refer to BODY FRONT END (SEC. 10-4).

Power Door Lock Switch

Figure 13

Remove or Disconnect

1. Screws (28) attaching the power door lock switch (27) to the trim pad switch and remote handle mount panel.
2. Power door lock switch (27) from the trim pad switch and remote handle mount panel.
3. Connector (29) from the power door lock switch (27) by releasing the locking tabs.

Install or Connect

1. Connector (29) to the power door lock switch (27) by pressing to engage locking tabs.
2. Power door lock switch (27) to the trim pad switch and remote handle mount panel.

NOTICE: See "Notice" on page 10-5-1 of this section.

3. Screws (28).

Tighten

- Screws (28) to 0.5 N·m (4 lb. in.).

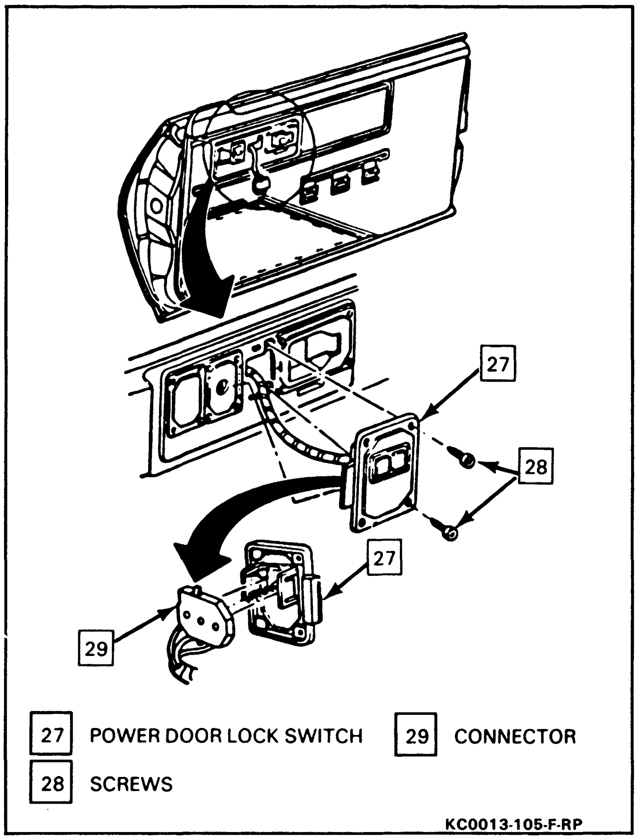


Figure 13 - Power Door Lock Switch

Outside Mirror Electric Touch Control Switch

Figure 14

Remove or Disconnect

1. Screws (32) attaching the mirror touch control switch (30) to the remote handle mount panel (5).
2. Mirror touch control switch (30) from the trim pad switch and remote handle mount panel (5).
3. Connector (31) from the mirror touch control switch (30).

Install or Connect

1. Connector (31) to the mirror control switch (30) by pressing to engage the locking tabs.
2. Mirror touch control switch (30) to the trim pad switch and remote handle mount panel (5).

NOTICE: See "Notice" on page 10-5-1 of this section.

3. Screws (32).

Tighten

- Screws (32) to 0.5 N·m (4 lb. in.).

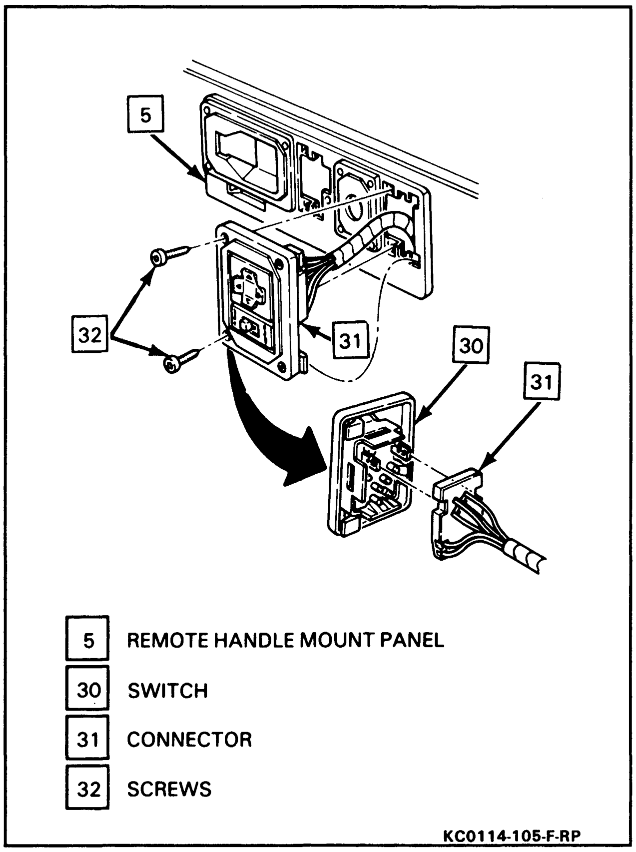


Figure 14 - Mirror Touch Control Switch

GLASS CHANNELS AND GUIDES

Window Guide Cam

Figures 15 and 16

Remove or Disconnect

- Roll the window up halfway.

1. Water deflector. Refer to "Water Deflector" in this section.
2. Bolts (36) retaining the window guide cam (34) to the door inner panel.
3. Window guide cam (34) by pulling up and back and rotating 180 degrees.
4. Window guide cam (34) through rear access hole.

Install or Connect

1. Window guide cam (34) through rear access hole.
2. Window guide cam (34) to window regulator cam and door inner panel.

NOTICE: See "Notice" on page 10-5-1 of this section.

3. Bolts (36) retaining window guide cam (34) to door inner panel.

Tighten

- Bolts (36) to 11 N·m (97 lb. in.).

4. Water deflector. Refer to "Water Deflector" in this section.

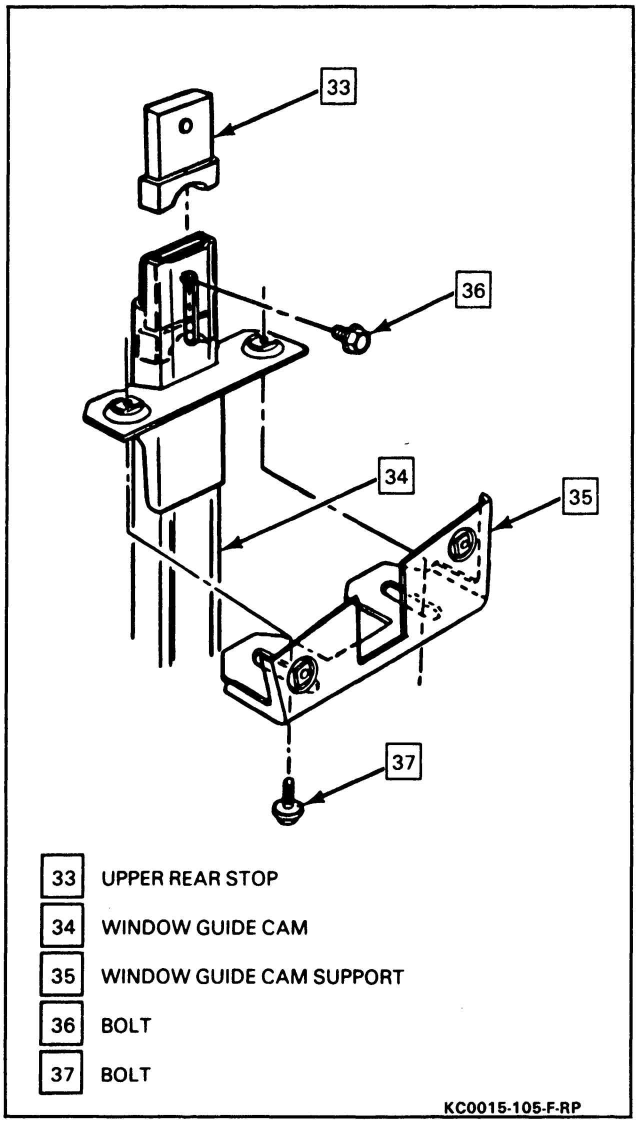


Figure 15 - Window Guide Cam

Door Window Regulator Cam

Figure 17

Remove or Disconnect

1. Water deflector. Refer to "Water Deflector" in this section.
2. Door glass. Refer to "Glass" in this section.

- Slide the regulator cam (38) off the window regulator rollers.

3. Regulator cam (38) from the door through the rear access hole.

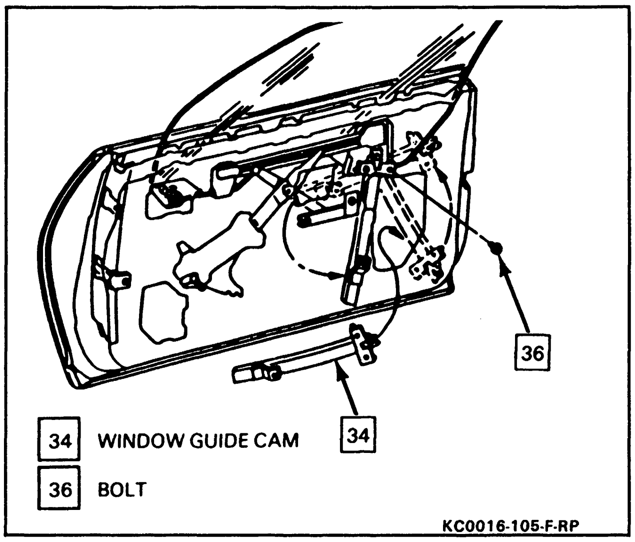


Figure 16 - Installing Window Guide Cam

Install or Connect

1. Regulator cam (38) to the window regulator rollers.
2. Door glass to regulator cam. Refer to "Glass" in this section.
3. Water deflector. Refer to "Water Deflector" in this section.

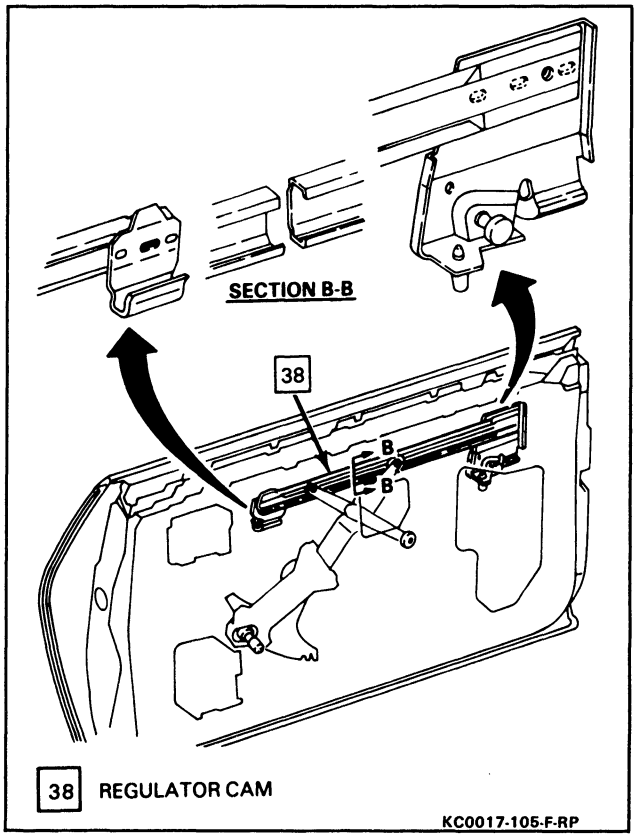


Figure 17 - Door Window Regulator Cam

Inner Panel Cam

Figure 18

Remove or Disconnect

1. Water deflector. Refer to "Water Deflector" in this section.
2. Bolts (41) retaining inner panel cam (40) to the door inner panel.
3. Inner panel cam (40) from window regulator balance arm roller (39).
4. Inner panel cam (40) through access hole.

Install or Connect

1. Inner panel cam (40) to window regulator balance arm roller (39).
2. Inner panel cam (40) to inner door panel.

NOTICE: See "Notice" on page 10-5-1 of this section.

3. Bolts (41) retaining inner panel cam (40) to the door inner panel.

Tighten

- Bolts (41) to 11 N·m (97 lb. in.).

4. Water deflector. Refer to "Water Deflector" in this section.

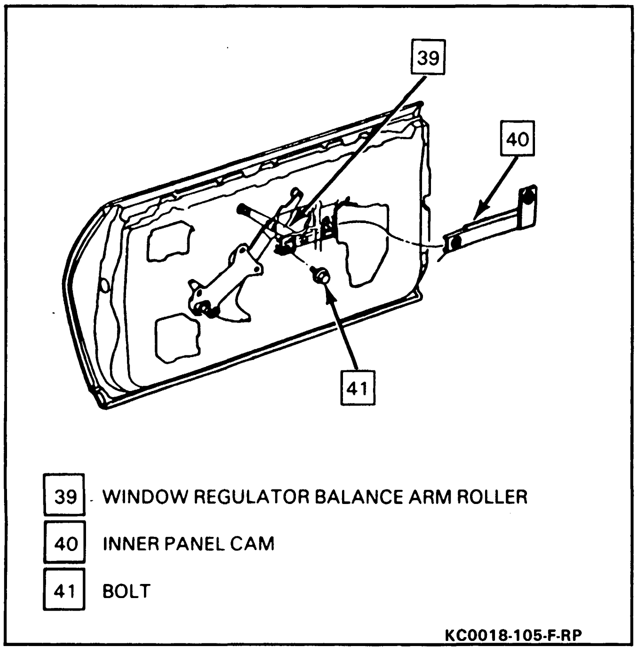


Figure 18 - Inner Panel Cam

Window Glass Run Channel Retainer

Figure 19

Remove or Disconnect

1. Water deflector. Refer to "Water Deflector" in this section.
2. Weatherstrip enough to provide access to the channel retainer (43).

- Loosen the two nuts (42) on the channel retainer support (45).

3. Bolt (44) attaching the channel retainer support (45) to the door inner panel.
4. Channel retainer support (45) by removing nuts (42).
5. Bolts (46) at the channel retainer lower attachment.
6. Channel retainer (43) by pulling up and rotating 90 degrees through the opening at the belt line.

Install or Connect

NOTICE: See "Notice" on page 10-5-1 of this section for steps 4 and 5.

1. Channel retainer (43) through the opening at the belt line.
2. Lower attachment retaining bolt (46).

Tighten

- Bolt (46) to 11 N·m (97 lb. in.).

3. Channel retainer support (45) to the door inner panel.
4. Bolt (44) to channel retainer support (45).

Tighten

- Bolt (44) to 11 N·m (97 lb. in.).

5. Nuts (42) to channel retainer support (45).

Tighten

- Nuts (42) to 11 N·m (97 lb. in.).

6. Weatherstrip.
7. Water deflector. Refer to "Water Deflector" in this section.

WATER DEFLECTOR

Figure 20

Waterproof deflectors are used to seal the door inner panel and prevent entry of water into the body. The deflector is secured by an adhesive sealer material along the front edges, rear edges and bottom, and by the application of waterproof sealing tape. Whenever work is performed where the water deflector has been disturbed, the deflector must be properly sealed and taped to the inner panel to prevent waterleaks. For service sealing, strip caulking is recommended if additional sealing material is required.

When access to the inner panel is required to perform service operations, the deflector may be completely or partially detached from the inner panel. If the existing water deflector is damaged so that it will not properly seal the door, replace the deflector. The water deflector is available as a service part.

The following procedure covers complete removal and installation of the water deflector. If only partial removal of the deflector is required, perform only those steps which are necessary to expose the required area of the door inner panel.

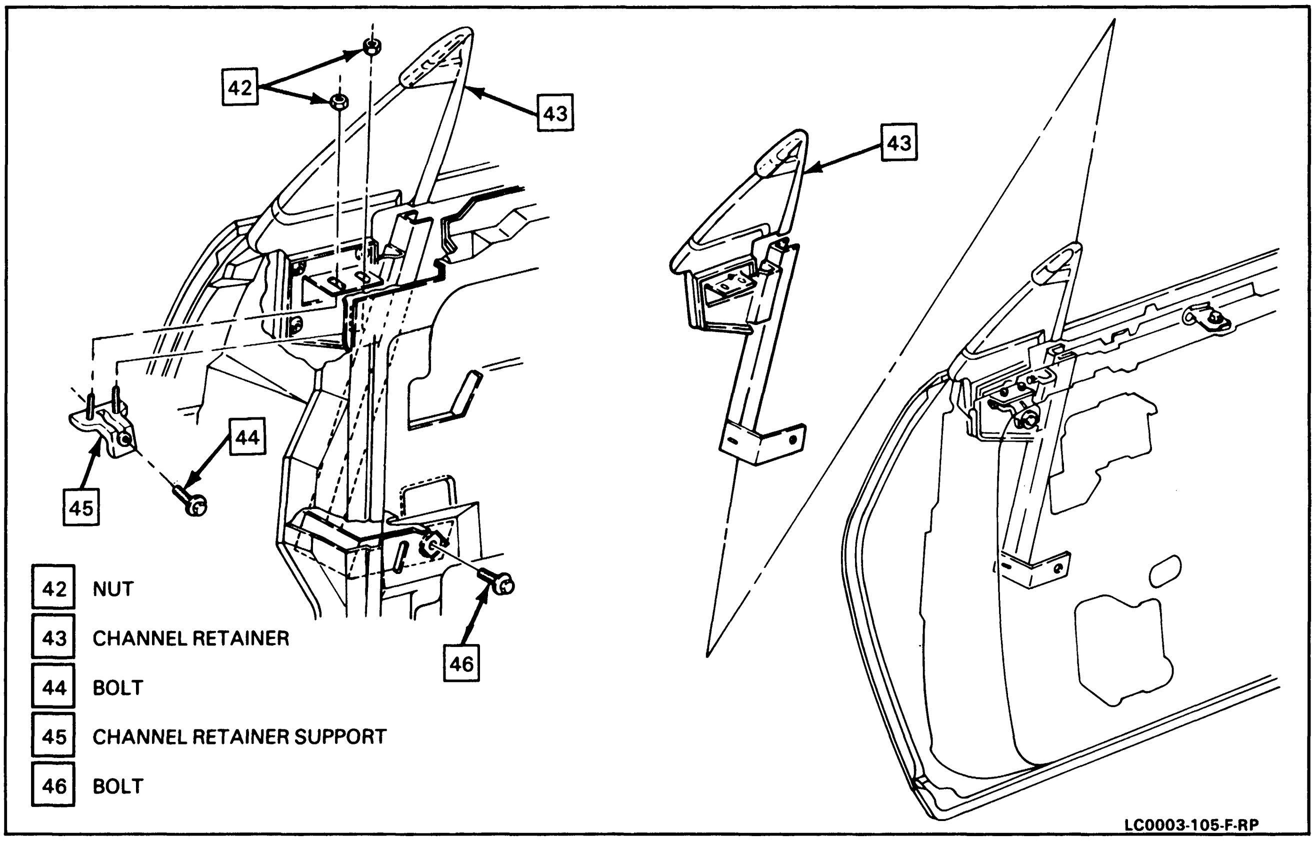


Figure 19 - Window Glass Run Channel Retainer

Remove or Disconnect

1. Door trim panel. Refer to "Door Trim Panel" in this section.
2. Water deflector (47).
   - Use a flat-bladed tool to break the sealer bond between the water deflector (47) and the door inner panel.
3. Tape from the door inner panel, carefully.
4. Water deflector (47) from the door inner panel drain slot.
5. Water deflector (47).

Inspect

- Water deflector (47) for tears or holes. Repair tears or holes using waterproof body tape on both sides of the water deflector (47).

Install or Connect

1. Water deflector (47).
   - Apply a string sealer in a continuous bead that will guide water to the drain slots.
   - Insert the water deflector tabs in the door inner panel.
   - Firmly press the edges of the water deflector (47) to obtain a good bond between the water deflector sealer and the door inner panel.
   - Apply body caulking to any screw heads or piercings in the door inner panel below the water deflector (47).
2. Door trim panel. Refer to "Door Trim Panel" in this section.

SEALING STRIPS

Bottom Sealing Strip

Figure 21

Remove or Disconnect

1. Door trim panel. Refer to "Door Trim Panel" in this section.
2. Bottom sealing strip (48) from fasteners (92) on door trim panel (1).

Install or Connect

1. Bottom sealing strip (48) to fasteners (92) on door trim panel (1).
   - Push bottom sealing strip (48) downward to secure.
2. Door trim panel. Refer to "Door Trim Panel" in this section.

Window Belt Inner Sealing Strip

Tool Required:

J 28626-A Inverted Nut Driver

Remove or Disconnect

1. Door trim panel. Refer to "Door Trim Panel" in this section.

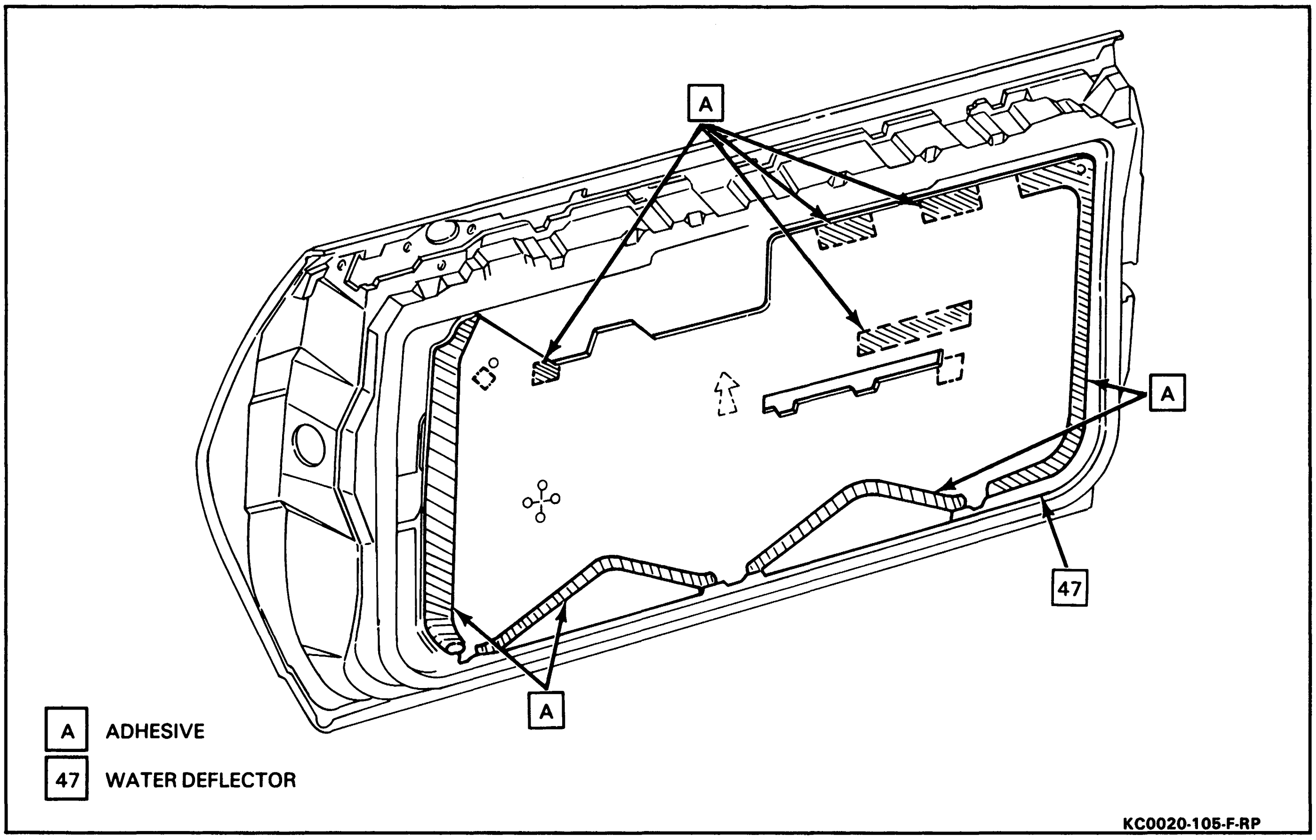


Figure 20 - Water Deflector

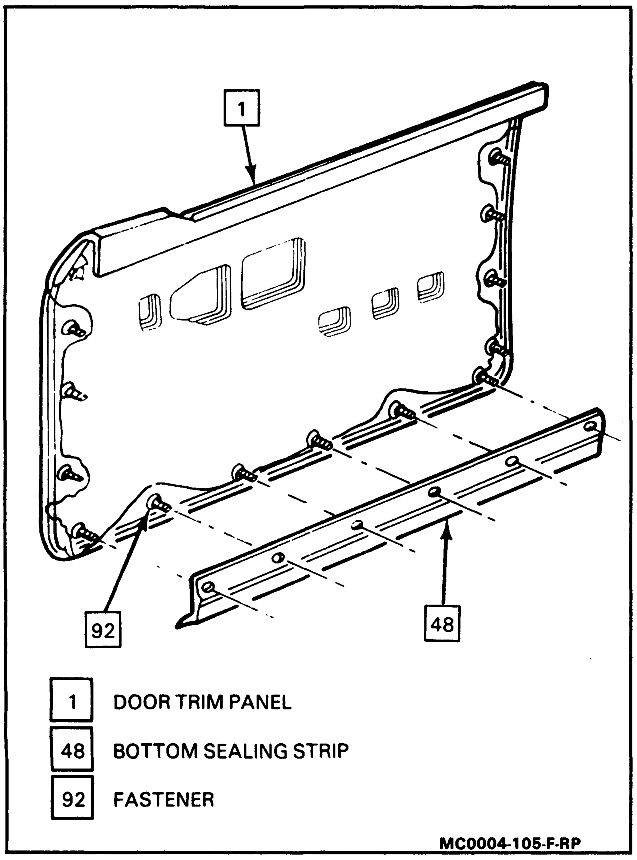


Figure 21 - Bottom Sealing Strip

2. Inverted nuts attaching the window sealing strip to the door trim panel using J 28626-A.
3. Window sealing strip.

Install or Connect

1. Window sealing strip.
2. Inverted nuts attaching window sealing strip to door trim panel using J 28626-A.
3. Door trim panel. Refer to "Door Trim Panel" in this section.

Window Belt Outer Sealing Strip

Figure 22

Remove or Disconnect

- Apply a cloth-backed tape as a protective cover over the painted surface of the door next to the window belt outer sealing strip (49).

1. Water deflector. Refer to "Water Deflector" in this section.
2. Door glass. Refer to "Glass" in this section.
3. Screws (50) retaining window belt outer sealing strip (49) to door.
4. Window belt outer sealing strip (49) by pulling up and out of the door inner panel.

Install or Connect

1. Window belt outer sealing strip (49) to door inner panel.
2. Screws (50) retaining window belt outer sealing strip (49) to door.

3. Door glass. Refer to "Glass" in this section.
4. Water deflector. Refer to "Water Deflector" in this section.

- Remove cloth-backed tape.

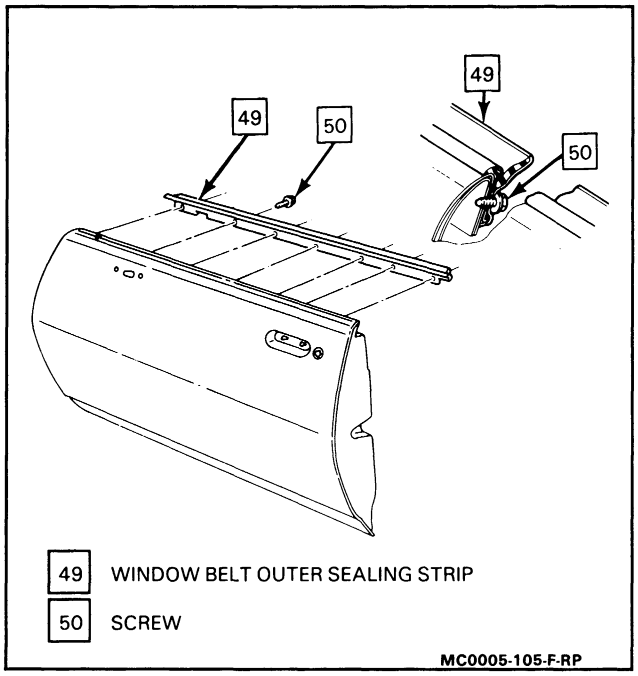


Figure 22 - Window Belt Outer Sealing Strip

MIRRORS AND MIRROR CABLES

Mirror Face

Remove or Disconnect

CAUTION: To minimize the chance of personal injury, gloves and safety glasses should be worn when removing broken glass.

NOTICE: When breaking the mirror, cover the door area surrounding the mirror to avoid damage to the paint.

- Mirror face from the mirror assembly.
  - Place tape over the mirror face.
  - Break the mirror face.
  - Remove the broken pieces from the mirror assembly.

Clean

- Inside of the mirror frame with a clean cloth.

Install or Connect

- Mirror face.
  - Remove paper backing to expose adhesive.
  - Press the mirror face firmly onto the center of the mirror frame.

Outside Standard Mirror

Figure 23

Remove or Disconnect

1. Door trim panel. Refer to "Door Trim Panel" in this section.
2. Water deflector far enough to obtain access to the mirror retaining nuts.
3. Nuts from mirror base studs.
4. Standard mirror (51).

Install or Connect

- Align mirror gasket on door outer panel.

1. Standard mirror (51) to door outer panel.

NOTICE: See "Notice" on page 10-5-1 of this section.

2. Nuts to mirror base studs.

Tighten

- Nuts to 5 N·m (44 lb. in.).

3. Area of water deflector previously detached.
4. Door trim panel. Refer to "Door Trim Panel" in this section.

Outside Remote Control Mirror

Figures 23 and 24

Remove or Disconnect

1. Door trim panel. Refer to "Door Trim Panel" in this section.
2. Screws (57) retaining remote control mirror escutcheon (54) to the trim pad switch and remote handle mount panel (5).
3. Escutcheon (54) from the trim pad switch and remote handle mount panel (5).
4. Retainer (56) from the rear of the escutcheon (54).
5. Remote control mirror cable (55) from the escutcheon (54).
6. Water deflector far enough to gain access to mirror retaining nuts.
7. Nuts from mirror base studs.
8. Remote control mirror (52) with the cable (55).

Install or Connect

NOTICE: See "Notice" on page 10-5-1 of this section.

1. Remote control mirror (52) with the cable (55).
2. Nuts to the mirror base studs.

Tighten

- Nuts to 5 N·m (44 lb. in.).

3. Area of water deflector previously detached.

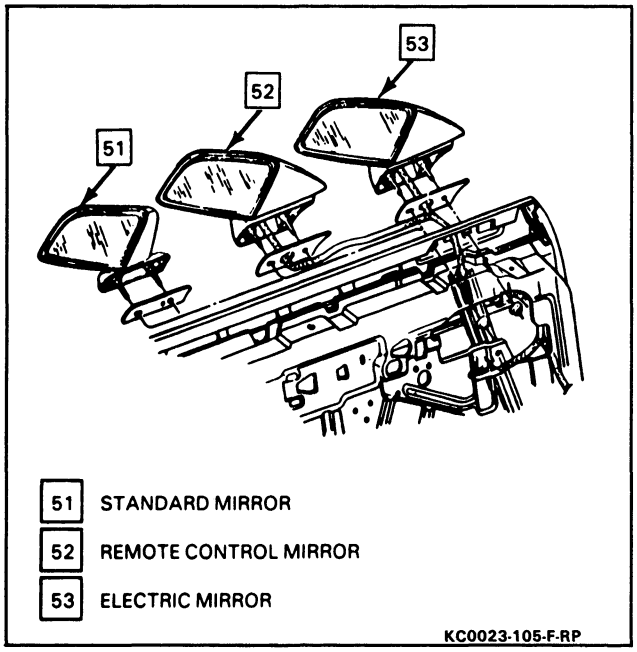


Figure 23 - Outside Mirrors

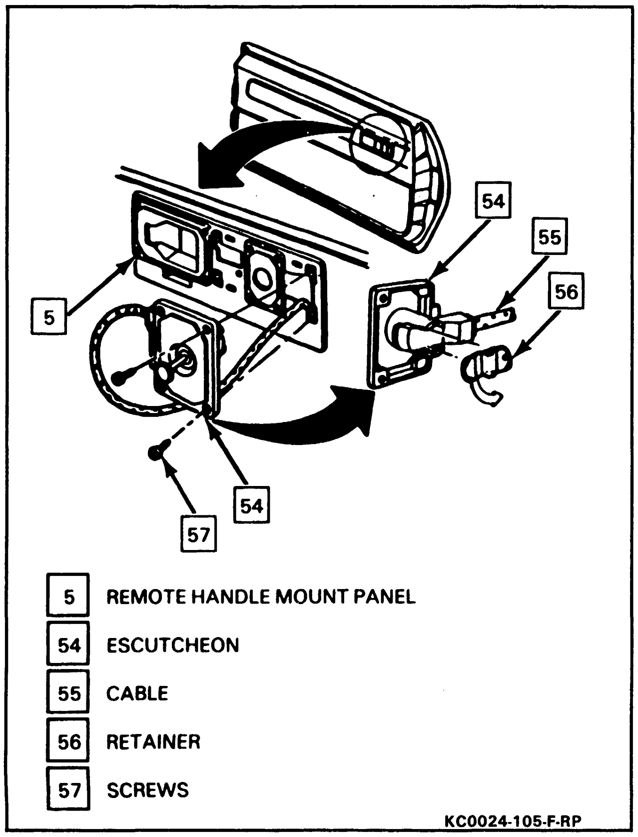


Figure 24 - Remote Mirror Control

4. Remote control mirror cable (55) to the escutcheon (54).
5. Retainer (56) to the escutcheon (54).
   - Rotate retainer (56) 90 degrees counterclockwise to secure.
6. Escutcheon (54) to the trim pad switch and remote handle mount panel (5).
7. Screws (57) retaining the escutcheon (54) to the trim pad switch and remote handle mount panel (5).

Tighten

- Screws (57) to 0.5 N·m (4 lb. in.).

8. Door trim panel. Refer to "Door Trim Panel" in this section.

Outside Remote Control Electric Mirror

Figure 23

Remove or Disconnect

1. Outside mirror electric touch control switch. Refer to "Switches" in this section.
2. Door trim panel. Refer to "Door Trim Panel" in this section.
   - Peel back the water deflector enough to detach the wiring harness from the retaining tabs in the door.
3. Nuts retaining the mirror base to door.
4. Electric mirror (53) with the wiring harness.

Install or Connect

1. Electric mirror (53) with the wiring harness to the door outer panel.
2. Nuts retaining the mirror base to the door outer panel.

   Tighten

   - Nuts to 5 N·m (44 lb. in.).
3. Wiring harness to the retaining tabs in the door.
4. Water deflector to the area where it was previously removed.
5. Door trim panel. Refer to "Door Trim Panel" in this section.
6. Outside mirror electric touch control switch. Refer to "Switches" in this section.

SPEAKERS

For information on removal and installation of the front instrument panel mounted speakers, refer to AUDIO SYSTEMS (SEC. 9A).

For information on the removal and installation of the side shroud finishing trim panel mounted speakers, refer to BODY FRONT END (SEC. 10-4).

SPRING CLIPS

Figure 25

Spring clips are used to secure remote control lock connecting rods and inside locking rods to door lock levers and remote handles. A slot in the clip provides for disengagement of the clips, allowing easier detachment of linkage. To disengage a spring clip, use a screwdriver or other suitable thin-bladed tool to slide clip (60) out of engagement. To engage a spring clip (60), use a screwdriver or other suitable thin-bladed tool to slide the clip (60) onto the engagement.

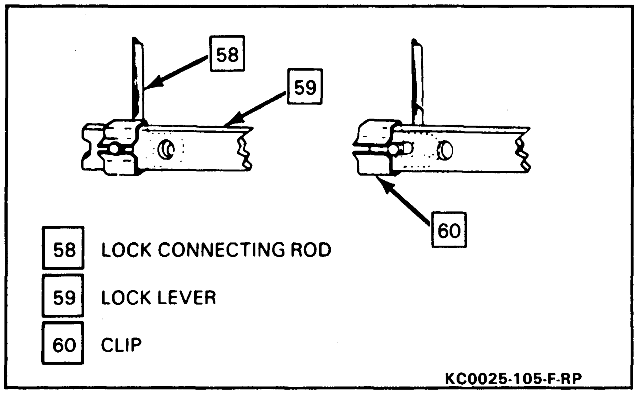


Figure 25 - Removing Spring Clip

DOOR LOCKS AND STRIKERS

Door Locks

Figures 26 through 28

> **CAUTION: Do not attempt to repair a broken lock. A lock malfunction may result in serious bodily injury. A broken lock must be replaced.**

Remove or Disconnect

- Raise the window.

1. Water deflector. Refer to "Water Deflector" in this section.
2. Inside handle-to-lock rod from the door lock (25).
3. Inside locking-to-lock rod (61) from the door lock (25).
4. Outside handle-to-lock rod (23) from the door lock (25).
5. Lock cylinder-to-lock rod (62) from the door lock (25).
6. Door lock screws.
7. Door lock (25).

Install or Connect

NOTICE: See "Notice" on page 10-5-1 of this section.

1. Door lock (25).
2. Door lock screws.

Tighten

- Screws to 7 N·m (62 lb. in.).

3. Lock cylinder-to-lock rod (62) to the door lock (25).
4. Outside handle-to-lock rod (23) to the door lock (25).
5. Inside locking-to-lock rod (61) to the door lock (25).
6. Inside handle-to-lock rod to the door lock (25).
7. Water deflector. Refer to "Water Deflector" in this section.

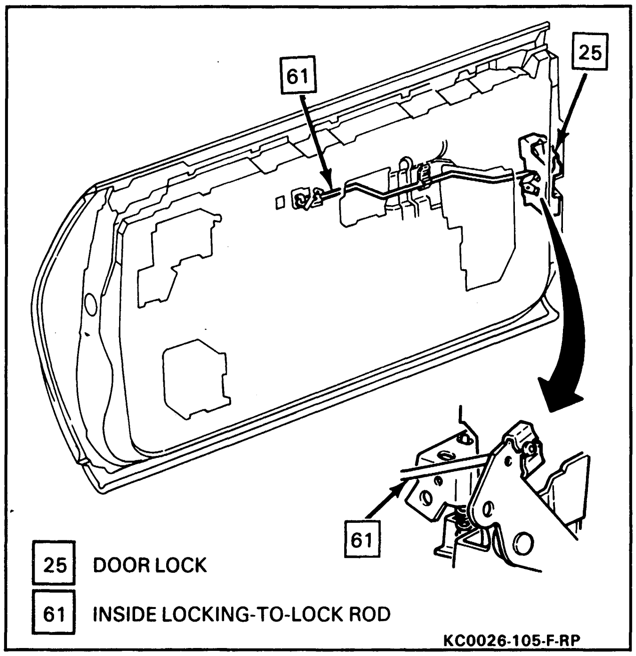


Figure 26 - Inside Locking-to-Lock Rod

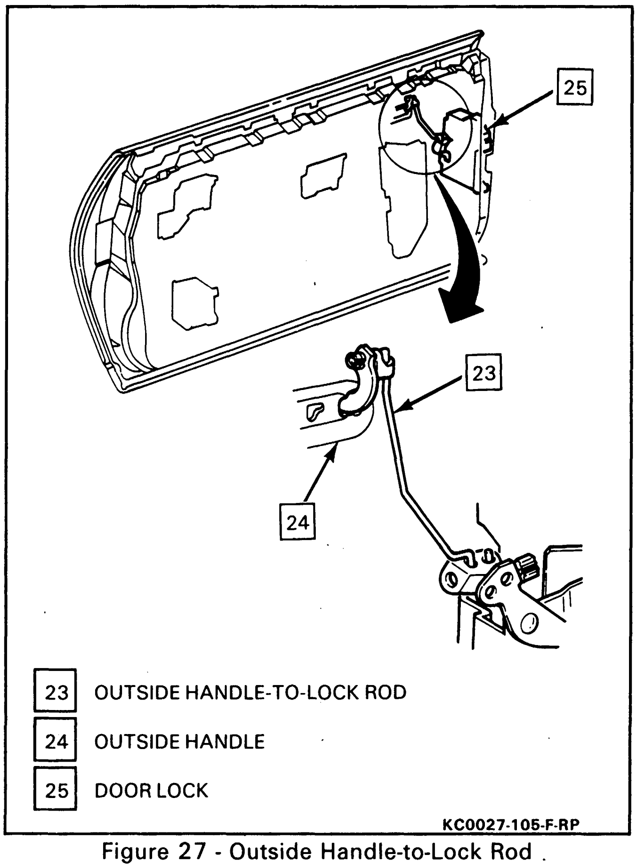


Figure 27 - Outside Handle-to-Lock Rod

Door Lock Striker Adjustment

Figures 29 through 31

The door lock striker consists of a single metal bolt and washer assembly that is threaded into a tapped, floating anchor plate located in the body lock pillar. The door is secured in the closed position when the door lock fork bolt snaps over and engages the striker bolt.

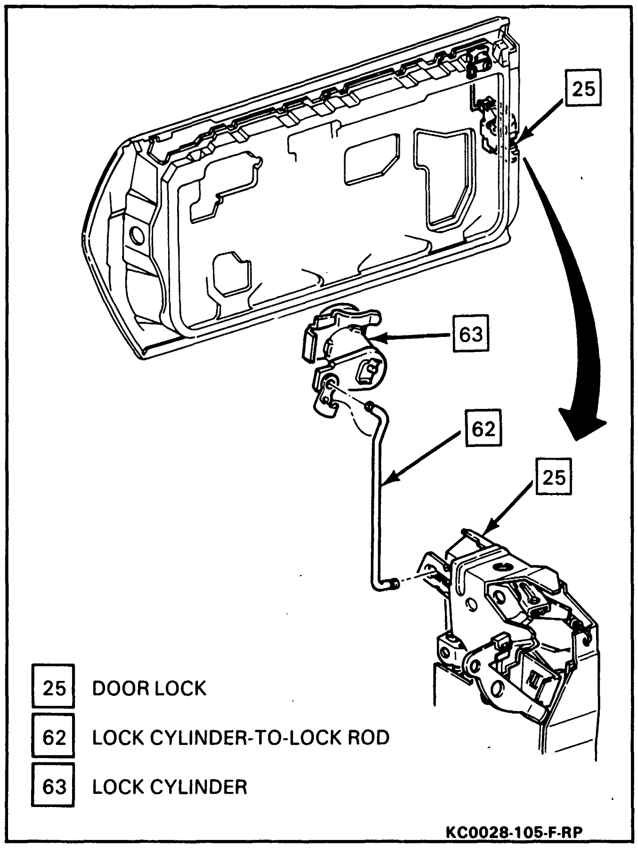


Figure 28 - Lock Cylinder-to-Lock Rod

Important

- The door must be properly aligned prior to adjusting the door lock striker.

Adjust

NOTICE: See "Notice" on page 10-5-1 of this section.

- Door lock striker bolt (65).
  - Loosen the striker bolt (65).
  - Shift the striker bolt (65) up or down, inboard or outboard, as required.
    - Striker bolt (65) should enter the center of the striker opening and should not pull the door up or down when closed.
  - Apply modeling clay or body caulking compound to the lock striker opening on the door lock.
- Close the door only far enough for the lock striker bolt (65) to make an impression in the clay or caulking compound. Closing the door too far will make it difficult to remove the clay or caulking compound.
- Open the door and check the forward and rearward adjustment.
  - The striker bolt impression should be centered forward and rearward.
  - The minimum allowable distance between the forward edge of the door lock fork bolt and the rear edge of the impression is 2 mm (3/32-inch).
  - A 2 mm (3/32 inch) spacer, GM part number 4469196 or equivalent, is available to achieve the desired forward and rearward alignment.
- If forward or rearward adjustment is needed:
  - Mark the location of the striker bolt (65) on the body.
  - Remove the striker bolt (65), washer (66) and any spacers (67).
  - Add or remove spacers (67) as needed.
  - Install the striker bolt (65), washer (66) and any spacers (67) to the location marked on the body.

Tighten

- Striker bolt (65) to 53 N•m (39 lb. ft.).

- Touch up any exposed, unpainted metal.
- Additional striker adjustment, up or down and in or out can be made using the following procedure:
  - Remove the striker. Refer to "Door Lock Striker" in this section.

NOTICE: It is important that a flat end rotary file be used to enlarge the striker bolt hole so that the tapped anchor plate is not damaged. The striker bolt and the tapped anchor plate are important attaching parts that could affect the performance of vital components and systems.

- Enlarge the striker bolt hole in the direction required.
- Install striker bolt (65), washer (66) and any spacers (67) to the correct position. Refer to "Door Lock Striker" in this section.

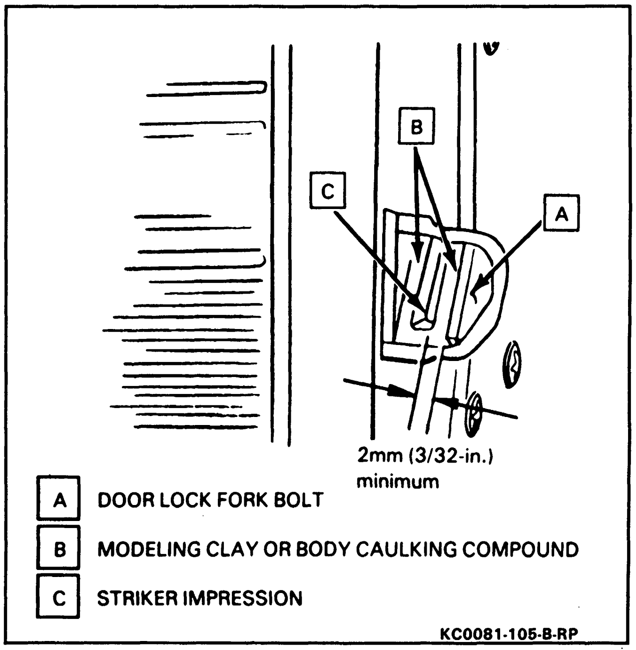


Figure 29 - Door Lock Striker Forward and Rearward Adjustment

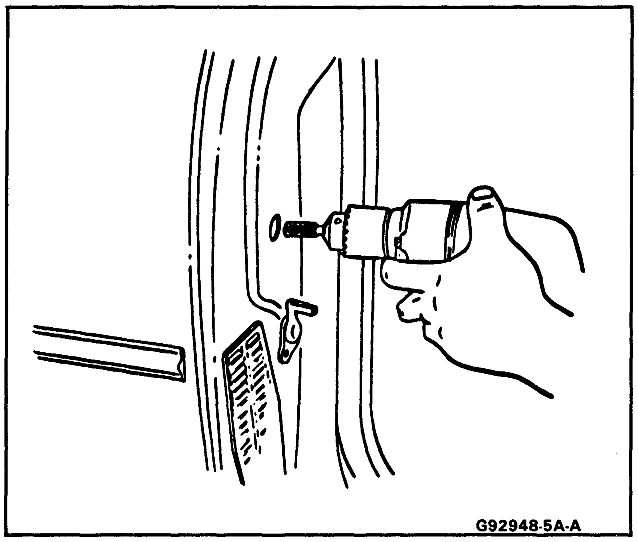


Figure 30 - Enlarging Striker at Bolt Hole

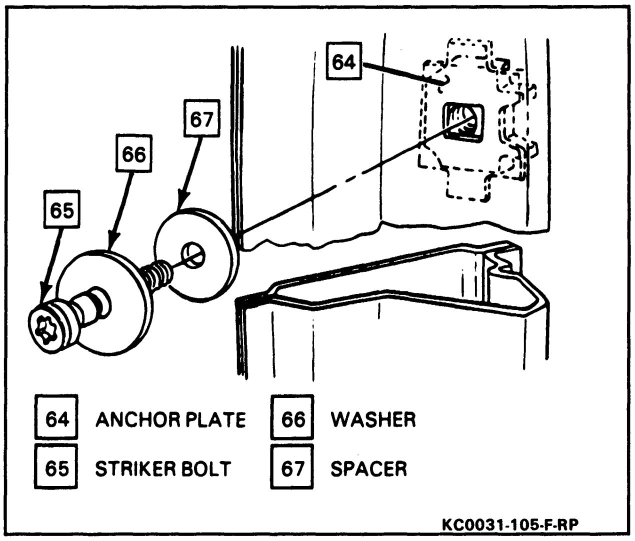


Figure 31 - Installing Door Lock Striker

Door Lock Striker

Figure 31

Remove or Disconnect

- Mark the position of the door lock striker on the body using a pencil.
- Door lock striker bolt (65), washer (66), and any spacers (67).

Install or Connect

NOTICE: See "Notice" on page 10-5-1 of this section.

- Door lock striker bolt (65), washer (66) and spacers (67), if needed, to location marked on the body.

Tighten

- Striker to 53 N·m (39 lb. ft.).

Inspect

- Engagement of lock fork bolt to door lock striker. If adjustment is needed, refer to "Door Lock Striker Adjustment" in this section.

Door Wedge Plate

Figure 32

To achieve a friction fit between the door and the wedge plate (70), silencers (68 and 69) can be removed or added as required to the wedge plate (70). The addition of silencers (68 and 69) may require longer screws (72) to retain the wedge plate (70) to the door. Silencers (68 and 69) are available in 1 mm and 2 mm thicknesses.

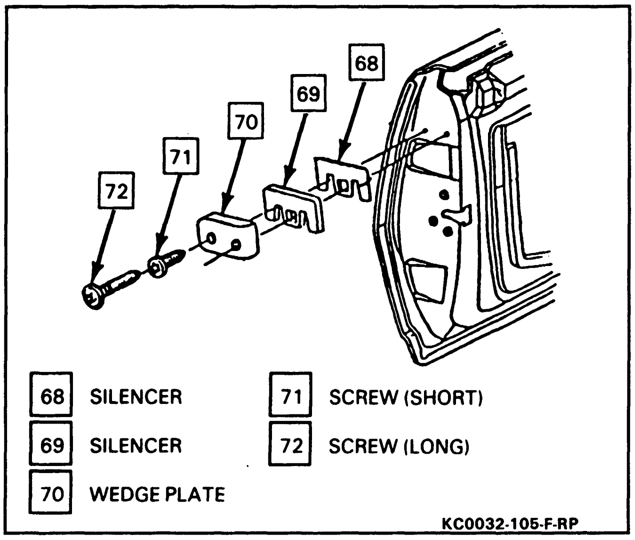


Figure 32 - Door Wedge Plate

LOCK CYLINDERS

Figures 28 and 33

Remove or Disconnect

- Raise the window all the way up.

1. Door trim panel. Refer to "Door Trim Panel" in this section.
2. Water deflector enough to gain access to the lock cylinder.
3. Lock cylinder-to-lock rod (62) from lock cylinder (63).

   CAUTION: If removing lock cylinder retainer by hand, wear gloves to prevent personal injury.

4. Lock cylinder retainer (73).
   - Slide retainer (73) forward using a screwdriver or a similar tool until disengaged.
   - If removing the lock cylinder (63) by hand, grasp the anti-theft shield at the top of the

retainer (73) and rotate until lock cylinder is disengaged.

5. Lock cylinder (63).
6. Lock cylinder gasket (74).

- For information on assembling and coding lock cylinders, refer to GENERAL BODY SERVICE PROCEDURES (SEC. 10-1).

Install or Connect

- Lubricate black lock cylinders with a light oil.
- Lubricate all other lock cylinders with a general purpose silicone lubricant.

1. Lock cylinder gasket (74) to the lock cylinder (63).
2. Lock cylinder (63) to the door.
3. Retainer (73) to the shoulder of the lock cylinder (63).
4. Lock cylinder-to-lock rod (62) to the lock cylinder (63).
5. Water deflector to the area from which it was previously removed.
6. Door trim panel. Refer to "Door Trim Panel" in this section.

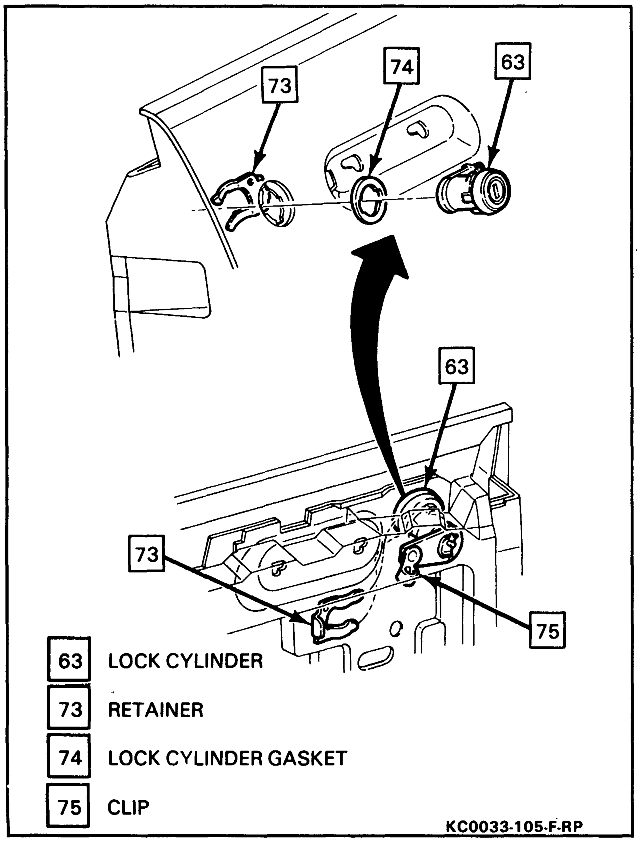


Figure 33 - Lock Cylinder

Bellcrank (Power Door Locks)

Remove or Disconnect

- Raise the window all the way.

1. Water deflector. Refer to "Water Deflector" in this section.
2. Center pin of the rivet retaining the bellcrank to the door inner panel by punching out.
3. Rivet using a 3/16-inch drill bit and a drill.
4. Inside lock knob-to-bellcrank rod from the bellcrank.
5. Bellcrank-to-actuator rod from bellcrank.
6. Bellcrank-to-lock rod from bellcrank.
7. Bellcrank.

Install or Connect

Tool Required:

J 34940 Heavy Duty Rivet Gun

1. Bellcrank-to-lock rod to the bellcrank.
2. Bellcrank-to-actuator rod to the bellcrank.
3. Inside lock knob-to-bellcrank rod to the bellcrank.
4. Tab on the bellcrank to the slot in the door inner panel.
5. Bellcrank using a 3/16 x 5/16-inch rivet and J 34940.
6. Water deflector. Refer to "Water Deflector" in this section.

DOORS

Remove or Disconnect

Tool Required:

J 36604 Door Hinge Spring Compressor

- Steps 1 through 4 apply only to doors equipped with power-operated components.

1. Water deflector. Refer to "Water Deflector" in this section.
2. Wire harness from all components in the door.
3. Rubber conduit from the door.
4. Wire harness from the door through the conduit access hole.

- Tape the area on the door pillar and the body pillar above the lower hinge with cloth-backed body tape.

CAUTION: Before removing the door hinge spring, cover the spring with a shop cloth to prevent the spring from flying off and causing personal injury or damage.

5. Door hinge spring using a long flat-bladed screwdriver or J 36604.
   - Using a screwdriver:
     - Insert the screwdriver under the pivot point of the hold-open link and over the top of the spring. Do not apply pressure to the hold-open link.
     - Lift the screwdriver to disengage the spring.
   - Using J 36604:
     - Insert the blades of J 36604 between the spring coils.
     - Turn the barrel nut to compress and hold the spring.

   - Remove the spring and J 36604 from the hinge assembly. Do not remove the spring from J 36604.
6. Hinge pin clips.
   - Spread the clip and move it above the recess in the pin.
   - As the pin is removed, the clip will ride on the pin, and fall free of the pin.
7. Lower hinge pin.
   - With the aid of a helper to support the door, use a soft-headed hammer and locking-type pliers to remove the pin.
   - Insert a bolt into the hole of the lower hinge to maintain door attachment during upper hinge removal.
8. Upper hinge bolts from the pillar using a 13 mm socket.
9. Bolt from the lower hinge.
10. Door from the body.

Install or Connect

Tool Required:

J 36604 Door Hinge Spring Compressor

- Before installing the door, replace the hinge pin clip, if available, or reuse the old clip.

1. Door to the hinge straps with the aid of a helper.
2. Insert a bolt into the hole of the lower hinge.
3. Upper hinge bolts to the pillar.

- Remove the bolt from the lower hinge.

4. Lower hinge pin.
5. Hinge spring.
   - Place the new spring in J 36604.
   - Turn the barrel nut until the spring is fully compressed.
   - Place J 36604 into position in the lower hinge.
   - Turn the barrel nut of J 36604 to release the spring.
   - Remove J 36604 from the door hinge.
   - Check the operation of the spring.

- Remove the tape from the door and the body pillars.

6. Wiring harness for power operated components through the conduit access hole.
7. Rubber conduit to the door.
8. Wiring harness to all the power-operated components in the door.
9. Water deflector. Refer to "Water Deflector" in this section.

HINGES

NOTICE: See "Notice" on page 10-5-1 of this section.

The door hinges are made of steel and are welded to the door and bolted to the body hinge pillars. No adjustment provisions are used in this type system. The upper hinge is a one-piece type. The lower hinge is made up of a door side and body side strap with a removable hinge pin. The removable hinge pin has a barrel-type retaining clip and a serrated shank near the head, which provides a friction fit with the mating surface on the hinge. All service hinge straps have holes to permit bolt-on installation. Tapped anchor plates must be used instead of nuts and washers to insure structural integrity when replacing a door side hinge strap assembly. No service welding is required when replacing door hinge straps. The door lower hinge has an integral two stage hold-open feature. Door side and body side hinge straps, hinge pins, tapped anchor plates, hinge bolts and bushings are available as separate service parts.

Door Side Hinge Strap

Figures 34 through 37

Remove or Disconnect

1. Water deflector. Refer to "Water Deflector" in this section.
2. Door. Refer to "Doors" in this section.

- Punch the upper and lower inboard corners of the upper and lower door hinge straps (77 and 80) using a center punch.
- Scribe the location of the upper and lower door hinge straps (77 and 80) on the door hinge pillar.

Important

- When drilling out welds, drill only deep enough to penetrate the hinge base in order to release the hinge from the panel.

- Using a 1/8-inch hole as a guide, drill out the welds with a 1/2-inch drill bit.
- A slight amount of weld may still retain the hinge base to the panel. If so, drive a chisel between the panel and the hinge base to separate the hinge from the panel.

Install or Connect

NOTICE: Do not substitute nuts and bolts for tapped anchor plates. Tapped anchor plates (available as service parts) must be used to maintain the structural integrity of the door hinge system.

- Position the replacement bolt-on hinge within the scribe marks on the hinge pillar facing.
- Punch the bolt hole locations in the hinge pillar using a center punch.
- Drill the hinge attaching holes using a 1/2-inch drill bit. These holes will provide for some in and out door adjustment when reinstalling the door assembly.
- Coat with a medium-bodied sealer the surface of the hinge strap that mates with the hinge pillar.

1. Upper and lower door hinge straps (77 and 80) within the scribe marks.

NOTICE: See "Notice" on page 10-5-1 of this section.

2. Bolts (83) and service anchor plate (84).

Tighten

- Bolts (83) to 31 N·m (23 lb. ft.).

3. Door. Refer to "Doors" in this section.

Important

- When the upper and lower door hinge straps (77 and 80) have been replaced and the door reinstalled, do not close the door completely until a visual check is made to determine if the lock fork bolt will correctly engage with the striker. If the lock fork bolt will not correctly engage with the striker, adjust the striker. Refer to "Door Lock Striker Adjustment" in this section.

4. Water deflector. Refer to "Water Deflector" in this section.

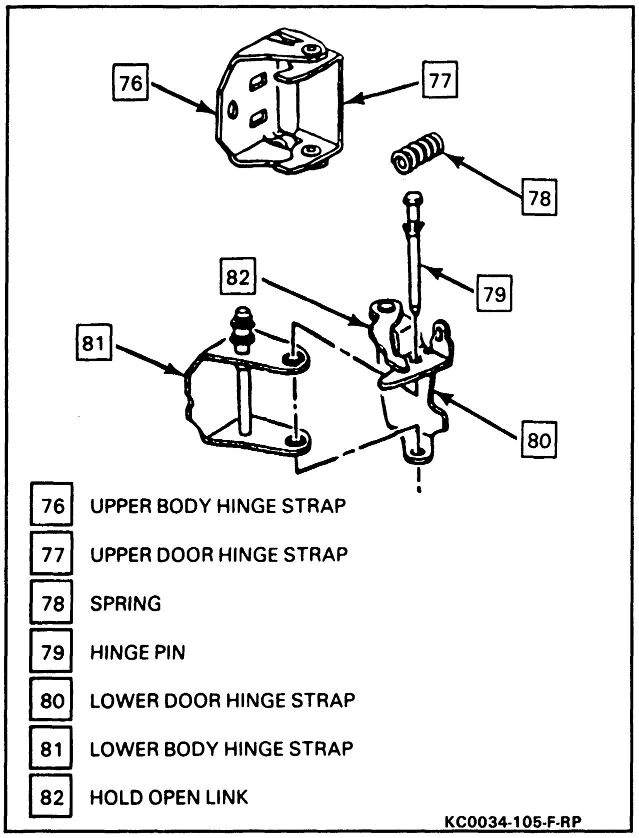


Figure 34 - Door Hinge System

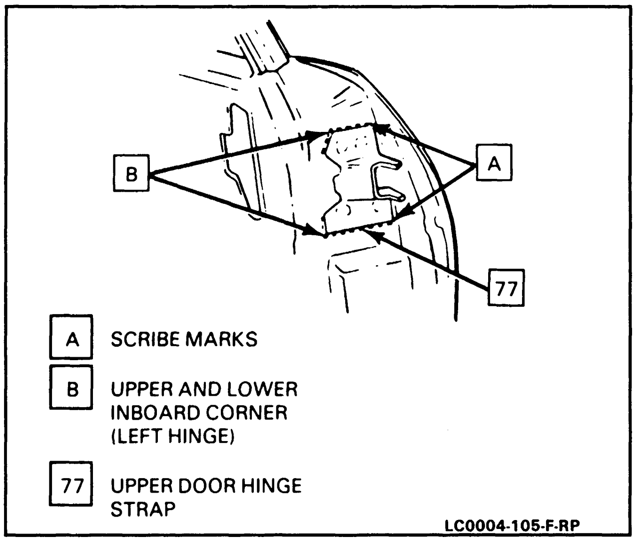


Figure 35 - Removing Hinge Strap from Door

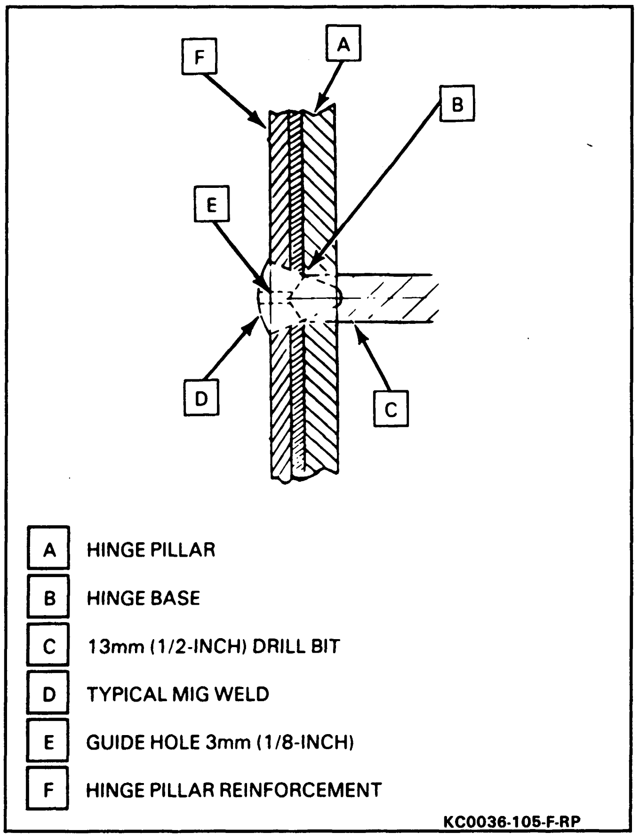


Figure 36 - Door Hinge Weld

Body Side Hinge Strap

Figure 38

Remove or Disconnect

1. Door. Refer to "Doors" in this section.

- With a center punch, mark the location of the upper or lower body hinge strap (76 or 81) on the body hinge pillar.

2. One of the following items, depending on which hinge strap is being repaired:
   - Left hand lower hinge.
     - Remove left hand shroud side trim finishing panel. Refer to BODY FRONT END (SEC. 10-4).
   - Right hand lower hinge.
     - Remove right hand shroud side trim finishing panel. Refer to BODY FRONT END (SEC. 10-4).
3. Noise control adhesive patch to gain access to the bolt which was installed from the inboard side of the vehicle.
4. Screw retaining VATS II relay to body, if equipped.

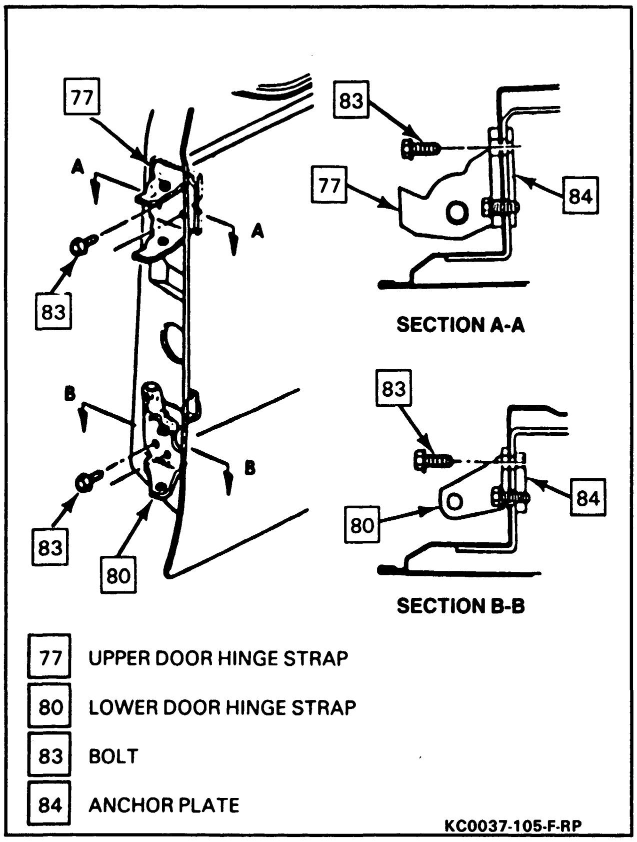


Figure 37 - Installing Hinge Strap to Door

- Move relay aside.

5. Bolt (86) from inside of the body hinge pillar using a 15 mm socket, for lower body hinge strap (81).
6. Bolts (83) from outside of the body hinge pillar using a 13 mm socket.
7. Upper or lower body hinge strap (76 or 81) from the body.

Install or Connect

1. Upper or lower body hinge strap (76 or 81).
   - Using the original hinge strap, make a paper template.
   - Locate the centerline of the required bolt hole on the template.
   - Push a pen through the template at this location.
   - Align the template on the new hinge strap.
   - Center punch the new hinge strap using the hole in the template as a locator.
   - Drill a hole at the punch using an 11/32-inch drill bit.
   - Coat with a medium-bodied sealer the surface of the hinge strap that mates with the body pillar.
   - Hand start the bolt (86) from the inside of the lower body hinge strap (81).

NOTICE: See "Notice" on page 10-5-1 of this section.

2. Upper or lower bolts (83) from the outside of the body hinge pillar through the lower body hinge strap (76 or 81).

Tighten

- Outside bolts (83) to 31 N·m (23 lb. ft.).
- Inside bolt (86) to 48 N·m (35 lb. ft.).

3. VATS II relay, if equipped.
4. Noise control adhesive patch.
5. Left or right lower shroud trim panel. Refer to BODY FRONT END (SEC. 10-4).
6. Door. Refer to "Doors" in this section.

Important

- When the upper or lower body hinge straps (76 or 81) have been replaced and the door reinstalled, do not close the door completely until a visual check is made to determine if the lock fork will correctly engage with the striker. If the lock fork bolt will not correctly engage with the striker, adjust the striker. Refer to "Door Lock Striker Adjustment" in this section.

GLASS

Figures 39 through 42

Tool Required:

J 34940 Heavy Duty Rivet Gun

CAUTION: Wear approved safety glasses and gloves when performing these procedures to reduce the chance of personal injury if glass breakage occurs.

Remove or Disconnect

1. Water deflector. Refer to "Water Deflector" in this section.

- Raise the window to the half-up position.

2. Rivets (100) attaching the glass (98) to the regulator cam (38).

- Loosen the glass stabilizer bolts (89) and slide the glass stabilizers away from the glass (98).

3. Glass (98) from the window regulator cam (38) by raising the glass (98) out of the door inner panel.

Inspect

- Bushings (202), glass up-stop (200), pin assemblies (203) and retainers (206) on the glass (98) for damage.

4. Bushings, (202) and retainers (206), if necessary, using a flat-bladed tool covered with cloth body tape.
5. Bolt (201) attaching the glass up-stop (200), washer (204) and nut (205) to the glass (98), if necessary.
6. Glass up-stop (200), washer (204) and nut (205), if necessary.

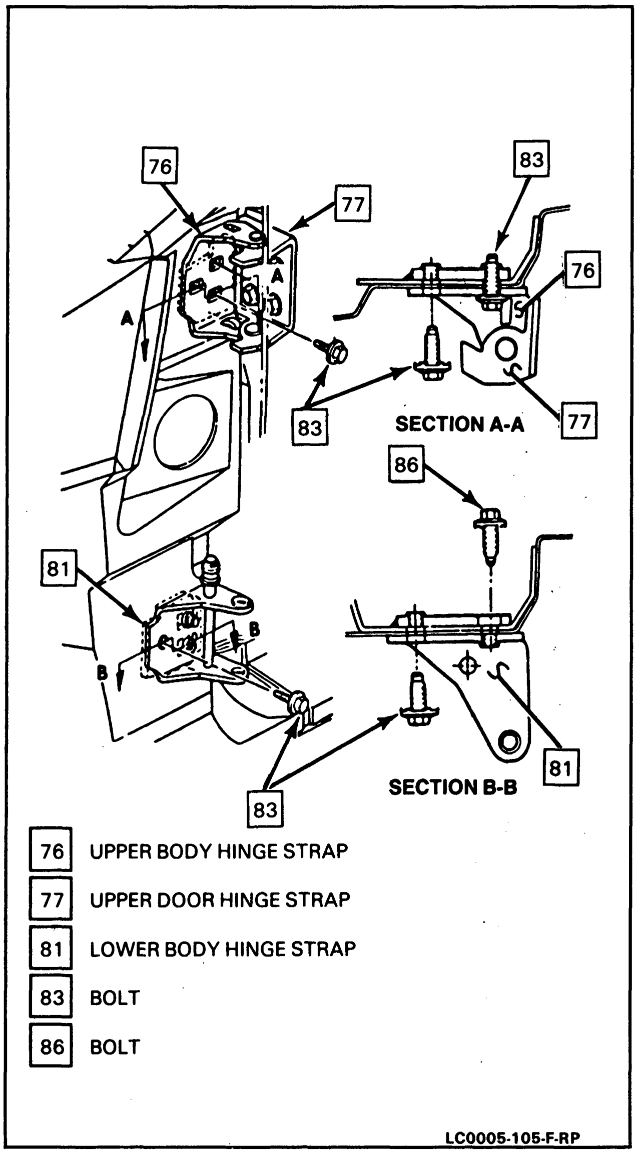


Figure 38 - Installing Body Hinge Straps

7. Bolts (201) retaining the pin assemblies (203) and nuts (205) to the glass (98), if necessary.
8. Pin assemblies (203), if necessary.

Install or Connect

NOTICE: See "Notice" on page 10-5-1 of this section.

1. Bushings (202) and retainers (206) to the glass (98), if required.
2. Glass up-stops (200), washer (204) and nut (205) to the glass (98).
3. Bolts (201) retaining the glass up-stops (200) to the glass (98).

   Tighten

   - Bolts (201) to 6 N•m (53 lb. in.).

4. Pin assemblies (203) to the glass (98), if removed.
5. Bolts (201) retaining the pin assemblies (203) and nuts (205) to the glass (98), if removed.

   Tighten

   - Bolts (201) to 6 N•m (53 lb. in.).

   - Lower the glass (98) into the door and position the glass (98) on the regulator cam (38) so that the holes in the regulator cam (38) line up with the holes in the bushings (202).

6. Rivets (100) holding glass (98) to window regulator cam (38) using J 34940.

   Adjust

   - Glass stabilizers. Refer to "Window Glass Adjustment" in this section.

   Important

   - Before installing the trim parts, check the window for proper fit to the roof rail weatherstrip and proper functioning.

7. Water deflector. Refer to "Water Deflector" in this section.

Window Glass Adjustment

Figures 15 and 39

In the following steps, the trim panel, the door armrest, and the water deflector must be removed prior to making adjustments. The following indicates conditions and corrections for window adjustments.

NOTICE: See "Notice" on page 10-5-1 of this section.

- Window rotated.
  - Loosen the guide stabilizer bolts (89).
  - Loosen the inner panel cam bolts (41).
  - Adjust window so that upper edge of glass is parallel with the side roof rail weatherstrip.

    Tighten

    - Bolts (89) to 12 N•m (106 lb. in.).
    - Bolts (41) to 11 N•m (97 lb. in.).
- Window upper edge inboard or outboard.
  - Loosen the in and out adjustment bolt (301) on the front up-stop (303).
  - Loosen the two lower bolts (37) on the window guide cam support (35) (Figure 15).
  - Adjust the glass (98) to the desired position.
    - Some adjustment of the channel retainer at the belt may be required. If so, loosen the channel retainer bolts (44 and 46) and adjust as necessary.

    Tighten

    - Bolts (37, 44, 46 and 301) to 11 N•m (97 lb. ft.).
- Window too far forward or rearward.
  - Loosen window glass run retainer bolt (44).
  - Roll up glass halfway.

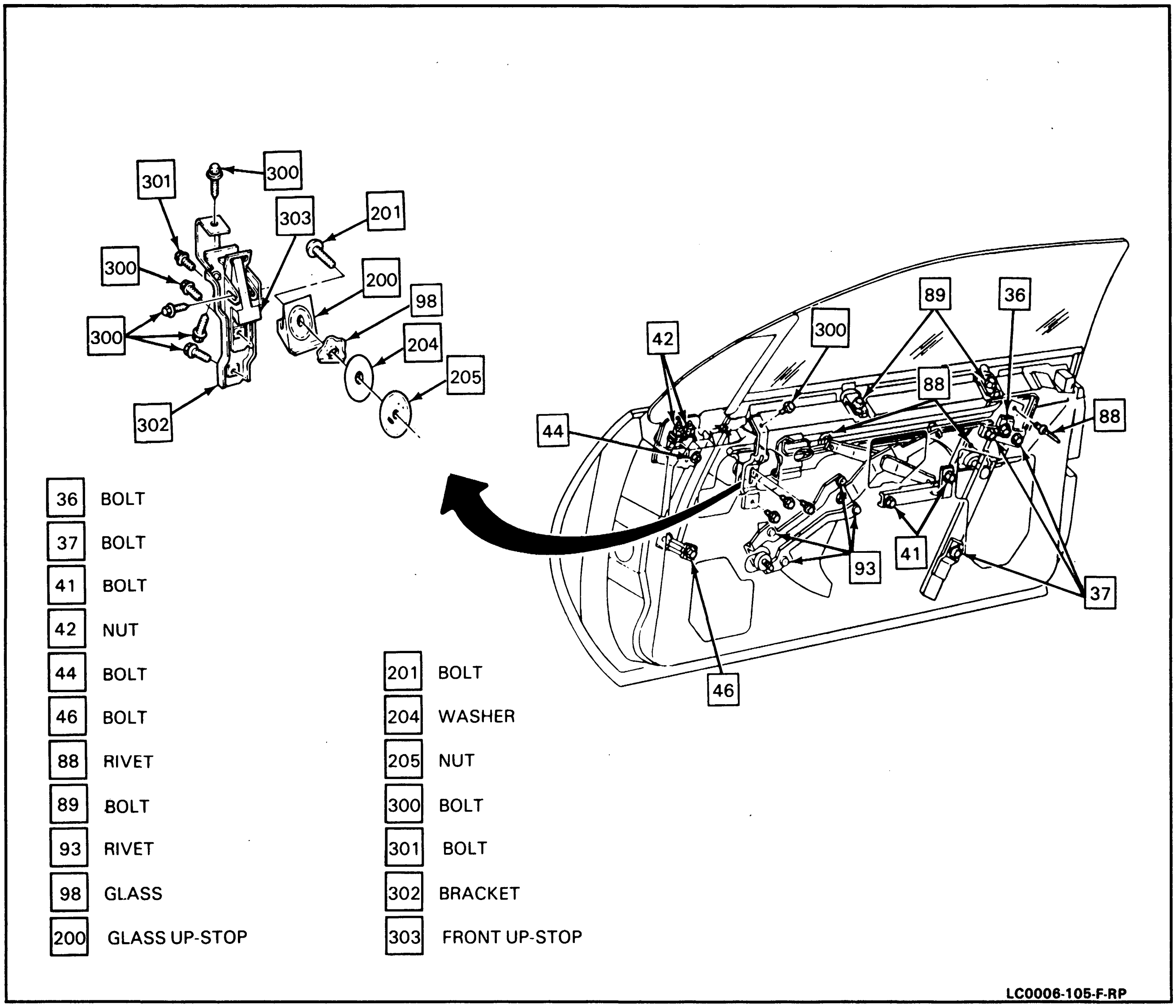


Figure 39 - Glass Adjustments

- Loosen window guide cam bolts (37).
- Position glass as required.

Tighten

  - Bolts (37 and 44) to 11 N·m (97 lb. in.).

- Window too high or too low in the up position.

Adjust

  - Front up-stop, as necessary.

- Window binds.
  - Ease of window operation and stability depend to a great extent on the guide stabilizers at the belt line. Contact should be enough to stabilize the glass but not restrict window operation.

Adjust

  - Glass stabilizers.
    - Raise glass to full up position.
    - Loosen stabilizer bolts (89).
    - Apply a slight pressure outward on the door glass (98) at the belt line.
    - Move the glass stabilizers outward to increase glass stability.

Tighten

  - Stabilizer bolts (89) to 12 N·m (106 lb. in.).

FRONT UP-STOP

Figure 39

Remove or Disconnect

- Roll window down halfway.

1. Water deflector. Refer to "Water Deflector" in this section.
2. Bolts (300) attaching the front up-stop assembly to the door inner panel.
3. Front up-stop assembly.

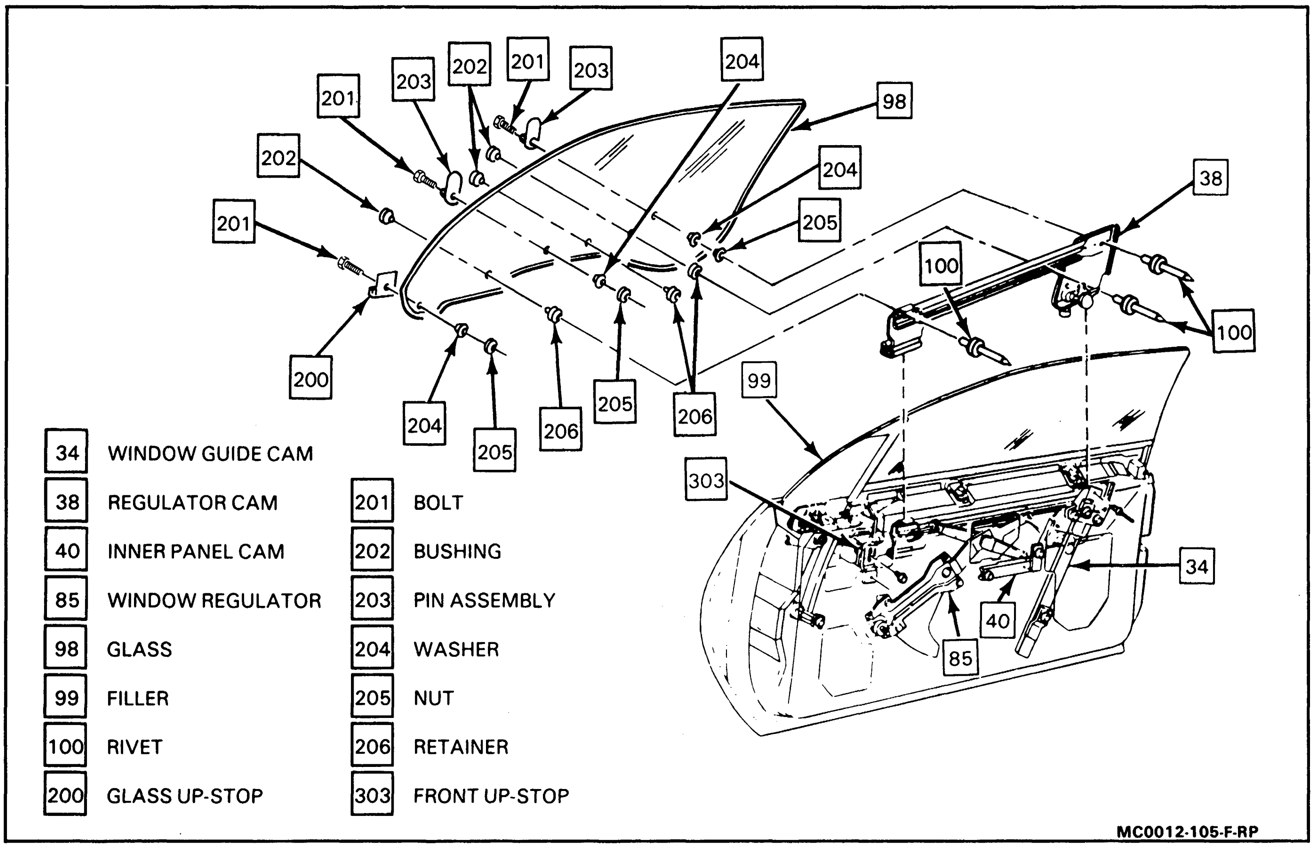


Figure 40 - Door Hardware and Glass

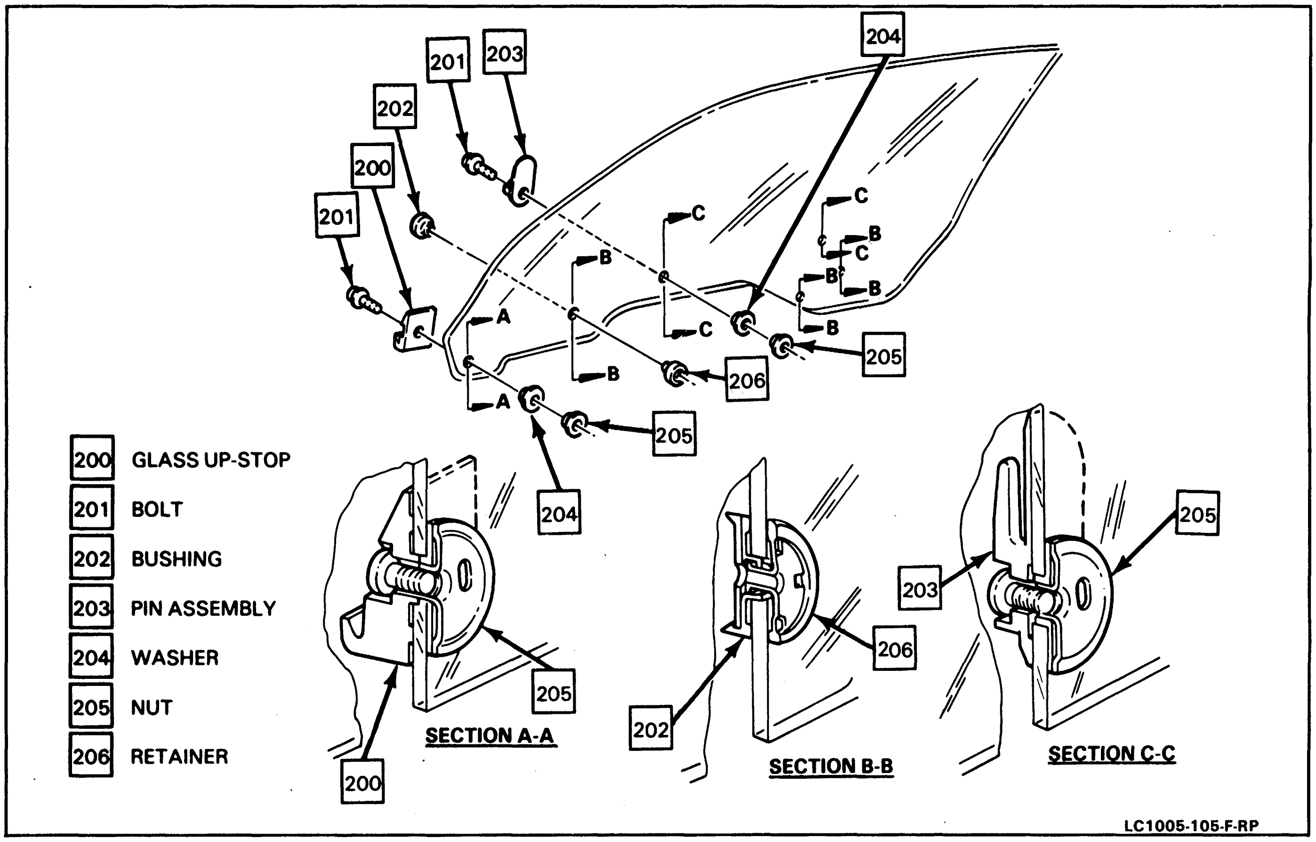


Figure 41 - Up-Stops and Bushings to Door Glass

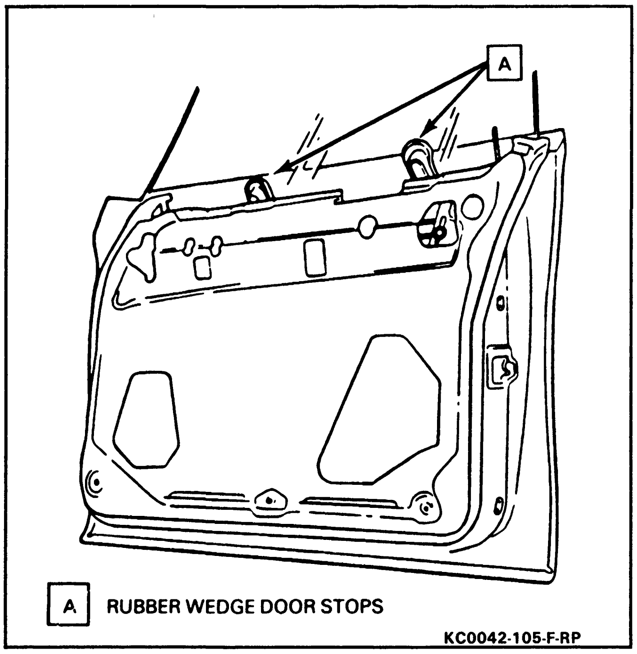


Figure 42 - Propping Door Glass

Install or Connect

NOTICE: See "Notice" on page 10-5-1 of this section.

1. Front up-stop assembly to door inner panel.
2. Bolts (300) attaching front up-stop assembly to the door inner panel.

Tighten

- Bolts (300) to 11 N·m (97 lb. in.).

3. Water deflector. Refer to "Water Deflector" in this section.

REGULATORS

Remove or Disconnect

1. Water deflector. Refer to "Water Deflector" in this section.

- Raise the window halfway up.
- Hold the window in place by inserting rubber wedge door stops at the front and the rear of the window between the window and the door inner panel.

2. Window guide cam. Refer to "Window Guide Cam" in this section.
3. Inner panel cam. Refer to "Inner Panel Cam" in this section.
4. Center pins of the regulator rivets by punching out.
5. Rivets, using a 1/4-inch drill bit and drill.

- Move window regulator and window regulator motor, if equipped, rearward.

6. Wire connector from window regulator motor if equipped.
7. Roller on the regulator lift arm from the regulator cam.
8. Window regulator and motor if equipped, through rear access hole.

Install or Connect

Tool Required:

J 34940 Heavy Duty Rivet Gun

1. Window regulator and window regulator motor if equipped, through rear access hole.
2. Lift arm roller into the regulator cam.
3. Wire connector to window regulator motor, if equipped.
4. Regulator to inner panel using J 34940 and 1/4-inch peel-type rivet.
   - If J 34940 is not available, use the following nut and bolt method.
     - Install U-clips on the window regulator at attaching locations. Be sure to install the clips with clinch nuts on the outboard side of the window regulator.
     - Fit the lift arm roller into the regulator cam.
     - Align the window regulator with the clinch nuts to the holes in the inner door panel.
     - Attach the window regulator to the door inner panel using M6.0 x 1 x 13 (1/4-20 x 1/2-inch) bolts into 6 mm (1/4-inch) nuts with integral washers.

NOTICE: See "Notice" on page 10-5-1 of this section.

Tighten

- Bolts to 12 N·m (106 lb. in.).

5. Inner panel cam. Refer to "Inner Panel Cam" in this section.
6. Window guide cam. Refer to "Window Guide Cam" in this section.

Inspect

- Window regulator operation.
- Window glass adjustments and make adjustments as needed. Refer to "Window Glass Adjustment" in this section.

7. Water deflector. Refer to "Water Deflector" in this section.

SOLENOIDS

Power Door Lock Actuator

Figure 43

The power door lock system has a power door lock actuator in each door. An actuator rod connects the power door lock actuator to the bell crank. A rod on the bell crank attaches to the lock assembly. The system is actuated by a control switch in each door trim panel. Both doors lock and unlock at the same time from either control switch. Each lock can also be operated manually by sliding the locking knob in the desired direction. The locking knob shows red when in the unlocked position. Each power door lock actuator has an internal circuit breaker which may require one to three minutes to reset.

Remove or Disconnect

1. Water deflector. Refer to "Water Deflector" in this section.
- Raise the window all the way.
2. Electrical connector (106) to power door lock actuator (104).
3. Rivet center pins by driving them out.
4. Rivets (105) using a 1/4-inch drill bit and drill.
5. Actuator rod (103) from the power door lock actuator (104).
6. Power door lock actuator (104) from the door inner panel.

Install or Connect

Tool Required:

J 34940 Heavy Duty Rivet Gun

1. Power door lock actuator (104) to door inner panel using J 34940 and 1/4 x 1/2-inch aluminum peel type rivets.
   - If a hand rivet tool is not available, attach the power door lock actuator (104) to the door inner panel using M6.0 x 1 x 13 (1/4-20 x 1/2-inch) nuts and bolts.

NOTICE: See "Notice" on page 10-5-1 of this section.

Tighten

- Bolts to 12 N·m (106 lb. in.).

2. Electrical connector (106) to power door lock actuator (104).
3. Actuator rod (103) to power door lock actuator (104).
4. Water deflector. Refer to "Water Deflector" in this section.

MOTORS

Window Regulator Motor

Figure 44

Remove or Disconnect

CAUTION: If electric motor removal from the regulator is required, the sector gear must be locked in position. The regulator lift arm is under tension from the counterbalance spring and could cause personal injury if the sector gear is not locked in position.

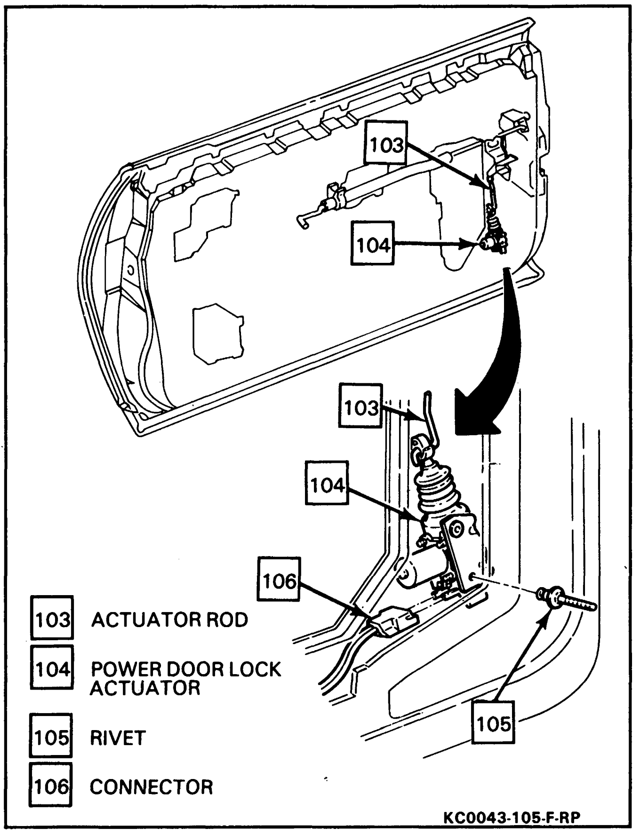


Figure 43 - Power Door Lock Actuator

1. Window regulator and motor, if equipped. Refer to "Regulators" in this section.
- Drill a hole through the window regulator sector gear and backplate.
- Install a bolt and a nut to lock the sector gear into position.
2. Rivets holding window regulator motor (107) to window regulator (85) using a 3/16-inch drill bit and a drill.
3. Window regulator motor (107) from the window regulator (85) through rear access panel.

Install or Connect

Tool Required:

J 34940 Heavy Duty Rivet Gun

1. Window regulator motor (107) to the window regulator (85) using J 34940 and 3/16-inch nuts and bolts.
- Remove the bolt and nut used to secure the sector gear into position during the removal procedure.
2. Window regulator and motor. Refer to "Regulators" in this section.

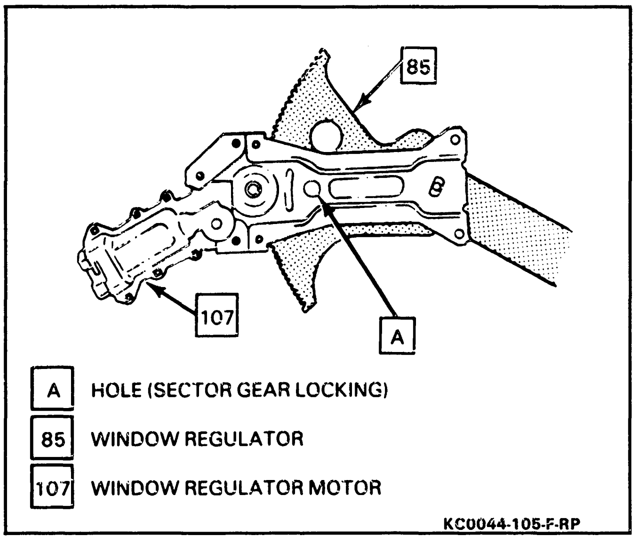


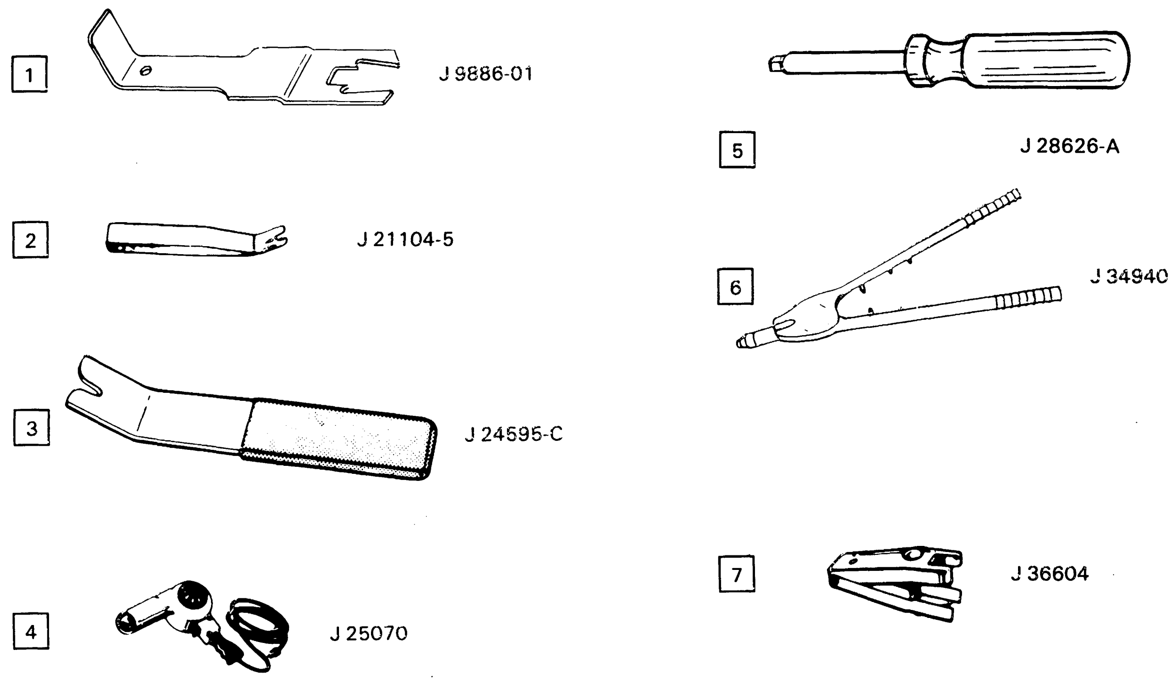
Figure 44 - Window Regulator and Motor

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Armrest-to-Door Trim Panel Attaching Screw	5 N·m (44 lb. in.)
Trim Pad Switch and Remote Handle Mount Panel-to-Door Trim Panel Screw	2.5 N·m (22 lb. in.)
Door Lower Molding-to-Door Screw	3.4 N·m (30 lb. in.)
Outside Handle-to-Door Nut	7 N·m (62 lb. in.)
Power Door Lock Switch-to-Remote Handle Mount Panel Screw	0.5 N·m (4 lb. in.)
Mirror Touch Control Switch-to-Remote Handle Mount Panel Screw	0.5 N·m (4 lb. in.)
Window Guide Cam-to-Door Inner Panel Bolt	11 N·m (97 lb. in.)
Inner Panel Cam-to-Door Inner Panel Bolt	11 N·m (97 lb. in.)
Channel Retainer-to-Door Inner Panel: Support	
Bolt	11 N·m (97 lb. in.)
Nut	11 N·m (97 lb. in.)
Mirror-to-Door Nut	5 N·m (44 lb. in.)
Mirror Escutcheon-to-Remote Handle Mount Panel Screw	0.5 N·m (4 lb. in.)
Door Lock Screw-to-Door	7 N·m (62 lb. in.)
Door Lock Striker Bolt	53 N·m (39 lb. ft.)
Anchor Plate-to-Body Bolt (Hinge)	31 N·m (23 lb. ft.)
Body Side Hinge Strap-to-Body Bolt	
Outside	31 N·m (23 lb. ft.)
Inside	48 N·m (35 lb. ft.)
Window Glass-to-Up-Stop Bolt	6 N·m (53 lb. in.)
Power Door Lock Actuator-to-Door Inner Panel Bolt	12 N·m (106 lb. in.)
Pressure Relief Valve Screw-to-Body	1.9 N·m (17 lb. in.)
Up-Stop In and Out Adjustment Bolt	11 N·m (97 lb. in)
Window Guide Cam Support-to-Window Guide Cam Bolt	11 N·m (97 lb. in.)
Channel Retainer-to-Door Inner Panel Bolt	11 N·m (97 lb. in.)
Door Glass Stabilizer-to-Door Bolt	12 N·m (106 lb. in.)
Front Up-Stop-to-Door Inner Panel Bolt	11 N·m (97 lb. in.)
Window Regulator-to-Door Inner Panel Bolt	12 N·m (106 lb. in.)

SPECIAL TOOLS



1	DOOR HANDLE CLIP REMOVER	5	INVERTED NUT DRIVER (LARGE)
2	UNIVERSAL WEATHERSTRIP REMOVER	6	HEAVY DUTY RIVET GUN
3	DOOR TRIM PAD AND GARNISH CLIP REMOVER	7	DOOR HINGE SPRING COMPRESSOR
4	HEAT GUN		

MC0006-105-F-RP

SECTION 10-6

REAR QUARTERS

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 10-6-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

NOTICE: The anti-theft label found on some major sheet metal, engines, and transmissions must be masked prior to painting, rustproofing, undercoating, etc. The mask MUST be removed following the above operations. Failure to keep the label clean and readable may result in liability for violation of Federal Vehicle Theft Prevention Standard, and subject the vehicle owner to possible suspicion that the part was stolen.

CONTENTS

QUARTER TRIM - INTERIOR

QUARTER UPPER PANEL

Figures 1 through 4

↔ Remove or Disconnect

- Raise compartment lift window.

1. Shade cover and supports, if equipped. Refer to "Luggage Compartment Shade Cover Assembly and Supports" in this section.
2. Upper body lock pillar panel. Refer to "Upper Body Lock Pillar Panel" in this section.

- Lower the folding seatback.

3. Coat hook screw (1) and coat hook (2).
4. Compartment lift support mount cover. Refer to BODY REAR END (SEC. 10-7).
5. Striker bolt (4), rear seatback lock striker (5) and washer (29).
6. Spare tire cover, if removing the right quarter upper panel (9). Refer to "Spare Tire Cover" in this section.

- If removing the left-hand quarter upper trim panel, remove the rear end trim panel. Refer to BODY REAR END (SEC. 10-7).

7. Screw (6) from upper end of quarter upper panel (7 or 9).
8. Quarter upper panel (7 or 9).
   - Lift up on quarter upper panel (7 or 9) to remove pre-installed fasteners on quarter upper panel (7 or 9) from pre-installed nuts in quarter inner panel area.

→← Install or Connect

NOTICE: See "Notice" on page 10-6-1 of this section.

1. Quarter upper panel (7 or 9).
   - Position to back edge of quarter upper trim foundation (8 and 14). Apply downward pressure to press pre-installed fasteners in quarter upper panel (7 or 9) to pre-installed nuts in quarter inner panel area.
2. Screw (6) to upper end of quarter upper panel (7 or 9).

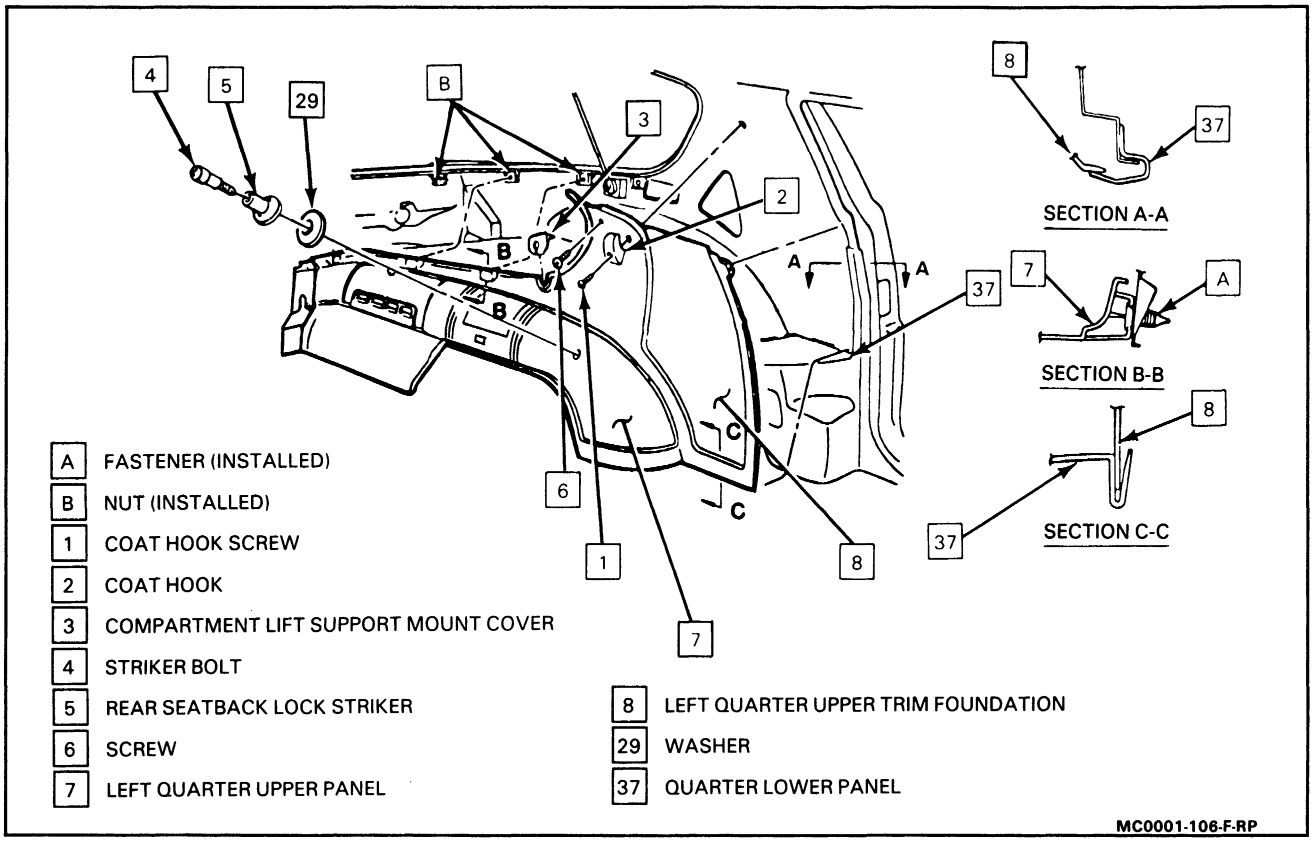


Figure 1 - Left Quarter Upper Panel

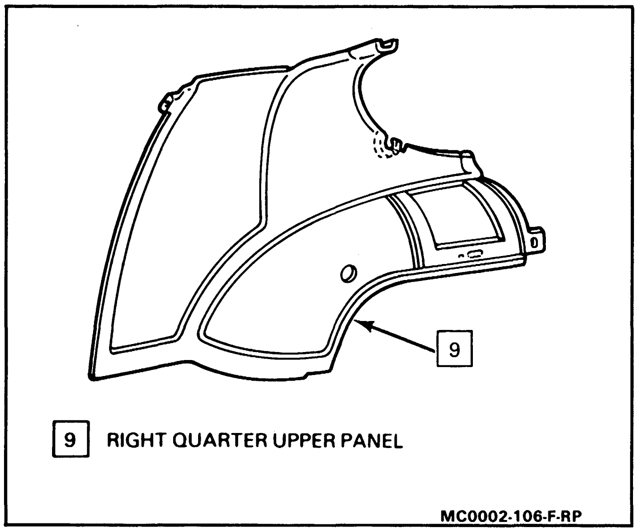


Figure 2 - Right Quarter Upper Panel

- If installing the left-hand quarter upper trim panel, install the rear end trim panel also. Refer to BODY REAR END (SEC. 10-7).

3. Spare tire cover, if installing right quarter upper panel (9). Refer to "Spare Tire Cover" in this section.
4. Washer (29), rear seatback lock striker (5) and striker bolt (4).

Tighten

- Striker bolt (4) to 50 N·m (37 lb. ft.).

5. Compartment lift support mount cover (3). Refer to BODY REAR END (SEC. 10-7).
6. Coat hook (2) and coat hook screw (1).

- Raise the folding seatback.

7. Upper body lock pillar panel. Refer to "Upper Body Lock Pillar Panel" in this section.
8. Luggage shade cover and supports. Refer to "Luggage Compartment Shade Cover Assembly and Supports" in this section.

UPPER BODY LOCK PILLAR PANEL

Figures 1 through 3

Tool Required:

J 24595-C Trim Pad Remover

Remove or Disconnect

1. Screw (10).
2. Screw (20), if equipped with removable roof panels.
3. Upper body lock pillar panel (11 or 13).

- Lift off quarter upper panel using J 24595-C.

Install or Connect

1. Upper body lock pillar panel (11 or 13) to quarter upper panel (7 or 9).
    - Press in firmly onto quarter upper panel.
2. Screw (20), if equipped with removable roof panels.
3. Screw (10).

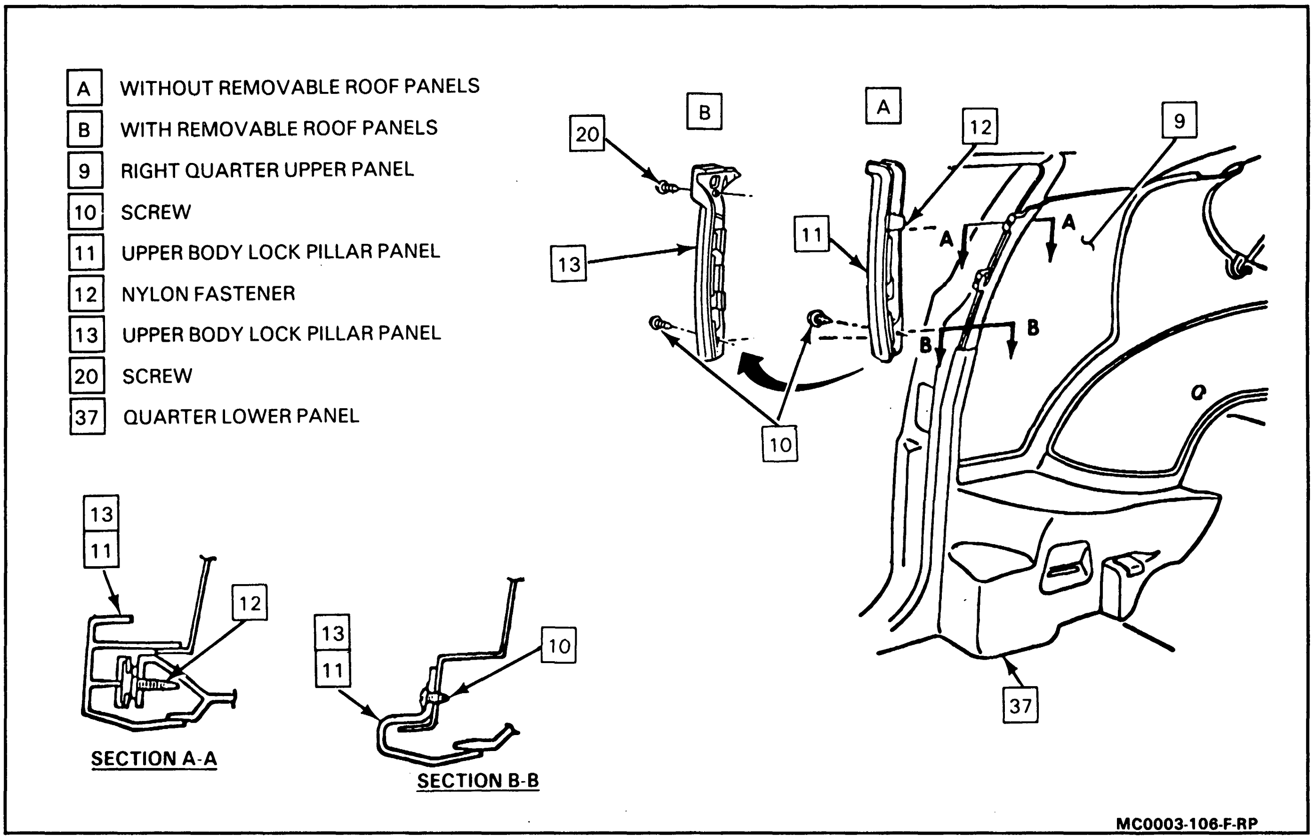


Figure 3 - Upper Body Lock Pillar Panel

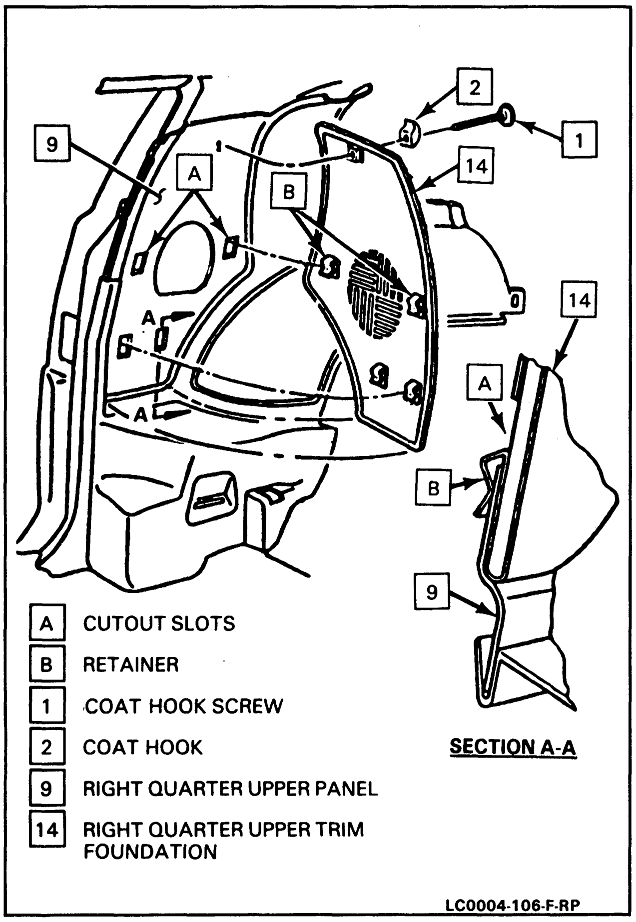


Figure 4 - Quarter Upper Trim Foundation

QUARTER UPPER TRIM FOUNDATION

Figures 1 and 4

↔ Remove or Disconnect

1. Coat hook screw (1) and coat hook (2).
2. Quarter upper trim foundation (8 or 14).
    - Grasp quarter upper trim foundation (8 or 14) with hand and pull upward to disengage retainers from cutout slots in quarter upper panel (7 or 9).

→← Install or Connect

1. Quarter upper trim foundation (8 or 14).
    - Push in to engage retainers in cutout slots in quarter upper panel (7 or 9).
2. Coat hook (2) and coat hook screw (1).

REAR BUMPER FASCIA EXTENSION

For information on rear bumper fascia extension refer to FRONT END BODY PANELS (SEC. 2C).

STOWAGE COMPARTMENT TRIM AND LOCK ASSEMBLY

Figures 5 and 6

The stowage compartment trim (15) is located in the left quarter upper panel (7). The stowage compartment door (17) is equipped with a lock cylinder (18). The lock cylinder (18) is secured in the stowage compartment door (17) with a lock retainer

(19). The stowage compartment trim (15) is a flat, scored hardboard material that is folded at the scored lines to form the compartment box. To retain the box shape, it is stapled together along the sides. The prepierced holes in the stowage compartment trim (15) are aligned and positioned with studs located on the back side of the left quarter upper panel (7). Nuts (16) are used to retain the stowage compartment trim (15) to the left upper quarter panel (7).

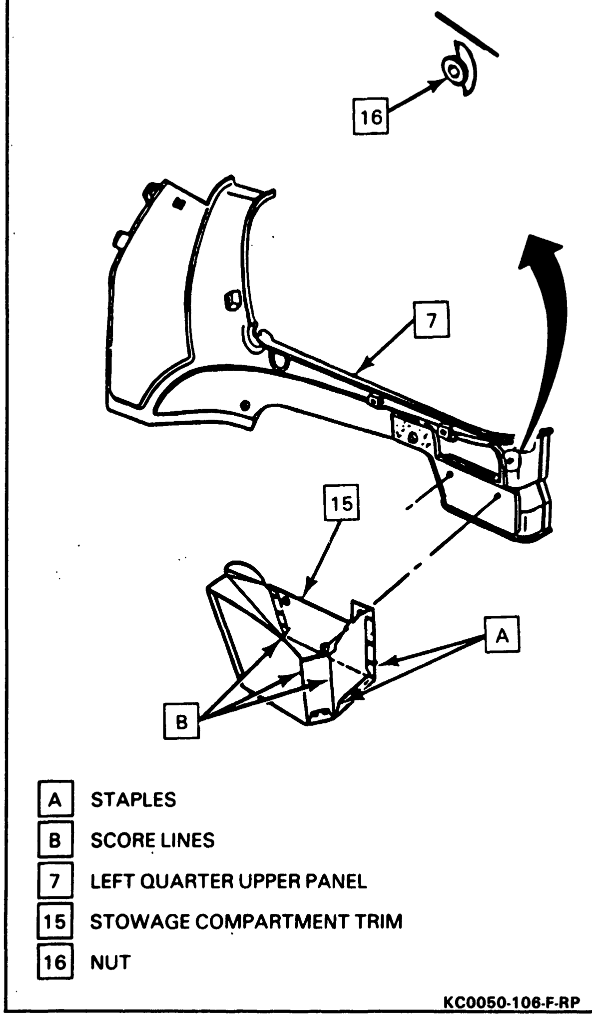


Figure 5 - Stowage Compartment Installation

Remove or Disconnect

- Open compartment lift window and stowage compartment door (17).

1. Lock retainer (19).
2. Lock cylinder (18).
3. Nuts (16).
4. Stowage compartment trim (15).

Install or Connect

1. Stowage compartment trim (15) to studs in left quarter upper panel (7).
2. Nuts (16).
3. Lock cylinder (18).
4. Lock retainer (19).

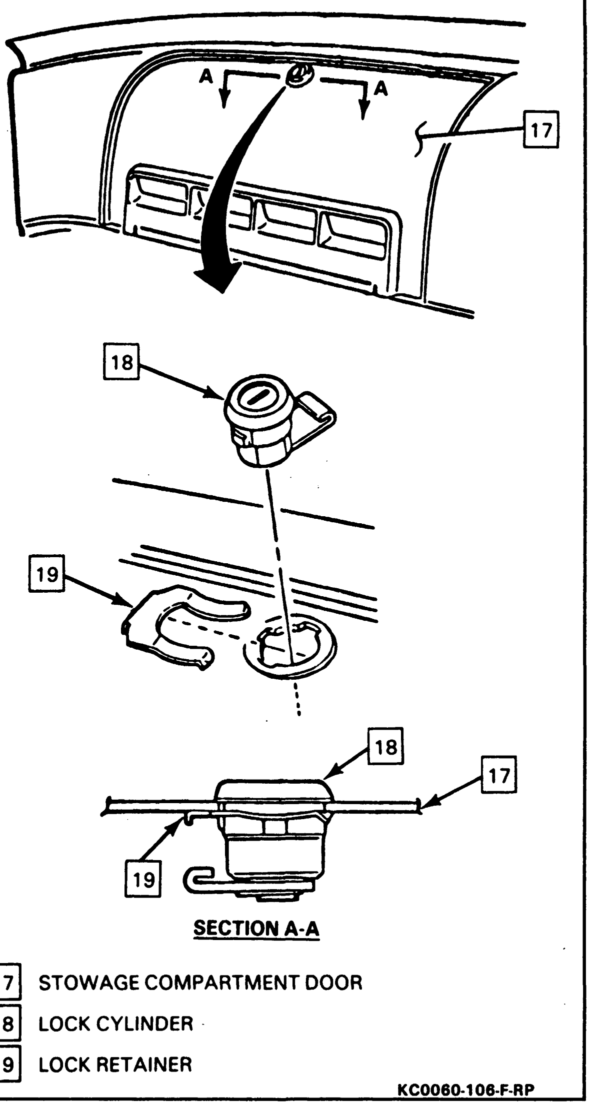


Figure 6 - Stowage Compartment Door Lock Assembly

QUARTER INNER UPPER TRIM CAP (CONVERTIBLE)

Figure 7

Remove or Disconnect

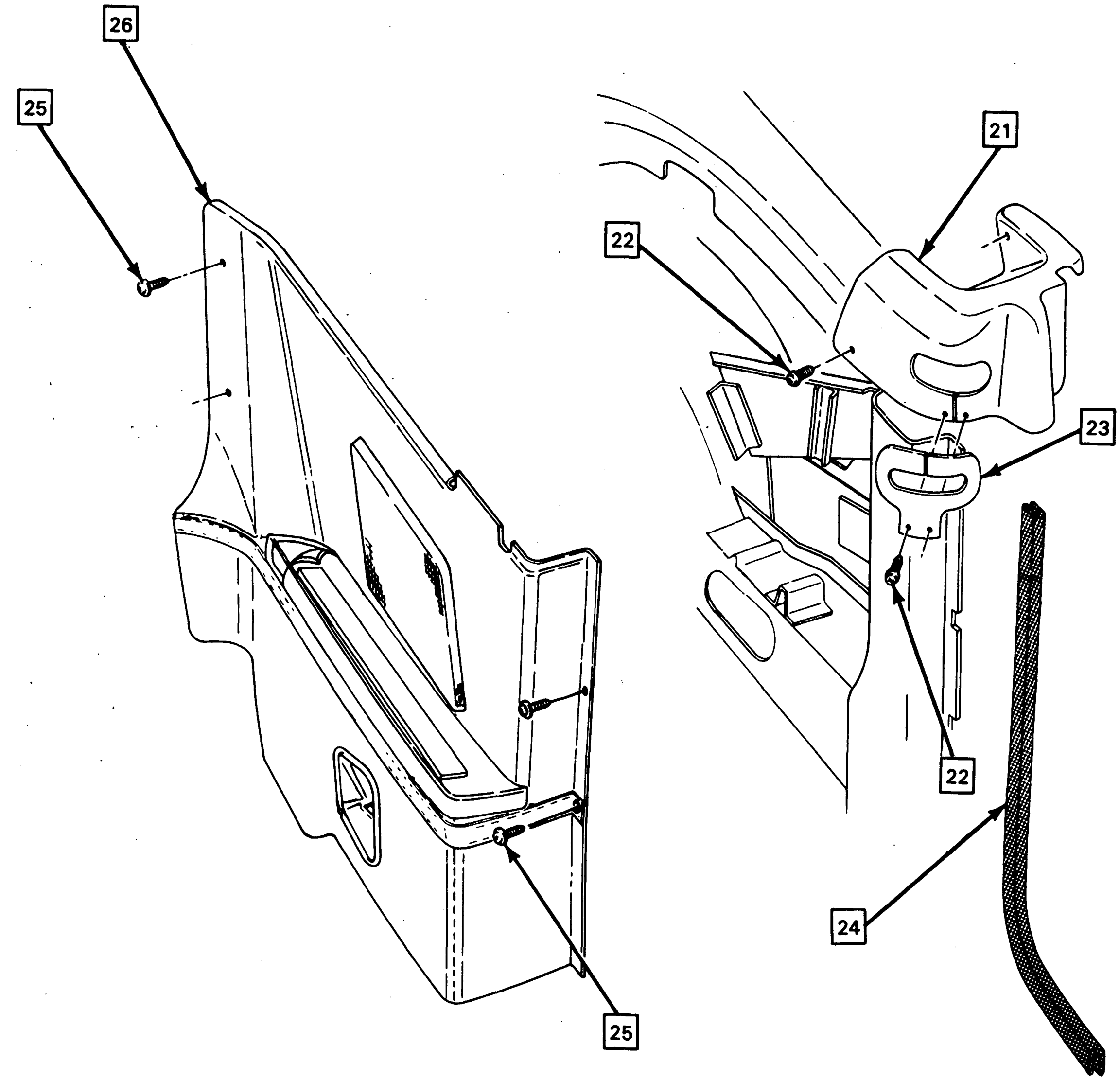
- Lower convertible top. Refer to ROOF AND CONVERTIBLE TOP (SEC. 10-8).

1. Screws (22).
2. Quarter inner upper trim cap (21) and safety belt bezel (23).

Install or Connect

1. Quarter inner upper trim cap (21) and safety belt bezel (23).
2. Screws (22).

- Raise convertible top. Refer to ROOF AND CONVERTIBLE TOP (SEC. 10-8).



21	QUARTER INNER UPPER TRIM CAP	25	SCREW
22	SCREW	26	QUARTER TRIM PANEL
23	SAFETY BELT BEZEL		
24	CORT WELT		

MC0007-106-F-RP

Figure 7 - Quarter Inner Upper Trim (Convertible)

QUARTER TRIM PANEL (CONVERTIBLE)

Figure 7

Remove or Disconnect

1. Rear seat cushion. Refer to SEATS (SEC. 10-9).
2. Sill plate and carpet retainer.
3. Quarter inner upper trim cap (21). Refer to "Quarter Inner Upper Trim Cap (Convertible)" in this section.
4. Cort welt (24).
5. Screws (25).
6. Speaker wire connectors.
7. Quarter trim panel (26).
   - Push safety belt through slot in quarter trim panel (26).

Install or Connect

1. Quarter trim panel (26).
   - Position quarter trim panel (26) to body.
   - Thread safety belt through slot in quarter trim panel (26).
2. Wire connectors to speaker.
3. Screws (25).
4. Cort welt (24).
5. Quarter inner upper trim cap. Refer to "Quarter Inner Upper Trim Cap (Convertible)" in this section.
6. Sill plate and carpet retainer.
7. Rear seat cushion. Refer to SEATS (SEC. 10-9).

QUARTER CAP BELT MOLDING (CONVERTIBLE)

Figures 7 and 8

The quarter cap belt moldings (27) are attached to the body by screws (28) and adhesive tape. The quarter cap belt molding (27) can be removed from the body with the use of a hot air gun to break the adhesive tape bond.

> **NOTICE:** When removing or installing quarter cap belt molding, care should be exercised. Adjacent finishes should be protected to prevent damage to finish. Proper tools and care should be used to guard against molding damage.

Remove or Disconnect

1. Quarter inner upper trim cap (21). Refer to "Quarter Inner Upper Trim Cap (Convertible)" in this section.
2. Screws (28).
3. Quarter cap belt molding (27).
   - Using a hot air gun held about 12 inches from the surface, apply heat in a circular motion, and carefully lift the quarter cap belt molding (27) from the body surface.

Clean

- Quarter trim panel (26) area with soap and water and wipe dry.
- Wipe quarter trim panel (26) and adhesive side of quarter cap belt molding with a clean rag using oil-free naphtha or alcohol to remove all traces of adhesive tape from the quarter trim panel (26) and back side of quarter cap belt molding (27).

Install or Connect

1. A double-coated adhesive automotive attachment tape to the quarter cap belt molding (27).
2. Quarter cap belt molding (27).
   - Warm quarter trim panel (26) with heat lamp or heat gun about 21°C (70°F).
   - Align quarter cap belt molding (27) and press firmly in place.
3. Screws (28).
4. Quarter inner upper trim cap (21). Refer to "Quarter Inner Upper Trim Cap (Convertible)" in this section.

REAR QUARTER SPEAKERS

Tool Required:

J 24595-C Trim Pad Remover

The rear quarter speakers are installed to a speaker retainer. The speaker retainer and speakers are then attached to the quarter inner panel by bolts.

Standard Speakers

Remove or Disconnect

1. Coat hook screw and coat hook.
2. Quarter upper trim foundation.
3. Electrical connector from upper speaker.
4. Bolts securing speaker retainer.
5. Upper speaker.

Install or Connect

1. Upper speaker to retainer and quarter inner panel.
2. Bolts.
3. Electrical connector.
4. Quarter upper trim foundation.
5. Coat hook and coat hook screw.

QUARTER LOWER PANEL

Figures 1, 3, 4, and 9

Remove or Disconnect

1. Upper body lock pillar panel (11 or 13). Refer to "Upper Body Lock Pillar Panel" in this section.
2. Striker bolt (4), washer (29) and rear seatback lock striker (5).
3. Retaining screw (35) from the rear of quarter lower panel (37).

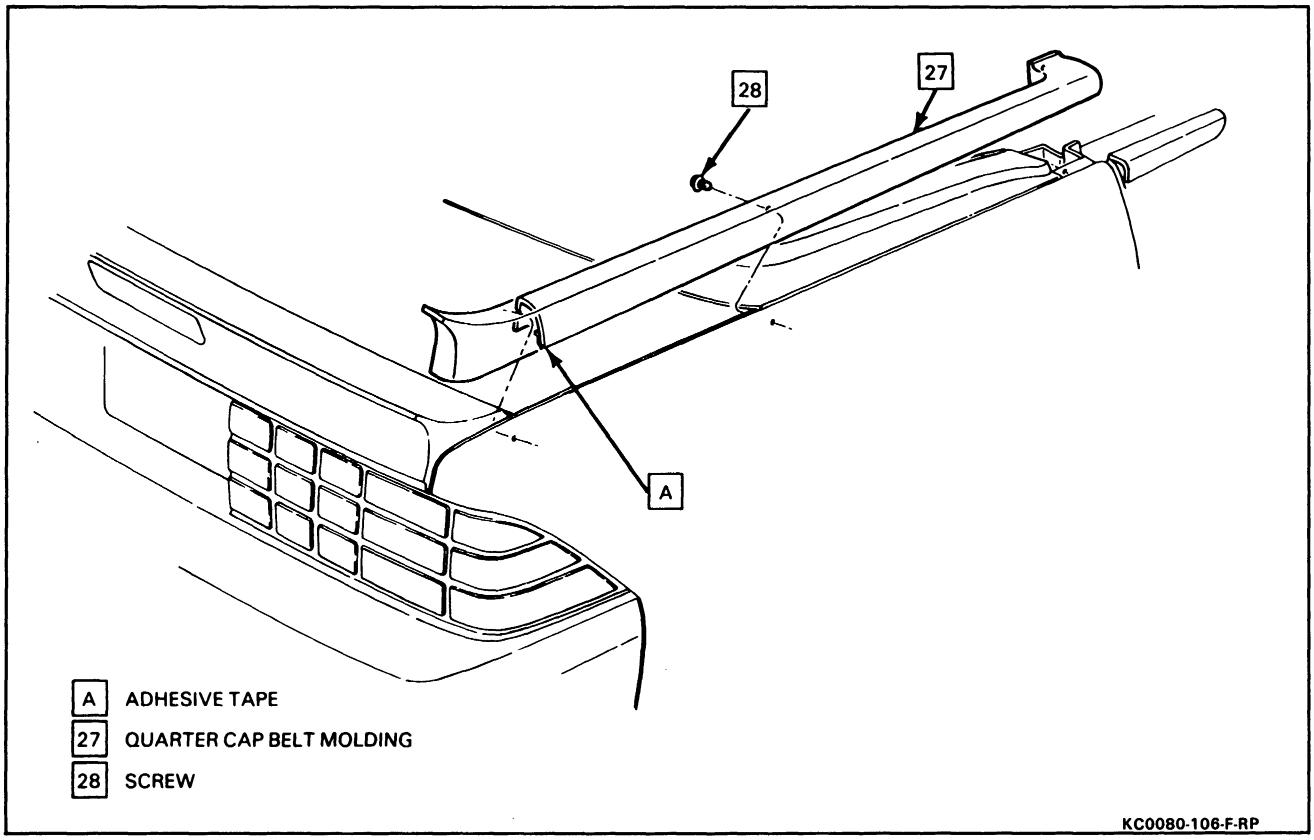


Figure 8 - Quarter Cap Belt Molding (Convertible)

4. Rear screws from sill plate.
5. Safety belt (36).
   - Feed safety belt (36) through slot in quarter lower panel (37).
6. Quarter lower panel (37).
   - Grasp quarter lower panel (37) with hand, pull forward and down to disengage from pinchweld flange at weatherstrip and quarter upper trim foundation (8 or 14).
   - Lift up on rear portion of sill plate and then pull panel inward to remove.

→← Install or Connect

NOTICE: See "Notice" on page 10-6-1 of this section.

1. Quarter lower panel (37).
   - Position quarter lower panel to pinch-weld flange at weatherstrip and quarter upper trim foundation (8 or 14).
2. Safety belt (36).
   - Feed safety belt (36) through slot in quarter lower panel (37).
3. Rear screws from sill plate.
4. Retaining screw (35) to rear of quarter lower panel (37).
5. Rear seatback lock striker (5), washer (29) and striker bolt (4).

Tighten

- Striker bolt (4) to 50 N·m (37 lb. ft.).

6. Upper body lock pillar panel (11 or 13). Refer to "Upper Body Lock Pillar Panel" in this section.

SPARE TIRE COVER

Figure 10

←→ Remove or Disconnect

1. Fasteners (39) from nuts (40).
2. Spare tire cover (38).
   - Grasp spare tire cover (38) with hand and pull upward to disengage retaining tabs from slots in the rear compartment floor.

→← Install or Connect

1. Spare tire cover (38).
   - Push cover downward to engage retaining tabs with slots in the rear compartment floor.
2. Fasteners (39) to nuts (40).

PRESSURE RELIEF VALVE

Figure 11

The pressure relief valve (41) is attached to body lock pillar (in door opening below bolt) with a screw (42).

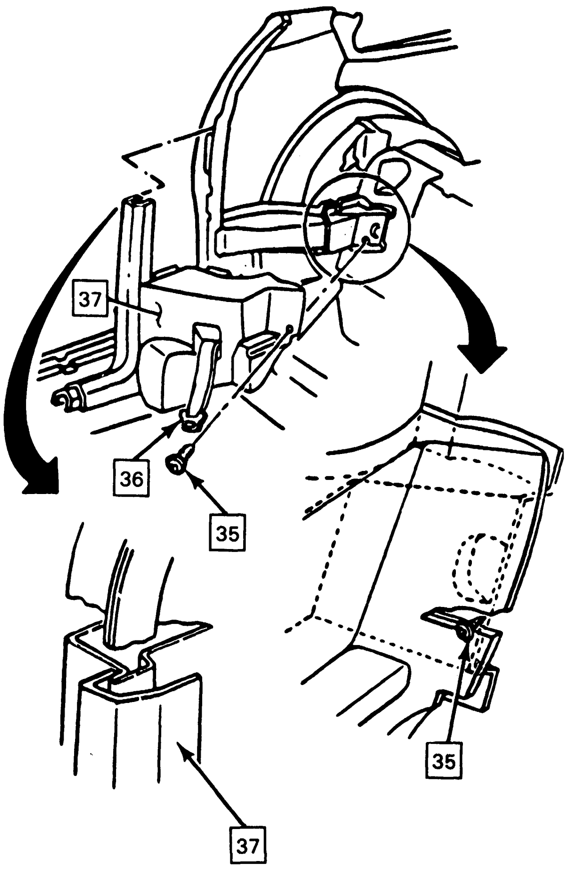


Figure 9 - Quarter Lower Panel

←→ Remove or Disconnect

1. Screw (42).
2. Pressure relief valve (41).
   - Slide pressure relief valve up to disengage hook-type attaching clip.

→← Install or Connect

1. Pressure relief valve (41).
   - Engage hook-type attaching clip.
2. Screw (42).

QUARTER TRIM - EXTERIOR

EXTERIOR MOLDINGS

Exterior moldings are secured to the body by any one or a combination of attaching screws, weld studs and adhesive (urethane or butyl tape).

NOTICE: When removing or installing any lower quarter exterior molding, emblem or nameplate, care should be exercised. Adjacent

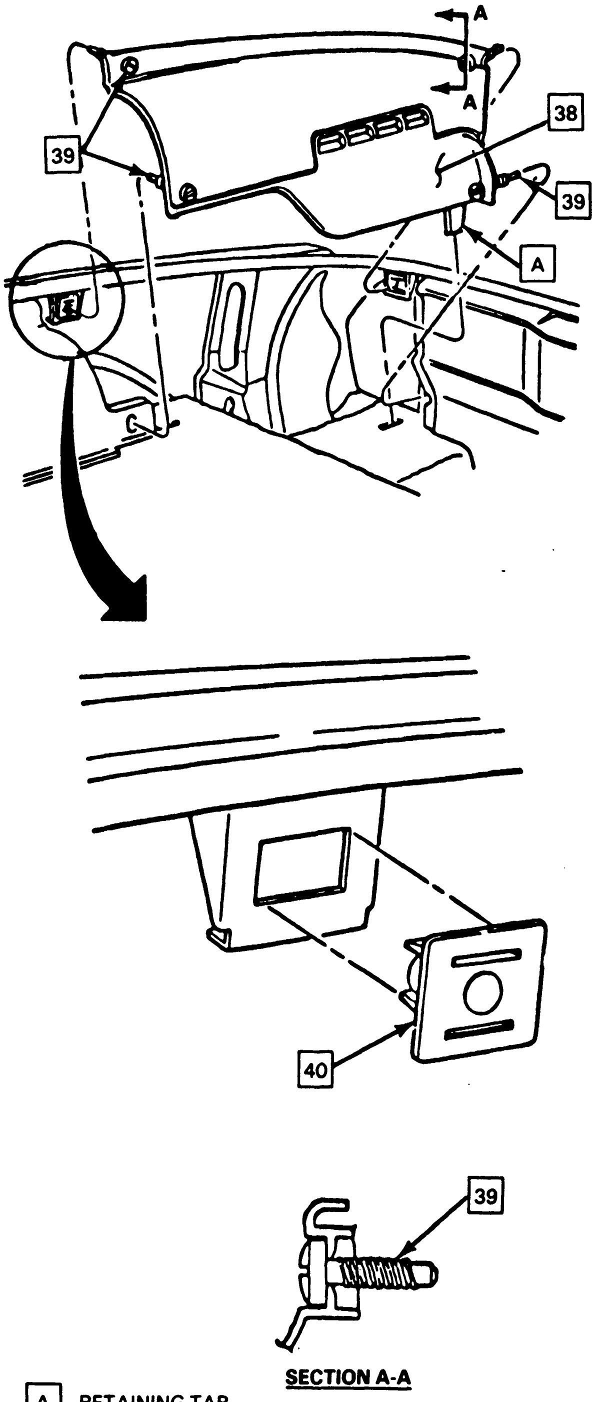


Figure 10 - Spare Tire Cover

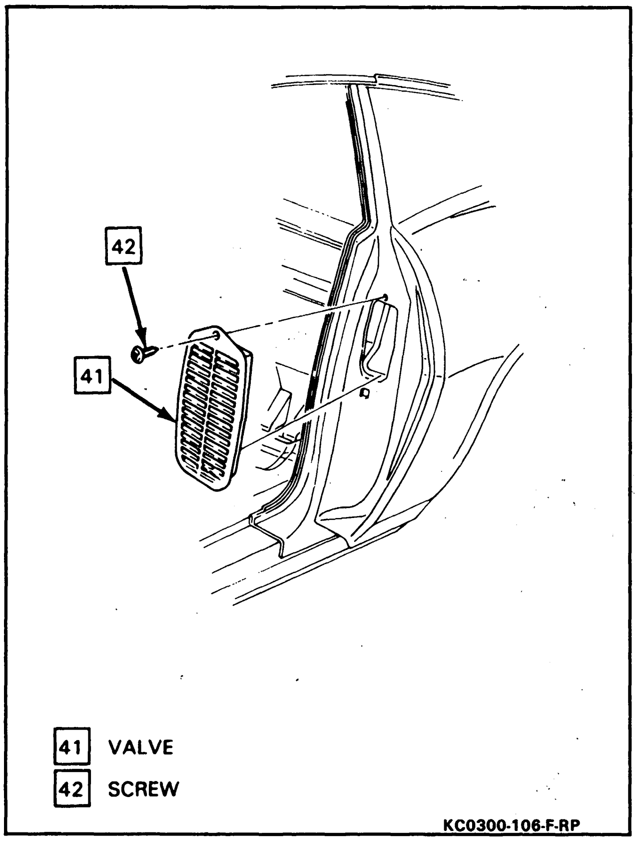


Figure 11 - Pressure Relief Valve

finishes should be covered with masking tape to prevent damage to finish. Proper tools and care should be used to guard against molding damage. Holes in body panels for screws, bolts or clips that would permit water entry into the body interior must be sealed with body caulking compound or presealed screws, nuts or clips.

REAR QUARTER LOWER MOLDING

Figure 12

NOTICE: See "Notice" on page 10-6-1 of this section.

Remove or Disconnect

1. Screws (33).
2. Nuts (32) from studs (31).
3. Molding (34) from rear quarter panel (56).

Install or Connect

1. Molding (34) to rear quarter panel (56).
2. Nuts (32) to studs (31).

   Tighten

   - Nuts (32) to 3 N·m (27 lb. in.).
3. Screws (33).

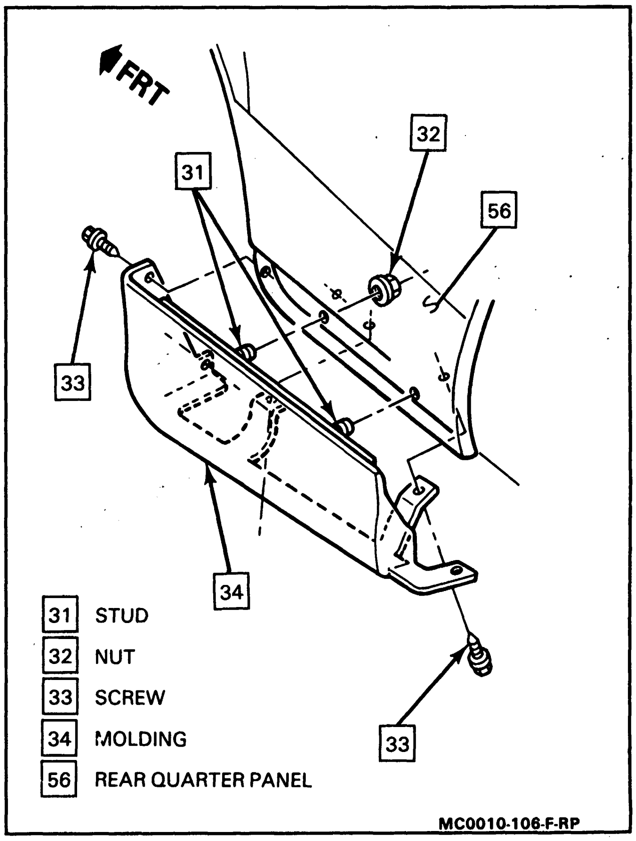


Figure 12 - Rear Quarter Lower Molding

MOLDING, NAMEPLATE AND EMBLEM RETENTION

Figure 13

Remove or Disconnect

- Emblem molding or nameplate (43) from body surface.
  - Hold hot air gun 304 mm (12 inches) from the surface of the part to be removed.
  - Apply heat, using a circular motion for about 30 seconds.
  - Using care, peel part from surface.

Install or Connect

- Molding, emblem or nameplate (43).
  - Body surface must be warm, 21°C (70°F), clean and wax free.
  - If installing a previously removed part, or a partially loosened molding, emblem, or nameplate, apply a thin, even film of GM part number 1052621 adhesive, or equivalent to adhesive portion of emblem, align and press firmly into place.

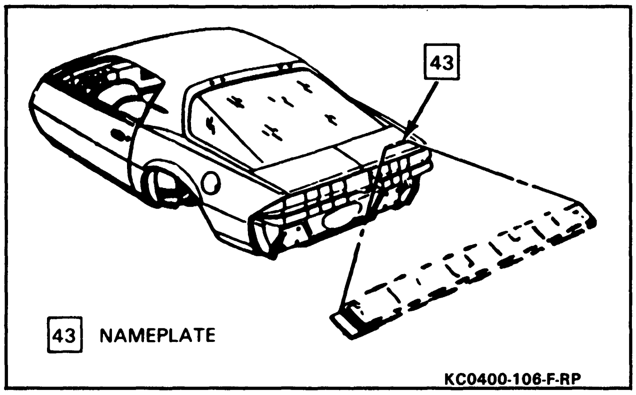


Figure 13 - Molding, Nameplate and Emblem Retention

ROOF DRIP AND QUARTER TO BODY REVEAL MOLDING

Figure 14

←→ Remove or Disconnect

1. Weatherstrip (44).
2. Screws (45).
3. Molding (46).

→← Install or Connect

1. Molding (46).
2. Screws (45).
3. Weatherstrip (44).

SPOILER EXTENSION

Figure 15

←→ Remove or Disconnect

1. Spare tire panel. Refer to "Spare Tire Cover" in this section.
2. Left quarter upper panel. Refer to "Quarter Upper Panel" in this section.
3. Plugs (47).
4. Retaining nuts (48).
5. Spoiler extension (49) and washer (50).

→← Install or Connect

1. Spoiler extension (49) and washer (50).
2. Retaining nuts (48).
3. Plug (47).
4. Left quarter upper panel. Refer to "Quarter Upper Panel" in this section.
5. Spare tire cover. Refer to "Spare Tire Cover" in this section.

FUEL TANK FILLER DOOR

Figure 16

The fuel tank filler door attaches to the fuel tank pocket on the left side of the vehicle.

←→ Remove or Disconnect

1. Screws (55).

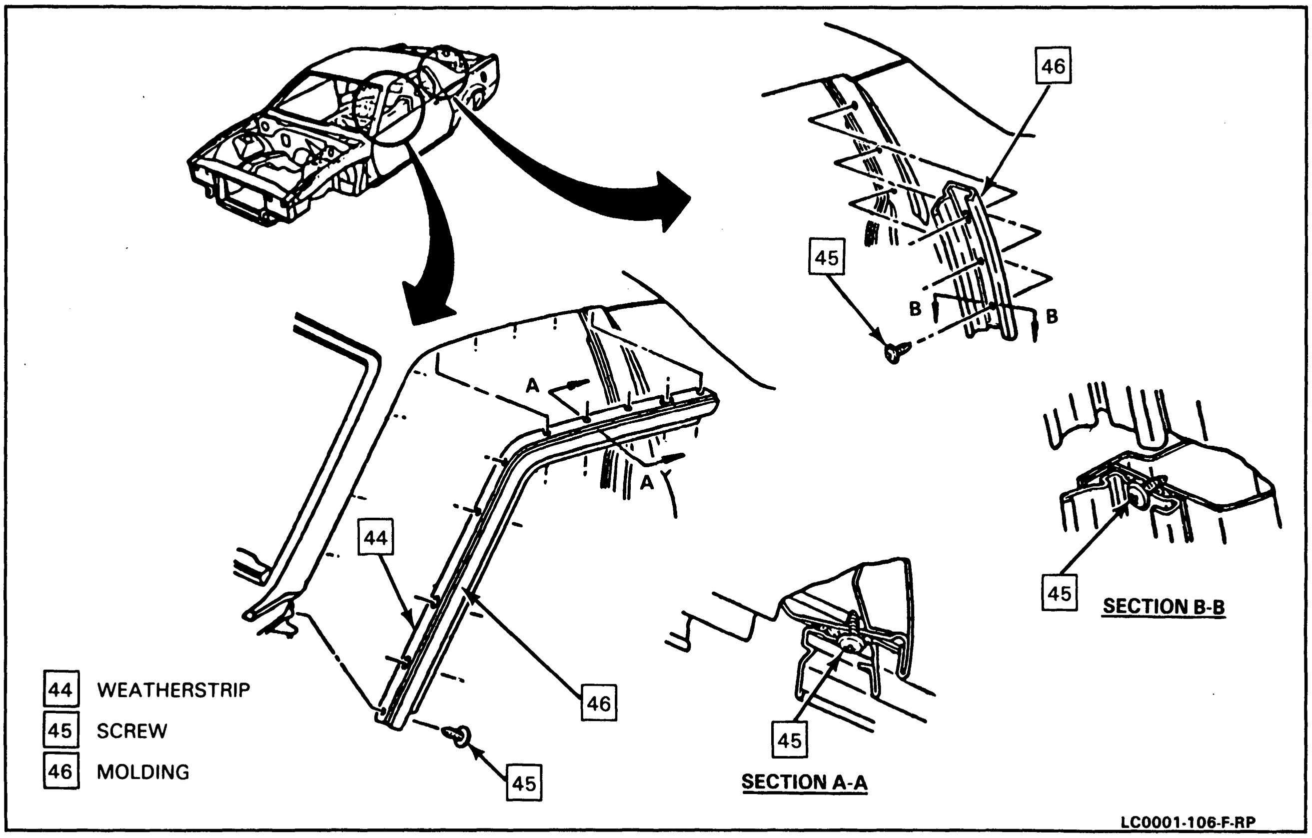


Figure 14 - Installing Roof Drip and Quarter to Body Reveal Molding

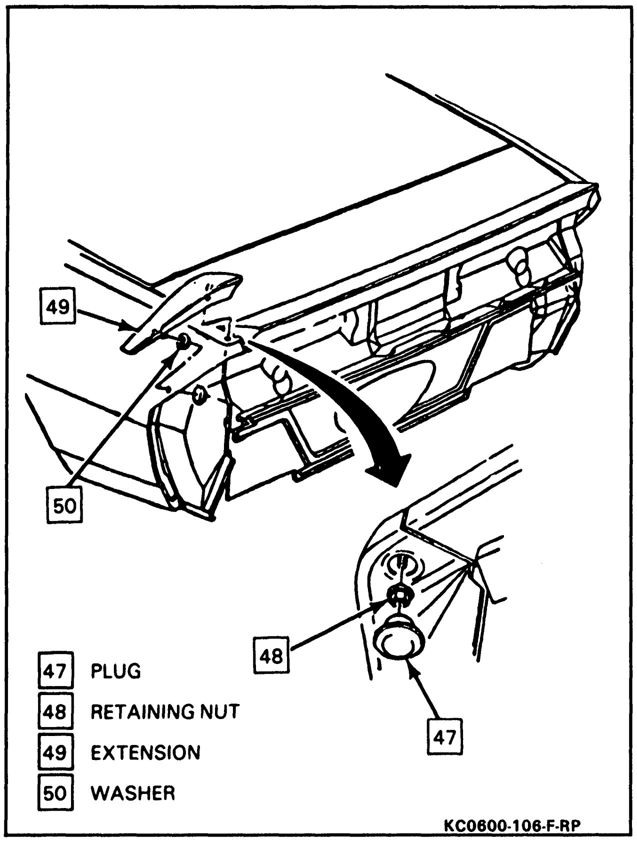


Figure 15 - Spoiler Extension - Quarter Rear

2. Gas cap.
3. Fuel tank filler door (54) and gasket (53).
   - Lift fuel tank filler door (54) from fuel tank pocket (52).

Install or Connect

1. Fuel tank filler door (54) and new gasket (53).
   - Insert in fuel tank pocket (52).
2. Screws (55).
3. Gas cap.

Fuel Tank Pocket

Figure 16

Remove or Disconnect

1. Fuel tank filler door. Refer to "Fuel Tank Filler Door" in this section.
2. Screw (51).
3. Fuel tank pocket (52).

Install or Connect

1. Fuel tank pocket (52) to body.
2. Screw (51).
3. Fuel tank filler door. Refer to "Fuel Tank Filler Door" in this section.

LUGGAGE COMPARTMENT SHADE COVER ASSEMBLY AND SUPPORTS

Figures 1, 2, 17 and 18

Remove or Disconnect

1. Shade cover (66).
   - Grasp shade cover (66) with hand and pull rearward to disengage from retainers (67) mounted on the lift window inner cover stiffener.
   - Lift shade cover (66) up and off from supports (68) on left and right quarter upper panels (7 and 9).
2. Screws (69).
3. Supports (68).

Install or Connect

1. Supports (68).
2. Screws (69).
3. Shade cover (66).
   - Engage to supports (68) mounted on left and right quarter upper panels (7 and 9).
   - Engage to retainers (67) mounted on the lift window inner cover stiffener.

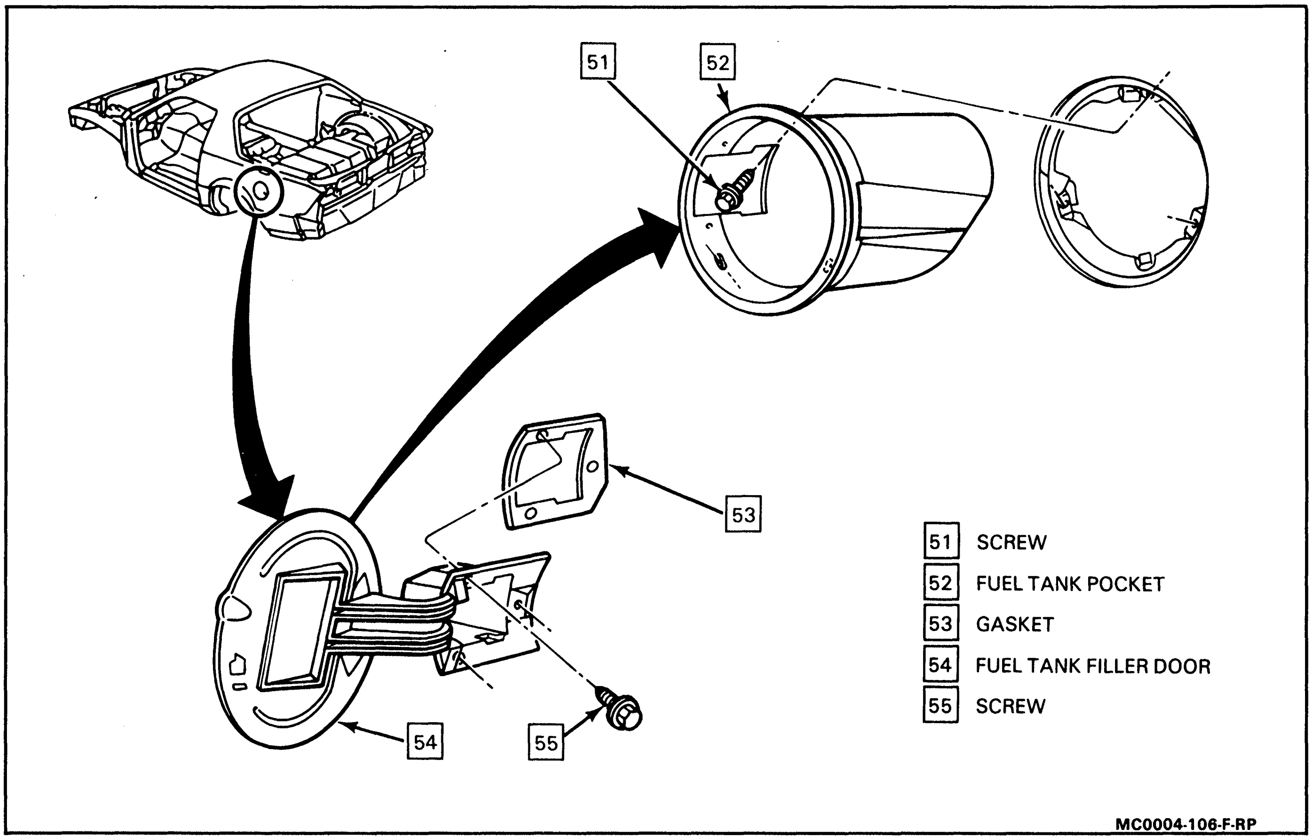


Figure 16 - Fuel Tank Filler Door and Pocket

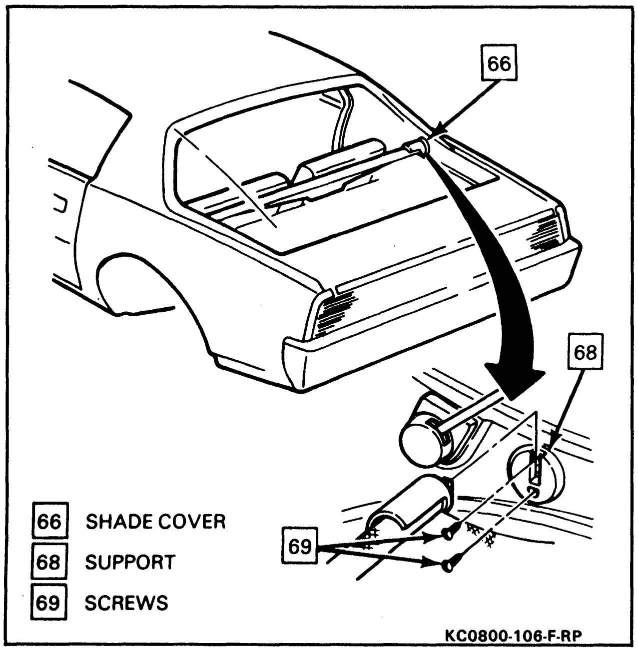


Figure 17 - Luggage Compartment Shade Cover

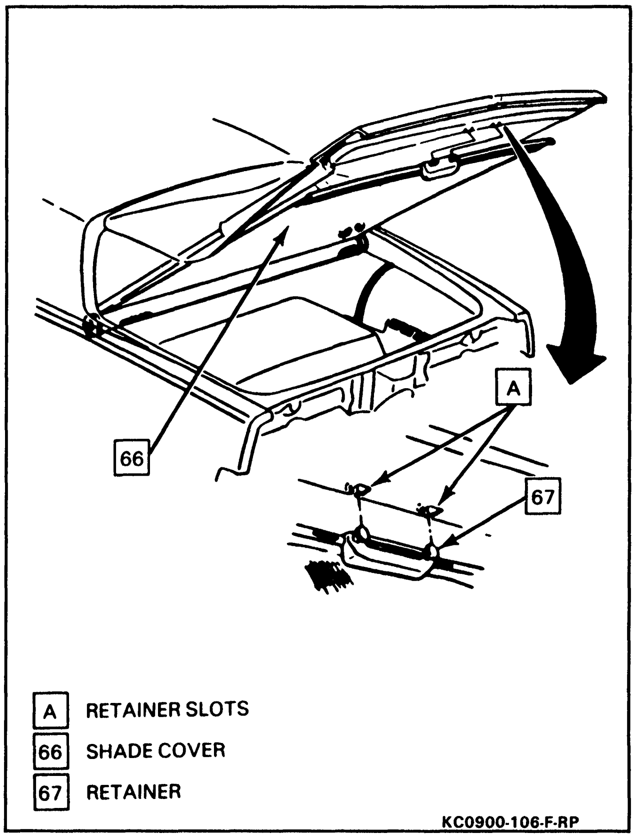


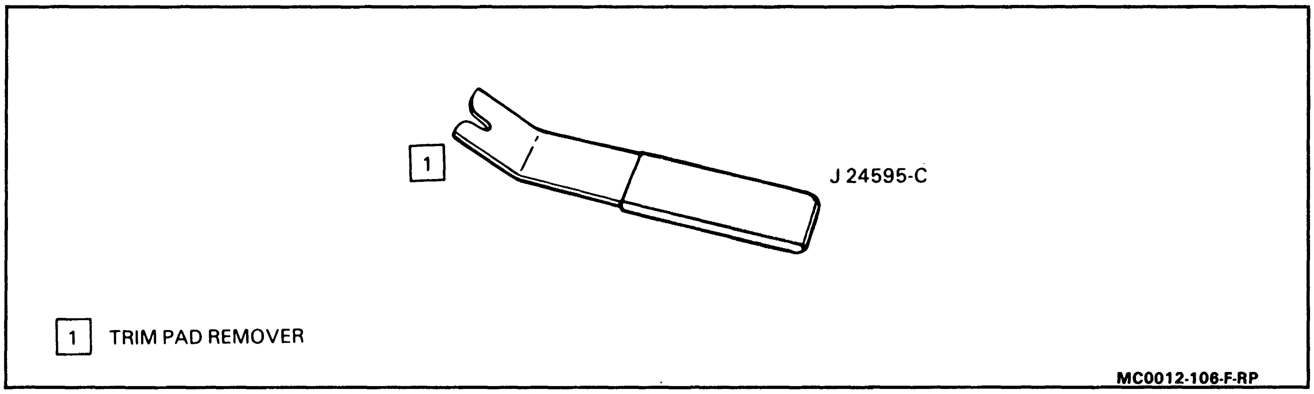
Figure 18 - Luggage Compartment Shade Cover Retainer

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Striker Bolt	50 N·m (37 lb. ft.)
Rear Quarter Lower Molding Nut	3 N·m (27 lb. in.)

SPECIAL TOOLS



SECTION 10-7

BODY REAR END

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 10-7-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

REAR COMPARTMENT TRIM

REAR END TRIM PANEL REPLACEMENT

Figure 1

↔ **Remove or Disconnect**

- Open compartment lift window.
- Open load floor panel, if equipped.

1. Load floor storage compartment striker, if equipped.
2. Plastic fasteners (3) at both sides of rear end trim panel (1).
3. Screws (2) at top of rear end trim panel (1).
- Lift up on rear end trim panel (1) to disengage trim panel lower retaining tabs.
4. Wiring harness from luggage compartment lamp (6).

5. Rear end trim panel (1) from rear compartment.

Install or Connect

1. Rear end trim panel (1) into rear compartment.
2. Wiring harness to luggage compartment lamp (6).
- Lift up on rear end trim panel (1) and insert trim panel tabs into rear body panel retainers.
3. Screws (2) at top of rear end trim panel (1).
4. Plastic fasteners (3) at right and left side of rear end trim panel (1).
5. Load floor storage compartment striker, if equipped.
- Close load floor panel, if equipped.
- Close compartment lift window.

LUGGAGE COMPARTMENT LAMP

Bulb Replacement

Figure 1

Remove or Disconnect

- Open compartment lift window.
1. Luggage compartment lamp (6) from rear end trim panel (1) by using a flat bladed tool to pry up on left side of luggage compartment lamp (6).
2. Bulb (7) from luggage compartment lamp (6).

Install or Connect

1. Bulb (7) to luggage compartment lamp (6).
2. Luggage compartment lamp (6) by inserting right side of lamp (6) into cutout in rear end trim panel (1) and snapping left side into place.
- Close compartment lift window.

Lens Replacement

Figure 1

Remove or Disconnect

- Open compartment lift window.
1. Luggage compartment lamp. Refer to "Bulb Replacement" in this section.
2. Wiring harness.
3. Lens.

Install or Connect

1. Lens to luggage compartment lamp (6).
2. Wiring harness.
3. Luggage compartment lamp. Refer to "Bulb Replacement" in this section.
- Close compartment lift window.

LOAD FLOOR PANEL REPLACEMENT

Figure 2

Remove or Disconnect

- Open compartment lift window.
- Open load floor panel (8).
1. Hinge covers (9).
2. Hinge nuts (10).
3. Load floor panel (8).

Install or Connect

1. Load floor panel (8) to attaching studs.

   NOTICE: See "Notice" on page 10-7-1 of this section.
2. Hinge nuts (10).

   Tighten

   - Hinge nuts (10) to 11 N·m (97 lb. in.).
3. Hinge covers.
- Close load floor panel (8).
- Close compartment lift window.

LOAD FLOOR PANEL LOCK CYLINDER REPLACEMENT

Figure 3

Remove or Disconnect

- Open compartment lift window.
- Open load floor panel (8).
1. Load floor panel lock cylinder retainer (12) using a flat bladed tool to push from load floor panel lock cylinder (11).
2. Load floor panel lock cylinder (11).

Install or Connect

1. Load floor panel lock cylinder (11) to load floor panel (8).
2. Load floor panel lock cylinder retainer (12).
- Close load floor panel (8).
- Close compartment lid window.

LOAD FLOOR PANEL STRIKER REPLACEMENT

Figure 4

Remove or Disconnect

- Open compartment lid window.
- Open load floor panel.
1. Screws (14) from load floor panel striker (13) to rear body panel.
2. Load floor panel striker (13).

Install or Connect

1. Load floor panel striker (13) to rear body panel through elongated hole in rear end trim panel (1).

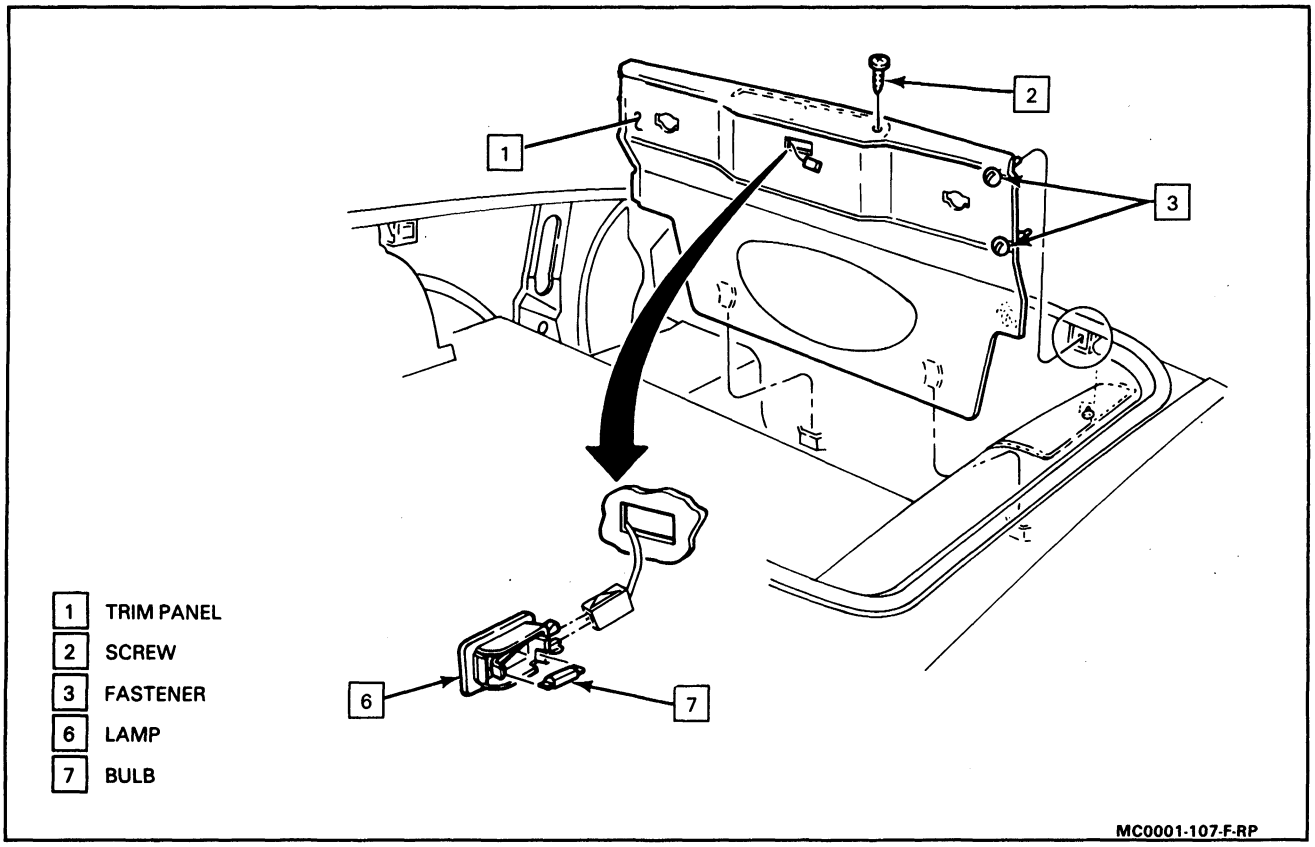


Figure 1 - Rear End Trim Panel

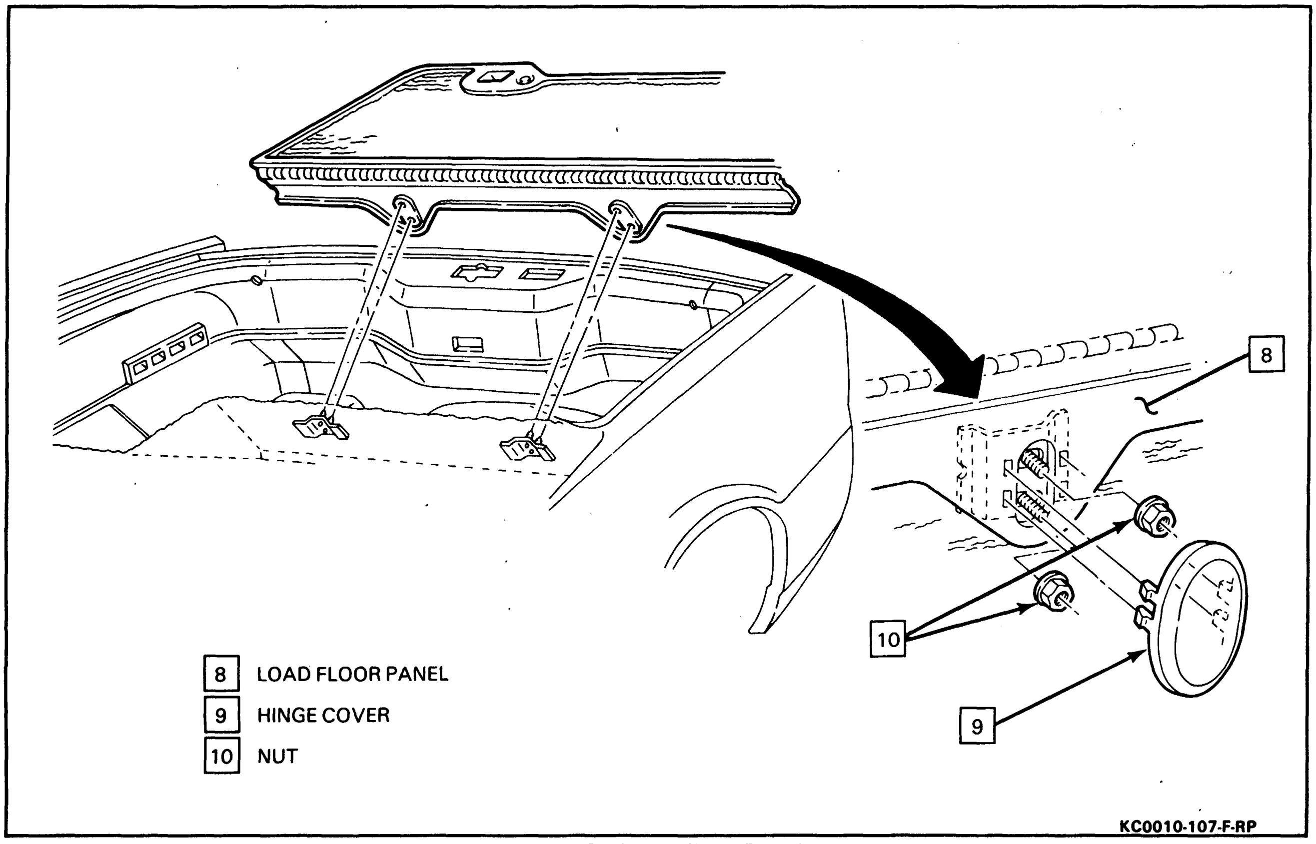


Figure 2 - Load Floor Panel

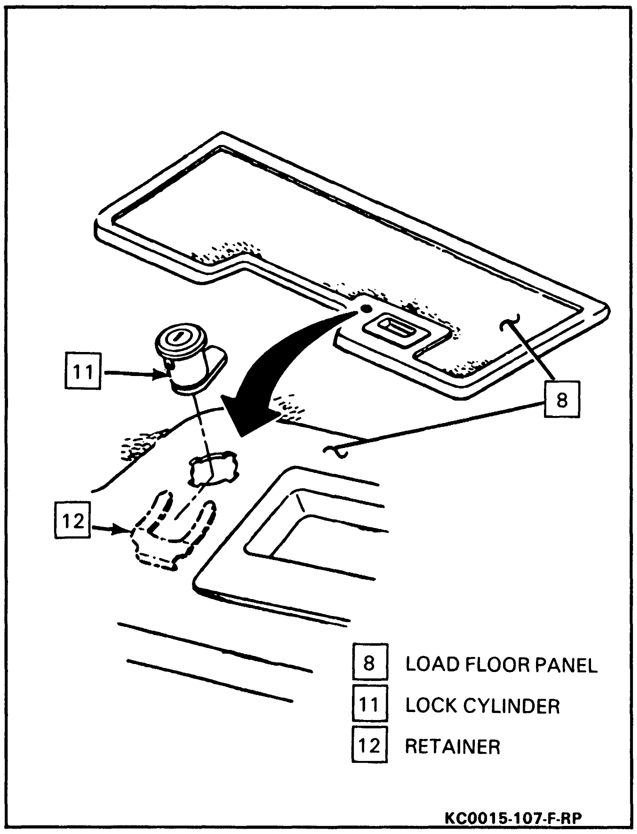


Figure 3 - Load Floor Panel Lock Cylinder

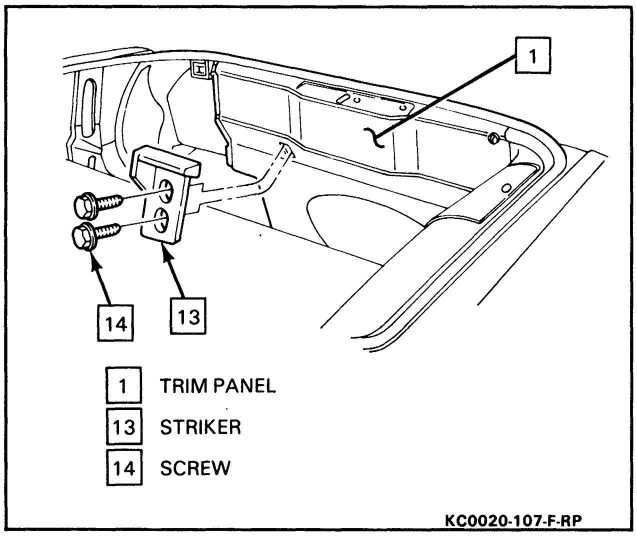


Figure 4 - Load Floor Panel Striker

2. Screws (14) to load floor panel striker (13) to rear body panel.

- Close load floor panel.
- Close compartment lift window.

REAR COMPARTMENT CARPET REPLACEMENT

Figure 5

Remove or Disconnect

1. Rear seatback and cushion. Refer to SEATS (SEC. 10-9).
2. Left and right quarter trim panels. Refer to REAR QUARTERS (SEC. 10-6).
3. Rear end trim panel. Refer to "Rear End Trim Panel Replacement" in this section.
4. Load floor panel, if equipped. Refer to "Load Floor Panel Replacement" in this section.
5. Roof lift-off panel stow bag retainers, if equipped.
6. Rear compartment carpet (15).

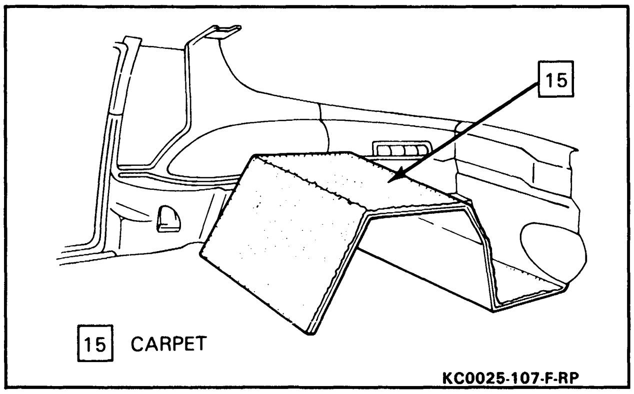


Figure 5 - Rear Compartment Carpet

Install or Connect

1. Rear compartment carpet (15).
2. Roof lift-off panel stow bag retainers, if equipped.
3. Load floor panel, if equipped. Refer to "Load Floor Panel Replacement" in this section.
4. Rear end trim panel. Refer to "Rear End Trim Panel Replacement" in this section.
5. Left and right quarter trim panels. Refer to REAR QUARTERS (SEC. 10-6).
6. Rear seatback and cushion. Refer to SEATS (SEC. 10-9).

REAR COMPARTMENT SHADE REPLACEMENT

Figure 6

Remove or Disconnect

- Open compartment lift window.
- Rear compartment shade (17).
  - If rear compartment shade (17) is extended, pull toward the rear and disengage from shade retainer in compartment lift window.
  - Lift rear compartment shade (17) from the cover supports (16).

Install or Connect

- Rear compartment shade (17).
  - Rear compartment shade (17) should be rolled up on its spring-load spool before installation.
  - Insert ends of rear compartment shade (17) into shade supports (16).

Inspect

- Rear compartment shade (17) for proper operation by pulling toward the rear of the vehicle and then allowing it to rewind again.

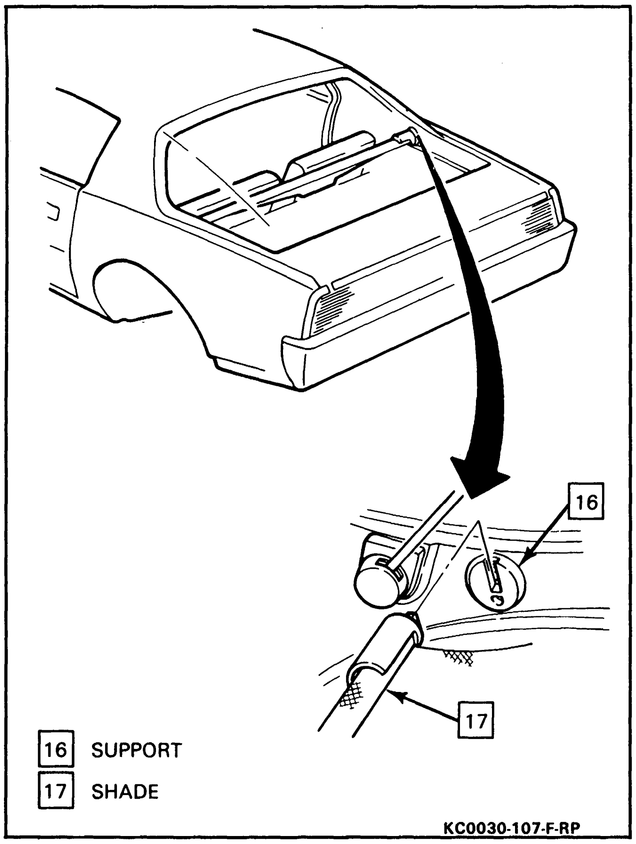


Figure 6 - Rear Compartment Shade

- Close compartment lift window.

REAR COMPARTMENT SPEAKER REPLACEMENT (BOSE SYSTEM)

↔ Remove or Disconnect

- Open compartment lift window.

1. Screws from speaker grille to load floor panel.
2. Speaker grille.
3. Screws from speaker to load floor panel.

- Lift speaker from load floor panel.

4. Speaker wire terminals from speaker.
5. Speaker.

→← Install or Connect

1. Speaker wire terminals to speaker.
2. Speaker to load floor panel.
3. Screws to speaker and load floor panel.
4. Speaker grille.
5. Screws to speaker grille and load floor panel.

- Close compartment lift window.

COMPARTMENT LIFT WINDOW

The compartment lift window assembly consists of a solid formed tempered safety glass with a two-piece black painted molding attached with urethane. A finishing panel is bolted to the bottom of the glass. Two counterbalance supports (tubular gas charged supports) are mounted to the compartment lift window and body to assist in opening. Counterbalance supports vary in output levels depending on options such as rear glass defogger, window sunshade or spoilers.

COMPARTMENT LIFT WINDOW ADJUSTMENTS

CAUTION: Glass side of hinge assembly has slots. These slots are for production build use and not intended for service adjustment of glass. Follow recommended adjustment procedure or glass breakage and personal injury could occur.

CAUTION: Approved safety glasses and gloves should be worn when performing these procedures to reduce the chance of personal injury should glass breakage occur.

Compartment Lift Window Fore and Aft and Side to Side Adjustment

Figure 7

↔ Remove or Disconnect

1. Compartment lift window sunshade, if equipped. Refer to "Compartment Lift Window Sunshade Replacement" in this section.

- Open compartment lift window (27) and suitably support it.

2. Compartment lift window opening upper finishing molding. Refer to REAR QUARTERS (SEC. 10-6).
3. Counterbalance supports at compartment lift window. Refer to "Counterbalance Support Replacement" in this section.

- Loosen hinge-to-body nuts (28).
- Close compartment lift window (27).

Adjust

- Compartment lift window (27) fore and aft and from side to side as necessary by moving hinge studs in oversize body attaching holes.

NOTICE: See "Notice" on page 10-7-1 of this section.

Tighten

- Hinge-to-body nuts (28) to 24 N·m (18 lb. ft.) by reaching through door opening.

→← Install or Connect

- Open compartment lift window (27) and support it.

1. Counterbalance supports to compartment lift window. Refer to "Counterbalance Support Replacement" in this section.
2. Compartment lift window opening upper finishing molding. Refer to REAR QUARTERS (SEC. 10-6).

- Close compartment lift window (27).

3. Compartment lift window sunshade, if equipped. Refer to "Compartment Lift Window Sunshade Replacement" in this section.

Compartment Lift Window Height Adjustment

Figure 7

Remove or Disconnect

- Compartment lift window by disconnecting hinges from body. Refer to "Compartment Lift Window Replacement" in this section.

Adjust

- Install spacers (23) as necessary to adjust height of upper compartment lift window to roof.

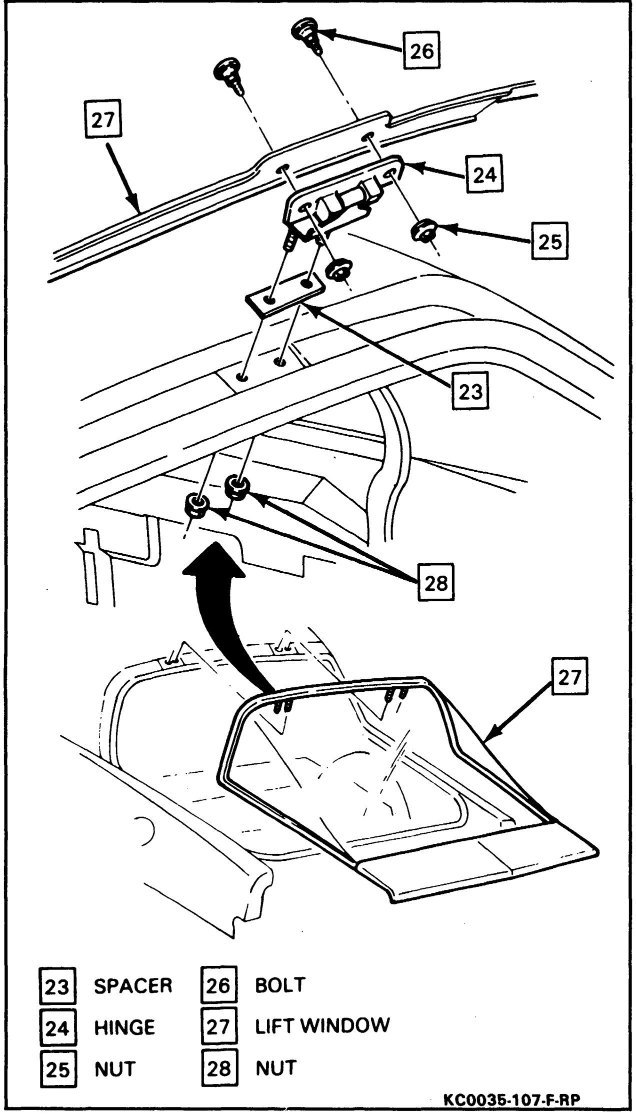


Figure 7 - Compartment Lift Window Hinge

Install or Connect

- Compartment lift window. Refer to "Compartment Lift Window Replacement" in this section.

Adjust

- Bumpers on inside of lift window panel lower corners as necessary to match the height of the rear quarter panels.

COUNTERBALANCE SUPPORT

Figure 8

The counterbalance supports are used to assist with the opening of the compartment lift window. They are secured by retainers at the lift window and body. The supports are color coded according to a specified output and must be replaced with a support of the same output.

Counterbalance Support Diagnosis

Figure 8

If the compartment lift window (27) will not open or remain in a full open position it may be due to the following conditions.

- In extremely cold temperatures, -29°C (-20°F), it is normal for the gas pressure in the counterbalance support (30) to be reduced. This results in less force to hold the lift window (27) open until warmer weather. A buildup of snow on the lift window (27) will prevent the supports (30) from working properly.
- One or both of the supports (30) are worn and need to be replaced. Very seldom do both supports (30) wear out at the same time.
  - Replace support (30) on one side of lift window (27) with a new support (30) that has the same color code.
  - If the lift window (27) will not remain open, replace the support (30) on the other side with the support (30) just removed.
  - If the lift window (27) still does not remain open, replace the old support (30) installed in the previous step with a new support of the same color code.

Counterbalance Support Replacement

Figure 8

Remove or Disconnect

CAUTION: Do not attempt to remove or loosen the counterbalance support without the lift window fully open. A support removed under pressure may result in personal injury.

- Open compartment lift window (27) and suitably support it.

1. Electrical connections, if equipped, from both ends of support (30).
2. End cover (32) and mounting cover (29).
3. Bolt (31).
4. Screw (33).
5. Support (30).

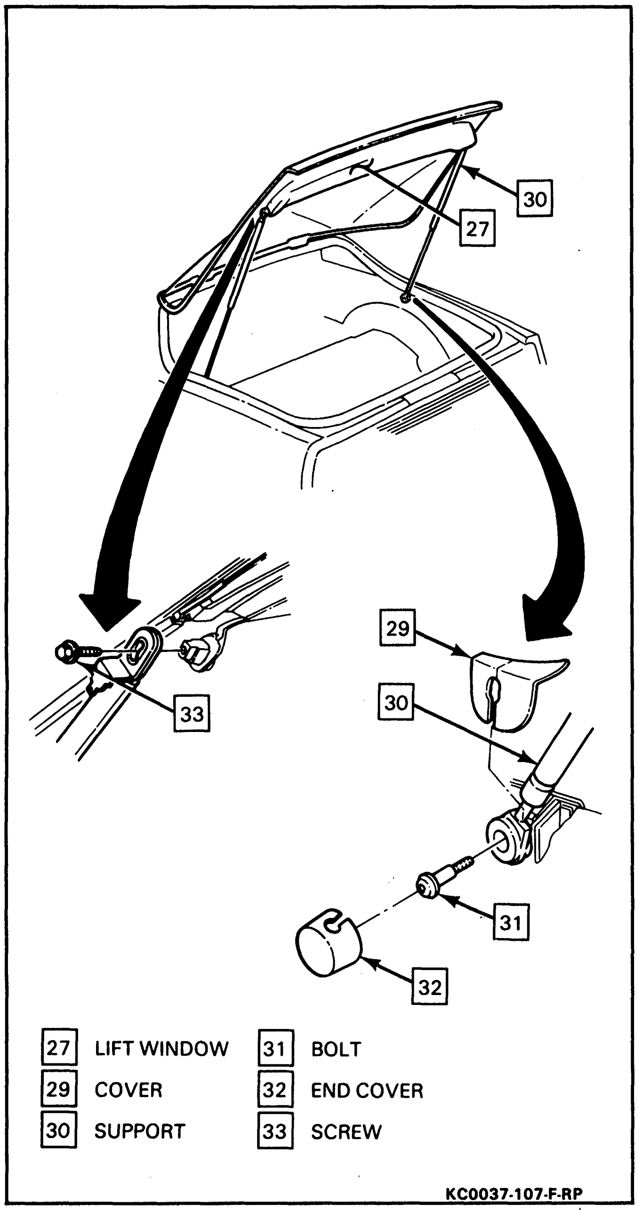


Figure 8 - Counterbalance Support

Install or Connect

NOTICE: See "Notice" on page 10-7-1 of this section.

1. Support (30) to body with bolt (31).

   #### Tighten

   - Bolt (31) to 24 N·m (18 lb. ft.).

2. Screw (33).

   #### Tighten

   - Screw (33) to 6 N·m (53 lb. in.).

3. End cover (32) and mounting cover (29).
4. Electrical connections, if equipped, to both ends of support (30).

- Remove support and close lift window (27).

COMPARTMENT LIFT WINDOW REPLACEMENT

Figure 7

The bracket for the center high-mounted stoplamp comes already attached to the lift window glass.

> **CAUTION: These steps must be performed with the assistance of a helper to reduce the possibility of glass breakage or personal injury.**
>
> **CAUTION: Approved safety glasses and gloves should be worn when performing these procedures to reduce chance of personal injury should glass breakage occur.**

Remove or Disconnect

1. Compartment lift window sunshade, if present. Refer to "Compartment Lift Window Sunshade Replacement" in this section.
2. Electrical connection to center high-mounted stoplamp.
   - Remove screws.
   - Remove cover.
   - Disconnect electrical connector.

- Open lift window (27) and support it.

3. Counterbalance supports from lift window. Refer to "Counterbalance Support Replacement" in this section.
4. Lift window (27).
   - If lift window-to-body height adjustment or hinge replacement is necessary, remove lift window (27) and hinges (24) from body.
     - Remove lift window opening upper finishing molding. Refer to REAR QUARTERS (SEC. 10-6).
     - Close lift window.
     - Remove hinge-to-body nuts (28) by reaching through door opening.
     - Remove lift window (27) with the assistance of a helper.
   - If glass or molding replacement is necessary, remove lift window (27) from hinges (24) and leave hinges (24) attached to body.
     - Remove hinge-to-glass nuts (25).
     - Remove hinge-to-glass bolts (26).
     - Remove lift window (27).

Install or Connect

NOTICE: See "Notice" on page 10-7-1 of this section.

1. Lift window (27).
   - If installing lift window (27) with hinges (24) attached to glass:
     - Install lift window (27) to body with the assistance of a helper.

    - Install hinge-to-body nuts (28) by reaching through door opening.

      Tighten

      - Nuts (28) to 24 N·m (18 lb. ft.).
    - Open lift window and support it.
    - Install lift window opening upper finishing molding. Refer to REAR QUARTERS (SEC. 10-6).
- If installing lift window (27) with hinges (24) attached to body:
    - Install lift window (27) to body and support in an open position.
    - Install hinge-to-glass bolts (26).
    - Install hinge-to-glass nuts (25).

CAUTION: When tightening hinge-to-glass nuts be sure to torque to specification. Overtightening could cause glass breakage and possible personal injury.

Tighten

- Nuts (25) to 14 N·m (124 lb. in.).

2. Counterbalance supports to lift window. Refer to "Counterbalance Support Replacement" in this section.
3. Electrical connection to center high-mounted stoplamp.
    - Connect electrical connector.
    - Replace cover.
    - Install screws.
- Close lift window (27).
4. Lift window sunshade, if equipped. Refer to "Compartment Lift Window Sunshade Replacement" in this section.

COMPARTMENT LIFT WINDOW HINGE REPLACEMENT

Figure 7

Remove or Disconnect

1. Compartment lift window sunshade, if equipped. Refer to "Compartment Lift Window Sunshade Replacement" in this section.
2. Compartment lift window with hinges from body. Refer to "Compartment Lift Window Replacement" in this section.
3. Hinge-to-glass nuts (25).
4. Hinge-to-glass bolts (26).
5. Hinge (24).

Install or Connect

1. Hinge (24).
2. Hinge-to-glass bolts (26).

NOTICE: See "Notice" on page 10-7-1 of this section.

3. Hinge-to-glass nuts (25).

CAUTION: When tightening hinge-to-glass nuts, be sure to torque to specification. Overtightening could cause glass breakage and possible personal injury.

Tighten

- Nuts (25) to 14 N·m (124 lb. in.).

4. Compartment lift window. Refer to "Compartment Lift Window Replacement" in this section.
5. Compartment lift window sunshade, if equipped. Refer to "Compartment Lift Window Sunshade Replacement" in this section.

COMPARTMENT LIFT WINDOW PANEL REPLACEMENT

Figures 9 through 12

Remove or Disconnect

1. Compartment lift window. Refer to "Compartment Lift Window Replacement" in this section.
- Place lift window upside down on a protected surface.
2. Compartment lift window trim panel. Refer to "Compartment Lift Window Trim Panel Replacement" in this section.
3. Nuts (34).
4. Reinforcement panel (35).
5. Screws from lift window glass molding to lift window panel (38).
6. Bushings (39).
7. Inner panel seal (44) by cutting urethane between seal (44) and glass (40).
    - Turn lift window right side up.
8. Lift window panel (38).
    - Mask off top edge of panel (38) next to glass (40).
    - Using a sharp, flat-bladed tool, cut through butyl sealing strip (41) and foam front sealing strip (42) between panel (38) and glass (40).
9. Upper electrical contact, if new lift window panel is to be installed. Refer to "Upper Electrical Contact Replacement" in this section.
10. Lock striker, if new lift window panel is to be installed. Refer to "Compartment Lift Window Lock Striker Replacement" in this section.
11. Rubber bumpers from lower corners of panel (38) if new lift window panel (38) is to be installed.
12. Spacers (43) if new lift window panel (38) is to be installed.

Clean

- Glass (40) of all adhesive and seals using, a razor blade and a cloth dampened with alcohol or oil free naphtha.

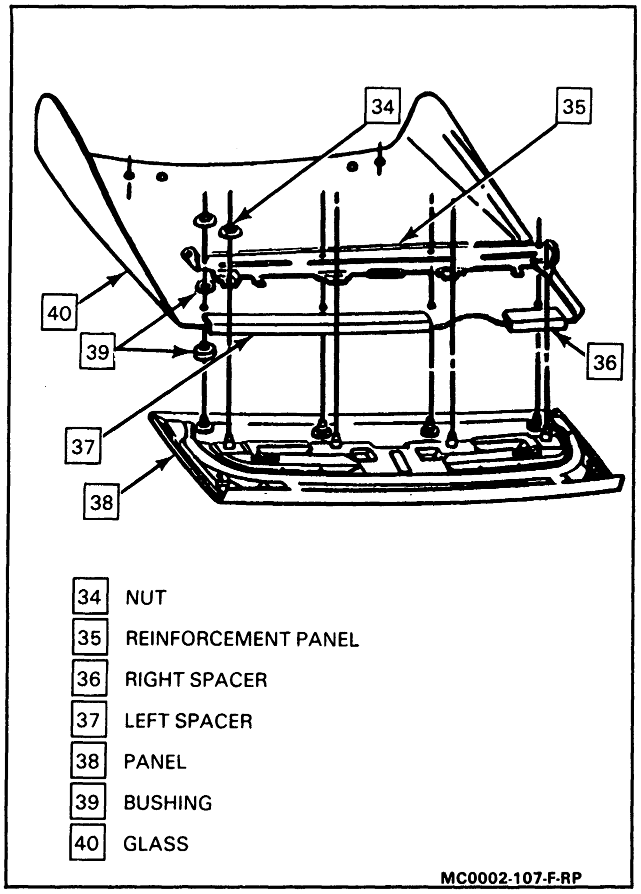


Figure 9 - Compartment Lift Window Panel

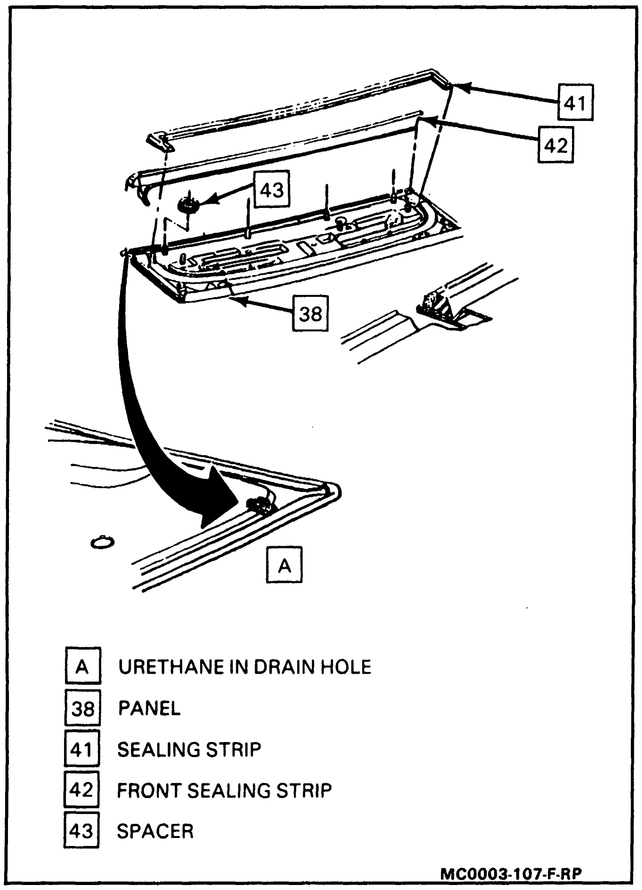


Figure 10 - Installing Sealing Strip to Lift Window Panel

- Panel of all adhesive and seals, if original panel is to be reinstalled.

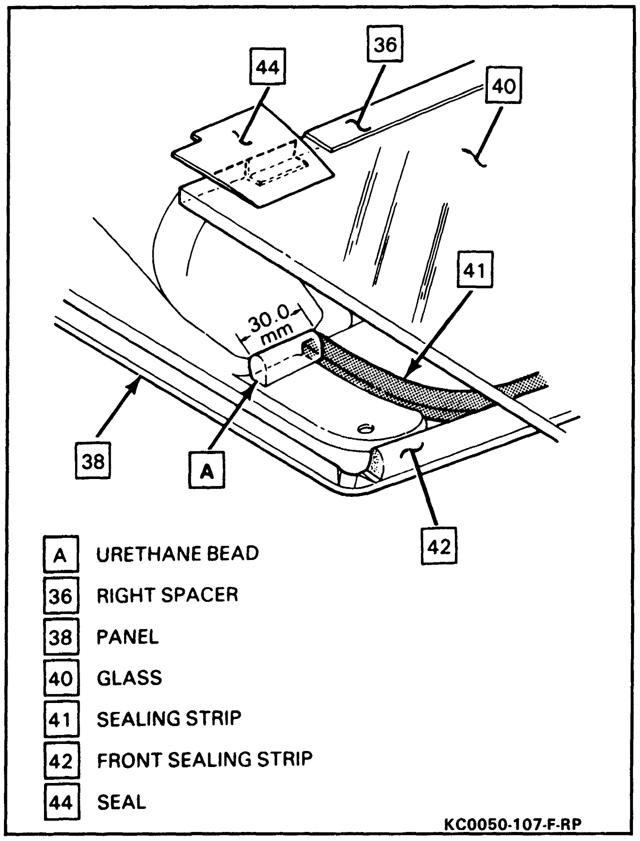


Figure 11 - Compartment Lift Window Seals

Install or Connect

- Place glass (40) upside down.

1. Front sealing strip (42) to front hem flange of lift window panel (38).
2. Sealing strip (41) next to front sealing strip (42) in path of lift window panel (38).

- Trim 25 mm (1-inch) of sealing strip (41) from each end and apply to forward outer drain holes in lift window panel (38), if installing new lift window panel (38).
- Apply primer to outer glass attaching end of lift window panel. See Figure 12. Allow primer to dry for 30 minutes.
- Apply a bead of urethane 15 mm (19/32 inch) in diameter and 30 mm (1-3/16 inch) long to area of primer on lift window panel (38) next to sealing strip (41).
- Apply a 3 mm (1/8-inch) diameter bead of urethane to outer edge of seals (44) on the seal-to-glass side.

3. Seal (44) to glass (40).
4. Spacer (43) to lift window panel stud if installing new lift window panel (38).
5. Rubber bumpers to lower corners of lift window panel (38) if installing new lift window panel (38).
6. Lock striker to lift window panel if installing new lift window panel. Refer to "Compartment Lift Window Lock Striker Replacement" in this section.

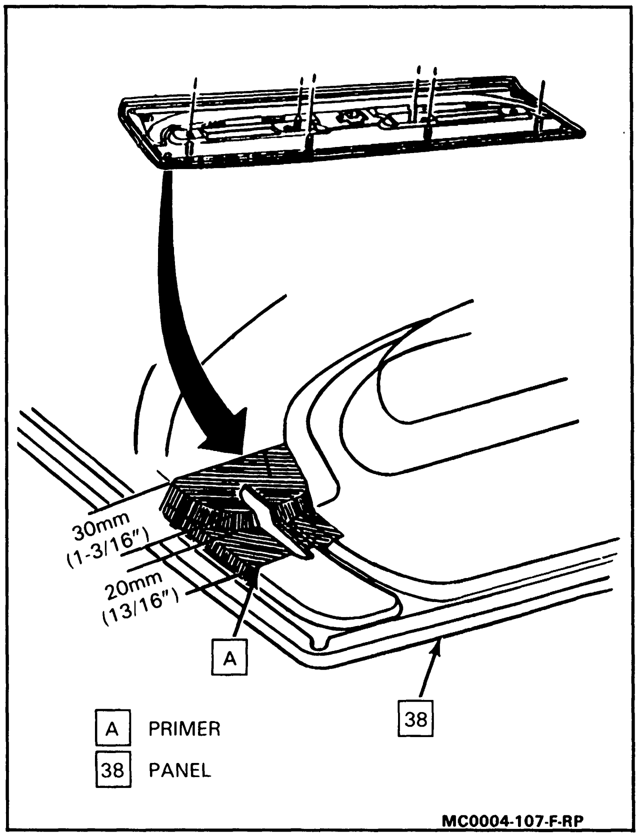


Figure 12 - Priming Lift Window Panel

7. Upper electrical contact to lift window panel (38) if installing new lift window panel (38).
8. Lift window panel (38) to glass (40).
9. Bushings (39) over panel studs with the bushing side through the holes in the glass.
10. Reinforcement panel (35).

NOTICE: See "Notice" on page 10-7-1 of this section.

11. Nuts (34) hand tight.

- Align panel (38) to glass (40).

CAUTION: When tightening panel-to-glass nuts be sure to torque to specification and in proper order to prevent glass breakage and possible personal injury.

Tighten

- Nuts (34) to 14 N·m (124 lb. in.) in the following order:
  - Forward center.
  - Rearward center.
  - All remaining nuts.

12. Screws attaching lift window glass molding to lift window panel (38).
13. Lift window trim panel. Refer to "Compartment Lift Window Trim Panel Replacement" in this section.
14. Compartment lift window. Refer to "Compartment Lift Window Replacement" in this section.

COMPARTMENT LIFT WINDOW MOLDING REPLACEMENT

Figures 13 through 15

Remove or Disconnect

1. Compartment lift window. Refer to "Compartment Lift Window Replacement" in this section.

- Place lift window upside down on a protected work surface.

2. Compartment lift window hinges. Refer to "Compartment Lift Window Hinge Replacement" in this section.
3. Screws from lift window left molding (45) and right molding (46) to lift window panel.

CAUTION: Perform the urethane burn-out operation in a well ventilated area and avoid inhalation of fumes being emitted as these fumes may be hazardous.

4. Left molding (45) and right molding (46) from glass (40).
   - Use an acetylene torch with a number two tip and start from the top of left molding (45) or top of right molding (46) and apply heat for a distance of 200 mm (8 inches) in a back and forth motion.
   - Immediately grasp heated section of the left molding (45) or right molding (46) with pliers and pull away from glass (40).
   - Repeat the previous steps for the length of the other molding on both sides of glass until the molding is removed.

Clean

- Glass (40) by removing adhesive with a razor blade and a cloth dampened with alcohol or oil free naphtha.

Install or Connect

- Apply clear urethane primer to glass (40) (Figure 14).
- Apply black urethane primer over same areas of glass (40). Allow primer to air dry for five minutes.
- Apply black urethane primer to inside molding channels. Allow primer to air dry for five minutes.
- Apply a 4.5 mm (3/16 inch) bead of urethane to inside molding channels. Do not apply urethane for a distance of 25 mm (1 inch) from top ends of moldings (Figure 15).

1. Escutcheon (47) into top channel of right molding (46).
2. Left molding (45) to glass (40).
3. Right molding (46) to glass (40).

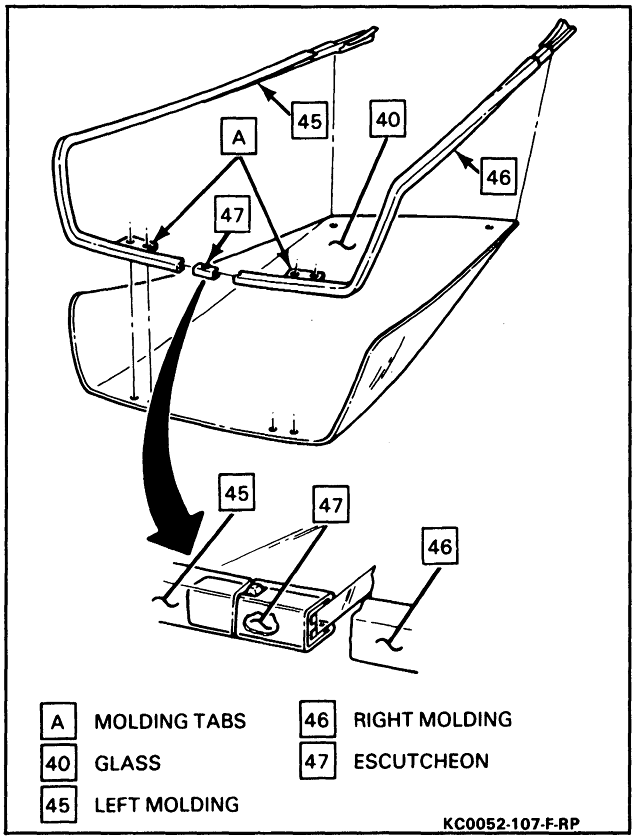


Figure 13 - Compartment Lift Window Molding

Adjust

- Holes in molding tabs to align with holes in glass.
- Escutcheon (47) to left molding (45).
- Tap the left molding (45) and right molding (46) with a mallet to seat them on the glass.

Inspect

- Left molding (45) and right molding (46) along radius to see that they are seated properly to the glass.

- Apply cloth tape over the left molding (45) and right molding (46) to glass every 200 mm (8 inches) to hold moldings in place while urethane cures. Allow 6 hours cure time.

4. Screws for left molding (45) and right molding (46) to panel.
5. Lift window hinges. Refer to "Compartment Lift Window Hinge Replacement" in this section.
6. Lift window. Refer to "Compartment Lift Window Replacement" in this section.

COMPARTMENT LIFT WINDOW GLASS REPLACEMENT

The bracket for the center high-mounted stoplamp comes already attached to the lift window glass.

Remove or Disconnect

1. Compartment lift window. Refer to "Compartment Lift Window Replacement" in this section.

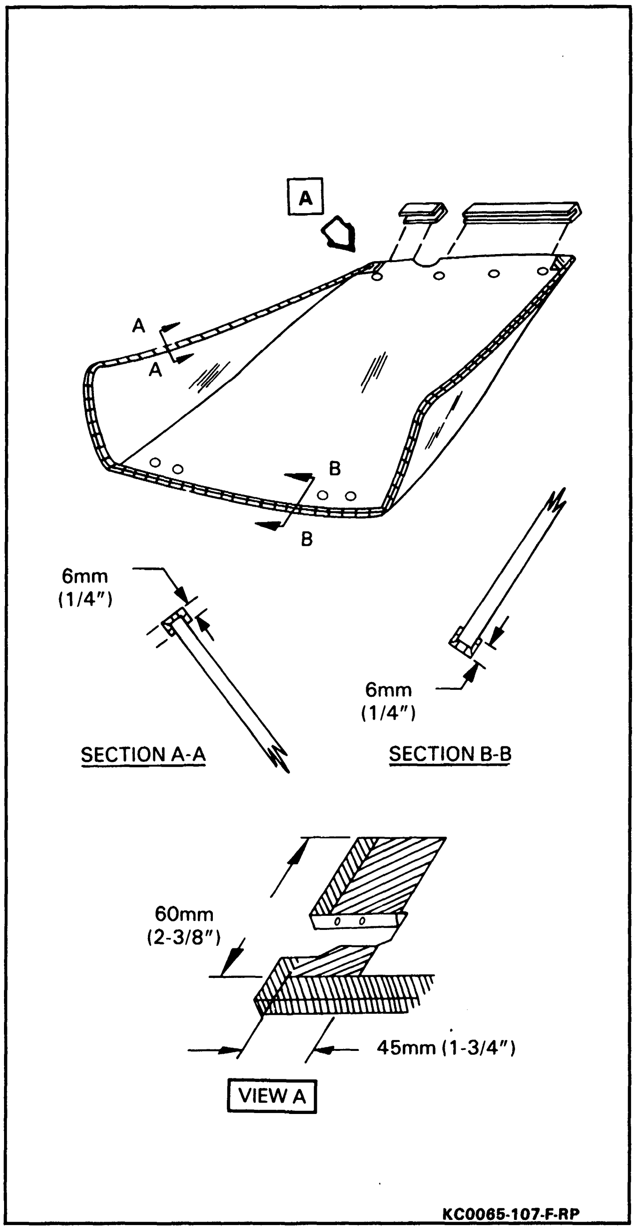


Figure 14 - Priming Compartment Lift Window Glass

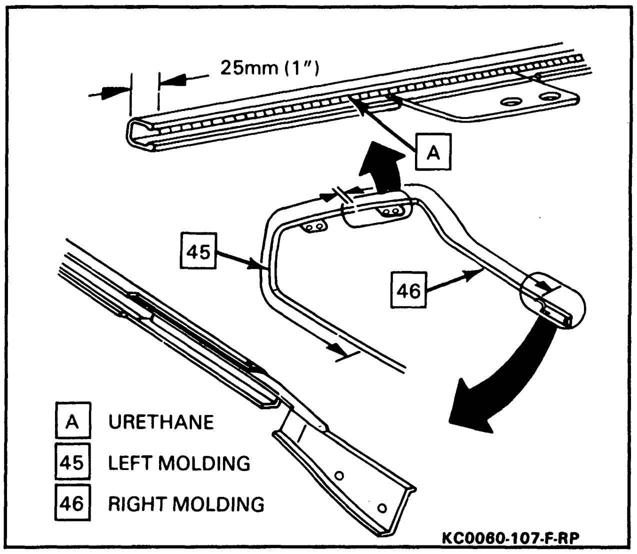


Figure 15 - Applying Urethane to Molding

2. Compartment lift window panel. Refer to "Compartment Lift Window Panel Replacement" in this section.
3. Compartment lift window moldings. Refer to "Compartment Lift Window Molding Replacement" in this section.

Install or Connect

1. Compartment lift window moldings. Refer to "Compartment Lift Window Molding Replacement" in this section.
2. Compartment lift window panel. Refer to "Compartment Lift Window Panel Replacement" in this section.
3. Compartment lift window to body. Refer to "Compartment Lift Window Replacement" in this section.

COMPARTMENT LIFT WINDOW LOCK STRIKER REPLACEMENT

Figure 16

Remove or Disconnect

- Open compartment lift window.

1. Compartment lift window trim panel. Refer to "Compartment Lift Window Trim Panel Replacement" in this section.
2. Nut (34).
3. Nuts (54).
4. Striker (55).

Install or Connect

NOTICE: See "Notice" on page 10-7-1 of this section for steps 3 and 4.

1. Striker (55).
2. Nut (34).

Tighten

- Nut (34) to 14 N·m (124 lb. in.).

3. Nuts (54).

Tighten

- Nuts (54) to 11 N·m (97 lb. in.).

4. Compartment lift window trim panel. Refer to "Compartment Lift Window Trim Panel Replacement" in this section.

- Close compartment lift window.

COMPARTMENT LIFT WINDOW LOCK CYLINDER REPLACEMENT

Figure 17

Remove or Disconnect

- Open compartment lift window.
- Pull down license plate mounting bracket.

1. Rear end trim panel. Refer to "Rear End Trim Panel Replacement" in this section.
2. Lock cylinder retainer (56).
3. Lock cylinder (58) and gasket (57).

Install or Connect

1. Gasket (57) to lock cylinder (58), if new lock cylinder (58) is being installed.
2. Lock cylinder (58) to rear end panel while guiding lock cylinder shaft into slot of pull-down unit cable end.

- Check lock cylinder (58) for correct operation.

3. Lock cylinder retainer (56) to shoulder of lock cylinder (58).
4. Rear end trim panel. Refer to "Rear End Trim Panel Replacement" in this section.

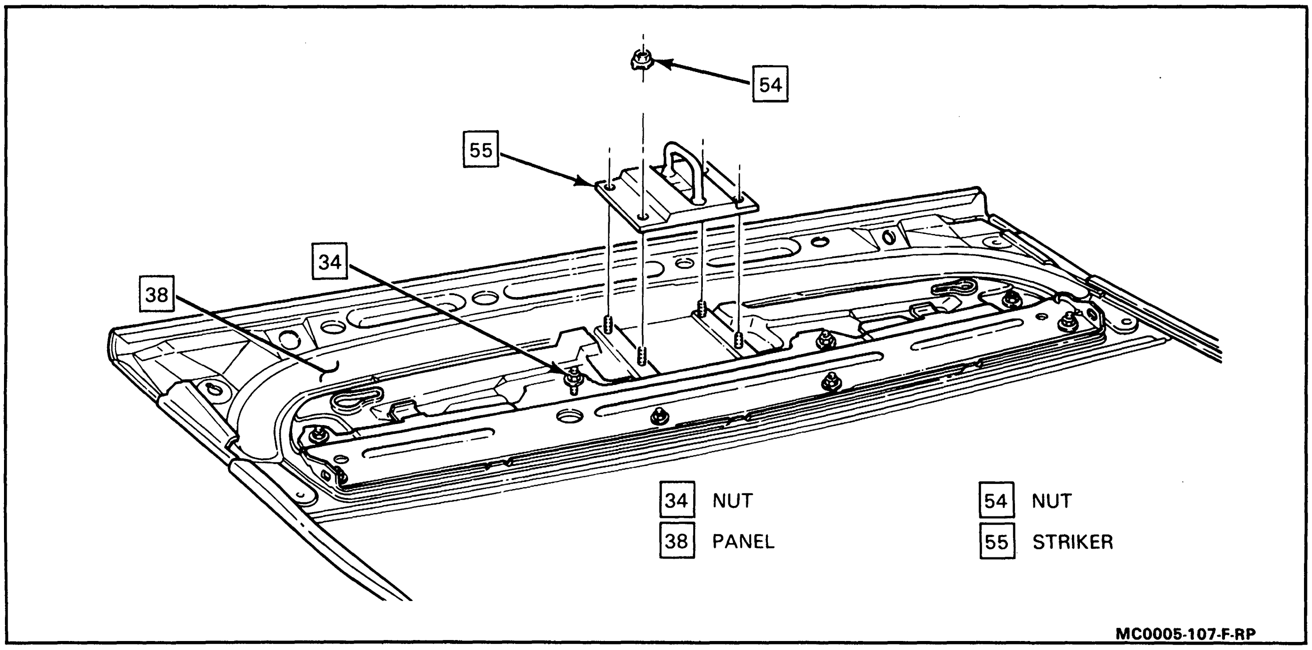


Figure 16 - Compartment Lift Window Striker

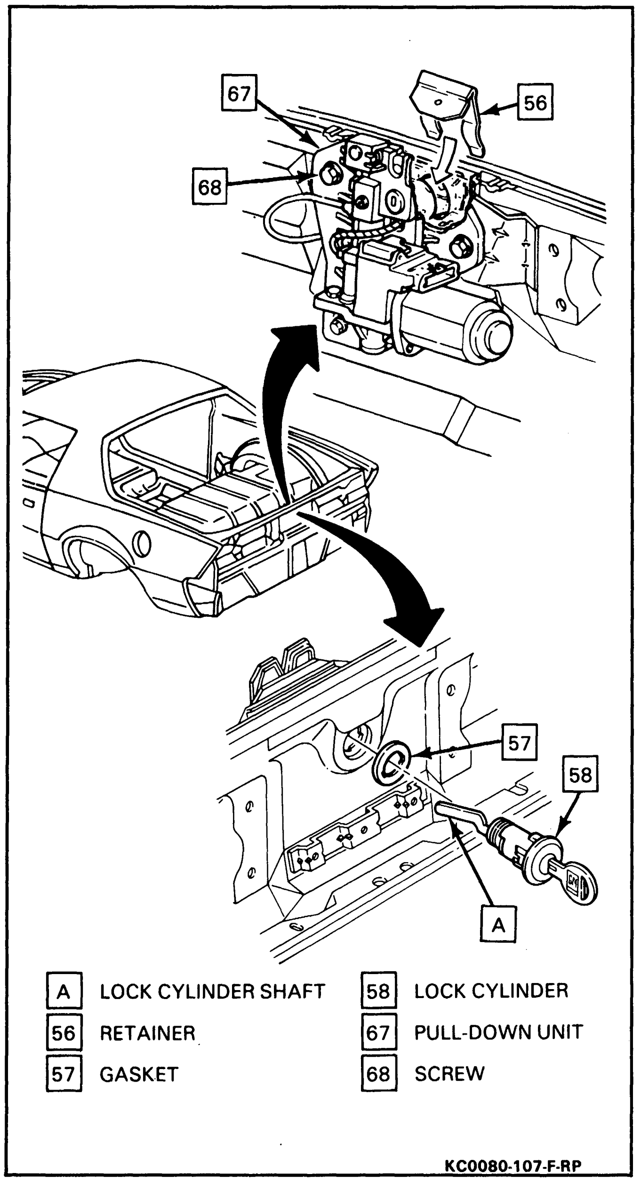


Figure 17 - Installing Lift Window Lock Cylinder

- Close compartment lift window.
- Close license plate mounting bracket.

COMPARTMENT LIFT WINDOW TRIM PANEL REPLACEMENT

Figure 18

Remove or Disconnect

- Open compartment lift window (27).

1. Screws (60).
2. Trim panel (61) by sliding forward and pulling down.

Install or Connect

1. Trim panel (61).
2. Screws (60).

- Close compartment lift window (27).

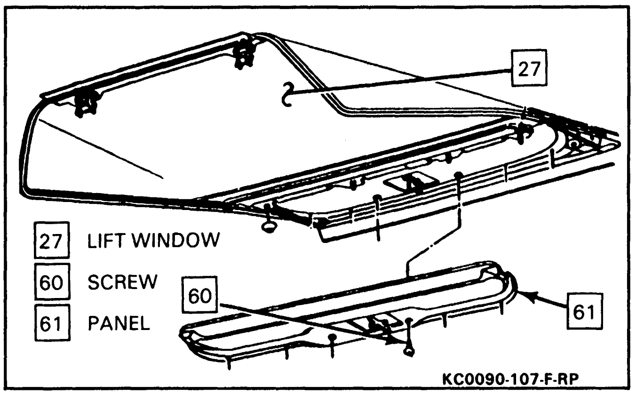


Figure 18 - Compartment Lift Window Trim Panel

UPPER ELECTRICAL CONTACT REPLACEMENT

Figure 16

Remove or Disconnect

- Open compartment lift window.

1. Trim panel. Refer to "Compartment Lift Window Trim Panel Replacement" in this section.
2. Upper left striker nut (54).
3. Reinforcement panel nut (34).
4. Contact electrical connector.
5. Upper electrical contact.

Install or Connect

NOTICE: See "Notice" on page 10-7-1 of this section.

1. Contact electrical connector.
2. Upper electrical contact.
3. Reinforcement panel nut (34).

   Tighten

   - Nut (34) to 14 N·m (124 lb. in.).
4. Upper left striker nut (54).

   Tighten

   - Nut (54) to 11 N·m (97 lb. in.).
5. Trim panel. Refer to "Compartment Lift Window Trim Panel Replacement" in this section.

- Close compartment lift window.

COMPARTMENT LIFT WINDOW OPENING WEATHERSTRIP REPLACEMENT

A clinch type weatherstrip is used to seal the opening of the lift window. The weatherstrip has an integral metal reinforced section which grips and seals the weatherstrip to the pinch-weld flange.

Remove or Disconnect

- Weatherstrip by peeling from pinch-weld flange.

Clean

- All weatherstrip sealer from pinch-weld flange.

Install or Connect

- Weatherstrip.
  - Apply a bead of weatherstrip sealer around the perimeter of the pinch-weld flange 2 mm (5/64-inch) below the top of the flange.
  - Locate center mark on weatherstrip to top center of pinch-weld flange.
  - Engage weatherstrip to pinch-weld flange at top and seat weatherstrip working down each side toward the bottom.

CENTER HIGH-MOUNTED STOPLAMP REPLACEMENT

Figure 19

The center high-mounted stoplamp is mounted to the rear lift window (27). The bracket for the lamp assembly comes with the lift window glass.

Remove or Disconnect

1. Screws (90).
2. Cover (89).
3. Wire harness connector from cover (89).
4. Screws (86).
5. Lamp assembly (87).
   - Pull lamp assembly (87) down and slide toward the front of the vehicle to remove from bracket (85).

Install or Connect

1. Lamp assembly (87).
   - Slide lamp assembly (87) into the bracket (85) and push up.
2. Screws (86).
3. Wire connector (88).
   - The strain relief bushing must be placed into and forward of the busing retainer slot on the cover (89).
4. Cover (89).
5. Screws (90).

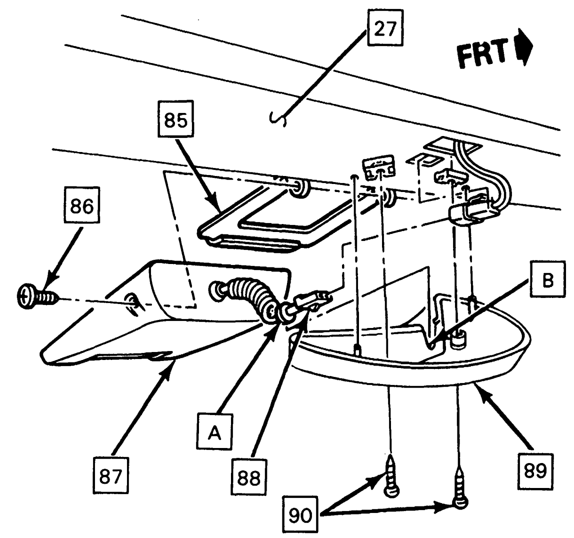
COMPARTMENT LIFT WINDOW PULL-DOWN UNIT REPLACEMENT

Figure 20

The compartment lift window pull-down unit (67) is attached to the rear body panel and assists with opening or closing the lift window by raising or lowering the lock. The pull-down unit (67) can be adjusted for proper striker-to-lock engagement.

Remove or Disconnect

- Open compartment lift window.



A	STRAIN RELIEF BUSHING	87	LAMP ASSEMBLY
B	BUSHING RETAINER SLOT	88	CONNECTOR
27	LIFT WINDOW	89	COVER
85	BRACKET	90	SCREWS
86	SCREW		

MC0006-107-F-RP

Figure 19 - Center High-Mounted Stoplamp

1. Rear end trim panel. Refer to "Rear End Trim Panel Replacement" in this section.
2. Electrical connection.
3. Screws (68).
4. Pull-down unit lock cable connection from lock cylinder.
5. Pull-down unit (67).

Install or Connect

- Place pull-down unit near rear panel support.

1. Lock cable connection through opening in support to lock cylinder.
2. Pull-down unit (67) to support.

NOTICE: See "Notice" on page 10-7-1 of this section.

3. Screws (68).

Adjust

- Pull-down unit as necessary for proper lock striker engagement.

Tighten

- Screws (68) to 24 N·m (18 lb. ft.).

4. Electrical connection.
5. Rear end trim panel. Refer to "Rear End Trim Panel Replacement" in this section.

- Close compartment lift window.

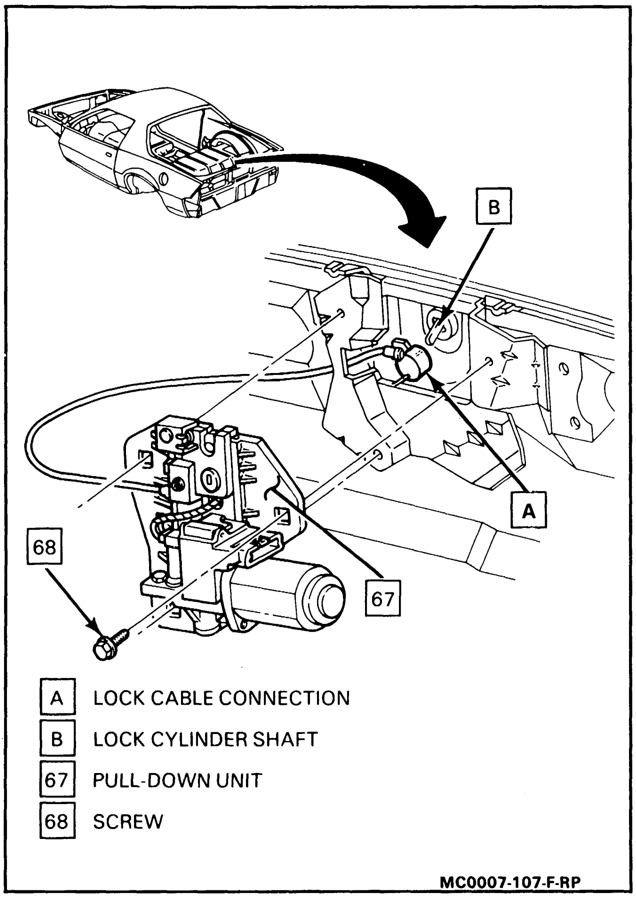


Figure 20 - Lift Window Pull-Down Unit

COMPARTMENT LIFT WINDOW SPOILER REPLACEMENT

Lift Window Spoiler Assembly

Figure 21

This style spoiler is mounted on the compartment lift window panel and also has extensions on the rear quarter panels. For the rear quarter panel extensions, refer to REAR QUARTERS (SEC. 10-6).

↔ Remove or Disconnect

- Open compartment lift window.

1. Plugs (66).
2. Nuts (65).
3. Spoiler (64).
4. Washers (69) from studs on spoiler (64).

→← Install or Connect

NOTICE: Care should be exercised to prevent waterleaks in the rear compartment area when sealing surfaces are disturbed. Holes in the deck lid panel for mounting studs that would permit water entry into the rear compartment and cause possible trim damage must be sealed with a presealed washer or body caulking compound.

1. Washers (69) to studs on spoiler (64).
2. Spoiler (64).

NOTICE: See "Notice" on page 10-7-1 of this section.

3. Nuts (65).

Tighten

- Nuts (65) to 7 N·m (62 lb. in.).

4. Plugs (66).

- Close compartment lift window.

Aero Wing Style Spoiler

Figure 22

↔ Remove or Disconnect

- Open compartment lift window.

1. Lift window trim panel. Refer to "Compartment Lift Window Trim Panel Replacement" in this section.
2. Plugs (72).
3. Nuts (71).

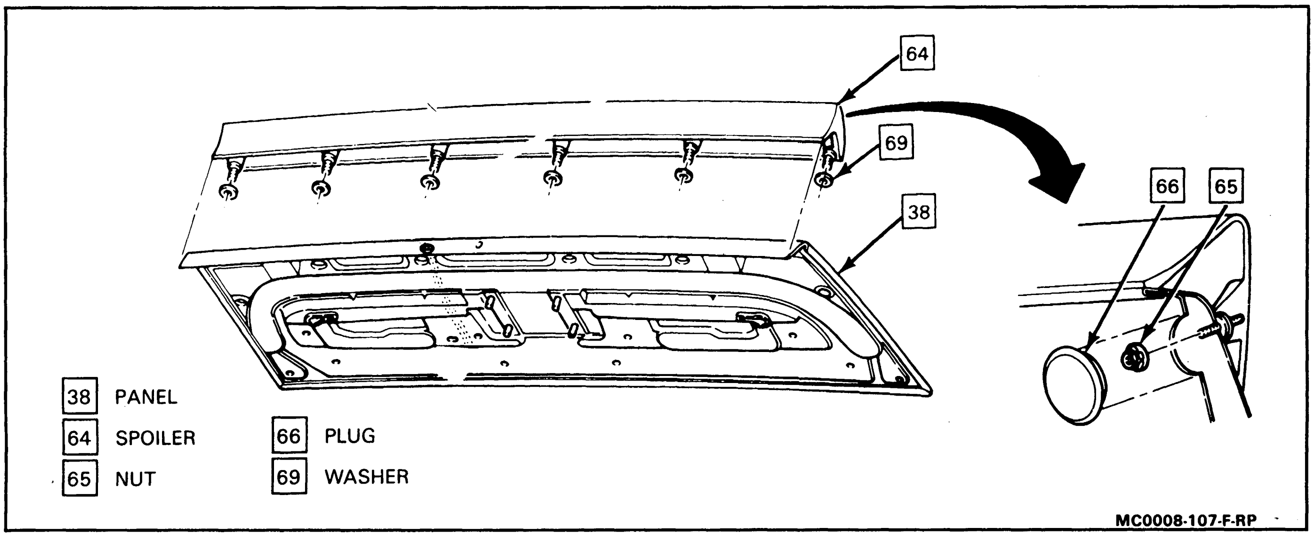


Figure 21 - Spoiler Assembly

4. Spoiler (70).

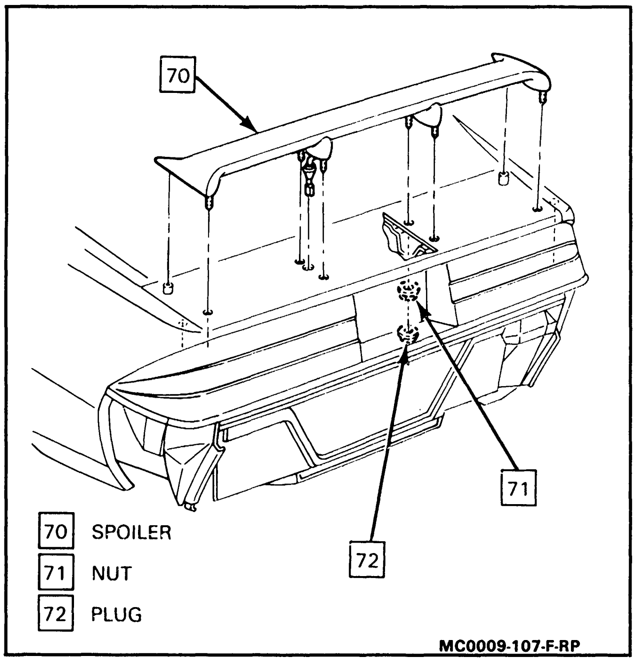


Figure 22 - Aero Wing Spoiler

Install or Connect

NOTICE: Care should be exercised to prevent waterleaks in the rear compartment area when sealing surfaces are disturbed. Holes in the deck lid panel for mounting studs that would permit water entry into the rear compartment and cause possible trim damage must be sealed with a presealed washer or body caulking compound.

1. Spoiler (70).

NOTICE: See "Notice" on page 10-7-1 of this section.

2. Nuts (71).

Tighten

- Nuts (71) to 6 N·m (53 lb. in.).

3. Plugs (72).
4. Lift window trim panel. Refer to "Compartment Lift Window Trim Panel Replacement" in this section.

- Close compartment lift window.

COMPARTMENT LIFT WINDOW SUNSHADE REPLACEMENT

Figure 23

Remove or Disconnect

- Rotate studs on sunshade (73) one-quarter turn counterclockwise to disengage from brackets.
- Lift sunshade (73) and have a helper support it.

1. Nuts (74) from hinge studs.
2. Sunshade (73) with assistance of helper.

Install or Connect

1. Sunshade (73) to hinge studs with assistance of helper. Hold in an open position.
2. Nuts (74) to hinges.

- Lower sunshade (73).
- Rotate studs of sunshade (73) one-quarter turn clockwise to engage brackets.

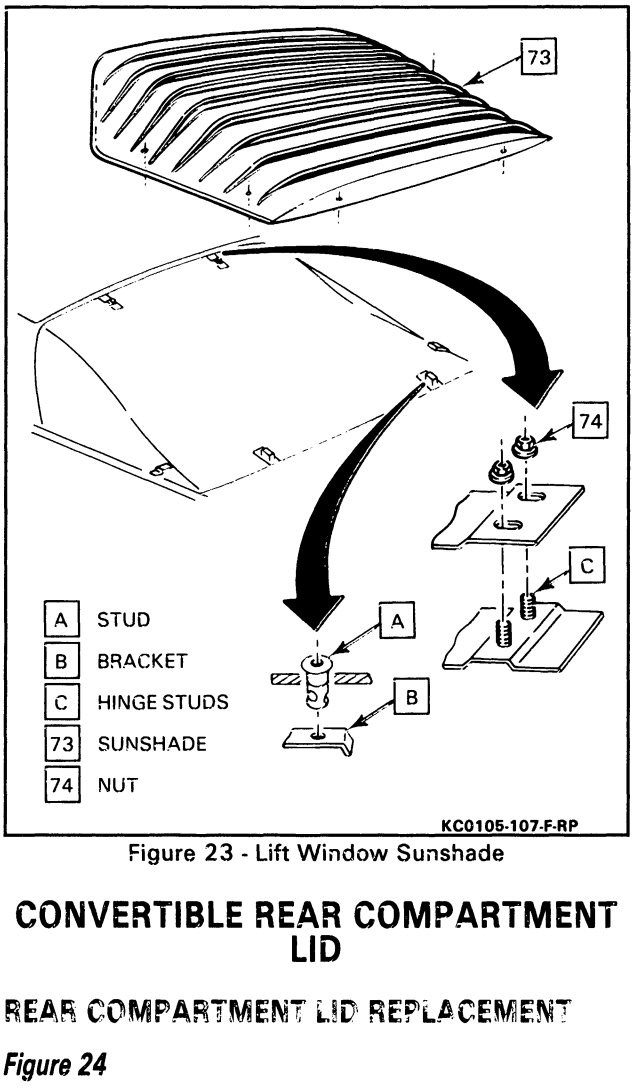


Figure 23 - Lift Window Sunshade

CONVERTIBLE REAR COMPARTMENT LID

REAR COMPARTMENT LID REPLACEMENT

Figure 24

The rear compartment lid consists of an inner panel and an outer panel that are hemmed around the perimeter and bonded together with structural adhesive. Opening assist is provided by the use of gas support assemblies.

Remove or Disconnect

CAUTION: Do not attempt to remove or loosen the gas support without the rear compartment lid fully open. A support removed under pressure may result in personal injury.

- Open rear compartment lid (80) and have an assistant support it.

1. Gas supports (78) by disengaging clips from the gas support ends of the rear compartment lid (80) and body.

2. Bolts (79).
3. Rear compartment lid (80).

Install or Connect

NOTICE: See "Notice" on 10-7-1 of this section.

1. Rear compartment lid (80) to hinges with the assistance of a helper.
2. Bolts (79), hand tight.
3. Gas supports (78).

Adjust

- Rear compartment lid (80) fore and aft, side-to-side, and front height as necessary and tighten bolts.

  Tighten

  - Bolts (79) to 24 N·m (18 lb. ft.).
- Rear compartment lid rear corner height by screwing rubber bumpers (82) in or out as necessary.
- Close rear compartment lid.

REAR COMPARTMENT LID SPOILER ASSEMBLY

Figure 25

This style spoiler is mounted on the rear compartment lid and also has extensions on the rear quarter panels. For the rear quarter panel extensions, refer to REAR QUARTERS (SEC. 10-6).

Remove or Disconnect

- Open rear compartment lid (80).

1. Center high-mounted stoplamp. Refer to "Center High-Mounted Stoplamp Replacement" in this section.
2. Plugs (66).
3. Nuts (65).
4. Spoiler (64).
5. Washers (69) from studs on spoiler (64).

Install or Connect

NOTICE: Care should be exercised to prevent waterleaks in the rear compartment area when sealing surfaces are disturbed. Holes in the rear compartment lid for mounting studs that would permit water entry into the rear compartment and cause possible trim damage must be sealed with a presealed washer or body caulking compound.

1. Washers (69) to studs on spoiler (64).
2. Spoiler (64).

NOTICE: See "Notice" on page 10-7-1 of this section.

3. Nuts (65).

Tighten

- Nuts (65) to 7 N·m (62 lb. in.).

4. Plugs (66).
5. Center high-mounted stoplamp. Refer to "Center High-Mounted Stoplamp Replacement" in this section.

- Close rear compartment lid.

CENTER HIGH-MOUNTED STOPLAMP REPLACEMENT

Figure 25

The center high-mounted stoplamp is mounted to the rear compartment lid spoiler assembly.

Remove or Disconnect

1. Screws (83).

- Pull lamp (84) away from spoiler (64).

2. Wire harness connection from lamp (84).
3. Lamp (84).

Install or Connect

1. Wire harness connection to lamp (84).

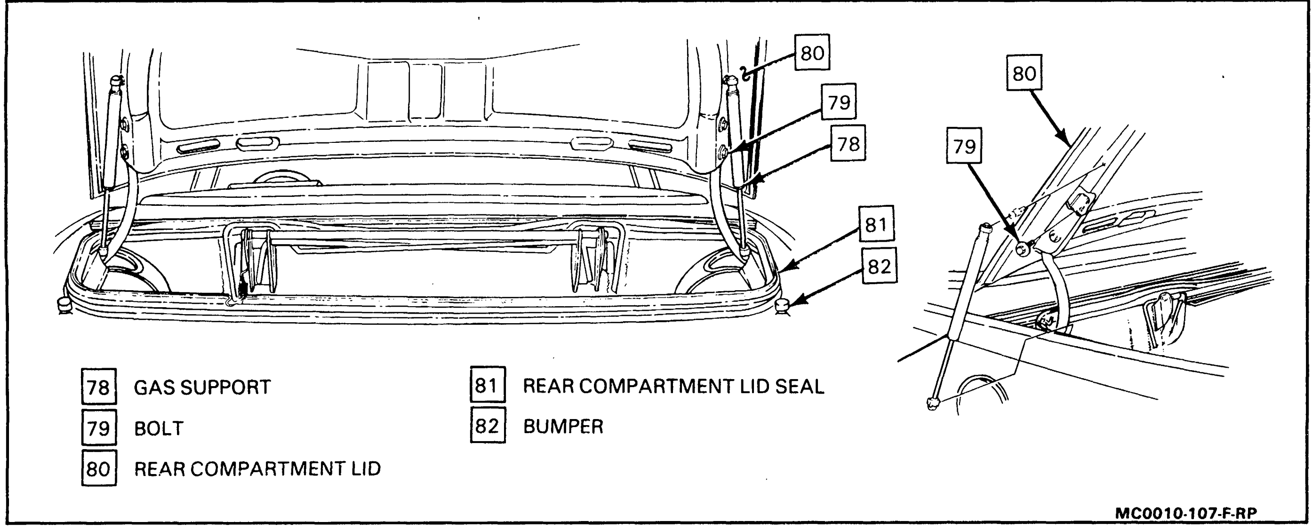


Figure 24 - Rear Compartment Lid

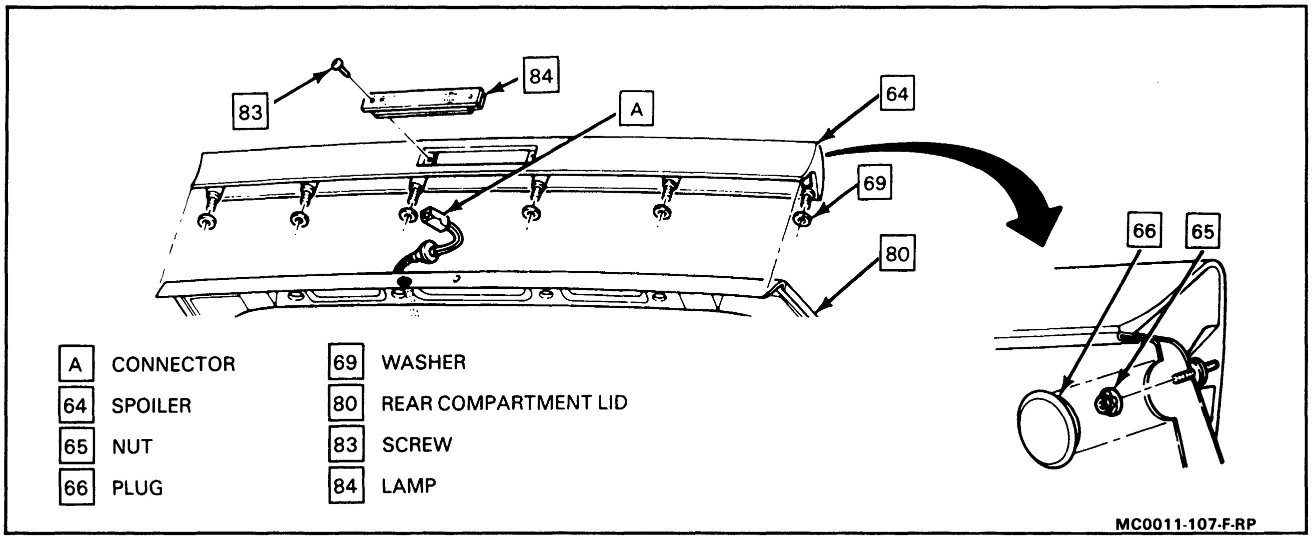


Figure 25 - Rear Compartment Lid Spoiler Assembly and Stoplamp

2. Lamp (84) to spoiler.
3. Screws (83).

REAR COMPARTMENT LID SEAL REPLACEMENT

Refer to "Compartment Lift Window Opening Weatherstrip Replacement" in this section.

REAR END PANEL

REAR LICENSE PLATE BRACKET REPLACEMENT

Figure 26

The license plate bracket (76) is bolted to the rear end panel and is hinged to provide access to the lock cylinder.

Remove or Disconnect

1. Screws (77).
2. Bracket (76).

Install or Connect

1. Bracket (76).
2. Screws (77).

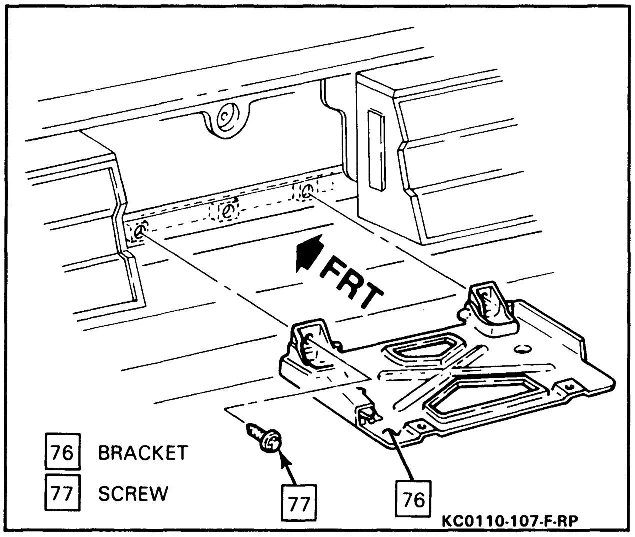


Figure 26 - License Plate Bracket

TAILLAMP REPLACEMENT

Refer to LIGHTING SYSTEMS AND HORNS (SEC. 8B) for replacement procedures.

LICENSE LAMP REPLACEMENT

Refer to LIGHTING SYSTEMS AND HORNS (SEC. 8B) for replacement procedures.

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Load Floor Panel Hinge Nut	11 N·m (97 lb. in.)
Compartment Lift Window Hinge-to-Body Nut	24 N·m (18 lb. ft.)
Counterbalance Upper Screw	6 N·m (53 lb. in.)
Counterbalance Lower Bolt	24 N·m (18 lb. ft.)
Compartment Lift Window Hinge-to-Body Nuts	24 N·m (18 lb. ft.)
Compartment Lift Window Hinge-to-Glass Nut	14 N·m (124 lb. in.)
Lift Window Reinforcement Panel Nut	14 N·m (124 lb. in.)
Lift Window Striker Nut	11 N·m (97 lb. in.)
Lift Window Pull-Down Unit Screw	24 N·m (18 lb. ft.)

Lift Window Spoiler Nut	7 N·m (62 lb. in.)
Lift Window Panel Aero Wing Spoiler Nut	6 N·m (53 lb. in.)
Rear Compartment Lid Hinge Bolt	24 N·m (18 lb. ft.)
Rear Compartment Lid Spoiler Nut	7 N·m (62 lb. ft.)

SECTION 10-8

ROOF AND CONVERTIBLE TOP

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 10-8-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

FORMED HEADLINING

The one-piece formed headlining is made of a molded fiberglass substrate covered with a foam and cloth facing. The headlining is serviced as a complete assembly.

The headlining is held in place with clips and nearby interior moldings and roof attachments. The clips are attached to the headlining and fit into slots in the roof panel.

Figure 1

Remove or Disconnect

1. Negative (-) battery cable.
2. Dome lamp. Refer to "Interior Lighting" in this section.
3. Sunshade screws.
4. Sunshade.
5. Coat hook screws.
6. Coat hooks.
7. Shoulder belt escutcheon by unsnapping it from the headlining (1).
8. Lift window opening molding. Refer to "Lift Window Opening Molding" in this section.
9. Quarter upper trim panel. Refer to REAR QUARTERS (SEC. 10-6).
10. Body lock pillar panel. Refer to REAR QUARTERS (SEC. 10-6).
11. Windshield side upper molding. Refer to "Windshield Side Upper Molding" in this section.
12. Headlining clips (2) in the headlining (1) from slots in the roof panel.
13. Headlining (1) through the compartment lift-window opening.

Install or Connect

NOTICE: Be careful when loading the headlining. Flexing it too much may cause damage.

1. Headlining (1).
   - Load the headlining (1) through the compartment lift-window opening.
   - Align the headlining (1) with cutouts for sunshades and dome lamp and install sunshade brackets and dome lamp housing.
     - Do not tighten sunshade bracket and dome lamp screws completely until the headlining (1) is aligned properly at all hardware attaching locations.
     - Align headlining (1) to roof panel with headlining clips (2) positioned over holes in roof panel and using palm of hand, push up on headlining (1) at clip locations.
2. Windshield side upper molding. Refer to "Windshield Side Upper Molding" in this section.

3. Body lock pillar panels. Refer to REAR QUARTERS (SEC. 10-6).
4. Quarter upper trim panels. Refer to REAR QUARTERS (SEC. 10-6).
5. Lift-window opening molding. Refer to "Lift Window Opening Molding" in this section.
6. Shoulder belt cover escutcheon by snapping it to the headlining (1).
7. Coat hooks.
8. Coat hook screws.
9. Sunshade.
10. Sunshade screws.
11. Dome lamp. Refer to "Interior Lighting" in this section.
12. Negative (-) battery cable.

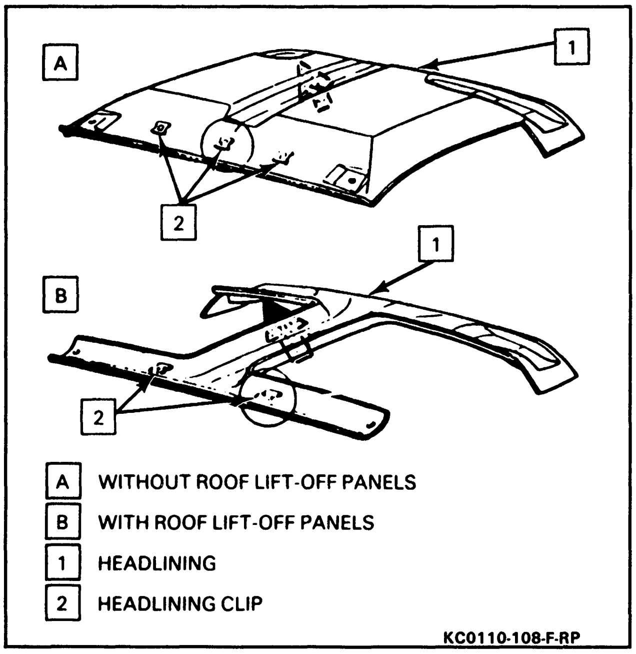


Figure 1 - Headlining

INTERIOR ROOF MOLDINGS AND ATTACHMENTS

SUNSHADE

The sunshade is attached to the roof panel with screws through cutouts in the headlining.

INTERIOR LIGHTING

Figure 2

The dome lamp lights when the door is opened or when the headlamp switch is turned to the dome lamp position. A lighted rearview mirror is also available. It is attached to the windshield. Refer to STATIONARY GLASS (SEC. 10-2).

Remove or Disconnect

1. Lens (8) by squeezing it.
2. Bulb (7) from terminal clips (3).
3. Retainers (6) from studs (4).
4. Reflector (5).

Install or Connect

1. Reflector (5).
2. Retainers (6) to studs (4).
3. Bulb (7) to terminal clips (3).
4. Lens (8).

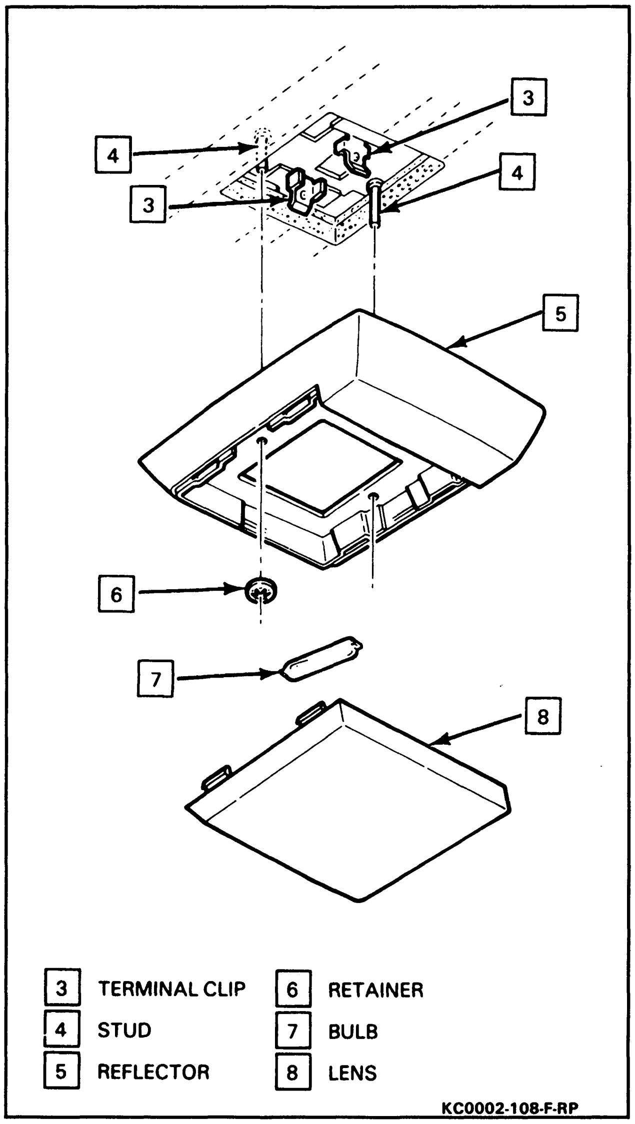


Figure 2 - Dome Lamp

INTERIOR MOLDINGS

Interior moldings are made of plastic or metal and painted to match the interior of the vehicle. The moldings are held on with screws or clips.

Windshield Side Upper Molding

Figure 3

Remove or Disconnect

1. Roof lift-off panel, if equipped. Refer to "Roof Lift-Off Panel Replacement" in this section.
2. Screw (13) on vehicles with roof lift-off panels.

3. Clips (11) from windshield pillar by pulling down on windshield side upper molding (12).

Install or Connect

1. Windshield side upper molding (12) by snapping the clips (11) on the windshield side upper molding (12) into the holes in the windshield pillar.
2. Screw (13) on vehicles with roof lift-off panels.
3. Roof lift-off panel, if equipped. Refer to "Roof Lift-Off Panel Replacement" in this section.

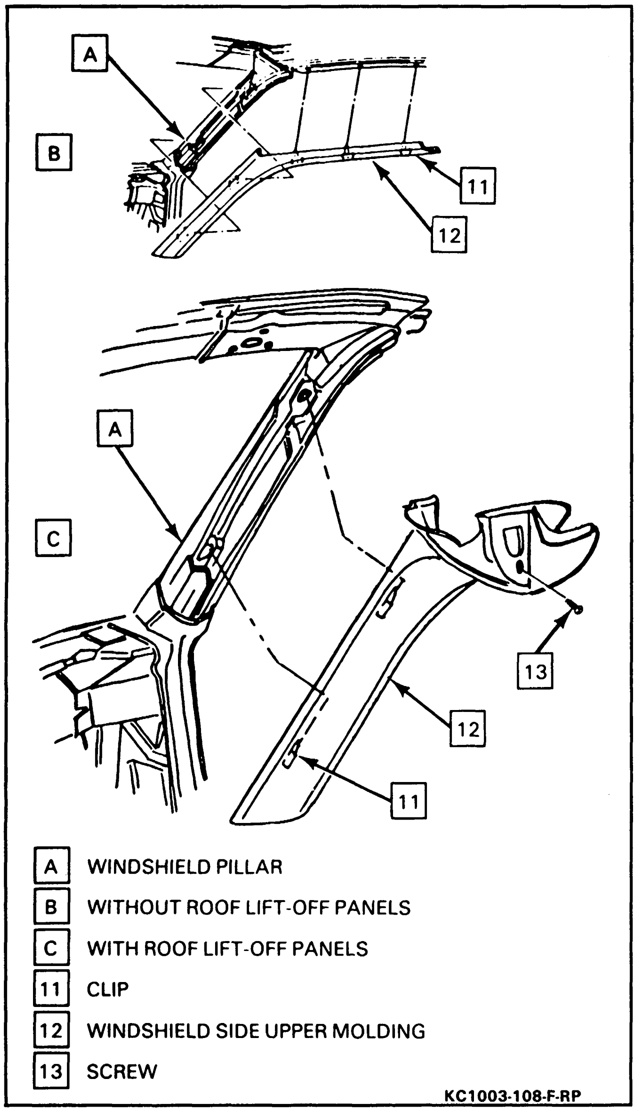


Figure 3 - Windshield Side Upper Molding

Windshield Side Lower Molding

Figure 4

Remove or Disconnect

1. Windshield side upper molding. Refer to "Windshield Side Upper Molding" in this section.
2. Screw (14).
3. Windshield side lower molding (15) by sliding it from the shroud panel.

Install or Connect

1. Windshield side lower molding (15) by sliding it onto the shroud panel.
2. Screw (14).
3. Windshield side upper molding. Refer to "Windshield Side Upper Molding" in this section.

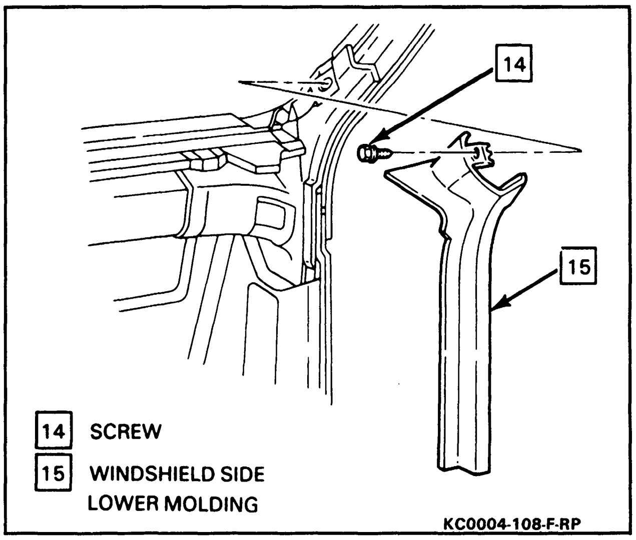


Figure 4 - Windshield Side Lower Molding

Lift Window Opening Molding

Figure 5

Remove or Disconnect

1. Screws (16).
2. Lift window opening molding (17).

Install or Connect

1. Lift window opening molding (17).
2. Screws (16).

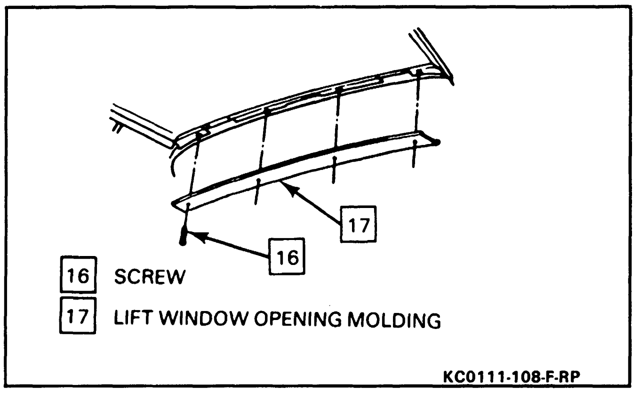


Figure 5 - Lift Window Opening Molding

EXTERIOR ROOF MOLDINGS AND ATTACHMENTS

ROOF DRIP MOLDING

Figure 6

Remove or Disconnect

1. Screws (29).
2. Roof drip molding (28).

Install or Connect

1. Roof drip molding (28).
2. Screws (29).
   - Seal screws (29) to prevent waterleaks.

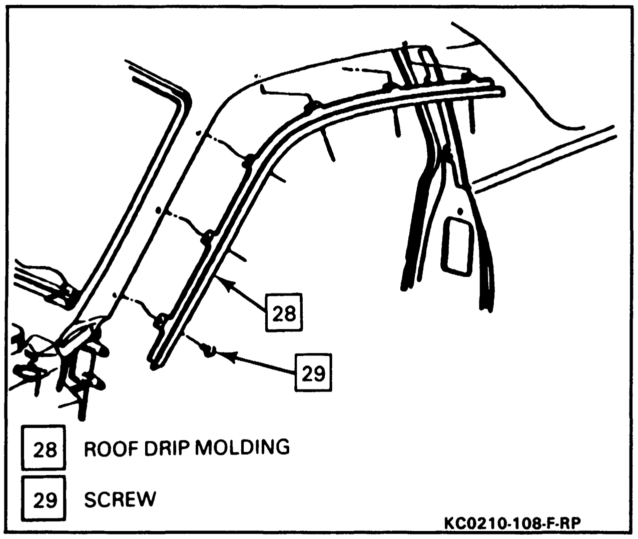


Figure 6 - Roof Drip Molding

PANEL OPENING CENTER UPPER MOLDING

Figure 7

Remove or Disconnect

1. Roof lift-off panels. Refer to "Roof Lift-Off Panel Replacement" in this section.
2. Lift-off panel opening weatherstrips. Refer to "Lift-Off Panel Opening Weatherstrip" in this section.
3. Screws (30).
4. Panel opening center upper molding (31).

Install or Connect

1. Panel opening center upper molding (31).
2. Screws (30).
   - Be sure to seal the screws (30) and all around the outside edges of the panel opening center upper molding (31) to prevent possible waterleaks.
3. Lift-off panel opening weatherstrips. Refer to "Lift-Off Panel Opening Weatherstrip" in this section.
4. Roof lift-off panels. Refer to "Roof Lift-Off Panel Replacement" in this section.

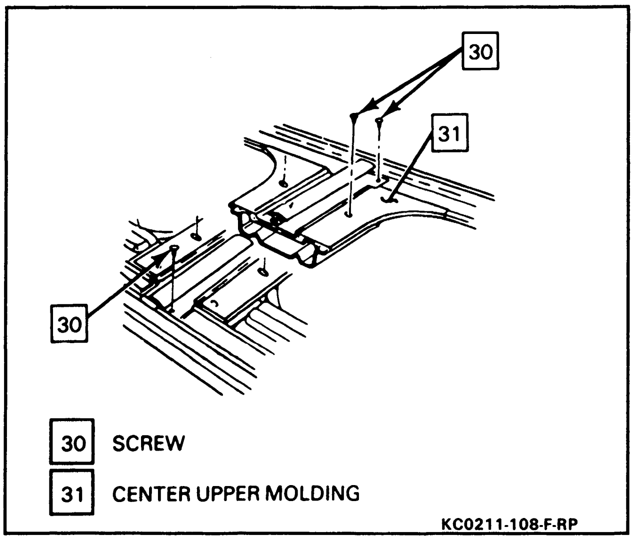


Figure 7 - Panel Opening Center Upper Molding

ROOF EMBLEMS

Remove or Disconnect

- Roof emblem by applying heat with a heat gun.
  - Make certain the heat gun is held at least 152 mm (6 inches) from the emblem and moved in a circular motion.

Install or Connect

- Roof emblem.
  - Wash affected area of the roof panel with detergent and water.
  - Wipe dry.
  - Wipe roof panel and adhesive side of the roof emblem with oil-free naphtha or alcohol.
  - Apply emblem adhesive and press the roof emblem in place.
  - Apply constant pressure to the roof emblem for 30 seconds. Bonding starts immediately. The roof emblem cannot be moved after contact with the roof panel.

FOLDING TOP (CONVERTIBLE)

Chevrolet dealers should refer to the latest Chevrolet Service Bulletins for proper convertible top procedures.

ROOF LIFT-OFF PANEL

The roof lift-off panels are manually operated. The panels are curved to match the contour of the roof and are made of tinted, tempered glass or tinted acrylic. The roof opening weatherstrips are one piece and molded to the shape of the roof opening.

ON-VEHICLE SERVICE

Roof Lift-Off Panel Replacement

The roof lift-off panels can be removed and stored in the storage bags located in the rear compartment.

Remove or Disconnect

- Roof lift-off panels.
  - Pull on the release handle.
  - Pivot roof lift-off panel upward slightly and pull outward to release it from under the panel opening center upper molding.
  - Repeat for other roof lift-off panel.
  - Store roof lift-off panel in the storage bag.

Install or Connect

- Roof lift-off panels.
  - Place the edge of the roof lift-off panel on top of the weatherstrip lip.
  - Lift slightly and carefully insert the roof lift-off panel under the panel opening center upper molding.
  - Lower the roof lift-off panel and latch in place.
  - Repeat for other lift-off panel.
  - Check for proper fit and adjust if necessary. Refer to "Roof Lift-Off Panel Adjustments" in this section.

Roof Lift-Off Panel Adjustments

Figure 8

The roof lift-off panel is adjustable within the lift-off panel opening. The striker screws adjust up and down travel of the roof lift-off panels. In and out and fore and aft travel is adjusted with the support plate nuts. Adjustments should be made to get a flush fit of the roof lift-off panels to the roof.

Remove or Disconnect

NOTICE: See "Notice" on page 10-8-1 of this section.

1. Roof lift-off panel from roof. Refer to "Roof Lift-Off Panel Replacement" in this section.
2. Windshield side upper molding. Refer to "Windshield Side Upper Molding" in this section.
3. Body lock pillar panel. Refer to REAR QUARTERS (SEC. 10-6).

Adjust

NOTICE: See "Notice" on page 10-8-1 of this section.

- Support mount latch plates (89).
  - Loosen nuts (90).
  - Move support mount latch plates (89) fore or aft as required.

  Tighten

  - Nuts (90) to 7 N·m (62 lb. in.).
- Latch strikers (91).
  - Loosen screws (92).
  - Move latch stikers (91) up or down as required.

  Tighten

  - Screws (92) to 6 N·m (53 lb. in.).

Install or Connect

- Roof lift-off panels. Refer to "Roof Lift-Off Panel Replacement" in this section.

Inspect

- Roof lift-off panels for proper fit.

Remove or Disconnect

- Roof lift-off panels. Refer to "Roof Lift-Off Panel Replacement" in this section.

Install or Connect

1. Body lock pillar panel. Refer to REAR QUARTERS (SEC. 10-6).
2. Windshield side upper molding. Refer to "Windshield Side Upper Molding" in this section.
3. Roof lift-off panels. Refer to "Roof Lift-Off Panel Replacement" in this section.

Lift-Off Panel Opening Weatherstrip

Figure 9

Remove or Disconnect

Tool Required:

J 21104-B Weatherstrip Remover

1. Windshield side upper molding. Refer to "Windshield Side Upper Molding" in this section.
2. Retainers (94) from lift-off panel opening weatherstrip (93) using J 21104-B.

NOTICE: Break the weatherstrip adhesive bond carefully to prevent damage to the weatherstrip.

- Grasp the lift-off panel opening weatherstrip (93) and pull upward gently while inserting J 21104-B between the weatherstrip retainers and the lift-off panel opening weatherstrip (93) to break the adhesive bond.
  - Using a suitable release agent or heat gun will help break the weatherstrip adhesive bond.

3. Locator butt joints from the brackets on the front and rear weatherstrip retainers.

Install or Connect

- Scrape excess sealer from weatherstrip retainers.
- Apply a continuous bead of black weatherstrip adhesive to both sides of retainer channel.
- Using a flat-bladed tool, install the lift-off panel opening weatherstrip (93) at the center upper area and begin tucking in corners and top edges

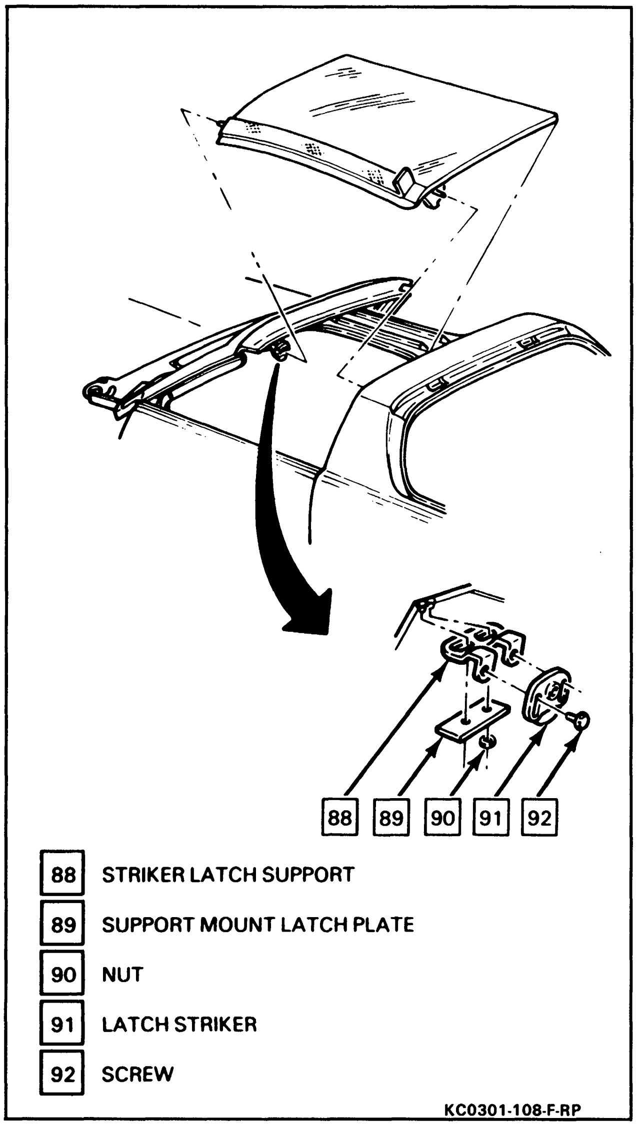


Figure 8 - Latch Striker

of weatherstrip, working around to the sides of the opening.

- When the weatherstrip is in position, place the roof lift-off panel on top of the weatherstrip so that proper adjustments between the lift-off panel weatherstrip and the lift-off panel opening weatherstrip (93) can be made, and also to allow for correct alignment between the locator butt joints and the brackets on the front and rear weatherstrip retainers.

1. Locator butt joints into brackets.
2. Lock pillar end of lift-off panel opening weatherstrip (93) into weatherstrip retainer starting at the lift-off panel opening and working downward.
3. Retainers (94).
4. Windshield pillar end of lift-off panel opening weatherstrip (93) into weatherstrip retainer starting at the lift-off panel opening and working downward.
5. Windshield side upper molding. Refer to "Windshield Side Upper Molding" in this section.

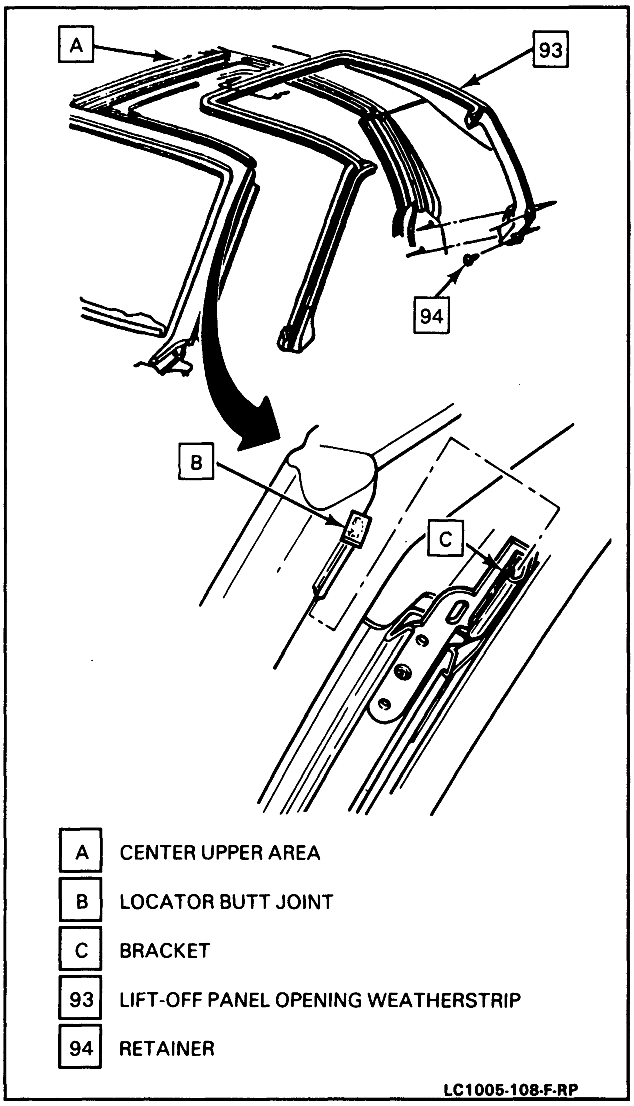


Figure 9 - Lift-Off Panel Opening Weatherstrip

Weatherstrip Retainers

Figure 10

The weatherstrip retainers include the weatherstrip windshield pillar retainer (96) and the weatherstrip body lock pillar retainer (97).

←→ Remove or Disconnect

1. Lift-off panel opening weatherstrip. Refer to "Lift-Off Panel Opening Weatherstrip" in this section.
2. Screws (95).
3. Weatherstrip windshield pillar retainer (96) and weatherstrip body lock pillar retainer (97).

→← Install or Connect

1. Weatherstrip windshield pillar retainer (96) and weatherstrip body lock pillar retainer (97).
2. Screws (95).
   - Seal screws (95) to prevent waterleaks.
3. Lift-off panel opening weatherstrip. Refer to "Lift-Off Panel Opening Weatherstrip" in this section.

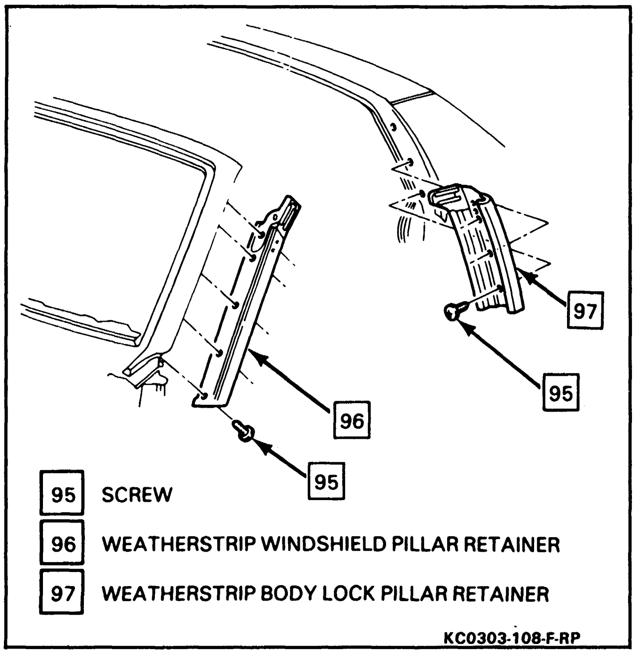


Figure 10 - Weatherstrip Retainers

UNIT REPAIR

If a new lift-off panel is being installed, transfer the hardware from the original panel to the new panel as a bench operation.

Roof Lift-Off Panel Assembly

Figures 11 through 14

Remove or Disconnect

- Roof lift-off panel from vehicle. Refer to "Roof Lift-Off Panel Replacement" in this section.
- Place on a clean, protected surface.

Disassemble

Tool Required:
J 21104-B Weatherstrip Remover

1. Lock handle screw (101).
2. Lock handle (100).
3. Support cover screws (98).
4. Support cover (99).
5. Screws (104).

NOTICE: Break the weatherstrip adhesive bond carefully to prevent damage to the weatherstrip.

6. Side roof rail weatherstrip (103) from the weatherstrip retainer (102) by carefully pulling on the side roof rail weatherstrip (103) while breaking the adhesive bond with J 21104-B.
   - A suitable release agent or heat gun will help break the weatherstrip adhesive bond.
7. Tabs on side roof rail weatherstrip (103) through the retainer slots.
8. Screws (106).
9. Weatherstrip retainer (102) using a flat-bladed tool.

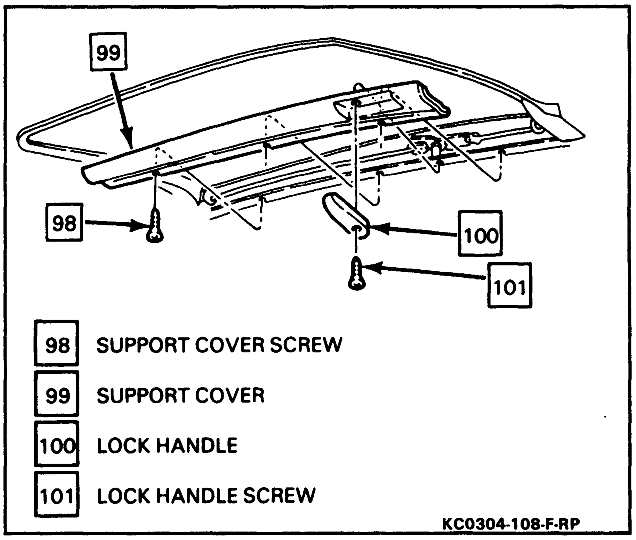


Figure 11 - Lock Handle and Support Cover

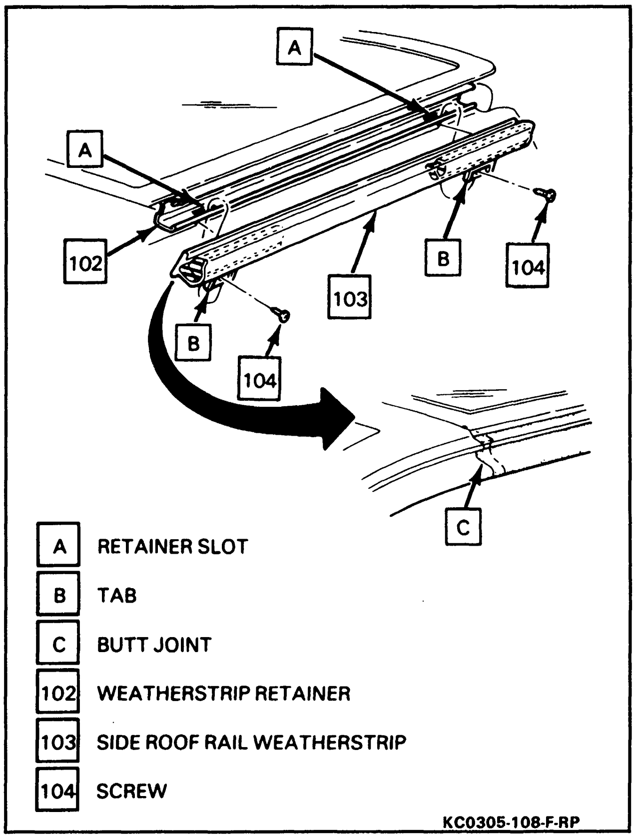


Figure 12 - Side Roof Rail Weatherstrip

10. Latch screw (109).
11. Latch (108).

Assemble

1. Latch (108).
2. Latch screw (109).
3. Weatherstrip retainer (102).
4. Screws (106).
   - Be sure to seal screws (106) to prevent waterleaks.
5. Side roof rail weatherstrip (103).

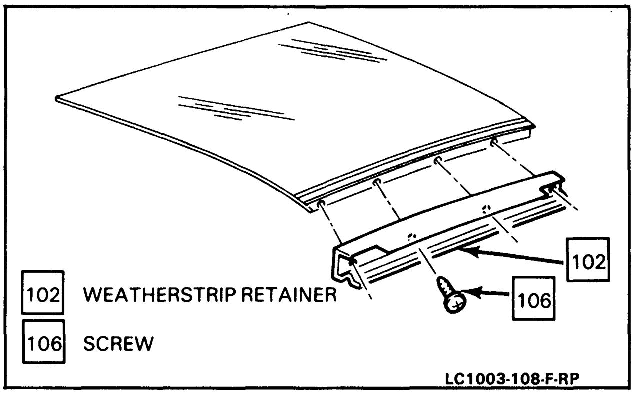


Figure 13 - Weatherstrip Retainer

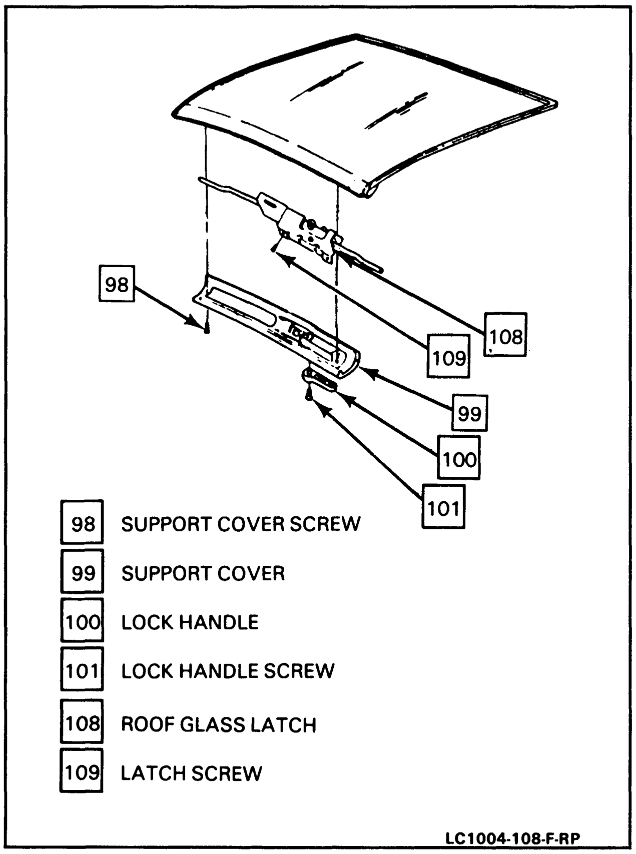


Figure 14 - Latch

- Scrape excess sealer from weatherstrip retainer (102).
- Apply a continuous bead of black weatherstrip adhesive to weatherstrip retainer (102).
- Insert tabs on the side roof rail weatherstrip (103) into the retainer slots.

6. Screws (104).
   - Loosely install screws (104).
   - Align butt joints at front and rear.
   - Completely install screws (104).
7. Support cover (99).
8. Support cover screws (98).
9. Lock handle (100).
10. Lock handle screw (101).

Install or Connect

- Roof lift-off panel to vehicle. Refer to "Roof Lift-Off Panel Replacement" in this section.

Latch Lock

Figures 14 and 15

Remove or Disconnect

1. Roof lift-off panel from vehicle. Refer to "Roof Lift-Off Panel Replacement" in this section.
   - Place on a clean, protected surface.
2. Lock handle screw (101).
3. Lock handle (100).
4. Support cover screws (98).
5. Support cover (99).
   - Drill out rivets (113) in the lock cylinder cover (112).
6. Lock cylinder cover (112).
7. Retainer (111).
8. Latch lock (110).

Install or Connect

1. Latch lock (110).
2. Retainer (111).
3. Lock cylinder cover (112).
4. Rivets (113).
5. Support cover (99).
6. Support cover screws (98).
7. Lock handle (100).
8. Lock handle screw (101).
9. Roof lift-off panel to vehicle. Refer to "Roof Lift-Off Panel Replacement" in this section.

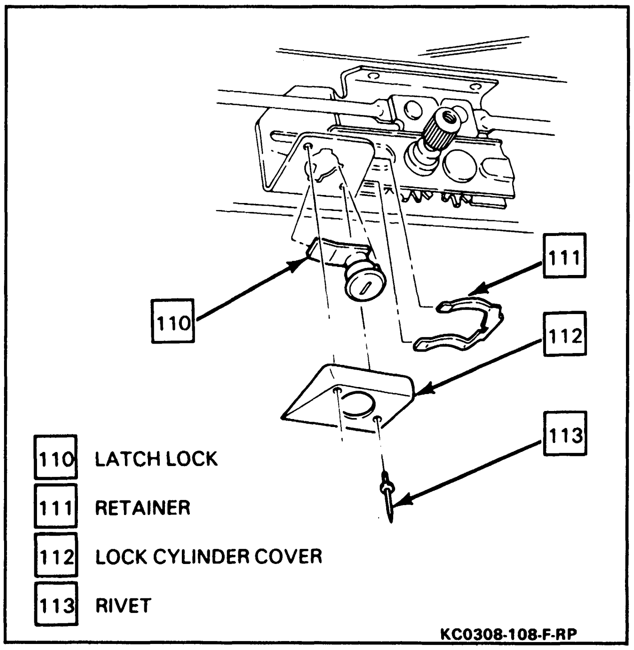


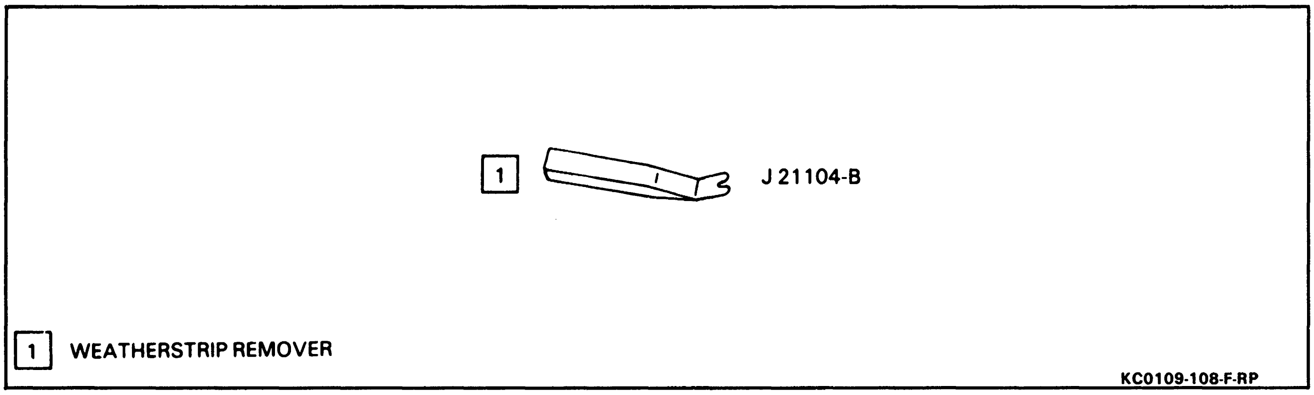
Figure 15 - Latch Lock

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Support Mount Latch Plate Nut	7 N·m (62 lb. in.)
Latch Striker Screw	6 N·m (53 lb. in.)

SPECIAL TOOLS



SECTION 10-9

SEATS

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 10-9-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

FRONT SEATS

The Camaro has two different bucket seats available (Figure 1). Both seat types have inertia seatback locks, manual seatback recliners and manual seat adjusters. A power 6-way seat adjuster is available on the driver's seat. The optional custom seat has an adjustable head restraint.

The seatbacks and seat cushions have formed foam pads that fit the contours of the seatback and seat cushion frames.

CAUTION: Do not try to change the designed seat position by changing the seat adjuster-to-floor pan anchor placement or the seat adjuster-to-seat frame anchor placement. Changing the designed seat position could affect the safe performance of the seat and cause personal injury.

FRONT SEAT ASSEMBLY

Figure 2

The front seats are held onto the floor pan by nuts installed onto anchor plate studs. Adjuster track covers are installed over the nuts.

Remove or Disconnect

- Move the seat to full-forward position.
1. Screws (1).
2. Adjuster track covers (2).
3. Nuts (3).
- Move the seat to full-rearward position.
4. Screws (1).
5. Adjuster track covers (2).
6. Nuts (3).
- Tilt the seat rearward and disconnect the electrical connectors, if present.

NOTICE: Failure to place a protective shield over nearby trim and paint may cause damage to the vehicle.

- Place a protective shield over nearby trim and paint.
7. Seat from vehicle.

Install or Connect

NOTICE: See "Notice" on page 10-9-1 of this section for steps 2 and 5.

1. Seat to vehicle.
- Tilt seat rearward and connect electrical connectors, if present.

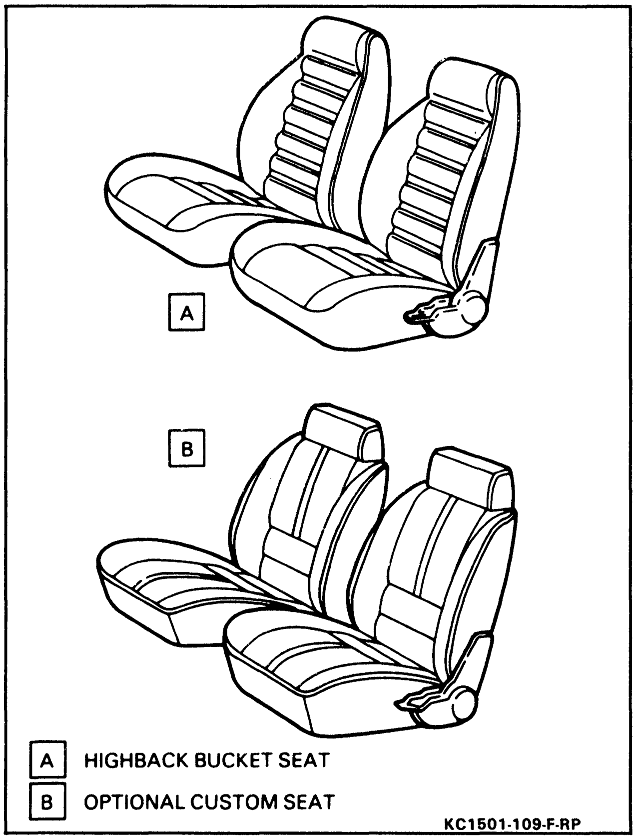


Figure 1 - Front Seats

- Remove protective shield.
- If the seat is not full-rearward, move the seat to full-rearward position.

2. Nuts (3).

Tighten

- Nuts (3) to 25 N·m (18 lb. ft.).

3. Adjuster track covers (2).
4. Screws (1).

- Move seat to full-forward position.

5. Nuts (3).

Tighten

- Nuts (3) to 25 N·m (18 lb. ft.).

6. Adjuster track covers (2).
7. Screws (1).

TRIM AND COVERS

The seatbacks and seat cushions have formed foam pads that fit the contours of the seatback and seat cushion frames. The pads are covered by either cloth or leather seat covers.

Trim Removal

Figures 3 and 4

Any trim that is on the seats must be removed before the seat covers can be removed. Seat trim includes the shoulder strap guide (10) on all seats; the upper hinge cover (7), lower hinge cover (8) with the adjuster switch on power seats; and the upper hinge cover (7) and lower hinge cover (8) on manual seats. To remove the trim, remove the screws (6).

NOTICE: Overtightening the trim screws may cause damage to the trim.

To replace the trim, hold the trim in position and install the screws (6).

Seat Covers

Figures 4 through 9

Replacement seat covers are one piece. They cover foam pads and are held onto the seat frame with bolster wires, J-arrow closeouts and trim retainer rings. Seat cover repair is not recommended because of the high-stress use of the seat covers.

Remove or Disconnect

1. Head restraint from optional custom seat. Refer to "Head Restraint" in this section.
2. Head restraint guide from optional custom seat. Refer to "Head Restraint Guide" in this section.
3. Shoulder strap guide screws (6) on highback seat.
4. Shoulder strap guide (10) on highback seat.

- If the seatback cover only is being removed, then the entire seat assembly does not have to be removed. Skip steps 5 and 6.

5. Seat. Refer to "Front Seat Assembly" in this section.
6. Seat adjusters. Refer to "Manual Seat Adjusters" or "Power Seat Adjusters" in this section.
7. Seat trim. Refer to "Trim Removal" in this section.
8. Recliner bolts (15).
9. Seatback pivot bolt (11), bushing (12) and washer (13).
10. Seatback (14).
11. Seatback cover (17), if necessary as follows:
    - Unsnap J-arrow closeout.
    - Remove bolster wires (20) from padwire.
    - Remove cover.
12. Seat cushion cover (19), if necessary as follows:
    - Note position of trim retainer rings (18).
    - Remove trim retainer rings (18).
    - Remove bolster wires (20).
    - Remove cover.

Install or Connect

NOTICE: See "Notice" on page 10-9-1 of this section for steps 4 and 5.

1. Seat cushion cover (19), if necessary as follows:
    - Install seat cushion cover (19) over pad.
    - If installing a replacement seat cushion cover, remove the bolster wires (20) from the old seat cover and insert the bolster wires (20) into the pockets in the replacement seat cover.

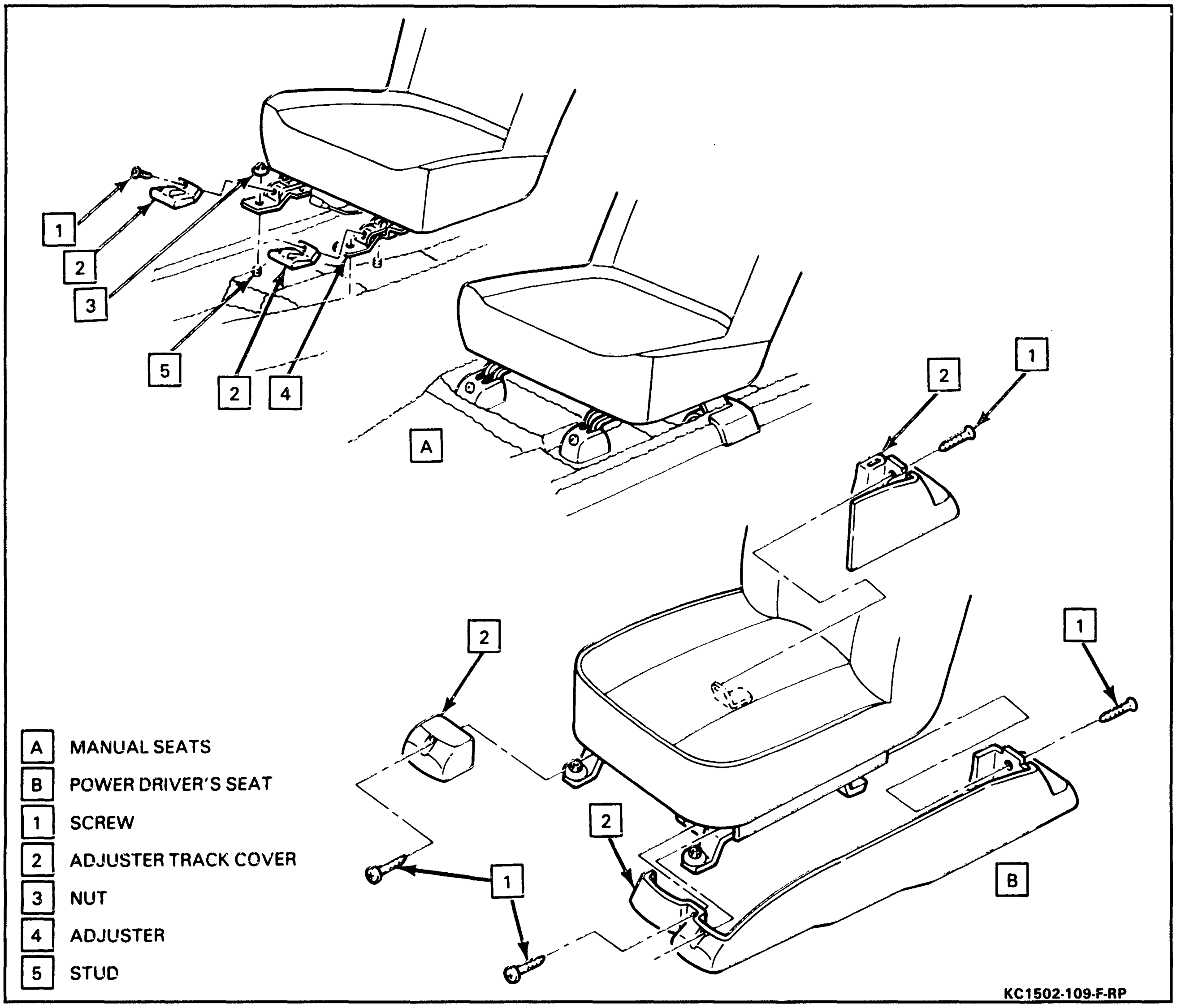


Figure 2 - Removing Seats From Floor Pan

- Install bolster wires (20).
- Install trim retainer rings (18).

2. Seatback cover (17), if necessary as follows:
    - Install seatback cover (17) over pad.
    - If installing a replacement seatback cover, remove the bolster wires (20) from the old seat cover and insert the bolster wires (20) into the pockets in the replacement seat cover.
    - Install bolster wires (20).
    - Snap together J-retainer and arrow retainer.
3. Seatback (14).
4. Bushing (12), seatback pivot bolt (11) and washer (13).

Tighten

- Seatback pivot bolt (11) to 50 N·m (37 lb. ft.).

5. Recliner bolts (15).

Tighten

- Recliner bolts (15) to 27 N·m (20 lb. ft.).

6. Seat trim. Refer to "Trim Removal" in this section.
7. Seat adjusters. Refer to "Manual Seat Adjusters" or "Power Seat Adjusters" in this section.
8. Seat. Refer to "Front Seat Assembly" in this section.
9. Shoulder strap guide (10).
10. Shoulder strap guide screws (6).
11. Head restraint guide. Refer to "Head Restraint Guide" in this section.
12. Head restraint. Refer to "Head Restraint" in this section.

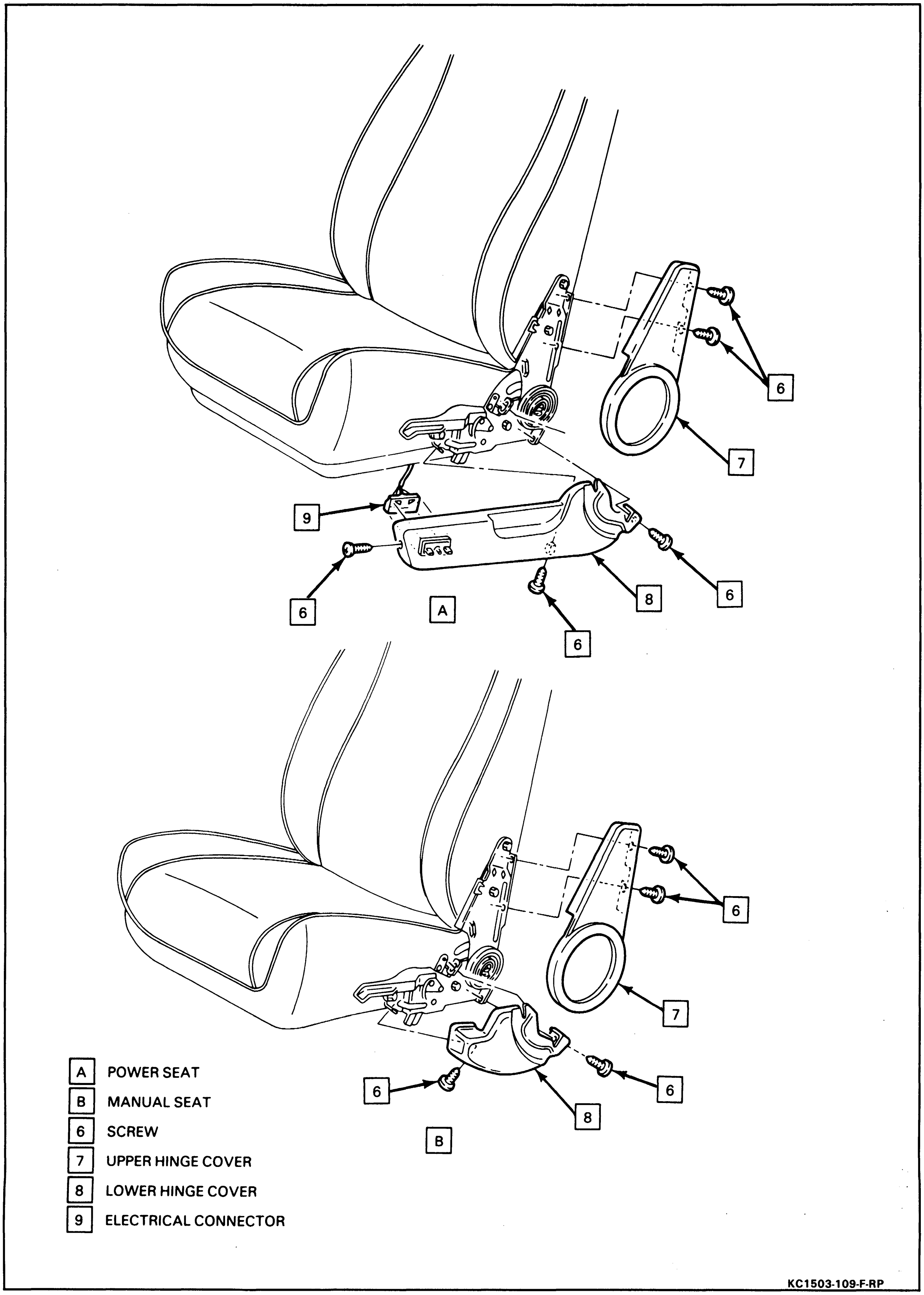


Figure 3 - Hinge Covers

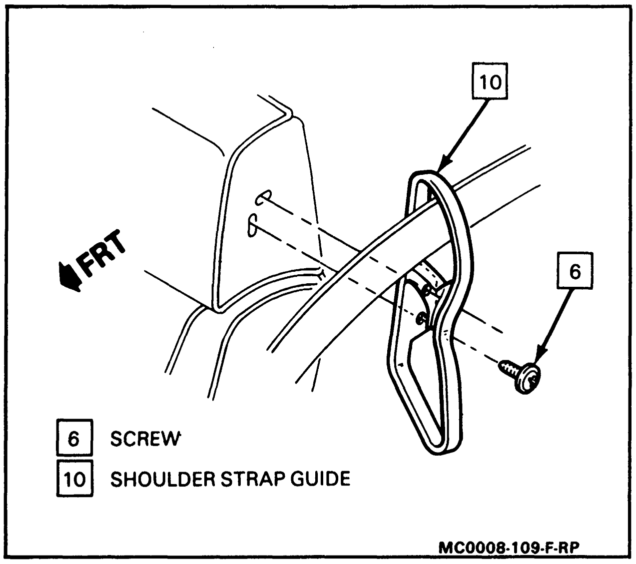


Figure 4 - Shoulder Strap Guide

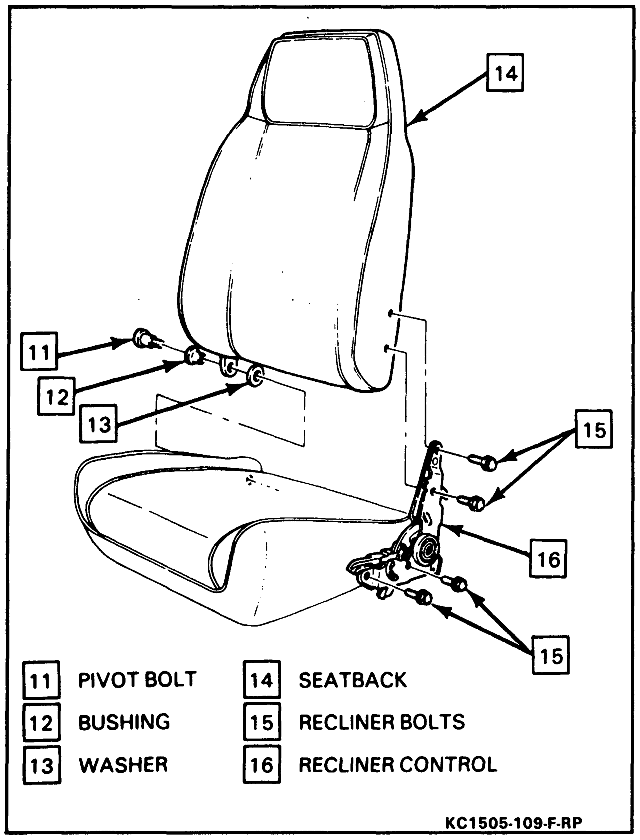


Figure 5 - Removing Seatback (Typical)

Head Restraint Cover

Figure 10

←→ Remove or Disconnect

1. Head restraint. Refer to "Head Restraint" in this section.
- Unsnap J-arrow closeout.
2. Head restraint cover (21).

→← Install or Connect

1. Head restraint cover (21).
- Snap together J-retainer and arrow retainer.
2. Head restraint. Refer to "Head Restraint" in this section.

HEAD RESTRAINT

Figures 11 and 12

The optional custom seat has an adjustable head restraint with a single support rod. The head restraint is designed so that it cannot be removed from the seatback without first inserting a flat tool inside the head restraint guide to release the lock clip. A head restraint lock-releasing tool can be made from 0.4 mm (1/64 inch) flexible steal strap (Figure 11). The flat surface of the tool will release the spring lock tab.

←→ Remove or Disconnect

1. Screw (6).
2. Shoulder strap guide (10).
3. Head restraint (22).
    - Raise head restraint (22) to up position.
    - Insert head restraint lock-releasing tool down the front surface of the support rod (23) until the head restraint lock-releasing tool stops.
    - Push the head restraint (22) and the head restraint lock-releasing tool to down position at the same time.
    - Lift the head restraint (22) out of the seatback.
    - Lift the head restraint lock-releasing tool out of the seatback.

→← Install or Connect

1. Head restraint (22) by inserting the support rod (23) into the seatback and lowering the head restraint (22) to down position.
2. Shoulder strap guide (10).
3. Screw (6).

HEAD RESTRAINT GUIDE

Figure 13

←→ Remove or Disconnect

1. Head restraint. Refer to "Head Restraint" in this section.
2. Screws (24).
3. Head restraint escutcheon (25).
4. Guide (26).
    - Move foam pad away from the guide (26).
    - Using hard thumb pressure, unsnap the guide (26) from the seatback panel.

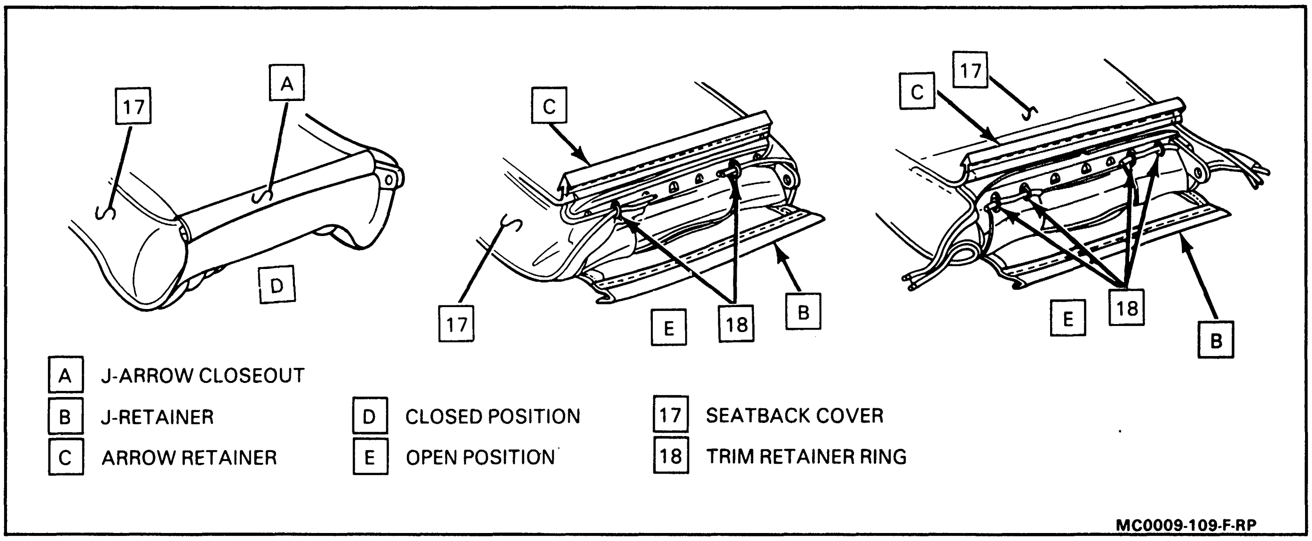


Figure 6 - Seatback Cover

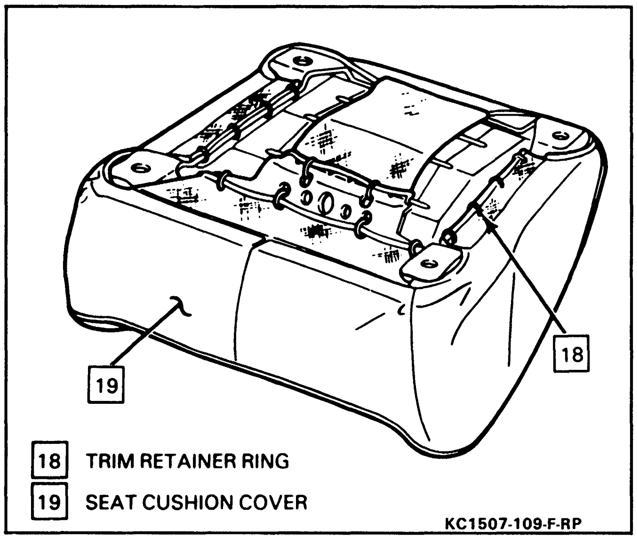


Figure 7 - Trim Retainer Rings

Install or Connect

1. Guide (26) into seatback. Snap into position.
2. Head restraint escutcheon (25).
3. Screws (24).
4. Head restraint. Refer to "Head Restraint" in this section.

RECLINING SEATBACK

Figure 14

Bucket seats have a tubular frame seatback and a manual seatback recliner. The recliner control (16) is mounted on the outboard side of the seat and controls the seatback angle. The inner hinge arm bolt acts as a pivot point for the seatback. The recliner control (16) has an inertia seatback lock that lets the occupant move the seatback without a lever. If the vehicle stops or slows down suddenly or if the vehicle is declined 20 degrees or more, the inertia seatback lock locks the seatback and the emergency release lever must be used to move the seatback.

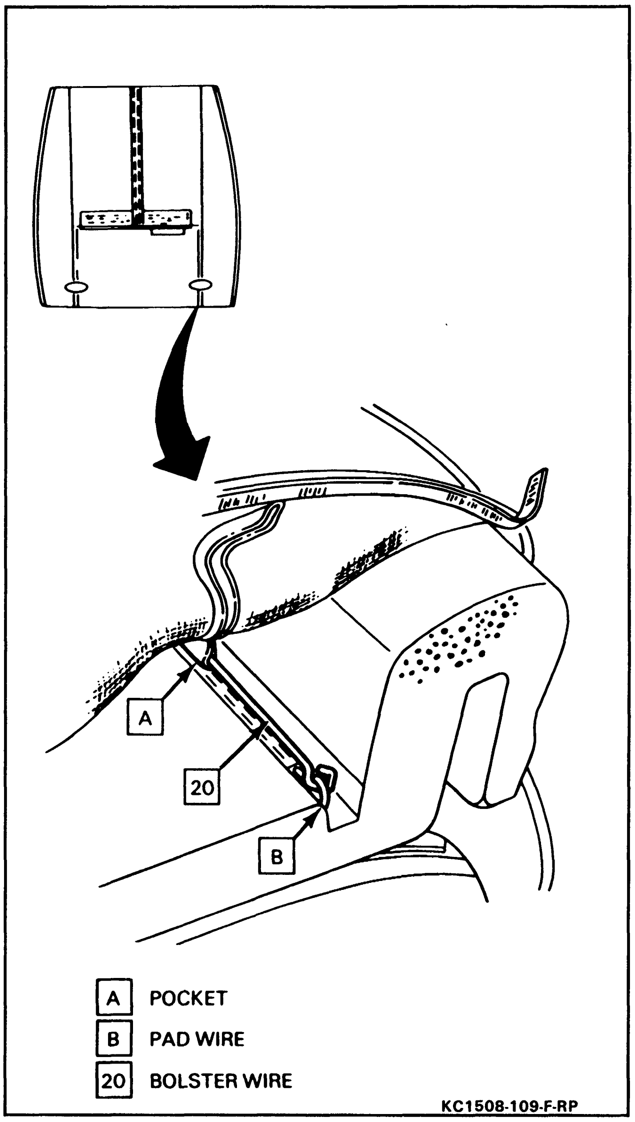


Figure 8 - Seatback Bolster Wire (Typical)

The seatback angle can be changed by lifting the recliner control handle (30). Lifting the recliner control handle (30) releases the lock bars (28) and lets the seatback pivot forward or rearward. Releasing the

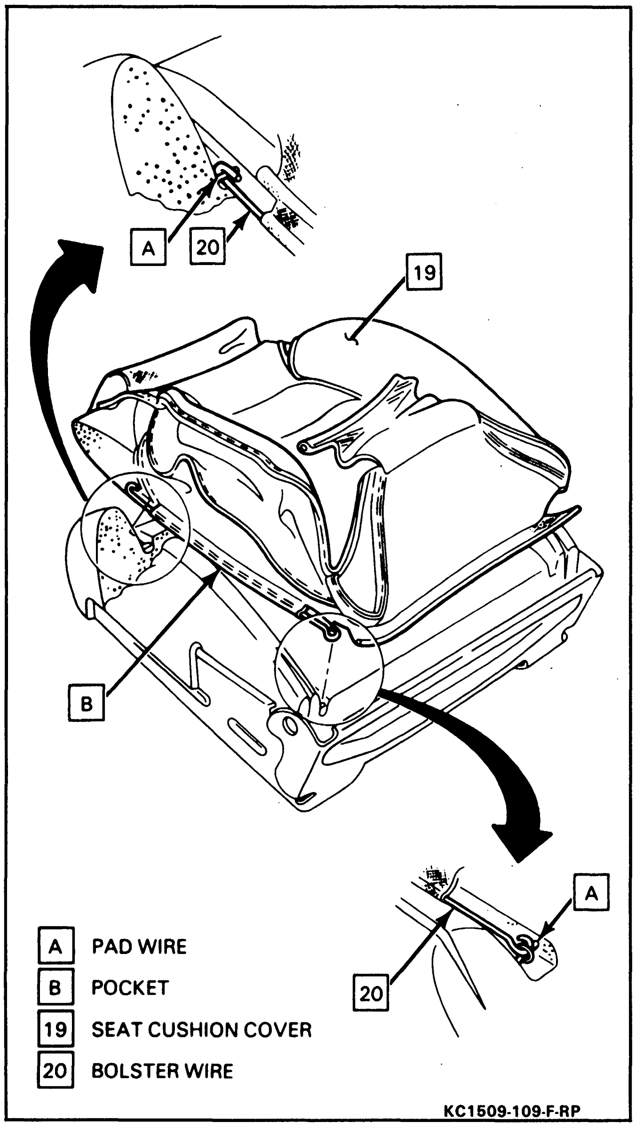


Figure 9 - Seat Cushion Bolster Wire

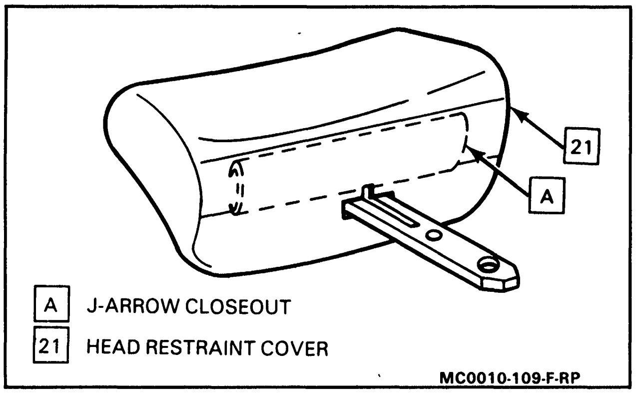


Figure 10 - Head Restraint Cover

recliner control handle (30) lets the cam plate (29) move clockwise, which causes the lock bar teeth to lock the seatback in the new position. The recliner control handle (30) should return automatically to its original position.

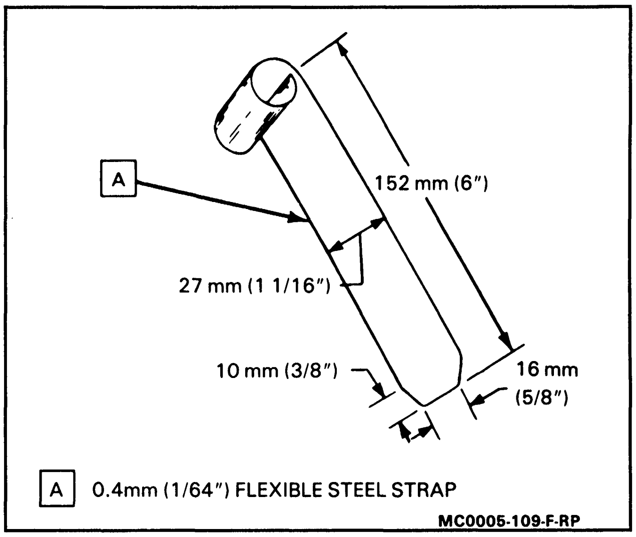


Figure 11 - Head Restraint Lock-Releasing Tool

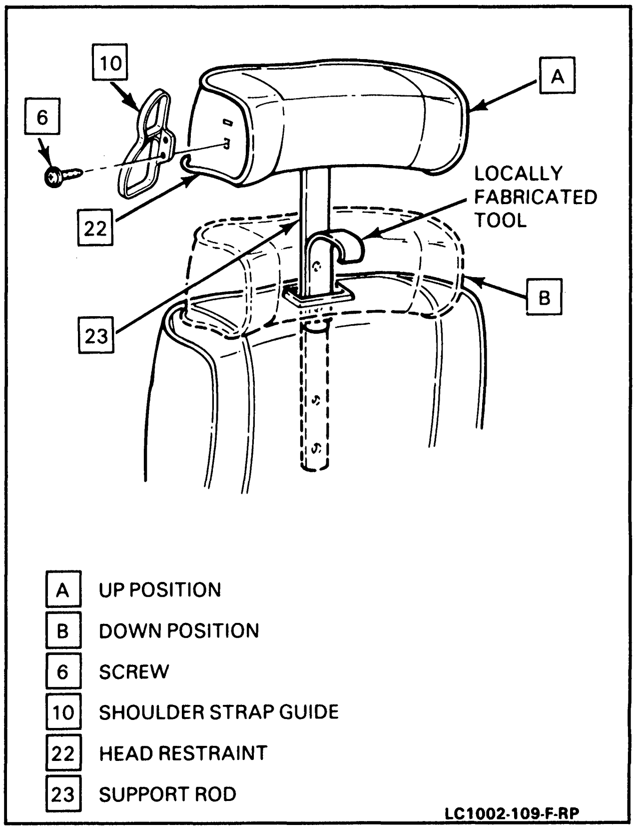


Figure 12 - Removing Head Restraint

Recliner Control Check

Inspect

- Recliner Control
  - Lift the recliner control handle (30) and press the seatback rearward into the fully reclined position, checking ease of recliner control handle operation and seatback movement.
  - Release the recliner control handle (30), checking that it returns to its original position and that the seatback remains fully reclined.

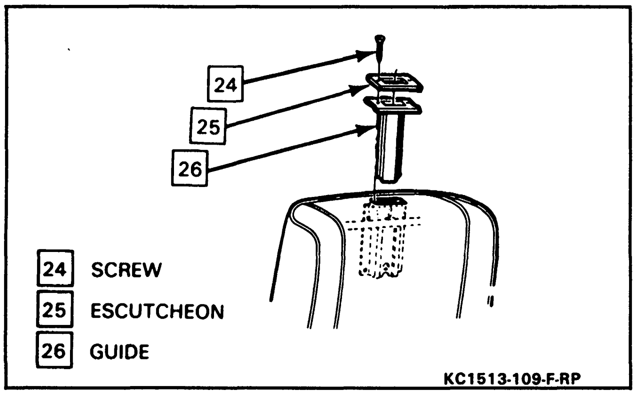


Figure 13 - Head Restraint Guide

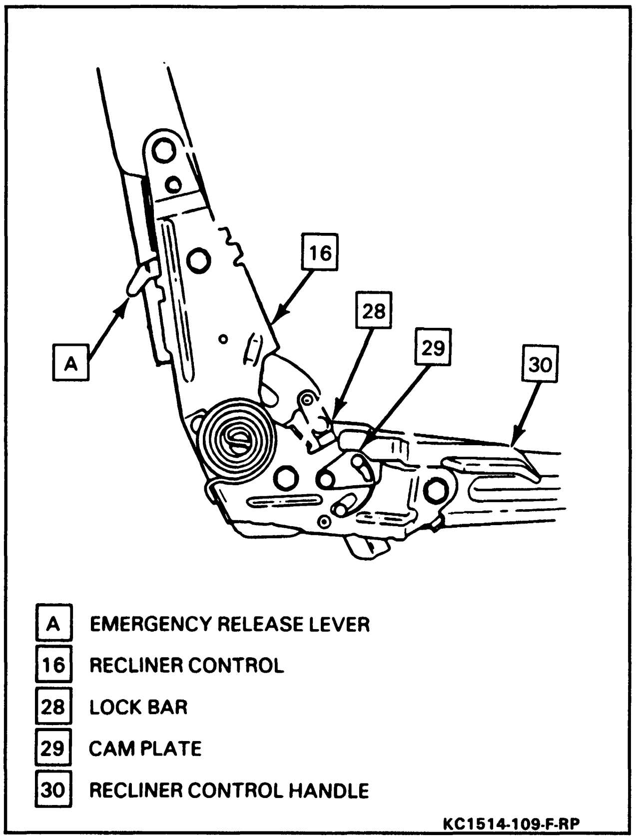


Figure 14 - Recliner Control Installed

  - Lift the recliner control handle (30) and pull the seatback forward to an intermediate reclined position.
  - Release recliner control handle (30).
  - Press the seatback rearward to check that the seatback is locked and stays in position.
  - Lift the recliner control handle (30) and move the seatback to normal position, checking ease of recliner control handle operation and seatback return.
  - Release recliner control handle (30).
  - Press the seatback rearward to check that the seatback is locked and stays in position.
- If the recliner control does not operate correctly, remove and replace. Refer to "Recliner Control" in this section.

Inertia Seatback Lock Check

In-Vehicle

Inspect

- Inertia seatback lock.

  CAUTION: Perform the check in an area clear of other vehicles or obstructions. The driver must be buckled into the restraint system, and a helper must be buckled into the rear seat restraint system. The helper should hold the sides of the passenger seatback near the top with arms still and body relaxed. Failure to perform these precautions may cause damage to the vehicle and possible personal injury.

  - Drive the vehicle forward between 16 and 24 km/h (10 and 15 mph).
    - When performing this check on the driver's seatback, the driver should lean forward slightly.
    - The helper must not push forward on the seatback before the driver applies the brakes.
  - Quickly apply the brakes to stop the vehicle as fast as possible without skidding the tires.
  - The inertia seatback lock should lock, and the top of the seatback should only move forward about 100 mm (4 inches).
- If either inertia seatback lock does not lock, perform the out-of-vehicle check.

Out-of-Vehicle

Figure 15

Inspect

- Inertia seatback lock.
  - Remove the seat from the vehicle. Refer to "Front Seat Assembly" in this section.
  - Place the seat right side up on a clean surface.
  - Raise the rear of the seat until the seatback is 6 degrees forward of vertical.
  - Place blocks under the rear of the seat to hold it in position (Figure 15).
  - Check that the seatback is locked in position.
  - Install the seat into the vehicle if the inertia seatback lock works properly. Refer to "Front Seat Assembly" in this section.
- If the inertia seatback lock does not work properly, the entire recliner control must be replaced. Refer to "Recliner Control" in this section.

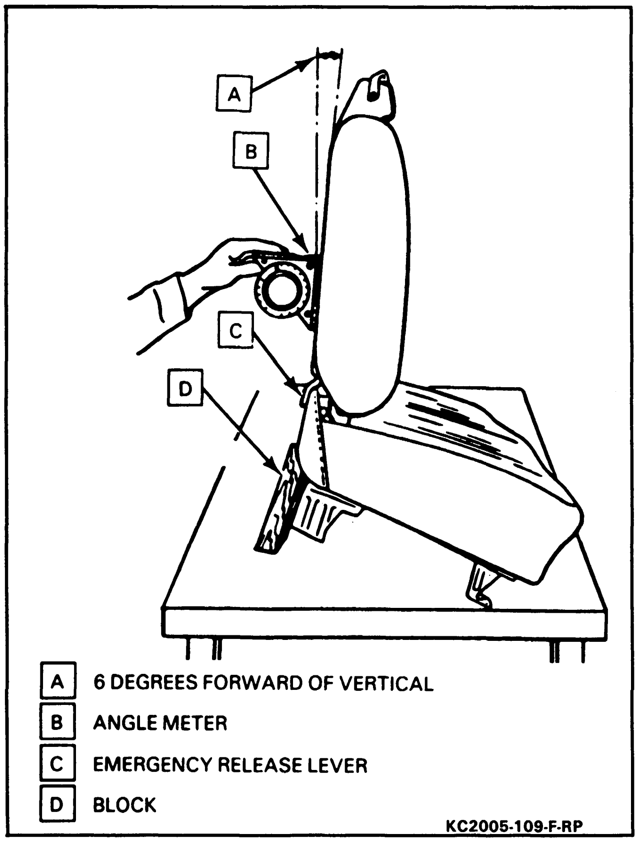


Figure 15 - Checking Inertia Seatback Lock

Recliner Control

Figure 16

Remove or Disconnect

- Place seatback in full-up position.

1. Screws (6).
2. Upper hinge cover (7).
3. Lower hinge cover (8).

NOTICE: While removing the recliner bolts, have a helper support the seatback. Without support the seatback may fall and cause damage to the pivot bolt.

4. Recliner bolts (15).
5. Recliner control (16).

- Carefully lower the seatback.

Install or Connect

- Carefully raise the seatback and have a helper support it while the recliner control and recliner bolts are being installed.

1. Recliner control (16).

NOTICE: See "Notice" on page 10-9-1 of this section.

2. Recliner bolts (15).

Tighten

- Recliner bolts (15) to 27 N·m (20 lb. ft.).

3. Lower hinge cover (8).
4. Upper hinge cover (7).
5. Screws (6).

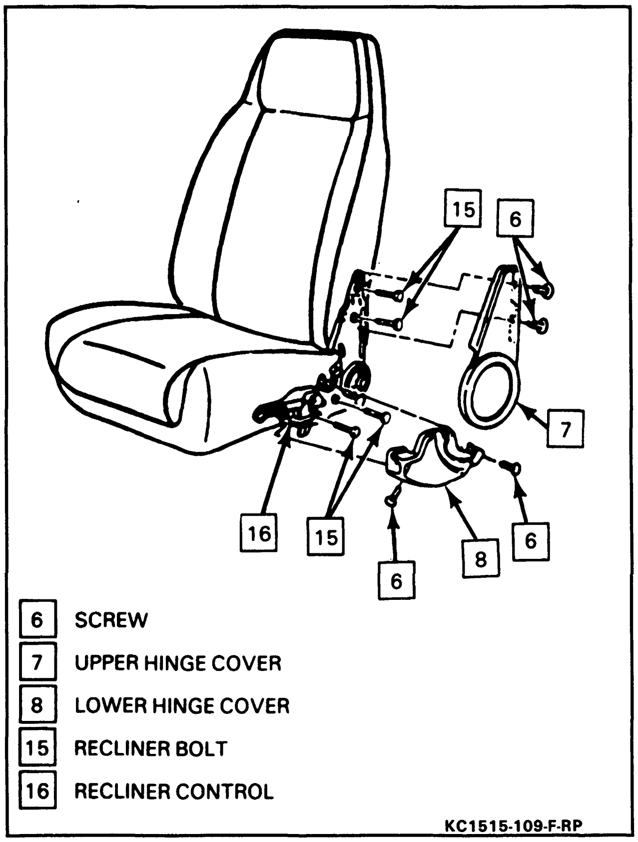


Figure 16 - Removing Recliner Control

MANUAL SEAT ADJUSTERS

All passenger seats and some driver seats have manual seat adjusters attached to the seat cushion frame. An adjuster actuator lever is located at the lower front edge of the seat cushion. When the lever is moved to the left, the seat adjusters unlock. The seat can then be moved forward and rearward. The seat locks in place when the lever is released.

The seat adjusters are held onto the seat cushion frame with bolts and to the floor pan with nuts installed over studs. Adjuster channel covers are installed between the seat cushion frame and the seat adjusters.

Diagnosis

1. Adjusters will not lock or will not unlock.
   - Linking wire may be too loose, too tight or disconnected.
   - Return spring may be disconnected or damaged.
   - Lock bar may be stuck, or damaged.
2. One adjuster locks and the other adjuster does not lock.
   - One adjuster may be forward or rearward of other adjuster. Make adjustments at the floor pan attachments.
3. Seat is hard to move forward or rearward.

- Adjusters may be new. Move seat forward and rearward several times to work tightness out of the channels.
- Adjusters may not be lubricated properly.
- Adjuster channels may be damaged.
- Adjusters may not be parallel. Make adjustments at the floor pan attachments.

Floor Pan Attachment Adjustment

Figure 2

A small amount of forward and rearward or side adjustment is possible at the seat adjuster floor pan attaching points. The adjustment can be used to align the seat adjusters with each other.

Adjust

- Floor pan attachment.

Remove or Disconnect

- Screws (1).
- Adjuster track covers (2).
- Loosen nuts (3).
- Align seat adjusters (4).
  - Make sure seat adjusters are lined up front to rear.
  - Make sure seat adjusters are parallel to each other.

NOTICE: See "Notice" on page 10-9-1 of this section.

Tighten

- Nuts (3) to 27 N·m (20 lb. ft.).

Install or Connect

- Adjuster track covers (2).
- Screws (1).

Inspect

- Floor pan attachment by moving the seat all the way forward and rearward, locking it in several sections.
  - Both seat adjusters (4) should lock at each position.
  - Seat should move easily forward and rearward.

Adjuster Replacement

Figure 17

Remove or Disconnect

1. Seat. Refer to "Front Seat Assembly" in this section.
2. Lock bar spring (35) from the adjuster (4) being removed.
3. Linking wire (32).
   - Squeeze hooked end of linking wire (32).
   - Slide retainer spring (33) over hump in the linking wire (32).
   - Unhook linking wire (32) from lock bar (31).
4. Seat bolts (36).
5. Adjuster (4).
6. Adjuster channel covers (34).

Install or Connect

1. Adjuster channel covers (34).
2. Adjuster (4).

NOTICE: See "Notice" on page 10-9-1 of this section.

3. Seat bolts (36).

Tighten

- Seat bolts (36) to 27 N·m (20 lb. ft.).

4. Linking wire (32) to lock bar (31).
   - Slide retainer spring (33) over the hump in the linking wire (32).
5. Lock bar spring (35).
6. Seat. Refer to "Front Seat Assembly" in this section.

Adjuster Actuator Lever Knob

Figure 18

The adjuster actuator lever knob fits over the end of the adjuster actuator lever that comes out from under the seat cushion. The knob can generally be removed and installed several times without becoming too loose.

Remove or Disconnect

- Knob (37) from adjuster actuator lever.
  - Place a protective covering over nearby trim.
  - Clamp locking pliers onto adjuster actuator lever.
  - Using a body spoon, pry downward to remove the knob.

Install or Connect

- Knob (37) to adjuster actuator lever.
  - Place a protective covering over nearby trim.
  - Draw a pencil line on the adjuster actuator lever 25 mm (1 inch) from the end as a guide for full-depth fit of the knob (37).
  - Secure locking pliers to the adjuster actuator between the pencil line and the seat.

NOTICE: While installing the adjuster actuator lever knob, take care not to bend the adjuster actuator lever.

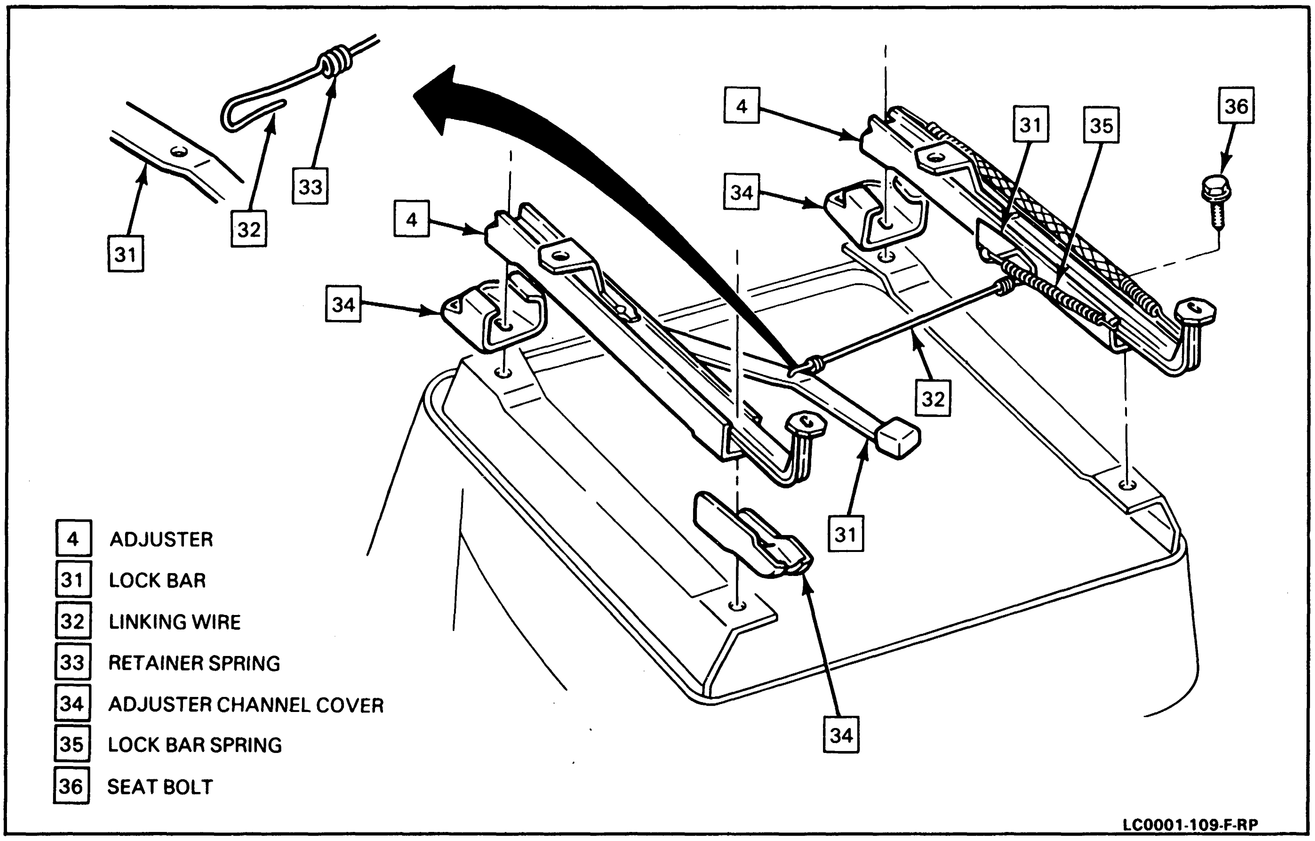


Figure 17 - Manual Seat Adjusters (Typical)

- Insert the knob (37) onto the adjuster actuator lever.
  - Gate marks on the knob (37) must face to the rear.
- Press the knob (37) firmly onto the aduster actuator lever.

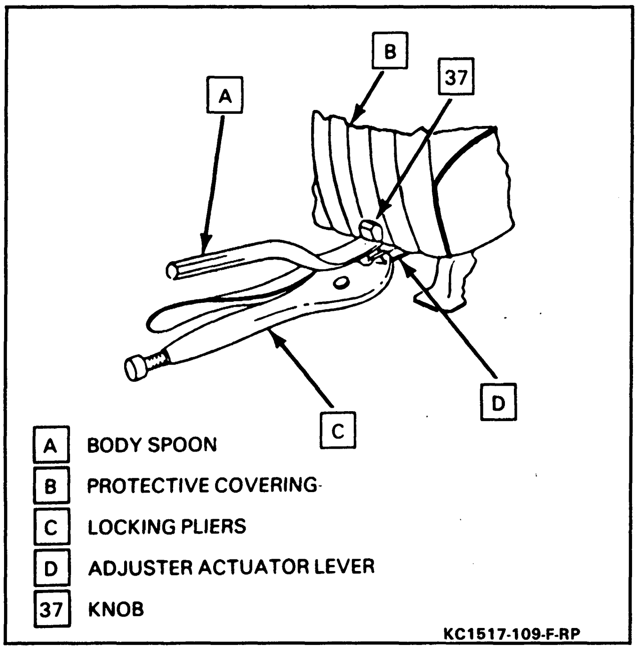


Figure 18 - Adjuster Actuator Lever Knob

POWER SEAT ADJUSTERS

Six-way power seat adjusters are available on the driver's seat. The adjusters use three 12 volt reversible, permanent-magnet motors controlled by a switch on the forward outboard side of the seat.

Diagnosis

1. One adjuster reaches maximum horizontal or vertical position before the other adjuster.
   - Adjusters may be out of phase.
2. Seat does not move smoothly.
   - Adjuster shoes and channels may not be properly lubricated.
   - Horizontal actuator gear may be too tight.
3. One adjuster will not move forward and backward.
   - Horizontal drive cable may be disconnected or damaged.
   - Horizontal actuator may be damaged.
4. One adjuster will not move up and down.
   - Vertical drive cable may be disconnected or damaged.
   - Vertical actuator may be damaged.

Adjustments

Figure 19

With seat adjuster assembly installed chucking or jerking can be corrected by tightening or loosening the horizontal actuator and pinion gear to the adjuster lower track rack gear.

Adjust

- Horizontal actuator (39).
  - Operate seat to full-up position and about 3/4-forward position.
  - Loosen screws (38).
  - Using a large screwdriver apply 67 to 111 newtons (15 to 25 pounds) of outward pressure on the horizontal actuator (39). At the same time use the horizontal switch to move the seat forward and backward to help seat the horizontal actuator pinion gear teeth tight to the lower track rack gear teeth and eliminate any free play.
  - While keeping pressure on the horizontal actuator (39), tighten the screw (38).

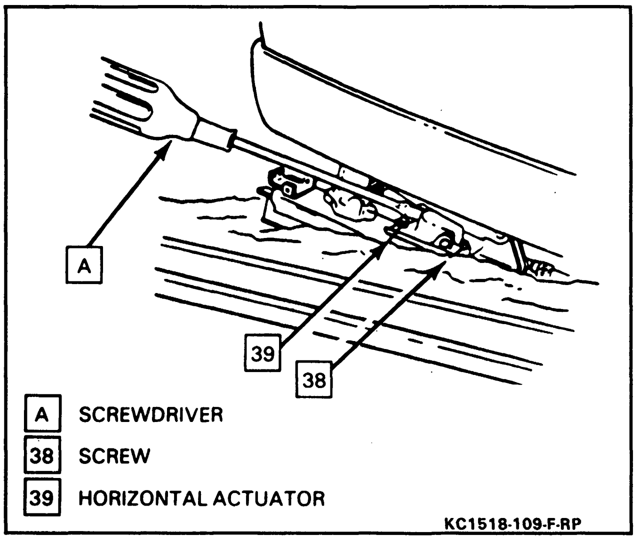


Figure 19 - Adjuster Horizontal Actuator

Seat Adjuster Phase

When one adjuster reaches either maximum horizontal or maximum vertical travel before the other, the adjusters are out of phase. Out-of-phase adjusters can occur over time or when the seats are serviced.

Adjust

1. Horizontal phase.
   - Operate horizontal switch until one adjuster reaches full-forward position.
   - Detach horizontal drive cable from the full-forward adjuster.
   - Operate horizontal switch until the other adjuster reaches full-forward position.
   - Connect horizontal drive cable.

   ### Inspect

   - Horizontal travel.
2. Vertical phase.
   - Operate vertical switch until one adjuster reaches full-up position at both front and rear.
   - Disconnect both front and rear vertical drive cables from the full-up adjuster.
   - Operate vertical switch until the other adjuster reaches full-up position at both front and rear.
   - Connect vertical drive cables.

   ### Inspect

   - Vertical travel.

Adjuster Assembly

Figures 20 through 22

Remove or Disconnect

1. Seat. Refer to "Front Seat Assembly" in this section.
2. Drive cables (41).
3. Electrical connector from motors (40).
4. Nut (45) securing the front of the motor support (44) to the adjuster (4).
5. Motor support (44) with motors (40) attached.
6. Seat bolts (36).
7. Cover (42).
8. Adjuster (4).

Disassemble

- Adjuster (4).

  CAUTION: Failure to place the adjuster in a bench vise before removing the rear vertical actuator nut will cause ejection of the compressed assist spring and possible personal injury.

  - Remove rear vertical actuator nut (49).
    - Place adjuster (4) in a bench vise and remove the rear vertical actuator nut (49).
    - Open the vise slowly to relieve assist spring compression and remove the adjuster (4) from the vise.
  - Remove assist spring (51).
  - Remove front vertical actuator nut (48).
  - Remove screw (38).
  - Remove horizontal actuator (39).
  - Remove vertical actuator screws (50).
  - Remove rear vertical actuator (47).
  - Remove front vertical actuator (46).

Assemble

- Adjuster (4).
  - Install front vertical actuator (46).
  - Install rear vertical actuator (47).
  - Install vertical actuator screws (50).
  - Install horizontal actuator (39).
  - Install screw (38).
  - Install front vertical actuator nut (48).
  - Install assist spring (51).

- Install rear vertical actuator nut (49).
  - Place adjuster (4) into a benchvise.
  - Carefully compress the assist spring (51) and install the rear vertical actuator nut (49).
  - Remove adjuster (4) from the benchvise.

Install or Connect

1. Adjuster (4).
2. Cover (42).

NOTICE: See "Notice" on page 10-9-1 of this section.

3. Seat bolts (36).

Tighten

- Seat bolts (36) to 27 N·m (20 lb. ft.).

4. Motor support (44) with motors (40) attached.
5. Nut (45).
6. Electrical connector to motors (40).
7. Drive cables (41).
8. Seat. Refer to "Front Seat Assembly" in this section.

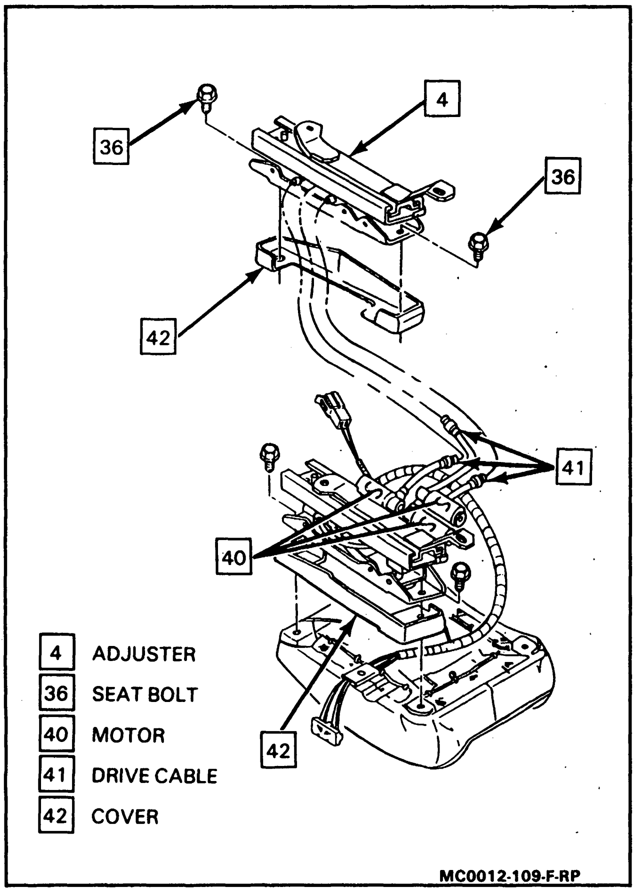


Figure 20 - Power Seat Adjusters

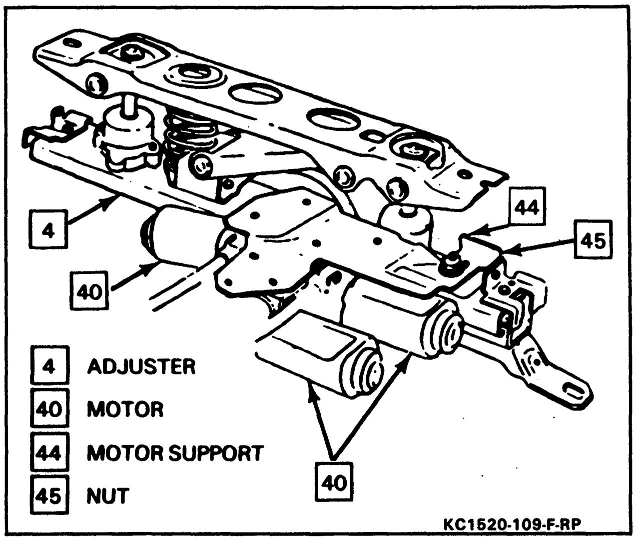


Figure 21 - Motor Support

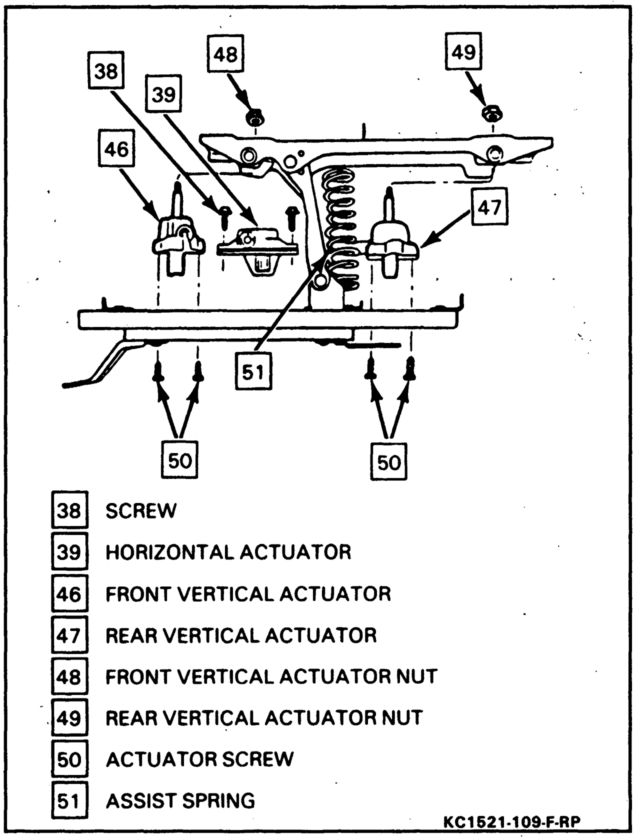


Figure 22 - Actuators

Motor Replacement

Figures 20 and 21

Remove or Disconnect

1. Seat. Refer to "Front Seat Assembly" in this section.
2. Drive cables (41).
3. Electrical connector from motors (40).
4. Nut (45).
5. Motor support (44) with motors (40) attached.

6. Motors (40) from motor support (44).
   - Grind off ends of grommet to separate the motors (40) from the motor support (44).

Install or Connect

1. Motors (40) and new grommet to the motor support (44).
   - Drill out top end of grommet using a 3/16-inch drill.
   - Secure motors (40) to motor support (44) with 3/16-inch rivets.
2. Motor support (44) with motors (40) attached.
3. Nut (45).
4. Electrical connector to motors (40).
5. Drive cables (41).
6. Seat. Refer to "Front Seat Assembly" in this section.

Power Adjuster Switch

Figure 23

Remove or Disconnect

1. Screws (6).
2. Upper hinge cover (7).
3. Lower hinge cover (8).
4. Electrical connector (9).
5. Switch screws (55) from retainers (52).
6. Escutcheon (54) and switch (53) from lower hinge cover (8).
7. Escutcheon (54) from switch (53).

Install or Connect

1. Escutcheon (54) to switch (53).
2. Escutcheon (54) and switch (53) to lower hinge cover (8).
3. Switch screws (55) through lower hinge cover (8) and escutcheon (54).
4. Retainers (52) to switch screws (55).
5. Electrical connector (9).
6. Lower hinge cover (8).
7. Upper hinge cover (7).
8. Screws (6).

REAR SEATS

The rear seatback is either full or split. Both types are held onto the vehicle with studs and nuts.

The rear seat cushions are split. They are held onto the vehicle with bolts.

SEAT CUSHION

Figure 24

Remove or Disconnect

1. Bolt (57).

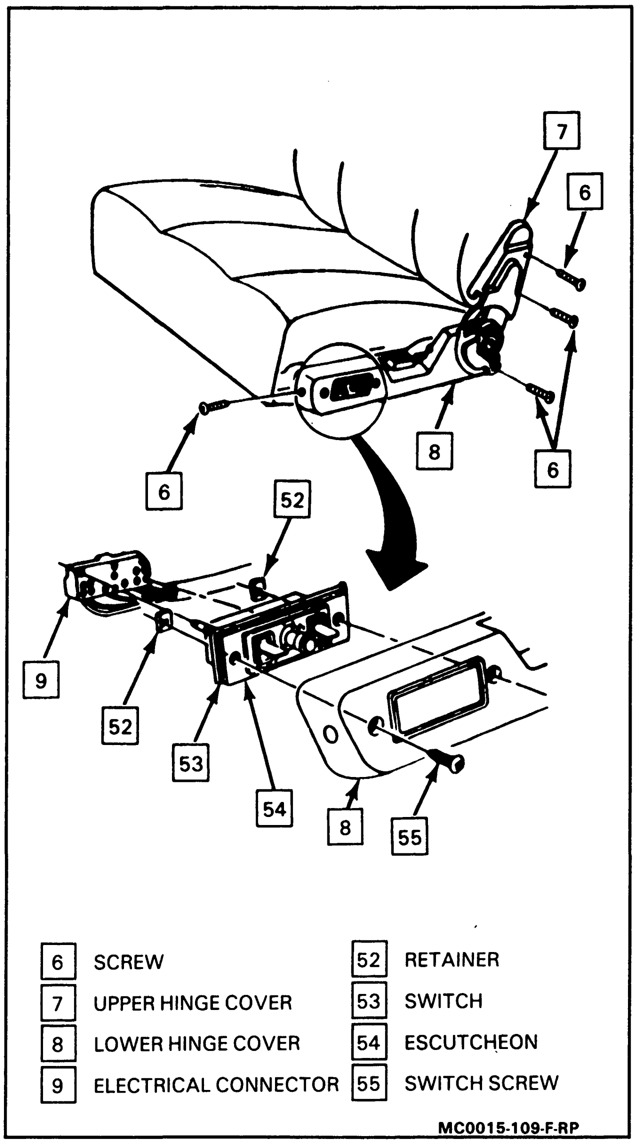


Figure 23 - Power Adjuster Switch

2. Seat cushion (56) by pulling upward and forward.

NOTICE: Failure to place a protective shield over nearby trim and paint may cause damage to the vehicle.

- Place a protective shield over nearby trim and paint.

3. Seat cushion (56) from vehicle.
   - On the convertible, remove the seat cushion through the side door, being careful not to damage front seats.
   - On the hardtop, remove the seat cushion through the rear compartment lift window, being careful not to damage the rear seatback.
   - Remove Protective shield.

Install or Connect

NOTICE: Failure to place a protective shield over nearby trim and paint may cause damage to the vehicle.

- Place a protective shield over nearby trim and paint.

1. Seat cushion (56) into vehicle.
   - On the convertible, load the seat cushion through the side door, being careful not to damage the front seats.
   - On the hardtop, load the seat cushion through the rear compartment lift window, being careful not to damage the rear seatback.
   - Remove protective shield.
2. Seat cushion by pushing the seat cushion (56) rearward.

NOTICE: See "Notice" on page 10-9-1 of this section.

3. Bolt (57) through anchor wire loop into the hole in the floor pan.

Tighten

- Bolt (57) to 12 N·m (106 lb. in.).

SEATBACK

Figure 25

Remove or Disconnect

1. Seat cushion. Refer to "Seat Cushion" in this section.
2. Shoulder strap guide. Refer to "Shoulder Strap Guide" in this section.
3. Seatback lock (59) from striker (58).
4. Nuts (61) from seat studs.
5. Seat studs from outer pivot supports by lifting upward on the outboard side of the seatback (60).

- On split seatbacks, slide the inner pivot support off of the floor stud.

NOTICE: Failure to place a protective shield over nearby trim and paint may cause damage to the vehicle.

- Place a protective shield over nearby trim and paint.

6. Seatback (60) from vehicle.
   - On the convertible, remove the seatback (60) through the side door, being careful not to damage the front seats.
   - On the hardtop remove the seatback (60) through the rear compartment lift window.
   - Protective shield.

Install or Connect

NOTICE: Failure to place a protective shield over nearby trim and paint may cause damage to the vehicle.

1. Protective shield over nearby trim and paint.
2. Seatback (60) into vehicle.
   - On the convertible, load the seatback (60) through the side door, being careful not to damage front seats.
   - On the hardtop, load the seatback (60) through the rear compartment lift window.

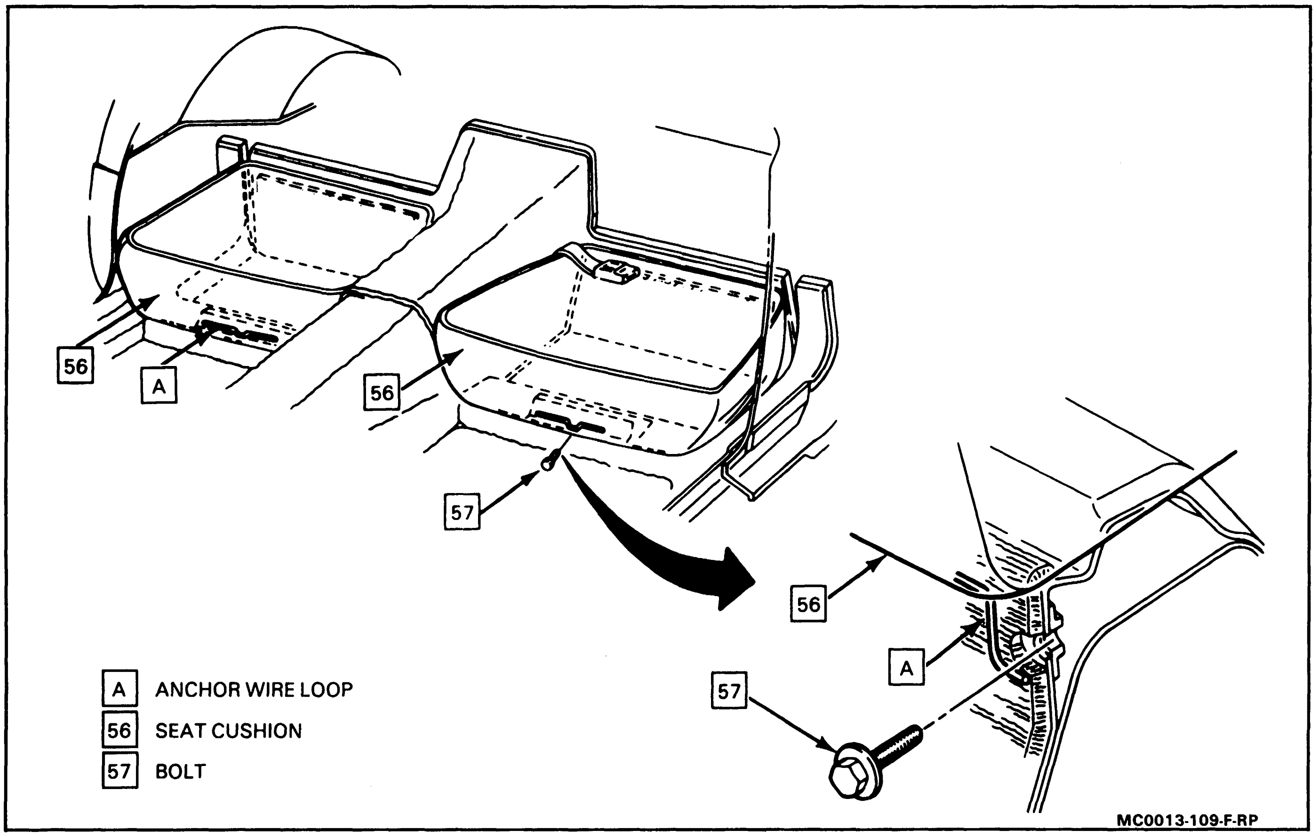


Figure 24 - Rear Seat Cushion

- Remove protective shield.
- On split seatbacks, slide the inner pivot support onto the floor stud.

3. Seat studs into outer pivot supports.
4. Nuts (61) to seat studs loosely.
5. Seatback lock (59) to striker (58).

NOTICE: See "Notice" on page 10-9-1 of this section.

Tighten

- Nuts (61) on the split rear seatback to 27 N·m (20 lb. ft.).
- Nuts (61) on the full rear seatback to 25 N·m (18 lb. ft.).

6. Seat cushion. Refer to "Seat Cushion" in this section.
7. Shoulder strap guide. Refer to "Shoulder Strap Guide" in this section.

TRIM AND COVERS

The rear seat cushions and seatbacks have formed foam pads that fit the contour of the seat frames. The seat covers are either cloth or leather. They are held onto the seat with trim retainer rings, bolster wires and zippers. A shoulder strap guide is attached to the outboard sides of the seats with screws.

Shoulder Strap Guide

Figure 26

Remove or Disconnect

1. Screws (63).
2. Shoulder strap guide (62).

Install or Connect

1. Shoulder strap guide (62).

NOTICE: See "Notice" on page 10-9-1 of this section.

2. Screws (63).

Tighten

- Screws (63) to 10 N·m (89 lb. in.).

Seat Cushion Cover

Figure 27

Remove or Disconnect

1. Seat cushion from vehicle. Refer to "Seat Cushion" in this section.
2. Trim retainer rings (18) on the bottom of the seat cushion.
   - Note position of trim retainer rings (18).
   - Pull seat cushion cover (64) away from the foam pad to expose the bolster wires (20).
3. Remaining trim retainer rings (18).
   - Note position of trim retainer rings.
4. Bolster wires (20) from the pad wires.
5. Seat cushion cover (64).

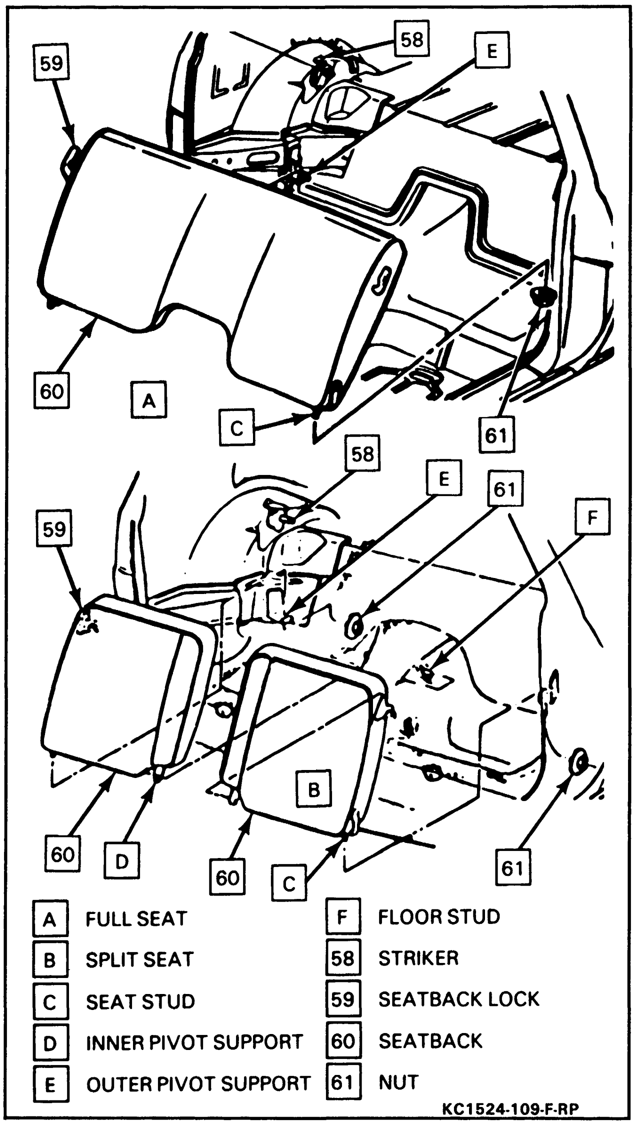


Figure 25 - Rear Seatback

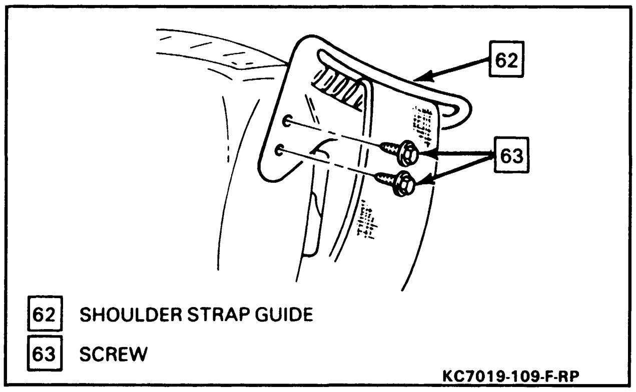


Figure 26 - Rear Seat Shoulder Strap Guide

Install or Connect

- Turn seat cushion cover (64) inside out.
- If installing a replacement seat cushion cover (64), remove the bolster wires (20) from the old

seat cushion cover pockets, and slide the bolster wires (20) into the replacement seat cushion cover pockets.

1. Bolster wires (20) to the pad wires.
2. Trim retainer rings (18) where the old trim retainer rings were removed.
3. Seat cushion cover (64) over pad by turning the seat cushion cover (64) right side out.
4. Trim retainer rings (18) where the old trim retainer rings (18) were removed from the bottom of the seat cushion.
5. Seat cushion to vehicle. Refer to "Seat Cushion" in this section.

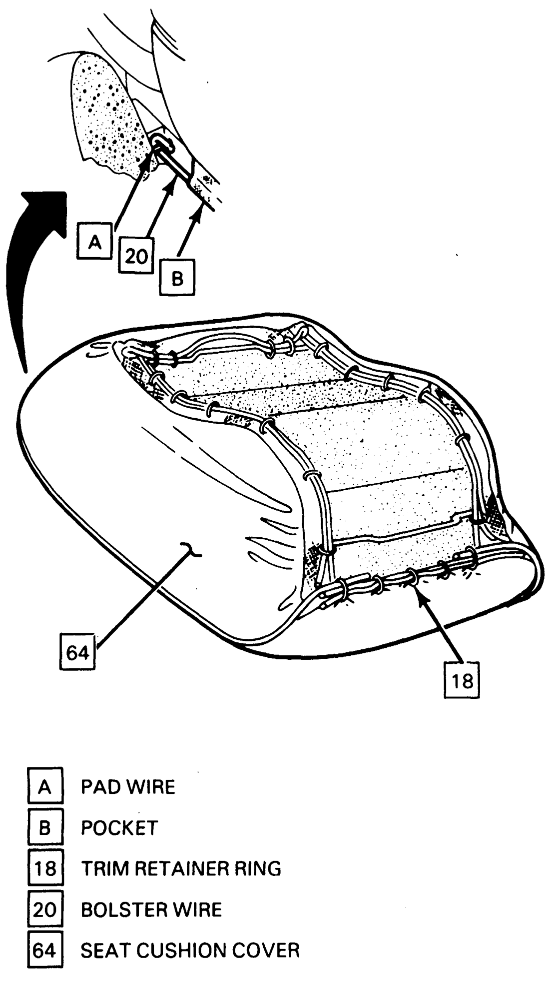


Figure 27 - Rear Seat Cushion Cover

Seatback Cover

Figures 28, 29 and 30

Remove or Disconnect

1. Seatback from vehicle. Refer to "Seatback" in this section.
- Unzip zipper.
2. Trim retainer rings (18) at the bottom of the seatback.
    - Note position of trim retainer rings.
3. Trim retainer rings (18) from the cord pocket (base seat) or trim retainer ring (18) from the sew strip (up-level seat).
    - Lift seatback cover (65) away from the pad to expose the cord pocket or sewstrip.
4. Seatback cover (65).

Install or Connect

1. Seatback cover (65).
2. Trim retainer rings (18) through the cord pocket to the pad wire (base seat) or trim retaining ring (18) through sew strip (up-level seat).
    - Fold seatback cover (65) to expose the cord pocket.
- Pull seatback cover (65) down over foam pad.
- Pull side facings into position.
3. Trim retainer rings (18).
- On split seats, pull the seaming laces into position.
4. Trim retainer rings (18).
- Pull the front facing extension into position, if present.
5. Trim retainer rings (18).
- Pull rear facing extension into position.
- Zip zipper.
6. Seatback. Refer to "Seatback" in this section.

SEATBACK LOCK AND STRIKER

The rear seat folds down to provide additional storage space in the rear of the vehicle. The seatback locks are located on the outboard sides of the seat. The strikers are located on the wheelhouse panels.

Seatback Lock

Figure 31

Remove or Disconnect

1. Seat cushion. Refer to "Seat Cushion" in this section.
2. Seatback. Refer to "Seatback" in this section.
3. Screws (66).
4. Seatback lock (59) and washer (67).

Install or Connect

1. Washer (67) and seatback lock (59).

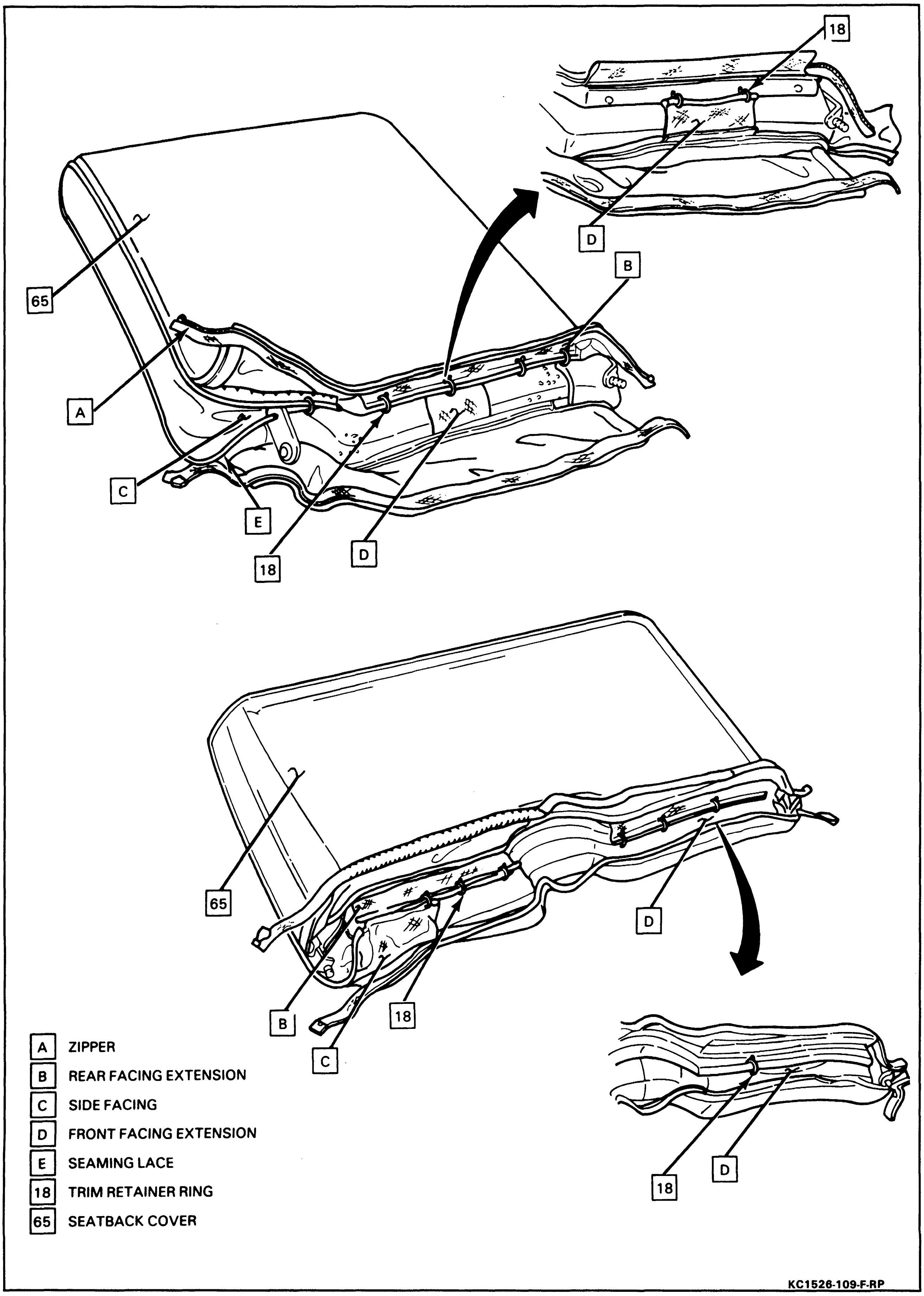
    NOTICE: See "Notice" on page 10-9-1 of this section.

2. Screw (66).

    #### Tighten

    - Screw (66) to 27 N·m (20 lb. ft.).

3. Seatback. Refer to "Seatback" in this section.



A	ZIPPER
B	REAR FACING EXTENSION
C	SIDE FACING
D	FRONT FACING EXTENSION
E	SEAMING LACE
18	TRIM RETAINER RING
65	SEATBACK COVER

Figure 28 - Seatback Cover Bottom Attachment

4. Seat cushion. Refer to "Seat Cushion" in this section.

Striker

Figure 32

Remove or Disconnect

- Striker bolt (70), sleeve (69) and washer (68).

Install or Connect

1. Washer (68) and sleeve (69) over striker bolt (70).

   NOTICE: See "Notice" on page 10-9-1 of this section.

2. Striker bolt (70).

   Tighten

   - Striker bolt (70) to 50 N·m (37 lb. ft.).

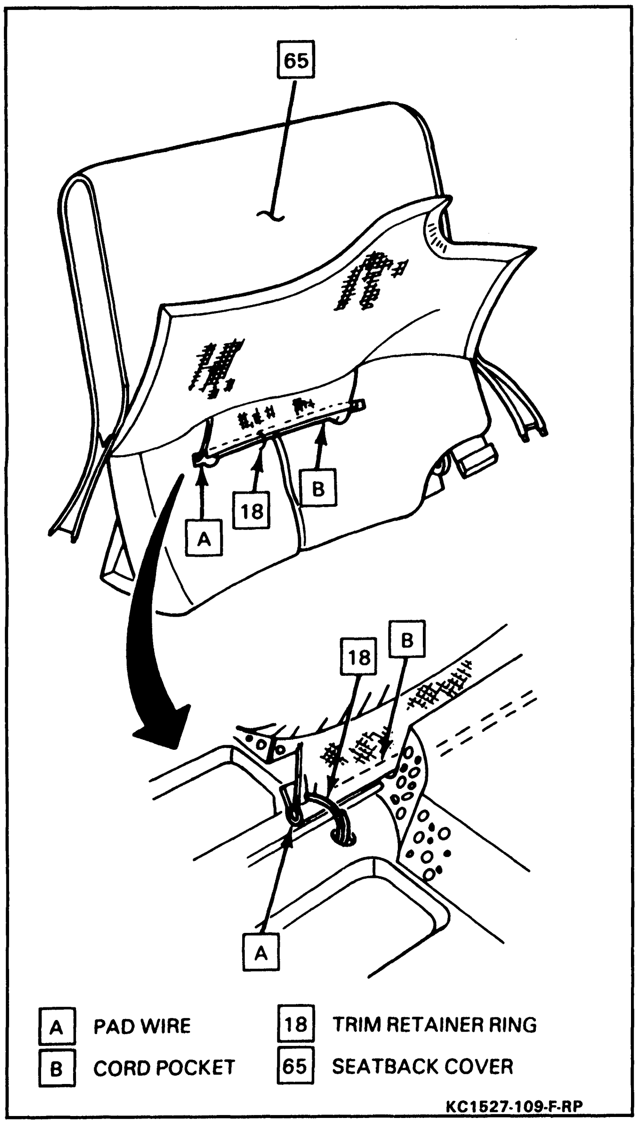


Figure 29 - Seatback Cover Inner Attachment (Base Seat)

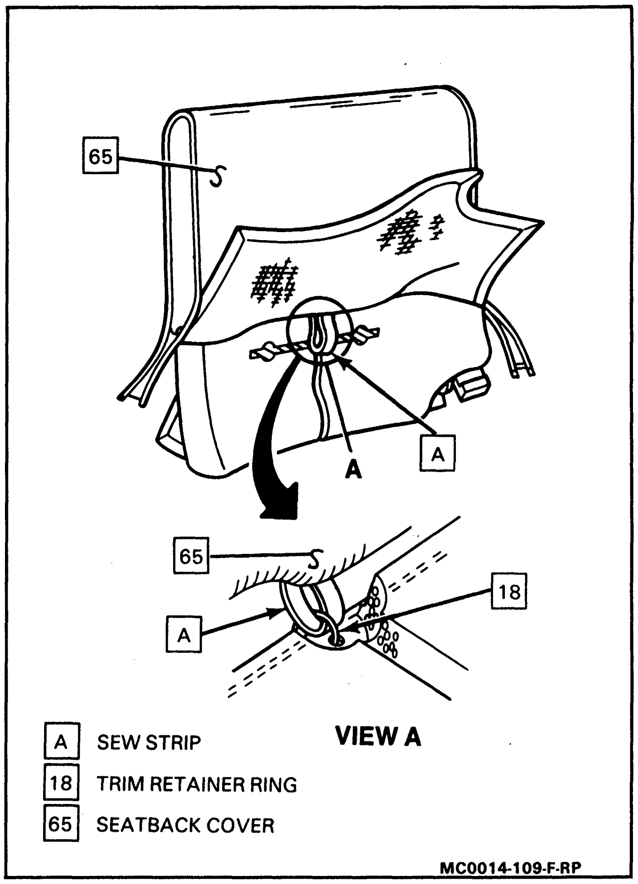


Figure 30 - Seatback Cover Inner Attachment (Up-Level Seat)

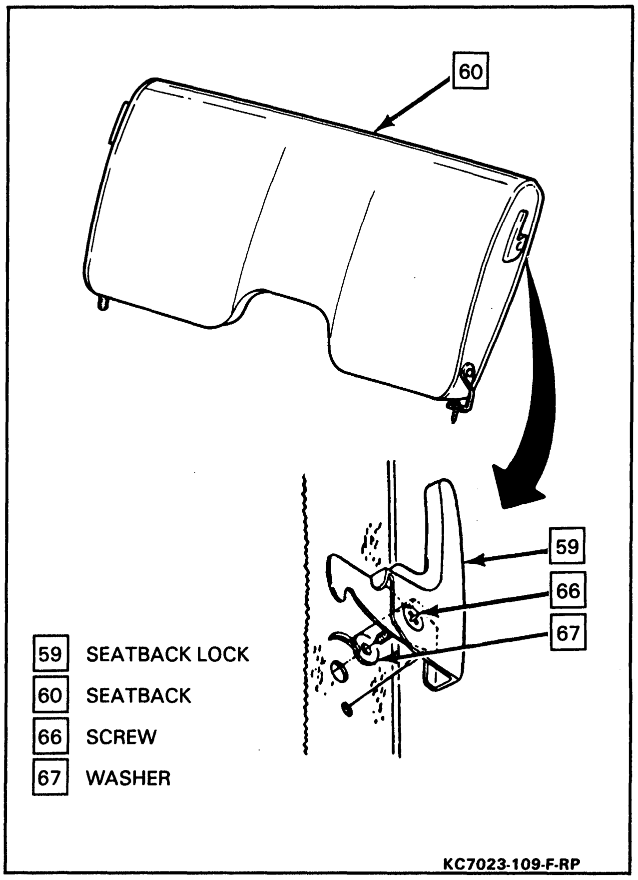


Figure 31 - Seatback Lock

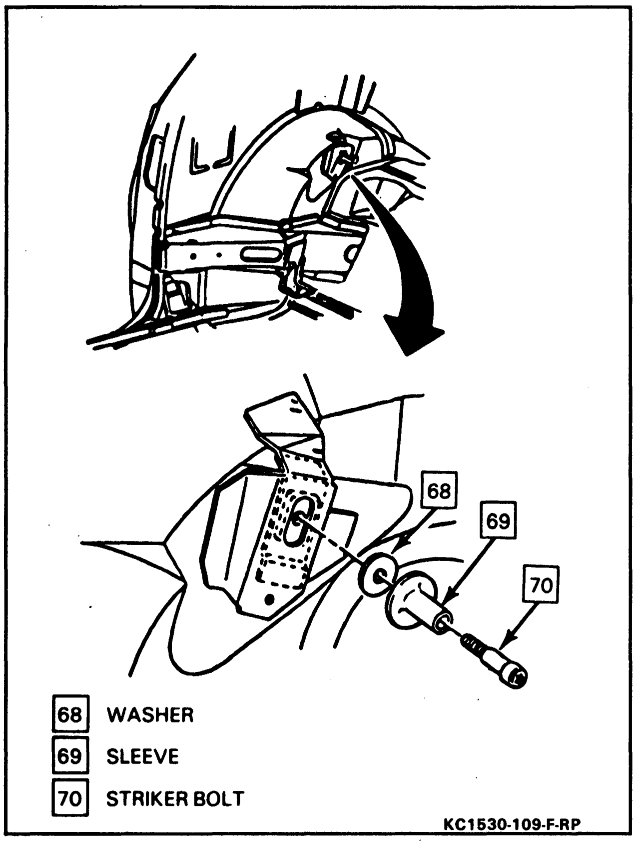


Figure 32 - Striker

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Seat Adjuster-to-Floor Pan Nut	25 N·m (18 lb. ft.)
Seat Adjuster-to-Seat Frame Bolt	27 N·m (20 lb. ft.)
Front Seat Pivot Bolt	50 N·m(37 lb. ft.)
Recliner-to-Seat Frame Bolt	27 N·m (20 lb. ft.)
Rear Seat Cushion-to-Seat Floor Pan Bolt	12 N·m (106 lb. in.)
Seat Studs-to-Outer Pivot Support Nut	
Split Seatback	27 N·m (20 lb. ft.)
Full Seatback	25 N·m (18 lb. ft.)
Rear Shoulder Strap Guide-to-Seatback Frame	10 N·m (89 lb. in.)
Seatback Lock-to-Seatback Frame Screw	27 N·m (20 lb. ft.)
Striker Bolt	50 N·m (37 lb. ft.)

SECTION 10-10

SAFETY BELTS

The following "Notice" applies to one or more steps in the assembly procedure of components in this portion of the manual as indicated at appropriate locations by the terminology: "NOTICE: See "Notice" on page 10-10-1 of this section."

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

CONTENTS

RESTRAINT SYSTEMS

CAUTION: Replace belts, retractors, and hardware in use during all but a minor collision. Also, restraint systems should be replaced and anchorages properly repaired if they were in areas damaged by a collision, whether the belt was in use or not. If there is any question, replace the belt system. Damage, whether visible or not, could result in serious personal injury in the event of an accident. In convertibles, the front seat lap-shoulder belt has a small loop of webbing lightly stitched into the belt under the sleeve next to the door sill. Within this loop is a "REPLACE BELT" label that is normally not visible. If the loop has been pulled out for any reason (making the "REPLACE BELT" label visible), the belt must be replaced to help restore optimum restraint system effectiveness in accidents. To determine if the loop has been pulled out, inspect the webbing between the lap-shoulder belt latch plate and the sleeve.

The restraint system includes front and rear shoulder belts. A dealer-installed child tether is available on all Canadian vehicles.

The driver's seat safety belt includes a reminder lamp and tone alarm to warn the driver that the safety belt is not buckled and the engine control switch is turned "ON." If the driver's seat safety belt is buckled, the tone alarm will not operate, but the reminder lamp will stay on for 4 to 8 seconds. If the driver's seat safety belt is not buckled, both the tone alarm and the reminder lamp will operate and stay on for 4 to 8 seconds. To diagnose a system failure for the tone alarm or reminder lamp, refer to ELECTRICAL DIAGNOSIS (SEC. 8A).

OPERATIONAL AND FUNCTIONAL CHECKS

Safety Belt Check

1. Remove the rear seat cushions. Refer to SEATS (SEC. 10-9).
2. Grasp the safety belt floor attachments both at the front and rear locations and manually check that the attachments are secure.
3. Install the rear seat cushions. Refer to SEATS (SEC. 10-9).
4. Open lap belt retractor cover doors and remove shoulder belt retractor escutcheons.
5. Check that the retractor attachments are secure.
6. Close lap belt retractor cover doors and install shoulder belt retractor escutcheons.
7. Visually check that the shoulder belt buckles face inboard and are accessible.
8. Fully extend the shoulder belt and visually check that no twists are in it and that it extends completely and easily.
9. Allow the shoulder belt to retract.
10. Snap latch into buckle.
11. Tug sharply on the buckle, checking that it remains locked.
12. Push button on buckle. The latch must release from the buckle easily and the button must return to its original position.

MANUAL SAFETY BELTS

The manual safety belts include both front and rear shoulder belt assemblies. The front shoulder belt assembly includes a retracting lap and retracting shoulder belt. The two belts are connected with a latch plate that connects to the buckle-side belt. On the hardtop, the rear shoulder belt assembly has a sliding latch plate and retracts at the shoulder. On the convertible, the rear shoulder belt assembly includes a retracting lap belt with a latch plate and a shoulder belt with a connector. The connector attaches to the latch plate. On both models, the latch plate connects to a buckle-side belt.

Safety belts are important to the safety of vehicle users. Special care must be taken when servicing the safety belts. Do not attempt to make repairs to individual parts of the safety belt assemblies. The entire assembly must be replaced with a new service replacement assembly.

Service Precautions

- Keep sharp edges and damaging objects away from safety belts.
- Avoid bending or damaging any part of the safety belt buckle or latch plate.
- Do not bleach or dye safety belt webbing. Clean only with a mild soap solution and water.

NOTICE: See "Notice" on page 10-10-1 of this section.

- Use correct safety belt anchor bolts and tighten to the correct torque values. Refer to "Specifications" in this section.

Inner Floor Attachments

Figures 1 and 2

Remove or Disconnect

1. Rear seat cushion for rear safety belt removal. Refer to SEATS (SEC. 10-9).
2. Plug (2) from front seat safety belt anchor bolt (3).
3. Anchor bolt (3).
4. Front seat safety belt (1) or rear seat safety belt (5) and bushing (4).

Install or Connect

NOTICE: See "Notice on page 10-10-1 of this section.

1. Front seat safety belt (1) or rear seat safety belt (5) and bushing (4).
2. Anchor bolt (3).

Tighten

- Anchor bolt (3) to 42 N·m (31 lb. ft.).

3. Plug (2).
4. Rear seat cushion. Refer to SEATS (SEC. 10-9).

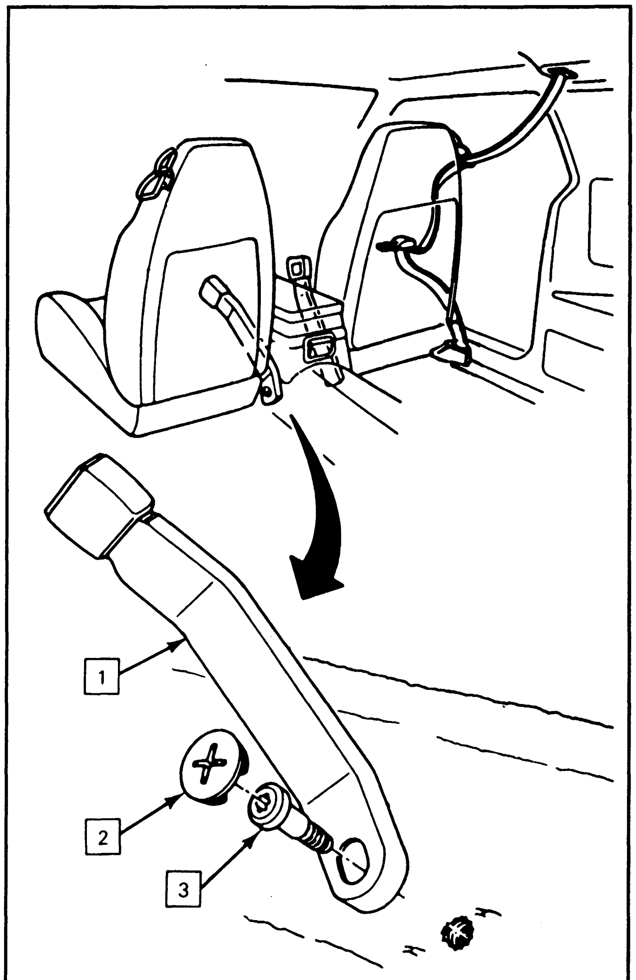


Figure 1 - Front Safety Belt Inner Floor Attachment

Retractor Side Safety Belts (Hardtop)

Figures 3 through 5

Front Seat

Remove or Disconnect

1. Electrical connector (6).
- Open retractor cover door.
2. Lap belt retractor anchor bolt (3).
3. Screws (9).
4. Shoulder strap guide (7).
5. Escutcheon (10) by unsnapping it from the headlining.
6. Coat hook screw.
7. Coat hook.
8. Windshield side upper molding, if without roof lift-off panels. Refer to ROOF AND CONVERTIBLE TOP (SEC. 10-8).
9. Clips on headlining from the roof panel.

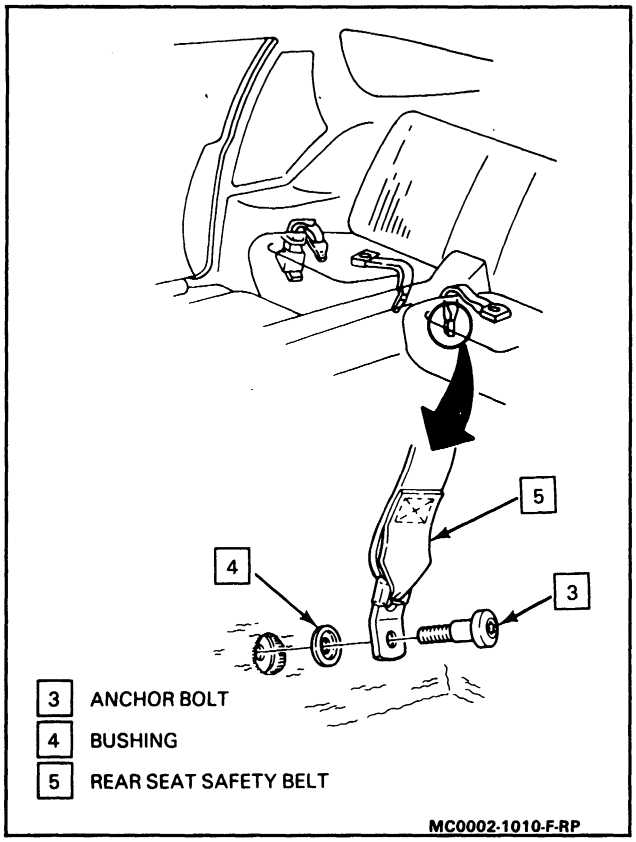


Figure 2 - Rear Safety Belt Inner Floor Attachment (Typical)

NOTICE: Pulling too hard on the formed headlining will cause damage.

- Carefully pull down on the headlining to reach the shoulder belt retractor anchor bolts (3).

CAUTION: Failure to support the shoulder belt retractor while removing the anchor bolts will allow the shoulder belt retractor to fall, causing damage to the vehicle and possible personal injury.

10. Shoulder belt retractor anchor bolts (3).
11. Shoulder belt retractor (11) from between the roof panel and the headlining.
12. Safety belt (8) with the shoulder belt retractor (11), shoulder strap guide (7) and lap belt retractor (12) attached.

Install or Connect

NOTICE: See "Notice" on page 10-10-1 of this section.

1. Safety belt (8) with the shoulder belt retractor (11), shoulder strap guide (7) and lap belt retractor (12) attached.
2. Shoulder belt retractor (11) to the roof panel.
3. Shoulder belt retractor anchor bolts.

Tighten

- Shoulder belt retractor anchor bolts (3) to 27 N·m (20 lb. ft.).

4. Clips on the headlining to the roof panel.
5. Windshield side upper molding, if without roof lift-off panels. Refer to ROOF AND CONVERTIBLE TOP (SEC. 10-8).
6. Coat Hook.
7. Coat hook screw.
8. Escutcheon (10).
9. Shoulder strap guide (7).
10. Screws (9).
11. Lap belt retractor anchor bolts (3).

Tighten

- Lap belt retractor anchor bolts (3) to 42 N·m (31 lb. ft.).

- Close retractor cover door.

12. Electrical connector (6).

Rear Seat

Remove or Disconnect

1. Rear seat cushion. Refer to SEATS (SEC. 10-9).
2. Lap belt anchor bolt (3).
3. Guide loop screws (15).
4. Guide loop (14) from seatback.
5. Guide screw (17).
6. Shoulder belt guide (16).
7. Safety belt (13) from shoulder belt guide (16).
8. Nut (19).
9. Safety belt (13) with retractor (18) and guide loop (14) attached.

Install or Connect

NOTICE: See "Notice" on Page 10-10-1 of this section.

1. Safety belt (13) with retractor (18) and guide loop (14) attached.
2. Nut (19).

Tighten

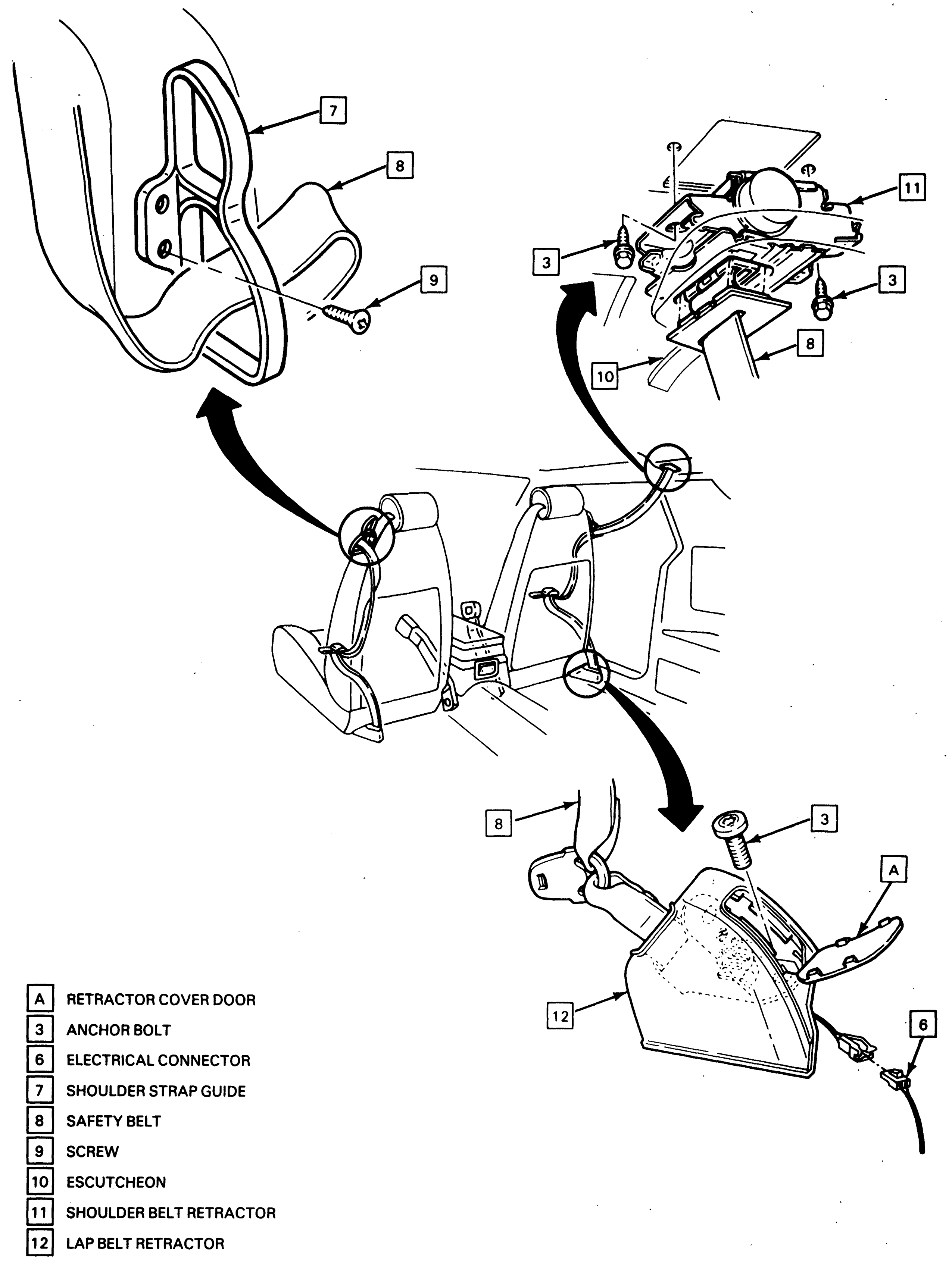
- Nut (19) to 42 N·m (31 lb. ft.).

3. Safety belt (13) through shoulder belt guide (16).
4. Shoulder belt guide (16).
5. Guide screw (17).
6. Guide loop (14) to seatback.
7. Guide loop screws (15).
8. Lap belt anchor bolt (3).

Tighten

- Lap belt anchor bolt (3) to 42 N·m (31 lb. ft.).

9. Rear seat cushion. Refer to SEATS (SEC. 10-9).



A	RETRACTOR COVER DOOR
3	ANCHOR BOLT
6	ELECTRICAL CONNECTOR
7	SHOULDER STRAP GUIDE
8	SAFETY BELT
9	SCREW
10	ESCUTCHEON
11	SHOULDER BELT RETRACTOR
12	LAP BELT RETRACTOR

Figure 3 - Front Seat Retractor Side Safety Belt (Hardtop)

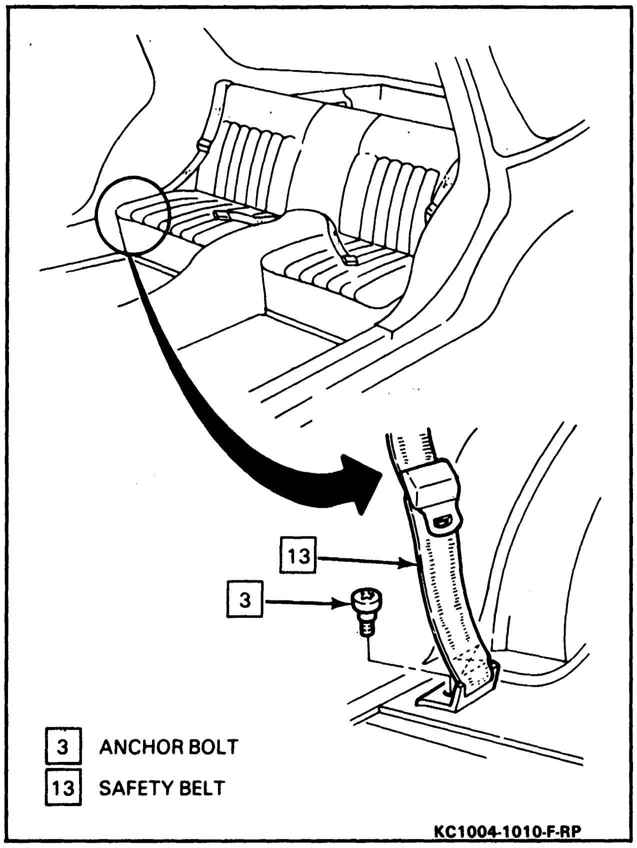


Figure 4 - Rear Seat Retractor Side Safety Belt Lower Attachment (Hardtop)

Retractor Side Safety Belts (Convertible)

Figures 6 and 7

Front Seats

Remove or Disconnect

1. Quarter trim panel. Refer to REAR QUARTERS (SEC. 10-6).
2. Shoulder belt retractor anchor bolt (3).
3. "D" ring bolt (20).
4. Electrical connector (4) on driver's seat.
- Open retractor cover door.
5. Lap belt retractor anchor bolt (3).
6. Safety belt (22) with shoulder belt retractor (23), "D" ring (21) and lap belt retractor (24) attached.

Install or Connect

NOTICE: See "Notice" on page 10-10-1 of this section.

1. Safety belt (22) with shoulder belt retractor (23), "D" ring (21) and lap belt retractor (24) attached.
2. Lap belt retractor anchor bolt (3).

Tighten

- Lap belt retractor anchor bolt (3) to 42 N·m (31 lb. ft.).

- Close retractor cover door.

3. Electrical connector (4) on driver's seat.
4. "D" ring bolt (20).

Tighten

- "D" ring bolt (20) to 42 N·m (31 lb. ft.).

5. Shoulder belt retractor anchor bolt (3).

Tighten

- Shoulder belt retractor anchor bolt (3) to 42 N·m (31 lb. ft.).

6. Quarter trim panel. Refer to REAR QUARTERS (SEC. 10-6).

Rear Seat Lap Belt

Figure 7

Remove or Disconnect

1. Rear Seat Cushion. Refer to SEATS (SEC. 10-9).
2. Lap belt bezel (32) by unsnapping it from the quarter trim panel.
3. Lap belt retractor anchor bolt (3).
4. Lap belt (31) with lap belt retractor (33) and lap belt bezel (32) attached.

Install or Connect

NOTICE: See "Notice" on page 10-10-1 of this section.

1. Lap belt (31) with lap belt retractor (33) and lap belt bezel (32) attached.
2. Lap belt retractor bolt (3).

Tighten

- Lap belt retractor bolt (3) to 42 N·m (31 lb. ft.).

3. Lap belt bezel (32) to quarter trim panel.
4. Rear seat cushion. Refer to SEATS (SEC. 10-9)

Rear Seat Shoulder Belt

Figure 7

Remove or Disconnect

1. Bezel screws (30).
2. Shoulder belt bezel (29) from tonneau panel (25).
- Raise tonneau panel (25).
3. Retractor cover (27) by unsnapping it from the shoulder belt retractor (28).

CAUTION: Failure to support the shoulder belt retractor while removing the anchor bolts will allow the shoulder belt retractor to fall, causing damage to the vehicle and possible personal injury.

4. Shoulder belt retractor anchor bolts (3).
5. Shoulder belt (26) with shoulder belt retractor (28) and shoulder belt bezel (29) attached.

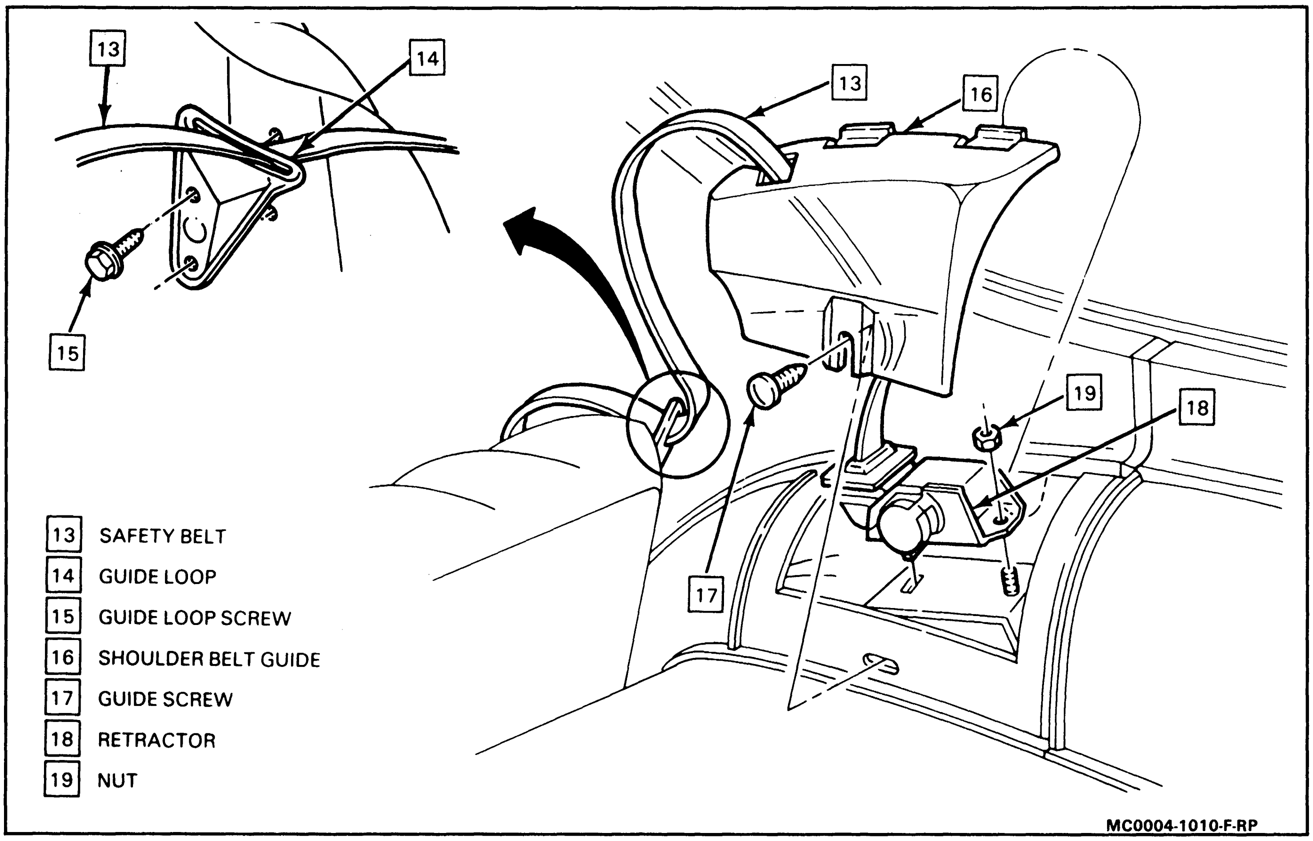


Figure 5 - Rear Seat Shoulder Belt Retractor (Hardtop)

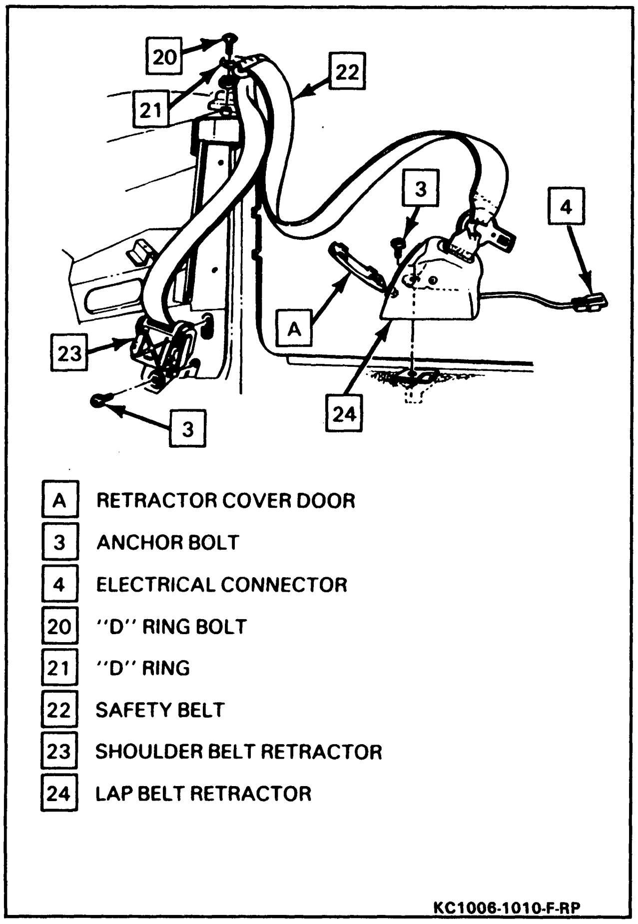


Figure 6 - Front Seat Retractor Side Safety Belt (Convertible)

Install or Connect

NOTICE: See "Notice" on page 10-10-1 of this section.

1. Shoulder belt (26), with shoulder belt retractor (28) and shoulder belt bezel (29) attached, to the tonneau panel (25).
2. Shoulder belt retractor anchor bolts (3).

Tighten

- Shoulder belt retractor anchor bolts to 29 N·m (21 lb. ft.).

3. Retractor cover (27).

- Lower tonneau panel (25).

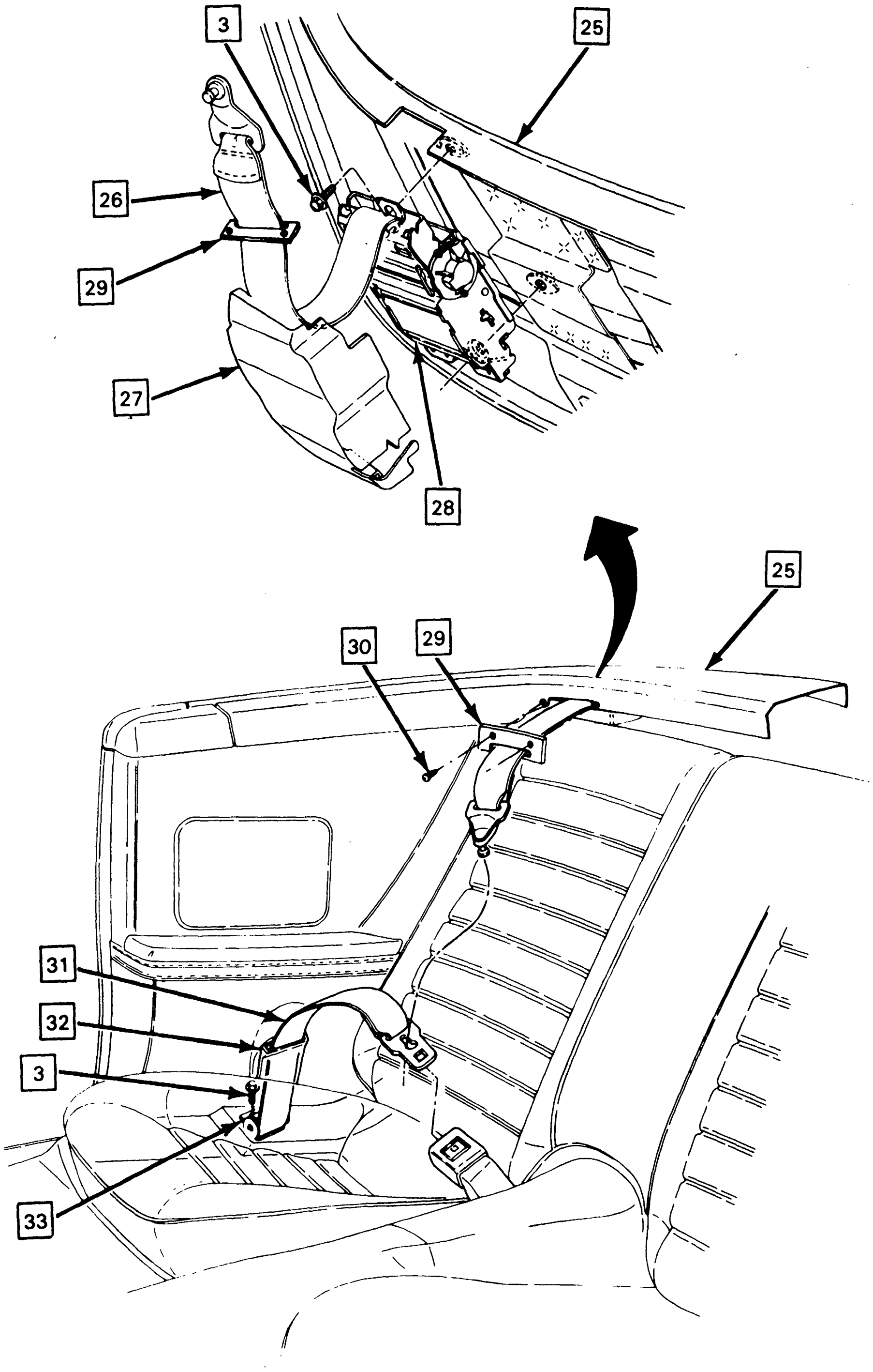
4. Shoulder belt bezel (29) to tonneau panel (25).
5. Bezel screws (30).

CHILD SEAT

Figure 8

All Canadian hardtop vehicles are equipped with child seat tether retainers. The retainers are attached to a bracket on the rear end body panel. If either retainer becomes damaged, it must be replaced.

CAUTION: A child seat with a top strap should not be used in the rear seat of the convertible. No provisions are made for the top strap, and damage to the vehicle and injury to the child and other passengers could result.



3	ANCHOR BOLT	29	SHOULDER BELT BEZEL
25	TONNEAU PANEL	30	BEZEL SCREW
26	SHOULDER BELT	31	LAP BELT
27	RETRACTOR COVER	32	LAP BELT BEZEL
28	SHOULDER BELT RETRACTOR	33	LAP BELT RETRACTOR

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Figure 7 - Rear Seat Retractor Side Safety Belts (Convertible)

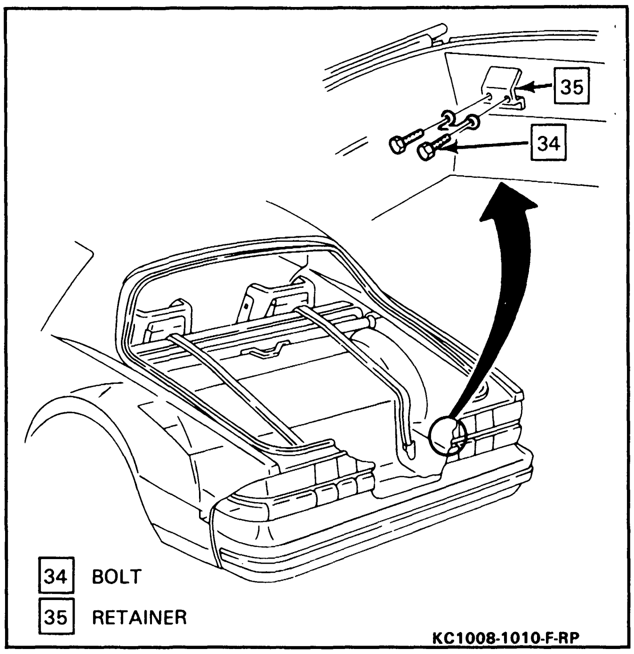

Figure 8 - Child Seat Tether Retainer

Remove or Disconnect

1. Bolts (34).
2. Retainer (35).

Install or Connect

NOTICE: See "Notice" on page 10-10-1 of this section.

1. Retainer (35).
2. Bolts (34).

Tighten

- Bolts (34) to 9 N·m (80 lb. in.).

SPECIFICATIONS

FASTENER TORQUE SPECIFICATIONS

Safety Belt-to-Floor Pan Bolt	42 N·m (31 lb. ft.)
Front Shoulder Belt Retractor-to-Roof Panel Bolt (Hardtop)	27 N·m (20 lb. ft.)
Front Lap Belt Retractor-to-Floor Pan Bolt (Hardtop)	42 N·m (31 lb. ft.)
Rear Shoulder Belt Retractor-to-Wheelhouse Panel Nut	42 N·m (31 lb. ft.)
Rear Lap Belt Plate-to-Floor Pan Bolt	42 N·m (31 lb. ft.)
Front Lap Belt Retractor-to-Pillar Panel Bolt (Convertible)	42 N·m (31lb. ft.)
Front "D" Ring-to-Pillar Panel Bolt (Convertible)	42 N·m (31 lb. ft.)
Front Shoulder Belt Retractor-to-Floor Pan Bolt (Convertible)	42 N·m (31lb. ft.)
Rear Shoulder Belt Retractor-to-Tonneau Panel Bolt	29 N·m (21 lb. ft.)
Rear Lap Belt Retractor-to-Quarter Body Panel Bolt	42 N·m (31 lb. ft.)
Child Seat Tether Retainer-to-Rear End Body Panel Bolt	9 N·m (80 lb. in.)