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8.1L

ENGINE SERVICE MANUAL



17506 Marine Power Industrial Park
Ponchatoula, LA 70454

Parts Direct Line: (504) 386-3571 or (877) 388-9555

Parts Direct Fax: (504) 386-0076

General Description

Visual / Physical Inspection

A careful visual and physical inspection must be performed as part of any diagnostic procedure. This can often lead to fixing a problem without further diagnostics.

Inspect all vacuum hoses for correct routing, pinches, cracks or disconnects. Be sure to inspect hoses that are difficult to see. Inspect all the wires in the engine compartment for proper connections, burned or chafed spots, pinched wires or contact with sharp edges or hot 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. You should be familiar with wiring diagrams, the meaning of voltage, ohms, amps and the basic theories of electricity. You should also understand what happens if a circuit becomes open, shorted to ground or shorted to voltage.

To perform system diagnostics, several special tools and equipment are required. Please become acquainted with the tools and their use before attempting to diagnose the system. Special tools that are required for system service are illustrated in 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 feel the zap of a static discharge.

There are several ways a person can 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 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.

Engine Wiring

When it is necessary to move any of the wiring, whether to lift wires away from their harnesses or move harnesses to reach some component, take care that all wiring is replaced in its original position and all harnesses are routed correctly. If clips or retainers break, replace them. Electrical problems can result from wiring or harnesses becoming loose and moving from their original positions, or from being rerouted.

Engine Control Module (ECM) Self-Diagnostics

The Engine Control Module (ECM) performs a continuous 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 (DTC's). The DTC's are two digit numbers that can range from 12 to 81. When a malfunction is detected by the ECM, a DTC is set and the Malfunction Indicator Lamp (MIL) is illuminated.

Malfunction Indicator Lamp (MIL)

The Malfunction Indicator Lamp (MIL) is part of the Diagnostic Trouble Code (DTC) tool, or it can be a dash mounted warning light on some applications.

- If present, it informs the operator that a problem has occurred and that the boat should be taken for service as soon as reasonably possible.
- It displays DTC's stored by the ECM which help the technician diagnose system problems.

As a bulb and system check, the light will come "ON" with the key "ON," engine "OFF." 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 DTC 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 drivability problem, the "On-Board Diagnostic (OBD) System Check" must be performed as the first step. These checks will expose malfunctions which may not be detected if other diagnostics are performed prematurely.

Intermittent Malfunction Indicator Lamp (MIL)

In the case of an "intermittent" problem, the Malfunction Indicator Lamp (MIL) may light for 10 seconds, and then go out. However, the corresponding DTC will be stored in the memory of the ECM. When DTC's are set by an intermittent malfunction, they could be helpful in diagnosing the system.

If an intermittent DTC is cleared, it may or may not reset. If it is an intermittent failure, consult the "Diagnostic Aids" on the facing page of the corresponding DTC table. *Symptoms* section also covers the topic of "Intermittents." A physical inspection of the applicable sub-system most often will resolve the problem.

Reading Diagnostic Trouble Codes (DTC's)

The provision for communicating with the ECM is the Data Link Connector (DLC) (Figure 1-1). It is part of the engine wiring harness, and is a 10-pin connector, which is electrically connected to the ECM. It is used in the assembly plant to receive information in checking that the engine is operating properly before it leaves the plant. The DTC(s) stored in the ECM's memory can be retrieved two different ways. One way is with a Diagnostic Trouble Code (DTC) tool. The preferred way is through a scan tool, a hand-held diagnostic scanner plugged into the DLC.

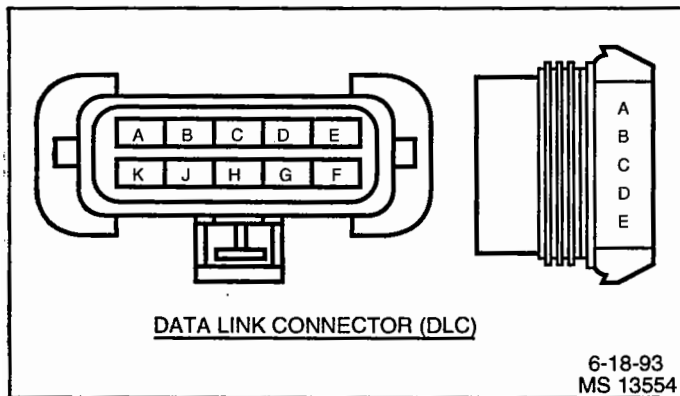


Figure 1-1 - Data Link Connector (DLC)

Once the DTC tool has been connected, and "service mode" or "ON" selected, the ignition switch must be moved to the ignition "ON," engine "OFF" position. At this point, the MIL should flash DTC 12 two times consecutively. This would be the following flash sequence: "flash, pause, flash-flash, long pause, flash, pause, flash-flash." DTC 12 indicates that the ECM's diagnostic system is operating. If DTC 12 is not indicated, a problem is present within the diagnostic system itself, and should be addressed by consulting the "On-Board Diagnostic (OBD) System Check."

Following the output of DTC 12, the MIL will indicate a DTC two times if a DTC is present, or it will continue to flash DTC 12. If more than one DTC has been stored in the ECM's memory, the DTC's will be flashed out from the lowest to the highest, with each DTC being flashed two times. At the end of the DTC's, the ECM will simply go back and start over with flashing DTC 12.

Service Mode

MEFI 4

When the DTC tool is installed at the DLC and "service mode" or "ON" is selected, the system will enter what is called the "Service Mode." In this mode, the ECM will:

- Display a DTC 12 by flashing the MIL, indicating that the diagnostic system is working.
- Display any stored DTC's by flashing the MIL. Each DTC will be flashed two times, then DTC 12 will be flashed again.
- The ignition timing is controlled to a fixed timing degree programmed in the ECM. This will allow base timing to be adjusted on distributor ignition engines.
- Control the Idle Air Control (IAC) valve to maintain approximately 1000 RPM.

Normal Mode

When the DTC tool is in the "normal mode" or "OFF," it has no affect on the engine operation.

On-Board Diagnostic (OBD) System Check

After the visual/physical inspection, the "On-Board Diagnostic (OBD) System Check" is the starting point for all diagnostic procedures.

The correct procedure to diagnose a problem is to follow two basic steps:

1. Are the on-board diagnostics working? This is determined by performing the "On-Board Diagnostic (OBD) System Check." Since this is the starting point for the diagnostic procedures, always begin here. If the on-board diagnostics are not working, the OBD system check will lead to a diagnostic table to correct the problem. If the on-board diagnostics are working properly, the next step is:
2. Is there a DTC stored? If a DTC is stored, go directly to the number DTC table. This will determine if the fault is still present.

DLC Scan Tools

The ECM can communicate a variety of information through the DLC. This data is transmitted at a high frequency which requires a scan tool for interpretation.

With an understanding of the data which the scan tool displays, and knowledge of the circuits involved, the scan tool can be very useful in obtaining information which would be more difficult or impossible to obtain with other equipment.

A scan tool does not make the use of diagnostic tables unnecessary, nor do they indicate exactly where the problem is in a particular circuit. Tables are provided for the use of a scan tool (scan diagnostics), or with the DTC tool (non-scan diagnostics). The non-scan diagnostics are limited to basic circuits. For complete diagnostics, a scan tool must be used.

Scan Tool Use With Intermittents

The scan tool provides the ability to perform a "wiggle test" on wiring harnesses or components with the engine not running, while observing the scan tool display.

The scan tool can be plugged in and observed while driving the vehicle under the condition when the MIL turns "ON" or the engine drivability is poor. If the problem seems to be related to certain parameters that can be checked on the scan tool, 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 scan tool can be checked on each position, watching for a period of time to see if there is any change in the readings that indicates an intermittent operation.

The scan tool 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 DTC. Comparing the sensor's readings with those of a known good identical vehicle may uncover the problem.

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 technicians ability to understand the system they are trying to diagnose, as well as an understanding of the scan tool operation and limitations. The technician should read the tool manufacturer's operating manual to become familiar with the tool's operation.

How Diagnostic Trouble Codes (DTC) Are Set

The ECM is programmed to receive calibrated voltage signals from the sensors. The voltage signal from the sensor may range from as low as 0.1 volt to as high as 4.9 volts. The sensor voltage signal is calibrated for engine application. This would be the sensor's operating parameter or "window." The ECM and sensors will be discussed further in the *ECM and Sensor* section.

If a sensor is within its operating or acceptable parameters (Figure 1-2), the ECM does not detect a problem. When a sensor voltage signal falls out of this "window," the ECM no longer receives a signal voltage within the operating "window." When the ECM does not receive the "window" voltage for a calibratable length of time, a DTC will be stored. The MIL will be illuminated and a known default value will replace the sensor value to restore limited engine performance.

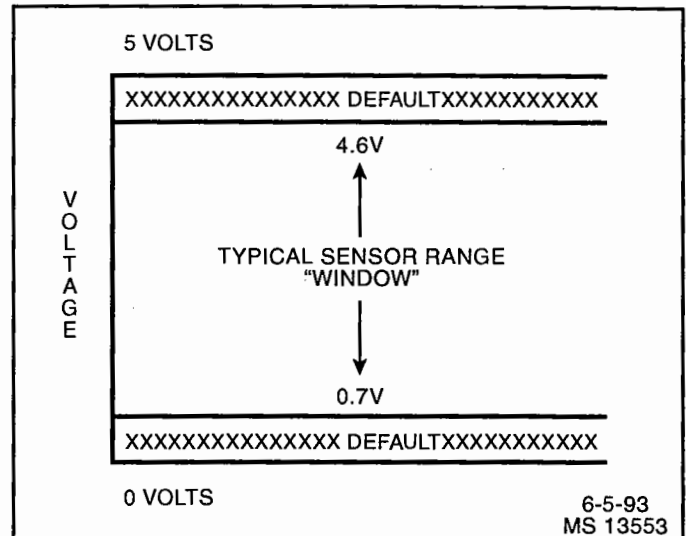


Figure 1-2 - Example of Sensor Normal Operation

Clearing Diagnostic Trouble Codes (Non-Scan)

1. Install Diagnostic Trouble Code (DTC) tool.
2. Ignition "ON," engine "OFF."
3. Switch DTC tool to "service mode" or "ON."
4. Move the throttle from 0% (idle) to 100% (WOT) and back to 0%.
5. Switch DTC tool to "normal mode" or "OFF." (If this step is not performed, the engine may not start and run).
6. Turn ignition "OFF" for at least 20 seconds.
7. Ignition "ON," engine "OFF."
8. Switch DTC tool to "service mode" or "ON" and verify DTC 12 only. Remove DTC tool.
9. If original DTC(s) are still present, check "Notice" below and repeat the DTC clearing procedure.
10. If new DTC(s) are displayed, perform the OBD system check.

NOTICE: When clearing DTC's with or without the use of a scan tool, the ignition must be cycled to the "OFF" position after codes are cleared or the DTC's will not clear.

Clearing Diagnostic Trouble Codes (Scan)

1. Install scan tool.
2. Start engine.
3. Select "clear DTC's" function.
4. Clear DTC's.
5. Turn ignition "OFF" for at least 20 seconds.
6. Turn ignition "ON" and read DTC's. If DTC's are still present, check "Notice" below and repeat procedure following from step 2.

NOTICE: When clearing DTC's with or without the use of a scan tool, the ignition must be cycled to the "OFF" position after codes are cleared or the DTC's will not clear.

Non-Scan Diagnosis Of Drivability Concerns (No DTC's Set)

If a drivability concern still exists after following the OBD system check and reviewing the Symptoms tables, an out of range sensor may be suspected. Because of the unique design of the MEFI system, the ECM will replace sensed values with calibrated default values in the case of a sensor or circuit malfunction. By allowing this to occur, limited engine performance is restored until the vehicle is repaired. A basic understanding of sensor operation is necessary to be able to diagnose an out of range sensor.

If the sensor is out of range, but still within the operating "window" of the ECM, the problem will go undetected by the ECM and may result in a drivability concern.

A good example of this would be if the coolant sensor was reading incorrectly and indicating to the ECM that coolant temperature was at 50°F, but actual coolant temperature was at 150°F (Figure 1-3). This would cause the ECM to deliver more fuel than what was actually needed by the engine. This resulted in an overly rich condition, causing rough running. This condition would not have caused a DTC to set, as the ECM interprets this as within the operating "window."

To identify a sensor that is out of range, you may unplug the sensor electrical connector while the engine is running. After about 2 minutes, the DTC for that sensor will set, illuminate the MIL, and replace the sensed value with a calibrated default value. If at that point, a noticeable performance increase is observed, the non-scan DTC table for that particular sensor should be followed to correct the problem.

NOTICE: Be sure to clear each DTC after disconnecting and reconnecting each sensor. Failure to do so may result in a misdiagnosis of the drivability concern.

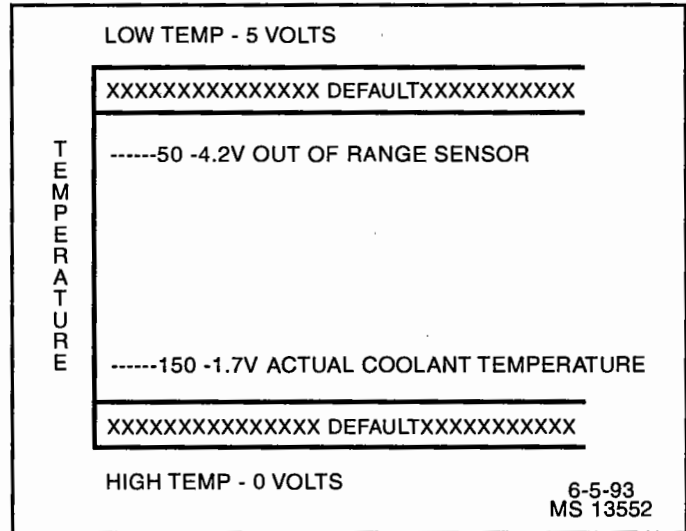


Figure 1-3 - Example of Shifted Sensor Operation

Service Precautions

The following requirements must be observed when working on MEFI equipped engines.

1. Before removing any ECM system component, disconnect the negative battery cable.
2. Never start the engine without the battery being solidly connected.
3. Never separate the battery from the on-board electrical system while the engine is running.
4. Never separate the battery feed wire from the charging system while the engine is running.
5. When charging the battery, disconnect it from the vehicle's electrical system.
6. Ensure that all cable harnesses are connected solidly and the battery connections are thoroughly clean.
7. Never connect or disconnect the wiring harness at the ECM when the ignition is switched "ON."
8. Before attempting any electric arc welding on the vehicle, disconnect the battery leads and the ECM connector(s).
9. When steam cleaning engines, do not direct the nozzle at any ECM system components. If this happens, corrosion of the terminals or damage of components can take place.
10. Use only the test equipment specified in the diagnostic tables, since other test equipment may either give incorrect test results or damage good components.
11. All measurements using a multimeter must use a digital meter with a rating of 10 megaohm input impedance.
12. When a test light is specified, a "low-power" test light must be used. Do not use a high-wattage test light. While a particular brand of test light is not suggested, a simple test on any test light will ensure it to be safe for system circuit testing (Figure 1-4). Connect an accurate ammeter (such as the high-impedance digital multimeter) in series with the test light being tested, and power the test light ammeter circuit with the vehicle battery.

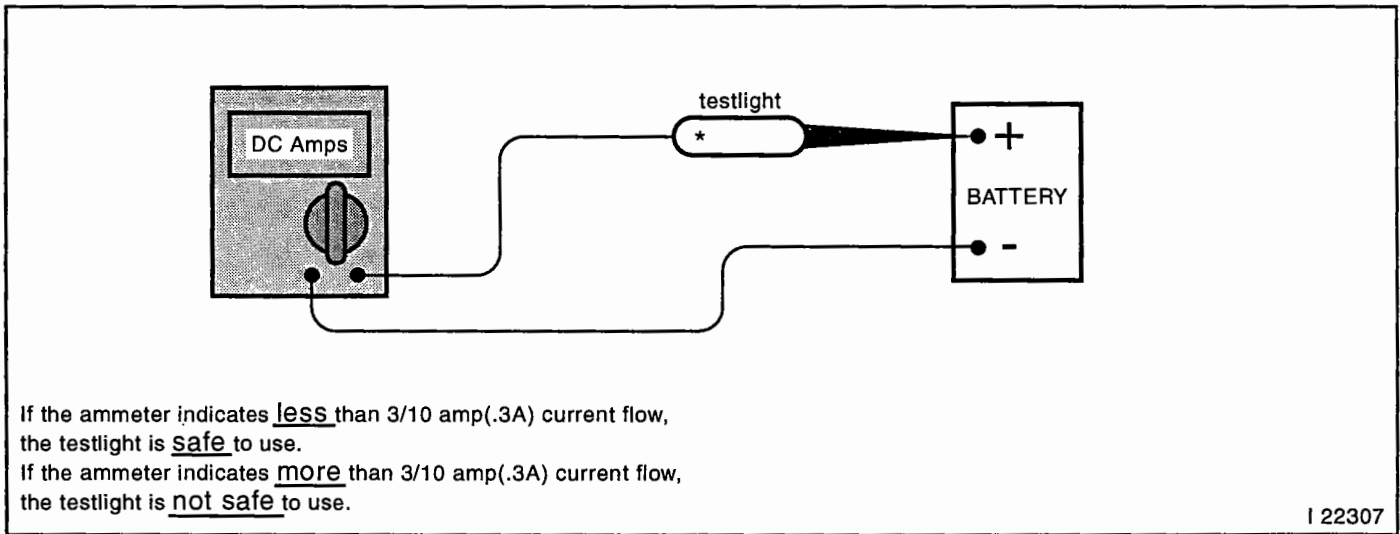


Figure 1-4 - Test Light Amperage Draw Test

Tools Needed To Service The System

Refer to *Special Tools* in this section for engine control tools for servicing the system.

Abbreviations

BARO	-	BAROMETRIC PRESSURE	INJ	-	INJECTOR
BAT	-	BATTERY, BATTERY POSITIVE TERMINAL, BATTERY OR SYSTEM VOLTAGE	I/O	-	INPUT/OUTPUT
B+	-	BATTERY POSITIVE	kPa	-	KILOPASCAL
CEFI	-	COMMERCIAL ELECTRONIC FUEL INJECTION	KS	-	KNOCK SENSOR
CKT	-	CIRCUIT	KV	-	KILOVOLTS
CONN	-	CONNECTOR	MAP	-	MANIFOLD ABSOLUTE PRESSURE
CYL	-	CYLINDER	MFI	-	MULTIPOINT FUEL INJECTION
DEG	-	DEGREES	MIL	-	MALFUNCTION INDICATOR LAMP
DI	-	DISTRIBUTOR IGNITION	MSEC	-	MILLSECOND
DIAG	-	DIAGNOSTIC	N/C	-	NORMALLY CLOSED
DIST	-	DISTRIBUTOR	N/O	-	NORMALLY OPEN
DLC	-	DATA LINK CONNECTOR	OBD	-	ON-BOARD DIAGNOSTIC
DTC	-	DIAGNOSTIC TROUBLE CODE	OPT	-	OPTIONAL
DVOM	-	DIGITAL VOLT OHMMETER	PFI	-	PORT FUEL INJECTION
ECM	-	ENGINE CONTROL MODULE	PWM	-	PULSE WIDTH MODULATION
ECT	-	ENGINE COOLANT TEMPERATURE	RAM	-	RANDOM ACCESS MEMORY
EEPROM-	-	ELECTRONIC ERASABLE PROGRAMMABLE READ ONLY MEMORY	REF HI	-	REFERENCE HIGH
EI	-	ELECTRONIC IGNITION	REF LO-	-	REFERENCE LOW
EMI	-	ELECTROMAGNETIC INTER- FERENCE	ROM	-	READ ONLY MEMORY
ENG	-	ENGINE	SLV	-	SLAVE
E-STOP-	-	EMERGENCY STOP	SW	-	SWITCH
GND	-	GROUND	TACH	-	TACHOMETER
GOV	-	GOVERNOR	TBI	-	THROTTLE BODY INJECTION
GPH	-	GALLONS PER HOUR	TERM	-	TERMINAL
HO ₂	-	HEATED OXYGEN SENSOR	TP	-	THROTTLE POSITION
IAC	-	IDLE AIR CONTROL	V	-	VOLTS
IAT	-	INTAKE AIR TEMPERATURE	VAC	-	VACUUM
IC	-	IGNITION CONTROL	VSS	-	VEHICLE SPEED SENSOR
IGN	-	IGNITION	WOT	-	WIDE OPEN THROTTLE
			" HG	-	INCHES OF MERCURY

Diagnosis

The diagnostic tables and functional checks in this manual are designed to locate a faulty circuit or component through logic based on the process of elimination. The tables are prepared with the requirement that the system functioned correctly at the time of assembly and that there are no multiple failures.

Engine control circuits contain many special design features not found in standard vehicle wiring. Environmental protection is used extensively to protect electrical contacts. Proper splicing methods must be used when necessary.

The proper operation of low amperage input/output circuits depend upon good continuity between circuit connectors. It is important before component replacement and/or during normal troubleshooting procedures that a visual inspection of any questionable mating connector is performed. Mating surfaces should be properly formed, clean and likely to make proper contact. Some typical causes of connector problems are listed below:

- Improperly formed contacts and/or connector housing.
- Damaged contacts or housing due to improper engagement.
- Corrosion, sealer or other contaminants on the contact mating surfaces.
- Incomplete mating of the connector halves during initial assembly or during subsequent troubleshooting procedures.

- Tendency for connectors to come apart due to vibration and/or temperature cycling.
- Terminals not fully seated in the connector body.
- Inadequate terminal crimps to the wire.

Engine Controls - 8.1L

Specifications

Temperature vs. Resistance

°C	°F	OHMS
Temperature vs Resistance Values (Approximate)		
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

Temperature vs. Resistance (cont'd)

°C	°F	OHMS
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

Ignition System Specifications

Application	Specifications	
	Metric	English
Firing Order	1-8-7-2-6-5-4-3	
Spark Plug Wire Resistance	10,000 ohms per foot	
Spark Plug Torque	15 N·m	11 lb ft
Spark Plug Gap	1.52 mm	.060 in
Spark Plug Type	TJ14R-P15 (Denso plug type)	

Fastener Tightening Specifications

Application	Specifications	
	Metric	English
Camshaft Position (CMP) Sensor Bolt	25 N·m	18 lb ft
Crankshaft Position (CKP) Sensor Bolt	25 N·m	18 lb ft
Engine Control Module (ECM) Mounting Screws	10-14 N·m	88-124 lb in
Engine Coolant Temperature (ECT) Sensor	17 N·m	13 lb ft
Engine Sight Shield Bolts	10 N·m	89 lb in
Engine Sight Shield Bracket Bolts	10 N·m	89 lb in
Fuel Filter Fitting	30 N·m	22 lb ft
Fuel Rail Attaching Bolts	10 N·m	89 lb in
Idle Air Control (IAC) Valve Attaching Screws		
Ignition Coil Attaching Bolts	12 N·m	106 lb in
Knock Sensor (KS)	20 N·m	15 lb ft
Throttle Body Attaching Bolts	10 N·m	88.5 lb in
Throttle Position (TP) Sensor Attaching Screws		

Engine Scan Tool Data List

The Engine Scan Tool Data List contains all engine related parameters that are available on the scan tool. Use the Engine Scan Tool Data List only after the following is determined:

- On-Board Diagnostic System Check is completed.
- No Diagnostic Trouble Codes (DTCs).
- On-board diagnostics are functioning properly.

Scan tool values from a properly running engine may be used for comparison with the engine you are diagnosing. The Engine Scan Tool Data List represents values that would be seen on a normal running engine.

Important: A scan tool that displays faulty data should not be used. The scan tool problem should be reported to the manufacturer. Use of a faulty scan tool can result in misdiagnosis and unnecessary parts replacement.

Only the parameters listed below are referenced in this service manual for use in diagnosis. If all values are within the typical range described below, refer to *Symptoms* for diagnosis.

Engine Scan Tool Data List - Standard

Scan Tool Parameter	Units	Parameter Range
Calibration ID	Numeric	0-255. Identification number assigned to a specific calibration.
Calibration Checksum	Numeric	0-65535
Engine Speed	RPM	0-6000
Desired Idle	RPM	0-1600
ECT	°C, °F	-40°C - 151°C , -40°F - 304°F
IAT	°C, °F	-40°C - 151°C , -40°F - 304°F
MAP	kPa / Volts	8 - 207 kPa, 0.00 - 4.98 volts
Baro	kPa / Volts	8 - 207 kPa, 0.00 - 4.98 volts
TP Sensor	Volts	0.00 - 4.98 volts
Throttle Angle	Percent	0 - 100%
Injector A Pulse Width	Milliseconds	0.0 - 500 ms
Injector B Pulse Width	Milliseconds	0.0 - 500 ms
Spark Advance	Degrees	-20° - 69.6484°
Cam Retard	Degrees	0° - 90°
Knock Retard	Degrees	0° - 89.6484°
KS System Enabled	Yes / No	Yes / No
Knock Signal	Yes / No	Yes / No
IAC Position	Counts	0 - 255 Counts
IAC Throttle Follower	Counts	0 - 255 Counts
Closed Throttle	Yes / No	Yes / No
Vessel Speed	MPH	0 - 255 mph
Battery / Ignition Voltage	Volts	0.0 - 25.5 Volts
System Voltage Warning	Discrete	OK / Low Voltage
J1-20 Input	Discrete	On / Off
J2-21 Input	Discrete	On / Off
Emergency Stop Mode	Discrete	On / Off
Troll RPM Limit	Discrete	On / Off
Malfunction Indicator Lamp	Discrete	On / Off
Fuel Pump Relay	Discrete	On / Off
Cause Power Reduction	Discrete	On / Off
Power Reduction	Discrete	Yes / No
Overheat Detection	Discrete	Yes / No

Engine Scan Tool Data List - Standard (cont'd)

Scan Tool Parameter	Units	Parameter Range
Oil Pressure Input	Discrete	OK / Low Press
J1-9 Output	Discrete	On / Off
Oil Level Input	Discrete	OK / Low
Low Oil Level Lamp	Discrete	On / Off
Buzzer	Discrete	On / Off
J1-19 Input	Discrete	On / Off
J1-22 Output	Discrete	On / Off
J1-4 Input	Discrete	On / Off
J1-23 Output	Discrete	On / Off
Master / Slave	Discrete	Master / Slave
J1-7 RPM Output	Discrete	On / Off
Time From Start	Hours:Minutes:Seconds	00:00:00 - 18:12:15
Engine Hour Meter	Hours	0.0 - 1193046,47 hours
Fuel Consumption	Gallons per Hour	0.0 - 255 gph

Engine Scan Tool Data List - Governor

Scan Tool Parameter	Units	Parameter Range
Calibration ID	Numeric	0-255. Identification number assigned to a specific calibration.
Calibration Checksum	Numeric	0-65535
Engine Speed	RPM	0-6000
Desired Idle	RPM	0-1600
ECT	°C, °F	-40°C - 151°C , -40°F - 304°F
IAT	°C, °F	-40°C - 151°C , -40°F - 304°F
MAP	kPa / Volts	8 - 207 kPa, 0.00 - 4.98 volts
Baro	kPa / Volts	8 - 207 kPa, 0.00 - 4.98 volts
TP Sensor Position	Volts	0.00 - 4.98 volts
Throttle Angle	Percent	0 - 100%
Injector A Pulse Width	Milliseconds	0.0 - 500 ms
Injector B Pulse Width	Milliseconds	0.0 - 500 ms
Spark Advance	Degrees	-20° - 69.6484°
Cam Retard	Degrees	0° - 90°
Knock Retard	Degrees	0° - 89.6484°
KS System Enabled	Yes / No	Yes / No
Knock Signal	Yes / No	Yes / No
IAC Position	Counts	0 - 255 Counts
IAC Throttle Follower	Counts	0 - 255 Counts
Closed Throttle	Yes / No	Yes / No
Vessel Speed	MPH	0 - 255 mph
Battery / Ignition Voltage	Volts	0.0 - 25.5 Volts
System Voltage Warning	Discrete	OK / Low Voltage
J1-20 Input	Discrete	On / Off
J2-21 Input	Discrete	On / Off
Emergency Stop Mode	Discrete	On / Off
Troll RPM Limit	Discrete	On / Off
Malfunction Indicator Lamp	Discrete	On / Off
Fuel Pump Relay	Discrete	On / Off
Cause Power Reduction	Discrete	On / Off
Power Reduction	Discrete	Yes / No
Overheat Detection	Discrete	Yes / No
Oil Pressure Input	Discrete	OK / Low Press
J1-9 Output	Discrete	On / Off
Oil Level Input	Discrete	OK / Low
Low Oil Level Lamp	Discrete	On / Off
Buzzer	Discrete	On / Off
J1-19 Input	Discrete	On / Off
J1-22 Output	Discrete	On / Off
J1-4 Input	Discrete	On / Off
J1-23 Output	Discrete	On / Off
Master / Slave	Discrete	Master / Slave
J1-7 RPM Output	Discrete	On / Off
Time From Start	Hours:Minutes:Seconds	00:00:00 - 18:12:15

Engine Scan Tool Data List - Governor (cont'd)

Scan Tool Parameter	Units	Parameter Range
Engine Hour Meter	Hours	0.0 - 1193046.47 hours
RPM Control	Discrete	Yes / No
Over RPM Lamp	Discrete	On / Off
MPH Control	Discrete	Yes / No
Over MPH	Discrete	Yes / No
Desired Throttle	Percent	0 - 100%
Governor Duty Cycle	Percent	0 - 100%

Engine Scan Tool Data List - Oxygen (O₂) Sensor

Scan Tool Parameter	Units	Parameter Range
Calibration ID	Numeric	0-255. Identification number assigned to a specific calibration.
Calibration Checksum	Numeric	0-65535
Engine Speed	RPM	0-6000
Desired Idle	RPM	0-1600
ECT	°C, °F	-40°C - 151°C , -40°F - 304°F
IAT	°C, °F	-40°C - 151°C , -40°F - 304°F
MAP	kPa / Volts	8 - 207 kPa, 0.00 - 4.98 volts
Baro	kPa / Volts	8 - 207 kPa, 0.00 - 4.98 volts
Oil Pressure / Catalyst Temp	Volts	0 - 5 volts
TP Sensor Position	Volts	0.00 - 4.98 volts
Throttle Angle	Percent	0 - 100%
Fuel Consumption	Gallons per Hour	0.0 - 255 gph
Injector A Pulse Width	Milliseconds	0.0 - 500 ms
Injector B Pulse Width	Milliseconds	0.0 - 500 ms
Spark Advance	Degrees	-20° - 69.6484°
Knock Retard	Degrees	0° - 89.6484°
KS System Enabled	Yes / No	Yes / No
Knock Signal	Yes / No	Yes / No
IAC Position	Counts	0 - 255 Counts
IAC Throttle Follower	Counts	0 - 255 Counts
Closed Throttle	Yes / No	Yes / No
Vessel Speed	MPH	0 - 255 mph
Battery / Ignition Voltage	Volts	0.0 - 25.5 Volts
System Voltage Warning	Discrete	OK / Low Voltage
J1-20 Input	Discrete	On / Off
J2-21 Input	Discrete	On / Off
Emergency Stop Mode	Discrete	On / Off
Troll RPM Limit	Discrete	On / Off
Malfunction Indicator Lamp	Discrete	On / Off
Fuel Pump Relay	Discrete	On / Off
Cause Power Reduction	Discrete	On / Off
Power Reduction	Discrete	Yes / No
Overheat Detection	Discrete	Yes / No
Oil Press/Catalyst Temp Input	Discrete	OK / Low Press
J1-9 Output	Discrete	On / Off
Oil Level Input	Discrete	OK / Low
Low Oil Level Lamp	Discrete	On / Off
Buzzer	Discrete	On / Off
J1-19 Input	Discrete	On / Off
J1-22 Output	Discrete	On / Off
J1-4 Input	Discrete	On / Off
J1-23 Output	Discrete	On / Off
Master / Slave	Discrete	Master / Slave
J1-7 RPM Output	Discrete	On / Off

Engine Scan Tool Data List - Oxygen (O₂) Sensor (cont'd)

Scan Tool Parameter	Units	Parameter Range
Time From Start	Hours:Minutes:Seconds	00:00:00 - 18:12:15
Engine Hour Meter	Hours	0.0 - 1193046.47 hours
Closed Loop Fuel	Discrete	Yes / No
O2 Sensor 1	Voltage	0 - 1.25 volts
O2 Sensor 2	Voltage	0 - 1.25 volts
O2 Sensor 1 Status	Discrete	Rich / Lean
O2 Sensor 2 Status	Discrete	Rich / Lean
O2 Sensor 1 Cross Counts	Counts	0 - 255 counts
O2 Sensor 2 Cross Counts	Counts	0 - 255 counts
O2 Sensor 1 Blk Lrn Corr	Multiplier	0 - 1.99
O2 Sensor 2 Blk Lrn Corr	Multiplier	0 - 1.99
Block Learn Cell	Numeric	0 - 255

Engine Scan Tool Data List - Exhaust Gas Recirculation (EGR)

Scan Tool Parameter	Units	Parameter Range
Calibration ID	Numeric	0-255. Identification number assigned to a specific calibration.
Calibration Checksum	Numeric	0-65535
Engine Speed	RPM	0-6000
Desired Idle	RPM	0-1600
ECT	°C, °F	-40°C - 151°C , -40°F - 304°F
IAT	°C, °F	-40°C - 151°C , -40°F - 304°F
MAP	kPa / Volts	8 - 207 kPa, 0.00 - 4.98 volts
Baro	kPa / Volts	8 - 207 kPa, 0.00 - 4.98 volts
TP Sensor Position	Volts	0.00 - 4.98 volts
Throttle Angle	Percent	0 - 100%
Injector A Pulse Width	Milliseconds	0.0 - 500 ms
Injector B Pulse Width	Milliseconds	0.0 - 500 ms
Spark Advance	Degrees	-20° - 69.6484°
Knock Retard	Degrees	0° - 89.6484°
KS System Enabled	Yes / No	Yes / No
Knock Signal	Yes / No	Yes / No
IAC Position	Counts	0 - 255 Counts
IAC Throttle Follower	Counts	0 - 255 Counts
Closed Throttle	Yes / No	Yes / No
Vessel Speed	MPH	0 - 255 mph
Battery / Ignition Voltage	Volts	0.0 - 25.5 Volts
System Voltage Warning	Discrete	OK / Low Voltage
J1-20 Input	Discrete	On / Off
J2-21 Input	Discrete	On / Off
Emergency Stop Mode	Discrete	On / Off
Troll RPM Limit	Discrete	On / Off
Malfunction Indicator Lamp	Discrete	On / Off
Fuel Pump Relay	Discrete	On / Off
Cause Power Reduction	Discrete	On / Off
Power Reduction	Discrete	Yes / No
Overheat Detection	Discrete	Yes / No
Oil Pressure Input	Discrete	OK / Low Press
J1-9 Output	Discrete	On / Off
Oil Level Input	Discrete	OK / Low
Low Oil Level Lamp	Discrete	On / Off
Buzzer	Discrete	On / Off
J1-19 Input	Discrete	On / Off
J1-22 Output	Discrete	On / Off
J1-4 Input	Discrete	On / Off
J1-23 Output	Discrete	On / Off
Master / Slave	Discrete	Master / Slave
J1-7 RPM Output	Discrete	On / Off
Time From Start	Hours:Minutes:Seconds	00:00:00 - 18:12:15
Engine Hour Meter	Hours	0.0 - 1193046.47 hours

Engine Scan Tool Data List - Exhaust Gas Recirculation (EGR) (cont'd)

Scan Tool Parameter	Units	Parameter Range
Desired EGR Position	Percent	0 - 100%
Actual EGR Position	Percent	0 - 100%
EGR Error	Percent	0 - 100%
EGR Duty Cycle	Percent	0 - 100%

Engine Scan Tool Data List - Fuel Pressure

Scan Tool Parameter	Units	Parameter Range
Calibration ID	Numeric	0-255. Identification number assigned to a specific calibration.
Calibration Checksum	Numeric	0-65535
Engine Speed	RPM	0-6000
Desired Idle	RPM	0-1600
ECT	°C, °F	-40°C - 151°C , -40°F - 304°F
IAT	°C, °F	-40°C - 151°C , -40°F - 304°F
MAP	kPa / Volts	8 - 207 kPa, 0.00 - 4.98 volts
Baro	kPa / Volts	8 - 207 kPa, 0.00 - 4.98 volts
TP Sensor Position	Volts	0.00 - 4.98 volts
Throttle Angle	Percent	0 - 100%
Fuel Consumption	Gallons per Hour	0.0 - 255 gph
Injector A Pulse Width	Milliseconds	0.0 - 500 ms
Injector B Pulse Width	Milliseconds	0.0 - 500 ms
Spark Advance	Degrees	-20° - 69.6484°
Knock Retard	Degrees	0° - 89.6484°
KS System Enabled	Yes / No	Yes / No
Knock Signal	Yes / No	Yes / No
IAC Position	Counts	0 - 255 Counts
IAC Throttle Follower	Counts	0 - 255 Counts
Closed Throttle	Yes / No	Yes / No
Vessel Speed	MPH	0 - 255 mph
Battery / Ignition Voltage	Volts	0.0 - 25.5 Volts
System Voltage Warning	Discrete	OK / Low Voltage
J1-20 Input	Discrete	On / Off
J2-21 Input	Discrete	On / Off
Emergency Stop Mode	Discrete	On / Off
Troll RPM Limit	Discrete	On / Off
Malfunction Indicator Lamp	Discrete	On / Off
Fuel Pump Relay	Discrete	On / Off
Cause Power Reduction	Discrete	On / Off
Power Reduction	Discrete	Yes / No
Overheat Detection	Discrete	Yes / No
Oil Pressure Input	Discrete	OK / Low Press
J1-9 Output	Discrete	On / Off
Oil Level Input	Discrete	OK / Low
Low Oil Level Lamp	Discrete	On / Off
Buzzer	Discrete	On / Off
J1-19 Input	Discrete	On / Off
J1-22 Output	Discrete	On / Off
J1-4 Input	Discrete	On / Off
J1-23 Output	Discrete	On / Off
Master / Slave	Discrete	Master / Slave
J1-7 RPM Output	Discrete	On / Off
Time From Start	Hours:Minutes:Seconds	00:00:00 - 18:12:15

Engine Scan Tool Data List - Fuel Pressure (cont'd)

Scan Tool Parameter	Units	Parameter Range
Engine Hour Meter	Hours	0.0 - 1193046.47 hours
Fuel Pressure Volts	Volts	0.00 - 5.00 volts
Low Fuel Pressure Warning	Discrete	OK / Low Pressure
Fuel Temp	Volts	0 - 5 volts

Engine Scan Tool Data List - Electronic Throttle Control (ETC)

Scan Tool Parameter	Units	Parameter Range
Calibration ID	Numeric	0-255. Identification number assigned to a specific calibration.
Calibration Checksum	Numeric	0-65535
Engine Speed	RPM	0-6000
Desired Idle	RPM	0-1600
ECT	°C, °F	-40°C - 151°C , -40°F - 304°F
IAT	°C, °F	-40°C - 151°C , -40°F - 304°F
MAP	kPa / Volts	8 - 207 kPa, 0.00 - 4.98 volts
Baro	kPa / Volts	8 - 207 kPa, 0.00 - 4.98 volts
Oil Press / Catalyst Temp	Volts	0 - 5 volts
TP Sensor Position	Volts	0.00 - 4.98 volts
Throttle Angle	Percent	0 - 100%
Fuel Consumption	Gallons per Hour	0.0 - 255 gph
Injector A Pulse Width	Milliseconds	0.0 - 500 ms
Injector B Pulse Width	Milliseconds	0.0 - 500 ms
Spark Advance	Degrees	-20° - 69.6484°
Knock Retard	Degrees	0° - 89.6484°
KS System Enabled	Yes / No	Yes / No
Knock Signal	Yes / No	Yes / No
IAC Position	Counts	0 - 255 Counts
IAC Throttle Follower	Counts	0 - 255 Counts
Closed Throttle	Yes / No	Yes / No
Vessel Speed	MPH	0 - 255 mph
Battery / Ignition Voltage	Volts	0.0 - 25.5 Volts
System Voltage Warning	Discrete	OK / Low Voltage
J1-20 Input	Discrete	On / Off
J2-21 Input	Discrete	On / Off
Emergency Stop Mode	Discrete	On / Off
Malfunction Indicator Lamp	Discrete	On / Off
Fuel Pump Relay	Discrete	On / Off
Cause Power Reduction	Discrete	On / Off
Power Reduction	Discrete	Yes / No
Overheat Detection	Discrete	Yes / No
Oil Press/Catalyst Temp Input	Discrete	OK / Low Press
J1-9 Output	Discrete	On / Off
Oil Level Input	Discrete	OK / Low
Low Oil Level Lamp	Discrete	On / Off
Buzzer	Discrete	On / Off
J1-19 Input	Discrete	On / Off
J1-22 Output	Discrete	On / Off
J1-4 Input	Discrete	On / Off
J1-23 Output	Discrete	On / Off
Master / Slave	Discrete	Master / Slave
J1-7 RPM Output	Discrete	On / Off
Time From Start	Hours:Minutes:Seconds	00:00:00 - 18:12:15

Engine Scan Tool Data List - Electronic Throttle Control (ETC) (cont'd)

Scan Tool Parameter	Units	Parameter Range
Engine Hour Meter	Hours	0.0 - 1193046.47 hours
ETC Pedal Angle	Percent	0 - 100%
ETC Desired Throttle	Percent	0 - 99.609375%
ETC Raw Pedal	Counts	0 - 65535 counts
ETC Raw Desired	Counts	0 - 65535 counts
ETC Raw Throttle	Counts	0 - 65535 counts

EngineScan Tool Data Definitions

The Engine Scan Tool Data Definitions contains a brief description of all engine related parameters available on the scan tool.

ECM Data Descriptions

CALIBRATION ID - Scan Tool Range 0-255 - This is an identification number given to each calibration by the OEM.

CALIBRATION CHECKSUM - Scan Tool Range 0-65535 - This number is automatically calculated by the ECM. This number may also be used as a calibration identifier.

ENGINE SPEED - Scan Tool Range 0-9999 RPM - Engine speed is computed by the ECM from the Ignition Control reference input. It should remain close to the desired idle under various engine loads with engine idling.

DESIRED IDLE - Scan Tool Range 0-3187 RPM - The idle speed that is commanded by the ECM. The ECM will compensate for various engine loads based on engine coolant temperature to keep the engine at the desired speed.

ECT - Scan Tool Range -40°C to 151°C, -40°F to 304°F - The Engine Coolant Temperature (ECT) sensor is mounted in the coolant stream and sends engine temperature information to the ECM. The ECM supplies 5 volts to the ECT sensor circuit. The sensor is a thermistor which changes internal resistance as temperature changes. When the sensor is cold (internal resistance high), the ECM monitors a high signal voltage and interprets it as a cold engine. As the sensor warms (internal resistance decreases), the voltage signal will decrease and the ECM will interpret the lower voltage as a warm engine.

IAT - Scan Tool Range -40°C to 151°C, -40°F to 304°F - The ECM converts the resistance of the intake air temperature sensor to degrees. Intake Air Temperature (IAT) is used by the ECM to adjust fuel delivery and spark timing according to incoming air density. (Big Block Multiport Fuel Injection Application Only).

MAP - Scan Tool Range 10-210 kPa/0.00-5.00 Volts - The Manifold Absolute Pressure (MAP) sensor measures the change in the intake manifold pressure from engine load and speed changes. As intake manifold pressure increases, intake vacuum decreases resulting in a higher MAP sensor voltage and kPa reading.

BARO - Scan Tool Range 10-105 kPa/0.00-5.00 Volts - The Barometric Pressure reading displayed is measured from the MAP sensor signal monitored at ignition "ON," engine "OFF" and WOT conditions. The Barometric Pressure is used to compensate for altitude differences.

TP SENSOR - Scan Tool Range 0.00-5.00 Volts - This is the voltage being monitored by the ECM on the TP sensor signal circuit.

TP ANGLE - Scan Tool Range 0% - 100% - TP Angle is computed by the ECM from the TP Sensor voltage. TP Angle should display 0% at idle and 100% at wide open throttle.

FUEL CONSUMPTION - Scan Tool Range 0-100 gph -

This is the gallons per hour of fuel that the engine is consuming.

INJ. PULSE WIDTH - Scan Tool Range 0-1000 msec. - Indicates the amount of time the ECM is commanding the injectors "ON" during each engine cycle. A larger injector pulse width will cause more fuel to be delivered. Inj. Pulse Width should increase with increased engine load.

SPARK ADVANCE - Scan Tool Range -90° to 90° - This is a display of the spark advance (IC) calculations which the ECM calculates and then provides all spark advance to the ignition system. The ECM computes the desired spark advance using data such as engine temperature, RPM, engine load, vessel speed, and operating mode. There is no adjustment for spark advance. The ECM also uses spark advance to help maintain idle speed. Under normal operating condition, with the engine warmed up and 0% throttle angle, it is normal to see timing vary continuously.

KNOCK RETARD - Scan Tool Range 0.0°-45.5° - Indicates the amount of spark the ECM is removing from IC spark advance in response to the signal from the knock sensor (KS).

KS ENABLED - Scan Tool Displays "YES" or "NO" - This is informing you whether or not the Knock System is enabled.

KNOCK SIGNAL - Scan Tool Displays "YES" or "NO" - Indicates whether or not a knock signal is being detected by the ECM. Should display "NO" at idle.

KNOCK SENSOR 1 - Scan Tool Displays "OK" or "Fault" - Indicates whether or not a fault is being detected on the knock sensor 1 circuit.

KNOCK SENSOR 2 - Scan Tool Displays "OK" or "Fault" - Indicates whether or not a fault is being detected on the knock sensor 2 circuit.

IAC POSITION - Scan Tool Range 0-255 - Displays the commanded position of the idle air control pintle in counts. A larger number of counts means that more air is being commanded through the idle air passage. Idle air control should respond fairly quickly to changes in engine load to maintain desired idle RPM.

IAC THROTTLE FOLLOWER - Scan Tool Range 0-255 - When the throttle is moved from the closed throttle position, some idle air control counts are added to prevent stalling when returned to the closed throttle position.

CLOSED THROTTLE - Scan Tool Displays "YES" or "NO" - Indicates whether the throttle is in the closed position.

VESSEL SPEED - Scan Tool Range 0-255 MPH - Indicates the speed of the vessel in MPH.

BATTERY / IGNITION VOLTAGE - Scan Tool Range 0.0 - 25.5 volts - This represents the system voltage

SYSTEM VOLTAGE WARNING - Scan Tool Displays "OK" or "LOW VOLTAGE" - Indicates if there may be a fault in the charging system.

J2-9 INPUT - Scan Tool Displays "ON" or "OFF" - This is a discrete input to the ECM that is determined and calibratable per OEM.

J2-20 INPUT - Scan Tool Displays "ON" or "OFF" - This is

a discrete input to the ECM that is determined and calibratable per OEM.

EMERGENCY STOP MODE - Scan Tool Displays "YES" or "NO" - Indicates whether you are in emergency stop mode or not.

TROLL RPM LIMIT - Scan Tool Displays "ON" or "OFF" - This is a discrete input to the ECM which limits the RPM for such things as trolling. This RPM limit is calibratable by the OEM.

MIL - Scan Tool Displays "ON" or "OFF" - Indicates the ECM commanded state of the Malfunction Indicator Lamp.

FUEL PUMP RELAY - Scan Tool Displays "ON" or "OFF" - Indicates the ECM commanded state of the fuel pump relay driver circuit.

CAUSE POWER REDUCTION - Scan Tool Displays "YES" or "NO" - Indicates whether or not the ECM has recognized a fault which would put the engine into Power Reduction when the appropriate RPM is achieved.

POWER REDUCTION - Scan Tool Displays "YES" or "NO" - Indicates whether or not the ECM is functioning in Power Reduction mode. During this mode, the ECM only triggers one injector driver resulting in fuel to only half of the cylinders.

OVERHEAT DETECTED - Scan Tool Displays "YES" or "NO" - Indicates if the ECM has recognized an overheat condition with the engine.

OIL PRESSURE WARNING - Scan Tool Displays "OK" or "LOW PRESSURE" - Indicates if the ECM has recognized a fault in the oil pressure circuit.

CHECK GAUGES LAMP - Scan Tool Displays "ON" or "OFF" - Indicates the ECM commanded state of the Check Gauges lamp.

OIL LEVEL WARNING - Scan Tool Displays "OK" or "LOW" - Indicates if the ECM has recognized a fault in the oil level circuit.

BUZZER - Scan Tool Displays "ON" or "OFF" - Indicates the ECM commanded state of the Buzzer.

GENERAL WARNING 1 - Scan Tool Displays "OK" or "Fault Detected" - This is a discrete input to the ECM that is determined and calibratable per OEM.

J1-21 OUTPUT - Scan Tool Displays "ON" or "OFF" - Indicates the ECM commanded state of this output circuit.

GENERAL WARNING 2 - Scan Tool Displays "OK" or "Fault Detected" - This is a discrete input to the ECM that is determined and calibratable per OEM.

J1-22 OUTPUT - Scan Tool Displays "ON" or "OFF" - ECM driven output that is determined and calibratable per OEM.

ECM MASTER / SLAVE - Scan Tool Displays "MASTER" or "SLAVE" - Indicates whether you are receiving data from a master or a slave engine.

J1-8 RPM OUTPUT - Scan Tool Displays "ON" or "OFF" - ECM driven output that is determined and calibratable per OEM.

TIME FROM START - Scan Tool Range 00:00:00-99:99:99 Hrs:Min:Sec - Indicates the amount of time the ignition key

was in the "ON" or "RUN" position. Once the key has been cycled to the "OFF" position, this counter will reset to 00:00.

ENGINE HOUR METER - Scan Tool Range 00:00:00-99:99:99 Hrs:Min:Sec - Indicates the engine run time.

ECM Diagnostic Trouble Codes

The Malfunction Indicator Lamp (MIL) will be "ON" if the malfunction exists under the conditions listed below. If the malfunction clears, the lamp will go out and the Diagnostic Trouble Code (DTC) will be stored in the ECM. Any DTC's stored will be erased if no problem reoccurs within 50 engine starts. The amount of time after the malfunction occurs before the MIL illuminates is calibratable. (Instantly or up to one minute).

Many of the DTC tables include a functional check of the system that may pinpoint a problem. However, it is important to remember that the DTC tables are specifically designed for use only when a DTC is set. Therefore, a thorough understanding of the normal operation of the system being diagnosed is necessary, and use of the tables for this purpose is at the discretion of the technician.

NOTICE: Some DTC's are referred as "Latching Codes." A latching code will cause the MIL lamp to stay "ON" during an ignition cycle whether the malfunction is corrected or not. This also means you can not clear the DTC during the same ignition cycle.

Diagnostic Trouble Code (DTC) Table

DTC	Description
DTC 13	Oxygen (O2) Sensor 1 Circuit Inactive
DTC 13	Oxygen (O2) Sensor 2 Circuit Inactive
DTC 14	Engine Coolant Temperature (ECT) Sensor Circuit. Low Temperature Indicated.
DTC 15	Engine Coolant Temperature (ECT) Sensor Circuit. High Temperature Indicated.
DTC 21	Throttle Position (TP) Sensor Circuit. High Signal Voltage Indicated.
DTC 22	Throttle Position (TP) Sensor Circuit. Low Signal Voltage Indicated.
DTC 23	Intake Air Temperature (IAT) Sensor Circuit. Low Temperature Indicated.
DTC 24	Vehicle Speed Sensor (VSS) Circuit Inactive.
DTC 25	Intake Air Temperature (IAT) Sensor Circuit. High Temperature Indicated.
DTC 31	Governor System Inactive
DTC 32	Exhaust Gas Recirculation (EGR) Valve Circuit Inactive.
DTC 33	Manifold Absolute Pressure (MAP) Sensor Circuit. High Signal Voltage Indicated.
DTC 34	Manifold Absolute Pressure (MAP) Sensor Circuit. Low Signal Voltage Indicated.
DTC 41	Ignition Control (IC) H Fault.
DTC 41	Ignition Control (IC) G Fault.
DTC 41	Ignition Control (IC) F Fault.
DTC 41	Ignition Control (IC) E Fault.
DTC 41	Ignition Control (IC) D Fault.
DTC 41	Ignition Control (IC) C Fault.
DTC 41	Ignition Control (IC) B Fault.
DTC 41	Ignition Control (IC) A Fault.
DTC 44	Knock Sensor (KS) 1 Circuit Inactive.
DTC 44	Knock Sensor (KS) 2 Circuit Inactive.
DTC 51	Calibration Checksum Failure.
DTC 54	Oxygen (O2) Sensor 1 Low Voltage. Lean Exhaust Indicated.

Diagnostic Trouble Code (DTC) Table (cont'd)

DTC	Description
DTC 54	Oxygen (O2) Sensor 2 Low Voltage. Lean Exhaust Indicated.
DTC 55	Oxygen (O2) Sensor 1 Low Voltage. Rich Exhaust Indicated.
DTC 55	Oxygen (O2) Sensor 2 Low Voltage. Rich Exhaust Indicated.
DTC 61	High Fuel Pressure Indicated.
DTC 62	Low Fuel Pressure Indicated.
DTC 63	High Fuel Temperature Indicated.
DTC 64	Low Fuel Temperature Indicated.
DTC 81	Crankshaft Position (CKP) Sensor Circuit Fault.
DTC 81	Camshaft Position (CMP) Sensor Circuit Fault.
DTC 81	Throttle Actuator Control (TAC) Malfunction - ETC Applications.
DTC 81	Fuel Pump High, Low or Open.
DTC 81	Injector Driver A Circuit High, Low or Open.
DTC 81	Injector Driver B Circuit High, Low or Open.
DTC 81	Recirc J1-32 Fault.
DTC 81	5 Volt Reference Circuit Out of Range.
DTC 81	DEPSPWR Circuit Out of Range.
DTC 81	CAN Bus Fault
DTC 81	Oil/Catalyst Temperature High.
DTC 81	Throttle Position (TP) Sensor 2 Out of Range - ETC Applications.
DTC 81	Throttle Position (TP) Sensor 1 Out of Range - ETC Applications.
DTC 81	Pedal Position Sensor (PPS) 3 Out of Range - ETC Applications.
DTC 81	Pedal Position Sensor (PPS) 2 Out of Range - ETC Applications.
DTC 81	Pedal Position Sensor (PPS) 1 Out of Range - ETC Applications.
DTC 81	Bad Checksum - ETC Applications.
DTC 81	No TAC Module Reply - ETC Applications.
DTC 81	CAN Bus Contention.
DTC 81	Serial Communication Fault - ETC Applications.
DTC 81	Throttle Position (TP) Sensor 1 / 2 Correction - ETC Applications
DTC 81	Pedal Position Sensor (PPS) 2 / 3 Correction - ETC Applications.
DTC 81	Pedal Position Sensor (PPS) 1 / 3 Correction - ETC Applications.
DTC 81	Pedal Position Sensor (PPS) 1 / 2 Correction - ETC Applications.
DTC 81	Limited Authority - ETC Applications.
DTC 81	Actuation Fault - ETC Applications.
DTC 81	Process Fault - ETC Applications.
DTC 81	Not Tracking - ETC Applications.
DTC 81	Throttle Return Fault - ETC Applications.

Logged Warnings

These warnings will be displayed following the Diagnostic Trouble Codes. They can be cleared the same as the trouble codes. Unlike trouble codes, these warnings can not be flashed out through the MIL using the DTC tool.

Description
Overheat
Low Oil Pressure / Catalyst Temperature
Low System Voltage
Low Oil Level
General Warning 1 (J1-19)
General Warning 2 (J1-4)
Low Fuel Pressure
Stop Engine Warning

Clearing Diagnostic Trouble Codes - Scan

1. Install scan tool.
2. Start engine.
3. Select "Clear DTC's" function.
4. Clear DTC's.
5. Turn ignition "OFF" for at least 20 seconds.
6. Turn ignition "ON" and read DTC's. If DTC's are still present, check "Notice" below and repeat procedure following from step 2.

NOTICE: When clearing DTC's with or without the use of a scan tool, the ignition must be cycled to the "OFF" position or the DTC's will not clear.

Clearing Diagnostic Trouble Codes - Non Scan

1. Install Diagnostic Trouble Code (DTC) tool.
2. Ignition "ON," engine "OFF"
3. Switch DTC tool to "service mode" or "ON."
4. Move the throttle from 0% (idle) to 100% (WOT) and back to 0%.
5. Switch DTC tool to "normal mode" or "OFF." (If this step is not performed, the engine may not start and run).
6. Turn ignition "OFF" for at least 20 seconds.
7. Ignition "ON," engine "OFF"
8. Switch DTC tool to "service mode" or "ON" and verify DTC 12 only. Remove MDTC tool.
9. If original DTC's are still present, check "Notice" below and repeat the DTC clearing procedure.
10. If new DTC's are displayed, perform the "On-Board Diagnostic" (OBD) system check.

System Configuration Options

Scan Tool Parameter	Units	Parameter Range
Cam Sensor	Discrete	Yes / No
58x Crank Sensor	Discrete	Yes / No
7x Crank Sensor	Discrete	Yes / No
24x Encoded Crank Sensor	Discrete	Yes / No
TAC Module Present	Discrete	Yes / No
Knock Sensor	Discrete	Yes / No
Intake Air Temp Sensor	Discrete	Yes / No
Linear EGR	Discrete	Yes / No
GPH Calculation Enabled	Discrete	Yes / No
Alternate Fuel Spark Curve	Discrete	Yes / No
2 Atmosphere MAP	Discrete	Yes / No
MPH Sensor	Discrete	Yes / No

System Configuration Options (cont'd)

Scan Tool Parameter	Units	Parameter Range
Governor	Discrete	Yes / No
Load Anticipate 1	Discrete	Yes / No
Load Anticipate 2	Discrete	Yes / No
RPM Change State	Discrete	Yes / No
Troll Mode	Discrete	Yes / No
Shift Interrupt	Discrete	Yes / No
Transmission Upshift	Discrete	Yes / No
Twin Engine Shift Sync.	Discrete	Yes / No
Emergency Stop	Discrete	Yes / No
Canister Purge	Discrete	Yes / No
Power Balance	Discrete	Yes / No
Oxygen Sensor 1 Present	Discrete	Yes / No
Oxygen Sensor 2 Present	Discrete	Yes / No
Fuel Temperature Sensor	Discrete	Yes / No
Fuel Pressure Sensor	Discrete	Yes / No
Bosch IAT/MAP Sensor	Discrete	Yes / No

Fuel System Specifications

Use regular unleaded gasoline rated at 87 octane or higher. It is recommended that the gasoline meet specifications which were developed by the American Automobile Manufacturers Association for better vehicle performance and engine protection. Gasoline meeting the AAMA specification could provide improved driveability and emission control system protection compared to other gasolines.

Be sure the posted octane is at least 87. If the octane is less than 87, you may get a heavy knocking noise when you drive. If it's bad enough, it can damage your engine.

If you are using fuel rated at the recommended octane or higher and you still hear a heavy knocking, your engine needs service. But don't worry if you hear a little pinging noise when you're accelerating. That's normal, and you don't have to buy a higher octane fuel to get rid of pinging. It's the heavy, constant knock that means you have a problem.

Some gasolines that are not reformulated for low emissions contain an octane-enhancing additive called methylcyclopentadienyl manganese tricarbonyl (MMT); ask your service station operator whether or not this fuel contains MMT. General Motors does not recommend the use of such gasolines. If fuels containing MMT are used, spark plug life may be reduced and your system performance may be affected.

To provide cleaner air, all gasolines in the United States are now required to contain additives that will help prevent deposits from forming in your engine and fuel system, allowing your emission control system to function properly.

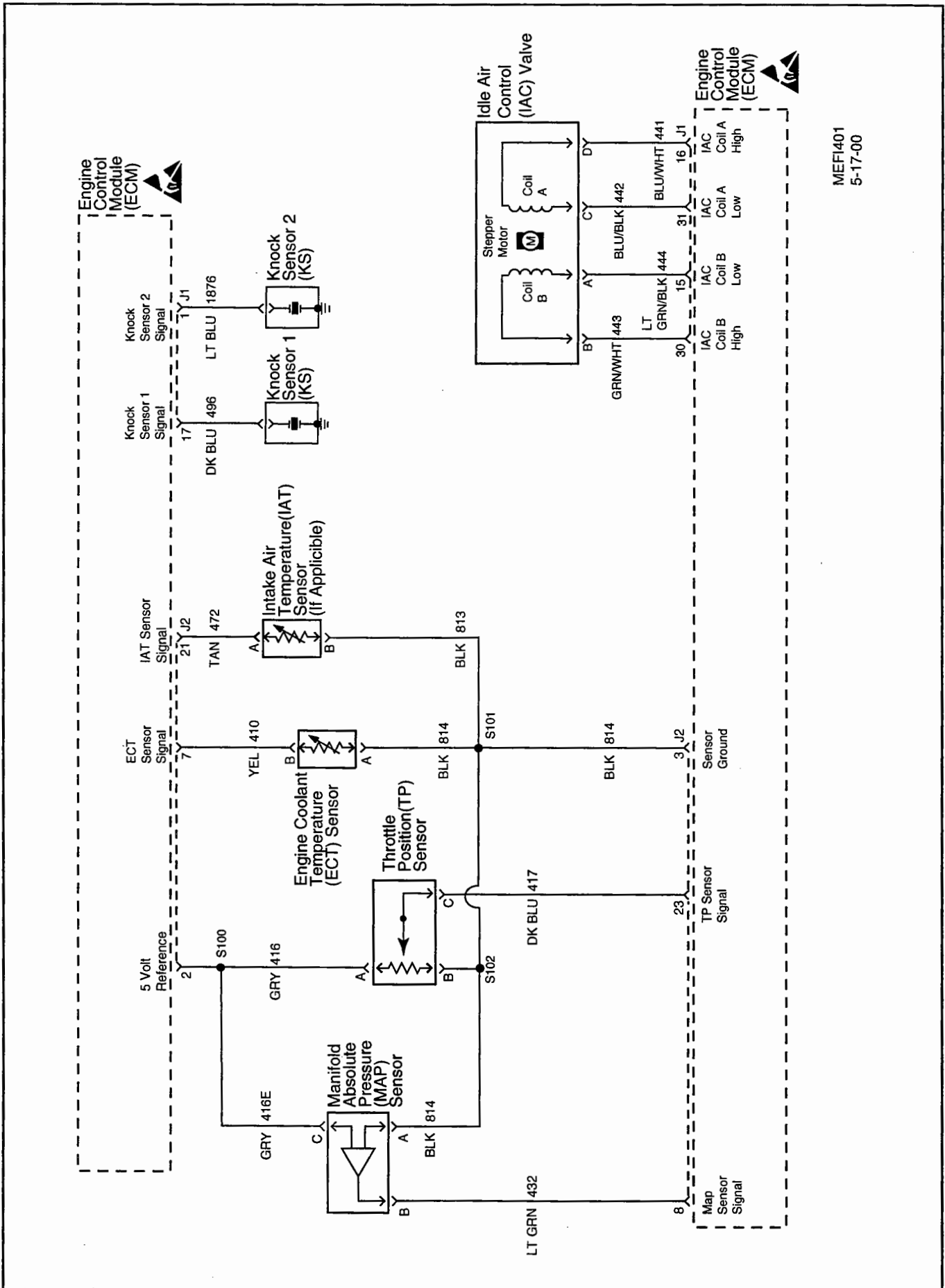
Therefore, you should not have to add anything to the fuel. In addition, gasolines containing oxygenates, such as ethers and ethanol, and reformulated gasolines may be available in your area to help clean the air. General Motors recommends that you use these gasolines if they comply with the specifications described earlier.

Notice: Your vehicle was not designed for fuel that contains methanol. Don't use it. It can corrode metal parts in your fuel system and also damage plastic and rubber parts.

Fuels in Foreign Countries (Gasoline Engines)

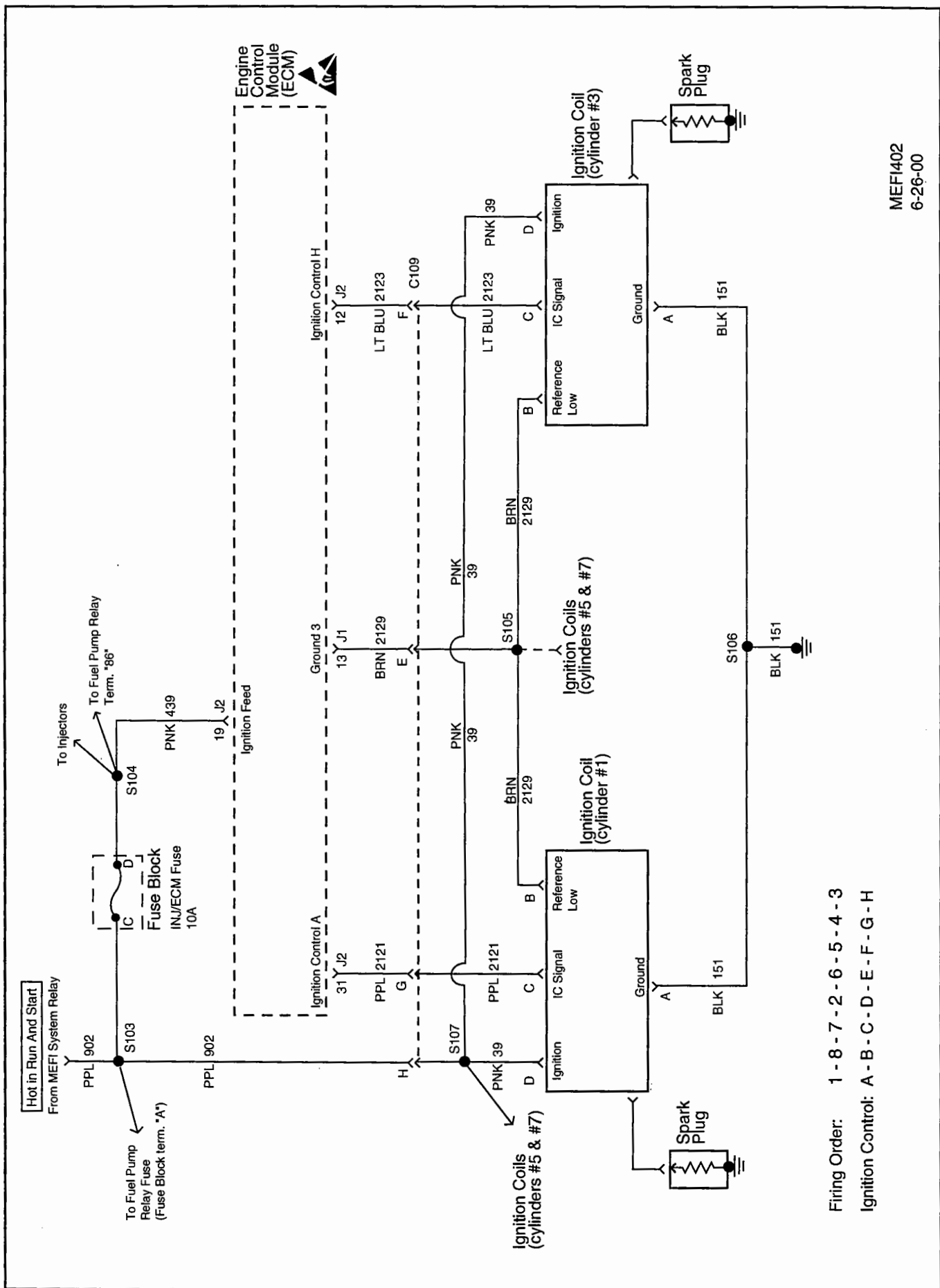
If you plan on operating this engine in another country outside the United States and Canada, the proper fuel may be hard to find. Never use leaded gasoline or any other fuel not recommended in the previous text on fuel.

Engine Controls Schematics (8.1L - Sensors)



MEFI401
5-17-00

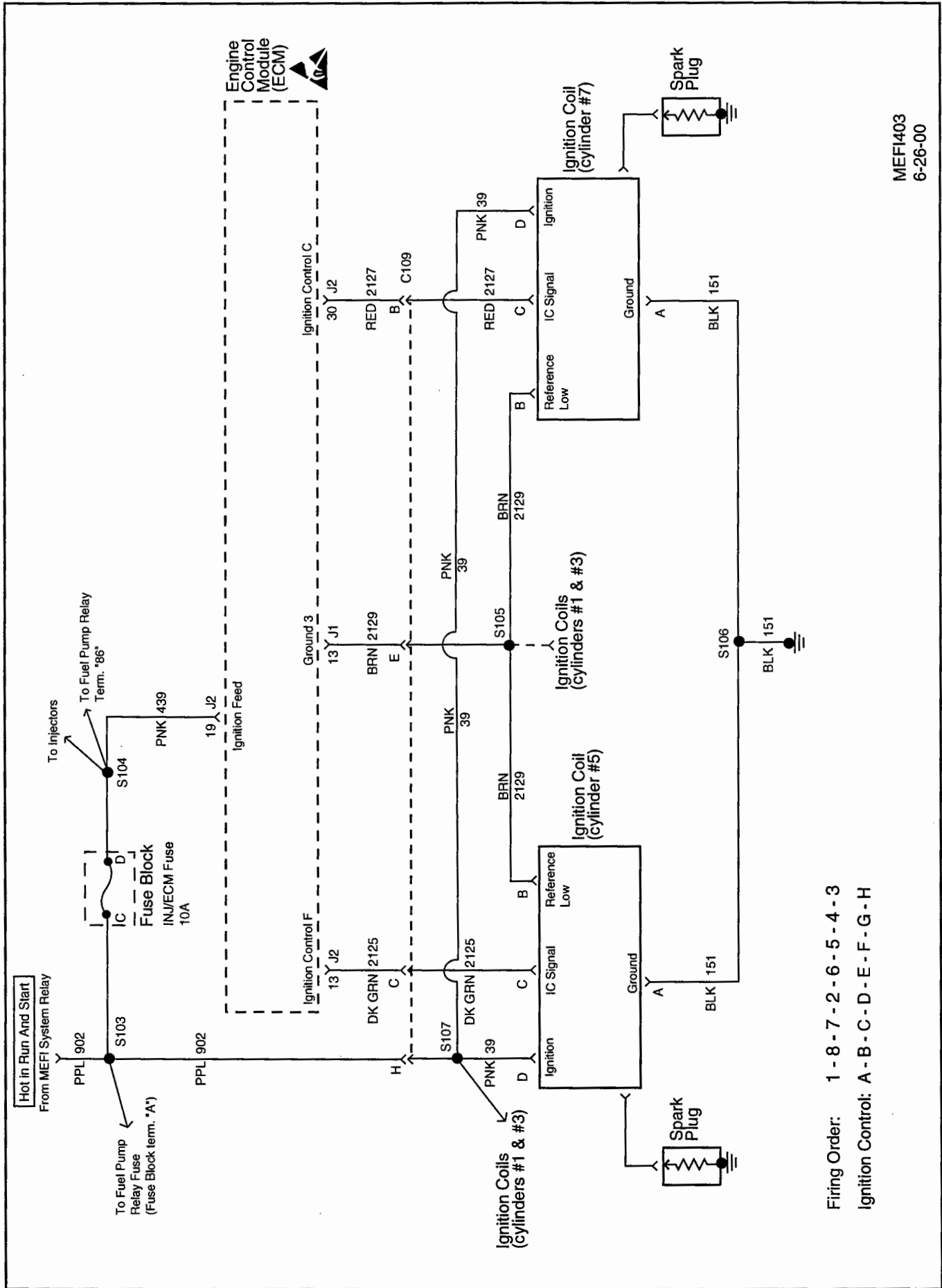
Engine Controls Schematics (8.1L - Ignition Coils 1 & 3)



Firing Order: 1 - 8 - 7 - 2 - 6 - 5 - 4 - 3
 Ignition Control: A - B - C - D - E - F - G - H

MEF1402
 6-26-00

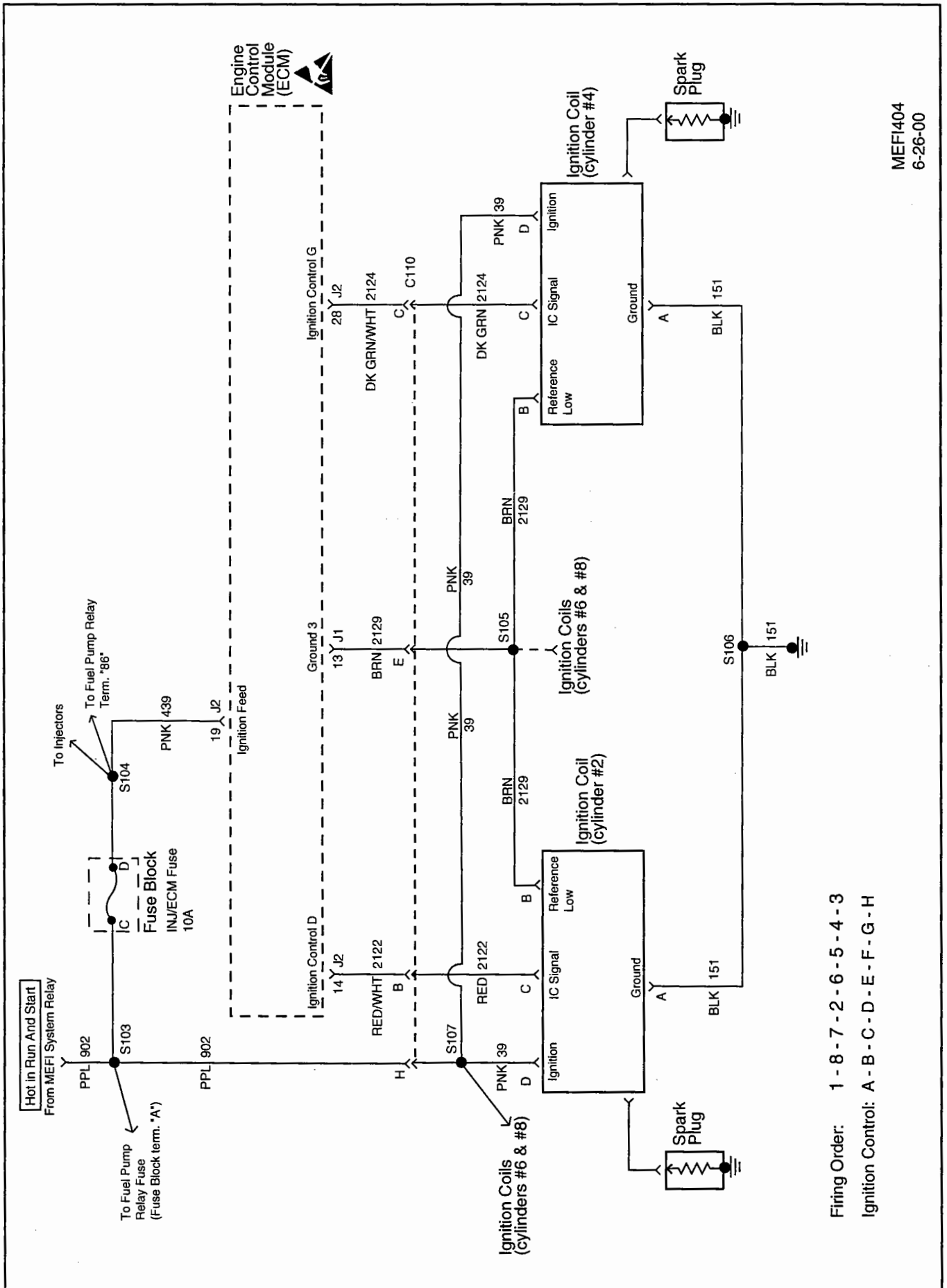
Engine Controls Schematics (8.1L - Ignition Coils 5 & 7)



Firing Order: 1 - 8 - 7 - 2 - 6 - 5 - 4 - 3
 Ignition Control: A - B - C - D - E - F - G - H

MEFI403
 6-26-00

Engine Controls Schematics (8.1L - Ignition Coils 2 & 4)

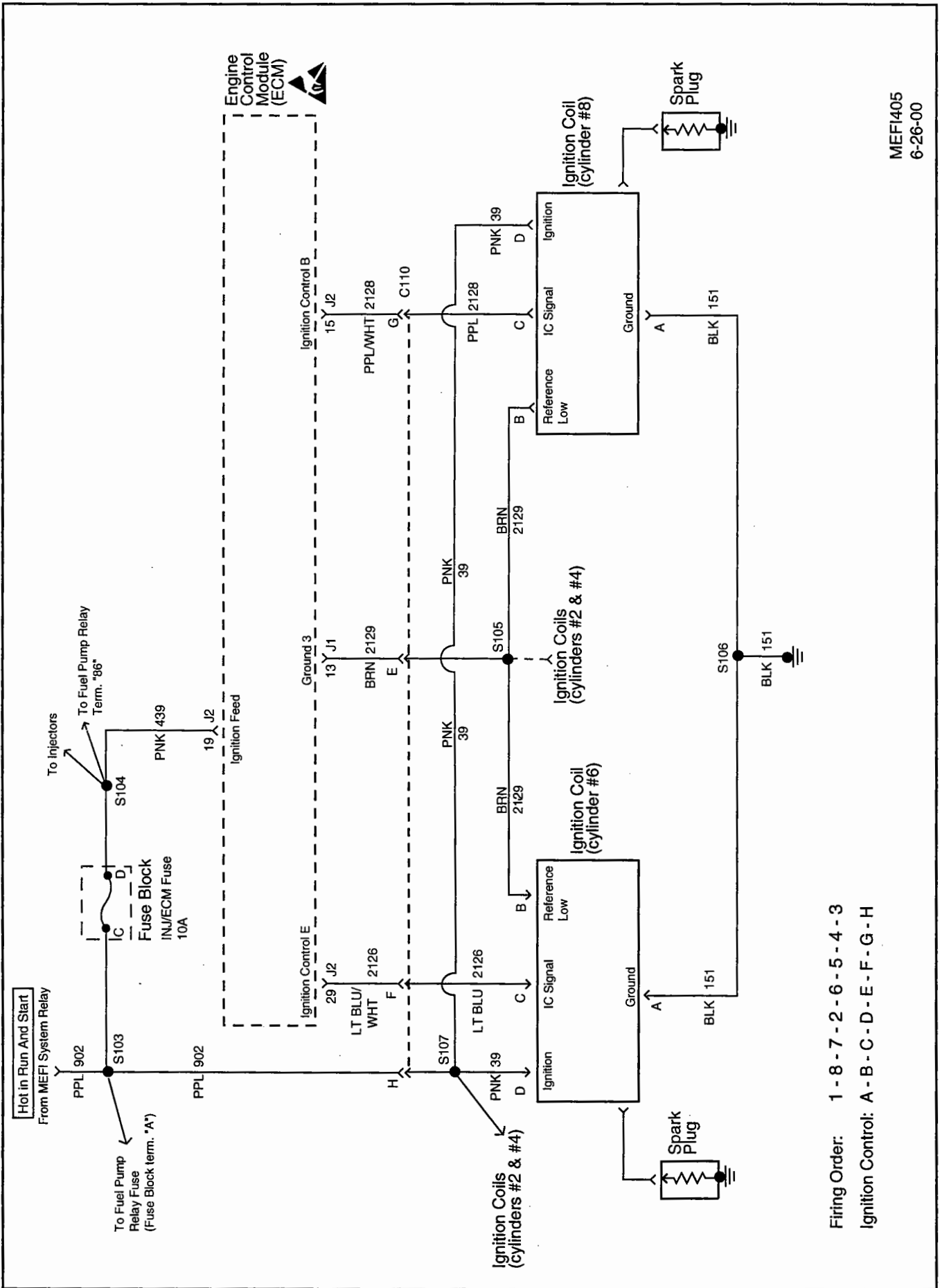


Firing Order: 1 - 8 - 7 - 2 - 6 - 5 - 4 - 3

Ignition Control: A - B - C - D - E - F - G - H

MEFI404
6-26-00

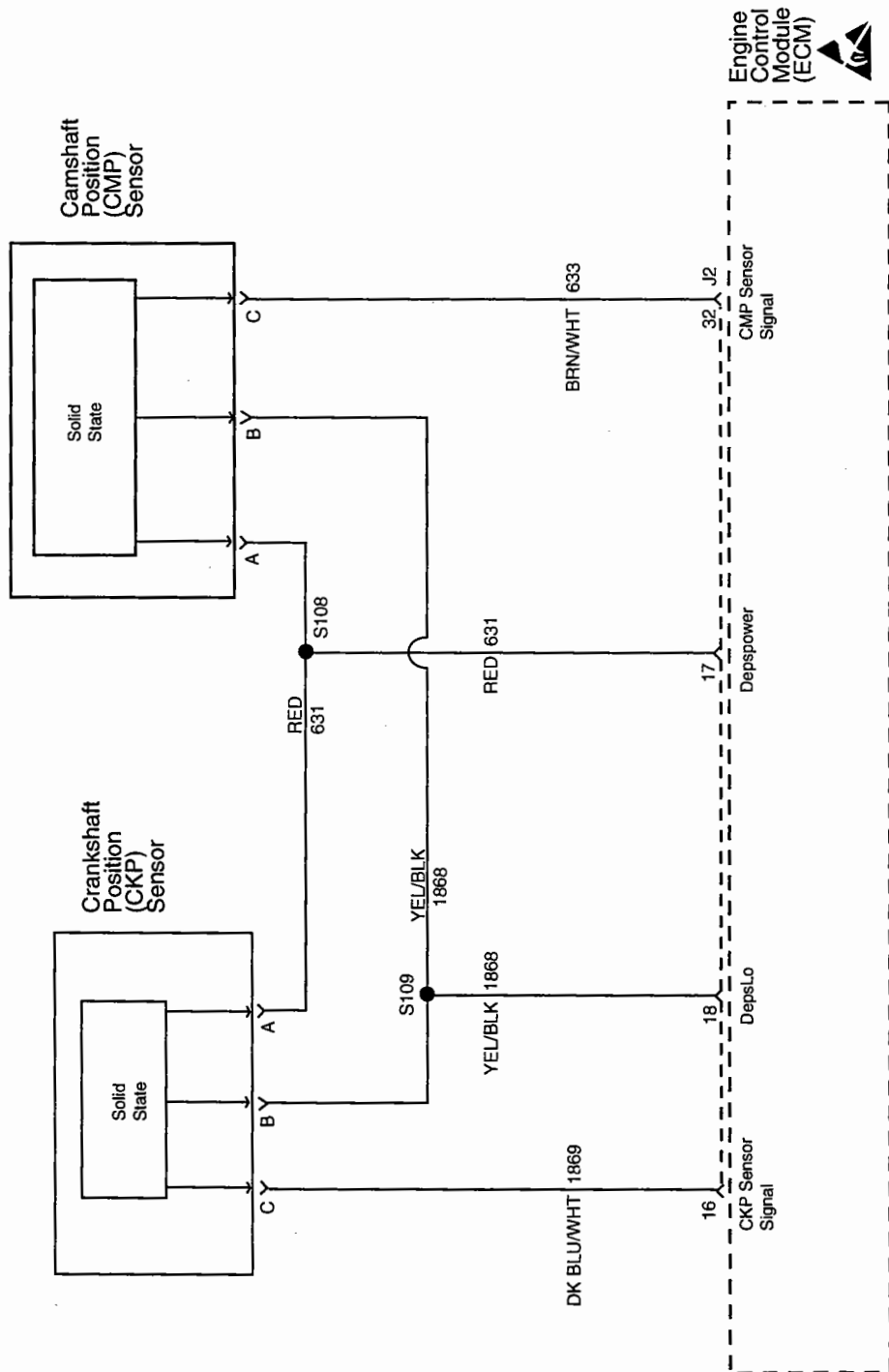
Engine Controls Schematics (8.1L - Ignition Coils 6 & 8)



Firing Order: 1 - 8 - 7 - 2 - 6 - 5 - 4 - 3
 Ignition Control: A - B - C - D - E - F - G - H

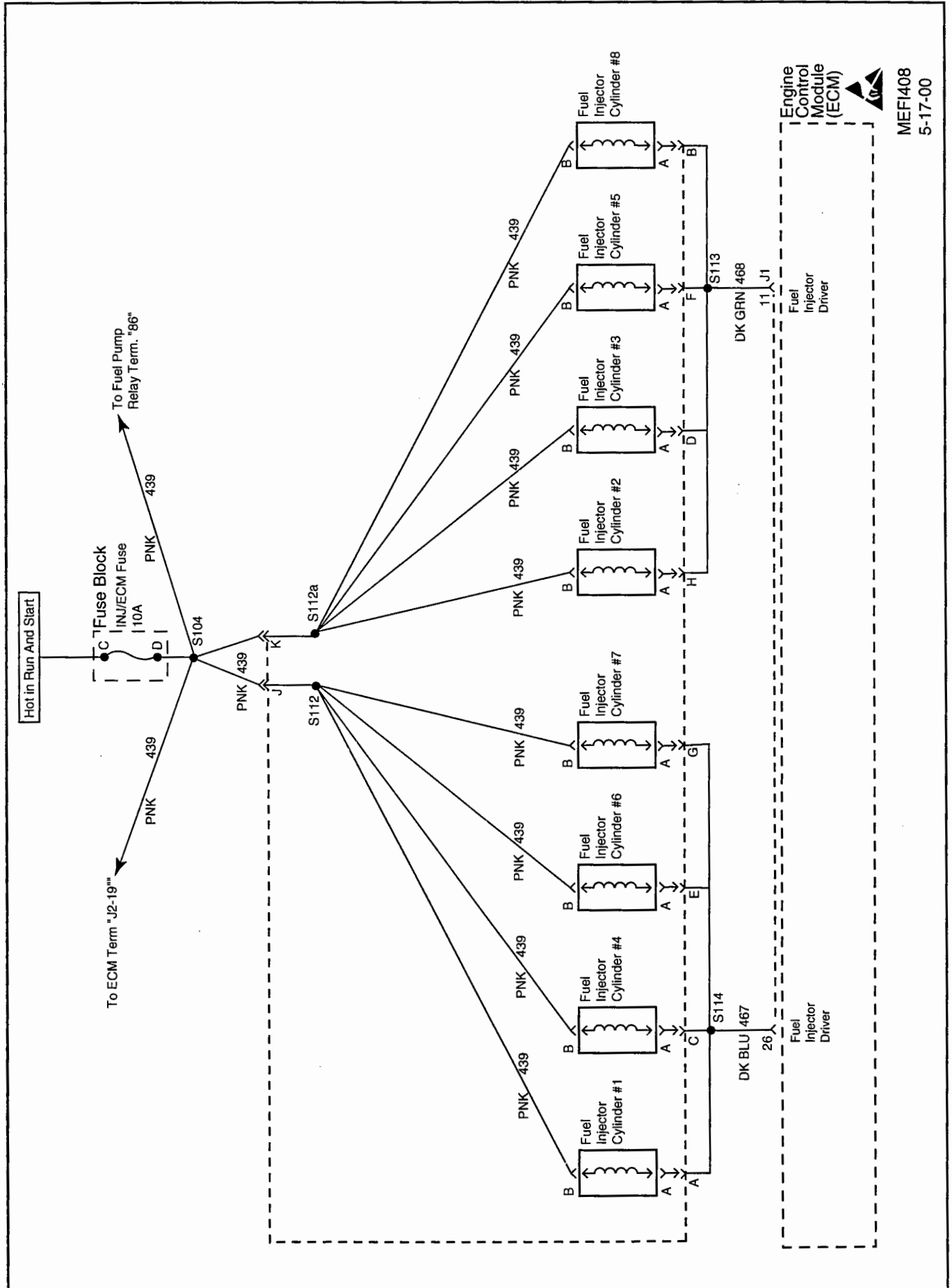
MEFI405
 6-26-00

Engine Controls Schematics (CMP & CKP Sensors)



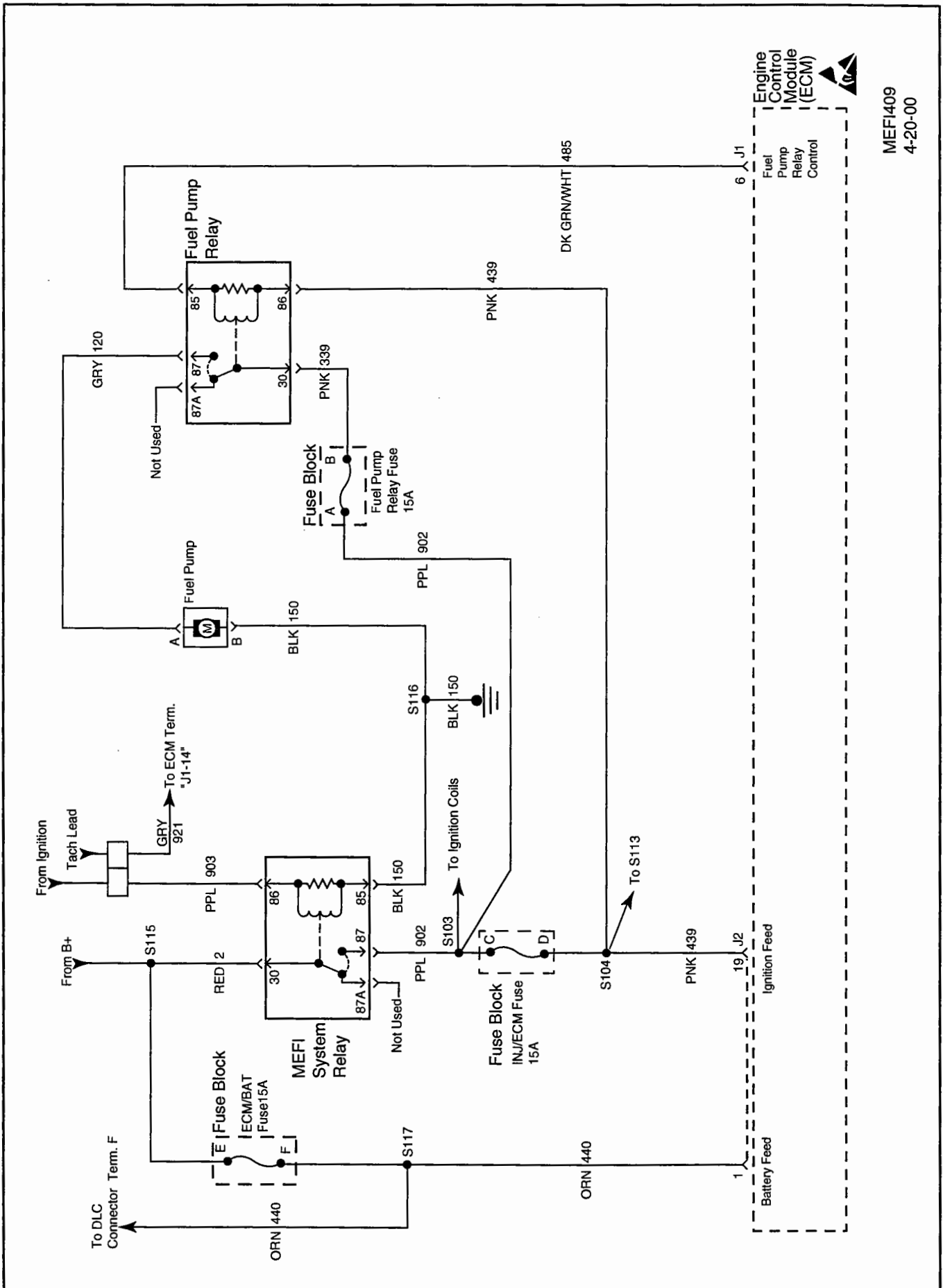
MEFI406
5-17-00

Engine Controls Schematics (8.1L - Fuel Injectors)



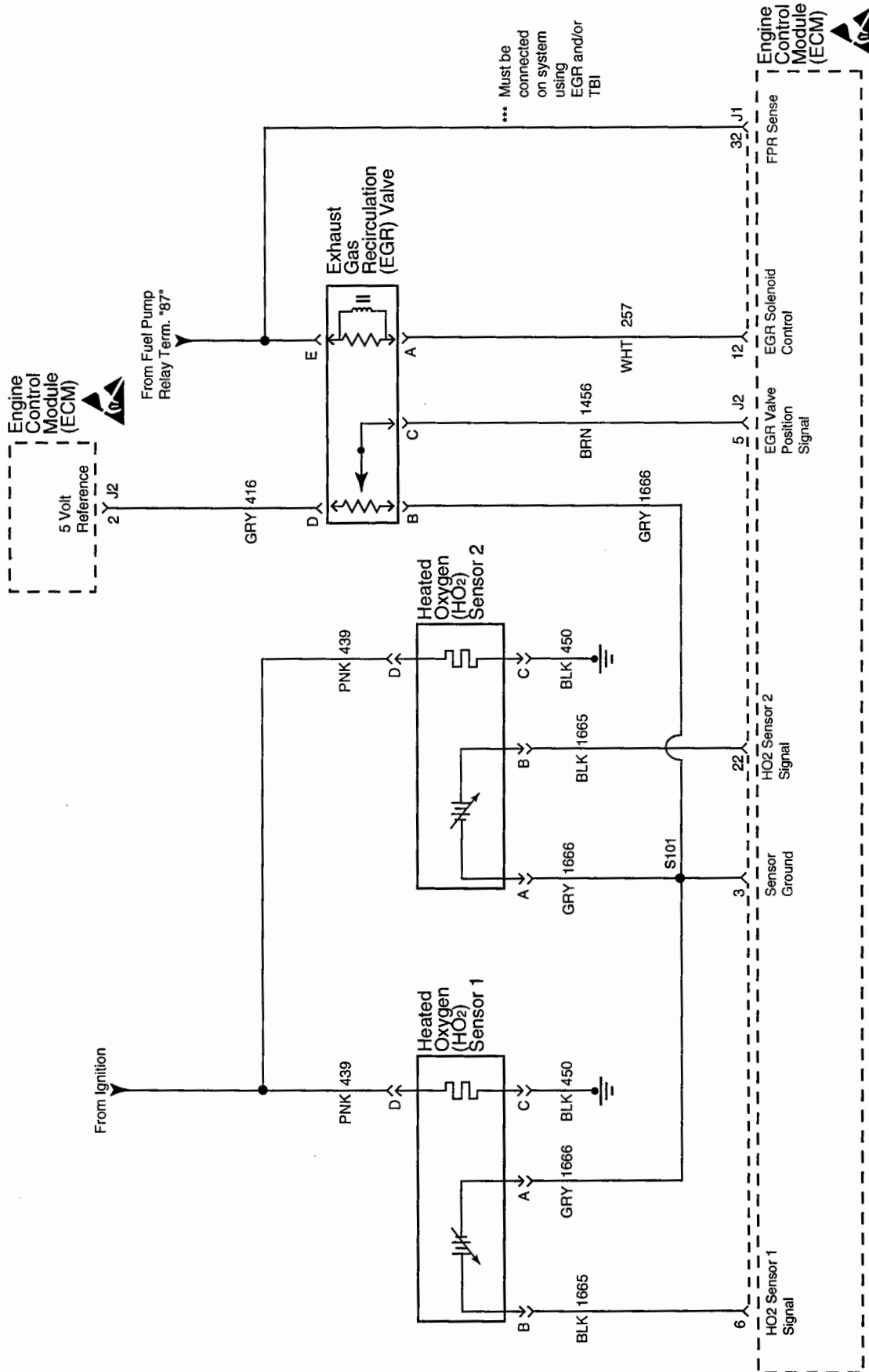
MEFI408
5-17-00

Engine Controls Schematics (8.1L - MEFI System Relay & Fuel Pump)



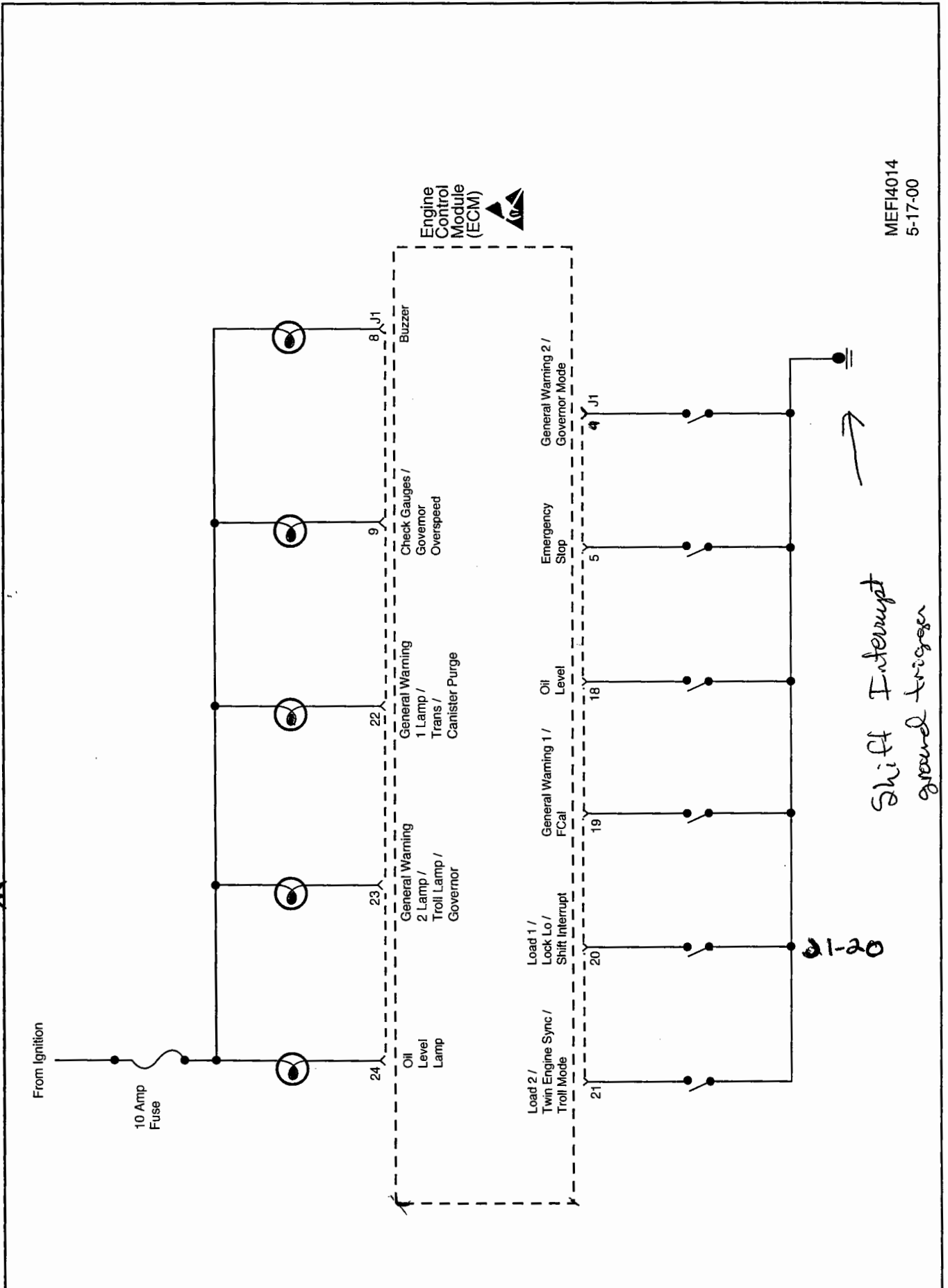
MEFI409
4-20-00

Engine Controls Schematics (8.1L - HO2S & EGR Valve)



MEFI4015
6-25-00

Engine Controls Schematics (8.1L - Discrete Inputs & Outputs)

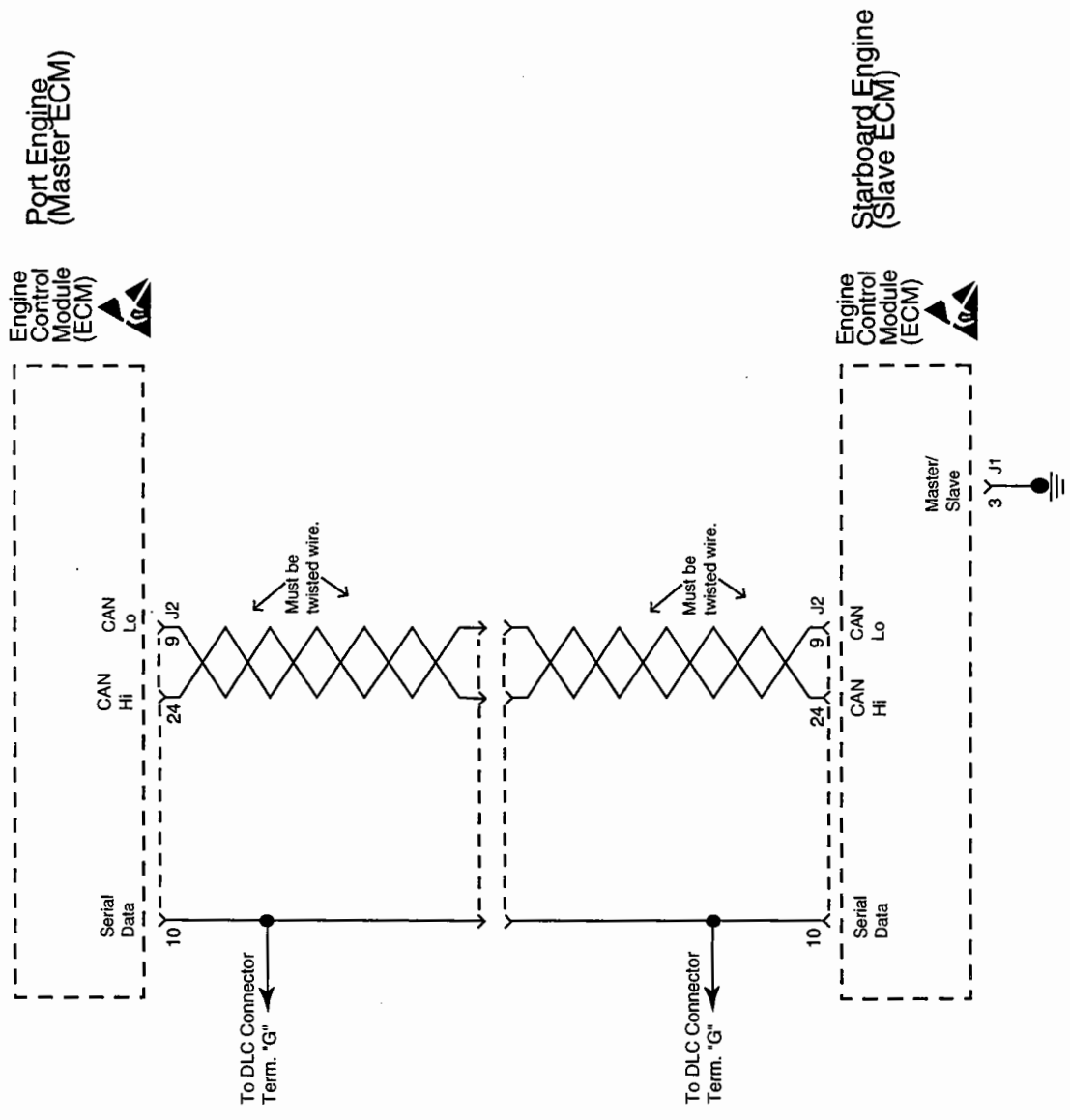


MEFI4014
5-17-00

Shift Interrupt
ground trigger

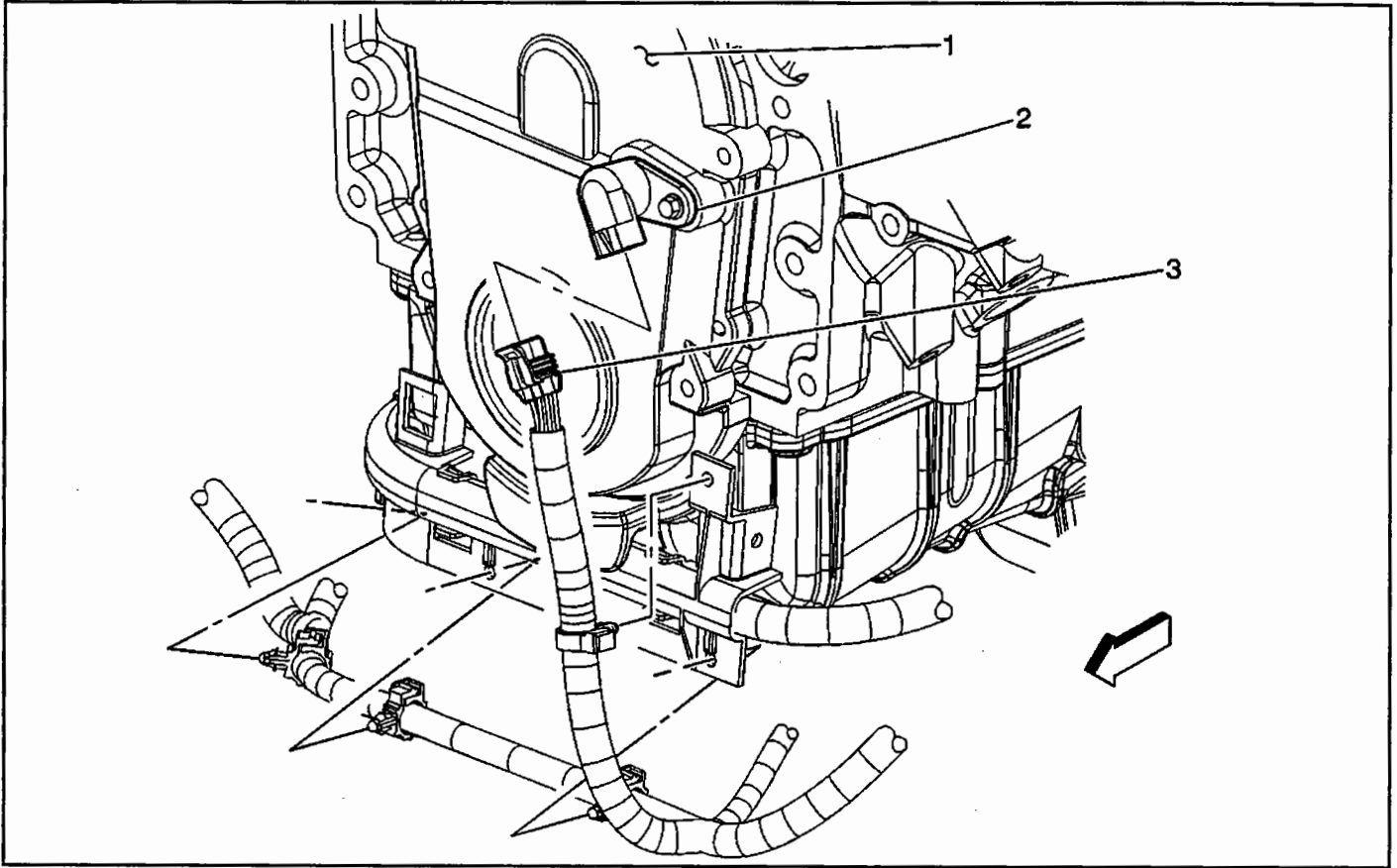
Handwritten notes:
COP - Muffler
Camp

Engine Controls Schematics (8.1L - Twin Engine)



MEFI4020
5-10-00

Camshaft Sensor - 8.1L

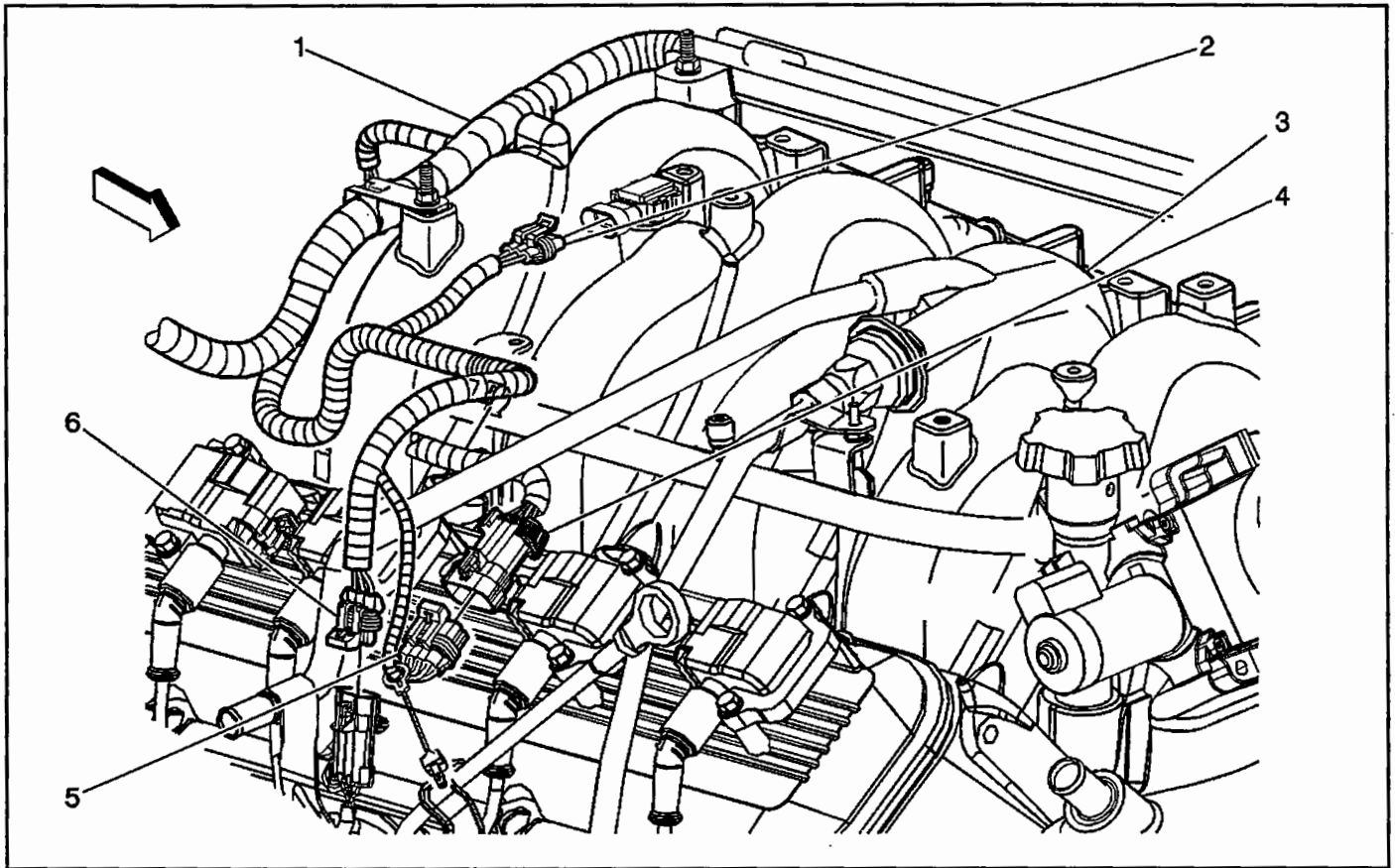


656525

Legend

- (1) Engine - 8.1L
- (2) Camshaft Sensor
- (3) Camshaft Sensor Connector

Engine View - Upper Right (8.1L)

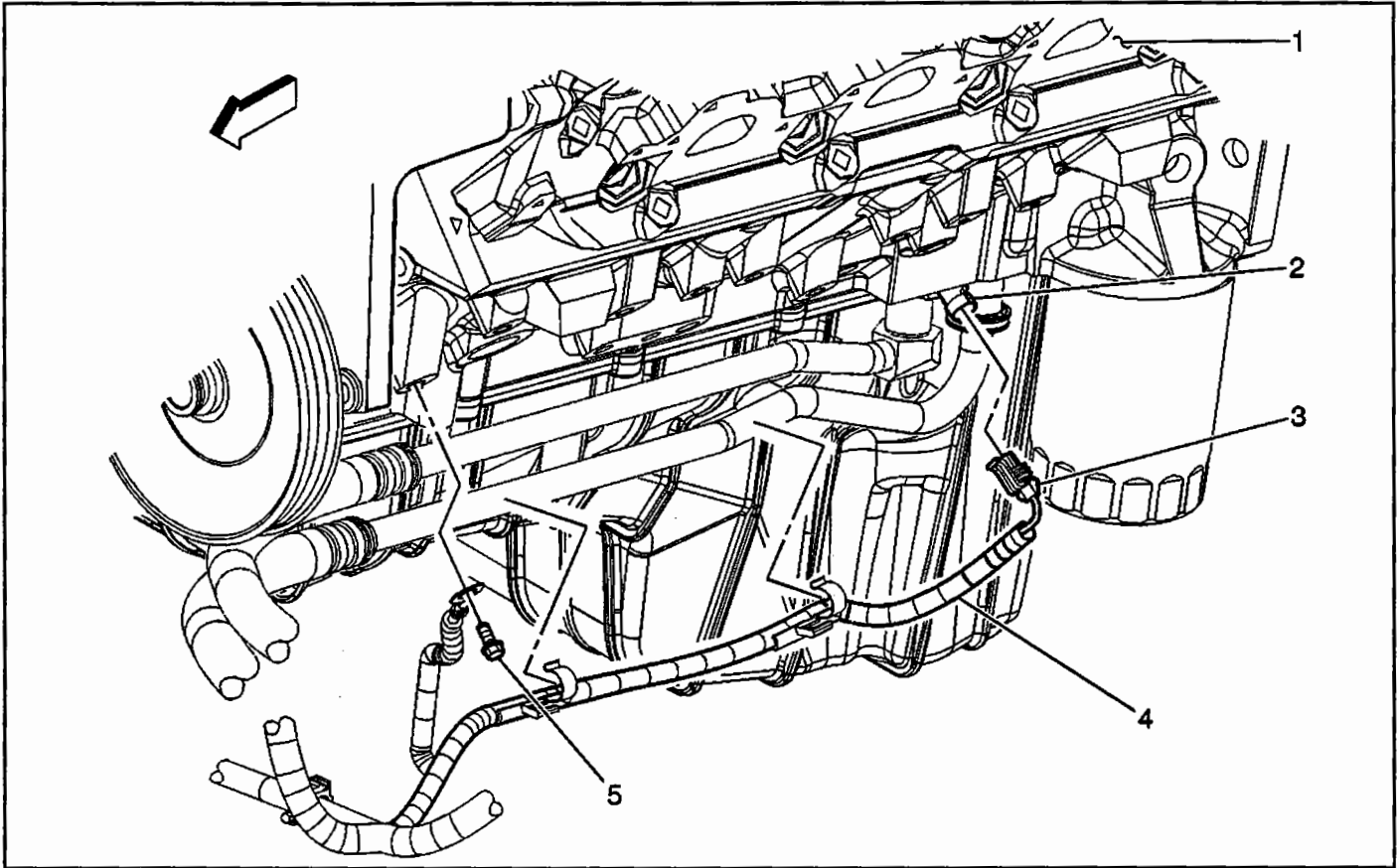


656520

Legend

- (1) Engine Harness
- (2) Manifold Absolute Pressure (MAP) Sensor
- (3) Engine - 8.1L
- (4) Engine Coil Harness Connector
- (5) Engine Coil Connector

Engine View - Lower Left (8.1L)

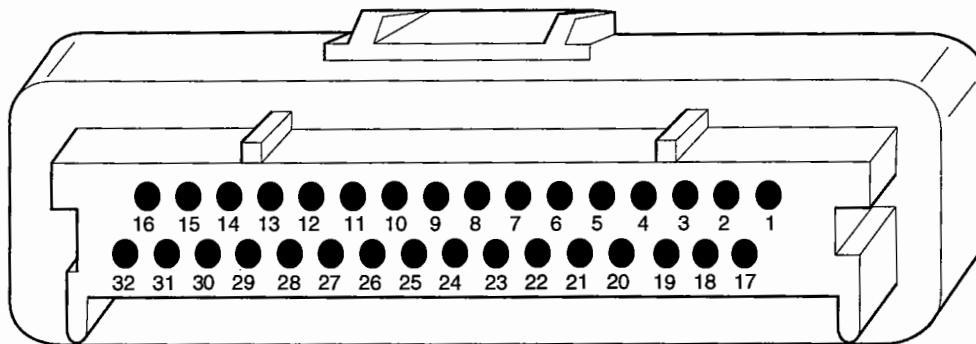


656528

Legend

- (1) Engine - 8.1L
- (2) Engine Knock Sensor
- (3) Engine Knock Sensor Connector
- (4) Engine Harness
- (5) Engine Harness Ground

ECM Connector Identification (1 of 2)

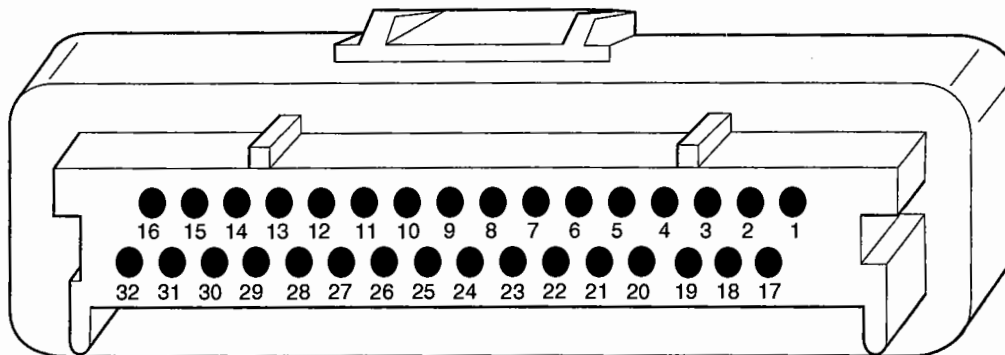


J-1

ECM 32 WAY OUTPUT CONNECTOR

ECM PIN NUMBER	CKT(WIRE) NUMBER	CKT (WIRE) COLOR	CIRCUIT DESCRIPTION
J1-1	468	LT GRN	KNOCK SENSOR 2 SIGNAL (OPTIONAL)
J1-2	451	BLK/WHT	DIAGNOSTIC "TEST" TERMINAL
J1-3	916	YEL	MASTER/SLAVE
J1-4			GENERAL WARNING 2 / GOVERNOR MODE
J1-5			EMERGENCY STOP
J1-6	485	DK GRN/WHT	FUEL PUMP RELAY CONTROL
J1-7			RPM CHANGE STATE
J1-8			BUZZER
J1-9			CHECK GAUGES / GOVERNOR OVERSPEED LAMP
J1-10			
J1-11	468	DK GRN	FUEL INJECTOR B DRIVER
J1-12			EXHAUST GAS RECIRCULATION (EGR) VALVE
J1-13	450	BLK	ECM GROUND
J1-14			TACHOMETER OUTPUT
J1-15	444	GRN/BLK	IDLE AIR CONTROL (IAC) COIL "B" LOW
J1-16	441	BLU/WHT	IDLE AIR CONTROL (IAC) COIL "A" HIGH
J1-17	467	DK BLU	KNOCK SENSOR 1 SIGNAL
J1-18			OIL LEVEL
J1-19			GENERAL WARNING 1 / FCAL
J1-20			LOAD 1 / LOCK LO / SHIFT INTERRUPT
J1-21			LOAD 2 / TWIN ENGINE SYNC / TROLL MODE
J1-22			GENERAL WARNING 1 LAMP / TRANS LAMP / CANISTER PURGE
J1-23			GENERAL WARNING 2 LAMP / TROLL LAMP / GOVERNOR
J1-24			OIL LEVEL LAMP
J1-25			
J1-26	467	DK BLU	FUEL INJECTOR A DRIVER
J1-27	444	GRN/BLK	IDLE AIR CONTROL (IAC) COIL "B" LOW
J1-28	450	BLK	ECM GROUND
J1-29	450	BLK	ECM GROUND
J1-30	443	GRN/WHT	IDLE AIR CONTROL (IAC) COIL "B" HIGH
J1-31	442	BLU/BLK	IDLE AIR CONTROL (IAC) COIL "A" LOW
J1-32			FUEL PRESSURE RELAY SENSE

ECM Connector Identification (2 of 2)



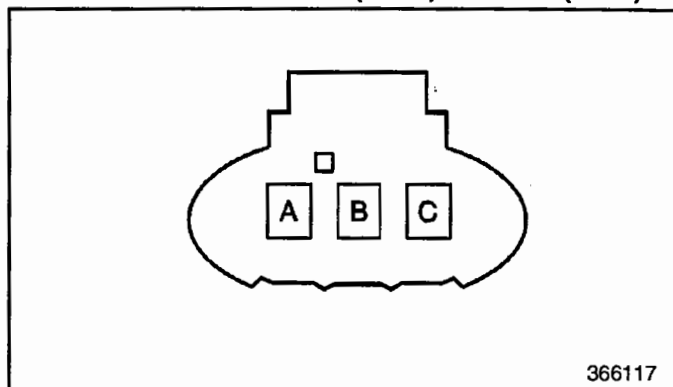
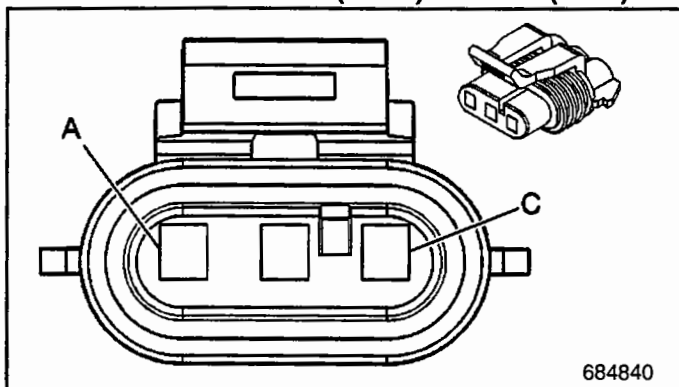
J-2

ECM 32 WAY OUTPUT CONNECTOR

ECM PIN NUMBER	CKT(WIRE) NUMBER	CKT (WIRE) COLOR	CIRCUIT DESCRIPTION
J2-1	440	ORN	BATTERY FEED
J2-2	416	GRY	5 VOLT REFERENCE
J2-3	814	BLK	SENSOR GROUND
J2-4			FUEL PRESSURE SENSOR SIGNAL
J2-5			EXHAUST GAS RECIRCULATION (EGR) VALVE FEEDBACK
J2-6			HEATED OXYGEN (HO2) SENSOR "1" SIGNAL
J2-7	410	YEL	ECT SENSOR SIGNAL
J2-8	432	LT GRN	MAP SENSOR SIGNAL
J2-9			
J2-10	461	ORN	SERIAL DATA
J2-11	410	YEL	TAC SERIAL DATA 2
J2-12	2123	LT BLU	IGNITION CONTROL H
J2-13	2125	DK GRN	IGNITION CONTROL F
J2-14	2122	PPL/WHT	IGNITION CONTROL D
J2-15	2128	RED/WHT	IGNITION CONTROL B / BYPASS (DISTRIBUTOR APP.)
J2-16	634	DK BLU/WHT	CRANK SENSOR SIGNAL
J2-17	631	RED	DEPSPOWER
J2-18	632	YEL/BLK	DEPSLO
J2-19	439	PNK	IGNITION FEED
J2-20			OIL PRESSURE INPUT
J2-21	472	TAN	IAT SENSOR SIGNAL
J2-22			HEATED OXYGEN (HO2) SENSOR "2" SIGNAL
J2-23	417	DK BLU	TP SENSOR SIGNAL
J2-24			
J2-25			SPEED SENSOR SIGNAL (VF)
J2-26			SPEED SENSOR SIGNAL (AN) / FUEL TEMPERATURE
J2-27	1061	ORN/BLK	TAC SERIAL DATA 1
J2-28	2124	LT BLU/WHT	IGNITION CONTROL G
J2-29	2126	GRN/WHT	IGNITION CONTROL E
J2-30	2127	RED	IGNITION CONTROL C
J2-31	2121	PPL	IGNITION CONTROL A
J2-32	633	BRN/WHT	CAM SENSOR SIGNAL

Camshaft Position (CMP) Sensor (8.1L)

Crankshaft Position (CKP) Sensor (8.1L)



684840

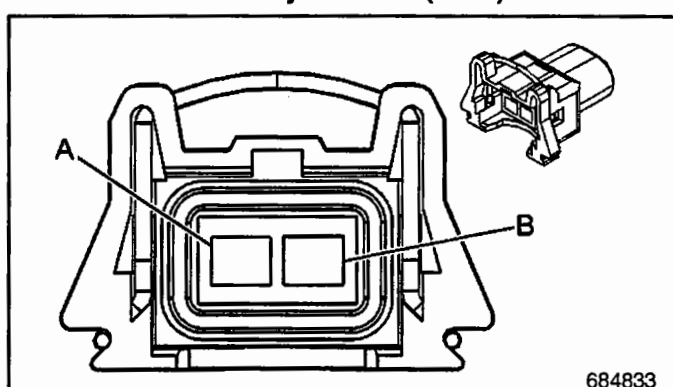
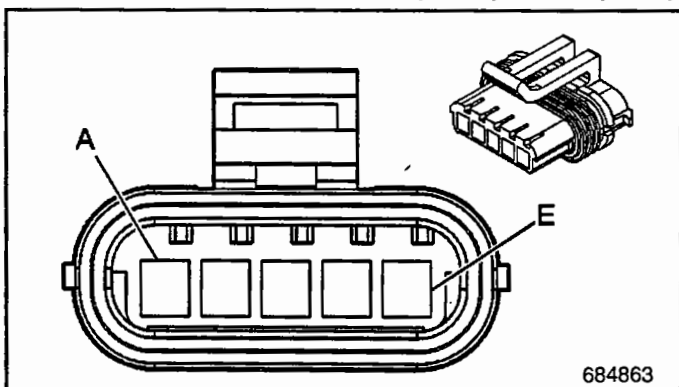
366117

Connector Part Information		<ul style="list-style-type: none"> • 12129946 • 3-Way F Metri-Pack 150 Series Sealed 	
Pin	Wire Color	Circuit No.	Function
A	RED	631	DEPSPOWER (12V Ref)
B	YEL/BLK	1868	DEPSLO (Low Ref)
C	BRN/WHT	633	CMP Sensor Signal

Connector Part Information		<ul style="list-style-type: none"> • 15324165 • 3-Way F Metri-Pack 150 Series Sealed 	
Pin	Wire Color	Circuit No.	Function
A	RED	631	DEPSPOWER (12V Ref)
B	YEL/BLK	1868	DEPSLO (Low Ref)
C	DK BLU/WHT	1869	CMP Sensor Signal

Exhaust Gas Recirculation (EGR) Valve (8.1L)

Fuel Injector #1 (8.1L)



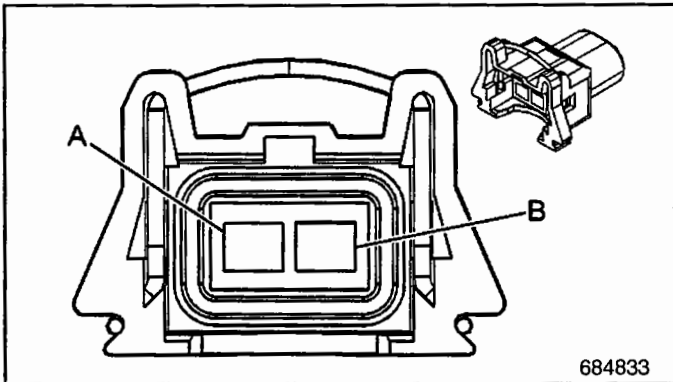
684863

684833

Connector Part Information		<ul style="list-style-type: none"> • 15324589 • 3-Way F Metri-Pack 150 Series Sealed 	
Pin	Wire Color	Circuit No.	Function
A	WHT	257	EGR Solenoid Control
B	GRY	1666	Sensor Ground
C	BRN	1456	EGR Valve Position Signal
D	GRY	416	5 Volt Reference
E	RED	1676	EGR Valve Supply Voltage

Connector Part Information		<ul style="list-style-type: none"> • 12129140 • 2-Way F Metri-Pack 280.1 P2S (BLK) 	
Pin	Wire Color	Circuit No.	Function
A	DK BLU	467	Fuel Injector 1 Control
B	PNK	439	Ignition Voltage

Fuel Injector #2 (8.1L)

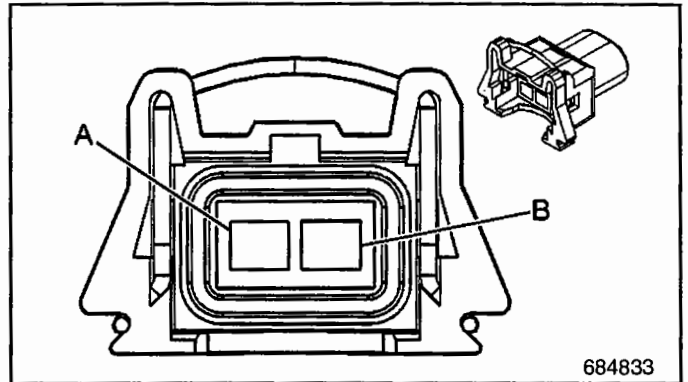


684833

Connector Part Information		<ul style="list-style-type: none"> • 12129140 • 2-Way F Metri-Pack 280.1 P2S (BLK) 	
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Pin	Wire Color	Circuit No.	Function
A	DK GRN	468	Fuel Injector 2 Control
B	PNK	439	Ignition Voltage

Fuel Injector #4 (8.1L)

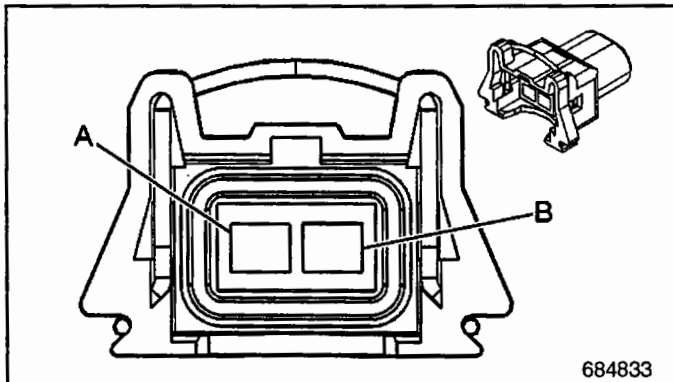


684833

Connector Part Information		<ul style="list-style-type: none"> • 12129140 • 2-Way F Metri-Pack 280.1 P2S (BLK) 	
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Pin	Wire Color	Circuit No.	Function
A	DK BLU	467	Fuel Injector 4 Control
B	PNK	439	Ignition Voltage

Fuel Injector #3 (8.1L)

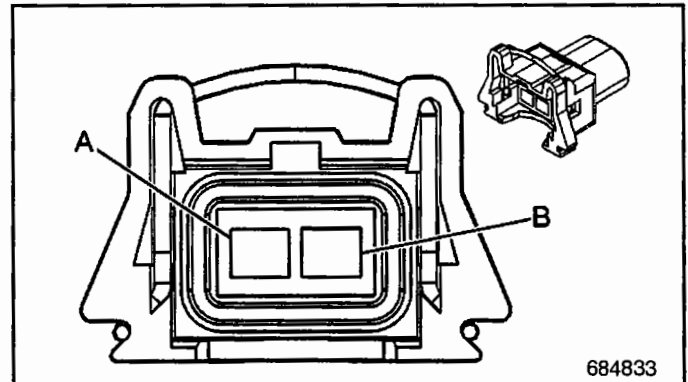


684833

Connector Part Information		<ul style="list-style-type: none"> • 12129140 • 2-Way F Metri-Pack 280.1 P2S (BLK) 	
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Pin	Wire Color	Circuit No.	Function
A	DK GRN	468	Fuel Injector 3 Control
B	PNK	439	Ignition Voltage

Fuel Injector #5 (8.1L)

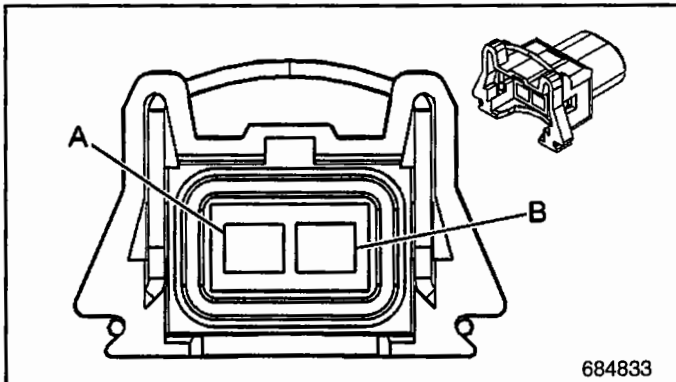


684833

Connector Part Information		<ul style="list-style-type: none"> • 12129140 • 2-Way F Metri-Pack 280.1 P2S (BLK) 	
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Pin	Wire Color	Circuit No.	Function
A	DK GRN	468	Fuel Injector 5 Control
B	PNK	439	Ignition Voltage

Fuel Injector #6 (8.1L)

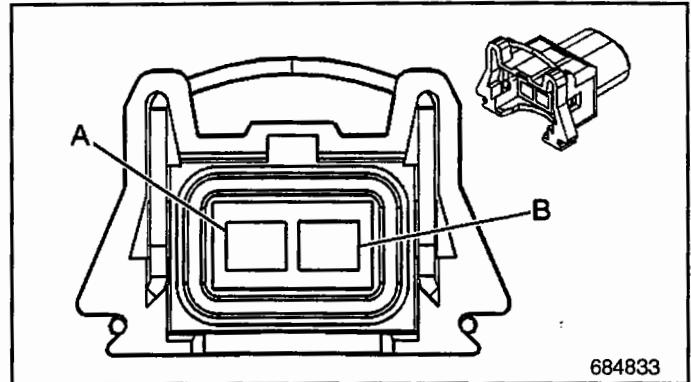


684833

Connector Part Information	• 12129140
	• 2-Way F Metri-Pack 280.1 P2S (BLK)

Pin	Wire Color	Circuit No.	Function
A	DK BLU	467	Fuel Injector 6 Control
B	PNK	439	Ignition Voltage

Fuel Injector #8 (8.1L)

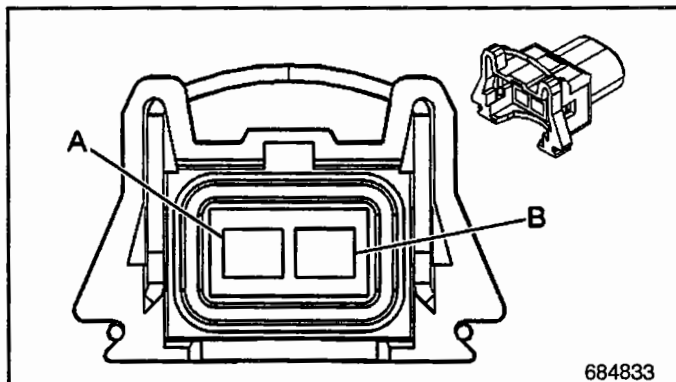


684833

Connector Part Information	• 12129140
	• 2-Way F Metri-Pack 280.1 P2S (BLK)

Pin	Wire Color	Circuit No.	Function
A	DK GRN	468	Fuel Injector 8 Control
B	PNK	439	Ignition Voltage

Fuel Injector #7 (8.1L)

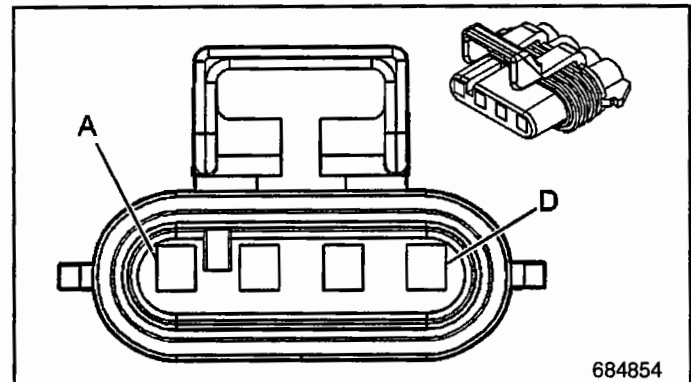


684833

Connector Part Information	• 12129140
	• 2-Way F Metri-Pack 280.1 P2S (BLK)

Pin	Wire Color	Circuit No.	Function
A	DK BLU	467	Fuel Injector 7 Control
B	PNK	439	Ignition Voltage

Ignition Coil/Driver - Cylinder #1 (8.1L)

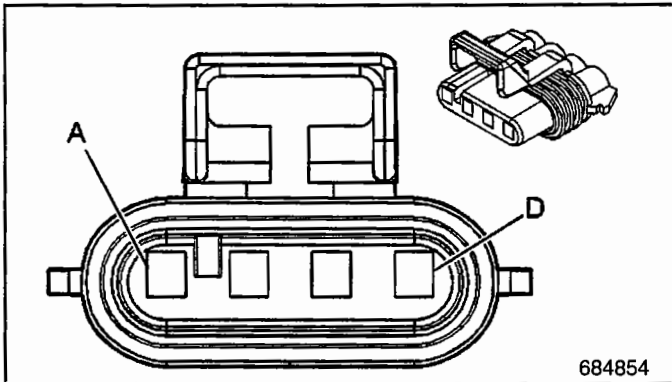


684854

Connector Part Information	• 12162144
	• 4-Way F Metri-Pack 150 Series Sealed (BLK)

Pin	Wire Color	Circuit No.	Function
A	BLK	151	Ground
B	BRN	2129	Low Reference
C	PPL	2121	IC 1 Control
D	PNK	39	Ignition Voltage

Ignition Coil/Driver - Cylinder #3 (8.1L)



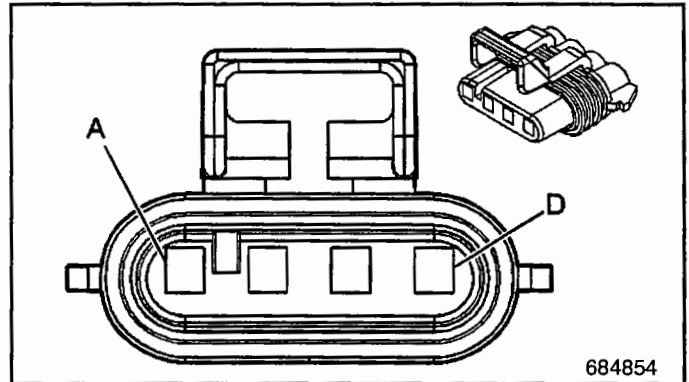
684854

Connector Part Information

- 12162144
- 4-Way F Metri-Pack
- 150 Series Sealed (BLK)

Pin	Wire Color	Circuit No.	Function
A	BLK	151	Ground
B	BRN	2129	Low Reference
C	LT BLU	2123	IC 3 Control
D	PNK	39	Ignition Voltage

Ignition Coil/Driver - Cylinder #7 (8.1L)



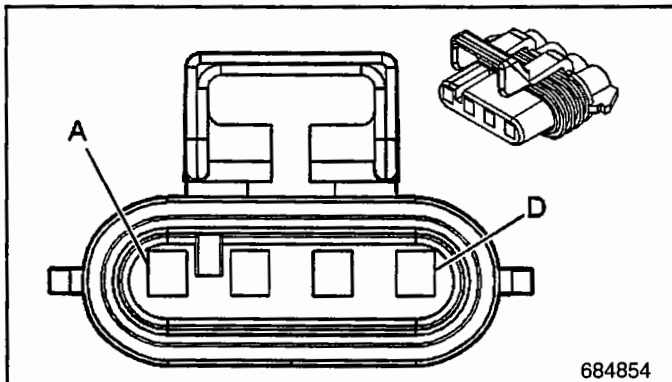
684854

Connector Part Information

- 12162144
- 4-Way F Metri-Pack
- 150 Series Sealed (BLK)

Pin	Wire Color	Circuit No.	Function
A	BLK	151	Ground
B	BRN	2129	Low Reference
C	RED	2127	IC 7 Control
D	PNK	39	Ignition Voltage

Ignition Coil/Driver - Cylinder #5 (8.1L)



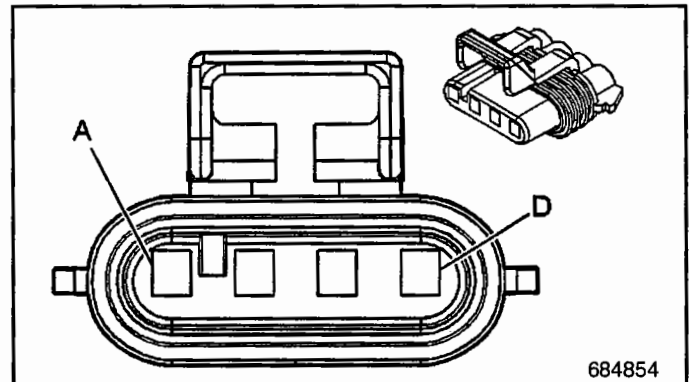
684854

Connector Part Information

- 12162144
- 4-Way F Metri-Pack
- 150 Series Sealed (BLK)

Pin	Wire Color	Circuit No.	Function
A	BLK	151	Ground
B	BRN	2129	Low Reference
C	DK GRN	2125	IC 5 Control
D	PNK	39	Ignition Voltage

Ignition Coil/Driver - Cylinder #2 (8.1L)



684854

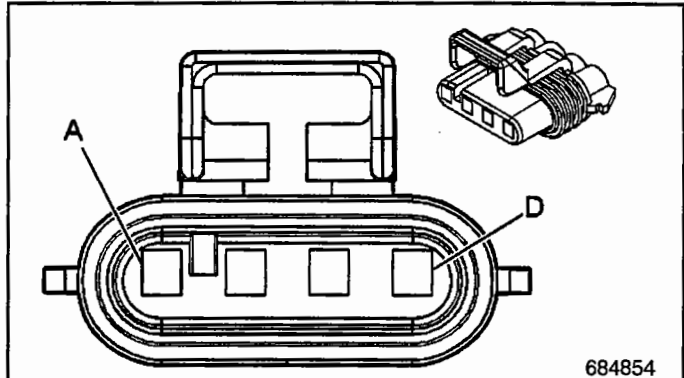
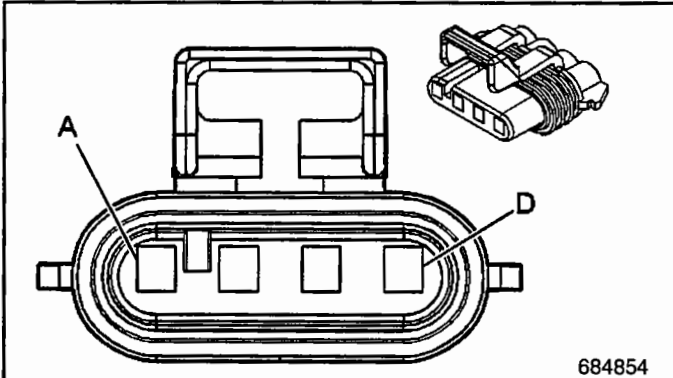
Connector Part Information

- 12162144
- 4-Way F Metri-Pack
- 150 Series Sealed (BLK)

Pin	Wire Color	Circuit No.	Function
A	BLK	151	Ground
B	BRN	2130	Low Reference
C	RED	2122	IC 2 Control
D	PNK	39	Ignition Voltage

Ignition Coil/Driver - Cylinder #4 (8.1L)

Ignition Coil/Driver - Cylinder #8 (8.1L)

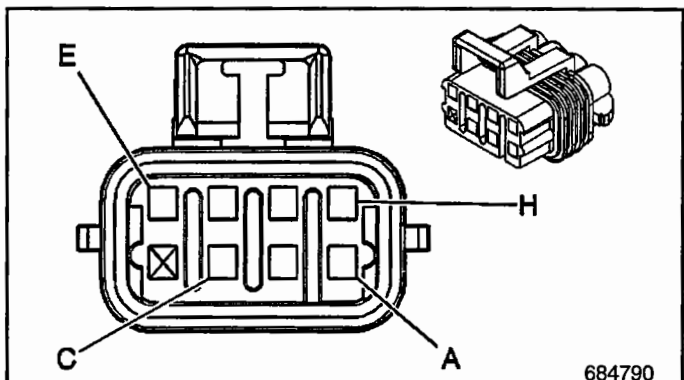
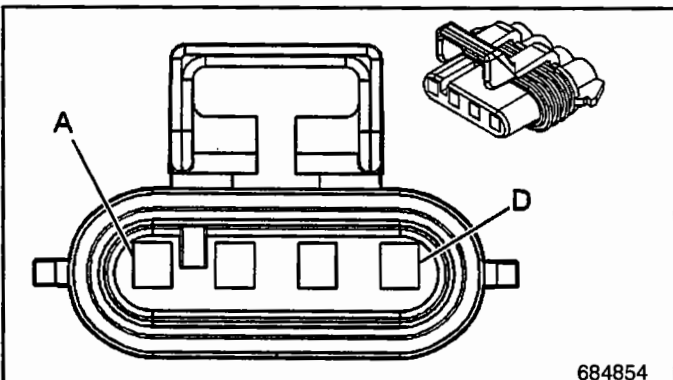


Connector Part Information		<ul style="list-style-type: none"> • 12162144 • 4-Way F Metri-Pack 150 Series Sealed (BLK) 	
Pin	Wire Color	Circuit No.	Function
A	BLK	151	Ground
B	BRN	2130	Low Reference
C	DK GRN	2124	IC 4 Control
D	PNK	39	Ignition Voltage

Connector Part Information		<ul style="list-style-type: none"> • 12162144 • 4-Way F Metri-Pack 150 Series Sealed (BLK) 	
Pin	Wire Color	Circuit No.	Function
A	BLK	151	Ground
B	BRN	2130	Low Reference
C	PPL	2128	IC 8 Control
D	PNK	39	Ignition Voltage

Ignition Coil/Driver - Cylinder #6 (8.1L)

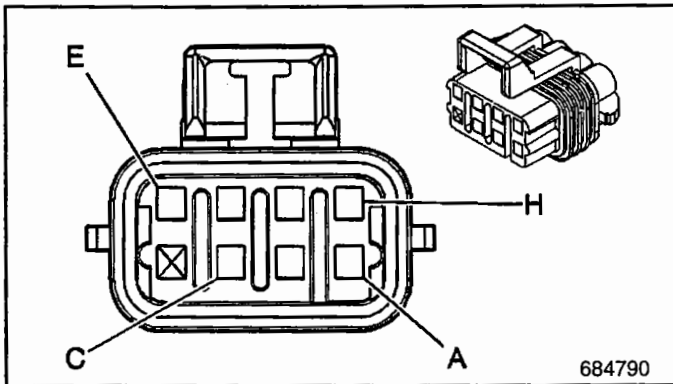
Ignition Coils - 1,3,5,7 (Inline Connector-8.1L)



Connector Part Information		<ul style="list-style-type: none"> • 12162144 • 4-Way F Metri-Pack 150 Series Sealed (BLK) 	
Pin	Wire Color	Circuit No.	Function
A	BLK	151	Ground
B	BRN	2130	Low Reference
C	LT BLU	2126	IC 6 Control
D	PNK	39	Ignition Voltage

Connector Part Information		<ul style="list-style-type: none"> • 12047938 • 7-Way F Metri-Pack 150 Series Sealed (LT GRN) 	
Pin	Wire Color	Circuit No.	Function
A	BLK	151	Ground
B	RED	2127	IC 7 Control
C	DK GRN	2125	IC 5 Control
E	BRN	2129	Low Reference
F	LT BLU	2123	IC 3 Control
G	PPL	2121	IC 1 Control
H	PNK	39	Ignition Voltage

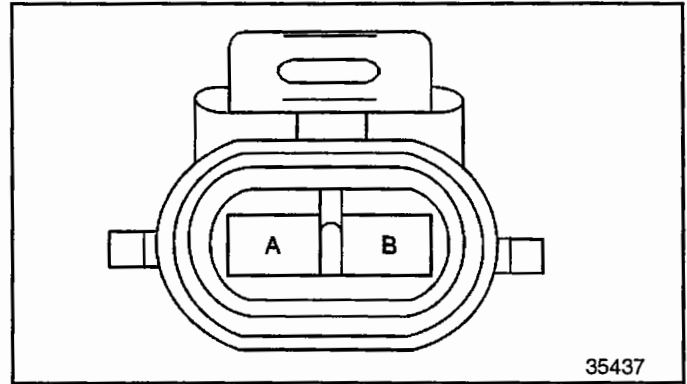
Ignition Coils - 2,4,6,8 (Inline Connector-8.1L)



Connector Part Information	<ul style="list-style-type: none"> • 12047938 • 7-Way F Metri-Pack 150 Series Sealed (LT GRY)
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Pin	Wire Color	Circuit No.	Function
A	BLK	151	Ground
B	RED/WHT	2122	IC 2 Control
C	DK GRN/WHT	2124	IC 4 Control
E	BRN/WHT	2130	Low Reference
F	LT BLU/WHT	2126	IC 6 Control
G	PPL/WHT	2128	IC 8 Control
H	PNK	39	Ignition Voltage

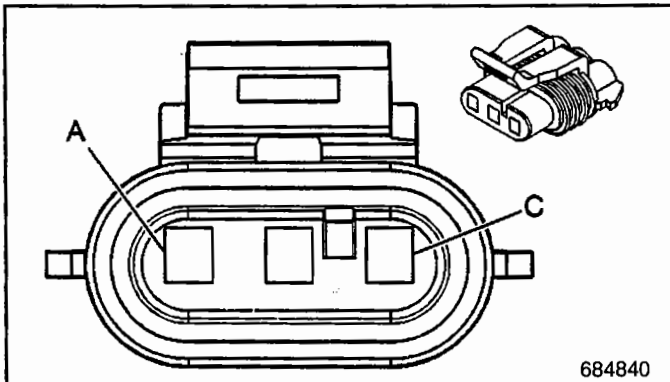
Knock Sensor, LH - Odd (8.1L)



Connector Part Information	<ul style="list-style-type: none"> • 15355362 • 1-Way F Metri-Pack 150 Series Sealed (NAT)
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Pin	Wire Color	Circuit No.	Function
A	DK BLU	496	KS 1 Signal

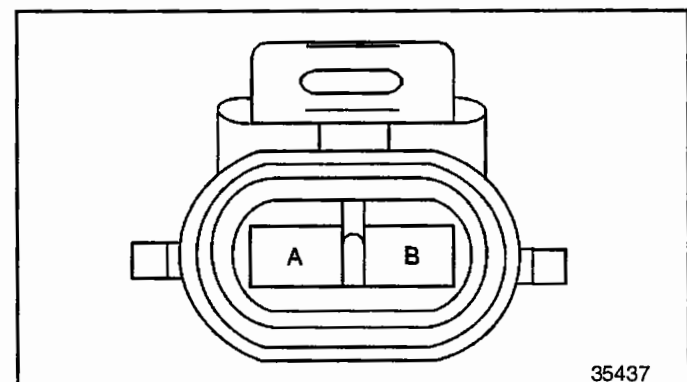
Manifold Absolute Pressure (MAP) Sensor (8.1L)



Connector Part Information	<ul style="list-style-type: none"> • 12129946 • 3-Way F Metri-Pack 150 Series Sealed (GRY)
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Pin	Wire Color	Circuit No.	Function
A	BLK	814	Low Reference
B	LT GRN	432	MAP Sensor Signal
C	GRY	416E	5 Volt Reference

Knock Sensor, RH - Even (8.1L)



Connector Part Information	<ul style="list-style-type: none"> • 15355362 • 1-Way F Metri-Pack 150 Series Sealed (NAT)
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Pin	Wire Color	Circuit No.	Function
A	LT BLU	1876	KS 2 Signal

Diagnostic Information and Procedures

A Diagnostic Starting Point - Engine Controls

Begin the system diagnosis with *A Diagnostic System Check-Engine Controls*. The Diagnostic System Check will provide the following information:

- The ability of the control module to communicate through the serial data circuit.
- The identification of any stored Diagnostic Trouble Codes (DTCs) and Logged Warnings.

The use of the Diagnostic System Check will identify the correct procedure for diagnosing the system.

A Diagnostic System Check - Engine Controls

Description

The Diagnostic System Check is an organized approach to identifying a condition that is created by a malfunction in

the electronic engine control system. The Diagnostic System Check must be the starting point for any driveability concern. The Diagnostic System Check directs the service technician to the next logical step in order to diagnose the concern. Understanding, and correctly using the diagnostic table reduces diagnostic time, and prevents the replacement of good parts.

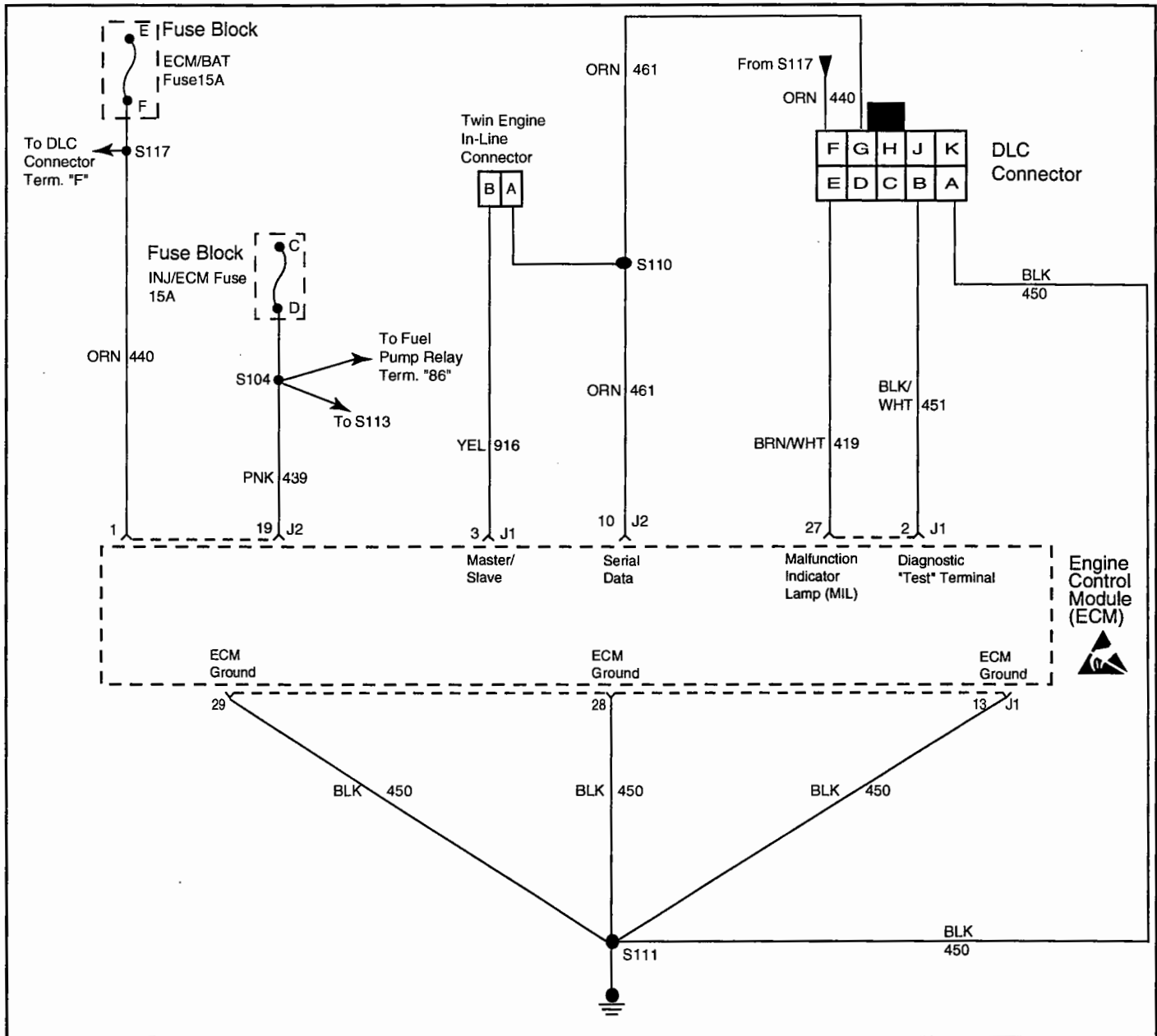
Test Description

Number(s) below refer to the Step number(s) on the Diagnostic Table:

1. The MIL should be "ON" steady with the ignition "ON," engine "OFF." If not, Table A-1 should be used to isolate the malfunction.
3. Checks the serial data circuit and ensures that the ECM is able to transmit serial data.
5. If the engine will not start, Table A-3 should be used to diagnose the condition.
8. A scan tool parameter which is not within the typical range may help to isolate the area which is causing the problem.

On-Board Diagnostic (OBD) System Check - Scan

Step	Action	Value	Yes	No
1	<p>Important:</p> <ul style="list-style-type: none"> Do not perform this diagnostic if there is not a driveability concern, unless another procedure directs you to this diagnostic. Before you proceed with diagnosis, search for applicable service bulletins. Unless a diagnostic procedure instructs you, DO NOT clear the DTC's. If there is a condition with the starting system, repair that first. Ensure the battery has a full charge. Ensure the battery cables are clean and tight. Ensure the ECM grounds are clean, tight and in the correct location. <p>Install a scan tool. Does the scan tool turn ON?</p>	—	Go to Step 2	Go to Data Link Connector Diagnosis
2	<p>Attempt to start the engine. Does the engine start and idle?</p>	—	Go to Step 3	Go to Engine Cranks but Does Not Run
3	<p>Select the DTC display function on the scan tool. Does the scan tool display DTCs?</p>	—	Go to Applicable DTC Table	Go to Step 4
4	<ol style="list-style-type: none"> Review the following symptoms. Refer to the applicable symptom diagnostic table. <ul style="list-style-type: none"> Hard Start Surges/Chuggles Lack of Power, Sluggishness or Sponginess Detonation/Spark Knock Hesitation, Sag or Stumble Cuts Out, Misses Poor Fuel Economy Rough, Unstable or Incorrect Idle and Stalling Dieseling, Run-On Backfire <p>Did you find and correct the condition?</p>	—	System OK	Go to Intermittent Conditions



Data Link Connector Diagnosis

MEFI4302
4-20-00

Circuit Description

Use a properly functioning scan tool with the diagnostic tables in this section. DO NOT clear the DTC's unless directed by a diagnostic procedure. Clearing the DTC's may also clear valuable diagnostic information.

Test Description

Number(s) below refer to the step number(s) on the diagnostic table:

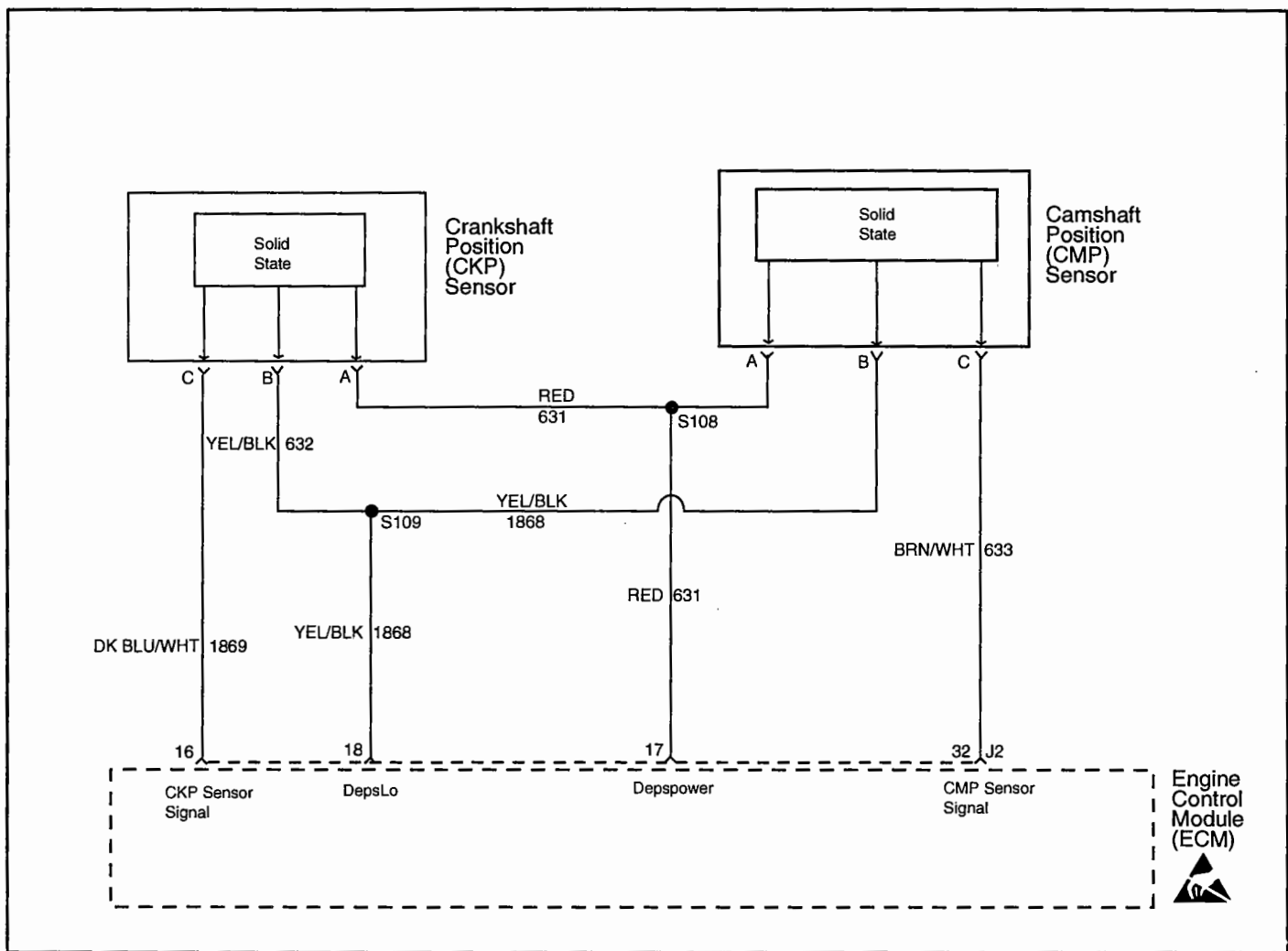
3. An engine that just cranks and does not attempt to start indicates that the ECM is not powered-up.
5. This step is checking for a B+ supply to the Data Link Connector (DLC).
6. A ground must be available for the scan tool to function properly.
9. A no start condition occurs when the fuse(s) for the battery or ignition feed circuits is open. The MIL is inoperative when the battery and ignition feed circuit fuses open. Inspect the circuits for being grounded when either of these fuses open.
12. The scan tool does not communicate when the serial data circuit from the ECM to the DLC is open.
14. If the test lamp not illuminate for a circuit, inspect the fuse for being open. If the fuse is open, inspect the circuit for a short to ground.
15. Inspect for an open ground circuit.
16. Inspect for an open fuse that supplies the DLC. If the fuse is open, repair the grounded circuit.

Data Link Connector Diagnosis

Step	Action	Value	Yes	No
1	Did you perform the On-Board Diagnostic (OBD) System Check?	—	Go to Step 2	Go to OBD System Check
2	Important: This table assumes that the scan tool you are using is functional. 1. Turn ON the ignition leaving the engine OFF. 2. Connect the scan tool to the Data Link Connector (DLC). Does the scan tool power-up?	—	Go to Step 3	Go to Step 5
3	Does the engine start and continue to operate?	—	Go to Step 6	Go to Step 4
4	Does the engine start and stall?	—	Go to Step 12	Go to Step 9
5	1. Disconnect the scan tool from the DLC. 2. Turn ON the ignition leaving the engine OFF. 3. Probe the DLC terminal F using a test lamp J 34142-B connected to the battery ground. Is the test lamp illuminated?	—	Go to Step 6	Go to Step 16
6	Probe the DLC terminal A using a test lamp J 34142-B connected to B+. Is the test lamp illuminated?	—	Go to Step 7	Go to Step 8
7	Inspect the scan tool connections at the DLC. Also inspect the terminals for proper terminal tension at the DLC. Did you find and repair the condition?	—	Go to OBD System Check	Go to Step 12
8	Repair the open ground circuit to the DLC terminal A. Is the action complete?	—	Go to OBD System Check	—
9	1. Turn OFF the ignition. 2. Disconnect the ECM connector J2. 3. Turn ON the ignition leaving the engine OFF. 4. Probe the ECM battery and the ECM ignition feed circuits (J2-1 and J2-19) in the ECM harness connector using a test lamp J 34142-B connected to a battery ground. Does the test lamp illuminate for each circuit?	—	Go to Step 10	Go to Step 14
10	1. Turn OFF the ignition. 2. Disconnect the ECM connector J1. 3. Measure the resistance between the battery ground and the ECM ground circuits (J1-13, J1-28 and J1-29) in the ECM harness connectors using a DMM J 39200. Does the DMM display between the specified range on each circuit?	0-2 ohms	Go to Step 11	Go to Step 15
11	Inspect the ECM for proper connections. Did you find and correct the condition?	—	Go to OBD System Check	Go to Step 13
12	Inspect the serial data circuit for being open, shorted or a poor connection at the ECM. Did you find and repair the condition?	—	Go to OBD System Check	Go to Step 13

Data Link Connector Diagnosis (cont'd)

Step	Action	Value	Yes	No
13	Replace the ECM. Is action complete?	—	Go to OBD System Check	—
14	Repair the circuit that did not illuminate the test lamp. Is action complete?	—	Go to OBD System Check	—
15	Repair the faulty ECM ground circuit(s). Is action complete?	—	Go to OBD System Check	—
16	Repair the faulty B+ supply circuit. Is action complete?	—	Go to OBD System Check	—



MEFI4301
5-17-00

Engine Cranks but Does Not Run

Circuit Description

The Engine Cranks but Does Not Run diagnostic table assumes that battery condition and engine cranking speed are OK. If the battery condition and the cranking speed are not OK, refer to those conditions first. Make sure that there is adequate fuel in the fuel tank(s).

Test Description

Number(s) below refer to the step number(s) on the diagnostic table:

4. It may be necessary to connect a battery charger to the battery for this step. If the battery state of charge is low, the scan tool may reset during the cranking test.
5. This step tests the system relay for proper operation. The system relay supplies voltage to the injectors and the ignition coils. When the system relay is not operating properly, a no start condition occurs. If the test lamp does not illuminate, this indicates the system relay is not supplying a voltage to the fuses.
6. The Crankshaft Position sensor is located at the left rear of the engine.
7. The Camshaft Position sensor is located in the front engine cover.
8. The ignition feed circuit for the Camshaft and Crankshaft Position sensors is internally connected within the ECM. A short to ground on either circuit will cause a no start condition.
10. You may need to get close to the fuel pump in order to hear if the fuel pump is operating.
12. At this point, the engine should start. Refer to *Hard Start Symptom* for further diagnosis.

Engine Cranks but Does Not Run

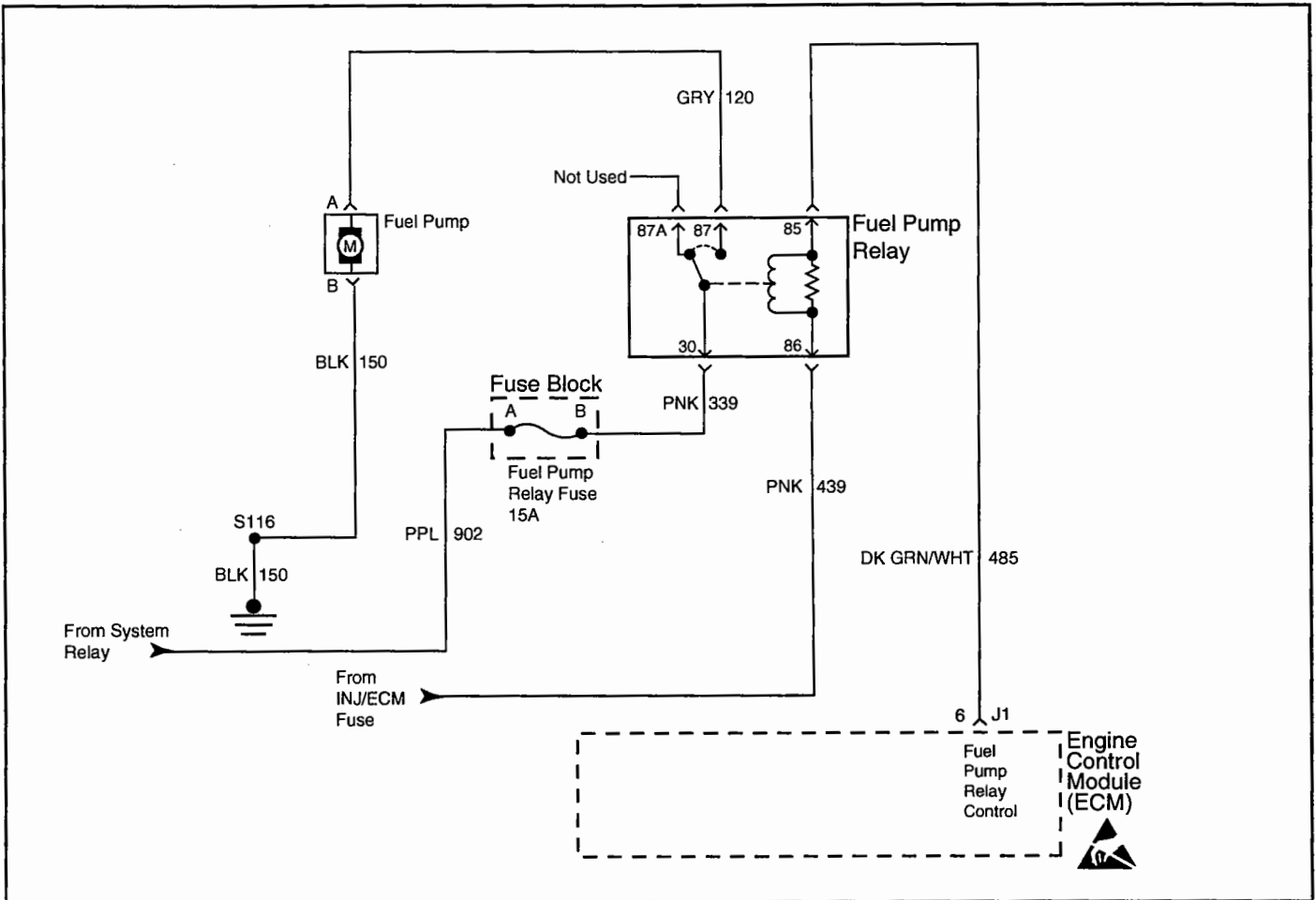
Step	Action	Value	Yes	No
1	Did you perform the On-Board Diagnostic (OBD) System Check?	—	Go to Step 2	Go to OBD System Check
2	Important: Refer to the applicable DTC table if any of the following DTC's are set: 41 or 81. Monitor the engine speed while cranking the engine. Is engine RPM indicated on the scan tool?	—	Go to Step 3	Go to Step 4
3	1. Turn ON the ignition leaving the engine OFF. 2. Probe both sides of the fuses listed below using a test test lamp J 34142-B connected to ground. • INJ A • INJ B • ECM Does the test lamp illuminate on both sides of the fuses?	—	Go to Step 7	Go to System Relay Diagnosis
4	1. Disconnect the Crankshaft Position (CKP) sensor electrical connector. 2. Measure the voltage at the ignition feed circuit at the CKP electrical connector using a DMM J 39200. Does the DMM display near the specified voltage?	B+	Go to Step 11	Go to Step 5
5	1. Disconnect the Camshaft Position (CMP) sensor electrical connector. 2. Measure the voltage at the ignition feed circuit at the CMP electrical connector using a DMM J 39200. Does the DMM display near the specified voltage?	B+	Go to Step 12	Go to Step 6
6	Inspect the Camshaft and Crankshaft Position sensor ignition feed circuits for a short to ground. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
7	Monitor the engine coolant temperature using the scan tool. Is the engine coolant temperature on the scan tool close to the actual engine temperature?	—	Go to Step 8	Go to DTC 15 Engine Coolant Temperature (ECT) Sensor Circuit High Voltage
8	Enable the fuel pump using the scan tool. Does the fuel pump operate?	—	Go to Step 9	Go to Fuel Pump Relay Diagnosis
9	1. Turn OFF the ignition. 2. Install a fuel pressure gauge. Important: The fuel pump operates for about 2 seconds when the ignition is turned ON. The fuel pressure must be observed when the fuel pump is operating. 3. Turn ON the ignition leaving the engine OFF. 4. Observe the fuel pressure while the fuel pump is operating. Is the fuel pressure within the specified range?	379-427 kPa (55-62 psi)	Go to Step 10	Go to Fuel System Diagnosis

Engine Cranks but Does Not Run (cont'd)

Step	Action	Value	Yes	No
10	<p>Perform the following additional inspections:</p> <ul style="list-style-type: none"> Inspect that the throttle angle is at 0% at a closed throttle. If the throttle angle is not at 0%, refer to DTC 21 <i>Throttle Position (TP) Sensor Circuit High Voltage</i> or DTC 22 <i>Throttle Position (TP) Sensor Circuit Low Voltage</i>. Inspect the spark plugs for being gas fouled. If the spark plugs are gas fouled, determine what caused the rich condition. Inspect for an engine mechanical failure that causes an engine not to start (i.e. timing chain, low compression). Refer to <i>Engine Compression Test</i> in Engine Mechanical. Compare MAP/BARO parameters to another vehicle. The parameter values should be close to each other. 	—	Go to Step 14	Go to Hard Start for diagnosis
11	<p>Replace the CKP sensor. Refer to <i>Crankshaft Position Sensor Replacement</i>. Is the action complete?</p>	—	Go to Step 14	—
12	<p>Replace the CMP sensor. Refer to <i>Camshaft Position Sensor Replacement</i>. Is the action complete?</p>	—	Go to Step 14	—
13	<p>Replace the ECM. Is the action complete?</p>	—	Go to Step 14	—
14	<p>1. Select the Diagnostic Trouble Codes (DTC) option and the Clear DTC option using the scan tool. 2. Attempt to start the engine. Does the engine start and continue to run?</p>	—	Go to Step 15	Go to Step 2
15	<p>1. Idle the engine at the normal operating temperature. 2. Select the Diagnostic Trouble Codes (DTC) option using the scan tool. Are any DTCs displayed?</p>	—	Go to the applicable DTC table	System OK

System Relay Diagnosis

Step	Action	Value	Yes	No
1	Did you perform the On-Board Diagnostic (OBD) System Check?	—	Go to Step 2	Go to OBD System Check
2	1. Turn OFF the ignition. 2. Disconnect the system relay electrical connector. 3. Probe the system relay B+ feed circuit (switch side of the relay) using a test lamp J 34142-B connected to a ground. Does the test lamp illuminate?	—	Go to Step 3	Go to Step 8
3	1. Turn ON the ignition leaving the engine OFF. 2. Probe the system relay ignition feed circuit using a test lamp J 34142-B connected to a ground. Does the test lamp illuminate?	—	Go to Step 4	Go to Step 9
4	1. Turn OFF the ignition. 2. Measure the resistance of the system relay ground circuit using a DMM J 39200 connected to the battery ground. Is the resistance less than the specified value?	0-5 ohms	Go to Step 5	Go to Step 10
5	1. Turn OFF the ignition. 2. Jumper the system relay B+ feed circuit and the system relay load circuit together using a fused jumper wire. 3. Probe the fuses for the following components with a test lamp J 34142-B connected to a ground. <ul style="list-style-type: none"> • Injectors • Ignition coils Does the test lamp illuminate?	—	Go to Step 6	Go to Step 11
6	Inspect for poor terminal contact at the system relay connector. Did you find and correct the condition?	—	System OK	Go to Step 7
7	Replace the system relay. Is the action complete?	—	System OK	—
8	Repair the open B+ supply to the system relay. Is the action complete?	—	System OK	—
9	Repair the ignition feed circuit to the system relay. Is the action complete?	—	System OK	—
10	Repair the system relay ground circuit. Is the action complete?	—	System OK	—
11	Repair the system relay load circuit. Is the action complete?	—	System OK	—



MEFI4304
4-20-00

Fuel Pump Relay Circuit Diagnosis

Circuit Description

When the ignition switch is ON, the ECM activates the electric fuel pump. The fuel pump remains ON as long as the ECM receives reference pulses from the ignition system. If there are no reference pulses, the ECM turns the fuel pump OFF after about 2 seconds. The pump delivers fuel to the fuel rail and injectors, then to the pressure regulator, where the system pressure remains at 379-427 kPa (55-62 psi) while the fuel pump is running. Excess fuel returns to the fuel tank. When the engine is stopped, a scan tool in the output controls function can turn ON the fuel pump.

Improper fuel system pressure results in one or many of the following symptoms:

- Cranks but will not run
- Cuts out, may feel like an ignition problem
- Poor fuel economy
- Loss of power
- Hesitation
- DTCs

Diagnostic Aids

The following conditions may have caused the fuel pump fuse to open:

- The fuse is faulty
- There is an intermittent short in the fuel pump power feed circuit.
- The fuel pump has an intermittent internal problem.

For an intermittent condition, refer to *Symptoms*.

Test Description

Number(s) below refer to the step number(s) on the diagnostic table:

3. Refer to Thumbnail Schematic for proper terminal identification.
5. The test lamp only illuminates for two seconds even through the scan tool commanded position is ON. You will have to command the fuel pump OFF then ON to re-enable the ECM fuel pump control.
12. Inspect the fuel pump fuse for an open. If the fuse is open, inspect the circuit for a short to ground.
20. Inspect the fuel pump fuse for an open. If the fuse is open, inspect the circuit for a short to ground.

Fuel Pump Relay Circuit Diagnosis

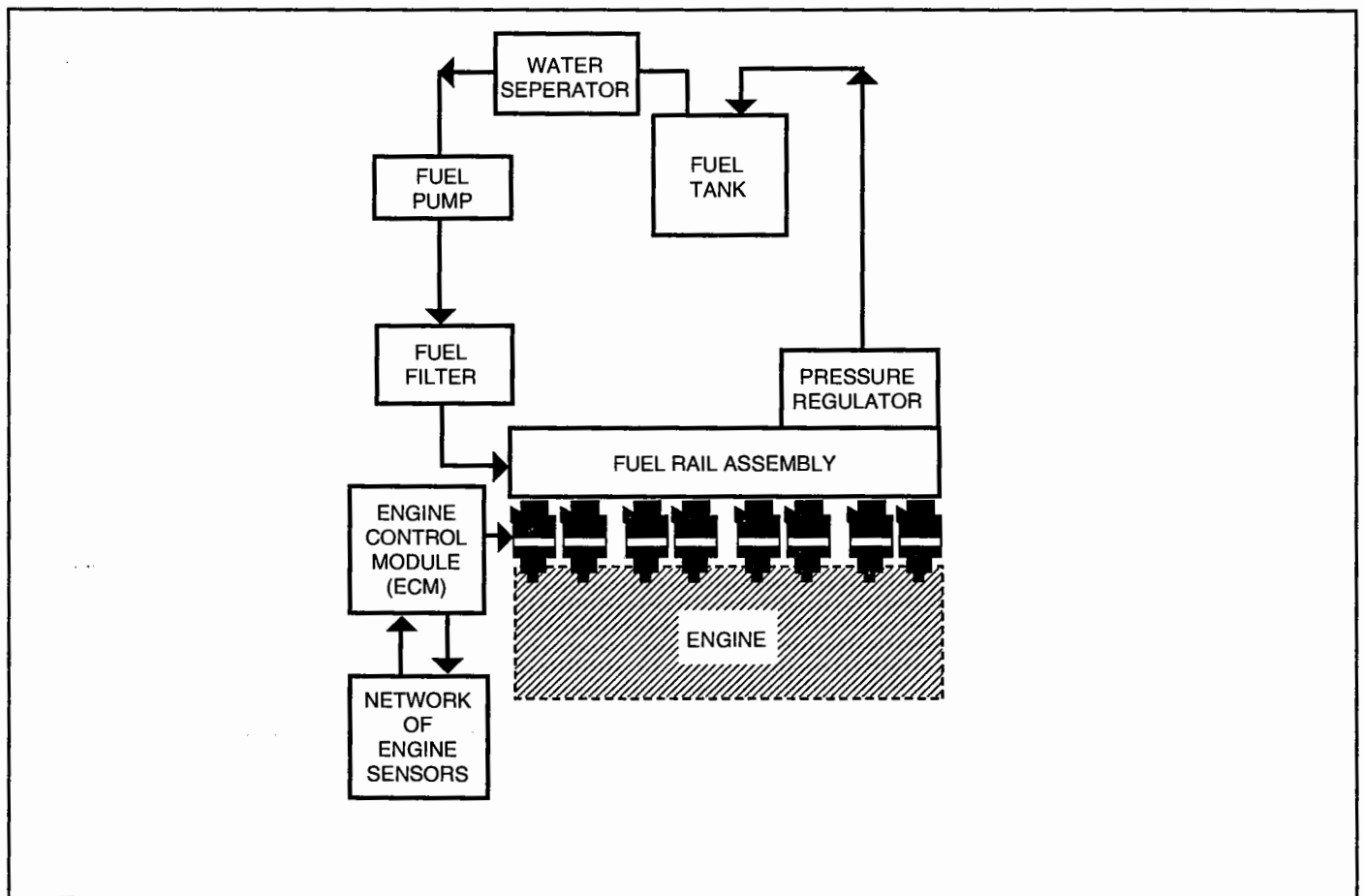
Step	Action	Value	Yes	No
1	Did you perform the On-Board Diagnostic (OBD) System Check?	—	Go to Step 2	Go to OBD System Check
2	Check the fuel pump fuse. Is the fuse open?	—	Go to Step 9	Go to Step 3
3	1. Install a scan tool. 2. Disconnect the fuel pump relay harness connector. 3. Turn ON the ignition leaving the engine OFF. 4. Probe the fuel pump relay battery feed circuit at the harness connector with a test lamp J 34142-B connected to ground. Does the test lamp illuminate?	—	Go to Step 4	Go to Step 12
4	Probe the fuel pump relay ground circuit at the harness connector with a test lamp J 34142-B connected to B+. Refer to the thumbnail wiring schematic for the proper terminal identification. Does the test lamp illuminate?	—	Go to Step 5	Go to Step 13
5	1. Probe the fuel pump control circuit at the harness connector with a test lamp J 34142-B connected to ground. Refer to the thumbnail wiring schematic for the proper terminal identification. 2. Enable the fuel pump using the scan tool. Does the test lamp illuminate?	—	Go to Step 6	Go to Step 11
6	Important: Ignition must be ON before performing this step. Jumper the fuel pump relay battery feed circuit to the fuel pump load circuit at the harness connector using a fused jumper wire. Does the fuel pump operate?	—	Go to Step 18	Go to Step 7
7	1. Leave the fused jumper wire connected. 2. Disconnect the fuel pump harness connector at the fuel pump. 3. Probe the power feed circuit in the fuel pump harness connector with a test lamp J 34142-B connected to ground. Does the test lamp illuminate?	—	Go to Step 8	Go to Step 14
8	1. Leave the fused jumper wire connected. 2. Connect the test lamp J 34142-B between the battery feed circuit and the ground circuit in the fuel pump harness connector. Does the test lamp illuminate?	—	Go to Step 25	Go to Step 15
9	1. Turn OFF the ignition. 2. Remove the fuel pump fuse. 3. Disconnect the fuel pump harness connector at the fuel pump.			

Fuel Pump Relay Circuit Diagnosis (cont'd)

Step	Action	Value	Yes	No
9	4. Probe the load circuit for the fuel pump relay at the harness connector with a test lamp J 34142-B connected to B+. Does the test lamp illuminate?	—	Go to Step 16	Go to Step 10
10	Probe the battery feed circuit for the fuel pump relay at the harness connector with a test lamp J 34142-B connected to B+. Does the test lamp illuminate?	—	Go to Step 20	Go to Step 21
11	1. Turn OFF the ignition. 2. Disconnect the ECM connector J1. 3. Measure the continuity of the fuel pump relay control circuit from the fuel pump relay harness connector to the ECM connector using the DMM J 39200. Does the DMM display the specified value or lower?	5 ohms	Go to Step 22	Go to Step 17
12	Repair the open or grounded battery feed circuit to the relay. Replace the fuel pump fuse if the fuse is open. Is the action complete?	—	Go to Step 26	—
13	Repair the open fuel pump relay ground circuit. Is the action complete?	—	Go to Step 26	—
14	Repair the open circuit between the fuel pump relay and the fuel pump. Is the action complete?	—	Go to Step 26	—
15	Repair the open fuel pump ground circuit. Is the action complete?	—	Go to Step 26	—
16	Repair the short to ground in the fuel pump relay load circuit between the relay and the fuel pump. Is the action complete?	—	Go to Step 26	—
17	Repair the fuel pump relay control circuit. Is the action complete?	—	Go to Step 26	—
18	Inspect for poor connections at the relay harness connector. Did you find and correct the condition?	—	Go to Step 26	Go to Step 19
19	Replace the relay. Refer to <i>Fuel Pump Relay Replacement</i> . Is the action complete?	—	Go to Step 26	—
20	Repair the short to ground in the battery feed circuit to the fuel pump relay. Is the action complete?	—	Go to Step 26	—
21	1. Turn OFF the ignition. 2. Re-install the fuel pump relay. 3. Install a new fuse. 4. Connect the fuel pump harness to the fuel pump. 5. Turn ON the ignition leaving the engine OFF. 6. Command the fuel pump relay ON using a scan tool. Is the fuel pump fuse open?	—	Go to Step 24	Go to Diagnostic Aids

Fuel Pump Relay Circuit Diagnosis (cont'd)

Step	Action	Value	Yes	No
22	Inspect for a poor connection at the ECM. Did you find and correct the condition?	—	Go to Step 26	Go to Step 23
23	Replace the ECM. Is the action complete?	—	Go to Step 26	—
24	1. Inspect the fuel pump harness for a short to ground. 2. If you find a short, repair the circuit as necessary. Did you find and correct the condition?	—	Go to Step 26	Go to Step 25
25	Important: Inspect for poor electrical connections at the fuel pump harness before replacing the fuel pump. Replace the fuel pump. Is the action complete?	—	Go to Step 26	—
26	1. Select the Diagnostic Trouble Code (DTC) option and the Clear DTC Information option using the scan tool. 2. Attempt to start the engine. Does the engine start and continue to operate?	—	Go to Step 27	Go to Step 2
27	1. Idle the engine until the normal operating temperature is reached. 2. Select the Diagnostic Trouble Code (DTC) option. Are any DTCs displayed?	—	Go to the applicable DTC table	System OK



MEFI 4305
4-20-00

Fuel System Diagnosis

Circuit Description

When the ignition switch is ON, the ECM activates the electric fuel pump. The fuel pump remains ON as long as the ECM receives reference pulses from the ignition system. If there are no reference pulses, the ECM turns the fuel pump OFF after about 2 seconds.

The electric pump delivers fuel through an in-pipe fuel filter to the fuel rail assembly. The fuel pump provides fuel at a pressure above the pressure needed by the fuel injectors. A fuel pressure regulator, attached to the fuel rail, keeps the fuel available to the fuel injectors at a regulated pressure. Unused fuel returns to the fuel tank by a separate fuel return pipe.

Test Description

Number(s) below refer to the step number(s) on the diagnostic table:

2. When the ignition switch is ON and the fuel pump is running, the fuel pressure indicated by the fuel pressure gauge should read 379-427 kPa (55-62 psi). The spring pressure inside the fuel pressure regulator controls the fuel pressure.
3. A fuel system that drops more than 14 kPa (2 psi) in 10 minutes has a leak in one or more of the following areas:

- The fuel pump check valve.
 - The fuel pump flex pipe.
 - The valve or valve seat within the fuel pressure regulator.
 - The fuel injector(s).
4. A fuel system that drops more than 14 kPa (2 psi) in 10 minutes after being relieved to 69 kPa (10 psi) indicates a leaking fuel pump check valve.
 5. Fuel pressure that drops off during acceleration, cruise or hard cornering may cause a lean condition. A lean condition can cause a loss of power, surging or misfire.
 8. When the engine is at idle, the manifold pressure is low (high vacuum). This low pressure (high vacuum) is applied to the fuel pressure regulator diaphragm. The low pressure (high vacuum) will offset the pressure being applied to the fuel pressure regulator diaphragm by the spring inside the fuel pressure regulator. When this happens, the result is lower fuel pressure. The fuel pressure at idle will vary slightly as the barometric pressure changes, but the fuel pressure at idle should always be less than the fuel pressure noted in step 2 with the engine OFF.

12. A rich condition may result from the fuel pressure being above 427 kPa (62 psi). Driveability conditions associated with rich conditions can include hard starting followed by black smoke and a strong sulfur smell in the exhaust.
13. This test determines if the high fuel pressure is due to a restricted fuel return pipe or if the high fuel pressure is due to a faulty fuel pressure regulator.
15. A lean condition may result from the fuel pressure being below 379 kPa (55 psi). Driveability conditions associated with lean conditions can include hard starting (when the engine is cold), hesitation, poor driveability, lack of power, surging and misfiring.

Notice: Do not allow the fuel pressure to exceed 517 kPa (75 psi). Excessive pressure may damage the fuel pressure regulator.

16. Restricting the fuel return pipe with the J 37287 fuel pipe shut-off adapter causes the fuel pressure to rise above the regulated pressure. Using a scan tool to pressurize the fuel system, the fuel pressure should rise above 427 kPa (62 psi) as the valve on the fuel pipe shut-off adapter connected to the fuel return pipe becomes partially closed.
22. Check the spark plug associated with a particular fuel injector for fouling or saturation in order to

determine if that particular fuel injector is leaking. If checking the spark plug associated with a particular fuel injector for fouling or saturation does not determine that a particular fuel injector is leaking, use the following procedure.

1. Remove the fuel rail. Refer to *Fuel Rail Assembly Replacement*.
2. Reinstall the crossover pipe to the right fuel rail. Refer to *Fuel Rail Assembly Replacement*.
3. Connect the fuel feed pipe and the fuel return pipe to the fuel rail. Refer to *Fuel Rail Assembly Replacement*.
4. Lift the fuel rail just enough to leave the fuel injector nozzles in the fuel injector ports.

Caution: In order to reduce the risk of fire and personal injury that may result from fuel spraying on the engine, verify that the fuel rail is positioned over the fuel injector ports. Also verify that the fuel injector retaining clips are intact.

5. Pressurize the fuel system by using the scan tool fuel pump enable.
6. Visually and physically inspect the fuel injector nozzles for leaks.

Fuel System Diagnosis

Step	Action	Value	Yes	No
1	Did you perform the On-Board Diagnostic (OBD) System Check?	—	Go to Step 2	Go to OBD System Check
2	<ol style="list-style-type: none"> 1. Turn OFF the ignition. <p>Caution: Wrap a shop towel around the fuel pressure connection in order to reduce the risk of fire and personal injury. The towel will absorb any fuel leakage that occurs during the connection of the fuel pressure gauge. Place the towel in an approved container when the connection of the fuel pressure gauge is complete.</p> <ol style="list-style-type: none"> 2. Install the J 34730-1A fuel pressure gauge. 3. Place the bleed hose of the fuel pressure gauge into an approved gasoline container. 4. Turn the ignition ON leaving the engine OFF. 5. Bleed the air out of the fuel pressure gauge. 6. Turn the ignition OFF for 10 seconds. 7. Turn the ignition ON leaving the engine OFF. <p>Important: The fuel pump will run for approximately 2 seconds. Cycle the ignition as necessary in order to achieve the highest possible fuel pressure.</p> <ol style="list-style-type: none"> 8. Observe the fuel pressure with the fuel pump running. Is the fuel pressure within the specified limits? 	379-427 kPa (55-62 psi)	Go to Step 3	Go to Step 12

Fuel System Diagnosis (cont'd)

Step	Action	Value	Yes	No
3	Important: The fuel pressure may vary slightly when the fuel pump stops running. After the fuel pump stops running, the fuel pressure should stabilize and remain constant. Does the fuel pressure drop more than the specified value in 10 minutes?	—	Go to Step 10	Go to Step 4
4	Relieve the fuel pressure to the first specified value. Does the fuel pressure drop more than the second specified value in 10 minutes?	69 kPa (10 psi) 14 kPa (2 psi)	Go to Step 19	Go to Step 5
5	Do you suspect the fuel pressure of dropping-off during acceleration, cruise or hard cornering?	—	Go to Step 6	Go to Step 8
6	Visually and physically inspect the following items for a restriction: <ul style="list-style-type: none"> The fuel filter The fuel feed pipe Did you find a restriction?	—	Go to Step 24	Go to Step 7
7	1. Remove the fuel sender assembly. 2. Visually and physically inspect the following items: <ul style="list-style-type: none"> The fuel strainer/check valve for a restriction. The fuel pump pipe for leaks. Verify the fuel pump is the correct fuel pump for this vehicle. Did you find a problem in any of these areas?	—	Go to Step 24	Go to Step 19
8	1. Start the engine. 2. Allow the engine to idle at normal operating temperature. Does the fuel pressure drop by the amount specified?	21-69 kPa (3-10 psi)	Go to Symptoms	Go to Step 9
9	1. Disconnect the vacuum hose from the fuel pressure regulator. 2. With the engine idling, apply 12-14 inches of vacuum to the fuel pressure regulator. Does the fuel pressure drop by the amount specified?	21-69 kPa (3-10 psi)	Go to Step 20	Go to Step 21
10	1. Relieve the fuel pressure. Refer to <i>Fuel Pressure Relief Procedure</i> . 2. Disconnect the fuel feed pipe and the fuel return pipe from the fuel rail. 3. Install the J 37287 fuel pipe shut-off adapters between the fuel feed pipe and the fuel return pipe and the fuel rail. 4. Open the valves on the fuel pipe shut-off adapters. 5. Turn the ignition ON. 6. Pressurize the fuel system using a scan tool. 7. Place the bleed hose of the fuel pressure gauge into			

Fuel System Diagnosis (cont'd)

Step	Action	Value	Yes	No
10	<p>an approved gasoline container.</p> <p>8. Bleed the air out of the fuel pressure gauge.</p> <p>9. Wait for the fuel pressure to build.</p> <p>10. Close the valve in the fuel pipe shut-off adapter that is connected to the fuel return pipe.</p> <p>Does the fuel pressure remain constant?</p>	—	Go to Step 19	Go to Step 11
11	<p>1. Open the valve in the fuel pipe shut-off adapter that is connected to the fuel feed pipe.</p> <p>2. Pressurize the fuel system using a scan tool.</p> <p>3. Wait for the fuel pressure to build.</p> <p>4. Close the valve in the fuel pipe shut-off adapter that is connected to the fuel return pipe.</p> <p>Does the fuel pressure remain constant?</p>	—	Go to Step 21	Go to Step 22
12	Is the fuel pressure above the specified limit?	427 kPa (62 psi)	Go to Step 13	Go to Step 15
13	<p>1. Relieve the fuel pressure. Refer to the <i>Fuel Pressure Relief Procedure</i>.</p> <p>2. Disconnect the fuel return pipe from the fuel rail.</p> <p>3. Attach a length of flexible fuel hose to the fuel rail outlet passage.</p> <p>4. Place the open end of the flexible fuel hose into an approved gasoline container.</p> <p>5. Turn the ignition OFF for 10 seconds.</p> <p>6. Turn the ignition ON.</p> <p>7. Observe the fuel pressure with the fuel pump running.</p> <p>Is the fuel pressure within the specified limits?</p>	379-427 kPa (55-62 psi)	Go to Step 23	Go to Step 14
14	<p>Visually and physically inspect the fuel rail outlet passages for a restriction.</p> <p>Was a restriction found?</p>	—	Go to Step 24	Go to Step 21
15	Is the fuel pressure above the specified value?	0 kPa (0 psi)	Go to Step 16	Go to Step 17
16	<p>1. Relieve the fuel pressure. Refer to <i>Fuel Pressure Relief Procedure</i>.</p> <p>2. Disconnect the fuel return pipe from the fuel rail.</p> <p>3. Install the J 37287 fuel pipe shut-off adapter between the fuel return pipe and the fuel rail.</p> <p>4. Open the valve on the fuel pipe shut-off adapter.</p> <p>5. Turn the ignition ON.</p> <p>6. Pressurize the fuel system using a scan tool.</p> <p>7. Place the bleed hose of the fuel pressure gauge into an approved gasoline container.</p> <p>8. Bleed the air out of the fuel pressure gauge.</p> <p>Notice: Do not allow the fuel pressure to exceed 517 kPa (75 psi). Excessive pressure may damage the fuel</p>			

Fuel System Diagnosis (cont'd)

Step	Action	Value	Yes	No
16	pressure regulator. 9. Slowly close the valve in the fuel pipe shut-off adapter that is connected to the fuel return pipe. Does the fuel pressure rise above the specified value?	427 kPa (62 psi)	Go to Step 21	Go to Step 7
17	Turn ON the fuel pump using a scan tool. Does the fuel pump run?	—	Go to Step 18	Go to Fuel Pump Relay Circuit Diagnosis
18	Visually and physically inspect the following items: <ul style="list-style-type: none"> • The fuel filter for obstructions. • The fuel feed pipe for a restriction. • The fuel strainer for obstructions. • The fuel pump pipe for leaks. Did you find a problem in any of these areas?	—	Go to Step 24	Go to Step 19
19	Replace the fuel pump. Is the action complete?	—	System OK	—
20	Locate and repair the loss of vacuum to the fuel pressure regulator. Is the action complete?	—	System OK	—
21	Replace the fuel pressure regulator. Is the action complete?	—	System OK	—
22	Locate and replace any leaking fuel injector(s). Is the action complete?	—	System OK	—
23	Locate and repair the restriction in the fuel return pipe. Is the action complete?	—	System OK	—
24	Repair the problem as necessary. Is the action complete?	—	System OK	—

Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35 Degrees C (50-95 Degrees F)

Test Description

- The engine coolant temperature affects the ability of the fuel injector tester to detect a faulty fuel injector. If the engine coolant temperature is NOT between 10-35 degrees C (50-95 degrees F), use *Fuel Injector Test - Engine Coolant Temperature (ECT) Outside 10-35 Degrees C (50-95 Degrees F)* table.
- The first second of the voltage displayed by the DMM may be inaccurate due to the initial current surge. Therefore, record the lowest voltage displayed by the DMM after the first second of the test. The voltage displayed by the DMM should be within the specified range. Refer to the Example. The voltage displayed by the DMM may increase throughout the test as the fuel injector windings warm and the resistance of the fuel injector windings changes. An erratic voltage reading with large fluctuations in voltage that do not stabilize, indicates an intermittent connection with the fuel injector.

Resistance Ohms	Voltage Specification at 10-35 Degrees C (50-95 Degrees F)	
11.8-12.6	5.7-6.6 V	
Fuel Injector Number	Voltage Reading	Pass/Fail
1	6.3	P
2	5.9	P
3	6.2	P
4	6.1	P
5	4.8	F
6	6.0	P
7	5.0	P
8	5.3	P

Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35 Degrees C (50-95 Degrees F)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Connect the scan tool. 2. Check the engine coolant temperature. Is the engine coolant temperature within the specified limits?	10°C-35°C (50°F-95°F)	Go to Step 3	Go to Fuel Injector Coil Test-ECT Outside 10-35°C (50-95°F)
3	1. Turn the ignition OFF. Notice: Be careful not to flood a single cylinder. 2. Relieve the fuel pressure per manufacturers recommendation. 3. Access the fuel injector electrical connectors as required. 4. Connect the J 39021 fuel injector tester to B+ and ground. 5. Set the amperage supply selector switch on the fuel injector tester to the Coil Test 0.5 amp position. 6. Connect the leads from the DMM to the fuel injector tester. 7. Set the DMM to the tenths scale (0.0). 8. Connect the fuel injector tester to a fuel injector using the J 39021-380 injector test adapter. Important: Check the engine coolant temperature again in order to ensure that the correct chart is being used.			

Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35 Degrees C (50-95 Degrees F) (cont'd)

Step	Action	Value	Yes	No
3	9. Press the Push to Start Test button on the fuel injector tester. Important: The voltage reading may rise during the test. 10. Observe the voltage reading on the DMM. 11. Record the lowest voltage observed after the first second of the test. 12. Repeat steps 8 through 11 for each fuel injector. Did any fuel injector have an erratic voltage reading with large fluctuations in voltage that do not stabilize, or a voltage reading outside the specified limits?	5.7-6.6 V	Go to Step 4	Go to Fuel Injector Balance Test with Special Tool
4	Replace the faulty fuel injectors. Refer to <i>Fuel Injector Replacement</i> . Is the action complete?	—	Go to Fuel Injector Balance Test with Special Tool	—

Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Outside 10-35 Degrees C (50-95 Degrees F)

Test Description

- The engine coolant temperature affects the ability of the fuel injector tester to detect a faulty fuel injector. If the engine coolant temperature is between 10-35 degrees C (50-95 degrees F), use *Fuel Injector Test - Engine Coolant Temperature (ECT) Between 10-35 Degrees C (50-95 Degrees F)* table.
- The first second of the voltage displayed by the DMM may be inaccurate due to the initial current surge. Therefore, record the lowest voltage displayed by the DMM after the first second of the test. The voltage displayed by the DMM may increase throughout the test as the fuel injector windings warm and the resistance of the fuel injector windings changes. An erratic voltage reading with large fluctuations in voltage that do not stabilize, indicates an intermittent connection with the fuel injector. From the voltages recorded, identify the highest voltage, excluding any voltages above 9.5 volts. Subtract each voltage that is not above 9.5 volts from the highest voltage. Record each subtracted value. Refer to the Example. The subtracted value that is more than 0.6 volt is faulty. Replace the fuel injector. A fuel injector with a recorded voltage above 9.5 volts is also faulty. Replace the fuel injector.

Highest Voltage Reading		Acceptable Subtracted Value Above/Below 10-35°C (50-95°F)	
7.1 V		0.6 V	
Injector Number	Voltage	Subtracted Value	Pass/Fail
1	9.8	—	F
2	6.6	0.5	P
3	6.9	0.2	P
4	5.8	1.3	F
5	7.0	0.1	P
6	7.1	0.0	P
7	9.6	—	F
8	6.0	1.1	F

Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Outside 10-35 Degrees C (50-95 Degrees F)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Connect the scan tool. 2. Check the engine coolant temperature. Is the engine coolant temperature within the specified limits?	10°C-35°C (50°F-95°F)	Go to Step 3	Go to Fuel Injector Coil Test-ECT Between 10-35°C (50-95°F)
3	1. Turn the ignition OFF. Notice: Be careful not to flood a single cylinder. 2. Relieve the fuel pressure per manufacturers recommendation. 3. Access the fuel injector electrical connectors as required. 4. Connect the J 39021 fuel injector tester to B+ and ground. 5. Set the amperage supply selector switch on the fuel injector tester to the Coil Test 0.5 amp position. 6. Connect the leads from the DMM to the fuel injector tester. 7. Set the DMM to the tenths scale (0.0). 8. Connect the fuel injector tester to a fuel injector using the J 39021-380 injector test adapter. Important: Check the engine coolant temperature again in order to ensure that the correct chart is being used. 9. Press the Push to Start Test button on the fuel injector tester. Important: The voltage reading may rise during the test. 10. Observe the voltage reading on the DMM. 11. Record the lowest voltage observed after the first second of the test. 12. Repeat steps 8 through 11 for each fuel injector. 13. Identify the highest voltage reading recorded other than those above 9.5 volts. 14. Subtract any other voltage readings recorded from the highest voltage reading recorded. 15. Repeat step 14 for all the remaining fuel injectors. Is any value that resulted from subtraction more than the specified value?	0.6 V	Go to Step 4	Go to Fuel Injector Balance Test with Special Tool
4	Replace any fuel injector that had any of the following: <ul style="list-style-type: none"> • A subtracted value exceeding 0.6 volts • An initial reading above 9.5 volts • An erratic reading Refer to <i>Fuel Injector Replacement</i> . Is the action complete?	—	Go to Fuel Injector Balance Test with Special Tool	—

Fuel Injector Balance Test with Special Tool

Test Description

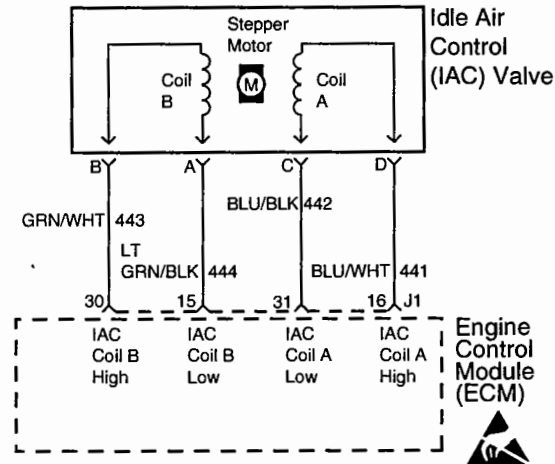
4. The engine coolant temperature must be below the operating temperature in order to avoid irregular fuel pressure readings due to Hot Soak fuel boiling.
5. The fuel pressure should be within the specified range.
6. The fuel pressure should reach a steady value.
7. If the fuel pressure drop value for each injector is within 10 Kpa (1.5 psi) of the average pressure drop value, the fuel injectors are flowing properly. Calculate the pressure drop value for each fuel injector by subtracting the second pressure reading from the first pressure reading.

Fuel Injector Balance Test with Special Tool

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Did you perform the Fuel Injector Coil Test Procedure?	—	Go to Step 3	Go to Fuel Injector Coil Test-ECT Between 10-35°C (50-95°F)
3	Is the engine coolant temperature above the specified value?	94°C(201°F)	Go to Step 4	Go to Step 5
4	Allow the engine to cool below the specified value. Is the engine coolant temperature below the specified value?	94°C(201°F)	Go to Step 5	—
5	<ol style="list-style-type: none"> 1. Turn the ignition OFF. 2. Connect the J 34730-1A fuel pressure gauge to the fuel pressure test port. 3. Turn ON the ignition leaving the engine OFF. 4. Install the scan tool. 5. Energize the fuel pump using the scan tool. 6. Place the bleed hose of the fuel pressure gauge into an approved gasoline container. 7. Bleed the air out of the fuel pressure gauge. 8. Again energize the fuel pump using the scan tool. <p>Important: The fuel pump will run for approximately 2 seconds. Repeat step 8 as necessary in order to achieve the highest possible fuel pressure.</p> <ol style="list-style-type: none"> 9. Wait for the fuel pressure to build. 10. Observe the reading on the fuel pressure gauge while the fuel pump is running. Is the fuel pressure within the specified limits?	379-427 kPa (55-62 psi)	Go to Step 6	Go to Fuel System Diagnosis
6	After the fuel pump stops, the fuel pressure may vary slightly, then should hold steady. Does the fuel pressure remain constant within the specified value?	379-427 kPa (55-62 psi)	Go to Step 7	Go to Fuel System Diagnosis

Fuel Injector Balance Test with Special Tool (cont'd)

Step	Action	Value	Yes	No
7	<ol style="list-style-type: none"> 1. Connect the J 39021 fuel injector tester to a fuel injector using the J 39021-380 injector test adapter. 2. Set the amperage supply selector switch on the fuel injector tester to the balance test 0.5-2.5 amp position. 3. Energize the fuel pump using the scan tool in order to pressurize the fuel system. 4. Record the fuel pressure indicated by the fuel pressure gauge after the fuel pressure stabilizes. This is the 1st pressure reading. 5. Energize the fuel injector by depressing the Push to Start Test button on the fuel injector tester. 6. Record the fuel pressure indicated by the fuel pressure gauge after the fuel pressure gauge needle has stopped moving. This is the 2nd pressure reading. 7. Repeat steps 1 through 6 for each fuel injector. 8. Subtract the 2nd pressure reading from the 1st pressure reading for one fuel injector. The result is the pressure drop value. 9. Obtain a pressure drop value for each fuel injector. 10. Add all of the individual pressure drop values. This is the total pressure drop. 11. Divide the total pressure drop by the number of fuel injectors. This is the average pressure drop. <p>Does any fuel injector have a pressure drop value that is either higher than the average pressure drop or lower than the average pressure drop by the specified value?</p>	10 kPa (1.5 psi)	Go to Step 8	Go to Symptoms
8	<p>Notice: Do Not repeat any portion of this test before running the engine in order to prevent the engine from flooding.</p> <p>Retest any fuel injector that does not meet the specification. Refer to the procedure in step 7.</p> <p>Does any fuel injector still have a pressure drop value that is either higher than the average pressure drop or lower than the average pressure drop by the specified value?</p>	10 kPa (1.5 psi)	Go to Step 9	Go to Symptoms
9	<p>Replace the faulty fuel injectors. Refer to <i>Fuel Injector Replacement</i>.</p> <p>Is the action complete?</p>	—	System OK	—



Idle Air Control Functional Test

MEFI 4306
4-20-00

Circuit Description

The ECM controls idle speed to a calibrated "desired" RPM based on sensor inputs and actual engine RPM. The ECM uses four (4) circuits to move the Idle Air Control (IAC) valve. The movement of the IAC valve varies the amount of air flow bypassing the throttle plates. The ECM controls idle speed by determining the position of the IAC valve.

Diagnostic Aids

An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation. Check for the following items:

- **Poor connection or damaged harness.** Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection and damaged harness.
- Check for vacuum leaks, disconnected or brittle vacuum hoses, cuts, etc. Examine manifold and throttle body gaskets for proper seal. Check for cracked intake manifold.

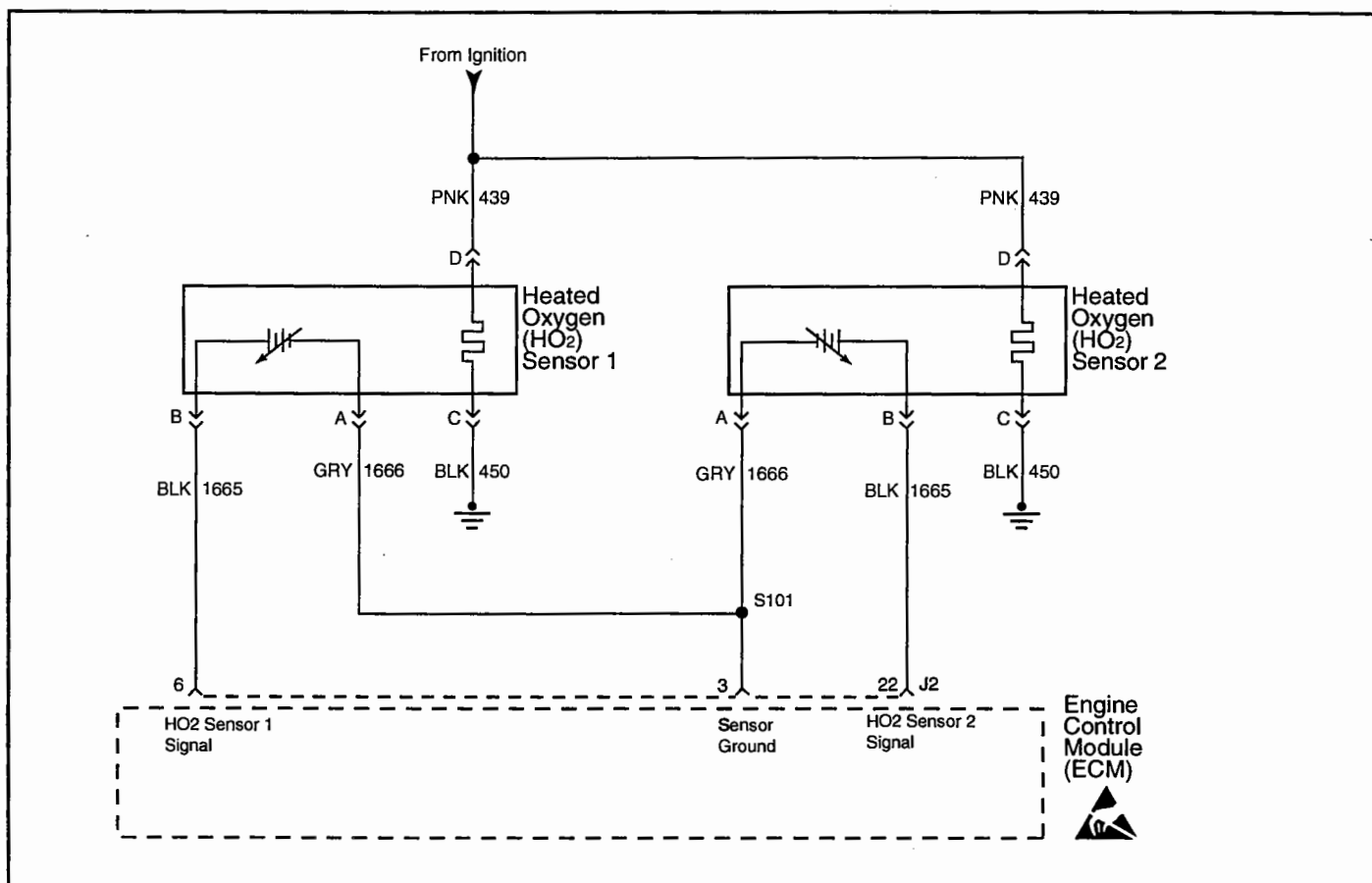
- Check for poor connections, opens or short to grounds in CKT's 441, 442, 443 and 444. This may result in improper idle control.
- An IAC valve which is "frozen" and will not respond to the ECM, a throttle stop screw which has been tampered with, or a damaged throttle body or linkage may cause improper idle.

Test Description

2. This step determines if the IAC valve is functioning properly.
4. This step determines if the circuitry or the IAC valve is faulty.

Idle Air Control Functional Test

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Engine should be at normal operating temperature. 2. Start engine and allow idle to stabilize. 3. Record RPM. 4. Ignition "OFF" for 10 seconds. 5. Disconnect IAC harness connector. 6. Restart engine and record RPM. Is RPM higher than the first recorded RPM by more than the specified value?	200 RPM	Go to Step 3	Go to Step 4
3	1. Reinstall IAC harness connector. 2. Idle speed should gradually return within 75 RPM of the original recorded RPM within 30 seconds. Does RPM return to original recorded RPM?	—	Go to Step 5	Go to Step 4
4	1. Ignition "OFF" for 10 seconds. 2. Disconnect IAC harness connector. 3. Restart engine. 4. Using a test lamp J 34142-B connected to ground, probe each one of the four IAC harness terminals. Does the test lamp blink on all four terminals?	—	Go to Step 7	Go to Step 6
5	IAC circuit is functioning properly.	—	—	—
6	Locate and repair poor connection, open, or short to ground in the IAC circuit that did not blink. If a problem was found, repair as necessary. Was a problem found?	—	Go to OBD System Check	Go to Step 8
7	Check for poor IAC connections or replace the faulty IAC valve. Is action complete?	—	Go to OBD System Check	—
8	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Go to OBD System Check	—



MEFI4313
4-26-00

DTC 13 - Heated Oxygen (HO₂) Sensor 1 Circuit Inactive (Non-Scan Diagnostics)

Circuit Description

The Heated Oxygen (HO₂) Sensor(s) varies voltage within a range from about 1.0 volt if the exhaust is rich, down to about 0.1 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 oxygen sensor circuit or cold oxygen sensor causes an Open Loop operation.

The heater provides for a faster sensor warm-up. This allows the sensor(s) to become active in a shorter period of time and remain active during a long extended idle.

DTC 13 determines if the heated oxygen sensor circuit(s) has developed an open. With an active DTC 13 set, the system operates in an Open Loop mode and the Malfunction Indicator Lamp (MIL) is turned on.

Diagnostic Aids

Check for the following conditions:

- **Poor connection in harness.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.

Never solder the HO₂ wires. For proper wire and connection repairs, refer to "Wiring Repair."

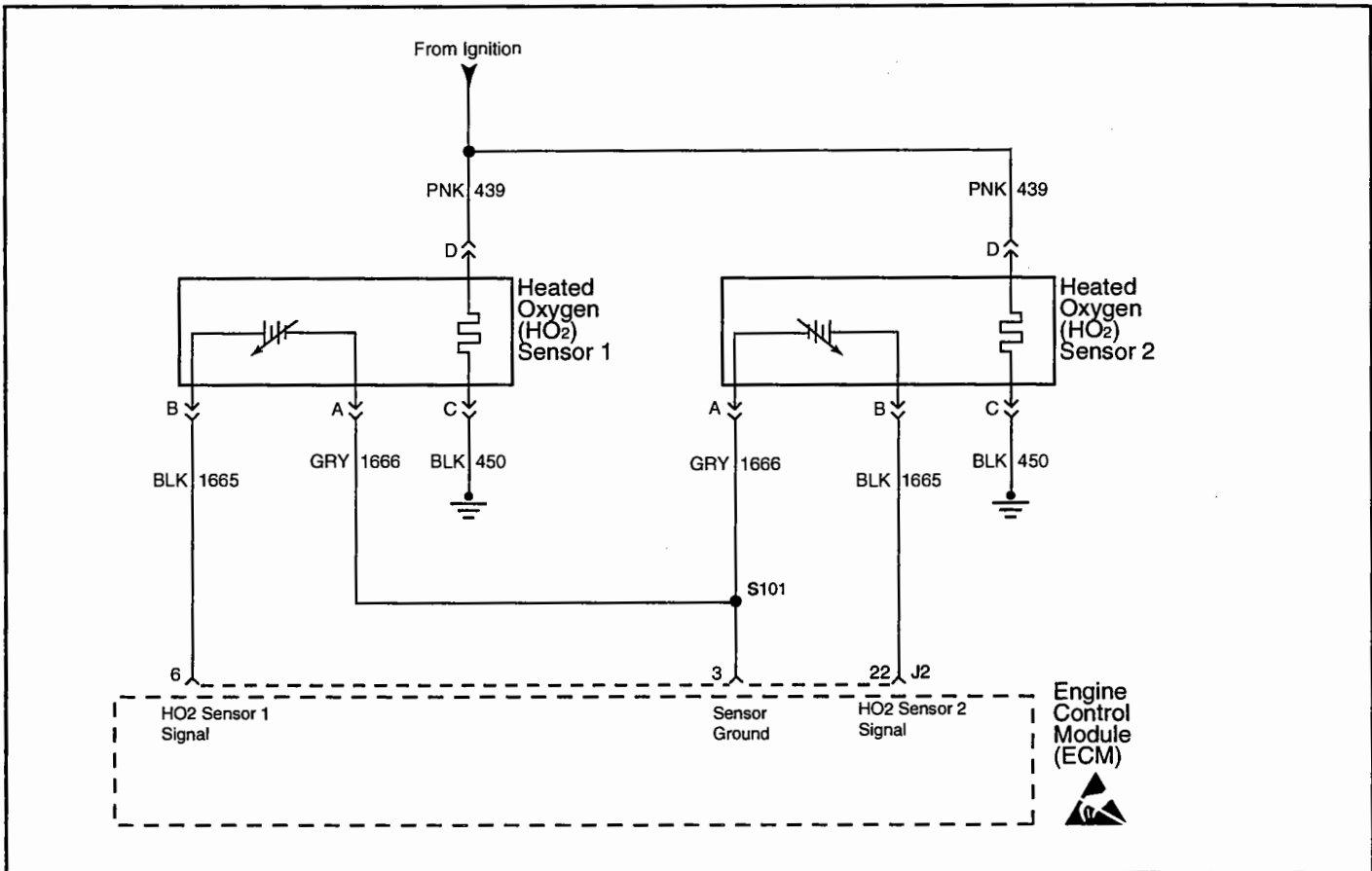
After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

2. Probing terminal "D" of the HO₂ sensor harness connector verifies if the voltage is available to the HO₂ sensor heater.
3. Verifies a good ground circuit for the HO₂ sensor heater circuit.
4. Checks for ignition "ON" bias voltage on the HO₂ sensor signal circuit. This should be between 0.423 and 0.487 volts with the ignition "ON".
5. Checks for a good ground for the HO₂ sensor circuit.

DTC 13 - Heated Oxygen (HO₂) Sensor 1 Circuit Inactive (Non-Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Disconnect the HO ₂ sensor 1 electrical connector. 2. Ignition turned ON. 3. With a test light connected to a known good ground, probe terminal "D" of the ECM harness connector. Does the test light illuminate brightly?	—	Go to Step 3	Go to Step 6
3	Connect test light between terminals "C" and "D" of the ECM harness connector. Does the test light illuminate brightly?	—	Go to Step 4	Go to Step 7
4	1. Ignition turned ON. 2. Using DVOM J 39200 connected to a known good ground, probe terminal "B" of the ECM harness connector. Is the voltage within the specified value?	0.423 - 0.487 volt	Go to Step 5	Go to Step 8
5	1. Ignition turned ON. 2. Using DVOM J 39200, check voltage between terminals "A" and "B" of the ECM harness connector. Is the voltage within the specified value?	0.423 - 0.487 volt	Go to Step 10	Go to Step 9
6	Locate and repair open or short to ground in the ignition feed circuit for the HO ₂ heater. Is action complete?	—	Verify Repair	—
7	Locate and repair open in the ground circuit for the HO ₂ heater. Is action complete?	—	Verify Repair	—
8	Locate and repair open in the HO ₂ sensor 1 signal circuit. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 11
9	Locate and repair open in the HO ₂ sensor 1 ground circuit. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 11
10	Check for faulty HO ₂ sensor 1 connections. If OK, replace HO ₂ sensor 1. Is action complete?	—	Verify Repair	—
11	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—



MEFI4313
4-26-00

DTC 13 - Heated Oxygen (HO₂) Sensor 2 Circuit Inactive (Non-Scan Diagnostics)

Circuit Description

The Heated Oxygen (HO₂) Sensor(s) varies voltage within a range from about 1.0 volt if the exhaust is rich, down to about 0.1 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 oxygen sensor circuit or cold oxygen sensor causes an Open Loop operation.

The heater provides for a faster sensor warm-up. This allows the sensor(s) to become active in a shorter period of time and remain active during a long extended idle.

DTC 13 determines if the heated oxygen sensor circuit(s) has developed an open. With an active DTC 13 set, the system operates in an Open Loop mode and the Malfunction Indicator Lamp (MIL) is turned on.

Diagnostic Aids

Check for the following conditions:

- **Poor connection in harness.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.

Never solder the HO₂ wires. For proper wire and connection repairs, refer to "Wiring Repair."

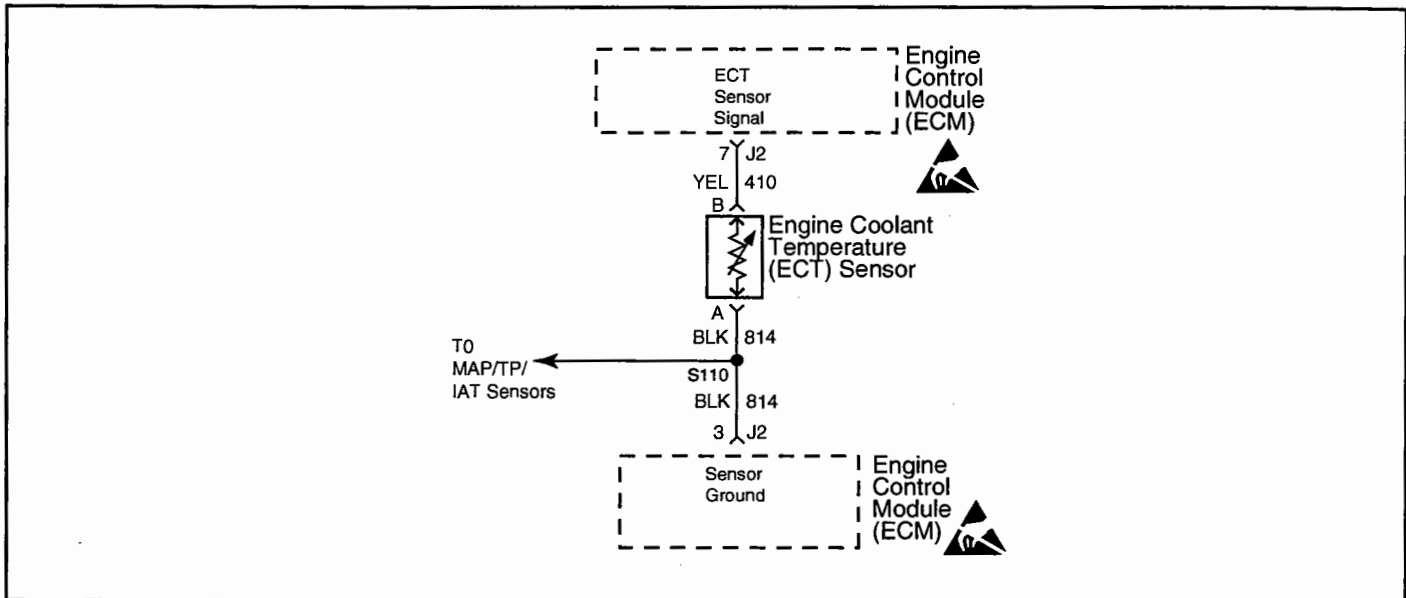
After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

2. Probing terminal "D" of the HO₂ sensor harness connector verifies if the voltage is available to the HO₂ sensor heater.
3. Verifies a good ground circuit for the HO₂ sensor heater circuit.
4. Checks for ignition "ON" bias voltage on the HO₂ sensor signal circuit. This should be between 0.423 and 0.487 volts with the ignition "ON".
5. Checks for a good ground for the HO₂ sensor circuit.

DTC 13 - Heated Oxygen (HO₂) Sensor 2 Circuit Inactive (Non-Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Disconnect the HO ₂ sensor 2 electrical connector. 2. Ignition turned ON. 3. With a test light connected to a known good ground, probe terminal "D" of the ECM harness connector. Does the test light illuminate brightly?	—	Go to Step 3	Go to Step 6
3	Connect test light between terminals "C" and "D" of the ECM harness connector. Does the test light illuminate brightly?	—	Go to Step 4	Go to Step 7
4	1. Ignition turned ON. 2. Using DVOM J 39200 connected to a known good ground, probe terminal "B" of the ECM harness connector. Is the voltage within the specified value?	0.423 - 0.487 volt	Go to Step 5	Go to Step 8
5	1. Ignition turned ON. 2. Using DVOM J 39200, check voltage between terminals "A" and "B" of the ECM harness connector. Is the voltage within the specified value?	0.423 - 0.487 volt	Go to Step 10	Go to Step 9
6	Locate and repair open or short to ground in the ignition feed circuit for the HO ₂ heater. Is action complete?	—	Verify Repair	—
7	Locate and repair open in the ground circuit for the HO ₂ heater. Is action complete?	—	Verify Repair	—
8	Locate and repair open in the HO ₂ sensor 2 signal circuit. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 11
9	Locate and repair open in the HO ₂ sensor 2 ground circuit. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 11
10	Check for faulty HO ₂ sensor 2 connections. If OK, replace HO ₂ sensor 2. Is action complete?	—	Verify Repair	—
11	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—



MEFI 4307
4-20-00

DTC 14 - Engine Coolant Temperature (ECT) Sensor Circuit - Low Temp Indicated (Non-Scan Diagnostics)

Circuit Description

The Engine Coolant Temperature (ECT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts on CKT 410 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high. As the engine coolant warms up, the sensor resistance becomes less. See engine coolant temperature sensor table under "Diagnostic Aids." At normal operating temperature (85°C - 95°C or 185°F - 203°F), the voltage will measure about 1.5-2.0 volts.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the ECT display on the scan tool while moving connectors and wiring harnesses related to the ECT sensor. A change in the ECT display will indicate the location of the fault.
- If DTC 33 is also set, check for open ground CKT 814.

After repairs, clear DTC's following "Clear DTC's Procedure" in the *General Information* section. Failure to do so may result in DTC's not properly being cleared.

Test Description

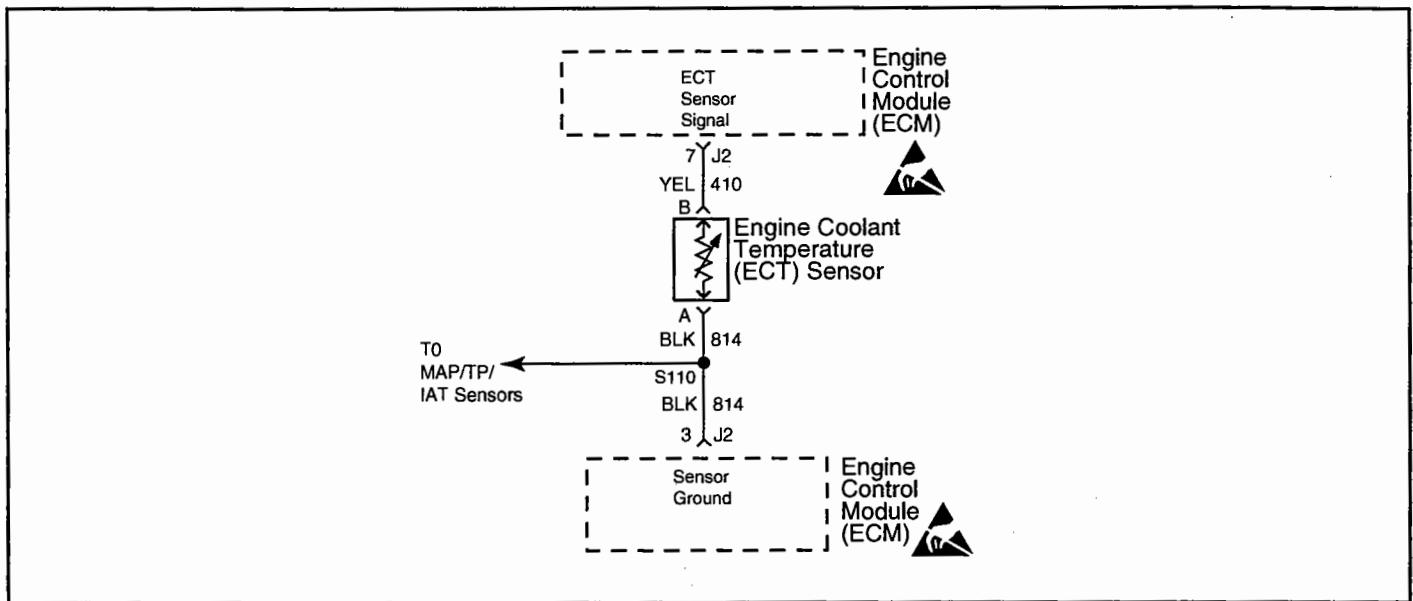
2. This step checks if there is a problem with the ECM and wiring or if the problem is the ECT sensor.
3. This step will isolate the problem to CKT 410 (5 volt reference) or to CKT 814 (sensor ground).
4. Check the harness terminals thoroughly for loose connections. If the resistance of the ECT sensor is monitored, the resistance should steadily decrease as the engine coolant warms up. The resistance reading should stabilize when the thermostat opens.

Engine Coolant Temperature Sensor Table

°C	°F	OHMS
Temperature vs Resistance Values (Approximate)		
100	212	177
80	176	332
60	140	667
45	113	1188
35	95	1802
25	77	2796
15	59	4450
5	41	7280
-5	23	12300
-15	5	21450
-30	-22	52700
-40	-40	100700

DTC 14 - Engine Coolant Temperature (ECT) Sensor Circuit - Low Temp Indicated (Non-Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Ignition "OFF" 2. Disconnect ECT sensor harness connector. 3. Ignition "ON," engine "OFF" 4. Connect DVOM across the coolant sensor harness terminals. Is voltage above the specified value?	4 volts	Go to Step 4	Go to Step 3
3	1. Connect positive DVOM lead to harness terminal "B" CKT 410 (5 volt reference). 2. Connect negative DVOM lead to a known good ground. Is voltage above the specified value?	4 volts	Go to Step 6	Go to Step 5
4	Locate and repair intermittent faulty connections. If OK, replace faulty ECT sensor. Is action complete?	—	Verify Repair	—
5	Locate and repair open CKT 410. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 7
6	Locate and repair open ground CKT 814. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 7
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—



MEFI 4307
4-20-00

DTC 15 - Engine Coolant Temperature (ECT) Sensor Circuit - High Temp Indicated (Non-Scan Diagnostics)

Circuit Description

The Engine Coolant Temperature (ECT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts on CKT 410 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high. As the engine coolant warms up, the sensor resistance becomes less. See engine coolant temperature sensor table under "Diagnostic Aids." At normal operating temperature (85°C - 95°C or 185°F - 203°F), the voltage will measure about 1.5-2.0 volts.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the ECT display on the scan tool while moving connectors and wiring harnesses related to the ECT sensor. A change in the ECT display will indicate the location of the fault.
- Check harness routing for a potential short to ground in CKT 410.

After repairs, clear DTC's following "Clear DTC's Procedure" in the *General Information* section. Failure to do so may result in DTC's not properly being cleared.

Test Description

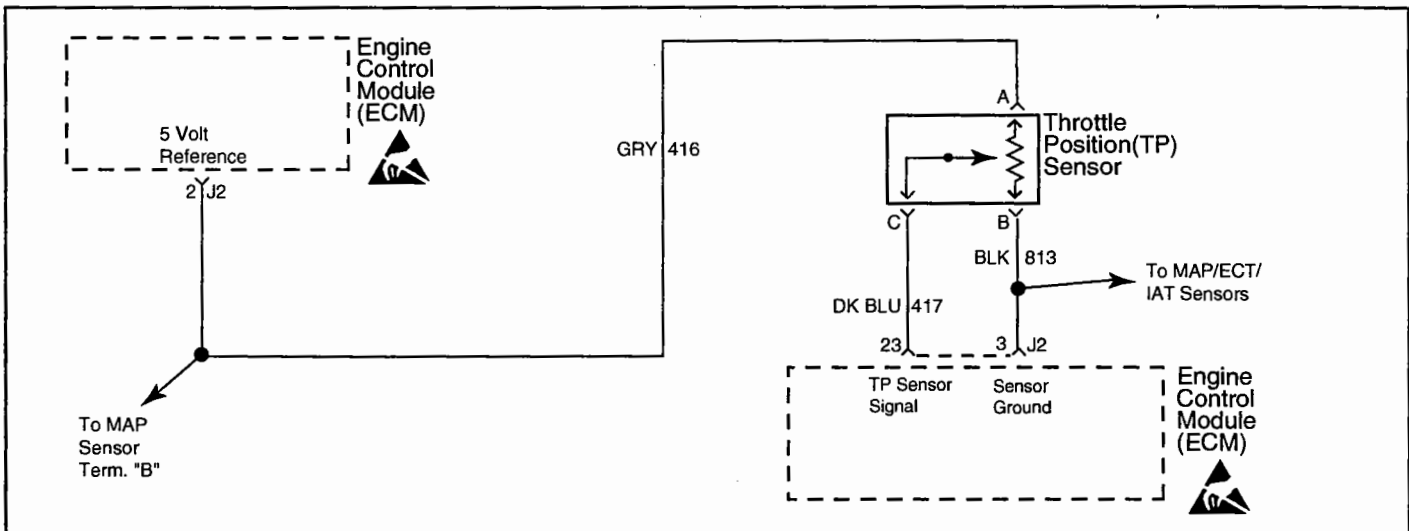
2. This step checks if there is a problem with the ECM and wiring or if the problem is the ECT sensor.
3. Check the harness terminals thoroughly for loose connections. If the resistance of the ECT sensor is monitored, the resistance should steadily decrease as the engine coolant warms up. The resistance reading should stabilize when the thermostat opens.

Engine Coolant Temperature Sensor Table

°C	°F	OHMS
Temperature vs Resistance Values (Approximate)		
100	212	177
80	176	332
60	140	667
45	113	1188
35	95	1802
25	77	2796
15	59	4450
5	41	7280
-5	23	12300
-15	5	21450
-30	-22	52700
-40	-40	100700

**DTC 15 - Engine Coolant Temperature (ECT) Sensor Circuit - High Temp Indicated
(Non-Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Ignition "OFF" 2. Disconnect ECT sensor harness connector. 3. Ignition "ON," engine "OFF" 4. Connect DVOM across the coolant sensor harness terminals. Is voltage above the specified value?	4 volts	Go to Step 3	Go to Step 4
3	Locate and repair intermittent faulty connections. If OK, replace faulty ECT sensor. Is action complete?	—	Verify Repair	—
4	Locate and repair short to ground in CKT 410. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 5
5	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

MEFI4308
4-20-00

DTC 21 - Throttle Position (TP) Sensor Circuit - Signal Voltage High (Non-Scan Diagnostics)

Circuit Description

The Throttle Position (TP) sensor is a potentiometer that provides a voltage signal that changes relative to the throttle blade. Signal voltage should vary from about .7 volt at idle to about 4.8 volts at Wide Open Throttle (WOT).

The TP sensor signal is one of the most important inputs used by the ECM for fuel control and for IAC control.

The ECM supplies a 5 volt signal to the sensor through CKT 416. CKT 813 is the TP sensor ground circuit. The TP sensor will send a voltage signal back to the ECM, through CKT 417, according to where the throttle blades are positioned.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the TP sensor display on the scan tool while moving connectors and wiring harnesses related to the TP sensor. A change in the TP sensor display will indicate the location of the fault.
- If a TP sensor circuit failure is present, the MAP sensor default value will be used along with the TP sensor default value.

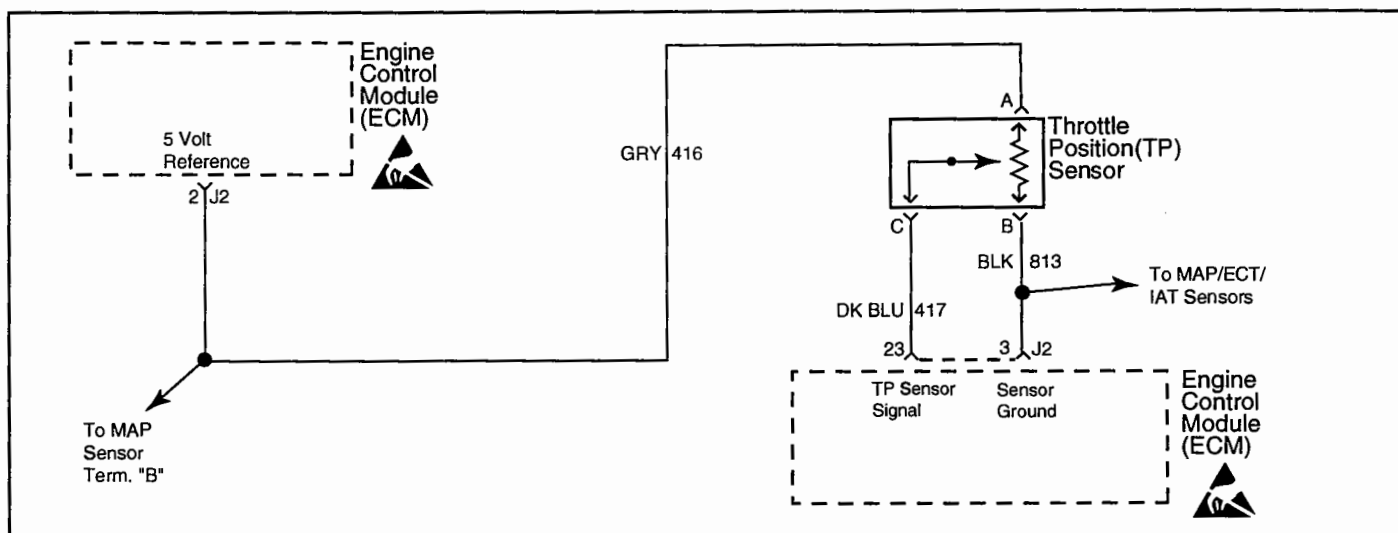
After repairs, clear DTC's following "Clear DTC's Procedure" in the *General Information* section. Failure to do so may result in DTC's not properly being cleared.

Test Description

2. This step simulates a DTC 22. If the ECM recognizes the low signal voltage and sets DTC 22, the ECM and wiring are OK.
3. This step checks to see if CKT 813 is open.

DTC 21 - Throttle Position (TP) Sensor Circuit - Signal Voltage High (Non-Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Diagnostic Trouble Code (DTC) tool switched to "normal mode," or "OFF" 2. Ignition "OFF" 3. Disconnect TP sensor harness connector. 4. Start engine and idle for 2 minutes or until DTC tool indicates a stored DTC. 5. Ignition "ON," engine "OFF" 6. Switch DTC tool to "service mode," or "ON" and note DTC. Is DTC 22 present?	—	Go to Step 4	Go to Step 3
3	1. TP sensor harness connector disconnected. 2. Ignition "ON," engine "OFF" 3. Connect DVOM from harness terminal "B" (CKT 813) to harness terminal "A" (CKT 416). Is voltage reading above the specified value?	4 volts	Go to Step 6	Go to Step 5
4	Locate and repair intermittent faulty connections. If OK, replace faulty TP sensor. Is action complete?	—	Verify Repair	—
5	Locate and repair open in CKT 813. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 7
6	Locate and repair short to voltage in CKT 417. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 7
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

MEFI4308
4-20-00

DTC 22 - Throttle Position (TP) Sensor Circuit - Signal Voltage Low (Non-Scan Diagnostics)

Circuit Description

The Throttle Position (TP) sensor is a potentiometer that provides a voltage signal that changes relative to the throttle blade. Signal voltage should vary from about .7 volt at idle to about 4.8 volts at Wide Open Throttle (WOT).

The TP sensor signal is one of the most important inputs used by the ECM for fuel control and for IAC control.

The ECM supplies a 5 volt signal to the sensor through CKT 416. CKT 813 is the TP sensor ground circuit. The TP sensor will send a voltage signal back to the ECM, through CKT 417, according to where the throttle blades are positioned.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the TP sensor display on the scan tool while moving connectors and wiring harnesses related to the TP sensor. A change in the TP sensor display will indicate the location of the fault.
- If DTC 34 is also set, check for a short to ground in CKT 416 or CKT 416E.
- If a TP sensor circuit failure is present, the MAP sensor default value will be used along with the TP sensor default value.

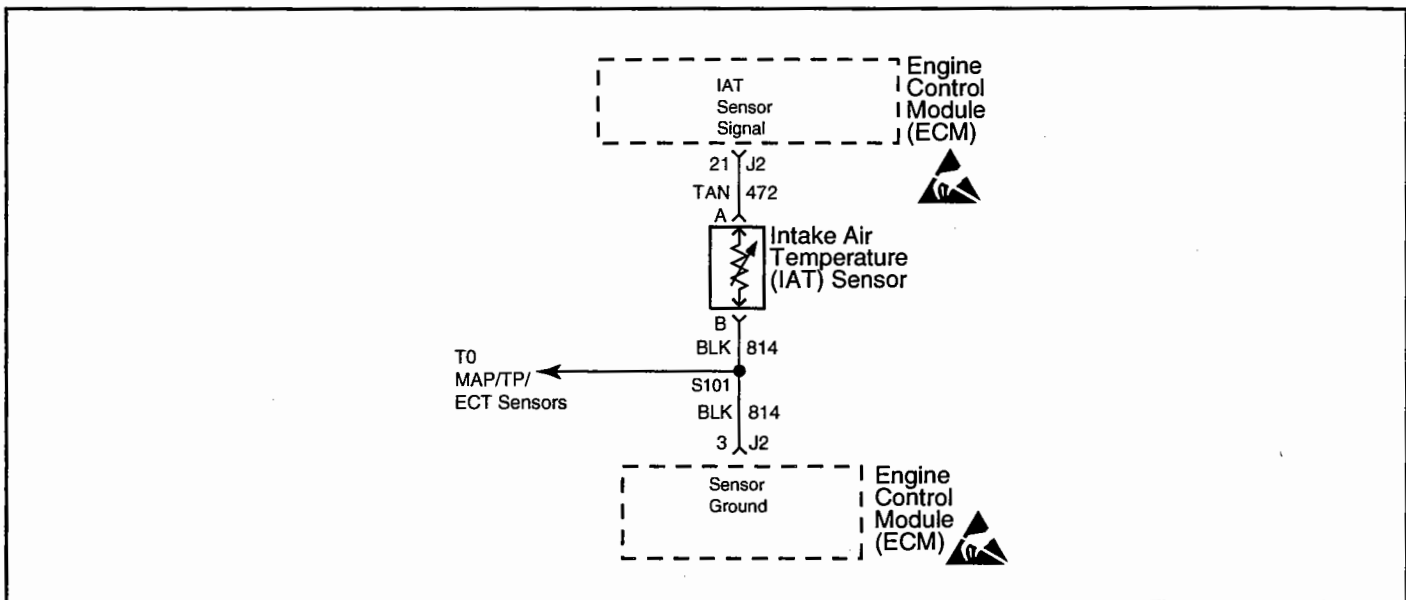
After repairs, clear DTC's following "Clear DTC's Procedure" in the *General Information* section. Failure to do so may result in DTC's not properly being cleared.

Test Description

2. This step simulates a DTC 21. If the ECM recognizes the high signal voltage and sets a DTC 21, the ECM and wiring are OK.
3. This step checks CKT 416 for the 5 volt reference.

DTC 22 - Throttle Position (TP) Sensor Circuit - Signal Voltage Low (Non-Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Diagnostic Trouble Code (DTC) tool switched to "normal mode," or "OFF" 2. Ignition "OFF" 3. Disconnect TP sensor harness connector. 4. Connect a jumper wire from harness terminal "A" (CKT 416) to harness terminal "C" (CKT 417). 5. Start engine and idle for 2 minutes or until DTC tool indicates a stored DTC. 6. Ignition "ON," engine "OFF" 7. Switch DTC tool to "service mode," or "ON" and note DTC. Is DTC 21 present?	—	Go to Step 4	Go to Step 3
3	1. Remove jumper wire from CKT 416 and 417. 2. Connect DVOM from harness terminal "A" (CKT 416) to harness terminal "B" (CKT 813). Is voltage reading above the specified value?	4 volts	Go to Step 5	Go to Step 6
4	Locate and repair intermittent faulty connections. If OK, replace faulty TP sensor. Is action complete?	—	Verify repair	—
5	Locate and repair open or short to ground in CKT 417. If a problem is found, repair as necessary. Was a problem found?	—	Verify repair	Go to Step 7
6	Locate and repair open or short to ground in CKT 416. Also check CKT 416E to the MAP sensor for a short to ground. If a problem is found, repair as necessary. Was a problem found?	—	Verify repair	Go to Step 7
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—



MEFI 4322
6-11-00

DTC 23 - Intake Air Temperature (IAT) Sensor Circuit - Low Temp Indicated (Non-Scan Diagnostics)

Circuit Description

The Intake Air Temperature (IAT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts on CKT 472 to the sensor. When the intake air temperature is cold, the sensor (thermistor) resistance is high. As the intake air temperature warms up, the sensor resistance becomes less. See intake air temperature sensor table under "Diagnostic Aids."

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the IAT display on the scan tool while moving connectors and wiring harnesses related to the IAT sensor. A change in the IAT display will indicate the location of the fault.
- If DTC 33 is also set, check for open ground CKT 814.

After repairs, clear DTC's following "Clear DTC's Procedure" in the *General Information* section. Failure to do so may result in DTC's not properly being cleared.

Test Description

2. This step checks if there is a problem with the ECM and

wiring or if the problem is the IAT sensor.

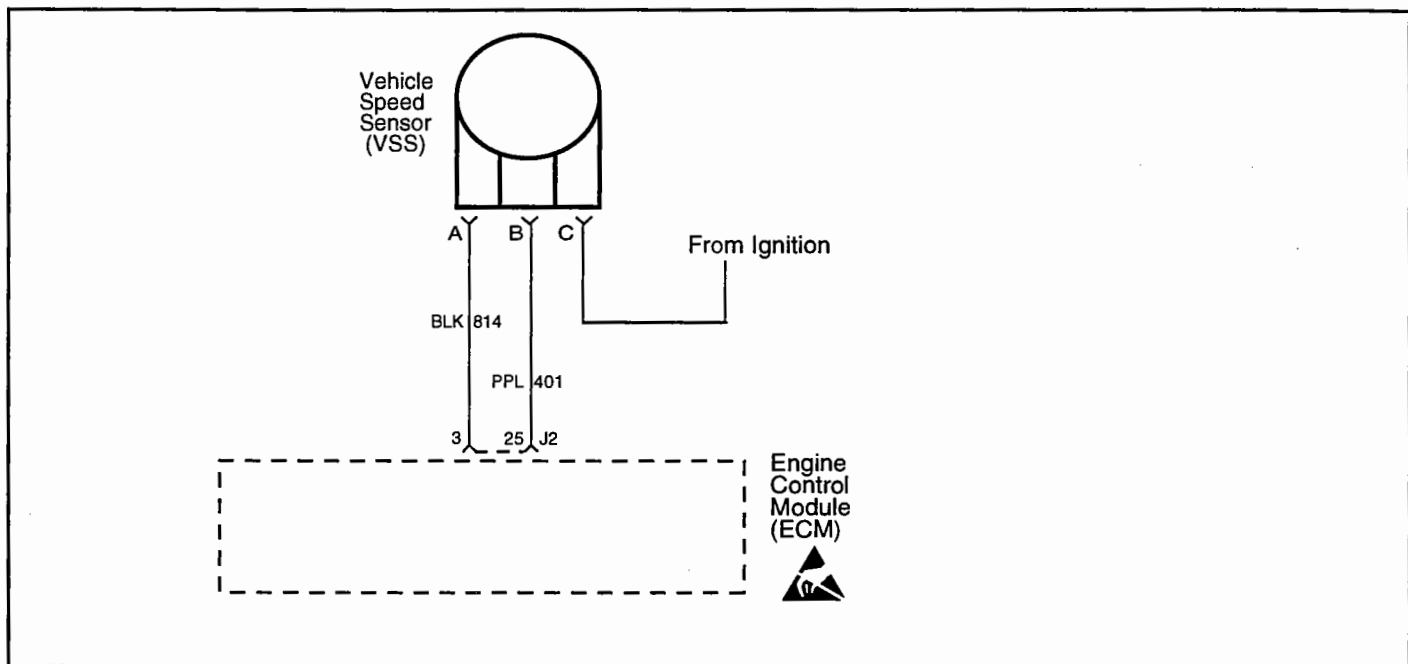
3. This step will isolate the problem to CKT 472 (5 volt reference) or to CKT 814 (sensor ground).
4. Check the harness terminals thoroughly for loose connections. If the resistance of the IAT sensor is monitored, the resistance should steadily decrease as the intake air temperature warms up.

Intake Air Temperature Sensor Table

°C	°F	OHMS
Temperature vs Resistance Values (Approximate)		
100	212	177
80	176	332
60	140	667
45	113	1188
35	95	1802
25	77	2796
15	59	4450
5	41	7280
-5	23	12300
-15	5	21450
-30	-22	52700
-40	-40	100700

DTC 23 - Intake Air Temperature (IAT) Sensor Circuit - Low Temp Indicated (Non-Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Ignition "OFF" 2. Disconnect IAT sensor harness connector. 3. Ignition "ON," engine "OFF" 4. Connect DVOM across the intake air temperature sensor harness terminals. Is voltage above the specified value?	4 volts	Go to Step 4	Go to Step 3
3	1. Connect positive DVOM lead to harness terminal "A" CKT 472 (5 volt reference). 2. Connect negative DVOM lead to a known good ground. Is voltage above the specified value?	4 volts	Go to Step 6	Go to Step 5
4	Locate and repair intermittent faulty connections. If OK, replace faulty IAT sensor. Is action complete?	—	Verify Repair	—
5	Locate and repair open CKT 472. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 7
6	Locate and repair open ground CKT 814. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 7
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

MEFI4314
4-26-00

DTC 24 - Vehicle Speed Sensor (VSS) Circuit (Non-Scan Diagnostics)

Circuit Description

The vehicle speed is provided to the ECM by means of the Vehicle Speed Sensor (VSS). The sensor may be mounted in the transmission, but the actual location depends on the application. The sensor produces a 12 volt digital signal whenever the vehicle is moving. The number of pulses increases with vehicle speed. The ECM converts this signal into MPH, which can be monitored with a scan tool. This information may be used by the ECM for several reasons such as governing the vehicle speed to a maximum road speed.

The sensor is a three-wire sensor. Terminal "A" of the sensor is provided a ground on CKT 814 through the ECM. Terminal "C" of the sensor is provided ignition voltage. Terminal "B" of the sensor is the signal to the ECM through CKT 400.

Diagnostic Aids

Check for the following conditions:

- Poor connection in harness. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.

Check VSS circuits for proper connections and the harness is routed properly.

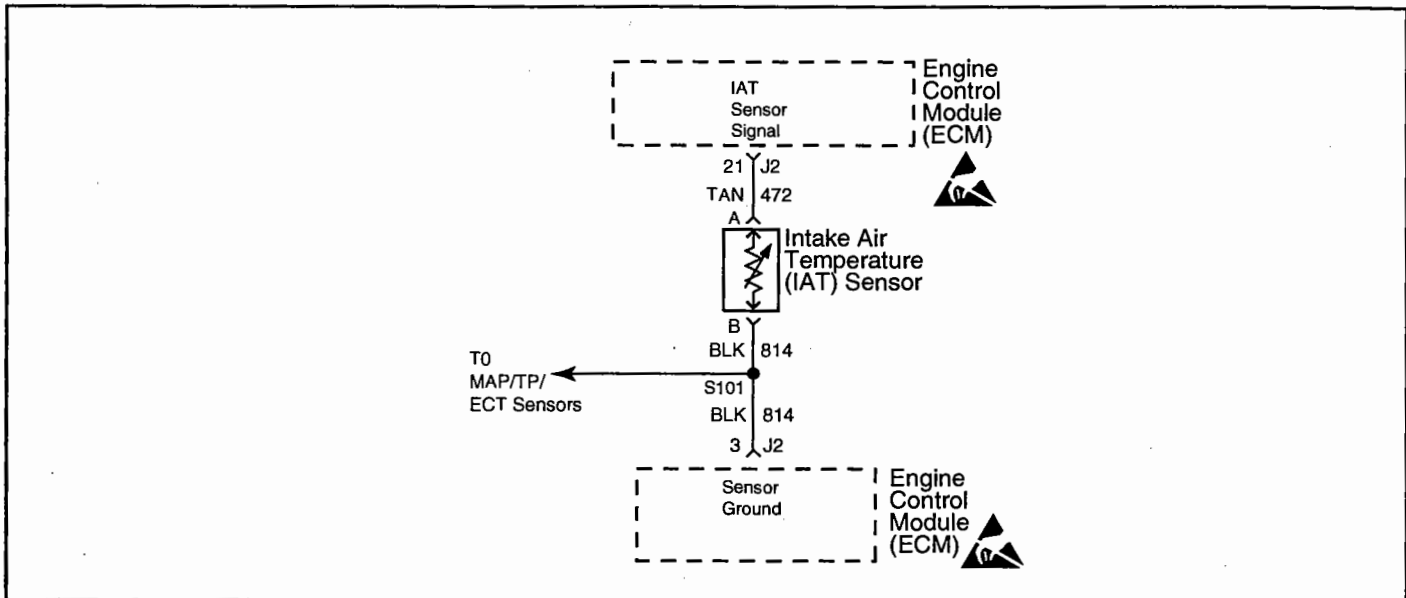
After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

2. This step determines if the VSS is receiving ignition voltage.
3. This step checks for a good ground circuit.

DTC 24 - Vehicle Speed Sensor (VSS) Circuit (Non-Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Disconnect the vehicle speed sensor electrical connector. 2. Ignition turned ON. 3. Using a test light connected to a known good ground, probe ECM harness terminal "C". Does the test light illuminate brightly?	—	Go to Step 3	Go to Step 7
3	1. Ignition turned ON. 2. Using a test light connected to B+, probe ECM harness terminal "A". Does the test light illuminate brightly?	—	Go to Step 4	Go to Step 8
4	1. Ignition OFF. 2. Reconnect VSS electrical connector. 3. Ignition turned ON. 4. Raise and support the vehicle drive wheel(s) per manufacturer's recommendations. 5. Using DVOM J 39200 connected to a known good ground, back probe ECM harness connector terminal "J2-25". 6. While observing the DVOM, slowly rotate the drive wheel(s). Does the DVOM indicate a voltage changing as the wheels are rotated?	—	Go to Step 9	Go to Step 5
5	Locate and repair open or short to ground on CKT 400. If a problem is found, repair as necessary. Was a problem found?	—	Verify repair	Go to Step 6
6	Replace faulty VSS. Is action complete?	—	Verify repair	—
7	Locate and repair open or short to ground in the ignition circuit to the VSS. Is action complete?	—	Verify Repair	—
8	Locate and repair open in the ground circuit to the VSS. Is action complete?	—	Verify Repair	—
9	DTC 24 may be intermittent. Clear DTC and drive the vehicle. If DTC 24 returns, repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—



MEFI 4322
6-11-00

DTC 25 - Intake Air Temperature (IAT) Sensor Circuit - High Temp Indicated (Non-Scan Diagnostics)

Circuit Description

The Intake Air Temperature (IAT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts on CKT 472 to the sensor. When the intake air temperature is cold, the sensor (thermistor) resistance is high. As the intake air temperature warms up, the sensor resistance becomes less. See intake air temperature sensor table under "Diagnostic Aids."

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the IAT display on the scan tool while moving connectors and wiring harnesses related to the IAT sensor. A change in the IAT display will indicate the location of the fault.
- Check harness routing for a potential short to ground in CKT 814.

After repairs, clear DTC's following "Clear DTC's Procedure" in the *General Information* section. Failure to do so may result in DTC's not properly being cleared.

Test Description

2. This step checks if there is a problem with the ECM and

wiring or if the problem is the IAT sensor.

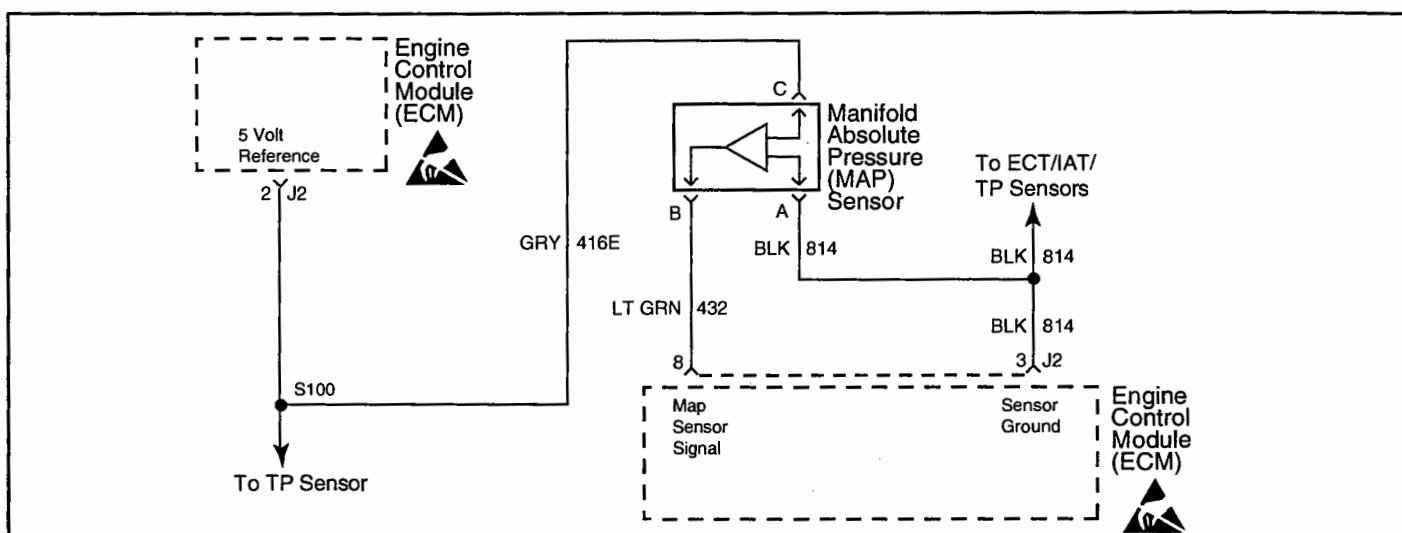
3. Check the harness terminals thoroughly for loose connections. If the resistance of the IAT sensor is monitored, the resistance should steadily decrease as the intake air temperature warms up.

Intake Air Temperature Sensor Table

°C	°F	OHMS
Temperature vs Resistance Values (Approximate)		
100	212	177
80	176	332
60	140	667
45	113	1188
35	95	1802
25	77	2796
15	59	4450
5	41	7280
-5	23	12300
-15	5	21450
-30	-22	52700
-40	-40	100700

**DTC 25 - Intake Air Temperature (IAT) Sensor Circuit - High Temp Indicated
(Non-Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Ignition "OFF" 2. Disconnect IAT sensor harness connector. 3. Ignition "ON," engine "OFF." 4. Connect DVOM across the IAT sensor harness terminals. Is voltage above the specified value?	4 volts	<i>Go to Step 3</i>	<i>Go to Step 4</i>
3	Locate and repair intermittent faulty connections. If OK, replace faulty IAT sensor. Is action complete?	—	Verify Repair	—
4	Locate and repair short to ground in CKT 472. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	<i>Go to Step 5</i>
5	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

MEFI4309
4-20-00

DTC 33 - Manifold Absolute Pressure (MAP) Sensor Circuit - Signal Voltage High (Non-Scan Diagnostics)

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 1.0-1.5 volts at idle to about 4.0-4.5 volts at Wide Open Throttle (WOT).

If the MAP sensor fails, the ECM will substitute a default MAP value that will vary with RPM.

The MAP sensor voltage of 5 volts is delivered to the MAP sensor through CKT 416E. CKT 814 is the ground circuit for the MAP sensor. The MAP signal CKT 432 will send a voltage signal back to the ECM according to what the manifold pressure is.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the MAP sensor display on the scan tool while moving connectors and wiring harnesses related to the MAP sensor. A change in the MAP sensor display will indicate the location of the fault.

- If the idle is rough or unstable, refer to *Symptoms* section for items which may cause an unstable idle.
- With the ignition "ON," 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 altitude and is referred to as BARO.
- If DTC 14 is also set, check for open in ground CKT 814.
- If a MAP sensor circuit failure is present, the TP sensor default value will be used along with the MAP sensor default value.

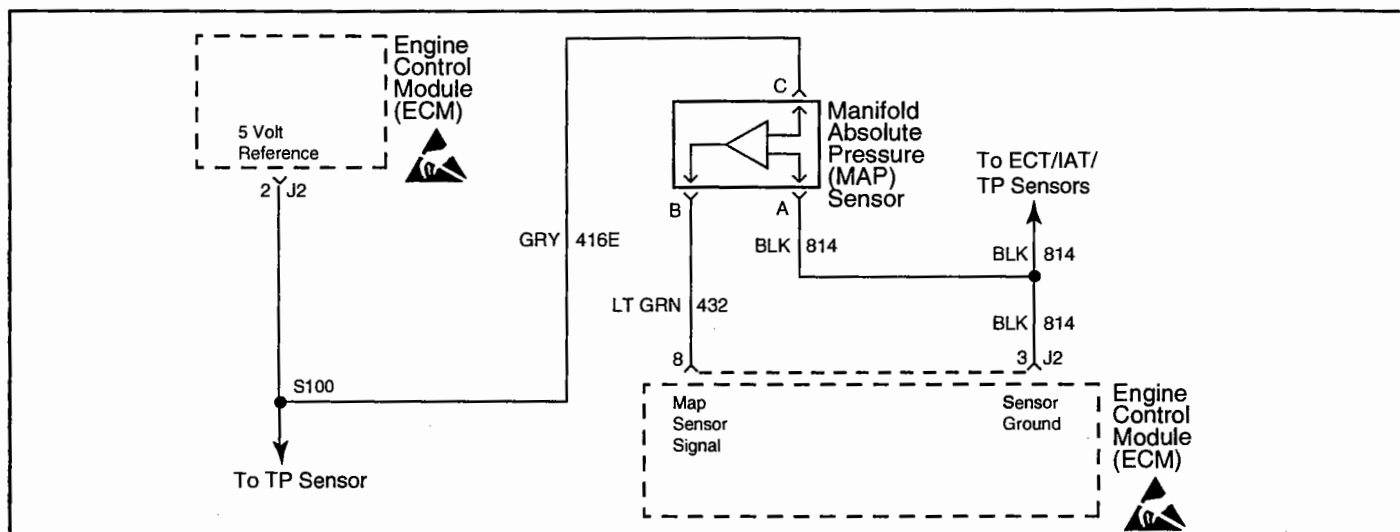
After repairs, clear DTC's following "Clear DTC's Procedure" in the *General Information* section. Failure to do so may result in DTC's not properly being cleared.

Test Description

2. This step will determine if there is an adequate vacuum supply to the MAP sensor. If the vacuum gauge reading is erratic, refer to the "Rough or Unstable Idle" symptom.
3. This step simulates a DTC 34. If the ECM recognizes the low signal voltage and sets a DTC 34, the ECM and wiring are OK.
4. This step checks to see if CKT 814 is open.
5. Low manifold vacuum may result from a restriction in the MAP sensor hose or from vacuum leaks in the engine induction system.

**DTC 33 - Manifold Absolute Pressure (MAP) Sensor Circuit - Signal Voltage High
(Non-Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Ignition "OFF" 2. Install a vacuum gauge to a manifold vacuum source. 3. Start engine and raise to about 1000 RPM in neutral. 4. The vacuum reading should be steady. Is the vacuum gauge reading steady and above the specified value?	14 ¹⁴ Hg (455 kPa)	Go to Step 3	Go to Step 5
3	1. Diagnostic Trouble Code (DTC) tool switched to "normal mode," or "OFF." 2. Ignition "OFF" 3. Disconnect MAP sensor harness connector. 4. Start engine and idle for 2 minutes or until DTC tool indicates a stored DTC. 5. Ignition "ON," engine "OFF" 6. Switch DTC tool to "service mode," or "ON" and note DTC. Is DTC 34 present?	—	Go to Step 6	Go to Step 4
4	1. MAP sensor harness connector disconnected. 2. Ignition "ON," engine "OFF" 3. Connect DVOM from harness terminal "A" (CKT 814) to harness terminal "C" (CKT 416E). Is voltage reading above the specified value?	4 volts	Go to Step 7	Go to Step 8
5	Repair low or unsteady vacuum problem. Is action complete?	—	Verify Repair	—
6	Check for plugged or leaking sensor vacuum fitting. Also locate and repair intermittent faulty connections. If OK, replace faulty MAP sensor. Is action complete?	—	Verify Repair	—
7	Locate and repair short to voltage in CKT 432. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 9
8	Locate and repair open in CKT 814. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 9
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

MEFI4309
4-20-00

DTC 34 - Manifold Absolute Pressure (MAP) Sensor Circuit - Signal Voltage Low (Non-Scan Diagnostics)

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 1.0-1.5 volts at idle to about 4.0-4.5 volts at Wide Open Throttle (WOT).

If the MAP sensor fails, the ECM will substitute a default MAP value that will vary with RPM.

The MAP sensor voltage of 5 volts is delivered to the MAP sensor through CKT 416E. CKT 814 is the ground circuit for the MAP sensor. The MAP signal CKT 432 will send a voltage signal back to the ECM according to what the manifold pressure is.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the MAP sensor display on the scan tool while moving connectors and wiring harnesses related to the MAP sensor. A change in the MAP sensor display will indicate the location of the fault.

- If the idle is rough or unstable, refer to *Symptoms* section for items which may cause an unstable idle.
- With the ignition "ON," 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 altitude and is referred to as BARO.
- If a MAP sensor circuit failure is present, the TP sensor default value will be used along with the MAP sensor default value.

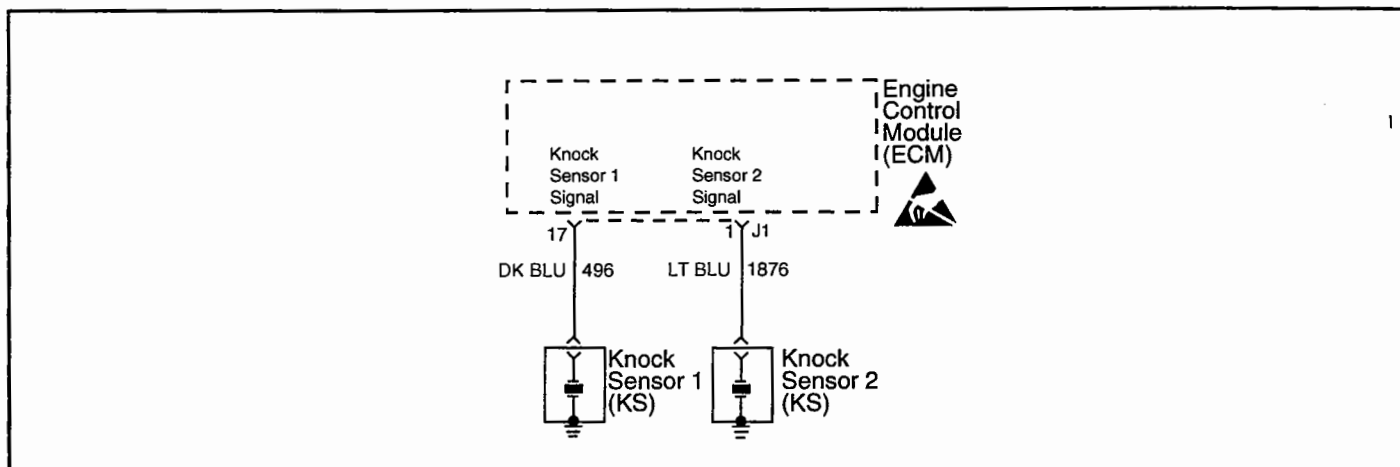
After repairs, clear DTC's following "Clear DTC's Procedure" in the *General Information* section. Failure to do so may result in DTC's not properly being cleared.

Test Description

2. This step simulates a DTC 33. If the ECM recognizes the high signal voltage and sets a DTC 33, the ECM and wiring are OK.
3. This step checks CKT 416E for the 5 volt reference.

**DTC 34 - Manifold Absolute Pressure (MAP) Sensor Circuit - Signal Voltage Low
(Non-Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Marine Diagnostic Trouble Code (MDTC) tool switched to "normal mode," or "OFF." 2. Ignition "OFF." 3. Disconnect MAP sensor harness connector. 4. Connect a jumper wire from harness terminal "B" (CKT 432) to harness terminal "C" (CKT 416E). 5. Start engine and idle for 2 minutes or until MDTC tool indicates a stored DTC. 6. Ignition "ON," engine "OFF." 7. Switch MDTC tool to "service mode," or "ON" and note DTC. Is DTC 33 present?	—	Go to Step 4	Go to Step 3
3	1. Remove jumper wire from CKT 416E and 432. 2. Connect DVOM from harness terminal "A" (CKT 814) to harness terminal "C" (CKT 416E). Is voltage reading above the specified value?	4 volts	Go to Step 5	Go to Step 6
4	Locate and repair intermittent faulty connections. If OK, replace faulty MAP sensor. Is action complete?	—	Verify repair	—
5	Locate and repair open or short to ground in CKT 432. If a problem is found, repair as necessary. Was a problem found?	—	Verify repair	Go to Step 7
6	Locate and repair open or short to ground in CKT 416E. Also check CKT 416 to the TP sensor for a short to ground. If a problem is found, repair as necessary. Was a problem found?	—	Verify repair	Go to Step 7
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

MEFI4310
6-28-00

DTC 44 - Knock Sensor (KS) 1 System Inactive (Non-Scan Diagnostics)

Circuit Description

The ECM uses the Knock Sensors in order to detect engine detonation. This detection allows the ECM to retard spark timing based on the KS signal coming into the ECM. DTC 44 will set only if the ECM does not see any activity on the KS signal circuits.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage.
- Loose Knock Sensors in engine block.
- Poor connection at the Knock Sensors.

After repairs, clear DTC's following "Clear DTC's Procedure" in the *General Information* section. Failure to do so may result in DTC's not properly being cleared.

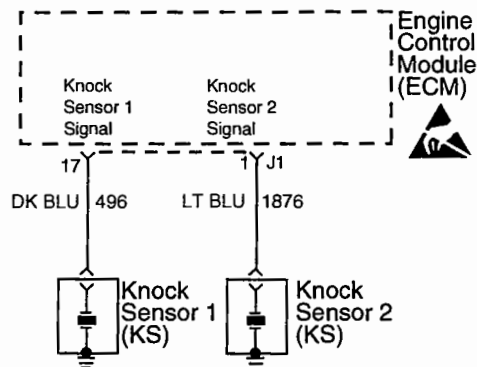
If CKT 496 or CKT497 are routed too close to secondary ignition wires, the ECM may see the interference as a knock signal, resulting in false timing retard.

Test Description

4. This step ensures the knock sensors are secured properly in the engine block.
5. Checks to see that each knock sensor circuit is within specifications. Some engines use two knock sensors, so both circuits need to be checked individually.

DTC 44 - Knock Sensor (KS) 1 System Inactive (Non-Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important: If you can hear the engine knock, repair the engine mechanical problem before proceeding with this diagnostic table. Check the KS signal circuits for incorrect routing near the secondary wires. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 3
3	Check the KS signal circuits for any terminals not being fully seated or for incorrect installation. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 4
4	Checks knock sensors for being loose in the engine block. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 5
5	1. Ignition "OFF" 2. Disconnect "J1" harness connector. 3. Connect DVOM from "J1-17" (CKT 496 - Knock Signal 1) to a known good ground near knock sensor. Is resistance between the specified value for each circuit?	100,000 ohms	Go to Step 8	Go to Step 6
6	Locate and repair open or short to ground in the circuit(s) that were out of range. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 7
7	Inspect knock sensor terminal contacts. If OK, replace faulty knock sensor(s). Is action complete?	—	Verify Repair	—
8	Replace faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

MEFI4310
6-28-00

DTC 44 - Knock Sensor (KS) 2 System Inactive (Non-Scan Diagnostics)

Circuit Description

The ECM uses the Knock Sensors in order to detect engine detonation. This detection allows the ECM to retard spark timing based on the KS signal coming into the ECM. DTC 44 will set only if the ECM does not see any activity on the KS signal circuits.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage.
- Loose Knock Sensors in engine block.
- Poor connection at the Knock Sensors.

After repairs, clear DTC's following "Clear DTC's Procedure" in the *General Information* section. Failure to do so may result in DTC's not properly being cleared.

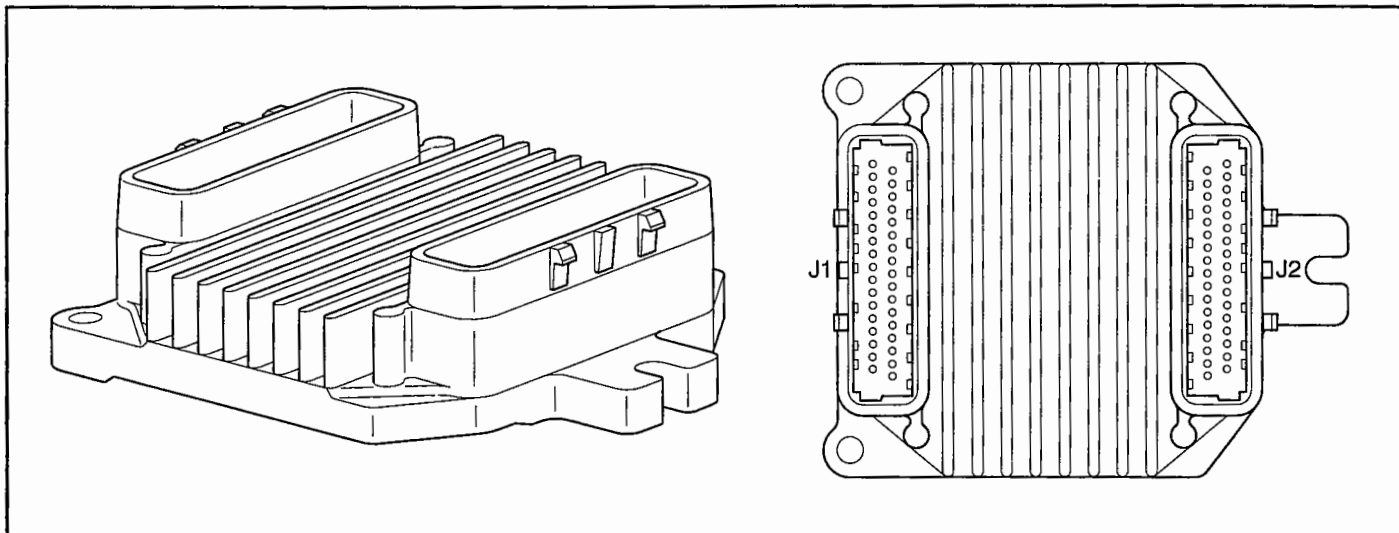
If CKT 496 or CKT497 are routed too close to secondary ignition wires, the ECM may see the interference as a knock signal, resulting in false timing retard.

Test Description

4. This step ensures the knock sensors are secured properly in the engine block.
5. Checks to see that each knock sensor circuit is within specifications. Some engines use two knock sensors, so both circuits need to be checked individually.

DTC 44 - Knock Sensor (KS) 2 System Inactive (Non-Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important: If you can hear the engine knock, repair the engine mechanical problem before proceeding with this diagnostic table. Check the KS signal circuits for incorrect routing near the secondary wires. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 3
3	Check the KS signal circuits for any terminals not being fully seated or for incorrect installation. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 4
4	Checks knock sensors for being loose in the engine block. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 5
5	1. Ignition "OFF" 2. Disconnect "J1" harness connector. 3. Connect DVOM from "J1-1" (CKT 497 - Knock Signal 2) to a known good ground near knock sensor. Is resistance between the specified value for each circuit?	? ohms	Go to Step 8	Go to Step 6
6	Locate and repair open or short to ground in the circuit(s) that were out of range. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 7
7	Inspect knock sensor terminal contacts. If OK, replace faulty knock sensor(s). Is action complete?	—	Verify Repair	—
8	Replace faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—



MEFI3004

DTC 51 - Calibration Checksum Failure (Non-Scan Diagnostics)

Circuit Description

This test allows the ECM to check for a calibration failure by comparing the calibration value to a known value stored in the EEPROM.

This test is also used as a security measure to prevent improper use of calibration or changes to these calibrations that may alter the designed function of MEFI.

Diagnostic Aids

If DTC 51 failed more than once, but is intermittent, replace the ECM.

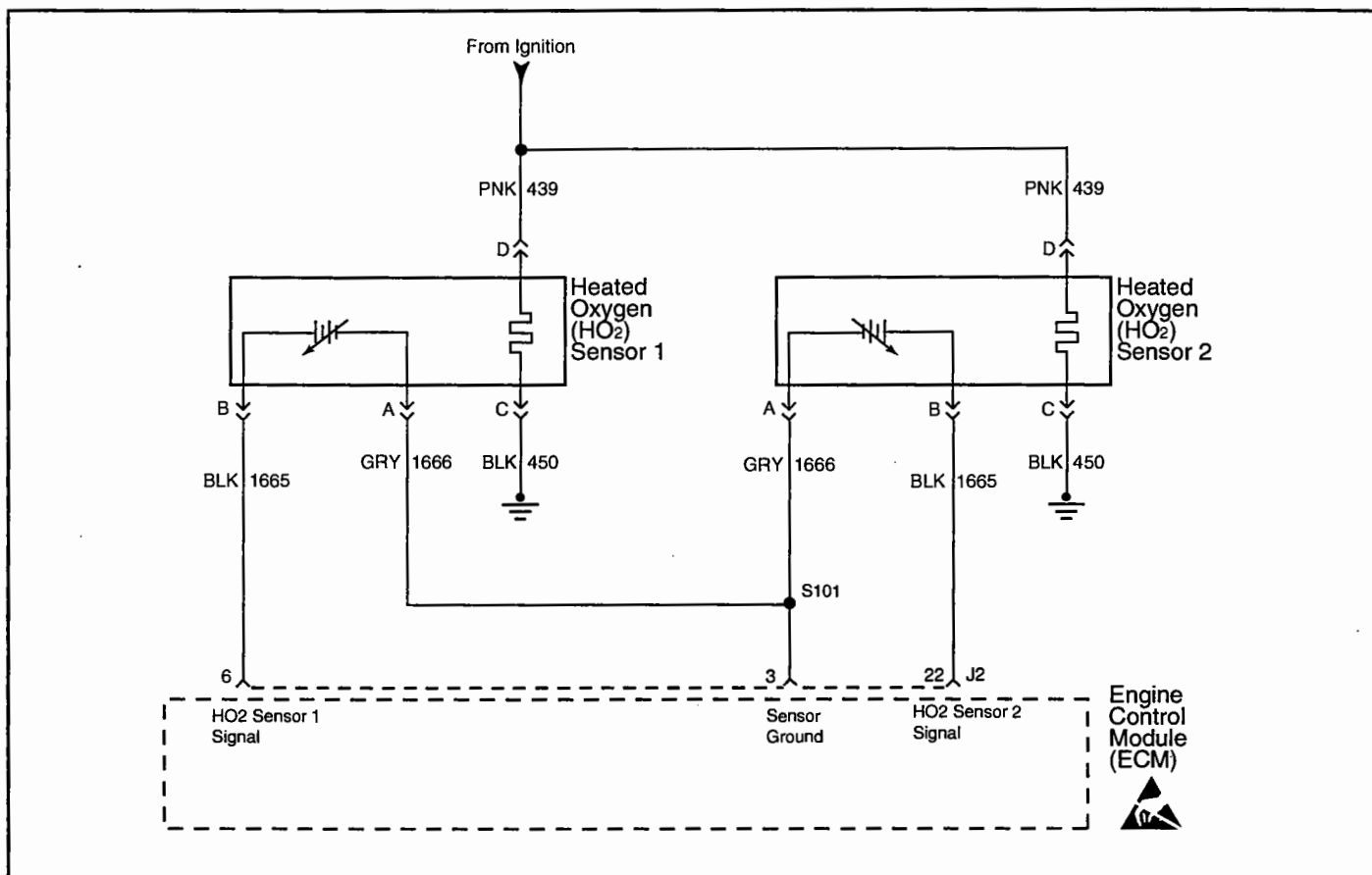
Test Description

2. This step checks to see if the fault is present during diagnosis. If present, the ECM is not functioning properly and must be replaced or reprogrammed.

DTC 51 - Calibration Checksum Failure (Non-Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Install Diagnostic Trouble Code (DTC) tool. 2. Using "Clear DTC Procedure," clear DTC 51. 3. Ignition "ON." 4. Switch DTC tool to "service mode," or "ON." Does DTC 51 reset?	—	Go to Step 3	Refer to Diagnostic Aids
3	Replace or reprogram faulty ECM and verify DTC does not reset. Is action complete?	—	Verify Repair	—

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MEFI4313
4-26-00

DTC 54 - Heated Oxygen (HO₂) Sensor 1 Circuit Low Voltage - Lean Exhaust Indicated (Non-Scan Diagnostics)

Circuit Description

The Heated Oxygen (HO₂) Sensor(s) varies voltage within a range from about 1.0 volt if the exhaust is rich, down to about 0.1 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 oxygen sensor circuit or cold oxygen sensor causes an Open Loop operation.

Diagnostic Aids

Check for the following conditions:

- **Poor connection in harness.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- An intermittent short to ground in the HO₂ sensor signal circuit.

Contamination: Water, even in small amounts on the injectors can cause a lean condition.

If the fuel pressure is too low, the system order to confirm, monitor a fuel pressure gauge while driving the vehicle at various speeds and

loads.

- **Exhaust Leaks:** If there is an exhaust leak, the engine may pull the outside air into the exhaust and past the sensor.
- **Vacuum leaks** can cause a lean condition or high idle.

Never solder the HO₂ wires. For proper wire and connection repairs, refer to "Wiring Repair."

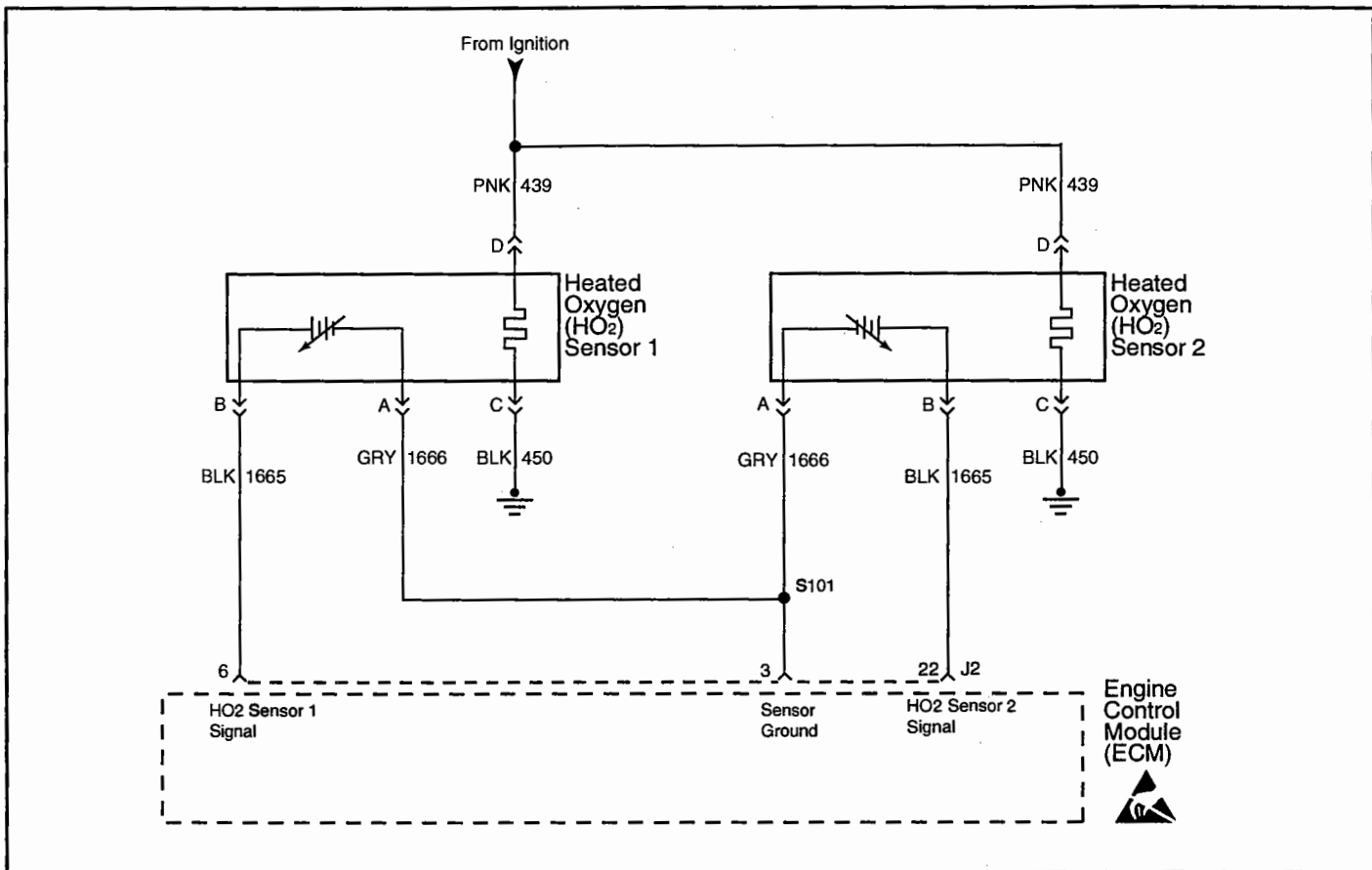
After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

2. Running the engine at 1200 RPM keeps the HO₂ sensor hot in order to ensure the oxygen sensor remains active and can indicate the exhaust oxygen content accurately.
3. Opening the heated oxygen sensor circuit should result in a displayed voltage between 0.423 volt and 0.487 volt. If the display is fixed below 0.100 volt, the fault is a short to ground in HO₂ sensor signal circuit or a faulty ECM.

**DTC 54 - Heated Oxygen (HO₂) Sensor 1 Circuit Low Voltage - Lean Exhaust Indicated
(Non-Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Disconnect HO ₂ sensor 1 electrical connector. 2. Install jumper wires between the two harness connectors. 3. Run the engine at the normal operating temperature. 4. Place the vehicle in park or neutral. 5. Increase the engine speed to the specified value. 6. Using DVOM J 39200, check the voltage between CKT 1665 and CKT 1666. Is the voltage displayed fixed less than the specified value?	1200 RPM 0.100 volt	Go to Step 3	Go to Step 4
3	1. Disconnect the HO ₂ sensor electrical connector. 2. Using a jumper wire, connect the HO ₂ sensor 1 Low circuit to a known good ground. 3. Ignition turned ON. Is the voltage displayed within the specified value?	0.423- 0.487 volt	Refer to Diagnostic Aids	Go to Step 5
4	DTC 54 is intermittent. If no additional DTC's are stored, refer to the Diagnostic Aids. If any additional DTC's are stored, refer to those table(s) first.	—	Go to Applicable DTC Table	—
5	Locate and repair short to ground in the HO ₂ sensor 1 signal circuit. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 6
6	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

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4-26-00

DTC 54 - Heated Oxygen (HO₂) Sensor 2 Circuit Low Voltage - Lean Exhaust Indicated (Non-Scan Diagnostics)

Circuit Description

The Heated Oxygen (HO₂) Sensor(s) varies voltage within a range from about 1.0 volt if the exhaust is rich, down to about 0.1 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 oxygen sensor circuit or cold oxygen sensor causes an Open Loop operation.

Diagnostic Aids

Check for the following conditions:

- **Poor connection in harness.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- An intermittent short to ground in the HO₂ sensor signal circuit.
- Fuel contamination: Water, even in small amounts delivered to the injectors can cause a lean condition.
- Fuel Pressure: If the fuel pressure is too low, the system will be lean. In order to confirm, monitor a fuel pressure gauge while driving the vehicle at various speeds and

loads.

- **Exhaust Leaks:** If there is an exhaust leak, the engine may pull the outside air into the exhaust and past the sensor.
- Vacuum leaks can cause a lean condition or high idle.

Never solder the HO₂ wires. For proper wire and connection repairs, refer to "Wiring Repair."

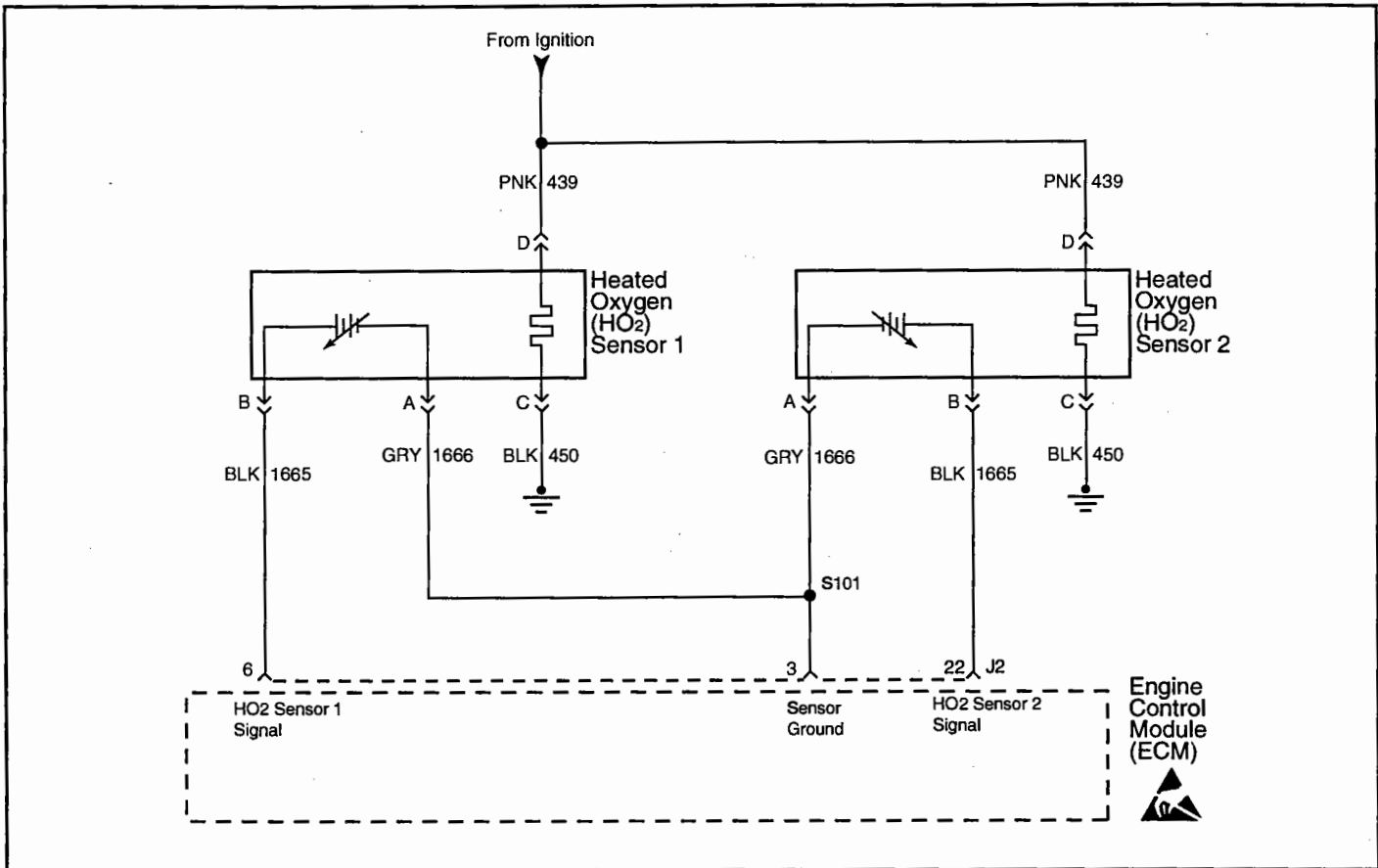
After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

2. Running the engine at 1200 RPM keeps the HO₂ sensor hot in order to ensure the oxygen sensor remains active and can indicate the exhaust oxygen content accurately.
3. Opening the heated oxygen sensor circuit should result in a displayed voltage between 0.423 volt and 0.487 volt. If the display is fixed below 0.100 volt, the fault is a short to ground in HO₂ sensor signal circuit or a faulty ECM.

**DTC 54 - Heated Oxygen (HO₂) Sensor 2 Circuit Low Voltage - Lean Exhaust Indicated
(Non-Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Disconnect HO ₂ sensor 2 electrical connector. 2. Install jumper wires between the two harness connectors. 3. Run the engine at the normal operating temperature. 4. Place the vehicle in park or neutral. 5. Increase the engine speed to the specified value. 6. Using DVOM J 39200, check the voltage between CKT 1665 and CKT 1666. Is the voltage displayed fixed less than the specified value?	1200 RPM 0.100 volt	Go to Step 3	Go to Step 4
3	1. Disconnect the HO ₂ sensor electrical connector. 2. Using a jumper wire, connect the HO ₂ sensor 2 Low circuit to a known good ground. 3. Ignition turned ON. Is the voltage displayed within the specified value?	0.423- 0.487 volt	Refer to Diagnostic Aids	Go to Step 5
4	DTC 54 is intermittent. If no additional DTC's are stored, refer to the Diagnostic Aids. If any additional DTC's are stored, refer to those table(s) first.	—	Go to Applicable DTC Table	—
5	Locate and repair short to ground in the HO ₂ sensor 2 signal circuit. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 6
6	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—



MEFI4313
4-26-00

DTC 55 - Heated Oxygen (HO₂) Sensor 1 Circuit High Voltage - Rich Exhaust Indicated (Non-Scan Diagnostics)

Circuit Description

The Heated Oxygen (HO₂) Sensor varies voltage within a range from about 1.0 volt if the exhaust is rich, down to about 0.1 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 oxygen sensor circuit or cold oxygen sensor causes an Open Loop operation.

Diagnostic Aids

Check for the following conditions:

- **Poor connection in harness.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- A leaking injector.
- Fuel contaminated oil.
- Fuel Pressure: If the fuel pressure is too high, the system will be rich. In order to confirm, monitor a fuel pressure gauge while driving the vehicle at various speeds and loads.
- Leaking fuel pressure regulator. Check for fuel in the

vacuum line to regulator.

- The TP sensor: An intermittent TP sensor output can cause the system to run rich due to a false indication of the throttle moving.
- False rich indication due to silicon contamination of the HO₂ sensor. A DTC 55 accompanied by lean drivability conditions and a powdery white deposit on the sensor indicates a false rich condition.
- Faulty HO₂ sensor: The HO₂ sensor is internally shorted, the HO₂ sensor voltage displayed will be over 1.0 volt.

Never solder the HO₂ wires. For proper wire and connection repairs, refer to "Wiring Repair."

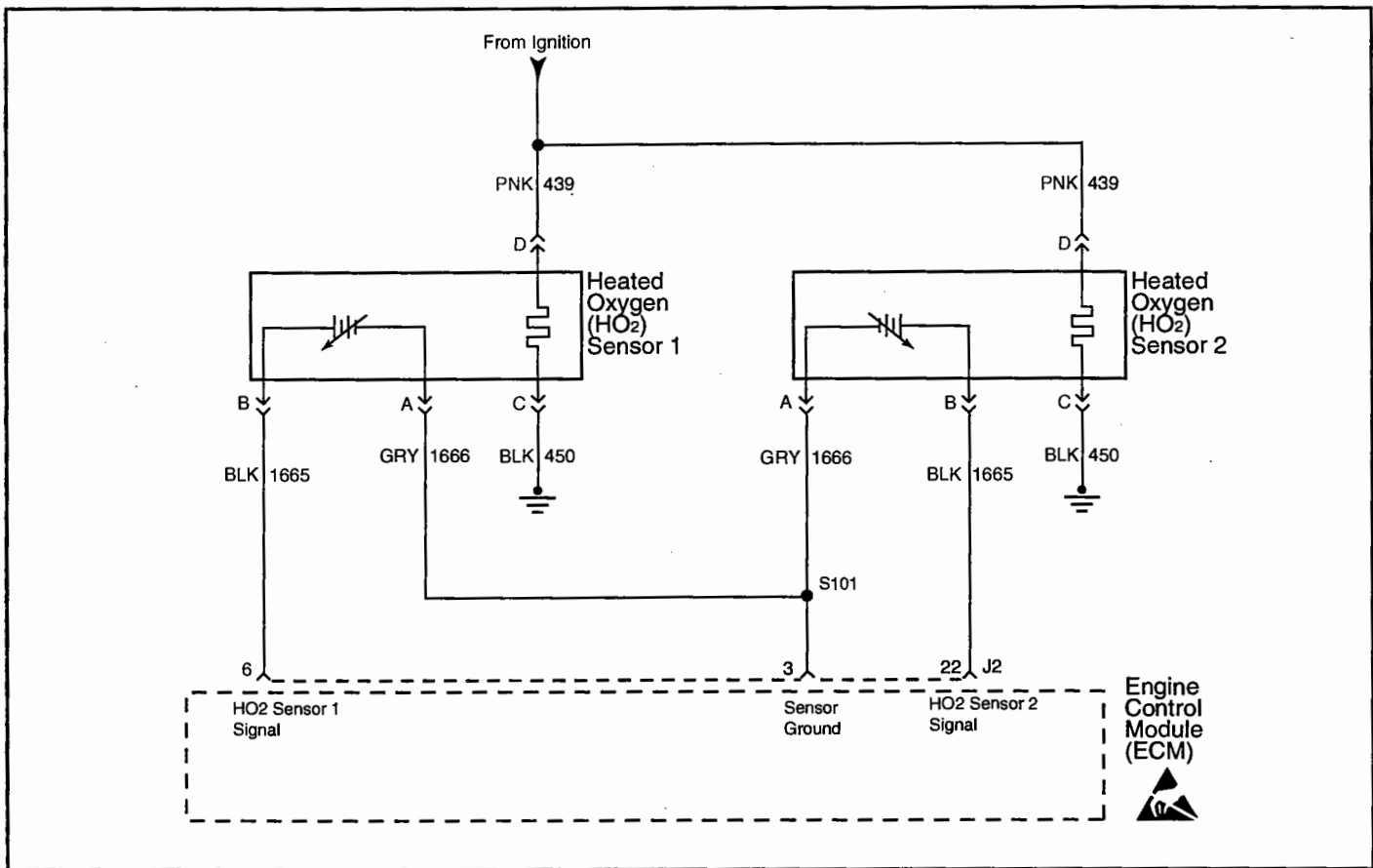
After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

2. This test determines if the conditions exist in order to set DTC 55.

**DTC 55 - Heated Oxygen (HO₂) Sensor 1 Circuit High Voltage - Rich Exhaust Indicated
(Non-Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Disconnect HO ₂ sensor 1 electrical connector. 2. Install jumper wires between the two harness connectors. 3. Run the engine at the normal operating temperature. 4. Place the vehicle in park or neutral. 5. Increase the engine speed to the specified value. 6. Using a DVOM, check the voltage between CKT 1665 and CKT 1666. Is the voltage displayed fixed above the specified value?	1200 RPM 0.900 volt	Go to Step 3	Go to Step 5
3	Ignition turned ON. Is the voltage displayed fixed above the specified value?	0.900 volt	Go to Step 4	Refer to Diagnostic Aids
4	1. Disconnect the HO ₂ sensor 1 electrical connector. 2. Ignition turned ON. Is the voltage displayed fixed above the specified value?	0.900 volt	Go to Step 7	Go to Step 6
5	DTC 55 is intermittent. If no additional DTC's are stored, refer to the Diagnostic Aids. If any additional DTC's are stored, refer to those table(s) first.	—	Go to Applicable DTC Table	—
6	Replace HO ₂ sensor 1. Is action complete?	—	Verify Repair	—
7	Locate and repair short to voltage in the HO ₂ sensor 1 signal circuit. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 8
8	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—



MEFI4313
4-26-00

DTC 55 - Heated Oxygen (HO₂) Sensor 2 Circuit High Voltage - Rich Exhaust Indicated (Non-Scan Diagnostics)

Circuit Description

The Heated Oxygen (HO₂) Sensor varies voltage within a range from about 1.0 volt if the exhaust is rich, down to about 0.1 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 oxygen sensor circuit or cold oxygen sensor causes an Open Loop operation.

Diagnostic Aids

Check for the following conditions:

- **Poor connection in harness.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- A leaking injector.
- Fuel contaminated oil.
- Fuel Pressure: If the fuel pressure is too high, the system will be rich. In order to confirm, monitor a fuel pressure gauge while driving the vehicle at various speeds and loads.
- Leaking fuel pressure regulator. Check for fuel in the

vacuum line to regulator.

- The TP sensor: An intermittent TP sensor output can cause the system to run rich due to a false indication of the throttle moving.
- False rich indication due to silicon contamination of the HO₂ sensor. A DTC 55 accompanied by lean drivability conditions and a powdery white deposit on the sensor indicates a false rich condition.
- Faulty HO₂ sensor: The HO₂ sensor is internally shorted, the HO₂ sensor voltage displayed will be over 1.0 volt.

Never solder the HO₂ wires. For proper wire and connection repairs, refer to "Wiring Repair."

After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

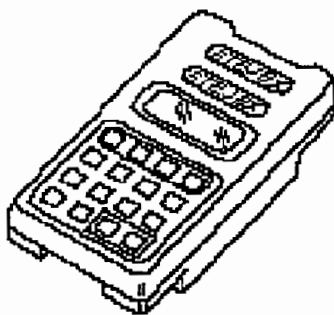
2. This test determines if the conditions exist in order to set DTC 55.

**DTC 55 - Heated Oxygen (HO2) Sensor 2 Circuit High Voltage - Rich Exhaust Indicated
(Non-Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Disconnect HO2 sensor 2 electrical connector. 2. Install jumper wires between the two harness connectors. 3. Run the engine at the normal operating temperature. 4. Place the vehicle in park or neutral. 5. Increase the engine speed to the specified value. 6. Using a DVOM, check the voltage between CKT 1665 and CKT 1666. Is the voltage displayed fixed above the specified value?	1200 RPM 0.900 volt	Go to Step 3	Go to Step 5
3	Ignition turned ON. Is the voltage displayed fixed above the specified value?	0.900 volt	Go to Step 4	Refer to Diagnostic Aids
4	1. Disconnect the HO2 sensor 2 electrical connector. 2. Ignition turned ON. Is the voltage displayed fixed above the specified value?	0.900 volt	Go to Step 7	Go to Step 6
5	DTC 55 is intermittent. If no additional DTC's are stored, refer to the Diagnostic Aids. If any additional DTC's are stored, refer to those table(s) first.	—	Go to Applicable DTC Table	—
6	Replace HO2 sensor 2. Is action complete?	—	Verify Repair	—
7	Locate and repair short to voltage in the HO2 sensor 2 signal circuit. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 8
8	Repair faulty ECM connections or replace faulty ECM.- Is action complete?	—	Verify Repair	—

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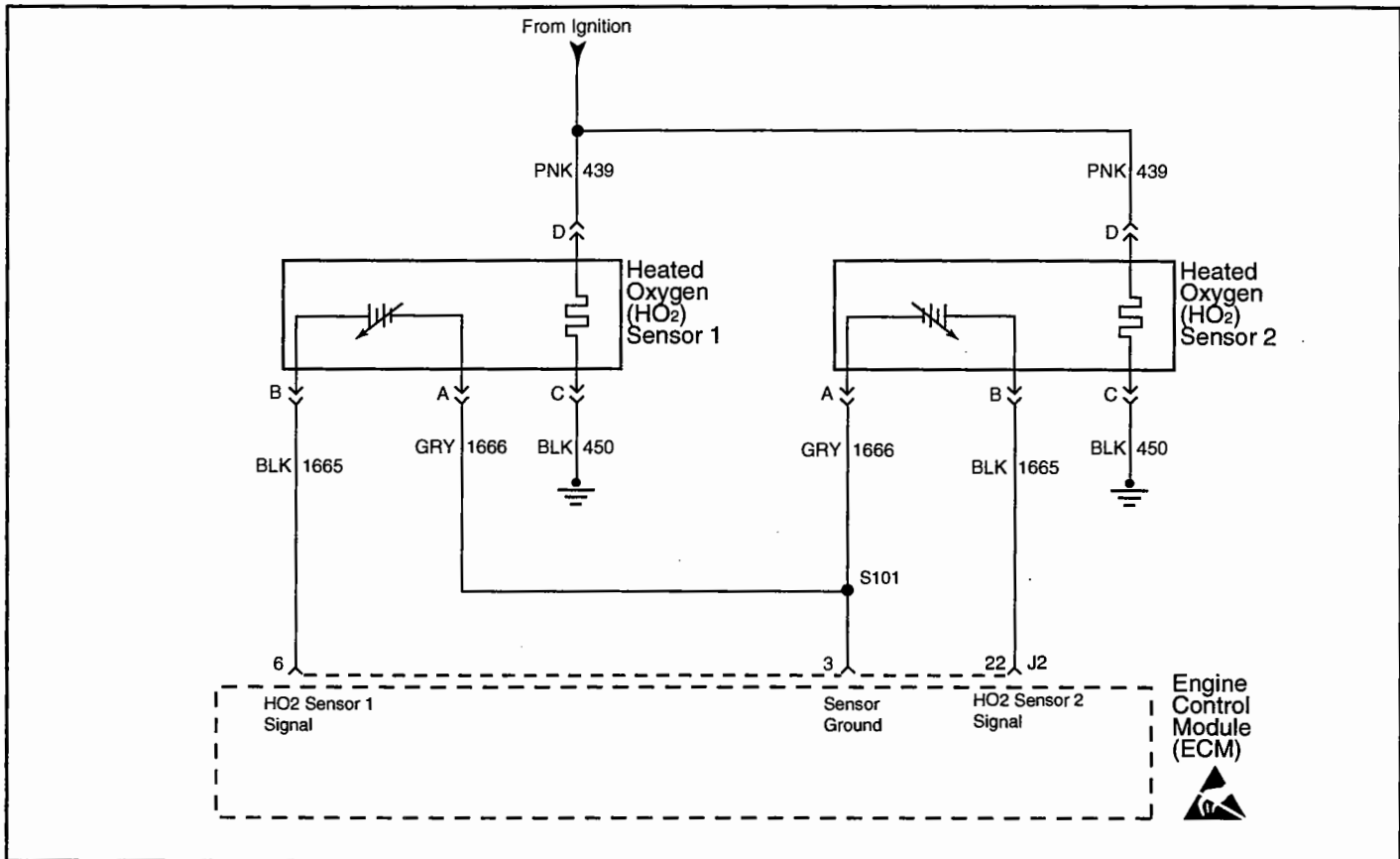
DTC 81 -Non-Scan Diagnostics

MEFI4323
6-12-00

Diagnostic Aids

When a DTC 81 is flashed out using a Diagnostic Trouble Code (DTC) tool, a scan tool **MUST** be used for further diagnostics. DTC 81 has multiple failures, and are only distinguished using a scan tool.

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MEFI4313
4-26-00

DTC 13 - Heated Oxygen (HO₂) Sensor 1 Circuit Inactive (Scan Diagnostics)

Circuit Description

The Heated Oxygen (HO₂) Sensor varies voltage within a range from about 1.0 volt if the exhaust is rich, down to about 0.1 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 oxygen sensor circuit or cold oxygen sensor causes an Open Loop operation.

The heater provides for a faster sensor warm-up. This allows the sensor to become active in a shorter period of time and remain active during a long extended idle.

DTC 13 determines if the heated oxygen sensor circuit has developed an open. With an active DTC 13 set, the system operates in an Open Loop mode and the Malfunction Indicator Lamp (MIL) is turned on.

Diagnostic Aids

Check for the following conditions:

- **Poor connection in harness.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- A faulty HO₂ heater or heater circuit. With ignition "ON," engine "OFF," the HO₂ voltage displayed on the scan tool should gradually drop to below 0.150 volt, indicating that the heater works properly. If not, disconnect the HO₂

sensor connector and connect a test light between harness terminals "C" and "D." If the test light does not illuminate brightly, repair the open in the ignition feed or ground for the HO₂ heater circuit. If the test light illuminates brightly, replace the HO₂ sensor.

Never solder the HO₂ wires. For proper wire and connection repairs, refer to "Wiring Repair."

After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

2. With ignition "ON," engine "OFF," the HO₂ Sensor Voltage displayed on the scan tool should gradually decrease down to approximately 0.150 volt, indicating that the heater is working properly. The HO₂ voltage may rise as high as 0.975 volt before it toggles back down. The main thing to look for is a change.
3. Probing terminal "D" of the HO₂ sensor harness connector verifies if the voltage is available to the HO₂ sensor heater.
5. If conditions for setting DTC 13 exist, the system will not go into Closed Loop Fuel.
7. This test checks the continuity of the HO₂ signal circuit.

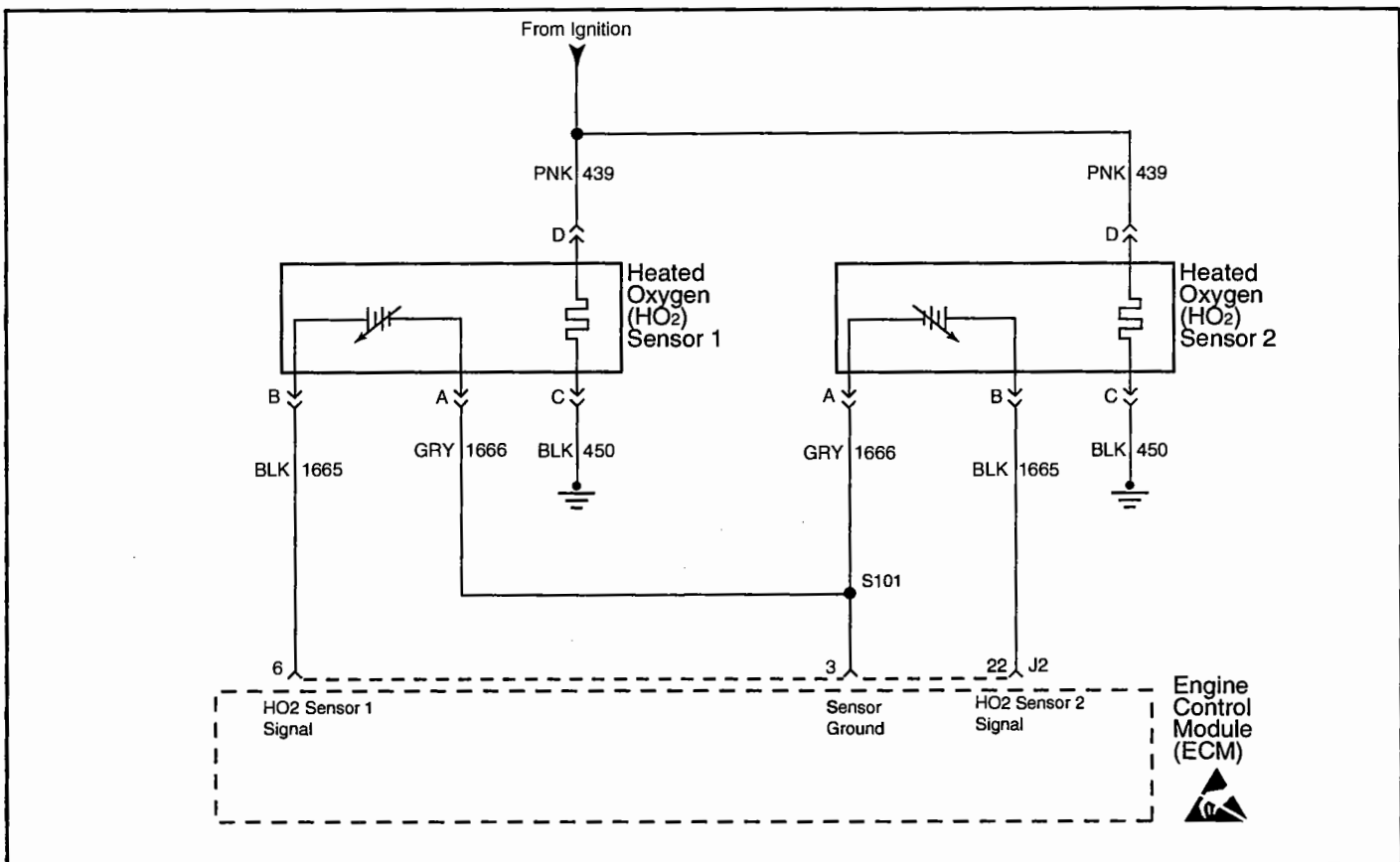
DTC 13 - Heated Oxygen (HO₂) Sensor 1 Circuit Inactive (Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostics"(OBD) System Check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Connect scan tool. 2. Ignition turned ON. 3. Monitor the HO ₂ Sensor 1 Voltage. Does the voltage displayed gradually decrease down to approximately the specified value?	0.150 volt	Go to Step 5	Go to Step 3
3	1. Disconnect the HO ₂ sensor 1 electrical connector. 2. Using a test light connected to a known good ground, probe terminal "D" of the ECM harness connector. Does the test light illuminate brightly?	—	Go to Step 4	Go to Step 9
4	Connect test light between terminals "C" and "D" of the HO ₂ sensor 1 harness connector. Does the test light illuminate brightly?	—	Go to Step 5	Go to Step 10
5	1. Reconnect HO ₂ sensor 1 electrical connector. 2. Connect scan tool. 3. Run the engine at the normal operating temperature. 4. Run the engine above the specified value for 2 minutes. Does the scan tool indicate Closed Loop Fuel control?	1200 RPM	Go to Step 8	Go to Step 6
6	1. Disconnect the Heated Oxygen (HO ₂) sensor 1 electrical connector. 2. Install a jumper between the HO ₂ sensor 1 signal and ground circuit on the ECM harness side. 3. Ignition turned ON. Does the scan tool HO ₂ Sensor 1 Voltage display indicate a voltage less than the specified value?	0.100 volt	Go to Step 13	Go to Step 7
7	1. Turn ignition OFF. 2. Remove the jumpers. 3. Using a test light connected to B+, probe the HO ₂ sensor 1 ground circuit on the ECM harness side. Does the test light illuminate brightly?	—	Go to Step 11	Go to Step 12
8	DTC 13 is intermittent. If no additional DTC's are stored, refer to the Diagnostic Aids. If any additional DTC's are stored, refer to those table(s) first.	—	Go to Applicable DTC Table	—
9	Locate and repair open or short to ground in the ignition feed circuit for the HO ₂ heater. Is action complete?	—	Verify Repair	—
10	Locate and repair open in the ground circuit for the HO ₂ heater. Is action complete?	—	Verify Repair	—

DTC 13 - Heated Oxygen (HO₂) Sensor 1 Circuit Inactive (Scan Diagnostics)

Step	Action	Value	Yes	No
11	Locate and repair open in the HO ₂ sensor 1 signal circuit. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 14
12	Locate and repair open in the HO ₂ sensor 1 ground circuit. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 14
13	Check for faulty HO ₂ sensor 1 connections. If OK, replace HO ₂ sensor. Is action complete?	—	Verify Repair	—
14	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

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MEFI4313
4-26-00

DTC 13 - Heated Oxygen (HO₂) Sensor 2 Circuit Inactive (Scan Diagnostics)

Circuit Description

The Heated Oxygen (HO₂) Sensor varies voltage within a range from about 1.0 volt if the exhaust is rich, down to about 0.1 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 oxygen sensor circuit or cold oxygen sensor causes an Open Loop operation.

The heater provides for a faster sensor warm-up. This allows the sensor to become active in a shorter period of time and remain active during a long extended idle.

DTC 13 determines if the heated oxygen sensor circuit has developed an open. With an active DTC 13 set, the system operates in an Open Loop mode and the Malfunction Indicator Lamp (MIL) is turned on.

Diagnostic Aids

Check for the following conditions:

- **Poor connection in harness.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- A faulty HO₂ heater or heater circuit. With ignition "ON," engine "OFF," the HO₂ voltage displayed on the scan tool should gradually drop to below 0.150 volt, indicating that the heater works properly. If not, disconnect the HO₂

sensor connector and connect a test light between harness terminals "C" and "D." If the test light does not illuminate brightly, repair the open in the ignition feed or ground for the HO₂ heater circuit. If the test light illuminates brightly, replace the HO₂ sensor.

Never solder the HO₂ wires. For proper wire and connection repairs, refer to "Wiring Repair."

After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

2. With ignition "ON", engine "OFF", the HO₂ Sensor Voltage displayed on the scan tool should gradually decrease down to approximately 0.150 volt, indicating that the heater is working properly. The HO₂ voltage may rise as high as 0.975 volt before it toggles back down. The main thing to look for is a change.
3. Probing terminal "D" of the HO₂ sensor harness connector verifies if the voltage is available to the HO₂ sensor heater.
5. If conditions for setting DTC 13 exist, the system will not go into Closed Loop Fuel.
7. This test checks the continuity of the HO₂ signal circuit.

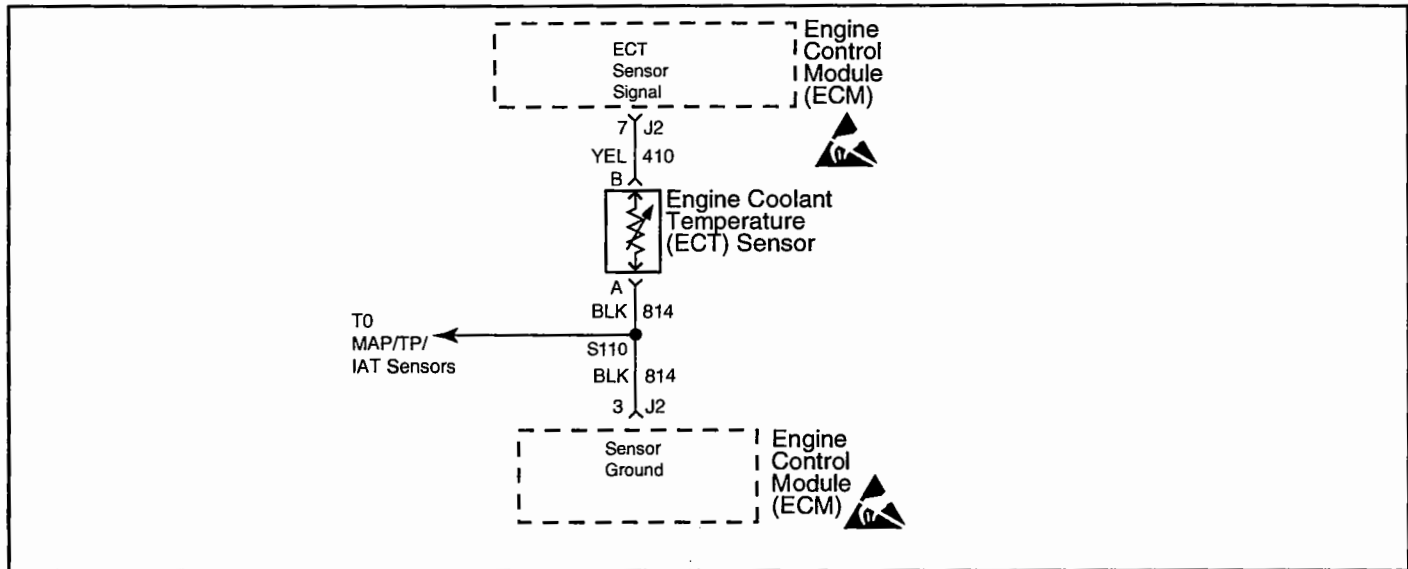
DTC 13 - Heated Oxygen (HO₂) Sensor 2 Circuit Inactive (Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostics"(OBD) System Check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Connect scan tool. 2. Ignition turned ON. 3. Monitor the HO ₂ Sensor 2 Voltage. Does the voltage displayed gradually decrease down to approximately the specified value?	0.150 volt	Go to Step 5	Go to Step 3
3	1. Disconnect the HO ₂ sensor 2 electrical connector. 2. Using a test light connected to a known good ground, probe terminal "D" of the ECM harness connector. Does the test light illuminate brightly?	—	Go to Step 4	Go to Step 9
4	Connect test light between terminals "C" and "D" of the HO ₂ sensor 1 harness connector. Does the test light illuminate brightly?	—	Go to Step 5	Go to Step 10
5	1. Reconnect HO ₂ sensor 2 electrical connector. 2. Connect scan tool. 3. Run the engine at the normal operating temperature. 4. Run the engine above the specified value for 2 minutes. Does the scan tool indicate Closed Loop Fuel control?	1200 RPM	Go to Step 8	Go to Step 6
6	1. Disconnect the Heated Oxygen (HO ₂) sensor 2 electrical connector. 2. Install a jumper between the HO ₂ sensor 2 signal and ground circuit on the ECM harness side. 3. Ignition turned ON. Does the scan tool HO ₂ Sensor 2 Voltage display indicate a voltage less than the specified value?	0.100 volt	Go to Step 13	Go to Step 7
7	1. Turn ignition OFF. 2. Remove the jumpers. 3. Using a test light connected to B+, probe the HO ₂ sensor 2 ground circuit on the ECM harness side. Does the test light illuminate brightly?	—	Go to Step 11	Go to Step 12
8	DTC 13 is intermittent. If no additional DTC's are stored, refer to the Diagnostic Aids. If any additional DTC's are stored, refer to those table(s) first.	—	Go to Applicable DTC Table	—
9	Locate and repair open or short to ground in the ignition feed circuit for the HO ₂ heater. Is action complete?	—	Verify Repair	—
10	Locate and repair open in the ground circuit for the HO ₂ heater. Is action complete?	—	Verify Repair	—

DTC 13 - Heated Oxygen (HO2) Sensor 2 Circuit Inactive (Scan Diagnostics)

Step	Action	Value	Yes	No
11	Locate and repair open in the HO2 sensor 2 signal circuit. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 14
12	Locate and repair open in the HO2 sensor 2 ground circuit. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 14
13	Check for faulty HO2 sensor 2 connections. If OK, replace HO2 sensor. Is action complete?	—	Verify Repair	—
14	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

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MEFI 4307
4-20-00

DTC 14 - Engine Coolant Temperature (ECT) Sensor Circuit - Low Temp Indicated (Scan Diagnostics)

Circuit Description

The Engine Coolant Temperature (ECT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts on CKT 410 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high. As the engine coolant warms up, the sensor resistance becomes less. See engine coolant temperature sensor table under "Diagnostic Aids." At normal operating temperature (85°C - 95°C or 185°F - 203°F), the voltage will measure about 1.5-2.0 volts.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the ECT display on the scan tool while moving connectors and wiring harnesses related to the ECT sensor. A change in the ECT display will indicate the location of the fault.
- The scan tool displays engine coolant temperature in degrees celsius and fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display a ECT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a "shifted" coolant sensor. After engine is started, the temperature should rise steadily and then stabilize at operating temperature when the thermostat opens.
- If DTC 33 is also set, check for open ground CKT 814.

After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

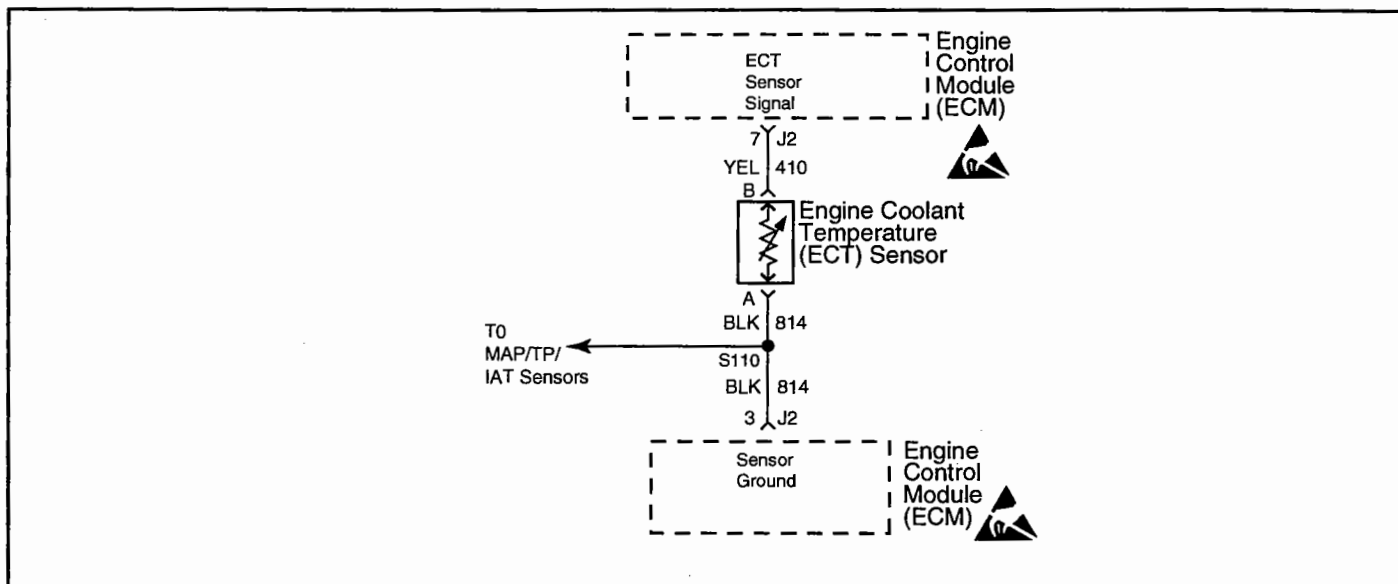
2. DTC 14 will set if signal voltage indicates a coolant temperature below -30°C (-22°F).
3. This test simulates a DTC 15. If the ECM recognizes the low voltage signal and displays a high temperature, the ECM and wiring are OK.

Engine Coolant Temperature Sensor Table

°C	°F	OHMS
Temperature vs Resistance Values (Approximate)		
100	212	177
80	176	332
60	140	667
45	113	1188
35	95	1802
25	77	2796
15	59	4450
5	41	7280
-5	23	12300
-15	5	21450
-30	-22	52700
-40	-40	100700

**DTC 14 - Engine Coolant Temperature (ECT) Sensor Circuit - Low Temp Indicated
(Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Turn ignition ON, leaving engine OFF. Does scan tool display a coolant temperature less than the specified value?	-30°C (-22°F)	Go to Step 3	Go to Step 4
3	1. Turn ignition OFF. 2. Disconnect the ECT sensor harness connector. 3. Connect a jumper wire from harness terminal "A" (CKT 814) to harness terminal "B" (CKT 410). 4. Turn ignition ON, leaving engine OFF. Does scan tool display a coolant temperature above the specified value?	130°C (266°F)	Go to Step 6	Go to Step 5
4	DTC 14 is intermittent. Locate and repair intermittent faulty connections. • Refer to "Diagnostic Aids."	—	Verify Repair	—
5	Locate and repair open in CKT 410 or CKT 814. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 7
6	Repair faulty ECT sensor. Is action complete?	—	Verify Repair	—
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—



MEFI 4307
4-20-00

DTC 15 - Engine Coolant Temperature (ECT) Sensor Circuit - High Temp Indicated (Scan Diagnostics)

Circuit Description

The Engine Coolant Temperature (ECT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts on CKT 410 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high. As the engine coolant warms up, the sensor resistance becomes less. See engine coolant temperature sensor table under "Diagnostic Aids." At normal operating temperature (85°C - 95°C or 185°F - 203°F), the voltage will measure about 1.5-2.0 volts.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the ECT display on the scan tool while moving connectors and wiring harnesses related to the ECT sensor. A change in the ECT display will indicate the location of the fault.
- The scan tool displays engine coolant temperature in degrees celsius and fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display a ECT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a "shifted" coolant sensor. After engine is started, the temperature should rise steadily and then stabilize at operating temperature when the thermostat opens.

- Check harness routing for a potential short to ground in CKT 410.

After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

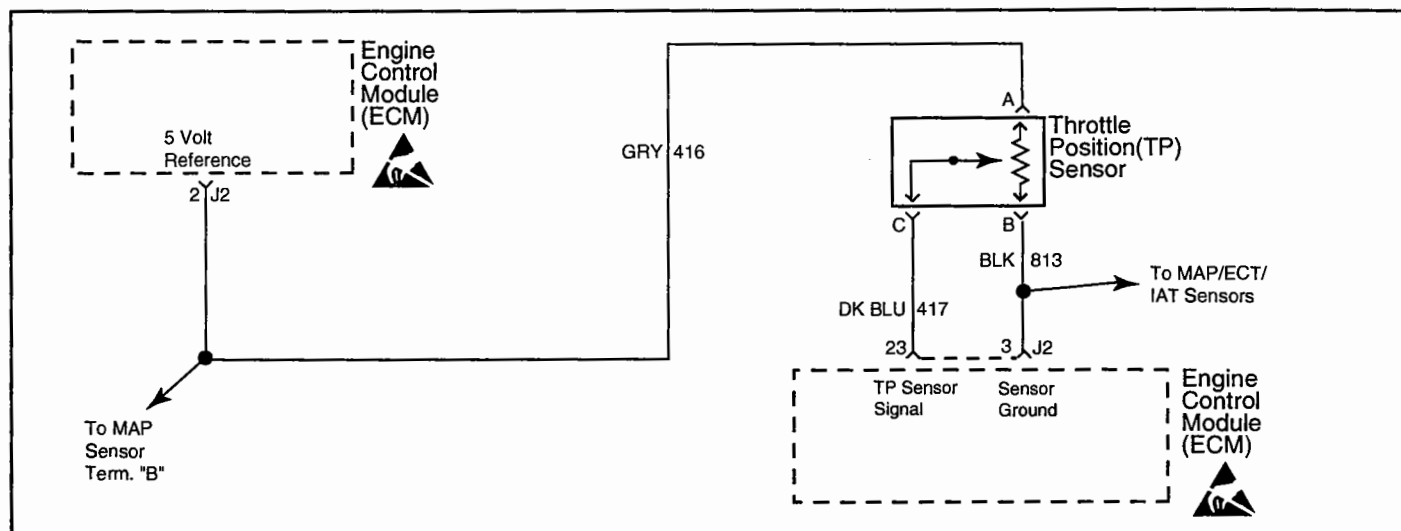
2. DTC 15 will set if signal voltage indicates a coolant temperature above 130°C or 266°F.
3. This test simulates a DTC 14. If the ECM recognizes the high voltage signal and displays a low temperature, the ECM and wiring are OK.

Engine Coolant Temperature Sensor Table

°C	°F	OHMS
Temperature vs Resistance Values (Approximate)		
100	212	177
80	176	332
60	140	667
45	113	1188
35	95	1802
25	77	2796
15	59	4450
5	41	7280
-5	23	12300
-15	5	21450
-30	-22	52700
-40	-40	100700

**DTC 15 - Engine Coolant Temperature (ECT) Sensor Circuit - High Temp Indicated
(Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Turn ignition ON, leaving engine OFF. Does scan tool display a coolant temperature greater than the specified value?	130°C (266°F)	Go to Step 3	Go to Step 4
3	1. Turn ignition OFF. 2. Disconnect ECT sensor harness connector. 3. Turn ignition ON, leaving engine OFF. Does scan tool display a coolant temperature below the specified value?	-30°C (-22°F)	Go to Step 6	Go to Step 5
4	DTC 15 is intermittent. Locate and repair intermittent faulty connections. • Refer to "Diagnostic Aids."	—	Verify Repair	—
5	Locate and repair short to ground in CKT 410. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 7
6	Repair faulty ECT sensor. Is action complete?	—	Verify Repair	—
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

MEFI4308
4-20-00

DTC 21 - Throttle Position (TP) Sensor Circuit - Signal Voltage High (Scan Diagnostics)

Circuit Description

The Throttle Position (TP) sensor is a potentiometer that provides a voltage signal that changes relative to the throttle blade. Signal voltage should vary from about .7 volt at idle to about 4.8 volts at Wide Open Throttle (WOT).

The TP sensor signal is one of the most important inputs used by the ECM for fuel control and for IAC control.

The ECM supplies a 5 volt signal to the sensor through CKT 416. CKT 813 is the TP sensor ground circuit. The TP sensor will send a voltage signal back to the ECM, through CKT 417, according to where the throttle blades are positioned.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the TP sensor display on the scan tool while moving connectors and wiring harnesses related to the TP sensor. A change in the TP sensor display will indicate the location of the fault.
- The scan tool reads throttle position in voltage and percentage relative to the throttle blade opening. With ignition "ON," engine "OFF," throttle blades closed (idle), the voltage should be 0.3-0.9 volts. The voltage should steadily increase as the throttle is moved toward Wide Open Throttle (WOT).
- If a TP sensor circuit failure is present, the MAP sensor default value will be used along with the TP sensor default value.

After repairs, clear DTC's following "Clear DTC's Procedure."

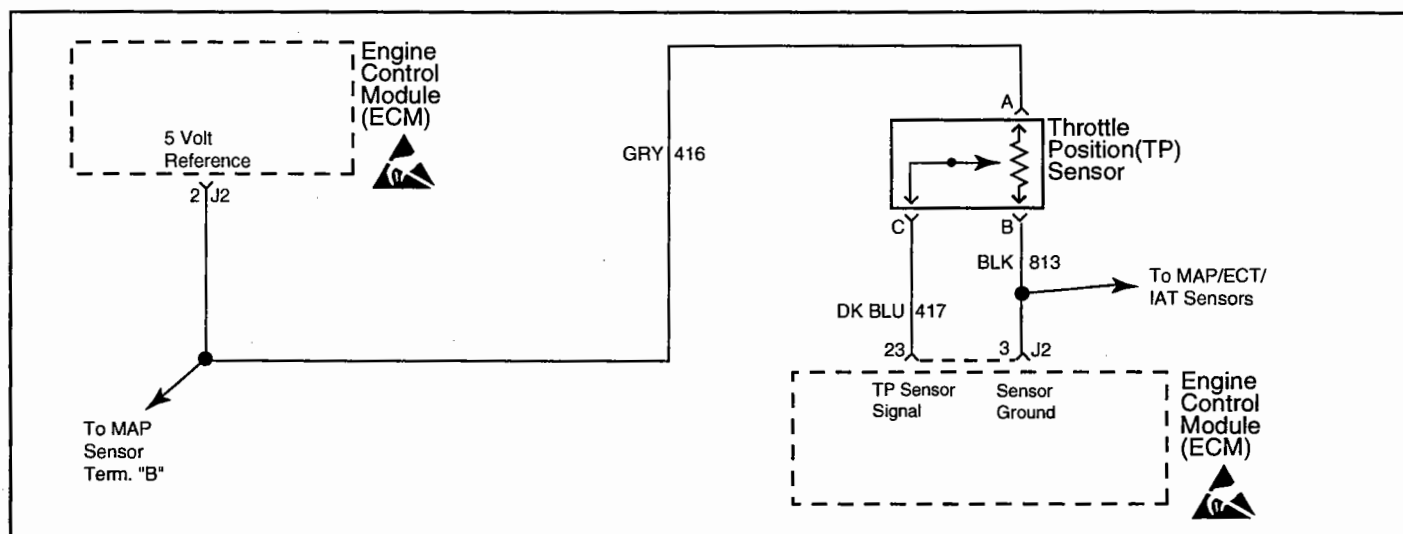
Failure to do so may result in DTC's not properly being cleared.

Test Description

2. With the throttle closed, the TP sensor voltage should read 0.3-0.9 volt. If it does not, check the throttle cable adjustment or for bent or binding linkage.
3. This test simulates a DTC 22. If the ECM recognizes the low voltage signal, the ECM and wiring are OK.
4. Using DVOM from harness terminal "A" (CKT 416) harness terminal "B" (CKT 813) checks the sensor ground circuit. A faulty sensor ground CKT 813 will cause a DTC 21.

DTC 21 - Throttle Position (TP) Sensor Circuit - Signal Voltage High (Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Throttle closed. 2. Turn ignition ON, leaving engine OFF. Does scan tool indicate TP sensor voltage greater than the specified value?	4 volts	Go to Step 3	Go to Step 5
3	1. Turn ignition OFF. 2. Disconnect TP sensor harness connector. 3. Turn ignition ON, leaving engine OFF. Does DVOM indicate a voltage less than the specified value?	.36 volt	Go to Step 4	Go to Step 6
4	Connect DVOM from harness terminal "A" (CKT 416) to harness terminal "B" (CKT 813). Does DVOM indicate a voltage greater than the specified value?	4 volts	Go to Step 8	Go to Step 7
5	DTC 21 is intermittent. Locate and repair intermittent faulty connections. • Refer to "Diagnostic Aids."	—	—	—
6	Locate and repair short to voltage in CKT 417. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 9
7	Locate and repair open in ground CKT 813. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 9
8	Replace faulty TP sensor. Is action complete?	—	Verify Repair	—
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

MEFI4308
4-20-00

DTC 22 - Throttle Position (TP) Sensor Circuit - Signal Voltage Low (Scan Diagnostics)

Circuit Description

The Throttle Position (TP) sensor is a potentiometer that provides a voltage signal that changes relative to the throttle blade. Signal voltage should vary from about .7 volt at idle to about 4.8 volts at Wide Open Throttle (WOT).

The TP sensor signal is one of the most important inputs used by the ECM for fuel control and for IAC control.

The ECM supplies a 5 volt signal to the sensor through CKT 416. CKT 813 is the TP sensor ground circuit. The TP sensor will send a voltage signal back to the ECM, through CKT 417, according to where the throttle blades are positioned.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the TP sensor display on the scan tool while moving connectors and wiring harnesses related to the TP sensor. A change in the TP sensor display will indicate the location of the fault.

- The scan tool reads throttle position in voltage and percentage relative to the throttle blade opening. With ignition "ON," engine "OFF," throttle blades closed (idle), the voltage should be 0.3-0.9 volts. The voltage should steadily increase as the throttle is moved toward Wide Open Throttle (WOT).
- If DTC 34 is also set, check for a short to ground in CKT 416 or CKT 416E.
- If a TP sensor circuit failure is present, the MAP sensor default value will be used along with the TP sensor default value.

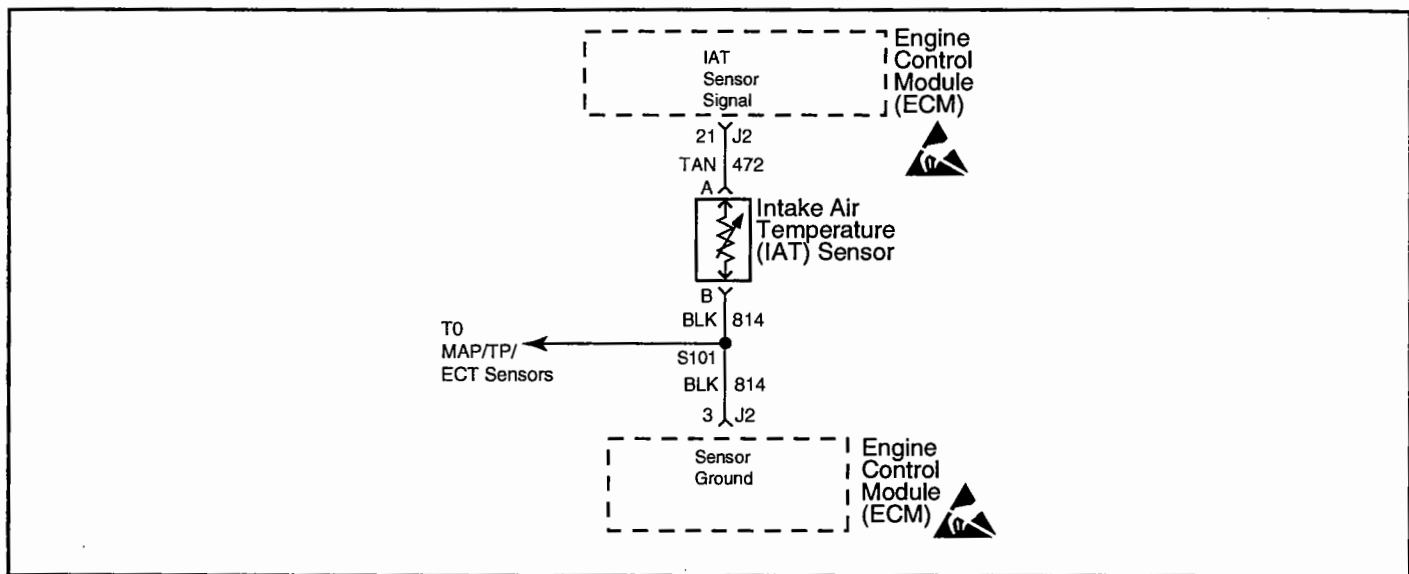
After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

2. With the throttle closed, the TP sensor voltage should read 0.3-0.9 volt. If it does not, check the throttle cable adjustment or for bent or binding linkage.
3. This test simulates a DTC 21. If the ECM recognizes the high signal voltage, the ECM and wiring are OK.
4. This test checks for the 5 volt reference on CKT 416.

DTC 22 - Throttle Position (TP) Sensor Circuit - Signal Voltage Low (Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Throttle closed. 2. Turn ignition ON, leaving engine OFF. Does scan tool indicate TP sensor voltage less than the specified value?	.36 volt	Go to Step 3	Go to Step 5
3	1. Turn ignition OFF. 2. Disconnect TP sensor harness connector. 3. Connect a jumper wire from harness terminal "A" (CKT 416) to harness terminal "C" (CKT 417). 4. Turn ignition ON, leaving engine OFF. Does scan tool indicate TP sensor voltage greater than the specified value?	4 volts	Go to Step 8	Go to Step 4
4	1. Turn ignition OFF. 2. Connect DVOM from harness terminal "A" (CKT 416) to a known good ground. 3. Turn ignition ON, leaving engine OFF. Does DVOM indicate a voltage greater than the specified value?	4 volts	Go to Step 7	Go to Step 6
5	DTC 22 is intermittent. Locate and repair intermittent faulty connections. • Refer to "Diagnostic Aids."	—	—	—
6	Locate and repair open or short to ground in CKT 416. Also check CKT 416E to the MAP sensor for a short to ground. If a problem is found, repair as necessary. Was a problem found?	—	Verify repair	Go to Step 9
7	Locate and repair open or short to ground in CKT 417. If a problem is found, repair as necessary. Was a problem found?	—	Verify repair	Go to Step 9
8	Replace faulty TP sensor. Is action complete?	—	Verify repair	—
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify repair	—

MEFI 4322
6-11-00

DTC 23 - Intake Air Temperature (IAT) Sensor Circuit - Low Temp Indicated (Scan Diagnostics)

Circuit Description

The Intake Air Temperature (IAT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts on CKT 472 to the sensor. When the intake air temperature is cold, the sensor (thermistor) resistance is high. As the intake air temperature warms up, the sensor resistance becomes less. See intake air temperature sensor table under "Diagnostic Aids."

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the IAT display on the scan tool while moving connectors and wiring harnesses related to the IAT sensor. A change in the IAT display will indicate the location of the fault.
- The scan tool displays intake air temperature in degrees celsius and fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display a IAT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a "shifted" IAT sensor.
- If DTC 33 is also set, check for open ground CKT 814.

After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

2. DTC 23 will set if signal voltage indicates a intake air

temperature below -30°C (-22°F).

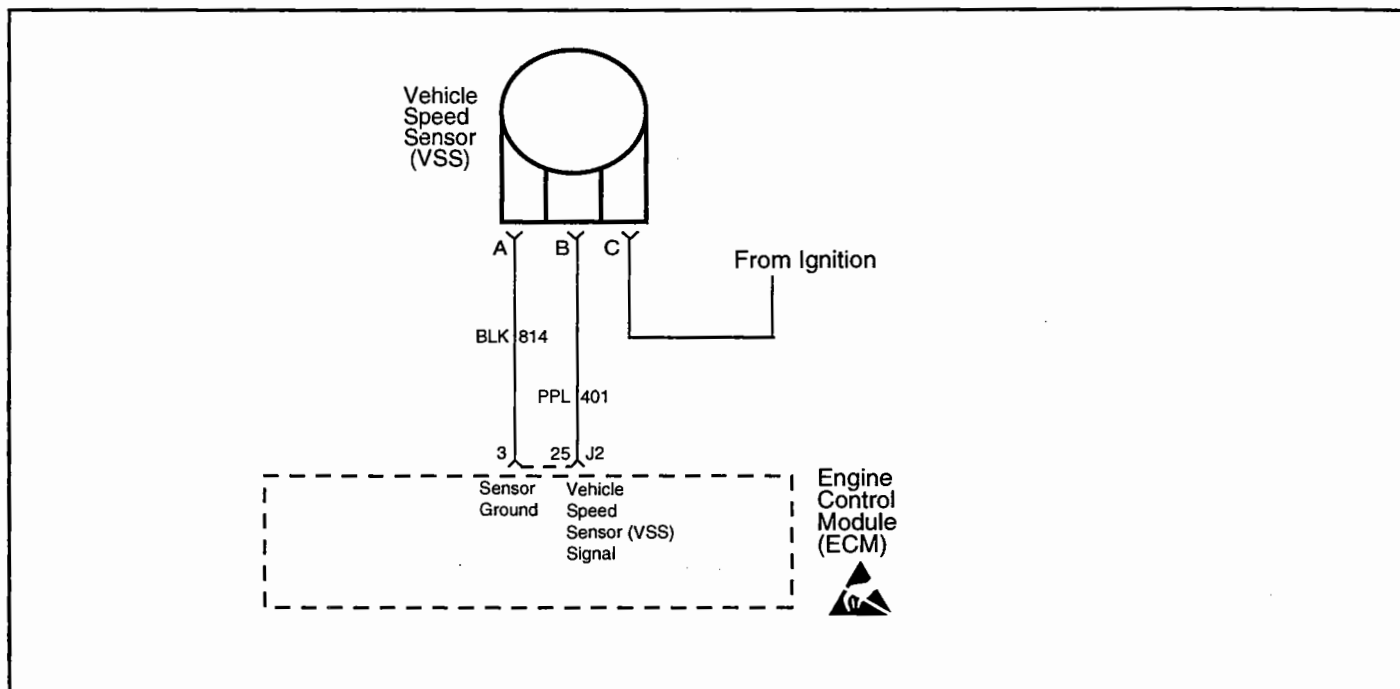
3. This test simulates a DTC 25. If the ECM recognizes the low voltage signal and displays a high temperature, the ECM and wiring are OK.

Intake Air Temperature Sensor Table

$^{\circ}\text{C}$	$^{\circ}\text{F}$	OHMS
Temperature vs Resistance Values (Approximate)		
100	212	177
80	176	332
60	140	667
45	113	1188
35	95	1802
25	77	2796
15	59	4450
5	41	7280
-5	23	12300
-15	5	21450
-30	-22	52700
-40	-40	100700

**DTC 23 - Intake Air Temperature (IAT) Sensor Circuit - Low Temp Indicated
(Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Turn ignition ON, leaving engine OFF. Does scan tool display an intake air temperature less than the specified value?	-30°C (-22°F)	Go to Step 3	Go to Step 4
3	1. Turn ignition OFF. 2. Disconnect IAT sensor harness connector. 3. Connect a jumper wire from harness terminal "A" (CKT 472) to harness terminal "B" (CKT 814). 4. Turn ignition ON, leaving engine OFF. Does scan tool display a coolant temperature above the specified value?	130°C (266°F)	Go to Step 6	Go to Step 5
4	DTC 23 is intermittent. Locate and repair intermittent faulty connections. • Refer to "Diagnostic Aids."	—	Verify Repair	—
5	Locate and repair open in CKT 472 or CKT 814. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 7
6	Repair faulty IAT sensor. Is action complete?	—	Verify Repair	—
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

MEFI4314
6-30-00

DTC 24 - Vehicle Speed Sensor (VSS) Circuit (Scan Diagnostics)

Circuit Description

The vehicle speed is provided to the ECM by means of the Vehicle Speed Sensor (VSS). The sensor may be mounted in the transmission, but the actual location depends on the application. The sensor produces a 12 volt digital signal whenever the vehicle is moving. The number of pulses increases with vehicle speed. The ECM converts this signal into MPH, which can be monitored with a scan tool. This information may be used by the ECM for several reasons such as governing the vehicle speed to a maximum road speed.

The sensor is a three-wire sensor. Terminal "A" of the sensor is provided a ground on CKT 814 through the ECM. Terminal "C" of the sensor is provided ignition voltage. Terminal "B" of the sensor is the signal to the ECM through CKT 401.

Diagnostic Aids

Check for the following conditions:

- Poor connection in harness. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.

Check VSS circuits for proper connections and the harness is routed properly.

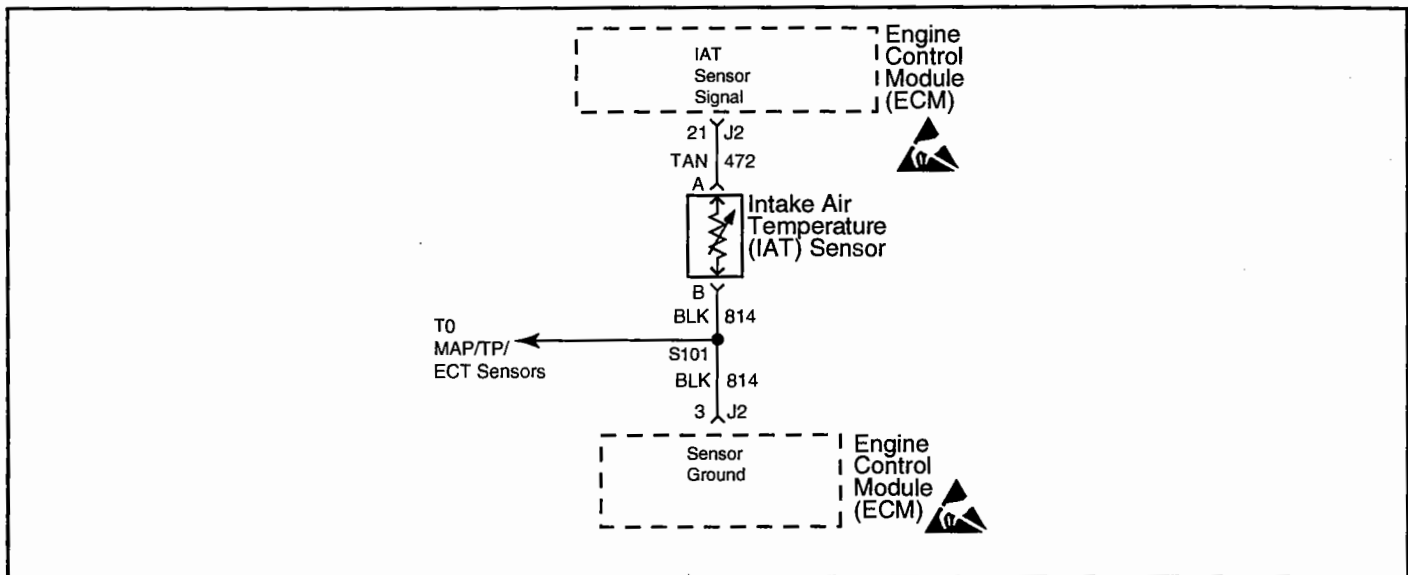
After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

2. This step determines if the VSS is receiving ignition voltage.
3. This step checks for a good ground circuit.

DTC 24 - Vehicle Speed Sensor (VSS) Circuit (Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Disconnect the vehicle speed sensor harness connector. 2. Turn ignition ON, leaving engine OFF. 3. Using a test light connected to a known good ground, probe ECM harness terminal "C". Does the test light illuminate brightly?	—	Go to Step 3	Go to Step 7
3	1. Turn ignition ON, leaving engine OFF. 2. Using a test light connected to B+, probe ECM harness terminal "A". Does the test light illuminate brightly?	—	Go to Step 4	Go to Step 8
4	1. Turn ignition OFF. 2. Reconnect VSS harness connector. 3. Turn ignition ON, leaving engine OFF. 4. Raise and support the vehicle drive wheel(s) per manufacturer's recommendations. 5. Using a DMM connected to a known good ground, back probe ECM harness connector terminal "J2-25". 6. While observing the DMM, slowly rotate the drive wheel(s). Does the DMM indicate a voltage changing as the wheels are rotated?	—	Go to Step 9	Go to Step 5
5	Locate and repair open or short to ground on CKT 401. If a problem is found, repair as necessary. Was a problem found?	—	Verify repair	Go to Step 6
6	Replace faulty VSS. Is action complete?	—	Verify repair	—
7	Locate and repair open or short to ground in the ignition circuit to the VSS. Is action complete?	—	Verify Repair	—
8	Locate and repair open in the ground circuit to the VSS. Is action complete?	—	Verify Repair	—
9	DTC 24 may be intermittent. Clear DTC and drive the vehicle. If DTC 24 returns, repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—



MEFI 4322
6-11-00

DTC 25 - Intake Air Temperature (IAT) Sensor Circuit - High Temp Indicated (Scan Diagnostics)

Circuit Description

The Intake Air Temperature (IAT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts on CKT 472 to the sensor. When the intake air temperature is cold, the sensor (thermistor) resistance is high. As the intake air temperature warms up, the sensor resistance becomes less. See intake air temperature sensor table under "Diagnostic Aids."

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the IAT display on the scan tool while moving connectors and wiring harnesses related to the IAT sensor. A change in the IAT display will indicate the location of the fault.
- The scan tool displays intake air temperature in degrees celsius and fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display an IAT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a "shifted" IAT sensor.
- Check harness routing for a potential short to ground in CKT 472.

After repairs, clear DTC's following "Clear DTC's Procedure. Failure to do so may result in DTC's not properly being cleared.

Test Description

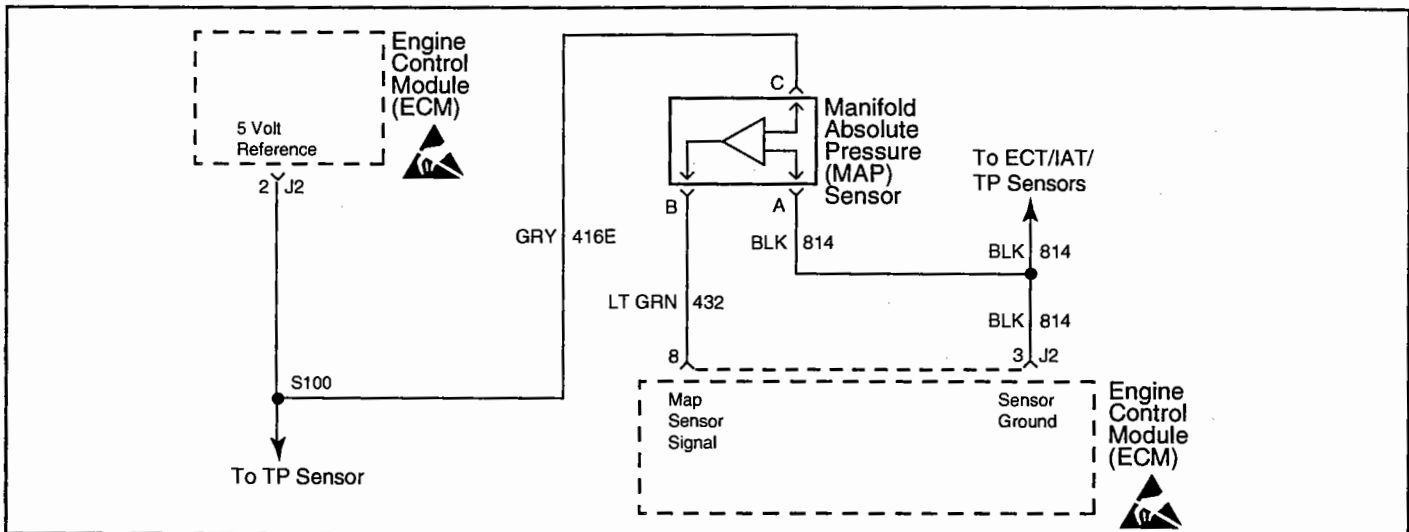
2. DTC 25 will set if signal voltage indicates an intake air temperature above 130°C or 266°F.
3. This test simulates a DTC 23. If the ECM recognizes the high voltage signal and displays a low temperature, the ECM and wiring are OK.

Intake Air Temperature Sensor Table

°C	°F	OHMS
Temperature vs Resistance Values (Approximate)		
100	212	177
80	176	332
60	140	667
45	113	1188
35	95	1802
25	77	2796
15	59	4450
5	41	7280
-5	23	12300
-15	5	21450
-30	-22	52700
-40	-40	100700

**DTC 25 - Intake Air Temperature (IAT) Sensor Circuit - High Temp Indicated
(Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Turn ignition ON, leaving engine OFF. Does scan tool display an intake air temperature greater than the specified value?	130°C (266°F)	Go to Step 3	Go to Step 4
3	1. Turn ignition OFF. 2. Disconnect IAT sensor harness connector. 3. Turn ignition ON, leaving engine OFF. Does scan tool display an intake air temperature below the specified value?	-30°C (-22°F)	Go to Step 6	Go to Step 5
4	DTC 25 is intermittent. Locate and repair intermittent faulty connections. • Refer to "Diagnostic Aids."	—	Verify Repair	—
5	Locate and repair short to ground in CKT 472. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 7
6	Repair faulty IAT sensor. Is action complete?	—	Verify Repair	—
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

MEFI4309
4-20-00

DTC 33 - Manifold Absolute Pressure (MAP) Sensor Circuit - Signal Voltage High (Scan Diagnostics)

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 1.0-1.5 volts at idle to about 4.0-4.5 volts at Wide Open Throttle (WOT).

If the MAP sensor fails, the ECM will substitute a default MAP value that will vary with RPM.

The MAP sensor voltage of 5 volts is delivered to the MAP sensor through CKT 416E. CKT 814 is the ground circuit for the MAP sensor. The MAP signal CKT 432 will send a voltage signal back to the ECM according to what the manifold pressure is.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the MAP sensor display on the scan tool while moving connectors and wiring harnesses related to the MAP sensor. A change in the MAP sensor display will indicate the location of the fault.

- If the idle is rough or unstable, refer to *Symptoms* for items which may cause an unstable idle.
- With the ignition "ON," 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 altitude and is referred to as BARO. Comparison of this BARO reading, with a known good MAP sensor, is a good way to check the accuracy of a "suspect" sensor. Reading should be the same, plus or minus 0.4 volt.
- If DTC 14 is also set, check for open in ground CKT 814.
- If a MAP sensor circuit failure is present, the TP sensor default value will be used along with the MAP sensor default value.

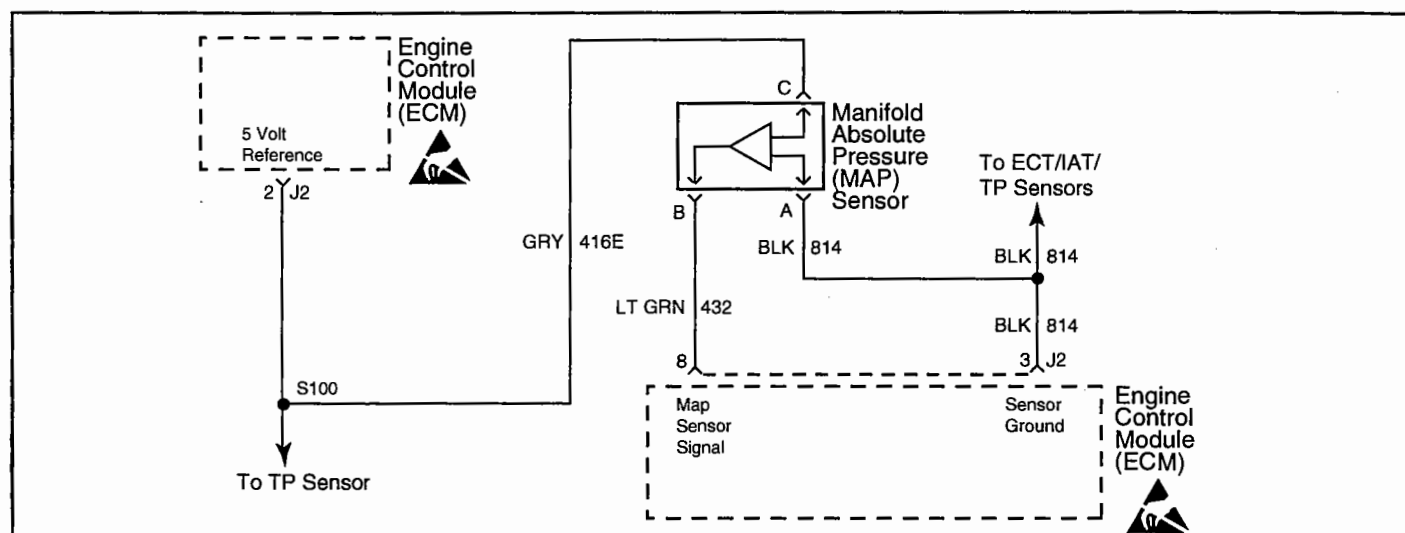
After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

2. This step will determine if there is an adequate vacuum supply to the MAP sensor. If the vacuum gauge reading is erratic, refer to the "Rough or Unstable Idle" symptom.
4. This step simulates a DTC 34. If the ECM recognizes the low signal voltage and sets a DTC 34, the ECM and wiring are OK.
5. This step checks for an open in ground CKT 814.

**DTC 33 - Manifold Absolute Pressure (MAP) Sensor Circuit - Signal Voltage High
(Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Install a vacuum gauge to a manifold vacuum source. 2. Start engine and raise to about 1000 RPM in neutral. 3. The vacuum reading should be steady. Is the vacuum gauge reading steady and above the specified value?	14" Hg (45.5 kPa)	Go to Step 3	Go to Step 6
3	1. Install a scan tool. 2. Start the engine and allow engine to idle. Does scan tool indicate MAP sensor voltage greater than the specified value?	4 volts	Go to Step 4	Go to Step 7
4	1. Turn the ignition OFF. 2. Disconnect MAP sensor harness connector. 3. Turn the ignition ON, leaving the engine OFF. Does scan tool indicate MAP sensor voltage less than the specified value?	1 volt	Go to Step 5	Go to Step 8
5	1. Turn the ignition OFF. 2. Connect DMM from harness terminal "A" (CKT 814) to harness terminal "C" (CKT 416E). 3. Turn the ignition ON, leaving the engine OFF. Does DMM indicate a voltage greater than the specified value?	4 volts	Go to Step 10	Go to Step 9
6	Repair low or unsteady vacuum problem. Is action complete?	—	Verify Repair	—
7	DTC 33 is intermittent. Locate and repair intermittent faulty connections. • Refer to "Diagnostic Aids."	—	—	—
8	Locate and repair short to voltage in CKT 432. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 11
9	Locate and repair open in CKT 814. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 11
10	Check for plugged or leaking sensor vacuum fitting. If OK, replace faulty MAP sensor. Is action complete?	—	Verify Repair	—
11	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

MEFI4309
4-20-00

DTC 34 - Manifold Absolute Pressure (MAP) Sensor Circuit - Signal Voltage Low (Scan Diagnostics)

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 1.0-1.5 volts at idle to about 4.0-4.5 volts at Wide Open Throttle (WOT).

If the MAP sensor fails, the ECM will substitute a default MAP value that will vary with RPM.

The MAP sensor voltage of 5 volts is delivered to the MAP sensor through CKT 416E. CKT 814 is the ground circuit for the MAP sensor. The MAP signal CKT 432 will send a voltage signal back to the ECM according to what the manifold pressure is.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the MAP sensor display on the scan tool while moving connectors and wiring harnesses related to the MAP sensor. A change in the MAP sensor display will indicate the location of the fault.

- If the idle is rough or unstable, refer to *Symptoms* for items which may cause an unstable idle.
- With the ignition "ON," 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 altitude and is referred to as BARO. Comparison of this BARO reading, with a known good MAP sensor, is a good way to check the accuracy of a "suspect" sensor. Reading should be the same, plus or minus 0.4 volt.
- If a MAP sensor circuit failure is present, the TP sensor default value will be used along with the MAP sensor default value.

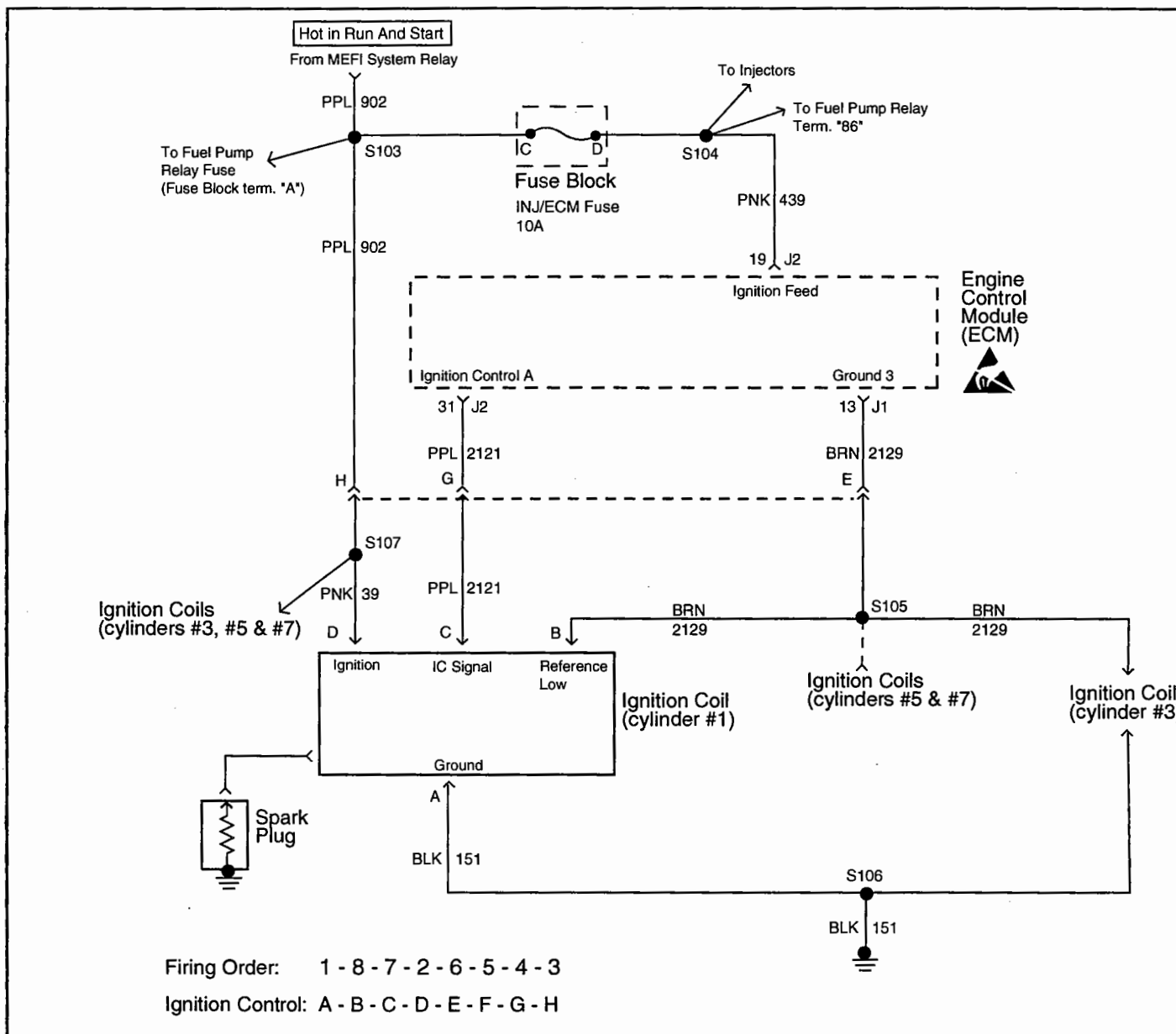
After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

2. This step will determine if there is an adequate vacuum supply to the MAP sensor. If the vacuum gauge reading is erratic, refer to the "Rough or Unstable Idle" symptom.
3. This step determines if DTC 34 is the result of a hard failure or an intermittent condition. A DTC will set when MAP signal voltage is too low with engine running.
4. This step simulates a DTC 33. If the ECM recognizes the high signal voltage, the ECM and wiring are OK.
5. This step checks for the 5 volt reference on CKT 416E.

DTC 34 - Manifold Absolute Pressure (MAP) Sensor Circuit - Signal Voltage Low (Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Turn the ignition OFF. 2. Install a vacuum gauge to a manifold vacuum source. 3. Start engine and raise to about 1000 RPM in neutral. 4. The vacuum reading should be steady. Is the vacuum gauge reading steady and above the specified value?	14" Hg (45.5 kPa)	Go to Step 3	Go to Step 6
3	1. Install a scan tool. 2. Start the engine and allow the engine to idle. Does scan tool indicate MAP sensor voltage less than the specified value?	1 volt	Go to Step 4	Go to Step 7
4	1. Turn the ignition OFF. 2. Disconnect MAP sensor harness connector. 3. Connect a jumper wire from harness terminal "B" (CKT 432) to harness terminal "C" (CKT 416E). 4. Turn the ignition ON, leaving the engine OFF. Does scan tool indicate MAP sensor voltage greater than the specified value?	4 volts	Go to Step 10	Go to Step 5
5	1. Turn OFF the ignition. 2. Connect DMM from harness terminal "C" (CKT 416E) to a known good ground. 3. Turn ON the ignition, leaving the engine OFF. Does DMM indicate a voltage greater than the specified value?	4 volts	Go to Step 9	Go to Step 8
6	Repair low or unsteady vacuum problem. Is action complete?	—	Verify Repair	—
7	DTC 34 is intermittent. Locate and repair intermittent faulty connections. • Refer to "Diagnostic Aids."	—	—	—
8	Locate and repair open or short to ground in CKT 416E. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 11
9	Locate and repair open or short to ground in CKT 432. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 11
10	Check for plugged or leaking sensor vacuum fitting. If OK, replace faulty MAP sensor. Is action complete?	—	Verify Repair	—
11	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—



MEFI4311
7-01-00

DTC 41 - Ignition Coil 1 Control Circuit

Circuit Description

The ignition system on this engine uses an individual ignition coil/module for each cylinder. The ECM controls the ignition system operation. The ECM controls each coil using one of eight Ignition Control (IC) circuits. The ECM commands the IC circuit low when a spark event is requested. This causes the IC module to energize the ignition coil to create a spark at the spark plug. Each ignition coil/module has the following circuits:

- A power feed
- A ground circuit
- An Ignition Control (IC) circuit
- A reference low circuit

Sequencing and timing are ECM controlled. This DTC sets

when the IC circuit is out of range.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Corrosion
- Mis-routed harness
- Rubbed through wire insulation
- Broken wire inside the insulation

Test Description

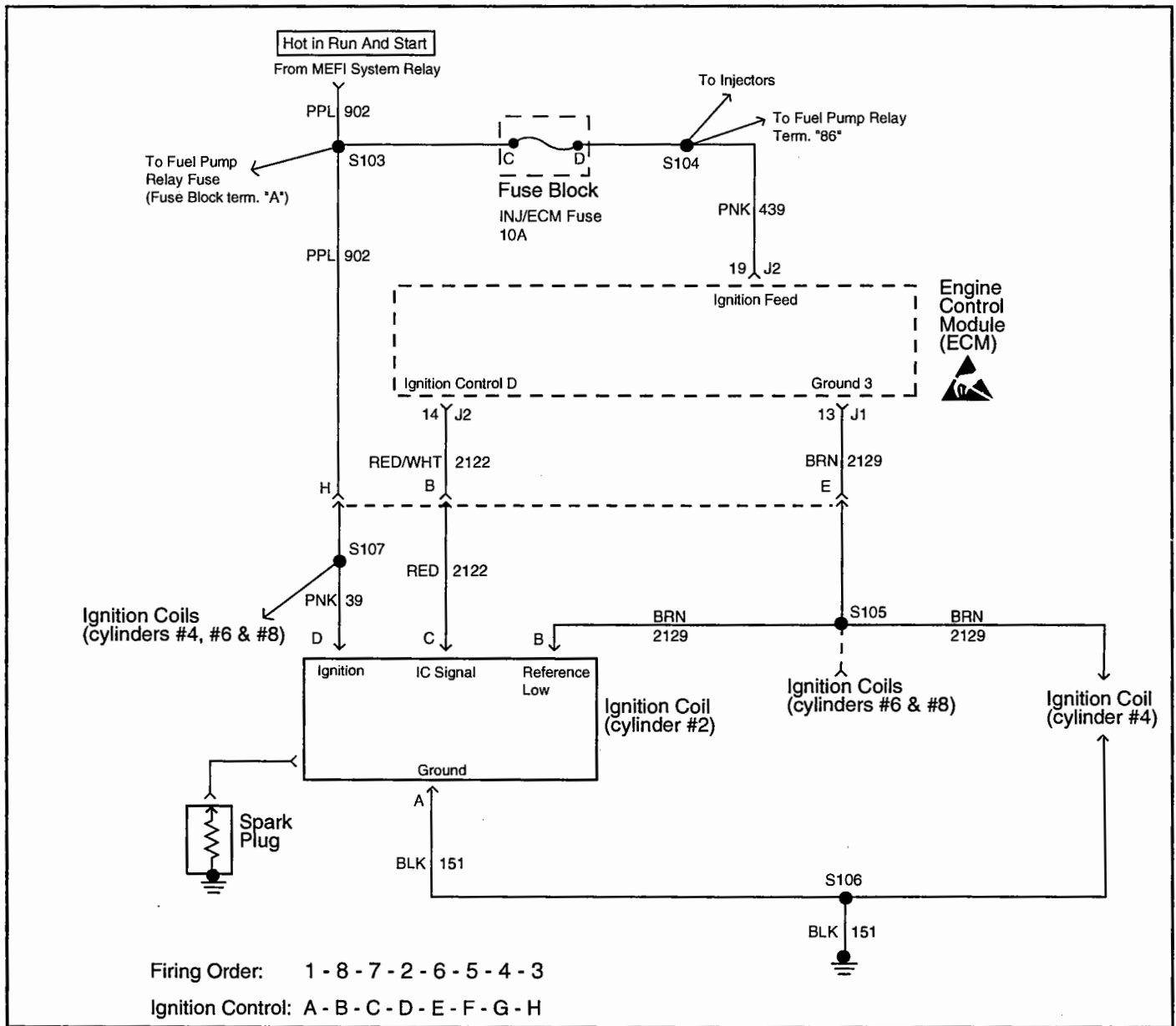
- 2. This step verifies the fault is present.
- 4. This step tests the integrity of the IC circuit and the ECM output.
- 5. This step tests for a short to ground on the IC signal circuit.

DTC 41 - Ignition Coil 1 Control Circuit

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important: If all the Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 1?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using the DVOM J 39200 on the DC Hertz scale. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the DVOM J 39200. Is the voltage greater that the specified value?	1.0 volts	Go to Step 8	Go to Step 5
5	1. Turn OFF the engine. 2. Disconnect the ECM connector J2. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the DVOM J 39200. Does the DVOM indicate continuity?	—	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the DVOM J 39200. Does the DVOM indicate OL?	—	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	—	Go to Step 12	—
8	Repair the Ignition Control circuit for a short to voltage. Is the action complete?	—	Go to Step 12	—
9	Repair the Ignition Control circuit for an open or grounded circuit. Is the action complete?	—	Go to Step 12	—
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	—	Go to Step 12	Go to Step 11

DTC 41 - Ignition Coil 1 Control Circuit (cont'd)

Step	Action	Value	Yes	No
11	Replace the ECM. Is the action complete?	—	Go to Step 12	—
12	1. Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. 2. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	—	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	—	Go to the applicable DTC table	System OK



MEFI4312
7-01-00

DTC 41 - Ignition Coil 2 Control Circuit

Circuit Description

The ignition system on this engine uses an individual ignition coil/module for each cylinder. The ECM controls the ignition system operation. The ECM controls each coil using one of eight Ignition Control (IC) circuits. The ECM commands the IC circuit low when a spark event is requested. This causes the IC module to energize the ignition coil to create a spark at the spark plug. Each ignition coil/module has the following circuits:

- A power feed
- A ground circuit
- An Ignition Control (IC) circuit
- A reference low circuit

Sequencing and timing are ECM controlled. This DTC sets

when the IC circuit is out of range.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Corrosion
- Mis-routed harness
- Rubbed through wire insulation
- Broken wire inside the insulation

Test Description

2. This step verifies the fault is present.
4. This step tests the integrity of the IC circuit and the ECM output.

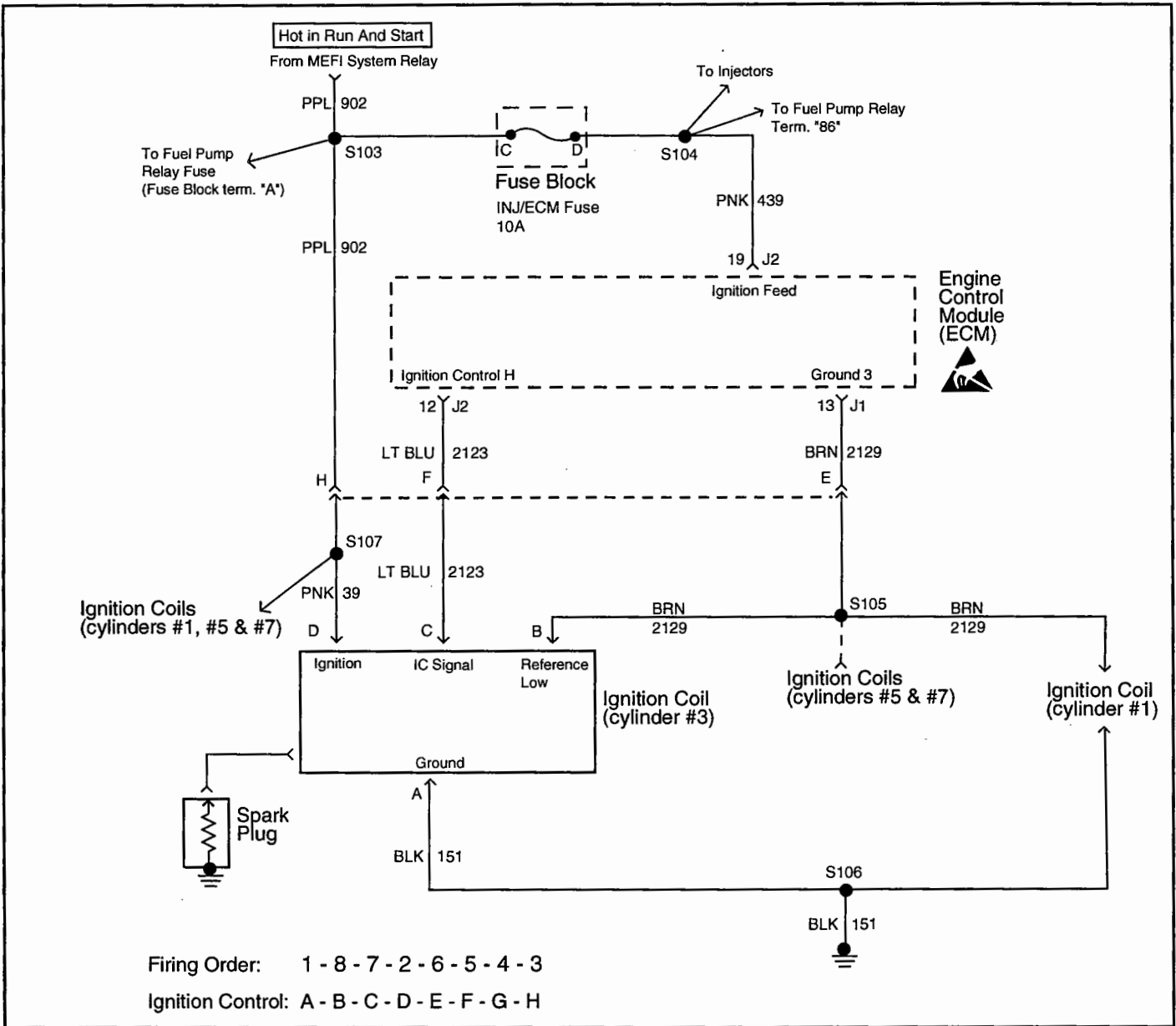
5. This step tests for a short to ground on the IC signal circuit.

DTC 41 - Ignition Coil 2 Control Circuit

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important: If all the Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 2?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using the DVOM J 39200 on the DC Hertz scale. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the DVOM J 39200. Is the voltage greater than the specified value?	1.0 volts	Go to Step 8	Go to Step 5
5	1. Turn OFF the engine. 2. Disconnect the ECM connector J2. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the DVOM J 39200. Does the DVOM indicate continuity?	—	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the DVOM J 39200. Does the DVOM indicate OL?	—	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	—	Go to Step 12	—
8	Repair the Ignition Control circuit for a short to voltage. Is the action complete?	—	Go to Step 12	—
9	Repair the Ignition Control circuit for an open or grounded circuit. Is the action complete?	—	Go to Step 12	—
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	—	Go to Step 12	Go to Step 11

DTC 41 - Ignition Coil 2 Control Circuit (cont'd)

Step	Action	Value	Yes	No
11	Replace the ECM. Is the action complete?	—	Go to Step 12	—
12	1. Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. 2. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	—	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	—	Go to the applicable DTC table	System OK



MEFI4315
4-26-00

DTC 41 - Ignition Coil 3 Control Circuit

Circuit Description

The ignition system on this engine uses an individual ignition coil/module for each cylinder. The ECM controls the ignition system operation. The ECM controls each coil using one of eight Ignition Control (IC) circuits. The ECM commands the IC circuit low when a spark event is requested. This causes the IC module to energize the ignition coil to create a spark at the spark plug. Each ignition coil/module has the following circuits:

- A power feed
- A ground circuit
- An Ignition Control (IC) circuit
- A reference low circuit

Sequencing and timing are ECM controlled. This DTC sets

when the IC circuit is out of range.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Corrosion
- Mis-routed harness
- Rubbed through wire insulation
- Broken wire inside the insulation

Test Description

2. This step verifies the fault is present.
4. This step tests the integrity of the IC circuit and the ECM output.

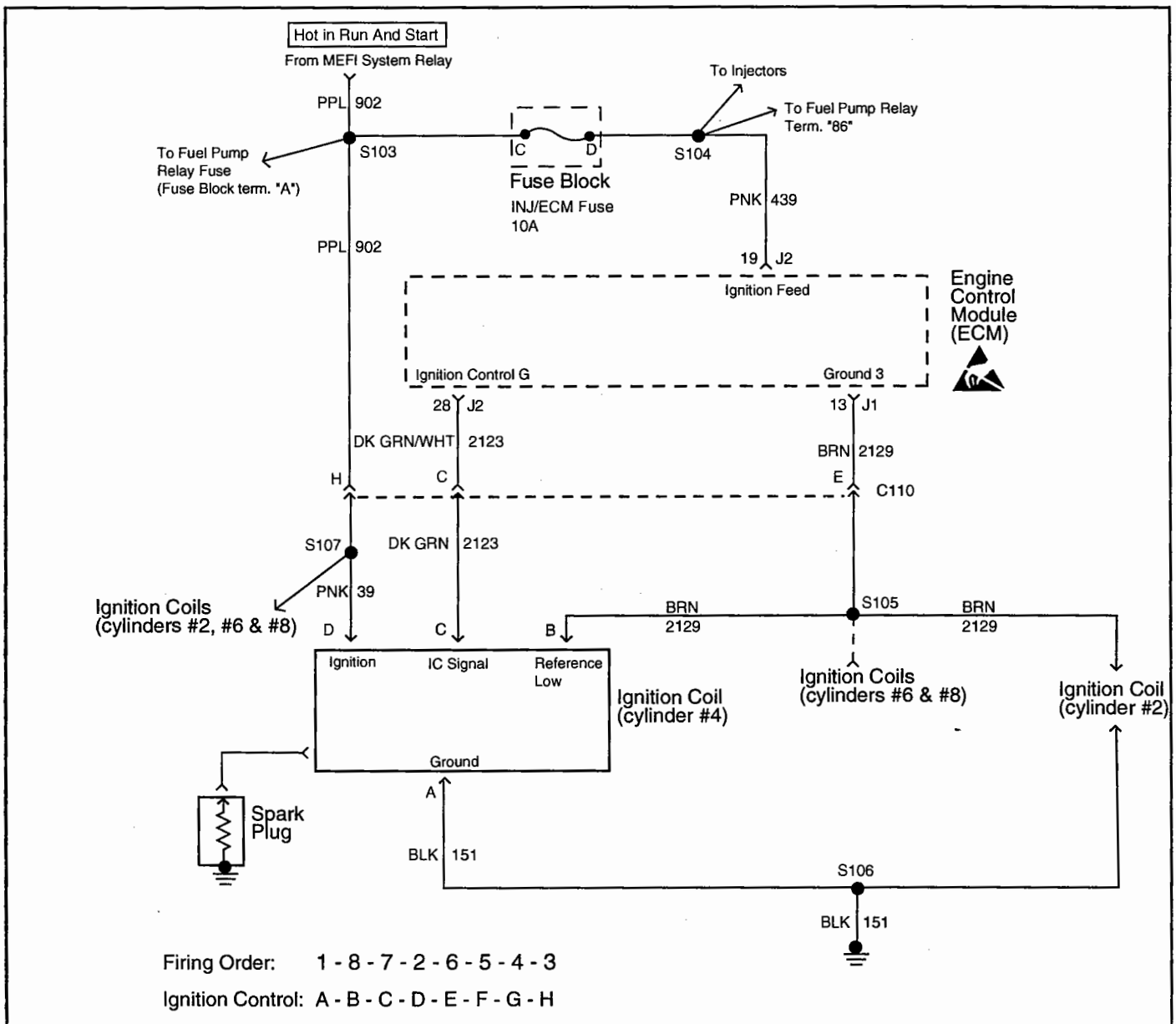
5. This step tests for a short to ground on the IC signal circuit.

DTC 41 - Ignition Coil 3 Control Circuit

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important: If all the Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 3?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using the DVOM J 39200 on the DC Hertz scale. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the DVOM J 39200. Is the voltage greater than the specified value?	1.0 volts	Go to Step 8	Go to Step 5
5	1. Turn OFF the engine. 2. Disconnect the ECM connector J2. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the DVOM J 39200. Does the DVOM indicate continuity?	—	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the DVOM J 39200. Does the DVOM indicate OL?	—	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	—	Go to Step 12	—
8	Repair the Ignition Control circuit for a short to voltage. Is the action complete?	—	Go to Step 12	—
9	Repair the Ignition Control circuit for an open or grounded circuit. Is the action complete?	—	Go to Step 12	—
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	—	Go to Step 12	Go to Step 11

DTC 41 - Ignition Coil 3 Control Circuit (cont'd)

Step	Action	Value	Yes	No
11	Replace the ECM. Is the action complete?	—	Go to Step 12	—
12	1. Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. 2. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	—	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	—	Go to the applicable DTC table	System OK



MEFI4316
7-01-00

DTC 41 - Ignition Coil 4 Control Circuit

Circuit Description

The ignition system on this engine uses an individual ignition coil/module for each cylinder. The ECM controls the ignition system operation. The ECM controls each coil using one of eight Ignition Control (IC) circuits. The ECM commands the IC circuit low when a spark event is requested. This causes the IC module to energize the ignition coil to create a spark at the spark plug. Each ignition coil/module has the following circuits:

- A power feed
- A ground circuit
- An Ignition Control (IC) circuit
- A reference low circuit

Sequencing and timing are ECM controlled. This DTC sets

when the IC circuit is out of range.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Corrosion
- Mis-routed harness
- Rubbed through wire insulation
- Broken wire inside the insulation

Test Description

2. This step verifies the fault is present.
4. This step tests the integrity of the IC circuit and the ECM output.

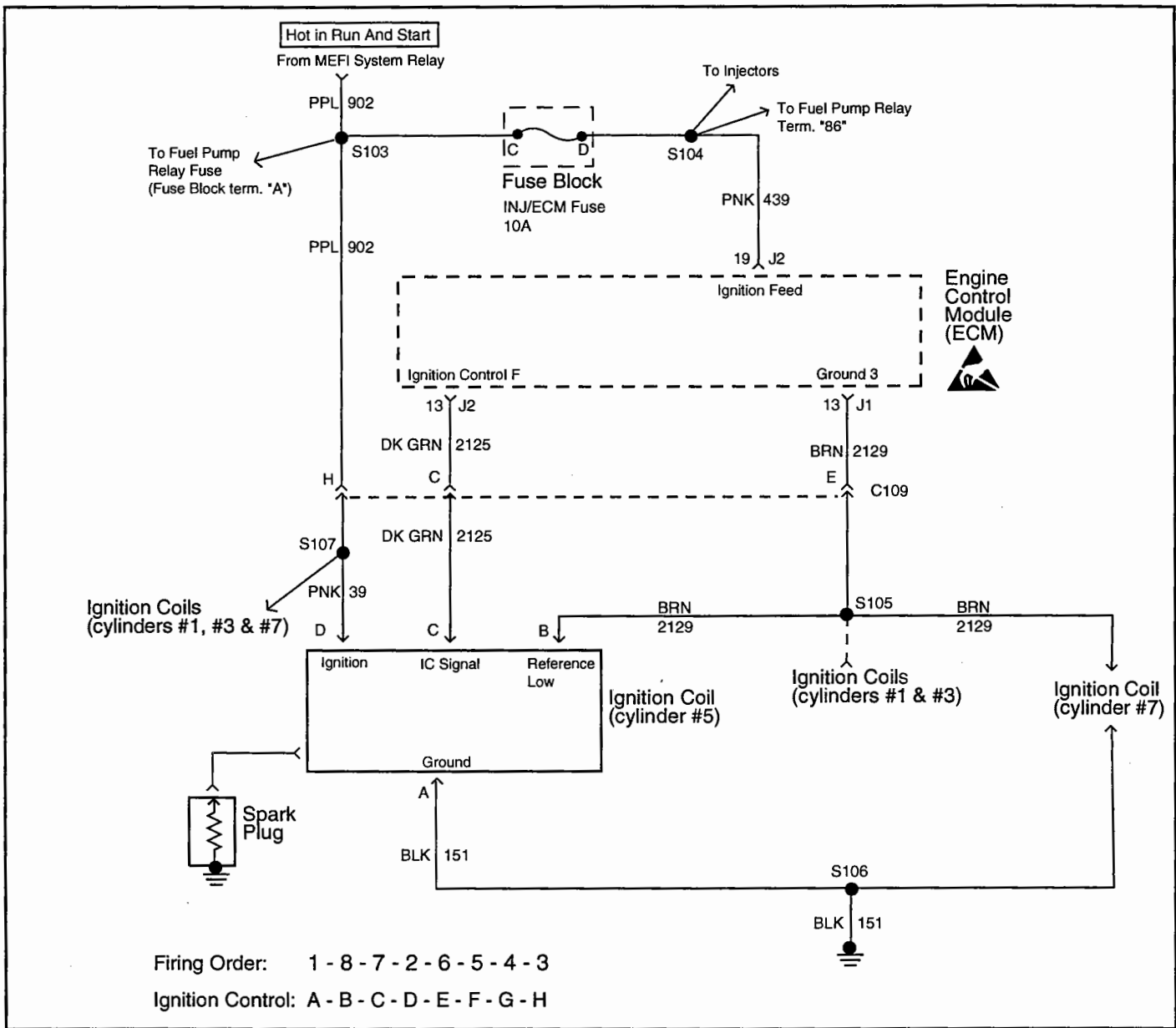
5. This step tests for a short to ground on the IC signal circuit.

DTC 41 - Ignition Coil 4 Control Circuit

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important: If all the Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 4?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using the DVOM J 39200 on the DC Hertz scale. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the DVOM J 39200. Is the voltage greater than the specified value?	1.0 volts	Go to Step 8	Go to Step 5
5	1. Turn OFF the engine. 2. Disconnect the ECM connector J2. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the DVOM J 39200. Does the DVOM indicate continuity?	—	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the DVOM J 39200. Does the DVOM indicate OL?	—	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	—	Go to Step 12	—
8	Repair the Ignition Control circuit for a short to voltage. Is the action complete?	—	Go to Step 12	—
9	Repair the Ignition Control circuit for an open or grounded circuit. Is the action complete?	—	Go to Step 12	—
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	—	Go to Step 12	Go to Step 11

DTC 41 - Ignition Coil 4 Control Circuit (cont'd)

Step	Action	Value	Yes	No
11	Replace the ECM. Is the action complete?	—	Go to Step 12	—
12	1. Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. 2. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	—	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	—	Go to the applicable DTC table	System OK



MEFI4317
7-01-00

DTC 41 - Ignition Coil 5 Control Circuit

Circuit Description

The ignition system on this engine uses an individual ignition coil/module for each cylinder. The ECM controls the ignition system operation. The ECM controls each coil using one of eight Ignition Control (IC) circuits. The ECM commands the IC circuit low when a spark event is requested. This causes the IC module to energize the ignition coil to create a spark at the spark plug. Each ignition coil/module has the following circuits:

- A power feed
- A ground circuit
- An Ignition Control (IC) circuit
- A reference low circuit

Sequencing and timing are ECM controlled. This DTC sets

when the IC circuit is out of range.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Corrosion
- Mis-routed harness
- Rubbed through wire insulation
- Broken wire inside the insulation

Test Description

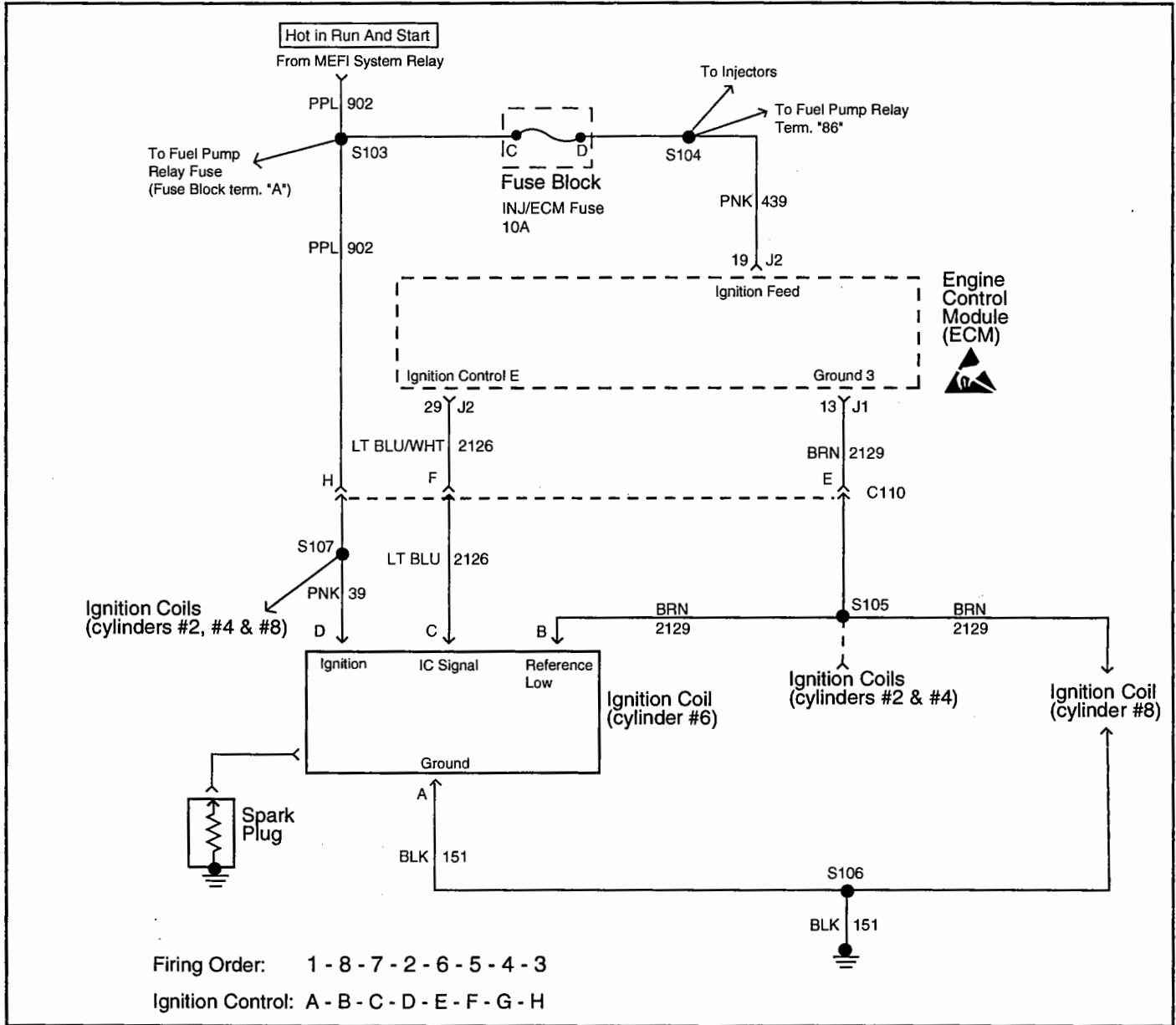
- 2. This step verifies the fault is present.
- 4. This step tests the integrity of the IC circuit and the ECM output.
- 5. This step tests for a short to ground on the IC signal circuit.

DTC 41 - Ignition Coil 5 Control Circuit

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important: If all the Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 5?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using the DVOM J 39200 on the DC Hertz scale. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the DVOM J 39200. Is the voltage greater than the specified value?	1.0 volts	Go to Step 8	Go to Step 5
5	1. Turn OFF the engine. 2. Disconnect the ECM connector J2. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the DVOM J 39200. Does the DVOM indicate continuity?	—	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the DVOM J 39200. Does the DVOM indicate OL?	—	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	—	Go to Step 12	—
8	Repair the Ignition Control circuit for a short to voltage. Is the action complete?	—	Go to Step 12	—
9	Repair the Ignition Control circuit for an open or grounded circuit. Is the action complete?	—	Go to Step 12	—
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	—	Go to Step 12	Go to Step 11

DTC 41 - Ignition Coil 5 Control Circuit (cont'd)

Step	Action	Value	Yes	No
11	Replace the ECM. Is the action complete?	—	Go to Step 12	—
12	1. Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. 2. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	—	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	—	Go to the applicable DTC table	System OK



MEFI4318
7-01-00

DTC 41 - Ignition Coil 6 Control Circuit

Circuit Description

The ignition system on this engine uses an individual ignition coil/module for each cylinder. The ECM controls the ignition system operation. The ECM controls each coil using one of eight Ignition Control (IC) circuits. The ECM commands the IC circuit low when a spark event is requested. This causes the IC module to energize the ignition coil to create a spark at the spark plug. Each ignition coil/module has the following circuits:

- A power feed
- A ground circuit
- An Ignition Control (IC) circuit
- A reference low circuit

Sequencing and timing are ECM controlled. This DTC sets

when the IC circuit is out of range.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Corrosion
- Mis-routed harness
- Rubbed through wire insulation
- Broken wire inside the insulation

Test Description

2. This step verifies the fault is present.
4. This step tests the integrity of the IC circuit and the ECM output.

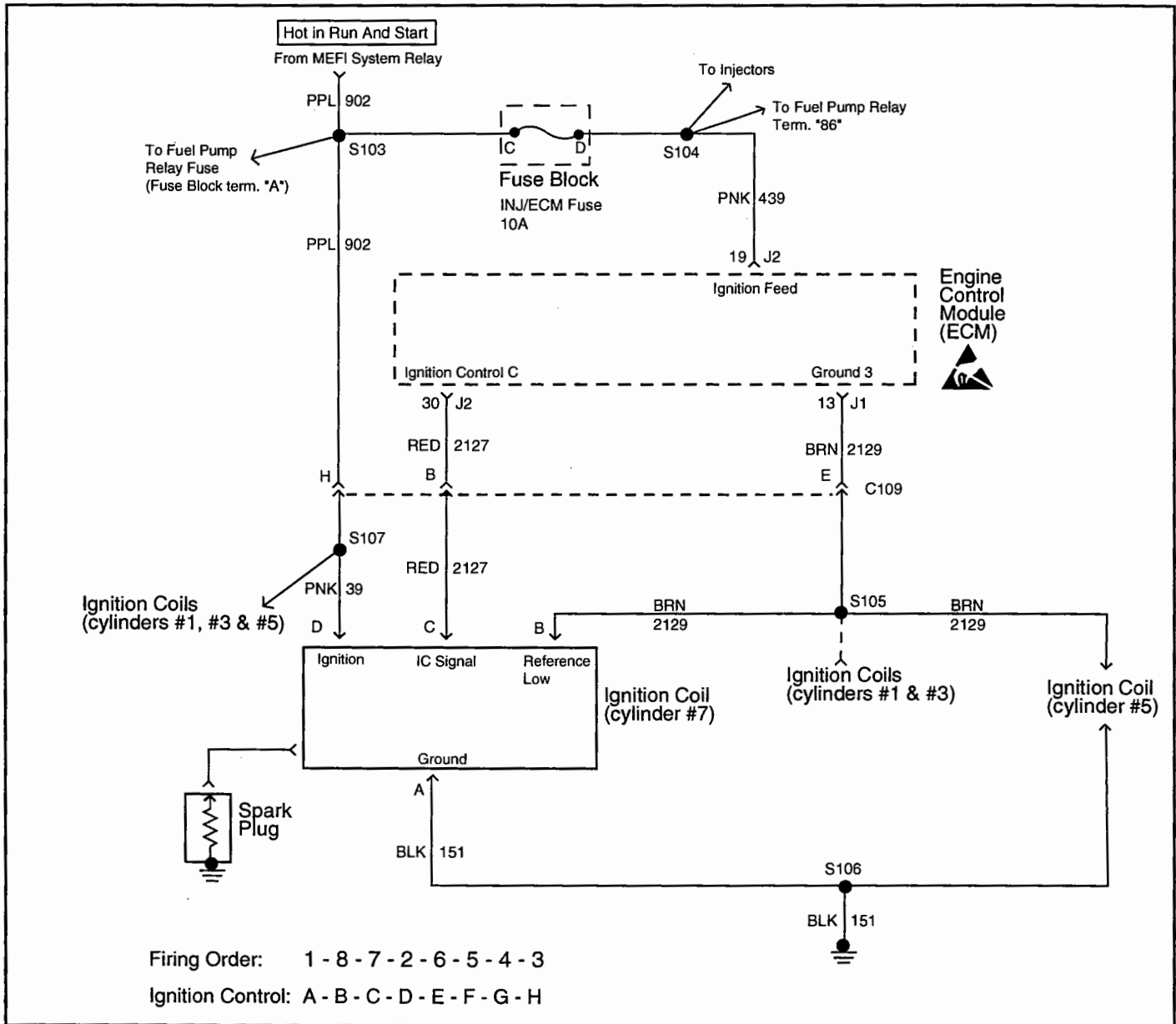
5. This step tests for a short to ground on the IC signal circuit.

DTC 41 - Ignition Coil 6 Control Circuit

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important: If all the Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 6?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using the DVOM J 39200 on the DC Hertz scale. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the DVOM J 39200. Is the voltage greater than the specified value?	1.0 volts	Go to Step 8	Go to Step 5
5	1. Turn OFF the engine. 2. Disconnect the ECM connector J2. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the DVOM J 39200. Does the DVOM indicate continuity?	—	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the DVOM J 39200. Does the DVOM indicate OL?	—	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	—	Go to Step 12	—
8	Repair the Ignition Control circuit for a short to voltage. Is the action complete?	—	Go to Step 12	—
9	Repair the Ignition Control circuit for an open or grounded circuit. Is the action complete?	—	Go to Step 12	—
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	—	Go to Step 12	Go to Step 11

DTC 41 - Ignition Coil 6 Control Circuit (cont'd)

Step	Action	Value	Yes	No
11	Replace the ECM. Is the action complete?	—	Go to Step 12	—
12	1. Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. 2. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	—	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	—	Go to the applicable DTC table	System OK



MEFI4319
4-26-00

DTC 41 - Ignition Coil 7 Control Circuit

Circuit Description

The ignition system on this engine uses an individual ignition coil/module for each cylinder. The ECM controls the ignition system operation. The ECM controls each coil using one of eight Ignition Control (IC) circuits. The ECM commands the IC circuit low when a spark event is requested. This causes the IC module to energize the ignition coil to create a spark at the spark plug. Each ignition coil/module has the following circuits:

- A power feed
- A ground circuit
- An Ignition Control (IC) circuit
- A reference low circuit

Sequencing and timing are ECM controlled. This DTC sets

when the IC circuit is out of range.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Corrosion
- Mis-routed harness
- Rubbed through wire insulation
- Broken wire inside the insulation

Test Description

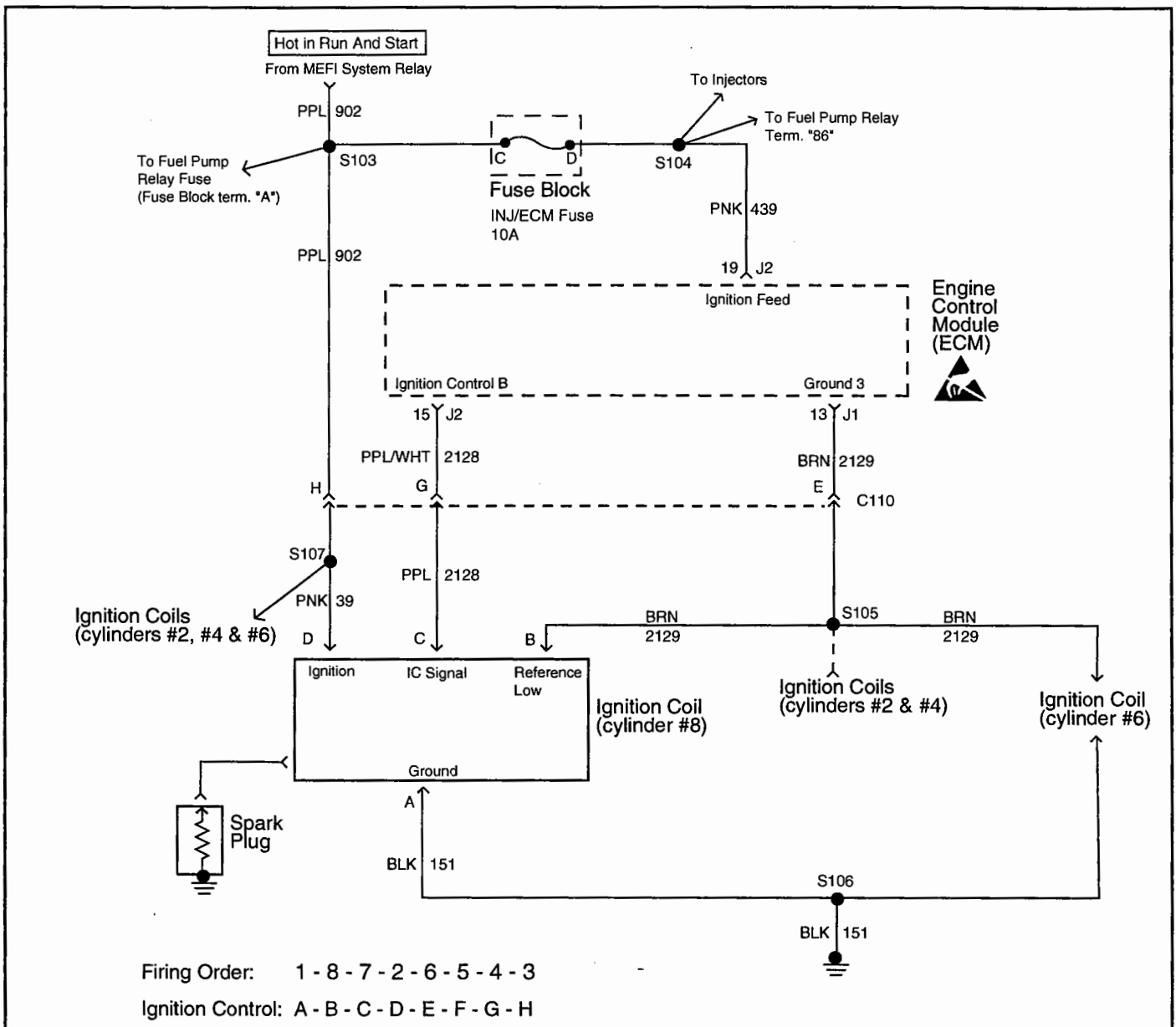
- 2. This step verifies the fault is present.
- 4. This step tests the integrity of the IC circuit and the ECM output.
- 5. This step tests for a short to ground on the IC signal circuit.

DTC 41 - Ignition Coil 7 Control Circuit

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important: If all the Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 7?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using the DVOM J 39200 on the DC Hertz scale. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the DVOM J 39200. Is the voltage greater than the specified value?	1.0 volts	Go to Step 8	Go to Step 5
5	1. Turn OFF the engine. 2. Disconnect the ECM connector J2. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the DVOM J 39200. Does the DVOM indicate continuity?	—	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the DVOM J 39200. Does the DVOM indicate OL?	—	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	—	Go to Step 12	—
8	Repair the Ignition Control circuit for a short to voltage. Is the action complete?	—	Go to Step 12	—
9	Repair the Ignition Control circuit for an open or grounded circuit. Is the action complete?	—	Go to Step 12	—
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	—	Go to Step 12	Go to Step 11

DTC 41 - Ignition Coil 7 Control Circuit (cont'd)

Step	Action	Value	Yes	No
11	Replace the ECM. Is the action complete?	—	Go to Step 12	—
12	1. Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. 2. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	—	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	—	Go to the applicable DTC table	System OK



MEFI4320
7-01-00

DTC 41 - Ignition Coil 8 Control Circuit

Circuit Description

The ignition system on this engine uses an individual ignition coil/module for each cylinder. The ECM controls the ignition system operation. The ECM controls each coil using one of eight Ignition Control (IC) circuits. The ECM commands the IC circuit low when a spark event is requested. This causes the IC module to energize the ignition coil to create a spark at the spark plug. Each ignition coil/module has the following circuits:

- A power feed
- A ground circuit
- An Ignition Control (IC) circuit
- A reference low circuit

Sequencing and timing are ECM controlled. This DTC sets

when the IC circuit is out of range.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Corrosion
- Mis-routed harness
- Rubbed through wire insulation
- Broken wire inside the insulation

Test Description

2. This step verifies the fault is present.
4. This step tests the integrity of the IC circuit and the ECM output.

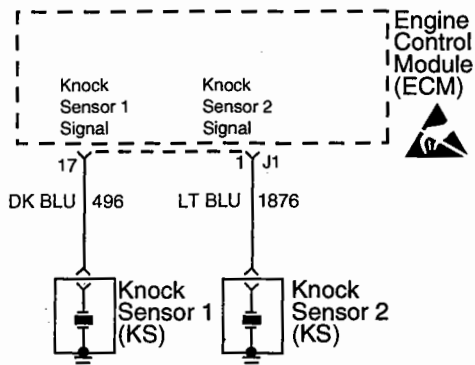
5. This step tests for a short to ground on the IC signal circuit.

DTC 41 - Ignition Coil 8 Control Circuit

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important: If all the Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 8?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using the DVOM J 39200 on the DC Hertz scale. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the DVOM J 39200. Is the voltage greater than the specified value?	1.0 volts	Go to Step 8	Go to Step 5
5	1. Turn OFF the engine. 2. Disconnect the ECM connector J2. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the DVOM J 39200. Does the DVOM indicate continuity?	—	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the DVOM J 39200. Does the DVOM indicate OL?	—	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	—	Go to Step 12	—
8	Repair the Ignition Control circuit for a short to voltage. Is the action complete?	—	Go to Step 12	—
9	Repair the Ignition Control circuit for an open or grounded circuit. Is the action complete?	—	Go to Step 12	—
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	—	Go to Step 12	Go to Step 11

DTC 41 - Ignition Coil 8 Control Circuit (cont'd)

Step	Action	Value	Yes	No
11	Replace the ECM. Is the action complete?	—	Go to Step 12	—
12	1. Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. 2. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	—	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	—	Go to the applicable DTC table	System OK

MEFI4310
6-28-00

DTC 44 - Knock Sensor (KS) 1 Circuit (Scan Diagnostics)

Circuit Description

The ECM uses the Knock Sensor(s) in order to detect engine detonation. This detection allows the ECM to retard spark timing based on the KS signal coming into the ECM. DTC 44 will set only if the ECM does not see any activity on the KS signal circuit(s).

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage.
- Loose Knock Sensor(s) in engine block.
- Poor connection at the Knock Sensor(s).

After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

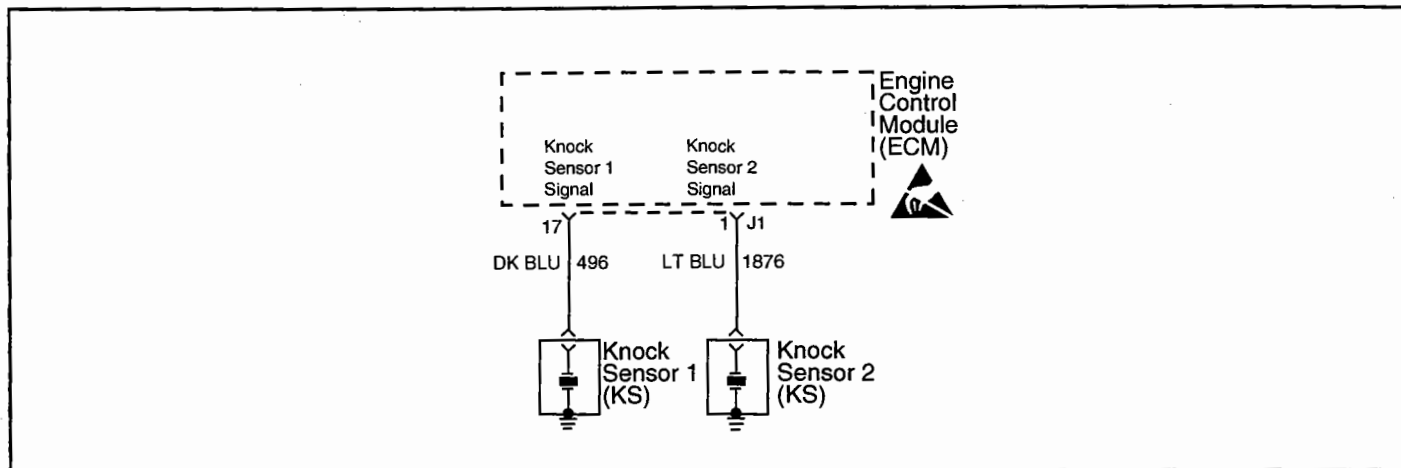
If CKT 496 or CKT 1876 are routed too close to secondary ignition wires, the ECM may see the interference as a knock signal, resulting in false timing retard.

Test Description

4. This step ensures the knock sensor is secured properly in the engine block.
5. Checks to see that the knock sensor circuit is within specifications.

DTC 44 - Knock Sensor (KS) 1 Circuit (Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important: If you can hear the engine knock, repair the engine mechanical problem before proceeding with this diagnostic table. Check the KS signal circuit for incorrect routing near the secondary wires. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 3
3	Check the KS signal circuit for any terminals not being fully seated or for incorrect installation. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 4
4	Check knock sensor for being loose in the engine block. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 5
5	1. Install scan tool. 2. Select the option to view the data list. 3. Select to view the knock signal 1 parameter. 4. Disconnect "J1" harness connector. 5. Connect a DMM from "J1-17" (CKT 496 - Knock Signal 1) to a known good ground near the knock sensor. Is resistance between the specified value?	93-107K ohms	Go to Step 8	Go to Step 6
6	Locate and repair open or short to ground in the circuit that were out of range. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 7
7	Inspect knock sensor terminal contacts. If OK, replace faulty knock sensor. Is action complete?	—	Verify Repair	—
8	Replace faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—



MEFI4310
6-28-00

DTC 44 - Knock Sensor (KS) 2 Circuit (Scan Diagnostics)

Circuit Description

The ECM uses the Knock Sensor(s) in order to detect engine detonation. This detection allows the ECM to retard spark timing based on the KS signal coming into the ECM. DTC 44 will set only if the ECM does not see any activity on the KS signal circuit(s).

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage.
- Loose Knock Sensor(s) in engine block.
- Poor connection at the Knock Sensor(s).

After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

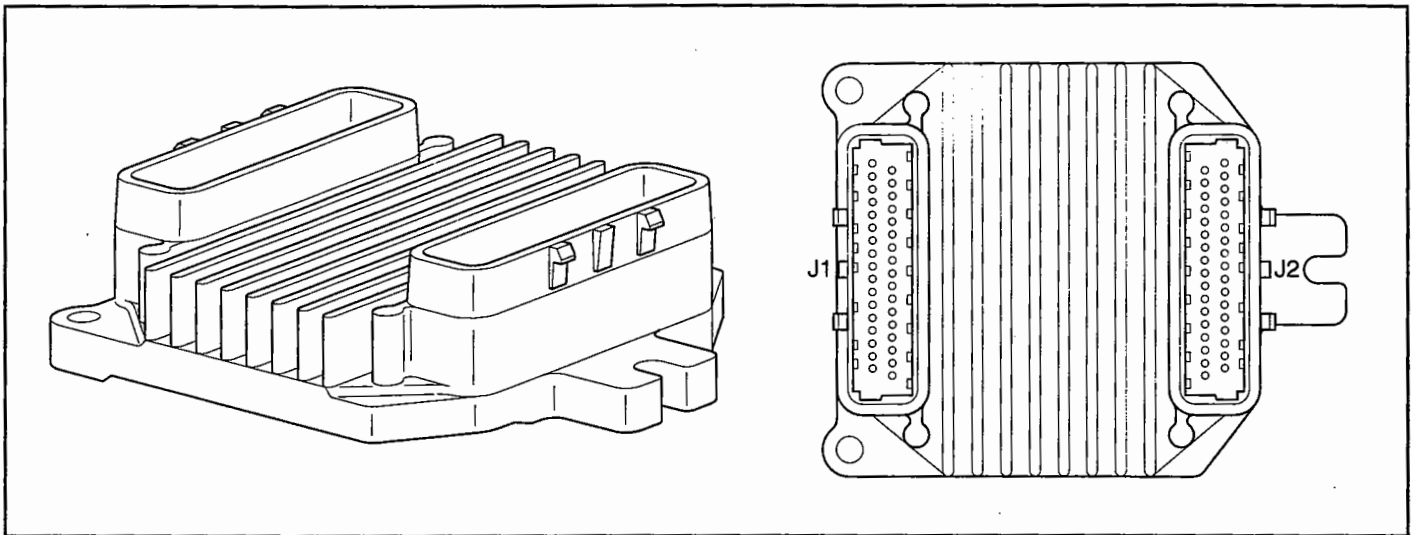
If CKT 496 or CKT 1876 are routed too close to secondary ignition wires, the ECM may see the interference as a knock signal, resulting in false timing retard.

Test Description

4. This step ensures the knock sensor is secured properly in the engine block.
5. Checks to see that the knock sensor circuit is within specifications.

DTC 44 - Knock Sensor (KS) 2 Circuit (Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important: If you can hear the engine knock, repair the engine mechanical problem before proceeding with this diagnostic table. Check the KS signal circuit for incorrect routing near the secondary wires. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 3
3	Check the KS signal circuit for any terminals not being fully seated or for incorrect installation. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 4
4	Check knock sensor for being loose in the engine block. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 5
5	1. Install scan tool. 2. Select the option to view the data list. 3. Select to view the knock signal 2 parameter. 4. Disconnect "J1" harness connector. 5. Connect a DMM from "J1-1" (CKT 1876 - Knock Signal 2) to a known good ground near knock sensor. Is resistance between the specified value?	93-107K ohms	Go to Step 8	Go to Step 6
6	Locate and repair open or short to ground in the circuit that were out of range. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 7
7	Inspect knock sensor terminal contacts. If OK, replace faulty knock sensor. Is action complete?	—	Verify Repair	—
8	Replace faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—



MEFI3004

DTC 51 - Calibration Checksum Failure (Scan Diagnostics)

Circuit Description

This test allows the ECM to check for a calibration failure by comparing the calibration value to a known value stored in the EEPROM.

This test is also used as a security measure to prevent improper use of calibration or changes to these calibrations that may alter the designed function of MEFI.

Diagnostic Aids

If DTC 51 failed more than once, but is intermittent, replace the ECM.

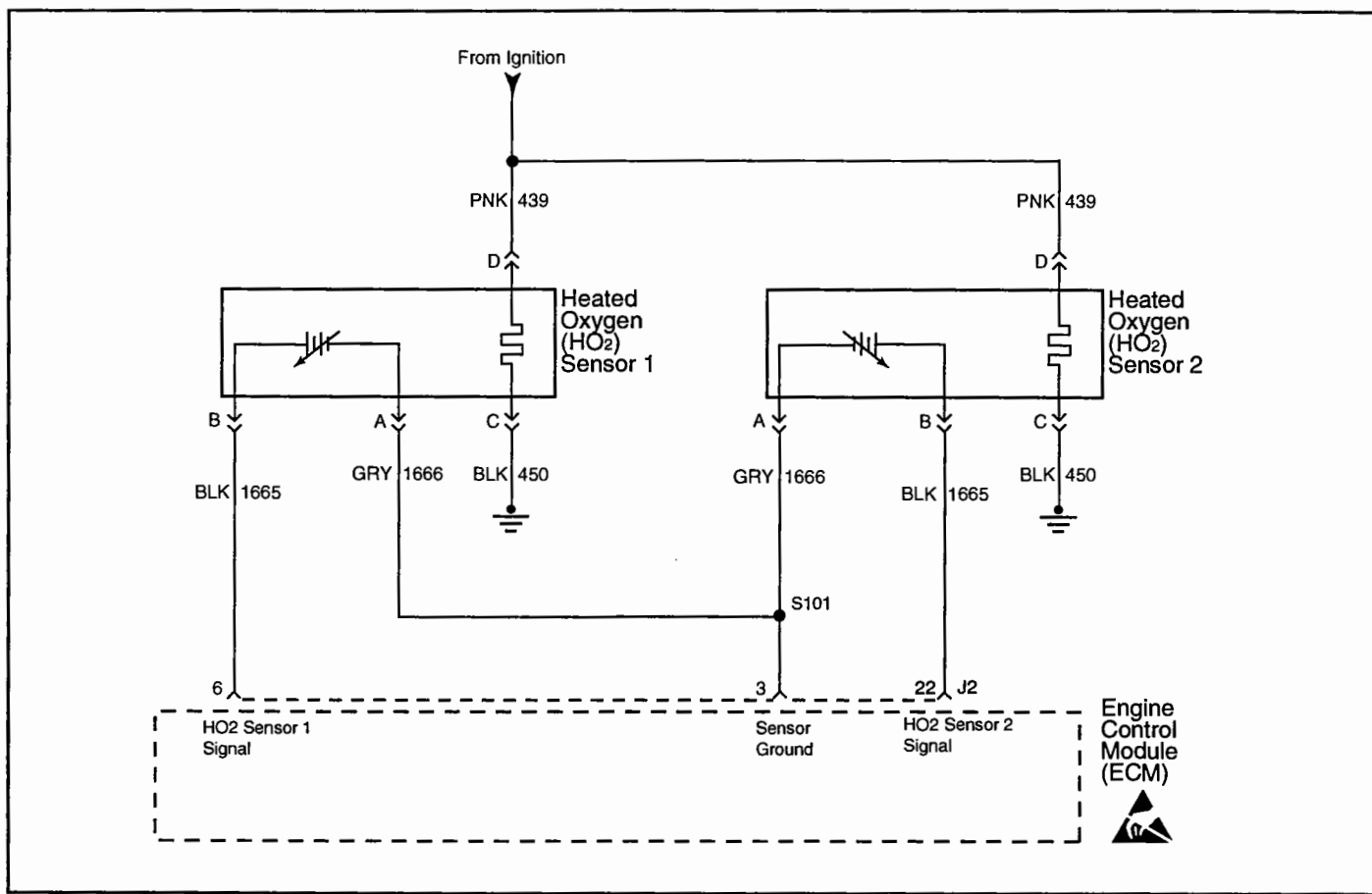
Test Description

- This step checks to see if the fault is present during diagnosis. If present, the ECM is not functioning properly and must be replaced or reprogrammed.

DTC 51 - Calibration Checksum Failure (Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Install Diagnostic Trouble Code (DTC) tool. 2. Using "Clear DTC Procedure," clear DTC 51. 3. Turn the ignition ON, leaving the engine OFF. 4. Switch DTC tool to "service mode," or "ON." Does DTC 51 reset?	—	Go to Step 3	Refer to Diagnostic Aids
3	Replace or reprogram faulty ECM and verify DTC does not reset. Is action complete?	—	Verify Repair	—

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MEFI4313

4-26-00

DTC 54 - Heated Oxygen (HO₂) Sensor 1 Circuit Low Voltage - Lean Exhaust Indicated (Scan Diagnostics)

Circuit Description

The Heated Oxygen (HO₂) Sensor varies voltage within a range from about 1.0 volt if the exhaust is rich, down to about 0.1 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 oxygen sensor circuit or cold oxygen sensor causes an Open Loop operation.

Diagnostic Aids

Check for the following conditions:

- **Poor connection in harness.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- An intermittent short to ground in the HO₂ sensor signal circuit.
- Fuel contamination: Water, even in small amounts delivered to the injectors can cause a lean condition.
- Fuel Pressure: If the fuel pressure is too low, the system will be lean. In order to confirm, monitor a fuel pressure gauge while driving the vehicle at various speeds and

loads.

- **Exhaust Leaks:** If there is an exhaust leak, the engine may pull the outside air into the exhaust and past the sensor.
 - **Vacuum leaks** can cause a lean condition or high idle.
- Never solder the HO₂ wires. For proper wire and connection repairs, refer to "Wiring Repair."

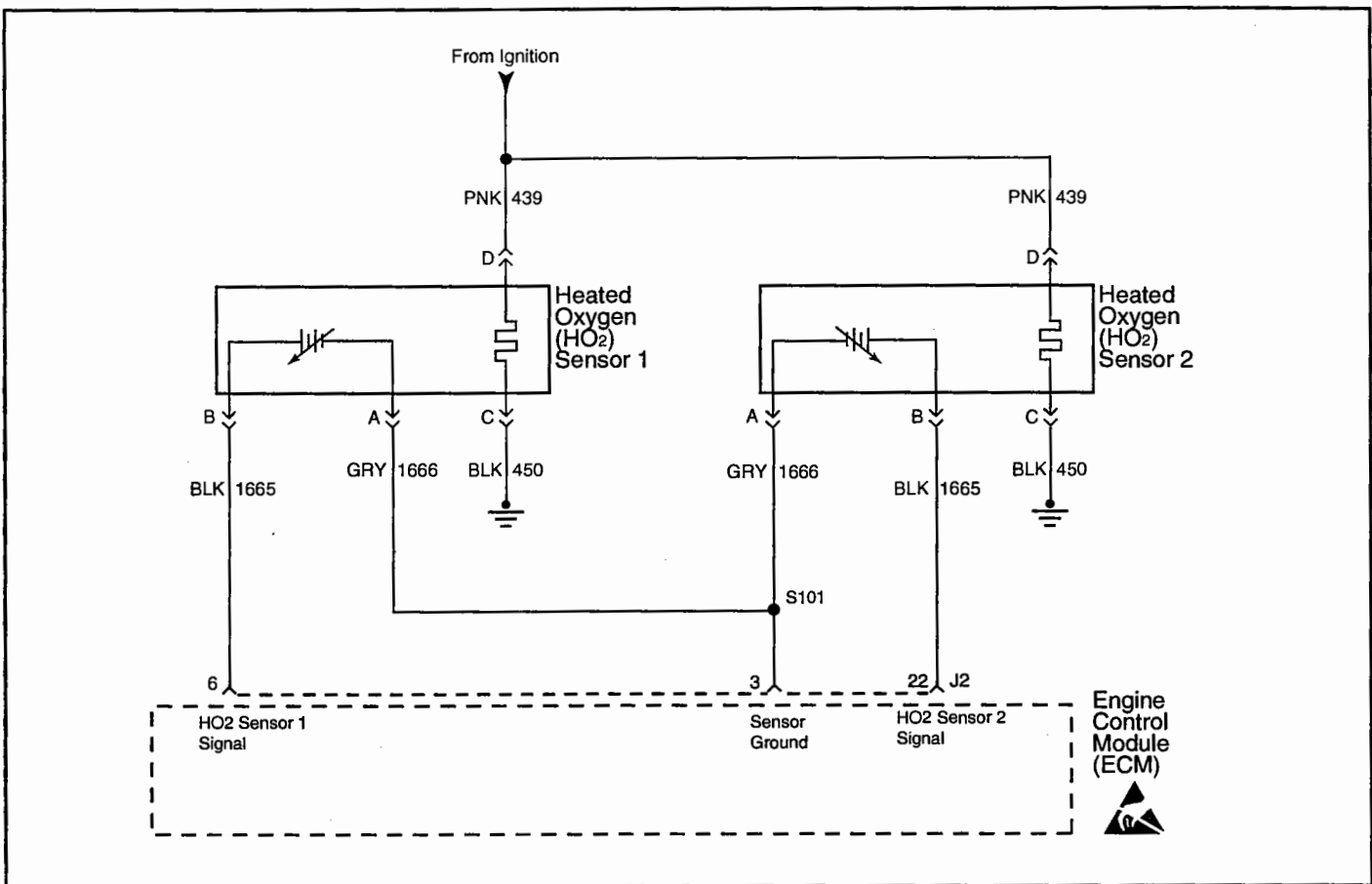
After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

- Running the engine at 1200 RPM keeps the HO₂ sensor hot in order to ensure the oxygen sensor remains active and can indicate the exhaust oxygen content accurately.
- Opening the heated oxygen sensor circuit should result in a displayed voltage between 0.423 volt and 0.487 volt. If the display is fixed below 0.100 volt, the fault is a short to ground in HO₂ sensor signal circuit or a faulty ECM.

**DTC 54 - Heated Oxygen (HO2) Sensor 1 Circuit Low Voltage - Lean Exhaust Indicated
(Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Connect a scan tool. 2. Run the engine at the normal operating temperature. 3. Place the vehicle in park or neutral. 4. Increase the engine speed to the specified value. Is the HO2 sensor 1 voltage displayed fixed less than the specified value?	1200 RPM 0.100 volt	Go to Step 3	Go to Step 4
3	1. Disconnect the HO2 sensor 1 electrical connector. 2. Using a jumper wire, connect the HO2 sensor 1 Low circuit to a known good ground. 3. Turn the ignition ON, leaving the engine OFF. Does the scan tool HO2 Sensor 1 Voltage display indicate a voltage within the specified value?	0.423 - 0.487 volt	Refer to Diagnostic Aids	Go to Step 5
4	DTC 54 is intermittent. If no additional DTC's are stored, refer to the Diagnostic Aids. If any additional DTC's are stored, refer to those table(s) first.	—	Go to Applicable DTC Table	—
5	Locate and repair short to ground in the HO2 sensor 1 signal circuit. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 6
6	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

MEFI4313
4-26-00

DTC 54 - Heated Oxygen (HO₂) Sensor 2 Circuit Low Voltage - Lean Exhaust Indicated (Scan Diagnostics)

Circuit Description

The Heated Oxygen (HO₂) Sensor varies voltage within a range from about 1.0 volt if the exhaust is rich, down to about 0.1 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 oxygen sensor circuit or cold oxygen sensor causes an Open Loop operation.

Diagnostic Aids

Check for the following conditions:

- **Poor connection in harness.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- An intermittent short to ground in the HO₂ sensor signal circuit.
- Fuel contamination: Water, even in small amounts delivered to the injectors can cause a lean condition.
- Fuel Pressure: If the fuel pressure is too low, the system will be lean. In order to confirm, monitor a fuel pressure gauge while driving the vehicle at various speeds and

loads.

- Exhaust Leaks: If there is an exhaust leak, the engine may pull the outside air into the exhaust and past the sensor.
- Vacuum leaks can cause a lean condition or high idle.

Never solder the HO₂ wires. For proper wire and connection repairs, refer to "Wiring Repair."

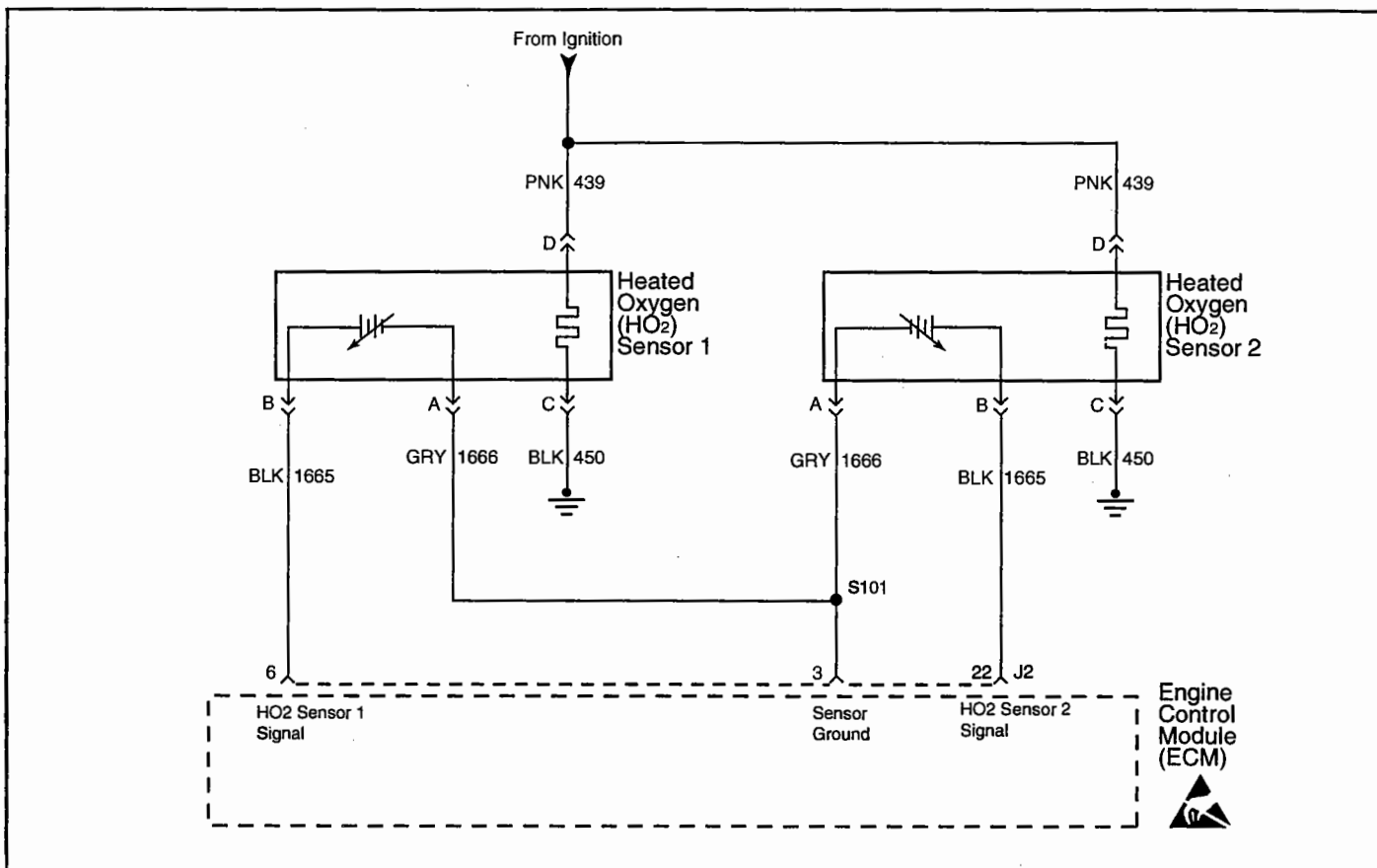
After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

2. Running the engine at 1200 RPM keeps the HO₂ sensor hot in order to ensure the oxygen sensor remains active and can indicate the exhaust oxygen content accurately.
3. Opening the heated oxygen sensor circuit should result in a displayed voltage between 0.423 volt and 0.487 volt. If the display is fixed below 0.100 volt, the fault is a short to ground in HO₂ sensor signal circuit or a faulty ECM.

**DTC 54 - Heated Oxygen (HO2) Sensor 2 Circuit Low Voltage - Lean Exhaust Indicated
(Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Connect scan tool. 2. Run the engine at the normal operating temperature. 3. Place the vehicle in park or neutral. 4. Increase the engine speed to the specified value. Is the HO2 sensor 2 voltage displayed fixed less than the specified value?	1200 RPM 0.100 volt	Go to Step 3	Go to Step 4
3	1. Disconnect the HO2 sensor 2 electrical connector. 2. Using a jumper wire, connect the HO2 sensor 2 Low circuit to a known good ground. 3. Turn the ignition ON, leaving the engine OFF. Does the scan tool HO2 Sensor 2 Voltage display indicate a voltage within the specified value?	0.423 - 0.487 volt	Refer to Diagnostic Aids	Go to Step 5
4	DTC 54 is intermittent. If no additional DTC's are stored, refer to the Diagnostic Aids. If any additional DTC's are stored, refer to those table(s) first.	—	Go to Applicable DTC Table	—
5	Locate and repair short to ground in the HO2 sensor 2 signal circuit. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 6
6	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—



MEFI4313
4-26-00

DTC 55 - Heated Oxygen (HO₂) Sensor 1 Circuit High Voltage - Rich Exhaust Indicated (Scan Diagnostics)

Circuit Description

The Heated Oxygen (HO₂) Sensor varies voltage within a range from about 1.0 volt if the exhaust is rich, down to about 0.1 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 oxygen sensor circuit or cold oxygen sensor causes an Open Loop operation.

Diagnostic Aids

Check for the following conditions:

- **Poor connection in harness.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- A leaking injector.
- Fuel contaminated oil.
- Fuel Pressure: If the fuel pressure is too high, the system will be rich. In order to confirm, monitor a fuel pressure gauge while driving the vehicle at various speeds and loads.
- Leaking fuel pressure regulator. Check for fuel in the vacuum line to regulator.

- The TP sensor: An intermittent TP sensor output can cause the system to run rich due to a false indication of the throttle moving.
- False rich indication due to silicon contamination of the HO₂ sensor. A DTC 55 accompanied by lean drivability conditions and a powdery white deposit on the sensor indicates a false rich condition.
- Faulty HO₂ sensor: The HO₂ sensor is internally shorted, the HO₂ Sensor Voltage displayed on the scan tool will be over 1.0 volt. Try disconnecting the HO₂ electrical connector, if the displayed voltage goes from over 1.0 volt down to about 0.5 volt, replace the HO₂ sensor.

Never solder the HO₂ wires. For proper wire and connection repairs, refer to "Wiring Repair."

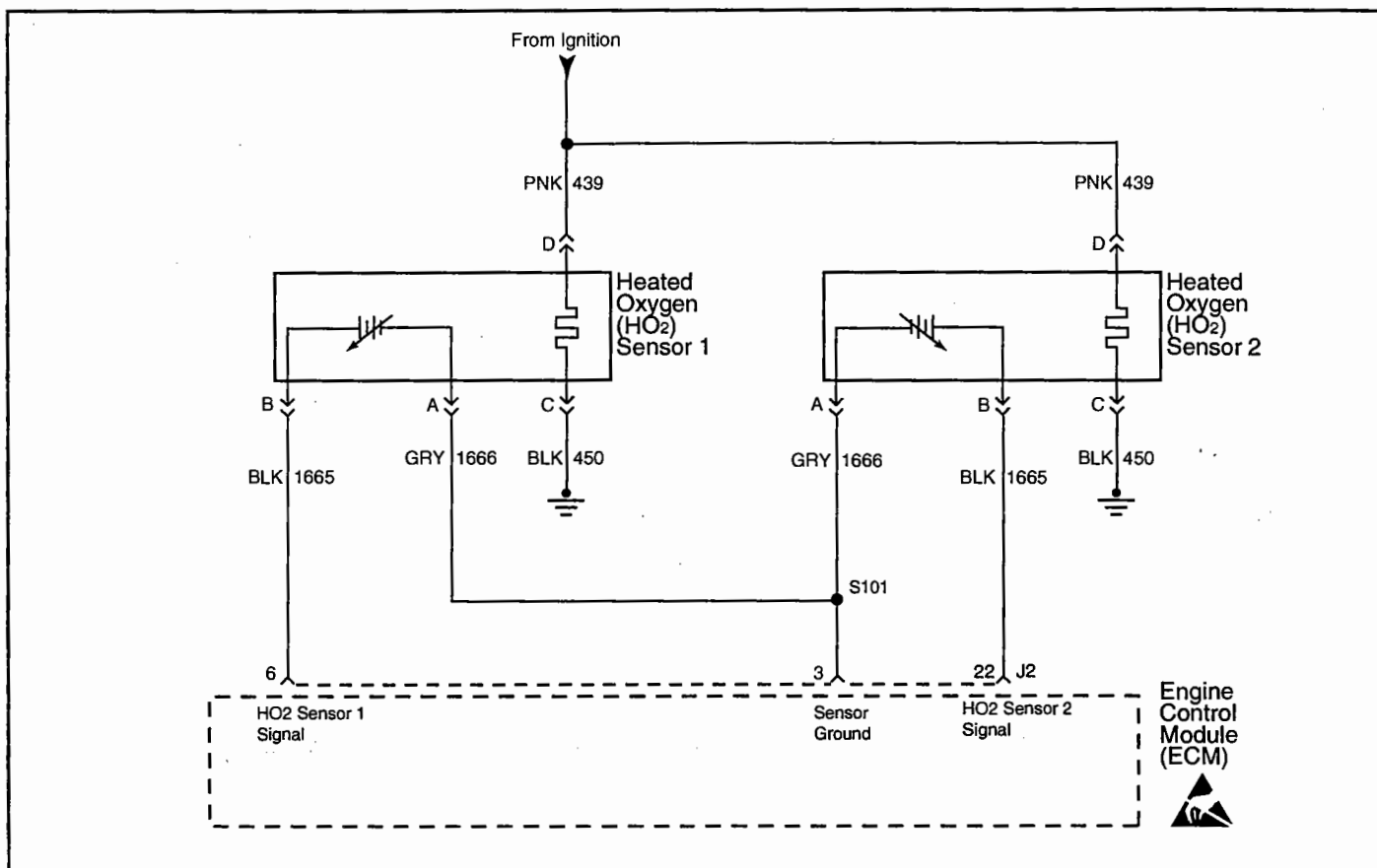
After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

2. This test determines if the conditions exist in order to set DTC 55.

**DTC 55 - Heated Oxygen (HO₂) Sensor 1 Circuit High Voltage - Rich Exhaust Indicated
(Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Connect scan tool. 2. Run the engine at the normal operating temperature. 3. Place the vehicle in park or neutral. 4. Increase the engine speed to the specified value. Is the HO ₂ sensor 1 voltage displayed fixed above than the specified value?	1200 RPM 0.900 volt	Go to Step 3	Go to Step 5
3	Turn the ignition ON, leaving the engine OFF. Does the scan tool HO ₂ Sensor 1 Voltage display indicate a voltage fixed above the specified value?	0.900 volt	Go to Step 4	Refer to Diagnostic Aids
4	1. Disconnect the HO ₂ sensor 1 electrical connector. 2. Turn the ignition ON, leaving the engine OFF. Does the scan tool HO ₂ Sensor 1 Voltage display indicate a voltage fixed above the specified value?	0.900 volt	Go to Step 7	Go to Step 6
5	DTC 55 is intermittent. If no additional DTC's are stored, refer to the Diagnostic Aids. If any additional DTC's are stored, refer to those table(s) first.	—	Go to Applicable DTC Table	—
6	Replace HO ₂ sensor 1. Is action complete?	—	Verify Repair	—
7	Locate and repair short to voltage on the HO ₂ sensor 1 signal circuit. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 8
8	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

MEFI4313
4-26-00

DTC 55 - Heated Oxygen (HO₂) Sensor 2 Circuit High Voltage - Rich Exhaust Indicated (Scan Diagnostics)

Circuit Description

The Heated Oxygen (HO₂) Sensor varies voltage within a range from about 1.0 volt if the exhaust is rich, down to about 0.1 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 oxygen sensor circuit or cold oxygen sensor causes an Open Loop operation.

Diagnostic Aids

Check for the following conditions:

- **Poor connection in harness.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- A leaking injector.
- Fuel contaminated oil.
- Fuel Pressure: If the fuel pressure is too high, the system will be rich. In order to confirm, monitor a fuel pressure gauge while driving the vehicle at various speeds and loads.
- Leaking fuel pressure regulator. Check for fuel in the vacuum line to regulator.

- The TP sensor: An intermittent TP sensor output can cause the system to run rich due to a false indication of the throttle moving.
- False rich indication due to silicon contamination of the HO₂ sensor. A DTC 55 accompanied by lean drivability conditions and a powdery white deposit on the sensor indicates a false rich condition.
- Faulty HO₂ sensor: The HO₂ sensor is internally shorted, the HO₂ Sensor Voltage displayed on the scan tool will be over 1.0 volt. Try disconnecting the HO₂ electrical connector, if the displayed voltage goes from over 1.0 volt down to about 0.5 volt, replace the HO₂ sensor.

Never solder the HO₂ wires. For proper wire and connection repairs, refer to "Wiring Repair."

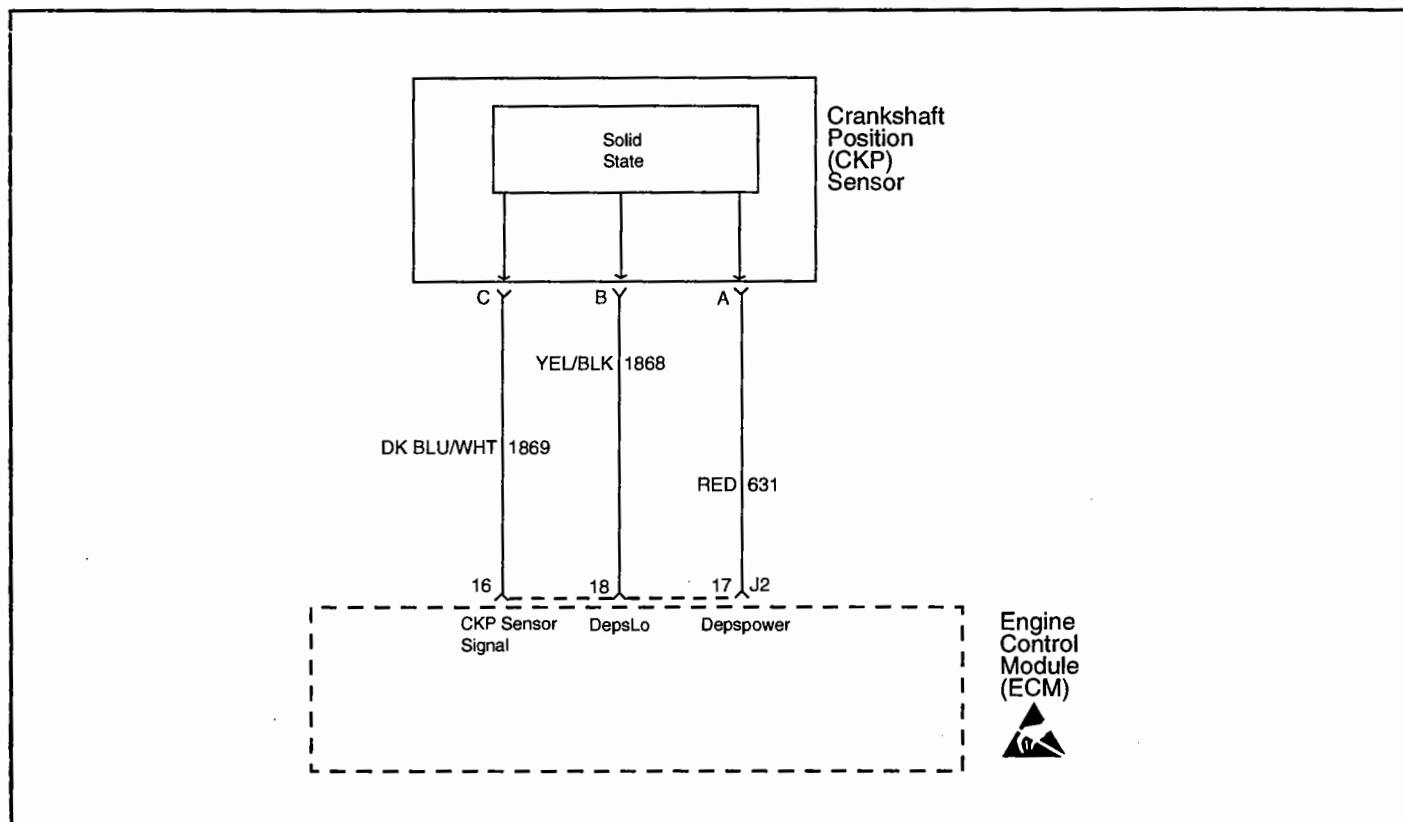
After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

2. This test determines if the conditions exist in order to set DTC 55.

**DTC 55 - Heated Oxygen (HO₂) Sensor 2 Circuit High Voltage - Rich Exhaust Indicated
(Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Connect scan tool. 2. Run the engine at the normal operating temperature. 3. Place the vehicle in park or neutral. 4. Increase the engine speed to the specified value. Is the HO ₂ sensor 2 voltage displayed fixed above than the specified value?	1200 RPM 0.900 volt	Go to Step 3	Go to Step 5
3	Turn the ignition ON, leaving the engine OFF. Does the scan tool HO ₂ Sensor 2 Voltage display indicate a voltage fixed above the specified value?	0.900 volt	Go to Step 4	Refer to Diagnostic Aids
4	1. Disconnect the HO ₂ sensor 2 electrical connector. 2. Turn the ignition ON, leaving the engine OFF. Does the scan tool HO ₂ Sensor 2 Voltage display indicate a voltage fixed above the specified value?	0.900 volt	Go to Step 7	Go to Step 6
5	DTC 55 is intermittent. If no additional DTC's are stored, refer to the Diagnostic Aids. If any additional DTC's are stored, refer to those table(s) first.	—	Go to Applicable DTC Table	—
6	Replace HO ₂ sensor 2. Is action complete?	—	Verify Repair	—
7	Locate and repair short to voltage on the HO ₂ sensor 2 signal circuit. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 8
8	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

MEFI4325
6-15-00

DTC 81 - Crankshaft Position (CKP) Sensor Circuit Fault (Scan Diagnostics)

Circuit Description

The CKP sensor works in conjunction with a 24X reluctor wheel. The CKP sensor has a B+ power supply, a ground and a signal circuit.

As the crankshaft rotates, the reluctor wheel teeth interrupt a magnetic field produced by a magnet within the sensor. The sensor's internal circuitry detects this and produces a signal which the ECM reads. The ECM uses this signal to accurately measure crankshaft velocity which is a variable used in order to detect misfire, and control spark and fueling.

Diagnostic Aids

Check for the following conditions:

- Poor connection in harness. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Crankshaft reluctor wheel damage or improper installation
- Excessive air gap between the CKP sensor and the reluctor wheel

Excess crankshaft end play causes the CKP sensor reluctor wheel to move out of alignment with the CKP sensor. This

could result in any one of the following:

- A no start
- A start and stall
- Erratic performance

Test Description

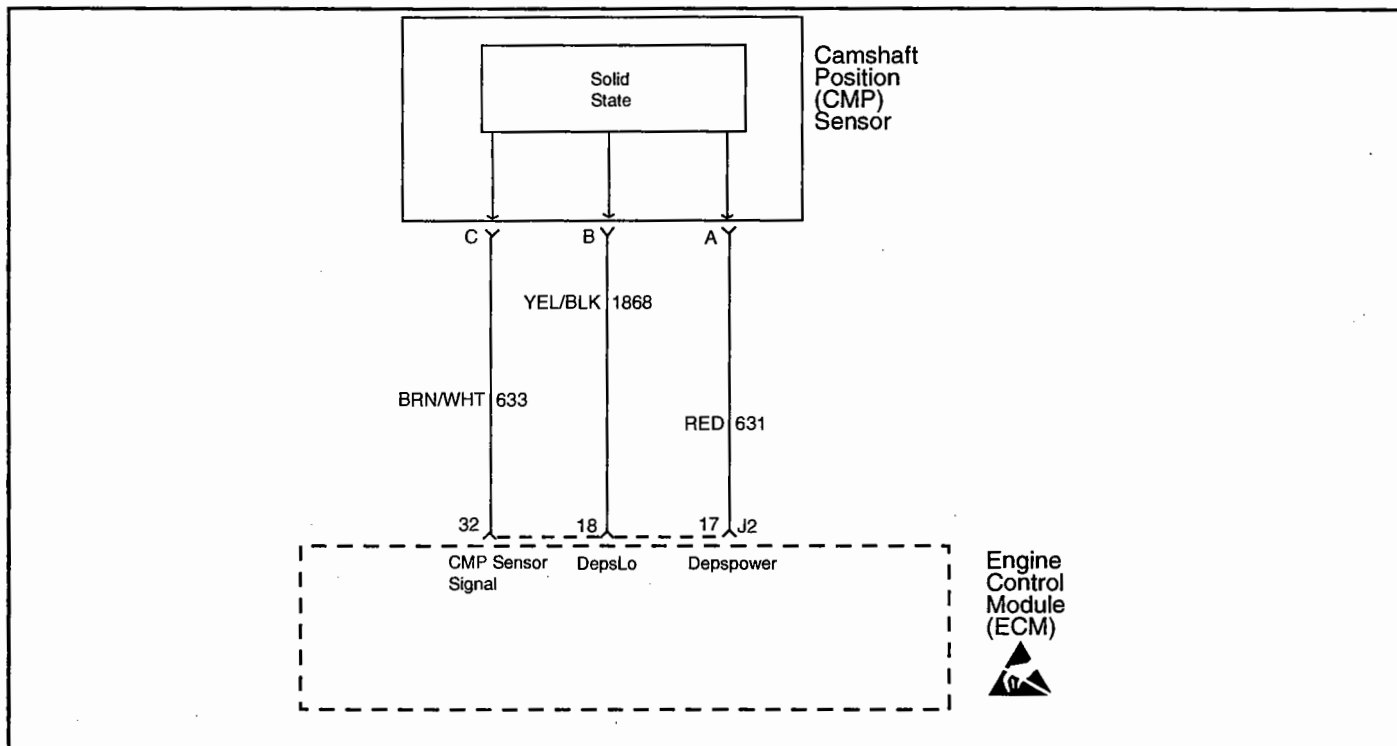
2. This test determines if the conditions exist in order to set DTC 55.

**DTC 81 - Crankshaft Position (CKP) Sensor Circuit Fault
(Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Does the engine start and continue to run?	—	Go to Step 3	Go to Step 4
3	<p>Caution: Before proceeding, remove the fuses for the ignition coil and fuel injector feed circuits in order to prevent personal injury from engine rotation, sparks and excessive engine fueling.</p> <ol style="list-style-type: none"> Turn ON the ignition leaving the engine OFF. Disconnect the Crankshaft Position (CKP) sensor harness connector. Using a DMM connected to a known good ground, measure the voltage at terminal "A" (Depspower) at the CKP sensor harness. <p>Does the DMM display the specified value?</p>	B+	Go to Step 4	Go to Step 7
4	<p>Using a DMM, measure the voltage between the CKP sensor harness connector terminals "A" (Depspower) and "B" (Depslo).</p> <p>Does the DMM display the specified value?</p>	B+	Go to Step 5	Go to Step 8
5	<p>Using a test lamp connected to harness connector terminal "A" (Depspower), momentarily touch the other end to terminal "C" (CKP sensor signal).</p> <p>Does the fuel pump operate when the ignition voltage was applied to the CKP sensor signal circuit?</p>	—	Go to Step 10	Go to Step 6
6	<ol style="list-style-type: none"> Jumper terminal "A" of the CKP sensor harness connector to terminal "A" of the CKP sensor using a fused jumper wire. Jumper terminal "B" of the CKP sensor harness connector to terminal "B" of the CKP sensor. Using a DMM connected to a known good ground, probe terminal "C" (sensor signal) of the CKP sensor. Hand crank the engine. <p>Does the voltage transition between 0 and more than 7 volts?</p>	—	Go to Step 13	Go to Step 9
7	<p>Locate and repair an open in the CKP sensor "Depspower" circuit.</p> <p>Was a problem found?</p>	—	Verify repair	Go to Step 13
8	<p>Locate and repair an open or poor connection in the CKP sensor "Depslo" circuit.</p> <p>Was a problem found?</p>	—	Verify repair	Go to Step 13

DTC 81 - Crankshaft Position (CKP) Sensor Circuit Fault (cont'd)
(Scan Diagnostics)

Step	Action	Value	Yes	No
9	Locate and repair an open, short to ground or short to voltage in the CKP sensor signal circuit. Was a problem found?	—	Verify Repair	Go to Step 10
10	1. Remove the CKP sensor. 2. Visually inspect the CKP sensor for physical damage, loose or improper installation or wiring routed too closely to secondary ignition components. 3. Repair the circuit as necessary. Was a problem found?	—	Verify Repair	Go to Step 11
11	Inspect for poor connections at the CKP sensor. Was a problem found?	—	Verify Repair	Go to Step 12
12	Replace the faulty CKP sensor. Is the action complete?	—	Verify Repair	—
13	Replace the ECM. Is the action complete?	—	Verify Repair	—



MEFI4326
6-15-00

DTC 81 - Camshaft Position (CMP) Sensor Circuit Fault (Scan Diagnostics)

Circuit Description

The CMP sensor works in conjunction with a 1X reluctor wheel on the camshaft. The Engine Control Module (ECM) provides a 12 volt reference to the CMP sensor as well as a low reference and a signal circuit.

The CMP sensor determines whether a cylinder is on a firing stroke or on an exhaust stroke. As the camshaft rotates, the reluctor wheel interrupts a magnetic field produced by a magnet within the sensor. The sensor's internal circuitry detects this and produces a signal which the ECM reads. The ECM uses this 1X signal in combination with the crankshaft position (CKP) sensor 24X signal in order to determine crankshaft position and stroke.

Observe that as long as the ECM receives the CKP sensor 24X signal, the engine will start. The ECM can determine top dead center for all cylinders by using the CKP sensor 24X signal alone. The CMP sensor 1X signal is used by the ECM to determine if the cylinder at top dead center is on the firing stroke or the exhaust stroke. The system attempts synchronization and looks for an increase in engine speed indicating the engine started. If the ECM does not detect an increase in engine speed, the ECM assumes it is incorrectly synchronized to the exhaust stroke and re-syncs to the exhaust stroke and re-syncs to the opposite cam position. A slightly longer cranking time may be a symptom of this condition.

Diagnostic Aids

Check for the following conditions:

- Camshaft reluctor wheel damage
- The sensor coming in contact with the reluctor wheel
- A cracked or damaged sensor
- Foreign material passing between the sensor and reluctor wheel

If you find damage to the reluctor wheel or camshaft, refer to *Camshaft Replacement* in Engine Mechanical.

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

Test Description

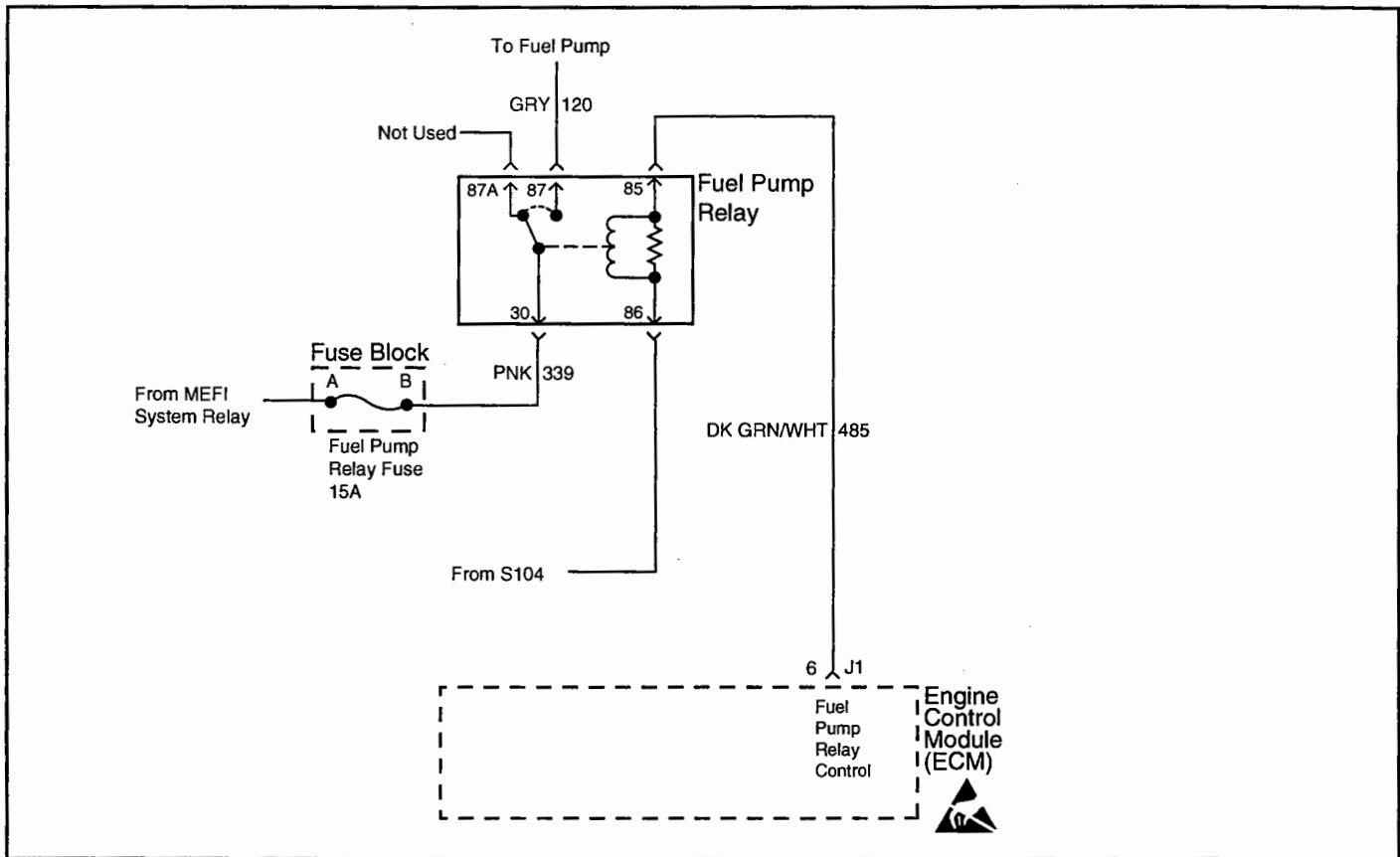
2. This test determines if the conditions exist in order to set DTC 55.

**DTC 81 - Camshaft Position (CMP) Sensor Circuit Fault
(Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Disconnect the Camshaft Position (CMP) sensor harness connector. 2. Turn ON the ignition, with the engine OFF. 3. Using a DMM connected to a known good ground, measure the voltage at terminal "A" (Depspower) at the CMP sensor harness. Does the DMM display the specified value?	B+	Go to Step 3	Go to Step 5
3	Using a DMM, measure the voltage between the CKP sensor harness connector terminal "A" (Depspower) and terminal "B" (Depslo). Does the DMM display the specified value?	B+	Go to Step 4	Go to Step 7
4	1. Start the engine. 2. Monitor the CAM signal input - high to low and low to high transition using the scan tool. 3. Using a test lamp connected to harness connector terminal "A" (Depspower), momentarily touch the other end to terminal "C" (CMP sensor signal). Does the CAM signal input - High to Low and Low to High transition counters increment when the test lamp contacts the signal circuit?	—	Go to Step 14	Go to Step 9
5	1. Turn OFF the engine. 2. Disconnect ECM connector J2. 3. Using a DMM, measure the resistance of the CMP sensor depspower circuit between the ECM and the CMP sensor. Does the resistance measure with the specified range?	0-5 ohms	Go to Step 6	Go to Step 11
6	Locate and repair a short to ground or poor connection in the CMP sensor "Depspower" circuit. Was a problem found?	—	Verify repair	Go to Step 15
7	1. Turn OFF the ignition. 2. Disconnect ECM connector J2. 3. Using a DMM, measure the resistance of the CMP sensor depslo circuit between the ECM and the CMP sensor. Does the resistance measure with the specified range?	0-5 ohms	Go to Step 15	Go to Step 8
8	Locate and repair an open or poor connection in the CMP sensor "Depslo" circuit. Is action complete?	—	Verify repair	—

DTC 81 - Camshaft Position (CMP) Sensor Circuit Fault (cont'd)
(Scan Diagnostics)

Step	Action	Value	Yes	No
9	1. Turn OFF the ignition. 2. Disconnect ECM connector J2. 3. Using a DMM, measure the resistance of the CMP sensor signal circuit between the ECM and the CMP sensor. Does the resistance measure with the specified range?	0-5 ohms	Go to Step 10	Go to Step 13
10	1. Turn ON the ignition, with the engine OFF. 2. Locate and repair a short to ground or a short to voltage on the CMP sensor signal circuit. Was a problem found?	—	Verify Repair	Go to Step 15
11	Locate and repair an open in the CMP sensor deppower circuit. Was a problem found?	—	Verify Repair	Go to Step15
12	Locate and repair an open in the CMP sensor deplsio circuit. Is the action complete?	—	Verify Repair	—
13	Locate and repair an open in the CMP sensor signal circuit. Is action complete?	—	Verify Repair	—
14	Locate and repair a poor connection at the CMP sensor harness connector. Was a problem found?	—	Verify Repair	Go to Step 16
15	Locate and repair a poor connection at the ECM harness connector. Was a problem found?	—	Verify Repair	Go to Step17
16	Replace the faulty CMP sensor. Is action complete?	—	Verify Repair	—
17	Replace the ECM. Is the action complete?	—	Verify Repair	—

MEFI4327
6-21-00

DTC 81 - Fuel Pump Relay Driver Circuit High, Low or Open (Scan Diagnostics)

Circuit Description

The Engine Control Module (ECM) controls the relay by grounding the control circuit via an internal switch called a driver. The primary function of the driver is to supply the ground for the controlled component. This driver has a fault line which the ECM monitors. When the ECM commands the relay ON, the voltage of the control circuit should be low, near 0 volts. When the ECM commands the relay OFF, the voltage should be high, near battery voltage. If the fault detection circuit senses a voltage other than what the ECM expects, the fault line status changes causing the DTC to set.

The relay controls the high current flow to the fuel pump. This allows the ECM driver to only have to control the relatively low current used by the relay.

Diagnostic Aids

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

Test Description

2. Listen for an audible click when the relay operates. Command both the ON and OFF states. Repeat the commands if necessary.

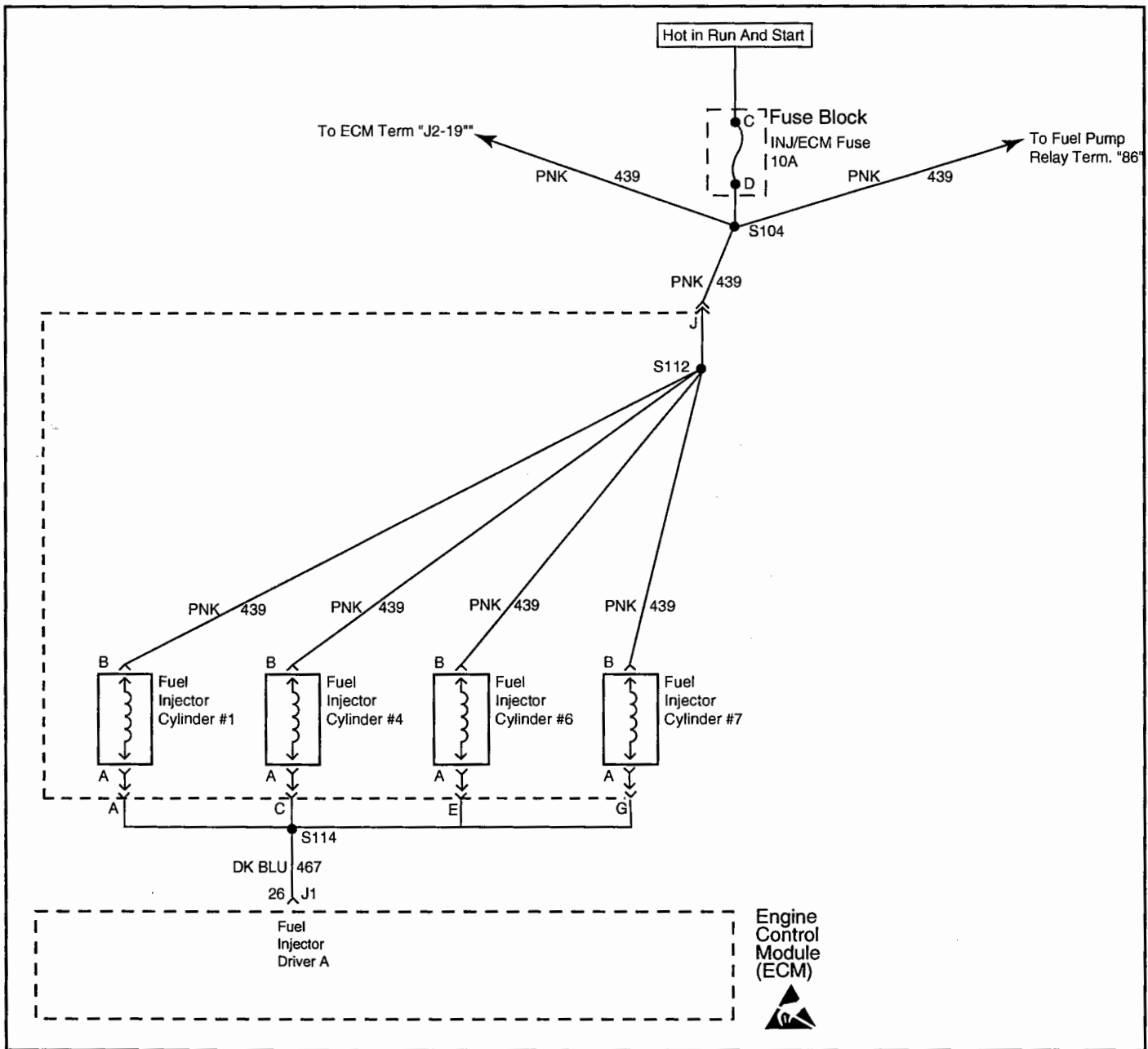
3. This test can detect a partially shorted coil which would cause an excessive current flow. Leaving the circuit energized for 2 minutes allows the coil to warm up. When warm, the coil may open, and the current drops to 0, or the coil may short, and the current goes above 0.75 amp.
5. Identify and test the relay coil terminals in order to avoid improper diagnosis.
12. If no trouble is found in the control circuit or the connection at the ECM, the ECM may be faulty. However, this is an extremely unlikely failure.

**DTC 81 - Fuel Pump Relay Driver Circuit High, Low or Open
(Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Turn ON the ignition, with the engine OFF. 2. Command the relay ON and OFF using a scan tool. Does the relay turn ON and OFF when commanded?	—	Go to Step 3	Go to Step 5
3	1. Turn OFF the ignition. 2. Disconnect the ECM connector J1. 3. Install a 5 amp fused jumper wire from a known good ground to the control circuit at the ECM harness connector (J1-6). 4. Turn ON the ignition, with the engine OFF. Important: Replace the relay if the DMM goes to 0 during the current draw test. 5. Using a DMM on 40 amp scale, measure the current from the relay control circuit in the ECM harness connector to ground for 2 minutes. Does the current draw measure less than the specified value?	0.75 A	Go to Diagnostic Aids	Go to Step 4
4	1. Turn OFF the ignition. 2. Disconnect the fuel pump relay connector. 3. Using a DMM, measure the resistance from the relay control circuit in the ECM harness connector to ground. Does the DMM display infinite resistance or OL?	—	Go to Step 12	Go to Step 10
5	1. Turn OFF the engine. 2. Disconnect the fuel pump relay connector. 3. Connect a test lamp between the fuel pump relay control circuit and the fuel pump relay ignition feed circuit, on the coil side of the relay, at the fuel pump relay harness connector. 4. Turn ON the ignition, with the engine OFF. 5. Using a scan tool, command the relay ON and OFF. Does the test lamp turn ON and OFF when commanded?	—	Go to Step 8	Go to Step 6
6	Using a test lamp connected to ground, probe the ignition feed circuit, on the coil side of the fuel pump relay harness connector. Is the test lamp illuminated?	—	Go to Step 7	Go to Step 11

DTC 81 - Fuel Pump Relay Driver Circuit High, Low or Open (cont'd)
(Scan Diagnostics)

Step	Action	Value	Yes	No
7	1. Turn OFF the ignition. 2. Reconnect the relay. 3. Disconnect the ECM connector J2. 4. Turn ON the ignition, with the engine OFF. 5. Using a fused jumper wire connected to ground, momentarily probe the relay control circuit in the ECM harness connector. Does the relay turn ON when the circuit is grounded and OFF when the circuit is opened?	—	<i>Go to Step 9</i>	<i>Go to Step 10</i>
8	Locate and repair faulty connections at the relay. Was a problem found?	—	Verify Repair	<i>Go to Step 12</i>
9	Locate and repair faulty connections at the ECM. Was a problem found?	—	Verify Repair	<i>Go to Step 13</i>
10	Repair the faulty relay control circuit. Is action complete?	—	Verify Repair	—
11	Repair the faulty relay ignition feed circuit. Is action complete?	—	Verify Repair	—
12	Replace the faulty relay. Is action complete?	—	Verify Repair	—
13	Replace the ECM Is action complete?	—	Verify Repair	—



MEFI4328
6-21-00

DTC 81 - Fuel Injector Driver A Circuit High, Low or Open (Scan Diagnostics)

Circuit Description

The Engine Control Module (ECM) enables the fuel injector drivers. An ignition voltage is supplied to the fuel injectors. The ECM controls each fuel injector driver by grounding the control circuit via a solid state device called a driver. The ECM monitors the status of each driver. If the ECM detects an incorrect voltage for the commanded state of the driver, a fuel injector control DTC sets.

Diagnostic Aids

Performing the Fuel Injector Coil test may help isolate an intermittent condition. Refer to *Fuel Injector Coil Test* -

Engine Coolant Temperature (ECT) Between 10-35 Degrees C (50-95 Degrees F) or Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Outside 10-35 Degrees C (50-95 Degrees F).

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

Test Description

- This step tests for voltage at the fuel injector harness connector. The ECM/INJ fuse supplies power to the coil side of the fuel injector harness connector. If the fuse is open, a short to ground on the fuel injector B+ supply

circuit is indicated. The ECM/INJ fuse also supplies voltage to the ignition coils. If the fuse is open, inspect the circuits to the ignition coils for a short to ground.

5. This test verifies that the ECM is able to control the fuel

injector. If the test lamp blinks, then the ECM and wiring are OK.

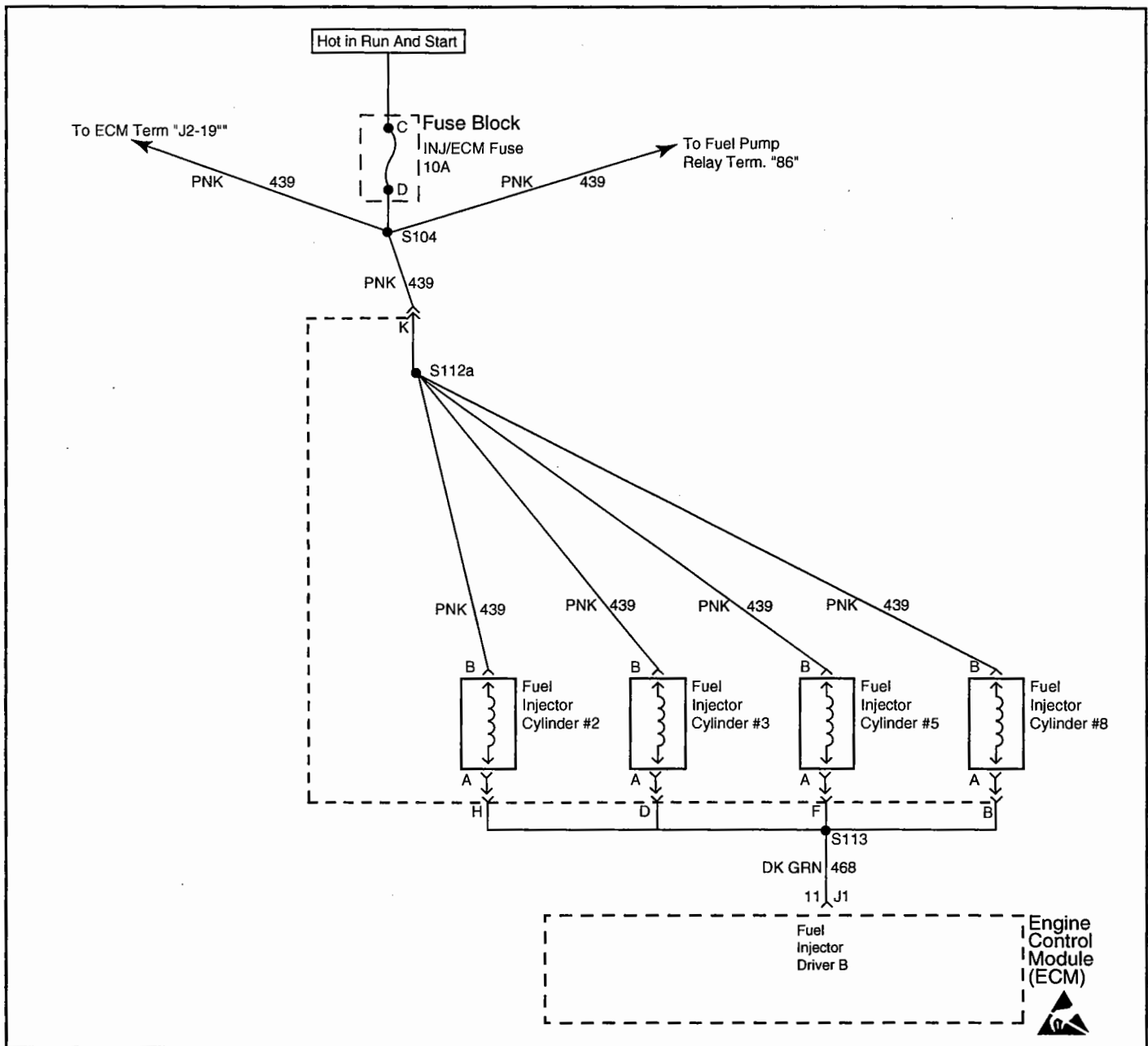
6. This step tests if a ground is constantly being applied to the fuel injector.

DTC 81 - Fuel Injector Driver A Circuit High, Low or Open (Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Disconnect the appropriate harness connectors of the four fuel injectors. 2. Turn ON the ignition, with the engine OFF. 3. Using a test lamp connected to a know good ground, probe the ignition voltage circuits of each fuel injector on the harness connector. Does the test lamp illuminate on all four circuits?	—	Go to Step 3	Go to Step 8
3	1. Connect the fuel injector test lamp J 34730-2C between the control circuit and the ignition voltage circuit of the fuel injector harness connector. Repeat for all four fuel injectors. 2. Start the engine. Does the test lamp blink on all four fuel injector harness connectors?	—	Go to Step 7	Go to Step 4
4	Does the test lamp remain illuminated at all times on any of the four fuel injector harness connectors?	—	Go to Step 6	Go to Step 5
5	Locate and repair an open or short to voltage in the fuel injector control circuit. Was a problem found?	—	Verify Repair	Go to Step 8
6	Locate and repair a short to ground in the fuel injector control circuit. Was a problem found?	—	Verify Repair	Go to Step 11
7	Locate and repair poor connections at the harness connector of the fuel injector. Was a problem found?	—	Verify Repair	Go to Step 10
8	Locate and repair poor connections at the harness connector of the ECM. Was a problem found?	—	Verify Repair	Go to Step 11
9	Important: The ECM/INJ fuse also supplies voltage to the ignition coils. If the fuse is open, inspect all related circuits for a short to ground. Repair an open or short to ground in the fuel injector ignition voltage circuit. Was a problem found?	—	Verify Repair	—

**DTC 81 - Fuel Injector Driver A Circuit High, Low or Open (cont'd)
(Scan Diagnostics)**

Step	Action	Value	Yes	No
10	Replace the fuel injector. Is action complete?	—	Verify Repair	—
11	Replace the ECM. Is action complete?	—	Verify Repair	—



MEFI4329
6-21-00

DTC 81 - Fuel Injector Driver B Circuit High, Low or Open (Scan Diagnostics)

Circuit Description

The Engine Control Module (ECM) enables the fuel injector drivers. An ignition voltage is supplied to the fuel injectors. The ECM controls each fuel injector driver by grounding the control circuit via a solid state device called a driver. The ECM monitors the status of each driver. If the ECM detects an incorrect voltage for the commanded state of the driver, a fuel injector control DTC sets.

Diagnostic Aids

Performing the Fuel Injector Coil test may help isolate an intermittent condition. Refer to *Fuel Injector Coil Test* -

Engine Coolant Temperature (ECT) Between 10-35 Degrees C (50-95 Degrees F) or Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Outside 10-35 Degrees C (50-95 Degrees F).

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

Test Description

- This step tests for voltage at the fuel injector harness connector. The ECM/INJ fuse supplies power to the coil side of the fuel injector harness connector. If the fuse is open, a short to ground on the fuel injector B+ supply

circuit is indicated. The ECM/INJ fuse also supplies voltage to the ignition coils. If the fuse is open, inspect the circuits to the ignition coils for a short to ground.

injector. If the test lamp blinks, then the ECM and wiring are OK.

5. This test verifies that the ECM is able to control the fuel

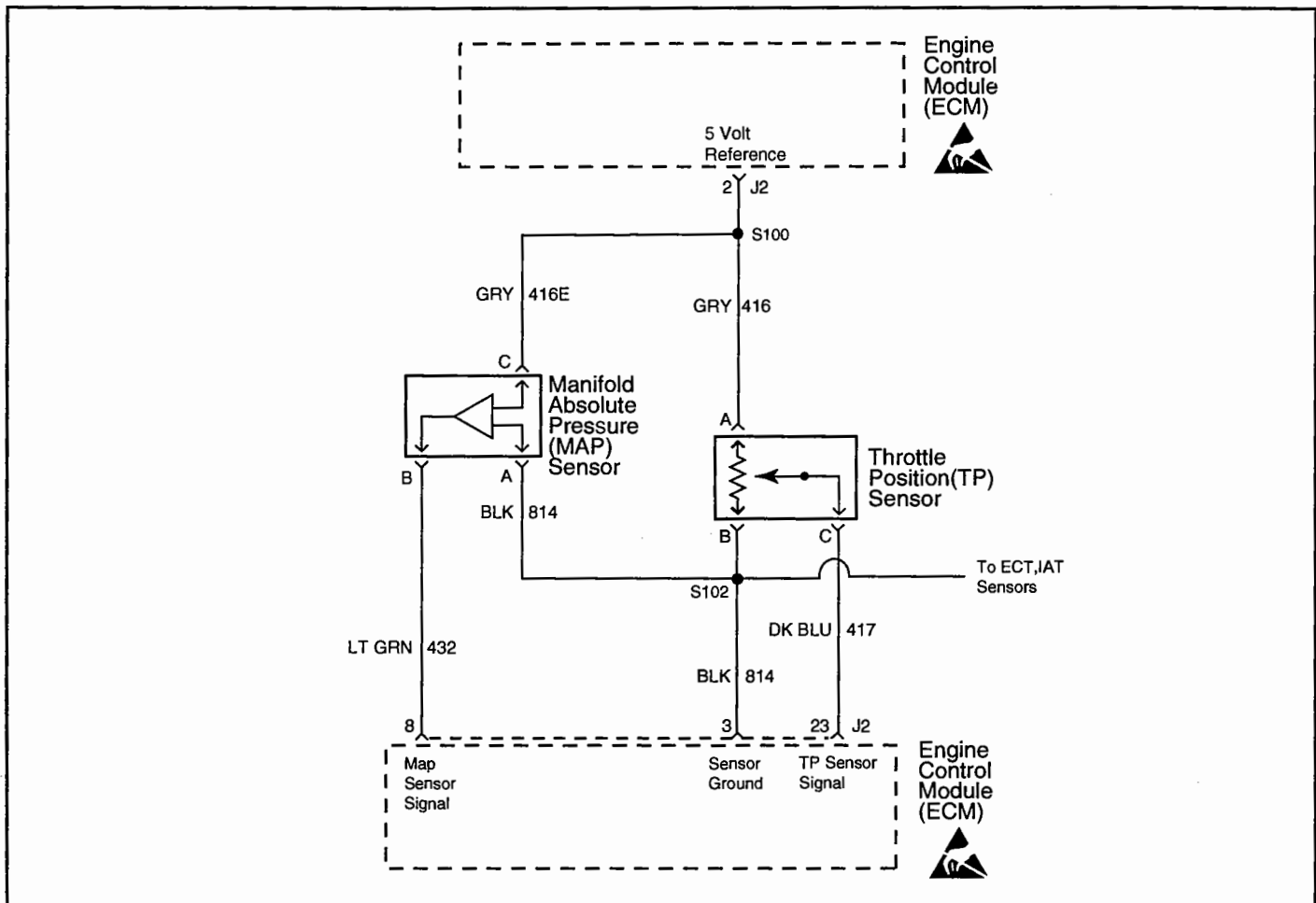
6. This step tests if a ground is constantly being applied to the fuel injector.

DTC 81 - Fuel Injector Driver B Circuit High, Low or Open (Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Disconnect the appropriate harness connectors of the four fuel injectors. 2. Turn ON the ignition, with the engine OFF. 3. Using a test lamp connected to a know good ground, probe the ignition voltage circuits of each fuel injector on the harness connector. Does the test lamp illuminate on all four circuits?	—	Go to Step 3	Go to Step 8
3	1. Connect the fuel injector test lamp J 34730-2C between the control circuit and the ignition voltage circuit of the fuel injector harness connector. Repeat for all four fuel injectors. 2. Start the engine. Does the test lamp blink on all four fuel injector harness connectors?	—	Go to Step 7	Go to Step 4
4	Does the test lamp remain illuminated at all times on any of the four fuel injector harness connectors?	—	Go to Step 6	Go to Step 5
5	Locate and repair an open or short to voltage in the fuel injector control circuit. Was a problem found?	—	Verify Repair	Go to Step 8
6	Locate and repair a short to ground in the fuel injector control circuit. Was a problem found?	—	Verify Repair	Go to Step 11
7	Locate and repair poor connections at the harness connector of the fuel injector. Was a problem found?	—	Verify Repair	Go to Step 10
8	Locate and repair poor connections at the harness connector of the ECM. Was a problem found?	—	Verify Repair	Go to Step 11
9	Important: The ECM/INJ fuse also supplies voltage to the ignition coils. If the fuse is open, inspect all related circuits for a short to ground. Repair an open or short to ground in the fuel injector ignition voltage circuit. Was a problem found?	—	Verify Repair	—

DTC 81 - Fuel Injector Driver B Circuit High, Low or Open (cont'd)
(Scan Diagnostics)

Step	Action	Value	Yes	No
10	Replace the fuel injector. Is action complete?	—	Verify Repair	—
11	Replace the ECM. Is action complete?	—	Verify Repair	—

MEFI4330
6-21-00

DTC 81 - 5 Volt Reference Circuit Out of Range (Scan Diagnostics)

Circuit Description

The Engine Control Module (ECM) uses a common 5 volt reference circuit as a sensor feed. This circuit supplies 5 volts to the Manifold Absolute Pressure (MAP) sensor and the Throttle Position (TP) sensor. The ECM monitors the voltage on the 5 volt reference circuit. This DTC sets if the voltage is out of range.

Diagnostic Aids

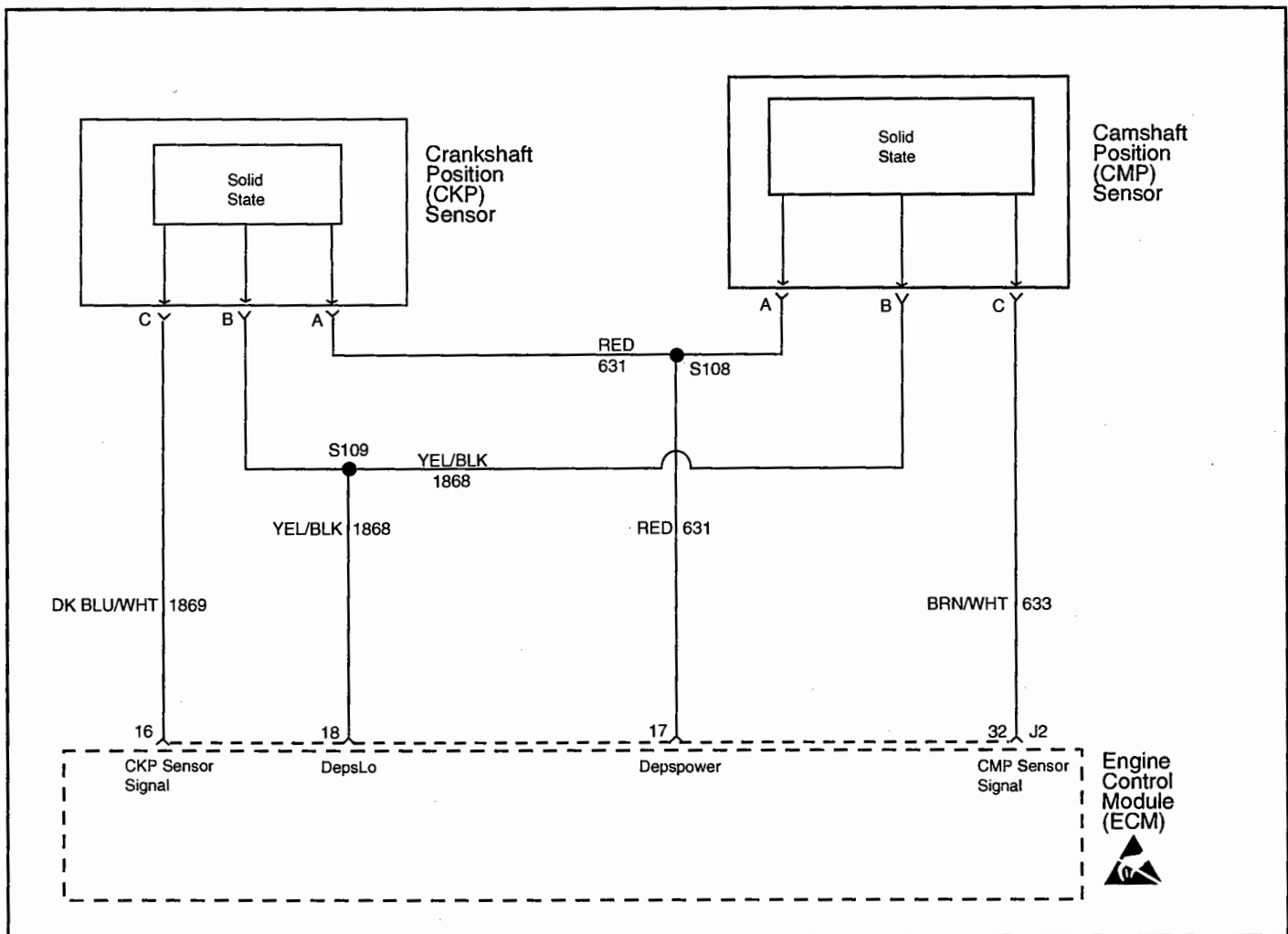
If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

Test Description

3. The 5 volt reference circuit may be shorted to another ECM circuit. The shorted circuit may not be apparent when the ECM harness connector is disconnected.

**DTC 81 - 5 Volt Reference Circuit Out of Range
(Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	<i>Go to Step 2</i>	<i>Go to OBD System Check</i>
2	1. Disconnect the ECM harness connector J2. 2. Turn ON the ignition, with the engine OFF. 3. Using a DMM connected to a known good ground, probe the other lead of the DMM to the 5 volt reference circuit (J2-2) at the ECM harness connector. Does the circuit measure more than the specified value?	5.1 V	<i>Go to Step 6</i>	<i>Go to Step 3</i>
3	Before proceeding, remove the following fuses: <ul style="list-style-type: none"> • ECM/BAT • INJ/ECM • MEFI System Relay 1. Disconnect the MAP sensor and the TP sensor harness connectors. 2. Using a DMM, test the continuity from the 5 volt reference circuit to all other ECM circuits at the ECM J2 harness connector. Do any of the circuits indicate a resistance within the specified range?	0-2 ohms	<i>Go to Step 7</i>	<i>Go to Step 9</i>
4	1. Turn OFF the ignition. 2. Disconnect the ECM connector J2. 3. Using a test lamp connected to B+, probe 5 volt reference circuit (J2-2) at the ECM harness connector. Does the test lamp illuminate?	—	<i>Go to Step 8</i>	<i>Go to Step 5</i>
5	Using a DMM, test the continuity from the 5 volt reference circuit to all other ECM circuits at the ECM J2 harness connector. Do any of the circuits indicate a resistance within the specified range?	0-2 ohms	<i>Go to Step 7</i>	<i>Go to Step 9</i>
6	Locate and repair a short to voltage on the 5 volt reference circuit. Is action complete?	—	Verify Repair	—
7	Locate and repair short between the 5 volt reference circuit and the ECM circuit that had continuity. Is action complete?	—	Verify Repair	—
8	Locate and repair short to ground on the 5 volt reference circuit. Is action complete?	—	Verify Repair	—
9	Replace the ECM. Is action complete?	—	Verify Repair	—

MEFI4331
6-21-00

DTC 81 - Depspower Circuit Out of Range (Scan Diagnostics)

Circuit Description

The Engine Control Module (ECM) uses a dedicated 5 volt reference circuit for the Crankshaft Position (CKP) sensor and the Camshaft Position (CMP) sensor. This circuit supplies 5 volts to only the CKP and the CMP sensor circuits. This circuit is referred to as Depspower. The ECM monitors the voltage on the Depspower circuit. This DTC sets if the voltage is out of range.

Diagnostic Aids

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

Test Description

3. The Depspower circuit may be shorted to another ECM circuit. The shorted circuit may not be apparent when the ECM harness connector is disconnected.

**DTC 81 - Depspower Circuit Out of Range
(Scan Diagnostics)**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Disconnect the ECM harness connector J2. 2. Turn ON the ignition, with the engine OFF. 3. Using a DMM connected to a known good ground, probe the other lead of the DMM to the Depspower circuit (J2-17) at the ECM harness connector. Does the circuit measure more than the specified value?	5.1 V	Go to Step 6	Go to Step 3
3	Before proceeding, remove the following fuses: • ECM/BAT • INJ/ECM • MEFI System Relay 1. Disconnect the CKP sensor and the CMP sensor harness connectors. 2. Using a DMM, test the continuity from the Depspower circuit to all other ECM circuits at the ECM J2 harness connector. Do any of the circuits indicate a resistance within the specified range?	0-2 ohms	Go to Step 7	Go to Step 9
4	1. Turn OFF the ignition. 2. Disconnect the ECM connector J2. 3. Using a test lamp connected to B+, probe Depspower circuit (J2-17) at the ECM harness connector. Does the test lamp illuminate?	—	Go to Step 8	Go to Step 5
5	Using a DMM, test the continuity from the Depspower circuit to all other ECM circuits at the ECM J2 harness connector. Do any of the circuits indicate a resistance within the specified range?	0-2 ohms	Go to Step 7	Go to Step 9
6	Locate and repair a short to voltage on the Depspower circuit. Is action complete?	—	Verify Repair	—
7	Locate and repair short between the Depspower circuit and the ECM circuit that had continuity. Is action complete?	—	Verify Repair	—
8	Locate and repair short to ground on the Depspower circuit. Is action complete?	—	Verify Repair	—
9	Replace the ECM. Is action complete?	—	Verify Repair	—

Symptoms - Engine Controls

Important Preliminary Checks Before Starting

Before using this section you should have performed the "On-Board Diagnostic (OBD) System Check" and determined that:

- The ECM and MIL (Malfunction Indicator Lamp) are operating correctly.
- There are no DTC(s) stored.
- Ensure that the engine is not in RPM reduction mode. The ECM turns certain injectors off when the ECM detects certain conditions such as engine over-temp.
- 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. 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. This check should include:

- ECM grounds and sensor connections for being clean, tight and in their proper location.
- Vacuum hoses for splits, kinks and proper connections. Check thoroughly for any type of leak or restriction.
- Air leaks at throttle body mounting area and intake manifold sealing surfaces.
- Ignition wires for cracking, hardness, proper routing and carbon tracking.
- Wiring for proper connections, pinches and cuts.
- Moisture in primary or secondary ignition circuit connections.
- Corrosion on electrical connections and exposed throttle body linkages.

Intermittents

Important: Check for improper installation of electrical components if an intermittent condition exists. Inspect for aftermarket theft deterrent devices, lights, cellular phones, etc. If you cannot locate an intermittent condition, a cellular phone signal communication may cause the condition.

Important: Problem may or may not turn "ON" the Malfunction Indicator Lamp (MIL) or store a DTC. DO NOT use the Diagnostic Trouble Code (DTC) tables for intermittent problems. The fault must be present to locate the problem.

Most intermittent problems are caused by faulty electrical connections or wiring. Perform careful visual/physical check. Check for the following conditions:

- Poor mating of the connector halves, or a terminal not fully seated in the connector body (backed out or loose).
- Improperly formed or damaged terminals and/or connectors.

- All connector terminals in the problem circuit should be carefully checked for proper contact tension.
- Poor terminal to wire connection (crimping). This requires removing the terminal from the connector body to check. Refer to "Wiring Harness Service" in the *General Information* section.

The vehicle may be driven with a J 39200 Digital Multimeter connected to a suspected circuit. An abnormal voltage when malfunction occurs is a good indication that there is a fault in the circuit being monitored.

A scan tool may also be used to help detect intermittent conditions. The Snapshot feature (if applicable) can be triggered to capture and store engine parameters within the scan tool when the malfunction occurs. This stored information then can be reviewed by the service technician to see what caused the malfunction.

To check loss of DTC memory, disconnect TP sensor and idle engine until the MIL comes "ON." DTC 22 should be stored and kept in memory when ignition is turned "OFF." If not the ECM is faulty. When this test is completed, make sure that you clear the DTC 22 from memory using "Clearing DTC Procedure."

An intermittent MIL with no stored DTC may be caused by the following:

- Ignition coil shorted to ground and arcing at ignition wires or plugs.
- MIL wire to ECM shorted to ground.
- Poor ECM grounds.
- Check for an electrical system interference caused by 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, radios, etc.
- Check that knock sensor wire(s) are routed away from spark plug wires, ignition system components and charging system components.
- Check for secondary ignition components shorted to ground, or an open ignition coil ground (coil mounting brackets).
- Check for components internally shorted to ground such as starters, alternators or relays.

All Ignition Coil wiring should kept away from the alternator. Check all wires from the ECM to the ignition coils for poor connections.

If problem has not been found go to "ECM Connector Symptom Tables" at the end of *Symptoms* section.

Hard Start Symptom

Checks	Action
Definition: Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.	
Preliminary	<ul style="list-style-type: none"> • Refer to Important Preliminary Checks Before Starting in <i>Symptoms - Engine Controls</i>. • Check the ECM grounds for being clean, tight and in the proper locations. • Search for bulletins.
Sensor/System	<ul style="list-style-type: none"> • Check the engine coolant temperature (ECT) sensor for being shifted in value. Connect a scan tool. Compare the engine coolant temperature against the intake air temperature (IAT) on a cold engine. The ECT and IAT sensor values should be within 3 C (5 F) of each other. If the ECT sensor is out of range with the IAT sensor, check the resistance of the ECT sensor. Replace the ECT sensor if the resistance is not within specification. If the sensor is within specification, repair the ECT signal circuit for high resistance. • Check the camshaft position (CMP) sensor for proper mounting and/or a bad connection. A long crank time occurs if the ECM does not receive a CMP signal.
Fuel System	<ul style="list-style-type: none"> • Check the fuel pump relay operation. The fuel pump should turn ON for 2 seconds when you turn ON the ignition. • A faulty fuel pump check valve allows the fuel in the lines to drain back to the tank after the engine stops. • Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition.
Ignition System	<ul style="list-style-type: none"> • Check for proper ignition voltage output per manufacturers recommendations. • Remove the spark plugs and check for the following: <ul style="list-style-type: none"> – Correct heat range – Wet plugs – Cracks – Wear – Improper gap – Burned electrodes – Heavy deposits • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds.
Engine Mechanical	<ul style="list-style-type: none"> • Excessive oil in combustion chamber - Leaking valve seals. • Low cylinder compression • Combustion chambers for excessive carbon buildup. Clean the chambers using top engine cleaner. Follow the instructions on the can. • Inspect the following components for incorrect basic engine parts: <ul style="list-style-type: none"> – Cylinder Heads – Camshaft – Pistons, etc. <p>Refer to the appropriate procedures in Engine Mechanical.</p>

Surges/Chuggles Symptom

Checks	Action
Definition: Engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and slows down with no change in the accelerator pedal position.	
Preliminary	<ul style="list-style-type: none"> • Refer to Important Preliminary Checks Before Starting in <i>Symptoms - Engine Controls</i>. • Check the ECM grounds for being clean, tight and in the proper locations. • Search for bulletins.
Sensor/System	<ul style="list-style-type: none"> • Check the heated oxygen sensors (HO2s). The HO2s should respond quickly to different throttle positions. If they do not, check the HO2s for silicon or other contaminants from fuel or the use of improper RTV sealant. The sensors may have a white powdery coating and result in a high but false rich exhaust indication. The ECM will then reduce the amount of fuel delivered to the engine causing a severe drivability problem.
Fuel System	<ul style="list-style-type: none"> • Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check that each injector harness is connected to the correct injector or cylinder according to the firing order. • Check the items that cause an engine to run rich long term. • Check the items that cause an engine to run lean long term.
Ignition System	<ul style="list-style-type: none"> • Wet down the secondary ignition system with water from a spray bottle. Wetting down the secondary ignition system may help locate damaged or deteriorated components. Look and listen for arcing or misfiring as you apply the water. • Check for proper ignition voltage output per manufacturers recommendations. • Remove the spark plugs and check for the following: <ul style="list-style-type: none"> – Correct heat range – Wet plugs – Cracks – Wear – Improper gap – Burned electrodes – Heavy deposits • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds.
Engine Mechanical	<ul style="list-style-type: none"> • Ensure that the engine is not overheating, causing the engine to go into RPM reduction mode.
Additional Checks	<ul style="list-style-type: none"> • Visually (physically) check vacuum hoses for splits, kinks and proper connections and routing.

Lack of Power, Sluggishness or Sponginess Symptom

Checks	Action
Definition: Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.	
Preliminary	<ul style="list-style-type: none"> • Refer to Important Preliminary Checks Before Starting in <i>Symptoms - Engine Controls</i>. • Check the ECM grounds for being clean, tight and in the proper locations. • Search for bulletins. • Remove the spark arrestor/air filter element and check for dirt or for being restricted.
Sensor/System	<ul style="list-style-type: none"> • Ensure that the engine is not going into RPM reduction mode. • Use a scan tool in order to monitor the knock sensor system for excessive spark retard activity.
Fuel System	<ul style="list-style-type: none"> • Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check the fuel injectors. Refer to <i>Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35 degrees C (50-95 Degrees F)</i>. • Check the items that cause an engine to run rich long term. • Check the items that cause an engine to run lean long term.
Ignition System	<ul style="list-style-type: none"> • Wet down the secondary ignition system with water from a spray bottle. Wetting down the secondary ignition system may help locate damaged or deteriorated components. Look and listen for arcing or misfiring as you apply the water. • Check for proper ignition voltage output per manufacturers recommendations. • Remove the spark plugs and check for the following: <ul style="list-style-type: none"> – Correct heat range – Wet plugs – Cracks – Wear – Improper gap – Burned electrodes – Heavy deposits • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds.
Engine Mechanical	<ul style="list-style-type: none"> • Excessive oil in combustion chamber - Leaking valve seals. • Low cylinder compression • Combustion chambers for excessive carbon buildup. Clean the chambers using top engine cleaner. Follow the instructions on the can. • Inspect the following components for incorrect basic engine parts: <ul style="list-style-type: none"> – Cylinder Heads – Camshaft – Pistons, etc. <p>Refer to the appropriate procedures in Engine Mechanical.</p>
Additional Checks	<ul style="list-style-type: none"> • Inspect the exhaust system for possible restrictions.

Detonation/Spark Knock Symptom

Checks	Action
Definition: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening.	
Preliminary	<ul style="list-style-type: none"> • Refer to Important Preliminary Checks Before Starting in <i>Symptoms - Engine Controls</i>. • Check the ECM grounds for being clean, tight and in the proper locations. • Search for bulletins. • If the scan tool readings are normal, refer to supporting text of the Engine Controls Diagnostic Check, and there are no engine mechanical faults, fill the fuel tank with a known high quality fuel that meets the vehicles minimum octane requirements. Refer to <i>Fuel System Specifications</i>. Road test vehicle and re-evaluate the vehicles performance.
Fuel System	<ul style="list-style-type: none"> • Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check the items that cause an engine to run lean long term.
Ignition System	<ul style="list-style-type: none"> • Check the spark plugs for being the proper heat range.
Engine Cooling System	<ul style="list-style-type: none"> • Check for obvious overheating problems. <ul style="list-style-type: none"> – Low engine coolant – Restricted air flow to the radiator – Insufficient coolant flow through the radiator – Wrong or stuck thermostat – Inoperative cooling fan
Engine Mechanical	<ul style="list-style-type: none"> • Excessive oil in combustion chamber - Leaking valve seals. • Low cylinder compression • Combustion chambers for excessive carbon buildup. Clean the chambers using top engine cleaner. Follow the instructions on the can. • Inspect the following components for incorrect basic engine parts: <ul style="list-style-type: none"> – Cylinder Heads – Camshaft – Pistons, etc. <p>Refer to the appropriate procedures in Engine Mechanical.</p>

Hesitation, Sag or Stumble Symptom

Checks	Action
<p>Definition: Momentary lack of response as the accelerator is pushed down. Can occur at any vehicle speed. Usually more pronounced when first trying to make the vehicle move, as from a stop. May cause the engine to stall if severe enough.</p>	
<p>Preliminary</p>	<ul style="list-style-type: none"> • Refer to Important Preliminary Checks Before Starting in <i>Symptoms - Engine Controls</i>. • Check the ECM grounds for being clean, tight and in the proper locations. • Search for bulletins.
<p>Sensor/System</p>	<ul style="list-style-type: none"> • Check the MAP sensor operation. • Check the TP sensor operation.
<p>Fuel System</p>	<ul style="list-style-type: none"> • Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check the fuel injectors. Refer to <i>Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35 degrees C (50-95 Degrees F)</i>. • Check the items that cause an engine to run rich long term. • Check the items that cause an engine to run lean long term.
<p>Ignition System</p>	<ul style="list-style-type: none"> • Wet down the secondary ignition system with water from a spray bottle. Wetting down the secondary ignition system may help locate damaged or deteriorated components. Look and listen for arcing or misfiring as you apply the water. • Check for proper ignition voltage output per manufacturers recommendations. • Remove the spark plugs and check for the following: <ul style="list-style-type: none"> – Correct heat range – Wet plugs – Cracks – Wear – Improper gap – Burned electrodes – Heavy deposits • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds.
<p>Engine Cooling System</p>	<ul style="list-style-type: none"> • Check the engine thermostat for proper operation and heat range.
<p>Additional Checks</p>	<ul style="list-style-type: none"> • Check the alternator output voltage. Repair the charging system if the alternator output voltage is less than 10 volts or more than 16 volts.

Cuts Out, Misses Symptom

Checks	Action
Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases. This condition is not normally felt above 1,500 RPM. The exhaust has a steady spitting sound at idle or low speed.	
Preliminary	<ul style="list-style-type: none"> • Refer to Important Preliminary Checks Before Starting in <i>Symptoms - Engine Controls</i>. • Check the ECM grounds for being clean, tight and in the proper locations. • Search for bulletins. • Remove the flame arrestor/air filter element and check for dirt or for being restricted.
Fuel System	<ul style="list-style-type: none"> • Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check the items that cause an engine to run rich long term. • Check the items that cause an engine to run lean long term.
Sensor System	<ul style="list-style-type: none"> • Use a scan to in order to monitor the knock sensor system for excessive spark retard activity.
Ignition System	<ul style="list-style-type: none"> • Wet down the secondary ignition system with water from a spray bottle. Wetting down the secondary ignition system may help locate damaged or deteriorated components. Look and listen for arcing or misfiring as you apply the water. • Check for proper ignition voltage output per manufacturers recommendations. • Remove the spark plugs and check for the following: <ul style="list-style-type: none"> – Correct heat range – Wet plugs – Cracks – Wear – Improper gap – Burned electrodes – Heavy deposits • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds. • Visually and physically inspect the secondary ignition for the following: <ul style="list-style-type: none"> – Ignition wires arcing to ground – Ignition wires for proper engagement to spark plug and coil – Ignition coils for cracks or carbon tracking
Engine Mechanical	<ul style="list-style-type: none"> • Check engine mechanical for the following: <ul style="list-style-type: none"> – Low compression – Sticking or leaking valves – Worn camshaft lobes – Valve timing – Bent push rods – Worn rocker arms – Broken Valve Springs – Excessive oil in the combustion chamber - Leaking valve seals.

Cuts Out, Misses Symptom (cont'd)

Checks	Action
Engine Mechanical (cont'd)	<ul style="list-style-type: none"> • Inspect the following components for incorrect basic engine parts: <ul style="list-style-type: none"> – Camshaft – Cylinder heads – Pistons, etc. <p>Refer to the appropriate procedures in Engine Mechanical.</p>
Additional Checks	<ul style="list-style-type: none"> • Inspect the exhaust system for possible restriction. • Electromagnetic interference (EMI) on the reference circuit can cause an engine miss condition. A sudden increase in indicated RPM with little change in actual engine RPM change indicates EMI is present. Check for high voltage components near ignition control circuits if a problem exists. • Check the intake manifold and the exhaust manifold passages for casting flash.

Poor Fuel Economy Symptom

Checks	Action
<p>Definition: Fuel economy, as measured by actual fuel used, is noticeably lower than expected. Also, fuel economy is noticeably lower than it was on this vehicle at one time, as previously shown by actual measurement.</p>	
Preliminary	<ul style="list-style-type: none"> • Refer to Important Preliminary Checks Before Starting in <i>Symptoms - Engine Controls</i>. • Check the ECM grounds for being clean, tight and in the proper locations. • Search for bulletins. • Check the owners driving habits. <ul style="list-style-type: none"> – Is there excessively heavy loads being carried? – Is the acceleration rate too much, too often? – Remove the flame arrestor/air filter element and check for dirt or for being restricted.
Fuel System	<ul style="list-style-type: none"> • Check the type, quality and alcohol content of the fuel. Oxygenated fuels have lower energy and may deliver reduced fuel economy. • Check the fuel injectors. Refer to <i>Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35 degrees C (50-95 Degrees F)</i>. • Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check that each injector harness is connected to the correct injector and cylinder. • Check for foreign material accumulation in the throttle bore, coking on the throttle valve or on the throttle shaft. Also check for throttle body tampering. • Check the items that cause an engine to run rich long term.
Sensor System	<ul style="list-style-type: none"> • Check the air intake system and crankcase for air leaks. • Check the crankcase ventilation valve for proper operation. Place a finger over the inlet hole in the valve end several times. The valve should snap back. If not, replace valve. • Use a scan tool in order to monitor the knock sensor (KS) system for excessive spark retard activity.

Poor Fuel Economy Symptom (cont'd)

Checks	Action
Ignition System	<ul style="list-style-type: none"> • Wet down the secondary ignition system with water from a spray bottle. Wetting down the secondary ignition system may help locate damaged or deteriorated components. Look and listen for arcing or misfiring as you apply the water. • Check for proper ignition voltage output per manufacturers recommendations. • Remove the spark plugs and check for the following: <ul style="list-style-type: none"> – Correct heat range – Wet plugs – Cracks – Wear – Improper gap – Burned electrodes – Heavy deposits • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds. • Visually and physically inspect the secondary ignition for the following: <ul style="list-style-type: none"> – Ignition wires arcing to ground – Ignition wires for proper engagement to spark plug and coil – Ignition coils for cracks or carbon tracking
Engine Cooling System	<ul style="list-style-type: none"> • Check for engine coolant level for being low. • Check the engine thermostat for proper operation and for the correct heat range.
Engine Mechanical	<ul style="list-style-type: none"> • Check engine mechanical for the following: <ul style="list-style-type: none"> – Low compression – Sticking or leaking valves – Worn camshaft lobes – Valve timing – Bent push rods – Worn rocker arms – Broken Valve Springs – Excessive oil in the combustion chamber - Leaking valve seals. • Inspect the following components for incorrect basic engine parts: <ul style="list-style-type: none"> – Camshaft – Cylinder heads – Pistons, etc. <p>Refer to the appropriate procedures in Engine Mechanical.</p>
Additional Checks	<ul style="list-style-type: none"> • Inspect the exhaust system for possible restriction. • Electromagnetic interference (EMI) on the reference circuit can cause an engine miss condition. A sudden increase in indicated RPM with little change in actual engine RPM change indicates EMI is present. Check for high voltage components near ignition control circuits if a problem exists.

Poor Fuel Economy Symptom (cont'd)

Checks	Action
Additional Checks (cont'd)	<ul style="list-style-type: none"> • Check the intake manifold and the exhaust manifold passages for casting flash. • Check for excessive drag on the vehicle.

Rough, Unstable or Incorrect Idle and Stalling Symptom

Checks	Action
<p>Definition: Engine runs unevenly at idle. If severe, the engine or vehicle may shake. Engine idle speed may vary in RPM. Either condition may be severe enough to stall the engine.</p>	
Preliminary	<ul style="list-style-type: none"> • Refer to Important Preliminary Checks Before Starting in <i>Symptoms - Engine Controls</i>. • Check the ECM grounds for being clean, tight and in the proper locations. • Search for bulletins. • Remove the flame arrestor/air filter element and check for dirt or for being restricted.
Fuel System	<ul style="list-style-type: none"> • Check the fuel injectors. Refer to <i>Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35 degrees C (50-95 Degrees F)</i>. • Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check that each injector harness is connected to the correct injector and cylinder. • Check for foreign material accumulation in the throttle bore, coking on the throttle valve or on the throttle shaft. Also check for throttle body tampering. • Check the items that cause an engine to run rich long term. • Check the items that cause an engine to run lean long term.
Sensor System	<ul style="list-style-type: none"> • Check the air intake system and crankcase for air leaks. • Check the crankcase ventilation valve for proper operation. Place a finger over the inlet hole in the valve end several times. The valve should snap back. If not, replace valve. • Check the idle air control (IAC) valve for proper operation. • Use a scan tool in order to monitor the knock sensor (KS) system for excessive spark retard activity.
Ignition System	<ul style="list-style-type: none"> • Wet down the secondary ignition system with water from a spray bottle. Wetting down the secondary ignition system may help locate damaged or deteriorated components. Look and listen for arcing or misfiring as you apply the water. • Check for proper ignition voltage output per manufacturers recommendations. • Remove the spark plugs and check for the following: <ul style="list-style-type: none"> – Correct heat range – Wet plugs – Cracks – Wear – Improper gap

Rough, Unstable or Incorrect Idle and Stalling Symptom (cont'd)

Checks	Action
Ignition System	<ul style="list-style-type: none"> - Burned electrodes - Heavy deposits • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds. • Visually and physically inspect the secondary ignition for the following: <ul style="list-style-type: none"> - Ignition wires arcing to ground - Ignition wires for proper engagement to spark plug and coil - Ignition coils for cracks or carbon tracking
Engine Mechanical	<ul style="list-style-type: none"> • Check engine mechanical for the following: <ul style="list-style-type: none"> - Low compression - Sticking or leaking valves - Worn camshaft lobes - Valve timing - Bent push rods - Worn rocker arms - Broken Valve Springs - Excessive oil in the combustion chamber - Leaking valve seals. • Inspect the following components for incorrect basic engine parts: <ul style="list-style-type: none"> - Camshaft - Cylinder heads - Pistons, etc. <p>Refer to the appropriate procedures in Engine Mechanical.</p>
Additional Checks	<ul style="list-style-type: none"> • Inspect the exhaust system for possible restriction. • Electromagnetic interference (EMI) on the reference circuit can cause an engine miss condition. A sudden increase in indicated RPM with little change in actual engine RPM change indicates EMI is present. Check for high voltage components near ignition control circuits if a problem exists. • Check for faulty motor mounts. • Check the intake manifold and the exhaust manifold passages for casting flash. • Check for an exhaust gas recirculation (EGR) valve stuck open or EGR pintle not seating properly. Inspect EGR valve gasket for leaks.

Dieseling, Run-On Symptom

Checks	Action
Definition: Engine continues to run after key is turned OFF, but runs very rough. If the engine runs smooth, check the ignition switch and the ignition switch adjustment.	
Preliminary	<ul style="list-style-type: none"> • Refer to Important Preliminary Checks Before Starting in <i>Symptoms - Engine Controls</i>. • Check the ECM grounds for being clean, tight and in the proper locations. • Search for bulletins.
Fuel System	<ul style="list-style-type: none"> • Inspect the injectors for a leaking condition.

Backfire Symptom

Checks	Action
Definition: Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.	
Preliminary	<ul style="list-style-type: none"> • Refer to Important Preliminary Checks Before Starting in <i>Symptoms - Engine Controls</i>. • Check the ECM grounds for being clean, tight and in the proper locations. • Search for bulletins.
Fuel System	<ul style="list-style-type: none"> • Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check the fuel injectors. Refer to <i>Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35 degrees C (50-95 Degrees F)</i>. • Check that each injector harness is connected to the correct injector and cylinder.
Sensor System	<ul style="list-style-type: none"> • Check the air intake system and crankcase for air leaks. • Check the crankcase ventilation valve for proper operation. Place a finger over the inlet hole in the valve end several times. The valve should snap back. If not, replace the valve. • Use a scan to in order to monitor the knock sensor system for excessive spark retard activity.
Ignition System	<ul style="list-style-type: none"> • Wet down the secondary ignition system with water from a spray bottle. Wetting down the secondary ignition system may help locate damaged or deteriorated components. Look and listen for arcing or misfiring as you apply the water. • Check for proper ignition voltage output per manufacturers recommendations. • Remove the spark plugs and check for the following: <ul style="list-style-type: none"> – Correct heat range – Wet plugs – Cracks – Wear – Improper gap – Burned electrodes – Heavy deposits • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds. • Visually and physically inspect the secondary ignition for the following: <ul style="list-style-type: none"> – Ignition wires arcing to ground – Ignition wires for proper routing – Ignition coils for cracks or carbon tracking
Engine Cooling System	<ul style="list-style-type: none"> • Check the engine coolant level for being low. • Check the engine thermostat for proper operation and for the correct heat range.

Backfire Symptom (cont'd)

Checks	Action
Engine Mechanical	<ul style="list-style-type: none"> • Check engine mechanical for the following: <ul style="list-style-type: none"> – Low compression – Sticking or leaking valves – Worn camshaft lobes – Valve timing – Bent push rods – Worn rocker arms – Broken Valve Springs – Excessive oil in the combustion chamber - Leaking valve seals. • Inspect the following components for incorrect basic engine parts: <ul style="list-style-type: none"> – Camshaft – Cylinder heads – Pistons, etc. <p>Refer to the appropriate procedures in Engine Mechanical.</p>
Additional Checks	<ul style="list-style-type: none"> • Inspect the exhaust system for possible restriction. • Electromagnetic interference (EMI) on the reference circuit can cause an engine miss condition. A sudden increase in indicated RPM with little change in actual engine RPM change indicates EMI is present. Check for high voltage components near ignition control circuits if a problem exists. • Check for faulty motor mounts. • Check the intake manifold and the exhaust manifold passages for casting flash. • Visually and physically check the vacuum hoses for splits, kinks and proper connections and routing.

Repair Instructions

Wiring Harness Service

Wiring harnesses should be replaced with proper part number harnesses. When wires are spliced into a harness, use the same gauge wire with high temperature insulation only.

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 in Figure 1-4.

Use care when probing a connector or replacing a connector terminal. It is possible to short between opposite terminals. If this happens, certain components can be damaged. Always use jumper wires with the corresponding mating terminals between connectors for circuit checking. **NEVER** probe through connector seals, wire insulation, secondary ignition wires, boots, nipples or covers. Microscopic damage or holes may result in water intrusion, corrosion and/or component failure.

DRAIN WIRE

OUTER JACKET

MYLAR

- 1 REMOVE OUTER JACKET.
- 2 UNWRAP ALUMINUM/MYLAR TAPE. DO NOT REMOVE MYLAR.

- 1 LOCATE DAMAGED WIRE.
- 2 REMOVE INSULATION AS REQUIRED.

- 3 UNTWIST CONDUCTORS. STRIP INSULATION AS NECESSARY.
- 3 SPLICE TWO WIRES TOGETHER USING SPLICE CLIPS AND ROSIN CORE SOLDER.

DRAIN WIRE

- 4 SPLICE WIRES USING SPLICE CLIPS AND ROSIN CORE SOLDER. WRAP EACH SPLICE TO INSULATE.
- 4 COVER SPLICE WITH TAPE TO INSULATE FROM OTHER WIRES.
- 5 WRAP WITH MYLAR AND DRAIN (UNINSULATED) WIRE.
- 5 RETWIST AS BEFORE AND TAPE WITH ELECTRICAL TAPE AND HOLD IN PLACE.

- 6 TAPE OVER WHOLE BUNDLE TO SECURE AS BEFORE.

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Wiring Harness Repair

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 sensors 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. Some connectors look similar but are serviced differently. Replacement connectors and terminals are listed in the parts catalog.

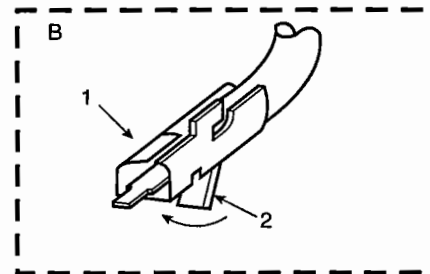
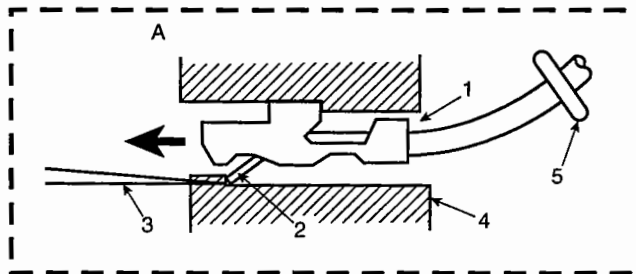
Metri-Pack Series 150 Terminals

Some ECM harness connectors contain terminals called Metri-Pack. These are used at some of the sensors and the distributor connector.

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 and connector. The terminal is then crimped on the wire, and the terminal is 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 J 35689 or equivalent to release the terminal locking tang.
3. Push the wire and terminal out through the connector. If the terminal is being reused, reshape the locking tang.



1. METRI-PACK SERIES 150 FEMALE TERMINAL.
2. LOCKING TANG.

3. TOOL J35689 OR BT-8446.
4. CONNECTOR BODY.
5. SEAL.

RS 22187

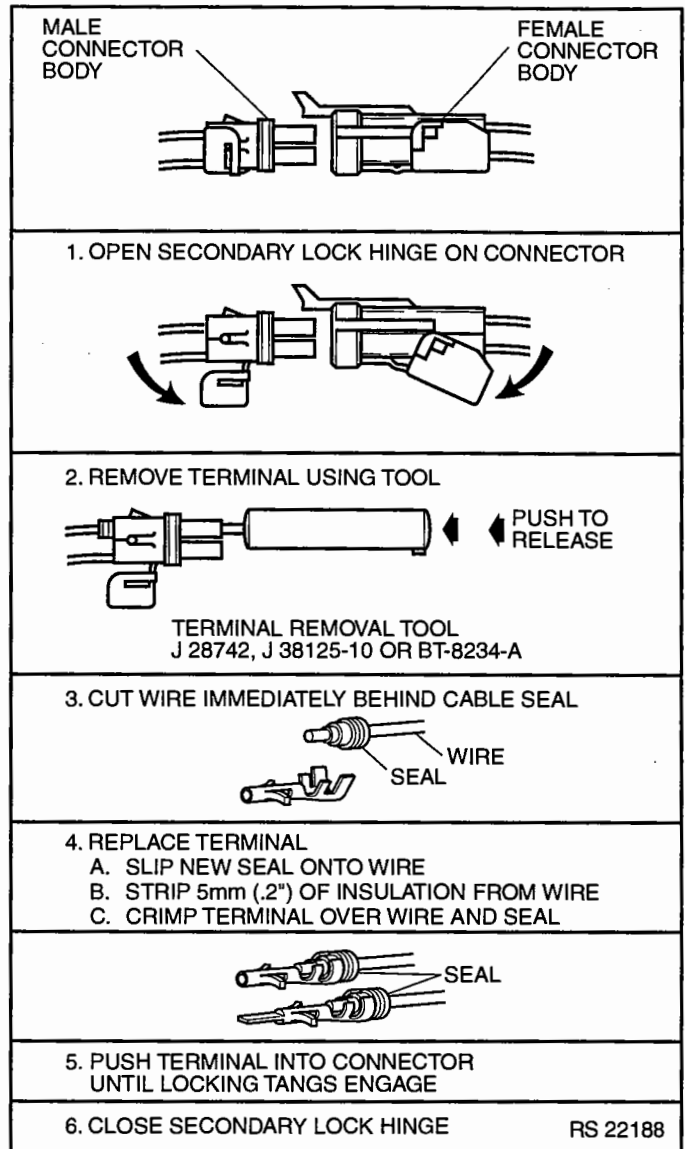
Metri-Pack Series 150 Terminal Removal

Weather-Pack Connectors

This figure shows a Weather-Pack connector and the tool (J 28742 or equivalent) required to service it. This tool is used to remove the pin and sleeve terminals. If terminal removal is attempted without using the special tool required, 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.



Weather-Pack Terminal Repair

Micro-Pack 100/W Series Connectors

The harness connectors used with the ECM "J1" and "J2" connectors are Micro-Pack 100/W Series. It is used for its ruggedized construction, capable of carrying more current and provides good sealing ability. The connector is made up of five different parts : Strain Relief (1), Seal (2), Connector (3), Index Cover (4) and Terminals (not shown).

Remove or Disconnect

1. Negative battery cable.
2. Connector from ECM by lifting up locking tab with thumb and pulling on connector body.

Inspect

- Check strain relief for being cracked or locking tab damaged.
- Check index cover for being cracked.
- Check seal for being torn, twisted or out of shape from improper installation.
- Check terminals for being corroded, out of position, bent or stretched out.
 - Use a wire gauge .038 for checking terminal internal fit. Wire gauge should slide with smooth feel and not be loose.

Notice: If you are only going to clean terminals, complete disassembly is not necessary. Remove index cover from the connector by pushing on Tab C on both sides and sliding off cover. Care must be taken not to move terminals out of their position. The index cover locks the terminals in position. If repair or replacement of parts is needed, DO NOT remove index cover at this time.

3. With a small screwdriver, move Tabs A on strain relief (1) to unlock position.
4. Open strain relief as shown in View B.
5. Release Tabs B (View C) on connector (3) by pushing inward with both thumbs or small screwdriver.
6. Push Tabs B through strain relief (1) with thumbs or small screwdriver while in released position.

Important

- Where there are not wires in strain relief, small plugs are installed. DO NOT lose the plugs, they are important to help keep connector assembly sealed.
7. Remove plugs where there are not any wires.
 8. Slide strain relief off of seal and back on wires.
 9. Slide seal off of connector and back on wires.

Important

- To insure proper engine operation after repair of connector assembly, wires must be in proper connector location. Before removing index cover, note if there are any wires of the same color. Mark these wires from the location that they were removed. The strain relief is

numbered for identifying wire location.

10. Index cover (4) by pushing in on Tabs C with a small screwdriver.
11. Terminals by pulling out of connector.
12. Seal (2) from wires.
13. Strain relief (1) from wires.

Clean and Inspect

- Terminals for corrosion.
 - Use spray electrical contact cleaner.
- Loose crimps on terminals.
- Broken wires at terminals.

Notice: For terminal replacement, refer to instructions found with terminal repair kit and crimper tool.

Install or Connect

1. Align index cover (4) on connector (3) and lock into position. Make sure Tabs C are locked.
2. Align seal (2) on connector (3) and slide all the way on.
 - DO NOT install strain relief (1) onto connector (3) yet.
3. One wire with terminal installed, through strain relief (1) in location that it was removed.
 - Start with the lowest numbered wire position for that connector.
4. Terminal through seal (2), connector (3) and into index cover (4) until it locks in place.
5. Remaining wires one at a time per same method.
 - Keep wires straight.
 - DO NOT kink wires.
6. Strain relief (1) onto seal (2) and connector (3).
7. Lock Tabs B into strain relief (1).
8. Plugs into strain relief (1) where there are not any wires.
9. Fold strain relief (1) together and lock Tabs A.
10. Connector assembly to ECM.
11. Negative battery cable.

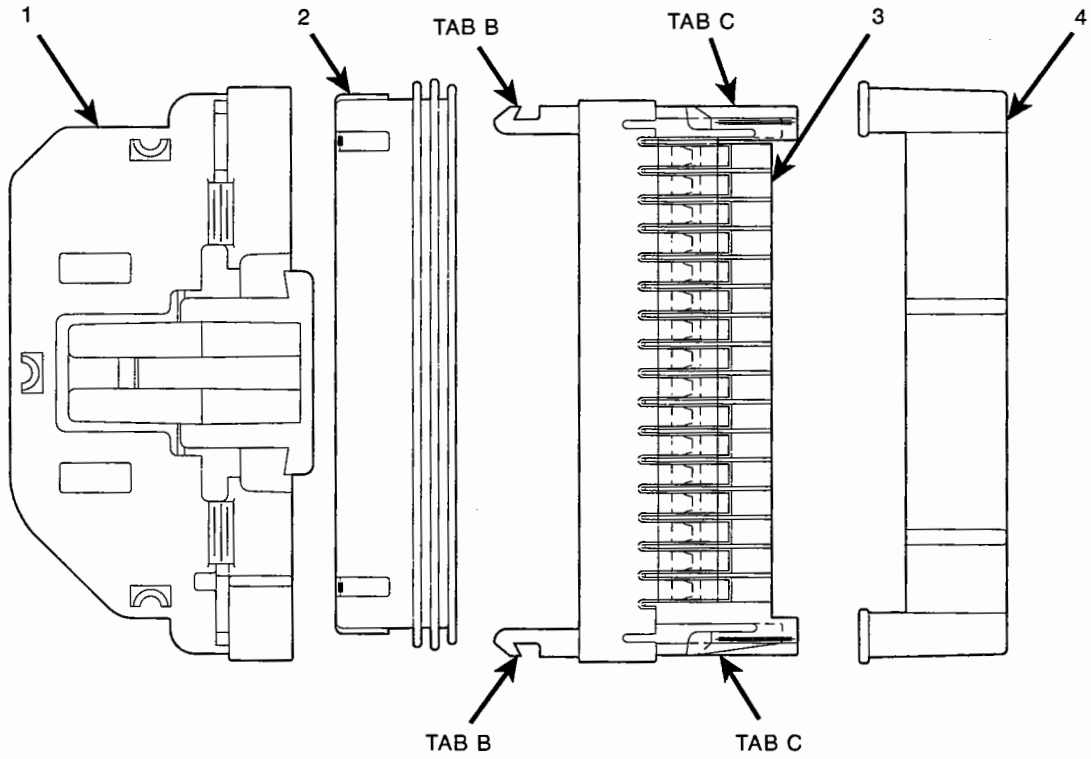


FIGURE A - EXPLODED VIEW OF CONNECTOR ASSEMBLY

- | | |
|-----------------|---------------|
| 1 STRAIN RELIEF | 3 CONNECTOR |
| 2 SEAL | 4 INDEX COVER |

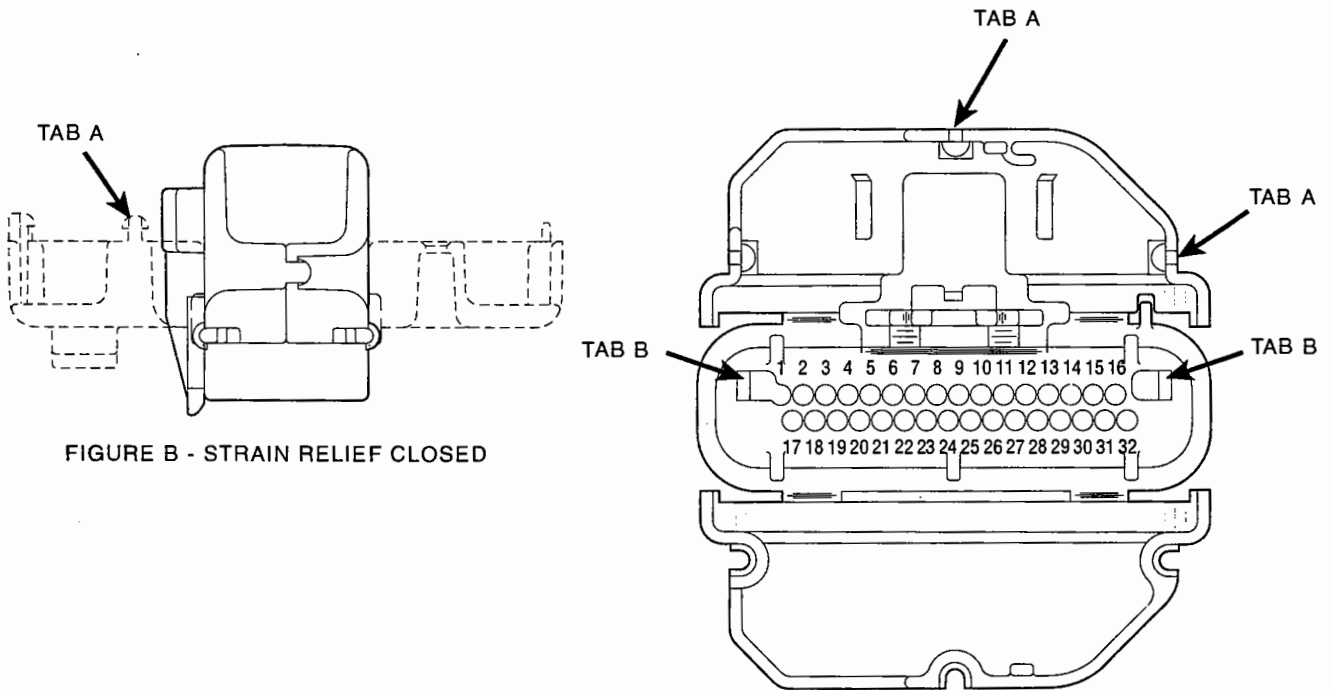
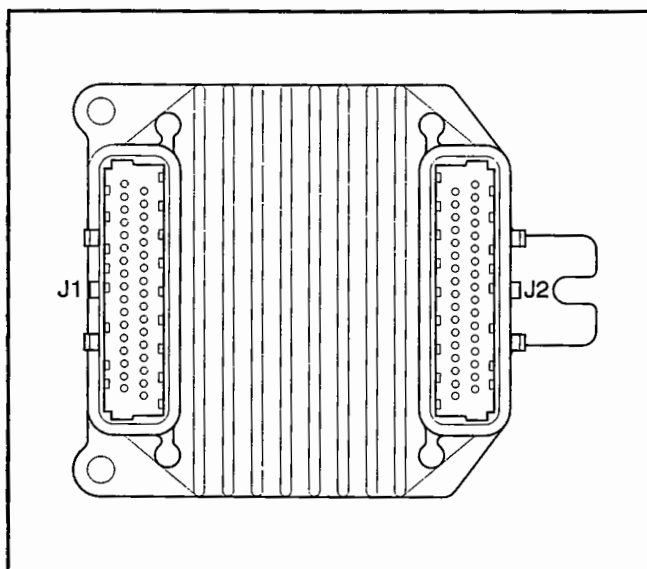


FIGURE B - STRAIN RELIEF CLOSED

FIGURE C - STRAIN RELIEF OPENED

PS 19745

Micro-Pack 100/W Series



mefi4332

Engine Control Module (ECM) Replacement

Notice: When replacing the ECM, the ignition must be "OFF" and disconnect the battery before disconnecting or reconnecting the ECM "J1" and "J2" connectors to prevent internal damage to the ECM.

Notice: To prevent possible electrostatic discharge damage to the ECM, do not touch the connector pins. The ECM is an electrical component. Do Not soak in any liquid cleaner or solvent, as damage may result.

Removal Procedure

1. Disconnect the negative battery cable.
2. Disconnect the "J1" and "J2" connectors from ECM.
3. Remove the three ECM mounting screws.
4. Remove the ECM from mounting bracket.

Installation Procedure

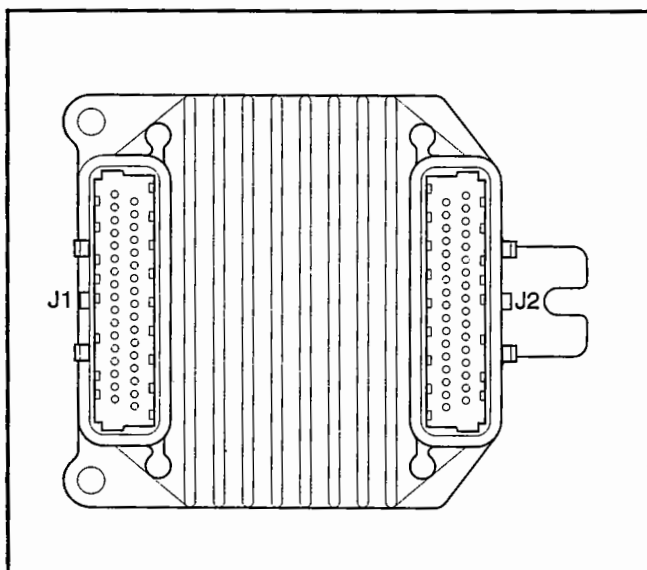
Important: Make sure the new ECM has the same part number and service number as the old ECM, to ensure proper engine performance.

1. Install the new ECM to the mounting bracket.
2. Install the three ECM mounting screws.

Tighten

Tighten the ECM to 10-14 N•m (88-124 lb in).

3. Reconnect the "J1" and "J2" connectors to the ECM.
4. Reconnect the negative battery cable.



mefi4332

System Relay Replacement

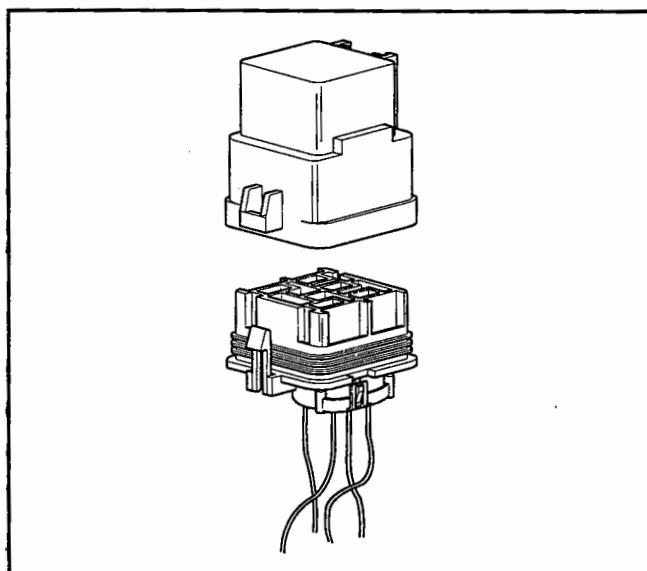
Removal Procedure

1. Turn the ignition OFF.
2. Remove the retainer.
3. Disconnect the system relay electrical connector.
4. Remove the system relay.

Important: The system relay is an electrical component. Do Not soak in any liquid or solvent as damage may result.

Installation Procedure

1. Install the system relay.
2. Reconnect the system electrical connector.
3. Install the retainer clip.



mefi4337

Fuel Pump Relay Replacement

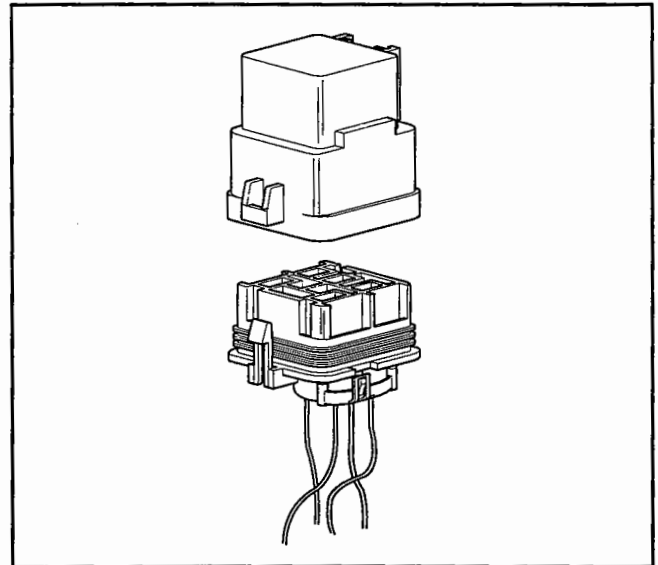
Removal Procedure

1. Turn the ignition OFF.
2. Remove the retainer.
3. Disconnect the fuel pump relay electrical connector.
4. Remove the fuel pump relay.

Important: The fuel pump relay is an electrical component. Do Not soak in any liquid or solvent as damage may result.

Installation Procedure

1. Install the fuel pump relay.
2. Reconnect the fuel pump relay electrical connector.
3. Install the retainer clip.



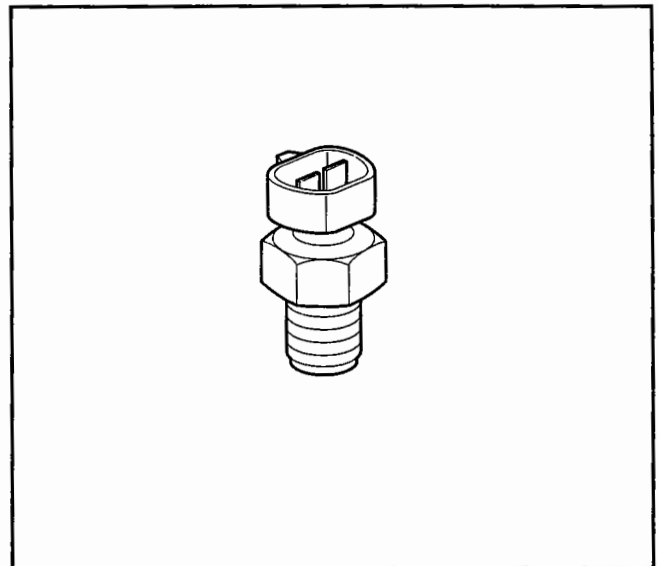
mefi4337

Engine Coolant Temperature (ECT) Sensor Replacement

Notice: Care must be taken when handling the ECT sensor. Damage to the sensor will affect proper operation of the MEFI system.

Remove or Disconnect

1. Turn OFF the ignition.
2. Drain the cooling system below the level of the ECT sensor.
3. Disconnect the ECT electrical connector.
4. Remove the ECT sensor.



mefi4333

Installation Procedure

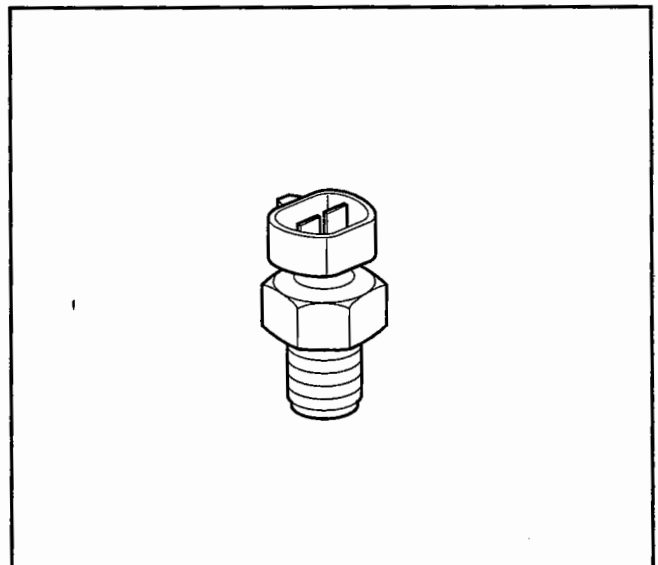
Important: Coat ECT sensor threads with teflon tape sealant prior to installation.

1. Install the ECT sensor.

Tighten

Tighten the ECT sensor to 20 N•m (15 lb ft).

2. Reconnect the ECT electrical connector.
3. Refill the cooling system.



mefi4333

Heated Oxygen (HO₂) Sensor Replacement

Removal Procedure

Notice: The Heated Oxygen (HO₂) sensor uses a permanently attached pigtail and connector. Do not remove this pigtail from the HO₂ sensor. Damage or the removal of the pigtail or the connector may affect the proper operation of the sensor.

Take care when handling the HO₂ sensor. Keep the in-line electrical connector and the louvered end free of grease, dirt or other contaminants. Also avoid using cleaning solvents of any type. Do not drop or roughly handle the HO₂ sensor.

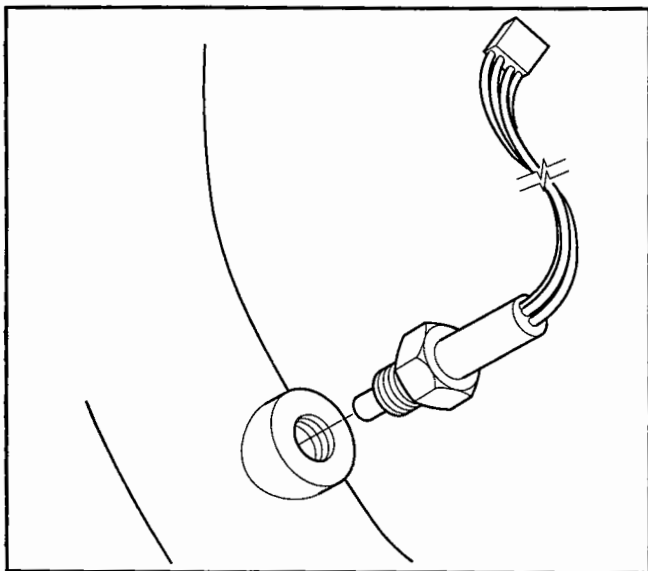
If the heated oxygen sensor pigtail wiring, connector or terminal is damaged, the entire oxygen sensor assembly must be replaced. Do not attempt to repair the wiring, connector or terminals. In order for the sensor to function properly, it must have provided to it a clean air reference. This clean air reference is obtained by way of the oxygen sensor signal and heater wires. Any attempt to repair the wires, connectors or terminals may result in the obstruction of the air reference and degraded sensor performance.

The following guidelines should be used when servicing the heated oxygen sensor:

- Do not apply contact cleaner or other materials to the sensor or vehicle harness connectors. These materials may get into the sensor causing poor performance.
- The sensor pigtail and harness wires must not be damaged in such a way that the wires inside are exposed. This could provide a path for foreign materials to enter the sensor and cause performance problems.
- Neither the sensor or vehicle lead wires should be bent sharply or kinked. Sharp bends, kinks, etc., could block the reference air path through the lead wire.
- To prevent damage due to water intrusion, be sure that the peripheral seal remains intact on the vehicle harness connector. Under no circumstances should repairs be soldered since this could result in the air reference being obstructed.

The HO₂ sensor may be difficult to remove when the engine temperature is below 48° C (120°F). Excessive force may damage the threads in the exhaust manifold or exhaust pipe.

1. Disconnect the negative battery cable.
2. Disconnect the HO₂ sensor electrical connector.
3. Remove the HO₂ sensor from the exhaust.



mefi4334

Installation Procedure

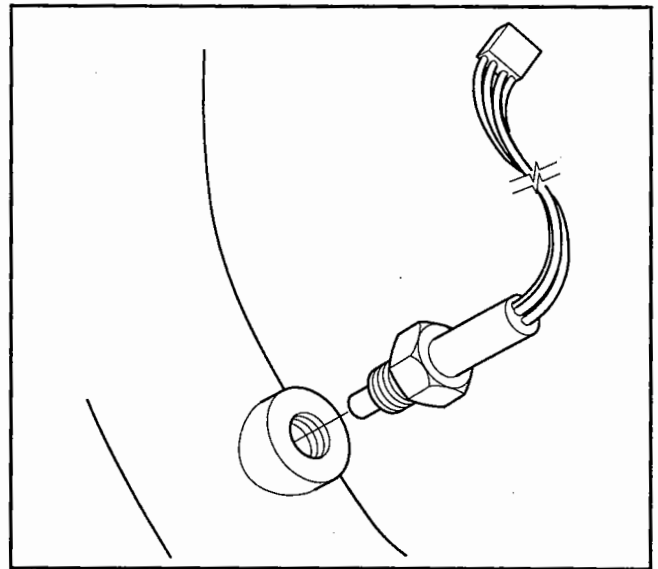
Important: A special anti-seize compound is used on the HO2 sensor threads. The compound consists of liquid graphite and glass beads. The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New, or service replacement sensors already have the compound applied to the threads. If the 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 the HO2 sensor with anti-seize compound GM P/N 5613695 or the equivalent if necessary.
2. Install the HO2 sensor.

Tighten

Tighten the HO2 sensor to 41 N•m (30 lb. ft.).

3. Reconnect HO2 sensor electrical connector.
4. Reconnect the negative battery cable.



mefi4334

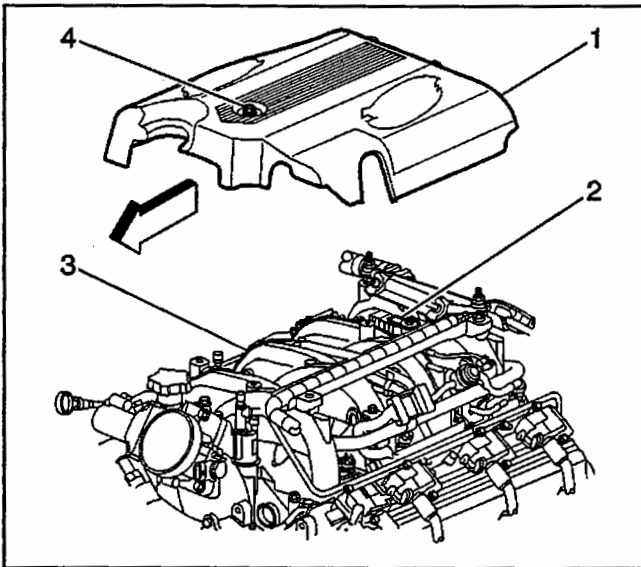
Vehicle Speed Sensor (VSS) Procedure**Removal Procedure**

Important: The VSS is an electrical component. Do Not soak it in any liquid cleaner or solvent, as damage may result.

1. Disconnect the negative battery cable.
2. Disconnect the VSS electrical connector.
3. Remove the vehicle speed sensor.

Installation Procedure

1. Install the vehicle speed sensor.
2. Reconnect the VSS electrical connector.
3. Reconnect the negative battery cable.

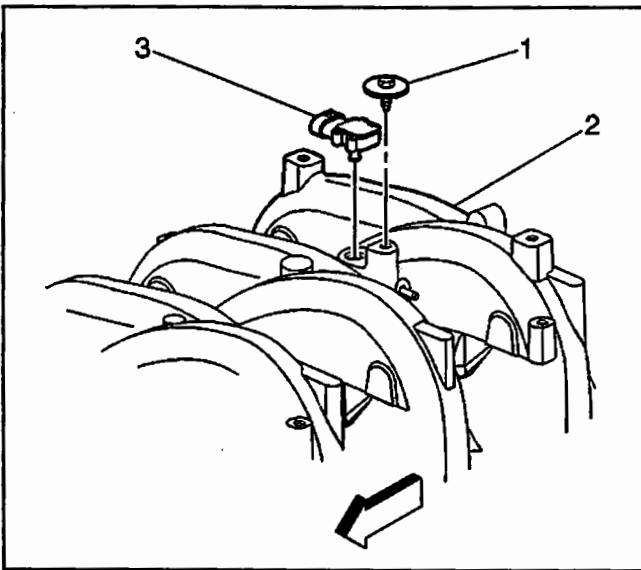


684798

Manifold Absolute Pressure (MAP) Sensor Replacement

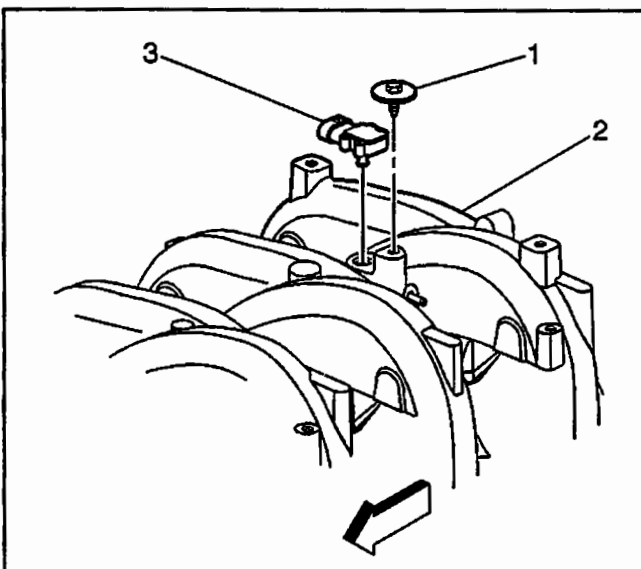
Removal Procedure

1. Loosen the fastener (4) from the intake manifold sight shield.
2. Remove the sight shield (1) from the intake manifold (3).
3. Disconnect the manifold absolute pressure (MAP) sensor electrical connector.



684801

4. Remove the MAP sensor retaining bolt and washer (1).
5. Remove the MAP sensor (3) from the intake manifold (2).
6. Inspect the MAP sensor seal for wear or damage and replace as necessary.



684801

Installation Procedure

Important: Lightly coat the MAP sensor seal with rubber lubricant part number 9985770 before installing the sensor. The lubricant should be applied with a sponge or brush. To prevent blockage, avoid dipping the sensor port directly into the lubricant.

1. Install the MAP sensor (3).
2. Install the MAP sensor retaining bolt and washer (1).

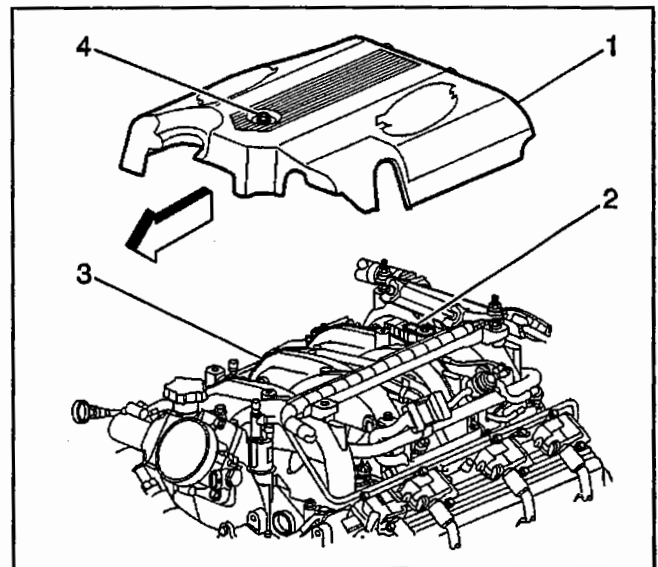
Tighten

Tighten the MAP sensor retaining bolt to 12 N·m (106 lb in).

3. Connect the MAP sensor electrical connector (2).
4. Install the intake manifold sight shield (1).

Tighten

Tighten the sight shield fastener to 10 N·m (89 lb in).



684798

Flame Arrestor/Air Filter Element Replacement

Removal Procedure

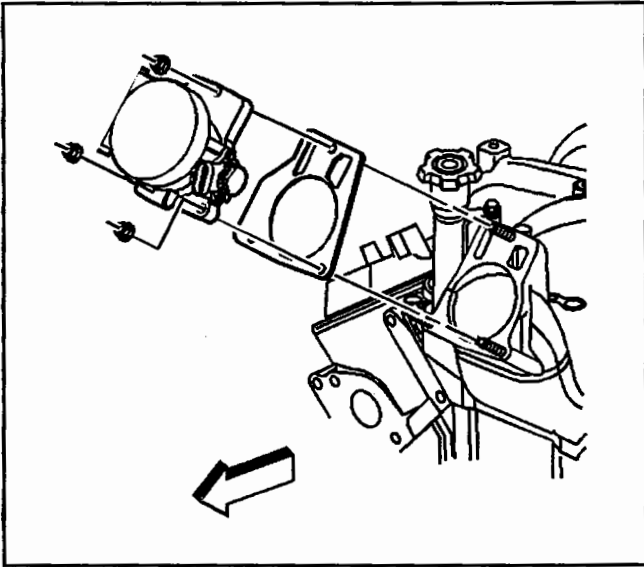
1. Loosen the flame arrestor/air filter element retaining clamp.
2. Disconnect any hoses from the flame arrestor/air filter.
3. Remove the flame arrestor/air filter element.

Important: Inspect the flame arrestor/air filter element for dust, dirt or water. Replace if required.

Installation Procedure

Notice: Flame arrestor/air filter element may be baffled, install it per manufacturer's instructions for correct air distribution.

1. Install the flame arrestor/air filter element to the throttle body.
2. Tighten the flame arrestor retaining clamp to flame arrestor/air filter element.
3. Reconnect any hoses to the flame arrestor/air filter element.



mefi4335

Throttle Body Assembly Replacement

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the flame arrestor/air filter, breather hoses and gasket (if applicable).
3. Disconnect the electrical connectors from the IAC valve and the TP sensor.
4. Disconnect the throttle linkage and return spring(s).
5. Remove the throttle body assembly attaching nuts.
6. Remove the throttle body assembly and gasket.
7. Discard the gasket.

Important: To prevent damage to the throttle valve, it is essential that the unit be placed on a holding fixture before performing service.

Notice: Stuff a rag in the intake manifold opening to prevent foreign material from entering the engine.

Inspect

- Manifold bore for loose parts and foreign material.
- Manifold mating surface for cleanliness or burrs that could affect gasket sealing.

Important: Clean the throttle bore and valve deposits 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 in a cold, immersion type cleaner following the disassembly of the unit.

Notice: The TP sensor and IAC valve should not come in contact with solvent or cleaner, as they may be damaged. These components must be removed before immersion. Follow the procedures outlined in this section.

Caution: *Safety glasses must be worn when using compressed air, as flying dirt particles may cause eye injury.*

- Clean all metal parts thoroughly and blow dry with compressed air. Be sure that all fuel and air passages are free of dirt and burrs.
- Inspect the mating surfaces for damage that could affect gasket sealing.
- Inspect throttle body for cracks in casting.
- The thread-locking compound supplied in the service repair kit is a small vial of thread-locking compound with directions for use. If this material is not available, use Loctite® 262 or equivalent.

Notice: When precoating the mounting bolts, do not use a higher strength locking compound than recommended. This may cause the removal of the bolts to be very difficult.

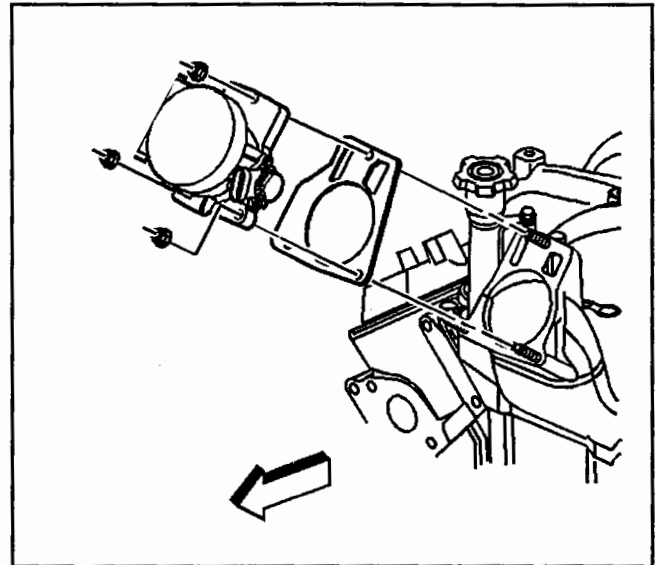
Installation Procedure

1. Install a new throttle body gasket.
2. Install the throttle body assembly and the throttle body assembly attaching nuts.

Tighten

Tighten the throttle body assembly attaching nuts to 10 N·m (89 lb in).

3. Reconnect the throttle linkage and return spring(s).
4. Reconnect the electrical connectors to the IAC valve and the TP sensor.
5. Install the flame arrestor/air filter, breather hoses and gasket (if applicable).
6. Reconnect the negative battery cable.



mefi4335

Fuel Pressure Relief Procedure

Caution: To reduce the risk of fire and personal injury, relieve fuel system pressure before servicing fuel system components.

After relieving fuel 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 disconnection is completed.

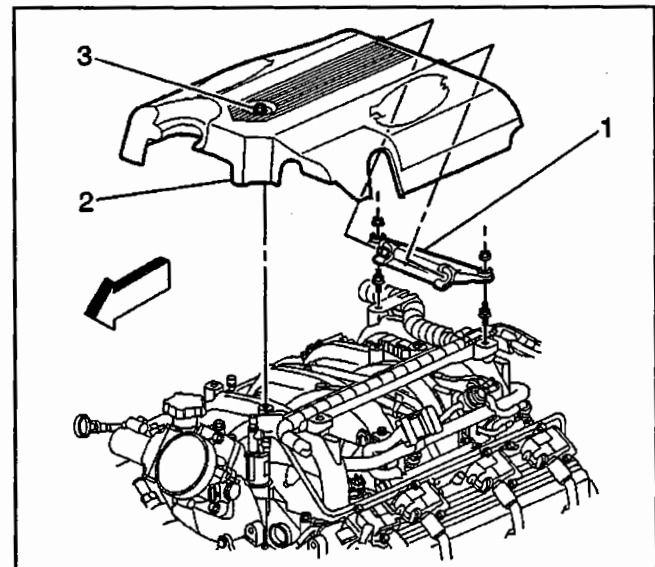
The following is general information required when working on the fuel system:

- Always keep a dry chemical fire extinguisher near the work area.
- Do not replace fuel pipe with fuel hose.
- Always bleed off fuel pressure before servicing any fuel system components.
- Do not do any repairs on the fuel system until you have read the instructions and checked the figures relating the repair.
- Observe all notices and cautions.

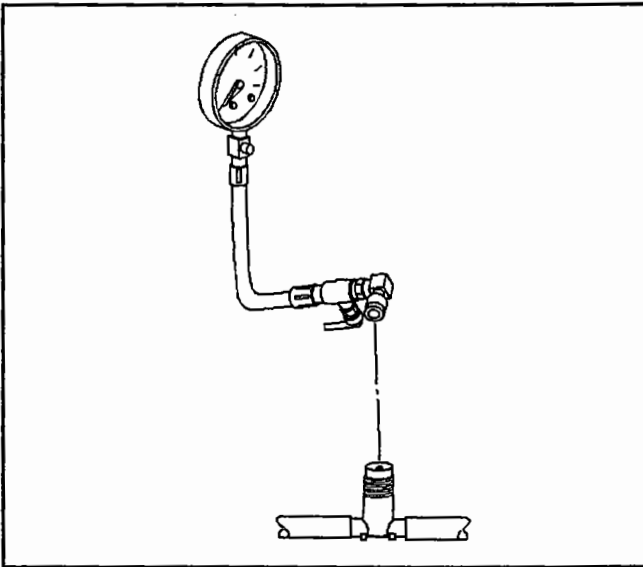
Tools Required

J 34730-1A Fuel Pressure Gauge

1. Turn the ignition OFF.
2. Disconnect the negative battery cable in order to avoid possible fuel discharge if an accidental attempt is made to start the engine.
3. Remove the fuel injector sight shield.

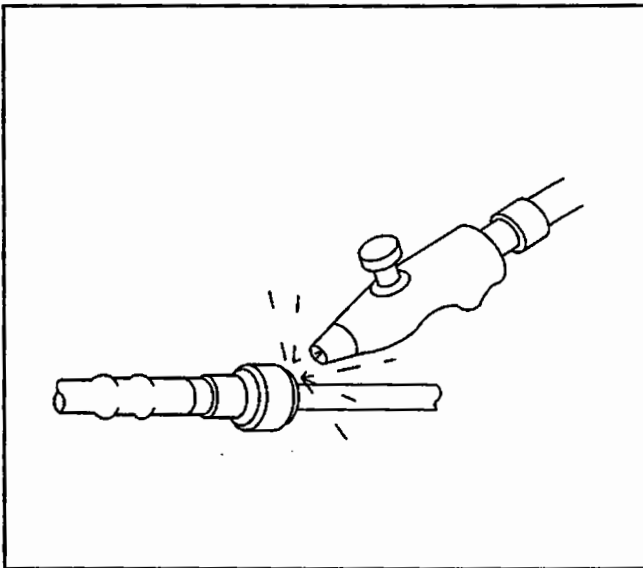


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180378

4. Connect the J 34730-1A fuel pressure gauge to the fuel pressure valve. Wrap a shop towel around the fitting while connecting the gauge in order to avoid spillage.
5. Install the bleed hose of the gauge into an approved container.
6. Open the valve on the gauge to bleed the system pressure. The fuel connections are now safe for servicing.
7. Drain any fuel remaining in the gauge into an approved container.



12776

Quick Connect Fitting(s) Service (Metal Collar)

Tools Required

J 37088-A Tool Set, Fuel Line Quick-Connect Separator

J 44581 Fuel Line Quick Connect Separator

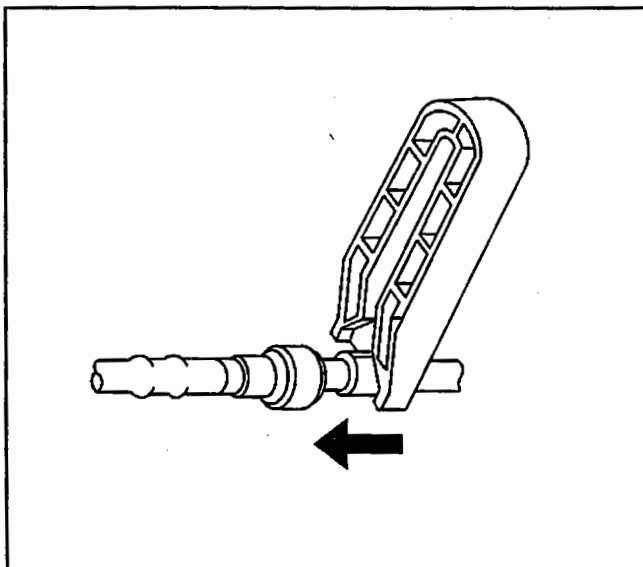
Removal Procedure

1. Relieve the fuel system pressure before servicing any fuel system connection. Refer to *Fuel Pressure Relief Procedure*.

2. Remove the retainer from the quick-connect fitting.

Caution: Wear safety glasses in order to avoid eye damage.

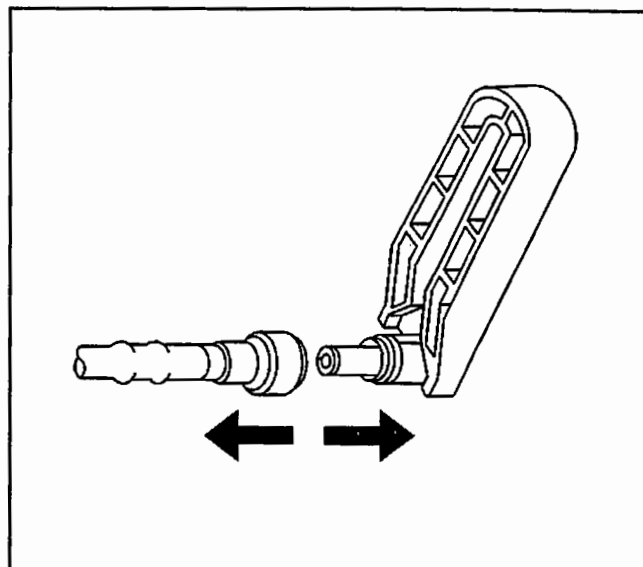
3. Blow dirt out of the fitting using compressed air.



12780

4. Choose the correct tool from the tool set for the size of the fitting. Insert the tool into the female connector, then push inward in order to release the locking tabs.

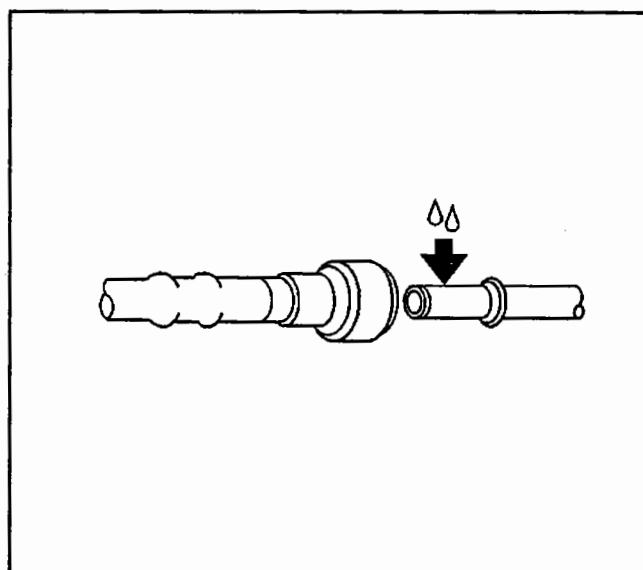
5. Pull the connection apart.
6. Use a clean shop towel in order to wipe off the male pipe end.
7. Inspect both ends of the fitting for dirt and burrs. Clean or replace the components as required.



12782

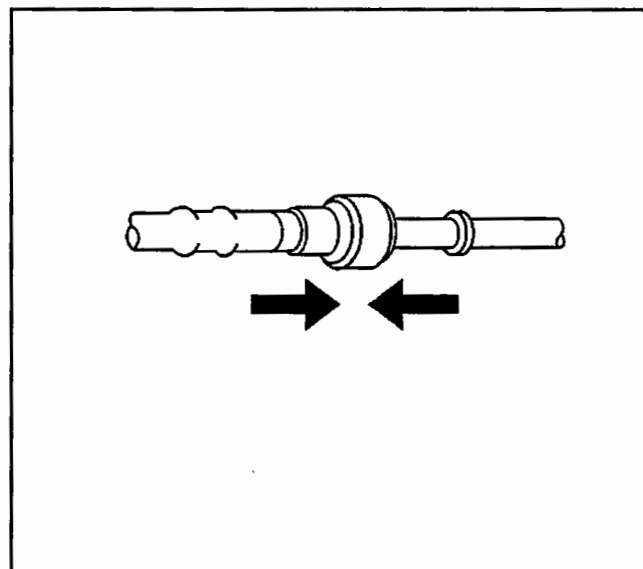
Installation Procedure

1. Apply a few drops of clean engine oil to the male pipe end.

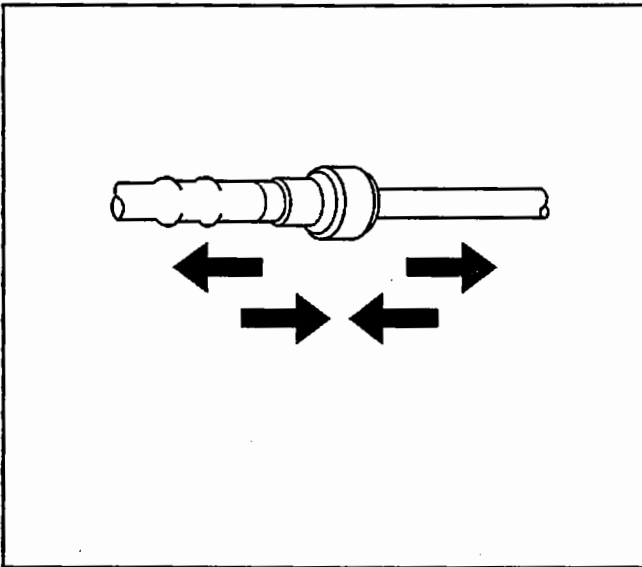


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2. Push both sides of the fitting together in order to snap the retaining tabs into place.

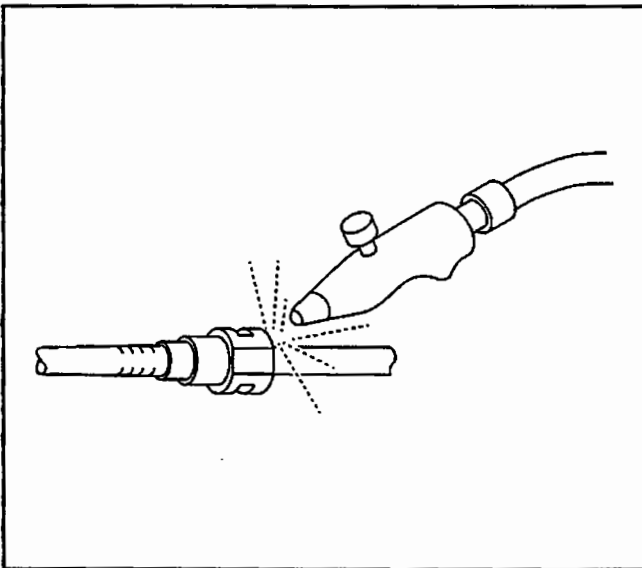


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12787

3. Once installed, pull on both sides of the fitting in order to make sure the connection is secure.
4. Install the retainer to the quick-connect fitting.



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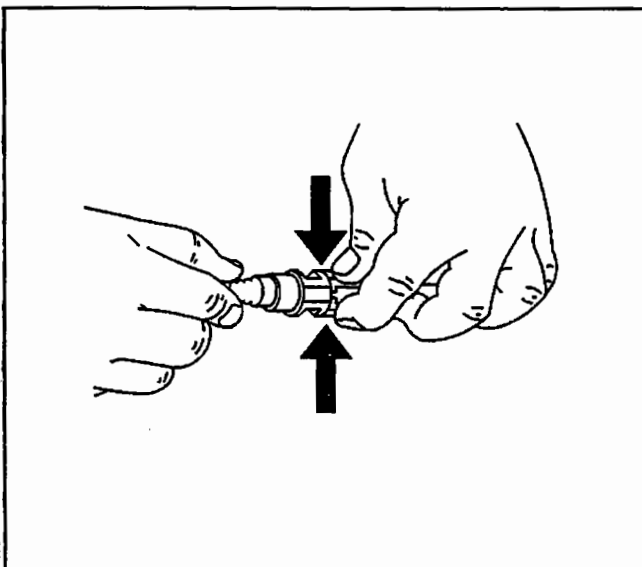
Quick Connect Fitting(s) Service (Plastic Collar)

Removal Procedure

1. Relieve the fuel system pressure before servicing any fuel system connection. Refer to *Fuel Pressure Relief Procedure*.

Caution: Wear safety glasses in order to avoid eye damage.

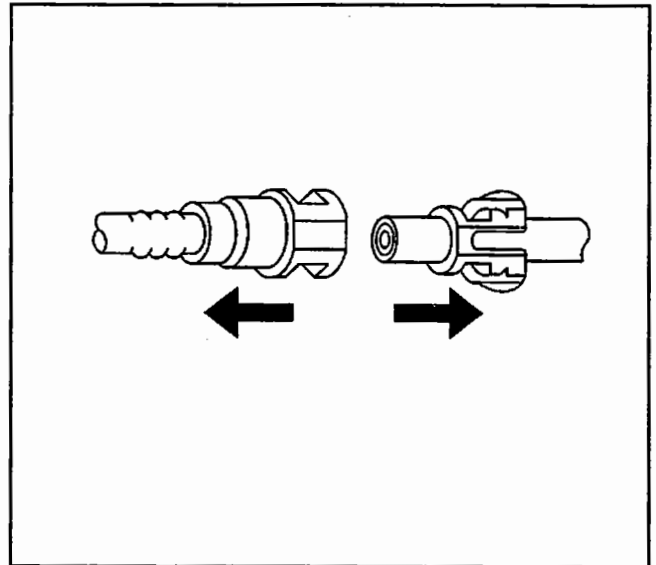
2. Blow dirt out of the fitting using compressed air.



12777

3. Squeeze the plastic retainer release tabs.

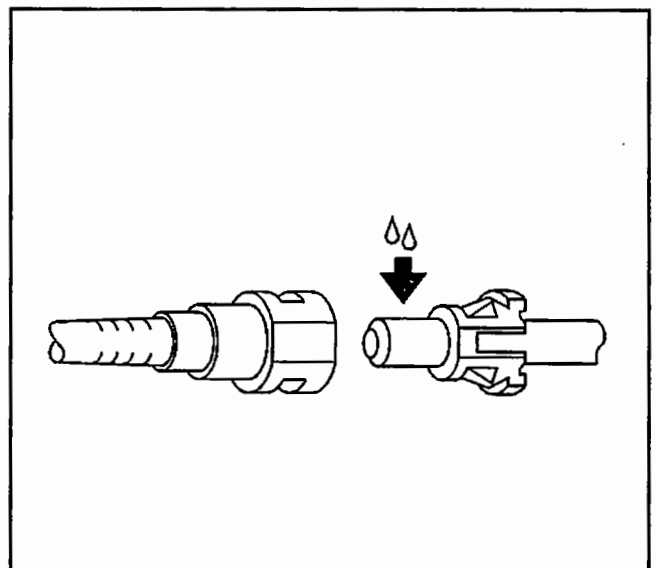
- 4. Pull the connection apart.



12778

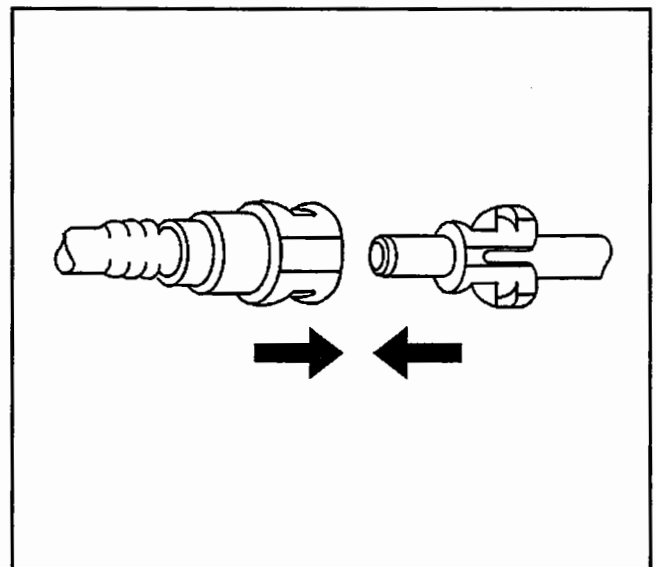
Installation Procedure

- 1. Apply a few drops of clean engine oil to the male pipe end.

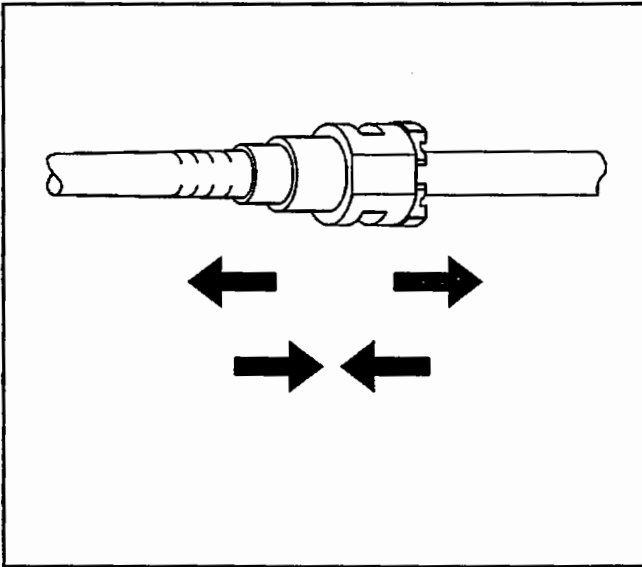


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- 2. Push both sides of the quick-connect fitting together in order to cause the retaining tabs to snap into place.

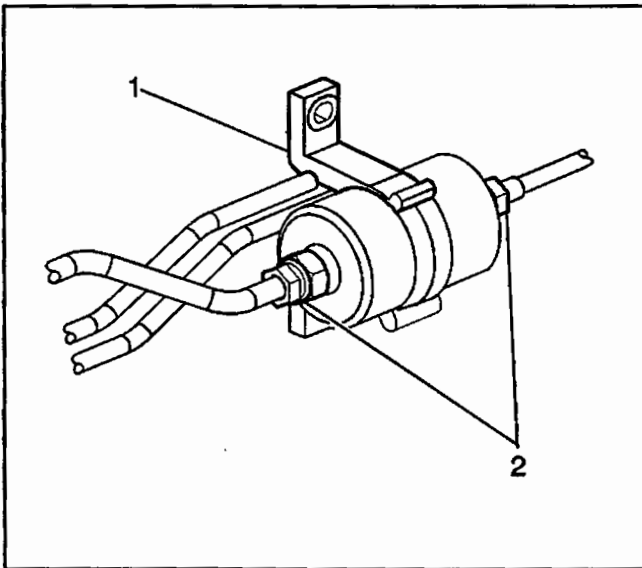


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- Once installed, pull on both sides of the fitting in order to make sure the connection is secure.

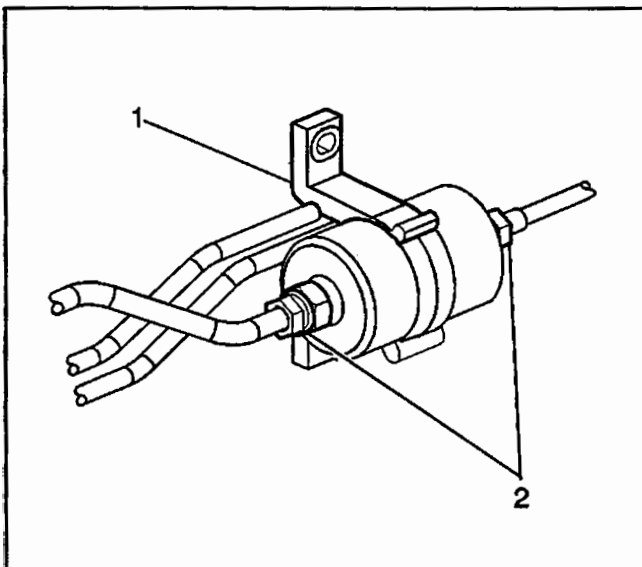


713146

In-Line Fuel Filter Replacement

Removal Procedure

- Disconnect negative battery cable.
- Relieve the fuel system pressure before servicing any fuel system component. Refer to *Fuel Pressure Relief Procedure*.
- Clean all the fuel filter connections and the surrounding areas before disconnecting the fuel pipes in order to avoid possible contamination of the fuel system.
- Disconnect the threaded fittings (2) from the filter.
- Cap the fuel pipes in order to prevent possible fuel system contamination.
- Slide the fuel filter from the bracket (1).
- Inspect the fuel pipe O-rings for cuts, cracks, nicks, swelling or distortion. Replace the O-rings if necessary.



713146

Installation Procedure

- Slide the filter into the bracket (1).
- Remove the caps from the fuel pipes.
- Connect the threaded fittings (2) to the fuel filter.

Tighten

Tighten the fittings to 25 N·m (18 lb ft).

- Connect the negative battery cable.
- Inspect for leaks.
 - Turn the ignition ON for 2 seconds.
 - Turn the ignition OFF for 10 seconds.
 - Turn the ignition ON.
 - Inspect for fuel leaks.

Fuel Pump Replacement

Removal Procedure

1. Disconnect negative battery cable.
2. Relieve the fuel system pressure before servicing any fuel system component. Refer to *Fuel Pressure Relief Procedure*.
3. Clean all the fuel fitting connections and the surrounding areas before disconnecting the fuel pipes in order to avoid possible contamination of the fuel system.
4. Disconnect the threaded fittings from the fuel pump.
5. Cap the fuel pipes in order to prevent possible fuel system contamination.
6. Disconnect the fuel pump electrical connector.
7. Remove the fuel pump.

Installation Procedure

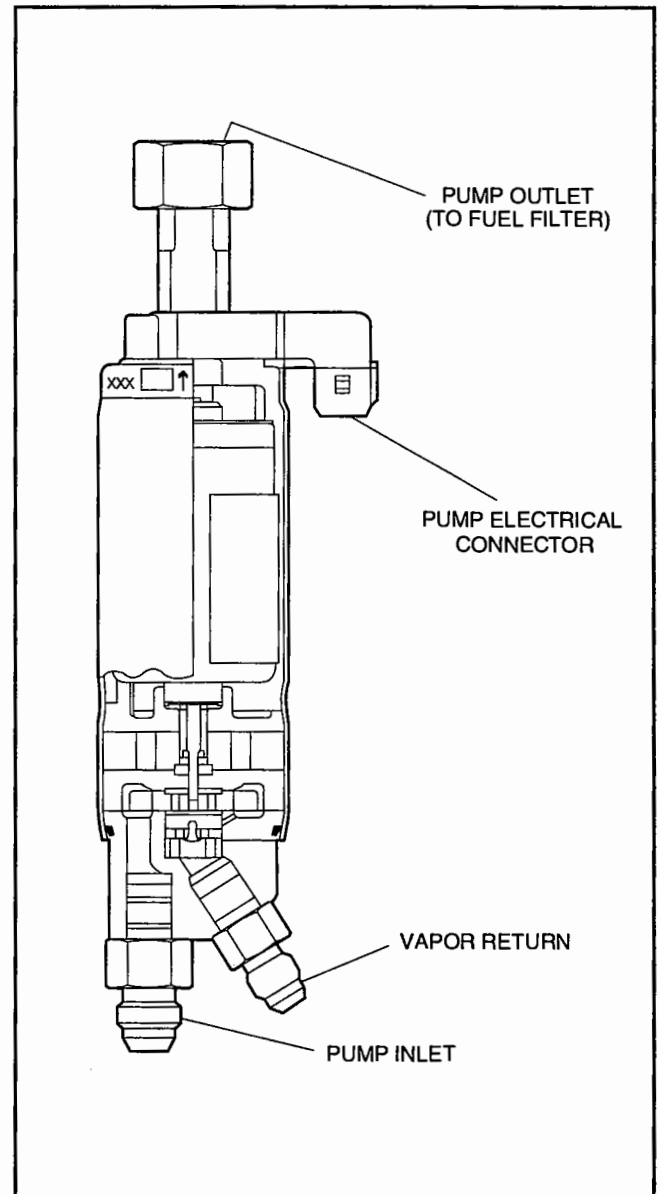
Notice: Make sure to replace the fuel pump with the identical part number.

1. Install the fuel pump.
2. Reconnect the fuel pump electrical connector.
3. Remove the caps from the fuel pipes.
4. Reconnect the threaded fittings into the fuel pump.

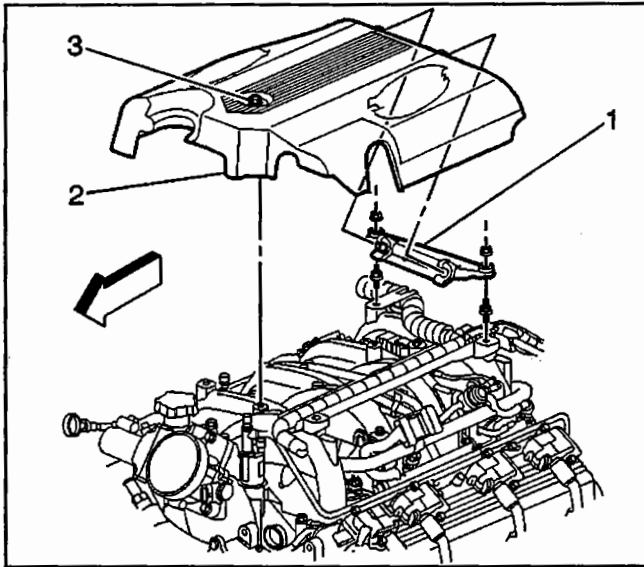
Tighten

Tighten the fittings to 25 N·m (18 lb ft).

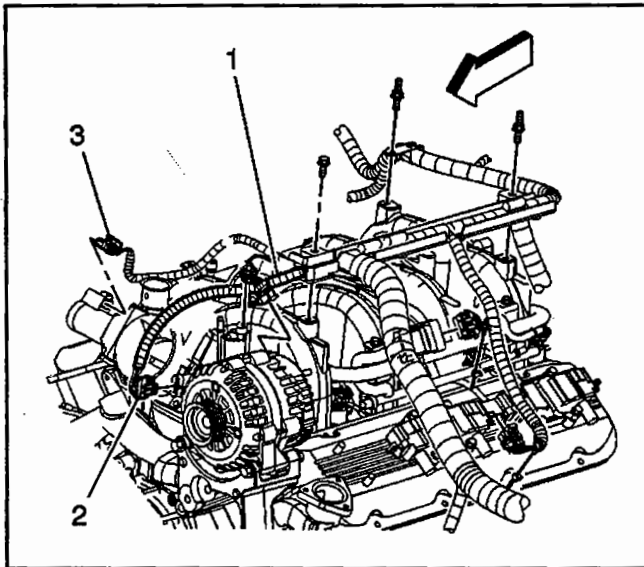
5. Connect the negative battery cable.
6. Inspect for leaks.
 - 6.1. Turn the ignition ON for 2 seconds.
 - 6.2. Turn the ignition OFF for 10 seconds.
 - 6.3. Turn the ignition ON.
 - 6.4. Inspect for fuel leaks.



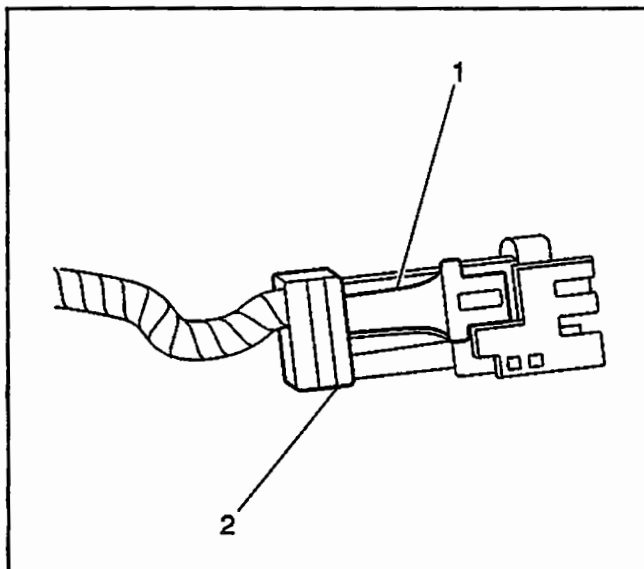
mefi4336



665445



mefi4338



372749

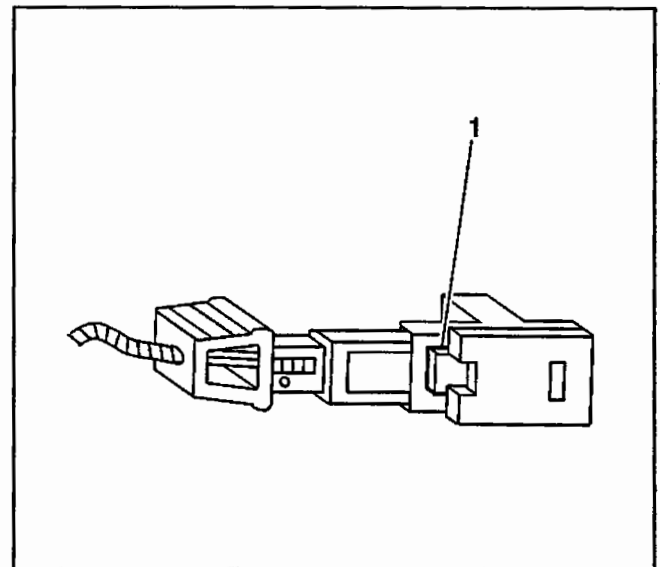
Fuel Rail Assembly Replacement

Removal Procedure

An eight digit identification number is located on the fuel rail assembly. Refer to this model identification number if servicing or part replacement is required.

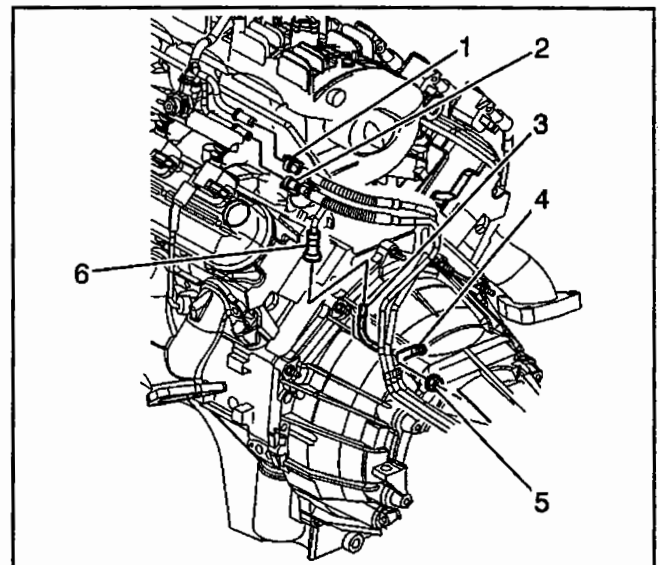
1. Relieve the fuel system pressure. Refer to *Fuel Pressure Relief Procedure*.
2. Before removal, clean the fuel rail assembly with a spray type engine cleaner, GM X-30A or equivalent, if necessary. Follow the package instructions. Do not soak fuel rails in liquid cleaning solvent.
3. Remove the engine sight shield bracket (1) nuts and bracket.
4. Disconnect the generator harness connector (1).
5. Disconnect the TP sensor harness connector (2).
6. Disconnect the IAC valve harness connector (3).
7. Remove the upper engine wiring harness bracket studs and position the upper engine wire harness aside.
8. Identify the connectors to their corresponding injectors to ensure correct injector firing order after reassembly.
9. Pull the top portion (2) of the injector connector up. Do not pull the top portion of the connector past the top of the white portion (1).

10. Push the tab (1) on the ower side of the injector connector in order to release the connector from the injector.
11. Repeat step 9 and step 10 for each injector connector.



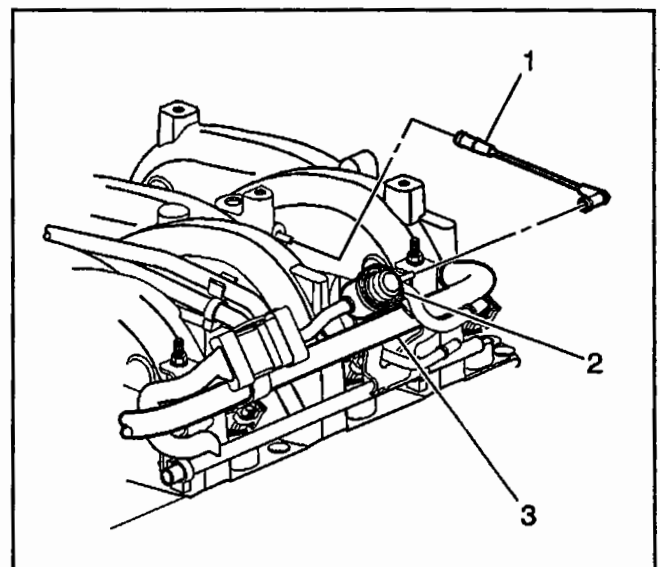
372753

12. Disconnect the fuel feed and return pipes (1), (2) from the fuel rail.

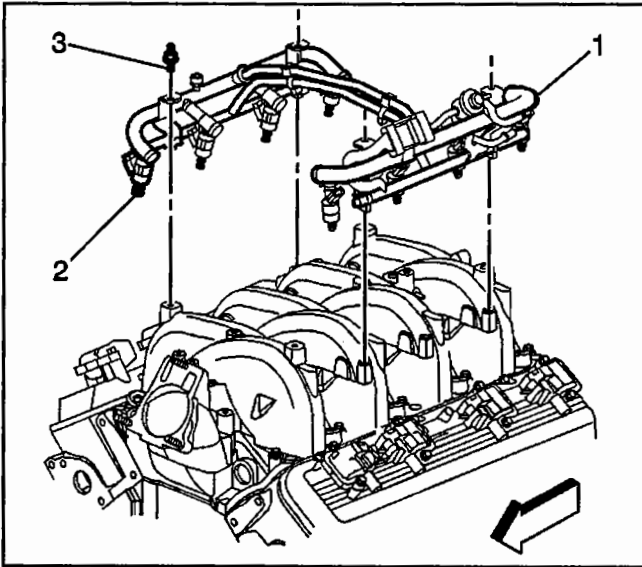


300360

13. Disconnect the fuel pressure regulator vacuum line.

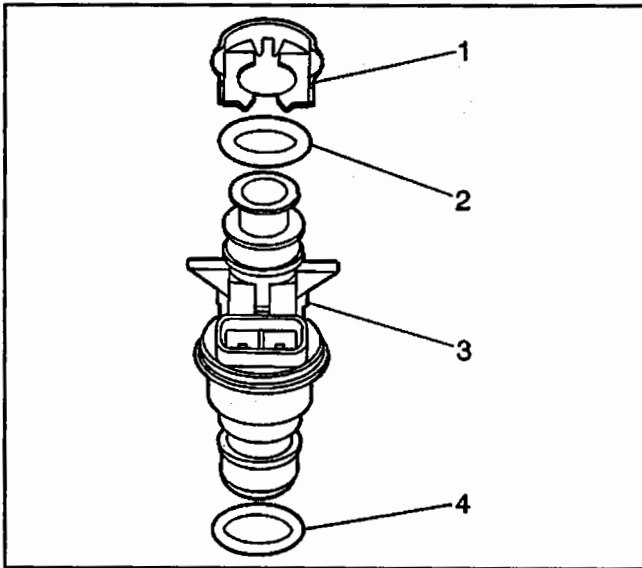


665447



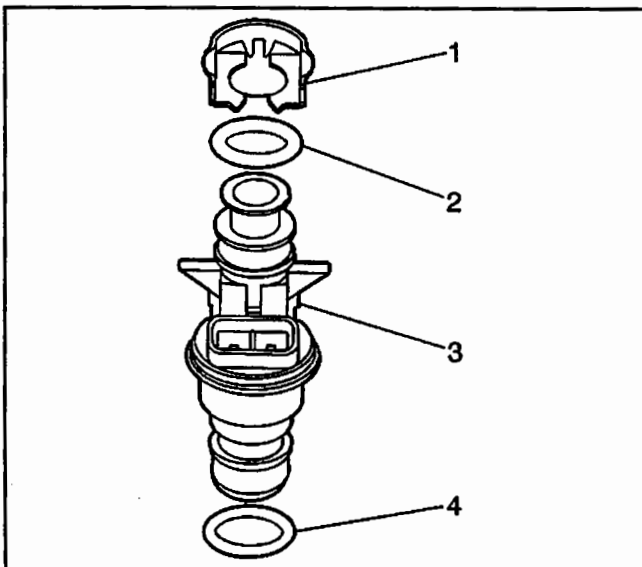
665443

14. Remove the fuel rail attaching bolts.
15. Remove the fuel rail assembly.



351185

16. Remove the injector lower O-ring seal (4) from the spray tip end of each injector (3).
17. Discard the O-ring seals.



351185

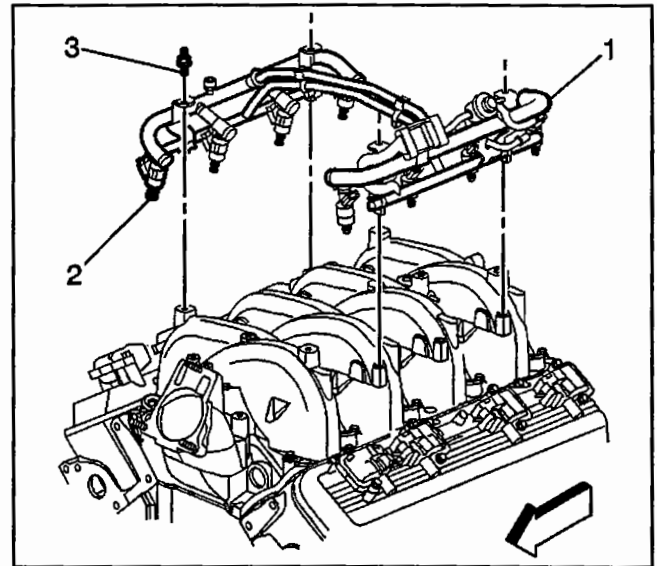
Installation Procedure

1. Lubricate the new lower injector O-ring seals (4) with clean engine oil.
2. Install the new O-ring seals (4) on the spray tip end of each injector (3).

- 3. Install the fuel rail assembly to the intake manifold.
- 4. Apply a 5 mm (0.020 in) band of GM P/N 12345382 threadlock or equivalent to the threads of the fuel rail attaching bolts.
- 5. Install the fuel rail attaching bolts.

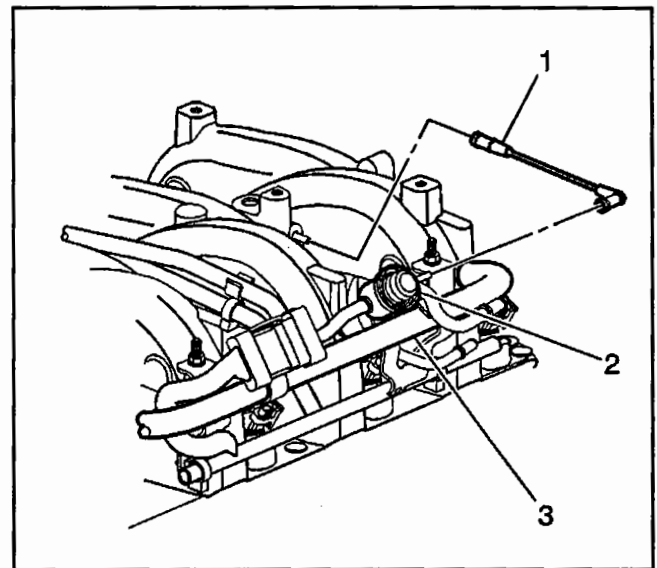
Tighten

Tighten the fuel rail attaching bolts to 12 N·m (106 lb in).



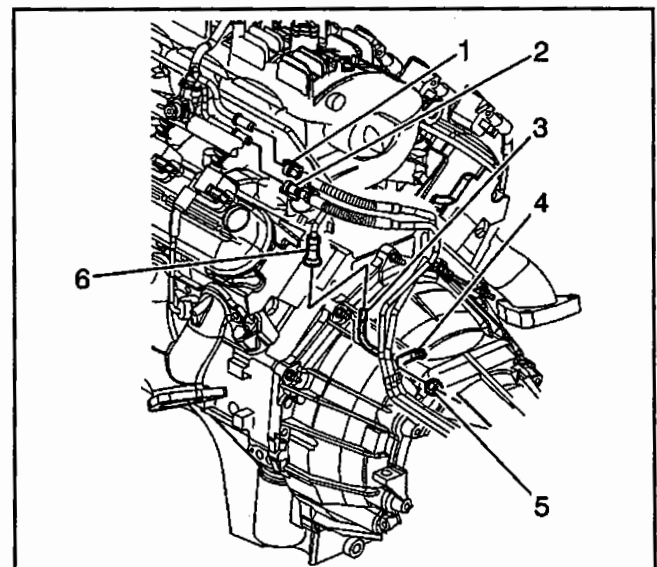
665443

- 6. Connect the fuel pressure regulator vacuum line.

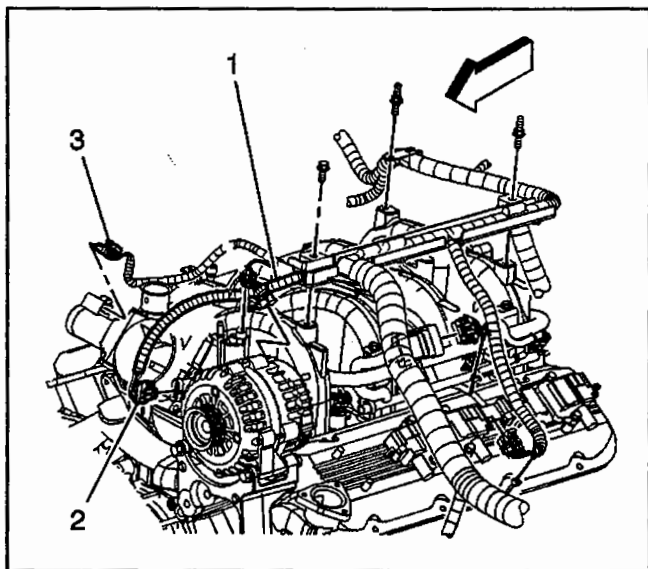


665447

- 7. Connect the fuel feed and return pipes (1), (2) to the fuel rail.



300360

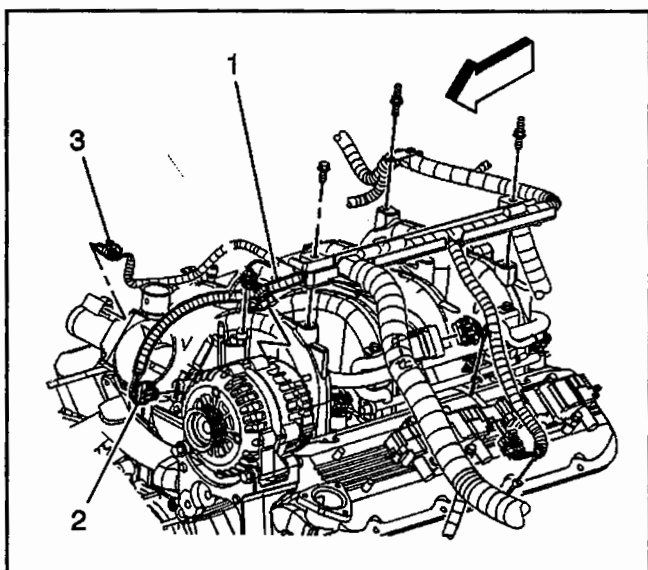


mefi4338

8. Connect the injector electrical connectors
 - Install each connector on the proper injector in order to ensure correct injector firing order.
 - Rotate the injectors as required in order to avoid stretching the wire harness.
9. Install the upper engine wire harness bracket.
10. Install the retainer studs to the upper engine wire harness.

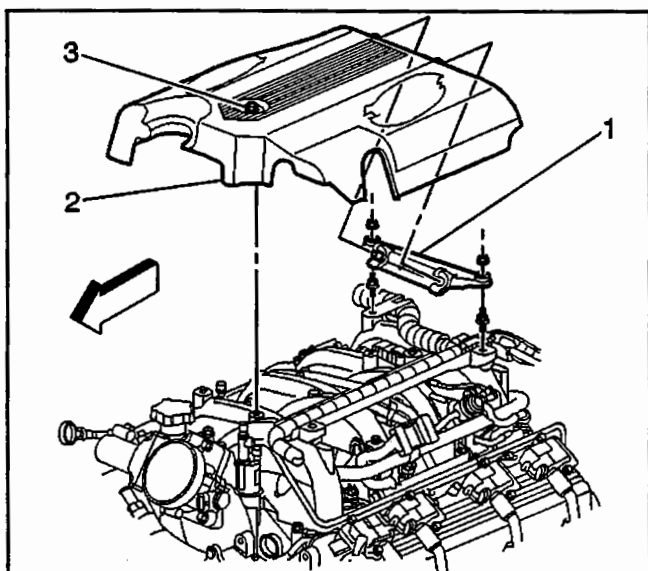
Tighten

Tighten the nut to 10 N·m (89 lb in).



mefi4338

11. Reconnect the generator harness connector (1).
12. Reconnect the TP sensor harness connector (2).
13. Reconnect the IAC valve harness connector (3).



665445

14. Install the engine sight shield mounting bracket and nuts.

Tighten

Tighten the bolts 10 N·m (89 lb in).

15. Connect the negative battery cable.
16. Inspect for leaks.
 - 16.1. Turn the ignition ON for 2 seconds.
 - 16.2. Turn the ignition OFF for 10 seconds.
 - 16.3. Turn the ignition ON.
 - 16.4. Inspect for fuel leaks.
17. Install the engine sight shield.

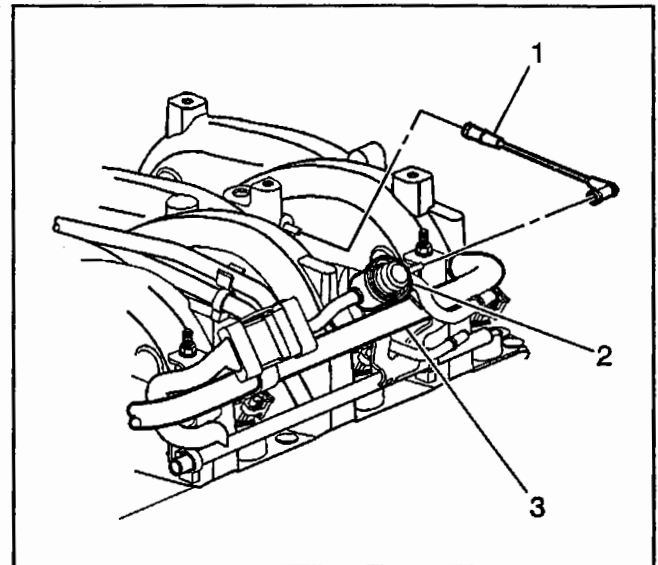
Tighten

Tighten the bolts 10 N·m (89 lb in).

Fuel Pressure Regulator Replacement

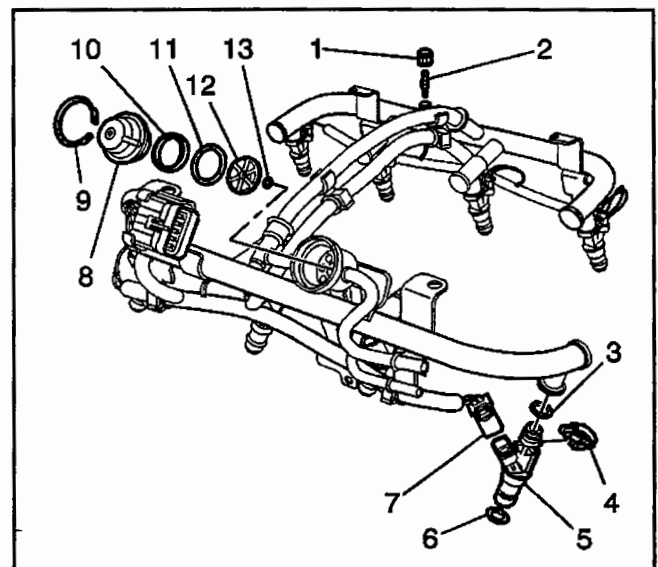
Removal Procedure

1. Relieve the fuel system pressure. Refer to *Fuel Pressure Relief Procedure*.
2. Disconnect the fuel pressure regulator vacuum line (1).



665447

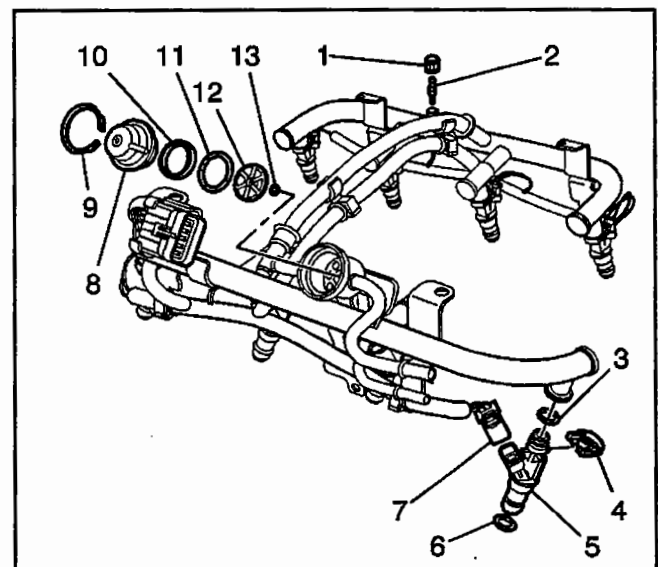
3. Clean any dirt from the fuel pressure regulator retainer and the surrounding area.
4. Remove the fuel pressure regulator retainer (9).
5. Remove the fuel pressure regulator (8) from the fuel pressure regulator housing.



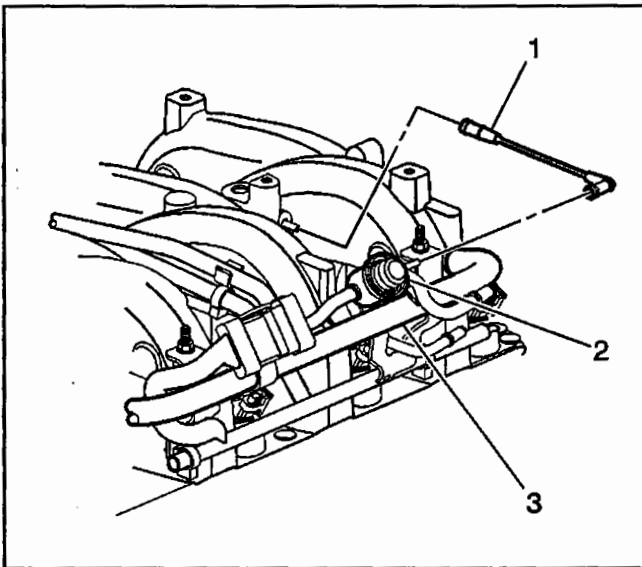
705539

Installation Procedure

1. Install the backup ring (10) on the fuel pressure regulator (8).
2. Install the new large O-ring (11) on the fuel pressure regulator.
3. Install the regulator filter (12) on the fuel pressure regulator.
4. Install the new small O-ring (13) on the fuel pressure regulator.
5. Lubricate the fuel pressure regulator large O-ring and the small O-ring with clean engine oil.
6. Push the fuel pressure regulator into the regulator housing on the fuel rail.
7. Install a new fuel pressure regulator retainer (9).

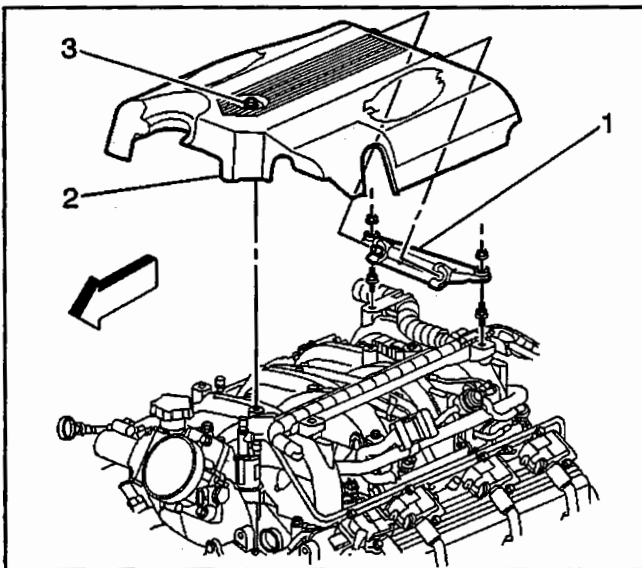


705539



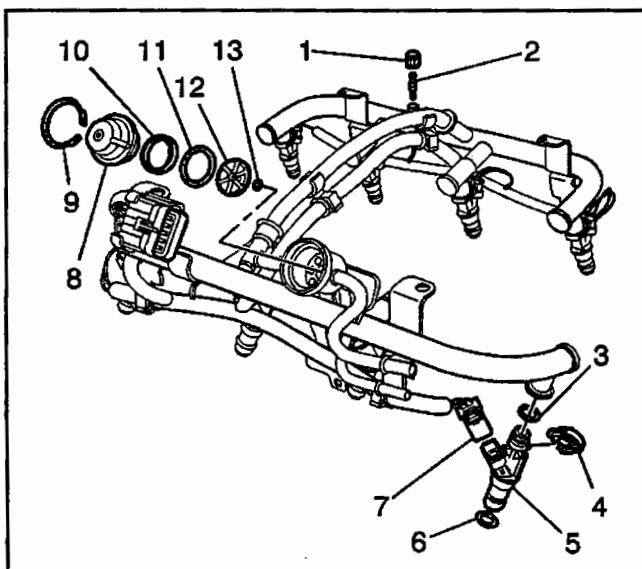
665447

8. Connect the fuel pressure regulator vacuum line.
9. Connect the negative battery cable.
10. Inspect for leaks.
 - 10.1. Turn the ignition ON for 2 seconds.
 - 10.2. Turn the ignition OFF for 10 seconds.
 - 10.3. Turn the ignition ON.
 - 10.4. Inspect for fuel leaks.



665445

11. Install the engine sight shield.



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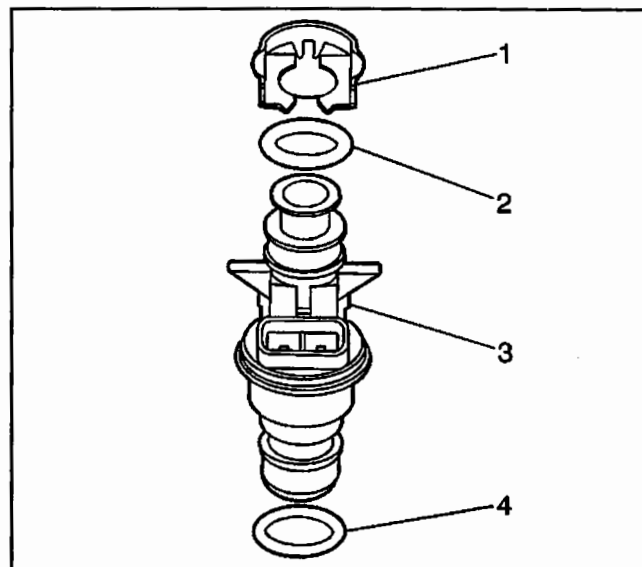
Fuel Injector Replacement

Removal Procedure

Important: The engine oil may be contaminated with fuel if the fuel injectors are leaking.

1. Remove the fuel rail assembly. Refer to *Fuel Rail Assembly Replacement*.
2. Remove the injector retainer clip (4).
3. Insert the fork of J 43013, the fuel injector assembly removal tool, between the fuel rail pod and the 3 protruding retaining clip ledges. Use a prying motion while inserting the tool in order to force the injector out of the fuel rail pod.

4. Discard the injector retainer clip (1).
5. Remove the injector O-ring seals (2), (4) from both ends of the injector. Discard the O-ring seals.

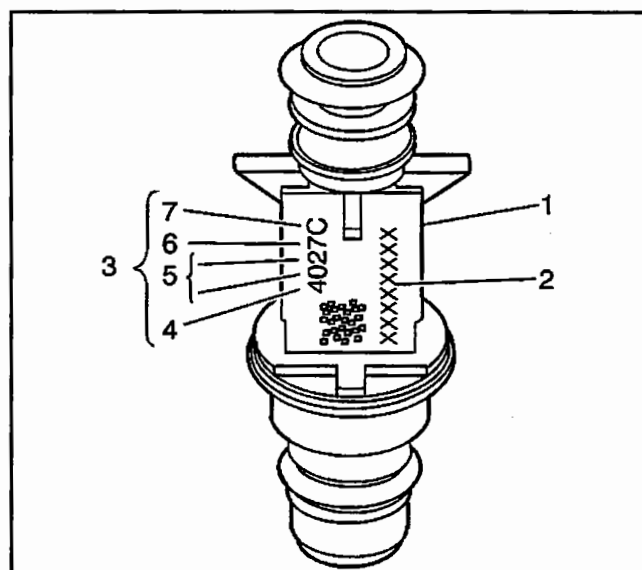


351185

Installation Procedure

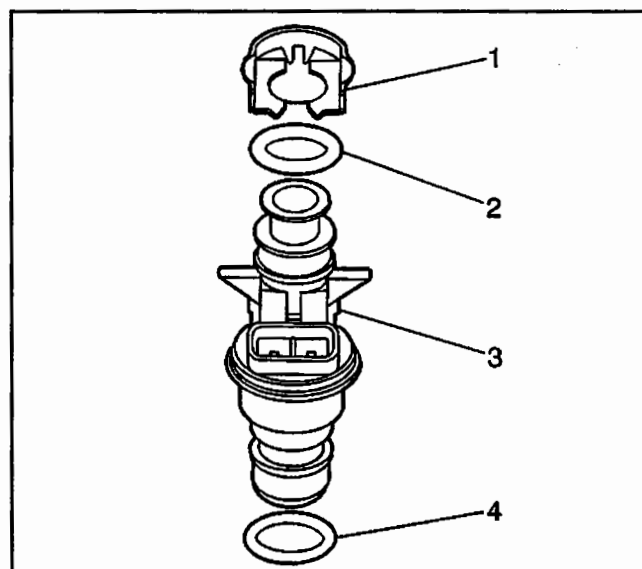
Important: When ordering new fuel injectors, be sure to order the correct injector for the application being serviced.

The fuel injector assembly (1) is stamped with a part number identification (2). A four digit build date code (3) indicates the month (4), day (5), year (6) and the shift (7) that built the injector.

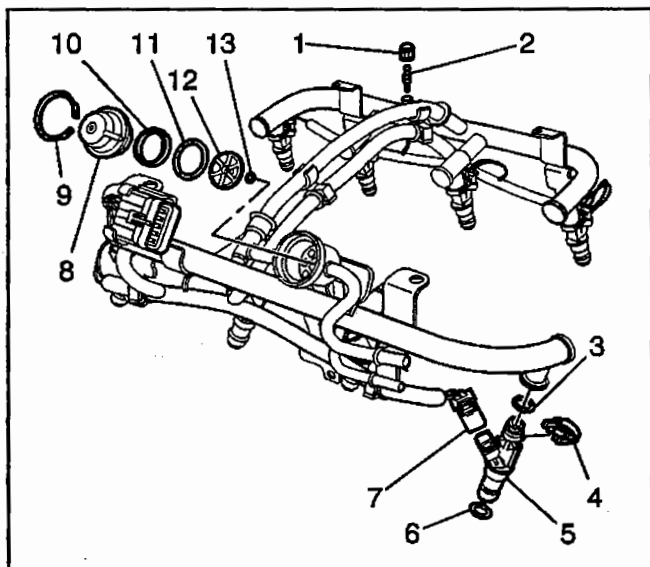


351196

1. Lubricate the new O-ring seals (2), (4) with clean engine oil.
2. Install the new injector O-ring seals on the injector.
3. Install a new retainer clip (1) on the injector.

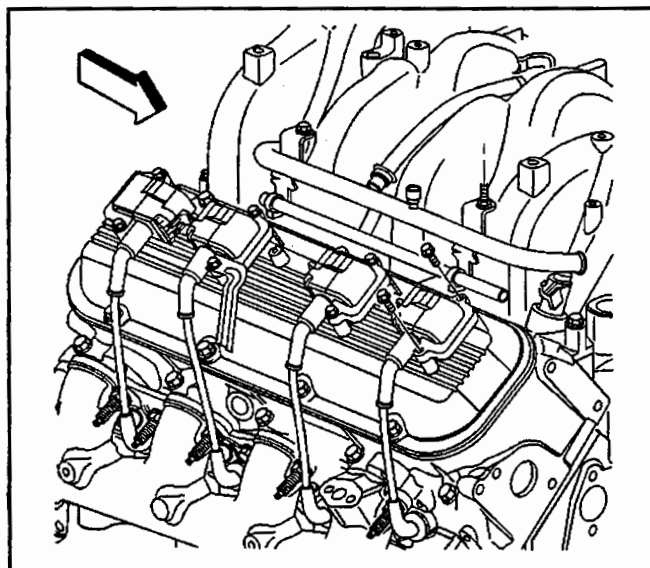


351185



705539

4. Push the fuel injector (5) into the fuel rail injector socket with the electrical connector facing outwards. The retainer clip (4) locks on to a flange on the fuel rail injector socket.
5. Install the fuel rail assembly. Refer to *Fuel Rail Assembly Replacement*.

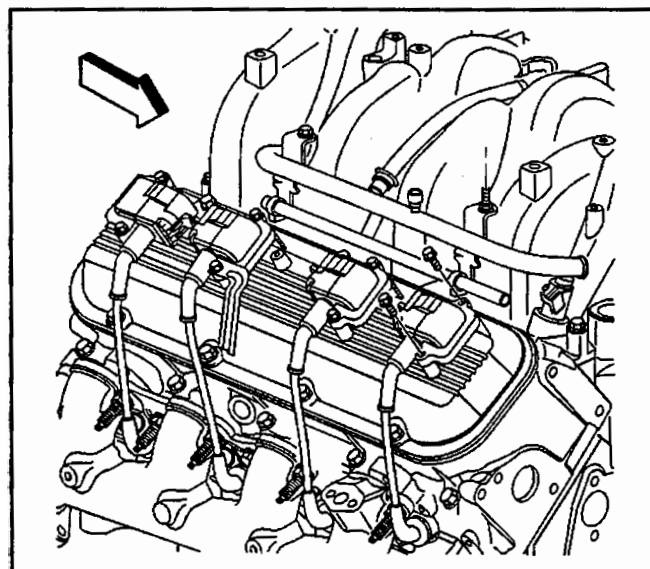


703554

Ignition Coil(s) Replacement

Removal Procedure

1. Disconnect the spark plug wires at the ignition coils. Refer to *Spark Plug Wire Replacement*.
2. Disconnect the ignition coil harness connector.
3. Remove the ignition coil mounting bolts.
4. Remove the ignition coil.



703554

Installation Procedure

1. Install the ignition coil.
2. Install the ignition coil mounting bolts.

Tighten

Tighten the ignition coil mounting bolts to 12 N·m (106 lb in).

3. Connect the ignition coil harness connector.
4. Connect the spark plug wires at the ignition coils. Refer to *Spark Plug Wire Replacement*.

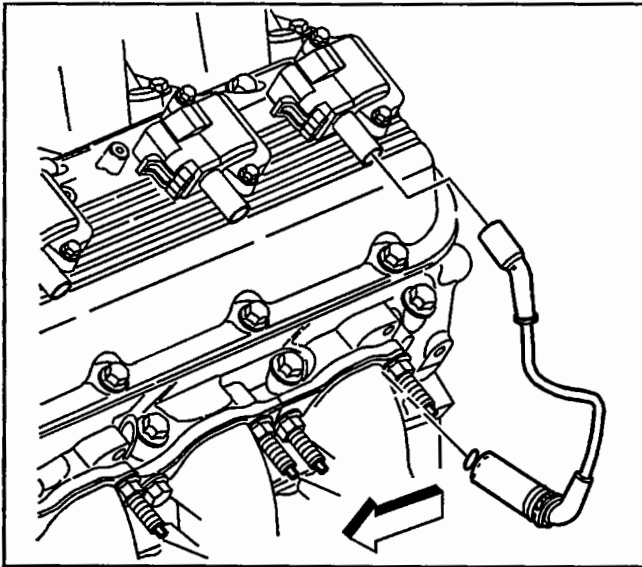
Spark Plug Wire Inspection

Spark plug wire integrity is vital for proper engine operation. A thorough inspection will be necessary to accurately identify conditions that may affect engine operation. Inspect for the following conditions:

1. Correct routing of the spark plug wires. Incorrect routing may cause cross-firing.
2. Any signs of cracks or splits in the wires.
3. Inspect each boot for the following conditions:

- Tearing
- Piercing
- Arcing
- Carbon tracking
- Corroded terminal

If corrosion, carbon tracking or arcing are indicated on a spark plug wire boot or on a terminal, replace the wire and the component connected to the wire.

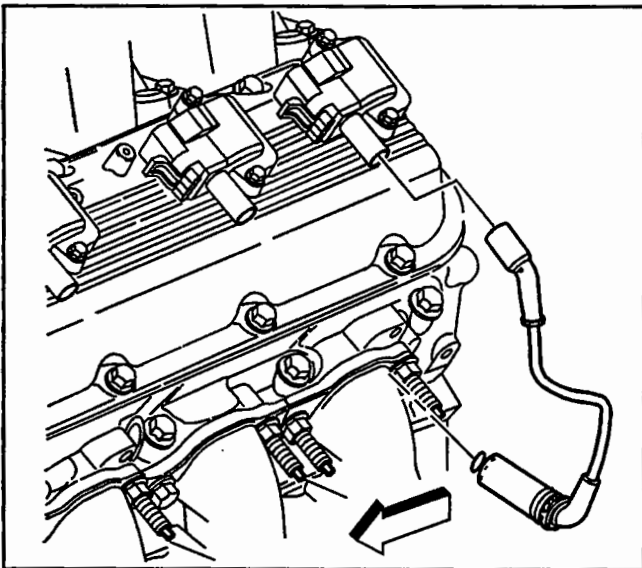


470666

Spark Plug Wire Replacement

Removal Procedure

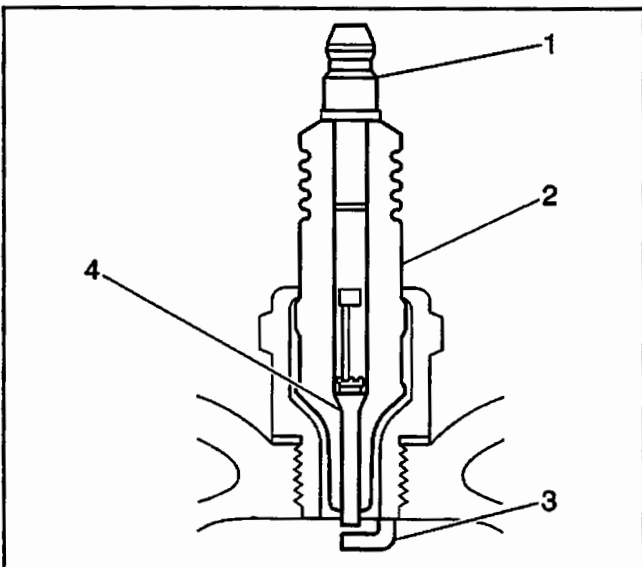
1. Disconnect the spark plug wire at each spark plug.
 - 1.1. Twist each spark plug wire 1/2 turn.
 - 1.2. Pull only on the boot in order to remove the wire from each spark plug.
2. Disconnect the spark plug wire from each ignition coil.
 - 2.1. Twist each spark plug wire 1/2 turn.
 - 2.1. Pull only on the boot in order to remove the wire from each ignition coil.



470666

Installation Procedure

1. Install the spark plug wire at each ignition coil.
2. Install the spark plug wire at each spark plug.
3. Inspect the wires for proper installation:
 - 3.1. Push sideways on each boot in order to inspect the seating.
 - 3.2. Reinstall any loose boot.



622530

Spark Plug Inspection

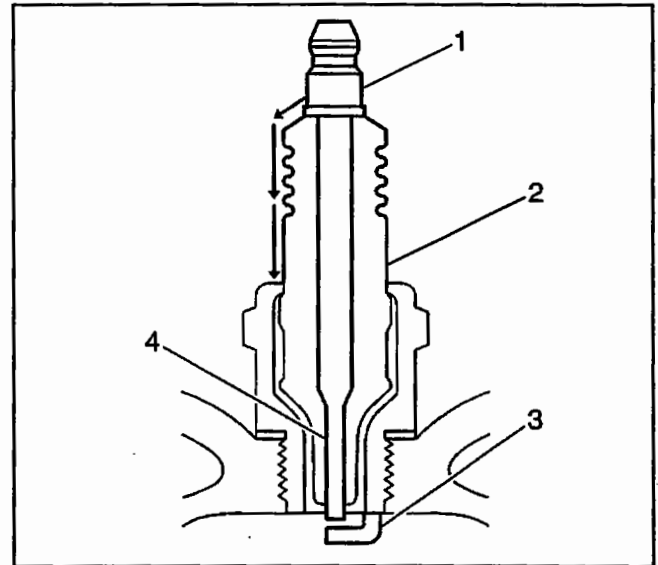
Spark Plug Usage

- Ensure that the correct spark plug is installed. An incorrect spark plug causes drivability conditions.
- Ensure that the spark plug has the correct heat range. An incorrect heat range causes the following conditions:
 - Spark plug fouling - colder plug
 - Pre-ignition causing spark plug and/or engine damage - hotter plug

Spark Plug Inspection

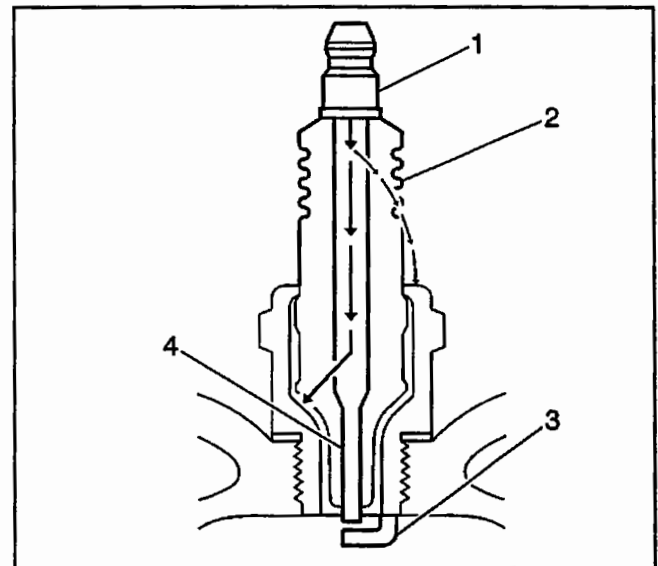
- Inspect the terminal post (1) for damage.
 - Inspect for a bent or broken terminal post (1).

- Test for a loose terminal post (1) by twisting and pulling the post. The terminal post (1) should NOT move.
- Inspect the insulator (2) for flashover or carbon tracking, soot. This is caused by the electrical charge traveling across the insulator (2) between the terminal post (1) and ground. Inspect for the following conditions:

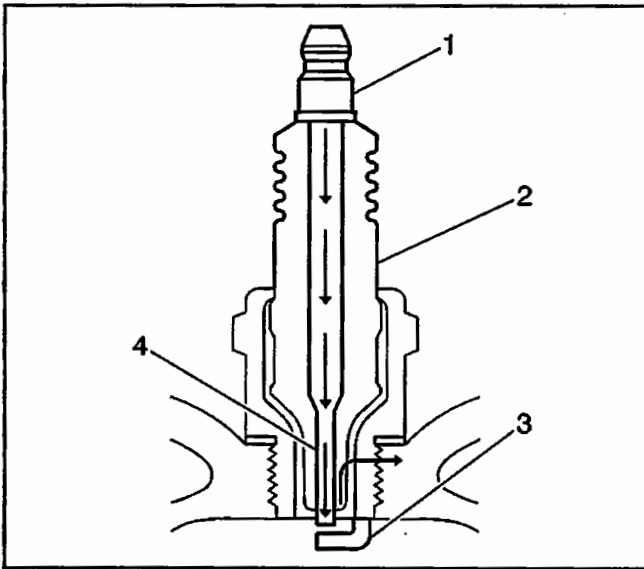


622529

- Inspect the spark plug boot for damage.
- Inspect the spark plug recess area of the cylinder head for moisture, such as oil, coolant or water. A spark plug boot that is saturated causes arcing to ground.
- Inspect the insulator (2) for cracks. All or part of the electrical charge may arc through the crack instead of the electrodes (3,4).



622528



622527

- Inspect for evidence of improper arcing.
 - Measure the gap between the center electrode (4) and the side electrode (3) terminals. An excessively wide electrode gap can prevent correct spark plug operation.
 - Inspect for the correct spark plug torque. Insufficient torque can prevent correct spark plug operation. An over torqued spark plug may cause the insulator (2) to crack.
 - Inspect for signs of tracking that occurred near the insulator tip instead of the center electrode (4).
 - Inspect for a broken or worn side electrode (3).
 - Inspect for a broken, worn or loose center electrode (4) by shaking the spark plug.
 - A rattling sound indicates internal damage.
 - A loose center electrode (4) reduces the spark intensity.
 - Inspect for bridged electrodes (3, 4). Deposits on the electrodes (3, 4) reduce or eliminates the gap.
 - Inspect for worn or missing platinum pads on the electrodes (3, 4), if equipped.
 - Inspect for excessive fouling.
- Inspect the spark plug recess area of the cylinder head for debris. Dirty or damaged threads can cause the spark plug not to seat correctly during installation.

Spark Plug Visual Inspection

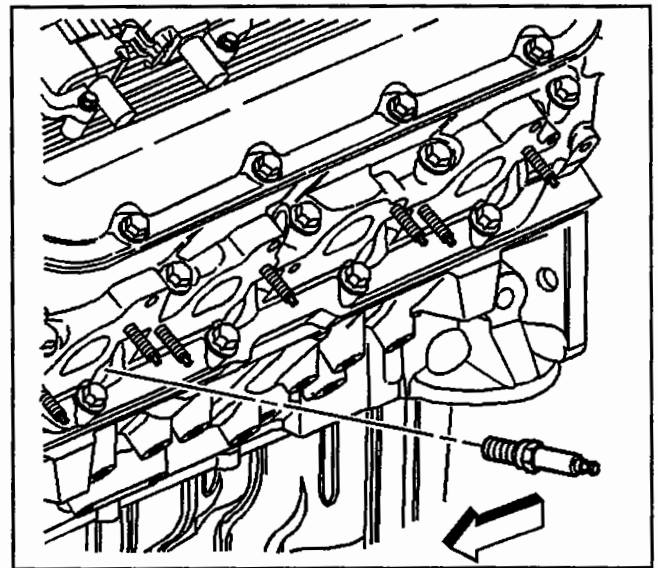
- Normal Operation - Brown to grayish-tan with small amounts of white powdery deposits are normal combustion by-products from fuels with additives.
- Carbon Fouled - Dry, fluffy black carbon, or soot caused by the following condition:
 - Rich fuel mixtures
 - Leaking fuel injectors
 - Excessive fuel pressure
 - Restricted flame arrestor/air filter element
 - Incorrect combustion
 - Reduced ignition system voltage output
 - Weak coil(s)
 - Worn ignition wires
 - Incorrect spark plug gap
 - Excessive idling or slow speeds under light loads can keep spark plug temperatures so low that normal combustion deposits may not burn off.

- Deposit Fouling - Oil, coolant or additives that include substances such as silicone, very white coating, reduces the spark intensity. Most powdery deposits will not effect spark intensity unless they form into a glazing over the electrode.

Spark Plug Replacement

Removal Procedure

1. Remove the spark plug wires. Refer to *Spark Plug Wire Replacement*.
2. Loosen each spark plug one or two turns.
3. Brush or air blast away any dirt from around the spark plugs.
4. Remove the spark plugs one at a time and place each plug in a tray marked with the corresponding cylinder numbers.



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Installation Procedure

1. Properly position each spark plug washer.
2. Inspect each spark plug gap. Adjust each plug as needed.

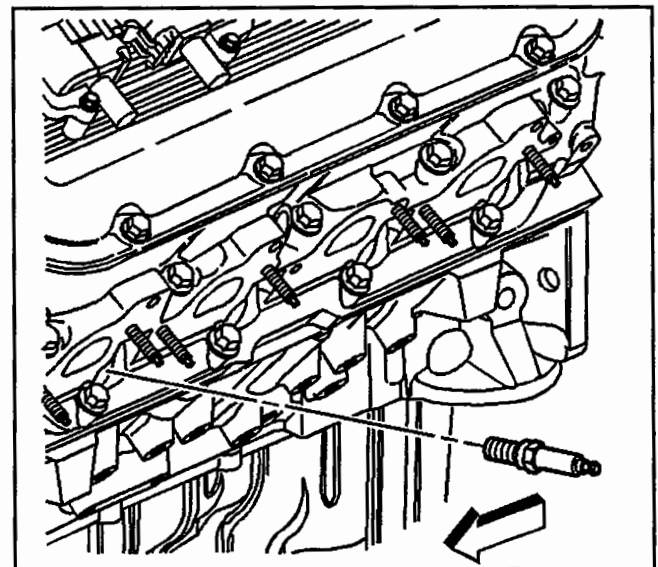
Specification

Spark plug gap: 1.524 mm (0.060 in)

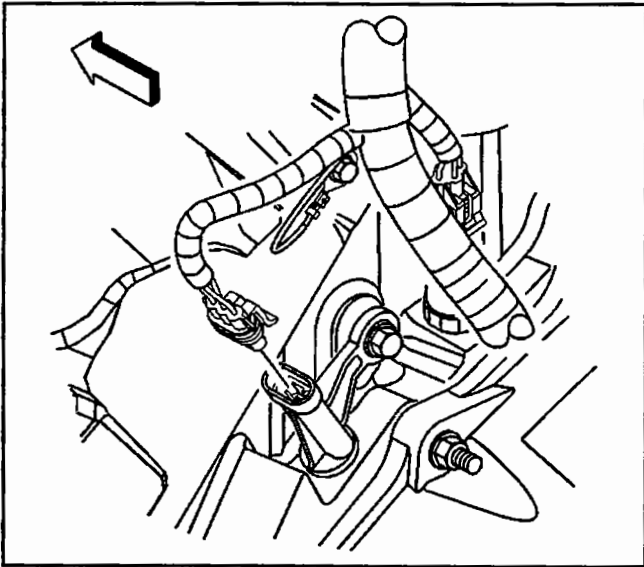
3. Install the spark plugs.

Tighten

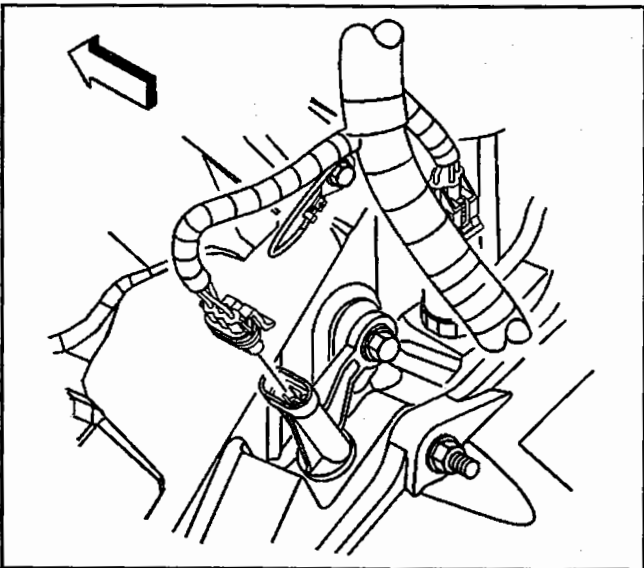
- For (IRON Head - all Subsequent Installations), tighten the spark plugs to 20 N·m (15 lb ft).
 - For new iron heads, tighten the spark plugs to 30 N·m (22 lb ft).
4. Install the spark plug wires. Refer to *Spark Plug Wire Replacement*.



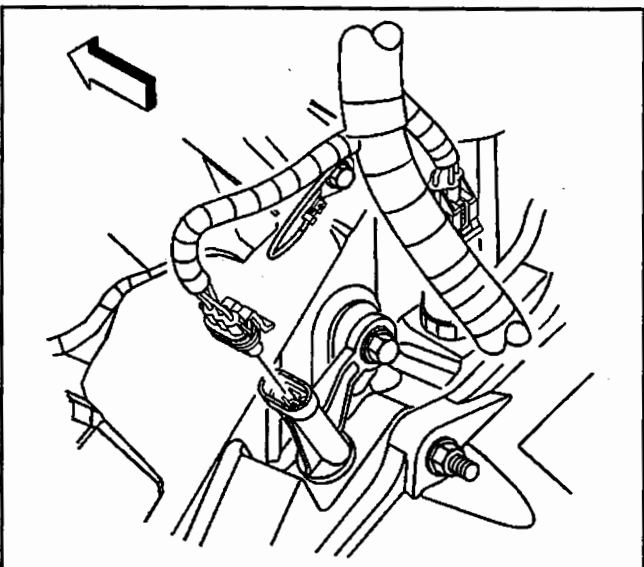
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674728



624728



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Crankshaft Position (CKP) Sensor Replacement

Removal Procedure

1. Disconnect the crankshaft position (CKP) sensor harness connector at the CKP sensor.
2. Remove the CKP sensor retaining bolt.
3. Remove the CKP sensor.

Installation Procedure

Important: Inspect the CKP sensor O-ring for wear or damage. If a problem is found, replace the O-ring. Lubricate the new O-ring with clean engine oil before installing.

1. Install the CKP sensor.
2. Install the CKP sensor retaining bolt.

Tighten

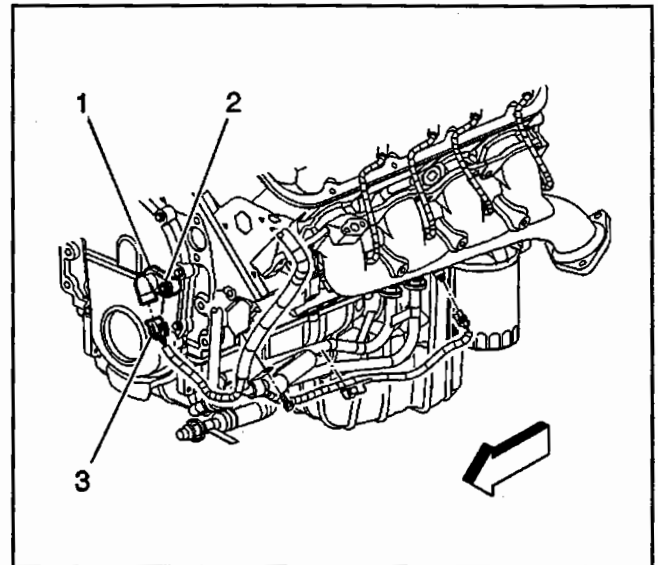
Tighten the bolt 10 N·m (88 lb in).

3. Connect the CKP sensor harness connector.

Camshaft Position (CMP) Sensor Replacement

Removal Procedure

1. Disconnect the camshaft position (CMP) sensor harness connector (3) from the CMP sensor (1).
2. Remove the CMP sensor retaining bolt (2).
3. Remove the CMP sensor (1).
4. Inspect the CMP sensor for wear, cracks or leakage if the sensor is not being replaced.

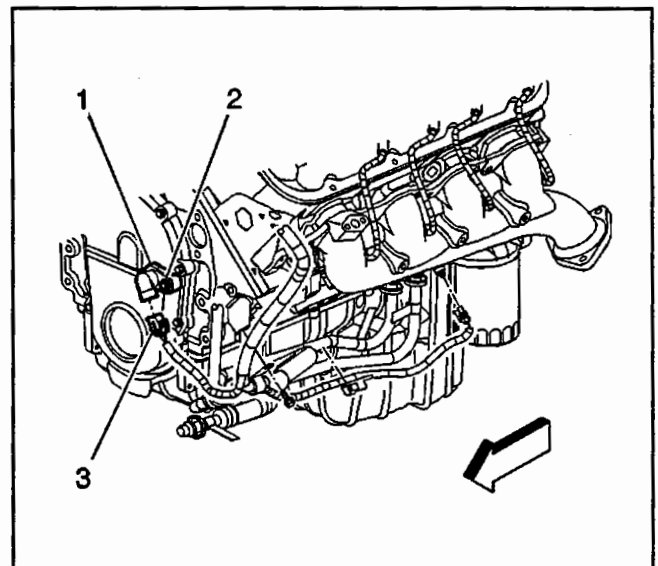


690593

Installation Procedure

Important: Inspect the CMP sensor O-ring for wear or damage. If a problem is found, replace the O-ring. Lubricate the new O-ring with clean engine oil before installing.

1. Install the CMP sensor (1).
 2. Install the CMP sensor retaining bolt (2).
- Tighten**
Tighten the bolt 10 N·m (88 lb in).
3. Connect the CMP sensor harness connector (3).

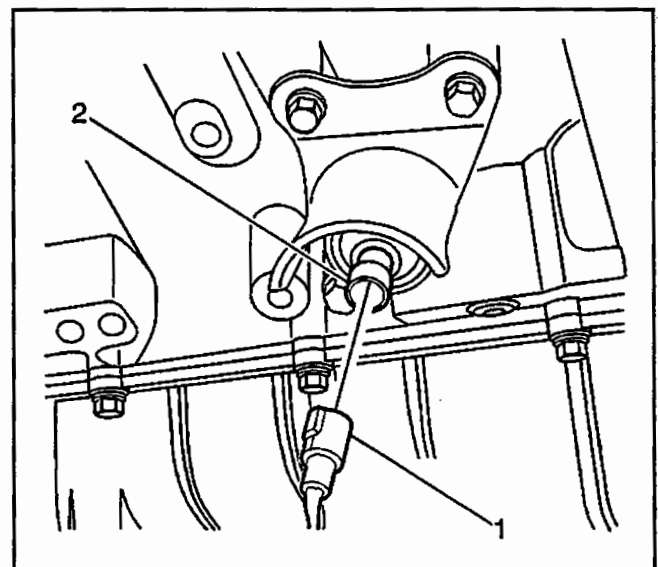


690593

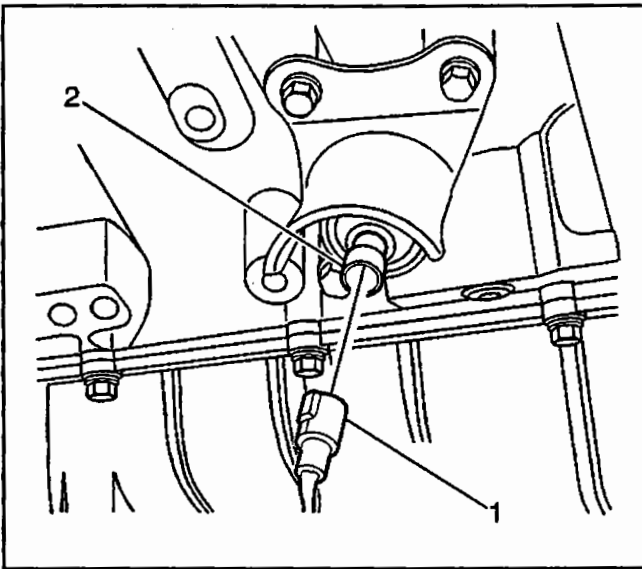
Knock Sensor (KS) 1 Replacement

Removal Procedure

1. Remove the wiring harness connector (1) from the knock sensor (2).
2. Remove the knock sensor (2) from the engine block.



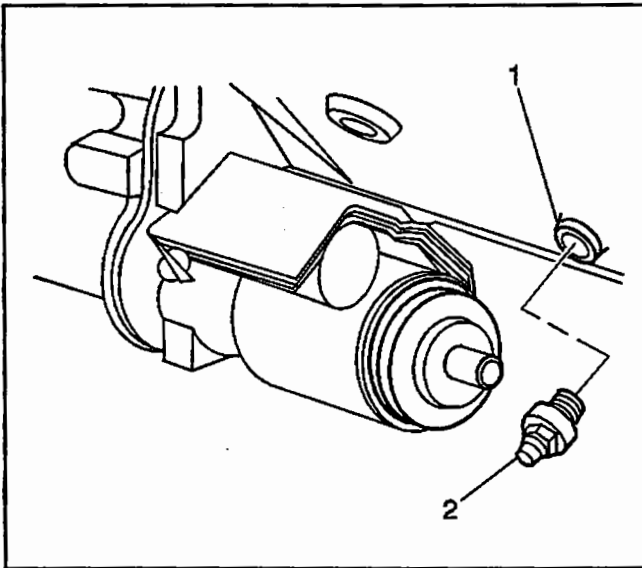
678815



678815

Installation Procedure

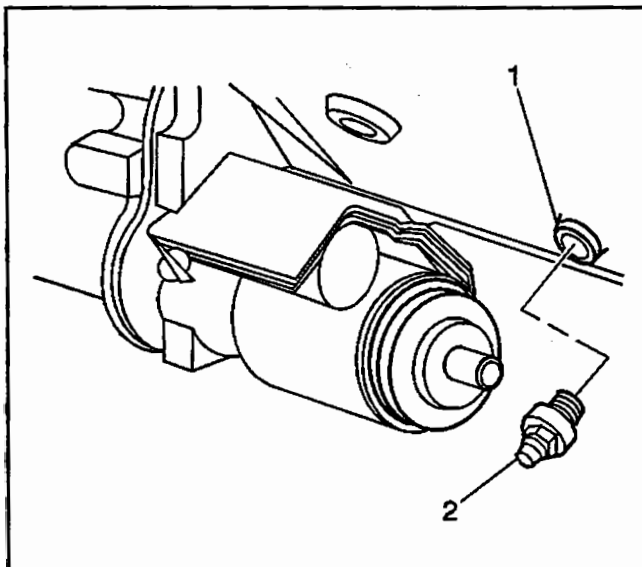
1. Install the knock sensor (2) into the engine block.
Tighten
Tighten the knock sensor to 19 N·m (14 lb ft).
2. Connect the knock sensor harness connector (1) to the knock sensor (2).



20272

Knock Sensor (KS) 2 Replacement**Removal Procedure**

1. Remove the wiring harness connector from the knock sensor (2).
2. Remove the knock sensor (2) from the engine block (1).



20272

Installation Procedure

1. Install the knock sensor (2) into the engine block (1).
Tighten
Tighten the knock sensor to 19 N·m (14 lb ft).
2. Connect the knock sensor harness connector to the knock sensor (2).

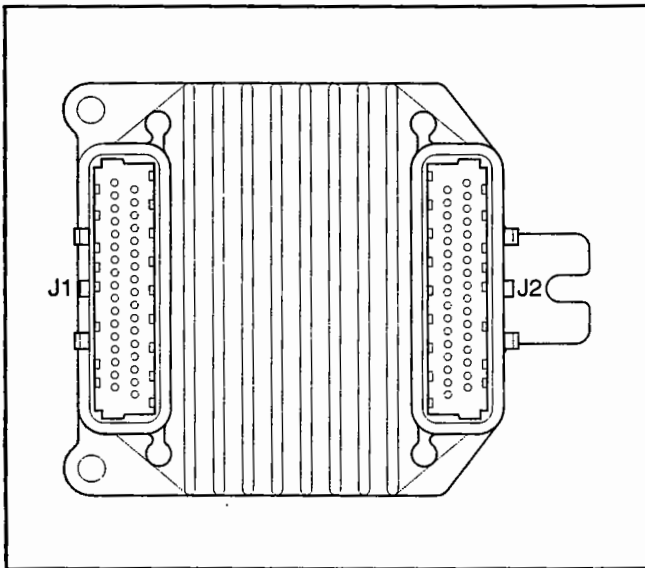
Description and Operation

Engine Control Module (ECM) Description

The engine control module (ECM) is designed to maintain exhaust emission levels while maintaining excellent driveability and fuel efficiency. The ECM controls the following conditions:

- The fuel control
- The ignition control (IC)
- The knock sensor (KS) system
- The idle air control (IAC)
- The exhaust gas recirculation (EGR)
- Various other discrete outputs

Engine Control Module (ECM)



mefi4332

The engine control module (ECM) is the control center of the engine and controls the following systems:

- The fuel metering system
- The ignition timing
- The on-board diagnostics

The ECM constantly monitors the information from various sensors and controls the systems that affect vehicle performance and emissions. The ECM also performs the diagnostic functions for those systems. The ECM can recognize operational problems and alert the operator through the malfunction indicator lamp (MIL) when a malfunction has occurred. When a malfunction is detected, the ECM stores a diagnostic trouble code (DTC) or a logged warning which helps to identify problem areas. This is done to aid the technician in making repairs.

The ECM supplies either 5.0 or 12.0 volts to power various sensors and switches. This is done through resistances in the ECM. The resistance is so high in value that a test

lamp does not illuminate when connected to the circuit. In some cases, even an ordinary shop voltmeter does not give an accurate reading because the voltmeters resistance is too low. Therefore, a DMM with a minimum of 10 megaohms input impedance is required to ensure accurate voltage readings.

The ECM controls output circuits such as the fuel injectors, ignition coils, the idle air control (IAC) and various relays by controlling the ground or power feed circuit through transistors or a device called an output driver module (ODM).

RPM Reduction Mode

RPM reduction mode is a function of the ECM that reduces engine power under certain conditions. RPM reduction will disable one fuel injector driver when the engine speed goes above a certain RPM and enable the fuel injector driver when the engine speed drops below a certain RPM. RPM reduction may be active for the following conditions:

- Engine coolant temperature too high
- Low oil pressure
- General warning 1
- General warning 2

ECM Function

The ECM supplies a buffered voltage to various sensors and switches. The ECM controls most components with electronic switches which complete a ground circuit when turned ON.

Use of Circuit Testing Tools

Do not use a test lamp in order to diagnose the engine electrical systems unless specifically instructed by the diagnostic procedures. Use the J 35616-A connector test adapter kit whenever diagnostic procedures call for probing any connectors.

Basic Knowledge Required

Without basic knowledge of electricity, it will be difficult to use the diagnostic procedures contained in this section. You should understand the basic theory of electricity and know the meaning of voltage (volts), current (amps) and resistance (ohms). You should understand what happens in a circuit with an open or shorted wire. You should be able to read and understand a wiring diagram.

ECM Service Precautions

The ECM is designed to withstand normal current draws associated with engine operation. Avoid overloading any circuit. When testing for opens or shorts, do not ground any of the ECM circuits unless instructed. When testing for opens or shorts, do not apply voltage to any of the ECM circuits unless instructed. Only test these circuits with a DMM while the ECM connectors remain connected.

Aftermarket (Add-On) Electrical And Vacuum Equipment

Aftermarket, add-on electrical and vacuum equipment is defined as any equipment installed on a vehicle after leaving the factory that connects to the vehicles electrical or vacuum systems.

Notice: Do not attach add-on vacuum operated equipment to this engine. The use of add-on vacuum equipment may result in damage to engine components or systems.

Notice: Connect any add-on electrically operated equipment to the vehicle's electrical system at the battery (power and ground) in order to prevent damage to the vehicle.

Add-on electrical equipment, even when installed to these strict guidelines, may still cause the powertrain system to malfunction. This may also include equipment not connected to the vehicle's electrical system such as portable telephones and radios. Therefore, the first step in diagnosing any powertrain problem, is to eliminate all aftermarket electrical equipment from the vehicle. After this is done, if the problem still exists, diagnose the problem in the normal manner.

Electrostatic Discharge Damage

Notice: In order to prevent possible Electrostatic Discharge damage to the ECM, Do Not touch the connector pins.

Electronic components used in the control systems are often designed in order to carry very low voltage. Electronic components are susceptible to damage caused by electrostatic discharge. Less than 100 volts of static electricity can cause damage to some electronic components. 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. 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 can cause damage. Therefore, it is important to use care when handling and testing electronic components.

Engine Controls Information

The driveability and emissions information describes the function and operation of the engine control module (ECM).

The engine controls information contains the following:

- Wiring diagrams
- ECM terminal end views and terminal definitions
- On-Board Diagnostic (OBD) System Check
- Diagnostic Trouble Code (DTC) tables

The Component System includes the following items:

- Component and circuit description
- Service for each sub-system
- Functional checks and diagnostic tables

The DTCs also contain diagnostic support information containing circuit diagrams, circuit or system information and helpful diagnostic information.

Visual and Physical Inspection

Important: This visual and physical inspection is very important. Perform this inspection carefully and thoroughly. Perform a careful visual and physical inspection when performing any diagnostic procedure. This can often lead to repairing a problem without further steps. Use the following guidelines when performing a visual and physical inspection:

- Inspect all vacuum hoses for the following conditions:
 - Correct routing
 - Pinches
 - Cuts
 - Disconnects
- Inspect all wires in the engine compartment for the following conditions:
 - Proper connections
 - Burned or chafed spots
 - Pinched wires
 - Contact with sharp edges
 - Contact with hot exhaust manifolds

Basic Knowledge Of Tools Required

Important: Lack of basic knowledge of this powertrain when performing diagnostic procedures could result in incorrect diagnosis or damage to powertrain components. Do not attempt to diagnose a powertrain problem without this basic knowledge.

A basic understanding of hand tools is necessary in order to effectively use this information.

Heated Oxygen Sensors

The main function of the heated oxygen sensor (HO2S) is to provide the ECM with exhaust stream information in order to maintain proper fueling to hold emissions within acceptable levels. After the sensor reaches the operating temperature, the sensor generates a voltage inversely proportional to the amount of oxygen present in the exhaust gases.

The ECM uses the signal voltage from the heated oxygen sensors in order to adjust the fuel injector pulse width. While in a Closed Loop, the ECM can adjust fuel delivery in order to maintain an air fuel ratio which allows the best combination of emission control and driveability.

If the oxygen sensor pigtail wiring, connector or terminal are damaged, replace the entire oxygen sensor assembly. Do not attempt to repair the wiring, the connector or the terminals. In order for the sensor to function properly, the sensor must have a clean air reference provided to it. This clean air reference is obtained by way of the oxygen sensor wires. Any attempt to repair the wires, connector or terminals, could result in the obstruction of the air reference. This could also degrade oxygen sensor performance.

Input Components

The ECM monitors the input components for circuit continuity and out-of-range values. This includes performance checking. Performance checking refers to indicating a fault when the signal from a sensor does not seem reasonable, such as a throttle position (TP) sensor that indicates high throttle position at low engine loads or MAP voltage. The input components may include, but are not limited to, the following sensors:

- Vehicle speed sensor (VSS)
- Intake air temperature (IAT) sensor
- Crankshaft position (CKP) sensor
- Camshaft position (CMP) sensor
- Knock sensor (KS)
- Throttle position (TP) sensor
- Engine coolant temperature (ECT) sensor
- Manifold absolute pressure (MAP) sensor

Output Components

Diagnose the output components for the proper response to ECM commands. Components where functional monitoring is not feasible, will be monitored for circuit continuity and out-of-range values, if applicable.

Output components to be monitored include, but are not limited to, the following circuits:

- The vehicle speed sensor (VSS)
- The malfunction indicator lamp (MIL) control
- The check gauges lamp control
- The general warning 1 and general warning 2 lamp controls
- The buzzer control

Wiring Harness Service

Replace the wire harnesses with the proper part number replacement. When splicing signal wires into a harness, use the wiring that has high temperature insulation.

Consider the low amperage and voltage levels utilized in the engine control systems. Make the best possible bond at all splices. Use rosin-core solder in these areas.

Molded-on connectors require complete replacement of the connector. Splice a new connector into the harness.

Connector and Terminals

In order to prevent shorting between opposite terminals, use care when probing a connector and when replacing terminals. Damage to the components could result.

Always use jumper wires between connectors for circuit checking.

Never probe through Weather-Pack seals.

The J 35616-A connector test adapter kit, or the equivalent, contains an assortment of flexible connectors used to probe terminals during diagnosis.

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 temporarily correct the open circuit. Oxidized or loose connections may cause intermittent problems.

Be certain of the type of connector and terminal before making any connector or terminal repair.

Fuel System Description

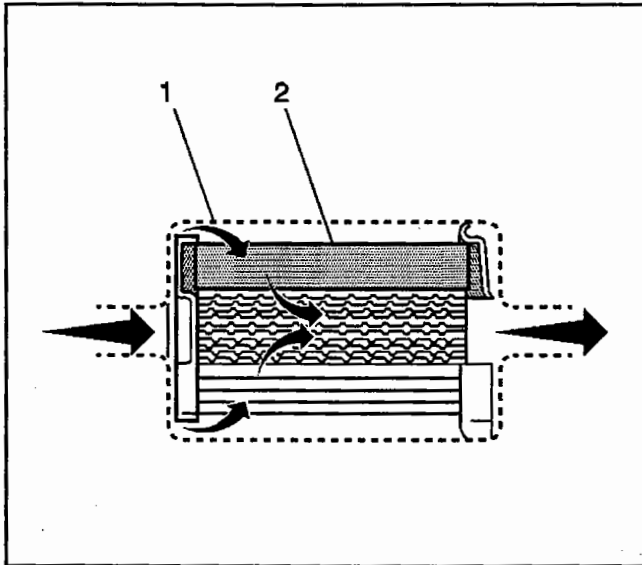
Fuel System Overview

The fuel tank stores the fuel supply. An electric fuel pump pumps fuel through an in-line fuel filter to the fuel rail assembly. The fuel pump supplies fuel at a pressure more than is needed by the injectors. The fuel pressure regulator, part of the fuel rail assembly, keeps fuel available to the fuel injectors at a regulated pressure. A separate pipe returns unused fuel to the fuel tank.

Fuel Pump

The fuel pump is an electric high pressure pump. Fuel is pumped to the fuel rail at a specified flow and pressure. Excess fuel from the fuel rail assembly returns to the fuel tank through the fuel return pipe. The fuel pump delivers a constant flow of fuel to the engine even during low fuel conditions and aggressive vehicle maneuvers. The engine control module (ECM) controls the electric fuel pump operation through a fuel pump relay.

In-Line Fuel Filter



12628

The fuel filter is located on the fuel feed pipe, between the fuel pump and the fuel injectors. The paper filter element (2) traps particles in the fuel that may damage the fuel injection system. The filter housing (1) is made to withstand maximum fuel system pressure, exposure to fuel additives and changes in temperature.

Fuel Feed and Return Pipes

The fuel feed pipe carries fuel from the fuel tank to the fuel rail assembly. The fuel return pipe carries unused fuel from the fuel rail assembly back to the fuel tank.

Nylon Fuel Pipes

Nylon pipes are constructed to withstand maximum fuel system pressure, exposure to fuel additives and changes in temperature. There are 3 sizes of nylon pipes used: 3/8 in. ID for the fuel feed, 5/16 in. ID for the fuel return and 1/2 in. ID for the vent. Heat resistant rubber hose or corrugated plastic conduit protect the sections of the pipes that are exposed to chafing, high temperature or vibration.

Nylon fuel pipes are somewhat flexible and can be formed around gradual turns. However, if nylon fuel pipes are forced into sharp bends, the pipes kink and restrict the fuel flow. Also, once exposed to fuel, nylon pipes may become stiffer and are more likely to kink if bent too far. Take special care when working on a vehicle with nylon fuel pipes.

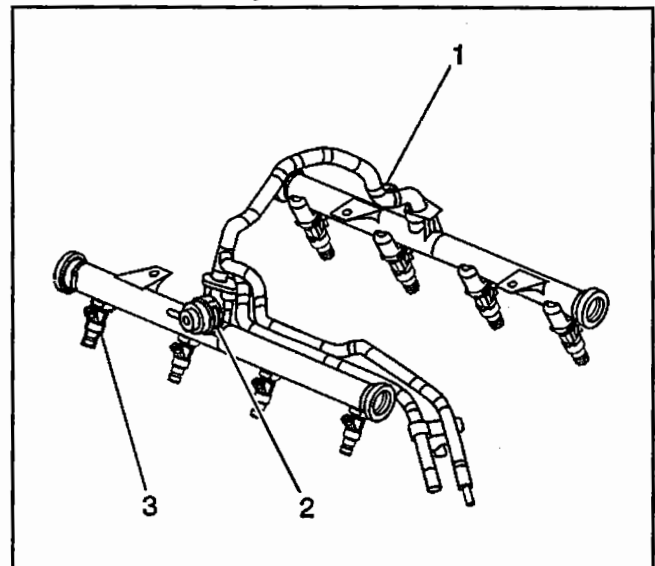
Quick-Connect Fittings

Quick-Connect fittings provide a simplified means of installing and connecting fuel system components. The fittings consists of a unique female connector and a compatible male pipe end. O-rings, located inside the female connector, provide the fuel seal. Integral locking tabs inside the female connector hold the fittings together.

Fuel Pipe O-Rings

O-rings seal the threaded connections in the fuel system. Fuel system O-ring seals are made of special material. Service the O-ring seals with the correct service part.

Fuel Rail Assembly



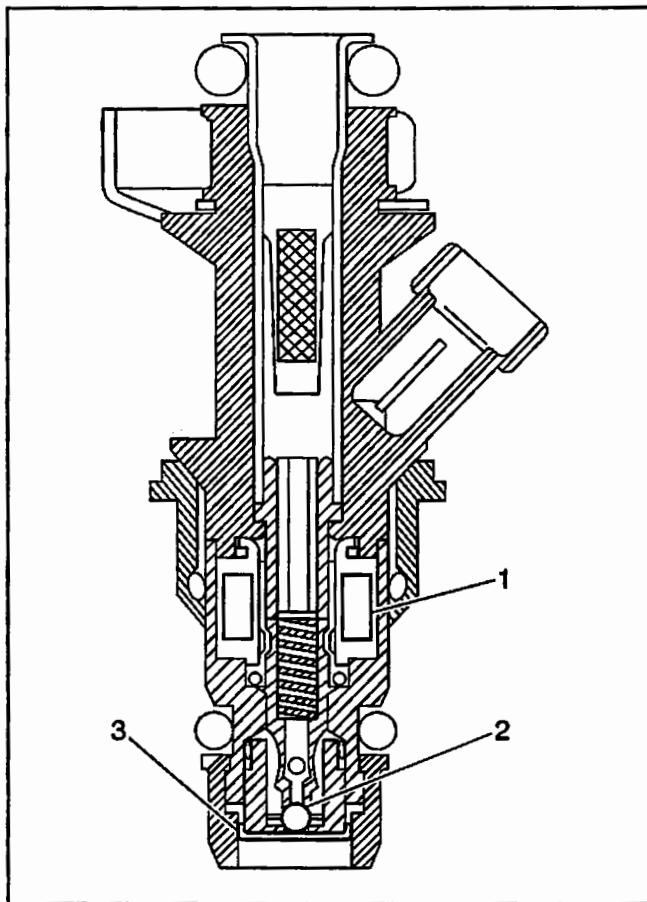
341661

The fuel rail assembly attaches to the engine intake manifold. The fuel rail assembly performs the following functions:

- Positions the injectors (3) in the intake manifold
- Distributes fuel evenly to the injectors
- Integrates the fuel pressure regulator (2) with the fuel metering system

Fuel Injectors

Fuel Injectors

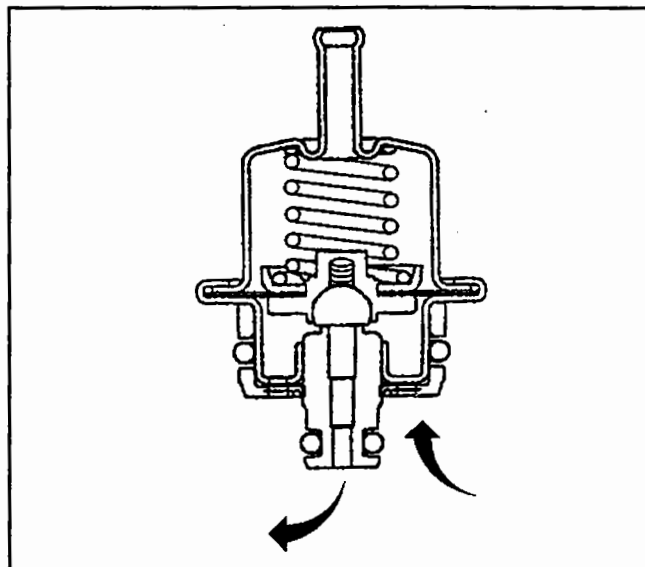


351198

The Multec 2 fuel injector assembly is a solenoid operated device, controlled by the ECM, that meters pressurized fuel to a single engine cylinder. The ECM energizes the high-impedance (12.2 ohms) injector solenoid (1) to open a normally closed ball valve (2). This allows fuel to flow into the top of the injector, past the ball valve and through a director plate (3) at the injector outlet. The director plate has four machined holes that control the fuel flow, generating a spray of finely atomized fuel at the injector tip. Fuel from the injector tip is directed at the intake valve, causing it to become further atomized and vaporized before entering the combustion chamber. An injector stuck partly open can cause a loss of pressure after engine shutdown. Consequently, long engine cranking times would be noticed on some engines.

Fuel Pressure Regulator Assembly

The fuel pressure regulator is a vacuum operated diaphragm relief valve with fuel pump pressure on one side and regulator spring pressure and intake manifold vacuum on the other side. The fuel pressure regulator maintains a constant pressure differential across the injectors at all times. The pressure regulator compensates for engine load by increasing fuel pressure as the engine vacuum drops.



69059

Fuel Metering Modes of Operation

The engine control module (ECM) reads voltages from several sensors in order to determine how much fuel to give the engine. The fuel is delivered under one of several conditions called modes. The ECM controls all modes.

Starting Mode

With the ignition switch in the ON position, before engaging the starter, the ECM energizes the fuel pump relay for 2 seconds allowing the fuel pump to build up pressure. The ECM uses the engine coolant temperature (ECT), the throttle position (TP) and the manifold absolute pressure (MAP) sensors to determine the proper air/fuel ratio for starting. The ECM controls the amount of fuel delivered in the starting mode by changing the pulse width of the injectors. This is done by pulsing the injectors for very short times.

Clear Flood Mode

If the engine floods, clear the engine by opening the throttle plates to 100 percent. When the throttle position (TP) sensor is at wide open throttle, the ECM reduces the injector pulse width in order to increase the air to fuel ratio. The ECM holds this injector rate as long as the throttle stays wide open and the engine speed is below a predetermined RPM. If the throttle is not held wide open, the ECM returns to the starting mode.

Run Mode

The run mode has 2 conditions called Open Loop and Closed Loop. When the engine is first started and the engine speed is above a predetermined RPM, the system begins Open Loop operation. The ECM ignores the signal from the heated oxygen sensor (HO2S) and calculates the air/fuel ratio based on inputs from the ECT, MAP and TP sensors. The system stays in Open Loop until meeting the following conditions:

- The HO2S has varying voltage output, showing that

it is hot enough to operate properly. This depends on the engine temperature.

- The ECT sensor is above a specified temperature.
- A specific amount of time has elapsed after starting the engine.

Specified values for the above conditions exist for each different engine, and are stored in the electrically erasable programmable read-only memory (EEPROM). The system begins Closed Loop operation after reaching these values. In Closed Loop, the ECM calculates the air/fuel ratio (injector on-time) based upon the signal from various sensors, but mainly from the HO2S.

Acceleration Mode

When the driver moves the accelerator, 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 ECM determines the amount of fuel required based upon the throttle position, the coolant temperature, the manifold pressure and the engine speed.

Deceleration Mode

When the driver releases the accelerator, air flow into the engine is reduced. The ECM reads the corresponding changes in throttle position and manifold pressure. The ECM shuts OFF fuel completely if the deceleration is very rapid, or for long periods.

Battery Correction Mode

When the battery voltage is low, the ECM compensates for the weak spark delivered by the ignition system in the following ways:

- Increasing the amount of fuel delivered
- Increasing the idle RPM
- Increasing the ignition dwell time

Fuel Cutoff Mode

The ECM cuts off fuel from the fuel injectors when the following conditions are met in order to protect the powertrain from damage and improve driveability:

- The ignition is OFF. This prevents engine run-on.
- The ignition is ON but there is no ignition reference signal. This prevents flooding or backfiring.
- Engine speed is too high, above rev limit.

Electronic Ignition (EI) System Description

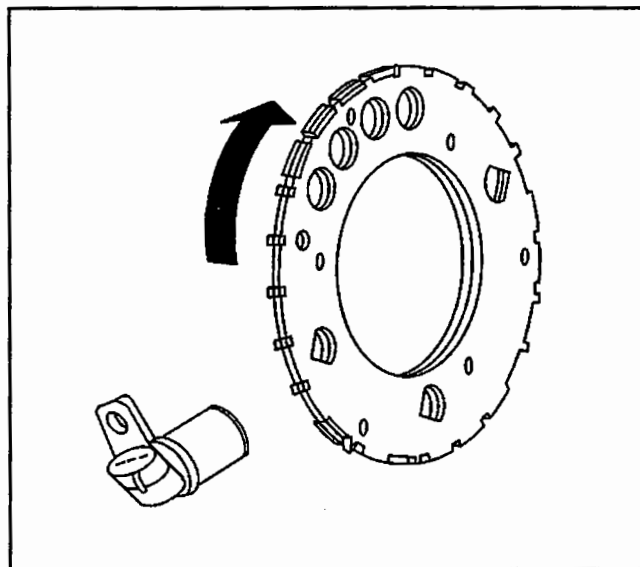
Ignition System Overview

The ignition system consists of the following components or circuits:

- The 8 ignition secondary wires
- The 8 ignition coils

- The 8 ignition control (IC) circuits
- The camshaft position (CMP) sensor
- The camshaft reluctor wheel
- The crankshaft position (CKP) sensor
- The crankshaft reluctor wheel
- The related connecting wires
- The engine control module (ECM)

Crankshaft Position (CKP) Sensor and Reluctor Wheel

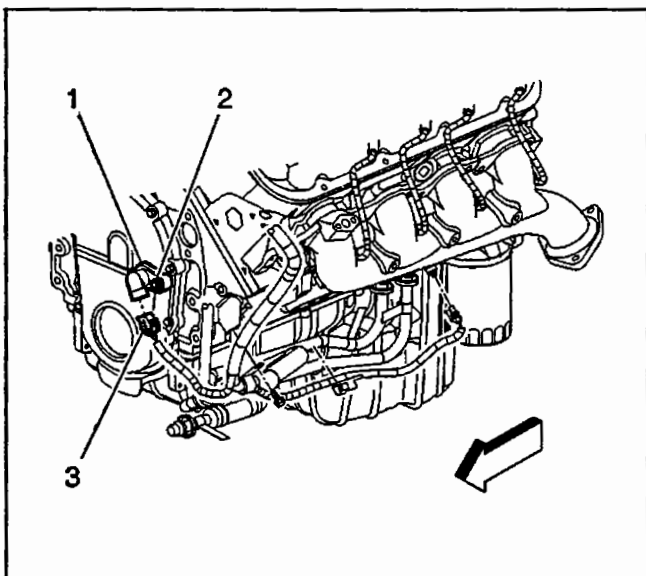


65872

The crankshaft position (CKP) sensor is a magneto resistive type sensor. The CKP sensor works in conjunction with a 24X reluctor wheel. The reluctor wheel is mounted on the rear of the crankshaft. The 24X reluctor wheel uses 2 different width notches that are 15 degrees apart. This pulse width encoded pattern allows cylinder position identification within 90 degrees of crankshaft rotation. In some cases, this can be achieved within 45 degrees of crankshaft rotation. The reluctor wheel also has dual track notches that are 180 degrees out of phase. This design allows for quicker starts and accuracy. The CKP sensor also outputs a 4X signal for spark control, tachometer output and fuel control. All CKP signals are output as a digital waveform.

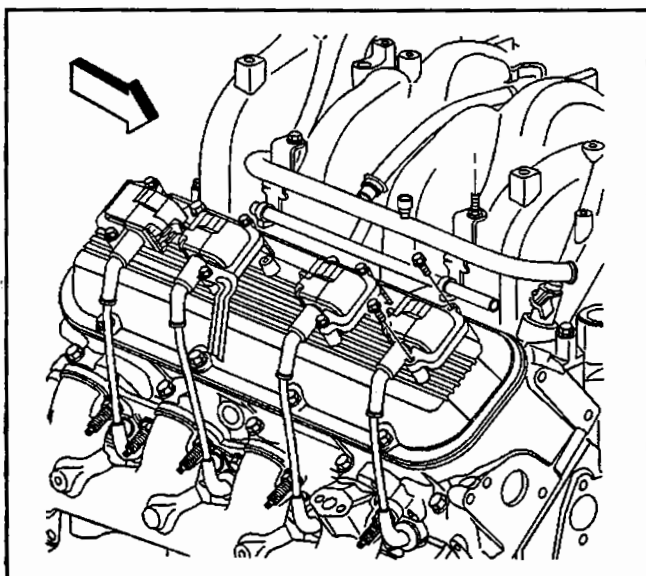
Camshaft Position (CMP) Sensor and Reluctor Wheel

The camshaft position (CMP) sensor works in conjunction with a 1X reluctor wheel mounted at the rear of the camshaft. The CMP is used to determine the top dead center position of cylinder #1, and will synchronize with the 24X CKP sensor signal for quicker starting. The CMP signals are output as a digital waveform.



690593

Ignition Coils

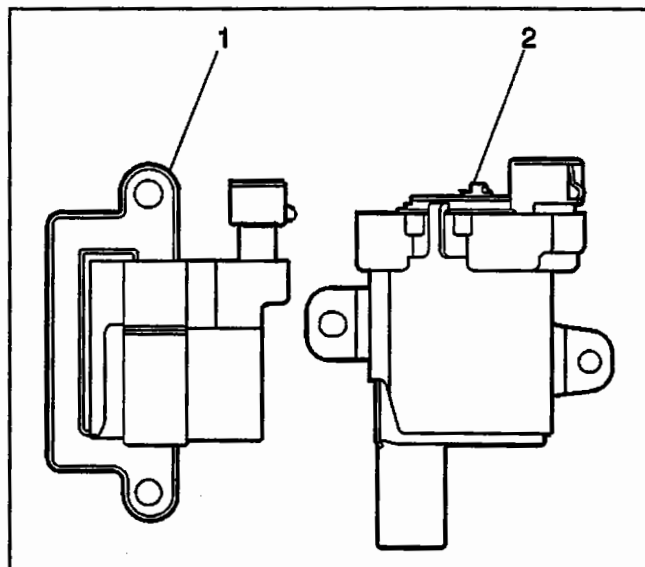


703554

The ignition system on this engine features a multiple coil configuration and is known as coil near plug. There are two styles of ignition coil assemblies (1,2). The engine could have either style. The ignition coil mounting bracket is attached to the rocker cover.

The 8 ignition coils are individually mounted above each cylinder on the rocker covers, the coils are fired sequentially. There is an ignition control (IC) circuit for each ignition coil. The 8 ignition control circuits are connected to the ECM. The ECM triggers each ignition coil individually and makes all timing decisions. The ignition coils are supplied with the following circuits:

- The ignition voltage circuit
- The ignition control circuit
- The ground circuit
- The reference low circuit



260177

The ignition voltage circuits also supply the power for the fuel injectors. Each coil is serviced separately.

This system puts out very high ignition energy for plug firing. Less energy is lost to ignition wire resistance because the ignition wires are much shorter than in a conventional ignition system.

Circuits Affecting Ignition Control

To properly control ignition timing, the ECM relies on the following information:

- The engine load, manifold pressure or vacuum
- The atmospheric, barometric, pressure
- The engine temperature
- The intake air temperature, if applicable
- The crankshaft position
- The engine speed (RPM)

The ignition control (IC) system consists of the following components:

- The ignition coils
- The 24X crankshaft position sensor
- The engine control module (ECM)
- All connecting wires

The ignition control utilizes the following to control spark timing functions:

- The 24X signal - The 24X crankshaft position sensor sends a signal to the ECM. The ECM uses this signal to determine crankshaft position.
- The ignition control (IC) circuits - The ECM uses these circuits to trigger the ignition coils.

Noteworthy Ignition Information

There are important considerations to point out when servicing the ignition system. The following noteworthy

information will list some of these to help the technician in servicing the ignition system.

- The ignition coils secondary voltage output capabilities are very high - more than 40,000 volts. Avoid body contact with ignition high voltage secondary components when the engine is running or personal injury may result.
- The 24X crankshaft position (CKP) sensor is the most critical part of the ignition system. If the sensor is damaged so that the pulses are not generated, the engine does not start.
- The CKP sensor clearance is very important. If the interrupter ring is bent or damaged in any way, the CKP sensor may be destroyed. Extreme care must be exercised during removal and installation procedures.
- The ignition timing is not adjustable. There are no timing marks on the crankshaft balancer or the timing chain cover.
- Be careful not to damage the secondary ignition wires or boots when servicing the ignition system. Rotate each boot in order to dislodge the boot from the plug or coil tower before pulling the boot from the spark plug or the ignition coil tower.

Engine Control Module (ECM)

The ECM is responsible for maintaining proper spark and fuel injection timing for all driving conditions. To provide optimum driveability and emissions, the ECM monitors input signals from the additional following components in calculating ignition control (IC) spark timing:

- The engine coolant temperature (ECT) sensor
- The intake air temperature (IAT) sensor
- The throttle position (TP) sensor
- The vehicle speed sensor (VSS)

Knock Sensor (KS) System Description

Purpose:

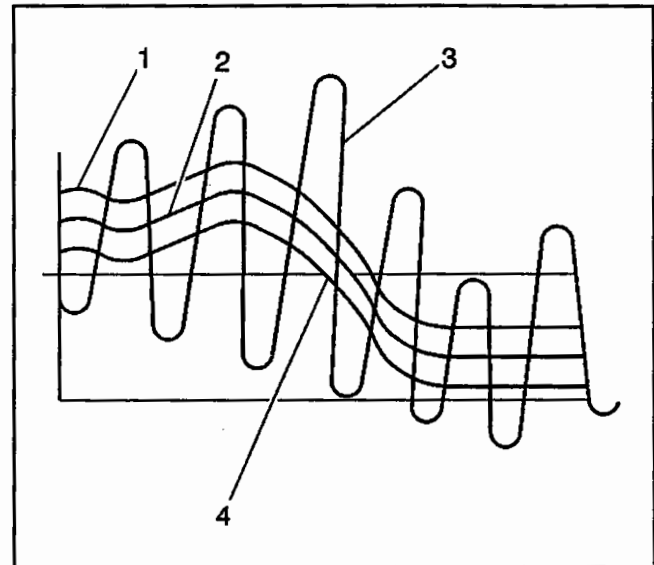
To control spark knock (detonation), a knock sensor (KS) system is used. This system is designed to retard spark timing when excessive spark knock is detected in the engine. The KS system allows the engine to use maximum spark advance for optimal driveability and fuel economy under all operating conditions.

Operation:

The ECM uses a knock sensor(s) to detect abnormal vibration in the engine (detonation/spark knock). Mounted on the engine block, the knock sensor(s) produces an AC voltage signal at all engine speeds and loads. The ECM then adjusts the spark timing based on the amplitude and frequency of the KS signal. The ECM uses the KS signal to calculate an average voltage. Then, the ECM assigns a

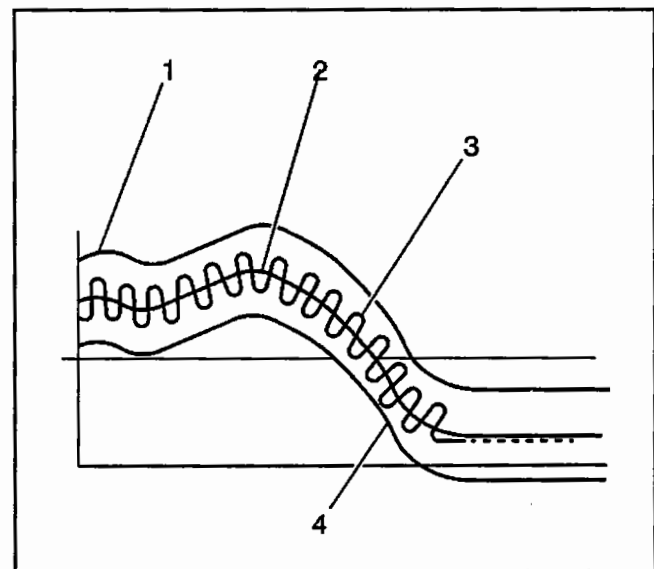
voltage range above and below the average voltage value. The ECM checks the KS and related wiring by comparing the actual knock signal to the assigned voltage range. A normal KS signal should vary outside the assigned voltage range as shown in the NORMAL KS figure. If the ECM detects a KS signal within the assigned voltage range as shown in the ABNORMAL KS figure, the applicable DTC will set.

Normal Knock Sensor Signal



245253

Abnormal Knock Sensor Signal



245257

Legend

1. Upper fail region
2. Knock sensor calculated average
3. Knock sensor signal
4. Lower fail region

Ignition Coils

A diagnostic trouble code (DTC) may set for the following conditions or faults:

The ECM malfunctions in a manner which will not allow the ECM to run a diagnostic of the KS circuit.

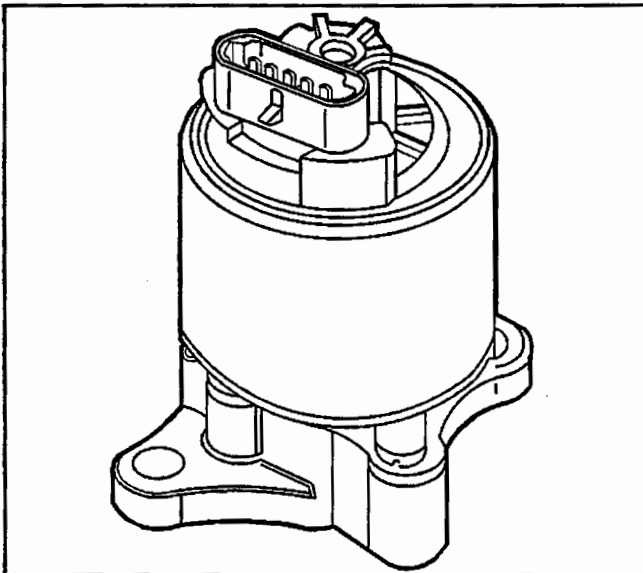
The KS signal is within the assigned voltage range.

The KS signal is not present.

The ECM is unable to eliminate the knocking condition using maximum spark retard.

Exhaust Gas Recirculation (EGR) System Description

EGR Valve



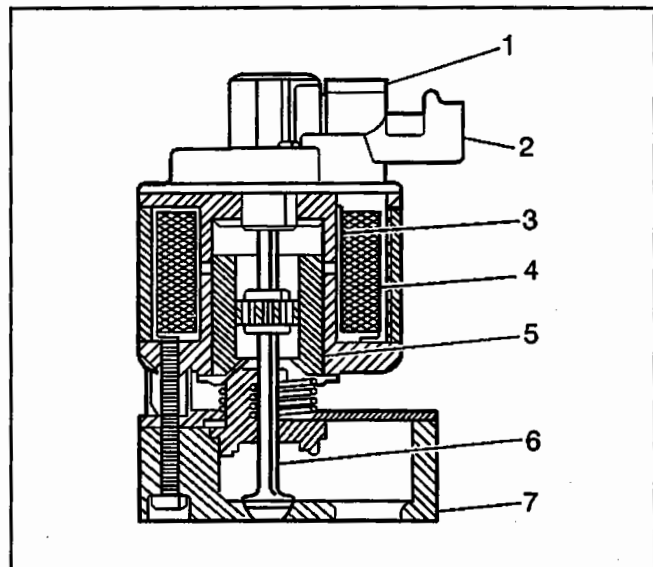
14441

Purpose

An exhaust gas recirculation (EGR) system is used in order to lower oxides of nitrogen (NOx) emission levels. The EGR system accomplishes this by feeding small amounts of exhaust gas back into the combustion chamber. High combustion temperatures cause NOx. Combustion temperatures are reduced when the air-fuel mixture is diluted with the exhaust gases.

Operation

The EGR valve is designed to accurately supply exhaust gases to the engine without the use of intake manifold vacuum. The EGR valve controls the exhaust flow into the intake manifold from the exhaust manifold through an orifice with a engine control module (ECM) controlled pintle. The ECM controls the pintle position using inputs from the engine coolant temperature (ECT) sensor, the throttle position (TP) sensor and the manifold absolute pressure (MAP) sensor. The ECM commands the EGR valve in order to supply the correct amount of exhaust gas recirculation for the current engine operating conditions. This can be monitored on a scan tool as the Desired EGR Position.



11696

Legend

1. Cap-Sensor
2. Sensor-EGR Pintle Position
3. Pole Piece-Primary
4. Bobbin and Coil Assembly
5. Sleeve-Armature
6. Valve-Pintle
7. Armature and Base Assembly

The ECM monitors the position of the EGR valve through a feedback signal. The ECM supplies a 5.0 volt reference and a ground to the EGR valve. A voltage signal representing the EGR valve pintle position is sent to the ECM from the EGR valve. This feedback signal can also be monitored on a scan tool and is the actual position of the EGR valve pintle. The actual EGR position should always be near the commanded or desired EGR position.

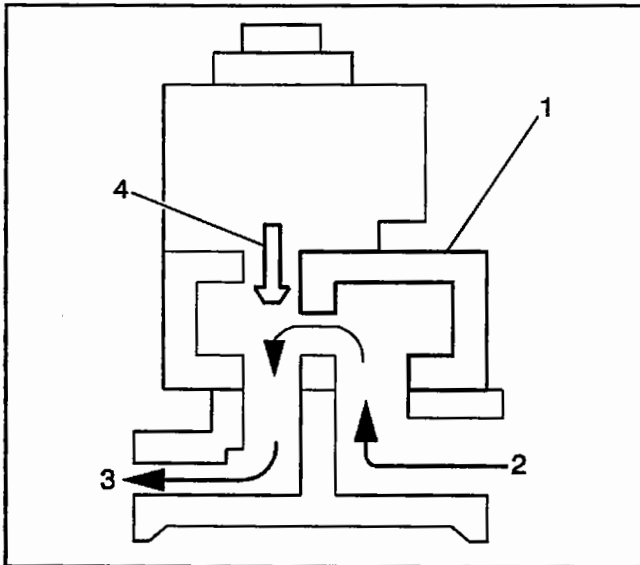
The EGR valve is usually activated under the following conditions:

- The engine is warm.
- The engine is above the idle speed.

Diagnosis

Too much EGR flow causes any of the following conditions to occur:

- The engine stalls after a cold start.
- The engine stalls during closed throttle conditions.
- The engine surges during a cruise condition.
- A rough idle



11699

Legend

1. Linear EGR Valve
2. Exhaust Gas
3. To Cylinders
4. Pintle

Too little or no EGR flow allows the combustion temperatures to increase. This causes the following symptoms:

- Spark knock, detonation
- Engine overheating
- Poor fuel economy

Special Tools and Equipment

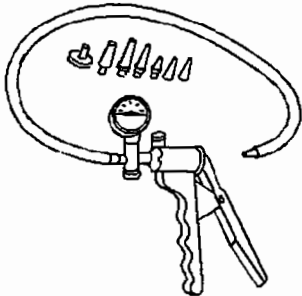
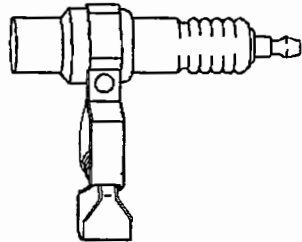
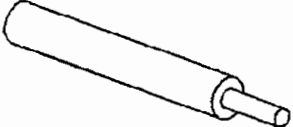
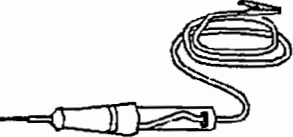
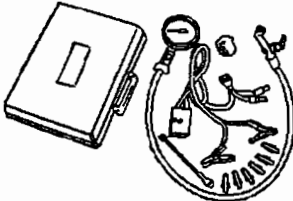
Illustration	Tool Number/Description
	<p>J 23738-A Vacuum Pump</p>
	<p>J 26792 Spark Tester</p>
	<p>J 28742-A Weather Pack Terminal Remover</p>
	<p>J 34142-B Test Lamp</p>
	<p>J 34730-E Fuel Pressure Gauge Kit</p>

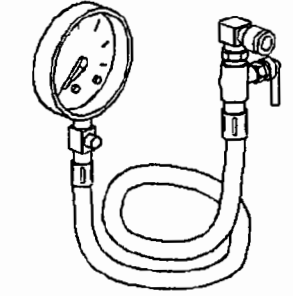
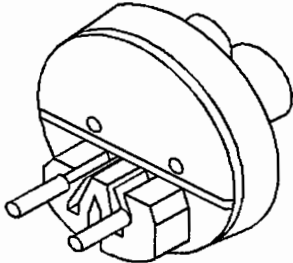
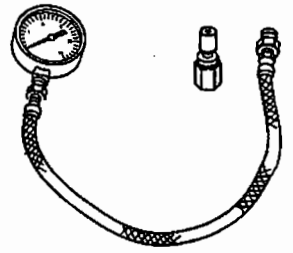

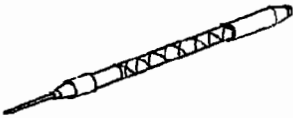
Illustration	Tool Number/Description
	<p>J 34730-1A Fuel Pressure Gauge</p>
	<p>J 34730-405 Injector Test Lamp</p>
	<p>J 35314-A Exhaust Back Pressure Tester</p>
	<p>J 35616-A Connector Test Adapter Kit</p>
	<p>J 35689-A Metri-Pack Terminal Kit</p>

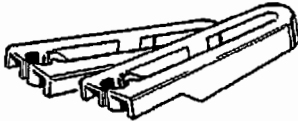
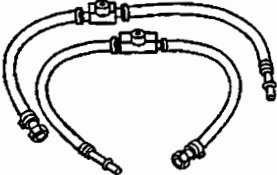
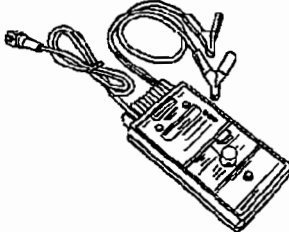
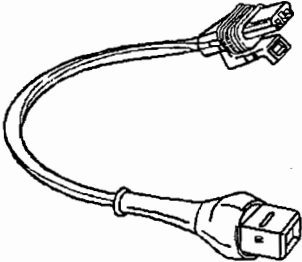


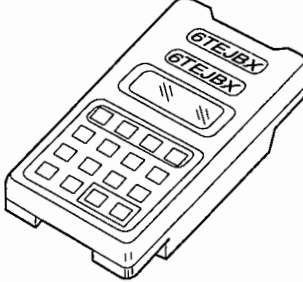
Illustration	Tool Number/Description
	<p>J 37088-A Fuel Line Quick Connect Separator</p>
	<p>J 37287 Inlet and Return Fuel Line Shut-Off Adapters</p>
	<p>J 39021 Fuel Injector Coil and Balance Tester</p>
	<p>J 39021-380 Fuel Injector Test Harness</p>
	<p>J 39200 Digital Multimeter</p>

Illustration	Tool Number/Description
	<p>J 43013 Fuel Injector Assembly Removal Tool</p>
	<p>Scan Tool</p>

