GENERAL MOTORS MARINE ELECTRONIC FUEL INJECTION (MEFI) TROUBLESHOOTING AND REPAIR

(MEFI 2 - 1996 Software)

PLEASURECRAFT® ENGINE GROUP

SEA MAXX MARINE ENGINES PCM Crusader

This Page Was

Intentionally Left

Blank

Marine Electronic Fuel Injection (MEFI)

Section 1

General Information

Contents

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 at the end of this section.

Electrostatic Discharge Damage

Electronic components used in control systems are often designed to carry very low voltage, and are very susceptible to damage caused by electrostatic discharge. It is possible for less than 100 volts of static electricity to cause damage to some electronic components. By comparison, it takes as much as 4,000 volts for a person to 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 and an object 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 52. When a malfunction is detected by the ECM, a DTC is set and the Malfunction Indicator Lamp (MIL) is illuminated.

Malfunction Indicator Lamp (MIL)

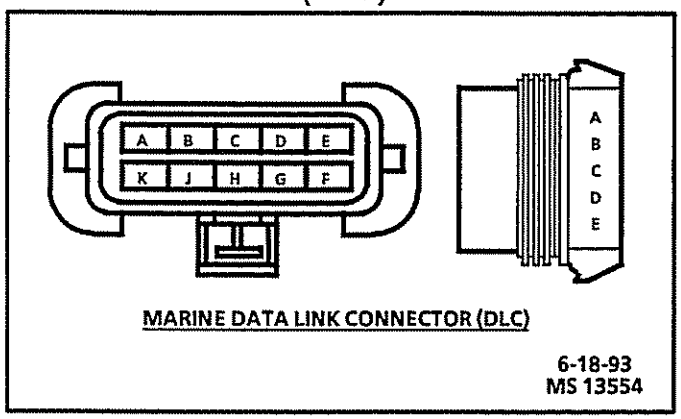
The Malfunction Indicator Lamp (MIL) is part of the Marine Diagnostic Trouble Code (MDTC) tool, or it can be a dash mounted warning light on some boat models.

- 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 driveability problem, the MEFI "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.

Figure 1-1 - Marine Data Link Connector (DLC)



Intermittent Malfunction Indicator Lamp (MIL)

In the case of an "intermittent" problem, the Malfunction Indicator Lamp (MIL) will 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) (See Figure 1-1). It is part of the MEFI 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 to count the number of flashes of the MIL when the MDTC tool is switched to "service mode." The other way is through a scan tool, a hand-held diagnostic scanner plugged into the DLC.

Once the MDTC tool has been connected, and "service mode" selected the ignition switch must be moved to the key "ON," engine "OFF" position. At this point, the MIL should flash DTC 12 three times consecutively. This would be the following flash sequence: "flash, pause, flash-flash, long pause, flash, pause, flash-flash, long pause, flash, pause, flash-flash." 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 appropriate diagnostic table in the "Diagnosis" section.

Following the output of DTC 12, the MIL will indicate a DTC three 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 three times. At the end of the DTC's, the ECM will simply go back and start over with flashing DTC 12.

Service Mode

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

1. Display a DTC 12 by flashing the MIL, indicating that the diagnostic system is working.
2. Display any stored DTC's by flashing the MIL. Each DTC will be flashed three times, then DTC 12 will be flashed again.
3. 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.
4. The Idle Air Control (IAC) valve moves to its fully extended position on most models, blocking the idle air passage. This is important to remember, as an attempt to run the engine while in "service mode" may result in an abnormally low idle speed.

Normal Mode

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

MEFI 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 procedure. Refer to "Diagnosis" section.

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 in the "Diagnosis" section 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 in the "Diagnosis" section. 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. Diagnostic Tables incorporate diagnostic procedures with the use of a scan tool (scan diagnostics), or with the MDTC tool (non-scan diagnostics).

Scan Tool Use With Intermittents

The scan tool provides the ability to check, (wiggle test) of 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 boat under the condition when the MIL turns "ON" momentarily or when the engine driveability is momentarily poor. If the problem seems to be related to certain parameters that can be checked on the scan tool, they should be checked while driving the boat. 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 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 the "Scan Tool Data" table, 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 he is 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 (DTCs) Are Set

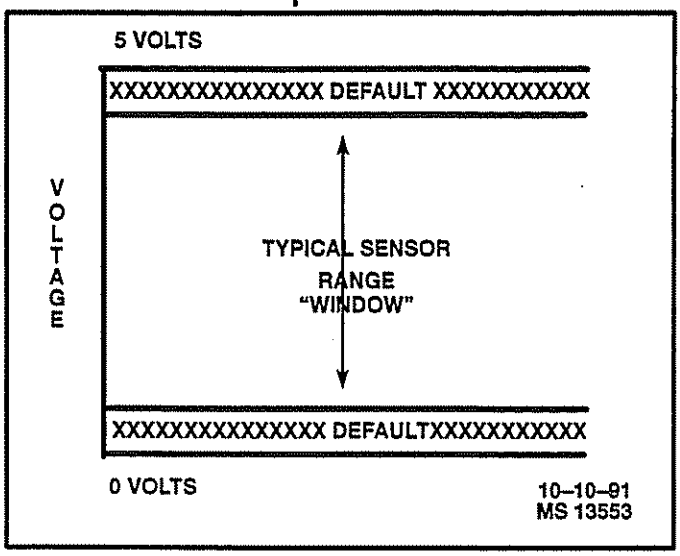
The ECM is programmed to receive calibrated voltage signals from the sensors. The voltage signal from the sensor may range from as low as 0.1 volt to as high as 4.9 volts. The sensor voltage signal is calibrated for engine application. This would be the sensor's operating parameter or "window." The ECM 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 calibratible 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 engine performance.

Clearing Diagnostic Trouble Codes (Non-Scan)

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

Figure 1-2 - Example of Sensor Normal Operation



Notice: When clearing DTC's with or without the use of a scan tool, the voltage to the ECM on CKT 440 must not drop below 6.9 volts at any time during the code clearing process. If this happens, the ECM will be reset and the DTC's will not clear from the ECM memory.

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 voltage to the ECM on CKT 440 must not drop below 6.9 volts at any time during the code clearing process. If this happens, the ECM will reset and the DTC's will not clear from the ECM memory.

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

If a driveability concern still exists after following the OBD system check and reviewing the "Symptoms" section, 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 boat is repaired. A basic understanding of sensor operation is necessary to be able to diagnose an out of range sensor.

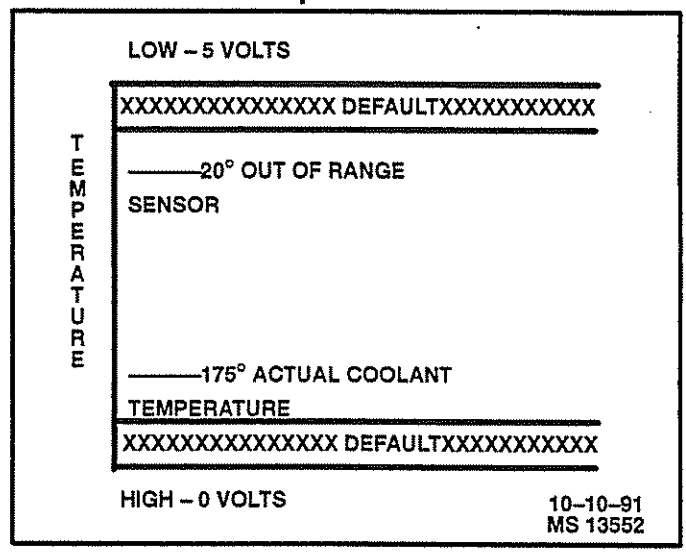
If the sensor is out of range, but still within the operating "window" of the ECM, the problem will go undetected by the ECM and may result in a driveability concern.

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 driveability concern.

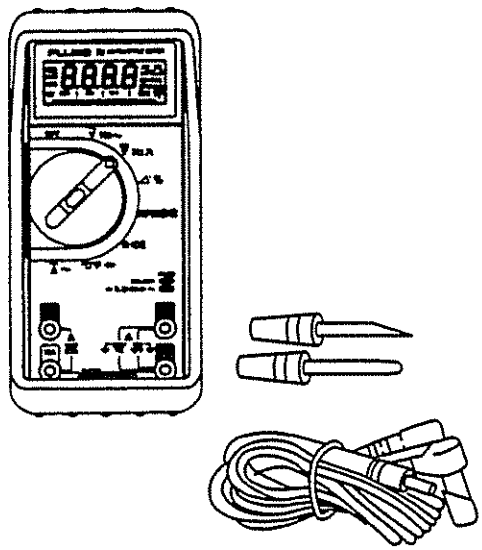
Figure 1-3 - Example of Shifted Sensor Operation



Tools Needed To Service The System

Refer to *Special Tools* at the end of this section for engine control tools for servicing the system.

Special Tools (1 of 3)



J 39978

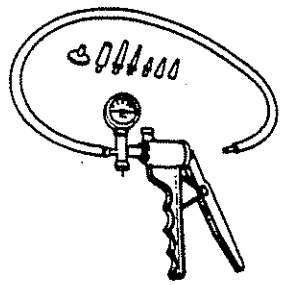
VOLTMETER - Voltage position measures magnitude of voltage when connected in parallel to an existing circuit. A digital voltmeter with a 10 megohm input impedance is used because this type of meter will not load down the circuit and result in faulty readings. Some circuits require accurate low voltage readings because they have a very high resistance.

AMMETER - When used as an ammeter, this meter accurately measures extremely low current flow. Refer to meter instructions for more information.

- Selector must be set properly for both function and range. DC is used for most measurements.

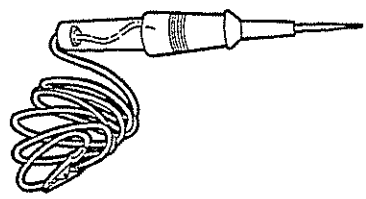
OHMMETER - Measures resistance of circuit directly in ohms. Refer to meter instructions for more information.

- OL display in all ranges indicates open circuit.
- Zero display in all ranges indicates a short circuit.
- An intermittent connection in a circuit may be indicated by a digital reading that will not stabilize on the circuit.
- Range Switch - Automatic and Manual.
  - 200Ω - Reads ohms directly
  - 2K, 20K, 200KΩ - Reads ohms in thousands
  - 2M, 20M, 200MΩ - Reads ohms in millions



J 23738-A

VACUUM PUMP WITH GAGE (20 IN. HG. MINIMUM)
Use the gage to monitor manifold engine vacuum and use the hand pump to check vacuum sensors, solenoids and valves.



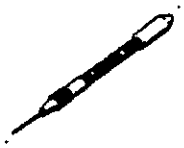
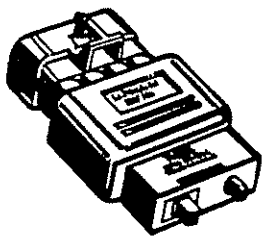
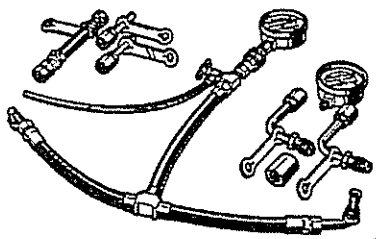
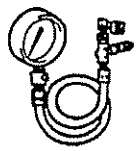
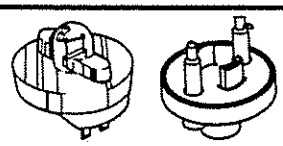
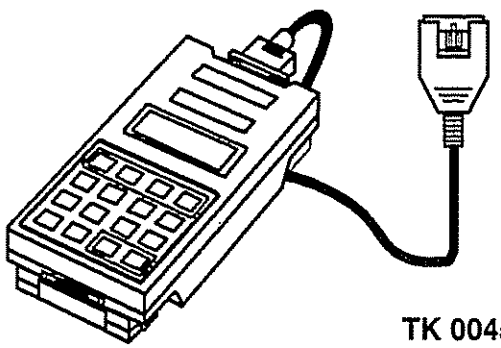
J 34142-B

UNPOWERED TEST LIGHT
Used for checking wiring for complete circuit, short to ground, or voltage.

TACHOMETER
Must have inductive trigger signal pick-up.

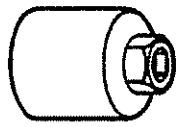
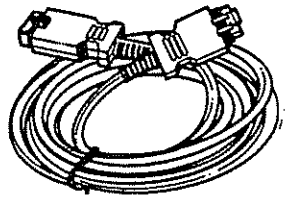
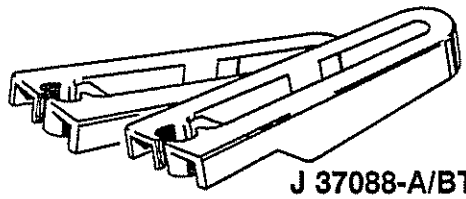
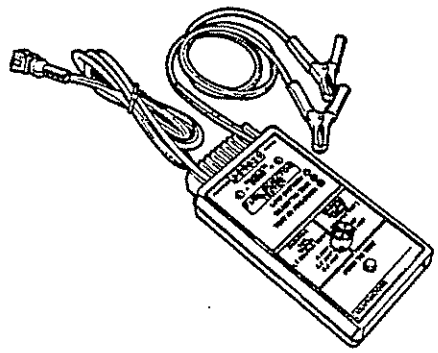
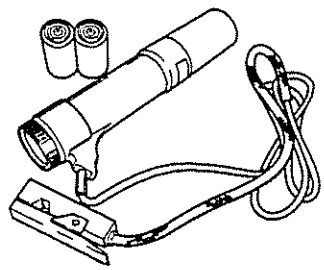
9-1-94
NS 14574

Special Tools (2 of 3)

 J 35689	**METRI-PACK TERMINAL REMOVER** Used for removing 150 series Metri-Pack "pull-to-seat" terminals from connectors. Refer to wiring harness service in MEFI General Information Section for removal procedure.
 J 28742-A/BT-8234-A	**WEATHER PACK TERMINAL REMOVER** Used for removing terminals from Weather Pack connectors. Refer to wiring harness service in MEFI General Information Section for removal procedure.
 TA 06075	**MARINE DIAGNOSTIC TROUBLE CODE (MDTC) TOOL** A hand held diagnostic tool that is used to diagnose fuel and emission systems. It will flash a code when a problem is detected.
 J 29658-D	**FUEL PRESSURE GAUGE** Used for checking fuel system pressure on TBI engines.
 J 34730-1A	**FUEL PRESSURE GAUGE** Used for checking fuel pump pressure on MFI engines.
 J 34730-2C & J 34730-350/BT 8329	**INJECTOR HARNESS TEST LIGHT** A specially designed light used to visually indicate injector electrical impulses from the ECM.
 TK 00450	**TECH 1 SCAN TOOL (Optional)** A hand held diagnostic tool that is used to diagnose fuel and emission systems. It will display various parameters. (A cartridge is required: TK 01940.)

9-23-94
NS 15871

Special Tools (3 of 3)

 J 33031	**IDLE AIR CONTROL (IAC) WRENCH** Used for removing and installing the thread mounted IAC valve on the throttle body.
 J 35632/BT-8514A	**IDLE AIR CONTROL REMOVER** Used to remove idle air control assembly on port fuel injection engine.
 J 35616	**HARNESS TEST ADAPTER KIT** Used to make electrical test connections in current Weather Pack, Metri-Pack, and Micro-Pack style terminals.
 TA 06076	**20′ DIAGNOSTIC CONNECTOR EXTENSION CABLE** Extension cable to go between the "Tech 1" and the DLC on the engine harness.
 J 37088-A/BT-9171	**FUEL LINE QUICK-CONNECT SEPARATOR** Used to release fuel line quick-connect fittings.
 J 39021	**INJECTOR TESTER** Separately energized each injector to compare for equal impulses over a constant time interval.
 J 34186	**TIMING LIGHT** Must have inductive signal pickup.

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 charts 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 and 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.

On-Board Service

Wiring Harness Service

Wiring harnesses should be replaced with proper part number harnesses. When signal 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.

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 (Figure 1-5). These are used at some of the sensors and the distributor connector.

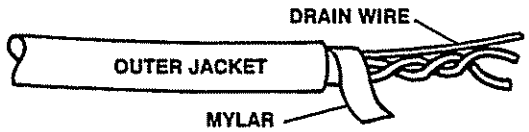
Metri-Pack terminals are also called "Pull-To-Seat" terminals because, to install a terminal on a wire, the wire is first inserted through the seal and connector. The terminal is then crimped on the wire, and the terminal is pulled back into the connector to seat it in place.

To remove a terminal:

1. Slide the seal back on the wire.
2. Insert tool J 35689 or equivalent, as shown in Figure 1-5, 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.

Figure 1-4 - Wiring Harness Repair

TWISTED/SHIELDED CABLE



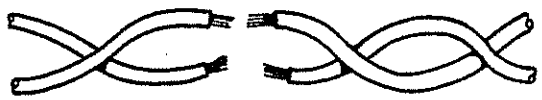
1 REMOVE OUTER JACKET.
2 UNWRAP ALUMINUM/MYLAR TAPE. DO NOT REMOVE MYLAR.

3 UNTWIST CONDUCTORS. STRIP INSULATION AS NECESSARY.

4 SPLICE WIRES USING SPLICE CLIPS AND ROSIN CORE SOLDER. WRAP EACH SPLICE TO INSULATE.
5 WRAP WITH MYLAR AND DRAIN (UNINSULATED) WIRE.

6 TAPE OVER WHOLE BUNDLE TO SECURE AS BEFORE.

TWISTED LEADS



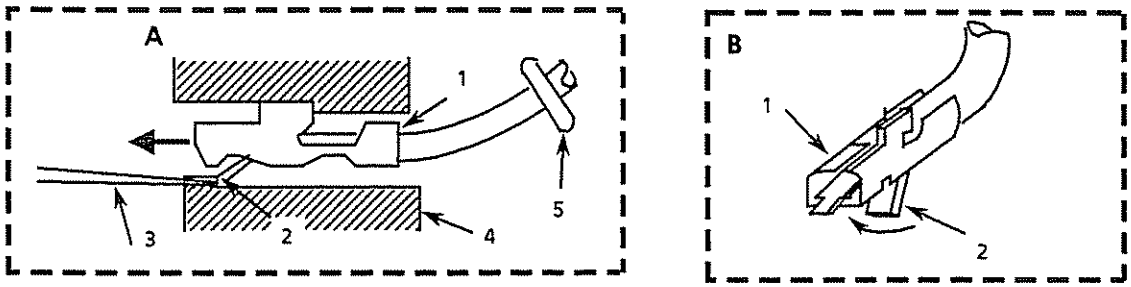
1 LOCATE DAMAGED WIRE.
2 REMOVE INSULATION AS REQUIRED.

3 SPLICE TWO WIRES TOGETHER USING SPLICE CLIPS AND ROSIN CORE SOLDER.

4 COVER SPLICE WITH TAPE TO INSULATE FROM OTHER WIRES.
5 RETWIST AS BEFORE AND TAPE WITH ELECTRICAL TAPE AND HOLD IN PLACE.

8-24-94
RS 22186

Figure 1-5 - Metri-Pack Series 150 Terminal Removal



1. METRI-PACK SERIES 150 FEMALE TERMINAL
2. LOCKING TANG
3. TOOL J 35689 OR BT-8446
4. CONNECTOR BODY
5. SEAL

2-5-90
*7S 3213-6E

Weather-Pack Connectors

Figure 1-6 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.

Micro-Pack 100/W Series Connectors

Figure 1-7

The harness connectors used with the ECM "J1" and "J2" connector is a 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, refer to Figure 1-7 view A: Strain Relief (1), Seal (2), Connector (3), Index Cover (4), and Terminals (not shown).

Remove or Disconnect

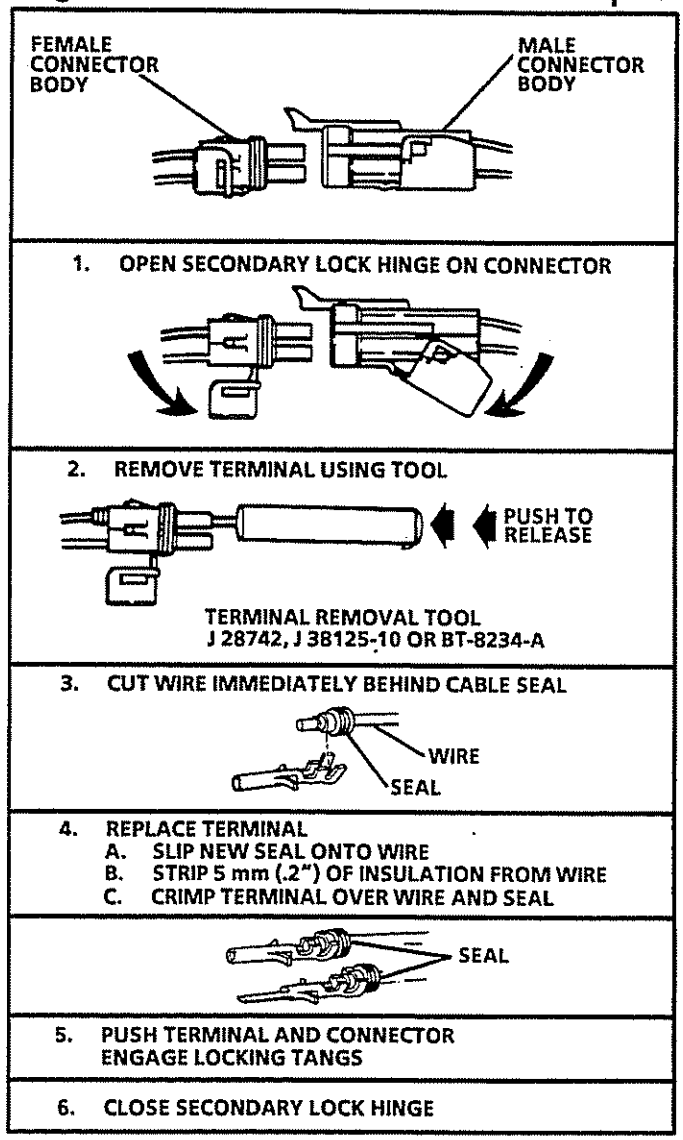
1. Negative battery cable.
2. Connector from ECM by lifting up lock tab with thumb and pulling on connector body.

Inspect

- Check strain relief for being cracked or lock 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.

Figure 1-6 - Weather-Pack Terminal Repair



5S–1555–6E

3. With small screwdriver, move Tabs A on strain relief (1) to unlock position.
4. Open strain relief as 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. For the remaining wires, their location can be found by referring to "ECM/Component Connector Identification" in the "Diagnosis" section. The strain relief is numbered for identifying wire location.

10. Index cover (4) by pushing in on Tabs C with 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 1-7 - Micro-Pack 100/W Series

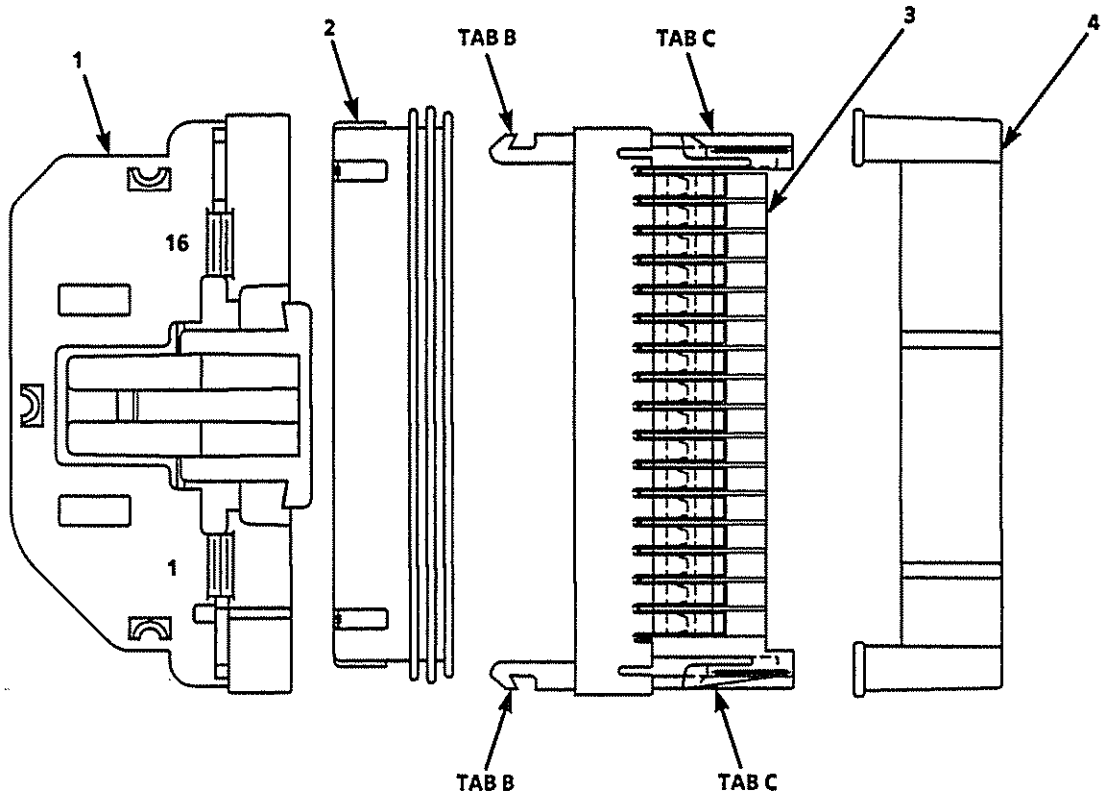


FIGURE A - EXPLODED VIEW OF CONNECTOR ASSEMBLY

1	STRAIN RELIEF	3	CONNECTOR
2	SEAL	4	INDEX COVER

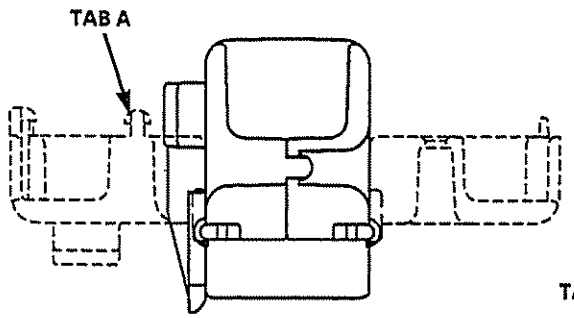


FIGURE B - STRAIN RELIEF CLOSED

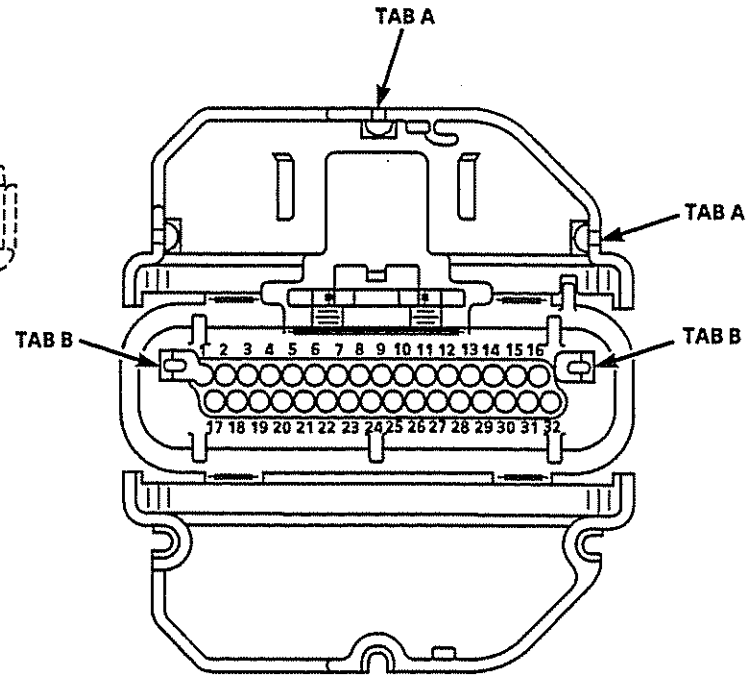


FIGURE C - STRAIN RELIEF OPENED

PS 19745

Marine Electronic Fuel Injection (MEFI)

Section 2

Engine Control Module (ECM) and Sensors

This section will describe the function of the Engine Control Module (ECM) and the sensors. The section explains how voltages reflect the inputs and outputs of the ECM. The sensors are described how they operate and how to replace them.

Contents

General Description

The Marine Electronic Fuel Injection (MEFI) system is equipped with a computer that provides the operator with state-of-the-art control of fuel and spark delivery. Before we discuss the computers on the Marine applications, let's discuss how computers use voltage to send and receive information.

Computers and Voltage Signals

Voltage is electrical pressure. Voltage does not flow through circuits. Instead, voltage causes current. Current does the real work in electrical circuits. It is current, the flow of electrically charged particles, that energizes solenoids, closes relays, and illuminates lamps.

Besides causing current flow in circuits, voltage can be used as a signal. Voltage signals can send information by changing levels, changing waveform (shape), or changing the speed at which the signal switches from one level to another. Computers use voltage signals to communicate with one another. The different sections inside computers also use voltage signals to talk to each other.

There are two kinds of voltage signals, analog and digital. Both of these are used in computer systems. It is important to understand the difference between them and the different ways they are used.

Analog Signals

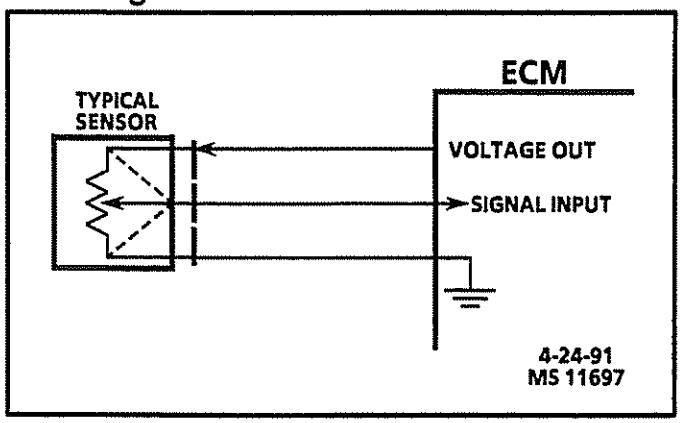
An analog signal is continuously variable. This means that the signal can be any voltage within a certain range.

An analog signal usually gives information about a condition that changes continuously over a certain range. For example, in a marine engine, temperature is usually provided by an analog signal. There are two general types of sensors that produce analog signals, the 3-wire and the 2-wire sensors.

Three-Wire Sensors

Figure 2-1 shows a schematic representation of a 3-wire sensor. All 3-wire sensors have a reference voltage, a ground, and a variable "wiper." The lead coming off of the "wiper" will be the signal to the Engine Control Module (ECM). As this "wiper" position changes, the signal voltage to the ECM also changes.

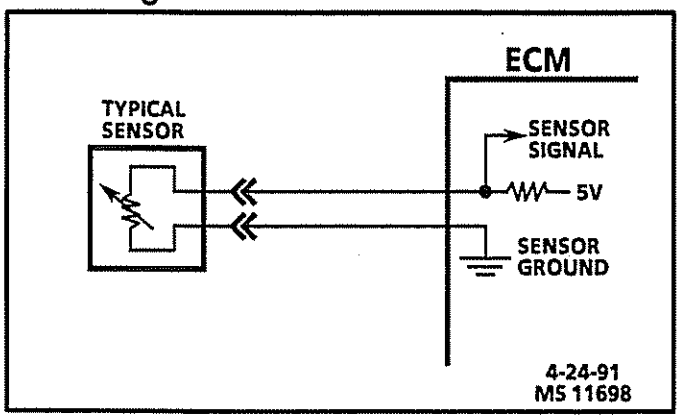
Figure 2-1 - Three-Wire Sensors



Two-Wire Sensors

Figure 2-2 is the schematic of a 2-wire sensor. This sensor is basically a variable resistor in series with a known-fixed resistor within the ECM. By knowing the values of the input voltage and the voltage drop across the known resistor, the value of the variable resistor can be determined. The variable resistors that are commonly used are called thermistors. A thermistor's resistance varies with temperature.

Figure 2-2 - Two-Wire Sensors



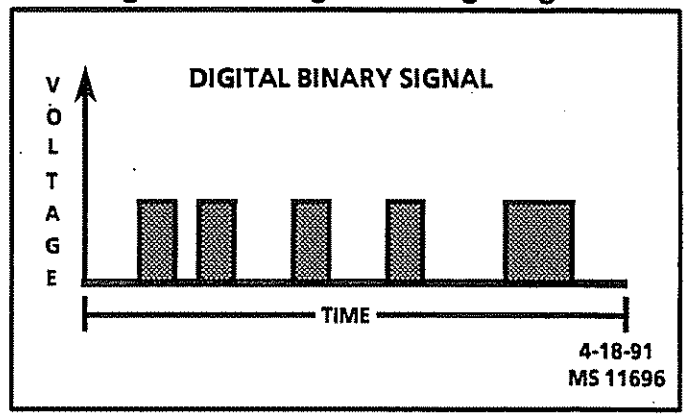
Digital Signals

Digital signals are also variable, but not continuously. They can only be represented by distinct voltages within a range. For example, 1V, 2V, or 3V would be allowed, but 1.27V or 2.56V would not. Digital signals are especially useful when the information can only refer to two conditions: "YES" and "NO," "ON" and "OFF," or "HIGH" and "LOW." This would be called a digital binary signal. A digital binary signal is limited to two voltage levels. One level is a positive voltage, the other is no voltage (zero volts). As you can see in Figure 2-3, a digital binary signal is a square wave.

The ECM uses digital signals in a code that contains only ones and zeros. The high voltage of the digital signal represents a one (1), and no voltage represents a zero (0). Each "zero" and each "one" is called a bit of information, or just a "bit." Eight bits together are called a "word." A word, therefore, contains some combination of eight binary code bits.

Binary code is used inside the ECM and between a computer and any electronic device that understands the code. By stringing together thousands of bits, computers can communicate and store an infinite varieties of information. To a computer that understands binary, 11001011 might mean that it should turn an output device "ON" at slow speed. Although the ECM uses 8-bit digital codes internally and when talking to another computer, each bit can have a meaning.

Figure 2-3 - Digital Voltage Signal



Switch Types

Switched inputs (also known as discretes) to the ECM can cause one bit to change, resulting in information being communicated to the ECM. Switched inputs can come in two types: "pull-up" and "pull-down" types. Both types will be discussed.

With "pull-up" type switch, the ECM will sense a voltage when the switch is CLOSED. With "pull-down" type switch, the ECM will sense a voltage when the switch is OPEN.

Pulse Counters

For the ECM to determine frequency information from a switched input, the ECM must measure the time between the voltage pulses. As a number of pulses are recorded in a set amount of time, the ECM can calculate the frequency. The meaning of the frequency number can have any number of meanings to the ECM.

An example of a pulse counter type of input is the distributor reference pulse input. The ECM can count a train of pulses, a given number of pulses per engine revolution. In this way, the ECM can determine the RPM of the engine.

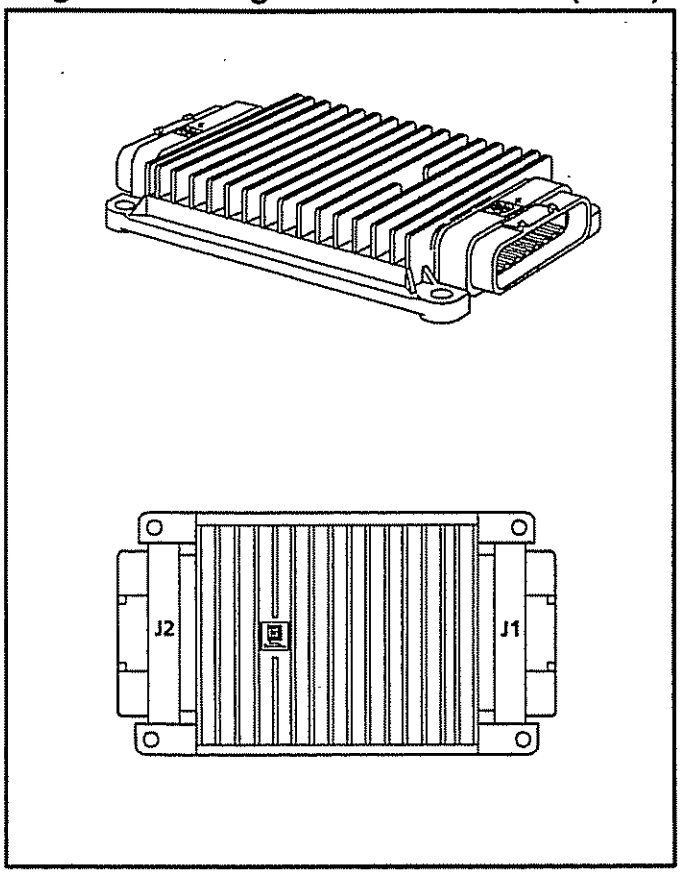
Engine Control Module (ECM)

The Engine Control Module (ECM), located on the engine, is the control center of the fuel injection system. It controls the following:

- Fuel metering system.
- Ignition timing.
- On-board diagnostics for engine functions.

It constantly looks at the information from various sensors, and controls the systems that affect engine performance. The ECM also performs the diagnostic function of the system. It can recognize operational problems, alert the driver through the MIL (Malfunction Indicator Lamp), and store diagnostic trouble codes which identify the problem areas to aid the technician in making repairs. Refer to *General Information* section for more information on using the diagnostic function of the ECM.

Figure 2-4 - Engine Control Module (ECM)



MS 12852

ECM Function

The ECM supplies either 5 or 12 volts to power various sensors or switches. This is done through resistances in the ECM which are so high in value that a test light will not light when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give an accurate reading because its resistance is too low. Therefore, a digital voltmeter with at least 10 megohms input impedance is required to ensure accurate voltage readings. Tool J 39978 meets this requirement.

The ECM controls output circuits such as the injectors, IAC, relays, etc. by controlling the ground or power feed circuit.

Memory

There are three types of memory storage within the ECM. They are ROM, RAM, and EEPROM.

ROM

Read Only Memory (ROM) is a permanent memory that is physically soldered to the circuit boards within the ECM. The ROM contains the overall control programs. Once the ROM is programmed, it cannot be changed. The ROM memory is non-erasable, and does not need power to be retained.

RAM

Random Access Memory (RAM) is the microprocessor "scratch pad." The processor can write into, or read from this memory as needed. This memory is erasable and needs a constant supply of voltage to be retained. If the voltage is lost, the memory is lost.

EEPROM

The Electronically Erasable Programmable Read Only Memory (EEPROM) is a permanent memory that is physically soldered within the ECM. The EEPROM contains program and calibration information that the ECM needs to control engine operation.

The EEPROM is not replaceable. If the ECM is replaced, the new ECM will need to be programmed by the OEM with the calibration information that is specific to each marine application.

Speed Density System

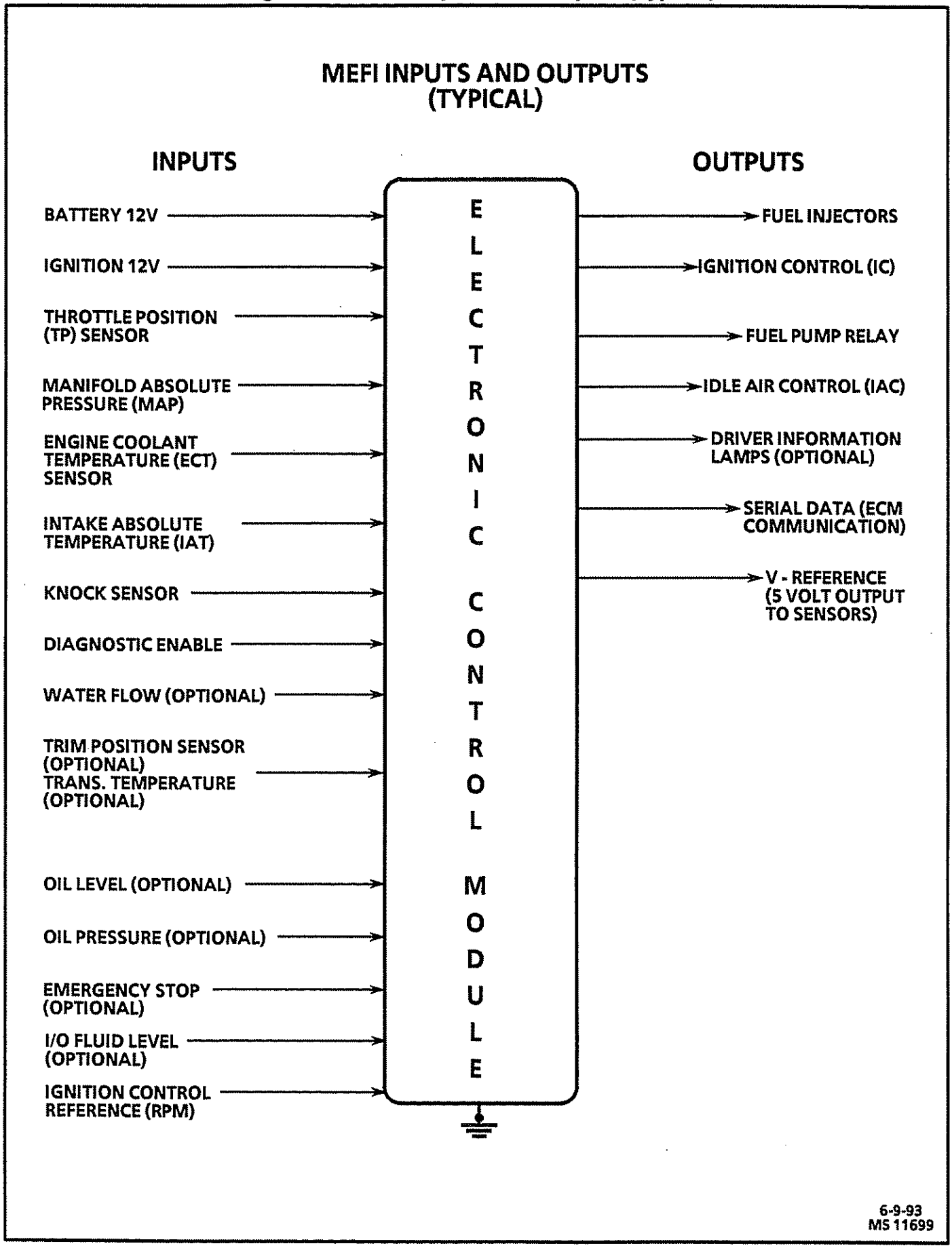
The Marine Electronic Fuel Injection (MEFI) system is a speed and air density system. The system is based on "speed density" fuel management.

Sensors provide the ECM with the basic information for the fuel management portion of its operation. Signals to the ECM establish the engine speed and air density factors.

Speed

The engine speed signal comes from the Ignition Control (IC) module to the ECM on the IC reference high circuit. The ECM uses this information to determine the "speed" or RPM factor for fuel and spark management.

Figure 2-5 - ECM Inputs and Outputs (Typical)



Density

One particular sensor contributes to the density factor, the Manifold Absolute Pressure (MAP) sensor. The MAP sensor is a 3-wire sensor that monitors the changes in intake manifold pressure which results from changes in engine loads. These pressure changes are supplied to the ECM in the form of electrical signals.

As intake manifold pressure increases, the vacuum decreases. The air density in the intake manifold also increases, and additional fuel is needed.

The MAP sensor sends this pressure information to the ECM, and the ECM increases the amount of fuel injected, by increasing the injector pulse width. As manifold pressure decreases, the vacuum increases, and the amount of fuel is decreased.

These two inputs, MAP and RPM, are the major determinants of the air/fuel mixture delivered by the fuel injection system.

The remaining sensors and switches provide electrical inputs to the ECM, which are used for modification of the air/fuel mixture, as well as for other ECM control functions, such as idle control.

ECM Inputs and Sensor Descriptions

Figure 2-5 lists the data sensors, switches, and other inputs used by the ECM to control its various systems. Although we will not cover them all in great detail, there will be a brief description of each.

Engine Coolant Temperature (ECT) Sensor

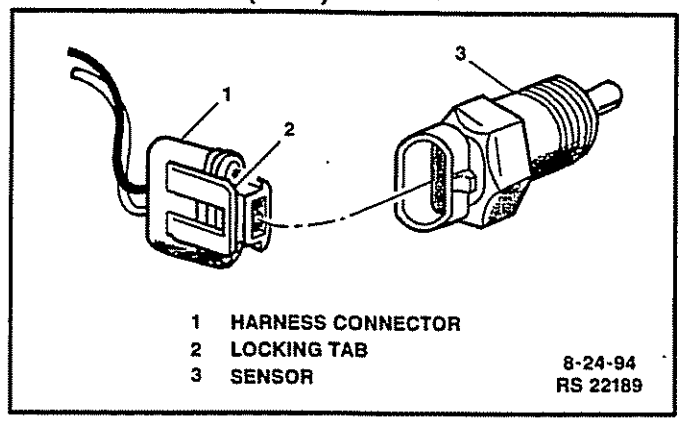
Figure 2-6

The engine coolant temperature (ECT) sensor is a thermistor (a resistor which changes value based on temperature) mounted in the engine coolant stream. Low coolant temperature produces a high resistance (100,000 ohms at -40°C/-40°F) while high temperature causes low resistance (70 ohms at 130°C/266°F).

The ECM supplies a 5 volt signal to the ECT sensor through a resistor in the ECM and measures the voltage. The voltage will be high when the engine is cold, and low when the engine is hot. By measuring the voltage, the ECM calculates the engine coolant temperature. Engine coolant temperature affects most systems the ECM controls.

A hard fault in the engine coolant sensor circuit should set DTC 14 or DTC 15; an intermittent fault may or may not set a DTC. The DTC "Diagnostic Aids" also contains a chart to check for sensor resistance values relative to temperature.

Figure 2-6 - Engine Coolant Temperature (ECT) Sensor



Manifold Absolute Pressure (MAP) Sensor

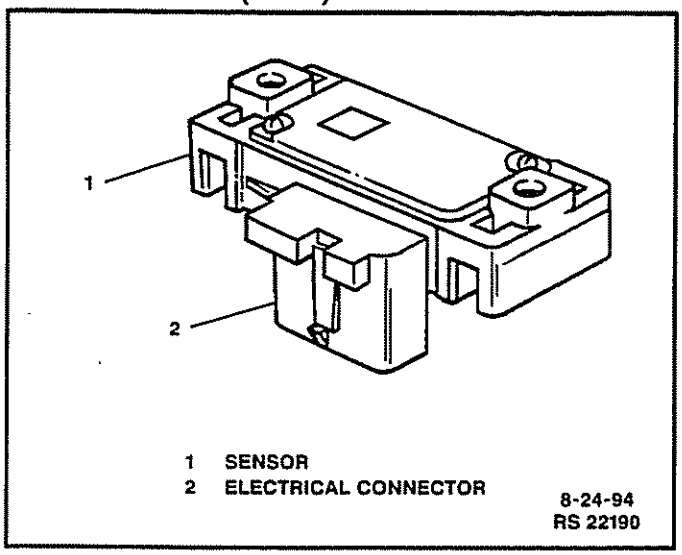
Figure 2-7

The Manifold Absolute Pressure (MAP) sensor (Figure 7) is a pressure transducer that measures the changes in the intake manifold pressure. The pressure changes as a result of engine load and speed change, and the MAP sensor converts this into a voltage output.

A closed throttle on engine coastdown would produce a relatively low MAP output voltage, while a wide open throttle would produce a high MAP output voltage. This high output voltage is produced because the pressure inside the manifold is almost the same as outside the manifold, so you measure almost 100% of outside air pressure. MAP is the opposite of what you would measure on a vacuum gauge. When manifold pressure is high, vacuum is low, causing a high MAP output voltage. The MAP sensor is also used to measure barometric pressure under certain conditions, which allows the ECM to automatically adjust for different altitudes.

The ECM sends a 5 volt reference voltage to the MAP sensor. As the manifold pressure changes, the electrical resistance of the MAP sensor also changes. By monitoring the sensor output voltage, the ECM knows the manifold pressure. A higher pressure, low vacuum (high voltage) requires more fuel. A lower pressure, high vacuum (low voltage) requires less fuel. The ECM uses the MAP sensor to control fuel delivery and ignition timing. A failure in the MAP sensor circuit should set a DTC 33 or DTC 34.

Figure 2-7 - Manifold Absolute Pressure (MAP) Sensor



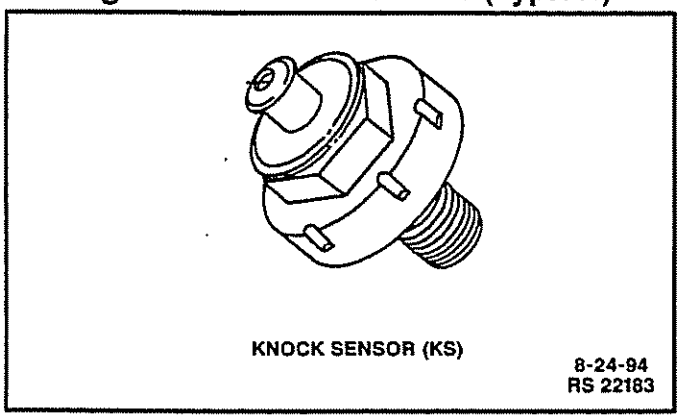
Knock Sensor

Figure 2-8

The knock sensor is mounted in the engine block. The location depends on engine application.

When abnormal engine vibrations (spark knock) are present, the sensor produces an AC voltage signal which is sent to the Knock Sensor (KS) module and then onto the ECM. The ECM uses this signal to aid in calculating spark timing.

Figure 2-8 - Knock Sensor (Typical)



Knock Sensor (KS) Module

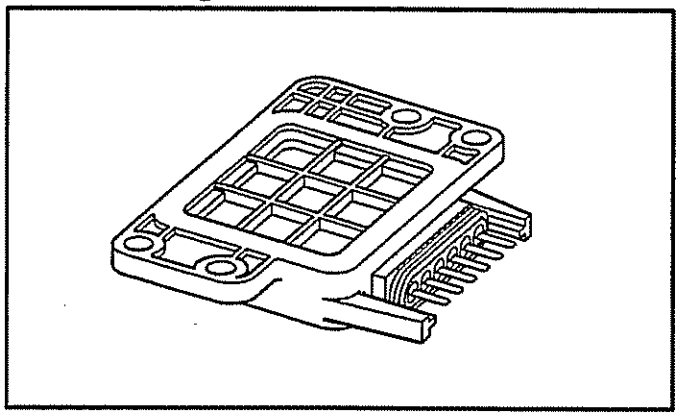
Figure 2-9

The Knock Sensor (KS) module contains solid state circuitry which monitors the knock sensor AC voltage signal and then supplies a 8-10 volt signal to the ECM.

It is extremely important that the correct KS module be used for the engine application. Using an incorrect KS module can result in unrecognized spark knock and cause engine damage, or cause poor performance due to false spark knock being detected and ignition timing be retarded.

The KS module terminal "B" is powered by a 12 volt supply from the ignition switch. If the 12 volts are not present, the KS module can not send an 8-10 volt signal to the ECM and a false constant spark retard would result. Terminal "E" of the KS module is the signal line from the knock sensor. If this circuit is open or shorted to ground, the KS module would never remove the 8-10 volt signal from the ECM, and no spark retard could occur. The ground circuit for the KS module is connected to terminal "D" of the KS module. If the ground circuit became open, the KS module would not be able to remove the 8-10 volt signal to the ECM, and spark knock could not be controlled.

Figure 2-9 - KS Module



NS 15481

Figure 2-10 - Knock Sensor System

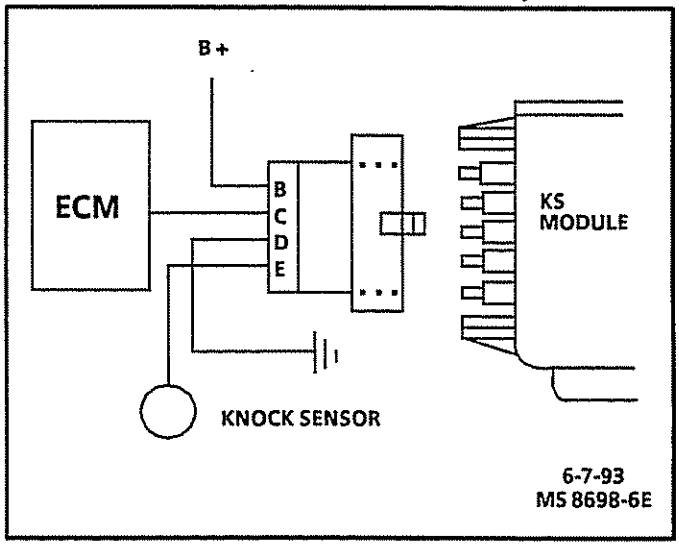
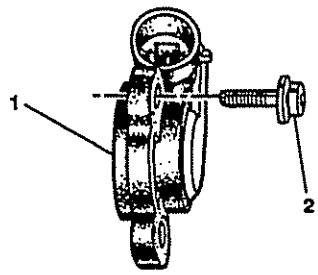


Figure 2-11 - Throttle Position (TP) Sensor (Typical)

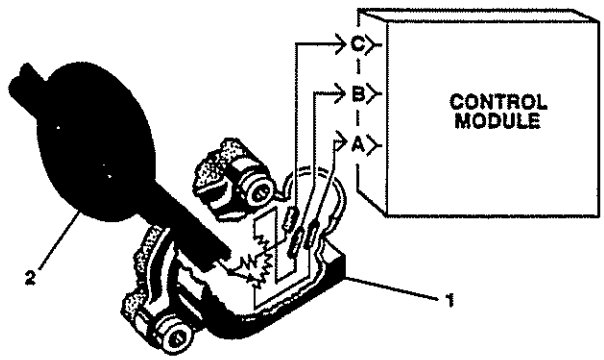


1 SENSOR - THROTTLE POSITION (TP)

2 SCREW - TP SENSOR ATTACHING

8-31-94
RS 22191

Figure 2-12 - Throttle Position (TP) Sensor (Typical)



1 THROTTLE POSITION (TP) SENSOR

2 THROTTLE VALVE

8-25-94
RS 22192

Throttle Position (TP) Sensor

Figure 2-11 and 2-12

The Throttle Position (TP) sensor is a potentiometer connected to the throttle shaft on the throttle body. By monitoring the voltage on the signal line, the ECM calculates throttle position. As the throttle valve angle is changed (accelerator pedal moved), the TP sensor signal also changes. At a closed throttle position, the output of the TP sensor is low. As the throttle valve opens, the output increases so that at Wide Open Throttle (WOT), the output voltage should be above 4 volts.

The ECM calculates fuel delivery based on throttle valve angle (driver demand). A broken or loose TP sensor may cause intermittent bursts of fuel from an injector and unstable idle because the ECM thinks the throttle is moving. A hard failure in the TP sensor circuits should set either a DTC 21 or DTC 22. Once a DTC is set, the ECM will use a calibratible default value for throttle position and some engine performance will return.

Ignition Control (IC) Reference

The Ignition Control (IC) reference (RPM Signal) is supplied to the ECM by way of the IC reference line from the distributor ignition module. This pulse counter type input creates the timing signal for the pulsing of the fuel injectors, as well as the IC functions. This signal is used for a number of control and testing functions within the ECM.

Trim Position Sensor (Optional)

The trim position sensor is a 3-wire sensor that sends degree or trim angle information to the ECM. The sensor is physically mounted to the outdrive.

Trim position information is used by the ECM primarily to identify if trim angle is too high. If the ECM detects an abnormally high trim angle, an overtrim protection (RPM Reduction Mode) will be entered by the ECM.

Discrete Switch Inputs (Optional)

Several discrete switch inputs are utilized by the MEFI system to identify abnormal conditions that may affect engine operation. Pull-up and pull-down type switches are currently used in conjunction with the ECM to detect critical conditions to engine operation.

If a switch changes states from its normal at rest position, that is, normally closed to open, or normally open to closed, the ECM senses a change in voltage and responds by entering RPM reduction mode.

This engine protection feature allows the operator normal engine operations up to OEM specifications (approx. 2000 RPM), but disables half the fuel injectors until the engine drops below 1200 RPM. Then normal engine operation is restored until the RPM limit is exceeded. This feature allows the operator a safe maneuvering speed while removing the possibility of high RPM engine operation until the problem is corrected.

Switches that may be used with the MEFI system to detect critical engine operation parameters are:

- Transmission temperature N/O
- Oil level N/O
- Oil pressure N/O
- Emergency stop N/O
- I/P fluid level N/O
- Water flow N/C

Diagnosis

Engine Control Module (ECM)

To read and clear diagnostic trouble codes, use a scan tool or Marine Diagnostic Trouble Code (MDTC) tool.

Important: Use of a scan tool is recommended to clear diagnostic trouble codes from the ECM memory. Diagnostic trouble codes can also be cleared by using the MDTC tool, TA 06075.

Since the ECM can have a failure which may affect only one circuit, following the diagnostic procedures in this section will determine which circuit has a problem and where it is.

If a diagnostic table indicates that the ECM connections or ECM is the cause of a problem and the ECM is replaced, but does not correct the problem, one of the following may be the reason:

- There is a problem with the ECM terminal connections. The diagnostic table will say ECM connections or ECM. The terminals may have to be removed from the connector in order to check them properly.
- EEPROM program is not correct for the application. Incorrect components may cause a malfunction and may or may not set a DTC.
- The problem is intermittent. This means that the problem is not present at the time the system is being checked. In this case, refer to the *Symptoms* portion of the manual and make a careful physical inspection of all portions of the system involved.
- Shorted relay coil or harness. Relays are turned "ON" and "OFF" by the ECM using internal electronic switches called drivers. A shorted relay coil or harness will not damage the ECM but will cause the relay to be inoperative.

On-Board Service

Engine Control Module (ECM)

Figure 2-13

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.

Remove or Disconnect

1. Negative battery cable.
2. "J1" and "J2" connectors from ECM.
3. Four ECM mounting screws.
4. ECM from mounting bracket.

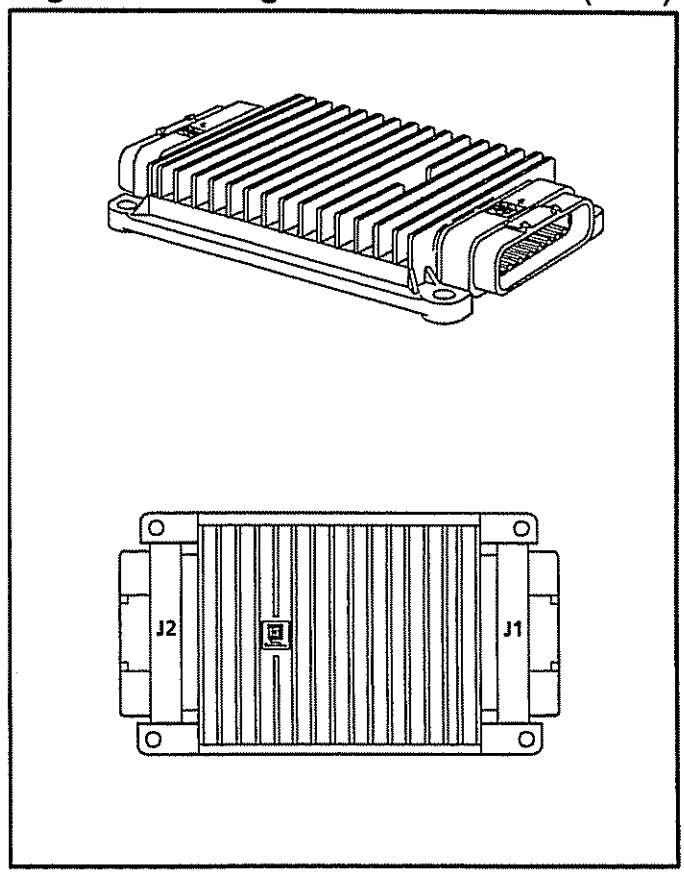
Important

- Make sure the new ECM has the same part number and service number as the old ECM, to insure proper engine performance.

Install or Connect

1. New ECM to mounting bracket.
2. Four ECM mounting screws. Torque to 10-14 N•m (88-124 lb. in.).
3. "J1" and "J2" connectors to ECM.
4. Negative battery cable.

Figure 2-13 - Engine Control Module (ECM)



MS 12852

Engine Coolant Temperature (ECT) Sensor

Figure 2-14

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. Negative battery cable.
2. ECT electrical connector.
3. ECT sensor.

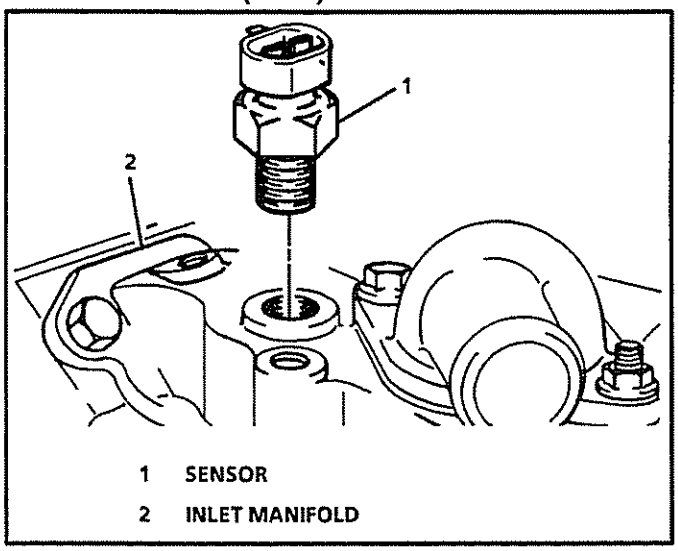
Important

- Coat ECT sensor threads with teflon tape sealant prior to installation.

Install or Connect

1. ECT sensor into manifold. Torque to 12 N•m (108 lb. in.).
2. ECT electrical connector.
3. Negative battery cable.

Figure 2-14 - Engine Coolant Temperature (ECT) Sensor



7S 3815-6E

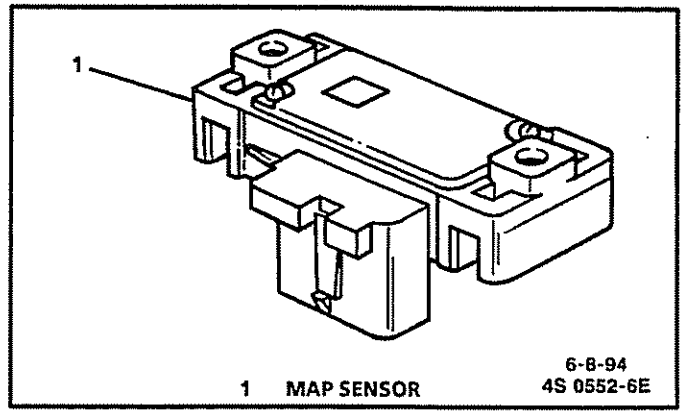
Manifold Absolute Pressure (MAP) Sensor

Figure 2-15

Remove or Disconnect

1. Negative battery cable.
2. MAP sensor electrical connector.
3. MAP sensor attaching screws.
4. MAP sensor from bracket.
5. Vacuum hose from MAP sensor.

Figure 2-15 - Manifold Absolute Pressure (MAP) Sensor



Important

- The MAP sensor is an electrical component. Do Not soak in any liquid cleaner or solvent, as damage may result.

Install or Connect

1. Vacuum hose to MAP sensor.
2. MAP sensor to bracket.
3. MAP sensor attaching screws. Torque to 5-7 N•m (44-62 lb. in.).
4. MAP sensor electrical connector.
5. Negative battery cable.

Throttle Position (TP) Sensor

Figure 2-16

Remove or Disconnect

1. Flame arrestor.
2. TP sensor electrical connector.
3. TP sensor attaching screws.
4. TP sensor and seal.

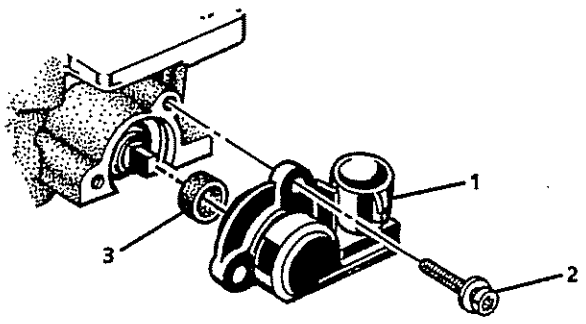
Important

- The TP sensor is an electrical component. Do Not soak in any liquid cleaner or solvent, as damage may result.
- If replacing TP sensor, install new screws that are supplied with the TP sensor service package.

Install or Connect

1. TP sensor seal over throttle shaft as shown in Figure 2-16.
2. With throttle plates closed, position on throttle shaft, then align the screw holes.
3. TP sensor attaching screws. Torque to 2 N•m (18 lb. in.).
4. TP sensor electrical connector.
5. Flame arrestor.

Figure 2-16 - Throttle Position (TP) Sensor



1 SENSOR
2 SCREW ASSEMBLY
3 SEAL

MP 1205-AS

Idle Air Control (IAC) Valve

Figures 2-17 and 2-18

Remove or Disconnect

1. Flame arrestor.
2. IAC electrical connector.
3. IAC valve.
   - On thread mounted units, use a 32 mm or a 1 1/4" wrench or socket J 35632, (Figure 2-17).
   - On flange mounted units, remove screw assemblies (Figure 2-18).
4. IAC valve gasket or O-ring and discard.

Notice: On IAC valves that have been in service, Do Not push or pull on the IAC valve pintle. The force required to move the pintle may damage the threads on the worm drive. Also, Do Not soak IAC valve in any liquid cleaner or solvent, as damage may result.

Clean and Inspect

- Thread mounted - both original and replacement IAC valves have a special factory applied thread-locking compound applied to the threads. If the valve removed from the throttle body is being reinstalled, Do Not remove the thread-locking compound that may be on the threads.
- Clean IAC valve sealing surface, pintle, valve seat, and air passage.
  - Use carburetor cleaner to remove carbon deposits. Do Not use a cleaner that contains methyl ethyl ketone, an extremely strong solvent, and not necessary for this type of deposit.
  - Shiny spots on the pintle or seat are normal, and do not indicate misalignment or a bent pintle shaft.

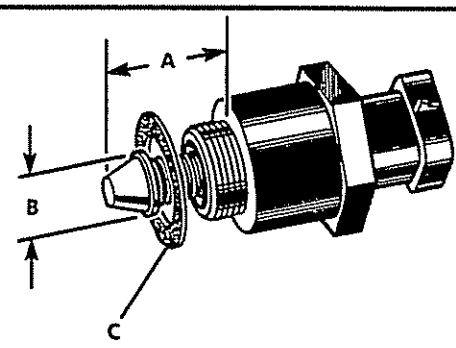
Important

- If installing a new IAC valve, be sure to replace with an identical part number. IAC valve pintle shape and diameter are designed for the specific application.

Measure (If installing a new IAC valve)

- Distance between tip of IAC valve pintle and mounting surface.
  - If greater than 28 mm, use finger pressure to slowly retract the pintle. The force required to retract the pintle of a new valve will not cause damage to the valve.

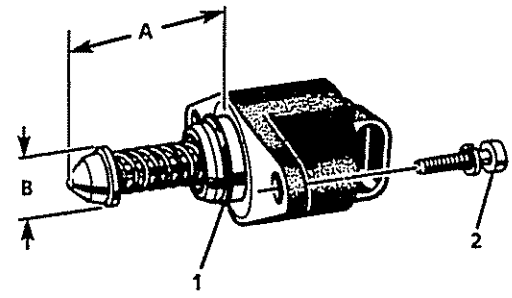
Figure 2-17 - Thread Mounted Type IAC Valve



A DISTANCE OF PINTLE EXTENSION
B DIAMETER AND SHAPE OF PINTLE
C IAC VALVE GASKET

9P 1058-AS

Figure 2-18 - Flange Mounted Type IAC Valve



1 IAC VALVE O-RING
2 IAC VALVE ATTACHING SCREW ASSEMBLY
A DISTANCE OF PINTLE EXTENSION
B DIAMETER OF PINTLE

LP 1220-AS

Install or Connect

1. IAC valve into throttle body as follows:
   - Thread mounted valve - install with new gasket. Torque to 18 N•m (13 lb. ft.).
   - Flange mounted valve - install with new lubricated O-ring, using attaching screw assemblies. Torque to 3.2 N•m (28 lb. in.).

Notice: New IAC valves have been preset at the factory and should not require any adjustment.

2. IAC valve electrical connector.
3. Reset IAC valve pintle position:
   - Turn ignition "OFF" for 10 seconds.
   - Start and run engine for 5 seconds.
   - Ignition "OFF" for 10 seconds.

Knock Sensor (KS)

Figures 2-19 and 2-20

Remove or Disconnect

1. Negative battery cable.
2. Knock sensor electrical connector.
3. Knock sensor from engine block.

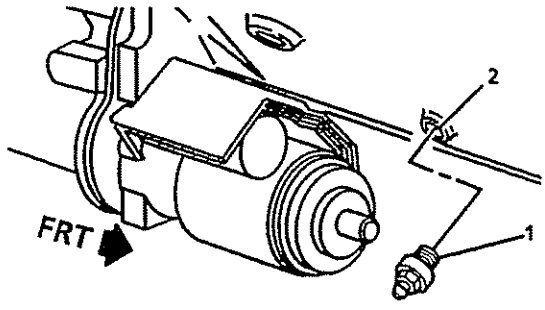
Important

- If installing a new knock sensor, be sure to replace with an identical part number.
- When installing knock sensor, be sure to install in the same location removed from.
- If installing knock sensor in water jacket, use teflon sealer #1052040 or equivalent.

Install or Connect

1. Knock sensor into engine block. Be sure threads are clean. Torque to 15-22 N•m (11-16 lb. ft.).
2. Knock sensor electrical connector.
3. Negative battery cable.

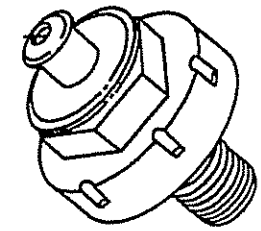
Figure 2-19 - Knock Sensor Location



1 KNOCK SENSOR
2 ENGINE BLOCK

6S 2892-6E

Figure 2-20 - Typical Knock Sensor



KNOCK SENSOR (KS)

8-24-94
RS 22183

Knock Sensor (KS) Module

Figure 2-21

Remove or Disconnect

1. Negative battery cable.
2. KS module electrical connector.
3. KS module attaching screws.
4. KS module.

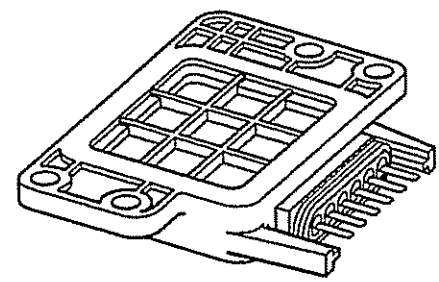
Important

- The knock sensor and module are electrical components. Do Not soak in any liquid cleaner or solvent, as damage may result.
- When removing or installing the KS module, caution must be taken to avoid damaging KS mounting studs in module.

Install or Connect

1. KS module.
2. KS module attaching screws. Torque to 5 N•m (44 lb. in.).
3. KS module electrical connector.
4. Negative battery cable.

Figure 2-21 - KS Module



NS 15481

Torque Specifications

Fastener Tightening Specifications

Application	N•m	Lb Ft	Lb In
ECM Mounting Screws	10-14		88-124
ECT Sensor	12		108
MAP Sensor Attaching Screws	5-7		44-62
TP Sensor Attaching Screws	2		18
Thread mounted IAC Valve	18	13	
Flange mounted IAC Valve Attaching Screws	3.2		28
Knock Sensor	15-22	11-16	
KS Module	5		44

Marine Electronic Fuel Injection (MEFI)

Section 3

Fuel Metering System - Throttle Body Fuel Injection (TBI)

This section describes how the fuel metering system operates, and provides a description of components used on the Marine Electronic Fuel Injection equipped engines. The fuel metering system information described in this manual is limited to Throttle Body Fuel Injection (TBI). Multiport Fuel Injection (MFI) will be detailed in a separate manual. In distinguishing fuel systems used on specific applications, the following rules apply. TBI systems use two injectors mounted at the top of the throttle body assembly. MFI systems have separate injectors for each cylinder. The injectors are located in each of the intake manifold runners and are supplied by a fuel rail.

Contents

General Description

Purpose

The function of the fuel metering system is to deliver the correct amount of fuel to the engine under all operating conditions. Fuel is delivered to the engine by the Throttle Body Fuel Injection (TBI) unit, which is controlled by the ECM.

Modes Of Operation

The ECM looks at inputs from several sensors to determine how much fuel to give the engine. The fuel is delivered under one of several conditions, called "modes." All the "modes" are controlled by the ECM and are described below.

Starting Mode

When the ignition switch is turned to the crank position, the ECM turns the fuel pump relay "ON," and the fuel pump builds up pressure. The ECM then checks the ECT sensor and TP sensor and determines the proper air/fuel ratio for starting. The ECM controls the amount of fuel delivered in the starting mode by changing how long the injectors are turned "ON" and "OFF." This is done by "pulsing" the injectors for very short times.

Clear Flood Mode

If the engine floods, it can be cleared by opening the throttle to 100% (wide open throttle) during cranking. The ECM then shuts down the fuel injectors so no fuel is delivered. The ECM holds this injector rate as long as the throttle stays at 100%, and the engine speed is below 300 RPM. If the throttle position becomes less than 100%, the ECM returns to the starting mode.

Run Mode

When the engine is first started and RPM is above 300 RPM, the system operates in the run mode. The ECM will calculate the desired air/fuel ratio based on these ECM inputs: RPM, ECT, and MAP. Higher engine loads (MAP input) and colder engine temperatures (ECT input) require more fuel, or a richer air/fuel ratio.

Acceleration Mode

The ECM looks at rapid changes in TP sensor and MAP, and provides extra fuel by increasing the injector pulse width.

Fuel Cutoff Mode

No fuel is delivered by the injector when the ignition is "OFF," to prevent dieseling. Also, fuel pulses are not

Fuel Cutoff Mode

No fuel is delivered by the injector when the ignition is "OFF," to prevent dieseling. Also, fuel pulses are not delivered if the ECM does not receive distributor reference pulses, which means the engine is not running. The fuel cutoff mode is also enabled at high engine RPM, as an overspeed protection for the engine. When cutoff is in effect due to high RPM, injector pulses will resume after engine RPM drops below the maximum OEM RPM specification (Rev Limit).

RPM Reduction Mode

The ECM recognizes change of state in a discrete switch input that identifies an abnormal condition that may affect proper engine operation. As an engine protection feature (optional), RPM reduction mode allows normal fuel injection up to OEM specification (approximately 2000 RPM). Above the OEM specified RPM limit, fuel delivery is limited to half the fuel injectors until the engine drops below 1200 RPM. Then normal engine operation is restored until the RPM limit is exceeded again. This feature allows maneuverability of the boat while removing the possibility of high engine speed operation until the problem is corrected.

Fuel Metering System Components

Figure 3-1

The fuel metering system (Figure 3-1) is made up of the following parts:

- Fuel supply components (fuel tank, pump, lines, water separator).
- Fuel pump electrical circuit.
- Fuel rail assembly, including fuel injectors and pressure regulator assembly.
- Throttle body assembly, including fuel injectors, pressure regulator assembly, an IAC valve, and a TP sensor.

Fuel Supply Components (Typical)

Figures 3-1 and 3-2

The fuel supply is stored in the fuel tank. An electric pump (Figure 3-2), located near the water separator assembly, pumps fuel through an in-line fuel filter to the TBI assembly. The pump is designed to provide fuel at a pressure greater than is needed by the injectors. The pressure regulator, part of the TBI assembly, keeps fuel available to the injectors at a regulated pressure. Unused fuel is returned to the fuel tank by a separate line.

Figure 3-1 - Fuel Metering System (Typical)

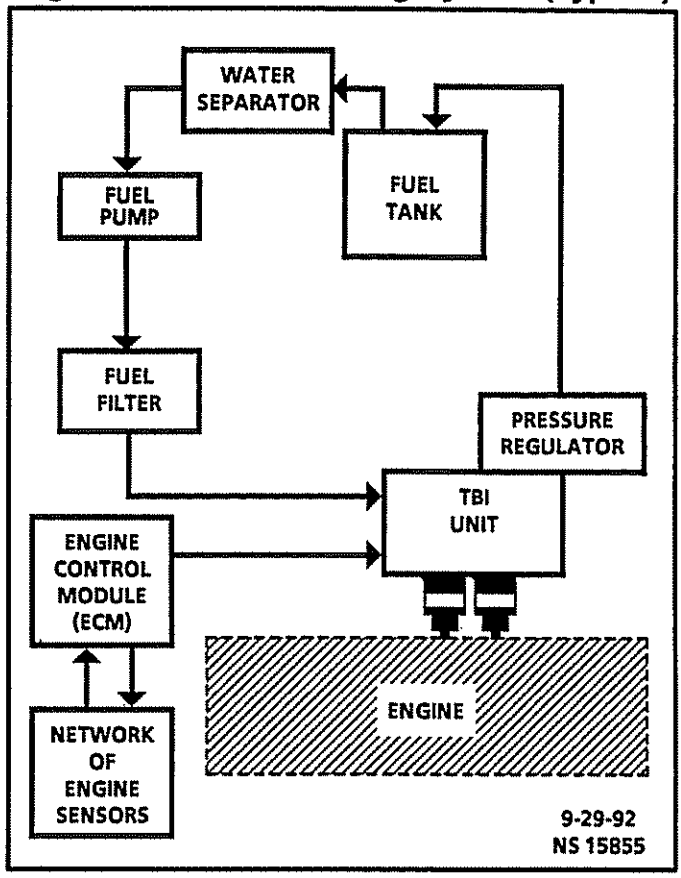
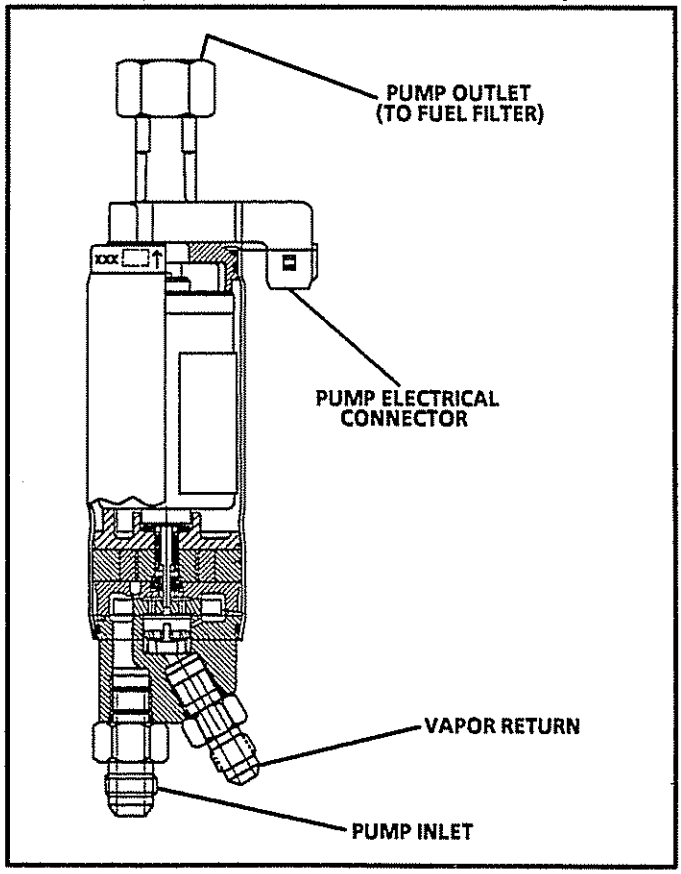


Figure 3-2 - Electric Fuel Pump



MS 13555

Fuel Pump Electrical Circuit

When the ignition switch is turned "ON," the ECM turns the fuel pump relay "ON" for two seconds causing the fuel pump to pressurize the MEFI fuel system.

When the ignition switch is turned to the crank position, the ECM turns the fuel pump relay "ON" causing the fuel pump to run.

If the ECM does not receive ignition reference pulses (engine cranking or running), it shuts "OFF" the fuel pump relay, causing the fuel pump to stop.

An inoperative fuel pump relay will result in an "Engine Cranks But Won't Run" condition.

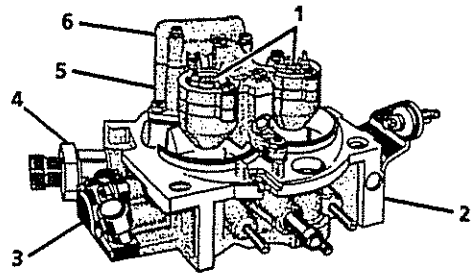
Throttle Body Fuel Injection (TBI) Unit

Figures 3-3 and 3-4

The TBI unit consists of three major assemblies:

- Fuel meter cover.
  - Fuel pressure regulator.
- Fuel meter body.
  - Fuel injectors.
- Throttle body.
  - Two throttle plates to control air flow into the engine.
  - Idle Air Control (IAC) valve.
  - IAC passage splitter for improved distribution of idle air flow.
  - Throttle Position (TP) sensor.

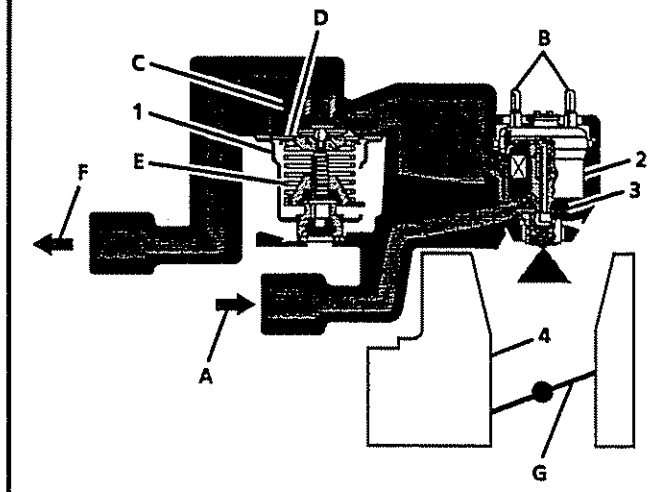
Figure 3-3 - Throttle Body Fuel Injection (TBI) Unit



1 INJECTOR ASSEMBLY - THROTTLE BODY FUEL
2 BODY ASSEMBLY - THROTTLE
3 SENSOR - THROTTLE POSITION (TP)
4 VALVE ASSEMBLY - IDLE AIR CONTROL (IAC)
5 BODY ASSEMBLY - FUEL METER
6 COVER ASSEMBLY - FUEL METER

MP 1191 AS

Figure 3-4 - Fuel Flow Diagram



1	PRESSURE REGULATOR	C	CONSTANT BLEED - (SOME MODELS)
2	FUEL INJECTOR	D	PRESSURE REGULATOR DIAPHRAGM ASSEMBLY
3	FUEL INJECTOR INLET FILTER	E	PRESSURE REGULATOR SPRING
4	THROTTLE BODY ASSEMBLY	F	FUEL RETURN TO TANK
A	FUEL FROM PUMP	G	THROTTLE VALVE
B	INJECTOR ELECTRICAL TERMINALS		

BP 0320-SY

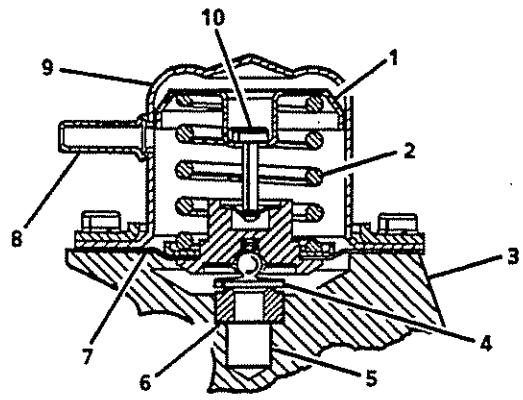
Pressure Regulator Assembly

Figure 3-5

The pressure regulator is a diaphragm-operated relief valve with fuel pump pressure on one side, and regulator spring pressure on the other side (Figure 3-5). The regulator's function is to maintain a constant pressure differential across the injectors at all times.

With the ignition "ON," engine "OFF," fuel pressure should be 186-228 kPa (27-33 psi). Fuel pressure will drop to zero within a few seconds after the fuel pump shuts off. If the pressure is too low, poor performance or a "no-start" may result. If pressure is too high, excessive odor may result.

Figure 3-5 - Pressure Regulator Assembly



1	LOWER SPRING RETAINER	6	VALVE SEAT
2	SPRING	7	DIAPHRAGM ASSEMBLY
3	BASE	8	VACUUM CONNECTION TUBE
4	PRESSURE REGULATOR VALVE	9	COVER
5	FUEL RETURN	10	SPRING RETAINER TIE ROD

9P 0974-AS

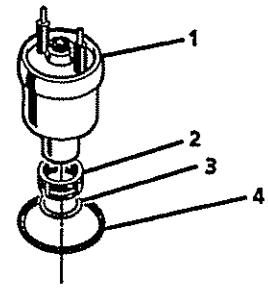
Fuel Injectors

Figure 3-6

The TBI injector assembly is a solenoid-operated device, controlled by the ECM, that meters pressurized fuel to the intake manifold. The ECM energizes the injector solenoid, which opens a ball valve, allowing fuel to flow past the ball valve, and through a recessed flow director plate. The director plate has six machined holes that control the fuel flow, generating a conical spray pattern of finely atomized fuel at the injector tip. Fuel is directed at the throttle plates, causing it to become further atomized and vaporized before entering the intake manifold.

An injector that is stuck partly open can be visually seen. After engine shut down, watch for fuel dripping out of the injector tip. Consequently, long cranking times would be noticed. Dieseling could also occur, because some fuel could be delivered to the engine after the ignition is turned "OFF." A fuel injector that does not open, may cause a "no-start" or a misfire.

Figure 3-6 - TBI Injector Assembly



1	FUEL INJECTOR ASSEMBLY
2	FUEL INJECTOR INLET FILTER
3	FUEL INJECTOR LOWER "O" RING
4	FUEL INJECTOR UPPER "O" RING

PS 18610

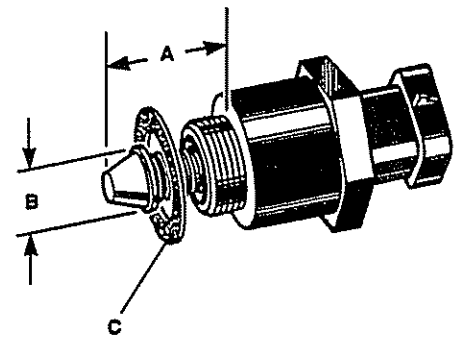
Idle Air Control (IAC) Valve

Figures 3-7 through 3-9

The purpose of the IAC valve assembly (Figures 3-7 and 3-8) is to control engine idle speed, while preventing stalls due to changes in engine load.

There are two types of IAC valves, thread mounted and flange mounted. Depending on production date, an engine could be equipped with one or the other.

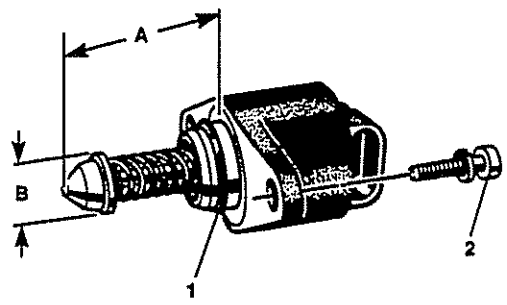
Figure 3-7 - Thread Mounted Type IAC Valve



A	DISTANCE OF PINTLE EXTENSION
B	DIAMETER AND SHAPE OF PINTLE
C	IAC VALVE GASKET

8-25-94
RS 22180

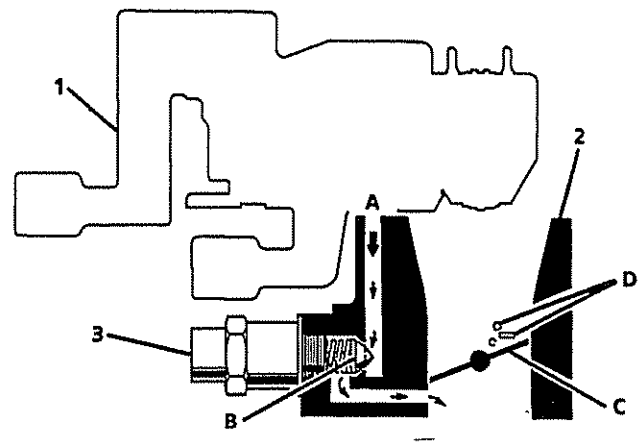
Figure 3-8 - Flange Mounted Type IAC Valve



1 O-RING - IAC VALVE
2 SCREW ASSEMBLY - IAC VALVE ATTACHING
A DISTANCE OF PINTLE EXTENSION
B DIAMETER OF PINTLE

8-24-94
RS 22181

Figure 3-9 - IAC Valve Air Flow Diagram



1 FUEL METER COVER & BODY ASSEMBLIES
2 THROTTLE BODY ASSEMBLY
3 IDLE AIR CONTROL (IAC) VALVE ASSEMBLY
A FILTERED AIR INLET
B PINTLE
C THROTTLE VALVE
D VACUUM PORTS - FOR ENGINE OR EMISSION CONTROLS

4-13-94
8P 0319-SY

The IAC valve, mounted in the throttle body, controls bypass air around the throttle plates (Figure 3-9). By moving a conical valve known as a pintle, IN, towards the seat (to decrease air flow); or OUT, away from the seat (to increase air flow), a controlled amount of air moves around the throttle plates. If RPM is too low, more air is bypassed around the throttle plates to increase it. If RPM is too high, less air is bypassed around the throttle plates to decrease it.

The ECM moves the IAC valve in small steps. These can be measured by scan tool test equipment, which plugs into the Data Link Connector (DLC).

During idle, the proper position of the IAC valve is calculated by the ECM, based on battery voltage, coolant temperature, and engine RPM. If the RPM drops below specification and the throttle plates are closed, the ECM senses a near stall condition and calculates a new valve position to prevent stalling.

- Engine idle speed is a function of total air flow into the engine based on IAC valve pintle position plus throttle plates opening.
- "Controlled" idle speed is programmed into the ECM, which determines the correct IAC valve pintle position to maintain the desired idle speed for all engine operating conditions and loads.
- The minimum air rate is set at the factory with a stop screw. This setting allows enough air flow by the throttle plates to cause the IAC valve pintle to be positioned a calibrated number of steps (counts) from the seat, during "controlled" idle operation. This minimum air rate setting should not be altered by turning the stop screw or bending the linkage. Improper idle control will result.

Diagnosis

If the Engine Cranks But Will Not Run or immediately stalls, Chart A-3 must be used to determine if the failure is in the ignition system or the fuel system.

On-Board Service

Flame Arrestor

Remove or Disconnect

1. Flame arrestor retaining clamp.
2. Hoses from flame arrestor.
3. Flame arrestor.

Inspect

- Flame arrestor element for dust, dirt, or water. Replace if required.

Notice: Flame arrestor may be baffled, install it per manufacturer's instructions for correct air distribution.

Install or Connect

1. Flame arrestor to throttle body.
2. Flame arrestor retaining clamp to flame arrestor.
3. Hoses to flame arrestor.

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.

Fuel Control On-Board Service

The following is general information required when working on the fuel system:

- Always keep a dry chemical fire extinguisher near the work area.
- Fuel pipe fittings require new O-rings when assembling.
- 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.

Fuel Pressure Relief Procedure

Important

- Refer to manufacturer's warnings and cautions before proceeding.

1. Disconnect negative battery cable to avoid possible fuel discharge if an accidental attempt is made to start the engine.
2. Loosen fuel filler cap to relieve any tank vapor pressure.
3. The internal constant bleed feature of the TBI unit relieves fuel pump system pressure when the engine is turned "OFF." Therefore, no further pressure relief procedure is required.

Throttle Body Fuel Injection (TBI) Unit

Figures 3-10 through 3-20

Clean

- The throttle bore and valve deposits may be cleaned on vessel, using carburetor cleaner and a parts cleaning brush. Do Not use a cleaner that contains methyl ethyl ketone, an extremely strong solvent, and not necessary for this type of deposit.
- The throttle body metal parts may be cleaned following disassembly, in a cold, immersion type cleaner.

Notice: The fuel injectors, pressure regulator, TP sensor, and IAC valve should not come in contact with solvent or cleaner, as they may be damaged. These components should be removed before immersion.

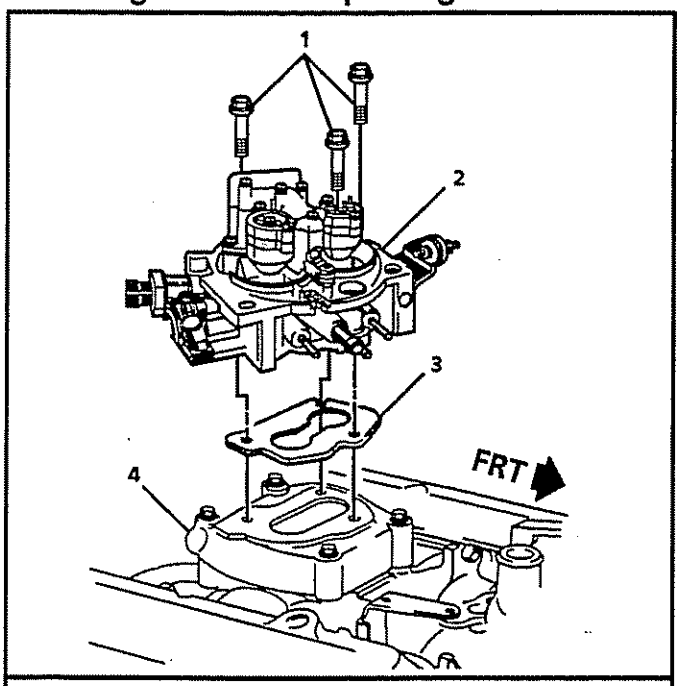
- Clean all metal parts thoroughly and blow dry with compressed air. Be sure that all fuel and air passages are free of dirt and burrs.
- Inspect mating surfaces for damage that could affect gasket sealing and inspect throttle body for cracks in casting.
- Thread-locking compound supplied in the service repair kit is a small vial of thread-locking compound with directions for use. If material is not available, use Loctite 262 or equivalent.

Notice: In precoating screws, do not use a higher strength locking compound than recommended, since to do so could make removing the screws very difficult, or resulting in damaging the screw head.

Remove or Disconnect

1. Negative battery cable.
2. Flame arrestor, breather hoses (if applicable), and gasket. Discard gasket.
3. Electrical connectors - IAC valve, TP sensor, and fuel injectors. Squeeze plastic tabs on injectors and pull straight up.
4. Grommet with wires from throttle body.
5. Throttle linkage and return spring(s).
6. Relieve fuel pressure.
   - Refer to the "Fuel Pressure Relief Procedure."
7. Inlet and outlet fuel line nuts, using a back up wrench.
8. Fuel line O-rings from nuts and discard.
9. TBI mounting hardware.
10. TBI unit from adapter plate.

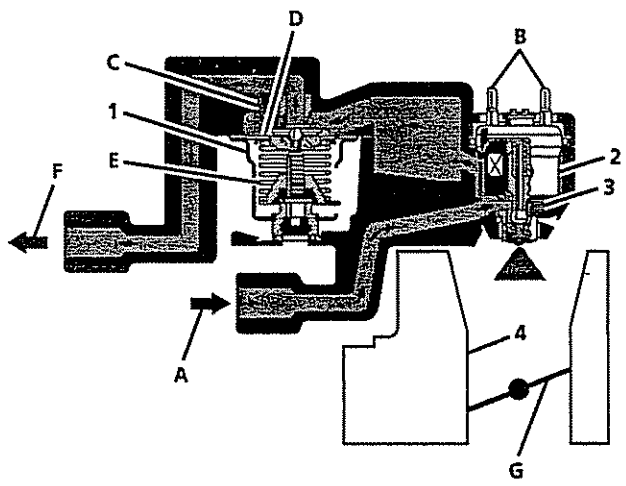
Figure 3-10 - Replacing TBI Unit



1	BOLT - TIGHTEN TO 16 N·m (12 lb. ft.)
2	TBI UNIT
3	GASKET
4	MOUNTING BRACKET

NS 16501

Figure 3-11 - TBI Unit Operation



1	PRESSURE REGULATOR	C	CONSTANT BLEED - (SOME MODELS)
2	FUEL INJECTOR	D	PRESSURE REGULATOR DIAPHRAGM ASSEMBLY
3	FUEL INJECTOR INLET FILTER	E	PRESSURE REGULATOR SPRING
4	THROTTLE BODY ASSEMBLY	F	FUEL RETURN TO TANK
A	FUEL FROM PUMP	G	THROTTLE VALVE
B	INJECTOR ELECTRICAL TERMINALS		

8P 0320-SY

Notice: To prevent damage to the throttle valve, it is essential that the unit be placed on a holding fixture, before performing service.

10. TBI flange (adapter mounting) gasket.

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.

Install or Connect

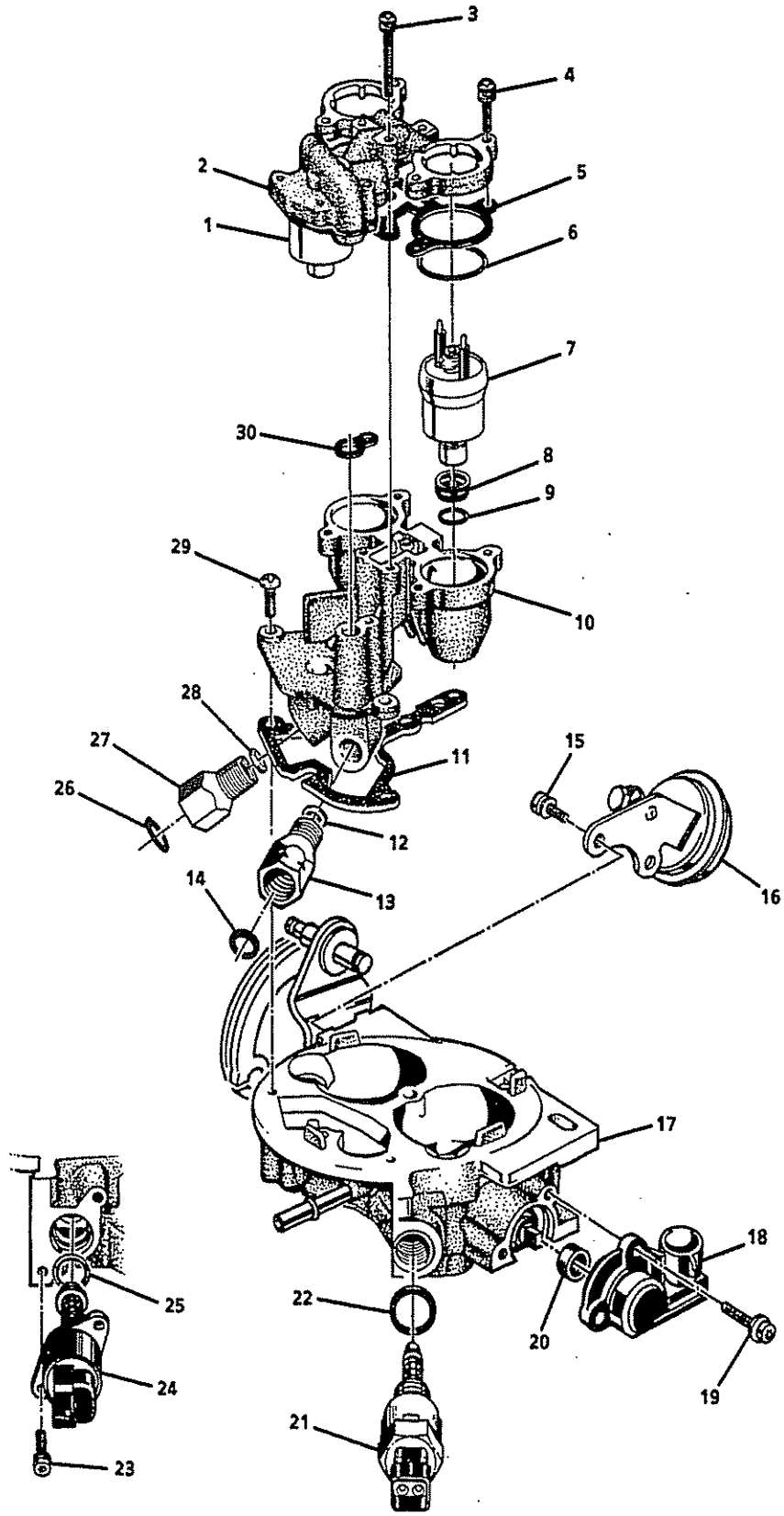
1. New TBI flange (adapter mounting) gasket.
2. TBI with mounting hardware. Torque bolts to 16 N•m (12 lb. ft.).
3. New O-rings on fuel line nuts.
4. Fuel line inlet and outlet nuts by hand. Using back up wrench, torque fuel line nuts to 23 N•m (17 lb. ft.).
5. Throttle linkage and return spring(s).
6. Grommet with wires to throttle body.
7. Electrical connectors, making sure connectors are fully seated and latched.
8. Check to see if the throttle is free, by moving the throttle lever to 100% and back to 0% while the engine is "OFF."
9. Negative battery cable.

Inspect

- Turn ignition switch to the "ON" position for 2 seconds, then turn to the "OFF" position for 10 seconds. Turn the ignition switch back to the "ON" position and check for fuel leaks.

10. Flame arrestor with new gasket.
11. Start engine and check for fuel leaks again.

Figure 3-12 - Throttle Body



1	REGULATOR ASSEMBLY - FUEL PRESSURE
2	COVER ASSEMBLY - FUEL METER
3	SCREW - FUEL METER COVER ATTACHING - LONG
4	SCREW - FUEL METER COVER ATTACHING - SHORT
5	GASKET - FUEL METER COVER
6	O-RING - FUEL INJECTOR UPPER
7	INJECTOR ASSEMBLY - TBI FUEL
8	FILTER - FUEL INJECTOR INLET
9	O-RING - FUEL INJECTOR LOWER
10	BODY ASSEMBLY - FUEL METER
11	GASKET - THROTTLE BODY TO FUEL METER BODY
12	GASKET - FUEL OUTLET NUT
13	NUT - FUEL OUTLET
14	O-RING - FUEL RETURN PIPE
15	SCREW - ISC ACTUATOR ASSEMBLY ATTACHING
16	ACTUATOR ASSEMBLY - IDLE SPEED CONTROL (ISC)
17	BODY ASSEMBLY - THROTTLE
18	SENSOR - THROTTLE POSITION (TP)
19	SCREW - TP SENSOR ATTACHING
20	SEAL - TP SENSOR
21	VALVE ASSEMBLY - IDLE AIR CONTROL (IAC) - THREAD MOUNTED
22	GASKET - IAC VALVE
23	SCREW - IAC VALVE ATTACHING
24	VALVE ASSEMBLY - IDLE AIR CONTROL (IAC) - FLANGE MOUNTED
25	O-RING - IAC VALVE
26	O-RING - FUEL FEED PIPE
27	NUT - FUEL INLET
28	GASKET - FUEL INLET NUT
29	SCREW - FUEL METER BODY TO THROTTLE BODY ATTACHING
30	GASKET - FUEL METER OUTLET

5-4-94
LP 0171-XV

TBI Fuel Meter Cover Assembly

Figure 3-13

The fuel meter cover assembly contains the fuel pressure regulator assembly. The regulator has been adjusted at the factory and should only be serviced as a complete preset assembly.

Caution:

Do Not remove the four screws securing the pressure regulator to the fuel meter cover. The fuel pressure regulator includes a large spring under heavy compression which, if accidentally released, could cause personal injury. Disassembly may also result in a fuel leak between the diaphragm and the regulator container.

Remove or Disconnect

1. Negative battery cable.
2. Relieve fuel pressure.
   - Refer to the "Fuel Pressure Relief Procedure."
3. Electrical connectors to fuel injectors. Squeeze plastic tabs on injectors and pull straight up.
4. Long and short fuel meter cover screw assemblies.
5. Fuel meter cover assembly.

Notice: Do Not immerse the fuel meter cover (with pressure regulator) in cleaner, as damage to the regulator diaphragm and gasket may occur.

6. Fuel meter outlet gasket and pressure regulator seal. Discard gaskets and seal.

Inspect

- For dirt, foreign material, and casting warpage.

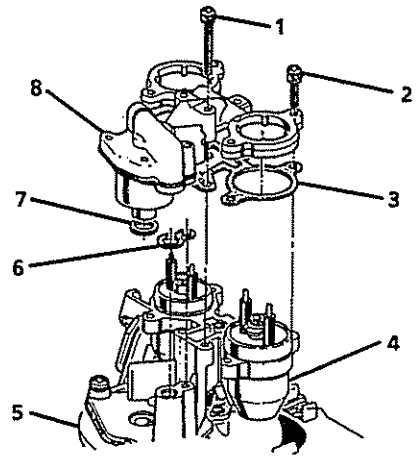
Install or Connect

1. New pressure regulator seal, fuel meter outlet passage gasket, and cover gasket.
2. Fuel meter cover assembly.
3. Attaching screw assemblies, precoated with appropriate locking compound to the threads. (Short screws are next to the injectors). Torque to 3 N•m (28 lb. in.).
4. Electrical connectors to the injectors.
5. Negative battery cable.

Inspect

- Turn ignition switch to the "ON" position for 2 seconds, then turn to the "OFF" position for 10 seconds. Turn the ignition switch back to the "ON" position and check for fuel leaks.

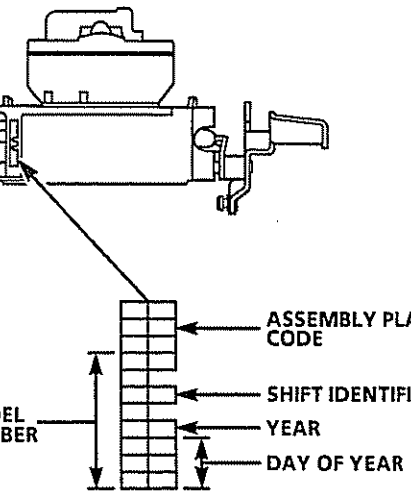
Figure 3-13 - Replacing Fuel Meter Cover



1	FUEL METER COVER ATTACHING SCREW ASSEMBLY - LONG
2	FUEL METER COVER ATTACHING SCREW ASSEMBLY - SHORT
3	FUEL METER COVER GASKET
4	FUEL METER BODY ASSEMBLY
5	THROTTLE BODY ASSEMBLY
6	FUEL METER OUTLET GASKET
7	PRESSURE REGULATOR SEAL
8	FUEL METER COVER ASSEMBLY

8P 0924-AS

Figure 3-14 - TBI Identification



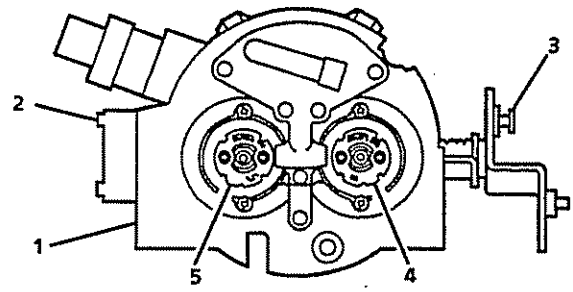
9P 0154-AS

Fuel Injector Assembly

Figures 3-15 through 3-19

Notice: Use care in removing the fuel injectors to prevent damage to the electrical connector terminals, the injector filter, and the fuel nozzle. The fuel injector is serviced as a complete assembly only (refer to Figure 3-15). Also, since the injectors are electrical components, they should not be immersed in any type of liquid solvent or cleaner as damage may occur.

Figure 3-15 - Fuel Injectors



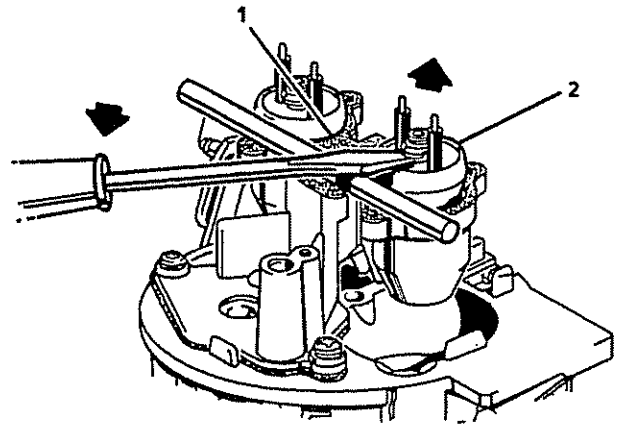
1 TBI MODEL NUMBER
2 THROTTLE POSITION (TP) SENSOR
3 THROTTLE LEVER
4 INJECTOR
5 INJECTOR

8S 3999-6E

Remove or Disconnect

1. Negative battery cable.
2. Relieve fuel pressure.
   - Refer to the "Fuel Pressure Relief Procedure."
3. Electrical connectors to fuel injectors. Squeeze plastic tabs on injectors and pull straight up.
4. Fuel meter cover assembly following procedure outlined in this section.
5. With fuel meter cover gasket in place to prevent damage to casting, use a screwdriver and fulcrum to carefully lift out each injector (Figure 3-16).

Figure 3-16 - Removing Fuel Injector



1 FUEL METER COVER GASKET
2 REMOVING FUEL INJECTOR

5S 1697-6E

6. Lower (small) O-ring from nozzle of injectors and discard.
7. Fuel meter cover gasket and discard.
8. Upper (large) O-ring and steel backup washer from top of fuel injector cavity and discard.

Inspect

- Fuel injector filter for evidence of dirt and contamination. If present, check for presence of dirt in fuel lines and fuel tank.

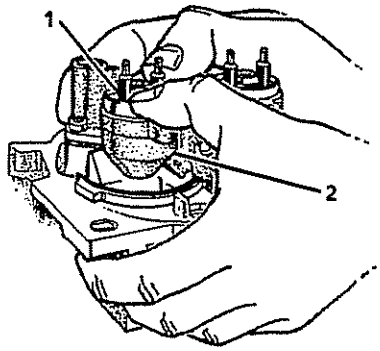
Important

- Be sure to replace the injector with one having an identical part number. Injectors from other models can also fit in the TBI unit, but are calibrated for different flow rates. (Refer to Figure 3-18 for part number location).

Install or Connect

1. Lubricate new lower (small) O-ring with automatic transmission fluid and push on nozzle end of injector until it presses against injector fuel filter.
2. Steel injector backup washer in counterbore of fuel meter body.

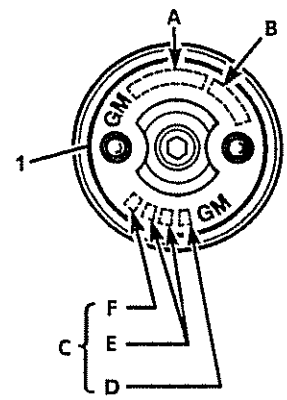
Figure 3-17 - Installing Fuel Injector



1 FUEL INJECTOR ASSEMBLY
2 FUEL METER BODY ASSEMBLY

3-31-94
MP 1202-AS

Figure 3-18 - Fuel Injector Part Number Location



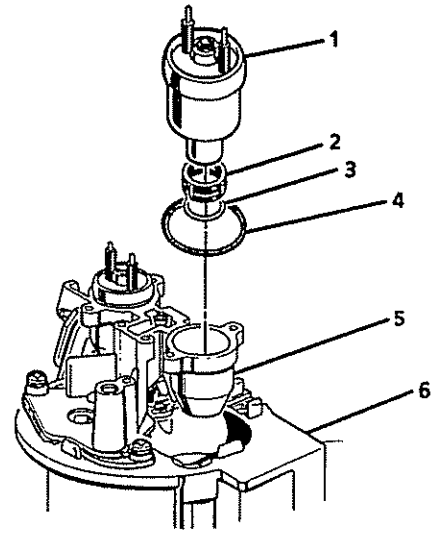
1 INJECTOR ASSEMBLY - (TOP VIEW) TBI FUEL
A PART IDENTIFICATION NUMBER
B VENDOR IDENTIFICATION
C BUILD DATE CODE
D YEAR
E DAY
F MONTH
1 - 9 (JAN - SEPT)
O, N, D (OCT, NOV, DEC)

6-9-94
9P 1071-AS

3. Lubricate upper (large) O-ring with automatic transmission fluid and install directly over the backup washer. Be sure O-ring is seated properly and is flush with top of fuel meter body surface.

Notice: Backup washers and O-rings must be installed before the injectors, or improper seating of large O-ring may cause a fuel leak.

Figure 3-19 - Fuel Injector



1 FUEL INJECTOR ASSEMBLY
2 FUEL INJECTOR INLET FILTER
3 FUEL INJECTOR LOWER "O" RING
4 FUEL INJECTOR UPPER "O" RING
5 FUEL METER BODY ASSEMBLY
6 THROTTLE BODY ASSEMBLY

6-10-94
MP 1200 AS

4. Injector, aligning raised lug on each injector base with notch in the fuel meter body cavity. Push down on injector until it is fully seated in fuel meter body (Figure 3-17). Injector electrical terminals should be parallel with the throttle shaft.

Important

- Be sure to install the injectors in their proper location.

5. Fuel meter cover gasket.
6. Fuel meter cover following procedure outlined in this section.
7. Electrical connectors to injectors.
8. Negative battery cable.

Inspect

- Turn ignition switch to the "ON" position for 2 seconds, then turn to the "OFF" position for 10 seconds. Turn the ignition switch back to the "ON" position and check for fuel leaks.

Fuel Meter Body Assembly

Figure 3-20

Remove or Disconnect

1. Negative battery cable.
2. Relieve fuel pressure.
   - Refer to the "Fuel Pressure Relief Procedure."
3. Electrical connectors to fuel injectors. Squeeze plastic tabs on injectors and pull straight up.
4. Fuel meter cover assembly following procedure outlined in this section.
5. Fuel injectors following procedure outlined in this section.
6. Inlet and outlet fuel line nuts, using a back up wrench.
7. Fuel line O-rings from nuts and discard.
8. Inlet and outlet adapter nuts and gaskets from the fuel meter body assembly. Discard gaskets.

Important

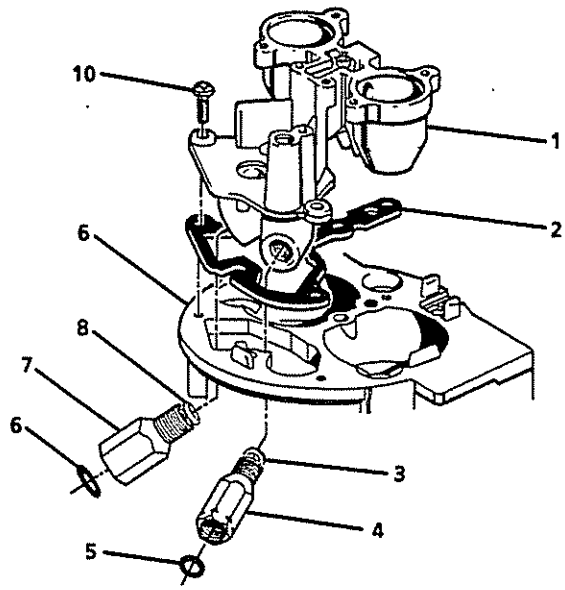
- Note locations of nuts for proper reassembly later. Inlet nut has a larger passage than the outlet nut.

9. Fuel meter body to throttle body attaching screws.
10. Fuel meter body assembly from the throttle body assembly.
11. Throttle body to fuel meter body gasket and discard.

Install or Connect

1. New throttle body to fuel meter body gasket. Match cut-out portions in gasket with openings in the throttle body.
2. Fuel meter body assembly on throttle body assembly.
3. Fuel meter body-to-throttle body attaching screws, precoated with appropriate locking compound. Torque to 4 N•m (30 lb. in.).
4. Inlet and outlet adapter nuts with new gaskets to the fuel meter body assembly.
   - Torque inlet adapter nut to 40 N•m (30 lb. ft.).
   - Torque outlet adapter nut to 29 N•m (21 lb. ft.).
5. New fuel line O-rings.
6. Inlet and outlet fuel line nuts, using a back up wrench. Torque to 23 N•m (17 lb. ft.).
7. Fuel injectors following procedure outlined in this section.
8. Fuel meter cover gasket, fuel meter outlet gasket, and pressure regulator seal.

Figure 3-20 - Fuel Meter Body Assembly



1	FUEL METER BODY ASSEMBLY
2	THROTTLE BODY TO FUEL METER BODY GASKET
3	FUEL OUTLET NUT GASKET
4	FUEL OUTLET NUT
5	FUEL RETURN LINE O-RING
6	FUEL INLET LINE O-RING
7	FUEL INLET NUT
8	FUEL INLET NUT GASKET
9	THROTTLE BODY ASSEMBLY
10	FUEL METER BODY - THROTTLE BODY ATTACHING SCREW

MP 1234-AS

9. Fuel meter cover assembly following procedure outlined in this section.
10. Electrical connectors to fuel injectors.
11. Negative battery cable.

Inspect

- Turn ignition switch to the "ON" position for 2 seconds, then turn to the "OFF" position for 10 seconds. Turn the ignition switch back to the "ON" position and check for fuel leaks.

Fuel Pump

Figure 3-21

Important

- Fuel pressure must be relieved before servicing the fuel pump.
- Refer to "Fuel Pressure Relief Procedure."

Remove or Disconnect

1. Negative battery cable.
2. Fuel pump electrical connector.
3. Inlet and outlet fuel line fittings.
4. Vapor return line fitting.
5. Fuel pump.

Notice: Make sure to replace the fuel pump with the identical part number.

Install or Connect

1. Fuel pump.
2. Vapor return line fitting.
3. Inlet and outlet fuel line fittings.
4. Fuel pump electrical connector.
5. Negative battery cable.

Inspect

- Turn ignition switch to the "ON" position for 2 seconds, then turn to the "OFF" position for 10 seconds. Turn the ignition switch back to the "ON" position and check for fuel leaks.

Fuel Pump Relay

Figure 3-22

Remove or Disconnect

1. Retainer, if installed.
2. Fuel pump relay electrical connector.
3. Fuel pump relay.

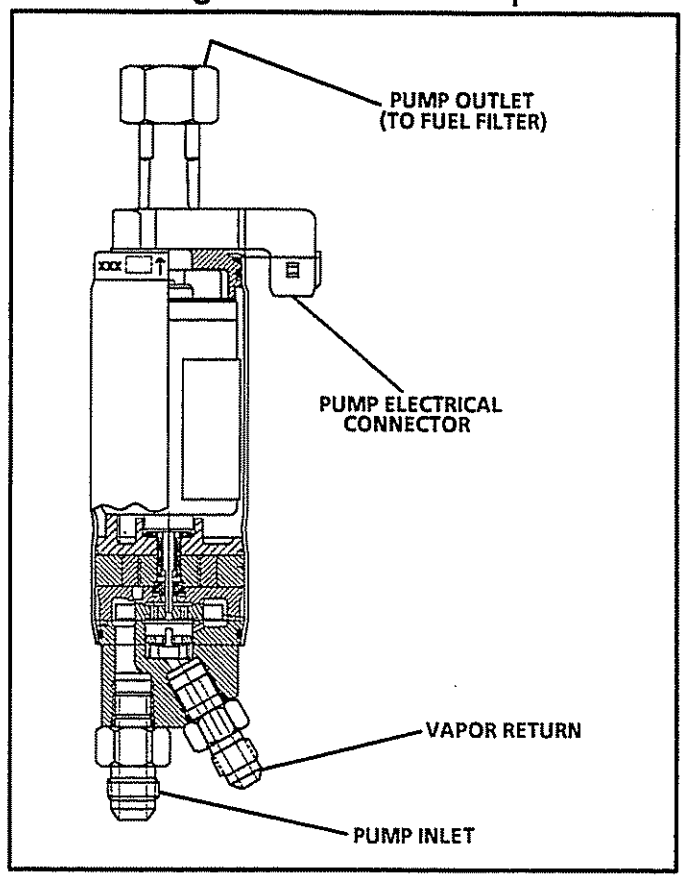
Important

- The fuel pump relay is a electrical component. Do Not soak in any liquid cleaner or solvent as damage may result.

Install or Connect

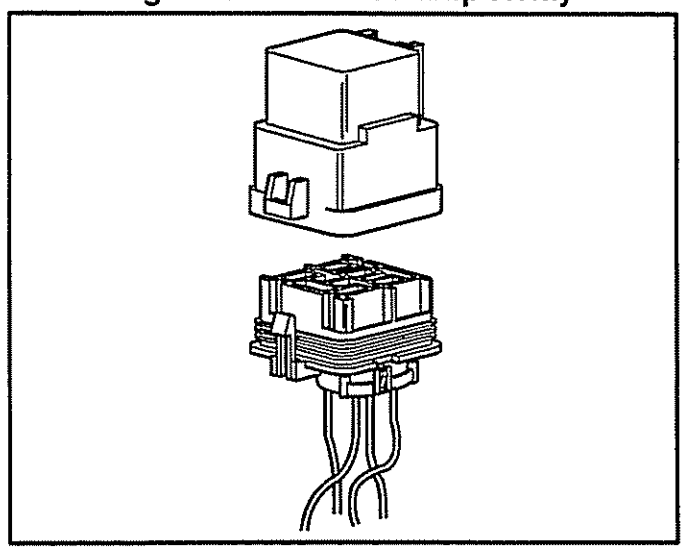
1. Fuel pump relay.
2. Fuel pump relay electrical connector.
3. Retainer clip.

Figure 3-21 - Fuel Pump



MS 13555

Figure 3-22 - Fuel Pump Relay



PS 16871

In-Line Fuel Filter

Figure 3-23

Important

- Fuel pressure must be relieved before servicing the fuel pump.
- Refer to "Fuel Pressure Relief Procedure."

Remove or Disconnect

1. Fuel line fittings.
2. Clamp bolt and clamp.

Inspect

- In-line fuel filter for being plugged or contaminated. Replace as necessary.

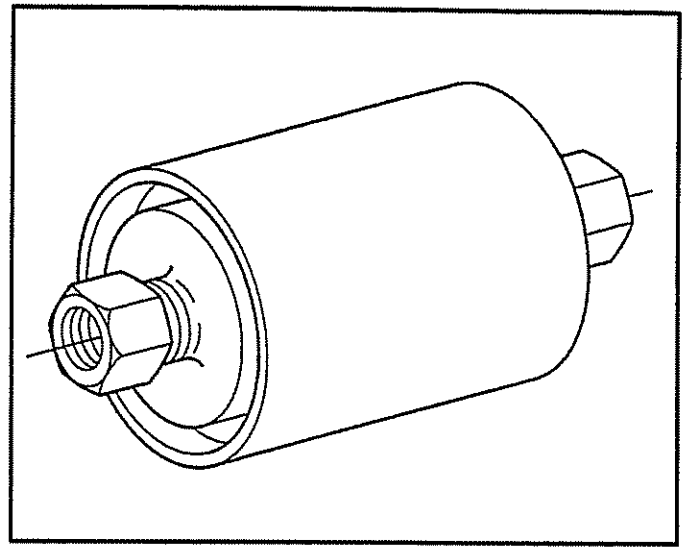
Install or Connect

1. Clamp and clamp bolt.
2. Fuel line nuts to filter.

Inspect

- Turn ignition switch to the "ON" position for 2 seconds, then turn to the "OFF" position for 10 seconds. Turn the ignition switch back to the "ON" position and check for fuel leaks.

Figure 3-23 - In-Line Fuel Filter



NS 15480

Water Separator

When it is necessary to change the water separator, follow the manufacturer's recommendations.

Important

- Fuel system needs to be primed and air bled out of the lines before the engine is started. With the engine "OFF," cycle ignition switch "ON" then "OFF" until pressure is built back up in the system.

Torque Specifications

Fastener Tightening Specifications

Application	N•m	Lb Ft	Lb In
TBI Unit Mounting Bolts	16	12	
TBI Fuel Line Nut to Inlet/Outlet Adapter Nuts	23	17	
TBI Fuel Metering Cover Attaching Screws	3		28
TBI Fuel Meter Body Assembly Attaching Screws	4		30
TBI Fuel Meter Body Assembly Inlet Adapter Nut	40	30	
TBI Fuel Meter Body Assembly Outlet Adapter Nut	29	21	

Marine Electronic Fuel Injection (MEFI)

Section 4

Distributor Ignition (DI) System

This section will describe how the Distributor Ignition (DI) system operates. It will also give a description and show how to repair each component used on the Marine Electronic Fuel Injection equipped engines. The DI system is used on all engines except for the 5.7 LT1 engine.

Contents

General Information

All Distributor Ignition (DI) systems include these essential components: battery, distributor, ignition coil, ignition switch, spark plugs, and primary and secondary wiring. The DI system is connected to the Engine Control Module (ECM). The ECM monitors from various engine sensors, computes the desired spark timing and signals the ignition control module in the distributor to change timing. The distributor does not contain centrifugal advance weights, springs, or vacuum advance units.

Delco Remy Distributors

Figures 4-1 and 4-2

The distributor used on the Marine Electronic Fuel Injection (MEFI) equipped engine is designed for the marine environment. The base plate of the distributor is equipped with two special vents to prevent any fuel vapors from igniting. The pick-up coil is sealed to keep out moisture and prevent electromagnetic interference. With the high voltage produced by the Delco Remy distributor, a special material is used for the distributor cap and rotor. It is a thermoplastic, injection-molded, glass-reinforced polyester. This material provides the dielectric and insulation property needed and also prevents carbon tracking. The posts in the distributor cap are made up of different metals to prevent corrosion.

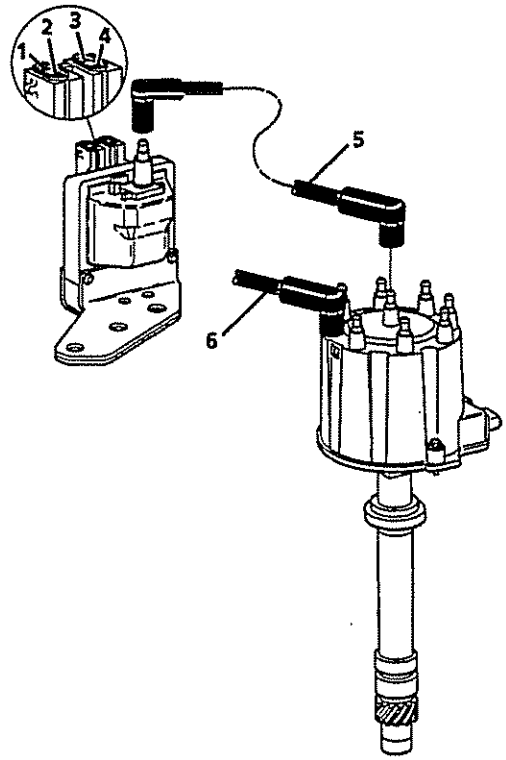
Distributors with a separate coil are used on the MEFI engine (Figures 4-1 and 4-2). The ignition coil connects to the distributor cap through a high tension wire.

There is no scheduled maintenance or periodic lubrication required. Engine oil lubricates the lower bushing and the upper bushing is pre-lubricated and sealed.

The distributor uses an internal magnetic pick-up assembly that consists of a permanent magnet, pole piece with internal teeth, and pick-up coil. When the rotating teeth of the timer core line up with the teeth of the pole piece, voltage is induced in the pick-up coil. This voltage signals the ignition control module to trigger the primary ignition circuit. Current flow in the primary circuit is interrupted and a high voltage of up to 35,000 volts is induced in the ignition coil secondary winding. This high voltage is directed through the secondary ignition circuit to fire the spark plugs.

The number of teeth on the stationary pole piece and shaft rotating teeth reflects the number of cylinders in the engine that it is supposed to be used on (eight teeth for eight cylinders). Although there are minor differences between applications, all DI systems operate the same.

Figure 4-1 - Distributor With Separate Coil



1	TACH TERMINAL
2	B+ TO COIL
3	COIL TRIGGER SIGNAL
4	B+ TO DISTRIBUTOR
5	HIGH TENSION WIRE TO COIL
6	HIGH TENSION WIRE TO SPARK PLUG

PS 18668

Ignition Coil

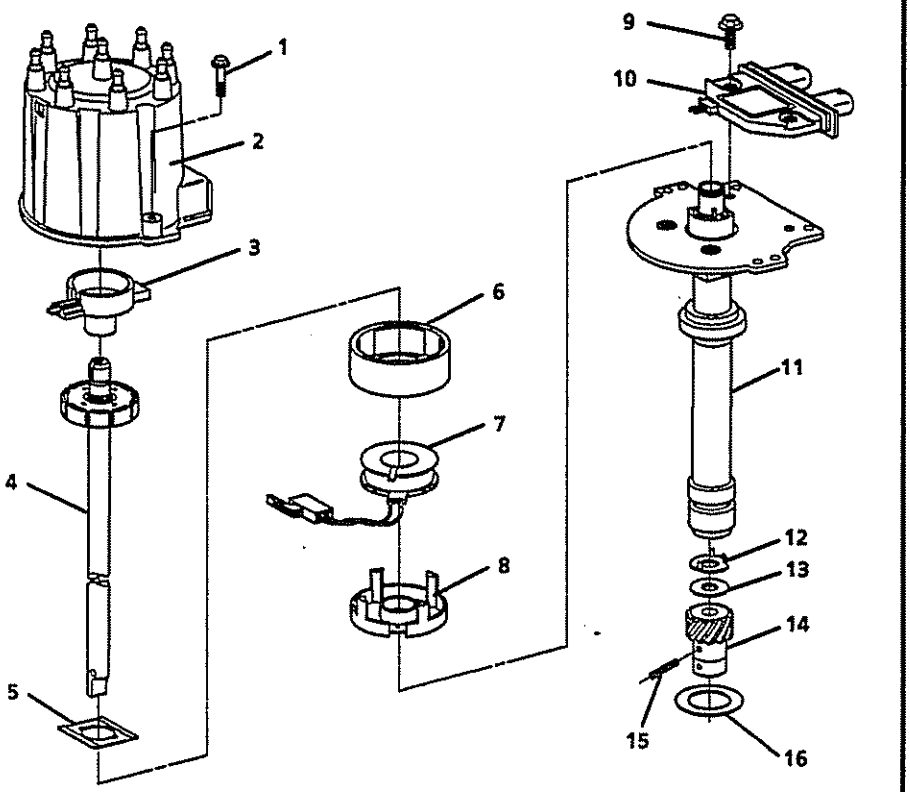
Figure 4-1

The design construction of the ignition coil affects its output. The DI system ignition coil was designed to produce greater spark voltage, longer spark, and operate at higher RPM. The DI system coil has the secondary winding wrapped around the primary winding, and the primary winding is wrapped around the iron core. The coil is not oil filled, the windings are covered in an epoxy compound for protection against moisture and arc over.

There is an iron laminated square frame around the coil windings. This is to increase magnetic flux path and store energy to produce higher secondary spark voltage. The coil's mounting bracket is attached to the frame.

The coil generates a high secondary voltage (up to 35,000 volts) when the primary circuit is broken. It is connected to the distributor by a high tension wire connected to the post mounted in the top of the coil. There are two 2-wire connectors on the coil used for battery voltage input, primary voltage sent to the distributor Ignition Control (IC) module, trigger signal from the IC module, and for the tach output signal.

Figure 4-2 - Typical V8 Distributor



1 CAP MOUNT SCREW
2 CAP
3 ROTOR
4 SHAFT ASSEMBLY
5 RETAINER
6 SHIELD
7 PICK UP COIL
8 POLE PIECE
9 MODULE MOUNT SCREW
10 IGNITION CONTROL MODULE
11 HOUSING
12 TANG WASHER
13 WASHER
14 DRIVE GEAR
15 ROLL PIN
16 GASKET

MS 11770

Ignition Control (IC) Module

Figure 4-3

The Ignition Control (IC) module is located in the distributor (Figure 4-3). It is mounted by two screws and they are used for the ground. The IC module is a solid state unit with transistorized relays and switches for controlling circuits. The IC module has several functions:

- It changes the voltage signal of the pick-up coil to a square digital signal.
- It sends the digital signal as a reference signal (REF HI) to the ECM for ignition control.
- It provides a ground reference (REF LO).
- It provides a means for the ECM to control spark advance (BYPASS AND IGNITION CONTROL) called IGNITION CONTROL MODE.
- It provides a limited means of controlling spark advance without ECM input, called MODULE MODE.
- It provides the trigger signal for the ignition coil.

Pole Piece And Coil Assembly

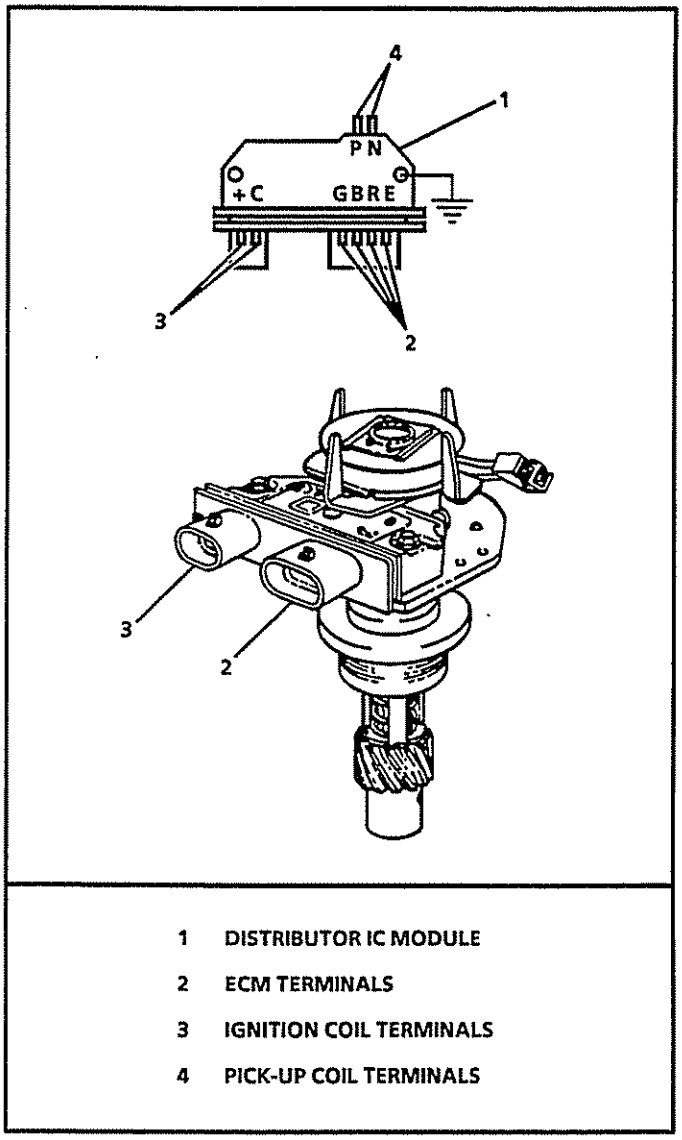
Figure 4-4

The pole piece and plate assembly (often referred to as the pick-up coil assembly) consists of a stationary pole piece with internal teeth, a pick-coil and magnet that are located between the pole piece and a bottom plate (Figure 4-4).

The pick-up coil produces an alternating signal voltage as the teeth pass the magnet. There is a signal produced for each engine cylinder during one revolution of the distributor.

The pick-up coil is connected to the IC module by a 2-wire connector. As with all marine electrical devices, the pick-up coil must be approved for this application.

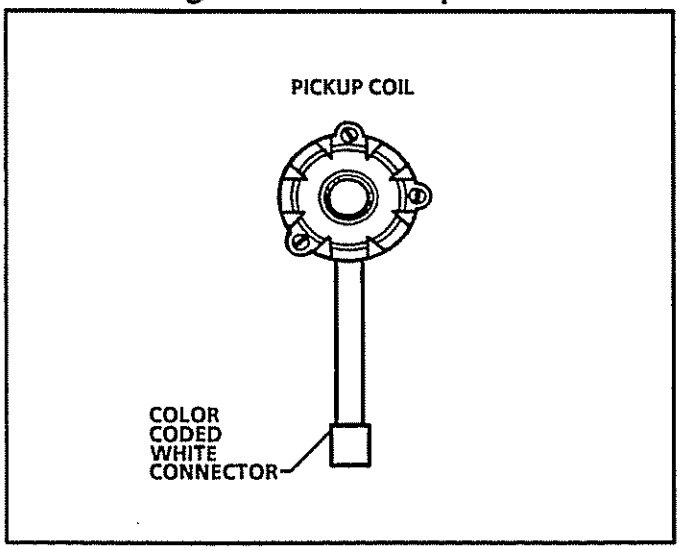
Figure 4-3 - IC Module Terminal Identification



1	DISTRIBUTOR IC MODULE
2	ECM TERMINALS
3	IGNITION COIL TERMINALS
4	PICK-UP COIL TERMINALS

MS 13632

Figure 4-4 - Pick-Up Coil



MS 8488-6E

Spark Plug Wires

The spark plug wires are a carbon-impregnated cord conductor encased in and 8 millimeter diameter silicone rubber jacket. Silicone wiring will withstand very high temperature and is an excellent insulator for the higher voltages. The silicone spark plug boots provide a tight seal on the spark plug.

Silicone is soft, pliable, and therefore, more susceptible to scuffing and cutting. It is extremely important that the spark plug cables be handled with care. They should be routed so as not to cross each other or to be in contact with other parts of the engine to prevent rubbing.

Do not force anything between the boot and wiring or through the silicone jacket. Connections should be made using an appropriate adapter.

Engine Control Module (ECM)

The Engine Control Module (ECM) controls spark advance and fuel injection for all driving conditions. The ECM monitors input signals for the following components as part of its ignition control function to determine the required ignition timing:

- Ignition Control (IC) module.
- Engine Coolant Temperature (ECT) sensor.
- Manifold Absolute Pressure (MAP) sensor.
- Throttle Position (TP) sensor.

Modes Of Operation

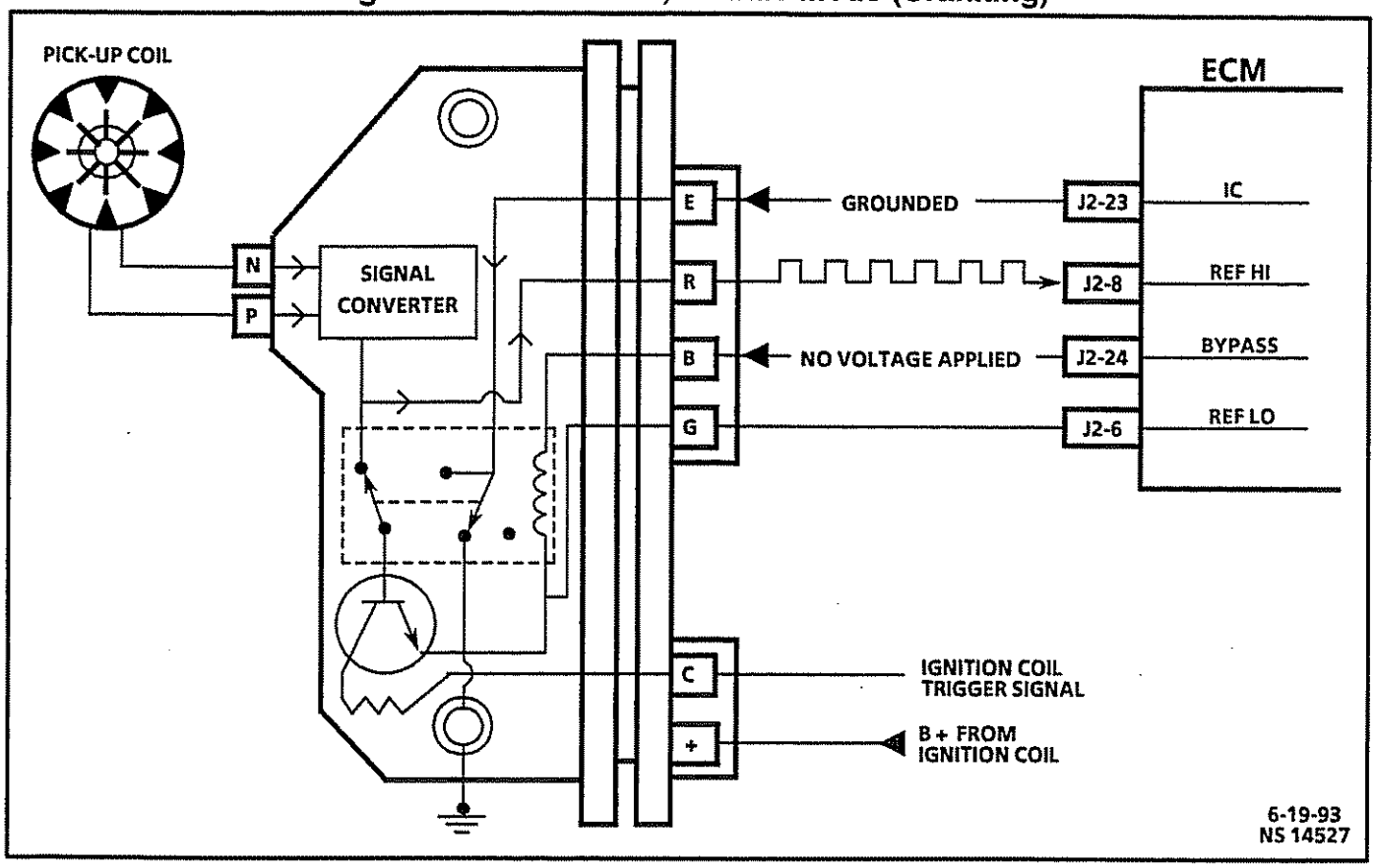
There are two "modes" of ignition system operation, "module mode (cranking)" and "ignition control mode (running)." In "module mode," the ignition system operates independently from the ECM. The ignition control module maintains a base ignition timing of 10 degrees BTDC and is able to change this ignition timing slightly with increased engine speed. "Module mode" is in effect whenever an ignition control fault is detected while the engine is running, and it will have a noticeable effect on engine operation.

In "ignition control mode," the ECM controls the ignition timing. The ECM calculates the desired ignition timing based on information it gets from its input sensors.

Ignition Timing

In order to change base timing on a DI system, the ECM has to be entered into the "service mode" by using a scan tool or MDTC tool. The IC module not receiving voltage on the bypass circuit from the ECM will go into "module mode." The IC module will go to base ignition timing of 10 degrees BTDC. At this time, the base timing can be adjusted by turning the distributor.

Figure 4-5 - IC Module, Module Mode (Cranking)



The ECM incorporates a permanent spark control override, which allows base ignition timing to be lowered electronically if spark knock (detonation) is encountered during normal operation due to the use of low octane fuel. Base ignition timing can be lowered using this override down to 6 degrees BTDC.

IC Operation - Module Mode (Cranking)

Figure 4-5

The following describes IC operation during cranking and when the engine starts running. To help understand how IC circuits operate, a relay with a double set of contact points is shown in the IC module. Solid state circuitry is used in the module, but adding the relay makes it easier to visualize how IC functions.

During cranking, the relay is in the de-energized position (Figure 4-5). This connects the pick-up coil to the base of the transistor. When the pick-up coil applies a positive voltage to the transistor, it turns "ON." When the voltage is removed, the transistor turns "OFF." When the transistor turns "ON," current flows through the primary windings of the ignition coil. When it turns "OFF," the primary current stops and a spark is developed at the spark plug. A small amount of advance is built into the IC module via a timing circuit, in case the engine remains in the ignition timing module mode.

With the relay de-energized, a set of contacts (shown "closed") would ground the IC line signal.

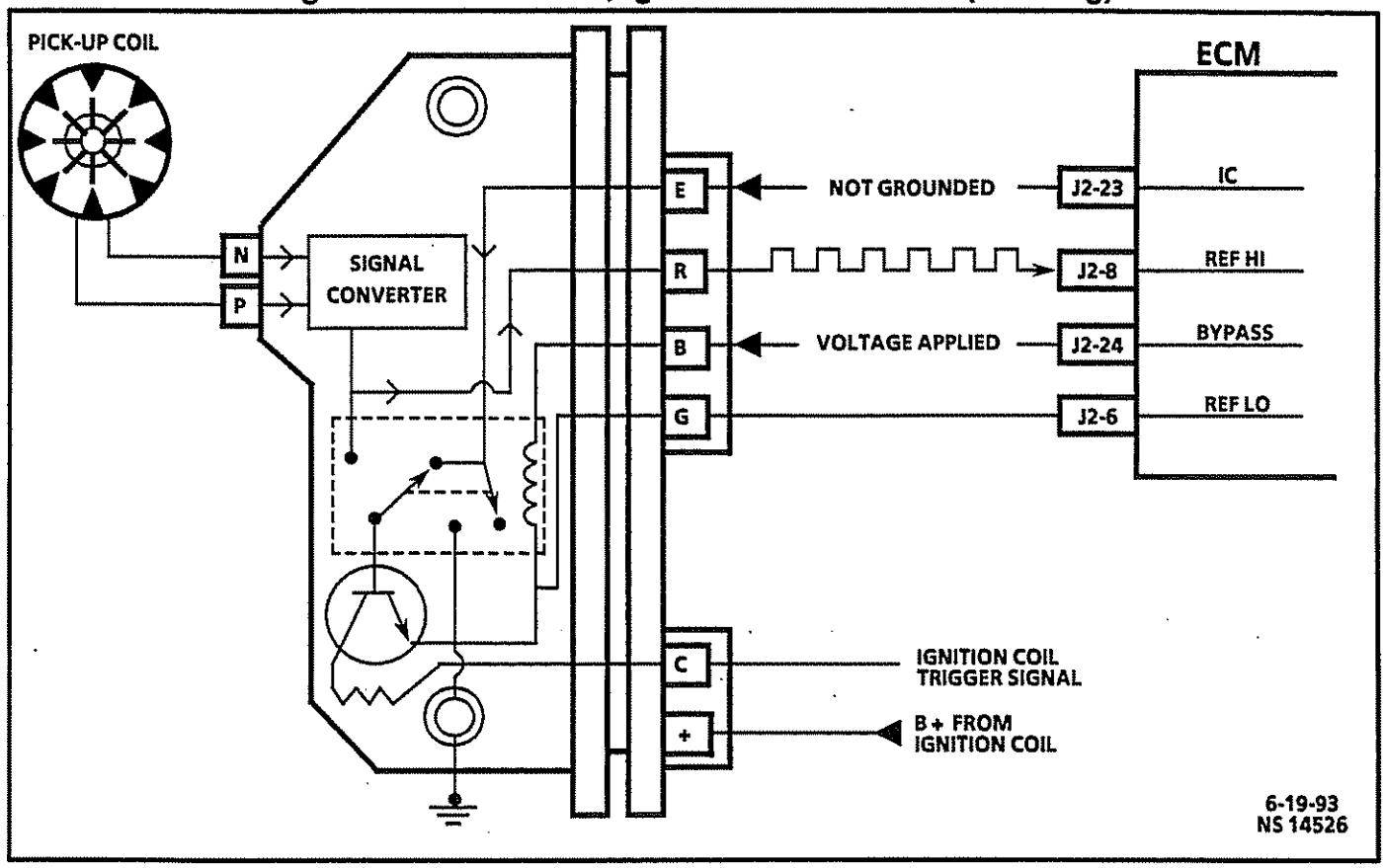
IC Operation - Ignition Control Mode (Running)

Figure 4-6

When the engine RPM reaches a predetermined value (for this example, 300 RPM), the ECM considers the engine running and applies 5 volts on the bypass line to the IC module. This energizes the relay and causes the points from the pick-up coil as well as the grounding points for the IC line to open (Figure 4-6). This connects the IC line to the base of the power transistor, and bypasses the ignition module timing control.

The DI system is now controlled by the IC signal from the ECM and the time at which the spark occurs can be determined by a variable time circuit in the ECM. This is called the ignition control mode.

Figure 4-6 - IC Module, Ignition Control Mode (Running)



Results Of Incorrect Operation

An open or short to ground in the bypass circuit or connector to the ECM will cause the engine to run on the IC module timing. This will cause reduced performance and poor fuel economy.

Open IC line from the ECM to the IC module - While the engine is cranking, the ECM expects to see the IC signal pulled to virtually zero because it is grounded in the IC module. Since the IC line is open, it cannot be grounded by the module and the IC signal will be able to rise and fall, or do what is called "toggling" as an abnormal condition, and will not apply bypass voltage to the IC module when the engine reaches run RPM.

Since bypass voltage is not applied to the relay, it remains open and the engine continues to run on the pick-up coil triggering in the ignition module timing mode. If this condition were to occur while the engine was running, the engine would stop, but it would restart and run in the ignition module timing mode with reduced power.

Grounded IC line - During cranking, the IC voltage would be at virtually zero so the ECM would not recognize a problem. When engine RPM reaches the value for the run conditions, the ECM would apply bypass voltage to the IC module. Bypass voltage on the module switches the IC power transistor to the IC line. Because the IC line is grounded, it would have no voltage applied so it could not operate the power transistor to enter the IC mode.

If the IC line should become grounded while the engine was running, the engine would stop and be difficult to restart.

Open or grounded bypass line - While the engine is cranking, the IC line would be grounded and the ECM would not notice anything abnormal. When run RPM is reached, the ECM would apply bypass voltage to the bypass line, but because of the open or ground, it would not be able to energize the relay. Therefore, the relay would stay de-energized and the IC line would remain grounded.

When the ECM sees the IC line not "toggling," it will not enter the IC mode. Since the relay is de-energized, the engine would continue to run in the ignition module timing mode. If this condition were to occur while the engine was running, it would simply operate in the ignition module timing mode.

Open or grounded "REF HI" line - This line provides the ECM with engine speed information. If this line were open or grounded, the ECM would not know that the engine is cranking, and would not make any attempt to control spark. If this condition occurs, the engine will not run.

Open or grounded "REF LO" line - This wire is grounded in the ignition module and provides a reference ground from the ignition module to the ECM. The ECM compares reference ground with reference high voltage. If this circuit is open, or grounded at any other location than through the module, it may cause poor performance.

Diagnosis

If the Engine Cranks But Will Not Run or immediately stalls, Chart A-3 must be used to determine if the failure is in the ignition system or the fuel system. If DTC 41 or DTC 42 is set, the appropriate diagnostic trouble code table must be used for diagnosis.

On-Board Service

Distributor Repair

Figures 4-7 through 4-9

Replacement distributors are not available already assembled. If a distributor needs replaced, kits are available with all necessary components to assemble a new distributor.

Some components of the distributor can be replaced without removal of the distributor. These are the distributor cap, rotor, and the ignition control module.

If any other components need replacement, the distributor needs to be removed and disassembled.

Removal

Remove or Disconnect

1. Negative battery cable.
2. Wiring harness connectors at the side of the distributor cap.
3. Two screws on the sides of the distributor cap.
4. Coil wire and spark plug wires on either the left or the right side of the distributor.
5. Distributor cap and move it aside.
   - Scribe a mark on the side of the distributor housing in line with the rotor.
   - Scribe a mark on the engine in line with the rotor.
   - Note the position of the distributor housing in relation to the engine.
6. Distributor bolt and hold-down clamp.
7. Distributor.

Installation

Install or Connect

- To ensure correct timing of the distributor, it must be installed with the rotor correctly positioned as noted in Step 5 of the removal procedure. Line up the rotor, the mark on the distributor housing, and the mark on the engine.
- If the distributor shaft won't drop into the engine, insert a screwdriver into the hole for the distributor and turn the oil pump driveshaft.

1. Distributor.
2. Distributor hold-down clamp and bolt. Torque to 40 N•m (30 lb. ft.).
3. Distributor cap and attaching screws.
4. Wiring harness connectors at the side of the distributor.
5. Spark plug wires and coil wire.
6. Negative battery cable.
   - Check the ignition timing following procedures outlined in this section.

Disassembly

Figure 4-7

Remove or Disconnect

- Any time the distributor is disassembled, the retainer (5) must be replaced. Do not attempt to reuse the old retainer.

1. Screws (1) and washers holding the cap to the housing.
2. Cap (2) from the housing.
   - Place marks on the rotor and the housing to help line up the rotor during assembly.
3. Rotor (3) from the shaft by lifting or prying straight up.
4. Roll pin (15) from the shaft (4).
   - Mark the shaft and drive gear for reassembly.
   - Drive out the roll pin with a small punch (Figure 4-8).
5. Drive gear (14), washer or spring (13), and spring retainer or tang washer (12).
6. Shaft (4) with pole piece (8) and plate from the housing (11).
7. Retainer (5) from the housing (11).

CAUTION: Wear eye protection when cutting and removing spring steel retainer clips as described in this procedure. If your eyes are not protected, flying metal pieces may cause injury.

   - Wear safety goggles.
   - Use needle nose pliers to bend two corners upward on the fluted end of the retainer.
   - Pull the retainer off the center bushing and discard the retainer.

8. Shield (6).
9. Pick-up coil connector from the module (10).
10. Pick-up coil (7).
11. Two screws holding the module to the housing.
12. Ignition control module (10).

Inspect

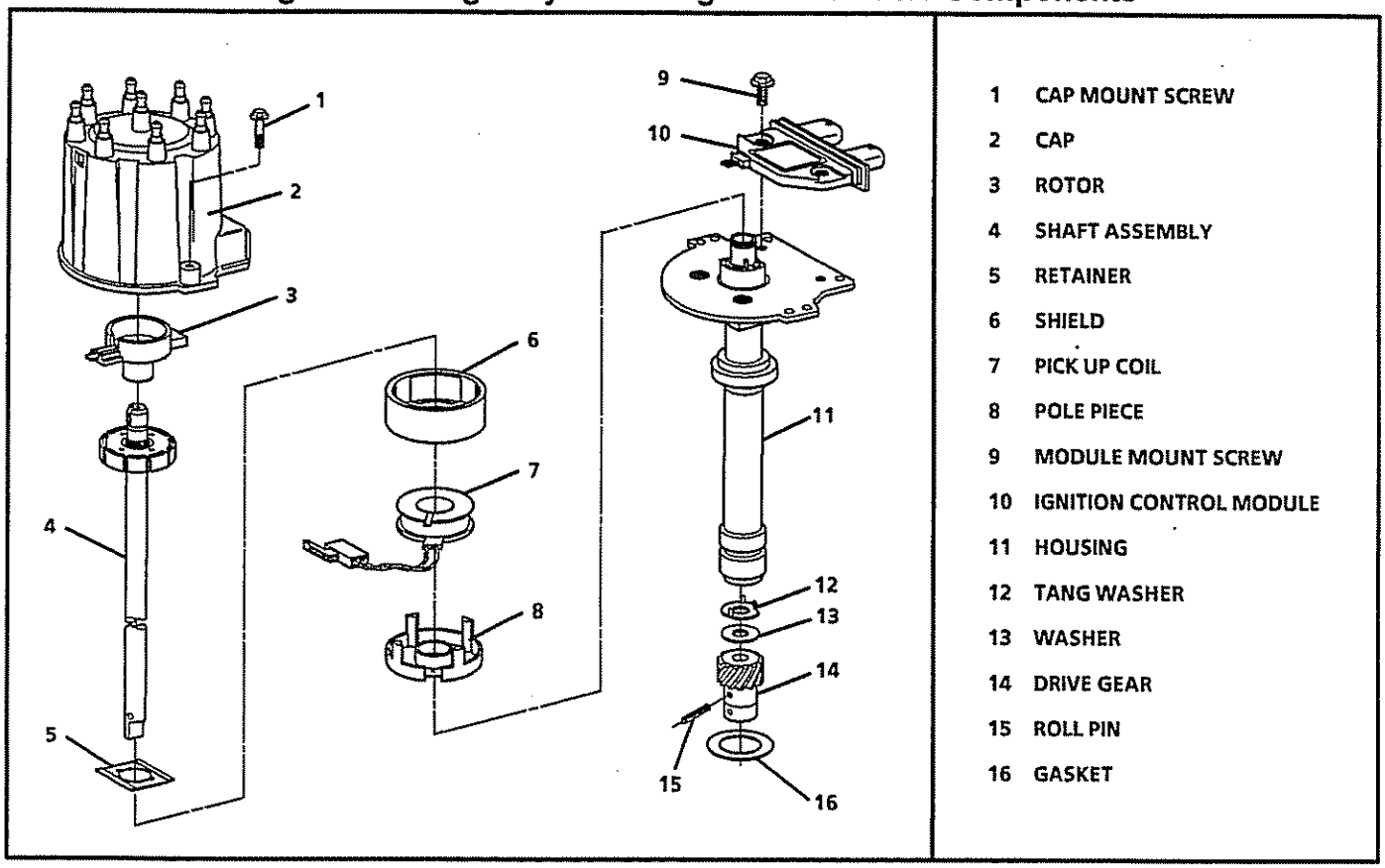
1. Distributor cap for cracks or tiny holes. Replace the cap if it is damaged at all.
2. Metal terminals in the cap for corrosion. Scrape them clean with a knife or replace the cap.
3. Rotor for wear or burning at the outer terminal. The presence of carbon on the terminal indicates rotor wear and the need for replacement.

4. Shaft for shaft-to-bushing looseness. Insert the shaft in the housing. If the shaft wobbles, replace the housing and/or shaft.
5. Housing for cracks or damage.

Measure

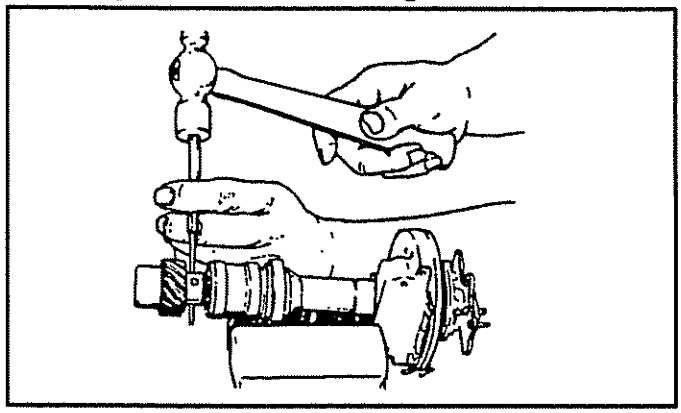
- Resistance of pick-up coil with an ohmmeter.
  - Connect an ohmmeter to either pick-up coil lead and the housing as shown in Figure 4-9, Test 1. The reading should be infinite. If not, replace the pick-up coil.
  - Connect an ohmmeter to both pick-up coil leads as shown in Figure 4-9, Test 2. Flex the leads by hand at the coil and the connector to locate any intermittent opens. The ohmmeter should read a constant unchanging value in the 500 to 1500 ohm range. If not, replace the pick-up coil.

Figure 4-7 - Eight Cylinder Engine Distributor Components



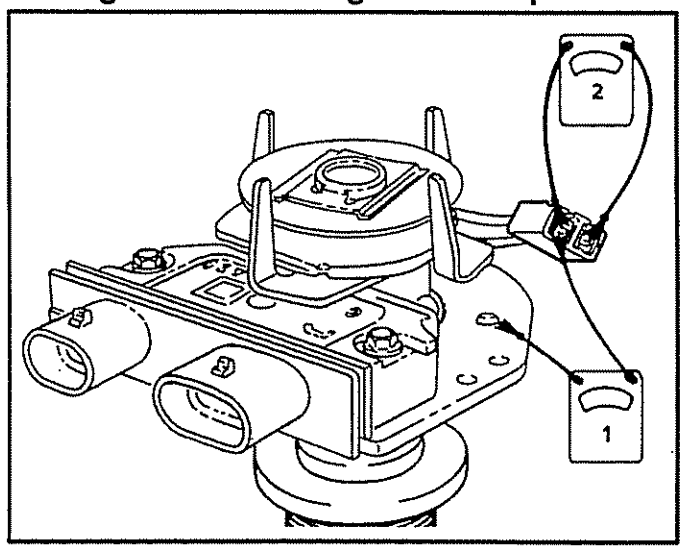
MS 11770

Figure 4-8 - Removing the Roll Pin



MS 11769

Figure 4-9 - Testing the Pick-up Coil



MS 13638

Assembly

Figures 4-7 and 4-10

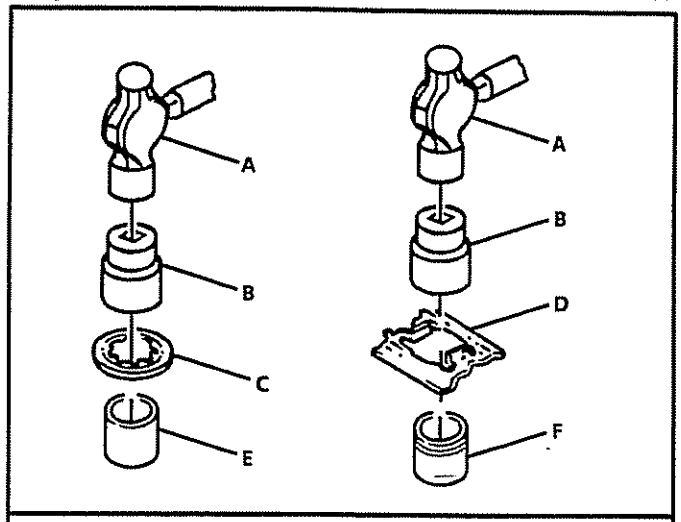
Install or Connect

Notice: Be sure to thoroughly coat the bottom of the ignition module with silicone grease. Failure to do so could result in heat damage to the module.

- Lubricate bottom of the ignition module and the module rest pad on the housing with silicone grease or an equivalent heat transfer substance.

1. Ignition module (10) to the housing (11) with two screws.
2. Pick-up coil (7).
   - Fit the tab on the bottom of the coil into the anchor hole in the housing.
3. Pick-up coil wiring connector to the module.
   - Make sure the locking tab is in place.
4. Shield (6) onto the pick-up coil.
5. Retainer (5) onto the housing (Figure 4-10).
   - Place the retainer over the center bushing with the teeth pointing upward.
   - Place a 15 mm (5/8 inch) socket head onto the edge of the retainer. Keep the socket centered on the retainer so the teeth are not damaged. Use a small hammer to tap the retainer evenly down onto the center bushing. When installing the square retainer, make sure both teeth are seated in the groove on the bushing.
   - The retainer should hold the shield, pick-up coil, and pole piece firmly.
6. Shaft assembly (4) onto the housing (11).
7. Tang washer (12), washer (13), and drive gear (14) onto the bottom of the shaft.
   - Align the marks on the drive gear and shaft assembly.
8. Roll pin (15) into the gear.
   - Spin the shaft and make sure the teeth on the shaft assembly do not touch the pole piece.
9. Rotor (3) onto the shaft (4).
   - Fit the tab in the rotor into the slot on the shaft.
10. Distributor cap to the housing with screws and washers.

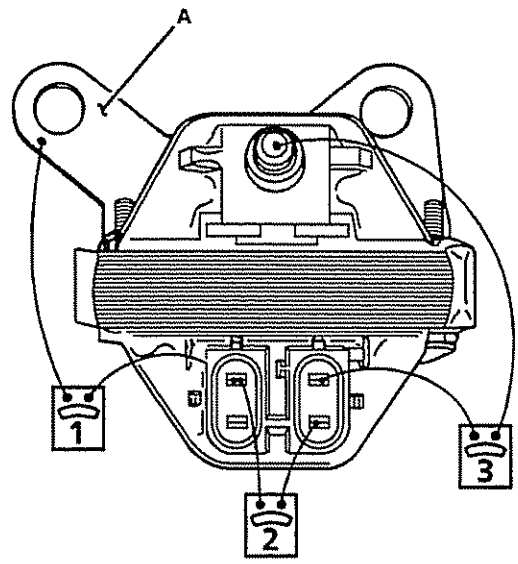
Figure 4-10 - Retainer to Shield Installation



A	HAMMER
B	15 mm (5/8 in.) SOCKET
C	ROUND RETAINER
D	SQUARE RETAINER
E	DISTRIBUTOR CENTER BUSHING (WITHOUT GROOVE)
F	DISTRIBUTOR CENTER BUSHING (WITH GROOVE)

MS 11768

Figure 4-11 - Testing the Ignition Coil



A	SCRAPE CLEAN METAL GROUND

MS 13634

Ignition Control Module

Figure 4-7 Item 10

Remove or Disconnect

1. Negative battery cable.
2. Wiring harness connectors at the side of the distributor cap.
3. Two screws on the sides of the distributor cap.
4. Coil wire and spark plug wires on either the left or the right side of the distributor.
5. Distributor cap and move it aside.
6. Wire harness connector from pick-up coil.
7. Two screw attaching ignition module to the distributor base plate.
8. Ignition control module.

Install or Connect

Notice: Be sure to thoroughly coat the bottom of the ignition module with silicone grease. Failure to do so could result in heat damage to the module.

- Lubricate bottom of the ignition module and the module rest pad on the housing with silicone grease or an equivalent heat transfer substance.

1. Ignition module to the housing with two screws.
2. Wire harness connector from pick-up coil.
3. Distributor cap and two attaching screws.
4. Coil wire and spark plug wires.
5. Wiring harness connectors at the side of the distributor cap.
6. Negative battery cable.

Ignition Coil

Figure 4-11

Remove or Disconnect

1. Negative battery cable.
2. Wiring connectors at the side of the coil.
3. Coil wire.
4. Nuts holding the coil bracket and coil to the engine.
5. Coil bracket and coil.
   - Drill and punch out the two rivets holding the coil to the bracket.
6. Coil from bracket.

Measure

- Resistance of the ignition coil with an ohmmeter.
  - Connect an ohmmeter as shown in Figure 4-11, Test 1. Use the high scale. The reading should be infinite. If not, replace the ignition coil.
  - Connect an ohmmeter as shown in Figure 4-11, Test 2. Use the low scale. The ohmmeter should read very low or zero. If not, replace the ignition coil.
  - Connect an ohmmeter as shown in Figure 4-11, Test 3. Use the high scale. The reading should not be infinite. If it does, replace the ignition coil.

Install or Connect

- A replacement ignition coil kit comes with two screws to attach the coil to the bracket.

1. Ignition coil to the bracket with two screws.
2. Coil bracket to the engine bracket with studs and nuts. Torque to 22 N•m (16 lb. ft.).
3. Coil wire.
4. Wiring connectors at the side of the coil.
5. Negative battery cable.

Ignition Timing Set Procedure

Ignition timing is controlled electronically by the IC module and the ECM. There may be instances when ignition timing needs to be checked for advancing or retarding.

- If checking the IC circuit for properly advancing, you should see approximately 15 to 25 degrees of advance at about 3000 RPM.
- If checking the KS system for retarding, you should see approximately 6 to 10 degrees of retard.
- When engine is idling, the timing will be advancing up and down. This is normal because the ECM is controlling the timing for a smooth idle condition.
- If checking base timing, when MDTC tool or scan tool is switched to "service mode," the timing will go to 10 degrees BTDC and will not move with RPM change.

Notice: Engine must be completely warmed up and at normal operating temperature.

Install or Connect

1. An inductive pick-up timing light (J 34186 or equivalent) to cylinder number 1 ignition wire.
2. A scan tool or MDTC tool to the DLC.
   - If using MDTC tool, manually adjust throttle to 1000 RPM.
   - With engine running, set MDTC tool to "service mode" or scan tool to "set timing mode."
   - If using a scan tool, follow manufacturer's instructions for setting ignition timing.

Notice: The scan tool may not go into "set timing mode" if DTC 41 or DTC 42 is set, or if the engine speed is above 1600 RPM.

- Shine the timing light at the timing mark indicator located on the timing chain cover.

Notice: See manufacturer's specification for base timing.

- If adjustment is needed, loosen the distributor hold-down bolt.
- Rotate distributor to adjust timing.
- Tighten distributor hold-down bolt, torque to 40 N•m (30 lb. ft.).
- Manually bring throttle to idle.
- Set MDTC tool or scan tool to "normal mode."

Spark Plug Replacement

Remove or Disconnect

1. Negative battery cable.
2. Spark plug wires and boots.
   - Turn each boot one-half turn before removing it.
   - Label the plug wires if the identification numbers have worn off.
3. Spark plugs.

Inspect

- Each plug for wear and gap.

Install or Connect

1. Spark plugs. Torque to 15 N•m (11 lb. ft.).
2. Wire and boot assemblies. Refer to "Spark Plug Wiring and Boots" below for precautions.
3. Negative battery cable.

Spark Plug Wiring And Boots

Precautions

1. Twist boots one-half turn before removing.
2. When removing the boot, do not use pliers or other tools that may tear the boot.
3. Do not force anything between the wire and the boot, or through the silicone jacket of the wiring.
4. Do not pull on the wires to remove the boot. Pull on the boot, or use a tool designed for this purpose.
5. Special care should be used when installing spark plug boots to make sure the metal terminal within the boot is fully seated on the spark plug terminal and the boot has not moved on the wire. If boot to wire movement has occurred, the boot will give a fast visual impression of being fully seated. A good check to make sure the boots have been properly installed is to push sideways on them. If they have been correctly installed, a stiff boot with only slight looseness will be noted. If the terminal has not been properly seated on the spark plug, only the resistance of the rubber boot will be felt when pushing sideways.

Replacement

Wire routings must be kept intact during service and followed exactly when wires have been disconnected, or when replacement of the wires is necessary. Failure to route the wires properly can lead to radio noise and crossfiring of the plugs, or shorting of the leads to ground.

Torque Specifications

Fastener Tightening Specifications

Application	N•m	Lb Ft	Lb In
Distributor Hold Down	40	30	
Coil Bracket Screws	22	16	
Spark Plugs	15	11	

BLANK

Marine Electronic Fuel Injection (MEFI)

Section 5

Throttle Body Fuel Injection (TBI) Diagnosis

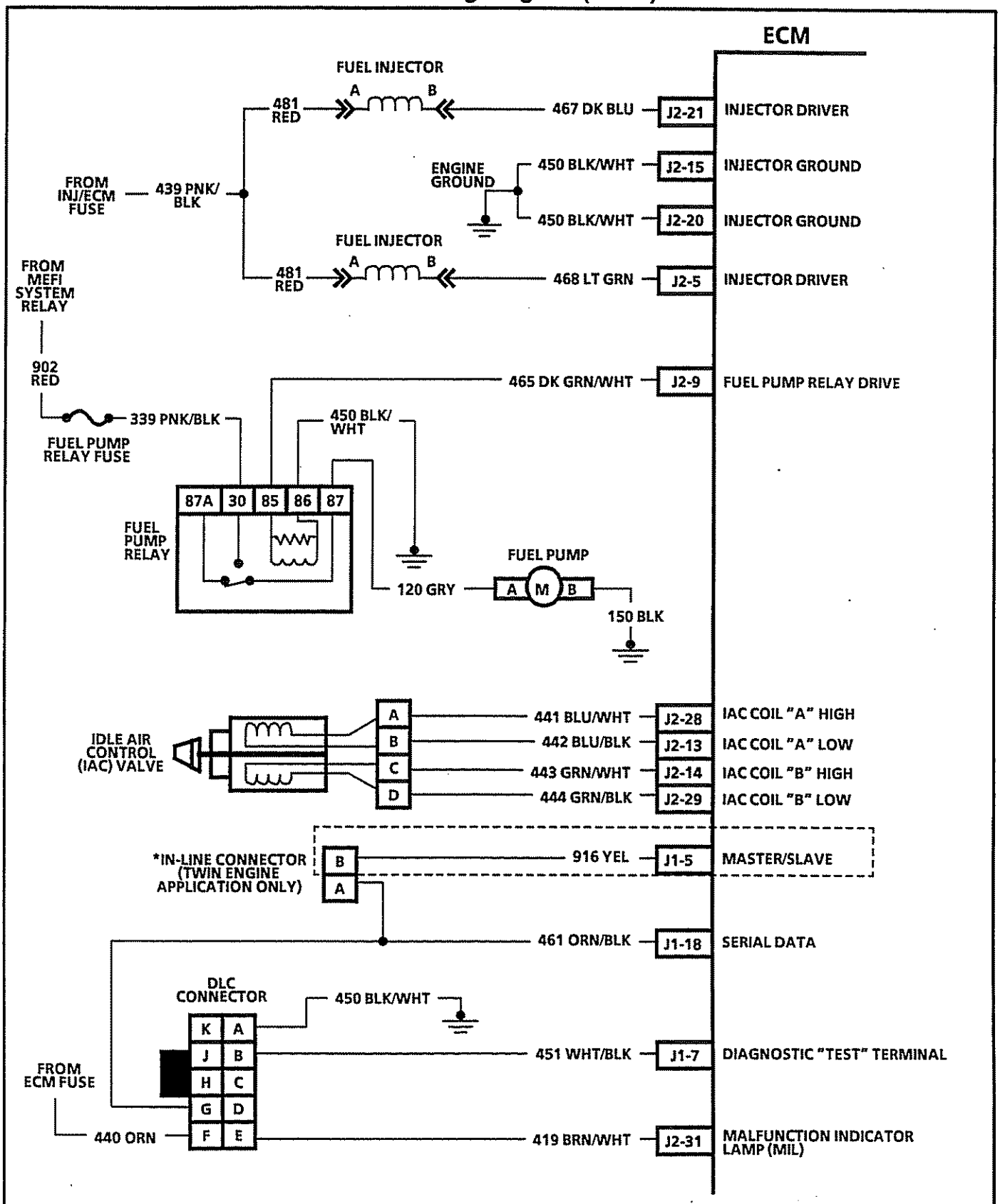
This section will be used to perform diagnostic procedures on the Marine Electronic Fuel Injection equipped engines. The section describes system circuits and diagnostic tables used to diagnose the circuits. It will be used to correct Diagnostic Trouble Codes (DTCs) by following tables for either non-scan or scan tool use. This section contains the On-Board Diagnostic (OBD) system check that is the first step to perform before any further diagnostics or repairs are made to the MEFI system.

The assumption is made that on all diagnostic tables, the engine is equipped with GM Marine ECM, sensors, wiring harness, fuel components, and ignition components. The wiring schematics and circuit identifications are for the GM MEFI originally equipped wiring harness.

The diagnostic tables and voltages shown are prepared with the requirement that the system functioned correctly at the time of assembly and that there are no multiple failures.

Contents

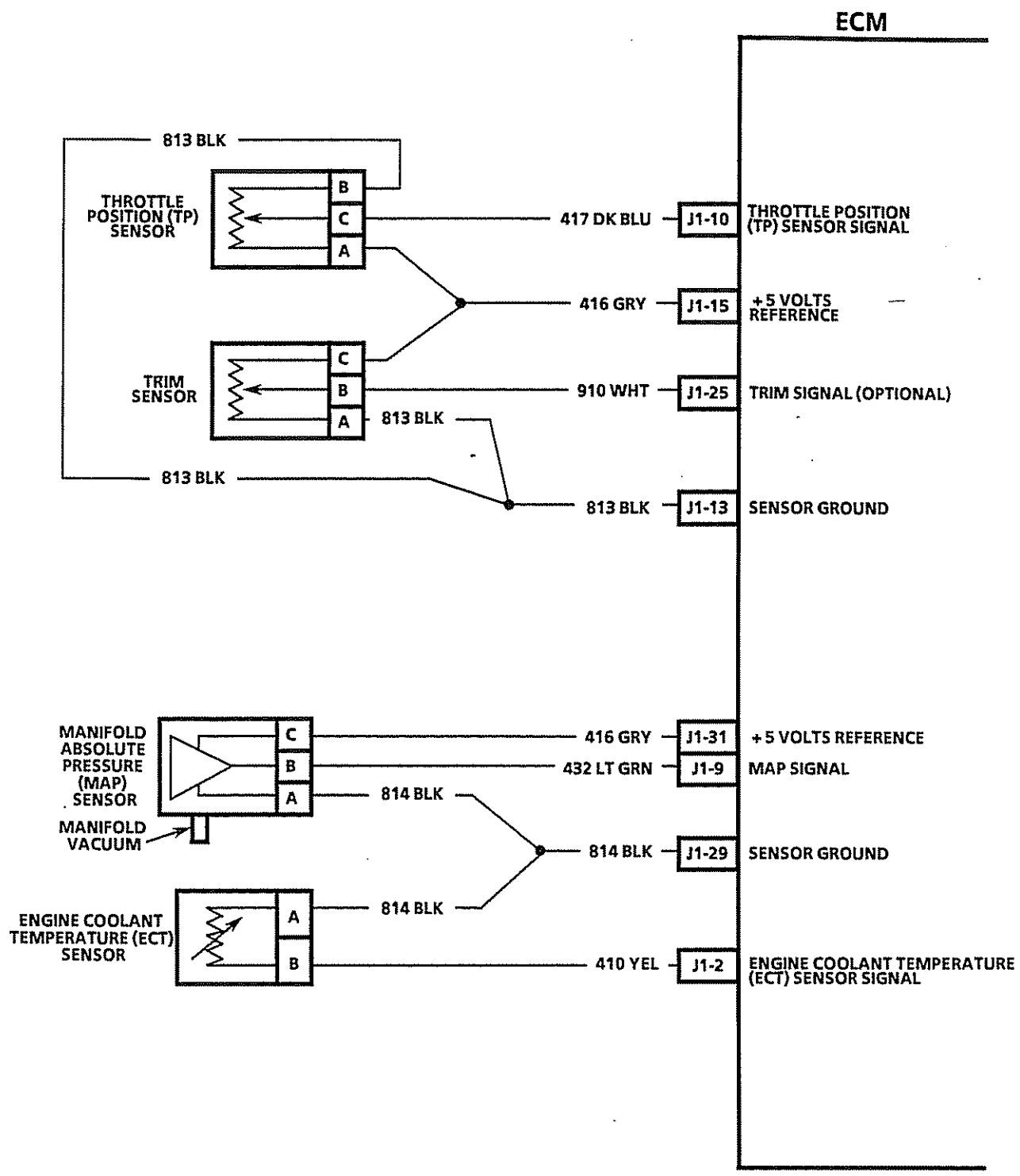
ECM Wiring Diagram (1 of 4)



***NOTICE:** On early production wire harnesses master/slave CKT 916 and serial data CKT 461 each had separate plugs for twin engine application. Current harnesses will have a two wire plug with both circuits.

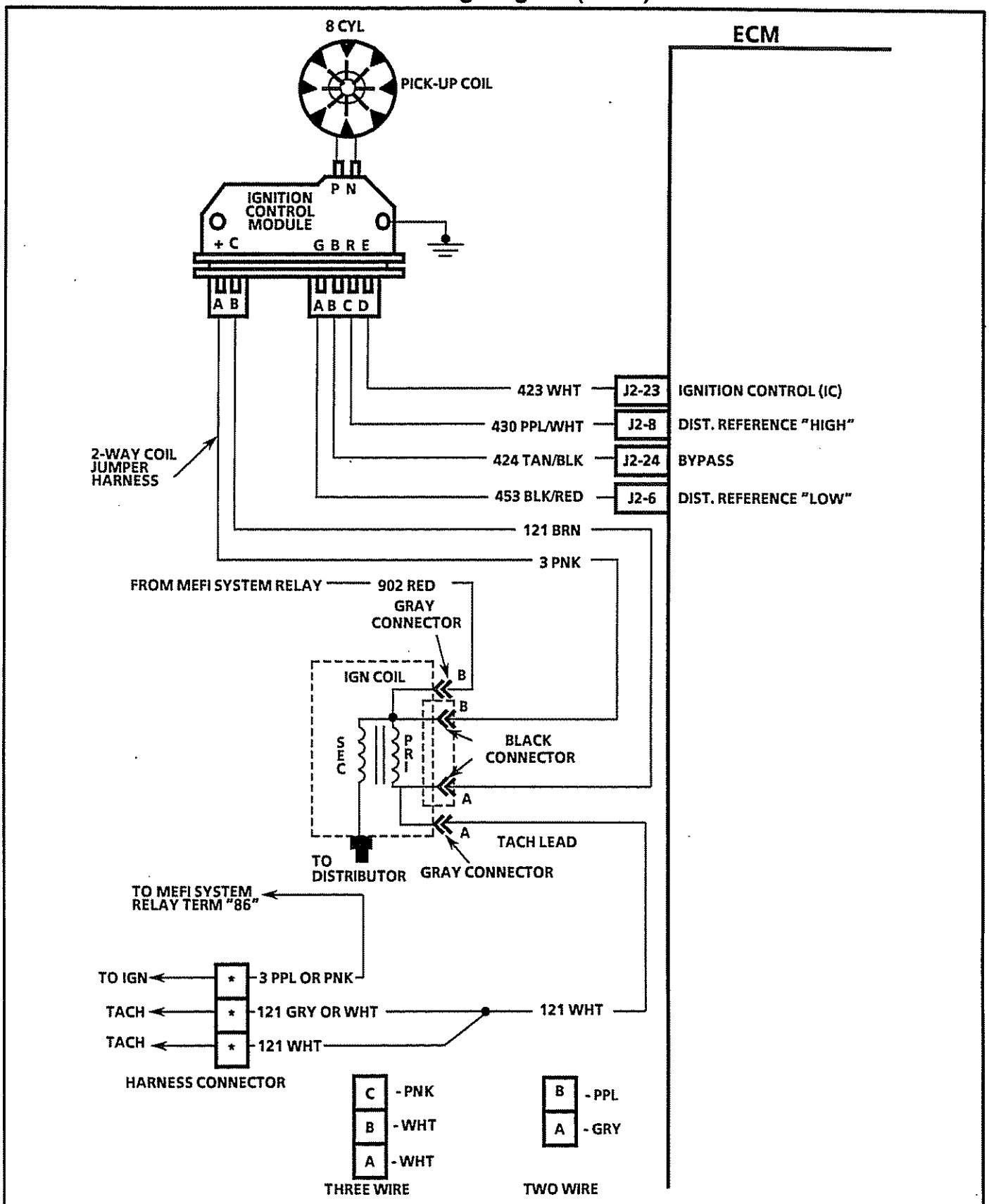
7-6-93
NS 15496

ECM Wiring Diagram (2 of 4)



4-22-93
NS 15841

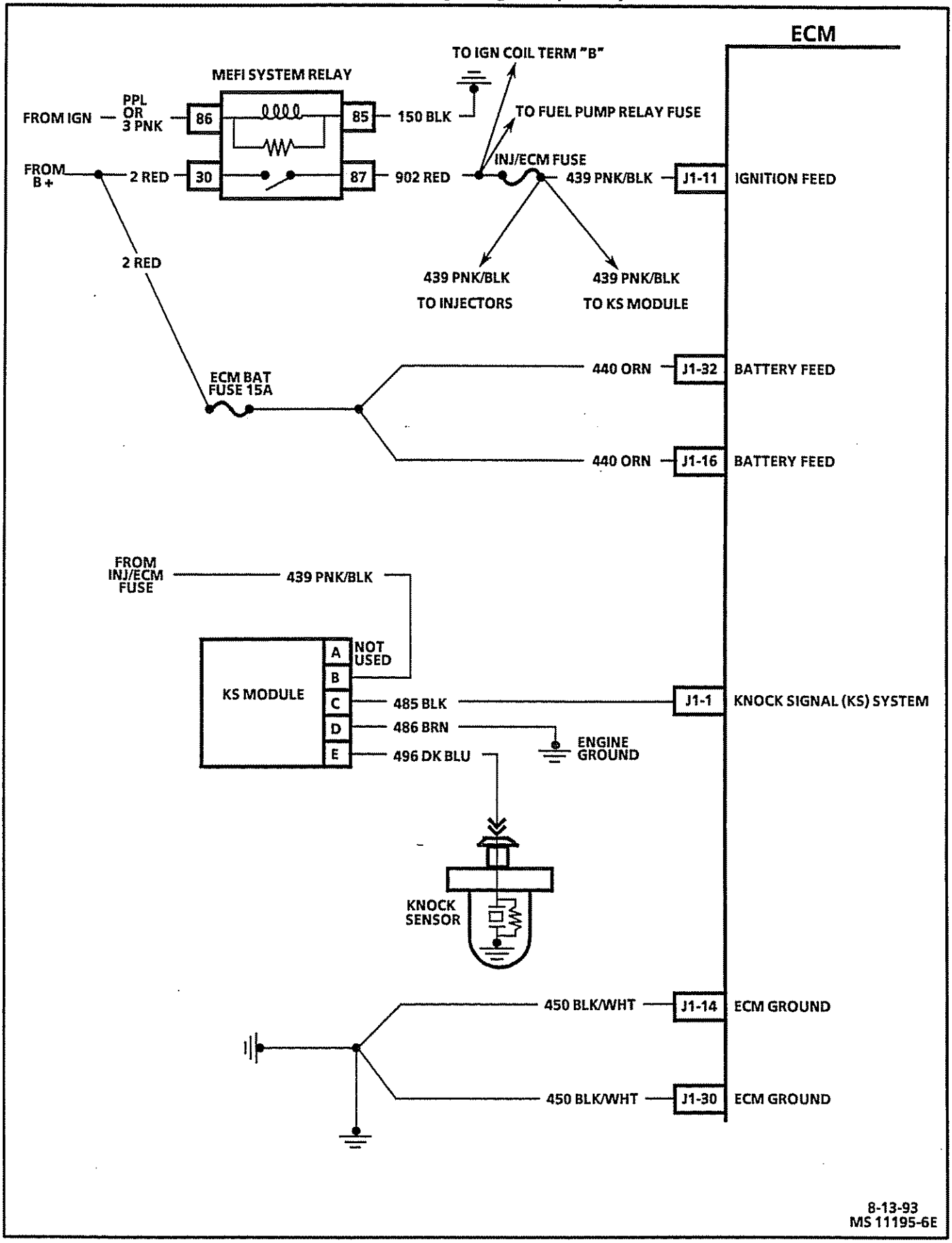
ECM Wiring Diagram (3 of 4)



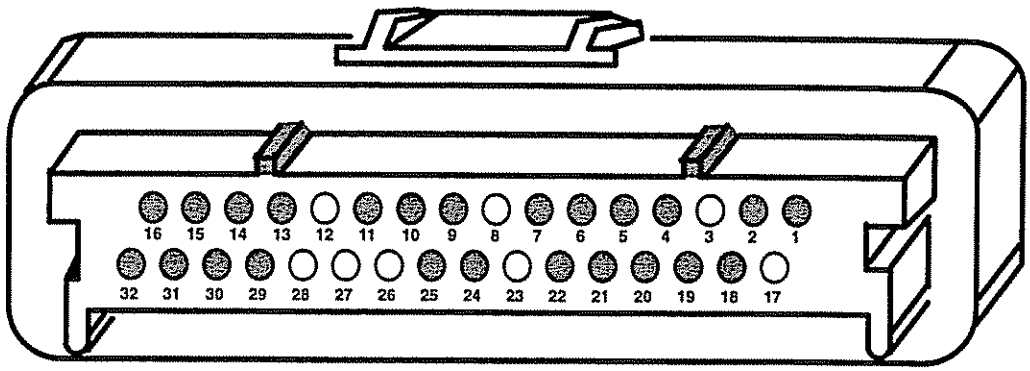
* NOTICE: ON EARLY PRODUCTION WIRE HARNESSES CKT 3 IS A PINK WIRE, CKT 121 IS A WHITE WIRE FROM THREE WIRE CONNECTOR TO BOAT HARNESS FOR IGNITION AND TACH. CURRENT HARNESSES HAVE BEEN CHANGED TO A TWO WIRE CONNECTOR WITH A PURPLE WIRE FOR CKT 3 AND GRAY WIRE FOR CKT 121.

8-16-93
MS 11193-6E

ECM Wiring Diagram (4 of 4)



Component Connector Identification (1 of 2)

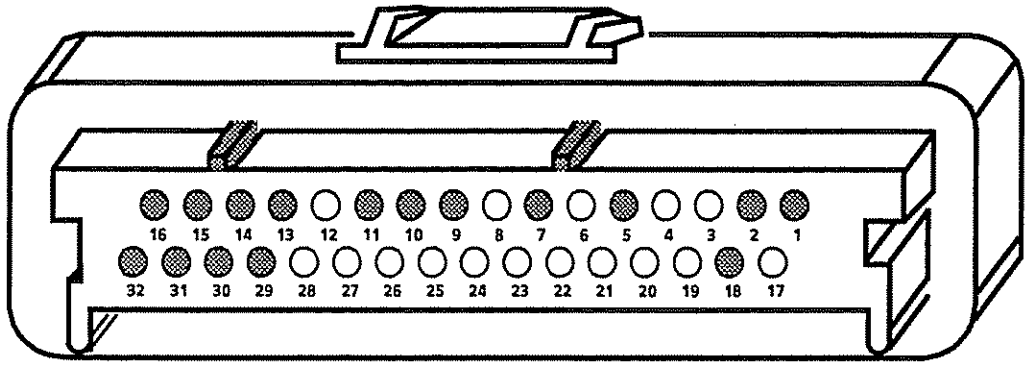


J - 1
ECM 32 WAY OUTPUT CONNECTOR

ECM PIN NUMBER	CKT (WIRE) NUMBER	CKT (WIRE) COLOR	CIRCUIT DESCRIPTION
J1 - 1	485	BLK	KNOCK SENSOR (KS) SYSTEM
J1 - 2	410	YEL	ENGINE COOLANT TEMPERATURE (ECT) SENSOR SIGNAL
J1 - 3			
J1 - 4	911	DK GRN	GENERAL WARNING 2 (OPTIONAL)
J1 - 5	916	YEL	MASTER/SLAVE ECM (TWIN ENG. ONLY)
J1 - 6	931	BRN	OIL PRESSURE SWITCH (OPTIONAL)
J1 - 7	451	WHT/BLK	DIAGNOSTIC "TEST" (SERVICE MODE)
J1 - 8			
J1 - 9	432	LT GRN	MAP SENSOR SIGNAL
J1 - 10	417	DK BLU	TP SENSOR SIGNAL
J1 - 11	439	PNK/BLK	IGNITION 12V
J1 - 12			
J1 - 13	813	BLK	SENSOR GROUND (IAT, TP, TRIM)
J1 - 14	450	BLK/WHT	ECM GROUND
J1 - 15	416	GRY	5 VOLT REF (TP, TRIM, SENSORS)
J1 - 16	440	ORN	BATTERY 12V
J1 - 17			
J1 - 18	461	ORN/BLK	SERIAL DATA (SCAN TOOL COMMUNICATION)
J1 - 19	940	LT GRN	SHIFT INTERRUPT OR LOAD ANTICIPATE (OPTIONAL)
J1 - 20	1174	BRN	OIL LEVEL SWITCH (OPTIONAL)
J1 - 21	942	PNK	EMERGENCY STOP SWITCH (OPTIONAL)
J1 - 22	920	LT BLU	GENERAL WARNING 1 (OPTIONAL)
J1 - 23			
J1 - 24	472	TAN	IAT SENSOR SIGNAL
J1 - 25	910	WHT	TRIM SENSOR SIGNAL
J1 - 26			
J1 - 27			
J1 - 28			
J1 - 29	814	BLK	SENSOR GROUND (MAP, ECT)
J1 - 30	450	BLK/WHT	ECM GROUND
J1 - 31	416	GRY	5 VOLT REF (MAP SENSOR)
J1 - 32	440	ORN	BATTERY 12V

7-27-94
MS 11767

Component Connector Identification (2 of 2)



10-27-94
MS 11766

J - 2
ECM 32 WAY OUTPUT CONNECTOR

ECM PIN NUMBER	CKT (WIRE) NUMBER	CKT (WIRE) COLOR	CIRCUIT DESCRIPTION
J2 - 1			
J2 - 2			
J2 - 3			
J2 - 4			
J2 - 5	468	LT GRN	INJECTOR DRIVER (CYL'S 1,4,6,7)
J2 - 6	453	BLK/RED	DISTRIBUTOR REF LOW
J2 - 7	901	WHT	PORT FUEL JUMPER
J2 - 8	430	PPL/WHT	DISTRIBUTOR REF HIGH
J2 - 9	465	DK GRN/WHT	FUEL PUMP RELAY DRIVE
J2 - 10			
J2 - 11	112	DR GRN	CHECK GAUGES (OPTIONAL)
J2 - 12	914	PPL	BUZZER (OPTIONAL)
J2 - 13	442	BLU/BLK	IDLE AIR CONTROL (IAC) COIL "A" LOW
J2 - 14	443	GRN/WHT	IDLE AIR CONTROL (IAC) COIL "B" HIGH
J2 - 15	450	BLK/WHT	FUEL INJECTOR GROUND
J2 - 16			
J2 - 17			
J2 - 18			
J2 - 19			
J2 - 20	450	BLK/WHT	FUEL INJECTOR GROUND
J2 - 21	467	DK BLU	INJECTOR DRIVER (CYL'S 2,3,5,8)
J2 - 22	901	WHT	PORT FUEL JUMPER
J2 - 23	423	WHT	IGNITION CONTROL (IC)
J2 - 24	424	TAN/BLK	IC BYPASS
J2 - 25			
J2 - 26	912	DK BLU	GENERAL WARNING 1 LAMP (OPTIONAL)
J2 - 27	31	TAN	RPM CHANGE STATE (OPTIONAL)
J2 - 28	441	BLU/WHT	IDLE AIR CONTROL (IAC) COIL "A" HIGH
J2 - 29	444	GRN/BLK	IDLE AIR CONTROL (IAC) COIL "B" LOW
J2 - 30	930	GRY	OIL LEVEL LAMP OUTPUT (OPTIONAL)
J2 - 31	419	BRN/WHT	MALFUNCTION INDICATOR LAMP OUTPUT (OPTIONAL)
J2 - 32			

7-28-94
MS 11766

Typical Scan Tool Data Values

Use the TYPICAL SCAN DATA VALUES table only after the On-Board Diagnostic System Check has been completed, no DTC(s) were noted and you have determined the 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 TYPICAL SCAN DATA values represent values that would be seen on a normally running engine.

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

Only the parameters listed below are referred to in this service manual for use in diagnosis. For further information on using the scan tool to diagnose the ECM and related sensors, refer to the applicable reference section listed below. If all values are within the typical range described below, refer to *Symptoms* section for diagnosis.

TEST CONDITIONS

Idle/Warm Engine/Closed Throttle/Neutral

Scan Tool Data

Scan Tool Parameter	Units Displayed	Typical Data Value	Reference Section
Engine Speed	RPM	±100 RPM from Desired Idle.	
Desired Idle	RPM	ECM commanded idle speed (varies with temperature).	
ECT	°C, °F	65°C - 75°C/149°F - 167°F (varies with temperature).	
IAT	°C, °F	Varies with ambient air temperature. (Big Block Only).	
MAP	kPa/Volts	29 - 48 kPa/1 - 2 Volts (Depends on engine vacuum and barometric pressure).	
Baro	kPa/Volts	65 - 110 kPa (Depends on altitude and barometric pressure).	
TP Sensor	Volts	0.70 - 0.80 Volts	
TP Angle	Percent	0 - 2%	
Fuel Consumption	GPH	? GPH (Varies with application).	
Injector Pulse Width	mSEC	? mSEC (Varies with application).	
Spark Advance	Degrees	6 - 26° (Varies Continuously)	
KS Enabled	No/Yes	Yes	
Knock Retard	Degrees of Retard	0°	
Knock Signal	No/Yes	No	
Idle Air Control	Counts	20 - 40 Counts	
Min IAC Position	Counts	20 - 60 Counts	
Trim Sensor	Volts	0.00 Volts	
Battery/Ignition Voltage	Volts	12.0 - 14.5 Volts	
Malfunction Indicator Lamp (MIL)	Off/On	Off	
Fuel Pump Relay	Off/On	On	
RPM Reduction	No/Yes	No	

Scan Tool Data (continued)

Scan Tool Parameter	Units Displayed	Typical Data Value	Reference Section
Engine Speed	RPM	100 RPM from Desired Idle.	
Overheat Detected	No/Yes	No	
Low Oil Pressure Switch	OK/Low Pressure	OK	
Low Oil Level Switch	OK/Low	OK	
Shift Interrupt/Load Anticipate	Shift/-Idle Air Control (IAC) valve.Load	Depends on Application	
General Warning 1	Calibratible by OEM	Calibratible by OEM	
General Warning 2	Calibratible by OEM	Calibratible by OEM	
Emergency Stop Mode	No/Yes	No	
ECM Master/Slave	Master/Slave	Master (usable for twin engine diagnosis).	
Engine Hour Meter	Hrs:Min	Dependent on Engine Run Time.	
Fuel System Configuration	MFI/TBI	Dependent on Fuel System.	
Time From Start	Hrs:Min	Dependent on Time of Ignition Cycle.	

ECM Scan Tool Data Definitions

The scan tool information will assist in diagnosing emission or Driveability problems. The displays can be viewed while the vessel is being driven. Always perform the "On-Board Diagnostic (OBD) System Check" first. The "OBD System Check" will confirm proper system operation.

ECM Data Descriptions

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 10-105 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.

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

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).

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.

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.

MINIMUM IAC POSITION - Scan Tool Range 0-255 - This is the minimum idle air control motor position commanded by the ECM.

TRIM SENSOR - Scan Tool Range 0.00-5.00 volts - This is a voltage input to the ECM from a potentiometer sensor located on the drive unit. Informs the ECM at what position the drive unit is at in case of an over-trim condition.

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

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.

RPM REDUCTION - Scan Tool Displays "NO" or "YES" - Indicates whether or not the ECM is functioning in RPM 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.

LOW OIL PRESSURE SWITCH - Scan Tool Displays "OK" or "LOW PRESSURE" - Indicates the commanded condition of the engine oil pressure to the ECM.

LOW OIL LEVEL SWITCH - Scan Tool Displays "OK" or "LOW" - Indicates the commanded oil level to the ECM.

SHIFT INTERRUPT/LOAD ANTICIPATE - Scan Tool Displays "SHIFT" or "LOAD" - Indicates whether the ECM software is calibrated for shift interrupt or load anticipate.

GENERAL WARNING 1 - Scan Tool Displays - This is a discrete input to the ECM that is determined and calibratible per OEM.

GENERAL WARNING 2 - Scan Tool Displays - This is a discrete input to the ECM that is determined and calibratible per OEM.

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

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

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

FUEL SYSTEM CONFIGURATION - Scan Tool Displays "MFI" or "TBI" - Indicates whether the fuel system configuration is a multiport fuel injection or a throttle body fuel injection.

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.

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.

Notice: The amount of time after the malfunction occurs before the MIL illuminates is calibratible. (Instantly or up to one minute).

DTC	Description	Type	Illuminate MIl
DTC 14	Engine Coolant Temperature (ECT) Sensor Circuit. Low Temperature Indicated.	—	Yes
DTC 15	Engine Coolant Temperature (ECT) Sensor Circuit. High Temperature Indicated.	—	Yes
DTC 21	Throttle Position (TP) Sensor Circuit. High Signal Voltage Indicated.	—	Yes
DTC 22	Throttle Position (TP) Sensor Circuit. Low Signal Voltage Indicated.	—	Yes
DTC 33	Manifold Absolute Pressure (MAP) Sensor Circuit. High Signal Voltage Indicated.	—	Yes
DTC 34	Manifold Absolute Pressure (MAP) Sensor Circuit. Low Signal Voltage Indicated.	—	Yes
DTC 41	Ignition Control (IC) System. Open IC Circuit.	—	Yes
DTC 42	Ignition Control (IC) System. Grounded IC Circuit, Open or Grounded Bypass Circuit.	—	Yes
DTC 43	Knock Sensor (KS) System. Continuous Knock Detected.	—	Yes
DTC 44	Knock Sensor (KS) System. No Knock Detected.	—	Yes
DTC 51	Calibration Memory Failure. Faulty ECM.	—	Yes
DTC 52	EEPROM Failure. Faulty ECM.	—	Yes

Clearing Diagnostic Trouble Codes - Non Scan

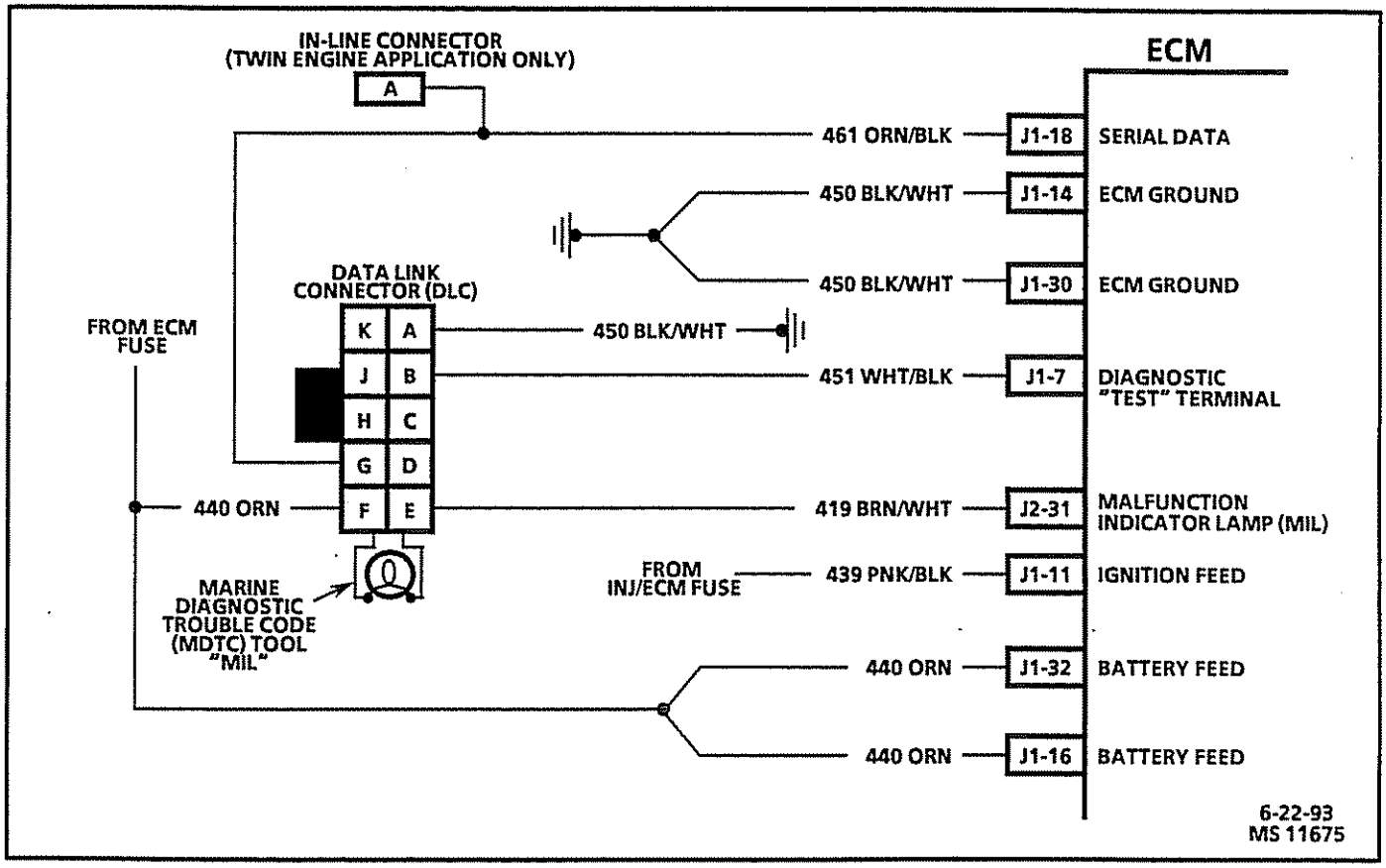
1. Install Marine Diagnostic Trouble Code (MDTC) tool.
2. Ignition "ON," engine "OFF."
3. Select "service" mode on MDTC tool.
4. Move the throttle from 0% (idle) to 100% (WOT) and back to 0%.
5. Select "normal" mode on MDTC tool. (If this step is not performed, the engine may not start and run).
6. Turn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

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 voltage to the ECM on CKT 440 must not drop below 6.9 volts at any time during the code clearing process. If this happens, the ECM will reset and the DTC's will not clear from the ECM memory.

On-Board Diagnostic (OBD) System Check - Non Scan



Circuit Description

The on-board diagnostic system check must be the starting point for any driveability complaint diagnosis. Before using this procedure, you should perform a careful visual/physical check of the ECM and engine grounds for being clean and tight.

The on-board diagnostic system check is an organized approach to identifying a problem created by an electronic engine control system malfunction.

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:

- Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection, and damaged harness.

Test Description

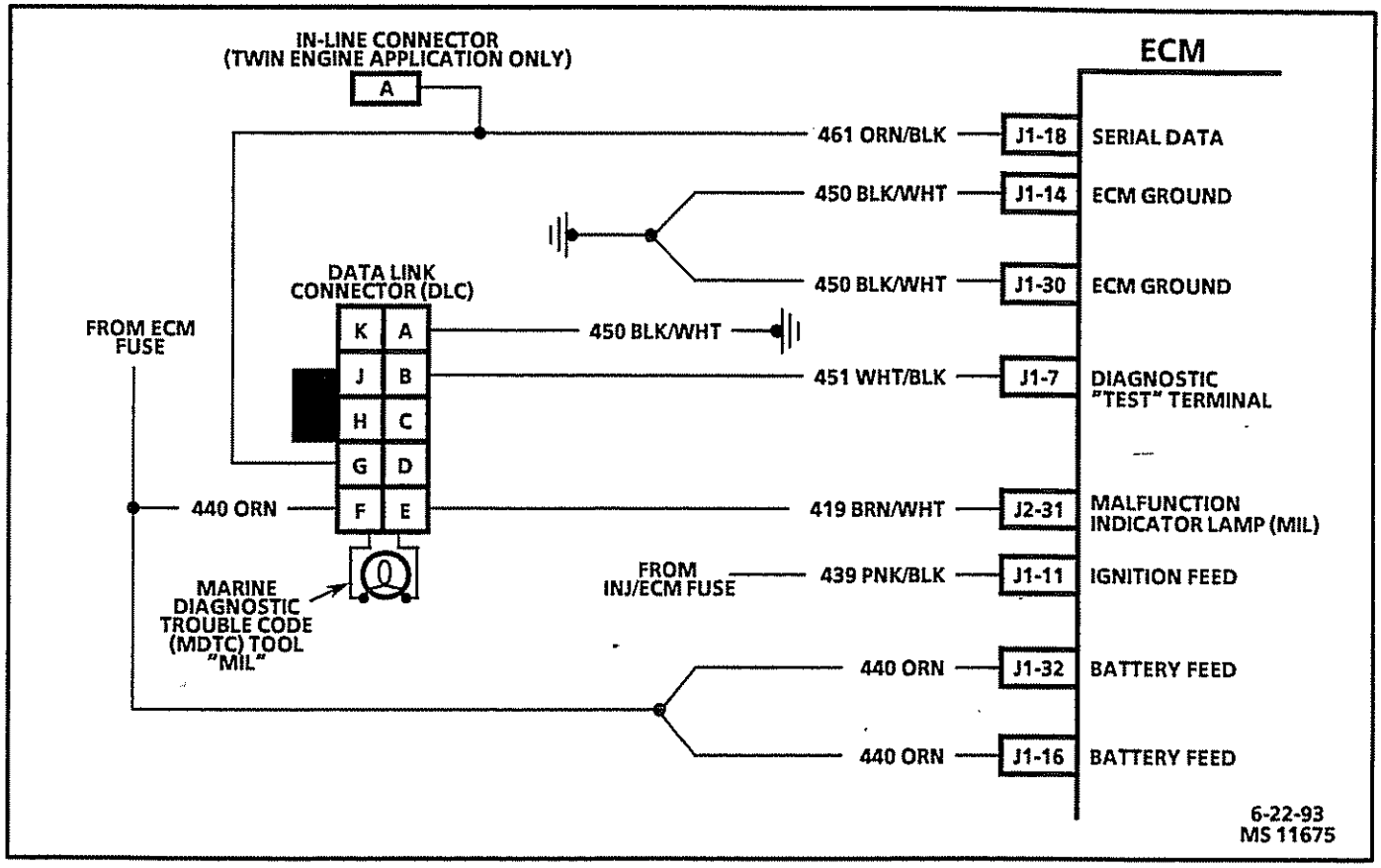
Number(s) below refer to the Step number(s) on the Diagnostic Table:

1. The MIL should be "ON" steady with the ignition "ON," engine "OFF." If not, chart A-1 should be used to isolate the malfunction.
2. Checks for grounded CKT 451 and ensures that the MIL driver circuit is not shorted to ground.
3. This test ensures that the ECM is capable of controlling the MIL.
4. If the engine will not start, chart A-3 should be used to diagnose the condition.
5. Refer to "ECM Diagnostic Trouble Code" chart for a list of valid Diagnostic Trouble Codes (DTC). An invalid DTC may be the result of a faulty MDTC tool, EEPROM, or ECM.
6. If the customer complaint or driveability problem does not currently exist, refer to "Diagnostic Aids" to check for an intermittent problem.

On-Board Diagnostic (OBD) System Check - Non Scan

Step	Action	Value(s)	Yes	No
1	1. Ignition "ON," engine "OFF." 2. Install Marine Diagnostic Trouble Code (MDTC) tool and switch it to "normal mode." 3. Observe the Malfunction Indicator Lamp (MIL). Is the MIL "ON?"	—	Go to Step 2	Go to *Chart A-1*
2	1. With Marine Diagnostic Trouble Code Tool on "normal mode." 2. Ignition "ON," engine "OFF." 3. Observe the Malfunction Indicator Lamp on the MDTC tool. Does the MIL flash DTC 12?	—	Go to Step 7	Go to Step 3
3	1. Switch Marine Diagnostic Trouble Code Tool to "service mode." 2. Ignition "ON," engine "OFF." 3. Observe the Malfunction Indicator Lamp on the MDTC tool. Does the MIL flash DTC 12?	—	Go to Step 4	Go to *Chart A-2*
4	1. Switch MDTC tool to "normal mode." 2. Attempt to start the engine. Did the engine start and continue to run?	—	Go to Step 5	Go to *Chart A-3*
5	1. Ignition "ON," engine "OFF." 2. Switch MDTC tool to "service mode." Are any additional DTCs stored?	—	Go to applicable DTC Chart	Go to Step 6
6	Does a customer complaint or driveability problem currently exist?	—	Refer to "Symptoms" section	Refer to "Diagnostic Aids"
7	1. Ignition "ON," engine "OFF." 2. Check CKT 451 for a short to ground. 3. If a problem is found, repair as necessary. Was a problem found?	—	Repeat *OBD System Check*	Go to Step 8
8	Replace the ECM. Is action complete?	—	Repeat *OBD System Check*	—

On-Board Diagnostic (OBD) System Check - Scan



Circuit Description

The on-board diagnostic system check must be the starting point for any driveability complaint diagnosis. Before using this procedure, you should perform a careful visual/physical check of the ECM and engine grounds for being clean and tight.

The on-board diagnostic system check is an organized approach to identifying a problem created by an electronic engine control system malfunction.

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:

- Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection, and damaged harness.

Test Description

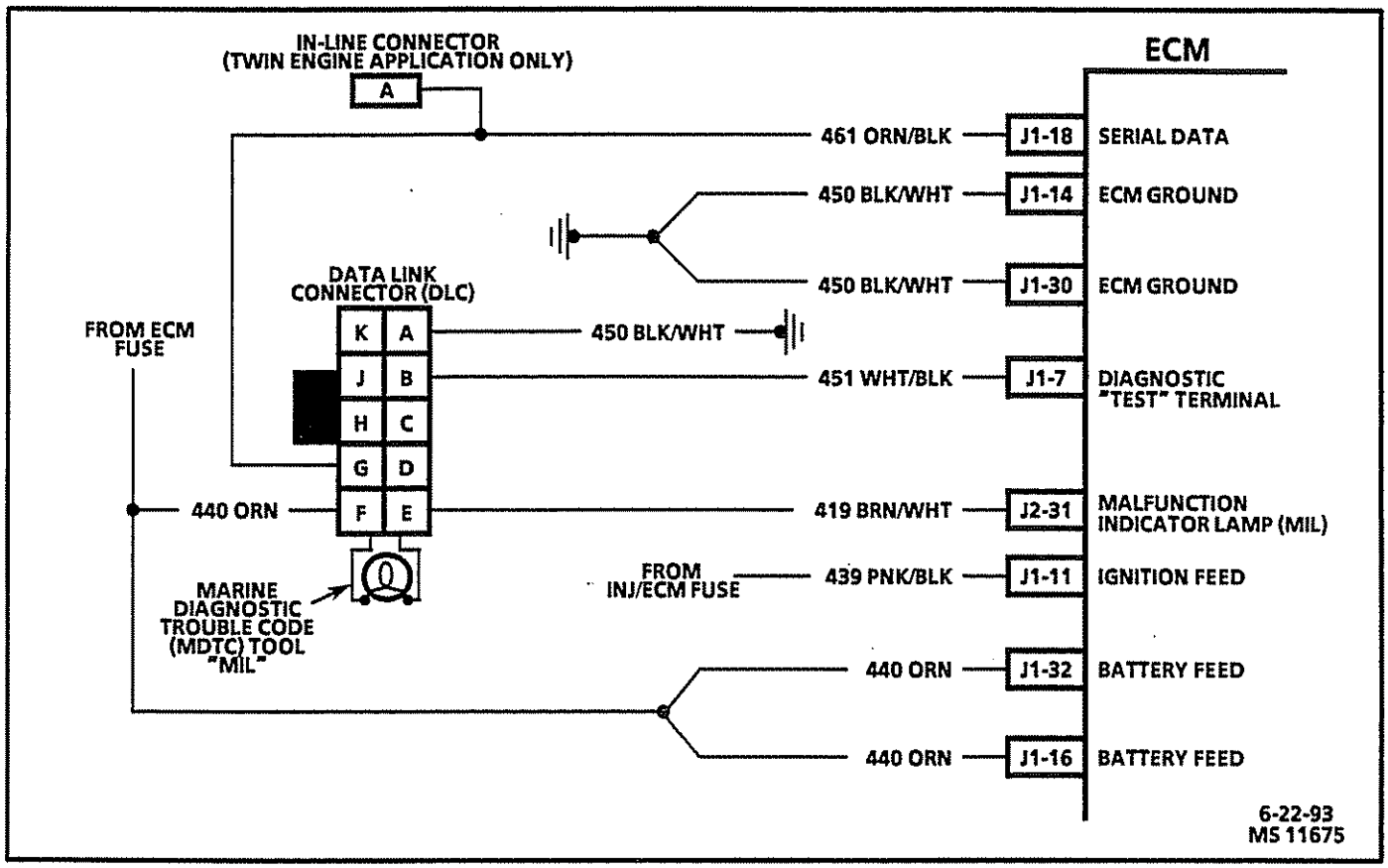
Number(s) below refer to the Step number(s) on the Diagnostic Table:

1. The MIL should be "ON" steady with the ignition "ON," engine "OFF." If not, chart A-1 should be used to isolate the malfunction.
2. Checks the serial data circuit and ensures that the ECM is able to transmit serial data.
3. This test ensures that the ECM is capable of controlling the MIL and the MIL driver circuit is not shorted to ground.
4. If the engine will not start, chart A-3 should be used to diagnose the condition.
6. 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(s)	Yes	No
1	1. Ignition "ON," engine "OFF." 2. Install Marine Diagnostic Trouble Code (MDTC) tool and switch it to "normal mode." 3. Observe the Malfunction Indicator Lamp (MIL). Is the MIL "ON?"	—	Go to Step 2	Go to *Chart A-1*
2	1. Ignition "OFF." 2. Install a scan tool. 3. Ignition "ON." 4. Attempt to display ECM data with the scan tool. Does the scan tool display ECM data?	—	Go to Step 3	Go to Step 7
3	1. Using the scan tool output controls function, select MIL lamp control and command the MIL "OFF." 2. Look at ECM data and look at Malfunction Indicator Lamp and see if "OFF" is displayed. Is "OFF" displayed?	—	Go to Step 4	Go to *Chart A-2*
4	Attempt to start the engine. Did the engine start and continue to run?	—	Go to Step 5	Go to *Chart A-3*
5	Select "Display DTCs" with the scan tool. Are any DTCs stored?	—	Go to applicable DTC Chart	Go to Step 6
6	Compare ECM data values displayed on the scan tool to the typical scan tool data values page. Are the displayed values normal or close to the typical values?	—	Refer to "Symptoms" section	Refer to "Component System" Check
7	1. Ignition "OFF." 2. Disconnect the ECM. 3. Check the serial data CKT 461 for an open, short to ground, or short to voltage. Also, check the DLC battery feed circuit for an open or short to ground and the DLC ground CKT 450 for an open. 4. If a problem is found, repair as necessary. Was a problem found?	—	Repeat *OBD System Check*	Go to Step 7
8	Replace the ECM. Is action complete?	—	Repeat *OBD System Check*	—

Chart A-1 - No Malfunction Indicator Lamp (MIL) - Marine Diagnostic Trouble Code (MDTC) Tool Installed



Circuit Description

When the Marine Diagnostic Trouble Code (MDTC) tool is installed, it plugs into the DLC terminals "F" and "E". It receives voltage through CKT 440 terminal "F". Terminal "E" is ground through CKT 419 from the ECM terminal "J2-31". There should always be a steady MIL with the ignition "ON" and the engine stopped. The Electronic Control Module (ECM) turns the MIL "ON" by grounding the MIL driver circuit.

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:

- Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection, and damaged harness.

If the engine runs OK, check for a faulty light bulb or an open in the MIL driver circuit (CKT 419).

If the engine cranks but will not run, check for an open ECM ignition or battery feed or a poor ECM to engine ground.

Test Description

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

3. This step ensures that battery voltage is available to terminal "F" of the DLC connector.
4. This step checks for ground present at terminal "E" of the DLC connector. This indicates the ECM is capable of completing the ground to the MIL.
5. This step isolates the cause of an incomplete ground circuit to either faulty wiring or faulty ECM circuitry.
7. This step ensures that battery voltage is available to the ECM.

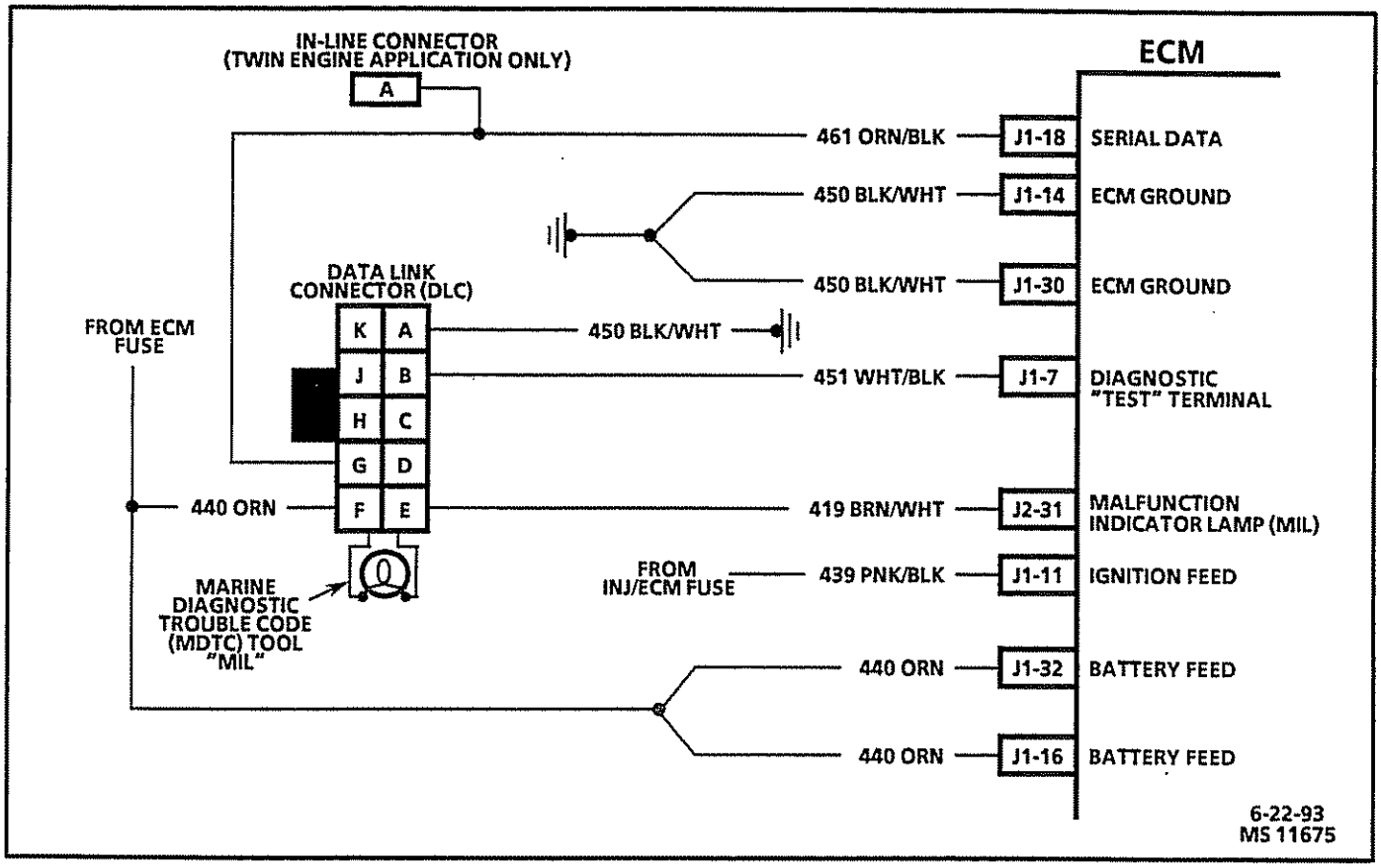
Chart A-1 - No Malfunction Indicator Lamp (MIL) - Marine Diagnostic Trouble Code (MDTC) Tool Installed

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System Check performed?	—	Go to Step 2	Go to *OBD System Check*
2	Attempt to start the engine. Does the engine start?	—	Go to Step 3	Go to Step 6
3	1. Remove Marine Diagnostic Trouble Code (MDTC) tool. 2. Ignition "ON," engine "OFF." 3. Using a test light connected to ground, probe terminal "F" of the DLC. Does the test light illuminate brightly?	—	Go to Step 4	Go to Step 10
4	Using a test light connected to B+, probe terminal "E" of the DLC. Does the test light illuminate brightly?	—	Go to Step 11	Go to Step 5
5	1. Ignition "OFF." 2. Disconnect ECM "J2" connector. 3. Using a DVOM, measure the resistance between ECM harness connector terminal "J2-31" and DLC terminal "E." Is the resistance within the specified values?	0 ohms	Go to Step 17	Go to Step 13
6	Check the ECM fuse. Is the fuse good?	—	Go to Step 7	Go to Step 14
7	1. Ignition "OFF." 2. Disconnect the ECM connectors. 3. Using a test light connected to ground, probe ECM harness connector pins "J1-16" and "J1-32." Does the test light illuminate brightly on both circuits?	—	Go to Step 8	Go to Step 15
8	1. Ignition "ON," engine "OFF." 2. Using a test light connected to ground, probe ECM harness connector pin "J1-11." Does the test light illuminate brightly?	—	Go to Step 12	Go to Step 9
9	Check the INJ/ECM fuse. Is the fuse good?	—	Go to *Chart A-6*	Go to Step 16
10	Locate and repair open or short to ground in CKT 440. Is action complete?	—	Go to *OBD System Check*	—
11	Repair or replace faulty Marine Diagnostic Trouble Code tool. Is action complete?	—	Go to *OBD System Check*	—
12	1. Locate and repair faulty ECM grounds. 2. If a problem is found, repair as necessary. Is action complete?	—	Go to *OBD System Check*	Go to Step 17
13	Locate and repair open in CKT 419. Is action complete?	—	Go to *OBD System Check*	—
14	Locate and repair short to ground in the battery feed circuit. Is action complete?	—	Go to *OBD System Check*	—

Chart A-1 - No Malfunction Indicator Lamp (MIL) - Marine Diagnostic Trouble Code (MDTC) Tool Installed (continued)

Step	Action	Value(s)	Yes	No
15	Locate and repair open in the circuit that did not light the test light. Is action complete?	—	Go to *OBD System Check*	—
16	Locate and repair short to ground in CKT 439. Is action complete?	—	Go to *OBD System Check*	—
17	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Go to *OBD System Check*	—

Chart A-2 - Malfunction Indicator Lamp (MIL) "On" Steady - No DLC Data or Will Not Flash DTC 12 - Marine Diagnostic Trouble Code (MDTC) Tool Installed



Circuit Description

When the Marine Diagnostic Trouble Code (MDTC) tool is installed, it plugs into the DLC terminals "F" and "E". It receives voltage through CKT 440 terminal "F". Terminal "E" is ground through CKT 419 from the ECM terminal "J2-31". There should always be a steady MIL with the ignition "ON" and the engine stopped. The Electronic Control Module (ECM) turns the MIL "ON" by grounding the MIL driver circuit.

When the diagnostic "test" terminal on the DLC is grounded by jumping terminal "B" to terminal "A", the ground circuit is completed. The MIL will flash a DTC 12 followed by any DTC's stored in memory. A steady light suggests CKT 419 is shorted to ground or an open in CKT 451 from the ECM to the DLC.

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.

Test Description

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

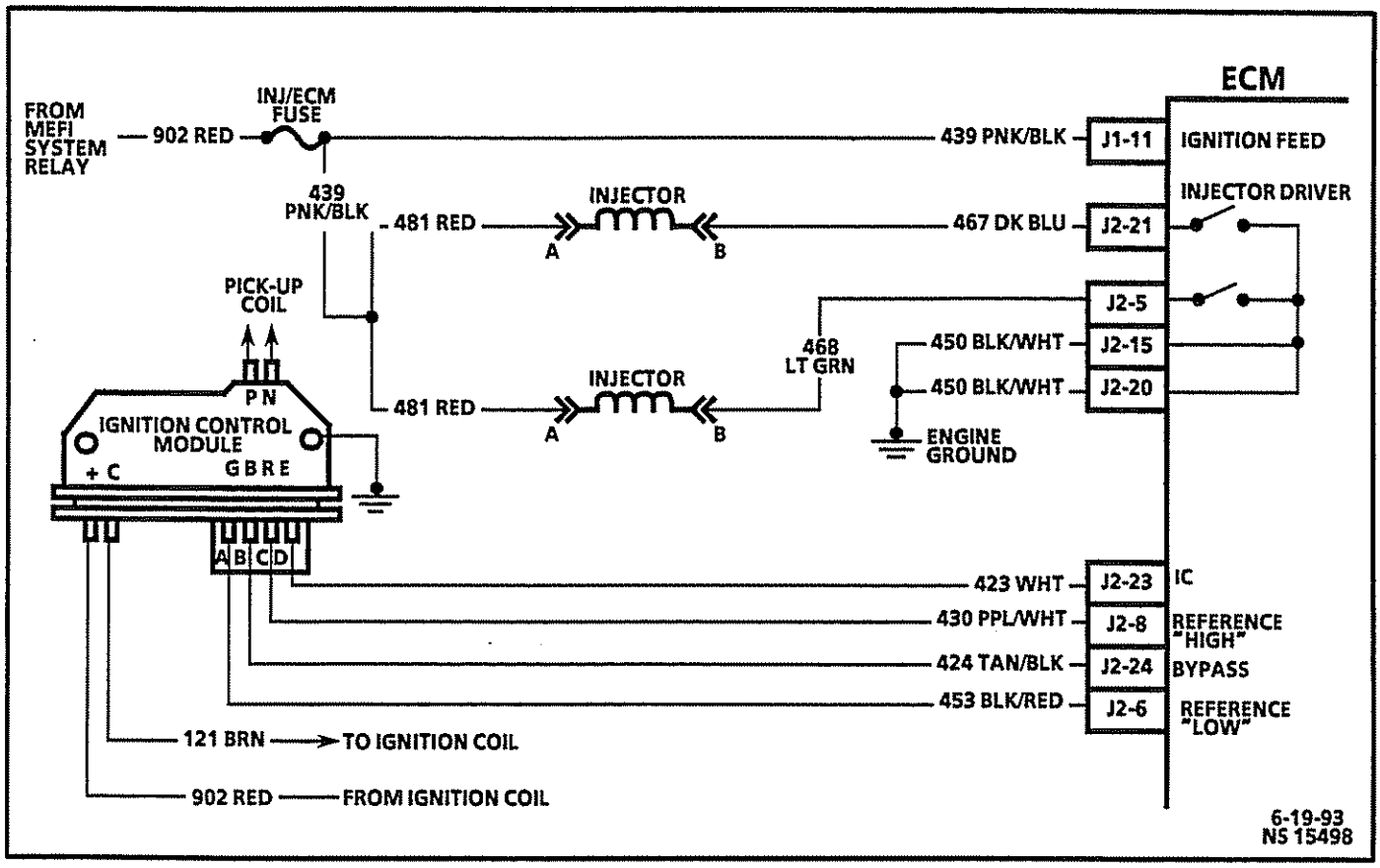
3. If the light goes "OFF" when the ECM connectors are disconnected, CKT 419 is not shorted to ground.
4. This step will check for an open diagnostic CKT 451.
6. If there is a problem with the ECM that prevents a scan tool from reading serial data, the ECM will not flash a DTC 12. If DTC 12 is flashing, check for short to ground in CKT 451 and verify that the scan tool is working properly on another vehicle.
9. At this point, the MIL wiring is OK. If DTC 12 does not flash, replace the ECM.

Notice: Before replacing ECM, check the MDTC tool on another engine to make sure it is working properly.

Chart A-2 - Malfunction Indicator Lamp (MIL) "On" Steady - No DLC Data or Will Not Flash DTC 12 - Marine Diagnostic Trouble Code (MDTC) Tool Installed

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System Check performed?	—	Go to Step 2	Go to *OBD System Check*
2	1. Ignition "ON," engine "OFF." 2. Switch MDTC tool to "service mode." Does the MIL flash DTC 12?	—	Go to Step 6	Go to Step 3
3	1. Ignition "OFF," disconnect ECM connectors. 2. Ignition "ON," engine "OFF," observe the MIL. Is the MIL "ON?"	—	Go to Step 7	Go to Step 4
4	1. Ignition "OFF." 2. With ECM "J1" connector disconnected, jump terminals "A" to "B" at the DLC. 3. Connect test light between ECM connector terminal "J1-7" and B+. Does test light illuminate brightly?	—	Go to Step 5	Go to Step 8
5	1. Verify correct operation of MDTC tool on a known good system. 2. If a problem is found, repair as necessary. Is action complete?	—	Go to *OBD System Check*	Go to Step 9
6	1. If problem was no DLC data (using scan tool), check serial data CKT 461 for an open or short to ground. 2. If a problem is found, repair as necessary. Is action complete?	—	Go to *OBD System Check*	Go to Step 9
7	Locate and repair short to ground in CKT 419. Is action complete?	—	Go to *OBD System Check*	—
8	Locate and repair open in CKT 450 and/or CKT 451. Is action complete?	—	Go to *OBD System Check*	—
9	1. Repair faulty ECM connections or replace faulty ECM. 2. Recheck for DTC 12. Is action complete?	—	Go to *OBD System Check*	—

Chart A-3 - Engine Cranks But Will Not Run



Circuit Description

In the Distributor Ignition (DI) system and the fuel injector circuit, the supply voltage comes from the MEFI system relay. From the MEFI system relay, CKT 902 delivers supply voltage to the injector/ECM fuse, and to the ignition coil gray connector terminal "B."

After supply voltage passes through the injector/ECM fuse, it branches out into two separate CKT's 439. One is the supply voltage for injector harness CKT 481 and the other goes to ECM terminal "J1-11." The ECM will control the opening and closing of the injectors through injector driver CKT 467 and CKT 468 by connecting them to ground.

The Ignition Control (IC) module receives supply voltage through CKT 3 from the gray connector at the coil where it is connected with CKT 902. The IC module will control spark from the coil through CKT 121. The IC module interfaces with the ECM through CKT 430. The ECM will control the timing of the spark through CKT 423. For further explanation of distributor ignition system, see "Distributor Ignition System Check," CHART A-7.

Diagnostic Aids

This chart assumes that battery voltage and engine cranking speed are OK, and there is adequate fuel in the tank.

Water or foreign material in fuel system can cause a no start.

A defective MAP sensor may cause a no start or a start and stall condition. To determine if the MAP sensor is causing the problem, disconnect the electrical connector. The ECM will then use a default value for the sensor. If the condition is corrected and the connections are OK, then replace the sensor.

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.

If above are all OK, refer to "Hard Start" in "Symptoms" section.

Test Description

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

5. No spark may be caused by one of several components related to the distributor ignition system. The distributor ignition system check will address all problems related to the causes of a no spark condition.
6. This test will determine if there is fuel pressure at the injectors and that the injectors are operating.
8. Use fuel pressure gauge J 29658-D or equivalent. Wrap shop towel around the fuel pressure tap to absorb any small amount of fuel leakage that may occur when installing the gauge.
9. No spark may be caused by one of several components related to the distributor ignition system. The distributor ignition system check will address all problems related to the causes of a no spark condition.
12. Checks for 12 volt supply to injectors. Due to the injectors wired in parallel, there should be a light on both terminals.
13. Checks continuity of CKT 467 and CKT 468.
14. If the ECM is seeing a high TP sensor voltage, it may be in "clear flood" mode. Disconnecting the TP sensor will allow the ECM to use a default value and turn the injectors "ON."
19. CKT 481 supplies ignition voltage to the injectors. Probe each harness terminal with a test light connected to ground. There should be a light "ON" at one harness terminal of each connector. If the test light confirms ignition voltage ignition voltage at the harness connector, the ECM injector driver CKT 467 and CKT 468 may be open. Reconnect the injector. Using a test light connected to ground, check for a light at the applicable ECM connector terminal. A light at this point indicates that the injector wiring circuit involved is OK. If an ECM repeat failure has occurred, the injector is shorted. Replace the injector and ECM.

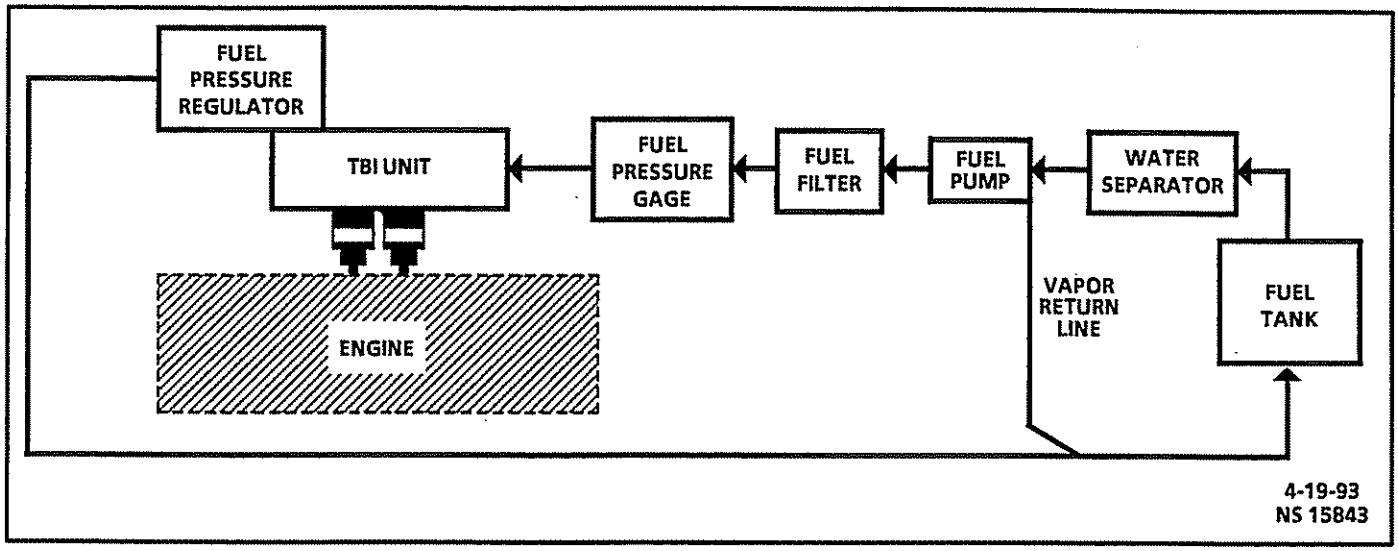
Chart A-3 - Engine Cranks But Will Not Run

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System Check performed?	—	Go to Step 2	Go to *OBD System Check*
2	Disconnect Throttle Position(TP) sensor. Does the engine start?	—	Go to Step 21	Go to Step 3
3	1. Key "OFF" for minimum of 10 seconds. 2. Key "ON." 3. Listen for fuel pump to run. Does fuel pump run for 2 seconds?	—	Go to Step 4	Go to *Chart A-4*
4	Crank engine for 1 second and listen for fuel pump to run. Does fuel pump run?	—	Go to Step 5	Go to Step 9
5	Check for secondary ignition spark per manufactures recommendation. Is adequate spark present at all cylinders?	—	Go to Step 6	Go to *Chart A-7*
6	1. Remove flame arrestor. 2. Observe injector fuel spray while cranking engine. Do both injectors spray while cranking?	—	Go to Step 7	Go to Step 11
7	1. Disconnect both injectors. 2. Observe injector fuel spray while cranking engine. Does either injector spray or leak fuel while cranking?	—	Go to Step 22	Go to Step 8
8	1. Install fuel pressure gauge J 29658-D or equivalent. 2. Ignition "OFF" for 10 seconds. 3. Ignition "ON." Fuel pump will run for about 2 seconds 4. Note fuel pressure with pump running. The pressure may drop after the pump stops running Is fuel pressure within specified value?	186-228 kPa (27-33 psi)	Refer to *Diagnostic Aids* on Facing Page	Go to *Chart A-4*
9	Check for secondary ignition spark per manufactures recommendation. Is adequate spark present at all cylinders?	—	Go to Step 10	Refer to *Ignition System Check*
10	1. Ignition "OFF." 2. Disconnect ECM "J2" connector. 3. Using a DVOM connected to ground, probe "J2-8" of the ECM harness connector while cranking the engine. Is the voltage within the specified value?	1-2 volts	Go to Step 27	Go to Step 23
11	Is there no fuel spray on both injectors?	—	Go to Step 12	Go to Step 15
12	1. Ignition "OFF." 2. Disconnect both injector harness connectors. 3. Ignition "ON," engine "OFF." 4. With a test light connected to ground, probe harness terminal "A" at each injector connector. Does test light illuminate brightly?	—	Go to Step 13	Go to Step 24
13	1. Connect test light J 34730-350 to injector harness connector. 2. While cranking engine, check for blinking light. 3. Remove test light and reconnect injector harness connector. 4. Repeat this test for both injectors. 5. If any lights are blinking dimly, check for shorted injector by comparing injector resistance values. Were both lights blinking brightly?	—	Go to *Chart A-4*	Go to Step 14

Chart A-3 - Engine Cranks But Will Not Run (continued)

Step	Action	Value(s)	Yes	No
14	1. Ignition "OFF." 2. Disconnect TP sensor. 3. Note injector test light while cranking engine. Is test light blinking brightly?	—	Refer to DTC 21 Table	Go to Step 23
15	1. Disconnect inoperative injector harness connector. 2. Connect test light J 34730-350 to injector harness connector. 3. While cranking engine, check for blinking light. Is injector test light on steady?	—	Go to Step 17	Go to Step 16
16	Is injector test light blinking brightly?	—	Go to Step 22	Go to Step 19
17	Check for short to ground in CKT 467 or CKT 468. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 18
18	Check the injector driver circuit with the steady light for a short to ground. If circuit is not shorted, check resistance across injector in the circuit. Is resistance close to the specified value?	1.2 ohms	Go to Step 27	Go to Step 22
19	1. Ignition "ON," engine "OFF." 2. Using a test light connected to ground, probe each injector harness terminal on the affected circuit. Does test light illuminate brightly on both terminals?	—	Go to Step 26	Go to Step 20
20	Does test light illuminate brightly on one terminal?	—	Go to Step 25	Go to Step 24
21	Replace faulty TP sensor. Is action complete?	—	Go to *OBD System Check*	—
22	Replace faulty injector seal or faulty injector. Is action complete?	—	Go to *OBD System Check*	—
23	1. Locate and repair open or short to ground in CKT 430. 2. If OK, replace faulty ignition control module. Was a problem found?	—	Go to *OBD System Check*	Go to Step 25
24	Locate and repair open in ignition feed circuit to injector. Is action complete?	—	Go to *OBD System Check*	—
25	Locate and repair open in CKT 467 or CKT 468. Was a problem found?	—	Go to *OBD System Check*	Go to Step 27
26	Locate and repair short to voltage in CKT 467 or CKT 468. Is action complete?	—	Go to *OBD System Check*	—
27	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Go to *OBD System Check*	—

CHART A-4 Fuel System Diagnosis



Circuit Description

When the ignition is turned "ON," the Engine Control Module (ECM) will turn the fuel pump "ON" for 2 seconds. During engine cranking, the ECM will turn "ON" the fuel pump. It will remain "ON" as long as the engine is cranking or running, and the ECM is receiving ignition reference pulses. If there are no reference pulses, the ECM will shut "OFF" the fuel pump.

The pump will deliver fuel to the injectors, then to the pressure regulator, where the system pressure is controlled to about 186-228 kPa (27-33 psi). Excess fuel is then returned to the fuel tank.

Test Description

2. Wrap a shop towel around the fuel pressure connector to absorb any small amount of fuel leakage that may occur when installing the gauge. Ignition "ON," pump pressure should be 186-228 kPa (27-33 psi). This pressure is controlled by spring pressure within the regulator assembly.

Notice: Fuel pump pressure will read lower if battery is not fully charged.

5. Low fuel pressure can be caused by a restriction in the inlet fuel line. This can include fuel tank pick-up, rubber and steel lines, fuel fittings, and filters.
6. Restricting the fuel return line allows the fuel pressure to build above regulated pressure. Pressure should rise as the fuel return hose is gradually restricted.

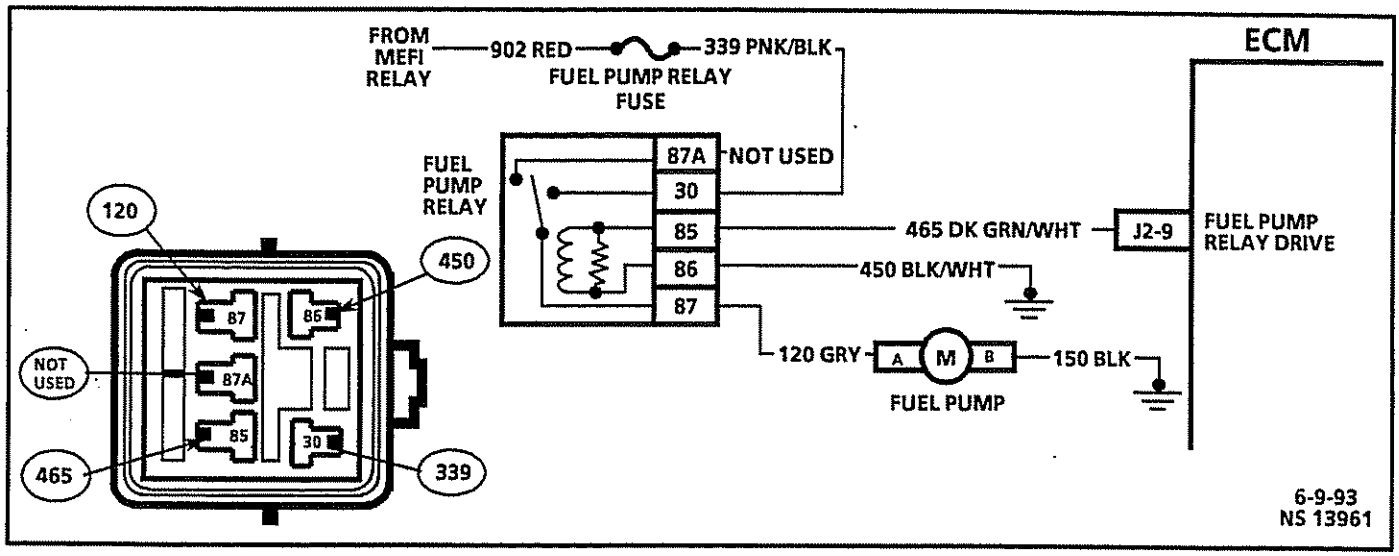
Notice: Do Not allow the fuel pressure to exceed 414 kPa (60 psi). Fuel pressure in excess of 414 kPa (60 psi) may damage the Fuel Pressure Regulator.

7. This test determines if the high fuel pressure is due to a restricted fuel return line or a pressure regulator problem.

CHART A-4 Fuel System Diagnosis

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostics" (OBD) System Check performed?	—	Go to Step 2	Go to *OBD System Check*
2	1. Install fuel pressure gauge J29658-D or equivalent. 2. Ignition "OFF" for 10 seconds. 3. Ignition "ON." Fuel pump will run for about 2 seconds. 4. Note fuel pressure with pump running. The pressure may drop after the pump stops running. Is fuel pressure within specified value?	186-228 kPa (27-33 psi)	Refer to *Symptoms Section*	Go to Step 3
3	Was fuel pressure present at all?	—	Go to Step 4	Go to *Chart A-5*
4	Is fuel pressure below specified value?	186 kPa (27 psi)	Go to Step 5	Go to Step 7
5	Check for restricted inlet fuel lines and fittings. Also, check for restricted in-line fuel filters. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 6
6	1. Ignition "OFF." 2. Disconnect fuel pump relay. 3. Using a 10-amp fused jumper wire, apply battery voltage to fuel pump relay connector cavity "87." 4. Gradually pinch pressure gauge outlet hose and note fuel pressure. Does fuel pressure rise above the specified value?	228 kPa (33 psi)	Go to Step 9	Go to Step 10
7	1. Ignition "OFF." 2. Disconnect fuel return line. 3. Following manufactures recommendations, connect a hose to pressure regulator side of return line. Insert the other end into an approved gasoline container. 4. Ignition "ON." Note fuel pressure within 2 seconds of ignition "ON." Is fuel pressure within the specified value?	186-228 kPa (27-33 psi)	Go to Step 11	Go to Step 8
8	Check for restricted fuel return line from fuel pressure regulator to point where fuel line was disconnected. Was a problem found?	—	Go to *OBD System Check*	Go to Step 9
9	If lines are OK, replace fuel meter cover, which includes a new pressure regulator. Is action complete?	—	Go to *OBD System Check*	—
10	Check for leaking pump fittings or lines, inlet filter, and low battery voltage. If OK, replace faulty fuel pump. Is action complete?	—	Go to *OBD System Check*	—
11	Locate and repair restricted fuel return line to fuel tank. Is action complete?	—	Go to *OBD System Check*	—

Chart A-5 - Fuel System Electrical Test



Circuit Description

The fuel system circuit receives a supply voltage from MEFI relay system CKT 902. The fuel system is protected by a 15 amp fuse. After the fuse, supply voltage is delivered by CKT 339 to fuel pump relay terminal "30." The fuel pump relay is turned on by the ECM by supplying voltage to CKT 465. The fuel pump relay will remain "ON" as long as the engine is running or cranking and the ECM is receiving reference pulses. If no reference pulses are present, the ECM de-energizes the fuel pump relay within 2 seconds after the ignition is turned "ON" or the engine is stopped.

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.

Contaminated or dirty fuel may cause the fuel pump to seize, which will cause the fuel pump relay fuse to fail.

Test Description

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

2. Verifies that there is power to the fuel pump relay.
3. Bypassing the relay circuit should cause the fuel pump to run. This step should identify if the fault is in the relay or in the fuel pump circuit.
4. This step checks if there is a open in the ground circuit.
5. This step checks if the ECM is functioning properly.

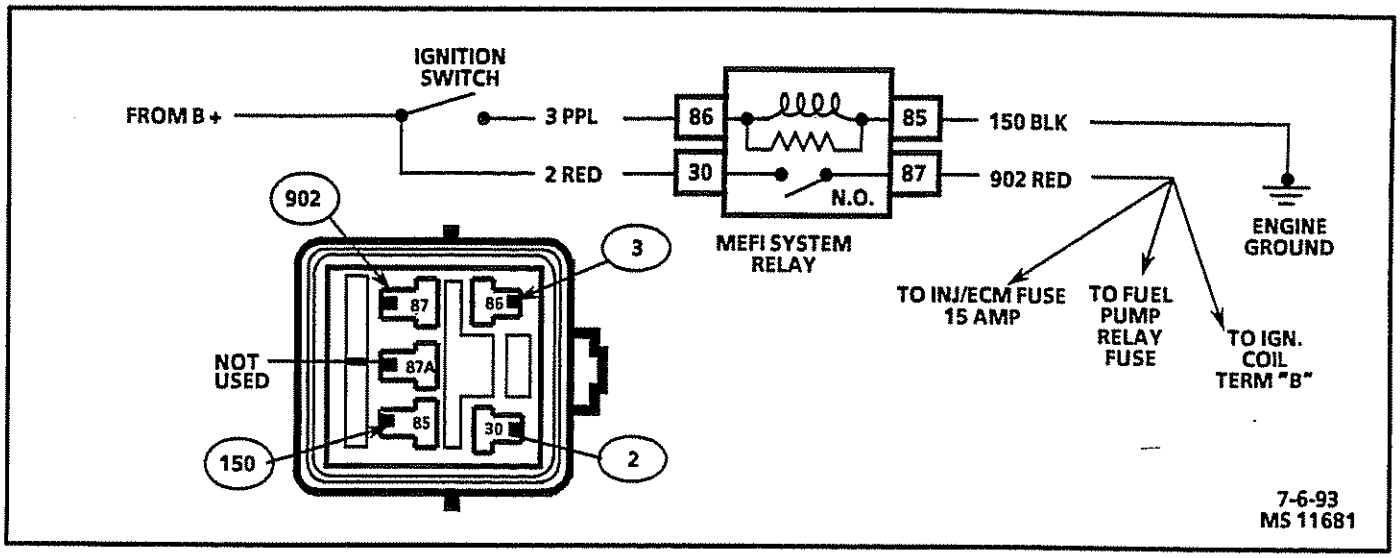
Chart A-5 - Fuel System Electrical Test

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostics" (OBD) System Check performed?	—	Go to Step 2	Go to *OBD System Check*
2	1. Ignition "OFF." 2. Remove fuel pump relay. 3. Ignition "ON." 4. Using test light connected to ground, probe fuel pump relay harness connector terminal "30." Does test light illuminate brightly?	—	Go to Step 3	Go to Step 7

Chart A-5 - Fuel System Electrical Test (continued)

Step	Action	Value(s)	Yes	No
3	1. Ignition "OFF." 2. Using a fused jumper wire, connect terminals "30" and "87" of the fuel pump relay connector together. 3. Ignition "ON." Does fuel pump run?	—	Go to Step 4	Go to Step 12
4	1. Ignition "OFF." 2. Disconnect fused jumper wire. 3. Using a test light connected to B+, probe terminal "86" of the fuel pump relay connector. Does the test light illuminate brightly?	—	Go to Step 5	Go to Step 14
5	1. Using a test light connected to ground, probe terminal "85" of the fuel pump relay connector. 2. Ignition "ON." Does test light illuminate brightly for 2 seconds and then go off?	—	Go to Step 8	Go to Step 6
6	Locate and repair faulty ECM connection at "J2-9" or repair open in CKT 465. Was a problem found?	—	Go to *OBD System Check*	Go to Step 15
7	Check fuel pump relay fuse. Is fuse OK?	—	Go to Step 10	Go to Step 11
8	Replace fuel pump relay and re-test. Is fuel pressure within specified values?	186-228 kPa (27-33 psi)	Go to *OBD System Check*	Go to Step 9
9	1. Check for plugged in-line filter, vapor lock condition, restricted fuel lines, disconnected hoses, and proper fuel level. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 13
10	Locate and repair open in CKT 339 or CKT 902. Is action complete?	—	Go to *OBD System Check*	—
11	Locate and repair short to ground in CKT 339 or CKT 120. Also check for contamination in fuel lines or fuel tank. If OK, replace fuel pump and fuse. Is action complete?	—	Go to *OBD System Check*	—
12	Locate and repair open in CKT 120 or CKT 150. Was a problem found?	—	Go to *OBD System Check*	Go to Step 13
13	Replace faulty fuel pump. Is action complete?	—	Go to *OBD System Check*	—
14	Locate and repair open in CKT 450. Is action complete?	—	Go to *OBD System Check*	—
15	Replace faulty ECM. Is action complete?	—	Go to *OBD System Check*	—

Chart A-6 - MEFI System Relay Check



Circuit Description

Battery voltage is constantly supplied to terminal "30" of the system relay. When the ignition switch is moved to the "run" position, battery voltage is supplied to terminal "86" of the system relay. The pull-in coil is then energized creating a magnetic field which closes the contacts of the system relay. Voltage and current are then supplied to the ignition control module, injectors, ECM, and fuel pump relay through terminal "87" CKT 902 of the system relay.

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.

Contaminated or dirty fuel may cause the fuel pump to seize, which will cause the fuel pump relay fuse to fail.

Test Description

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

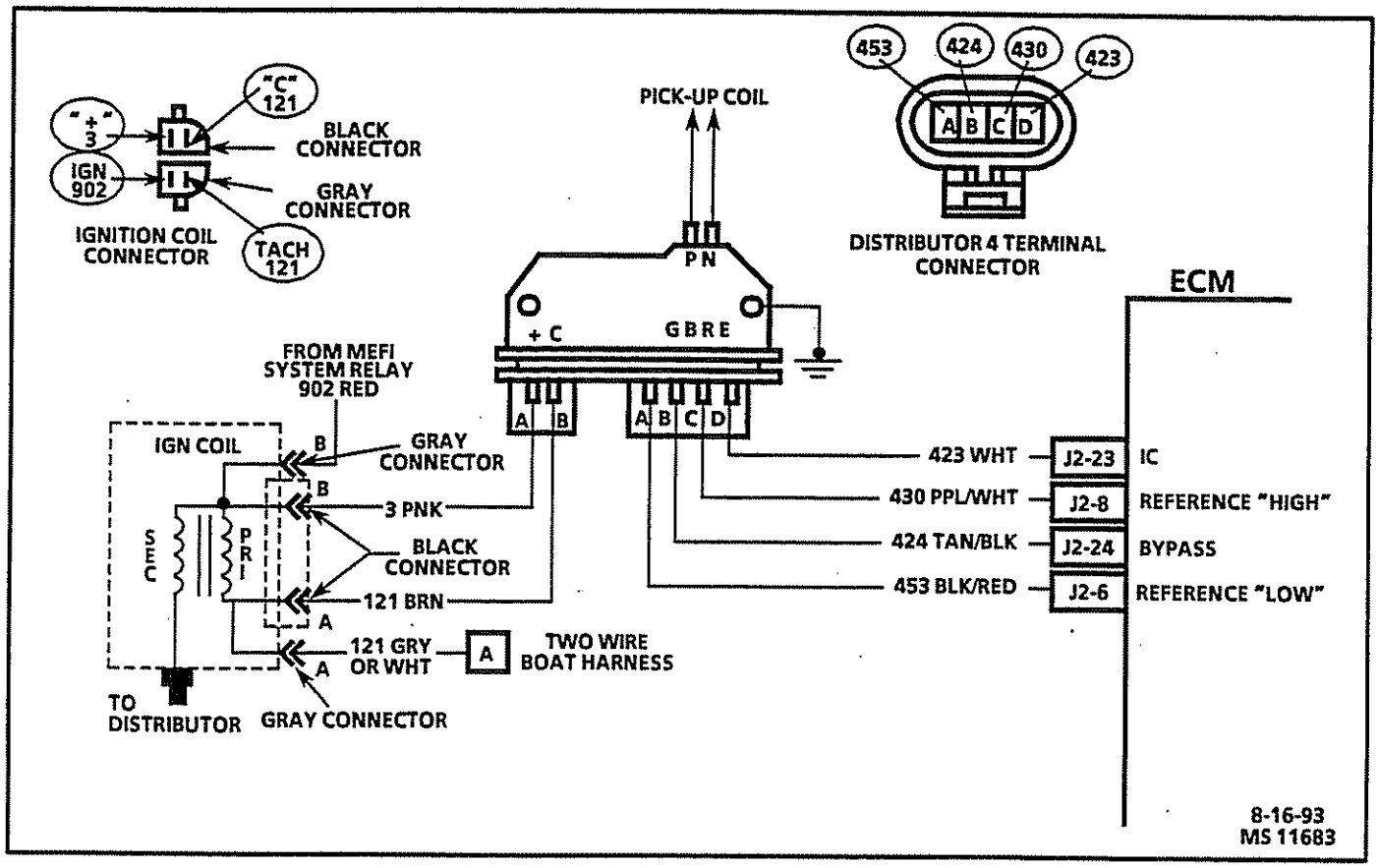
diagnosis.

2. Verifies that there is power to the MEFI System relay.
3. This step checks if there is a open in the ground circuit.

Chart A-6 - MEFI System Relay Check

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostics" (OBD) System Check performed?	—	Go to Step 2	Go to *OBD System Check*
2	1. Ignition "OFF." 2. Remove MEFI system relay connector. 3. Ignition "ON." 4. With test light still connected to ground, probe relay harness connector terminals "86" and "30." Does test light illuminate brightly on both terminals?	—	Go to Step 3	Go to Step 5
3	Using test light connected to B+, probe relay harness connector terminal "85." Does test light illuminate brightly?	—	Go to Step 4	Go to Step 6
4	Check relay connector for poor contact or corrosion. If OK, replace faulty MEFI system relay. Is action complete?	—	Go to *OBD System Check*	—
5	Locate and repair open or short to ground in circuit that did not light (CKT 2 and/or CKT 3). Is action complete?	—	Go to *OBD System Check*	—
6	Locate and repair open ground CKT 150. Is action complete?	—	Go to *OBD System Check*	—

Chart A-7 - Distributor Ignition (DI) System Check



Circuit Description

The Distributor Ignition (DI) system receives supply voltage from the MEFI system relay through CKT 902 to the ignition coil gray connector "B." Inside the ignition coil, the gray connector terminal "B" is connected to the black connector terminal "B." Supply voltage is delivered from the ignition coil black connector terminal "B" to the distributor Ignition Control (IC) module "+" terminal through CKT 3.

Inside the distributor, the pick-up coil and pole piece will produce a voltage signal for cylinder spark. The voltage signals are processed in the IC module and sent to the ECM. The ECM will decide if the engine is in the cranking or running mode and adjust timing accordingly. The voltages or signals are sent between the ECM and the IC module through CKT's 423, 430, and 424. CKT 453 is the ground circuit.

The IC module will send the voltage signal to the ignition coil black connector terminal "A" through CKT 121. The signal will trigger the coil creating secondary spark to be produced. This secondary spark is sent to the distributor by a high tension lead.

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.

The "tach" needs to be disconnected while testing the ignition system. You will also need a place to check oil trigger voltage. By disconnecting the "2-wire boat harness" (gray and purple wires), this will give you a test terminal to check coil trigger voltage as needed in several steps. After "tach" is disconnected, try starting the engine. If the engine starts, check for a short to ground in the boat "tach" circuit.

Test Description

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

2. Two wires are checked to ensure that an open is not present in a spark plug wire.
4. A spark indicates the problem must be in the distributor cap, rotor, or coil output wire.
6. Normally, there should be battery voltage at the "C" and "+" terminals. Low voltage would indicate an open or a high resistance circuit from the distributor to the coil or ignition switch. If "C" terminal voltage was low, but "+" terminal voltage is 10 volts or more, circuit from "C" terminal to ignition coil is open or primary winding of the ignition coil is open.

8. Checks for a shorted module or grounded circuit from the ignition coil to the module. The distributor module should be turned "OFF," so normal voltage should be about 12 volts. If the module is turned "ON," the voltage would be low, but above 1 volt. This could cause the ignition coil to fail from excessive heat. With an open ignition coil primary winding, a small amount of voltage will leak through the module from the "batt" to the "tach" terminal.
11. Applying a voltage (1.35-1.50 volts) to the module terminal "P" should turn the module "ON" and the tach voltage should drop to about 7-9 volts. This test will determine whether the module or coil is faulty or if the pick-up coil is not generating the proper signal to turn the module "ON." This test can be performed by using a DC test battery with a rating of 1.5 volts (Such as AA, C, or D cell). The battery must be a known good battery with a voltage of over 1.35 volts.
12. This should turn the module "OFF" and cause a spark. If no spark occurs, the fault is most likely in the ignition coil because most module problems would have been found before this point in the procedure.

Chart A-7 - Distributor Ignition (DI) System Check

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostics" (OBD) System Check performed?	—	Go to Step 2	Go to *OBD System Check*
2	1. Check spark plug wires for open circuits, cracks in insulation, or improper seating of terminals at spark plugs, distributor cap, and coil tower before proceeding with this table. 2. Disconnect 2-wire boat harness (gray and purple wires). 3. Install a temporary jumper wire between the 2 purple wires at the connector of the boat harness. This is CKT 3 for the ignition circuit. 4. Check for secondary spark per manufactures recommendation. If there is "no spark" at one wire, check a few more wires. A few sparks and then nothing is considered "no spark." Is adequate spark present at all cylinders?	—	Refer to *Symptoms Section*	Go to Step 3
3	Remove distributor cap and verify rotation of distributor rotor. Is the distributor rotor turning?	—	Go to Step 4	Go to Step 25
4	1. Disconnect distributor 4-wire connector. 2. Check for secondary spark per manufactures recommendation. Is adequate spark present?	—	Go to Step 18	Go to Step 5
5	1. Reconnect distributor 4-wire connector. 2. Check for secondary spark per manufactures recommendation from the coil tower using a known good coil wire. Is adequate spark present?	—	Go to Step 19	Go to Step 6
6	1. Disconnect distributor 2-wire "C/+" connector harness. 2. Ignition "ON," engine "OFF." 3. Using DVOM J 39978 or equivalent, check voltage at "+" and "C" terminals of the 2-wire distributor harness connector. Is voltage reading greater than the specified value at both terminals?	10 volts	Go to Step 8	Go to Step 7
7	Is voltage reading less than the specified value at both terminals?	10 volts	Go to Step 20	Go to Step 21

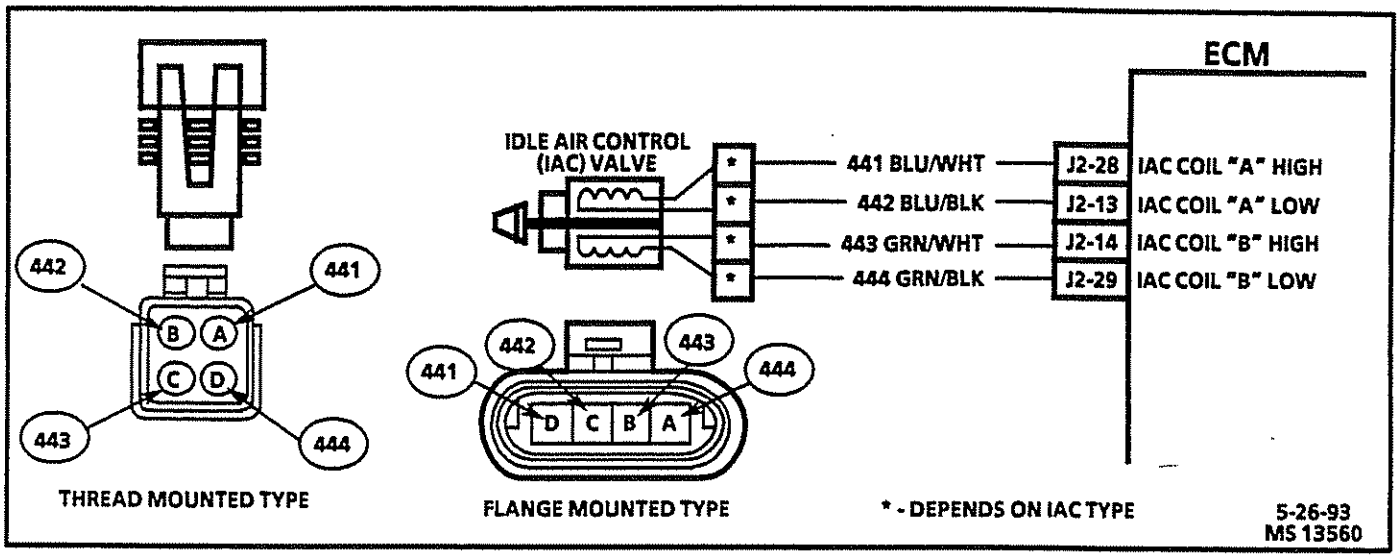
Chart A-7 - Distributor Ignition (DI) System Check (continued)

Step	Action	Value(s)	Yes	No
8	1. Reconnect distributor 2-wire connector. 2. Ignition "ON," engine "OFF." 3. Using DVOM J 39978 or equivalent, check voltage from tach terminal to ground. 4. The tach terminal can be accessed at the 2-wire boat connector. The tach circuit is the gray wire CKT 121. Is voltage reading within the specified value?	1-10 volts	Go to Step 15	Go to Step 9
9	Is voltage reading greater than the specified value?	10 volts	Go to Step 10	Go to Step 22
10	1. Using a test light connected to ground, probe tach terminal at the 2-wire boat harness. 2. Observe the test light while cranking engine. Is test light blinking?	—	Go to Step 13	Go to Step 11
11	1. Disconnect distributor 4-wire connector. 2. Remove distributor cap. 3. Disconnect pick-up coil connector from the distributor ignition control module. 4. Connect DVOM to tach terminal at the 2-wire boat harness and ground. 5. Ignition "ON," engine "OFF." 6. Connect positive (+) end of a known good 1.5 volt test battery to the "P" terminal on the distributor ignition control module. Observe the voltage at the tach terminal as the negative (-) end of the test battery is momentarily grounded to a known good ground. Does the voltage drop?	—	Go to Step 12	Go to Step 23
12	Check for spark from the coil wire as the test battery lead is removed? Is adequate spark present?	—	Go to Step 17	Go to Step 13
13	Replace ignition coil and recheck for spark as set up in steps 11 and 12. Is adequate spark present?	—	Go to OBD System Check	Go to Step 14
14	Ignition coil removed is OK. Reinstall coil and check coil wire from distributor cap. If OK, replace ignition module. Is action complete?	—	Go to *OBD System Check*	—
15	Replace ignition module and recheck for spark as set up in steps 11 and 12. Is adequate spark present?	—	Go to *OBD System Check*	Go to Step 16
16	Replace ignition coil, it too is faulty. Is action complete?	—	Go to *OBD System Check*	—
17	Is the rotating pole piece still magnetized?	—	Go to Step 18	Go to Step 24
18	Replace faulty pick-up coil. Is action complete?	—	Go to *OBD System Check*	—
19	Inspect distributor cap for water, cracks, etc. If OK, replace faulty distributor rotor. Is action complete?	—	Go to *OBD System Check*	—

Chart A-7 - Distributor Ignition (DI) System Check (continued)

Step	Action	Value(s)	Yes	No
20	Check for open or short to ground in CKT 3, the pink wire from the ignition module "+" terminal to the ignition coil. Also check for open CKT 902, the red wire from the MEFI relay to the ignition coil. Is action complete?	—	Go to *OBD System Check*	—
21	Check for open or short to ground in CKT 121, the brown wire from the ignition module "C" terminal to the ignition coil. If OK, replace faulty ignition coil. Is action complete?	—	Go to *OBD System Check*	—
22	Repair faulty connections or open tach lead. Repeat step 8.	—	—	—
23	Check ignition module ground. If OK, replace faulty ignition module. Is action complete?	—	Go to *OBD System Check*	—
24	Replace distributor pole piece and shaft assembly. Is action complete?	—	Go to *OBD System Check*	—
25	A mechanical repair will be necessary before continuing with this test.	—	—	—

Chart A-8 - Idle Air Control Functional Test



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.

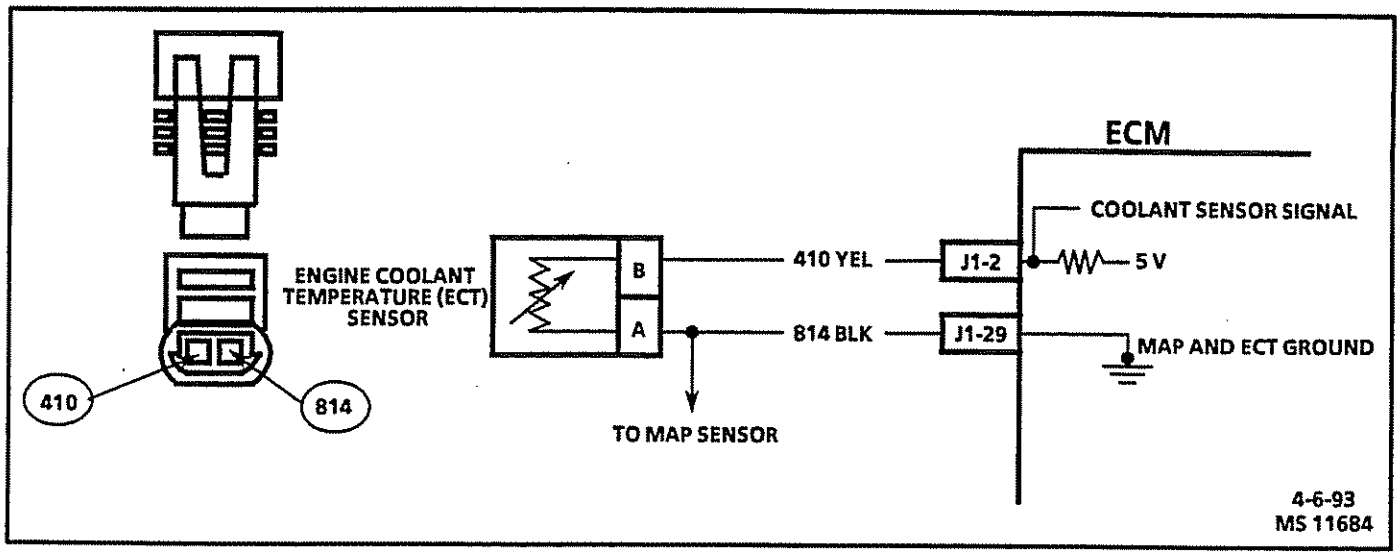
Test Description

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

Chart A-8 - Idle Air Control Functional Test

Step	Action	Value(s)	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 light connected to ground, probe each one of the four IAC harness terminals. Does the test light 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*	—

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 chart 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.

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 DTC 33 is also set, check for open ground CKT 814.

Engine Coolant Temperature Sensor Chart

°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

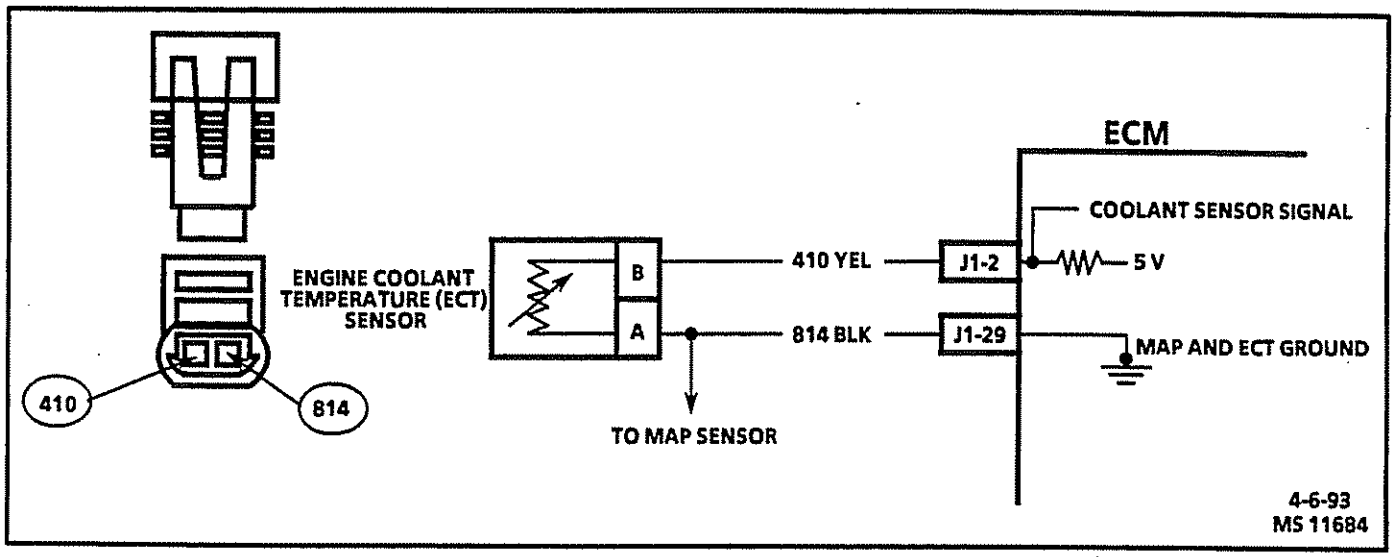
Test Description

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.

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

Step	Action	Value(s)	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	—

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 chart 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.

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.

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

Engine Coolant Temperature Sensor Chart

°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

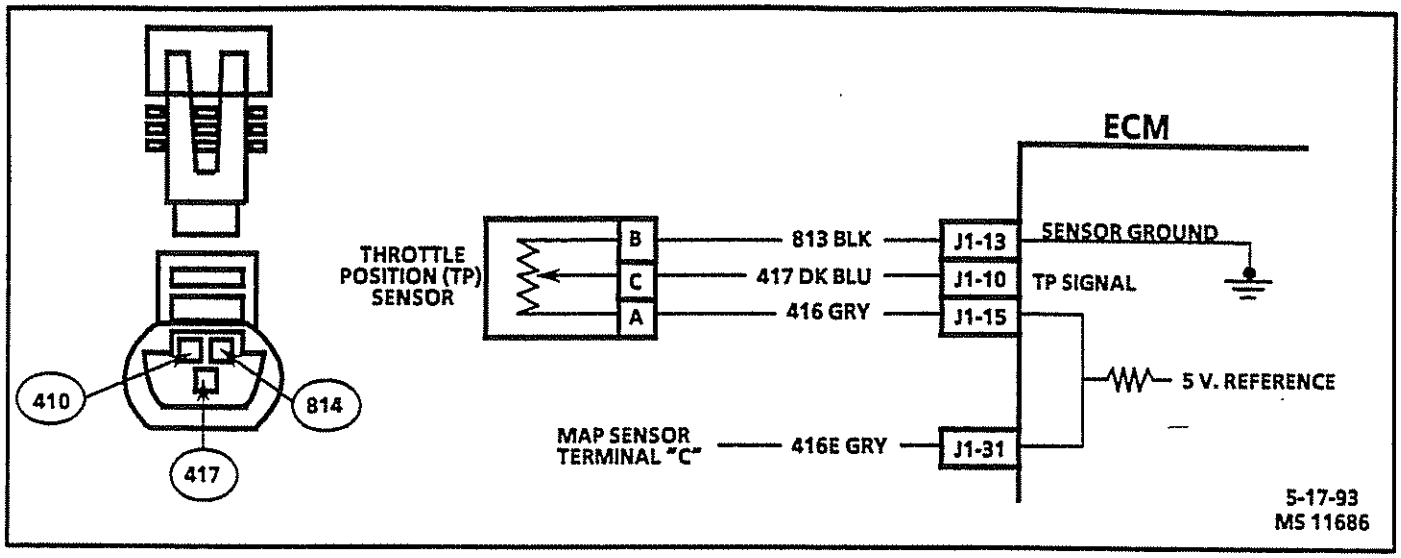
Test Description

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) either shorted to ground 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.

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

Step	Action	Value(s)	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. Remove DVOM. 2. Ignition "OFF." 3. Disconnect ECM harness connectors. 4. Using a test light connected to B+, probe ECT sensor harness terminal "B" (CKT 410). Does test light illuminate brightly?	—	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 CKT 410 shorted to CKT 814 or 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 ground in CKT 410. Is action complete?	—	Verify Repair	—
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

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.

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.

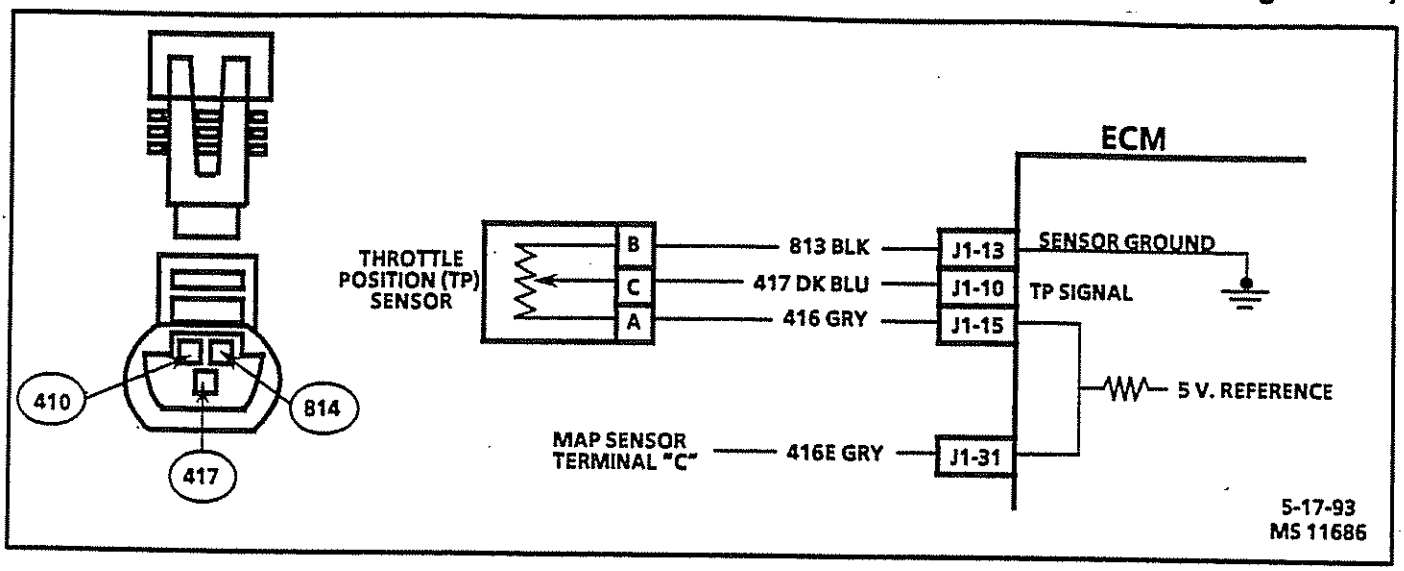
Test Description

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 417 is shorted to voltage.

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

Step	Action	Value(s)	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." 2. Ignition "OFF." 3. Disconnect TP sensor harness connector. 4. Start engine and idle for 2 minutes or until MDTC tool indicates a stored DTC. 5. Ignition "ON," engine "OFF." 6. Switch MDTC tool to "service mode" and note DTC. Is DTC 22 present?	—	Go to Step 4	Go to Step 3
3	1. Ignition "OFF." 2. Disconnect ECM harness connector "J1." 3. Ignition "ON," engine "OFF." 4. Using a test light connected to ground, probe harness connector "J1-10." Does test light illuminate brightly?	—	Go to Step 6	Go to Step 5
4	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. Is action complete?	—	Verify Repair	—
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

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.

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 DTC 34 is also set, check for a short to ground in CKT 416 or CKT 416E.

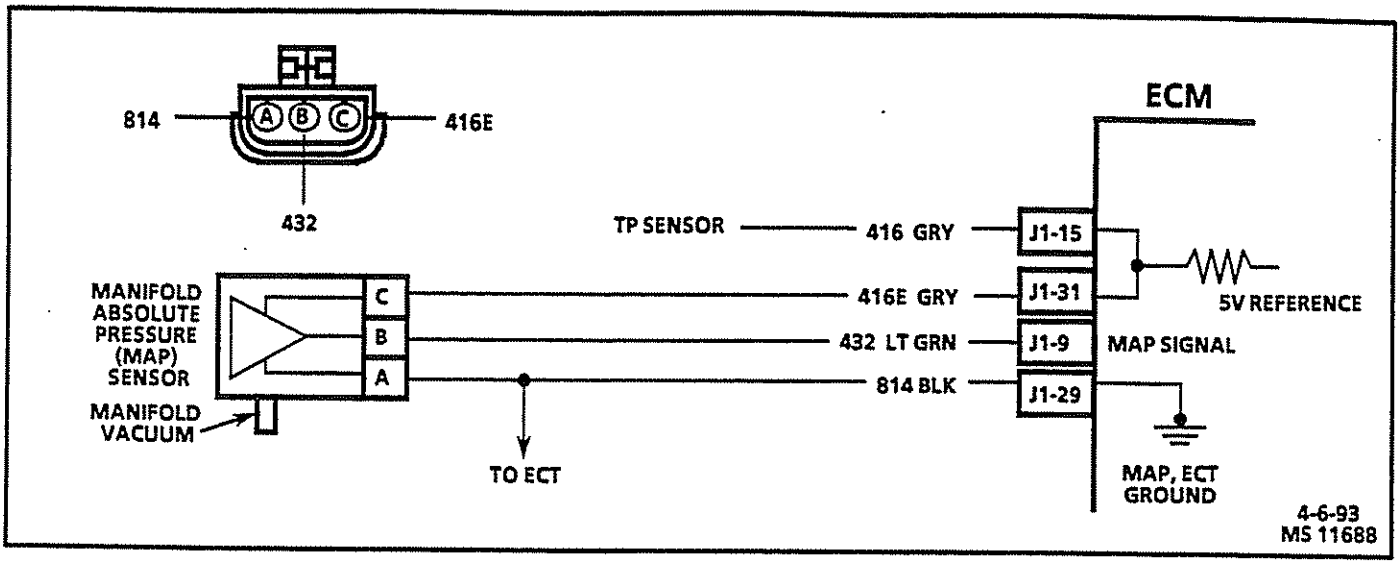
Test Description

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(s)	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." 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 MDTC tool indicates a stored DTC. 6. Ignition "ON," engine "OFF." 7. Switch MDTC tool to "service mode" 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	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	—

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.

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 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.

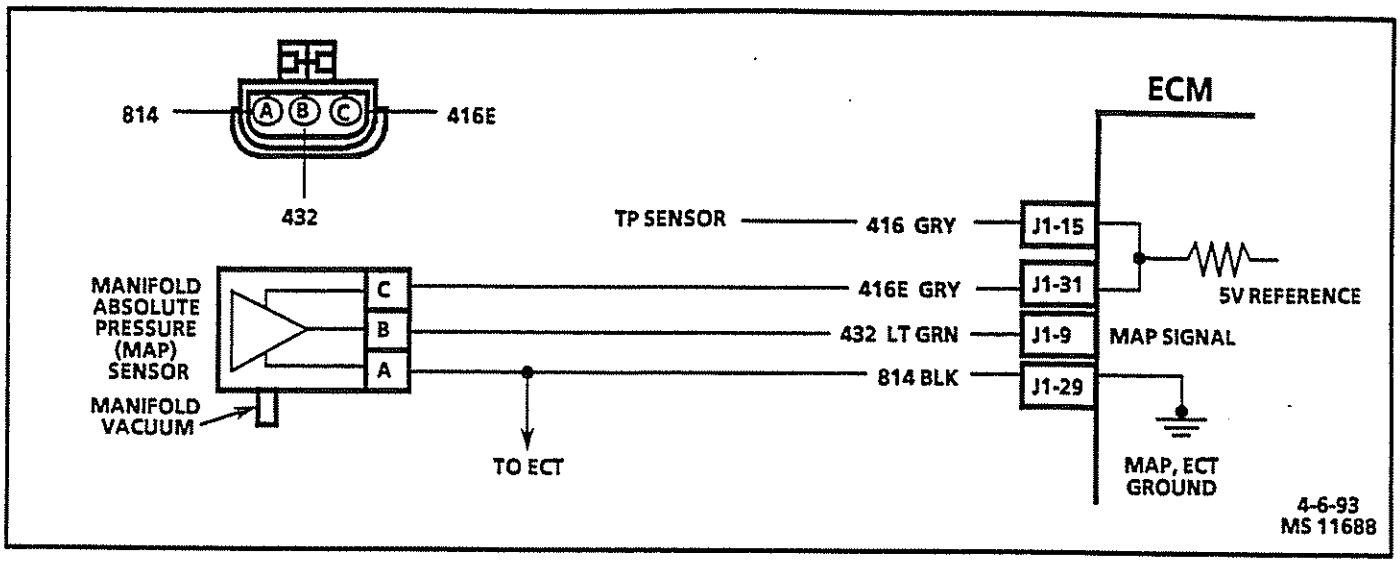
Test Description

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 432 is shorted to voltage.
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(s)	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 vacuum cap at throttle body and install a vacuum gauge where the cap was removed. 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 5
3	1. Marine Diagnostic Trouble Code (MDTC) tool switched to "normal mode." 2. Ignition "OFF." 3. Disconnect MAP sensor harness connector. 4. Start engine and idle for 2 minutes or until MDTC tool indicates a stored DTC. 5. Ignition "ON," engine "OFF." 6. Switch MDTC tool to "service mode" and note DTC. Is DTC 34 present?	—	Go to Step 6	Go to Step 4
4	1. Ignition "OFF." 2. Disconnect ECM harness connector "J1." 3. Ignition "ON," engine "OFF." 4. Using a test light connected to ground, probe harness connector "J1-9." Does test light illuminate brightly?	—	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. 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	—

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.

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 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.

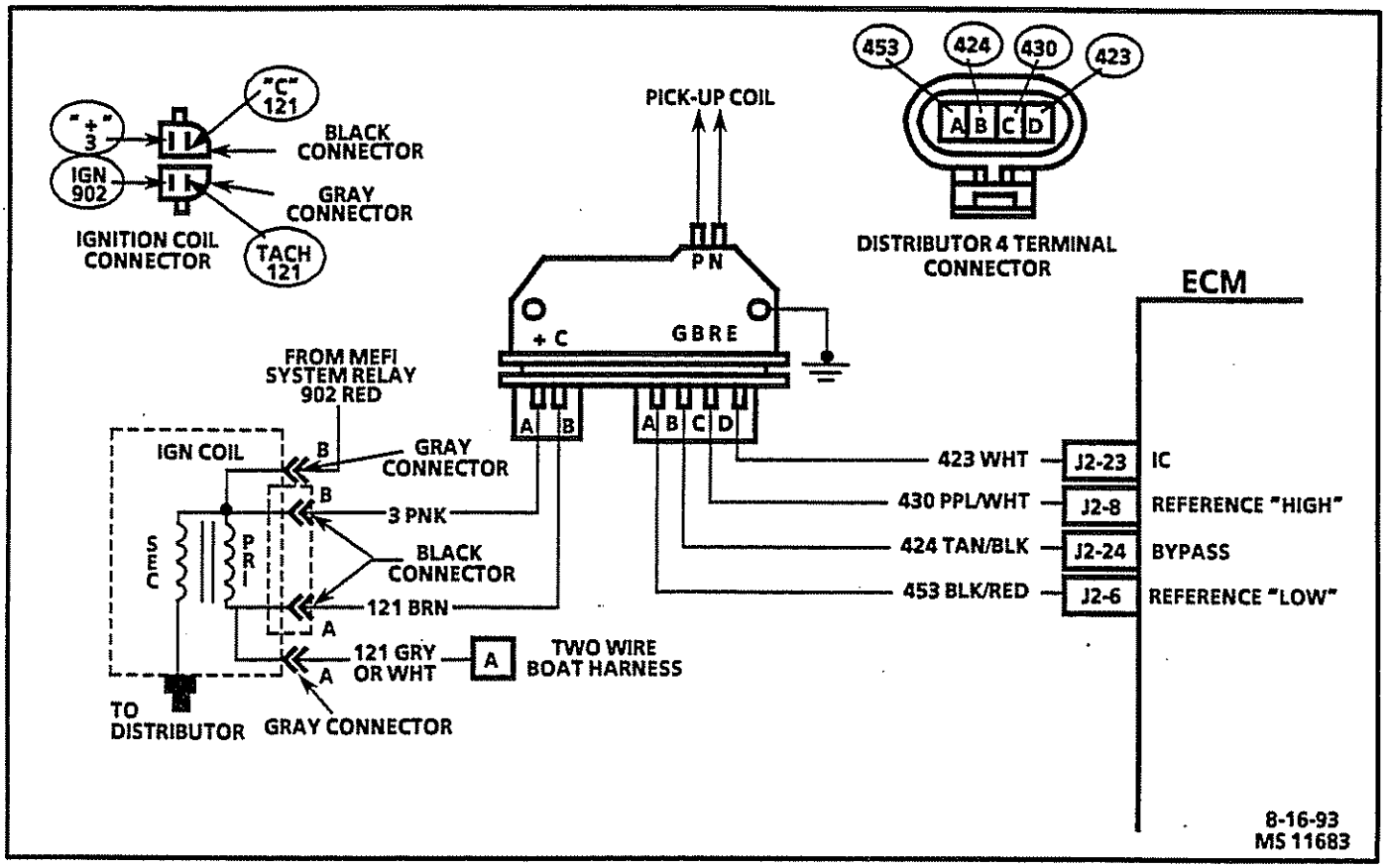
Test Description

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(s)	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." 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" 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	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	—

DTC 41 - Ignition Control (IC) Circuit - Open IC Circuit (Non-Scan Diagnostics)



Circuit Description

When the system is running in the ignition module, or crank mode, there is no voltage on the bypass line, and the Ignition Control (IC) module grounds the IC signal. The ECM expects to see no voltage on the IC line during this mode. If the ECM sees voltage, it sets a DTC 41 and will not go into the IC mode.

When the RPM for IC is reached (about 300 RPM), and bypass voltage is applied on CKT 424 by the ECM, the IC line, CKT 423, should no longer be grounded in the IC module. CKT 423 should have varying voltage on it at this point.

If the bypass line is open or shorted to ground, the IC module will not switch to IC mode. The IC line, CKT 423, voltage will be low and DTC 42 will be set.

If CKT 423 is grounded, the IC module will switch to IC mode but, because the line is grounded, there will be no IC signal and a DTC 42 will set.

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.

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 the engine starts and stalls, it may set a false DTC 41. Clear DTC's and repair stalling condition.

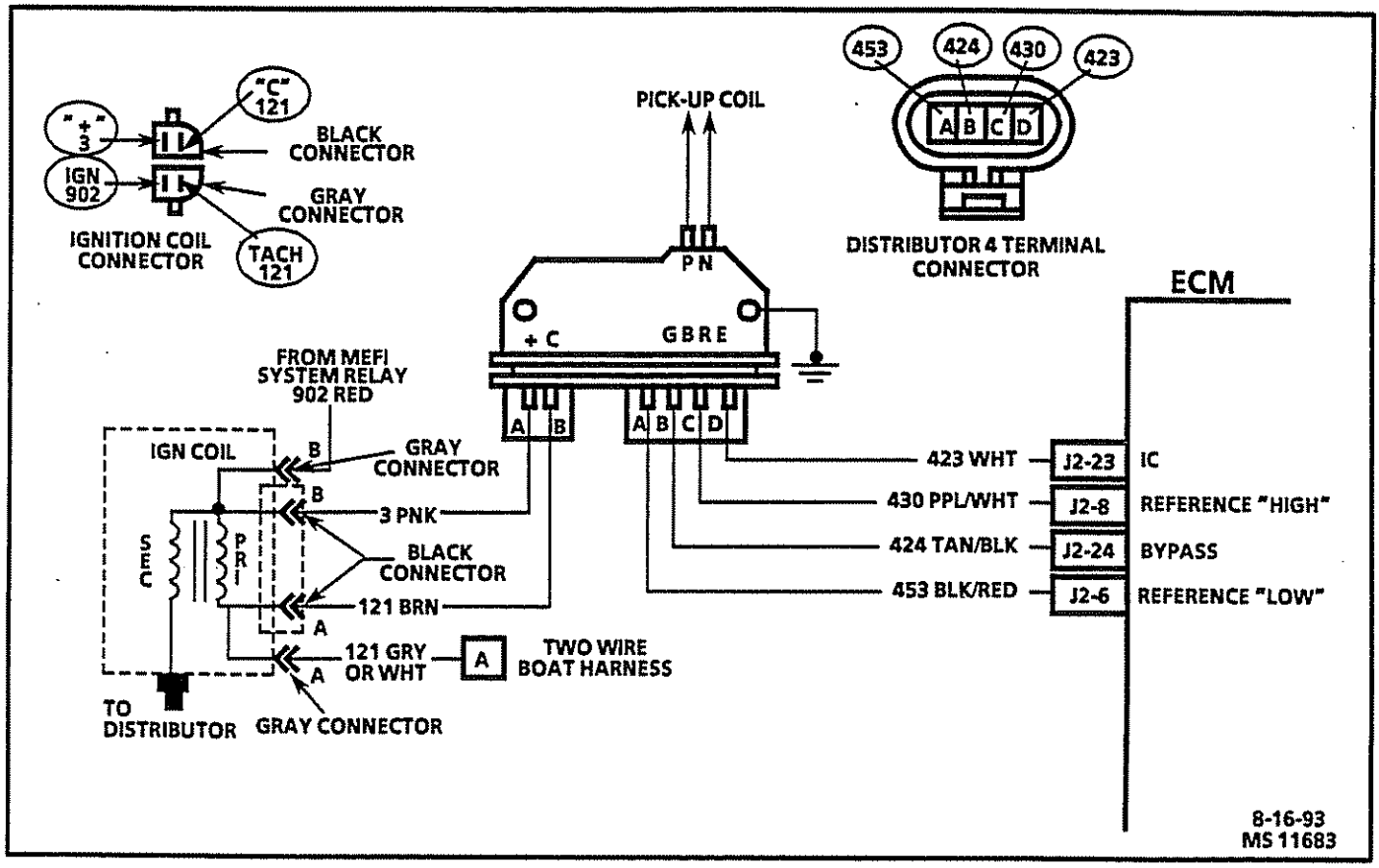
Test Description

2. DTC 41 means the ECM has seen an open in the IC circuit. This test confirms DTC 41 and that the fault causing the DTC is present.
3. Checks for a normal IC ground path through the Ignition Control (IC) module.
4. Confirms that DTC 41 is a faulty ECM and not an intermittent open in CKT 423.

DTC 41 - Ignition Control (IC) Circuit - Open IC Circuit (Non-Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to *OBD System Check*
2	1. Install Marine Diagnostic Trouble Code (MDTC) tool. 2. Clear DTC 41. Refer to "Clear DTC Procedure." 3. Start engine and idle for 2 minutes or until MDTC tool indicates a stored trouble code. 4. Ignition "ON," engine "OFF." 5. Switch MDTC tool to "service mode" and note DTC. Is DTC 41 present?	—	Go to Step 3	Go to Step 8
3	1. Ignition "OFF." 2. Disconnect ECM harness connectors. 3. Using a DVOM selected for ohms, probe ECM harness terminal "J2-23" to ground. Is resistance within the specified value?	3000-6000 ohms	Go to Step 4	Go to Step 5
4	1. Reconnect ECM. 2. Start engine and idle for 2 minutes or until MDTC tool indicates a stored trouble code. 3. Ignition "ON," engine "OFF." 4. Switch MDTC tool to "service mode" and note DTC. Is DTC 41 present?	—	Go to Step 7	Go to Step 8
5	Locate and repair open in CKT 423. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 6
6	Replace faulty distributor ignition module. Is action complete?	—	Verify Repair	—
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—
8	DTC 41 is intermittent. Refer to "Diagnostic Aids" on facing page. Check harness and connectors for an intermittent open in CKT 423.	—	—	—

DTC 42 - Ignition Control (IC) Circuit - Grounded IC Circuit, Open or Grounded Bypass (Non-Scan Diagnostics)



Circuit Description

When the system is running in the ignition module, or crank mode, there is no voltage on the bypass line, and the Ignition Control (IC) module grounds the IC signal. The ECM expects to see no voltage on the IC line during this mode. If the ECM sees voltage, it sets a DTC 41 and will not go into the IC mode.

When the RPM for IC is reached (about 300 RPM), and bypass voltage is applied on CKT 424 by the ECM, the IC line, CKT 423, should no longer be grounded in the IC module. CKT 423 should have varying voltage on it at this point.

If the bypass line is open or shorted to ground, the IC module will not switch to IC mode. The IC line, CKT 423, voltage will be low and DTC 42 will be set.

If CKT 423 is grounded, the IC module will switch to IC mode but, because the line is grounded, there will be no IC signal and a DTC 42 will set.

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.

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 the engine starts and stalls, it may set a false DTC 42. Clear DTC's and repair stalling condition.

Test Description

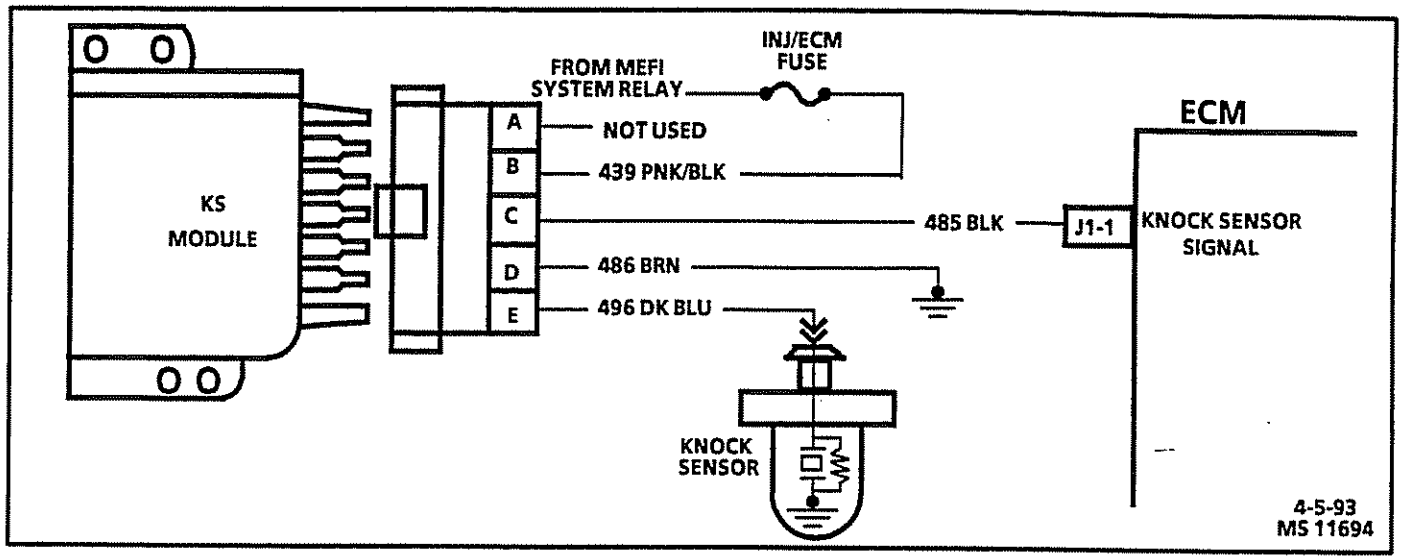
2. DTC 42 means the ECM has seen an open or short to ground in the bypass circuit, or a short to ground in the IC circuit. This test confirms a DTC 42 and that the fault causing the DTC is present.
3. Checks for a normal IC ground path through the Ignition Control (IC) module. An IC CKT 423 shorted to ground will also read less than 3000 ohms, however, this will be checked later.
4. As the test light voltage touches CKT 424, the module should switch , causing the DVOM reading to go from over 3000 ohms to under 1000 ohms. The important thing is that the module switched.

5. The module did not switch and this step checks for:
   - Bypass CKT 424 open.
   - Bypass CKT 424 shorted to ground.
   - Faulty ignition module.
7. Confirms that DTC 42 is a faulty ECM and not an intermittent in CKT 423 or CKT 424.

DTC 42 - Ignition Control (IC) Circuit - Grounded IC Circuit, Open or Grounded Bypass (Non-Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to *OBD System Check*
2	1. Install Marine Diagnostic Trouble Code (MDTC) tool. 2. Clear DTC 42. Refer to "Clear DTC Procedure." 3. Start engine and idle for 2 minutes or until MDTC tool indicates a stored trouble code. 4. Ignition "ON," engine "OFF." 5. Switch MDTC tool to "service mode" and note DTC. Is DTC 42 present?	—	Go to Step 3	Go to Step 13
3	1. Ignition "OFF." 2. Disconnect ECM harness connectors. 3. Using a DVOM selected for ohms, probe ECM harness terminal "J2-23" to ground. Is resistance within the specified value?	3000-6000 ohms	Go to Step 4	Go to Step 8
4	1. Leave DVOM connected from ECM harness terminal "J2-23" to ground. 2. Using a test light connected to B+, probe ECM harness terminal "J2-24." 3. As the test light contacts "J2-24," the resistance should switch from over 3000 ohms to under 1000 ohms. Does the resistance switch to under the specified value?	1000 ohms	Go to Step 7	Go to Step 5
5	Using a test light connected to B+, probe ECM harness terminal "J2-24" (CKT 424). Does test light illuminate brightly?	—	Go to Step 6	Go to Step 9
6	Disconnect ignition module 4-wire connector. Does test light illuminate brightly?	—	Go to Step 10	Go to Step 11
7	1. Reconnect ECM. 2. Start engine and idle for 2 minutes or until MDTC tool indicates a stored trouble code. Is DTC 42 present?	—	Go to Step 12	Go to Step 13
8	Locate and repair short to ground in CKT 423. 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 424. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 11
10	Locate and repair short to ground in CKT 424. Is action complete?	—	Verify Repair	—
11	Replace faulty ignition module. Is action complete?	—	Verify Repair	—
12	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—
13	DTC 42 is intermittent. Refer to "Diagnostic Aids" on facing page. Check harness and connectors for an intermittent open or short to ground in CKT 424, or an intermittent short to ground in CKT 423.	—	—	—

DTC 43 - Knock Sensor (KS) System - Continuous Knock Detected (Non-Scan Diagnostics)



Circuit Description

Knock Sensor (KS) system circuit is accomplished with a module that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage from the KS module to the ECM drops, and this signals the ECM to start retarding timing. The ECM will retard timing when knock is detected and RPM or engine coolant temperature is above a certain value.

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.

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 is routed too close to secondary ignition wires, the KS module may see the interference as a knock signal, resulting in false timing retard.

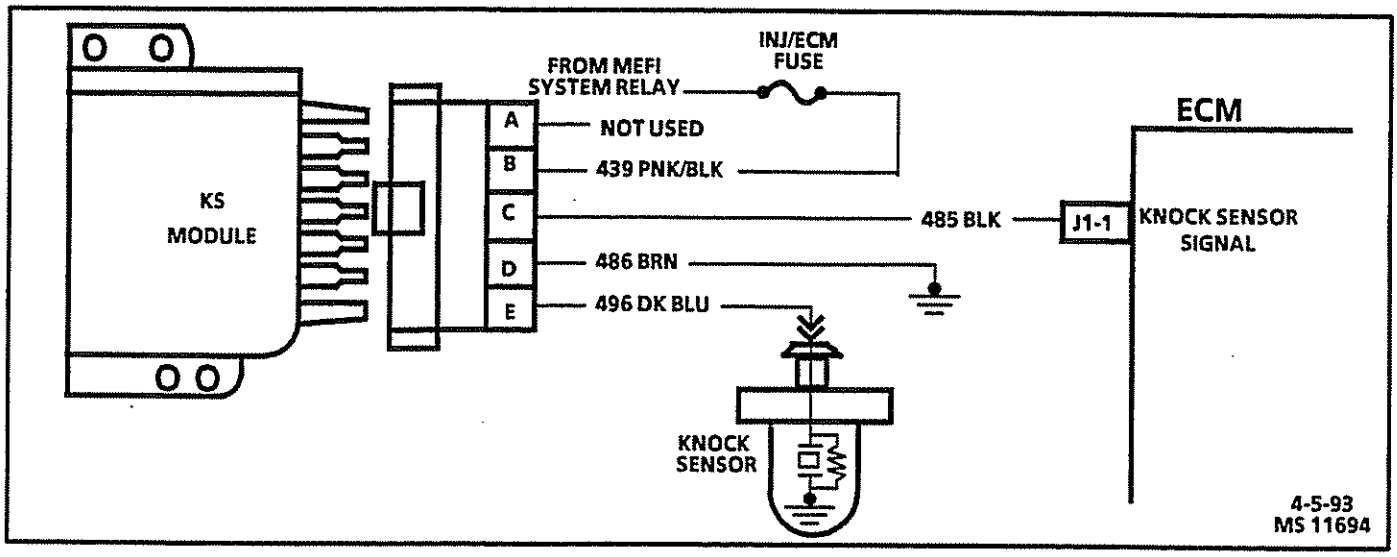
Notice: If there is abnormal mechanical engine noise (rattles or knocks), they may give a false DTC 43. If fuel octane is too low, a false DTC 43 may be set.

2. This step determines if ignition voltage is available to power up the KS module.
3. This step checks the ground circuit from the KS module. If the test light is dim, check ground CKT 486 for excessive resistance.
4. This step checks if a voltage signal from the KS module is present at the ECM.

DTC 43 - Knock Sensor (KS) System - Continuous Knock Detected (Non-Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to *OBD System Check*
2	1. Disconnect 5-wire Knock Sensor (KS) module harness connector. 2. Ignition "ON," engine "OFF." 3. Using a test light connected to ground, probe KS module harness terminal "B" (CKT 439). Does test light illuminate brightly?	—	Go to Step 3	Go to Step 5
3	Using a test light connected to B+, probe KS module harness terminal "D" (CKT 486). Does test light illuminate brightly?	—	Go to Step 4	Go to Step 6
4	1. Ignition "OFF." 2. Reconnect KS module harness connector. 3. Disconnect ECM "J1" connector. 4. Ignition "ON," engine "OFF." 5. Connect DVOM from ECM harness terminal "J1-1" (CKT 485) to a known good ground. Is the voltage within the specified value?	8-10 volts	Go to Step 9	Go to Step 7
5	Locate and repair open or short to ground in CKT 439. Is action complete?	—	Verify Repair	—
6	Locate and repair open in CKT 486. Is action complete?	—	Verify Repair	—
7	Locate and repair open or short to ground in CKT 485. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 8
8	Replace faulty KS module. Is action complete?	—	Verify Repair	—
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

DTC 44 - Knock Sensor (KS) System - No Knock Detected (Non-Scan Diagnostics)



Circuit Description

Knock Sensor (KS) system circuit is accomplished with a module that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage from the KS module to the ECM drops, and this signals the ECM to start retarding timing. The ECM will retard timing when knock is detected and RPM or engine coolant temperature is above a certain value.

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.

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.

Notice: Iif fuel octane is too high, a false DTC 44 may be set.

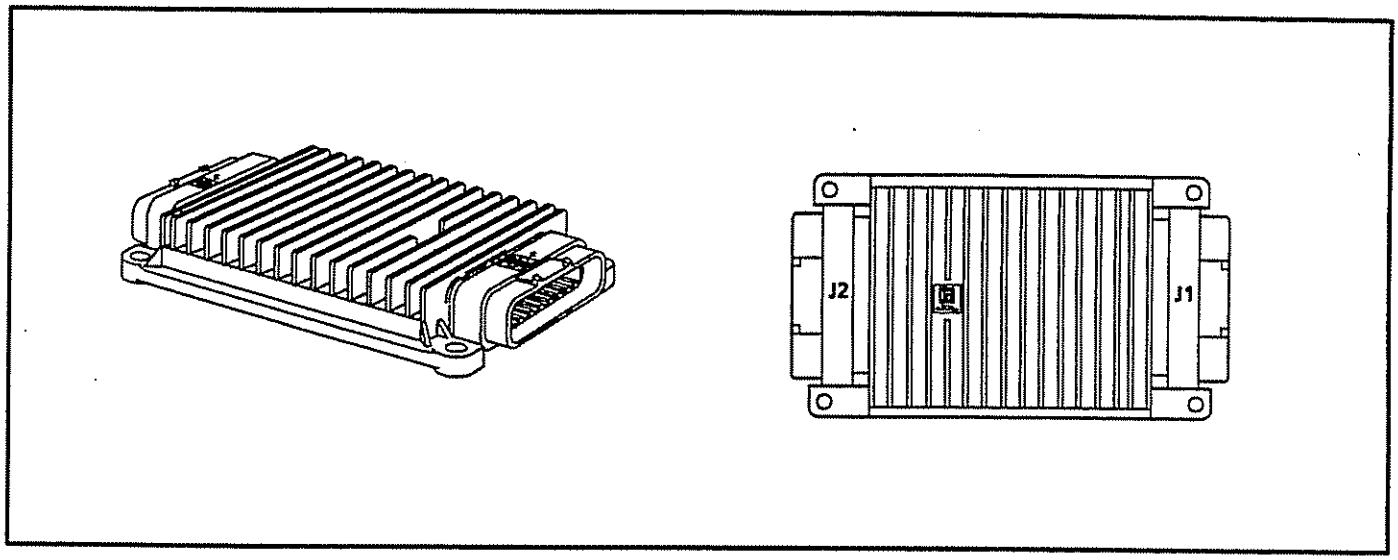
Test Description

2. This step ensures the knock sensor circuitry is within the proper resistance value.
3. Applying 12 volts with a test light to CKT 496 simulates a signal from the knock sensor. The knock sensor is faulty if a response occurs.
4. This step confirms the ability of the KS module to remove the voltage from the signal line when it detects spark knock. Since the knock sensor produces an AC voltage signal, it may be necessary to repeatedly touch (tickle) the harness connector with the test light to simulate this type of signal.
5. This step checks the ground circuit from the KS module. If the test light is dim, check ground CKT 486 for excessive resistance.
6. This step determines if CKT 485 is shorted to voltage or if the KS module is faulty.

DTC 44 - Knock Sensor (KS) System - No Knock Detected (Non-Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to *OBD System Check*
2	1. Disconnect 5-wire Knock Sensor (KS) module harness connector. 2. Connect DVOM from KS module harness terminal "E" (CKT 496) to a known good ground near knock sensor. Is resistance between the specified value?	3300-4500 ohms	Go to Step 3	Go to Step 7
3	1. Reconnect KS module harness connector. 2. Disconnect knock sensor harness connector. 3. Start engine. 4. Hold engine speed steady above 2500 RPM. 5. Using a test light connected to B+, repeatedly touch knock sensor harness terminal (CKT 496). Does a noticeable RPM drop occur, or using a timing light, does the timing retard?	—	Go to Step 8	Go to Step 4
4	1. Ignition "OFF." 2. Disconnect ECM "J1" connector. 3. Connect DVOM from ECM harness terminal "J1-1" (CKT 485) to a known good ground. Should see 8-10 volts. 4. Allow DVOM voltage to stabilize. 5. Using a test light connected to B+, repeatedly touch knock sensor harness terminal (CKT 496). Does the voltage value change?	—	Go to Step 13	Go to Step 5
5	1. Disconnect KS module 5-wire harness connector. 2. Using a test light connected to B+, probe KS module harness terminal "D" (CKT 486). Does test light illuminate brightly?	—	Go to Step 6	Go to Step 9
6	Using a test light connected to ground, probe KS module harness terminal "C" (CKT 485). Does test light illuminate brightly?	—	Go to Step 10	Go to Step 12
7	Locate and repair open or short to ground in CKT 496. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 11
8	Inspect knock sensor terminal contacts. Also check for abnormal mechanical engine noises. If OK, replace faulty knock sensor. Is action complete?	—	Verify Repair	—
9	Locate and repair open in ground CKT 486. Is action complete?	—	Verify Repair	—
10	Locate and repair short to voltage in CKT 485. Is action complete?	—	Verify Repair	—
11	Replace faulty knock sensor. Is action complete?	—	Verify Repair	—
12	Replace faulty KS module. Is action complete?	—	Verify Repair	—
13	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

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



PS 17655

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.

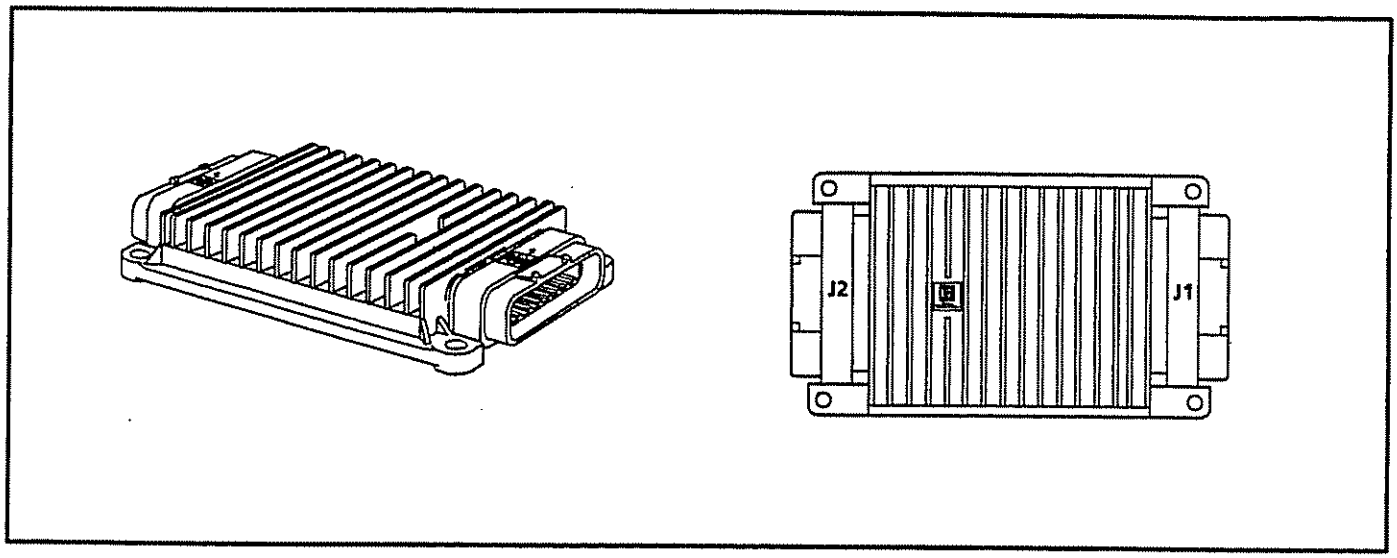
Test Description

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 Memory Failure (Non-Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to *OBD System Check*
2	1. Install Marine Diagnostic Trouble Code (MDTC) tool. 2. Using "Clear DTC Procedure," clear DTC 51. 3. Ignition "ON." 4. Switch MDTC tool to "service mode." 5. 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	—

DTC 52 - EEPROM Failure (Non-Scan Diagnostics)



PS 17655

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 52 failed more than once, but is intermittent, replace the ECM.

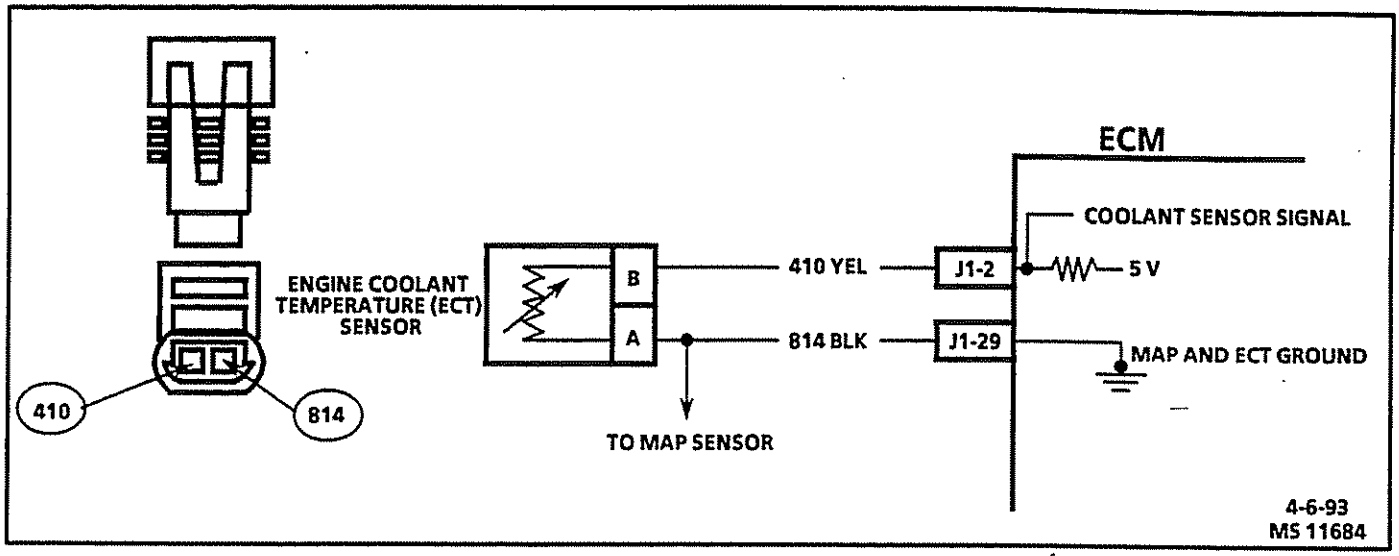
Test Description

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 52 - EEPROM Failure (Non-Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to *OBD System Check*
2	1. Install Marine Diagnostic Trouble Code (MDTC) tool. 2. Using "Clear DTC Procedure," clear DTC 52. 3. Ignition "ON." 4. Switch MDTC tool to "service mode." 5. Does DTC 52 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	—

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 chart 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.

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.

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.

Engine Coolant Temperature Sensor Chart

°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

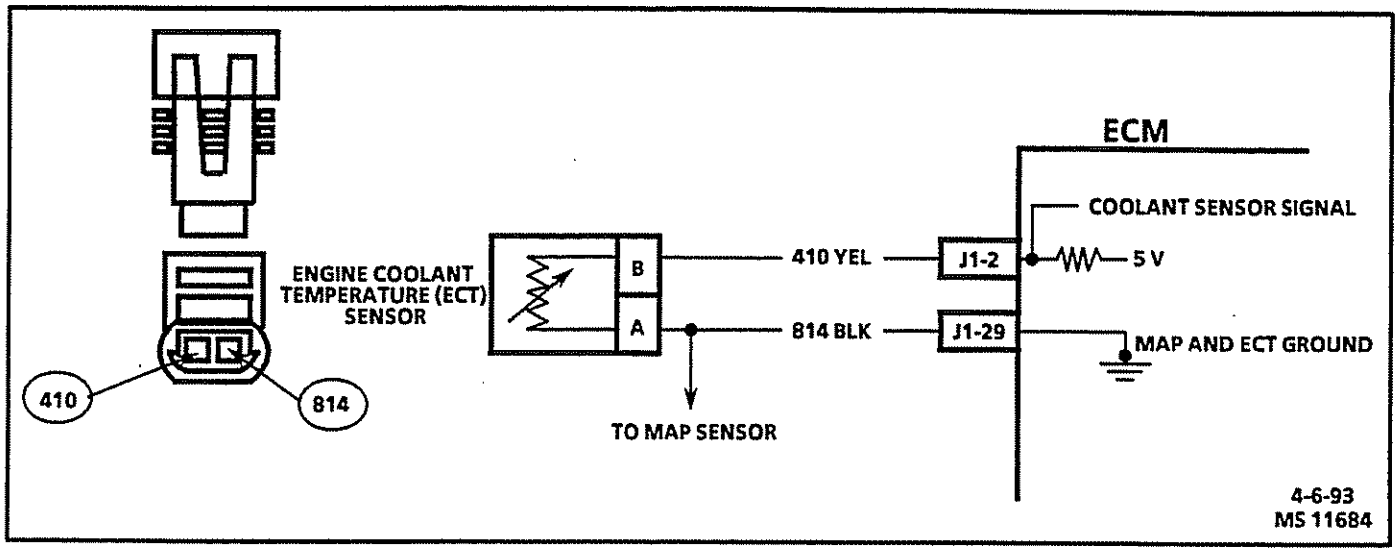
Test Description

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.

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

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to *OBD System Check*
2	Ignition "ON." 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. Ignition "OFF." 2. Disconnect ECT harness connector. 3. Connect a jumper wire from harness terminal "A" (CKT 814) to harness terminal "B" (CKT 410). 4. Ignition "ON," 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	—

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 chart 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.

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.

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.

Engine Coolant Temperature Sensor Chart

°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

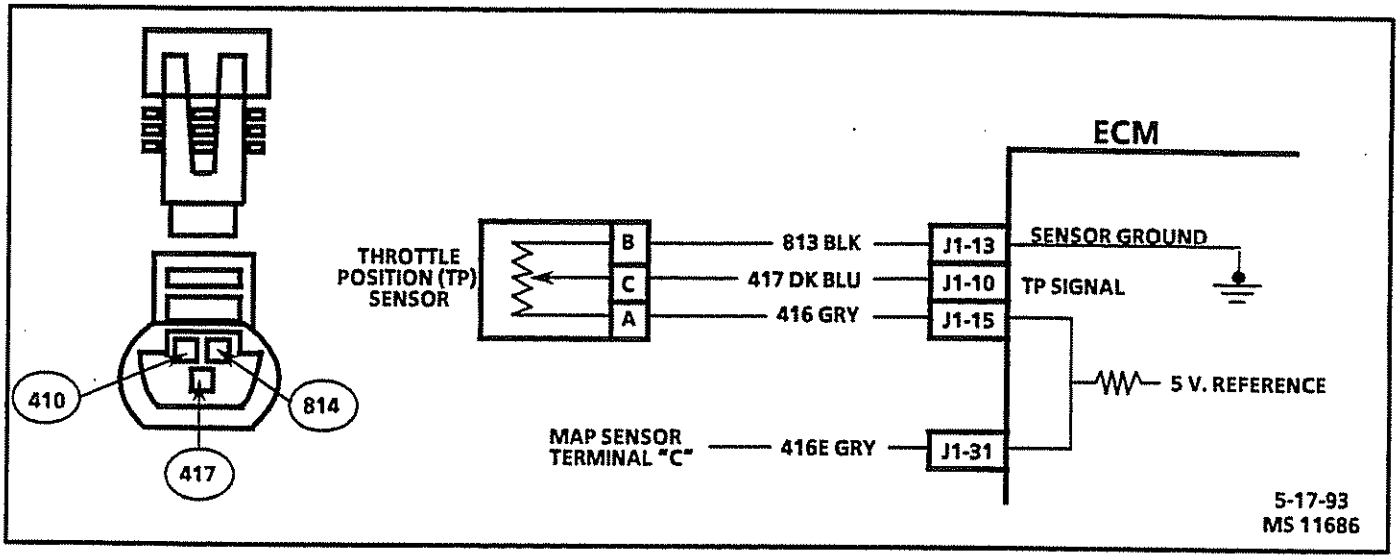
Test Description

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.

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

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to *OBD System Check*
2	Ignition "ON." 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. Ignition "OFF." 2. Disconnect ECT harness connector. 3. Ignition "ON," 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	—

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.

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.

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).

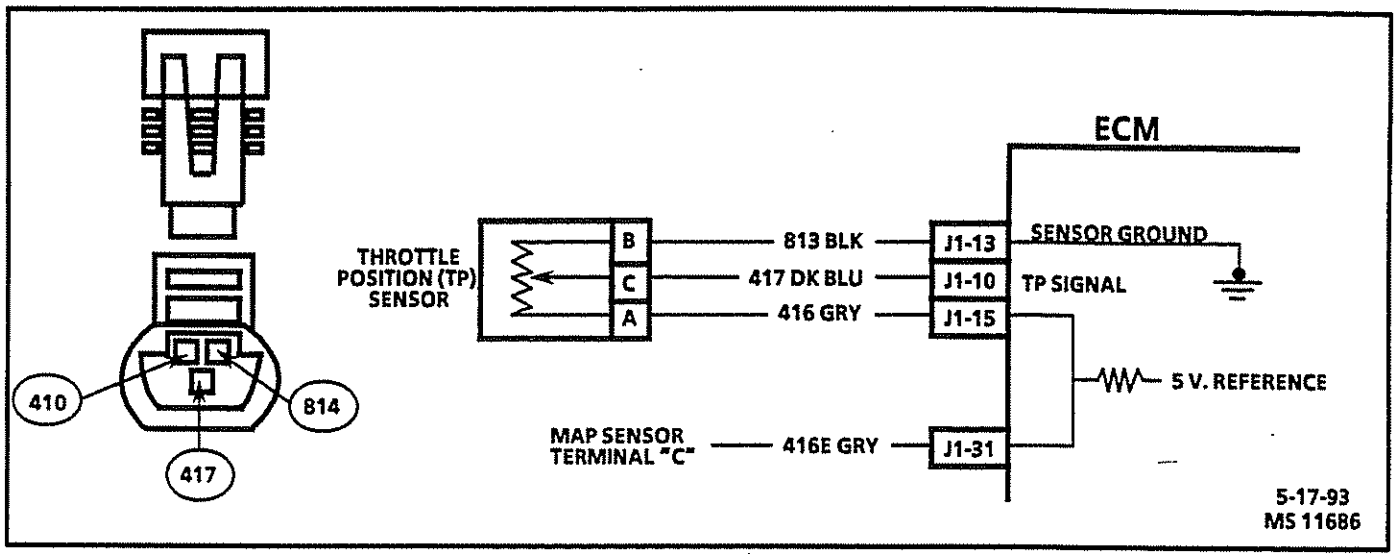
Test Description

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(s)	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. Ignition "ON," 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. Ignition "OFF." 2. Disconnect TP sensor harness connector. 3. Ignition "ON," engine "OFF." Does scan tool indicate TP sensor 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 scan tool indicate TP sensor voltage greater than the specified value?	4 volts	Go to Step 7	Go to Step 8
5	DTC 21 is intermittent. Locate and repair intermittent faulty connections. Refer to "Diagnostic Aids."	—	—	—
6	Locate and repair where CKT 417 is shorted to CKT 416 or CKT 416E. 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	—

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.

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.

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.

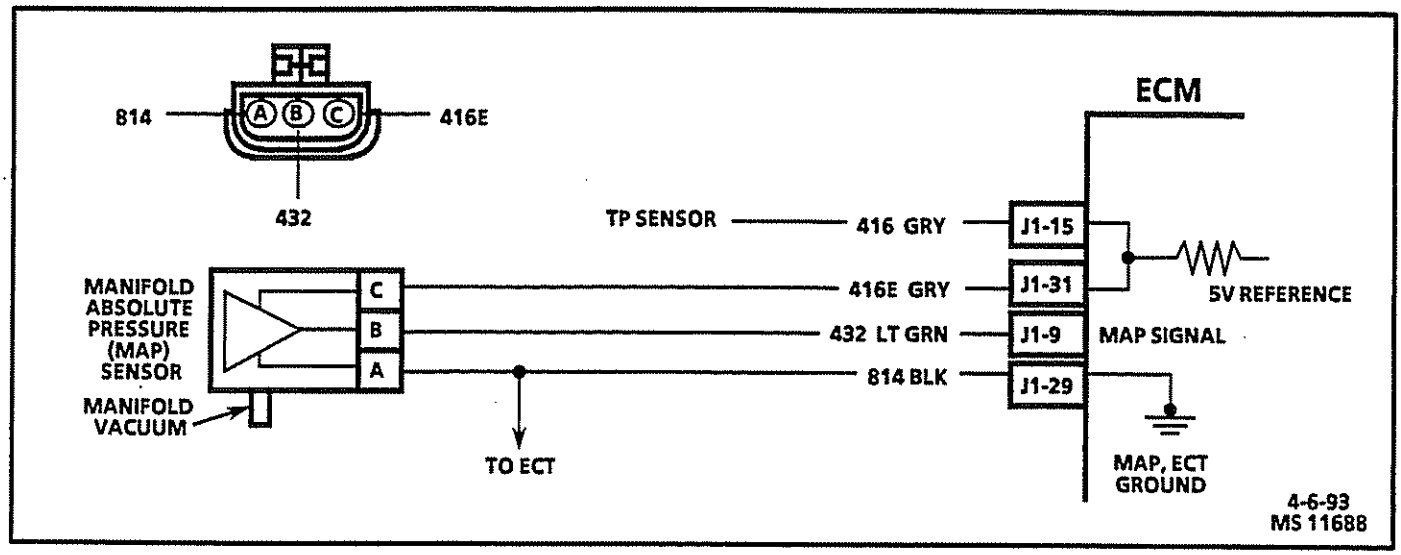
Test Description

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(s)	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. Ignition "ON," 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. 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. Ignition "ON," 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. Ignition "OFF." 2. Connect DVOM from harness terminal "A" (CKT 416) to a known good ground. Does scan tool indicate TP sensor 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	—

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.

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 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. 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.

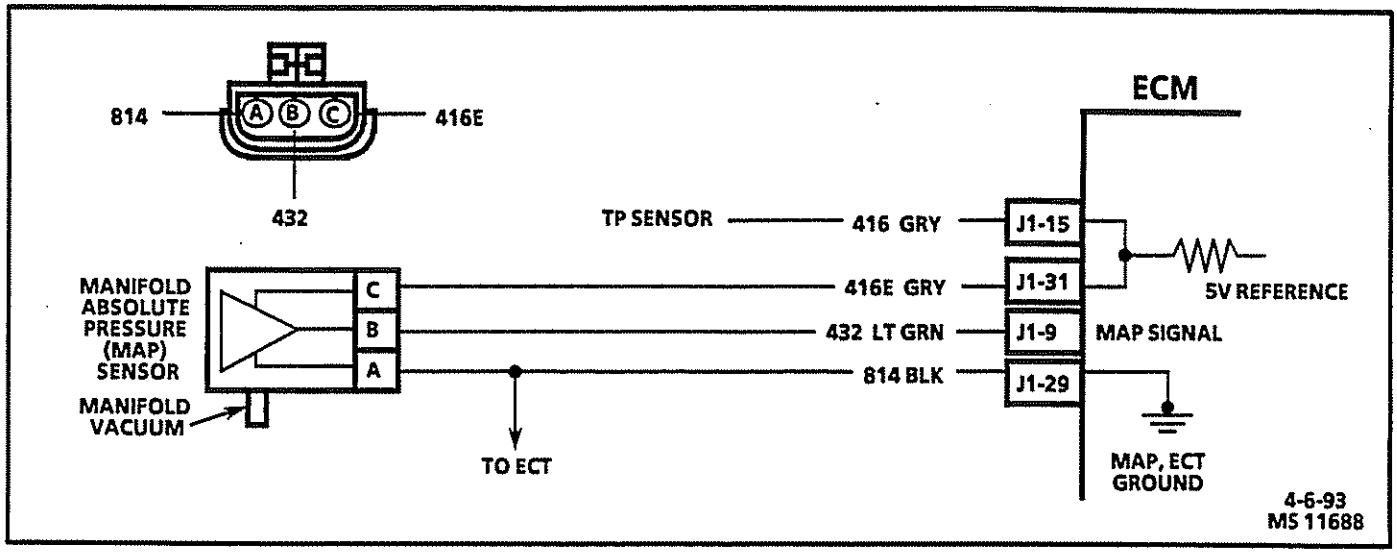
Test Description

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(s)	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 vacuum cap at throttle body and install a vacuum gauge where the cap was removed. 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	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. Ignition "OFF." 2. Disconnect MAP sensor harness connector. 3. Ignition "ON," 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. Ignition "OFF." 2. Connect DVOM from harness terminal "A" (CKT 814) to harness terminal "C" (CKT 416E). 3. Ignition "ON," engine "OFF." Does scan tool indicate MAP sensor 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	—

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.

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 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. 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.

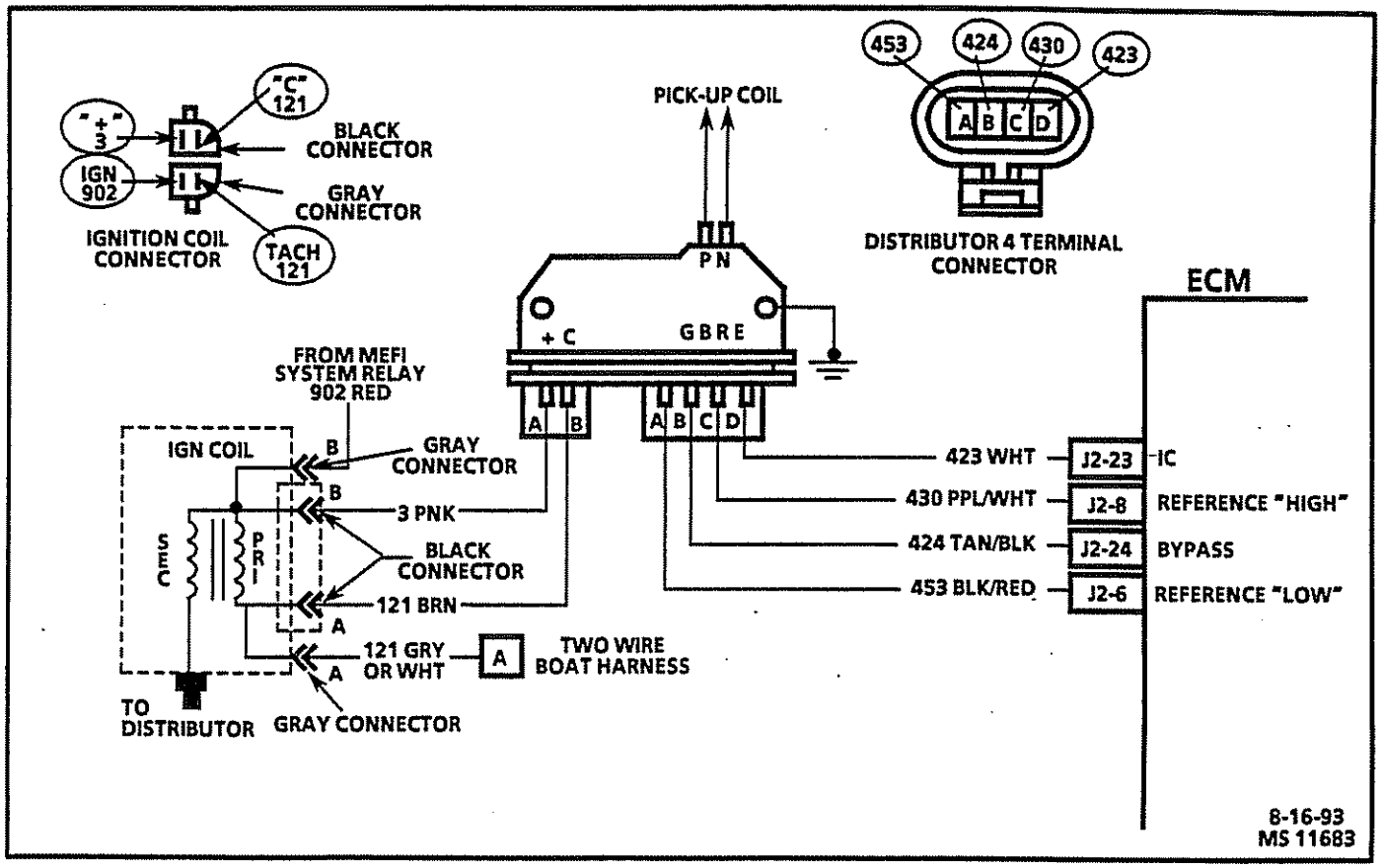
Test Description

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(s)	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 vacuum cap at throttle body and install a vacuum gauge where the cap was removed. 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	Allow 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. 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. Ignition "ON," 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. Ignition "OFF." 2. Connect DVOM from harness terminal "C" (CKT 416E) to a known good ground. 3. Ignition "ON," engine "OFF." Does scan tool indicate MAP sensor 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	—

DTC 41 - Ignition Control (IC) Circuit - Open IC Circuit (Scan Diagnostics)



Circuit Description

When the system is running in the ignition module, or crank mode, there is no voltage on the bypass line, and the Ignition Control (IC) module grounds the IC signal. The ECM expects to see no voltage on the IC line during this mode. If the ECM sees voltage, it sets a DTC 41 and will not go into the IC mode.

When the RPM for IC is reached (about 300 RPM), and bypass voltage is applied on CKT 424 by the ECM, the IC line, CKT 423, should no longer be grounded in the IC module. CKT 423 should have varying voltage on it at this point.

If the bypass line is open or shorted to ground, the IC module will not switch to IC mode. The IC line, CKT 423, voltage will be low and DTC 42 will be set.

If CKT 423 is grounded, the IC module will switch to IC mode but, because the line is grounded, there will be no IC signal and a DTC 42 will set.

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.

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 the engine starts and stalls, it may set a false DTC 41 or 42. Clear DTC's and repair stalling condition.

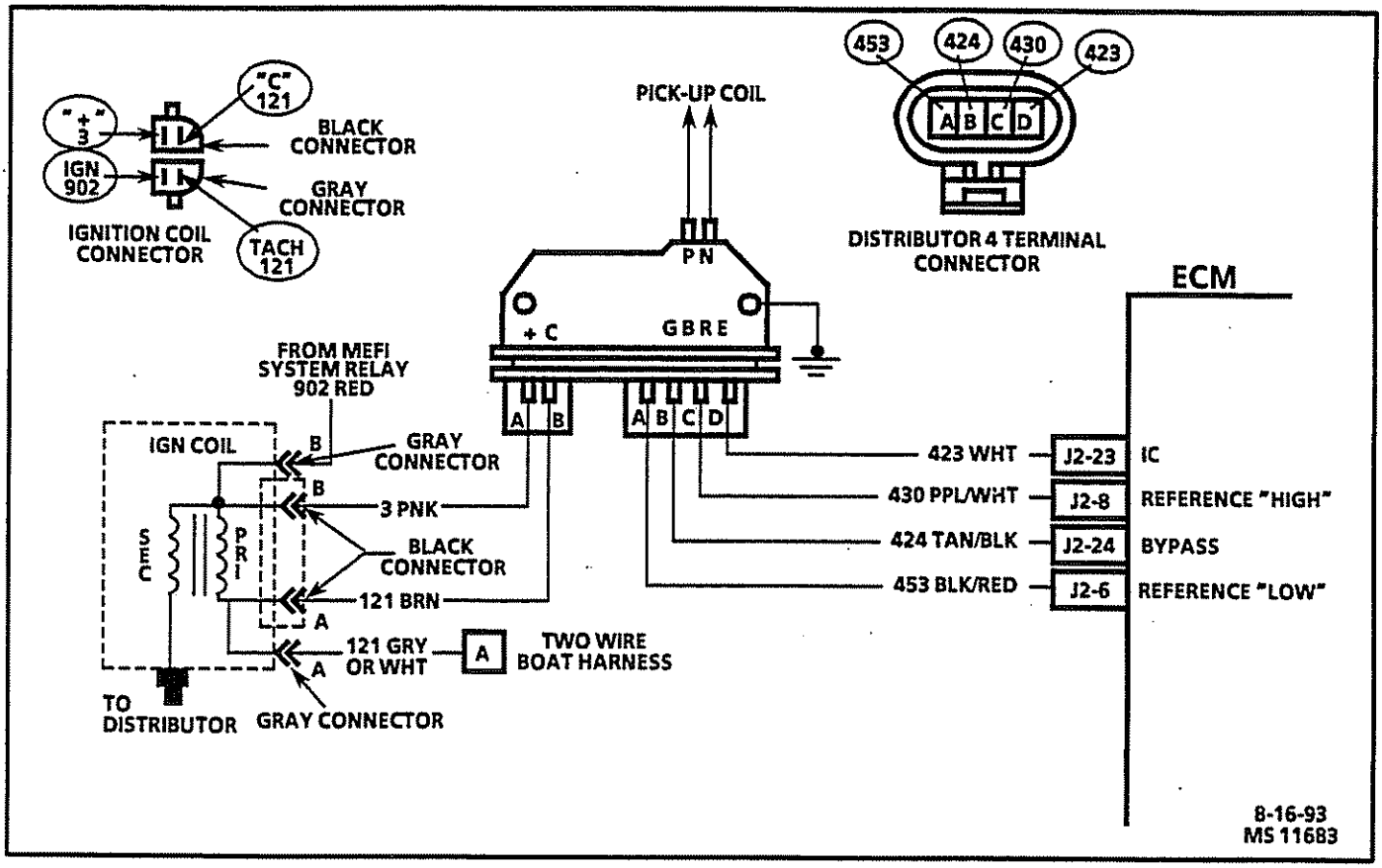
Test Description

2. DTC 41 means the ECM has seen an open in the IC circuit. This test confirms DTC 41 and that the fault causing the DTC is present.
3. Checks for a normal IC ground path through the Ignition Control (IC) module.
4. Confirms that DTC 41 is a faulty ECM and not an intermittent open in CKT 423.

DTC 41 - Ignition Control (IC) Circuit - Open IC Circuit (Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?		Go to Step 2	Go to *OBD System Check*
2	1. Clear DTC 41. Refer to "Clear DTC Procedure." 2. Start engine and idle for 2 minutes or until DTC 41 sets. Is DTC 41 present?	—	Go to Step 3	Go to Step 8
3	1. Ignition "OFF." 2. Disconnect ECM harness connectors. 3. Using a DVOM selected for ohms, probe ECM harness terminal "J2-23" to ground. Is resistance within the specified value?	3000-6000 ohms	Go to Step 4	Go to Step 5
4	1. Reconnect ECM. 2. Start engine and idle for 2 minutes or until DTC 41 sets Is DTC 41 present?	—	Go to Step 7	Go to Step 8
5	Locate and repair open in CKT 423. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 6
6	Replace faulty distributor ignition module. Is action complete?	—	Verify Repair	—
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—
8	DTC 41 is intermittent. Refer to "Diagnostic Aids" on facing page. Check harness and connectors for an intermittent open in CKT 423.	—	—	—

DTC 42 - Ignition Control (IC) Circuit - Grounded IC Circuit, Open or Grounded Bypass (Scan Diagnostics)



Circuit Description

When the system is running in the ignition module, or crank mode, there is no voltage on the bypass line, and the Ignition Control (IC) module grounds the IC signal. The ECM expects to see no voltage on the IC line during this mode. If the ECM sees voltage, it sets a DTC 41 and will not go into the IC mode.

When the RPM for IC is reached (about 300 RPM), and bypass voltage is applied on CKT 424 by the ECM, the IC line, CKT 423, should no longer be grounded in the IC module. CKT 423 should have varying voltage on it at this point.

If the bypass line is open or shorted to ground, the IC module will not switch to IC mode. The IC line, CKT 423, voltage will be low and DTC 42 will be set.

If CKT 423 is grounded, the IC module will switch to IC mode but, because the line is grounded, there will be no IC signal and a DTC 42 will set.

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.

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 the engine starts and stalls, it may set a false DTC 41 or 42. Clear DTC's and repair stalling condition.

Test Description

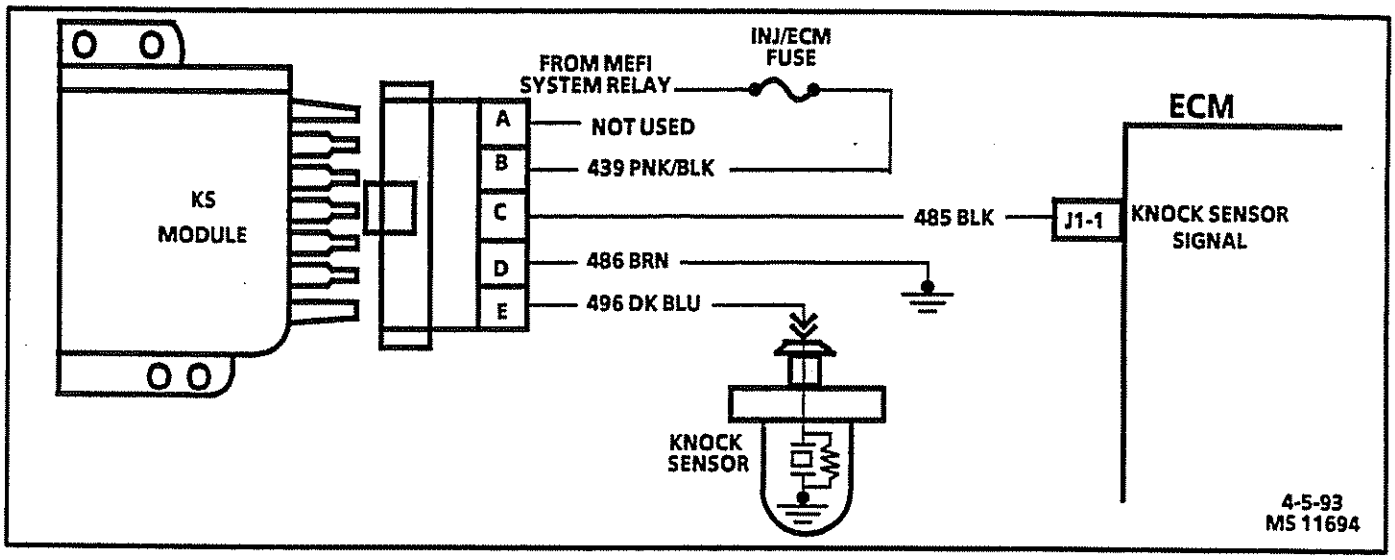
2. DTC 42 means the ECM has seen an open or short to ground in the bypass circuit, or a short to ground in the IC circuit. This test confirms a DTC 42 and that the fault causing the DTC is present.
3. Checks for a normal IC ground path through the Ignition Control (IC) module. An IC CKT 423 shorted to ground will also read less than 3000 ohms, however, this will be checked later.
4. As the test light voltage touches CKT 424, the module should switch , causing the DVOM reading to go from over 3000 ohms to under 1000 ohms. The important thing is that the module switched.

5. The module did not switch and this step checks for:
   - Bypass CKT 424 open.
   - Bypass CKT 424 shorted to ground.
   - Faulty ignition module.
7. Confirms that DTC 42 is a faulty ECM and not an intermittent in CKT 423 or CKT 424.

DTC 42 - Ignition Control (IC) Circuit - Grounded IC Circuit, Open or Grounded Bypass (Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?		Go to Step 2	Go to *OBD System Check*
2	1. Clear DTC 42. Refer to "Clear DTC Procedure." 2. Start engine and idle for 2 minutes or until DTC 42 sets. Is DTC 42 present?	—	Go to Step 3	Go to Step 13
3	1. Ignition "OFF." 2. Disconnect ECM harness connectors. 3. Using a DVOM selected for ohms, probe ECM harness terminal "J2-23" to ground. Is resistance within the specified value?	3000-6000 ohms	Go to Step 4	Go to Step 8
4	1. Leave DVOM connected from ECM harness terminal "J2-23" to ground. 2. Using a test light connected to B+, probe ECM harness terminal "J2-24." 3. As the test light contacts "J2-24," the resistance should switch from over 3000 ohms to under 1000 ohms. Does the resistance switch to under the specified value?	1000 ohms	Go to Step 7	Go to Step 5
5	Using a test light connected to B+, probe ECM harness terminal "J2-24" (CKT 424). Does test light illuminate brightly?	—	Go to Step 6	Go to Step 9
6	Disconnect ignition module 4-wire connector. Does test light illuminate brightly?	—	Go to Step 10	Go to Step 11
7	1. Reconnect ECM. 2. Start engine and idle for 2 minutes or until DTC 42 sets. Is DTC 42 present?	—	Go to Step 12	Go to Step 13
8	Locate and repair short to ground in CKT 423. 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 424. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 11
10	Locate and repair short to ground in CKT 424. Is action complete?	—	Verify Repair	—
11	Replace faulty ignition module. Is action complete?	—	Verify Repair	—
12	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—
13	DTC 42 is intermittent. Refer to "Diagnostic Aids" on facing page. Check harness and connectors for an intermittent open or short to ground in CKT 424, or an intermittent short to ground in CKT 423.	—	—	—

DTC 43 - Knock Sensor (KS) System - Continuous Knock Detected (Scan Diagnostics)



Circuit Description

Knock Sensor (KS) system circuit is accomplished with a module that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage from the KS module to the ECM drops, and this signals the ECM to start retarding timing. The ECM will retard timing when knock is detected and RPM or engine coolant temperature is above a certain value.

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.

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 is routed too close to secondary ignition wires, the KS module may see the interference as a knock signal, resulting in false timing retard.

Notice: If there is abnormal mechanical engine noise (rattles or knocks), they may give a false DTC 43. If fuel octane is too low, a false DTC 43 may be set.

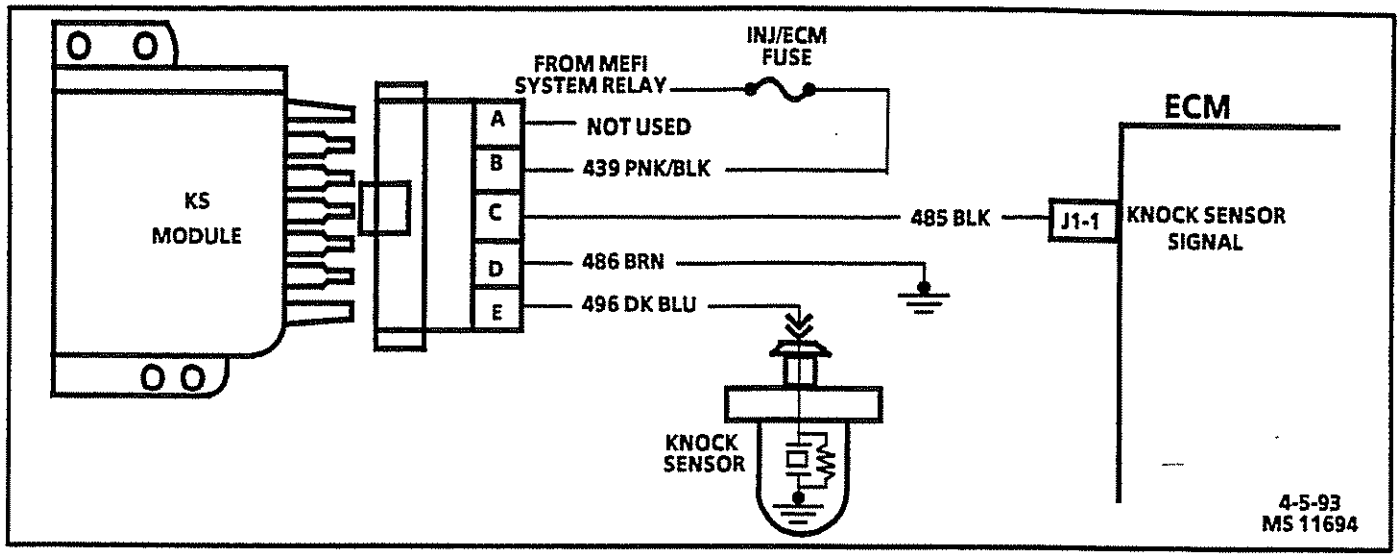
Test Description

2. This step determines if ignition voltage is available to power up the KS module.
3. This step checks the ground circuit from the KS module. If the test light is dim, check ground CKT 486 for excessive resistance.
4. This step checks if a voltage signal from the KS module is present at the ECM.

DTC 43 - Knock Sensor (KS) System - Continuous Knock Detected (Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to *OBD System Check*
2	1. Disconnect 5-wire Knock Sensor (KS) module harness connector. 2. Ignition "ON," engine "OFF." 3. Using a test light connected to ground, probe KS module harness terminal "B" (CKT 439). Does test light illuminate brightly?	—	Go to Step 3	Go to Step 5
3	Using a test light connected to B+, probe KS module harness terminal "D" (CKT 486). Does test light illuminate brightly?	—	Go to Step 4	Go to Step 6
4	1. Ignition "OFF." 2. Reconnect KS module harness connector. 3. Disconnect ECM "J1" connector. 4. Ignition "ON," engine "OFF." 5. Connect DVOM from ECM harness terminal "J1-1" (CKT 485) to a known good ground. Is the voltage within the specified value?	8-10 volts	Go to Step 9	Go to Step 7
5	Locate and repair open or short to ground in CKT 439. Is action complete?	—	Verify Repair	—
6	Locate and repair open in CKT 486. Is action complete?	—	Verify Repair	—
7	Locate and repair open or short to ground in CKT 485. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 8
8	Replace faulty KS module. Is action complete?	—	Verify Repair	—
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

DTC 44 - Knock Sensor (KS) System - No Knock Detected (Scan Diagnostics)



Circuit Description

Knock Sensor (KS) system circuit is accomplished with a module that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage from the KS module to the ECM drops, and this signals the ECM to start retarding timing. The ECM will retard timing when knock is detected and RPM or engine coolant temperature is above a certain value.

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.

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.

Notice: If fuel octane is too high, a false DTC 44 may be set.

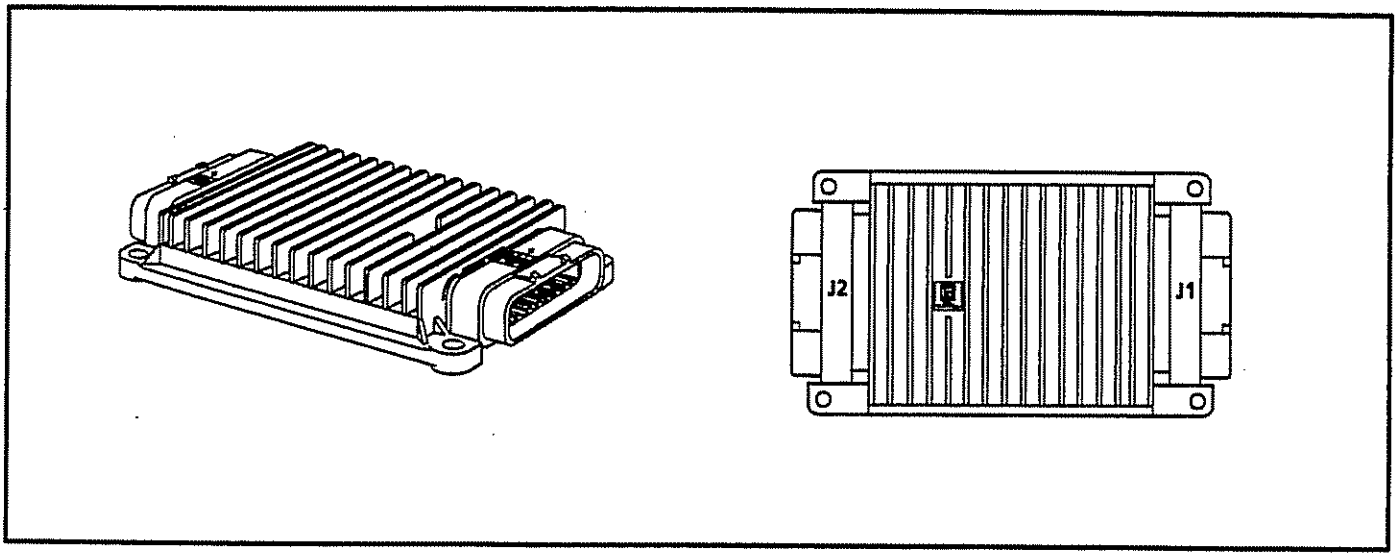
Test Description

2. This step ensures the knock sensor circuitry is within the proper resistance value.
3. Applying 12 volts with a test light to CKT 496 simulates a signal from the knock sensor. The knock sensor is faulty if a response occurs.
4. This step confirms the ability of the KS module to remove the voltage from the signal line when it detects spark knock. Since the knock sensor produces an AC voltage signal, it may be necessary to repeatedly touch (tickle) the harness connector with the test light to simulate this type of signal.
5. This step checks the ground circuit from the KS module. If the test light is dim, check ground CKT 486 for excessive resistance.
6. This step determines if CKT 485 is shorted to voltage or if the KS module is faulty.

DTC 44 - Knock Sensor (KS) System - No Knock Detected (Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to *OBD System Check*
2	1. Disconnect 5-wire Knock Sensor (KS) module harness connector. 2. Connect DVOM from KS module harness terminal "E" (CKT 496) to a known good ground near knock sensor. Is resistance between the specified value?	3300-4500 ohms	Go to Step 3	Go to Step 7
3	1. Reconnect KS module harness connector. 2. Disconnect knock sensor harness connector. 3. Start engine. 4. Hold engine speed steady above 2500 RPM. 5. Using a test light connected to B+, repeatedly touch knock sensor harness terminal (CKT 496). Does a noticeable RPM drop occur, or using a timing light, does the timing retard?	—	Go to Step 8	Go to Step 4
4	1. Ignition "OFF." 2. Disconnect ECM "J1" connector. 3. Connect DVOM from ECM harness terminal "J1-1" (CKT 485) to a known good ground. Should see 8-10 volts. 4. Allow DVOM voltage to stabilize. 5. Using a test light connected to B+, repeatedly touch knock sensor harness terminal (CKT 496). Does the voltage value change?	—	Go to Step 13	Go to Step 5
5	1. Disconnect KS module 5-wire harness connector. 2. Using a test light connected to B+, probe KS module harness terminal "D" (CKT 486). Does test light illuminate brightly?	—	Go to Step 6	Go to Step 9
6	Using a test light connected to ground, probe KS module harness terminal "C" (CKT 485). Does test light illuminate brightly?	—	Go to Step 10	Go to Step 12
7	Locate and repair open or short to ground in CKT 496. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 11
8	Inspect knock sensor terminal contacts. Also check for abnormal mechanical engine noises. If OK, replace faulty knock sensor. Is action complete?	—	Verify Repair	—
9	Locate and repair open in ground CKT 486. Is action complete?	—	Verify Repair	—
10	Locate and repair short to voltage in CKT 485. Is action complete?	—	Verify Repair	—
11	Replace faulty knock sensor. Is action complete?	—	Verify Repair	—
12	Replace faulty KS module. Is action complete?	—	Verify Repair	—
13	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

DTC 51 - Calibration Memory Failure (Scan Diagnostics)



PS 17655

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.

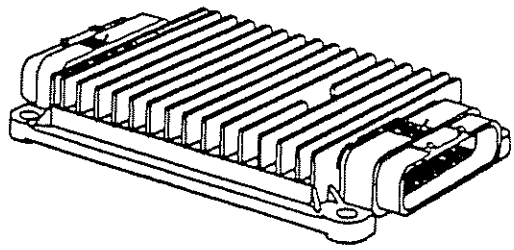
Test Description

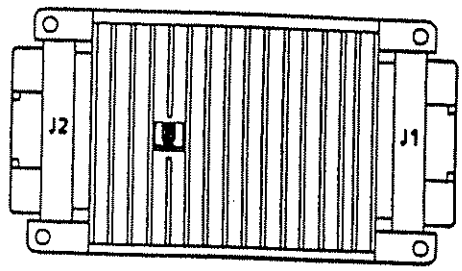
2. This step checks to see if the fault is present during diagnosis. If present, the ECM is not functioning properly and must be replaced or reprogrammed.

DTC 51 - Calibration Memory Failure (Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to *OBD System Check*
2	1. Install Marine Diagnostic Trouble Code (MDTC) tool. 2. Using "Clear DTC Procedure," clear DTC 51. 3. Ignition "ON." 4. Switch MDTC tool to "service mode." 5. 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	—

DTC 52 - EEPROM Failure (Scan Diagnostics)





PS 17655

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 52 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 52 - EEPROM Failure (Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to *OBD System Check*
2	1. Install Marine Diagnostic Trouble Code (MDTC) tool. 2. Using "Clear DTC Procedure," clear DTC 52. 3. Ignition "ON." 4. Switch MDTC tool to "service mode." 5. Does DTC 52 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	—

BLANK

Marine Electronic Fuel Injection (MEFI)

Section 6

Symptoms - Throttle Body Fuel Injection (TBI)

Contents

Symptoms

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.

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. If wiring harness or connector repair is necessary, refer to "General Information" section for correct procedure.
- Moisture in primary or secondary ignition circuit connections.
- Salt corrosion on electrical connections and exposed throttle body linkages.

Intermittents

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) charts 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 vessel 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 can be used to help detect intermittent conditions. The scan tool has several features that can be used to locate an intermittent condition. The following features can be used in finding an intermittent fault:

- The Snapshot feature 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 (Check Engine) 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" found in "General Information" section.

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, go to ECM wiring diagrams.
- 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, ship to shore radios, sonar, etc.
- Check that knock sensor wires 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 Control (IC) module wiring should kept away from the alternator. Check all wires from the ECM to the ignition control module for poor connections.

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

Hard Start Symptom

Step	Action	Value(s)	Yes	No
Definition: Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.				
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to Step 2	Go to *OBD System Check*
2	Check to see if the driver is using the correct starting procedure as described in the owners manual. Educate the driver if they do not know. Does the driver know the correct starting procedure?	—	Go to Step 3	System normal
3	Was visual/physical check performed?	—	Go to Step 4	Go to *Visual/ Physical Check*
4	1. Check for proper operation of fuel pump relay circuit. Refer to *Chart A-5.* 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 5
5	1. Check for contaminated fuel. 2. Check fuel filters and water separator. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 6
6	1. Check for proper fuel pressure. Refer to *Chart A-4.* 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 7
7	1. Check for proper ignition voltage output. Refer to *Chart A-7.* 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 8
8	Is a scan tool being used?	—	Go to Step 10	Go to Step 9
9	1. Check for a ECT sensor shifted in value. 2. With engine completely cool, measure the resistance of the ECT sensor. 3. Refer to the *Engine Coolant Temperature Sensor Temperature vs. Resistance value chart* on the facing page of DTC 14 in the "Diagnostics" section. Compare the approximate temperature of the ECT sensor to an accurate reading of ambient air temperature. Are the readings within the specified value?	-12°C (10°F)	Go to Step 14	Go to Step 13
10	1. Check ECT sensor for being shifted in value. 2. With the engine completely cool, compare the ECT sensor temperature with an accurate reading of ambient air temperature. Are the temperatures within the specified value of each other?	-12°C (10°F)	Go to Step 11	Go to Step 13
11	1. Using a scan tool, display ECT sensor temperature and note value. 2. Check resistance of ECT sensor. 3. Go to *Engine Coolant Temperature Sensor Temperature vs. Resistance value chart* on the facing page of DTC 14 in the "Diagnostics" section. Is resistance value of ECT sensor near the resistance of the value noted?	—	Go to Step 14	Go to Step 12

Hard Start Symptom (continued)

Step	Action	Value(s)	Yes	No
12	Locate and repair high resistance or poor connection in the ECT signal circuit or the ECT sensor ground. Is action complete?	—	Go to *OBD System Check*	
13	Replace the ECT sensor. Is action complete?	—	Go to *OBD System Check*	—
14	1. Check for intermittent opens or shorts to ground in the MAP sensor circuits. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 15
15	1. Check for proper operation of the TP sensor. 2. Check for throttle linkage sticking, binding, or worn causing TP sensor voltage to be higher than normal. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 16
16	1. Check for proper operation of the IAC valve. Refer to *Chart A-8.* 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 17
17	1. Check for the following Engine Mechanical problems: • Low compression. • Leaking cylinder head gaskets. • Worn or incorrect camshaft. • Proper valve timing/valve train problem. • Restricted exhaust system. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 18
18	1. Review all diagnostic procedures within this chart. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Contact OEM

Surges and/or Chuggles Symptom

Step	Action	Value(s)	Yes	No
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.				
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to Step 2	Go to *OBD System Check*
2	Was visual/physical check performed?	—	Go to Step 3	Go to *Visual/Physical check*
3	1. Check for engine going into RPM reduction mode. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 4
4	1. Check for contaminated fuel. 2. Check fuel filters and water separator. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 5
5	1. Check for proper fuel pressure while the condition exists. Refer to *Chart A-4.* 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 6
6	1. Check for intermittent opens or short to grounds in the ECT sensor, MAP sensor, and TP sensor circuits. Also check for throttle linkage sticking, binding, or worn. 2. An intermittent failure may not store a DTC. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 7
7	1. Check for proper ignition voltage output. Refer to *Chart A-7.* 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 8
8	1. Check ignition coils for cracks or carbon tracking. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 9
9	1. Check integrity of the primary and secondary wiring. 2. Check routing of the wiring. 3. Check condition of IC module, pick-up coil, distributor cap, rotor, and spark plug wires. 4. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 10
10	1. Remove spark plugs and check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Refer to *Distributor Ignition System.* ***Notice:*** If spark plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 11
11	1. Check items that can cause the engine to run rich. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 12

Surges and/or Chuggles Symptom (continued)

Step	Action	Value(s)	Yes	No
12	1. Check items that can cause the engine to run lean. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 13
13	1. Check the injector connections for proper mating. 2. If any of the injectors connectors are connected to an incorrect cylinder, correct as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 14
14	1. Check ECM grounds for being clean, tight and in the proper locations. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 15
15	1. Visually/physically check vacuum hoses for splits, kinks, and proper connections and routing. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 16
16	1. Check for proper alternator voltage output. 2. The voltage should be between specified values. 3. If a problem is found, repair as necessary. Was a problem found?	11-16V	Go to *OBD System Check*	Go to Step 17
17	1. Review all diagnostic procedures within this chart. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Contact OEM

Lack of Power, Sluggish or Spongy Symptom

Step	Action	Value(s)	Yes	No
Definition: Engine delivers less than expected power. Little or no increase in speed when accelerator pedal is pushed down part way.				
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to Step 2	Go to *OBD System Check*
2	Compare vehicle performance with a similar vehicle. Both vehicle's performance should be close. Is vehicle performance close to similar vehicle?	—	No problem found	Go to Step 3
3	Was visual/physical check performed?	—	Go to Step 4	Go to *Visual/Physical check*
4	1. Remove and check flame arrestor for dirt, or for being restricted. 2. Replace flame arrestor if necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 5
5	1. Check for contaminated fuel. 2. Check fuel filters and water separator. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 6
6	1. Check for proper fuel pressure while the condition exists. Refer to *Chart A-4*. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 7
7	1. Check for injector driver CKT's 467 or 468 for an open. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 8
8	1. Check base timing. Refer to *Ignition Timing Set Procedure* in the "Distributor Ignition" section. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 9
9	1. Check for proper operation of Ignition Control (IC) circuit and the Knock Sensor (KS) circuit. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 10
10	1. Check for proper ignition voltage output. Refer to *Chart A-7*. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 11
11	1. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Refer to *Distributor Ignition System.* ***Notice:*** If spark plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 12
12	1. Check ignition coils for cracks or carbon tracking. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 13

Lack of Power, Sluggish or Spongy Symptom (continued)

Step	Action	Value(s)	Yes	No
13	1. Check for intermittent opens or short to grounds in the ECT sensor, MAP sensor, and TP sensor circuits. Also check for throttle linkage sticking, binding, or worn. 2. An intermittent failure may not store a DTC. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 14
14	1. Check ECM grounds for being clean, tight and in their proper locations. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 15
15	1. Check for engine going into RPM reduction mode. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 16
16	1. Check diagnostic test CKT 451 for being shorted to ground. This will cause the RPM to be lowered. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 17
17	1. Check for proper alternator voltage output. 2. The voltage should be between specified values. 3. If a problem is found, repair as necessary. Was a problem found?	11-16V	Go to *OBD System Check*	Go to Step 18
18	1. Check for the following Engine Mechanical problems: • Low compression. • Leaking cylinder head gaskets. • Worn or incorrect camshaft. • Proper valve timing/valve train problem. • Restricted exhaust system. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 19
19	1. Check for excessive resistance on the bottom of the boat such as dirt, barnacles, etc. 2. Check for proper propeller size and pitch for that application. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 20
20	1. Review all diagnostic procedures within this chart. 2. When all procedures have been completed and no malfunctions are found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Contact OEM

Detonation/Spark Knock Symptom

Step	Action	Value(s)	Yes	No
Definition: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening.				
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to Step 2	Go to *OBD System Check*
2	Was visual/physical check performed?	—	Go to Step 3	Go to *Visual/Physical check*
3	1. Check base timing. Refer to *Ignition Timing Set Procedure* in the "Distributor Ignition" section. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 4
4	1. Check for proper operation of Ignition Control (IC) circuit and the Knock Sensor (KS) circuit. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 5
5	1. Check for good ignition system ground. 2. Check spark plugs for proper gap and heat range. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 6
6	1. Check for contaminated fuel. 2. Check for poor fuel quality and proper octane rating. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 7
7	1. Check for proper fuel pressure. Refer to *Chart A-4.* 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 8
8	Is a scan tool being used?	—	Go to Step 9	Go to Step 10
9	1. If scan tool readings are normal (refer to "Typical Scan Values") and there are no engine mechanical faults, fill fuel tank with a known quality gasoline that has a minimum octane reading of 92 and re-evaluate vehicle performance. Is detonation present?	—	Go to Step 10	Go to *OBD System Check*
10	1. Check for obvious overheating problems: • Loose water pump belt. • Faulty or incorrect water pump. • Restriction in cooling system. • Faulty or incorrect thermostat. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 11
11	1. Check items that can cause an engine to run lean. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 12
12	1. Check for ECT sensor being shifted in value. 2. Check for proper output voltage of the TP sensor at closed throttle and wide open throttle. Also check throttle linkage for sticking, binding, or worn. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 13

Detonation/Spark Knock Symptom (continued)

Step	Action	Value(s)	Yes	No
13	1. Check for the following Engine Mechanical problems: • Low compression. • Low oil level. • Excessive oil in the combustion chambers due to valve seals leaking. • Worn or incorrect camshaft. • Proper valve timing/valve train problem. • Combustion chambers for excessive carbon build up. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 14
14	1. Remove excessive carbon buildup with a top engine cleaner. Refer to instructions on top engine cleaner can. 2. Re-evaluate vehicle performance. Is detonation still present?	—	Go to Step 15	Go to *OBD System Check*
15	1. Review all diagnostic procedures within this chart. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Contact OEM

Hesitation, Sag, Stumble Symptom

Step	Action	Value(s)	Yes	No
Definition: Momentary lack of response as the accelerator is pushed down. Can occur at all vehicle speeds. Usually most severe when first trying to make the vehicle move. as from a stop sign. May cause engine to stall if severe enough.				
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to Step 2	Go to *OBD System Check*
2	Was visual/physical check performed?	—	Go to Step 3	Go to *Visual/Physical check*
3	1. Check for contaminated fuel. 2. Check fuel filters and water separator. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 4
4	1. Check for proper fuel pressure while the condition exists. Refer to *Chart A-4.* 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 5
5	1. Check fuel injectors. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 6
6	1. Check base timing. Refer to *Ignition Timing Set Procedure* in the "Distributor Ignition" section. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 7
7	1. Check for proper operation of Ignition Control (IC) circuit and the Knock Sensor (KS) circuit. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 8
8	1. Check integrity of the primary and secondary wiring. 2. Check routing of the wiring. 3. Check condition of IC module, pick-up coil, distributor cap, rotor, and spark plug wires. 4. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 9
9	1. Remove spark plugs and check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Refer to *Distributor Ignition System.* ***Notice:*** If spark plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 10
10	1. Check for the ECT sensor shifted in value. 2. Check for intermittent opens or short to grounds in the ECT sensor, MAP sensor, and TP sensor circuits. Also check for throttle linkage sticking, binding, or worn. 3. An intermittent failure may not store a DTC. 4. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 11

Hesitation, Sag, Stumble Symptom (continued)

Step	Action	Value(s)	Yes	No
11	1. Check for engine going into RPM reduction mode. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 12
12	1. Check for proper alternator voltage output. 2. The voltage should be between specified values. 3. If a problem is found, repair as necessary. Was a problem found?	11-16V	Go to *OBD System Check*	Go to Step 13
13	1. Check for faulty or incorrect thermostat. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 14
14	1. Check intake valves for valve deposits. 2. If deposits are found, remove as necessary. Were deposits found on the intake valves?	—	Go to *OBD System Check*	Go to Step 15
15	1. Review all diagnostic procedures within this chart. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Contact OEM

Cuts Out, Misses Symptom

Step	Action	Value(s)	Yes	No
Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases, not normally felt above 1500 RPM or 48 km/h (30 mph). The exhaust has a steady spitting sound at idle, low speed or on hard acceleration for fuel starvation that can cause engine to cut out.				
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to Step 2	Go to *OBD System Check*
2	Was visual/physical check performed?	—	Go to Step 3	Go to *Visual/Physical check*
3	1. Check for contaminated fuel. 2. Check fuel filters and water separator. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 4
4	1. Check for proper fuel pressure while the condition exists. Refer to *Chart A-4*. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 5
5	1. Disconnect all injector harness connectors and install an injector test light J 34730-2 between the harness terminal connector of each injector. 2. Crank engine and note light on each connector. If test light fails to blink at any one of the connectors, it is a faulty injector drive circuit harness, connector or terminal. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 6
6	1. Check fuel injectors. Refer to *Injector Balance Test* at the end of this section. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 7
7	1. Check for proper spark at each cylinder per manufactures recommendation. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 8
8	1. Check the spark plugs for the following: • Insulator cracks. • Improper gap. • Burned electrodes. • Heavy deposits. ***Notice:*** If spark plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 9

Cuts Out, Misses Symptom (continued)

Step	Action	Value(s)	Yes	No
9	1. Check engine mechanical for the following conditions. • Low compression. • Sticking or leaking valves. • Bent push rods. • Worn rocker arms. • Broken valve springs. • Worn camshaft lobe(s). • Incorrect valve timing. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 10
10	1. Check Intake and exhaust manifold(s) for casting flash. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 11
11	1. Check for Electromagnetic Interference (EMI). A missing condition can be caused by EMI on the reference circuit. EMI can usually be detected by monitoring engine RPM with a scan tool or tachometer. A sudden increase in RPM with little change in actual engine RPM change, indicates EMI is present. 2. If EMI is present, locate and repair the source. Was a problem found?	—	Go to *OBD System Check*	Go to Step 12
12	1. Review all diagnostic procedures within this chart. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Contact OEM

Rough, Unstable, or Incorrect Idle, Stalling Symptom

Step	Action	Value(s)	Yes	No
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.				
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to Step 2	Go to *OBD System Check*
2	Was visual/physical check performed?	—	Go to Step 3	Go to *Visual/Physical check*
3	1. Check for proper operation of the IAC valve. Refer to *Chart A-8*. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 4
4	1. Check base timing. Refer to *Ignition Timing Set Procedure* in the "Distributor Ignition" section. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 5
5	1. Check for proper operation of Ignition Control (IC) circuit and the Knock Sensor (KS) circuit. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 6
6	1. Check integrity of the primary and secondary wiring. 2. Check routing of the wiring. 3. Check condition of IC module, pick-up coil, distributor cap, rotor, and spark plug wires. 4. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 7
7	1. Check ignition coils for cracks or carbon tracking. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 8
8	1. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Refer to *Distributor Ignition System.* ***Notice:*** If spark plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 9
9	1. Check the injector connections. If any of the injectors are connected to an incorrect cylinder, correct as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 10
10	1. Disconnect all injector harness connectors and install an injector test light J 34730-2 between the harness terminal connector of each injector. 2. Crank engine and note light on each connector. If test light fails to blink at any one of the connectors, it is a faulty injector drive circuit harness, connector or terminal. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 11
11	1. Check fuel injectors. Refer to *Injector Balance Test* at the end of this section. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 12

Rough, Unstable, or Incorrect Idle, Stalling Symptom (continued)

Step	Action	Value(s)	Yes	No
12	1. Check for fuel in pressure regulator vacuum hose. 2. If fuel is present, replace the fuel pressure regulator assembly. Refer to *Fuel Metering System.* 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 13
13	1. Check for intermittent opens or short to grounds in the ECT sensor, MAP sensor, and TP sensor circuits. Also check for throttle linkage sticking, binding, or worn. 2. An intermittent failure may not store a DTC. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 14
14	1. Check ECM grounds for being clean, tight and in their proper locations. 2. Also check that battery cables and ground straps are clean and secure. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 15
15	1. Check items that can cause the engine to run rich. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 16
16	1. Check items that can cause the engine to run lean. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 17
17	1. Check for proper alternator voltage output. 2. The voltage should be between specified values. 3. If a problem is found, repair as necessary. Was a problem found?	11-16V	Go to *OBD System Check*	Go to Step 18
18	1. Check the following engine mechanical items: • Check compression. • Sticking or leaking valves. • Worn camshaft lobe(s). • Valve timing. • Broken valve springs. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 19
19	1. Check intake valves for valve deposits. 2. If deposits are found, remove as necessary. Were deposits found on the intake valves?	—	Go to *OBD System Check*	Go to Step 20
20	1. Check for faulty motor mounts. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 21
21	1. Review all diagnostic procedures within this chart. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Contact OEM

Poor Fuel Economy Symptom

Step	Action	Value(s)	Yes	No
Definition: Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.				
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to Step 2	Go to *OBD System Check*
2	Was visual/physical check performed?	—	Go to Step 3	Go to *Visual/Physical check*
3	1. Check owner's driving habits. • Are excessively heavy loads being carried? • Is accelerating too much, too often? 2. If a problem is found, repair as necessary. Was a problem found?	—	System normal	Go to Step 4
4	1. Check flame arrestor for dirt or being plugged. 2. Check for fuel leaks. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 5
5	1. Check for proper fuel pressure. Refer to *Chart A-4.* 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 6
6	1. Check for proper operation of Ignition Control (IC) circuit and the Knock Sensor (KS) circuit. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 7
7	1. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Refer to *Distributor Ignition System.* ***Notice:*** If spark plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 8
8	1. Visually (physically) check Vacuum hoses for splits, kinks, and improper connections and routing. 2. If a problem is found, repair as necessary. Was a repair required?	—	Go to *OBD System Check*	Go to Step 9
9	1. Check engine compression for being low. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 10
10	1. Check exhaust system for possible restriction 2. Inspect exhaust system for damaged or collapsed pipes. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 11

Poor Fuel Economy Symptom (continued)

Step	Action	Value(s)	Yes	No
11	1. Check for excessive resistance on the bottom of the boat such as dirt, barnacles, etc. 2. Check for proper propeller size and pitch for that application. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 12
12	1. Review all diagnostic procedures within this chart. 2. When all procedures have been completed and no malfunctions are found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Contact OEM

Dieseling, Run-On Symptom

Step	Action	Value(s)	Yes	No
Definition: Engine continues to run after key is turned "OFF," but runs very rough. If engine runs smooth, check ignition switch and adjustment.				
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to Step 2	Go to *OBD System Check*
2	Was visual/physical check performed?	—	Go to Step 3	Go to *Visual/Physical check*
3	1. Check for leaking fuel injectors. Refer to *Chart A-4.* 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 4
4	1. Check for proper operation of Ignition Control (IC) circuit and the Knock Sensor (KS) circuit. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 5
5	1. Check for obvious overheating problems: • Loose water pump belt. • Faulty or incorrect water pump. • Restriction in cooling system. • Faulty or incorrect thermostat. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 6
6	1. Check for proper operation of the MEFI relay. Refer to *Chart A-6.* 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 7
7	1. Review all diagnostic procedures within this chart. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Contact OEM

Backfire Symptom

Step	Action	Value(s)	Yes	No
Definition: Fuel ignites in the intake manifold, or in the exhaust system, making loud popping noise.				
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to Step 2	Go to *OBD System Check*
2	Was visual/physical check performed?		Go to Step 3	Go to *Visual/Physical check*
3	1. Check flame arrestor for proper installation per manufactures recommendation. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 4
4	1. Check for proper fuel pressure. Refer to *Chart A-4.* 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 5
5	1. Check the injector connections. If any of the injectors are connected to an incorrect cylinder, correct as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 6
6	1. Check fuel injectors. Refer to *Injector Balance Test* at the end of this section. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 7
7	1. Check base timing. Refer to *Ignition Timing Set Procedure* in the "Distributor Ignition" section. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 8
8	1. Check for proper operation of Ignition Control (IC) circuit and the Knock Sensor (KS) circuit. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 9
9	1. Check integrity of the primary and secondary wiring. 2. Check routing of the wiring. 3. Check condition of IC module, pick-up coil, distributor cap, rotor, and spark plug wires. 4. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 10
10	1. Check ignition coils for cracks or carbon tracking. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 11
11	1. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Refer to *Distributor Ignition System.* ***Notice:*** If spark plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 12
12	1. Check for intermittent opens or short to grounds in the MAP sensor and TP sensor circuits. Also check for throttle linkage sticking, binding, or worn. 2. An intermittent failure may not store a DTC. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 13

Backfire Symptom (continued)

Step	Action	Value(s)	Yes	No
13	1. Check engine mechanical for the following conditions. • Low compression. • Sticking or leaking valves. • Worn camshaft lobe(s). • Incorrect valve timing. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 14
14	1. Check Intake and exhaust manifold(s) for casting flash. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Go to Step 15
15	1. Review all diagnostic procedures within this chart. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. Was a problem found?	—	Go to *OBD System Check*	Contact OEM

ECM Connector "J1"

Pin Function		CKT No.	Wire Color	BOB PIN No.	Component Connector	DTC(s) Affected	Possible Symptoms From Faulty Circuit
J1-01	Knock Sensor Signal	485	blk		Knock Sensor	43 & 44	Poor Fuel Economy, Poor Performance, Detonation
J1-02	ECT Signal	410	yel		ECT Sensor	14 & 15	Poor Performance, Exhaust Odor, Rough Idle, RPM Reduction
J1-03	Not Used						
J1-04	General Warning 2 (Optional)	911	dk grn		In-Line Boat 8-Way Harness	None	RPM Reduction
J1-05	Master/Slave	916	yel		Twin Engine In-Line Connector	None	Lack of Data From Other Engine
J1-06	Oil Pressure Switch (Optional)	931	brn		In-Line Boat 8-Way Harness	None	RPM Reduction
J1-07	Diagnostic Test Terminal	451	wht/blk		Data Link Connector	None	Incorrect Idle, Poor Performance
J1-08	Not Used						
J1-09	MAP Signal	432	lt grn		MAP Sensor	33 & 34	Poor Performance, Surge, Poor Fuel Economy, Exhaust Odor
J1-10	TP Signal	417	dk blu		TP Sensor	21 & 22	Poor Acceleration and Performance, Incorrect Idle
J1-11	Ignition Fused	439	pnk/blk		Splice	None	No Start, MIL Inoperative
J1-12	Not Used						
J1-13	Sensor Ground, TP, Trim, and IAT Sensors	813	blk		TP, Trim, and IAT Sensors	21 & 23	High Idle, Rough Idle, Poor Performance
J1-14	ECM Ground	450	blk/wht		Engine Block	None	An open ground or high resistance ground may cause any or all symptoms.
J1-15	TP 5 Volt Reference	416	gry		TP Sensor	22	Lack of Power, Idle Surge, High Idle, Exhaust Odor
J1-16	Battery Feed	440	orn		Splice	None	No Start
J1-17	Not Used						
J1-18	Serial Data	461	orn/blk		Data Link Connector	None	No Serial Data
J1-19	Shift Interrupt or Load Anticipate	940	lt grn		In-Line Boat 8-Way Harness	None	RPM Reduction
J1-20	Oil Level (Optional)	1174	brn		In-Line Boat 8-Way Harness	None	RPM Reduction
J1-21	Emergency Stop Switch (Optional)	942	pnk		In-Line Boat 8-Way Harness	None	RPM Reduction

ECM Connector "J1" (continued)

Pin Function		CKT No.	Wire Color	BOB PIN No.	Component Connector Cavity	DTC(s) Affected	Possible Symptoms From Faulty Circuit
J1-22	General Warning 1 (Optional)	920	lt blu		In-Line Boat 8-Way Harness	None	RPM Reduction
J1-23	Not Used						
J1-24	IAT Signal	472	tan		IAT Sensor	23	Rough Idle
J1-25	Trim Signal	910	wht		Trim Sensor	None	
J1-26	Not Used						
J1-27	Not Used						
J1-28	Not Used						
J1-29	Sensor Ground, MAP and ECT Sensors	814	blk		MAP and ECT Sensors	14 & 33	Lack of Performance, Exhaust Odor, Stalling
J1-30	ECM Ground	450	blk/wht		Engine Block	None	An open ground or high resistance ground may cause any or all symptoms.
J1-31	MAP 5 Volt Reference	416E	gry		MAP Sensor	34	Lack of Power, Surge, Rough Idle, Exhaust Odor
J1-32	Battery Feed	440	orn		Splice	None	No Start

(1) Open Circuit
(2) Grounded Circuit
(3) Open/Grounded Circuit

ECM Connector "J2"

Pin Function		CKT No.	Wire Color	BOB PIN No.	Component Connector Cavity	DTC(s) Affected	Possible Symptoms From Faulty Circuit
J2-01	Not Used						
J2-02	Not Used						
J2-03	Not Used						
J2-04	Not Used						
J2-05	Injector Driver (Cyl's 1,4,6,7)	468	lt grn		Injectors	None	Rough Idle, Lack of Power, Stalling
J2-06	IC Reference Low	453	blk/red		Ignition Control Module	None	Lack of Performance, Poor Fuel Economy
J2-07	Port Fuel Jumper	901	wht		ECM	None	
J2-08	IC Reference High	430	ppl/wht		Ignition Control Module	None	No Start
J2-09	Fuel Pump Relay Driver	465	dk grn/wht		Fuel Pump Relay	None	No Start
J2-10	Not Used						
J2-11	Check Gauges (Optional)	112	dk grn		In-Line Boat 6-Way Harness	None	Loss of Instrument Indicator
J2-12	Buzzer (Optional)	914	ppl		In-Line Boat 6-Way Harness	None	Loss of Instrument Indicator
J2-13	IAC "A" Low	442	blu/blk		IAC Valve	None	Rough, Unstable, or Incorrect Idle
J2-14	IAC "B" High	443	grn/wht		IAC Valve	None	Rough, Unstable, or Incorrect Idle
J2-15	Fuel Injector Ground	450	blk/wht		Engine Block	None	An open ground or high resistance ground may cause any or all symptoms.
J2-16	Not Used						
J2-17	Not Used						
J2-18	Not Used						
J2-19	Not Used						
J2-20	Fuel Injector Ground	450	blk/wht		Engine Block	None	An open ground or high resistance ground may cause any or all symptoms.
J2-21	Injector Driver (Cyl's 2, 3, 5, 8)	467	dk blu		Injectors	None	Rough Idle, Lack of Power, Stalling
J2-22	Port Fuel Jumper	901	wht		ECM	None	
J2-23	IC Signal	423	wht		Ignition Control Module	41 & 42	Lack of Power, Fixed Timing
J2-24	IC Bypass	424	tan/blk		Ignition Control Module	42	Lack of Power, Fixed Timing
J2-25	Not Used						

ECM Connector "J2" (continued)

Pin Function		CKT No.	Wire Color	BOB PIN No.	Component Connector Cavity	DTC(s) Affected	Possible Symptoms From Faulty Circuit
J2-26	General Warning 1 Lamp (Optional)	912	dk blu		In-Line Boat 6-Way Harness	None	Loss of Instrument Light
J2-27	RPM Change State (Optional)	31	tan		In-Line Boat 6-Way Harness	None	
J2-28	IAC "A" High	441	blu/wht		IAC Valve	None	Rough, Unstable, or Incorrect Idle
J2-29	IAC "B" Low	444	grn/blk		IAC Valve	None	Rough, Unstable, or Incorrect Idle
J2-30	Oil Level Lamp Output (Optional)	930	gry		In-Line Boat 6-Way Harness	None	Loss of Instrument Light
J2-31	Malfunction Indicator Lamp	419	brn/wht		DLC	None	MIL Inoperative
J2-32	Not Used						

(1) Open circuit
(2) Grounded circuit
(3) Open/Grounded circuit