

**GENERAL MOTORS  
MARINE ELECTRONIC  
FUEL INJECTION (MEFI)  
TROUBLESHOOTING  
AND  
REPAIR  
(MEFI 3 - 1998 Software)**





### **CAUTION**

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

Proper service and repair are important to the safety of the service technician and the safe, reliable operation of all Marine Electronic Fuel Injection (MEFI) equipped engines. If part replacement is necessary, the part must be replaced with one of the same part number or with an equivalent part. Do not use a replacement part of lesser quality.

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

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

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

# MARINE ELECTRONIC FUEL INJECTION (MEFI) DIAGNOSTIC MANUAL

At the beginning of each individual section is a Table of Contents which gives the page number on which each subject begins.

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

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

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

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### FOREWORD

This service manual includes general description, diagnosis, symptoms and on-board service procedures for the fuel control and ignition systems used on GM equipped Marine Electronic Fuel Injection (MEFI) engines.

### INTRODUCTION

The following manual has been prepared for effective diagnosis of the Marine Electronic Fuel Injection (MEFI) system.

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

This manual should be kept in a handy place for ready reference. If properly used, it will meet the needs of technicians and boat owners.

**GM Powertrain Division service manuals are intended for the use by professional, qualified technicians. Attempting repairs or service without the appropriate training, tools and equipment could cause injury to you or others and damage to boat that may cause it not to operate safely and properly.**

# Marine Electronic Fuel Injection (MEFI)

## Section 1

### General Information

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## General Description

### Visual / Physical Inspection

**A careful visual and physical inspection must be performed as part of any diagnostic procedure. This can often lead to fixing a problem without further diagnostics.** Inspect all vacuum hoses for correct routing, pinches, cracks or disconnects. Be sure to inspect hoses that are difficult to see. Inspect all the wires in the engine compartment for proper connections, burned or chafed spots, pinched wires or contact with sharp edges or hot manifolds. This visual/physical inspection is very important. It must be done carefully and thoroughly.

### Basic Knowledge and Tools Required

To use this manual most effectively, a general understanding of basic electrical circuits and circuit testing tools is required. You should be familiar with wiring diagrams, the meaning of voltage, ohms, amps and the basic theories of electricity. You should also understand what happens if a circuit becomes open, shorted to ground or shorted to voltage.

To perform system diagnostics, several special tools and equipment are required. Please become acquainted with the tools and their use before attempting to diagnose the system. Special tools that are required for system service are illustrated in this section.

### Electrostatic Discharge Damage

Electronic components used in control systems are often designed to carry very low voltage, and are very susceptible to damage caused by electrostatic discharge. It is possible for less than 100 volts of static electricity to cause damage to some electronic components. By comparison, it takes as much as 4,000 volts for a person to feel the zap of a static discharge.

There are several ways a person can become statically charged. The most common methods of charging are by friction and by induction. An example of charging by friction is a person sliding across a seat, in which a charge of as much as 25,000 volts can build up. Charging by induction occurs when a person with well insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off, leaving the person highly charged with the opposite polarity. Static charges of either type can cause damage. Therefore, it is important to use care when handling and testing electronic components.

### Engine Wiring

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

### Engine Control Module (ECM) Self-Diagnostics

The Engine Control Module (ECM) performs a continuous self-diagnosis on certain control functions. This diagnostic capability is complemented by the diagnostic procedures contained in this manual. The ECM's language for communicating the source of a malfunction is a system of Diagnostic Trouble Codes (DTC's). The DTC's are two digit numbers that can range from 12 to 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.

- ï 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.
- ï 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 ìONî with the key ìON,î engine ìOFF.î When the engine is started, the light will turn ìOFF.î If the light remains ìON,î 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 ìONî while the engine is running, or when a malfunction is suspected due to a drivability problem, the MEFI ìOn-Board Diagnostic (OBD) System Checkî must be performed as the first step. These checks will expose malfunctions which may not be detected if other diagnostics are performed prematurely.

### Intermittent Malfunction Indicator Lamp (MIL)

In the case of an intermittent problem, the Malfunction Indicator Lamp (MIL) will light for 10 seconds, and then go out. However, the corresponding DTC will be stored in the memory of the ECM. When DTCs 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 (DTCs)

The provision for communicating with the ECM is the Data Link Connector (DLC) (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 with a Marine Diagnostic Trouble Code (MDTC) tool. The other way is through a scan tool, a hand-held diagnostic scanner plugged into the DLC.

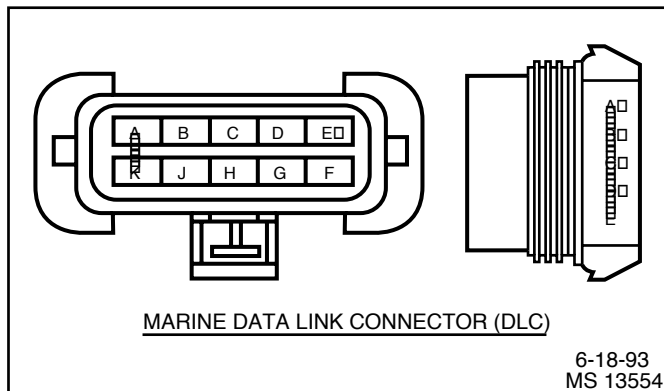


Figure 1-1 - Marine Data Link Connector (DLC)

Once the MDTC tool has been connected, and service mode or ION 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. DTC 12 indicates that the ECM's diagnostic system is operating. If DTC 12 is not indicated, a problem is present within the diagnostic system itself, and should be addressed by consulting the On-Board Diagnostic (OBD) System Check 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 DTCs will be flashed out from the lowest to the highest, with each DTC being flashed three times. At the end of the DTCs, 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 or ION is selected, the system will enter what is called the Service Mode. In this mode, the ECM will:

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

### Normal Mode

When the MDTC tool is in the normal mode or OFF, it has no effect 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 procedures. 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 perform a wiggle test on wiring harnesses or components with the engine not running, while observing the scan tool display.

The scan tool can be plugged in and observed while driving the boat under the condition when the MIL turns ON momentarily or when the engine drivability 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 technician's ability to understand the system they are trying to diagnose, as well as an understanding of the scan tool operation and limitations. The technician should read the tool manufacturer's operating manual to become familiar with the tool's operation.

## How Diagnostic Trouble Codes (DTC) Are Set

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

If a sensor is within its operating or acceptable parameters (Figure 1-2), the ECM does not detect a problem. When a sensor voltage signal falls out of this window, the ECM no longer receives a signal voltage within the operating window. When the ECM does not receive the window voltage for a calibratable length of time, a DTC will be stored.

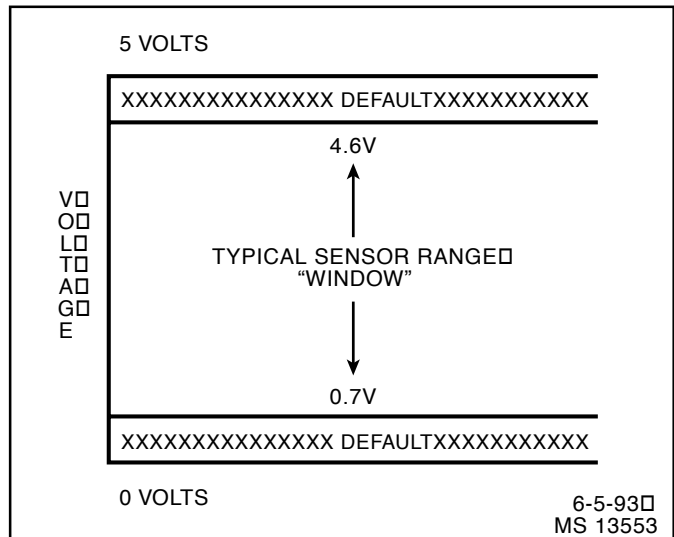


Figure 1-2 - Example of Sensor Normal Operation

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

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

to set, as the ECM interprets this as within the operating window.

### Clearing Diagnostic Trouble Codes (Scan)

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

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

### Non-Scan Diagnosis Of Drivability Concerns (No DTCs Set)

If a drivability 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 drivability concern.

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

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

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

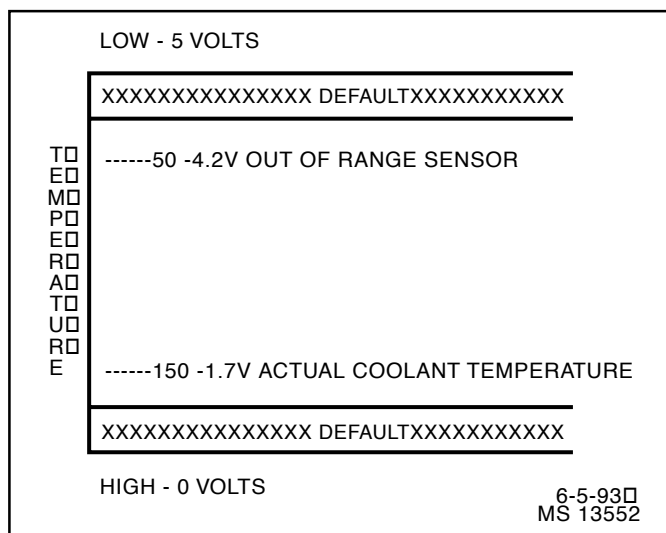
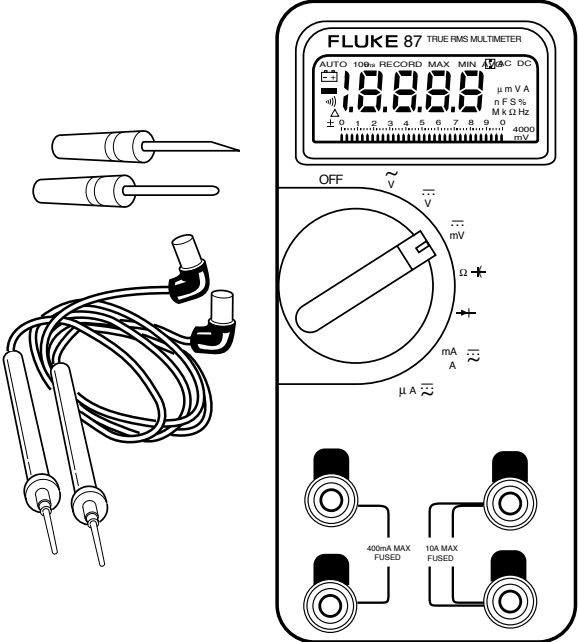
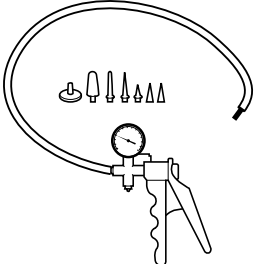
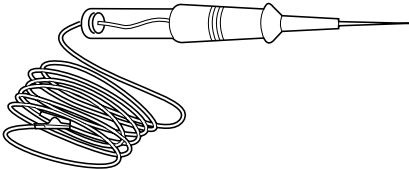
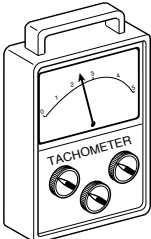


Figure 1-3 - Example of Shifted Sensor Operation

### Tools Needed To Service The System

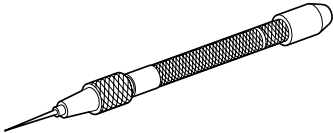
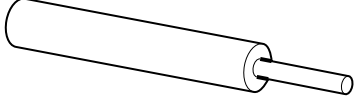
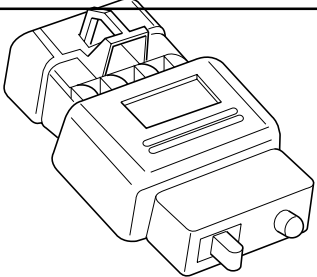
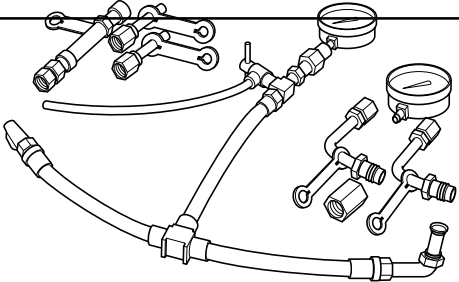
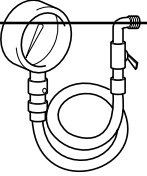
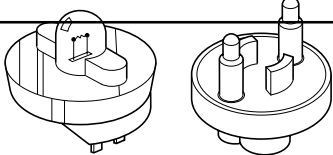
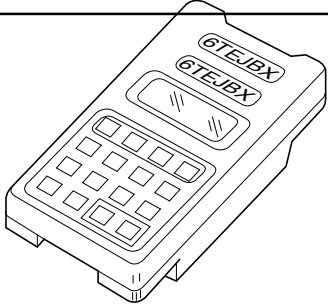
Refer to *Special Tools* in this section for engine control tools for servicing the system.

Special Tools (1 of 3)

 <p style="text-align: right;">J 39978</p>	<p><b>VOLTMETER</b> - 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.</p> <p><b>AMMETER</b> - When used as an ammeter, this meter accurately measures extremely low current flow. Refer to meter instructions for more information.</p> <ul style="list-style-type: none"> <li>• Selector must be set properly for both function and range. DC is used for most measurements.</li> </ul> <p><b>OHMMETER</b> - Measures resistance of circuit directly in ohms. Refer to meter instructions for more information.</p> <ul style="list-style-type: none"> <li>• OL display in all ranges indicates open circuit.</li> <li>• Zero display in all ranges indicates a short circuit.</li> <li>• An intermittent connection in a circuit may be indicated by a digital reading that will not stabilize on the circuit.</li> <li>• Range Switch - Automatic and Manual.             <ul style="list-style-type: none"> <li>200" - Reads ohms directly</li> <li>2K, 20K, 200K" - Reads ohms in thousands</li> <li>2M, 20M, 200M" - Reads ohms in millions</li> </ul> </li> </ul>
 <p style="text-align: right;">J 23738-A</p>	<p><b>VACUUM PUMP WITH GAUGE (20 IN. HG. MINIMUM)</b></p> <p>Use the gauge to monitor manifold engine vacuum and use the hand pump to check vacuum sensors, solenoids and valves.</p>
 <p style="text-align: right;">J 34142-B</p>	<p><b>UNPOWERED TEST LIGHT</b></p> <p>Used for checking wiring for a complete circuit, voltages and grounds.</p>
	<p><b>TACHOMETER</b></p> <p>Must have inductive trigger signal pick-up.</p>

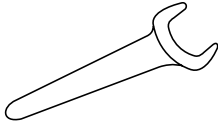
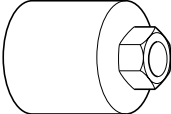
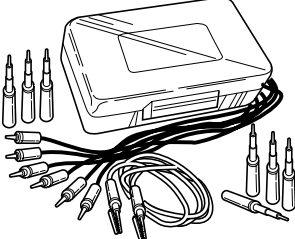
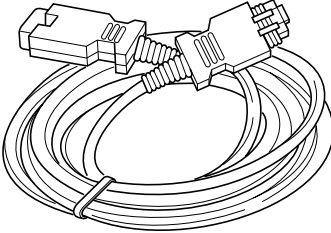
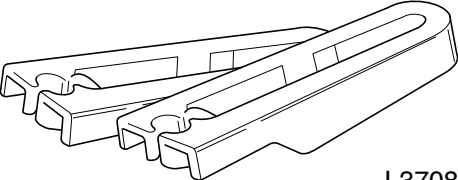
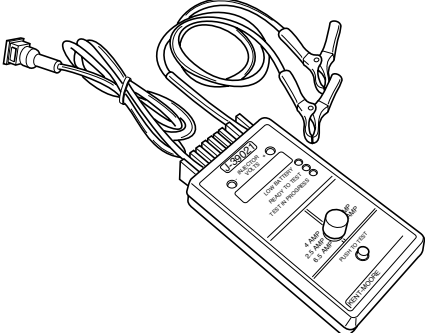
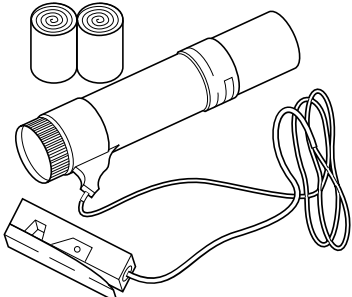
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Special Tools (2 of 3)

 <p>J 35689</p>	<p><b>METRI-PACK TERMINAL REMOVER</b> 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.</p>
 <p>J 28741-A/BT-8234-A</p>	<p><b>WEATHER PACK TERMINAL REMOVER</b> Used for removing terminals from Weather Pack connectors. Refer to wiring harness service in MEFI General Information Section for removal procedure.</p>
 <p>TA 06075</p>	<p><b>MARINE DIAGNOSTIC TROUBLE CODE (MDTC) TOOL</b> A hand held diagnostic tool that plugs into the DLC connector for various diagnostics.</p>
 <p>J 29658-D</p>	<p><b>FUEL PRESSURE GAUGE</b> Used for checking fuel system pressure on TBI engines.</p>
 <p>J 34730-1A</p>	<p><b>FUEL PRESSURE GAUGE</b> Used for checking fuel system pressure on MFI and PFI engines.</p>
 <p>J 34730-2C &amp; J 34730-350/BT 8329</p>	<p><b>INJECTOR HARNESS TEST LIGHT</b> A specially designed light used to visually indicate injector electrical pulses from the ECM.</p>
 <p>TK 00450</p>	<p><b>SCAN TOOL (Optional)</b> A hand held diagnostic tool that plugs into the DLC connector for various diagnostics. It will display various parameters.</p>

NS 15871

## Special Tools (3 of 3)

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

MS 13617

## ABBREVIATIONS

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

## Diagnosis

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

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

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

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

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

## On-Board Service

### Wiring Harness Service

Figure 1-4

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

With the low current and voltage levels found in the system, it is important that the best possible bond be made at all wire splices by soldering the splices as shown in Figure 1-4.

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

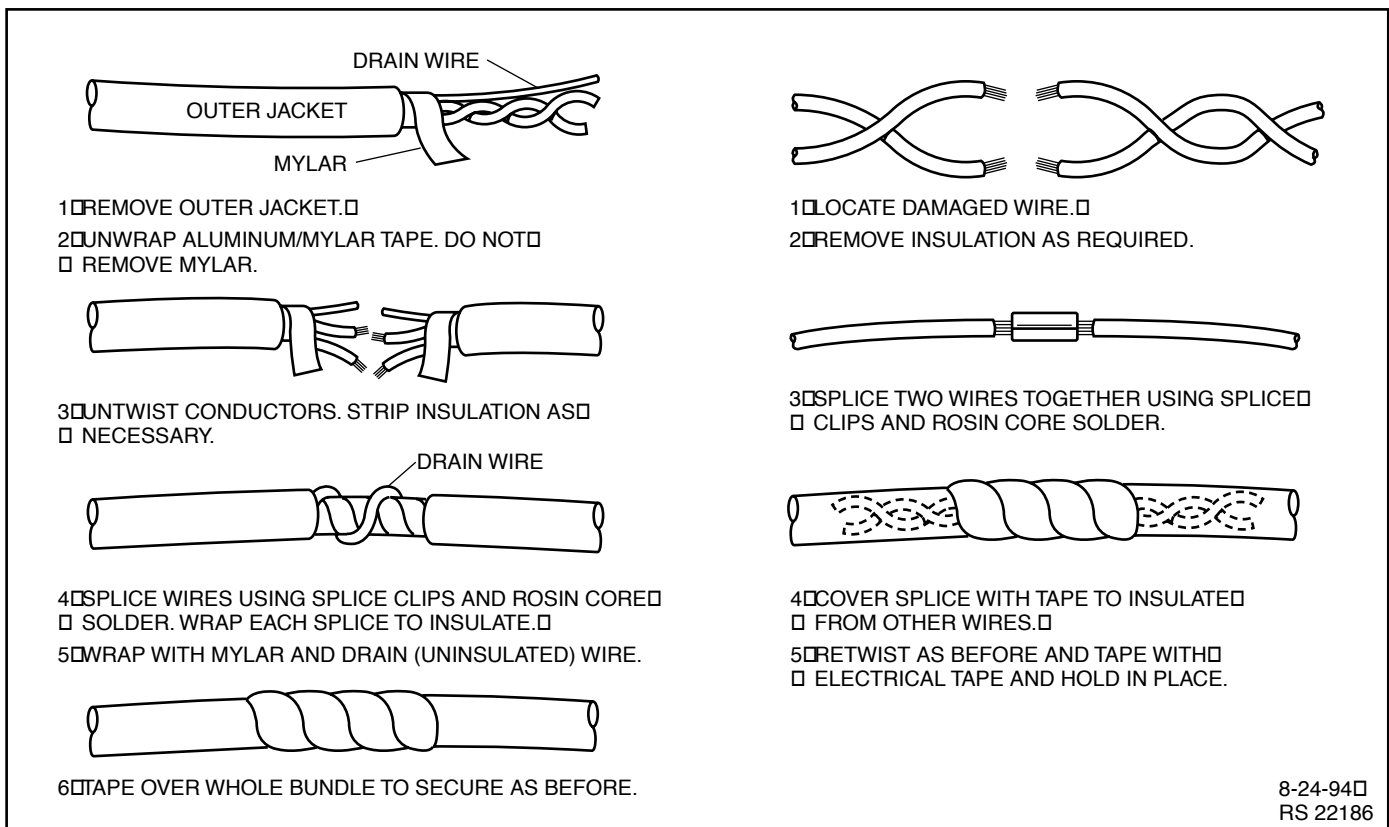


Figure 1-4 - Wiring Harness Repair

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

#### Figure 1-5

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 iPull-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

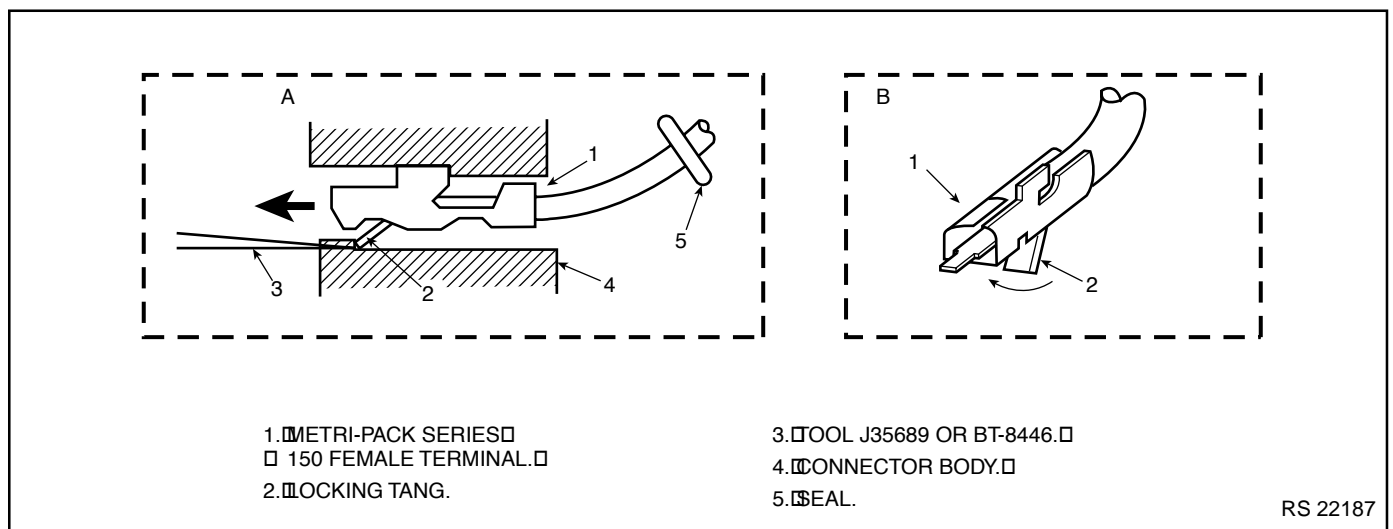


Figure 1-5 - Metri-Pack Series 150 Terminal Removal



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.

**Weather-Pack Connectors**

Figure 1-6

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.

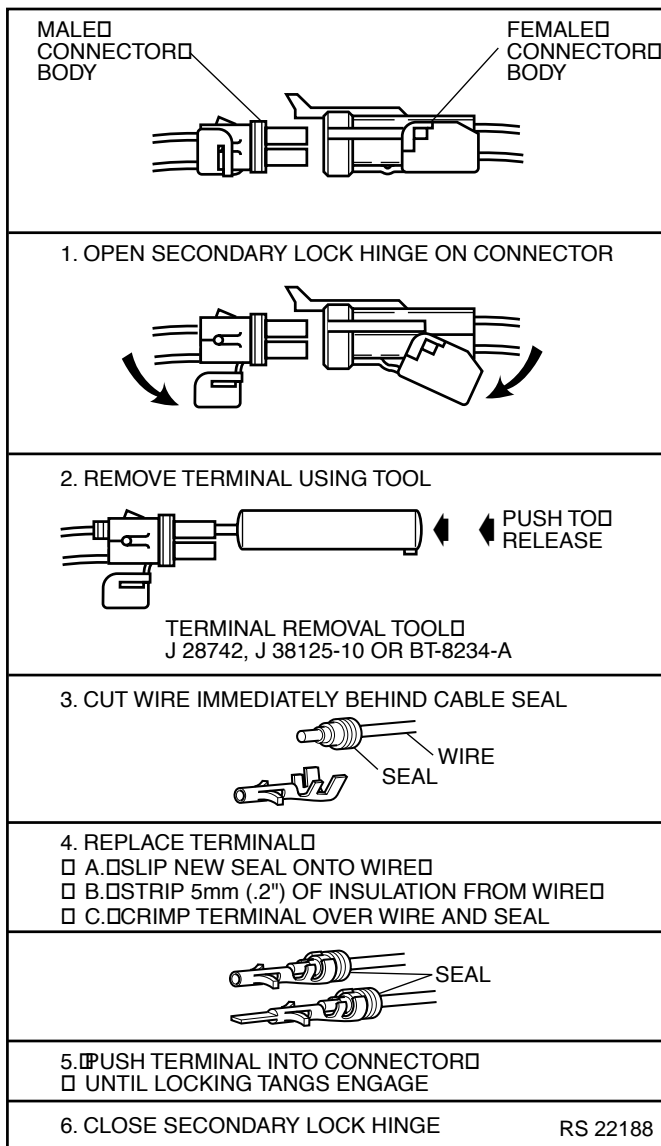


Figure 1-6 - Weather-Pack Terminal Repair

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 iJ1î and iJ2î connectors are Micro-Pack 100/W Series. It is used for its ruggedized construction, capable of carrying more current and provides good sealing ability. The connector is made up of five different parts (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 locking tab with thumb and pulling on connector body.

#### Inspect

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

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

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

#### Important

- ï 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

- ï 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 iECM/ Component Connector Identificationî in the *Diagnosis* section. The strain relief is numbered for identifying wire location.
10. Index cover (4) by pushing in on Tabs C with a small screwdriver.
  11. Terminals by pulling out of connector.
  12. Seal (2) from wires.
  13. Strain relief (1) from wires.

#### Clean and Inspect

- ï Terminals for corrosion.
  - ñ Use spray electrical contact cleaner.
- ï Loose crimps on terminals.
- ï 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.
  - ï 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.
  - ï 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.
  - ï Keep wires straight.
  - ï DO NOT kink wires.
6. Strain relief (1) onto seal (2) and connector (3).
7. Lock Tabs B into strain relief (1).
8. Plugs into strain relief (1) where there are not any wires.
9. Fold strain relief (1) together and lock Tabs A.
10. Connector assembly to ECM.
11. Negative battery cable.

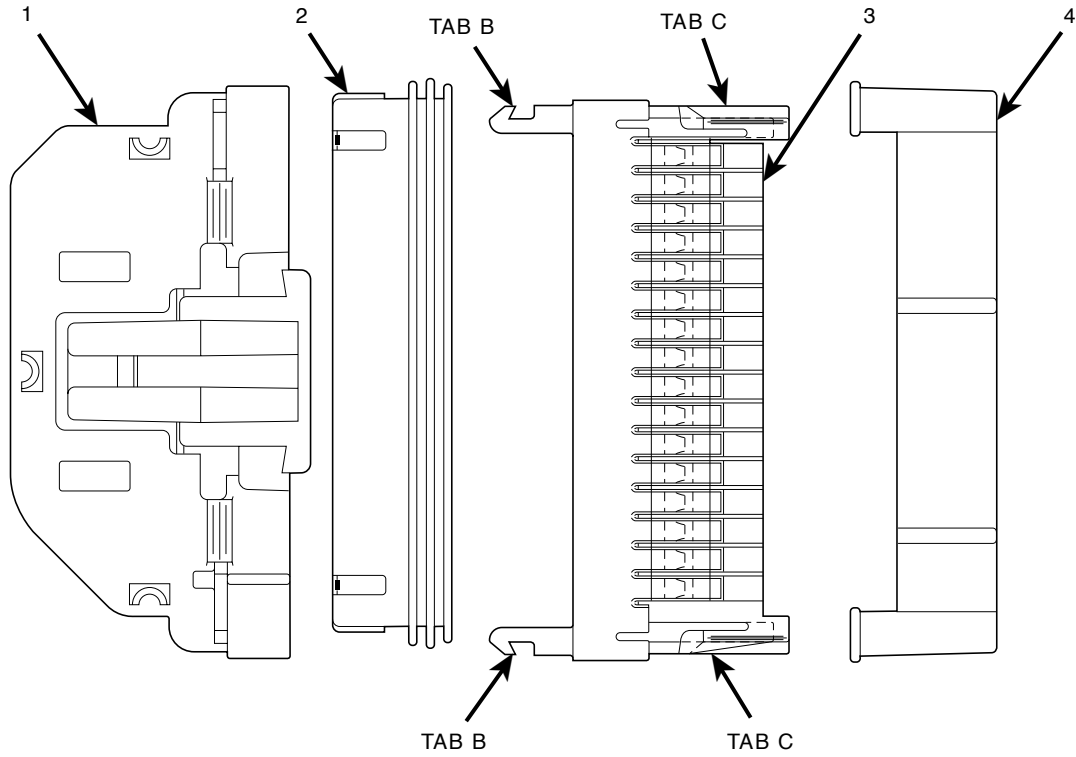


FIGURE A - EXPLODED VIEW OF CONNECTOR ASSEMBLY

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

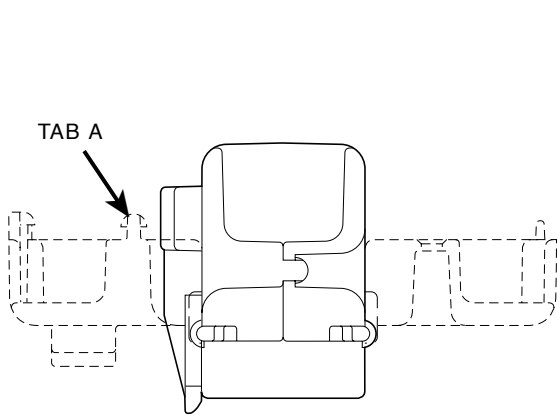


FIGURE B - STRAIN RELIEF CLOSED

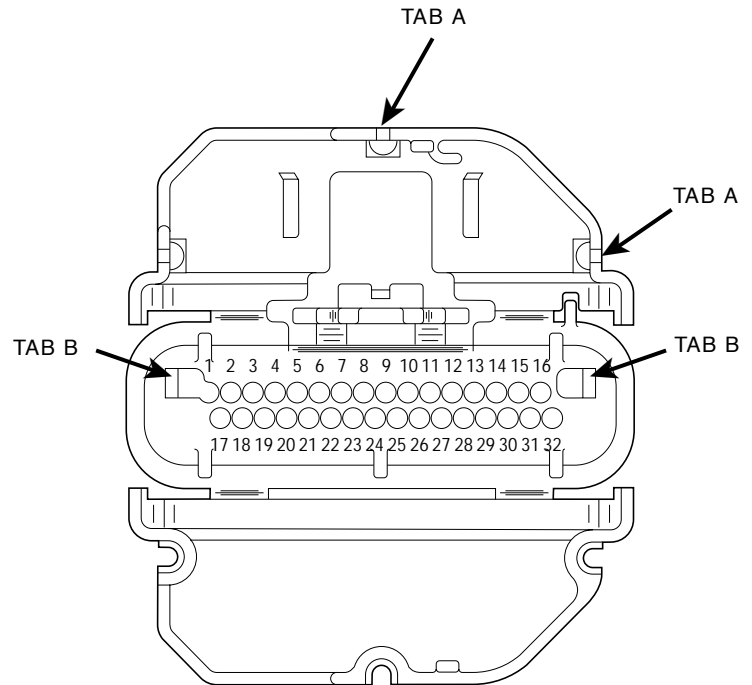


FIGURE C - STRAIN RELIEF OPENED

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## 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.

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## 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 circuits 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.

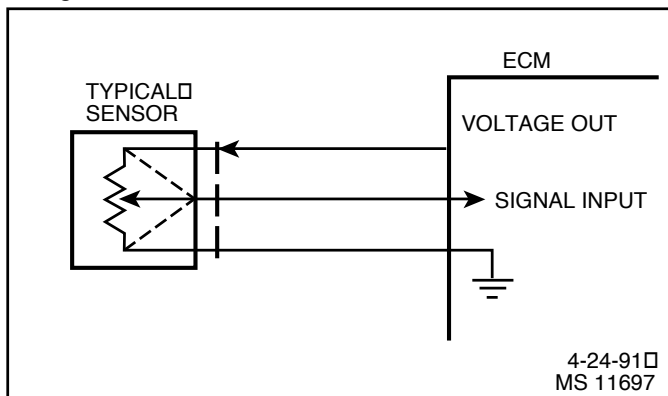


Figure 2-1 - Three-Wire Sensors

### Two-Wire Sensors

Figure 2-2 shows a schematic representation 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.

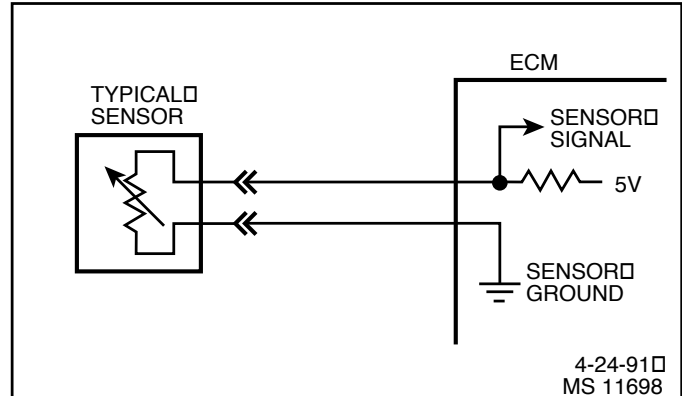


Figure 2-2 - Two-Wire Sensors

## 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.

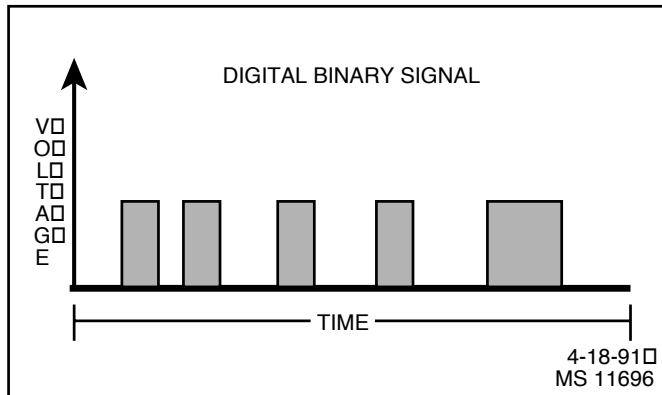


Figure 2-3 - Digital Voltage Signal

## 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:

- ï Fuel metering system.
- ï Ignition timing.
- ï Idle speed.
- ï 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.

### 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.

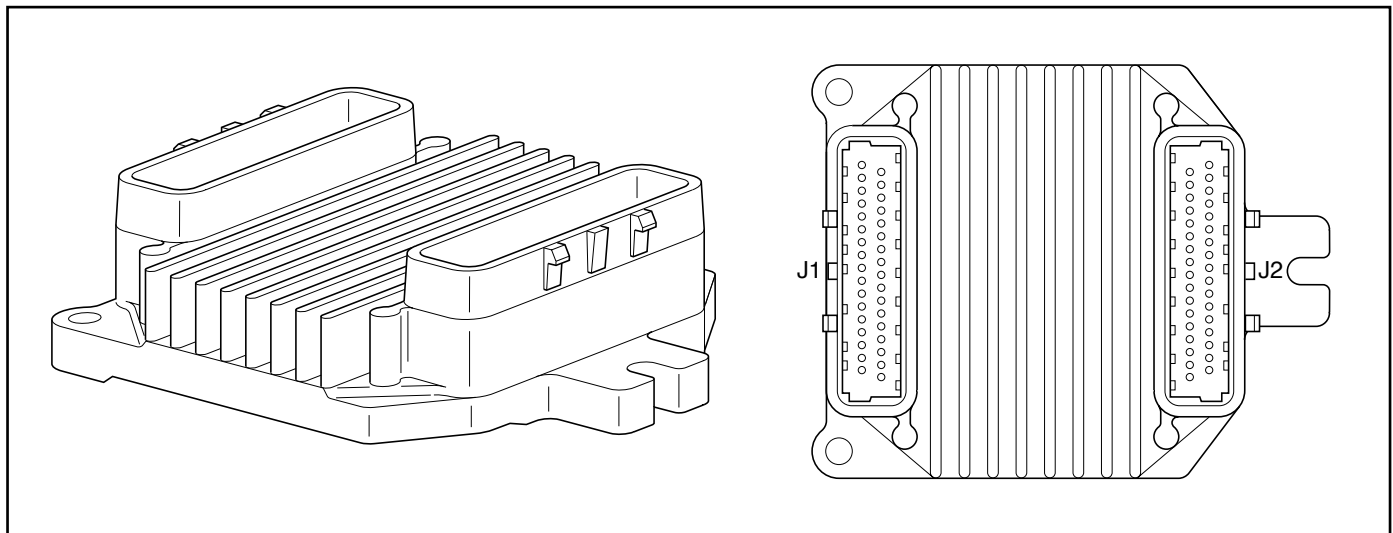


Figure 2-4 - Engine Control Module (ECM)

MEFI3004



## 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.

### 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.

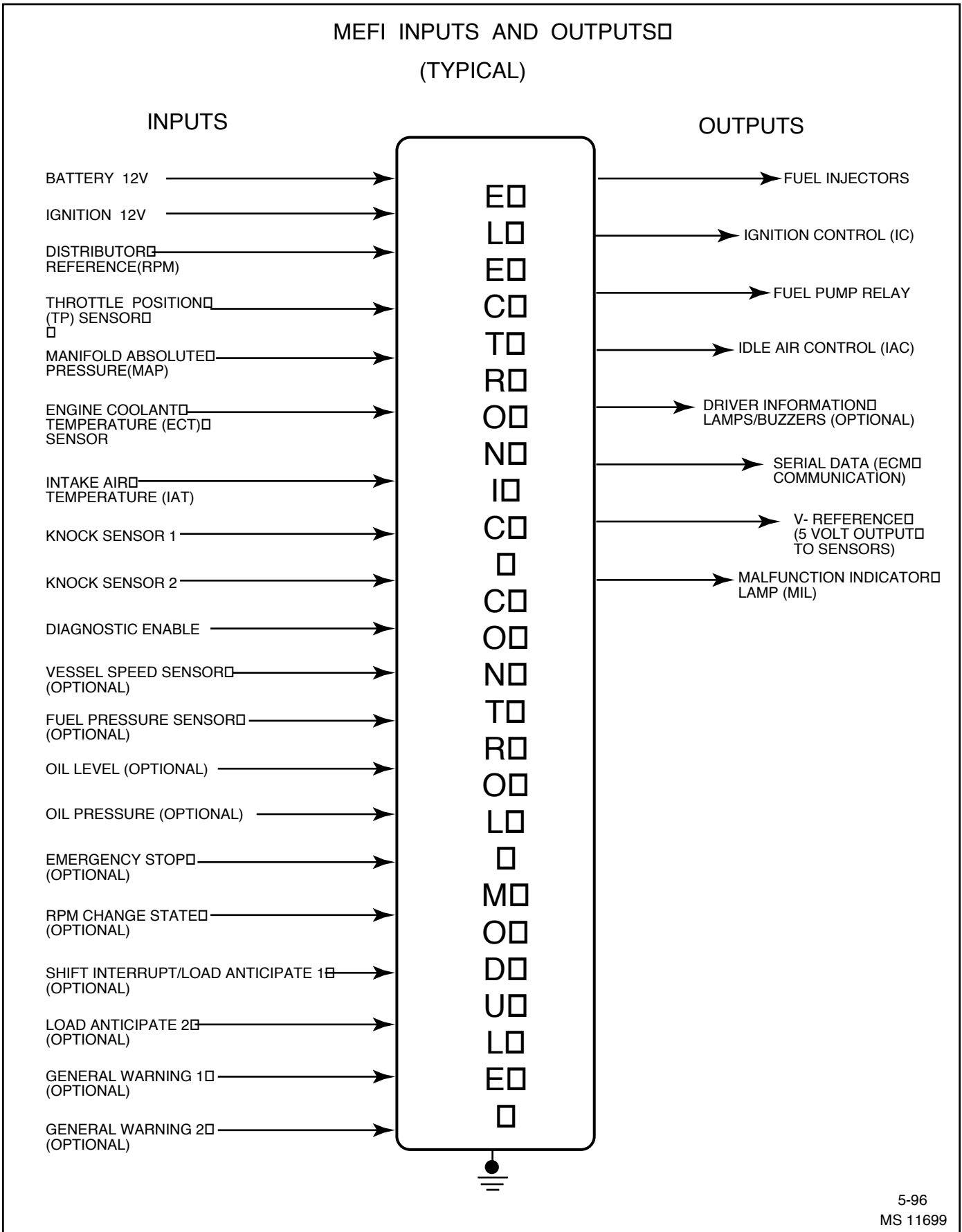


Figure 2-5 - ECM Inputs and Outputs (Typical)

**Engine Coolant Temperature (ECT) Sensor**

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 iDiagnostic Aidsi also contains a chart to check for sensor resistance values relative to temperature.

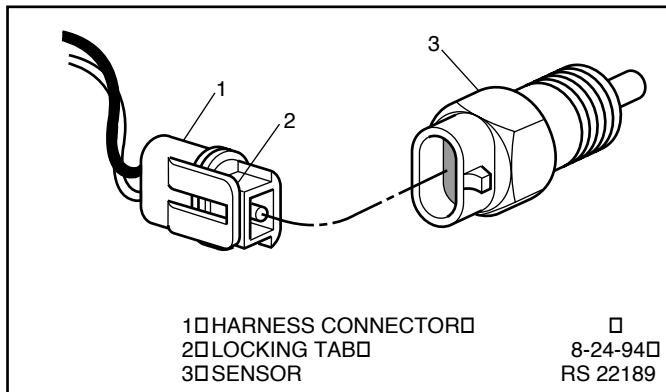


Figure 2-6 - Engine Coolant Temperature (ECT) Sensor

**Manifold Absolute Pressure (MAP) Sensor**

The Manifold Absolute Pressure (MAP) sensor 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 supplies 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.

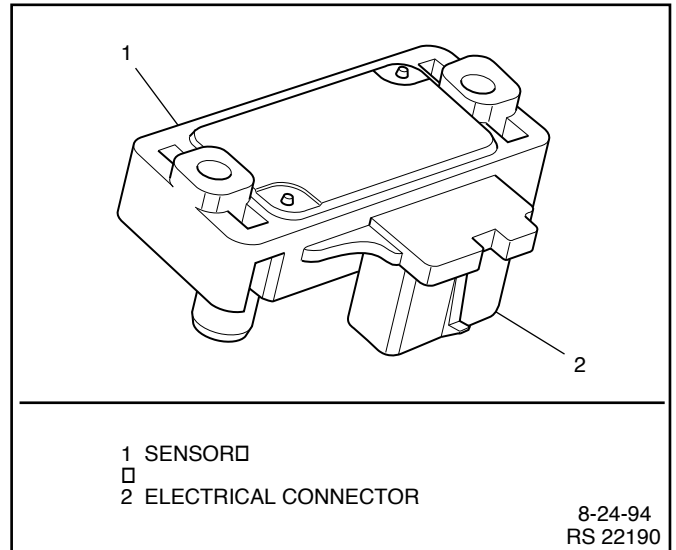


Figure 2-7 - Manifold Absolute Pressure (MAP) Sensor (Used On 7.4/8.2L TBI Engines)

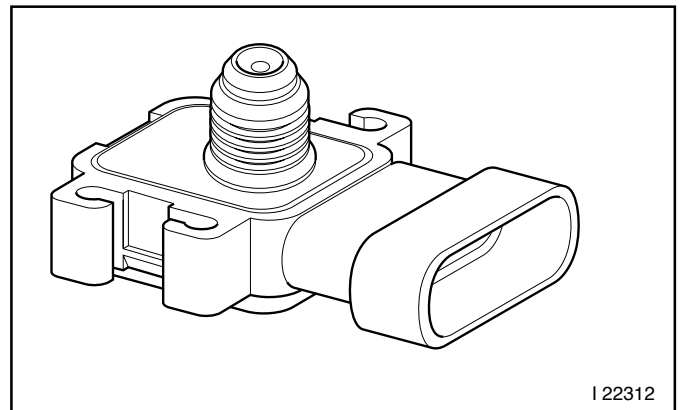
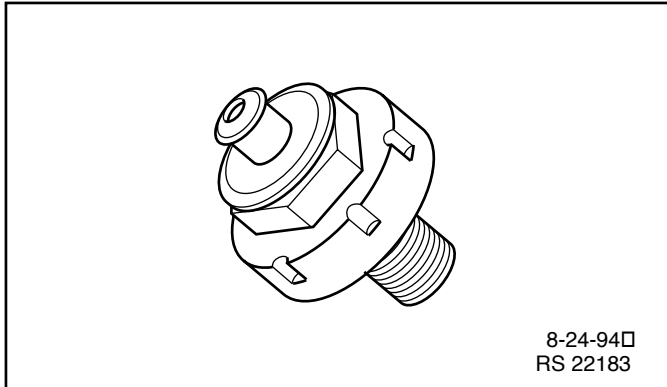


Figure 2-8 - Manifold Absolute Pressure (MAP) Sensor (Used On 5.0/5.7L/L29 Engines)

**Knock Sensor**

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

An ECM is used in conjunction with a knock sensor in order to control detonation. The knock module circuitry is internal in the ECM.



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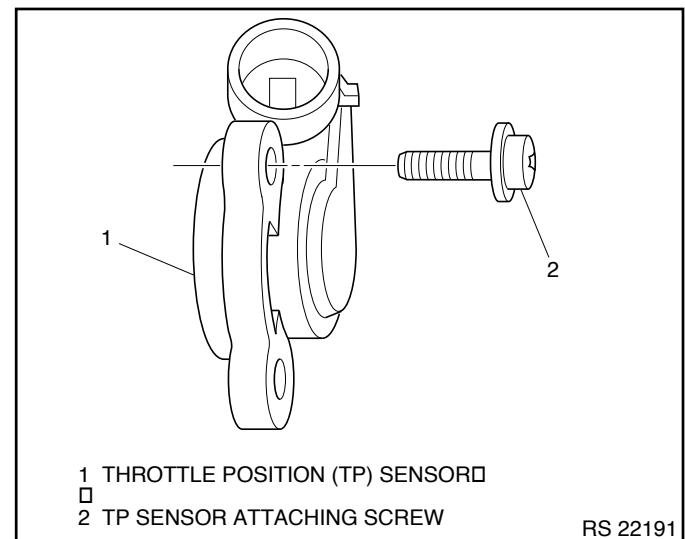
Figure 2-9 - Knock Sensor (Typical)

When knock is present, a small AC voltage is produced by the knock sensor and transmitted to the ECM. An AC voltage monitor inside the ECM will detect the knock and start retarding spark timing.

**Throttle Position (TP) Sensor**

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.

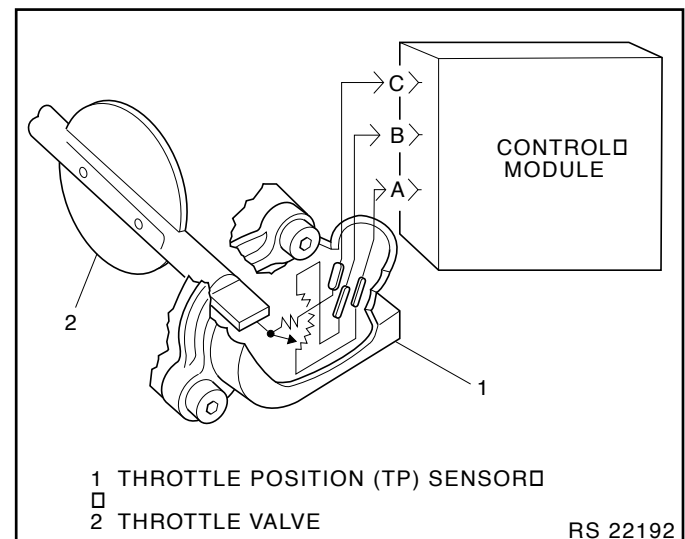
The ECM calculates fuel delivery based on throttle valve angle (driver demand). A broken or loose TP sensor may cause intermittent bursts of fuel from an injector and unstable idle because the ECM thinks the throttle is moving. A hard failure in the TP sensor circuit should set either a DTC 21 or DTC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



1 THROTTLE POSITION (TP) SENSOR  
2 TP SENSOR ATTACHING SCREW

RS 22191

Figure 2-10 - Throttle Position (TP) Sensor (Typical)



1 THROTTLE POSITION (TP) SENSOR  
2 THROTTLE VALVE

RS 22192

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

### Intake Air Temperature (IAT) Sensor

The Intake Air Temperature (IAT) sensor is a thermistor which changes value based on the temperature of air entering the engine (Figure 2-11). Low temperature produces a high resistance (100,000 ohms at  $-40^{\circ}\text{C}/-40^{\circ}\text{F}$ ) while high temperature causes low resistance (70 ohms at  $130^{\circ}\text{C}/266^{\circ}\text{F}$ ).

The ECM supplies a 5 volt signal to the sensor through a resistor in the ECM and measures the voltage. The voltage will be high when the incoming air is cold, and low when the incoming air is hot. By measuring the voltage, the ECM calculates the incoming air temperature. The IAT sensor signal is used to determine spark timing based on incoming air density.

The scan tool displays temperature of the air entering the engine, which should read close to ambient air temperature when engine is cold, and rise as engine compartment temperature increases. If the engine has not been run for several hours (overnight), the IAT sensor and ECT sensor temperatures should read close to each other. A failure in the IAT sensor circuit should set DTC 23 or DTC 25.

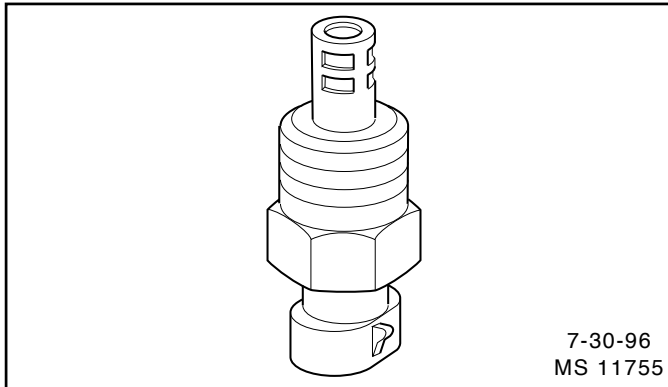


Figure 2 -12 - Intake Air Temperature (IAT) Sensor  
(All Except 5.0/5.7L MEFI Engines)

### 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 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.

### 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:

•	Oil level	N/O
•	Oil pressure	N/O
•	Emergency stop	N/O
•	General Warning 1	N/O
•	General Warning 2	N/O
•	Shift Interrupt/Load Anticipate 1	N/O
•	Load Anticipate 2	N/O

## 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 more than one circuit, following the diagnostic procedures 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:

- ï 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.
- ï EEPROM program is not correct for the application. Incorrect components may cause a malfunction and may or may not set a DTC.
- ï 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.
- ï 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) Replacement

*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

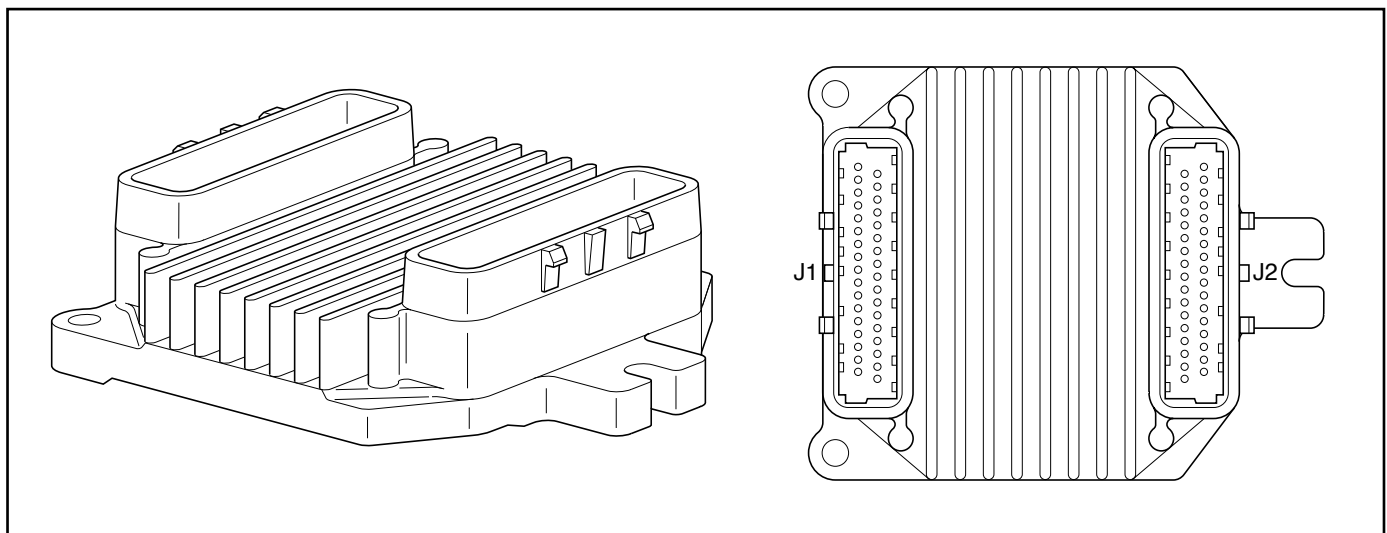
1. Negative battery cable.
2. *J1* and *J2* connectors from ECM.
3. Three ECM mounting screws.
4. ECM from mounting bracket.

#### Important

- ï 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. Three ECM mounting screws. Torque to 10-14 N·m (88-124 lb in).
3. *J1* and *J2* connectors to ECM.
4. Negative battery cable.



MEFI3004

Figure 2-13 - Engine Control Module (ECM)

### Engine Coolant Temperature (ECT) Sensor

Figure 2-14 and 2-15

**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. Torque to 12 N·m (108 lb in).
2. ECT electrical connector.
3. Negative battery cable.

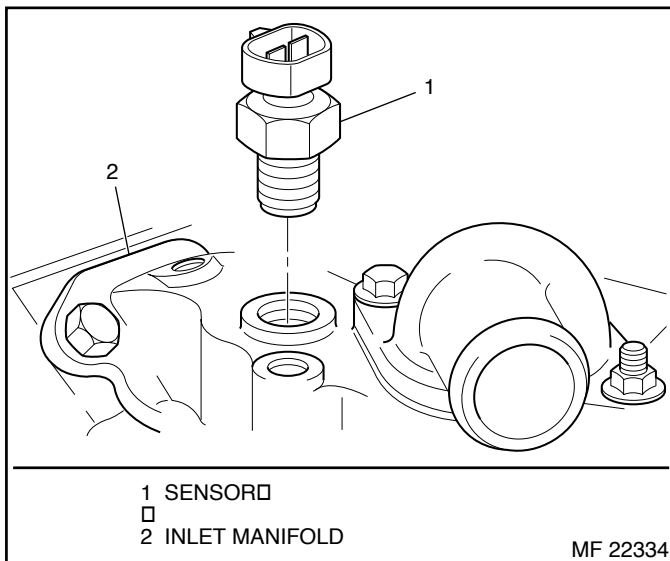


Figure 2-14 - Engine Coolant Temperature (ECT) Sensor (On 7.4L TBI Engines)

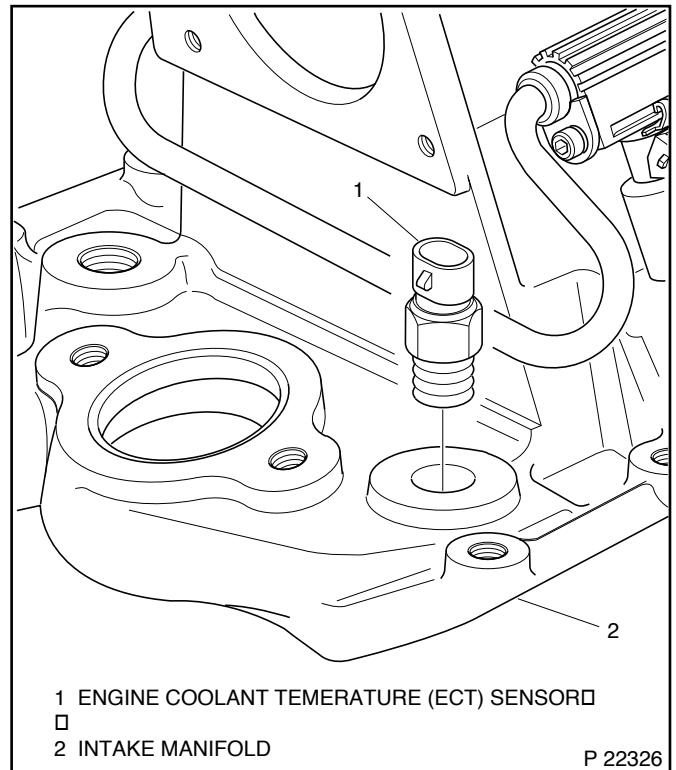


Figure 2-15 - Engine Coolant Temperature (ECT) Sensor (On 5.0/5.7L Engines)

**Manifold Absolute Pressure (MAP) Sensor**

Figure 2-16 through 2-19

**Remove or Disconnect**

1. Negative battery cable.
2. MAP sensor electrical connector.
3. MAP sensor attaching screws.
4. MAP sensor with seal.

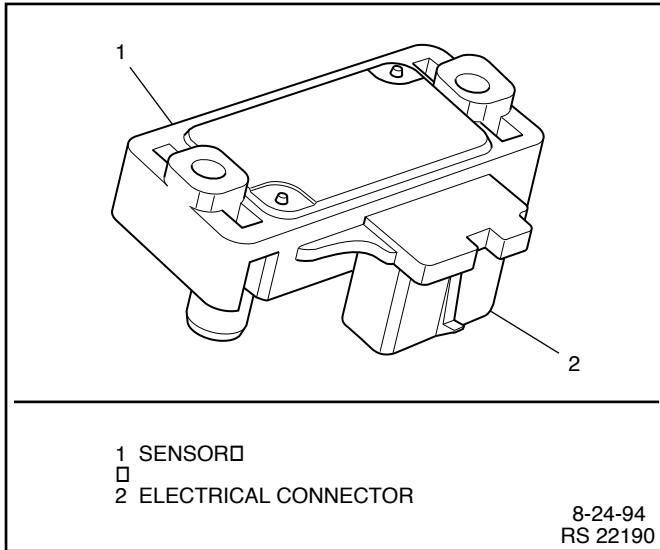


Figure 2-16 - Manifold Absolute Pressure (MAP) Sensor  
 (For 7.4/8.2L TBI Only)

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

**Install or Connect**

1. New seal on MAP sensor.
2. MAP sensor.
3. MAP sensor attaching screws. Torque to 5-7 Nïm (44-62 lb in).
4. MAP sensor electrical connector.
5. Negative battery cable.

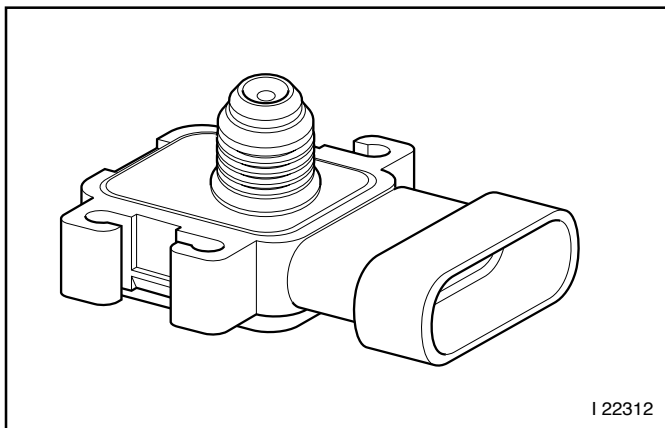


Figure 2-17 - Manifold Absolute Pressure (MAP) Sensor  
 (For 5.0/5.7L/L29 Only)

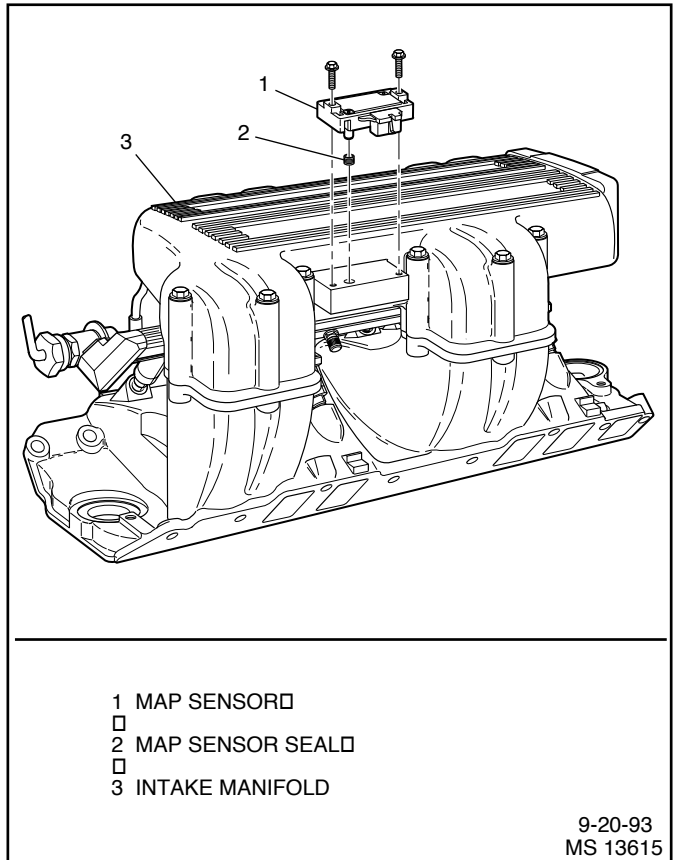


Figure 2-18 - MAP Sensor Mounting Location  
 (For 7.4/8.2L TBI Only)

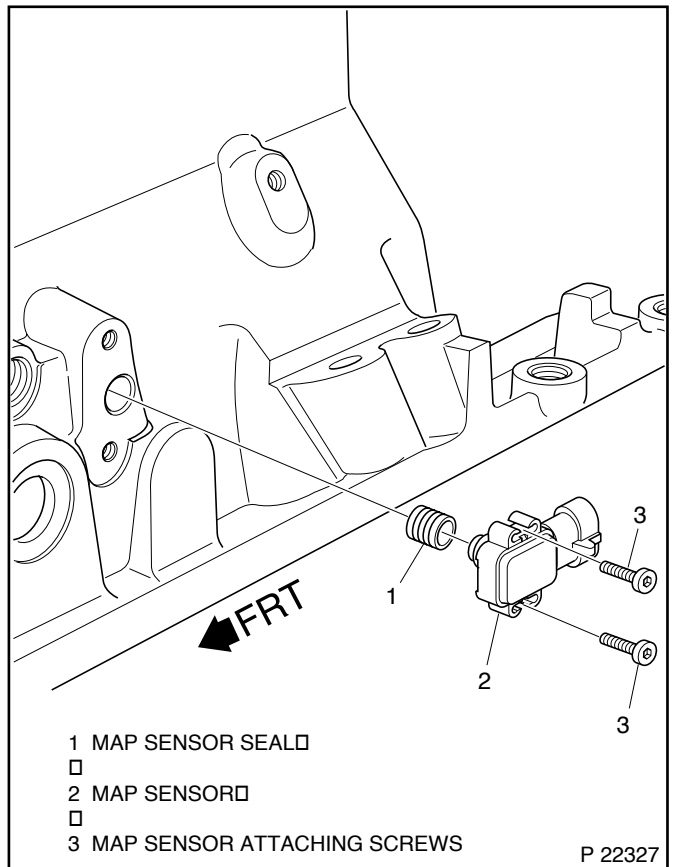


Figure 2-19 - MAP Sensor Mounting Location  
 (For 5.0/5.7L/L29 Only)



**Throttle Position (TP) Sensor**

Figures 2-20 and 2-21

**Remove or Disconnect**

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

**Important**

- ï The TP sensor is an electrical component. Do Not soak in any liquid cleaner or solvent, as damage may result.
- ï 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 2-20.
2. With throttle valve in the normal closed position (idle), install TP sensor on throttle body assembly, making sure TP sensor pickup lever lines up with the tang on the throttle actuator lever.
3. TP sensor attaching screws. Torque to 2 Nim (18 lb in).
4. TP sensor electrical connector.
5. Flame arrestor.

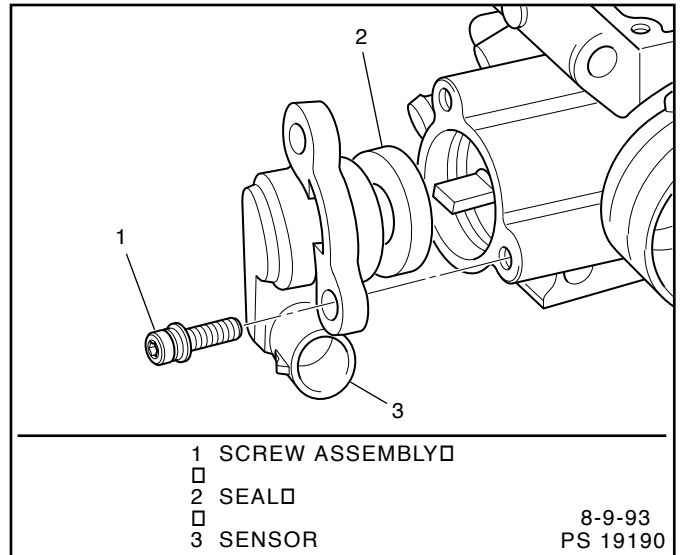


Figure 2-20 - Throttle Position (TP) Sensor

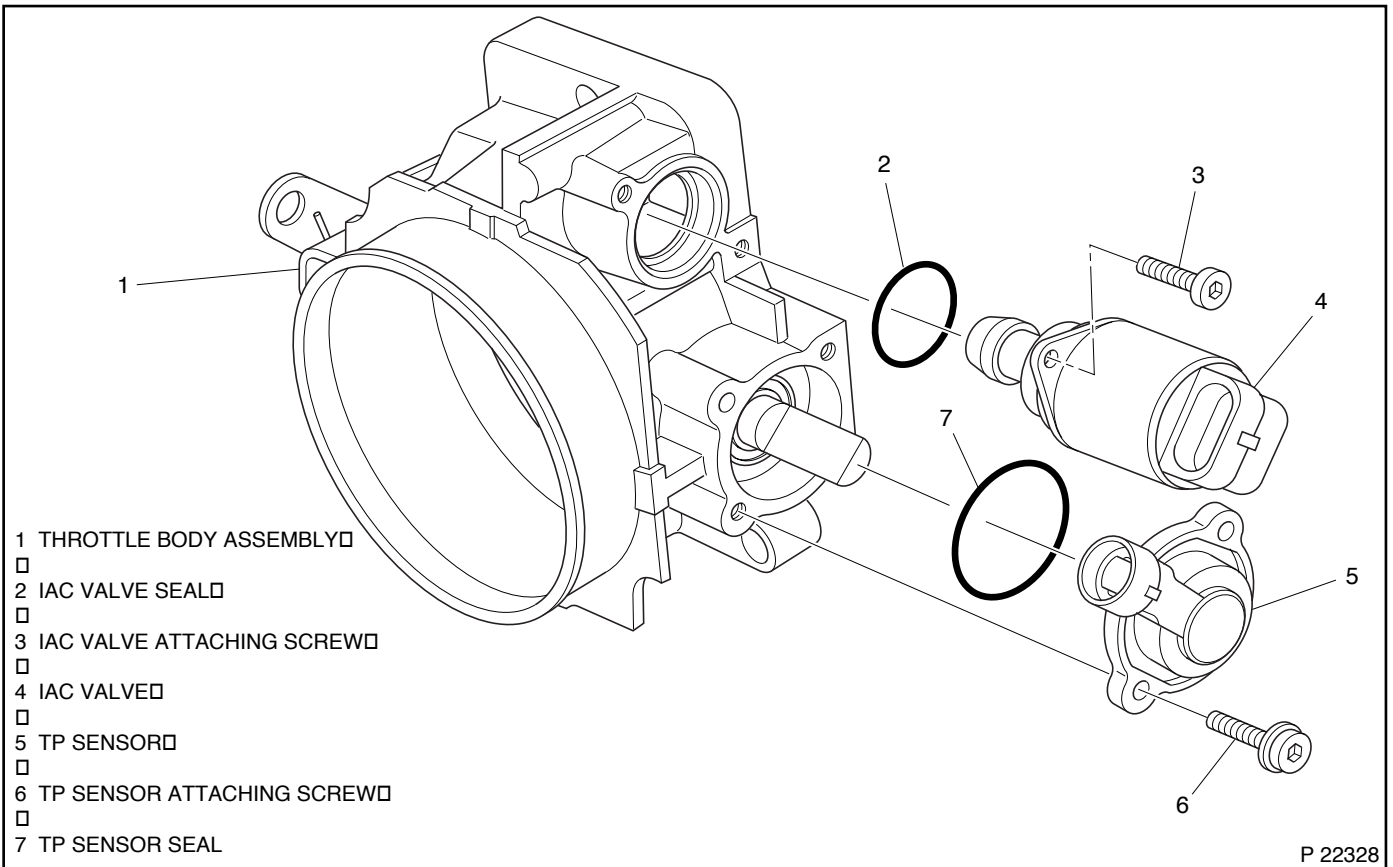


Figure 2-21 - Throttle Body Assembly  
(For 5.0/5.7L/L29 Engines)

## Idle Air Control (IAC) Valve

Figure 2-22

### Remove or Disconnect

1. Flame arrestor.
2. IAC electrical connector.
3. IAC valve attaching screws.
4. IAC valve 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

- ï Clean IAC valve O-ring sealing surface, pintle valve seat and air passage.
  - ñ 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.
  - ñ Shiny spots on the pintle or seat are normal, and do not indicate misalignment or a bent pintle shaft.

### Important

- ï 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.

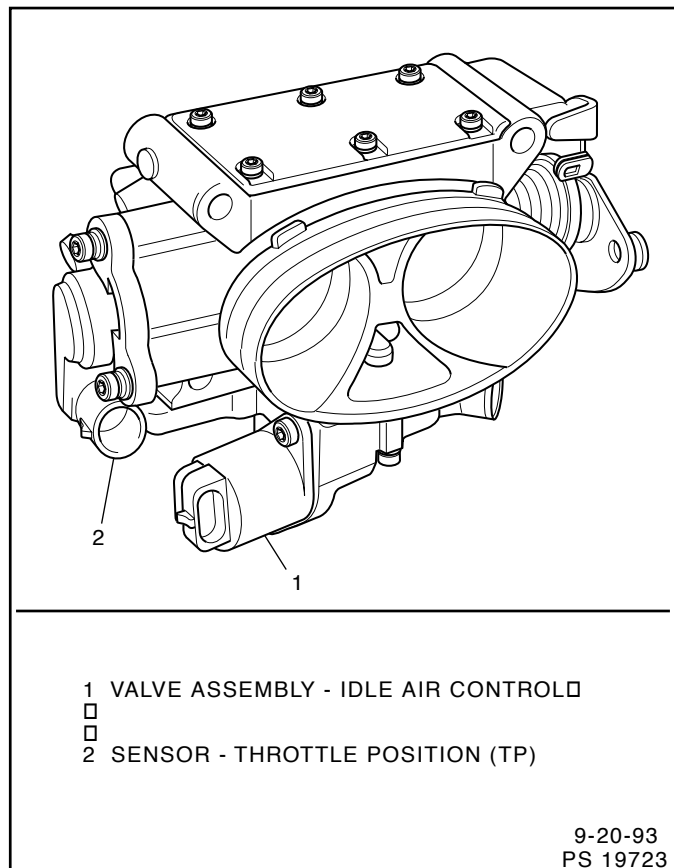


Figure 2-22 - Throttle Body Assembly  
 (For 7.4/8.2L Only)

## Measure (If installing a new IAC valve)

Figure 2-23

- ï Distance between tip of IAC valve pintle and mounting surface.
  - ñ 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.

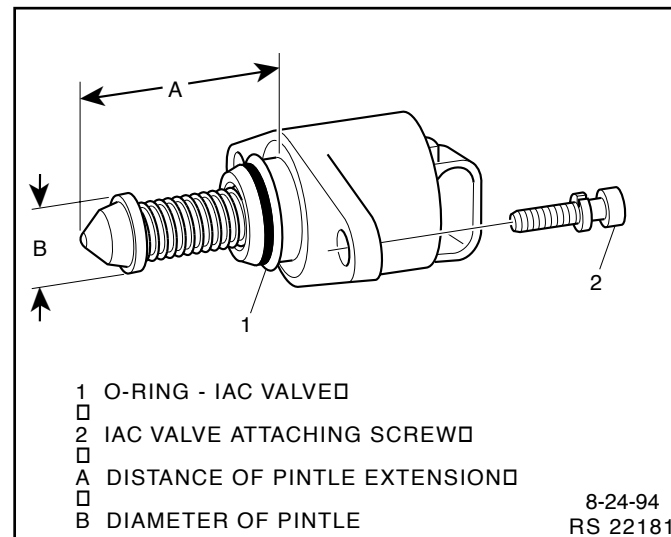


Figure 2-23 - Flange Mounted Type IAC Valve

### Install or Connect

1. New O-ring on IAC valve and lubricate.
- Notice:** New IAC valves have been preset at the factory and should not require any adjustment.
2. IAC valve to throttle body using attaching screws. Torque to 3.2 Nm (28 lb in).
  3. IAC valve electrical connector.
  4. Reset IAC valve pintle position:
    - ï Turn ignition *OFF* for 10 seconds.
    - ï Start and run engine for 5 seconds.
    - ï Ignition *OFF* for 10 seconds.
    - ï Restart engine and check for proper idle.

## Intake Air Temperature (IAT) Sensor

Figures 2-24 and 2-25

**Notice:** Care must be taken when handling the IAT sensor. Damage to the sensor will affect proper operation of the MEFI system.

### Remove or Disconnect

1. Negative battery cable.
2. IAT sensor electrical connector.
3. IAT sensor.

### Important

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

### Install or Connect

1. IAT sensor. Torque to 15 N·m (11 lb.ft.).
2. IAT sensor electrical connector.
3. Negative battery cable.

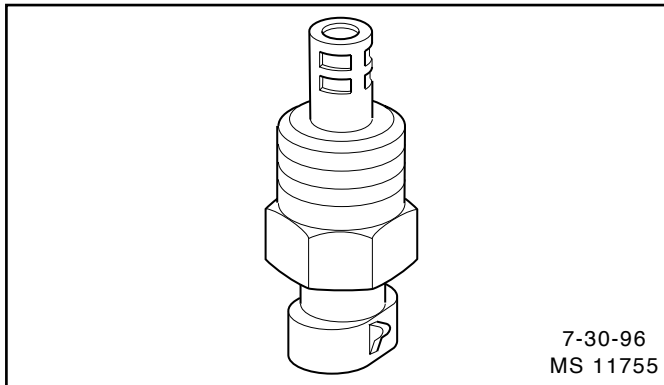


Figure 2-24 - Intake Air Temperature (IAT) Sensor

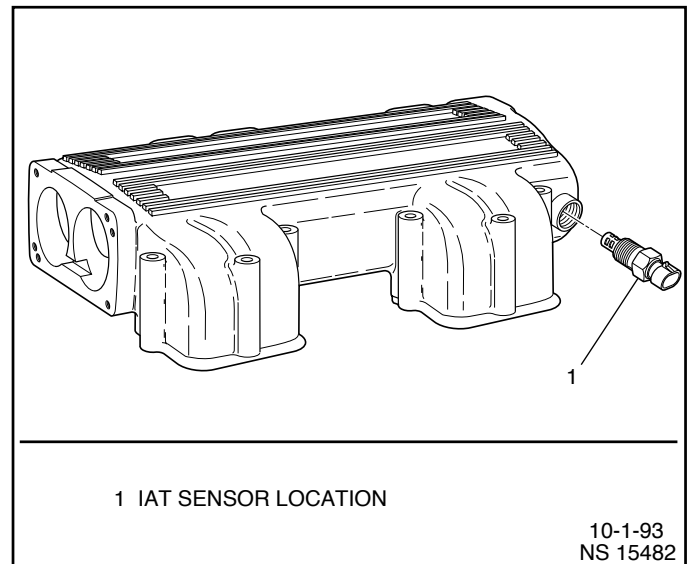


Figure 2-25 - IAT Sensor Location

**Knock Sensor (KS)**

Figures 2-26 and 2-27

**Remove or Disconnect**

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

**Important**

- ï If installing a new knock sensor, be sure to replace with an identical part number.
- ï When installing knock sensor, be sure to install in the same location removed from.
- ï 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 Nïm (11-16 lb ft).
2. Knock sensor electrical connector.
3. Negative battery cable.

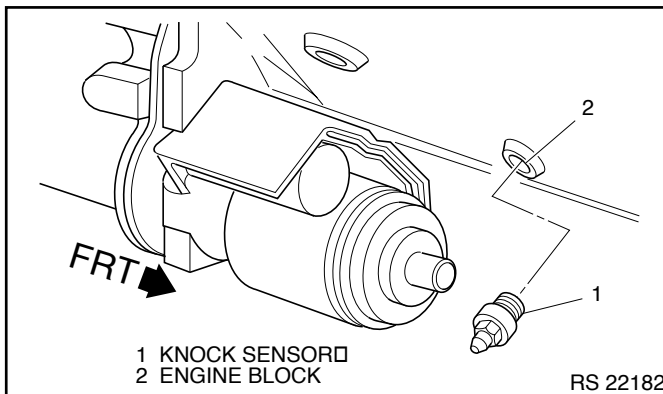


Figure 2-26 - Knock Sensor Location

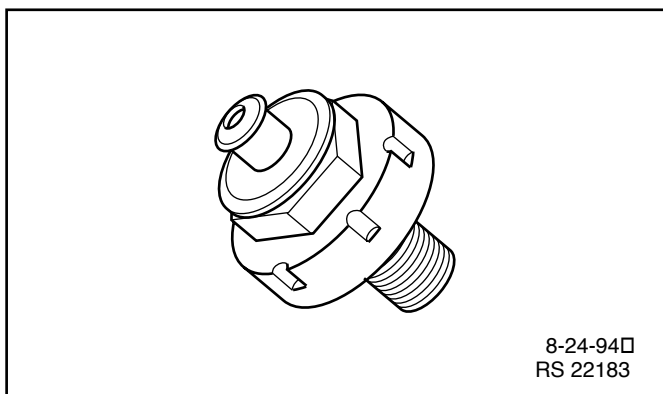


Figure 2-27 - Typical Knock Sensor

**Torque Specifications**

**Fastener Tightening Specifications**

Application	Nïm	Lb Ft	Lb In
ECM Mounting Screws	10-14		88-124
ECT Sensor	12		108
IAT Sensor	15	11	
MAP Sensor Attaching Screws	5-7		44-62
TP Sensor Attaching Screws	2		18
IAC Valve Attaching Screws	3.2		28
Knock Sensor	15-22	11-16	

## Marine Electronic Fuel Injection (MEFI)

### Section 3A

## Fuel Metering System - Port Fuel Injection (PFI) - 5.0/5.7L

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 Port Fuel Injection (PFI) used on the 5.0/5.7L. All other systems will be detailed in a separate manual. In distinguishing fuel systems used on specific applications, the following rules apply. PFI 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. TBI systems use two injectors mounted at the top of the throttle body assembly.

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## General Description

### Purpose

The function of the fuel metering system is to deliver the correct amount of fuel to the engine under all operating conditions. Fuel is delivered to the engine by individual fuel injectors mounted in the intake manifold near each cylinder.

### 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, injector 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 fuel cutoff is in effect due to high RPM, injector pulses will resume after engine RPM drops below the maximum OEM RPM specification (Rev Limit).

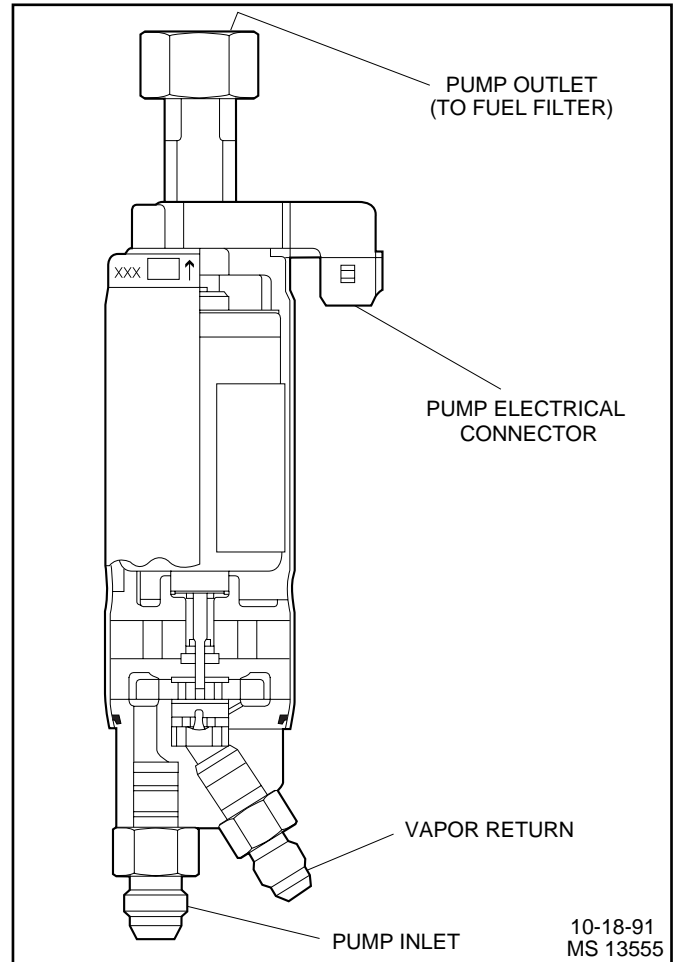
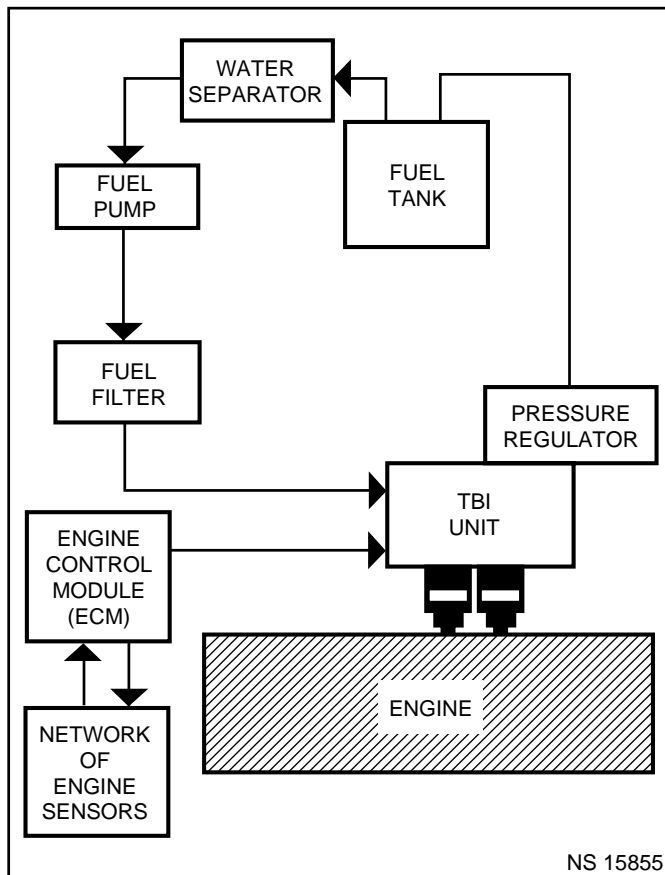
### RPM Reduction Mode

The ECM recognizes a change of state in a discrete switch input that identifies an abnormal condition. During these abnormal conditions, 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

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

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



### Fuel Supply Components (Typical)

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 fuel rail assembly. The pump is designed to provide fuel at a pressure greater than is needed by the injectors. The pressure regulator, part of the fuel rail assembly, keeps fuel available to the injectors at a regulated pressure. Unused fuel is returned to the fuel tank by a separate line.

**Fuel Pump Electrical Circuit**

When the ignition switch is turned ìON,î the ECM turns the fuel pump relay ìONî 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 ìONî causing the fuel pump to run.

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

An inoperative fuel pump relay will result in an ìEngine Cranks But Will Not Runî condition.

**Fuel Rail Assembly**

The fuel rail (Figure 3-3) is mounted to the engine intake manifold, and performs several functions. It positions the injectors in the intake manifold, distributes fuel evenly to the injectors, and integrates the fuel pressure regulator into the fuel metering system.

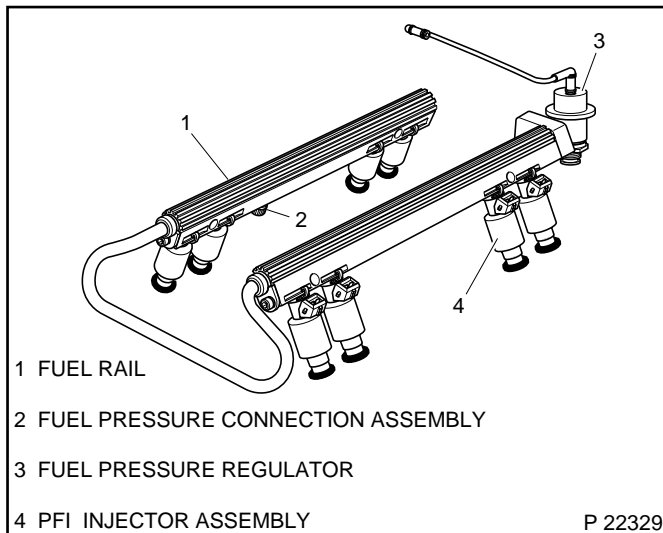


Figure 3-3 - Fuel Rail Assembly

**Fuel Injectors**

The Port Fuel Injection (PFI) injector assembly is a solenoid-operated device, controlled by the ECM, that meters pressurized fuel to a single engine cylinder (Figure 3-4). The ECM energizes the injector solenoid, which opens a ball valve, allowing fuel to flow past the ball valve, and through a recessed flow director plate. The director plate has six machined holes that control the fuel flow, generating a conical spray pattern of finely atomized fuel at the injector tip. Fuel is directed at the intake valve, causing it to become further atomized and vaporized before entering the combustion chamber.

An injector that is stuck partly open would cause loss of pressure after engine shut down. 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 ìOFF.î A fuel injector that does not open, may cause a ìno-startî or a misfire.

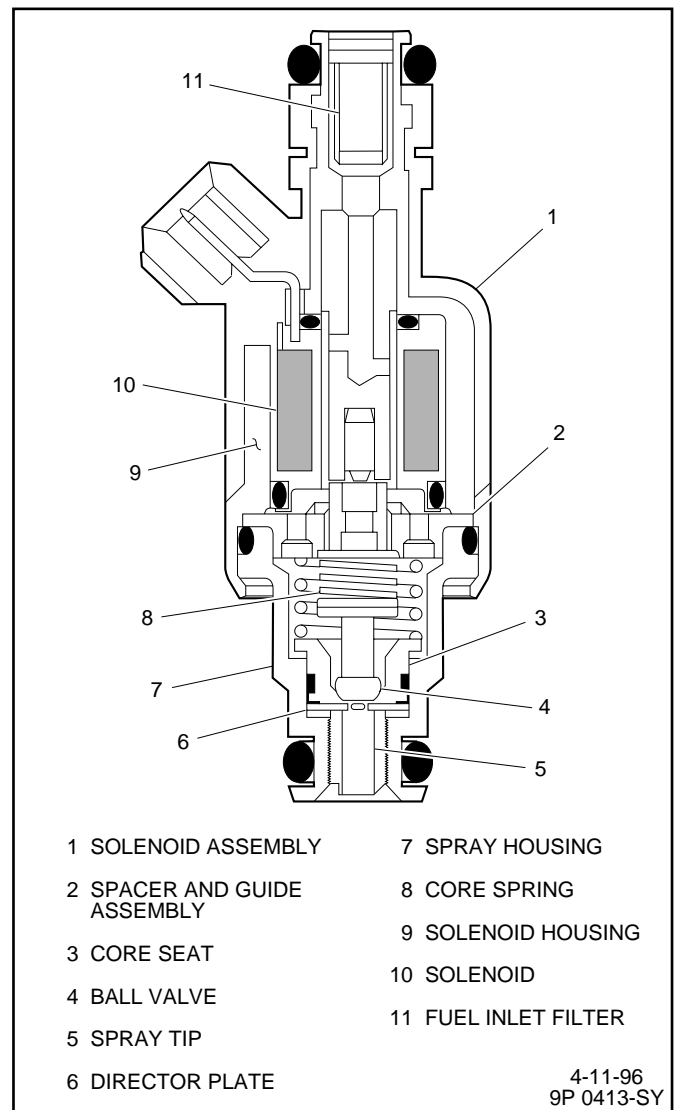


Figure 3-4 - PFI Injector Assembly (Typical)



**Pressure Regulator Assembly**

The pressure regulator is a diaphragm-operated relief valve with fuel pump pressure on one side, and regulator spring pressure and intake manifold vacuum on the other side (Figure 3-5). The regulatorís function is to maintain a constant pressure differential across the injectors at all times. The pressure regulator compensates for engine load by increasing fuel pressure as engine vacuum drops.

With the ignition iON,î engine iOFFî (zero vacuum), fuel pressure at the pressure test connection should be 284-325 kPa (41-47 psi). If the pressure is too low, poor performance or a ino-startî may result. If pressure is too high, excessive odor may result.

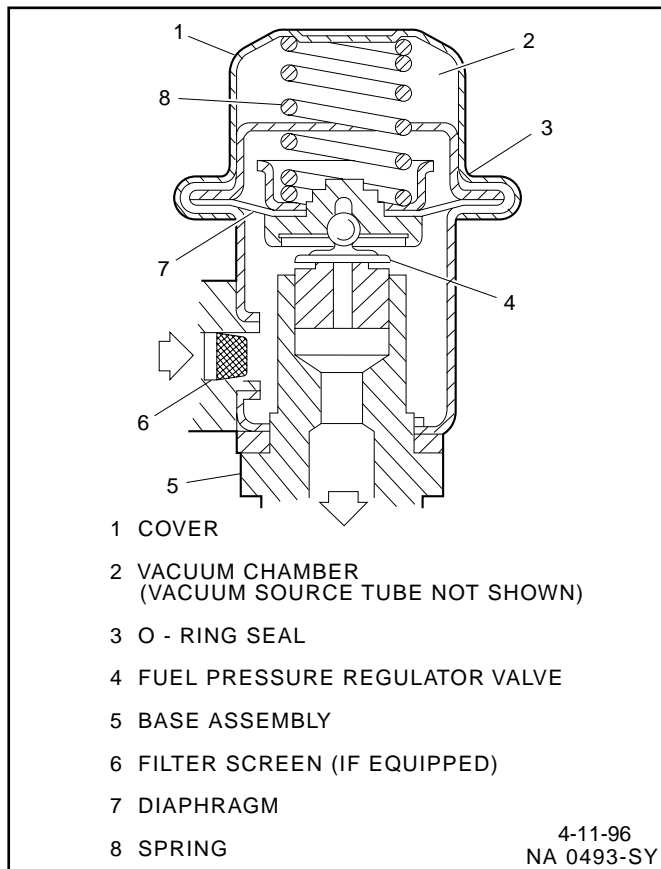


Figure 3-5 - Pressure Regulator Assembly (Typical)

**Throttle Body Assembly**

The throttle body assembly is attached to the intake manifold air plenum, and is used to control air flow into the engine, thereby controlling engine output (Figure 3-6). The throttle plates within the throttle body are opened by the driver through the throttle controls. During engine idle, the throttle plates are closed, and air flow control is handled by the Idle Air Control (IAC) valve, described below.

The throttle body also provides the location for mounting the TP sensor and for sensing changes in engine vacuum due to throttle plates position.

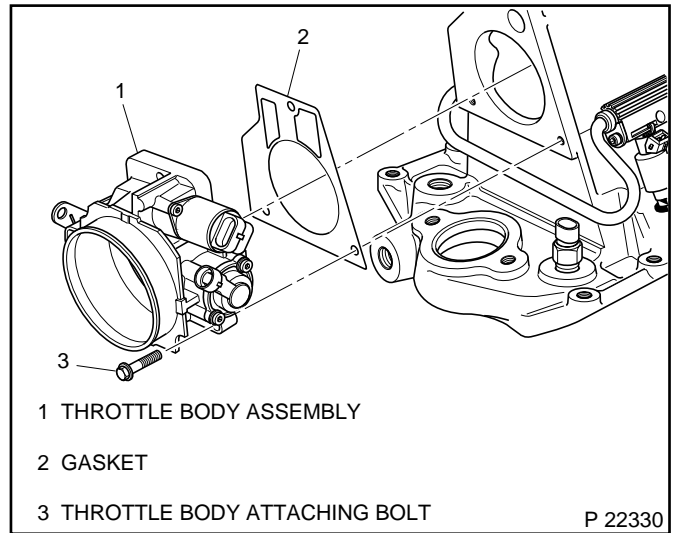


Figure 3-6 - Throttle Body Assembly

**Idle Air Control (IAC) Valve**

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.

The IAC valve, mounted to the throttle body, controls bypass air around the throttle plates (Figure 3-7). 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 monitored 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.

- ï Engine idle speed is a function of total air flow into the engine based on IAC valve pintle position plus throttle plates opening.

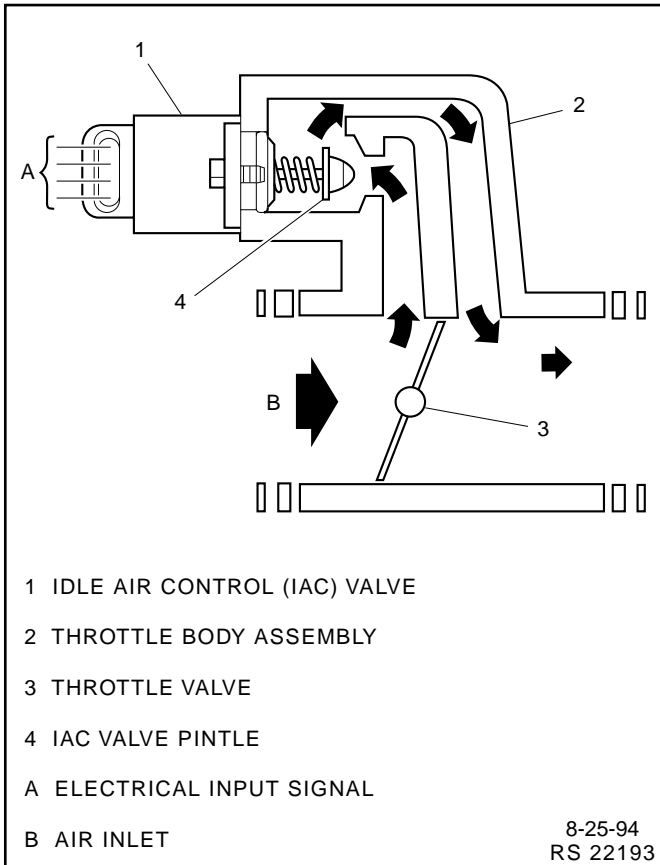


Figure 3-7 - IAC Valve Air Flow Diagram

- ï iControlledí 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.
- ï 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 at a calibrated number of steps (counts) from the seat, during icontrolledí 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.

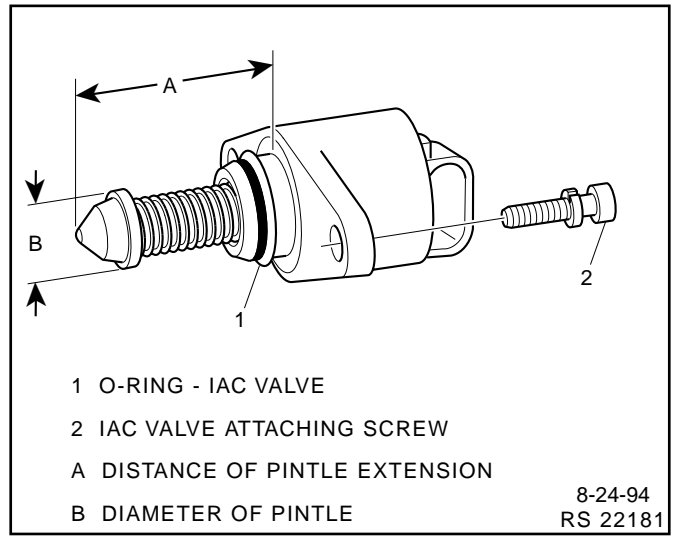


Figure 3-8 - Flange Mounted Type IAC Valve

**Diagnosis**

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

**On-Board Service**

**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:

- ï Always keep a dry chemical fire extinguisher near the work area.
- ï Fuel pipe fittings require new O-rings when assembling.
- ï Do not replace fuel pipe with fuel hose.
- ï Always bleed off fuel pressure before servicing any fuel system components.
- ï Do not do any repairs on the fuel system until you have read the instructions and checked the figures relating the repair.
- ï Observe all notices and cautions.

### Fuel Pressure Relief Procedure

Tool Required:

J 34730-1, Fuel Pressure Gauge

### Important

- ï 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. Connect fuel pressure gauge J 34730-1 to fuel pressure connector assembly. Wrap a shop towel around fitting while connecting the gauge to avoid any spillage.
4. Install bleed hose into an approved container and open valve to bleed system pressure. Fuel connections are now safe for servicing.
5. Drain any fuel remaining in the gauge into an approved container.

### Flame Arrestor

#### Remove or Disconnect

1. Flame arrestor retaining clamp.
2. Flame arrestor.

#### Inspect

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

#### Install or Connect

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

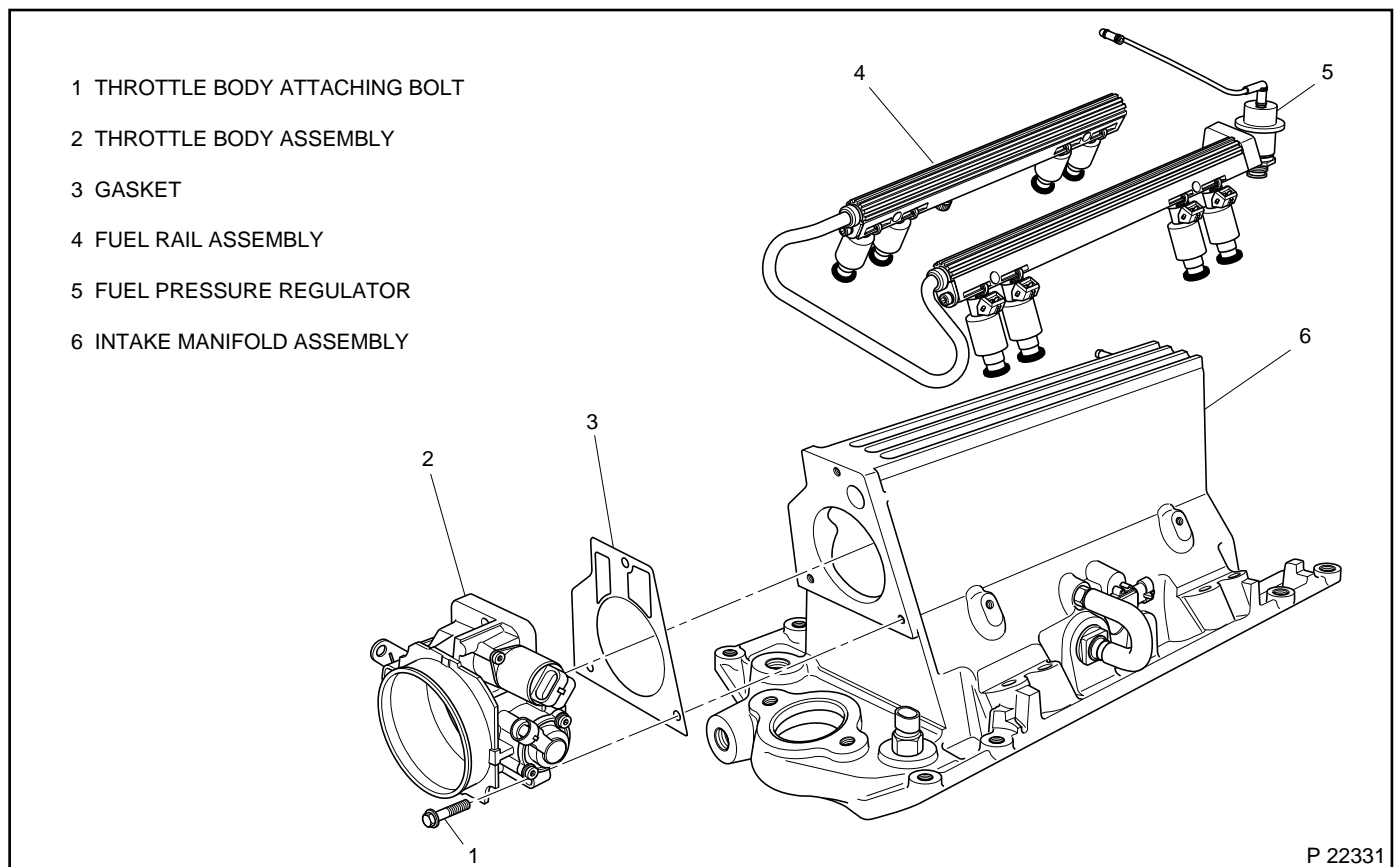


Figure 3-9 - Fuel Rail and Throttle Body Assemblies

## Throttle Body Assembly

Figures 3-10 and 3-11

The throttle body assembly repair procedures cover component replacement with the unit on the vessel. However, throttle body replacement requires that the complete unit be removed from the engine.

### Clean

#### Important

ï Do not soak the throttle body in cold immersion type cleaner. The throttle valves have a factory applied sealing compound (DAG material is applied to outside edge of each valve and throttle bore) to prevent air bypass at closed throttle. Strong solvents or brushing will remove the material. To clean the throttle body following disassembly, use a spray type cleaner such as GM X66-A or GM 1052626. Use a shop towel to remove heavy deposits.

**Notice:** The TP sensor and the IAC valve are electrical components and should NOT come in contact with solvent or cleaner as they may be damaged.

### Remove or Disconnect

1. Negative battery cable.
2. Flame arrestor.
3. Electrical connectors from TP sensor and IAC valve.
4. Vacuum lines.
5. Throttle adjuster to throttle body cable.
6. Throttle body attaching bolts.
7. Throttle body assembly and flange gasket.
  - ï Discard gasket.

### Clean

**Notice:** Use care in cleaning old gasket material from machined aluminum surfaces as sharp tools may damage sealing surfaces.

ï Gasket sealing surfaces.

### Install or Connect

1. Throttle body assembly with new flange gasket.
2. Throttle body attaching bolts. Torque to 15 N·m (11 lb.ft.).
3. Throttle adjuster to throttle body cable.
4. Vacuum lines.
5. Electrical connectors to TP sensor and IAC valve.
6. Flame arrestor.
7. Negative battery cable.

### Inspect

- ï With the engine ìOFF,î check to see that the throttle lever is free.
  - ñ Move the throttle lever to wide open throttle and release.

Reset IAC valve pintle position:

- ï Move throttle lever slightly.
- ï Start and run engine for 5 seconds.
- ï Turn ignition ìOFFî for 10 seconds.
- ï Restart engine and check for proper idle operation.

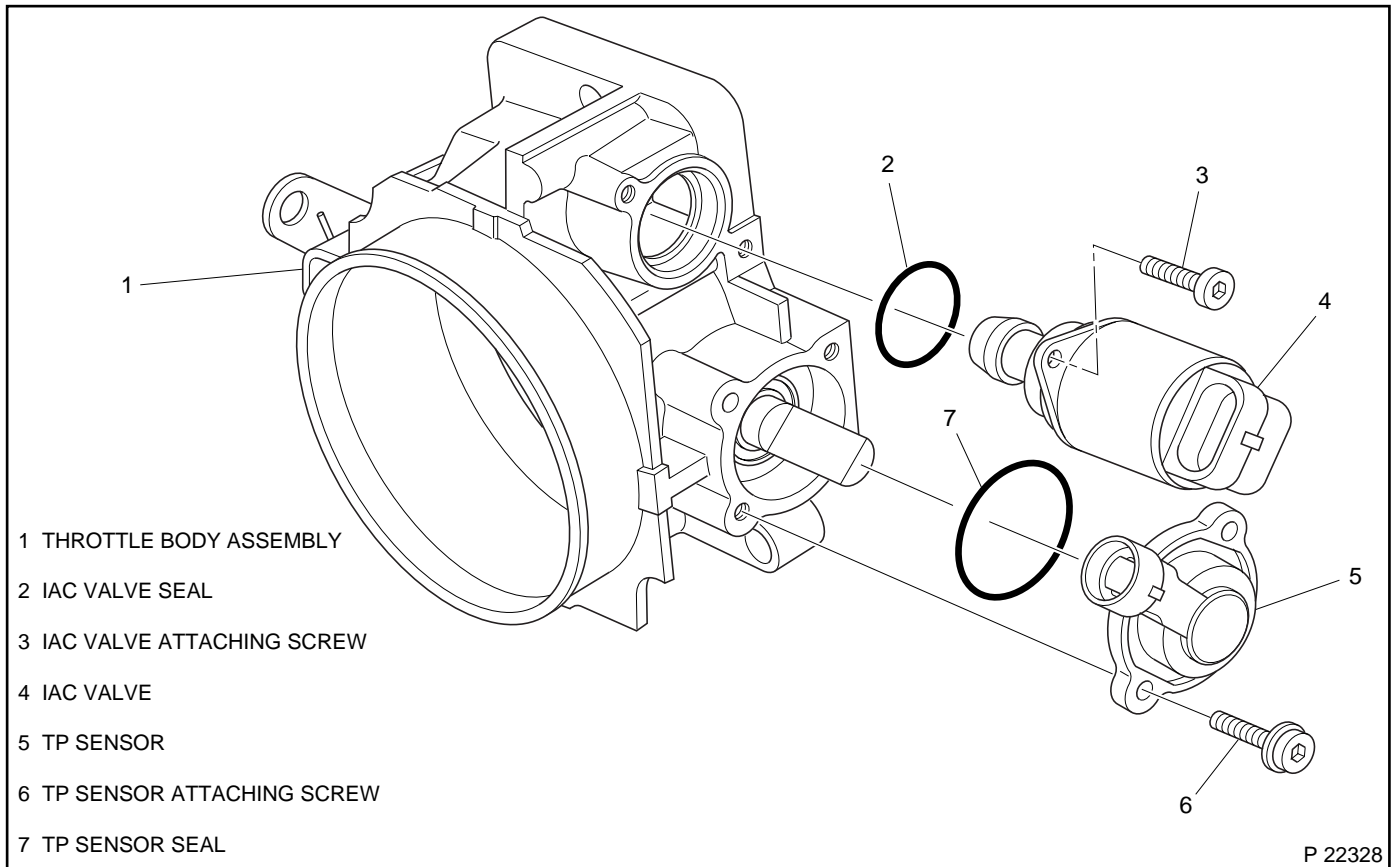


Figure 3-10 - Throttle Body Assembly

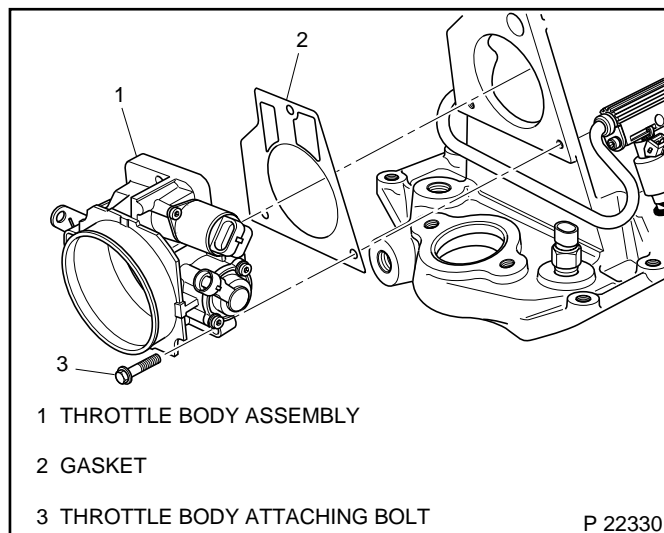


Figure 3-11 - Throttle Body Removal

## Fuel Pressure Connector Assembly

Figure 3-13

### Clean

- ï Area around fuel pressure connection with GM X-30A or equivalent.

### Remove or Disconnect

1. Negative battery cable.
2. Relieve fuel pressure.
  - ï Refer to the ìFuel Pressure Relief Procedure.î
3. Fuel pressure connection and seal.

### Install or Connect

1. New seal on fuel pressure connection.
2. Fuel pressure connection in fuel rail. Torque to 13 N·m (115 lb.in.).
3. Negative battery cable.

### Inspect

- ï Turn ignition switch to the ìONî position for 2 seconds, then turn to the ìOFFî position for 10 seconds. Turn the ignition switch back to the ìONî position and check for fuel leaks.

## Fuel Rail Assembly

Figures 3-12 and 3-13

The fuel rails should be removed as an assembly with the injectors attached. Names of component parts will be found on the numbered list that accompanies the disassembled view (Figure 3-13).

### Notice:

- ï Use care in removing the fuel rail assembly to prevent damage to the injector electrical connector terminals and the injector spray tips.
- ï When removed, support the rail to avoid damaging its components.
- ï Prevent dirt and other contaminants from entering open lines and passages. Fittings should be capped and holes plugged during servicing.

### Clean

- ï Before removal, the fuel rail assembly may be cleaned with a spray type engine cleaner, GM X-30A or equivalent, following package instructions. Do Not soak fuel rails in liquid cleaning solvent.

**Caution: Safety glasses must be worn when using compressed air as flying dirt particles may cause eye injury.**

- ï Where injectors fit into intake manifold, use compressed air to blow out dirt from around injectors before removing.

### Remove or Disconnect

**Caution: To reduce the risk of fire and personal injury, relieve the fuel system pressure before servicing the fuel system components.**

1. Negative battery cable.
2. Relieve fuel pressure.
  - ï Refer to the ïFuel Pressure Relief Procedure.ï
  - ï Fuel pressure connector assembly is located on right side rail in center of fuel rail.
3. Fuel inlet line, hold fitting in rail with a wrench to keep from turning.
4. Fuel outlet fitting at pressure regulator.
  - ï Hold pressure regulator with a wrench to keep from turning and damaging.
5. Vacuum line to fuel pressure regulator.
6. Retaining screw for pressure regulator and pressure regulator.
7. Electrical connectors from injectors.
  - ï To release electrical connector from injector, squeeze on metal loop with thumb and pull connector from injector.
8. Move wire harness out of way.
9. Four attaching screws for fuel rail.
10. Fuel rails as an assembly with injectors.

11. Injectors from rails, follow procedure for injector removal outlined in this section.
12. Retaining screws for fuel rail jumper line.
13. Twist and remove jumper line from rail.

### Clean and Inspect

**Notice:** If it is necessary to remove rust or burrs from the fuel rail pipes, use emery cloth in a radial motion with the tube end to prevent damage to the O-ring sealing surface.

- ï Use a clean shop towel to wipe off male pipe ends.
- ï Inspect all connectors for dirt and burrs. Clean or replace components/assemblies as required.

### Disassemble

- ï Injector O-ring seal from spray tip end of each injector. Discard O-ring seals.

### Assemble

- ï Lubricate new injector O-ring seals with clean engine oil and install on spray tip end of each injector.

### Install or Connect

1. Lubricate new O-ring seals and install on rail jumper line ends.
2. Rail jumper line in rails, long side of jumper to left rail.
3. Jumper line attaching screws. Torque to 7 Nïm (62 lb.in.).
4. Lubricate injector O-ring seals and install injectors following injector installation procedure outlined in this section.
5. Fuel rails as an assembly with injectors onto intake manifold.
  - ï If injectors are lined up properly they will slide into place.
  - ï Push gently and evenly on rail to set injectors all the way into their bores
6. Fuel rail attaching screws. Torque to 10 Nïm (88 lb.in.).
7. Injector electrical connectors and secure harness in place.
8. Lubricate new O-ring seal on pressure regulator and install pressure regulator.
9. Pressure regulator attaching screw. Torque to 9.5 Nïm (84 lb.in.).
10. Vacuum line to fuel pressure regulator.
11. Lubricate new O-ring seal on pressure regulator outlet fitting and tighten fitting, careful not to twist regulator. Torque to 17.5 Nïm (13 lb.ft.).
12. Inlet fuel line.
13. Negative battery cable.
14. Prime fuel system by cycling key ïONï and ïOFFï a few times with engine ïOFF.ï

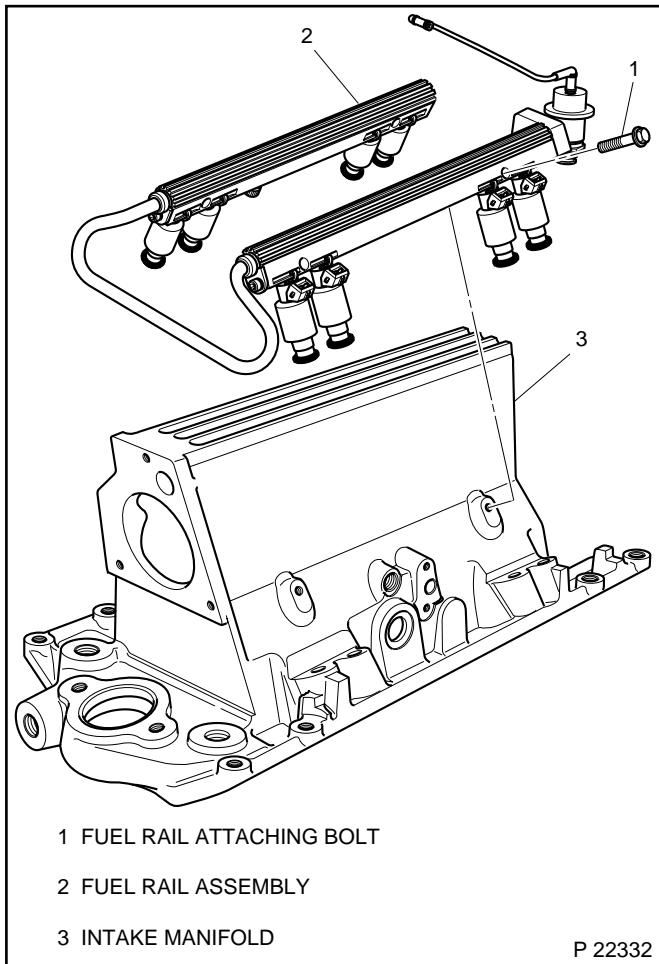
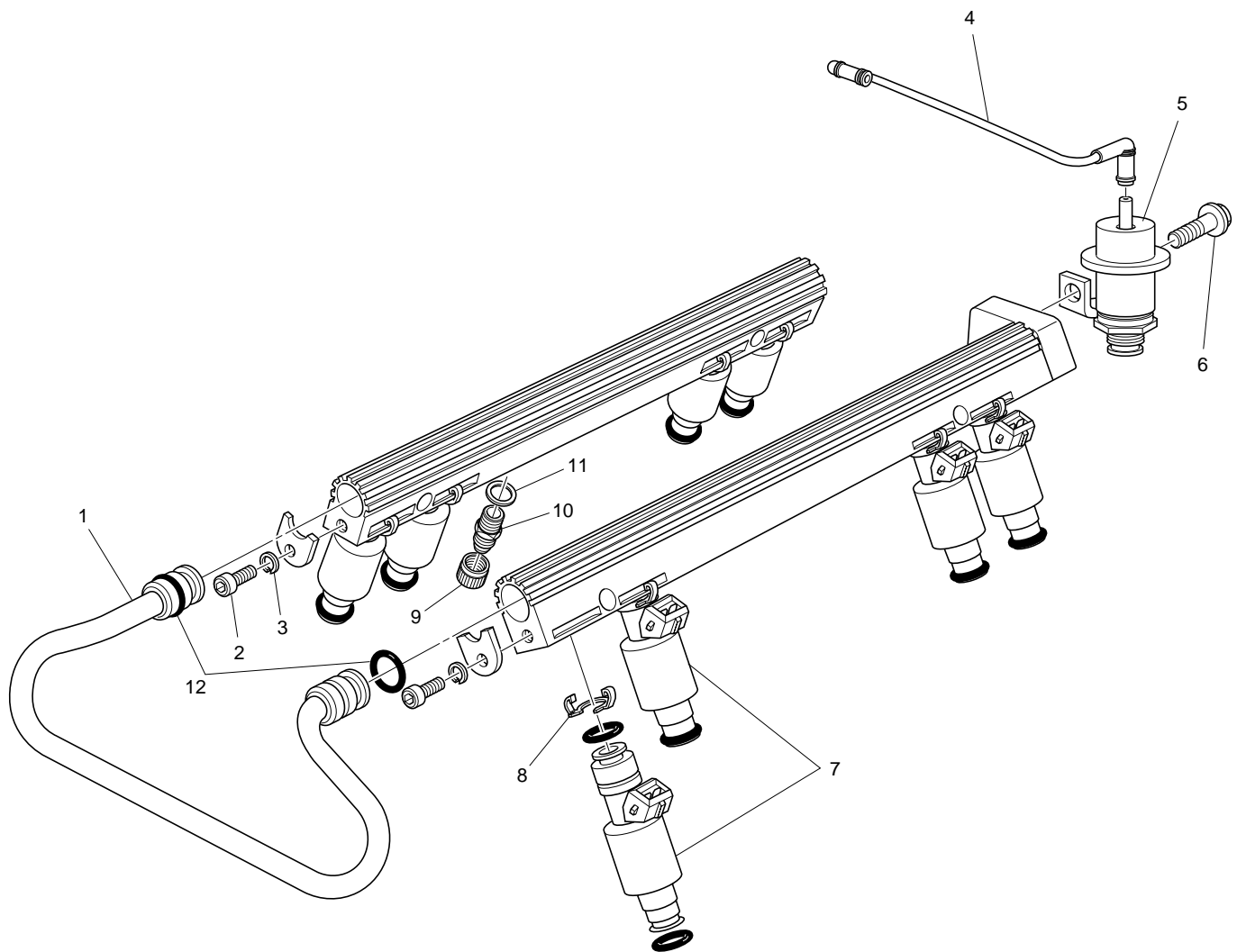


Figure 3-12 - Fuel Rail Removal and Installation

### Inspect

- İ Turn ignition switch to the iONi position for 2 seconds, then turn to the iOFFi position for 10 seconds. Turn the ignition switch back to the iONi position and check for fuel leaks.



- 1 FUEL RAIL JUMPER LINE
- 2 FUEL RAIL JUMPER LINE ATTACHING SCREW
- 3 FUEL RAIL JUMPER LINE WASHER
- 4 FUEL PRESSURE REGULATOR VACUUM LINE
- 5 FUEL PRESSURE REGULATOR ASSEMBLY
- 6 FUEL PRESSURE REGULATOR ATTACHING BOLT
- 7 PFI FUEL INJECTOR O - RING
- 8 PFI FUEL INJECTOR RETAINER CLIP
- 9 FUEL PRESSURE CONNECTION CAP
- 10 FUEL PRESSURE CONNECTION ASSEMBLY
- 11 FUEL PRESSURE CONNECTION SEAL
- 12 O - RINGS

P 22333

Figure 3-13 - Fuel Rail Assembly



## Fuel Injectors

Figures 3-13 through 3-15

**Notice:** Use care in removing injectors to prevent damage to the injector electrical connector pins or the injector spray tips. The fuel injector is serviced as a complete assembly only. Since it is an electrical component, Do Not immerse it in any cleaner.

### Remove or Disconnect

1. Negative battery cable.
2. Relieve fuel pressure.
  - ï Refer to the iFuel Pressure Relief Procedure.î
3. Fuel rail assembly following the procedures outlined in this section.

### Disassemble

1. Release injector clip by sliding off injector (Figure 3-14).
2. PFI injector from rail.
3. Injector O-ring seals from both ends of the injector and discard.
4. Injector retainer clip from rail.

### Clean and Inspect

- ï Injector bores in fuel rail and intake manifold for nicks, burrs or corrosion damage. If severe, replace. Clean lightly with emery cloth in a radial motion.
- ï Injector O-ring seal grooves for nicks, burrs or corrosion. Replace injector if damaged. Clean with spray cleaner and wipe groove clean with lint free cloth.
- ï Do Not use abrasive materials or wire brush on injectors. They are plated with an anti-corrosive material.

### Important

- ï When ordering individual replacement fuel injectors, be sure to order the identical part number that is inscribed on the old injector.

### Assemble

1. Lubricate new injector O-ring seals with clean engine oil and install on injector.
2. New retainer clip onto injector.
3. PFI fuel injector assembly into fuel rail injector socket with electrical connector facing outward.
4. Rotate injector retainer clip to locking position.

### Install or Connect

1. Fuel rail assembly following procedures outlined in this section.
2. Negative battery cable.

### Inspect

- ï Turn ignition switch to the iONî position for 2 seconds, then turn to the iOFFî position for 10 seconds. Turn the ignition switch back to the iONî position and check for fuel leaks.

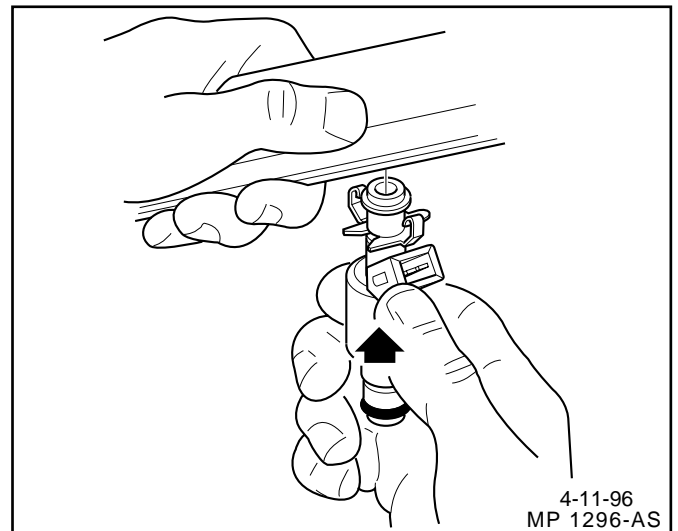


Figure 3-14 - PFI Fuel Injector and Retainer Clip

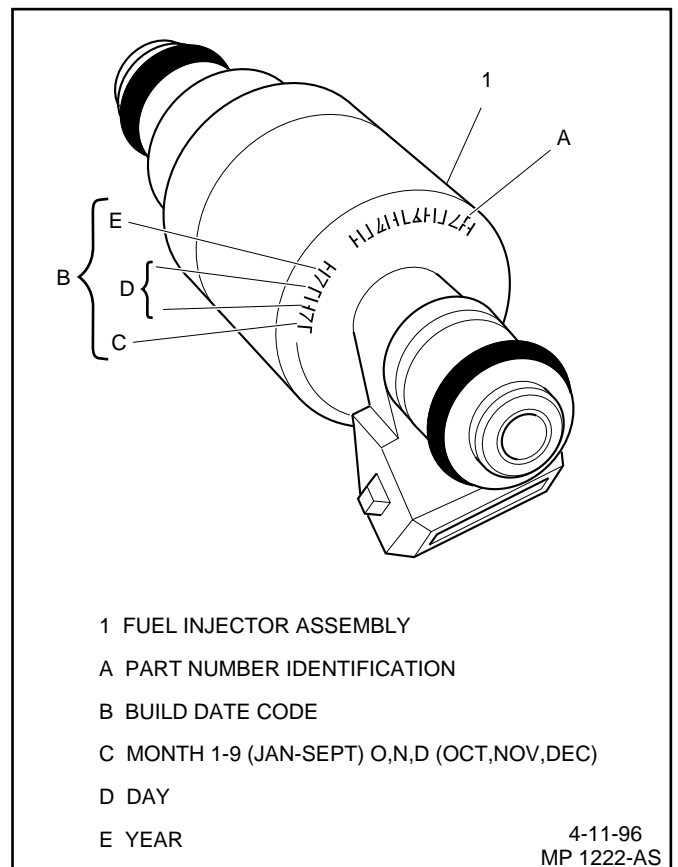


Figure 3-15 - Injector Part Number Location

## Fuel Pressure Regulator Assembly

Figure 3-16

### Important

- ï The fuel pressure regulator is serviced as a complete assembly only.
- ï Fuel pressure must be relieved before servicing the fuel system.
- ï Refer to ïFuel Pressure Relief Procedure.ï

### Remove or Disconnect

1. Negative battery cable.
2. Vacuum hose from regulator.
3. Fuel outlet line nut.
  - ï Use back up wrench to hold pressure regulator to keep from turning and damage.
  - ï Discard outlet line nut O-ring.
4. Pressure regulator attaching screw.
5. Pressure regulator from fuel rail.
6. Pressure regulator O-ring and discard.

### Inspect

- ï The fuel input port of the pressure regulator may contain a filter screen. Inspect the screen for dirt and debris. If dirty, use a pick to remove filter screen and discard. Replace with new filter screen supplied in service package.

### Install or Connect

1. Lubricate new fuel pressure regulator O-ring with clean engine oil and install on regulator.
2. Push pressure regulator into rail.
3. Pressure regulator attaching screw. Finger tighten only.
4. Lubricate new outlet line O-ring and install on end of line.
5. Outlet line assembly with nut to pressure regulator. Finger tighten only.
6. Torque pressure regulator attaching screw to 9.5 Nïm (84 lb.in.).
7. Torque outlet line nut to 17.5 Nïm (13 lb.ft.).
  - ï Use backup wrench to keep pressure regulator from turning and damage.
8. Vacuum line to pressure regulator.
9. Negative battery cable.

### Inspect

- ï Turn ignition switch to the ïONï position for 2 seconds, then turn to the ïOFFï position for 10 seconds. Turn the ignition switch back to the ïONï position and check for fuel leaks.

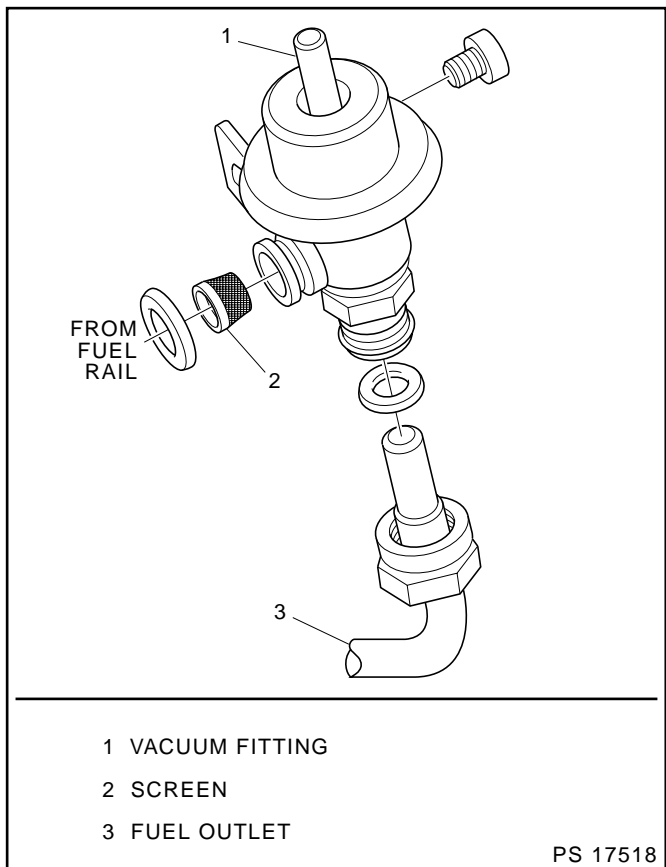


Figure 3-16 - Fuel Pressure Regulator

## Fuel Pump

Figure 3-17

### Important

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

### 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

- ï Turn ignition switch to the ìONî position for 2 seconds, then turn to the ìOFFî position for 10 seconds. Turn the ignition switch back to the ìONî position and check for fuel leaks.

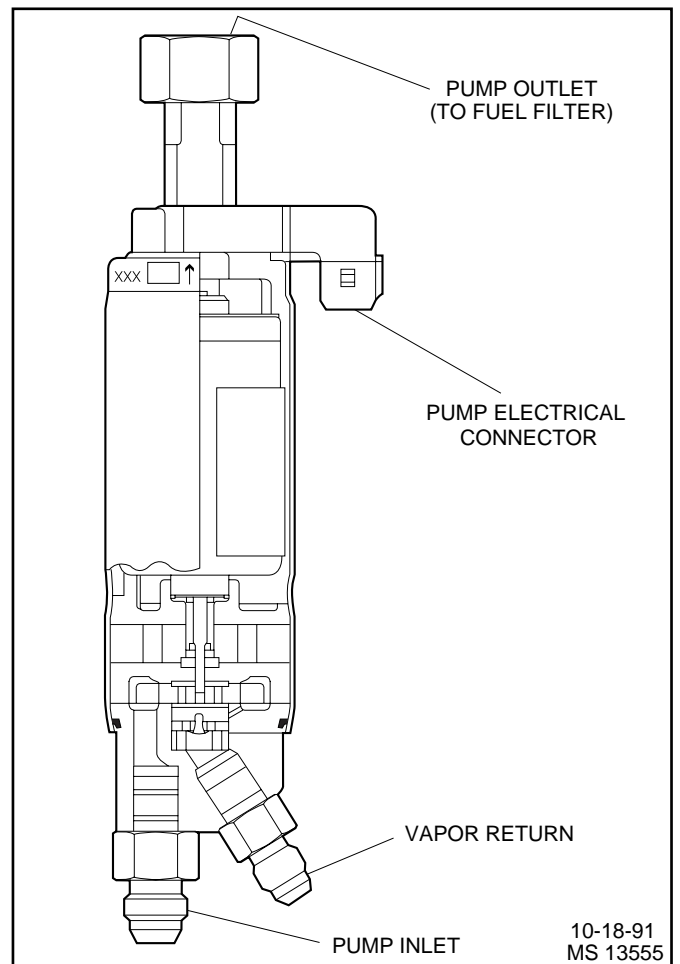


Figure 3-17 - Fuel Pump

## Fuel Pump Relay

Figure 3-18

### Remove or Disconnect

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

### Important

- ï 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.

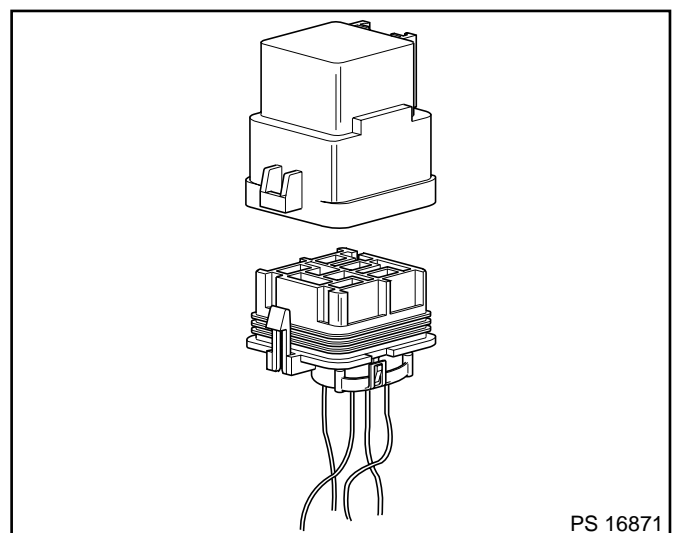


Figure 3-18- Fuel Pump Relay

**In-Line Fuel Filter**

Figure 3-19

**Important**

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

**Remove or Disconnect**

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

**Inspect**

- ï 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**

- ï Turn ignition switch to the ìONî position for 2 seconds, then turn to the ìOFFî position for 10 seconds. Turn the ignition switch back to the ìONî position and check for fuel leaks.

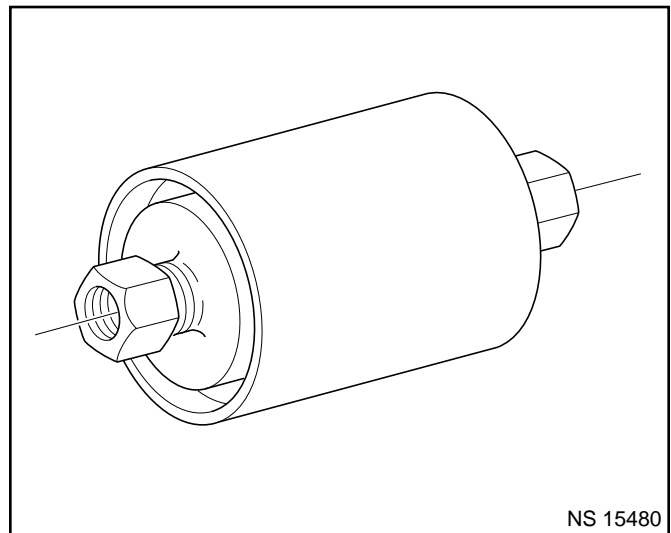


Figure 3-19 - In-Line Fuel Filter

**Water Separator**

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

**Important**

- ï Fuel system needs to be primed and air bled out of the lines before the engine is started. Follow manufacturer's recommendation for priming fuel system.

**Torque Specifications****Fastener Tightening Specifications**

Application	Nim	Lb Ft	Lb In
Throttle Body Attaching Screws	15	11	
IAC Valve Attaching Screws	3.2		28
Fuel Pressure Connector	13		115
Fuel Pressure Regulator Attaching Screw	9.5		84
Fuel Pressure Regulator Outlet Line Nut	17.5	13	
Fuel Rail Jumper Line Attaching Screws	7		62
Fuel Rail Attaching Screws	10		88

## Marine Electronic Fuel Injection (MEFI)

### Section 3B

## Fuel Metering System - Throttle Body 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 Injection (TBI). All other systems will be detailed in a separate manual. In distinguishing fuel systems used on specific applications, the following rules apply. 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. TBI systems use two injectors mounted at the top of the throttle body assembly.

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## 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 two fuel injectors mounted in the Throttle Body Injection (TBI) Unit.

### 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 imodes. All the imodes 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, injector 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 fuel 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 a change of state in a discrete switch input that identifies an abnormal condition. During these abnormal conditions, 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 one injector 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

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

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

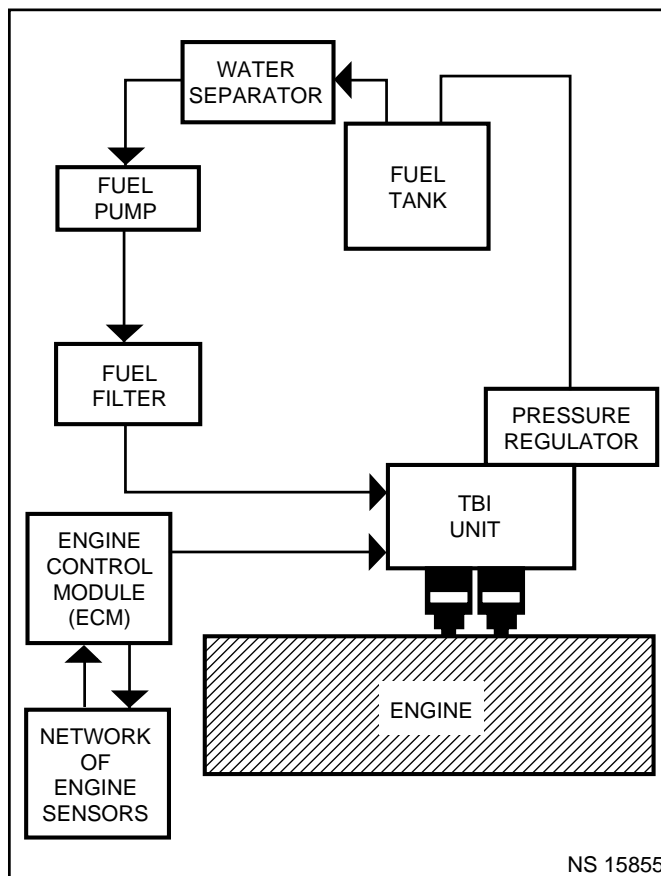


Figure 3-1 - Fuel Metering System (Typical)

### Fuel Supply Components (Typical)

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.

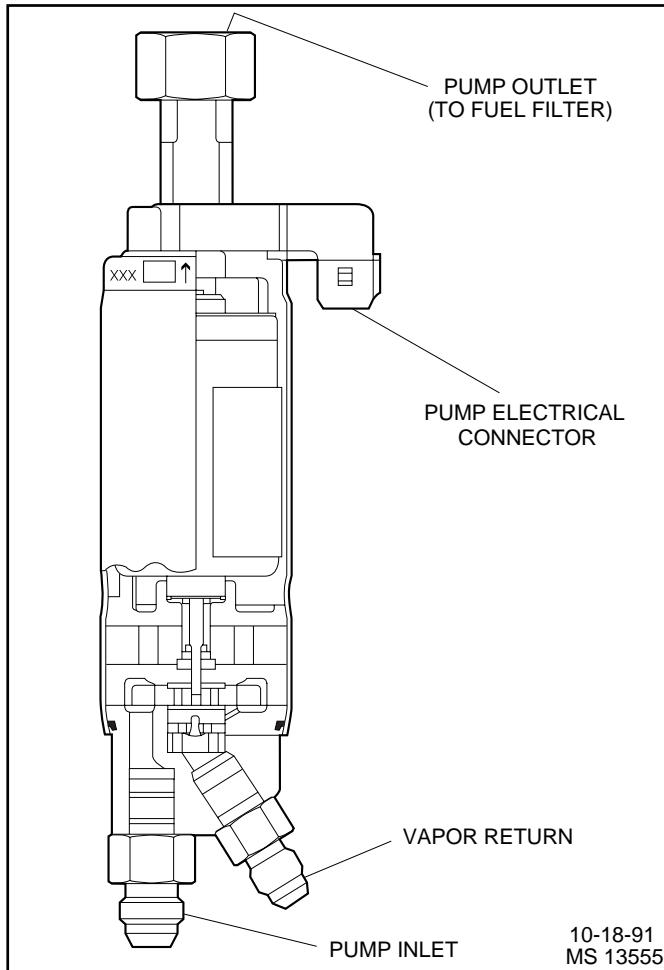


Figure 3-2 - Electric Fuel Pump (Typical)

### 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.

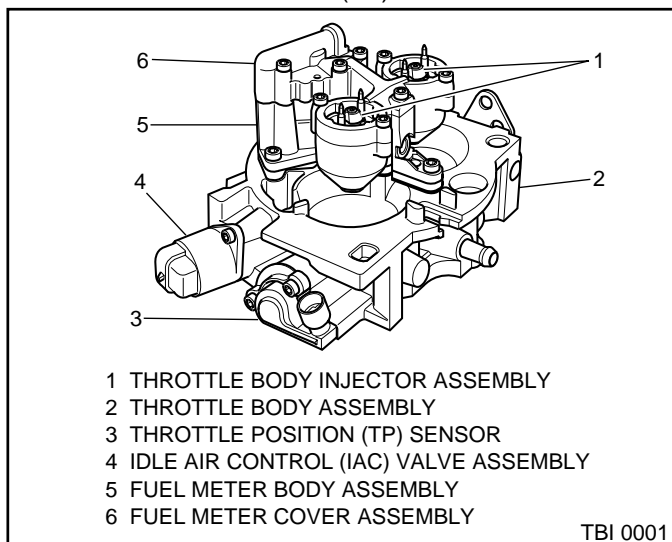
If the ECM does not receive ignition reference pulses (engine cranking or running), it shuts *OFF* the fuel pump relay, causing the fuel pump to stop.

An inoperative fuel pump relay will result in an *Engine Cranks But Will Not Run* condition.

### Throttle Body Injection (TBI) Unit

The TBI unit consists of three major assemblies:

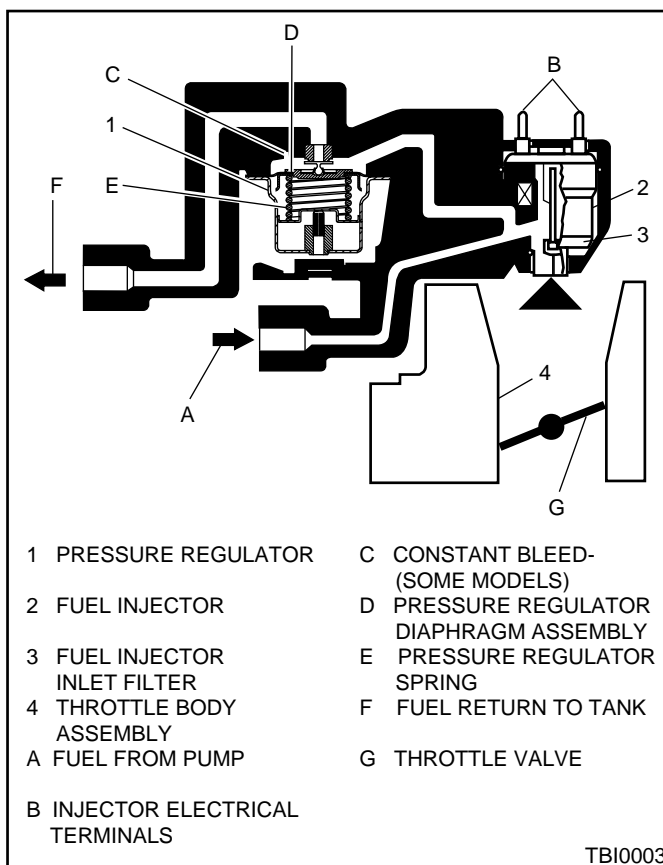
- ï Fuel meter cover.
  - ñ Fuel pressure regulator.
- ï Fuel meter body.
  - ñ Fuel injectors.
- ï Throttle body.
  - ñ Two throttle plates to control air flow into the engine.
  - ñ Idle Air Control (IAC) valve.
  - ñ IAC passage splitter for improved distribution of idle air flow.
  - ñ Throttle Position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



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

TBI 0001

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



- |                                 |   |
|---------------------------------|---|
| 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 |   |

TBI0003

Figure 3-4 - Fuel Flow Diagram



**Fuel Injectors**

The TBI injector assembly is a solenoid-operated device, controlled by the ECM, that meters pressurized fuel to the intake manifold (Figure 3-5). 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 combustion chamber.

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.

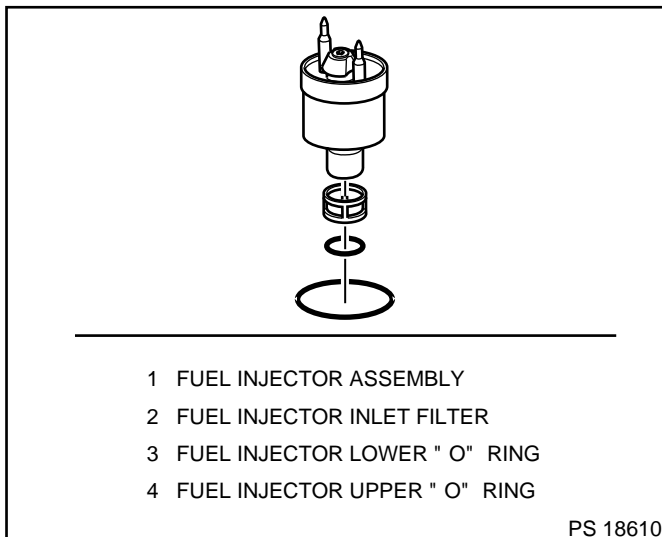


Figure 3-5 - TBI Injector Assembly (Typical)

**Pressure Regulator Assembly**

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 3-6). 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). If the pressure is too low, poor performance or a no-start may result. If pressure is too high, excessive odor may result.

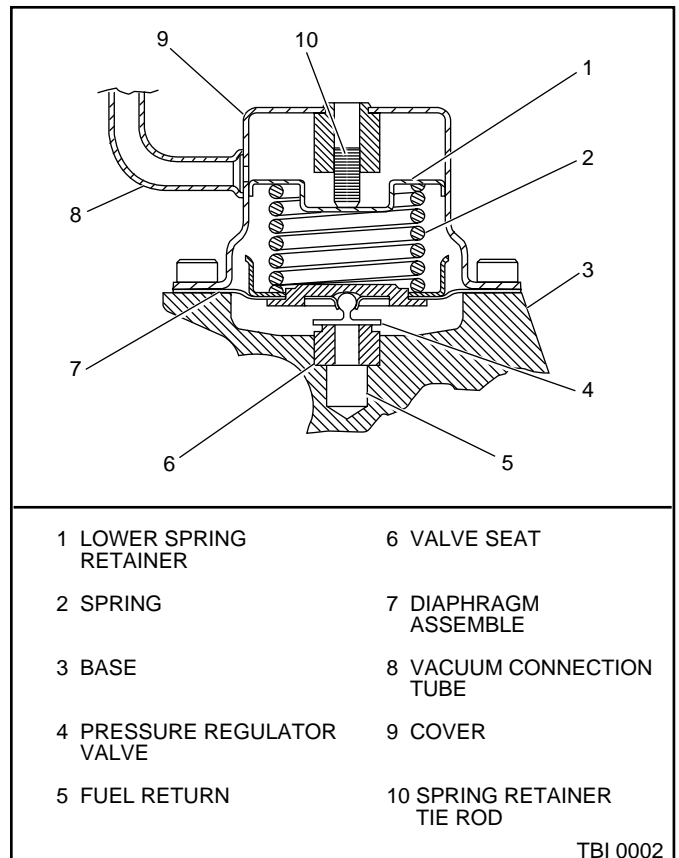


Figure 3-6 - Pressure Regulator Assembly (Typical)

**Throttle Body Assembly**

The throttle body assembly is attached to the intake manifold, and is used to control air flow into the engine, thereby controlling engine output. The throttle plates within the throttle body are opened by the driver through the throttle controls. During engine idle, the throttle plates are closed, and air flow control is handled by the Idle Air Control (IAC) valve, described below.

The throttle body also provides the location for mounting the TP sensor and for sensing changes in engine vacuum due to throttle plates position.

**Idle Air Control (IAC) Valve**

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.

The IAC valve, mounted to the throttle body, controls bypass air around the throttle plates (Figure 3-7). 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 monitored 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.

- ï Engine idle speed is a function of total air flow into the engine based on IAC valve pintle position plus throttle plates opening.
- ï iControlledï 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.
- ï 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 at a calibrated number of steps (counts) from the seat, during icontrolledï 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.

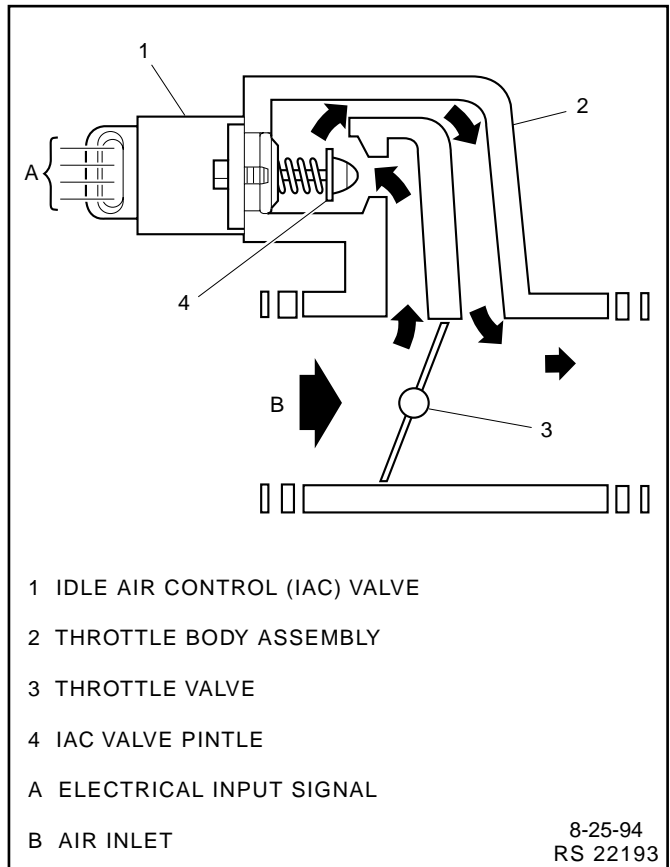


Figure 3-7 - IAC Valve Air Flow Diagram

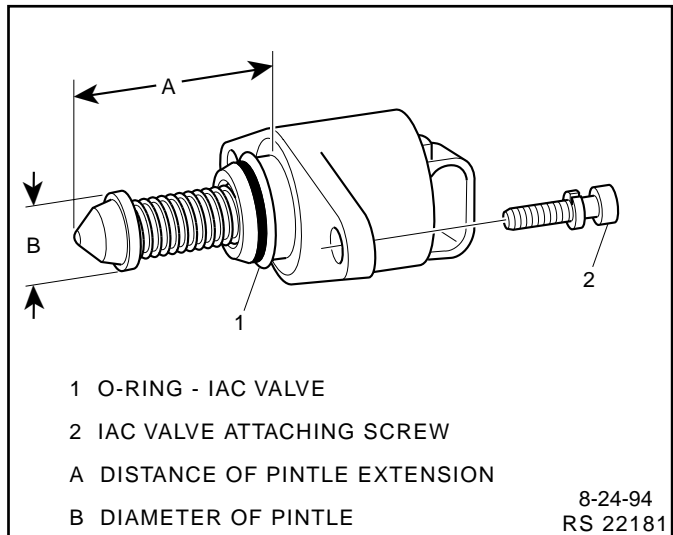


Figure 3-8 - Flange Mounted Type IAC Valve

## Diagnosis

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

## On-Board Service

**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:

- ï Always keep a dry chemical fire extinguisher near the work area.
- ï Fuel pipe fittings require new O-rings when assembling.
- ï Do not replace fuel pipe with fuel hose.
- ï Always bleed off fuel pressure before servicing any fuel system components.
- ï Do not do any repairs on the fuel system until you have read the instructions and checked the figures relating the repair.
- ï Observe all notices and cautions.

### Fuel Pressure Relief Procedure

#### Important

- ï 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.

### Flame Arrestor

#### Remove or Disconnect

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

#### Inspect

- ï 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.

### Throttle Body Injection (TBI) Unit

Figures 3-9 through 3-18

#### Clean

- ï The throttle bore and valve deposits may be cleaned on the 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.
- ï The throttle body metal parts may be cleaned in a cold, immersion type cleaner following the disassembly of the unit.

**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 must be removed before immersion. Follow the procedures outlined in this section.

**Caution:** Safety glasses must be worn when using compressed air, as flying dirt particles may cause eye injury.

- ï 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.
- ï Inspect the mating surfaces for damage that could affect gasket sealing.
- ï Inspect throttle body for cracks in casting.
- ï The thread-locking compound supplied in the service repair kit is a small vial of thread-locking compound with directions for use. If this material is not available, use LoctiteÆ262 or equivalent.

**Notice:** When precoating the mounting bolts, do not use a higher strength locking compound than recommended. This may cause the removal of the bolts to be very difficult.

#### Remove or Disconnect

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

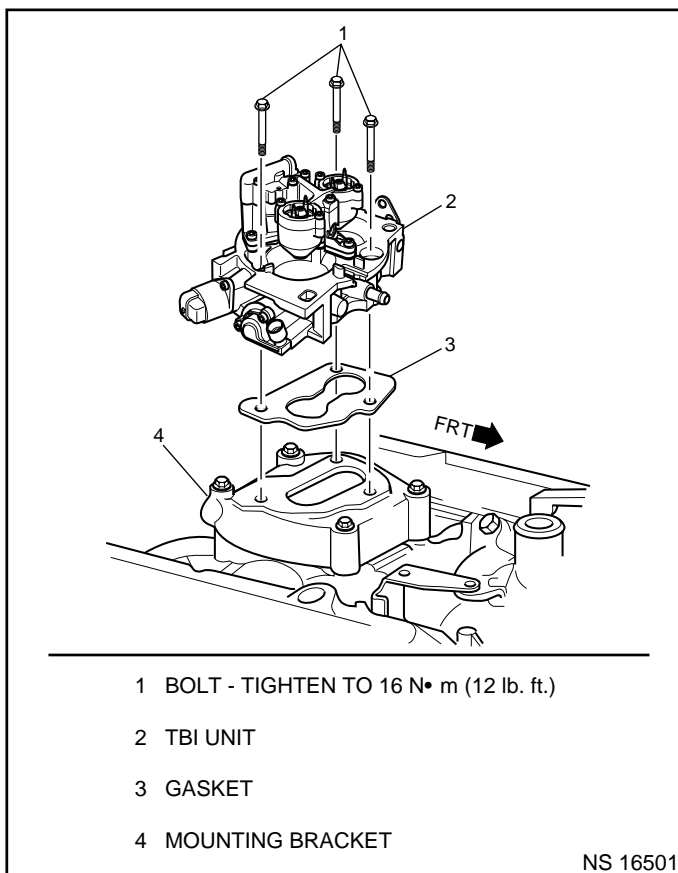


Figure 3-9 - TBI Unit Removal

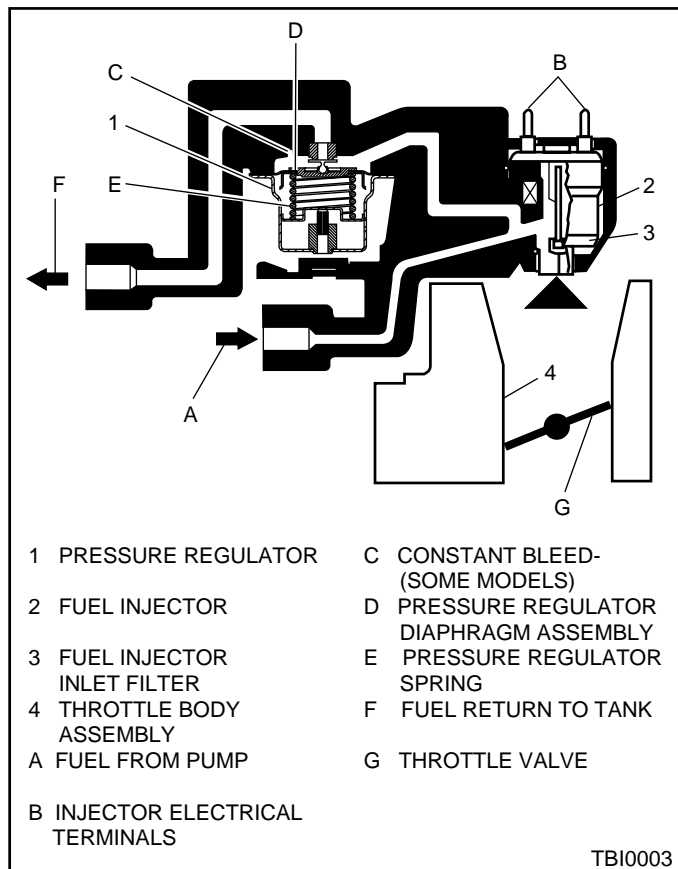


Figure 3-10 - TBI Unit Operation

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

**Notice:** Stuff a rag in the intake manifold opening to prevent foreign material from entering the engine.

**Inspect**

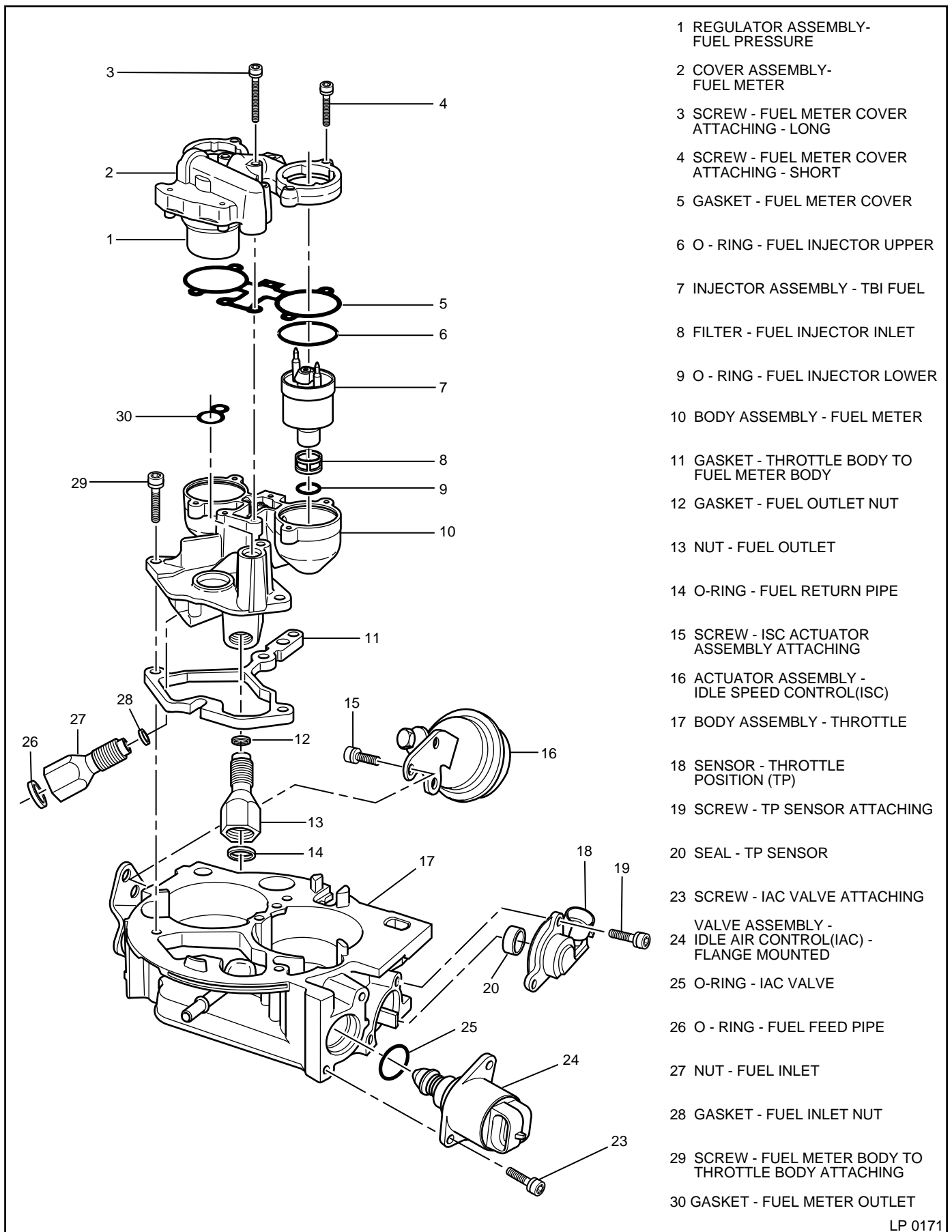
- ï Manifold bore for loose parts and foreign material.
- ï Manifold mating surface for cleanliness or burrs that could affect gasket sealing.

**Install or Connect**

1. New TBI gasket.
2. TBI unit with mounting bolts. Torque bolts to 16 Nïm (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 Nïm (17 lb ft).
5. Throttle linkage and return spring(s).
6. Grommet with wires to throttle body.
7. Electrical connectors from the IAC valve, TP sensor and fuel injectors, making sure connectors are fully seated and latched.
8. Negative battery cable.

**Inspect**

- ï With the engine iOFF,ï check to see that the throttle lever is free.
  - ñ Move the throttle lever to 100% and back to 0%.
- ï Turn ignition switch to the iONï position for 2 seconds, then turn to the iOFFï position for 10 seconds. Turn the ignition switch back to the iONï position and check for fuel leaks.
- 10. Flame arrestor, breather hoses (if applicable) and new gasket.
- 11. Start engine and check for fuel leaks again.



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Figure 3-11 - Throttle Body Unit

## TBI Fuel Meter Cover Assembly

Figure 3-12

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. Flame arrestor, breather hoses (if applicable) and gasket.
3. Relieve fuel pressure.
  - Refer to the Fuel Pressure Relief Procedure.
4. Electrical connectors to fuel injectors. Squeeze plastic tabs on injector connectors and pull straight up.
5. Long and short fuel meter cover screw assemblies.
6. Fuel meter cover assembly and gasket.
7. Discard gasket.

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

8. 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 fuel meter 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.
6. Flame arrestor, breather hoses (if applicable) and new gasket.

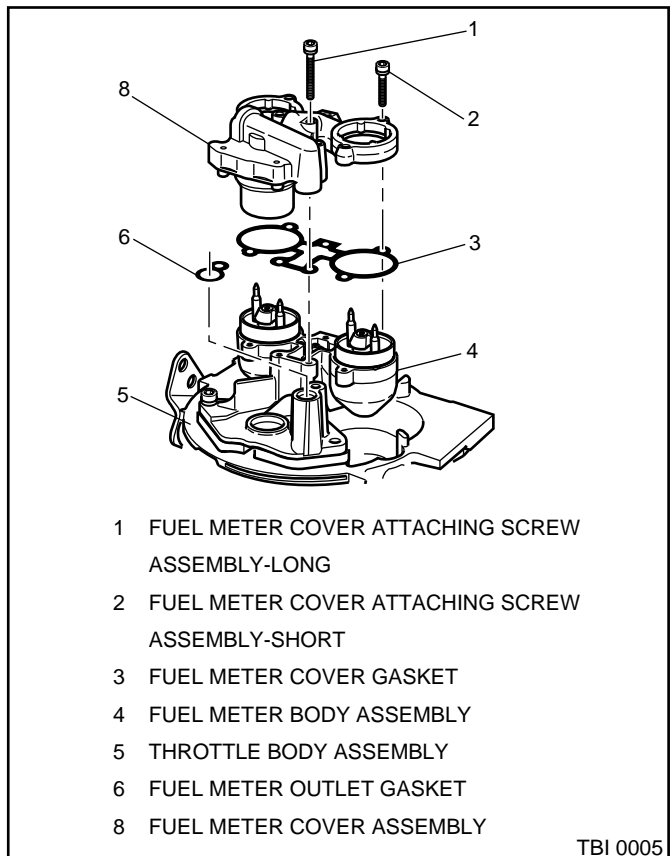


Figure 3-12 - Replacing Fuel Meter Cover

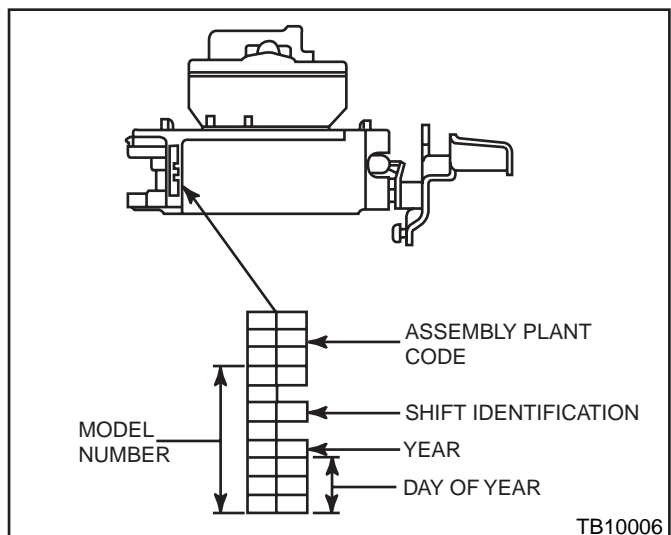


Figure 3-13 - TBI Identification

## Fuel Injector Assembly

Figures 3-14 through 3-18

**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 3-13). Also, since the injectors are electrical components, they should not be immersed in any type of liquid solvent or cleaner, as damage may occur.

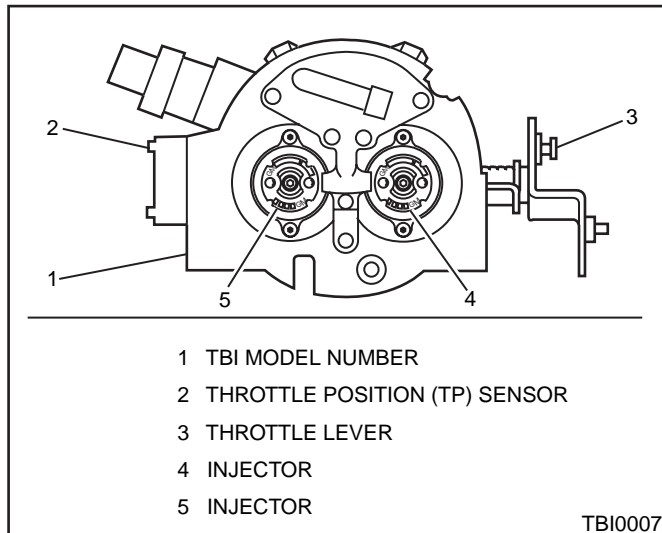


Figure 3-14 - Fuel Injectors

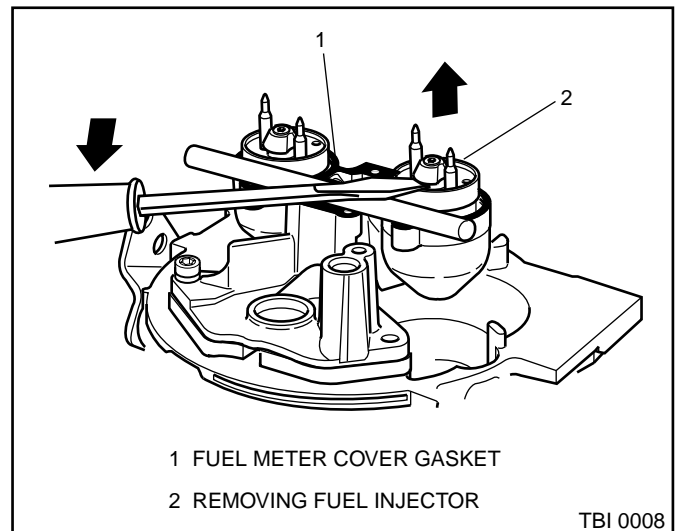


Figure 3-15 - Removing Fuel Injector

### Remove or Disconnect

1. Negative battery cable.
2. Flame arrestor, breather hoses (if applicable) and gasket.
3. Relieve fuel pressure.
  - ï Refer to the ïFuel Pressure Relief Procedure.ï
4. Electrical connectors to fuel injectors. Squeeze plastic tabs on injector connector and pull straight up.
5. Fuel meter cover assembly following procedure outlined in this section.
6. With fuel meter cover gasket in place to prevent damage to casting, use a screwdriver and fulcrum to carefully lift out each injector (Figure 3-15).
7. Lower (small) O-ring from nozzle of injectors and discard.
8. Fuel meter cover gasket and discard.
9. Upper (large) O-ring and steel backup washer from top of fuel injector cavity and discard.

**Inspect**

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

**Important**

- i 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 3-17 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.

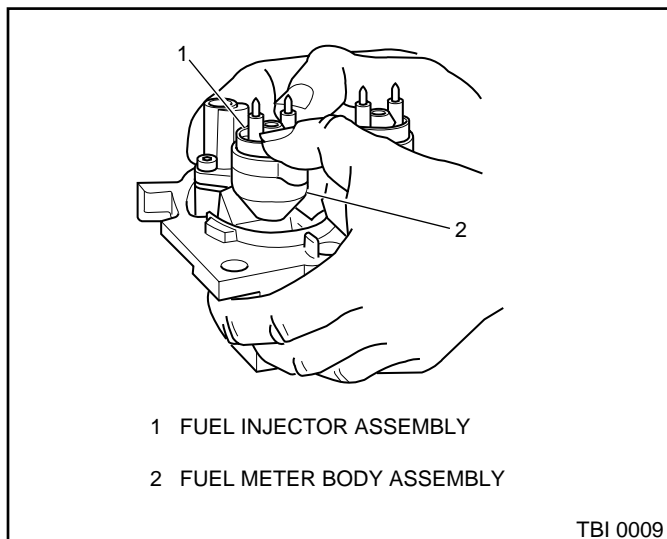


Figure 3-16 - Installing Fuel Injector

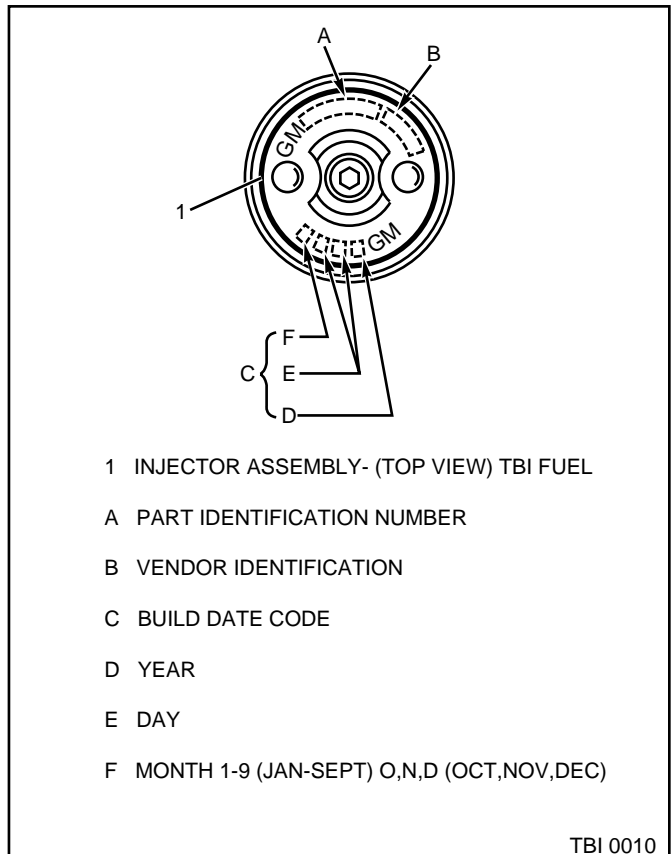


Figure 3-17 - Fuel Injector Part Number Location

3. Lubricate new 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.

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 3-16). Injector electrical terminals should be parallel with the throttle shaft.



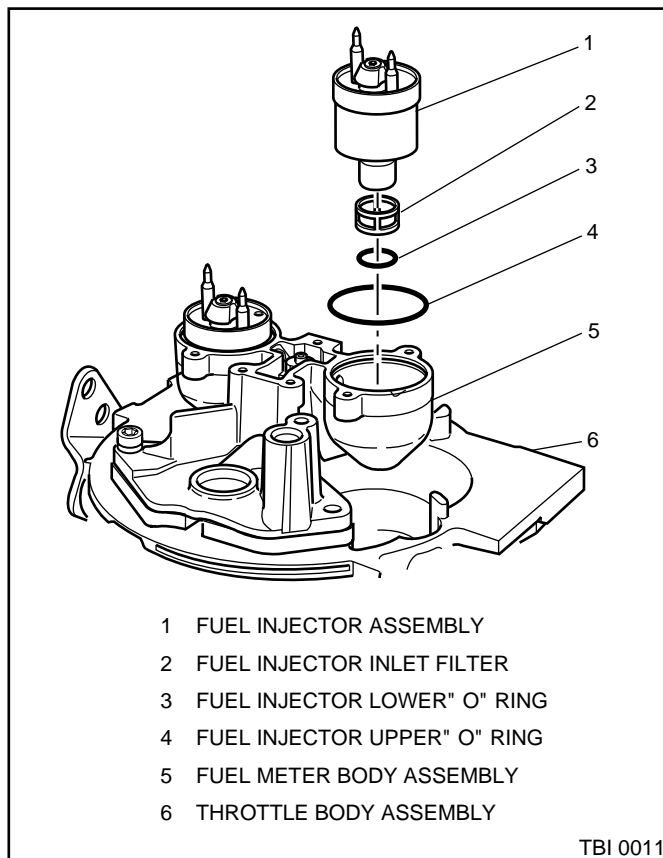


Figure 3-18 - Fuel Injector

**Important**

- ï Be sure to install the injectors in their proper location.
- 5. New fuel meter cover gasket.
- 6. Fuel meter cover following procedure outlined in this section.
- 7. Electrical connectors to injectors.
- 8. Negative battery cable.

**Inspect**

- ï Turn ignition switch to the ìONî position for 2 seconds, then trun to the ìOFFî position for 10 seconds. Turn the ignition switch back to the ìONî position and check for fuel leaks.
- 9. Flame arrestor, breather hoses (if applicable) and new gasket.

**Fuel Meter Body Assembly**

Figure 3-19

**Remove or Disconnect**

1. Negative battery cable.
2. Flame arrestor, breather hoses (if applicable) and gasket.
3. Relieve fuel pressure.
  - ï Refer to the ìFuel Pressure Relief Procedure.î
4. Electrical connectors to fuel injectors. Squeeze plastic tabs on injector connetors and pull straight up.
5. Fuel meter cover assembly following procedure outlined in this section.

6. Fuel injectors following procedure outlined in this section.
7. Inlet and outlet fuel line nuts, using a back up wrench.
8. Fuel line O-rings from nuts and discard.
9. Inlet and outlet adapter nuts and gaskets from the fuel meter body assembly. Discard gaskets.

**Important**

- ï Note locations of nuts for proper reassembly later. Inlet nut has a larger passage than the outlet nut.
- 10. Fuel meter body to throttle body attaching screws.
- 11. Fuel meter body assembly from the throttle body assembly.
- 12. Throttle body to fuel meter body gasket and discard.

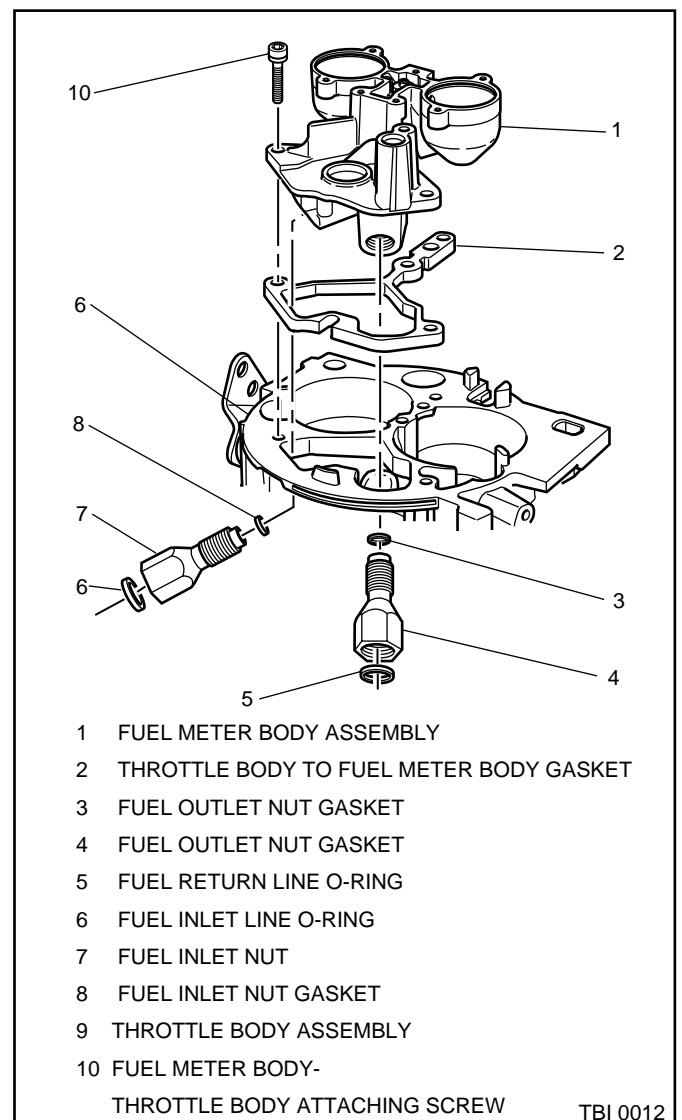


Figure 3-19 - Fuel Meter Body Assembly

**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 $\cdot$ m (30 lb in).
4. Inlet and outlet adapter nuts with new gaskets to the fuel meter body assembly.
  - ï Torque inlet adapter nut to 40 N $\cdot$ m (30 lb ft).
  - ï Torque outlet adapter nut to 29 N $\cdot$ 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 $\cdot$ m (17 lb ft).
7. Fuel injectors following procedure outlined in this section.
8. New fuel meter cover gasket, fuel meter outlet gasket, and pressure regulator seal.
9. Fuel meter cover assembly following procedure outlined in this section.
10. Electrical connectors to fuel injectors.
11. Negative battery cable.

**Inspect**

- ï 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.
- 9. Flame arrestor, breather hoses (if applicable) and new gasket.

**Fuel Pump**

Figure 3-20

**Important**

- ï Fuel pressure must be relieved before servicing the fuel pump.
- ï 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**

- ï 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.

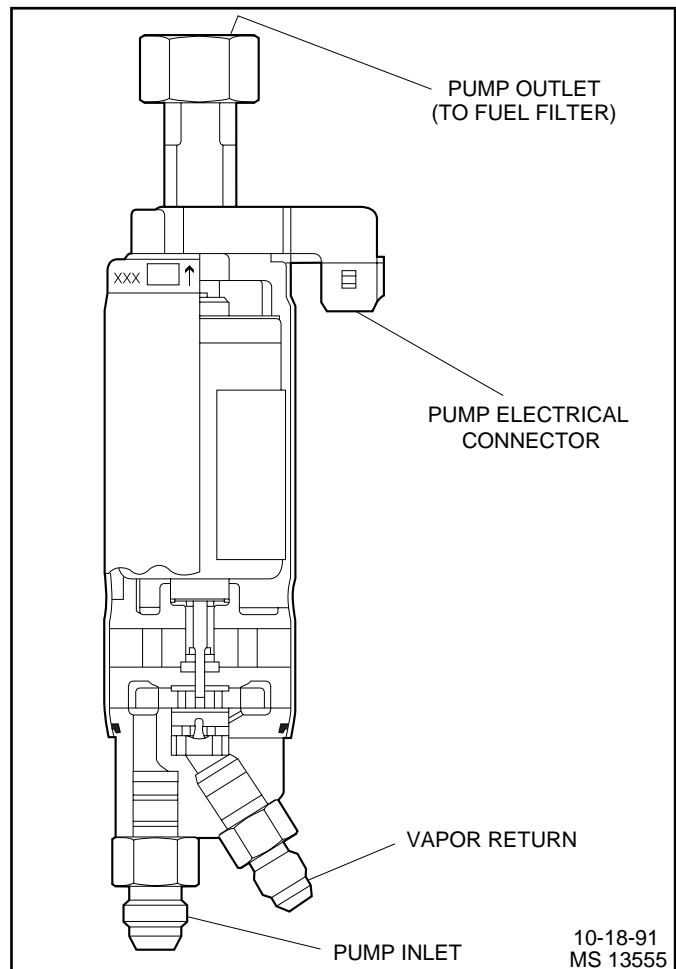


Figure 3-20 - Fuel Pump

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**Fuel Pump Relay**

Figure 3-21

**Remove or Disconnect**

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

**Important**

- ï The fuel pump relay is an 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.

**In-Line Fuel Filter**

Figure 3-22

**Important**

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

**Remove or Disconnect**

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

**Inspect**

- ï 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**

- ï Turn ignition switch to the ìONî position for 2 seconds, then turn to the ìOFFî position for 10 seconds. Turn the ignition switch back to the ìONî position and check for fuel leaks.

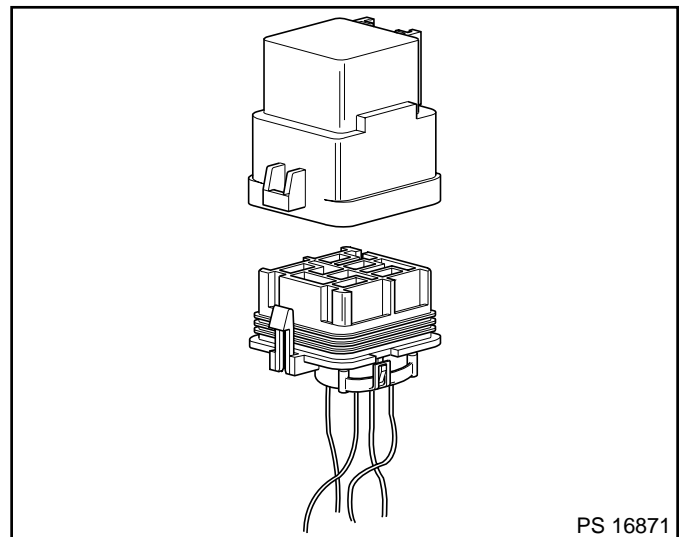


Figure 3-21 - Fuel Pump Relay

**Water Separator**

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

**Important**

- ï Fuel system needs to be primed and air bled out of the lines before the engine is started. Follow manufacturer's recommendation for priming fuel system.

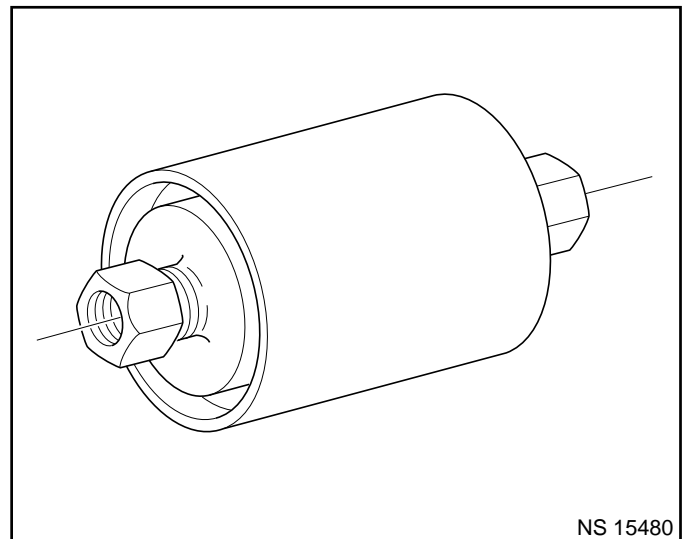


Figure 3-22 - In-Line Fuel Filter

**Torque Specifications**

**Fastener Tightening Specifications**

Application	Nim	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	

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## Marine Electronic Fuel Injection (MEFI)

### Section 3C

## Fuel Metering System - Multiport Fuel Injection (MFI) - 7.4L L29

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 Multiport Fuel Injection (MFI) used on the 7.4L L29. All other systems will be detailed in a separate manual. In distinguishing fuel systems used on specific applications, the following rules apply. 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. TBI systems use two injectors mounted at the top of the throttle body assembly.

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## General Description

### Purpose

The function of the fuel metering system is to deliver the correct amount of fuel to the engine under all operating conditions. Fuel is delivered to the engine by individual fuel injectors mounted in the intake manifold near each cylinder.

### 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 imodes. All the imodes 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, injector 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 fuel 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 a change of state in a discrete switch input that identifies an abnormal condition. During these abnormal conditions, 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

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

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

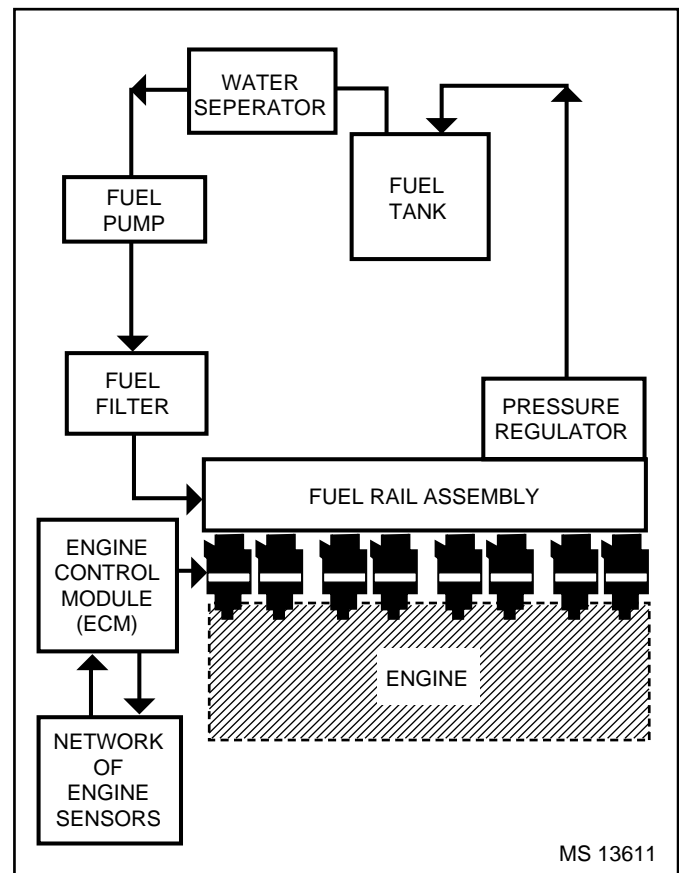


Figure 3-1 - Fuel Metering System (Typical)

### Fuel Supply Components (Typical)

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 fuel rail assembly. The pump is designed to provide fuel at a pressure greater than is needed by the injectors. The pressure regulator, part of the fuel rail assembly, keeps fuel available to the injectors at a regulated pressure. Unused fuel is returned to the fuel tank by a separate line.

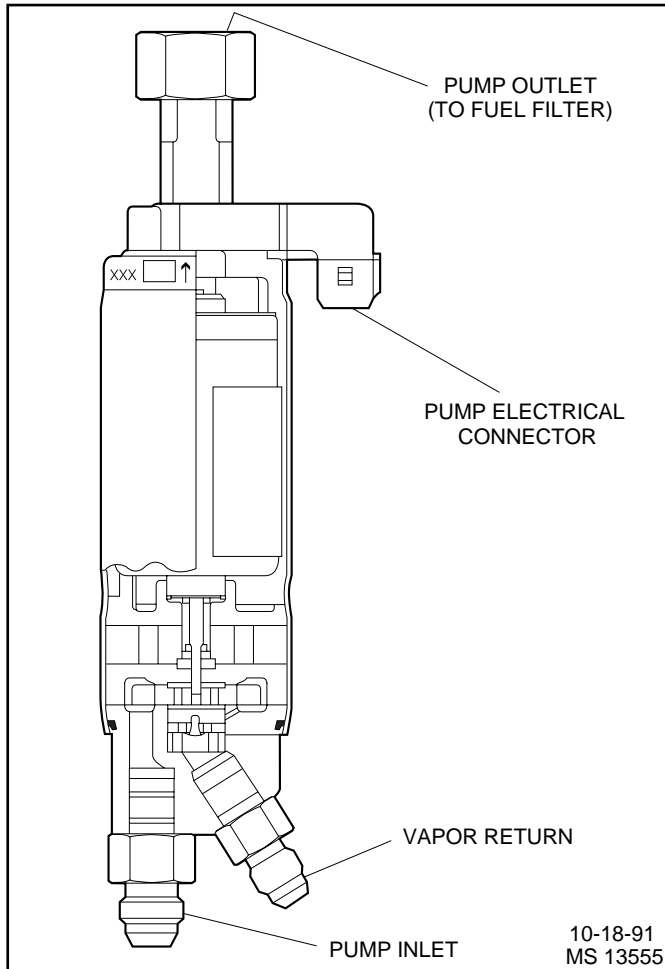


Figure 3-2 - Electric Fuel Pump (Typical)

### 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 Will Not Run* condition.

### Fuel Rail Assembly

The fuel rail (Figure 3-3) is mounted to the engine intake manifold, and performs several functions. It positions the injectors in the intake manifold, distributes fuel evenly to the injectors and integrates the fuel pressure regulator into the fuel metering system.

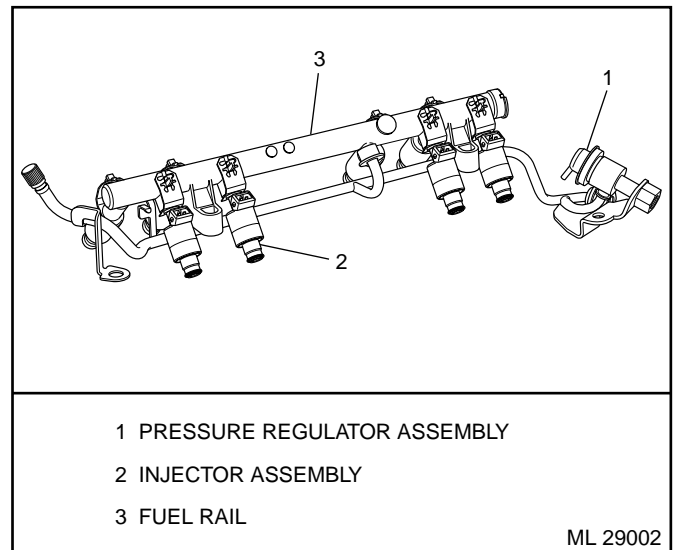


Figure 3-3 - Fuel Rail Assembly

**Fuel Injectors**

The Multiport Fuel Injection (MFI) injector assembly is a solenoid-operated device, controlled by the ECM, that meters pressurized fuel to a single engine cylinder (Figure 3-4). The ECM energizes the injector solenoid, which opens a ball valve, allowing fuel to flow past the ball valve, and through a recessed flow director plate. The director plate has six machined holes that control the fuel flow, generating a conical spray pattern of finely atomized fuel at the injector tip. Fuel is directed at the intake valve, causing it to become further atomized and vaporized before entering the combustion chamber.

An injector that is stuck partly open would cause loss of pressure after engine shut down. 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.

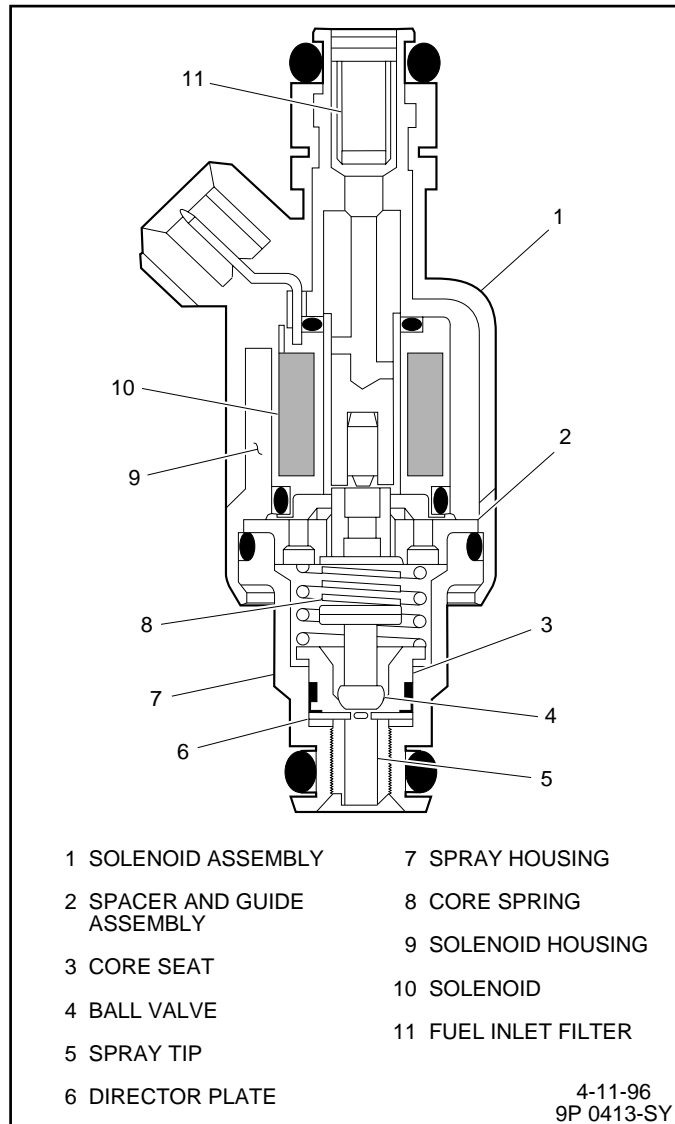


Figure 3-4 - MFI Injector Assembly (Typical)

**Pressure Regulator Assembly**

The pressure regulator is a diaphragm-operated relief valve with fuel pump pressure on one side, and regulator spring pressure and intake manifold vacuum on the other side (Figure 3-5). The regulator's function is to maintain a constant pressure differential across the injectors at all times. The pressure regulator compensates for engine load by increasing fuel pressure as engine vacuum drops.

With the ignition ON, engine OFF (zero vacuum), fuel pressure at the pressure test connection should be 284-325 kPa (41-47 psi). If the pressure is too low, poor performance or a no-start may result. If pressure is too high, excessive odor may result.

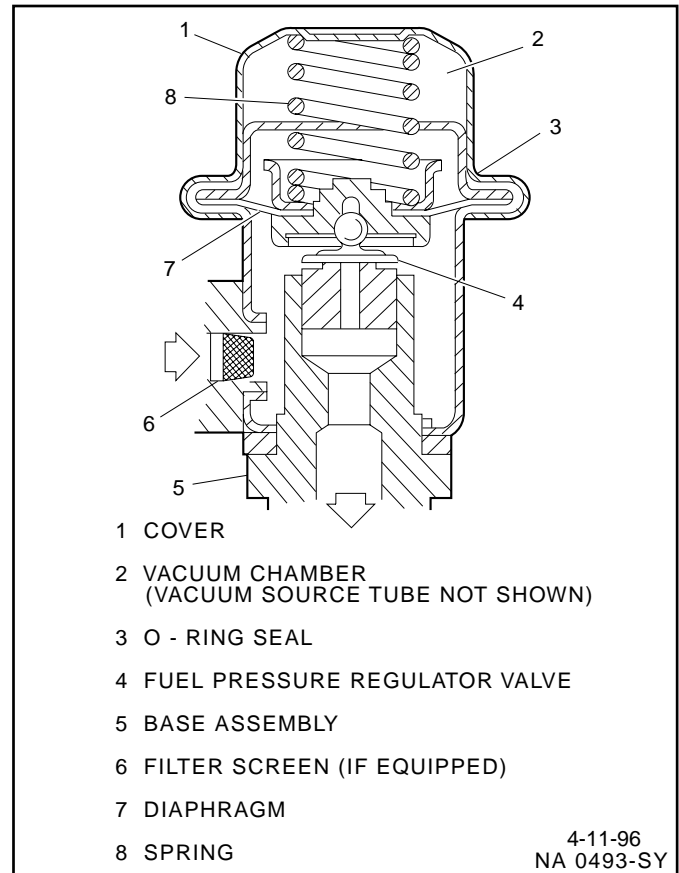


Figure 3-5 - Pressure Regulator Assembly (Typical)

**Throttle Body Assembly**

The throttle body assembly is attached to the intake manifold air plenum, and is used to control air flow into the engine, thereby controlling engine output (Figure 3-6). The throttle plates within the throttle body are opened by the driver through the throttle controls. During engine idle, the throttle plates are closed, and air flow control is handled by the Idle Air Control (IAC) valve, described below.

The throttle body also provides the location for mounting the TP sensor and for sensing changes in engine vacuum due to throttle plates position.



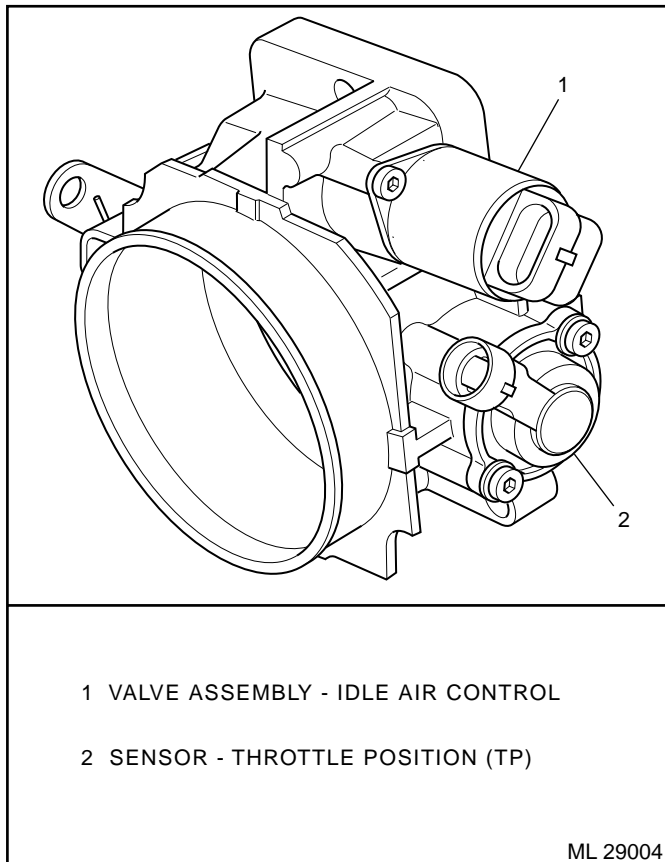


Figure 3-6 - Throttle Body Assembly

**Idle Air Control (IAC) Valve**

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.

The IAC valve, mounted to the throttle body, controls bypass air around the throttle plates (Figure 3-7). 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 monitored 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.

- ï Engine idle speed is a function of total air flow into the engine based on IAC valve pintle position plus throttle plates opening.
- ï ìControlledî 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.

- ï 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 at a calibrated number of steps (counts) from the seat, during ìcontrolledî 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.

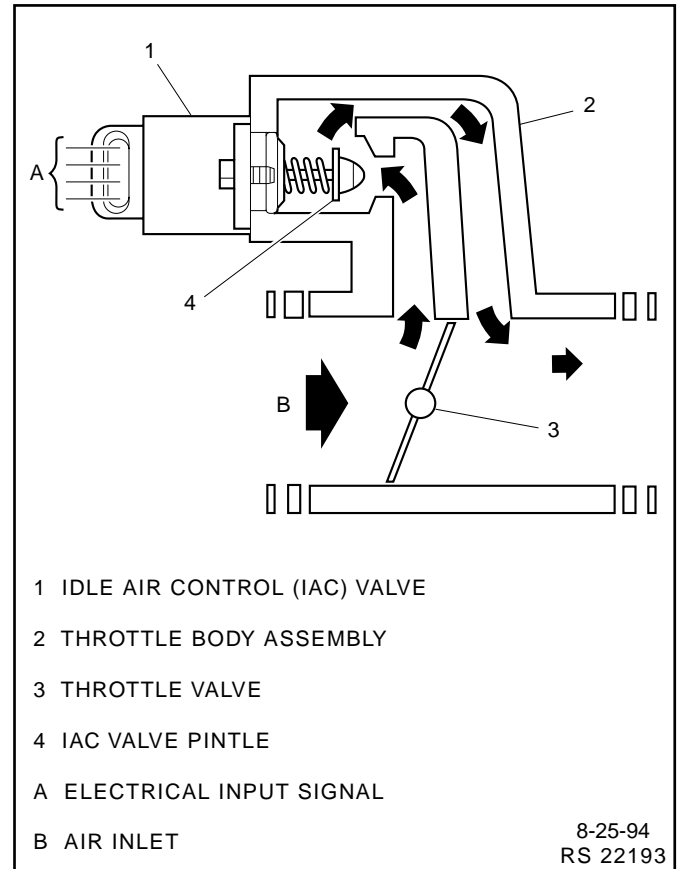


Figure 3-7 - IAC Valve Air Flow Diagram

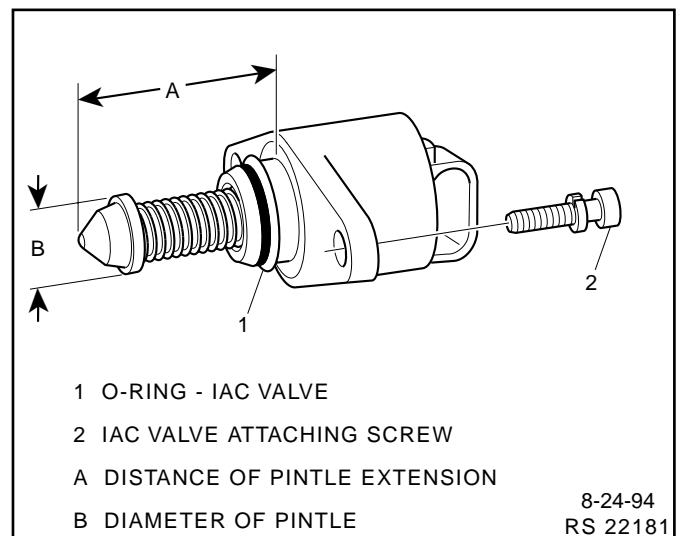
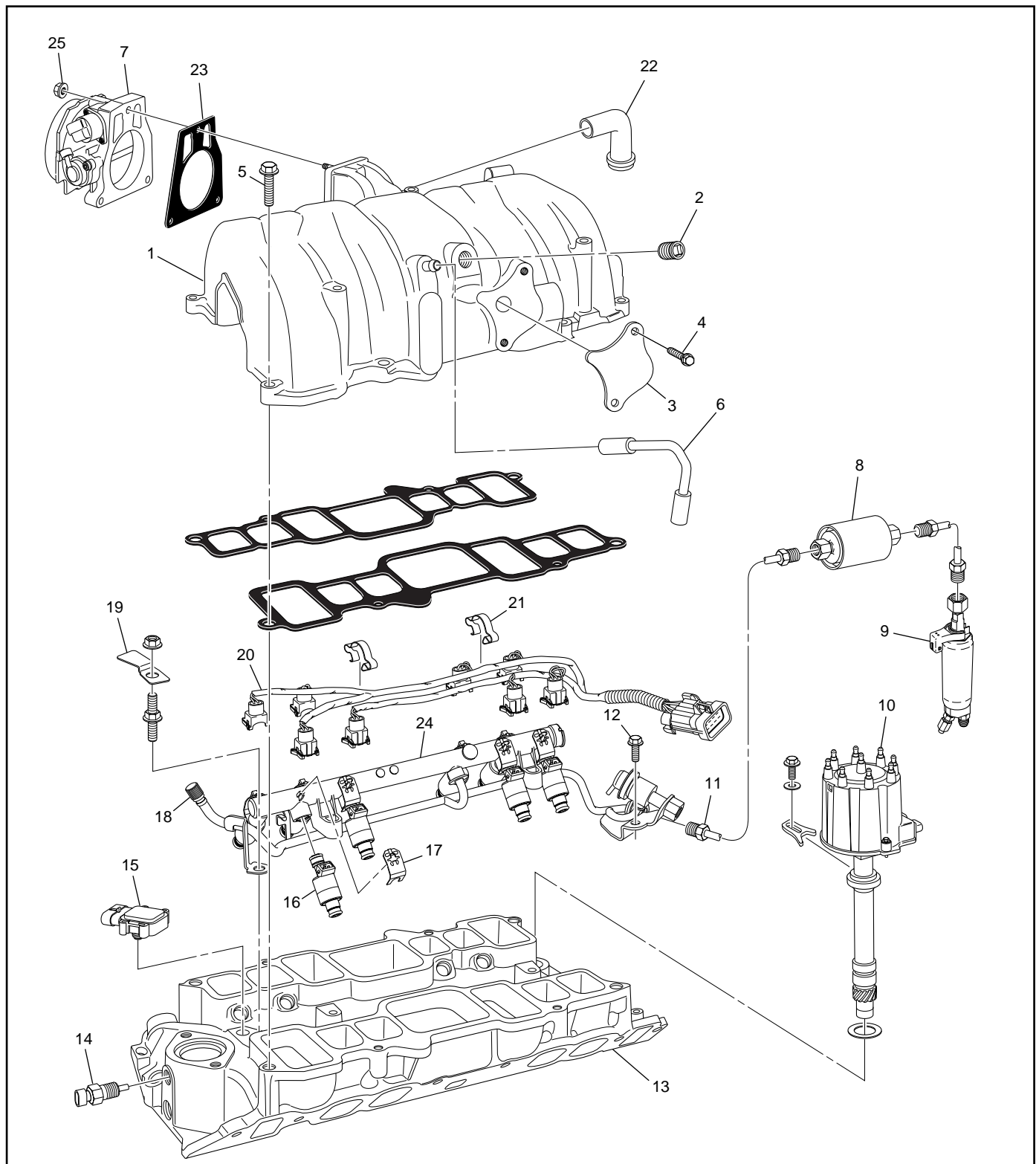


Figure 3-8 - Flange Mounted Type IAC Valve



- |                                   |  |   |
|-----------------------------------|--|---|
| 1 UPPER INTAKE PLENUM             | 10 DISTRIBUTOR ASSEMBLY                | 19 MAP SENSOR RETAINER                        |
| 2 PLUG                            | 11 INLET FUEL FITTING                  | 20 FUEL INJECTOR WIRING HARNESS               |
| 3 PLATE - BLOCKOFF                | 12 SCREW ASSEMBLY - PRESSURE REGULATOR | 21 FUEL INJECTOR WIRING HARNESS RETAINER CLIP |
| 4 SCREW ASSEMBLY - BLOCKOFF PLATE | 13 INTAKE MANIFOLD                     | 22 FRESH AIR ELBOW                            |
| 5 SCREW ASSEMBLY - INTAKE PLENUM  | 14 ECT SENSOR                          | 23 GASKET - THROTTLE BODY                     |
| 6 CRANKCASE VENTILATION TUBE      | 15 MAP SENSOR                          | 24 FUEL RAIL                                  |
| 7 THROTTLE BODY                   | 16 FUEL INJECTOR                       | 25 NUT - THROTTLE BODY ATTACHING              |
| 8 INLINE FUEL FILTER              | 17 FUEL INJECTOR RETAINER CLIP         |   |
| 9 FUEL PUMP                       | 18 FUEL PRESSURE CONNECTOR             |   |

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Figure 3-9 - Fuel Rail and Throttle Body Assemblies

## Diagnosis

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

## On-Board Service

### 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:

- ï Always keep a dry chemical fire extinguisher near the work area.
- ï Fuel pipe fittings require new O-rings when assembling.
- ï Do not replace fuel pipe with fuel hose.
- ï Always bleed off fuel pressure before servicing any fuel system components.
- ï Do not do any repairs on the fuel system until you have read the instructions and checked the figures relating the repair.
- ï Observe all notices and cautions.

## Fuel Pressure Relief Procedure

Tool Required:

J 34730-1, Fuel Pressure Gauge

### Important

- ï 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. Connect fuel pressure gauge J 34730-1 to fuel pressure connector assembly. Wrap a shop towel around fitting while connecting the gauge to avoid any spillage.
  4. Install bleed hose into an approved container and open valve to bleed system pressure. Fuel connections are now safe for servicing.
  5. Drain any fuel remaining in the gauge into an approved container.

## Flame Arrestor

### Remove or Disconnect

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

### Inspect

- ï 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.

## Throttle Body Assembly

Figures 3-10 and 3-11

The throttle body assembly repair procedures cover component replacement with the unit on the vessel. However, throttle body replacement requires that the complete unit be removed from the engine.

### Clean

#### Important

Do not soak the throttle body in cold immersion type cleaner. The throttle valves have a factory applied sealing compound (DAG material is applied to outside edge of each valve and throttle bore) to prevent air bypass at closed throttle. Strong solvents or brushing will remove the material. To clean the throttle body following disassembly, use a spray type cleaner such as GM X66-A or GM 1052626. Use a shop towel to remove heavy deposits.

**Notice:** The TP sensor and the IAC valve are electrical components and should NOT come in contact with solvent or cleaner as they may be damaged.

#### Remove or Disconnect

1. Negative battery cable.
2. Flame arrestor.
3. Electrical connectors from TP sensor and IAC valve.
4. Vacuum lines.
5. Throttle adjuster to throttle body cable.
6. Throttle body attaching nuts.
7. Throttle body assembly and flange gasket.
8. Discard gasket.

### Clean

**Notice:** Use care in cleaning old gasket material from machined aluminum surfaces as sharp tools may damage sealing surfaces.

- ï Gasket sealing surfaces.

#### Install or Connect

1. Throttle body assembly with new flange gasket.
2. Throttle body attaching nuts. Torque to 15 N·m (11 lb.ft.).
3. Throttle adjuster to throttle body cable.
4. Vacuum lines.
5. Electrical connectors to TP sensor and IAC valve.
6. Flame arrestor.
7. Negative battery cable.

### Inspect

- ï With the engine ìOFF,î check to see that the throttle lever is free.
- ñ Move the throttle lever to wide open throttle and release.

Reset IAC valve pintle position:

- ï Move throttle lever slightly.
- ï Start and run engine for 5 seconds.
- ï Turn ignition ìOFFî for 10 seconds.
- ï Restart engine and check for proper idle operation.

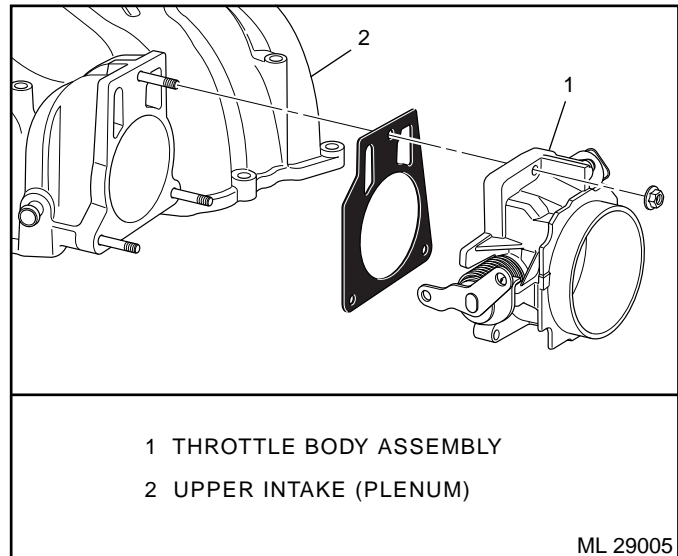


Figure 3-10 - Throttle Body Removal

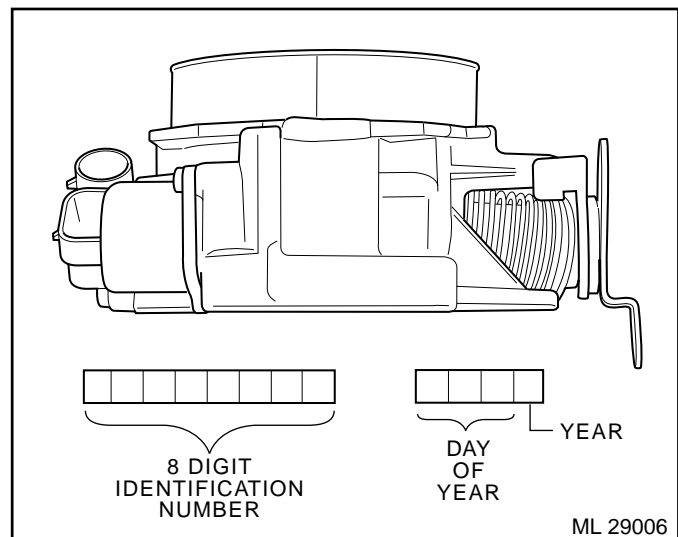


Figure 3-11 - Throttle Body Identification

## Intake Plenum (Upper Intake Section)

Figure 3-12 and 3-13

### Remove or Disconnect

1. Negative battery cable.
2. Throttle cable and bracket from the upper plenum.
3. Electrical connectors from:
  - ï ECM iJ1î and iJ2î connectors.
  - ï TP sensor.
  - ï IAC valve.
4. Crankcase ventilation tube.
5. Fresh air elbow.
6. Plenum retaining bolts.
7. Intake plenum and gaskets.

**Notice:** Caution must be taken when handling the intake plenum, not to damage the plenum to lower intake manifold mating surfaces and the throttle body mounting surface. Also, after the manifold has been removed, cover exposed lower intake manifold ports to prevent any foreign material from entering the engine and causing serious damage.

7. If plenum is to be replaced, remove the attached components according to procedures outlined in this section.

### Clean

**Notice:** When cleaning the plenum, caution must be taken because the plenum is made of aluminum. Do Not gouge gasket surfaces or use a power wire brush.

- ï All gasket surfaces of old gasket.
- ï Interior of plenum of any sludge or oil build up.
  - ñ Use spray carburetor cleaner that does not contain methyl ethyl ketone, an extremely strong solvent. It is necessary for this type of deposit.

### Important

- ï Do Not soak intake plenum in any liquid cleaner or solvent if any components are still attached, as damage may result to the components.

**Notice:** In either case, whether using a new or used plenum, follow these inspection procedures.

### Inspect

- ï Entire plenum mating surfaces for burrs and flaws.
- ï Entire plenum for porosity (small holes in casting due to manufacturing flaws).
- ï Entire plenum for cracks caused from manufacturing flaw or handling.

### Install or Connect

1. New gaskets on lower intake.
2. Plenum on lower intake, being careful not to move the gaskets.

### Important

- ï Lightly coat threads and shaft of bolts with anti-seize compound.
3. All plenum retaining bolts. Torque to 14 Nîm (124 lb.in.) in sequence as shown in Figure 3-13.
  4. Crankcase ventilation tube.
  5. Fresh air elbow.
  6. Electrical connectors to:
    - ï ECM iJ1î and iJ2î connectors.
    - ï TP sensor.
    - ï IAC valve.
  7. Throttle cable and bracket to the upper plenum.
  8. Negative battery cable.

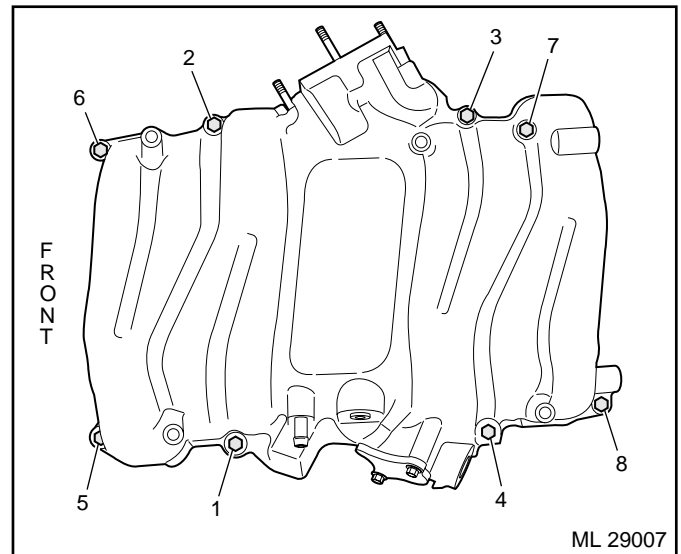
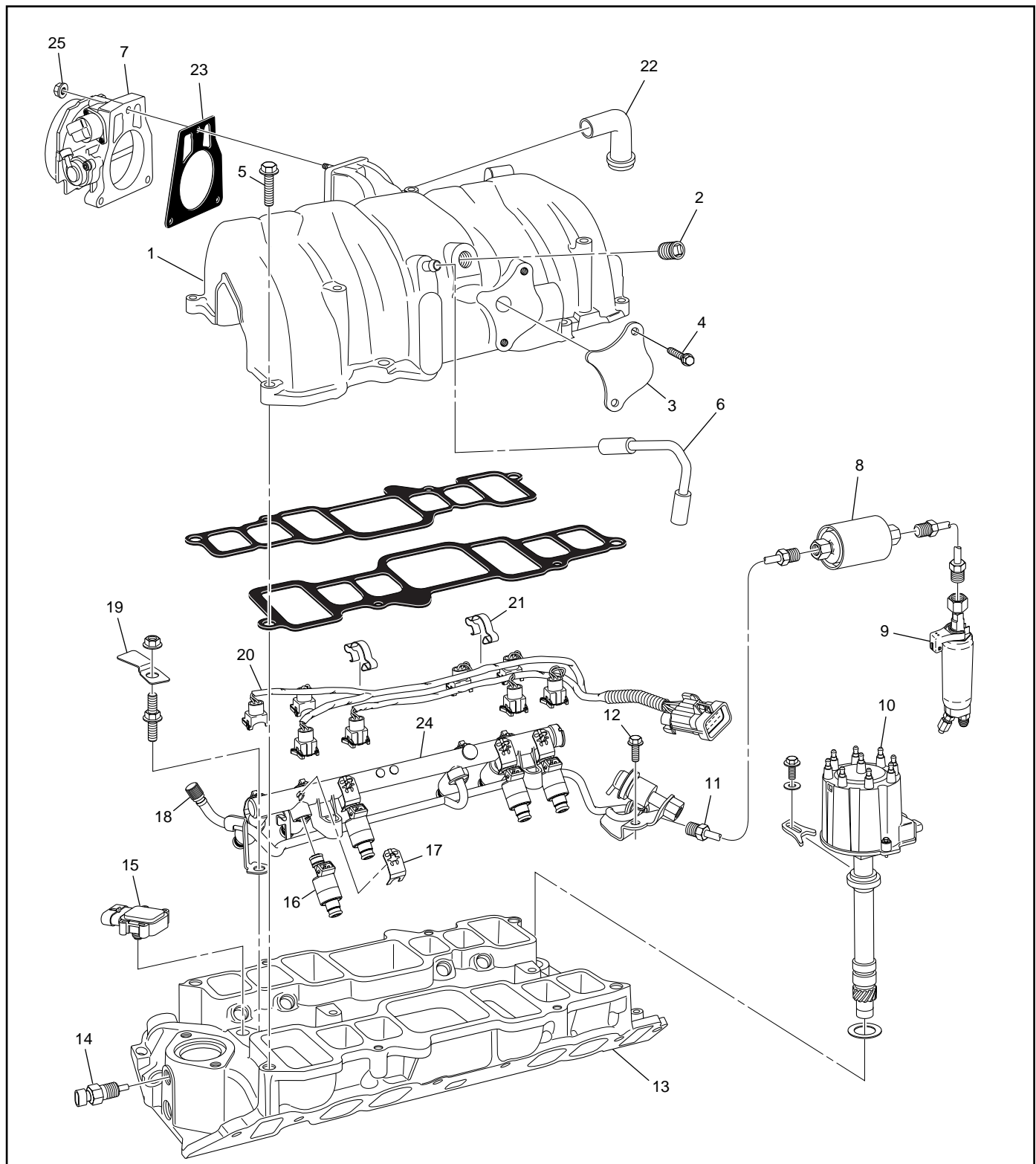


Figure 3-12 - Intake Plenum Tightening Sequence



- |                                   |  |   |
|-----------------------------------|--|---|
| 1 UPPER INTAKE PLENUM             | 10 DISTRIBUTOR ASSEMBLY                | 19 MAP SENSOR RETAINER                        |
| 2 PLUG                            | 11 INLET FUEL FITTING                  | 20 FUEL INJECTOR WIRING HARNESS               |
| 3 PLATE - BLOCKOFF                | 12 SCREW ASSEMBLY - PRESSURE REGULATOR | 21 FUEL INJECTOR WIRING HARNESS RETAINER CLIP |
| 4 SCREW ASSEMBLY - BLOCKOFF PLATE | 13 INTAKE MANIFOLD                     | 22 FRESH AIR ELBOW                            |
| 5 SCREW ASSEMBLY - INTAKE PLENUM  | 14 ECT SENSOR                          | 23 GASKET - THROTTLE BODY                     |
| 6 CRANKCASE VENTILATION TUBE      | 15 MAP SENSOR                          | 24 FUEL RAIL                                  |
| 7 THROTTLE BODY                   | 16 FUEL INJECTOR                       | 25 NUT - THROTTLE BODY ATTACHING              |
| 8 INLINE FUEL FILTER              | 17 FUEL INJECTOR RETAINER CLIP         |   |
| 9 FUEL PUMP                       | 18 FUEL PRESSURE CONNECTOR             |   |

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Figure 3-13 - Intake and Fuel System

## Fuel Rail Assembly

Figures 3-13 and 3-14

The fuel rail should be removed as an assembly with the injectors attached. Names of component parts will be found on the numbered list that accompanies the disassembled view (Figure 3-13).

### Notice:

- ï Use care in removing the fuel rail assembly to prevent damage to the injector electrical connector terminals and the injector spray tips.
- ï When removed, support the rail to avoid damaging its components.
- ï Prevent dirt and other contaminants from entering open lines and passages. Fittings should be capped and holes plugged during servicing.

### Clean

- ï Before removal, the fuel rail assembly may be cleaned with a spray type engine cleaner, GM X-30A or equivalent, following package instructions. Do Not soak fuel rails in liquid cleaning solvent.

**Caution: Safety glasses must be worn when using compressed air as flying dirt particles may cause eye injury.**

- ï Where injectors fit into intake manifold, use compressed air to blow out dirt from around injectors before removing.

### Remove or Disconnect

**Caution: To reduce the risk of fire and personal injury, relieve the fuel system pressure before servicing the fuel system components.**

1. Negative battery cable.
2. Relieve fuel pressure.
  - ï Refer to the ìFuel Pressure Relief Procedure.î
  - ï Fuel pressure connector assembly is located in the front of the fuel rail.

3. Upper intake plenum following the procedures outlined in this section.
4. 10-Wire fuel injector harness.
5. Fuel inlet line, hold fitting in rail with a wrench to keep from turning.
6. Fuel outlet fitting at pressure regulator.
  - ï Hold pressure regulator with a wrench to keep from turning and damaging.
7. Vacuum line to fuel pressure regulator.
8. Two retaining screws for pressure regulator.
9. Fuel pressure regulator.
10. Two attaching screws for fuel rail.
11. Fuel rail as an assembly with injectors.
12. Injectors from rails, follow procedure for injector removal outlined in this section.

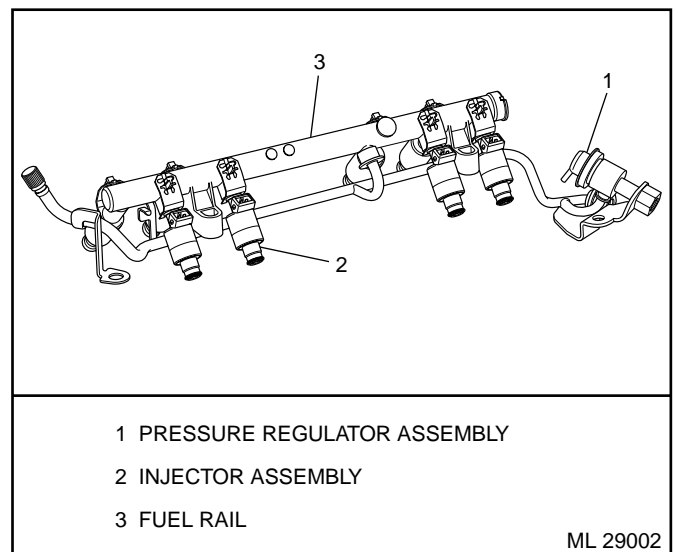


Figure 3-14 - Fuel Rail Assembly

**Clean and Inspect**

**Notice:** If it is necessary to remove rust or burrs from the fuel rail, use emery cloth in a radial motion with the tube end to prevent damage.

- ï Use a clean shop towel to wipe off male pipe ends.
- ï Inspect all connectors for dirt and burrs. Clean or replace components/assemblies as required.

**Disassemble**

- ï Injector O-ring seals from each injector. Discard O-ring seals.

**Assemble**

- ï Lubricate new injector O-ring seals with clean engine oil and install on ends of each injector.

**Install or Connect**

1. Lubricate injector O-ring seals and install injectors following injector installation procedure outlined in this section.
2. Fuel rail as an assembly with injectors onto intake manifold.
  - ï If injectors are lined up properly they will slide into place.
  - ï Push gently and evenly on rail to set injectors all the way into their bores
3. Two fuel rail attaching screws. Torque to 10 Nîm (88 lb.in.).
4. Lubricate new O-ring seal on pressure regulator and install pressure regulator.
5. Pressure regulator attaching screws. Torque to 9.5 Nîm (84 lb.in.).
6. Vacuum line to fuel pressure regulator.
7. Lubricate new O-ring seal on pressure regulator outlet fitting and tighten fitting, careful not to twist regulator. Torque to 17.5 Nîm (13 lb.ft.).
8. Inlet fuel line.
9. 10-Wire fuel injector harness.
10. Upper intake plenum following procedures outlined in this section.
11. Negative battery cable.
12. Prime fuel system by cycling key ìONî and ìOFFî a few times with engine ìOFFî.

**Inspect**

- ï Turn ignition switch to the ìONî position for 2 seconds, then turn to the ìOFFî position for 10 seconds. Turn the ignition switch back to the ìONî position and check for fuel leaks.

**Fuel Injectors**

Figures 3-15 through 3-18

**Notice:** Use care in removing injectors to prevent damage to the injector electrical connector pins or the injector spray tips. The fuel injector is serviced as a complete assembly only. Since it is an electrical component, Do Not immerse it in any cleaner.

**Remove or Disconnect**

1. Negative battery cable.
2. Relieve fuel pressure.
  - ï Refer to the ìFuel Pressure Relief Procedureî.
3. Upper intake plenum following procedures outlined in this section.
4. Fuel rail assembly following procedures outlined in this section.
5. Injector wiring harness.

**Disassemble**

1. Release injector clip by sliding off injector (Figure 3-15).

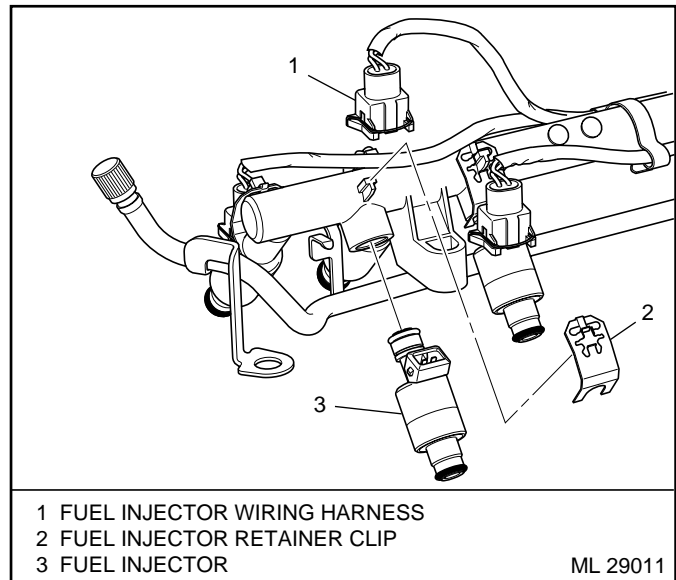


Figure 3-15 - Injector Clip Removal

2. MFI injector from rail.
3. Injector O-ring seals from both ends of the injector and discard.
4. Injector retainer clip from rail.



**Clean and Inspect**

- ï Injector bores in fuel rail and intake manifold for nicks, burrs or corrosion damage. If severe, replace. Clean lightly with emery cloth in a radial motion.
- ï Injector O-ring seal grooves for nicks, burrs or corrosion. Replace injector if damaged. Clean with spray cleaner and wipe groove clean with lint free cloth.
- ï Do Not use abrasive materials or wire brush on injectors. They are plated with an anti-corrosive material.

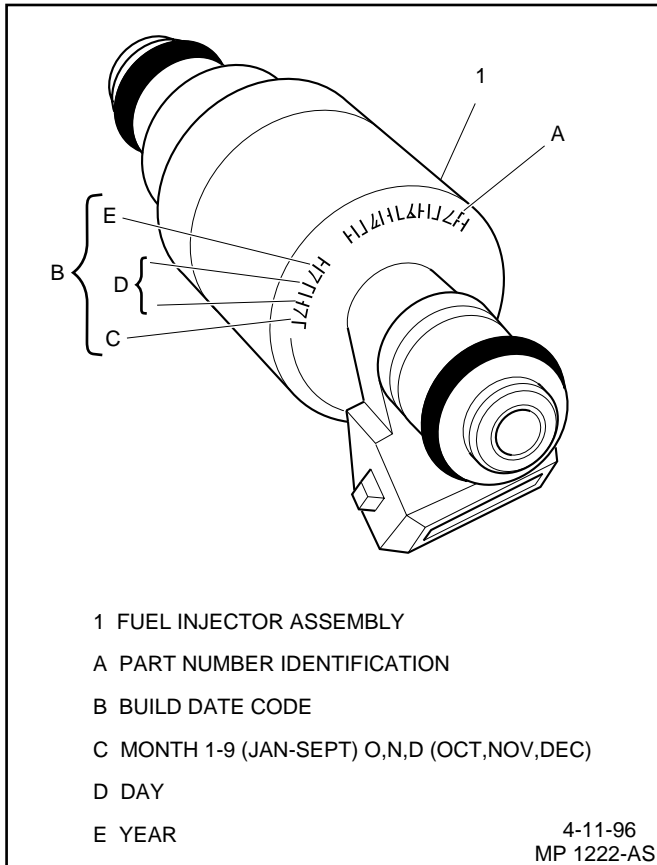


Figure 3-16 - Injector Part Number Location

**Important**

- ï When ordering individual replacement fuel injectors, be sure to order the identical part number that is inscribed on the old injector.

**Assemble**

1. Lubricate new injector O-ring seals with clean engine oil and install on injector.
2. New retainer clip onto injector.
3. MFI fuel injector assembly into fuel rail injector socket with electrical connector facing outward.
4. Rotate injector retainer clip to locking position.

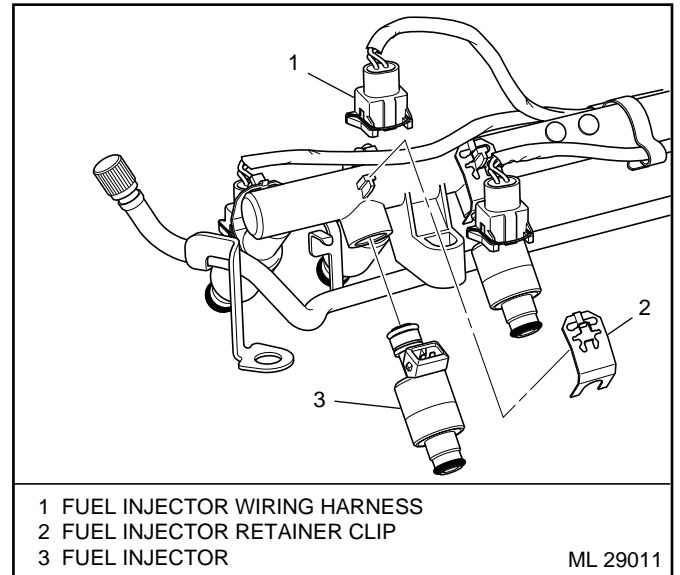


Figure 3-17 - MFI Fuel Injector and Retainer Clip

**Install or Connect**

1. Fuel rail assembly following procedures outlined in this section.
2. Upper intake plenum following procedures outlined in this section.
3. Negative battery cable.

**Inspect**

- ï Turn ignition switch to the ìONî position for 2 seconds, then turn to the ìOFFî position for 10 seconds. Turn the ignition switch back to the ìONî position and check for fuel leaks.

## Fuel Pressure Regulator Assembly

Figure 3-18

### Important

- ï The fuel pressure regulator is serviced as a complete assembly only.
- ï Fuel pressure must be relieved before servicing the fuel pump.
- ï Refer to ìFuel Pressure Relief Procedure.î

### Remove or Disconnect

1. Negative battery cable.
2. Vacuum hose from regulator.
3. Fuel outlet line nut.
  - ï Use back up wrench to hold pressure regulator to keep from turning and damage.
  - ï Discard outlet line nut O-ring.
4. Pressure regulator attaching screws.
5. Pressure regulator from fuel rail.
6. Pressure regulator O-ring and discard.

### Inspect

- ï The fuel input port of the pressure regulator may contain a filter screen. Inspect the screen for dirt and debris. If dirty, use a pick to remove filter screen and discard. Replace with new filter screen supplied in service package.

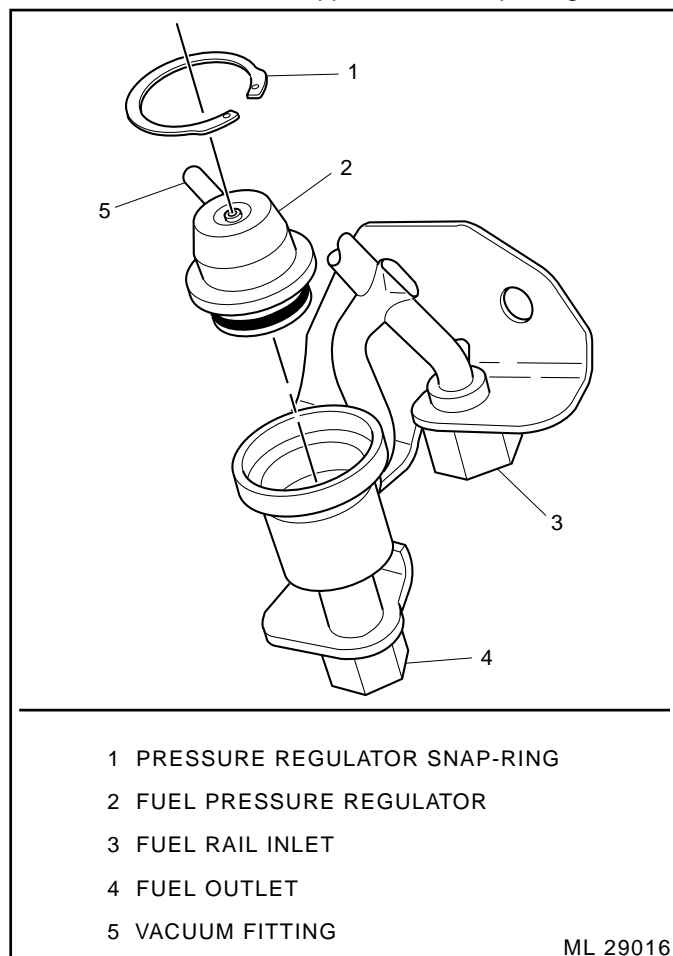


Figure 3-18 - Fuel Pressure Regulator

### Install or Connect

1. Lubricate new fuel pressure regulator O-ring with clean engine oil and install on regulator.
2. Push pressure regulator into rail.
3. Pressure regulator attaching screws. Finger tighten only.
4. Lubricate new outlet line O-ring and install on end of line.
5. Outlet line assembly with nut to pressure regulator. Finger tighten only.
6. Torque pressure regulator attaching screw to 9.5 Nïm (84 lb.in.).
7. Torque outlet line nut to 17.5 Nïm (13 lb.ft.).
  - ï Use backup wrench to keep pressure regulator from turning and damage.
8. Vacuum line to pressure regulator.
9. Negative battery cable.

### Inspect

- ï Turn ignition switch to the ìONî position for 2 seconds, then turn to the ìOFFî position for 10 seconds. Turn the ignition switch back to the ìONî position and check for fuel leaks.

## Fuel Pump

Figure 3-19

### Important

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

### 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

- ï Turn ignition switch to the ìONî position for 2 seconds, then turn to the ìOFFî position for 10 seconds. Turn the ignition switch back to the ìONî position and check for fuel leaks.

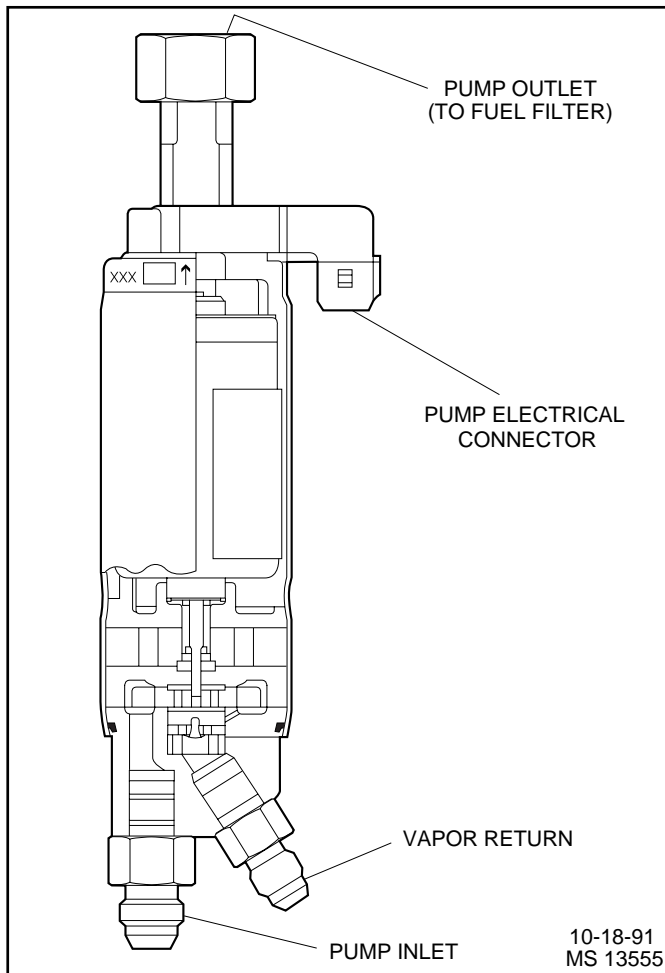


Figure 3-19 - Fuel Pump

### Fuel Pump Relay

Figure 3-20

#### Remove or Disconnect

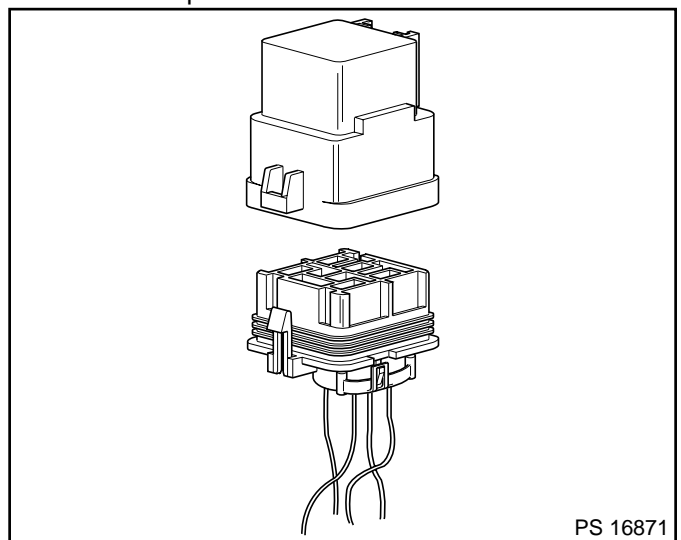
1. Retainer, if installed.
2. Fuel pump relay electrical connector.
3. Fuel pump relay.

#### Important

- ï The fuel pump relay is an 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.



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Figure 3-20 - Fuel Pump Relay

## In-Line Fuel Filter

Figure 3-21

### Important

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

### Remove or Disconnect

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

### Inspect

- ï 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

- ï Turn ignition switch to the ïONï position for 2 seconds, then turn to the ïOFFï position for 10 seconds. Turn the ignition switch back to the ïONï position and check for fuel leaks.

## Water Separator

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

### Important

- ï Fuel system needs to be primed and air bled out of the lines before the engine is started. Follow manufacturer's recommendation for priming fuel system.

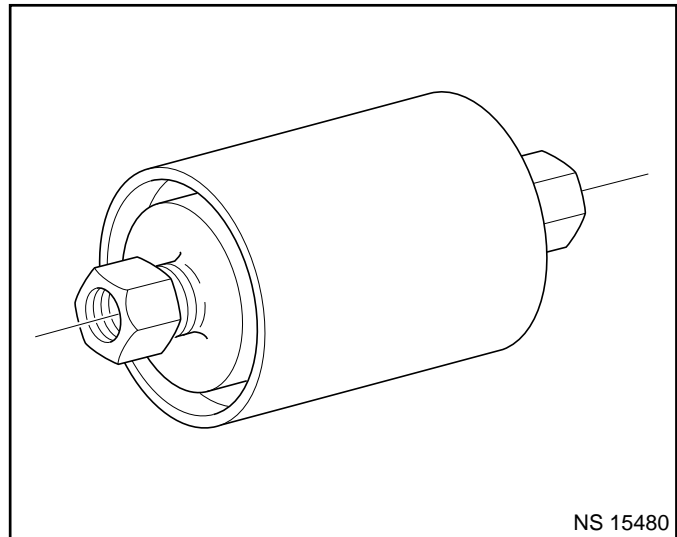


Figure 3-21 - In-Line Fuel Filter

## Torque Specifications

### Fastener Tightening Specifications

Application	Nïm	Lb Ft	Lb In
Throttle Body Attaching Nuts	15	11	
IAC Valve Attaching Screws	3.2		28
Upper Intake Plenum Retaining Bolts (Figure 3-12)	14		124
Fuel Pressure Regulator Attaching Screws	9.5		84
Fuel Pressure Regulator Outlet Line Nut	17.5	13	
Fuel Rail Attaching Screws	10		88

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## Marine Electronic Fuel Injection (MEFI)

### Section 3D

## Fuel Metering System - Multiport Fuel Injection (MFI) - 7.4/8.2L

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 Multiport Fuel Injection (MFI) used on the 7.4/8.2L. All other systems will be detailed in a separate manual. In distinguishing fuel systems used on specific applications, the following rules apply. 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. TBI systems use two injectors mounted at the top of the throttle body assembly.

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## General Description

### Purpose

The function of the fuel metering system is to deliver the correct amount of fuel to the engine under all operating conditions. Fuel is delivered to the engine by individual fuel injectors mounted in the intake manifold near each cylinder.

### 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 imodes. All the imodes 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, injector 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 fuel 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 a change of state in a discrete switch input that identifies an abnormal condition. During these abnormal conditions, 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

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

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

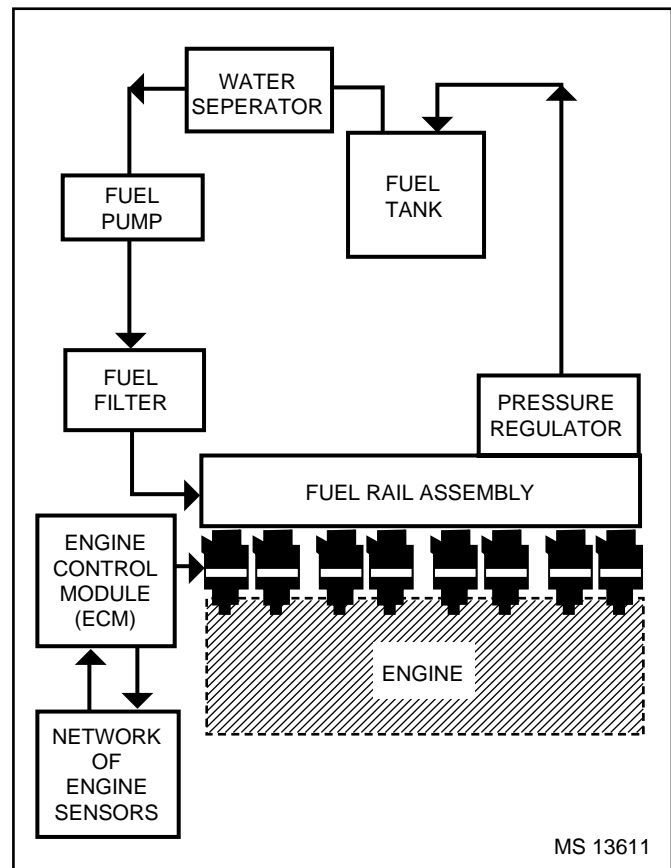


Figure 3-1 - Fuel Metering System (Typical)

**Fuel Supply Components (Typical)**

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 fuel rail assembly. The pump is designed to provide fuel at a pressure greater than is needed by the injectors. The pressure regulator, part of the fuel rail assembly, keeps fuel available to the injectors at a regulated pressure. Unused fuel is returned to the fuel tank by a separate line.

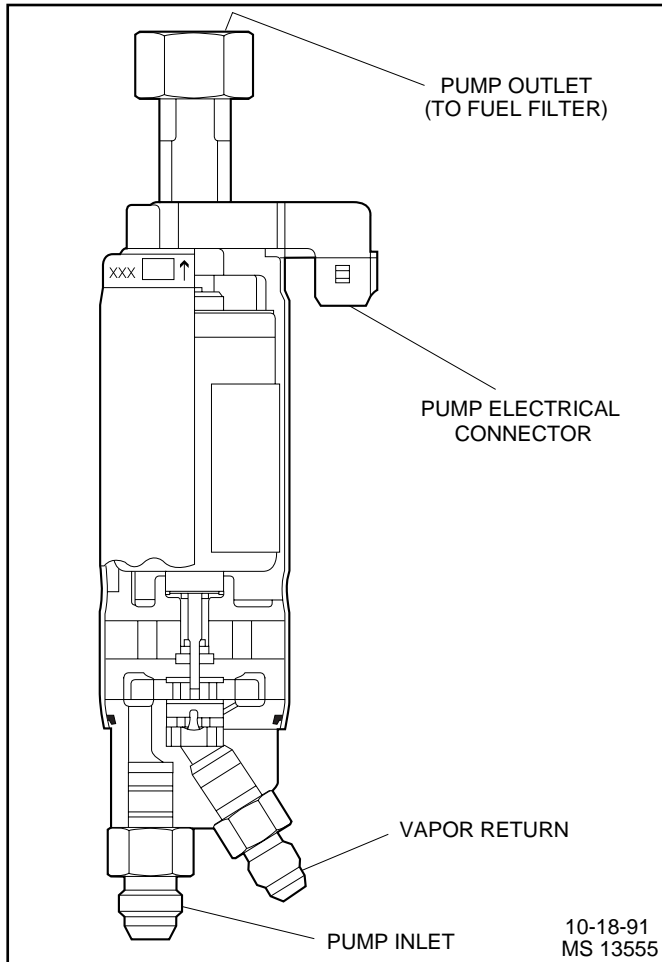


Figure 3-2 - Electric Fuel Pump (Typical)

**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.

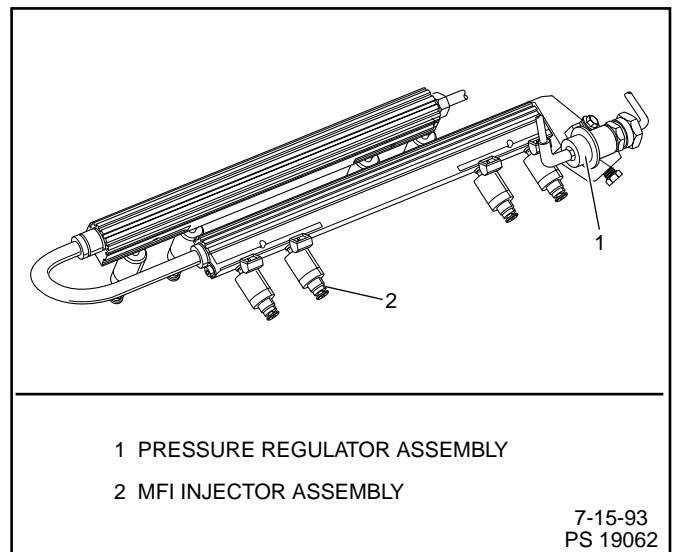
When the ignition switch is turned to the crank position, the ECM turns the fuel pump relay *ON* causing the fuel pump to run.

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 Will Not Run* condition.

**Fuel Rail Assembly**

The fuel rail (Figure 3-3) is mounted to the engine intake manifold, and performs several functions. It positions the injectors in the intake manifold, distributes fuel evenly to the injectors, and integrates the fuel pressure regulator into the fuel metering system.



- 1 PRESSURE REGULATOR ASSEMBLY
- 2 MFI INJECTOR ASSEMBLY

Figure 3-3 - Fuel Rail Assembly



**Fuel Injectors**

The Multiport Fuel Injection (MFI) injector assembly is a solenoid-operated device, controlled by the ECM, that meters pressurized fuel to a single engine cylinder (Figure 3-4). The ECM energizes the injector solenoid, which opens a ball valve, allowing fuel to flow past the ball valve, and through a recessed flow director plate. The director plate has six machined holes that control the fuel flow, generating a conical spray pattern of finely atomized fuel at the injector tip. Fuel is directed at the intake valve, causing it to become further atomized and vaporized before entering the combustion chamber.

An injector that is stuck partly open would cause loss of pressure after engine shut down. 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.

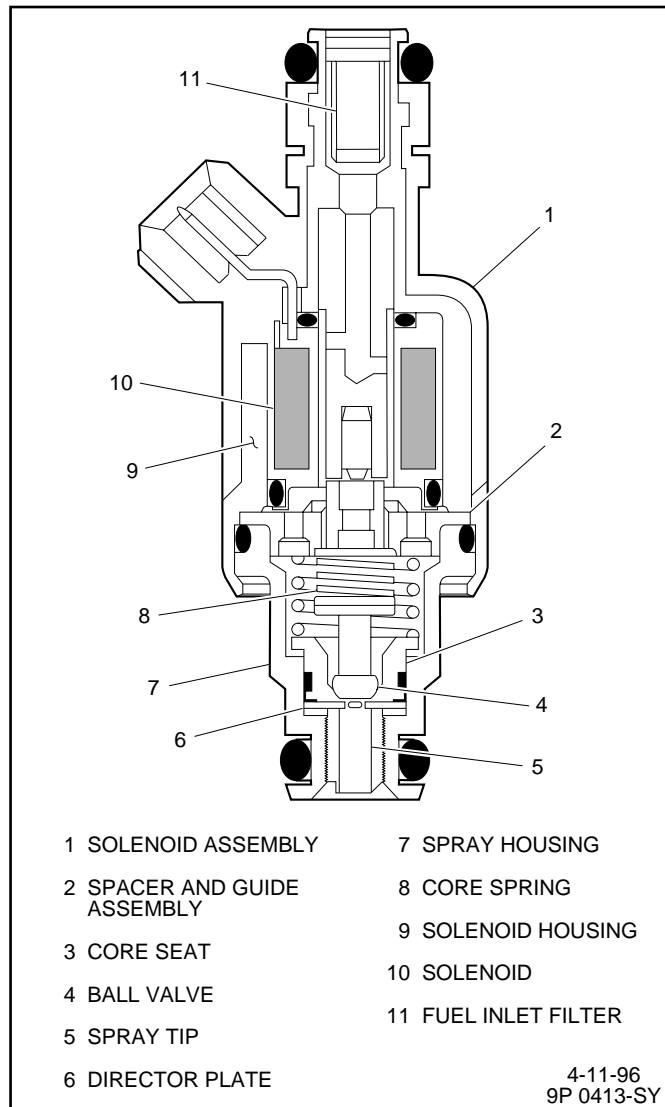


Figure 3-4 - MFI Injector Assembly (Typical)

**Pressure Regulator Assembly**

The pressure regulator is a diaphragm-operated relief valve with fuel pump pressure on one side, and regulator spring pressure and intake manifold vacuum on the other side (Figure 3-5). The regulator's function is to maintain a constant pressure differential across the injectors at all times. The pressure regulator compensates for engine load by increasing fuel pressure as engine vacuum drops.

With the ignition ON, if engine OFF (zero vacuum), fuel pressure at the pressure test connection should be 284-325 kPa (41-47 psi). If the pressure is too low, poor performance or a no-start may result. If pressure is too high, excessive odor may result.

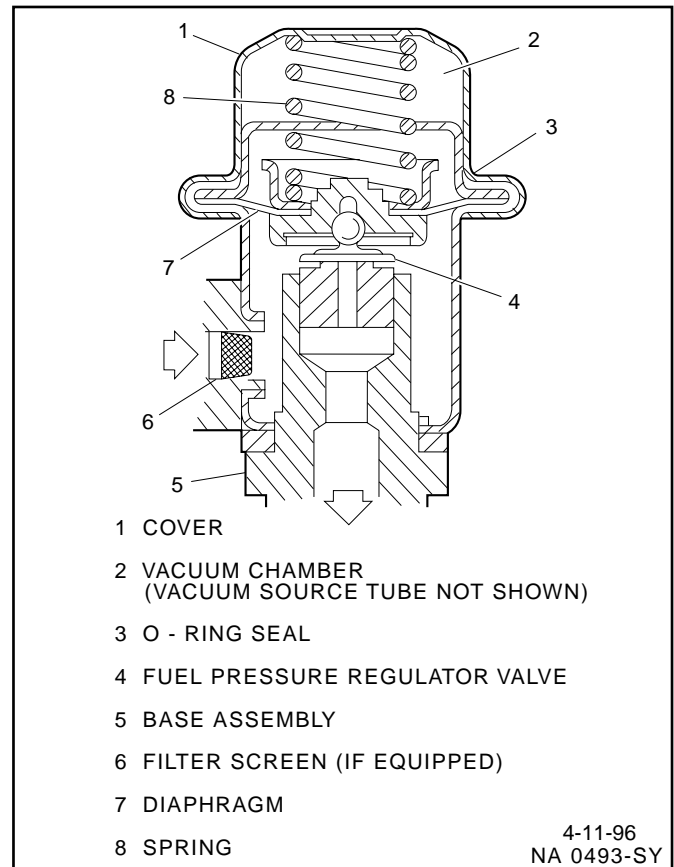


Figure 3-5 - Pressure Regulator Assembly (Typical)

**Throttle Body Assembly**

The throttle body assembly is attached to the intake manifold air plenum, and is used to control air flow into the engine, thereby controlling engine output (Figure 3-6). The throttle plates within the throttle body are opened by the driver through the throttle controls. During engine idle, the throttle plates are closed, and air flow control is handled by the Idle Air Control (IAC) valve, described below.

The throttle body also provides the location for mounting the TP sensor and for sensing changes in engine vacuum due to throttle plates position.

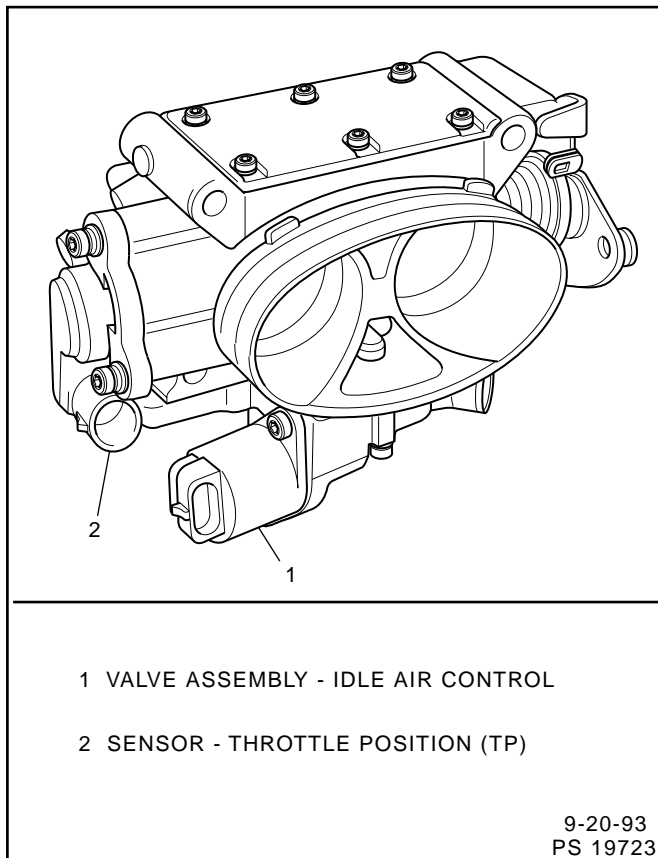


Figure 3-6 - Throttle Body Assembly

**Idle Air Control (IAC) Valve**

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.

The IAC valve, mounted to the throttle body, controls bypass air around the throttle plates (Figure 3-7). 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 monitored 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.

- ï Engine idle speed is a function of total air flow into the engine based on IAC valve pintle position plus throttle plates opening.
- ï iControlled 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.

- ï 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 at a calibrated number of steps (counts) from the seat, during icontrolled 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.

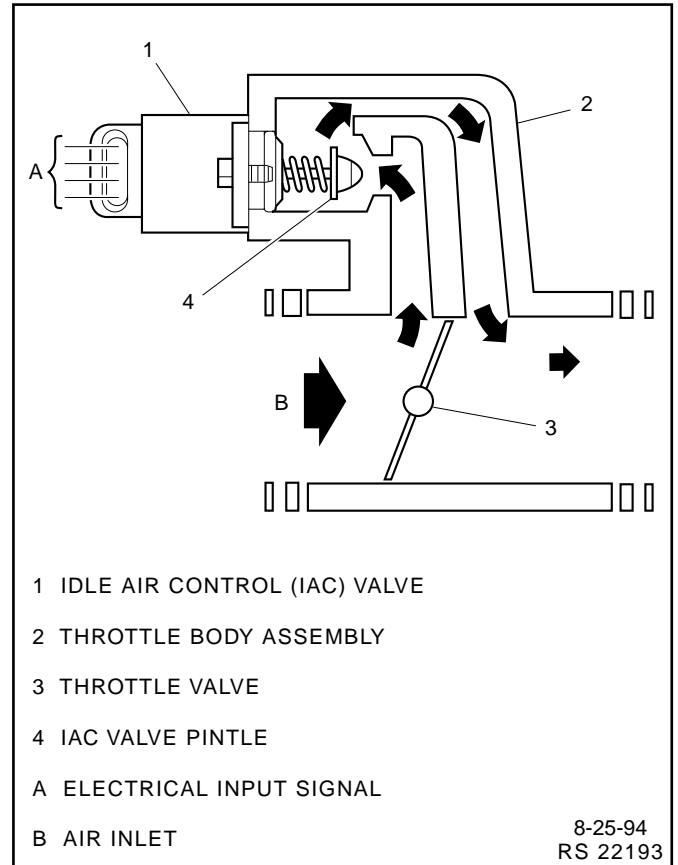


Figure 3-7 - IAC Valve Air Flow Diagram

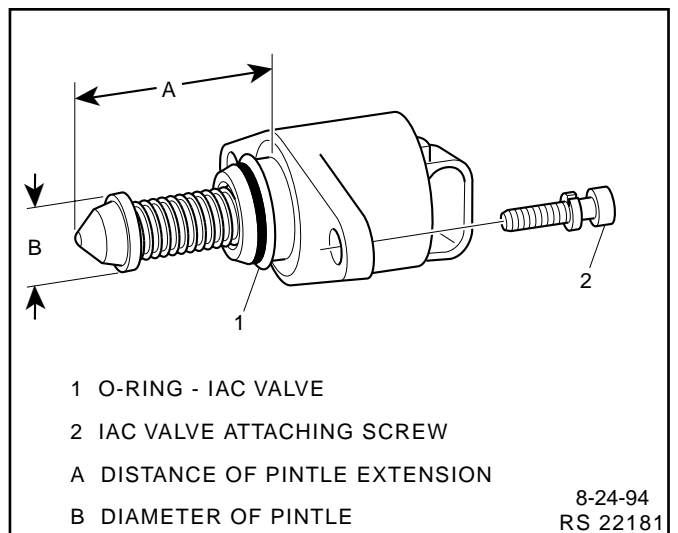
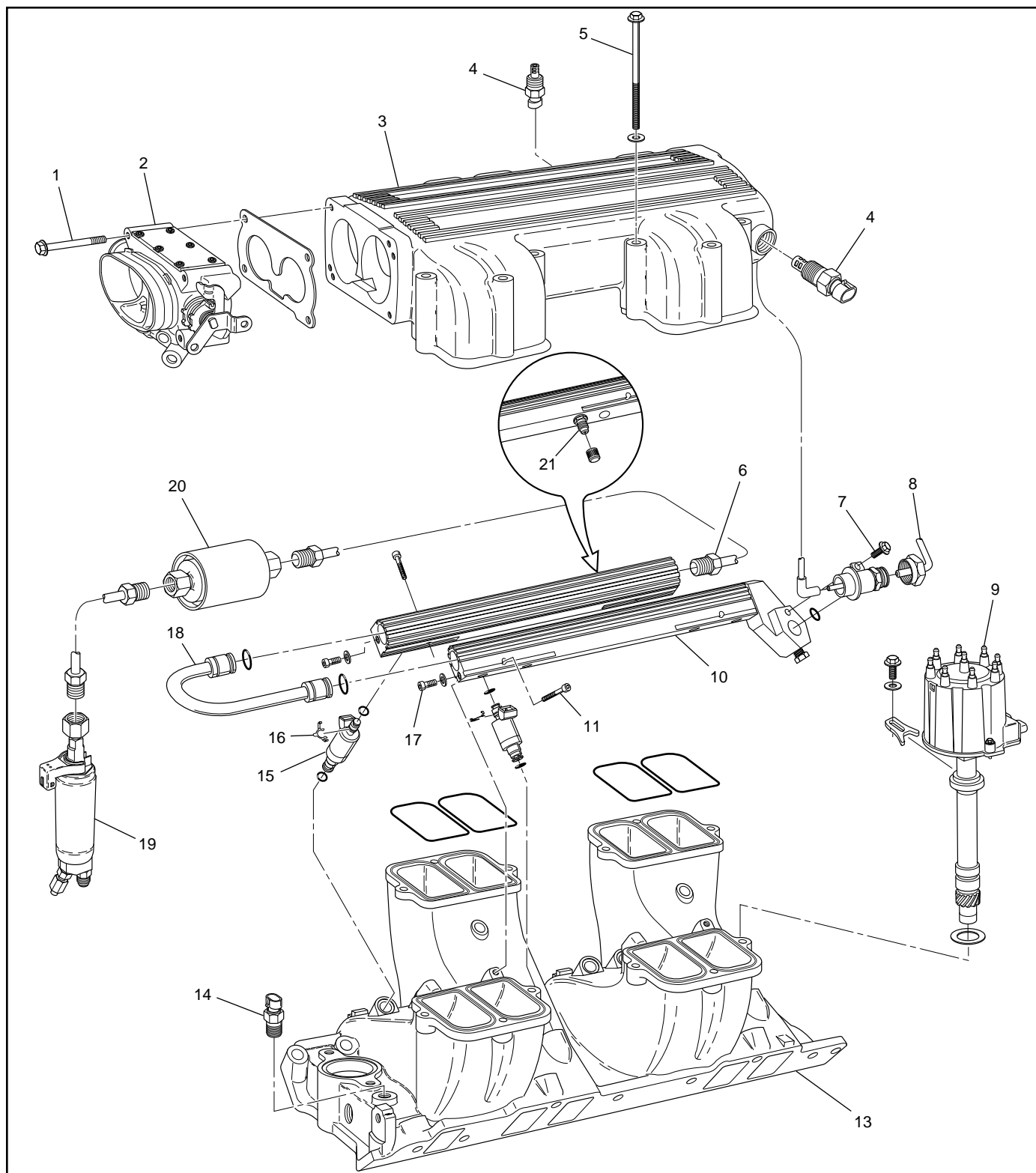


Figure 3-8 - Flange Mounted Type IAC Valve



- |                                  |                               |                                     |
|----------------------------------|-------------------------------|-------------------------------------|
| 1 SCREW ASSEMBLY - THROTTLE BODY | 8 OUTLET FUEL LINE NUT        | 15 MFI INJECTOR                     |
| 2 THROTTLE BODY ASSEMBLY         | 9 DISTRIBUTOR                 | 16 INJECTOR RETAINER CLIP           |
| 3 INTAKE PLENUM                  | 10 FUEL RAIL                  | 17 SCREW ASSEMBLY - FUEL RAIL       |
| 4 IAT SENSOR                     | 11 SCREW ASSEMBLY - FUEL RAIL | 18 FUEL RAIL JUMPER LINE            |
| 5 SCREW ASSEMBLY - INTAKE PLENUM | 12 O-RING - INTAKE            | 19 FUEL PUMP                        |
| 6 INLET FUEL FITTING             | 13 INTAKE MANIFOLD            | 20 INLINE FUEL FILTER               |
| 7 FUEL PRESSURE REGULATOR        | 14 ECT SENSOR                 | 21 FUEL PRESSURE CONNECTOR ASSEMBLY |

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Figure 3-9 - Fuel Rail and Throttle Body Assemblies

## Diagnosis

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

## On-Board Service

### 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:

- ï Always keep a dry chemical fire extinguisher near the work area.
- ï Fuel pipe fittings require new O-rings when assembling.
- ï Do not replace fuel pipe with fuel hose.
- ï Always bleed off fuel pressure before servicing any fuel system components.
- ï Do not do any repairs on the fuel system until you have read the instructions and checked the figures relating the repair.
- ï Observe all notices and cautions.

## Fuel Pressure Relief Procedure

Tool Required:

J 34730-1, Fuel Pressure Gauge

### Important

- ï 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. Connect fuel pressure gauge J 34730-1 to fuel pressure connector assembly. Wrap a shop towel around fitting while connecting the gauge to avoid any spillage.
- 4. Install bleed hose into an approved container and open valve to bleed system pressure. Fuel connections are now safe for servicing.
- 5. Drain any fuel remaining in the gauge into an approved container.

## Flame Arrestor

### Remove or Disconnect

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

### Inspect

- ï 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.

## Throttle Body Assembly

Figures 3-10 through 3-12

The throttle body assembly repair procedures cover component replacement with the unit on the vessel. However, throttle body replacement requires that the complete unit be removed from the engine.

### Clean

#### Important

Do not soak the throttle body in cold immersion type cleaner. The throttle valves have a factory applied sealing compound (DAG material is applied to outside edge of each valve and throttle bore) to prevent air bypass at closed throttle. Strong solvents or brushing will remove the material. To clean the throttle body following disassembly, use a spray type cleaner such as GM X66-A or GM 1052626. Use a shop towel to remove heavy deposits.

**Notice:** The TP sensor and the IAC valve are electrical components and should NOT come in contact with solvent or cleaner as they may be damaged.

#### Remove or Disconnect

1. Negative battery cable.
2. Flame arrestor.
3. Electrical connectors from TP sensor and IAC valve.
4. Vacuum lines.
5. Throttle adjuster to throttle body cable.
6. Throttle body attaching bolts.
7. Throttle body assembly and flange gasket.
8. Discard gasket.

### Clean

**Notice:** Use care in cleaning old gasket material from machined aluminum surfaces as sharp tools may damage sealing surfaces.

- Gasket sealing surfaces.

#### Install or Connect

1. Throttle body assembly with new flange gasket.
2. Throttle body attaching bolts. Torque to 15 N·m (11 lb.ft.).
3. Throttle adjuster to throttle body cable.
4. Vacuum lines.
5. Electrical connectors to TP sensor and IAC valve.
6. Flame arrestor.
7. Negative battery cable.

### Inspect

- With the engine OFF, check to see that the throttle lever is free.
- Move the throttle lever to wide open throttle and release.

Reset IAC valve pintle position:

- Move throttle lever slightly.
- Start and run engine for 5 seconds.
- Turn ignition OFF for 10 seconds.
- Restart engine and check for proper idle operation.

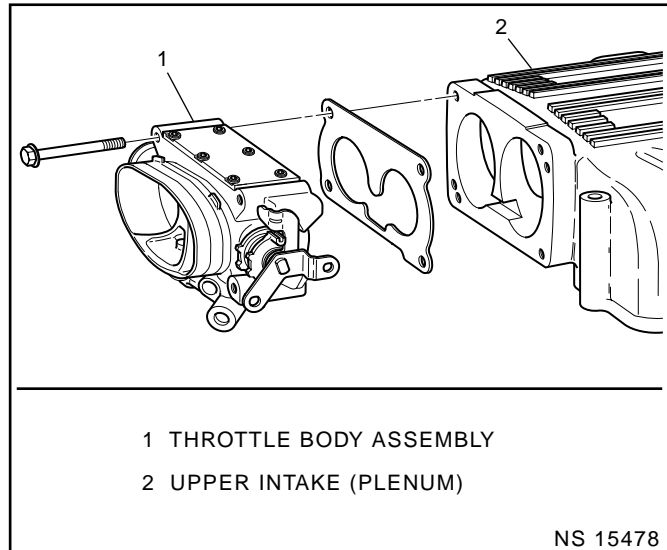


Figure 3-10 - Throttle Body Removal

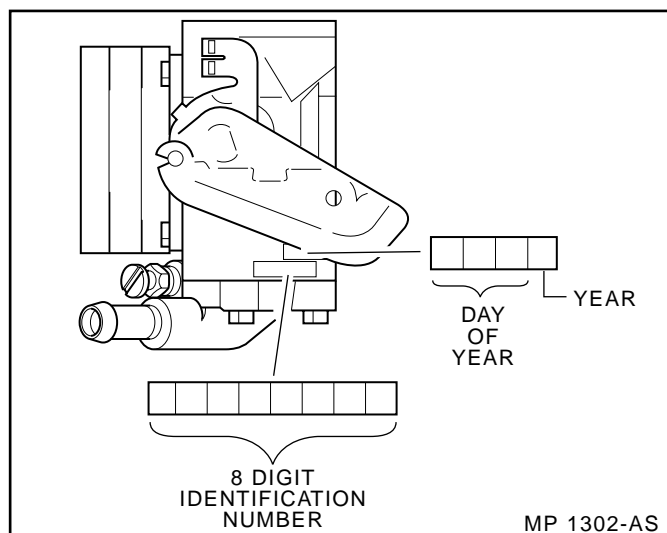
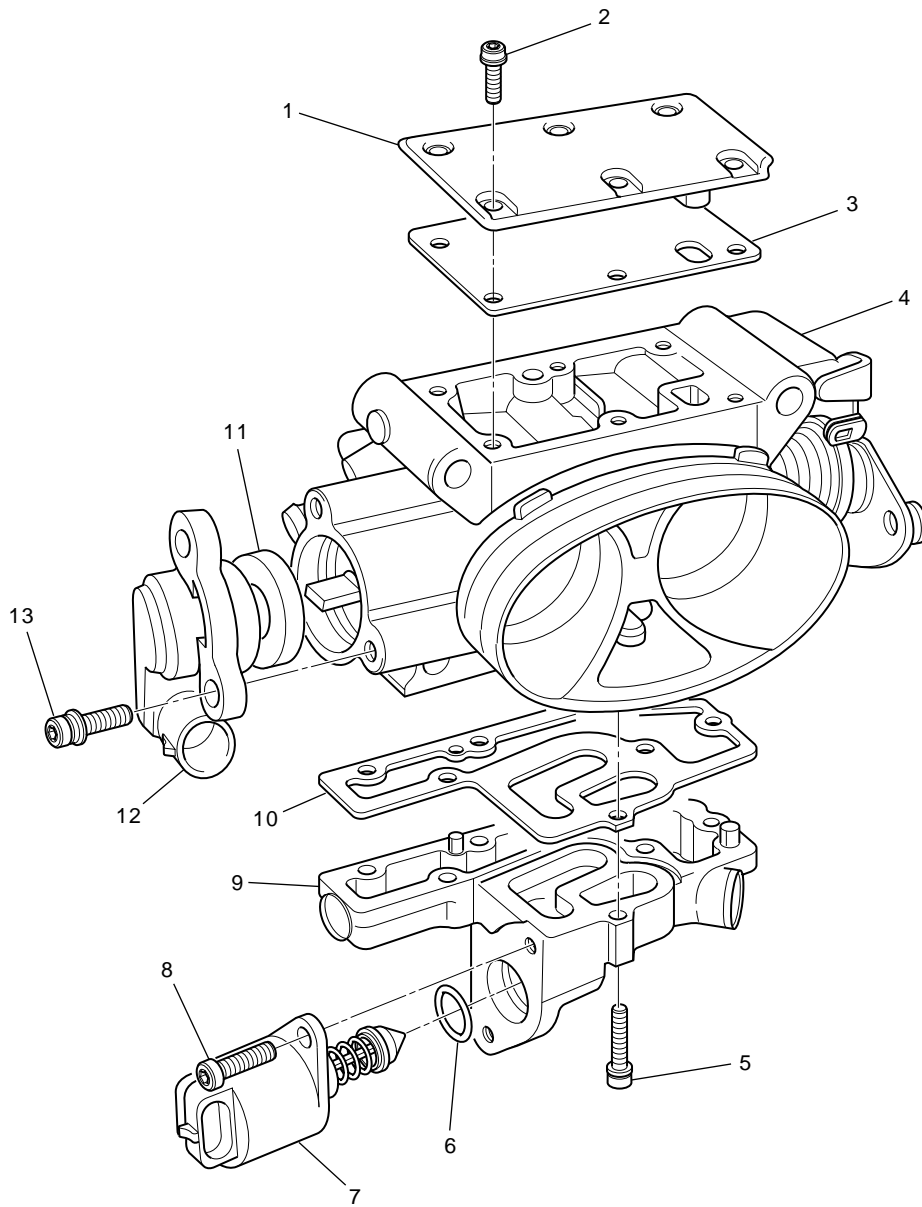


Figure 3-11 - Throttle Body Identification



- |   |   |
|---|---|
| 1 COVER - CLEAN AIR                       | 8 SCREW - AIC VALVE ATTACHING                   |
| 2 SCREW - CLEAN AIR COVER ATTACHING       | 9 COVER ASSEMBLY - IACV/COOLANT                 |
| 3 GASKET - CLEAN AIR COVER                | 10 GASKET - IACV/COOLANT COVER TO THROTTLE BODY |
| 4 BODY ASSEMBLY - THROTTLE                | 11 SEAL - STATIC                                |
| 5 SCREW - IACV/COOLANT COVER ATTACHING    | 12 SENSOR - THROTTLE POSITION (TP)              |
| 6 O-RING - IAC VALVE ASSEMBLY             | 13 SCREW - TP SENSOR ATTACHING                  |
| 7 VALVE ASSEMBLY - IDLE AIR CONTROL (IAC) |   |

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Figure 3-12 - Throttle Body Assembly

### Idle Air Control (IAC) Valve/Coolant Cover Assembly

Figure 3-12

#### Remove or Disconnect

- Throttle body assembly from upper intake.
  - Refer to Throttle Body Assembly.

#### Disassemble

1. IAC valve assembly and gasket. Discard gasket.
2. IAC valve cover assembly screws.
3. Cover assembly and gasket. Discard gasket.

#### Clean and Inspect

- Clean gasket sealing surface.
- Inspect gasket sealing surface for corrosion or damage that would cause a leak. Replace cover assembly or throttle body if necessary.

#### Assemble

1. New cover gasket.
2. Cover assembly.
3. Cover screws. Torque to 3.2 N·m (28 lb.in.).

#### 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.
- 4. IAC valve assembly with new O-ring.

#### Tighten

- Attaching screw assemblies to 3.2 N·m (28 lb.in.).

### Intake Plenum (Upper Intake Section)

Figure 3-13 and 3-14

#### Remove or Disconnect

1. Negative positive cable.
2. Throttle cable from throttle body.
3. Electrical connectors from:
  - ECM J1 and J2 connectors.
  - KS module.
  - TP sensor.
  - IAC valve.
  - MAP sensor.
  - IAT sensor.
4. Vacuum hose to fuel pressure regulator.
5. Plenum retaining bolts.
6. Intake plenum.

**Notice:** Caution must be taken when handling the intake plenum, not to damage the plenum to lower intake manifold mating surfaces and the throttle body mounting surface. Also, after the manifold has been removed, cover exposed lower intake manifold ports to prevent any foreign material from entering the engine and causing serious damage.

7. If plenum is to be replaced, remove the attached components according to procedures outlined in this section.
8. Gasket and O-ring seals.

#### Clean

**Notice:** When cleaning the plenum, caution must be taken because the plenum is made of aluminum. Do Not gouge gasket or O-ring seal surfaces or use a power wire brush.

- All gasket surfaces of old gasket and O-ring seals.
- Interior of plenum of any sludge or oil build up.
  - Use spray carburetor cleaner that does not contain methyl ethyl ketone, an extremely strong solvent. It is necessary for this type of deposit.

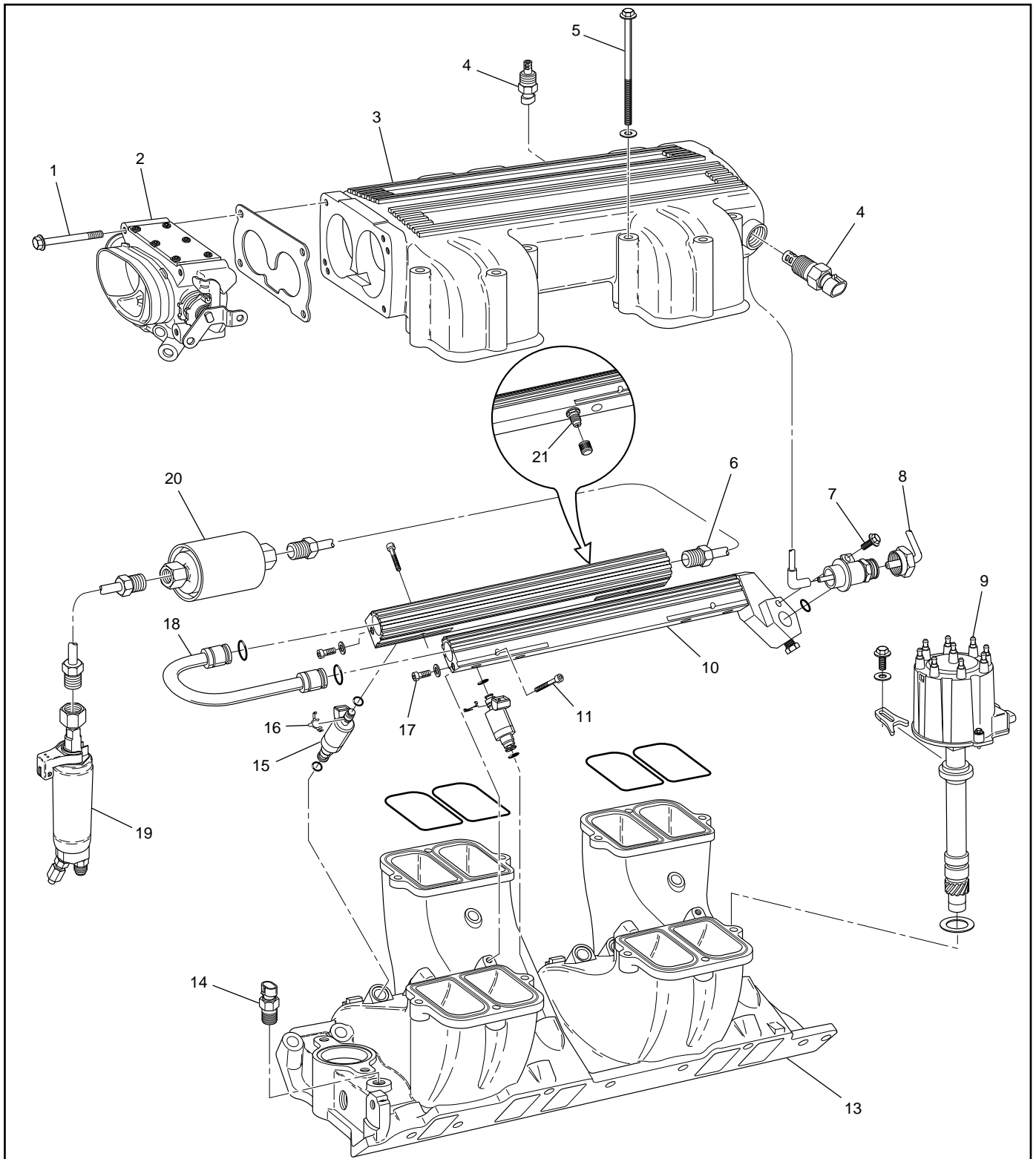
#### Important

- Do Not soak intake plenum in any liquid cleaner or solvent if any components are still attached, as damage may result to the components.

**Notice:** In either case, whether using a new or used plenum, follow these inspection procedures.

#### Inspect

- Entire plenum mating surfaces for burrs and flaws.
- Entire plenum for porosity (small holes in casting due to manufacturing flaws).
- Entire plenum for cracks caused from manufacturing flaw or handling.



- |                                  |                               |   |
|----------------------------------|-------------------------------|---|
| 1 SCREW ASSEMBLY - THROTTLE BODY | 8 OUTLET FUEL LINE NUT        | 15 MFI INJECTOR                           |
| 2 THROTTLE BODY ASSEMBLY         | 9 DISTRIBUTOR                 | 16 INJECTOR RETAINER CLIP                 |
| 3 INTAKE PLENUM                  | 10 FUEL RAIL                  | 17 SCREW ASSEMBLY - FUEL RAIL JUMPER LINE |
| 4 IAT SENSOR                     | 11 SCREW ASSEMBLY - FUEL RAIL | 18 FUEL RAIL JUMPER LINE                  |
| 5 SCREW ASSEMBLY - INTAKE PLENUM | 12 O-RING - INTAKE            | 19 FUEL PUMP                              |
| 6 INLET FUEL FITTING             | 13 INTAKE MANIFOLD            | 20 INLINE FUEL FILTER                     |
| 7 FUEL PRESSURE REGULATOR        | 14 ECT SENSOR                 | 21 FUEL PRESSURE CONNECTOR ASSEMBLY       |

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Figure 3-13 - Intake and Fuel System



**Install or Connect**

1. Lubricate O-ring seals with light grease.
2. O-ring seals in lower intake O-ring grooves.
3. Plenum on lower intake, being careful not to move the O-ring seals out of their grooves.

**Important**

- ï Lightly coat threads and shaft of bolts with anti-seize compound.
4. All plenum retaining bolts. Torque to 14 N·m (124 lb.in.) in sequence as shown in Figure 3-14.
  5. Vacuum hose to fuel pressure regulator.
  6. Electrical connectors to:
    - ï ECM iJ1i and iJ2i connectors.
    - ï KS module.
    - ï TP sensor.
    - ï IAC valve.
    - ï MAP sensor.
    - ï IAT sensor.
  7. Throttle cable to throttle body.
  8. Negative battery cable.

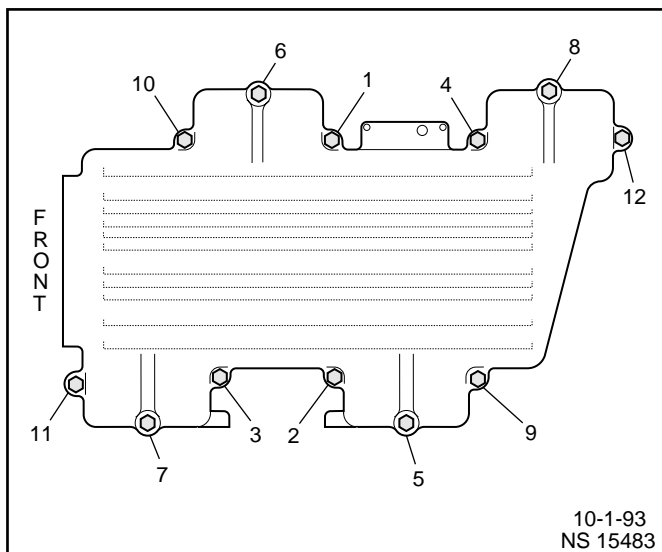


Figure 3-14 - Intake Plenum Tightening Sequence

**Fuel Pressure Connector Assembly**

Figure 3-13

**Clean**

- ï Area around fuel pressure connection with GM X-30A or equivalent.

**Remove or Disconnect**

1. Negative battery cable.
2. Relieve fuel pressure.
  - ï Refer to the iFuel Pressure Relief Procedure.i
3. Fuel pressure connection and seal.

**Install or Connect**

1. New seal on fuel pressure connection.
2. Fuel pressure connection in fuel rail. Torque to 13 N·m (115 lb.in.).
3. Negative battery cable.

**Inspect**

- ï Turn ignition switch to the iONi position for 2 seconds, then turn to the iOFFi position for 10 seconds. Turn the ignition switch back to the iONi position and check for fuel leaks.

**Fuel Rail Assembly**

Figures 3-13 and 3-15

The fuel rails should be removed as an assembly with the injectors attached. Names of component parts will be found on the numbered list that accompanies the disassembled view (Figure 3-13).

**Notice:**

- ï Use care in removing the fuel rail assembly to prevent damage to the injector electrical connector terminals and the injector spray tips.
- ï When removed, support the rail to avoid damaging its components.
- ï Prevent dirt and other contaminants from entering open lines and passages. Fittings should be capped and holes plugged during servicing.

**Clean**

- ï Before removal, the fuel rail assembly may be cleaned with a spray type engine cleaner, GM X-30A or equivalent, following package instructions. Do Not soak fuel rails in liquid cleaning solvent.

**Caution: Safety glasses must be worn when using compressed air as flying dirt particles may cause eye injury.**

- ï Where injectors fit into intake manifold, use compressed air to blow out dirt from around injectors before removing.

**Remove or Disconnect**

**Caution:** To reduce the risk of fire and personal injury, relieve the fuel system pressure before servicing the fuel system components.

1. Negative battery cable.
2. Relieve fuel pressure.
  - ï Refer to the iFuel Pressure Relief Procedure.î
  - ï Fuel pressure connector assembly is located on right side rail in center of fuel rail.
3. Upper intake plenum following the procedures outlined in this section.
4. Fuel inlet line, hold fitting in rail with a wrench to keep from turning.
5. Fuel outlet fitting at pressure regulator.
  - ï Hold pressure regulator with a wrench to keep from turning and damaging.
6. Vacuum line to fuel pressure regulator.
7. Retaining screw for pressure regulator and pressure regulator.
8. Electrical connectors from injectors.
  - ï To release electrical connector from injector, squeeze on metal loop with thumb and pull connector from injector.
9. Move wire harness out of way.
10. Four attaching screws for fuel rail.
11. Fuel rails as an assembly with injectors.
12. Injectors from rails, follow procedure for injector removal outlined in this section.
13. Retaining screws for fuel rail jumper line.
14. Twist and remove jumper line from rail.

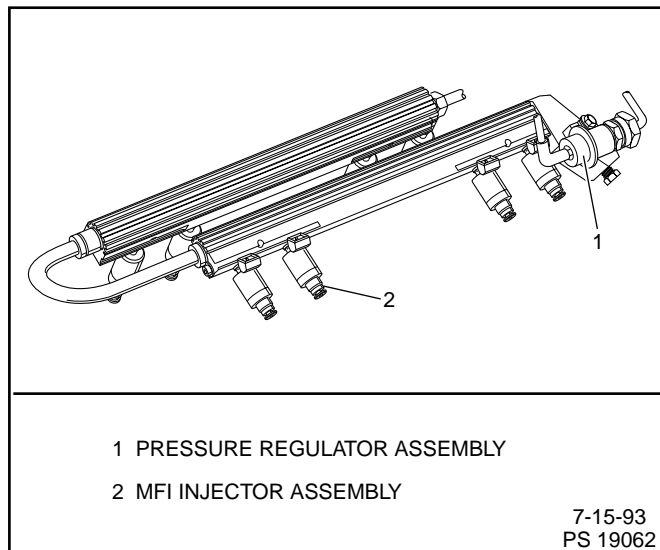


Figure 3-15 - Fuel Rail Assembly

**Clean and Inspect**

**Notice:** If it is necessary to remove rust or burrs from the fuel rail pipes, use emery cloth in a radial motion with the tube end to prevent damage to the O-ring sealing surface.

- ï Use a clean shop towel to wipe off male pipe ends.
- ï Inspect all connectors for dirt and burrs. Clean or replace components/assemblies as required.

**Disassemble**

- ï Injector O-ring seal from spray tip end of each injector. Discard O-ring seals.

**Assemble**

- ï Lubricate new injector O-ring seals with clean engine oil and install on spray tip end of each injector.

**Install or Connect**

1. Lubricate new O-ring seals and install on rail jumper line ends.
2. Rail jumper line in rails, long side of jumper to left rail.
3. Jumper line attaching screws. Torque to 7 Nîm (62 lb.in.).
4. Lubricate injector O-ring seals and install injectors following injector installation procedure outlined in this section.
5. Fuel rails as an assembly with injectors onto intake manifold.
  - ï If injectors are lined up properly they will slide into place.
  - ï Push gently and evenly on rail to set injectors all the way into their bores
6. Fuel rail attaching screws. Torque to 10 Nîm (88 lb.in.).
7. Injector electrical connectors and secure harness in place.
8. Lubricate new O-ring seal on pressure regulator and install pressure regulator.
9. Pressure regulator attaching screw. Torque to 9.5 Nîm (84 lb.in.).
10. Vacuum line to fuel pressure regulator.
11. Lubricate new O-ring seal on pressure regulator outlet fitting and tighten fitting, careful not to twist regulator. Torque to 17.5 Nîm (13 lb.ft.).
12. Inlet fuel line.
13. Upper intake plenum following procedures outlined in this section.
14. Negative battery cable.
15. Prime fuel system by cycling key iONî and iOFFî a few times with engine iOFF.î

**Inspect**

- ï Turn ignition switch to the iONî position for 2 seconds, then turn to the iOFFî position for 10 seconds. Turn the ignition switch back to the iONî position and check for fuel leaks.

## Fuel Injectors

Figures 3-16 through 3-18

**Notice:** Use care in removing injectors to prevent damage to the injector electrical connector pins or the injector spray tips. The fuel injector is serviced as a complete assembly only. Since it is an electrical component, Do Not immerse it in any cleaner.

### Remove or Disconnect

1. Negative battery cable.
2. Relieve fuel pressure.
  - ï Refer to the ìFuel Pressure Relief Procedure.î
3. Upper intake plenum following procedures outlined in this section.
4. Fuel rail assembly following procedures outlined in this section.

### Disassemble

1. Release injector clip by sliding off injector (Figure 3-16).

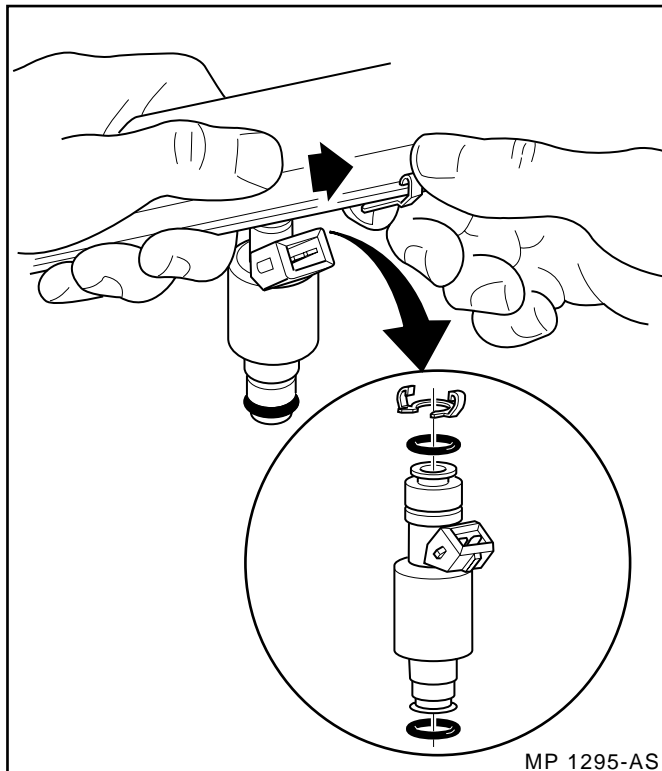


Figure 3-16 - Injector Clip Removal

2. MFI injector from rail.
3. Injector O-ring seals from both ends of the injector and discard.
4. Injector retainer clip from rail.

### Clean and Inspect

- ï Injector bores in fuel rail and intake manifold for nicks, burrs, or corrosion damage. If severe, replace. Clean lightly with emery cloth in a radial motion.

- ï Injector O-ring seal grooves for nicks, burrs, or corrosion. Replace injector if damaged. Clean with spray cleaner and wipe groove clean with lint free cloth.
- ï Do Not use abrasive materials or wire brush on injectors. They are plated with an anti-corrosive material.

### Important

- ï When ordering individual replacement fuel injectors, be sure to order the identical part number that is inscribed on the old injector.

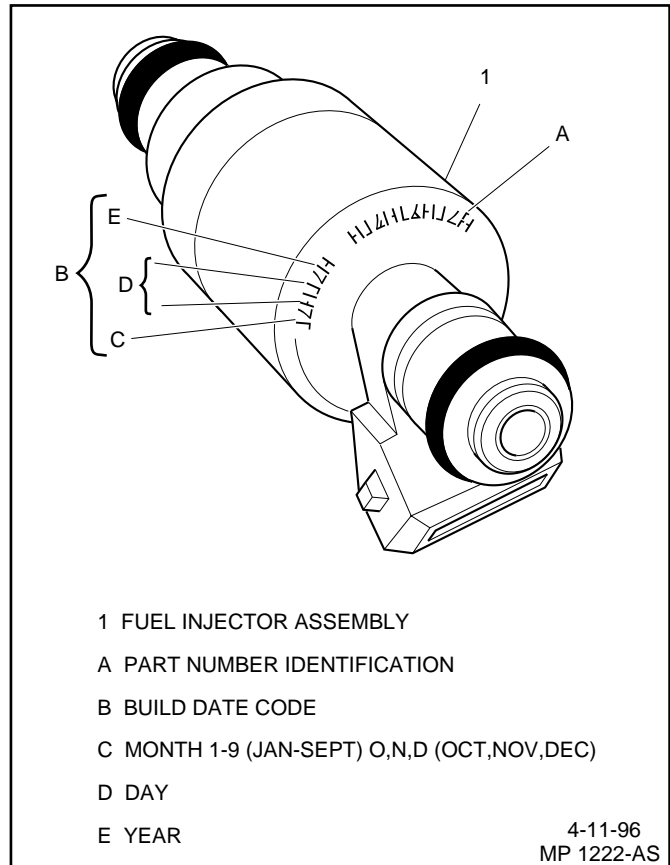


Figure 3-17 - Injector Part Number Location

### Assemble

1. Lubricate new injector O-ring seals with clean engine oil and install on injector.
2. New retainer clip onto injector.
3. MFI fuel injector assembly into fuel rail injector socket with electrical connector facing outward.
4. Rotate injector retainer clip to locking position.

### Install or Connect

1. Fuel rail assembly following procedures outlined in this section.
2. Upper intake plenum following procedures outlined in this section.
3. Negative battery cable.

### Inspect

- ï Turn ignition switch to the ìONî position for 2 seconds, then turn to the ìOFFî position for 10 seconds. Turn the ignition switch back to the ìONî position and check for fuel leaks.

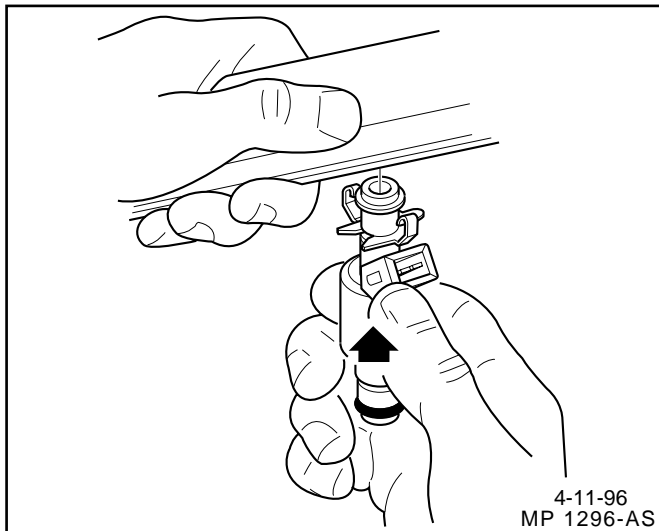


Figure 3-18 - MFI Fuel Injector and Retainer Clip

## Fuel Pressure Regulator Assembly

Figure 3-19

### Important

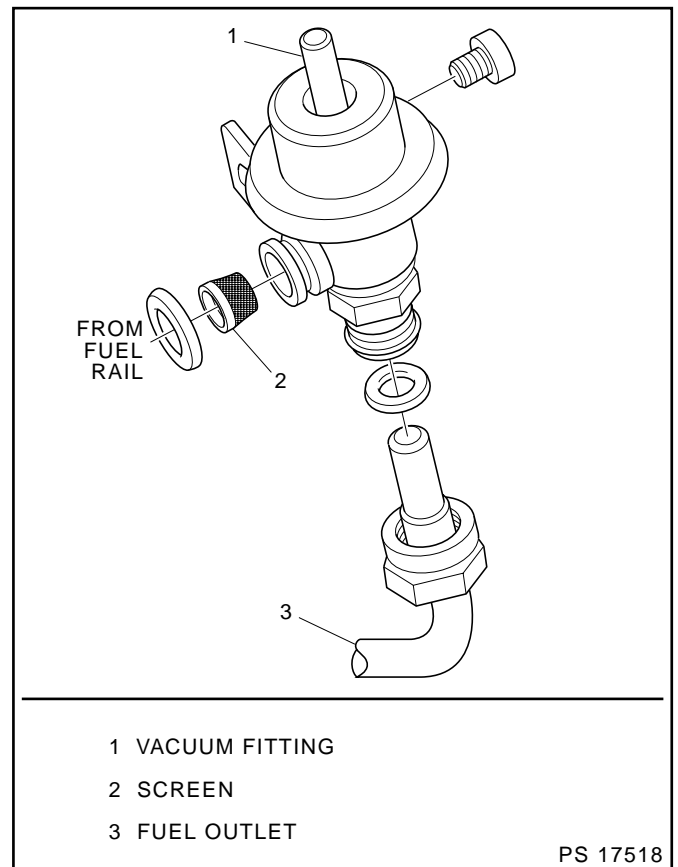
- ï The fuel pressure regulator is serviced as a complete assembly only.
- ï Fuel pressure must be relieved before servicing the fuel pump.
- ï Refer to Fuel Pressure Relief Procedure.

### Remove or Disconnect

1. Negative battery cable.
2. Vacuum hose from regulator.
3. Fuel outlet line nut.
  - ï Use back up wrench to hold pressure regulator to keep from turning and damage.
  - ï Discard outlet line nut O-ring.
4. Pressure regulator attaching screw.
5. Pressure regulator from fuel rail.
6. Pressure regulator O-ring and discard.

### Inspect

- ï The fuel input port of the pressure regulator may contain a filter screen. Inspect the screen for dirt and debris. If dirty, use a pick to remove filter screen and discard. Replace with new filter screen supplied in service package.



- 1 VACUUM FITTING
- 2 SCREEN
- 3 FUEL OUTLET

PS 17518

Figure 3-19 - Fuel Pressure Regulator

### Install or Connect

1. Lubricate new fuel pressure regulator O-ring with clean engine oil and install on regulator.
2. Push pressure regulator into rail.
3. Pressure regulator attaching screw. Finger tighten only.
4. Lubricate new outlet line O-ring and install on end of line.
5. Outlet line assembly with nut to pressure regulator. Finger tighten only.
6. Torque pressure regulator attaching screw to 9.5 Nïm (84 lb.in.).
7. Torque outlet line nut to 17.5 Nïm (13 lb.ft.).
  - ï Use backup wrench to keep pressure regulator from turning and damage.
8. Vacuum line to pressure regulator.
9. Negative battery cable.

### Inspect

- ï Turn ignition switch to the ìONî position for 2 seconds, then turn to the ìOFFî position for 10 seconds. Turn the ignition switch back to the ìONî position and check for fuel leaks.

## Fuel Pump

Figure 3-20

### Important

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

### 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

- ï Turn ignition switch to the iONî position for 2 seconds, then turn to the iOFFî position for 10 seconds. Turn the ignition switch back to the iONî position and check for fuel leaks.

## Fuel Pump Relay

Figure 3-21

### Remove or Disconnect

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

### Important

- ï 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.

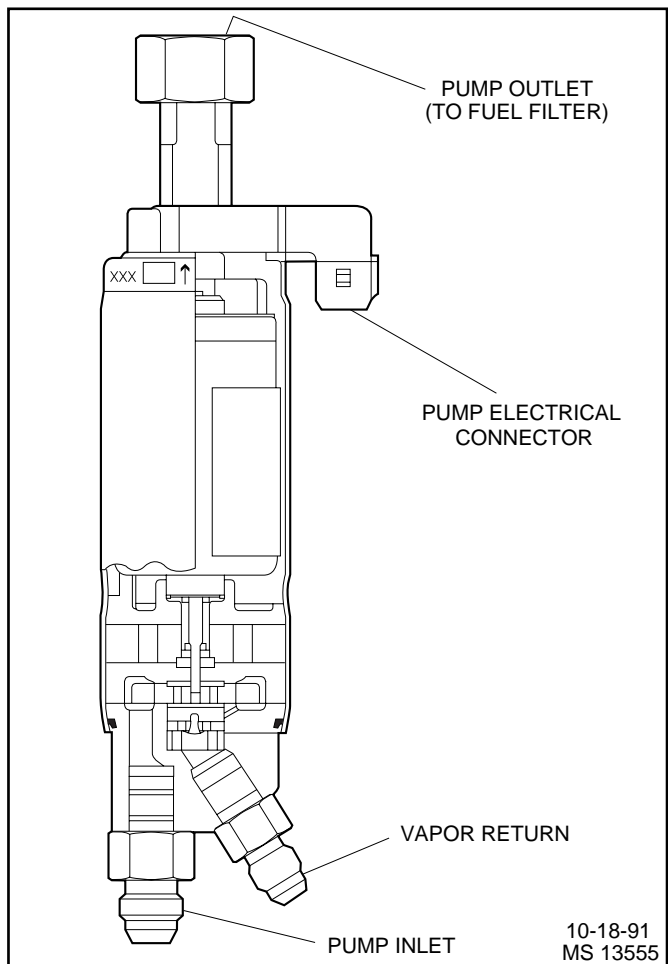


Figure 3-20 - Fuel Pump

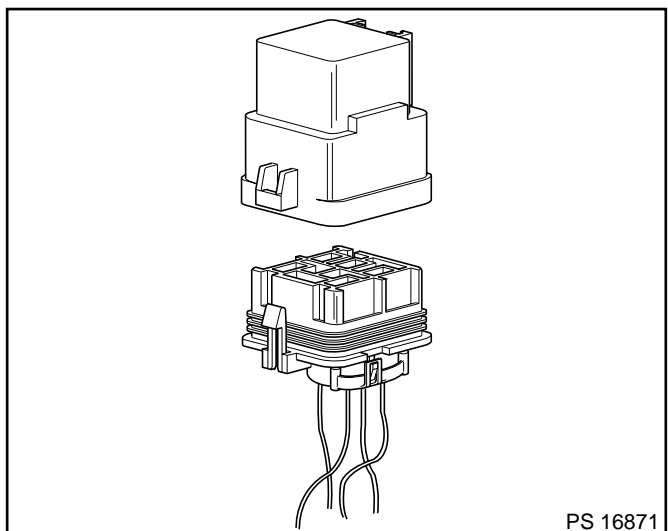


Figure 3-21 - Fuel Pump Relay

**In-Line Fuel Filter**

Figure 3-22

**Important**

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

**Remove or Disconnect**

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

**Inspect**

- ï 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**

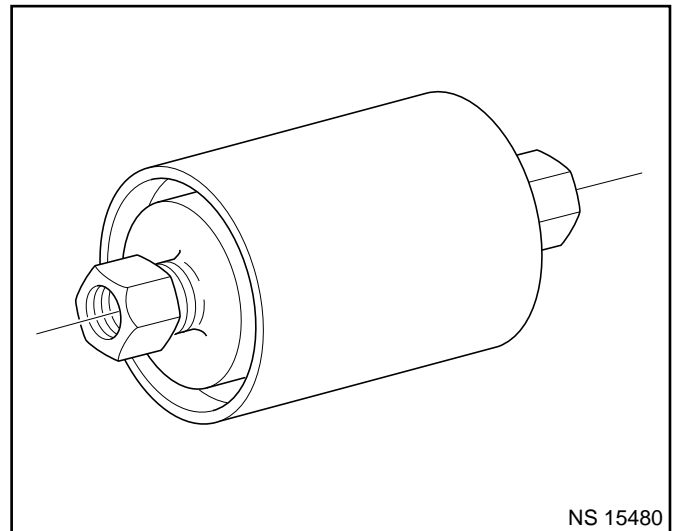
- ï Turn ignition switch to the ïONï position for 2 seconds, then turn to the ïOFFï position for 10 seconds. Turn the ignition switch back to the ïONï position and check for fuel leaks.

**Water Separator**

When it is necessary to change the water separator, follow the manufacturerís recommendations.

**Important**

- ï Fuel system needs to be primed and air bled out of the lines before the engine is started. Follow manufacturers recommendation for priming fuel system.



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Figure 3-22 - In-Line Fuel Filter

**Torque Specifications****Fastener Tightening Specifications**

Application	Nïm	Lb Ft	Lb In
Throttle Body Attaching Screws	15	11	
Coolant Cover Assembly Screws	3.2		28
IAC Valve Attaching Screws	3.2		28
Upper Intake Plenum Retaining Bolts (Figure 3-14)	14		124
Fuel Pressure Connector	13		115
Fuel Pressure Regulator Attaching Screw	9.5		84
Fuel Pressure Regulator Outlet Line Nut	17.5	13	
Fuel Rail Jumper Line Attaching Screws	7		62
Fuel Rail Attaching Screws	10		88

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## 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.

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## 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 various engine sensors, computes the desired spark timing and signals the Ignition Control (IC) module in the distributor to change timing. The distributor does not contain centrifugal advance weights, springs or vacuum advance units.

### Delco Remy Distributors

The distributor used on the MEFI equipped engines is designed for the marine/industrial 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.

Distributors with separate coils are used on the MEFI engines (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 rotating shaft 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.

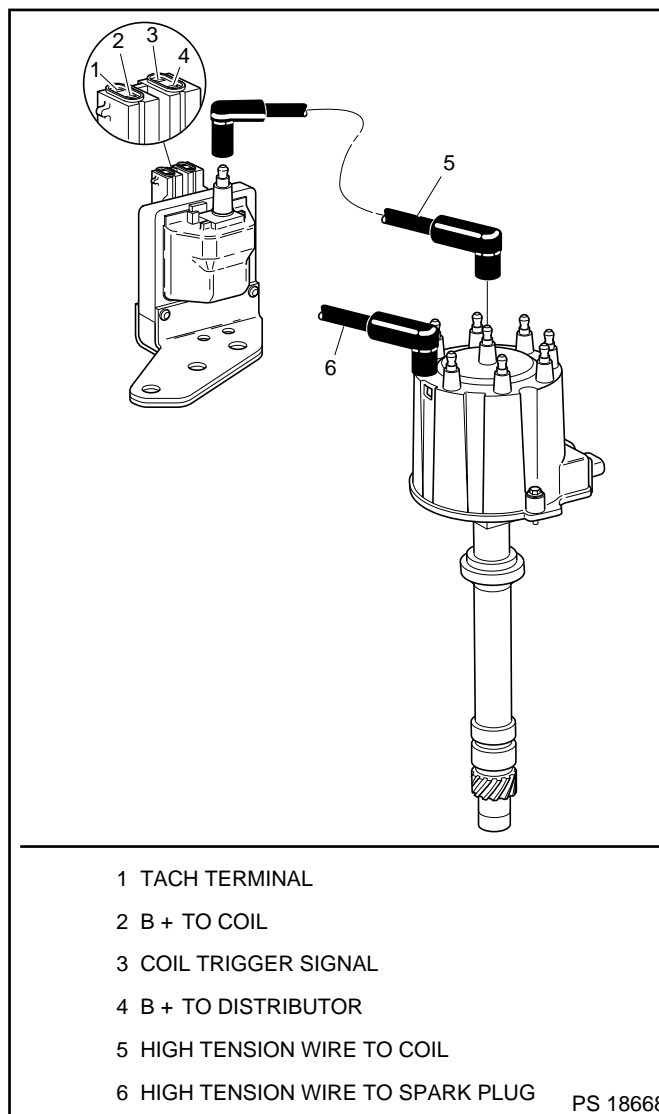


Figure 4-1 - Distributor With Separate Coil

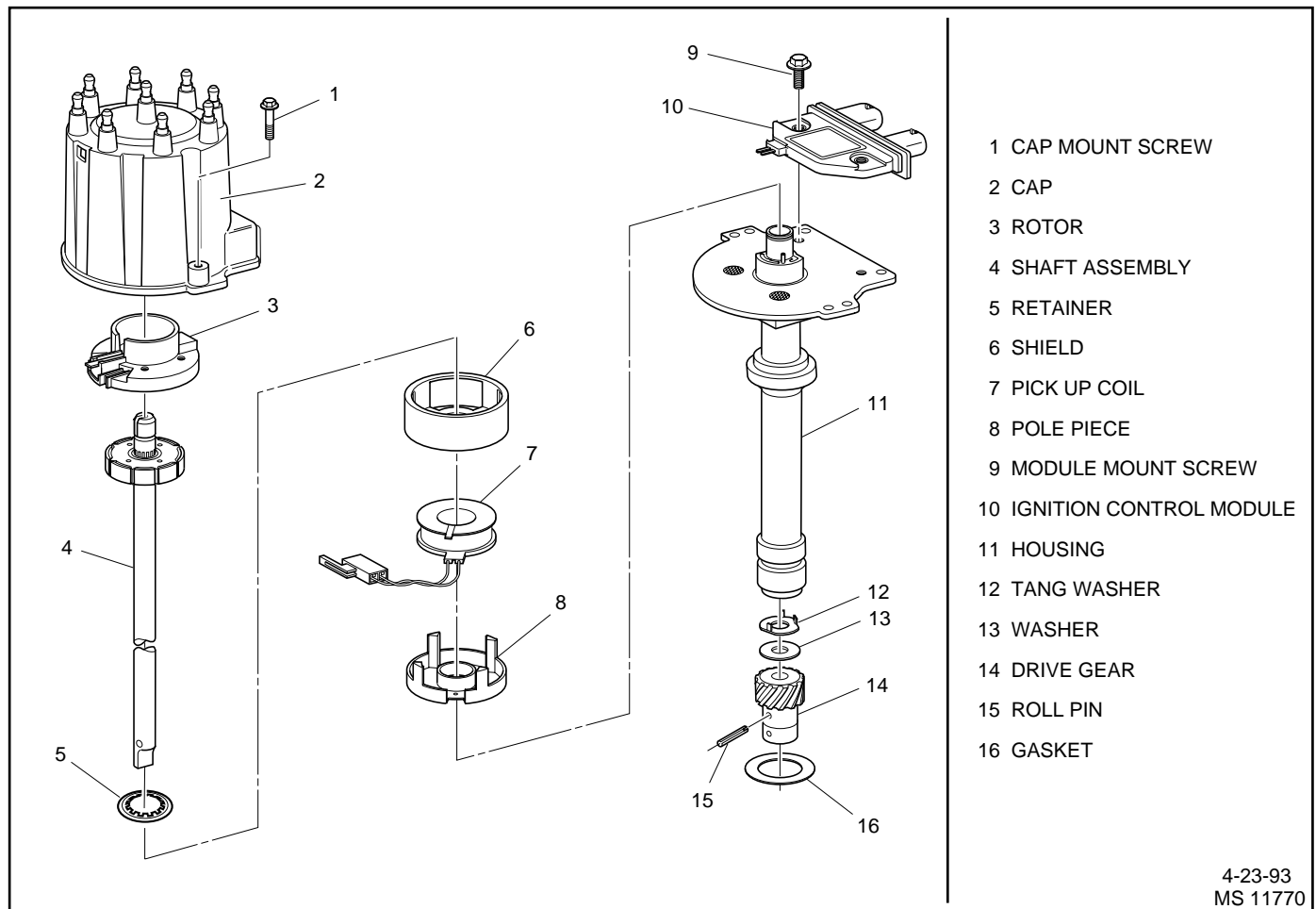


Figure 4-2 - Typical V8 Distributor

### Ignition Coil

The design construction of the ignition coil (Figure 4-1) 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. A secondary high tension wire connects from the top post of the coil to the center post of the distributor cap. There are two 2-wire connectors on the coil that are 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.

## Ignition Control (IC) Module

The Ignition Control (IC) module is located in the distributor (Figure 4-3). It is mounted by two screws that 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 analog signal of the pick-up coil to a 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.

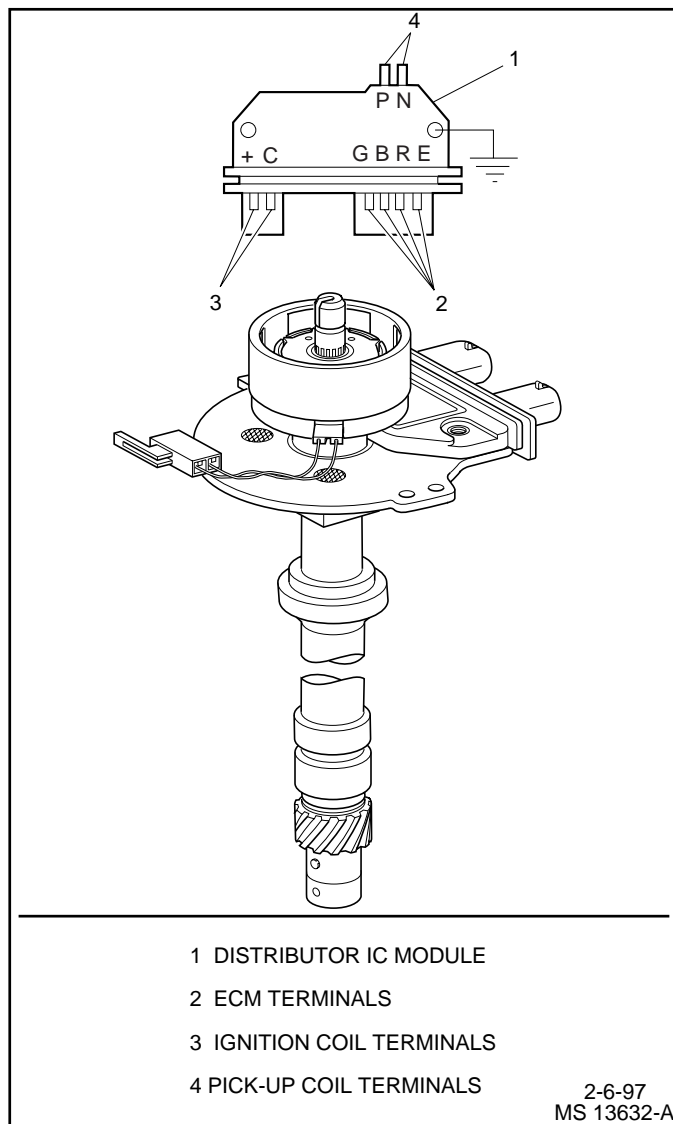


Figure 4-3 - IC Module Terminal Identification

## Pole Piece And Coil Assembly

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 electrical devices, the pick-up coil must be approved for this application.

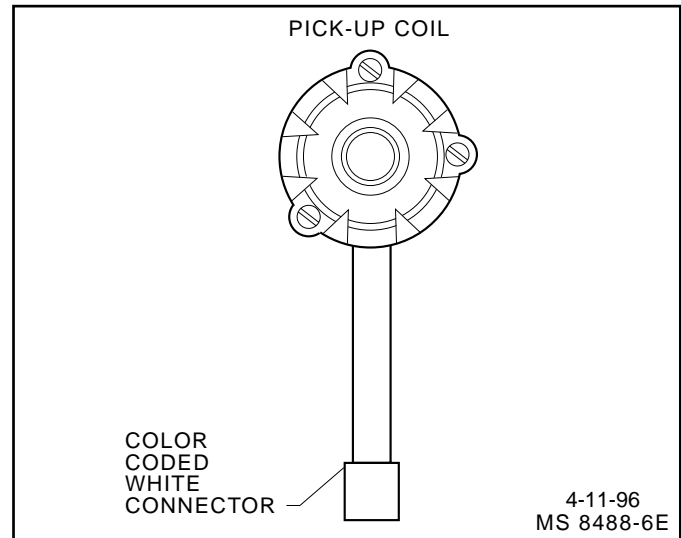


Figure 4-4 - Pick-Up Coil

## Spark Plug Wires

The spark plug wires are a carbon-impregnated cord conductor encased in a 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 for all operating conditions. The ECM monitors input signals from 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.
- Knock Sensor (KS) module.

**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 and is able to change this ignition timing 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. In service mode, ignition timing will be fixed. At this time, the base timing can be adjusted by turning the distributor.

The ECM incorporates a permanent spark control override. This allows ignition timing to be lowered electronically if spark knock (detonation) is encountered during normal operation due to the use of low octane fuel.

**IC Operation - Module Mode (Cranking)**

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 it 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 certain 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.

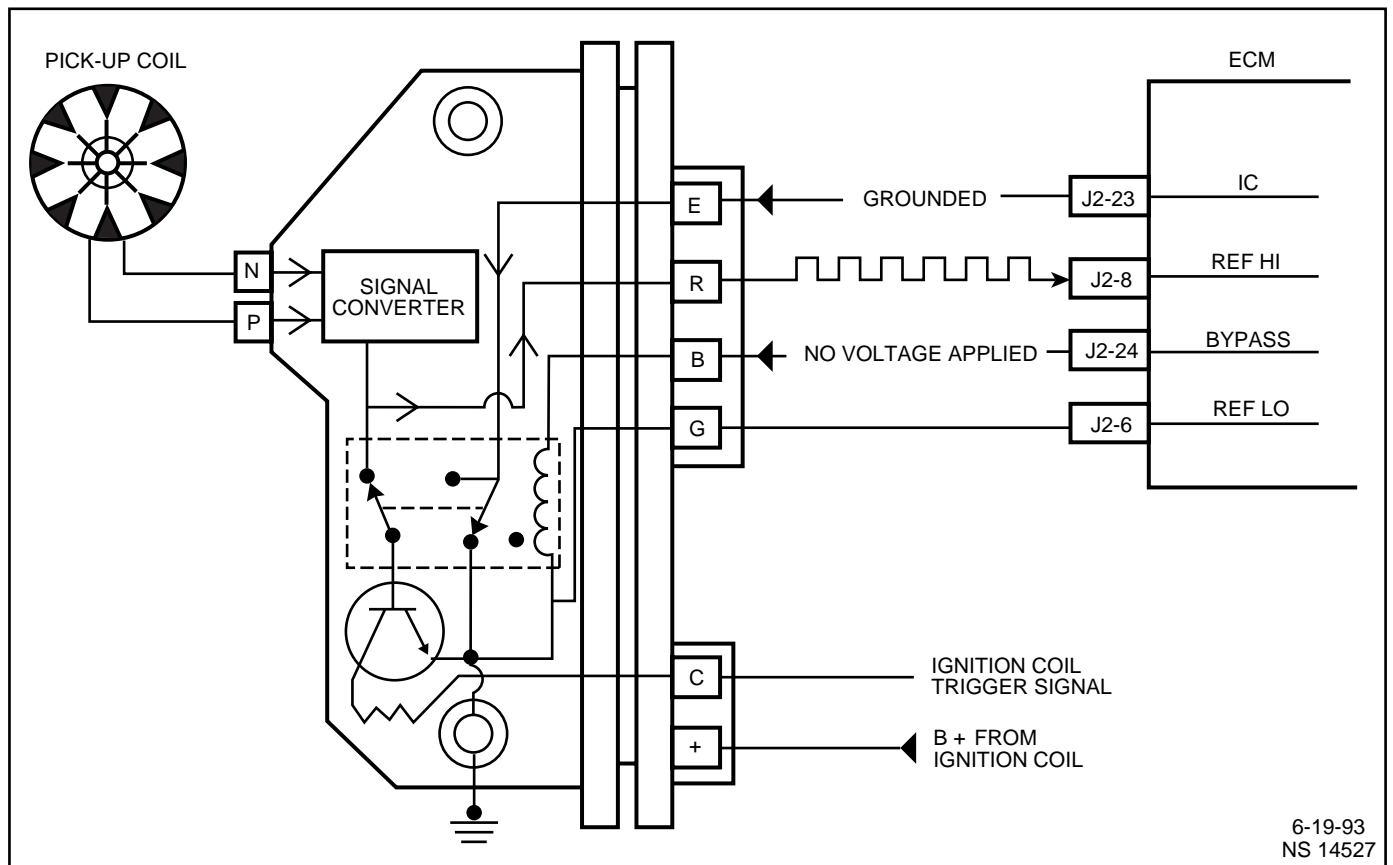


Figure 4-5 - IC Module, Module Mode (Cranking)

**IC Operation - Ignition Control Mode (Running)**

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 control of the IC module .

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.†

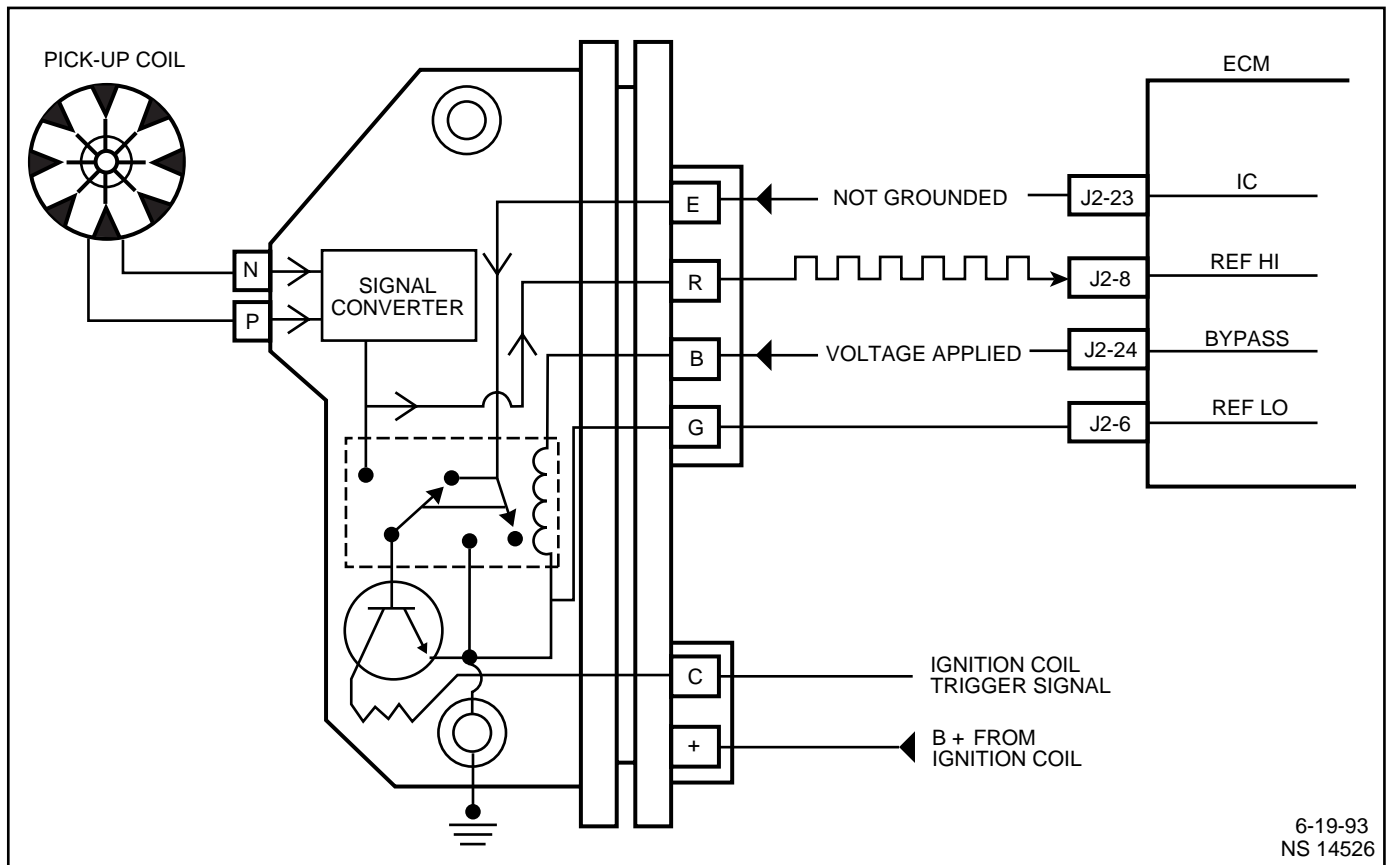


Figure 4-6 - IC Module, Ignition Control Mode (Running)

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## 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 timing module mode. If this condition were to occur while the engine was running, the engine would stop, but it would restart and run in the "module 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 is 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 "module mode." If this condition were to occur while the engine was running, it would simply operate in the "module mode."

**Open or grounded iREF 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 running.

**Open or grounded iREF 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, Table 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-Vehicle Service

### Distributor Repair

Figures 4-7 through 4-9

Replacement distributors may not be 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. Coil wire and spark plug wires on either the left or the right side of the distributor.
4. Two screws on the sides of the distributor cap.
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**

I Resistance of pick-up coil with an ohmmeter.

- ñ 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.

- ñ 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.

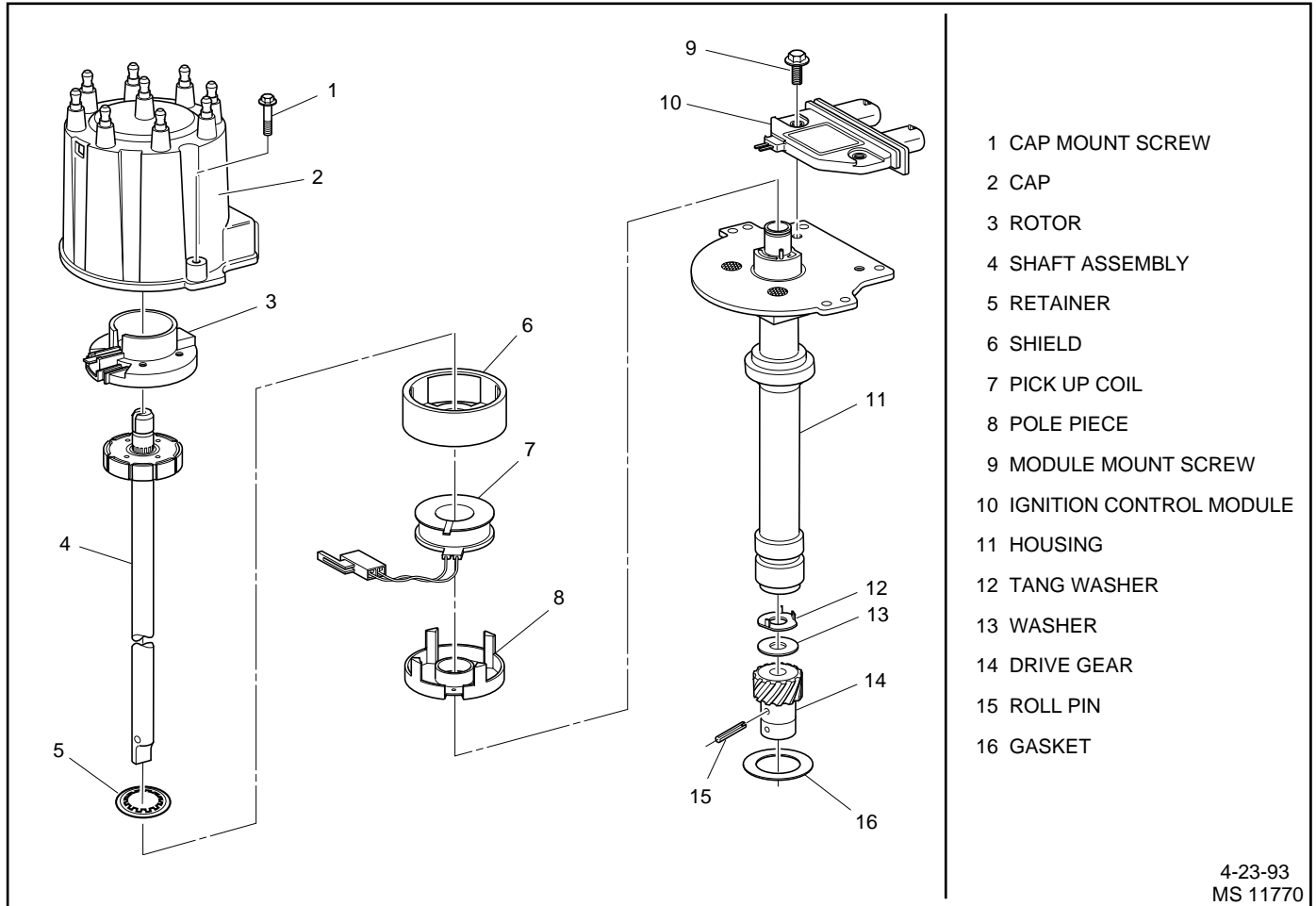


Figure 4-7 - Eight Cylinder Engine Distributor Components

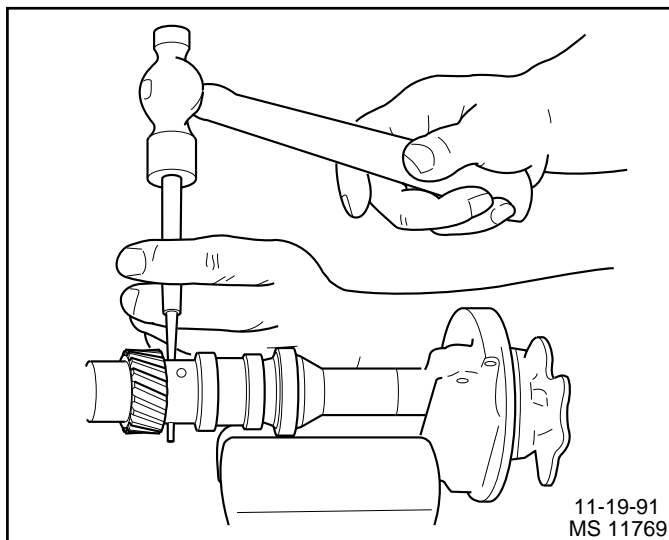


Figure 4-8 - Removing the Roll Pin

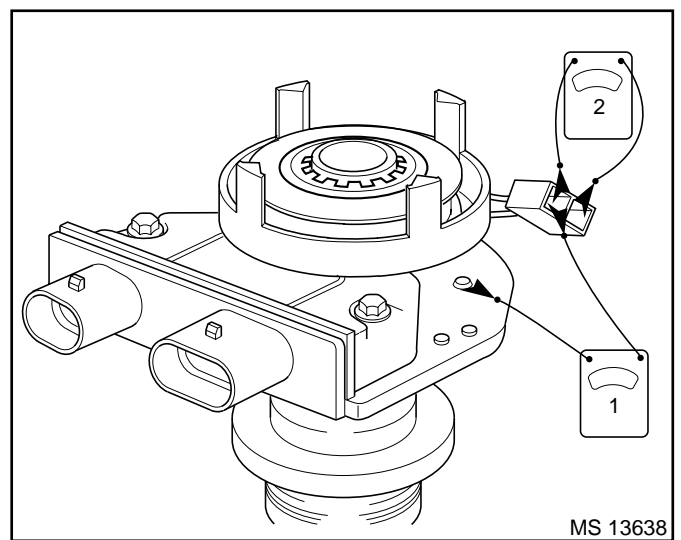


Figure 4-9 - Testing the Pick-up Coil



**Assembly***Figures 4-7 and 4-10***Install or Connect**

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

- Ï Lubricate bottom of the ignition control module and the module rest pad on the housing with silicone grease or an equivalent heat transfer substance.
1. Ignition control module (10) to the housing (11) with two screws.
  2. Pick-up coil (7).
    - Ï 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.
    - Ï 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).
    - Ï Place the retainer over the center bushing with the teeth pointing upward.
    - Ï 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.
    - Ï 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.
    - Ï Align the marks on the drive gear and shaft assembly.
  8. Roll pin (15) into the gear.
    - Ï 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).
    - Ï Fit the tab in the rotor into the slot on the shaft.
  10. Distributor cap to the housing with screws and washers.

**Ignition Control (IC) 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. Coil wire and spark plug wires on either the left or the right side of the distributor.
4. Two screws on the sides of the distributor cap.

5. Distributor cap and move it aside.
6. Wire harness connector from pick-up coil.
7. Two screws attaching ignition control module to the distributor base plate.
8. Ignition control module.

**Install or Connect**

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

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

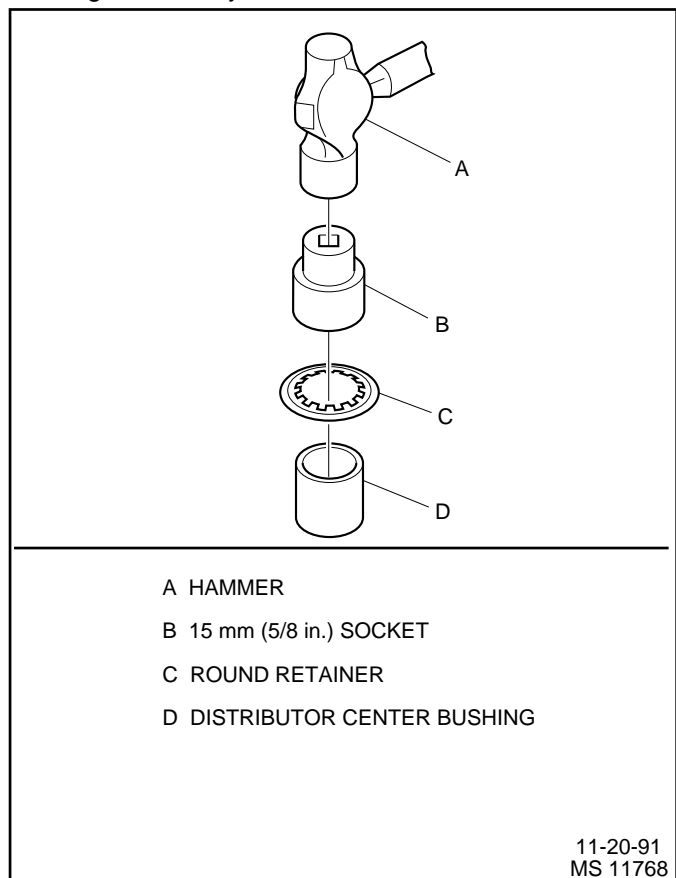


Figure 4-10 - Retainer to Shield Installation

## 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 can maintain 2500 RPM. Check ignition timing. Now disconnect MAP sensor harness connector and timing should change.
- 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, in the *service mode*, the timing will be fixed and will not move with RPM change.

**NOTICE:** Engine must be at normal operating temperature.

1. Install 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 back to idle.
- Set MDTC tool or scan tool to *normal mode*.

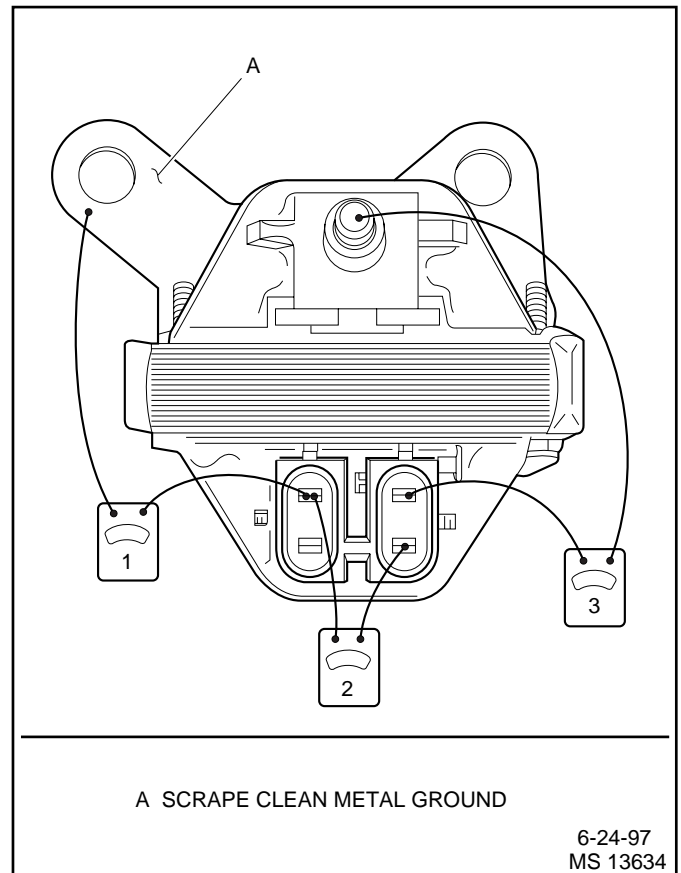


Figure 4-11 - Testing the Ignition Coil

## 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. If wires have been disconnected, or replacement of the wires is necessary, route the wires in their original positions. Failure to route the wires properly may result in drivability problems.

## 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	

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## Marine Electronic Fuel Injection (MEFI)

### Section 5

### Diagnosis - PFI, TBI and MFI

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.

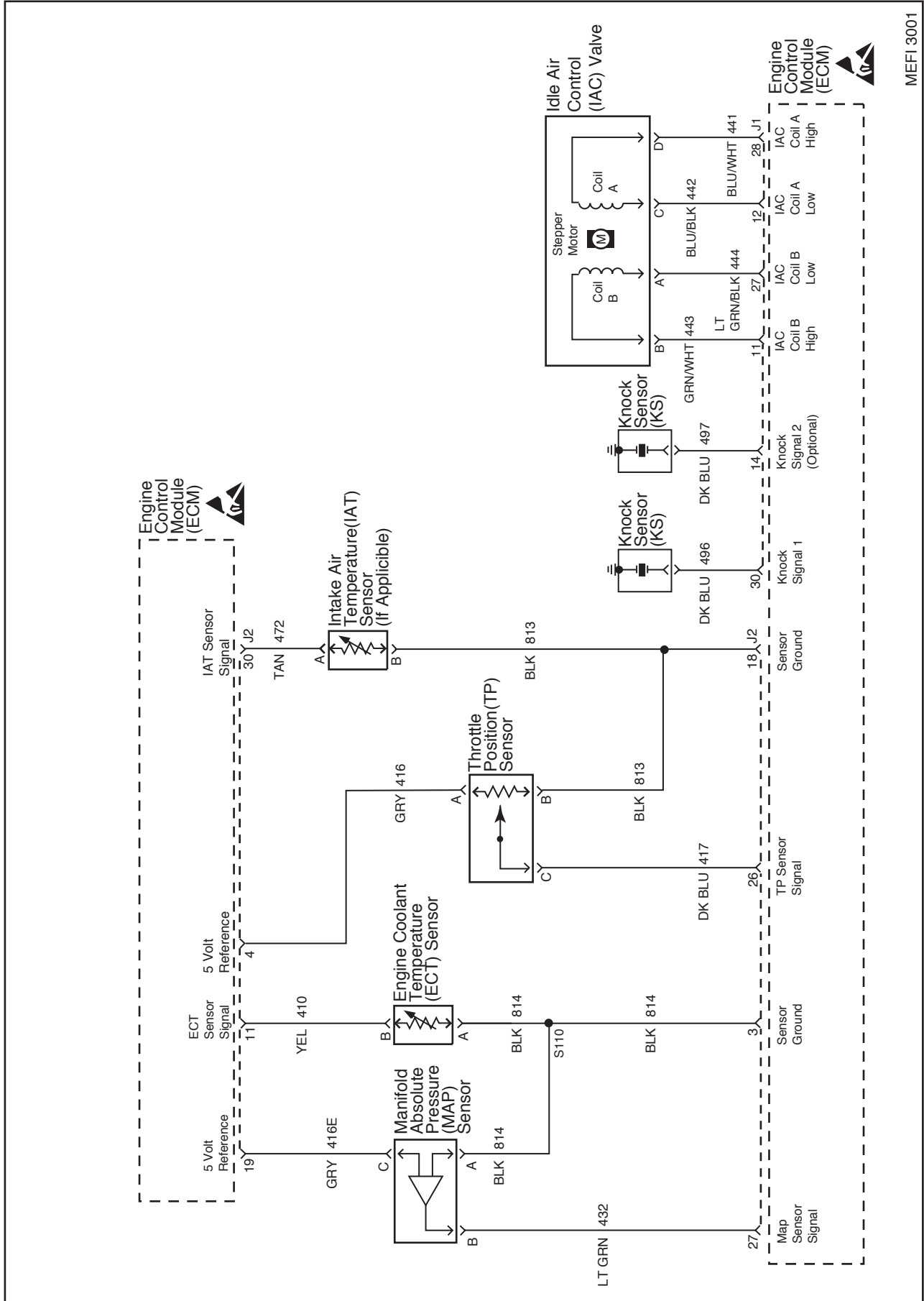
The assumption is made that on all diagnostic tables, the engine is equipped with GM Marine ECM, sensors, wiring harness, fuel components and ignition components. The wiring schematics and circuit identifications are for the GM MEFI originally equipped wiring harness.

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

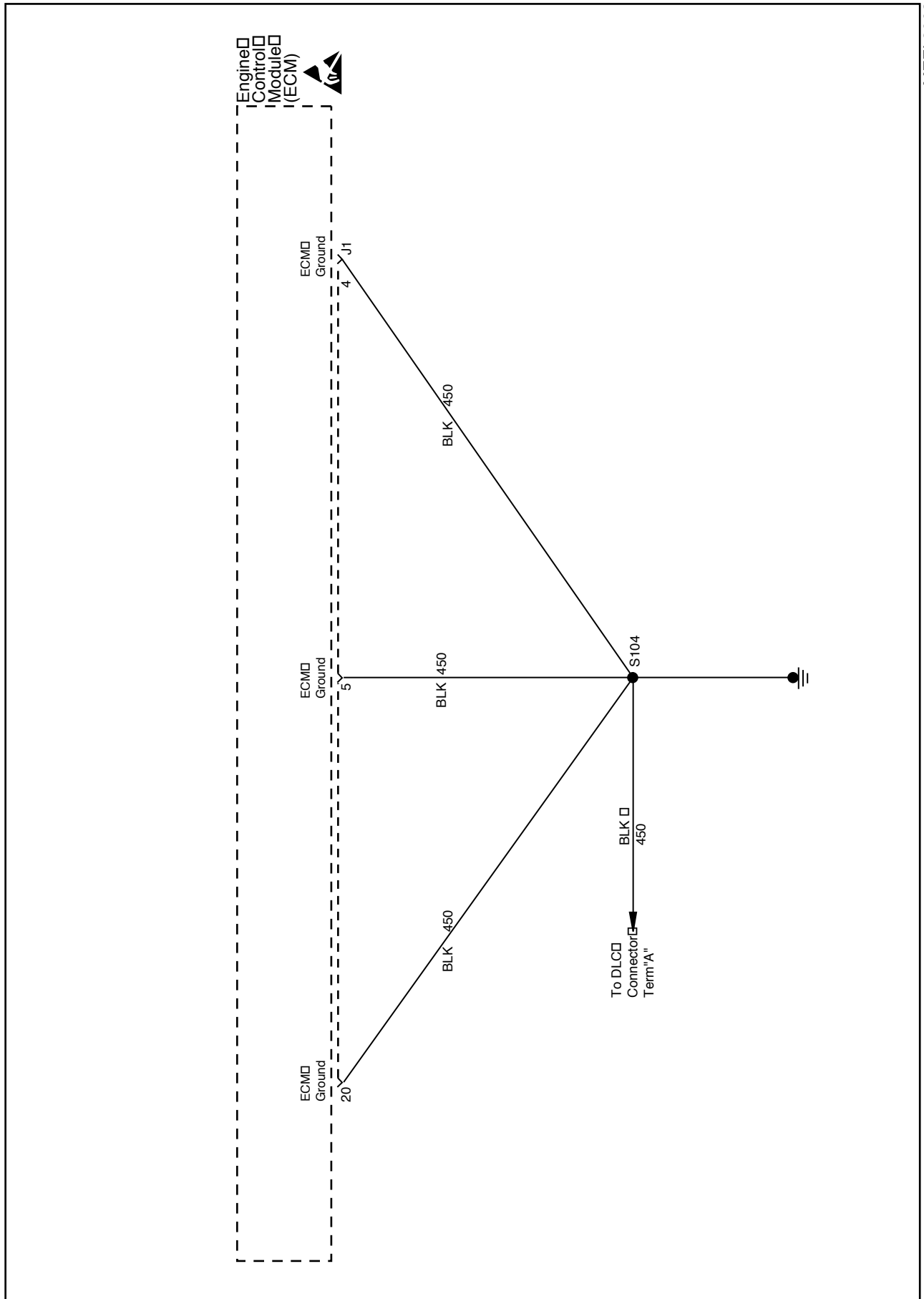
ECM Wiring .....	Page 2	DTC 22 TP Sensor Circuit Low Non-Scan .....	Page 60
ECM Connector Identification .....	Page 9	DTC 23 IAT Sensor Circuit Low Non-Scan .....	Page 62
Typical Scan Tool Data Values .....	Page 11	DTC 25 IAT Sensor Circuit High Non-Scan .....	Page 64
Scan Tool Data Definitions .....	Page 13	DTC 33 MAP Sensor Circuit High Non-Scan .....	Page 66
DTC Identification .....	Page 15	DTC 34 MAP Sensor Circuit Low Non-Scan .....	Page 68
OBD System Check Non-Scan .....	Page 18	DTC 41 IC Circuit Open IC Non-Scan .....	Page 70
OBD System Check Scan .....	Page 20	DTC 42 IC Circuit Grounded IC Open or Grounded Bypass Non-Scan .....	Page 72
No MIL - Table A-1 .....	Page 22	DTC 44 Knock Sensor System Non-Scan .....	Page 76
No DLC Data No DTC 12 - Table A-2 .....	Page 26	DTC 51 Calibration Checksum Failure Non-Scan .....	Page 78
Engine Cranks But Will Not Run - Table A-3A (ALL PFI and MFI ENGINES) .....	Page 28	DTC 14 ECT Sensor Circuit Low Scan .....	Page 80
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Fuel System Diagnosis - Table A-4A (ALL PFI and MFI ENGINES) .....	Page 36	DTC 21 TP Sensor Circuit High Scan .....	Page 84
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Fuel System Electrical Test - Table A-5 .....	Page 42	DTC 23 IAT Sensor Circuit Low Scan .....	Page 88
MEFI System Relay Check - Table A-6 .....	Page 46	DTC 25 IAT Sensor Circuit High Scan .....	Page 90
DI System Check - Table A-7 .....	Page 48	DTC 33 MAP Sensor Circuit High Scan .....	Page 92
IAC Functional Test - Table A-8 .....	Page 52	DTC 34 MAP Sensor Circuit Low Scan .....	Page 94
DTC 14 ECT Sensor Circuit Low Non-Scan .....	Page 54	DTC 41 IC Circuit - Open IC Scan .....	Page 96
DTC 15 ECT Sensor Circuit High Non-Scan .....	Page 56	DTC 42 IC Circuit - Grounded IC Open or Grounded Bypass Scan .....	Page 98
DTC 21 TP Sensor Circuit High Non-Scan .....	Page 58	DTC 44 Knock Sensor System Scan .....	Page 102
		DTC 51 Calibration Checksum Failure Scan .....	Page 104

ECM Wiring (1 of 6)



MEFI 3001

ECM Wiring (2 of 6)

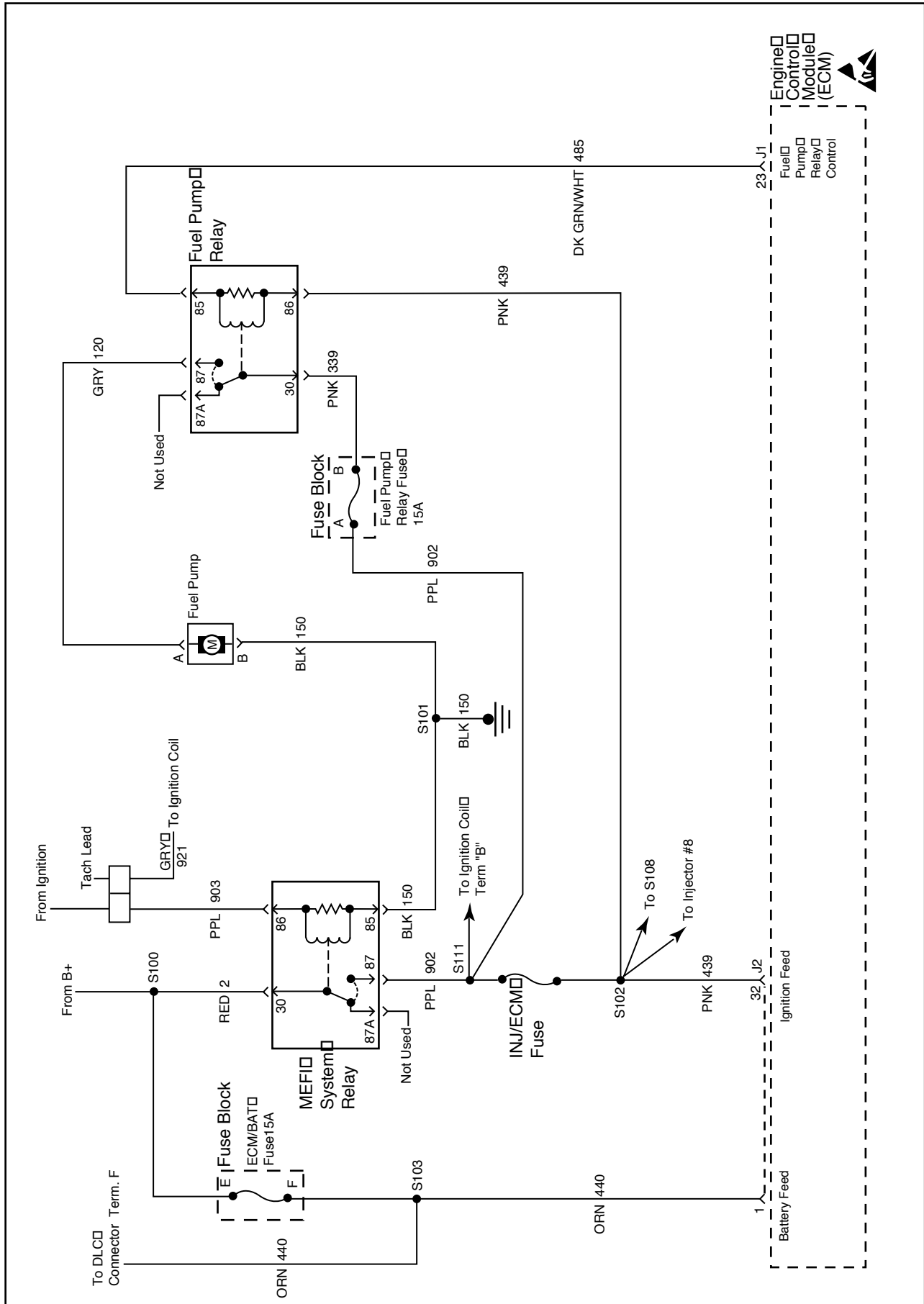


MEFI 3002



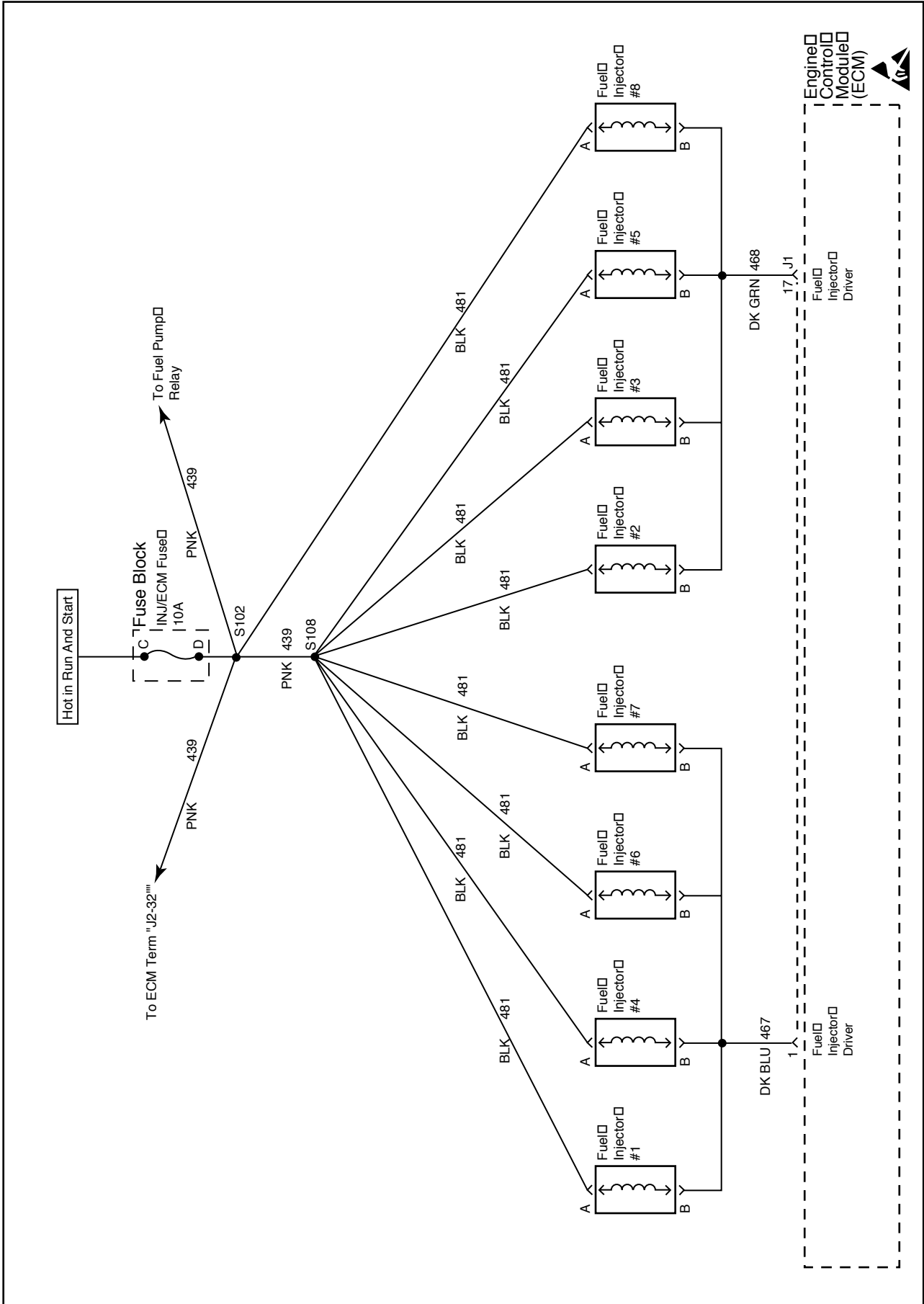


ECM Wiring (4 of 6)



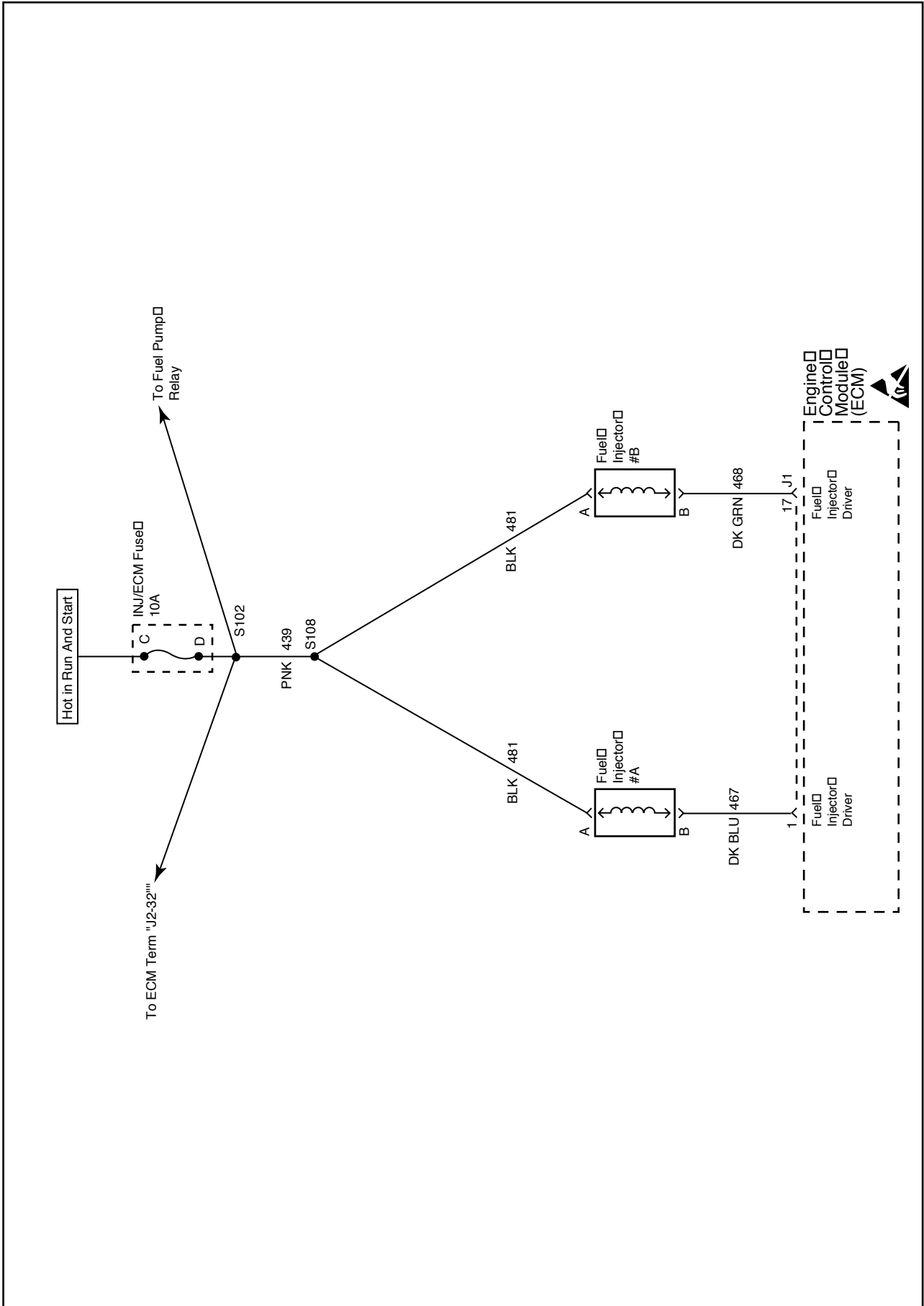
MEFI 3005

ECM Wiring (5 of 6) (ALL ENGINES EXCEPT TBI)



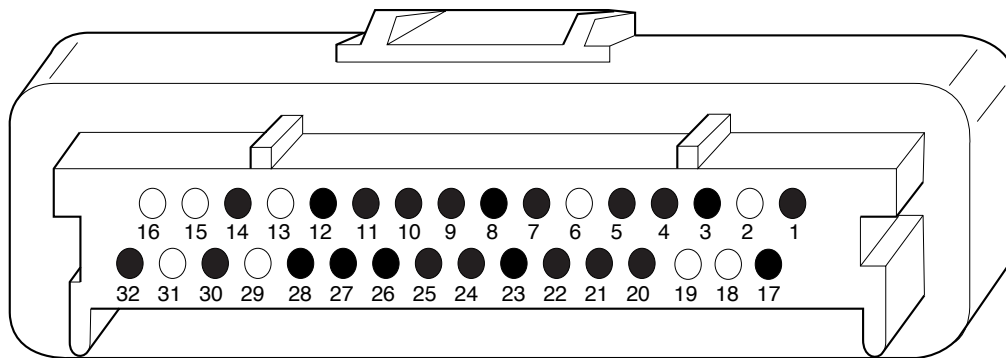
MEFI 3006

ECM Wiring (6 of 6) (ALL TBI ENGINES)



MEF13007

## ECM Connector Identification (1 of 2)

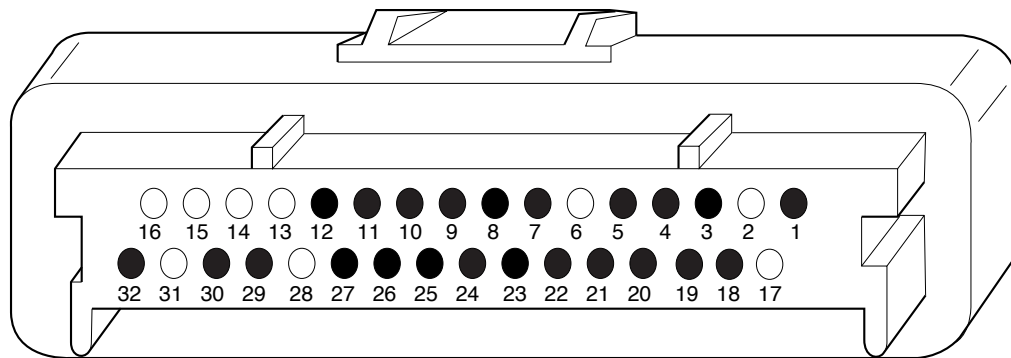


J-1

## ECM 32 WAY OUTPUT CONNECTOR

ECM PIN NUMBER	CKT(WIRE) NUMBER	CKT (WIRE) COLOR	CIRCUIT DESCRIPTION
J1-1	468	LT GRN	FUEL INJECTOR DRIVER (CYLs 1,4,6,7)
J1-2			
J1-3	453	BLK/RED	IC REFERENCE LOW
J1-4	450	BLK	ECM GROUND
J1-5	450	BLK	ECM GROUND
J1-6			
J1-7	112	DK GRN	CHECK GAUGES (OPTIONAL)
J1-8	31	TAN	RPM CHANGE STATE (OPTIONAL)
J1-9	419	BRN/WHT	MALFUNCTION INDICATOR LAMP (MIL)
J1-10	423	WHT	IC SIGNAL
J1-11	443	GRN/WHT	IDLE AIR CONTROL (IAC) COIL $\bar{b}$ HIGH
J1-12	442	BLU/BLK	IDLE AIR CONTROL (IAC) COIL $\bar{a}$ LOW
J1-13			
J1-14	497	DK BLU	KNOCK SENSOR 2 SIGNAL
J1-15			
J1-16			
J1-17	467	DK BLU	FUEL INJECTOR DRIVER (CYLs 2,3,5,8)
J1-18			
J1-19			
J1-20	450	BLK	ECM GROUND
J1-21	912	DK BLU	GENERAL WARNING 1 LAMP (OPTIONAL)
J1-22	911	DK GRN	GENERAL WARNING 2 LAMP (OPTIONAL)
J1-23	465	DK GRN/WHT	FUEL PUMP RELAY DRIVER
J1-24	424	TAN/BLK	IC BYPASS
J1-25	930	GRY	OIL LEVEL LAMP OUTPUT (OPTIONAL)
J1-26	914	PPL	BUZZER (OPTIONAL)
J1-27	444	GRN/BLK	IDLE AIR CONTROL (IAC) COIL $\bar{b}$ LOW
J1-28	441	BLU/WHT	IDLE AIR CONTROL (IAC) COIL $\bar{a}$ HIGH
J1-29			
J1-30	496	DK BLU	KNOCK SENSOR 1 SIGNAL
J1-31			
J1-32	461	ORN/BLK	SERIAL DATA (SCAN TOOL COMMUNICATION)

## ECM Connector Identification (2 of 2)



J-2

## ECM 32 WAY OUTPUT CONNECTOR

ECM PIN NUMBER	CKT(WIRE) NUMBER	CKT (WIRE) COLOR	CIRCUIT DESCRIPTION
J2-1	440	ORN	BATTERY FEED
J2-2			
J2-3	814	BLK	MAP, ECT SENSOR GROUND
J2-4	416E	GRY	MAP SENSOR 5 VOLT REFERENCE
J2-5	942	PNK	EMERGENCY STOP SWITCH (OPTIONAL)
J2-6			
J2-7	932	BRN	OIL PRESSURE LAMP (OPTIONAL)
J2-8	921	LT BLU/BLK	GENERAL WARNING 2 (OPTIONAL)
J2-9	940	LT GRN	SHIFT INTERRUPT/LOAD ANTICIPATION 1 (OPTIONAL)
J2-10	430	PPL/WHT	DISTRIBUTOR REFERENCE HIGH
J2-11	410	YEL	ECT SENSOR SIGNAL
J2-12			FUEL PRESSURE INPUT (OPTIONAL)
J2-13			
J2-14			
J2-15			
J2-16			
J2-17			
J2-18	813	BLK	TP, IAT SENSOR GROUND
J2-19	416	GRY	TP SENSOR 5 VOLT REFERENCE
J2-20	941	LT GRN	LOAD ANTICIPATION 2 (OPTIONAL)
J2-21	916	YEL	MASTER/SLAVE
J2-22	451	WHT/BLK	DIAGNOSTIC TEST TERMINAL
J2-23	1174	BRN	OIL LEVEL INPUT (OPTIONAL)
J2-24	920	LT BLU	GENERAL WARNING 1 (OPTIONAL)
J2-25			SPEED SENSOR SIGNAL (OPTIONAL)
J2-26	417	DK BLU	TP SENSOR SIGNAL
J2-27	432	LT GRN	MAP SENSOR SIGNAL
J2-28			
J2-29	931	BRN	OIL PRESSURE SWITCH (OPTIONAL)
J2-30	472	TAN	IAT SENSOR SIGNAL ( BIG BLOCK ONLY)
J2-31			
J2-32	439	PNK/BLK	IGNITION FEED

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### Typical Scan Tool Data Values

Use the TYPICAL SCAN TOOL DATA VALUES table only after the On-Board Diagnostic (OBD) 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 TOOL 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. 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 Values

Scan Tool Parameter	Units Displayed	Typical Data Value
Calibration ID	Numeric	0-255. Identification number assigned to a specific calibration.
Calibration Checksum	Numeric	0-65535
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)
Knock Retard	Degrees of Retard	0°
KS Enabled	Yes / No	Yes
Knock Signal	Yes / No	No
Knock 1	OK / Fault	OK
Knock 2	OK / Fault	OK
Idle Air Control	Counts	20 - 40 Counts
IAC Throttle Follower	Counts	20 - 60 Counts
Closed Throttle	Yes / No	Yes
Vessel Speed	MPH	0 MPH
Battery / Ignition Voltage	Volts	12.0 - 14.5 Volts
System Voltage Warning	OK / Low Voltage	OK
J2-9 Input	On / Off	Dependent on usage.
J2-20 Input	On / Off	Dependent on usage.
Emergency Stop Mode	Yes / No	No
Troll RPM Limit	On / Off	Off
Malfunction Indicator Lamp (MIL)	On / Off	Off

## Scan Tool Data Values cont.

Scan Tool Parameter	Units Displayed	Typical Data Value
Fuel Pump Relay	On / Off	On
Cause Power Reduction	Yes / No	No
Power Reduction	Yes / No	No
Overheat Detected	Yes / No	No
Oil Pressure Warning	OK / Low Pressure	OK
Check Gauges Lamp	On / Off	Off
Oil Level Warning	OK / Low	OK
Low Oil Level Lamp	On / Off	Off
Buzzer	On / Off	Off
General Warning 1	OK / Fault Detected	OK
J1-21 Output	On / Off	Dependent on usage.
General Warning 2	OK / Fault Detected	OK
J1-22 Output	On / Off	Dependent on usage.
ECM Master / Slave	Master / Slave	Master (usable for twin engine diagnosis).
J1-8 RPM Output	On / Off	Dependent on usage.
Time From Start	Hrs:Min	Dependent on Time of Ignition Cycle.
Engine Hour Meter	Hours	Dependent on Engine Run Time.



## System Configuration Options

This is an options menu that can be used in order to determine how this system is configured. Each item in the 'Option' column will be displayed with either a 'Yes' or 'No' following it.

Option	Configured
4mH Ignition Coil	Yes / No
Knock Sensor(s)	Yes / No
Knock Sensor Module	Yes / No
Intake Air Temperature (IAT) Sensor	Yes / No
Linear EGR Valve	Yes / No
Engine Sync Pulse	Yes / No
Internal Coil Driver	Yes / No
2 Atmosphere MAP Sensor	Yes / No
Vessel Speed Sensor	Yes / No
Governor	Yes / No
Load Anticipate 1	Yes / No
Load Anticipate 2	Yes / No
RPM Change State	Yes / No
Troll Mode	Yes / No
Shift Interrupt	Yes / No
Transmission Upshift	Yes / No
Twin Engine Shift Sync	Yes / No
Emergency Stop Switch	Yes / No
Twin Engine System	Yes / No

## Scan Tool Data Definitions

The scan tool information will assist in diagnosing emission or drivability 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

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

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

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

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

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

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

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

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

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

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

**FUEL CONSUMPTION - Scan Tool Range 0-100 gph** - This is the gallons per hour of fuel that the engine is consuming.

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

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

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

**KS ENABLED - Scan Tool Displays ìYESî or ìNOî** - This is informing you whether or not the Knock System is enabled.

**KNOCK SIGNAL - Scan Tool Displays ìYESî or ìNOî** - Indicates whether or not a knock signal is being detected by the ECM. Should display ìNOî at idle.

**KNOCK SENSOR 1 - Scan Tool Displays ìOKî or ìFaultî** - Indicates whether or not a fault is being detected on the knock sensor 1 circuit.

**KNOCK SENSOR 2 - Scan Tool Displays ìOKî or ìFaultî** - Indicates whether or not a fault is being detected on the knock sensor 2 circuit.

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

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

**CLOSED THROTTLE - Scan Tool Displays ìYESî or ìNOî** - Indicates whether the throttle is in the closed position.

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

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

**SYSTEM VOLTAGE WARNING - Scan Tool Displays ìOKî or ìLOW VOLTAGEî** - Indicates if there may be a fault in the charging system.

**J2-9 INPUT - Scan Tool Displays ìONî or ìOFFî** - This is a discrete input to the ECM that is determined and calibratable per OEM.

**J2-20 INPUT - Scan Tool Displays ìONî or ìOFFî** - This is a discrete input to the ECM that is determined and calibratable per OEM.

**EMERGENCY STOP MODE - Scan Tool Displays ì YESî or ìNOî** - Indicates whether you are in emergency stop mode or not.

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

**MIL - Scan Tool Displays ìONî or ìOFFî** - Indicates the ECM commanded state of the Malfunction Indicator Lamp.

**FUEL PUMP RELAY - Scan Tool Displays ìONî or ìOFFî** - Indicates the ECM commanded state of the fuel pump relay driver circuit.

**CAUSE POWER REDUCTION - Scan Tool Displays ì YESî or ìNOî** - Indicates whether or not the ECM has recognized a fault which would put the engine into Power Reduction when the appropriate RPM is achieved.

**POWER REDUCTION - Scan Tool Displays ìYESî or ìNOî** - Indicates whether or not the ECM is functioning in Power Reduction mode. During this mode, the ECM only triggers one injector driver resulting in fuel to only half of the cylinders.

**OVERHEAT DETECTED - Scan Tool Displays ìYESî or ìNOî** - Indicates if the ECM has recognized an overheat condition with the engine.

**OIL PRESSURE WARNING - Scan Tool Displays ìOKî or ìLOW PRESSUREî** - Indicates if the ECM has recognized a fault in the oil pressure circuit.

**CHECK GAUGES LAMP - Scan Tool Displays ìONî or ìOFFî** - Indicates the ECM commanded state of the Check Gauges lamp.

**OIL LEVEL WARNING - Scan Tool Displays ìOKî or ìLOWî** - Indicates if the ECM has recognized a fault in the oil level circuit.

**BUZZER - Scan Tool Displays ìONî or ìOFFî** - Indicates the ECM commanded state of the Buzzer.

**GENERAL WARNING 1 - Scan Tool Displays ìOKî or ìFault Detectedî** - This is a discrete input to the ECM that is determined and calibratable per OEM.

**J1-21 OUTPUT - Scan Tool Displays ìONî or ìOFFî** - ECM driven output that is determined and calibratable per OEM.

**GENERAL WARNING 2 - Scan Tool Displays ìOKî or ìFault Detectedî** - This is a discrete input to the ECM that is determined and calibratable per OEM.

**J1-22 OUTPUT - Scan Tool Displays ìONî or ìOFFî** - ECM driven output that is determined and calibratable per OEM.

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

**J1-8 RPM OUTPUT - Scan Tool Displays ìONî or ìOFFî** - ECM driven output that is determined and calibratable per OEM.

**TIME FROM START - Scan Tool Range 00:00:00-99:99:99 Hrs:Min:Sec** - Indicates the amount of time the ignition key was in the ìONî or ìRUNî position. Once the key has been cycled to the ìOFFî position, this counter will reset to 00:00.

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

### ECM Diagnostic Trouble Codes

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

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

DTC	Description	Illuminate Mil	Latching Code
DTC 14	Engine Coolant Temperature (ECT) Sensor Circuit. Low Temperature Indicated.	Yes	No
DTC 15	Engine Coolant Temperature (ECT) Sensor Circuit. High Temperature Indicated.	Yes	No
DTC 21	Throttle Position (TP) Sensor Circuit. High Signal Voltage Indicated.	Yes	No
DTC 22	Throttle Position (TP) Sensor Circuit. Low Signal Voltage Indicated.	Yes	No
DTC 23	Intake Air Temperature (IAT) Sensor Circuit. Low Temperature Indicated.	Yes	No
DTC 25	Intake Air Temperature (IAT) Sensor Circuit. High Temperature Indicated.	Yes	No
DTC 33	Manifold Absolute Pressure (MAP) Sensor Circuit. High Signal Voltage Indicated.	Yes	Yes
DTC 34	Manifold Absolute Pressure (MAP) Sensor Circuit. Low Signal Voltage Indicated.	Yes	Yes
DTC 41	Ignition Control (IC) System. Open IC Circuit.	Yes	Yes
DTC 42	Ignition Control (IC) System. Grounded IC Circuit, Open or Grounded Bypass Circuit.	Yes	Yes
DTC 44	Knock Sensor (KS) System Inactive.	Yes	Yes
DTC 51	Calibration Checksum Failure. Faulty ECM.	Yes	Yes

### Logged Warnings

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

Description
Engine Overheat
Low Oil Pressure
Low System Voltage
Low Oil Level
General Warning 1 (J2-24)
General Warning 2 (J2-8)
Low Fuel Pressure

### Clearing Diagnostic Trouble Codes - Non Scan

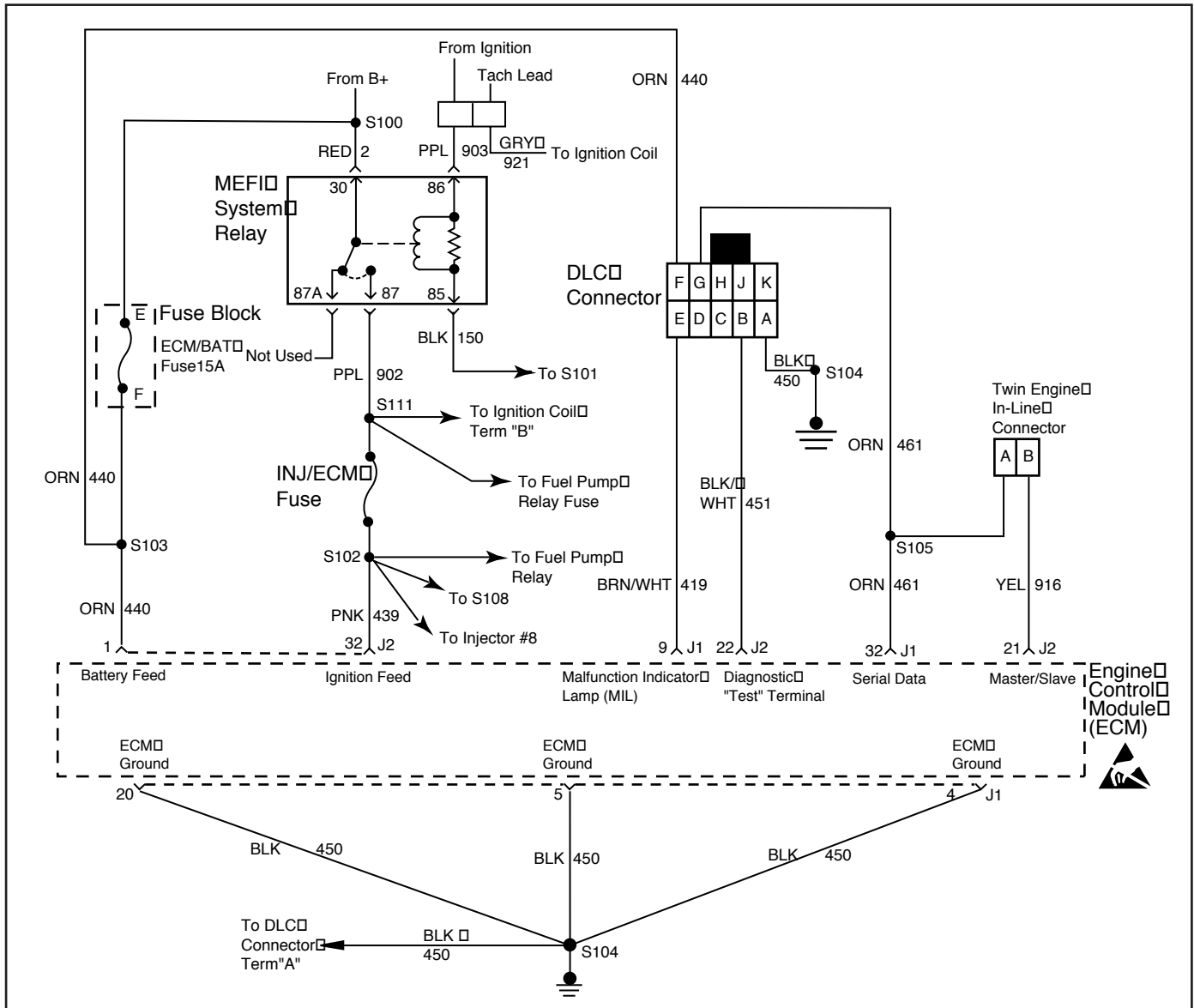
1. Install Marine Diagnostic Trouble Code (MDTC) tool.
2. Ignition *ON*, engine *OFF*.
3. Switch MDTC tool to *service mode* or *ON*.
4. Move the throttle from 0% (idle) to 100% (WOT) and back to 0%.
5. Switch MDTC tool to *normal mode* or *OFF*. (If this step is not performed, the engine may not start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

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

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MEFI 3008

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

#### Circuit Description

The on-board diagnostic system check must be the starting point for any drivability 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:

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

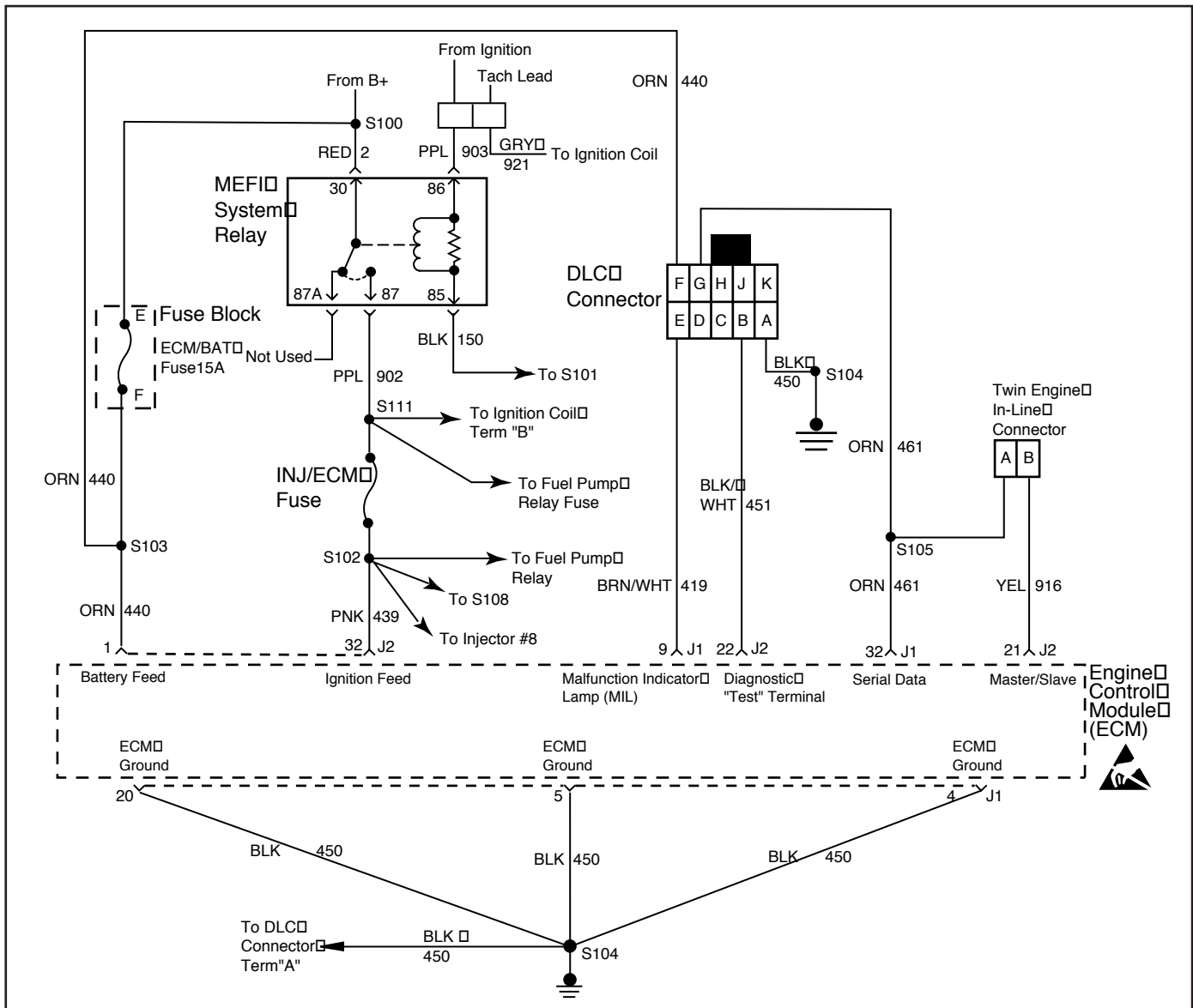
#### Test Description

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



MEFI 3008

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

#### Circuit Description

The on-board diagnostic system check must be the starting point for any drivability 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:

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

#### 1999 Marine

#### Test Description

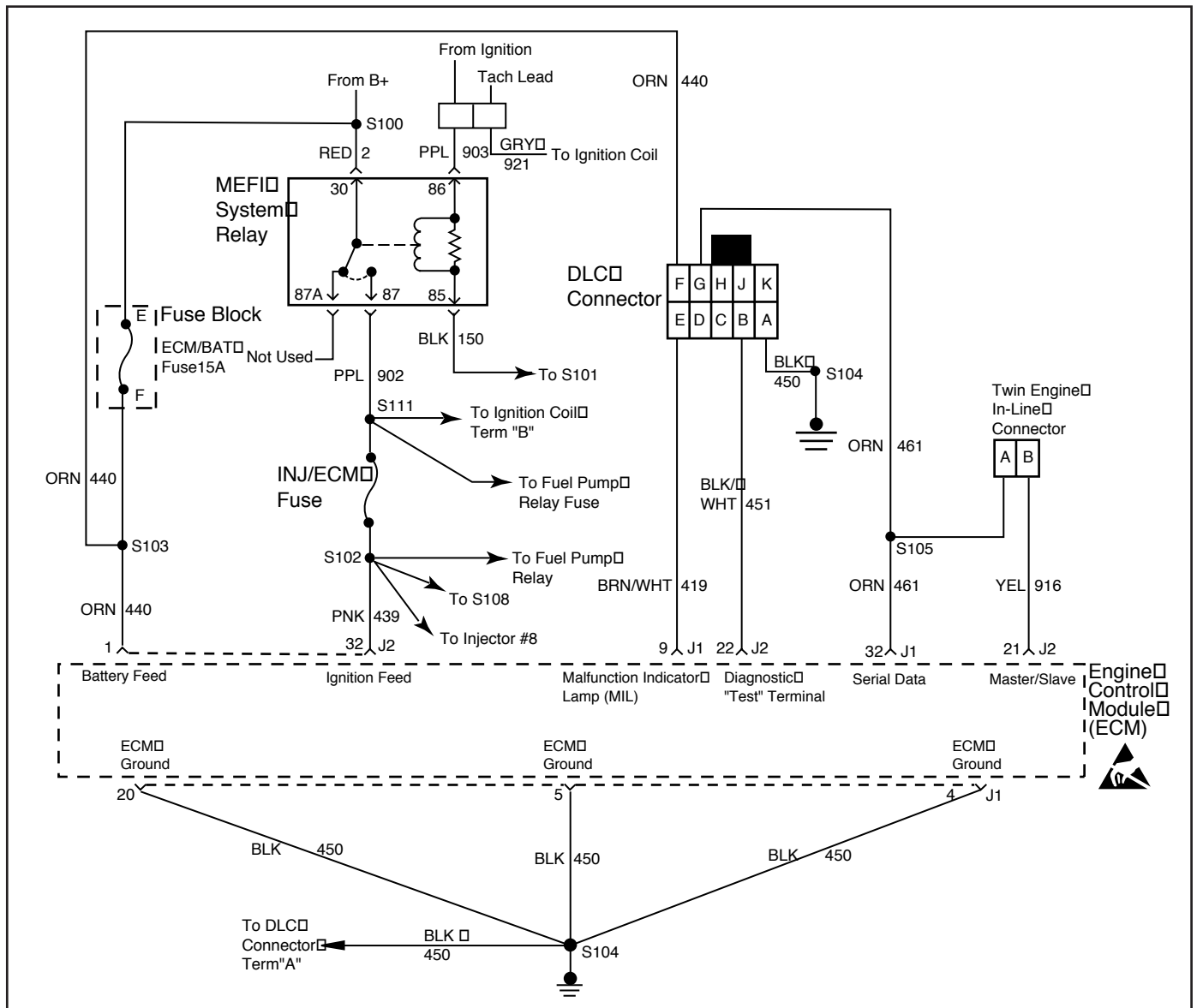
Number(s) below refer to the Step number(s) on the Diagnostic Table:

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



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

Step	Action	Value	Yes	No
1	1. Ignition ìON,î engine ìOFF.î 2. Install Marine Diagnostic Trouble Code (MDTC) tool and switch it to ìnormal mode,î or ìOFF.î 3. Observe the Malfunction Indicator Lamp (MIL). Is the MIL ìON?î	ó	Go to Step 2	Go to Table A-1
2	1. Switch Marine Diagnostic Trouble Code Tool to ìservice mode,î or ìON.î 2. Ignition ìON,î engine ìOFF.î 3. Observe the Malfunction Indicator Lamp on the MDTC tool. Does the MIL flash DTC 12?	ó	Go to Step 3	Go to Table A-2
3	1. Ignition ìOFF.î 2. Install a scan tool. 3. Ignition ìON.î 4. Attempt to display ECM data with the scan tool. Does the scan tool display ECM data?	ó	Go to Step 4	Go to Step 9
4	Attempt to start the engine. Did the engine start and continue to run?	ó	Go to Step 7	Go to Step 5
5	Crack the throttle open no more than 25% (if a flooded engine is suspected, go to wide open throttle) and reattempt to start the engine. Did the engine start and continue to run?	ó	Go to Step 6	Go to Table A-3
6	Close the throttle and let the engine idle. Did the engine continue to run?	ó	Go to Step 7	Refer to Symptoms section
7	Select ìDisplay DTCsî with the scan tool. Are any DTCs stored?	ó	Go to applicable DTC Table	Go to Step 8
8	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?	ó	Refer to Symptoms section	Refer to ìComponent Systemî Check
9	1. Ignition ìOFF.î 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 CKT 440 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?	ó	Repeat OBD System Check	Go to Step 10
10	Replace the ECM. Is action complete?	ó	Repeat OBD System Check	ó



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**Table 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 iF and iE. It receives voltage through CKT 440 terminal iF. Terminal iE is ground through CKT 419 from the ECM terminal iJ1-9. There should always be a steady MIL with the ignition iON and the engine iOFF. The Electronic Control Module (ECM) turns the MIL iON by providing the ground to CKT 419.

**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:

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

- i If the engine runs OK, check for a faulty light bulb or an open in the MIL driver circuit (CKT 419).
- i 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 iF of the DLC connector.
4. This step checks for ground present at terminal iE 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.

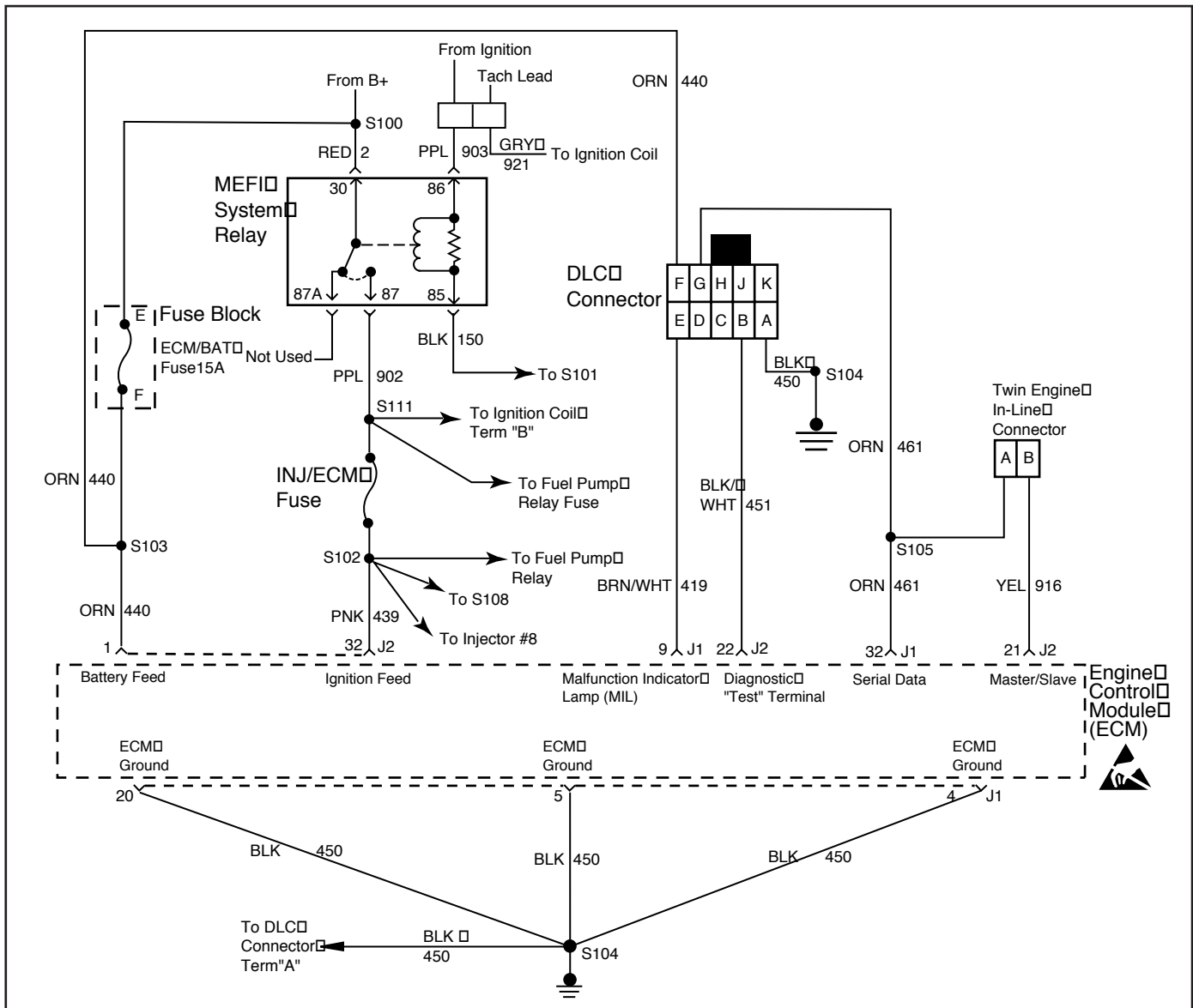
**Table A-1 - No Malfunction Indicator Lamp (MIL) - Marine Diagnostic Trouble Code (MDTC) Tool Installed**

<b>Step</b>	<b>Action</b>	<b>Value</b>	<b>Yes</b>	<b>No</b>
<b>1</b>	Was the iOn-Board Diagnostici (OBD) System Check performed?	0	Go to Step 2	Go to OBD System Check
<b>2</b>	Attempt to start the engine. Does the engine start?	0	Go to Step 3	Go to Step 6
<b>3</b>	1. Remove Marine Diagnostic Trouble Code (MDTC) tool. 2. Ignition iON,i engine iOFF.i 3. Using a test light connected to ground, probe terminal iFi of the DLC. Does the test light illuminate brightly?	0	Go to Step 4	Go to Step 10
<b>4</b>	Using a test light connected to B+, probe terminal iEi of the DLC. Does the test light illuminate brightly?	0	Go to Step 11	Go to Step 5
<b>5</b>	1. Ignition iOFF.i 2. Disconnect ECM iJ2i connector. 3. Using a DVOM, measure the resistance between ECM harness connector terminal iJ1-9i and DLC terminal iE.i Is the resistance within the specified values?	0 ohms	Go to Step 17	Go to Step 13
<b>6</b>	Check the ECM/BAT fuse. Is the fuse good?	0	Go to Step 7	Go to Step 14
<b>7</b>	1. Ignition iOFF.i 2. Disconnect the ECM connectors. 3. Using a test light connected to ground, probe ECM harness connector pin iJ2-1.i Does the test light illuminate brightly?	0	Go to Step 8	Go to Step 15
<b>8</b>	1. Ignition iON,i engine iOFF.i 2. Using a test light connected to ground, probe ECM harness connector pin iJ2-32.i Does the test light illuminate brightly?	0	Go to Step 12	Go to Step 9
<b>9</b>	Check the INJ/ECM fuse. Is the fuse good?	0	Go to Table A-6	Go to Step 16
<b>10</b>	Locate and repair open or short to ground in CKT 440. Is action complete?	0	Go to OBD System Check	0

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

<b>Step</b>	<b>Action</b>	<b>Value</b>	<b>Yes</b>	<b>No</b>
<b>11</b>	Repair or replace faulty Marine Diagnostic Trouble Code tool. Is action complete?	ó	Go to OBD System Check	ó
<b>12</b>	1. Locate and repair faulty ECM grounds. 2. If a problem is found, repair as necessary. Is action complete?	ó	Go to OBD System Check	Go to Step 17
<b>13</b>	Locate and repair open in CKT 419. Is action complete?	ó	Go to OBD System Check	ó -
<b>14</b>	Locate and repair short to ground in CKT 440. Is action complete?	ó	Go to OBD System Check	ó
<b>15</b>	Locate and repair open in CKT 440. Is action complete?	ó	Go to OBD System Check	ó
<b>16</b>	Locate and repair short to ground in CKT 439. Is action complete?	ó	Go to OBD System Check	ó
<b>17</b>	Repair faulty ECM connections or replace faulty ECM. Is action complete?	ó	Go to OBD System Check	ó

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MEFI 3008

**Table 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 (J1-9). There should always be a steady MIL with the ignition (ON) and the engine (OFF). The Electronic Control Module (ECM) turns the MIL (ON) by providing the ground to CKT 419.

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 DTCs 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:

- i 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**

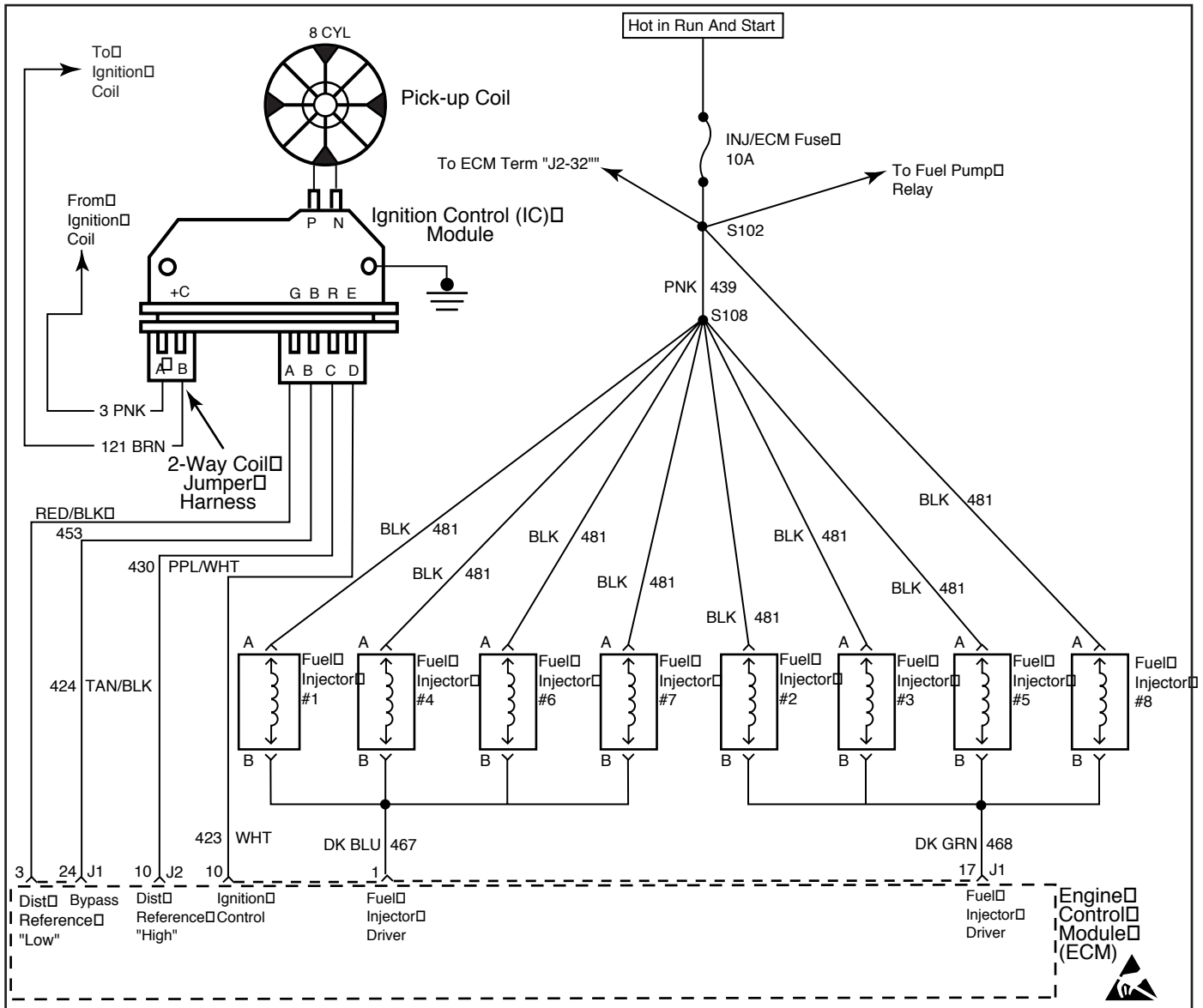
Number(s) below refer to the Step number(s) on the Diagnostic Table

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.

**Table 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	Yes	No
1	Was the On-Board Diagnostic (OBD) System Check performed?	ó	Go to Step 2	Go to OBD System Check
2	1. Ignition ON, engine OFF. 2. Switch MDTC tool to service mode or ON. Does the MIL flash DTC 12?	ó	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?	ó	Go to Step 7	Go to Step 4
4	1. Ignition OFF. 2. With ECM J2 connector disconnected, jump terminals A to B at the DLC. 3. Connect test light between ECM connector terminal J2-22 and B+. Does test light illuminate brightly?	ó	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?	ó	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?	ó	Go to OBD System Check	Go to Step 9
7	Locate and repair short to ground in CKT 419. Is action complete?	ó	Go to OBD System Check	ó
8	Locate and repair open in CKT 450 and/or CKT 451. Is action complete?	ó	Go to OBD System Check	ó
9	1. Repair faulty ECM connections or replace faulty ECM. 2. Recheck for DTC 12. Is action complete?	ó	Go to OBD System Check	ó



MEFI 3009

**Table A-3A - Engine Cranks But Will Not Run (ALL PFI and MFI ENGINES)**

**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 INJ/ECM fuse, Fuel Pump Relay fuse and to the ignition coil gray connector terminal iB.

After supply voltage passes through the INJ/ECM fuse, it branches out into separate CKT's 439. One is the supply voltage for injector harness CKT 481 and another one goes to ECM terminal iJ2-32. The ECM will control the opening and closing of the injectors through injector driver CKT 468 and CKT 467 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 to 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 iDistributor Ignition System Check,i Table A-7.

**1999 Marine**

**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:

- i 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.
- i This table assumes that battery voltage and engine cranking speed are OK, and there is adequate fuel in the tank.
- i Water or foreign material in fuel system can cause a no start.
- i A defective MAP sensor may cause a no start or a start and stall condition.

If above are all OK, refer to iHard Starti in *Symptoms* section.



**Test Description**

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

- 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. The test light should blink indicating the ECM is controlling the injectors *ON*. All lights should blink at the same brightness. All injectors should be within 1 ohm of each other and should not be less than 10 ohms at 21°C (70°F). If an injector is suspected for a no start condition, unplug the suspected injector and try to start the engine.
- 7. Use fuel pressure gauge J 34730-1A 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.
- 8. 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.

**Table A-3A - Engine Cranks But Will Not Run (ALL PFI and MFI ENGINES)**

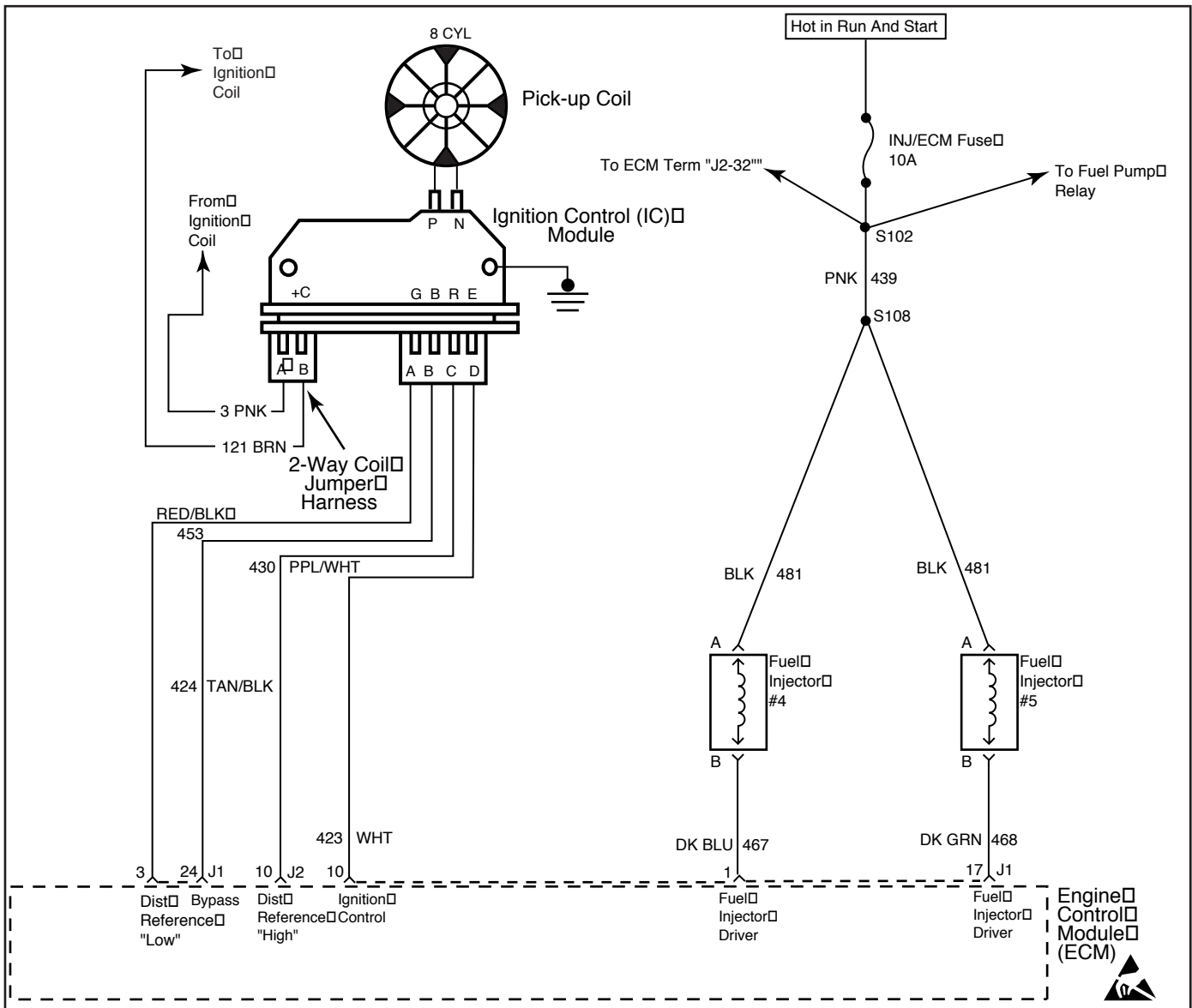
Step	Action	Value	Yes	No
1	Was the <i>On-Board Diagnostic</i> (OBD) System Check performed?	ó	Go to Step 2	Go to OBD System Check
2	Disconnect Throttle Position(TP) sensor. Does the engine start?	ó	Go to Step 14	Go to Step 3
3	1. Key <i>OFF</i> for minimum of 10 seconds. 2. Key <i>ON</i> . 3. Listen for fuel pump to run. Does fuel pump run for 2 seconds?	ó	Go to Step 4	Go to Table A-4
4	Crank engine for 1 second and listen for fuel pump to run. Does fuel pump run?	ó	Go to Step 5	Go to Step 8
5	Check for secondary ignition spark per manufactures recommendation. Is adequate spark present at all cylinders?	ó	Go to Step 6	Go to Table A-7
6	1. Disconnect one injector electrical connector. 2. Connect test light J 34730-2C to injector harness connector. 3. While cranking engine, check for blinking light. 4. Remove test light and reconnect injector harness connector. Repeat this test for all injectors. 5. If any lights are blinking dimly, check for shorted injector by comparing injector resistance values. Were all lights blinking brightly?	ó	Go to Step 7	Go to Step 10
7	1. Install fuel pressure gauge J 34730-1A or equivalent. 2. Ignition <i>OFF</i> for 10 seconds. 3. Ignition <i>ON</i> . Fuel pump will run for about 2 seconds 4. Note fuel pressure with pump running. The pressure may drop after the pump stops running, but the pressure should not drop immediately to 0 psi. System should hold pressure for at least 15 to 20 seconds. Is fuel pressure within specified value?	234-325 kPa (34-47 psi)	Refer to Diagnostic Aids on Facing Page	Go to Table A-4

**Table A-3A - Engine Cranks But Will Not Run (ALL PFI and MFI ENGINES)**

Step	Action	Value	Yes	No
<b>8</b>	Check for secondary ignition spark per manufactures recommendation. Is adequate spark present at all cylinders?	ó	Go to Step 9	Refer to DI System Check
<b>9</b>	1. Ignition ìOFF.î 2. Disconnect ECM ìJ2î connector. 3. Using a DVOM connected to ground, probe ìJ2-10î of the ECM harness connector while cranking the engine. Is the voltage within the specified value?	1-2 volts	Go to Step 20	Go to Step 15
<b>10</b>	Was the test light a steady light?	ó	Go to Step 11	Go to Step 12
<b>11</b>	Check the injector driver circuit with the steady light for a short to ground. If circuit is not shorted, check resistance across each injector in the circuit. Is resistance greater than the specified value?	10 ohms	Go to Step 20	Go to Step 16
<b>12</b>	1. Disconnect injector that did not blink. 2. Ignition ìON.î 3. Using a test light connected to ground, probe injector harness connector terminals. Does test light illuminate brightly on both terminals?	ó	Go to Step 13	Go to Step 17
<b>13</b>	1. Reconnect injector(s). 2. Ignition ìOFF.î 3. Disconnect ECM. 4. Ignition ìON.î 5. Using a test light connected to ground, probe ECM harness terminals ìJ1-1î and ìJ1-17.î Does test light illuminate brightly?	ó	Go to Step 19	Go to Step 18
<b>14</b>	Replace faulty TP sensor. Is action complete?	ó	Go to OBD System Check	ó
<b>15</b>	1. Locate and repair open or short to ground in CKT 430. 2. If OK, replace faulty ignition control module. Is action complete?	ó	Go to OBD System Check	ó
<b>16</b>	Locate and repair short to ground or replace any injector that measures under 10 ohms. Is action complete?	ó	Go to OBD System Check	ó
<b>17</b>	1. If the light was ìOFFî on both terminals, locate and repair open in injector feed circuit. 2. Due to the injectors wired in parallel, there should be a light on both terminals. If not, locate and repair open in the harness to the tested injector. Is action complete?	ó	Go to OBD System Check	ó
<b>18</b>	Locate and repair open in CKT 467 or CKT 468. Is action complete?	ó	Go to OBD System Check	ó

**Table A-3A - Engine Cranks But Will Not Run (ALL PFI and MFI ENGINES)**

Step	Action	Value	Yes	No
19	1. All checks made to this point would indicate that the ECM is at fault. However, there is a possibility of CKT 467 and CKT 468 being shorted to voltage source either in the engine harness or in the injector harness. 2. Disconnect all injectors. 3. Ignition $\bar{O}N$ . 4. Using a test light connected to ground, probe CKT 467 and CKT 468 on the ECM side of the injector harness. (Test one injector harness on each side of the engine.) If light is $\bar{O}N$ , locate and repair short to voltage. 5. Check injector harness connector. Be sure terminals are not backed out of connector and contacting each other. 6. If all OK, replace faulty ECM. Is action complete?	ó	Go to OBD System Check	ó
20	Repair faulty ECM connections or replace faulty ECM. Is action complete?	ó	Go to OBD System Check	ó



TBI 3009

**Table A-3B - Engine Cranks But Will Not Run (ALL TBI ENGINES)**

**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 INJ/ECM fuse, Fuel Pump Relay fuse and to the ignition coil gray connector terminal IB.

After supply voltage passes through the INJ/ECM fuse, it branches out into separate CKT's 439. One is the supply voltage for injector harness CKT 481 and another one goes to ECM terminal J2-32. 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, Table A-7.

**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.
- This table 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.

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 Table:

- 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 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.

**Table A-3B - Engine Cranks But Will Not Run (ALL TBI ENGINES)**

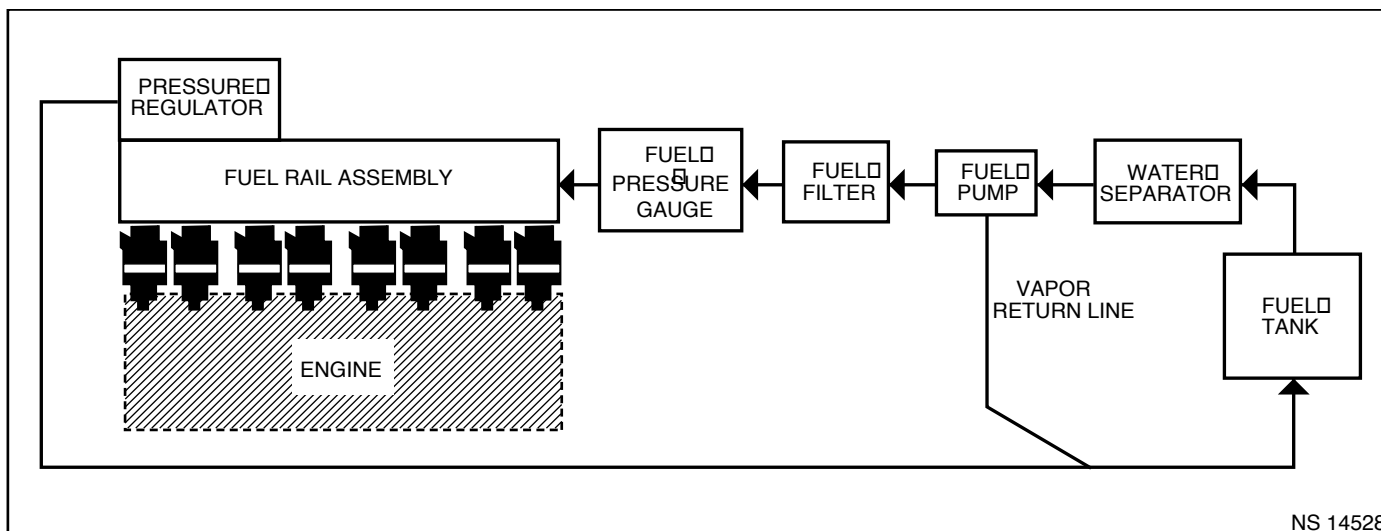
Step	Action	Value	Yes	No
1	Was the 'On-Board Diagnostic' (OBD) System Check performed?	ó	Go to Step 2	Go to OBD System Check
2	Disconnect Throttle Position (TP) sensor. Does the engine start?	ó	Go to Step 21	Go to Step 3
3	1. Key 'OFF' for minimum of 10 seconds. 2. Key 'ON'. 3. Listen for fuel pump to run. Does fuel pump run for 2 seconds?	ó	Go to Step 4	Go to Table A-4
4	Crank engine for 1 second and listen for fuel pump to run. Does fuel pump run?	ó	Go to Step 5	Go to Step 9
5	Check for secondary ignition spark per manufactures recommendation. Is adequate spark present at all cylinders?	ó	Go to Step 6	Go to Table A-7
6	1. Remove flame arrestor. 2. Observe injector fuel spray while cranking engine. Do both injectors spray while cranking?	ó	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?	ó	Go to Step 22	Go to Step 8
8	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 Diagnostic Aids on Facing Page	Go to Table A-4

**Table A-3B - Engine Cranks But Will Not Run (ALL TBI ENGINES)**

Step	Action	Value	Yes	No
9	Check for secondary ignition spark per manufactures recommendation. Is adequate spark present at all cylinders?	ó	Go to Step 10	Refer to DI System Check
10	1. Ignition ìOFF.î 2. Disconnect ECM ìJ2î connector. 3. Using a DVOM connected to ground, probe ìJ2-10î 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?	ó	Go to Step 12	Go to Step 15
12	1. Ignition ìOFF.î 2. Disconnect both injector harness connectors. 3. Ignition ìON,î engine ìOFF.î 4. With a test light connected to ground, probe harness terminal ìAî at each injector connector. Does test light illuminate brightly?	ó	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?	ó	Go to Table A-4	Go to Step 14
14	1. Ignition ìOFF.î 2. Disconnect TP sensor. 3. Note injector test light while cranking engine. Is test light blinking brightly?	ó	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?	ó	Go to Step 17	Go to Step 16
16	Is injector test light blinking brightly?	ó	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?	ó	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

**Table A-3B - Engine Cranks But Will Not Run (ALL TBI ENGINES)**

<b>Step</b>	<b>Action</b>	<b>Value</b>	<b>Yes</b>	<b>No</b>
<b>19</b>	1. Ignition ìON,î engine ìOFF.î 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?	ó	Go to Step 26	Go to Step 20
<b>20</b>	Does test light illuminate brightly on one terminal?	ó	Go to Step 25	Go to Step 24
<b>21</b>	Replace faulty TP sensor. Is action complete?	ó	Go to OBD System Check	ó
<b>22</b>	Replace faulty injector seal or faulty injector. Is action complete?	ó	Go to OBD System Check	ó
<b>23</b>	1. Locate and repair open or short to ground in CKT 430. 2. If OK, replace faulty ignition control module. Was a problem found?	ó	Go to OBD System Check	Go to Step 25
<b>24</b>	Locate and repair open in ignition feed circuit to injector. Is action complete?	ó	Go to OBD System Check	ó
<b>25</b>	Locate and repair open in CKT 467 or CKT468. Was a problem found?	ó	Go to OBD System Check	Go to Step 27
<b>26</b>	Locate and repair short to voltage in CKT 467 or CKT 468. Is action complete?	ó	Go to OBD System Check	ó
<b>27</b>	Repair faulty ECM connections or replace faulty ECM. Is action complete?	ó	Go to OBD System Check	ó



**Table A-4A Fuel System Diagnosis (ALL PFI and MFI ENGINES)**

### 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 fuel rail and injectors, then to the pressure regulator, where the system pressure is controlled to about 234-325 kPa (34-47 psi). Excess fuel is then returned to the fuel tank.

### 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:

- ï 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.
- ï Contaminated or dirty fuel may cause the fuel pump to seize, which will cause the fuel pump relay fuse to fail.
- ï The ability to maintain a constant fuel pressure is very critical in the drivability of fuel injection. If the fuel pressure drops below the specification of that application, multiple drivability problems may occur. The vessel may have to be operated under a load, or certain conditions, as the lack of fuel pressure may be intermittent.

### 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 234-325 kPa (34-47 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.

3. When engine is idling, high vacuum is applied to the fuel regulator diaphragm. This will offset the spring and result in a lower fuel pressure. This idle vacuum will vary somewhat depending on barometric pressure. However, the pressure idling should be less, indicating pressure regulator control.
6. Pressure that leaks down is caused by one of the following:
  - ï Fuel pressure regulator valve leaking.
  - ï Injector(s) sticking open.
  - ï Defective fuel pump.
  - ï External fuel leak.
11. Restricting the fuel return line allows the fuel pressure to build above regulated pressure. Pressure should rise to 414 kPa (60 psi) 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.

12. This test determines if the high fuel pressure is due to a restricted fuel return line or a pressure regulator problem.
15. If an injector is stuck open, it will send fuel to its respective cylinder, which may saturate or foul a spark plug(s). In order to determine which injector(s) is leaking, the spark plugs must be removed and inspected for fouling or saturation. Once the saturated spark plug(s) is found, replace the corresponding injector(s) and install new spark plugs.



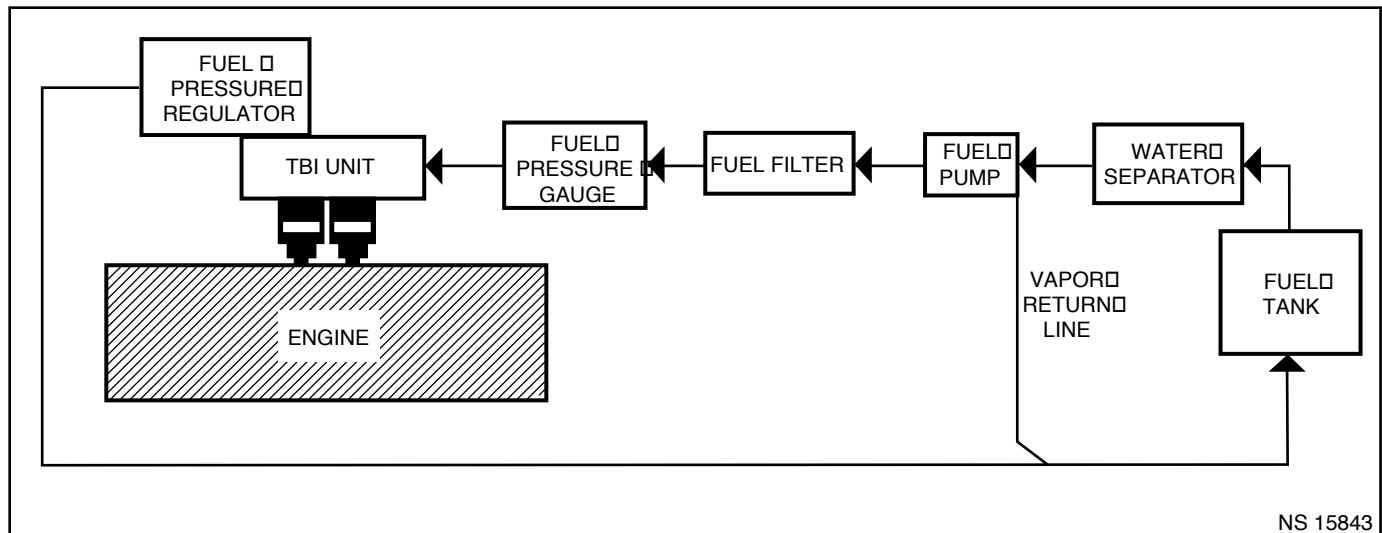
**Table A-4A Fuel System Diagnosis (ALL PFI and MFI ENGINES)**

Step	Action	Value	Yes	No
1	Was the On-Board Diagnostics (OBD) System Check performed?	ó	Go to Step 2	Go to OBD System Check
2	<ol style="list-style-type: none"> <li>1. Install fuel pressure gauge J 34730-1A or equivalent.</li> <li>2. Ignition OFF for 10 seconds.</li> <li>3. Ignition ON. Fuel pump will run for about 2 seconds.</li> <li>4. Note fuel pressure with pump running. The pressure may drop after the pump stops running, but the pressure should not drop immediately to 0 psi. System should hold pressure for at least 15 to 20 seconds.</li> </ol> Is fuel pressure within specified value?	234-325 kPa (34-47 psi)	Go to Step 3	Go to Step 5
3	Start engine and idle at normal operating temperature. Is fuel pressure lower by the specified value?	21-69 kPa (3-10 psi)	Refer to Symptoms Section	Go to Step 4
4	With engine still idling, connect an external vacuum source to the fuel pressure regulator and apply 10 in. of vacuum. Is fuel pressure lower by the specified value?	21-69 kPa (3-10 psi)	Go to Step 14	Go to Step 16
5	Was fuel pressure present at all?	ó	Go to Step 6	Go to Table A-5
6	Does the system establish fuel pressure and then drop immediately to 0 psi?	ó	Go to Step 7	Go to Step 9
7	<ol style="list-style-type: none"> <li>1. Ignition OFF for 10 seconds.</li> <li>2. Ignition ON.</li> <li>3. Block fuel pressure line between the fuel pump and fuel rail per manufactures recommendations.</li> </ol> Does fuel pressure hold?	ó	Go to Step 18	Go to Step 8
8	<ol style="list-style-type: none"> <li>1. Ignition OFF for 10 seconds.</li> <li>2. Ignition ON.</li> <li>3. Block fuel return line per manufactures recommendations.</li> </ol> Does fuel pressure hold?	ó	Go to Step 16	Go to Step 15
9	Is fuel pressure below specified value?	234 kPa (34 psi)	Go to Step 10	Go to Step 12
10	Check for restricted in-line filter or fuel lines. If a problem is found, repair as necessary. Was a problem found?	ó	Go to OBD System Check	Go to Step 11
11	<ol style="list-style-type: none"> <li>1. Ignition OFF.</li> <li>2. Block fuel return line per manufactures recommendations.</li> <li>3. Ignition ON.</li> </ol> Does fuel pressure rise above the specified value?	325 kPa (47 psi)	Go to Step 16	Go to Step 18

**Table A-4A Fuel System Diagnosis (ALL PFI and MFI ENGINES)**

Step	Action	Value	Yes	No
<b>12</b>	1. Ignition <i>OFF</i> . 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 <i>ON</i> . Note fuel pressure within 2 seconds of ignition <i>ON</i> . Is fuel pressure within the specified value?	234-325 kPa (34-47 psi)	Go to Step 17	Go to Step 13
<b>13</b>	Check for restricted fuel return line from fuel pressure regulator to point where fuel line was disconnected. Was a problem found?	ó	Go to OBD System Check	Go to Step 16
<b>14</b>	Locate and repair vacuum source to fuel pressure regulator. Is action complete?	ó	Go to OBD System Check	ó
<b>15</b>	Locate and repair leaking injector(s). Is action complete?	ó	Go to OBD System Check	ó
<b>16</b>	Replace faulty fuel pressure regulator. Is action complete?	ó	Go to OBD System Check	ó
<b>17</b>	Locate and repair restricted fuel return line to fuel tank. Is action complete?	ó	Go to OBD System Check	ó
<b>18</b>	Check for leaking pump fittings or lines, inlet filter, and low battery voltage. If OK, replace faulty fuel pump. Is action complete?	ó	Go to OBD System Check	ó

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**Table A-4B Fuel System Diagnosis (ALL TBI ENGINES)**

### 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.

### 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:

- ï 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.
- ï Contaminated or dirty fuel may cause the fuel pump to seize, which will cause the fuel pump relay fuse to fail.
- ï The ability to maintain a constant fuel pressure is very critical in the drivability of fuel injection. If the fuel pressure drops below the specification of that application, multiple drivability problems may occur. The vessel may have to be operated under a load, or certain conditions, as the lack of fuel pressure may be intermittent.

### 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.

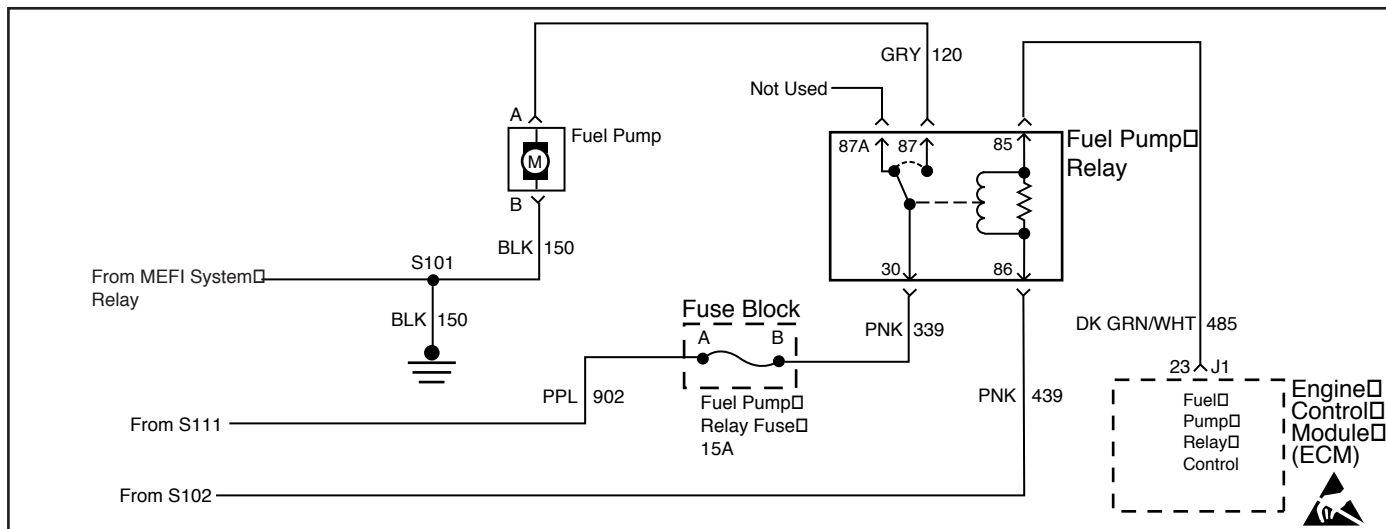
5. Low fuel pressure can be caused by a restriction in the inlet fuel line. This can include fuel tank pick-up, rubber and steel lines, fuel fittings and filters.
6. Restricting the fuel return line allows the fuel pressure to build above regulated pressure. Pressure should rise as the fuel return hose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

**Table A-4B Fuel System Diagnosis (ALL TBI ENGINES)**

Step	Action	Value	Yes	No
1	Was the On-Board Diagnostics (OBD) System Check performed?	ó	Go to Step 2	Go to OBD System Check
2	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 Symptoms Section	Go to Step 3
3	Was fuel pressure present at all?	ó	Go to Step 4	Go to Table 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?	ó	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?	ó	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?	ó	Go to OBD System Check	ó
10	Check for leaking pump fittings or lines, inlet filter, and low battery voltage. If OK, replace faulty fuel pump. Is action complete?	ó	Go to OBD System Check	ó
11	Locate and repair restricted fuel return line to fuel tank. Is action complete?	ó	Go to OBD System Check	ó



MEFI 3010

Table 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 a ground 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:

- ï 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.
- ï 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 Table:

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 an open in the ground circuit.
5. This step checks if the ECM is functioning properly.

Table A-5 - Fuel System Electrical Test

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostics" (OBD) System Check performed?	ó	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?	ó	Go to Step 3	Go to Step 7
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?	ó	Go to Step 4	Go to Step 12
4	1. Ignition "OFF." 2. Disconnect fused jumper wire. 3. Ignition "ON." 4. Using a test light connected to ground, probe terminal "86" of the fuel pump relay connector. Does the test light illuminate brightly?	ó	Go to Step 5	Go to Step 14
5	1. Using a test light connected to B+, probe terminal "85" of the fuel pump relay connector. 2. Ignition "ON." Does test light illuminate brightly for 2 seconds and then go off?	ó	Go to Step 8	Go to Step 6
6	Locate and repair faulty ECM connection at "J1-23" or repair open in CKT 465. Was a problem found?	ó	Go to OBD System Check	Go to Step 15
7	Check fuel pump relay fuse. Is fuse OK?	ó	Go to Step 10	Go to Step 11
8	Replace fuel pump relay and re-test. Is fuel pressure within specified values?	234-325 kPa (34-47 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?	ó	Go to OBD System Check	Go to Step 13
10	Locate and repair open in CKT 339 or CKT 902. Is action complete?	ó	Go to OBD System Check	ó

**Table A-5 - Fuel System Electrical Test**

<b>Step</b>	<b>Action</b>	<b>Value</b>	<b>Yes</b>	<b>No</b>
<b>11</b>	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?	ó	Go to OBD System Check	ó
<b>12</b>	Locate and repair open in CKT 120 or CKT 150. Was a problem found?	ó	Go to OBD System Check	Go to Step 13
<b>13</b>	Replace faulty fuel pump. Is action complete?	ó	Go to OBD System Check	ó
<b>14</b>	Locate and repair open in CKT 439. Is action complete?	ó	Go to OBD System Check	ó
<b>15</b>	Replace faulty ECM. Is action complete?	ó	Go to OBD System Check	ó



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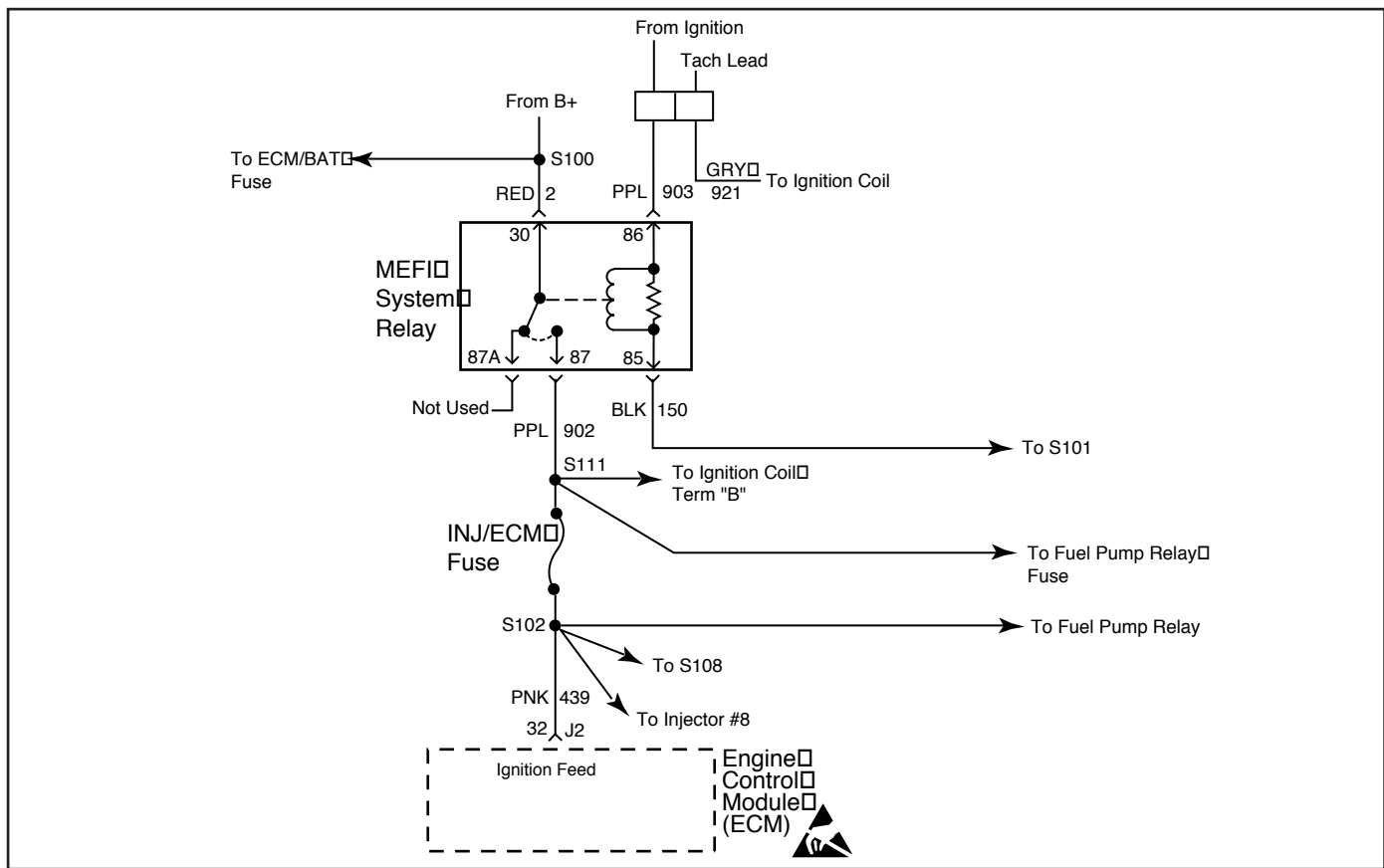


Table A-6 - MEFI System Relay Check

MEFI 3011

**Circuit Description**

Battery voltage is constantly supplied to terminal 30 of the system relay. When the ignition switch is moved to the run position, 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 coil, injectors, ECM and fuel pump relay through terminal 87 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:

- i 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.
- i 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 Table:

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

Table A-6 - MEFI System Relay Check

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostics" (OBD) System Check performed?	ó	Go to Step 2	Go to OBD System Check
2	1. Ignition "OFF." 2. Remove MEFI system relay. 3. Ignition "ON." 4. With test light connected to ground, probe relay harness connector terminals "86" and "30." Does test light illuminate brightly on both terminals?	ó	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?	ó	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?	ó	Go to OBD System Check	ó
5	Locate and repair open or short to ground in circuit that did not light (CKT 2 and/or CKT 903). Is action complete?	ó	Go to OBD System Check	ó
6	Locate and repair open ground CKT 150. Is action complete?	ó	Go to OBD System Check	ó

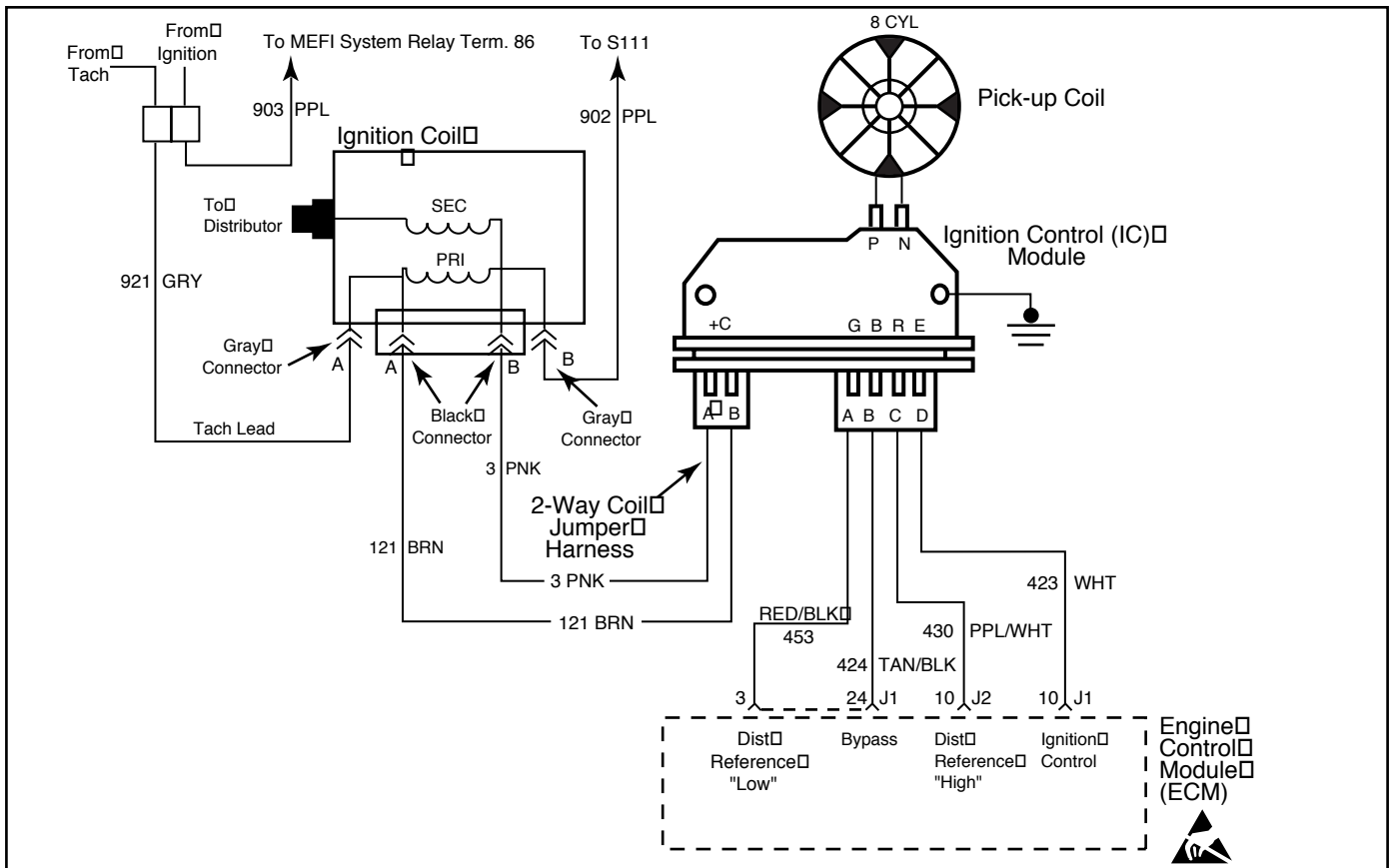


Table A-7 - Distributor Ignition (DI) System Check

MEFI 3012

**Circuit Description**

The Distributor Ignition (DI) system receives supply voltage from the MEFI system relay through CKT 902 to the ignition coil gray connector terminal 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 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:

- ï 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.
- ï The tach needs to be disconnected while testing the ignition system. You will also need a place to check coil 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 Table:

- 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 *iC* and *i+* terminals. Low voltage would indicate an open or a high resistance circuit from the distributor to the coil or ignition switch. If *iC* terminal voltage was low, but *i+* terminal voltage is 10 volts or more, circuit from *iC* 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 *iOFF*, so normal voltage should be about 12 volts. If the module is turned *iON*, 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 *ibatt* to the *itach* terminal.

- 11. Applying a voltage (1.35-1.50 volts) to the module terminal *iP* should turn the module *iON* 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 *iON*. 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 *iOFF* 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.

**Table A-7 - Distributor Ignition (DI) System Check**

Step	Action	Value	Yes	No
1	Was the <i>iOn-Board Diagnostics</i> (OBD) System Check performed?	ó	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 903 for the ignition circuit. 4. Check for secondary spark per manufactures recommendation. If there is <i>ino spark</i> at one wire, check a few more wires. A few sparks and then nothing is considered <i>ino spark</i> . Is adequate spark present at all cylinders?	ó	Refer to Symptoms Section	Go to Step 3
3	Remove distributor cap and verify rotation of distributor rotor. Is the distributor rotor turning?	ó	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?	ó	Go to Step 18	Go to Step 5

**Table A-7 - Distributor Ignition (DI) System Check**

Step	Action	Value	Yes	No
5	<ol style="list-style-type: none"> <li>1. Reconnect distributor 4-wire connector.</li> <li>2. Check for secondary spark per manufactures recommendation from the coil tower using a known good coil wire.</li> </ol> <p>Is adequate spark present?</p>	ó	Go to Step 19	Go to Step 6
6	<ol style="list-style-type: none"> <li>1. Disconnect distributor 2-wire ìC/+î connector harness.</li> <li>2. Ignition ìON,î engine ìOFF.î</li> <li>3. Using DVOM J 39978 or equivalent, check voltage at ì+î and ìCî terminals of the 2-wire distributor harness connector.</li> </ol> <p>Is voltage reading greater than the specified value at both terminals?</p>	0 volts	Go to Step 8	Go to Step 7
7	<p>Is voltage reading less than the specified value at both terminals?</p>	10 volts	Go to Step 20	Go to Step 21
8	<ol style="list-style-type: none"> <li>1. Reconnect distributor 2-wire connector.</li> <li>2. Ignition ìON,î engine ìOFF.î</li> <li>3. Using DVOM J 39978 or equivalent, check voltage from tach terminal to ground.</li> <li>4. The tach terminal can be accessed at the 2-wire boat connector. The tach circuit is the gray wire CKT 921.</li> </ol> <p>Is voltage reading within the specified value?</p>	1-10 volts	Go to Step 15	Go to Step 9
9	<p>Is voltage reading greater than the specified value?</p>	10 volts	Go to Step 10	Go to Step 22
10	<ol style="list-style-type: none"> <li>1. Using a test light connected to ground, probe tach terminal at the 2-wire boat harness.</li> <li>2. Observe the test light while cranking engine.</li> </ol> <p>Is test light blinking?</p>	ó	Go to Step 13	Go to Step 11
11	<ol style="list-style-type: none"> <li>1. Disconnect distributor 4-wire connector.</li> <li>2. Remove distributor cap.</li> <li>3. Disconnect pick-up coil connector from the distributor ignition control module.</li> <li>4. Connect DVOM to tach terminal at the 2-wire boat harness and ground.</li> <li>5. Ignition ìON,î engine ìOFF.î</li> <li>6. Connect positive (+) end of a known good 1.5 volt test battery to the ìPî 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.</li> </ol> <p>Does the voltage drop?</p>	ó	Go to Step 12	Go to Step 23
12	<p>Check for spark from the coil wire as the test battery lead is removed?</p> <p>Is adequate spark present?</p>	ó	Go to Step 17	Go to Step 13

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

Step	Action	Value	Yes	No
13	Replace ignition coil and recheck for spark as set up in steps 11 and 12. Is adequate spark present?	ó	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?	ó	Go to OBD System Check	ó
15	Replace ignition module and recheck for spark as set up in steps 11 and 12. Is adequate spark present?	ó	Go to OBD System Check	Go to Step 16
16	Replace ignition coil, it too is faulty. Is action complete?	ó	Go to OBD System Check	ó
17	Is the rotating pole piece still magnetized?	ó	Go to Step 18	Go to Step 24
18	Replace faulty pick-up coil. Is action complete?	ó	Go to OBD System Check	ó
19	Inspect distributor cap for water, cracks, etc. If OK, replace faulty distributor rotor. Is action complete?	ó	Go to OBD System Check	ó
20	Check for open or short to ground in CKT 3, the pink wire from the ignition module ì+î 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?	ó	Go to OBD System Check	ó
21	Check for open or short to ground in CKT 121, the brown wire from the ignition module ìCî terminal to the ignition coil. If OK, replace faulty ignition coil. Is action complete?	ó	Go to OBD System Check	ó
22	Repair faulty connections or open tach lead. Repeat step 8.	ó	ó	ó
23	Check ignition module ground. If OK, replace faulty ignition module. Is action complete?	ó	Go to OBD System Check	ó
24	Replace distributor pole piece and shaft assembly. Is action complete?	ó	Go to OBD System Check	ó
25	A mechanical repair will be necessary before continuing with this test.	ó	ó	ó

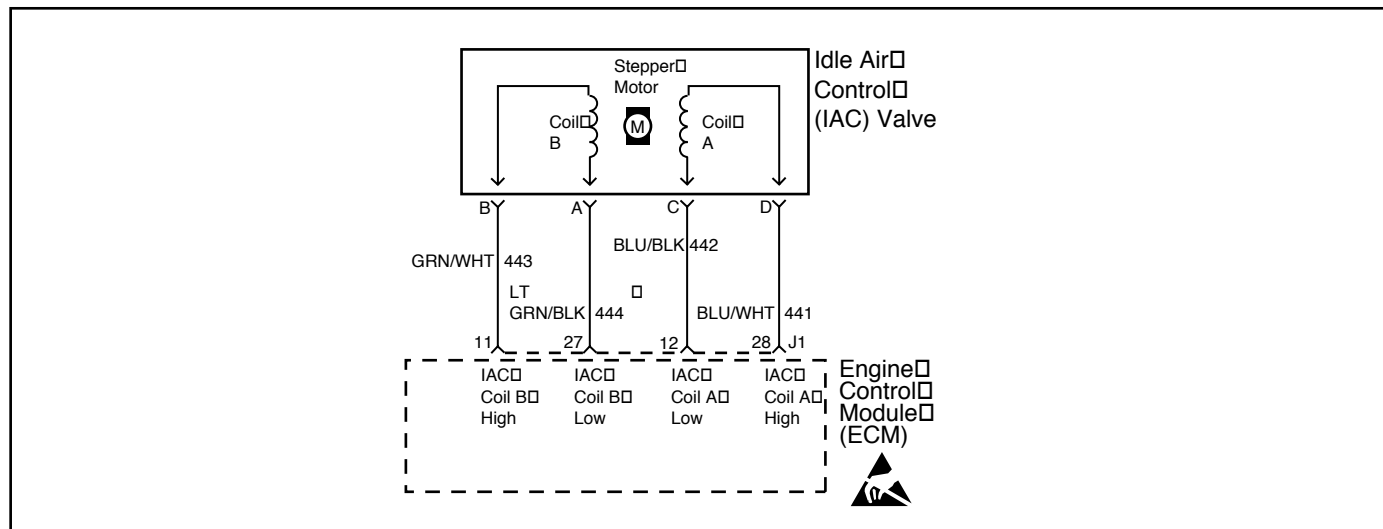


Table A-8 - Idle Air Control Functional Test

MEFI 3013

### 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:

- ï 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.
- ï 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.

- ï Check for poor connections, opens or short to grounds in CKTs 441, 442, 443 and 444. This may result in improper idle control.
- ï 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.

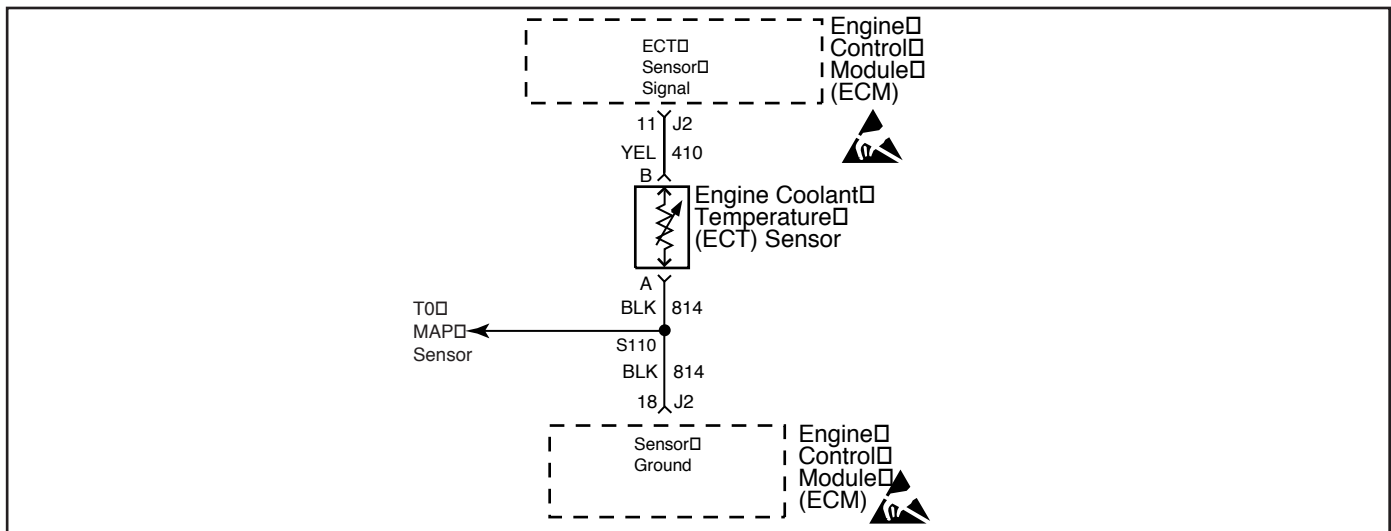
### Test Description

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



Table A-8 - Idle Air Control Functional Test

Step	Action	Value	Yes	No
1	Was the On-Board Diagnostic (OBD) system check performed?	0	Go to Step 2	Go to OBD System Check
2	<ol style="list-style-type: none"> <li>1. Engine should be at normal operating temperature.</li> <li>2. Start engine and allow idle to stabilize.</li> <li>3. Record RPM.</li> <li>4. Ignition OFF for 10 seconds.</li> <li>5. Disconnect IAC harness connector.</li> <li>6. Restart engine and record RPM.</li> </ol> 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	<ol style="list-style-type: none"> <li>1. Reinstall IAC harness connector.</li> <li>2. Idle speed should gradually return within 75 RPM of the original recorded RPM within 30 seconds.</li> </ol> Does RPM return to original recorded RPM?	0	Go to Step 5	Go to Step 4
4	<ol style="list-style-type: none"> <li>1. Ignition OFF for 10 seconds.</li> <li>2. Disconnect IAC harness connector.</li> <li>3. Restart engine.</li> <li>4. Using a test light connected to ground, probe each one of the four IAC harness terminals.</li> </ol> Does the test light blink on all four terminals?	0	Go to Step 7	Go to Step 6
5	IAC circuit is functioning properly.	0	0	0
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?	0	Go to OBD System Check	Go to Step 8
7	Check for poor IAC connections or replace the faulty IAC valve. Is action complete?	0	Go to OBD System Check	0
8	Repair faulty ECM connections or replace faulty ECM. Is action complete?	0	Go to OBD System Check	0



MEFI 3014

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

#### Circuit Description

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

#### Diagnostic Aids

Check for the following conditions:

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

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

#### Test Description

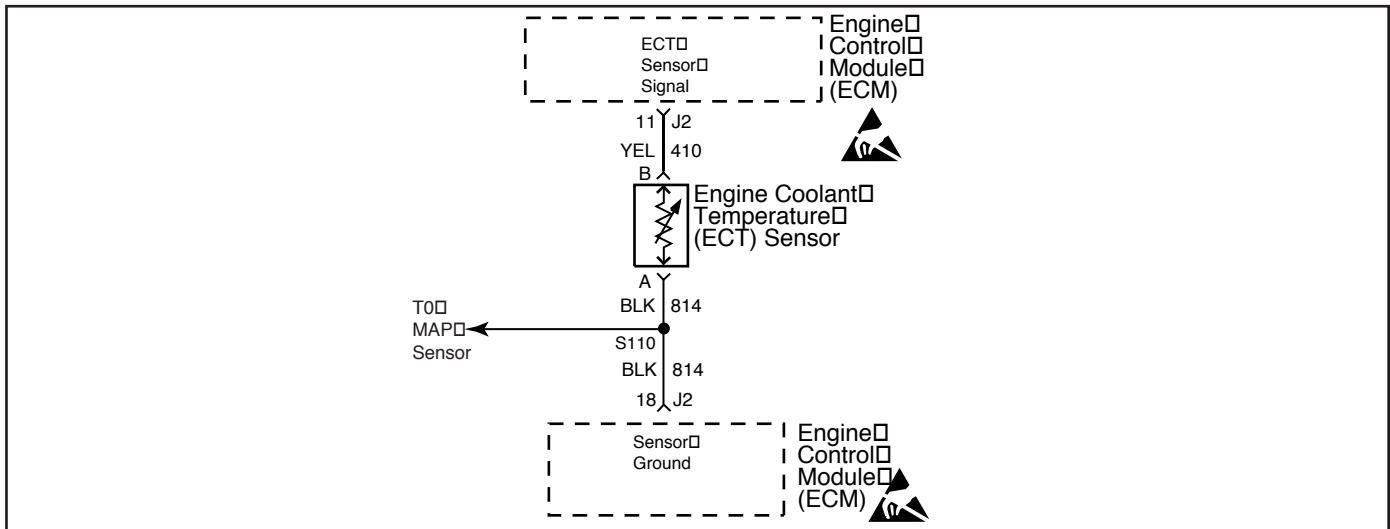
2. This step checks if there is a problem with the ECM and wiring or if the problem is the ECT sensor.
3. This step will isolate the problem to CKT 410 (5 volt reference) or to CKT 814 (sensor ground).
4. Check the harness terminals thoroughly for loose connections. If the resistance of the ECT sensor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

#### Engine Coolant Temperature Sensor Table

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

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

Step	Action	Value	Yes	No
<b>1</b>	Was the On-Board Diagnostic (OBD) system check performed?	0	Go to Step 2	Go to OBD System Check
<b>2</b>	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
<b>3</b>	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
<b>4</b>	Locate and repair intermittent faulty connections. If OK, replace faulty ECT sensor. Is action complete?	0	Verify Repair	0
<b>5</b>	Locate and repair open CKT 410. If a problem is found, repair as necessary. Was a problem found?	0	Verify Repair	Go to Step 7
<b>6</b>	Locate and repair open ground CKT 814. If a problem is found, repair as necessary. Was a problem found?	0	Verify Repair	Go to Step 7
<b>7</b>	Repair faulty ECM connections or replace faulty ECM. Is action complete?	0	Verify Repair	0



MEFI 3014

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

**Circuit Description**

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

**Diagnostic Aids**

Check for the following conditions:

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

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

**Test Description**

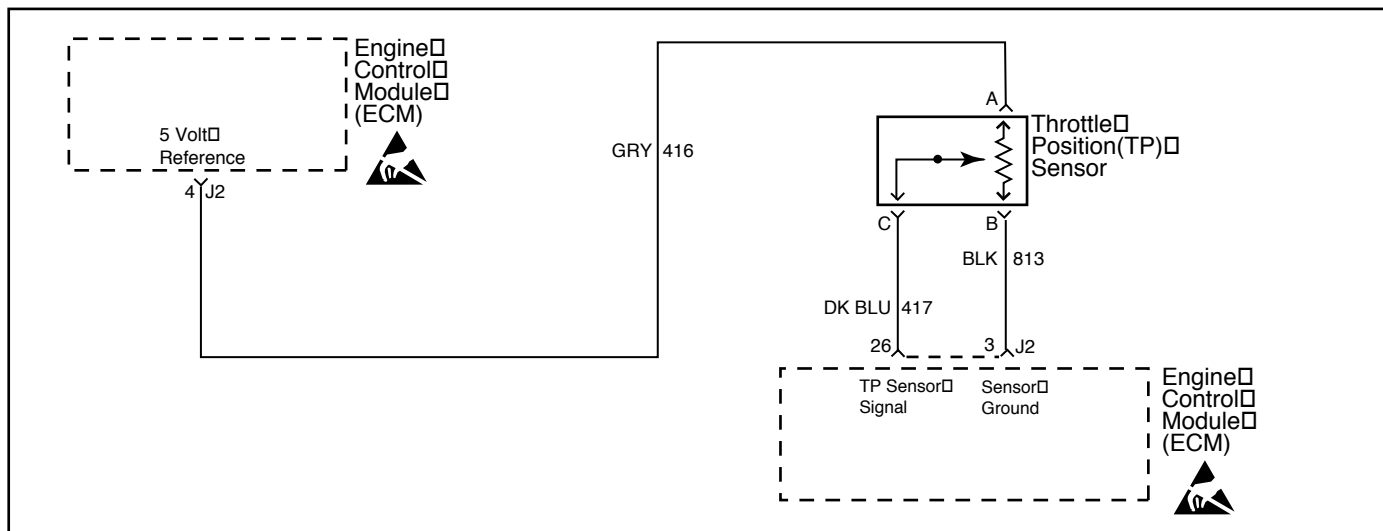
2. This step checks if there is a problem with the ECM and wiring or if the problem is the ECT sensor.
3. Check the harness terminals thoroughly for loose connections. If the resistance of the ECT sensor is monitored, the resistance should steadily decrease as the engine coolant warms up. The resistance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

**Engine Coolant Temperature Sensor Table**

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

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

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



MEFI 3015A

### 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:

- ï 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.
- ï 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.
- ï If a TP sensor circuit failure is present, the MAP sensor default value will be used along with the TP sensor default value.

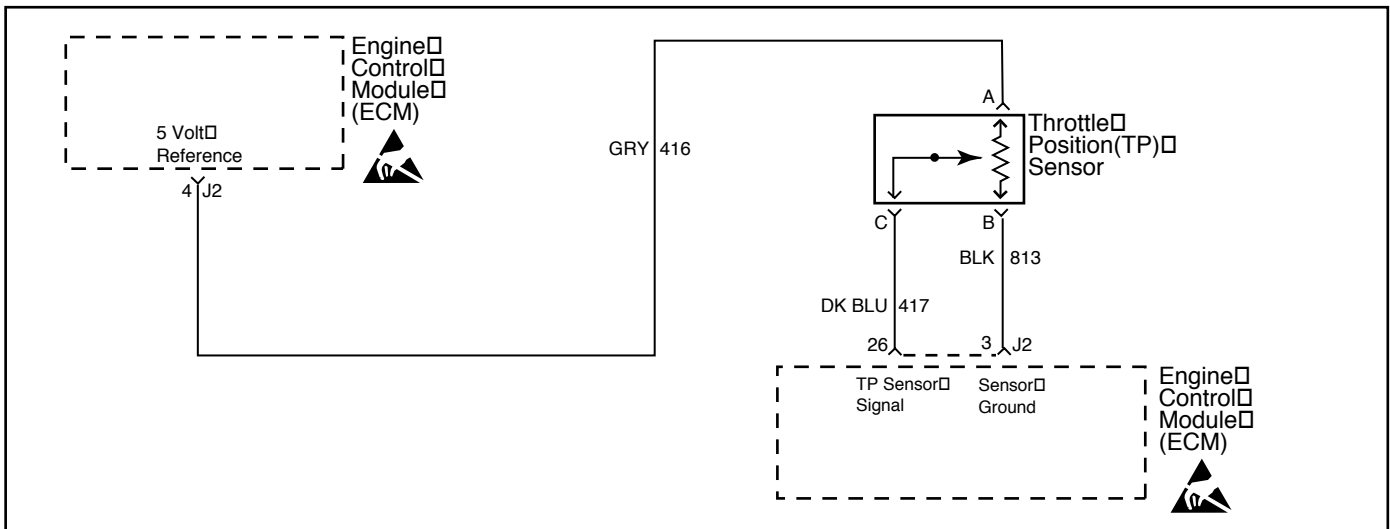
After repairs, clear DTCs following "Clear DTCs Procedure" in the *General Information* section. Failure to do so may result in DTCs not properly being cleared.

#### Test Description

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

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

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	ó	Go to Step 2	Go to OBD System Check
2	<ol style="list-style-type: none"> <li>1. Marine Diagnostic Trouble Code (MDTC) tool switched to "normal mode," or "OFF."</li> <li>2. Ignition "OFF."</li> <li>3. Disconnect TP sensor harness connector.</li> <li>4. Start engine and idle for 2 minutes or until MDTC tool indicates a stored DTC.</li> <li>5. Ignition "ON," engine "OFF."</li> <li>6. Switch MDTC tool to "service mode," or "ON" and note DTC.</li> </ol> Is DTC 22 present?	ó	Go to Step 4	Go to Step 3
3	<ol style="list-style-type: none"> <li>1. TP sensor harness connector disconnected.</li> <li>2. Ignition "ON," engine "OFF."</li> <li>3. Connect DVOM from harness terminal "B" (CKT 813) to harness terminal "A" (CKT 416).</li> </ol> Is voltage reading above the specified value?	4 volts	Go to Step 6	Go to Step 5
4	Locate and repair intermittent faulty connections. If OK, replace faulty TP sensor. Is action complete?	ó	Verify Repair	ó
5	Locate and repair open in CKT 813. If a problem is found, repair as necessary. Was a problem found?	ó	Verify Repair	Go to Step 7
6	Locate and repair short to voltage in CKT 417. If a problem is found, repair as necessary. Was a problem found?	ó	Verify Repair	Go to Step 7
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	ó	Verify Repair	ó



MEFI 3015A

### 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:

- ï 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.
- ï 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.
- ï If DTC 34 is also set, check for a short to ground in CKT 416 or CKT 416E.
- ï If a TP sensor circuit failure is present, the MAP sensor default value will be used along with the TP sensor default value.

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

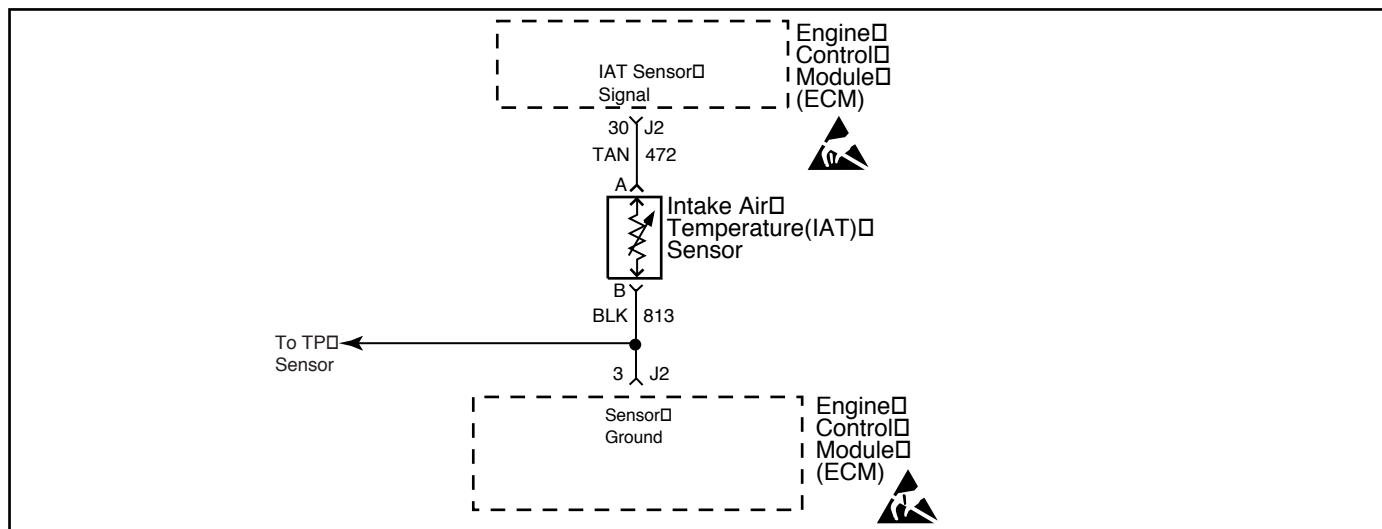
#### Test Description

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



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

Step	Action	Value	Yes	No
1	Was the On-Board Diagnostic (OBD) system check performed?	ó	Go to Step 2	Go to OBD System Check
2	<ol style="list-style-type: none"> <li>1. Marine Diagnostic Trouble Code (MDTC) tool switched to normal mode, or OFF.</li> <li>2. Ignition OFF.</li> <li>3. Disconnect TP sensor harness connector.</li> <li>4. Connect a jumper wire from harness terminal A (CKT 416) to harness terminal C (CKT 417).</li> <li>5. Start engine and idle for 2 minutes or until MDTC tool indicates a stored DTC.</li> <li>6. Ignition ON, engine OFF.</li> <li>7. Switch MDTC tool to service mode, or ON and note DTC.</li> </ol> Is DTC 21 present?	ó	Go to Step 4	Go to Step 3
3	<ol style="list-style-type: none"> <li>1. Remove jumper wire from CKT 416 and 417.</li> <li>2. Connect DVOM from harness terminal A (CKT 416) to harness terminal B (CKT 813).</li> </ol> Is voltage reading above the specified value?	4 volts	Go to Step 5	Go to Step 6
4	Locate and repair intermittent faulty connections. If OK, replace faulty TP sensor. Is action complete?	ó	Verify repair	ó
5	Locate and repair open or short to ground in CKT 417. If a problem is found, repair as necessary. Was a problem found?	ó	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?	ó	Verify repair	Go to Step 7
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	ó	Verify Repair	ó



MEFI 3016

### DTC 23 - Intake Air Temperature (IAT) Sensor Circuit - Low Temp Indicated (Non-Scan Diagnostics) - 7.4/8.2L MFI ENGINES ONLY)

#### Circuit Description

The Intake Air Temperature (IAT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts on CKT 472 to the sensor. When the air is cold, the sensor (thermistor) resistance is high. As the intake air warms up, the sensor resistance becomes less. See engine intake air temperature sensor table under *Diagnostic Aids*. At normal operating temperature (85°C - 95°C or 185°F - 203°F), the voltage will measure about 1.5-2.0 volts.

#### Diagnostic Aids

Check for the following conditions:

- i 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.
- ii Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the IAT display on the scan tool while moving connectors and wiring harnesses related to the IAT sensor. A change in the IAT display will indicate the location of the fault.

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

#### Test Description

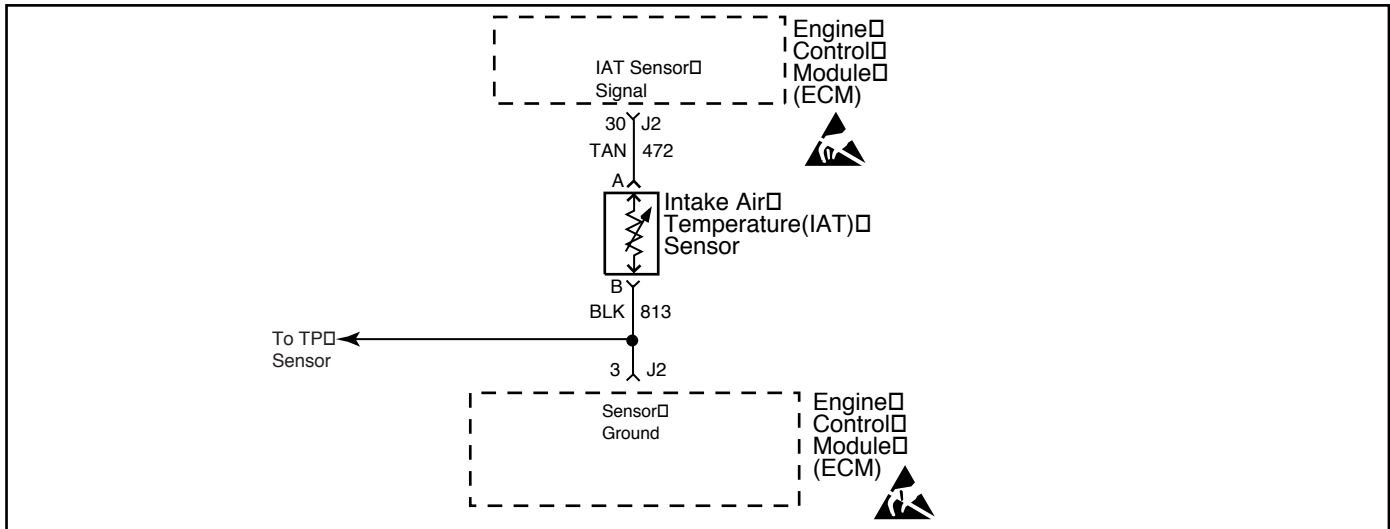
2. This step checks if there is a problem with the ECM and wiring or if the problem is the IAT sensor.
3. This step will isolate the problem to CKT 472 (5 volt reference) or to CKT 813 (sensor ground).
4. Check the harness terminals thoroughly for loose connections. If the resistance of the IAT sensor is monitored, the resistance should steadily decrease as the intake air temperature warms up.

#### Intake Air Temperature Sensor Table

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

**DTC 23 - Intake Air Temperature (IAT) Sensor Circuit - Low Temp Indicated  
(Non-Scan Diagnostics) - 7.4/8.2L MFI ENGINES ONLY**

<b>Step</b>	<b>Action</b>	<b>Value</b>	<b>Yes</b>	<b>No</b>
<b>1</b>	Was the On-Board Diagnostic (OBD) system check performed?	0	Go to Step 2	Go to OBD System Check
<b>2</b>	1. Ignition OFF. 2. Disconnect IAT sensor harness connector. 3. Ignition ON, engine OFF. 4. Connect DVOM across the IAT sensor harness terminals. Is voltage above the specified value?	4 volts	Go to Step 4	Go to Step 3
<b>3</b>	1. Connect positive DVOM lead to harness terminal A (CKT 472 (5 volt reference)). 2. Connect negative DVOM lead to a known good ground. Is voltage above the specified value?	4 volts	Go to Step 6	Go to Step 5
<b>4</b>	Locate and repair intermittent faulty connections. If OK, replace faulty IAT sensor. Is action complete?	0	Verify Repair	0
<b>5</b>	Locate and repair open CKT 472. If a problem is found, repair as necessary. Was a problem found?	0	Verify Repair	Go to Step 7
<b>6</b>	Locate and repair open ground CKT 813. If a problem is found, repair as necessary. Was a problem found?	0	Verify Repair	Go to Step 7
<b>7</b>	Repair faulty ECM connections or replace faulty ECM. Is action complete?	0	Verify Repair	0



MEFI 3016

**DTC 25 - Intake Air Temperature (IAT) Sensor Circuit -High Temp Indicated (Non-Scan Diagnostics) - 7.4/8.2L MFI ENGINES ONLY)**

**Circuit Description**

The Intake Air Temperature (IAT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts on CKT 472 to the sensor. When the air is cold, the sensor (thermistor) resistance is high. As the intake air warms up, the sensor resistance becomes less. See engine intake air temperature sensor table under *Diagnostic Aids*. At normal operating temperature (85°C - 95°C or 185°F - 203°F), the voltage will measure about 1.5-2.0 volts.

**Diagnostic Aids**

Check for the following conditions:

- ï **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.
- ï **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the IAT display on the scan tool while moving connectors and wiring harnesses related to the IAT sensor. A change in the IAT display will indicate the location of the fault.

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

**Test Description**

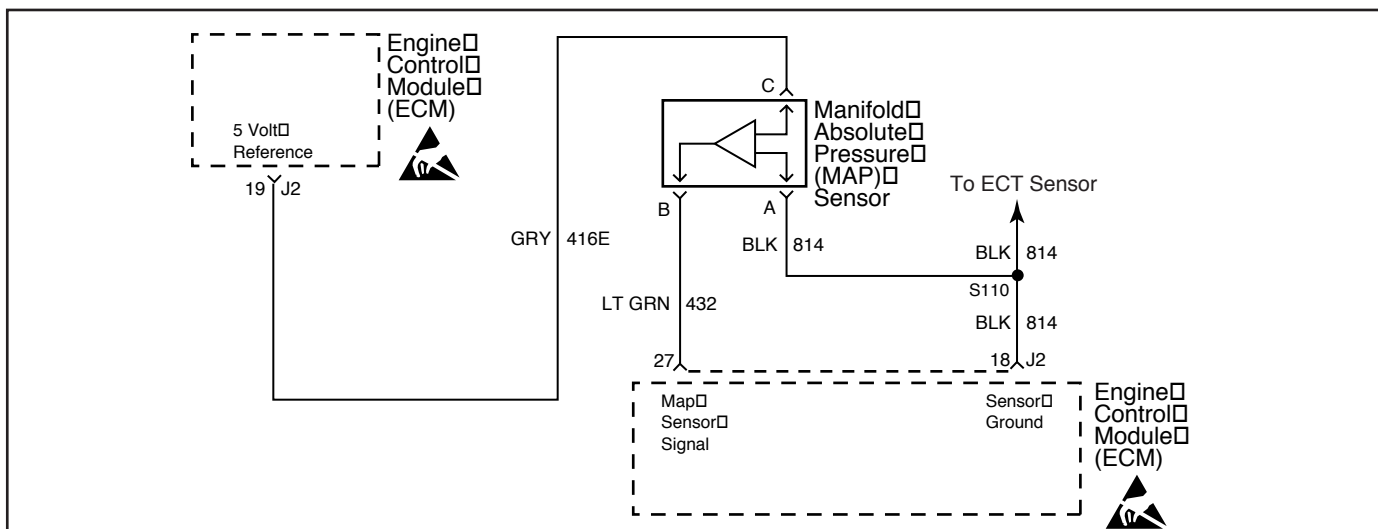
2. This step checks if there is a problem with the ECM and wiring or if the problem is the IAT sensor.
3. Check the harness terminals thoroughly for loose connections. If the resistance of the IAT sensor is monitored, the resistance should steadily decrease as the intake air temperature warms up.

**Engine Coolant Temperature Sensor Table**

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

**DTC 25 - Intake Air Temperature (IAT) Sensor Circuit -High Temp Indicated  
(Non-Scan Diagnostics) - 7.4/8.2L MFI ENGINES ONLY)**

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



MEFI 3017

### 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:

- ï 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.
- ï 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.

- ï If the idle is rough or unstable, refer to *Symptoms* section for items which may cause an unstable idle.
- ï With the ignition ìON,î engine ìOFF,î 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.
- ï If DTC 14 is also set, check for open in ground CKT 814.
- ï If a MAP sensor circuit failure is present, the TP sensor default value will be used along with the MAP sensor default value.

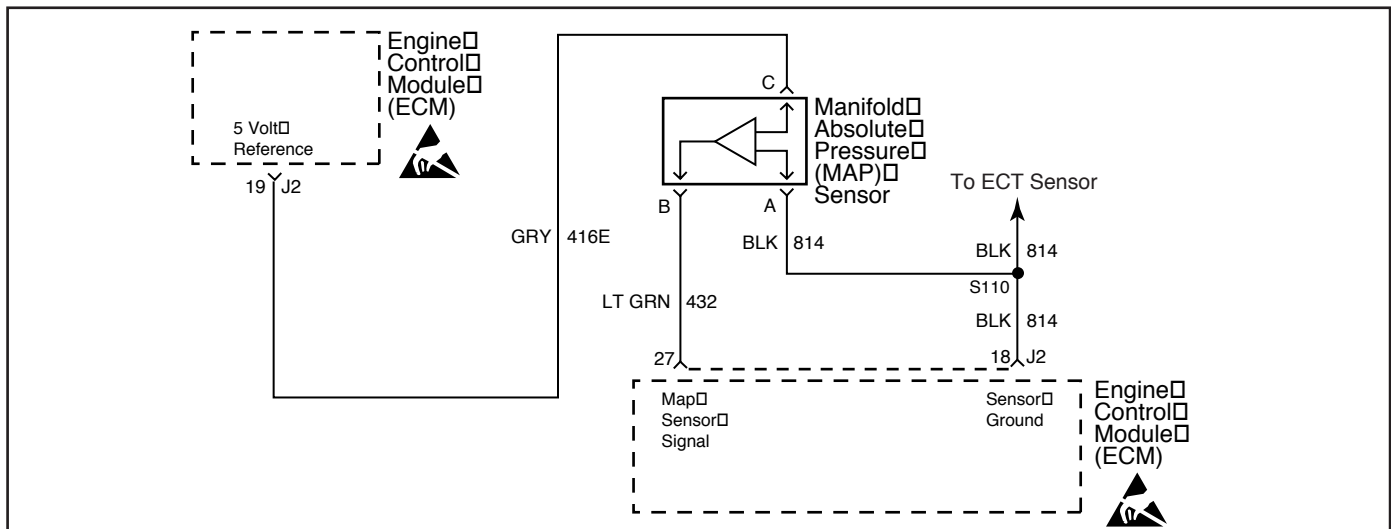
After repairs, clear DTCís following ìClear DTCís Procedureî in the *General Information* section. Failure to do so may result in DTCís not properly being cleared.

#### Test Description

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

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

Step	Action	Value	Yes	No
1	Was the iOn-Board Diagnostici (OBD) system check performed?	ó	Go to Step 2	Go to OBD System Check
2	1. Ignition iOFF.i 2. Install a vacuum gauge to a manifold vacuum source. 3. Start engine and raise to about 1000 RPM in neutral. 4. The vacuum reading should be steady. Is the vacuum gauge reading steady and above the specified value?	14i Hg (45.5 kPa)	Go to Step 3	Go to Step 5
3	1. Marine Diagnostic Trouble Code (MDTC) tool switched to inormal mode,i or iOFF.i 2. Ignition iOFF.i 3. Disconnect MAP sensor harness connector. 4. Start engine and idle for 2 minutes or until MDTC tool indicates a stored DTC. 5. Ignition iON,i engine iOFF.i 6. Switch MDTC tool to iservice mode,i or iONi and note DTC. Is DTC 34 present?	ó	Go to Step 6	Go to Step 4
4	1. MAP sensor harness connector disconnected. 2. Ignition iON,i engine iOFF.i 3. Connect DVOM from harness terminal iAi (CKT 814) to harness terminal iCi (CKT 416E). Is voltage reading above the specified value?	4 volts	Go to Step 7	Go to Step 8
5	Repair low or unsteady vacuum problem. Is action complete?	ó	Verify Repair	ó
6	Check for plugged or leaking sensor vacuum fitting. Also locate and repair intermittent faulty connections. If OK, replace faulty MAP sensor. Is action complete?	ó	Verify Repair	ó
7	Locate and repair short to voltage in CKT 432. If a problem is found, repair as necessary. Was a problem found?	ó	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?	ó	Verify Repair	Go to Step 9
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	ó	Verify Repair	ó



MEFI 3017

### 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:

- ï 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.
- ï 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.

- ï If the idle is rough or unstable, refer to *Symptoms* section for items which may cause an unstable idle.
- ï With the ignition ìON, engine ìOFF, 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.
- ï If a MAP sensor circuit failure is present, the TP sensor default value will be used along with the MAP sensor default value.

After repairs, clear DTCs following ìClear DTCs Procedureî in the *General Information* section. Failure to do so may result in DTCs not properly being cleared.

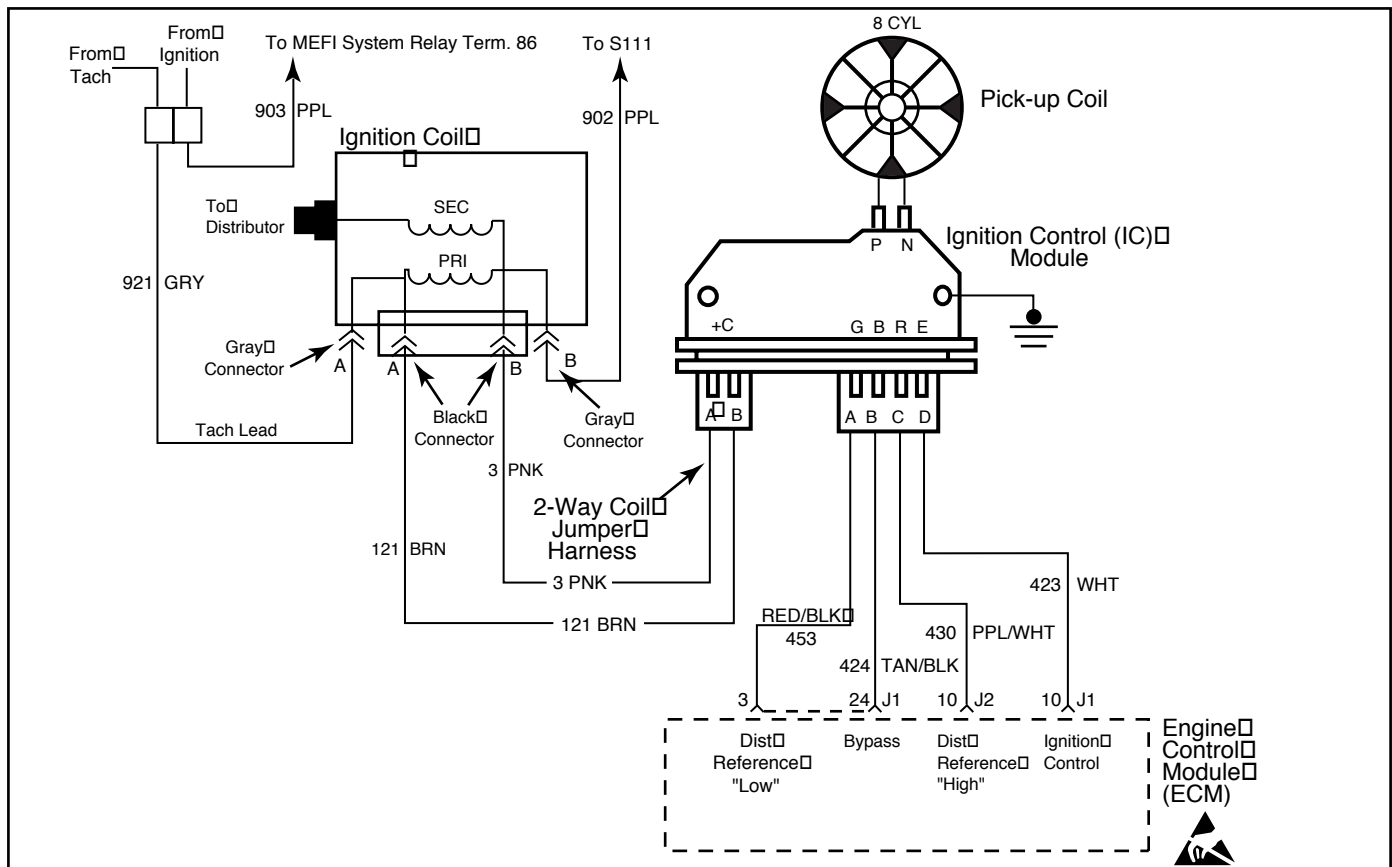
#### Test Description

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



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

Step	Action	Value	Yes	No
<b>1</b>	Was the iOn-Board Diagnostici (OBD) system check performed?	ó	Go to Step 2	Go to OBD System Check
<b>2</b>	1. Marine Diagnostic Trouble Code (MDTC) tool switched to inormal mode,î or iOFF.î 2. Ignition iOFF.î 3. Disconnect MAP sensor harness connector. 4. Connect a jumper wire from harness terminal iBî (CKT 432) to harness terminal iCî (CKT 416E). 5. Start engine and idle for 2 minutes or until MDTC tool indicates a stored DTC. 6. Ignition iON,î engine iOFF.î 7. Switch MDTC tool to iservice mode,î or iONî and note DTC. Is DTC 33 present?	ó	Go to Step 4	Go to Step 3
<b>3</b>	1. Remove jumper wire from CKT 416E and 432. 2. Connect DVOM from harness terminal iAî (CKT 814) to harness terminal iCî (CKT 416E). Is voltage reading above the specified value?	4 volts	Go to Step 5	Go to Step 6
<b>4</b>	Locate and repair intermittent faulty connections. If OK, replace faulty MAP sensor. Is action complete?	ó	Verify repair	ó
<b>5</b>	Locate and repair open or short to ground in CKT 432. If a problem is found, repair as necessary. Was a problem found?	ó	Verify repair	Go to Step 7
<b>6</b>	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?	ó	Verify repair	Go to Step 7
<b>7</b>	Repair faulty ECM connections or replace faulty ECM. Is action complete?	ó	Verify Repair	ó



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

MEFI 3012

#### 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 the IC line grounded during this mode. If not, 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:

- ï 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.
- ï Damaged harness. Inspect the wiring harness for damage.
- ï If the engine starts and stalls, it may set a false DTC 41. Clear DTCs and repair stalling condition.

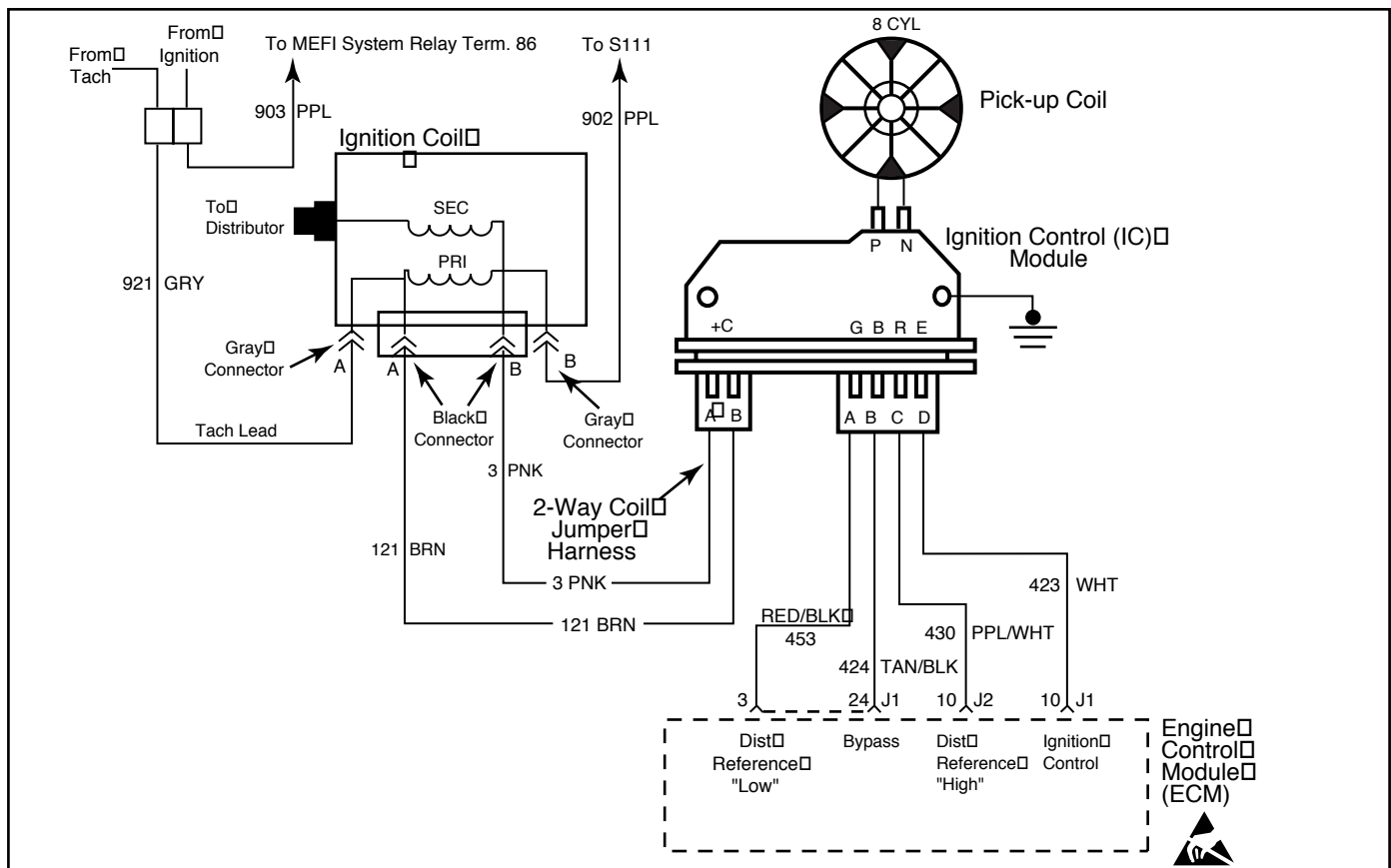
After repairs, clear DTCs following iClear DTCs Procedurei in the *General Information* section. Failure to do so may result in DTCs not properly being cleared.

#### 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	Yes	No
1	Was the On-Board Diagnostic (OBD) system check performed?	ó	Go to Step 2	Go to OBD System Check
2	<ol style="list-style-type: none"> <li>1. Install Marine Diagnostic Trouble Code (MDTC) tool.</li> <li>2. Clear DTC 41.     Refer to Clear DTC Procedure.</li> <li>3. Start engine and idle for 2 minutes or until MDTC tool indicates a stored trouble code.</li> <li>4. Ignition ON, engine OFF.</li> <li>5. Switch MDTC tool to service mode, or ON and note DTC.</li> </ol> Is DTC 41 present?	ó	Go to Step 3	Go to Step 8
3	<ol style="list-style-type: none"> <li>1. Ignition OFF.</li> <li>2. Disconnect ECM harness connectors.</li> <li>3. Using a DVOM selected for ohms, probe ECM harness terminal J1-10 to ground.</li> </ol> Is resistance within the specified value?	3000-6000 ohms	Go to Step 4	Go to Step 5
4	<ol style="list-style-type: none"> <li>1. Reconnect ECM.</li> <li>2. Start engine and idle for 2 minutes or until MDTC tool indicates a stored trouble code.</li> <li>3. Ignition ON, engine OFF.</li> <li>4. Switch MDTC tool to service mode or ON and note DTC.</li> </ol> Is DTC 41 present?	ó	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?	ó	Verify Repair	Go to Step 6
6	Replace faulty distributor ignition control module. Is action complete?	ó	Verify Repair	ó
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	ó	Verify Repair	ó
8	DTC 41 is intermittent. Refer to Diagnostic Aids on facing page. Check harness and connectors for an intermittent open in CKT 423.	ó	ó	ó



MEFI 3012

### 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 the IC line grounded during this mode. If not, 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:

- ï **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.
- ï **Damaged harness.** Inspect the wiring harness for damage.
- ï If the engine starts and stalls, it may set a false DTC 42. Clear DTC's and repair stalling condition.

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

**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:
  - ï Bypass CKT 424 open.
  - ï Bypass CKT 424 shorted to ground.
  - ï Faulty ignition module.
7. Confirms that DTC 42 is a faulty ECM and not an intermittent in CKT 423 or CKT 424.

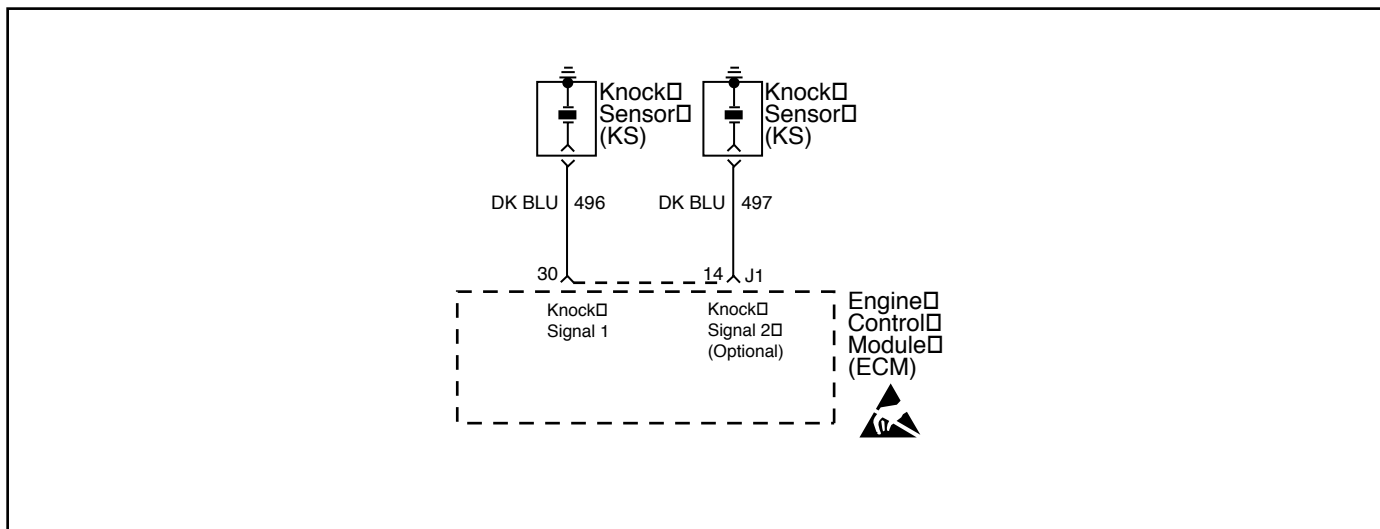
**DTC 42 - Ignition Control (IC) Circuit - Grounded IC Circuit, Open or Grounded Bypass (Non-Scan Diagnostics)**

Step	Action	Value	Yes	No
<b>1</b>	Was the iOn-Board Diagnosticî (OBD) system check performed?	ó	Go to Step 2	Go to OBD System Check
<b>2</b>	1. Install Marine Diagnostic Trouble Code (MDTC) tool. 2. Clear DTC 42. ï Refer to ìClear DTC Procedure.î 3. Start engine and idle for 2 minutes or until MDTC tool indicates a stored trouble code. 4. Ignition ìON,î engine ìOFF.î 5. Switch MDTC tool to ìservice mode,î or ìONî and note DTC. Is DTC 42 present?	ó	Go to Step 3	Go to Step 13
<b>3</b>	1. Ignition ìOFF.î 2. Disconnect ECM harness connectors. 3. Using a DVOM selected for ohms, probe ECM harness terminal ìJ1-10î to ground. Is resistance within the specified value?	3000-6000 ohms	Go to Step 4	Go to Step 8
<b>4</b>	1. Leave DVOM connected from ECM harness terminal ìJ1-10î to ground. 2. Using a test light connected to B+, probe ECM harness terminal ìJ1-24.î 3. As the test light contacts ìJ1-24,î 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
<b>5</b>	Using a test light connected to B+, probe ECM harness terminal ìJ1-24î (CKT 424). Does test light illuminate brightly?	ó	Go to Step 6	Go to Step 9
<b>6</b>	Disconnect ignition control module 4-wire connector. Does test light illuminate brightly?	ó	Go to Step 10	Go to Step 11

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

<b>Step</b>	<b>Action</b>	<b>Value</b>	<b>Yes</b>	<b>No</b>
<b>7</b>	1. Reconnect ECM. 2. Start engine and idle for 2 minutes or until MDTC tool indicates a stored trouble code. Is DTC 42 present?	ó	Go to Step 12	Go to Step 13
<b>8</b>	Locate and repair short to ground in CKT 423. If a problem is found, repair as necessary. Was a problem found?	ó	Verify Repair	Go to Step 11
<b>9</b>	Locate and repair open in CKT 424. If a problem is found, repair as necessary. Was a problem found?	ó	Verify Repair	Go to Step 11
<b>10</b>	Locate and repair short to ground in CKT 424. Is action complete?	ó	Verify Repair	ó
<b>11</b>	Replace faulty ignition control module. Is action complete?	ó	Verify Repair	ó
<b>12</b>	Repair faulty ECM connections or replace faulty ECM. Is action complete?	ó	Verify Repair	ó
<b>13</b>	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.	ó	ó	ó

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

MEFI 3018

#### Circuit Description

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

#### Diagnostic Aids

Check for the following conditions:

- ï 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.
- ï Damaged harness. Inspect the wiring harness for damage.
- ï Loose Knock Sensor(s) in engine block.
- ï Poor connection at the Knock Sensor(s).

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

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

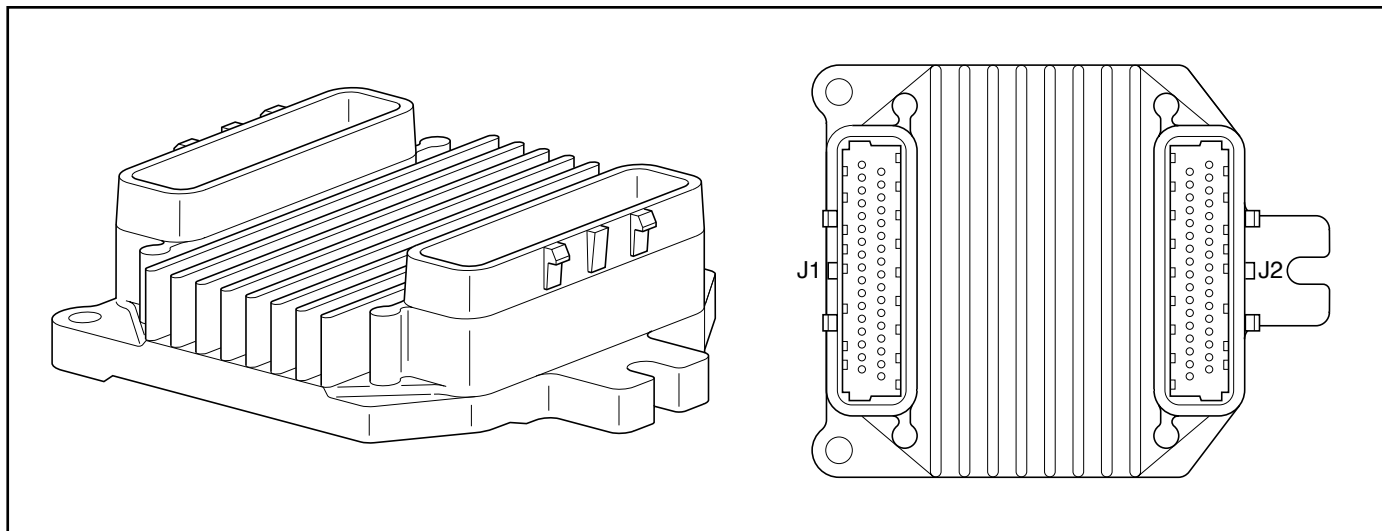
#### Test Description

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



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

Step	Action	Value	Yes	No
1	Was the On-Board Diagnostic (OBD) system check performed?	ó	Go to Step 2	Go to OBD System Check
2	<b>Important:</b> If you can hear the engine knock, repair the engine mechanical problem before proceeding with this diagnostic table. Check the KS signal circuit(s) for incorrect routing near the secondary wires. If a problem is found, repair as necessary. Was a problem found?	ó	Verify Repair	Go to Step 3
3	Check the KS signal circuit(s) for any terminals not being fully seated or for incorrect installation. If a problem is found, repair as necessary. Was a problem found?	ó	Verify Repair	Go to Step 4
4	Checks knock sensor(s) for being loose in the engine block. If a problem is found, repair as necessary. Was a problem found?	ó	Verify Repair	Go to Step 5
5	1. Ignition OFF. 2. Disconnect J1 harness connector. 3. Connect DVOM from J1-30 (CKT 496 - Knock Signal 1) to a known good ground near knock sensor. 4. Repeat step 3 if two knock sensors are being used. This time, connect DVOM from J1-14 (CKT 497 - Knock Signal 2) to a known good ground near knock sensor. Is resistance between the specified value for each circuit?	85,000 - 100,000 ohms	Go to Step 8	Go to Step 6
6	Locate and repair open or short to ground in the circuit(s) that were out of range. If a problem is found, repair as necessary. Was a problem found?	ó	Verify Repair	Go to Step 7
7	Inspect knock sensor terminal contacts. If OK, replace faulty knock sensor(s). Is action complete?	ó	Verify Repair	ó
8	Replace faulty ECM connections or replace faulty ECM. Is action complete?	ó	Verify Repair	ó



MEFI3004

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

**Circuit Description**

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

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

**Diagnostic Aids**

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

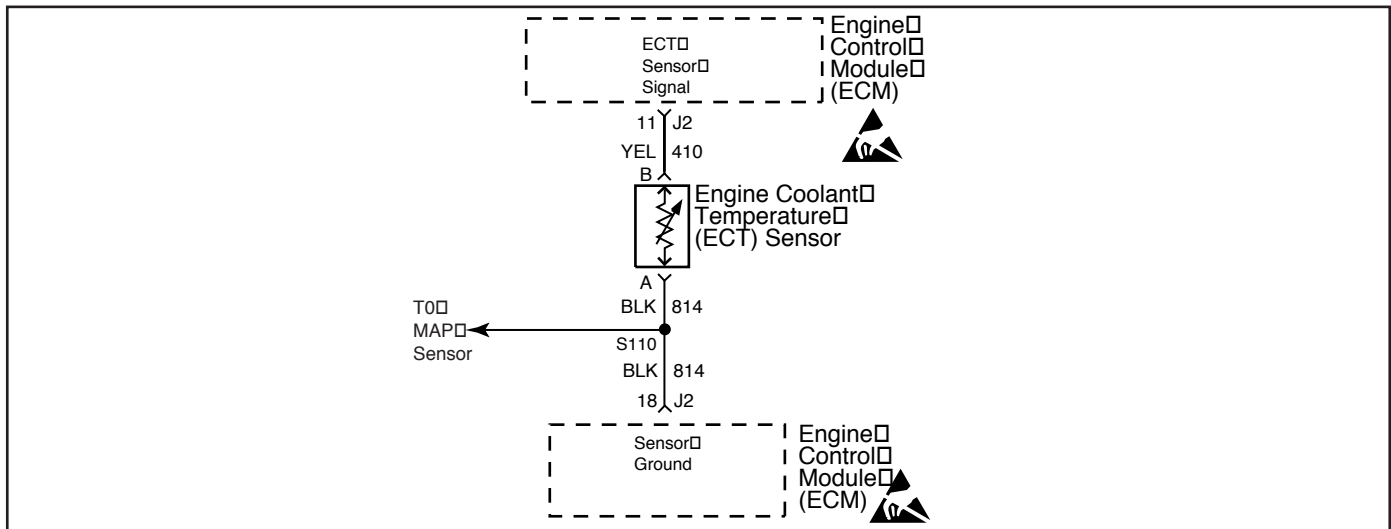
**Test Description**

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

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

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	ó	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," or "ON." Does DTC 51 reset?	ó	Go to Step 3	Refer to Diagnostic Aids
3	Replace or reprogram faulty ECM and verify DTC does not reset. Is action complete?	ó	Verify Repair	ó

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

MEFI 3014

#### Circuit Description

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

#### Diagnostic Aids

Check for the following conditions:

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

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

#### Test Description

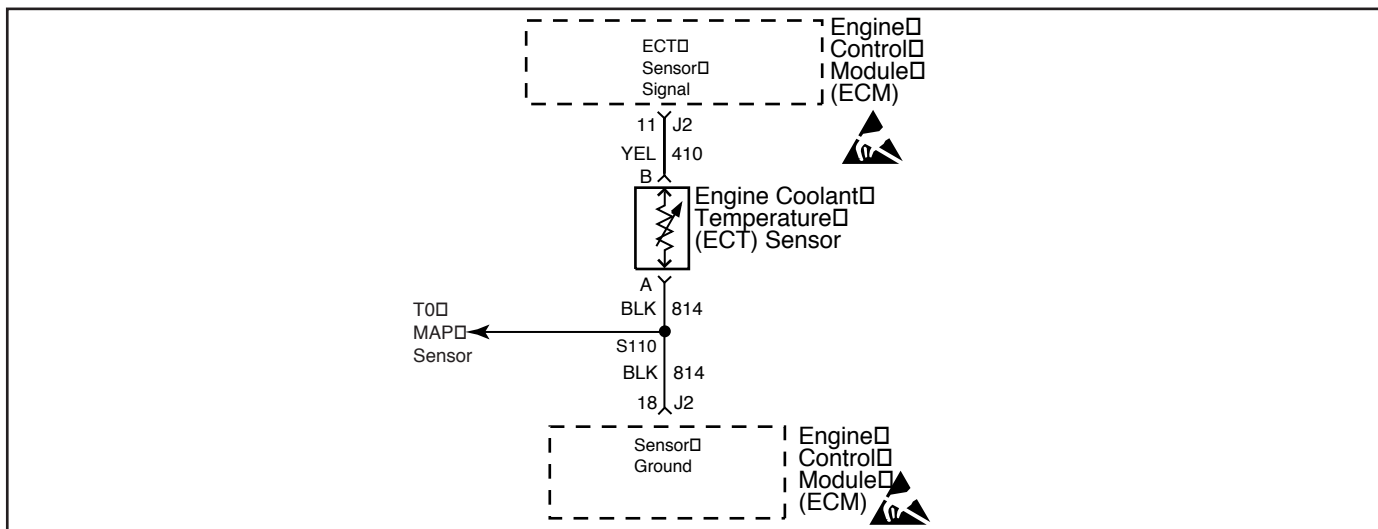
2. DTC 14 will set if signal voltage indicates a coolant temperature below -30°C (-22°F).
3. This test simulates a DTC 15. If the ECM recognizes the low voltage signal and displays a high temperature, the ECM and wiring are OK.

#### Engine Coolant Temperature Sensor Table

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

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

Step	Action	Value	Yes	No
1	Was the On-Board Diagnostic (OBD) system check performed?	ó	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.	ó	Verify Repair	ó
5	Locate and repair open in CKT 410 or CKT 814. If a problem is found, repair as necessary. Was a problem found?	ó	Verify Repair	Go to Step 7
6	Repair faulty ECT sensor. Is action complete?	ó	Verify Repair	ó
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	ó	Verify Repair	ó



MEFI 3014

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

#### Circuit Description

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

#### Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the ECT display on the scan tool while moving connectors and wiring harnesses related to the ECT sensor. A change in the ECT display will indicate the location of the fault.
- The scan tool displays engine coolant temperature in degrees celsius and fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display a ECT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a shifted coolant sensor. After engine is started, the temperature should rise steadily and then stabilize at operating temperature when the thermostat opens.
- Check harness routing for a potential short to ground in CKT 410.

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

#### 1999 Marine

#### Test Description

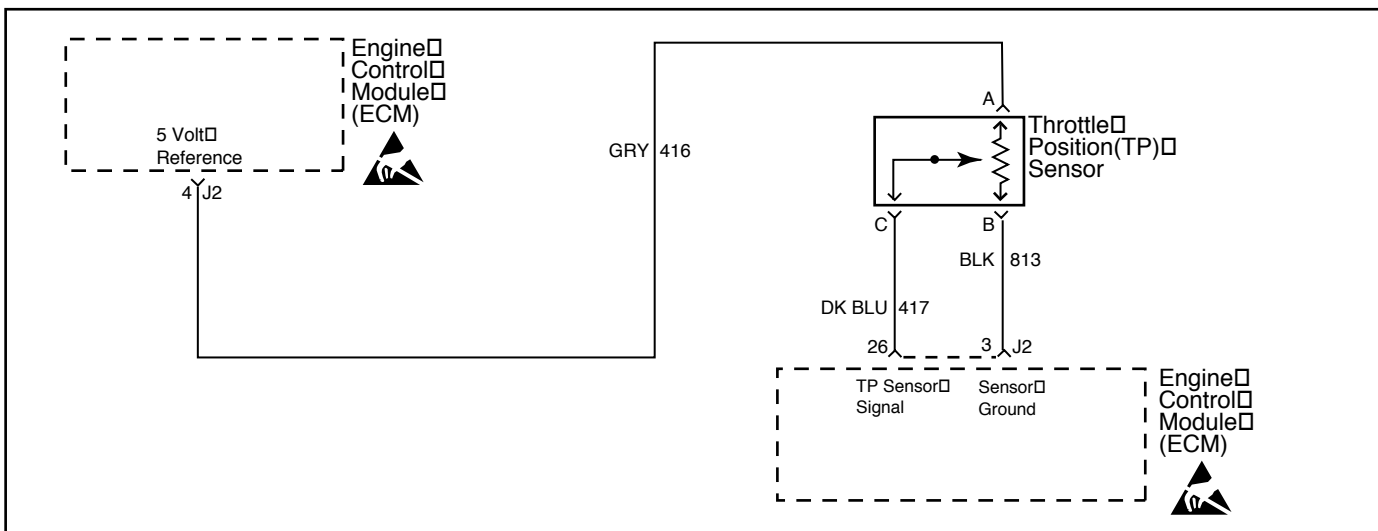
2. DTC 15 will set if signal voltage indicates a coolant temperature above 130°C or 266°F.
3. This test simulates a DTC 14. If the ECM recognizes the high voltage signal and displays a low temperature, the ECM and wiring are OK.

#### Engine Coolant Temperature Sensor Table

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

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

Step	Action	Value	Yes	No
1	Was the On-Board Diagnostic (OBD) system check performed?	ó	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.	ó	Verify Repair	ó
5	Locate and repair short to ground in CKT 410. If a problem is found, repair as necessary. Was a problem found?	ó	Verify Repair	Go to Step 7
6	Repair faulty ECT sensor. Is action complete?	ó	Verify Repair	ó
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	ó	Verify Repair	ó



MEFI 3015A

### 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:

- ï 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.
- ï 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.
- ï The scan tool reads throttle position in voltage and percentage relative to the throttle blade opening. With ignition ìON,î engine ìOFF,î 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).
- ï If a TP sensor circuit failure is present, the MAP sensor default value will be used along with the TP sensor default value.

After repairs, clear DTCís following ìClear DTCís Procedureî in the *General Information* section. Failure to do so may result in DTCís not properly being cleared.

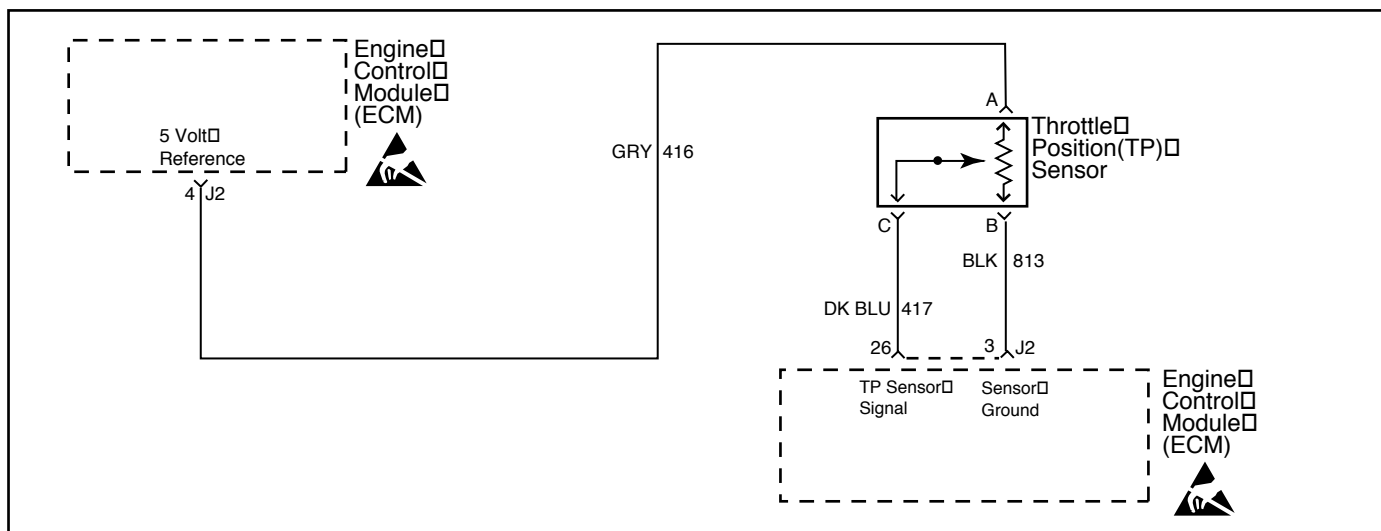
#### Test Description

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



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

Step	Action	Value	Yes	No
1	Was the On-Board Diagnostic (OBD) system check performed?	ó	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 DVOM indicate a voltage less than the specified value?	.36 volt	Go to Step 4	Go to Step 6
4	Connect DVOM from harness terminal A (CKT 416) to harness terminal B (CKT 813). Does DVOM indicate a voltage greater than the specified value?	4 volts	Go to Step 8	Go to Step 7
5	DTC 21 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	ó	ó	ó
6	Locate and repair short to voltage in CKT 417. If a problem is found, repair as necessary. Was a problem found?	ó	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?	ó	Verify Repair	Go to Step 9
8	Replace faulty TP sensor. Is action complete?	ó	Verify Repair	ó
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	ó	Verify Repair	ó



MEFI 3015A

### 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:

- ï 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.
- ï 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.

- ï 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).
- ï If DTC 34 is also set, check for a short to ground in CKT 416 or CKT 416E.
- ï If a TP sensor circuit failure is present, the MAP sensor default value will be used along with the TP sensor default value.

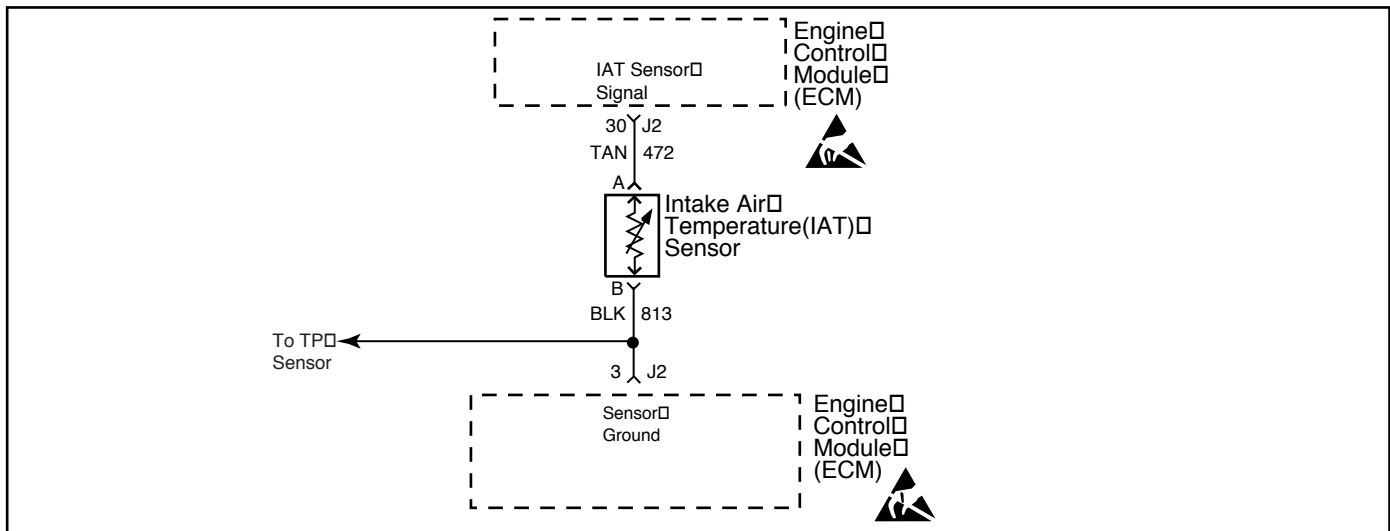
After repairs, clear DTCs following 'Clear DTCs Procedure' in the *General Information* section. Failure to do so may result in DTCs not properly being cleared.

#### Test Description

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

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

Step	Action	Value	Yes	No
1	Was the On-Board Diagnostic (OBD) system check performed?	ó	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 DVOM indicate a voltage greater than the specified value?	4 volts	Go to Step 7	Go to Step 6
5	DTC 22 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	ó	ó	ó
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?	ó	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?	ó	Verify repair	Go to Step 9
8	Replace faulty TP sensor. Is action complete?	ó	Verify repair	ó
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	ó	Verify repair	ó



MEFI 3016

**DTC 23 - Intake Air Temperature (IAT) Sensor Circuit - Low Temp Indicated (Scan Diagnostics) - 7.4/8.2L MFI ENGINES ONLY**

**Circuit Description**

The Intake Air Temperature (IAT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts on CKT 472 to the sensor. When the air is cold, the sensor (thermistor) resistance is high. As the intake air warms up, the sensor resistance becomes less. See engine intake air temperature sensor table under *Diagnostic Aids*. At normal operating temperature (85°C - 95°C or 185°F - 203°F), the voltage will measure about 1.5-2.0 volts.

**Diagnostic Aids**

Check for the following conditions:

- ï **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.
- ï **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the IAT display on the scan tool while moving connectors and wiring harnesses related to the IAT sensor. A change in the IAT display will indicate the location of the fault.
- ï The scan tool displays intake air temperature in degrees celsius and fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display an IAT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a *shifted* IAT sensor. After engine is started, the temperature should rise steadily and then stabilize at operating temperature.

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

**Test Description**

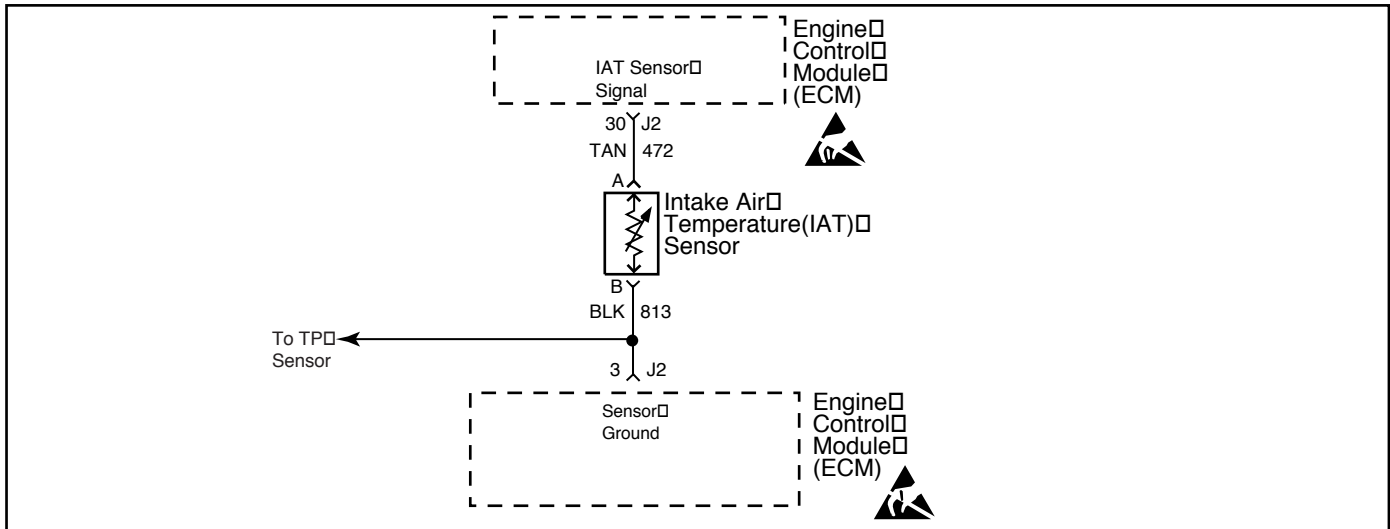
2. DTC 23 will set if signal voltage indicates an intake air temperature below -30°C (-22°F).
3. This test simulates a DTC 25. If the ECM recognizes the low voltage signal and displays a high temperature, the ECM and wiring are OK.

**Intake Air Temperature Sensor Table**

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

**DTC 23 - Intake Air Temperature (IAT) Sensor Circuit - Low Temp Indicated (Scan Diagnostics) - 7.4/8.2L MFI ENGINES ONLY**

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	ó	Go to Step 2	Go to OBD System Check
2	Ignition "ON." Does scan tool display an intake air temperature less than the specified value?	-30°C (-22°F)	Go to Step 3	Go to Step 4
3	1. Ignition "OFF." 2. Disconnect IAT harness connector. 3. Connect a jumper wire from harness terminal "A" (CKT 472) to harness terminal "B" (CKT 813). 4. Ignition "ON," engine "OFF." Does scan tool display an intake air temperature above the specified value?	130°C (266°F)	Go to Step 6	Go to Step 5
4	DTC 23 is intermittent. Locate and repair intermittent faulty connections. Refer to "Diagnostic Aids"	ó	Verify Repair	ó
5	Locate and repair open in CKT 472 or CKT 813. If a problem is found, repair as necessary. Was a problem found?	ó	Verify Repair	Go to Step 7
6	Repair faulty IAT sensor. Is action complete?	ó	Verify Repair	ó
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	ó	Verify Repair	ó



MEFI 3016

### DTC 25 - Intake Air Temperature (IAT) Sensor Circuit - High Temp Indicated (Scan Diagnostics) - 7.4/8.2L MFI ENGINES ONLY

#### Circuit Description

The Intake Air Temperature (IAT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts on CKT 472 to the sensor. When the air is cold, the sensor (thermistor) resistance is high. As the intake air warms up, the sensor resistance becomes less. See engine intake air temperature sensor table under Diagnostic Aids. At normal operating temperature (85°C - 95°C or 185°F - 203°F), the voltage will measure about 1.5-2.0 volts.

#### Diagnostic Aids

Check for the following conditions:

- i 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.
- i Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the IAT display on the scan tool while moving connectors and wiring harnesses related to the IAT sensor. A change in the IAT display will indicate the location of the fault.
- i The scan tool displays intake air temperature in degrees celsius and fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display an IAT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a shifted IAT sensor. After engine is started, the temperature should rise steadily and then stabilize at operating temperature.

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

#### Test Description

2. DTC 25 will set if signal voltage indicates an intake air

temperature above 130°C or 266°F.

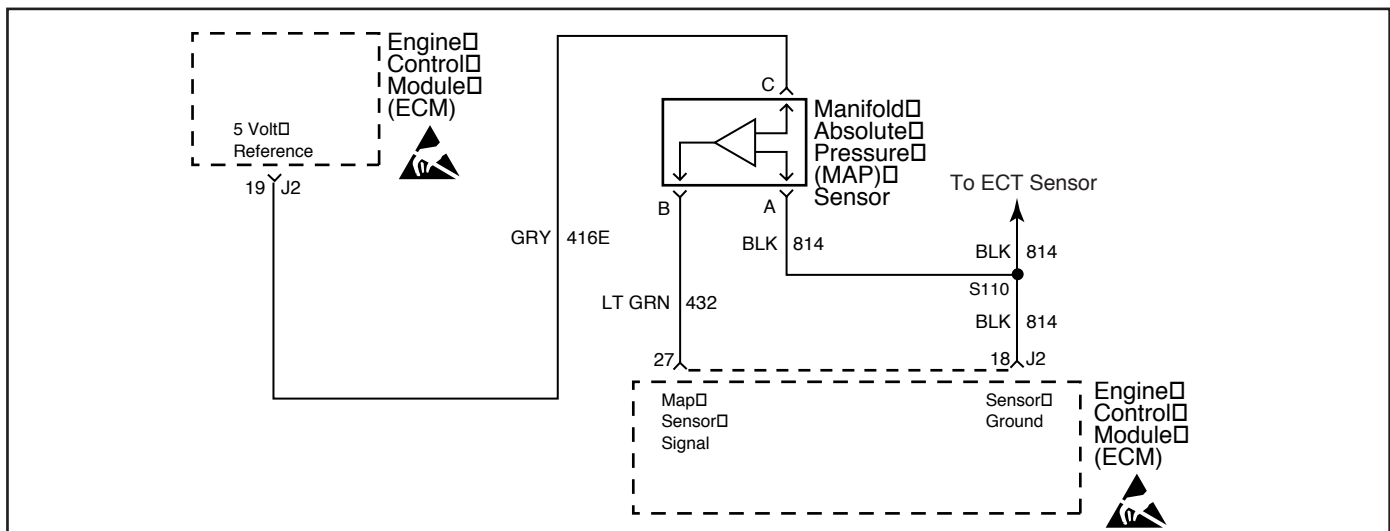
3. This test simulates a DTC 23. If the ECM recognizes the high voltage signal and displays a low temperature, the ECM and wiring are OK.

#### Intake Air Temperature Sensor Table

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

**DTC 25 - Intake Air Temperature (IAT) Sensor Circuit - High Temp Indicated (Scan Diagnostics) - 7.4/8.2L MFI ENGINES ONLY**

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



MEFI 3017

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

#### Circuit Description

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1.0-1.5 volts at idle to about 4.0-4.5 volts at Wide Open Throttle (WOT).

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

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

#### Diagnostic Aids

Check for the following conditions:

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

- If the idle is rough or unstable, refer to *Symptoms* 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.
- If a MAP sensor circuit failure is present, the TP sensor default value will be used along with the MAP sensor default value.

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

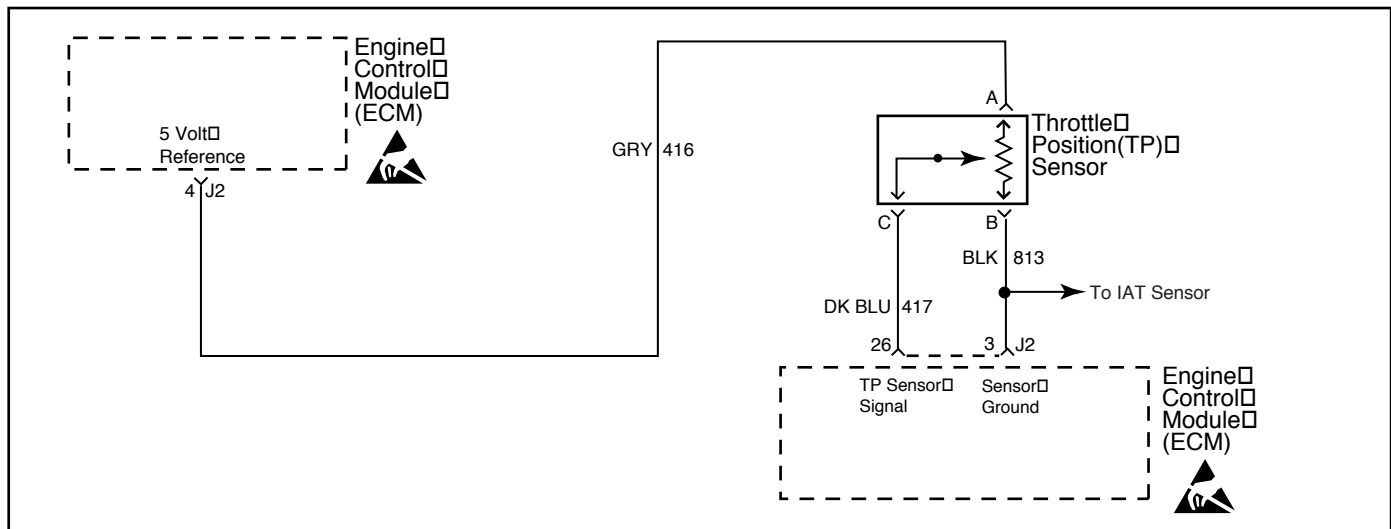
#### Test Description

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



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

Step	Action	Value	Yes	No
1	Was the iOn-Board Diagnostici (OBD) system check performed?	ó	Go to Step 2	Go to OBD System Check
2	1. Ignition iOFF.i 2. Install a vacuum gauge to a manifold vacuum source. 3. Start engine and raise to about 1000 RPM in neutral. 4. The vacuum reading should be steady. Is the vacuum gauge reading steady and above the specified value?	14i 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 iOFF.i 2. Disconnect MAP sensor harness connector. 3. Ignition iON,i engine iOFF.i 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 iOFF.i 2. Connect DVOM from harness terminal iAi (CKT 814) to harness terminal iCi (CKT 416E). 3. Ignition iON,i engine iOFF.i Does DVOM indicate a voltage greater than the specified value?	4 volts	Go to Step 10	Go to Step 9
6	Repair low or unsteady vacuum problem. Is action complete?	ó	Verify Repair	ó
7	DTC 33 is intermittent. Locate and repair intermittent faulty connections. i Refer to iDiagnostic Aids.i	ó	ó	ó
8	Locate and repair short to voltage in CKT 432. If a problem is found, repair as necessary. Was a problem found?	ó	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?	ó	Verify Repair	Go to Step 11
10	Check for plugged or leaking sensor vacuum fitting. If OK, replace faulty MAP sensor. Is action complete?	ó	Verify Repair	ó
11	Repair faulty ECM connections or replace faulty ECM. Is action complete?	ó	Verify Repair	ó



MEFI 3015

### 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:

- ï 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.
- ï 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.

- ï If the idle is rough or unstable, refer to *Symptoms* section for items which may cause an unstable idle.
- ï With the ignition ìON,î engine ìOFF,î 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 ìsuspectî sensor. Reading should be the same, plus or minus 0.4 volt.
- ï If a MAP sensor circuit failure is present, the TP sensor default value will be used along with the MAP sensor default value.

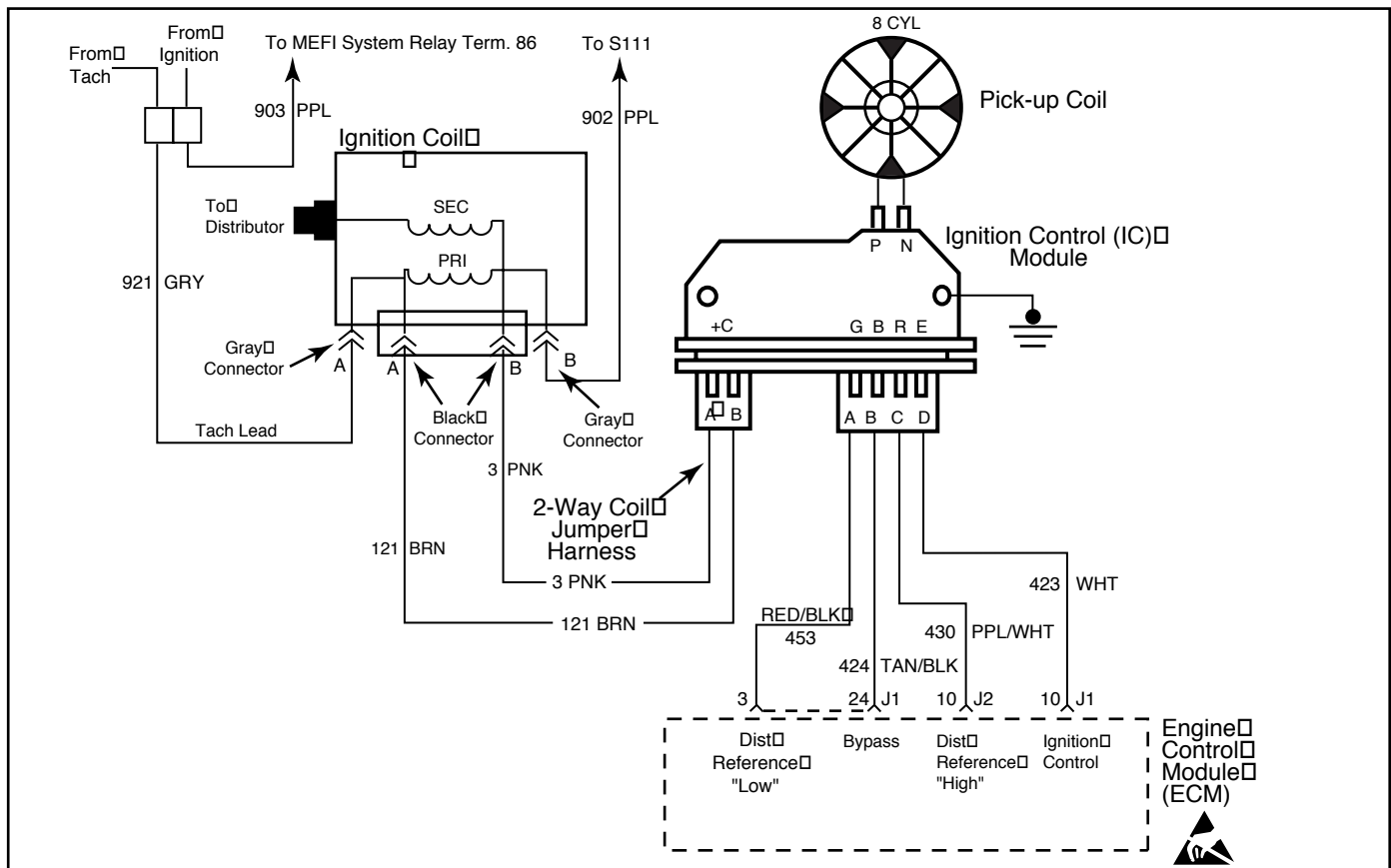
After repairs, clear DTCís following ìClear DTCís Procedureî in the *General Information* section. Failure to do so may result in DTCís not properly being cleared.

#### Test Description

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

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

Step	Action	Value	Yes	No
1	Was the iOn-Board Diagnostici (OBD) system check performed?	ó	Go to Step 2	Go to OBD System Check
2	1. Ignition iOFF.i 2. Install a vacuum gauge to a manifold vacuum source. 3. Start engine and raise to about 1000 RPM in neutral. 4. The vacuum reading should be steady. Is the vacuum gauge reading steady and above the specified value?	14i 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 iOFF.i 2. Disconnect MAP sensor harness connector. 3. Connect a jumper wire from harness terminal iBi (CKT 432) to harness terminal iCi (CKT 416E). 4. Ignition iON,i engine iOFF.i 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 iOFF.i 2. Connect DVOM from harness terminal iCi (CKT 416E) to a known good ground. 3. Ignition iON,i engine iOFF.i Does DVOM indicate a voltage greater than the specified value?	4 volts	Go to Step 9	Go to Step 8
6	Repair low or unsteady vacuum problem. Is action complete?	ó	Verify Repair	ó
7	DTC 34 is intermittent. Locate and repair intermittent faulty connections. i Refer to iDiagnostic Aids.i	ó	ó	ó
8	Locate and repair open or short to ground in CKT 416E. If a problem is found, repair as necessary. Was a problem found?	ó	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?	ó	Verify Repair	Go to Step 11
10	Check for plugged or leaking sensor vacuum fitting. If OK, replace faulty MAP sensor. Is action complete?	ó	Verify Repair	ó
11	Repair faulty ECM connections or replace faulty ECM. Is action complete?	ó	Verify Repair	ó



MEFI 3012

### 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 the IC line grounded during this mode. If not, 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:

- ï 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.
- ï Damaged harness. Inspect the wiring harness for damage.
- ï If the engine starts and stalls, it may set a false DTC 41 or 42. Clear DTCs and repair stalling condition.

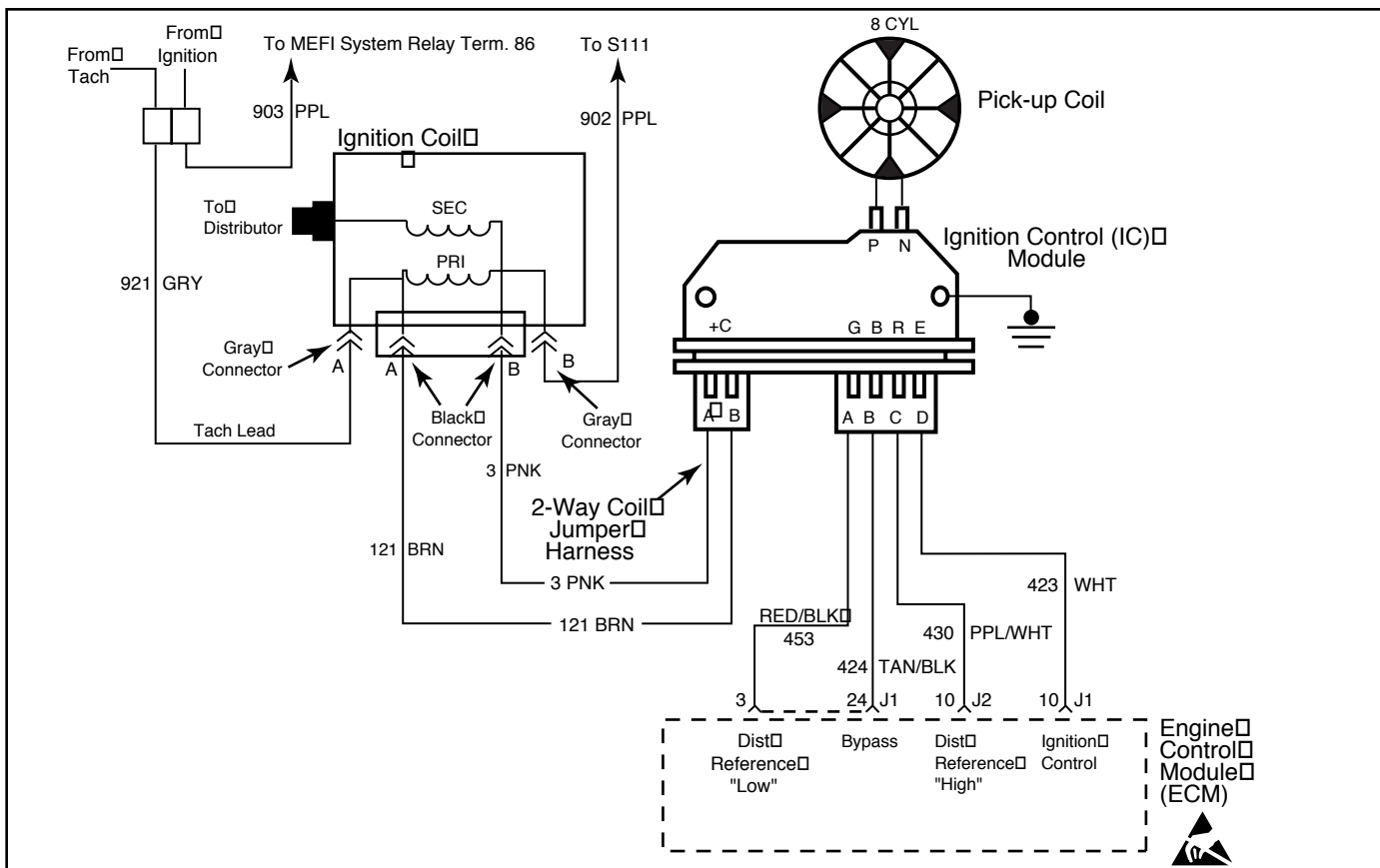
After repairs, clear DTCs following iClear DTCs Procedure in the *General Information* section. Failure to do so may result in DTCs not properly being cleared.

#### 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	Yes	No
1	Was the On-Board Diagnostic (OBD) system check performed?	ó	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?	ó	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 J1-10 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?	ó	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?	ó	Verify Repair	Go to Step 6
6	Replace faulty distributor ignition control module. Is action complete?	ó	Verify Repair	ó
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	ó	Verify Repair	ó
8	DTC 41 is intermittent. Refer to Diagnostic Aids on facing page. Check harness and connectors for an intermittent open in CKT 423.	ó	ó	ó



MEFI 3012

### 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 the IC line grounded during this mode. If not, 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:

- ï 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.
- ï Damaged harness. Inspect the wiring harness for damage.
- ï If the engine starts and stalls, it may set a false DTC 41 or 42. Clear DTCs and repair stalling condition.

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

**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:
  - ï Bypass CKT 424 open.
  - ï Bypass CKT 424 shorted to ground.
  - ï Faulty ignition control 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)**

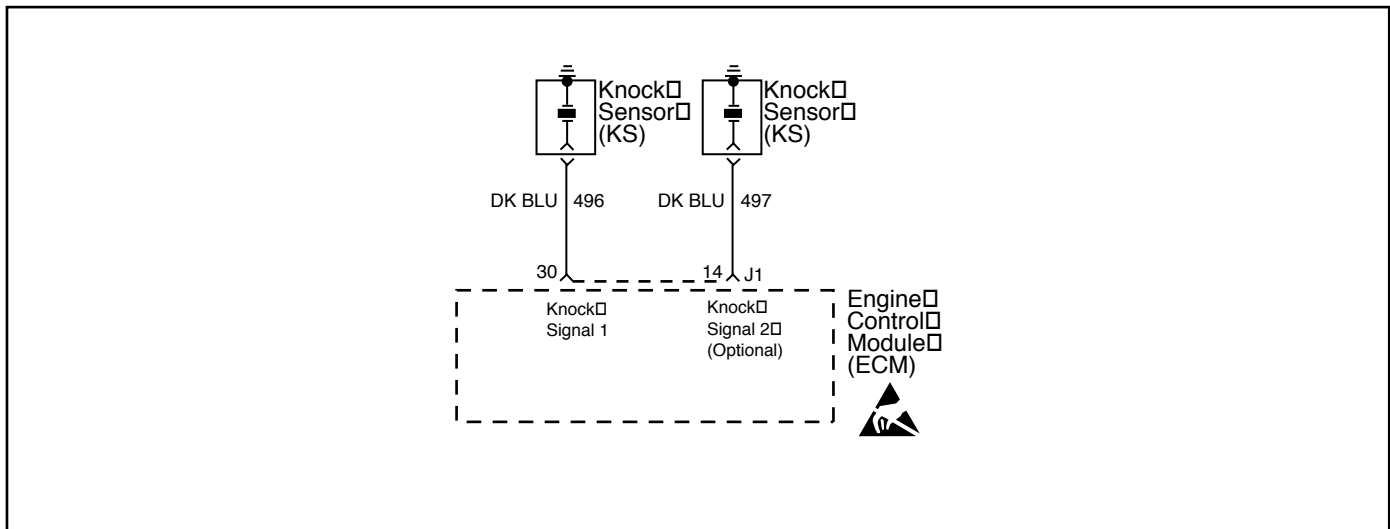
Step	Action	Value	Yes	No
<b>1</b>	Was the "On-Board Diagnostic" (OBD) system check performed?	ó	Go to Step 2	Go to OBD System Check
<b>2</b>	1. Clear DTC 42. Refer to "Clear DTC Procedure." 2. Start engine and idle for 2 minutes or until DTC 42 sets. Is DTC 42 present?	ó	Go to Step 3	Go to Step 13
<b>3</b>	1. Ignition "OFF." 2. Disconnect ECM harness connectors. 3. Using a DVOM selected for ohms, probe ECM harness terminal "J1-10" to ground. Is resistance within the specified value?	3000-6000 ohms	Go to Step 4	Go to Step 8
<b>4</b>	1. Leave DVOM connected from ECM harness terminal "J1-10" to ground. 2. Using a test light connected to B+, probe ECM harness terminal "J1-24." 3. As the test light contacts "J1-24," 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
<b>5</b>	Using a test light connected to B+, probe ECM harness terminal "J1-24" (CKT 424). Does test light illuminate brightly?	ó	Go to Step 6	Go to Step 9
<b>6</b>	Disconnect ignition control module 4-wire connector. Does test light illuminate brightly?	ó	Go to Step 10	Go to Step 11
<b>7</b>	1. Reconnect ECM. 2. Start engine and idle for 2 minutes or until DTC 42 sets. Is DTC 42 present?	ó	Go to Step 12	Go to Step 13
<b>8</b>	Locate and repair short to ground in CKT 423. If a problem is found, repair as necessary. Was a problem found?	ó	Verify Repair	Go to Step 11

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

<b>Step</b>	<b>Action</b>	<b>Value</b>	<b>Yes</b>	<b>No</b>
<b>9</b>	Locate and repair open in CKT 424. If a problem is found, repair as necessary. Was a problem found?	ó	Verify Repair	Go to Step 11
<b>10</b>	Locate and repair short to ground in CKT 424. Is action complete?	ó	Verify Repair	ó
<b>11</b>	Replace faulty ignition control module. Is action complete?	ó	Verify Repair	ó
<b>12</b>	Repair faulty ECM connections or replace faulty ECM. Is action complete?	ó	Verify Repair	ó
<b>13</b>	DTC 42 is intermittent. Refer to ìDiagnostic Aidsî 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.	ó	ó	ó



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

#### Circuit Description

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

#### Diagnostic Aids

Check for the following conditions:

- ï 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.
- ï Damaged harness. Inspect the wiring harness for damage.
- ï Loose Knock Sensor(s) in engine block.
- ï Poor connection at the Knock Sensor(s).

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

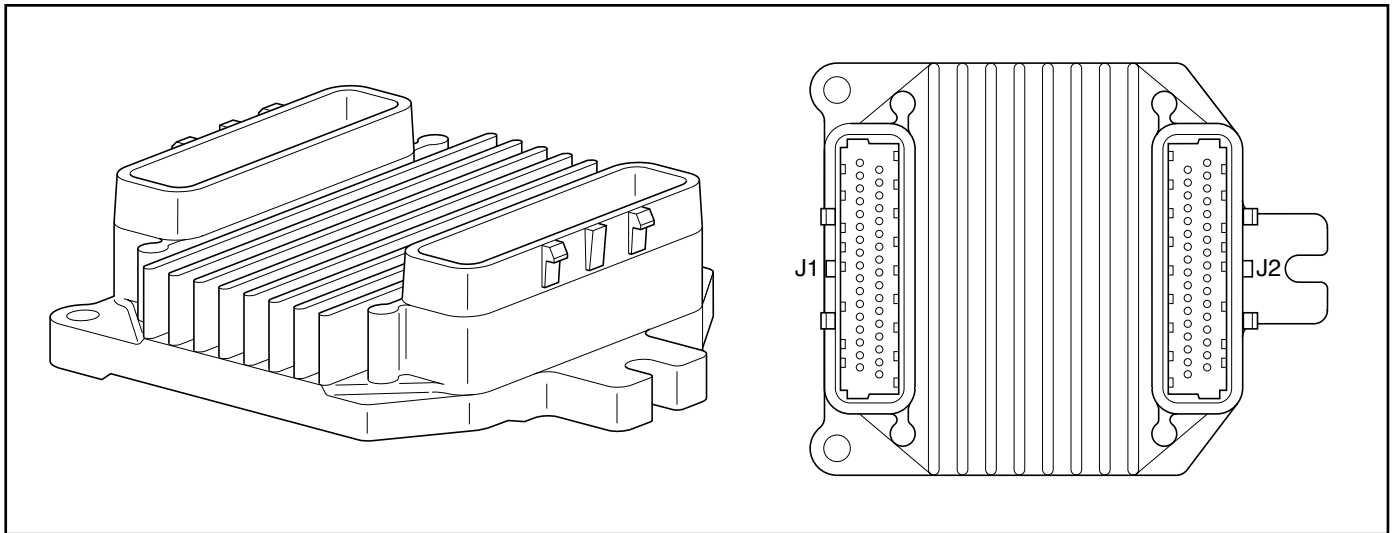
If CKT 496 or CKT 497 are routed too close to secondary ignition wires, the ECM may see the interference as a knock signal, resulting in false timing retard.

#### Test Description

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

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

Step	Action	Value	Yes	No
1	Was the On-Board Diagnostic (OBD) system check performed?	ó	Go to Step 2	Go to OBD System Check
2	<b>Important:</b> If you can hear the engine knock, repair the engine mechanical problem before proceeding with this diagnostic table. Check the KS signal circuit(s) for incorrect routing near the secondary wires. If a problem is found, repair as necessary. Was a problem found?	ó	Verify Repair	Go to Step 3
3	Check the KS signal circuit for any terminals not being fully seated or for incorrect installation. If a problem is found, repair as necessary. Was a problem found?	ó	Verify Repair	Go to Step 4
4	Check knock sensor(s) for being loose in the engine block. If a problem is found, repair as necessary. Was a problem found?	ó	Verify Repair	Go to Step 5
5	1. Install scan tool. 2. Select the option to view the data list. 3. Select to view the knock signal 1 and knock sensor 2 (if applicable) parameter(s) and see which circuit(s) indicate a fault present. 4. Disconnect J1 harness connector. 5. If knock sensor 1 is indicating a fault, connect DVOM from J1-30 (CKT 496 - Knock Signal 1) to a known good ground near knock sensor. 6. If knock sensor 2 is indicating a fault, connect DVOM from J1-14 (CKT 497 - Knock Signal 2) to a known good ground near knock sensor. Is resistance between the specified value for the circuit(s) indicating a fault?	85,000 - 100,000 ohms	Go to Step 8	Go to Step 6
6	Locate and repair open or short to ground in the circuit(s) that were out of range. If a problem is found, repair as necessary. Was a problem found?	ó	Verify Repair	Go to Step 7
7	Inspect knock sensor terminal contacts. If OK, replace faulty knock sensor(s). Is action complete?	ó	Verify Repair	ó
8	Replace faulty ECM connections or replace faulty ECM. Is action complete?	ó	Verify Repair	ó



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

**Circuit Description**

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

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

**Diagnostic Aids**

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

**Test Description**

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

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

Step	Action	Value	Yes	No
1	Was the 'On-Board Diagnostic' (OBD) system check performed?	0	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,' or 'ON.' Does DTC 51 reset?	0	Go to Step 3	Refer to Diagnostic Aids
3	Replace or reprogram faulty ECM and verify DTC does not reset. Is action complete?	0	Verify Repair	0

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# Marine Electronic Fuel Injection (MEFI)

## Section 6

### Positive Crankcase Ventilation (PCV) System

#### Contents

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Functional Check of Positive Crankcase Ventilation (PCV) Valve .....	Page 2		

### General Description

A closed crankcase ventilation system is used to provide a more complete scavenging of crankcase vapors. Fresh air from the air cleaner is supplied to the crankcase, mixed with blow-by gases, and then passed through a Positive Crankcase Ventilation (PCV) valve into the intake manifold (Figure 6-1).

#### Operation

The primary control is through the PCV valve (Figure 6-2) which meters the flow at a rate depending on manifold vacuum.

To maintain idle quality, the PCV valve restricts the flow when intake manifold vacuum is high. If abnormal operating conditions arise, the system is designed to allow excessive amounts of blow-by gases to back flow through the crankcase vent tube into the engine air inlet to be consumed by normal combustion.

#### Results of Incorrect Operation

A plugged valve or hose may cause:

- ▣ Rough idle.
- ▣ Stalling or slow idle speed.
- ▣ Oil leaks.
- ▣ Sludge in the engine.

A leaking valve or hose may cause:

- ▣ Rough idle.
- ▣ Stalling.
- ▣ High idle speed.

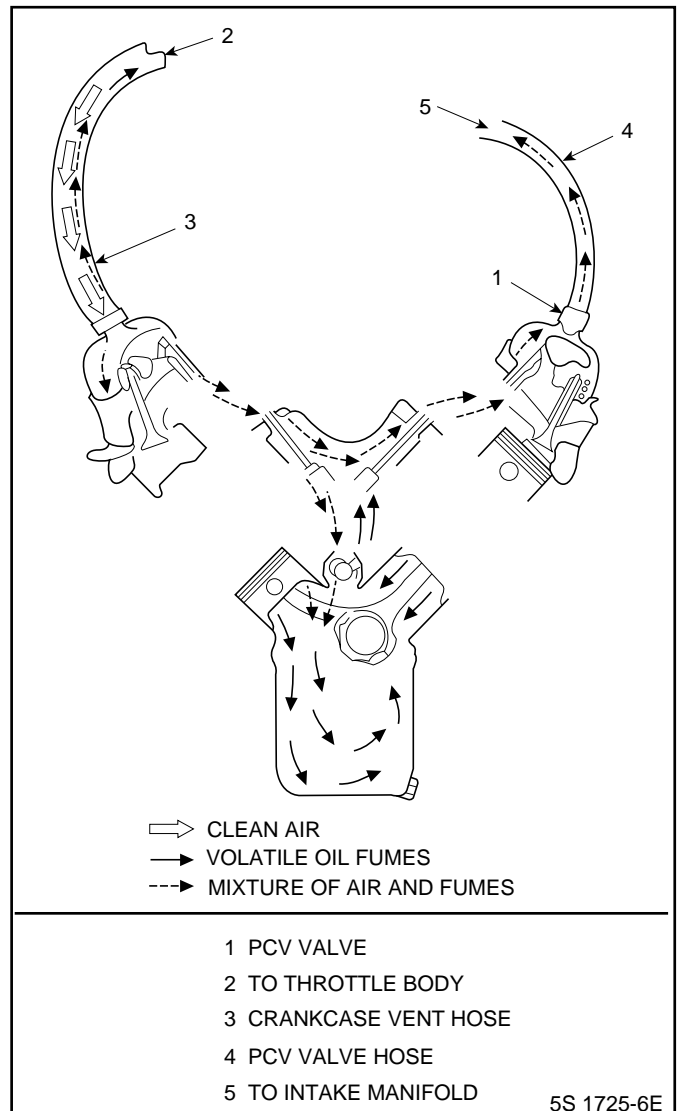


Figure 6-1 - Positive Crankcase Ventilation (PCV) Valve Flow (Typical)

## Diagnosis

### Functional Check of Positive Crankcase Ventilation (PCV) Valve

If an engine is idling rough, check for a plugged PCV valve or hose. Perform the following functional check of the PCV valve:

1. Remove PCV valve from the intake manifold.
2. Run the engine at idle.
3. Place your thumb over the end of the PCV valve to check for vacuum. If there is no vacuum present at the valve, check for plugged PCV valve, hoses, or manifold vacuum port. Replace plugged or deteriorated hoses.
4. Turn engine iOFFi and remove the PCV valve. Shake the valve and listen for the rattle of the check needle inside the valve. If the valve does not rattle, replace the PCV valve.

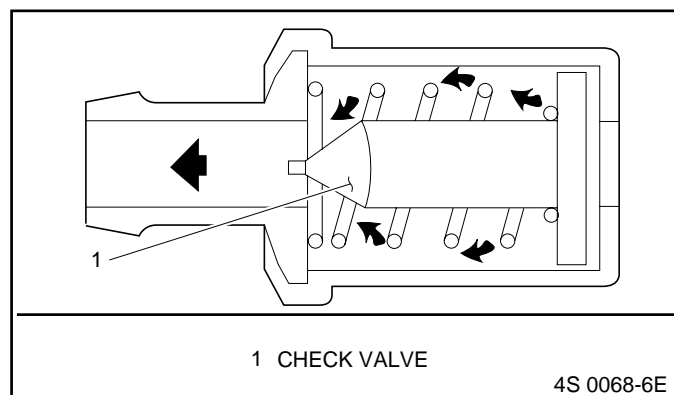


Figure 6-2 - PCV Valve Cross-Section

With this system, any blow-by in excess of the system capacity (from a badly-worn engine, sustained heavy load, etc.) is exhausted into the intake manifold and is drawn into the engine. Proper operation of the PCV system is dependent upon a sealed engine. If oil sludging or dilution is noted, and the PCV system is functioning properly, check engine for possible cause and correct to ensure that the system will function as intended.

### Functional Check of Positive Crankcase Ventilation (PCV) System

1. Check PCV valve for correct application.
2. Engine at normal operating temperature.
3. Block off PCV system fresh air inlet passage.
4. Remove the engine oil dipstick and install a vacuum gauge on the dipstick tube.
5. Run the engine at 1500 RPM for 30 seconds and then read vacuum gauge while at 1500 RPM.

If vacuum is present, the PCV system is functioning properly. No vacuum indicated, the engine may not be sealed and/or is drawing in outside air. Check valve cover gasket, oil pan gasket, etc. for leaks. If the vacuum gauge registers a pressure, or the vacuum gauge is pushed out of the dipstick tube, check for the correct PCV valve, a plugged hose or excessive engine blow-by.

## On-Board Service

An engine which is operated without any crankcase ventilation can be damaged. Therefore, it is important to replace the PCV valve at the intervals recommended by the manufacturer.

Periodically, inspect the hoses and clamps and replace any showing signs of deterioration.

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# Marine Electronic Fuel Injection (MEFI)

## Section 7

### Symptoms

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## Symptoms

### Important Preliminary Checks

#### Before Starting

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

- ï The ECM and MIL (Malfunction Indicator Lamp) are operating correctly.
- ï 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:

- ï ECM grounds and sensor connections for being clean, tight and in their proper location.
- ï Vacuum hoses for splits, kinks and proper connections. Check thoroughly for any type of leak or restriction.
- ï Air leaks at throttle body mounting area and intake manifold sealing surfaces.
- ï Ignition wires for cracking, hardness, proper routing and carbon tracking.
- ï Wiring for proper connections, pinches and cuts. If wiring harness or connector repair is necessary, refer to *General Information* section for correct procedure.
- ï Moisture in primary or secondary ignition circuit connections.
- ï 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) tables for intermittent problems. The fault must be present to locate the problem.

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

- ï Poor mating of the connector halves, or a terminal not fully seated in the connector body (backed out or loose).
- ï Improperly formed or damaged terminals and/or connectors.
- ï All connector terminals in the problem circuit should be carefully checked for proper contact tension.

- ï 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 may also be used to help detect intermittent conditions. 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 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:

- ï Ignition coil shorted to ground and arcing at ignition wires or plugs.
- ï MIL wire to ECM shorted to ground.
- ï Poor ECM grounds.
- ï Check for an electrical system interference caused by a sharp electrical surge. Normally, the problem will occur when the faulty component is operated.
- ï Check for improper installation of electrical options such as lights, ship to shore radios, sonar, etc.
- ï Check that knock sensor wires are routed away from spark plug wires, ignition system components and charging system components.
- ï Check for secondary ignition components shorted to ground, or an open ignition coil ground (coil mounting brackets).
- ï Check for components internally shorted to ground such as starters, alternators or relays.

All Ignition Control (IC) module wiring should be 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 Tables* at the end of *Symptoms* section.

## Hard Start Symptom

Step	Action	Value	Yes	No
<b>Definition:</b> Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.				
1	Was the iOn-Board Diagnostic (OBD) System Check performed?	ó	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?	ó	Go to Step 3	System normal
3	Was visual/physical check performed?	ó	Go to Step 4	Go to Visual/Physical Check
4	1. Check for correct base ignition timing. i Refer to Ignition Timing Set Procedure in the Distributor Ignition Section. 2. If a problem is found, repair as necessary. Was a problem found?	ó	Go to OBD System Check	Go to Step 5
5	1. Check for proper operation of fuel pump relay circuit. i Refer to Table A-5. 2. If a problem is found, repair as necessary. Was a problem found?	ó	Go to OBD System Check	Go to Step 6
6	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?	ó	Go to OBD System Check	Go to Step 7
7	1. Check for proper fuel pressure. i Refer to Table A-4. 2. If a problem is found, repair as necessary. Was a problem found?	ó	Go to OBD System Check	Go to Step 8
8	1. Check for proper ignition voltage output. i Refer to Table A-7. 2. If a problem is found, repair as necessary. Was a problem found?	ó	Go to OBD System Check	Go to Step 9
9	Is a scan tool being used?	ó	Go to Step 11	Go to Step 10
10	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 table 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 15	Go to Step 14

## Hard Start Symptom

Step	Action	Value	Yes	No
11	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 <sup>∞</sup> C (10 <sup>∞</sup> F)	Go to Step 12	Go to Step 14
12	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 table on the facing page of DTC 14 in the <i>Diagnostics</i> section. Is resistance value of ECT sensor near the resistance of the value noted?	ó	Go to Step 15	Go to Step 13
13	Locate and repair high resistance or poor connection in the ECT signal circuit or the ECT sensor ground. Is action complete?	ó	Go to OBD System Check	ó
14	Replace the ECT sensor. Is action complete?	ó	Go to OBD System Check	ó
15	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?	ó	Go to OBD System Check	Go to Step 16
16	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?	ó	Go to OBD System Check	Go to Step 17
17	1. Check for proper operation of the IAC valve. i Refer to Table A-8. 2. If a problem is found, repair as necessary. Was a problem found?	ó	Go to OBD System Check	Go to Step 18
18	1. Check for the following engine mechanical problems: i Low compression. i Leaking cylinder head gaskets. i Worn or incorrect camshaft. i Proper valve timing/valve train problem. i Restricted exhaust system. 2. If a problem is found, repair as necessary. Was a problem found?	ó	Go to OBD System Check	Go to Step 19

<p><b>19</b></p>	<p>1. Review all diagnostic procedures within this table.</p> <p>2. If all procedures have been completed and no malfunctions have been found, review/inspect the following:</p> <ul style="list-style-type: none"> <li>ï Visual/physical inspection.</li> <li>ï Scan tool data.</li> <li>ï All electrical connections within a suspected circuit and/or system.</li> </ul> <p>3. If a problem is found, repair as necessary.</p> <p>Was a problem found?</p>	<p>ó</p>	<p><i>Go to OBD System Check</i></p>	<p>Contact OEM</p>
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## Surges and/or Chuggles Symptom

Step	Action	Value	Yes	No
<b>Definition:</b> 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?	0	Go to Step 2	Go to OBD System Check
2	Was visual/physical check performed?	0	Go to Step 3	Go to Visual/Physical check
3	1. Check for correct base ignition timing. " Refer to "Ignition Timing Set Procedure" in the <i>Distributor Ignition</i> section. 2. If a problem is found, repair as necessary. Was a problem found?	0	Go to OBD System Check	Go to Step 4
4	1. Check for engine going into RPM reduction mode. 2. If a problem is found, repair as necessary. Was a problem found?	0	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?	0	Go to OBD System Check	Go to Step 6
6	1. Check for proper fuel pressure while the condition exists. " Refer to Table A-4. 2. If a problem is found, repair as necessary. Was a problem found?	0	Go to OBD System Check	Go to Step 7
7	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?	0	Go to OBD System Check	Go to Step 8
8	1. Check for proper ignition voltage output. " Refer to Table A-7. 2. If a problem is found, repair as necessary. Was a problem found?	0	Go to OBD System Check	Go to Step 9
9	1. Check ignition coil for cracks or carbon tracking. 2. If a problem is found, repair as necessary. Was a problem found?	0	Go to OBD System Check	Go to Step 10
10	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?	0	Go to OBD System Check	Go to Step 11

## Surges and/or Chuggles Symptom

Step	Action	Value	Yes	No
11	<p>1. Remove spark plugs and check for wet plugs, cracks, wear, improper gap, burned electrodes or heavy deposits.                ï Refer to Distributor Ignition System.</p> <p><b>Notice:</b> If spark plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs.</p> <p>2. If a problem is found, repair as necessary.            Was a problem found?</p>	ó	Go to OBD System Check	Go to Step 12
12	<p>1. Check items that can cause the engine to run rich.            2. If a problem is found, repair as necessary.            Was a problem found?</p>	ó	Go to OBD System Check	Go to Step 13
13	<p>1. Check items that can cause the engine to run lean.            2. If a problem is found, repair as necessary.            Was a problem found?</p>	ó	Go to OBD System Check	Go to Step 14
14	<p>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?</p>	ó	Go to OBD System Check	Go to Step 15
15	<p>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?</p>	ó	Go to OBD System Check	Go to Step 16
16	<p>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?</p>	ó	Go to OBD System Check	Go to Step 17
17	<p>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?</p>	11-16V	Go to OBD System Check	Go to Step 18
18	<p>1. Review all diagnostic procedures within this table.            2. If all procedures have been completed and no malfunctions have been found, review/inspect the following:                ï Visual/physical inspection.                ï Scan tool data.                ï All electrical connections within a suspected circuit and/or system.            3. If a problem is found, repair as necessary.            Was a problem found?</p>	ó	Go to OBD System Check	Contact OEM

## Lack of Power, Sluggish or Spongy Symptom

Step	Action	Value	Yes	No
<b>Definition:</b> 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?	0	Go to Step 2	Go to OBD System Check
2	Compare vessel performance with a similar vessel. Both vehicle's performance should be close. Is vehicle performance close to similar vehicle.	0	No problem found	Go to Step 3
3	Was visual/physical check performed?	0	Go to Step 4	Go to Visual/Physical check
4	1. Check for correct base ignition 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?	0	Go to OBD System Check	Go to Step 5
5	1. Remove and check flame arrestor for dirt, or for being restricted. 2. Replace flame arrestor if necessary. Was a problem found?	0	Go to OBD System Check	Go to Step 6
6	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?	0	Go to OBD System Check	Go to Step 7
7	1. Check for proper fuel pressure while the condition exists. Refer to Table A-4. 2. If a problem is found, repair as necessary. Was a problem found?	0	Go to OBD System Check	Go to Step 8
8	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?	0	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(s). 2. If a problem is found, repair as necessary. Was a problem found?	0	Go to OBD System Check	Go to Step 10
10	1. Check for proper ignition voltage output. Refer to Table A-7. 2. If a problem is found, repair as necessary. Was a problem found?	0	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. <b>Notice:</b> 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?	0	Go to OBD System Check	Go to Step 12



## Lack of Power, Sluggish or Spongy Symptom

Step	Action	Value	Yes	No
12	1. Check ignition coil for cracks or carbon tracking. 2. If a problem is found, repair as necessary. Was a problem found?	ó	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?	ó	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?	ó	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?	ó	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?	ó	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: ï Low compression. ï Leaking cylinder head gaskets. ï Worn or incorrect camshaft. ï Proper valve timing/valve train problem. ï Restricted exhaust system. 2. If a problem is found, repair as necessary. Was a problem found?	ó	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?	ó	Go to OBD System Check	Go to Step 20
20	1. Review all diagnostic procedures within this table. 2. When all procedures have been completed and no malfunctions are found, review/inspect the following: ï Visual/physical inspection. ï Scan tool data. ï All connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. Was a problem found?	ó	Go to OBD System Check	Contact OEM

## Detonation/Spark Knock Symptom

Step	Action	Value	Yes	No
<b>Definition:</b> 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?	ó	Go to Step 2	Go to OBD System Check
2	Was visual/physical check performed?	ó	Go to Step 3	Go to Visual/Physical check
3	1. Check for correct base ignition timing. i Refer to 'Ignition Timing Set Procedure' in the <i>Distributor Ignition</i> section. 2. If a problem is found, repair as necessary. Was a problem found?	ó	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(s). 2. If a problem is found, repair as necessary. Was a problem found?	ó	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?	ó	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?	ó	Go to OBD System Check	Go to Step 7
7	1. Check for proper fuel pressure. i Refer to Table A-4. 2. If a problem is found, repair as necessary. Was a problem found?	ó	Go to OBD System Check	Go to Step 8
8	Is a scan tool being used?	ó	Go to Step 9	Go to Step 10
9	If scan tool readings are normal ( <i>Refer to 'Typical Scan Values'</i> ) 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?	ó	Go to Step 10	Go to OBD System Check
10	1. Check for obvious overheating problems: i Loose water pump belt. i Faulty or incorrect water pump. i Restriction in cooling system. i Faulty or incorrect thermostat. 2. If a problem is found, repair as necessary. Was a problem found?	ó	Go to OBD System Check	Go to Step 11

## Detonation/Spark Knock Symptom

Step	Action	Value	Yes	No
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?	ó	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. 2. If a problem is found, repair as necessary. Was a problem found?	ó	Go to OBD System Check	Go to Step 13
13	1. Check for the following engine mechanical problems: <ul style="list-style-type: none"> <li>ï Low compression.</li> <li>ï Low oil level.</li> <li>ï Excessive oil in the combustion chambers due to valve seals leaking.</li> <li>ï Worn or incorrect camshaft.</li> <li>ï Proper valve timing/valve train problem.</li> <li>ï Combustion chambers for excessive carbon build up.</li> </ul> 2. If a problem is found, repair as necessary. Was a problem found?	ó	Go to OBD System Check	Go to Step 14
14	1. Remove excessive carbon buildup with a top engine cleaner. <ul style="list-style-type: none"> <li>ï Refer to instructions on top engine cleaner can.</li> </ul> 2. Re-evaluate vehicle performance. Is detonation still present?	ó	Go to Step 15	Go to OBD System Check
15	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: <ul style="list-style-type: none"> <li>ï Visual/physical inspection.</li> <li>ï Scan tool data.</li> <li>ï All electrical connections within a suspected circuit and/or system.</li> </ul> 3. If a problem is found, repair as necessary. Was a problem found?	ó	Go to OBD System Check	Contact OEM

## Hesitation, Sag, Stumble Symptom

Step	Action	Value	Yes	No
<b>Definition:</b> 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. May cause engine to stall if severe enough.				
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	0	Go to Step 2	Go to OBD System Check
2	Was visual/physical check performed?	0	Go to Step 3	Go to Visual/Physical check
3	1. Check for correct base ignition timing. i Refer to "Ignition Timing Set Procedure" in the <i>Distributor Ignition</i> section. 2. If a problem is found, repair as necessary. Was a problem found?	0	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?	0	Go to OBD System Check	Go to Step 5
5	1. Check for proper fuel pressure while the condition exists. i Refer to Table A-4. 2. If a problem is found, repair as necessary. Was a problem found?	0	Go to OBD System Check	Go to Step 6
6	1. Check fuel injectors. i Refer to Injector Coil Test and Injector Balance Test at the end of this section. 2. If a problem is found, repair as necessary. Was a problem found?	0	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(s). 2. If a problem is found, repair as necessary. Was a problem found?	0	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?	0	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. i Refer to Table A-6. <b>Notice:</b> 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?	0	Go to OBD System Check	Go to Step 10

## Hesitation, Sag, Stumble Symptom

Step	Action	Value	Yes	No
10	<ol style="list-style-type: none"> <li>1. Check for the ECT sensor shifted in value.</li> <li>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.</li> <li>3. An intermittent failure may not store a DTC.</li> <li>4. If a problem is found, repair as necessary.</li> </ol> Was a problem found?	ó	Go to OBD System Check	Go to Step 11
11	<ol style="list-style-type: none"> <li>1. Check for engine going into RPM reduction mode.</li> <li>2. If a problem is found, repair as necessary.</li> </ol> Was a problem found?	ó	Go to OBD System Check	Go to Step 12
12	<ol style="list-style-type: none"> <li>1. Check for proper alternator voltage output.</li> <li>2. The voltage should be between specified values.</li> <li>3. If a problem is found, repair as necessary.</li> </ol> Was a problem found?	11-16V	Go to OBD System Check	Go to Step 13
13	<ol style="list-style-type: none"> <li>1. Check for faulty or incorrect thermostat.</li> <li>2. If a problem is found, repair as necessary.</li> </ol> Was a problem found?	ó	Go to OBD System Check	Go to Step 14
14	<ol style="list-style-type: none"> <li>1. Check intake valves for valve deposits.</li> <li>2. If deposits are found, remove as necessary.</li> </ol> Were deposits found on the intake valves?	ó	Go to OBD System Check	Go to Step 15
15	<ol style="list-style-type: none"> <li>1. Review all diagnostic procedures within this table.</li> <li>2. If all procedures have been completed and no malfunctions have been found, review/inspect the following:               <ul style="list-style-type: none"> <li>ï Visual/physical inspection.</li> <li>ï Scan tool data.</li> <li>ï All electrical connections within a suspected circuit and/or system.</li> </ul> </li> <li>3. If a problem is found, repair as necessary.</li> </ol> Was a problem found?	ó	Go to OBD System Check	Contact OEM

## Cuts Out, Misses Symptom

Step	Action	Value	Yes	No
<p><b>Definition:</b> Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases. 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.</p>				
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	0	Go to Step 2	Go to OBD System Check
2	Was visual/physical check performed?	0	Go to Step 3	Go to Visual/Physical check
3	<ol style="list-style-type: none"> <li>1. Check for contaminated fuel.</li> <li>2. Check fuel filters and water separator.</li> <li>3. If a problem is found, repair as necessary.</li> </ol> Was a problem found?	0	Go to OBD System Check	Go to Step 4
4	<ol style="list-style-type: none"> <li>1. Check for proper fuel pressure while the condition exists. Refer to Table A-4.</li> <li>2. If a problem is found, repair as necessary.</li> </ol> Was a problem found?	0	Go to OBD System Check	Go to Step 5
5	<ol style="list-style-type: none"> <li>1. Disconnect all injector harness connectors and install an injector test light J 34730-2 between the harness terminal connector of each injector.</li> <li>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.</li> <li>3. If a problem is found, repair as necessary.</li> </ol> Was a problem found?	0	Go to OBD System Check	Go to Step 6
6	<ol style="list-style-type: none"> <li>1. Check fuel injectors. Refer to Injector Coil Test and Injector Balance Test at the end of this section.</li> <li>2. If a problem is found, repair as necessary.</li> </ol> Was a problem found?	0	Go to OBD System Check	Go to Step 7
7	<ol style="list-style-type: none"> <li>1. Check for proper spark at each cylinder per manufactures recommendation.</li> <li>2. If a problem is found, repair as necessary.</li> </ol> Was a problem found?	0	Go to OBD System Check	Go to Step 8
8	<ol style="list-style-type: none"> <li>1. Remove spark plugs and check for wet plugs, cracks, wear, improper gap, burned electrodes or heavy deposits. <b>Notice:</b> If spark plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs.</li> <li>2. If a problem is found, repair as necessary.</li> </ol> Was a problem found?	0	Go to OBD System Check	Go to Step 9

## Cuts Out, Misses Symptom

Step	Action	Value	Yes	No
9	1. Check engine mechanical for the following conditions. <ul style="list-style-type: none"> <li>• Low compression.</li> <li>• Sticking or leaking valves.</li> <li>• Bent push rods.</li> <li>• Worn rocker arms.</li> <li>• Broken valve springs.</li> <li>• Worn camshaft lobe(s).</li> <li>• Incorrect valve timing.</li> </ul> 2. If a problem is found, repair as necessary. Was a problem found?	ó	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?	ó	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, may indicate EMI is present. 2. If EMI is present, locate and repair the source. Was a problem found?	ó	Go to OBD System Check	Go to Step 12
12	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: <ul style="list-style-type: none"> <li>• Visual/physical inspection.</li> <li>• Scan tool data.</li> <li>• All electrical connections within a suspected circuit and/or system.</li> </ul> 3. If a problem is found, repair as necessary. Was a problem found?	ó	Go to OBD System Check	Contact OEM

## Rough, Unstable or Incorrect Idle, Stalling Symptom

Step	Action	Value	Yes	No
<b>Definition:</b> Engine runs unevenly at idle. If severe, the engine or vehicle may shake. Engine idle speed varies in RPM. Either condition may be severe enough to stall the engine.				
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	0	Go to Step 2	Go to OBD System Check
2	Was visual/physical check performed?	0	Go to Step 3	Go to Visual/Physical check
3	1. Check for correct base ignition timing. i Refer to "Ignition Timing Set Procedure" in the <i>Distributor Ignition</i> section. 2. If a problem is found, repair as necessary. Was a problem found?	0	Go to OBD System Check	Go to Step 4
4	1. Check for proper operation of the IAC valve. i Refer to Table A-8. 2. If a problem is found, repair as necessary. Was a problem found?	0	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(s). 2. If a problem is found, repair as necessary. Was a problem found?	0	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?	0	Go to OBD System Check	Go to Step 7
7	1. Check ignition coil for cracks or carbon tracking. 2. If a problem is found, repair as necessary. Was a problem found?	0	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. i Refer to Table A-6. <b>Notice:</b> 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?	0	Go to OBD System Check	Go to Step 9
9	Check the injector connections. If any of the injectors are connected to an incorrect cylinder, correct as necessary. Was a problem found?	0	Go to OBD System Check	Go to Step 10



## Rough, Unstable or Incorrect Idle, Stalling Symptom

Step	Action	Value	Yes	No
10	<ol style="list-style-type: none"> <li>1. Disconnect all injector harness connectors and install an injector test light J 34730-2 between the harness terminal connector of each injector.</li> <li>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.</li> <li>3. If a problem is found, repair as necessary.</li> </ol> <p>Was a problem found?</p>	ó	Go to OBD System Check	Go to Step 11
11	<ol style="list-style-type: none"> <li>1. Check fuel injectors. <ul style="list-style-type: none"> <li>ï Refer to Injector Coil Test and Injector Balance Test at the end of this section.</li> </ul> </li> <li>2. If a problem is found, repair as necessary.</li> </ol> <p>Was a problem found?</p>	ó	Go to OBD System Check	Go to Step 12
12	<ol style="list-style-type: none"> <li>1. Check for fuel in pressure regulator vacuum hose.</li> <li>2. If fuel is present, replace the fuel pressure regulator assembly. <ul style="list-style-type: none"> <li>ï Refer to Fuel Metering System.</li> </ul> </li> <li>3. If a problem is found, repair as necessary.</li> </ol> <p>Was a problem found?</p>	ó	Go to OBD System Check	Go to Step 13
13	<ol style="list-style-type: none"> <li>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.</li> <li>2. An intermittent failure may not store a DTC.</li> <li>3. If a problem is found, repair as necessary.</li> </ol> <p>Was a problem found?</p>	ó	Go to OBD System Check	Go to Step 14
14	<ol style="list-style-type: none"> <li>1. Check ECM grounds for being clean, tight and in their proper locations.</li> <li>2. Also check that battery cables and ground straps are clean and secure.</li> <li>3. If a problem is found, repair as necessary.</li> </ol> <p>Was a problem found?</p>	ó	Go to OBD System Check	Go to Step 15
15	<ol style="list-style-type: none"> <li>1. Check items that can cause the engine to run rich.</li> <li>2. If a problem is found, repair as necessary.</li> </ol> <p>Was a problem found?</p>	ó	Go to OBD System Check	Go to Step 16
16	<ol style="list-style-type: none"> <li>1. Check items that can cause the engine to run lean.</li> <li>2. If a problem is found, repair as necessary.</li> </ol> <p>Was a problem found?</p>	ó	Go to OBD System Check	Go to Step 17
17	<ol style="list-style-type: none"> <li>1. Check for proper alternator voltage output.</li> <li>2. The voltage should be between specified values.</li> <li>3. If a problem is found, repair as necessary.</li> </ol> <p>Was a problem found?</p>	11-16V	Go to OBD System Check	Go to Step 18

**Rough, Unstable, or Incorrect Idle, Stalling Symptom**

<b>Step</b>	<b>Action</b>	<b>Value</b>	<b>Yes</b>	<b>No</b>
<b>18</b>	1. Check the following engine mechanical items: <ul style="list-style-type: none"> <li>ī Check compression.</li> <li>ī Sticking or leaking valves.</li> <li>ī Worn camshaft lobe(s).</li> <li>ī Valve timing.</li> <li>ī Broken valve springs.</li> </ul> 2. If a problem is found, repair as necessary. Was a problem found?	ó	Go to OBD System Check	Go to Step 19
<b>19</b>	1. Check intake valves for valve deposits. 2. If deposits are found, remove as necessary. Were deposits found on the intake valves?	ó	Go to OBD System Check	Go to Step 20
<b>20</b>	1. Check for faulty motor mounts. 2. If a problem is found, repair as necessary. Was a problem found?	ó	Go to OBD System Check	Go to Step 21
<b>21</b>	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: <ul style="list-style-type: none"> <li>ī Visual/physical inspection.</li> <li>ī Scan tool data.</li> <li>ī All electrical connections within a suspected circuit and/or system.</li> </ul> 3. If a problem is found, repair as necessary. Was a problem found?	ó	Go to OBD System Check	Contact OEM

## Poor Fuel Economy Symptom

Step	Action	Value	Yes	No
<b>Definition:</b> Fuel economy, as measured at selected intervals, is noticeably lower than expected. Also, economy is noticeably lower than it was on this vehicle at one time, as previously shown by documentation.				
1	Was the iOn-Board Diagnostic (OBD) System Check performed?	ó	Go to Step 2	Go to OBD System Check
2	Was visual/physical check performed?	ó	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?	ó	System normal	Go to Step 4
4	1. Check for correct base ignition 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?	ó	Go to OBD System Check	Go to Step 5
5	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?	ó	Go to OBD System Check	Go to Step 6
6	1. Check for proper fuel pressure. Refer to Table A-4. 2. If a problem is found, repair as necessary. Was a problem found?	ó	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(s). 2. If a problem is found, repair as necessary. Was a problem found?	ó	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 Table A-6 <b>Notice:</b> 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?	ó	Go to OBD System Check	Go to Step 9
9	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?	ó	Go to OBD System Check	Go to Step 10
10	1. Check engine compression for being low. 2. If a problem is found, repair as necessary. Was a problem found?	ó	Go to OBD System Check	Go to Step 11

### Poor Fuel Economy Symptom

Step	Action	Value	Yes	No
<b>11</b>	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?	ó	<i>Go to OBD System Check</i>	<i>Go to Step 12</i>
<b>12</b>	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?	ó	<i>Go to OBD System Check</i>	<i>Go to Step 13</i>
<b>13</b>	1. Review all diagnostic procedures within this table. 2. When all procedures have been completed and no malfunctions are found, review/inspect the following: <ul style="list-style-type: none"> <li>ı Visual/physical inspection.</li> <li>ı Scan tool data.</li> <li>ı All connections within a suspected circuit and/or system.</li> </ul> 3. If a problem is found, repair as necessary. Was a problem found?	ó	<i>Go to OBD System Check</i>	<i>Contact OEM</i>

## Dieseling, Run-On Symptom

Step	Action	Value	Yes	No
<b>Definition:</b> 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?	0	Go to Step 2	Go to OBD System Check
2	Was visual/physical check performed?	0	Go to Step 3	Go to Visual/Physical check
3	1. Check for leaking fuel injectors. <ul style="list-style-type: none"> <li>• Refer to Table A-4.</li> </ul> 2. If a problem is found, repair as necessary. Was a problem found?	0	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(s). 2. If a problem is found, repair as necessary. Was a problem found?	0	Go to OBD System Check	Go to Step 5
5	1. Check for obvious overheating problems: <ul style="list-style-type: none"> <li>• Loose water pump belt.</li> <li>• Faulty or incorrect water pump.</li> <li>• Restriction in cooling system.</li> <li>• Faulty or incorrect thermostat.</li> </ul> 2. If a problem is found, repair as necessary. Was a problem found?	0	Go to OBD System Check	Go to Step 6
6	1. Check for proper operation of the MEFI relay. <ul style="list-style-type: none"> <li>• Refer to Table A-6.</li> </ul> 2. If a problem is found, repair as necessary. Was a problem found?	0	Go to OBD System Check	Go to Step 7
7	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: <ul style="list-style-type: none"> <li>• Visual/physical inspection.</li> <li>• Scan tool data.</li> <li>• All electrical connections within a suspected circuit and/or system.</li> </ul> 3. If a problem is found, repair as necessary. Was a problem found?	0	Go to OBD System Check	Contact OEM

## Backfire Symptom

Step	Action	Value	Yes	No
<b>Definition:</b> 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?	0	Go to Step 2	Go to OBD System Check
2	Was visual/physical check performed?	0	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?	0	Go to OBD System Check	Go to Step 4
4	1. Check for proper fuel pressure. i Refer to Table A-4. 2. If a problem is found, repair as necessary. Was a problem found?	0	Go to OBD System Check	Go to Step 5
5	1. Check for correct base ignition timing. i Refer to Ignition Timing Set Procedure in the Distributor Ignition section. 2. If a problem is found, repair as necessary. Was a problem found?	0	Go to OBD System Check	Go to Step 6
6	1. Check to see if engine is going into RPM reduction. 2. If a problem is found, repair as necessary. Was a problem found?	0	Go to OBD System Check	Go to Step 7
7	Check the injector connections. If any of the injectors are connected to an incorrect cylinder, correct as necessary. Was a problem found?	0	Go to OBD System Check	Go to Step 8
8	1. Check fuel injectors. i Refer to Injector Coil Test and Injector Balance Test at the end of this section. 2. If a problem is found, repair as necessary. Was a problem found?	0	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(s). 2. If a problem is found, repair as necessary. Was a problem found?	0	Go to OBD System Check	Go to Step 10
10	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?	0	Go to OBD System Check	Go to Step 11
11	1. Check ignition coil for cracks or carbon tracking. 2. If a problem is found, repair as necessary. Was a problem found?	0	Go to OBD System Check	Go to Step 12

## Backfire Symptom

Step	Action	Value	Yes	No
12	Check for intermittent open or short to ground in the ignition circuit to the system relay. Was a problem found?	ó	Go to OBD System Check	Go to Step 13
13	1. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes or heavy deposits. <b>Notice:</b> 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?	ó	Go to OBD System Check	Go to Step 14
14	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?	ó	Go to OBD System Check	Go to Step 15
15	1. Check engine mechanical for the following conditions: ï Low compression. ï Sticking or leaking valves. ï Worn camshaft lobe(s). ï Incorrect valve timing. 2. If a problem is found, repair as necessary. Was a problem found?	ó	Go to OBD System Check	Go to Step 16
16	1. Check Intake and exhaust manifold(s) for casting flash. 2. If a problem is found, repair as necessary. Was a problem found?	ó	Go to OBD System Check	Go to Step 17
17	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: ï Visual/physical inspection. ï Scan tool data. ï All electrical connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. Was a problem found?	ó	Go to OBD System Check	Contact OEM

## ECM Connector J1

Pin Function		CKT No.	Wire Color	Component Connector	DTC(s) Affected	Possible Symptoms From Faulty Circuit
J1-01	Injector Driver (Cylís 1,4,6,7)	468	lt grn	Injectors	None	Rough Idle, Lack of Power, Stalling
J1-02	Not Used					
J1-03	IC Reference Low	453	blk/red	Ignition Control Module	None	Lack of Performance, Poor Fuel Economy
J1-04	ECM Ground	450	blk	Engine Block	None	An open ground or high resistance ground may cause any or all symptoms.
J1-05	ECM Ground	450	blk	Engine Block	None	An open ground or high resistance ground may cause any or all symptoms.
J1-06	Not Used					
J1-07	Check Gauges (Optional)	112	dk grn	In-Line Boat Harness	None	Loss of Instrument Indicator
J1-08	RPM Change State (Optional)	31	tan	In-Line Boat Harness	None	
J1-09	Malfunction Indicator Lamp	419	brn/wht	DLC	None	MIL Inoperative
J1-10	IC Signal	423	wht	Ignition Control Module	41 & 42	Lack of Power, Fixed Timing
J1-11	IAC iBí High	443	grn/wht	IAC Valve	None	Rough, Unstable or Incorrect Idle
J1-12	IAC iAí Low	442	blu/blk	IAC Valve	None	Rough, Unstable or Incorrect Idle
J1-13	Not Used					
J1-14	Knock Sensor 2 Signal	497	dk blu	Knock Sensor 2	44	Poor Fuel Economy, Poor Performance
J1-15	Not Used					
J1-16	Not Used					
J1-17	Injector Driver (Cylís 2, 3, 5, 8)	467	dk blu	Injectors	None	Rough Idle, Lack of Power, Stalling
J1-18	Not Used					
J1-19	Not Used					
J1-20	ECM Ground	450	blk	Engine Block	None	An open ground or high resistance ground may cause any or all symptoms.



## ECM Connector J1

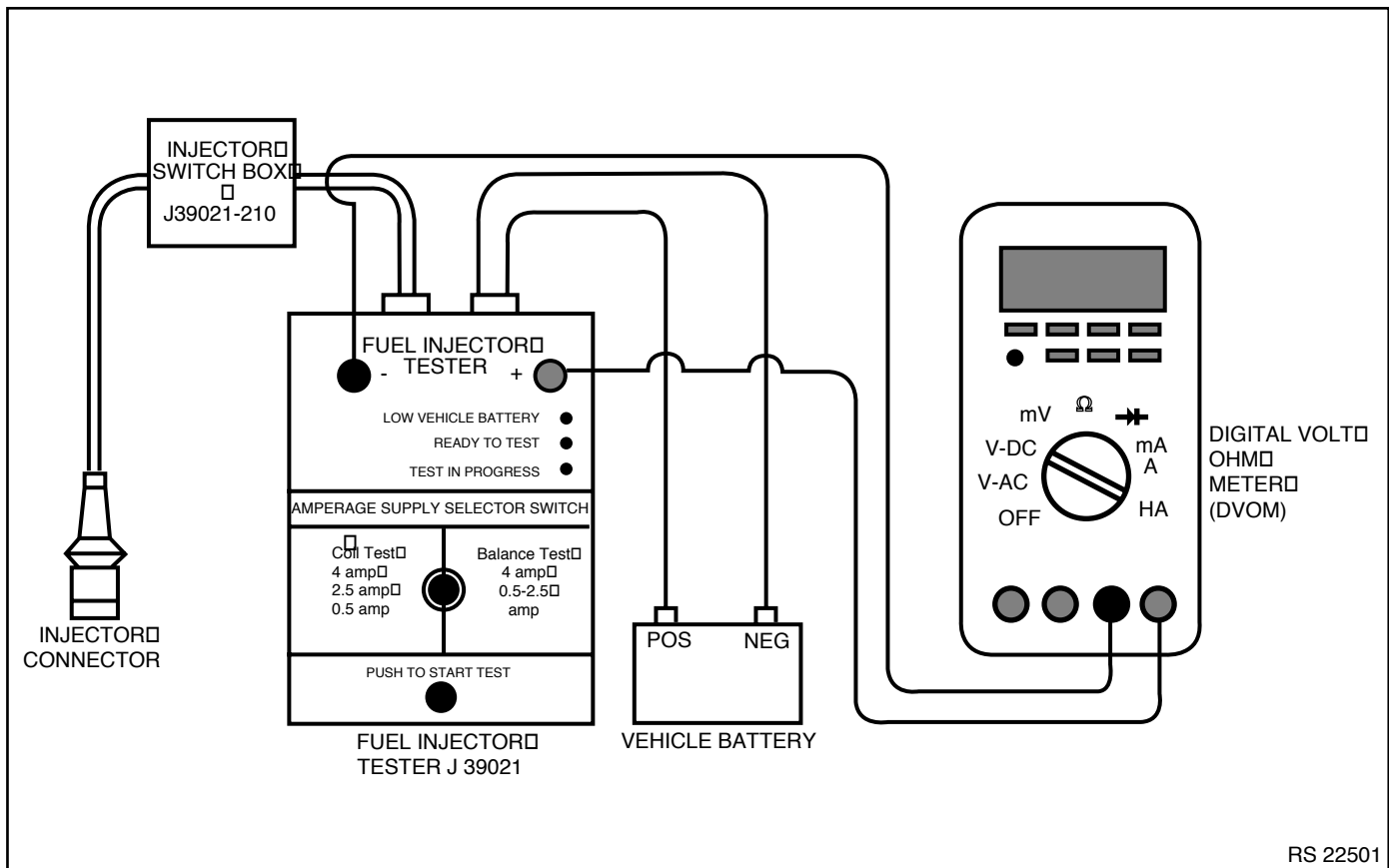
Pin Function		CKT No.	Wire Color	Component Connector	DTC(s) Affected	Possible Symptoms From Faulty Circuit
J1-21	General Warning 1 Lamp (Optional)	912	dk blu	In-Line Boat Harness	None	Loss of Instrument Light
J1-22	General Warning 2 (Optional)	911	dk grn	In-Line Boat Harness	None	Loss of Instrument Light
J1-23	Fuel Pump Relay Driver	465	dk grn/wht	Fuel Pump Relay	None	No Start
J1-24	IC Bypass	424	tan/blk	Ignition Control Module	42	Lack of Power, Fixed Timing
J1-25	Oil Level Lamp Output (Optional)	930	gry	In-Line Boat Harness	None	Loss of Instrument Light
J1-26	Buzzer (Optional)	914	ppl	In-Line Boat Harness	None	Loss of Instrument Indicator
J1-27	IAC Low	444	grn/blk	IAC Valve	None	Rough, Unstable or Incorrect Idle
J1-28	IAC High	441	blu/wht	IAC Valve	None	Rough, Unstable or Incorrect Idle
J1-29	Not Used					
J1-30	Knock Sensor 1 Signal	496	dk blu	Knock Sensor 1	44	Poor Fuel Economy, Poor Performance
J1-31	Not Used					
J1-32	Serial Data	461	orn/blk	Data Link Connector	None	No Serial Data
(1) Open Circuit (2) Grounded Circuit (3) Open/Grounded Circuit						

## ECM Connector J2

Pin Function		CKT No.	Wire Color	Component Connector Cavity	DTC(s) Affected	Possible Symptoms From Faulty Circuit
J2-01	Battery Feed	440	orn	Splice	None	No Start
J2-02	Not Used					
J2-03	Sensor Ground, MAP and ECT Sensors	814	blk	MAP and ECT Sensors	14 & 33	Lack of Performance, Exhaust Odor, Stalling
J2-04	MAP 5 Volt Reference	416E	gry	MAP Sensor	34	Lack of Power, Surge, Rough Idle, Exhaust Odor
J2-05	Emergency Stop Switch (Optional)	942	pnk	In-Line Boat Harness	None	RPM Reduction
J2-06	Not Used					
J2-07	Oil Pressure Lamp (Optional)	932	brn	In-Line Boat Harness	None	Loss of Instrument Indicator
J2-08	General Warning 2 (Optional)	921	lt blu/blk	In-Line Boat Harness	None	RPM Reduction
J2-09	Shift Interrupt or Load Anticipate 1 (Optional)	940	lt grn	In-Line Boat Harness	None	Improper or hard shifting
J2-10	Distributor Reference High	430	ppl/wht	Ignition Control Module	None	No Start
J2-11	ECT Signal	410	yel	ECT Sensor	14 & 15	Poor Performance, Exhaust Odor Rough Idle, RPM Reduction
J2-12	Fuel Pressure Signal (Optional)			Fuel Pressure Sensor	61 & 62	
J2-13	Not Used					
J2-14	Not Used					
J2-15	Not Used					
J2-16	Not Used					
J2-17	Not Used					
J2-18	Sensor Ground, TP and IAT Sensors	813	blk	TP and IAT Sensors	21 & 23	High Idle, Rough Idle, Poor Performance
J2-19	TP 5 Volt Reference	416	gry	TP Sensor	22	Lack of Power, Idle Surge, High Idle, Exhaust Odor
J2-20	Load Anticipate 2 (Optional)	941	lt grn	In-Line Boat Harness	None	

## ECM Connector J2

Pin Function		CKT No.	Wire Color	Component Connector	DTC(s) Affected	Possible Symptoms From Faulty Circuit
J2-21	Master/Slave	916	yel	Twin Engine In-Line Connector	None	Lack of Data From Other Engine
J2-22	Diagnostic Test Terminal	451	wht/blk	Data Link Connector	None	Incorrect Idle, Poor Performance
J2-23	Oil Level (Optional)	1174	brn	In-Line Boat Harness	None	RPM Reduction
J2-24	General Warning 1 (Optional)	920	lt blu	In-Line Boat Harness	None	RPM Reduction
J2-25	Vessel Speed Sensor (Optional)				24	
J2-26	TP Signal	417	dk blu	TP Sensor	21 & 22	Poor Acceleration and Performance, Incorrect Idle
J2-27	MAP Signal	432	lt grn	MAP Sensor	33 & 34	Poor Performance, Surge, Poor Fuel Economy, Exhaust Odor
J2-28	Not Used					
J2-29	Oil Pressure Switch (Optional)	931	brn	In-Line Boat Harness	None	RPM Reduction
J2-30	IAT Signal (Big Block)	472	tan	IAT Sensor	23 & 25	Rough Idle
J2-31	Not Used					
J2-32	Ignition Fused	439	pnk/blk	Splice	None	No Start, MIL Inoperative
(1) Open circuit (2) Grounded circuit (3) Open/Grounded circuit						



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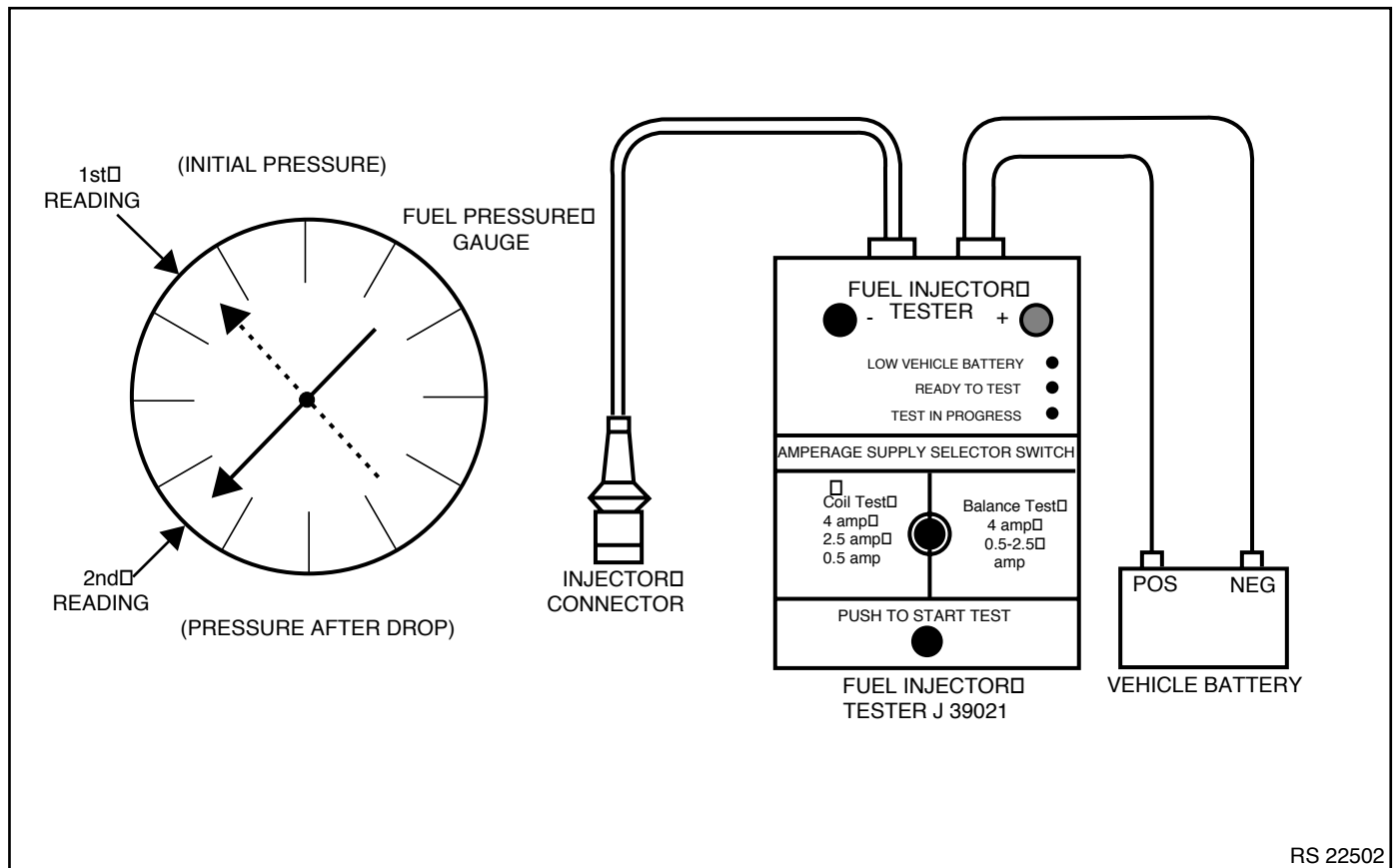
### Fuel Injector Coil Test

#### Test Description

- This is the set-up step for performing the Fuel Injector Coil Test Procedure. In addition to following the steps in this diagnostic table, also read the instructions included with the tools used to perform this test procedure.
- The engine coolant temperature affects the ability of the Fuel Injector Tester to detect a faulty Fuel Injector. If the engine coolant temperature is **NOT** between 50°F and 95°F, allow the engine to warm or cool as necessary.
- Due to a current surge, the first second of the voltage displayed by the DVOM may be inaccurate; therefore, begin recording after the first second of the voltage reading. The voltage displayed by the DVOM should be within the specified range. The voltage displayed by the DVOM may increase throughout the test as the fuel injector windings warm up and the resistance changes. An erratic voltage reading (large fluctuations in voltage that do not stabilize) indicates an intermittent connection within the fuel injector.

## Fuel Injector Coil Test

Step	Action	Value	Yes	No
1	Was the On-Board Diagnostic (OBD) System Check performed?	ó	Go to Step 2	Go to OBD System Check
2	<ol style="list-style-type: none"> <li>Turn the engine OFF.</li> <li>Relieve the fuel pressure. Refer to the Fuel Pressure Relief Procedure in the Fuel Metering section.</li> <li>Access the Fuel Injector electrical connectors as required. Refer to the Fuel Injector portion of the Fuel Metering section.</li> <li>Connect the J 39021 Fuel Injector Tester to B+ and Ground.</li> <li>Set the Amperage Supply Selector Switch on the Fuel Injector Tester to the Coil Test 0.5 amp position.</li> <li>Connect the leads from the DVOM to the Fuel Injector Tester. Refer to the illustrations associated with the test description.</li> <li>Set the DVOM to the Tenths Scale (0.0).</li> <li>Connect a scan tool.</li> <li>Observe the Engine Coolant Temperature.</li> </ol> Is the Engine Coolant Temperature within the specified limits?	10°C-35°C (50°F-95°F)	Go to Step 4	Go to Step 3
3	Allow the engine to warm or cool as necessary. Is the Engine Coolant Temperature within the specified limits?	10°C-35°C (50°F-95°F)	Go to Step 4	ó
4	<ol style="list-style-type: none"> <li>Connect the Fuel Injector Tester to a fuel injector.</li> <li>Press the Push to Start Test Button on the Fuel Injector Tester.</li> <li>Observe the voltage reading on the DVOM. <b>Notice:</b> The voltage reading may rise during the test. Watch for erratic voltage readings.</li> <li>Repeat Steps 1 through 3 for each injector.</li> </ol> Does any of the injector voltage readings fall outside of the specified value?	5.44-7.53 volts	Go to Step 5	Go to the Fuel Injector Balance Test
5	Replace the faulty fuel injector(s) that were not within the specified value. Refer to the Fuel Injector portion of the Fuel Metering section. Is the action complete?	5.44-7.53 volts	Go to Step 6	ó
6	<ol style="list-style-type: none"> <li>Using a scan tool, check for any DTC(s) present and clear them.</li> <li>Attempt to start the engine.</li> </ol> Does the engine start and continue to run?	ó	Go to Step 7	Go to Step 2
7	<ol style="list-style-type: none"> <li>Allow the engine to idle until reaching normal operating temperature.</li> <li>Check for any DTC(s) present.</li> </ol> Are any DTC(s) present?	ó	Go to Applicable DTC Table	System OK



### Fuel Injector Balance Test

Cylinder	1	2	3	4	5	6
1st Reading	296 kPa (43 psi)	296 kPa (43 psi)	296 kPa (43 psi)	296 kPa (43 psi)	296 kPa (43 psi)	296 kPa (43 psi)
2nd Reading	131 kPa (19 psi)	117 kPa (17 psi)	124 kPa (18 psi)	145 kPa (21 psi)	131 kPa (19 psi)	130 kPa (19 psi)
Amount of drop	165 kPa (24 psi)	179 kPa (26 psi)	172 kPa (25 psi)	151 kPa (22 psi)	165 kPa (24 psi)	166 kPa (24 psi)
Acceptable Range Average $\pm 10$ kPa: 86 $\pm 10$ kPa 76-96 kPa (12 psi $\pm$ 1.5 psi 11-14psi)	Injector OK	Faulty injector- too much fuel drop	Injector OK	Faulty injector- too little fuel drop	Injector OK	Injector OK

### Circuit Description

The Fuel Injector Tester J 39021, the Injector Switch Box J 39021-210 and the Injector Harness Connector J39021-303 energize the injector for a precise amount of time allowing a measured amount of fuel into the manifold. This causes a drop in system fuel pressure that can be recorded and used to compare each injector. All injectors should be within the same pressure drop range, the average pressure drop value for all injectors is  $\pm 10$  kPa (1.5 psi).

### Test Description

**Caution:** Wrap a shop towel around the fuel pressure connection in order to reduce the risk of fire and personal injury. The towel will absorb any fuel leakage that occurs during the connection of the fuel pressure gauge. Place the towel in an approved container when the connection of the fuel pressure gauge is complete.

4. The engine coolant temperature must be below the operating temperature in order to avoid irregular fuel pressure readings due to Hot Soak fuel boiling.
5. The fuel pressure should be within the specified range. If the fuel pressure is not within the specified range, go to Table A-4 Fuel System Diagnosis in the *Diagnosis* section.
6. Allow the fuel pressure to stabilize about 3 minutes. On a hot engine, fuel pressure may increase due to fuel expansion after the pump stops running. This is a normal condition, but the fuel pressure should stabilize and hold. The fuel pressure should reach a steady value. If the fuel pressure does not reach a steady value, go to Table A-4 Fuel System Diagnosis in the Diagnosis section.
7. If the pressure drop value for each injector is within 10 kPa (1.5 psi) of the average pressure drop value, the injectors are flowing properly. Calculate the pressure drop value for each injector by subtracting the second pressure reading from the first pressure reading. Refer to the illustration above.

### Fuel Injector Balance Test

Step	Action	Value	Yes	No
1	Was the On-Board Diagnostic (OBD) System Check performed?	ó	Go to Step 2	Go to OBD System Check
2	Was the Fuel Injector Coil Test performed?	ó	Go to Step 3	Go to Fuel Injector Coil Test
3	Is the Engine Coolant Temperature above the specified value?	94°C (201°F)	Go to Step 4	Go to Step 5
4	Allow the engine to cool below the specified value. Is the action complete?	94°C (201°F)	Go to Step 5	ó
5	<ol style="list-style-type: none"> <li>1. Turn ignition OFF.</li> <li>2. Relieve the fuel pressure. Refer to the Fuel Pressure Relief Procedure in the Fuel Metering section.</li> <li>3. Install a fuel pressure gauge.</li> <li>4. Ignition ON, engine OFF.</li> <li>5. Energize the fuel pump using the scan tool.</li> <li>6. Place the bleed hose of the fuel pressure gauge into an approved gasoline container.</li> <li>7. Bleed the air out of the fuel pressure gauge.</li> <li>8. Use the scan tool in order to energize the fuel pump and pressurize the fuel system.</li> <li>9. Wait for the fuel pressure to build.</li> </ol> <p><b>Important:</b> The fuel pump will run for approximately 2 seconds. Repeat step 5 as necessary in order to achieve the highest possible fuel pressure.</p> <ol style="list-style-type: none"> <li>10. Observe the reading on the fuel pressure gauge. Is the fuel pressure within the specified limits?</li> </ol>	284-325 kPa (41-47psi)	Go to Step 6	Go to Table A-4
6	Turn the fuel pump OFF. Does the fuel pressure remain constant?	ó	Go to Step 7	Go to Table A-4

## Fuel Injector Balance Test

Step	Action	Value	Yes	No
7	<ol style="list-style-type: none"> <li>1. Turn the ignition <i>OFF</i>.</li> <li>2. Connect the J 39021 Fuel Injector Tester, the J39021-303 Injector Harness Connector (if needed) and the J 39021-210 Injector Switch Box to a fuel injector.</li> <li>3. Set the Amperage Supply Selector Switch on the Fuel Injector Tester to the <i>Balance Test</i> 0.5-2.5 amp position.</li> <li>4. Select the injector to be tested on the Injector Switch Box.</li> <li>5. Ignition <i>ON</i>, engine <i>OFF</i>.</li> <li>6. Use a scan tool in order to pressurize the fuel system.</li> <li>7. Record the fuel pressure indicated by the fuel pressure gauge after the fuel pressure stabilizes. This is the 1st pressure reading.</li> <li>8. Energize the fuel injector by depressing the <i>Push to Start Test</i> Button on the Fuel Injector Tester.</li> <li>9. Record the fuel pressure indicated by the fuel pressure gauge after the fuel pressure gauge needle has stopped moving. This is the 2nd pressure reading.</li> <li>10. Repeat Steps 4 through 9 for each fuel injector.</li> <li>11. Subtract the 2nd pressure reading from the 1st pressure reading for one fuel injector. The result is the pressure drop value.</li> <li>12. Obtain a pressure drop value for each fuel injector.</li> <li>13. Add all of the individual pressure drop values. This is the total pressure drop.</li> <li>14. Divide the total pressure drip by the number of fuel injectors. This is the average pressure drop.</li> </ol> <p>Does any fuel injector have a pressure drop value that is either higher than the average pressure drop or lower than the average pressure drop by the specified amount?</p>	10 kPa (1.5 psi)	Go to Step 8	Review <i>Symptoms</i> Section
8	<p><b>Notice:</b> Do Not repeat any portion of this test before running the engine in order to prevent the engine from flooding.</p> <p>Re-test any fuel injector that does not meet the specification. Refer to the procedure in Step 7.</p> <p>Does any fuel injector still have a pressure drop value that is either higher than the average pressure drop or lower than the average pressure drop by the specified amount?</p>	10 kPa (1.5 psi)	Go to Step 9	Review <i>Symptoms</i> Section
9	<p>Replace the faulty fuel injector(s). Refer to the <i>Fuel Injector</i> portion of the <i>Fuel Metering</i> section.</p> <p>Is the action complete?</p>	ó	Go to Step 10	ó



Fuel Injector Balance Test

Step	Action	Value	Yes	No
10	1. Turn ignition <i>OFF</i> . 2. Remove test equipment. 3. Re-connect all harnesses and fuel lines. 4. Install a scan tool. 5. Ignition <i>ON</i> , engine <i>OFF</i> . 6. Check for fuel leaks. 7. Using the scan tool, clear any DTC(s) that are present. 8. Start the engine. 9. Idle the engine until it reaches normal operating temperature. 10. Check for any DTC(s) present. Are any DTC(s) present?	0	Go to applicable DTC Table	System OK

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