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EFI
SERVICE MANUAL

(ELECTRONIC FUEL INJECTION)

DECEMBER, 1996

MARINE ELECTRONIC FUEL INJECTION
(MEFI)
DIAGNOSTIC MANUAL

The Table of Contents on the following page indicates the sections covered in this 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 taht 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.

MARINE POWER, INC.
Ponchatoula, Louisiana

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.

This Marine Power EFI service manual is intended for 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 properly.

MARINE ELECTRONIC FUEL INJECTION
MEFI
TABLE OF CONTENTS

The Table of contents on this page indicates the sections covered on this manual. At the beginning of each individual section is a table of contents which gives the page number on which each major subject begins.

GENERAL INFO

MARINE ELECTRONIC FUEL INJECTION (MEFI)
SECTION 1
GENERAL INFORMATION
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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 steps. Inspect all vacuum hoses for correct routing, pinches, cuts, 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 exhaust manifolds. This visual/physical inspection is very important. It must be done carefully and thoroughly.

BASIC KNOWLEDGE AND TOOLS REQUIRED

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

To perform system diagnosis, several special tools and equipment are required. Please become acquainted with the tools and their use before attempting to diagnose the system. Special tools which are required for system service are illustrated at the end of this section.

ELECTROSTATIC DISCHARGE DAMAGE

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

There are several ways for a person to become statically charged. The most common methods of charging are by friction and by induction. An example of charging by friction is a person sliding across a 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.

DIAGNOSTIC INFORMATION

The diagnostic charts and functional checks in this manual are designed to locate a faulty circuit or component through logic based on the process of elimination.

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

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

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

1. Improperly formed contacts and/or connector housing.
2. Damaged contacts or housing due to improper engagement.
3. Corrosion, sealer or other contaminants on the contact mating surfaces.
4. Incomplete mating of the connector halves during initial assembly or during subsequent troubleshooting procedures.
5. Tendency for connectors to come apart due to vibration and/or temperature cycling.
6. Terminals not fully seated in the connector body.
7. Inadequate terminal crimps to the wire.

WIRING HARNESS SERVICE

Wire harnesses should be replaced with proper part number harnesses. When signal wires are spliced into a harness, use the same gage 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.

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

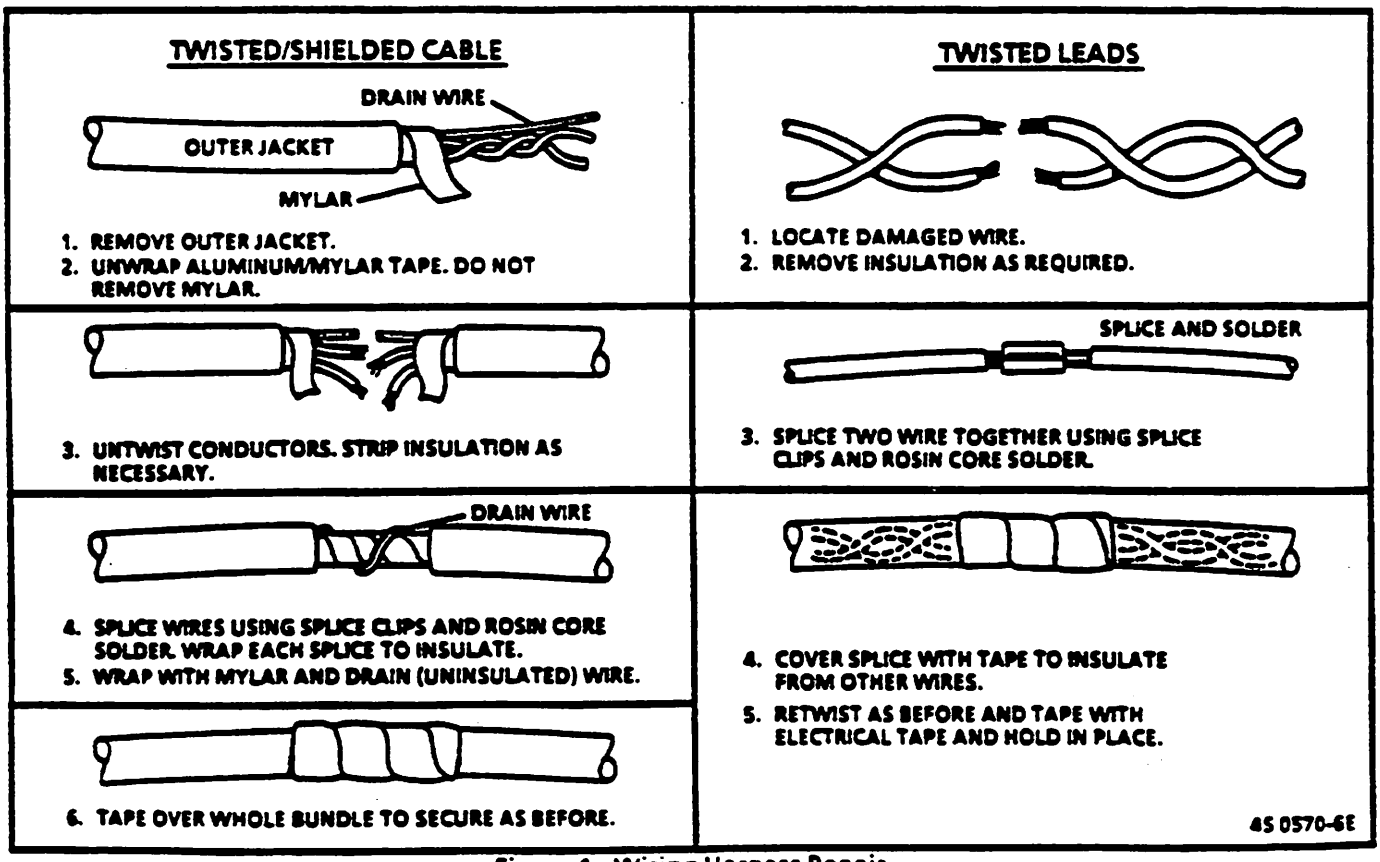


Figure 1 - Wiring Harness Repair

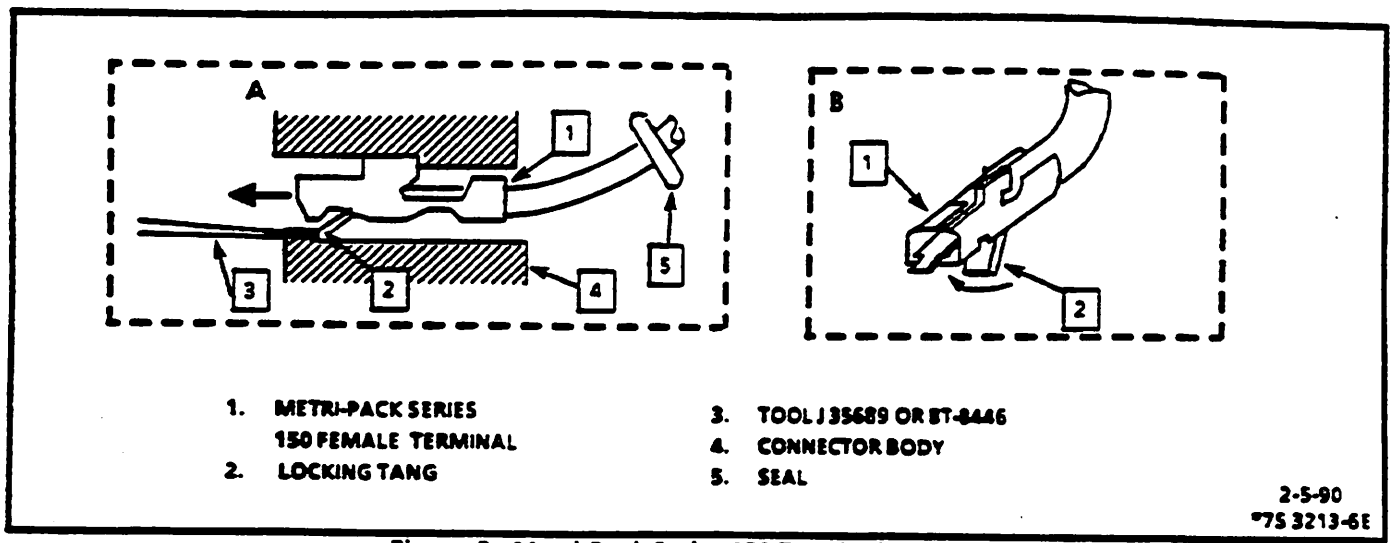


Figure 2 - Metri-Pack Series 150 Terminal Removal

WIRING CONNECTOR SERVICE

Most connectors in the engine compartment are protected against moisture and dirt which could create oxidation and deposits on the terminals. This protection is important because of the very low voltage and current levels found in the electronic system. The connectors have a lock which secures the male and female terminals together. A secondary lock holds the seal and terminal into the connector.

When diagnosing, open circuits are often difficult to locate by sight because oxidation or terminal misalignment are hidden by the connectors. Merely wiggling a connector on a sensor or in the wiring harness may locate the open circuit condition. This should always be considered when an open circuit or failed sensor is indicated. Intermittent problems may also be caused by oxidized or loose connections.

Before making a connector repair, be certain of the type of connector. Some connectors look similar but are serviced differently. Replacement connectors and terminals are listed in the parts catalog.

Metri-Pack Series 150 Terminals

Some ECM harness connectors contain terminals called Metri-Pack (Figure 2). These are used at some of the sensors and the distributor connector.

Metri-Pack terminals are also called "Pull-To-Seat" terminals because to install a terminal on a wire, the wire is first inserted through the seal (5) and connector (4). The terminal is then crimped on the wire, and the terminal pulled back into the connector to seat it in place.

To remove a terminal:

1. Slide the seal back on the wire.
2. Insert tool (3) BT-8518, J 35689, or equivalent as shown in insert "A" and "B" to release the terminal locking tang (2).
3. Push the wire and terminal out through the connector.
   If the terminal is being reused, reshape the locking tang (2).

Weather-Pack Connectors

Figure 3 shows a Weather-Pack connector and the tool (J 28742, BT-8234-A or equivalent) required to service it. This tool is used to remove the pin and sleeve terminals. If terminal removal is attempted without using the special tool required, there is a good chance that the terminal will be bent or deformed, and unlike standard blade type terminals, these terminals cannot be straightened once they are bent.

Make certain that the connectors are properly seated and all of the sealing rings in place when connecting leads. The hinge-type flap provides a secondary locking feature for the connector. It improves the connector reliability by retaining the terminals if the small terminal lock tangs are not positioned properly.

Weather-Pack connections cannot be replaced with standard connections. Instructions are provided with Weather-Pack connector and terminal packages.

ENGINE CONTROL MODULE (ECM) SELF-DIAGNOSTICS

The Engine Control Module (ECM) performs a continual self-diagnosis on certain control functions. This diagnostic capability is complemented by the diagnostic procedures contained in this manual. The ECM's language for communicating the source of a malfunction is a system of Diagnostic Trouble Codes (DTCs). The DTCs are two digit numbers that can range from 12 to 51. When a malfunction is detected by the ECM, a DTC is set and the malfunction indicator lamp is illuminated.

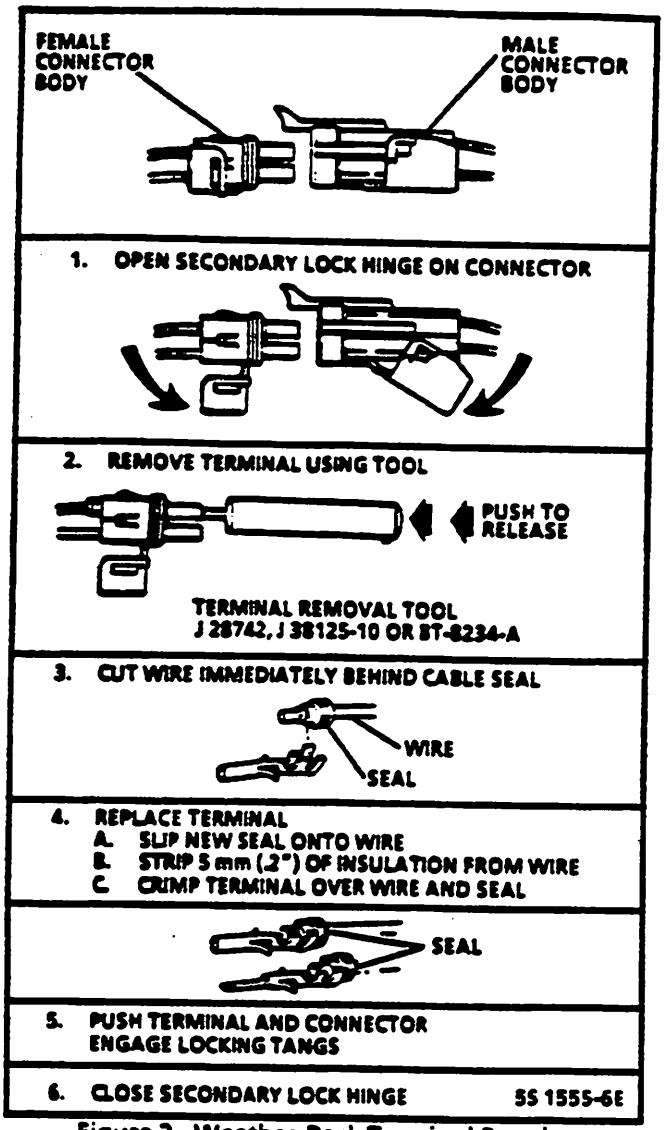


Figure 3 - Weather-Pack Terminal Repair

MALFUNCTION INDICATOR LAMP (MIL)

The malfunction indicator lamp is part of the Marine Diagnostic Trouble Code (MDTC) tool (TA-06075), or it can be a dash mounted warning light on some boat models.

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

As a bulb and system check, the light will come "ON" with the key "ON" and the engine not running. When the engine is started, the light will turn "OFF." If the light remains "ON," the self-diagnostic system has detected a problem. If the problem goes away, the light will go out in most cases after 10 seconds, but a DTC will remain stored in the ECM.

When the light remains "ON" while the engine is running, or when a malfunction is suspected due to a driveability problem, "MEFI On-Board Diagnostic

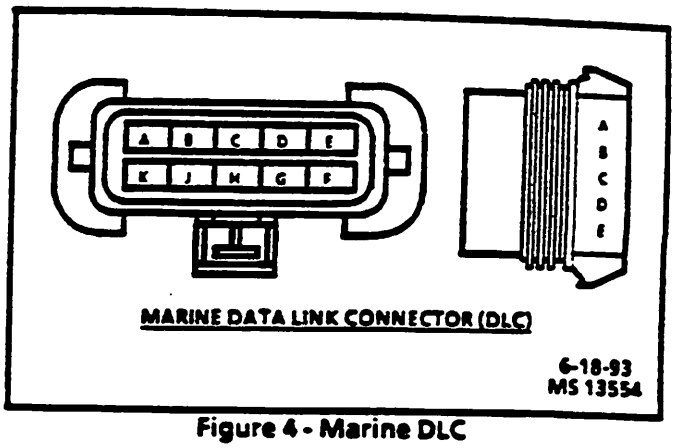


Figure 4 - Marine DLC

(OBD) System Check" must be performed. 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 will light for ten (10) seconds and then will go out. However, the corresponding Diagnostic Trouble Code (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.

An intermittent DTC if cleared may or may not reset. If it is an intermittent failure, consult the "Diagnostic Aids" on the page facing the DTC chart corresponding to the intermittent DTC. "Symptoms" 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) (See Figure 4). 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 read either through scan tool, a hand-held diagnostic scanner plugged into the DLC or by counting the number of flashes of the MIL when the marine diagnostic trouble code tool is installed and "Service" mode is selected.

Once the marine diagnostic trouble code tool has been connected, the ignition switch must be moved to the "ON" position, with the engine not running. At this point, the MIL should flash DTC 12 three times consecutively.

This would be the following flash sequence: "flash, pause, flash-flash, long pause, flash, pause, flash-flash, long pause, flash, pause, flash-flash." DTC 12 indicates that the ECM's diagnostic system is operating. If DTC 12 is not indicated, a problem is present within the diagnostic system itself, and should be addressed by consulting the appropriate diagnostic chart 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 simply continue to output DTC 12. If more than one DTC has been stored in the ECM's memory, the DTCs will be output from the lowest to the highest, with each DTC being displayed three times.

Service Mode

When the marine diagnostic trouble code tool is installed at the DLC and the switch is selected to "Service," the system will enter what is called the Service Mode. In this mode the ECM will:

1. Display a DTC 12 by flashing the MIL (indicating the system is operating correctly).
2. Display any stored DTCs by flashing the MIL. Each DTC will be flashed three times, then DTC 12 will be flashed again.
3. The ignition timing is controlled to a fixed timing degree programmed in the ECM. This will allow base timing to be adjusted on distributor ignition engines.
4. The IAC valve moves to its fully extended position on most models, blocking the idle air passage. This is important to remember, as an attempt to run the boat while in "Service" mode will most likely result in an abnormally low idle speed.

Normal Mode

The normal mode will have no effect on engine operation.

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 charts unnecessary, nor can they indicate exactly where a problem is in a particular circuit. Tree charts incorporate diagnosis procedures using a scan tool where possible or a marine diagnostic trouble code tool (non-scan) if a scan tool is unavailable.

MEFI ON-BOARD DIAGNOSTIC (OBD) SYSTEM CHECK

After the visual/physical inspection, the "On-Board Diagnostic 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 aren't working, the OBD system check will lead to a diagnostic chart in "Diagnosis" section to correct the problem. If the on-board diagnostics are working correctly, the next step is:
2. Is there a DTC stored? If a DTC is stored, go directly to the numbered DTC chart in "Diagnosis" section. This will determine if the fault is still present.

SCAN TOOL USE WITH INTERMITTENTS

The scan tool provides the ability to check, (wiggle test) of wiring harnesses or components with the engine not running, while observing the scan tool readout.

The scan tool can be plugged in and observed while driving the boat under the condition when the MIL turns "ON" momentarily or when the engine driveability is momentarily poor. If the problem seems to be related to certain parameters that can be checked on the scan tool, they should be checked while driving the boat. If there does not seem to be any correlation between the problem and any specific circuit, the scan tool can be checked on each position, watching for a period of time to see if there is any change in the readings that indicates intermittent operation.

The scan tool is also an easy way to compare the operating parameters of a poorly operating engine with those of a known good one. For example, a sensor may shift in value but not set a diagnostic trouble code. Comparing the sensor's readings, with those of the typical scan tool data readings, 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 he is trying to diagnose as well as an understanding of the scan tool operation and limitations.

The technician should read the tool manufacturer's operating manual to become familiar with the tool's operation.

HOW DIAGNOSTIC TROUBLE CODES 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 .1 volt to as high as 4.9 volts. The sensor voltage signal is calibrated for engine application. This would be the sensor's working parameter or "window." The ECM and sensors will be discussed further in the "ECM and Sensor" section.

If a sensor is within its working or acceptable parameters (Figure 5), the ECM does not detect a problem. When a sensor voltage signal falls out of this "window," or an open or short occurs in the wiring to the sensor, the ECM would not receive the "window" voltage for that sensor. When the ECM does not receive the "window" voltage for a programmed length of time a DTC will be stored. The MIL will be illuminated and a known default value will replace the sensed value to restore engine performance.

CLEARING DIAGNOSTIC TROUBLE CODES (NON-SCAN)

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

NOTICE: When clearing DTCs without the use of a scan tool, the battery must be fully charged and cranking speed must be at least 200 RPM. The ability to clear DTCs is directly dependent on battery being fully charged and able to crank engine with adequate cranking RPM.

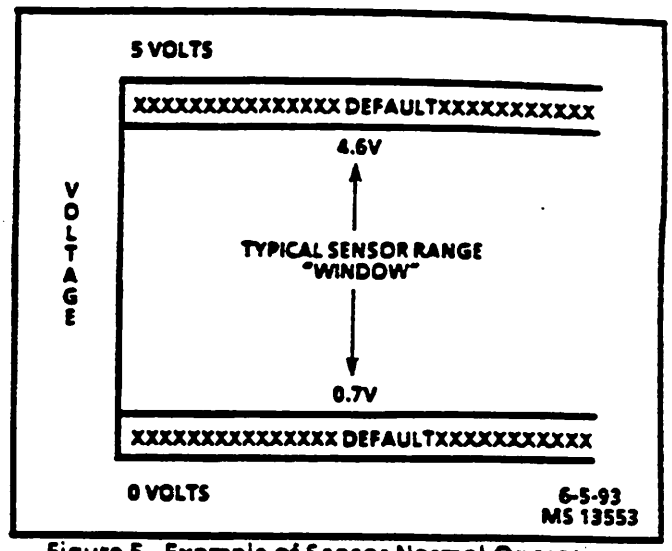


Figure 5 - Example of Sensor Normal Operation

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 20 seconds.
6. Turn ignition "ON" and read DTCs. If DTCs are still present, check "Notice" below and repeat following from Step 2.

NOTICE: When clearing DTCs with the use of a scan tool, the battery must be fully charged and cranking speed must be at least 200 RPM. The ability to clear DTCs is directly dependent on battery being fully charged and able to start engine with adequate cranking RPM.

A poorly charged battery or engine cranking problem may result in an ECM "reset" and may not allow stored DTCs to be cleared from EEPROM memory.

If this condition exists, be sure battery is fully charged and repair charging/starting system before attempting to clear DTCs from memory.

NON-SCAN DIAGNOSIS OF DRIVEABILITY CONCERNS (WITH NO DTCs SET)

If a driveability concern still exists after following the diagnostic circuit check and reviewing the "Symptoms" section, an out of range sensor may be suspected. Because of the unique design of the MEFI system, fail safes have been programmed into the ECM to replace a sensed value with a default value in the case of a sensor malfunction or sensor wiring concern. By allowing this to occur, limited engine performance is restored until the vehicle is repaired.

A basic understanding of sensor operation is necessary to be able to diagnose an out of range sensor.

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

A good example of this would be if the coolant sensor was reading incorrectly and indicating to the ECM that coolant temperature was at 50°F, but actual coolant temperature was 150°F (Figure 6). This would cause the ECM to deliver more fuel than was actually needed and result in an overly rich, rough running condition. This condition would not have caused a DTC to set as the ECM interprets this as within it's "Range."

To identify a sensor which is out of range, you may unplug it while running the engine. After approximately 2 minutes, the DTC for that sensor will set, illuminate the MIL, and replace the sensed value with a default value. If at that point a noticeable performance increase is observed, the non-scan DTC chart 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 mis-diagnosis of the driveability concern.

TOOLS NEEDED TO SERVICE THE SYSTEM

The system requires a scan tool or Marine Diagnostic Trouble Code (MDTC) tool, inductive pick-up timing light, fuel pressure test gauge, tachometer, test light, digital volt ohmmeter with a minimum of 10 megohms impedance (J 34029-A or equivalent), vacuum pump with gage and jumper wires for diagnosis. A test light or DVOM must be used when specified in the procedures. See the end of this section for special tools needed to diagnose or repair a system. For more complete information on the operation of these tools, consult the tool manufacturer's instructions.

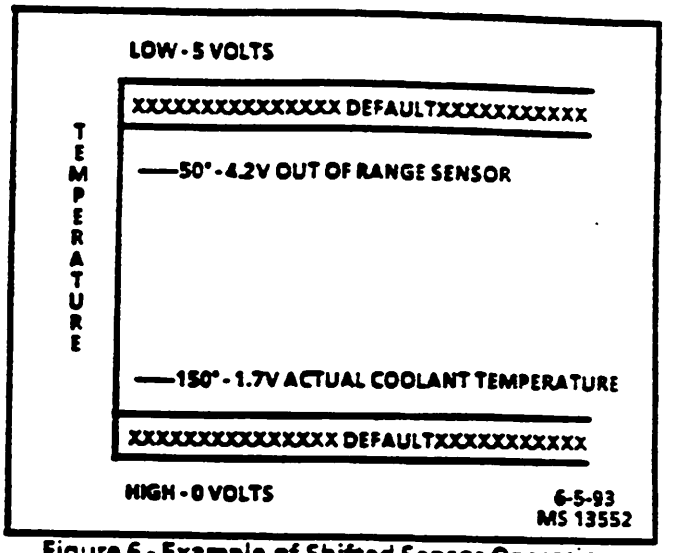


Figure 6 - Example of Shifted Sensor Operation

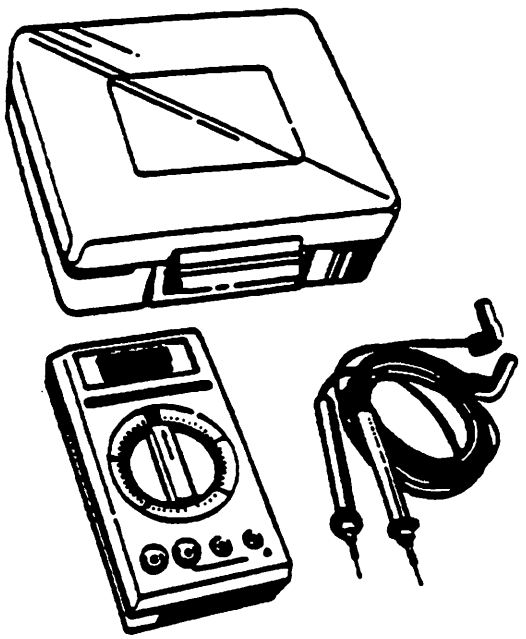
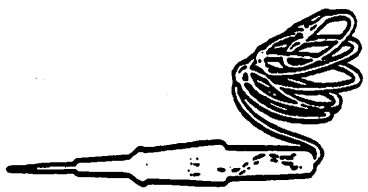
 HIGH IMPEDANCE MULTIMETER (DIGITAL VOLT-OHMMETER-DVOM) J 34029-A	**VOLTMETER** - Voltage position measures magnitude of voltage when connected in parallel to an existing circuit. A digital voltmeter with a 10 megohm input impedance is used because this type of meter will not load down the circuit and result in faulty readings. Some circuits require accurate low voltage readings because they have a very high resistance. **AMMETER** - When used as an ammeter, this meter accurately measures extremely low current flow. Refer to meter instructions for more information. • Selector must be set properly for both function and range. DC is used for most measurements. **OHMMETER** - Measures resistance of circuit directly in ohms. Refer to meter instructions for more information. • OL display in all ranges indicates open circuit. • Zero display in all ranges indicates a short circuit. • An intermittent connection in a circuit may be indicated by a digital reading that will not stabilize on the circuit. • Range Switch - Automatic and Manual. 200Ω – Reads ohms directly 2K, 20K, 200KΩ – Reads ohms in thousands 2M, 20MΩ, 200MΩ - Reads ohms in millions
 J 23738-A	**VACUUM PUMP WITH GAGE (20 IN. HG. MINIMUM)** Use the gage to monitor manifold engine vacuum and use the hand pump to check vacuum sensors, solenoids and valves.
 J 34142-B	**UNPOWERED TEST LIGHT** Used for checking wiring for complete circuit, short to ground, or voltage.
	**TACHOMETER** Must have inductive trigger signal pick-up. 4-14-92 NS 14574

Figure 7 - Special Tools (1 of 3)

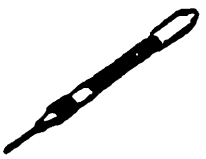
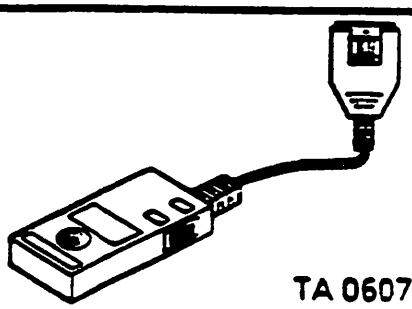
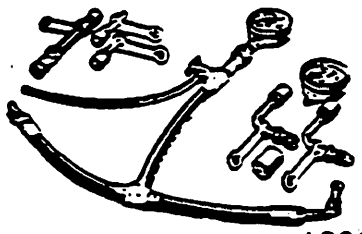
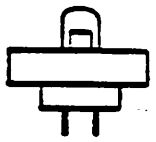
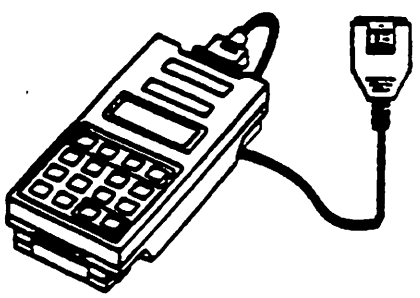
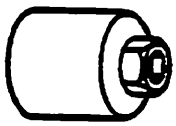
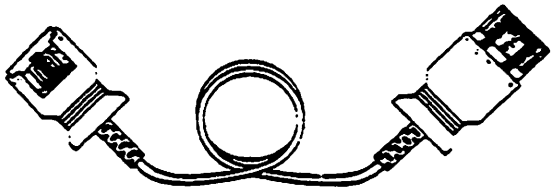
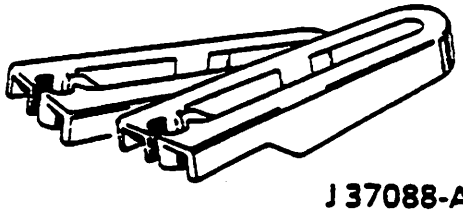
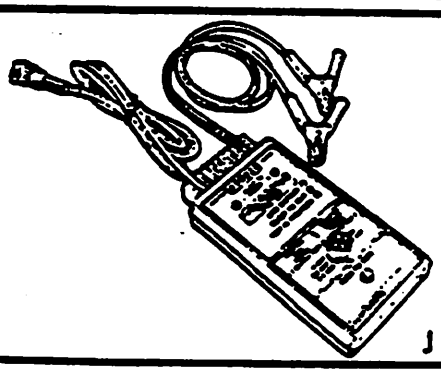
 J 35689	**METRI-PACK TERMINAL REMOVER** Used for removing 150 series Metri-Pack "pull-to-seat" terminals from connectors. Refer to wiring harness service in MEFI General Information Section for removal procedure.
 J 28742-A/BT-8234-A	**WEATHER PACK TERMINAL REMOVER** Used for removing terminals from Weather Pack connectors. Refer to wiring harness service in MEFI General Information Section for removal procedure.
 TA 06075	**MARINE DIAGNOSTIC TROUBLE CODE (MDTC) TOOL** A hand held diagnostic tool that is used to diagnose fuel and emission systems. It will flash a code when a problem is detected.
 J 29658-D	**FUEL PRESSURE GAUGE** Used for checking fuel system pressure on TBI engines.
 J 34730-1A	**FUEL PRESSURE GAUGE** Used for checking fuel pump pressure on MFI engines.
 J34730-2C & J 34730-350/BT 8329	**INJECTOR HARNESS TEST LIGHT** A specially designed light used to visually indicate injector electrical impulses from the ECM.
 TK 00450	**TECH 1 SCAN TOOL (Optional)** A hand held diagnostic tool that is used to diagnose fuel and emission systems. It will display various parameters. (A cartridge is required: TK 01940.) 7-6-93 NS 15871

Figure 8 - Special Tools (2 of 3)

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

7-6-93
MS 13617

Figure 9 - Special Tools (3 of 3)

ABBREVIATIONS

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

ABBREVIATIONS (CONT)

SW	-	SWITCH
TACH	-	TACHOMETER
TBI	-	THROTTLE BODY INJECTION
TERM	-	TERMINAL
TP	-	THROTTLE POSITION SENSOR
V	-	VOLTS
VAC	-	VACUUM
WOT	-	WIDE OPEN THROTTLE
" HG	-	INCHES OF MERCURY

ECM & SENSORS

MARINE ELECTRONIC FUEL INJECTION (MEFI)

SECTION 2

ENGINE CONTROL MODULE (ECM) AND SENSORS

CONTENTS

GENERAL DESCRIPTION

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

COMPUTERS AND VOLTAGE SIGNALS

Voltage is electrical pressure. Voltage does not flow thru 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 lights lamps.

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

There are two kinds of voltage signals, analog and digital. Both of these are used in computer systems. It's 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.

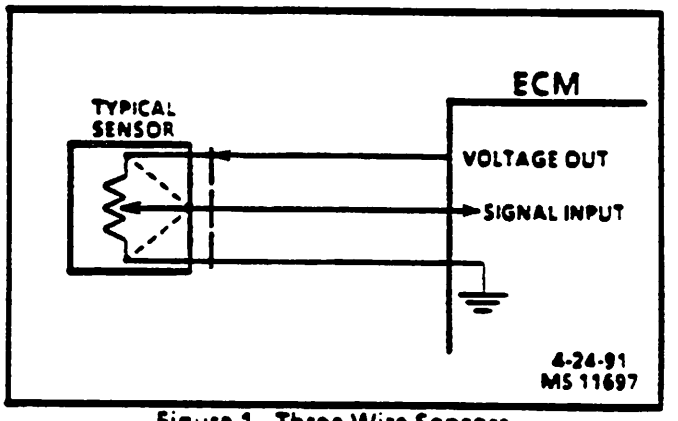


Figure 1 - Three Wire Sensors

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 sensor.

Three-Wire Sensors

Figure 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 returned to the computer also changes.

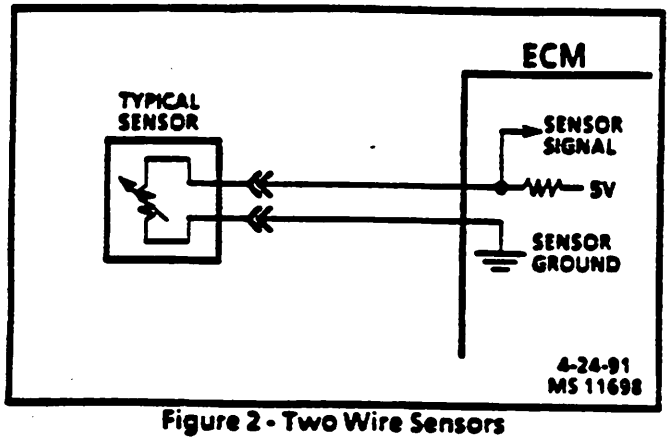


Figure 2 - Two Wire Sensors

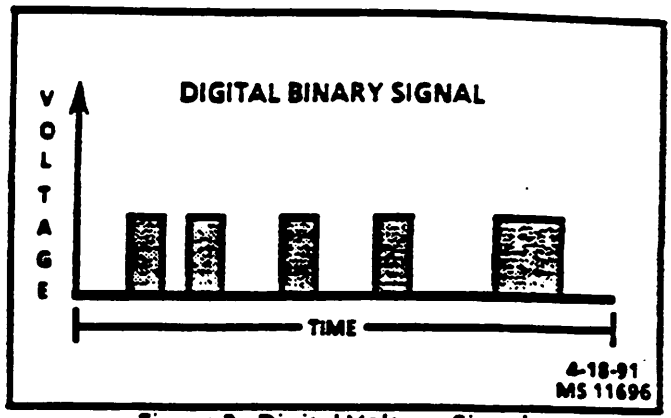


Figure 3 - Digital Voltage Signal

Two-Wire Sensors

Figure 2 is the schematic of a 2-wire type sensor. This sensor is basically a variable resistor in series with a fixed-known resistor within the computer. 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.

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 2.65V 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 3, a digital binary signal is a square wave.

The computer 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: eight ones, eight zeros, five ones and three zeros, and so on.

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

Switch Types

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

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

Pulse Counters

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

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

ENGINE CONTROL MODULE (ECM)

The Engine Control Module (ECM) (Figure 4) is the control center of the fuel injection system. It constantly monitors information from various sensors, and controls the systems that affect vehicle performance.

The ECM also performs a diagnostic function check of the system. It can recognize operational problems and store a Diagnostic Trouble Code(s) which identify the problem areas to aid the technician in making repairs.

ECM Function

The ECM supplies 5 or 12 volts to power various sensors or switches.

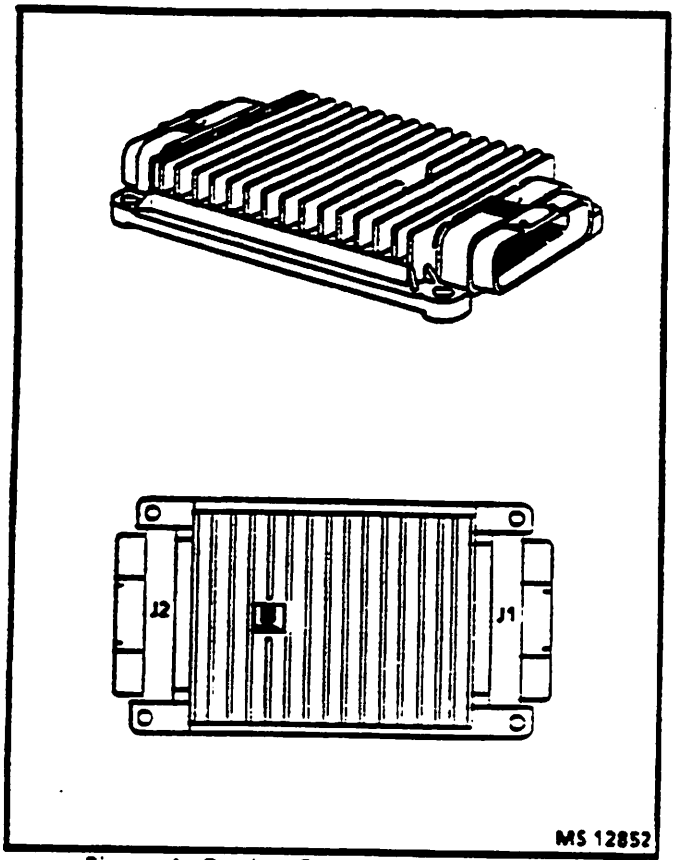


Figure 4 - Engine Control Module (ECM)

This is done through resistances in the ECM which are so high in value that a test light will not light when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give an accurate reading because its resistance is too low. Therefore, the use of a 10 megohm or greater input impedance digital voltmeter is required to assure accurate voltage readings.

Memory

There are three types of memory storage within the ECM: 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

Electronic Erasable Programmable Read Only Memory (EEPROM) is the portion of the ECM that contains the different engine calibration information that is specific to each marine application.

SPEED DENSITY SYSTEM

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

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

Speed

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

Density

One sensor contributes to the density factor, the Manifold Absolute Pressure (MAP) sensor.

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

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

The MAP sensor sends this pressure information to the ECM, and the ECM increases the amount of fuel injected, by increasing the injector pulse width. As manifold pressure decreases, 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 sensor and switches provide electrical inputs to the ECM which are used for modification of the air/fuel mixture, as well as for other ECM control functions, such as Idle Air Control (IAC).

ECM INPUTS AND SENSOR DESCRIPTIONS

Figure 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.

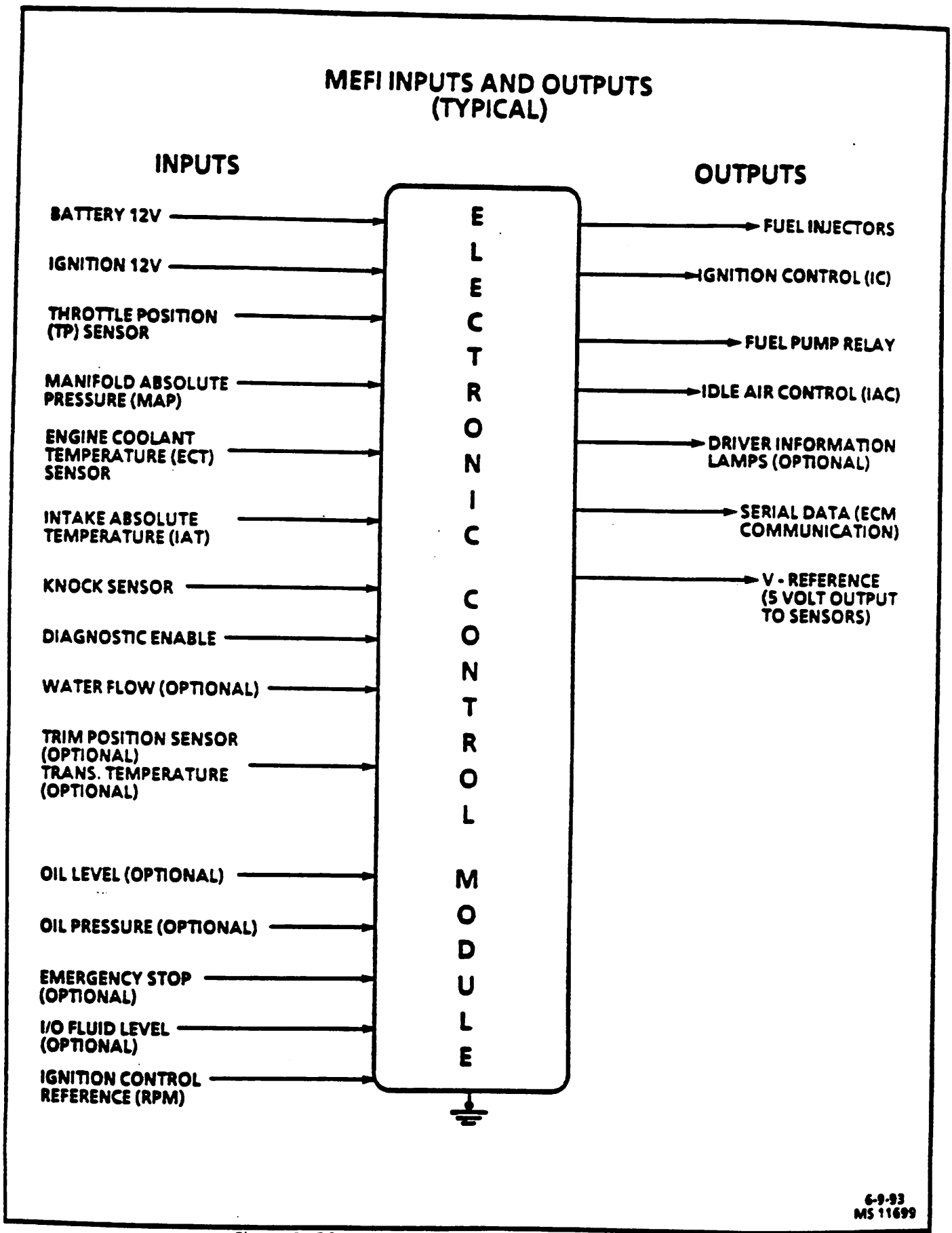
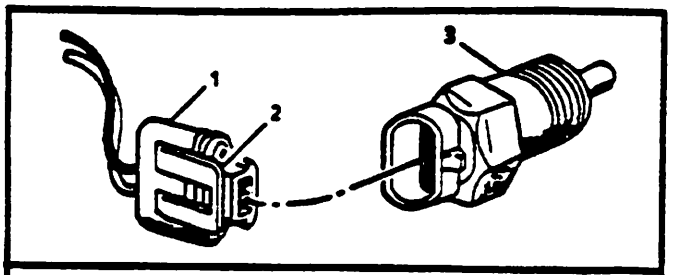


Figure 5 - ECM Inputs and Sensor Descriptions (Typical)



1 HARNESS CONNECTOR
2 LOCKING TAB
3 SENSOR

5S 1640-6E

Figure 6 - Engine Coolant Temperature (ECT) Sensor

Engine Coolant Temperature (ECT) Sensor *Figure 6*

The Engine Coolant Temperature (ECT) sensor is a thermistor (a resistor which changes value based on temperature) immersed in the engine coolant stream. Low coolant temperature produces a high resistance, while high temperature causes low resistance.

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

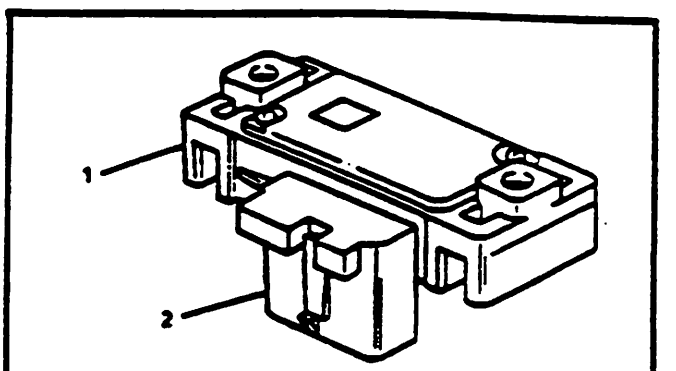
A failure in the ECT circuit should set DTC 14. Remember, this DTC indicates a failure in the coolant temperature sensor circuit; so proper use of the chart will lead to either repairing a wiring problem or replacing the sensor to repair a problem.

Manifold Absolute Pressure (MAP) Sensor *Figure 7*

The Manifold Absolute Pressure (MAP) sensor (Figure 7) is a pressure transducer that measures the changes in the intake manifold pressure. The pressure changes as a result of engine load and speed change, and the MAP sensor converts this to a voltage output (Figure 8).

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

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



1 SENSOR
2 ELECTRICAL CONNECTOR

6S 2648-6E

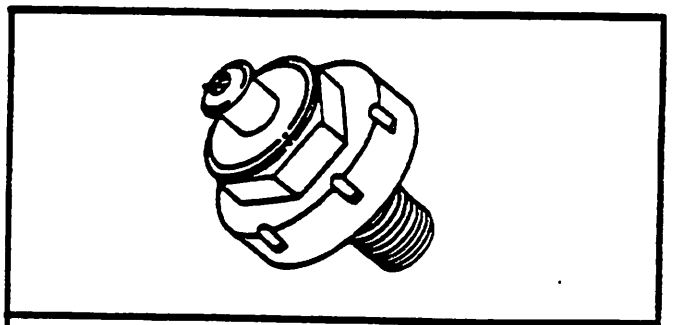
Figure 7 - Manifold Absolute Pressure (MAP) Sensor

A failure in the MAP sensor circuit should set a DTC 33.

MAP

kPa	100	90	80	70	60	50	40	30	20	10	0
Hg	29.6	26.6	23.7	20.7	17.7	14.8	11.8	8.9	5.9	2.9	0
V	4.9	4.4	3.8	3.3	2.7	2.2	1.7	1.1	0.6	0.3	0.3

Figure 8 - MAP to Voltage



KNOCK SENSOR (KS)

3S 0023-6E

Figure 9 - Typical Knock Sensor

Knock Sensor *Figure 9*

The knock sensor is mounted in the engine block, depending on engine application.

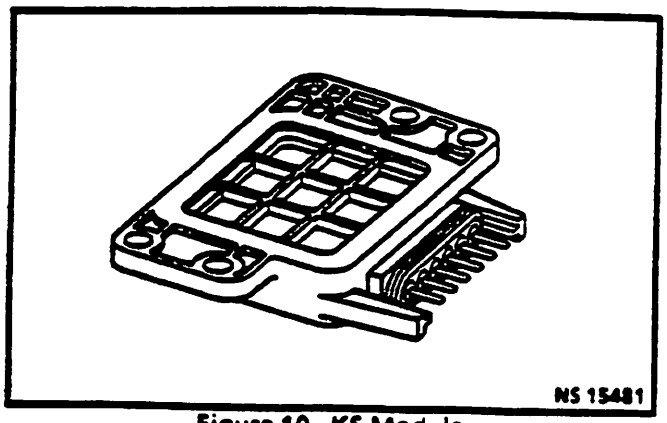


Figure 10 - KS Module

When abnormal engine vibrations (spark knock) are present, the sensor produces a voltage signal which is sent to the KS module and then onto the ECM.

The ECM uses this signal to aid in calculating ignition timing.

Knock Sensor (KS) Module
Figure 10

The KS module contains solid state circuitry which monitors the knock sensor's AC voltage signal and then supplies a 8-10 volt signal, if no spark knock is present, to the ECM. If spark knock is present, the KS module will remove the 8-10 volt signal to the ECM.

It is extremely important that the correct KS module be used for the engine application. Using an incorrect KS module can result in unrecognized spark knock and engine damage or cause poor performance by too much spark retard.

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

Throttle Position (TP) Sensor
Figures 12 and 13

The Throttle Position (TP) sensor (Figure 13) is a potentiometer connected to the throttle shaft on the throttle body. The TP sensor has one end connected to 5 volts from the ECM and the other to ECM ground.

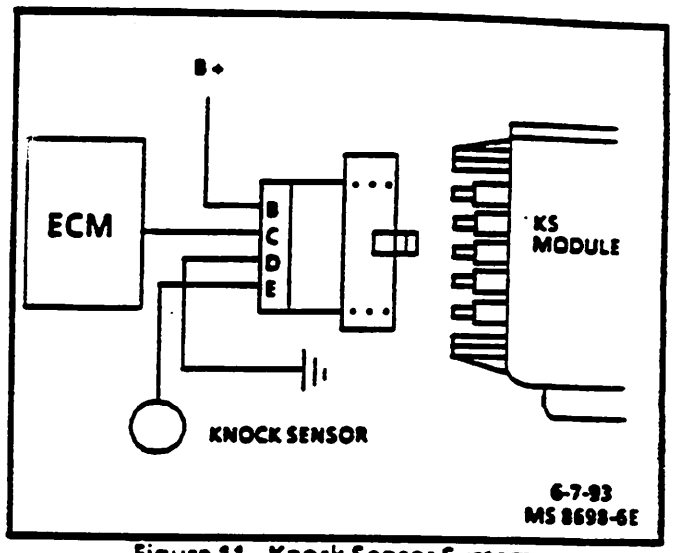


Figure 11 - Knock Sensor System

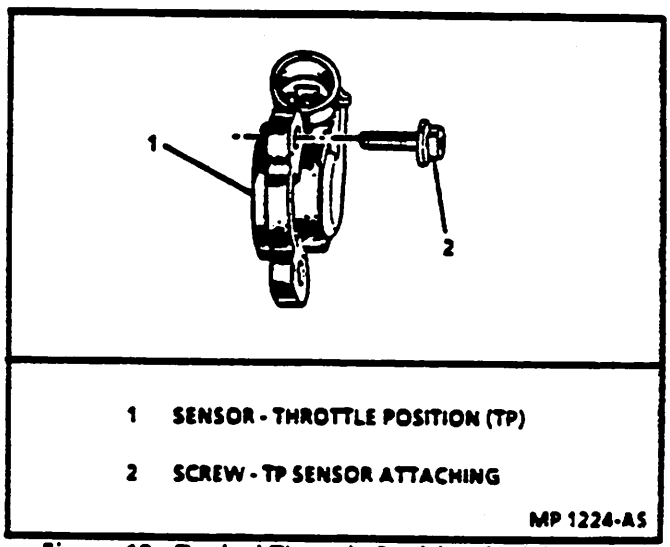


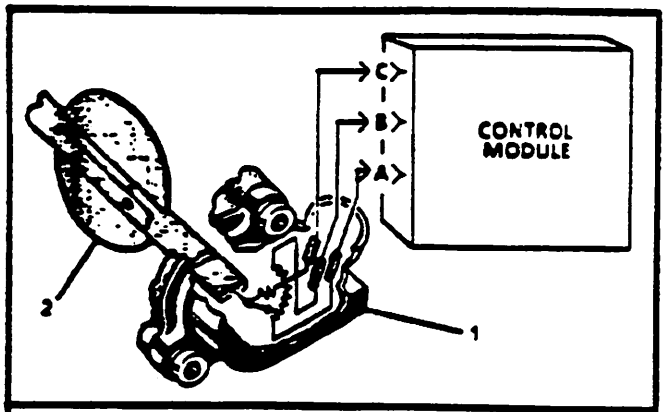
Figure 12 - Typical Throttle Position (TP) Sensor

A third wire is connected to the ECM to measure the voltage from the TP sensor. As the throttle valve angle is changed, the voltage output of the TP sensor also changes.

At a closed throttle position, the voltage output of the TP sensor is low (approximately .5 volt). As the throttle valve opens, the output increases so that at wide open throttle, the output voltage should be near 5 volts.

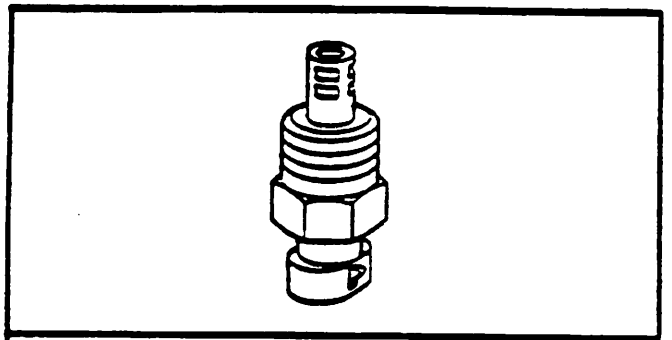
By monitoring the output voltage from the TP sensor, the ECM can determine fuel delivery based on throttle valve angle (operator demand). A broken or loose TP sensor can cause the ECM to interpret this as throttle movement and cause intermittent bursts of fuel from the injector and an unstable idle.

If the TP sensor circuit is open, the ECM will set a DTC 21. If the TP sensor circuit is shorted, the ECM will think the vehicle is at WOT, and a DTC 21 will be set. A problem in any of the TP sensor circuits will set a DTC 21. Once a DTC is set, the ECM will use a default value for TP sensor.



1 THROTTLE POSITION (TP) SENSOR
2 THROTTLE VALVE
9P 0394-SY

Figure 13 - Typical Throttle Position (TP) Sensor



1 IAT SENSOR
MS 11755

Figure 14 - Intake Air Temperature (IAT) Sensor

Intake Air Temperature (IAT) Sensor (Big Block Only)
Figure 14

The Intake Air Temperature (IAT) sensor is a thermistor (a resistor which changes value based on temperature) mounted on the underside of the plenum in the rear. Low temperature produces a high resistance, while high temperature causes a low resistance.

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 intake air is cold, and low when the intake manifold air is hot.

Ignition Control (IC) Reference

The ignition control reference (engine speed signal) is supplied to the ECM by way of the "IC Ref" 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 Ignition Control (IC) functions. This signal is used for a number of control and testing functions within the ECM.

Trim Position Sensor (Optional)

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

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

Discrete Switch Inputs (Optional)

Several discrete switch inputs are utilized by the MEFI system to identify abnormal conditions that may affect engine operation. Pull-up and pull-down 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 operation 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 which may be used with the MEFI system to detect critical engine operation parameters are.

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

SPARK MGMT
SYSTEMS

MARINE ELECTRONIC FUEL INJECTION (MEFI)
SECTION 4
SPARK MANAGEMENT SYSTEMS

This section will describe how the spark management systems operate and description of components used on the Marine Electronic Fuel Injection equipped engines. There are two types of spark management systems used. The Distributor Ignition (DI) System is used on all engines except on the LT 1 engine. On the LT 1 engine an Electronic Ignition (EI) System is used.

SPARK MANAGEMENT
DISTRIBUTOR IGNITION (DI) SYSTEM

CONTENTS

GENERAL INFORMATION

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

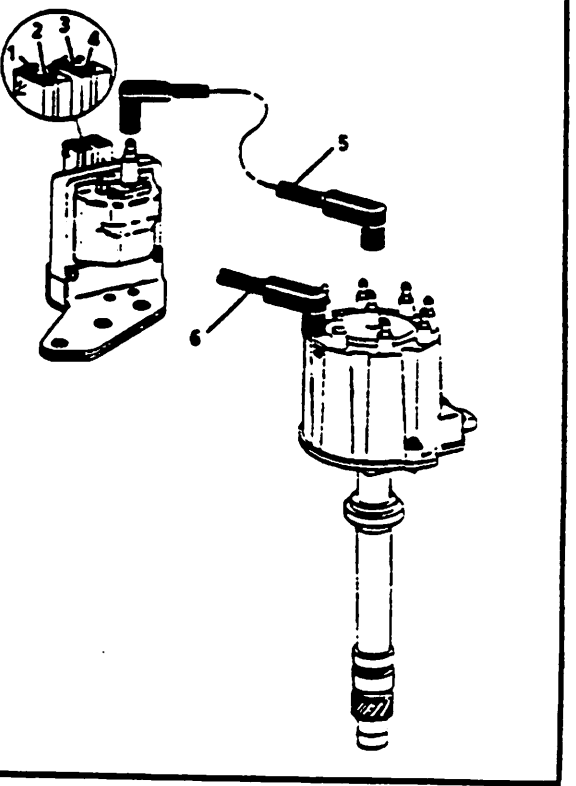
DELCO REMY DISTRIBUTORS
Figures 1 and 2

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

Distributors with a separate coil, are used on the MEFI engine (Figures 1 and 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 pickup assembly that consists of a permanent magnet, pole piece with internal teeth, and pickup coil. When the rotating teeth of the timer core line up with the teeth of the pole piece, voltage is induced in the pickup coil.



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

PS 18668

Figure 1 - Distributor with Separate 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.

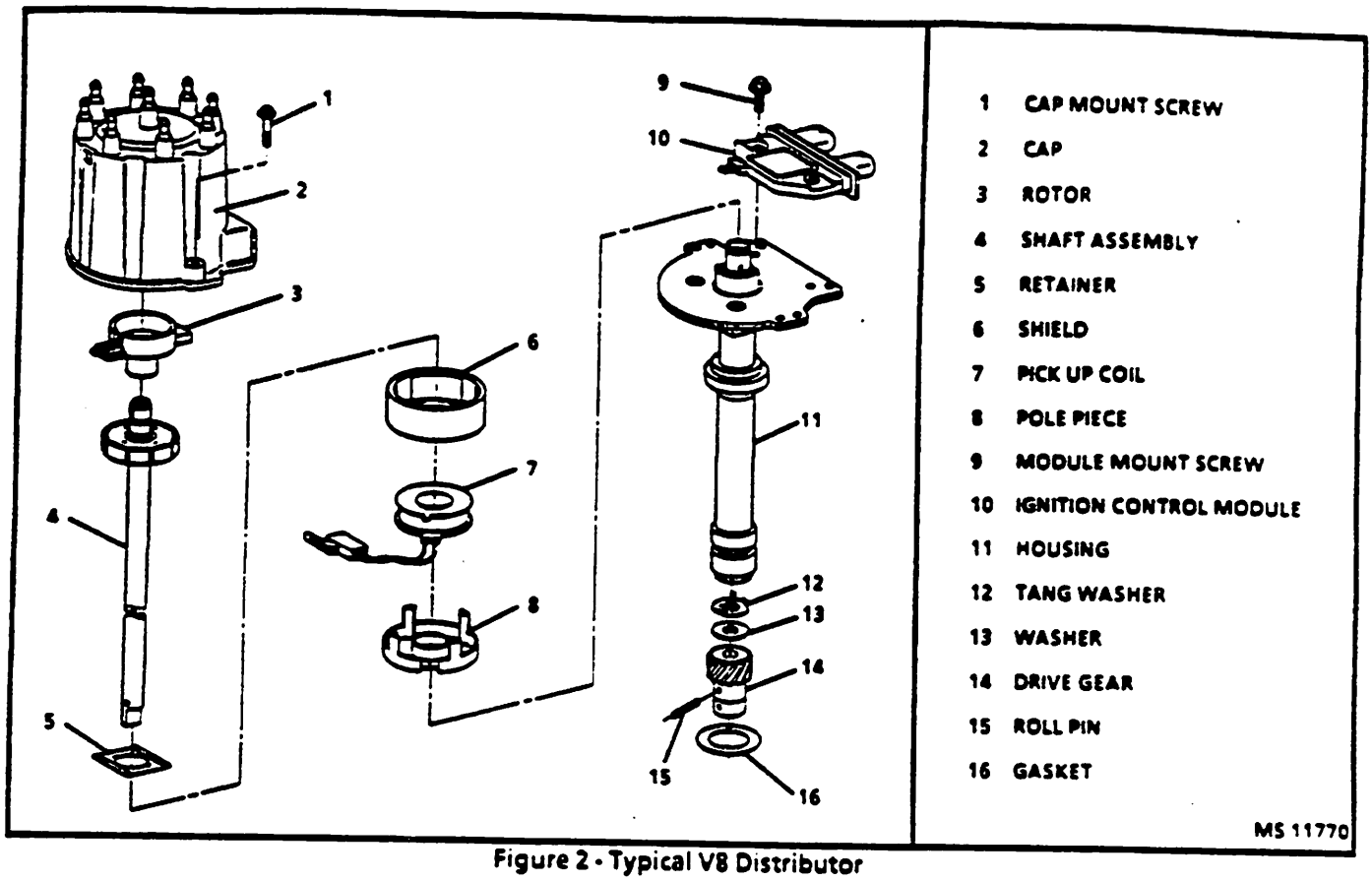


Figure 2 - Typical V8 Distributor

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

IGNITION COIL
Figure 1

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

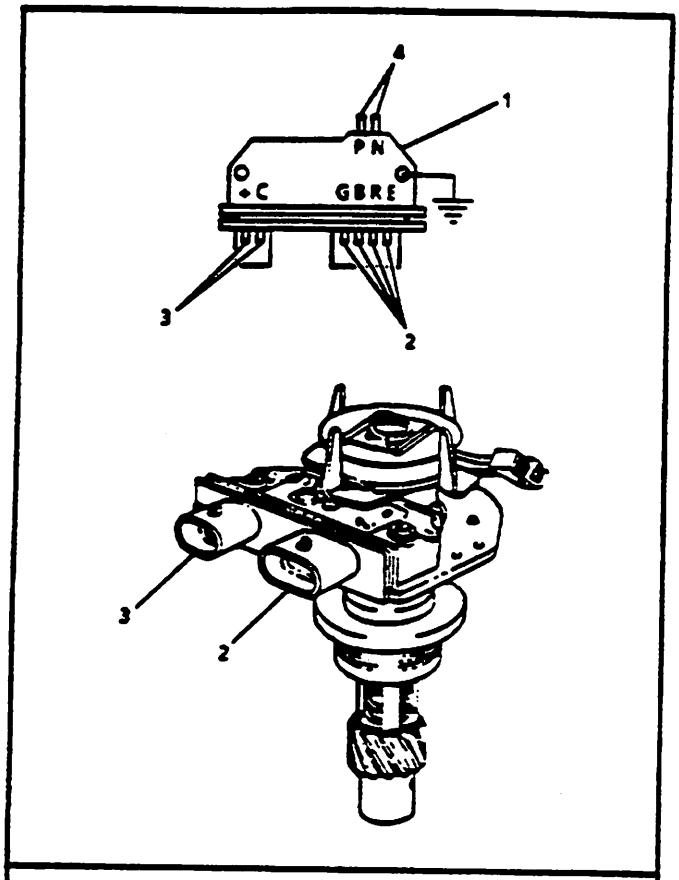
There is an iron laminated square frame around the coil windings. This is to increase magnetic flux path and store energy to produce higher secondary spark voltage. The coil's mounting bracket is attached to the frame.

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

IGNITION CONTROL (IC) MODULE
Figure 3

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

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



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

MS 13632

Figure 3 - IC Module Terminal Identification

POLE PIECE AND COIL ASSEMBLY
Figure 4

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

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

SPARK PLUG WIRES

The spark plug wires are a carbon-impregnated cord conductor encased in an 8 millimeter diameter

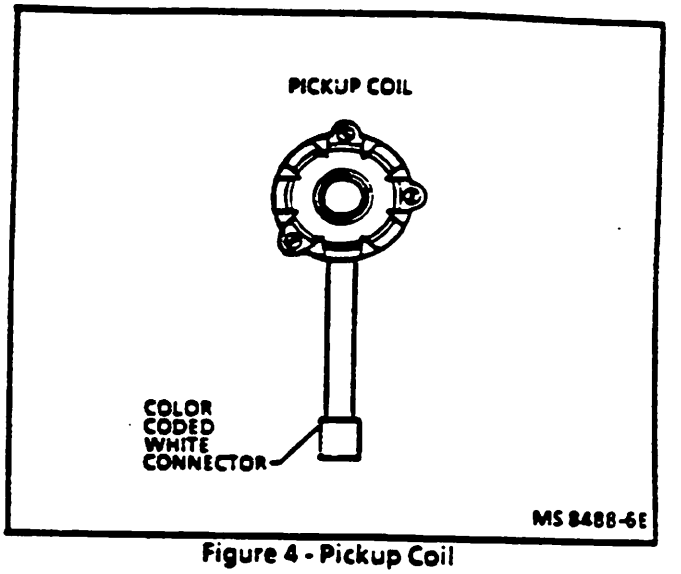


Figure 4 - Pickup Coil

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

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

MODES OF OPERATION

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

In IGNITION CONTROL MODE, the ECM controls the ignition timing. The ECM calculates the desired ignition timing based on information it gets from its input sensors.

IGNITION TIMING

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

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

IC OPERATION - MODULE MODE (CRANKING)
Figure 5

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

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

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

IC OPERATION - IGNITION CONTROL MODE (RUNNING)
Figure 6

When the engine RPM reaches a predetermined value (for this example: 400 RPM), the ECM considers the engine running and applies five volts on the bypass line to the IC module. This energizes the relay and causes the points from the pickup coil as well as the grounding points for the IC line to open (Figure 6). This connects the IC line to the base of the power transistor, and bypasses the ignition module timing control.

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

RESULTS OF INCORRECT OPERATION

An open or ground in the bypass circuit or connector to 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." The ECM recognizes the "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 pickup coil triggering in the ignition module timing mode.

If this condition were to occur while the engine was running, the engine would stop, but it would restart and run in the ignition module timing mode with reduced power.

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

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

Grounded or open 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 ground or open, it would not be able to energize the relay. Therefore, the relay would stay de-energized and the IC line would remain grounded.

When the ECM sees the IC line not "toggling," it will not enter the IC mode. Since the relay is de-energized, the engine would continue to run in the ignition module timing mode.

If this condition were to occur while the engine was running, it would simply operate in the ignition module timing mode.

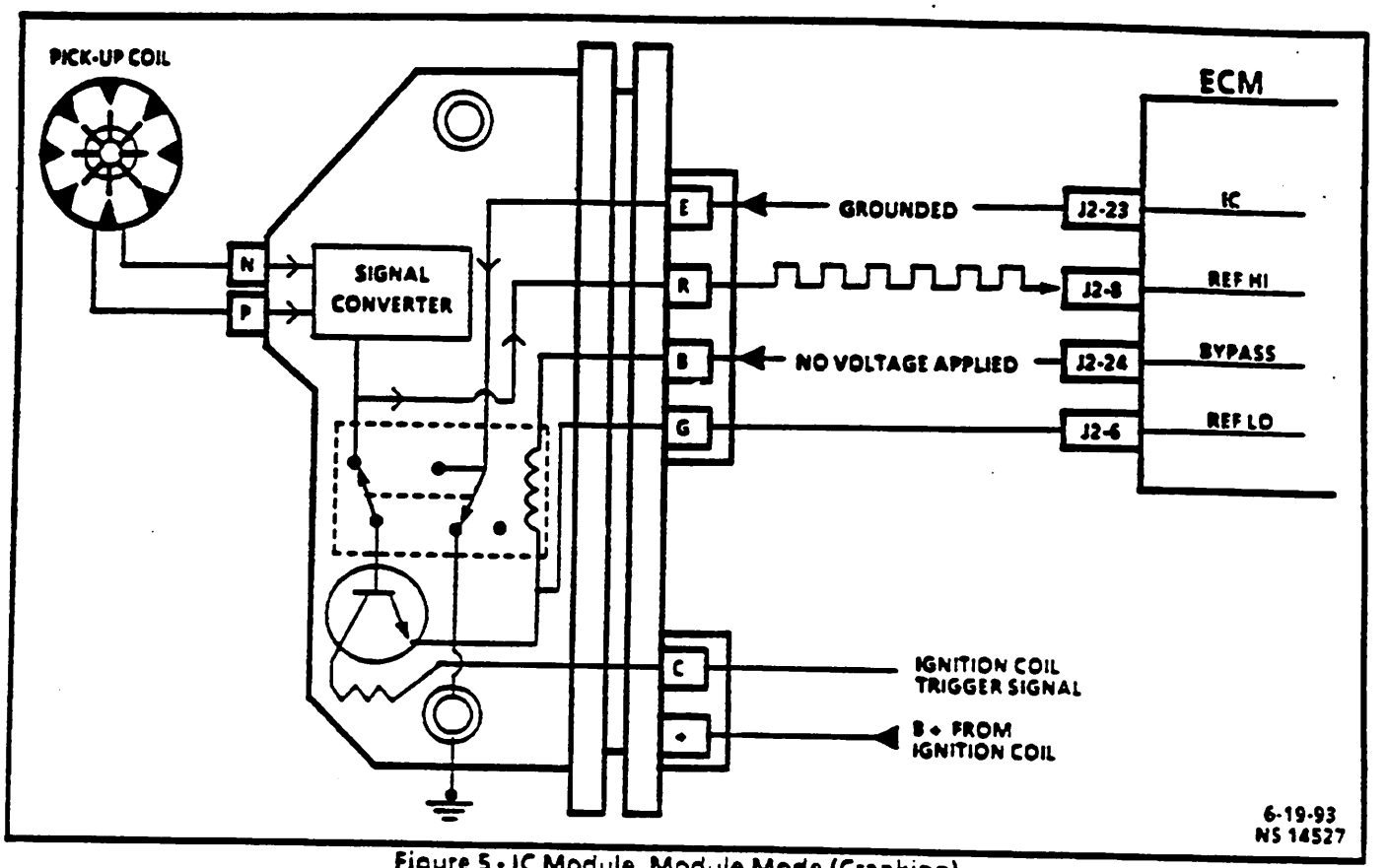


Figure 5 - IC Module, Module Mode (Cranking)

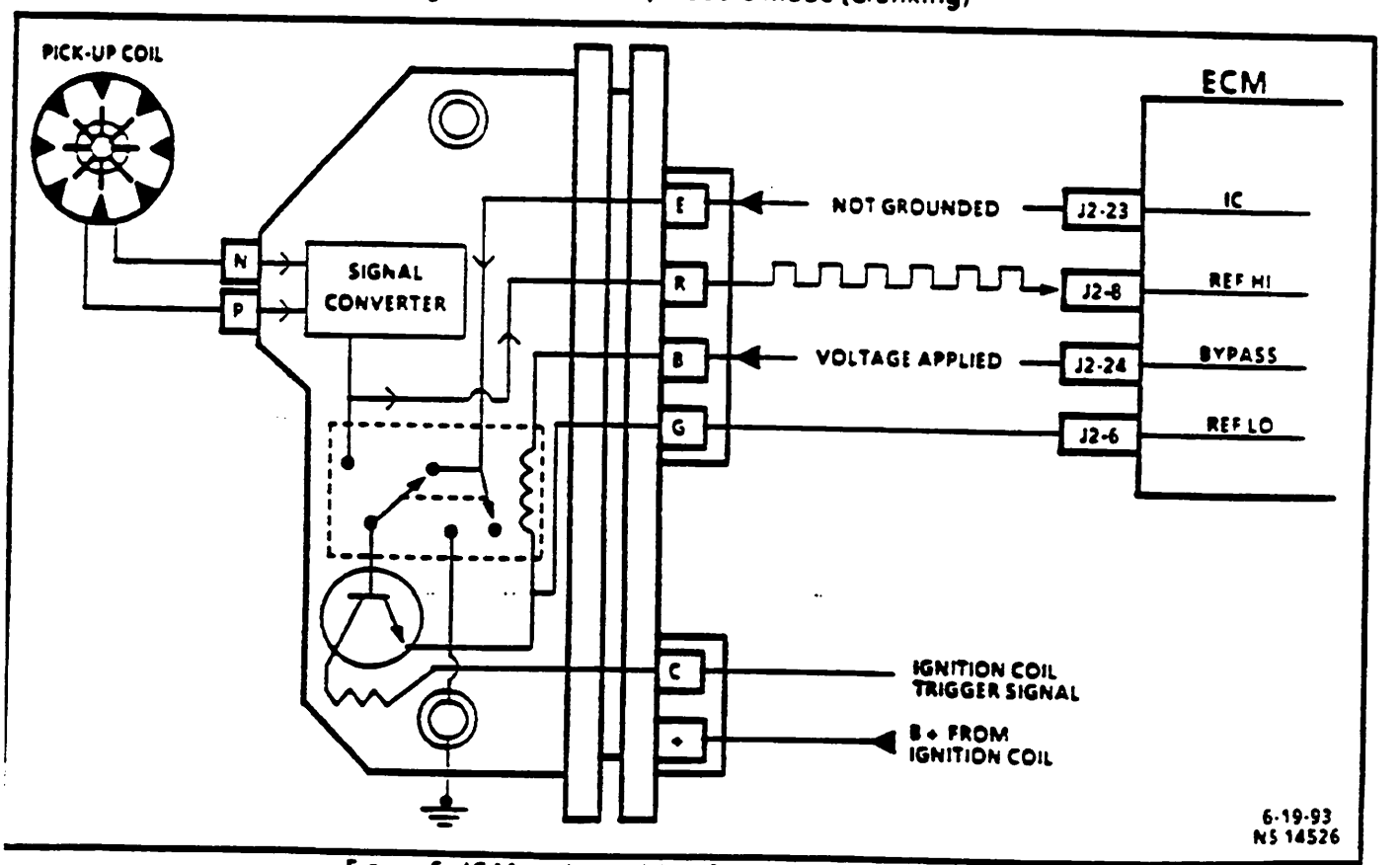


Figure 6 - IC Module, Ignition Control Mode (Running)

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

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

FUEL SYSTEMS
MFI

MARINE ELECTRONIC FUEL INJECTION (MEFI)
SECTION 3
FUEL METERING SYSTEMS

This section will describe how the fuel metering systems operate and description of components used on the Marine Electronic Fuel Injection equipped engines. The three fuel metering systems used are, Multiport Fuel Injection (MFI), Throttle Body Injection (TBI), and Central Multiport Fuel Injection (CMFI).

To distinguish what fuel system is used on what engine the following rules apply. On the MFI system, there are separate injectors for each cylinder and they are located in the intake manifold and fueled by a fuel rail. On the TBI there are two injectors and they are mounted at the top of the throttle body assembly. On the CMFI system there is one injector assembly located inside of the lower intake manifold with tubes running to independent poppet nozzles

FUEL METERING SYSTEM
MULTIPORT FUEL INJECTION (MFI)
CONTENTS

GENERAL DESCRIPTION

PURPOSE

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

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 "ON" the fuel pump relay and the fuel pump builds up pressure. The ECM then checks the Engine Coolant Temperature (ECT) sensor and Throttle Position (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 75% of its travel. 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 75%, and the engine speed is below 400 RPM. If the throttle position becomes slightly greater than 75%, or slightly less than 75%, the ECM returns to the starting mode.

Run Mode

When the engine is first started and RPM is above 400, the system operates in the run mode. The ECM will calculate the desired air/fuel ratio based on these ECM inputs: RPM, Manifold Absolute Pressure (MAP) sensor, and Engine Coolant Temperature (ECT) sensor. Higher engine load (from MAP) and colder engine temperature (from ECT) requires more fuel, or a richer air/fuel ratio.

Acceleration Mode

The ECM looks at rapid changes in Throttle Position (TP) sensor and manifold pressure (MAP), and provides extra fuel by increasing the injector pulse width.

Fuel Cutoff Mode

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

RPM Reduction Mode

The ECM recognizes change of state in a discrete switch input that identifies an abnormal condition that may affect proper engine operation.

As an engine protection feature (optional), RPM reduction mode allows normal fuel injection up to OEM specification (approximately 2000 RPM). Above the OEM specified RPM limit, fuel delivery is limited to half the fuel injectors until the engine drops below 1200 RPM. Then normal engine operation is restored until the RPM limit is exceeded.

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 1) is made up of the following parts:

- Fuel supply components (fuel tank, pump, lines, water separator).
- Fuel pump electrical circuit.
- Fuel rail assembly, including:
  - Fuel injectors.
  - Pressure regulator assembly.
- Throttle body assembly, including:
  - Idle Air Control (IAC) valve.
  - Throttle Position (TP) sensor.

FUEL SUPPLY COMPONENTS (TYPICAL)
Figures 1 and 2

The fuel supply is stored in the fuel tank. An electric fuel pump (Figure 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 "ON," the ECM turns the fuel pump relay "ON" for two seconds causing the fuel pump to pressurize the MEFI fuel system.

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

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

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

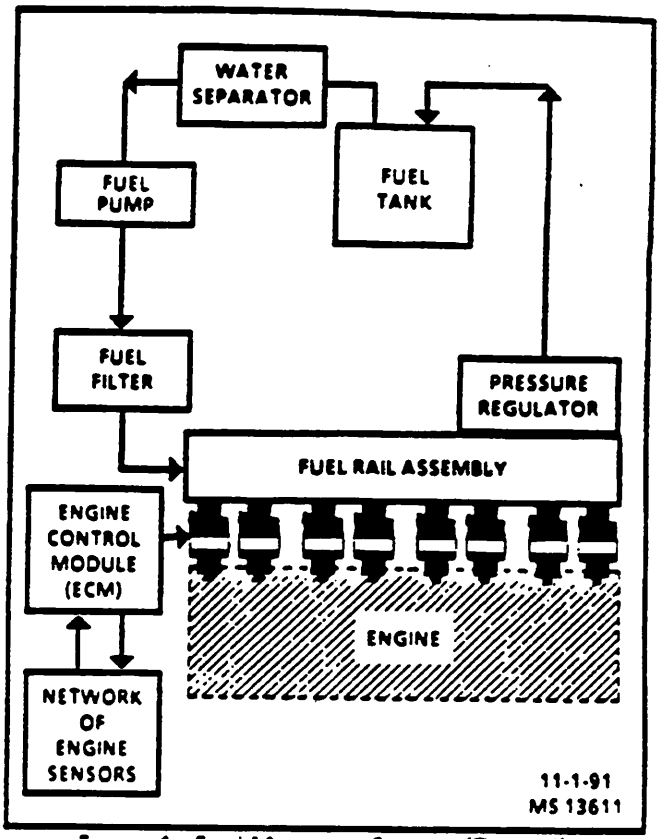


Figure 1 - Fuel Metering System (Typical)

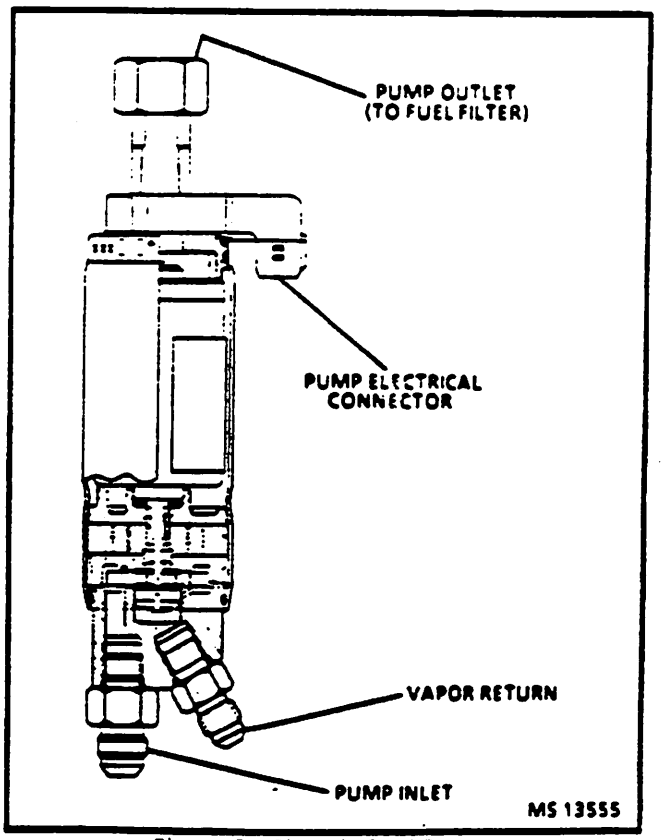
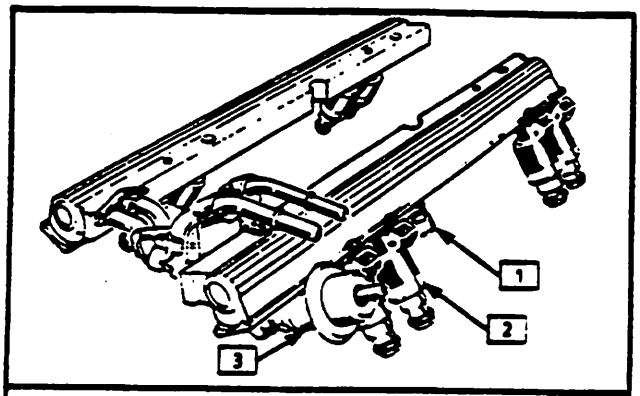


Figure 2 - Electric Fuel Pump

FUEL RAIL ASSEMBLY
Figures 3 and 4

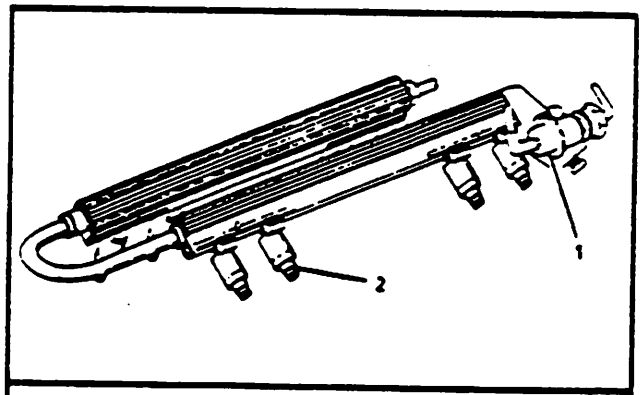
The fuel rail (Figure 3 and 4) is mounted to the engine intake manifold, and performs several functions: it positions the injectors in the intake manifold, distributes fuel evenly to the injectors, and integrates the fuel pressure regulator into the fuel metering system.



1 FUEL PRESSURE CONNECTION ASSEMBLY
2 MPFI INJECTOR ASSEMBLY
3 PRESSURE REGULATOR ASSEMBLY

MP 1299-AS

Figure 3 - Fuel Rail Assembly (LT1)



1 PRESSURE REGULATOR ASSEMBLY
2 MFI INJECTOR ASSEMBLY

PS 19062

Figure 4 - Assembly (Big Block) Fuel Rail

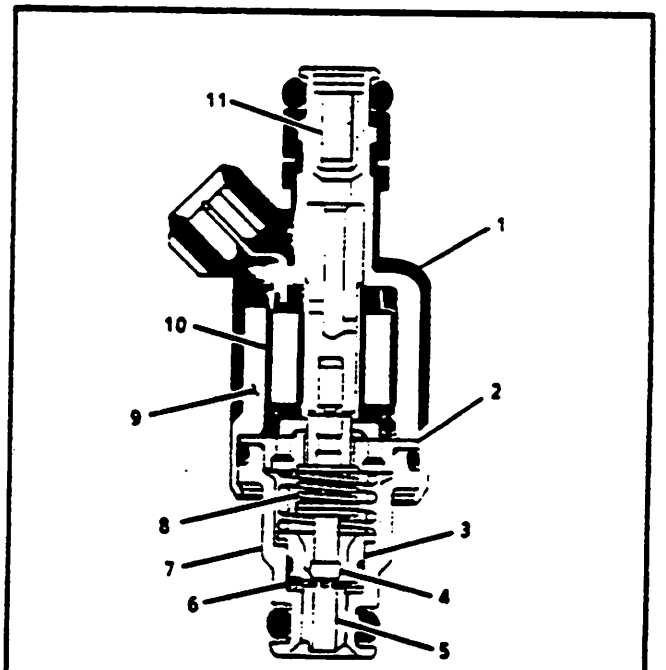
Fuel Injectors
Figure 5

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 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 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."

Pressure Regulator Assembly
Figure 6

The pressure regulator is a diaphragm-operated relief valve with fuel pump pressure on one side, and regulator spring pressure and intake manifold vacuum on the other (Figure 6). 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.



1	SOLENOID ASSEMBLY	7	HOUSING - SPRAY
2	SPACER AND GUIDE ASSEMBLY	8	SPRING - CORE
3	CORE SEAT	9	HOUSING - SOLENOID
4	VALVE - BALL	10	SOLENOID
5	SPRAY TIP	11	FILTER - FUEL INLET
6	PLATE - DIRECTOR		

9P 0413-SY

Figure 5 - MFI Injector Assembly

With the ignition "ON," and engine "OFF" (zero vacuum), fuel pressure at the pressure test connection should be 284-325 kPa (41-47 psi). If the pressure is too low, poor performance could result.

THROTTLE BODY ASSEMBLY
Figures 7 and 11

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 7). The throttle plates within the throttle body are opened by the driver through the throttle controls. During engine idle, the throttle plates are almost 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 Throttle Position (TP) sensor and for sensing changes in engine vacuum due to throttle plates position.

Idle Air Control (IAC) Valve
Figures 8 through 11

The purpose of the IAC valve assembly (shown in Figures 8 and 10) is to control engine idle speed, while preventing stalls due to changes in engine load.

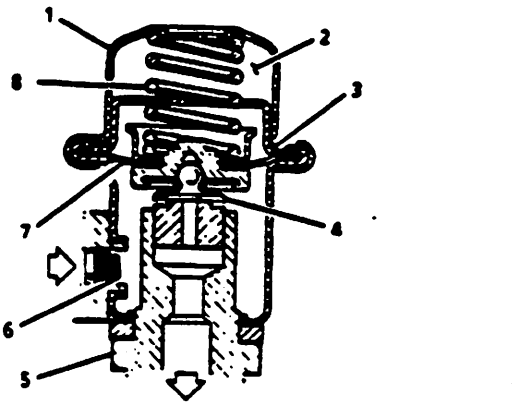
There are two types of IAC valves, thread mounted or flange mounted. Depending on production date, an engine could be equipped with one or the other.

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

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

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

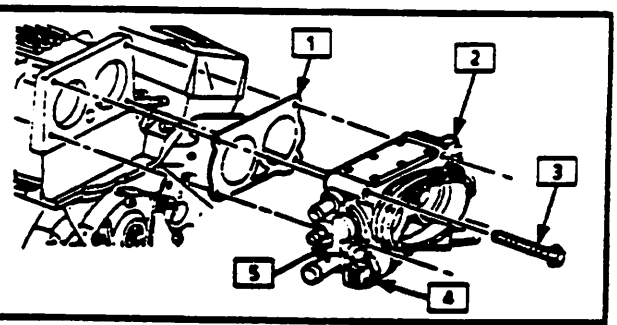
- Engine idle speed is a function of total air flow into the engine based on IAC valve pintle position + throttle plates opening.
- "Controlled" idle speed is programmed into the ECM, which determines the correct IAC valve pintle position to maintain the desired idle speed for all engine operating conditions and loads.
- The minimum idle air rate is set at the factory with a stop screw. This setting allows enough air flow by the throttle plates to cause the IAC valve pintle to be positioned a calibrated number of steps (counts) from the seat, during "controlled" idle operation.



1 COVER
2 VACUUM CHAMBER (VACUUM SOURCE TUBE NOT SHOWN)
3 SEAL - O-RING
4 VALVE - FUEL PRESSURE REGULATOR
5 BASE ASSEMBLY
6 FILTER - SCREEN (IF EQUIPPED)
7 DIAPHRAGM
8 SPRING

NA 0493-SY

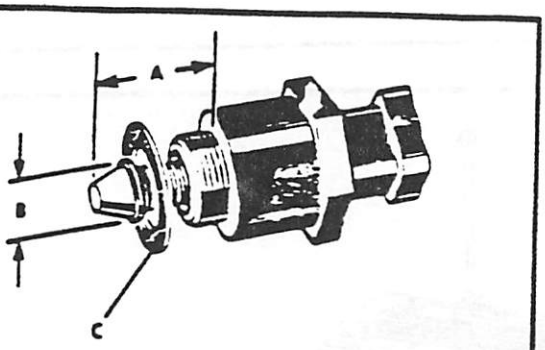
Figure 6 - Pressure Regulator Assembly (Typical)



1 GASKET
2 THROTTLE BODY ASSEMBLY
3 BOLT
4 IDLE AIR CONTROL (IAC) VALVE
5 THROTTLE POSITION SENSOR (TPS)

MS 12304

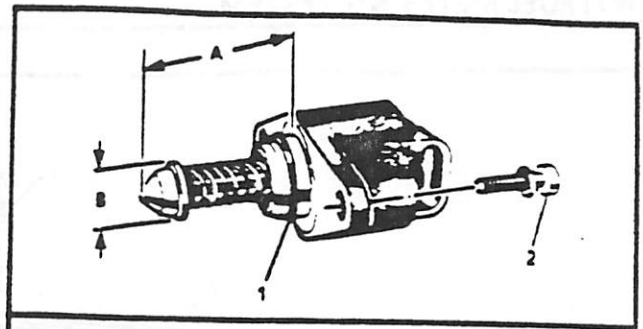
Figure 7 - Throttle Body Assembly (LT1)



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

9P 1058-AS

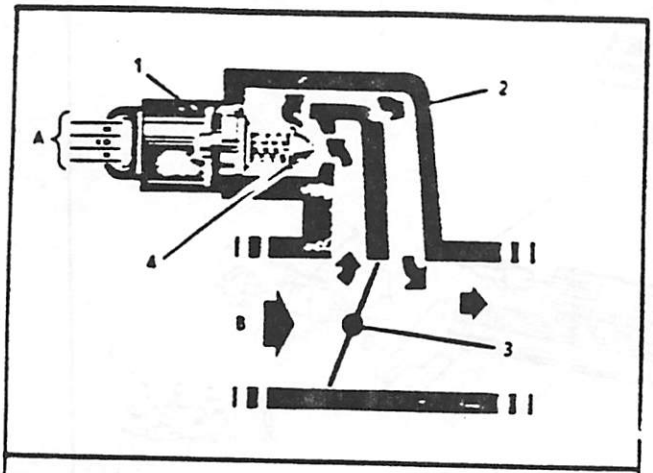
Figure 8 - Thread Mounted Type IAC Valve



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

LP 1220-AS

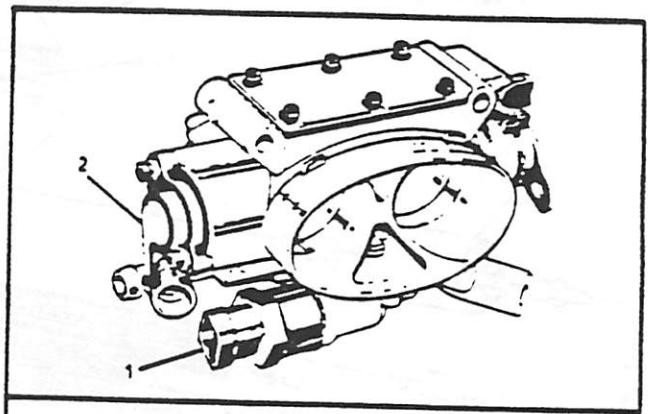
Figure 10 - Flange Mounted Type IAC Valve



1 VALVE ASSEMBLY - IDLE AIR CONTROL (IAC)
2 BODY ASSEMBLY - THROTTLE
3 VALVE - THROTTLE
4 PINTLE - IAC VALVE
A ELECTRICAL INPUT SIGNAL
B AIR INLET

NA 0494-SY

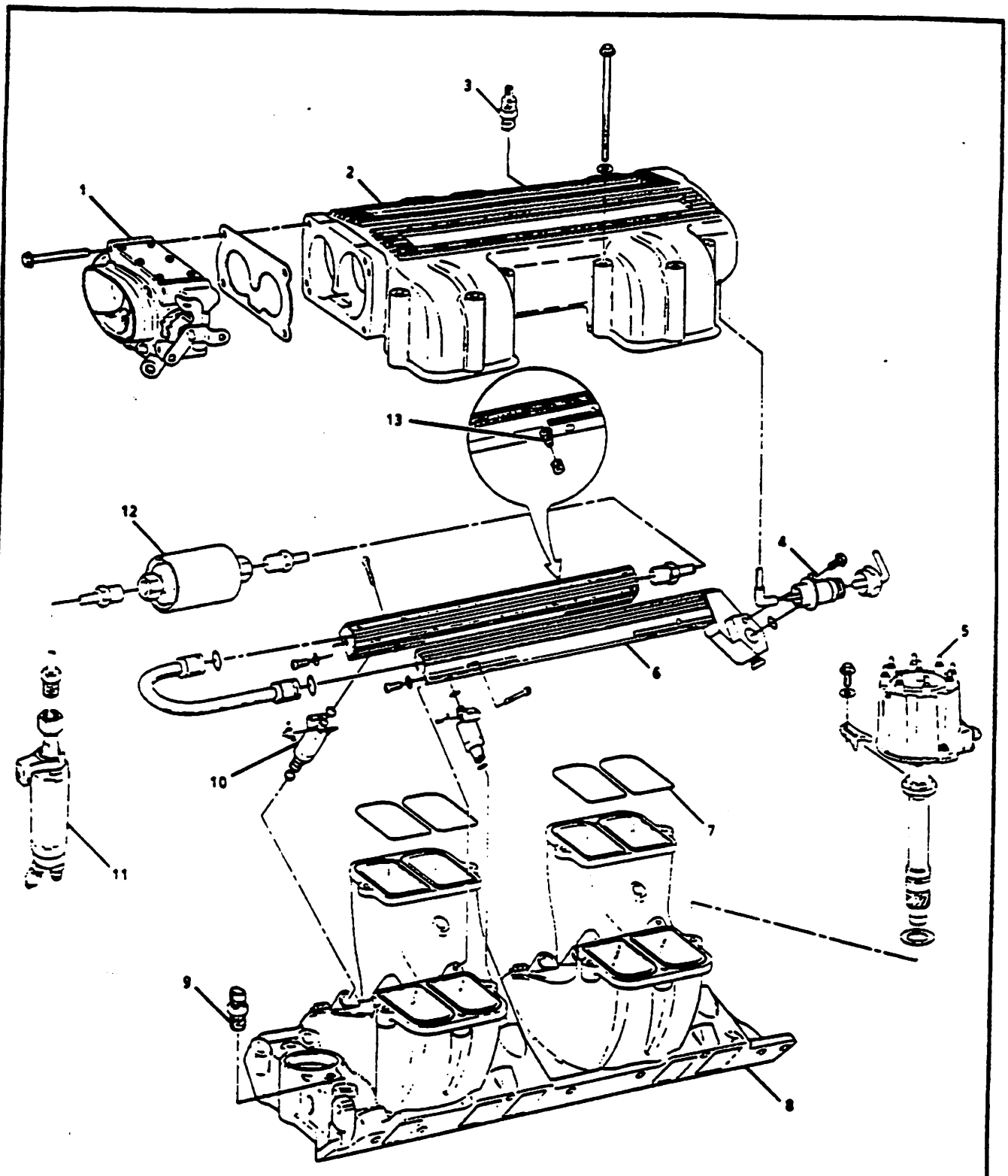
Figure 9 - IAC Valve Air Flow Diagram



1 VALVE ASSEMBLY - IDLE AIR CONTROL (IAC)
2 SENSOR - THROTTLE POSITION (TP)

MP 1314-AS

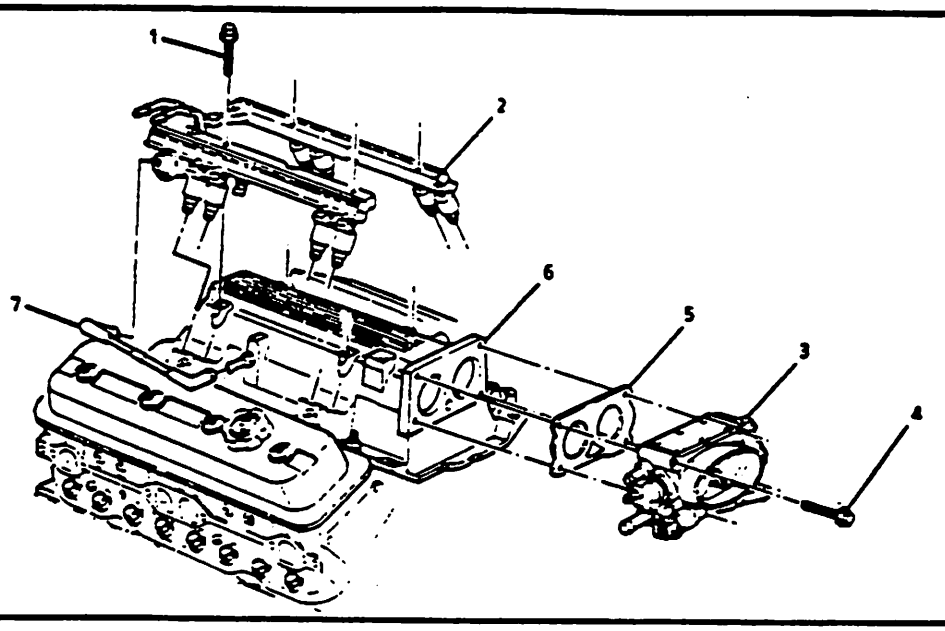
Figure 11 - Throttle Body Assembly



1	THROTTLE BODY ASSEMBLY	6	FUEL RAIL	10	MFI INJECTOR
2	UPPER INTAKE (PLENUM)	7	O-RING	11	FUEL PUMP
3	IAT SENSOR	8	LOWER INTAKE	12	FUEL FILTER
4	FUEL PRESSURE REGULATOR	9	ECT SENSOR	13	QUICK CONNECT FITTING
5	DISTRIBUTOR				

6-24-93
PS 18346

Figure 12 - Big Block Fuel Rail and Throttle Body Assemblies



1	BOLT SCREW, FUEL INJECTION FUEL RAIL	5	GASKET, THROTTLE BODY
2	RAIL ASSEMBLY, FUEL INJECTION FUEL	6	MANIFOLD ASSEMBLY, INTAKE
3	BODY ASSEMBLY, THROTTLE	7	TUBE ASSEMBLY, FUEL PRESSURE REGULATOR VACUUM
4	BOLT SCREW, THROTTLE BODY		

PS 19063

Figure 13 - LT1 Fuel Rail and Throttle Body Assemblies

DIAGNOSES
MFI

MARINE ELECTRONIC FUEL INJECTION (MEFI)
SECTION 5
DIAGNOSES

This section will be used to perform diagnostic procedures on the Marine Electronic Fuel Injection equipped engines. The section describes system circuits and flow charts used to diagnose the circuits. It will be used to correct Diagnostic Trouble Codes (DTCs) by following flow charts 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 diagnoses or before repairs are made to the MEFI system.

The assumption is made that on all diagnosis charts, 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 wire harness.

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

MFI DIAGNOSIS
CONTENTS

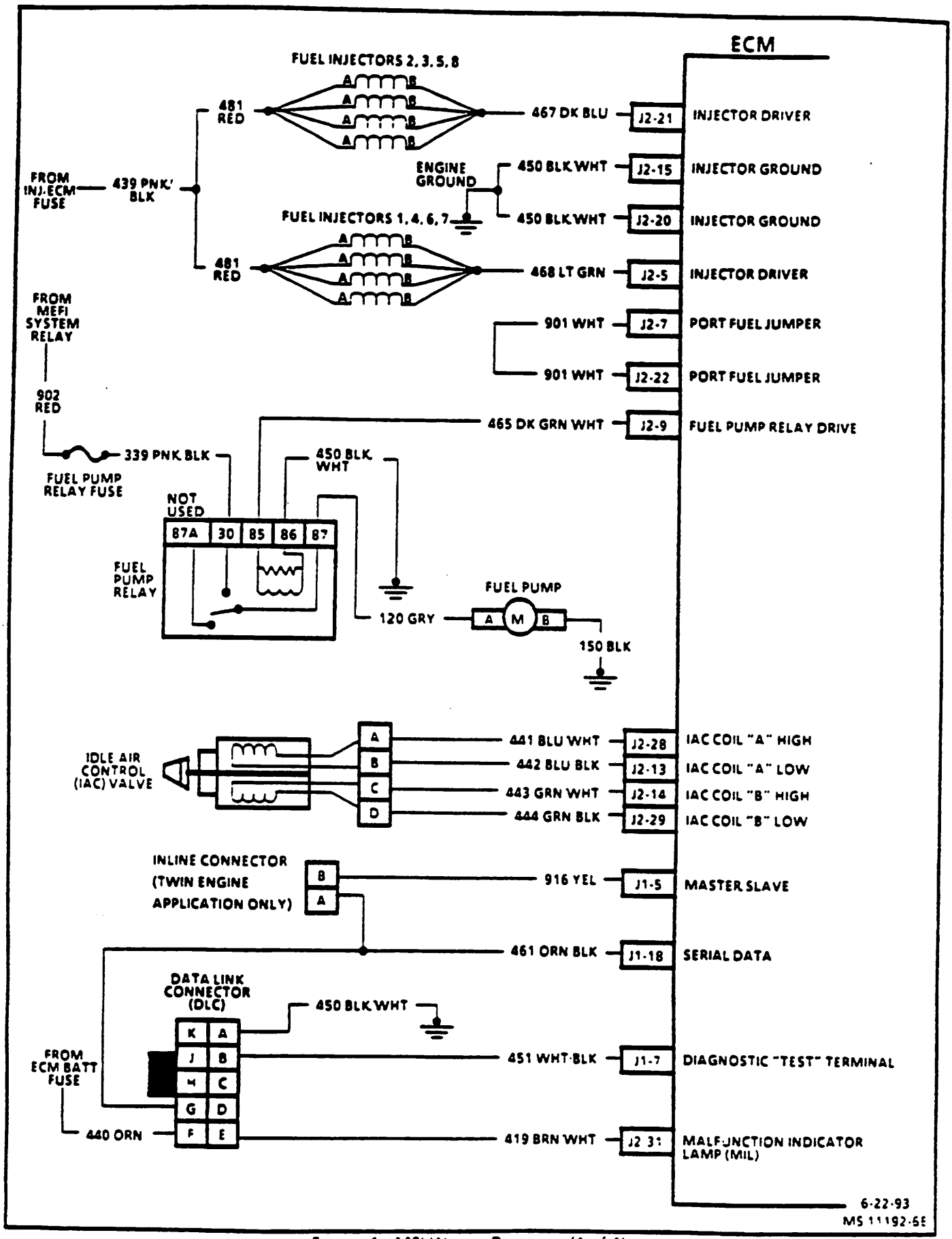


Figure 1 - MFI Wiring Diagram (1 of 4)

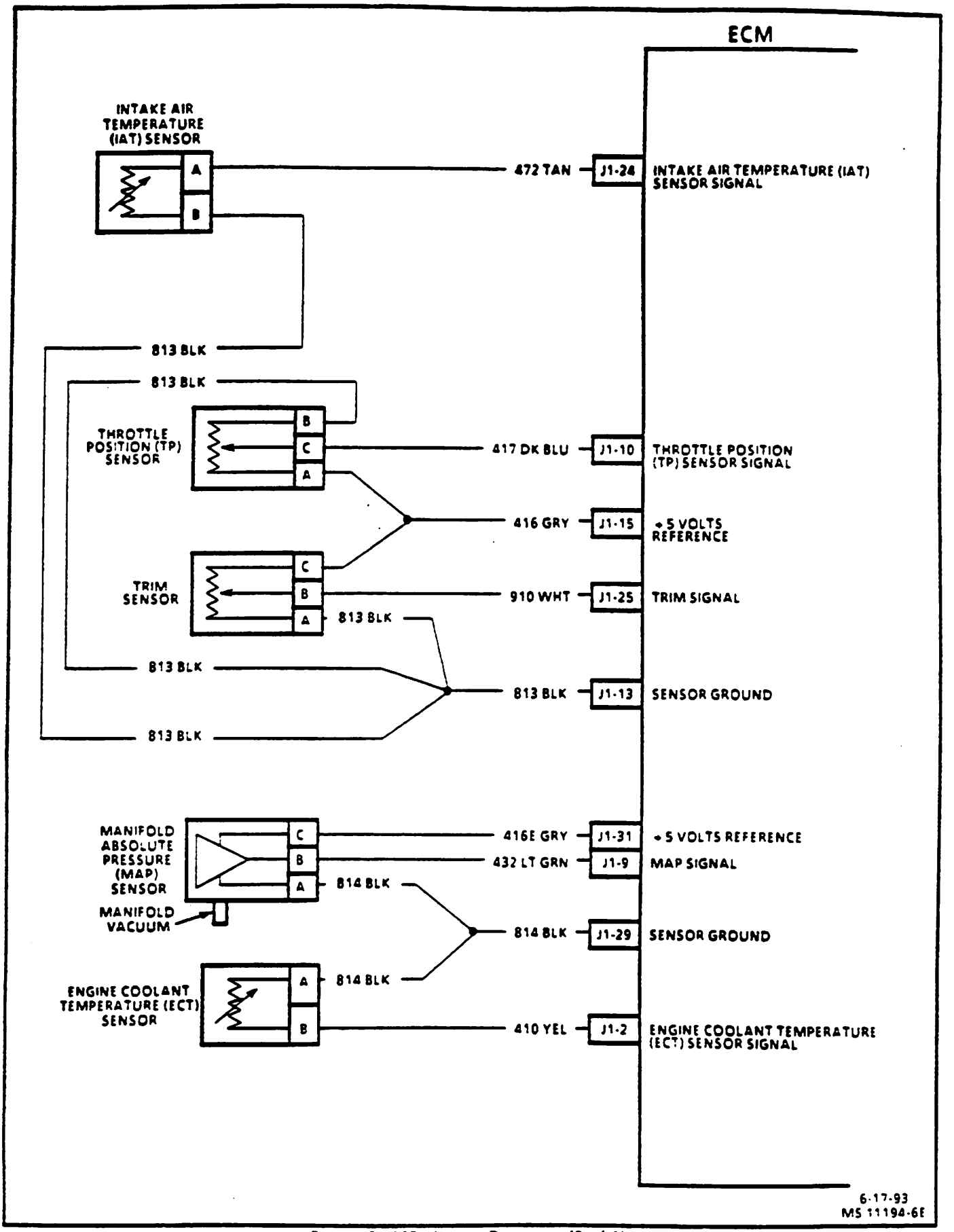
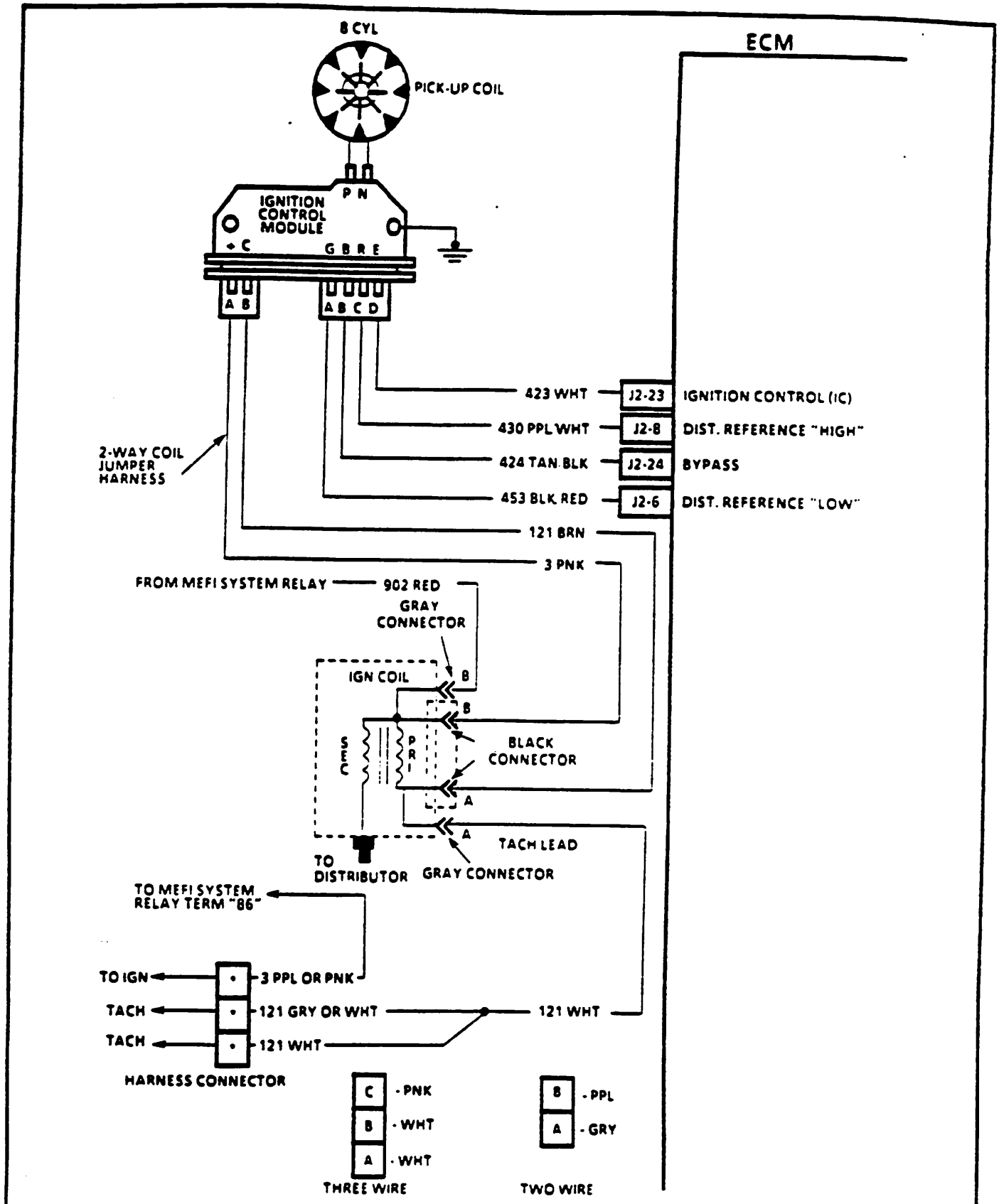


Figure 2 - MFI Wiring Diagram (2 of 4)



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

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MS 11193-6E

Figure 3 - MFI Wiring Diagram (3 of 4)

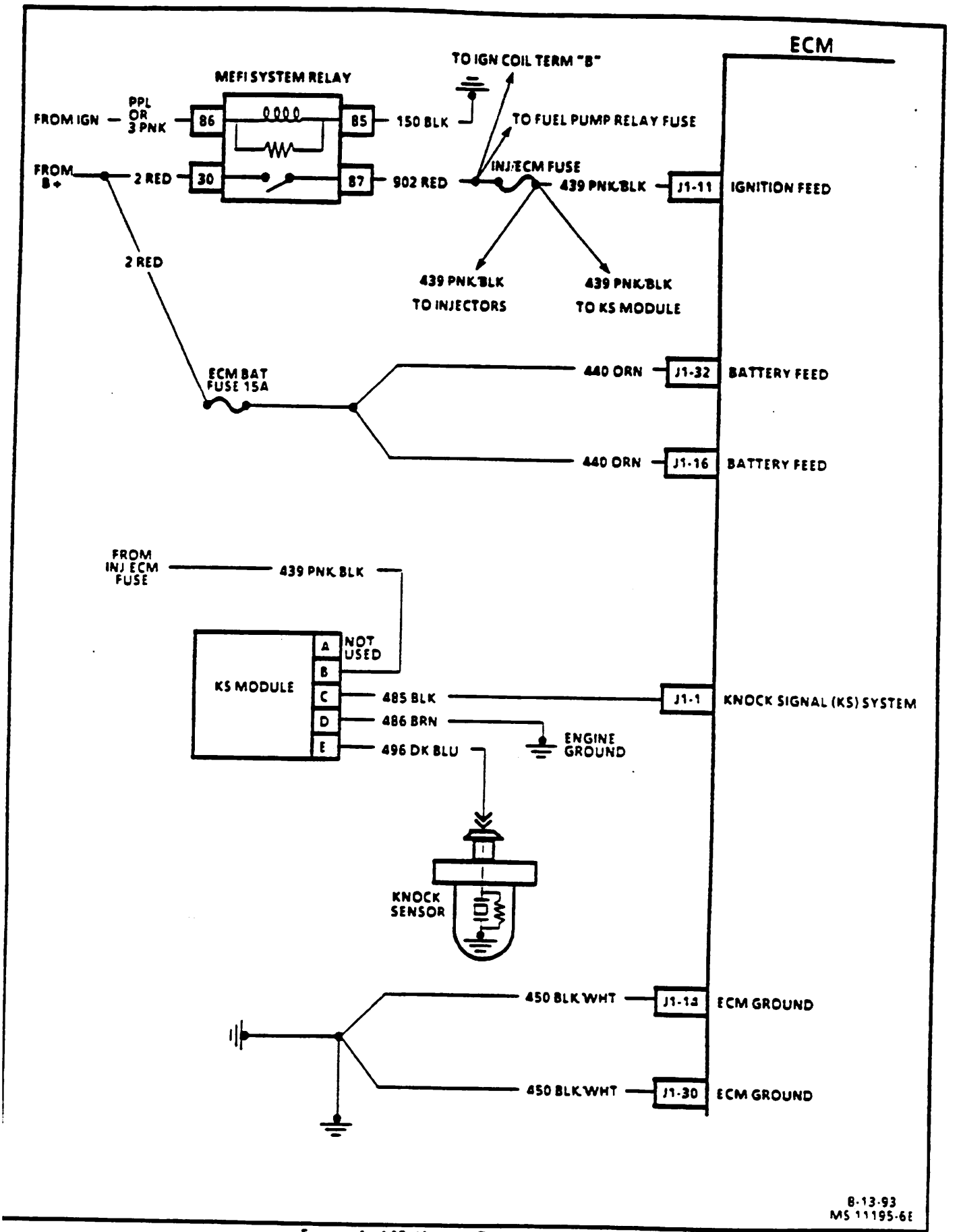
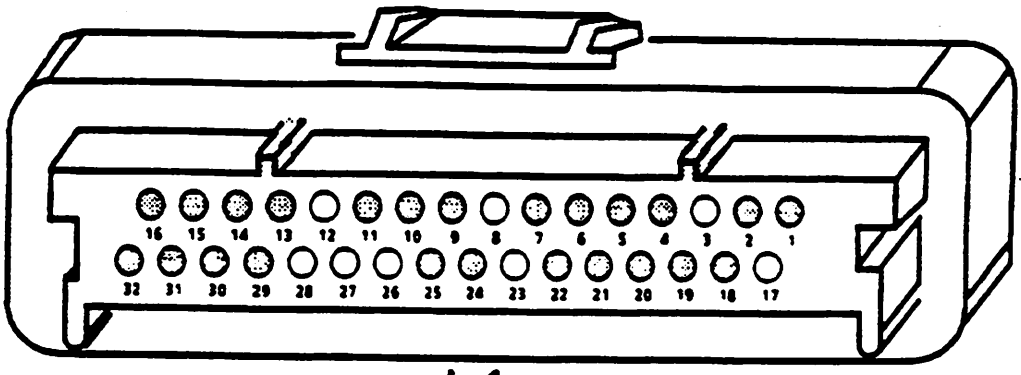


Figure 4 - MFI Wiring Diagram (4 of 4)



J-1

ECM 32 WAY OUTPUT CONNECTOR

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

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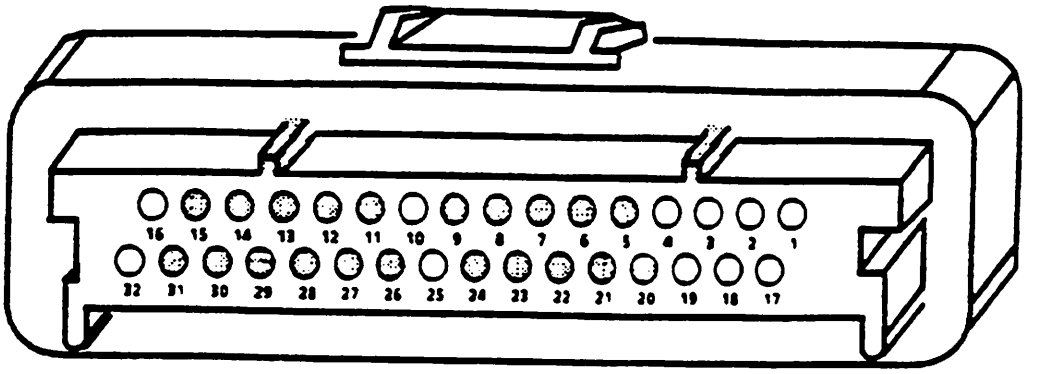

J - 2

ECM 32 WAY OUTPUT CONNECTOR

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

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MS 11766

TYPICAL SCAN TOOL DATA DEFINITIONS

ECM DATA DESCRIPTION

A list of explanations for each data message displayed on the scan tool begins below.

This information will assist in tracking down diagnostic problems, since the displays can be viewed while the vehicle is being driven. See the "On-board Diagnostic (OBD) System Check" for additional information.

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

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

ENGINE COOLANT TEMP - Range -40° to 151°C, -40° to 304°F - The Engine Coolant Temperature (ECT) sensor is mounted in the coolant system 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 which 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.

MAP - Range 11-105 kPa/0.00-5.10 Volts - The Manifold Absolute Pressure (MAP) sensor measures the change in the intake manifold pressure which results from engine load and speed changes. As intake manifold pressure increases, the air density in the intake manifold also increases and additional fuel is required.

KNOCK RETARD - Range 0° to 45° - Indicates the amount of spark advance the ECM is removing from IC in response to the Knock Sensor (KS) signal

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

BARO - Range 11-105 kPa/0.00-5.10 Volts - The BARO reading displayed is measured from the MAP sensor at the "ON," engine "OFF" and WOT conditions The BARO reading displayed represents barometric pressure and is used to compensate for altitude differences.

THROT POSITION - Range 0-5.10 Volts - Used by the ECM to determine the amount of throttle demanded by the driver. Should read .36-.96 volt at idle to above 4 volts at wide open throttle.

THROTTLE ANGLE - Range 0 - 100% - Computed by the ECM from TP sensor voltage (Throttle Position) and should read 0% at idle and 100% at wide open throttle. Refer to DTC 21 if TP sensor angle is not 0% at idle.

SPARK ADVANCE - Tech 1 Range -90° to 90° - This is a display of the spark advance (IC) calculation 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, load, vehicle speed, and operating mode. There is no adjustment for spark advance.

IDLE AIR CONTROL - Range 0-255 - Displays the commanded position of the idle air control pintle in counts. The higher the number counts, the greater the idle air passages opened.

INJECTOR PULSE WIDTH - Scan Tool - Range 0.0 to 999.9 - Indicates in milliseconds the time the injectors remain "ON." When engine load is increased, injector pulse width will increase

PROM ID - Range 0 to 99999 - The PROM identification describes the particular PROM being used in the ECM. The scan tool display number is not the service part number.

SYSTEM VOLTAGE - Range 0.0 to 25.5 Volts - This represents the system voltage measured by the ECM.

TIME FROM START - Range 0:00:00 to 18:12:15 HR:MIN:SEC - A measure of how long the engine has been running. When the engine stops, it is reset to zero.

INT AIR TEMP (IAT) - The ECM converts the resistance of the intake air temperature sensor to degrees. Intake Air Temperature (IAT) can be used by the ECM to adjust fuel delivery and spark timing according to oncoming air density

7-6-93
PS 18345

DIAGNOSTIC TROUBLE CODE (DTC) IDENTIFICATION

The Malfunction Indicator Lamp (MIL) will be "ON" if the malfunction exists under the condition 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.

NOTICE: There are time periods (instantly or up to 1 minute) that can be programmed in the ECM before the MIL comes "ON" or the DTC will set if a probable cause from below continues. In doing diagnosis for an intermittent, a wiggle of a wire or connector might not set the DTC. The times below are an example of those times and may not pertain to all engines.

DTC AND CIRCUIT	PROBABLE CAUSE
DTC 14 - Engine Coolant temperature (ECT) Sensor Circuit. High or low temperature indicated.	Sets if the sensor signal line becomes grounded or connections or wires opened for 3 seconds.
DTC 21 - Throttle Position (TP) Sensor Circuit. Signal too low or too high.	TP signal inconsistent with RPM and MAP, or a shorted to ground or opened signal circuit.
DTC 23 - Intake Air Temperature (IAT) Sensor Circuit. High or low temperature indicated.	Sets if the sensor, connection, or wires open or shorted to ground for 3 seconds.
DTC 33 - Manifold Absolute Pressure (MAP) Sensor Circuit. Signal voltage too high or too low.	MAP sensor output too high for 3 seconds or an open signal circuit, or low or no output from sensor with engine running, MAP inconsistent to RPM and throttle position.
DTC 42 - Ignition Control (IC) System. IC not receiving correct voltage.	ECM has seen an opened or grounded IC or bypass circuit.
DTC 43 - Knock Sensor (KS) Circuit. High volts or low volt signal indicated	KS circuit has been opened or grounded for 58 seconds
DTC 51 - Fault EEPROM	Faulty EEPROM or ECM.

CLEARING DIAGNOSTIC TROUBLE CODES (NON-SCAN)

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

NOTICE: When clearing DTCs with or without the use of a scan tool, the battery must be fully charged and cranking speed must be at least 200 RPM. The ability to clear DTCs is directly dependent on battery being fully charged and able to crank engine with adequate cranking RPM.

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PS 18408

MEFI ON-BOARD DIAGNOSTIC (OBD) SYSTEM CHECK

The On-Board Diagnostic (OBD) System Check is an organized approach to identifying a problem created by an electronic engine control system malfunction. It must be the starting point for any driveability compiaint diagnosis, because it directs the service technician to the next logical step in diagnosing the complaint.

The scan tool data listed in the table may be used for comparison, after completing the OBD system check and finding the on-board diagnostics functioning properly and no diagnostic trouble codes displayed. The "Typical Values" are an average of display values recorded from normally operating vehicles and are intended to represent what a normally functioning system would typically display.

A SCAN TOOL THAT DISPLAYS FAULTY DATA SHOULD NOT BE USED, AND THE PROBLEM SHOULD BE REPORTED TO THE MANUFACTURER. THE USE OF A FAULTY SCAN CAN RESULT IN MISDIAGNOSIS AND UNNECESSARY PARTS REPLACEMENT.

Only the parameters listed below are used in this manual for diagnosing. If a scan reads other parameters, the values are not recommended for use in diagnosing. If all values are within the range illustrated, refer to "Symptoms" section.

SCAN TOOL DATA

Idle / Warm Engine / Closed Throttle / Neutral

Scan Position	Units Displayed	Typical Data Value
Engine Speed Desired Idle	RPM RPM	650-700 RPM 655-700 RPM
Coolant Temp Intake Air Temp.	C° F° N/A	65 - 75°C N/A
MAP Baro	kPa, V kPa, V	1 - 3 Volts (Depends on Vacuum and Baro Pressure) 3 - 5 Volts (Depends on Altitude and Baro Pressure)
Throt Position Throttle Angle	Volts 0-100%	.78 Volts 0 - 100%
Fuel Consumption Inj. Pulse Width	GPH mSec.	1.7 GPH 2.5 - 3.5 mSec.
Spark Advance KS Enabled	# of Degrees No/Yes	6 - 26° Yes
Knock Retard Knock Signal	Degrees of Retard No/Yes	0° No
Idle Air Control Min IAC Position	Counts (Steps) Counts (Steps)	0 - 30 0 - 60
Trim Sensor Batt/IGN Volts	Volts Volts	0.00 Volts 12.0 - 14.5 Volts
Malfunction Indicator Lamp Fuel Pump Relay	Off/On Off/On	Off On
RPM Reduction Engine Speed	No/Yes RPM	No 650 - 700 RPM
Overheat Detected Lo Oil Pressure Sw.	No/Yes OK/Low Pressure	No OK
Lo Oil Level Sw. Lo Water Flow Sw.	OK/Low OK/Low Flow	OK OK
Trans Temp Sw. I/O Fluid Level	OK/Hot OK/Low	OK OK
Emerg. Stop Mode Over Trim Detect	No/Yes No/Yes	No No
ECM Master/SLV Eng. Hour Meter	Slave/Master Hrs-Min	Master (Usable For Twin Engine Diagnosis) (Dependent on Engine Run Time)
Fuel System Config. Time From Start	MFI/TBI 0:00 - 1092.00 Hrs	MFI (Depends On Fuel System Configuration) 00:00 Hr:Min (Dependent on Engine Run Time)

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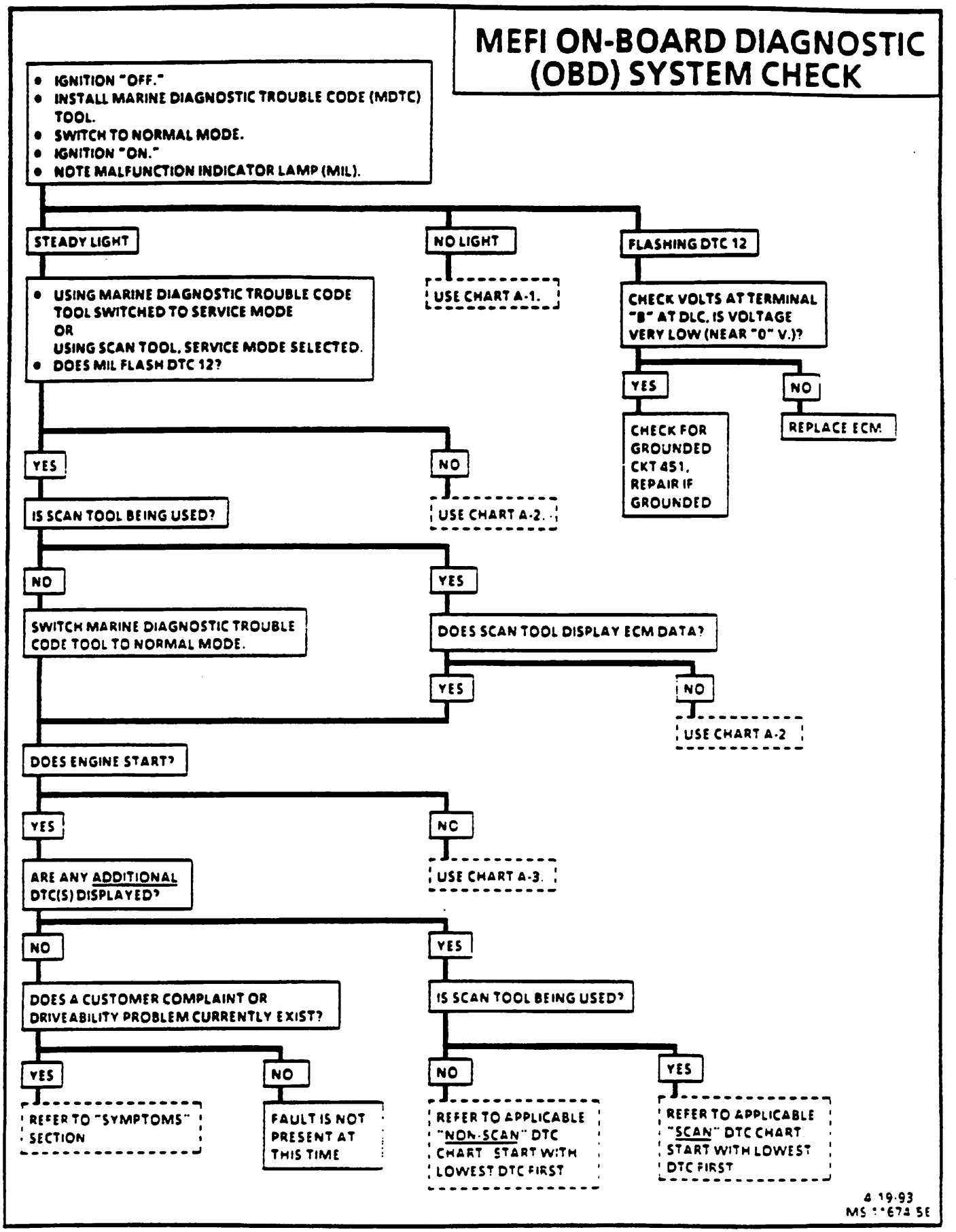
MEFI ON-BOARD DIAGNOSTIC (OBD) SYSTEM CHECK



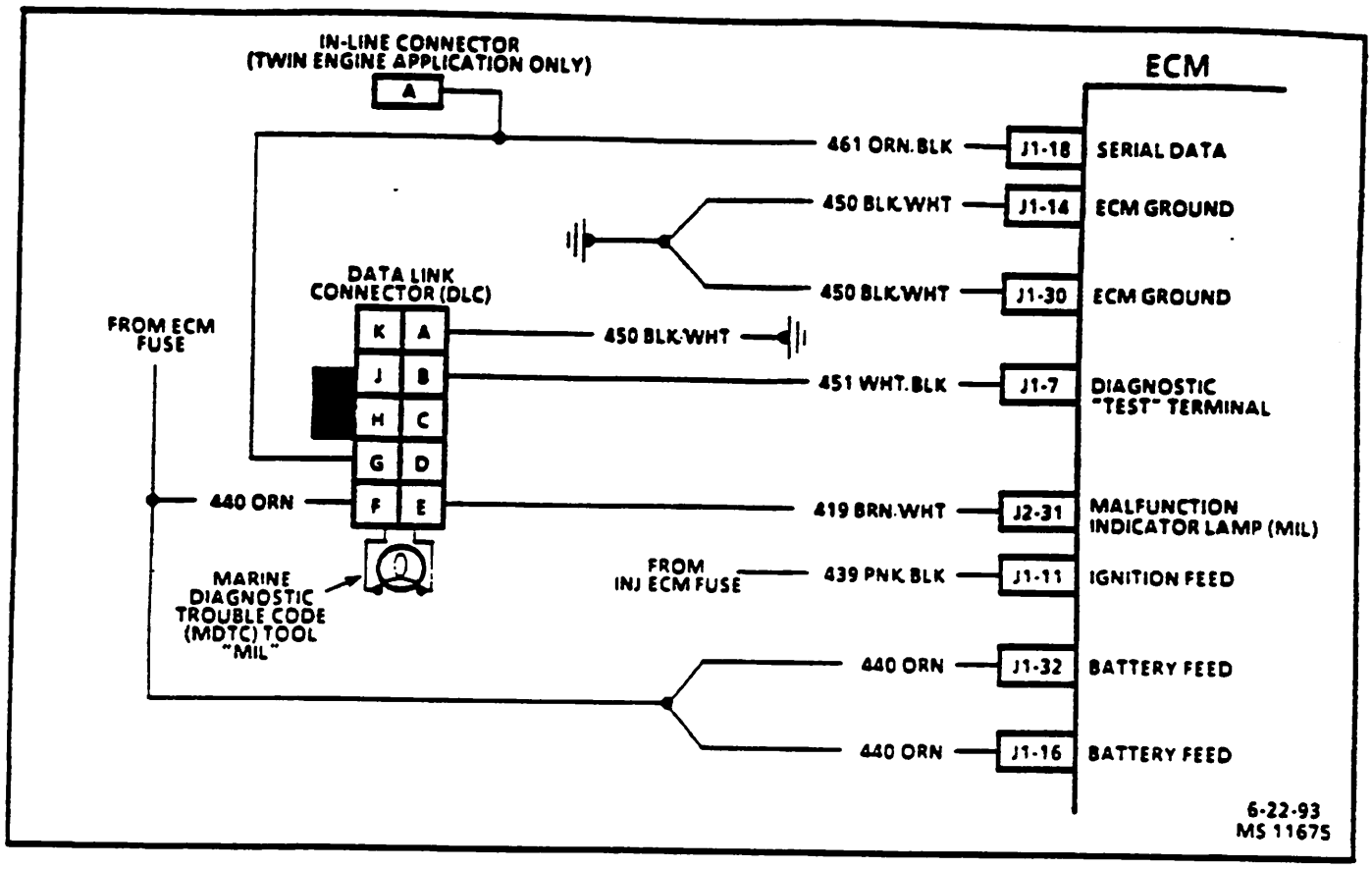


CHART A-1

NO MALFUNCTION INDICATOR LAMP (MIL)
[MARINE DIAGNOSTIC TROUBLE CODE (MDTC) TOOL INSTALLED]

Circuit Description:

When the Marine Diagnostic Trouble Code (MDTC) tool is installed, it plugs into the DLC terminals "F" and "E". It receives voltage through CKT 440 terminal "F". Terminal "E" is ground through CKT 419 from the ECM terminal "J2-31". There should always be a steady Malfunction Indicator Lamp (MIL) when the ignition is "ON" and engine not running. The ECM will control the light and turn it "ON" by providing ground.

Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. This step ensures that battery voltage is available to terminal "F" of the DLC and to supply voltage to the ECM.
2. This step checks for ground present in DLC terminal "E". This indicates that the ECM is capable of completing the ground to the MIL.
3. This step isolates the cause of incomplete ground to either a wiring or ECM circuitry.

Diagnostic Aids: Engine runs OK, check.

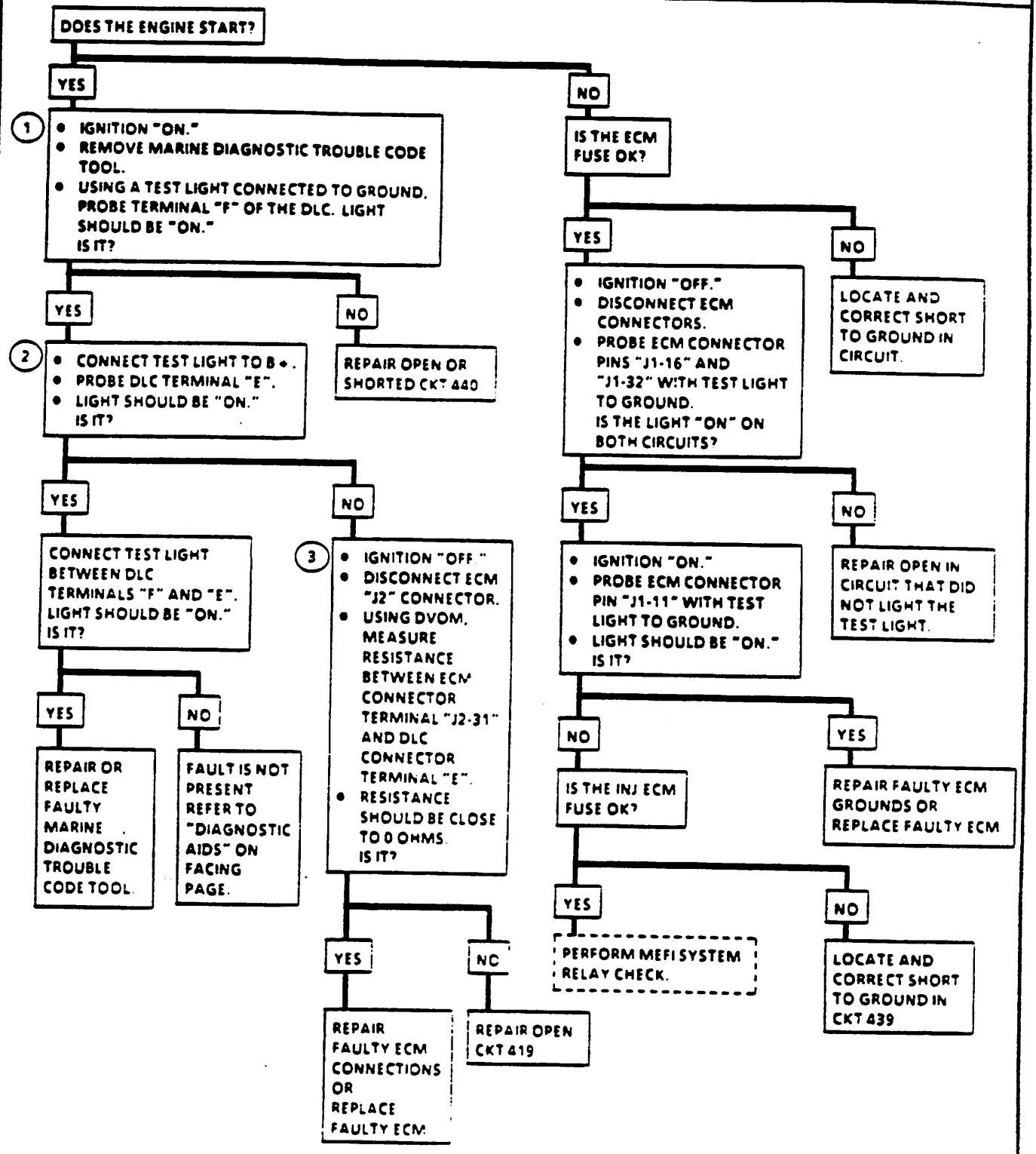
- Faulty light bulb.
- CKT 419 open.

Engine cranks but will not run, check:

- Continuous battery feed circuit breaker open.
- ECM fuse open.
- Battery circuit to ECM open.
- Ignition circuit to ECM open.
- Poor connection to ECM.
- Faulty ECM ground circuit(s).
- Perform MEFI system relay check.

CHART A-1

NO MALFUNCTION INDICATOR LAMP (MIL)
[MARINE DIAGNOSTIC TROUBLE CODE (MDTC) TOOL INSTALLED]



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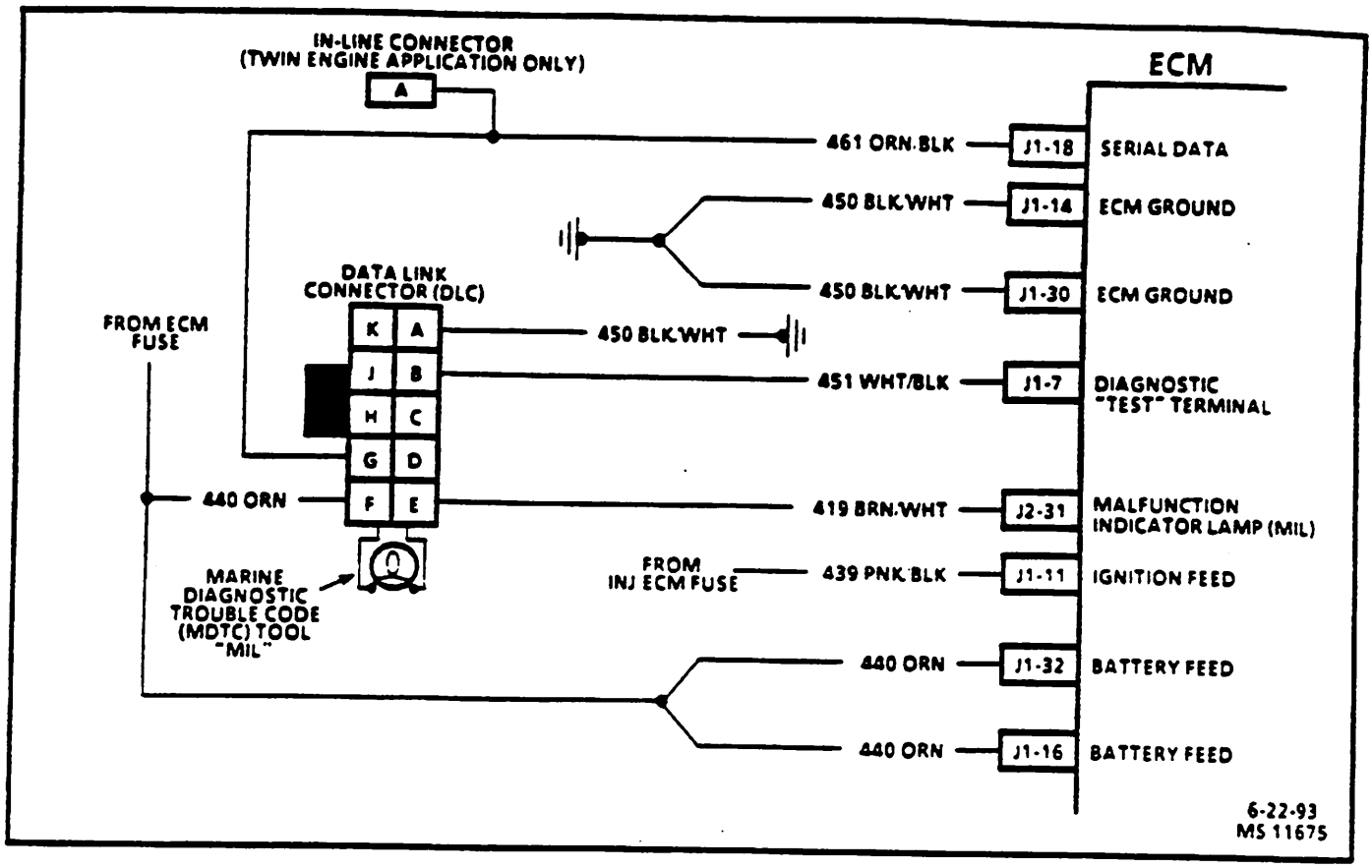


CHART A-2

NO DLC DATA OR WILL NOT FLASH DTC 12
MALFUNCTION INDICATOR LAMP (MIL) "ON" STEADY
[MARINE DIAGNOSTIC TROUBLE CODE (MDTC) TOOL INSTALLED]

Circuit Description:

When the Marine Diagnostic Trouble Code (MDTC) tool is installed, it plugs into the Data Link Connector (DLC) terminals "F" and "E". It receives voltage through CKT 440 terminal "F". Terminal "E" is ground through CKT 419 from the ECM terminal "J2-31". There should always be a steady Malfunction Indicator Lamp (MIL) when the ignition is "ON" and engine not running. The ECM will control the light and turn it "ON" by providing ground.

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 DLC.

Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart

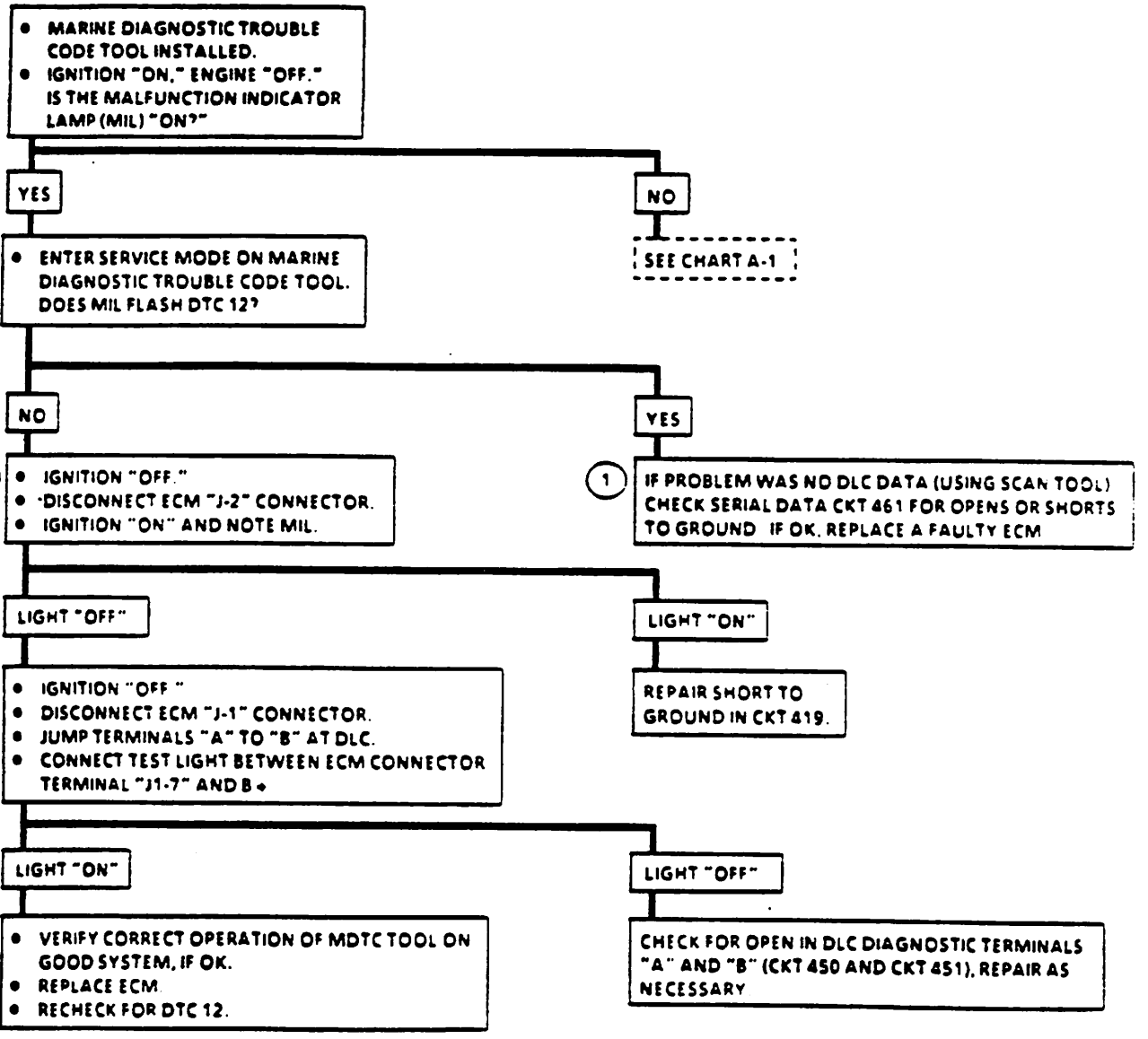
1 If there is a problem with the ECM that prevents a scan tool from reading serial data, the ECM will not flash a DTC 12. If DTC 12 is flashing, check CKT 451 for short to ground. If DTC 12 does flash, make sure that the scan tool is working properly on another vehicle

2. If the light goes "OFF," when the ECM connector is disconnected. CKT 419 is not shorted to ground
3 This step will check for an open diagnostic CKT 451.
4. At this point, the MIL wiring is OK. If DTC 12 does not flash, the ECM should be replaced.

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

CHART A-2

NO DLC DATA OR WILL NOT FLASH DTC 12 MALFUNCTION INDICATOR LAMP (MIL) "ON" STEADY [MARINE DIAGNOSTIC TROUBLE CODE (MDTC) TOOL INSTALLED]



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED CLEAR DTC(s) AND VERIFY PROPER OPERATION

7-6-93
MS 1677

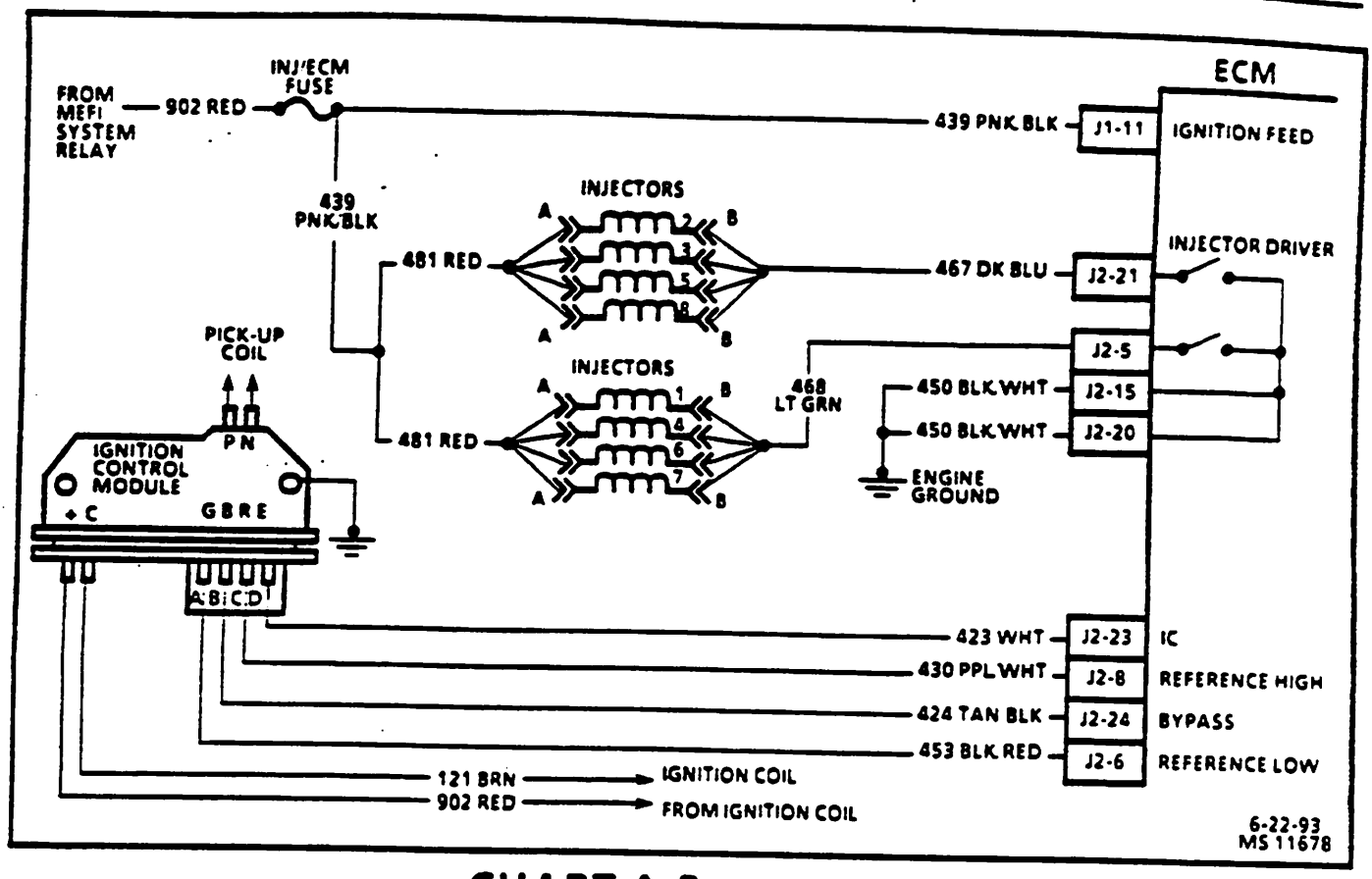


CHART A-3 (Page 1 of 2)

ENGINE CRANKS BUT WILL NOT RUN

Circuit Description:

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

After supply voltage passes through the injector ECM fuse it branches out into two separate CKTs 439. One is the supply voltage for injector harness CKT 481 and the other goes to ECM terminal "J1-11". The ECM will control the opening and closing of the injectors through injector driver CKT 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 the spark from the coil through CKT 121. The IC module interfaces with the ECM through CKT 430. The ECM will control the timing of the spark through CKT 423. For further explanation of distributor ignition system see "Distributor Ignition System Check," CHART A-6.

Chart Test Description:

Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. An ECT sensor that indicates engine coolant temperature less than actual temperature can flood the engine with fuel. An ECT sensor that indicates engine coolant temperature greater than actual can starve the engine of fuel. If TP sensor is over 2.5 volts, the engine may be in the clear flood mode, which will cause starting problems. The engine will not start without reference pulses and therefore, the scan tool should read engine RPM (reference) during cranking.
2. No spark may be caused by one of several components related to the distributor ignition IC system. The distributor ignition system check will address all problems related to the causes of a no spark condition.
3. The test light should blink, indicating the ECM is controlling the injectors "ON". All lights should blink at the same brightness.
4. All injectors should be within 1.0 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, unhook the suspected injector and try to start the engine.
5. Use fuel pressure gage J 34730-1 or equivalent. Wrap a shop towel around the fuel pressure tap to absorb any small amount of fuel leakage that may occur when installing the gage.

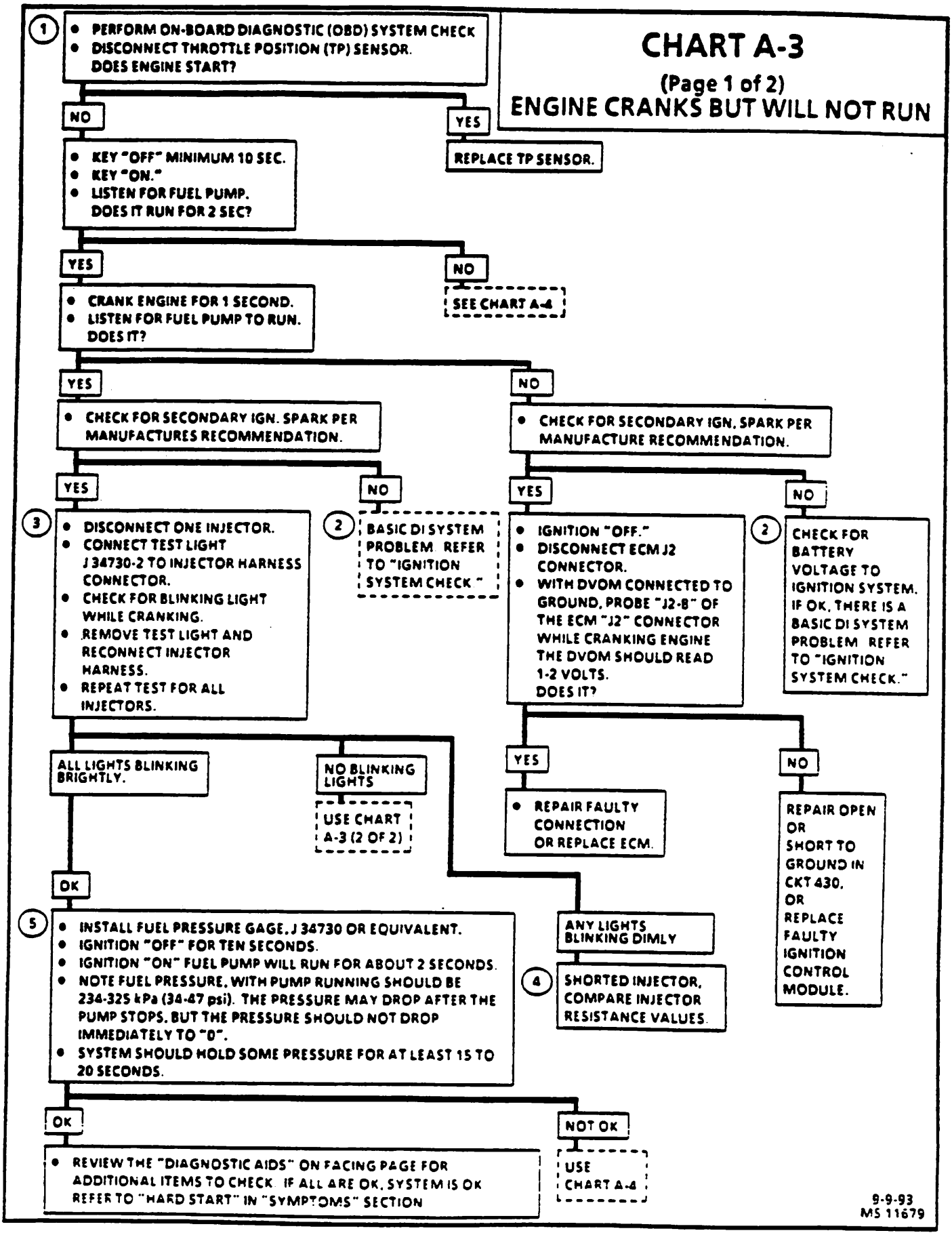
Diagnostic Aids:

- This chart assumes that battery condition and engine cranking speed are OK, and there is adequate fuel in the tank.
- Unless engine enters "Clear Flood" at the first indication of a flooding condition, it can result in a no start.
- Check for fouled plugs.
- Water or foreign material in fuel line can cause a no start.
- A defective MAP sensor may cause a no start or a stall after start. To determine if the sensor is causing the problem, disconnect it. The ECM will then use a default value for the sensor, and if the condition is corrected and the connections are OK, replace the sensor.
- If above are all OK, refer to "Symptoms" section.

CHART A-3

(Page 1 of 2)

ENGINE CRANKS BUT WILL NOT RUN



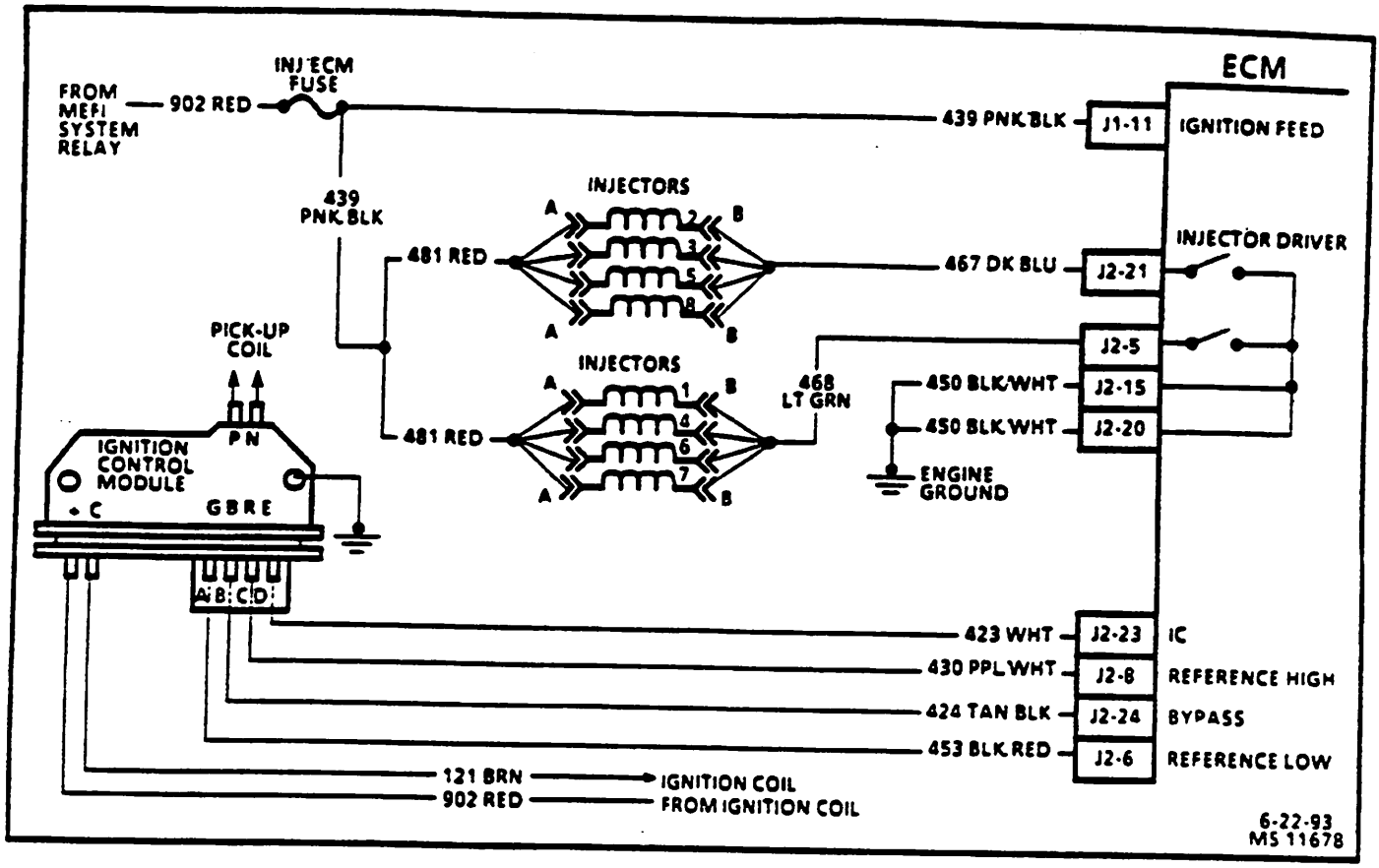


CHART A-3

(Page 2 of 2)
ENGINE CRANKS BUT WILL NOT RUN

Circuit Description:

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

After supply voltage passes through the injector ECM fuse it branches out into two separate CKTs 439. One is the supply voltage for injector harness CKT 481 and the other goes to ECM terminal "J1-11". The ECM will control the opening and closing of the injectors through injector driver CKT 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 the spark from the coil through CKT 121. The IC module interfaces with the ECM through CKT 430. The ECM will control the timing of the spark through CKT 423. For further explanation of distributor ignition system see "Distributor Ignition System Check," CHART A-6.

Chart Test Description:

Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. Checks for 12 volt supply to injectors. Due to the injectors wired in parallel, there should be light on both terminals.
2. Checks continuity of CKT 467 and CKT 468.
3. All checks made to this point would indicate that the ECM is at fault. However, there is a possibility of CKT 467 and CKT 468 being shorted to a voltage source either in the engine harness or in the injector harness.

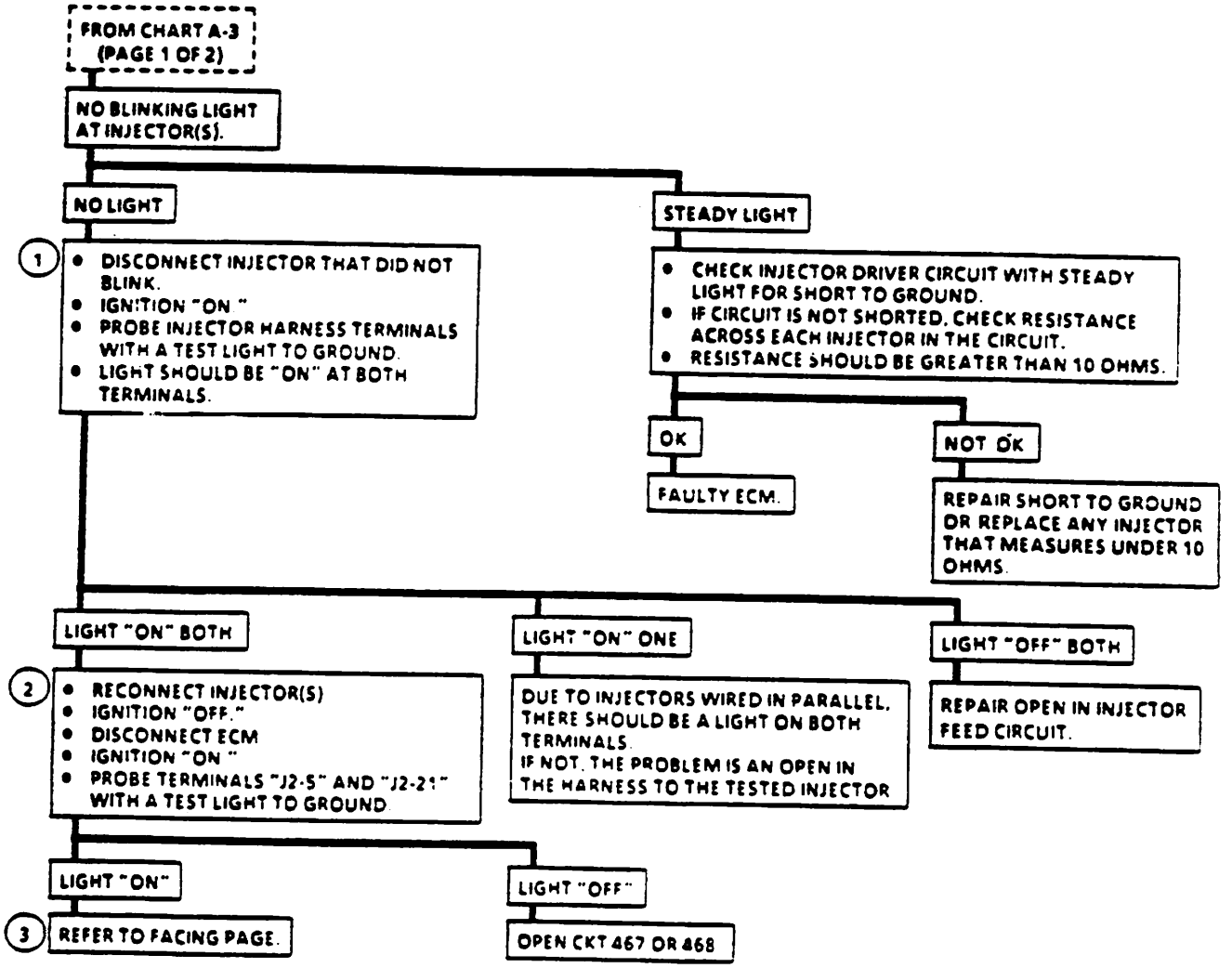
To test for this condition:

- Disconnect all injectors.
- Ignition "ON."
- Probe CKT 467 and CKT 468 on the ECM side of injector harness with a test light connected to ground. (Test one injector harness on each side of engine.) There should be no light. If light is "ON," repair short to voltage.
- Check injector harness connector. Be sure terminals are not backed out of connector and contacting each other.
- If all OK, replace ECM.

CHART A-3

(Page 2 of 2)

ENGINE CRANKS BUT WILL NOT RUN



9-17-93
MS 11680

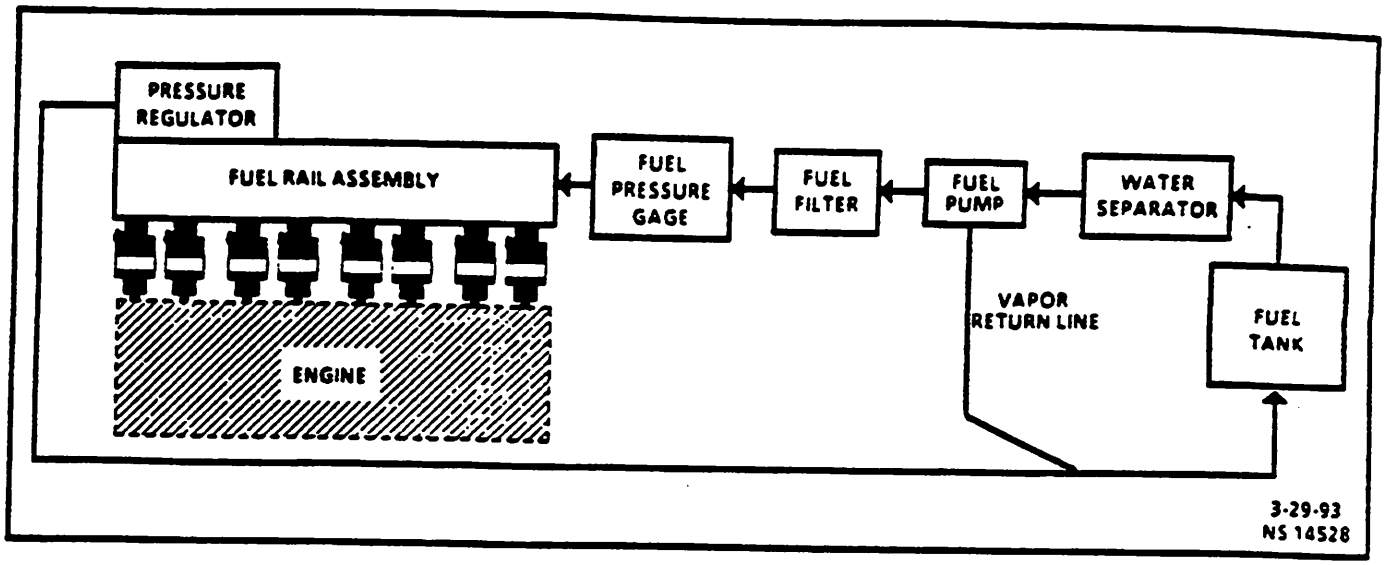


CHART A-4

(Page 1 of 3)
FUEL SYSTEM DIAGNOSIS

Circuit Description:

When the ignition is turned "ON," the Engine Control Module (ECM) will turn the fuel pump "ON" for 2 seconds. During engine cranking, the ECM will turn "ON" the fuel pump. It will remain "ON" as long as the engine is cranking or running, and the ECM is receiving 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 to 325 kPa (34 to 47 psi). Excess fuel is then returned to the fuel tank

Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1 Wrap a shop towel around the fuel pressure connector to absorb any small amount of fuel leakage that may occur when installing the gage

Ignition "ON," pump pressure should be 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 isn't fully charged.

2 When the 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

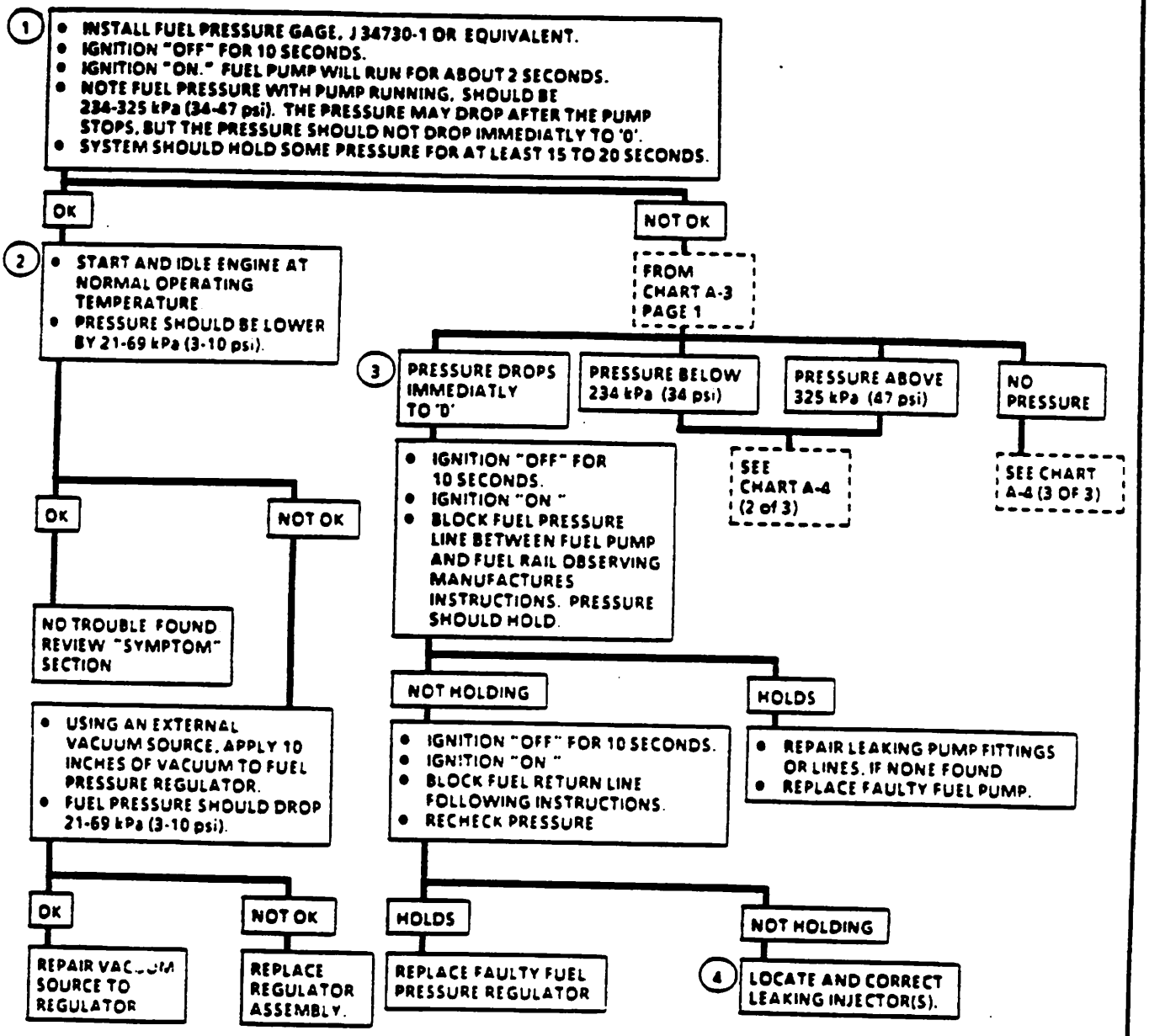
3. Pressure that leaks down is caused by one of the following:
   - Fuel pressure regulator valve leaking
   - Injector(s) sticking open.
   - Defective fuel pump
   - External leak.
4. If an injector is stuck open, it will send fuel to its respective cylinder, which may saturate or foul a spark plug(s). In order to determine which injector 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.

CHART A-4

(Page 1 of 3)

FUEL SYSTEM DIAGNOSIS

NOTICE: THE IGNITION MAY HAVE TO BE CYCLED "ON" MORE THAN ONCE TO OBTAIN MAXIMUM PRESSURE.



5-22-93
NS 13958

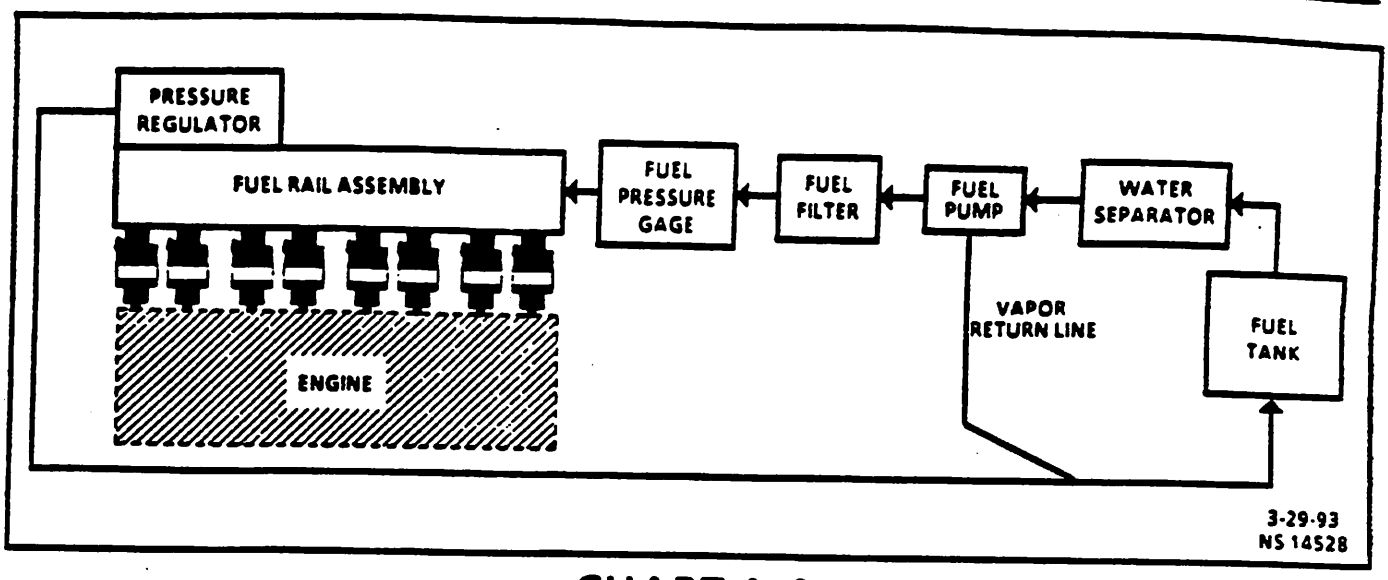


CHART A-4

(Page 2 of 3)
FUEL SYSTEM DIAGNOSIS

Circuit Description:

When the ignition is turned "ON," the Engine Control Module (ECM) will turn the fuel pump "ON" for 2 seconds. During engine cranking, the ECM will turn "ON" the fuel pump. It will remain "ON" as long as the engine is cranking or running, and the ECM is receiving 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 to 325 kPa (34 to 47 psi). Excess fuel is then returned to the fuel tank.

Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

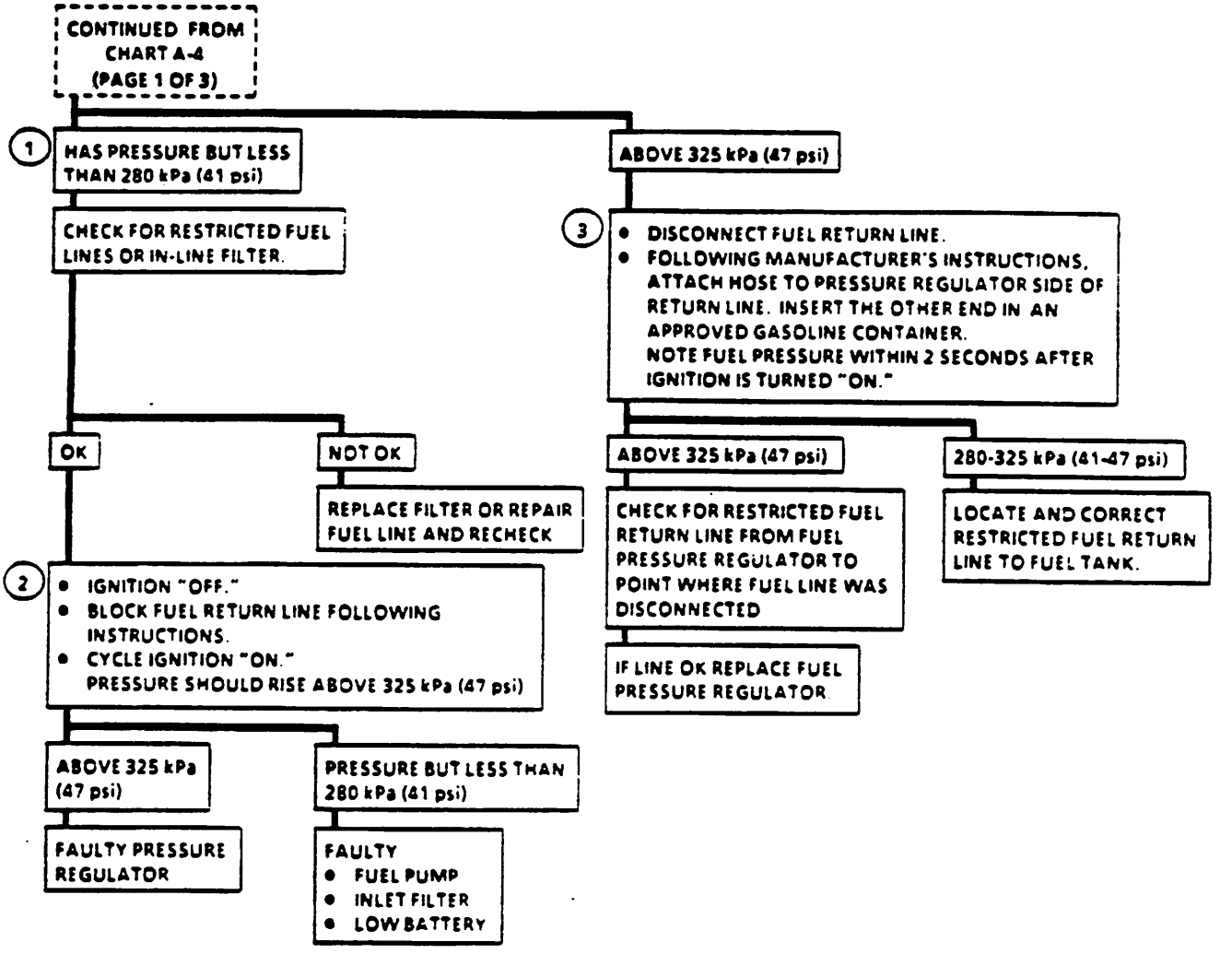
1. Pressure less than 280 kPa (41 psi) falls into two areas:
   - Regulated pressure less than 280 kPa (41 psi). The system will be running lean also, hard starting when cold and overall poor performance will be noticed.
   - Restricted flow causing pressure drop. Normally, a vehicle with a fuel pressure of less than 165 kPa (24 psi) at idle will not be drivable. However, if the pressure drop occurs only while driving, the engine will surge then stop running as pressure begins to drop rapidly. This is most likely caused by a restricted fuel line or plugged filter.
2. Restricting the fuel return line allows the fuel pressure to build above regulated pressure. Pressure should rise to 414 kPa (60 psi) as the fuel return hose is gradually pinched.

   NOTICE: Do not allow fuel pressure to exceed 414 kPa (60 psi), damage to the pressure regulator may result.

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

CHART A-4
(Page 2 of 3)
FUEL SYSTEM DIAGNOSIS

• **NOTICE:** THE IGNITION MAY HAVE TO BE CYCLED "ON" MORE THAN ONCE TO OBTAIN MAXIMUM PRESSURE.



5 '7-93
NS 13959

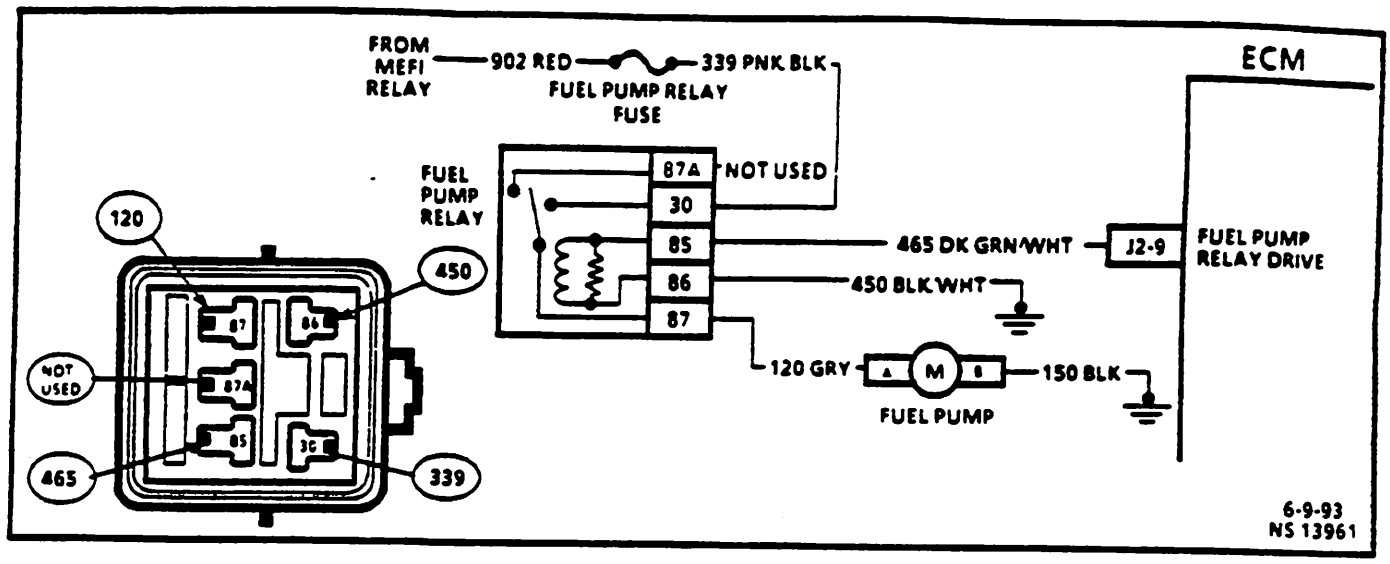


CHART A-4

(Page 3 of 3)
FUEL SYSTEM DIAGNOSIS - ELECTRICAL

Circuit Description:

The fuel system circuit receives a supply voltage from MEFI relay system CKT 902. The fuel system circuit is protected by a 15 amp fuse. After the fuse, supply voltage is delivered by CKT 339 to fuel pump relay terminal "30". During key "ON" for 2 seconds or when reference pulses (engine cranked or running) are received to the ECM, the ECM will turn "ON" CKT 465. If there are no reference pulses, the ECM will shut "OFF" the fuel pump. CKT 465 is the circuit that energizes the coil in fuel pump relay and closes the contacts. When the fuel pump relay contacts are closed, supply voltage passes through the relay to terminal "87". From terminal "87", supply voltage is delivered to fuel pump through CKT 120. The fuel pump is grounded through CKT 150.

Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. This step checks if there is power to the fuel pump relay.
2. 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.
3. This step checks if there is an open in the ground circuit.
4. This step checks if the ECM is functioning properly.

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

CHART A-4

(Page 3 of 3)

FUEL SYSTEM DIAGNOSIS - ELECTRICAL

FROM CHART A-4 (1 OF 3)

1
- IGNITION "OFF."
- REMOVE FUEL PUMP RELAY.
- IGNITION "ON."
- WITH TEST LIGHT CONNECTED TO GROUND, PROBE FUEL PUMP RELAY CONNECTOR CAVITY "30." TEST LIGHT SHOULD BE "ON." IS IT?

YES

2
- IGNITION "OFF."
- USING FUSED JUMPER WIRE, CONNECT TERMINALS "30" AND "87" OF FUEL PUMP RELAY CONNECTOR TOGETHER.
- IGNITION "ON "
- FUEL PUMP SHOULD RUN. DOES IT?

YES

3
- IGNITION "OFF."
- DISCONNECT JUMPER WIRE.
- CONNECT TEST LIGHT TO B+ AND PROBE CAVITY "86" OF THE FUEL PUMP RELAY CONNECTOR.
- LIGHT SHOULD BE "ON." IS IT?

YES

4
- CONNECT TEST LIGHT TO GROUND AND PROBE CAVITY "85" OF THE FUEL PUMP RELAY CONNECTOR
- IGNITION "ON "
- TEST LIGHT SHOULD BE "ON" FOR 2 SECONDS AND THEN GO "OFF." DOES IT?

YES

- REPLACE FUEL PUMP RELAY AND RETEST IF STILL NO PRESSURE, CHECK THE FOLLOWING
  - PLUGGED IN-LINE FILTER.
  - VAPOR LOCK CONDITION.
  - RESTRICTED FUEL LINE.
  - DISCONNECTED HOSES.
  - PROPER FUEL LEVEL.

  IF OK, REPLACE FUEL PUMP.

NO

- CHECK FUEL PUMP RELAY FUSE. IS IT OK?

YES

REPAIR OPEN CKT 339 OR 902.

NO

- CHECK FOR SHORT TO GROUND IN CKT 339 OR CKT 120.
- CHECK FOR FUEL TANK OR LINES FOR CONTAMINATION. IF OK, REPLACE FUEL PUMP AND FUSE.

NO

CHECK FOR:
- OPEN WIRE IN CKT 120.
- OPEN PUMP GROUND CKT 150.

IF OK, REPLACE FUEL PUMP

NO

REPAIR OPEN GROUND CKT 450.

NO

CHECK FOR OPEN IN CKT 465 OR FAULTY CONNECTION AT "J2-9".

YES

REPAIR OPEN IN CKT 465 OR FAULTY CONNECTION "J2-9"

NO

REPLACE FAULTY ECM

8-16-93
NS 13960

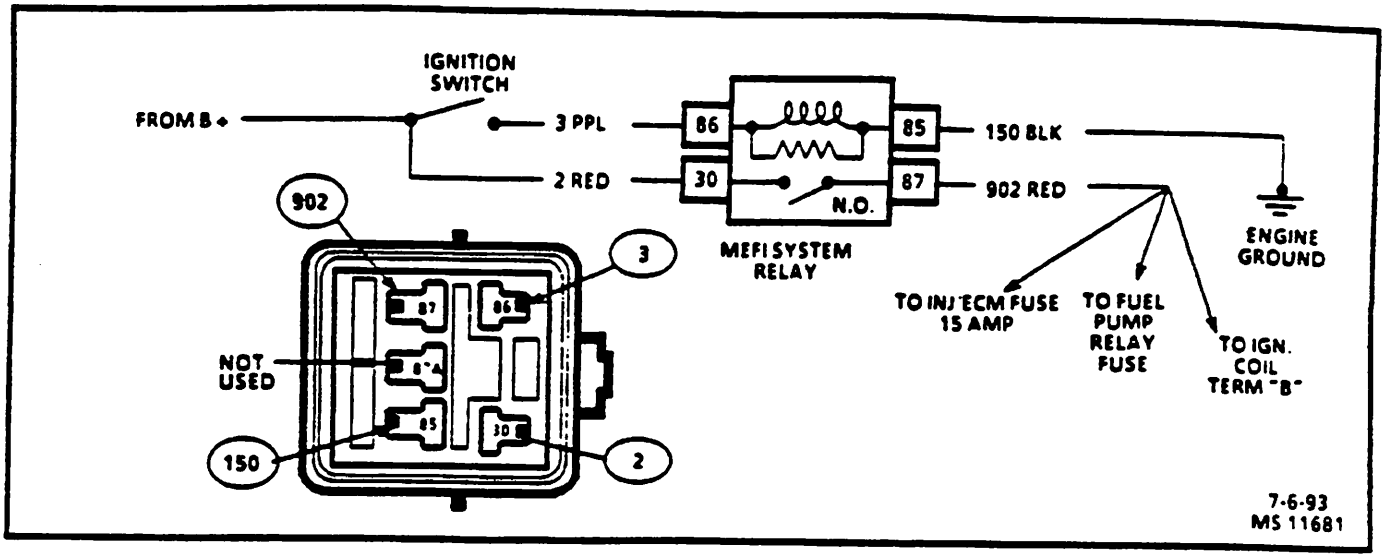


CHART A-5

MEFI SYSTEM RELAY CHECK

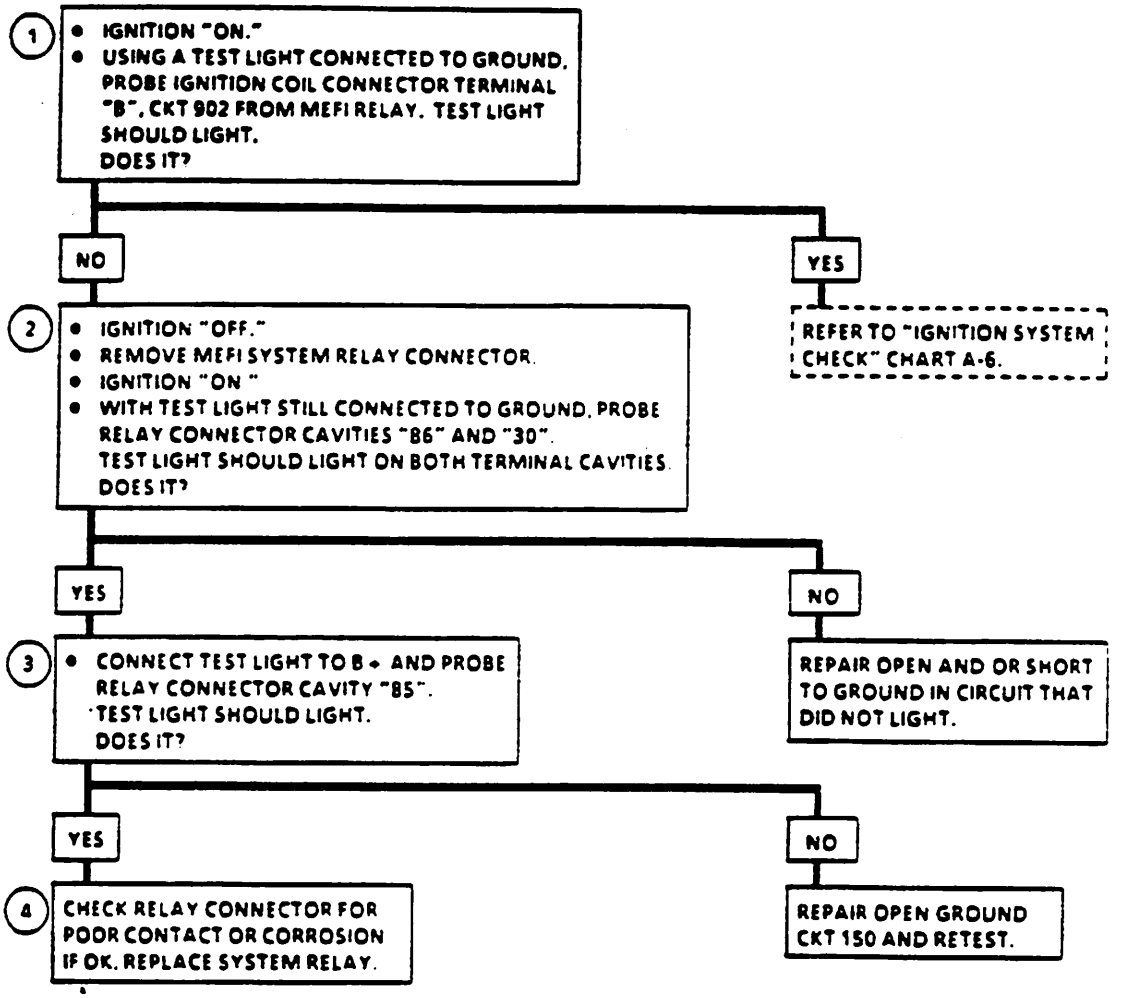
Circuit Description:

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

Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. This step identifies if the relay is functioning properly. If a fault in the relay circuit was present, voltage would not be available at terminal "B" of ignition coil.
2. This step ensures that battery and ignition voltage are available at the relay. An open or shorted condition in either supply would cause the relay not to operate
3. This step ensures that a good ground exists to terminal "85" of the system relay. An open ground to this terminal would not allow current to flow through the pull-in coil.
4. At this point, the circuits leading to the relay have been checked, and a careful visual inspection of the relay terminals should be performed prior to replacement of the system relay

CHART A-5
MEFI SYSTEM RELAY CHECK



6-18-93
PS 17911

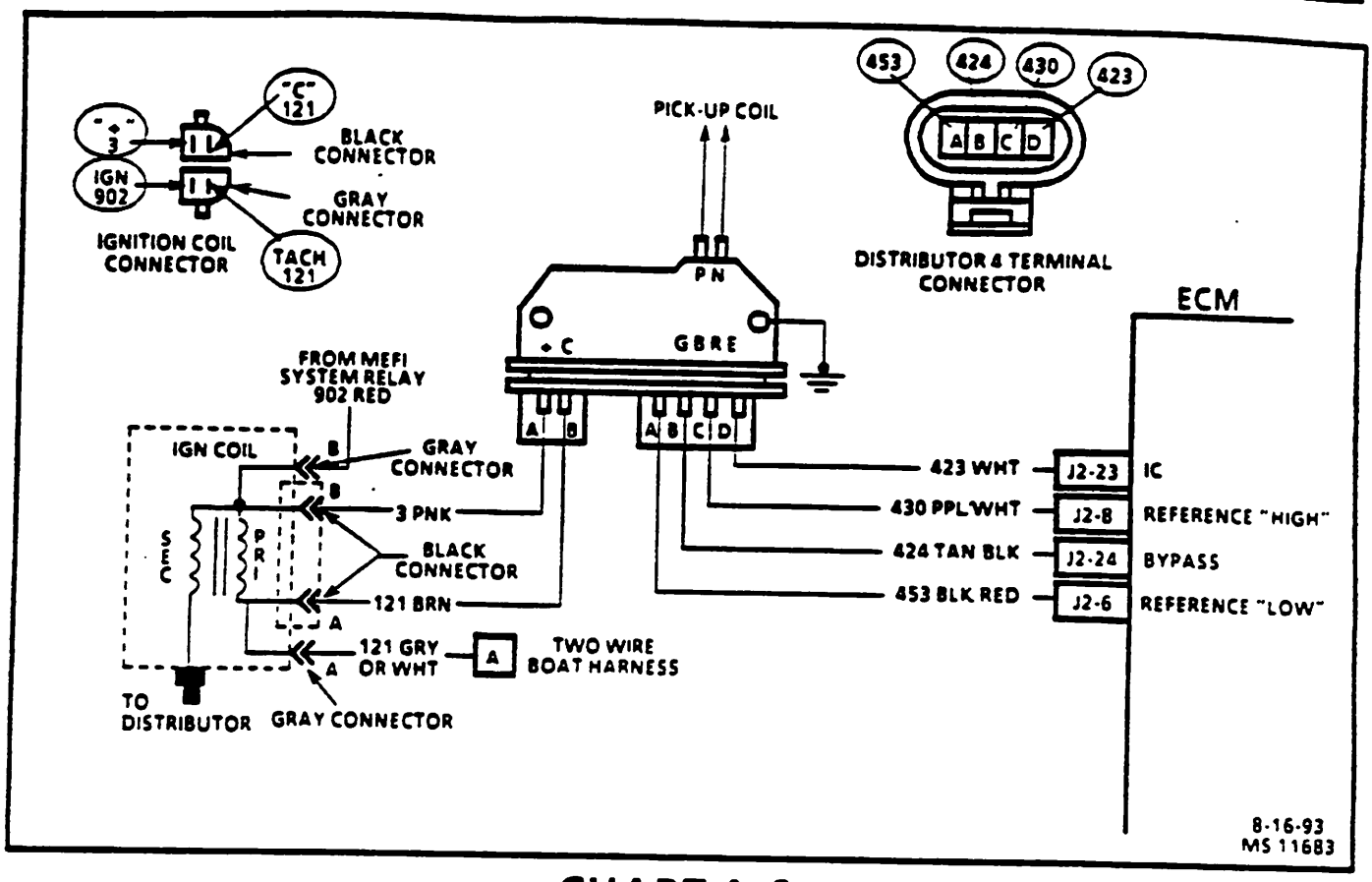


CHART A-6

(Page 1 of 2)

DISTRIBUTOR IGNITION SYSTEM CHECK

Circuit Description:

The Distributor Ignition (DI) system receives supply voltage from the MEFI relay through CKT 902 to the ignition coil gray connector "B". Inside the ignition coil, the gray connector terminal "B" is connected to 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 running or cranking mode, and adjust the timing accordingly. The voltages or signals are sent between ECM and IC module through CKTs 423, 430, and 424. CKT 453 is a 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 and secondary spark is produced and sent to the distributor by a high tension lead.

Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. Two wires are checked, to ensure that an open is not present in a spark plug wire.
2. A spark indicates the problem must be the distributor cap, rotor, or coil output wire.
3. Normally; there should be battery voltage at the "C" and "–" terminals. Low voltage would indicate an open or a high resistance circuit from the distributor to the coil or ignition switch. If "C" terminal voltage was low, but "–" terminal voltage is 10 volts or more, circuit from "C" terminal to ignition coil or ignition coil primary winding is open.
4. Checks for a shorted module or grounded circuit from the ignition coil to the module. The distributor module should be turned "OFF" so normal voltage should be about 12 volts. If the module is turned "ON," the voltage would be low, but above 1 volt. This could cause the ignition coil to fail from excessive heat. With an open ignition coil primary winding, a small amount of voltage will leak through the module from the "batt" to the "tach" terminal.

Diagnostic Aids: 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 two wire boat harnesses (gray and purple wires), this will give you a test terminal to check coil trigger voltage as needed in Steps 3, 4 and 5. After "tach" is disconnected, try starting engine. If starts, check for a ground or short in boat "tach" circuit.

CHART A-6

(Page 1 of 2) DISTRIBUTOR IGNITION SYSTEM CHECK

1. • CHECK SPARK PLUG WIRES FOR OPEN CIRCUITS, CRACKS IN INSULATION OR IMPROPER SEATING OF TERMINALS AT SPARK PLUGS, DISTRIBUTOR, AND IGNITION COIL BEFORE PROCEEDING WITH THIS TEST. DISCONNECT TWO WIRE BOAT HARNESS (PURPLE AND GRAY WIRES). INSTALL A TEMPORARY JUMPER BETWEEN PURPLE WIRE CONNECTORS. SEE DIAGNOSTIC AIDS.
   • CHECK SPARK AT PLUG PER MANUFACTURE RECOMMENDATIONS. CRANKING (IF NO SPARK ON ONE WIRE, CHECK A SECOND WIRE) A FEW SPARKS AND THEN NOTHING IS CONSIDERED NO SPARK.

- NO SPARK
- SPARK → CHECK FUEL, SPARK PLUGS, ETC. REFER TO "SYMPTOMS" IN SECTION 6.

2. • REMOVE DISTRIBUTOR CAP AND VERIFY ROTATION OF IGNITION ROTOR. IF NO ROTATION, A MECHANICAL REPAIR WILL BE NECESSARY BEFORE CONTINUING WITH THIS TEST.
   • DISCONNECT 4 TERMINAL DISTRIBUTOR CONNECTOR. CHECK FOR SPARK AT IGNITION COIL TOWER PER MANUFACTURE RECOMMENDATIONS WHILE CRANKING USING A KNOWN GOOD COIL WIRE. (LEAVE TESTER CONNECTED TO COIL TOWER FOR STEPS 3-6.)

- NO SPARK
- SPARK → CHECK CAP, ROTOR AND COIL WIRES FOR OPENS, DAMAGE, OR WEAR. REPLACE AS NECESSARY.

3. • DISCONNECT DISTRIBUTOR 2 TERMINAL "C/+" CONNECTOR HARNESS.
   • IGNITION SWITCH "ON," ENGINE STOPPED.
   • CHECK VOLTAGE AT "+" AND "C" TERMINALS OF DISTRIBUTOR AT HARNESS CONNECTOR AND TACH CKT 121 CONNECTOR AT TWO WIRE BOAT HARNESS CONNECTOR TERMINAL.*
   *NOTE. IF OTHER COMBINATIONS RESULT FROM TEST #3, A WIRING PROBLEM IS APPARENT AND SHOULD BE REPAIRED BEFORE CONTINUING WITH OTHER TESTS.

- ALL 3 TERMINALS 10 VOLTS OR MORE
- ALL 3 TERMINALS UNDER 10 VOLTS → REPAIR WIRE FROM DISTRIBUTOR IGNITION CONTROL MODULE "+" TERMINAL TO "B" TERMINAL OF BLACK IGNITION COIL CONNECTOR OR VOLTAGE SUPPLY TO COIL.
- UNDER 10 VOLTS "C" TERMINAL ONLY → CHECK FOR OPEN OR GROUND IN THE CIRCUIT FROM "C" TERMINAL TO IGNITION COIL. IF CIRCUIT IS OK, CHECK IGNITION COIL FOR OPEN COIL PRIMARY OR CONNECTION.

4. • RECONNECT DISTRIBUTOR 2 TERMINAL CONNECTOR.
   • WITH IGNITION "ON," CHECK VOLTAGE FROM TACH HARNESS TERMINAL TO GROUND.

- GREATER THAN 10 VOLTS
  • CONNECT TEST LIGHT FROM TACH HARNESS TERMINAL TO GROUND.
  • CRANK ENGINE AND OBSERVE LIGHT.
  - REFER TO IGNITION SYSTEM CHECK (2 OF 2).
- 1 TO 10 VOLTS → REPLACE DISTRIBUTOR IGNITION CONTROL MODULE AND CHECK FOR SPARK FROM COIL AS IN STEP 6.
  - SPARK → SYSTEM OK.
  - NO SPARK → REPLACE IGNITION COIL

WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION

8-16-93
NS 13616

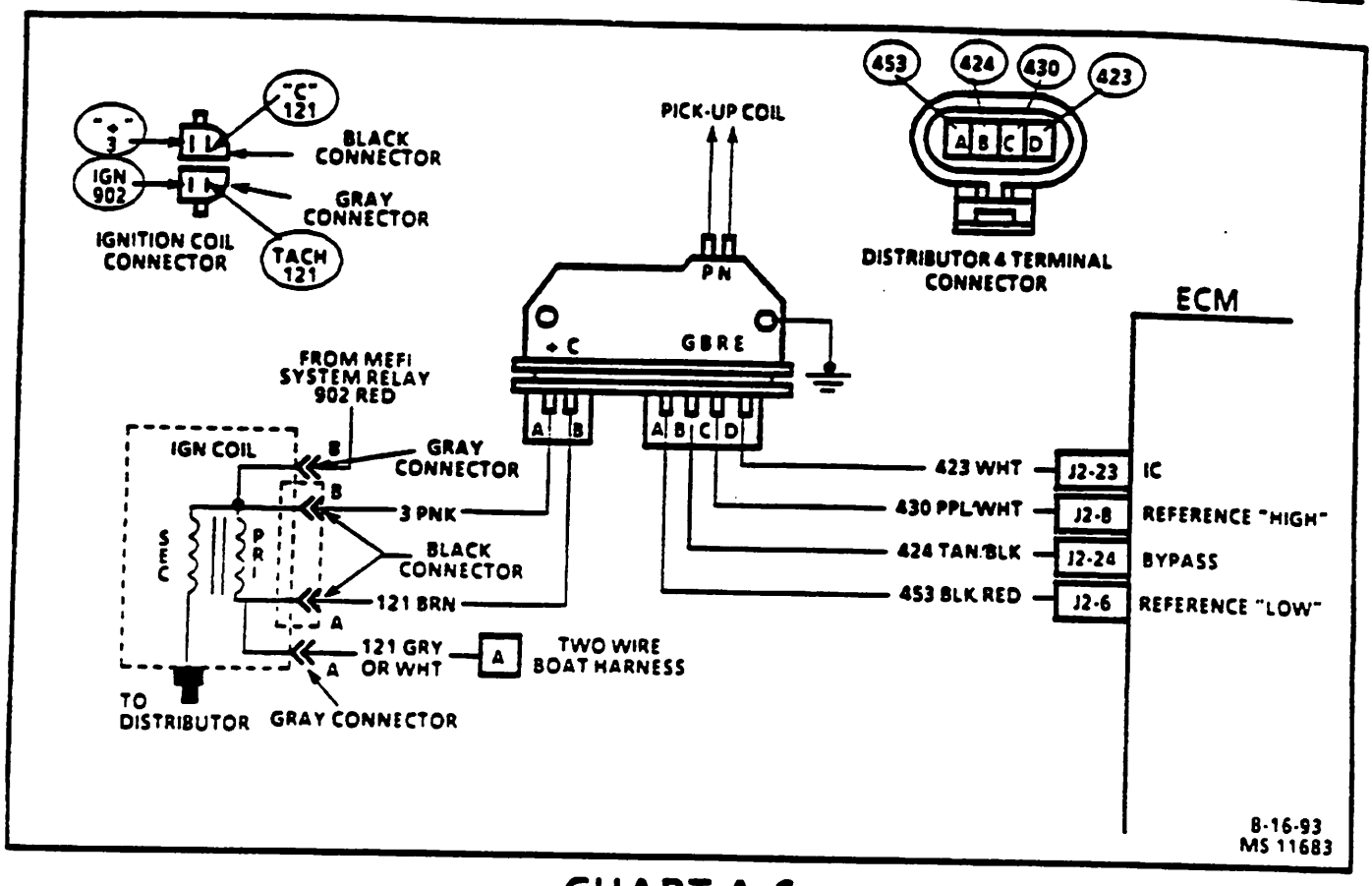


CHART A-6

(Page 2 of 2)
DISTRIBUTOR IGNITION SYSTEM CHECK

Circuit Description:

The Distributor Ignition (DI) system receives supply voltage from the MEFI relay through CKT 902 to the ignition coil gray connector "B". Inside the ignition coil, the gray connector terminal "B" is connected to 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 running or cranking mode, and adjust the timing accordingly. The voltages or signals are sent between ECM and IC module through CKTs 423, 430, and 424. CKT 453 is a 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 and secondary spark is produced and sent to the distributor by a high tension lead.

Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

5 Applying a voltage (1.35 to 1.50 volts) to module terminal "P" should turn the module "ON" and the "tach" terminal voltage should drop to about 7-9 volts. This test will determine whether the module or coil is faulty or if the pick-up coil is not generating the proper signal to turn the module "ON." This test can be performed by using a DC 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

6. This should turn "OFF" the module and cause a spark. If no spark occurs, the fault is most likely in the ignition coil because most module problems would have been found before this point in the procedure.

Diagnostic Aids: For further test on pick-up coil or ignition coil, see "On-board Service" section under distributor repair

CHART A-6

(Page 2 of 2)
DISTRIBUTOR IGNITION SYSTEM CHECK

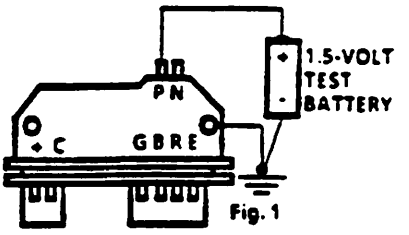


Fig. 1

FROM IGNITION SYSTEM CHECK PAGE (1 OF 2).

LIGHT "ON" STEADY

LIGHT FLASHES

REPLACE IGNITION COIL AND RECHECK FOR SPARK PER MANUFACTURER RECOMMENDATION. IF STILL NO SPARK, RE-INSTALL ORIGINAL COIL AND REPLACE DI CONTROL MODULE.

5
- DISCONNECT DISTRIBUTOR 4 TERMINAL CONNECTOR.
- REMOVE DISTRIBUTOR CAP.
- DISCONNECT PICK-UP COIL CONNECTOR FROM DISTRIBUTOR IGNITION CONTROL MODULE.
- CONNECT VOLTMETER FROM TACH HARNESS TERMINAL TO GROUND.
- IGNITION "ON."
- CONNECT POSITIVE (+) END OF KNOWN GOOD 1.5 VOLT TEST BATTERY TO "P" TERMINAL ON DISTRIBUTOR IGNITION CONTROL MODULE OBSERVE VOLTMETER AT TACH TERMINAL AS NEGATIVE (-) END OF TEST BATTERY IS MOMENTARILY GROUNDED TO DISTRIBUTOR HOUSING.

VOLTAGE DROPS

NO DROP IN VOLTAGE

CHECK DISTRIBUTOR IGNITION CONTROL MODULE GROUND IF OK, REPLACE DISTRIBUTOR IGNITION CONTROL MODULE.

6
CHECK FOR SPARK FROM COIL WIRE WITH SPARK TESTER PER MANUFACTURERS RECOMMENDATION. AS TEST BATTERY IS REMOVED FROM MODULE TERMINAL.

NO SPARK

SPARK

REPLACE IGNITION COIL AND REPEAT STEP 5.

CHECK PICK-UP COIL OR CONNECTIONS (COIL RESISTANCE SHOULD BE 500-1500 OHMS AND NOT GROUNDED)

NO SPARK

SPARK

IGNITION COIL REMOVED IS OK. REINSTALL COIL AND CHECK COIL WIRE FROM IGNITION COIL TO DISTRIBUTOR CAP WITH OHM METER. SHOULD BE CLOSE TO 2200 TO 3200 OHMS. IF OK, REPLACE DISTRIBUTOR IGNITION CONTROL MODULE.

SYSTEM OK

YES

NO

CK POLE PIECE. IS IT SECURE TO DISTRIBUTOR SHAFT? IF LOOSE, REPLACE DISTRIBUTOR SHAFT

REPLACE PICKUP COIL.

WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED CLEAR DTC(s) AND VERIFY PROPER OPERATION

8-16-93
PS 19409

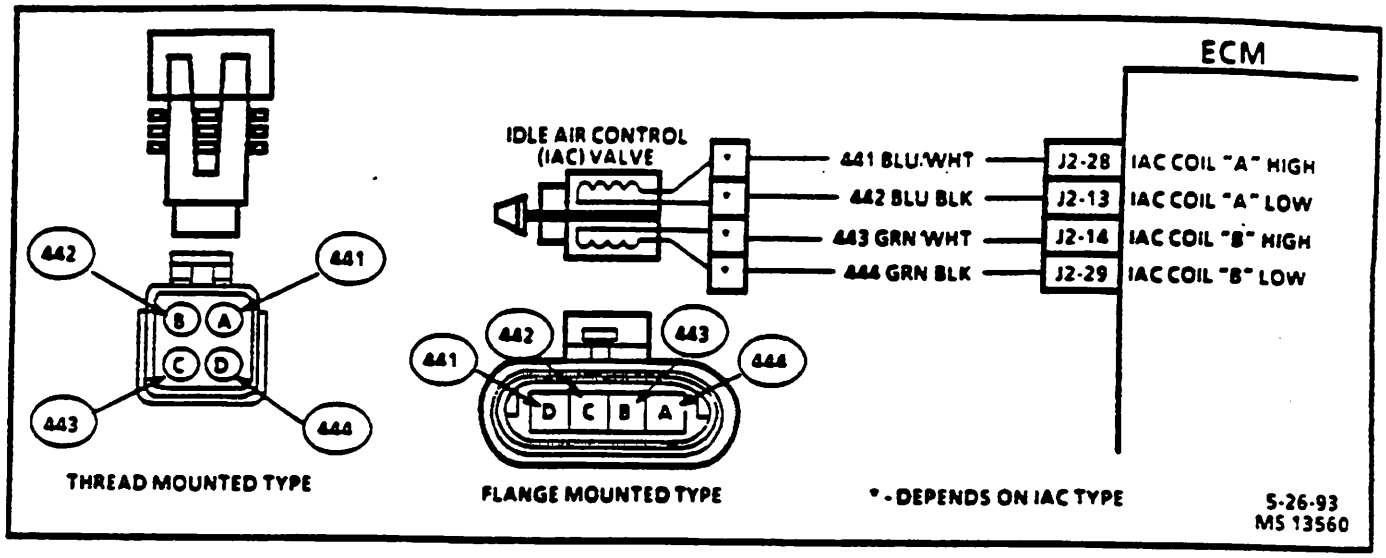


CHART A-7

IDLE AIR CONTROL FUNCTIONAL TEST

Circuit Description:

The ECM controls idle speed to a calculated, "desired" RPM based on sensor inputs and actual engine RPM, determined by the time between successive ignition reference pulses from the ignition module. The ECM uses 4 circuits to move an Idle Air Control (IAC) valve, which allows varying amounts of air flow into the intake manifold, controlling idle speed.

Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

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

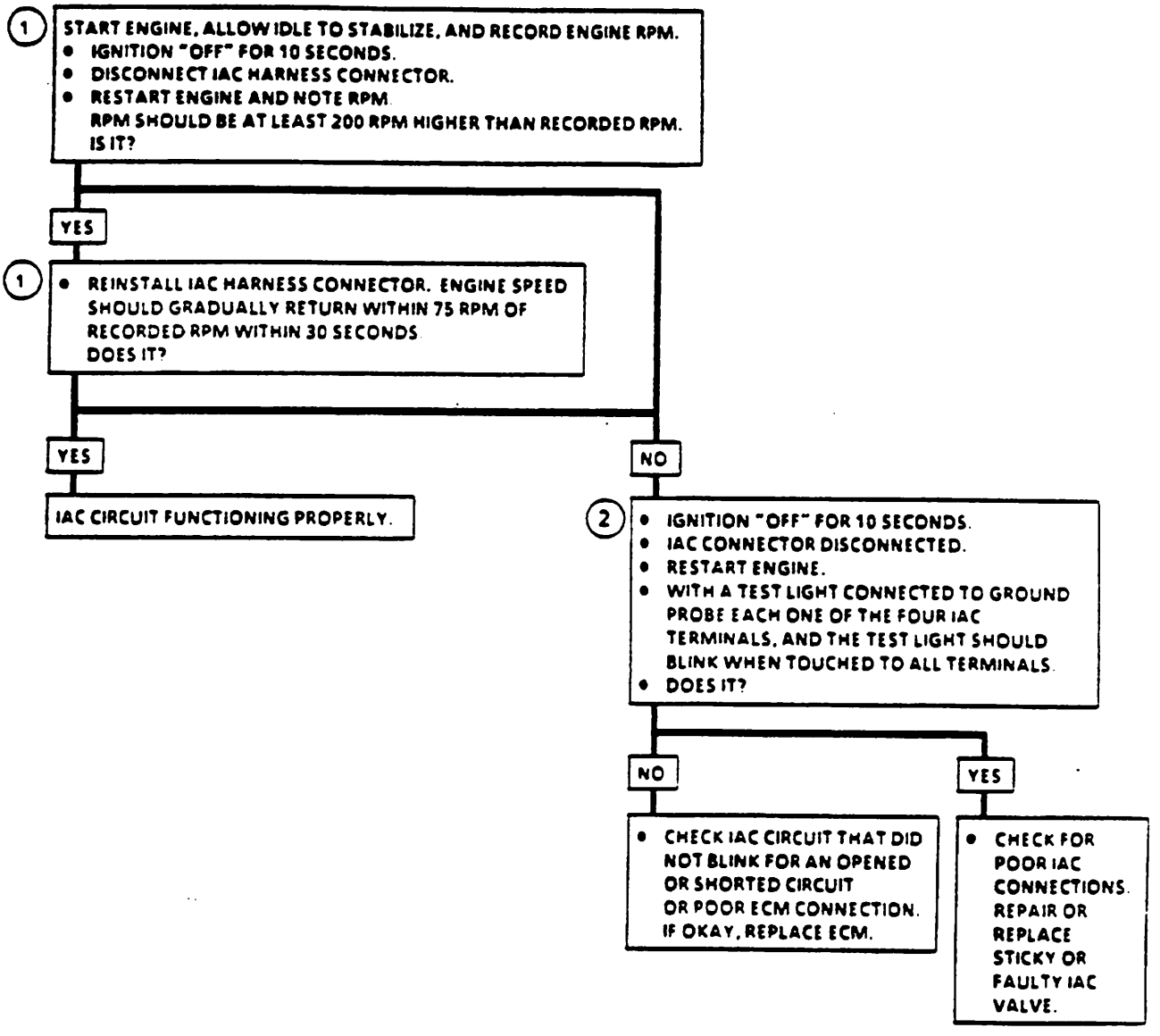
Diagnostic Aids: Check for vacuum leaks, unconnected or brittle vacuum hoses, cuts, etc. Examine manifold and throttle body gaskets for proper seal. Check for cracked intake manifold. Check open, shorts, or poor connections to IAC valve in CKTs 441, 442, 443 and 444.

An open, short, or poor connection in CKTs 441, 442, 443, or 444 will result in improper idle control and may cause improper idle.

An IAC valve which is stopped and cannot respond to the ECM, a throttle stop screw which has been tampered with, or a damaged throttle body or linkage could cause improper idle.

CHART A-7

IDLE AIR CONTROL FUNCTIONAL TEST



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION

4-6-93
MS *1695

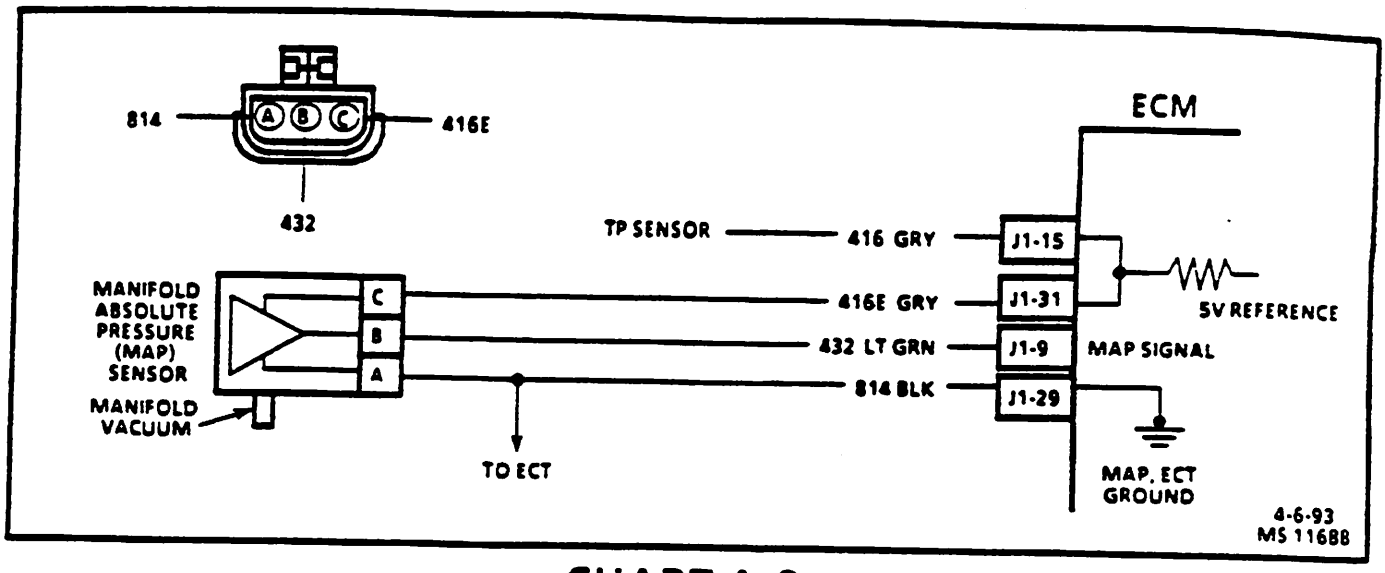


CHART A-8

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR OUTPUT CHECK

Circuit Description:

The Manifold Absolute Pressure (MAP) sensor measures the change in the intake manifold pressure which results from engine load (intake manifold vacuum) and RPM changes: and converts these into a voltage output. The ECM sends a 5 volt reference voltage to the MAP sensor. As the manifold pressure changes, the output voltage of the sensor also changes By monitoring the sensor output voltage, the ECM calculates the manifold pressure. A low pressure (low voltage) output voltage will be about 1 to 2 volts at idle. While high pressure (high voltage) output voltage will be about 4 to 4.8 at Wide Open Throttle (WOT). The MAP sensor is also used, under certain conditions, to measure barometric pressure, allowing the ECM to make adjustments for altitude changes. The ECM uses the MAP sensor to control fuel delivery and ignition timing.

Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

Important

- Be sure to use the same diagnostic test equipment for all measurements.

1. When comparing scan readings to a known good vehicle, it is important to compare vehicles that use a MAP sensor having the same color insert and the same "Hot Stamped" number. See Figures 1 and 2 on facing page.
2. Applying 34 kPa (10" Hg) vacuum to the MAP sensor should result in voltage readings of 1.5 to 2.1 volts less than the voltage in Step 1 Upon applying vacuum to the sensor, the change in voltage should be instantaneous. A slow voltage change indicates a faulty sensor
3. Check vacuum seal to sensor for leaking or restriction.

   NOTICE: Make sure electrical connector remains securely fastened.

4. Remove sensor from the intake plenum and twist sensor **(by hand only)** to check for intermittent connection. Output changes greater than .10 volt indicate a faulty sensor or connection. If OK, replace sensor Refer to "Sensors and Controls" in "On-Board Service" section.

CHART A-8

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR OUTPUT CHECK

IMPORTANT: THIS CHART ONLY APPLIES TO MAP SENSORS HAVING GREEN OR BLACK COLOR KEY INSERT (SEE BELOW).

(1)
- IGNITION "ON," ENGINE "OFF."
- SCAN DIAGNOSTIC TROUBLE CODES DTC(s). IF DTC 33 IS PRESENT, USE THAT CHART FIRST.
- SCAN TOOL SHOULD INDICATE A MAP SENSOR VOLTAGE.
- COMPARE THIS READING WITH THE READING OF A KNOWN GOOD VEHICLE. SEE FACING PAGE TEST DESCRIPTION, STEP 1.
  VOLTAGE READING SHOULD BE WITHIN ± .4 VOLT.
  IS IT?

YES

NO → REPLACE MAP SENSOR.

(2)
- REMOVE MAP SENSOR AND PLUG VACUUM PORT ON INTAKE MANIFOLD
- CONNECT A HAND VACUUM PUMP TO MAP SENSOR
- START ENGINE.
- NOTE MAP SENSOR VOLTAGE.
- APPLY 34 kPa (10" Hg) OF VACUUM AND NOTE VOLTAGE CHANGE. SUBTRACT SECOND READING FROM THE FIRST.
  VOLTAGE VALUE SHOULD BE GREATER THAN 1.5 VOLTS.
  IS IT?

YES

(3) NO TROUBLE FOUND. CHECK SENSOR INLET PORT FOR RESTRICTION
OR
LEAKING SEAL.

NO

(4) CHECK MAP SENSOR CONNECTION. IF OK, REPLACE MAP SENSOR

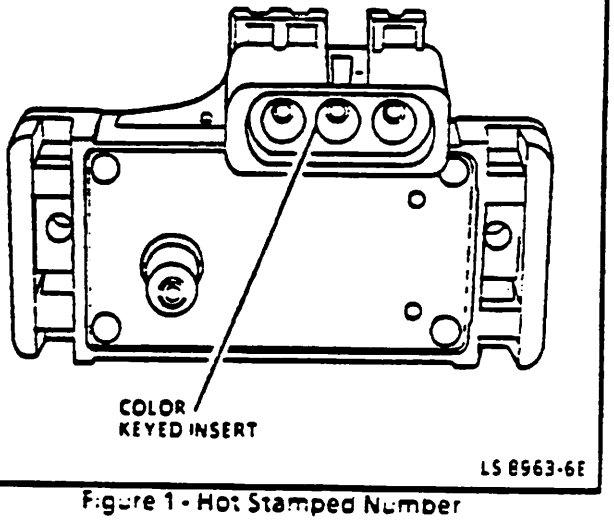


Figure 1 - Hot Stamped Number

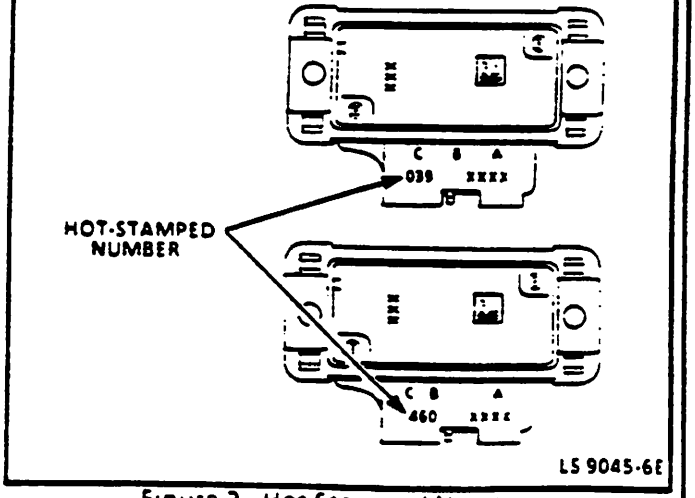
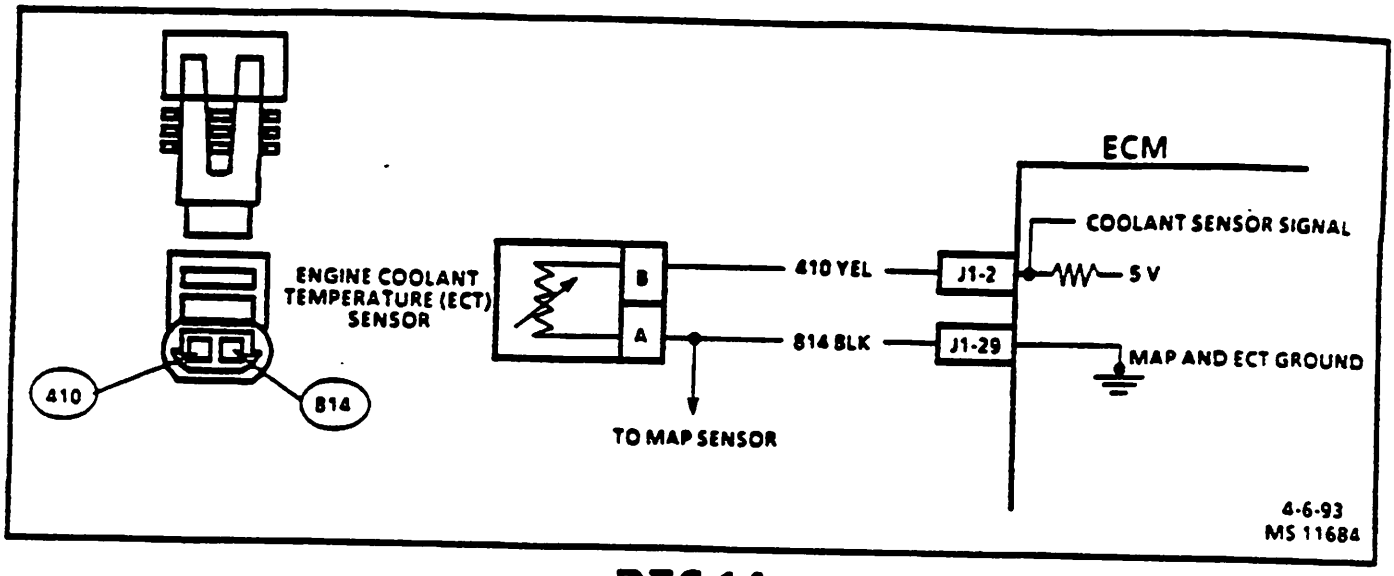


Figure 2 - Hot Stamped Number

7-12-93
MS 12859



DTC 14

ENGINE COOLANT TEMPERATURE (ECT) SENSOR CIRCUIT (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 a voltage on CKT 410 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high.

As the engine coolant warms, the sensor resistance becomes less, see engine coolant temperature sensor chart on facing page.

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

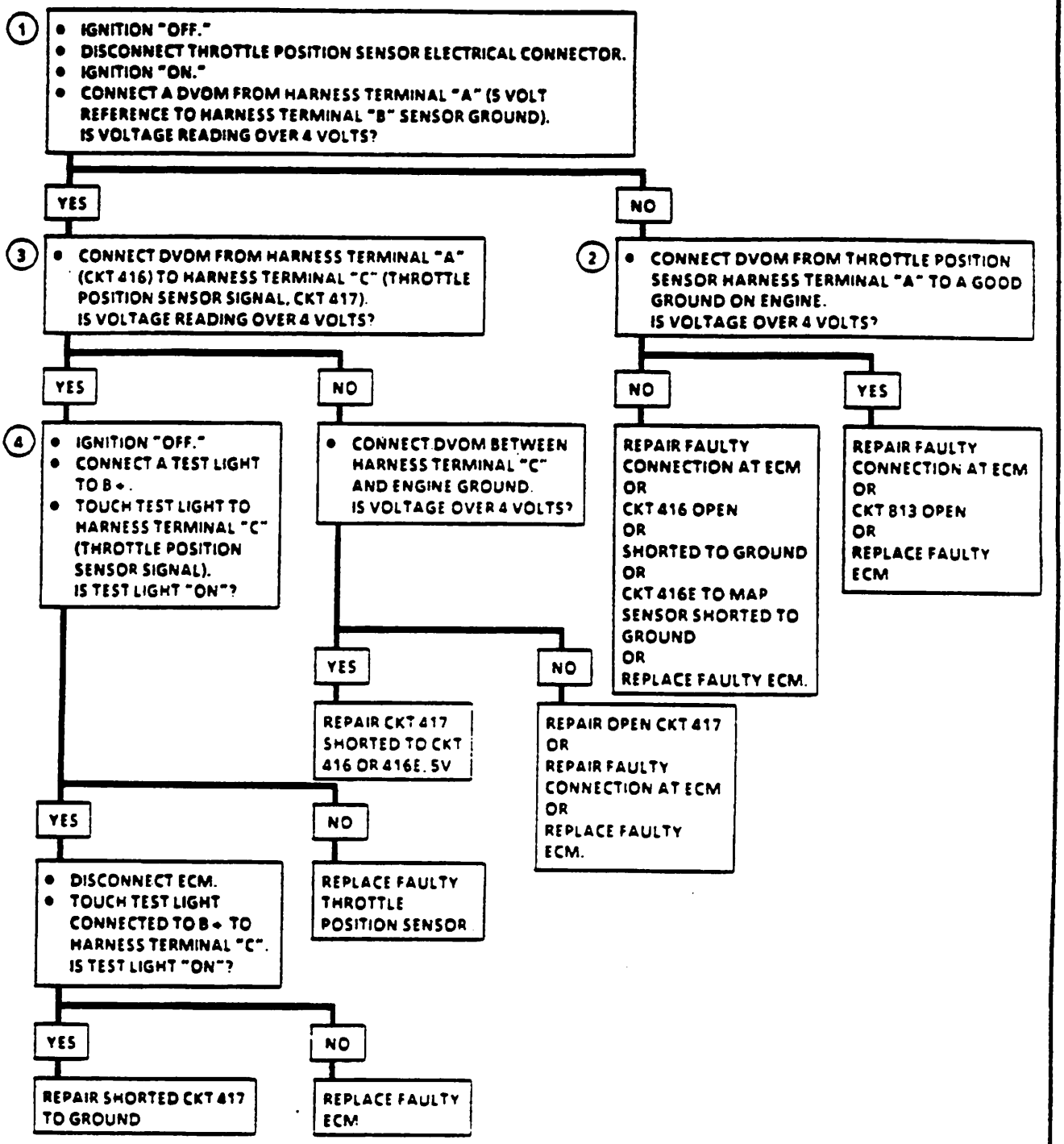
1. This step checks if there is a problem with the ECM and wiring or if the problem is the engine coolant sensor.
2. Check the harness terminals thoroughly for loose connections. If the resistance of the engine coolant sensor is monitored, the resistance should steadily decrease as the engine coolant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

Diagnostic Aids: An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear DTCs following "Clear DTCs Procedure" in "MEFI General Information." Failure to do so may result in DTCs not properly being cleared. Check harness routing for a potential short to ground in CKT 410. See "Intermittents" in "Symptoms" section. If DTC 33 is also set, check for open ground CKT 814.

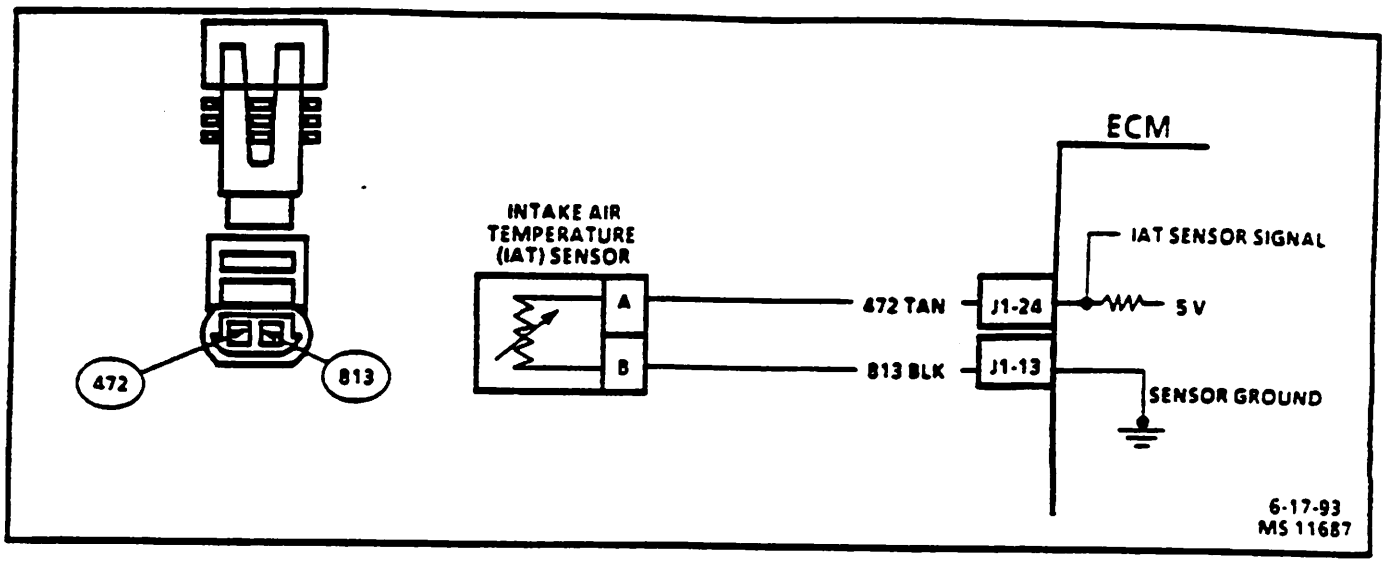
DTC 21

THROTTLE POSITION (TP) SENSOR CIRCUIT (NON-SCAN DIAGNOSTICS)



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED CLEAR DTC(s) AND VERIFY PROPER OPERATION

4-19-93
MS 11214



DTC 23

INTAKE AIR TEMPERATURE (IAT) SENSOR CIRCUIT (NON-SCAN DIAGNOSTICS)

Circuit Description:

The Intake Air Temperature (IAT) sensor uses a thermistor to control the signal voltage to the Engine Control Module (ECM). The ECM applies a voltage (about 5 volts) on CKT 472 to the sensor. When the air is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see a high signal voltage. If the air is warm, the sensor resistance is low, therefore, the ECM will see a low voltage.

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

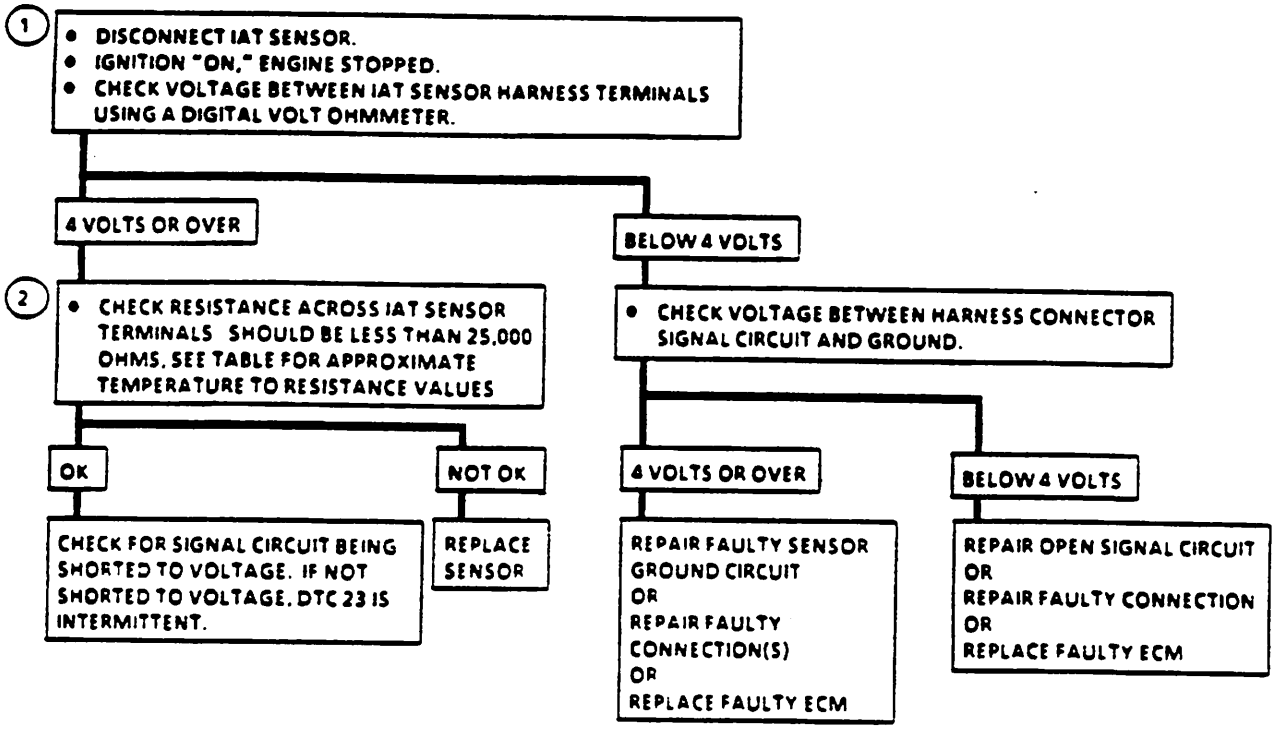
1. A DTC 23 will set, due to an open sensor, wire, or connection. This step will determine if the wiring and ECM are OK.
2. If the resistance is greater than 25,000 ohms, replace the sensor.

Diagnostic Aids: An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections, corroded terminals and or wiring, or physical damage to the wiring harness. After repairs, clear DTCs following "Clear DTCs Procedure" in "MEFI General Information." Failure to do so may result in DTCs not properly being cleared. If DTC 21 is also set, check CKT 813 for faulty wiring or connections. Check terminals at sensor for good contact.

DTC 23

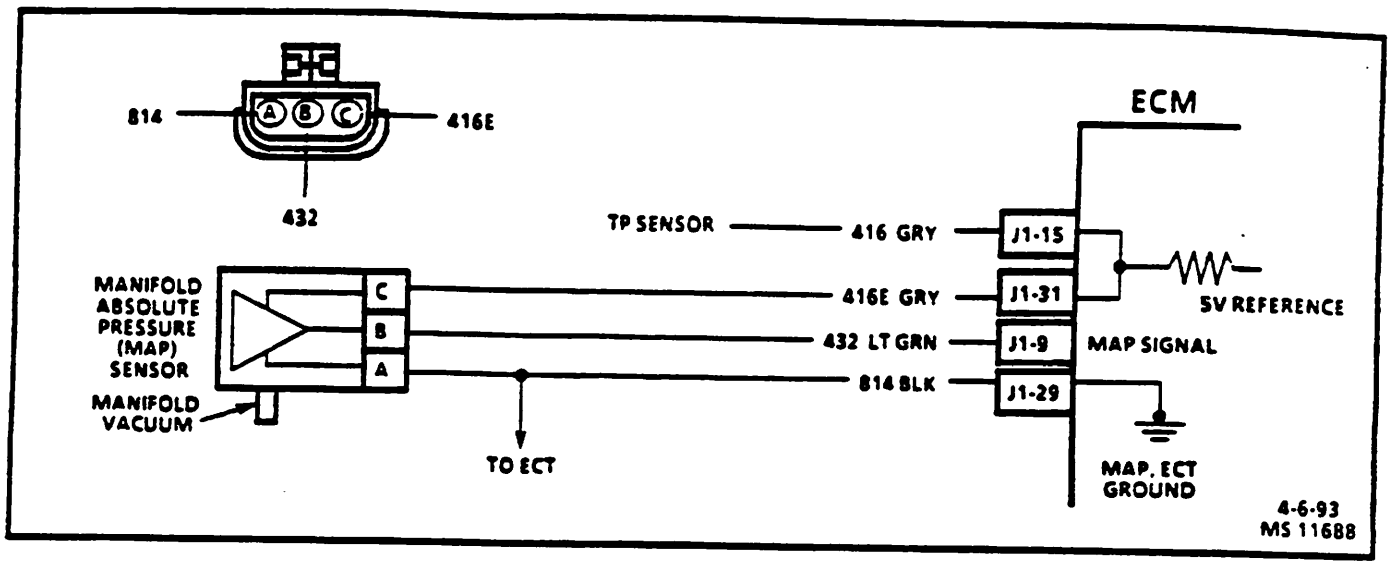
INTAKE AIR TEMPERATURE (IAT) SENSOR CIRCUIT (NON-SCAN DIAGNOSTICS)



IAT SENSOR TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE)		
°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION

6-23-93
MS 11215



DTC 33

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT (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 closed throttle idle, to 4.0-4.5 volts at Wide Open Throttle (WOT) (low vacuum).

If the MAP sensor fails, the ECM will substitute a fixed MAP value and use the Throttle Position (TP) sensor to control fuel delivery.

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

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

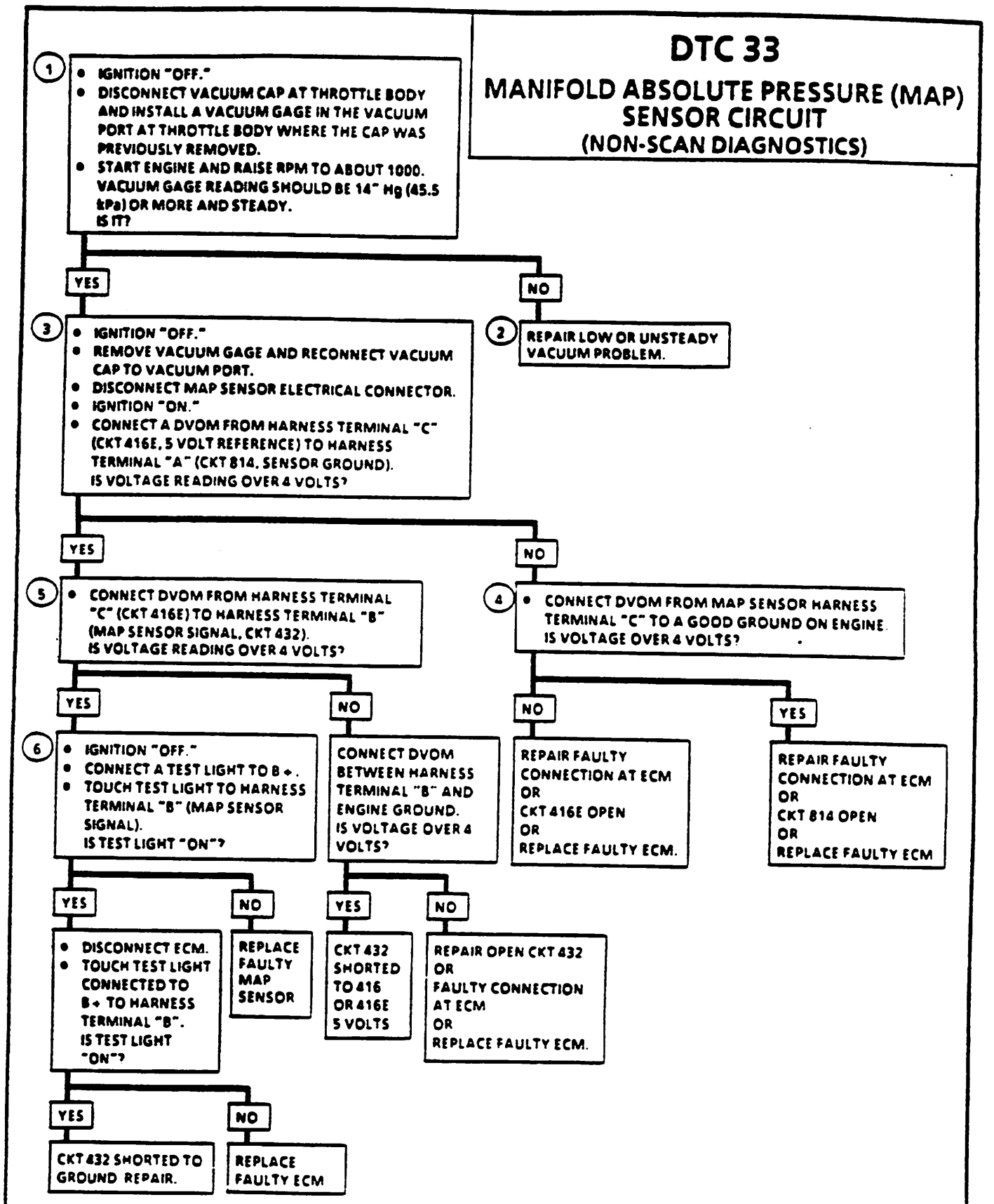
1. This step will determine if there is an adequate vacuum supply to the MAP sensor. If the gage reading is erratic, refer to the "Rough or Unstable Idle" symptom.
2. Low manifold vacuum may result from a restriction in the MAP sensor hose or from vacuum leaks in the engine induction system.
3. This step checks for a voltage from terminal "C" (5 volt reference) to terminal "A" (sensor ground).
4. This step will identify if the problem is in the supply 5V reference or ground circuit.
5. This step determines if the MAP signal circuit to the ECM is open.
6. This step completes the test for the ECM and wiring. If the test light is not "ON," the MAP sensor has an internal problem.

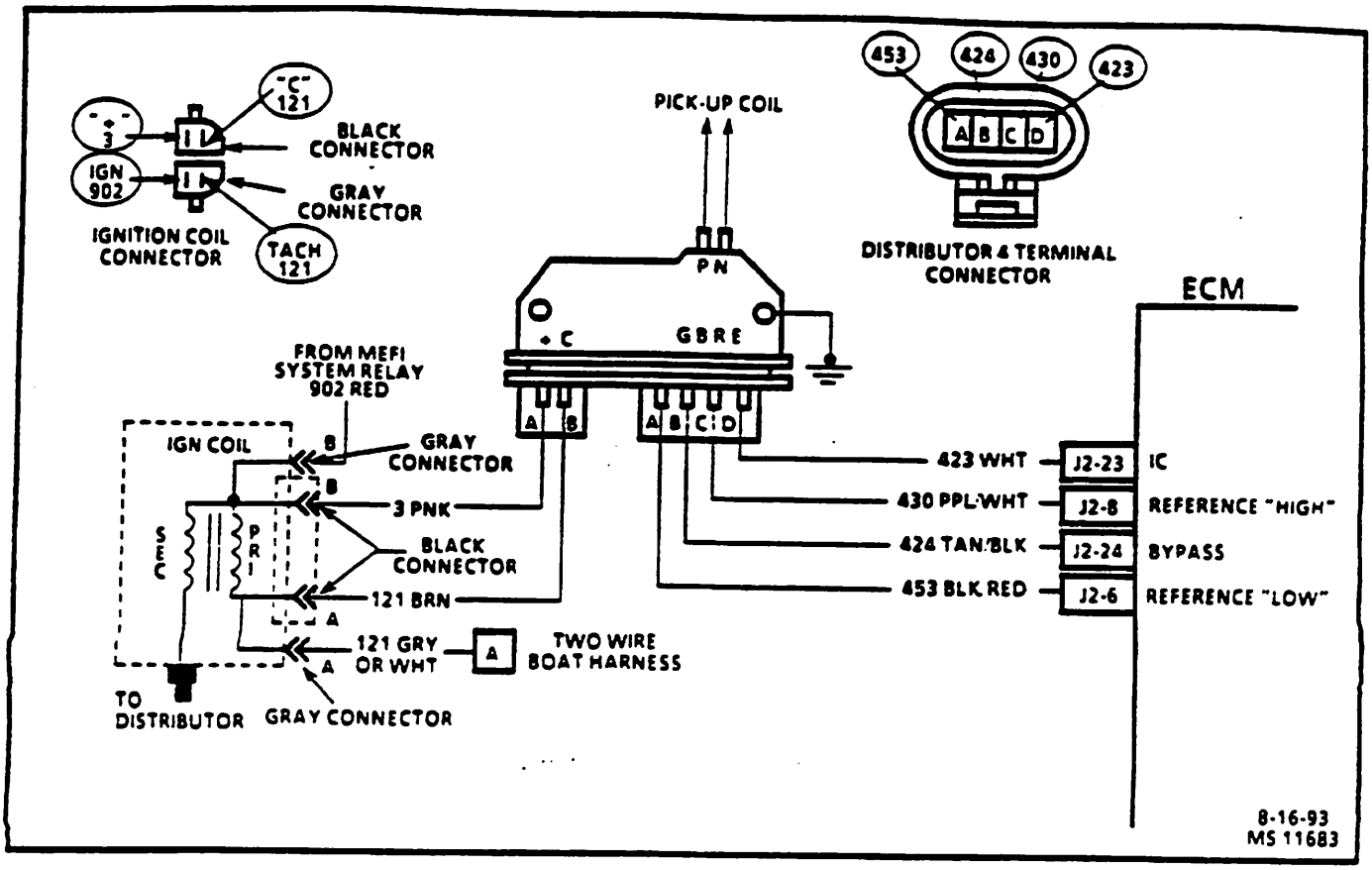
Diagnostic Aids: An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear DTCs following "Clear DTCs Procedure" in "MEFI General Information." Failure to do so may result in DTCs not properly being cleared. If DTC 14 is also set, check for open ground CKT 814.

DTC 33

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT (NON-SCAN DIAGNOSTICS)





DTC 42

IGNITION CONTROL (IC) CIRCUIT
(NON-SCAN DIAGNOSTICS)

Circuit Description:

When the system is running in the ignition module, (crank) mode, there is no voltage on the bypass line, and the Ignition Control (IC) module grounds the IC signal. The ECM expects to see no voltage on the IC line during this mode. If it sees a voltage, it sets DTC 42 and will not go into the IC mode.

When the RPM for IC is reached (about 400 RPM), and bypass voltage applied, the IC should no longer be grounded in the Ignition Control (IC) module, the IC voltage should be varying.

If the bypass line is open or grounded, the Ignition Control (IC) module will not switch to IC mode, the IC voltage will be low and DTC 42 will be set.

If the IC line is grounded, the Ignition Control (IC) module will switch to IC but, because the line is grounded, there will be no IC signal. A DTC 42 will be set.

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. DTC 42 means the ECM has seen an open or short to ground in the IC or bypass circuits. This test confirms DTC 42 and that the fault causing the DTC is present.
2. 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.
3. 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."
4. The module did not switch and this step checks for:
   - IC CKT 423 shorted to ground.
   - Bypass CKT 424 open.
   - Faulty Ignition Control (IC) module connection or IC module.
5. Confirms that DTC 42 is a faulty ECM and not an intermittent in CKT 424 or CKT 423.

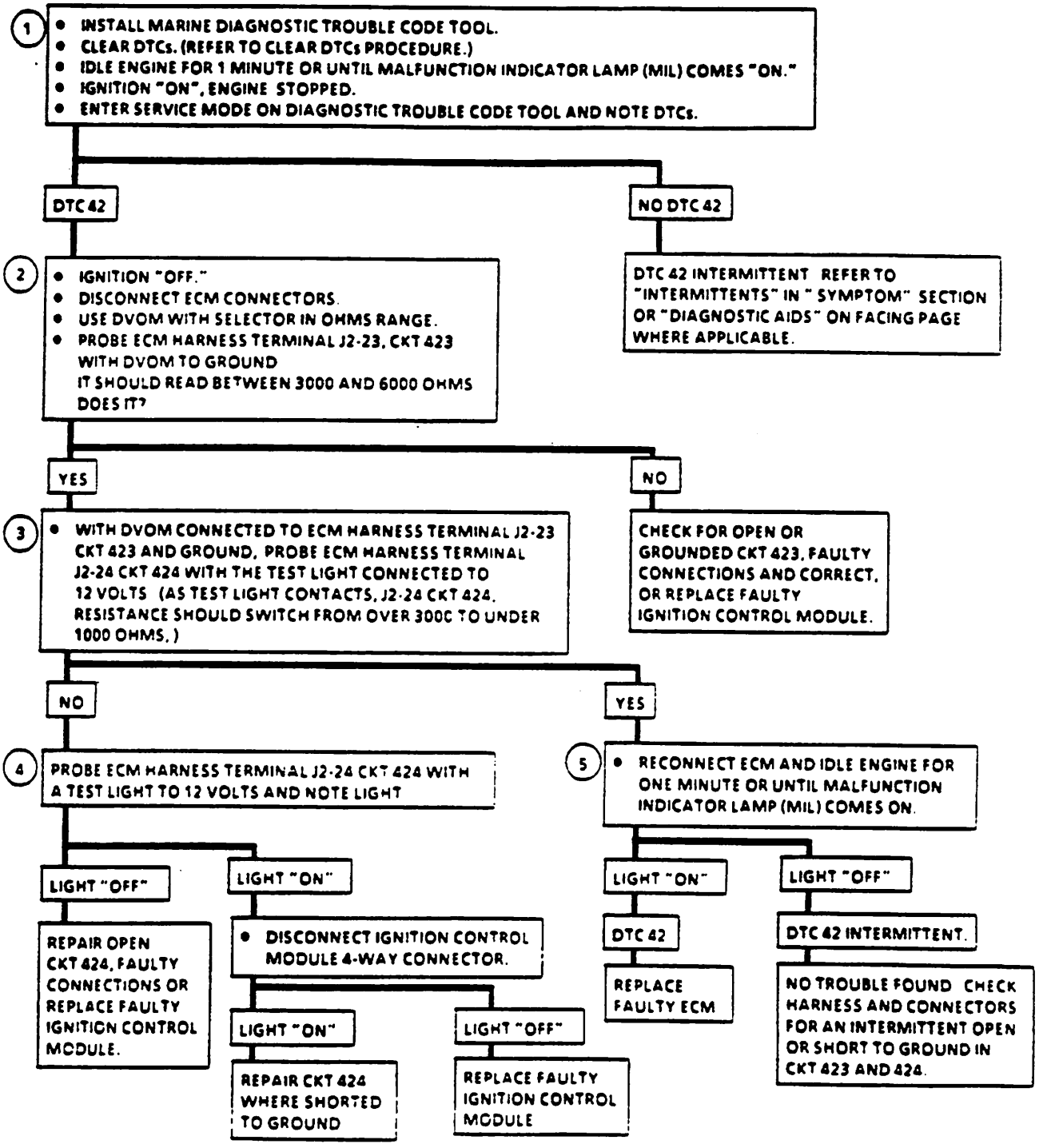
Diagnostic Aids: If engine starts and stalls, it may set a false DTC 42. Clear DTC and repair cause of stalling condition.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear DTCs following "Clear DTCs Procedure" in "MEFI General Information." Failure to do so may result in DTCs not properly being cleared.

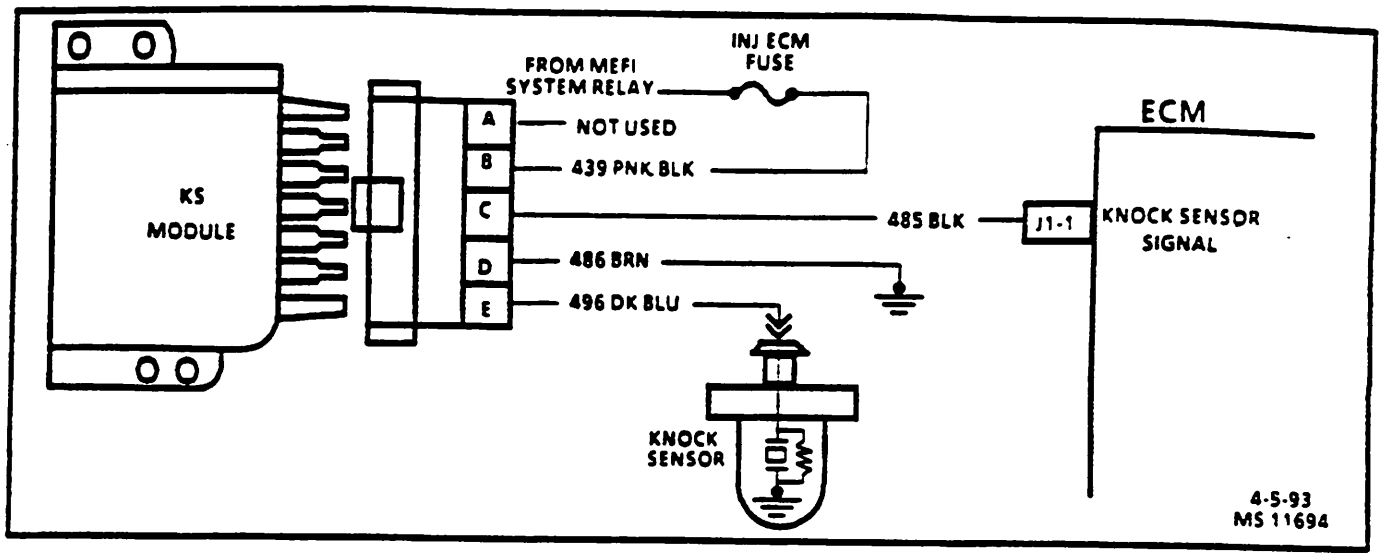
DTC 42

IGNITION CONTROL (IC) CIRCUIT (NON-SCAN DIAGNOSTICS)



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED CLEAR DTC(s) AND VERIFY PROPER OPERATION

6-18-93
NS 13618



DTC 43

KNOCK SENSOR (KS) SYSTEM
(NON-SCAN DIAGNOSTICS)

Circuit Description:

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

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. This step ensures that the knock sensor circuitry is within the proper resistance value
2. Applying 12 volts with a test light to CKT 496 simulates a signal from the knock sensor. The knock sensor is faulty if a response occurs
3. This step checks if a voltage signal from the KS module is present at the ECM.
4. This step determines if ignition voltage is available to power up the KS module.
5. This step confirms the ability of the KS module to remove the voltage from the signal line when it sees spark knock. Since the knock sensor produces an A/C voltage signal, it may be necessary to repeatedly touch (tickle) the harness connector with the test light probe to simulate this type of signal.
6. This step checks the ground circuit from the KS module. If the test light is dim, check ground (CKT 486) for excessive resistance.

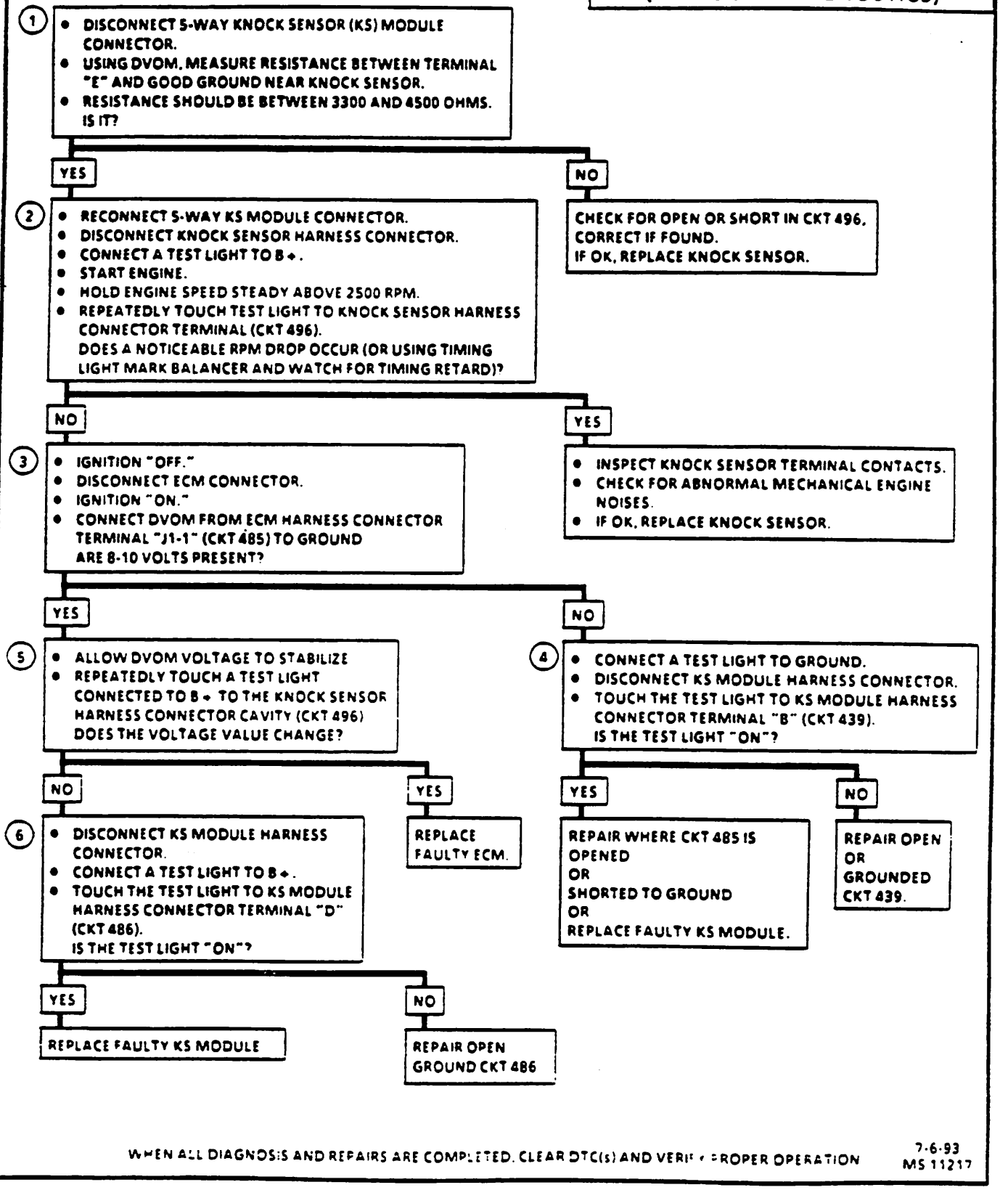
Diagnostic Aids: If CKT 496 is routed too close to secondary ignition wires, the KS module may see the interference as a knock signal, resulting in false retard.

An intermittent problem may be caused by a poor corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear DTCs following "Clear DTCs Procedure" in "MEFI General Information." Failure to do so may result in DTCs not properly being cleared.

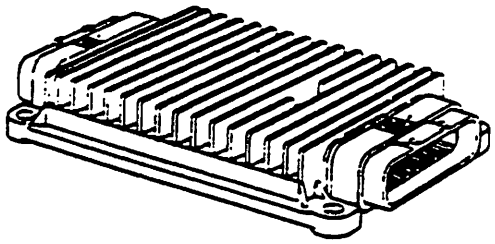
NOTICE: If there is abnormal mechanical engine noise (rattles or knocks), they may give a false DTC 43. If fuel octane is too high or too low, a false DTC 43 can be set.

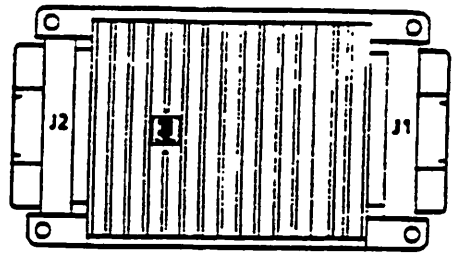
DTC 43
KNOCK SENSOR (KS) SYSTEM (NON-SCAN DIAGNOSTICS)



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION

7-6-93
MS 11217





PS 17655

DTC 51

CALIBRATION MEMORY 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 calibrations or changes to these calibrations that may alter the designed function of MEFI

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart

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

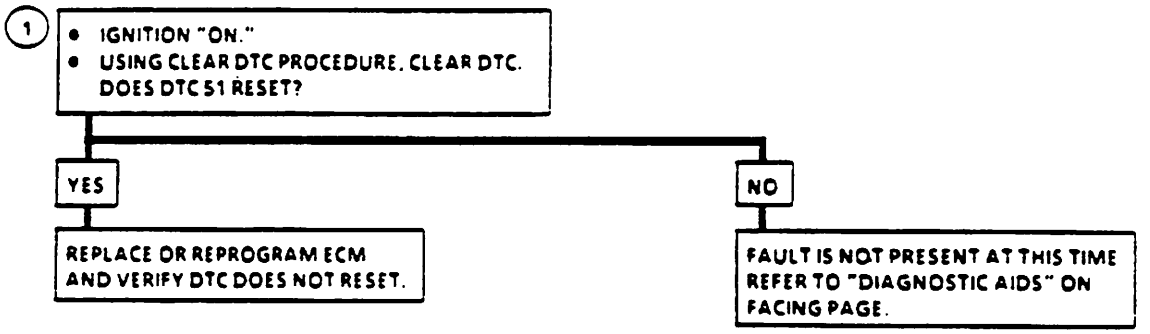
Important

- Vehicles with MEFI can be reprogrammed to correct this failure or replaced with a factory programmed ECM for your specific application

Diagnostic Aids: An intermittent DTC 51 may be caused by a bad cell in the EEPROM that is sensitive to temperature changes. If DTC 51 failed more than once, but is intermittent, replace ECM

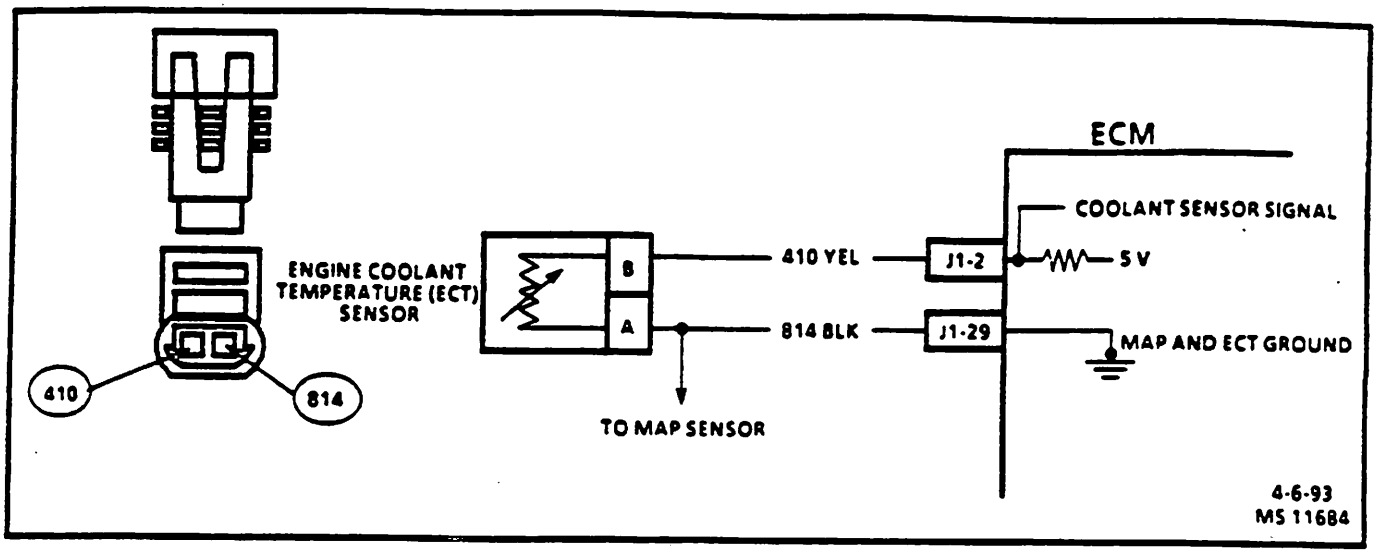
DTC 51

CALIBRATION MEMORY FAILURE (NON-SCAN DIAGNOSTICS)



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED CLEAR DTC(s) AND VERIFY PROPER OPERATION

3-29-93
MS 13556



DTC 14

ENGINE COOLANT TEMPERATURE (ECT) SENSOR CIRCUIT (SCAN DIAGNOSTICS)

Circuit Description:

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

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1 DTC 14 will set if.
- Signal voltage indicates a coolant temperature above 130°C (266°F) or below -30°C or -22°F

2 This test will determine if CKT 410 is shorted to ground, which will cause the condition for DTC 14.

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

Scan tool displays engine temperature in degrees celsius and fahrenheit. After engine is started, the temperature should rise steadily, reach normal operating temperature, and then stabilize when thermostat opens.

See "Intermittents" in "Symptoms" section.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear DTCs following "Clear DTCs Procedure" in "MEFI General Information." Failure to do so may result in DTCs not properly being cleared. If DTC 33 is also set, check for open ground CKT 814.

DTC 14

ENGINE COOLANT TEMPERATURE (ECT) SENSOR CIRCUIT (SCAN DIAGNOSTICS)

ECT SENSOR CHART		
TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)		
°C	°F	OHMS
100	210	185
70	160	450
38	100	1800
20	70	3400
4	40	7500
-7	20	13500
-18	0	25000
-40	-40	100700

(1) • IGNITION "ON."
DOES SCAN TOOL DISPLAY A COOLANT TEMPERATURE VALUE GREATER THAN 130°C (266°F) OR LESS THAN -30°C (-22°F)?

YES

NO

DTC 14 IS INTERMITTENT. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE

COOLANT TEMPERATURE SCAN DISPLAY GREATER THAN 130°C (266°F)

COOLANT TEMPERATURE SCAN DISPLAY LESS THAN -30°C (-22°F).

(2) • IGNITION "OFF."
• DISCONNECT ENGINE COOLANT TEMPERATURE SENSOR.
• IGNITION "ON."
• SCAN TOOL SHOULD DISPLAY COOLANT TEMPERATURE BELOW -30°C (-22°F).
DOES IT?

• IGNITION "OFF."
• DISCONNECT ENGINE COOLANT TEMPERATURE SENSOR.
• JUMP TERMINALS "A" AND "B" TOGETHER.
• IGNITION "ON."
• SCAN TOOL SHOULD DISPLAY COOLANT TEMPERATURE ABOVE 130°C (266°F).
DOES IT?

NO

REPAIR WHERE CKT 410 SHORTED TO GROUND OR REPLACE FAULTY ECM.

YES

REPLACE ENGINE COOLANT TEMPERATURE SENSOR

NO

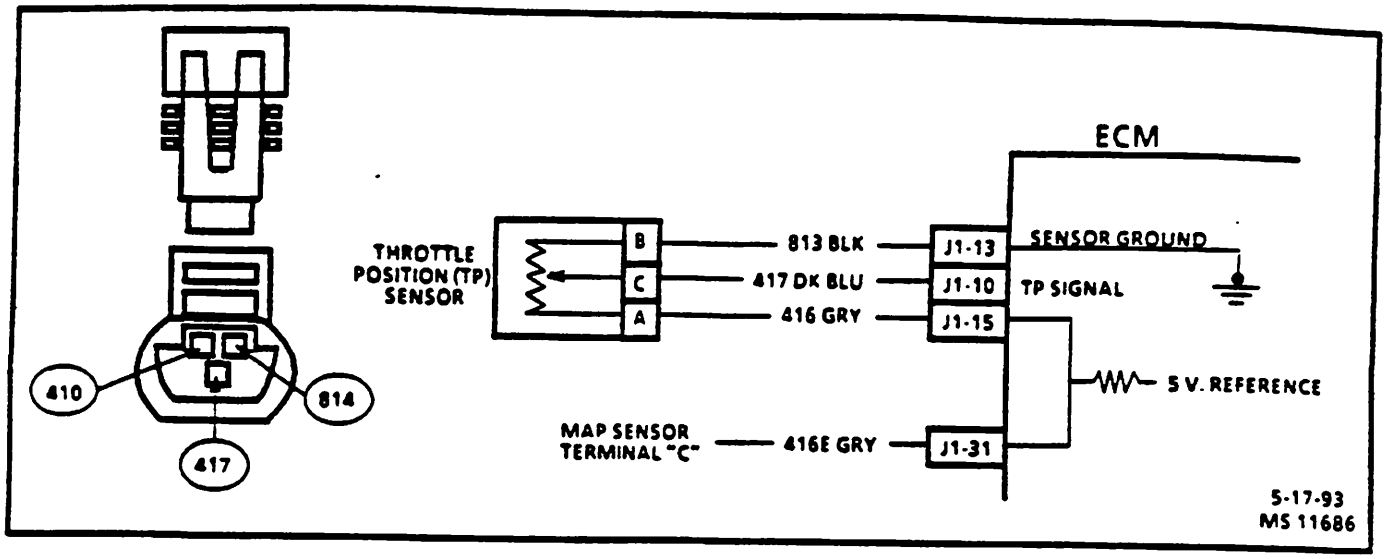
REPAIR OPEN CKT 410 OR 814 OR REPAIR FAULTY ECM.

YES

REPLACE ENGINE COOLANT TEMPERATURE SENSOR

WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION

7-6-93
MS 11282



DTC 21

THROTTLE POSITION (TP) SENSOR CIRCUIT (SCAN DIAGNOSTICS)

Circuit Description:

The Throttle Position (TP) sensor is a potentiometer that provides voltage signal changes, relative to the throttle blade. Signal voltage should vary from about .7 volt at idle to about 5 volts at Wide Open Throttle (WOT).

The TP sensor signal is one of the important inputs used by the Engine Control Module (ECM) for fuel control and for IAC control.

The TP sensor supply voltage of 5V is delivered to the TP sensor through CKT 416. CKT 813 is the TP sensor ground circuit. The TP sensor signal CKT 417 will send voltage back to the ECM according to where the throttle blades are positioned.

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. With throttle closed, the TP sensor should read between .3 and .9 volt. If it does not, check throttle cable adjustment or for bent linkage.
2. With the TP sensor disconnected, the TP sensor voltage should go low, if the ECM and wiring are OK.
3. Probing CKT 813 with a DVOM to CKT 416 checks the sensor ground. A faulty sensor ground will cause a DTC 21.

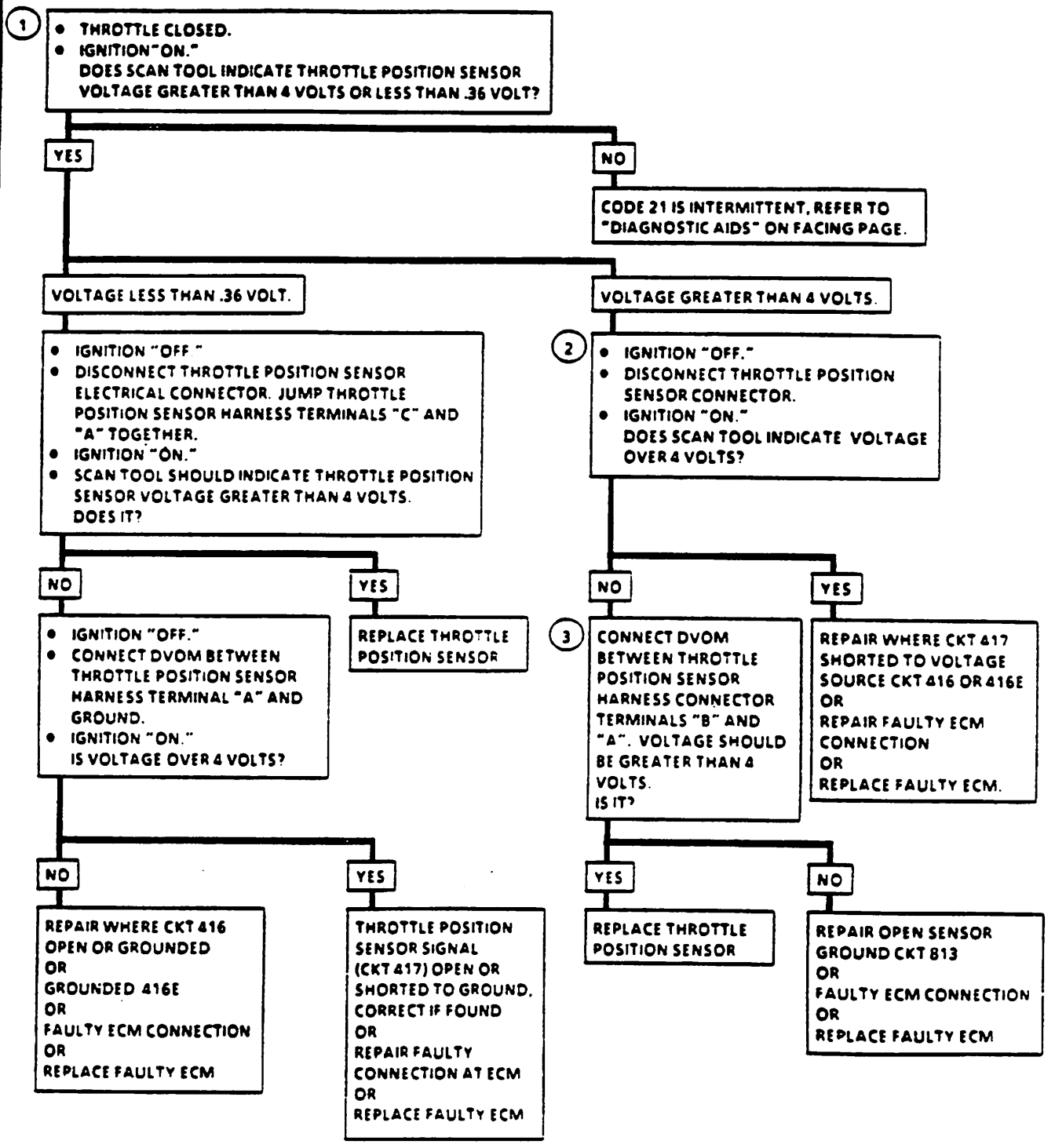
Diagnostic Aids: The scan tool reads throttle position in voltage and percentage of throttle blade opening. With ignition "ON" or at idle, TP sensor signal voltage should read between 3 and 9 volt with the throttle closed, and increase at a steady rate as throttle is moved toward Wide Open Throttle (WOT).

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear DTCs following "Clear DTCs Procedure" in "MEFI General Information." Failure to do so may result in DTCs not properly being cleared.

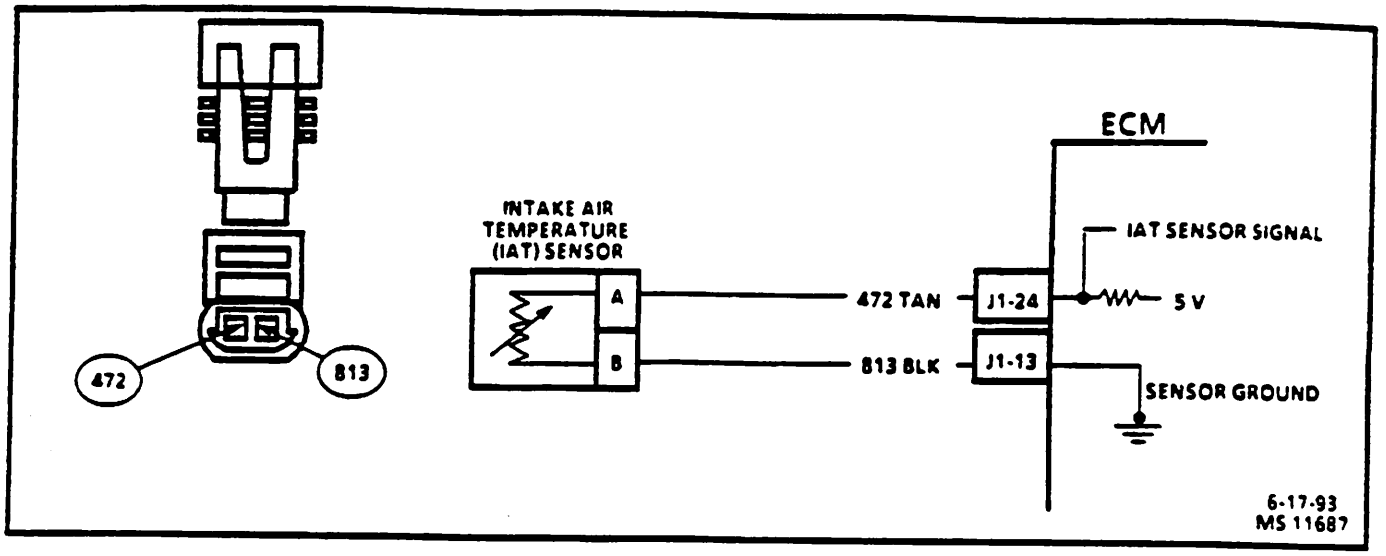
DTC 21

THROTTLE POSITION (TP) SENSOR CIRCUIT (SCAN DIAGNOSTICS)



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED CLEAR DTC(s) AND VERIFY PROPER OPERATION

5-12-93
MS 112E3



DTC 23

INTAKE AIR TEMPERATURE (IAT) SENSOR CIRCUIT (SCAN DIAGNOSTICS)

Circuit Description:

The Intake Air Temperature (IAT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage (about 5 volts) on CKT 472 to the sensor. When the intake air is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see a high signal voltage. If the intake air is warm, the sensor (thermistor) resistance is low, therefore, the ECM will see a low voltage.

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

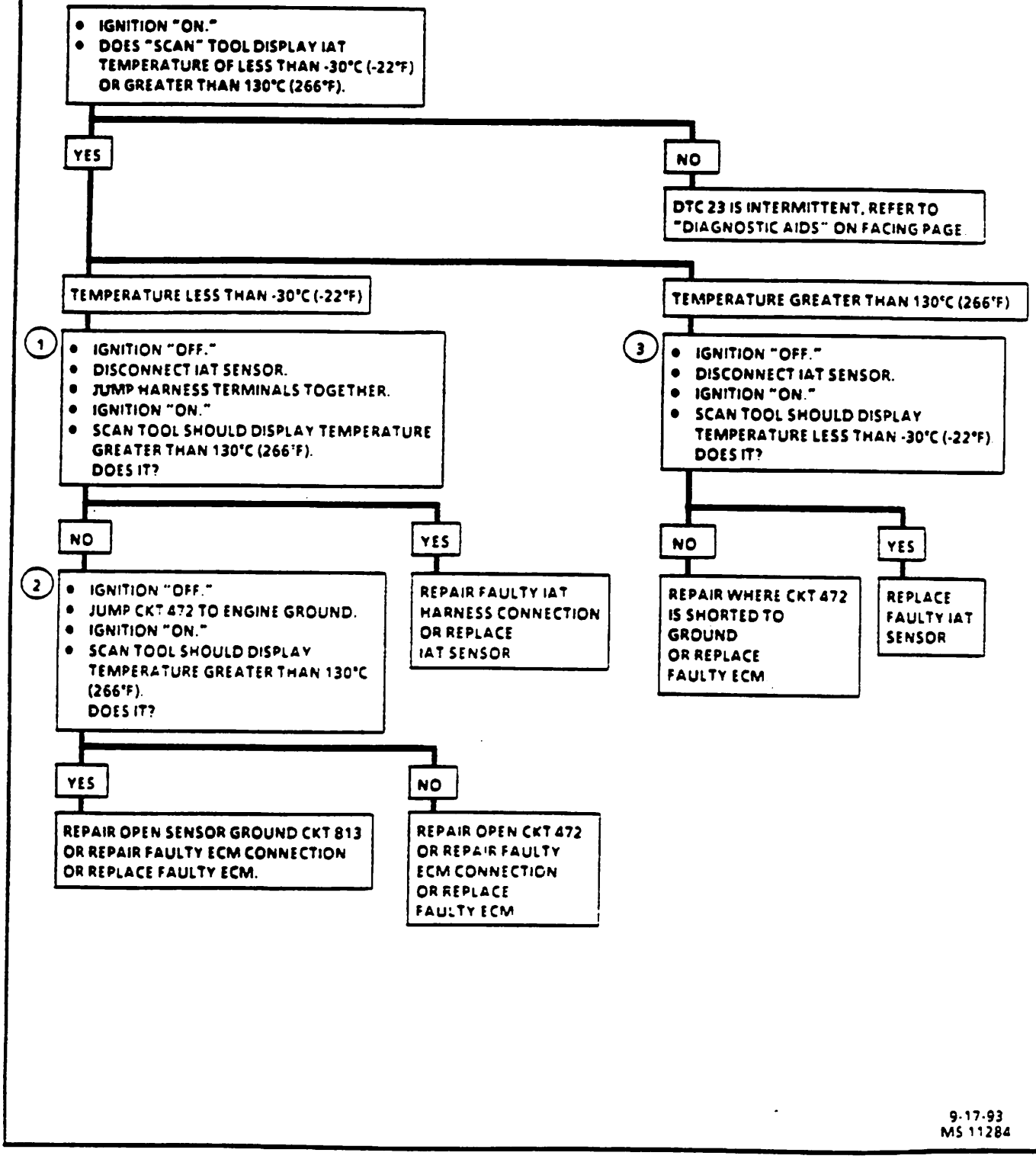
1. A DTC 23 will set, due to an open sensor, wire or connection. This test will determine if the wiring and ECM are OK. If the scan tool indicates a temperature of over 130°C (266°F), the harness to the sensor should be checked before replacing the sensor.
2. This will determine if the IAT sensor signal (CKT 472) or the IAT sensor ground (CKT 813) is open.
3. This step will determine if the fault is in the IAT sensor or the circuit.

Diagnostic Aids:

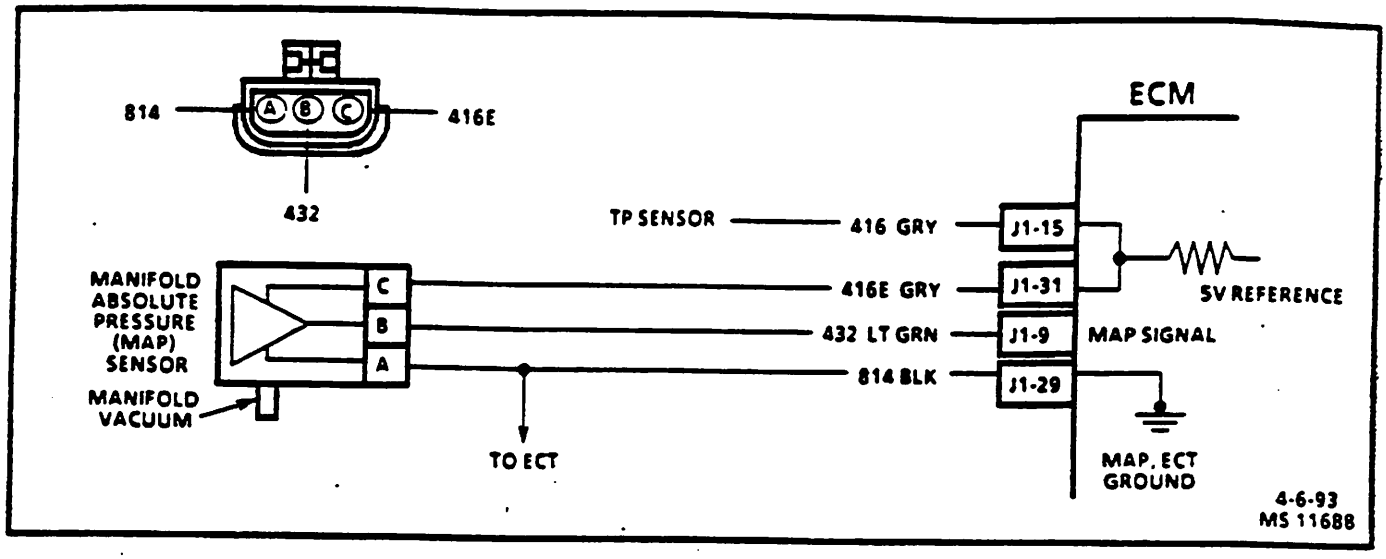
- The scan tool reads temperature of the air entering the engine and should read close to ambient air temperature when engine is cold, and rises as engine area temperature increases.
- Carefully check harness and connections for possible open.
- If the engine has been allowed to sit overnight, the intake air temperature and coolant temperature values should read within a few degrees of each other.
- An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.
- Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear DTCs following "Clear DTCs Procedure" in "MEFI General Information." Failure to do so may result in DTCs not properly being cleared.

DTC 23

INTAKE AIR TEMPERATURE (IAT) SENSOR CIRCUIT (SCAN DIAGNOSTICS)



9-17-93
MS 11284



DTC 33

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT (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 4.0-4.8 volts at Wide Open Throttle (WOT).

The scan tool displays manifold pressure in kPa of pressure and voltage. Low pressure (high vacuum) reads a low voltage while a high pressure (low vacuum) reads a high voltage.

If the MAP sensor fails, the ECM will substitute a fixed MAP value and use the Throttle Position (TP) sensor to control fuel delivery.

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

DTC Chart Test Description:

Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

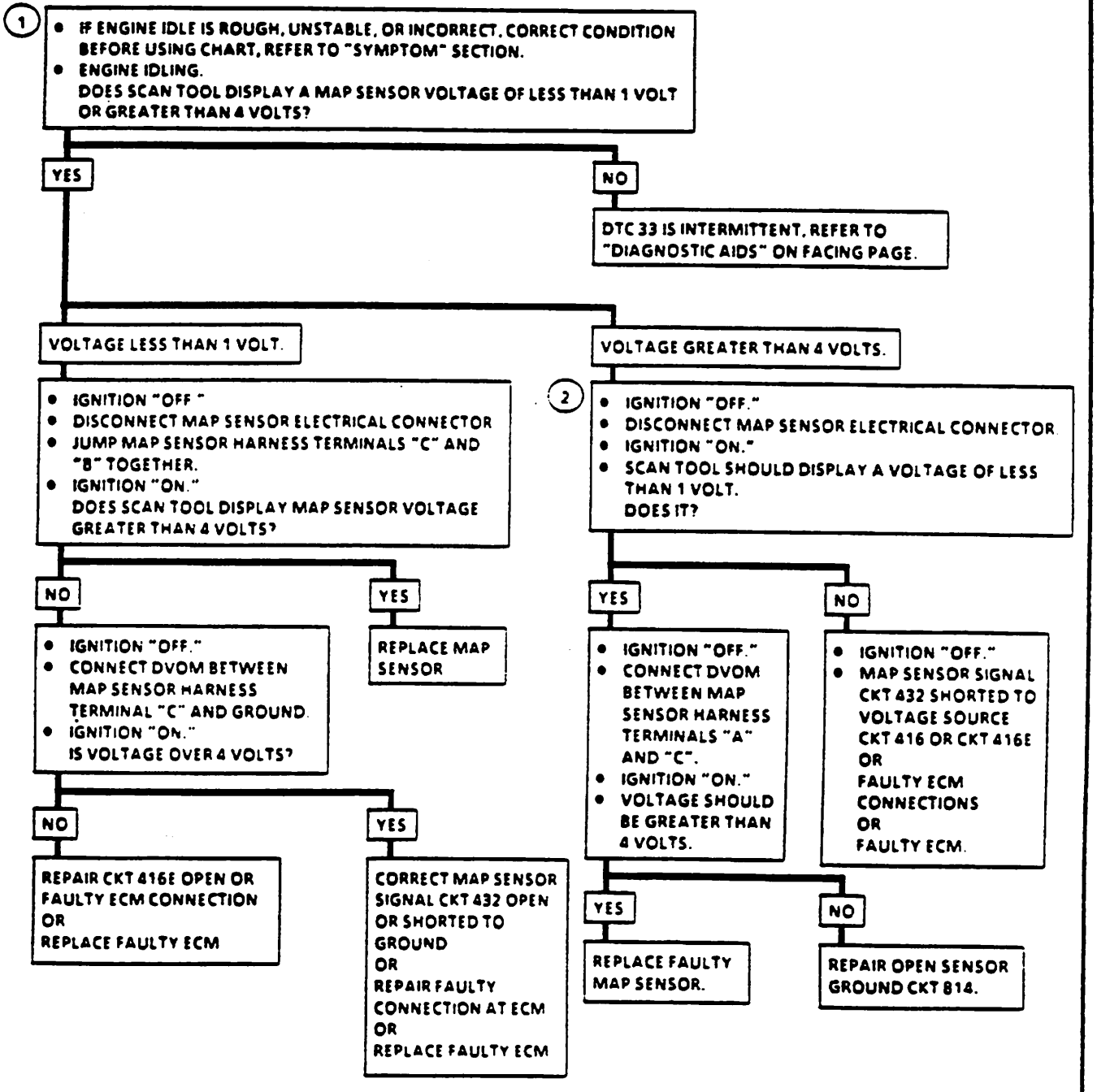
1. Engine misfire or a low unstable idle may set DTC 33. Disconnect MAP sensor and system will go into default mode. If the misfire or idle condition remains, refer to "Symptoms" section.
2. If the ECM recognizes the low MAP signal, the ECM and wiring are OK.

Diagnostic Aids:

- If the idle is rough or unstable, refer to "Symptoms" for items which can cause an unstable idle.
- With the ignition "ON," and the engine "OFF," the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of vehicle altitude and is referred to as BARO. Comparison of this BARO reading with a known good vehicle with the same sensor, is a good way to check accuracy of a "suspect" sensor. Reading should be the same ± 4 unit.
- An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.
- Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear DTCs following "Clear DTC Procedure" in "MEFI General Information." Failure to do so may result in DTCs not properly being cleared.
- Open CKT 814 may also set DTC 14.

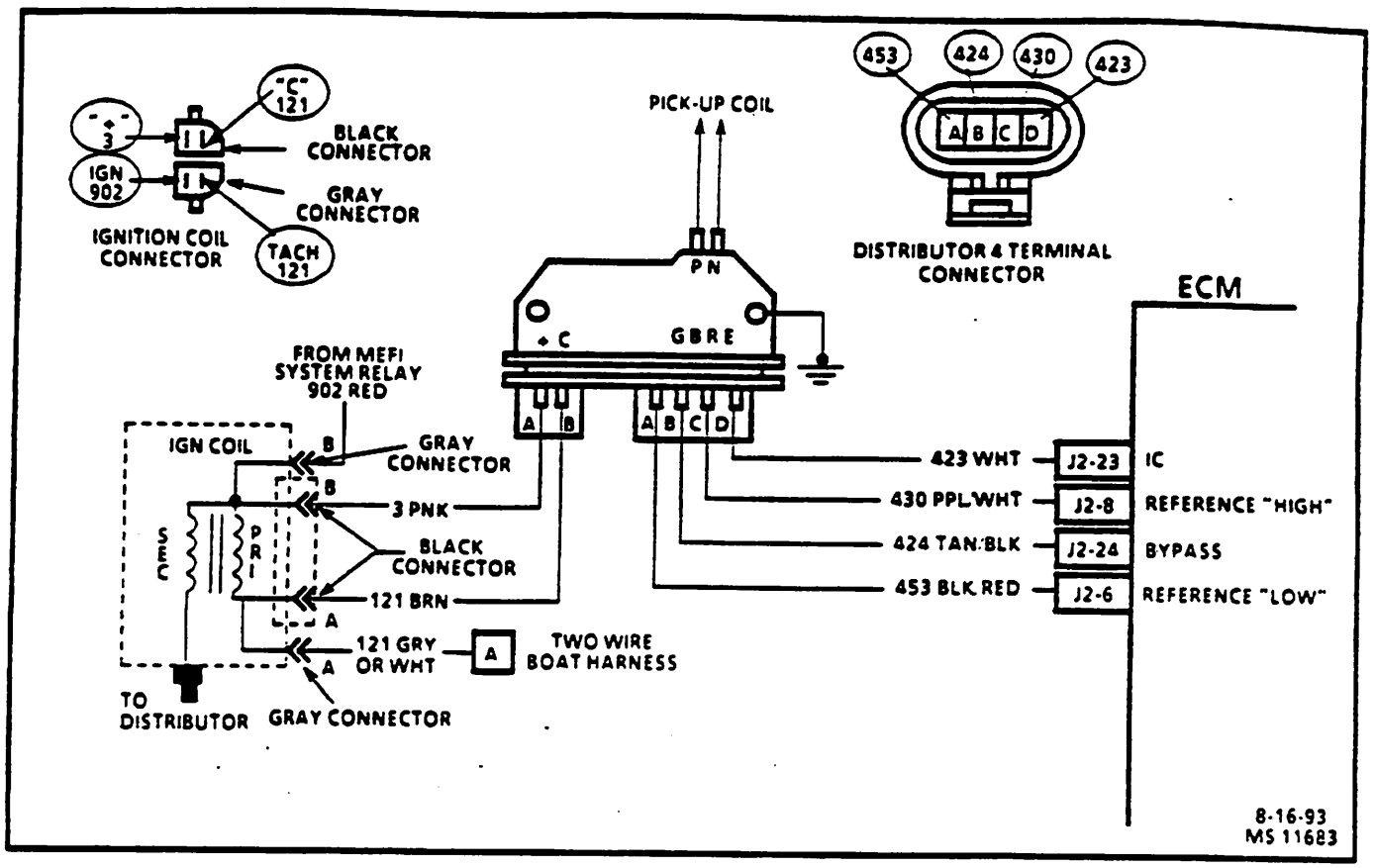
DTC 33

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT (SCAN DIAGNOSTICS)



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION

6-18-93
MS 11285



DTC 42

IGNITION CONTROL (IC) CIRCUIT
(SCAN DIAGNOSTICS)

Circuit Description:

When the system is in the ignition module (crank) mode, there is no voltage on the bypass line, and the Ignition Control (IC) module grounds the IC signal. The ECM expects to see no voltage on the IC line during this mode. If it sees a voltage, it sets DTC 42 and will not go into the IC mode.

When the RPM for IC is reached (about 400 RPM), and bypass voltage applied, the IC should no longer be grounded in the Ignition Control (IC) module, the IC voltage should be varying.

If the bypass line is open or grounded, the Ignition Control (IC) module will not switch to IC mode, the IC voltage will be low and DTC 42 will be set.

If the IC line is grounded, the Ignition Control (IC) module will switch to IC but, because the line is grounded, there will be no IC signal. A DTC 42 will be set.

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. DTC 42 means the ECM has seen an open or short to ground in the IC or bypass circuits. This test confirms DTC 42 and that the fault causing the DTC is present.
2. Checks for a normal IC ground path through the IC module. An IC CKT 424 shorted to ground will also read more than 3000 ohms; however, this will be checked later.
3. As the test light voltage touches CKT 423, the module should switch. The DVOM reading should change from over 3000 ohms to under 1000 ohms. The important thing is that the module "switched."
4. The module did not switch and this step checks for
   - IC CKT 424 shorted to ground.
   - Bypass CKT 423 open.
   - Faulty IC module connection or module.
5. Confirms that DTC 42 is a faulty ECM and not an intermittent in CKT 423 or CKT 424.

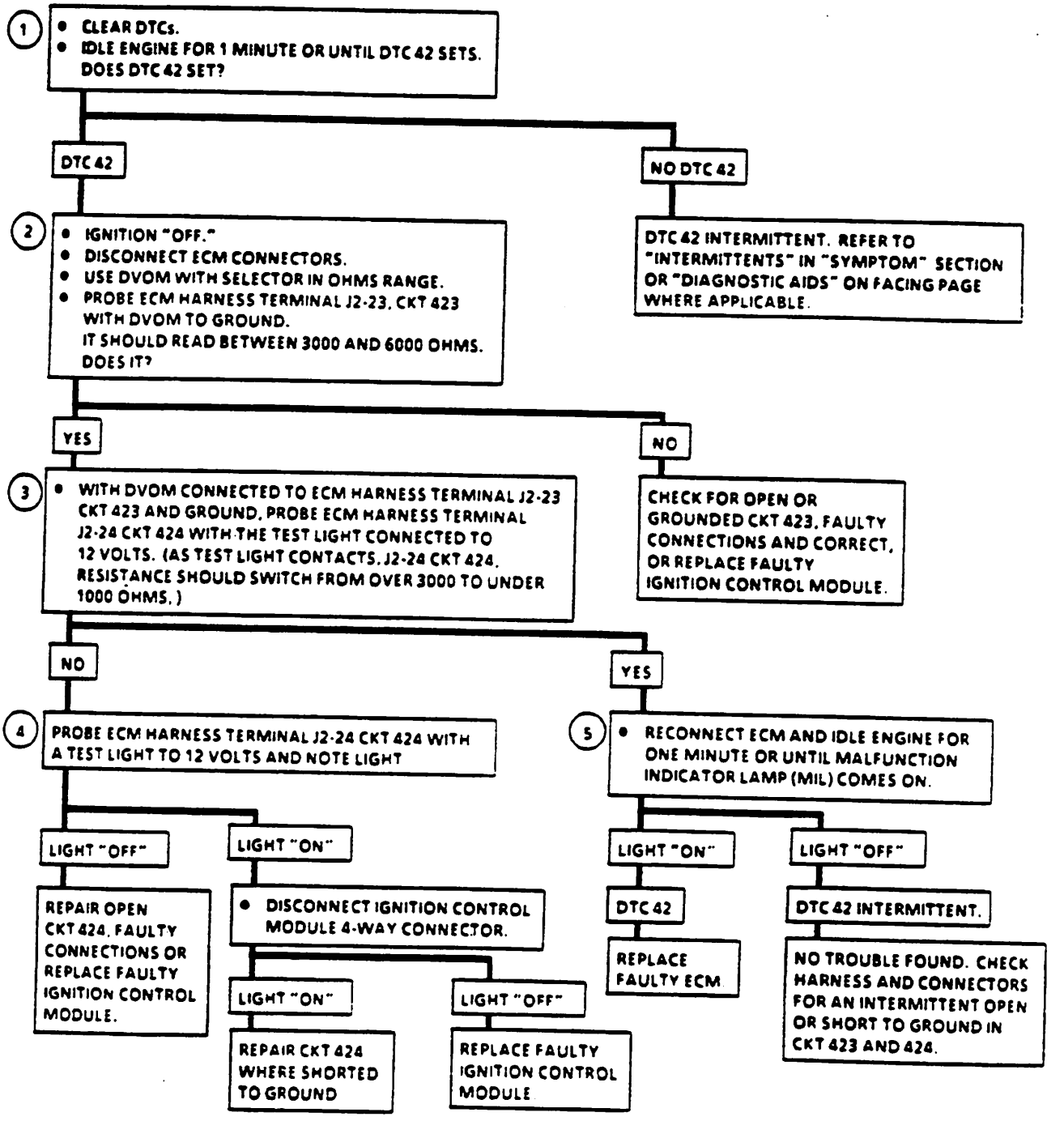
Diagnostic Aids: If engine starts and stalls, it may set a false DTC 42. Clear DTC and repair cause of stalling condition.

Refer to "Intermittents" in "Symptoms" section.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

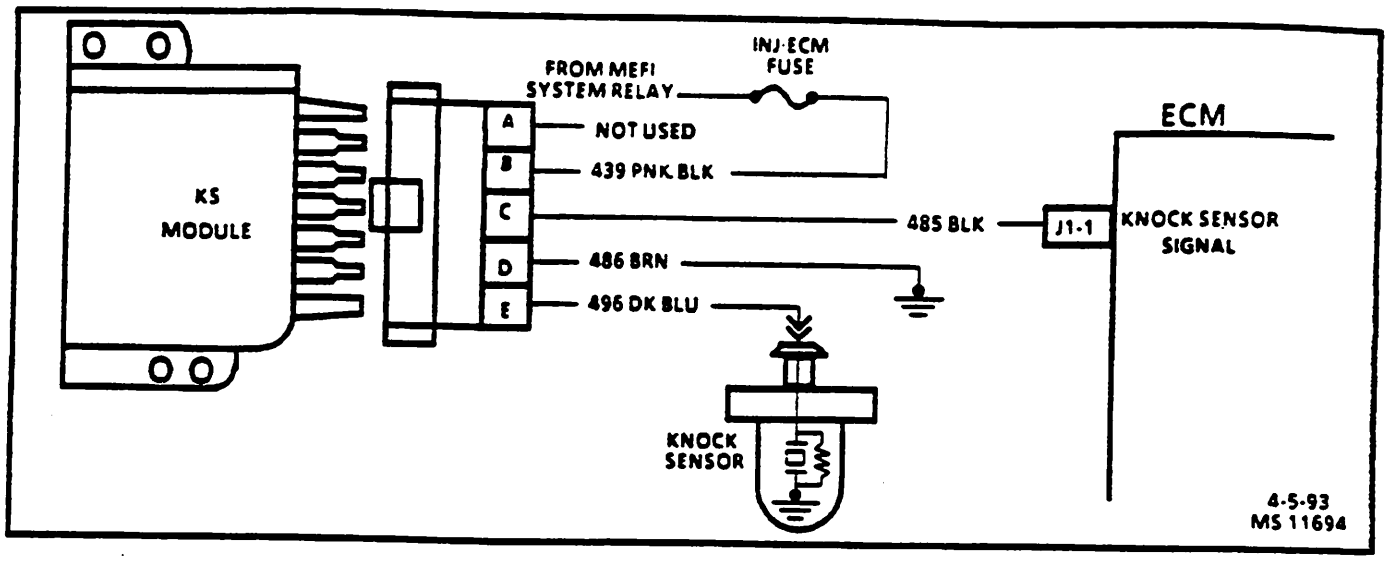
Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections, corroded terminals and or wiring, or physical damage to the wiring harness. After repairs, clear DTCs following "Clear DTCs Procedure" in "MEFI General Information." Failure to do so may result in DTCs not properly being cleared.

DTC 42
IGNITION CONTROL (IC) CIRCUIT (SCAN DIAGNOSTICS)



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED CLEAR DTC(s) AND VERIFY PROPER OPERATION

6-18-93
NS 14417



DTC 43

KNOCK SENSOR (KS) SYSTEM
(SCAN DIAGNOSTICS)

Circuit Description:

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

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. This step determines if there is a problem in the circuit. When a KS circuit fails, the ECM will switch to a default value of about 2 degrees.
2. This step checks if there is a voltage source to the knock sensor from the KS module.
3. This step will determine if the knock sensor is faulty.

Diagnostic Aids: If CKT 496 is routed too close to secondary ignition wires, the KS module may see the interference as a knock signal, resulting in false retard.

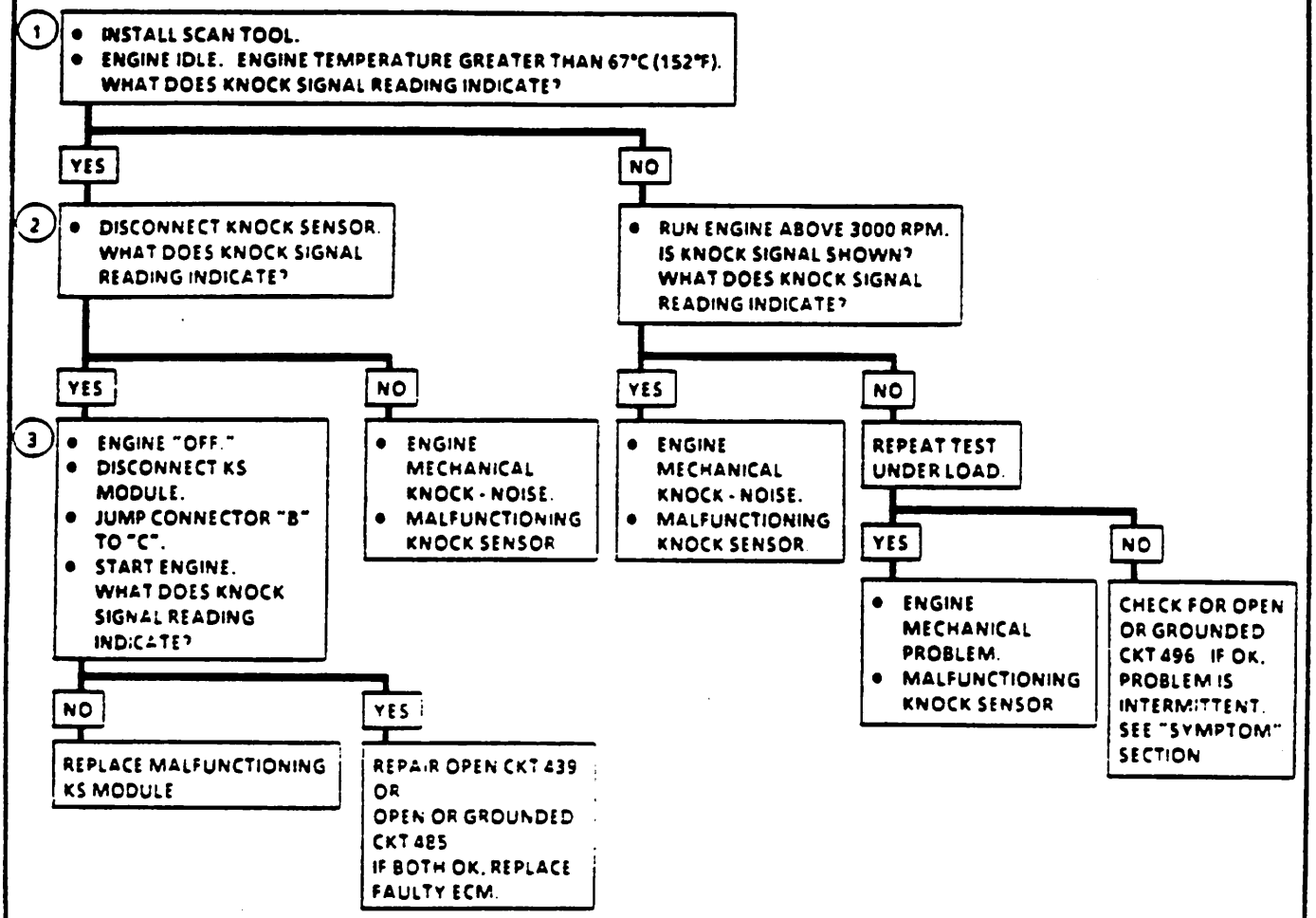
An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections, corroded terminals and or wiring, or physical damage to the wiring harness. After repairs, clear DTCs following "Clear DTCs Procedure" in "MEFI General Information." Failure to do so may result in DTCs not properly being cleared.

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

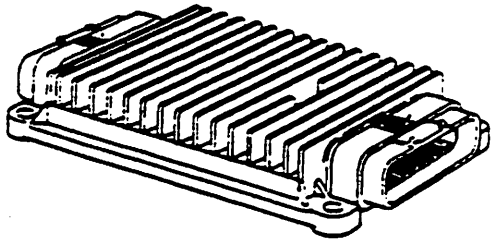
DTC 43

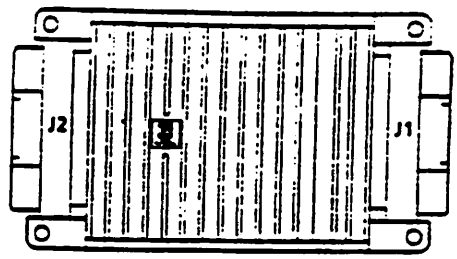
KNOCK SENSOR (KS) SYSTEM (SCAN DIAGNOSTICS)



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION

7-9-93
NS 13619





PS 17655

DTC 51

CALIBRATION MEMORY 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 calibrations or changes to these calibrations that may alter the designed function of MEFI.

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

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

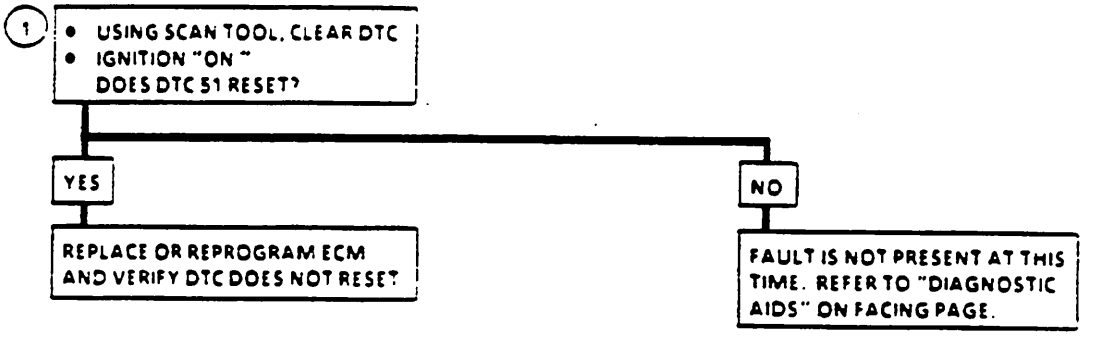
Important

- Vehicles with MEFI can be reprogrammed to correct this failure or replaced with a factory programmed ECM for your specific application

Diagnostic Aids: An intermittent DTC 51 may be caused by a bad cell in the EEPROM that is sensitive to temperature changes. If DTC 51 failed more than once, but is intermittent, replace ECM.

DTC 51

CALIBRATION MEMORY FAILURE
(SCAN DIAGNOSTICS)



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED CLEAR DTC(s) AND VERIFY PROPER OPERATION

4-6-93
MS 13557

SYMPTOMS
MFI

MARINE ELECTRONIC FUEL INJECTION (MEFI)
SECTION 6
SYMPTOMS

This section is to be used for diagnosis of driveability symptoms on the Marine Electronic Fuel Injection equipped engines. The section is to be used when there are no diagnostic trouble codes stored in the ECM. It is important that before the use of the symptom charts, the On-Board Diagnostic (OBD) System Check has been performed. The preliminary check chart needs to be completed before proceeding to the symptom. The symptom charts have sections that are listed in the order they need to be performed. Each section have "checks" that need to be performed in the order they are listed.

The assumption is made that on all symptom charts, the engine is equipped with GM Marine ECM, sensors, wiring harness, fuel components, and ignition components. The wiring identifications and circuit identifications are for the GM MEFI original equipped wire harness.

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

CONTENTS

MFI
SYMPTOMS
CONTENTS

IMPORTANT PRELIMINARY CHECKS

BEFORE USING THIS SECTION

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

1. The ECM is operating correctly.
2. There are no diagnostic trouble codes stored.

SYMPTOM

Verify the customer complaint, and locate the correct symptom in the table of contents. Check the items indicated under that symptom.

VISUAL/PHYSICAL CHECK

Several of the symptom procedures call for a careful visual/physical check. 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. These checks should include.

- ECM grounds and sensors for being clean, tight and in their proper locations
- Vacuum hoses for splits, kinks, and proper connections. Check thoroughly for any type of leak or restriction.
- Air leaks at throttle body mounting area and intake manifold sealing surfaces
- Ignition wires for cracking, hardness, proper routing and carbon tracking
- Wiring for proper connections, pinches and cuts. If wiring harness or connector repair is necessary, refer to "General Information" or "On-Board Service" sections for correct procedure.
- Moisture in primary or secondary ignition circuit connections.
- Salt corrosion on electrical connections and exposed throttle body linkages.

INTERMITTENTS

Definition: Problem occurs randomly. May or may not store a DTC.

- DO NOT use the diagnostic trouble code charts for intermittent problems, unless instructed to do so. If a fault is intermittent, incorrect use of diagnostic trouble code charts may result in replacement of good parts.

- Most intermittent problems are caused by faulty electrical connections or wiring Perform careful check of suspected circuits for:
  - Poor mating of the connector halves, or terminals not fully seated in the connector body (backed out or loose).
  - Improperly formed or damaged terminals and or connectors. All connector terminals and connectors in problem circuit should be carefully reformed or replaced to insure proper contact tension.
  - Poor terminal to wire connection (crimping). This requires removing the terminal from the connector body to check. Refer to "Wiring Harness Service" in "General Information" or "On Board Service" sections.

- If a visual/physical check does not find the cause of the problem, the MEFI system can be tested with a voltmeter or a scan tool connected while observing the suspected circuit. An abnormal reading, when the problem occurs, indicates the problem may be in that circuit.

- An intermittent may be caused by:
  - Electrical system interference caused by a sharp electrical surge Normally, the problem will occur when the faulty component is operated.
  - Improper installation of electrical options, such as lights, ship to shore radios, sonar, etc.
  - Knock sensor wires should be routed away from spark plug wires, ignition and charging system components.
  - Secondary ignition shorted to ground.
  - Arching at spark plug wires, plugs or open ignition coil ground (coil mounting brackets).
  - Part internal circuitry shorted to ground such as starters, relays and alternators.
  - Poor connection or open in CKT 453 (reference low/system ground) from ECM to ignition control module

HARD START

Definition: Engine cranks OK, but does not start for a long time. Engine does eventually run, or may start but immediately dies.

PRELIMINARY CHECKS

- Make sure proper starting procedure is being used. See Owner's Manual.
- Perform the careful visual/physical checks as described at the start of "MFI Symptoms" section.

FUEL SYSTEM

- **CHECK:** Fuel pump relay - Fuel pump should operate for 2 seconds when ignition is turned "ON." Also look for open in CKT 465, fuel pump relay drive. Refer to CHART A-4 in "Diagnosis" section.
- **CHECK:** Fuel filters and water separator.
- **CHECK:** For contaminated fuel.
- **CHECK:** For vapor lock condition or engine flooding, check fuel pressure. Refer to CHART A-4 in "Diagnosis" section.

IGNITION SYSTEM

- **CHECK:** Ignition timing - Refer to "On-Board Service" section.
- **CHECK:** Ignition wires for cracking, hardness and proper connections at both distributor cap and spark plugs.
- **CHECK:** For wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary.
- **CHECK:** Distributor cap inside and out for moisture, dust, cracks, burns, and arcing to coil mounting screws.
- **CHECK:** Distributor for:
  - Worn shaft.
  - Bare and shorted wires
  - Pick-up coil resistance and connections
  - Try to turn distributor shaft by hand. Drive pin may be broken.

SENSORS AND CONTROLS

- **CHECK:** Engine Coolant Temperature (ECT) sensor and Manifold Absolute Pressure (MAP) sensor - Ground CKT 814 for these sensors could have possible open and set a DTC 14 and/or DTC 33. Refer to these scan or non-scan code system diagnostics.
- **CHECK:** Throttle Position (TP) sensor. Ground CKT 813 could have a possible open and set DTC 21.
- **CHECK:** TP sensor - If a sticking throttle shaft or binding linkage causes a high TP sensor voltage, a scan tool and/or voltmeter should read less than .7 volt with throttle closed, or at idle position.
- **CHECK:** IAC operation. Refer to "Idle Air Control Function Test," CHART A-7.

MECHANICAL CHECK

- **CHECK:** For restricted exhaust.
- **CHECK:** Engine compression.
- **CHECK:** Proper camshaft timing/valve train problem.

SURGES

Definition: Engine power variation under steady throttle or cruise. Feels like the engine speeds up and slows down with no change in the throttle control.

PRELIMINARY CHECKS

- Perform the visual/physical checks as described at the start of "MFI Symptoms" section.

FUEL SYSTEM

- CHECK: Fuel filter. Replace if dirty or plugged.
- CHECK: Fuel pressure while condition exists. Refer to CHART A-4 of "Diagnosis" section.

IGNITION SYSTEM

- CHECK: 4-terminal IC connector at distributor and if routing of wires are near spark plug wires
- CHECK: Condition of IC module, coils and spark plug wires.
- CHECK: Intermittent ground connection on ignition coil.
- CHECK: Proper operation of IC, ignition timing for advancing or retarding.
- CHECK: Condition of distributor cap, rotor, and spark plug wires.
- CHECK: Distributor pick-up coil terminal for clean connection.
- CHECK: Spark plugs. Remove spark plugs, check for fuel fouled, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary.

SENSORS AND CONTROLS

- CHECK: MAP or ECT sensor grounds CKT 814 for intermittent opens. If intermittent for very brief period will not set DTC and cause a surge
- CHECK: MAP sensor 5 volt reference CKT 416E and MAP sensor signal CKT 432 for intermittent short to grounds or opens If intermittent for very brief period will not set DTC and cause a surge

ADDITIONAL CHECKS

- CHECK: Proper alternator output voltage.
- CHECK: For vacuum lines for leaks on kinks.
- CHECK: For RPM reduction mode.
- CHECK: ECM grounds for being clean, tight and in their proper locations

HESITATION, SAG, STUMBLE

Definition: Momentary lack of response as the throttle is opened. Can occur at all engine speeds. May cause engine to stall if severe enough

PRELIMINARY CHECKS

- Perform the important preliminary checks as described at the start of "MFI Symptom" section.

FUEL SYSTEM

- **CHECK:** For water contaminated fuel and dirty or restricted fuel filter.
- **CHECK:** Fuel pressure. Refer to CHART A-4 in "Diagnosis" section.
- **CHECK:** Fuel injectors. Perform "Injector Balance Test" at end of "MFI Symptom" section.

IGNITION SYSTEM

- **CHECK:** IC system for proper timing and advancing.
- **CHECK:** Spark plug wires for being faulty.
- **CHECK:** For RPM reduction mode.
- **CHECK:** KS system operation.
- **CHECK:** Spark plugs for being fouled or improper gap.

SENSORS & CONTROLS

- **CHECK:** TP sensor - For binding or sticking or salt corrosion. TP sensor voltage should increase as throttle is moved toward Wide Open Throttle (WOT).
- **CHECK:** TP sensor - 5 volt reference CKT 416 for open, DTC 21 may be set.
- **CHECK:** TP sensor circuit for open or grounds, DTC 21 may be set.
- **CHECK:** MAP output voltage check, CHART A-8, "Diagnosis" section.

ADDITIONAL CHECKS

- **CHECK:** Proper alternator output voltage.
- **CHECK:** For faulty or incorrect thermostat.
- **CHECK:** Throttle linkage for sticking or binding or worn.

DETONATION/SPARK KNOCK

Definition: A mild to severe ping, usually worse under acceleration or heavy load. The engine makes sharp metallic knocks that change with throttle opening.

PRELIMINARY CHECKS

- Perform the careful visual/physical checks as described at the start of "MFI Symptoms" section.

NOTICE: If scan tool is being used, and readings are normal (per facing page of OBD system checks) and there are no engine mechanical faults, fill fuel tank with a premium gasoline and re-evaluate detonation or spark knock.

IGNITION SYSTEM

- **CHECK:** Ignition timing.
- **CHECK:** KS system operation and if routing of wires are near secondary or primary ignition wires
- **CHECK:** Ignition system ground.
- **CHECK:** Spark plugs for proper heat range and gap

COOLING SYSTEM

- **CHECK:** For obvious overheating problems:
  - Loose water pump belt or faulty or incorrect water pump.
  - Restriction in cooling system
- **CHECK:** Faulty or incorrect thermostat

FUEL SYSTEM

- **CHECK:** For contaminated fuel
- **CHECK:** For poor fuel quality and proper octane rating
- **CHECK:** Fuel pressure. Refer to CHART A-4 in "Diagnosis" section

SENSORS AND CONTROLS

- **CHECK:** ECT - Which has shifted in value. Refer to scan or non-scan diagnosis in "Diagnosis" section.
- **CHECK:** TP sensor - For binding, sticking or salt corrosion. Voltage should increase as throttle is moved toward Wide Open Throttle (WOT).

ENGINE MECHANICAL

- **CHECK:** Low oil level.
- **CHECK:** For excessive oil in the combustion chamber.
  - Valve oil seals for leaking
- **CHECK:** Perform a compression test.
- **CHECK:** Combustion chambers for excessive carbon buildup. Remove carbon with top engine cleaner and follow instructions on can
- **CHECK:** Camshaft timing
- **CHECK:** For incorrect basic engine parts such as cam, heads, pistons, etc

LACK OF POWER, SLUGGISH OR SPONGY

(Page 1 of 2)

Definition: Engine delivers less than expected power. Little or no increase in speed when throttle control is moved toward Wide Open Throttle (WOT).

PRELIMINARY CHECKS

- Perform the careful visual/physical checks as described at the start of "MFI Symptoms" section.
- Remove flame arrestor and check for dirt, or for being plugged. Replace as necessary.

FUEL SYSTEM

- **CHECK:** Dirty or plugged fuel filter or water separator. Refer to CHART A-4 in "Diagnosis" section.
- **CHECK:** For contaminated fuel.
- **CHECK:** Injector driver CKTs 467 or 468 for open.
- **CHECK:** Improper fuel pressur·

IGNITION SYSTEM

- **CHECK:** Initial engine timing
- **CHECK:** Secondary ignition voltage, check per manufacturer's procedures.
- **CHECK:** For proper operation of IC/KS operation, an open or short to ground in CKT 423 IC or 485 KS will set a DTC 42 or 43. Refer to scan or non-scan diagnostics in "Diagnosis" section.

SENSORS AND CONTROLS

- **CHECK:** ECT and MAP sensors - Ground CKT 814 for these sensors could have possibly open and set a DTC 14 and/or 33. Refer to these scan or non-scan diagnostics in "Diagnosis" section.
- **CHECK:** TP sensor circuit if DTC 21 set for open or grounds. Refer to these scan or non-scan diagnostics in "Diagnosis" section.
- **CHECK:** TP sensor - If a sticky throttle shaft or binding linkage causes a high TP sensor voltage. A scan tool and/or voltmeter should read less than .7 volt with throttle closed or at idle position. Refer to scan or non-scan diagnostics in "Diagnosis" section.
- **CHECK:** If engine is in RPM reduction mode.
- **CHECK:** Diagnostic test CKT 451 for being grounded, will lower maximum RPMs.

LACK OF POWER, SLUGGISH OR SPONGY

(Page 2 of 2)

Definition: Engine delivers less than expected power. Little or no increase in speed, when throttle control is moved toward Wide Open Throttle (WOT).

ENGINE MECHANICAL

- **CHECK:** Restricted exhaust.
- **CHECK:** Engine compression.
- **CHECK:** Valve timing and for proper or worn camshaft.

ADDITIONAL CHECKS

- **CHECK:** Proper alternator output voltage.
- **CHECK:** ECM grounds for being clean, tight and in their proper locations.
- **CHECK:** Excessive resistance on bottom of boat (dirt, barnacles, etc.).
- **CHECK:** Propeller for proper size and pitch for application.

CUTS OUT, MISSES

(Page 1 of 2)

Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases. The exhaust has a steady spitting sound at idle or low speed.

PRELIMINARY CHECKS

- Perform the important preliminary checks as described at the start of the "MFI Symptoms" section.

IGNITION SYSTEM

- **CHECK:** For cylinder miss:
  1. Start engine, allow engine to stabilize, record RPM, then disconnect IAC motor. Stop engine, ground one spark plug wire at a time. Restart engine and record RPM.
  2. If there is an RPM drop on all cylinders, go to "Stalling, Rough, or Incorrect Idle" section. Reconnect IAC motor with engine "OFF."
  3. If there is no RPM drop on one or more cylinders, or excessive variation in RPM drop, check for spark on the suspected cylinder(s).
  4. If no spark, refer to "Distributor Ignition System Check." CHART A-6 for further diagnosis
  5. If there is a spark, remove spark plug(s) in these cylinders and check for:
     - Insulation cracks.
     - Insulator cracks.
     - Wear
     - Improper gap.
     - Burned electrodes.
     - Heavy deposits.
- **CHECK:** Spark plug wire resistance (should not exceed 30,000 ohms).
- **CHECK:** Ignition coil. Refer to "Distributor Ignition System Check," CHART A-6 of "Diagnosis" section.
- **CHECK:** With engine running, spray distributor cap and spark plug wires with a fine mist of water to check for shorts.

FUEL SYSTEM

- **CHECK:** For contaminated fuel or restricted fuel filter.
- **CHECK:** Fuel pressure. Refer to CHART A-4 in "Diagnosis" section.
- **CHECK:** Fuel injectors. Perform "Injector Balance Test" at end of "Symptoms" section.

SENSOR AND CONTROLS

- **CHECK:** TP sensor circuit for open or grounds in CKT 417 TP sensor signal or CKT 416 TP sensor 5 volt reference.

CUTS OUT, MISSES

(Page 2 of 2)

Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases. The exhaust has a steady spitting sound at idle or low speed.

ENGINE MECHANICAL

- **CHECK:** Cylinder compression.
- **CHECK:** Remove rocker covers, check for bent push rods, worn rocker arms, broken valve springs, worn camshaft lobes. Repair or replace as necessary.

ADDITIONAL CHECKS

- **CHECK:** For EMI interference. A missing condition can be caused by Electromagnetic Interference (EMI) on the reference circuit. EMI can usually be detected by monitoring engine RPM with a scan tool or a tachometer. A sudden increase in RPM with little change in actual engine RPM change, indicates EMI is present. If the problem exists, check routing of secondary wires, check ground circuit.

ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING

(Page 1 of 2)

Definition: Engine runs unevenly or rough at idle, also the idle may vary in RPM (called hunting). Either condition may be severe enough to cause stalling. Engine idles at incorrect speed.

PRELIMINARY CHECKS

- Perform the important preliminary checks as described at the start of "MFI Symptoms" section.

FUEL SYSTEM

- **CHECK:** For open in CKTs 467 or 468/injectors drivers. Refer to CHART A-3 in "Diagnosis" section.
- **CHECK:** For fuel injector(s) leaking, fuel pressure. Refer to CHART A-4 in "Diagnosis" section.
- **CHECK:** Fuel injectors. Perform "Injector Balance Test" at end of "Symptoms" section.

IGNITION SYSTEM

- **CHECK:** Ignition timing.
- **CHECK:** The following circuits for possible open, CKTs 424, 430 and 423
- **CHECK:** The following circuits for possible short to ground, CKTs 430, 424, and 423 Refer to mechanization drawings at the start of the "Diagnosis" section for circuit locations Then use "Diagnosis" section for affected circuit.
- **CHECK:** Ignition system Spark plugs, wires, etc.

SENSORS AND CONTROLS

- **CHECK:** IAC operation. Refer to "Idle Air Control Functional Test," CHART A-7 in the "Diagnosis" section.
- **CHECK:** The following circuits for possible open CKTs 410, 417, 416, 813 and 814 Refer to mechanization drawings at the start of the "Diagnosis" section for circuit locations
- **CHECK:** For possible short to ground in CKT 417, TP sensor signal, CKT 416 TP sensor 5 volt reference and CKT 451 diagnostic test circuit.
- **CHECK:** MAP sensor for response and accuracy. Refer to "MAP Output Check," CHART A-8 in the "Diagnosis" section.
- **CHECK:** TP sensor - For sticking throttle shaft, binding linkage and for salt corrosion. This causes a high TP sensor voltage (open throttle indication), the ECM will not control idle. Check voltage with a scan tool or voltmeter. Voltage should read approximately .7 volt closed throttle and approximately 5 volts at Wide Open Throttle (WOT).

ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING

(Page 2 of 2)

Definition: Engine runs unevenly or rough at idle, also the idle may vary in RPM (called hunting) Either condition may be severe enough to cause stalling Engine idles at incorrect speed.

ENGINE MECHANICAL

- **CHECK:** Perform a cylinder compression check.
- **CHECK:** For correct camshaft or weak valve springs.

ADDITIONAL CHECKS

- **CHECK:** Throttle linkage for sticking, binding and salt corrosion.
- **CHECK:** Proper alternator output voltage.
- **CHECK:** Battery cables and ground straps should be clean and secure Erratic voltage will cause IAC to change its position, resulting in poor idle quality.

BACKFIRE (INTAKE)

Definition: Fuel ignites in the manifold, making a loud popping noise.

PRELIMINARY CHECKS

- Perform the important preliminary checks as described at the start of "MFI Symptoms" section.

FUEL SYSTEM

- **CHECK:** Flame arrestor for proper installation, per manufacturer's instructions.
- **CHECK:** Perform fuel system diagnosis. Use CHART A-4 in "Diagnosis" section.
- **CHECK:** Fuel injectors. Perform "Injector Balance Test" at end of "Symptoms" section.

SENSOR AND CONTROLS

- **CHECK:** TP sensor circuit for opens or grounds in CKT 416 TP sensor 5 volt reference and CKT 417 TP sensor signal. DTC 21 will be set. Use "Diagnosis" section

IGNITION SYSTEM

- **CHECK:** Opens and grounds in CKTs 423, 424 and 430, refer to "Distributor Ignition System Check," CHART A-6 in "Diagnosis" section.
- **CHECK:** Ignition timing and for IC functioning properly, see "On-Board Ignition Timing Check."
- **CHECK:** Proper output voltage of ignition coils.
- **CHECK:** For crossfire between spark plugs, (distributor cap, spark plug wires and proper routing of plug wires).
- **CHECK:** Spark plug wires and boots
- **CHECK:** For faulty spark plugs

ENGINE MECHANICAL

- **CHECK:** Compression - Look for sticking or leaking valves.
- **CHECK:** Valve timing, broken or worn valve train parts.

BACKFIRE (EXHAUST)

Definition: Fuel ignites in the exhaust system, making a loud popping noise.

PRELIMINARY CHECKS

- Perform the important preliminary checks as described at the start of "MFI Symptoms" section.

IGNITION SYSTEM

- **CHECK:** Opens and grounds in CKTs 423, 424 and 430, refer to "Distributor Ignition System Check," CHART A-6 in "Diagnosis" section.
- **CHECK:** IC for functioning properly, timing for advancing and retarding.
- **CHECK:** Proper output voltage of ignition coil.
- **CHECK:** For crossfire between spark plugs, (distributor cap, spark plug wires and proper routing of plug wires).
- **CHECK:** Spark plug wires and boots.
- **CHECK:** For faulty spark plugs.

ENGINE MECHANICAL

- **CHECK:** Compression - Look for sticking or leaking valves.
- **CHECK:** Valve timing, broken or worn valve train parts.

FUEL SYSTEM

- **CHECK:** Perform fuel system diagnosis. Use CHART A-4 in "Diagnosis" section.
- **CHECK:** Fuel injectors. Perform "Injector Balance Test" at end of "Symptoms" section.

DIESELING, RUN-ON

Definition: Engine continues to run after key is turned "OFF," but runs very roughly. If engine runs smoothly, check ignition switch and adjustment.

PRELIMINARY CHECKS

- Perform the careful important preliminary checks as described at the start of "MFI Symptoms" section.

IGNITION SYSTEM

- **CHECK:** IC circuit for functioning properly, timing advancing and retarding, see "On-Board Ignition Timing Check."
- **CHECK:** MFI relay for proper operation.

COOLING SYSTEM

- **CHECK:** Faulty or incorrect thermostat.
- **CHECK:** Engine for overheating, resulting from cooling system restriction
- **CHECK:** For loose belts.

FUEL SYSTEM

- **CHECK:** For leaking injectors Refer to CHART A-4 in "Diagnosis" section.

POOR FUEL ECONOMY

Definition: Fuel economy is noticeably lower than expected

PRELIMINARY CHECKS

- Perform the important preliminary checks as described at the start of "MFI Symptoms" section
- **CHECK:** Owner's driving habits.
- **CHECK:** Flame arrestor for dirt or being plugged.
- **CHECK:** For fuel leaks.

IGNITION SYSTEM

- **CHECK:** IC circuit for functioning properly, timing advancing and retarding
- **CHECK:** Spark plugs. Remove spark plugs, check for fuel fouled plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary.
- **CHECK:** Knock sensor system operation Refer to KS system scan or non-scan diagnostics

FUEL SYSTEM

- **CHECK:** Fuel type. Quality of fuel.
- **CHECK:** Fuel pressure Refer to CHART A-4 in "Diagnosis" section.

ENGINE MECHANICAL

- **CHECK:** Compression.

ADDITIONAL CHECKS

- **CHECK:** For exhaust system restriction.
- **CHECK:** Excessive resistance on bottom of boat (dirt, barnacles, etc)
- **CHECK:** Propeller for proper size and pitch for application

ECM Connector and Symptoms Identification

This chart is to further aid in diagnosis of symptoms. These voltages were derived from a known good engine. The voltages shown were done with the electrical system completely hooked up and operational The voltages are to help identify what voltage is needed to operate the different circuits **NEVER ATTEMPT TO OBTAIN THESE VOLTAGES BY PROBING WIRES OR CONNECTORS.** Serious damage could result to wiring and connectors and loss of engine operation. The voltages you may get may vary due to low battery charge or other reasons, but they should be close.

The "B +" symbol indicates a system voltage.

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

• Engine at operating temperature • Engine idling (for "Engine Operating" column) • Test terminal not grounded • Scan tool not installed

PIN	PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR	NORMAL VOLTAGE		DTC(s) AFFECTED	POSSIBLE SYMPTOMS
					IGNITION "ON"	ENGINE OPERATING		
J1-1	KNOCK SENSOR SIGNAL	485	BLK	KNOCK SENSOR	9.5V	9.5V	43	POOR FUEL ECONOMY, POOR PERFORMANCE, DETONATION
J1-2	ECT SIGNAL	410	YEL	ECT SENSOR	1.95V (2)	1.95V (2)	14	POOR PERFORMANCE, EXHAUST ODOR, ROUGH IDLE, RPM REDUCTION
J1-3	NOT USED	-	-	-	-	-	-	-
J1-4	L'O FLUID LEVEL SWITCH (OPT)	911	DK GRN	IN-LINE BOAT 8-WAY HARNESS	B+	B+	NONE	RPM REDUCTION MODE
J1-5	MASTER SLAVE	916	YEL	BOAT HARNESS	B+ 0° (6)	B+.0° (6)	NONE	LACK OF DATA FROM OTHER ENGINE
J1-6	OIL PRESSURE SWITCH (OPT)	931	BRN	IN-LINE BOAT 8-WAY HARNESS	0°	B+	NONE	RPM REDUCTION MODE
J1-7	DIAGNOSIS TEST TERMINAL	451	WHT BLK	DATA LINK CONNECTOR	B+	B+	NONE	INCORRECT IDLE, POOR PERFORMANCE
J1-8	NOT USED	-	-	-	-	-	-	-
J1-9	MAP SIGNAL	432	LT GRN	MAP SENSOR	4.9V	1.46V (3)	33	POOR PERFORMANCE, SURGE, POOR FUEL ECONOMY, EXHAUST ODOR
J1-10	TP SIGNAL	417	DK BLU	TP SENSOR	.62V (4)	.62V (4)	21	POOR ACCELERATION AND PERFORMANCE, INCORRECT IDLE
J1-11	IGNITION FUSED	439	PNK BLK	SPLICE	B+	B+	NONE	NO START, MIL INOP
J1-12	NOT USED	-	-	-	-	-	-	-
J1-13	SENSOR GROUND TP, TRIM & IAT	813	BLK	IAT, TP & TRIM SENSOR	0°	0°	21 & 23	HIGH IDLE, ROUGH IDLE, POOR PERFORMANCE
J1-14	ECM GROUND	450	BLK/WHT	ENGINE BOCK	0°	0°	NONE	5°
J1-15	TP 5V REF	416	GRY	TP, TRIM SENSOR	5V	5V	21	LACK OF POWER, IDLE SURGE, HIGH IDLE, EXHAUST ODOR
J1-16	BATTERY FEED	440	ORN	SPLICE	B+	B+	NONE	NO START

(1) BATTERY VOLTAGE FOR FIRST TWO SECONDS, THEN 0 VOLTS.
(2) VARIES WITH TEMPERATURE.
(3) VARIES WITH MANIFOLD VACUUM.
(4) VARIES WITH THROTTLE MOVEMENT.
(5) HIGH RESISTANCE GROUND CAN CAUSE MULTITUDE OF SYMPTOMS.
• LESS THAN .5 VOLT (500 mV).
(6) WITH TWIN ENGINES 0 VOLTS.

9-17-93
PS 19341

ECM Connector and Symptoms Identification (1 of 4)

ECM Connector and Symptoms Identification

This chart is to further aid in diagnosis of symptoms. These voltages were derived from a known good engine. The voltages shown were done with the electrical system completely hooked up and operational. The voltages are to help identify what voltage is needed to operate the different circuits. **NEVER ATTEMPT TO OBTAIN THESE VOLTAGES BY PROBING WIRES OR CONNECTORS.** Serious damage could result to wiring and connectors and loss of engine operation. The voltages you may get may vary due to low battery charge or other reasons, but they should be close.

The "B+" symbol indicates a system voltage.

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

● Engine at operating temperature ● Engine idling (for "Engine Operating" column)
● Test terminal not grounded ● Scan tool not installed

PIN	PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR	NORMAL VOLTAGE		DTC(s) AFFECTED	POSSIBLE SYMPTOMS
					IGNITION "ON"	ENGINE OPERATING		
J1-17	NOT USED	-	-	-	-	-	-	-
J1-18	SERIAL DATA	461	ORN/BLK	DATA LINK CONNECTOR	5V	5V	NONE	NO SERIAL DATA
J1-19	WATER FLOW SWITCH (OPT)	940	LT GRN	IN-LINE BOAT 8-WAY HARNESS	B+	B+	NONE	RPM REDUCTION MODE
J1-20	OIL LEVEL (OPT)	1174	BRN	IN-LINE BOAT 8-WAY HARNESS	B+	B+	NONE	RPM REDUCTION MODE
J1-21	EMERGENCY STOP SW (OPT)	942	PNK	IN-LINE BOAT 8-WAY HARNESS	B+	B+	NONE	RPM REDUCTION MODE
J1-22	TRANS TEMP TRIM SET (OPT)	920	LT BLU	IN-LINE BOAT 8-WAY HARNESS	B+	B+	NONE	RPM REDUCTION MODE
J1-23	NOT USED	-	-	-	-	-	-	-
J1-24	IAT SIGNAL	472	TAN	IAT SENSOR	3.2V (2)	3.2V (2)	23	ROUGH IDLE
J1-25	TRIM SIGNAL	910	WHT	TRIM SENSOR	0*	0*	NONE	-
J1-26	NOT USED	-	-	-	-	-	-	-
J1-27	NOT USED	-	-	-	-	-	-	-
J1-28	NOT USED	-	-	-	-	-	-	-
J1-29	MAP AND ECT GROUND	814	BLK	MAP AND ECT SENSOR	0*	0*	14 & 33	LACK OF PERFORMANCE, EXHAUST ODOR, STALL
J1-30	ECM GROUND	450	BLK/WHT	ENGINE BOCK	0*	0*	NONE	(5)*
J1-31	MAP, 5V REFERENCE	416E	GRY	MAP SENSOR	5V	5V	33	LACK OF POWER, SURGE, ROUGH IDLE, EXHAUST ODOR
J1-32	BATTERY FEED	440	ORN	SPLICE	B+	B+	NONE	NO START

(1) BATTERY VOLTAGE FOR FIRST TWO SECONDS, THEN 0 VOLTS.
(2) VARIES WITH TEMPERATURE.
(3) VARIES WITH MANIFOLD VACUUM.
(4) VARIES WITH THROTTLE MOVEMENT.
(5) HIGH RESISTANCE GROUND CAN CAUSE MULTITUDE OF SYMPTOMS
* LESS THAN .5 VOLT (500 mV).

9-17-93
PS 19342

ECM Connector and Symptoms Identification (2 of 4)

ECM Connector and Symptoms Identification

This chart is to further aid in diagnosis of symptoms. These voltages were derived from a known good engine. The voltages shown were done with the electrical system completely hooked up and operational The voltages are to help identify what voltage is needed to operate the different circuits. **NEVER ATTEMPT TO OBTAIN THESE VOLTAGES BY PROBING WIRES OR CONNECTORS.** Serious damage could result to wiring and connectors and loss of engine operation. The voltages you may get may vary due to low battery charge or other reasons, but they should be close.

The "B +" symbol indicates a system voltage.

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

● Engine at operating temperature ● Engine idling (for "Engine Operating" column)
● Test terminal not grounded ● Scan tool not installed

PIN	PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR	NORMAL VOLTAGE		DTC(s) AFFECTED	POSSIBLE SYMPTOMS
					IGNITION "ON"	ENGINE OPERATING		
J2-1	NOT USED	-	-	-	-	-	-	-
J2-2	NOT USED	-	-	-	-	-	-	-
J2-3	NOT USED	-	-	-	-	-	-	-
J2-4	NOT USED	-	-	-	-	-	-	-
J2-5	INJECTOR DRIVERS (CYL'S 1, 4, 6, 7)	468	LT GRN	INJECTORS	B+	B+	NONE	ROUGH IDLE, LACK OF POWER, STALL
J2-6	IC REF LOW	453	BLK RED	IGNITION CONTROL MODULE	0*	0*	NONE	NO CHANGE
J2-7	PORT FUEL JUMPER	901	WHT	ECM	2.9V	2.9V	NONE	NO CHANGE
J2-8	IC REF HIGH	430	PPL/WHT	IGNITION CONTROL MODULE	.1V	1.5V	NONE	NO RESTART
J2-9	FUEL PUMP RELAY DRIVE	465	DK GRN/WHT	FUEL PUMP RELAY	0* (1)	B+	NONE	NO START
J2-10	NOT USED	-	-	-	-	-	-	-
J2-11	COOLANT LAMP OUTPUT (OPT)	112	DK GRN	IN-LINE BOAT 6-WAY HARNESS	0*	0*	NONE	LOSS OF INSTRUMENT LIGHT
J2-12	RPM REDUCTION WARN BUZZ (OPT)	914	PPL	IN-LINE BOAT 6-WAY HARNESS	0*	0*	NONE	LOSS OF INSTRUMENT LIGHT
J2-13	IAC "A" LOW	442	BLU BLK	IAC VALVE	NOT USABLE	NOT USABLE	NONE	ROUGH UNSTABLE OR INCORRECT IDLE
J2-14	IAC "B" HIGH	443	GRN/WHT	IAC VALVE	NOT USABLE	NOT USABLE	NONE	ROUGH UNSTABLE OR INCORRECT IDLE
J2-15	FUEL INJECTOR GROUND	450	BLK/WHT	ENGINE GROUND	0*	0*	NONE	NO CHANGE
J2-16	NOT USED	-	-	-	-	-	-	-

(1) BATTERY VOLTAGE FOR FIRST TWO SECONDS, THEN 0 VOLTS.
(2) VARIES WITH TEMPERATURE.
(3) VARIES WITH MANIFOLD VACUUM.
(4) VARIES WITH THROTTLE MOVEMENT.
* LESS THAN .5 VOLT (500 mV).

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PS 19343

ECM Connector and Symptoms Identification (3 of 4)

ECM Connector and Symptoms Identification

This chart is to further aid in diagnosis of symptoms. These voltages were derived from a known good engine. The voltages shown were done with the electrical system completely hooked up and operational. The voltages are to help identify what voltage is needed to operate the different circuits **NEVER ATTEMPT TO OBTAIN THESE VOLTAGES BY PROBING WIRES OR CONNECTORS.** Serious damage could result to wiring and connectors and loss of engine operation. The voltages you may get may vary due to low battery charge or other reasons, but they should be close.

The "B +" symbol indicates a system voltage.

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

• Engine at operating temperature • Engine idling (for "Engine Operating" column) • Test terminal not grounded • Scan tool not installed

PIN	PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR	NORMAL VOLTAGE		DTC(s) AFFECTED	POSSIBLE SYMPTOMS
					IGNITION "ON"	ENGINE OPERATING		
J2-17	NOT USED	-	-	-	-	-	-	-
J2-18	NOT USED	-	-	-	-	-	-	-
J2-19	NOT USED	-	-	-	-	-	-	-
J2-20	FUEL INJECTOR GROUND	450	BLK/WHT	ENGINE GROUND	0*	0*	NONE	NO CHANGE
J2-21	INJECTOR DRIVERS (CYL'S 2, 3, 5, 8)	467	DK BLU	INJECTORS	B+	B+	NONE	ROUGH IDLE, LACK OF POWER, STALLING
J2-22	PORT FUEL JUMPER	901	WHT	ECM	2.9V	2.9V	NONE	NO CHANGE
J2-23	IC SIGNAL	423	WHT	IGNITION CONTROL MODULE	0*	1.6V	42	WILL SWITCH TO BYPASS MODE, LACK OF POWER
J2-24	IC BYPASS	424	TAN BLK	IGNITION CONTROL MODULE	0*	3.9V	42	LACK OF POWER FIXED TIMING
J2-25	NOT USED	-	-	-	-	-	-	-
J2-26	I O FLUID WATER FLOW LAMP OUTPUT (OPT)	912	DK BLU	IN-LINE BOAT 6-WAY HARNESS	0*	0*	NONE	LOSS OF INSTRUMENT LIGHT
J2-27	OIL PRESS LAMP OUTPUT (OPT)	31	TAN	IN-LINE BOAT 6-WAY HARNESS	.6V	.5V	NONE	LOSS OF INSTRUMENT LIGHT
J2-28	IAC "A" HIGH	441	BLU WHT	IAC VALVE	NOT USABLE	NOT USABLE	NONE	ROUGH UNSTABLE OR INCORRECT IDLE
J2-29	IAC "B" LOW	444	GRN BLK	IAC VALVE	NOT USABLE	NOT USABLE	NONE	ROUGH UNSTABLE OR INCORRECT IDLE
J2-30	OIL LEVEL LAMP OUPUT (OPT)	930	GRY	IN-LINE BOAT 6-WAY HARNESS	0*	0*	NONE	LOSS OF INSTRUMENT LIGHT
J2-31	MALFUNCTION INDICATOR LAMP	419	BRN WHT	DLC	0*	0*	NONE	LAMP INOP
J2-32	NOT USED	-	-	-	-	-	-	-

(1) BATTERY VOLTAGE FOR FIRST TWO SECONDS, THEN 0 VOLTS.
(2) VARIES WITH TEMPERATURE.
(3) VARIES WITH MANIFOLD VACUUM
(4) VARIES WITH THROTTLE MOVEMENT.
* LESS THAN .5 VOLT (500 mV).

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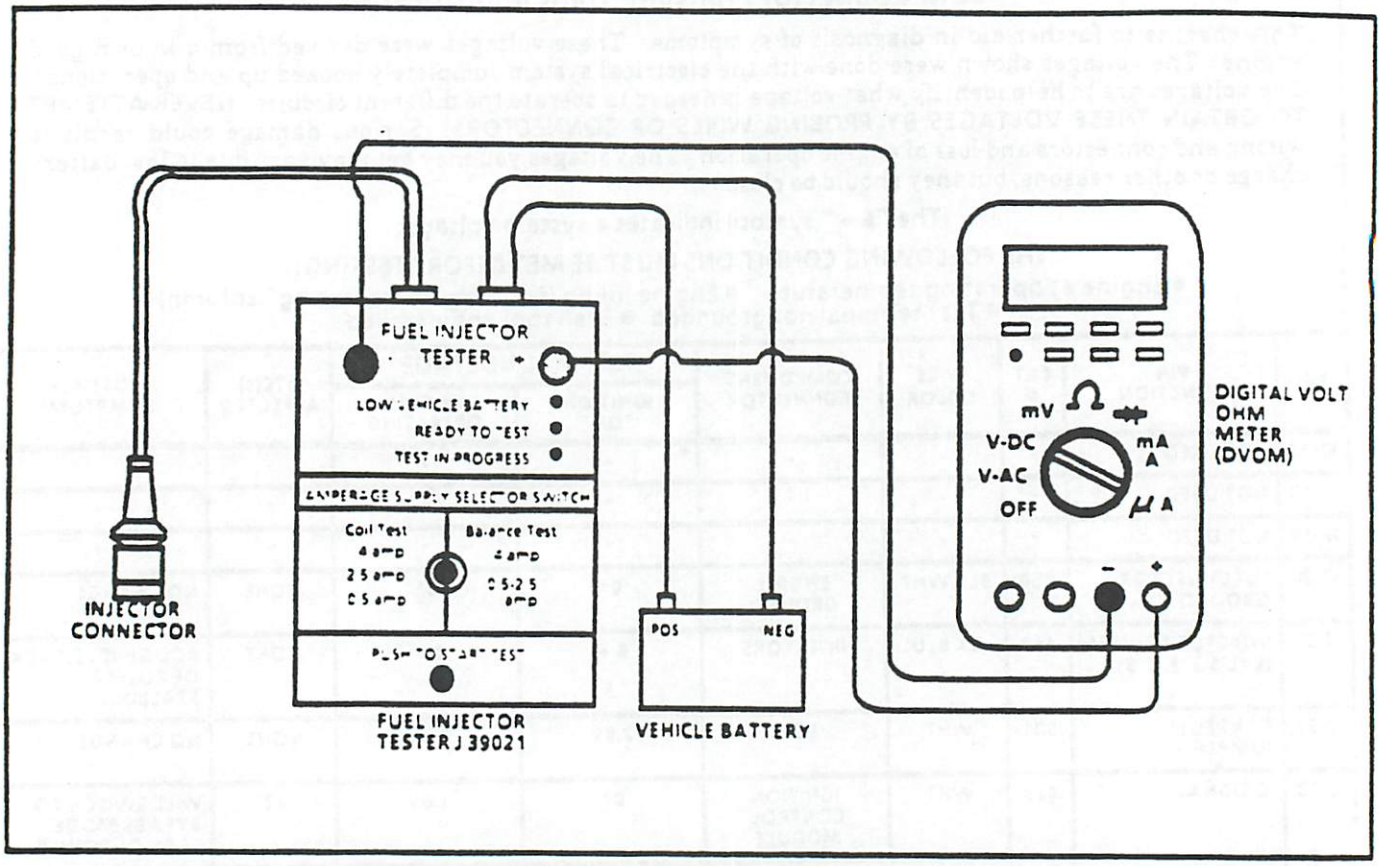
PS 19344

ECM Connector and Symptoms Identification (4 of 4)



INJECTOR BALANCE TEST PROCEDURE

(Page 1 of 3)

Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

1. This is the set-up step for performing the injector coil test. Also read instructions included with tools used for test.
2. Engine coolant temperature affects the tool's ability to detect a faulty injector. If engine coolant temperature is *NOT* between 50°F and 95°F the comparison chart (Page 2 of 3) must be used.
3. The first second of the voltage reading may be inaccurate due to initial current surge, therefore, record the lowest voltage displayed after the first second of test. The voltage reading should be within range (see example). The voltage reading may increase throughout the test as the injector windings warm and the resistance changes. An erratic voltage reading (one that jumps up and down) indicates an intermittent connection within the fuel injector.
4. To check the mechanical (fuel delivery) portion of the fuel injector, perform an injector balance test.

Resistance Ohms	Voltage Spec. at 50° - 95° F
11.8 - 12.6	5.7 - 6.6

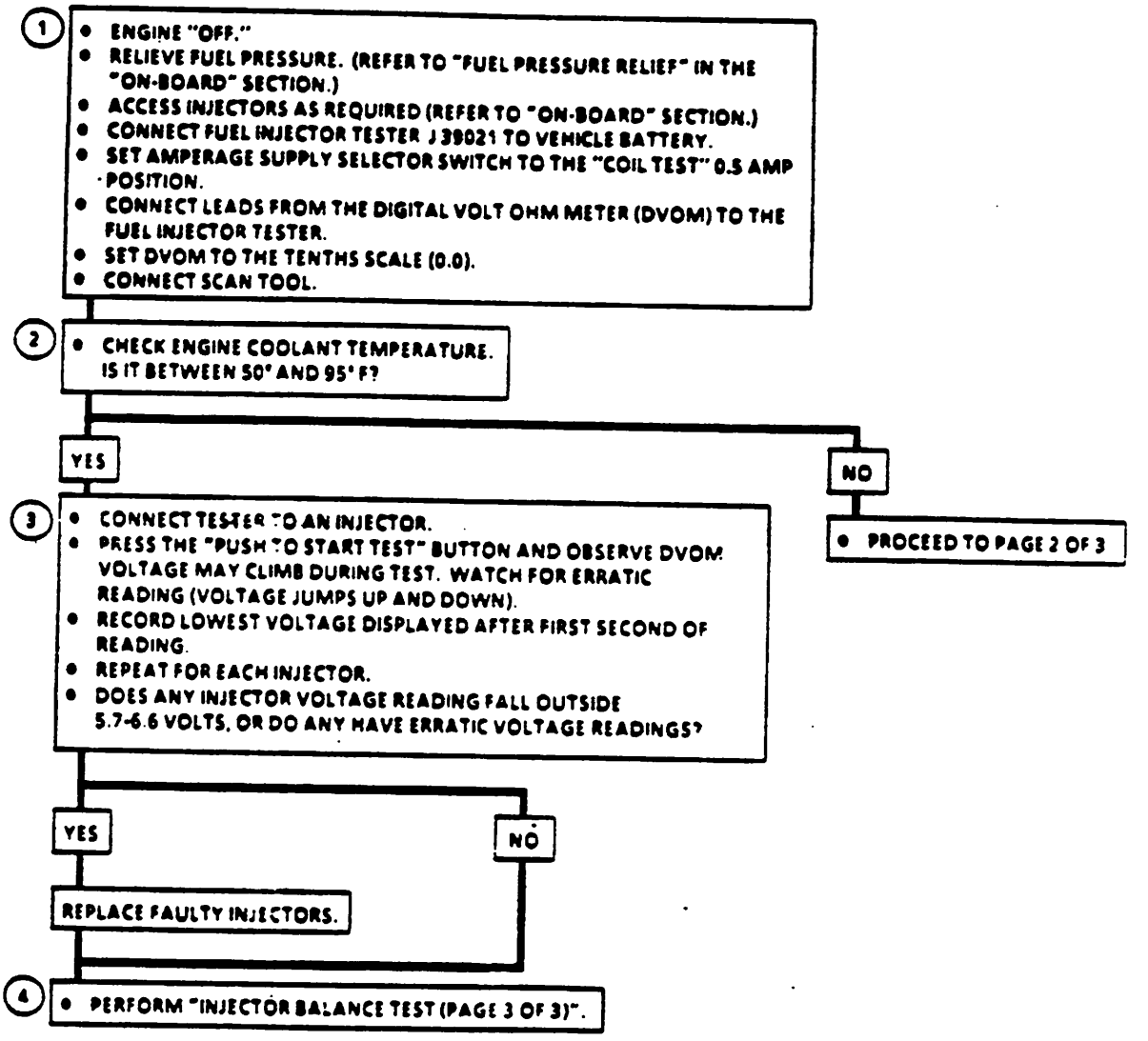
Inj#	Reading	Pass/Fail
1	6.3	P
2	5.9	P
3	6.2	P
4	6.1	P
5	4.8	F
6	6.0	P

EXAMPLE

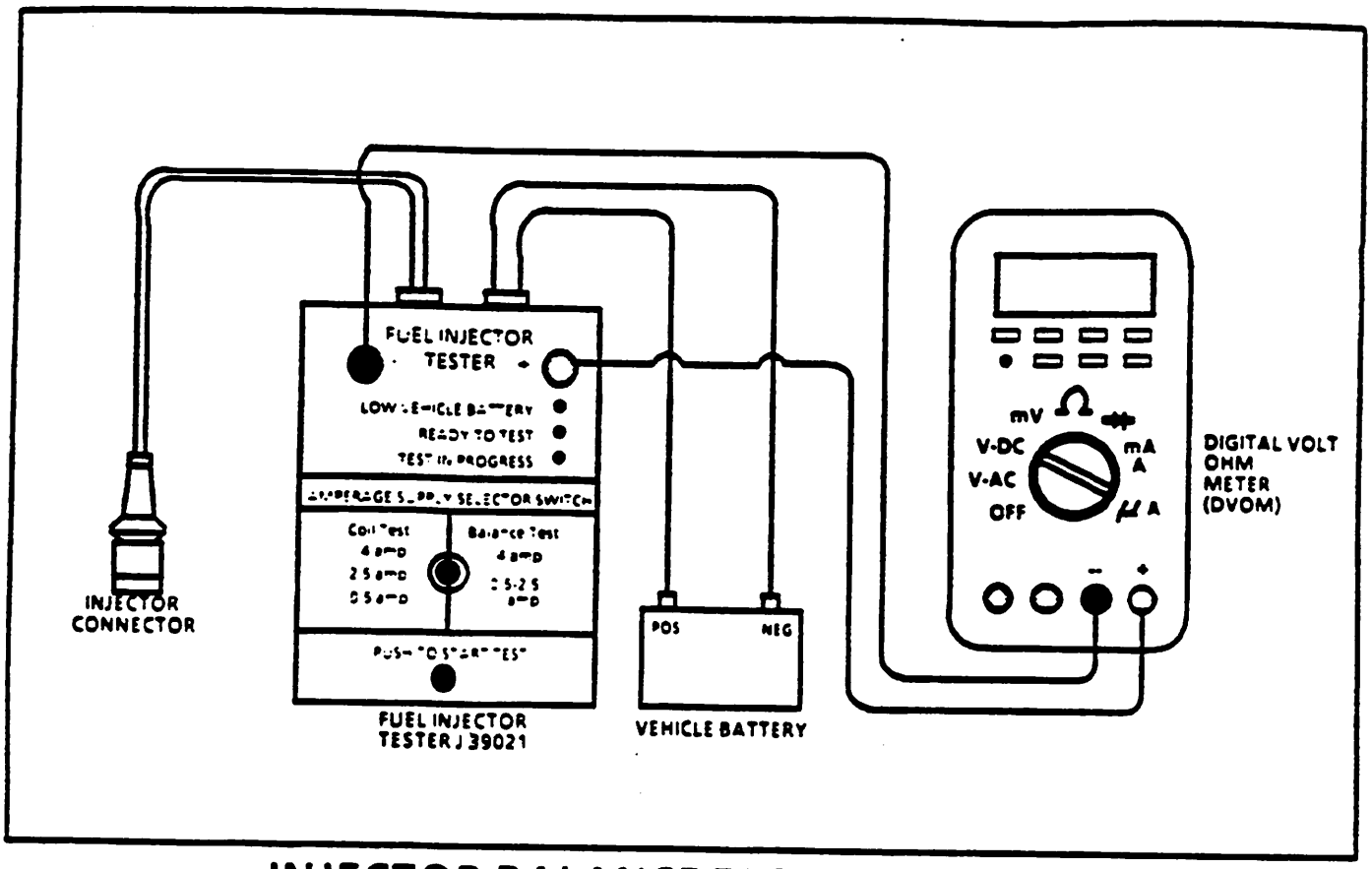
5-22-93
PS 18083

INJECTOR BALANCE TEST PROCEDURE

(Page 1 of 3)



5-24-93
PS 18084



INJECTOR BALANCE TEST PROCEDURE

(Page 2 of 3)

Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

1. The first second of the voltage reading may be inaccurate due to initial current surge, therefore, record the lowest voltage displayed after the first second of test. The voltage reading may increase throughout the test as the injector windings warm and the resistance changes. An erratic voltage reading (one that jumps up and down) indicates an intermittent connection within the fuel injector.
2. From recorded voltages (see example), identify the highest voltage reading recorded (other than those above 9.5 volts). Subtract all other voltages from the highest voltage recorded. The subtracted value for any injector must not exceed 0.6 volt.
3. To check the mechanical (fuel delivery) portion of the fuel injector, perform an injector balance test.

Highest Voltage Reading	7.1 Volts
Acceptable Subtracted Value Above/Below 50°-95°F.	0.6 Volt

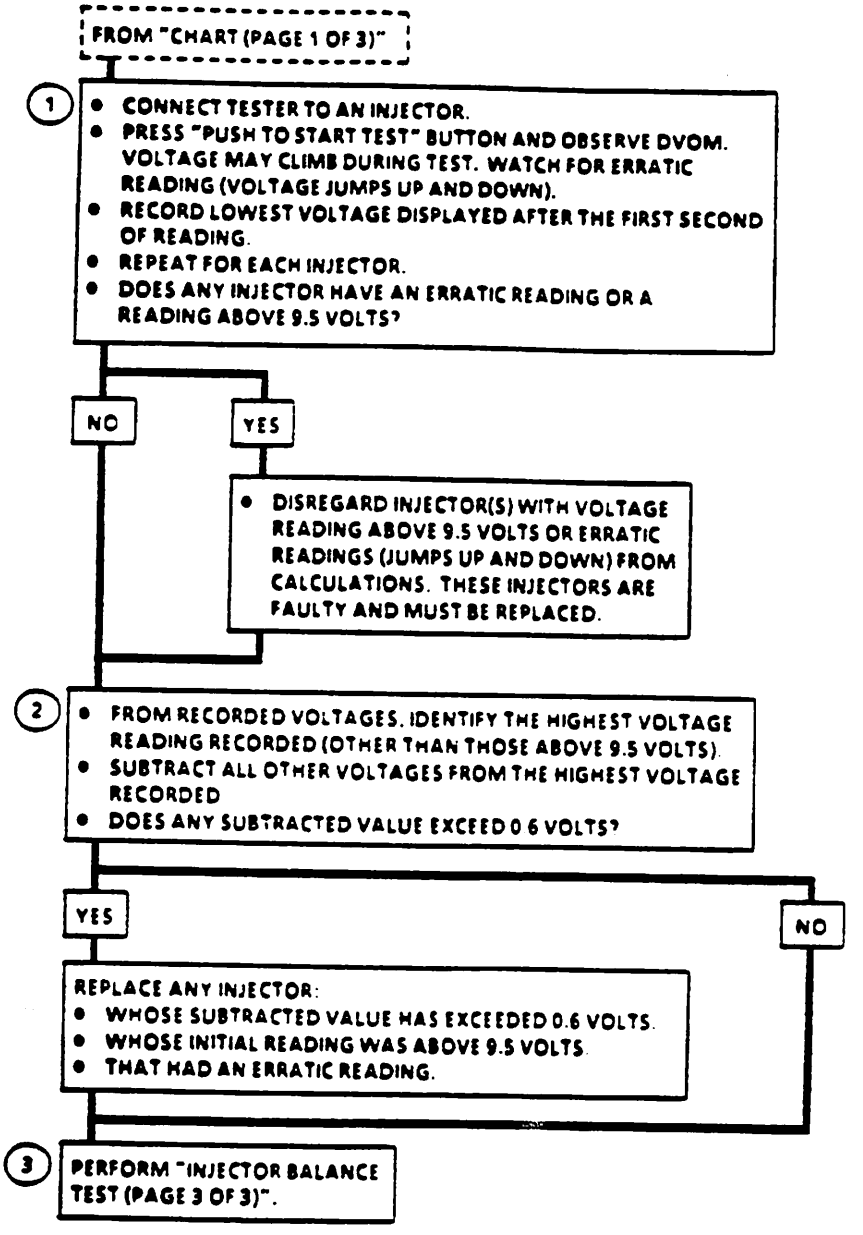
Inj. No.	Voltage Reading	Subtracted Value	Pass/Fail
1	9.8	---	F
2	6.6	0.5	P
3	6.9	0.2	P
4	5.8	1.3	F
5	7.0	0.1	P
6	7.1	0.0	P

EXAMPLE

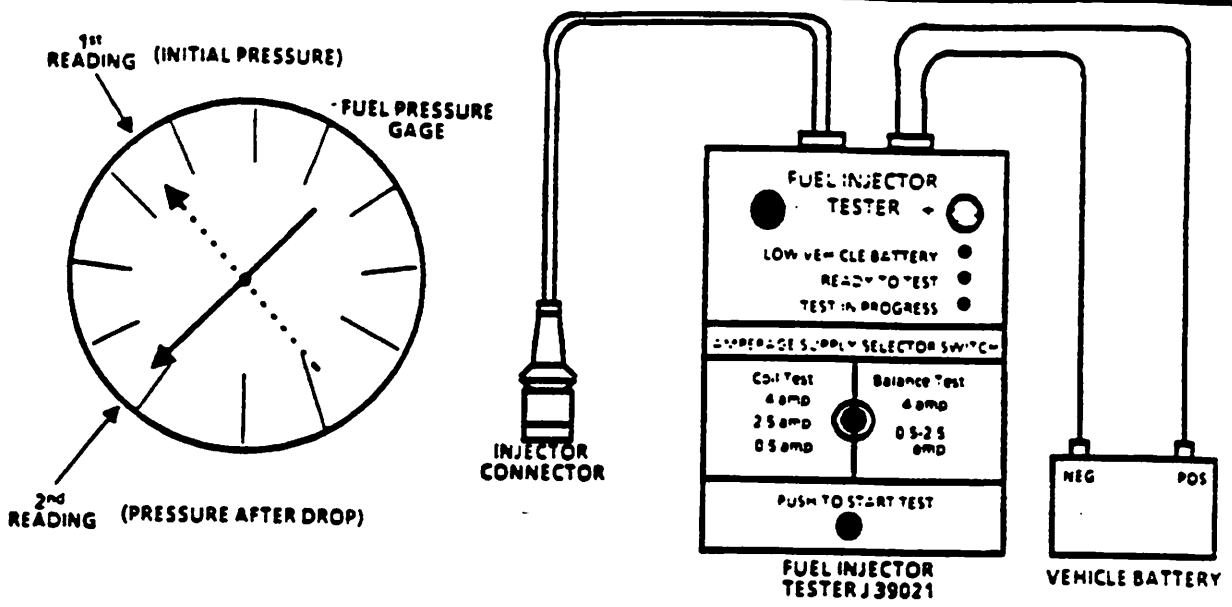
5-24-93
PS 18085

INJECTOR BALANCE TEST PROCEDURE

(Page 2 of 3)



5-26-93
PS 18086



EXAMPLE

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)
166 kPa/24 psi ave. ± 10 kPa/1.5 psi 156 kPa to 176 kPa 22.5 psi to 25.5 psi	OK	FAULTY, RICH (TOO MUCH FUEL DROP)	OK	FAULTY, LEAN (TOO LITTLE FUEL DROP)	OK	OK

INJECTOR BALANCE TEST PROCEDURE

(Page 3 of 3)

Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart.

1. Engine cool down period (10 minutes) is necessary to avoid irregular fuel pressure readings due to "Hot Soak" fuel boiling.
2. Energize tester one time and record pressure drop at the lowest point (Disregard any slight pressure variations).
3. If the pressure drop of all injectors is within 10 kPa (1.5 psi) of the average fuel pressure drop. the injectors are flowing properly. The actual amount of pressure drop is calculated by subtracting the second pressure reading from the first pressure reading.

ENGINE	FUEL PRESSURE RANGE
LT1, 7.4L & 8.2L MFI	284-325 kPa (41-47 psi)

8-24-93
PS 18087

INJECTOR BALANCE TEST PROCEDURE

(Page 3 of 3)

CAUTION: TO REDUCE THE RISK OF FIRE AND PERSONAL INJURY, WRAP A SHOP TOWEL AROUND THE FUEL PRESSURE CONNECTION TO ABSORB ANY FUEL LEAKAGE THAT MAY OCCUR WHEN INSTALLING THE PRESSURE GAGE. PLACE TOWEL IN APPROVED CONTAINER.

NOTICE: The entire test should NOT be repeated more than once without running the engine to prevent flooding. (This includes any retest on faulty injectors.)

Important

The injector coil test should be performed prior to this test. Refer to Page 1 of 3.

1. IF ENGINE IS AT OPERATING TEMPERATURE, ALLOW A 10 MINUTE "COOL DOWN" PERIOD
   - IGNITION "OFF."
   - CONNECT FUEL PRESSURE GAGE.
   - ENERGIZE FUEL PUMP USING AVAILABLE METHOD FOR VEHICLE (SCAN TOOL ENABLE)
   - PLACE OPEN END OF BLEED HOSE INTO AN APPROVED GASOLINE CONTAINER AND BLEED AIR FROM FUEL GAGE
   - WITH FUEL PUMP RUNNING NOTE FUEL PRESSURE. PRESSURE SHOULD BE WITHIN SPECIFIED RANGE SHOWN ON FACING PAGE IF NOT, REFER TO CHART A-4
   - TURN FUEL PUMP "OFF." WHEN PUMP STOPS, PRESSURE MAY VARY SLIGHTLY THEN SHOULD HOLD STEADY. IF NOT, REFER TO CHART A-4.

2. - CONNECT FUEL INJECTOR TESTER TO AN INJECTOR.
   - SET AMPERAGE SUPPLY SELECTOR SWITCH TO THE "BALANCE TEST" 0.5 - 2.5 AMP POSITION
   - CYCLE FUEL PUMP "ON" "OFF" TO PRESSURIZE FUEL SYSTEM
   - RECORD STABILIZED FUEL PRESSURE (1ST PRESSURE READING - SEE EXAMPLE ON FACING PAGE)
   - ENERGIZE FUEL INJECTOR BY DEPRESSING "PUSH TO START TEST" BUTTON.
   - NOTE FUEL PRESSURE THE INSTANT THE FUEL PRESSURE GAGE NEEDLE STOPS. RECORD FUEL PRESSURE READING (2ND PRESSURE READING - SEE EXAMPLE ON FACING PAGE).

3. - REPEAT STEP 2 ON ALL INJECTORS
   - SUBTRACT 2ND PRESSURE READING FROM 1ST PRESSURE READING TO OBTAIN PRESSURE DROP VALUES.
   - ADD ALL PRESSURE DROP VALUES AND DIVIDE BY THE NUMBER OF FUEL INJECTORS TO GET THE AVERAGE PRESSURE DROP.
   - ANY INJECTOR THAT HAS A 10 KPA (1.5 PSI) DIFFERENCE, EITHER MORE OR LESS FROM THE AVERAGE, IS CONSIDERED FAULTY.
   - RETEST ANY INJECTOR THAT APPEARS FAULTY.
   - ANY INJECTOR THAT FAILS THE RETEST IS FAULTY AND NEEDS TO BE REPLACED
   - IF NO PROBLEM IS FOUND, REVIEW "SYMPTOMS" SECTION "6".

5-27-93
PS 18088

ON BOARD
SERVICES
MFI

MARINE ELECTRONIC FUEL INJECTION
SECTION 7
ON BOARD SERVICE

This section will be used for the replacement or repair of components on the Marine Electronic Fuel Injection equipped engine. The removal and installation procedures are for a generic GM Marine engine The removal and installation of marinizers components need to be followed per manufacturer recommendations.

To avoid personal injury or damage to components, all action symbols and statements need to be followed, all cautions and notices need to be read, understood and followed up on before proceeding to next step.

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. If the above conditions are not followed, parts or system damage could result.

CONTENTS

ON-BOARD SERVICE 7.4L & 8.2L MULTIPORT FUEL INJECTION (MFI)

CONTENTS

SENSORS AND CONTROLS

ENGINE CONTROL MODULE (ECM)

Figure 1

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

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

Remove or Disconnect

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

Important

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

Install or Connect

1. New ECM to mounting bracket.
2. Four ECM mounting bolts.

Tighten

- Four ECM mounting bolts to 10-14 N·m (88-124 lb in.).

3. "J1" and "J2" connector to ECM.
4. Negative battery cable

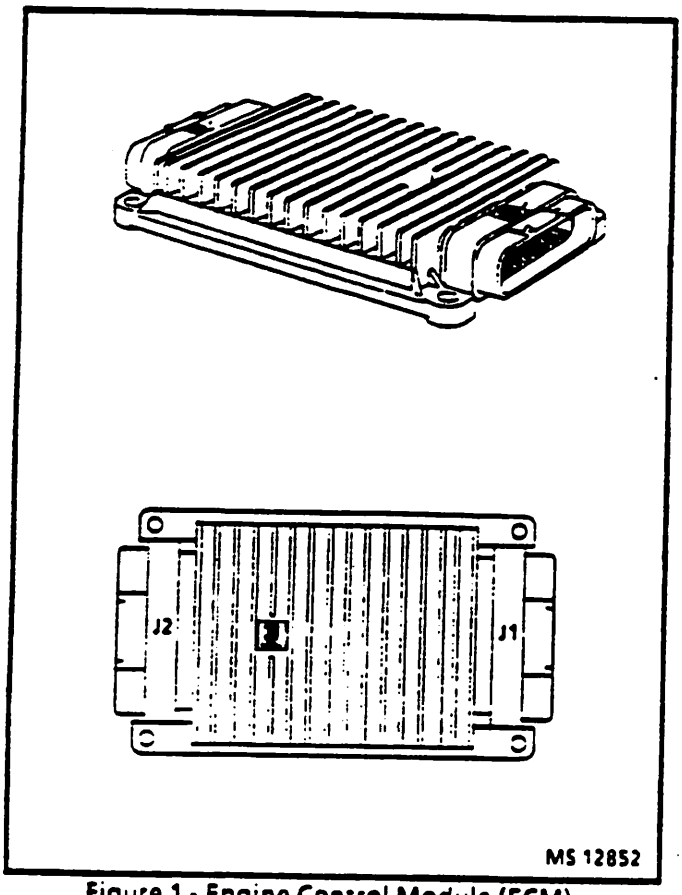


Figure 1 - Engine Control Module (ECM)

ENGINE COOLANT TEMPERATURE (ECT) SENSOR
Figure 2

NOTICE: Care must be taken when handling engine coolant temperature sensor. Damage to engine coolant temperature sensor will affect proper operation of the MEFI system.

Remove or Disconnect
1. Negative battery cable.
2. Electrical connector.
3. Coolant temperature sensor.

Important
- Coat temperature sensor threads with teflon tape sealant prior to reassembly.

Install or Connect
1. Coolant temperature sensor into manifold.

Tighten
- Sensor to 12.0 N·m (108 lb in.)

2. Electrical connector.
3. Negative battery cable

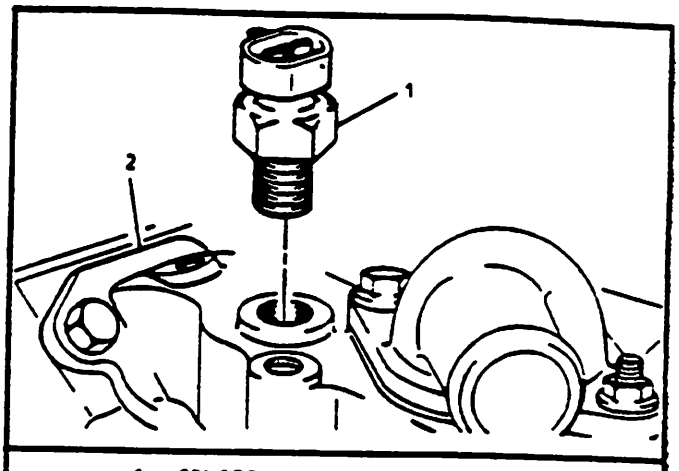


Figure 2 - Engine Coolant Temperature (ECT) Sensor

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR
Figures 3 and 4

Remove or Disconnect
1. Negative battery cable.
2. MAP sensor electrical connector.
3. MAP sensor attaching bolts.
4. MAP sensor with seal.

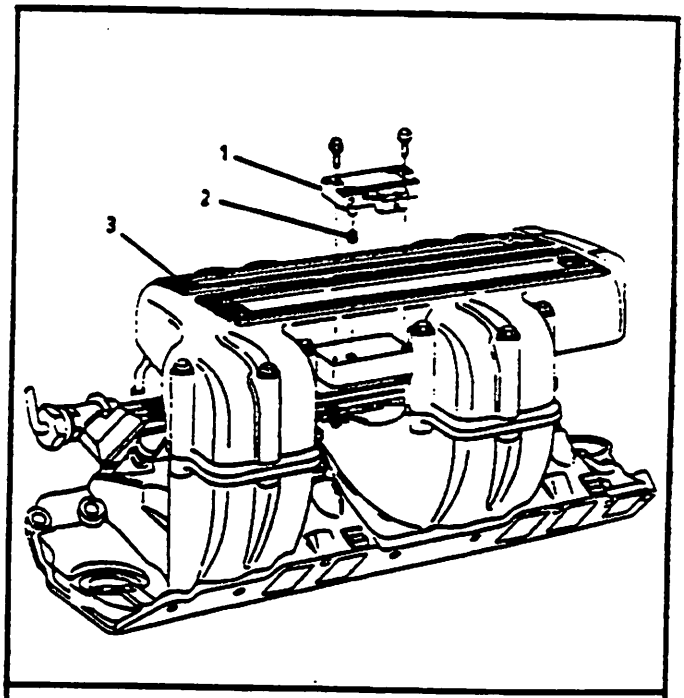


Figure 3 - MAP Sensor Mounting Location

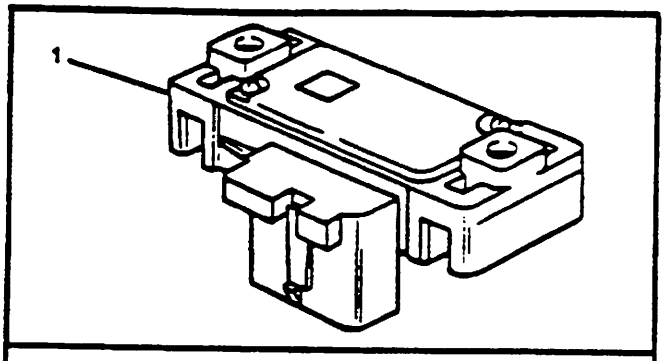


Figure 4 - Manifold Absolute Pressure (MAP) Sensor

Important

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

Install or Connect

1 New seal on MAP sensor
2 MAP sensor
3 MAP sensor attaching bolts.

Tighten

- Two bolts to 5-7 N·m (44-62 lb in.).

4. Electrical connector.
5 Negative battery cable

THROTTLE POSITION (TP) SENSOR
Figures 5 and 8

Remove or Disconnect

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

NOTICE: The TP sensor is an electrical component Do not soak it in any liquid cleaner or solvent as damage may result.

Install or Connect

Important

- If replacing TP sensor, install new screws that are supplied with TP sensor service package

1. TP sensor seal over throttle shaft as shown in Figure 5
2. With throttle plates closed, position on throttle shaft, then align the screw holes
3. TP sensor attaching screws

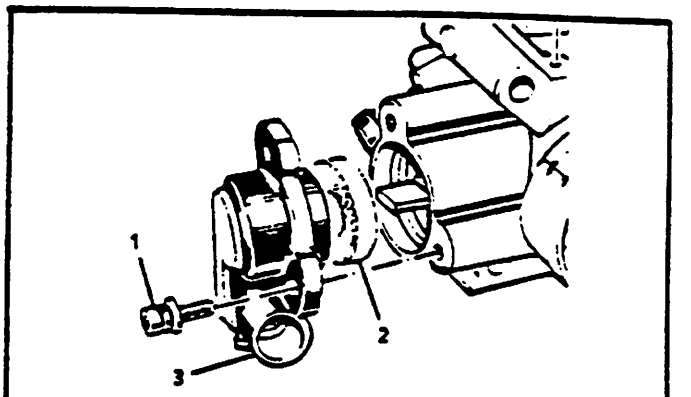


Figure 5 - Throttle Position (TP) Sensor

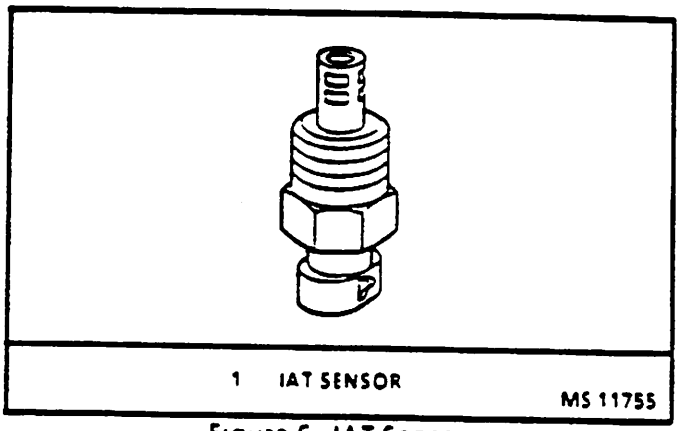


Figure 6 - IAT Sensor

Tighten

- Screw assemblies to 2.0 N·m (18.0 lb in.)

4 Electrical connector to TP sensor
5 Check for TP sensor output voltage
- Voltage should be approximately .7 volt at idle and approximately 5 volts at WOT

6. Flame arrestor.

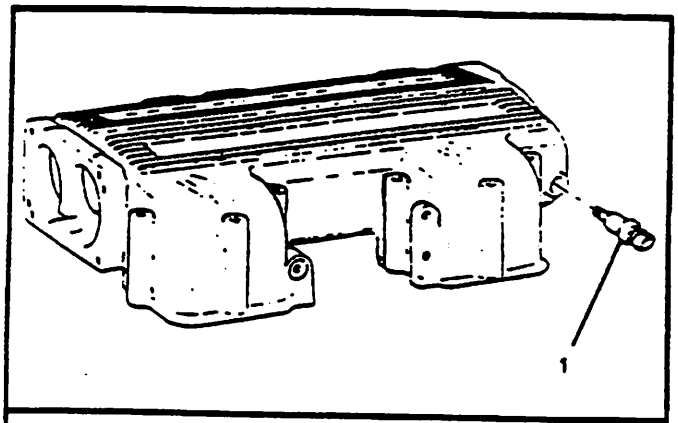
INTAKE AIR TEMPERATURE (IAT) SENSOR
Figure 6

Remove or Disconnect

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

Important

- The IAT sensor is an electrical component Do not sock in any liquid cleaner or solvent, as damage may result.
- Coat sensor threads with teflon tape sealant prior to reassembly



1 IAT SENSOR

NS 15482

Figure 7 - IAT Sensor Location

Install or Connect

1. IAT sensor

Tighten

- Sensor to 15 0 N·m (11 lb ft.).

2. Electrical connector to IAT sensor.
3. Negative battery cable.

IDLE AIR CONTROL (IAC) VALVE

Figures 8 and 9

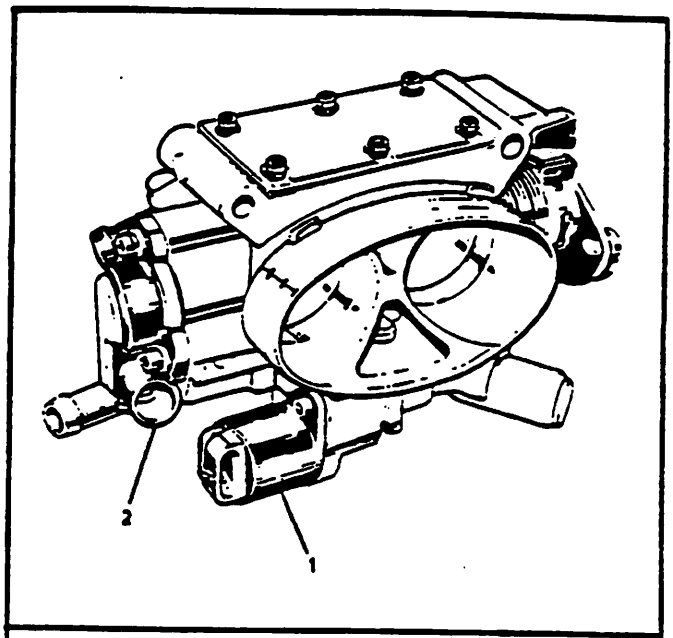
Remove or Disconnect

1. Flame arrestor.
2. 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

- Clean IAC valve O-ring sealing surface, pintle valve seat and air passage.
  - Use carburetor cleaner to remove carbon deposits. Do Not use a cleaner that contains methyl ethyl ketone, an extremely strong solvent, and not necessary for this type of deposit.
  - Shiny spots on the pintle or seat are normal. and do not indicate misalignment or a bent pintle shaft.

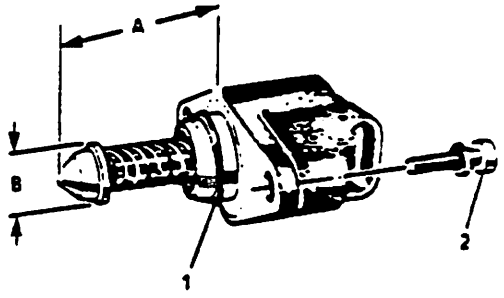


1 VALVE ASSEMBLY - IDLE AIR CONTROL

2 SENSOR - THROTTLE POSITION (TP)

PS 19723

Figure 8 - Throttle Body Assembly



1 O-RING - IAC VALVE

2 SCREW ASSEMBLY - IAC VALVE ATTACHING

A DISTANCE OF PINTLE EXTENSION

B DIAMETER OF PINTLE

LP 1220-AS

Figure 9 - Flange Mounted Type IAC Valve

Important

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

Measure (If Installing a New IAC Valve)

Figure 9

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

Install or Connect

1. New O-ring on IAC valve and lubricate.

   NOTICE: New IAC valves have been reset at the factory and should be installed in the throttle body in an "as is" condition without any adjustment.

2. IAC valve to throttle body using attaching screw assemblies

   #### Tighten
   - Attaching screw assemblies to 3.2 N·m (28.0 lb in.).
3. Electrical connector to IAC valve.
4. Reset IAC valve pintle position.
   - Turn ignition "OFF" for 10 seconds.
   - Start and run engine for 5 seconds
   - Ignition "OFF" for 10 seconds.

KNOCK SENSORS (KS)
Figures 10 and 11

Remove or Disconnect

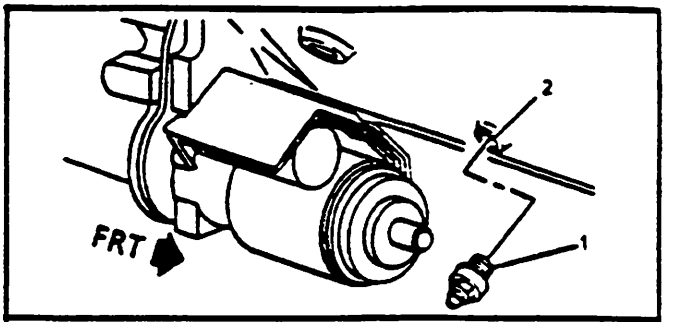
1. Negative battery cable.
2. Wiring harness connector from knock sensor.
3. Knock sensor from engine block.

Install or Connect

1. Knock sensor into engine block. Be sure threads are clean.
   - Tighten to 15-22 N·m (11-16 lb ft.).
2. Knock sensor system wiring harness connector to the knock sensor.
3. Negative battery cable.

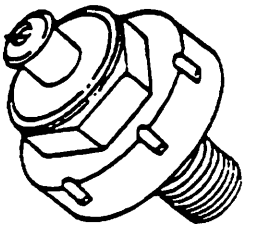
Important

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



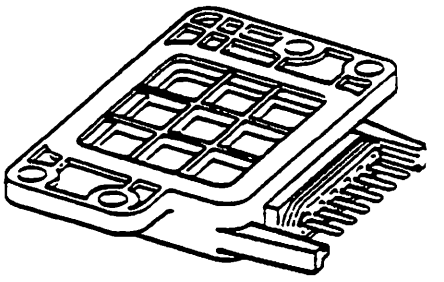
1 KNOCK SENSOR
2 ENGINE BLOCK 6S 2892-6E

Figure 10 - Knock Sensor Location



KNOCK SENSOR (KS) 3S 0023-6E

Figure 11 - Typical Knock Sensor (KS)



NS 15481

Figure 12 - KS Module

KNOCK SENSOR (KS) MODULE
Figure 12

Remove or Disconnect

1. KS module connector.
2. Attaching screws.
3. KS module.

Important

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

Install or Connect

1. KS module.
2. Attaching screws.
3. KS module connector.

DISTRIBUTOR IGNITION (DI) SYSTEM

DISTRIBUTOR REPAIR

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

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

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

Removal

Remove or Disconnect

1. Negative battery cable.
2. Wiring harness connectors at the side of the distributor cap.
3. Two screws on the sides of the distributor cap
4. Coil wire and spark plug wires on either the left or right side of the distributor.
5. Distributor cap and move it aside.
   - Scribe a mark on 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 shaft, 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.

Tighten

- Bolt 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 engine timing.

Disassembly
Figures 13 and 14

Remove or Disconnect

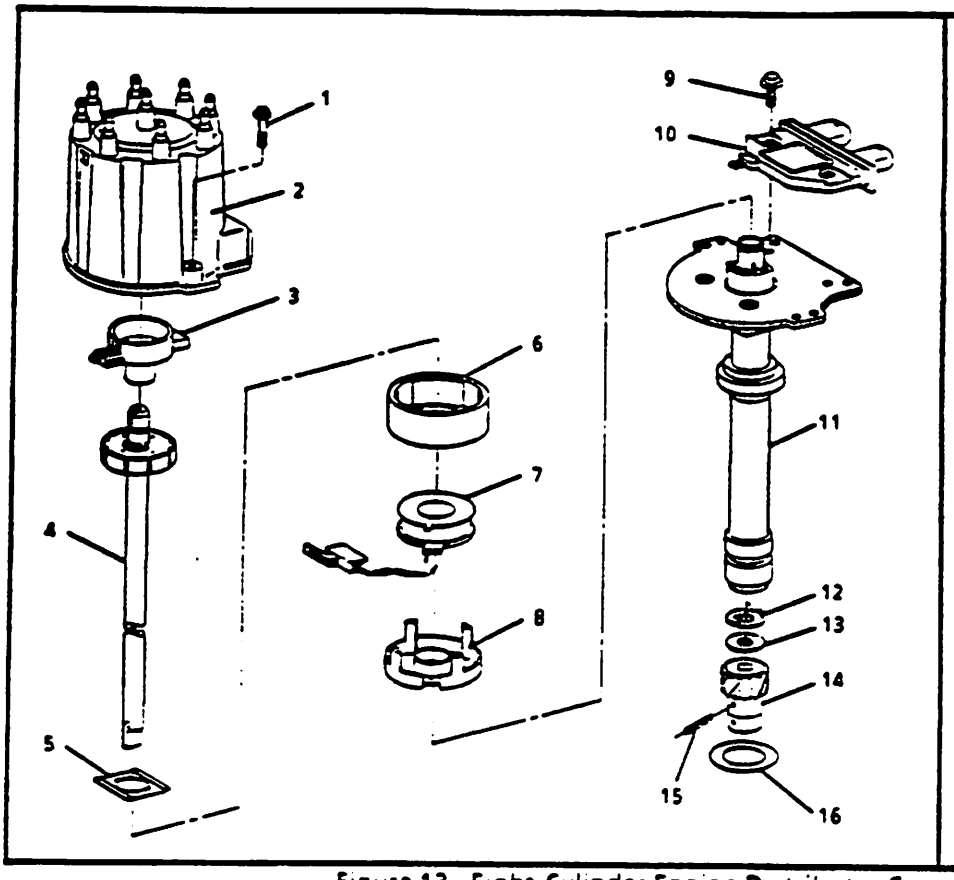
- Any time the distributor is disassembled, the retainer (5) must be replaced. Do not attempt to reuse the old retainer.

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 assembly 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).
   A. Mark the shaft and driven gear for reassembly.
   B. Drive out the roll pin with a small punch (Figure 14).
5. Driven gear (14), washer or spring (13), and spring retainer or tang washer (12).
6. Shaft assembly from the housing (11).
7. Retainer (5) from the housing (11) as follows:

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.

   A. Wear safety goggles.
   B. Use needle nose pliers to bend two corners upward on the fluted end of the retainer.
   C. Pull the retainer off the center bushing. Discard the retainer.

8. Shield (6).
9. Pickup coil connector from the module (10).
   - Lift the locking tab with a screwdriver.
10. Pickup coil (7).
11. Two screws holding the module to the housing
12. Module (10).



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

MS 11770

Figure 13 - Eight-Cylinder Engine Distributor Components

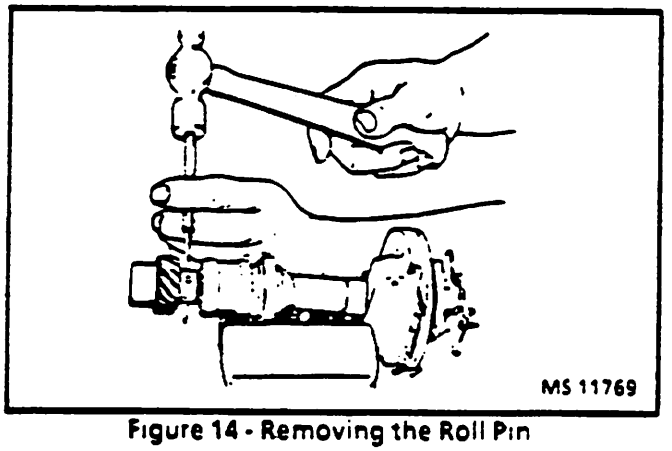


Figure 14 - Removing the Roll Pin

Inspect

1. Cap for cracks or tiny holes Replace the cap if it is damaged at all.
2. Metal terminals in the cap for corrosion Scrape them clean with a knife or replace the cap.
3. Rotor for wear or burning at the outer terminal The presence of carbon on the terminal indicates rotor wear and the need for replacement.
4. Shaft for shaft-to-bushing looseness Insert the shaft in the housing If the shaft wobbles, replace the housing and or shaft.
5. Housing for cracks or damage

Measure

- Resistance of pickup coil with an ohmmeter
  - Connect an ohmmeter to either pickup coil lead and the housing as shown in Figure 15, Step 1. The reading should be infinite If not, replace the coil.
  - Connect an ohmmeter to both pickup coil leads as shown in Figure 15, Step 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 coil.

Assembly
Figures 13 and 16

Install or Connect

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

- Lubricate
  - Bottom of the module and the module rest pad in the housing with silicone grease or an equivalent heat transfer substance
1. Ignition module (10) to the housing (4) with two screws

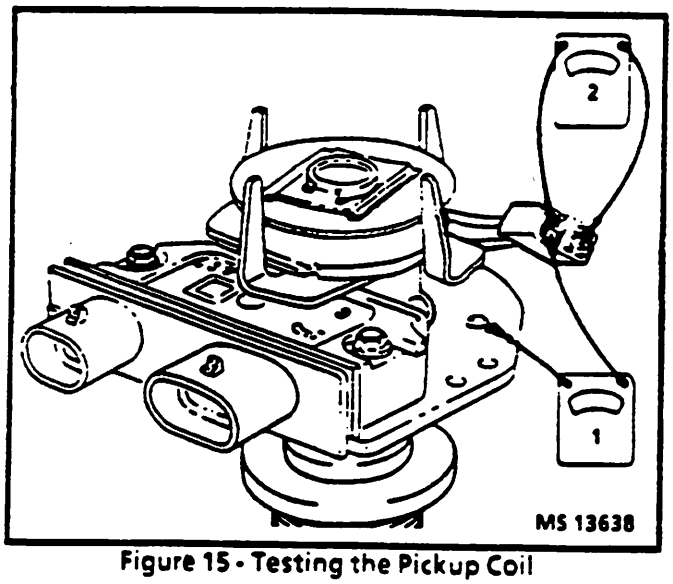


Figure 15 - Testing the Pickup Coil

2. Pickup coil (7).
   - Fit the tab on the bottom of the coil into the anchor hole in the housing.
3. Pickup coil wiring connector to the module.
   - Make sure the locking tab is in place.
4. Shield (6) onto the coil.
5. Retainer (5) onto the housing (Figure 16).
   - Use a new square retainer.
     A. Place the retainer over the center bushing with the teeth pointing upward.
     B. Place a 15 mm (5/8 inch) socket head onto the edge of the retainer. Keep the socket centered on the retainer so the teeth are not damaged. Use a small hammer to tap the retainer evenly down onto the center bushing. When installing the square retainer, make sure both teeth are seated in the groove on the bushing.
   - The retainer should hold the shield, pickup coil and pole piece firmly.
6. Shaft assembly (4) into the housing (11).
7. Tang washer (12), washer (13), and driven gear (14) onto the bottom of the shaft (distributors for six and eight-cylinder engines).
   - Align the marks on the driven gear, housing, and shaft assembly.
8. Roll pin (15) into the gear.
   - Spin the shaft and make sure the teeth on the shaft assembly do not touch the pole piece.
9. Rotor (3) onto the shaft.
   - Fit the tab in the rotor into the slot on the shaft.
10. Cap (2) to the housing with screws and washers.

IGNITION CONTROL MODULE
Figure 13 item #10

Remove or Disconnect

1. Negative battery cable.
2. Both wire harness connectors at side of the distributor cap.
3. Two screws on the sides of the distributor cap
4. Distributor cap and move it aside.
5. Wire connector at ignition control module.
6. Two screws attaching ignition control module to distributor base plate.
7. Ignition control module.

Install or Connect

NOTICE: Be sure to coat the bottom of module and rest pad on the housing with silicon grease or an equivalent heat transfer substance. Failure to do so could result in heat damage to the module.

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

IGNITION COIL
Figure 17

Remove or Disconnect

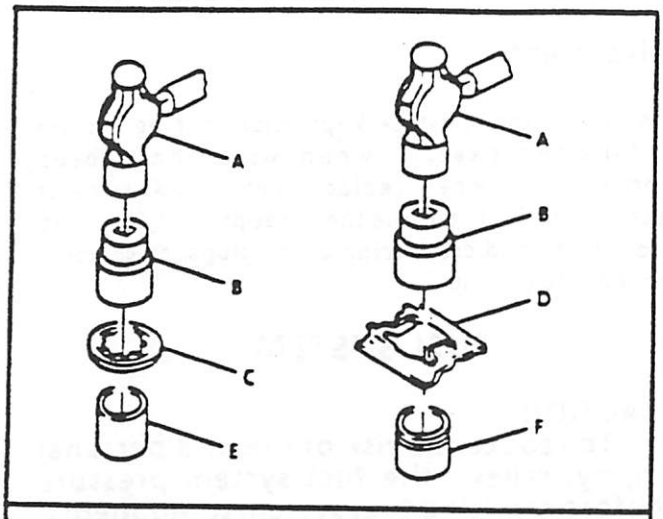
1. Negative battery cable
2. Wiring connectors at the side of the coil.
3. Coil wire.
4. Nuts holding the coil bracket and coil to the engine
5. Coil bracket and coil.
   - Drill and punch out the two rivets holding the coil to the bracket.
6. Coil from the bracket.

Measure

- Resistance of the ignition coil with an ohmmeter.
  - Connect the ohmmeter as shown in Figure 17, Step 1. Use the high scale. The reading should be infinite. If not, replace the coil.
  - Connect the ohmmeter as shown in Step 2. Use the low scale. The reading should be very low or zero. If not, replace the coil.
  - Connect the ohmmeter as shown in Step 3. Use the high scale. The meter should not read infinite. If it does, replace the coil.

Install or Connect

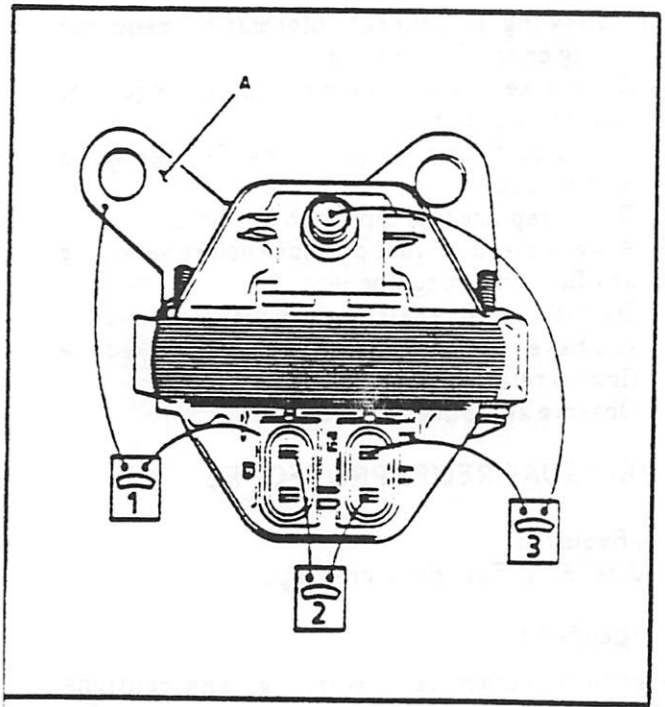
- A replacement coil kit comes with two screws to attach the coil to the bracket.



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

MS 11768

Figure 16 - Retainer to Shield Installation



A	SCRAPE CLEAN METAL GROUND

MS 13634

Figure 17 - Testing the Ignition Coil

1. Coil to the bracket with two screws.
2. Coil bracket to the engine bracket with studs and nuts.
3. Coil wire.
4. Wiring connectors.
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 proper advancing, should see approximately 15 to 25 degrees of advance at approximately 3000 RPM.
- If checking the KS system for retarding should see approximately 6 to 10 degrees of retard.
- When engine is idling the timing will be advancing up and down. This is normal because the ECM is controlling the timing for a smooth idle condition
- If checking base timing, when MDTC tool or scan tool is switched to service mode, the timing will go to 10 degrees BTDC and not move with RPM change.

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

Install or Connect

1. An inductive pick-up timing light to cylinder number 1 ignition wire.
2. A scan tool or Marine Diagnostic Trouble Code (MDTC) tool to DLC
   - If using Marine Diagnostic Trouble Code (MDTC) tool, manually adjust throttle to 1000 RPM.
   - With engine running, set Marine Diagnostic Trouble Code (MDTC) tool to service mode or scan tool to set timing mode.

     NOTICE: The scan tool will not go into set timing mode if DTC 42 is set or if 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 timing set specification.

   - If adjustment is needed, loosen distributor hold down bolt
   - Rotate distributor to adjust timing

Tighten

- Distributor hold down bolt to 40 N·m (30 lb. ft.).
- Manually bring throttle to idle.
- Set Marine Diagnostic Trouble Code (MDTC) tool or scan tool to normal mode.

SPARK PLUG REPLACEMENT

Remove or Disconnect

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

Inspect

- Each plug for wear and gap

Install or Connect

1. Spark plugs.

   #### Tighten

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

FUEL SYSTEM

CAUTION:
• To reduce the risk of fire and personal injury, relieve the fuel system pressure before servicing fuel system components.
• After relieving system pressure, a small amount of fuel may be released when servicing fuel lines or connections. To reduce the chance of personal injury, cover fuel line fittings with a shop towel before disconnecting to catch any fuel that may leak out. Place the towel in an approved container when disconnect is completed.

FUEL CONTROL ON-BOARD SERVICE

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

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

FUEL PRESSURE RELIEF PROCEDURE

Tool Required:
J 34730-1, Fuel Pressure Gage

Important

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

1. Disconnect negative battery cable to avoid possible fuel discharge if an accidental attempt is made to start the engine
2. Loosen fuel filler cap to relieve any tank vapor pressure.

3. Connect gage J 34730-1 to fuel pressure connector assembly (Figure 22, item #21)
   Wrap a shop towel around fitting while connecting gage to avoid spillage.
4. Install bleed hose into an approved container and open valve to bleed system pressure. Fuel connections are now safe for servicing.
5. Drain any fuel remaining in gage into an approved container.

FLAME ARRESTOR

Remove or Disconnect

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

Inspect

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

NOTICE: Flame arrestor may be baffled, install per manufactures 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 18, 19 and 20

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

An eight digit part identification number is stamped on the throttle body casting as shown in Figure 20. Refer to this number if servicing, or part replacement is required. For identification of parts during repair, refer to the disassembled view (Figure 18).

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 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. Throttle adjuster to throttle body cable.
5. Throttle body attaching bolts.
6. Throttle body assembly and flange gasket.
   - 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.

Tighten

- Throttle body attaching bolts to 15 N·m (11 lb ft.).

3. Throttle adjuster to throttle body cable
4. Electrical connectors, TP sensor and IAC valve
5. Flame arrestor.
6. Negative battery cable

Inspect

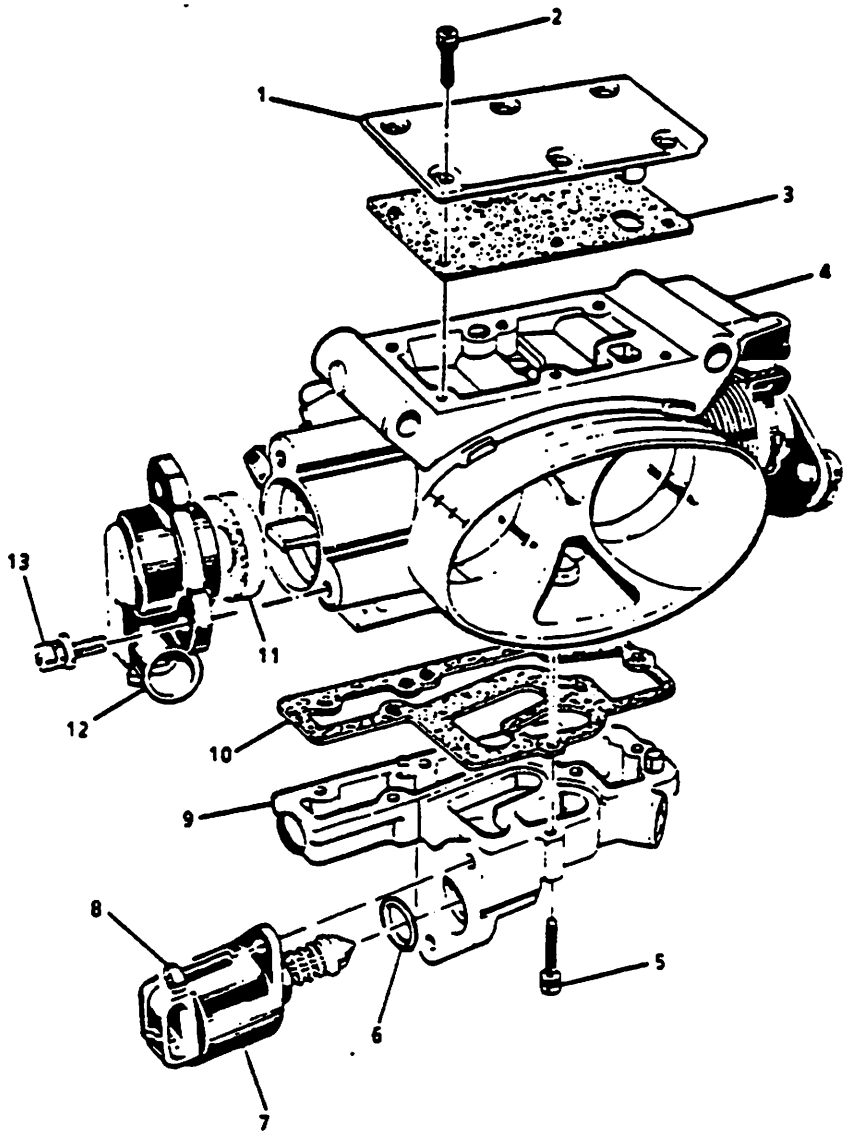
- With the engine "OFF," check to see that the throttle lever is free.
  - Move throttle lever to full throttle and release.

7. Reset IAC valve pintle position.
   A. Move throttle lever slightly.
   B. Start and run engine for five seconds.
   C. Turn ignition "OFF" for ten seconds.
   D. Restart engine and check for proper idle operation.

Idle Air Control Valve/Coolant Cover Assembly
Figure 18 item #9

Remove or Disconnect

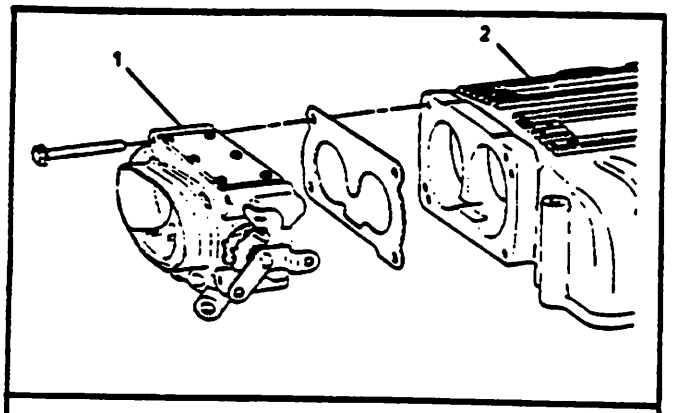
- Throttle body from intake manifold



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

PS 12858

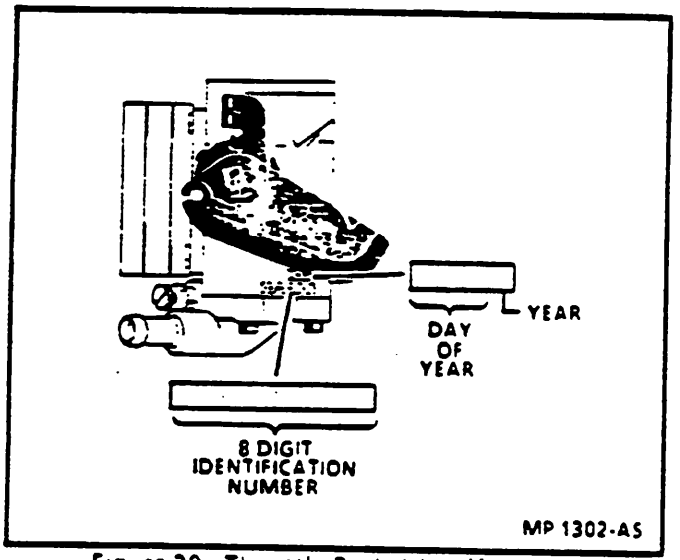
Figure 18 - Throttle Body Assembly



1 THROTTLE BODY ASSEMBLY
2 UPPER INTAKE (PLENUM)

NS 15478

Figure 19 - Throttle Body Removal



MP 1302-AS

Figure 20 - Throttle Body Identification

- 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

Tighten

- IAC valve cover screws to 3.2 N·m (28.0 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 (28.0 lb. in.).

INTAKE PLENUM (Upper Intake Section)

Figure 22 item #3

Remove or Disconnect

1. Negative battery cable.
2 Throttle cable from throttle body.
3 Electrical connections from
   - ECM "J1" and "J2" connectors.
   - Knock sensor 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 mating surfaces and the throttle body mating surface. Also, after manifold has been removed, covers must be installed over 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 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 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 not 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 manufacture flaws).
- Entire plenum for cracks caused from manufacturing flaw or handling

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 O-ring seals out of grooves.

Important

- Lightly coat threads and shaft of bolts with an anti-seize compound

4. All plenum retaining bolts.

Tighten

- Bolts to 14.0 N·m (124 lb in.) in sequence as shown in Figure 21.

5. Vacuum hose to fuel pressure regulator.
6. Electrical connectors to:
   - Knock sensor module.
   - TP sensor.
   - IAC valve.
   - MAP sensor.
   - IAT sensor.
   - ECM "J1" and "J2" connectors.
7. Throttle cable to throttle body.
8. Negative battery cable.

FUEL RAIL ASSEMBLY
Figures 22 and 23

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 22).

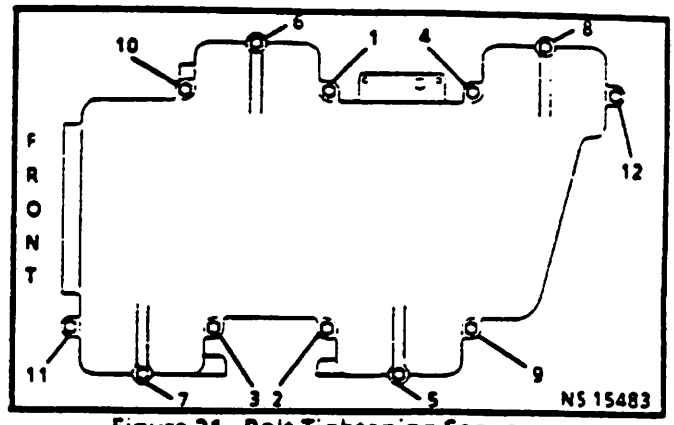


Figure 21 - Bolt Tightening Sequence

NOTICE:

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

Clean

- Before removal, the fuel rail assembly may be cleaned with a spray type engine cleaner, GM X-30A or equivalent, following package instructions.

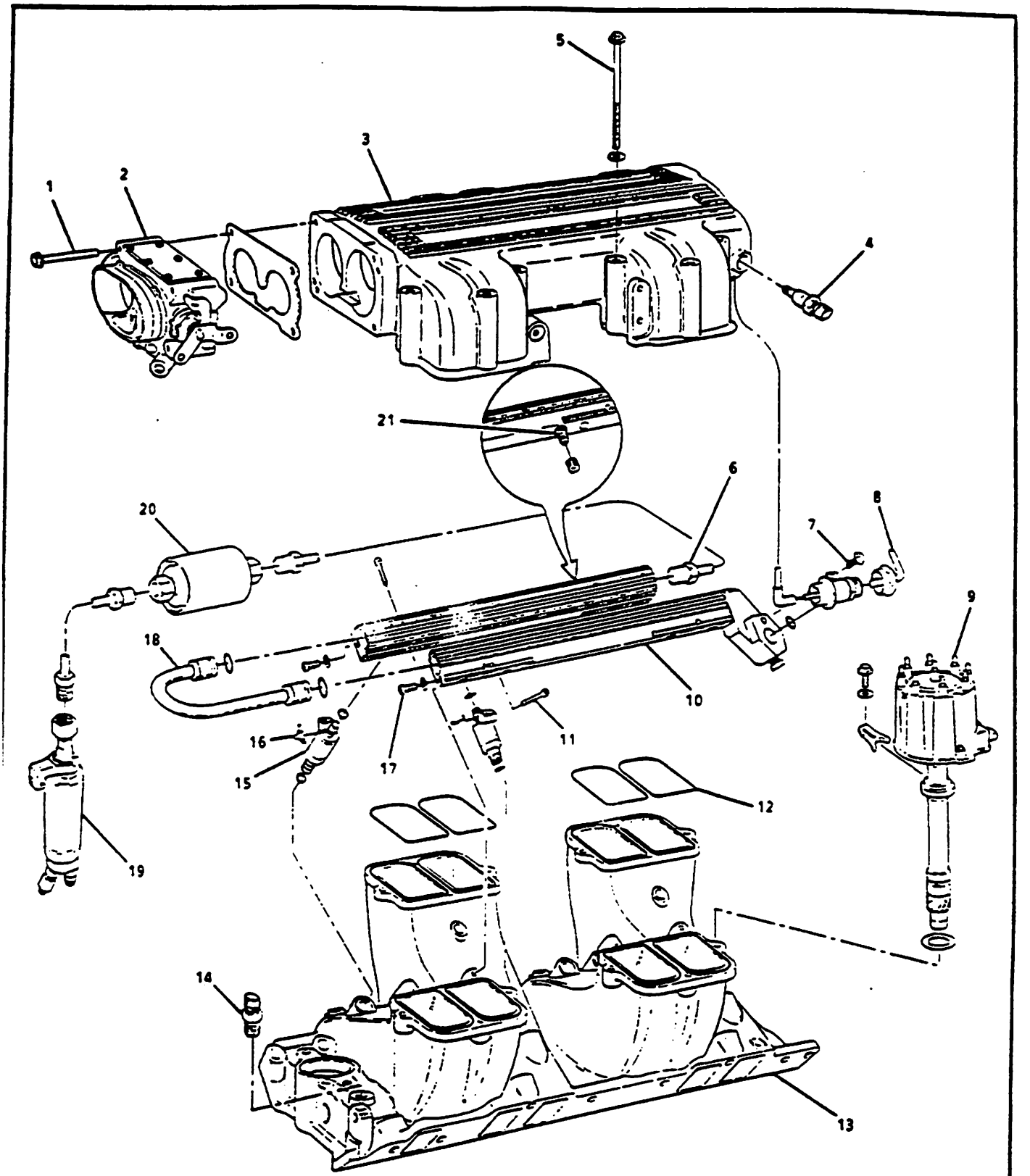
CAUTION: Safety glasses must be worn when using compressed air as flying dirt particles may cause eye injury.

- 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.

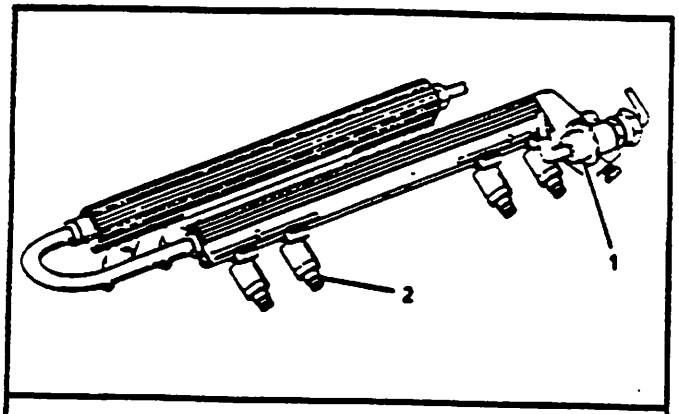
1. Negative battery cable.
2. Relieve fuel system pressure.
   - Refer to the "Fuel Pressure Relief Procedure."
   - Fuel pressure connector assembly is located on right side rail in center of fuel rail.
3. Intake plenum following the procedures outlined in this section.
4. Fuel inlet line, hold fitting in rail with wrench to keep from turning
5. Fuel outlet fitting at pressure regulator
   - Hold pressure regulator with wrench to keep from turning and damaging



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

PS 16346

Figure 22 - Intake and Fuel System



1 PRESSURE REGULATOR ASSEMBLY
2 MFI INJECTOR ASSEMBLY
PS 19062

Figure 23 - Fuel Rail Assembly

6. Retaining screw for pressure regulator and pressure regulator.
7. Electrical connector from injectors.
   - 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 in this section.
12. Retaining screws for fuel rail jumper line.
13. Twist and remove jumper line from rail.

Clean and Inspect

- The fuel rail assembly with a spray type cleaner, GM X-30A or equivalent, following package instructions. Do Not soak fuel rails in liquid cleaning solvent.
- Injector bores and fuel line connector bores for nicks, burrs or corrosion, clean lightly with emery cloth in a radial motion.
- O-ring seal grooves on fuel line connectors, pressure regulator fittings, and injectors.

Install or Connect

NOTICE: To prevent leakage and the risk of fire all O-ring seals need to be replaced to insure proper sealing.

LUBRICATE: All O-ring seals need to be lubricated with engine oil prior to assembly

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.

Tighten

- Fuel rail jumper line attaching screws to 7.0 N·m (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 on to intake manifold.
   - If injectors are lined up properly they will slide into place.
   - Push gently and evenly on rail to set injectors all the way into their bores
6. Fuel rails attaching screws.

Tighten

- Fuel rail attaching bolts to 10.0 N·m (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.

Tighten

- Pressure regulator attaching screw to 9.5 N·m (84 lb. in.).

10. Lubricate new O-ring seal on pressure regulator outlet fitting and tighten fitting, careful not to twist regulator

Tighten

- Fuel regulator connection to 17.5 N·m (13 lb. ft.).

11. Inlet fuel line.
12. Intake plenum following procedures in this section.
13. Negative battery cable.
14. Bleed fuel system by cycling key "ON" and "OFF" a few times with engine "OFF."

Inspect

- Turn ignition switch to the "ON" position for two seconds, then turn to the "OFF" position for ten seconds. Again turn to "ON" position and check for fuel leaks.

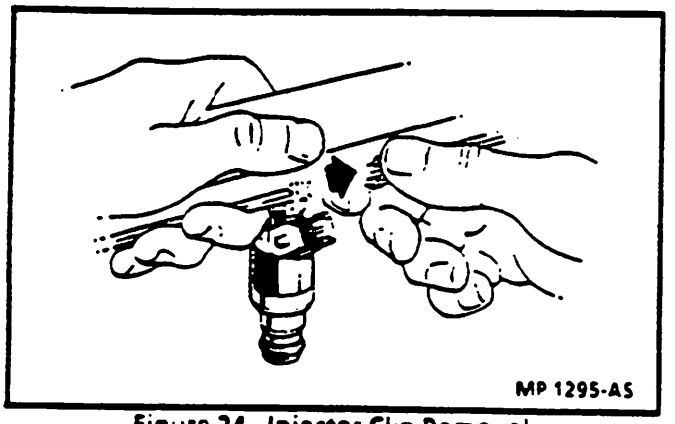


Figure 24 - Injector Clip Removal

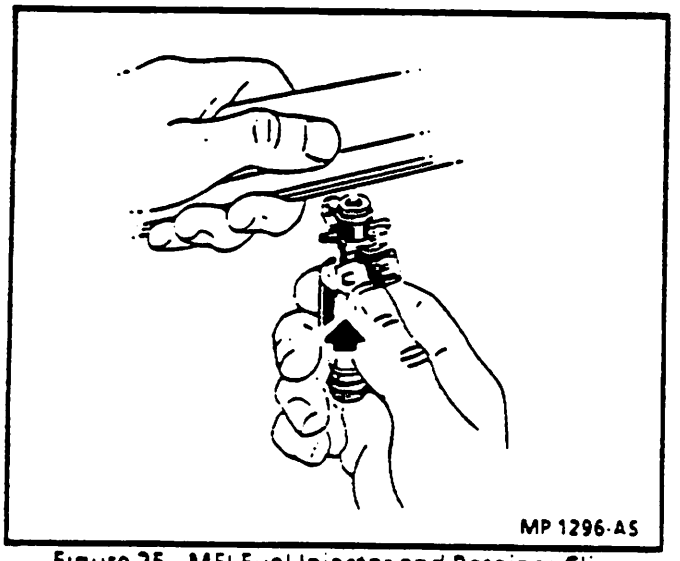


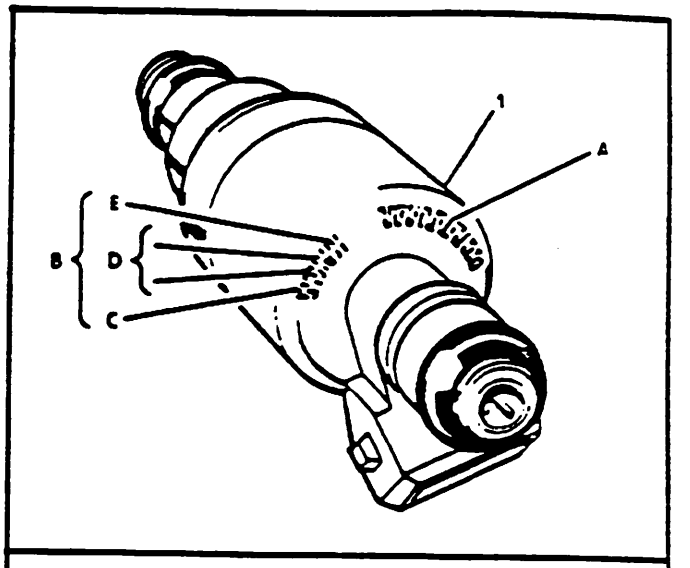
Figure 25 - MFI Fuel Injector and Retainer Clip

FUEL INJECTORS
Figures 24, 25 and 26

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 system pressure.
   - Refer to the "Fuel Pressure Relief Procedure."
3. Intake plenum following procedures in this section.
4. Fuel rail assembly following procedures in this section.

Disassemble
1. Release injector clip by sliding off injector (Figure 24).
2. MFI injector from rail
3. Injector O-ring seals from both ends of injector and discard



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

MP 1222-AS

Figure 26 - Injector Part Number Location

4. Injector retainer clip from rail.

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

Important
- 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 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. Snap retainer clip into grooves on fuel rail

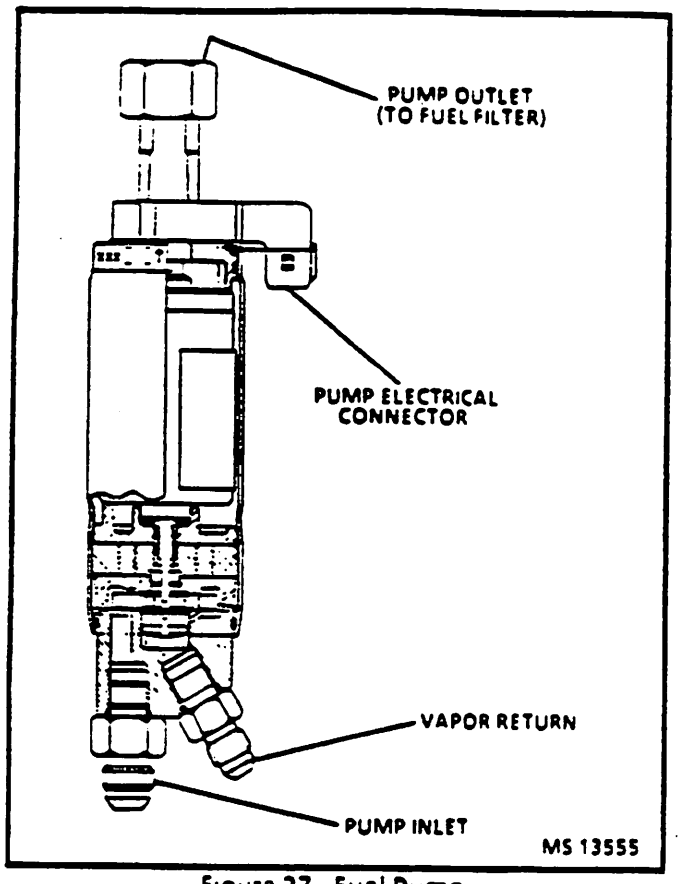


Figure 27 - Fuel Pump

Install or Connect

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

FUEL PUMP
Figure 27

Important

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

Remove or Disconnect

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

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

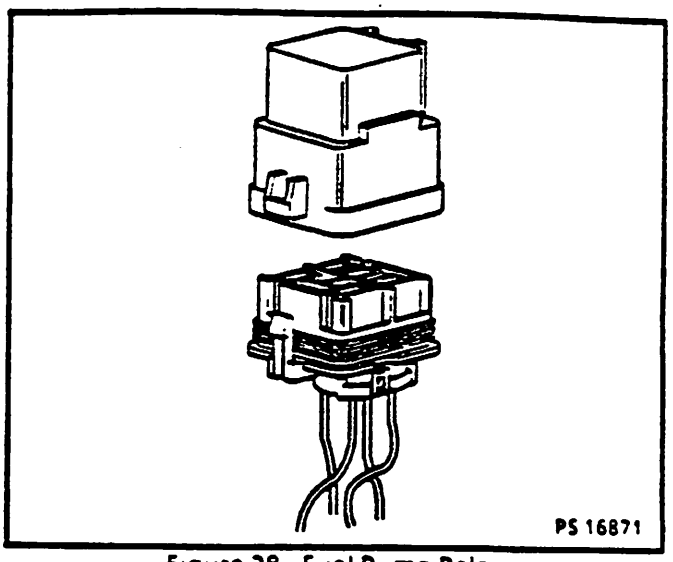


Figure 28 - Fuel Pump Relay

Install or Connect

1. Fuel pump.
2. Vapor return line fitting.
3. Inlet and outlet fuel fittings.
4. Fuel pump electrical connector.
5. Negative battery cable.
6. With engine "OFF," cycle ignition "ON" then "OFF" until fuel lines are primed, and check for leaks.

FUEL PUMP RELAY
Figure 28

Remove or Disconnect

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

Important

- The fuel pump relay is an electrical component. Do not soak in any liquid cleaner or solvent, damage may result.

Install or Connect

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

IN-LINE FUEL FILTER
Figure 29

Important

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

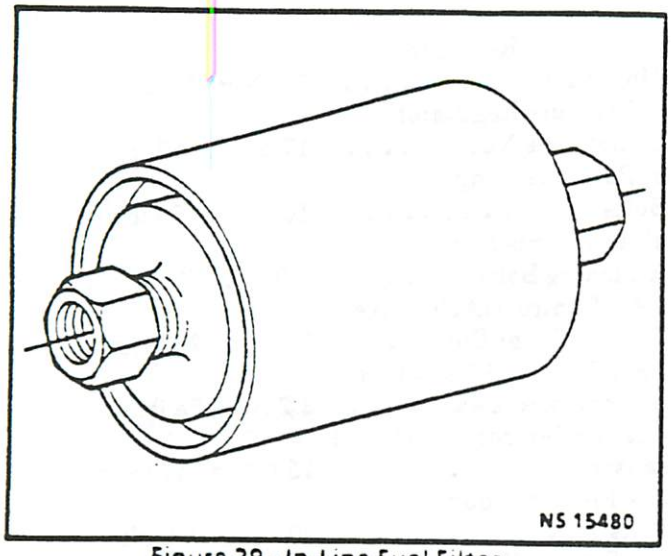


Figure 29 - In-Line Fuel Filter

Remove or Disconnect

1. Fuel line fittings
2. Clamp bolt and clamp

Inspect

- In-line fuel filter, for being plugged or contaminated. If filter is plugged or contaminated, replace filter.

Install or Connect

1. Clamp and clamp bolt.
2. Fuel line nuts to filter
3. With engine "OFF" cycle ignition switch "ON" then "OFF" until fuel lines are primed then check for leaks.

WATER SEPARATOR

When it is necessary to change water separator, follow manufacturer's recommended procedure.

Important

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

FUEL PRESSURE REGULATOR ASSEMBLY
Figure 30

Important

- The pressure regulator is serviced as a complete assembly only.

Remove or Disconnect

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

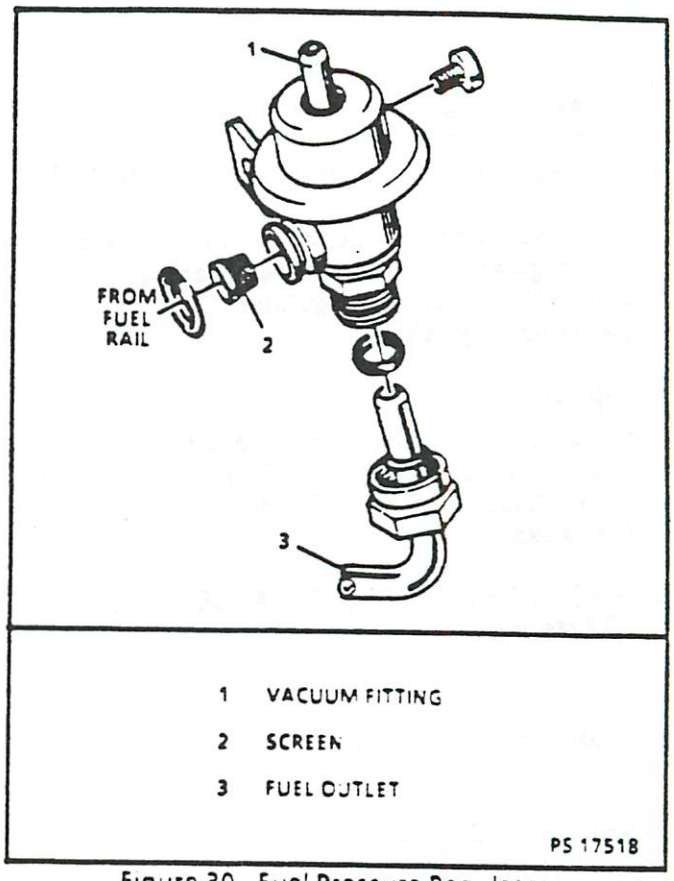


Figure 30 - Fuel Pressure Regulator

Inspect

- 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

Tighten

- Pressure regulator attaching screw to 9.5 N·m (84 lb. in).
- Outlet line nut regulator to 17.5 N·m (13 lb. ft.).
  - Use backup wrench to keep pressure regulator from turning and damage.

6. Vacuum line to pressure regulator.
7. Negative battery cable.

Inspect

- Turn ignition switch to "ON" position for two seconds, then turn to the "OFF" position for ten seconds. Again turn to "ON" position and check for fuel leaks.

FUEL PRESSURE CONNECTOR ASSEMBLY
Figure 22 item #21

Clean

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

Remove or Disconnect

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

Install or Connect

1. New seal on fuel pressure connection.
2. Fuel pressure connection in fuel rail.

Tighten

- Fuel pressure connection to 13 N·m (115 lb. in.).

3. Negative battery cable.

Inspect

- Turn ignition switch to the "ON" position for two seconds, then turn to the "OFF" position for ten seconds. Again turn the "ON" position, and check for fuel leaks.

TORQUE SPECIFICATIONS

Distributor Hold Down Bolt	40.0 N·m (30 lb. ft.)
Engine Coolant Temperature (ECT) Sensor	12.0 N·m (108 lb. in.)
Engine Control Module (ECM)	10.0-14.0 N·m (88-124 lb. in.)
Fuel Pressure Connector	13 N·m (115 lb. in.)
Fuel Pressure Regulator Mount Bolt	9.5 N·m (84 lb. in.)
Fuel Pressure Regulator Outlet Line Nut	17.5 N·m (13 lb. ft.)
Fuel Rail Attaching Bolts	10.0 N·m (88 lb. in.)
Fuel Rail Jumper Line Attaching Bolts	7.0 N·m (62 lb. in.)
Idle Air Control (IAC) Valve Coolant Cover Bolts	3.2 N·m (28 lb. in.)
Idle Air Control (IAC) Valve Attaching Screws	3.2 N·m (28 lb. in.)
Intake Air Temperature (IAT) Sensor	15.0 N·m (11 lb. ft.)
Intake Plenum Mount Bolts	20 N·m (15 lb. ft.)
Knock Sensor (KS)	15.0-22.0 N·m (11-16 lb. in.)
MAP Sensor Attaching Bolts	5.0-7.0 N·m (44-62 lb. in.)
Spark Plugs	15.0 N·m (11 lb. ft.)
Throttle Body Assembly	15.0 N·m (11 lb. ft.)
Throttle Position (TP) Sensor Attaching Screws	2.0 N·m (18 lb. in.)

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 For wire repair see general section.

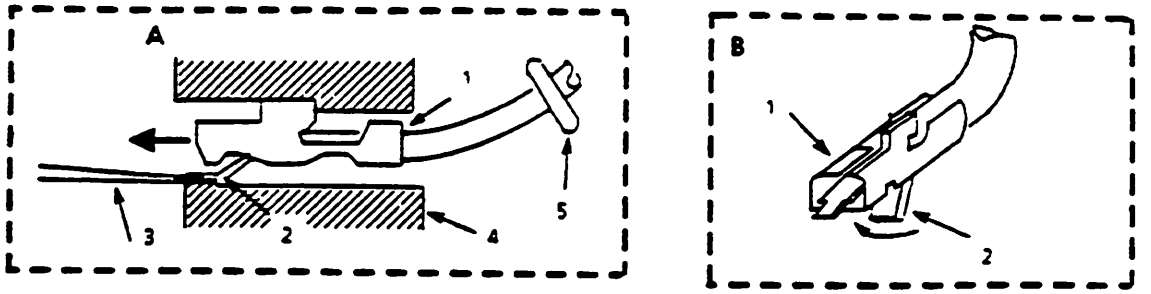
Metri-Pack Series 150 Terminals
Figure 31

Some ECM harness connectors contain terminals called Metri-Pack (Figure 31). These are used at some of the sensors and the distributor connector.

Metri-Pack terminals are also called "Pull-to-Seat" terminals because to install a terminal on a wire, the wire is first inserted through the seal (5) and connector (4). The terminal is then crimped on the wire, and the terminal pulled back into the connector to seat it in place.

To remove a terminal:

1. Slide the seal back on the wire.
2. Insert tool (3) BT-8446, J 35689, or equivalent as shown in insert "A" and "B" to release the terminal locking tang (2).
3. Push the wire and terminal out through the connector.



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

2-5-90
*75 3213-6E

Figure 31 - Metri-Pack Series 150 Terminal Removal

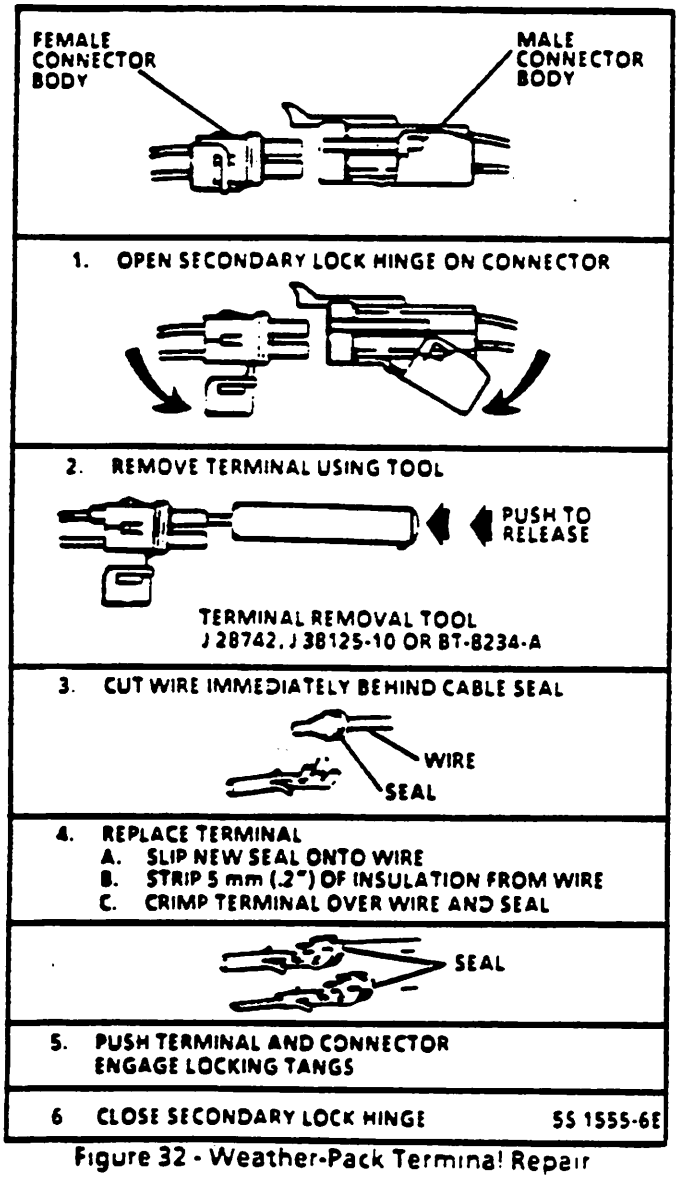


Figure 32 - Weather-Pack Terminal Repair

If the terminal is being reused, reshape the locking tang (2).

Weather-Pack Connectors
Figure 32

Figure 32 shows a Weather-Pack connector and the tool (J 28742, BT-8234-A or equivalent) required to service it. This tool is used to remove the pin and sleeve terminals.If terminal removal is attempted without using the special tool required, there is a good chance that the terminal will be bent or deformed, and unlike standard blade type terminals, these terminals cannot be straightened once they are bent.

Make certain that the connectors are properly seated and all of the sealing rings in place when connecting leads. The hinge-type flap provides a secondary locking feature for the connector. It improves the connector reliability by retaining the terminals if the small terminal lock tangs are not positioned properly

Weather-Pack connections cannot be replaced with standard connections. Instructions are provided with Weather-Pack connector and terminal packages.

Micro-Pack 100W Series Connectors
Figure 33

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

Disassembly

Remove or Disconnect

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

Inspect

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

NOTICE: If you are only going to just clean terminals complete disassembly is not necessary. Remove index cover (4) from connector by pushing in 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 small screwdriver move Tabs A on strain relief (1) to unlock position.
4. Open strain relief as in Figure B.
5. Release Tabs B (Figure C) on connector (3) by pushing inward with both thumbs or small screwdriver.
6. Push Tabs B through strain relief (1) with thumbs or small screwdriver while in released position.

Important

- Where there aren't 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 isn't any wires.
8. Slide strain relief off of seal and back on wires.
9. Slide seal off of connector and back on wires.

Important

- To insure proper engine operation after repair of connector assembly, wires must be in proper connector location. Before removing index cover note if there are any wires of the same color. Mark these wires from the location that they were removed For the remaining wires their location can be found by referring to "ECM Component Connector Identification" in "Diagnosis" section The strain relief is numbered for identifying wire location

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

Clean and Inspect

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

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

Assembly

Install or Connect

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

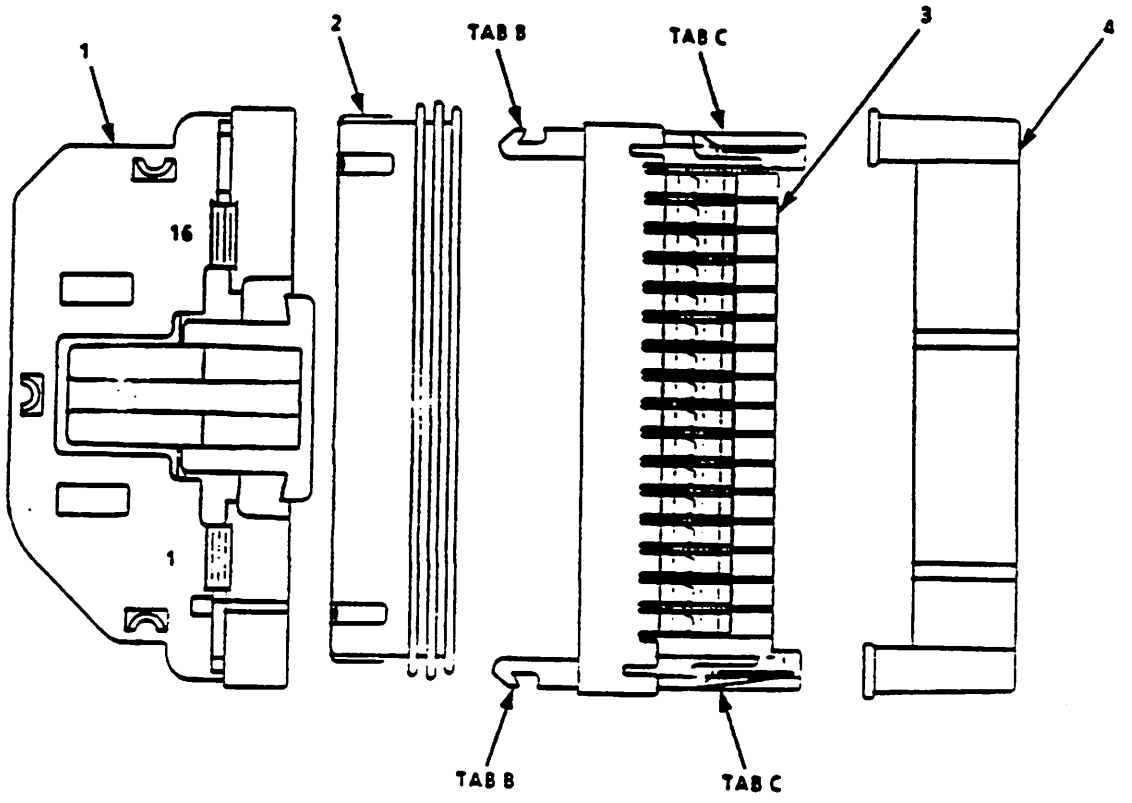


FIGURE A - EXPLODED VIEW OF CONNECTOR ASSEMBLY

1	STRAIN RELIEF	3	CONNECTOR
2	SEAL	4	INDEX COVER

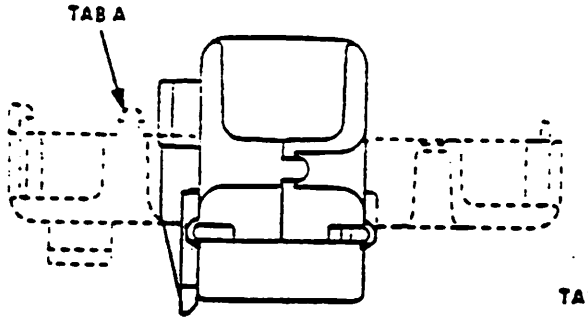


FIGURE B - STRAIN RELIEF CLOSED

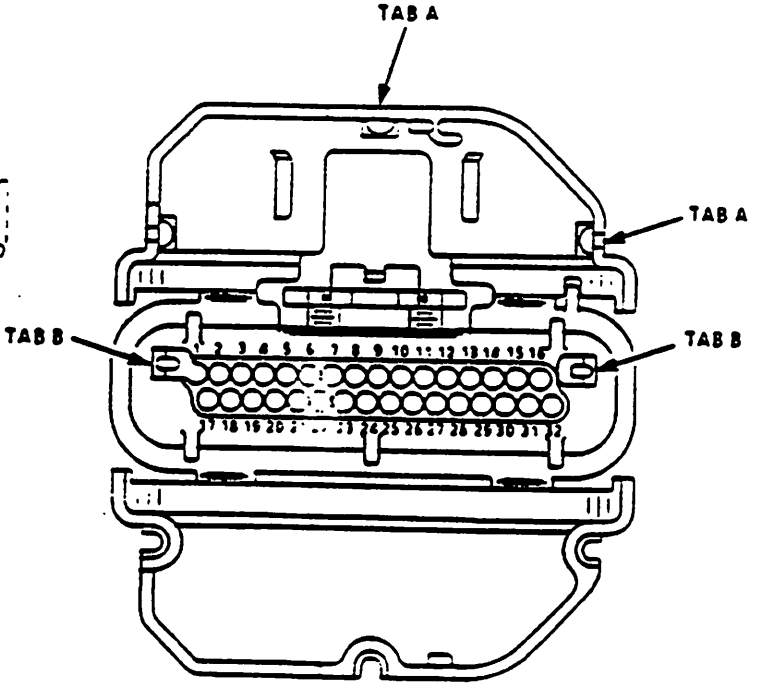


FIGURE C - STRAIN RELIEF OPENED

PS 19745

Figure 33 - Micro-Pack 100 W Series

FUEL SYSTEMS
TBI

FUEL METERING SYSTEM THROTTLE BODY INJECTION (TBI)

CONTENTS

GENERAL DESCRIPTION

PURPOSE

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

MODES OF OPERATION

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

Starting Mode

When the ignition switch is turned to the crank position, the ECM turns "ON" the fuel pump relay and the fuel pump builds up pressure. The ECM then checks the Engine Coolant Temperature (ECT) sensor and Throttle Position (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 75% of its travel. 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 75%, and the engine speed is below 400 RPM. If the throttle position becomes slightly greater than 75%, or slightly less than 75%, the ECM returns to the starting mode.

Run Mode

When the engine is first started and RPM is above 400, the system operates in the Run Mode. The ECM will calculate the desired air/fuel ratio based on these ECM inputs: RPM, Manifold Absolute Pressure (MAP) sensor, and Engine Coolant Temperature (ECT) sensor. Higher engine load (from MAP) and colder engine temperature (from ECT) requires more fuel, or a richer air/fuel ratio.

Acceleration Mode

The ECM looks at rapid changes in Throttle Position (TP) sensor and manifold pressure (MAP), and provides extra fuel by increasing the injector pulse width.

Fuel Cutoff Mode

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

RPM Reduction Mode

The ECM recognizes change of state in a discrete switch input that identifies an abnormal condition that may affect proper engine operation.

As an engine protection feature, RPM reduction mode allows normal fuel injection up to OEM specifications (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 RPM limit is exceeded.

This feature allows maneuverability of the boat while removing the possibility of high engine speed operation until the problem is corrected.

FUEL METERING SYSTEM COMPONENTS
Figure 1

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

- Fuel supply components (fuel tank, pump, lines, water separator).
- Fuel pump electrical circuit.
- Throttle body assembly, including:
  - Fuel injectors.
  - Pressure regulator assembly.
  - Idle Air Control (IAC) valve.
  - Throttle Position (TP) sensor.

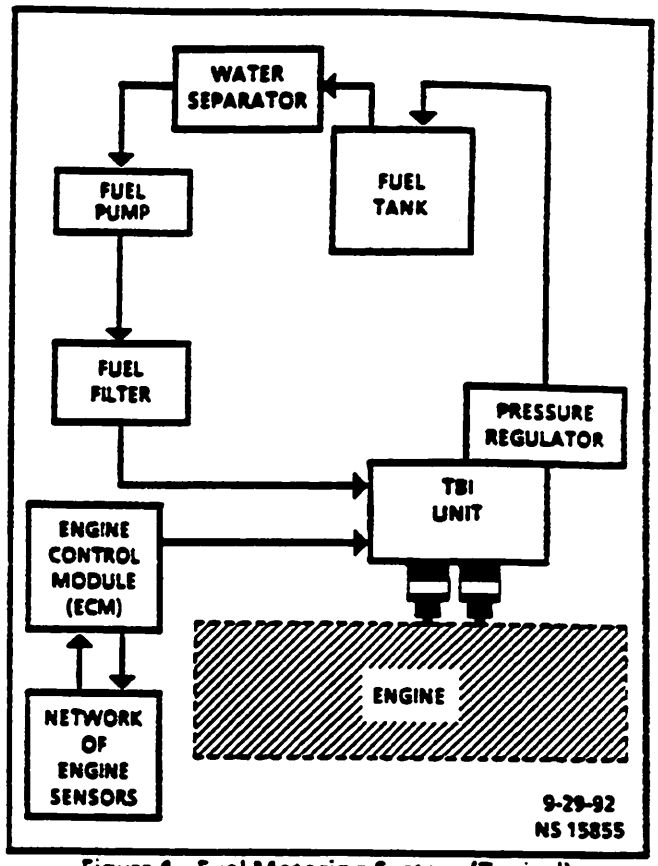


Figure 1 - Fuel Metering System (Typical)

FUEL SUPPLY COMPONENTS (TYPICAL)

The fuel supply is stored in the fuel tank. An electric fuel pump (Figure 2), located near the water separator assembly, pumps fuel through an in-line fuel filter to the throttle body assembly. The pump is designed to provide fuel at a pressure greater than is needed by the injectors. The pressure regulator, part of the throttle body 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 "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 can result in an "Engine Cranks But Won't Run" condition.

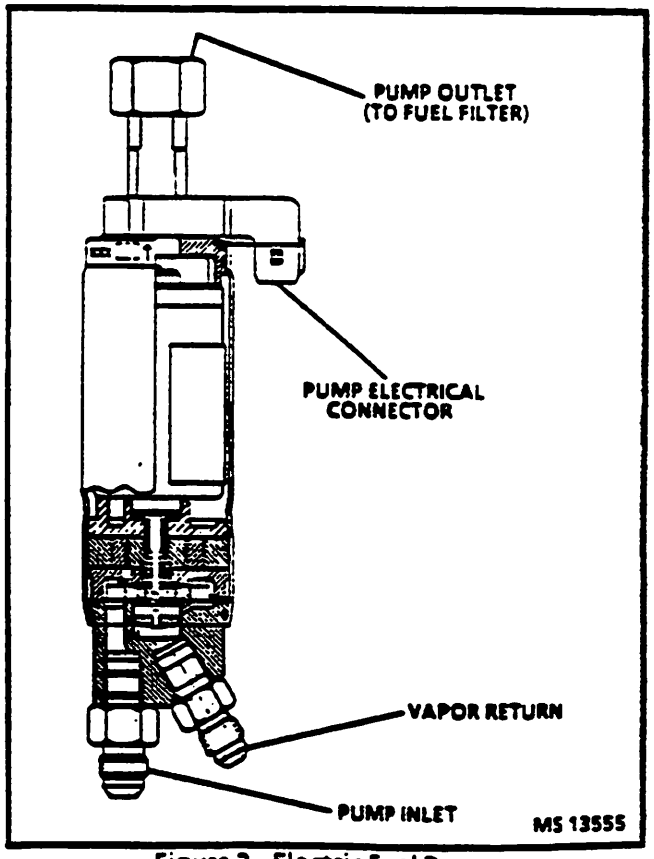
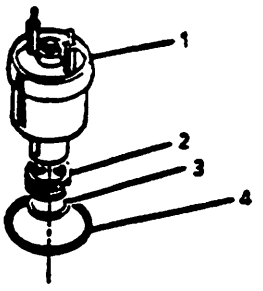


Figure 2 - Electric Fuel Pump

Fuel Injectors
Figure 3

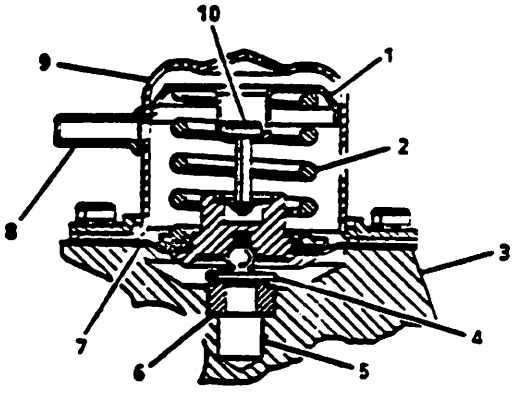
The MEFI injector assembly is a solenoid-operated device, controlled by the ECM, that meters pressurized fuel to intake manifold. The ECM energizes the injector solenoid, which opens a ball valve, allowing fuel to flow past the ball valve, and through a recessed flow director plate.



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

PS 18610

Figure 3 - Typical TBI Injector



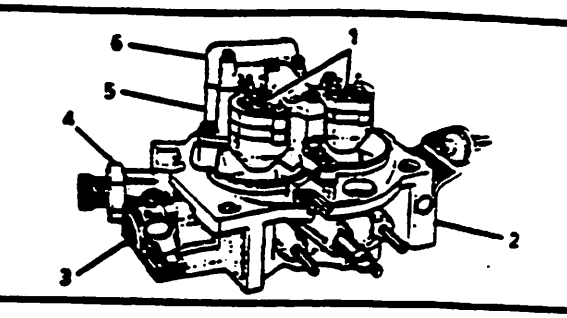
1	LOWER SPRING RETAINER	6	VALVE SEAT
2	SPRING	7	DIAPHRAGM ASSEMBLY
3	BASE	8	VACUUM CONNECTION TUBE
4	PRESSURE REGULATOR VALVE	9	COVER
5	FUEL RETURN	10	SPRING RETAINER TIE ROD

SP 0974-AS

Figure 4 - Pressure Regulator Assembly

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, causing it to become further atomized and vaporized before entering the intake manifold.

An injector that is stuck partly open would cause loss of pressure after engine shut down. Consequently, long cranking times would be noticed on some engines. Dieseling could also occur, because some fuel could be delivered to the engine after the ignition is turned "OFF."



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

MP 1191-AS

Figure 5 - Throttle Body Injector (TBI) Unit

Pressure Regulator Assembly
Figure 4

The pressure regulator is a diaphragm-operated relief valve with fuel pump pressure on one side, and regulator spring pressure on the other (Figure 4). The regulator's function is to maintain a constant pressure differential across the injectors at all times The pressure regulator compensates for engine load by increasing fuel pressure as engine vacuum drops.

With the ignition "ON," and engine "OFF," fuel pressure at the pressure test connection should be 62-89 kPa (9-13 psi). If the pressure is too low, poor performance could result.

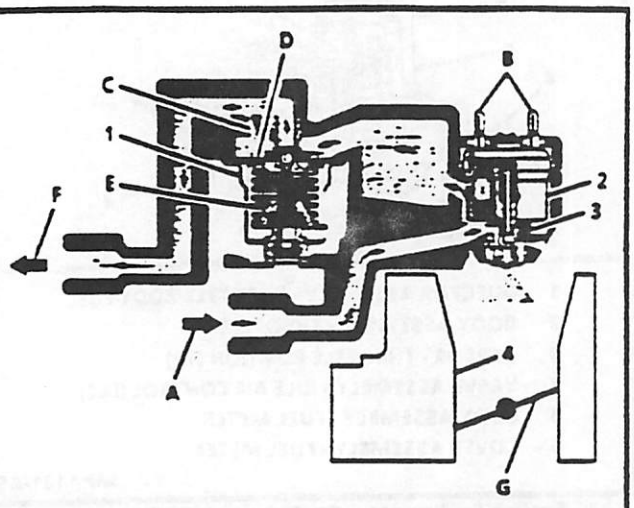
THROTTLE BODY FUEL INJECTION (TBI) UNIT
Figures 5 and 6

The Throttle Body Fuel Injection (TBI) unit consists of three major assemblies:

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

Idle Air Control (IAC) Valve
Figures 7 through 9

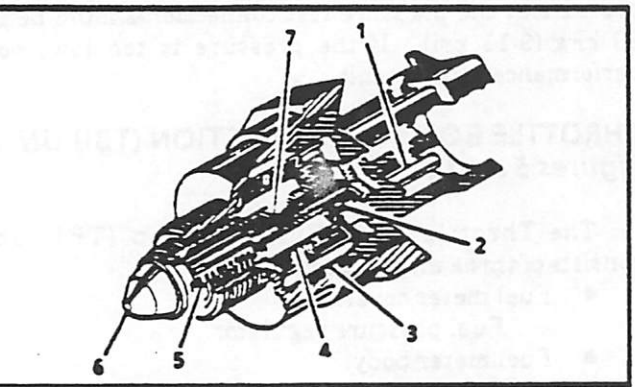
The purpose of the IAC valve assembly (shown in Figures 7 and 8) is to control engine idle speed, while preventing stalls due to changes in engine load.



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

8P 0320-SY

Figure 6 - Fuel Flow Diagram

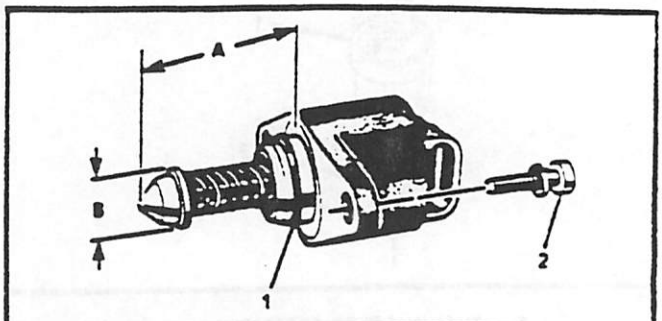


1	TERMINAL PINS	5	SPRING
2	BALL BEARING ASSEMBLY	6	PINTLE
3	STATOR ASSEMBLY	7	LEAD SCREW
4	ROTOR ASSEMBLY		

8P 0933-AS

Figure 7 - Idle Air Control (IAC) Valve Assembly (Typical Thread Mounted)

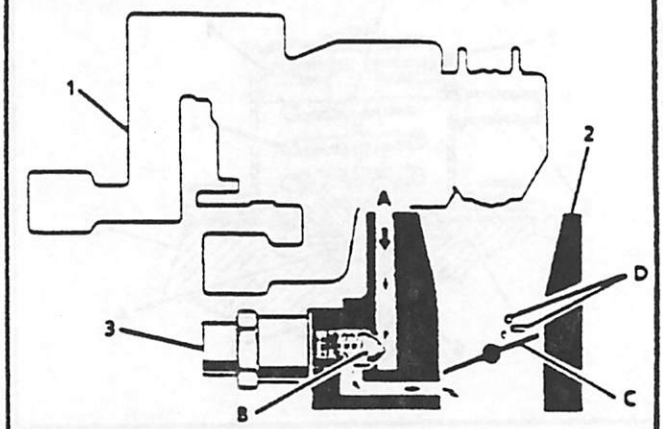
The IAC valve, mounted in the throttle body, controls bypass air around the throttle valves (Figure 9). By moving a conical valve known as a pintle, IN, towards the seat (to decrease air flow); or OUT, away from the seat (to increase air flow), a controlled amount of air moves around the throttle valve.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



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

LP 1220-AS

Figure 8 - Flange Mounted Type IAC Valve



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

8P 0319-SY

Figure 9 - IAC Valve Air Flow Diagram

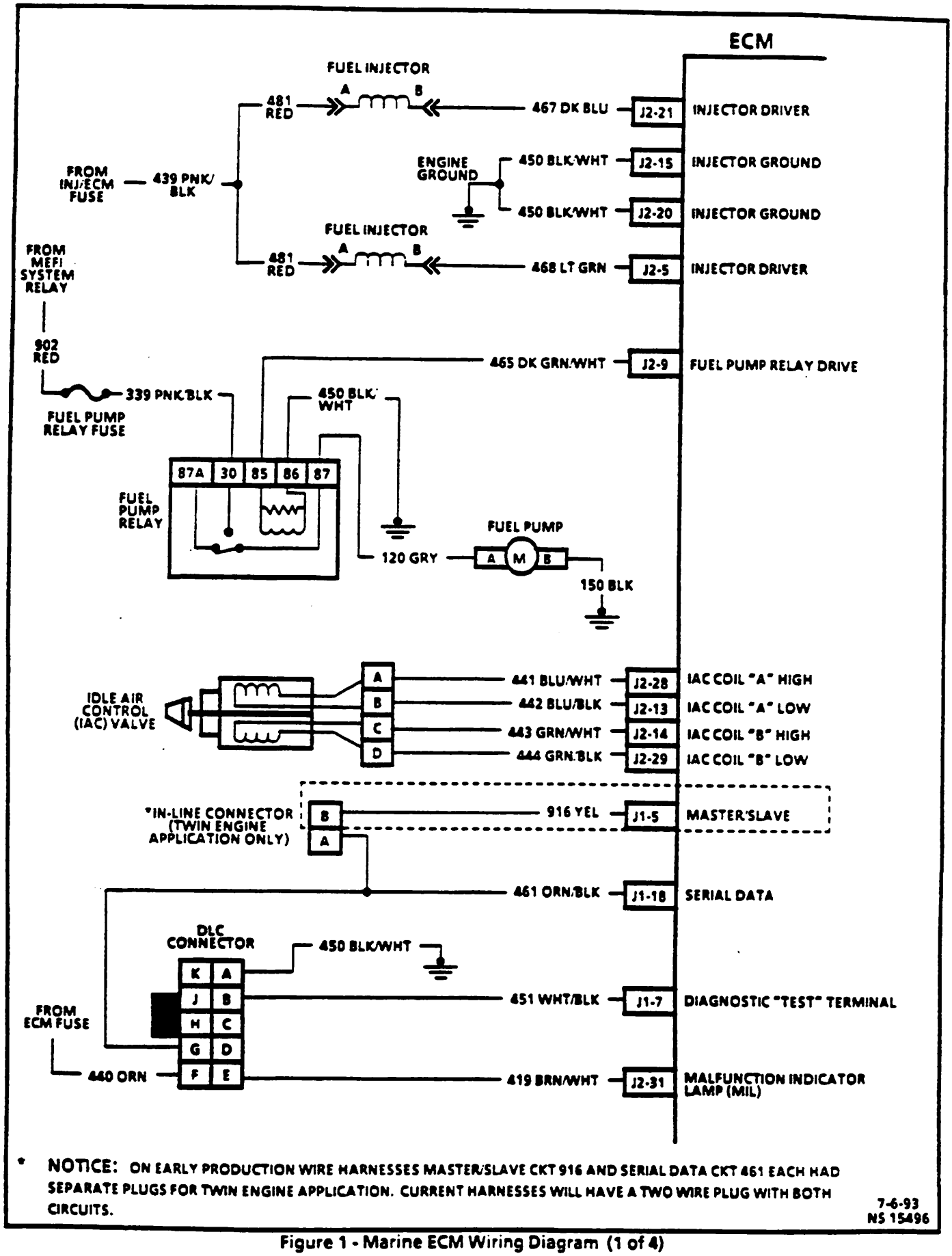
The ECM moves the IAC valve in small steps. These can be measured by scan tool test equipment, which plugs into the Data Link Connector (DLC).

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

- Engine idle speed is a function of total air flow into the engine based on IAC valve pintle position + throttle valve opening.
- "Controlled" idle speed is programmed into the ECM, which determines the correct IAC valve pintle position to maintain the desired idle speed for all engine operating conditions and loads.
- The minimum idle air rate is set at the factory with a stop screw. This setting allows enough air flow by the throttle valves to cause the IAC valve pintle to be positioned a calibrated number of steps (counts) from the seat, during "controlled" idle operation.

DIAGNOSES
TBI

TBI DIAGNOSIS
CONTENTS



* NOTICE: ON EARLY PRODUCTION WIRE HARNESSES MASTER/SLAVE CKT 916 AND SERIAL DATA CKT 461 EACH HAD SEPARATE PLUGS FOR TWIN ENGINE APPLICATION. CURRENT HARNESSES WILL HAVE A TWO WIRE PLUG WITH BOTH CIRCUITS.

7-6-93
NS 15496

Figure 1 - Marine ECM Wiring Diagram (1 of 4)

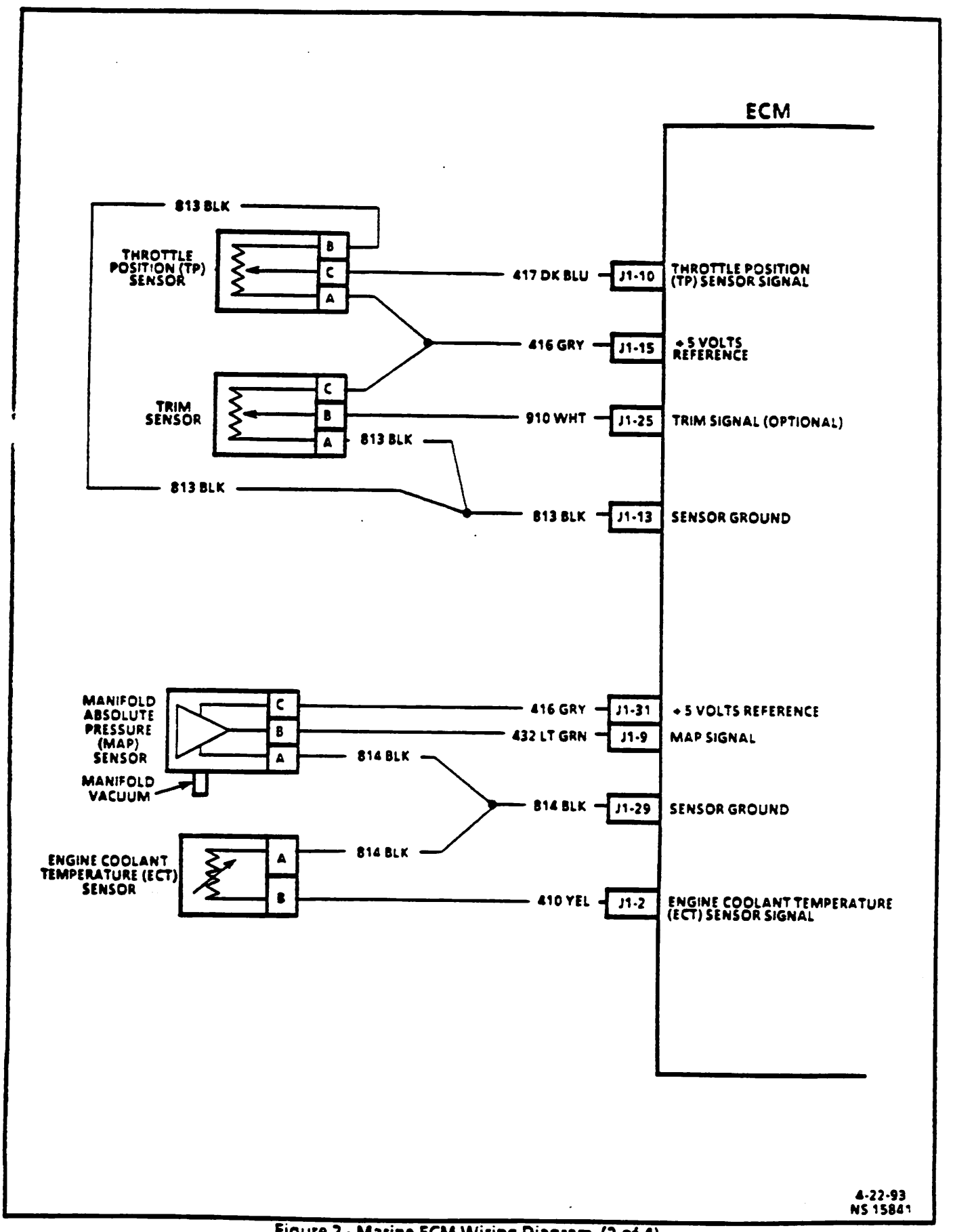
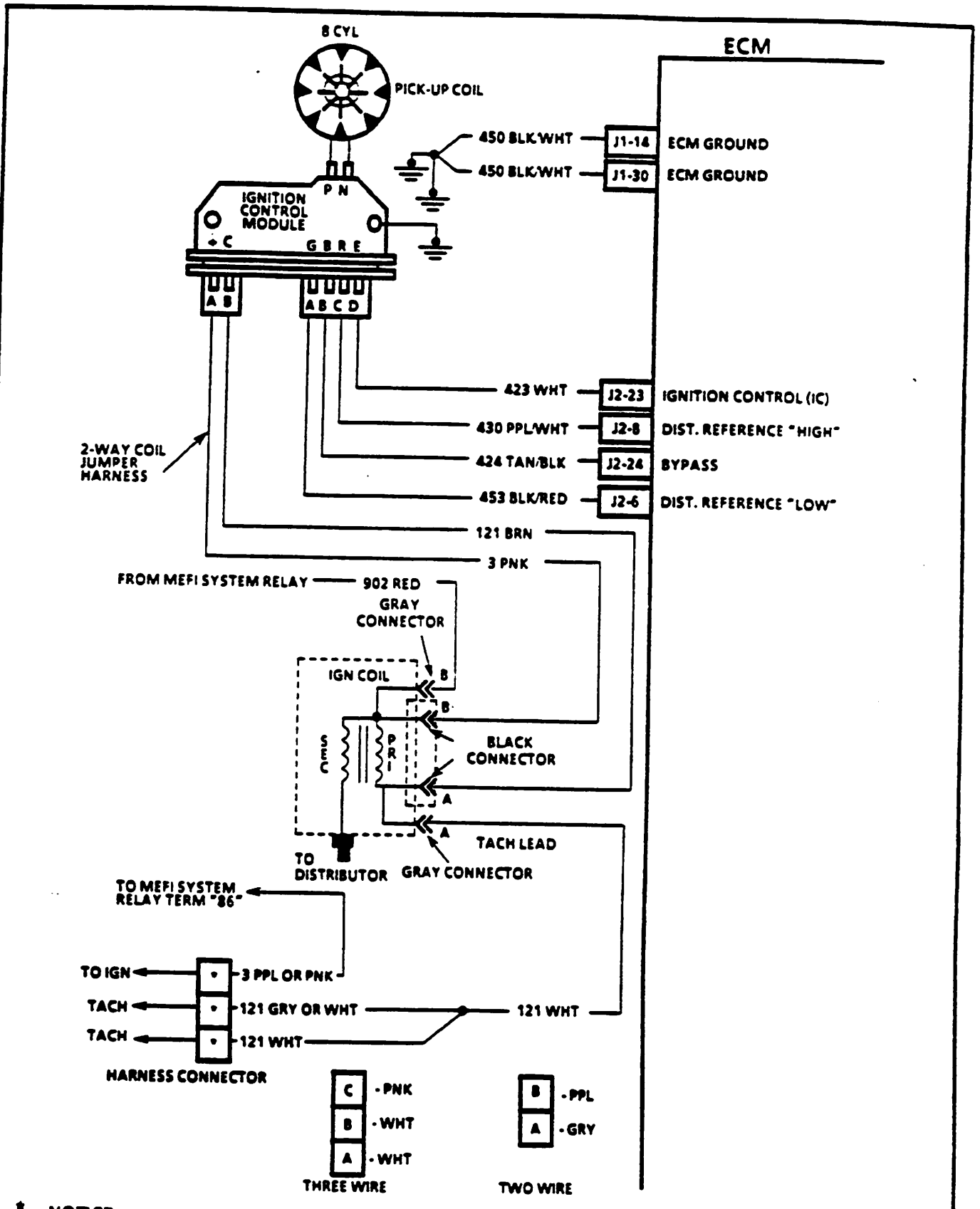


Figure 2 - Marine ECM Wiring Diagram (2 of 4)



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

7-6-93
MS 11193-6E

Figure 3 - Marine ECM Wiring Diagram (3 of 4)

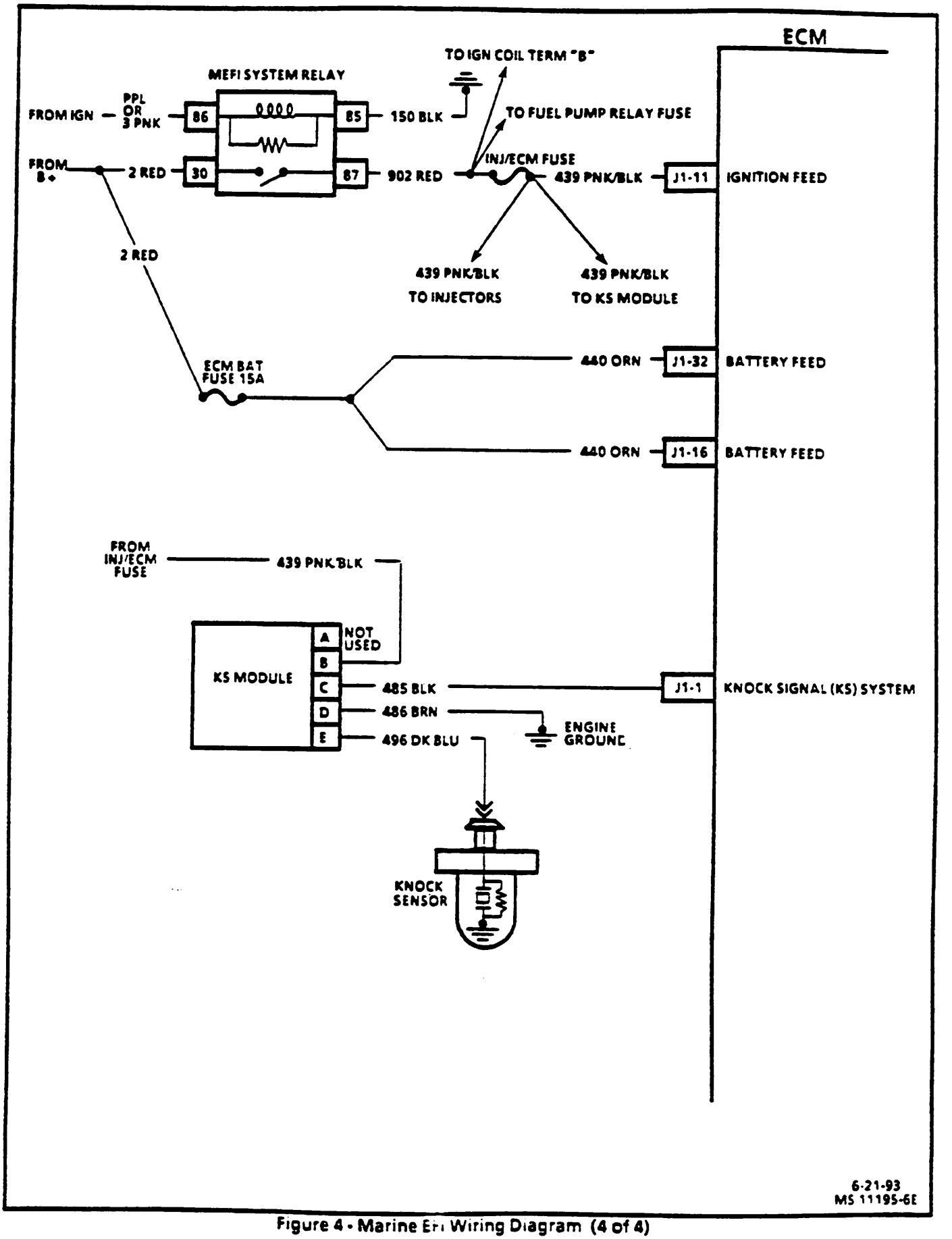
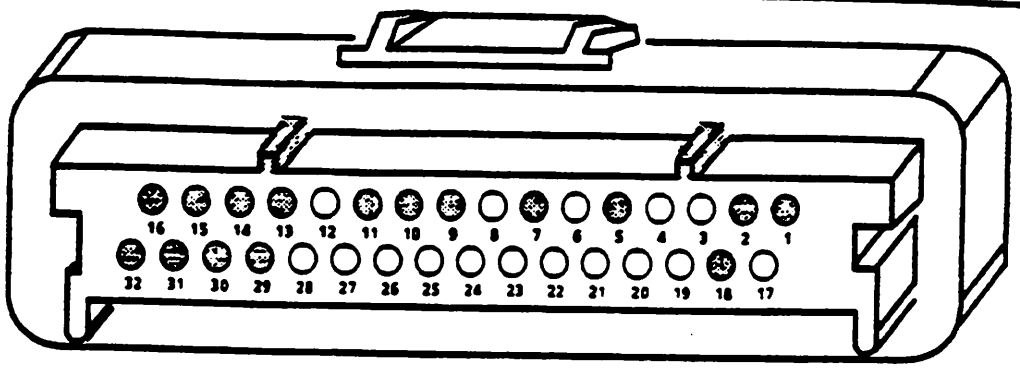


Figure 4 - Marine EFI Wiring Diagram (4 of 4)



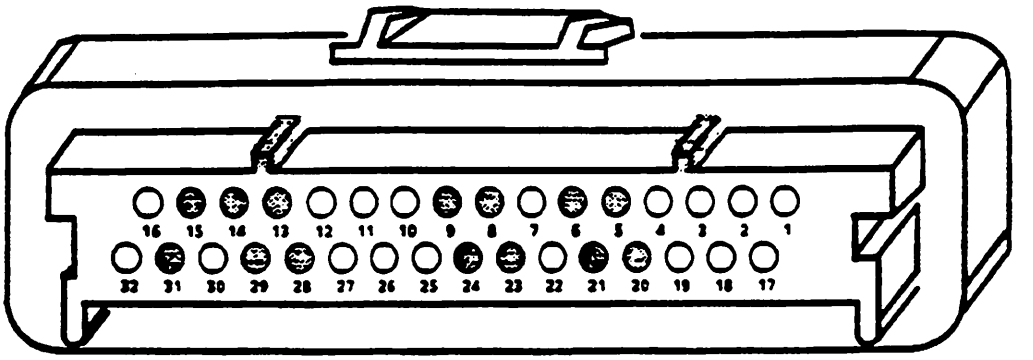
J - 1

ECM 32 WAY OUTPUT CONNECTOR

ECM PIN NUMBER	CKT (WIRE) NUMBER	CKT (WIRE) COLOR	CIRCUIT DESCRIPTION
J1 - 1	485	BLK	KNOCK SENSOR (KS) SIGNAL
J1 - 2	410	YEL	ENGINE COOLANT TEMPERATURE (ECT) SENSOR SIGNAL
J1 - 3			
J1 - 4			
J1 - 5	916	YEL	MASTER/SLAVE ECM (TWIN ENG. ONLY)
J1 - 6			
J1 - 7	451	WHT/BLK	DIAGNOSTIC "TEST" (SERVICE MODE)
J1 - 8			
J1 - 9	432	LT GRN	MAP SENSOR SIGNAL
J1 - 10	417	DK BLU	TP SENSOR SIGNAL
J1 - 11	439	PNK/BLK	IGNITION 12V
J1 - 12			
J1 - 13	813	BLK	SENSOR GROUND (TP, TRIM)
J1 - 14	450	BLK/WHT	ECM GROUND
J1 - 15	416	GRY	5 VOLT REF (TP, TRIM, SENSORS)
J1 - 16	440	ORN	BATTERY 12V
J1 - 17			
J1 - 18	461	ORN/BLK	SERIAL DATA (SCAN TOOL COMMUNICATION)
J1 - 19			
J1 - 20			
J1 - 21			
J1 - 22			
J1 - 23			
J1 - 24			
J1 - 25			
J1 - 26			
J1 - 27			
J1 - 28			
J1 - 29	814	BLK	SENSOR GROUND (MAP, ECT)
J1 - 30	450	BLK/WHT	ECM GROUND
J1 - 31	416	GRY	5 VOLT REF (MAP SENSOR)
J1 - 32	440	ORN	BATTERY 12V

4-26-93
NS 15842

Figure 5 - Component Connector Identification (1 of 2)



J-2

ECM 32-WAY OUTPUT CONNECTOR

ECM PIN NUMBER	CKT (WIRE) NUMBER	CKT (WIRE) COLOR	CIRCUIT DESCRIPTION
J2-1			
J2-2			
J2-3			
J2-4			
J2-5	468	LT GRN	INJECTOR DRIVER
J2-6	453	BLK/RED	DISTRIBUTOR REF LOW
J2-7			
J2-8	430	PPL/WHT	DISTRIBUTOR REF HIGH
J2-9	465	DK GRN/WHT	FUEL PUMP RELAY DRIVE
J2-10			
J2-11			
J2-12			
J2-13	442	BLU/BLK	IDLE AIR CONTROL (IAC) COIL "A" LOW
J2-14	443	GRN/WHT	IDLE AIR CONTROL (IAC) COIL "B" HIGH
J2-15	450	BLK/WHT	FUEL INJECTOR GROUND
J2-16			
J2-17			
J2-18			
J2-19			
J2-20	450	BLK/WHT	FUEL INJECTOR GROUND
J2-21	467	DK BLU	INJECTOR DRIVER
J2-22			
J2-23	423	WHT	IGNITION CONTROL (IC)
J2-24	424	TAN/BLK	IC BYPASS
J2-25			
J2-26			
J2-27			
J2-28	441	BLU/WHT	IDLE AIR CONTROL (IAC) COIL "A" HIGH
J2-29	444	GRN/BLK	IDLE AIR CONTROL (IAC) COIL "B" LOW
J2-30			
J2-31	419	BRN/WHT	MALFUNCTION INDICATOR LAMP (OPTIONAL)
J2-32			

5-24-93
NS 15497

Figure 6 - Component Connector Identification (2 of 2)

TYPICAL SCAN TOOL DATA DEFINITIONS

ECM DATA DESCRIPTION

A list of explanations for each data message displayed on the scan tool begins below.

This information will assist in tracking down diagnostic problems, since the displays can be viewed while the vehicle is being driven. See the "On-board Diagnostic (OBD) System Check" for additional information.

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

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

ENGINE COOLANT TEMP - Range -40° to 151°C, -40° to 304°F - The Engine Coolant Temperature (ECT) sensor is mounted in the coolant system 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 which 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.

MAP - Range 11-105 kPa/0.00-5.10 Volts - The Manifold Absolute Pressure (MAP) sensor measures the change in the intake manifold pressure which results from engine load and speed changes. As intake manifold pressure increases, the air density in the intake manifold also increases and additional fuel is required.

KNOCK RETARD - Range 0° to 45° - Indicates the amount of spark advance the ECM is removing from IC in response to the Knock Sensor (KS) signal.

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

BARO - Range 11-105 kPa/0.00-5.10 Volts - The BARO reading displayed is measured from the MAP sensor at the "ON," engine "OFF" and WOT conditions. The BARO reading displayed represents barometric pressure and is used to compensate for altitude differences.

THROT POSITION - Range 0-5.10 Volts - Used by the ECM to determine the amount of throttle demanded by the driver. Should read .36-.96 volt at idle to above 4 volts at wide open throttle.

THROTTLE ANGLE - Range 0 - 100% - Computed by the ECM from TP sensor voltage (Throttle Position) and should read 0% at idle and 100% at wide open throttle. Refer to DTC 21 if TP sensor angle is not 0% at idle.

SPARK ADVANCE - Tech 1 Range -90° to 90° - This is a display of the spark advance (IC) calculation 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, load, vehicle speed, and operating mode. There is no adjustment for spark advance.

IDLE AIR CONTROL - Range 0-255 - Displays the commanded position of the idle air control pintle in counts. The higher the number counts, the greater the idle air passages opened.

INJECTOR PULSE WIDTH - Scan Tool - Range 0.0 to 999.9 - Indicates in milliseconds the time the injectors remain "ON." When engine load is increased, injector pulse width will increase.

PROM ID - Range 0 to 99999 - The PROM identification describes the particular PROM being used in the ECM. The scan tool display number is not the service part number.

SYSTEM VOLTAGE - Range 0.0 to 25.5 Volts - This represents the system voltage measured by the ECM.

TIME FROM START - Range 0:00:00 to 18:12:15 HR/MIN/SEC - A measure of how long the engine has been running. When the engine stops, it is reset to zero.

INT AIR TEMP (IAT) - The ECM converts the resistance of the intake air temperature sensor to degrees. Intake Air Temperature (IAT) can be used by the ECM to adjust fuel delivery and spark timing according to oncoming air density

7-6-93
PS 18345

DIAGNOSTIC TROUBLE CODE (DTC) IDENTIFICATION

The Malfunction Indicator Lamp (MIL) will be "ON" if the malfunction exists under the condition 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.

NOTICE: There are time periods (instantly or up to 1 minute) that can be programmed in the ECM before the MIL comes "ON" or the DTC will set if a probable cause from below continues. In doing diagnosis for an intermittent, a wiggle of a wire or connector might not set the DTC. The times below are an example of those times and may not pertain to all engines.

DTC AND CIRCUIT	PROBABLE CAUSE
DTC 14 - Engine Coolant temperature (ECT) Sensor Circuit. High or low temperature indicated.	Sets if the sensor signal line becomes grounded or connections or wires opened for 3 seconds.
DTC 21 - Throttle Position (TP) Sensor Circuit. Signal too low or too high.	TP signal inconsistent with RPM and MAP, or a shorted to ground or opened signal circuit.
DTC 23 - Intake Air Temperature (IAT) Sensor Circuit. High or low temperature indicated.	Sets if the sensor, connection, or wires open or shorted to ground for 3 seconds.
DTC 33 - Manifold Absolute Pressure (MAP) Sensor Circuit. Signal voltage too high or too low..	MAP sensor output too high for 3 seconds or an open signal circuit, or low or no output from sensor with engine running, MAP inconsistent to RPM and throttle position.
DTC 42 - Ignition Control (IC) System. IC not receiving correct voltage.	ECM has seen an opened or grounded IC or bypass circuit.
DTC 43 - Knock Sensor (KS) Circuit. High volts or low volt signal indicated.	KS circuit has been opened or grounded for 58 seconds.
DTC 51 - Fault EEPROM	Faulty EEPROM or ECM.

CLEARING DIAGNOSTIC TROUBLE CODES (NON-SCAN)

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

NOTICE: When clearing DTCs with or without the use of a scan tool, the battery must be fully charged and cranking speed must be at least 200 RPM. The ability to clear DTCs is directly dependent on battery being fully charged and able to crank engine with adequate cranking RPM.

7-6-93
PS 18408

MEFI ON-BOARD DIAGNOSTIC (OBD) SYSTEM CHECK

On-Board Diagnostic (OBD) System Check is an organized approach to identifying a problem created by an electronic engine control system malfunction. It must be the starting point for any driveability complaint diagnosis, because it directs the service technician to the next logical step in diagnosing the complaint.

The scan tool data listed in the table may be used for comparison, after completing the OBD system check and finding the on-board diagnostics functioning properly and no diagnostic trouble codes displayed. The "Typical Values" are an average of display values recorded from normally operating vehicles and are intended to represent what a normally functioning system would typically display.

A SCAN TOOL THAT DISPLAYS FAULTY DATA SHOULD NOT BE USED, AND THE PROBLEM SHOULD BE REPORTED TO THE MANUFACTURER. THE USE OF A FAULTY SCAN CAN RESULT IN MISDIAGNOSIS AND UNNECESSARY PARTS REPLACEMENT.

Only the parameters listed below are used in this manual for diagnosing. If a scan reads other parameters, the values are not recommended for use in diagnosing. If all values are within the range illustrated, refer to "Symptom Section."

SCAN TOOL DATA

Idle / Warm Engine / Closed Throttle / Neutral

Scan Position	Units Displayed	Typical Data Value
Engine Speed Desired Idle	RPM RPM	550-600 RPM 550-600 RPM
Coolant Temp. Manifold Air Temp.	C° F° C° F°	65 - 75°C N/A (For TBI)
MAP Baro	kPa, V kPa, V	1 - 3 Volts (Depends on Vacuum and Baro Pressure) 3 - 5 Volts (Depends on Altitude and Baro Pressure)
Throt Position Throttle Angle	Volts 0-100%	.5 - .1Volt 0 - 1%
Fuel Consumption Inj. Pulse Width	GPH mSec.	1.0 GPH 1.7 - 2.5 mSec.
Spark Advance ESC Enabled	# of Degrees No/Yes	6 - 26° Yes
Knock Retard Knock Signal	Degrees of Retard No/Yes	0° No
Idle Air Control Min IAC Position	Counts (Steps) Counts (Steps)	0 - 60 0 - 60
*Trim Sensor Batt/IGN Volts	Volts Volts	0.00 Volts 12.0 - 14.5 Volts
Malfunction Indicator Lamp Fuel Pump Relay	Off/On Off/On	Off On
RPM Reduction Engine Speed	No/Yes RPM	No 550 - 600 RPM
Overheat Detected Lo Oil Pressure Sw.	No/Yes OK/Low Pressure	No OK
Lo Oil Level Sw. Lo Water Flow Sw.	OK/Low OK/Low Flow	OK OK
Trans Temp Sw. I/O Fluid Level	OK/Hot OK/Low	OK OK
Emerg. Stop Mode Over Trim Detect	No/Yes No/Yes	No No
ECM Master/SLV Eng. Hour Meter	Slave/Master XX Hrs XX Min	Master (Usable For Twin Engine Diagnosis) (Dependent on Engine Run Time)
Fuel System Config. Time From Start	PFI/TBI 0:00 - 1092.00 Hrs	TBI 00:00 HR:MIN (Dependent on Engine Run Time)

* Not Available For 1993 Applications.

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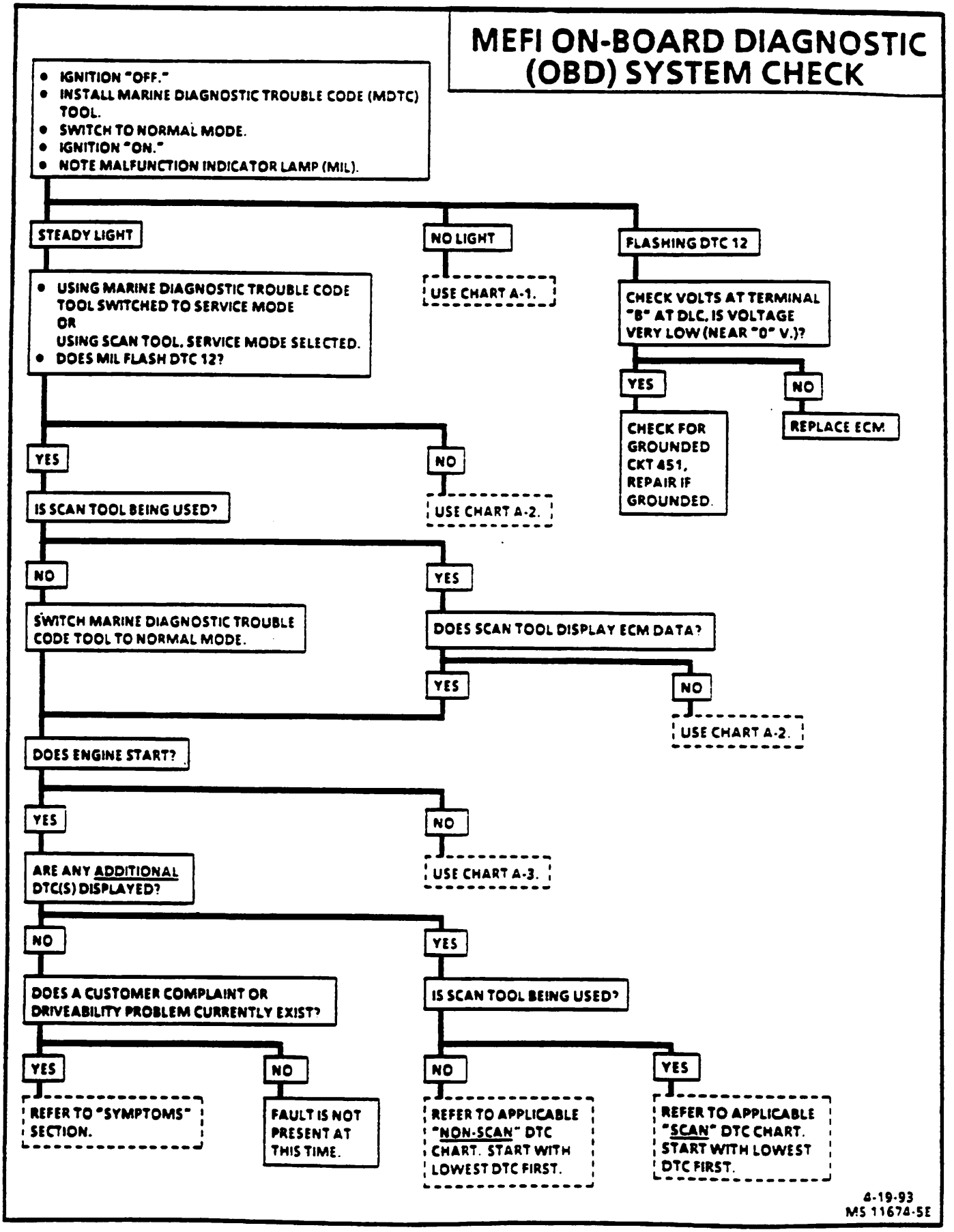
NS 15870

MEFI ON-BOARD DIAGNOSTIC (OBD) SYSTEM CHECK



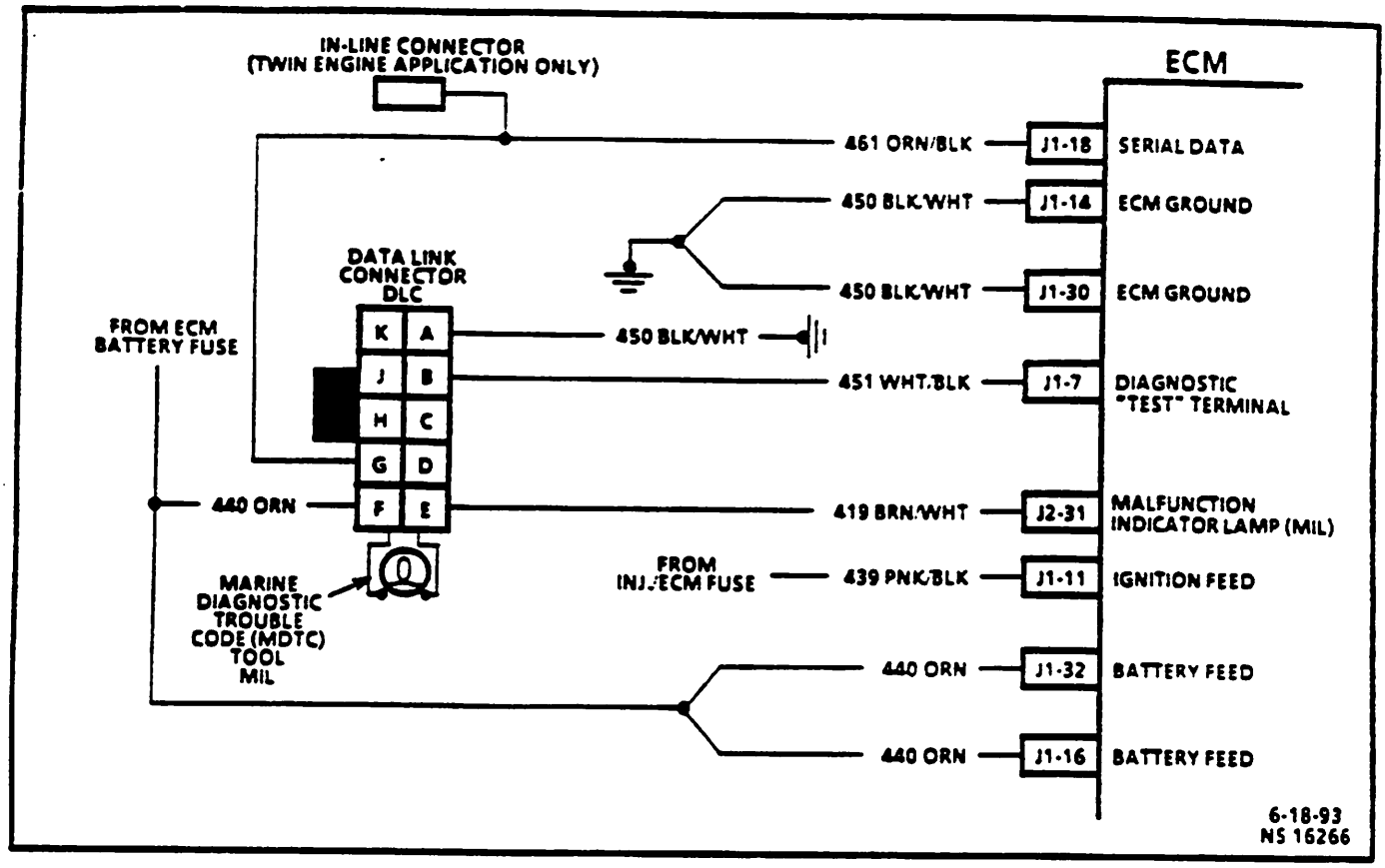


CHART A-1

NO MALFUNCTION INDICATOR LAMP (MIL)
[MARINE DIAGNOSTIC TROUBLE CODE (MDTC) TOOL INSTALLED]

Circuit Description:

When the Marine Diagnostic Trouble Code (MDTC) tool is installed, it plugs into the DLC terminals "F" and "E". It receives voltage through CKT 440 terminal "F". Terminal "E" is ground through CKT 419 from the ECM terminal "J2-31". There should always be a steady Malfunction Indicator Lamp (MIL) when the ignition is "ON" and engine not running. The ECM will control the light and turn it "ON" by providing ground.

Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. This step insures that battery voltage is available to terminal "F" of the DLC and to supply voltage to the ECM.
2. This step checks for ground present in DLC terminal "E". This indicates that the ECM is capable of completing the ground to the MIL light.
3. This step isolates the cause of incomplete ground to either a wiring or ECM circuitry.

Diagnostic Aids: Engine runs OK, check:

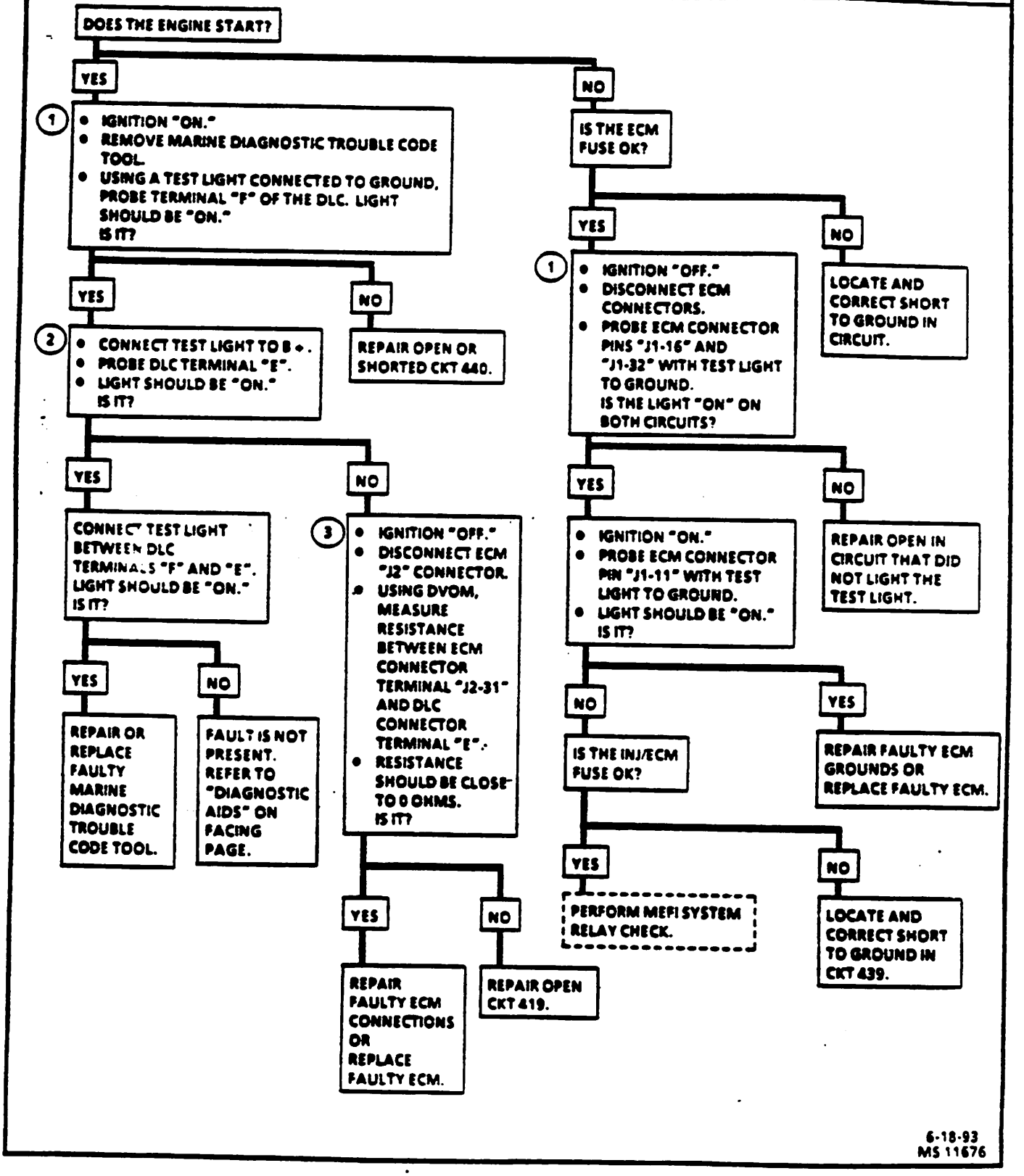
- Faulty light bulb.
- CKT 419 open.

Engine cranks but will not run, check:

- Continuous battery - fusible link open.
- ECM fuse open.
- Battery circuit to ECM open.
- Ignition circuit to ECM open.
- Poor connection to ECM.
- Faulty ECM ground circuit(s).
- Perform MEFI system relay check.

CHART A-1

NO MALFUNCTION INDICATOR LAMP (MIL)
[MARINE DIAGNOSTIC CODE TOOL (MDTC) INSTALLED]



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MS 11676

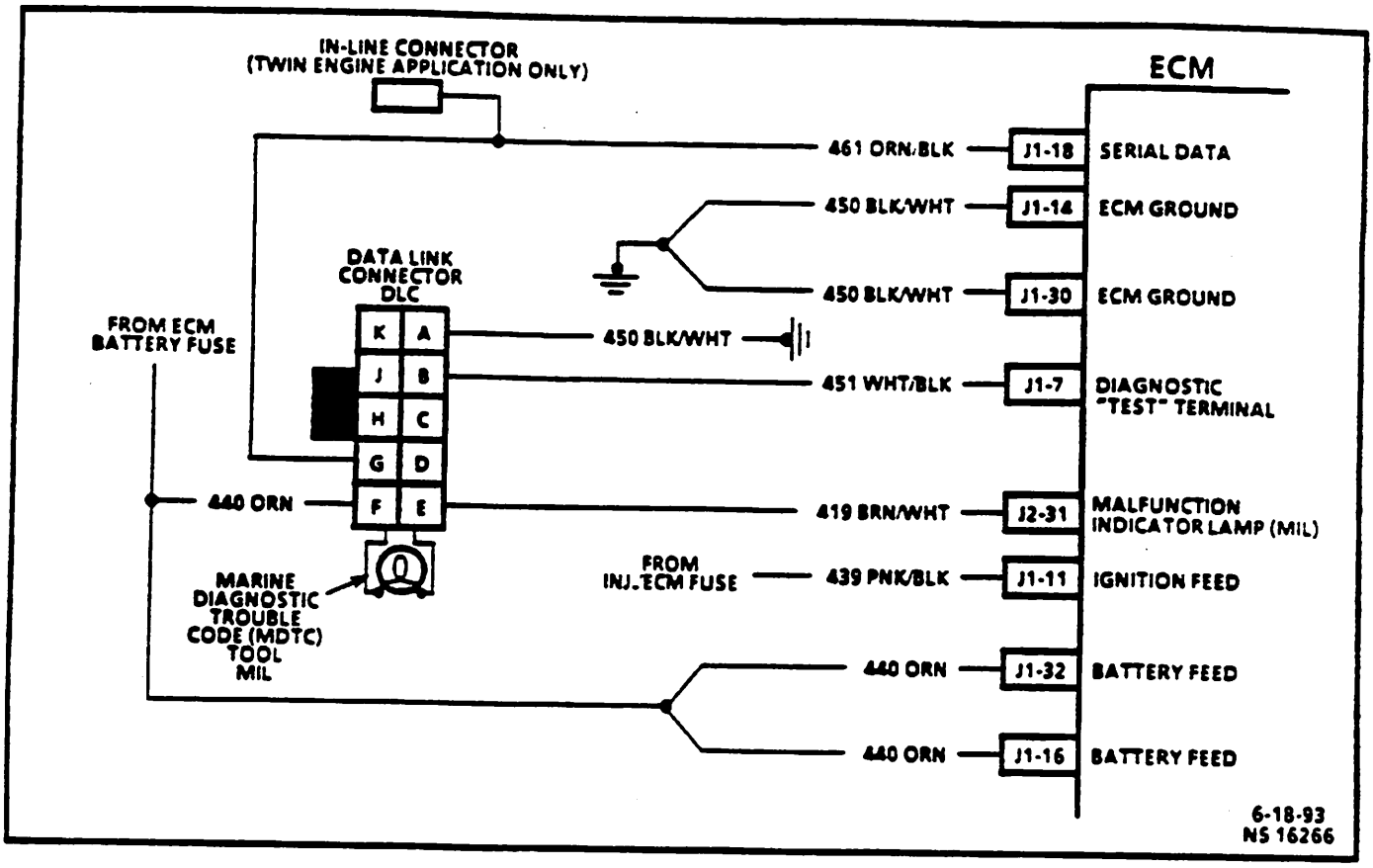


CHART A-2

NO DLC DATA OR WILL NOT FLASH DTC 12 MALFUNCTION INDICATOR LAMP (MIL) "ON" STEADY [MARINE DIAGNOSTIC TROUBLE CODE (MDTC) TOOL INSTALLED]

Circuit Description:

When the Marine Diagnostic Trouble Code (MDTC) tool is installed, it plugs into the Data Link Connector (DLC) terminals "F" and "E". It receives voltage through CKT 440 terminal "F". Terminal "E" is ground through CKT 419 from the ECM terminal "J2-31". There should always be a steady Malfunction Indicator Lamp (MIL) when the ignition is "ON" and engine not running. The ECM will control the light and turn it "ON" by providing ground.

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 DLC.

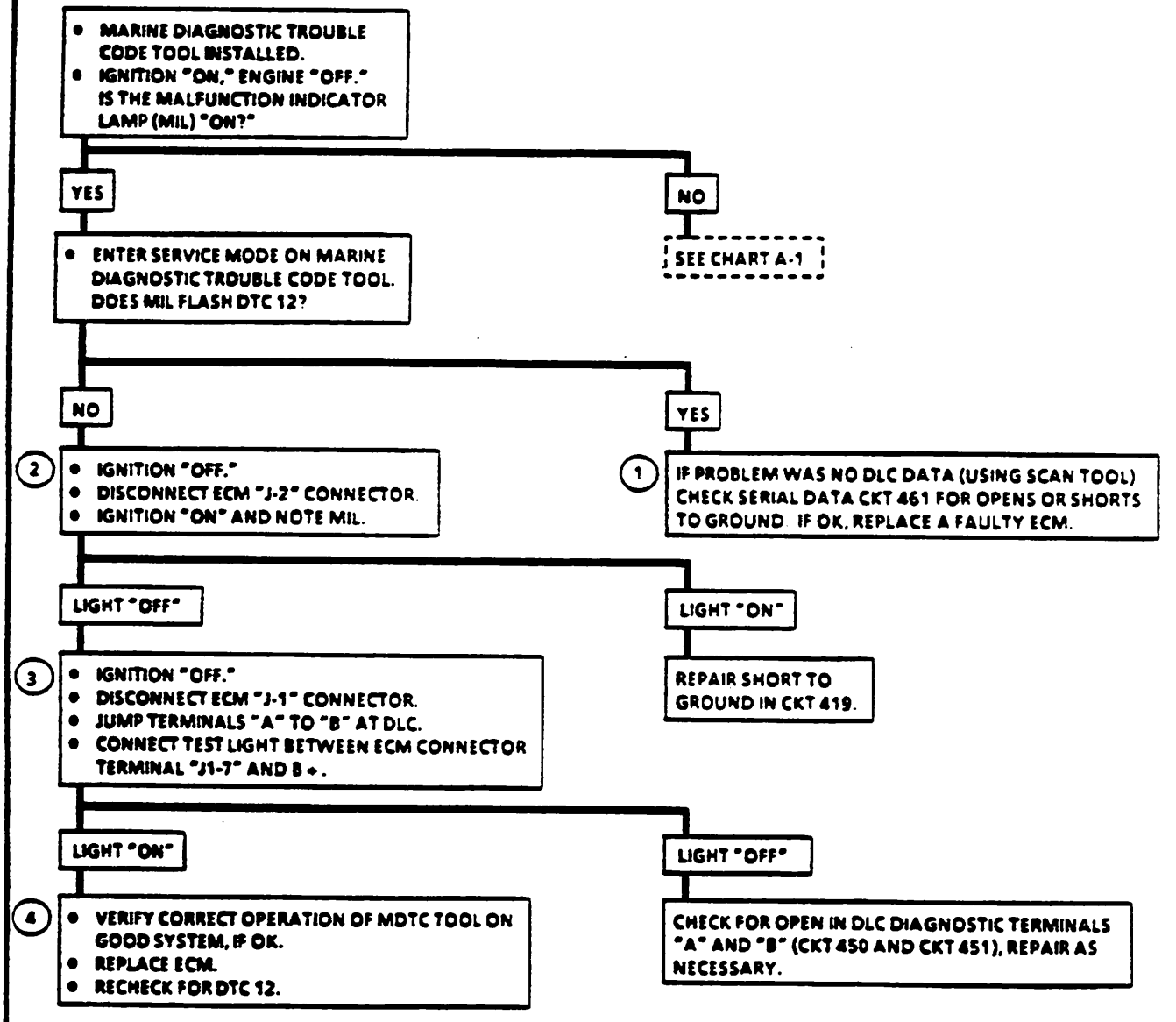
Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. 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 CKT 451 for short to ground. If DTC 12 does flash, make sure that the scan tool is working properly on another vehicle.
2. If the light goes "OFF," when the ECM connector is disconnected, CKT 419 is not shorted to ground.
3. This step will check for an open diagnostic CKT 451.
4. At this point, the MIL wiring is OK. If DTC 12 does not flash, the ECM should be replaced.

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

CHART A-2

NO DLC DATA OR WILL NOT FLASH DTC 12 MALFUNCTION INDICATOR LAMP (MIL) "ON" STEADY
[MARINE DIAGNOSTIC TROUBLE CODE (MDTC) TOOL INSTALLED]



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION.

7-6-93
MS 11677

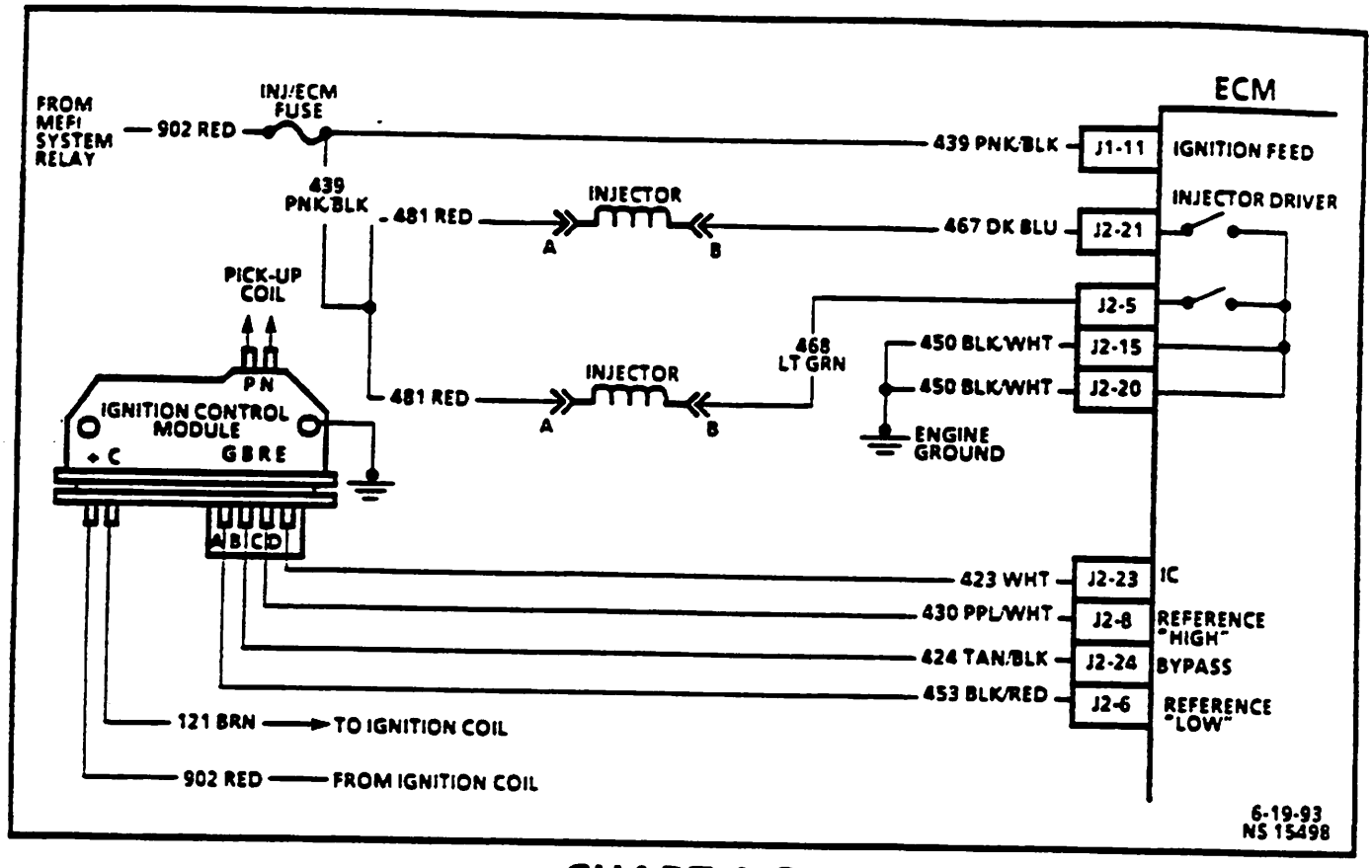


CHART A-3

(Page 1 of 2)
ENGINE CRANKS BUT WILL NOT RUN

Circuit Description:

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

After supply voltage passes through the Injector ECM fuse it branches out into two separate CKTs 439. One is the supply voltage for injector harness CKT 481 and the other goes to ECM terminal J1-11. The ECM will control the opening and closing of the injectors through injector driver CKT 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 the 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 Chart A-6 Distributor Ignition System Check.

Chart Test Description:

Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. A ECT that indicates coolant temperature less than actual temperature can flood the engine with fuel. A ECT that indicates coolant temperature greater than actual can starve the engine of fuel. The engine will not start without reference pulses and, therefore, the scan tool should read engine RPM (reference) during cranking.
2. No spark may be caused by one of several components related to the Distributor Ignition (DI) system. The ignition system will address all problems related to the causes of a no spark condition.
3. This test will determine if there is fuel pressure at the injectors and that the injectors are operating.

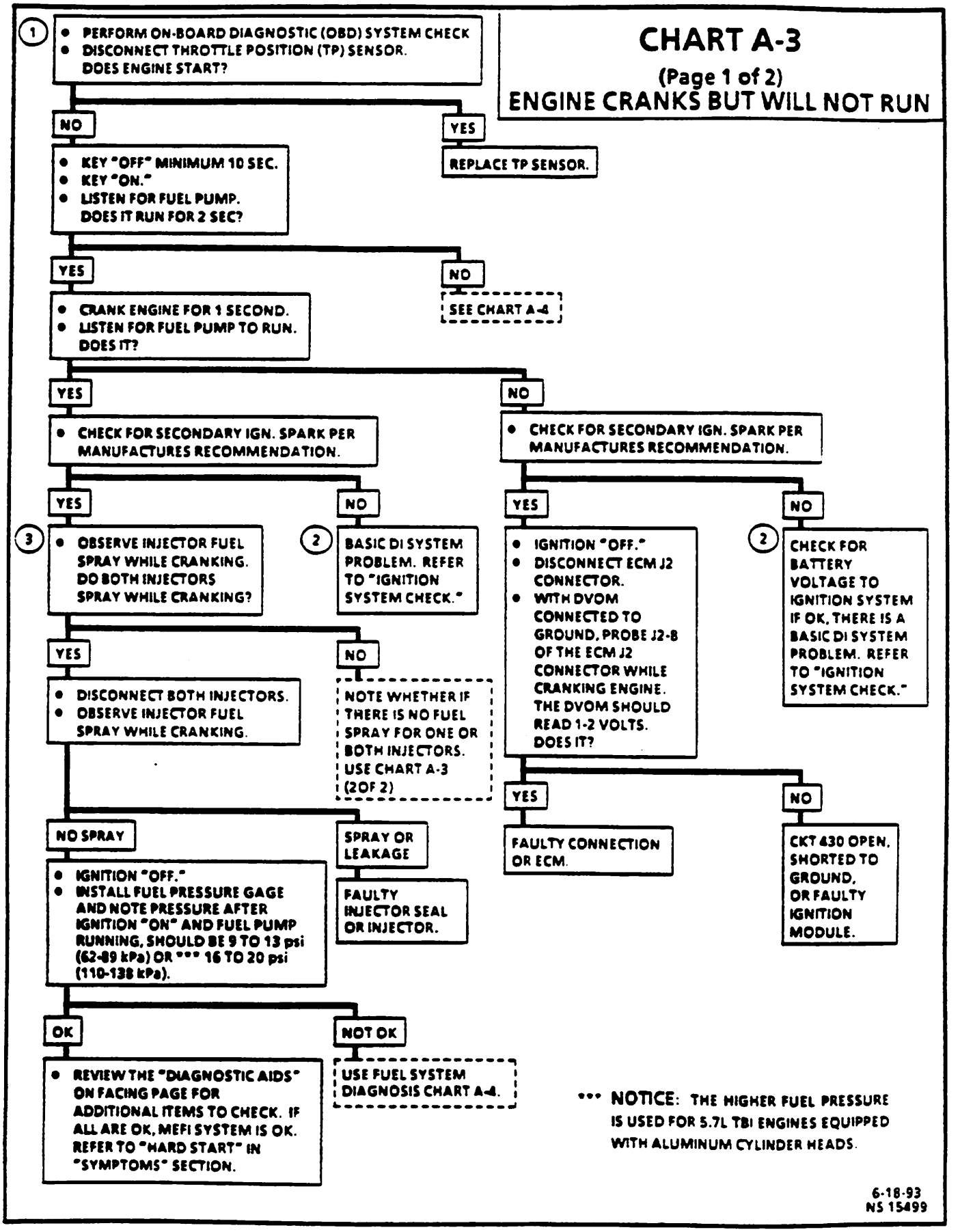
Diagnostic Aids:

- This chart assumes that battery condition and engine cranking speed are OK, and there is adequate fuel in the tank.
- Unless engine enters "Clear Flood" at the first indication of a flooding condition, it can result in a no start.
- Check for fouled plugs.
- Water or foreign material in fuel line can cause a no start in cold weather.
- A defective MAP sensor may cause a no start or a stall after start. To determine if the sensor is causing the problem, disconnect it. The ECM will then use a default value for the sensor, and if the condition is corrected and the connections are OK, replace the sensor.
- Check for blinking light at injector harness on both injectors. If not OK, check injector fuse.
- If above are all OK, refer to "Symptom" section.

CHART A-3

(Page 1 of 2)

ENGINE CRANKS BUT WILL NOT RUN



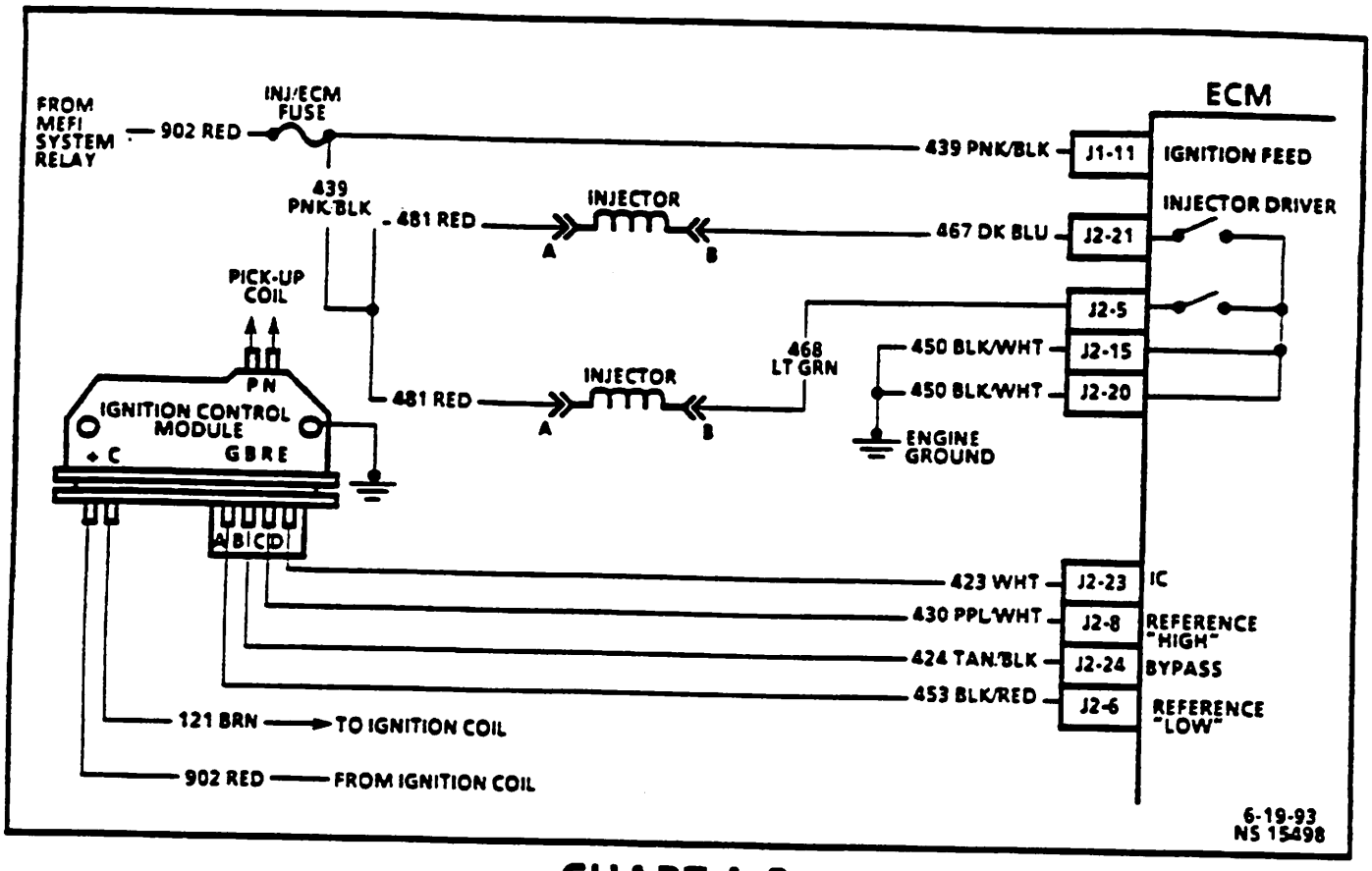


CHART A-3

(Page 2 of 2)
ENGINE CRANKS BUT WILL NOT RUN

Circuit Description:
Same as on Page 1 of Engine cranks but will not run.

Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

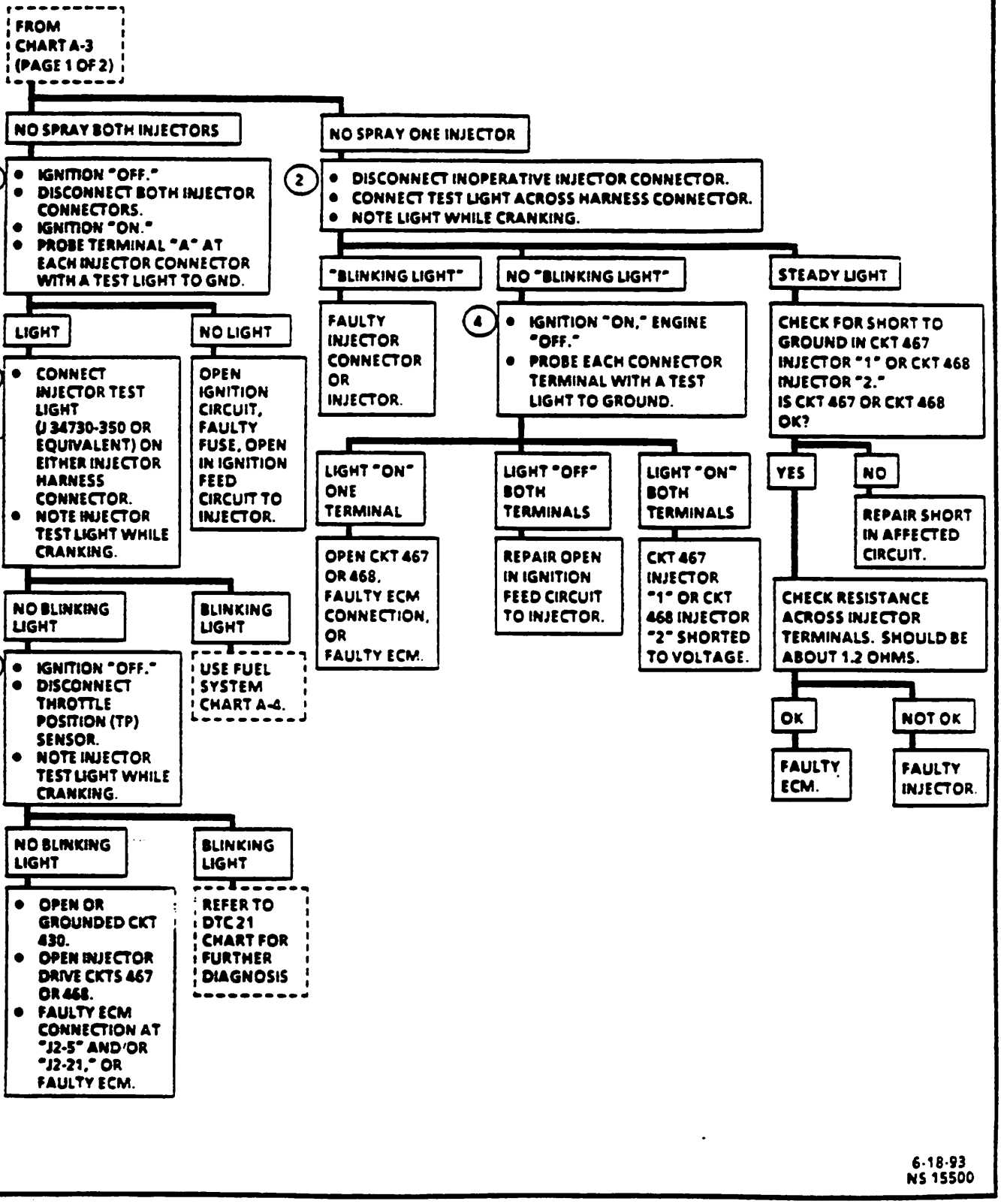
1. Checks for 12 volt supply to injectors. Due to the injectors wired in parallel, there should be a light "ON" on both terminals.
2. Checks continuity of CKT 467 and CKT 468.
3. All checks made to this point would indicate that the ECM is a fault. However, there is a possibility of CKT 467 and CKT 468 being shorted to a voltage source either in the engine harness or in the injector harness. To Test for this Condition:
   - Disconnect all injectors.
   - Ignition "ON."
   - Probe CKT 467 and CKT 468 on the ECM side of injector harness with a test light connected to ground. There should be no light. If light is "ON," repair short to voltage.
   - If OK, check the resistance of the injectors. Should be 1.26 ohms ± .1, but can be higher with warm engine.
   - Check injector harness connector. Be sure terminals are not backed out of connector and contacting each other.
4. CKT 481 supplies ignition voltage to the injectors. Probe each connector terminal with a test light to ground. There should be a light "ON" at one terminal of each connector. If the test light confirms ignition voltage at the connector, the ECM injector control 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.
5. If the ECM is seeing a high TP sensor voltage it may be in the clear flood mode. Disconnecting the TP sensor will allow the ECM to use a default value and turn the injectors "ON."

Diagnostic Aids: This chart assumes that battery condition and engine cranking speed are ok, and there is adequate fuel in the tank.

CHART A-3

(Page 2 of 2)

ENGINE CRANKS BUT WILL NOT RUN



6-18-93
NS 15500

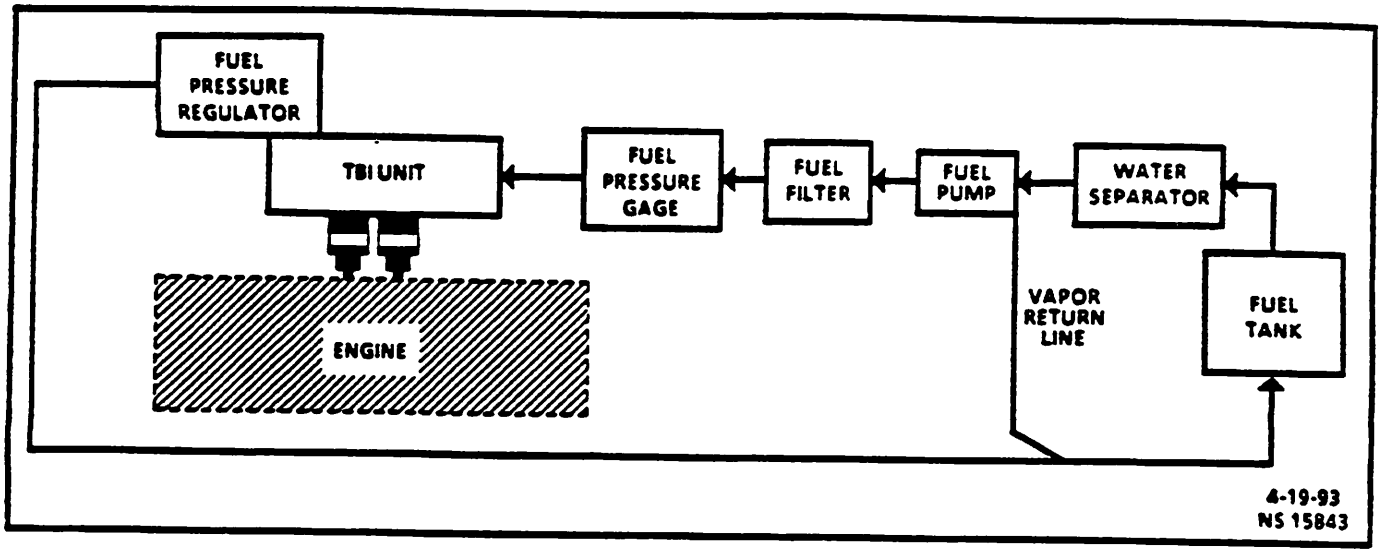


CHART A-4

(Page 1 of 2)
FUEL SYSTEM DIAGNOSIS

Circuit Description:

When the ignition is turned "ON," the Engine Control Module (ECM) will turn the fuel pump "ON" for 2 seconds. During engine cranking, the ECM will turn "ON" the fuel pump. It will remain "ON" as long as the engine is cranking or running, and the ECM is receiving 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 62 to 90 kPa (9 to 13 psi) or 110 to 138 kPa (16 to 20 psi). Excess fuel is then returned to the fuel tank.

Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. Wrap a shop towel around the fuel pressure connector to absorb any small amount of fuel leakage that may occur when installing the gage. Ignition "ON," pump pressure should be 62-90 kPa (9-13 psi) for 5.0L and 5.7L TBI engines equipped with cast iron cylinder heads or 110-138 kPa (16-20 psi) for 5.7L TBI engines equipped with aluminum cylinder heads. This pressure is controlled by spring pressure within the regulator assembly.
2. Pressure less than 62 kPa (9 psi), or 110 kPa (16 psi) falls into two areas:
   - Regulated pressure less than 62 kPa (9 psi), or 110 kPa (16 psi). The system will be running lean. Also, hard starting when cold and overall poor performance will be noticed.
   - Restricted flow causing pressure drop. Normally, a vehicle with a fuel pressure of less than 62 kPa (9 psi), at idle will not be drivable. However, if the pressure drop occurs only while driving, the engine will surge then stop running as pressure begins to drop rapidly. This is most likely caused by a restricted fuel line or plugged filter.
3. Turning the fuel pump "ON" and restricting fuel flow at the fuel pressure gage will determine if the fuel pump can supply enough fuel pressure to the injector to operate properly, above 62 kPa (9 psi), or 110 kPa (16 psi).

   NOTICE: Do not restrict the fuel return line as this may damage the fuel pressure regulator.

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

CHART A-4
(Page 1 of 2)
FUEL SYSTEM DIAGNOSIS

FROM CHART A-3 PAGE 1

1
- IGNITION "OFF."
- INSTALL FUEL PRESSURE GAGE J 29658-D OR EQUIVALENT.
- IGNITION "ON." FUEL PUMP WILL RUN FOR ABOUT 2 SECONDS.
- NOTE FUEL PRESSURE WITH PUMP RUNNING SHOULD BE 62-90 kPa (9-13 psi) OR * 16 TO 20 psi (110-138 kPa).

NOT OK

OK

NO TROUBLE FOUND. REVIEW "SYMPTOM" SECTION.

2 HAS PRESSURE BUT LESS THAN 62 kPa (9 psi) OR * 110 kPa (16 psi).

CHECK FOR RESTRICTED FUEL LINES OR IN-LINE FILTER.

OK

NOT OK

REPLACE FILTER OR REPAIR FUEL LINE AND RECHECK.

3
- IGNITION "OFF."
- DISCONNECT FUEL PUMP RELAY.
- APPLY BATTERY VOLTAGE TO FUEL PUMP RELAY CONNECTOR CAVITY "87" USING A 10 AMP FUSED JUMPER WIRE.
- GRADUALLY PINCH PRESSURE GAGE OUTLET HOSE AND NOTE PRESSURE.

PRESSURE ABOVE 90 kPa (13 psi) OR *138 kPa (20 psi).

IF LINES ARE OK, REPLACE FUEL METER COVER WHICH INCLUDES PRESSURE REGULATOR.

PRESSURE LESS THAN 62 kPa (9 psi) OR * 110 kPa (16 psi).

- CHECK:
  - FUEL PUMP FOR BEING FAULTY OR INCORRECT PART.
  - PARTIALLY DISCONNECTED PUMP COUPLING HOSE.

HAS PRESSURE ABOVE 90 kPa (13 psi) OR * 138 kPa (20 psi).

4
- DISCONNECT FUEL RETURN LINE.
- FOLLOWING MANUFACTURER'S INSTRUCTIONS, ATTACH HOSE TO PRESSURE REGULATOR SIDE OF RETURN LINE. INSERT THE OTHER END IN AN APPROVED GASOLINE CONTAINER. NOTE FUEL PRESSURE WITHIN 2 SECONDS AFTER IGNITION IS TURNED "ON."

ABOVE 90 kPa (13 psi) OR * 138 kPa (20 psi).

CHECK FOR RESTRICTED FUEL RETURN LINE FROM FUEL PRESSURE REGULATOR TO POINT WHERE FUEL LINE WAS DISCONNECTED.

IF LINE OK REPLACE FUEL METER COVER WHICH INCLUDES PRESSURE REGULATOR.

62-90 kPa (9-13psi) OR * 110 TO 138 kPa (16-20 psi).

LOCATE AND CORRECT RESTRICTED FUEL RETURN LINE TO FUEL TANK.

NO PRESSURE

SEE CHART A-4 (2 OF 2)

* NOTICE: THE HIGHER FUEL PRESSURE IS USED FOR 5.7L TBI ENGINES EQUIPPED WITH ALUMINUM CYLINDER HEADS.

6-18-93
NS 15501

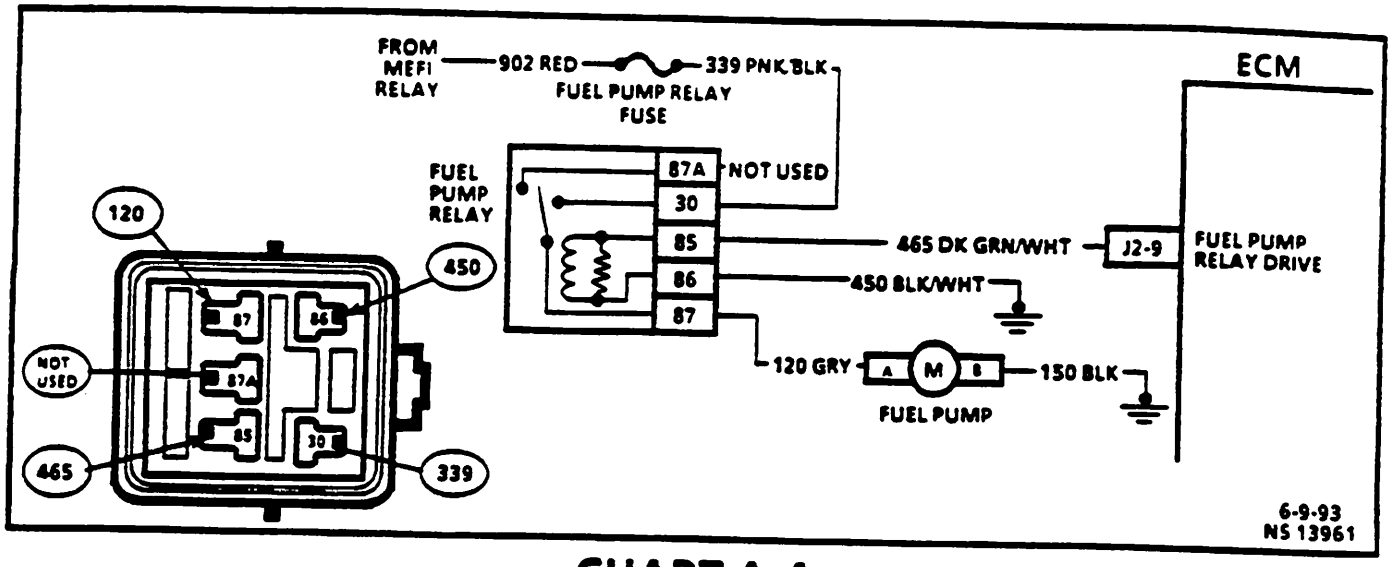


CHART A-4

(Page 2 of 2)
FUEL SYSTEM DIAGNOSIS

Circuit Description:

The fuel system circuit receives a supply voltage from MEFI relay system CKT 902. The fuel system circuit is protected by a 15 amp fuse. After the fuse, supply voltage is delivered by CKT 339 to fuel pump relay terminal "30". During key "ON" for 2 seconds or when reference pulses (engine cranked or running) are received to the ECM, the ECM will turn "ON" CKT 465. If there are no reference pulses, the ECM will shut "OFF" the fuel pump. CKT 465 is the circuit that energizes the coil in fuel pump relay and closes the contacts. When the fuel pump relay contacts are closed, supply voltage passes through the relay to terminal "87". From terminal "87", supply voltage is delivered to fuel pump throgh CKT 120. The fuel pump is grounded through CKT 150.

Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. This step checks if there is power to the fuel pump relay.
2. 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 circiut.
3. This step checks if there is an open in the ground circuit.
4. This step checks if the ECM is functioning properly.

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

CHART A-4

(Page 2 of 2)

FUEL SYSTEM DIAGNOSIS

FROM CHART A-4 (1 OF 2)

1
- IGNITION "OFF."
- REMOVE FUEL PUMP RELAY.
- IGNITION "ON."
- WITH TEST LIGHT CONNECTED TO GROUND, PROBE FUEL PUMP RELAY CONNECTOR CAVITY "30." TEST LIGHT SHOULD BE "ON," IS IT?

YES

2
- IGNITION "OFF."
- USING JUMPER WIRE, CONNECT TERMINALS "30" AND "87" OF FUEL PUMP RELAY CONNECTOR TOGETHER.
- IGNITION "ON."
- FUEL PUMP SHOULD RUN, DOES IT?

YES

3.
- IGNITION "OFF."
- DISCONNECT JUMPER WIRE.
- CONNECT TEST LIGHT TO B+ AND PROBE CAVITY "86" OF THE FUEL PUMP RELAY CONNECTOR.
- LIGHT SHOULD BE "ON," IS IT?

YES

4
- CONNECT TEST LIGHT TO GROUND AND PROBE CAVITY "85" OF THE FUEL PUMP RELAY CONNECTOR.
- IGNITION "ON."
- TEST LIGHT SHOULD BE "ON" FOR 2 SECONDS AND THEN GO "OFF," DOES IT?

YES

- REPLACE FUEL PUMP RELAY AND RETEST. IF STILL NO PRESSURE, CHECK THE FOLLOWING:
- PLUGGED IN-LINE FILTER.
- VAPOR LOCK CONDITION.
- RESTRICTED FUEL LINE.
- DISCONNECTED HOSES.
- PROPER FUEL LEVEL. IF OK, REPLACE FUEL PUMP.

NO

- CHECK FUEL PUMP RELAY FUSE, IS IT OK?

YES

REPAIR OPEN CKT 339 OR 902.

NO

- CHECK FOR SHORT TO GROUND IN CKT 339 OR CKT 120.
- CHECK FOR FUEL TANK OR LINES FOR CONTAMINATION. IF OK, REPLACE FUEL PUMP AND FUSE.

NO

CHECK FOR:
- OPEN WIRE IN CKT 120.
- OPEN PUMP GROUND CKT 150 IF OK, REPLACE FUEL PUMP.

NO

REPAIR OPEN GROUND CKT 450

NO

CHECK FOR OPEN IN CKT 465 OR FAULTY CONNECTION AT "J2-9".

YES

REPAIR OPEN IN CKT 465 OR FAULTY CONNECTION "J2-9".

NO

REPLACE FAULTY ECM.

6-18-93
NS 15502

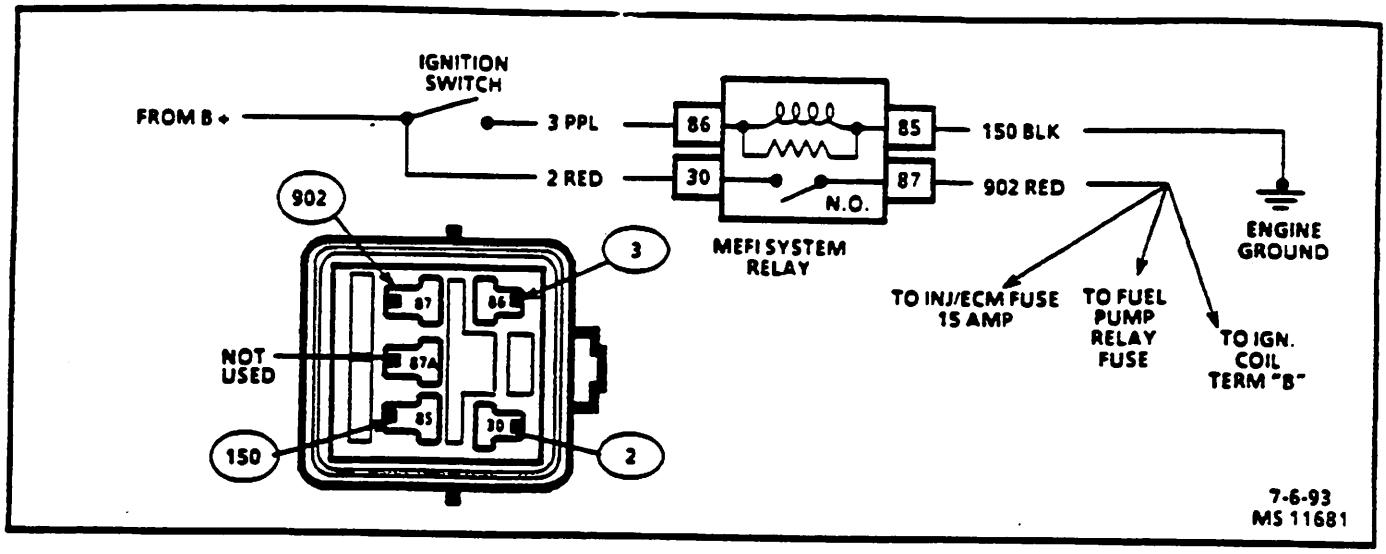


CHART A-5

MEFI SYSTEM RELAY CHECK

Circuit Description:

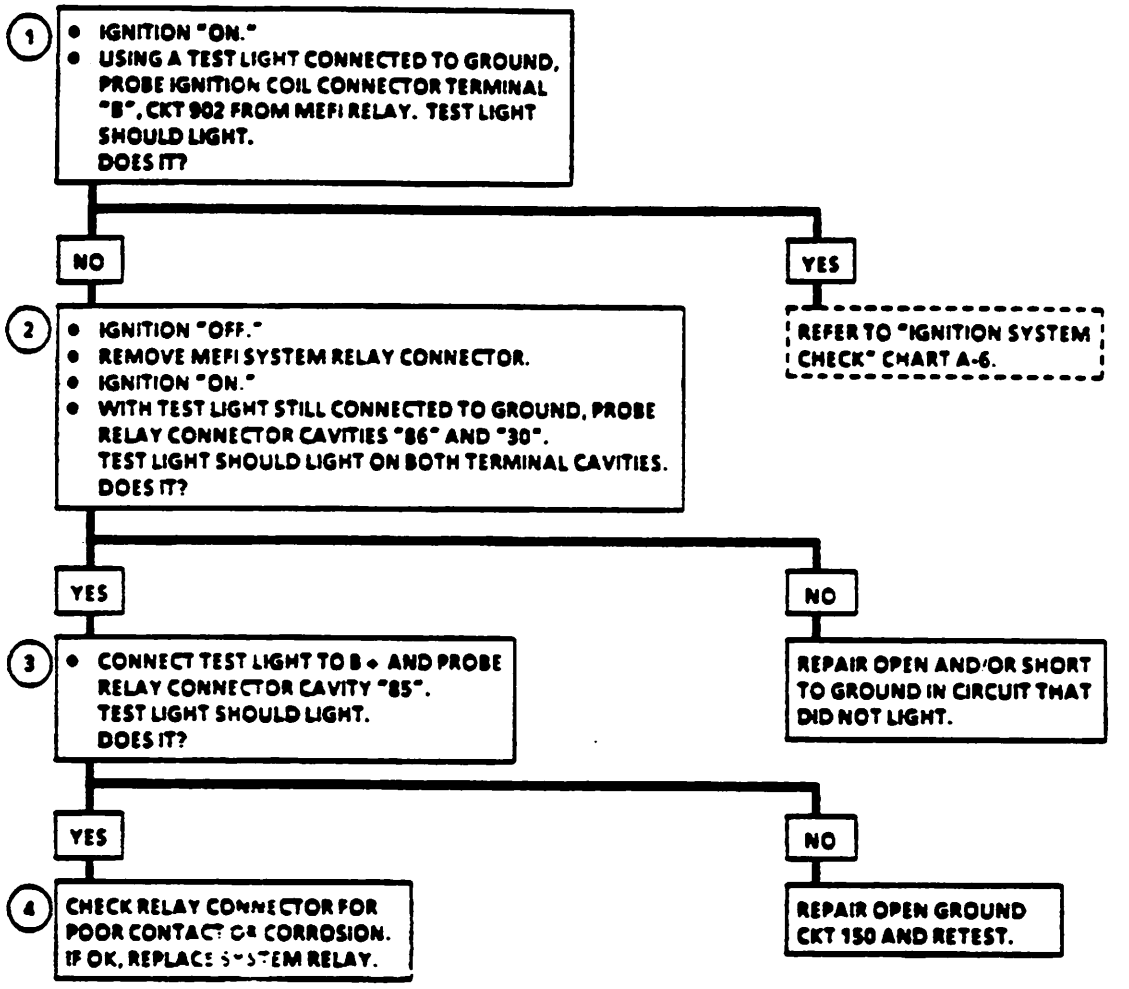
Battery voltage is constantly supplied to terminal "30" of the system relay. When the ignition switch is moved to the run position, battery voltage is supplied to terminal "86" of the system relay. The pull-in coil is then energized creating a magnetic field which closes the contacts of the system relay.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

Chart Test Description:

Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. This step identifies if the relay is functioning properly. If a fault in the relay circiut were present, voltage would not be available at terminal "B" of ignition coil.
2. This step insures that battery and ignition voltage are available at the relay. An open or shorted condition in either supply would cause the relay not to operate.
3. This step insures that a good ground exists to terminal "85" of the system relay. An open ground to this terminal would not allow current to flow through the pull-in coil.
4. At this point, the circuits leading to the relay have been checked, and a careful visual inspection of the relay terminals should be performed prior to replacement of the system relay.

CHART A-5
MEFI SYSTEM RELAY CHECK



6-18-93
PS 17911

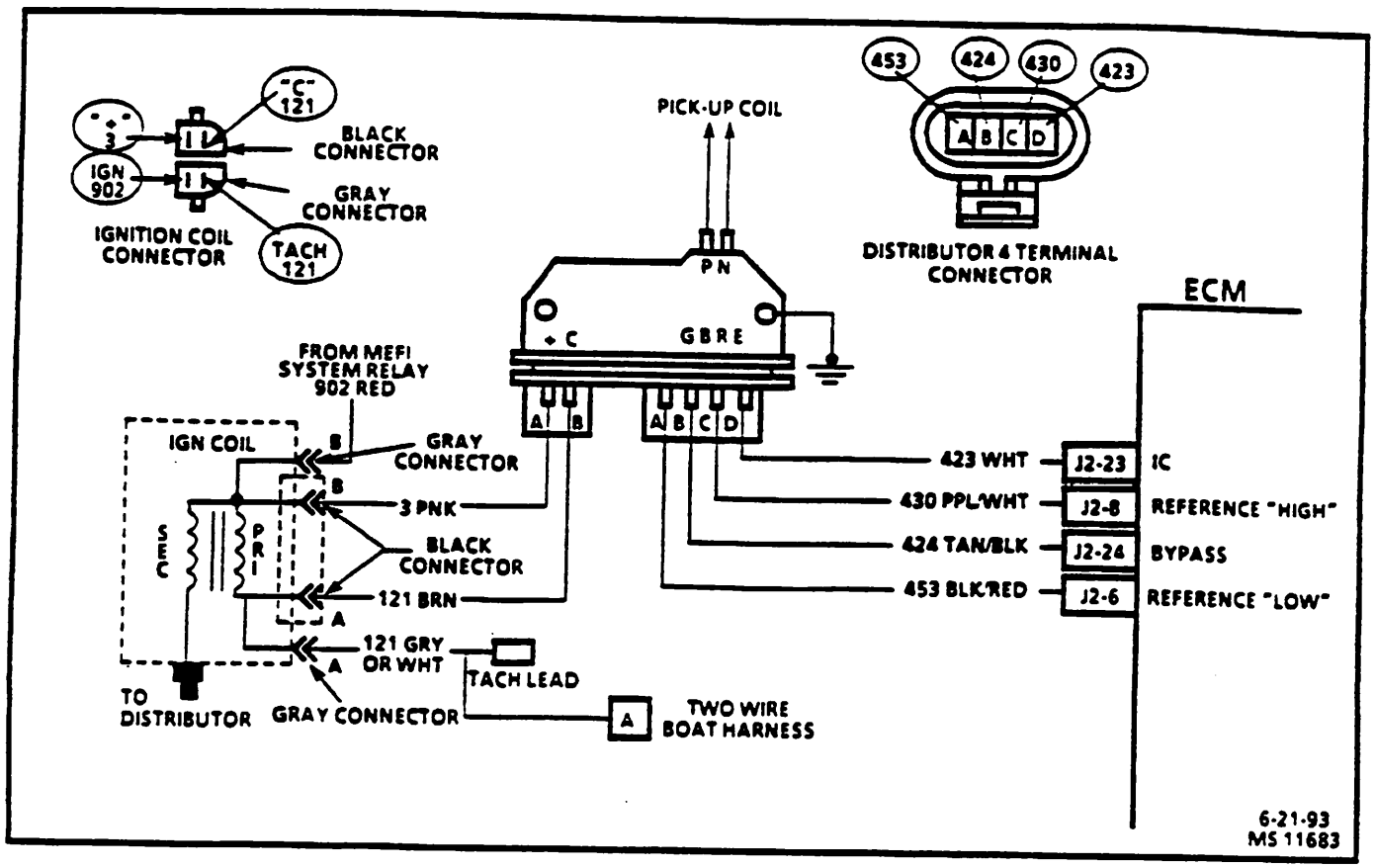


CHART A-6

(Page 1 of 2)
DISTRIBUTOR IGNITION SYSTEM CHECK

Circuit Description:

The Distributor Ignition (DI) System receives supply voltage from the MEFI relay through CKT 902 to the ignition coil gray connector "B". Inside the ignition coil, the gray connector terminal "B" is connected to 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. Once voltage is received at the IC module it is processed, switched to go to the ECM and back to the ignition coil by a transistorized relay and switches inside the IC module.

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 running or cranking mode, and adjust the timing accordingly. The voltages or signals are sent between ECM and IC module through CKTs 423, 430, and 424. CKT 453 is a balance or 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 and secondary spark is produced and sent to the distributor by a high tension lead.

Chart Test Description:

Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. Two wires are checked, to ensure that an open is not present in a spark plug wire.
2. A spark indicates the problem must be the distributor cap, rotor, or coil output wire.
3. Normally, there should be battery voltage at the "C" and "+" terminals. Low voltage would indicated an open or a high resistance circuit from the distributor to the coil or ignition switch. If "C" terminal voltage was low, but "+" terminal voltage is 10 volts or more, circuit from "C" terminal to ignition coil or ignition coil primary winding is open.
4. Checks for a shorted module or grounded circuit from the ignition coil to the module. The distributor module should be turned "OFF," so normal voltage should be about 12 volts. If the module is turned "ON," the voltage would be low, but above 1 volt. This could cause the ignition coil to fail from excessive heat. With an open ignition coil primary winding, a small amount of voltage will leak through the module from the "batt" to the "tach" terminal.

Diagnostic Aids:

If harness is equipped with tach lead it will be a loose white wire taped back in harness from the coil. If not equipped use a paper clip to insert next to white wire in gray connector, make sure there is good contact to terminal.

CHART A-6

(Page 1 of 2)
DISTRIBUTOR IGNITION SYSTEM CHECK

1

- CHECK SPARK PLUG WIRES FOR OPEN CIRCUITS, CRACKS IN INSULATION OR IMPROPER SEATING OF TERMINALS AT SPARK PLUGS, DISTRIBUTOR, AND IGNITION COIL BEFORE PROCEEDING WITH THIS TEST. IF A TACHOMETER IS CONNECTED TO THE TACH TERMINAL ON THE IGNITION COIL, DISCONNECT IT BEFORE PROCEEDING WITH TEST.
- CHECK SPARK AT PLUG PER MANUFACTURE RECOMMENDATIONS. CRANKING (IF NO SPARK ON ONE WIRE, CHECK A SECOND WIRE) A FEW SPARKS AND THEN NOTHING IS CONSIDERED NO SPARK.

NO SPARK

2

- REMOVE DISTRIBUTOR CAP AND VERIFY ROTATION OF IGNITION ROTOR.
  IF NO ROTATION, A MECHANICAL REPAIR WILL BE NECESSARY BEFORE CONTINUING WITH THIS TEST.
- DISCONNECT 4 TERMINAL DISTRIBUTOR CONNECTOR. CHECK FOR SPARK AT IGNITION COIL TOWER PER MANUFACTURE RECOMMENDATIONS WHILE CRANKING USING A KNOWN GOOD COIL WIRE. (LEAVE TESTER CONNECTED TO COIL TOWER FOR STEPS 3-6.)

SPARK

CHECK FUEL, SPARK PLUGS, ETC. REFER TO "SYMPTOMS" IN SECTION 6.

NO SPARK

3

- DISCONNECT DISTRIBUTOR 2 TERMINAL "C/◆" CONNECTOR HARNESS. ALSO DISCONNECT TACH PIGTAIL FROM HARNESS CONNECTOR IF EQUIPPED.
- IGNITION SWITCH "ON," ENGINE STOPPED.
- CHECK VOLTAGE AT "◆" AND "C" TERMINALS OF DISTRIBUTOR AT HARNESS CONNECTOR AND TACH PIGTAIL TERMINAL.*

*NOTE: IF OTHER COMBINATIONS RESULT FROM TEST #3, A WIRING PROBLEM IS APPARENT AND SHOULD BE REPAIRED BEFORE CONTINUING WITH OTHER TESTS.

SPARK

CHECK CAP, ROTOR AND COIL WIRES FOR OPENS, DAMAGE, OR WEAR. REPLACE AS NECESSARY.

ALL 3 TERMINALS 10 VOLTS OR MORE

ALL 3 TERMINALS UNDER 10 VOLTS

UNDER 10 VOLTS "C" TERMINAL ONLY

4

- RECONNECT DISTRIBUTOR 2 TERMINAL CONNECTOR.
- WITH IGNITION "ON," CHECK VOLTAGE FROM TACH PIGTAIL TO GROUND. SEE DIAGNOSTIC AIDS FACING PAGE.

REPAIR WIRE FROM DISTRIBUTOR IGNITION CONTROL MODULE "◆" TERMINAL TO "B" TERMINAL OF BLACK IGNITION COIL CONNECTOR OR VOLTAGE SUPPLY TO COIL.

CHECK FOR OPEN OR GROUND IN THE CIRCUIT FROM "C" TERMINAL TO IGNITION COIL. IF CIRCUIT IS OK, CHECK IGNITION COIL FOR OPEN COIL PRIMARY OR CONNECTION.

GREATER THAN 10 VOLTS

- CONNECT TEST LIGHT FROM TACHOMETER TERMINAL TO GROUND.
- CRANK ENGINE AND OBSERVE LIGHT.

REFER TO IGNITION SYSTEM CHECK (2 OF 2).

1 TO 10 VOLTS

REPLACE DISTRIBUTOR IGNITION CONTROL MODULE AND CHECK FOR SPARK FROM COIL AS IN STEP 6.

SPARK

SYSTEM OK.

NO SPARK

REPLACE IGNITION COIL.

WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION.

6-18-93
NS 13616

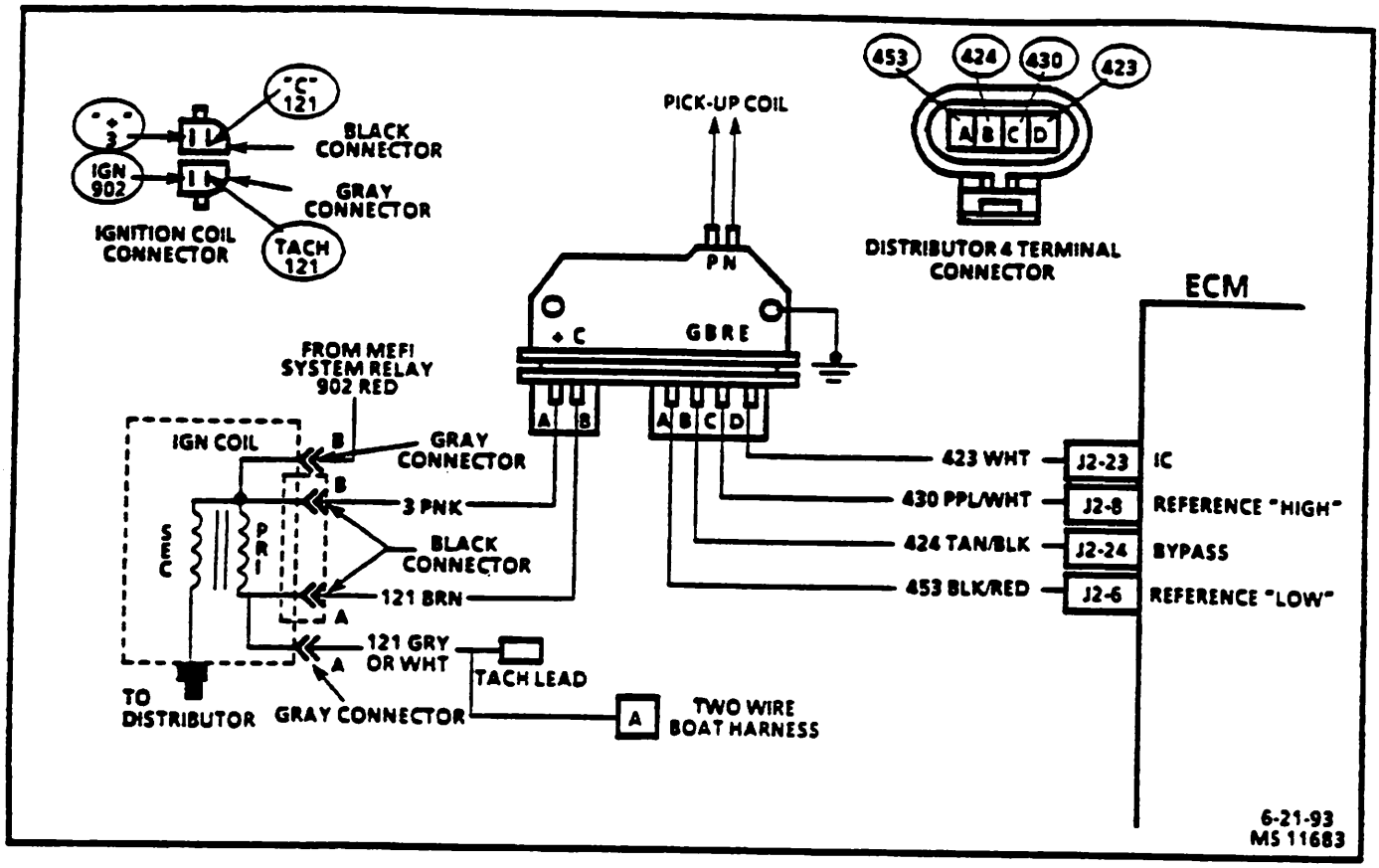


CHART A-6

(Page 2 of 2)
DISTRIBUTOR IGNITION SYSTEM CHECK

Circuit Description:

The Distributor Ignition (DI) System receives supply voltage from the MEFI relay through CKT 902 to the ignition coil gray connector "B". Inside the ignition coil, the gray connector terminal "B" is connected to 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. Once voltage is received at the IC module it is processed, switched to go to the ECM and back to the ignition coil by a transistorized relay and switches inside the IC module.

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 running or cranking mode, and adjust the timing accordingly. The voltages or signals are sent between ECM and IC module through CKTs 423, 430, and 424. CKT 453 is a balance or 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 and secondary spark is produced and sent to the distributor by a high tension lead.

Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

5. Applying a voltage (1.35 to 1.50 volts) to module terminal "P" should turn the module "ON" and the "tach" terminal voltage should drop to about 7-9 volts. This test will determine whether the module or coil is faulty or if the pick-up coil is not generating the proper signal to turn the module "ON." This test can be performed by using a DC test battery with a rating of 1.5 volts. (Such a AA, C, or D cell.) The battery must be a known good battery with a voltage of over 1.35 volts.
6. This should turn "OFF" the module and cause a spark. If no spark occurs, the fault is most likely in the ignition coil because most module problems would have been found before this point in the procedure.

Diagnostic Aids: For further test on pick-up coil or ignition coil see "On-board Service" section under distributor repair.

CHART A-6

(Page 2 of 2)
DISTRIBUTOR IGNITION SYSTEM CHECK

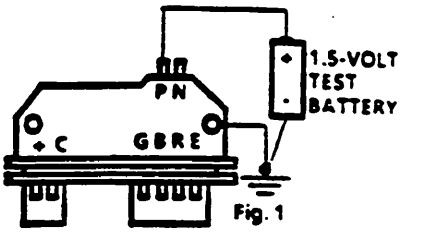


Fig. 1

FROM IGNITION SYSTEM CHECK PAGE (1 OF 2).

LIGHT "ON" STEADY

LIGHT FLASHES

REPLACE IGNITION COIL AND RECHECK FOR SPARK PER MANUFACTURER RECOMMENDATION. IF STILL NO SPARK, RE-INSTALL ORIGINAL COIL AND REPLACE DI CONTROL MODULE.

5
- DISCONNECT DISTRIBUTOR 4 TERMINAL CONNECTOR.
- REMOVE DISTRIBUTOR CAP.
- DISCONNECT PICK-UP COIL CONNECTOR FROM DISTRIBUTOR IGNITION CONTROL MODULE.
- CONNECT VOLTMETER FROM TACHOMETER TERMINAL OR PIGTAIL TO GROUND.
- IGNITION "ON."
- CONNECT POSITIVE (+) END OF KNOWN GOOD 1.5-VOLT TEST BATTERY TO "P" TERMINAL ON DISTRIBUTOR IGNITION CONTROL MODULE. OBSERVE VOLTMETER AT TACH TERMINAL AS NEGATIVE (-) END OF TEST BATTERY IS MOMENTARILY GROUNDED TO DISTRIBUTOR HOUSING.

VOLTAGE DROPS

NO DROP IN VOLTAGE

CHECK DISTRIBUTOR IGNITION CONTROL MODULE GROUND. IF OK, REPLACE DISTRIBUTOR IGNITION CONTROL MODULE.

6
- CHECK FOR SPARK FROM COIL WIRE WITH SPARK TESTER PER MANUFACTURERS RECOMMENDATION, AS TEST BATTERY IS REMOVED FROM MODULE TERMINAL.

NO SPARK

SPARK

- REPLACE IGNITION COIL AND REPEAT STEP 5.

CHECK PICK-UP COIL OR CONNECTIONS. (COIL RESISTANCE SHOULD BE 500-1500 OHMS AND NOT GROUNDED.)

NO SPARK

SPARK

IGNITION COIL REMOVED IS OK, REINSTALL COIL AND CHECK COIL WIRE FROM IGNITION COIL TO DISTRIBUTOR CAP WITH OHM METER. SHOULD BE CLOSE TO 2200 TO 3200 OHMS. IF OK, REPLACE DISTRIBUTOR IGNITION CONTROL MODULE.

SYSTEM OK.

YES

NO

CK POLE PIECE. IS IT SECURE TO DISTRIBUTOR SHAFT? IF LOOSE, REPLACE DISTRIBUTOR SHAFT.

REPLACE PICKUP COIL.

WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION.

6-21-93
PS 18409

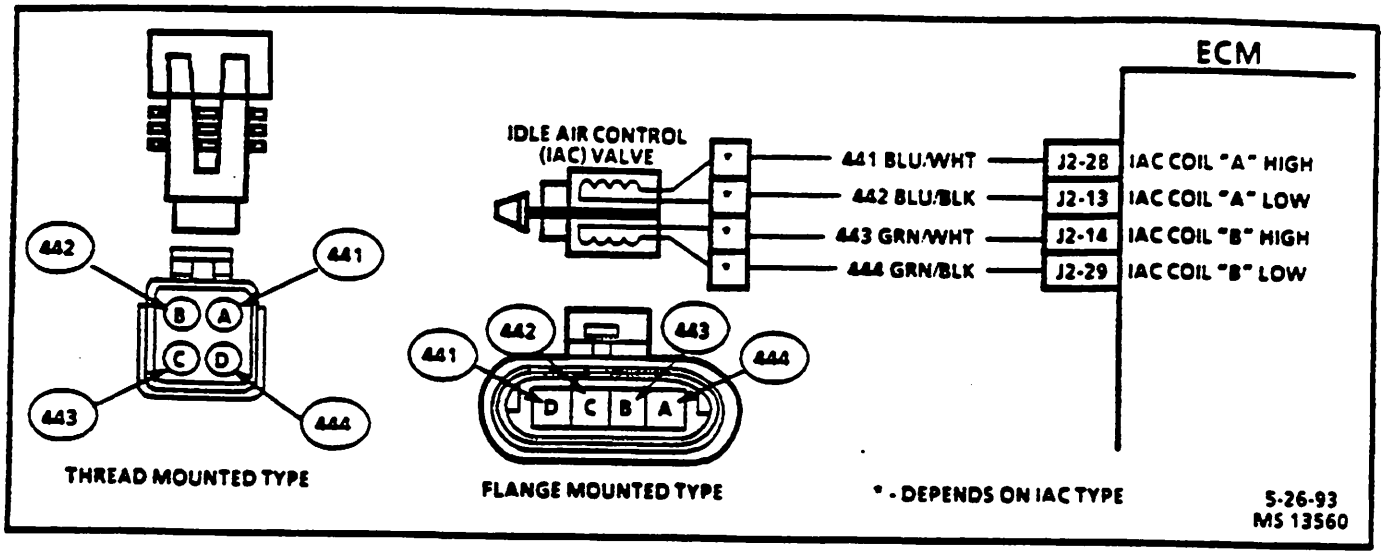


CHART A-7

IDLE AIR CONTROL FUNCTIONAL TEST

Circuit Description:

The ECM controls idle speed to a calculated, "desired" RPM based on sensor inputs and actual engine RPM, determined by the time between successive ignition reference pulses from the ignition module. The ECM uses 4 circuits to move an Idle Air Control (IAC) valve, which allows varying amounts of air flow into the intake manifold, controlling idle speed.

Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

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

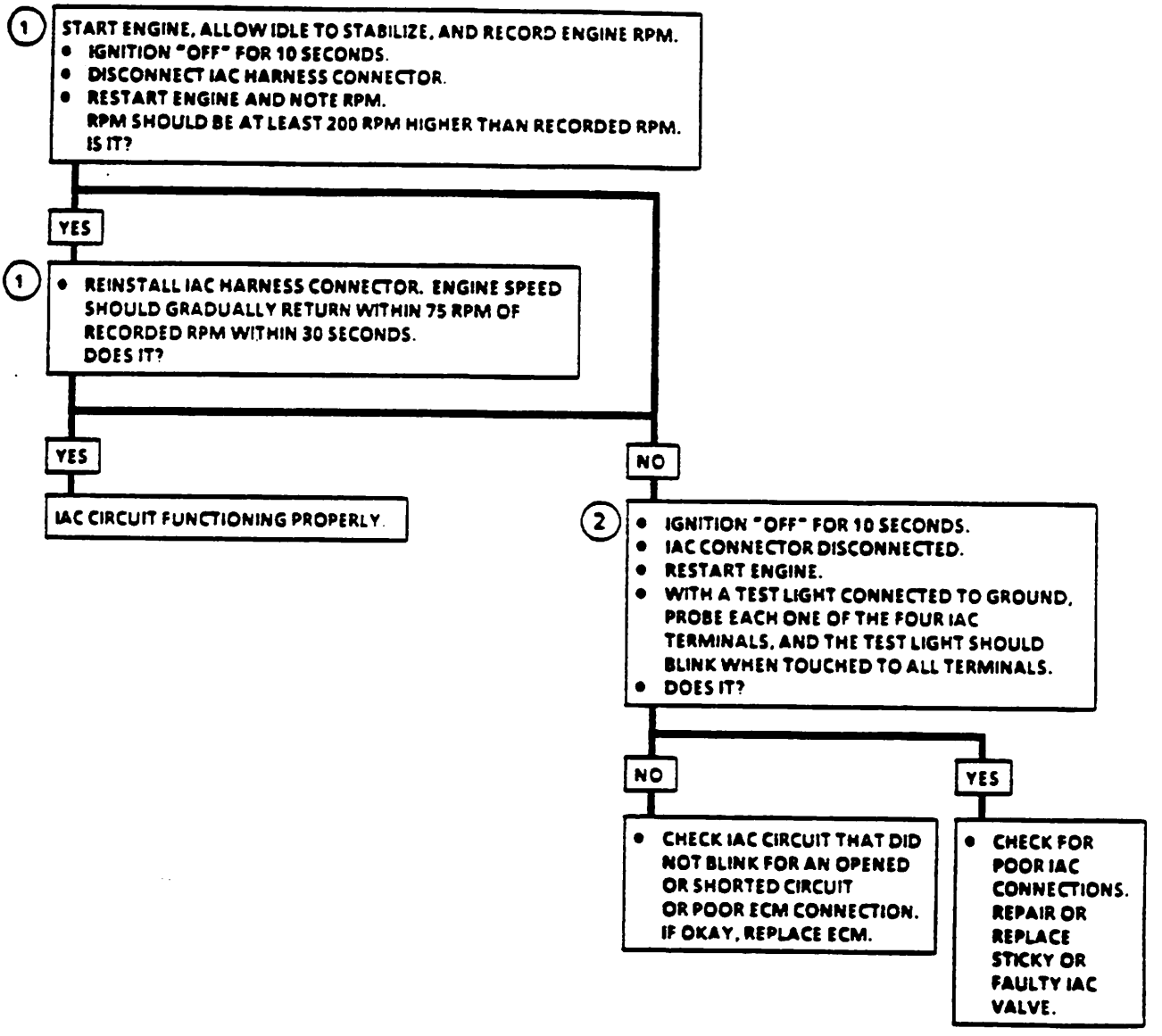
Diagnostic Aids: Check for vacuum leaks, unconnected or brittle vacuum hoses, cuts, etc. Examine manifold and throttle body gaskets for proper seal. Check for cracked intake manifold. Check open, shorts, or poor connections to IAC valve in CKTs 441, 442, 443 and 444.

An open, short, or poor connection in CKTs 441, 442, 443, or 444 will result in improper idle control and may cause improper idle.

An IAC valve which is stopped and cannot respond to the ECM, a throttle stop screw which has been tampered with, or a damaged throttle body or linkage could cause improper idle.

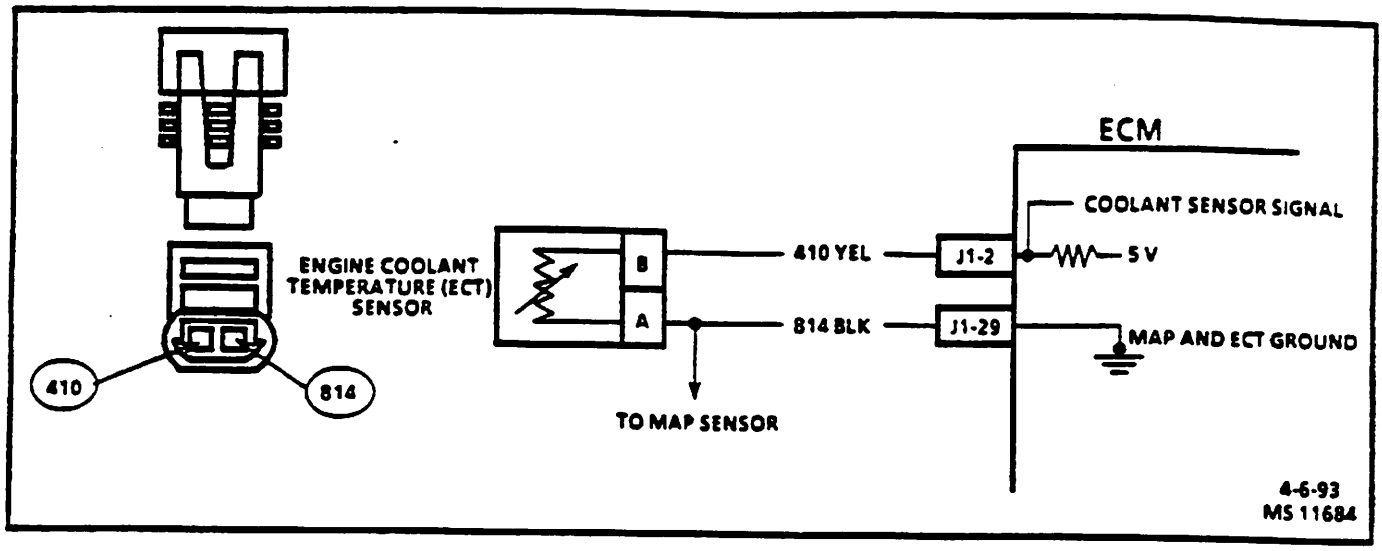
CHART A-7

IDLE AIR CONTROL FUNCTIONAL TEST



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION.

4-6-93
MS 11695



DTC 14

ENGINE COOLANT TEMPERATURE (ECT) SENSOR CIRCUIT
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 a voltage on CKT 410 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high.

As the engine coolant warms, the sensor resistance becomes less, see Engine Coolant Temperature sensor chart on facing page.

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

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

Diagnostic Aids: An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear DTCs following "Clear DTCs Procedure" in "MEFI General Information." Failure to do so may result in DTCs not properly being cleared. Check harness routing for a potential short to ground in CKT 410. See "Intermittents" in "Symptom" section. If DTC 33 is also set, check for open ground CKT 814.

DTC 14

ENGINE COOLANT TEMPERATURE (ECT) SENSOR CIRCUIT
NON-SCAN DIAGNOSTICS

ECT SENSOR CHART		
TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)		
°C	°F	OHMS
100	210	185
70	160	450
38	100	1800
20	70	3400
4	40	7500
-7	20	13500
-18	0	25000
-40	-40	100700

(1)
- IGNITION "OFF."
- DISCONNECT ENGINE COOLANT SENSOR CONNECTOR.
- IGNITION "ON."
- CONNECT DVOM ACROSS COOLANT SENSOR HARNESS TERMINALS.

IS VOLTAGE ABOVE 4 VOLTS?

NO

(3)
- CONNECT POSITIVE DVOM LEAD FROM HARNESS TERMINAL "B" CKT 410 (5 VOLT REFERENCE).
- CONNECT NEGATIVE DVOM LEAD TO A GOOD GROUND ON ENGINE.

IS VOLTAGE ABOVE 4 VOLTS?

NO

(4)
- REMOVE DVOM.
- IGNITION "ON."
- CONNECT A TEST LIGHT TO B+.
- TOUCH TEST LIGHT TO SENSOR HARNESS TERMINAL "B" (CKT 410).

IS TEST LIGHT "ON"?

NO

REPAIR OPEN CKT 410
OR
REPAIR FAULTY CONNECTION AT ECM
OR
REPLACE FAULTY ECM.

YES

- DISCONNECT ECM.

IS TEST LIGHT "ON"?

YES

CKT 410 SHORTED TO GROUND. REPAIR SHORT.

NO

REPAIR CKT 410 SHORTED TO CKT 814 OR CKT 813. IF OK, REPLACE FAULTY ECM.

YES

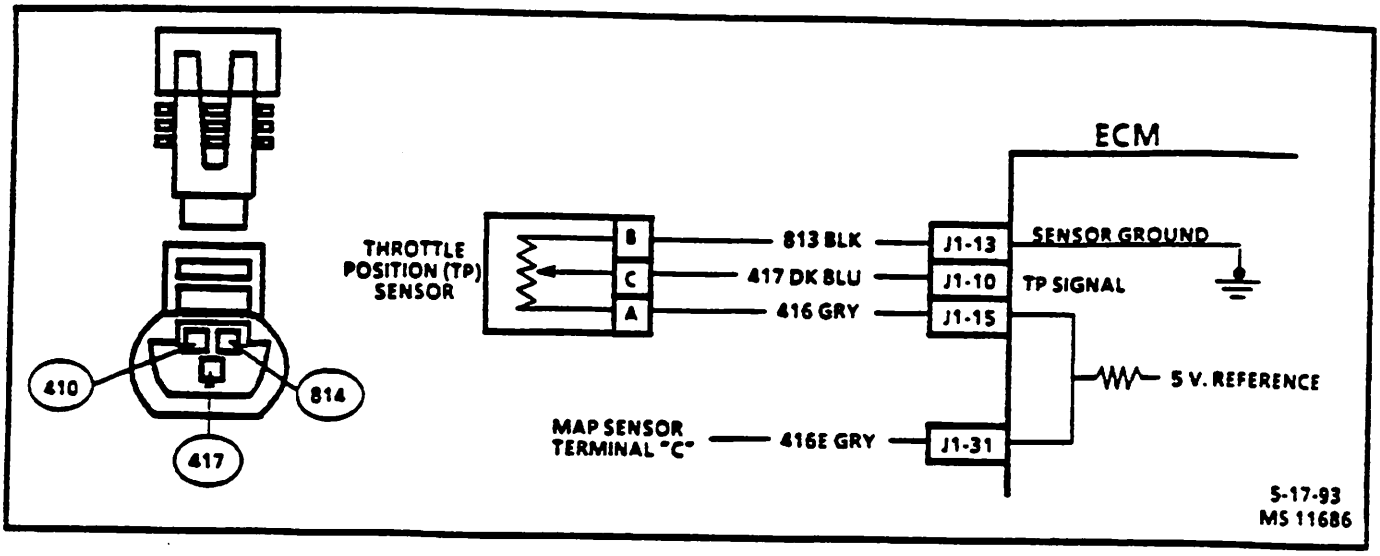
REPAIR OPEN SENSOR GROUND
OR
REPAIR FAULTY CONNECTION AT ECM
OR
REPLACE FAULTY ECM.

YES

(2) REPAIR INTERMITTENT CONNECTIONS. IF OKAY REPLACE FAULTY ENGINE COOLANT TEMPERATURE SENSOR.

WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION.

7-6-93
MS 8671-6E



DTC 21

THROTTLE POSITION (TP) SENSOR CIRCUIT
NON-SCAN DIAGNOSTICS

Circuit Description:

The Throttle Position (TP) Sensor is a potentiometer that provides voltage signal changes, relative to the throttle blade. Signal voltage should vary from about .7 volt at idle to about 5 volts at Wide Open Throttle (WOT).

The TP sensor signal is one of the important inputs used by the Engine Control Module (ECM) for fuel control and for IAC control.

The TP sensor supply voltage of 5V is delivered to the TP sensor through CKT 416. CKT 813 is the TP sensor ground circuit. The TP sensor signal CKT 417 will send voltage back to the ECM according to where the throttle blades are positioned.

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

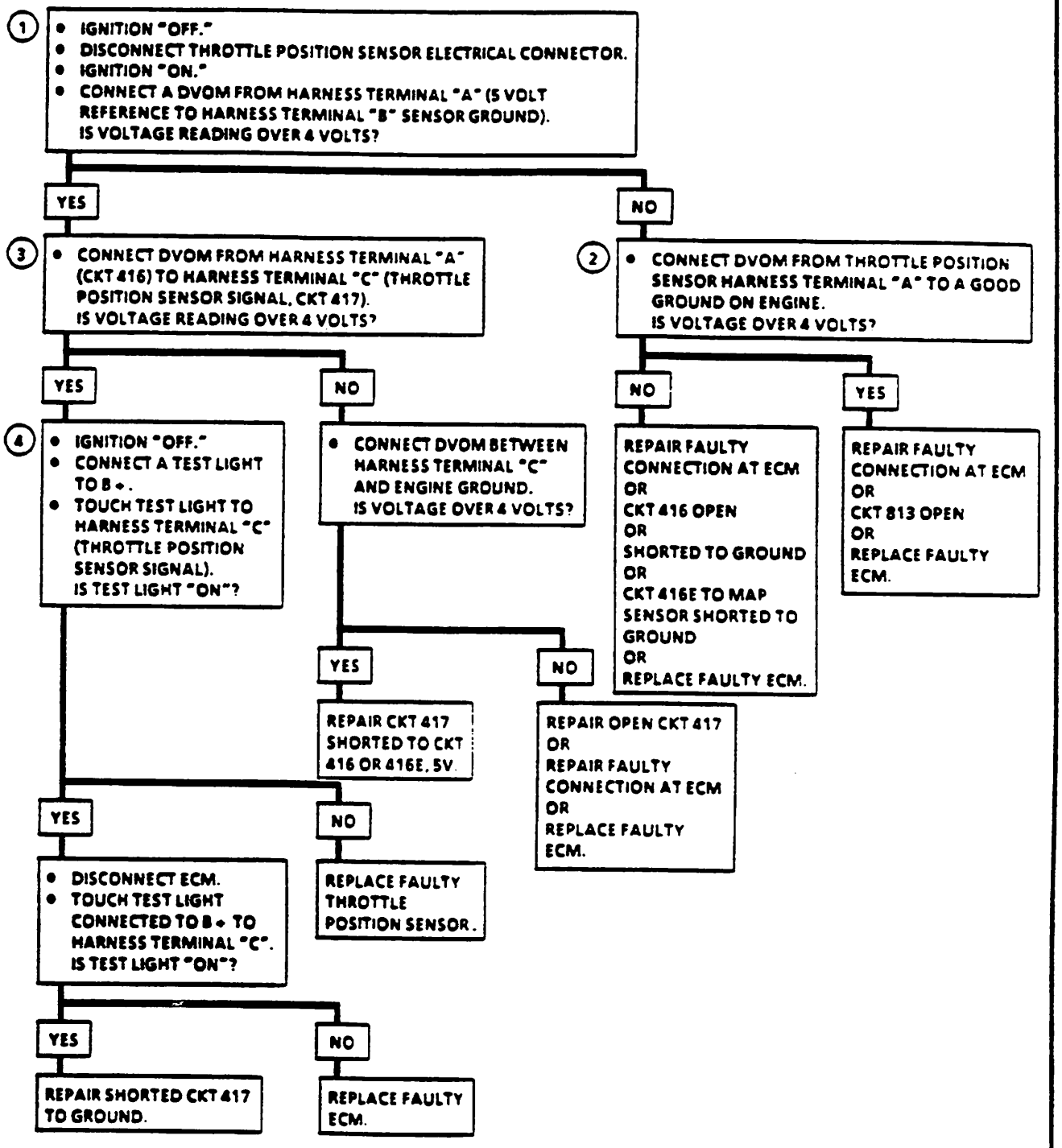
1. This step checks for a voltage from terminal "A" (5 volt reference) to terminal "B" (sensor ground).
2. This step will identify if the problem is in the supply or ground circuit.
3. This step determines if the Throttle Position (TP) sensor signal circuit to the ECM is open.
4. This step completes the test for the ECM and wiring. If the test light is not "ON," the TP sensor has an internal problem.

Diagnostic Aids: An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear DTCs following "Clear DTCs Procedure" in "MEFI General Information." Failure to do so may result in DTCs not properly being cleared. Check terminals at sensor for good contact.

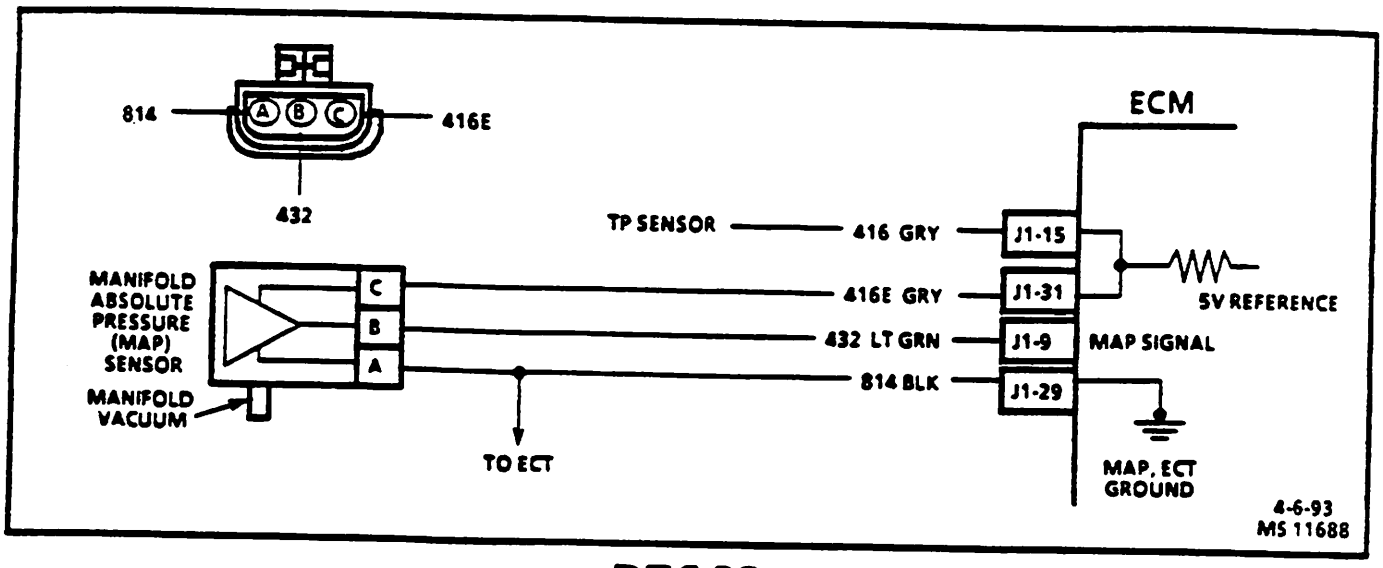
DTC 21

THROTTLE POSITION (TP) SENSOR CIRCUIT
NON-SCAN DIAGNOSTICS



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION

4-19-93
MS 11214



DTC 33

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT
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 closed throttle idle, to 4.0-4.5 volts at Wide Open Throttle (WOT) (low vacuum).

If the MAP sensor fails, the ECM will substitute a fixed MAP value and use the Throttle Position (TP) sensor to control fuel delivery.

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

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. This step will determine if there is an adequate vacuum supply to the MAP sensor. If the gage reading is erratic, refer to the "Rough or Unstable Idle" symptom.
2. Low manifold vacuum may result from a restriction in the MAP sensor hose or from vacuum leaks in the engine induction system.
3. This step checks for a voltage from terminal "C" (5 volt reference) to terminal "A" (sensor ground).
4. This step will identify if the problem is in the supply 5V ref or ground circuit.
5. This step determines if the MAP signal circuit to the ECM is open.
6. This step completes the test for the ECM and wiring. If the test light is not "ON," the MAP sensor has in internal problem.

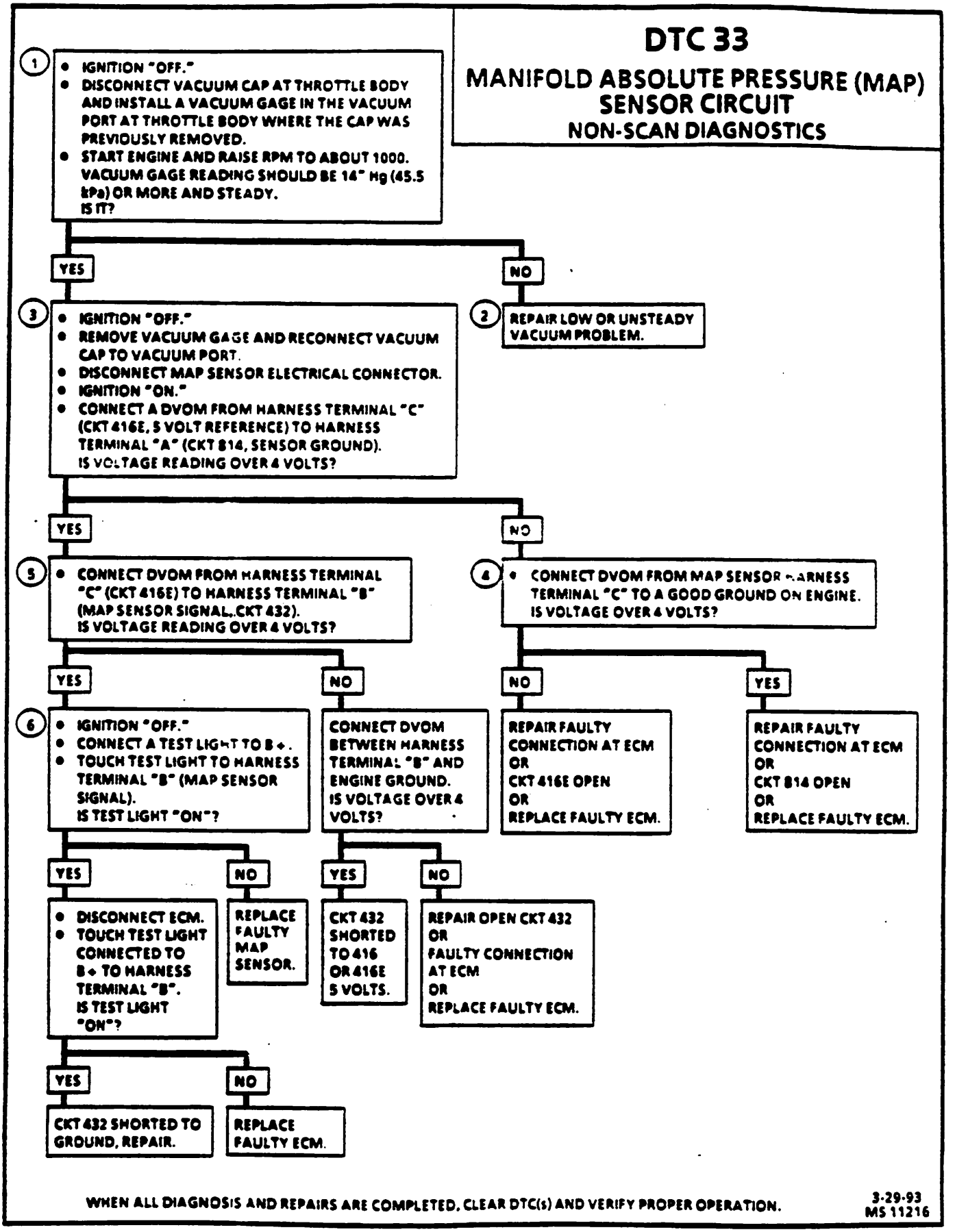
Diagnostic Aids: An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear DTCs following "Clear DTCs Procedure" in "MEFI General Information." Failure to do so may result in DTCs not properly being cleared. If DTC 14 is also set, check for open ground CKT 814.

DTC 33

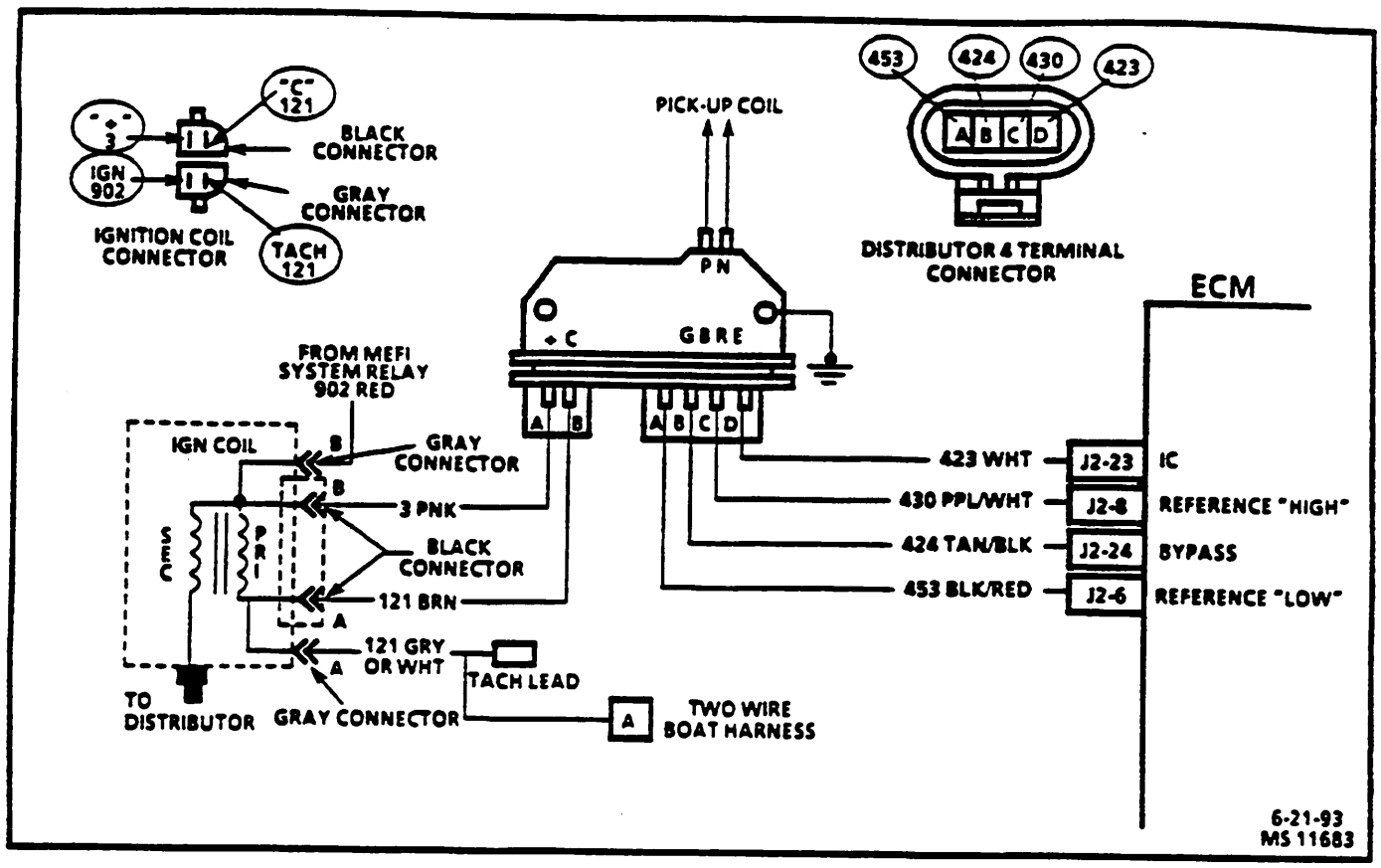
MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT

NON-SCAN DIAGNOSTICS



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION.

3-29-93
MS 11216



DTC 42

IGNITION CONTROL (IC) CIRCUIT
NON-SCAN DIAGNOSTICS

Circuit Description:

When the system is running in the ignition module, (crank) mode, there is no voltage on the bypass line, and the Ignition Control (IC) module grounds the IC signal. The ECM expects to see no voltage on the IC line during this mode. If it sees a voltage, it sets DTC 42 and will not go into the IC mode.

When the RPM for IC is reached (about 400 RPM), and bypass voltage applied, the IC should no longer be grounded in the Ignition Control (IC) module, the IC voltage should be varying.

If the bypass line is open or grounded, the Ignition Control (IC) module will not switch to IC mode, the IC voltage will be low and DTC 42 will be set.

If the IC line is grounded, the Ignition Control (IC) module will switch to IC but, because the line is grounded, there will be no IC signal. A DTC 42 will be set.

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. DTC 42 means the ECM has seen an open or short to ground in the IC or bypass circuits. This test confirms DTC 42 and that the fault causing the DTC is present.
2. 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.
3. 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."
4. The module did not switch and this step checks for:
   - IC CKT 423 shorted to ground.
   - Bypass CKT 424 open.
   - Faulty Ignition Control (IC) module connection or IC module.
5. Confirms that DTC 42 is a faulty ECM and not an intermittent in CKT 424 or CKT 423.

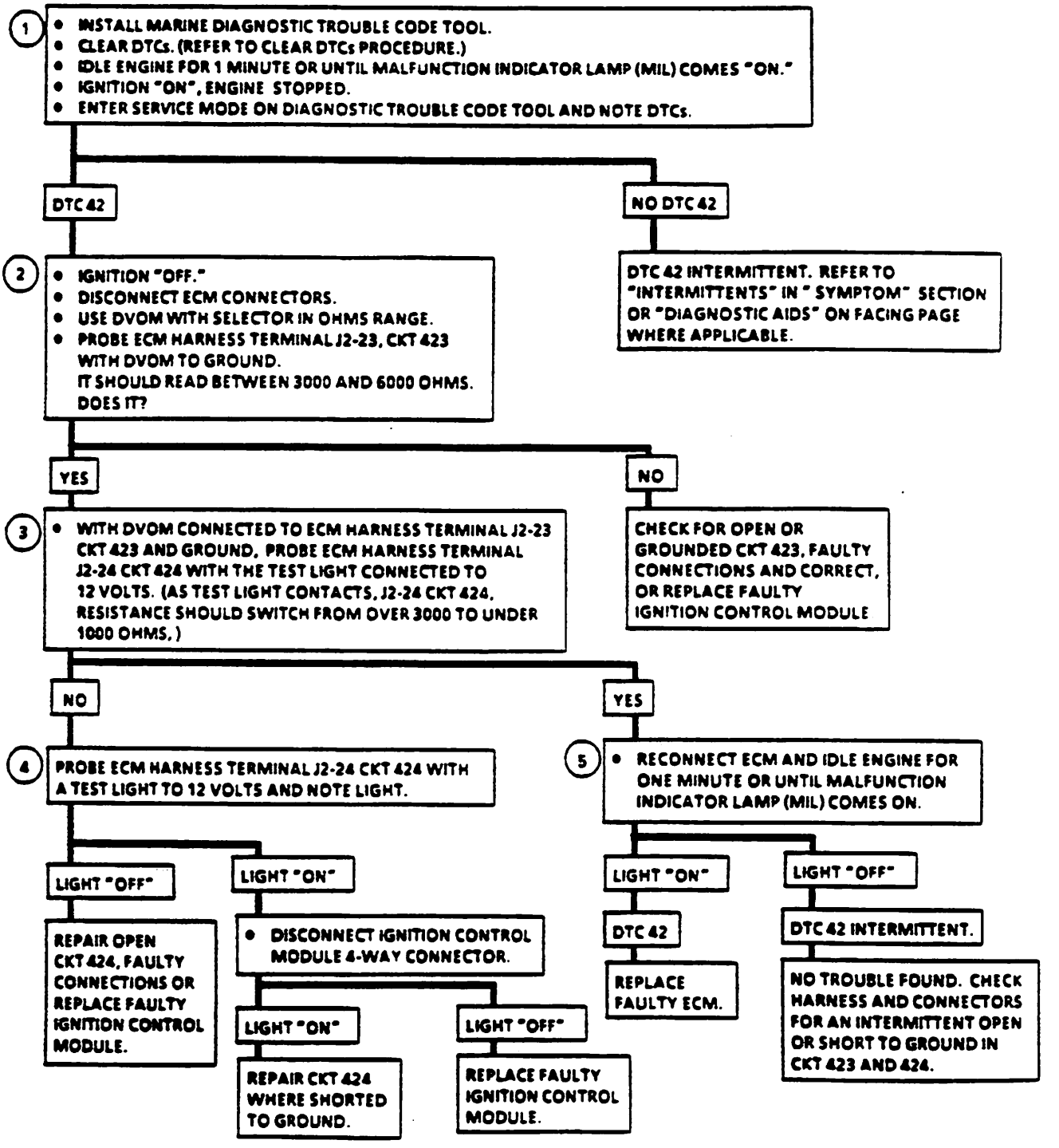
Diagnostic Aids: If engine starts and stalls, it may set a false DTC 42. Clear DTC and repair cause of stalling condition.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed, or damaged terminals, poor terminal to wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear DTCs following "Clear DTCs Procedure" in "MEFI General Information." Failure to do so may result in DTCs not properly being cleared.

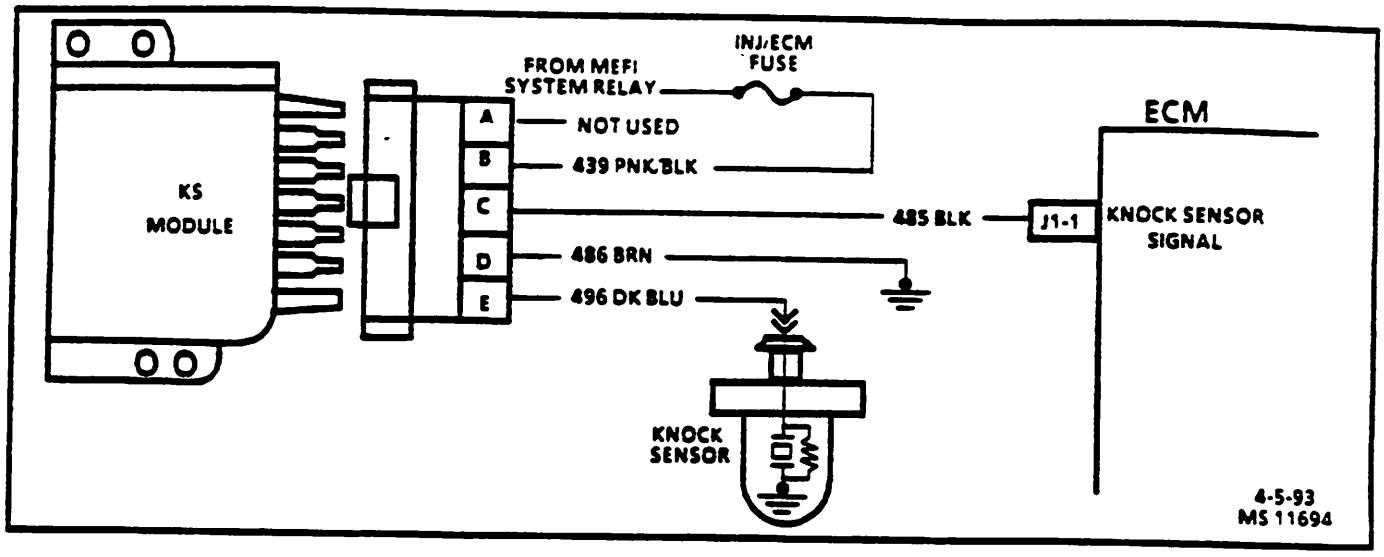
DTC 42

IGNITION CONTROL (IC) CIRCUIT
NON-SCAN DIAGNOSTICS



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION.

6-18-93
NS 13618



DTC 43

KNOCK SENSOR (KS) SYSTEM
NON-SCAN DIAGNOSTICS

Circuit Description:

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

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. This step insures that the knock sensor circuitry is within the proper resistance value.
2. Applying 12 volts with a test light to CKT 496 simulates a signal from the knock sensor. The knock sensor is faulty if a response occurs.
3. This step checks if a voltage signal from the KS module is present at the ECM.
4. This step determines if ignition voltage is available to power up the KS module.
5. This step confirms the ability of the KS module to remove the voltage from the signal line when it sees spark knock. Since the knock sensor produces an A/C voltage signal, it may be necessary to repeatedly touch (tickle) the harness connector with the test light probe to simulate this type of signal.
6. This step checks the ground circuit from the KS module. If the test light is dim, check ground (CKT 486) for excessive resistance.

Diagnostic Aids: If CKT 496 is routed too close to secondary ignition wires, the KS module may see the interference as a knock signal, resulting in false retard.

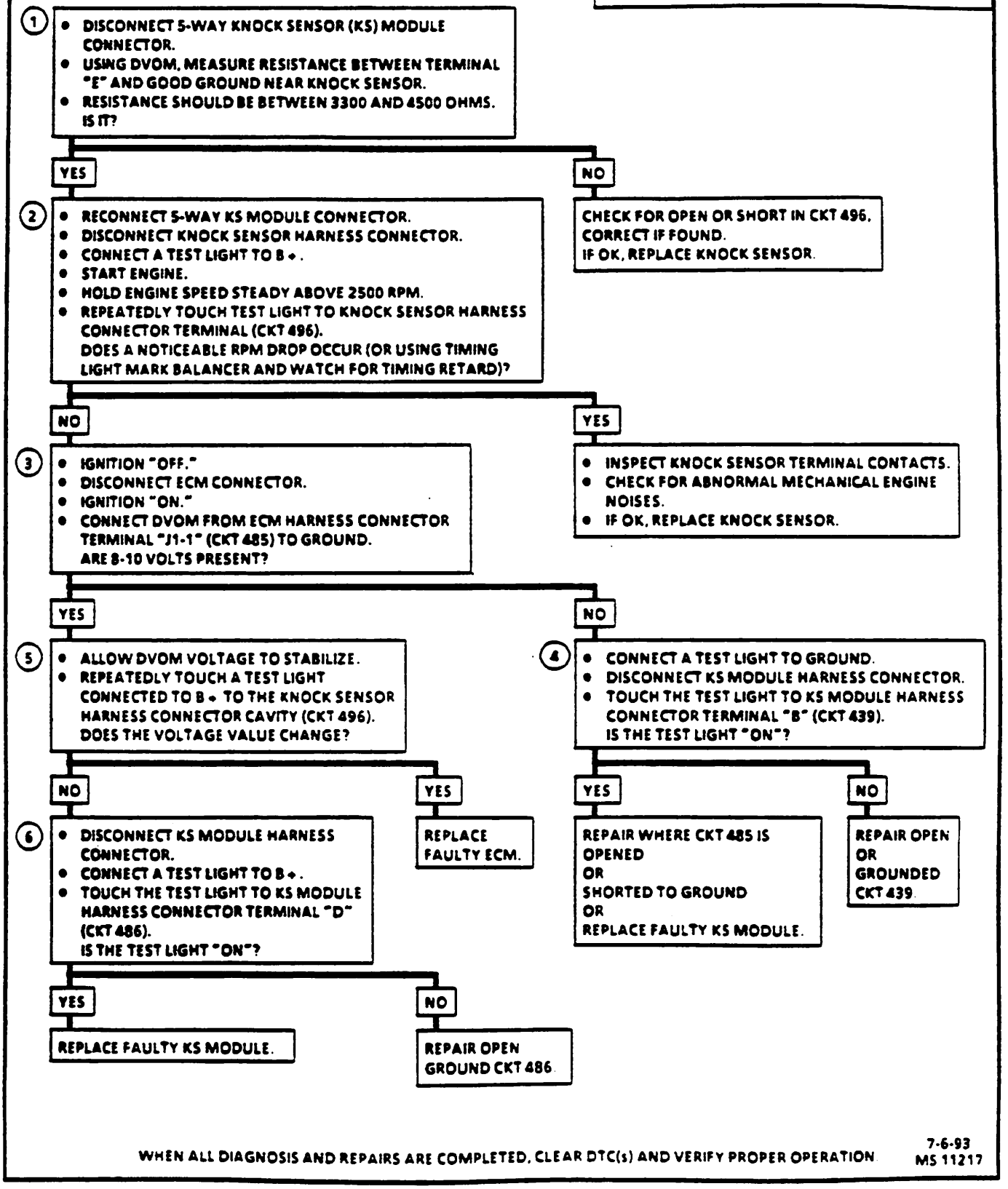
An intermittent problem may be caused by a poor corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear DTCs following "Clear DTCs Procedure" in "MEFI General Information." Failure to do so may result in DTCs not properly being cleared.

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

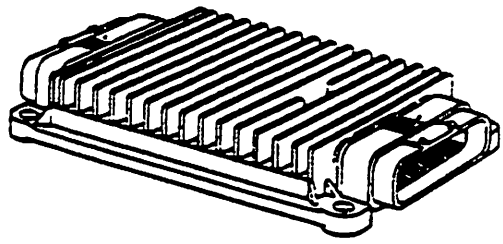
DTC 43

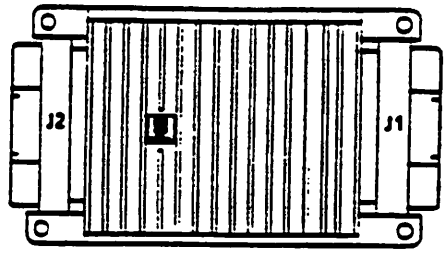
KNOCK SENSOR (KS) SYSTEM
NON-SCAN DIAGNOSTICS



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION.

7-6-93
MS 11217





PS 17655

DTC 51

CALIBRATION MEMORY 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 calibrations or changes to these calibrations that may alter the designed function of MEFI.

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

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

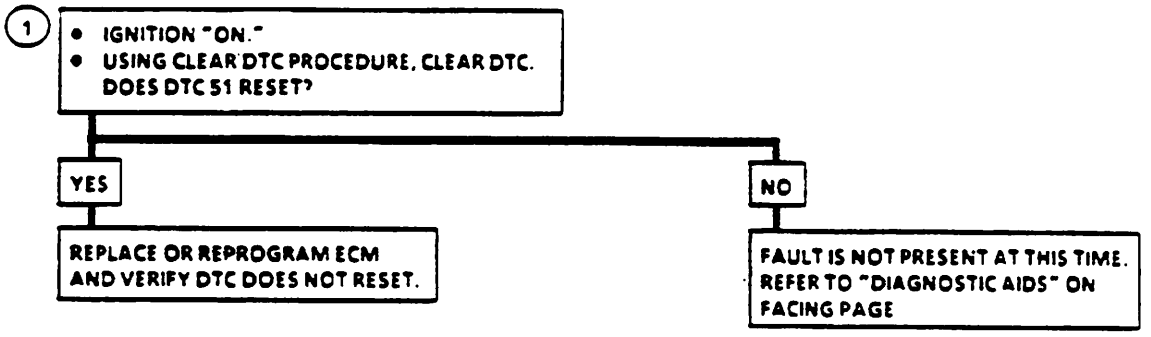
Important

- Vehicles with MEFI can be reprogrammed to correct this failure or replaced with a factory programmed ECM for your specific application.

Diagnostic Aids: An intermittent DTC 51 may be caused by a bad cell in the EEPROM that is sensitive to temperature changes. If DTC 51 failed more than once, but is intermittent, replace ECM.

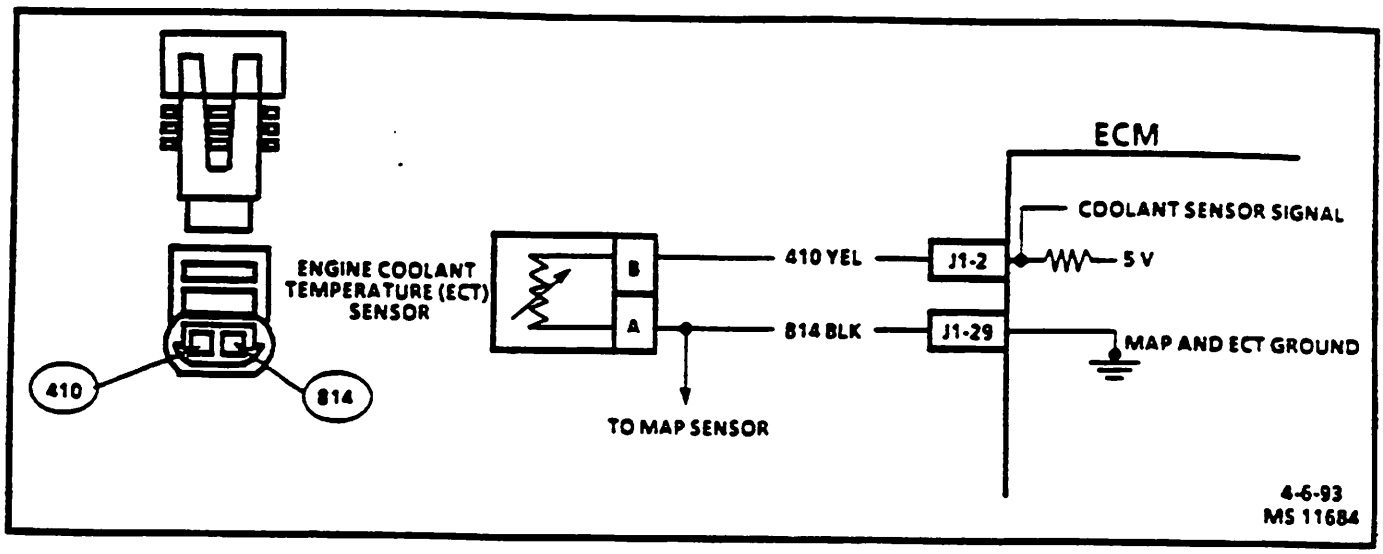
DTC 51

CALIBRATION MEMORY FAILURE
NON-SCAN DIAGNOSTICS



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION

3-29-93
MS 13556



DTC 14

ENGINE COOLANT TEMPERATURE (ECT) SENSOR CIRCUIT
SCAN DIAGNOSTICS

Circuit Description:

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

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. DTC 14 will set if:
   - Signal voltage indicates a coolant temperature above 130°C (266°F) or below -30°C or -22°F.
2. This test will determine if CKT 410 is shorted to ground, which will cause the condition for DTC 14.

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

Scan tool displays engine temperature in degrees Celsius and Fahrenheit. After engine is started, the temperature should rise steadily, reach normal operating temperature, and then stabilize when thermostat opens.

See "Intermittents" in "Symptom" section.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed, or damaged terminals, poor terminal to wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear DTCs following "Clear DTCs Procedure" in "MEFI General Information." Failure to do so may result in DTCs not properly being cleared. If DTC 33 is also set, check for open ground CKT 814.

DTC 14 CHART

ENGINE COOLANT TEMPERATURE (ECT) SENSOR CIRCUIT SCAN DIAGNOSTICS

ECT SENSOR CHART TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)		
°C	°F	OHMS
100	210	185
70	160	450
38	100	1800
20	70	3400
4	40	7500
-7	20	13500
-18	0	25000
-40	-40	100700

(1) • IGNITION "ON."
DOES SCAN TOOL DISPLAY A COOLANT TEMPERATURE VALUE GREATER THAN 130°C (266°F) OR LESS THAN -30°C (-22°F)?

YES

COOLANT TEMPERATURE SCAN DISPLAY GREATER THAN 130°C (266°F).

(2) • IGNITION "OFF."
• DISCONNECT ENGINE COOLANT TEMPERATURE SENSOR.
• IGNITION "ON."
• SCAN TOOL SHOULD DISPLAY COOLANT TEMPERATURE BELOW -30°C (-22°F).
DOES IT?

NO

REPAIR WHERE CKT 410 SHORTED TO GROUND OR REPLACE FAULTY ECM.

YES

REPLACE ENGINE COOLANT TEMPERATURE SENSOR.

NO

DTC 14 IS INTERMITTENT. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

COOLANT TEMPERATURE SCAN DISPLAY LESS THAN -30°C (-22°F).

• IGNITION "OFF."
• DISCONNECT ENGINE COOLANT TEMPERATURE SENSOR.
• JUMP TERMINALS "A" AND "B" TOGETHER.
• IGNITION "ON."
• SCAN TOOL SHOULD DISPLAY COOLANT TEMPERATURE ABOVE 130°C (266°F).
DOES IT?

NO

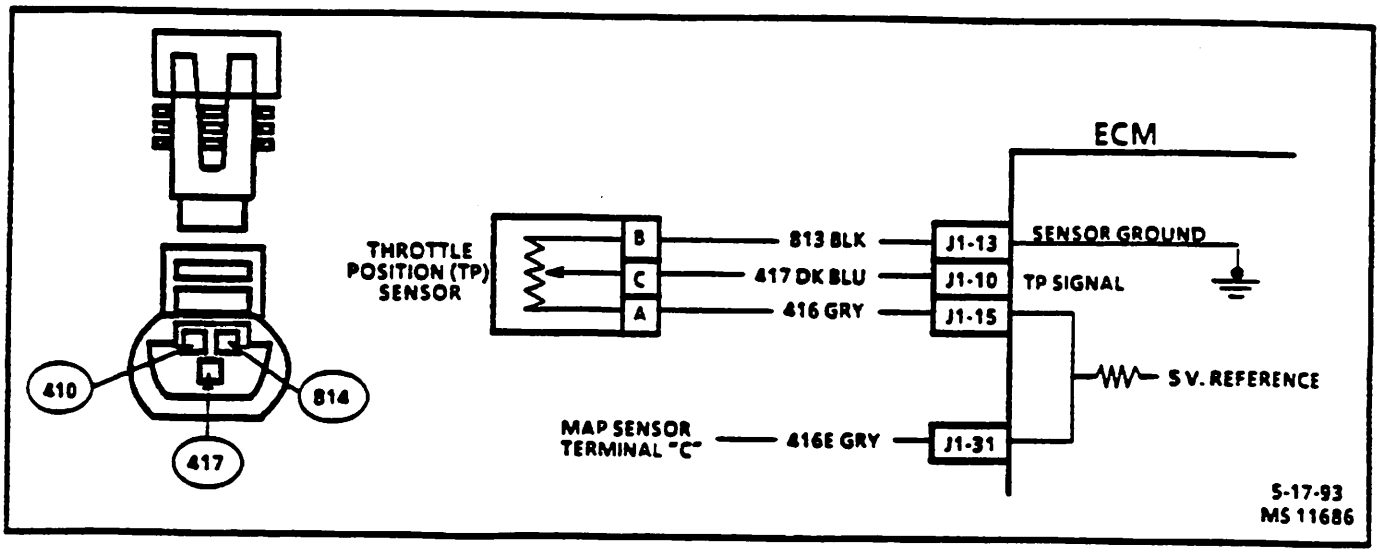
REPAIR OPEN CKT 410 OR 814 OR REPAIR FAULTY ECM.

YES

REPLACE ENGINE COOLANT TEMPERATURE SENSOR.

WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION

7-6-93
MS 11282



DTC 21

THROTTLE POSITION (TP) SENSOR CIRCUIT
SCAN DIAGNOSTICS

Circuit Description:

The Throttle Position (TP) Sensor is a potentiometer that provides voltage signal changes, relative to the throttle blade. Signal voltage should vary from about .7 volt at idle to about 5 volts at Wide Open Throttle (WOT).

The TP sensor signal is one of the important inputs used by the Engine Control Module (ECM) for fuel control and for IAC control.

The TP sensor supply voltage of 5V is delivered to the TP sensor through CKT 416. CKT 813 is the TP sensor ground circuit. The TP sensor signal CKT 417 will send voltage back to the ECM according to where the throttle blades are positioned.

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. With throttle closed the TP sensor should read between .3 and .9 volt. If it does not, check throttle cable adjustment or for bent linkage.
2. With the TP sensor disconnected, the TP sensor voltage should go low, if the ECM and wiring are OK.
3. Probing CKT 813 with a DVOM to CKT 416 checks the sensor ground. A faulty sensor ground will cause a DTC 21.

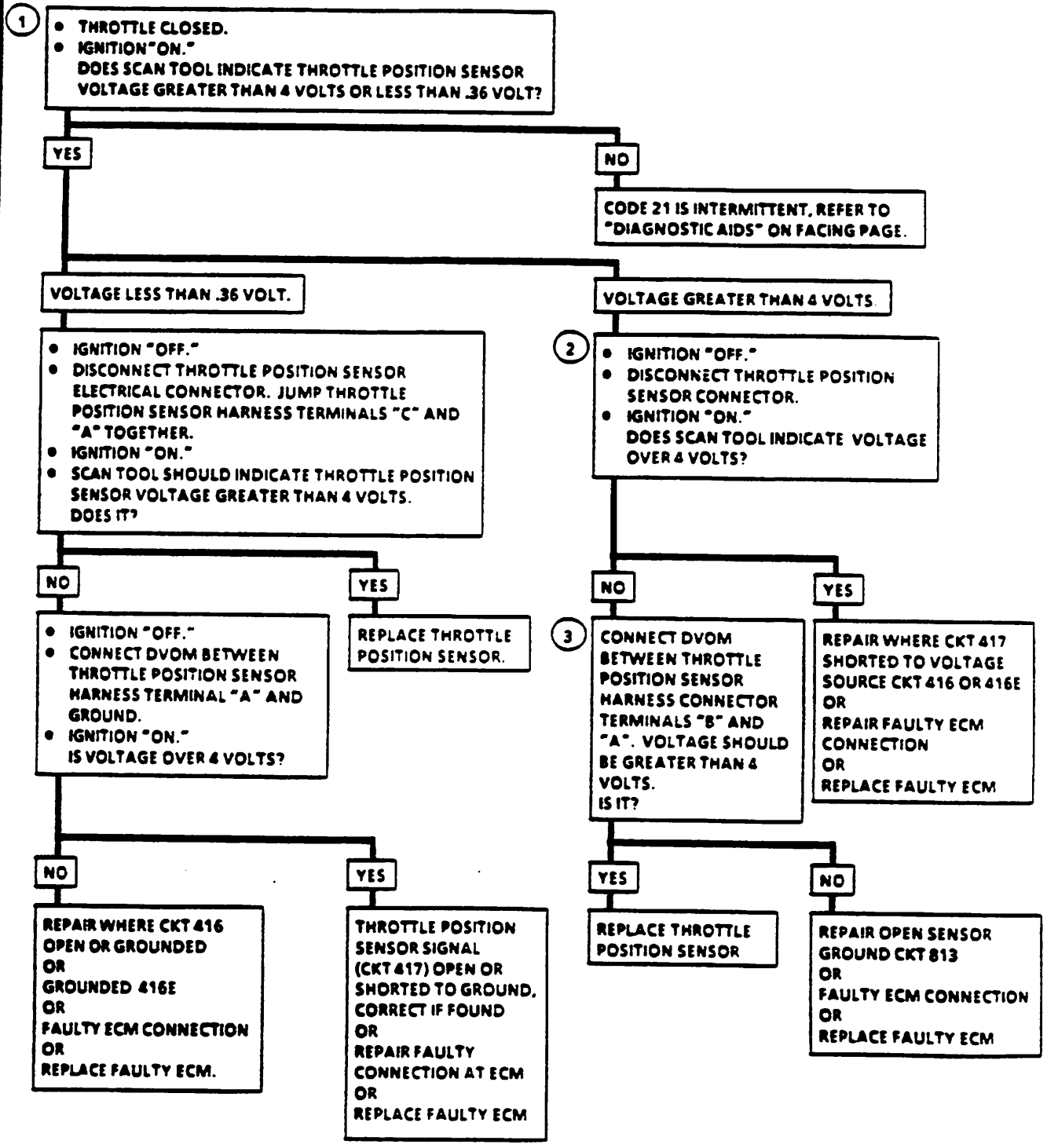
Diagnostic Aids: The scan tool reads throttle position in voltage and percentage of throttle blade opening. With ignition "ON" or at idle, TP sensor signal voltage should read between .3 and .9 volt with the throttle closed, and increase at a steady rate as throttle is moved toward Wide Open Throttle (WOT).

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear DTCs following "Clear DTCs Procedure" in "MEFI General Information." Failure to do so may result in DTCs not properly being cleared.

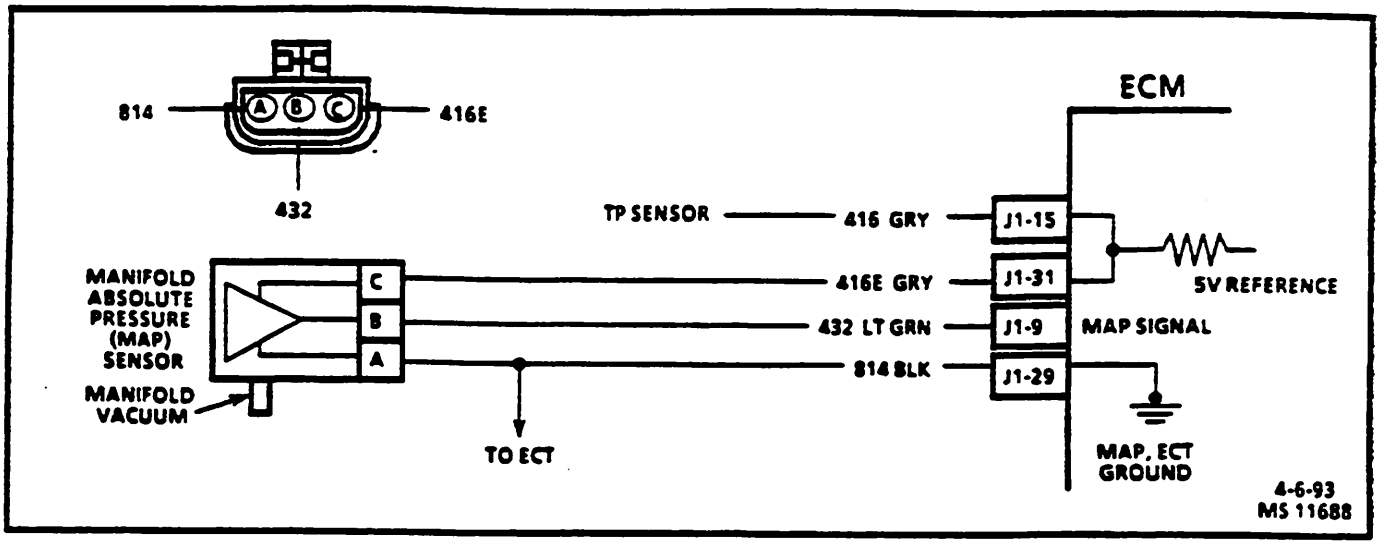
DTC 21

THROTTLE POSITION (TP) SENSOR CIRCUIT
SCAN DIAGNOSTICS



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION.

5-12-93
MS 11283



DTC 33

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT
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 4.0-4.8 volts at Wide Open Throttle (WOT).

The scan tool displays manifold pressure in kPa of pressure and voltage. Low pressure (high vacuum) reads a low voltage while a high pressure (low vacuum) reads a high voltage.

If the MAP sensor fails, the ECM will substitute a fixed MAP value and use the Throttle Position (TP) sensor to control fuel delivery.

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

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

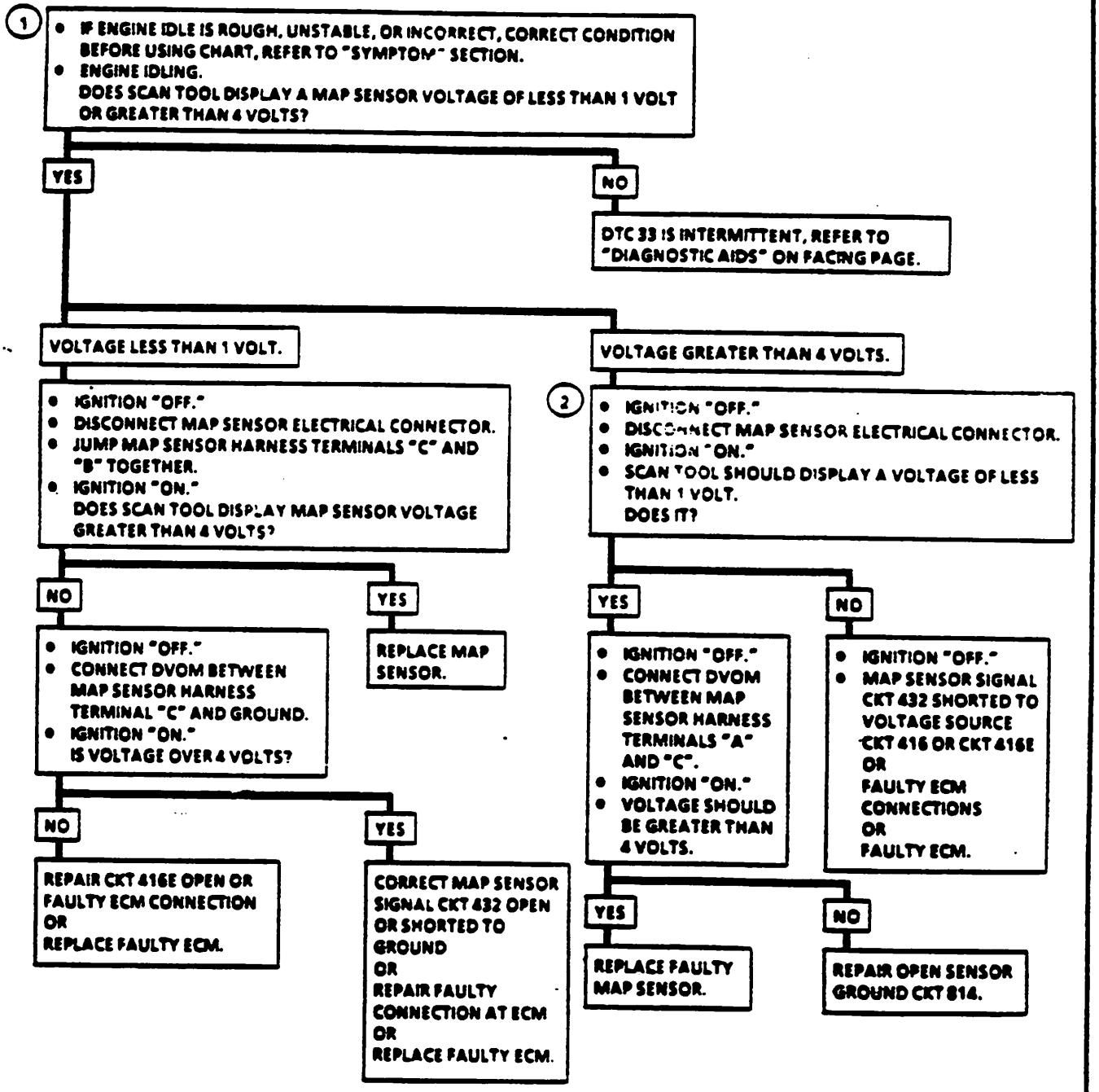
1. Engine misfire or a low unstable idle may set DTC 33. Disconnect MAP sensor and system will go into default mode. If the misfire or idle condition remains, refer to "Symptom" section.
2. If the ECM recognizes the low MAP signal, the ECM and wiring are OK.

Diagnostic Aids:

- If the idle is rough or unstable, refer to "Symptoms" for items which can cause an unstable idle.
- With the ignition "ON," and the engine "OFF," the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of vehicle altitude and is referred to as BARO. Comparison of this BARO reading, with a known good vehicle with the same sensor, is a good way to check accuracy of a "suspect" sensor. Reading should be the same, ± .4 volt."
- An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.
- Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear DTCs following "Clear DTC Procedure" in "MEFI General Information." Failure to do so may result in DTCs not properly being cleared.
- Open CKT 814 may also set DTC 14.

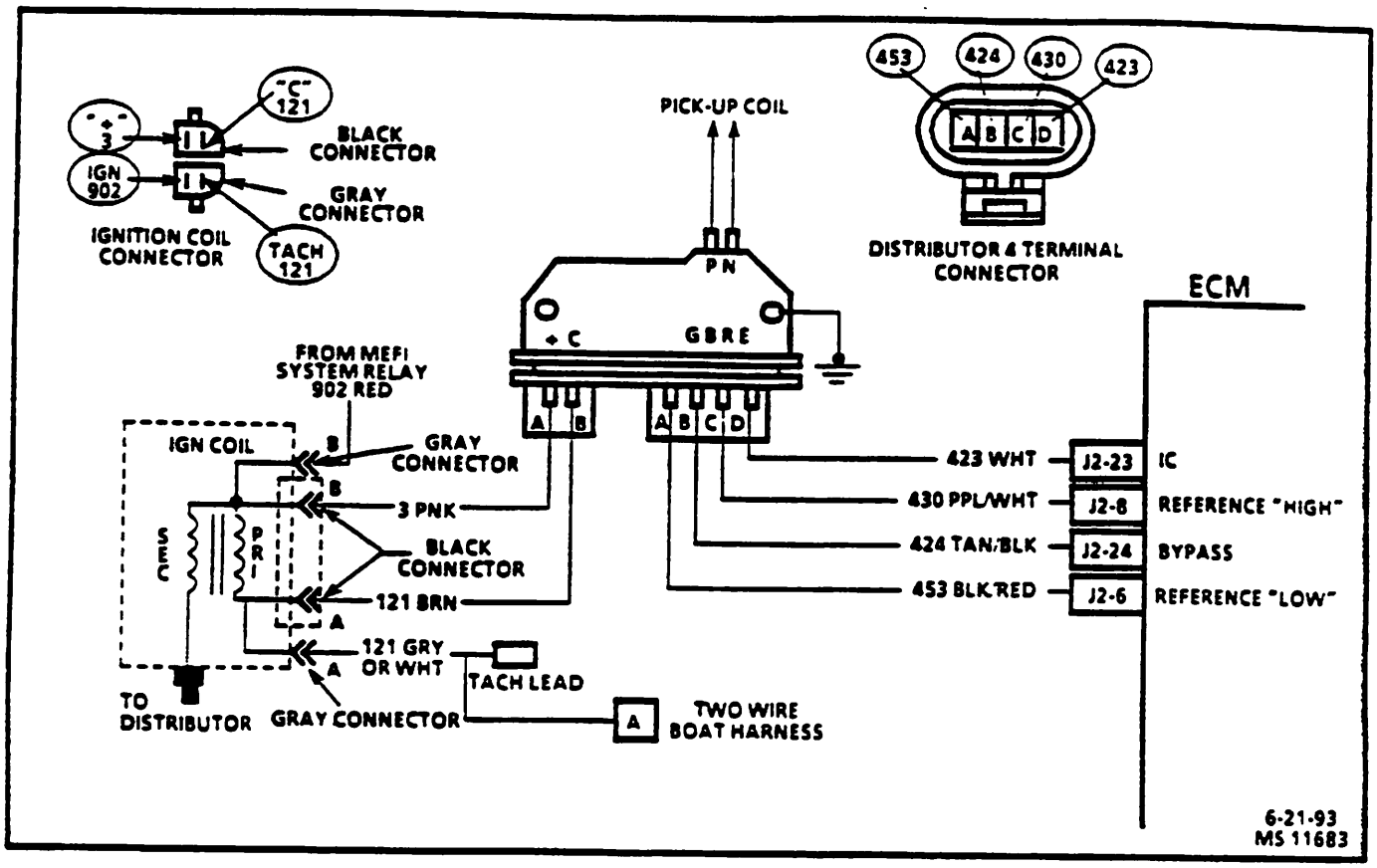
DTC 33

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT SCAN DIAGNOSTICS



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION.

6-18-93
MS 11285



DTC 42

IGNITION CONTROL (IC) CIRCUIT
SCAN DIAGNOSTICS

Circuit Description:

When the system is in the ignition module (crank) mode, there is no voltage on the bypass line, and the Ignition Control (IC) module grounds the IC signal. The ECM expects to see no voltage on the IC line during this mode. If it sees a voltage, it sets DTC 42 and will not go into the IC mode.

When the RPM for IC is reached (about 400 RPM), and bypass voltage applied, the IC should no longer be grounded in the Ignition Control (IC) module, the IC voltage should be varying.

If the bypass line is open or grounded, the Ignition Control (IC) module will not switch to IC mode, the IC voltage will be low and DTC 42 will be set.

If the IC line is grounded, the Ignition Control (IC) module will switch to IC but, because the line is grounded, there will be no IC signal. A DTC 42 will be set.

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. DTC 42 means the ECM has seen an open or short to ground in the IC or bypass circuits. This test confirms DTC 42 and that the fault causing the DTC is present.
2. Checks for a normal IC ground path through the IC module. An IC CKT 424 shorted to ground will also read more than 3000 ohms; however, this will be checked later.
3. As the test light voltage touches CKT 423, the module should switch. The DVOM reading should change from over 3000 ohms to under 1000 ohms. The important thing is that the module "switched."
4. The module did not switch and this step checks for:
   - IC CKT 424 shorted to ground.
   - Bypass CKT 423 open
   - Faulty IC module connection or module.
5. Confirms that DTC 42 is a faulty ECM and not an intermittent in CKT 423 or CKT 424.

Diagnostic Aids: If engine starts and stalls, it may set a false DTC 42. Clear DTC and repair cause of stalling condition.

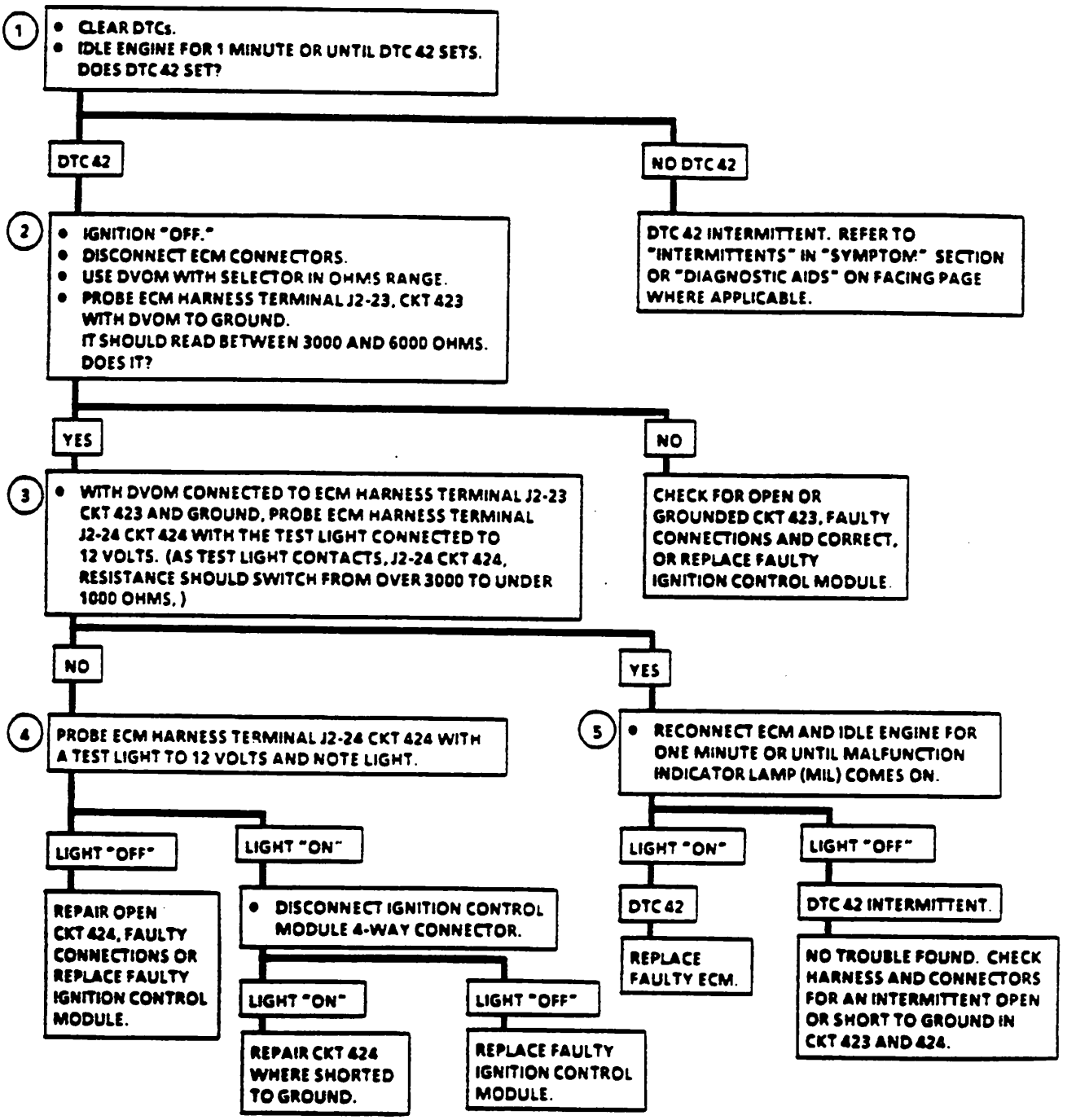
Refer to "Intermittents" in "Symptom" section.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear DTCs following "Clear DTCs Procedure" in "MEFI General Information." Failure to do so may result in DTCs not properly being cleared.

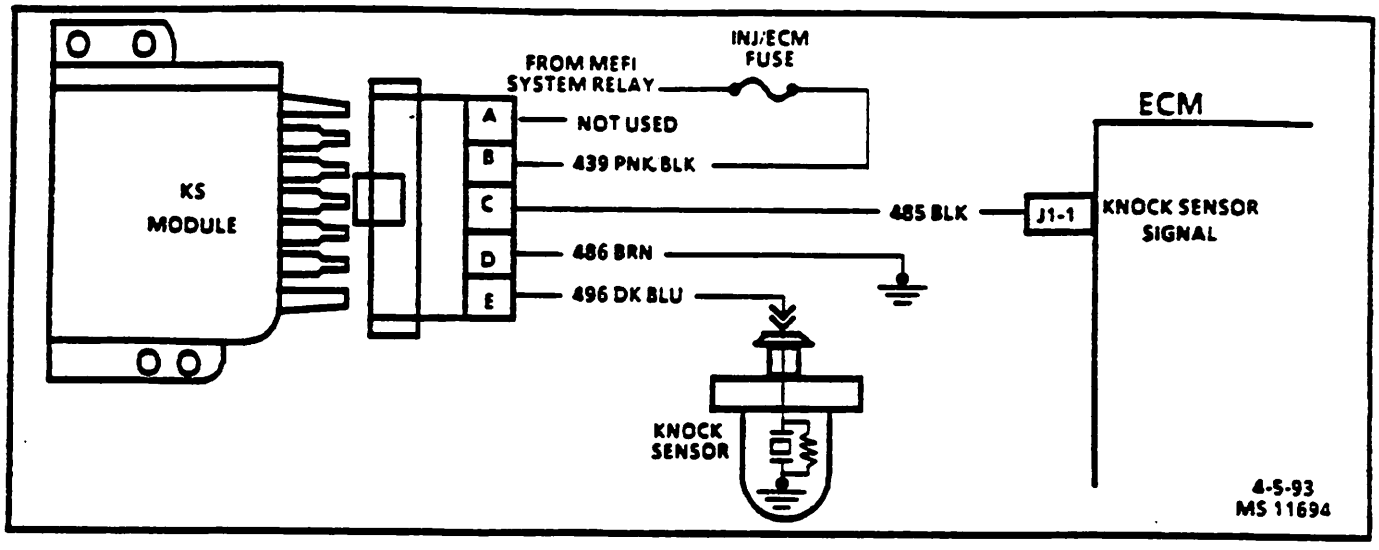
DTC 42

IGNITION CONTROL (IC) CIRCUIT SCAN DIAGNOSTICS



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION.

6-18-93
NS 14417



DTC 43

KNOCK SENSOR (KS) SYSTEM
SCAN DIAGNOSTICS

Circuit Description:

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

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

1. This step determines if there is a problem in the circuit. When a KS circuit fails, the ECM will switch to a default value of about 2 degrees.
2. This step checks if there is a voltage source to the knock sensor from the KS module.
3. This step will determine if the knock sensor is faulty.

Diagnostic Aids: If CKT 496 is routed too close to secondary ignition wires, the KS module may see the interference as a knock signal, resulting in false retard.

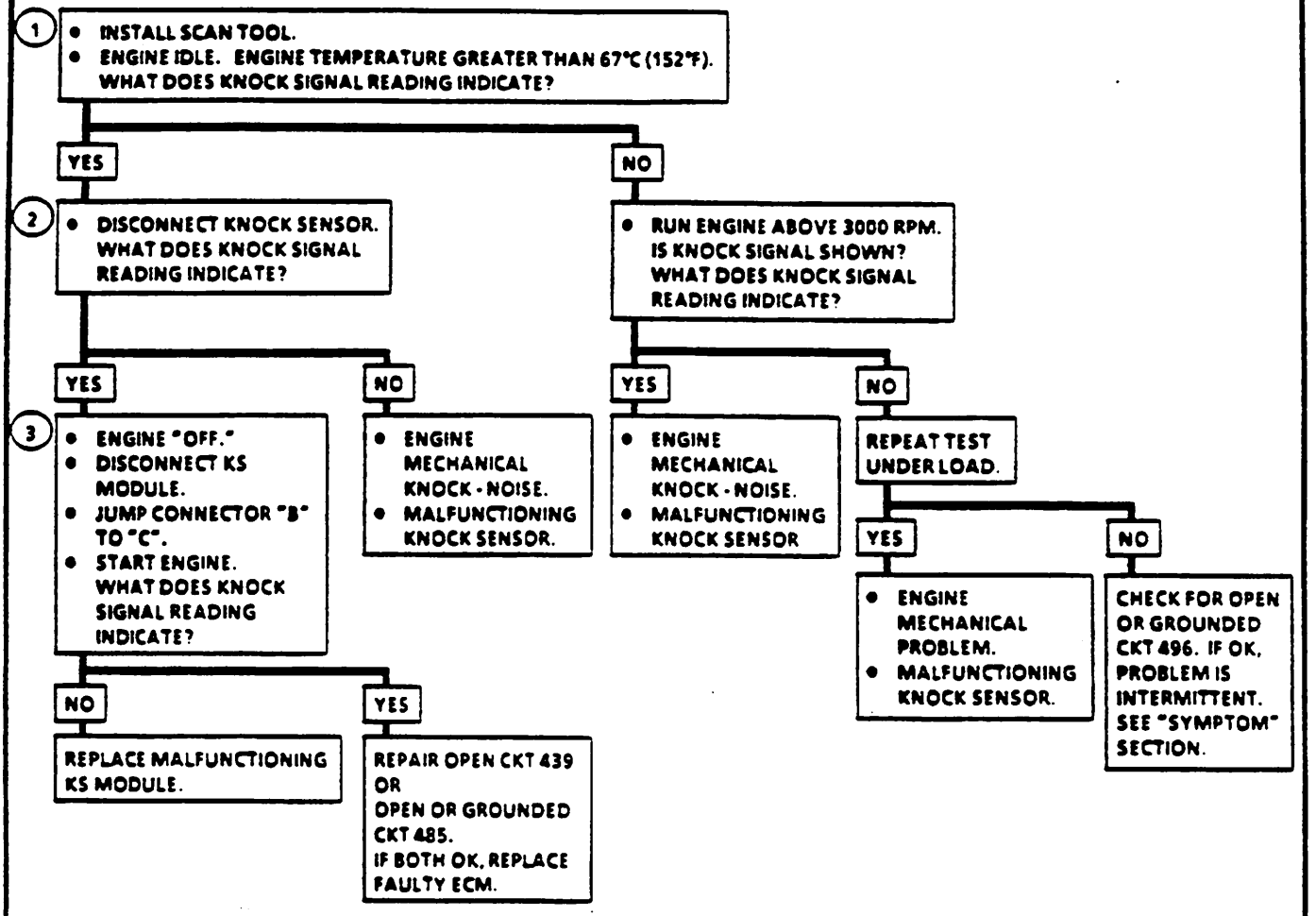
An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry, that is suspected as causing the intermittent complaint, should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear DTCs following "Clear DTCs Procedure" in "MEFI General Information." Failure to do so may result in DTCs not properly being cleared.

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

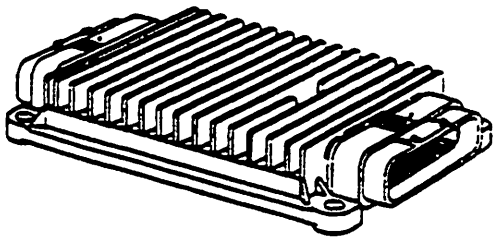
DTC 43

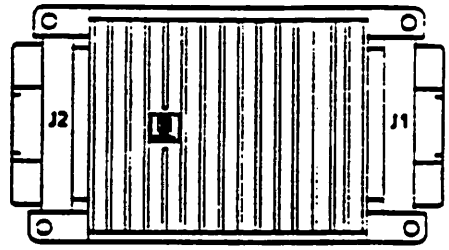
KNOCK SENSOR (KS) SYSTEM
SCAN DIAGNOSTICS



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION

7-6-93
NS 13619





PS 17655

DTC 51

CALIBRATION MEMORY 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 calibrations or changes to these calibrations that may alter the designed function of MEFI.

DTC Chart Test Description: Number(s) below refer to circled number(s) on the diagnostic chart. They are reference numbers, not steps to perform chart.

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

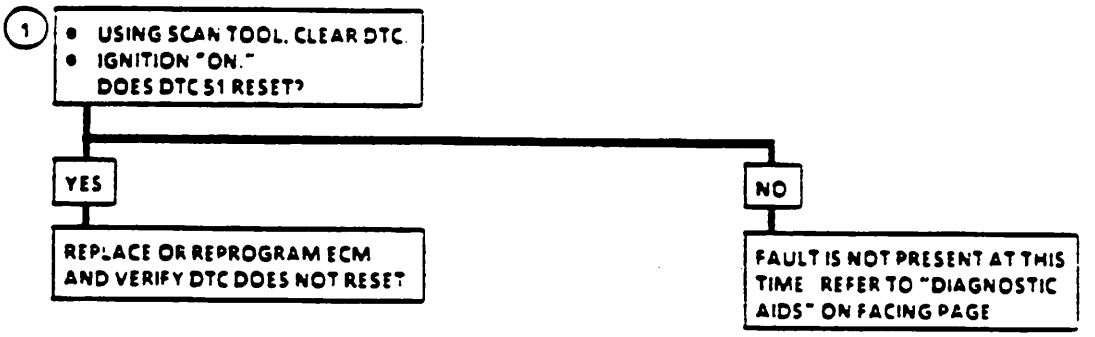
Important

- Vehicles with MEFI can be reprogrammed to correct this failure or replaced with a factory programmed ECM for your specific application.

Diagnostic Aids: An intermittent DTC 51 may be caused by a bad cell in the EEPROM that is sensitive to temperature changes. If DTC 51 failed more than once, but is intermittent, replace ECM.

DTC 51

CALIBRATION MEMORY FAILURE
SCAN DIAGNOSTICS



WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION

4-6-93
MS 13557

SYMPTOMS
TBI

TBI SYMPTOMS
CONTENTS

IMPORTANT PRELIMINARY CHECKS

BEFORE USING THIS SECTION

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

1. The ECM is operating correctly.
2. There are no diagnostic trouble codes stored.

SYMPTOM

Verify the customer complaint, and locate the correct symptom in the table of contents. Check the items indicated under that symptom.

VISUAL/PHYSICAL CHECK

Several of the symptom procedures call for a careful visual/physical check. 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. These checks should include:

- ECM grounds and sensors for being clean, tight and in their proper locations.
- Vacuum hoses for splits, kinks, and proper connections. Check thoroughly for any type of leak or restriction.
- Air leaks at throttle body mounting area and intake manifold sealing surfaces.
- Ignition wires for cracking, hardness, proper routing and carbon tracking
- Wiring for proper connections, pinches and cuts. If wiring harness or connector repair is necessary, refer to "General Information" section for correct procedure.
- Moisture in distributor cap, primary or secondary ignition circuit connections.
- Salt corrosion on electrical connections and exposed throttle body linkages.

INTERMITTENTS

Definition: Problem occurs randomly. May or may not store a DTC.

- DO NOT use the diagnostic trouble code charts for intermittent problems, unless instructed to do so. If a fault is intermittent, incorrect use of diagnostic trouble code charts may result in replacement of good parts.

- Most intermittent problems are caused by faulty electrical connections or wiring. Perform careful check of suspected circuits for:
  - Poor mating of the connector halves, or terminals not fully seated in the connector body (backed out or loose).
  - Improperly formed or damaged terminals and or connectors. All connector terminals and connectors in problem circuit should be carefully reformed or replaced to insure proper contact tension.
  - Poor terminal to wire connection (crimping). This requires removing the terminal from the connector body to check. Refer to "Wiring Harness Service" in "General Information" section.

- If a visual/physical check does not find the cause of the problem, the MEFI system can be tested with a voltmeter or a scan tool connected while observing the suspected circuit. An abnormal reading, when the problem occurs, indicates the problem may be in that circuit.

- An intermittent may be caused by:
  - Electrical system interference caused by a sharp electrical surge. Normally, the problem will occur when the faulty component is operated.
  - Improper installation of electrical options, such as lights, ship to shore radios, sonar, etc.
  - Knock sensor wires should be routed away from spark plug wires, ignition and charging system components.
  - Secondary ignition shorted to ground.
  - Arching at spark plug wires, plugs or open ignition coil ground (coil mounting brackets).
  - Part internal circuitry shorted to ground such as starters, relays and alternators.
  - Poor connection or open in CKT 453 (reference low/system ground) from ECM to ignition control module.

HARD START

Definition: Engine cranks OK, but does not start for a long time. Engine does eventually run, or may start but immediately dies.

PRELIMINARY CHECKS

- Make sure proper starting procedure is being used. See Owner's Manual.
- Perform the careful visual/physical checks as described at the start of "TBI Symptoms" section.

FUEL SYSTEM

- **CHECK:** Fuel pump relay - Fuel pump should operate for 2 seconds when ignition is turned "ON." Also look for open in CKT 465, fuel pump relay drive. Refer to CHART A-4 in "Diagnosis" section.
- **CHECK:** Fuel filters and water separator.
- **CHECK:** For contaminated fuel.
- **CHECK:** For vapor lock condition or engine flooding, check fuel pressure. Refer to CHART A-4 in "Diagnosis" section.

IGNITION SYSTEM

- **CHECK:** Ignition timing - Refer to "On-Vehicle Service" section.
- **CHECK:** Ignition wires for cracking, hardness and proper connections at both distributor cap and spark plugs.
- **CHECK:** For wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary.
- **CHECK:** Distributor cap inside and out for moisture, dust, cracks, burns, and arcing to coil mounting screws.
- **CHECK:** Distributor for:
  - Worn shaft.
  - Bare and shorted wires.
  - Pick-up coil resistance and connections.
  - Try to turn distributor shaft by hand Drive pin may be broken.

SENSORS AND CONTROLS

- **CHECK:** Engine Coolant Temperature (ECT) sensor and Manifold Absolute Pressure (MAP) sensor - Ground CKT 814 for these sensors could have possible open and set a DTC 14 and/or DTC 33. Refer to these scan or non-scan code system diagnostics.
- **CHECK:** Throttle Position (TP) sensor Ground CKT 813 could have a possible open and set DTC 21.
- **CHECK:** TP sensor - If a sticking throttle shaft or binding linkage causes a high TP sensor voltage, a scan tool and/or voltmeter should read less than .7 volt with throttle closed, or at idle position.
- **CHECK:** IAC operation. Refer to "Idle Air Control Function Test," CHART A-7.

MECHANICAL CHECK

- **CHECK:** For restricted exhaust.
- **CHECK:** Engine compression.
- **CHECK:** Proper camshaft timing/valve train problem.

SURGES

Definition: Engine power variation under steady throttle or cruise. Feels like the engine speeds up and slows down with no change in the throttle control.

PRELIMINARY CHECKS

- Perform the visual/physical checks as described at the start of "TBI Symptoms" section.

FUEL SYSTEM

- **CHECK:** Fuel filter. Replace if dirty or plugged.
- **CHECK:** Fuel pressure while condition exists. Refer to CHART A-4 of "Diagnosis" section.

IGNITION SYSTEM

- **CHECK:** 4-terminal IC connector at distributor and if routing of wires are near spark plug wires
- **CHECK:** Condition of IC module, coils and spark plug wires.
- **CHECK:** Intermittent ground connection on ignition coil.
- **CHECK:** Proper operation of IC, ignition timing for advancing or retarding.
- **CHECK:** Condition of distributor cap, rotor, and spark plug wires.
- **CHECK:** Distributor pick-up coil terminal for clean connection.
- **CHECK:** Spark plugs. Remove spark plugs, check for fuel fouled, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary.

SENSORS AND CONTROLS

- **CHECK:** MAP or ECT sensor grounds CKT 814 for intermittent opens. If intermittent for very brief period will not set DTC and cause a surge.
- **CHECK:** MAP sensor 5 volt reference CKT 416E and MAP sensor signal CKT 432 for intermittent short to grounds or opens. If intermittent for very brief period will not set DTC and cause a surge.

ADDITIONAL CHECKS

- **CHECK:** Proper alternator output voltage.
- **CHECK:** For vacuum lines for leaks on kinks.
- **CHECK:** For RPM reduction mode.
- **CHECK:** ECM grounds for being clean, tight and in their proper locations.

HESITATION, SAG, STUMBLE

Definition: Momentary lack of response as the throttle is opened. Can occur at all engine speeds. May cause engine to stall if severe enough.

PRELIMINARY CHECKS

- Perform the important preliminary checks as described at the start of "TBI Symptoms" section.

FUEL SYSTEM

- **CHECK:** For water contaminated fuel and dirty or restricted fuel filter.
- **CHECK:** Fuel pressure. Refer to CHART A-4 in "Diagnosis" section.
- **CHECK:** Fuel injectors.
- **CHECK:** Worn throttle linkage.

IGNITION SYSTEM

- **CHECK:** IC system for proper timing and advancing.
- **CHECK:** Spark plug wires for being faulty, fouled or improperly gapped spark plugs.
- **CHECK:** For RPM reduction mode.
- **CHECK:** KS system operation.

SENSORS AND CONTROLS

- **CHECK:** TP sensor - For binding or sticking or salt corrosion. TP sensor voltage should increase as throttle is moved toward Wide Open Throttle (WOT).
- **CHECK:** TP sensor - 5 volt reference CKT 416 for open, DTC 21 may be set.
- **CHECK:** TP sensor circuit for open or grounds, DTC 21 may be set.
- **CHECK:** MAP output voltage check.

ADDITIONAL CHECKS

- **CHECK:** Proper alternator output voltage.
- **CHECK:** For faulty or incorrect thermostat.
- **CHECK:** Throttle linkage for sticking or binding or worn.

DETONATION/SPARK KNOCK

Definition: A mild to severe ping, usually worse under acceleration or heavy load. The engine makes sharp metallic knocks that change with throttle opening.

PRELIMINARY CHECKS

- Perform the careful visual/physical checks as described at the start of "Diagnosis" section.

NOTICE: If scan tool is being used, and readings are normal (per facing page of OBD system checks) and there are no engine mechanical faults, fill fuel tank with a premium gasoline and re-evaluate detonation/or spark knock.

IGNITION SYSTEM

- **CHECK:** Ignition timing.
- **CHECK:** KS system operation and if routing of wires are near secondary or primary ignition wires.
- **CHECK:** Ignition system ground.
- **CHECK:** Spark plugs for proper heat range and gap.

COOLING SYSTEM

- **CHECK:** For obvious overheating problems:
  - Loose water pump belt or faulty or incorrect water pump.
  - Restriction in cooling system.
- **CHECK:** Faulty or incorrect thermostat.

FUEL SYSTEM

- **CHECK:** For contaminated fuel.
- **CHECK:** For poor fuel quality and proper octane rating.
- **CHECK:** Fuel pressure. Refer to CHART A-4 in "Diagnosis" section.

SENSORS AND CONTROLS

- **CHECK:** ECT - Which has shifted in value. Refer to scan or non-scan diagnosis in "Diagnosis" section.
- **CHECK:** TP sensor - For binding, sticking or salt corrosion. Voltage should increase as throttle is moved toward Wide Open Throttle (WOT).

ENGINE MECHANICAL

- **CHECK:** Low oil level.
- **CHECK:** For excessive oil in the combustion chamber.
  - Valve oil seals for leaking.
- **CHECK:** Perform a compression test.
- **CHECK:** Combustion chambers for excessive carbon build-up. Remove carbon with top engine cleaner and follow instructions on can.
- **CHECK:** Camshaft timing.
- **CHECK:** For incorrect basic engine parts such as cam, heads, pistons, etc.

LACK OF POWER, SLUGGISH OR SPONGY

(Page 1 of 2)

Definition: Engine delivers less than expected power. Little or no increase in speed when throttle control is moved toward Wide Open Throttle (WOT).

PRELIMINARY CHECKS

- Perform the careful visual/physical checks as described at the start of "TBI Symptoms" section.
- Remove flame arrestor and check for dirt, or for being plugged. Replace as necessary.

FUEL SYSTEM

- **CHECK:** Dirty or plugged fuel filter or water separator. Refer to CHART A-4 in "Diagnosis" section.
- **CHECK:** For contaminated fuel.
- **CHECK:** Injector driver CKTs 467 or 468 for open.
- **CHECK:** Improper fuel pressure.

IGNITION SYSTEM

- **CHECK:** Initial engine timing.
- **CHECK:** Secondary ignition voltage, check per manufacturers' procedures.
- **CHECK:** For proper operation of IC/KS operation, an open or short to ground in CKT 423 IC or 485 KS will set a DTC 42 or 43. Refer to scan or non-scan diagnostics in "Diagnosis" section.

SENSORS AND CONTROLS

- **CHECK:** ECT and MAP sensors - Ground CKT 814 for these sensors could have possibly open and set a DTC 14 and/or 33. Refer to these scan or non-scan diagnostics in "Diagnosis" section.
- **CHECK:** TP sensor circuit if DTC 21 set for open or grounds. Refer to these scan or non-scan diagnostics in "Diagnosis" section.
- **CHECK:** TP sensor - If a sticky throttle shaft or binding linkage causes a high TP sensor voltage. A scan tool and/or voltmeter should read less than .7 volt with throttle closed or at idle position. Refer to scan or non-scan diagnostics in "Diagnosis" section.
- **CHECK:** If engine is in RPM reduction mode.
- **CHECK:** Diagnostic test CKT 451 for being grounded, will lower maximum RPMs.

LACK OF POWER, SLUGGISH OR SPONGY

(Page 2 of 2)

Definition: Engine delivers less than expected power. Little or no increase in speed, when throttle control is moved toward Wide Open Throttle (WOT).

ENGINE MECHANICAL

- **CHECK:** Restricted exhaust system.
- **CHECK:** Engine compression.
- **CHECK:** Valve timing and for proper or worn camshaft.

ADDITIONAL CHECKS

- **CHECK:** Proper alternator output voltage.
- **CHECK:** ECM grounds for being clean, tight and in their proper locations.
- **CHECK:** Excessive resistance on bottom of boat (dirt, barnacles, etc.).
- **CHECK:** Propeller for proper size and pitch for application.

CUTS OUT, MISSES

(Page 1 of 2)

Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases. The exhaust has a steady spitting sound at idle or low speed.

PRELIMINARY CHECKS

- Perform the important preliminary checks as described at the start of the "TBI Symptoms" section.

IGNITION SYSTEM

- **CHECK:** For cylinder miss:
  1. Start engine, allow engine to stabilize, record RPM, then disconnect IAC motor. Stop engine, ground one spark plug wire at a time. Restart engine and record RPM.
  2. If there is an RPM drop on all cylinders, go to "Stalling, Rough, or Incorrect Idle" section. Reconnect IAC motor with engine "OFF."
  3. If there is no RPM drop on one or more cylinders, or excessive variation in RPM drop, check for spark on the suspected cylinder(s).
  4. If no spark, refer to "Distributor Ignition System Check," CHART A-6 for further diagnosis.
  5. If there is a spark, remove spark plug(s) in these cylinders and check for:
     - Insulation cracks.
     - Insulator cracks.
     - Wear.
     - Improper gap.
     - Burned electrodes.
     - Heavy deposits.
- **CHECK:** Spark plug wire resistance (should not exceed 30,000 ohms).
- **CHECK:** Ignition coil. Refer to "Distributor Ignition System Check," CHART A-6 of "Diagnosis" section.
- **CHECK:** With engine running, spray distributor cap and spark plug wires with a fine mist of water to check for shorts.

FUEL SYSTEM

- **CHECK:** For contaminated fuel or restricted fuel filter.
- **CHECK:** Fuel pressure. Refer to CHART A-4 in "Diagnosis" section.
- **CHECK:** Fuel injectors.

SENSOR AND CONTROLS

- **CHECK:** TP sensor circuit for open or grounds in CKT 417 TP sensor signal or CKT 416 TP sensor 5 volt reference.

CUTS OUT, MISSES

(Page 2 of 2)

Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases. The exhaust has a steady spitting sound at idle or low speed.

ENGINE MECHANICAL

- **CHECK:** Cylinder compression.
- **CHECK:** Remove rocker covers, check for bent push rods, worn rocker arms, broken valve springs, worn camshaft lobes. Repair or replace as necessary.

ADDITIONAL CHECKS

- **CHECK:** For EMI interference. A missing condition can be caused by Electromagnetic Interference (EMI) on the reference circuit. EMI can usually be detected by monitoring engine RPM with a scan tool or a tachometer. A sudden increase in RPM with little change in actual engine RPM change, indicates EMI is present. If the problem exists, check routing of secondary wires, check ground circuit.

ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING

(Page 1 of 2)

Definition: Engine runs unevenly or rough at idle, also the idle may vary in RPM (called hunting). Either condition may be severe enough to cause stalling. Engine idles at incorrect speed.

PRELIMINARY CHECKS

- Perform the important preliminary checks as described at the start of "TBI Symptoms" section.

FUEL SYSTEM

- **CHECK:** For open in CKTs 467 or 468/injectors drivers. Refer to CHART A-3 in "Diagnosis" section.
- **CHECK:** For fuel injector(s) leaking, fuel pressure. Refer to CHART A-4 in "Diagnosis" section.
- **CHECK:** Fuel injectors.

IGNITION SYSTEM

- **CHECK:** Ignition timing.
- **CHECK:** The following circuits for possible open, CKTs 424, 430 and 423.
- **CHECK:** The following circuits for possible short to ground, CKTs 430, 424, and 423. Refer to mechanization drawings at the start of the "Diagnosis" section for circuit locations. Then use "Diagnosis" section for affected circuit.
- **CHECK:** Ignition system. Spark plugs, wires, etc.

SENSORS AND CONTROLS

- **CHECK:** IAC operation. Refer to "Idle Air Control Functional Test," CHART A-7 in the "Diagnosis" section.
- **CHECK:** The following circuits for possible open CKTs 410, 417, 416, 813 and 814. Refer to mechanization drawings at the start of the "Diagnosis" section for circuit locations.
- **CHECK:** For possible short to ground in CKT 417, TP sensor signal, CKT 416 TP sensor 5 volt reference and CKT 451 diagnostic test circuit.
- **CHECK:** MAP sensor for response and accuracy. Refer to "MAP Output Check" in "Diagnosis" section.
- **CHECK:** TP sensor - For sticking throttle shaft, binding linkage and for salt corrosion. This causes a high TP sensor voltage (open throttle indication), the ECM will not control idle. Check voltage with a scan tool or voltmeter. Voltage should read approximately .7 volt closed throttle and approximately 5 volts at Wide Open Throttle (WOT).

ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING

(Page 2 of 2)

Definition: Engine runs unevenly or rough at idle, also the idle may vary in RPM (called hunting). Either condition may be severe enough to cause stalling. Engine idles at incorrect speed.

ENGINE MECHANICAL

- **CHECK:** Perform a cylinder compression check.
- **CHECK:** For correct camshaft or weak valve springs.

ADDITIONAL CHECKS

- **CHECK:** Throttle linkage for sticking, binding and salt corrosion.
- **CHECK:** Proper alternator output voltage.
- **CHECK:** Battery cables and ground straps should be clean and secure. Erratic voltage will cause IAC to change its position, resulting in poor idle quality.

BACKFIRE (INTAKE)

Definition: Fuel ignites in the manifold, making a loud popping noise.

PRELIMINARY CHECKS

- Perform the important preliminary checks as described at the start of "TBI Symptoms" section.

FUEL SYSTEM

- **CHECK:** Perform fuel system diagnosis. Use CHART A-4 in "Diagnosis" section.
- **CHECK:** Fuel injectors.

SENSOR AND CONTROLS

- **CHECK:** TP sensor circuit for opens or grounds in CKT 416 TP sensor 5 volt reference and CKT 417 TP sensor signal. DTC 21 will be set. Use "Diagnosis" section.

IGNITION SYSTEM

- **CHECK:** Opens and grounds in CKTs 423, 424 and 430, refer to "Distributor Ignition System Check," CHART A-6 in "Diagnosis" section.
- **CHECK:** Ignition timing and for IC functioning properly
- **CHECK:** Proper output voltage of ignition coil.
- **CHECK:** For crossfire between spark plugs, (distributor cap, spark plug wires and proper routing of plug wires).
- **CHECK:** Spark plug wires and boots.
- **CHECK:** For faulty spark plugs.

ENGINE MECHANICAL

- **CHECK:** Compression - Look for sticking or leaking valves.
- **CHECK:** Valve timing, broken or worn valve train parts.

BACKFIRE (EXHAUST)

Definition: Fuel ignites in the exhaust system, making a loud popping noise.

PRELIMINARY CHECKS

- Perform the important preliminary checks as described at the start of "TBI Symptoms" section.

IGNITION SYSTEM

- **CHECK:** Opens and grounds in CKTs 423, 424 and 430, refer to "Distributor Ignition System Check," CHART A-6 in "Diagnosis" section.
- **CHECK:** IC for functioning properly, timing for advancing and retarding.
- **CHECK:** Proper output voltage of ignition coil.
- **CHECK:** For crossfire between spark plugs, (distributor cap, spark plug wires and proper routing of plug wires).
- **CHECK:** Spark plug wires and boots.
- **CHECK:** For faulty spark plugs.

ENGINE MECHANICAL

- **CHECK:** Compression. Look for sticking or leaking valves.
- **CHECK:** Valve timing, broken or worn valve train parts

FUEL SYSTEM

- **CHECK:** Perform fuel system diagnosis. Use CHART A-4 in "Diagnosis" section.
- **CHECK:** Fuel injectors.

DIESELING, RUN-ON

Definition: Engine continues to run after key is turned "OFF," but runs very roughly. If engine runs smoothly, check ignition switch and adjustment.

PRELIMINARY CHECKS

- Perform the careful important preliminary checks as described at the start of "TBI Symptoms" section.

IGNITION SYSTEM

- CHECK: IC circuit for functioning properly, timing advancing and retarding.
- CHECK: MEFI relay for proper operation.

COOLING SYSTEM

- CHECK: Faulty or incorrect thermostat.
- CHECK: Engine for overheating, resulting from cooling system restriction.
- CHECK: For loose belts.

FUEL SYSTEM

- CHECK: For leaking injectors. Refer to CHART A-4 in "Diagnosis" section.

POOR FUEL ECONOMY

Definition: Fuel economy is noticeably lower than expected.

PRELIMINARY CHECKS

- Perform the important preliminary checks as described at the start of "Symptoms Diagnosis" section.
- **CHECK:** Owner's driving habits.
- **CHECK:** Flame arrestor for dirt or being plugged.
- **CHECK:** For fuel leaks.

IGNITION SYSTEM

- **CHECK:** IC circuit for functioning properly, timing advancing and retarding.
- **CHECK:** Spark plugs. Remove spark plugs, check for fuel fouled plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary.
- **CHECK:** Knock sensor system operation. Refer to KS system scan or non-scan diagnostics.

FUEL SYSTEM

- **CHECK:** Fuel type. Quality of fuel.
- **CHECK:** Fuel pressure. Refer to CHART A-4 in "Diagnosis" section.

ENGINE MECHANICAL

- **CHECK:** Compression.

ADDITIONAL CHECKS

- **CHECK:** For exhaust system restriction.
- **CHECK:** Excessive resistance on bottom of boat (dirt. barnacles, etc.)
- **CHECK:** Propeller for proper size and pitch for application.

ECM Connector and Symptoms Identification

This chart is to further aid in diagnosis of symptoms. These voltages were derived from a known good engine. The voltages shown were done with the electrical system completely hooked up and operational. The voltages are to help identify what voltage is needed to operate the different circuits. NEVER ATTEMPT TO OBTAIN THESE VOLTAGES BY PROBING WIRES OR CONNECTORS. Serious damage could result to wiring and connectors and loss of engine operation. The voltages you may get may vary due to low battery charge or other reasons, but they should be close.

The "B+" symbol indicates a system voltage.

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

- Engine at operating temperature
- Engine idling (for "Engine Operating" column)
- Test terminal not grounded
- Scan tool not installed

PIN	PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR	NORMAL VOLTAGE		DTC(s) AFFECTED	POSSIBLE SYMPTOMS
					IGNITION "ON"	ENGINE OPERATING		
J1-1	KNOCK SENSOR SIGNAL	485	BLK	KNOCK SENSOR	9.5V	9.5V	43	POOR FUEL ECONOMY, POOR PERFORMANCE, DETONATION
J1-2	ECT SIGNAL	410	YEL	ECT SENSOR	1.95V (2)	1.95V (2)	14	POOR PERFORMANCE, EXHAUST ODOR, ROUGH IDLE, RPM REDUCTION
J1-3	NOT USED	-	-	-	-	-	-	-
J1-4	NOT USED	-	-	-	-	-	-	-
J1-5	MASTER SLAVE	916	YEL	IN LINE BOAT HARNESS	B+	B+	NONE	LACK OF DATA FROM OTHER ENGINE
J1-6	NOT USED	-	-	-	-	-	-	-
J1-7	DIAGNOSIS TEST TERMINAL	451	WHT/BLK	DATA LINK CONNECTOR	B+	B+	NONE	INCORRECT IDLE, POOR PERFORMANCE
J1-8	NOT USED	-	-	-	-	-	-	-
J1-9	MAP SIGNAL	432	LT GRN	MAP SENSOR	4.9V	1.46V (3)	33	POOR PERFORMANCE SURGE, POOR FUEL ECONOMY, EXHAUST ODOR
J1-10	TP SIGNAL	417	DK BLU	TP SENSOR	.62V (4)	.62V (4)	21	POOR PERFORMANCE AND ACCELERATION, INCORRECT IDLE
J1-11	IGNITION FUSED	439	PNK/BLK	SPLICE	B+	B+	NONE	MIL INOP, NO START
J1-12	NOT USED	-	-	-	-	-	-	-
J1-13	TP GROUND	813	BLK	TP SENSOR	0*	0*	21	HIGH IDLE, ROUGH IDLE, POOR PERFORMANCE
J1-14	ECM GROUND	450	BLK/WHT	ENGINE BLOCK	0*	0*	NONE	NO CHANGE
J1-15	TP 5V REF	416	GRY	TP, MAP SENSOR	5V	5V	21, 33	LACK OF POWER, IDLE HIGH
J1-16	BATTERY FEED	440	ORN	SPLICE	B+	B+	NONE	NO START

(1) BATTERY VOLTAGE FOR FIRST TWO SECONDS, THEN 0 VOLTS.
(2) VARIES WITH TEMPERATURE.
(3) VARIES WITH MANIFOLD VACUUM.
(4) VARIES WITH THROTTLE MOVEMENT.
* LESS THAN .5 VOLT (500 mV).

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ECM Connector and Symptoms Identification (1 of 4)

ECM Connector and Symptoms Identification

This chart is to further aid in diagnosis of symptoms. These voltages were derived from a known good engine. The voltages shown were done with the electrical system completely hooked up and operational. The voltages are to help identify what voltage is needed to operate the different circuits. **NEVER ATTEMPT TO OBTAIN THESE VOLTAGES BY PROBING WIRES OR CONNECTORS.** Serious damage could result to wiring and connectors and loss of engine operation. The voltages you may get may vary due to low battery charge or other reasons, but they should be close.

The "B +" symbol indicates a system voltage.

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

- Engine at operating temperature
- Engine idling (for "Engine Operating" column)
- Test terminal not grounded
- Scan tool not installed

PIN	PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR	NORMAL VOLTAGE		DTC(s) AFFECTED	POSSIBLE SYMPTOMS
					IGNITION "ON"	ENGINE OPERATING		
J1-17	NOT USED	-	-	-	-	-	-	-
J1-18	SERIAL DATA	461	ORN/BLK	DATA LINK CONNECTOR	5V	5V	NONE	NO SERIAL DATA
J1-19	NOT USED	-	-	-	-	-	-	-
J1-20	NOT USED	-	-	-	-	-	-	-
J1-21	NOT USED	-	-	-	-	-	-	-
J1-22	NOT USED	-	-	-	-	-	-	-
J1-23	NOT USED	-	-	-	-	-	-	-
J1-24	NOT USED	-	-	-	-	-	-	-
J1-25	NOT USED	-	-	-	-	-	-	-
J1-26	NOT USED	-	-	-	-	-	-	-
J1-27	NOT USED	-	-	-	-	-	-	-
J1-28	NOT USED	-	-	-	-	-	-	-
J1-29	MAP GROUND	814	BLK	MAP SENSOR	0*	0*	33	LACK OF PERFORMANCE EXHAUST ODOR, STALL
J1-30	ECM GROUND	450	BLK/WHT	ENGINE BLOCK	0*	0*	NONE	NO CHANGE
J1-31	MAP, 5V REFERENCE	416E	GRY	MAP SENSOR	5V	5V	33	LACK OF POWER SURGE, ROUGH IDLE, EXHAUST ODOR
J1-32	BATTERY FEED	440	ORN	SPLICE	B+	B+	NONE	NO START

(1) BATTERY VOLTAGE FOR FIRST TWO SECONDS, THEN 0 VOLTS.
(2) VARIES WITH TEMPERATURE.
(3) VARIES WITH MANIFOLD VACUUM.
(4) VARIES WITH THROTTLE MOVEMENT.
* LESS THAN .5 VOLT (500 mV).

7-8-93
PS 18546

ECM Connector and Symptoms Identification (2 of 4)

ECM Connector and Symptoms Identification

This chart is to further aid in diagnosis of symptoms. These voltages were derived from a known good engine. The voltages shown were done with the electrical system completely hooked up and operational. The voltages are to help identify what voltage is needed to operate the different circuits. **NEVER ATTEMPT TO OBTAIN THESE VOLTAGES BY PROBING WIRES OR CONNECTORS.** Serious damage could result to wiring and connectors and loss of engine operation. The voltages you may get may vary due to low battery charge or other reasons, but they should be close.

The "B +" symbol indicates a system voltage.

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

- Engine at operating temperature
- Engine idling (for "Engine Operating" column)
- Test terminal not grounded
- Scan tool not installed

PIN	PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR	NORMAL VOLTAGE		DTC(s) AFFECTED	POSSIBLE SYMPTOMS
					IGNITION "ON"	ENGINE OPERATING		
J2-1	NOT USED	-	-	-	-	-	-	-
J2-2	NOT USED	-	-	-	-	-	-	-
J2-3	NOT USED	-	-	-	-	-	-	-
J2-4	NOT USED	-	-	-	-	-	-	-
J2-5	INJECTOR DRIVER	469	LT GRN	INJECTOR	B+	B+	NONE	ROUGH IDLE, LACK OF POWER, STALL
J2-6	IC REF LOW	463	BLK/WHT	IGNITION CONTROL MODULE	0*	0*	NONE	NO CHANGE
J2-7	NOT USED	-	-	-	-	-	-	-
J2-8	IC REF HIGH	430	PPL/WHT	IGNITION CONTROL MODULE	5V	1.6V	NONE	NO RESTART
J2-9	FUEL PUMP RELAY DRIVER	465	DK GRN/WHT	FUEL PUMP RELAY	0* (1)	B+	NONE	NO START
J2-10	NOT USED	-	-	-	-	-	-	-
J2-11	NOT USED	-	-	-	-	-	-	-
J2-12	NOT USED	-	-	-	-	-	-	-
J2-13	IAC "A" LOW	442	BLU/BLK	IAC VALVE	NOT USABLE	NOT USABLE	NONE	ROUGH UNSTABLE OR INCORRECT IDLE
J2-14	IAC "B" HIGH	443	GRN/WHT	IAC VALVE	NOT USABLE	NOT USABLE	NONE	ROUGH UNSTABLE OR INCORRECT IDLE
J2-15	FUEL INJECTOR GROUND	450	BLK/WHT	ENGINE GROUND	0*	0*	NONE	NO CHANGE
J2-16	NOT USED	-	-	-	-	-	-	-

(1) BATTERY VOLTAGE FOR FIRST TWO SECONDS, THEN 0 VOLTS.
(2) VARIES WITH TEMPERATURE.
(3) VARIES WITH MANIFOLD VACUUM.
(4) VARIES WITH THROTTLE MOVEMENT.
* LESS THAN .5 VOLT (500 mV).

7-8-93
PS 18547

ECM Connector and Symptoms Identification (3 of 4)

ECM Connector and Symptoms Identification

This chart is to further aid in diagnosis of symptoms. These voltages were derived from a known good engine. The voltages shown were done with the electrical system completely hooked up and operational The voltages are to help identify what voltage is needed to operate the different circuits. **NEVER ATTEMPT TO OBTAIN THESE VOLTAGES BY PROBING WIRES OR CONNECTORS.** Serious damage could result to wiring and connectors and loss of engine operation. The voltages you may get may vary due to low battery charge or other reasons, but they should be close.

The "B +" symbol indicates a system voltage.

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

- Engine at operating temperature
- Engine idling (for "Engine Operating" column)
- Test terminal not grounded
- Scan tool not installed

PIN	PIN FUNCTION	CKT #	WIRE COLOR	COMPONENT CONNECTOR	NORMAL VOLTAGE		DTC(s) AFFECTED	POSSIBLE SYMPTOMS
					IGNITION "ON"	ENGINE OPERATING		
J2-17	NOT USED	-	-	-	-	-	-	-
J2-18	NOT USED	-	-	-	-	-	-	-
J2-19	NOT USED	-	-	-	-	-	-	-
J2-20	FUEL INJECTOR GROUND	450	BLK/WHT	ENGINE GROUND	0*	0*	NONE	NO CHANGE
J2-21	INJECTOR DRIVER	467	DK BLU	INJECTOR	B+	B+	NONE	ROUGH IDLE, LACK OF POWER, STALLING
J2-22	NOT USED	-	-	-	-	-	-	-
J2-23	IC SIGNAL	423	WHT	IGNITION CONTROL MODULE	0*	1.2V	42	STALL, WILL RESTART IN BYPASS MODE, LACK OF POWER
J2-24	IC BYPASS	424	TAN/BLK	IGNITION CONTROL MODULE	0*	4.5V	42	LACK OF POWER, FIXED TIMING
J2-25	NOT USED	-	-	-	-	-	-	-
J2-26	NOT USED	-	-	-	-	-	-	-
J2-27	NOT USED	-	-	-	-	-	-	-
J2-28	IAC "A" HIGH	441	BLU/WHT	IAC VALVE	NOT USABLE	NOT USABLE	NONE	ROUGH UNSTABLE OR INCORRECT IDLE
J2-29	IAC "B" LOW	444	GRN/BLK	IAC VALVE	NOT USABLE	NOT USABLE	NONE	ROUGH UNSTABLE OR INCORRECT IDLE
J2-30	NOT	-	-	-	-	-	-	-
J2-31	MALFUNCTION INDICATOR LAMP	419	BRN/WHT	DLC	0*	0*	NONE	LAMP INOP
J2-32	NOT USED	-	-	-	-	-	-	-

(1) BATTERY VOLTAGE FOR FIRST TWO SECONDS, THEN 0 VOLTS.
(2) VARIES WITH TEMPERATURE.
(3) VARIES WITH MANIFOLD VACUUM.
(4) VARIES WITH THROTTLE MOVEMENT.
* LESS THAN .5 VOLT (500 mV).

7-8-93
PS 18548

ECM Connector and Symptoms Identification (4 of 4)

ON BOARD
SERVICES
TBI

ON-BOARD SERVICE 5.0L & 5.7L THROTTLE BODY INJECTION (TBI)

CONTENTS

ENGINE CONTROL MODULE (ECM) REPLACEMENT

Figure 1

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

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

Remove or Disconnect

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

Important

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

Install or Connect

1. New ECM to mounting bracket.
2. Four ECM mounting bolts.

Tighten

- Four ECM mounting bolts to 10 - 14 N·m (88 - 124 lb. in.).

3. "J1" and "J2" connector to ECM.
4. Negative battery cable.

SENSORS AND CONTROLS

ENGINE COOLANT TEMPERATURE (ECT) SENSOR

Figure 2

NOTICE: Care must be taken when handling engine coolant temperature sensor. Damage to engine coolant temperature sensor will affect proper operation of the MEFI system.

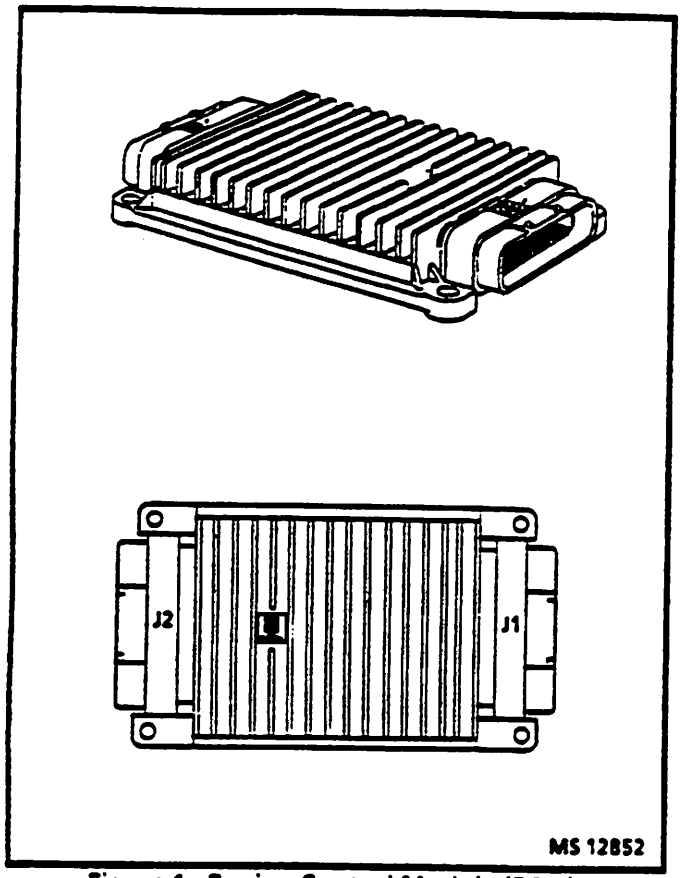


Figure 1 - Engine Control Module (ECM)

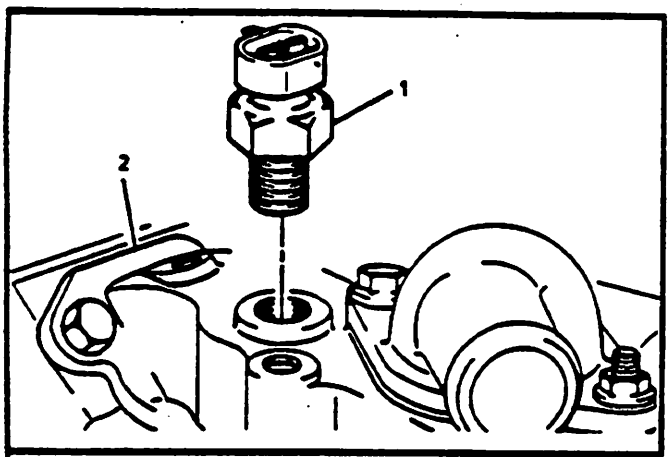


Figure 2 - Engine Coolant Temperature Sensor (ECT)

Remove or Disconnect

1. Negative battery cable.
2. Electrical connector.
3. Coolant temperature sensor.

Important

- Coat temperature sensor threads with teflon tape sealant prior to reassembly.

Install or Connect

1. Coolant temperature sensor into intake manifold.
2. Electrical connector.
3. Negative battery cable.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

Figure 3

Remove or Disconnect

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

Important

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

Install or Connect

1. Vacuum hose to MAP sensor.
2. MAP sensor attaching bolts.

Tighten

- Two bolts to 5 - 7 N·m (44 - 62 lb. in.).

3. Electrical connector.
4. Negative battery cable.

THROTTLE POSITION (TP) SENSOR

Figures 4 and 17

Remove or Disconnect

1. Flame arrestor.
2. Electrical connector from TP sensor.
3. TP sensor attaching screws.
4. TP sensor.

NOTICE: The TP sensor is an electrical component. Do not soak it in any liquid cleaner or solvent as damage may result.

Install or Connect

Important

- If replacing TP sensor, install new screws that are supplied with TP sensor service package.

1. With throttle valve closed, position on throttle shaft, then align the screw holes.
2. TP sensor attaching screws.

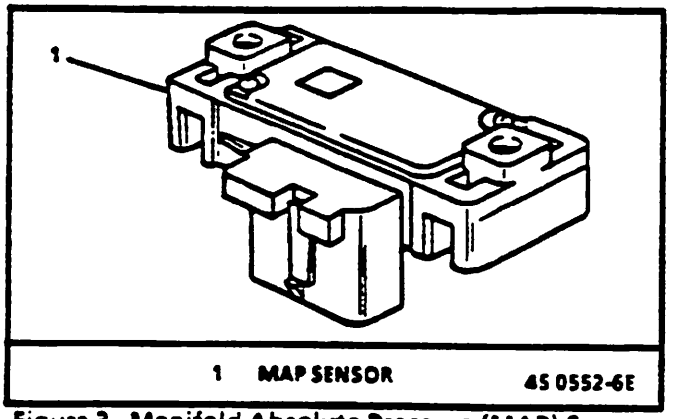


Figure 3 - Manifold Absolute Pressure (MAP) Sensor

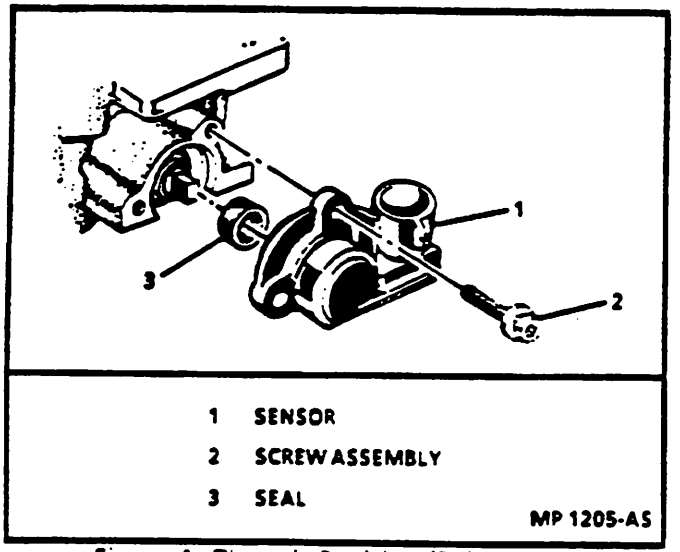


Figure 4 - Throttle Position (TP) Sensor

Tighten

- Screw assemblies to 2.0 N·m (18.0 lb. in.).

3. Electrical connector to TP sensor.
4. Check for TP sensor output voltage.
   - Voltage should be approximately .7v at idle and approximately 5v at WOT.
5. Flame arrestor.

IDLE AIR CONTROL (IAC) VALVE
Figures 5, 6 and 17

Remove or Disconnect

1. Flame arrestor.
2. Electrical connector.
3. IAC valve.
   - On thread mounted units, use a 32 mm 1 - $\frac{1}{4}$" wrench or socket J 35632, (Figure 5).
   - On flange-mounted units, remove screw assemblies (Figure 6).
4. IAC valve gasket or O-ring and discard.

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

Clean and Inspect

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

Important

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

Measure (If Installing a New IAC Valve)

Figures 5 and 6

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

Install or Connect

1. IAC valve into throttle body as follows:
   - Thread-mounted valve - install with new gasket.
   - Flange-mounted valve - install with new lubricated O-ring, using attaching screw assemblies.

NOTICE: New IAC valves have been reset at the factory and should be installed in the throttle body in an "as is" condition without any adjustment.

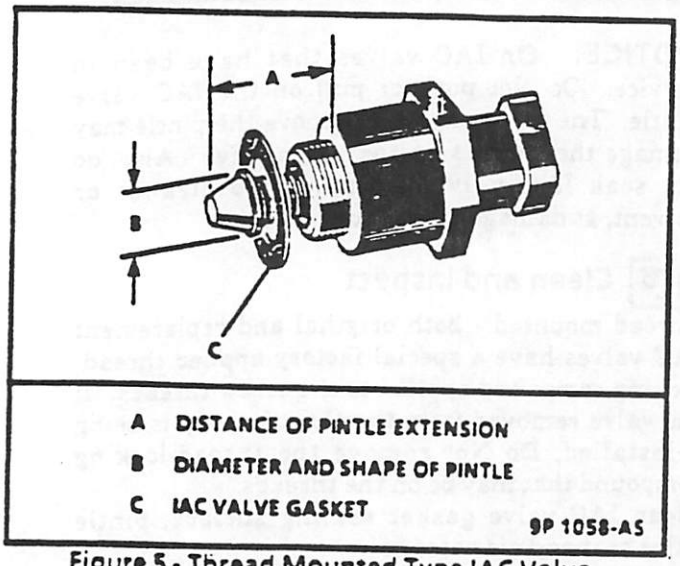


Figure 5 - Thread Mounted Type IAC Valve

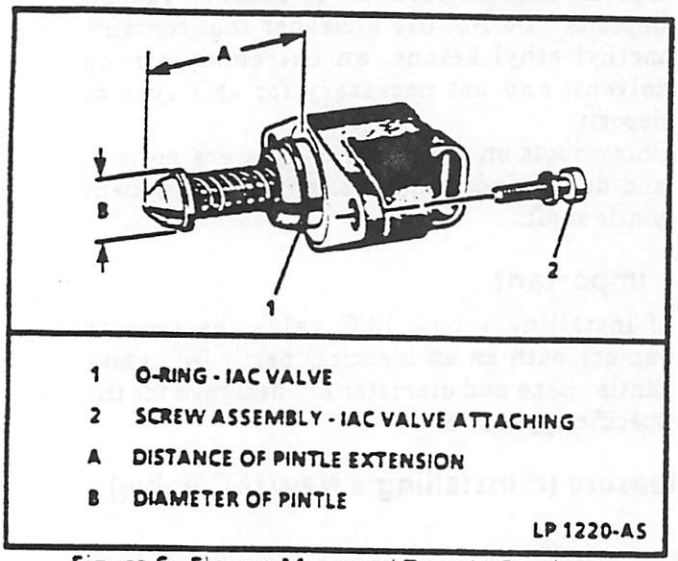


Figure 6 - Flange Mounted Type IAC Valve

Tighten

- Thread-mounted IAC valve assembly to 18.0 N·m (13.0 lb. ft.) with 32 mm (1 - $\frac{1}{4}$") wrench or socket J 35632.
- Flange-mounted attaching screw assemblies to 3.2 N·m (28.0 lb. in.).

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

KNOCK SENSORS (KS)
Figures 7 and 8

Remove or Disconnect

1. Negative battery cable.
2. Wiring harness connector from knock sensor.
3. Knock sensor from engine block.

Install or Connect

1. Knock sensor into engine block. Be sure threads are clean.
   - Tighten to 15 - 22 N·m (11 - 16 lb. ft.).
2. Knock wiring harness connector to the knock sensor.
3. Negative battery cable.

KNOCK SENSOR (KS) MODULE
Figure 9

Remove or Disconnect

1. KS module connector.
2. Attaching screws.
3. KS module.

Important

- The Knock sensor is an electrical component. Do not soak in any liquid cleaner or solvent, as damage to the KS module may result.
- When removing or installing the KS module, caution must be taken to avoid damaging KS mounting studs in module.

Install or Connect

1. KS module.
2. Attaching screws.
3. KS module connector.

DISTRIBUTOR IGNITION (DI) SYSTEM

REPLACEMENT AND REPAIR

Replacement
Figures 10 through 12

Replacement distributors are not available already assembled. Replacement kits contain all the components to assemble a new distributor.

Some components, such as the engine cover, may need to be removed to reach the distributor.

The distributor has a separate coil which is mounted to a bracket on top of the engine.

Remove or Disconnect

1. Negative battery cable.
2. Wiring harness connectors at the side of the distributor cap.
3. Two screws on the sides of the distributor cap.
4. Coil wire and spark plug wires on either the left or right side of the distributor.
5. Distributor cap and move it aside.

- Scribe a mark on the distributor shaft 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.

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 shaft, 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.

Tighten

- Bolt to 40 N·m (30 lb. ft.).

3. Distributor cap.
4. Wiring harness connectors at the side of the distributor.
5. Spark plug wires and coil wire.
6. Negative battery cable.
   - Check the engine timing.

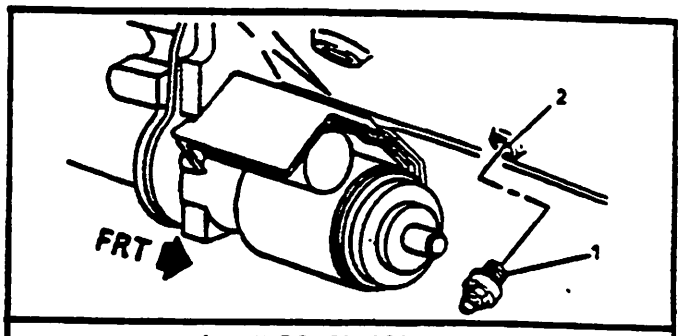
Disassembly

Figure 10

Remove or Disconnect

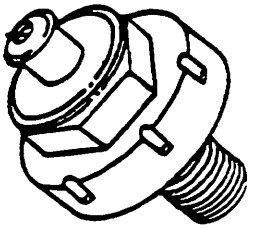
- Any time the distributor is disassembled, the retainer (5) must be replaced. Do not attempt to reuse the old retainer.

1. Screws (1) and washers holding the cap to the housing.
2. Cap (2) from the housing.
   - Place marks on the rotor and the shaft assembly 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).
   A. Mark the shaft and driven gear for reassembly.
   B. Drive out the roll pin with a small punch (Figure 11).
5. Driven gear (14), washer or spring (13), and spring retainer or tang washer (12).
6. Shaft (4) with the pole piece (8) and plate from the housing (11).
7. Retainer (5) from the housing (4) as follows:



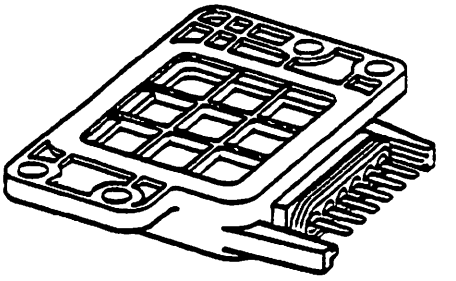
1 KNOCK SENSOR
2 ENGINE BLOCK
6S 2892-6E

Figure 7 - Knock Sensor Location



KNOCK SENSOR (KS)
3S 0023-6E

Figure 8 - Typical Knock Sensor (KS)



NS 15481

Figure 9 - KS Module

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.

- Round retainer:
  A. Wear safety goggles.
  B. Wedge a screwdriver under the edge of the retainer and use a "lift and twist" motion to pry the edge up just far enough to get the metal snips onto the edge.
  C. Use scissor type snips to cut the retainer.
  D. Use needle nose pliers to pull the retainer off the center bushing. Discard the retainer.
- Square retainer:
  A. Wear safety goggles.
  B. Use needle nose pliers to bend two corners upward on the fluted end of the retainer.
  C. Pull the retainer off the center bushing. Discard the retainer.

8. Shield (6).
9. Pickup coil connector from the module (10).
   - Lift the locking tab with a screwdriver.
10. Pickup coil (7).
11. Two screws holding the module to the housing.
12. Module (10).

Inspect

1. Cap for cracks or tiny holes. Replace the cap if it is damaged at all.
2. Metal terminals in the cap for corrosion. Scrape them clean with a knife or replace the cap.
3. Rotor for wear or burning at the outer terminal. The presence of carbon on the terminal indicates rotor wear and the need for replacement.
4. Shaft for shaft-to-bushing looseness. Insert the shaft in the housing. If the shaft wobbles, replace the housing and/or shaft.
5. Housing for cracks or damage.

Measure

- Resistance of pickup coil with an ohmmeter.
  - Connect an ohmmeter to either pickup coil lead and the housing as shown in Figure 12, Step 1. The reading should be infinite. If not, replace the coil.
  - Connect an ohmmeter to both pickup coil leads as shown in Figure 12, Step 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 coil.

Assembly
Figures 10 and 13

Install or Connect

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

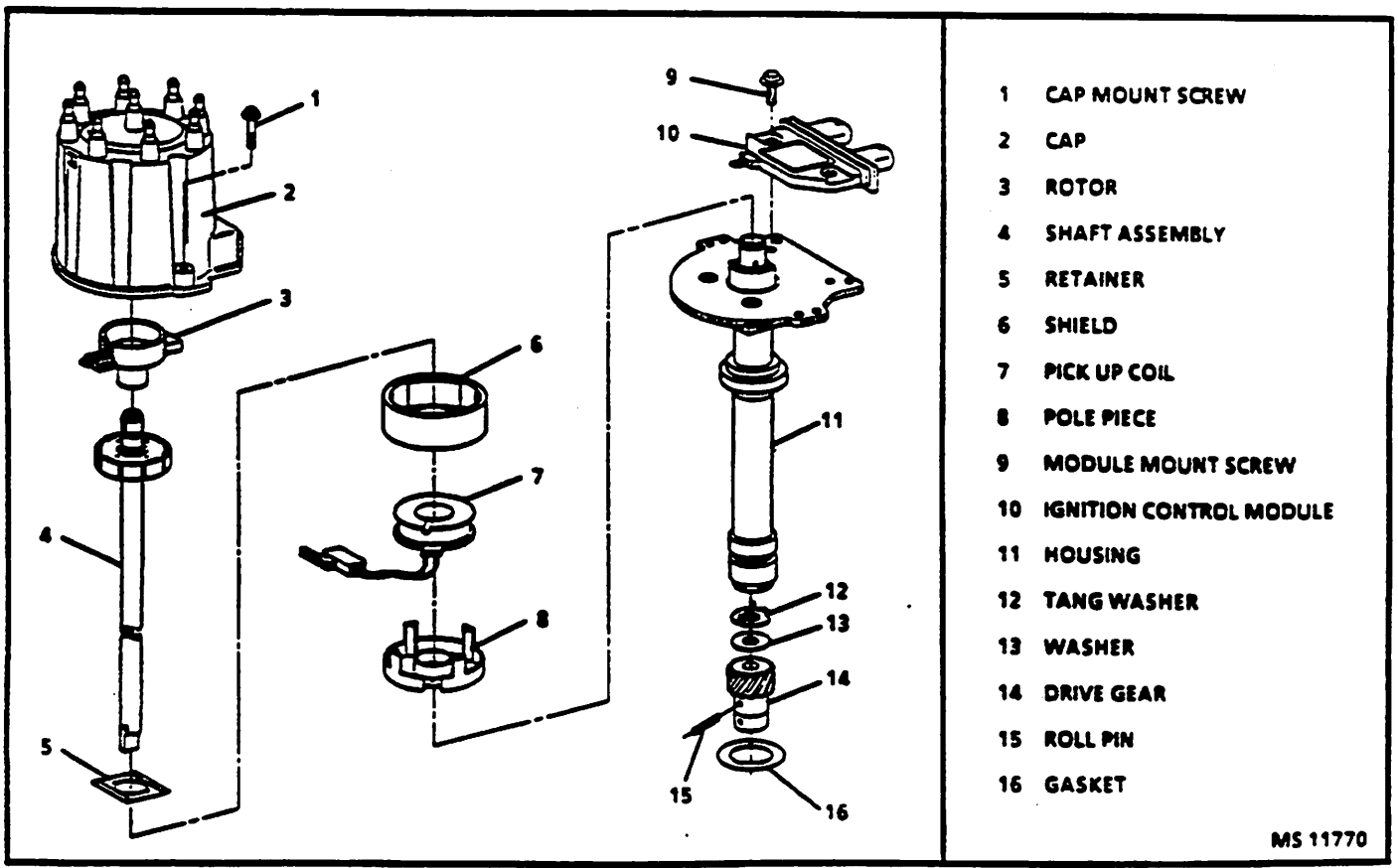


Figure 10 - Eight-Cylinder Engine Distributor Components

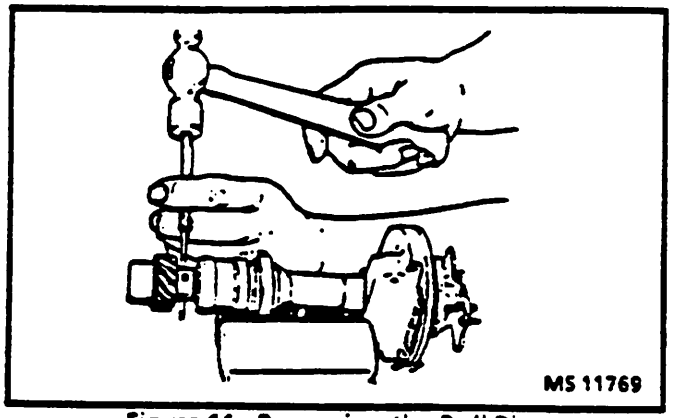


Figure 11 - Removing the Roll Pin

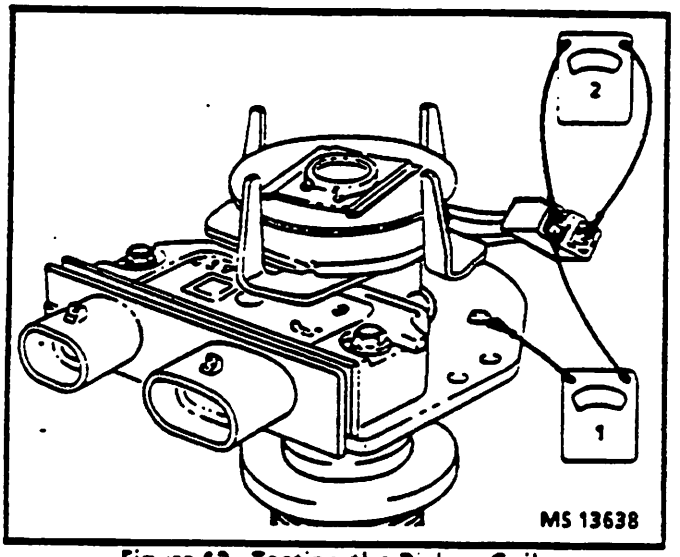


Figure 12 - Testing the Pickup Coil

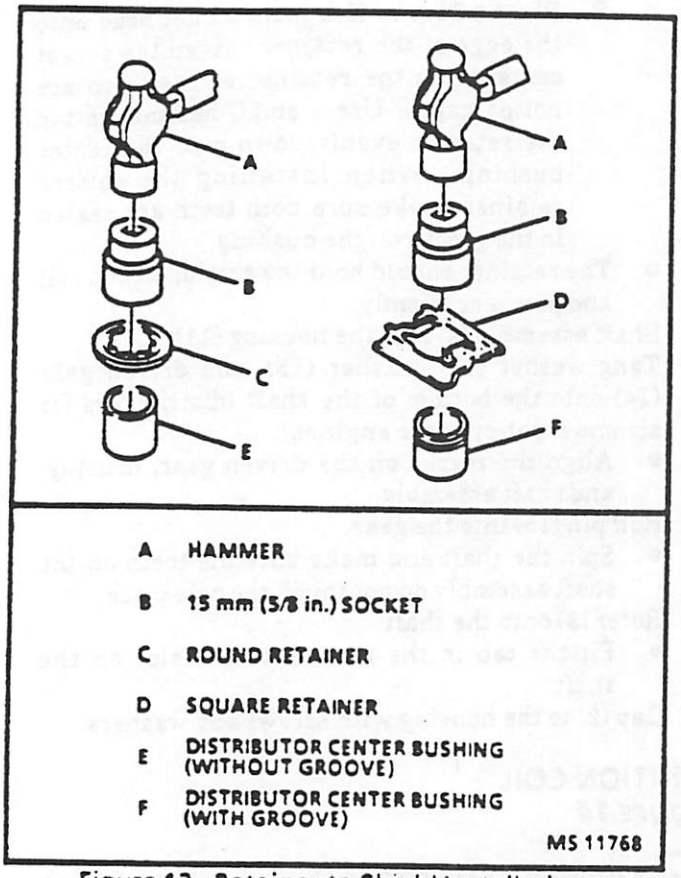
- Lubricate
  - Bottom of the module and the module rest pad in the housing with silicone grease or an equivalent heat transfer substance.

1. Ignition module (10) to the housing (4) with two screws.
2. Pickup coil (7).
   - Fit the tab on the bottom of the coil into the anchor hole in the housing.
3. Pickup coil wiring connector to the module.
   - Make sure the locking tab is in place.
4. Shield (6) onto the coil.
5. Retainer (5) onto the shield.
   - Use a new round retainer if the center bushing in the distributor base has no groove around the outside (Figure 13).
   - Use a new square retainer when there is a groove in the center bushing.
     A. Place the retainer over the center bushing with the teeth pointing upward.
     B. Place a 15 mm (5/8 inch) socket head onto the edge of the retainer. Keep the socket centered on the retainer so the teeth are not damaged. Use a small hammer to tap the retainer evenly down onto the center bushing. When installing the square retainer, make sure both teeth are seated in the groove on the bushing.
   - The retainer should hold the shield, pickup coil and pole piece firmly.
6. Shaft assembly (4) into the housing (11).
7. Tang washer (12), washer (13), and driven gear (14) onto the bottom of the shaft (distributors for six and eight-cylinder engines).
   - Align the marks on the driven gear, housing, and shaft assembly.
8. Roll pin (15) into the gear.
   - Spin the shaft and make sure the teeth on the shaft assembly do not touch the pole piece.
9. Rotor (3) onto the shaft.
   - Fit the tab in the rotor into the slot on the shaft.
10. Cap (2) to the housing with screws and washers.

IGNITION COIL
Figure 14

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 the bracket.

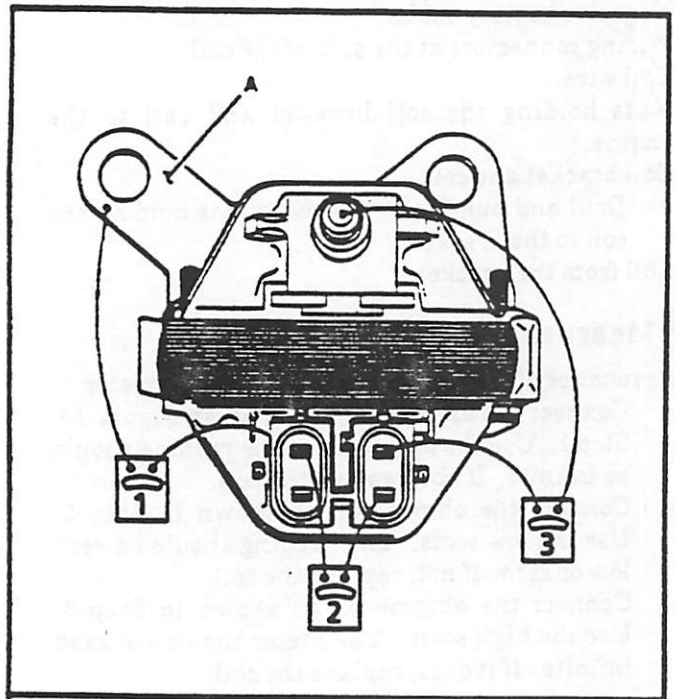
Measure
- Resistance of the ignition coil with an ohmmeter.
  - Connect the ohmmeter as shown in Figure 14, Step 1. Use the high scale. The reading should be infinite. If not, replace the coil.
  - Connect the ohmmeter as shown in Step 2. Use the low scale. The reading should be very low or zero. If not, replace the coil.
  - Connect the ohmmeter as shown in Step 3. Use the high scale. The meter should not read infinite. If it does, replace the coil.



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

MS 11768

Figure 13 - Retainer to Shield Installation



A SCRAPE CLEAN METAL GROUND

MS 13634

Figure 14 - Testing the Ignition Coil

Install or Connect

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

1. Coil to the bracket with two screws.
2. Coil bracket to the engine bracket with studs and nuts.
3. Coil wire.
4. Wiring connectors.
5. Negative battery cable.

IGNITION TIMING SET PROCEDURE

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

install or Connect

1. An inductive pick-up timing light to cylinder number 1 ignition wire.
2. A scan tool or Marine Diagnostic Trouble Code (MDTC) tool to DLC.
   - With engine running, set Marine Diagnostic Trouble Code (MDTC) tool to service mode or scan tool to set timing mode.

NOTICE: The scan tool will not go into set timing mode if DTC 42 is set or if engine speed is above 1600 RPM.

- If using Marine Diagnostic Trouble Code (MDTC) tool, manually adjust throttle to 1000 RPM.
- Shine the timing light at the timing mark indicator located on the timing chain cover.

NOTICE: See manufacturer's specification for timing set specification.

- If adjustment is needed, loosen distributor hold down bolt.
- Rotate distributor to adjust timing.

Tighten

- Distributor hold down bolt to 40 N·m (30 lb. ft.).
- Manually bring throttle to idle.
- Set Marine Diagnostic Trouble Code (MDTC) tool or scan tool to normal mode.

SPARK PLUG REPLACEMENT

Remove or Disconnect

1. Negative battery cable.
2. Spark plug wires and boots.
   - Turn each boot one-half turn before removing it.

- Label the plug wires if the identification numbers have worn off.

3. Spark plugs.

Inspect

- Each plug for wear and gap.

Install or Connect

1. Spark plugs.

Tighten

- Plugs 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. Twists 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.

SPARK PLUG WIRE REPLACEMENT

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

FUEL SYSTEM

FLAME ARRESTOR

Remove or Disconnect

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

Inspect

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

Install or Connect

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

CAUTION:

- **To reduce the risk of fire and personal injury, relieve the fuel system pressure before servicing fuel system components.**
- **After relieving system pressure, a small amount of fuel may be released when servicing fuel lines or connections. To reduce the chance of personal injury, cover fuel line fittings with a shop towel before disconnecting to catch any fuel that may leak out. Place the towel in a approved container when disconnect is completed.**

FUEL CONTROL ON-BOARD SERVICE

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

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

FUEL PRESSURE RELIEF PROCEDURE

Important

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

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

THROTTLE BODY INJECTOR (TBI) UNIT
Figures 15 through 25

Clean

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

NOTICE: The fuel injectors pressure regulator, TP sensor, TP sensor gasket, and IAC valve should not come in contact with solvent or cleaner, as they may be damaged. The fuel injector, pressure regulator, TP sensor, TP sensor gasket, and IAC valve should be removed prior to immersion.

- Clean all metal parts thoroughly and blow dry with compressed air. Be sure that all fuel and air passages are free of dirt and burrs.
- Inspect mating surfaces for damage that could affect gasket sealing and inspect throttle body for cracks in casting.

Thread locking compound supplied in the service repair kit is a small vial of thread-locking compound with directions for use. If material is not available, use Loctite 262 or equivalent.

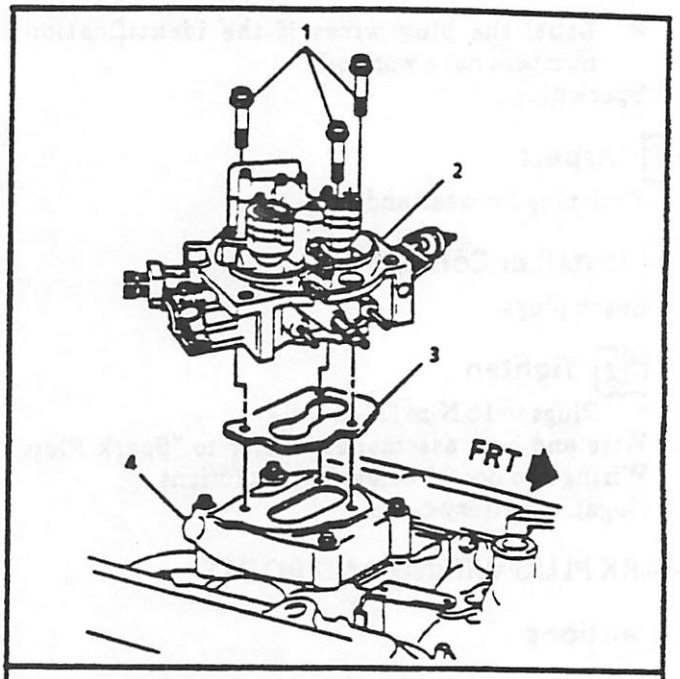
NOTICE: In precoating screws, do not use a higher strength locking compound than recommended, since to do so could make removing the screw extremely difficult, or result in damaging the screw head.

Remove or Disconnect

1. Flame arrestor, breather hoses (if applicable), and gasket. Discard gasket.
2. Electrical connectors - idle air control valve, throttle position sensor, and fuel injectors. (On TBI units, squeeze plastic tabs on injectors and pull straight up.)
3. Grommet with wires from throttle body.
4. Throttle linkage, return spring(s), (wherever applicable).
5. Inlet and outlet fuel line nuts, using back-up wrench.

CAUTION: Refer to "Fuel Pressure Relief Procedure," before disconnecting fuel lines.

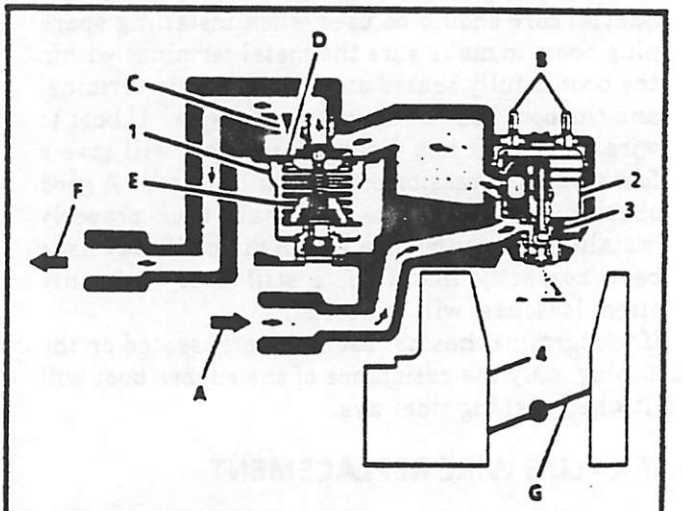
6. Fuel line O-rings from nuts and discard.
7. TBI mounting hardware.
8. TBI unit from adaptor plate.



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

NS 16501

Figure 15 - Replacing 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		

BP 0320-SY

Figure 16 - 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.

9. TBI flange (adaptor mounting) gasket.

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

Inspect

- Manifold bore for loose parts and foreign material.
- Intake manifold mating surface for cleanliness. Also check for burrs that can affect gasket sealing.

Install or Connect

1. New TBI flange (manifold mounting) gasket.
2. TBI with mounting hardware.

Tighten

- Bolts to 16.0 N·m (12.0 lb. ft.).

3. New O-rings on fuel line nuts.
4. Fuel line inlet and outlet nuts by hand.

Tighten

- Fuel line nut to 23.0 N·m (17.0 lb. ft.). (Use backup wrench to prevent TBI nuts from turning.)

5. Throttle linkage, return spring(s), (whenever applicable).
6. Grommet, with wire harness, to throttle body.
7. Electrical connectors, making sure connectors are fully seated and latched.
8. Check to see if throttle is free, by moving the throttle lever to 100% and back to 0% while engine is "OFF."
9. With engine "OFF," and ignition "ON," check for leaks around fuel line nuts.
10. Flame arrestor and new gasket.
11. Start engine and check again for fuel leaks.

TBI FUEL METER COVER ASSEMBLY
Figure 18

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 might also result in a fuel leak between the diaphragm and the regulator container.

Remove or Disconnect

1. Electrical connectors to fuel injectors. (Squeeze plastic tabs and pull straight up.)
2. Long and short fuel meter cover screw assemblies.
3. Fuel meter cover assembly.

NOTICE: DO NOT immerse the fuel meter cover (with pressure regulator) in cleaner, as damage to the regulator diaphragm and gasket could occur.

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

Inspect

- For dirt, foreign material and casting warpage.

Install or Connect

1. New pressure regulator seal, fuel meter outlet passage gasket, and cover gasket.
2. Fuel meter cover assembly.
3. Attaching screw assemblies, precoated with appropriate locking compound to threads. (Short screws are next to injectors.)

Tighten

- Screw assemblies to 3.0 N·m (28.0 lb. in.).

4. Electrical connectors to fuel injectors.
5. With engine "OFF," and ignition "ON," check for leaks around gasket and fuel line couplings.

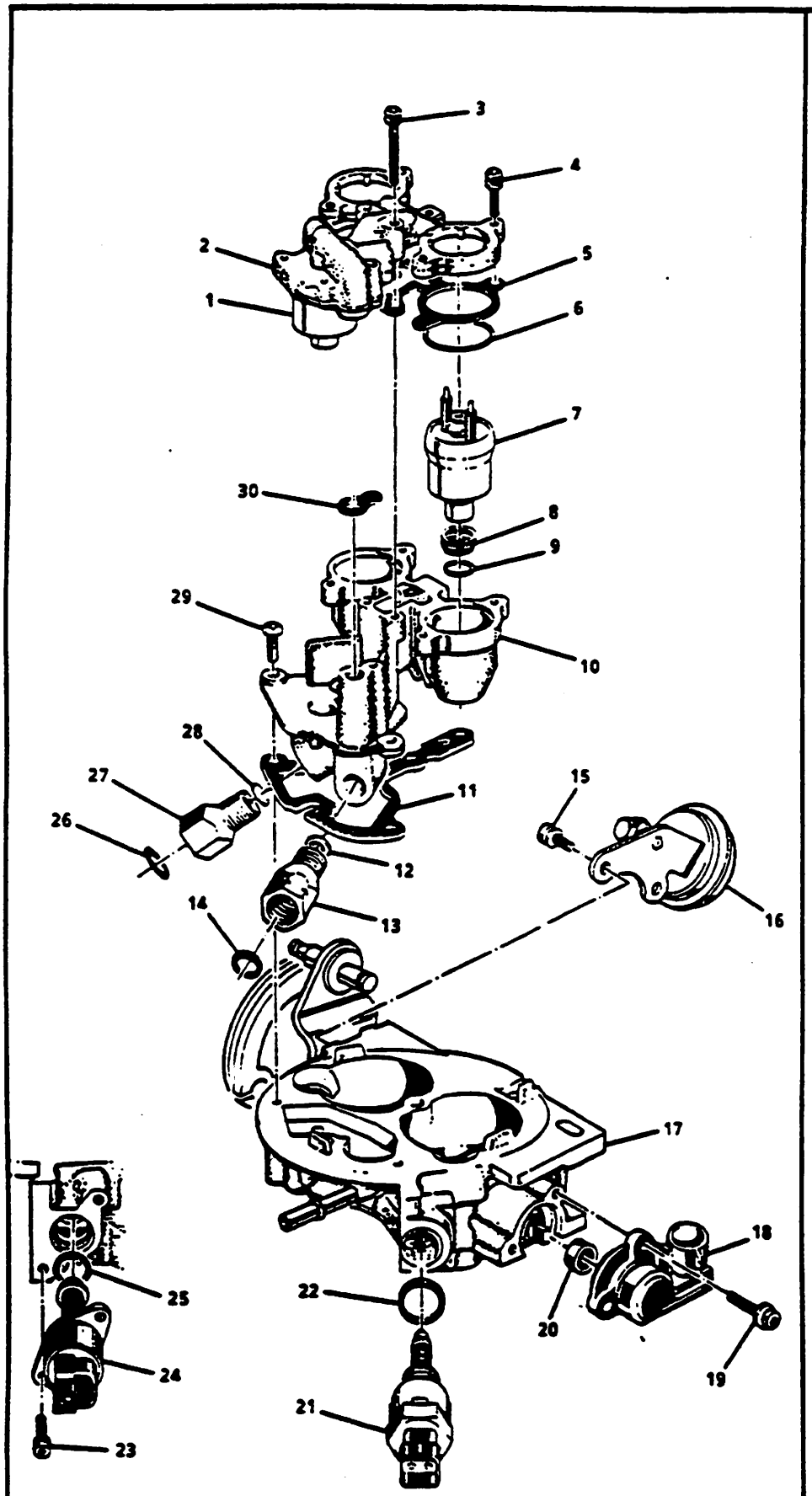
FUEL INJECTOR ASSEMBLY
Figures 20 through 24

Each fuel injector (refer to Figure 20) is serviced as a complete assembly only.

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

Remove or Disconnect

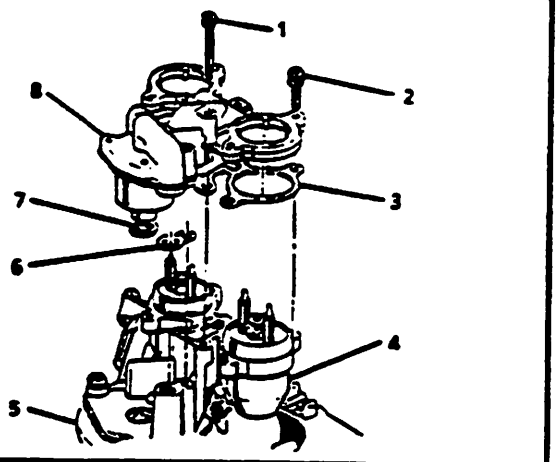
1. Electrical connectors to fuel injectors. (Squeeze plastic tabs and pull straight up.)
2. Fuel meter cover assembly, following above procedure.



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

LP 0171-XV

Figure 17 - Throttle Body



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

8P 0924-AS

Figure 18 - Replacing Fuel Meter Cover

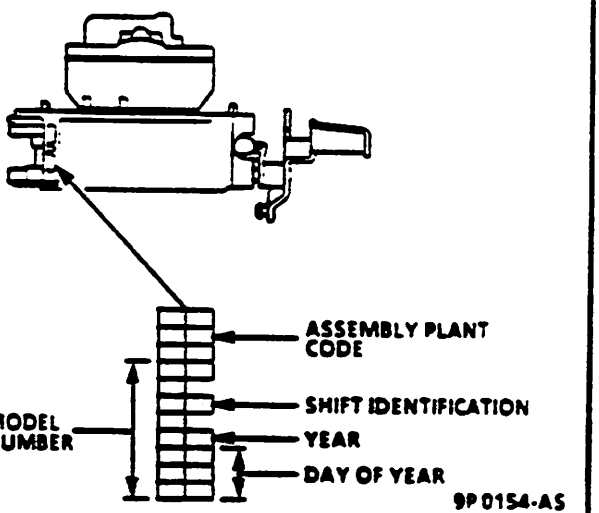
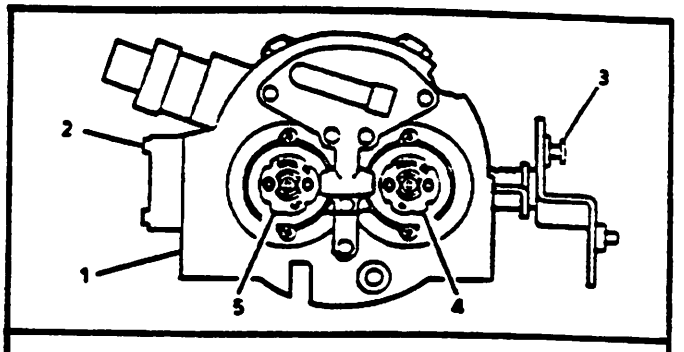


Figure 19 - TBI Identification

3. With fuel meter cover gasket in place to prevent damage to casting, use a screwdriver and fulcrum to carefully lift out each injector (Figure 21).
4. Lower (small) O-rings from nozzle of injectors and discard.
5. Fuel meter cover gasket and discard.
6. Upper (large) O-rings and steel backup washers from top of fuel injector cavity and discard.



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

8S 3999-6E

Figure 20 - Fuel Injectors

Inspect

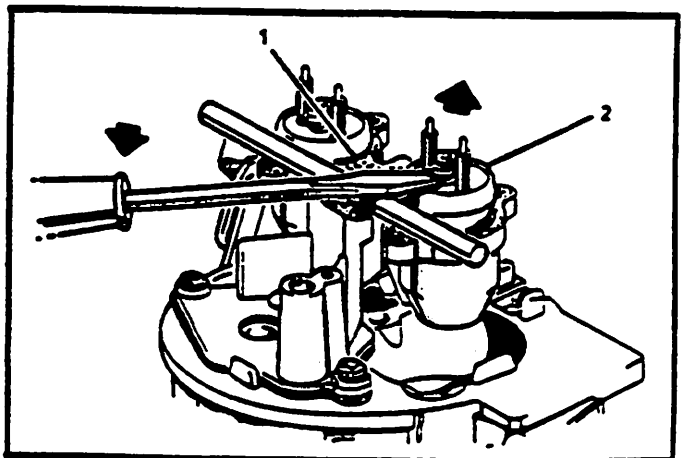
- Fuel injector filter for evidence of dirt and contamination. If present, check for presence of dirt in fuel lines and fuel tank.

Important

- Be sure to replace the injector with one having an identical part number. Injectors from other models can also fit in the TBI, but are calibrated for different flow rates. (Refer to Figure 23 for part number location)

Install or Connect

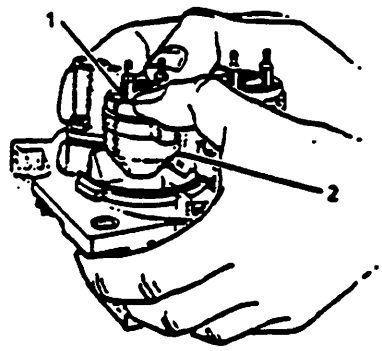
1. Lubricate new lower (small) O-rings with automatic transmission fluid and push on nozzle end of injector until it presses against injector fuel filter.
2. Steel injector backup washer in counterbore of fuel meter body.



1	FUEL METER COVER GASKET
2	REMOVING FUEL INJECTOR

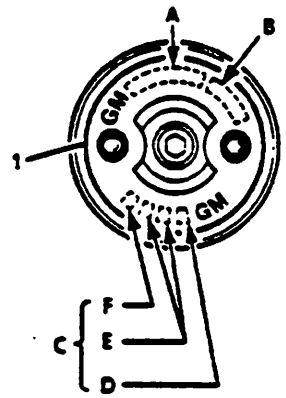
5S 1697-6E

Figure 21 - Removing Fuel Injector



1 FUEL INJECTOR ASSEMBLY
2 FUEL METER BODY ASSEMBLY
MP 1202-AS

Figure 22 - Installing Fuel Injector



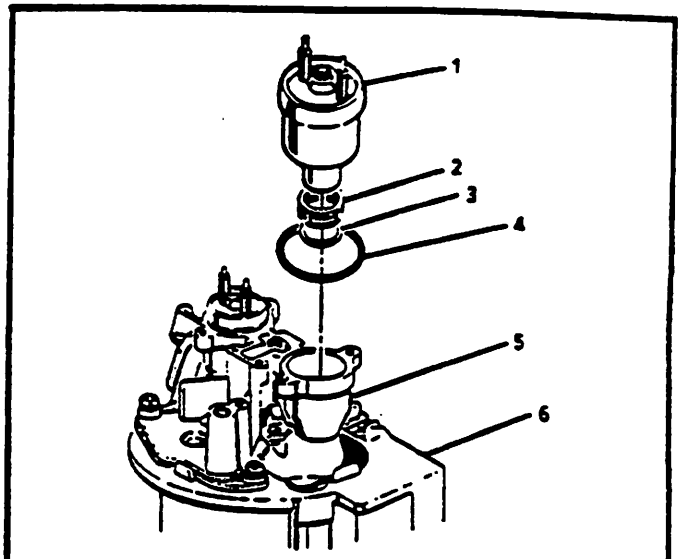
1 INJECTOR ASSEMBLY - (TOP VIEW) TBI FUEL
A PART IDENTIFICATION NUMBER
B VENDOR IDENTIFICATION
C BUILD DATE CODE
D YEAR
E DAY
F MONTH
1 - 9 (JAN - SEPT)
O, N, D (OCT, NOV, DEC)
9P 1071-AS

Figure 23 - 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 injectors, or improper seating of large O-ring could cause fuel to leak.

4. Injector, aligning raised lug on each injector base with notch in fuel meter body cavity. Push down on injector until it is fully seated in fuel meter body (Figure 22). (Electrical terminals of injector should be parallel with throttle shaft.)



1 FUEL INJECTOR ASSEMBLY
2 FUEL INJECTOR INLET FILTER
3 FUEL INJECTOR LOWER "O" RING
4 FUEL INJECTOR UPPER "O" RING
5 FUEL METER BODY ASSEMBLY
6 THROTTLE BODY ASSEMBLY
MP 1200AS

Figure 24 - Fuel injector

Important

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

5. Fuel meter cover gasket.
6. Fuel meter cover, following above procedure.
7. Electrical connectors to fuel injectors.
8. With engine "OFF" and ignition "ON," check for fuel leaks.

FUEL METER BODY ASSEMBLY
Figure 25

Remove or Disconnect

1. Electrical connections to fuel injectors. (Squeeze plastic tabs and pull straight up.)
2. Fuel meter cover assembly, following above procedure.
3. Fuel injectors, following above procedure.
4. Fuel inlet and return lines. Discard O-rings.
5. Fuel inlet and outlet nuts and gaskets from the fuel meter body assembly. Discard gaskets.

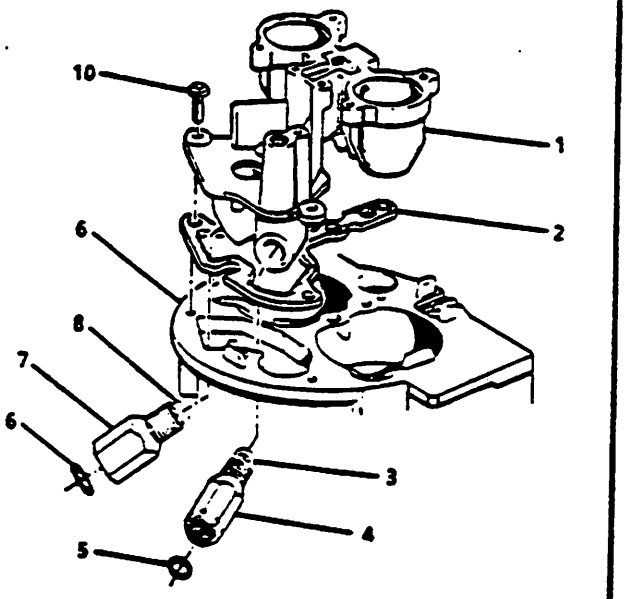
Important

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

6. Fuel meter body to throttle body attaching screw assemblies.
7. Fuel meter body assembly from throttle body assembly.
8. Throttle body to fuel meter body gasket and discard.

Install or Connect

1. New throttle body to fuel meter body gasket. Match cut-out portions in gasket with openings in throttle body.
2. Fuel meter body assembly on throttle body assembly.



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

MP 1234-A5

Figure 25 - Fuel Meter Body Assembly

3. Fuel meter body-to-throttle body attaching screw assemblies, precoated with appropriate locking compound.

Tighten

- Screw assemblies to 4.0 N·m (30.0 lb. in.).

4. Fuel inlet and outlet nuts with new gaskets to fuel meter body assembly.

Tighten

- Inlet nut to 40.0 N·m (30.0 lb. ft.).
- Outlet nut to 29.0 N·m (21.0 lb. ft.).

5. Fuel inlet and return lines and new O-rings. (Use backup wrench to keep TBI nuts from turning.)

Tighten

- Fuel lines to 23 N·m (17 lb. ft.).

6. Injectors, with new upper and lower O-rings in fuel meter body assembly.
7. Fuel meter cover gasket, fuel meter outlet gasket, and pressure regulator seal.
8. Fuel meter cover assembly.
9. Long and short fuel meter cover attaching screw assemblies, coated with appropriate thread-locking compound.

Tighten

- Screw assemblies to 3.0 N·m (28.0 lb. in.).

10. Electrical connectors to fuel injectors.
11. With engine "OFF" and ignition "ON," check for leaks around fuel meter body, gasket and around fuel line nuts.

FUEL PUMP

Figure 27

Important

- Fuel pressure must be relieved before servicing the fuel pump. Refer to fuel pressure relief procedures, "On-Vehicle Service" section.

Remove or Disconnect

1. Negative battery cable.
2. Fuel pump electrical connector.
3. Inlet and outlet fuel 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 fittings.
4. Fuel pump electrical connector.

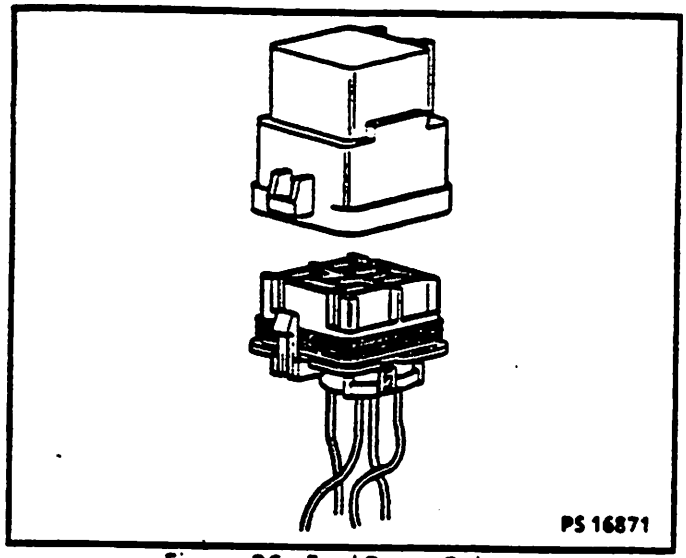


Figure 26 - Fuel Pump Relay

5. Negative battery cable.
6. With engine "OFF," cycle ignition "ON" then "OFF" four times to prime fuel lines, and check for leaks.

FUEL PUMP RELAY
Figure 26

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

Important
- 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.

IN-LINE FUEL FILTER
Figure 28

Important
- Fuel pressure must be relieved before servicing the fuel filter. Refer to fuel pressure relief procedures.

Remove or Disconnect
- Fuel line fittings.

Inspect
- In-line fuel filter, for being plugged or contamination. If filter is plugged or contaminated, replace filter.

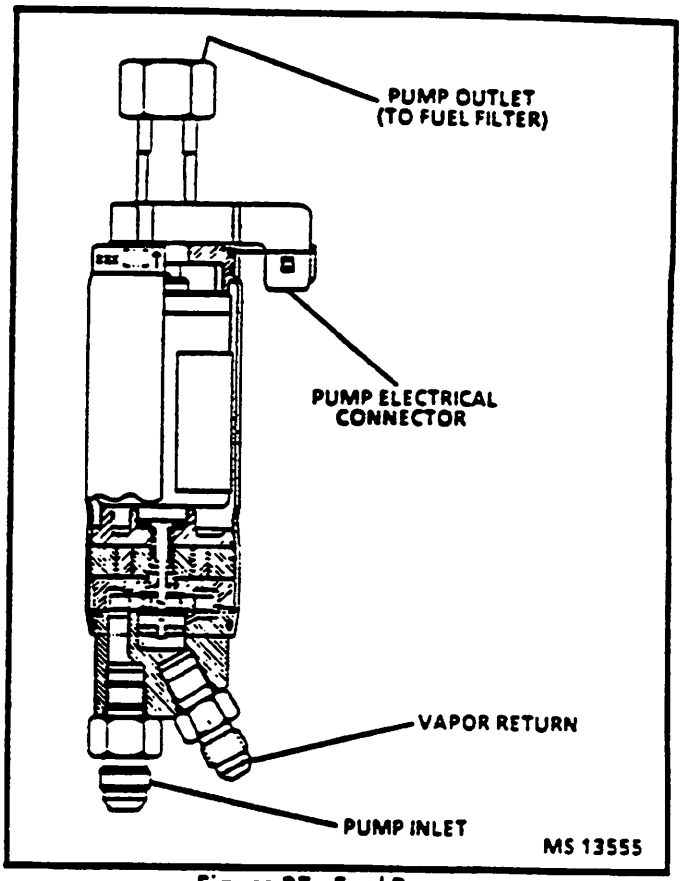


Figure 27 - Fuel Pump

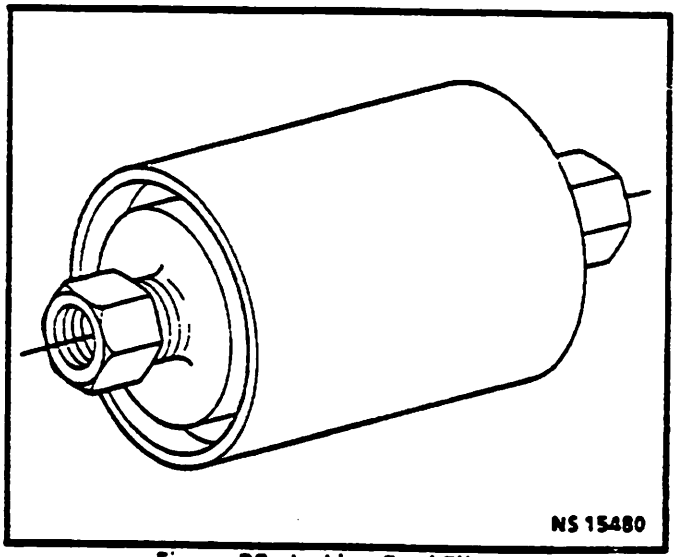


Figure 28 - In-Line Fuel Filter

Install or Connect
1. Fuel line nuts to filter.
2. With engine "OFF" cycle ignition switch "ON" then "OFF" four times to prime fuel lines then check for leaks.

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.

Metri-Pack Series 150 Terminals
Figure 29

Some ECM harness connectors contain terminals called Metri-Pack (Figure 29). These are used at some of the sensors and the distributor connector.

Metric-Pack terminals are also called "Pull-to-Seat" terminals because to install a terminal on a wire, the wire is first inserted through the seal (5) and connector (4). The terminal is then crimped on the wire, and the terminal pulled back into the connector to seat it in place.

To remove a terminal:

1. Slide the seal back on the wire.
2. Insert tool (3) BT-8446, J 35689, or equivalent as shown in insert "A" and "B" to release the terminal locking tang (2).
3. Push the wire and terminal out through the connector.
   If the terminal is being reused, reshape the locking tang (2).

Weather-Pack Connectors
Figure 30

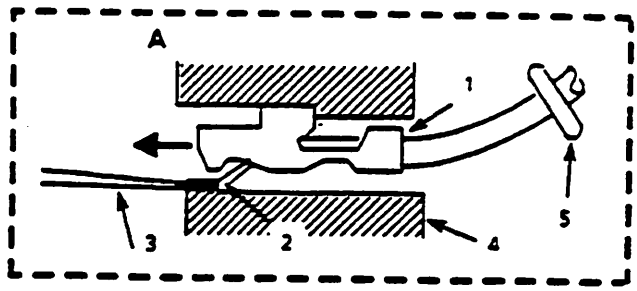
Figure 30 shows a Weather-Pack connector and the tool (J 28742, BT-8234-A or equivalent) required to service it. This tool is used to remove the pin and sleeve terminals.If terminal removal is attempted without using the special tool required, there is a good chance that the terminal will be bent or deformed, and unlike standard blade type terminals, these terminals cannot be straightened once they are bent.

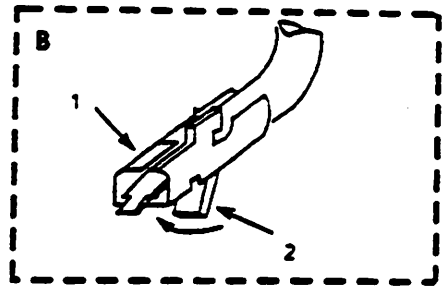
Make certain that the connectors are properly seated and all of the sealing rings in place when connecting leads. The hinge-type flap provides a secondary locking feature for the connector. It improves the connector reliability by retaining the terminals if the small terminal lock tangs are not positioned properly.

Weather-Pack connections cannot be replaced with standard connections. Instructions are provided with Weather-Pack connector and terminal packages.

TORQUE SPECIFICATIONS

Distributor Hold Down Bolt	40.0 N·m (30 lb. ft.)
Engine Coolant Temperature (ECT) Sensor	12.0 N·m (108 lb. in.)
Engine Control Module (ECM)	10.0-14.0 N·m (88-124 lb. in.)
Idle Air Control (IAC) Valve	
Flange Mounted	3.2 N·m (28 lb. in.)
Thread Mounted	18.0 N·m (13 lb. ft.)
Knock Sensor	15.0-22.0 N·m (11-16 lb. in.)
MAP Sensor Bolt	5.0-7.0 N·m (44-62 lb. in.)
Spark Plugs	15.0 N·m (11 lb. ft.)
TBI Fuel Metering Cover Attaching Screws	3.0 N·m (28 lb. in.)
TBI Fuel Meter Body Assembly Attaching Screws	4.0 N·m (30 lb. in.)
TBI Fuel Meter Body Assembly Fuel Inlet Nut	40.0 N·m (30 lb. ft.)
TBI Fuel Meter Body Assembly Fuel Outlet Nut	29.0 N·m (21 lb. ft.)
TBI Fuel Line Nut to In/Outlet Nuts	23.0 N·m (17 lb. in.)
Throttle Body Injector (TBI) Unit Mounting Bolts	16.0 N·m (12 lb. ft.)
Throttle Position (TP) Sensor Attaching Screws	2.0 N·m (18 lb. in.)





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

2-5-90
*75 3213-6E

Figure 29 - Metri-Pack Series 150 Terminal Removal

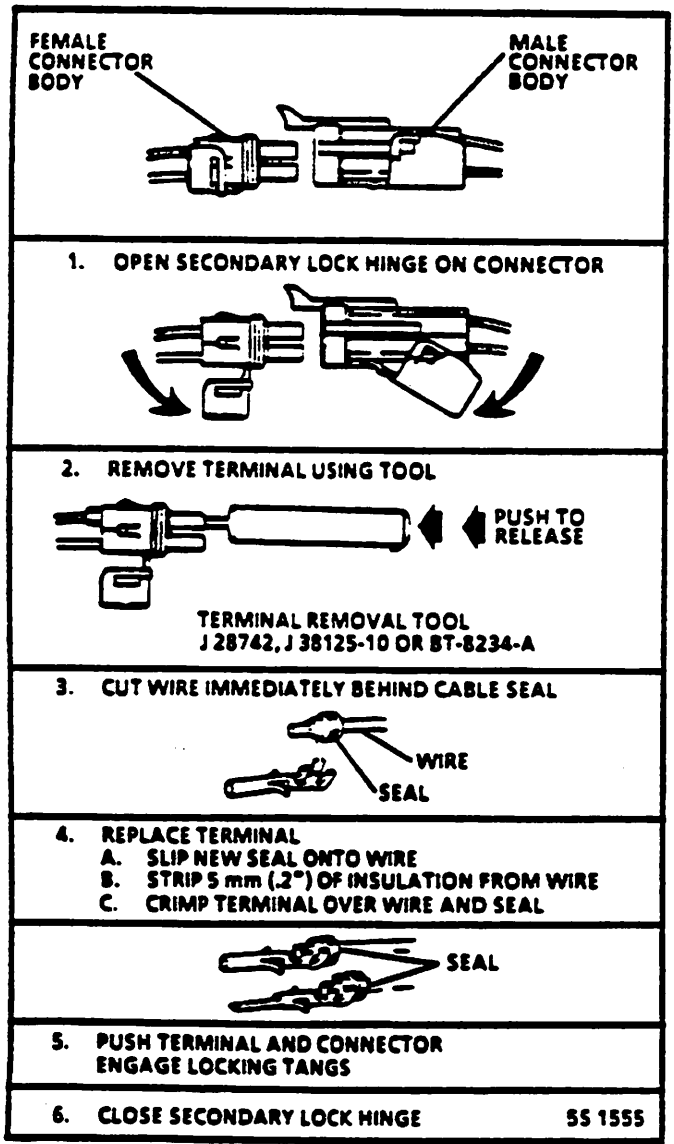


Figure 30 - Weather-Pack terminal Repair

ON-BOARD SERVICE 7.4L THROTTLE BODY INJECTION (TBI)

CONTENTS

SENSORS AND CONTROLS

ENGINE CONTROL MODULE (ECM) REPLACEMENT

Figure 1

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

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

Remove or Disconnect

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

Important

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

Install or Connect

1. New ECM to mounting bracket.
2. Four ECM mounting bolts.

Tighten

- Four ECM mounting bolts to 10 - 14 N·m (88 - 124 lb. in.).

3. "J1" and "J2" connector to ECM.
4. Negative battery cable.

ENGINE COOLANT TEMPERATURE (ECT) SENSOR
Figure 2

NOTICE: Care must be taken when handling engine coolant temperature sensor. Damage to engine coolant temperature sensor will affect proper operation of the MEFI system.

Remove or Disconnect
1. Negative battery cable.
2. Electrical connector.
3. Coolant temperature sensor.

Important
- Coat temperature sensor threads with teflon tape sealant prior to reassembly.

Install or Connect
1. Sensor in engine.
2. Electrical connector.
3. Negative battery cable.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR
Figure 3

Remove or Disconnect
1. Negative battery cable.
2. Electrical connector.
3. MAP sensor attaching bolts.
4. MAP sensor from bracket.
5. Vacuum hose from MAP sensor.

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

Install or Connect
1. Vacuum hose to MAP sensor.
2. MAP sensor attaching bolts to bracket.

Tighten
- Two bolts to 5 - 7 N·m (44 - 62 lb. in.).

3. MAP sensor bracket to engine.
4. Electrical connector.
5. Negative battery cable.

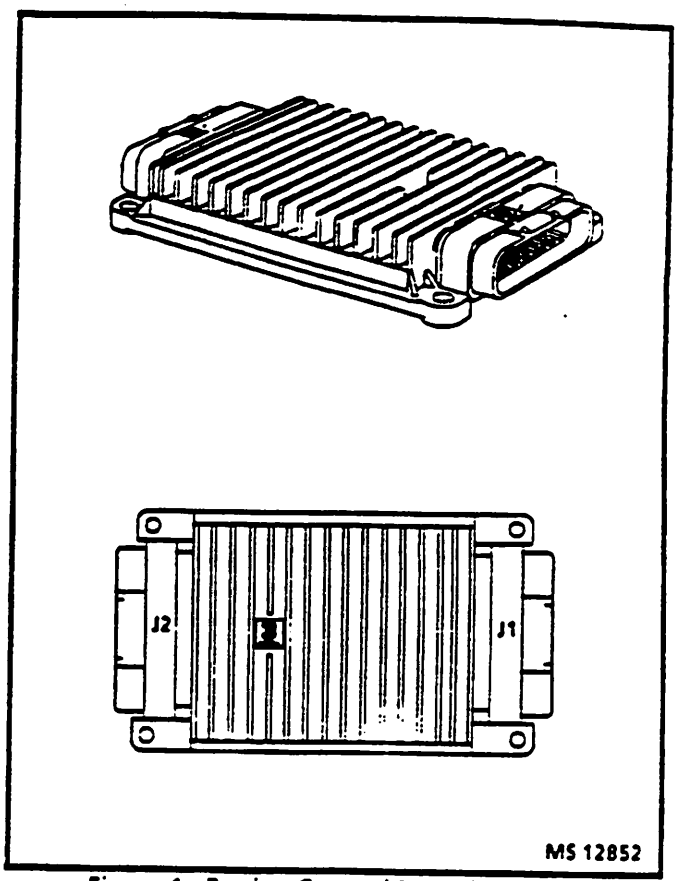


Figure 1 - Engine Control Module (ECM)

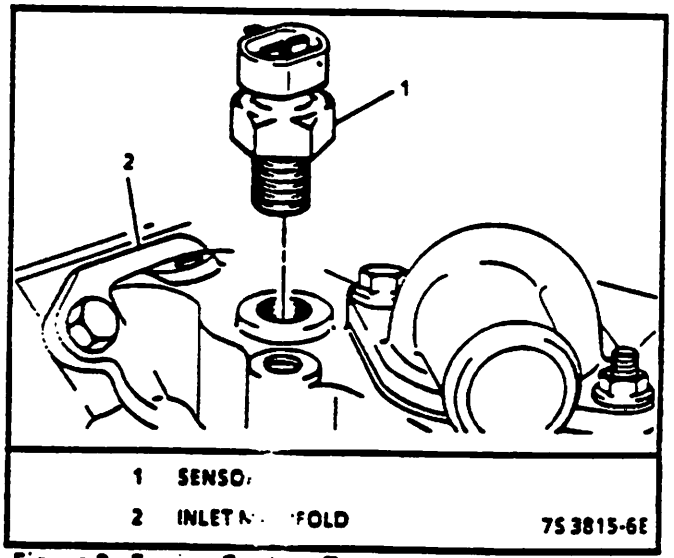


Figure 2 - Engine Coolant Temperature (ECT) Sensor

THROTTLE POSITION (TP) SENSOR
Figures 4 and 16

Remove or Disconnect
1. Flame arrestor.
2. Electrical connector from TP sensor.
3. TP sensor attaching screws.
4. TP sensor and seal.

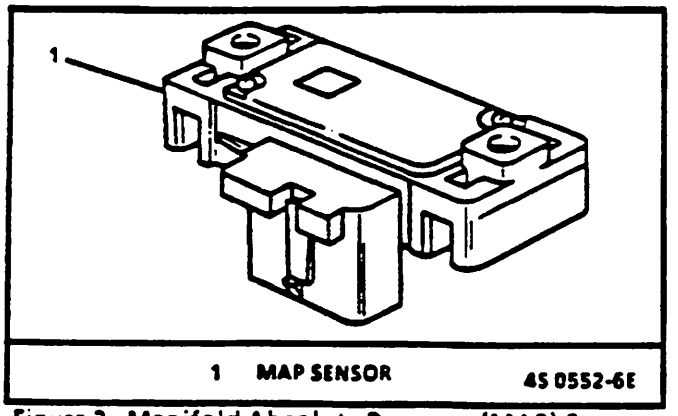


Figure 3 - Manifold Absolute Pressure (MAP) Sensor

NOTICE: The TP sensor is an electrical component. Do not soak it in any liquid cleaner or solvent as damage may result.

Install or Connect

Important

- If replacing TP sensor, install new screws that are supplied with TP sensor service package.

1. TP sensor seal over throttle shaft as shown in Figure 4.
2. With throttle plates closed, position on throttle shaft, then align the screw holes.
3. TP sensor attaching screws.

Tighten

- Screw assemblies to 2.0 N·m (18.0 lb. in.).

4. Electrical connector to TP sensor.
5. Check for TP sensor output voltage.
   - Voltage should be approximately .7 volts at idle and approximately 5 volts at WOT.
6. Flame arrestor.

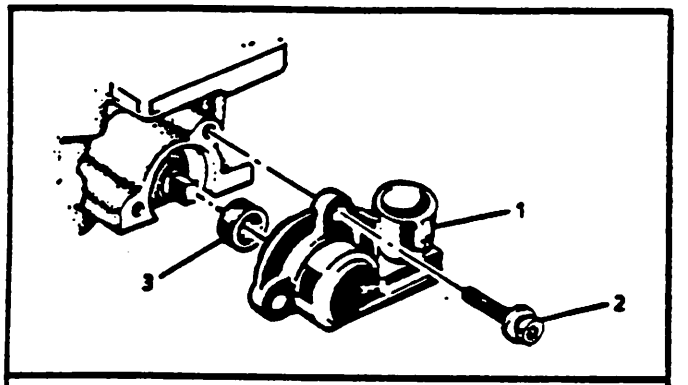


Figure 4 - Throttle Position (TP) Sensor

IDLE AIR CONTROL (IAC) VALVE
Figures 5 and 16

Remove or Disconnect

1. Flame arrestor.
2. 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

- Clean IAC valve O-ring sealing surface, pintle valve seat and air passage.
  - Use carburetor cleaner to remove carbon deposits. Do Not use a cleaner that contains methyl ethyl ketone, an extremely strong solvent, and not necessary for this type of deposit.
  - Shiny spots on the pintle or seat are normal, and do not indicate misalignment or a bent pintle shaft.

Important

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

Measure (If Installing a New IAC Valve)

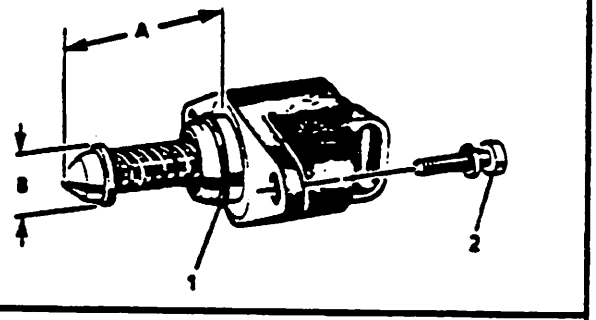
Figure 5

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

Install or Connect

1. New O-ring on the IAC valve and lubricate.
2. IAC valve to throttle body using attaching screw assemblies.

NOTICE: New IAC valves have been reset at the factory and should be installed in the throttle body in an "as is" condition without any adjustment.



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

LP 1220-AS

Figure 5 - Flange Mounted Type IAC Valve

Tighten

- Attaching screw assemblies to 3.2 N·m (28.0 lb. in.).

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

KNOCK SENSORS (KS)
Figures 6 and 7

Remove or Disconnect

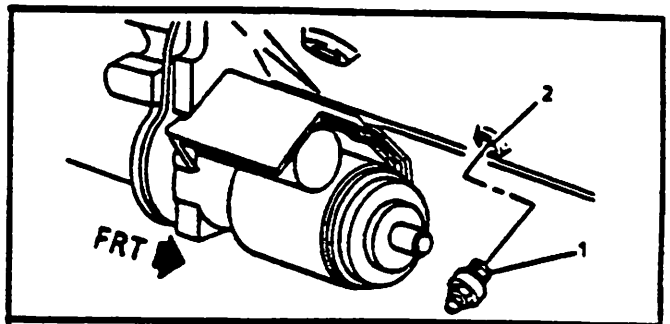
1. Negative battery cable.
2. Wiring harness connector from knock sensor.
3. Knock sensor from engine block.

Install or Connect

1. Knock sensor into engine block. Be sure threads are clean.
   - Tighten to 15 - 22 N·m (11 - 16 lb. ft.).
2. KS system wiring harness connector to the knock sensor.
3. Negative battery cable.

Important

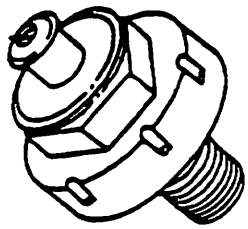
- If installing a new knock sensor be sure to replace with an identical part.
- When installing knock sensor be sure to install in same location removed.
- If installing knock sensor in water jacket, use teflon sealer # 1052040 or equivalent.



1 KNOCK SENSOR
2 ENGINE BLOCK

6S 2892-6E

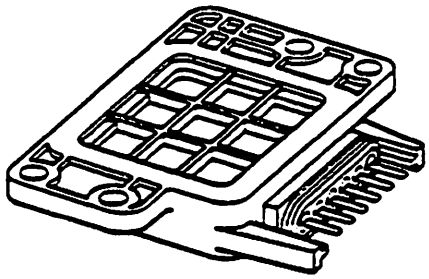
Figure 6 - Knock Sensor Location



KNOCK SENSOR (KS)

3S 0023-6E

Figure 7 - Typical Knock Sensor (KS)



NS 15481

Figure 8 - KS Module

KNOCK SENSOR (KS) MODULE
Figure 8

Remove or Disconnect

1. KS module connector.
2. Attaching screws.
3. KS module.

Important

- The knock sensor and module are electrical components. Do not soak in any liquid cleaner or solvent, as damage to the KS or module may result.

- When removing or installing the KS module, caution must be taken to avoid damaging KS mounting studs in module.

Install or Connect

1. KS module.
2. Attaching screws.
3. KS module connector.

DISTRIBUTOR IGNITION (DI) SYSTEM

DISTRIBUTOR REPAIR
Figures 9 through 11

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

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

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

Removal

Remove or Disconnect

1. Negative battery cable.
2. Wiring harness connectors at the side of the distributor cap.
3. Two screws on the sides of the distributor cap.
4. Coil wire and spark plug wires on either the left or right side of the distributor.
5. Distributor cap and move it aside.
   - Scribe a mark on 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.

Distributor.

Distributor hold-down clamp and bolt.

Tighten

- Bolt 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 engine timing

Disassembly
Figure 9

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).
   A. Mark the shaft and driven gear for reassembly.
   B. Drive out the roll pin with a small punch (Figure 10).
5. Driven gear (14), washer or spring (13), and spring retainer or tang washer (12).
6. Shaft (4) with the pole piece (8) and plate from the housing (11).
7. Retainer (5) from the housing (4) as follows:

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.

   A. Wear safety goggles.
   B. Use needle nose pliers to bend two corners upward on the fluted end of the retainer.
   C. Pull the retainer off the center bushing. Discard the retainer.

8. Shield (6).
9. Pickup coil connector from the module (10).
   - Lift the locking tab with a screwdriver.
10. Pickup coil (7).
11. Two screws holding the module to the housing
12. Module (10).

Inspect

1. Cap for cracks or tiny holes. Replace the cap if it is damaged at all.

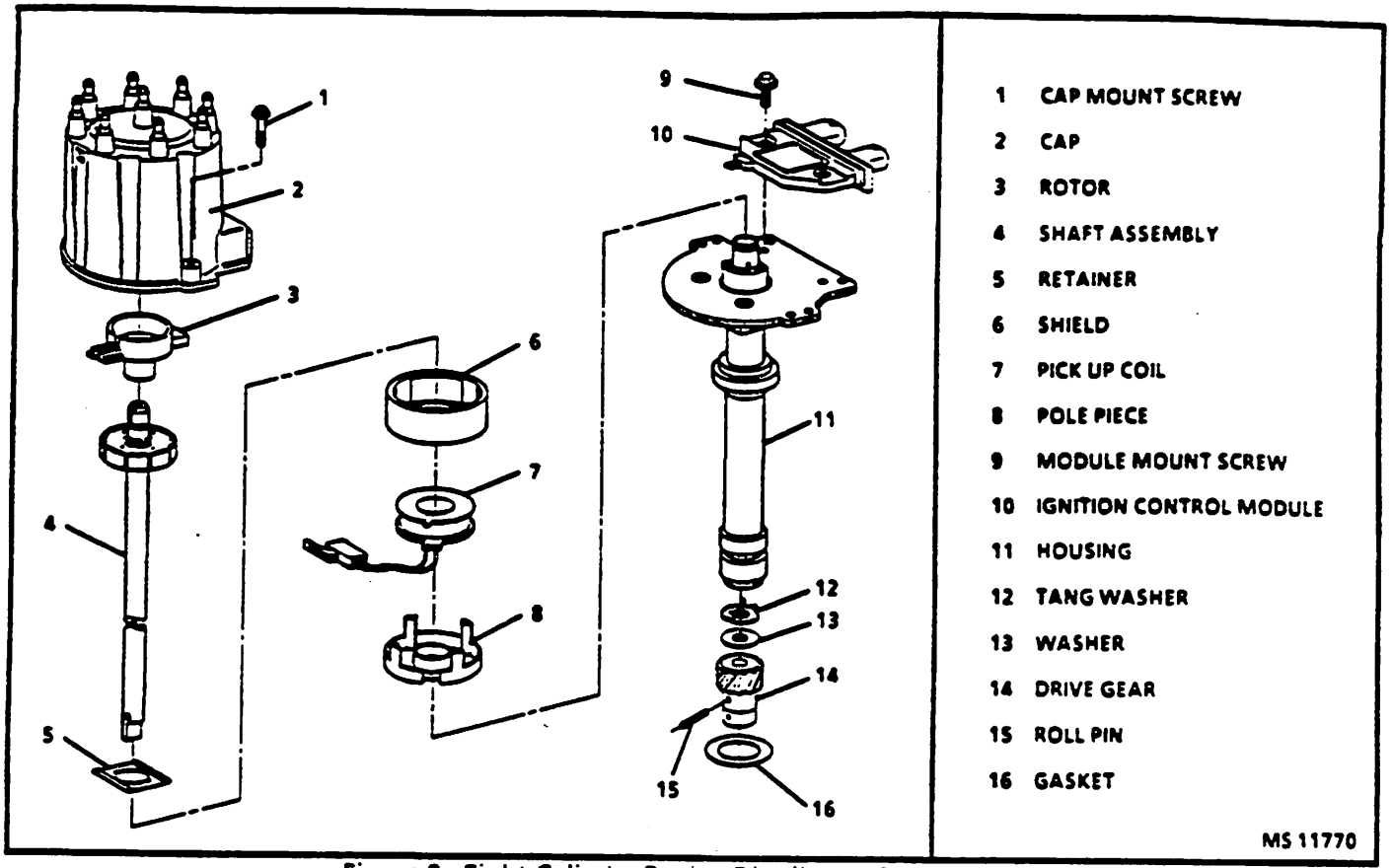


Figure 9 - Eight-Cylinder Engine Distributor Components

2. Metal terminals in the cap for corrosion. Scrape them clean with a knife or replace the cap.
3. Rotor for wear or burning at the outer terminal. The presence of carbon on the terminal indicates rotor wear and the need for replacement.
4. Shaft for shaft-to-bushing looseness. Insert the shaft in the housing. If the shaft wobbles, replace the housing and/or shaft.
5. Housing for cracks or damage.

Measure

- Resistance of pickup coil with an ohmmeter.
  - Connect an ohmmeter to either pickup coil lead and the housing as shown in Figure 11, Step 1. The reading should be infinite. If not, replace the coil.
  - Connect an ohmmeter to both pickup coil leads as shown in Figure 11, Step 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 coil.

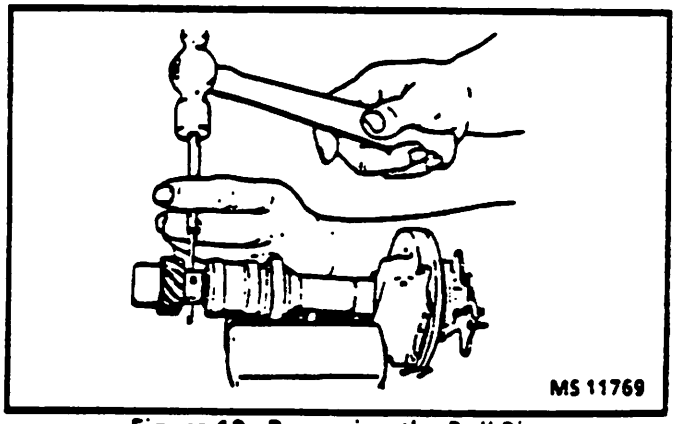


Figure 10 - Removing the Roll Pin

Assembly

Figures 9 and 12

Install or Connect

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

- Lubricate
  - Bottom of the module and the module rest pad in the housing with silicone grease or an equivalent heat transfer substance.

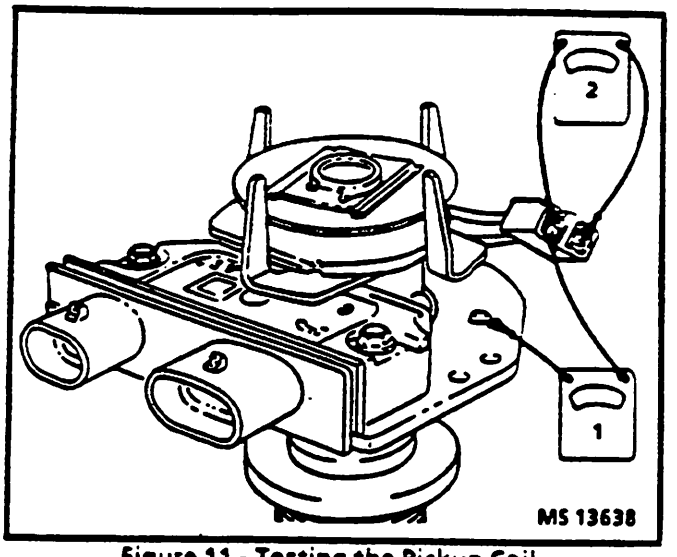


Figure 11 - Testing the Pickup Coil

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

GNITION CONTROL MODULE
Figure 9 item 10

Remove or Disconnect
1. Negative battery cable.
2. Both wire harness connectors at side of the distributor cap.
3. Two screws on the side of the distributor cap.
4. Distributor cap and move it aside.
5. Wire connector at ignition control module.
6. Two screws attaching ignition control module to distributor base plate.
7. Ignition control module.

Install or Connect

NOTICE: Be sure to coat the bottom of the module and rest pad on the housing with silicon grease or an equivalent heat transfer substance. Failure to do so could result in heat damage to the module.

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

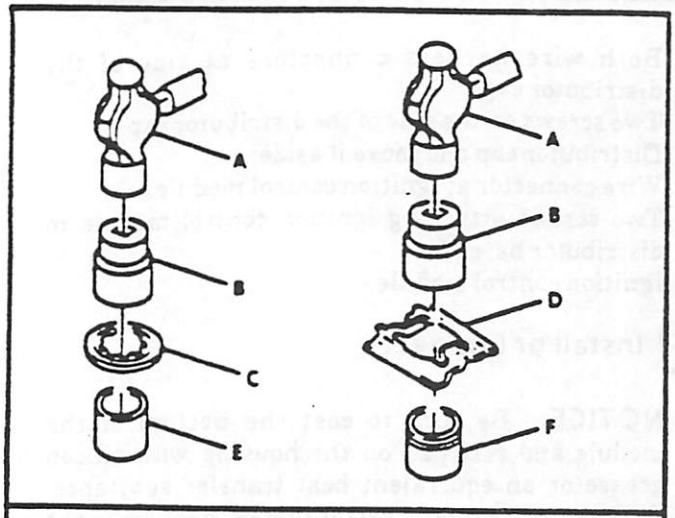
IGNITION COIL
Figure 13

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 the bracket.

Measure
- Resistance of the ignition coil with an ohmmeter.
  - Connect the ohmmeter as shown in Figure 13, Step 1. Use the high scale. The reading should be infinite. If not, replace the coil.
  - Connect the ohmmeter as shown in Step 2. Use the low scale. The reading should be very low or zero. If not, replace the coil.
  - Connect the ohmmeter as shown in Step 3. Use the high scale. The meter should not read infinite. If it does, replace the coil.

Install or Connect
- A replacement coil kit comes with two screws to attach the coil to the bracket.

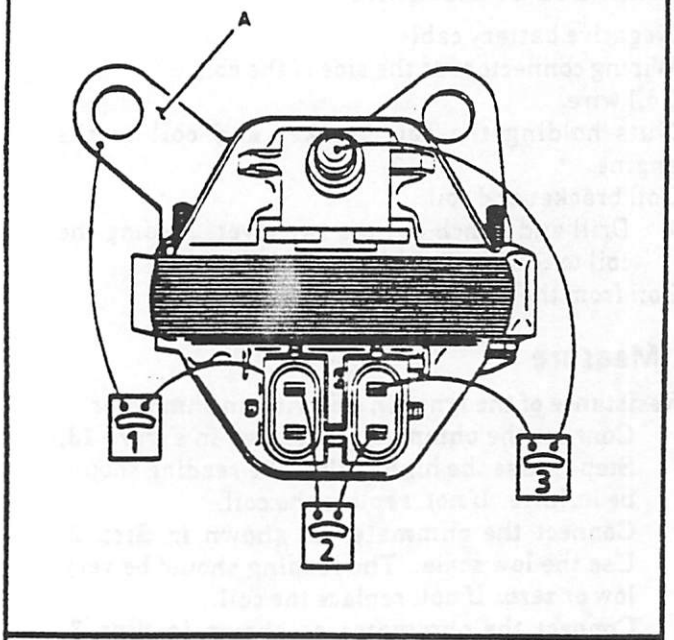
1. Coil to the bracket with two screws.



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

MS 11768

Figure 12 - Retainer to Shield Installation



A	SCRAPE CLEAN METAL GROUND

MS 13634

Figure 13 - Testing the Ignition Coil

2. Coil bracket to the engine bracket with studs and nuts.
3. Coil wire.
4. Wiring connectors.
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, should see approximately 15 to 25 degrees of advance at approximately 3000 RPM.
- If checking the KS system for retarding should see approximately 6 to 10 degrees of retard.
- When engine is idling the timing will be advancing up and down. This is normal because the ECM is controlling the timing for a smooth idle condition.
- If checking base timing, when MDTC tool or scan tool is switched to service mode, the timing will go to 10 degrees BTDC and will not move with RPM change.

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

Install or Connect

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

NOTICE: The scan tool will not go into set timing mode if DTC 42 is set or if 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 specification.

- If adjustment is needed, loosen distributor hold down bolt.

- Rotate distributor to adjust timing.

Tighten

- Distributor hold down bolt to 40 N·m (30 lb. ft.).
- Manually bring throttle to idle.
- Set Marine Diagnostic Trouble Code (MDTC) tool or scan tool to normal mode.

SPARK PLUG REPLACEMENT

Remove or Disconnect

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

Inspect

- Each plug for wear and gap.

Install or Connect

1. Spark plugs.

Tighten

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

   If the terminal has not been properly seated on the spark plug, only the resistance of the rubber boot will be felt when pushing sideways.

Replacement

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

FUEL SYSTEM

CAUTION:

- **To reduce the risk of fire and personal injury, relieve the fuel system pressure before servicing fuel system components.**
- **After relieving system pressure, a small amount of fuel may be released when servicing fuel lines or connections. To reduce the chance of personal injury, cover fuel line fittings with a shop towel before disconnecting to catch any fuel that may leak out. Place the towel in a approved container when disconnect is completed.**

FUEL CONTROL ON-BOARD SERVICE

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

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

FUEL PRESSURE RELIEF PROCEDURE

Important

- Refer to manufacturers warnings and cautions before proceeding.

1. Disconnect negative battery terminal to avoid possible fuel discharge if an accidental attempt is made to start the engine.
2. Loosen fuel filler cap to relieve 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 retainer.
2. Hoses from flame arrestor.
3. Flame arrestor.

Inspect

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

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

Install or Connect

1. Flame arrestor to throttle body.
2. Flame arrestor retainer.

THROTTLE BODY INJECTOR (TBI) UNIT
Figures 14 through 24

Clean

- The throttle bore and valve deposits may be cleaned on vehicle, using carburetor cleaner and a parts cleaning brush. Do not use a cleaner that contains methyl ethyl ketone, an extremely strong solvent, and not necessary for this type of deposit.

- The throttle body metal parts may be cleaned following disassembly, in a cold, immersion type cleaner.

NOTICE: The fuel injectors, pressure regulator, TP sensor, TP sensor gasket, and IAC valve should not come in contact with solvent or cleaner, as they may be damaged. The fuel injectors, pressure regulator, TP sensor, TP sensor gasket, and IAC valve should be removed prior to immersion.

- Clean all metal parts thoroughly and blow dry with compressed air. Be sure that all fuel and air passages are free of dirt and burrs.
- Inspect mating surfaces for damage that could affect gasket sealing and inspect throttle body for cracks in casting.

Thread-locking compound supplied in the service repair kit is a small vial of thread-locking compound with directions for use. If material is not available, use Loctite 262 or equivalent.

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

Remove or Disconnect

1. Flame arrestor, breather hoses (if applicable), and gasket. Discard gasket.
2. Electrical connectors - idle air control valve, throttle position sensor, and fuel injectors. (On TBI units, squeeze plastic tabs on injectors and pull straight up.)
3. Grommet with wires from throttle body.
4. Throttle linkage, return spring(s), (wherever applicable).
5. Inlet and outlet fuel line nuts, using backup wrench.

CAUTION: Refer to "Fuel Pressure Relief Procedure," before disconnecting fuel lines.

6. Fuel line O-rings from nuts and discard.
7. TBI mounting hardware.
8. TBI unit from adaptor plate.

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

9. TBI flange (adaptor mounting) gasket.

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

Inspect

- Manifold bore for loose parts and foreign material.
- Intake manifold mating surface for cleanliness. Also check for burrs that can affect gasket sealing.

Install or Connect

1. New TBI flange (manifold mounting) gasket.
2. TBI with mounting hardware.

Tighten

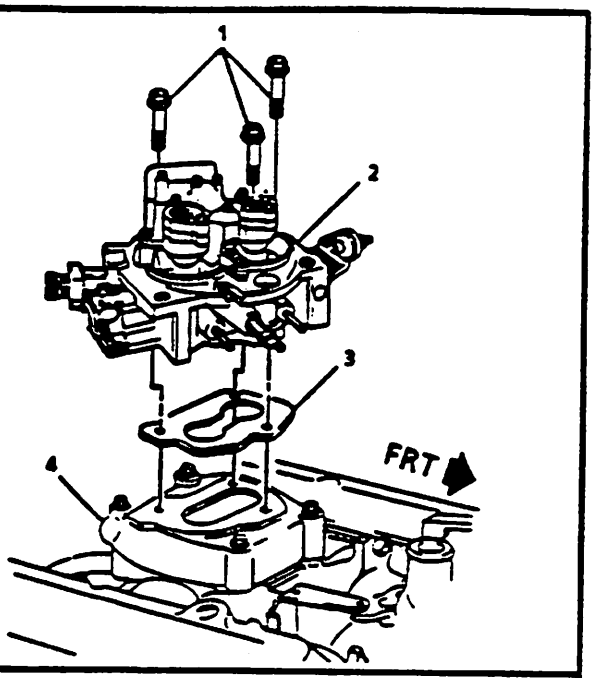
- Bolts to 16 N·m (12.0 lb. ft.).

3. New O-rings on fuel line nuts.
4. Fuel line inlet and outlet nuts by hand.

Tighten

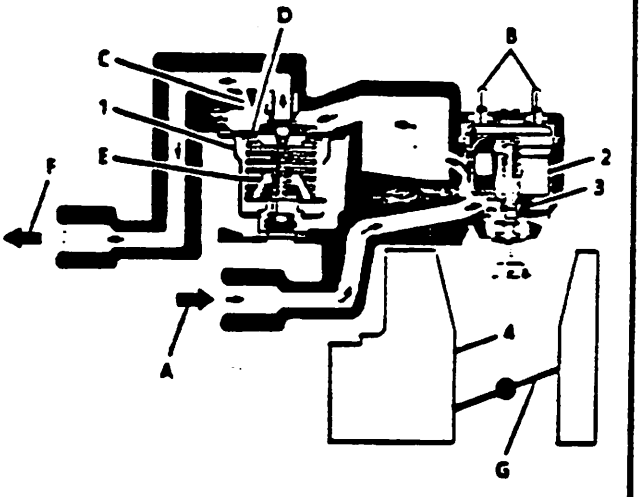
- Fuel line nut to 23.0 N·m (17.0 lb. ft.). (Use backup wrench to prevent TBI nuts from turning.)

5. Throttle linkage, return spring(s), (whenever applicable).
6. Grommet, with wire harness, to throttle body.



1 BOLT - TIGHTEN TO 16 N m (12 lb. ft.)
2 TBI UNIT
3 GASKET
4 MOUNTING BRACKET
NS 16501

Figure 14 - Replacing 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		

BP 0320-SY

Figure 15 - TBI Unit Operation

7. Electrical connectors, making sure connectors are fully seated and latched.
8. Check to see if throttle is free, by moving the throttle lever to 100% and back to 0% while engine is "OFF."
9. With engine "OFF," and ignition "ON," check for leaks around fuel line nuts.
10. Flame arrestor and new gasket.
11. Start engine and check again for fuel leaks

TBI FUEL METER COVER ASSEMBLY
Figure 17

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 might also result in a fuel leak between the diaphragm and the regulator container.

Remove or Disconnect

1. Electrical connectors to fuel injectors. (Squeeze plastic tabs and pull straight up.)
2. Long and short fuel meter cover screw assemblies.
3. Fuel meter cover assembly.

NOTICE: DO NOT immerse the fuel meter cover (with pressure regulator) in cleaner, as damage to the regulator diaphragm and gasket could occur.

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

Inspect

- For dirt, foreign material and casting warpage.

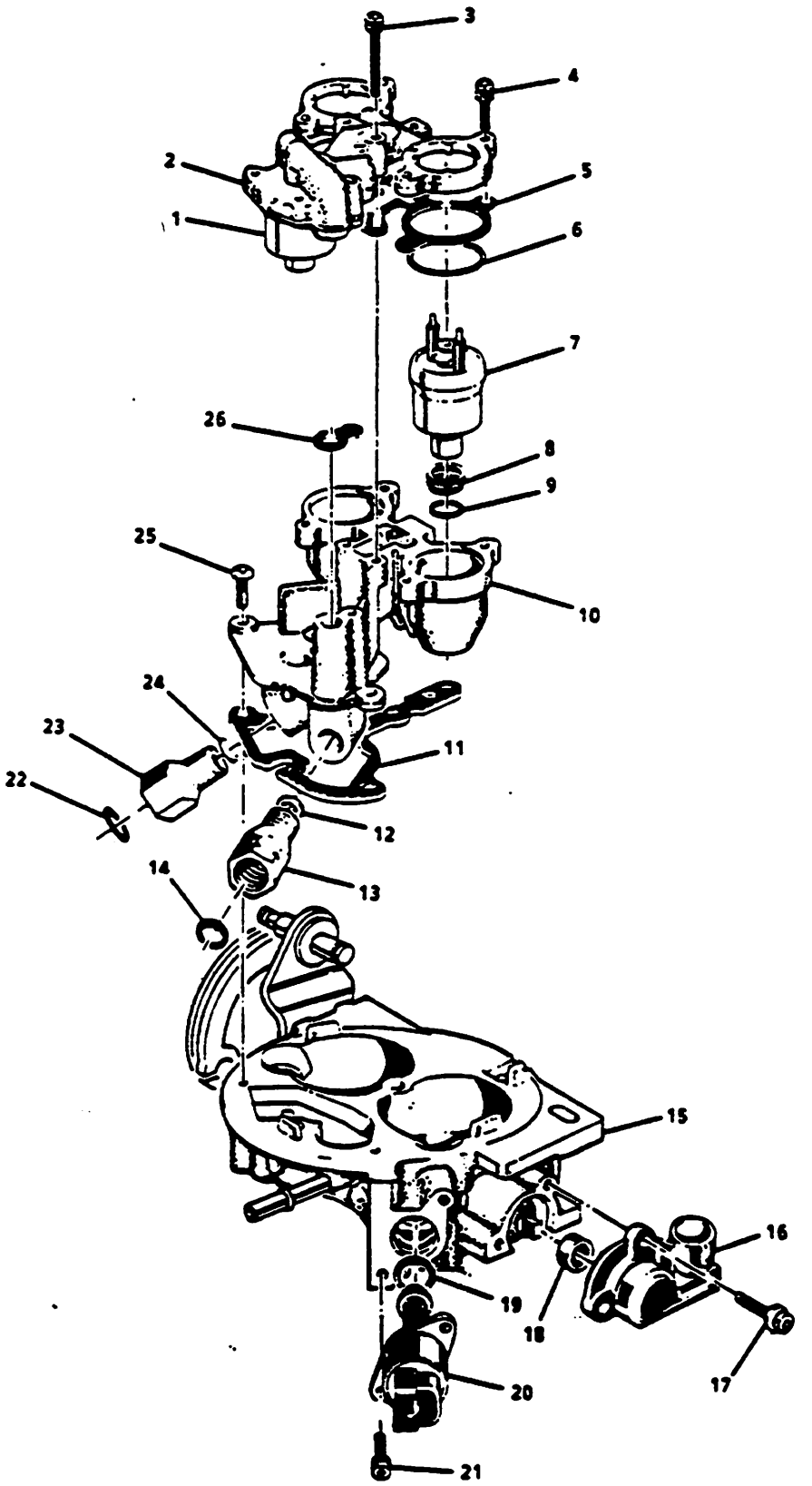
Install or Connect

1. New pressure regulator seal, fuel meter outlet passage gasket, and cover gasket.
2. Fuel meter cover assembly.
3. Attaching screw assemblies, precoated with appropriate locking compound to threads (Short screws are next to injectors.)

Tighten

- Screw assemblies to 3.0 N·m (28.0 lb. in.).

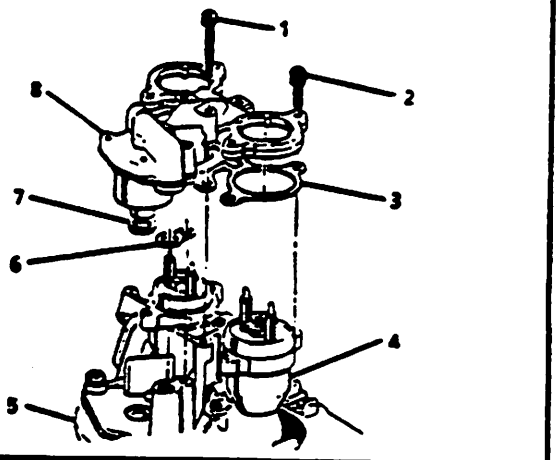
4. Electrical connectors to fuel injectors.
5. With engine "OFF," and ignition "ON," check for leaks around gasket and fuel line couplings



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

PS 19101

Figure 16 - Throttle Body



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

8P 0924-AS

Figure 17 - Replacing Fuel Meter Cover

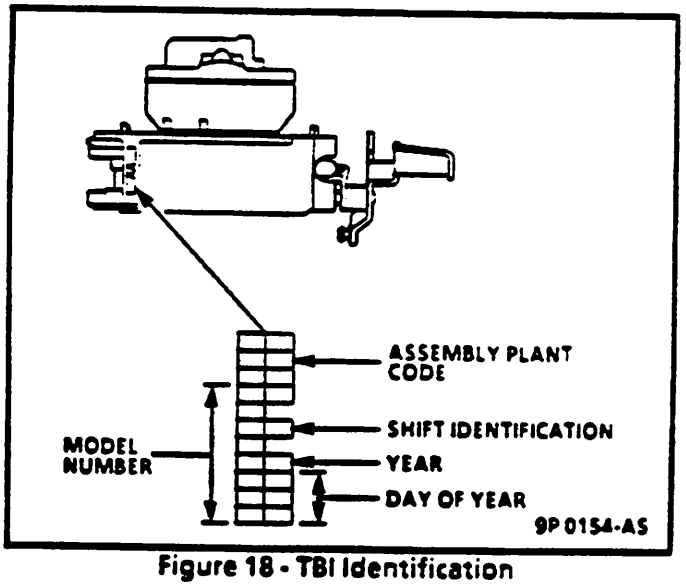
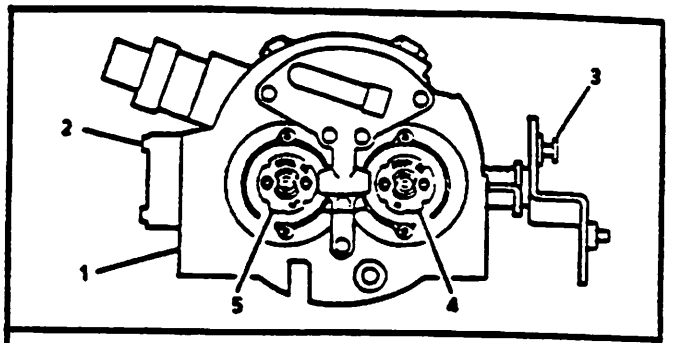


Figure 18 - TBI Identification

FUEL INJECTOR ASSEMBLY
Figures 19 through 23

Each fuel injector (Figures 19 and 23) is serviced as a complete assembly only.

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



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

8S 3999-6E

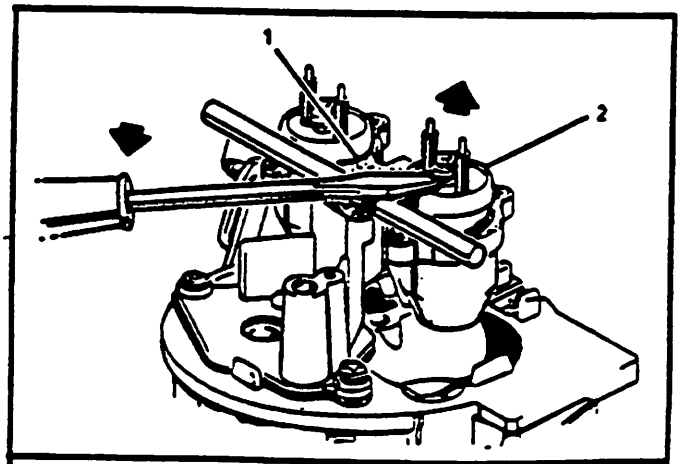
Figure 19 - Fuel Injectors

Remove or Disconnect

1. Electrical connectors to fuel injectors. (Squeeze plastic tabs and pull straight up.)
2. Fuel meter cover assembly, following above procedure.
3. With fuel meter cover gasket in place to prevent damage to casting, use a screwdriver and fulcrum to carefully lift out each injector (Figure 20).
4. Lower (small) O-rings from nozzle of injectors and discard.
5. Fuel meter cover gasket and discard.
6. Upper (large) O-rings and steel backup washers from top of fuel injector cavity and discard.

Inspect

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



1	FUEL METER COVER GASKET
2	REMOVING FUEL INJECTOR

5S 1697-6E

Figure 20 - Removing Fuel Injector

Important

- Be sure to replace the injector with one having an identical part number. Injectors from other models can also fit in the TBI, but are calibrated for different flow rates. (Refer to Figure 22 for part number location.)

Install or Connect

1. Lubricate new lower (small) O-rings 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.
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 injectors, or improper seating of large O-ring could cause fuel to leak.

4. Injector, aligning raised lug on each injector base with notch in fuel meter body cavity. Push down on injector until it is fully seated in fuel meter body (Figure 21). (Electrical terminals of injector should be parallel with throttle shaft.)

Important

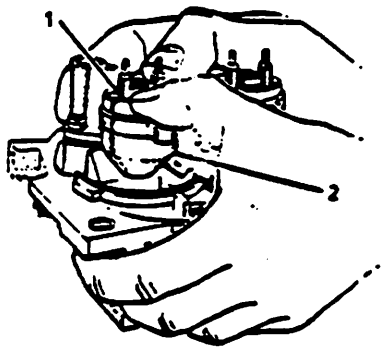
- Be sure to install the injectors in their proper location.

5. Fuel meter cover gasket.
6. Fuel meter cover, following above procedure.
7. Electrical connectors to fuel injectors.
8. With engine "OFF" and ignition "ON," check for fuel leaks.

FUEL METER BODY ASSEMBLY
Figure 24

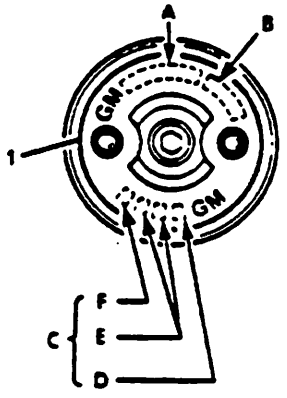
Remove or Disconnect

1. Electrical connections to fuel injectors. (Squeeze plastic tabs and pull straight up.)
2. Fuel meter cover assembly, following above procedure.
3. Fuel injectors, following above procedure.
4. Fuel inlet and return lines. Discard O-rings.
5. Fuel inlet and outlet nuts and gaskets from the fuel meter body assembly. Discard gaskets.



1 FUEL INJECTOR ASSEMBLY
2 FUEL METER BODY ASSEMBLY
MP 1202-AS

Figure 21 - Installing Fuel Injector



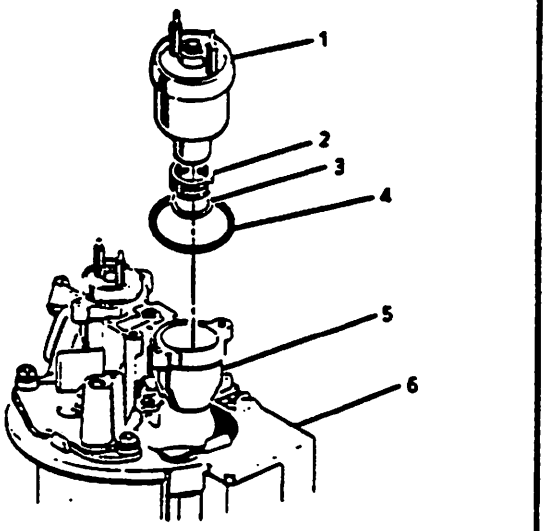
1 INJECTOR ASSEMBLY - (TOP VIEW) TBI FUEL
A PART IDENTIFICATION NUMBER
B VENDOR IDENTIFICATION
C BUILD DATE CODE
D YEAR
E DAY
F MONTH
1 - 9 (JAN - SEPT)
O, N, D (OCT, NOV, DEC)
9P 1071-AS

Figure 22 - Fuel Injector Part Number Location

Important

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

6. Fuel meter body to throttle body attaching screw assemblies.
7. Fuel meter body assembly from throttle body assembly.



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

MP 1200-AS

Figure 23 - Fuel Injector

8. Throttle body to fuel meter body gasket and discard.

Install or Connect

1. New throttle body to fuel meter body gasket. Match cut-out portions in gasket with openings in throttle body.
2. Fuel meter body assembly on throttle body assembly.
3. Fuel meter body-to-throttle body attaching screw assemblies, precoated with appropriate locking compound.

Tighten

- Screw assemblies to 4.0 N·m (30.0 lb. in.).

4. Fuel inlet and outlet nuts with new gaskets to fuel meter body assembly.

Tighten

- Inlet nut to 40.0 N·m (30.0 lb. ft.).
- Outlet nut to 29.0 N·m (21.0 lb. ft.).

5. Fuel inlet and return lines and new O-rings. (Use backup wrench to keep TBI nuts from turning.)

Tighten

- Fuel lines to 23 N·m (17 lb. ft.).

6. Injectors, with new upper and lower O-rings in fuel meter body assembly.
7. Fuel meter cover gasket, fuel meter outlet gasket, and pressure regulator seal.
8. Fuel meter cover assembly.
9. Long and short fuel meter cover attaching screw assemblies, coated with appropriate thread-locking compound.

Tighten

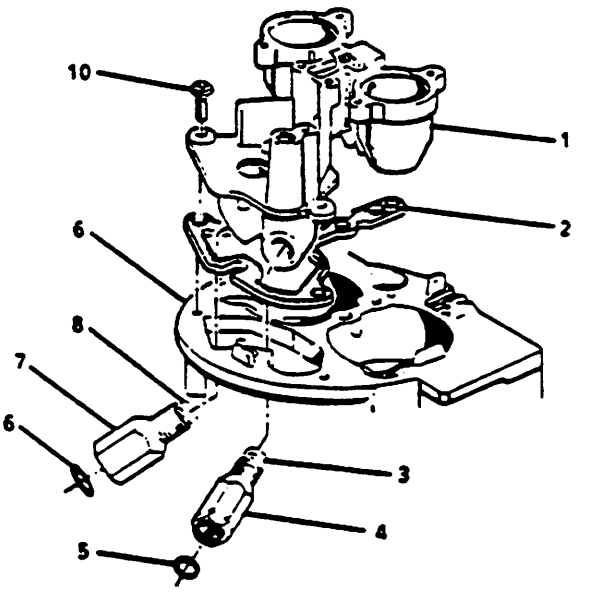
- Screw assemblies to 3.0 N·m (28.0 lb. in.).

10. Electrical connectors to fuel injectors.
11. With engine "OFF," and ignition "ON," check for leaks around fuel meter body, gasket and around fuel line nuts.

FUEL PUMP
Figure 25

Important

- Fuel pressure must be relieved before servicing the fuel pump. Refer to fuel pressure relief procedures, "On-Board Service" section.



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

MP 1234-AS

Figure 24 - Fuel Meter Body Assembly

Remove or Disconnect

1. Negative battery cable.
2. Fuel pump electrical connector.
3. Inlet and outlet fuel 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 fittings.
4. Fuel pump electrical connector.
5. Negative battery cable.
6. With engine "OFF," cycle ignition "ON" then "OFF" four times to prime fuel lines, and check for leaks.

FUEL PUMP RELAY

Figure 26

Remove or Disconnect

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

Important

- 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.

IN-LINE FUEL FILTER

Figure 27

Important

- Fuel pressure must be relieved before servicing the fuel filter. Refer to fuel pressure relief procedures.

Remove or Disconnect

- Fuel line fittings.

Inspect

- In-line fuel filter, for being plugged or contamination. If filter is plugged or contaminated, replace filter.

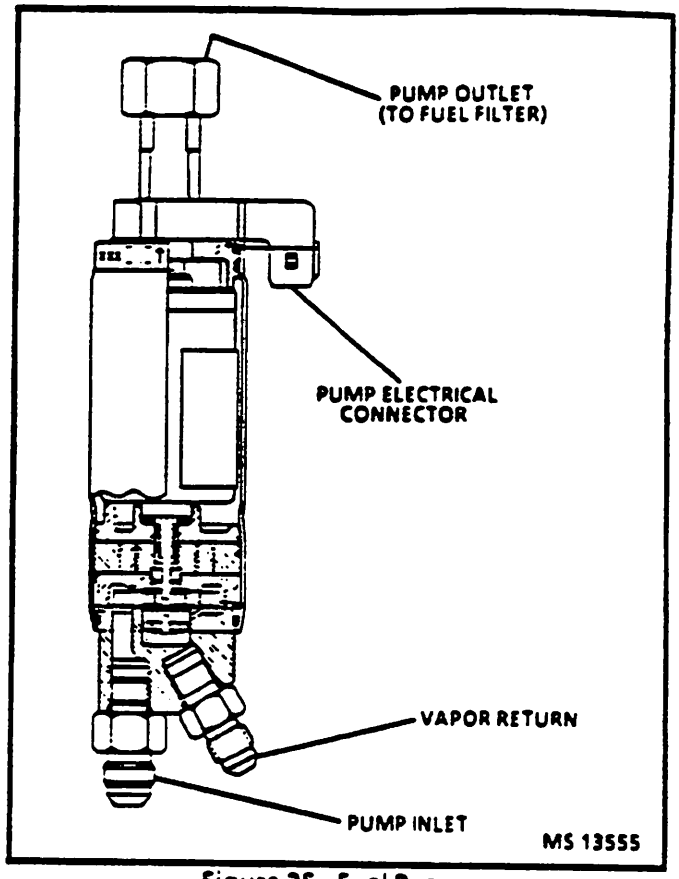


Figure 25 - Fuel Pump

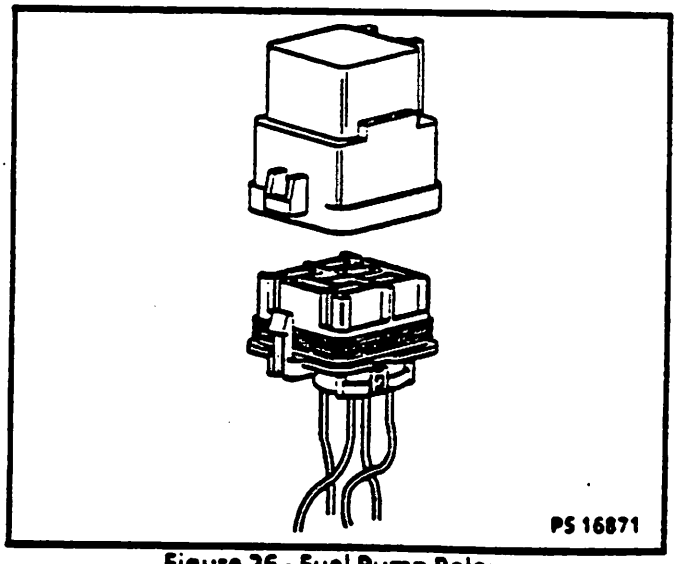


Figure 26 - Fuel Pump Relay

Install or Connect

1. Fuel line nuts to filter.
2. With engine "OFF" cycle ignition switch "ON" then "OFF" four times to prime fuel lines then check for leaks.

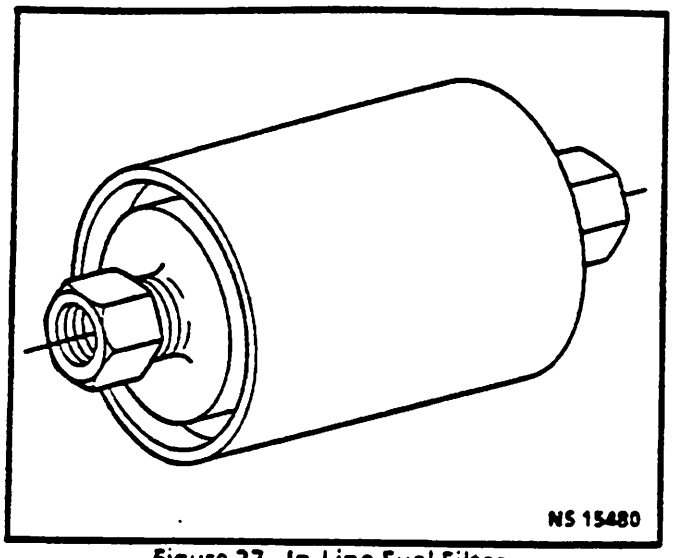


Figure 27 - In-Line Fuel Filter

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.

Metri-Pack Series 150 Terminals
Figure 28

Some ECM harness connectors contain terminals called Metri-Pack (Figure 28). These are used at some of the sensors and the distributor connector.

Metric-Pack terminals are also called "Pull-to-Seat" terminals because to install a terminal on a wire, the wire is first inserted through the seal (5) and connector (4). The terminal is then crimped on the wire, and the terminal pulled back into the connector to seat it in place.

To remove a terminal:

1. Slide the seal back on the wire.
2. Insert tool (3) BT-8446, J 35689, or equivalent as shown in insert "A" and "B" to release the terminal locking tang (2).
3. Push the wire and terminal out through the connector.
   If the terminal is being reused, reshape the locking tang (2).

Weather-Pack Connectors
Figure 29

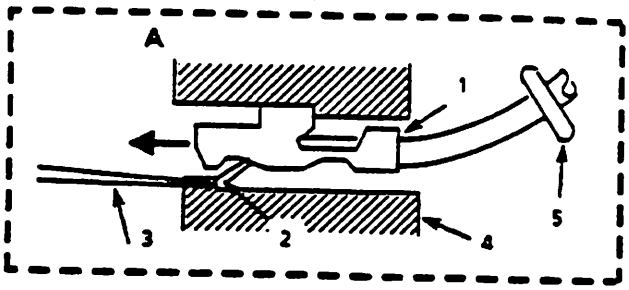
Figure 29 shows a Weather-Pack connector and the tool (J 28742, BT-8234-A or equivalent) required to service it. This tool is used to remove the pin and sleeve terminals. If terminal removal is attempted without using the special tool required, there is a good chance that the terminal will be bent or deformed, and unlike standard blade type terminals, these terminals cannot be straightened once they are bent.

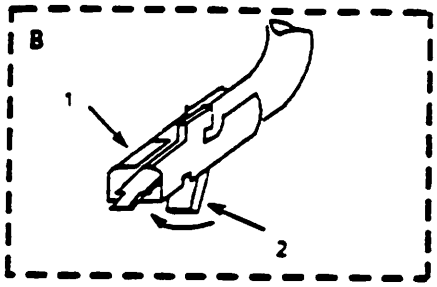
Make certain that the connectors are properly seated and all of the sealing rings in place when connecting leads. The hinge-type flap provides a secondary locking feature for the connector. It improves the connector reliability by retaining the terminals if the small terminal lock tangs are not positioned properly.

Weather-Pack connections cannot be replaced with standard connections. Instructions are provided with Weather-Pack connector and terminal packages.

TORQUE SPECIFICATIONS

Distributor Hold Down Bolt	40.0 N·m (30 lb. ft.)
Engine Coolant Temperature (ECT) Sensor	12.0 N·m (108 lb. in.)
Engine Control Module (ECM)	10.0-14.0 N·m (88-124 lb. in.)
Idle Air Control (IAC) Valve Attaching Screws	3.2 N·m (28 lb. in.)
Knock Sensor	15.0-22.0 N·m (11-16 lb. in.)
MAP Sensor Bolt	5.0-7.0 N·m (44-62 lb. in.)
Spark Plugs	15.0 N·m (11 lb. ft.)
TBI Fuel Metering Cover Attaching Screws	3.0 N·m (28 lb. in.)
TBI Fuel Meter Body Assembly Attaching Screws	4.0 N·m (30 lb. in.)
TBI Fuel Meter Body Assembly Fuel Inlet Nut	40.0 N·m (30 lb. ft.)
TBI Fuel Meter Body Assembly Fuel Outlet Nut	29.0 N·m (21 lb. ft.)
TBI Fuel Line Nut to In/Outlet Nuts	23.0 N·m (17 lb. in.)
Throttle Body Injector (TBI) Unit Mounting Bolts	16.0 N·m (12 lb. ft.)
Throttle Position (TP) Sensor Attaching Screws	2.0 N·m (18 lb. in.)





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

2-5-90
*75 3213-6E

Figure 28 - Metri-Pack Series 150 Terminal Removal

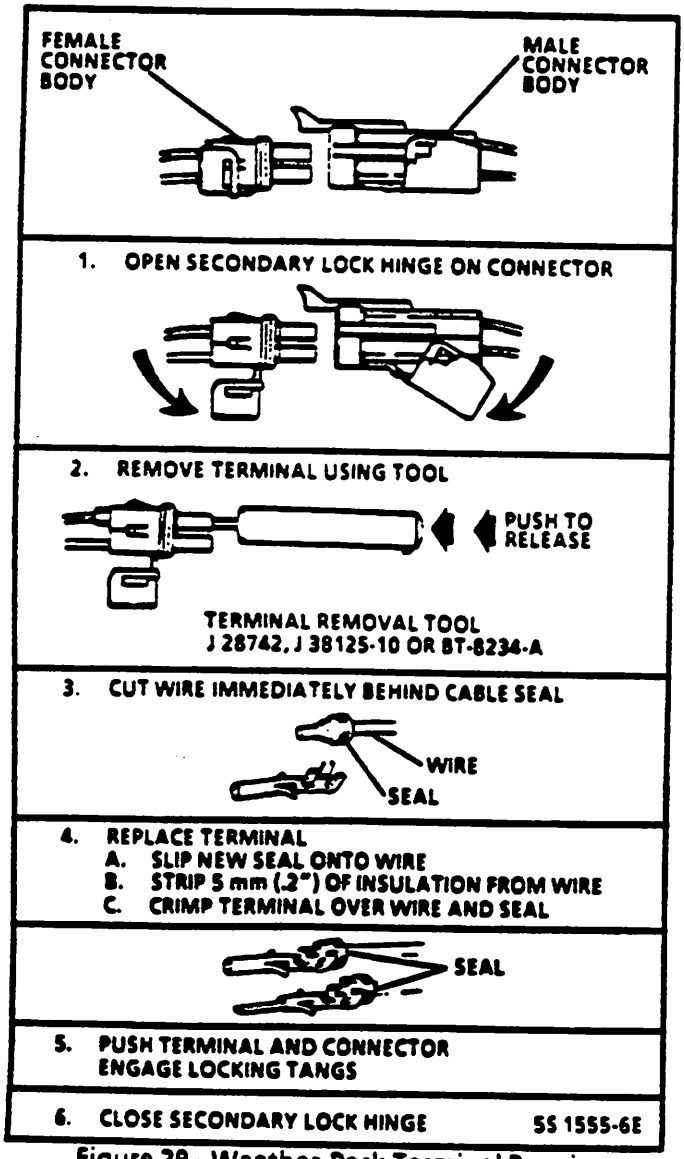


Figure 29 - Weather-Pack Terminal Repair