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LRG - 425 EFI

ELECTRONIC FUEL INJECTION SYSTEM DIAGNOSTIC SERVICE MANUAL

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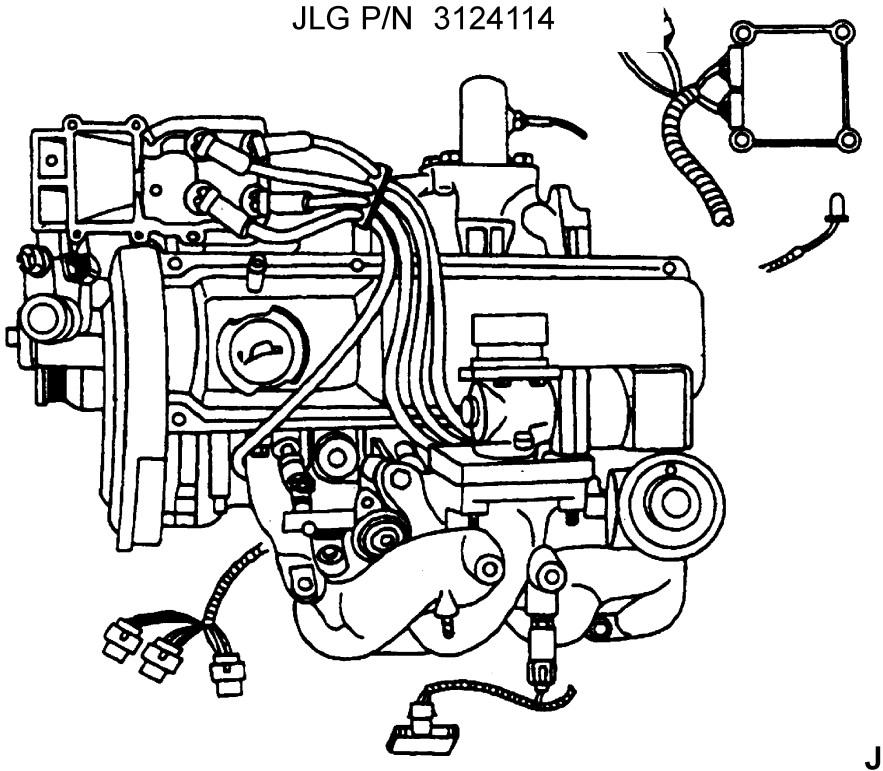
DIAGNOSTIC SERVICE MANUAL

FPP 194-306
JANUARY, 1998
JLG P/N 3124114



FPP 194-306
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FORD POWER PRODUCTS

2.5L EFI DIAGNOSTIC MANUAL

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the components.

TABLE OF CONTENTS

DIAGRAMS AND SCHEMATICS

WIRE COLOR CODE

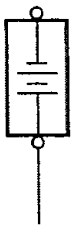
Insulated electrical wire uses a color-coded insulation for identification. The color codes are as follows:

Code	Color	Code	Color
BL	Blue	N	Natural
BK	Black	O	Orange
BR	Brown	PK	Pink
DB	Dark Blue	P	Purple
DG	Dark Green	R	Red
GN	Green	T	Tan
GY	Gray	W	White
LB	Light Blue	Y	Yellow
LG	Light Green	–	–

NOTE: Whenever a wire is labeled with two colors, the first color listed is the basic color of the wire and the secon color listed is the color of the stripe marking on the wire.

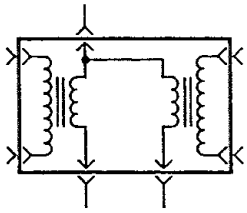
TABLE OF SCHEMATIC SYMBOLS

Battery

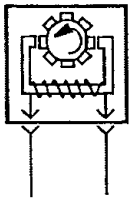


Motor

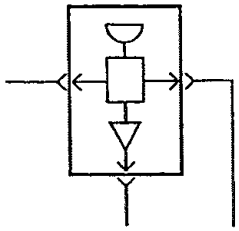
Coils (Primary and Secondary)



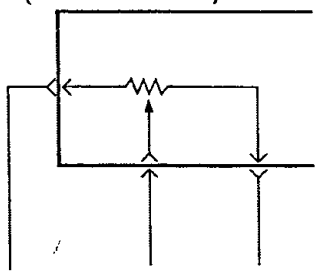
Variable Reluctor Type Sensor



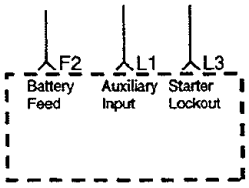
Manifold Absolute Pressure (MAP) Sensor



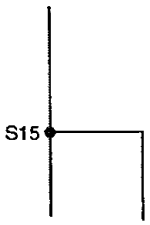
Potentiometer (Variable Resistor)



Pin Connector Numbers

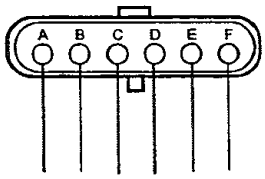


Splice

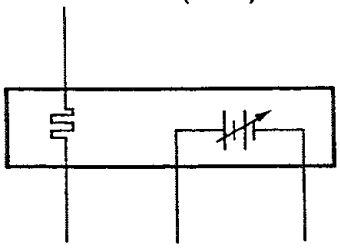


Solenoid

Connector (End View)

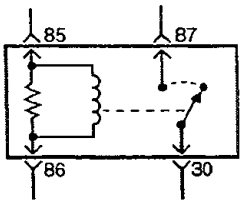


Heated Oxygen Sensor (HO2S)



Ground

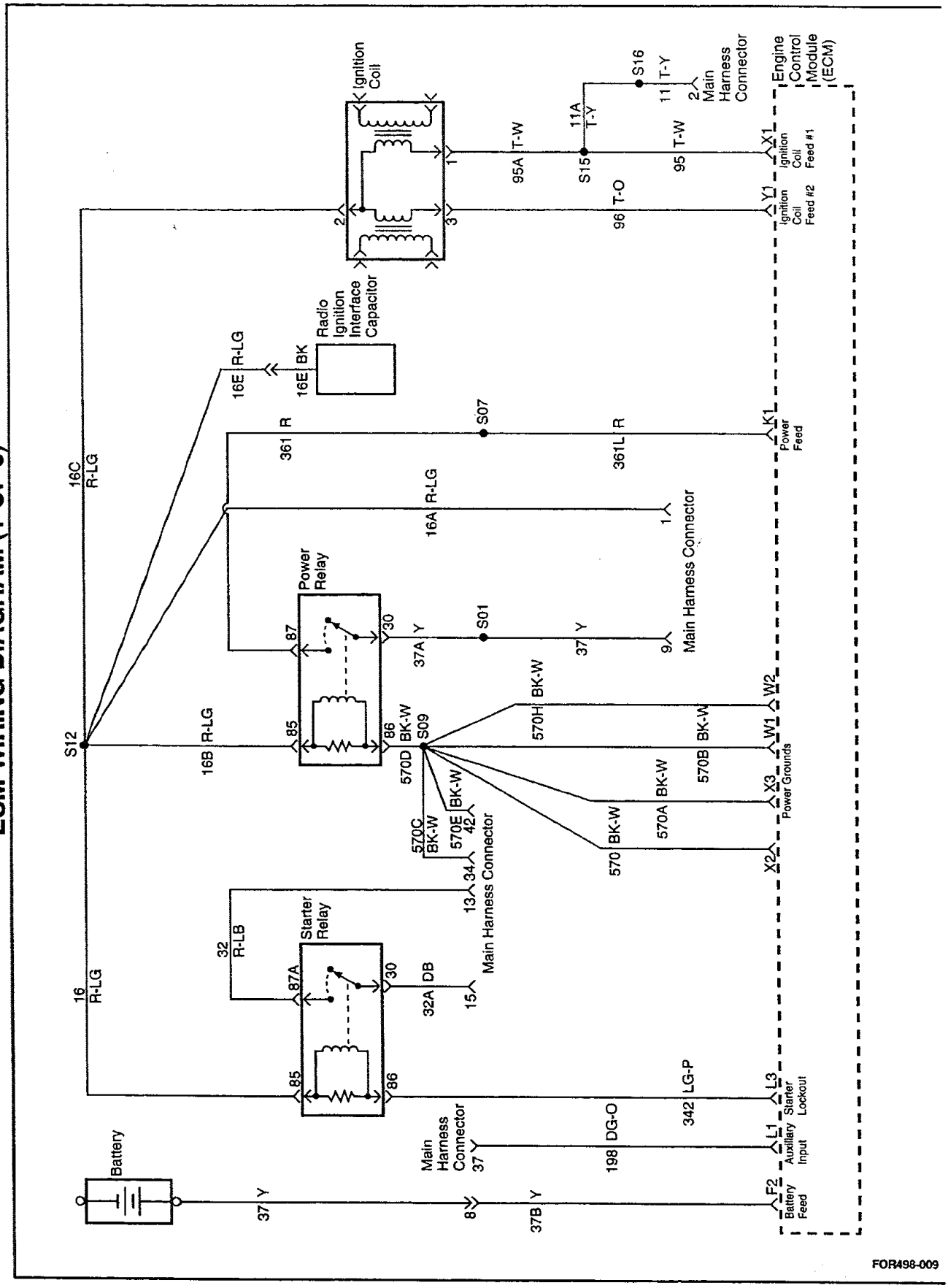
Relay



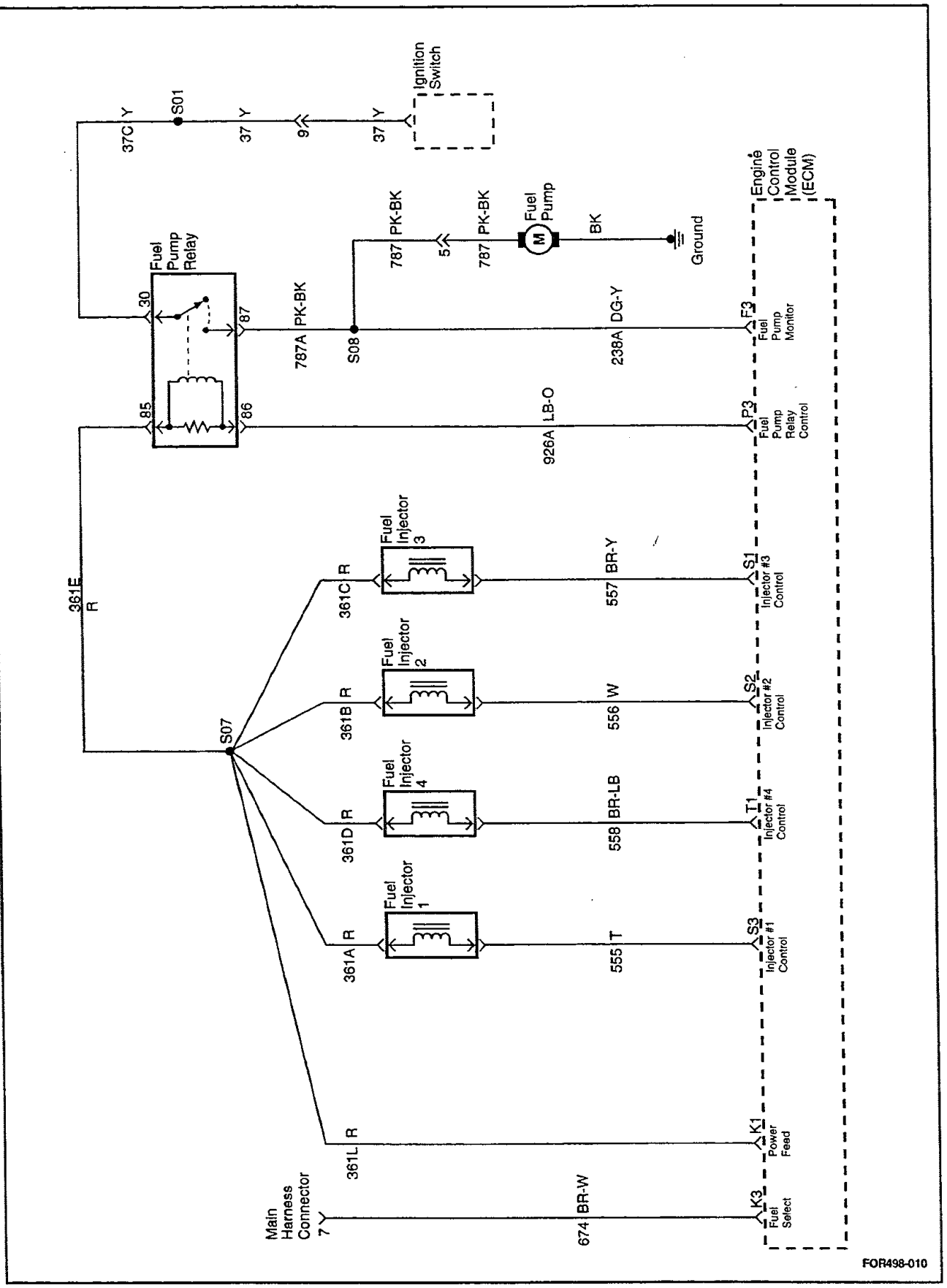
Thermistor

FOR498-049

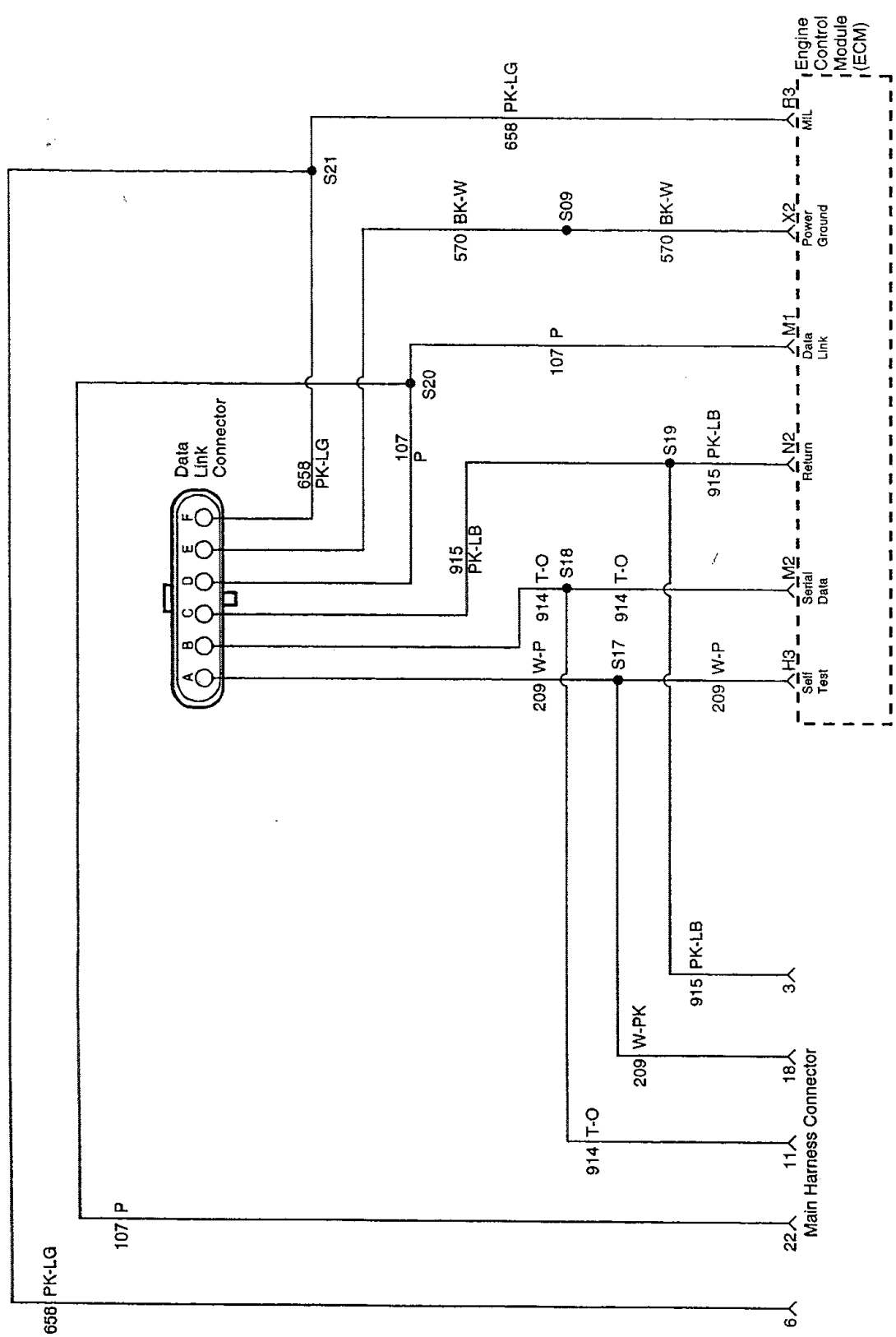
ECM WIRING DIAGRAM (1 OF 5)



ECM WIRING DIAGRAM (2 OF 5)

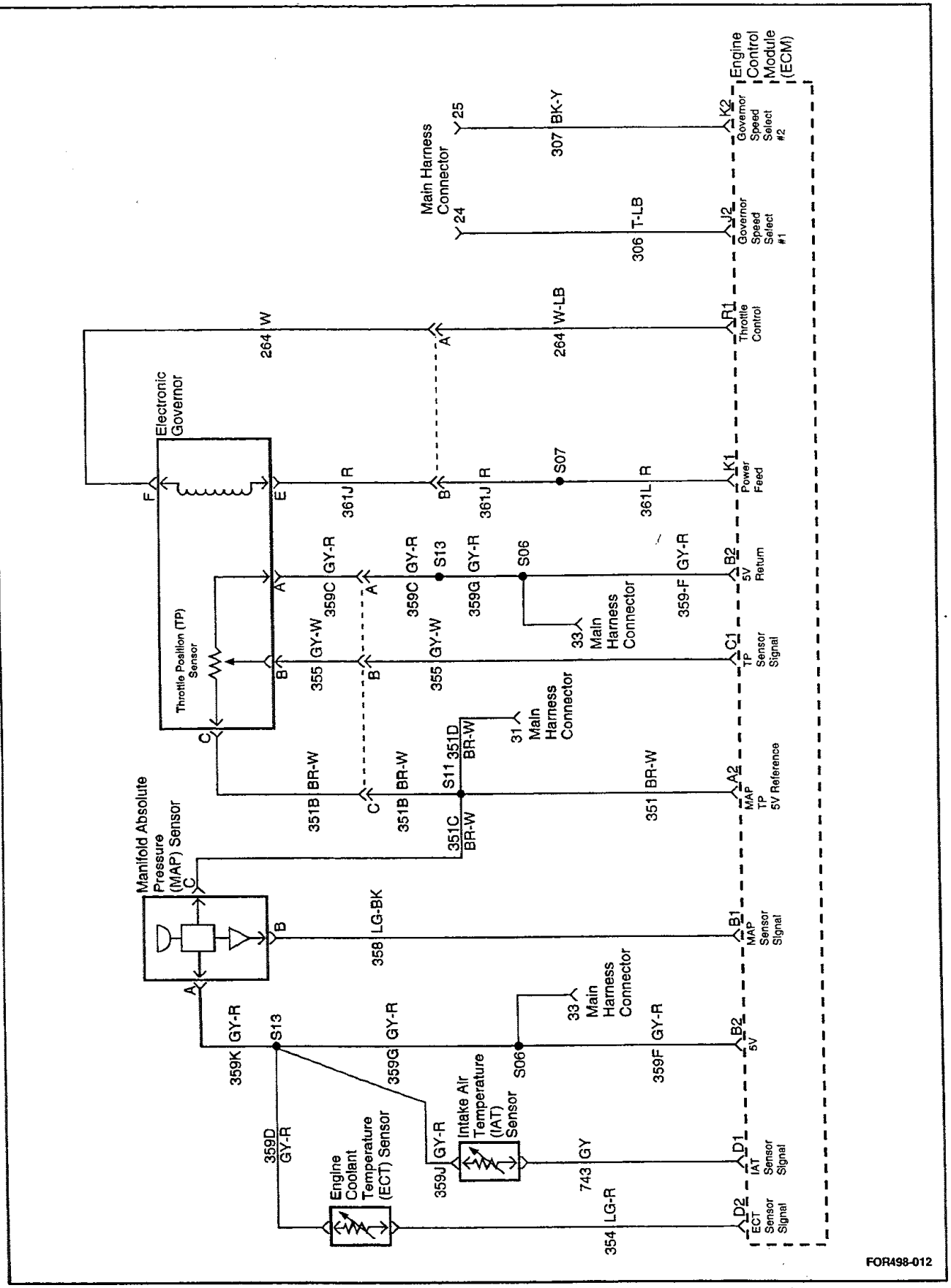


ECM WIRING DIAGRAM (3 OF 5)

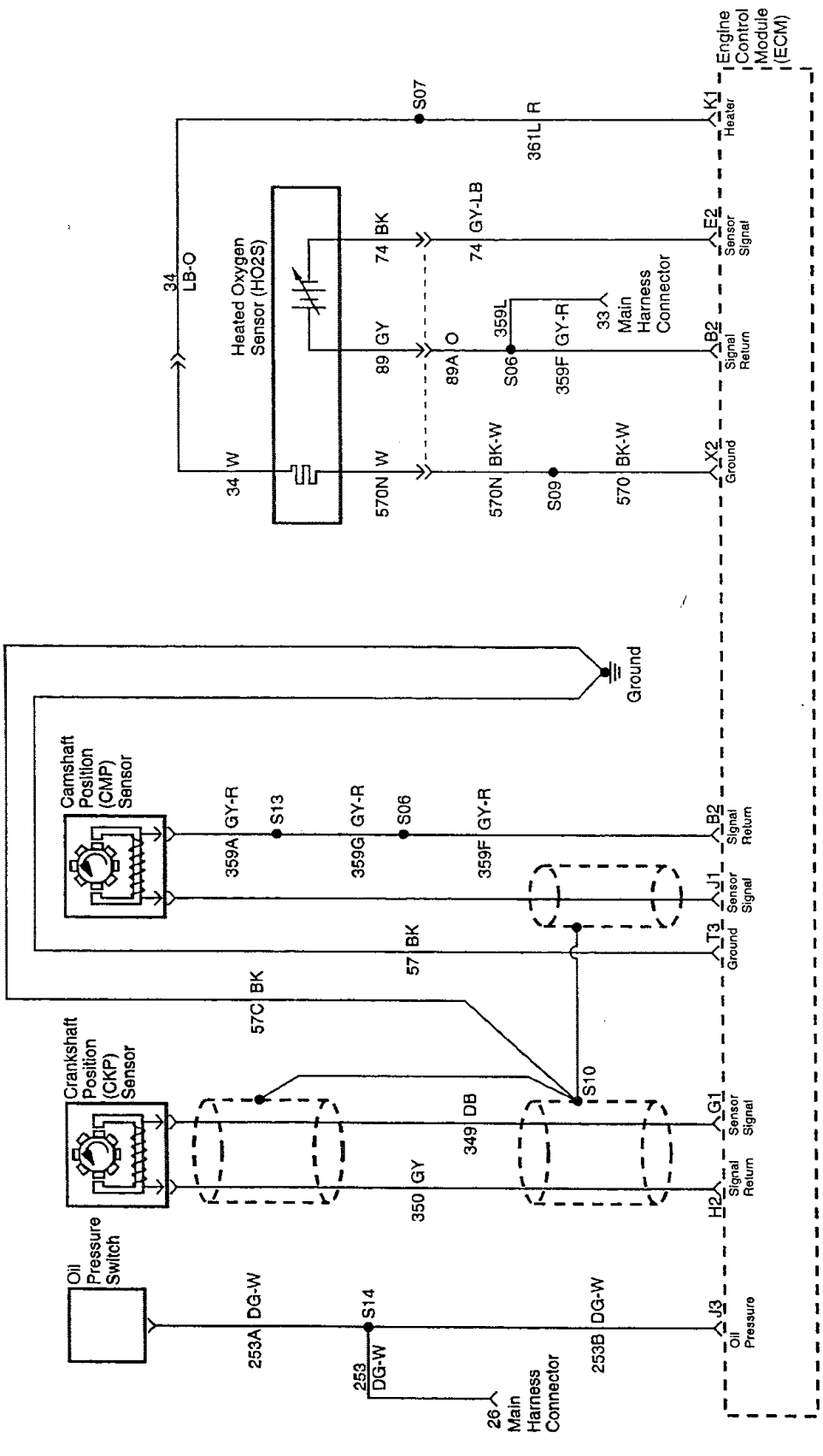


FOR498-011

ECM WIRING DIAGRAM (4 OF 5)



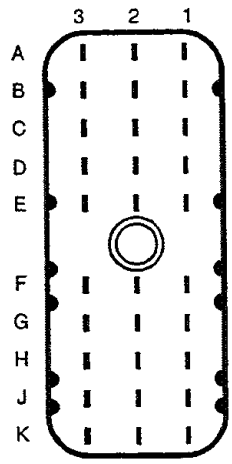
ECM WIRING DIAGRAM (5 OF 5)



FOR498-013

ECM CONNECTOR PINOUTS

30-Pin ECM Connector A-K Pinout

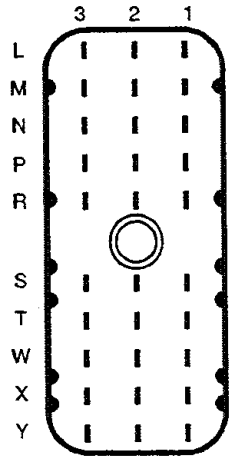


FOR390-004

30-Pin ECM Connector A-K Pinout Table

Pin No.	Circuit Number and Color	Circuit Function
A1	–	Not used
A2	351 BR-W	5-volt reference (VREF)
A3	–	Not used
B1	358 LG-BK	Manifold Absolute Pressure (MAP) sensor signal
B2	359F GY-R	Signal return
B3	–	Not used
C1	355 GY-W	Throttle Position (TP) sensor signal
C2	–	Not used
C3	–	Not used
D1	743 GY	Intake Air Temperature (IAT) sensor signal
D2	354 LG-R	Engine Coolant Temperature (ECT) sensor signal
D3	–	Not used
E1	–	Not used
E2	74 GY-LB	Heated Oxygen Sensor (HO2S) signal
E3	–	Not used
F1	–	Not used
F2	37B Y	Keep-alive Memory (KAM) (Battery voltage)
F3	238A DG-Y	Fuel pump monitor
G1	349 DB	Crankshaft Position (CKP) sensor signal
G2	–	Not used
G3	–	Not used
H1	–	Not used
H2	350 GY	Crankshaft Position (CKP) sensor return
H3	209 W-P	Self Test Input (STI)
J1	282 DB-O	Camshaft Position (CMP) sensor signal
J2	306 T-LB	Governor speed select #1
J3	253B DG-W	Oil pressure switch
K1	361L R	Vehicle power (VPWR)
K2	307 BK-Y	Governor speed select #2
K3	–	Not used

30-Pin ECM Connector L-Y Pinout



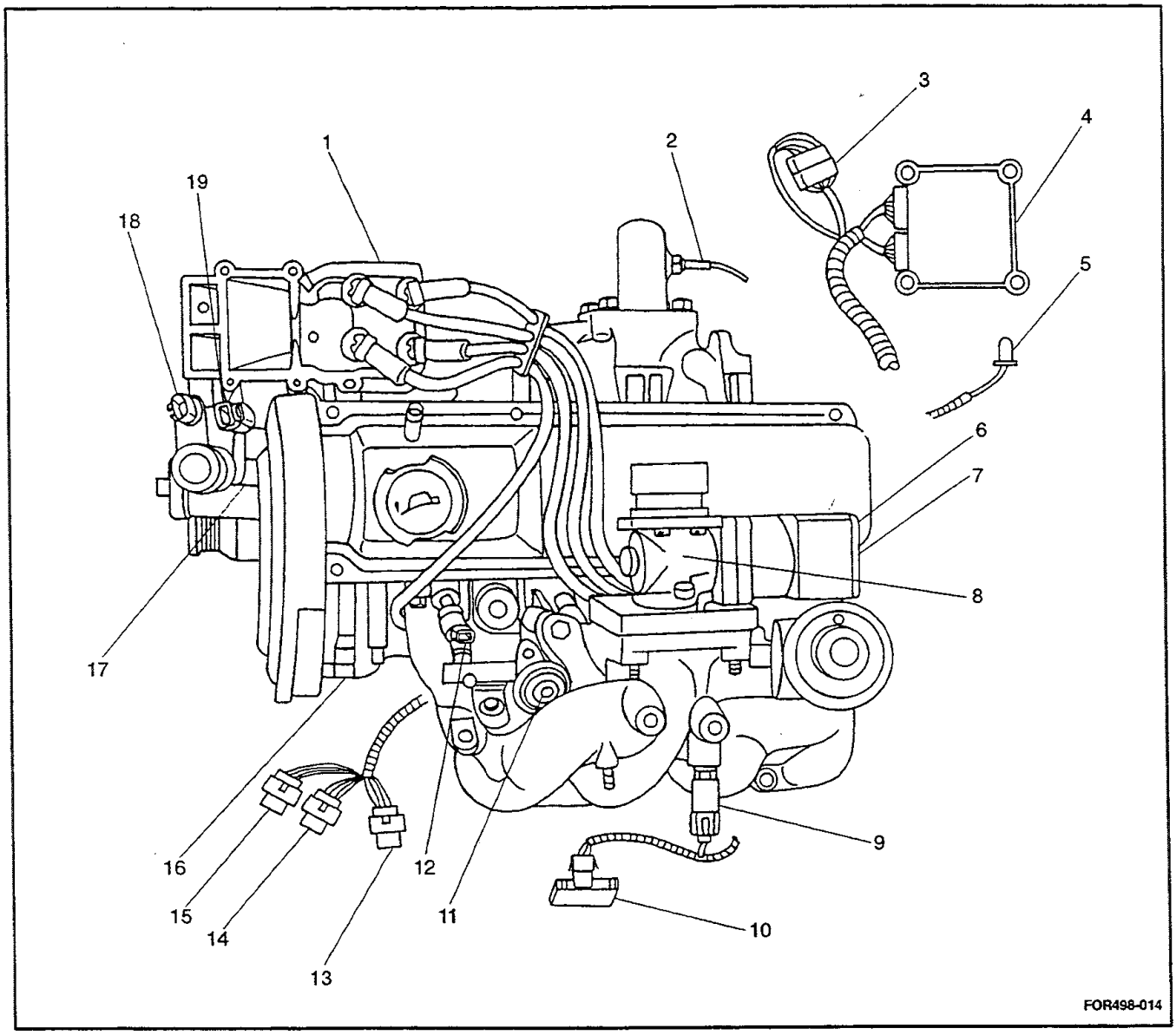
FOR390-005

30-Pin ECM Connector L-Y Pinout Table

Pin No.	Circuit Number and Color	Circuit Function
L1	198 DG-O	Auxillary input
L2	–	Not used
L3	342 LG-P	Starter lockout
M1	107 P	Data link
M2	914 T-O	Data Link Connector (DLC) (+)
M3	–	Not used
N1	–	Not used
N2	915 PK-LB	Data Link Connector (DLC) (–)
N3	–	Not used
P1	–	Not used
P2	–	Not used
P3	926A LB-O	Fuel pump relay control
R1	–	Not used
R2	–	Not used
R3	658 PK-LG	Malfunction Indicator Lamp (MIL)
S1	557 BR-Y	Fuel injector #3
S2	556 W	Fuel injector #2
S3	555 T	Fuel injector #1
T1	558 BR-LB	Fuel injector #4
T2	–	Not used
T3	57 BK	Ground
W1	570B BK-W	Power ground
W2	570H BK-W	Power ground
W3	–	Not used
X1	95 TW	Ignition coil #1
X2	570 BK-W	Power ground
X3	570A BK-W	Power ground
Y1	96 T-O	Ignition coil #2
Y2	–	Not used
Y3	–	Not used

COMPONENT LOCATOR

ENGINE COMPONENT LOCATOR VIEW



Legend

1 Ignition Coil Pack
2 Heated Oxygen Sensor (HO2S)
3 Data Link Connector (DLC)
4 Engine Control Module (ECM)*
5 Malfunction Indicator Lamp (MIL)*
6 Oil Pressure Switch (below the corner of the valve cover)
7 Electronic Governor
8 Throttle Position (TP) Sensor (contained within the electronic governor)
9 Intake Air Temperature (IAT) Sensor
10 Manifold Absolute Pressure (MAP) Sensor*
11 Fuel Pressure Dampener
12 Fuel Injectors
13 ECM Relay*
14 Fuel Pump Relay*
15 Starter Interlock Relay
16 Camshaft Position (CMP) Sensor
17 Crankshaft Position (CKP) Sensor
18 Coolant Temperature Sender
19 Engine Coolant Temperature (ECT) Sensor

* Component location determined by application.

DIAGNOSIS

USING ELECTRICAL SYSTEMS DIAGNOSTIC INFORMATION (STRATEGY-BASED DIAGNOSTICS)

Strategy-based diagnostics is a uniform approach for repairing all electrical/electronic systems. It is a step-by-step method and is the place to start when any repair is necessary.

1. Verify the customer's complaint and determine if it is a deviation from normal operation.
2. Once the complaint has been verified, preliminary checks can be done. Conduct a thorough visual inspection, be alert for unusual sounds or odors, and gather diagnostic trouble code information.
3. Perform a system check that will verify the proper operation of the system in question and check for recent information updates.
4. If a diagnostic trouble code (DTC) is stored, follow the designated DTC chart exactly to make an effective repair.
5. If no DTC is stored, select the symptom from the symptom tables and follow the diagnostic path or suggestions to complete the repair.
6. After the repair has been made and validated for proper operation, the old part should be momentarily re-installed to verify that it was indeed the source of the problem.

If no matching symptom is available, analyze the complaint and develop a plan for diagnostics utilizing the wiring diagrams, technical assistance, and repair history.

Intermittent conditions may be resolved by using a check sheet to pinpoint the circuit or electrical system component. Some diagnostic charts contain Diagnostic Aids which give additional information about a system. Be sure to use all of the information that is available to you.

VISUAL/PHYSICAL ENGINE INSPECTION CHECK

Perform a careful visual and physical engine inspection before performing any diagnostic procedure. Perform all necessary repairs before proceeding with additional diagnosis, this can often lead to repairing a problem without performing unnecessary steps. Use the following guidelines when performing a visual/physical inspection check:

- Inspect engine for modifications or aftermarket equipment that can contribute to the symptom; verify that all electrical and mechanical loads or accessory equipment is "OFF" or disconnected before performing diagnosis.
- Inspect engine fluids for correct levels and evidence of leaks.
- Inspect vacuum hoses for damage, leaks, cracks, kinks and improper routing, inspect intake manifold sealing surface for a possible vacuum leak.
- Inspect PCV valve for proper installation and operation.
- Inspect all wires and harnesses for proper connections and routing; bent or broken connector pins; burned, chafed, or pinched wires; and corrosion. Verify that harness grounds are clean and tight.
- Inspect engine control module (ECM), sensors, and actuators for physical damage.
- Inspect ECM grounds for cleanliness, tightness, and proper location.
- Inspect fuel system for adequate fuel level, and fuel quality (concerns such as proper octane, contamination, winter/summer blend).
- Inspect intake air system and air filter for restrictions.
- Inspect battery condition and starter current draw.

If no evidence of a problem is found after visual/physica engine check has been performed, proceed to MIL DTC retrieval procedure.

ON-BOARD DIAGNOSTICS

DIAGNOSTIC INFORMATION

The diagnostic tests and circuit charts are designed to assist the technician to locate a faulty circuit or component through a process of logical decisions. The tests and charts are prepared with the requirement that the engine functioned correctly at the time of assembly and that there were not multiple faults present.

There is a continuous self-diagnosis on certain control functions. This diagnostic capability is complimented by the diagnostic procedures contained in the LRG-425 2.5L Industrial Engine Service Manual. The language for communicating the source of the malfunction is a system of diagnostic trouble codes. When a malfunction is detected by the Engine Control Module (ECM), a diagnostic trouble code (DTC) is set and the Malfunctior Indicator (MIL) lamp will be illuminated (refer to *MIL DTC Retrieval Procedure* for process description). Refer tc *Diagnosing the 2.5L EFI Engine Using a Personal Computer* for information regarding performing ECM anc engine control system diagnosis with a personal computer.

Limp Home Mode

When an input to the ECM is outside of an establishec range, the appropriate DTC will set. The ECM will thei ignore the errant input signal, and carry on its function: as best it can via default, calculated, or estimatec

values. An engine operating under these conditions is said to be in "limp home" mode.

Engines are calibrated to run as smoothly as possible during limp home mode. However, engine performance during limp home mode varies according to which DTC is set. Overspeed Protection is hard-coded in ECM programming at 4000 rpm maximum. At 4000 rpm the engine will shut off, and DTC 21 will be set.

Limp Home Mode Process Description

When a malfunction occurs for DTC(s) with the limp home mode feature, a DTC will be set, the MIL will illuminate and corrective (limp home mode/default values) will be initiated. This operational mode will continue as long as the engine runs without being shut off. If the malfunction occurs and then corrects itself while the engine is continuously running, the DTC will be stored, the MIL will remain illuminated and the engine will continue to run in the limp home mode until shut off and restarted. Once restarted, if the malfunction does not reoccur, the engine will resume running in a normal operating mode.

MIL DTC RETRIEVAL PROCEDURE

NOTE: DTCs can be retrieved from the engine control module (ECM) by using either the MIL or an IBM-compatible personal computer using the optional serial interface available. Refer to *Diagnosing the 2.5L EFI Engine Using a Personal Computer* for information about using a personal computer to assist with unit diagnosis.

DTCs can only be retrieved by shorting the Self Test Input (STI) connector to ground. The STI circuit is a white/purple wire exiting pin H3 from the ECM. The STI white/purple wire branches off to terminal "A" of the 6-pin diagnostic connector. If no DTC is stored with key on/engine off (KOEO), a DTC 11 is flashed, indicating that all systems are OK.

During key on/engine running (KOER) operation, with no DTCs stored, the MIL is not illuminated. If during KOER operation a DTC is stored, the MIL will illuminate and remain on steady.

MIL BULB TEST: The MIL bulb test occurs KOEO with the STI connector not grounded. The MIL bulb will illuminate for 2-3 seconds, then remain off if no DTCs are present (except DTC 11). If DTCs are present (except DTC 11), the MIL bulb will illuminate and remain on. If the MIL bulb does not illuminate when bulb test is performed, inspect the bulb and replace it if damaged. If bulb is OK or does not illuminate after replacement, refer to MIL Circuit Test Procedure. Once MIL bulb illumination has been verified or established, DTCs can be extracted from the MIL as follows:

- KOEO, short the STI circuit to a known good ground. There will be a 5 second delay before DTCs begin flashing.

When extracting DTCs via the MIL the following apply:

- The flashing MIL is on for 0.4 second and off for 0.4 second.
- The MIL is off for 1.2 seconds between digits of two-digit DTCs.
- The MIL is off for 2.4 seconds between DTCs.
- Each DTC repeats 3 times before the next stored DTC begins flashing.
- Up to 6 DTCs can be stored.
- Once all stored DTCs are flashed, the process repeats with the first stored DTC.
- DTCs are flashed in the order in which they were set.

Once the DTC(s) is retrieved, refer to the appropriate DTC chart for explanation of what caused the DTC to set. Perform component and circuit test as required to conduct repair.

INTERMITTENT MALFUNCTION INDICATOR LAMP

Conditions that are only present from time to time are called intermittents. To resolve intermittents, perform the following steps:

1. Evaluate the history of DTC's observed with this particular engine.
2. Evaluate the symptoms and conditions described by the customer.
3. Use strategy-based diagnosis, especially where it relates to the elimination of bad connectors and wiring.
4. When using a personal computer with Ford Power Products software, data-capturing capabilities are available that can assist in detecting intermittents. Contact the Ford Power Products Customer Service Center Technical Support Hotline (1-800-521-0370) for more information.

When a malfunction occurs for DTC's with the "limp-home" mode feature, a DTC will be set, the MIL will illuminate, and the corrective action (limp-home mode or default values) will be initiated. This will continue as long as the engine runs without being shut off. If the malfunction occurs and then corrects itself while the engine is continuously running, the DTC will be stored, the MIL will remain illuminated, and the engine will continue to run in the limp-home mode until it is shut off and restarted. Once restarted, if the malfunction does not recur, the MIL stays on and engine will resume running in a normal operating mode.

DIAGNOSING THE 2.5L EFI ENGINE USING A PERSONAL COMPUTER

An IBM PC-compatible computer, especially a laptop, can be very helpful when diagnosing concerns that are related to electronic engine controls. With a properly-configured computer and Ford Power Products ECM

Calibration Software, you can perform the following functions:

- Read live data from engine sensors
- Calibrate the governor speed settings
- Reprogram a replacement ECM

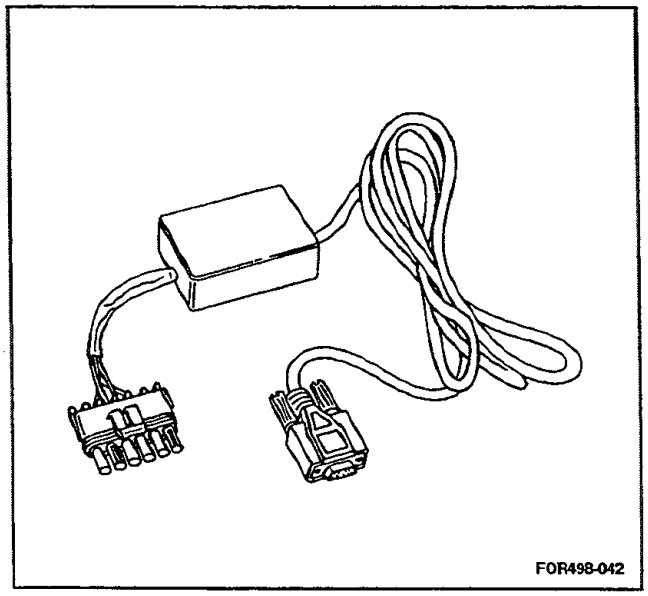
To diagnose the 2.5L EFI engine with a computer, you will need the following components:

- An IBM PC-compatible computer with the following configuration:
  - An 80386 or higher CPU
  - MS-DOS 3.0 or higher
  - At least 1 MB of RAM
  - At least 10 MB of available hard disk storage
  - A 3.5-inch floppy drive
  - An available serial ("COM") port (refer to the readme.txt file included with the software)
  - VGA graphics
- A Ford Power Products interface cable
- Ford Power Products ECM Calibration Software. The interface cable and software are available as a kit, part number F8JL-6K947-AA.

Interface Cable

The interface cable provides the physical and electrical hookup between the engine control module (ECM) and the personal computer (PC). The interface cable consists of the following components:

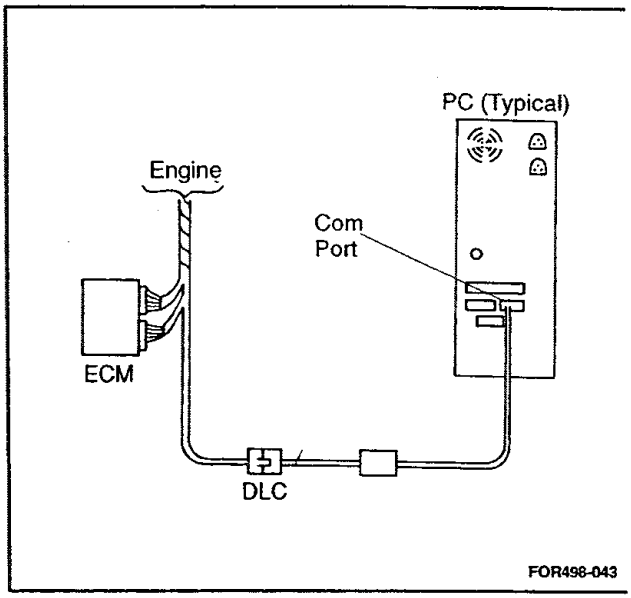
- A 6-way connector that plugs into the data link connector (DLC) at the engine
- An electronic module that converts the ECM signals into a format that the PC can recognize
- A 9-pin serial data connector that plugs into the PC



FOR498-042

To install the interface cable:

1. Make sure the engine key is OFF.
2. Plug the 6-way connector from the interface cable int the DLC at the engine.
3. Make sure the PC is OFF.
4. Plug the 9-pin serial data connector into an availabl COM port on the PC. If your COM port has a 25-pi connector, use a 9-pin to 25-pin adapter. These ar standard adapters which are readily available at mos computer stores.



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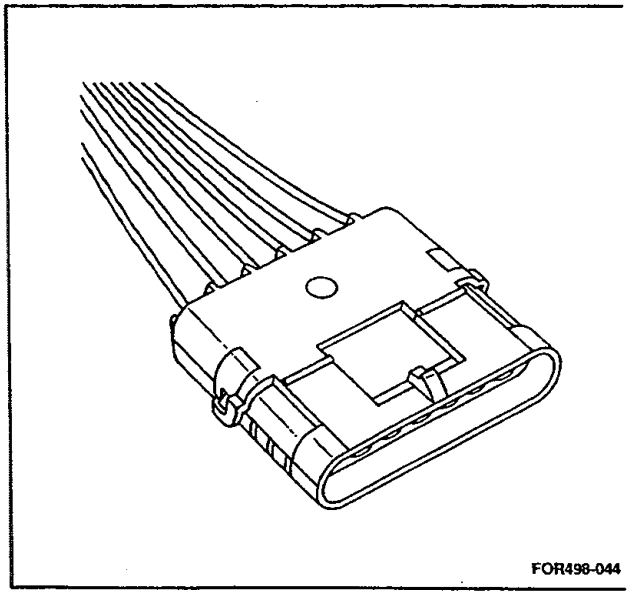
Data Link Connector

The data link connector (DLC) is a 6-way connector tha is used to connect the ECM to an external device suc as a personal computer. The DLC allows the externa device to read serial data from the ECM. This data con tains information from various engine sensors and i used for diagnosing engine control problems.



FOR498-044

Using the ECM Calibration Software

Ford Power Products ECM calibration software enables you to read data from the engine sensors, calibrate the governor speed settings, and reprogram a replacement ECM. This software is used in order to diagnose engine control problems with a personal computer. The program allows the personal computer to read data from the ECM through the interface cable. The software is distributed on a 3.5-inch floppy disk.

Starting the Program

1. Make sure the Ford Power Products ECM calibration software is properly installed. Refer to "Installing the Software" for more information.
2. Install the interface cable between the personal computer and the data link connector (DLC) at the engine. Refer to "Interface Cable" for more information.
3. KOEO.
4. At the C:> prompt on your computer screen, type CD FPPGOV [ENTER].
5. Type FPPGOV [ENTER].

As soon as the program starts, it will attempt to establish communications with the ECM. If it cannot, an "OFFLINE" message will be displayed in the lower right corner of the screen.

6. If an "OFFLINE" message is displayed, press [F5] to command the program to try establishing communications again.

When communications have been established between the PC and the ECM, an "ONLINE" message will be displayed in the lower right corner of the screen.

Menu Functions

The home screen contains a list, or menu, of all the functions that can be performed.

- To begin using a function, press the key for that function's menu letter.
- Press [ESC] to abort a function without affecting any of the parameters associated with it.
- From the home screen, hold down the [ALT] key while pressing the X key to end the program and return to MS-DOS.

[D] Transfer Calibration from PC to ECM

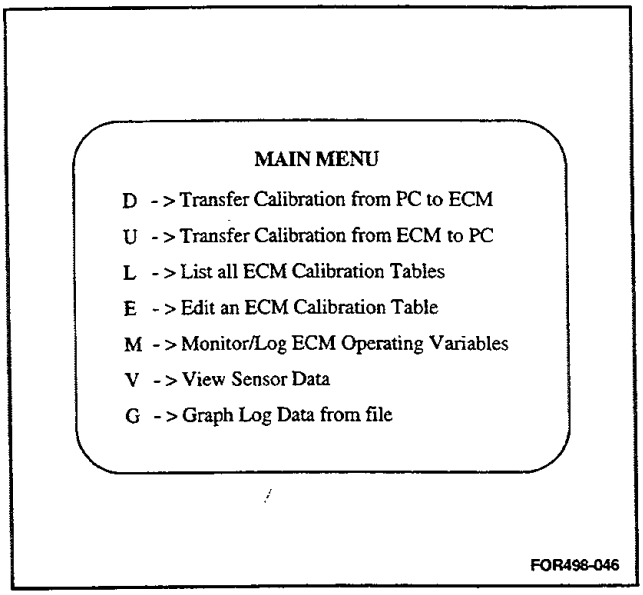
This function is used when programming a replacement ECM. Refer to "Programming a Replacement ECM" for more information.

[U] Transfer Calibration from ECM to PC

This function is used when programming a replacement ECM. Refer to "Programming a Replacement ECM" for more information.

[L] List all ECM Calibration Tables

When "L" is pressed, a list of all accessible ECM tables is displayed. To scroll through the list, use the up-arrow and down-arrow keys. To access a table from the list, highlight the desired table with the up-arrow or down-arrow keys and press [ENTER]. General users will only have access to the governor calibration functions.



[E] Edit an ECM Calibration Table

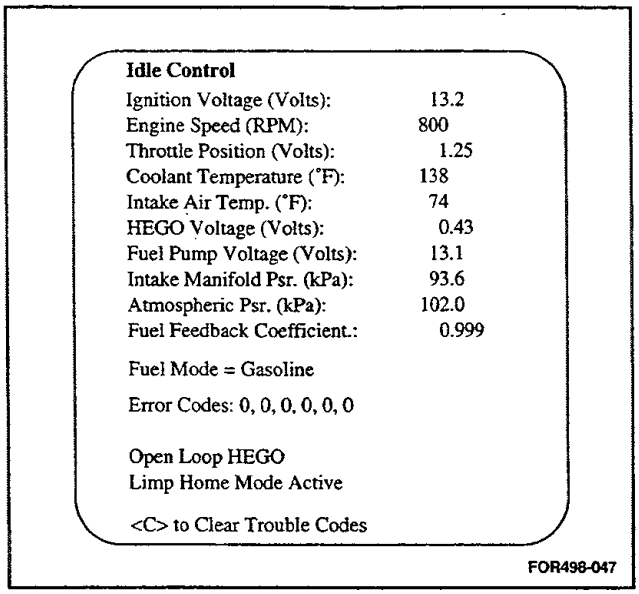
Press "E" while at the home screen to prepare the program to receive a table selection number. After pressing "E," enter the number of the table, as specified in the List function, to access that calibration table. This is a shortcut to selecting a table if the table index number is known. This shortcut can be used instead of scrolling through the list and highlighting with the [L] function. General users will only have access to the governor calibration functions.

[M] Monitor/Log ECM Operating Variables

This function is available to technical support personnel at the Ford Power Products Customer Service Center for detailed monitoring of engine functions. It is not currently implemented for field technicians.

[V] View Sensor Data

When the "V" key is pressed, the General View screen is displayed. **This is the main screen that you will use to retrieve DTC's and to observe engine operating conditions as they are happening.** The screen displays a standard group of ECM sensors and the live data that is being detected or produced by those sensors. Refer to "Engine Sensor Data Definitions and Ranges" for further information.



[G] Graph Log Data from File

This function is available to technical support personnel at the Ford Power Products Customer Service Center for displaying a graphic representation of the data stored with the Monitor/Log ECM Operating Variables function. It is not currently implemented for field technicians.

Installing the ECM Calibration Software

The Ford Power Products ECM calibration software is distributed on a 3.5-inch diskette. The program is DOS-based, but can also be installed through the DOS prompt available through Windows 3.x or Windows 95.

To Install from DOS

1. Place the diskette in the A: drive.
2. From the C:> prompt, type **a: setup** [ENTER].
3. Remove the diskette from the A: drive and store it in a safe place.
4. To start the ECM calibration program, type **CD FPPGOV** [ENTER].
5. Type **FPPGOV** [ENTER].
6. To use the software for engine diagnostics, refer to "Using the ECM Calibration Software."

To Install from Windows 3.x

1. Place the diskette in the A: drive.
2. In Program Manager, double-click the **Main** icon.
3. In the Main window, double-click the **MS-DOS** icon.
4. At the DOS prompt, type **cd ..**
5. From the C:> prompt, type **a: setup** [ENTER].
6. Remove the diskette from the A: drive and store it in a safe place.
7. To start the ECM calibration program, type **CD FPPGOV** [ENTER].
8. Type **FPPGOV** [ENTER].
9. To use the software for engine diagnostics, refer to "Using the ECM Calibration Software."

To Install from Windows 95

1. Place the diskette in the A: drive.
2. Click on the **Start** button in the lower left corner of the screen.
3. From the Start menu, click on the **Shut Down. . .** option.
4. From the Shut Down window, click on the **Restart the computer in MS-DOS mode** option.
5. Click the **Yes** button.
6. At the DOS prompt, type **cd ..**
7. From the C:> prompt, type **a: setup** [ENTER].
8. Remove the diskette from the A: drive and store it in a safe place.
9. To start the ECM calibration program, type **CD FPPGOV** [ENTER].
10. Type **FPPGOV** [ENTER].
11. To use the software for engine diagnostics, refer to "Using the ECM Calibration Software."

Clearing Diagnostic Trouble Codes

When diagnostic trouble codes (DTC's) occur, they are stored in memory in the engine control module (ECM). The ECM is capable of holding six DTC's in memory. After repairing a problem which caused a DTC to be set, the DTC will remain in memory until you erase it.

To erase DTC's from memory, disconnect the negative battery cable for five minutes, then reconnect it. There is a provision for using a personal computer command to erase DTC's. In the View Sensor Data screen, hitting the "C" key will clear codes.

DIAGNOSTIC SYSTEM CHECK

Circuit Description

The Diagnostic System Check is the starting point for any PC-based diagnosis of engine performance complaints. This routine verifies that the engine control module (ECM) is properly communicating with the PC. Before using this procedure, perform a careful visual/physical check of the ECM and engine grounds for cleanliness and tightness.

Diagnostic Aids

An intermittent may be caused by a poor connection, rubbed-through wire insulation, or a broken wire inside the insulation. Inspect the ECM harness and connectors for improper mating, improperly formed or damaged terminals, poor terminal-to-wire connections, or a damaged harness.

Diagnostic System Check

Step	Action	Value(s)	Yes	No
1	1. Ignition OFF. 2. Connect the PC to the data link connector. 3. KOEO. 4. Attempt to display the ECM engine data on the PC screen. Does the PC screen display the ECM engine data?	–	Go to *Step 2*	Go to *Step 4*
2	Attempt to start the engine. Did the engine start and continue to run?	–	Go to *Step 3*	Go to *Engine Cranks But Doesn't Start*
3	Are any DTC's displayed on the ECM engine data screen?	–	Go to applicable DTC table	Go to Symptom Diagnosis
4	1. Ignition OFF. 2. Disconnect the ECM. 3. With a self-powered test lamp check circuit 107 (Pink) for an open, short to ground, or short to voltage and circuit 570 (Black/White) for an open or short to ground. Was a problem found?	–	Go to *Step 5*	Check PC system for properly configured software
5	Repair the open, short to ground, or short to voltage in circuit 107 and/or the open or short to ground in circuit 570. Is the repair complete?	–	Re-test the system	–

ENGINE CONTROL MODULE (ECM) DIAGNOSIS

Note: Refer to *MIL DTC Retrieval Procedure* for information regarding how to perform ECM diagnosis via the malfunction indicator light. Refer to *Diagnosing the 2.5L EFI Engine Using a Personal Computer* for information regarding ECM diagnosis using a personal computer.

Important: Diagnostic trouble codes can only be cleared by turning the ignition "OFF" and disconnecting the battery power from the ECM for 5 minutes.

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

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

- There is a problem with the ECM terminal connections. The terminals may have to be removed from the connector in order to check them properly.
- The problem is intermittent. This means that the problem is not present at the time the system is being checked. Refer to the "Symptom Charts" and perform a careful visual/physical inspection of all components and wiring associated with the affected system.
- There is a shorted sensor, actuator, or harness. A shorted sensor, actuator, or harness should not damage the ECM but will cause the sensor or actuator circuit to be inoperative, and a DTC(s) may be set.

MULTIPLE ECM INFORMATION SENSOR DTC(S) SET

Circuit Description

The Electronic Engine Management System (EEMS) consists of a network of electronic and electromechanical components. The heart of the EEMS system is the engine control module (ECM), which monitors various sensors to determine engine operating conditions. The ECM controls fuel delivery and ignition spark timing. This system continuously varies engine operation in order to meet programmed parameters. The ECM provides the following sensors with a 5-volt reference and a signal return path:

- Manifold absolute pressure (MAP) sensor
- Engine coolant temperature (ECT) sensor
- Intake air temperature (IAT) sensor
- Throttle position (TP) sensor

The ECM monitors the separate feedback signals from these sensors in order to determine their operating status.

Important: If a sensor input circuit has been shorted to voltage, ensure that the sensor is not damaged. A damaged sensor will continue to indicate a high or low voltage after the affected circuit has been repaired. If the sensor has been damaged, replace it.

Multiple ECM Information Sensor DTC(s) Set

Step	Action	Value(s)	Yes	No
1	Was a Visual/Physical Check performed?	–	Go to *Step 2*	Perform Visual/Physical check
2	1. Ignition "OFF". 2. Disconnect ECM connectors. 3. Ignition "ON", check the 5 volt sensor reference circuit for the following conditions: A poor connection at the ECM. An open between the ECM connector and the splice. A short to ground or voltage. Is there an open or short?	–	Verify repair	Go to *Step 3*
3	Check the sensor ground circuit for the following conditions: • A poor connection at the ECM or the affected sensors. • An open between the ECM connector and the affected sensors. Is there an open or a poor connection?	–	Verify repair	Go to *Step 4*
4	Measure the voltage between the MAP sensor signal circuit at the ECM harness connector and ground. Does the voltage measure near the specified value?	0 V	Go to *Step 5*	Go to *Step 8*
5	Measure the voltage between the TP sensor signal circuit at the ECM harness connector and ground. Does the voltage measure near the specified value?	0 V	Go to *Step 6*	Go to *Step 9*
6	Measure the voltage between the IAT sensor signal circuit at the ECM harness connector and ground. Does the voltage measure near the specified value?	0 V	Go to *Step 7*	Go to *Step 10*
7	Measure the voltage between the ECT sensor signal circuit at the ECM harness connector and ground. Does the voltage measure near the specified value?	0 V	Go to *Step 12*	Go to *Step 11*

Multiple ECM Information Sensor DTC(s) Set (Cont'd)

Step	Action	Value(s)	Yes	No
8	Locate and repair the short to voltage in the MAP sensor signal circuit. Is the action complete?	–	Verify repair	–
9	Locate and repair the short to voltage in the TP sensor signal return circuit. Is the action complete?	–	Verify repair	–
10	Locate and repair the short to voltage in the IAT sensor signal circuit. Is the action complete?	–	Verify repair	–
11	Locate and repair the short to voltage in the ECT sensor signal circuit. Is the action complete?	–	Verify repair	–
12	Replace the ECM. Is the replacement complete?	–	Go to *Step 13*	–
13	Are multiple DTC(s) still present after replacement ECM was installed?	–	Contact Ford Power Products Customer Service Center Technical Support Hotline.	Remove replacement ECM and install original ECM. Go to *Step 14*
14	Are multiple DTC(s) still present with the original ECM?	–	Remove original ECM and reinstall replacement ECM.	–

ENGINE SENSOR DATA DEFINITIONS AND RANGES

The following engine data is available when using a personal computer and Ford Power Products diagnostic software to diagnose the 2.5L EFI engine. This data appears on the [V]iew Sensor Data screen.

Ignition Voltage (Volts) – This number indicates ignition system voltage and should be in a range from about 12-14.5 volts. Low voltage could indicate a possible low battery condition, low generator output, or faulty wiring. High voltage could indicate a faulty voltage regulator. A DTC 61 will set when voltage is 8.0 volts or less for at least two consecutive seconds. A DTC 62 will set when voltage is 18 volts or more for at least two consecutive seconds.

Engine Speed (RPM) – This indicates the engine speed as detected by the crankshaft position (CKP) sensor. A DTC 21 will set if the engine reaches 4000 rpm. If this happens, the fuel is immediately removed to shut off the engine. The engine may be restarted after the ignition switch is cycled off and then back on.

Throttle Position (Volts) – This indicates the amount of throttle opening, as detected by the throttle position (TP) sensor and measured in volts. The throttle position sensor will normally read within a range of about 0.5 volts at idle to about 4.9 volts at wide open throttle. A DTC 12 will set if the voltage is 0.3 volts or less for at least two consecutive seconds. A DTC 22 will set if the voltage is 4.9 volts or more for at least two consecutive seconds. In either of these cases, the ECM will force the throttle to a default position of 6 percent.

Coolant Temperature (°F) – This indicates the coolant temperature as measured by the engine coolant temperature (ECT) sensor. The ECT sensor sends a varying voltage to the ECM, which converts the voltage to a temperature reading. A DTC 33 will set if the ECT voltage is 4.93 volts or more for at least three consecutive seconds. This corresponds to a temperature of minus 50°F. A DTC 43 will set if the ECT voltage is 0.06 volts or less for at least three consecutive seconds. This corresponds to a temperature of 255°F. In either of these cases, the ECM defaults to an assumed coolant temperature of 50°F. In an overheat condition (DTC 43), the ECM has been programmed to take one of two possible actions:

- Shut off the engine. The engine can be restarted after the key is cycled off, then on. If the problem persists, the engine will be shut off again.
- No action.

A quick check of the reliability of the ECT sensor can be made if the engine has been off for a long period of time (such as overnight). In this case, the ECT reading should be within a degree or two of the IAT reading.

Intake Air Temperature (°F) – This indicates the temperature of the air in the intake manifold, as measured by

the intake air temperature (IAT) sensor. The IAT sensor sends a varying voltage to the ECM, which converts the voltage to a temperature reading. A DTC 35 will set if the IAT voltage is 4.93 volts or more for at least consecutive seconds. A DTC 45 will set if the IAT voltage is 0.06 volts or less for at least three consecutive seconds. In either of these cases, the ECM defaults to an assumed intake air temperature of 50°F. A quick check of the reliability of the IAT sensor can be made if the engine has been off for a long period of time (such as overnight). In this case, the IAT reading should be within a degree or two of the ECT reading.

HEGO Voltage (Volts) – This indicates the voltage produced by the heated oxygen sensor (HO2S, formerly known as HEGO). This voltage should always be fluctuating. HO2S voltage of less than 0.45 volts indicates a lean condition (high oxygen content in the exhaust). HO2S voltage of more than 0.45 volts indicates a rich condition (low oxygen content in the exhaust). A DTC 32 will set if the HO2S voltage is 0.2 volts or less for at least 20 consecutive seconds. A DTC 42 will set if the HO2S voltage is 0.65 volts or more for at least 20 consecutive seconds. In either of these cases, the ECM will switch to open loop fuel control and ignore the signal from the HO2S.

Fuel Pump Voltage (Volts) – This indicates the voltage being applied to the fuel pump (not the fuel pump relay). This information helps to diagnose a no-start condition. If voltage to the fuel pump is low, it could indicate a faulty relay or bad wiring. With KOEO, the fuel pump relay is energized for 2 seconds, applying power to the fuel pump. If no cranking has occurred, the fuel pump relay is de-energized, removing power from the fuel pump. With KOER, battery voltage should be present at the fuel pump. A DTC 31 will be set if voltage to the fuel pump is at least 2 volts less than ignition voltage for at least two consecutive seconds. DTC 31 will also set if voltage is present at the fuel pump when the ECM is NOT commanding it.

Intake Manifold Psr. (kPa) – This indicates the manifold absolute pressure as measured by the manifold absolute pressure (MAP) sensor. The MAP sensor sends a varying voltage to the ECM, which converts the voltage to a pressure reading stated in kilopascals (kPa). The ECM continuously estimates an expected MAP value using calculations that are based on throttle position and engine speed. A DTC 14 will set if the MAP voltage is significantly less than the estimated MAP value for at least two consecutive seconds. A DTC 24 will set if the MAP voltage is significantly higher than the estimated MAP value for at least two consecutive seconds.

Atmospheric Psr. (kPa) – This indicates the atmospheric pressure as measured by the MAP sensor at KOEO. The MAP sensor sends a voltage to the ECM, which converts the voltage to a pressure reading stated in kilopascals (kPa). By making a one-time reading of the MAP sensor just before the engine is started, the ECM can determine the atmospheric pressure. Because atmospheric pressure and air density both change with altitude, this information can be used to adjust the fuel control program to provide the correct air/fuel ratio at various altitudes.

Fuel Feedback Coefficient – This indicates the extent to which the air/fuel ratio is being corrected by the HO2S. This information is only applicable during closed loop operation. The fuel feedback coefficient should be within a range of about 0.82 to 1.18. In open loop, the fuel feedback coefficient should be stable at 0.999.

Error Codes – This is a display of DTC's that are presently in memory. This is the starting point for performing any DTC diagnostics. When diagnosing engine control problems without a personal computer, this information is only available by counting MIL flashes. The ECM can store and display up to 6 DTC's. After correcting a problem that caused a DTC to be set, clear the DTC(s) by removing the negative battery cable for at least 5 minutes.

Accumulated Run Time (Hrs.) – This indicates accumulated engine run time that has been stored in the ECM. The number is incremented every four hours.

Open Loop (or Closed Loop) HEGO – This tells you if the engine is currently operating in open loop fuel control or closed loop fuel control. To enter closed loop, the engine must have been running for at least 7 minutes and reached a coolant temperature of at least 160°F. Refer to "Open Loop and Closed Loop Operation" for more information.

NO MALFUNCTION INDICATOR LAMP (MIL)

The malfunction indicator lamp (MIL) alerts the unit operator that the engine control module (ECM) has detected a system fault. When this occurs a Diagnostic Trouble Code (DTC) will be set (refer to MIL DTC retrieval procedure).

Circuit Description

Power is supplied to the MIL whenever the ignition switch is in the "RUN" or "START" position. The MIL will remain on in the RUN/START mode as a bulb check for approximately 3 seconds. If the MIL remains on after the bulb check the following conditions apply:

- The ECM has a DTC stored (refer to MIL DTC retrieval procedure).
- The MIL circuit is shorted to ground.

If the MIL remains off when the ignition switch is in the RUN/START mode the following conditions apply:

- The MIL bulb is damaged.
- The MIL circuit is open.

Diagnostic Aids

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

- Inspect the ECM harness and connections for improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wire connection, and damaged harness.
- If the engine runs OK, check for a faulty light bulb, an open in the MIL driver circuit, or an open in the MIL feed circuit.
- If the engine cranks but will not run, check for an open ECM ignition or battery feed, or a poor ECM to engine ground.

Test Description

Number(s) below refer to the step number(s) on the Diagnostic Chart.

3. A "NO MIL" condition accompanied by a no-start condition suggests a faulty ECM ignition feed or battery feed circuit.
12. Using a test light connected to B+, probe each of the ECM ground terminals to ensure that a good ground is present.

No Malfunction Indicator Lamp (MIL) Circuit Test

Step	Action	Value(s)	Yes	No
1	Was a Visual/Physical check performed?	–	Go to *Step 2*	Go to *Visual/Physical Check*
2	Attempt to perform MIL DTC retrieval procedure. If MIL bulb illuminates and any DTC(s) are present, repair before proceeding. Is action complete (MIL circuit operation normal)?	–	Verify repair	Go to *Step 3*
3	Attempt to start the engine. Does the engine start?	–	Go to *Step 4*	Go to *Step 7*
4	Ignition "ON" (KOEO), probe the ignition feed circuit at the MIL lamp with a test light to ground. Is the test light "ON"?	–	Go to Step 5	Go to *Step 12*
5	Inspect bulb for damage, replace bulb if visual inspection reveals a concern. Ignition "ON" (KOEO), Does MIL light illuminate for 2 or 3 seconds or remain illuminated?	–	Verify repair, or perform DTC diagnosis if MIL remains illuminated	Go to *Step 6*
6	1. Ignition "OFF" 2. Disconnect the ECM connectors 3. Probe the MIL driver circuit at the ECM harness connector with a test light to ground. Is the test light "ON"?	–	Go to *Step 10*	Go to *Step 7*

No Malfunction Indicator Lamp (MIL) Circuit Test (Cont'd)

Step	Action	Value(s)	Yes	No
7	Check the ECM relay for proper connection. If no problem is found, replace the relay with a known good relay. Is action complete (MIL circuit operation normal)?	–	Remove replacement relay and install original relay. Go to *Step 8*	Remove replacement relay and install original relay. Go to *Step 10*
8	Is action complete (MIL circuit operation normal with original relay reinstalled)?	–	Keep original relay installed. Verify repair and Go to *MIL DTC retrieval procedure if required*	Remove original relay and reinstall replacement relay. Go to Step 9
9	Is action complete (MIL circuit operation again normal with replacement relay installed)?	–	Leave replacement relay installed. Verify repair and Go to *MIL DTC retrieval procedure if required*	Go to *Step 15*
10	1. Ignition "OFF" 2. Disconnect the ECM connectors 3. Ignition "ON" 4. Probe the ignition feed circuit at the ECM harness connector with a test light to ground. Is the test light "ON"?	–	Go to *Step 11*	Go to *Step 15*
11	Probe the battery feed circuit at the ECM harness connector with a test light to ground. Is the test light "ON"?	–	Go to *Step 12*	Go to *Step 16*
12	1. Check for a faulty ECM ground or a poor ECM ground connection. 2. If a problem is found, repair as necessary. Was a problem found?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 13*
13	1. Check for damaged terminals or a poor connection at the ECM. 2. If damaged terminals or a poor connection is found, repair as necessary. Was a problem found?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 19*
14	1. Check the MIL driver circuit for an open. 2. If the MIL driver circuit is open, repair as necessary. Was a problem found?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 19*
15	Locate and repair open in the ignition feed circuit to the MIL light. Is the action complete (MIL circuit operation normal)?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	–
16	Locate and repair open in ECM battery feed circuit. Is the action complete (MIL circuit operation normal)?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	–

No Malfunction Indicator Lamp (MIL) Circuit Test (Cont'd)

Step	Action	Value(s)	Yes	No
17	Locate and repair short to ground in the ECM ignition feed circuit. Is the action complete (MIL circuit operation normal)?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	–
18	Locate and repair short to ground in the ECM battery feed circuit. Is the action complete (MIL circuit operation normal)?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	–
19	Install replacement ECM. Is action complete (MIL circuit operation normal)?	–	Remove replacement ECM and install original ECM. Go to *Step 20*	Go to *Step 20*
20	Is action complete (MIL circuit operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Verify repair and Go to *MIL DTC retrieval procedure if required*	Remove original ECM and reinstall replacement ECM. Go to *Step 21*
21	Is action complete (MIL circuit operaton normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Verify repair and Go to *MIL DTC retrieval procedure if required*	Contact Ford Power Products Customer Service Center Technical Support Hotline.

MALFUNCTION INDICATOR LAMP (MIL) "ON" STEADY

Circuit Description

The malfunction indicator lamp (MIL) should not remain "ON" with the engine running and no DTC(s) set. A steady MIL with the engine running and no DTC(s) or only DTC 11 set suggests a short to ground in the MIL driver circuit. If during Key On, Engine Running (KOER) operation a DTC is stored, the MIL will illuminate and remain on steady. Verify that no DTC(s) other than DTC 11 are set before proceeding with additional diagnosis.

Diagnostic Aids

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

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

Malfunction Indicator Lamp (MIL) "On" Steady Circuit Test

Step	Action	Value(s)	Yes	No
1	Was a Visual/Physical check performed?	–	Go to *Step 2*	Perform Visual/Physical check
2	Perform MIL DTC retrieval procedure. If any DTC(s) are present, repair before proceeding. Was MIL fault code check performed?	–	Go to *Step 3*	Attempt MIL DTC retrieval procedure
3	1. Ignition "OFF" 2. Disconnect the ECM connectors 3. Ignition "ON", observe the MIL lamp. Is the MIL lamp "ON"?	–	Go to *Step 4*	Go to *Step 5*
4	1. Ignition "OFF" 2. Check the MIL driver circuit between the ECM and the MIL bulb for a short to ground. 3. If a problem is found repair as necessary. Was the MIL driver circuit shorted to ground?	–	Verify repair. Go to *MIL fault code check if required*	Go to *Step 5*
5	Install replacement ECM. Is action complete (MIL circuit operation normal)?	–	Remove replacement ECM and install original ECM. Go to *Step 6*	Go to *Step 6*
6	Is action complete (MIL circuit operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Verify repair and Go to *MIL DTC retrieval procedure if required*	Remove original ECM and reinstall replacement ECM. Go to *Step 7*
7	Is action complete (MIL circuit operation normal with replacement ECM reinstalled)?		Leave replacement relay installed. Verify repair and Go to *MIL DTC retrieval procedure if required*	Contact Ford Power Products Distributor

ENGINE CRANKS BUT DOESN'T START

Circuit Description

The electronic distributorless ignition system uses a four-tower coil pack to provide spark distribution. In the coil pack, two adjacent coil towers share a common coil and are called a matched pair. The matched pairs in this application are cylinders 1 and 4, and cylinders 2 and 3.

During crank, the ECM monitors the Crankshaft Position Signal (CKP) signal. The CKP signal is used to determine which cylinder will fire first. After the CKP signal has been processed by the ECM, it will command all four injectors to allow a priming shot of fuel for all the cylinders. After the priming, the injectors are left "OFF" during the next four reference pulses from the CKP. This allows each cylinder a chance to use the fuel from the priming shot. During this waiting period, a camshaft position (CMP) signal pulse will have been received by the ECM. The CMP signal allows the ECM to operate the injectors sequentially based on camshaft position. If the camshaft position signal is not present at start-up, the ECM will begin sequential fuel delivery with a 1-in-4 chance that fuel delivery is correct. The engine will run without a CMP signal, but will set a DTC code.

Diagnostic Aids

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

- Poor connection or damaged harness. Inspect the PCM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wire connections, or a damaged harness.
- Faulty engine coolant temperature sensor. Test and compare engine coolant temperature with intake air temperature on a completely cool engine. Engine coolant temperature should be within 10 degrees Celsius of intake air temperature. If not, replace the ECT sensor.

Test Description

Number(s) below refer to the step number(s) on the Diagnostic Chart.

28. An obvious cause of low fuel pressure would be an empty fuel tank.
32. By using a spark tester, the ignition coil's ability to produce at least 25,000 volts is verified.

Engine Cranks But Doesn't Start Circuit Test

Step	Action	Value(s)	Yes	No
1	Perform Visual/Physical check. Verify that all accessories are "OFF". Was a Visual/Physical check performed?	–	Go to *Step 2*	Perform Visual/Physical Check
2	Perform MIL DTC retrieval procedure. If any DTC(s) are present, repair before proceeding. Is action complete (MIL circuit operation normal and DTC(s) if present repaired)?	–	Go to *Step 3*	Refer to *MIL Circuit Diagnosis*
3	Attempt to start the engine. Does the engine start?	–	Verify repair and test engine for proper operation at all temperatures	Go to *Step 4*
4	Check the ECM relay for proper connection. If no problem is found, replace the relay with a known good relay. Does engine run?	–	Remove replacement relay and install original relay. Go to *Step 5*	Remove replacement relay and install original relay. Go to *Step 7*
5	Does engine run with original relay reinstalled?	–	Keep original relay installed, verify repair and Go to *MIL DTC retrieval procedure if required*	Remove original relay and reinstall replacement relay. Go to *Step 6*

Engine Cranks But Doesn't Start Circuit Test (Cont'd)

Step	Action	Value(s)	Yes	No
6	Does engine run once again with replacement relay installed?	–	Leave replacement relay installed, verify repair and Go to *MIL DTC retrieval procedure if required*	Go to *Step 7*
7	Check the Fuel Pump relay for proper connection. If no problem is found, replace the relay with a known "good" relay. Does engine run?	–	Remove replacement relay and install original relay	Remove replacement relay and install original relay Go to *Step 8*
8	Does engine run with original relay reinstalled?	–	Keep original relay installed, verify repair and Go to *MIL DTC retrieval procedure if required*	Remove original relay and reinstall replacement relay. Go to *Step 9*
9	Does engine run once again with replacement relay installed?	–	Leave replacement relay installed, Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 10*
10	1. Ignition "ON". 2. Remove ECM relay and Fuel Pump relay from connectors. 3. Use a grounded test lamp to verify that B+ is available at the ECM relay and Fuel Pump relay connectors. Was B+ available at both connectors?	–	Go to *Step 12*	Go to *Step 11*
11	Repair open in ECM relay or Fuel Pump relay feed circuit. Is action complete (engine operation normal)?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 12*
12	1. Ignition "OFF" 2. Disconnect the ECM connectors 3. Ignition "ON" 4. Probe the ignition feed circuit at the ECM harness connector with a test light to ground. Is the test light "ON"?	–	Go to *Step 13*	Go to *Step 15*
13	Probe the battery feed circuit at the ECM harness connector with a test light to ground. Is the test light "ON"?	–	Go to *Step 14*	Go to *Step 16*
14	1. Check for a faulty ECM ground or a poor ground connection at the ECM. 2. If a problem is found, repair as necessary. Was a problem found?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 13*

Engine Cranks But Doesn't Start Circuit Test (Cont'd)

Step	Action	Value(s)	Yes	No
15	Locate and repair open or short to ground in ECM ignition feed circuit. Was a problem found?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 16*
16	Locate and repair open or short to ground in ECM battery feed circuit. Was a problem found?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 17*
17	Install replacement ECM. Does engine start and run?	–	Remove replacement ECM and install original ECM	Go to *Step 18*
18	Does engine start and run?	–	Keep original ECM installed, Verify repair and Go to *MIL DTC retrieval procedure if required*	Remove original ECM and reinstall replacement ECM. Go to *Step 19*
19	Does engine start and run with replacement ECM installed?	–	Leave replacement ECM installed, Verify repair and Go to *MIL DTC retrieval procedure if required*	Go to *Step 20. (or Go to Step 26 if Steps 20-25 have already been performed)*
20	1. Ignition "OFF". 2. Disconnect CKP Sensor connector. 3. With a test light to ground, probe the harness connector ignition feed terminal. Is the light "ON"?	–	Go to *Step 22*	Go to *Step 21*
21	Check the ignition feed wire from the CKP sensor to the ECM for a short to ground or open circuit and repair as required. Is the action complete?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 22*
22	1. Ignition "ON". 2. At the CKP harness connector, connect a test light between the ignition and ground terminals. Is the light "ON"?	–	Go to *Step 24*	Go to *Step 23*
23	Check the CKP sensor ground circuit for an open or short to voltage. Was a problem found?	–	Verify repair. Go to *MIL DTC retrieval procedure if required.*	Go to *Step 24*
24	Check the signal circuit between the CKP sensor and the ECM for a short to ground, short to voltage, or an open. Was a problem found?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 25*

Engine Cranks But Doesn't Start Circuit Test (Cont'd)

Step	Action	Value(s)	Yes	No
25	Replace the CKP sensor. Is the action complete?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 17*
26	1. Test the fuel for water, alcohol, or other possible contamination. 2. If a problem is found, clean the fuel system and correct the contaminated fuel condition as necessary. Replace the fuel filter and replace any injectors that are not delivering fuel. (Refer to Fuel Injector Balance Test.) Was a problem found?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 27*
27	1. Ignition "OFF", install a suitable fuel pressure gauge at the fitting on the fuel rail. 2. Ignition "ON", observe the fuel pressure. Is the fuel pressure within the specified values, and does it hold steady?	285-375 kPa (43-55 PSI)	Go to *Step 29*	Go to *Step 28*
28	Is any fuel pressure indicated?	–	Go to Fuel System Electrical test	Go to *Fuel System Diagnostic test*
29	1. Ignition "OFF". 2. Install a test light to ground at the injector harness connectors. (CAUTION: Do not apply battery voltage (B+) directly to the fuel injector electrical connector terminals. The solenoids may be damaged internally in a matter of seconds.) 3. Ignition "ON", crank engine. Does the light blink at each injector when the engine is cranked?	–	Go to *Step 30*	–
30	Check for B+ at coil connector. (Refer to Distributorless Ignition System Diagnosis.) 1. Ignition "OFF". 2. Disconnect coil harness connector 3. Ignition "ON". 4. Measure voltage at coil connector between B+ Coil feed and ground (or use test light between feed and ground). 5. Ignition "OFF". Was voltage equal to the specified value (or is test light "ON")?	B+	Go to *Step 32*	Go to *Step 31*
31	Locate and repair open or short in coil ignition feed circuit. Was a problem found?	–	Verify repair, Go to *MIL DTC retrieval procedure if required*	Go to *Step 32*

Engine Cranks But Doesn't Start Circuit Test (Cont'd)

Step	Action	Value(s)	Yes	No
32	Perform spark test. (Refer to Distributorless Ignition System Diagnosis.) 1. Ignition "OFF". 2. Connect coil harness connector 3. Connect the end of one of the secondary spark plug wires to a suitable spark tester 4. Ignition "ON". 5. Observe the spark tester while the engine is cranking. 6. Ignition "OFF". Was a crisp blue spark observed? (Only one or two sparks followed by no result is considered the same as "No Spark".)	–	Verify repair, Go to *MIL DTC retrieval procedure if required*	Go to *Step 33*
33	Test the other 3 spark plug wires by using the test in Step 29 at each spark plug wire. When the engine is cranked, was a crisp blue spark observed? (Only one or two sparks followed by no result is the same as "No Spark".)	–	Go to *Step 35*	Go to *Step 34*
34	Inspect and test the secondary ignition spark plug wires. (Refer to Distributorless Ignition System Diagnosis.) Check for the following conditions: • Verify that the resistance of all ignition wires is less than the specified value. • Verify that ignition wires are correctly routed to eliminate cross-firing. • Verify that ignition wires are not arcing to ground. • Spraying the secondary ignition wires with a light mist of water may help locate an intermittent problem (key "ON", engine running). Was a problem found?	9,000-16,000 ohms	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 35*
35	1. Check the ignition coil primary resistance. (Refer to Distributorless Ignition System Diagnosis.) 2. Replace the coil if it is not within the specified range of resistance. Did the coil require replacement?	0.5-1.3 ohms	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 36*
36	1. Check the ignition coil secondary resistance. (Refer to Distributorless Ignition System Diagnosis.) 2. Replace the coil if it is not within the secondary range of resistance. Did the coil require replacement?	14,000 ohms	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 37*
37	1. Remove the spark plugs and check for gas or oil fouling, cracks, wear, improper gap, burned electrodes or heavy deposits. 2. If spark plugs are fouled, the cause of fouling must be determined before replacing the spark plugs. Was a problem found?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 38*
38	Check the electronic governor operation including the TPS function. (Refer to "Auxiliary Systems" in the LRG-425 2.5L Industrial Engine Service Manual.) Was a problem found?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 39*

Engine Cranks But Doesn't Start Circuit Test (Cont'd)

Step	Action	Value(s)	Yes	No
39	Check for the following engine mechanical problems (refer to the LRG-425 2.5L Industrial Engine Service Manual): • Camshaft drive belt slipped or stripped • Low compression • Leaking cylinder head gasket • Worn camshaft • Leaking or sticky valves or rings • Excessive valve deposits • Weak valve springs • Damaged, plugged or restricted exhaust system Is the action complete?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 40*
40	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/Physical inspection, including fuel quality check • All electrical connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. Was a problem found?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Contact Ford Power Products Customer Service Center Technical Support Hotline

FUEL SYSTEM ELECTRICAL TEST

Circuit Description

When the ignition switch is first turned "ON", the engine control module (ECM) energizes the fuel pump relay which applies power to the fuel pump. The fuel pump relay will remain "ON" as long as the engine is running or cranking and the ECM is receiving crankshaft position pulses. If no crankshaft position pulses are present, the ECM de-energizes the fuel pump relay within 2 seconds after the ignition is turned "ON" or the engine is stopped.

The fuel pump delivers fuel to the fuel rail and then to the fuel injectors.

Diagnostic Aids

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

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

Caution: To reduce the risk of fire and personal injury, it is necessary to relieve fuel system pressure before connecting a fuel pressure gauge. Refer to Fuel Pressure Relief Procedure, below. A small amount of fuel may be released when disconnecting the fuel lines. 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 the disconnect is completed.

Fuel pressure Relief Procedure:

1. Remove cap from fuel tank.
2. Remove fuel pump relay.
3. Start the engine and allow it to stall.
4. Crank the engine for an additional 3 seconds.

Fuel Pressure Gauge Installation:

1. Perform fuel pressure relief procedure above.
2. Remove cap from fuel pressure fitting.
3. Install a suitable fuel gauge to the fuel pressure fitting located on the fuel rail.
4. Reinstall fuel pump relay.

Fuel System Electrical Circuit Test

Step	Action	Value(s)	Yes	No
1	Was a Visual/Physical check performed?	–	Go to *Step 2*	Go to *Visual/Physical Check*
2	1. Perform MIL DTC retrieval procedure. 2. Ignition "ON", engine not running, short STI connector to ground. Do any fault codes flash and display?	–	Refer to DTC chart, perform component and circuit test as required	Go to *Step 3*
3	1. Ignition "OFF". 2. Listen for noise heard from fuel pump when ignition is turned "ON". 3. Ignition "ON". Was fuel pump heard to operate for approximately 2 seconds?	–	Electrical test completed. Refer to Fuel System Diagnostic Test	Go to *Step 4*
4	1. Ignition "OFF". 2. Remove the fuel pump relay. 3. Using a test light connected to ground, probe the battery feed circuit at the relay connector. Is the test light "ON"?	–	Go to *Step 6*	Go to *Step 5*
5	Repair open or short to ground in battery feed to fuel pump relay circuit. Was a problem found?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 6*

Fuel System Electrical Circuit Test (Cont'd)

Step	Action	Value(s)	Yes	No
6	Replace the fuel pump relay with a known "good" relay. Is fuel pump audible for 2 seconds when ignition turned "ON", and does engine run when start is attempted?	–	Remove replacement relay and install original relay	Remove replacement relay and install original relay Go to *Step 9*
7	Does engine run with original relay reinstalled?	–	Keep original relay installed, verify repair and Go to *MIL DTC retrieval procedure if required*	Remove original relay and reinstall replacement relay. Go to *Step 8*
8	Does engine run once again with replacement relay installed?	–	Leave replacement relay installed, Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 9*
9	1. Ignition "OFF". 2. Connect a test light between the two wires that connect to the fuel pump relay pull-in coil. 3. Ignition "ON". Did the test lamp go "ON" for 2 seconds and then turn "OFF"?	–	Go to *Step*	Go to *Step 7*
10	1. Ignition "OFF". 2. With a test light connected to battery (–), probe the fuel pump relay connector at the wire which runs from the relay pull-in coil to the ECM. 3. Ignition "ON". Did the test lamp go "ON" for 2 seconds and then turn "OFF"?	–	Go to *Step 12*	Go to *Step 11*
11	Locate and repair open in the fuel pump relay ground circuit. Is the action complete?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 12*
12	Check for open or short to ground between the ECM and the fuel pump relay. Was a problem found?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 13*
13	Check the fuel pump relay circuits for poor terminal connections at the ECM. Was a problem found?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 14*
14	1. Check for a faulty ECM ground or a poor ground connection at the ECM. 2. If a problem is found, repair as necessary. Was a problem found?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 15*

Fuel System Electrical Circuit Test (Cont'd)

Step	Action	Value(s)	Yes	No
15	Install replacement ECM. Does engine start and run?	–	Remove replacement ECM and install original ECM	Go to *Step 16*
16	Does engine start and run?	–	Keep original ECM installed, Verify repair and Go to *MIL DTC retrieval procedure if required*	Remove original ECM and reinstall replacement ECM. Go to *Step 17*
17	Does engine start and run with replacement ECM installed?	–	Leave replacement ECM installed, Verify repair and Go to *MIL DTC retrieval procedure if required*	Go to *Step 18*
18	1. Ignition "OFF". 2. Disconnect fuel pump feed wire connector at fuel pump. 3. Using a test light connected to ground, probe the fuel pump feed wire connector. 4. Ignition "ON". Did the test light go "ON" for 2 seconds and then turn "OFF".	–	Go to *Step 20*	Go to *Step 19*
19	Check for an open or short to ground in feed circuit between fuel pump relay and fuel pump. Was a problem found?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 20*
20	1. Ignition "OFF". 2. Disconnect fuel pump feed and ground wire connectors at fuel pump. 3. Connect a test light between the feed wire and ground wire. 4. Ignition "ON". Did the test light go "ON" for 2 seconds and then turn "OFF"?	–	Go to *Step 22*	Go to *Step 21*
21	Repair the open circuit in the fuel pump ground wire. Is the action complete?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Go to *Step 22*
22	Replace the fuel pump. Does the engine run?	–	Verify repair. Go to *MIL DTC retrieval procedure if required*	Contact Ford Power Products Customer Service Center Technical Support Hotline

FUEL SYSTEM DIAGNOSTIC TEST

Circuit Description

When the ignition switch is turned "ON", the engine control module (ECM) will turn on the fuel pump. The fuel pump will remain "ON" as long as the engine is cranking or running and the ECM is receiving crankshaft position pulses. If there are no crankshaft position pulses, the ECM will turn the fuel pump "OFF" 2 seconds after the ignition switch is turned "ON" or 2 seconds after the engine stops running.

The fuel pump receives fuel from the fuel tank through an in-line pre-filter and delivers fuel through a larger in-line filter to the fuel rail assembly. The fuel pump is designed to provide fuel at a pressure above the pressure needed by the fuel injectors. A fuel pressure regulator, attached to the fuel rail, keeps the fuel available to the fuel injectors at a regulated pressure. Unused fuel is returned to the fuel tank by a separate fuel return line.

Test Description

Number(s) below refer to the step number(s) on the Diagnostic Test Chart.

3. When connecting the fuel pressure gauge to the fuel feed line, wrap a shop towel around the fuel pressure connection in order to absorb any fuel leakage that may occur when installing the fuel pressure gauge. With the ignition switch "ON" and the fuel pump running, the fuel pressure indicated by the fuel pressure gauge should be 441 kPa (64 psi). This pressure is controlled by the amount of pressure the spring inside the fuel pressure regulator can provide.
4. A fuel system that cannot maintain a constant fuel pressure has a leak in one or more of the following areas:
   - The fuel pump check valve.
   - The fuel pump check line.
   - The valve or valve seat within the fuel pressure regulator.
   - The fuel injector(s).
5. Fuel pressure that drops off during engine acceleration may cause a lean condition. A lean condition can cause a lose of power, surging, or misfire. If an extremely lean condition occurs, the oxygen sensor will stop toggling. The oxygen sensor output voltage will drop below 500 mV. Also, the fuel injector pulse width will increase. Refer to DTC 32 if applicable When the engine is at idle, the manifold pressure is low (high vacuum). This low pressure (high vacuum) is applied to the fuel pressure regulator diaphragm. This low pressure (high vacuum) will offset the pressure being applied to the fuel pressure diaphragm by the spring inside the fuel pressure regulator. When this happens, the result is lower fuel pressure. The fuel pressure at idle will vary slightly as the barometric pressure changes, but the fuel pressure at idle should always be less than the fuel pressure noted in step 3 with the engine "OFF".
15. Check the spark plug associated with a particular fuel injector for fouling or fuel saturation in order to determine if that particular fuel injector is leaking. If checking the spark plug associated with a particular fuel injector for fouling or saturation does not determine that a particular fuel injector is leaking, use the following procedure:
    15.1 Remove the fuel rail, but leave the fuel lines and injectors connected to the fuel rail.
    15.2 Lift the fuel rail just enough to leave the fuel injector nozzles in the fuel injector ports.

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

    15.3 Pressurize the fuel system by connecting a 10 amp fused jumper between B+ and the fuel pump relay connector.
    15.4 Visually and physically inspect the fuel injector nozzles for leaks.
16. A rich condition may result from the fuel pressure being above 376 kPa (55 psi). A rich condition may cause DTC 42 to set. Engine running conditions associated with a rich condition can include hard starting (followed by black smoke from the exhaust pipe) and a strong fuel smell from the exhaust.
19. This test determines if the high fuel pressure is due to a restricted fuel return line or if the high fuel pressure is due to a faulty fuel pressure regulator.

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

Caution: To reduce the risk of fire and personal injury It is necessary to relieve fuel system pressure before connecting a fuel pressure gauge. Refer to Fuel Pressure Relief Procedure, below. A small amount of fuel may be released when disconnecting the fuel lines. 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 the disconnect is completed.

Fuel pressure Relief Procedure:

1. Remove cap from fuel tank.
2. Remove fuel pump relay.
3. Start the engine and allow it to stall.
4. Crank the engine for an additional 3 seconds.

Fuel Pressure Gauge Installation:

1. Perform fuel pressure relief procedure above.
2. Remove cap from fuel pressure fitting.
3. Install a suitable fuel gauge to the fuel pressure fitting located on the fuel rail.
4. Reinstall fuel pump relay.

Fuel System Diagnostic Test

Step	Action	Value(s)	Yes	No
1	Was a Visual/Physical check performed?	–	Go to *Step 2*	Go to *Visual/Physical Check*
2	Perform MIL DTC retrieval procedure. 1. Ignition "ON", engine not running, short STI connector to ground. Do any fault codes flash and display?	–	Refer to DTC chart, perform component and circuit test as required	Go to *Step 3*
3	1. Ignition "OFF". 2. Relieve fuel system pressure and install the fuel pressure gauge (refer to Fuel Pressure Relief and Fuel Gauge Installation Procedure). 3. Ignition "ON". **Note:** The fuel pump will run for approximately 2 seconds when ignition is turned to "ON". 4. Observe the fuel pressure indicated by the fuel pressure gauge with the fuel pump running. Is the fuel pressure correct?	441 kPa (64 psi)	Go to *Step 4*	Go to *Step 16*
4	After the fuel pump stops running, does the fuel pressure indicated by the pressure gauge remain constant? Note: The fuel pressure will drop when the fuel pump stops running, then it should stabilize and remain constant.	–	Go to *Step 5*	Go to *Step 12*
5	1. When the engine is at normal operating temperature, turn the ignition "ON" to build fuel pressure and observe the measurement on the gauge. 2. Start the engine and observe the fuel pressure gauge. Did the reading drop by the amount specified after the engine was started?	21-105 kPa (3-15 psi)	Go to *Step 6*	Go to *Step 9*
6	Is fuel pressure excessively dropping off when engine is accelerated?	–	Go to *Step 7*	Check for improper fuel
7	Visually and physically inspect the following items for a restriction: • Pre-filter before the fuel pump. • The fuel feed lines. • Fuel pump strainer. • Fuel filter between fuel pump and fuel rail. • Fuel tank feed line strainer (if applicable). Was a restriction found?	–	Verify repair	Go to *Fuel System Electrical Circuit Test to verify fuel pump for proper operation*
8	Replace the fuel pump. Is the action complete?	–	Verify repair	Remove replacement fuel pump and reinstall original pump. Go to *Step 9*

Fuel System Diagnostic Test (Cont'd)

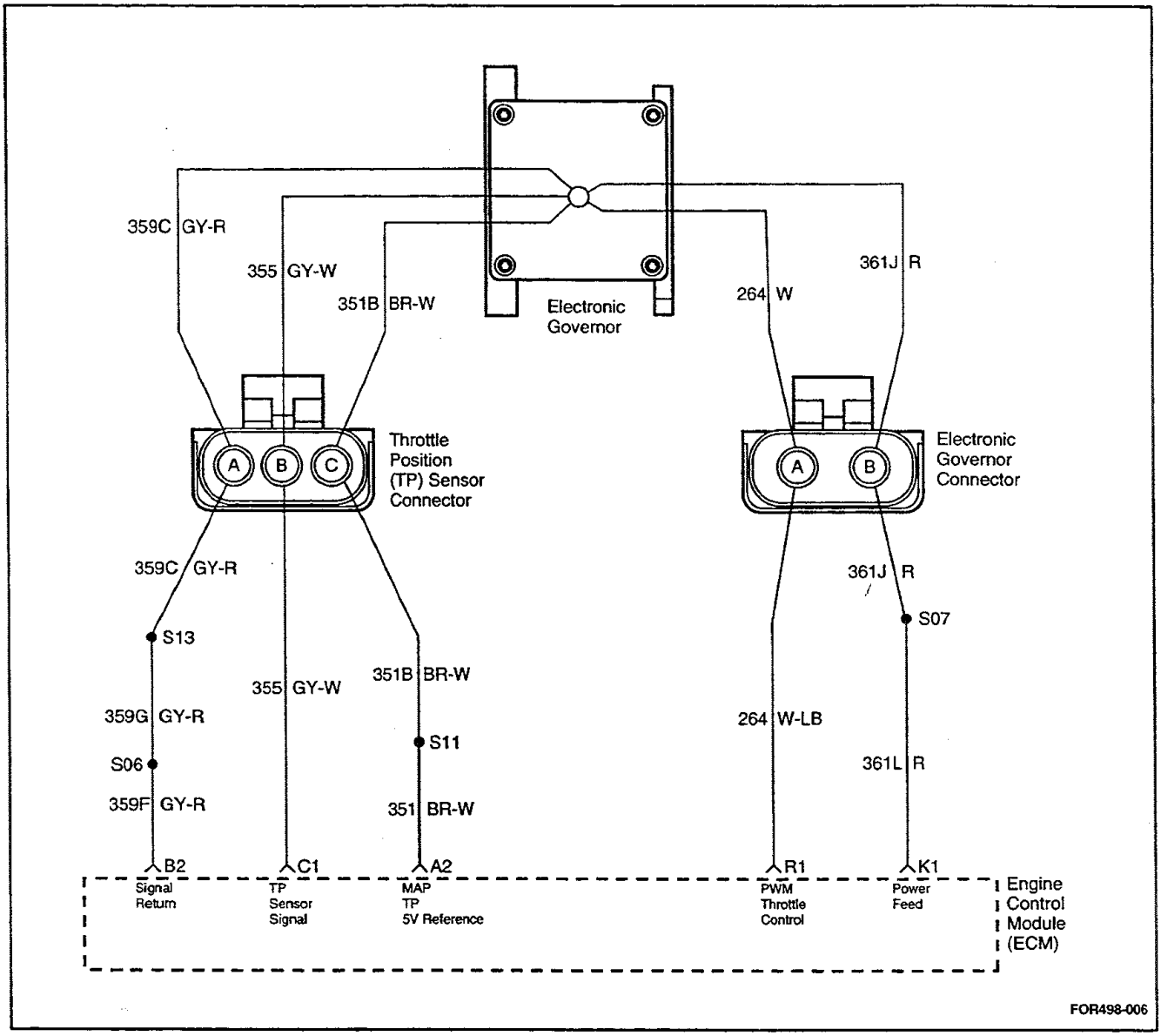
Step	Action	Value(s)	Yes	No
9	1. Disconnect the vacuum hose from the fuel pressure regulator. 2. With the engine idling, apply 12-14 inches of vacuum to the fuel pressure regulator. Does the fuel pressure indicated by the fuel pressure gauge drop by the amount specified?	21-105 kPa (3-15 psi)	Go to *Step 10*	Go to *Step 11*
10	Locate and repair the loss of vacuum to the fuel pressure regulator. Is the action complete?	–	Verify repair	Go to *Step 11*
11	Replace the fuel pressure regulator. Is the action complete?	–	Verify repair	–
12	1. Ignition "ON", let fuel system pressurize. 2. After pressure has built up, clamp the supply hose shut with suitable locking pliers. Does the fuel pressure indicated by the fuel pressure gauge remain constant?	–	Go to *Step 13*	Go to *Step 15*
13	Visually inspect the fuel supply line and repair any leaks, including in-tank fuel line. Was a problem found?	–	Verify repair	Go to *Step 14*
14	1. Ignition "OFF". 2. Clamp the fuel return line with suitable locking pliers, to prevent fuel from returning to the fuel tank. 3. Ignition "ON", let fuel system pressurize. 4. Ignition "OFF". Does the fuel pressure indicated by the fuel pressure gauge remain constant?	–	Go to *Step 11*	Go to *Step 15*
15	Locate and replace any leaking fuel injector(s). Is the action complete?	–	Verify repair	–
16	Is the fuel pressure indicated by the fuel pressure gauge above the specified limit?	441 kPa (64 psi)	Go to *Step 17*	Go to *DTC 41*
17	1. Ignition "OFF". 2. Relieve the fuel pressure (Refer to Fuel Pressure Relief Procedure). 3. Disconnect the fuel return line from the fuel rail. 4. Attach a length of flexible fuel line hose to the fuel rail return outlet passage. 5. Place the open end of the flexible fuel line hose into an approved gasoline container. 6. Ignition "ON". 7. Observe the fuel pressure indicated by the fuel pressure gauge while the fuel pump is running. Is the fuel pressure correct?	441 kPa (64 psi)	Go to *Step 18*	Go to *Step 19*
18	Locate and correct the restriction in the fuel return line. Is the action complete?	–	Verify repair	–
19	Visually and physically inspect the fuel rail outlet passages for a restriction. Was a restriction found?	–	Verify repair	Go to *Fuel System Electrical Circuit Test*

ECM DIAGNOSTIC TROUBLE CODES

The following table lists the diagnostic trouble codes (DTC's) supported by this application. If any DTC's not listed here are flashed by the Malfunction Indicator Lamp (MIL) or displayed on a PC, there may be a software error. Notify Ford Power Products Customer Service Center if any DTC's are displayed that are not included in the following table.

DTC	Description
11	All Systems OK
12	Throttle Position (TP) Sensor Low Voltage
14	Manifold Absolute Pressure (MAP) Low Voltage
21	Overspeed
22	Throttle Position (TP) Sensor High Voltage
24	Manifold Absolute Pressure (MAP) High Voltage
31	Fuel Pump Low Voltage
32	Heated Oxygen Sensor (HO2S) Low Voltage
33	Engine Coolant Temperature (ECT) Sensor High Voltage
35	Intake Air Temperature (IAT) Sensor High Voltage
41	Fuel Pump High Voltage
42	Heated Oxygen Sensor (HO2S) High Voltage
43	Engine Coolant Temperature (ECT) Sensor Low Voltage
45	Intake Air Temperature (IAT) Sensor Low Voltage
51	Low Oil Pressure
52	Crankshaft Position (CKP) Sensor Extra/Missing Pulses
53	Camshaft Position (CMP) Sensor Illegal Pattern
54	Engine Control Module (ECM) Fault Illegal Operation
55	Engine Control Module (ECM) Fault Illegal Interuption
56	Engine Control Module (ECM) Fault COP (Computer Operating Properly) Failure
61	System Voltage Low
62	System Voltage High

REPAIR CHARTS FOR DIAGNOSTIC TROUBLE CODES (DTC's)



DIAGNOSTIC TROUBLE CODE (DTC) 12
THROTTLE POSITION (TP) SENSOR LOW VOLTAGE

Circuit Description

The throttle position (TP) sensor is a potentiometer which is attached to the throttle plate shaft inside the electronic governor. The ECM provides a 5V reference voltage to the TP sensor between terminal A (Grey/Red, circuit 359C) and terminal C (Brown/White, circuit 351B) of the electronic governor. A TP signal is returned to the ECM from terminal B (Grey/White, circuit 355) of the electronic governor. The TP signal varies from about 1.5V at idle to 4.8V at WOT. The TP signal is an important input used by the ECM for fuel control and other engine-control functions.

Conditions for Setting the DTC

- KOEO or KOER.
- TP signal is 0.3V or less.
- Above conditions are present for at least 2 consecutive seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL).
- The ECM forces the throttle to a default position of 6% open.

Conditions for Clearing the DTC (Resetting the MIL)

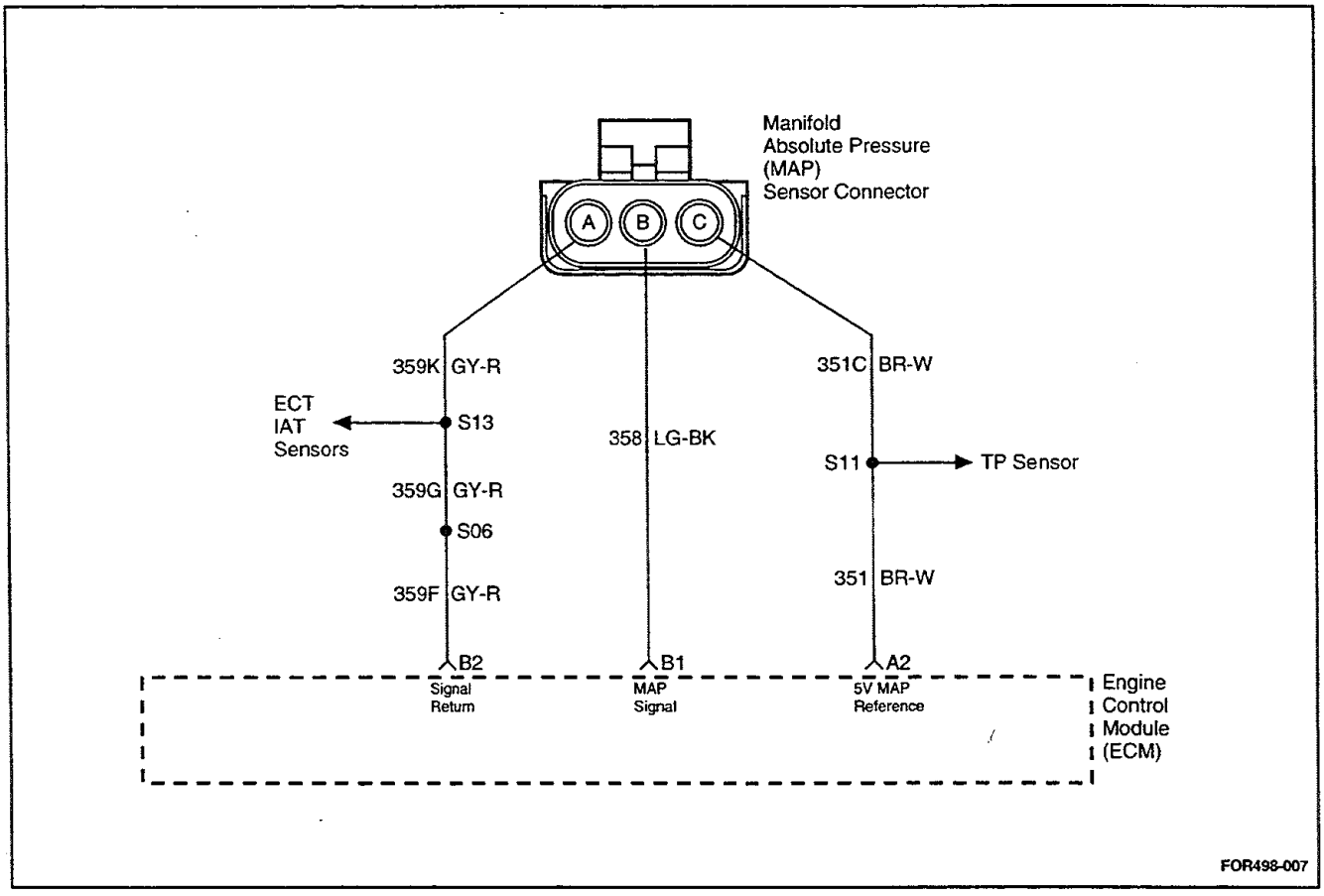
- The DTC can be cleared from memory by disconnecting the battery for 5 minutes.
- If a personal computer (PC) is connected to the engine, the DTC can be cleared from memory by hitting the "C" key while in the View Sensor Data screen.

DTC 12 – Throttle Position Sensor Low Voltage

Step	Action	Value(s)	Yes	No
1	Are you using a personal computer (PC) to perform this diagnosis?	–	Go to *Diagnostic System Check* before continuing at Step 2.	Go to *Step 2.*
2	Check the 5V reference signal from the ECM: 1. KOEO. 2. Check the voltage between terminals A and C on the electronic governor. Is the voltage within the specified values?	4.9-5.1V	Go to *Step 3.*	Go to *Step 6.*
3	Check the TP signal to the ECM: 1. KOEO. 2. Start the engine. 3. Using a suitable backprobing technique, connect a DVOM to pins B and C of the three-wire pigtail on the electronic governor. While observing the voltage reading, operate the engine throughout the widest available range of speeds (ideally, from idle to WOT). Note: If a PC is available, you can observe TP voltage on the engine data screen instead of using a DVOM. 4. Shut the engine off. Does the voltage vary between the specified values?	Approx.1 V at idle to 4.8 V at WOT	Go to *Step 4.*	Go to *Step 8.*
4	1. Disconnect ECM connector A thru K. 2. Disconnect the TP sensor connector. 3. Check for shorts or opens on circuit 355 between the TP sensor connector and the ECM connector. Were any shorts or opens found?	–	Repair the wiring. Re-test the system.	Go to *Step 5.*
5	Check circuit 355 for a poor terminal connection at the ECM. Does the terminal need to be replaced?	–	Repair the terminal. Re-test the system.	Go to *Step 9.*
6	1. Disconnect ECM connector A thru K. 2. Check for a short or open on circuits 351B and 359C. Were any shorts or opens found?	–	Repair the wiring. Re-test the system.	Go to *Step 7.*
7	Check circuits 351B and 359C for poor terminal connections at the ECM. Does either terminal need to be replaced?	–	Repair the terminal. Re-test the system.	Go to *Step 9.*
8	Replace the electronic governor. Is the repair complete?	–	Re-test the system.	–

DTC 12 – Throttle Position Sensor Low Voltage (Cont'd)

Step	Action	Value(s)	Yes	No
9	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 10*	–
10	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re-test the system	Remove original ECM and reinstall replacement ECM. Go to *Step 11*
11	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–



DIAGNOSTIC TROUBLE CODE (DTC) 14
MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR LOW VOLTAGE

Circuit Description

The manifold absolute pressure (MAP) sensor responds to changes in intake manifold pressure (vacuum). The ECM provides a 5V reference voltage to the MAP sensor between terminal A (Grey/Yellow, circuit 359K) and terminal C (Brown/White, circuit 351C) of the MAP sensor. A MAP signal is returned to the ECM from terminal B (Lt Green/Black, circuit 358) of the MAP sensor. The MAP signal varies from about 1V at idle (high vacuum) to 4.8V with KOEO or at WOT (low vacuum). The MAP signal is used by the ECM as an indication of engine load. This information is used to control spark advance and air/fuel ratio. The MAP signal is also used at KOEO to indicate barometric pressure. This information is used for altitude compensation when establishing spark advance and air/fuel ratio.

Conditions for Setting the DTC

- KOEO or KOER.
- MAP signal is significantly lower than estimated by the ECM.
- Above conditions are present for at least 2 consecutive seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL).
- The ECM uses an estimated MAP value based on throttle position and engine rpm.

Conditions for Clearing the DTC (Resetting the MIL)

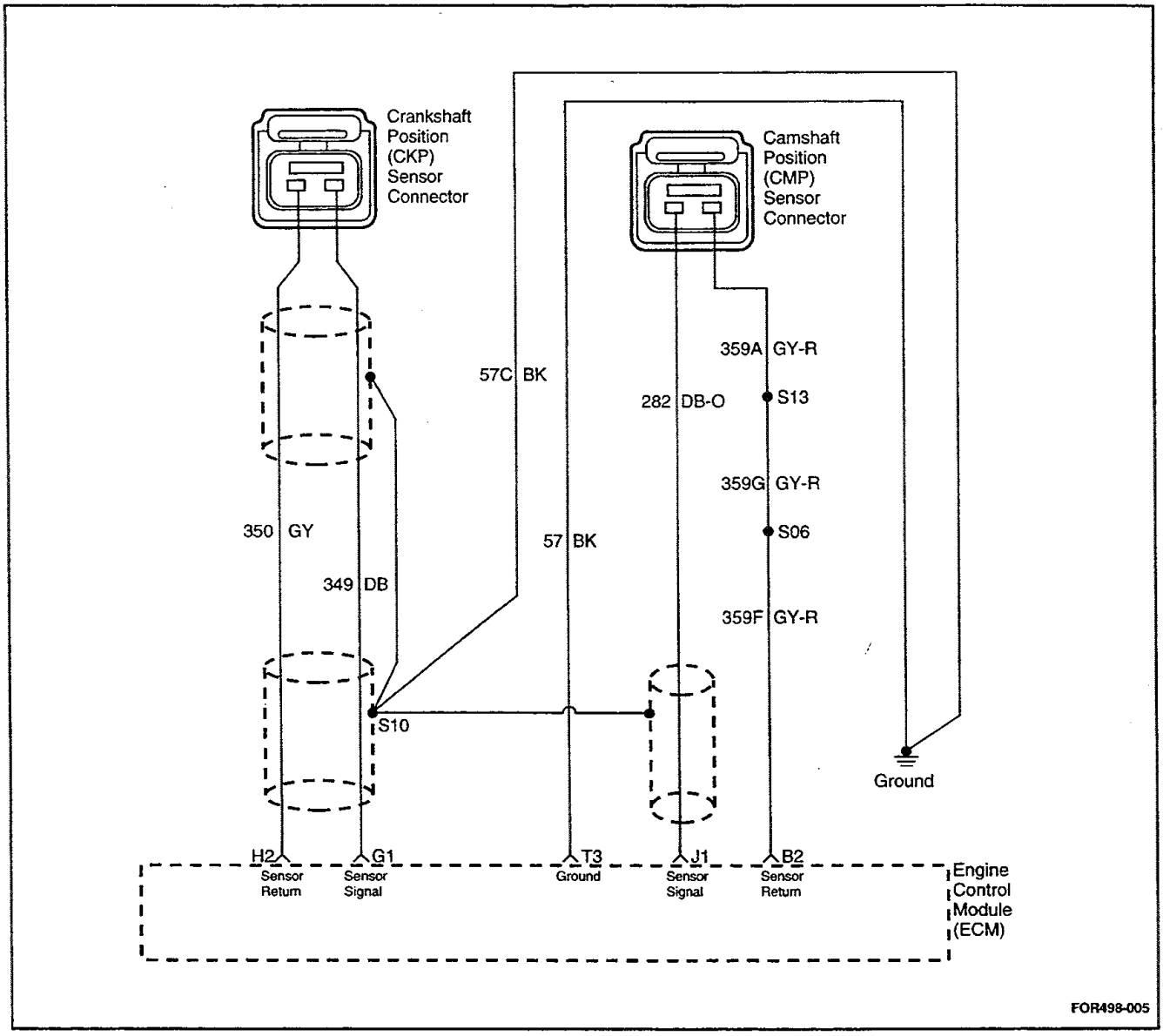
- The DTC can be cleared from memory by disconnecting the battery for 5 minutes.
- If a personal computer (PC) is connected to the engine, the DTC can be cleared from memory by hitting the "C" key while in the View Sensor Data screen.

DTC 14 – Manifold Absolute Pressure (MAP) Sensor Low Voltage

Step	Action	Value(s)	Yes	No
1	Are you using a personal computer (PC) to perform this diagnosis?	–	Go to *Diagnostic System Check* before continuing at Step 2.	Go to *Step 2.*
2	Check the 5V reference signal from the ECM: 1. KOEO. 2. Disconnect the MAP sensor electrical connector. 3. Check the voltage between terminals A and C on the MAP sensor electrical connector. Is the voltage within the specified values?	4.9-5.1V	Go to *Step 3.*	Go to *Step 6.*
3	Check the MAP signal to the ECM: 1. Reconnect the MAP sensor electrical connector. 2. No load on engine. 3. KOER. 4. Using a suitable backprobing technique, measure the voltage between terminals A and B at the MAP sensor. Note: If a PC is available, you can observe TP voltage on the engine data screen instead of using a DVOM. 5. While observing the voltage reading, increase the engine speed from idle to WOT. Does the voltage vary between the specified values?	Approx. 4.8V at idle to approx. 1V at WOT	Go to *Step 4.*	Go to *Step 8.*
4	1. Ignition OFF. 2. Disconnect ECM connector A thru K. 3. Disconnect the MAP sensor connector. 4. Check for shorts or opens on circuit 358 (Lt Green/Black) between the TP sensor connector and the ECM connector. Were any shorts or opens found?	–	Repair the wiring. Re-test the system.	Go to *Step 5.*
5	Check circuit 358 for a poor terminal connection at the ECM. Does the terminal need to be replaced?	–	Repair the terminal. Re-test the system.	Go to *Step 9.*
6	1. Disconnect ECM connector A thru K. 2. Check for a short or open on circuits 351C (Brown/White) and 359K (Grey/Yellow). Were any shorts or opens found?	–	Repair the wiring. Re-test the system.	Go to *Step 7.*
7	Check circuits 351C and 359K for poor terminal connections at the ECM. Does either terminal need to be replaced?	–	Repair the terminal. Re-test the system.	Go to *Step 9.*
8	Replace the MAP sensor. Is the repair complete?	–	Re-test the system.	–

DTC 14 – Manifold Absolute Pressure (MAP) Sensor Low Voltage (Cont'd)

Step	Action	Value(s)	Yes	No
9	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 10*	–
10	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re-test the system	Remove original ECM and reinstall replacement ECM. Go to *Step 11*
11	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–



DIAGNOSTIC TROUBLE CODE (DTC) 21 OVERSPEED

Circuit Description

The ECM monitors engine speed through the crankshaft position (CKP) sensor. If the engine speed reaches 4000 RPM, the fuel is immediately removed to shut off the engine. DTC 21 will set at this time. The engine may be restarted after the ignition switch is cycled off and back on.

Conditions for Setting the DTC

- KOER
- Engine reaches a threshold of 4000 RPM.

Action Taken When the DTC Sets

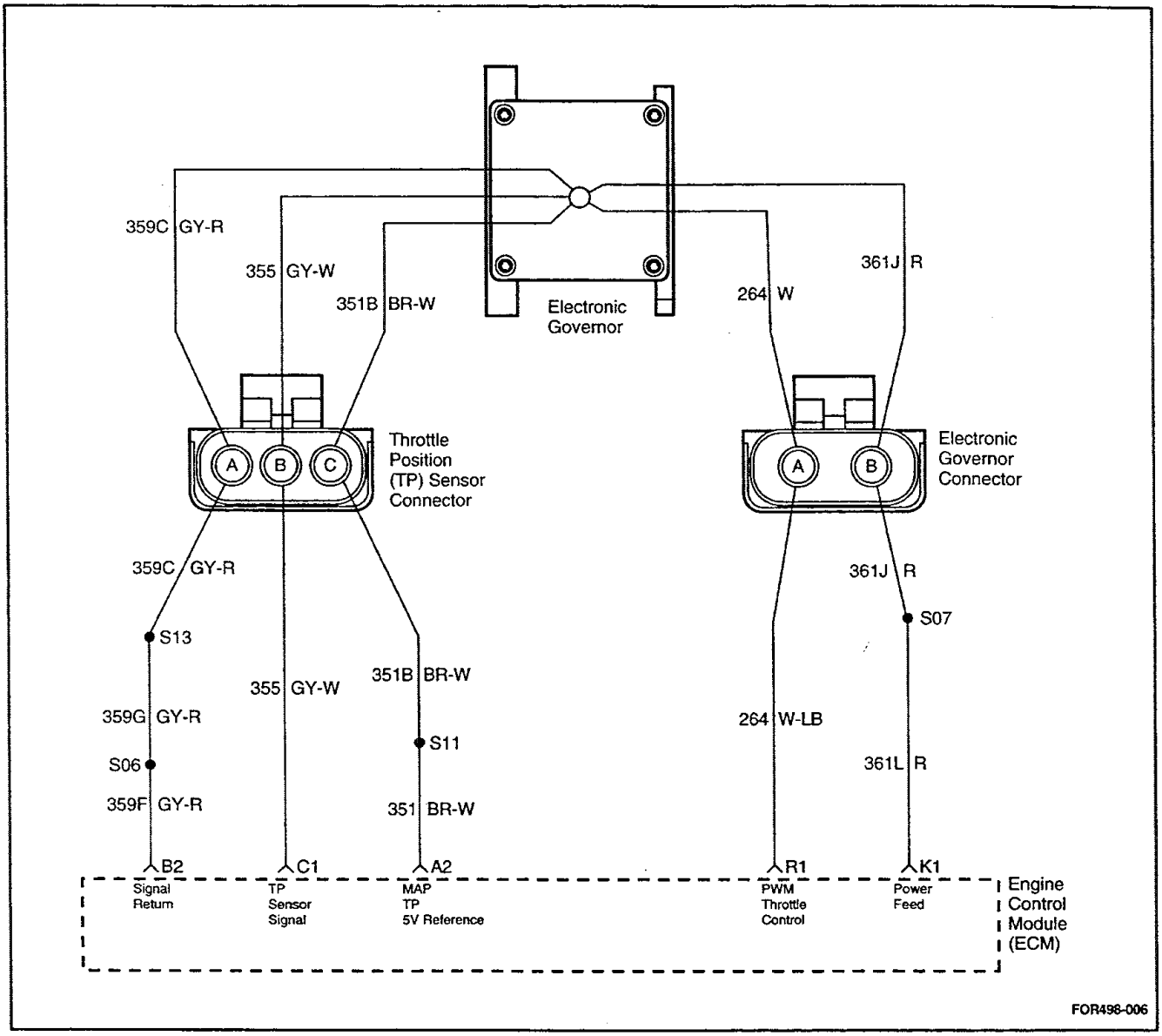
- The ECM illuminates the malfunction indicator lamp (MIL)
- The engine will shut off.

Conditions for Clearing the DTC (Resetting the MIL)

- The DTC can be cleared from memory by disconnecting the battery for 5 minutes.
- If a personal computer (PC) is connected to the engine, the DTC can be cleared from memory by hitting the "C" key while in the View Sensor Data screen.

DTC 21 – Overspeed

Step	Action	Value(s)	Yes	No
1	Are you using a personal computer (PC) to perform this diagnosis?	–	Go to *Diagnostic System Check* before continuing at Step 2.	Go to *Step 2.*
2	Check for obstructions in the throttle that would produce WOT and repair as necessary. Was a repair necessary?	–	Re-test the system	Go to *Step 3*
3	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 4*	–
4	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re-test the system	Remove original ECM and reinstall replacement ECM. Go to *Step 5*
5	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–



DIAGNOSTIC TROUBLE CODE (DTC) 22
THROTTLE POSITION (TP) SENSOR HIGH VOLTAGE

Circuit Description

The throttle position (TP) sensor is a potentiometer which is attached to the throttle plate shaft inside the electronic governor. The ECM provides a 5V reference voltage to the TP sensor between terminal A (Grey/Red, circuit 359C) and terminal C (Brown/White, circuit 351B) of the electronic governor. A TP signal is returned to the ECM from terminal B (Grey/White, circuit 355) of the electronic governor. The TP signal varies from about 1.5V at idle to 4.8V at WOT. The TP signal is an important input used by the ECM for fuel control and other engine-control functions.

Conditions for Setting the DTC

- KOEO or KOER.
- TP signal is 4.9V or more.
- Above conditions are present for at least 2 consecutive seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL).
- The ECM forces the throttle to a default position of 6% open.

Conditions for Clearing the DTC (Resetting the MIL)

- The DTC can be cleared from memory by disconnecting the battery for 5 minutes.
- If a personal computer (PC) is connected to the engine, the DTC can be cleared from memory by hitting the "C" key while in the View Sensor Data screen.

DTC 22 – Throttle Position Sensor High Voltage

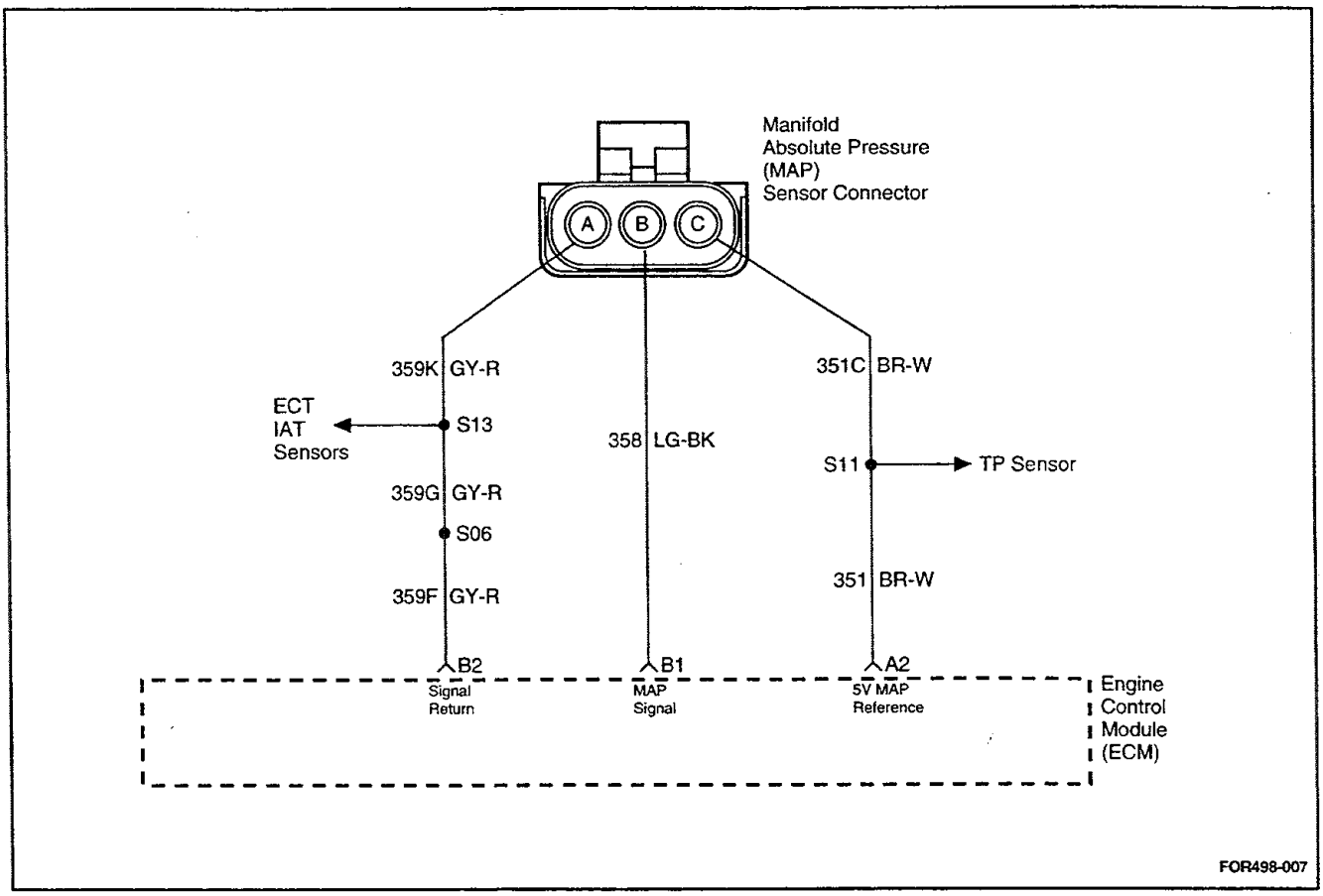
Step	Action	Value(s)	Yes	No
1	Are you using a personal computer (PC) to perform this diagnosis?	–	Go to *Diagnostic System Check* before continuing at Step 2.	Go to *Step 2.*
2	Check the 5V reference signal from the ECM: 1. KOEO. 2. Check the voltage between terminals A and C on the electronic governor. Is the voltage within the specified values?	4.9-5.1V	Go to *Step 3.*	Go to *Step 6.*
3	Check the TP signal to the ECM: 1. KOEO. 2. Start the engine. 3. Using a suitable backprobing technique, connect a DVOM to pins B and C of the three-wire pigtail on the electronic governor. While observing the voltage reading, operate the engine throughout the widest available range of speeds (ideally, from idle to WOT). Note: If a PC is available, you can observe TP voltage on the engine data screen instead of using a DVOM. 4. Shut the engine off. Does the voltage vary between the specified values?	Approx. 1 V at idle to 4.8V at WOT	Go to *Step 4.*	Go to *Step 8.*
4	1. Disconnect ECM connector A thru K. 2. Disconnect the TP sensor connector. 3. Check for shorts or opens on circuit 355 between the TP sensor connector and the ECM connector. Were any shorts or opens found?	–	Repair the wiring. Re-test the system.	Go to *Step 5.*
5	Check circuit 355 for a poor terminal connection at the ECM. Does the terminal need to be replaced?	–	Repair the terminal. Re-test the system.	Go to *Step 9.*
6	1. Disconnect ECM connector A thru K. 2. Check for a short or open on circuits 351B and 359C. Were any shorts or opens found?	–	Repair the wiring. Re-test the system.	Go to *Step 7.*
7	Check circuits 351B and 359C for poor terminal connections at the ECM. Does either terminal need to be replaced?	–	Repair the terminal. Re-test the system.	Go to *Step 9.*
8	Replace the electronic governor. Is the repair complete?	–	Re-test the system.	–

DTC 22 – Throttle Position Sensor High Voltage (Cont'd)

Step	Action	Value(s)	Yes	No
9	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 10*	–
10	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re-test the system	Remove original ECM and reinstall replacement ECM. Go to *Step 11*
11	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–

DIAGNOSTIC TROUBLE CODE (DTC) 23 OVER MAXIMUM DRIVE-BY-WIRE

This DTC is not currently implemented. If this DTC occurs, contact the Ford Power Products Customer Service Center Technical Support Hotline at 1-800-521-0370.



DIAGNOSTIC TROUBLE CODE (DTC) 24
MANIFOLD ABSOLUTE PRESSURE SENSOR HIGH VOLTAGE

Circuit Description

The manifold absolute pressure (MAP) sensor responds to changes in intake manifold pressure (vacuum). The ECM provides a 5V reference voltage to the MAP sensor between terminal A (circuit 359K, Grey/Yellow) and terminal C (circuit 351C, Brown/White). The MAP signal is returned to the ECM from terminal B (circuit 358, Lt Green/Black) from the MAP sensor. The MAP signal varies from about 1V at idle (high vacuum) to 4.8V with KOEO or at WOT (low vacuum). The MAP signal is used by the ECM as an indication of engine load. This information is used to control spark advance and air/fuel ratio. The MAP signal is also used at KOEO to indicate barometric pressure. This information is used for altitude compensation when establishing spark advance and air/fuel ratio.

Conditions for Setting the DTC

- KOEO or KOER.
- MAP sensor signal is significantly higher than that estimated by the ECM.
- The above conditions are present for at least 2 consecutive seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL).
- The ECM uses an estimated MAP value based on throttle position and engine RPM.

Conditions for Clearing the DTC (Resetting the MIL)

- The DTC can be cleared from memory by disconnecting the battery for 5 minutes.
- If a personal computer (PC) is connected to the engine, the DTC can be cleared from memory by hitting the "C" key while in the View Sensor Data screen.

Diagnostic Aids

The MAP sensor shares the same ground with the Engine Coolant Temperature (ECT) sensor and the Intake Air Temperature (IAT) sensor. Check the ground circuit 359 (Gray/Red-Gray/Yellow) if these DTC's are also set.

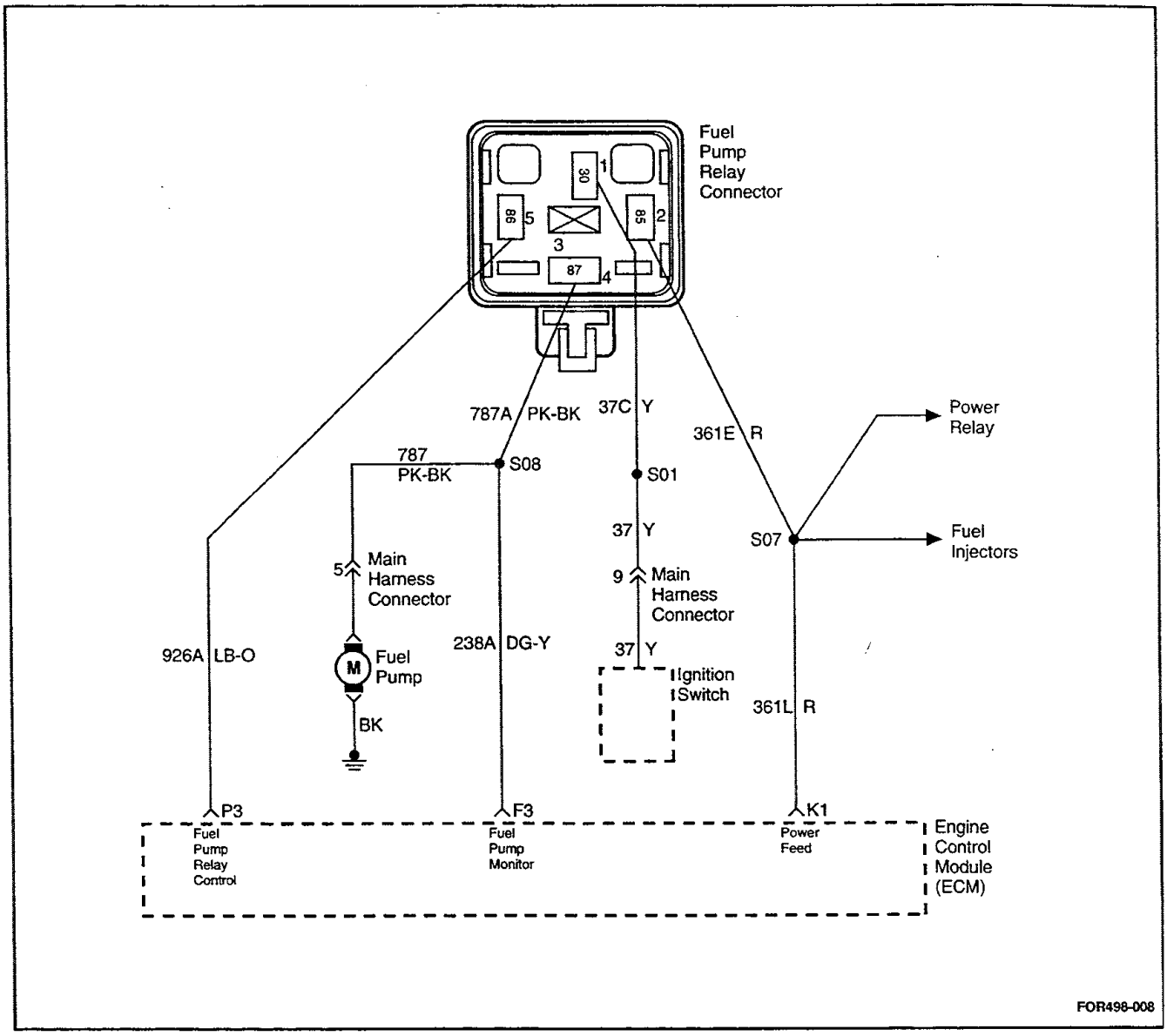
Inspect the harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connections. Inspect the wiring harness for damage.

DTC 24 – Manifold Absolute Pressure Sensor High Voltage

Step	Action	Value(s)	Yes	No
1	Are you using a personal computer (PC) to perform this diagnosis?	–	Go to *Diagnostic System Check* before continuing at Step 2.	Go to *Step 2.*
2	1. KOEO. 2. Disconnect the MAP sensor electrical connector. 3. Check the voltage between terminals A and C on the MAP sensor electrical connector. Is the voltage within the specified values?	4.9-5.1V	Go to *Step 3*	Go to *Step 6*
3	1. Reconnect the MAP sensor electrical connector. 2. KOER with no load on engine. 3. Using a suitable backprobing technique, measure the voltage between terminal A and B at the MAP sensor. 4. While observing the voltage reading, increase the engine speed from idle to WOT. Does the voltage vary between the specified values?	Approx. 4.8V at idle to Approx. 1V at WOT	Go to *Step 4*	Go to *Step 8*
4	1. Ignition OFF. 2. Disconnect the ECM connector A thru K. 3. Disconnect the MAP sensor connector. 4. Check for an open or short to ground on circuit 358, Lt Green/Black between the MAP sensor connector and the ECM connector and repair as necessary. Was a repair necessary?	–	Re-test the system	Go to *Step 5*
5	Check circuit 358, Lt Green/Black for a poor terminal connection at the ECM and repair if necessary. Was a repair necessary?	–	Re-test the system	Go to *Step 9*
6	1. Disconnect the ECM connector A thru K. 2. Check for an open or short to ground on circuits 351C, Brown/White and 359K, Grey/Yellow between the MAP sensor connector and the ECM connector and repair as necessary. Was a repair necessary?	–	Re-test the system	Go to *Step 7*
7	Check circuits 351C, Brown/White and 359K, Grey/Yellow for a poor terminal connection at the ECM and repair if necessary. Was a repair necessary?	–	Re-test the system	Go to *Step 9*
8	Replace the MAP sensor. Is the repair complete?	–	Re-test the system	–
9	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 10*	–

DTC 24 – Manifold Absolute Pressure Sensor High Voltage (Cont'd)

Step	Action	Value(s)	Yes	No
10	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re-test the system	Remove original ECM and reinstall replacement ECM. Go to *Step 11*
11	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–



DIAGNOSTIC TROUBLE CODE (DTC) 31
FUEL PUMP LOW VOLTAGE

Circuit Description

When the ignition switch is first turned on, the ECM energizes the fuel pump relay which applies power to the fuel pump. The fuel pump relay will remain active as long as the engine is running or cranking. If the fuel pump is not active the ECM will receive no signal. DTC 31 will set when the fuel pump voltage is greater than or equal to 2.0 volts below ignition voltage. This condition may indicate a problem with the relay or the wiring.

Conditions for Setting the DTC

- KOER or KOEO.
- Fuel pump voltage is greater than or equal to 2.0V below ignition voltage for at least 2 consecutive seconds.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicato lamp (MIL).

Conditions for Clearing the DTC (Resetting the MIL

- The DTC can be cleared from memory by disconnecting the battery for 5 minutes.
- If a personal computer (PC) is connected to the engine, the DTC can be cleared from memory by hitting the "C" key while in the View Sensor Data screen.

Diagnostic Aids

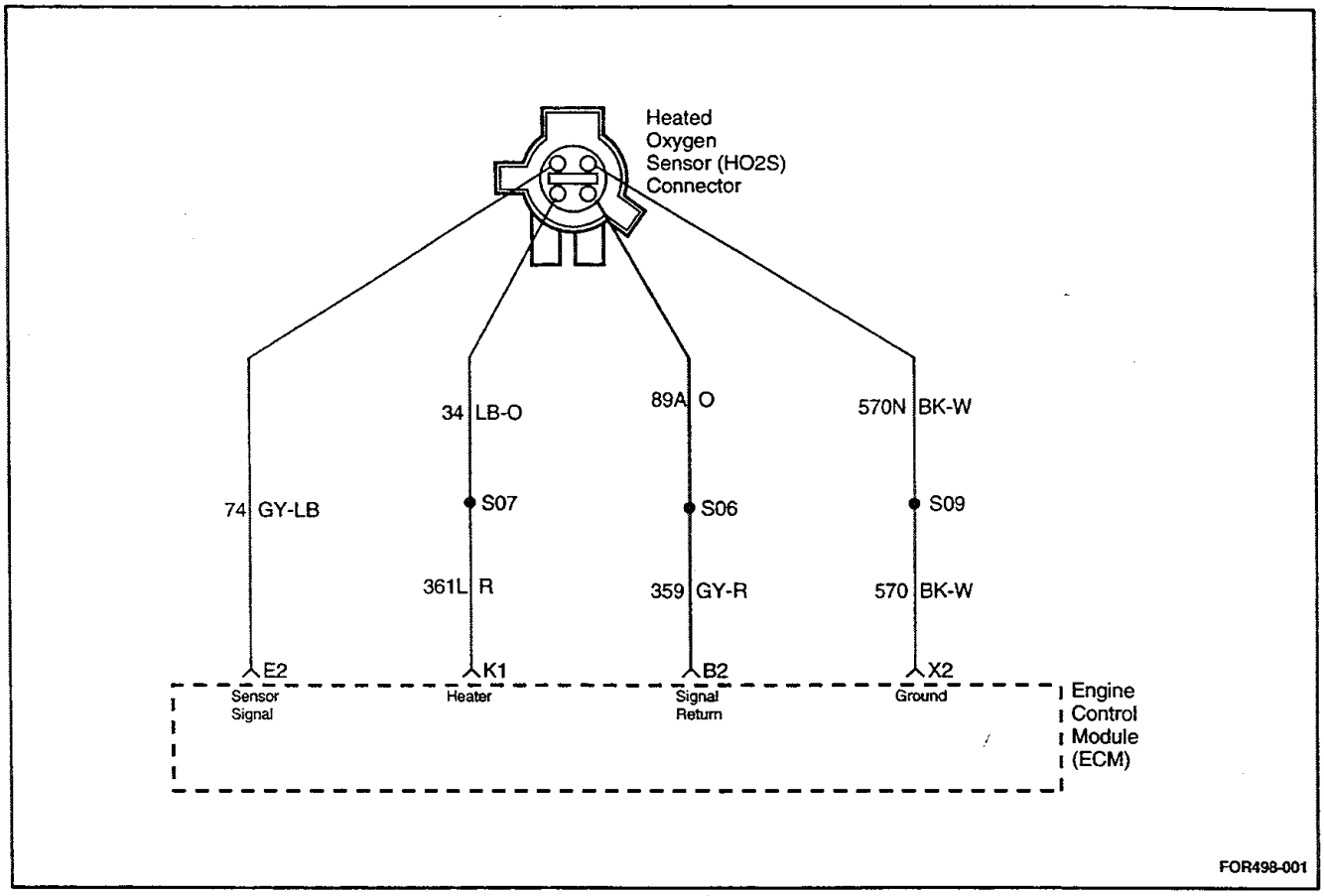
Inspect the harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connections. Inspect the wiring harness for damage. If the harness appears to be OK, backprobe the fuel pump relay connector with a digital voltmeter and observe the voltage while moving connectors and wiring harnesses related to the fuel pump relay. A change in the fuel pump voltage display will indicate the location of the fault.

DTC 31 – Fuel Pump Low Voltage

Step	Action	Value(s)	Yes	No
1	Are you using a personal computer (PC) to perform this diagnosis?	–	Go to *Diagnostic System Check* before continuing at Step 2.	Go to *Step 2.*
2	1. Ignition OFF. 2. Remove the fuel pump relay. 3. KOEO. 4. Connect a test lamp from cavity 86 to ground. Does the test lamp light?	–	Go to *Step 4*	Go to *Step 3*
3	Repair the open or short to ground in circuit 361, Red between the ECM and the fuel pump relay. Is the repair complete?	–	Re-test the system	–
4	Connect a test lamp from cavity 85 to ground. Does the test lamp light?	–	Go to *Step 6*	Go to *Step 5*
5	Repair the open or short to ground in circuit 926A, Lt Blue/Orange between the ECM and the fuel pump relay. Is the repair complete?	–	Re-test the system	–
6	Connect a test lamp from cavity 87 to ground. Does the test lamp light?	–	Go to *Step 8*	Go to *Step 7*
7	Repair the open or short to ground in circuit 37, Yellow between the ECM and the ignition. Is the repair complete?	–	Re-test the system	–
8	Connect a self-powered test lamp from cavity 30 to ground. Does the test lamp light?	–	Go to *Step 10*	Go to *Step 9*
9	Repair the open or short to ground in circuit 787, Pink/Black and circuit 238A, Dk Green/Yellow between the ECM and the fuel pump relay. Is the repair complete?	–	Re-test the system	–
10	Connect a test lamp between cavity 87 to cavity 30. Does the test lamp light?	–	Go to *Step 11*	Go to *Step 12*
11	Replace the fuel pump relay. Is the repair complete?	–	Re-test the system	–

DTC 31 – Fuel Pump Low Voltage (Cont'd)

Step	Action	Value(s)	Yes	No
12	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 13*	–
13	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re–test the system	Remove original ECM and reinstall replacement ECM. Go to *Step 14*
14	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–



DIAGNOSTIC TROUBLE CODE (DTC) 32
HO2S SENSOR LOW VOLTAGE

Circuit Description

The ECM supplies a voltage of about 0.45 volts to the heated oxygen sensor. This may read as low as 0.32 volts with a 10 megohm digital voltmeter. The oxygen sensor varies the voltage within a range of about 1 volt if the exhaust is rich, down through about 0.10 volts if the exhaust is lean. A cold sensor causes an open loop operation.

If the sensor pigtail wiring, connector, or terminal is damaged the entire oxygen sensor assembly must be replaced. Do not attempt to repair the wiring, connector, or terminals. In order for the sensor to function properly, it must have a clean air reference provided to it. This clean air reference is obtained by way of the signal return wire. Any attempt to repair the wires, connector, or terminals could result in the obstruction of the air reference and degrade the sensor performance.

Conditions for Setting the DTC

- KOER.
- HO2S sensor voltage is less than or equal to 0.20 volts for 20 consecutive seconds.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL).
- The ECM will switch to open loop fuel control.

Conditions for Clearing the DTC (Resetting the MIL)

- The DTC can be cleared from memory by disconnecting the battery for 5 minutes.
- If a personal computer (PC) is connected to the engine, the DTC can be cleared from memory by hitting the "C" key while in the View Sensor Data screen.

Diagnostic Aids

An output that causes the ECM to sense a lower than normal manifold pressure (high vacuum) can cause the system to go lean. Disconnecting the MAP sensor will allow the ECM to substitute a fixed (default) value for the MAP sensor. If the lean condition is gone when the MAP sensor is disconnected, substitute a known good MAP sensor and recheck.

Even small amounts of water delivered to the fuel injectors can cause a lean condition.

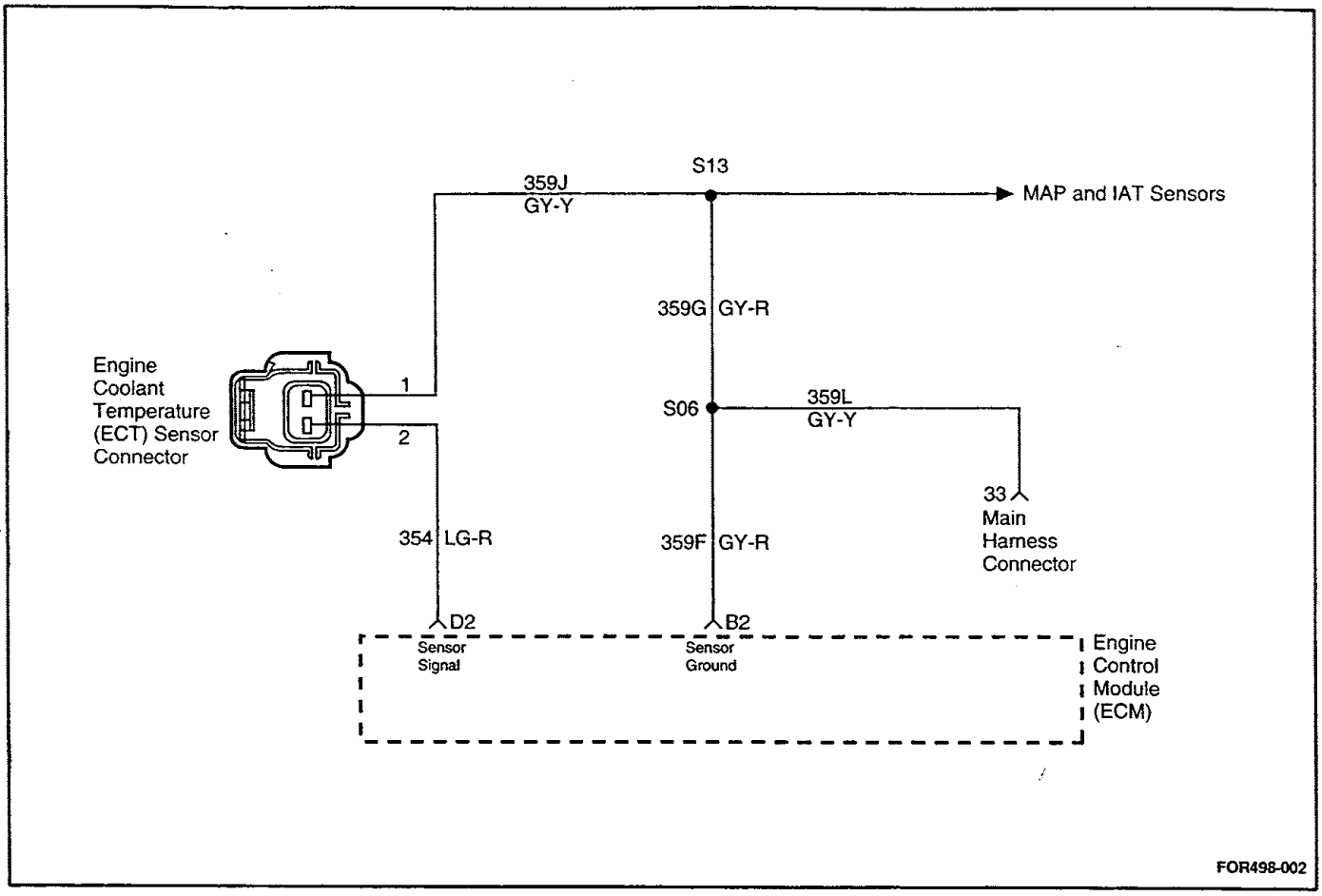
A misfiring cylinder will result in unburned oxygen in the exhaust which can cause a lean condition.

A plugged fuel filter can cause a lean condition.

Inspect the harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connections. Inspect the wiring harness for damage. If the harness appears to be OK, disconnect the ECM, turn on the ignition and observe a voltmeter connected to the HO2S return circuit at the ECM harness connector while moving connectors and wiring harnesses related to the ECM. A change in the voltage will indicate the location of the fault.

DTC 32 – HO2S Sensor Low Voltage

Step	Action	Value(s)	Yes	No
1	Are you using a personal computer (PC) to perform this diagnosis?	–	Go to *Diagnostic System Check* before continuing at Step 2.	Go to *Step 2.*
2	1. Let the sensor cool. 2. KOEO. 3. With a DVOM check the voltage between the signal circuit 74, Black and the return circuit 89A, Gray on the HO2S sensor. Note: If a PC is available, you can observe HO2S voltage on the engine data screen instead of using a DVOM. Is the sensor voltage approximate to the specified value?	0.45 V	Go to Diagnostic Aids	Go to *Step 3*
3	1. Disconnect the HO2S sensor electrical connector. 2. Check the sensor signal circuit 74, Black for a short to ground and repair if necessary. Was a repair necessary?	–	Re-test the system	Go to *Step 4*
4	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 5*	–
5	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re-test the system	Remove original ECM and reinstall replacement ECM. Go to *Step 6*
6	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–



DIAGNOSTIC TROUBLE CODE (DTC) 33
ENGINE COOLANT TEMPERATURE HIGH VOLTAGE

Circuit Description

The engine coolant temperature (ECT) sensor is a thermistor which measures the temperature of the coolant in the engine. The ECM supplies a ground (circuit 359, Gray/Red-Gray/Yellow) to the sensor and receives a voltage signal (circuit 354, Lt. Green/Red) from the sensor. When the engine coolant is cold, the sensor resistance is high and the ECM will monitor a high signal voltage at the ECT signal circuit. If the engine coolant is warm, the sensor resistance is lower, causing the ECM to monitor a lower voltage. DTC 33 will set when the ECM detects an excessively high signal voltage on the engine coolant temperature sensor signal circuit

Conditions for Setting the DTC

- KOEO or KOER
- ECT sensor signal is greater than or equal to 4.93 volts.
- Above conditions are present for at least 3 consecutive seconds.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL).
- The ECM will force the ECT sensor to a 50°F default value.

Conditions for Clearing the DTC (Resetting the MIL)

- The DTC can be cleared from memory by disconnecting the battery for 5 minutes.
- If a personal computer (PC) is connected to the engine, the DTC can be cleared from memory by hitting the "C" key while in the View Sensor Data screen.

Diagnostic Aids

The ECT sensor shares the same ground with the Manifold Absolute Pressure (MAP) sensor and the Intake Air Temperature (IAT) sensor. Check the ground circuit 359 (Gray/Red-Gray/Yellow) if these DTC's are also set.

Inspect the harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connections. Inspect the wiring harness for damage. If the harness appears to be OK, backprobe the ECT sensor connector with a digital voltmeter and observe the voltage while moving connectors and wiring harnesses related to the ECT sensor.

A change in the ECT display will indicate the location of the fault.

Engine Coolant Temperature Sensor

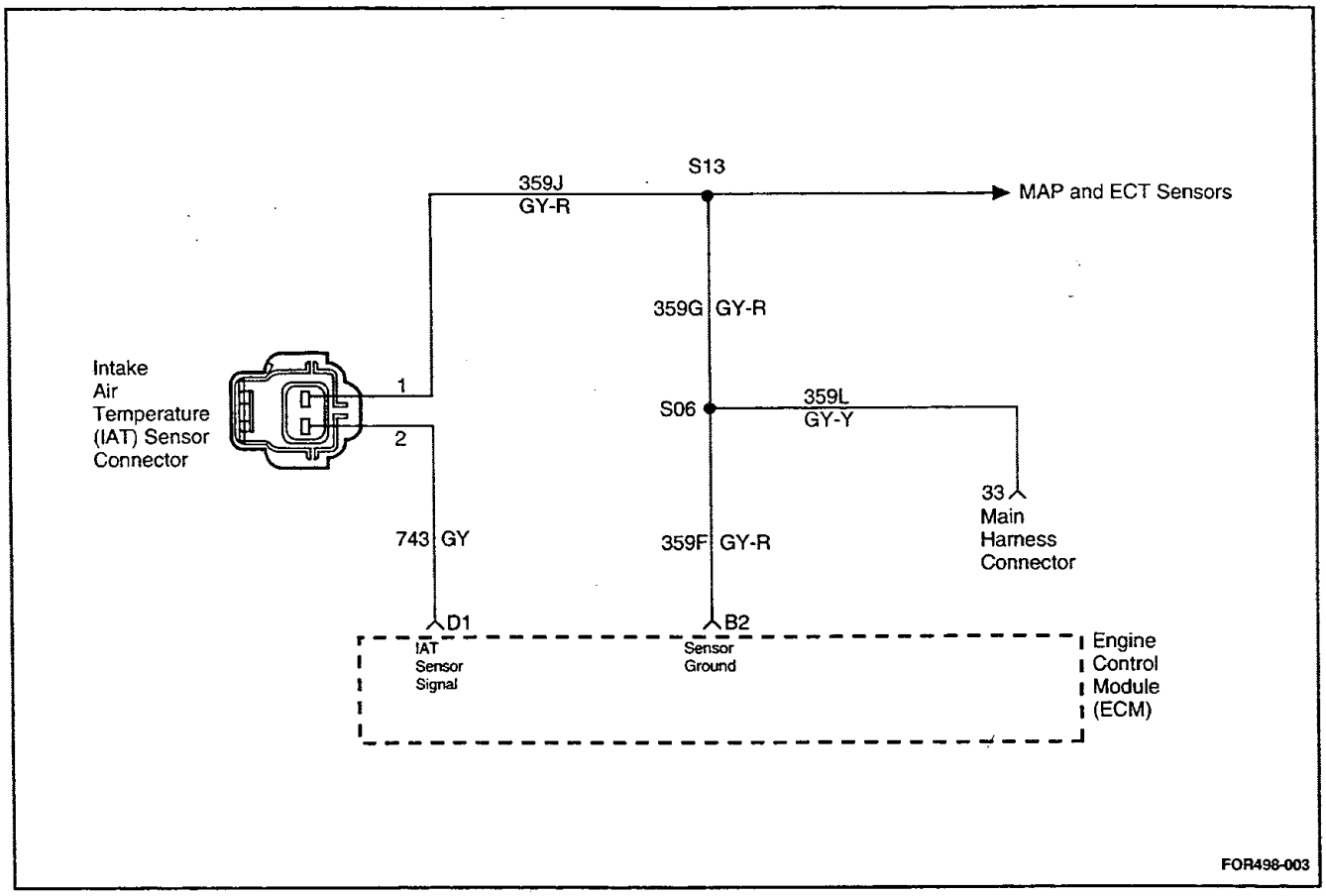
°C	°F	OHMS
Temperature vs. Resistance Values (approximate)		
100	212	2,080
80	176	3,837
60	140	7,548
45	113	13,236
35	95	19,716
25	77	30,000
15	59	46,774
5	41	74,914
−5	23	123,485
−15	5	209,816
−30	−22	496,051
−40	−40	925,021

DTC 33 – Engine Coolant Temperature High Voltage

Step	Action	Value(s)	Yes	No
1	Are you using a personal computer (PC) to perform this diagnosis?	–	Go to *Diagnostic System Check* before continuing at Step 2.	Go to *Step 2.*
2	1. Ignition OFF 2. Disconnect the ECT sensor electrical connector. 3. KOEO. 4. With a DVOM, measure the voltage on circuit 359, Gray/Yellow, cavity 1 Is the voltage greater than the specified value?	4.9 V	Go to *Step 3*	Go to *Step 4*
3	Check for a short to voltage on circuit 359, Gray/Yellow-Gray/Red and repair as necessary. Was a repair necessary?	–	Re-test the system	Go to *Step 7*
4	1. Reconnect the ECT sensor electrical connector. 2. With a suitable backprobing technique measure the voltage between cavity 2 (circuit 354, Lt Green/Red) and ground. Is the voltage greater than the specified value?	4.9 V	Go to *Step 6*	Go to *Step 5*
5	Check for a short to voltage on circuit 354, Lt Green and repair as necessary. Was a repair necessary?	–	Re-test the system	Go to *Step 7*
6	Replace the ECT sensor. Is the repair complete?	–	Re-test the system	–

DTC 33 – Engine Coolant Temperature High Voltage (Cont'd)

Step	Action	Value(s)	Yes	No
7	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 8*	–
8	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re-test the system	Remove original ECM and reinstall replacement ECM. Go to *Step 9*
9	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–



DIAGNOSTIC TROUBLE CODE (DTC) 35
INTAKE AIR TEMPERATURE HIGH VOLTAGE

Circuit Description

The intake air temperature (IAT) sensor is a thermistor which measures the temperature of the air entering the engine. The ECM supplies a ground (circuit 359, Gray/Red) to the sensor and receives a voltage signal (circuit 743, Gray) from the sensor. When the intake air is cold, the sensor resistance is high and the ECM will monitor a high signal voltage at the IAT signal circuit. If the intake air is warm, the sensor resistance is lower, causing the ECM to monitor a lower voltage. DTC 35 will set when the ECM detects an excessively high signal voltage on the intake air temperature sensor signal circuit

Conditions for Setting the DTC

- KOEO or KOER
- IAT sensor signal is greater than or equal to 4.93 volts.
- Above conditions are present for at least 3 consecutive seconds.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL).
- The ECM will force the IAT sensor to a 50° F default value.

Conditions for Clearing the DTC (Resetting the MIL)

- The DTC can be cleared from memory by disconnecting the battery for 5 minutes.
- If a personal computer (PC) is connected to the engine, the DTC can be cleared from memory by hitting the "C" key while in the View Sensor Data screen.

Diagnostic Aids

The IAT sensor shares the same ground with the Manifold Absolute Pressure (MAP) sensor and the Engine Coolant Temperature (ECT) sensor. Check the ground circuit 359 (Gray/Red) if these DTCs are also set.

Inspect the harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connections. Inspect the wiring harness for damage. If the harness appears to be OK, backprobe the IAT sensor connector with a digital voltmeter and observe the voltage while moving connectors and wiring harnesses related to the IAT sensor.

A change in the voltage reading will indicate the location of the fault.

Intake Air Temperature Sensor

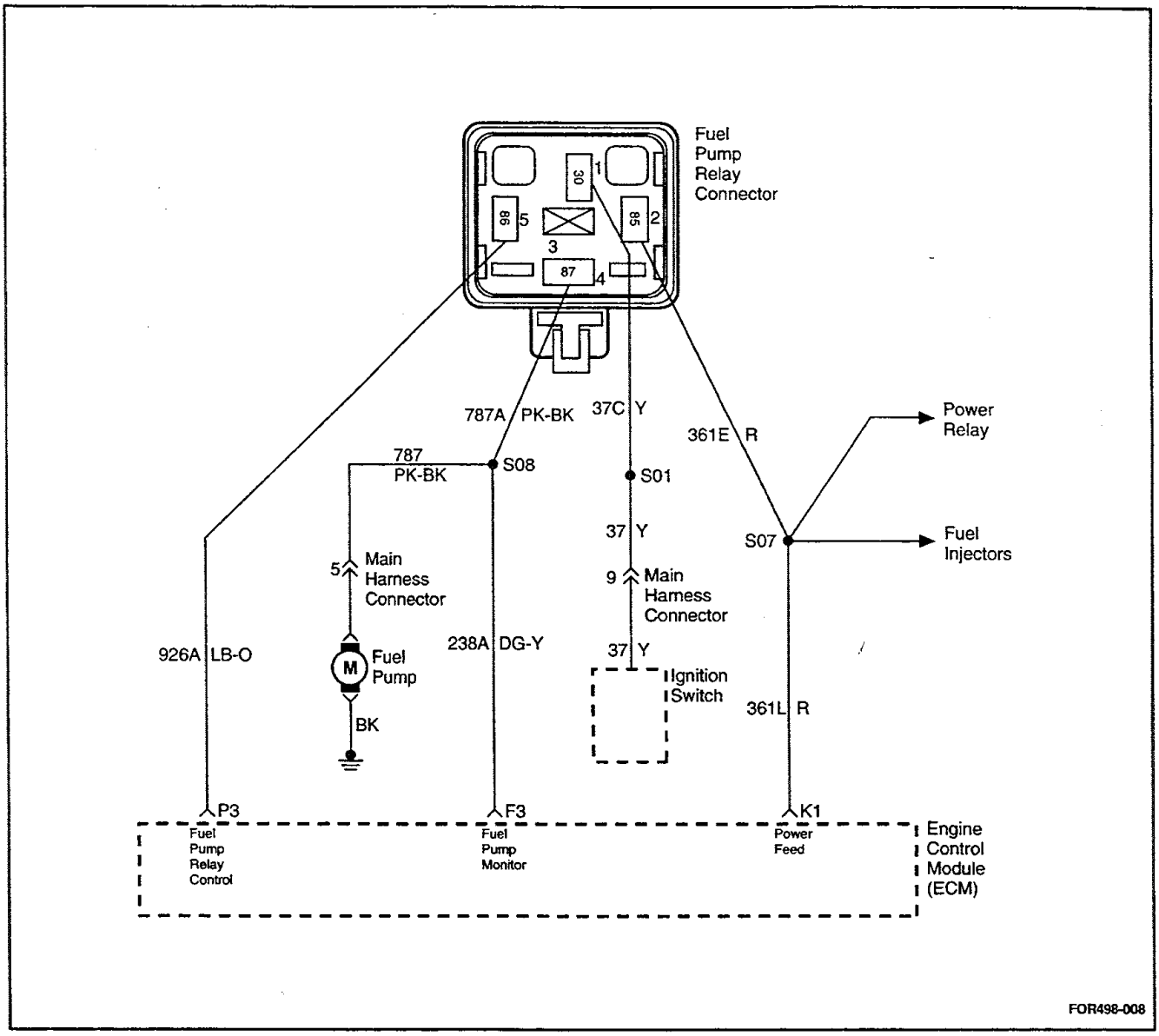
°C	°F	OHMS
Temperature vs. Resistance Values (approximate)		
100	212	2,080
80	176	3,837
60	140	7,548
45	113	13,236
35	95	19,716
25	77	30,000
15	59	46,774
5	41	74,914
−5	23	123,485
−15	5	209,816
−30	−22	496,051
−40	−40	925,021

DTC 35 – Intake Air Temperature High Voltage

Step	Action	Value(s)	Yes	No
1	Are you using a personal computer (PC) to perform this diagnosis?	–	Go to *Diagnostic System Check* before continuing at Step 2.	Go to *Step 2.*
2	1. Ignition OFF 2. Disconnect the IAT sensor electrical connector. 3. KOEO. 4. With a DVOM, measure the voltage on circuit 359, Gray/Yellow, cavity 1. Is the voltage greater than the specified value?	4.9 V	Go to *Step 3*	Go to *Step 4*
3	Check for a short to voltage on circuit 359, Gray/Red and repair as necessary. Was a repair necessary?	–	Re-test the system	Go to *Step 7*
4	1. Reconnect the IAT sensor electrical connector. 2. With a suitable backprobing technique measure the voltage between cavity 2 (circuit 743, Gray) and ground. Is the voltage greater than the specified value?	4.9 V	Go to *Step 6*	Go to *Step 5*
5	Check for a short to voltage on circuit 743, Gray and repair as necessary. Was a repair necessary?	–	Re-test the system	Go to *Step 7*
6	Replace the IAT sensor. Is the repair complete?	–	Re-test the system	–

DTC 35 – Intake Air Temperature High Voltage (Cont'd)

Step	Action	Value(s)	Yes	No
7	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 8*	–
8	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re-test the system.	Remove original ECM and reinstall replacement ECM. Go to *Step 9*
9	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–



DIAGNOSTIC TROUBLE CODE (DTC) 41
FUEL PUMP HIGH VOLTAGE

Circuit Description

When the ignition switch is first turned on, the ECM energizes the fuel pump relay which applies power to the fuel pump. The fuel pump relay will remain active as long as the engine is running or cranking. If the fuel pump is active when the ECM is not commanding it then DTC 31 will set. This condition indicates a problem with the relay or the wiring.

Conditions for Setting the DTC

- KOEO.
- Fuel pump voltage is active when the ECM is not commanding it.
- Above conditions must be meet for at least 2 consecutive seconds.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL).

Conditions for Clearing the DTC (Resetting the MIL)

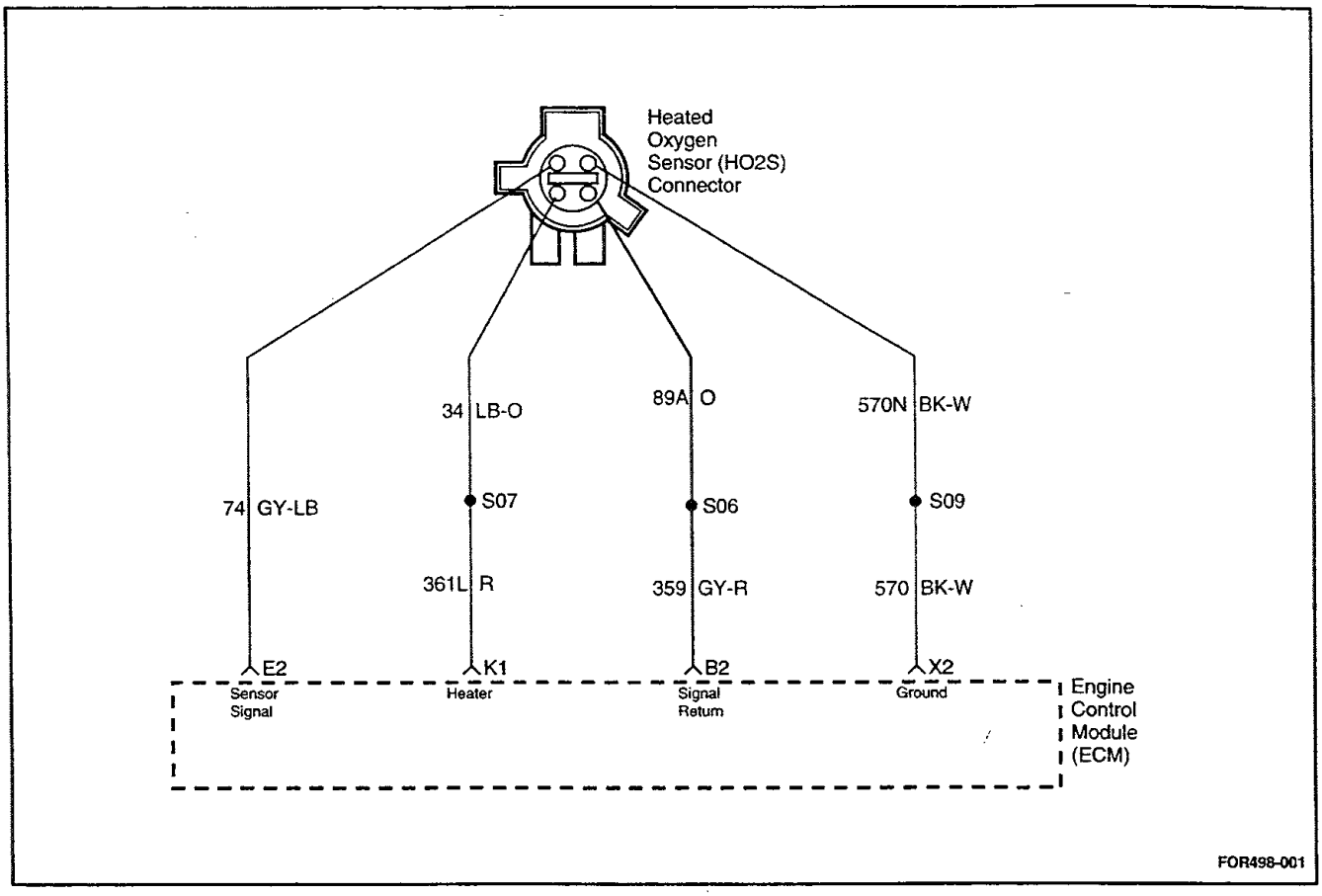
- The DTC can be cleared from memory by disconnecting the battery for 5 minutes.
- If a personal computer (PC) is connected to the engine, the DTC can be cleared from memory by hitting the "C" key while in the View Sensor Data screen.

Diagnostic Aids

Inspect the harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connections. Inspect the wiring harness for damage.

DTC 41 – Fuel Pump High Voltage

Step	Action	Value(s)	Yes	No
1	Are you using a personal computer (PC) to perform this diagnosis?	–	Go to *Diagnostic System Check* before continuing at Step 2.	Go to *Step 2.*
2	1. KOEO. 2. Disconnect the ECM connector A thru K. 3. Connect a test lamp from the ECM connector, cavity P3 to ground. Does the test lamp light?	–	Go to *Step 4*	Go to *Step 3*
3	Repair the open or short to ground in circuit 361, Red, between the ECM and the fuel pump relay. Is the repair complete?	–	Re-test the system	–
4	Connect a test lamp from cavity 85 to ground. Does the test lamp light?	–	Go to *Step 6*	Go to *Step 5*
5	Repair the open or short to ground in circuit 926A, Lt Blue/Orange, between the ECM and the fuel pump relay. Is the repair complete?	–	Re-test the system	–
6	Connect a test lamp from cavity 87 to ground. Does the test lamp light?	–	Go to *Step 8*	Go to *Step 7*
7	Repair the open or short to ground in circuit 37, Yellow between the ECM and the ignition. Is the repair complete?	–	Re-test the system	–
8	Connect a self-powered test lamp from cavity 30 to ground. Does the test lamp light?	–	Go to *Step 10*	Go to *Step 9*
9	Repair the open or short to ground in circuit 787, Pink/Black and circuit 238A, Dk Green/Yellow, between the ECM and the fuel pump relay. Is the repair complete?	–	Re-test the system	–
10	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 11*	–
11	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re-test the system	Remove original ECM and reinstall replacement ECM. Go to *Step 12*
12	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–



DIAGNOSTIC TROUBLE CODE (DTC) 42
HO2S SENSOR HIGH VOLTAGE

Circuit Description

The ECM supplies a voltage of about 0.45 volts to the heated oxygen sensor. This may read as low as 0.32 volts with a 10 megohm digital voltmeter. The oxygen sensor varies the voltage within a range of about 1 volt if the exhaust is rich, down through about 0.10 volts if the exhaust is lean. A cold sensor causes an open loop operation.

If the sensor pigtail wiring, connector, or terminal is damaged the entire oxygen sensor assembly must be replaced. Do not attempt to repair the wiring, connector, or terminals. In order for the sensor to function properly, it must have a clean air reference provided to it. This clean air reference is obtained by way of the signal return wire. Any attempt to repair the wires, connector, or terminals could result in the obstruction of the air reference and degrade the sensor performance.

Conditions for Setting the DTC

- KOER.
- HO2S sensor voltage is greater than or equal to 0.65 volts for 20 consecutive seconds.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL).
- The ECM will switch to open loop fuel control.

Conditions for Clearing the DTC (Resetting the MIL)

- The DTC can be cleared from memory by disconnecting the battery for 5 minutes.
- If a personal computer (PC) is connected to the engine, the DTC can be cleared from memory by hitting the "C" key while in the View Sensor Data screen.

Diagnostic Aids

An output that causes the ECM to sense a higher than normal manifold pressure (low vacuum) can cause the system to go rich. Disconnecting the MAP sensor will allow the ECM to substitute a fixed (default) value for the MAP sensor. If the rich condition is gone when the MAP sensor is disconnected, substitute a known good MAP sensor and recheck.

A leaking or malfunctioning fuel injector can cause the system to go rich.

A misfiring cylinder will result in unburned oxygen in the exhaust which can cause a lean condition.

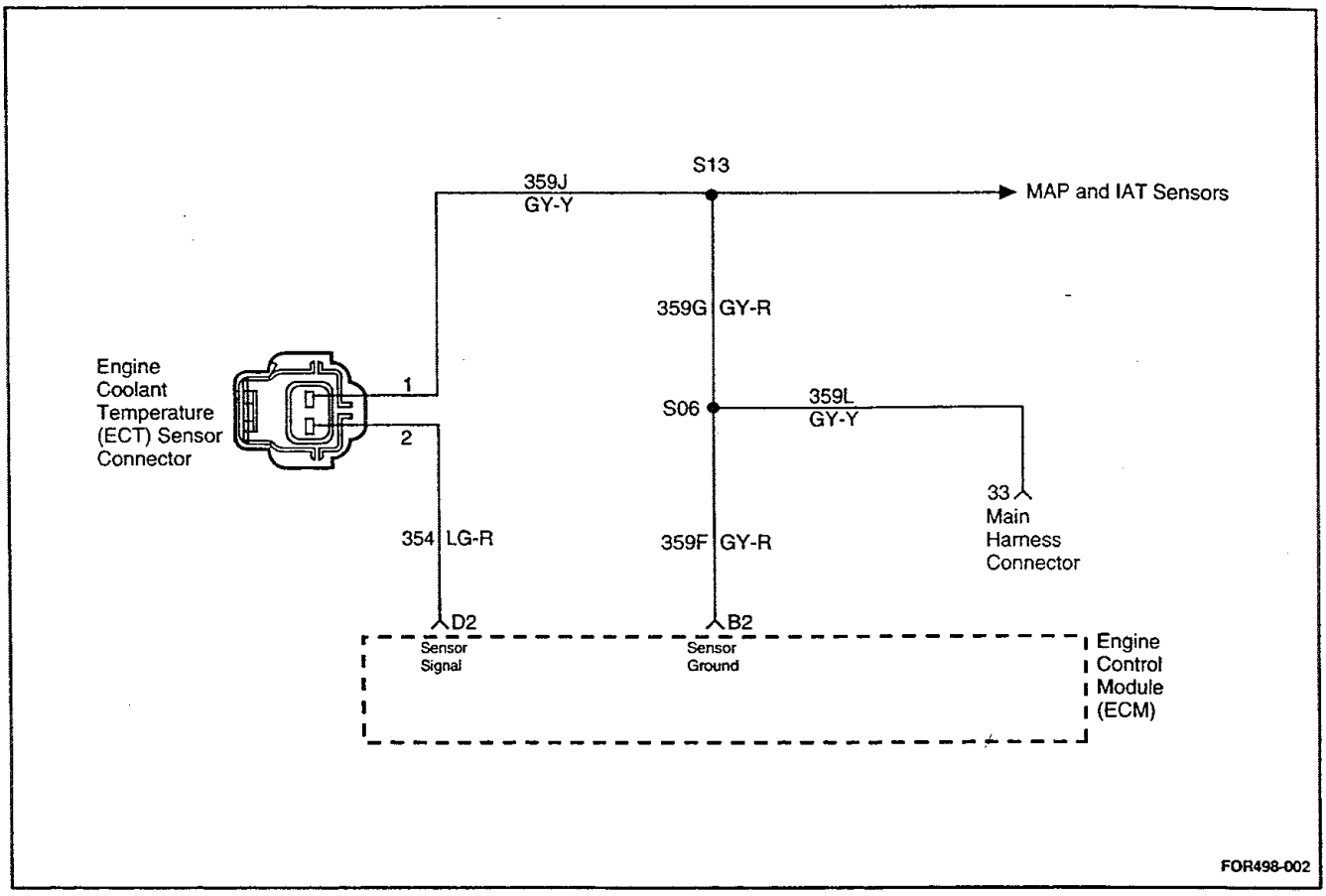
An intermittent throttle position sensor output will cause the system to go rich due to a false indication of the engine accelerating.

Inspect the oxygen sensor for silicone contamination from fuel or the use of improper room temperature vulcanizing (RTV) sealant. The sensor may have a white powdery coating which may result in a high but false voltage signal (rich exhaust indication).

Inspect the harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connections. Inspect the wiring harness for damage. If the harness appears to be OK, disconnect the ECM, turn on the ignition and observe a voltmeter connected to the HO2S return circuit at the ECM harness connector while moving connectors and wiring harnesses related to the ECM. A change in the voltage will indicate the location of the fault.

DTC 42 – HO2S Sensor High Voltage

Step	Action	Value(s)	Yes	No
1	Are you using a personal computer (PC) to perform this diagnosis?	–	Go to *Diagnostic System Check* before continuing at Step 2.	Go to *Step 2.*
2	1. Let the sensor cool. 2. KOEO. 3. With a suitable backprobing technique, measure the voltage between the signal circuit 74, Gray/Lt Blue, and the return circuit 89A, Orange. Note: If a PC is available, you can observe HO2S voltage on the engine data screen instead of using a DVOM. Is the HO2S voltage below the specified value?	0.50 V	Go to Diagnostic Aids	Go to *Step 3*
3	1. Disconnect the HO2S sensor electrical connector. 2. Check the sensor signal circuit 74, Gray/Lt Blue, for an open or a short to ground and repair if necessary. Was a repair necessary?	–	System OK	Go to *Step 4*
4	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 5*	–
5	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re-test the system	Remove original ECM and reinstall replacement ECM. Go to *Step 6*
6	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–



DIAGNOSTIC TROUBLE CODE (DTC) 43
ENGINE COOLANT TEMPERATURE LOW VOLTAGE

Circuit Description

The engine coolant temperature (ECT) sensor is a thermistor which measures the temperature of the coolant in the engine. The ECM supplies a ground (circuit 359, Gray/Red-Gray/Yellow) to the sensor and receives a voltage signal (circuit 354, Lt. Green/Red) from the sensor. When the engine coolant is cold, the sensor resistance is high and the ECM will monitor a high signal voltage at the ECT signal circuit. If the engine coolant is warm, the sensor resistance is lower, causing the ECM to monitor a lower voltage. DTC 43 will set when the ECM detects an excessively low signal voltage on the engine coolant temperature sensor signal circuit

Conditions for Setting the DTC

- KOEO or KOER
- ECT sensor signal is less than or equal to 0.06 volts.
- Above conditions are present for at least 3 consecutive seconds.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL).
- The ECM will force the ECT sensor to a 50° F default value.

Conditions for Clearing the DTC (Resetting the MIL)

- The DTC can be cleared from memory by disconnecting the battery for 5 minutes.
- If a personal computer (PC) is connected to the engine, the DTC can be cleared from memory by hitting the "C" key while in the View Sensor Data screen.

Diagnostic Aids

The ECT sensor shares the same ground with the Manifold Absolute Pressure (MAP) sensor and the Intake Air Temperature (IAT) sensor. Check the ground circuit 359 (Gray/Red-Gray/Yellow) if these DTCs are also set.

Inspect the harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connections. Inspect the wiring harness for damage. If the harness appears to be OK, backprobe the ECT sensor connector with a digital voltmeter and observe the voltage while moving connectors and wiring harnesses related to the ECT sensor. A change in the voltmeter display will indicate the location of the fault.

Engine Coolant Temperature Sensor

°C	°F	OHMS
Temperature vs. Resistance Values (approximate)		
100	212	2,080
80	176	3,837
60	140	7,548
45	113	13,236
35	95	19,716
25	77	30,000
15	59	46,774
5	41	74,914
−5	23	123,485
−15	5	209,816
−30	−22	496,051
−40	−40	925,021

DTC 43 – Engine Coolant Temperature Low Voltage (DVOM Diagnostic Method)

Step	Action	Value(s)	Yes	No
1	1. KOEO. 2. Disconnect the ECT sensor connector. 3. With a DVOM measure the voltage from the ECT sensor connector, cavity 2 to ground. Is the voltage greater than the specified value?	0 V	Go to *Step 3*	Go to *Step 2*
2	Locate and repair the open or short to ground in circuit 354, Lt Green/Red, between the ECT sensor connector and the ECM. Is the repair complete?	–	Re-test the system	–
3	Measure the voltage across the ECT sensor connector between cavity 1 and cavity 2. Is the voltage greater than the specified value?	0 V	Re-test the system	Go to *Step 4*
4	Locate and repair the open or short to ground in circuit 359, Gray/Red-Gray/Yellow, between the ECT sensor connector and the ECM. Is the repair complete?	–	Re-test the system	–
5	1. Connect the ECT sensor connector to the sensor. 2. With a suitable backprobing technique, measure the voltage across the ECT sensor connector between cavity 1 and cavity 2. Is the voltage less than the specified value?	5 V	Go to *Step 7*	Go to *Step 6*

DTC 43 – Engine Coolant Temperature Low Voltage (DVOM Diagnostic Method) (Cont'd)

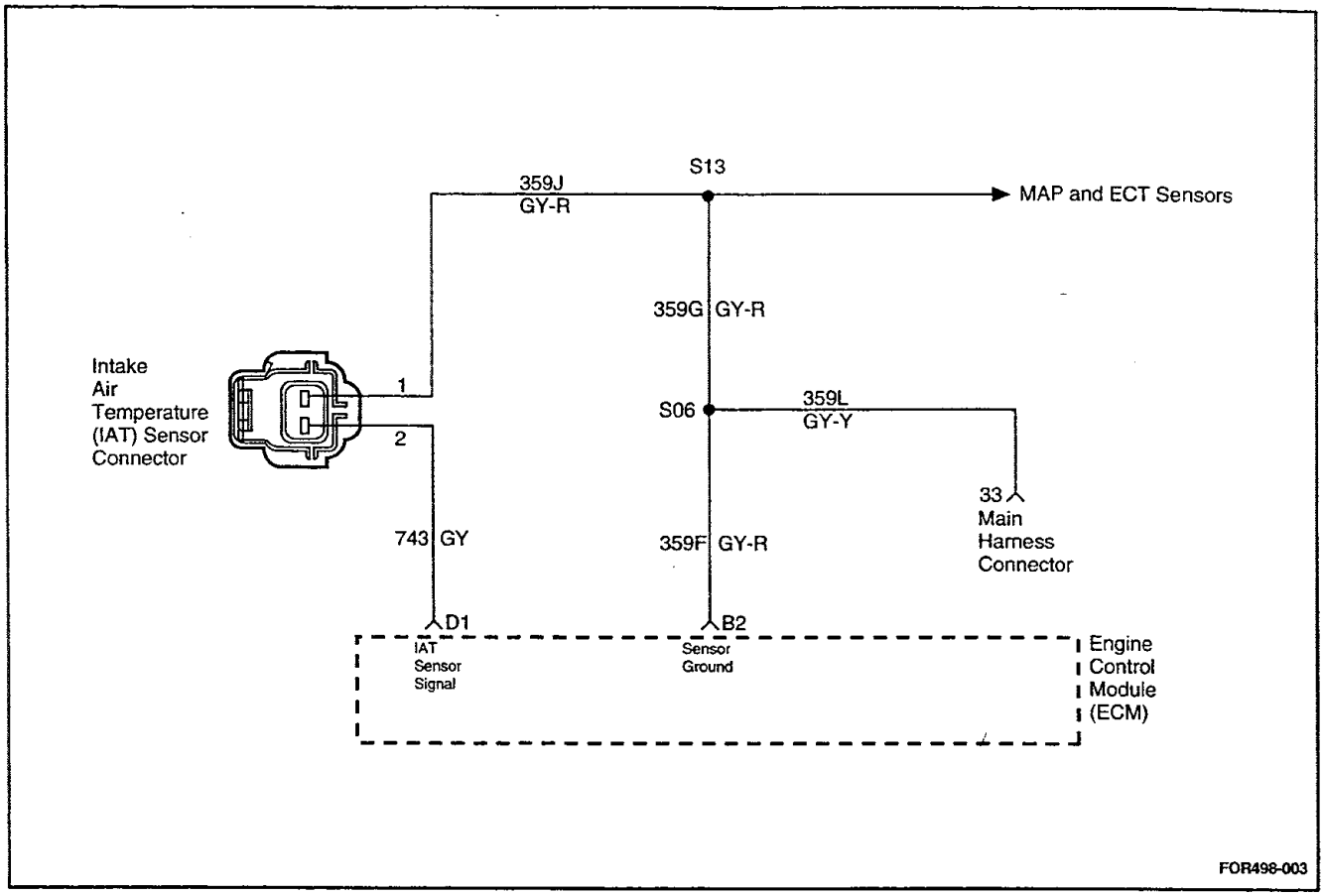
Step	Action	Value(s)	Yes	No
6	Replace the IAT sensor. Is the repair complete?	–	Re-test the system	–
7	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 8*	–
8	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re-test the system	Remove original ECM and reinstall replacement ECM. Go to *Step 9*
9	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–

DTC 43 – Engine Coolant Temperature Low Voltage (PC Diagnostic Method)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System check?	–	Go to *Step 2.*	Go to *Diagnostic System Check* before continuing at Step 2.
2	KOEO. Is the ECT value greater than the specified value?	255°F	Go to *Step 3*	Go to *Diagnostic Aids*
3	1. Ignition OFF. 2. Disconnect the ECT sensor electrical connector. 3. KOEO. 4. Observe the ECT value on the PC engine data screen. Is the ECT sensor value less than the specified value?	–50°F	Go to *Step 5*	Go to *Step 4*
4	1. Ignition OFF. 2. Disconnect the ECM electrical connectors. 3. Check the ECT sensor signal circuit 354, Lt. Green/Red, for a short to ground and repair as necessary. Was a repair necessary?	–	Re-test the system	Go to *Step 6*

DTC 43 – Engine Coolant Temperature Low Voltage (PC Diagnostic Method) (Cont'd)

Step	Action	Value(s)	Yes	No
5	Replace the ECT sensor. Is the repair complete?	–	Re-test the system	–
6	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 7*	–
7	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re-test the system	Remove original ECM and reinstall replacement ECM. Go to *Step 8*
8	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–



DIAGNOSTIC TROUBLE CODE (DTC) 45
INTAKE AIR TEMPERATURE LOW VOLTAGE

Circuit Description

The intake air temperature (IAT) sensor is a thermistor which measures the temperature of the air entering the engine. The ECM supplies a ground (circuit 359, Gray/Red) to the sensor and receives a voltage signal (circuit 743, Gray) from the sensor. When the intake air is cold, the sensor resistance is high and the ECM will monitor a high signal voltage at the IAT signal circuit. If the intake air is warm, the sensor resistance is lower, causing the ECM to monitor a lower voltage. DTC 45 will set when the ECM detects an excessively low signal voltage on the intake air temperature sensor signal circuit

Conditions for Setting the DTC

- KOEO or KOER
- ECT sensor signal is less than or equal to 0.06 volts.
- Above conditions are present for at least 3 consecutive seconds.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL).
- The ECM will force the ECT sensor to a 50° F default value.

Conditions for Clearing the DTC (Resetting the MIL)

- The DTC can be cleared from memory by disconnecting the battery for 5 minutes.
- If a personal computer (PC) is connected to the engine, the DTC can be cleared from memory by hitting the "C" key while in the View Sensor Data screen.

Diagnostic Aids

The IAT sensor shares the same ground with the Manifold Absolute Pressure (MAP) sensor and the Engine Coolant Temperature (ECT) sensor. Check the ground circuit 359 (Gray/Red) if these DTCs are also set.

Inspect the harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connections. Inspect the wiring harness for damage. If the harness appears to be OK, backprobe the IAT sensor connector with a digital voltmeter and observe the voltage while moving connectors and wiring harnesses related to the IAT sensor.

A change in the voltage reading will indicate the location of the fault.

Intake Air Temperature Sensor

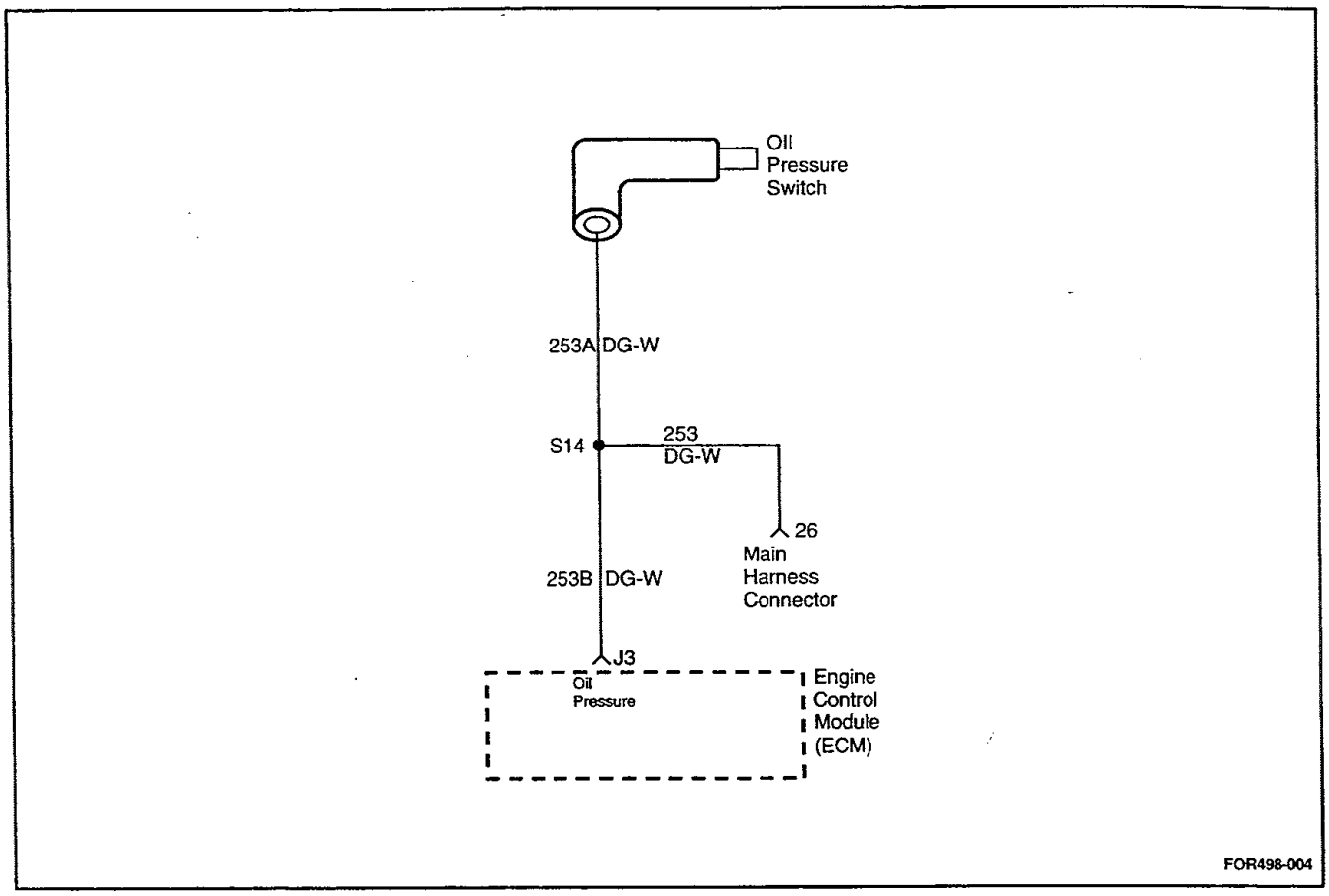
°C	°F	OHMS
Temperature vs. Resistance Values (approximate)		
100	212	2,080
80	176	3,837
60	140	7,548
45	113	13,236
35	95	19,716
25	77	30,000
15	59	46,774
5	41	74,914
−5	23	123,485
−15	5	209,816
−30	−22	496,051
−40	−40	925,021

DTC 45 – Intake Air Temperature Low Voltage

Step	Action	Value(s)	Yes	No
1	Are you using a personal computer (PC) to perform this diagnosis?	–	Go to *Diagnostic System Check* before continuing at Step 2.	Go to *Step 2.*
2	1. KOEO. 2. Disconnect the IAT sensor connector. 3. With a DVOM measure the voltage from the IAT sensor connector, cavity 2 to ground. Is the voltage greater than the specified value?	0 V	Go to *Step 4*	Go to *Step 3*
3	Locate and repair the open or short to ground in circuit 743, Gray between the IAT sensor connector and the ECM. Is the repair complete?	–	Re-test the system	–
4	Measure the voltage across the IAT sensor connector between cavity 1 and cavity 2. Is the voltage greater than the specified value?	0 V	Re-test the system	Go to *Step 5*
5	Locate and repair the open or short to ground in circuit 359, Gray/Red between the IAT sensor connector and the ECM. Is the repair complete?	–	Re-test the system	–
6	1. Connect the IAT sensor connector to the sensor. 2. With a suitable backprobing technique, measure the voltage across the IAT sensor connector between cavity 1 and cavity 2. Is the voltage less than the specified value?	5 V	Go to *Step 8*	Go to *Step 7*

DTC 45 – Intake Air Temperature Low Voltage (Cont'd)

Step	Action	Value(s)	Yes	No
7	Replace the IAT sensor. Is the repair complete?	–	Re-test the system	–
8	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 9*	–
9	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re-test the system	Remove original ECM and reinstall replacement ECM. Go to *Step 10*
10	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–



DIAGNOSTIC TROUBLE CODE (DTC) 51
LOW OIL PRESSURE

Circuit Description

The ECM monitors the oil pressure through circuit 253, Dk Green/White, from the oil pressure switch. If the oil pressure gets below an established pressure value the oil pressure switch will close to ground and the oil pressure light will come on. This action will set DTC 51.

Conditions for Setting the DTC

- KOER.
- Engine must be above 850 RPMs and 250 crankshaft rotations must have occurred.
- Oil switch must be closed to ground for at least 2.0 consecutive seconds.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL).

Conditions for Clearing the DTC (Resetting the MIL)

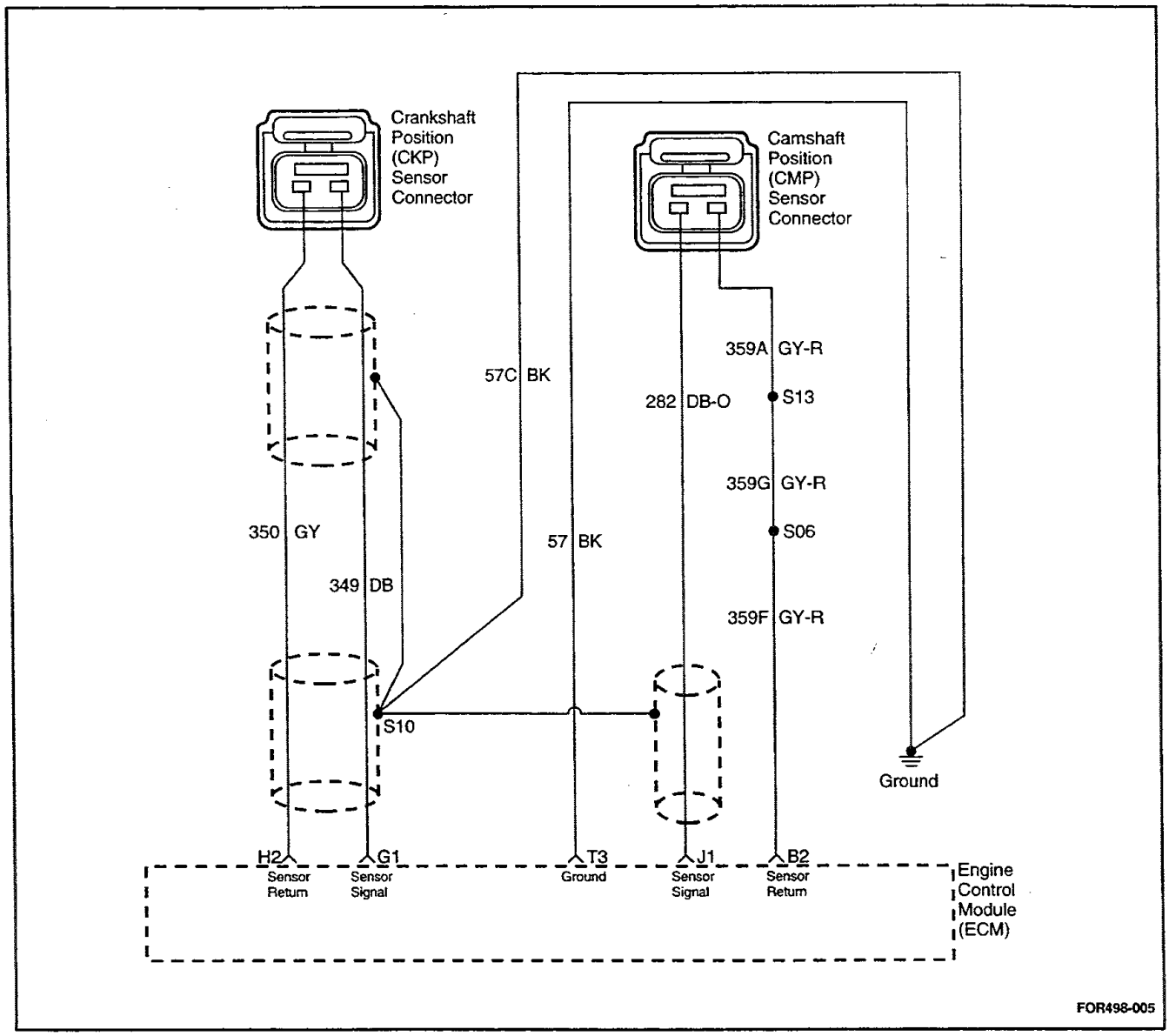
- The DTC can be cleared from memory by disconnecting the battery for 5 minutes.
- If a personal computer (PC) is connected to the engine, the DTC can be cleared from memory by hitting the "C" key while in the View Sensor Data screen.

Diagnostic Aids

Inspect the harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connections. Inspect the wiring harness for damage. If the harness appears to be OK, disconnect the ECM, turn on the ignition and observe a voltmeter connected to the oil pressure circuit at the ECM harness connector while moving connectors and wiring harnesses related to the ECM. A change in the voltage will indicate the location of the fault.

DTC 51 – Low Oil Pressure

Step	Action	Value(s)	Yes	No
1	Are you using a personal computer (PC) to perform this diagnosis?	–	Go to *Diagnostic System Check* before continuing at Step 2.	Go to *Step 2.*
2	1. Ignition OFF. 2. Disconnect the circuit 253, Dk Green/White, oil pressure switch wire from the oil pressure switch. 3. With a DVOM, measure the continuity on circuit 253B, Dk Green/White. Is there continuity?	–	Go to *Step 3*	Go to *Step 4*
3	Locate and repair the short to ground in circuit 253, Dk Green/White, between the oil pressure switch and the ECM connector, cavity J3. Is the repair complete?	–	Re-test the system	–
4	1. KOER. 2. Connect a DVOM to the oil pressure switch post and ground Is there continuity?	–	Go to *Step 5*	Go to *Step 6*
5	Replace the oil pressure switch. Is the repair complete?	–	Re-test the system	–
6	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 7*	–
7	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re-test the system	Remove original ECM and reinstall replacement ECM. Go to *Step 8*
8	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–



DIAGNOSTIC TROUBLE CODE (DTC) 52
CRANKSHAFT POSITION SENSOR EXTRA/MISSING PULSES

Circuit Description

The reference signal is produced by the crankshaft position (CKP) sensor. During one crankshaft revolution, a pre-determined number of crankshaft pulses will be produced. The ECM uses the reference signal to calculate engine RPM and crankshaft position. The ECM constantly monitors the number of pulses on the reference circuit and compares them to the number of camshaft position signal pulses being received. If the ECM receives an incorrect number of pulses on the reference circuit, DTC 52 will set.

Conditions for Setting the DTC

- KOER
- Extra or missing pulses are checked for after every 35 pulses.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL).
- The ECM will turn off the injectors and ignition for a minimum of one crankshaft rotation and wait for a valid pattern before turning the injectors and ignition back on. If a valid pattern is not available the engine will stall.

Conditions for Clearing the DTC (Resetting the MIL)

- The DTC can be cleared from memory by disconnecting the battery for 5 minutes.
- If a personal computer (PC) is connected to the engine, the DTC can be cleared from memory by hitting the "C" key while in the View Sensor Data screen.

Diagnostic Aids

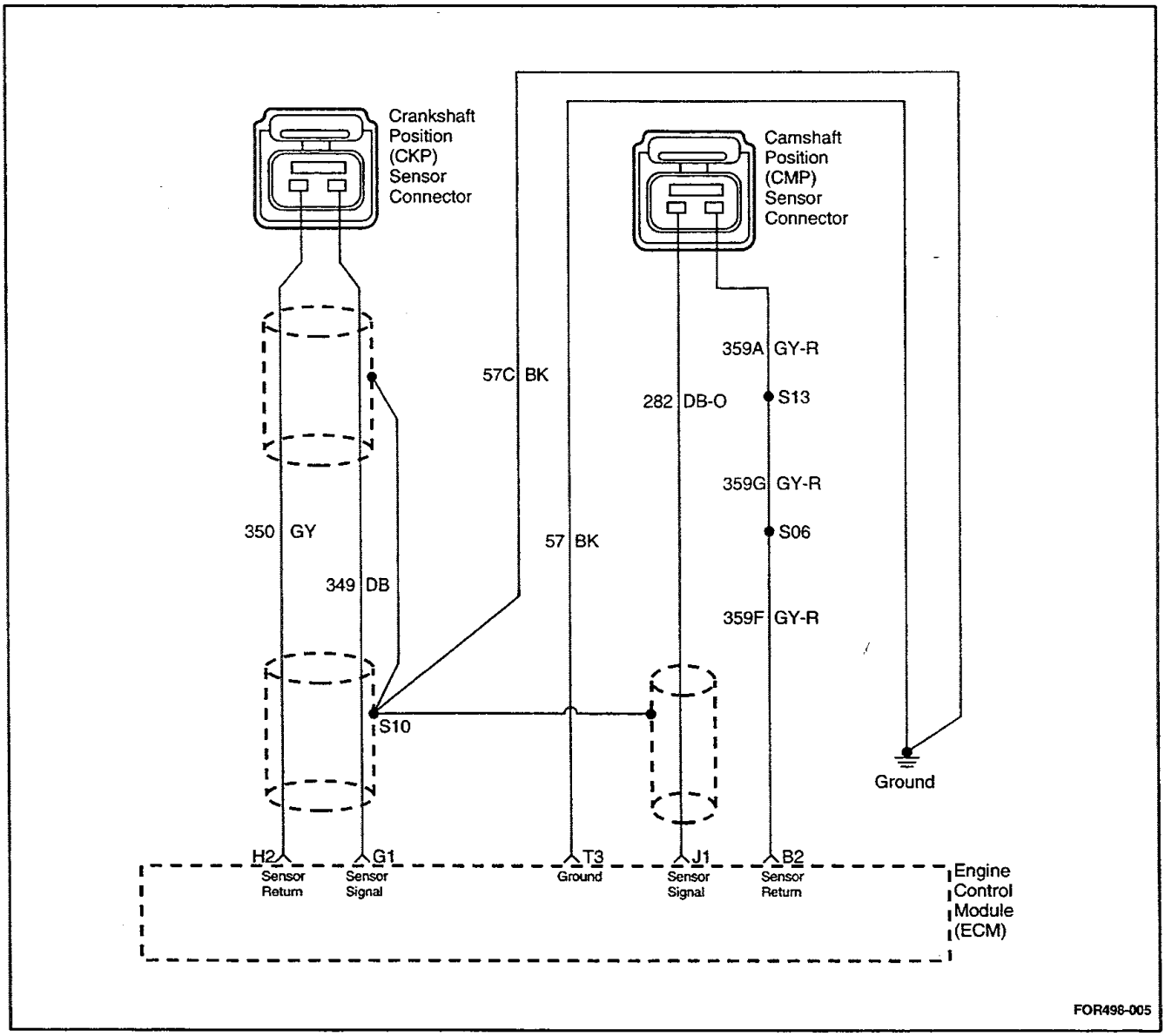
Inspect the harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connections. Inspect the wiring harness for damage. If the harness appears to be OK, disconnect the ECM, turn on the ignition and observe a voltmeter connected to the CKP reference circuit at the ECM harness connector while moving connectors and wiring harnesses related to the ECM. A change in the voltage will indicate the location of the fault.

DTC 52 – Crank Position Extra/Missing Pulses

Step	Action	Value(s)	Yes	No
1	Are you using a personal computer (PC) to perform this diagnosis?	–	Go to *Diagnostic System Check* before continuing at Step 2.	Go to *Step 2.*
2	Attempt to start the engine. Does the engine start?	–	Go to *Step 3*	Go to *Engine Cranks But Will Not Run*
3	1. KOEO. 2. Disconnect the ECM and the CKP sensor. 3. Check for an open or a short to ground in the CKP reference circuit 350, Gray, between the sensor connector and the ECM harness connector. Repair as necessary. Was a repair necessary?	–	Re-test the system	Go to *Step 4*
4	1. Reconnect the ECM and the CKP sensor. 2. Connect a DVOM to measure the voltage on the CKP reference circuit, terminal H2, at the ECM connector. 3. Observe the voltage while cranking the engine. Is the voltage near the specified value?	2.5 V	Go to *Step 7*	Go to *Step 5*
5	Check the connections at the CKP sensor and replace the terminals if necessary. Was a repair necessary?	–	Re-test the system	Go to *Step 6*
6	Replace the CKP sensor. Is the repair complete?	–	Re-test the system	–
7	Check the connections at the ECM and replace the terminals if necessary. Was a repair necessary?	–	Re-test the system	Go to *Step 8*

DTC 52 – Crank Position Extra/Missing Pulses (Cont'd)

Step	Action	Value(s)	Yes	No
8	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 9*	–
9	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re-test the system	Remove original ECM and reinstall replacement ECM. Go to *Step 10*
10	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–



DIAGNOSTIC TROUBLE CODE (DTC) 53
CAMSHAFT POSITION SENSOR ILLEGAL PATTERN

Circuit Description

The camshaft position (CMP) sensor signal is produced by the CMP sensor pulses when the engine is running and CKP sync pulses are also being received. The ECM uses the CMP signal pulses to initiate sequential fuel injection. The ECM constantly monitors the number of pulses on the CMP signal circuit and compares the number of CMP pulses to the number of CKP reference pulses received. If the ECM receives an incorrect number of pulses on the CMP reference circuit, DTC 53 will set. The engine will perform with little or no degradation in perceived performance.

Conditions for Setting the DTC

- KOER
- The correct number of crankshaft pulses (70) are not detected between each CKP pulse.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL)
- The ECM will default to the previously established injection sequence.

Conditions for Clearing the DTC (Resetting the MIL)

- The DTC can be cleared from memory by disconnecting the battery for 5 minutes.

- If a personal computer (PC) is connected to the engine, the DTC can be cleared from memory by hitting the "C" key while in the View Sensor Data screen.

Diagnostic Aids

Inspect the harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connections. Inspect the wiring harness for damage. If the harness appears to be OK, disconnect the ECM, turn on the ignition and observe a voltmeter connected to the CMP reference circuit at the ECM harness connector while moving connectors and wiring harnesses related to the ECM. A change in the voltage will indicate the location of the fault.

DTC 53 – Camshaft Position Sensor Illegal Pattern

Step	Action	Value(s)	Yes	No
1	Are you using a personal computer (PC) to perform this diagnosis?	–	Go to *Diagnostic System Check* before continuing at Step 2.	Go to *Step 2.*
2	1. Disconnect the CMP sensor. 2. Measure the voltage between the sensor signal circuit 282, Dk. Blue/Orange, and the sensor ground circuit 359, Gray/Red, at the CMP sensor connector. Does the voltage measure near the specified value?	4-6 V	Go to *Step 5*	Go to *Step 3*
3	Check the sensor signal circuit 282, Dk. Blue/Orange, and the sensor ground circuit 359, Gray/Red, for an open or short to ground and repair as necessary. Was a repair necessary?	–	Re-test the system	Go to *Step 4*
4	Check for poor connections at the ECM and repair if necessary. Was a repair necessary?	–	Re-test the system	Go to *Step 5*
5	1. Connect the CMP sensor. 2. With a DVOM, backprobe the CMP sensor signal circuit, terminal J1, while cranking the engine. Does the voltage toggle between the specified value?	4-0 V	Go to *Step 7*	Go to *Step 6*
6	Replace the camshaft position sensor. Is the repair complete?	–	Re-test the system	–
7	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 8*	–
8	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re-test the system	Remove original ECM and reinstall replacement ECM. Go to *Step 9*
9	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–

DIAGNOSTIC TROUBLE CODE (DTC) 54
ECM FAULT ILLEGAL OPERATION

System Description

The ECM continuously monitors electrical signals from the engine. If for some reason the ECM receives an illegal instruction it then executes an "exception handling code". The ECM will then go to a default program and return to normal operation, but it will set DTC 54 and will need to be replaced.

Conditions for Setting the DTC

- KOEO or KOER.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL)

Conditions for Clearing the DTC (Resetting the MIL)

- The DTC can be cleared from memory by disconnecting the battery for 5 minutes.
- If a personal computer (PC) is connected to the engine, the DTC can be cleared from memory by hitting the "C" key while in the View Sensor Data screen.

Diagnostic Aids

Inspect the harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connections. Inspect the wiring harness for damage. Check for shorts or open in the spark plug wires.

DTC 54 – ECM Fault Illegal Operation

Step	Action	Value(s)	Yes	No
1	Are you using a personal computer (PC) to perform this diagnosis?	–	Go to *Diagnostic System Check* before continuing at Step 2.	Go to *Step 2.*
2	Check the MIL or the PC engine data screen. Are any other DTCs set?	–	Go to applicable DTC	Go to *Step 3*
3	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 4*	–
4	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re-test the system	Remove original ECM and reinstall replacement ECM. Go to *Step 5*
5	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–

DIAGNOSTIC TROUBLE CODE (DTC) 55
ECM FAULT ILLEGAL INTERRUPTION

System Description

The ECM continuously monitors electrical signals from the engine. If for some reason the ECM receives an illegal interruption from one of those signals it then executes an "exception handling code". The ECM will then go to a default program and return to normal operation, but it will set DTC 55 and will need to be replaced.

Conditions for Setting the DTC

- KOEO or KOER.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL)

Conditions for Clearing the DTC (Resetting the MIL)

- The DTC can be cleared from memory by disconnecting the battery for 5 minutes.
- If a personal computer (PC) is connected to the engine, the DTC can be cleared from memory by hitting the "C" key while in the View Sensor Data screen.

Diagnostic Aids

Inspect the harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connections. Inspect the wiring harness for damage.

DTC 55 – ECM Fault Illegal Interruption

Step	Action	Value(s)	Yes	No
1	Are you using a personal computer (PC) to perform this diagnosis?	–	Go to *Diagnostic System Check* before continuing at Step 2.	Go to *Step 2.*
2	Check the MIL or the PC engine data screen. Are any other DTCs set?	–	Go to applicable DTC	Go to *Step 3*
3	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 4*	–
4	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re-test the system	Remove original ECM and reinstall replacement ECM. Go to *Step 5*
5	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–

DIAGNOSTIC TROUBLE CODE (DTC) 56
ECM FAULT – COMPUTER OPERATING PROPERLY (COP) FAILURE

System Description

The ECM continuously monitors electrical signals from the engine. Under normal operation the ECM will store numbers into memory. If this does not happen, the ECM will execute an "exception handling routine" and reset itself from the beginning. This is a "watch dog timer" function. If DTC 56 is set, the ECM will have to be replaced.

Conditions for Setting the DTC

- KOEO or KOER.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL)

Conditions for Clearing the DTC (Resetting the MIL)

- The DTC can be cleared from memory by disconnecting the battery for 5 minutes.
- If a personal computer (PC) is connected to the engine, the DTC can be cleared from memory by hitting the "C" key while in the View Sensor Data screen.

Diagnostic Aids

Inspect the harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connections. Inspect the wiring harness for damage.

DTC 56 – ECM Fault Computer COP Failure

Step	Action	Value(s)	Yes	No
1	Are you using a personal computer (PC) to perform this diagnosis?	–	Go to *Diagnostic System Check* before continuing at Step 2.	Go to *Step 2.*
2	Check the MIL or the PC engine data screen. Are any other DTCs set?	–	Go to applicable DTC	Go to *Step 3*
3	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 4*	–
4	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re-test the system	Remove original ECM and reinstall replacement ECM. Go to *Step 5*
5	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–

DIAGNOSTIC TROUBLE CODE (DTC) 61
SYSTEM VOLTAGE LOW

Circuit Description

The ECM monitors the system voltage through circuit 361, Red, terminal K1 (power feed) and circuit 37, Yellow, terminal F2 (battery feed). DTC 61 will set whenever the ECM detects a voltage that is below a calibrated value.

Conditions for Setting the DTC

- KOER.
- Engine RPM is greater than 700.
- System voltage is less than or equal to 8.0V for at least 2 consecutive seconds.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL).

Conditions for Clearing the DTC (Resetting the MIL)

- The DTC can be cleared from memory by disconnecting the battery for 5 minutes.
- If a personal computer (PC) is connected to the engine, the DTC can be cleared from memory by hitting the "C" key while in the View Sensor Data screen.

Diagnostic Aids

If the DTC sets when an accessory is operated, check for a poor connection or excessive current draw. Excessive current draw can be a result of a short circuit or partial short circuit due to corrosion, moisture or chafed insulation.

DTC 61 – System Voltage Low

Step	Action	Value(s)	Yes	No
1	Are you using a personal computer (PC) to perform this diagnosis?	–	Go to *Diagnostic System Check* before continuing at Step 2.	Go to *Step 2.*
2	Using a DVOM, measure the battery voltage at the battery. Is the battery voltage greater than the specified value?	11.5V	Go to *Step 3*	Charge the battery, then go to *Step 3*
3	1. Ignition OFF. 2. Disconnect the ECM connector A thru K. 3. With a DVOM, measure the battery voltage at the ECM connector, terminal F2. Is it approximately equal to the battery voltage?	–	Go to *Diagnostic Aids*	Go to *Step 4*
4	Check for faulty connections at the ECM harness terminals and repair if necessary. Was a repair necessary?	–	Re-test the system	Go to *Step 5*
5	Check for an open battery feed circuit 37, Yellow to the ECM and repair if necessary. Was a repair necessary?	–	Re-test the system	Go to *Step 6*

DTC 61 – System Voltage Low (Cont'd)

Step	Action	Value(s)	Yes	No
6	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 7*	–
7	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re-test the system	Remove original ECM and reinstall replacement ECM. Go to *Step 8*
8	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–

DIAGNOSTIC TROUBLE CODE (DTC) 62
SYSTEM VOLTAGE HIGH

Circuit Description

The ECM monitors the system voltage through circuit 361, Red, terminal K1 (power feed) and circuit 37, Yellow, terminal F2 (battery feed). DTC 62 will set whenever the ECM detects a voltage that is above a calibrated value.

Conditions for Setting the DTC

- KOER.
- Engine RPM is greater than 700.
- System voltage is greater than or equal to 18.0V for at least 2 consecutive seconds.

Action Taken When the DTC Sets

- The ECM will illuminate the malfunction indicator lamp (MIL).

Conditions for Clearing the DTC (Resetting the MIL)

- The DTC can be cleared from memory by disconnecting the battery for 5 minutes.
- If a personal computer (PC) is connected to the engine, the DTC can be cleared from memory by hitting the "C" key while in the View Sensor Data screen.

Diagnostic Aids

If the DTC sets when an accessory is operated, check for a poor connection or excessive current draw. Excessive current draw can be a result of a short circuit or partial short circuit due to corrosion, moisture or chafed insulation.

DTC 62 – System Voltage High

Step	Action	Value(s)	Yes	No
1	Are you using a personal computer (PC) to perform this diagnosis?	–	Go to *Diagnostic System Check* before continuing at Step 2.	Go to *Step 2.*
2	Using a DVOM, measure the battery voltage at the battery. Is the battery voltage less than the specified value?	11.5V	Go to *Step 3*	Go to *Step 4*
3	1. Charge the battery and clean the battery terminals. 2. Clean the battery ground cable connection if corrosion is indicated. Is the battery voltage less than the specified value.	11.5V	Replace battery	Go to *Step 4*
4.	1. Turn off all electrical accessories, if applicable. 2. Start the engine. Is the ignition voltage more than 2.5 volts greater that the measurement taken in step 3?	–	Verify that the alternator is functioning correctly.	Go to *Step 5*
5	Install replacement ECM. Is system operation normal with replacement ECM installed?	–	Remove replacement ECM and install original ECM. Go to *Step 6*	–
6	Is the repair complete (system operation normal with original ECM reinstalled)?	–	Keep original ECM installed. Re-test the system	Remove original ECM and reinstall replacement ECM. Go to *Step 7*
7	Is the repair complete (system operation normal with replacement ECM reinstalled)?	–	Leave replacement ECM installed. Re-test the system	–

SYMPTOM DIAGNOSIS

PRELIMINARY CHECKS

Before using this section, perform the MIL DTC Retrieval Procedure and verify all of the following items:

- The engine control module (ECM) and the malfunction indicator lamp are operating correctly.
- There are no DTC(s) stored.

Verify the customer complaint and refer to the appropriate symptom chart. Perform the procedure included in the symptom chart.

Visual/Physical Check

Several of the symptom procedures call for a careful visual/physical check. This can often lead to repairing a problem without performing unnecessary steps. Use the following guidelines when performing a visual/physical check:

Inspect unit for modifications or aftermarket equipment that can contribute to symptom, verify that all electrical and mechanical loads or accessory equipment is "OFF" or disconnected before performing diagnosis.

- Inspect engine fluids for correct levels and evidence of leaks.
- Inspect vacuum hoses for damage, leaks, cracks, kinks and proper routing, inspect intake manifold sealing surface for a possible vacuum leak.
- Inspect PCV valve for proper installation and operation.
- Inspect all wires and harnesses for proper connections and routing, bent or broken connector pins, burned, chafed, or pinched wires, corrosion, and verify harness grounds are clean and tight.
- Inspect engine control module (ECM), sensors and actuators for physical damage.
- Inspect ECM grounds for cleanliness, tightness and proper location.
- Inspect fuel system for adequate fuel level, and fuel quality (concerns such as proper octane, contamination, winter/summer blend).
- Inspect intake air system and air filter for restrictions.
- Inspect battery condition and starter current draw.

Intermittent Problems

Important: An intermittent problem may or may not turn on the malfunction indicator lamp (MIL) or store a DTC. Do not use the Diagnostic Trouble Code (DTC) charts for intermittent problems. The fault must be present to locate the problem.

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

- Poor mating of the connector halves or a terminal not fully seated in the connector (backed out).
- Improperly formed or damaged terminals.
- Improper contact tension. All connector terminals in the problem circuit should be carefully checked.
- Poor terminal-to-wire connections. This requires removing the terminal from the connector body to check.
- Improperly installed aftermarket equipment or accessories.

Operate the engine with accessories "OFF" and a suitable multimeter connected to the suspected circuit. An abnormal voltage when the malfunction occurs is a good indication that there is a fault in the circuit being monitored.

To check ECM for loss of diagnostic code memory, disconnect the MAP sensor connector and idle the engine until the MIL illuminates. Perform MIL DTC Retrieval Procedure. DTC 14 should be stored and kept in memory when the ignition is turned "OFF". If not, the ECM is faulty. When this test is completed, make sure that you clear DTC 14 from memory. An intermittent MIL with no stored DTC(s) may be caused by the following:

- DIS ignition coil shorted to ground and arcing at ignition wires or plugs.
- MIL circuit to ECM shorted to ground.
- Poor ECM grounds.

HARD START SYMPTOM

Step	Action	Value(s)	Yes	No
DEFINITION: Engine cranks, but does not start for a long time. Does eventually run, or may start but immediately stalls.				
1	Was a visual/physical check performed?	–	Go to Step 2	Go to *Visual/Physical Check*
2	Perform MIL DTC retrieval procedure. Ignition "ON", engine not running, short STI connector to ground. Do any fault codes flash and display?	–	Refer to DTC chart, perform component and circuit test as required.	Go to *Step 3*
3	Check engine coolant temperature (ECT) sensor for shift in value. 1. Measure the engine coolant temperature and note the value. 2. Check the resistance of the engine coolant temperature sensor. 3. Refer to Temperature vs. Resistance chart for resistance specifications. Is the actual resistance near the resistance value in the chart for the temperature that was noted?	–	Go to *Step 5*	Go to *Step 4*
4	Replace the ECT sensor. Is the action complete?	–	Verify repair	Go to *Step 5*
5	Locate and repair high resistance or improper connection in the ECT signal circuit or the ECM grounds. Was a problem found?	–	Verify repair	Go to *Step 6*
6	Check for a faulty, plugged, or incorrectly installed PCV valve. Was a problem found?	–	Verify repair	Go to *Step 7*
7	Inspect the secondary ignition wires. Check for the following conditions: • Verify that the resistance of all ignition wires is less than the specified value. • Verify that ignition wires are correctly routed to eliminate cross-firing. • Verify that ignition wires are not arcing to ground. Spraying the secondary ignition wires with a light mist of water may help locate an intermittent problem (key "ON", engine running). Was a problem found?	9,000-16,000 ohms	Verify repair	Go to *Step 8*
8	Check for proper ignition voltage output with a suitable spark tester. Was a problem found?	–	Verify repair	Go to *Step 9*
9	1. Remove the spark plugs and check for gas or oil fouling, cracks, wear, improper gap, burned electrodes or heavy deposits. 2. If spark plugs are fouled, the cause of fouling must be determined before replacing the spark plugs. Was a problem found?	–	Verify repair	Go to *Step 10*
10	Check the ECM grounds to verify that they are clean and tight. (Refer to the ECM wiring diagram.) Was a problem found?	–	Verify repair	Go to *Step 11*

Hard Start Symptom (Cont'd)

Step	Action	Value(s)	Yes	No
11	1. Check the ignition coil secondary resistance. 2. Replace the coil if it is not within the specified range of resistance. Did the coil require replacement?	9,000-16,000 ohms	Verify repair	Go to *Step 12*
12	Check the electronic governor operation including the TPS function. (Refer to "Auxiliary Systems" in the LRG-425 2.5L Industrial Engine Service Manual.) Was a problem found?	–	Verify repair	Go to *Step 13*
13	Check for water or alcohol contaminated fuel. Was a problem found?	–	Verify repair	Go to *Step 14*
14	Inspect the fuel delivery system to determined if there is a problem with fuel delivery. Was a problem found?	–	Verify repair	Go to *Step 15*
15	Check for the following engine mechanical problems (refer to the LRG-425 2.5L Industrial Engine Service Manual): • Low compression • Leaking cylinder head gasket • Worn camshaft • Camshaft drive belt slipped or stripped. Was a problem found?	–	Verify repair	Go to *Step 16*
16	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection, including fuel quality check • All electrical connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. Was a problem found?	–	Verify repair	Contact Ford Power Products Customer Service Center Technical support Hotline

ENGINE SURGES SYMPTOM

Step	Action	Value(s)	Yes	No
DEFINITION: Engine power variation under steady throttle setting. Feels like the engine speeds up and slows down with no change in the governor switch or throttle position.				
1	Was a visual/physical check performed?	–	Go to *Step 2*	Go to *Visual/Physical Check*
2	Perform MIL DTC retrieval procedure. Ignition "ON", engine not running, short STI connector to ground. Do any fault codes flash and display?	–	Refer to DTC chart, perform component and circuit test as required.	Go to *Step 3*
3	Check the heated oxygen sensor (HO2S) operation. • The HO2S should respond quickly to different throttle positions. If it doesn't, check for silicone or other contaminants from fuel or use of improper RTV sealant. The sensor may have a white powdery coating. Silicone contamination sends a rich exhaust signal which causes the ECM to command an excessively lean air/fuel mixture. Was a problem found?	–	Verify repair	Go to *Step 4*
4	Inspect the fuel delivery system to determine if there is a problem with fuel delivery. Was a problem found?	–	Verify repair	Go to *Step 5*
5	Check electronic governor operation including throttle position sensor function. (Refer to "Auxiliary Systems"in the LRG-425 2.5L Industrial Engine Service Manual.) Was a problem found?	–	Verify repair	Go to *Step 6*
6	Check items that can cause an engine to run rich. (Refer to DTC 42) Was a problem found?	–	Verify repair	Go to *Step 7*
7	Check items that can cause the engine to run lean. (Refer to DTC 32.) Was a problem found?	–	Verify repair	Go to *Step 8*
8	Check for proper ignition voltage output with a suitable spark tester. Was a problem found?	–	Verify repair	Go to *Step 9*
9	Check the ECM grounds to verify that they are clean and tight. Refer to the ECM wiring diagram. Was a problem found?	–	Verify repair	Go to *Step 10*
10	Inspect the secondary ignition wires. Check for the following conditions: • Verify that the resistance of all ignition wires is less than the specified value. • Verify that ignition wires are correctly routed to eliminate cross-firing. • Verify that ignition wires are not arcing to ground. Spraying the secondary ignition wires with a light mist of water may help locate an intermittent problem (key "ON", engine running). Was a problem found?	30,000 ohms	Verify repair	Go to *Step 11*

Engine Surges Symptom (cont'd)

Step	Action	Value(s)	Yes	No
11	1. Check the ignition coil secondary resistance. 2. Replace the coil if it is not within the specified value. Did the coil require replacement?	9,000-12,000 ohms	Verify repair	Go to *Step 12*
12	1. Remove the spark plugs and check for gas or oil fouling, cracks, wear, improper gap, burned electrodes, heavy deposits or improper heat range. 2. If spark plugs are fouled, the cause of fouling must be determined before replacing the spark plugs. Was a problem found?	–	Verify repair	Go to *Step 13*
13	1. Check the injector connectors. 2. If any of the connectors are connected at an improper cylinder, correct as necessary. Was a problem found?	–	Verify repair	Go to *Step 14*
14	Visually/physically check vacuum hoses for splits, kinks, and proper connections and routing. Was a problem found?	–	Verify repair	Go to *Step 15*
15	Check the exhaust system for a possible restriction: • Damaged or collapsed pipe • Internal muffler failure. Was a problem found?	–	Verify repair	Go to *Step 16*
16	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection, including fuel quality check • All electrical connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. Was a problem found?	–	Verify repair	Contact Ford Power Products Customer Service Center Technical Support Hotline

LACK OF POWER OR SLUGGISH SYMPTOM

Step	Action	Value(s)	Yes	No
DEFINITION: Engine delivers less than expected power. Little or no increase in speed when throttle position is increased.				
1	Was a visual/physical check performed?	–	Go to *Step 2*	Go to *Visual/Physical Check*
2	1. Remove and check air filter element for dirt or restrictions. 2. Replace the air filter element if necessary. Was a repair required?	–	Verify repair	Go to *Step 3*
3	Perform MIL DTC retrieval procedure. • Ignition "ON", engine not running, short STI connector to ground. Do any fault codes flash and display?	–	Refer to DTC chart, perform component and circuit test as required.	Go to *Step 4*
4	Check for proper ignition voltage output with a suitable spark tester. Was a problem found?	–	Verify repair	Go to *Step 5*
5	1. Remove the spark plugs and check for gas or oil fouling, cracks, wear, improper gap, burned electrodes, heavy deposits or improper heat range. 2. If spark plugs are fouled, the cause of fouling must be determined before replacing the spark plugs. Was a problem found?	–	Verify repair	Go to *Step 6*
6	Inspect the fuel delivery system to determine if there is a problem with fuel delivery. Was a problem found?	–	Verify repair	Go to *Step 7*
7	Check for water or alcohol contaminated fuel. Was a problem found?	–	Verify repair	Go to *Step 8*
8	Check the ECM grounds to verify that they are clean and tight. (Refer to the ECM wiring diagram.) Was a problem found?	–	Verify repair	Go to *Step 9*
9	Check the exhaust system for a possible restriction: • Damaged or collapsed pipe • Internal muffler failure Was a problem found?	–	Verify repair	Go to *Step 10*

Lack of Power or Sluggish Symptom (cont'd)

Step	Action	Value(s)	Yes	No
10	Check for the following engine mechanical problems (refer to the LRG-425 2.5L Industrial Engine Service Manual): • Low compression • Leaking cylinder head gasket • Worn camshaft • Camshaft drive belt slipped or stripped Was a problem found?	—	Verify repair	Go to *Step 11*
11	1. Review all the diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection, including fuel quality check. • All electrical connections within a suspected circuit and/or system. Was a problem found?	—	Verify repair	Contact Ford Power Products Customer Service Center Technical Support Hotline

DETONATION/SPARK KNOCK SYMPTOM

Step	Action	Value(s)	Yes	No
DEFINITION: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening.				
1	Was a visual/physical check performed?	–	Go to *Step 2*	Go to *Visual/Physical Check*
2	Perform MIL DTC retrieval procedure: Ignition "ON", engine not running, short STI connector to ground. Do any fault codes flash and display?	–	Refer to DTC chart, perform component and circuit test as required.	Go to Step 3
3	1. If no fault codes display from MIL light and there are no engine mechanical faults, fill the fuel tank with a known quality gasoline that has a minimum octane rating of 87. 2. Re-evaluate the engine performance. Is detonation present?	–	Go to *Step 4*	Verify repair
4	Check for obvious overheating problems: • Low engine coolant. • Restricted air flow to radiator, or restricted water flow through radiator. • Incorrect coolant solution. It should be a 50/50 mix of approved antifreeze/water. If a problem is found, repair as necessary. Was a problem found?	–	Verify repair	Go to *Step 5*
5	Inspect the fuel delivery system to determine if there is a problem with fuel delivery. Was a problem found?	–	Verify repair	Go to *Step 6*
6	Check items that can cause an engine to run lean. (Refer to DTC 32.) Was a problem found?	–	Verify repair	Go to *Step 7*
7	Check spark plugs for proper heat range. (Refer to the LRG-425 2.5L Industrial Engine Service Manual.)	–	Verify repair	Go to *Step 8*
8	1. Remove excessive carbon buildup with a top engine cleaner. Refer to instructions on the top engine cleaner can. 2. Re-evaluate engine performance. Is detonation still present?	–	Go to *Step 9*	Verify repair
9	Check for an engine mechanical problem. Perform a cylinder compression check. (Refer to the LRG-425 2.5L Industrial Engine Service Manual.) Was a problem found?	–	Verify repair	Go to *Step 10*
10	1. Review all the diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection, including fuel quality check • All electrical connections within a suspected circuit and/or system Was a problem found?	–	Verify repair	Contact Ford Power Products Customer Service Center Technical Support Hotline

ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING SYMPTOM

Step	Action	Value(s)	Yes	No
DEFINITION: Engine runs unevenly at idle. If severe, the engine may shake. Engine idle speed may vary in RPM. Either condition may be severe enough to stall the engine.				
1	Check for rough, unstable or incorrect idle, or stalling condition. Ensure that the following conditions are present: • Engine fully warm • Accessories are "OFF". Does engine run rough, idle fluctuate, or stall?	–	Go to *Step 2*	–
2	Perform a visual/physical check, including ignition coil and secondary ignition wire connections. Was a problem found?	–	Verify repair	Go to *Step 3*
3	Perform MIL DTC retrieval procedure: Ignition "ON", engine not running, short STI connector to ground. Do any fault codes flash and display?	–	Refer to DTC chart, perform component and circuit test as required.	Go to *Step 4*
4	Check the heated oxygen sensor (HO2S) operation: The HO2S should respond quickly to different throttle positions. If it doesn't, check for silicone or other contaminants from fuel or use of improper RTV sealant. The sensor may have a white powdery coating. Silicone contamination sends a rich exhaust signal which causes the ECM to command an excessively lean air/fuel mixture. Was a problem found?	–	Verify repair	Go to *Step 5*
5	Inspect the fuel delivery system to determine if there is a problem with fuel delivery. Was a problem found?	–	Verify repair	Go to *Step 6*
6	Inspect the secondary ignition wires. Check for the following conditions: • Verify that the resistance of all ignition wires is less than the specified value. • Verify that ignition wires are correctly routed to eliminate cross-firing. • Verify that ignition wires are not arcing to ground. Spraying the secondary ignition wires with a light mist of water may help locate an intermittent problem (key "ON", engine running). Was a problem found?	9,000-16,000 ohms	Verify repair	Go to *Step 7*
7	Check for proper ignition voltage output with a suitable spark tester. Was a problem found?	–	Verify repair	Go to *Step 8*
8	1. Check ignition coil secondary resistance. 2. Replace the coil if it is not within the specified value. Did the coil require replacement?	9,000-16,000 ohms	Verify repair	Go to *Step 9*
9	1. Remove the spark plugs and check for gas or oil fouling, cracks, wear, improper gap, burned electrodes or heavy deposits. 2. If spark plugs are fouled, the cause of fouling must be determined before replacing the spark plugs. Was a problem found?	–	Verify repair	Go to *Step 10*

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

Step	Action	Value(s)	Yes	No
10	Check the ECM grounds to verify that they are clean and tight. (Refer to the ECM wiring diagram.) Was a problem found?	–	Verify repair	Go to *Step 11*
11	Check the items that can cause the engine to run rich. (Refer to DTC 42.) Was a problem found?	–	Verify repair	Go to *Step 12*
12	Check items that can cause the engine to run lean. (Refer to DTC 32.) Was a problem found?	–	Verify repair	Go to *Step 13*
13	Check the injector connections. If any of the injector connections are connected to an incorrect cylinder, correct as necessary. Was a problem found?	–	Verify repair	Go to *Step 14*
14	Visually/physically check the vacuum hoses for splits, kinks, and proper connections and routing. Was a problem found?	–	Verify repair	Go to *Step 15*
15	Check the exhaust system for a possible restriction: • Damaged or collapsed pipe • Internal muffler failure. Was a problem found?	–	Verify repair	Go to *Step 16*
16	Check for a faulty, plugged, or incorrectly installed PCV valve. Was a problem found?	–	Verify repair	Go to *Step 17*
17	Check the following engine mechanical problems (refer to the LRG-425 2.5L Industrial Engine Service Manual): • Low compression • Leaking cylinder head gasket • Worn camshaft • Sticking or leaking valves • Valve timing • Broken valve springs • Camshaft drive belt slipped or stripped. Was a problem found?	–	Verify repair	Go to *Step 18*
18	1. Check for faulty motor mounts. (Refer to the LRG-425 2.5L Industrial Engine Service Manual.) 2. If a problem is found, repair as necessary. Was a problem found?	–	Verify repair	Go to *Step 19*
19	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection, including fuel quality check • All electrical connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. Was a problem found?	–	Verify repair	Contact Ford Power Products Customer Service Center Technical Support Hotline

EXCESSIVE FUEL CONSUMPTION SYMPTOM

Step	Action	Value(s)	Yes	No
DEFINITION: Fuel economy is noticeably lower than expected. Also, economy is noticeably lower than it was at one time previously.				
1	Was a visual/physical check performed?	–	Go to *Step 2*	Go to *Visual/Physical Check*
2	Perform MIL DTC retrieval procedure: Ignition "ON", engine not running, short STI connector to ground. Do any fault codes flash and display?	–	Refer to DTC chart, perform component and circuit test as required.	Go to *Step 3*
3	Visually/physically check: Vacuum hoses for splits, kinks, and improper connections and routing. Was a problem found?	–	Verify repair	Go to *Step 4*
4	Remove and check the air filter element for dirt or restrictions. Was a problem found?	–	Verify repair	Go to *Step 5*
5	1. Remove the spark plugs and check for gas or oil fouling, cracks, wear, improper gap, burned electrodes, or heavy deposits. 2. If spark plugs are fouled, the cause of fouling must be determined before replacing the spark plugs. Was a problem found?	–	Verify repair	Go to *Step 6*
6	Check for low engine coolant level. Was a problem found?	–	Verify repair	Go to *Step 7*
7	Check for an incorrect or faulty engine thermostat. (Refer to the LRG-425 2.5L Industrial Engine Service Manual.)	–	Verify repair	Go to *Step 8*
8	Check for low engine compression. (Refer to the LRG-425 2.5L Industrial Engine Service Manual.) Was a problem found?	–	Verify repair	Go to *Step 9*
9	Check for excessive exhaust system back-pressure. Possible problems could be: • Damaged or collapsed pipe • Internal muffler failure. Was a problem found?	–	Verify repair	Go to *Step 10*
10	Check the air intake system and the crankcase for air leaks. Was a problem found?	–	Verify repair	Go to *Step 11*
11	1. Review all the diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection, including fuel quality check • All connections within a suspected circuit and/or system. Was a problem found?	–	Verify repair	Contact Ford Power Products Customer Service Center Technical Support Hotline

DIESELING, RUN-ON SYMPTOM

Step	Action	Value(s)	Yes	No
DEFINITION: Engine continues to run after key is turned "OFF", but runs very rough. If engine runs smoothly, check the ignition switch and adjustment.				
1	Was a visual/physical check performed?	–	Go to *Step 2*	Go to Visual/Physical Check
2	Perform MIL DTC retrieval procedure: Ignition "ON", engine not running, short STI connector to ground. Do any fault codes flash and display?	–	Refer to DTC chart, perform component and circuit test as required.	Go to *Step 3*
3	Check for a short between B+ and the ignition feed circuit. Was a problem found?	–	Verify repair	Go to *Step 4*
4	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection, including fuel quality check. • All electrical connections within a suspected circuit and/or system. Was a problem found?	–	Verify repair	Contact Ford Power Products Customer Service Center Technical Support Hotline

BACKFIRE SYMPTOM

Step	Action	Value(s)	Yes	No
DEFINITION: Fuel ignites in the intake manifold, or in the exhaust system, making a loud popping noise.				
1	Was a visual/physical check performed?	–	Go to Step 2	Go to Visual/ Physical Check
2	Perform MIL DTC retrieval procedure: Ignition "ON", engine not running, short STI connector to ground. Do any fault codes flash and display?	–	Refer to DTC chart, perform component and circuit test as required.	Go to *Step 3*
3	Check for proper ignition voltage output with a suitable spark tester. Was a problem found?	–	Verify repair	Go to *Step 4*
4	1. Remove the spark plugs and check for gas or oil fouling, cracks, wear, improper gap, burned electrodes or heavy deposits. 2. If spark plugs are fouled, the cause of fouling must be determined before replacing the spark plugs. Was a problem found?	–	Verify repair	Go to *Step 5*
5	Inspect the secondary ignition wires. Check for the following conditions: • Verify that the resistance of all ignition wires is less than the specified value. • Verify that ignition wires are correctly routed to eliminate cross-firing. • Verify that ignition wires are not arcing to ground. spraying the secondary ignition wires with a light mist of water may help locate an intermittent problem (Ignition "ON", engine running). Was a problem found?	–	Verify repair	Go to *Step 6*
6	Check for an intermittent ignition system malfunction: • Intermittent crankshaft position sensor signal. • Intermittent ignition feed circuit or sensor ground circuit to the crankshaft position sensor. Was a problem found?	–	Verify repair	Go to *Step 7*
7	Inspect the fuel delivery system to determined if there is a problem with fuel delivery. Was a problem found?	–	Verify repair	Go to *Step 8*
8	Check for the following engine mechanical problems (refer to the LRG-425 2.5L Industrial Engine Service Manual): • Low compression • Leaking cylinder head gasket • Worn camshaft • Incorrect valve timing • Sticking or leaking valves • Camshaft drive belt slipped or stripped. Was a problem found?	–	Verify repair	Go to *Step 9*

Backfire Symptom (Cont'd)

Step	Action	Value(s)	Yes	No
9	Check the intake and exhaust manifold(s) for casting flash. (Refer to the LRG 425 2.5L Industrial Engine Service Manual.) Was a problem found?	–	Verify repair	Go to *Step 10*
10	1. Review all the diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection, including fuel quality check • All electrical connections within a suspected circuit and/or system Was a problem found?	–	Verify repair	Contact Ford Power Products Customer Service Center Technical Support Hotline

HESITATION, SAG, STUMBLE SYMPTOM

Step	Action	Value(s)	Yes	No
DEFINITION: Momentary lack of response as the throttle is opened. Can occur at any engine speed. Usually most pronounced when first trying to accelerate the engine. May cause the engine to stall if severe enough.				
1	Was a visual/physical check performed?	–	Go to *Step 2*	Go to *Visual/Physical Check*
2	Perform MIL DTC retrieval procedure: Ignition "ON", engine not running, short STI connector to ground. Do any fault codes flash and display?	–	Refer to DTC chart, perform component and circuit test as required.	Go to *Step 3*
3	Check the heated oxygen sensor (HO2S) operation: The HO2S should respond quickly to different throttle positions. If it doesn't, check for silicone or other contaminants from fuel or use of improper RTV sealant. The sensor may have a white powdery coating. Silicone contamination sends a rich exhaust signal which causes the ECM to command an excessively lean air/fuel mixture. Was a problem found?	–	Verify repair	Go to *Step 4*
4	Inspect the fuel delivery system to determine if there is a problem with fuel delivery. Was a problem found?	–	Verify repair	Go to *Step 5*
5	Check electronic governor operation including throttle position sensor function. (Refer to "Auxiliary Systems" in the LRG-425 2.5L Industrial Engine Service Manual) Was a problem found?	–	Verify repair	Go to *Step 6*
6	Check items that can cause an engine to run rich. (Refer to DTC 42.) Was a problem found?	–	Verify repair	Go to *Step 7*
7	Check items that can cause the engine to run lean. (Refer to DTC 32.) Was a problem found?	–	Verify repair	Go to *Step 8*
8	Check for proper ignition voltage output with a suitable spark tester. Was a problem found?	–	Verify repair	Go to *Step 9*
9	Inspect the secondary ignition wires. Check for the following conditions: • Verify that the resistance of all ignition wires is less than the specified value. • Verify that ignition wires are correctly routed to eliminate cross-firing. • Verify that ignition wires are not arcing to ground. Spraying the secondary ignition wires with a light mist of water may help locate an intermittent problem (key "ON", engine running). Was a problem found?	30,000 ohms	Verify repair	Go to *Step 10*

Hesitation, Sag, Stumble Symptom (Cont'd)

Step	Action	Value(s)	Yes	No
10	1. Check the ignition coil secondary resistance. 2. Replace the coil if it is not within the specified value. Did the coil require replacement?	9,000-12,000 ohms	Verify repair	Go to *Step 11*
11	1. Remove the spark plugs and check for gas or oil fouling, cracks, wear, improper gap, burned electrodes or heavy deposits. 2. If spark plugs are fouled, the cause of fouling must be determined before replacing the spark plugs. Was a problem found?	—	Verify repair	Go to *Step 12*
12	Check the ECM grounds to verify that they are clean and tight. Refer to the ECM wiring diagram. Was a problem found?	—	Verify repair	Go to *Step 13*
13	Visually/physically check vacuum hoses for splits, kinks, and proper connections and routing. Was a problem found?	—	Verify repair	Go to *Step 14*
14	Check for a faulty, plugged, or incorrectly installed PCV valve. Was a problem found?	—	Verify repair	Go to *Step 15*
15	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection, including fuel quality check • All electrical connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. Was a problem found?	—	Verify repair	Contact Ford Power Products Customer Service Center Technical Support Hotline

CUTS OUT, MISSES SYMPTOM

Step	Action	Value(s)	Yes	No
DEFINITION: Steady pulsation or jerking that follows engine speed; usually more pronounced as engine load increases.				
1	Check for incorrect idle speed. Ensure that the following conditions are present: • Engine fully warm • Accessories are "OFF". Does engine cut out or miss?	–	Go to *Step 2*	–
2	Perform a visual/physical check, including ignition coil and secondary ignition wire connections. Was a problem found?	–	Verify repair	Go to *Step 3*
3	Perform MIL DTC retrieval procedure: Ignition "ON", engine not running, short STI connector to ground. Do any fault codes flash and display?	–	Refer to DTC chart, perform component and circuit test as required.	Go to *Step 4*
4	Check the heated oxygen sensor (HO2S) operation: The HO2S should respond quickly to different throttle positions. If it doesn't, check for silicone or other contaminants from fuel or use of improper RTV sealant. The sensor may have a white powdery coating. Silicone contamination sends a rich exhaust signal which causes the ECM to command an excessively lean air/fuel mixture. Was a problem found?	–	Verify repair	Go to *Step 5*
5	Check the ECM grounds to verify that they are clean and tight. (Refer to the ECM wiring diagram.) Was a problem found?	–	Verify repair	Go to *Step 6*
6	Check the items that can cause the engine to run rich. (Refer to DTC 42.) Was a problem found?	–	Verify repair	Go to *Step 7*
7	Check items that can cause the engine to run lean. (Refer to DTC 32.) Was a problem found?	–	Verify repair	Go to *Step 8*
8	Inspect the fuel delivery system to determine if there is a problem with fuel delivery. Was a problem found?	–	Verify repair	Go to *Step 9*
9	Inspect the secondary ignition wires. Check for the following conditions: • Verify the resistance of all ignition wires is less than the specified value • Verify that ignition wires are correctly routed to eliminate cross-firing • Verify that ignition wires are not arcing to ground. Spraying the secondary ignition wires with a light mist of water may help to locate an intermittent problem (ignition "ON", engine running). Was a problem found?	–	Verify repair	Go to *Step 10*
10	1. Check ignition coil secondary resistance. 2. Replace the coil if it is not within the specified range of resistance. Was a problem found?	9,000-16,000 ohms	Verify repair	Go to *Step 11*

Cuts Out, Misses Symptom (Cont'd)

Step	Action	Value(s)	Yes	No
11	Check for proper ignition voltage output with a suitable spark tester. Was a problem found?	–	Verify repair	Go to *Step 12*
12	Check the injector connections. If any of the injector connections are connected to an incorrect cylinder, correct as necessary. Was a problem found?	–	Verify repair	Go to *Step 13*
13	1. Remove spark plugs and check for gas or oil fouling, cracks, wear, improper gap, burned electrodes or heavy deposits. 2. If spark plugs are fouled, the cause of fouling must be determined before replacing the spark plugs. Was a problem found?	–	Verify repair	Go to *Step 14*
14	Visually/physically check the vacuum hoses for splits, kinks, and improper connections and routing. Was a problem found?	–	Verify repair	Go to *Step 15*
15	Check the exhaust system for a possible restriction: • Damaged or collapsed pipe • Internal muffler failure. Was a problem found?	–	Verify repair	Go to *Step 16*
16	Check for a faulty, plugged, or incorrectly installed PCV valve. Was a problem found?	–	Verify repair	Go to *Step 17*
17	Check the following engine mechanical problems (refer to the LRG-425 2.5l Industrial Engine Service Manual): • Low compression • Leaking cylinder head gasket • Worn camshaft • Sticking or leaking valves • Valve timing • Broken valve springs • Camshaft drive belt slipped or stripped. Was a problem found?	–	Verify repair	Go to *Step 18*
18	1. Check for faulty motor mounts. (Refer to the LRG-425 2.5L Industrial Engine Service Manual.) 2. If a problem is found, repair as necessary. Was a problem found?	–	Verify repair	Go to *Step 19*
19	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection, including fuel quality check. • All electrical connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. Was a problem found?	–	Verify repair	Contact Ford Power Products Customer Service Center Technical Support Hotline

GENERAL DESCRIPTION AND OPERATION

ECM AND SENSORS

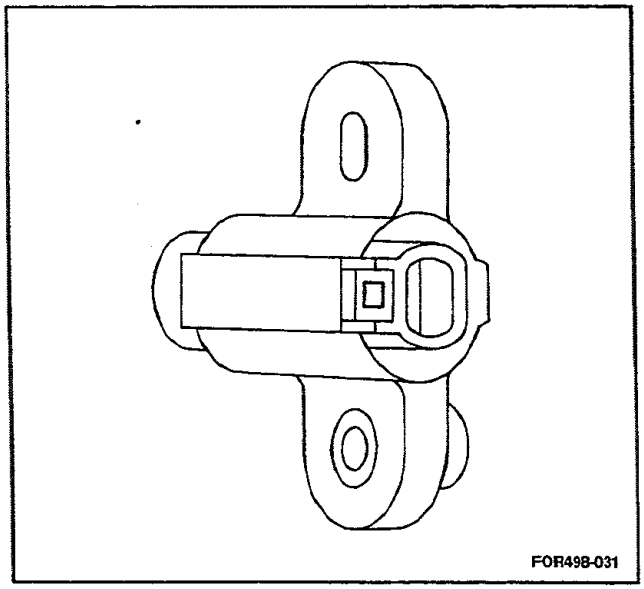
CRANKSHAFT POSITION (CKP) SENSOR

The crankshaft position (CKP) sensor provides a signal used by the engine control module (ECM) to calculate the ignition sequence. The CKP sensor initiates the reference pulses which the ECM uses to calculate RPM and crankshaft position.

CAMSHAFT POSITION (CMP) SENSOR AND SIGNAL

The camshaft position (CMP) sensor sends a CMP signal to the ECM. The ECM uses this signal as a "sync pulse" to trigger the injectors in the proper sequence. The ECM uses the CMP signal to indicate the position of the #1 piston during its power stroke. The CMP uses a Hall Effect sensor to measure piston position. This allows the ECM to calculate true sequential fuel injection (SFI) mode of operation. If the ECM detects an incorrect CMP signal while the engine is running, DTC 53 will set.

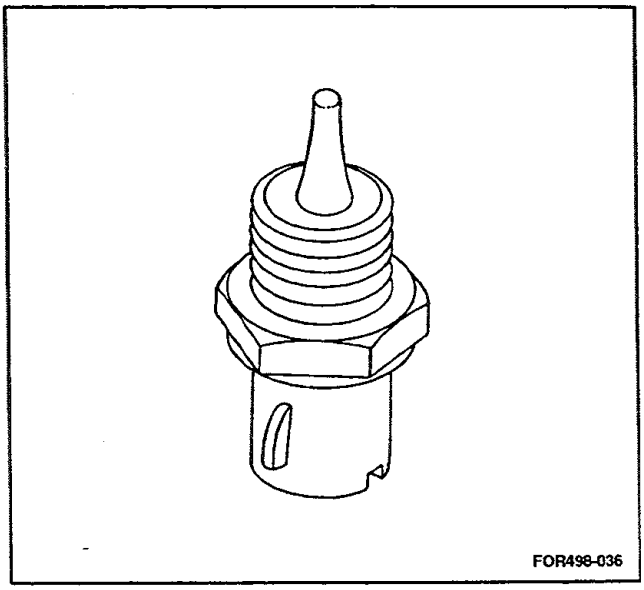
If the CMP signal is lost while the engine is running, the fuel injection system will shift to a calculated sequential fuel injection mode based on the last fuel injection pulse, and the engine will continue to run. As long as the fault is present, the engine can be restarted. It will run in the previously established injection sequence.



ENGINE COOLANT TEMPERATURE (ECT) SENSOR

The engine coolant temperature (ECT) sensor is a thermistor (a resistor which changes value based on temperature) mounted in the engine coolant stream. Low coolant temperature produces a high resistance of 100,000 ohms at −40°C (−40°F). High temperature causes a low resistance of 70 ohms at 130°C (266°F). The ECM supplies a 5-volt signal to the ECT sensor through resistors in the ECM and measures the voltage. The signal voltage will be high when the engine is cold and low when the engine is hot. By measuring the voltage, the ECM calculates the engine coolant temperature. Engine coolant temperature affects most of the systems that the ECM controls.

After engine start-up, the temperature should rise steadily to about 85°C (185°F). It then stabilizes when the thermostat opens. If the engine has not been run for several hours (overnight), the engine coolant temperature and intake air temperature displays should be close to each other. A fault in the engine coolant sensor circuit will set DTC 33 or DTC 43.



ECT SENSOR DATA

Temperature Sensor Characteristics

TEMPERATURE (C)	TEMPERATURE (F)	NOM R, (OHMS)	NOM E_{OUT} (VOLTS)
−40	−40	925,021	4.54
−35	−31	673,787	4.50
−30	−22	496,051	4.46
−25	−13	368,896	4.41
−20	−4	276,959	4.34
−15	5	209,816	4.25
−10	14	160,313	4.15
− 5	23	123,485	4.02
0	32	95,851	3.88
5	41	74,914	3.71
10	50	58,987	3.52
15	59	46,774	3.32
20	68	37,340	3.09
25	77	30,000	2.86
30	86	24,253	2.62
35	95	19,716	2.39
40	104	16,113	2.15
45	113	13,236	1.93
50	122	10,926	1.72
55	131	9,061	1.52
60	140	7,548	1.34
65	149	6,332	1.18
70	158	5,335	1.04
75	167	4,515	.91
80	176	3,837	.79
85	185	3,274	.70
90	194	2,804	.61
95	203	2,411	.53
100	212	2,080	.47
105	221	1,801	.41
110	230	1,564	.36
115	239	1,363	.32
120	248	1,191	.28
125	257	1,044	.25
130	266	918	.22
135	275	809	.19
140	284	715	.17
145	293	633	.15
150	302	563	.14

Voltage values calculated for VREF =5 volts (may vary ±15% due to sensor and VREF variations)

ELECTRICALLY ERASABLE PROGRAMMABLE READ ONLY MEMORY (EEPROM)

The electrically erasable programmable read only memory (EEPROM) is a permanent memory chip that is located within the ECM. The EEPROM contains the program and the calibration information that the ECM needs to control engine operations.

If the ECM is replaced, the new ECM will need to be programmed. An IBM-compatible computer and software containing the correct program and calibration for the application are required to program the ECM.

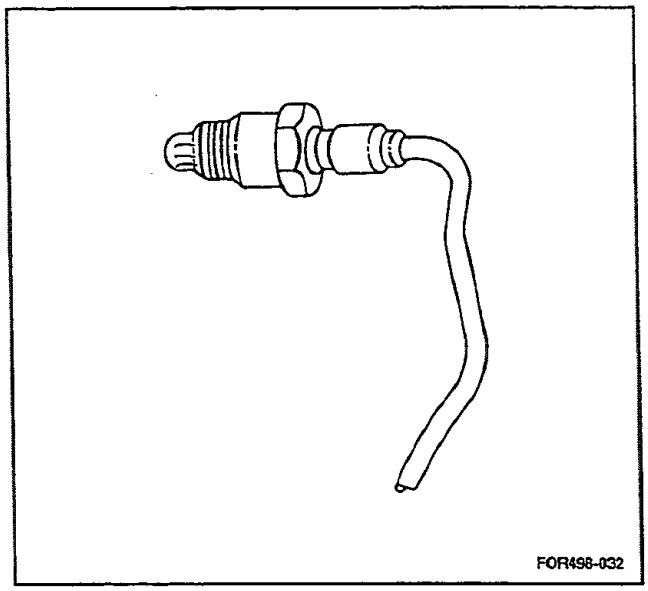
HEATED OXYGEN SENSOR

The heated oxygen sensor is mounted in the exhaust stream where it can monitor the oxygen content of the exhaust gas. The oxygen present in the exhaust gas reacts with the sensor to produce a voltage output. This voltage should constantly fluctuate from approximately 100 mV to 900 mV. The heated oxygen sensor voltage can be monitored on an IBM PC-compatible computer with diagnostic software. By monitoring the voltage output of the oxygen sensor, the ECM calculates the pulse width command for the injectors to produce the proper combustion chamber mixture.

Low HO2S voltage indicates a lean mixture which will result in a rich command to compensate.

High HO2S voltage indicates a rich mixture which will result in a lean command to compensate.

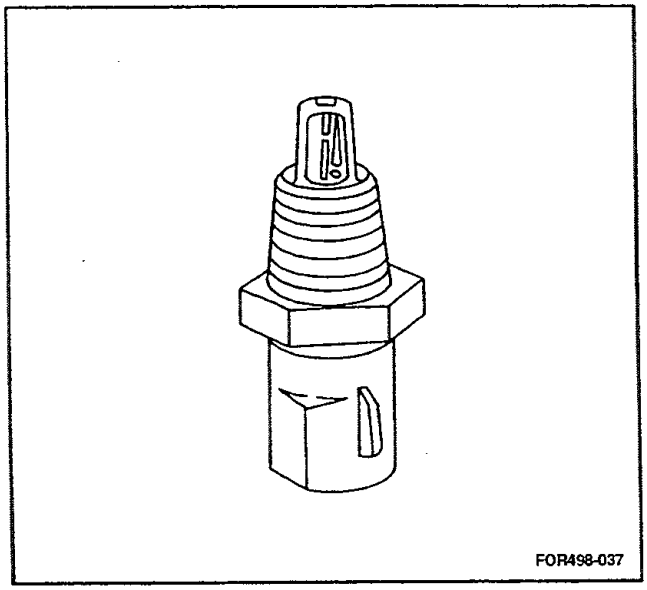
A constant voltage below 200 mV for 10 consecutive seconds will set DTC 32. A constant voltage above 650 mV for 10 consecutive seconds will set DTC 42.



INTAKE AIR TEMPERATURE (IAT) SENSOR

The intake air temperature (IAT) sensor is a thermistor which changes its resistance based on the temperature of air entering the engine. Low temperature produces a high resistance of 100,000 ohms at −40°C (−40°F). High temperature causes a low resistance of 70 ohms at 130°C (266°F). The ECM supplies a 5-volt signal to the sensor through a resistor in the ECM and monitors the signal voltage. The signal voltage will be high when the incoming air is cold and low when the incoming air is hot. By measuring the voltage, the ECM calculates the incoming air temperature. The IAT sensor signal is used to adjust spark timing according to the incoming air density.

An IBM PC-compatible computer with diagnostic software can be used to display the temperature of the air entering the engine. The temperature should read close to the ambient air temperature when the engine is cold, and rise as engine compartment temperature increases. If the engine has not been run for several hours (overnight), the IAT sensor temperature and engine coolant temperature should read close to each other. A failure in the IAT sensor circuit will set DTC 35 or DTC 45.



IAT SENSOR DATA

Temperature Sensor Characteristics

TEMPERATURE (C)	TEMPERATURE (F)	NOM R, (OHMS)	NOM E_{OUT} (VOLTS)
−40	−40	925,021	4.54
−35	−31	673,787	4.50
−30	−22	496,051	4.46
−25	−13	368,896	4.41
−20	−4	276,959	4.34
−15	5	209,816	4.25
−10	14	160,313	4.15
− 5	23	123,485	4.02
0	32	95,851	3.88
5	41	74,914	3.71
10	50	58,987	3.52
15	59	46,774	3.32
20	68	37,340	3.09
25	77	30,000	2.86
30	86	24,253	2.62
35	95	19,716	2.39
40	104	16,113	2.15
45	113	13,236	1.93
50	122	10,926	1.72
55	131	9,061	1.52
60	140	7,548	1.34
65	149	6,332	1.18
70	158	5,335	1.04
75	167	4,515	.91
80	176	3,837	.79
85	185	3,274	.70
90	194	2,804	.61
95	203	2,411	.53
100	212	2,080	.47
105	221	1,801	.41
110	230	1,564	.36
115	239	1,363	.32
120	248	1,191	.28
125	257	1,044	.25
130	266	918	.22
135	275	809	.19
140	284	715	.17
145	293	633	.15
150	302	563	.14

Voltage values calculated for VREF =5 volts (may vary ±15% due to sensor and VREF variations)

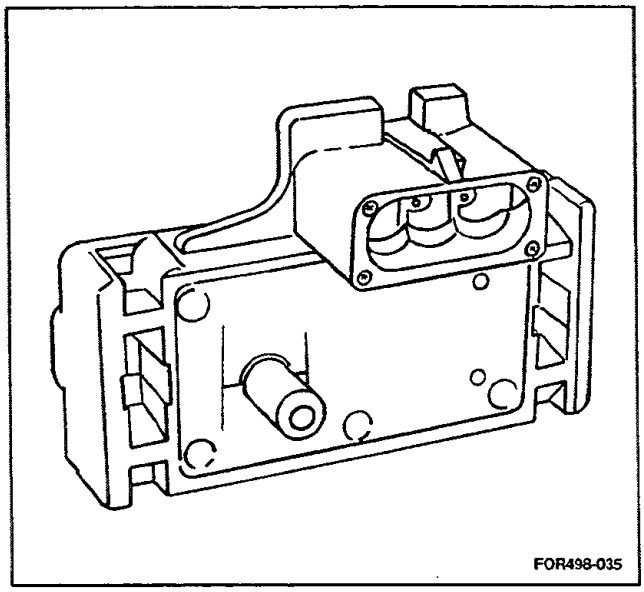
MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The manifold absolute pressure (MAP) sensor responds to changes in intake manifold pressure (vacuum). The MAP sensor signal voltage to the ECM varies from below 2 volts at idle (high vacuum) to above 4 volts with the ignition ON, engine not running or at wide-open throttle (low vacuum).

The MAP sensor is used to determine the following:

- Engine vacuum level for engine control purposes.
- Barometric pressure (BARO).

If the ECM detects a voltage that is significantly lower than the estimated MAP value for 2 or more consecutive seconds, DTC 14 will be set. A signal voltage significantly higher than the estimated MAP value for 2 or more consecutive seconds will set DTC 24.



ENGINE CONTROL MODULE (ECM)

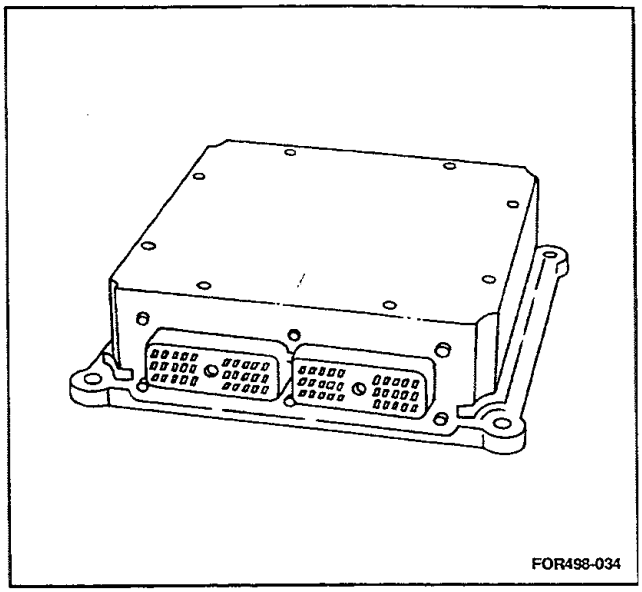
The ECM controls the following:

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

The ECM constantly observes the information from various sensors. The ECM controls the systems that affect engine performance. The ECM performs the diagnostic function of the system. It can recognize operational problems, alert the operator through the Malfunction Indicator Lamp (MIL), and store diagnostic trouble codes (DTCs). DTCs identify the problem areas to aid the technician in making repairs.

The ECM supplies either 5 or 12 volts to power various sensors or switches. The power is supplied through resistances in the ECM which are so high in value that a test light will not light when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give an accurate reading because its resistance is too low. Therefore, a digital voltmeter with at least 10 megohms input impedance is required to ensure accurate voltage readings. The ECM controls output circuits such as the fuel injectors, electronic governor, etc., by controlling the ground or the power feed circuit through transistors or other solid state devices.

The ECM is designed to maintain exhaust emission levels to government mandated standards while providing excellent operation and fuel efficiency. The ECM monitors numerous engine functions via electronic sensors such as the throttle position (TP) sensor and the heated oxygen sensor (HO2S).



ECM INPUTS/OUTPUTS

Inputs – Operating Conditions Read

- Engine Coolant Temperature
- Crankshaft Position
- Exhaust Oxygen Content
- Manifold Absolute Pressure
- Battery Voltage
- Throttle Position
- Fuel Pump Voltage
- Intake Air Temperature
- Camshaft Position

Outputs – System Controlled

- Fuel Control
- Idle Air Control
- Electric Fuel Pump
- Diagnostics:
  - Malfunction Indicator Lamp (Check Engine lamp)
  - Data Link Connector (DLC)

ECM SERVICE PRECAUTIONS

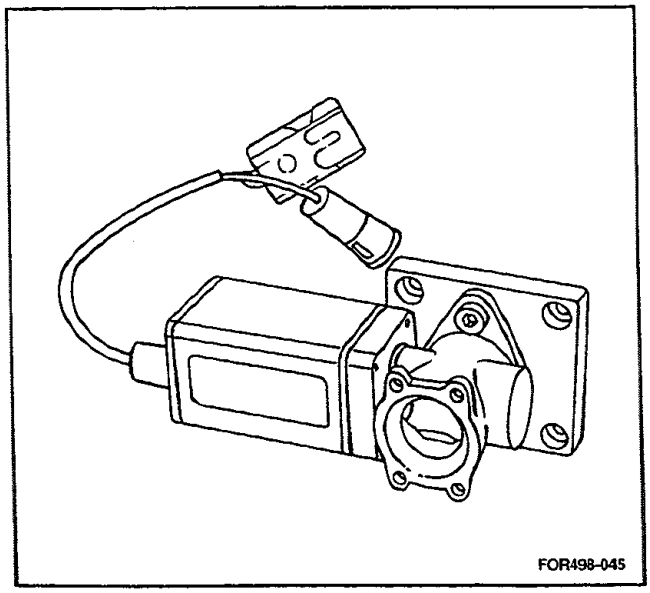
The ECM is designed to withstand normal current draws associated with engine operation. When servicing the ECM, observe the following guidelines:

- Do not overload any circuit.
- When testing for opens and shorts, do not ground or apply voltage to any of the ECM's circuits unless instructed to do so.
- When measuring voltages, use only a digital voltmeter with an input impedance of at least 10 megohms.
- Do not employ any non-standard practices such as charging the battery with an arc welder.
- Take proper precautions to avoid static damage to the ECM. Refer to "Electrostatic Discharge Damage" for more information.

THROTTLE POSITION (TP) SENSOR

The throttle position (TP) sensor is a potentiometer connected to the throttle shaft on the throttle body which is built into the electronic governor. The ECM monitors the voltage on the signal line and calculates throttle position. As the throttle valve angle is changed, the TP sensor signal also changes. At a closed throttle position, the output of the TP sensor is low. As the throttle valve opens, the output increases so that at wide open throttle (WOT), the output voltage should be above 4 volts.

The ECM calculates fuel delivery based on throttle valve angle (operator demand). A broken or loose TP sensor may cause intermittent bursts of fuel from an injector and unstable idle because the ECM thinks the throttle is moving. A hard failure in the TP sensor 5-Volt reference or signal circuits for greater than 2 consecutive seconds will set either a DTC 12 or DTC 22. A hard failure with the TP sensor ground circuit for more than two consecutive seconds may set DTC 22. If either DTC 12 or DTC 22 are set, the throttle will be forced to a 6% (idle) position.



USE OF CIRCUIT TESTING TOOLS

Do not use a test light to diagnose the engine electrical systems unless specifically instructed by the diagnostic procedures. A test light can put an excessive load on an ECM circuit and result in component damage. For voltage measurements, use only a digital voltmeter with an input impedance of at least 10 megohms.

ELECTROSTATIC DISCHARGE DAMAGE

Electronic components used in the ECM are often designed to carry very low voltage. Electronic components are susceptible to damage caused by electrostatic discharge. Less than 100 volts of static electricity can cause damage to some electronic components. By comparison, it takes as much as 4000 volts for a person to feel the spark 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 induction.

An example of charging by friction is a person sliding across a seat.

Charge by induction occurs when a person with well-insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off, leaving the person highly charged with the opposite polarity. Static charges can cause damage, therefore it is important to use care when handling and testing electronic components.

Notice: To prevent possible electrostatic discharge damage, follow these guidelines:

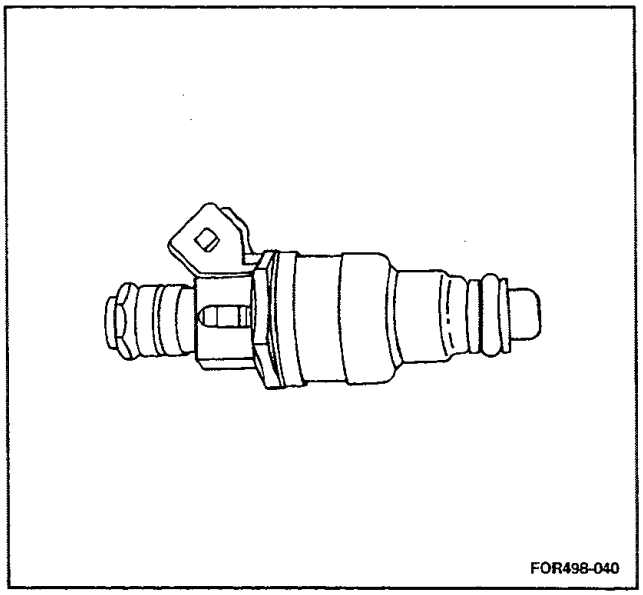
- Do not touch the ECM connector pins or soldered components on the ECM board.
- Do not open the replacement part package until the part is ready to be installed.
- Before removing the part from the package, ground the package to a known good ground on the equipment.
- If the part has been handled while sliding across a seat, while sitting down from a standing position, or while walking a distance, touch a known good ground before installing the part.

FUEL INJECTOR

The Electronic Fuel Injection (EFI) fuel injector is a solenoid-operated device controlled by the ECM. The ECM energizes the solenoid, which opens a valve to allow fuel delivery.

The fuel is injected under pressure in a conical spray pattern at the opening of the intake valve. Excess fuel not used by the injectors passes through the fuel pressure regulator before being returned to the fuel tank.

A fuel injector which is stuck partly open will cause a loss of fuel pressure after the engine is shut down, causing long crank times.



FUEL METERING SYSTEM COMPONENTS

The fuel metering system is made up of the following parts:

- The fuel injectors
- The fuel rail
- The fuel pressure regulator/filter assembly
- The electronic governor
- The ECM
- The crankshaft position (CKP) sensor
- The camshaft position (CMP) sensor
- The fuel pump
- The fuel pump relay

Basic System Operation

The fuel metering system starts with the fuel in the fuel tank. The fuel is drawn up to the fuel pump through a pre-filter. The electric fuel pump then delivers the fuel to the fuel rail through an in-line fuel filter. The pump is designed to provide fuel at a pressure above the pressure needed by the injectors. A fuel pressure regulator in the fuel filter assembly keeps fuel available to the fuel injectors at a constant pressure. A return line delivers unused fuel back to the tank.

FUEL METERING SYSTEM PURPOSE

The basic function of the air/fuel metering system is to control the air/fuel delivery to the engine. Fuel is delivered to the engine by individual fuel injectors mounted in the intake manifold near each intake valve.

The main control sensor is the heated oxygen sensor (HO2S) located in the exhaust system. The HO2S tells the ECM how much oxygen is in the exhaust gas. The ECM changes the air/fuel ratio to the engine by controlling the amount of time that the fuel injector is "ON." The best mixture to minimize exhaust emissions is 14.7 parts of air to 1 part of gasoline by weight, which provides the most efficient combustion. Because of the constant measuring and adjusting of the air/fuel ratio, the fuel injection system is called a "closed loop" system.

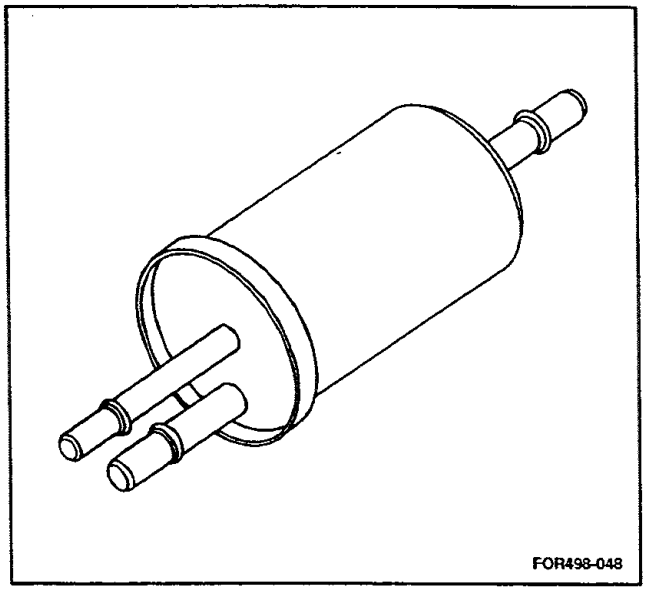
The ECM monitors signals from several sensors in order to determine the fuel needs of the engine. Fuel is delivered under one of several conditions called "modes." All modes are controlled by the ECM. Refer to "Open Loop and Closed Loop Operation" for more information.

FUEL PRESSURE REGULATOR

The fuel pressure regulator is a relief valve mounted in the fuel filter. It provides a constant fuel pressure of 441 kPa (64 psi).

If the pressure is too low, poor performance and a DTC 32 will set. If the pressure is too high, excessive odor and/or a DTC 42 will result.

When replacing the fuel filter, be sure to use an identical filter/regulator assembly. A standard fuel filter does not regulate pressure and could cause engine problems or component damage.



FUEL PUMP ELECTRICAL CIRCUIT

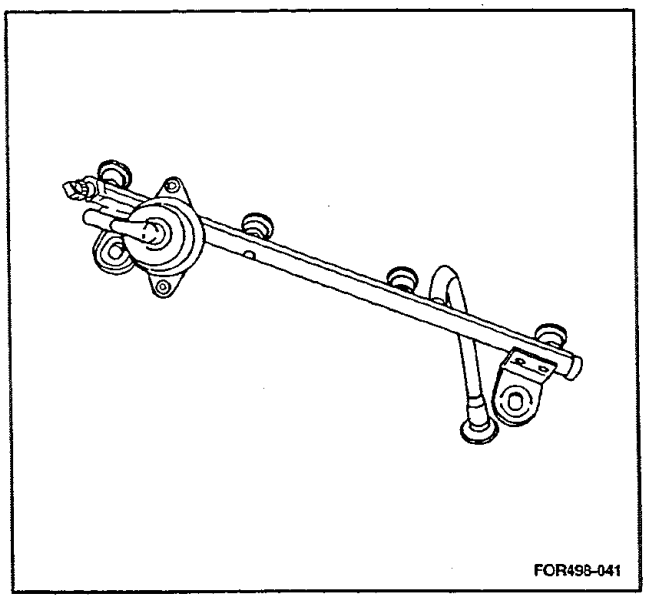
When the key is first turned "ON," the ECM energizes the fuel pump relay for two seconds to build up the fuel pressure quickly. If the engine is not started within two seconds, the ECM shuts the fuel pump off and waits until the engine is cranked. When the engine is cranked and crankshaft position signal has been detected by the

ECM, the ECM supplies 12 volts to the fuel pump relay to energize the electric fuel pump.

An inoperative fuel pump will cause a "no-start" condition. A fuel pump which does not provide enough pressure will result in poor performance.

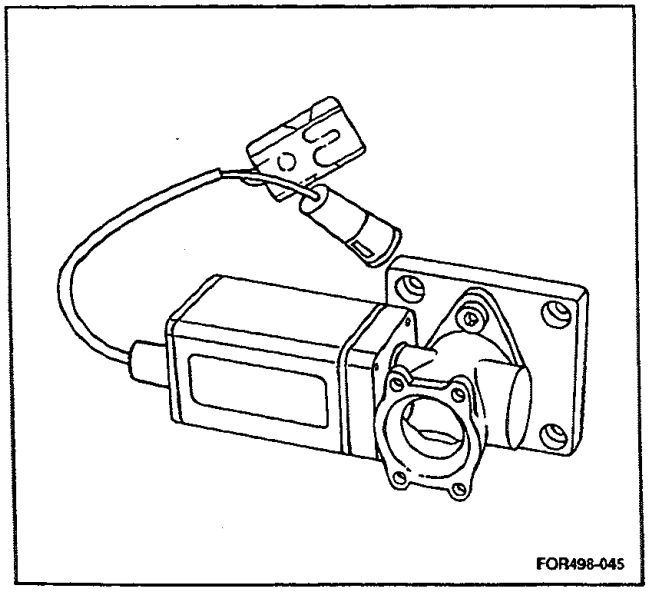
FUEL RAIL

The fuel rail is mounted to the top of the engine and distributes fuel to the individual injectors. Fuel is delivered to the fuel inlet tube of the fuel rail by the fuel lines.



ELECTRONIC GOVERNOR AND THROTTLE BODY

In the 2.5L EFI industrial engine, throttle control is achieved by using an electronic governor which is controlled by the engine control module (ECM).



The electronic governor consists of a throttle body, an electronically-actuated throttle plate, and a built-in throttle position (TP) sensor. There are two pigtails that exit the governor body. The 3-wire pigtail connects the TP sensor to the ECM. Refer to "Throttle Position (TP) Sensor" for more information.

The 2-wire pigtail carries the throttle signal from the ECM to the governor. Desired engine speeds are stored in the configuration program for each specific application, and can be changed with the ECM calibration software. When an engine speed is selected with the toggle switch, the ECM sends the appropriate signal to the governor. This is a pulse-width modulated (PWM) signal which cannot be read with conventional diagnostic tools such as a voltmeter. A 12-volt signal is pulsed on and off at a high rate of speed. The width of the "on" pulse determines the amount of throttle opening. The ECM sends a signal with the appropriate pulse width to the governor based on the operator's choice of switch settings.

The electronic governor also acts as an idle air control (IAC) valve. Changes in engine load are detected by the ECM by comparing manifold absolute pressure (MAP) with throttle position. When the ECM detects a change in engine load, it can adjust idle speed by changing the PWM signal to the governor.

OPEN LOOP AND CLOSED LOOP OPERATION

The ECM will operate in the following two modes:

- Open loop
- Closed loop

When the engine is first started, the system is in "open loop" operation. In open loop, the ECM ignores the signal from the heated oxygen sensor (HO2S). It uses a pre-programmed routine to calculate the air/fuel ratio based on inputs from the TP, ECT, and MAP sensors.

The system remains in open loop until the following conditions are met:

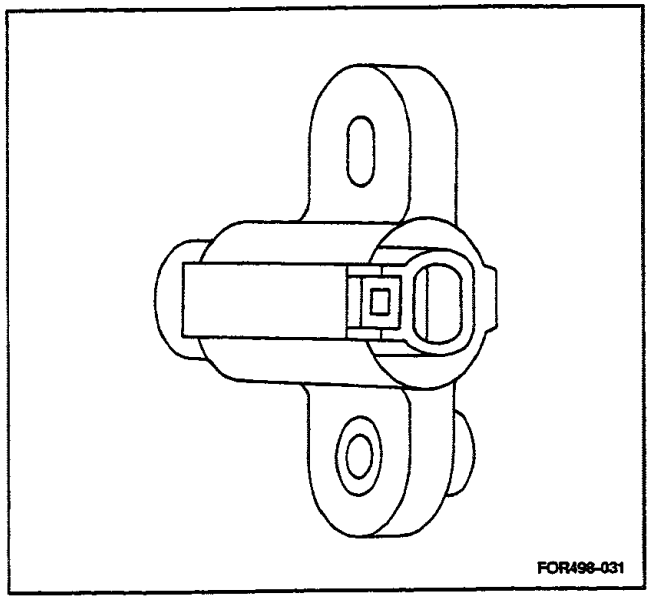
- The HO2S has a varying voltage output showing that it is hot enough to operate properly (this depends on temperature).
- The ECT has reached 160°F (71°C).
- Seven minutes has elapsed since starting the engine.

After these conditions are met, the engine is said to be operating in "closed loop." In closed loop, The ECM continuously adjusts the air/fuel ratio by responding to signals from the HO2S (except at wide-open throttle). When the HO2S reports a lean condition (low sensor signal voltage), the ECM responds by increasing the "on" time of the fuel injectors, thus enriching the mixture. When the HO2S reports a rich condition (high sensor signal voltage), the ECM responds by reducing the "on" time of the fuel injectors, thus leaning out the mixture.

ELECTRONIC IGNITION SYSTEM

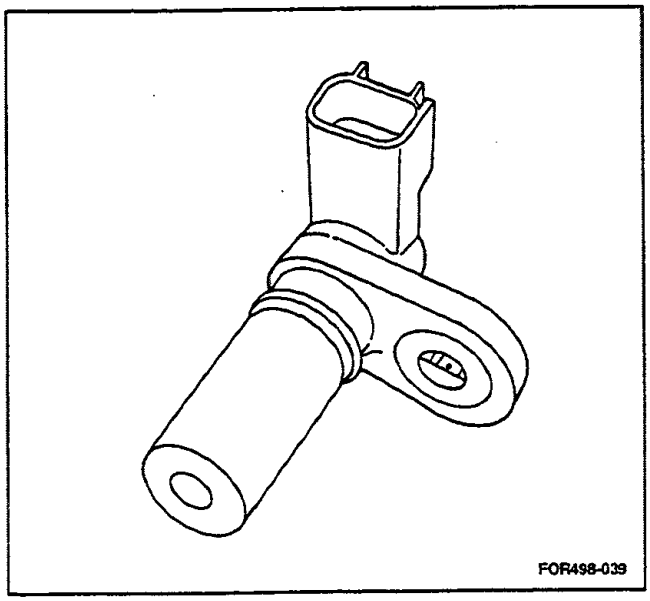
CAMSHAFT POSITION (CMP) SENSOR

The CMP sensor uses a variable reluctor sensor to detect camshaft position. The CMP signal is created as piston #1 is a pre-determined number of degrees after top dead center on the power stroke.



CRANKSHAFT POSITION (CKP) SENSOR

The crankshaft position (CKP) sensor provides a signal used by the engine control module (ECM) to calculate the ignition sequence. The sensor initiates the reference pulses which the ECM uses to calculate RPM and crankshaft position.



ELECTRONIC IGNITION

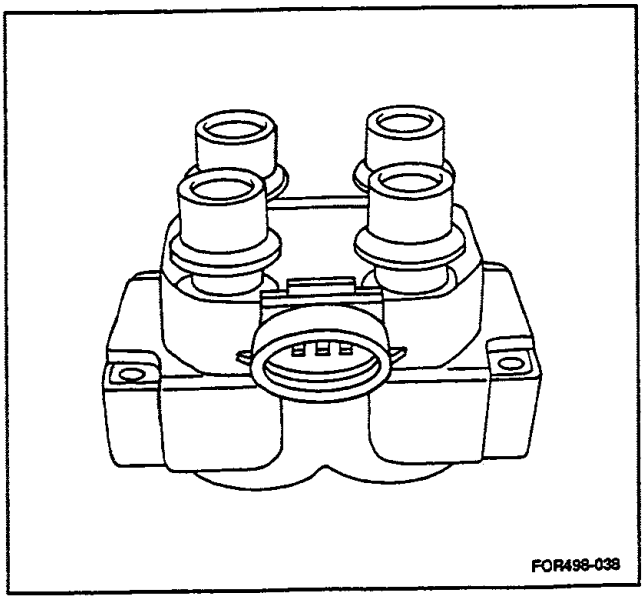
The electronic ignition system controls fuel combustion by providing a spark to ignite the compressed air/fuel mixture at the correct time. To provide optimum engine performance, fuel economy, and control of exhaust emissions, the ECM controls the spark advance of the ignition system. Electronic ignition has the following advantages over a mechanical distributor system:

- No moving parts
- Less maintenance
- Remote mounting capability
- No mechanical load on the engine
- More coil cooldown time between firing events
- Elimination of mechanical timing adjustments
- Increased available ignition coil saturation time

IGNITION COIL

The electronic ignition system uses a coil pack with one ignition coil for each two cylinders in the engine. Each cylinder is paired with its opposing cylinder in the firing order, so that one cylinder on compression fires simultaneously with the opposing cylinder on exhaust. The spark that occurs in the cylinder on the exhaust stroke is referred to as a "waste spark."

The primary coils in the coil pack are triggered by the "Ignition Coil Feed #1" and "Ignition Coil Feed #2" signals from the ECM.

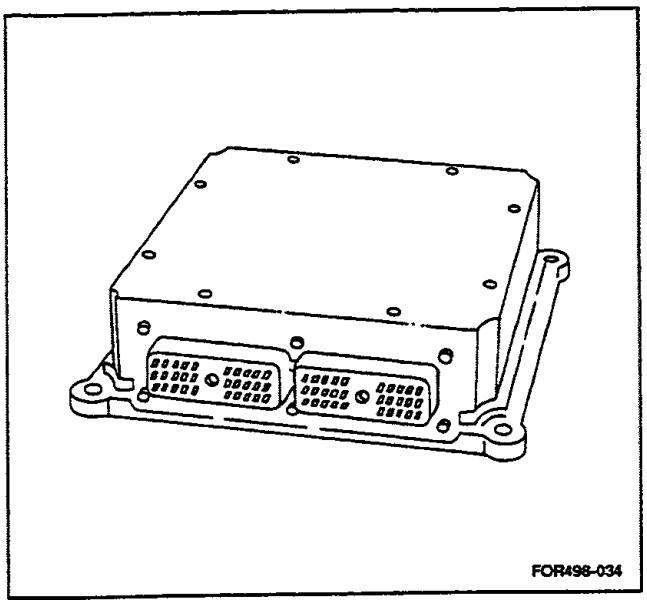


ENGINE CONTROL MODULE (ECM)

The ECM is responsible for maintaining proper spark and fuel injection timing for all operating conditions. To provide optimum operation and emissions, the ECM

monitors the input signals from the following components in order to calculate spark timing:

- Engine coolant temperature (ECT) sensor
- Intake air temperature (IAT) sensor
- Throttle position sensor
- Crankshaft position sensor



PROGRAMMING A REPLACEMENT ECM

The ECM contains information that controls the maximum engine speeds and target engine speeds for each application of the 2.5L EFI engine. Whenever an ECM is replaced, the new ECM must be programmed with the same information that was contained in the old ECM. This can be accomplished in three different ways:

- Reading the program from the old ECM into the personal computer (PC) and then re-installing the program into the new ECM.
- Manually entering engine speed information from the PC keyboard into the new ECM. This method should only be used when the program in the old ECM is unreadable due to electrical damage.
- Downloading a calibration that has previously been uploaded to the PC. For this option, contact the Ford Power Products Customer Service Center Technical Support Hotline at 1-800-521-0370.

Reinstalling the Program from a Defective ECM into a New ECM

If an ECM fails, there is a good chance that the engine control program contained within the ECM is still usable. To program the new ECM, use the following steps to copy the control program from the old ECM into the PC, and then from the PC into the new ECM:

1. With the ignition key OFF and the computer OFF, connect the interface cable from the old ECM to the PC. Refer to "Interface Cable" for more information.
2. KOEO.
3. Start the computer and load the Ford Power Products ECM calibration software. Refer to "Using the ECM Calibration Software" for more information.
4. From the Main Menu, select **U->Transfer Calibration from ECM to PC.** Make sure the status bar on the Main Menu says "ONLINE." Is the status bar displays "OFFLINE," press **[F5].**
5. Select the appropriate file name for storing the old ECM program onto your hard drive. There might only be one file name, or there might be additional file names for each different application using the 2.5L EFI engine.
6. Press **[Enter].** If the old control program has not been damaged, it will now be transferred into the PC. When the transfer is complete, the ECM Calibration Editor returns to the Main Menu.
7. Ignition key OFF.
8. Disconnect the negative battery cable.
9. Disconnect the faulty ECM.
10. Install the new ECM.
11. Reconnect the negative battery cable.
12. KOEO. Make sure the status bar on the Main Menu says "ONLINE." If the status bar displays "OFFLINE," press **[F5].**
13. From the Main Menu, select **D->Transfer Calibration from PC to ECM.**
14. Select the same file name that you used in Step 5.
15. Press **[Enter].** The original calibration will now be transferred into the new ECM. When the transfer is complete, the ECM Calibration Editor returns to the Main Menu.
16. Start the engine and verify normal operation.

Manually Calibrating a New ECM from the PC Keyboard

If the calibration program from the old ECM is not readable, you can manually calibrate the new ECM directly from the PC keyboard. You will be setting engine speeds for two separate functions:

- Governor rev limits. These are the "never exceed" speeds for each speed switch setting.
- RPM Targets. These are the desired operating speeds for each speed switch setting.

NOTICE: You MUST program the correct governor rev limits and rpm targets for your application, or damage may occur to the engine or to the powered equipment. If you have any doubt about the correct settings, contact the Ford Power Products Customer Service Center Technical Support Hotline at 1-800-521-0370.

Setting Target Engine Speeds

1. From the Main Menu, select **L–>List All ECM Calibration Tables**.
2. Use the down-arrow key to select **4) RPM targets (Config=fixed RPM)**. Press **[Enter]**.
3. The left side of the RPM Targets screen has a vertical scale with rpm settings. The hollow arrow to the left of the scale represents the engine speed toggle switch position. The caret to the right of the scale indicates where a new rpm target will be inserted. For more information, refer to the README.TXT file included on the calibration software diskette.
4. Set the engine speed toggle switch to the first position that you wish to program.
5. Using the up-arrow and down-arrow on the keyboard, move the caret to align with the hollow arrow.
6. Type in the desired rpm target for that switch setting. Press **[Enter]**.

NOTICE: You MUST program the correct governor rev limits and rpm targets for your application, or damage may occur to the engine or to the powered equipment. If you have any doubt about the correct settings, contact the Ford Power Products Customer Service Center Technical Support Hotline at 1-800-521-0370.

7. Repeat Steps 4-6 for each of the remaining toggle switch settings.
8. Press **[Esc]** to return to the Main Menu.
9. To exit the ECM Calibration Editor, press and hold the **[Alt]** key. While the **[Alt]** key is pressed, press the **X** key.

Setting the Governor Rev Limits

1. Ignition key OFF.
2. Disconnect the negative battery cable.
3. Install the new ECM.
4. Reconnect the negative battery cable.
5. KOEO.
6. Start the computer and load the Ford Power Products ECM calibration software. Refer to "Using the ECM Calibration Software" for more information.
7. Select **[D]** from the Main Menu.
8. Load the proper template, depending on whether your engine has an electronic governor or a standard throttle body.
   - For the electronic governor, use the arrow keys to select DISCRETE.GOV
   - For a standard throttle body, use the arrow keys to select STOCKTB.GOV
9. Press **[Esc]** to return to the Main Menu.
10. Select **L–>List all ECM Calibration Tables**.
11. Using the down-arrow key, select **3) Gov. Rev. Limits (RPM)**. Press **[Enter]**.
12. The left side of the Governor Rev Limits screen has a vertical scale with rpm settings. The hollow arrow to the left of the scale represents the engine speed toggle switch position. The caret to the right of the scale indicates where a new rpm limit will be inserted.
13. Set the engine speed toggle switch to the first position that you wish to program.
14. Using the up-arrow and down-arrow on the keyboard, move the caret to align with the hollow arrow.
15. Type in the desired rpm limit for that switch setting. Press **[Enter]**.

NOTICE: You MUST program the correct governor rev limits and rpm targets for your application, or damage may occur to the engine or to the powered equipment. If you have any doubt about the correct settings, contact the Ford Power Products Customer Service Center Technical Support Hotline at 1-800-521-0370.

16. Repeat Steps 13-15 for each of the remaining toggle switch settings.
17. Press **[Esc]** to return to the Main Menu.

GLOSSARY OF TERMS

Acronyms for Electronic Fuel Injections Training

A4LD	Automatic 4-speed Light Duty
BSFC	Brake Specific Fuel Consumption
CKP	Crankshaft Position
CMP	Camshaft Position
DTC	Diagnostic Trouble Code
DVOM	Digital Volt-Ohm Meter
ECM	Engine Control Module
ECT	Engine Coolant Temperature
EEMS	Electronic Engine Management System – Complete EFI System
EGR	Exhaust Gas Recirculation
FPP	Ford Power Products
HO2S	Heated Oxygen (HEGO) sensor
IAT	Intake Air Temperature
ICM	Ignition Control Module
IPP	Industrial Power Products
KOEO	Key On Engine Off (test mode)
KOER	Key On Engine Running (test mode)
LP	Liquefied Petroleum
MAP	Manifold Absolute Pressure
MIL	Malfunction Indicator Lamp
NG	Natural Gas
PCV	Positive Crankcase Ventilation
PEFI	Port Electronic Fuel Injection
PID	Proportional Integral Derivative
RPM	Revolutions Per Minute
SEFI	Sequential Electronic Fuel Injection
T	Torque
TP	Throttle Position
WOT	Wide Open Throttle

Acronyms for Computer Training

COM	Communication Port (on back of computer)
COP	Computer Operating Properly
DLC	Data Link Connector
IBM	International Business Machines
MB	Megabyte
MS-DOS	Microsoft Disk Operating System
PC	Personal Computer
RAM	Random Access Memory
VGA	Video Graphics Array/Accelerator