Powertrain Control/Emissions Diagnosis

On Board Diagnostics II

Vehicle Application:

1998 7.3L Diesel, 1998 1/2 7.3L Diesel Econoline and 1999 7.3L Diesel F-Series (over 8,500 GVW)

Ford
TECHNICAL
PUBLICATIONS DEPARTMENT
Ford Customer Service Division

INTRODUCTION

NOTE: The descriptions and specifications contained in this manual were in effect at the time this manual was approved for printing. Ford Motor Company reserves the right to discontinue models at any time, or change specifications or design without notice and without incurring any obligation.

IMPORTANT SAFETY NOTICE

Appropriate service methods and procedures are essential for the safe, reliable operation of all motor vehicles as well as the personal safety of the individual doing the work. This manual provides general directions for performing service with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedure, techniques, tools and parts for servicing vehicles, as well as in the skill of the individual doing the work. This manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this manual must first establish that he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools or parts.

NOTES, CAUTIONS, AND WARNINGS

As you read through the procedures, you will come across **NOTES**, **CAUTIONS**, and **WARNINGS**. Each one is there for a specific purpose. **NOTES** give you added information that will help you to perform a particular procedure. **CAUTIONS** are given to prevent you from making an error that could damage the vehicle. **WARNINGS** remind you to be especially careful in those areas where carelessness can cause you personal injury. The following list contains some general **WARNINGS** that you should follow when you work on a vehicle.

- **ALWAYS WEAR SAFETY GLASSES FOR EYE PROTECTION.**
- **USE SAFETY STANDS WHENEVER A PROCEDURE REQUIRES YOU TO BE UNDER THE VEHICLE.**
- **MAKE SURE THAT THE IGNITION SWITCH IS ALWAYS IN THE OFF POSITION, UNLESS OTHERWISE REQUIRED BY THE PROCEDURE.**
- **SET THE PARKING BRAKE WHEN WORKING ON THE VEHICLE. IF YOU HAVE AN AUTOMATIC TRANSMISSION, SET IN PARK UNLESS INSTRUCTED OTHERWISE FOR A SPECIFIC OPERATION. IF YOU HAVE A MANUAL TRANSMISSION, IT SHOULD BE IN REVERSE (ENGINE OFF) OR NEUTRAL (ENGINE ON) UNLESS INSTRUCTED OTHERWISE FOR A SPECIFIC OPERATION. PLACE WOOD BLOCKS (4" X 4" OR LARGER) AGAINST THE FRONT AND REAR SURFACES OF THE TIRES TO HELP PREVENT THE VEHICLE FROM MOVING.**
- **OPERATE THE ENGINE ONLY IN A WELL-VENTILATED AREA TO AVOID THE DANGER OF CARBON MONOXIDE POISONING.**
- **KEEP YOURSELF AND YOUR CLOTHING AWAY FROM MOVING PARTS WHEN THE ENGINE IS RUNNING, ESPECIALLY THE DRIVE BELTS.**
- **TO PREVENT SERIOUS BURNS, AVOID CONTACT WITH HOT METAL PARTS SUCH AS THE RADIATOR, EXHAUST MANIFOLD, TAIL PIPE, THREE-WAY CATALYTIC CONVERTER AND MUFFLER.**
- **DO NOT SMOKE WHILE WORKING ON A VEHICLE.**
- **TO AVOID INJURY, ALWAYS REMOVE RINGS, WATCHES, LOOSE HANGING JEWELRY AND LOOSE CLOTHING BEFORE BEGINNING TO WORK ON A VEHICLE.**
- **WHEN IT IS NECESSARY TO WORK UNDER THE HOOD, KEEP HANDS AND OTHER OBJECTS CLEAR OF THE RADIATOR FAN BLADES!**

Preface

This manual provides a step-by-step approach for diagnosing driveability, emission and powertrain control system symptoms. Before beginning diagnosis, it may be helpful to reference any Technical Service Bulletins (TSBs) or On-line Automotive Service Information System (OASIS) information when this is available.

This manual is used in conjunction with the Body, Chassis, Electrical, Powertrain Workshop Manuals and the Electrical Vacuum Troubleshooting Manuals (EVTM). The Workshop Manuals are used to provide additional diagnostics when directed by this manual. The Workshop Manuals are also used for component removal and replacement information. Refer to the EVTM for vehicle-specific wiring information and component, connector and splice location.

All references to specific "Groups" refer to groups in the Body, Chassis, Electrical, Powertrain Workshop Manuals. The following is a description of the information contained in each section of this manual.

Section 1: Description And Operation

This section contains description and operation information on powertrain control systems and components. This section is designed to give the technician a general knowledge of the powertrain control system. It should be used when general information about the powertrain control system is desired, and is rarely referenced from other sections of the manual.

Section 2: Diagnostic Methods

The Diagnostic Methods section contains information on specific diagnostic tasks that are used during diagnosis. Descriptions of specific diagnostic methods are included, as well as detailed instructions on how to access or perform the tasks. This section provides the technician with step-by-step instructions for performing routine diagnostic tasks.

Section 3: Symptom Charts

All diagnosis begins in Section 3 with the Symptom Index. The Symptom Index contains the list of symptoms addressed in this manual. The Symptom Index will refer the technician to the appropriate Symptom Chart, which guides the technician through diagnosis.

Section 4A/B: Diagnostic Subroutines

Section 4A/B contains the Hard Start/No Start and Performance Diagnostic Procedures that are used to obtain quick diagnostic information. This section also contains the Powertrain Diagnostic Trouble Code (DTC) "Go To" Charts. Section 3 will direct the technician to these tests when required.

Section 5: Pinpoint Tests

All the pinpoint tests are included in Section 5. Never enter a Pinpoint Test unless directed there. When directed to a Pinpoint Test, always read the information and look at the schematic included at the beginning of the Pinpoint Test.

Section 6: Reference Values

Section 6 contains the Control System Diagnostic Sheet Reference Chart.

How To Use The Diagnostic Procedures

How To Use The Diagnostic Procedures

- Use the information about the vehicle driveability or emission concern (from the service write-up or the Customer Information Worksheet to attempt to verify/re-create the symptom. Look for any vehicle modifications or aftermarket items that may contribute to the symptom. A check of any applicable TSBs or OASIS messages may be useful, if this information is available.
- Refer to the Symptom Index (Section 3), and select the symptom that best describes the vehicle symptom. (For multiple symptoms, select the one that is most noticeable.)
- Go to the Symptom Chart indicated in the Symptom Index.
- Begin the Chart at step number 1.
- Follow the instructions in the step.
  - If the step contains a test procedure or question (without a reference outside the step), perform the test step/answer the question and continue as directed.
  - If the step sends you to a specific area for testing (for example Hard Start/No Start Procedures, a Pinpoint Test Step in this manual or a Workshop Manual group), go to the procedures. Follow the directions given in those procedures, including directions to other tests or sections. If a damaged part is found, repair/replace as directed. If no fault is found, and diagnosis in that area is complete, return to the Symptom Chart and continue as directed.
- During diagnosis, if directed to test a system/component that is not contained on that vehicle, proceed to the next step.
- If the Symptom Chart for the vehicle symptom is completed and no fault is found, return to the Symptom Index to address the next most prominent symptom.
- After service, verify that the vehicle is operating properly and the original symptom is eliminated.

NOTE: If a symptom is determined to be intermittent, careful visual and physical underhood inspection of connectors, wiring harnesses, vacuum lines and components is required. The Customer Information Worksheet may contain more detailed symptom information. Before an in-depth diagnosis begins, start the engine and wiggle wires, tap on components, etc., while listening for an indication of a concern (such as rpm change or relay clicking)

Information about engine conditions is stored when a diagnostic trouble code (DTC) that lights the malfunction indicator lamp (MIL) is set.

SECTION 1

Description and Operation

Contents (continued)

Diesel Vehicle Emission Control Information

Decal Location

Location of the decal will be on the RH valve cover.

Engine Calibration Label Identification

An Emission Calibration label is attached to all vehicles. This label (Figure 3) is attached to the LH B-pillar. It identifies the engine year, calibration design, and design revision level. These numbers are used to identify service parts and engine specifications that make up the emission system designed for the vehicle.

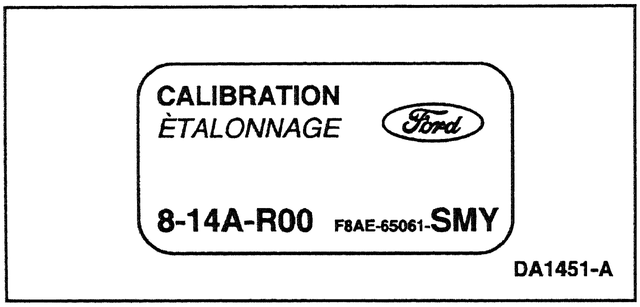


Figure 3: Typical Emission Calibration Label

Calibration Code

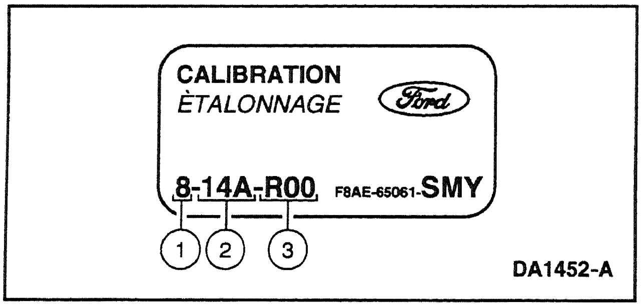


Figure 4: Typical Emission Calibration Label

Use the following to interpret the calibration code from the Emission Calibration Label:

1. MODEL YEAR
   This number represents the model year in which the Calibration was first introduced (the model year 1998).
2. CALIBRATION DESIGN LEVEL
   Represents the design level assigned to the engine (14A).
3. CALIBRATION REVISION LEVEL
   Represents the revision level of the calibration (R0O). These numbers will advance as revisions occur.

Diesel On Board Diagnostics II System

Overview

The California Air Resources Board (ARB) began regulation of On Board Diagnostic (OBD) for diesel vehicles sold in California beginning with the 1997 model year. OBD II requires monitoring of emission-related components. The Malfunction Indicator Lamp (MIL) was required to light and alert the driver of the malfunction and the need for service of the emission control system. The MIL must be labeled CHECK ENGINE. A fault code or Diagnostic Trouble Code (DTC) is associated with the MIL identifying the specific area of the fault.

The OBD II system meets government regulations by monitoring the emission control system. When a system or component exceeds emission thresholds or a component operates outside of tolerance, a Diagnostic Trouble Code (DTC) will be stored and the Malfunction Indicator Lamp (MIL) will be illuminated.

The OBD II Monitors detect system faults and initiate DTC setting and MIL activation. Fault detection strategy and MIL operation are associated with drive cycles. An OBD II pending DTC is stored in the PCM keep alive random access memory when a fault is first detected. In most cases the MIL is turned on after two consecutive drive cycles with the fault and the DTC is set. The DTC is cleared after 40 engine warm-up cycles without the fault being detected once the MIL is turned off. Once a Monitor turns on the MIL, it will require three consecutive drive cycles without a fault for the MIL to turn off. The operation of each of the OBD II Monitors is discussed in detail within this section.

The On Board diagnostic computer program in the Electronic EC Powertrain Control Module (PCM) coordinates the OBD II self-monitoring system. This program controls all the monitors and interactions, DTC and MIL operation, Freeze Frame data and scan tool interface.

Freeze Frame data describes stored engine conditions such as state of the engine rpm and load at the point the first fault is detected. This data is accessible with the scan tool to assist in repairing the vehicle.

OBD II Inspection Maintenance (IM) Readiness DTC P1000 indicates that not all of the OBD II monitors have been completed since the PCM's keep alive random access memory was last cleared. In certain states, it may be necessary to operate the vehicle until DTC P1000 is erased from the PCM in order to purchase a vehicle license.

The On Board Diagnostic System is comprised of the Comprehensive Component Monitor and the Glow Plug Monitor.

Diesel On Board Diagnostics II Monitors

This section provides a general description of each OBD II monitor. In these descriptions, the monitor strategy, hardware, testing requirements and methods are presented together to provide an overall understanding of each monitor operation. An illustration for each monitor is also provided to aid in the description. These illustrations should be used as typical examples and are not intended to represent all the possible configurations.

Each illustration depicts the Powertrain Control Module (PCM) as the main focus with the primary inputs and outputs for each monitor. The icons to the left of the PCM represent the inputs used by each of the monitor strategies to enable or activate the monitor. The components and subsystems to the right of the PCM represent the hardware and signals used while performing the tests and the systems being tested. The Comprehensive Component Monitor illustration has numerous components and signals involved and is shown generically. When referring to the illustrations, match the numbers to the corresponding numbers in the monitor descriptions for a better comprehension of the monitor and associated Diagnostic Trouble Codes (DTCs).

Diesel On Board Diagnostics II System

These monitor descriptions are intended as general information only.

Deviations From Standard Gasoline Implementation of OBD II

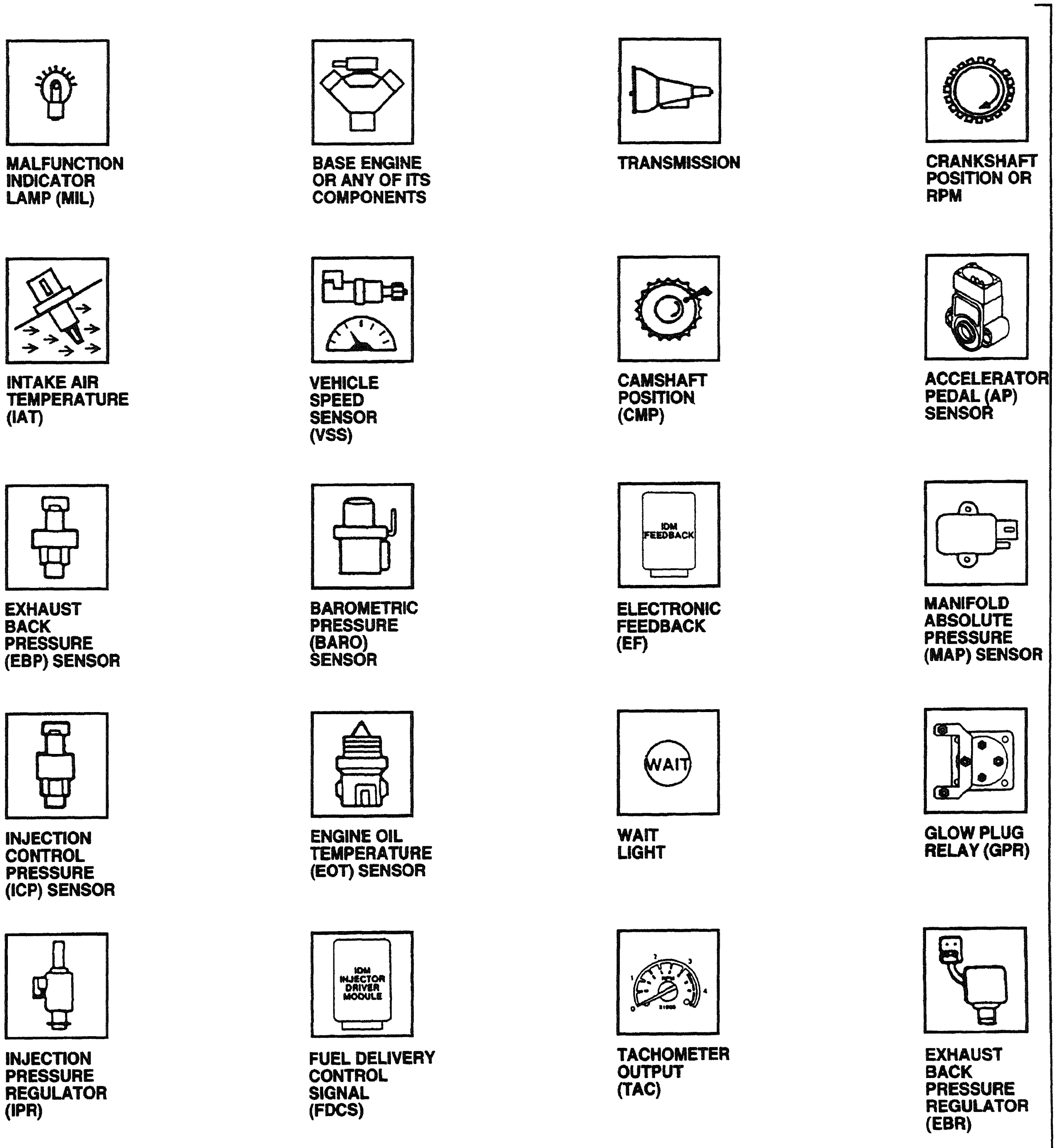
1. The Parameter IDs (PID) that are supported according to OBD II regulations are limited to: Calculated Load Value, MAP, VSS, IAT, and Engine Speed. Values for the other parameters are not accurate and are defaulted.
2. The Freeze Frame supports the following limited list of parameters: Freeze Frame Related Trouble Code, Calculated Load Value, MAP, VSS and Engine Speed. Values for the other parameters are not representative and are defaulted.
3. While gasoline vehicles evaluate Readiness (i.e.: all monitors complete) based on the diagnostics for any or all of the following systems:
   a. Catalyst Monitoring
   b. Heated Catalyst Monitoring
   c. Evaporative System Monitoring
   d. Secondary Air System Monitoring
   e. A / C System Refrigerant Monitoring
   f. Oxygen Sensor Monitoring
   g. Oxygen Sensor Heater Monitoring
   h. EGR System Monitoring

   The 7.3L Diesel does not use nor base Readiness on any of these systems.

   Readiness for the Diesel is based in each and every OBD II continuous code having run sufficiently to have found a fault without regard to whether or not a fault exists. This requires the execution of a specific drive cycle to enter the conditions for which ALL of the OBD II monitors might find a fault.

Diesel On Board Diagnostics II System

4. Unlike Ford gasoline vehicles, the OBD II command to Clear Codes will ONLY clear the OBD II system. Clearing codes from the vehicle specific menu will clear BOTH the manufacturer / vehicle specific codes and the OBD II codes. These icons are used in the illustrations of the OBD II monitors and throughout this section.



MALFUNCTION INDICATOR LAMP (MIL)

BASE ENGINE OR ANY OF ITS COMPONENTS

TRANSMISSION

CRANKSHAFT POSITION OR RPM

INTAKE AIR TEMPERATURE (IAT)

VEHICLE SPEED SENSOR (VSS)

CAMSHAFT POSITION (CMP)

ACCELERATOR PEDAL (AP) SENSOR

EXHAUST BACK PRESSURE (EBP) SENSOR

BAROMETRIC PRESSURE (BARO) SENSOR

ELECTRONIC FEEDBACK (EF)

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

INJECTION CONTROL PRESSURE (ICP) SENSOR

ENGINE OIL TEMPERATURE (EOT) SENSOR

WAIT LIGHT

GLOW PLUG RELAY (GPR)

INJECTION PRESSURE REGULATOR (IPR)

FUEL DELIVERY CONTROL SIGNAL (FDCS)

TACHOMETER OUTPUT (TAC)

EXHAUST BACK PRESSURE REGULATOR (EBR)

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Diesel On Board Diagnostics II System

Comprehensive Component Monitor

The Comprehensive Component Monitor (CCM) is an on-board strategy designed to monitor a fault in any electronic component or circuit that provides input or output signal to the Powertrain Control Module (PCM) and is not exclusively monitored by another monitor system. Inputs and outputs are considered inoperative when at a minimum a failure exists due to a lack of circuit continuity, out-of-range value, or a failed rationality check.

The CCM covers many components and circuits and tests them in various ways depending on the hardware, function, and type of signal. For example, analog inputs are typically checked for opens, shorts, and out of range values. This type of monitoring is performed continuously. Some digital inputs rely on rationality checks. These tests may require the monitoring of several components and can only be performed under the appropriate test conditions. Outputs are checked for opens and shorts by monitoring the Output State Monitor (OSM) or circuit associated with the output driver when the output is energized or de-energized. Other outputs, such as relays, require additional OSM circuits to monitor the secondary side of the component. Some outputs are also monitored for the proper function by observing the reaction of the control system to a given change in the output command. An example of this would be the Injection Pressure Regulator (IPR) Valve.

In general, the CCM covers a broad range of individual component and circuit checks and testing is performed under various conditions. The CCM is enabled shortly after the engine is started but requires certain conditions to occur for some components before it can totally complete. A Diagnostic Trouble Code (DTC) is stored in continuous memory when a fault is determined, and the Malfunction Indicator Lamp (MIL) is activated if the fault detected affects emissions. Most of the CCM Monitor tests are also performed during on demand self-test.

The following is an example of some of the input and output components monitored by the CCM. The components monitored may belong to the engine, transmission or any other PCM supported subsystem.

1. Inputs:

   Engine Oil Temperature, Accelerator Position Sensor (AP), Camshaft Position (CMP),...

2. Outputs:

   Injection Pressure Regulator, Fuel Delivery Command Signal (FDCS), Shift Solenoid (SS), Torque Converter Clutch (TCC),...

3. The MIL is activated after a fault is detected on two consecutive drive cycles, if the fault detected affects emissions.

Diesel On Board Diagnostics II System

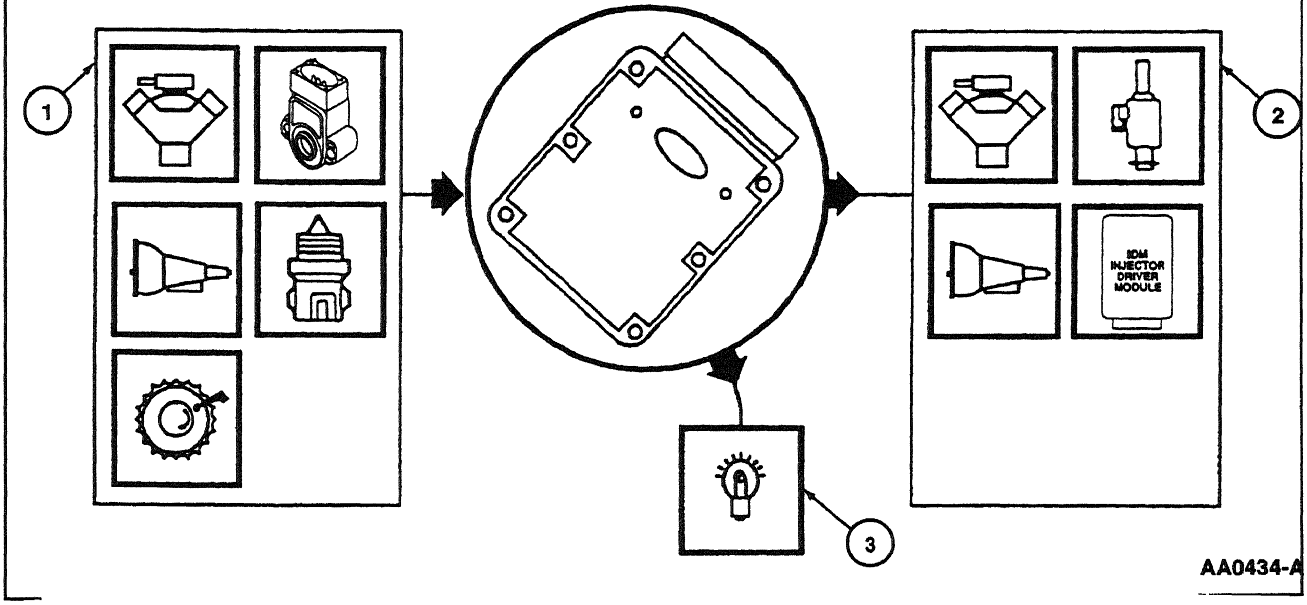


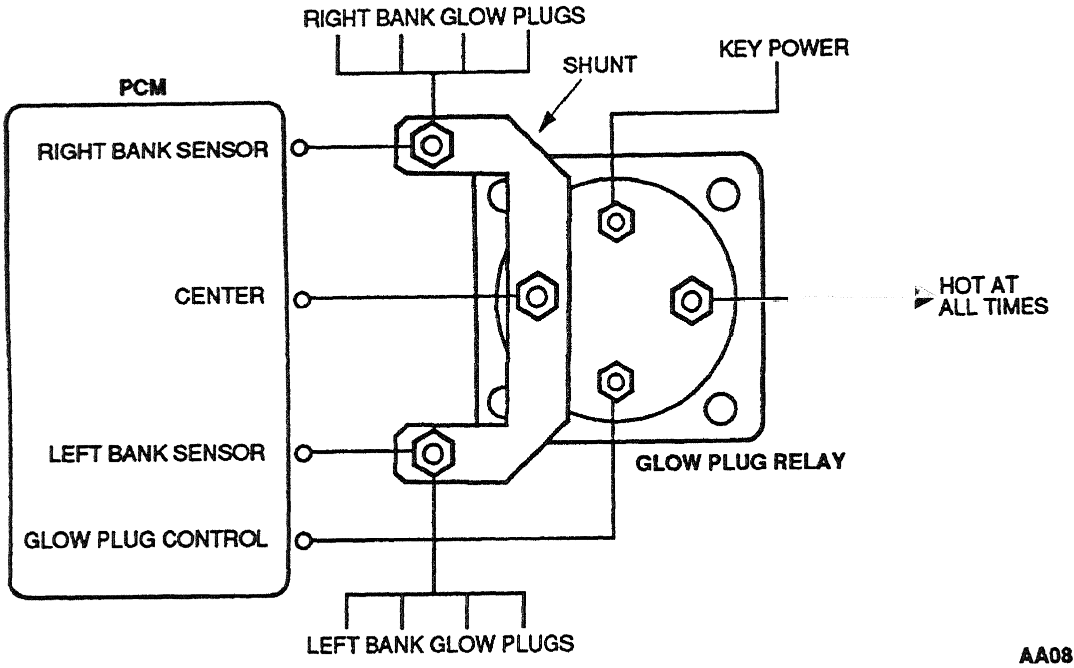
Figure 5: Comprehensive Component Monitor

Glow Plug Monitor

California and all Econoline vehicles utilize a Glow Plug Monitor (GPM) system designed to locate failed glow plugs or failed wiring in the glow plug system. Diagnostic Trouble Codes (DTCs) indicate which bank has failed glow plugs or failed glow plug wiring.

Diesel On Board Diagnostics II System

The GPM system uses two low resistance shunts. One shunt conducts the current to the glow plugs in the left cylinder head and the other shunt conducts the current for the right cylinder head. Three sensing wires measure the voltage drops across the shunts when the glow plugs are operating (the voltage drops are proportional to the current in the shunt). The voltage drops are measured after the glow plug current stabilizes (approximately 30 seconds). Therefore, this system only checks glow plug operation when oil temperature and / or altitude conditions cause the glow plugs to stay on for 30 seconds or more and system voltage is between 11.8 and 14.0 volts.



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A menu pick on the NGS tester KOER Glow Plug Monitor Test allows 30 second operation of the GPM system independent of oil temperature or altitude.

The GPM also checks the added sensing wires for out of range readings. These checks indicate a shorted or open sensing wire, or a glow plug relay failure by setting DTCs. The DTCs are stored in continuous memory when a fault is determined, and the Malfunction Indicator Lamp (MIL) is illuminated on the second drive cycle if an OBD II fault is detected. The 49 state Econoline vehicles use the GPM system and hardware to detect faults but do not illuminate the MIL.

The glow plug relay coil is checked for opens or shorts as part of Comprehensive Component Monitoring.

The following is an example of some of the input and output components monitored by the GP monitor. The components monitored belong to the engine system.

1. Inputs:

   Engine Oil Temperature, Barometric Pressure Sensor (BARO), ...

Diesel On Board Diagnostics II System

2. Outputs:
   Glow Plug Relay (GPR), Glow Plugs
3. The MIL is activated after a fault is detected on two consecutive drive cycles, if the fault detected affects emissions.

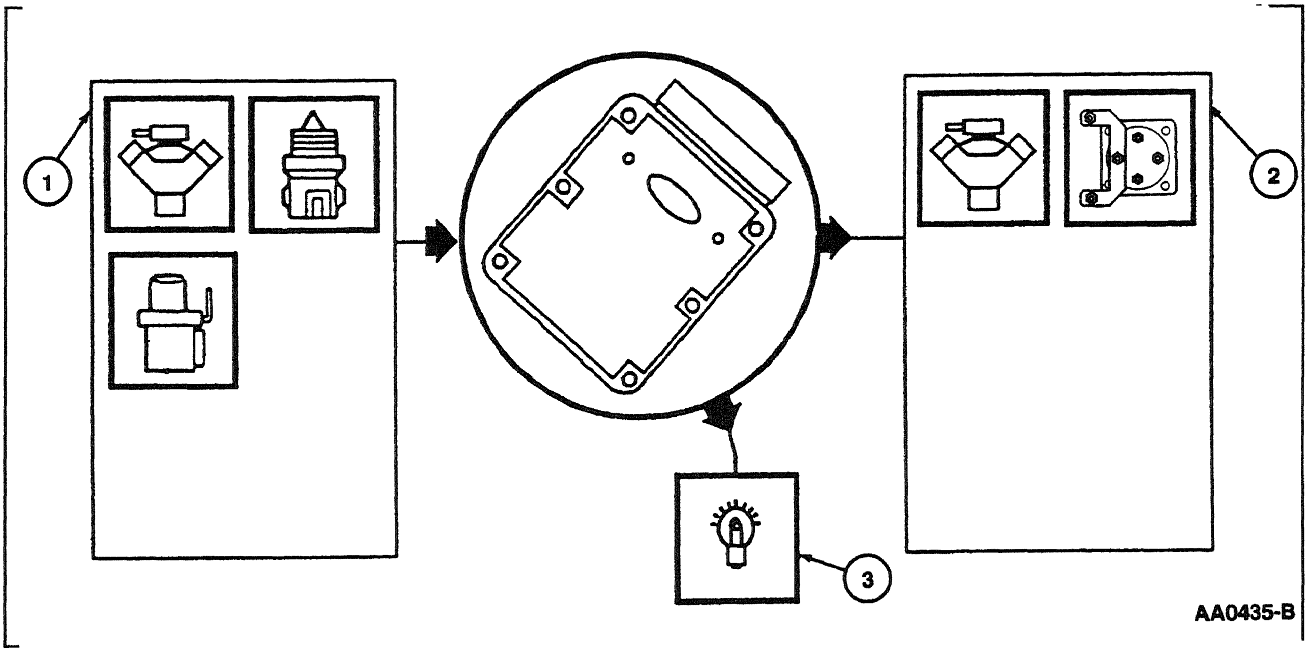


Figure 6: Glow Plug Monitor

Malfunction Indicator Lamp (MIL)

The Malfunction Indicator Lamp (MIL) alerts the driver that the Powertrain Control Module (PCM) has detected an OBD II emission-related component or system fault. When this occurs, an OBD II Diagnostic Trouble Code (DTC) will be set.

- The MIL is located on the instrument panel and is labeled CHECK ENGINE.
- 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 until the CKP signal is detected.
- The light may also be on due to a short to ground of the MIL circuit, or operation in the Hardware Limited Operation Strategy (HLOS).
- To turn off the MIL after a repair, a reset command from the Scan Tool must be sent, or three consecutive drive cycles must be completed without a fault.
- For any MIL concern, go to Section 3, Symptom Charts.

Diesel Electronic EC System

Overview

The Electronic Engine Control (EC) system provides optimum control of the engine and transmission through the enhanced capability of the Powertrain Control Module (PCM). The Electronic EC also has an on-board diagnostics monitoring system (On Board Diagnostics II) with features and functions to meet federal regulations on exhaust emissions.

The Electronic EC system has two major divisions: hardware and software. The hardware includes the Powertrain Control Module (PCM), Injection Drive Module (IDM), sensors, switches, actuators, solenoids, and interconnecting terminals. The software in the PCM provides the strategy control for outputs (engine hardware) based on the values of the inputs to the PCM. Electronic EC hardware and software are discussed in this section.

The PCM receives information from a variety of sensor and switch inputs. Based on the strategy and calibration stored within the memory chip, the PCM generates the appropriate output. The system is designed to minimize emissions and optimize fuel economy and driveability. The software strategy controls the basic operation of the engine and transmission, provides the OBD II strategy, controls the Malfunction Indicator Lamp (MIL), communicates to the scan tool [New Generation Star (NGS), etc.] via the Data Link Connector (DLC), allows for Flash Electrically Erasable Programmable Read Only Memory (FEEPROM), fuel trim, and controls Failure Mode Effects Management (FMEM).

Modifications to OBD II Vehicles

Modifications or additions to the vehicle may cause incorrect operation of the OBD II system. Burglar alarms, cellular telephones and CB radios must be carefully installed. **Do not install these devices by tapping into or running wires close to powertrain control system wires or components.**

Diesel Powertrain Control Software

Multiplexing

The increased number of modules on the vehicle dictate a more efficient method of communication. Multiplexing is the process of communicating several messages over the same signal path. This process allows multiple modules to communicate with each other through the signal path (BUS+ / BUS-). Modules communicate with the Powertrain Control Module using Standard Corporate Protocol (SCP) which determines the priority in which the signals are sent. (Refer to Standard Corporate Protocol for more information.)

Standard Corporate Protocol

The Standard Corporate Protocol (SCP) is a communication language used by Ford Motor Company for exchanging bi-directional messages (signals) between stand-alone modules and devices. Two or more signals can be sent over one circuit.

Included in these messages is diagnostic data that is output over the BUS + and BUS - lines to the Data Link Connector (DLC). This information is accessible with a scan tool. Information on this equipment is described in Section 2, Diagnostic Methods.

Flash Electrically Erasable Programmable Read Only Memory

The Flash Electrically Erasable Programmable Read Only Memory (FEEPROM) is an Integrated Circuit (IC) within the PCM. This integrated circuit contains the software code required by the PCM to control the powertrain. One feature of the FEEPROM is that it can be electrically erased and then reprogrammed without removing the PCM from the vehicle. If a software change is required to the PCM, the module no longer needs to be replaced, but can be reprogrammed at the dealership through the Service Bay Diagnostic System® (SBDS®). The reprogramming is done through the DLC.

Failure Mode Effects Management

Failure Mode Effects Management (FMEM) is an alternate system strategy in the PCM designed to maintain vehicle operation if one or more sensor inputs fail.

When a sensor input is perceived to be out-of-limits by the PCM, an alternative strategy is initiated. The PCM substitutes a fixed value and continues to monitor the incorrect sensor input. If the suspect sensor operates within limits, the PCM returns to the normal engine running strategy.

FMEM operation will result in Continuous Memory DTCs during normal engine operation and when performing Key On Engine Running Self-Test Mode.

Engine RPM / Vehicle Speed Limiter

The Powertrain Control Module (PCM) limits engine rpm by cutting off fuel whenever an engine rpm overspeed condition is detected. The purpose of the engine rpm limiter is to prevent damage to the powertrain.

Diesel Powertrain Control Software

Powertrain Control Module

The center of the Electronic EC system is a microprocessor called the Powertrain Control Module (PCM). The PCM has a 104-pin electrical connector. The PCM receives input from sensors and other electronic components (switches, relays, etc.) and places this information in RAM or Keep Alive RAM. Based on information programmed into its memory (ROM), the PCM generates output signals to control various relays, solenoids and actuators.

Keep Alive Random Access Memory (RAM)

The PCM stores information in Keep Alive RAM (a memory integrated circuit chip) about vehicle operating conditions, and then uses this information to compensate for component variability. Keep Alive RAM remains powered when the vehicle key is off so that this information is not lost.

Power and Ground Signals

Vehicle Power

When the key is turned to the start or run position, battery positive voltage (B+) is applied to the coil of the Electronic EC Power Relay. Since the other end of the coil is wired to ground, this energizes the coil and closes the contacts of the Electronic EC Power Relay. Vehicle power (VPWR) is now sent to the PCM and the Electronic EC System as VPWR.

Vehicle Reference Voltage

The Vehicle Reference Voltage (VREF) is a positive voltage (about 5.0 volts) that is output by the PCM. This is a consistent voltage that is used by the three-wire sensors.

Signal Return

The Signal Return (SIG RTN) is a dedicated ground circuit used by most Electronic EC sensors and some other inputs.

Power Ground

Power Ground (PWR GND) is an electric current path return for VPWR voltage circuit. The purpose of the PWR GND is to maintain sufficient voltage at the PCM.

Gold-Plated Pins

Some engine control hardware components have gold-plated pins on the connectors and mating harness connectors to improve electrical stability for low draw current circuits and to enhance corrosion resistance. The Electronic EC components equipped with gold terminals will vary by vehicle application.

NOTE: Damaged gold terminals should only be replaced with new gold terminals.

Diesel PCM Inputs

Air Conditioning Pressure Switch

The A/C Pressure Switch (ACPSW) (Figure 7) is used for additional A/C system pressure control. The ACPSW is either dual function for two speed electric fan applications or single function for all others. The ACPSW is also referred to as the Refrigerant Containment Switch (single function) or Refrigerant Containment/Fan Function Switch (dual function).

For refrigerant containment control, the normally closed high pressure contacts open at a predetermined A/C head pressure. This turns off the A/C by opening the A/C demand circuit, preventing the A/C pressure from rising to a level that would open the A/C High Pressure Relief Valve.

For fan function control, the normally open medium pressure contacts close at a predetermined A/C head pressure. This grounds the ACPSW circuit input to the PCM. The PCM will then turn on the high speed fan to help reduce the pressure.

For additional information, refer to the Service Manual Electrical Group, Ventilation/Climate Control Section.

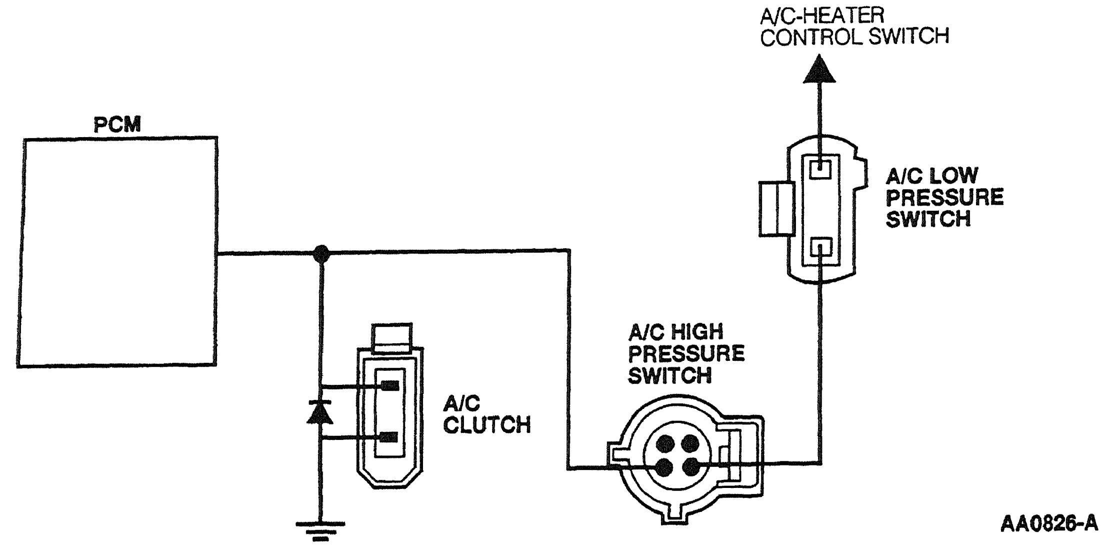


Figure 7: Air Conditioning Pressure Switch (ACPSW)

Brake Lamp Switch

The Brake Lamp Switch (Figure 8) signals the PCM with a battery positive voltage (B+) signal whenever the vehicle brake pedal is applied.

The signal informs the PCM to disengage the torque converter clutch.

If all the stoplamp bulbs are burned out (open), a high voltage is present at the PCM due to a pull-up resistor in the PCM. This provides fail-safe operation in the event the circuit to the Brake Lamp switch has failed.

Diesel PCM Inputs

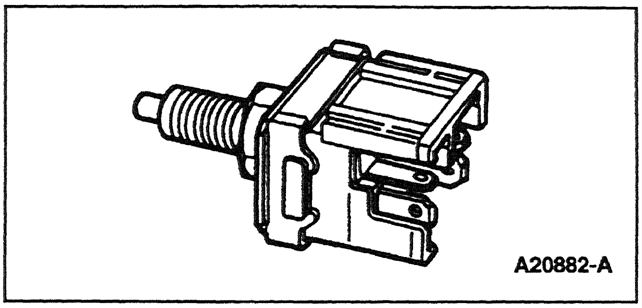


Figure 8: Brake Lamp Switch

Camshaft Position Sensor

The PCM receives engine rotational position information from the Camshaft Position (CMP) sensor (Figure 9). The CMP is a hall-effect device. It outputs 12 volts to the PCM whenever it detects the iron of a spoked target wheel in front of it, and it outputs 0 volts whenever it detects the space between the spokes. The target wheel spokes and spaces are each 15 crank degrees, except for narrow spoke which indicates cylinder No. 1 and a wide spoke which indicates cylinder No. 4 (fires 5th). The NGS PID RPM is generated by the PCM from the CMP signal.

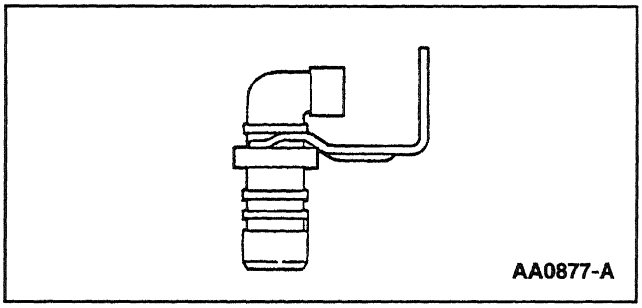


Figure 9: Camshaft Position (CMP) Sensor

Clutch Pedal Position Switch

The Clutch Pedal Position (CPP) switch (Figure 10) is an input to the PCM indicating the clutch pedal position. The CPP sends battery voltage to the PCM when the clutch is engaged (foot off of pedal) and zero voltage when the clutch is disengaged (pedal depressed).

Diesel PCM Inputs

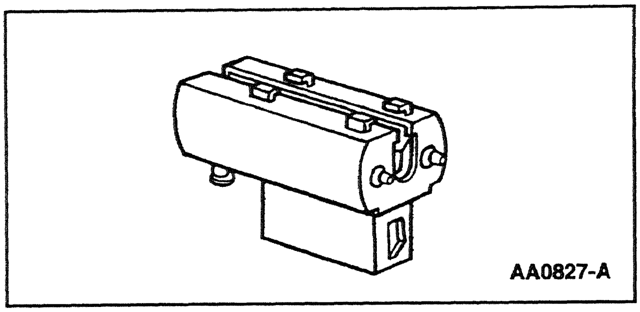


Figure 10: Clutch Pedal Position (CPP) Switch

Intake Air Temperature Sensor

The Intake Air Temperature (IAT) Sensors (Figure 11) are thermistor devices in which resistance changes with temperature. The electrical resistance of a thermistor decreases as the temperature increases, and increases as the temperature decreases. The varying resistance affects the voltage drop across the sensor terminals and provides electrical signals to the PCM corresponding to temperature.

Thermistor-type sensors are considered passive sensors. A passive sensor is connected to a voltage divider network so that varying the resistance of the passive sensor causes a variation in total current flow.

Voltage that is dropped across a fixed resistor in a series with the sensor resistor determines the voltage signal at the PCM. This voltage signal is equal to the reference voltage minus the voltage drop across the fixed resistor.

The IAT signal provides air temperature information to the PCM. The PCM uses the air temperature information to operate the Exhaust Back Pressure (EBP) system.

Diesel PCM Inputs

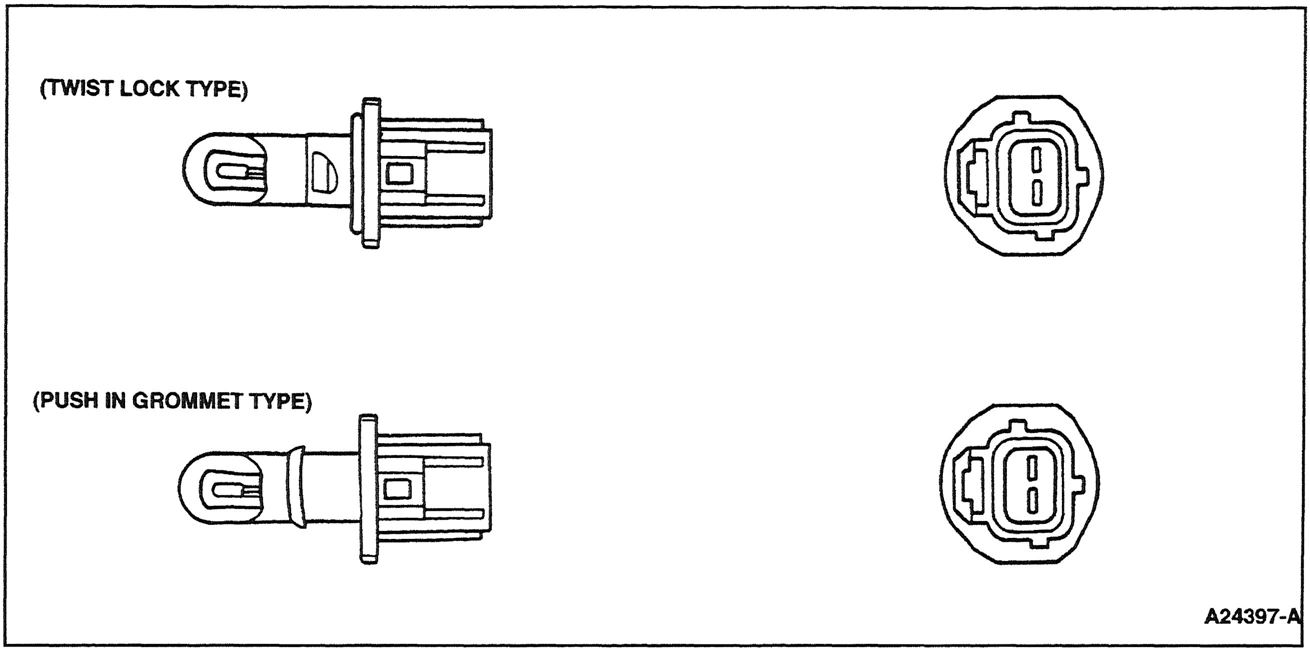


Figure 11: Intake Air Temperature (IAT) Sensor

Transmission Control Switch

The Transmission Control Switch (Figure 12) signals the PCM with key power whenever the transmission control switch is pressed. On vehicles with this feature, the Transmission Control Indicator Lamp (TCIL) (not shown) lights when the transmission control switch is cycled to disengage overdrive. The operator of the vehicle controls the position of the transmission control switch.

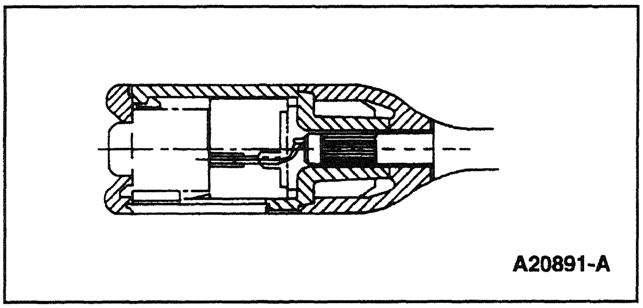


Figure 12: Column-Shift Transmission Control Switch

Diesel PCM Inputs

Vehicle Speed Sensor

For Econoline, the Vehicle Speed Sensor (VSS) (Figure 13) is a variable reluctance or Hall-effect type sensor that generates a waveform with a frequency that is proportional to the speed of the vehicle. If the vehicle is moving at a relatively low velocity, the sensor produces a signal with a low frequency. As the vehicle velocity increases, the sensor generates a signal with a higher frequency. The PCM uses the frequency signal generated by the VSS (and other inputs) to control such parameters as fuel injection, ignition control, transmission / transaxle shift scheduling and torque converter clutch scheduling.

For F-Series, the VSS signal is generated by the Programmable Speedometer / Odometer Module (PSOM). The PSOM generates VSS from a speed sensor on the rear axle.

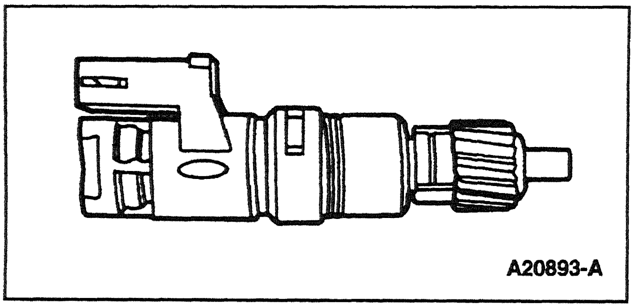


Figure 13: Vehicle Speed Sensor (VSS)

4x4 Low Switch

The 4x4 Low Switch sends a ground signal to the PCM when in 4x4L. This input is used to adjust the shift schedule.

Accelerator Pedal Sensor

The Accelerator Pedal (AP) sensor provides the PCM with the driver's demand for power. The AP sensor is a three-wire potentiometer that receives VREF from the PCM and returns a signal to the PCM directly proportional to the accelerator pedal position. The AP signal is used in calculating fuel quantity. Also, the AP input is used by the PCM to control the exhaust back-pressure regulator.

A PCM detected fault of the AP sensor will illuminate the Malfunction Indicator Lamp in the instrument cluster. An AP signal that is detected out of range, high or low, will cause the PCM to only allow the engine to operate at low idle.

Idle Validation Switch

The Idle Validation Switch verifies when the accelerator pedal is in the idle position. This switch protects against in-range failure of the AP sensor.

A PCM detected fault of the Idle Validation Switch will illuminate the Malfunction Indicator Lamp. An inoperative Idle Validation Switch detected by the PCM will only allow the engine to run at idle.

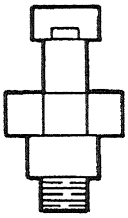
Diesel PCM Inputs

Exhaust Back-Pressure Sensor

The Exhaust Back-Pressure sensor is a variable capacitor sensor that is supplied a 5-volt reference signal by the PCM and returns a linear analog voltage signal that indicates pressure. The Exhaust Back-Pressure sensor measures the pressure in the RH exhaust manifold. This sensor is used in conjunction with the exhaust back-pressure regulator to form a closed loop exhaust back-pressure control system.

The exhaust back-pressure is controlled by the PCM to provide more heat to the coolant for cab heating when ambient air temperature is below 7 °C (45 °F) and engine oil temperature is below 75 °C (167 °F) during low load, low speed operating conditions.

An open or short in the Exhaust Back-Pressure sensor wiring will result in a low out of range voltage at the PCM, and the PCM will disable Exhaust Back-Pressure control.

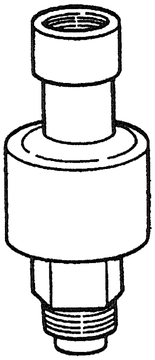


AA0828-A

Injection Control Pressure Sensor

The Injection Control Pressure sensor is a variable capacitor sensor that is supplied a 5-volt reference signal by the PCM and returns a linear analog voltage signal that indicates pressure. The sensor measures the oil pressure in the LH injection rail. PCM uses this information to determine injection control pressure. The Injection Control Pressure sensor along with the Injection Control Pressure Regulator form a closed loop fuel pressure control system.

If the PCM detects an inoperative Injection Control Pressure sensor, the PCM will control injection control pressure from a PCM-estimated injection control pressure.



AA0829-A

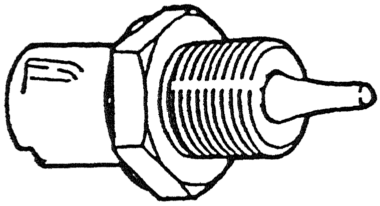
Diesel PCM Inputs

Engine Oil Temperature Sensor

The Engine Oil Temperature sensor is a thermistor mounted to the oil reservoir whose resistance decreases as engine oil temperature increases. The Engine Oil Temperature signal is used by the PCM to calculate fuel quantity, injection timing, glow plug operation and exhaust back-pressure.

At oil temperatures below 50°C (122°F), low idle is increased to a maximum of 900 rpm to increase engine warm-up. Fuel quantity and timing is controlled throughout the total operating range to provide adequate torque and power.

An Engine Oil Temperature signal detected out of range, high or low, by the PCM will cause the PCM to assume an engine oil temperature of 20°C (68°F) for starting purposes and 100°C (212°F) for operating purposes. The Malfunction Indicator Lamp in the instrument cluster will be illuminated as long as the fault condition exists.

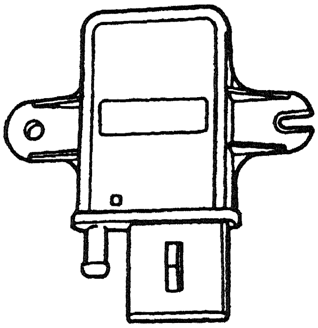


AA0830-A

Digital Manifold Absolute Pressure Sensor

The digital Manifold Absolute Pressure (MAP) sensor is a variable capacitor sensor that is supplied a 5-volt reference signal by the PCM and returns a digital frequency signal to the PCM relative to intake manifold pressure. The sensor frequency increases as pressure increases. The MAP sensor allows the PCM to determine engine load to calculate fuel quantity. In addition, the MAP signal is used to control smoke by limiting fuel quantity during acceleration until a specified boost pressure is obtained.

A MAP signal fault detected by the PCM will cause the PCM to calculate an estimated manifold pressure based on known engine conditions.



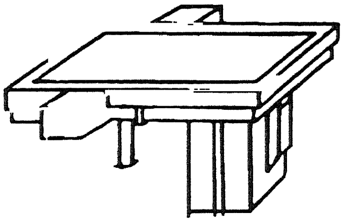
AA0831-A

Diesel PCM Inputs

Analog Manifold Absolute Pressure Sensor

The analog Manifold Absolute Pressure (MAP) sensor is a variable capacitor sensor that is supplied a 5-volt reference signal by the PCM and returns a voltage signal to the PCM relative to intake manifold pressure. The sensor voltage increases as pressure increases. The MAP sensor allows the PCM to determine engine load to calculate fuel quantity. In addition, the MAP signal is used to control smoke by limiting fuel quantity during acceleration until a specified boost pressure is obtained.

A MAP signal fault detected by the PCM will cause the PCM to calculate an estimated manifold pressure based on known engine conditions.

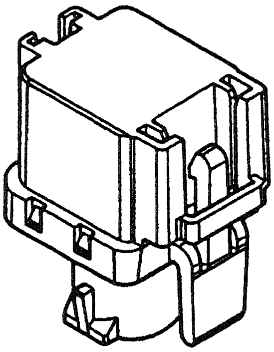


DA1453-A

Barometric Pressure Sensor

The Barometric Pressure (BARO) sensor is a variable capacitor sensor that is supplied a 5-volt reference signal by the PCM and returns a linear analog voltage signal which indicates atmospheric pressure. This allows the PCM to compensate for altitude. The PCM uses this information to calculate injection timing and glow plug control.

An open in the BARO sensor circuit will result in an out-of-range low signal to the PCM. Any other wiring faults will result in an out-of-range condition. The PCM will assume a default value of 100 kPa (14.5 psi).



AA0832-A

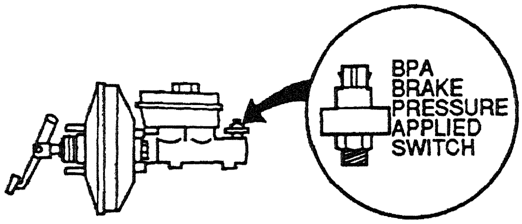
Parking Brake Signal Switch

The Parking Brake Signal switch indicates when the parking brake is applied. The Parking Brake Signal switch is located under the instrument panel. The Parking Brake Signal switch will deactivate speed control if the parking brake is applied during speed control operation.

Diesel PCM Inputs

Brake Pressure Applied

The Brake Pressure Applied switch is a hydraulically-actuated pressure switch that senses brake pressure and provides a back-up to the stoplight switch to deactivate speed control. The switch is totally independent (mechanically and electrically) from the brake lamp switch. The Brake Pressure Applied switch actuates after the Stoplight switch actuates. When the brake pedal is depressed, the switch is open. When the brake pedal is released, the switch is closed. The Brake Pressure Applied switch is located on the brake master cylinder.



AA0833-A

Speed Control Command Switches

The Speed Control Command Switches are momentary switches which are located on the steering wheel. They consist of one ON-OFF switch and one SET/ ACCEL-COAST-RESUME switch. These switches, when pressed, select one of several resistance values which is sent to the PCM to select speed control functions.

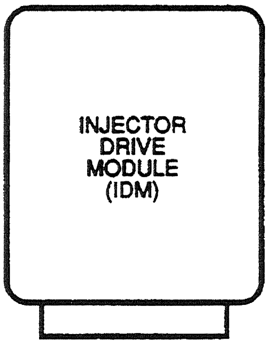
Injector Driver Module Feedback

The Injector Driver Module (IDM) provides an EF signal to the PCM which confirms that proper timing / duration of the PCM command was received by the IDM. The EF signal is also used to send diagnostic information about the IDM and fuel injector circuitry.

Diesel PCM Outputs

Injector Driver Module

The Injector Driver Module controls power to the fuel injectors based on information received from the PCM. The Injector Driver Module receives two digital control signals from the PCM: the Fuel Delivery Control Signal and the Camshaft Position signal. The Fuel Delivery Control Signal is used by the Injector Driver Module to control injection timing and injection duration. The CMP signal provides synchronization to the engine's first and the fifth injector (firing order, cylinders number one and four). The Injector Driver Module verifies that Fuel Delivery Control Signal and CMP occur at valid timing intervals for synchronization.

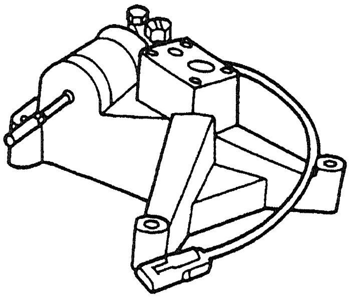


AA0834-A

Exhaust Back Pressure Regulator

The exhaust back pressure is controlled to provide more heat to the coolant for cab heating when ambient air temperature is below 5°C (40°F) and engine oil temperature is between -10°C (15°F) and 83°C (182°F) during low load, low speed operating conditions. At high load, high speed conditions, the back pressure system is disabled.

The exhaust back pressure regulator solenoid and exhaust back pressure piston are contained in the turbocharger mounting pedestal. Turbocharger pressurized lube oil is routed to the exhaust back pressure solenoid. Oil regulated by the exhaust back pressure solenoid actuates the piston which operates the back pressure valve in the exhaust housing.



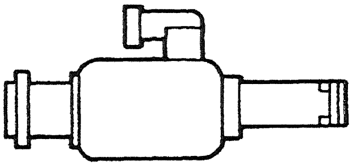
AA0835-A

Diesel PCM Outputs

Injection Pressure Regulator

The Injection Pressure Regulator controls injection oil pressure. An electrical signal to a solenoid creates a magnetic field which applies a variable force on a valve servo to control pressure. The quantity of fuel delivered to the combustion chamber is proportional to injection control pressure.

An open circuit will result in minimum oil pressure and a no-start situation. A short circuit results in maximum oil pressure, and is limited by a mechanical pop-off valve to 27,580 kPa (4000 psi).

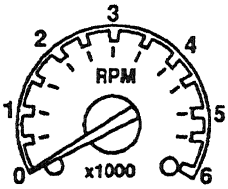


AA0836-A

Tachometer Output

The Tachometer Output provides a signal from the PCM to the instrumentation system. The signal is a buffered representation of the Camshaft Position Sensor (CMP). The tachometer is part of the instrument cluster.

An open or short circuit of the tachometer output wiring will result in an inoperative tachometer.



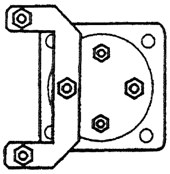
AA0837-A

Glow Plug Relay Control

The Glow Plug (GP) Relay Control is used to energize the glow plugs for assisting cold engine start-up. Engine Oil Temperature, battery positive voltage (B+), and Barometric Pressure (BARO) are used by the PCM to calculate glow plug on-time and the length of the duty cycle. On-time normally varies between 10 and 120 seconds. With colder oil temperatures and lower barometric pressures, the plugs are on longer. If battery voltage is abnormally high, the duty cycle is shortened to extend plug life. (The glow plug relay will only cycle on and off repeatedly when there is a system high voltage condition greater than 16 volts.)

Diesel PCM Outputs

An open in the glow plug relay circuit will render the glow plugs inoperative. A short circuit will result in a glow plug's always ON condition.



AA0838-A

Glow Plug Light Signal

The Glow Plug (GP) light signal controls the WAIT TO START indicator light located on the instrument panel. When the light goes off, the engine is ready to be started. The light comes on every time a key on reset occurs. On-time normally varies between 1 and 10 seconds. WAIT TO START light on-time is independent of glow plug relay on-time because the glow plugs may stay on to improve performance until engine reaches operating temperature.

An open circuit in the glow plug light wiring will result in an inoperative glow plug light. A short circuit will result in a glow plug light always ON condition.

AA0839-A

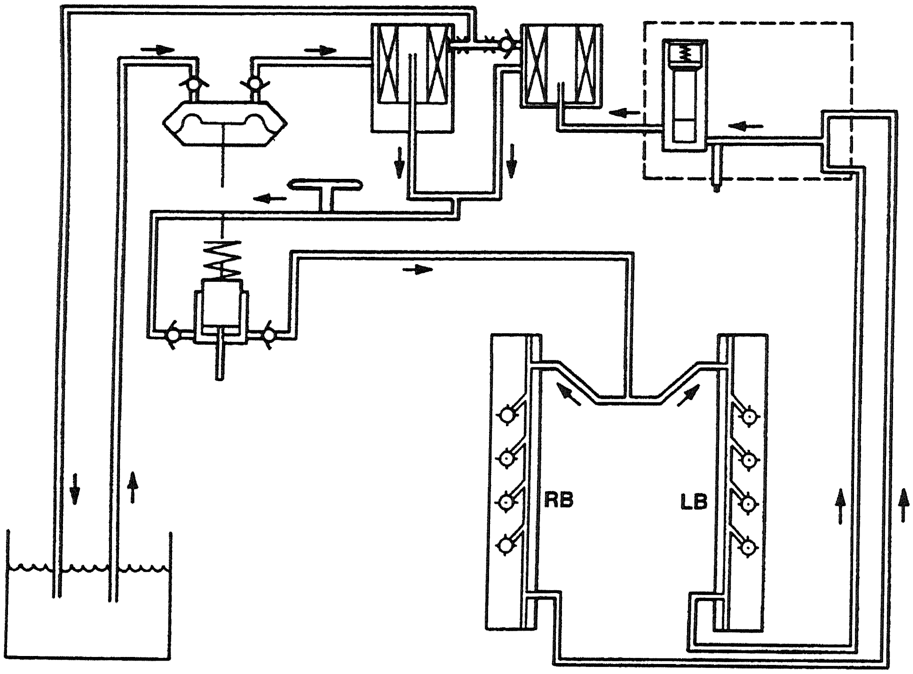
Diesel Fuel System

1998

Fuel is drawn from the fuel tank through the primary filter by the diaphragm section of the tandem fuel pump. Pressurized fuel (approximately 28 kPa (4 psi) is supplied to the secondary filter and returned to the second stage of the tandem fuel pump. The piston-actuated second stage of the tandem fuel pump supplies 276-483 kPa (40-70 psi) of fuel to the rear of each cylinder head where it flows to a fuel rail machined in each cylinder head.

Drillings in the cylinder head route the fuel to the plunger area of the fuel injector which can pressurize the fuel to 124 MPa (18,000 psi) for delivery to the combustion chamber via a conventional nozzle/valve tip arrangement.

Return fuel is plumbed from fittings at the front of each cylinder head to a regulator block which contains a piston/spring type regulator valve that maintains pressure to approximately 345 kPa (50 psi). A de-aeration bleed orifice between the fuel filter and the regulator block vents air trapped in the fuel filter. Most of the fuel from the regulator is recirculated to the inlet of the piston (high pressure) stage of the transfer pump. Fuel return to the tank is limited by the fuel filter bleed orifice and a 0.0008 mm (0.020-inch) fuel return bleed orifice. This prevents the fuel from overheating in the tank. A diaphragm accumulator is included on California and all Econoline vehicles.



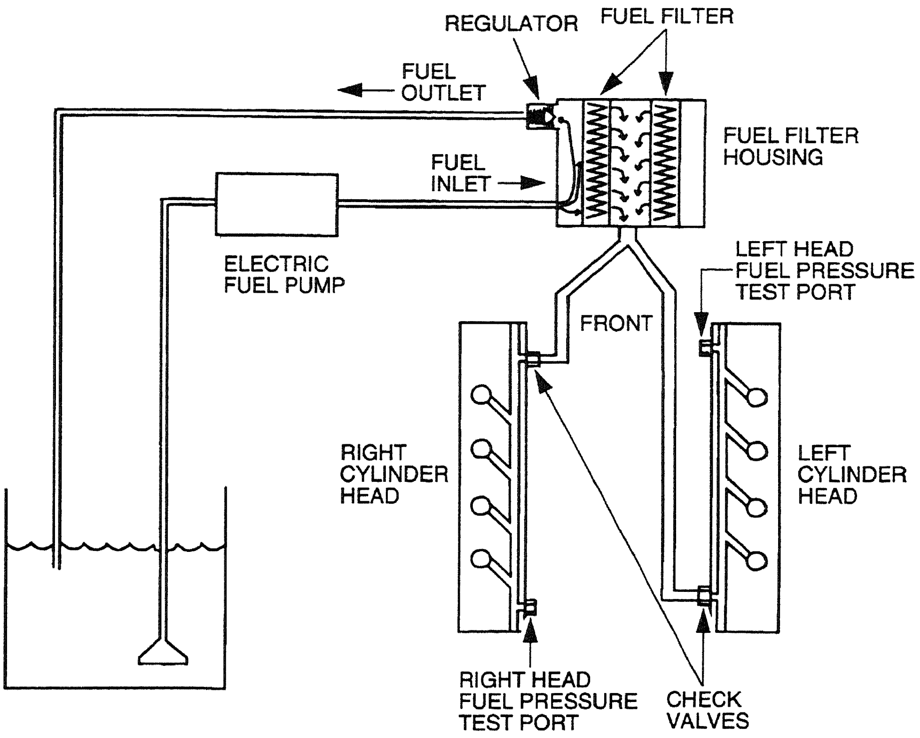
AA0439-B

This system is controlled by the PCM and is composed of the unit injectors, the high pressure oil system, the Injection Driver Module, and the fuel supply system.

Diesel Fuel System

1998-1/2 Econoline with Electric Fuel Pump and 1999 F-Series

Fuel is drawn from the fuel tank through the primary filter (the screen on the fuel tank sending unit) by the electric fuel pump. Pressurized fuel (approximately 276-552 kPa [40-80 psi) is supplied to the secondary filter (the fuel filter housing located in the V on top of the engine) by means of the electric pump and regulator valve. The regulator relieves the pressure, sending fuel back to the fuel tank. Only the filtered fuel going through the fuel filter will go to the heads. A check valve is located on both heads to prevent fuel pressure spikes in the fuel rail.

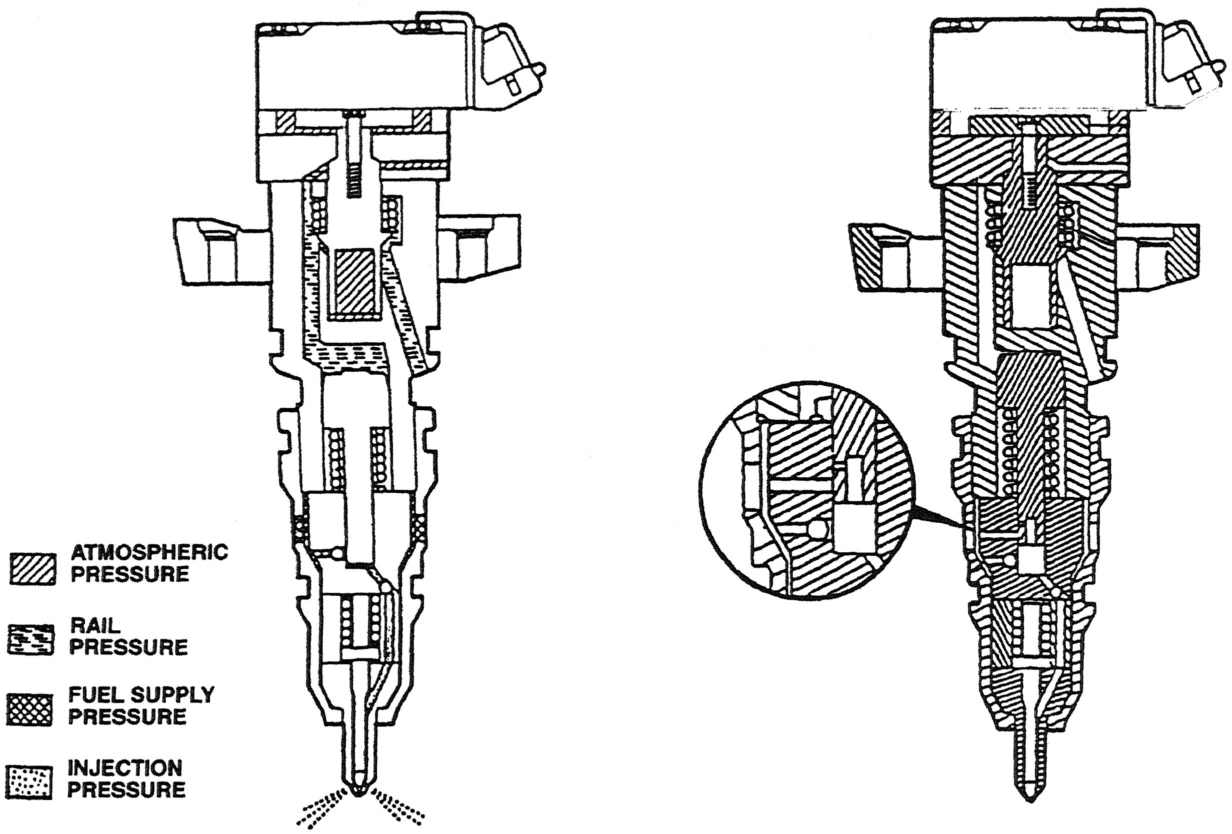


DA1369-A

Diesel Fuel System

Unit Injector

The unit injector is composed of five major components: The electronic solenoid, the poppet valve, the amplifier piston, the fuel plunger and the nozzle assembly. Operation of the injector is included in the following description.



49 STATES EXCEPT ECONOLINE

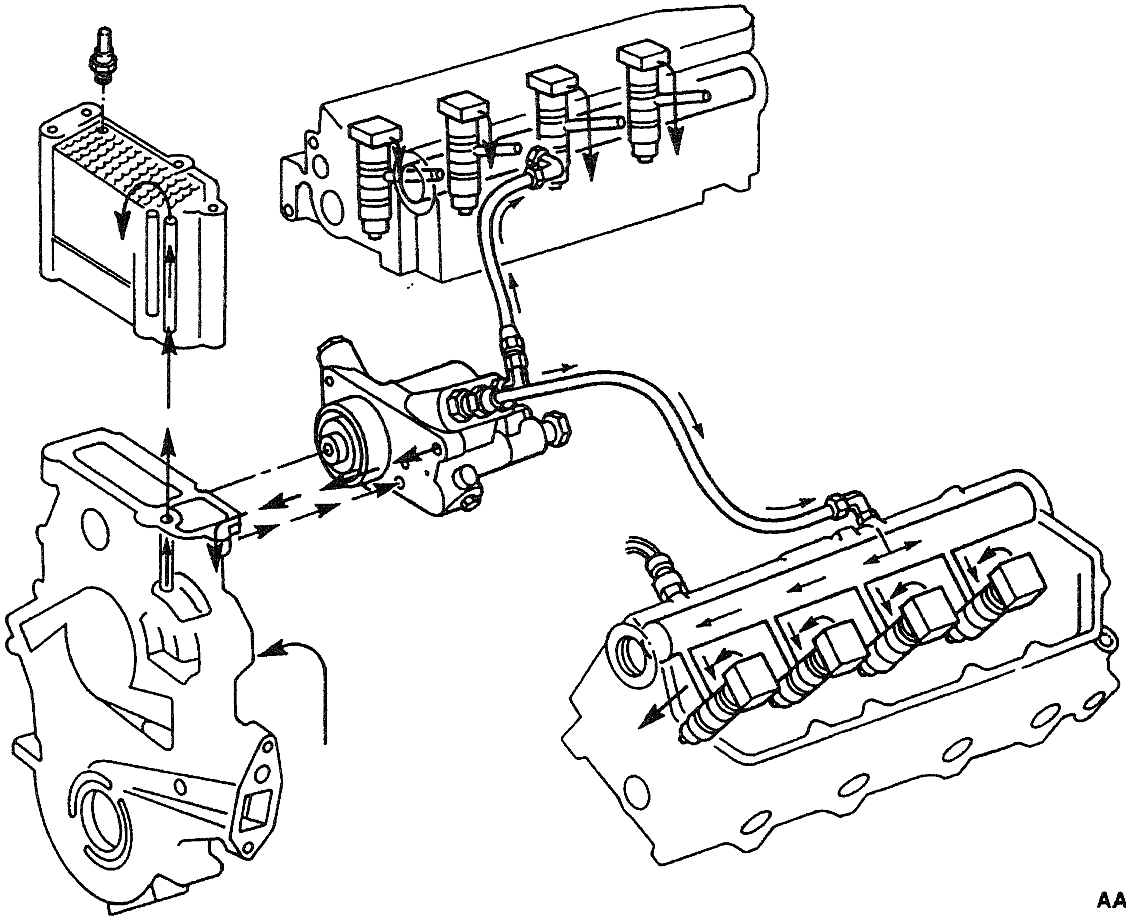
CALIFORNIA AND ALL ECONOLINE

AA0440-B

Diesel Fuel System

High Pressure Oil System

The 7.3L Powerstroke diesel injectors are powered by lubricating oil which is pressurized by a special swashplate pump (Rexroth pump) in the engine valley. The pump output pressure ranges from 3,102 to 20,685 kPa (450 psi to 3,000 psi). This oil pressure is controlled by the Powertrain Control Module (PCM) with a spill valve called the Injector Pressure Regulator. The high pressure oil is delivered to oil rails in the cylinder heads. An Injection Control Pressure sensor mounted on one of the oil rails sends an analog voltage signal (0.5V to 5.0V) to the PCM for feedback control of the oil pressure.



AA0441-A

Unit Injector Amplifier Piston

The high pressure oil flows from the oil rails into an amplifier piston located in the injector. Oil entry and exit to and from the amplifier piston is controlled by a solenoid-operated poppet valve.

Unit Injector Fuel Plunger

The fuel plunger is located in the injector and is driven by the amplifier piston. The fuel plunger injects fuel into the combustion chamber at pressures of up to 144,795 kPa (21,000 psi) through the nozzle assembly. Fuel is supplied to the fuel at approximately 483 kPa (70 psi) through fuel rails in the cylinder heads.

Diesel Fuel System

Injection Driver Module

The solenoid-operated poppet valve requires 115 volts at up to 8 amps to operate, which is more power than the PCM can supply. Therefore, a high power device, the Injection Driver Module, is used to supply power to the solenoid on command from the PCM.

PCM Control of Fuel Injection

The command signal from the PCM to the Injection Driver Module is the Fuel Delivery Control Signal. The poppet requires 12 volts to command the poppet open and 0 volts to command the poppet closed. The PCM also supplies a synchronizing signal, CMP, to indicate cylinder No. 1 (going from 0 to 12 volts) and cylinder No. 4 (fires 5th) (going from 12 to 0 volts).

Engine Timing

The PCM controls both duration and timing of the injection event with the fuel delivery control signal. Signal duration, or fuel pulse width, is shown as Parameter ID (PID) "FUEL__PW" on the New Generation Star (NGS) Tester 007-00500.

The PCM controls the fuel plunger injection pressure and fuel volume by varying the injection oil pressure with the Injection Pressure Regulator. The command to the Injection Pressure Regulator is a 12 volt, Pulse Width Modulated (PWM) signal (controlled on the ground side).

The injection oil pressure command is shown as NGS PID IPR which is the percentage ON of the pulse width modulated signal. Injection oil pressure is shown as NGS PID ICP.

The PCM receives engine rotational position information from the Camshaft Position sensor (CMP). The CMP is a hall-effect device. It outputs 12 volts to the PCM whenever it detects the iron of a spoked target wheel in front of it, and it outputs 0 volts whenever it detects the space between the spokes. The target wheel spokes and spaces are each 15 crank degrees, except for narrow spoke which indicates cylinder No. 1 and a wide spoke which indicates cylinder No. 4 (fires 5th). The NGS PID RPM is generated by the PCM from the CMP signal.

Fueling Corrections

The PCM adjusts injector output based on oil temperature information received from the Engine Oil Temperature sensor and turbo boost information received from the Manifold Absolute Pressure (MAP) Sensor, and the Barometric pressure (BARO) sensor. These corrections are necessary to meet emissions requirements and to optimize power. Outputs of these sensors are displayed on the NGS tester as EOT (temperature), MAP (pressure), MAP H (sensor frequency), BARO (pressure), and BARO V (volts). MGP shows boost, which is MAP minus BARO pressure.

Diesel Intake Air Systems

Intake Air System

This is similar to a gasoline system except it processes more air. It includes a filter minder to indicate when the air filter is clogging. The system feeds into the turbocharger compressor. Econoline systems include a resonator.

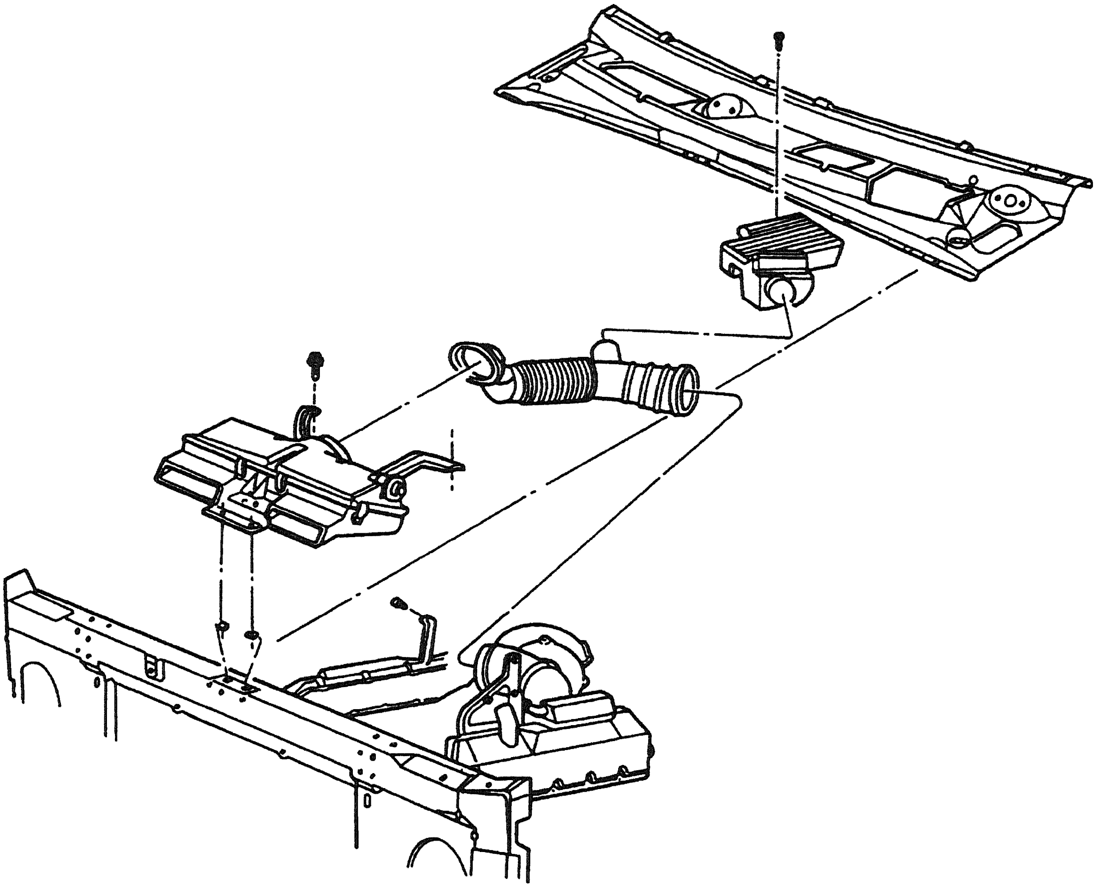


Figure 14: Engine Air Cleaner, 7.3L Diesel Engine—Econoline

Diesel Intake Air Systems

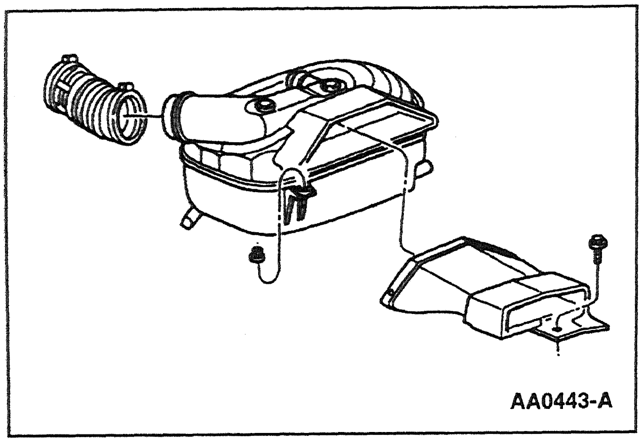


Figure 15: Engine Air Cleaner Installation, 7.3L Direct Injection Diesel Engine—F-Series

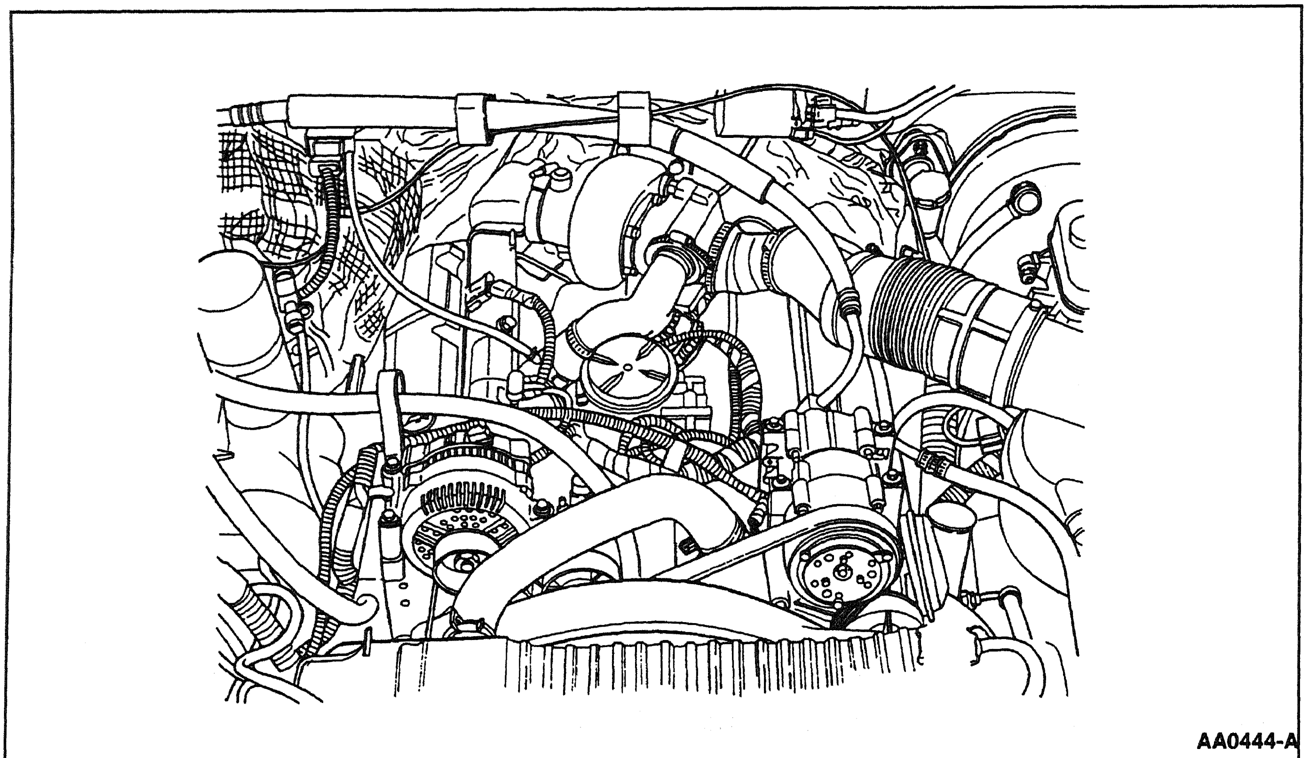


Figure 16: Turbocharger Intake Air Tube Assembly

Diesel Catalyst and Exhaust Systems

Catalytic Converter

The Diesel catalytic converter is designed to only oxidize the ''soluble oil fraction'' of diesel hydrocarbons. Other hydrocarbons, NOX, CO, and particulates are controlled in the combustion process. Diesels do not use heated oxygen sensor because properly fueled diesels run with excess oxygen under most running conditions.

SECTION 2

Diagnostic Methods

Contents

SECTION 2

Diagnostic Methods

Contents (continued)

SECTION 2

Diagnostic Methods

Contents (continued)

Diagnostic Methods

Overview

The Diagnostic Methods section provides detailed instructions on how to access or perform routine diagnostic tasks. This section can be referenced as many times as needed for step-by-step instructions for routine procedures.

When performing powertrain diagnostics, the system may be checked by an off board tester referred to as a scan tool. This section contains instructions for performing diagnostics with the New Generation Star (NGS) Tester.

Diagnostic Tools

Required Equipment

- New Generation Star (NGS) Tester 007-00500 or equivalent
- 104-Pin Breakout Box 014-00950 or equivalent
- 23 Multimeter 105-00050 or equivalent. Input impedance 10 megaohm minimum.
- 5 / 16-inch Fuel Line Disconnect Tool (Gray) T90T-9550-B or equivalent.
- 3 / 8-inch Fuel Line Disconnect Tool (Blue) T90T-9550-C or equivalent.
- Oil High Pressure Leakage Test Adapter Set D94T-6600-A or equivalent.
- Low Fuel Pressure Adapter 014-00931-2 or equivalent.
- High Fuel Pressure Adapter 014-00931-3 or equivalent.
- Glow Plug Adapter Compression Tool 014-00931-1 or equivalent.
- Crankcase Pressure Test Adapter 5631 or equivalent.
- Glow Plug Injector Adapter 014-00935 or equivalent.
- Crankcase Orifice Restrictor Tool 014-00743 or equivalent.
- ICP / EBP Adapter Cable D94T-50-A or equivalent.
- Pressure Test Adapter Kit 014-00761 or equivalent.
- Compression Test Kit 134-00085 or equivalent.

Optional Equipment

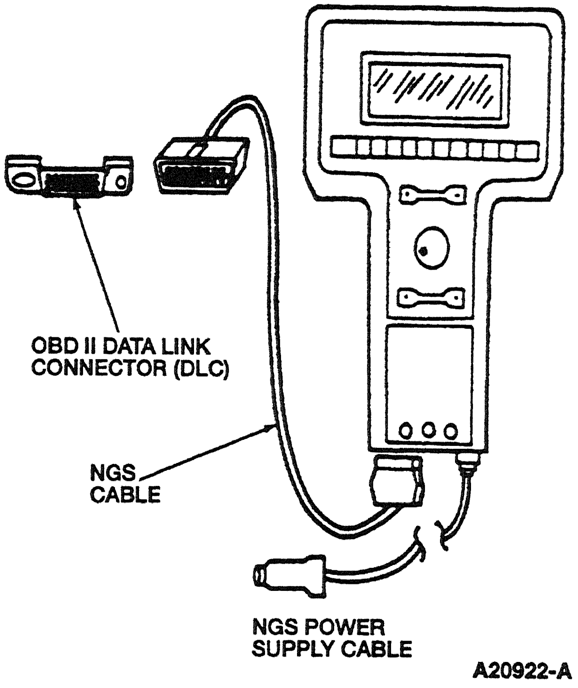
- R134A Manifold Gauge Set 176-R932A or equivalent.
- Non-powered test lamp.
- Service Bay Diagnostic System® (SBDS®) 001-00001.
- Vacuum / Pressure Tester 164-R0253 or equivalent. Range 101.3 kPa (0.30 in-Hg). Resolution 3.4 kPa (1 in-Hg).
- Fuel / Oil / Turbo Protector Cap Set T94T-9395-AH or equivalent.

SBDS ® is a stand-alone system containing universal testers and meters, specialized diagnostic tools and guided diagnostics. OASIS, Electrical and Vacuum Troubleshooting Manuals (EVTMs), Powertrain Control / Emissions Diagnosis (PC / ED) manuals, and Technical Service Bulletins (TSBs) are also available on SBDS®.

NOTE: Refer to equipment user's manual for details on tool accessories and function.

Scan Tool Hookup

The NGS Tester or generic scan tool must be connected to the Data Link Connector (DLC) for communication with the vehicle.



Data Link Connector

The DLC is located in the passenger compartment. It is attached under the dash-board and accessible from the driver's seat.

The DLC is rectangular in design and capable of accommodating up to 16 terminals. The connector has keying features to allow easy connection. The vehicle connector and the test equipment connector have latching features that ensure the test equipment connector will remain mated when properly connected.

The NGS Tester is capable of many functions. Some of these are as follows.

— Monitor, Record and Playback of PIDS

— Diagnostic Test Modes / Clear Diagnostic DTCs (PCM Reset)

— Digital Measurement System (DVOM, Duty Cycle and Pulse Width Meter)

— Diagnostic Monitoring Test Results (for OBD II On-Board Monitoring)

— On-Board System Readiness (OBD II Monitor Completion Status)

— Clear and Retrieve 4WABS Codes

Some of these functions are described in this section.

Scan Tool Hookup

Refer to the NGS Tester Instruction Manual or scan tool manufacturer's manual for specific information on scan tool setup and operation. Contact Rotunda for the latest version of the NGS Tester Instruction Manual at 1-800-ROTUNDA.

NOTE: You must recycle the key between each self test.

New Generation Star (NGS) Tester

- Key off.
- Verify that the proper memory (EPROM) card is inserted in the NGS Tester.
- Connect DLC adapter cable to the NGS Tester.
- Connect NGS Tester DLC adapter cable securely into the vehicle DLC.
- Connect the NGS Tester power supply cable to vehicle battery power supply through cigarette lighter, at the vehicle battery with alligator clip adapter, at the dashboard power point or into the pigtail power connector attached to the DLC adapter cable.
- Turn ignition key to the on position or start vehicle if necessary. The NGS Tester is ready to communicate with vehicle computers.
- Follow instructions on the NGS Tester or in the diagnostic manual.
- To disconnect NGS Tester, turn ignition key to the off position and disconnect NGS Tester from DLC and power supply.

Generic Scan Tool

- Refer to scan tool manufacturer's manual for specific cables and / or adapters required for scan tool hookup.

Communication Error

It is possible to get a communication error from a scan tool when initiating a test or viewing PIDs. The communication error could be caused by operator error, the vehicle wiring or connectors, or the powertrain control module (PCM) and other control modules connected to the DLC wiring. The PCM will respond to a scan tool whenever the scan tool requests a test. Some are normal responses to valid requests. The others are communication error responses. If the scan tool displays any of the communication error responses, refer to Section 5, Pinpoint Test QA — Step QA1, after checking scan tool connections, cable / adapters and entry of vehicle information. Verify auxiliary powertrain control (rpm control) is off when trying to perform self tests.

Quick Test Description

Quick Test is divided into eight specialized tests:

(1) Retrieve / Clear Continuous DTCs

(2) Key On Engine Off (KOEO) On-Demand Self Test

(3) Key On Engine Off (KOEO) Injector Electrical Self Test

(4) Key On Engine Off (KOEO) Output State Self Test

(5) Key On Engine Running (KOER) On-Demand Self Test

(6) Key On Engine Running (KOER) Switch Self Test

(7) Key On Engine Running (KOER) Cylinder Contribution Self Test

(8) Key On Engine Running (KOER) Glow Plug Monitoring Self Test

All eight are described below.

Quick Test checks the integrity and function of the EEC-V Powertrain Control system and outputs the test results upon demand. Quick Test also provides a quick end check of the powertrain control system and is usually performed at the start of each diagnostic procedure. It is also performed at the end of most pinpoint tests for verification of repair and to make sure no other faults were incurred while servicing a previous fault.

All self tests are completely menu driven in the New Generation Star (NGS) Tester.

NOTE: Retrieving continuous DTCs must be performed separately from KOEO Quick Tests.

Retrieve / Clear Continuous DTCs

Retrieve / Clear Continuous DTCs is a functional test of the PCM. DTCs can be retrieved or cleared with the key on and the engine off or running. Unlike KOEO and KOER self tests, which can only be activated on demand, the Continuous monitor is always active in monitoring the system. When a fault is detected, a code will be stored in memory to be retrieved at a later date, making it possible to diagnose intermittent faults. For California vehicles, P1000 DTC may be the only code displayed, indicating an incomplete OBD II drive cycle (more drive time needed). The IDM stores both historical and hard IDM fault codes. To retrieve IDM fault codes, you must run KOEO On Demand Self Test or KOEO Injector Electrical Self Test. The only way to clear IDM DTCs is to Clear Continuous even though IDM codes do not show up on the Continuous display.

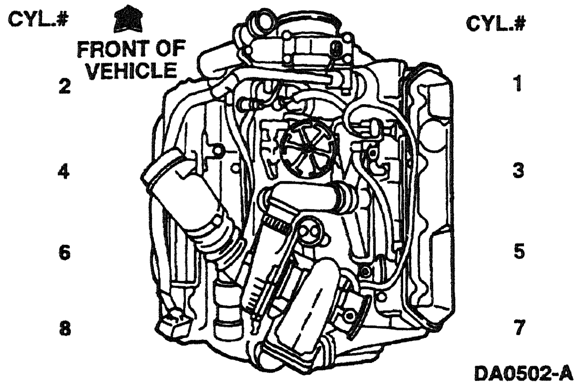
Key On Engine Off (KOEO) On-Demand Self Test

Key On Engine Off (KOEO) On-Demand Self Test is a functional test of the PCM performed on demand with the key on and the engine off. This test will check that all inputs and outputs (circuits, sensors, regulators, relays and solenoids) connected to the PCM are electrically operating without fault, with the exception of the Injector Driver Module DTCs. The IDM stores both historical and hard IDM fault codes; to ensure that IDM DTC is a hard fault, you must first clear continuous DTCs (be sure to record all fault codes before clearing). After clearing, rerun self test; a fault must be present at the time of testing for the KOEO On Demand Self Test to detect the fault. If a fault is detected, a Diagnostic Trouble Code (DTC) will be the output on the data link at the end of the test when requested by a scan tool. Only a hard fault code (DTC) will be displayed.

Quick Test Description

Key On Engine Off (KOEO) Injector Electrical Self Test

Key On Engine Off (KOEO) Injector Electrical Self Test is a functional test of the PCM performed on demand with the key on and the engine off. This test determines if the injector circuits and solenoids are electrically operating without fault. All injectors will first buzz (audible feedback of the injector solenoids energizing the injector valves) together for approximately 2 seconds, then each injector will buzz for approximately 1 second in numerical order (1 through 8). The IDM stores all historical IDM fault codes; to ensure that the DTC is a hard fault, you must first clear continuous DTCs (be sure to record all IDM fault codes before clearing). After clearing, rerun self test; a fault must be present at the time of testing for the KOEO Injector Electrical Self Test to detect the fault. If a fault is detected, a Diagnostic Trouble Code (DTC) will be the output on the data link at the end of the test when requested by a scan tool. Only a hard fault code (DTC) will be displayed.



Key On Engine Off (KOEO) Output State Self Test

Key On Engine Off (KOEO) Output State Self Test is a functional test of the PCM performed on demand with the key on and the engine off. This test is designed to cycle outputs high and low. After pressing the trigger to start the test, you must then depress and release the accelerator pedal to cycle the outputs high: solenoids, wait to start lamp, IDM relay, TCIL, FDCS, CID and EF. The second time the accelerator pedal is depressed and released the outputs are cycled low, with the exception of the glow plug relay (for 1998-1/2 Econoline with electric fuel pump and 1999 F-Series), which is cycled on for 5 seconds the first time only that the accelerator is pressed and released. This Self Test does not set any codes.

Key On Engine Running (KOER) Switch Self Test

Key On Engine Running (KOER) Switch Self Test is a functional test of the PCM performed on demand with the engine running. This test is designed to set DTC(s) if the test does not detect a transition on one or more of the switches. After pressing the trigger to start the test, wait 5 seconds before running through the driver-operated controls to eliminate the chance of setting a false IVS code. The accelerator pedal must first be depressed and released to begin test, then the Parking Brake, Speed Control ON, OFF, SET, RESUME, COAST, Transmission Control or Clutch. The last to be depressed and released must be the brake pedal, which will test both the brake pressure applied (BPA) switch and the brake ON/OFF (BOO) switch.

Quick Test Description

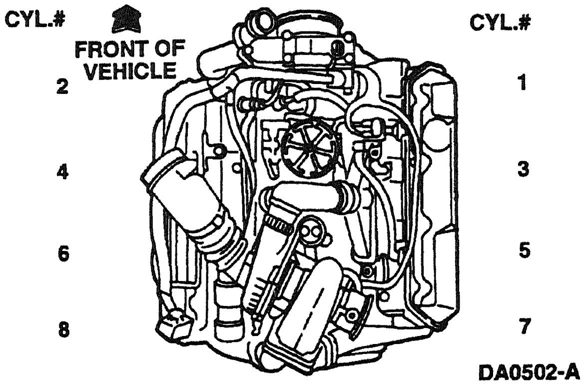
Key On Engine Running (KOER) On-Demand Self Test

Key On Engine Running (KOER) On-Demand Self Test is a functional test of the PCM performed on demand with the engine running. Temperature is not a factor, but A / C must be turned off. A check is made on the injection control pressure (ICP) and exhaust back pressure (EBP) systems. During this test, engine rpm will increase; the PCM will first command ICP high and low, then command EBP high and low. A fault must be present at the time of testing for the KOER On Demand Self Test to detect a fault. If a fault is detected, a Diagnostic Trouble Code (DTC) will be the output on the data link at the end of the test when requested by a scan tool. Only a hard fault code (DTC) will be displayed.

Key On Engine Running (KOER) Cylinder Contribution Self Test

1998

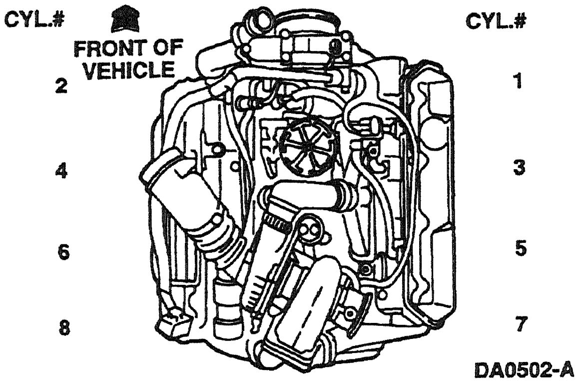
Key On Engine Running (KOER) Cylinder Contribution Self Test is a functional test of the PCM performed on-demand with the engine running, A / C off and engine oil temperature above 76.6°C (170 °F). This test will determine if all cylinders are contributing equally to engine performance. The PCM will test the cylinders in this order (1 through 8). This test consists of two portions. First, the 8-cylinder test checks for a non-contributing cylinder; then the 4-cylinder test detects a weak cylinder. The 4-cylinder portion of the test will never run if a fault is detected on the 8-cylinder portion of the test. The engine will give off smoke and rpm will vary for each test, although you will not hear an rpm difference between good and bad cylinders during the test. A fault must be present at the time of testing for the KOER Cylinder Contribution Self Test to detect a fault. If a fault is detected, a DTC will be output on the data link at the end of the test when requested by a scan tool. Only a hard fault code (DTC) will be displayed.



Quick Test Description

1998-1/2 Econoline with Electric Fuel Pump and 1999 F-Series

Key On Engine Running (KOER) Cylinder Contribution Self Test is a functional test of the PCM performed on-demand with the engine running, A/C off and engine oil temperature above 21°C (70 °F). This test will determine if all cylinders are contributing equally to engine performance. The PCM will test all 8 cylinders continuously during the test; there is no change in engine speed or operation that can be detected by the technician. The test checks for cylinder-to-cylinder decrease in speed, and sets a code if the decrease is too high. The test consists of three portions. Each portion runs for 20 seconds. The first test checks for a badly missing injector or cylinder with no compression, and the second and third tests check for weak injectors or low compression cylinders. A fault must be present at the time of testing for the KOER Cylinder Contribution Self Test to detect a fault, so the engine operating condition at which the idle is the worst will produce the best test results. For automatic transmission vehicles, the best results are reached with the parking brake set and the transmission in DRIVE. If a fault is detected, a Diagnostic Trouble Code (DTC) will be output on the data link at the end of the test when requested by a scan tool. Only a hard fault code (DTC) will be displayed.



Key On Engine Running (KOER) Glow Plug Monitor Self Test

1998

Key On Engine Running (KOER) Glow Plug Monitor Self Test is a functional test of the PCM performed on demand with the engine running and the A/C off. This test will activate the glow plug relay and detect any difference in the amount of current between both banks. Battery voltage must be 11.8-14 volts to complete the test. It may be necessary to raise engine rpm to maintain battery voltage. A fault must be present at the time of testing for the KOER Glow Plug Monitor Self Test to detect a fault. If a fault is detected, a Diagnostic Trouble Code (DTC) will be output on the data link at the end of the test when requested by a scan tool. Only a hard fault code (DTC) will be displayed.

Quick Test Description

1998-1/2 Econoline with Electric Fuel Pump and 1999 F-Series

Key On Engine Running (KOER) Glow Plug Monitor Self Test (California only) is a functional test of the PCM performed on demand with the engine running and the A/C off. The test will raise engine speed to 1200 rpm to maintain a system voltage of 11.5-14 volts. The PCM will activate the glow plug relay and monitor the glow plug circuits. A fault must be present at the time of testing for the test to detect a fault. If one bank is reading less than 32 amps or one bank is reading at least 8-1/2 amps lower than the other bank, a fault will be detected and a Diagnostic Trouble Code (DTC) will be output on the data link at the end of the test when requested by a scan tool. Only a hard fault code (DTC) will be displayed.

MIL DTCs

MIL DTCs are generated to alert the driver that there is a concern with the system or the vehicle is in Failure Management Effects Mode (FMEM). MIL DTCs are also used to indicate an emission concern for California vehicles. Non-MIL DTCs indicate a less serious or non-emission related concern with the system.

Quick Test Operation

Quick Test is performed by retrieving KOEO, KOER, and Continuous DTCs.

Special Notes

Before running Quick Test, always perform the necessary visual checks and safety precautions listed below.

Visual Check

- Inspect the air cleaner and inlet ducting.
- Check system wiring harness for proper connections, bent or broken pins, corrosion, loose wires, proper routing, etc.
- Check the PCM, sensors and actuators for physical damage.
- Check the engine coolant for proper level and mixture.
- Check the transmission fluid level and quality.
- Make all necessary repairs before continuing with Quick Test.

Vehicle Preparation

- Perform ALL safety steps required to start and run vehicle tests. Apply parking brake, place shift lever firmly into PARK position (NEUTRAL on manual transmission), block drive wheels, etc.
- Turn off ALL electrical loads-radios, lights, A/C, blower, fans, etc.
- Start engine and bring up to normal operating temperature before running Quick Test.

Quick Test Operation

For a Hard Start/No Start concern or a Performance concern, refer to Section 4A or Section 4B. For all other concerns, refer to the Symptom Charts in Section 3. Quick Test is performed by retrieving KOEO, KOER and Continuous Memory DTC's. If a code is retrieved, you must then go to the appropriate Pinpoint Test. If unable to complete a self test, go to Pinpoint Test QA1.

Key On Engine Off (KOEO) On-Demand Self Test

KOEO On-Demand Self Test

Connect the NGS Tester to the DLC under the dash. Turn off accessories. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select KOEO ON DEMAND SELF TEST.
- Turn key on.
- Follow operating instructions from the menu.
- Record DTCs and follow appropriate pinpoint test.
- After test, cycle key to off before running other tests or driving vehicle.

If performing repeated self tests, it may be necessary to unplug glow plug relay to keep battery from going dead. Ignore any glow plug codes while glow plug relay is unplugged.

Key On Engine Running (KOER) On-Demand Self Test

KOER On-Demand Self Test

Connect the NGS Tester to the DLC under the dash. Turn off accessories. Turn A/C off. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

NOTE: Engine will run rough during this test.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Start engine.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select KOEO ON DEMAND SELF TEST.
- Follow operating instructions from the menu.
- Record DTCs and follow appropriate pinpoint test.
- After test, cycle key to off before running other tests or driving vehicle.

Retrieve/Clear Continuous DTCs

Retrieve/Clear Continuous DTCs

Connect the NGS Tester to the DLC under the dash. Turn off accessories. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select RETRIEVE/CLEAR CONTINUOUS DTCs
- Turn key on.
- Follow operating instructions from the menu.
- Record DTCs and follow appropriate pinpoint test for continuous code diagnostics.
- After test, cycle key to off before running other tests or driving vehicle.
- Continuous DTCs must be cleared after repair is made.

KOEO Injector Electrical Self Test

KOEO Injector Electrical Self Test

NOTE: If no DTCs are present and the KOEO Injector Electrical Self Test aborts while trying to perform, go to Pinpoint Test NA — Step NA29.

Connect the NGS Tester to the DLC under the dash. Turn off accessories. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select KOEO INJECTOR ELECTRICAL SELF TEST.
- Follow operating instructions from the menu.
- Record DTCs and follow appropriate pinpoint test.
- After test, cycle key to off before running other tests or driving vehicle.

KOEO Output State Self Test

KOEO Output State Self Test

Connect the NGS Tester to the DLC under the dash. Turn off accessories. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select KOEO output state self test.
- Follow special instructions on screen.
- Depress and release accelerator pedal to cycle output state on relays, solenoids, wait to start light, FDCS, EF, CID and TCIL.
- After test, cycle key to off before running other tests or driving vehicle.

KOER Switch Self Test

KOER Switch Self Test

Connect the NGS Tester to the DLC under the dash. Turn off accessories. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Start engine.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select KOER switch self test.
- Follow instructions on screen. After pressing the trigger to start the test, wait 5 seconds before running through the driver-operated controls. The test may also take up to 5 minutes to complete.
- After test, cycle key to off before running other tests or driving vehicle.

KOER Cylinder Contribution Self Test

KOER Cylinder Contribution Self Test

Connect the NGS Tester to the DLC under the dash. Turn off accessories. Turn A/C off. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Start engine.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select KOER cylinder contribution self test.
- Follow instructions on screen.
- After test, cycle the key to off before running other tests or driving vehicle.

KOER Glow Plug Monitoring Self Test

KOER Glow Plug Monitoring Self Test

CALIFORNIA and all ECONOLINE

Connect the NGS Tester to the DLC under the dash. Turn off accessories. Turn A / C off. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self test.

NOTE: When running this self test, battery voltage must not drop below 11.8 volts for 1998 or 11.5 volts for 1998-1 / 2 Econoline and 1999 F-Series or go above 14 volts. Make sure that batteries are OK and the charging system is working properly.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Using a digital multimeter connected to the battery, monitor voltage. It may be necessary to raise rpm to maintain voltage.
- Start engine.
- Parking brake set, automatic transmission in PARK or manual transmission in NEUTRAL.
- Select VEHICLE & ENGINE SELECTION menu.
- Select NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.
- Select KOER GLOW PLUG MONITOR SELF TEST.
- Follow instructions on screen.
- Maintain system voltage until test is complete.
- Record DTCs and follow appropriate pinpoint test.

Parameter Identification (PID)

The Parameter Identification (PID) mode allows access to certain data values, analog and digital inputs and outputs, calculated values, and system status information. Throughout the manual, there will be references to PID values. PID Data Monitor and Record can be accessed from the Rotunda New Generation Star (NGS) Tester 007-00500 (or equivalent) through the Diagnostic Data Link menu.

Selecting Parameter Identification (PID)

Connect the NGS Tester to the DLC under the dash. Turn off accessories. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.
- Select PID / DATA MONITOR AND RECORD.
- Turn key on or start vehicle.
- Follow operating instructions from the menu.
- Select the PIDs, press START to begin monitoring.

Parameter Identification (PID) List

Acronym	Description	Measurement Units
4x4L	4x4 Low Switch	ON / OFF
ACCS	Air Conditioning Clutch Status	ON / OFF
AP	Accel Pedal Position Sensor	Volts
ARPMDES	Ancillary Engine Speed Desired	RPM
BARO	Barometric Pressure Sensor	PSI
BARO V	Barometric Pressure Sensor Actual	Volts
BOO	Brake ON / OFF Switch	ON / OFF
BPA	Brake Pressure Applied	ON / OFF
CCS	Coast Clutch Solenoid	ON / OFF
CPP	Clutch Pedal Position	ON / OFF
CPP / TCS	Clutch Pedal Position / TCS	ON / OFF
CRUISE	Cruise Control Mode (Driving)	ON / STNDBY / TAPUP / TAPDN
CSE GND	Case Ground	Volts
DTC CNT	Diagnostic Trouble Code Count	DTC No.
EBP	Exhaust Back Pressure	PSI (Absolute)
EBP V	Exhaust Back Pressure Actual	Volts
EOT	Engine Oil Temperature	°F

(Continued)

Parameter Identification (PID)

Acronym	Description	Measurement Units
EPC*	Electronic Pressure Control	PSI
EPC V	Electronic Pressure Control Actual	Volts
EPR	Exhaust Pressure Regulator	Percent
FLI	Fuel Level Input	Percent
FLI V	Fuel Level Input Actual (Voltage)	Volts
FP	Fuel Pump Control	Duty Cycle (100% = On)
FUEL PW	Fuel Pulse Width	Milliseconds
GEAR	Transmission Gear E4OD Only (Driving)	Trans. Gear
GPC	Glow Plug Control Duty Cycle	Percent
GPC TM	Glow Plug Control Time	Seconds
GPL TM	Glow Plug Lamp Time	Seconds
GPML	Glow Plug Monitoring Left Bank	Amp
GPMR	Glow Plug Monitoring Right Bank	Amp
IAT*	Intake Air Temperature	Degrees
IAT V	Intake Air Temperature Actual	Volts
ICP	Injector Control Pressure Sensor	PSI
ICP V	Injection Control Pressure Actual	Volts
IPR	Injector Control Pressure Regulator	Percent
IVS	Idle Validation Switch	ON/OFF
MAP	Manifold Absolute Pressure Sensor	PSI (Absolute)
MAP H	Manifold Absolute Pressure Actual	Hz
MAT	Manifold Air Temperature	Degrees
MAT V	Manifold Air Temperature Actual (Voltage)	Volts
MFDES	Mass Fuel Desired	Milligrams
MGP	Manifold Gauge Pressure	PSI
PBA	Parking Brake Applied	ON/OFF
RPM	Engine Speed	RPM
SCCS	Speed Control Command Switch	Volts
SCCS M	Speed Control Command Switch Mode	Mode
SS1	Shift Solenoid No. 1 — E4OD Only	ON/OFF
SS2	Shift Solenoid No. 2 — E4OD Only	ON/OFF
TCC	Torque Converter Clutch	ON/OFF
TCIL	Transmission Control Indicator Lamp	ON/OFF
TCS	Transmission Control Switch	ON/OFF
TFT V*	Transmission Fluid Temperature Sensor Actual	Volts
TORQUE	Engine Torque	Lb/Ft
TPREL	Low Idle Throttle Position	V
TR	Transmission Range Sensor Position	PRNDL
TR V	Transmission Ranger Sensor Actual	Volts
VFDES	Volume Fuel Desired	Cubic Millimeters

(Continued)

Parameter Identification (PID)

Acronym	Description	Measurement Units
VPWR	Vehicle Power Supply	Volts
VREF	Vehicle Reference Voltage	Volts
VS SET	Vehicle Speed Setting	MPH
VSS	Vehicle Speed Sensor	MPH
WG	Wastegate Control	Duty Cycle

* Designates PIDs that show PCM calculated values during fault.

NGS TESTER — DRIVER-OPERATED CONTROLS CHECK

PID	Operator's Setting	NGS Tester Reading	EEC Pin	Voltage	Pinpoint Test
AP	Foot OFF of Accelerator Foot ON at WOT	Approx. 0.6V Approx. 3.8 V	89	Approx. 0.6V Approx. 3.8V	DE
IVS	Foot OFF of Accelerator Foot ON Accelerator	OFF ON	5	0V B+	FE
BOO	Foot ON Service Brake Foot OFF Service Brake	ON OFF	92	B+ 0V	FD
BPA	Foot ON Service Brake Foot OFF Service Brake	ON OFF	31	0V B+	FB
CPP/TCS	(M5OD) Clutch Depressed Foot OFF Clutch Pedal	 ON OFF	29	 0V B+	FC
PBA	Parking Brake ON Parking Brake OFF	ON OFF	4	0V B+	FF
CPP/TCS	(E4OD) OD CNCL Button Held In OD CNCL Button Released	 ON OFF	29	 B+ 0 V	
TR	(E4OD) PRNDL in P PRNDL in R PRNDL in N PRNDL in OD PRNDL in OD with OD Cancel Light ON PRNDL in L2 PRNDL in L1	 P/N REV NTRL OD DRIVE MAN2 MAN1	64	 4.45V 3.64V 2.87V 2.87V 2.13V 1.40V 0.71V	
TCIL	(E4OD) After Key ON Push OD Cancel (Latch) Push OD Cancel (Unlatch)	 OFF ON OFF	79	 0V B+ 0V	
SCCS M	(Speed Control) After Key ON Speed Control OFF Speed Control ON SET/ACCEL	 OPEN OFF ON SET AC	61	 6.68V 0V B+ 2.74V	FG

(Continued)

Parameter Identification (PID)

NGS TESTER — DRIVER-OPERATED CONTROLS CHECK (Cont'd)

PID	Operator's Setting	NGS Tester Reading	EEC Pin	Voltage	Pinpoint Test
	COAST	COAST		0.68V	
	RESUME	RESUME		4.66V	
CRUISE	(Speed Control / When Driving Only)		61		FG
OFF	OFF	OFF		0V	
	ON	STNDBY		B+	
	SET/ACCEL (After Pressing)	Tap Up (Active)		2.74V	
	COAST (After Pressing)	Tap Down (Active)		0.68V	
4x4L	(Transfer Case Shifter)		14		FH
	4x4H or 2H	OFF		B+	
4x4L (Cont'd)	4x4L	ON	0 V		
ACCS	(A/C Controls)		41		FA
	MAX / NORM AC or MIX / DEF with A / C Clutch ON	ON		B+	
	Floor or Vent or A / C Clutch OFF	OFF		0 V	

* Refer to the Powertrain Group in the Workshop Manual.

Accumulating PCM Data

Accumulating PCM data can be done in a number of ways. Gather as much data as possible when the malfunction is occurring to prevent misdiagnosis. Data should be accumulated in different operating conditions and based on the customer description of the intermittent fault. Acquisition of PCM PID data using a scan tool is one of the easiest ways to gather information. Listed below are instructions for gathering PID data using a Rotunda New Generation Star (NGS) Tester 007-00500.

Selecting and Viewing PIDs

1. Select VEHICLE & ENGINE SELECTION menu.
2. SELECT NEW VEHICLE, YEAR & MODEL.
3. Select DIAGNOSTIC DATA LINK.
4. Select PCM — POWERTRAIN CONTROL MODULE.
5. Select PID / DATA MONITOR AND RECORD.
6. Select the PIDs from the intermittent symptom chart or the PCM Pinpoint Test. The star symbol next to each PID on the screen indicates that PID has been selected. Scroll through the PID list using the menu dial and select PIDs using the trigger button.
7. Turn ignition key on or start vehicle.
8. Select the START key and access the PIDs.

Storing PIDs

1. When ready to capture and store the selected PIDs, press the trigger button.
2. Press trigger again when ready to save information.
3. Information saved is now located in the main recording area. Save to a viewing area before starting another recording or the data will be overwritten.

Recording Measurements Along with PIDs

1. Select DIGITAL MEASUREMENT SYSTEM.
2. Select a meter (i.e., VOLTMETER).
3. Select LINK and LINK MONITOR.
4. Select the PIDs and START recording.
5. Press REC to save DVOM function and PID data.

Accumulating PCM Data

Playback of Stored PIDs

Look for abnormal behavior or values that are clearly incorrect. Inspect the signals for abrupt or unexpected changes. For example, during a steady cruise most of the sensor values should be relatively stable. Sensors such as accelerator pedal (AP), manifold absolute pressure (MAP) and rpm that change abruptly when the vehicle is traveling at a constant speed are clues to a possible fault area.

Look for agreement in related signals. For example, if accelerator pedal position is changed during acceleration, a corresponding change should occur in rpm.

Make sure the signals act in proper sequence. An increase in rpm after the accelerator pedal's position is increased is expected. However, if rpm increases without an accelerator pedal position change, then a problem may exist.

1. Select VIEW RECORDER AREAS.
2. Select a viewing area.
3. Select up to four PIDs to review in the table format or two PIDs to review in the graph mode.
4. Table Format: Scroll through the PID data while analyzing the information. Look for sudden drops or spikes in the values. (Refer to the following AP example or reference the EEC-V charts and graphs in this section.) Notice the major jump in the AP voltage while scrolling through the information.
5. Graph Format: Scroll through the PID data while analyzing the information. Look for sudden drops or spikes in the linear lines showing the transformation of values to the line graph. (Refer to the following TP example or reference the EEC-V charts and graphs in this section.) This example only applies to an analog signal.

Peripheral Inputs

Some signals may require certain peripherals or auxiliary tools. In some cases, these devices can be inserted into the measurement jacks of the scan tool or digital multimeter. The NGS Tester is capable of recording the value from the measurement jacks on the NGS Tester and storing the value with the other PIDs. For example, connecting an electronic fuel pressure gauge to monitor and record the fuel pressure would capture the data that would help find the fault. Listed are peripheral devices available.

Comparing PCM Data

After the PCM values have been acquired, it is necessary to determine the fault area. Typically, it will require the comparison of the actual values from the vehicle to the typical values. Refer to the pinpoint test procedures. Refer to the following example:

Accumulating PCM Data

Circuit	Good PID Values	Actual Vehicle PID Values
AP	0.8V	0.9V
EOT	205°F--->	35°F<--Example of Fault
IAT	2.8V	2.7V
IPR	35%	50%

Analyzing PCM Data

Various Data Procedures

Once the fault area is identified, the circuit must be checked to determine if the wiring or component is at fault. Use any of the following methods to diagnose a suspected PCM wire circuit or device. Some methods are particular to a certain type of PCM device.

- Change Condition to Cause Response by Input
- Change Input and Verify Output Response
- Click Testing / Output Test Mode (Solenoids / Relays)
- Coil Resistance (Solenoids / Relays)
- Harness Opens
- Harness Shorts

Change Condition to Cause Response by Input

The purpose is to verify sensor receives and responds to changes.

1. Select, view and record the appropriate sensor PID(s).
2. Create condition or cause condition to change.
3. If reading changes appropriately, then it should be operating OK.
   Examples:
   - View EOT PID while engine warms up.
   - It should change from a higher voltage (2.6V) for a cold engine, to a lower voltage as the engine warms up (0.6V).
   - Move accelerator pedal, observe AP PID change.
   - Press brake pedal, watch BOO PID change states.

Change Input and Verify Output Response

The purpose is to verify how the PCM and actuator circuit responds to sensor input.

1. Select, view the appropriate sensor PID(s).
2. Create condition to cause input condition to change.
3. Observe change (response) in actuator PID or actuator signal circuit measured by a measuring device.
   Example:
   - Increase accelerator pedal position under load, observe RPM PID and circuit change.

Analyzing PCM Data

Click Testing/Output Test Mode (Solenoids/Relays)

The purpose is to activate solenoid or relay from PCM by entering Output Test Mode.

1. Key on.
2. Enter Output Test Mode.
3. Turn outputs on and then off.
4. Listen for relays to click on and off. If a breakout box is connected to the PCM, measure the control circuit while turning the outputs on and off.

   Examples:

   - IDM relay and PCM power relay.

Coil Resistance (Solenoids/Relays)

The purpose is to measure the correct resistance value of device.

1. Key off.
2. DLC disconnected.
3. Disconnect component from vehicle harness.
4. Using an ohmmeter and referencing the Static Resistance Value Chart in this section, measure across the component terminals in question.

Harness Opens

The purpose is to check harness for open circuits

1. Key off.
2. DLC disconnected from any diagnostic tools.
3. Disconnect component from vehicle harness.
4. Install breakout box.
5. Using an ohmmeter, isolate the circuit in question from the breakout box to the component connector signal pin.
6. Reading should be less than 5 ohms.

Harness Shorts

The purpose is to check harness for short circuits (to ground or power).

Analyzing PCM Data

1. Key off only.
2. DLC disconnected from any diagnostic tools.
3. Disconnect component from vehicle harness.
4. Using an ohmmeter, measure between the signal circuit and signal return circuit or power ground circuit or vehicle power.
5. If reading is less than 10 kohms, then the two circuits are shorted.

On-Board System Readiness Test

Description

All OBD II scan tools should display the On-Board System Readiness (OSR) Test. The OSR will display the supported monitors on the vehicle, the status of all monitors (complete or not complete) and the MIL status. If any monitor is not complete, the scan tools will not identify which monitor has not completed. None of the typical OBD II monitors such as catalyst, heated catalyst, evaporative system, secondary air, A / C, HO2S or the EGR monitors, apply to the 7.3L diesel. The values of the monitors are not used. Readiness is reported based on the completeness of the comprehensive component monitors (CCM). Note that Misfire will be added in 1998. It is not possible to determine which individual monitors are complete / incomplete. Furthermore, the use of CCM to determine readiness for diesels is a relatively new feature and some scan tools may default to ALL OBD II MONITORS COMPLETE.

Accessing On-Board System Readiness Test

New Generation Star

- Perform the necessary vehicle preparation and visual inspection.
- Connect scan tool to DLC.
- Select VEHICLE & ENGINE SELECTION menu (optional).
- Select NEW VEHICLE, YEAR & MODEL.
- Select year, engine, model with the appropriate qualifier, if needed (for example, transmission, 49 States, California).
- Follow operating instructions from the menu.
- Select GENERIC OBD II FUNCTIONS.

NOTE: If all the monitors are not complete, the OSR test will automatically be displayed along with a message.

— Press TEST button to display OSR test.

- Select ON-BOARD SYSTEM READINESS.

Generic Scan Tool

Refer to the manufacturer's manual for specific instructions.

OBD II PID Data Monitor

The PID monitor for OBD II offers real time evaluation of several emissions-related parameters. Most of these are related to the HO2S and EGR, for which the diesel has no equivalent. The only parameters which apply to 7.3L diesel applications are CCNT, IAT, LOAD, MAP, MIL, RPM and VSS.

On-Board System Readiness Test

Accessing the PID Data Monitor

New Generation Star

- Perform the necessary vehicle preparation and visual inspection.
- Connect scan tool to DLC.
- Select VEHICLE & ENGINE SELECTION menu (optional).
- Select NEW VEHICLE, YEAR & MODEL.
- Select year, engine, model with the appropriate qualifier, if needed (for example, transmission, 49 States, California).
- Follow operating instructions from the menu.
- Select GENERIC OBD II FUNCTIONS.
- Select PID DATA MONITOR, choose only diesel-related PIDs.

Generic Scan Tool

- Refer to the manufacturer's manual for specific instructions.

OBD II Pending Codes

Pending codes are codes that have only set during one drive cycle and may not have set the MIL yet. While some codes can set the MIL during one drive cycle, they are not recorded as OBD II DTCs until failing during a second drive cycle. These DTCs may be identified using the Retrieve Pending Codes Feature. Additionally, they will be found in the vehicle-specific mode RETRIEVE / CLEAR CONTINUOUS DTCs from the instant that the code is set.

This function will only report pending failures that have occurred during the present drive cycle, but not indicate single failures that happened on any previous drive cycle.

Accessing the PID Data Monitor

New Generation Star

- Perform the necessary vehicle preparation and visual inspection.
- Connect scan tool to DLC.
- Select VEHICLE & ENGINE SELECTION menu (optional).
- Select NEW VEHICLE, YEAR & MODEL.
- Select year, engine, model with the appropriate qualifier, if needed (for example, transmission, 49 States, California).

On-Board System Readiness Test

- Follow operating instructions from the menu.
- Select GENERIC OBD II FUNCTIONS.
- Select RETRIEVE PENDING CODES.

Generic Scan Tool

- Refer to the manufacturer's manual for specific instructions.

Misfire Monitoring Supported

This menu pick can be used to determine if the misfire monitoring system is supported on your particular application. All California emission-equipped 7.3L diesel vehicles under 10,000 lbs (OBD II) utilize misfire detection for 1998-1/2 Econoline and 1999 F-Series model year. When selecting this function, a message will be displayed on the screen: "test not supported by this module" or "test supported by this module."

Comprehensive Component Monitoring Supported

This menu pick can be used to determine if the comprehensive component monitoring system is supported on your particular application. All California emission-equipped 7.3L diesel vehicles under 10,000 lbs (OBD II) utilize comprehensive component monitoring for 1998-1/2 Econoline and 1999 F-Series model year. When selecting this function, a message will be displayed on the screen: "test not supported by this module" or "test supported by this module."

Misfire Monitoring Status

This menu pick can be used to determine the status of the misfire monitoring system on your particular application. All California emission-equipped 7.3L diesel vehicles under 10,000 lbs (OBD II) utilize misfire detection for 1998-1/2 Econoline and 1999 F-Series model year. When selecting this function, a message will be displayed on the screen: "test complete, or not applicable" or "test not complete."

Comprehensive Component Monitoring Status

This menu pick can be used to determine the status of the comprehensive component monitoring system on your particular application. All California emission-equipped 7.3L diesel vehicles under 10,000 lbs (OBD II) utilize comprehensive component monitoring for 1998-1/2 Econoline and 1999 F-Series model year. When selecting this function, a message will be displayed on the screen: "test complete, or not applicable" or "test not complete."

PTO Status

This menu pick can be used to determine the status of the PTO system on your particular application. Some transmission OBD II monitors are disabled during PTO and split shaft operation. Vehicle must be out of PTO mode to clear P1000. When selecting this function, a message will be displayed on the screen: "PTO active" or "PTO non active."

Freeze Frame Data

Description

Freeze Frame Data allows access to emission related values from specific generic PIDs. These values are stored the instant an emission related DTC is stored in Continuous Memory. This provides a snapshot of the conditions that were present when the DTC was stored. Once one set of freeze frame data is stored, this data will remain in memory even if another emission related DTC is stored. There are no fuel system DTCs for the 7.3L diesel. When a DTC associated with the freeze frame is erased or a PCM memory reset is performed, new freeze frame data can be stored again. In the event of multiple emission related DTCs in memory, always note the DTC for the freeze frame data. Load, RPM and VSS are the only parameters used for the 7.3L Diesel; all other parameters are to be ignored.

FREEZE FRAME DATA TABLE

PID#	Acronym	Description	Measurement Units
0004	LOAD	Calculated Load Value	PERCENT
000C	RPM	Engine RPM	R/MIN
000D	VSS	Vehicle Speed	MPH-KMH

Accessing Freeze Frame PID Data

New Generation Star

- Perform the necessary vehicle preparation and visual inspection.
- Connect scan tool to DLC.
- Select NEW VEHICLE, YEAR & MODEL.
- Select VEHICLE & ENGINE SELECTION menu (optional).
- Select year, engine, model with the appropriate qualifier, if needed (i.e., transmission, 49 States, California).
- Follow operating instructions from the menu.
- Select GENERIC OBD II FUNCTIONS.
  - Press CONT button if all OBD II monitors are not complete.
- Turn key on.
- Select FREEZE FRAME PID REQUEST.

Generic Scan Tool

Refer to the manufacturer's manual for specific instructions.

OBD II PID Data Monitor

The PID monitor for OBD II offers real time evaluation of several emissions-related parameters. Most of these are related to the HO2S and EGR, for which the diesel has no equivalent. The only parameters which apply to 7.3L diesel applications are CCNT, IAT, LOAD, MAP, MIL, RPM and VSS.

Freeze Frame Data

Accessing the PID Data Monitor

New Generation Star

- Perform the necessary vehicle preparation and visual inspection.
- Connect scan tool to DLC.
- Select VEHICLE & ENGINE SELECTION menu (optional).
- Select NEW VEHICLE, YEAR & MODEL.
- Select year, engine, model with the appropriate qualifier, if needed (for example, transmission, 49 States, California).
- Follow operating instructions from the menu.
- Select GENERIC OBD II FUNCTIONS.
- Select PID DATA MONITOR, choose only diesel-related PIDs.

Generic Scan Tool

- Refer to the manufacturer's manual for specific instructions.

OBD II Pending Codes

Pending codes are codes that have only set during one drive cycle and may not have set the MIL yet. While some codes can set the MIL during one drive cycle, they are not recorded as OBD II DTCs until failing during a second drive cycle. These DTCs may be identified using the Retrieve Pending Codes Feature. Additionally, they will be found in the vehicle-specific mode RETRIEVE / CLEAR CONTINUOUS DTCs from the instant that the code is set.

This function will only report pending failures that have occurred during the present drive cycle, but not indicate single failures that happened on any previous drive cycle.

Accessing the PID Data Monitor

New Generation Star

- Perform the necessary vehicle preparation and visual inspection.
- Connect scan tool to DLC.
- Select VEHICLE & ENGINE SELECTION menu (optional).
- Select NEW VEHICLE, YEAR & MODEL.
- Select year, engine, model with the appropriate qualifier, if needed (for example, transmission, 49 States, California).

Freeze Frame Data

- Follow operating instructions from the menu.
- Select GENERIC OBD II FUNCTIONS.
- Select RETRIEVE PENDING CODES.

Generic Scan Tool

- Refer to the manufacturer's manual for specific instructions.

Powertrain Control Module (PCM) Reset

Description

The Powertrain Control Module (PCM) Reset allows the scan tool to command the PCM to clear all emission-related diagnostic information. When resetting the PCM, a DTC P1000 will be stored in the PCM until all the OBD II system monitors or components have been tested to satisfy a drive cycle, without any other faults occurring. For more information about a drive cycle, refer to Drive Cycles in this section. Clearing codes from the vehicle-specific RETRIEVE / CLEAR CONTINUOUS DTCs will clear all systems, except the IDM (see KOEO On-Demand Self Test), including OBD II systems. Clearing codes from the OBD II generic menu will only clear OBD II features for the 7.3L diesel.

The following events occur when a PCM reset is performed:

- Clears the number of Diagnostic Trouble Codes (DTC).
- Clears the DTCs.
- Clears the freeze frame data.
- Resets status of the OBD II system monitors.
- Sets DTC P1000 as a vehicle-specific DTC. P1000 will not appear as an OBD II code.

New Generation Star

- Turn key off.
- Perform the necessary vehicle preparation and visual inspection.
- Select VEHICLE & ENGINE SELECTION menu (optional).
- Select NEW VEHICLE YEAR & MODEL.
- Select year, engine, model with the appropriate qualifier, if needed (for example, transmission, 49 States, California).
- Follow operating instructions from the menu.
- Select GENERIC OBD II FUNCTIONS.
  - — Press CONT button if all OBD II monitors are not complete.
- Turn key on.
- Select CLEAR DIAGNOSTIC CODES.
- Press START Key.

Generic Scan Tool

Refer to the manufacturer's manual for specific instructions.

Resetting KAM

Disconnect the negative lead from the battery for a minimum of 5 minutes.

Powertrain Control Module (PCM) Reset

After KAM has been reset, DTCs P1000 and P0603 will be stored in the PCM.

Drive Cycles

OBD II Drive Cycle

Description

The primary intention of the OBD II Drive Cycle is to clear the DTC P1000 and to satisfy the specifications for SAE specification J1979. Each OBD II monitor must run during the drive cycle.

If the drive cycle is completed and P1000 is not cleared, repeat the entire drive cycle. If a particular step is interrupted, simply repeat the drive mode. If the drive cycle is interrupted with a key-off, only drive modes that were incomplete must be run.

If the drive is working alone, it is recommended that the scan tool be used after a drive cycle is completed to observe a monitor system status. A scan tool can be installed in the vehicle before a drive cycle to observe DTC or PID output.

CAUTION

Strict observance of posted speed limits and attention to driving conditions are mandatory when proceeding through the drive cycle.

Rough road conditions may prevent certain steady state conditions and steady accelerations from validating the transmission- and load-related monitors.

Vehicles equipped with Power Take-Off (PTO) must have that system disengaged before the OBD II drive cycle is initiated.

Drive Cycle Procedure:

1. Key on. Do not crank until the WAIT TO START light extinguishes, or at least 10 seconds, whichever is greater.
2. Start the engine. Idle in PARK or NEUTRAL for 40 seconds.
3. The following outlines the appropriate conditions for running certain OBD II monitors that require the engine to be under load:
   a. For vehicles with automatic transmission, select OVERDRIVE CANCEL to run the test in third gear. Turn on accessories such as headlamps, A / C compressor, blower fan, etc. Do not use hazards or PTO. Select an uphill or level road. Driving downhill will unload the engine, thereby defeating the test.
   b. Accelerate steadily to third gear (M / T use fourth gear) and hold at 1500 rpm for 3 seconds. Accelerate steadily from 35 mph to 65 mph over approximately 15 seconds (M / T 11 seconds minimum).
   c. Repeat Step 3b three times while maintaining the conditions in Step 3a.
   d. Before proceeding, turn all accessories off and disengage overdrive cancel.

Drive Cycles

4. Automatic transmission only:
   a. Drive in fourth gear continuously for 60 seconds.
   b. Accelerate steadily from a full stop to fourth gear and then return to a full stop. Repeat 10 times.
5. Before continuing, EOT must exceed 60°C (140°F).
6. Idle the vehicle for 20 seconds in PARK or NEUTRAL.
7. Key off.
8. Start the engine. Idle in PARK or NEUTRAL for 40 seconds.
9. Rerun Quick Test.

NOTE: If P1000 is present after running the drive cycle:

- Rerun Step 3b, being certain to maintain a minimum MFDES of 37 mg / stroke above 1500 rpm for 11 seconds. Also, maintain a minimum MFDES of 37 mg / stroke above 2300 rpm for at least 6 seconds.
- Rerun Step 6. MFDES must remain below 12 mg / stroke for 11 consecutive seconds.

OBD II PID Data Monitor

The PID monitor for OBD II offers real time evaluation of several emission-related parameters. Most of these are related to the HO2S and EGR, for which the diesel has no equivalent. The only parameters that apply to 7.3L diesel applications are CCNT, IAT, LOAD, MAP, MIL, RPM and VSS.

Accessing the PID Data Monitor

New Generation Star

- Perform the necessary vehicle preparation and visual inspection.
- Connect scan tool to DLC.
- Select VEHICLE & ENGINE SELECTION menu (optional).
- Select NEW VEHICLE, YEAR & MODEL.
- Select year, engine, model with the appropriate qualifier, if needed (for example, transmission, 49 States, California).
- Follow operating instructions from the menu.
- Select GENERIC OBD II FUNCTIONS.
- Select PID Data Monitor, choose only diesel-related PIDs.

Drive Cycles

Generic Scan Tool

Refer to the manufacturer's manual for specific instructions.

OBD II Pending Codes

Pending codes are codes that have only set during one drive cycle and may not have set the MIL yet. While some codes can set the MIL during one drive cycle, they are not recorded as OBD II DTCs until failing during a second drive cycle. These DTCs can be identified using the Retrieve Pending Codes feature. Additionally, they will be found in the vehicle-specific mode RETRIEVE / CLEAR CONTINUOUS DTCs from the instant the code is set.

This function will only report pending failures that have occurred during the present drive cycle, but will not indicate single failures that happened on any previous drive cycle.

Accessing the PID Data Monitor

New Generation Star

- Perform the necessary vehicle preparation and visual inspection.
- Connect scan tool to DLC.
- Select VEHICLE & ENGINE SELECTION menu (optional).
- Select NEW VEHICLE, YEAR & MODEL.
- Select year, engine, model with the appropriate qualifier, if needed (for example, transmission, 49 States, California).
- Follow operating instructions from the menu.
- Select GENERIC OBD II FUNCTIONS.
- Select RETRIEVE PENDING CODES.

Generic Scan Tool

Refer to the manufacturer's manual for specific instructions.

Intermittent Diagnostic Techniques

Intermittent diagnostic techniques help find and isolate the root cause of intermittent faults associated with the EEC-V system. The material is organized to help find the fault and perform the repair. There are examples that illustrate the diagnostic techniques. The process of finding and isolating an intermittent, starts with recreating a fault symptom, accumulating PCM data and comparing that data to typical values and analyzing the results.

Before proceeding, be sure that:

- Customary mechanical system tests and inspections do not reveal a problem. (Remember, mechanical component problems can make a PCM system react abnormally.)
- Review Technical Service Bulletins (TSBs) and OASIS messages, if available.
- Quick Test and associated Pinpoint diagnosis have been completed without finding a fault, and the symptom is still occurring.

Recreating the Fault

Recreating the fault is the first step in isolating the cause of the intermittent symptom. A thorough investigation should start with the customer information worksheet located in the Introduction. If Freeze Frame Data is available, it may help in recreating the conditions at the time of a Malfunction Indicator Lamp Diagnostic Trouble Code (MIL-type DTC). Listed below are some of the conditions for recreating the fault.

CONDITIONS TO RECREATE FAULT

Engine Type Conditions	Non-Engine Type Conditions
Engine Temperature	Ambient Temperature
Engine RPM	Moisture Conditions
Engine Load	Road Conditions
Engine idle/accel/decel	(smooth-bumpy)

Accumulating PCM Data

PCM data can be accumulated in a number of ways. Gather as much data as possible when the malfunction is occurring to prevent misdiagnosis. Data should be accumulated during different operating conditions and based on the customer description of the intermittent fault. Reference the known good data values located in Section 6C, Reference Value. This will require recording data in four conditions for comparison: 1) KOEO, 2) HOT IDLE, 3) 30 mph and 4) 55 mph. Acquisition of PCM PID data using a scan tool is one of the easiest ways to gather information. Listed below are instructions for gathering PID data using a New Generation Star (NGS) scan tool.

Selecting and Viewing PIDs

1. Select Vehicle and Engine Selection and enter the proper year, vehicle and engine package from the menu.
2. Select DIAGNOSTIC DATA LINK.
3. Select POWERTRAIN CONTROL MODULE (PCM).
4. Select PID / DATA MONITOR AND RECORD.

Intermittent Diagnostic Techniques

5. Select the PIDs from the intermittent symptom chart or the PCM Pinpoint test. The star symbol next to each PID on the screen indicates that PID has been selected.
6. Turn ignition key on or start vehicle.
7. Select the START key and access the PIDs.

Storing PIDs

1. When ready to capture and store the selected PIDs, press the trigger button.
2. Press trigger again when ready to save information.
3. The information is now located in the main recording area. Store to a viewing area before starting another recording or the data will be overwritten.

Recording DVOM Measurements Along with PIDs

1. Select DIGITAL MEASUREMENT SYSTEM.
2. Select one of the meters (i.e., VOLTMETER).
3. Select LINK.
4. Select PID / DATA MONITOR.
5. Select PCM.
6. Select the PIDs and START to record.
7. Press REC to save digital multimeter function and PID data.
8. Press TRIGGER to save, store and view.

Playback of Stored PIDs

Look for abnormal behavior or values that are clearly incorrect. Inspect the signals for abrupt or unexpected changes. For example, during a steady cruise most of the sensor values should be relatively stable. Sensors such as TP, MAF and RPM that change abruptly when the vehicle is traveling at a constant speed are clues to a possible fault area.

Look for agreement in related signals. For example, if TP is changed during acceleration, a corresponding change should occur in RPM PIDS.

Make sure the signals act in proper sequence. An increase in RPM after the TP is increased is expected. However, if RPM increases without a TP change, then a problem may exist.

1. Select VIEW RECORDER AREAS.

Intermittent Diagnostic Techniques

2. Select a viewing area.

3. Select up to four PIDs to review in the table format or two PIDs to review in the graph mode.

4. Table Format: Scroll through the PID data while analyzing the information. Look for sudden drops or spikes in the values. (Refer to the following TP example or reference the EEC-V charts and graphs in this section.) Notice the major jump in the TP voltage while scrolling through the information. This example would require a smooth and progressive throttle pedal travel during a key ON and engine OFF mode.

5. Graph Format: Scroll through the PID data while analyzing the information. Look for sudden drops or spikes in the linear lines showing the transformation of values to the line graph.

Peripheral Inputs

Some signals may require certain peripherals or auxiliary tools to aid in diagnostics. In some cases, these devices can be inserted into the measurement jacks of the scan tool or digital multimeter. The NGS is capable of recording the value from the measurement jacks on the NGS while storing the value from other PIDs.

Comparing PCM Data

After the PCM values have been acquired, it is necessary to determine the fault area. Typically, it will require the comparison of the actual values from the vehicle to the typical values from Reference Value Charts in Section 6.

Analyzing PCM Data

Once the fault area is identified, the circuit must be checked to determine if the wiring or component is at fault. When making circuit and component measurements, make sure all accessories and dome and hood lights are off. Use any of the following methods to diagnose a suspected PCM wire circuit or device. Some methods are particular to a certain type of PCM device.

- Change Condition to Cause Response by Input
- Change Input and Verify Output Response
- Click Testing / Output Test Mode (Solenoids / Relays)
- Coil Resistance (Solenoids / Relays)
- Harness Opens
- Harness Shorts

Change Conditions to Cause Response by Input

The purpose is to verify the sensor receives and responds to changes.

1. Select, view and record the appropriate sensor PID(s).

2. Create condition or cause condition to change.

Intermittent Diagnostic Techniques

3. If reading changes appropriately, then it should be operating OK.

   Examples:

   - EOT should change from a higher voltage (2.6V) for a cold engine, to a lower voltage as the engine warms up (0.6V).
   - Move TP, observe TP PID change.
   - Press brake pedal, watch BOO PID change states.

Change Input and Verify Output Response

The purpose is to verify how the PCM and actuator circuit responds to sensor input.

1. Select, view and record the appropriate sensor PID(s).
2. Create condition to cause input condition to change.
3. Observe change (response) in actuator PID or actuator signal circuit measured by a measuring device.

Click Testing (Solenoids/Relays)

The purpose is to activate a solenoid or relay from the PCM by entering Output Self Test Mode.

1. Key on.
2. Enter Output Self Test Mode.
3. Turn outputs on and then off. The state of the output can be changed by cycling the accelerator pedal.
4. Listen for relays to click on and off. If a breakout box is connected to the PCM, measure the control circuit while turning the outputs on and off. A voltage change of greater than 4 volts should occur during the ON and OFF transition. (NOTE: The glow plug relay will only cycle on for 5 seconds the first time the accelerator pedal is pressed.)

Coil Resistance (Solenoids/Relays)

The purpose is to measure the correct resistance value of a device.

1. Key off.
2. Data Link Connector (DLC) disconnected from any diagnostic tools.
3. Disconnect component from vehicle harness.
4. Using an ohmmeter and referencing the Static Resistance Value Chart in the EEC-V graphs and charts at the end of this section, measure across the component terminals.

Intermittent Diagnostic Techniques

Harness Opens

The purpose is to check harness for open circuits.

1. Key off.
2. DLC disconnected from any diagnostic tools.
3. Disconnect component from vehicle harness.
4. Install breakout box.
5. Using an ohmmeter, isolate the circuit in question from the breakout box to the component connector pin.
6. Reading should be less than 5 ohms.

Harness Shorts

The purpose is to check the harness for short circuits (to ground or power).

1. Key off only.
2. DLC disconnected from any diagnostic tools.
3. Disconnect component from vehicle harness.
4. Using a digital multimeter, measure between the signal circuit and signal return circuit or power ground circuit or vehicle power.
5. If reading is less than 10 kohms, then the two circuits may be shorted.

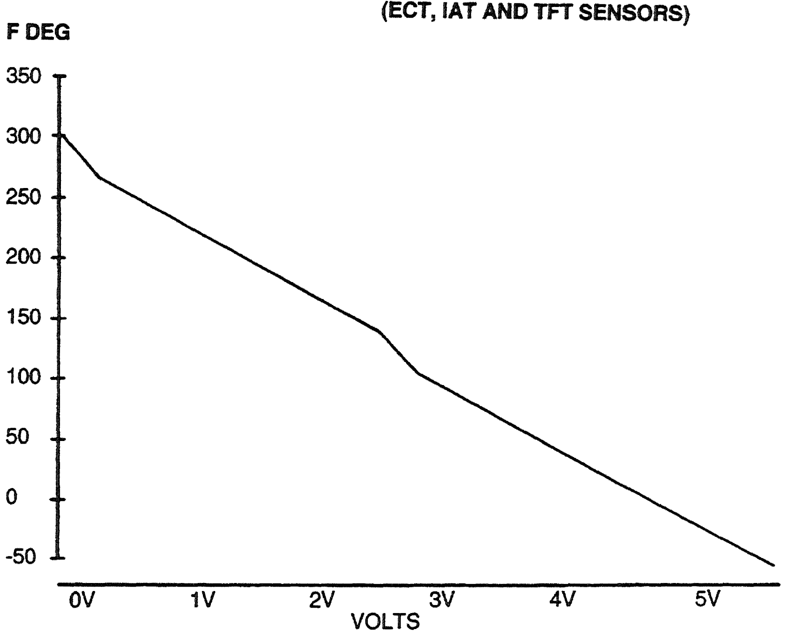
EEC-V Graphs and Charts

Static Resistance Values

Component	Ohm Value
EPC	3 to 5.1 ohms
SS 1	15 to 25 ohms
SS 2	15 to 25 ohms
TCC	0.9 to 1.9 ohms

Intermittent Diagnostic Techniques

**TEMPERATURE SENSOR GRAPH
(ECT, IAT AND TFT SENSORS)**

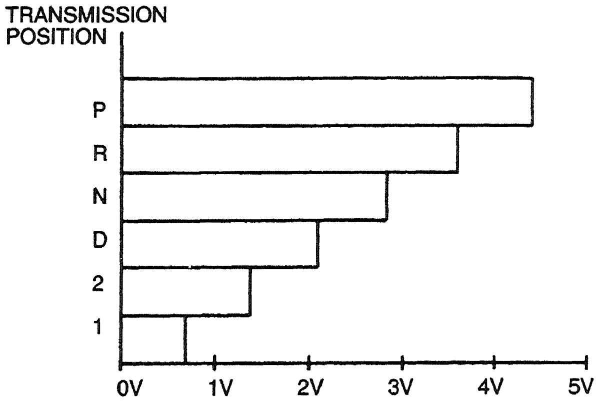


TRANSFORMATION TABLE

TEMPERATURE F DEG	TEMPERATURE C DEG	VOLTAGE VOLTS	RESISTANCE K OHMS
302	160	0.12	0.54
267	131	0.2	0.8
248	120	0.28	1.18
230	110	0.36	1.55
212	100	0.47	2.07
194	90	0.61	2.8
176	80	0.8	3.84
158	70	1.04	5.37
140	60	1.35	7.6
104	40	2.16	16.15
86	30	2.62	24.27
68	20	3.06	37.3
50	10	3.52	58.75
32	0	3.97	65.849
14	–10	4.422	78.194
–4	–20	4.874	90.539
–22	–30	4.89	102.884
–40	–40	4.91	115.229
–58	–50	5	127.574

A23729-A

TR SENSOR GRAPH



VOLTAGE READINGS

TRANSFORMATION TABLE

TRANSMISSION RANGE POSITION	VOLTAGE VALUE	RESISTANCE OHMS
P	4.41	4.16K
R	3.60	1.44K
N	2.83	733
D	2.09	401
2	1.37	211
1	0.68	81

TR SENSOR DATA:
VOLTAGE VALUES CALCULATED FOR VREF = 5.0V AND MAY VARY +/- 5%.

A21128-B

NOTE: The above illustrations are examples of generic NGS data and are not 7.3L diesel-specific.

Basic Circuit Checks

Description

Basic circuit checks help to minimize pinpoint test steps by providing a procedure to diagnose harness faults associated with the Electronic Engine Control (EC) System. The following techniques provide helpful reminders for diagnosing open circuits (continuity), shorts to ground and shorts to power.

NOTE:

- The suspect circuit must be isolated before testing.
- When disconnecting any harness connector, always inspect for damaged or pushed-out pins, corrosion and loose wires. Repair as necessary.
- The digital multimeter must be set to the correct scale. AUTO scale is used for NGS with the data link connector (DLC) disconnected.
- The techniques do no apply in all situations; therefore, it is necessary to perform each pinpoint test step accurately and completely.
- General resistance and voltage values are specified below. Always use the pinpoint test values if they differ.
- Always turn the key to the OFF position unless directed otherwise by the pinpoint test.

Each of the following procedures will require the powertrain control module (PCM) and component to be disconnected to isolate the harness.

Open Circuit (Continuity)

Install PCM breakout box and leave PCM disconnected. Measure the harness resistance between the suspect circuit at the harness connector and the appropriate PCM breakout box test pin. The resistance must be less than 5.0 ohms.

Shorts to Ground

Measure the harness resistance between the suspect circuit at the harness connector and a reliable ground (B-, chassis and or PWR and at the PCM breakout box). The resistance must be greater than 10,000 ohms.

Shorts to Power

Key ON to power up circuit. Measure voltage between the suspect circuit at the harness connector and a reliable ground. The voltage must be less than 1.0 volt.

SECTION 3

Symptom Charts

Contents

SECTION 3

Symptom Charts

Contents (continued)

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Driveability

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Unique Idle Concerns	Slow Return to Idle	617400	5	9
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	Fast Idle	619400	7	15

Driveability — Performance While Driving Concerns

Stalls / Quits (607000)	Idle	607400	2	4
	Acceleration	607500	2	4
	Cruise	607600	2	4
	Deceleration	607700	2	4
Runs Rough (608000)	Idle	608400	6	10
	Acceleration	608500	8	16
	Cruise	608600	8	16
Misses (609000)	Idle	609400	8	16
	Acceleration	609500	8	16
	Cruise	609600	8	16
Buck / Jerk (610000)	Acceleration	610500	8	16
	Cruise	610600	8	16
	Deceleration	610700	8	16
Hesitation / Stumble (611000)	Acceleration	611500	8	16
Surge (612000)	Acceleration	612500	9	17
	Cruise	612600	9	17
Lack / Loss of Power (614000)	Acceleration	614500	10	18
	Cruise	614600	10	18

Additional Driveability Concerns

Engine Will Only Idle	—	4	8

(Continued)

Symptom Chart Index

System / Symptom		OASIS Number	Chart Number	Page Number
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Symptom Chart 1

1-

Symptom	OASIS Number
Starting Concerns — No Crank / Slow Crank	601300

Test Step		Result ▶	Action to Take
1-1	PRELIMINARY CHECKS		
	● Perform the following preliminary checks: — Automatic transmission in PARK or NEUTRAL — Clutch fully depressed — Battery connections — Starter relay connections — Battery load test — Alarm anti-theft devices — Fuse links — Ignition switch ● **Are all checks OK?**	Yes ▶ No ▶	GO to 1-2. REPAIR as necessary.
1-2	CHECK STARTER RELAY		
	● Cycle ignition key. ● **Is a "clicking" sound heard from the starter relay when the ignition key is turned to start?**	Yes ▶ No ▶	GO to 1-4. GO to 1-3.
1-3	CHECK ELECTRICAL ACCESSORIES		
	● **Do any other electrical accessories operate (headlights, radio, etc.)?**	Yes ▶ No ▶	GO to 1-4. GO to the Electrical Group in the Workshop Manual to check the battery and charging systems.
1-4	CHECK STARTING SYSTEM SECONDARY CIRCUITS		
	● Go to the Powertrain Group in the Workshop Manual to check starter ground and starter relay cable to starter. ● **Is a fault indicated?**	Yes ▶ No ▶	REPAIR as required according to Workshop Manual direction. GO to 1-5.
1-5	CHECK STARTING SYSTEM COMPONENTS		
	● Go to the Powertrain Group in the Workshop Manual to check starter, starter relay, clutch pedal position sensor and manual lever position sensor. ● **Is a fault indicated?**	Yes ▶ No ▶	REPAIR as required according to Workshop Manual direction. GO to the Powertrain Group in the Workshop Manual to check for base engine concerns (seized / hydro-locked engine or damaged flywheel). REPAIR as required according to Workshop Manual direction.

Symptom Chart 2

2-

Symptom	OASIS Number
Stalls/Quits	607000
— Idle	607400
— Acceleration	607500
— Cruise	607600
— Deceleration	607700

Test Step		Result ▶	Action to Take
2-1	PRELIMINARY CHECKS		
	● Perform the following preliminary checks: — Engine overheating — Electrical connections — Engine oil level/quality — MAP sensor vacuum hose leak — Automatic transmission TCC — ATF level ● **Are all checks OK?**	Yes ▶	GO to 2-2.
		No ▶	REPAIR as necessary. VERIFY a symptom no longer exists.
2-2	CHECK FOR COLD WEATHER STALL		
	● **Does stall occur with cold oil (below 0°C [32°F]) after several minutes of operation?**	Yes ▶	Oil return to oil pan may be too slow. CONFIRM proper grade of oil for frigid conditions. GO to 2-3.
		No ▶	GO to 2-3.
2-3	CHECK PERFORMANCE DIAGNOSTICS		
	● GO to Section 4A or Section 4B, Diagnostic Subroutines. Perform Performance Diagnostic Procedures. ● **Is a fault indicated?**	Yes ▶	FOLLOW Performance Diagnostic Procedures direction.
		No ▶	GO to the Powertrain Group in the Workshop Manual to perform automatic transmission diagnosis.

Symptom Chart 3

3-

Symptom	OASIS Number
Starting Concerns	
— Hard Start / Long Crank / Erratic Start / Erratic Crank — Stall After Start	602300
— No Start / Normal Crank	603300
Stalls / Quits	607000
— Idle	607400

Test Step		Result ▶	Action to Take
3-1	PRELIMINARY CHECKS		
	NOTE: Refer to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures or the 11 x 17-inch Diagnostics Guide for the following preliminary checks. ● Perform the following preliminary checks: — Check engine oil level — Confirm proper dipstick part number — Check for sufficient clean fuel — Check for an intake restriction ● **Are all checks OK?**	Yes ▶ No ▶	GO to 3-2. REPAIR as necessary. VERIFY a symptom no longer exists.
3-2	CHECK HIGH PRESSURE PUMP OIL LEVEL		
	● Check engine oil level in high pressure pump reservoir. ● **Is oil level within 25.4 mm (1 inch) of inspection plug?**	Yes ▶ No ▶	GO to 3-4. GO to 3-3.
3-3	ATTEMPT TO START ENGINE		
	● Refill high pressure pump reservoir. ● Attempt to start engine. ● **Does engine start and then stall after about 15 seconds?**	Yes ▶ No ▶	Reservoir is not supplying enough oil to the high-pressure oil pump. GO to Symptom Chart 17. GO to 3-4. If no other faults are indicated, GO to Symptom Chart 17.
3-4	PERFORM KOEO ON-DEMAND SELF TEST		
	NOTE: NGS will reset below 9.5 volts. Charge batteries as necessary. ● Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform KOEO On-Demand Self Test. ● **Is a fault indicated?**	Yes ▶ No ▶	GO to appropriate pinpoint test. GO to 3-5.
3-5	PERFORM KOEO INJECTOR ELECTRICAL SELF TEST		
	● **Is a fault indicated?**	Yes ▶ No ▶	GO to appropriate pinpoint test. If test does not run, GO to 3-6. If no codes are present, Go to 3-7.

Symptom Chart 3

3-

Test Step		Result ▶	Action to Take
3-6	REPEAT KOEO INJECTOR ELECTRICAL SELF TEST		
	- Repeat KOEO Injector Electrical Self Test for each injector connector with one connector disconnected at a time. - **Does the KOEO Injector Electrical Self Test run?**	Yes ▶	REMOVE valve cover and INSPECT the disconnected valve cover wiring harness for a pinched or grounded injector wire.
		No ▶	GO to Pinpoint Test NC to check IDM power and ground. GO to Pinpoint Test NA29 to locate short to ground at IDM or in injector circuits.
3-7	CHECK PARAMETER IDENTIFICATIONS (PIDS)		
	- Go to Section 4A or Section 4B, Diagnostic Subroutines, Hard Start / No Start Diagnostics. Perform Steps 9a, 9b, 9c and 9d. - **Is a fault indicated?**	Yes ▶	GO to appropriate pinpoint test.
		No ▶	GO to 3-8.
3-8	CHECK GLOW PLUGS		
	NOTE: Run these checks if starting difficulty is in cold temperatures and / or if excessive white smoke is generated after starting in warmer temperatures. NOTE: Refer to Pinpoint Test KC for circuit diagrams. - Disconnect all glow plug / injector connectors on both valve cover gaskets. - Check resistance between ground and each glow plug connector using a digital multimeter and special tool. - **Is resistance between 0.1 and 2.0 ohms?**	Yes ▶	GO to 3-9.
		No ▶	REMOVE valve cover and INSPECT harness for opens and shorts. If harness is OK, REPLACE indicated glow plug.
3-9	CHECK GLOW PLUG CONNECTORS		
	- Check resistance between each glow plug contact in the engine harness and the two brown wires on the glow plug relay. - **Is resistance between 0 and 2.0 ohms?**	Yes ▶	GO to 3-10.
		No ▶	REPLACE engine wiring harness.
3-10	CHECK GLOW PLUG RELAY CIRCUIT		
	- Check voltage between glow plug relay Circuit 38 (BK / O) and chassis ground. - **Is battery voltage present?**	Yes ▶	GO to 3-11.
		No ▶	**CAUTION: Confirm resistance to ground is above 10,000 ohms before attaching to starter relay.** REPLACE relay feeder wire fusible links 299 (DB).

Symptom Chart 3

3-

Test Step		Result ▶	Action to Take
3-11	CHECK GLOW PLUG RELAY		
	● Connect all glow plug connectors. ● Connect glow plug control connector on side of relay. ● Disconnect EOT. ● Connect voltmeter between relay terminal with two brown wires and chassis ground. ● Measure voltage with key off and key on while wiggling wires connected to relay (relay will remain closed for two minutes with key on). ● **Does voltage change from 0 to battery voltage and stay at battery voltage for approximately 2 minutes?**	Yes ▶ No ▶	GO to 3-12. REPLACE glow plug relay.
3-12	CHECK FUEL PUMP PRESSURE		
	● Connect EOT. ● Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform Fuel Pump Pressure test. ● **Is fuel pressure less than 138 kPa (20 psi) at key on?**	Yes ▶ No ▶	GO to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostics, Step 7. REPAIR as necessary.

Symptom Chart 4

4-

Symptom	OASIS Number
Additional Driveability Concerns — Engine Will Only Idle	

Test Step		Result ▶	Action to Take
4-1	PRELIMINARY CHECKS		
	• Perform the following preliminary checks: — IVS and AP sensor connector attachment — Interference from floor mats — Accelerator pedal damage • **Are all checks OK?**	Yes ▶ No ▶	GO to Pinpoint Test FE REPAIR as necessary. VERIFY a symptom no longer exists.

Symptom Chart 5

5-

Symptom	OASIS Number
Unique Idle Concerns — Slow Return to Idle	617400

Test Step		Result ▶	Action to Take
5-1	PRELIMINARY CHECKS		
	● Perform the following preliminary checks: — Accelerator pedal for binding, broken return spring, stuck (floor mats) — External fuel source ● **Are all checks OK?**	Yes ▶ No ▶	GO to 5-2. REPAIR as necessary. VERIFY a symptom no longer exists.
5-2	PERFORM QUICK TEST OPERATION		
	● Go to Section 2, Diagnostic Methods. Perform Quick Test Operation. ● **Is a fault indicated?**	Yes ▶ No ▶	GO to appropriate pinpoint test. GO to 5-3.
5-3	CHECK ACCELERATOR PEDAL		
	● Check for floor mat interference. ● Check bushing for damage. ● Check return spring. ● **Is a fault indicated?**	Yes ▶ No ▶	REPAIR as required according to Workshop Manual direction. GO to 5-4.
5-4	CHECK CRANKCASE		
	● Check for overfilled crankcase. ● **Is crankcase overfilled?**	Yes ▶ No ▶	DRAIN crankcase to correct level. GO to 5-5.
5-5	CHECK ENGINE OIL		
	● Check for coolant in engine oil. ● **Is there coolant in engine oil?**	Yes ▶ No ▶	REPAIR as required according to Workshop Manual direction. GO to 5-6.
5-6	CHECK FOR FUEL CONTAMINATION		
	● Check crankcase for fuel contamination. ● **Does the crankcase have fuel contamination?**	Yes ▶ No ▶	GO to Section 4A or Section 4B, Diagnostic Subroutines. PERFORM Performance Diagnostic Procedures. GO to 5-7.
5-7	CHECK EOT SENSOR		
	● Warm engine to between 15°C and 70°C (59°F and 158°F). ● Remove fill / check plug from high-pressure oil pump reservoir. ● Measure reservoir oil temperature with an A / C thermometer. ● Measure EOT using NGS tester or DVOM. ● **Do readings between EOT and thermometer agree within ± 3°C (± 5.4°F)?**	Yes ▶ No ▶	GO to Symptom Chart 10. GO to Pinpoint Test DB. CONFIRM wiring is OK. If OK, REPLACE EOT according to Workshop Manual direction.

Symptom Chart 6

6-

Symptom	OASIS Number
Unique Idle Concerns — Rolling Idle — Stalls When Engaging Clutch	608400
Runs Rough — Idle	608000 608400

Test Step		Result ▶	Action to Take
6-1	PRELIMINARY CHECKS		
	• Perform the following preliminary checks: — Check engine oil level — Confirm oil change within 8046.5 km (5000 miles) (5632.6 km [3500 miles] if severe duty) — Check Filter Minder — Check MAP sensor hose for holes, blockage, or disconnection. Confirm correct MAP sensor — Check intake manifold system for leaks with soapy water with engine running. Include orange seals, gaskets and fittings — Confirm acceptable SAE oil viscosity: • 15W-40: preferred 30°F to 120°F • 10W-30: preferred -10°F to -30°F • 5W-30: preferred below -20°F to -30°F — Check fuel quality by opening filter drain and cranking engine. — Confirm proper dipstick part number. • **Are all checks OK?**	Yes ▶ No ▶	GO to 6-2. REPAIR as necessary. VERIFY a symptom no longer exists.
6-2	PERFORM KOEO ON-DEMAND SELF TEST		
	• Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform KOEO On-Demand Self Test. • **Is a fault indicated?**	Yes ▶ No ▶	GO to appropriate pinpoint test. GO to 6-3.
6-3	PERFORM KOEO INJECTOR ELECTRICAL SELF TEST		
	• Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform KOEO Injector Electrical Self Test. • **Is a fault indicated?**	Yes ▶ No ▶	GO to appropriate pinpoint test. GO to 6-4.

Symptom Chart 6 6-

Test Step		Result ▶	Action to Take
6-4	CHECK FOR AERATED OIL		
	CAUTION: Before running oil aeration tests, make sure the high-pressure oil passages are free of air from recent repairs by running vehicle hard for 32 kilometers (20 miles) after repair. **CAUTION: Engine must be warmed up to normal operating temperature.** ● Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform Injection Control Pressure Test. ● Run engine at WOT for 30 seconds. ● **Does ICP read greater than 11032 kPa (1600 psi) or 2.15 volts in 30 seconds or less?**	Yes ▶ No ▶	GO to 6-5. GO to 6-6.
6-5	CHECK FOR OIL LEAKS		
	● Confirm proper oil change interval. ● Confirm proper oil level and type. ● Overfill engine by 1.9 liters (2 quarts). ● Raise and support rear of vehicle 254 mm (10 inches). ● Run engine at WOT for 30 seconds. ● **Does ICP read greater than 11032 kPa (1600 psi [2.15 volts])?**	Yes ▶ No ▶	LOWER vehicle. RETURN oil level to normal. GO to 6-6. Aeration is caused by O-ring leak or a hole in the oil pickup tube. REPAIR as required according to Workshop Manual direction.
6-6	INJECTION CONTROL PRESSURE TEST		
	● Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform Injection Control Pressure Tests. ● Warm engine to normal operating temperature. ● Run engine at WOT for 3 minutes. ● **Does ICP read greater than 8756 kPa (1270 psi) or 1.75 volts?**	Yes ▶ No ▶	Oil is aerating due to lack of defoaming agents. CHANGE to oil that meets CG4 / SH specifications, and CONFIRM oil quantity is 13.2 liters (14 quarts). GO to 6-7.
6-7	LOW IDLE STABILITY TEST		
	● Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform Low Idle Stability Test. ● **Does idle immediately smooth out?**	Yes ▶ No ▶	GO to Pinpoint Test DD. CONFIRM wiring is OK. If OK, REPLACE ICP according to Workshop Manual direction. GO to 6-8.
6-8	CHECK FUEL PUMP PRESSURE		
	● Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform Fuel Pump Pressure Test. ● **Is fuel pressure less than 206 kPa (30 psi)?**	Yes ▶ No ▶	FOLLOW Performance Diagnostic Procedures direction. GO to 6-9.

Symptom Chart 6

6-

Test Step		Result	Action to Take
6-9	CHECK HIGH-PRESSURE OIL SYSTEM		
	● Confirm engine oil level in high-pressure pump reservoir is within 25.4 mm (1 inch) of inspection plug. ● Attach 689 kPa (100 psi) oil pressure gauge on gauge bar (14-00761) to reservoir. ● Warm engine to normal operating temperature. ● **Is oil pressure 69 kPa (10 psig) or greater at idle (650 rpm)?**	Yes ▶	GO to 6-10.
		No ▶	GO to the Powertrain Group in the Workshop Manual to check for cause of low oil pressure.
6-10	CHECK FOR BIASED ICP SENSOR		
	● Turn off engine for one minute. ● **Does ICP PID read greater than 0 kPa (0 psi) or ICP V PID read greater than 0.30 volt?**	Yes ▶	GO to Pinpoint Test DD. CONFIRM wiring is OK. If OK, REPLACE ICP sensor according to Workshop Manual direction.
		No ▶	GO to 6-11.
6-11	KOER ON-DEMAND SELF TEST		
	CAUTION: Before running KOER On-Demand Self Test, make sure that the high-pressure oil passages are free of air from recent repairs by running vehicle hard for 32 kilometers (20 miles) after repair. ● Warm engine to normal operating temperature. ● Clear codes. ● Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform KOER On-Demand Self Test. ● **Was DTC 1211 received?**	Yes ▶	GO to 6-12.
		No ▶	GO to 6-17.
6-12	CHECK PRESSURE BALANCE		
	● Plug off high-pressure hose for right cylinder head using special tool. ● Check IPR at 3000 rpm. ● Plug off high-pressure hose for left cylinder head using special tool, and reattach high-pressure hose on right cylinder head. ● Check IPR at 3000 rpm. ● **Is IPR duty cycle difference greater than 2%?**	Yes ▶	GO to 6-13.
		No ▶	REPLACE IPR according to Workshop Manual direction.
6-13	CHECK ROUGH IDLE		
	● **Was rough idle present when vehicle was new?**	Yes ▶	GO to 6-14.
		No ▶	GO to 6-15.

Symptom Chart 6

6-

Test Step		Result ▶	Action to Take
6-14	CHECK HIGH-PRESSURE OIL PUMP		
	• Attach right hose to left head and plug left hose. • Check IPR at idle. • Compare this reading to reading for left head in Step 6-20. • **Is difference in readings greater than 0.2 volt or 2%?**	Yes ▶	Imbalance caused by high-pressure oil pump. CONFIRM high-pressure hoses are clear, and REPLACE high-pressure oil pump according to Workshop Manual direction.
		No ▶	GO to 6-15.
6-15	KOER CYLINDER CONTRIBUTION TEST		
	• Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform KOER Cylinder Contribution Test. • **Is a cylinder identified?**	Yes ▶	REPLACE identified injector according to Workshop Manual direction.
		No ▶	GO to 6-16.
6-16	CHECK FOR LEAK SOURCE		
	• Remove valve cover on cylinder(s) with higher IPR reading. • With engine idling, look for bubbling around injector bores or oil gallery drain plugs. • Or, with engine off, attach approximately 689 kPa (100 psi) air pressure to high-pressure oil gallery. • Look / listen for leaks. • **Is a leak present?**	Yes ▶	REPLACE seals on injectors or RESEAL oil galleries as required according to Workshop Manual direction.
		No ▶	REPLACE seals on all injectors on the indicated bank according to Workshop Manual direction.
6-17	CHECK FOR WEAK CYLINDER		
	• Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform KOER Cylinder Contribution Test. • **Is a cylinder identified?**	Yes ▶	GO to 6-18.
		No ▶	GO to 6-19.
6-18	CHECK FOR ENGINE WEAR		
	• Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform Crankcase Pressure Test. • **Is crankcase pressure higher than 4 inches of H_2O or compression pressure lower than 2413 kPa (350 psig) and different from adjacent cylinders by 345 kPa (50 psig)?**	Yes ▶	REPAIR engine for rings or valves as required according to Workshop Manual direction.
		No ▶	REPLACE injector in identified cylinder according to Workshop Manual direction.
6-19	CHECK TRANSMISSION TYPE		
	• **Is vehicle equipped with a manual transmission?**	Yes ▶	GO to 6-20.
		No ▶	GO to 6-24.

Symptom Chart 6

6-

Test Step		Result ▶	Action to Take
6-20	CHECK FLYWHEEL		
	• Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform KOER On-Demand Self Test. • **During KOER On-Demand Self Test, or normal idling does flywheel make a rattling noise?**	Yes ▶ No ▶	GO to 6-21. GO to 6-24.
6-21	CHECK CLUTCH		
	• Press on clutch pedal. • **Does rattling noise remain?**	Yes ▶ No ▶	GO to 6-22. GO to 6-23.
6-22	CHECK RATTLING NOISE		
	• With noise present in normal running mode, slowly increase engine rpm to 850. • **Is rattling noise and rough idle eliminated?**	Yes ▶ No ▶	REPLACE dual mass flywheel according to Workshop Manual direction. GO to 6-24.
6-23	CHECK DUAL MASS FLYWHEEL		
	• Key off. • Remove flywheel cover. • Attempt to rotate secondary flywheel with respect to primary flywheel. • **Does flywheel freely rotate approximately 25.4 mm (1 inch)?**	Yes ▶ No ▶	REPLACE engine as required according to Workshop Manual direction. REPLACE dual mass flywheel according to Workshop Manual direction.
6-24	CHECK FOR INCORRECT INJECTOR APPLICATION		
	• Remove engine valve covers. • Check part number stamped on top of each injector. • **Are the correct injectors installed?**	Yes ▶ No ▶	Cause of rough idle cannot be determined. COMPARE idle performance with other vehicles. REPLACE injectors according to Workshop Manual direction.

Symptom Chart 7

7-

Symptom	OASIS Number
Unique Idle Concerns — Fast idle	619400

Test Step		Result ▶	Action to Take
7-1	PRELIMINARY CHECKS		
	● Perform the following preliminary checks: — PCM system check — Accelerator pedal for binding, broken return spring, stuck (floor mats) — External fuel source — Engine not reaching normal operating temperature — PTO and charge protect devices disengaged ● **Are all checks OK?**	Yes ▶ No ▶	GO to 7-2. REPAIR as necessary. VERIFY a symptom no longer exists.
7-2	PERFORM QUICK TEST OPERATION		
	● Go to Section 2, Diagnostic Methods. Perform Quick Test Operation. ● **Is a fault indicated?**	Yes ▶ No ▶	GO to appropriate pinpoint test. GO to 7-3.
7-3	CHECK PARAMETER IDENTIFICATIONS (PIDS)		
	● Go to Section 2, Diagnostic Methods, Parameter Identification (PID), Selecting Parameter Identification (PID). ● Warm engine to normal operating temperature. ● Select PID EOT. ● **Is EOT value below 38°C (100°F)?**	Yes ▶ No ▶	REPLACE EOT sensor according to Workshop Manual direction. GO to 7-4.
7-4	CHECK ACCELERATOR PEDAL		
	● Check for floor mat interference. ● Check bushing for damage. ● Check return spring. ● **Is a fault indicated?**	Yes ▶ No ▶	REPAIR as required according to Workshop Manual direction. GO to 7-5.
7-5	CHECK ENGINE OIL		
	● Check for coolant in engine oil. ● **Is there coolant in engine oil?**	Yes ▶ No ▶	REPAIR as required according to Workshop Manual direction. GO to 7-6.
7-6	CHECK FOR FUEL CONTAMINATION		
	● Check crankcase for fuel contamination. ● **Does the crankcase have fuel contamination?**	Yes ▶ No ▶	REPLACE tandem fuel pump according to Workshop Manual direction. GO to Symptom Chart 10.

Symptom Chart 8

8-

Symptom	OASIS Number
Runs Rough	608000
— Acceleration	608500
— Cruise	608600
Misses	609000
— Idle	609400
— Acceleration	609500
— Cruise	609600
Buck/Jerk	610000
— Acceleration	610500
— Cruise	610600
— Deceleration	610700
Hesitation/Stumble	611000
— Acceleration	611500

Test Step		Result ▶	Action to Take
8-1	PRELIMINARY CHECKS		
	● Perform the following preliminary checks: — Engine overheating — Electrical connections — Engine oil level / quality — MAP sensor vacuum hose leak — PCM automatically limits RPM at top engine speed — Automatic transmission TCC — ATF level ● **Are all checks OK?**	Yes ▶ No ▶	GO to 8-2. REPAIR as necessary. VERIFY a symptom no longer exists.
8-2	CHECK PERFORMANCE DIAGNOSTICS		
	● Go to Symptom Chart 10. ● **Is a fault indicated?**	Yes ▶ No ▶	FOLLOW Symptom Chart direction. GO to the Powertrain Group in the Workshop Manual to perform automatic transmission diagnosis.

Symptom Chart 9

9-

Symptom	OASIS Number
Surge	612000
— Acceleration	612500
— Cruise	612600

Test Step		Result ▶	Action to Take
9-1	PRELIMINARY CHECKS		
	● Perform the following preliminary checks: — Engine oil level / quality — Electrical wiring ● **Are all checks OK?**	Yes ▶	GO to 9-2.
		No ▶	REPAIR as necessary. VERIFY a symptom no longer exists.
9-2	CHECK PERFORMANCE DIAGNOSTICS		
	NOTE: Surges at rpm limiter or top end speed limiter are normal functions of the PCM. ● Go to Symptom Chart 10. ● **Is a fault indicated?**	Yes ▶	FOLLOW Symptom Chart direction.
		No ▶	GO to the Powertrain Group in the Workshop Manual to perform automatic transmission diagnosis.

Symptom Chart 10

10-

Symptom	OASIS Number
Lack/Loss of Power	614000
— Acceleration	614500
— Cruise	614600
Additional Driveability Concerns	
— Poor Fuel Economy	622000

Test Step		Result ▶	Action to Take
10-1	PRELIMINARY CHECKS		
	● Perform the following preliminary checks: — Confirm brakes are not dragging — Confirm transmission and axle fluid levels — Confirm transmission and axle tube are not "cooked" — Check for engine overheating — Check for oil in coolant — Check engine oil level — Confirm oil change within 8046.5 km (5000 miles), (5632.6 km [3500 miles] if severe duty) — Check Filter Minder — Check MAP sensor hose for holes, blockage, or disconnection. Confirm correct MAP sensor. — Check intake manifold system for leaks with soapy water with engine running. Include orange seals, gaskets and fittings — Confirm acceptable SAE oil viscosity: ● 15W-40: preferred 30°F to 120°F ● 10W-30: preferred -10°F to -30°F ● 5W-30: preferred below -20°F to -30°F — Check fuel quality by opening filter drain and cranking engine — Confirm proper dipstick part number. — Check for sufficient clean fuel — Check for an intake restriction — Check MAP sensor hose ● **Are all checks OK?**	Yes ▶ No ▶	GO to 10-2. REPAIR as necessary. VERIFY a symptom no longer exists.
10-2	PERFORM KOEO ON-DEMAND SELF TEST		
	● GO to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform KOEO On-Demand Self Test. ● **Is a fault indicated?**	Yes ▶ No ▶	GO to appropriate pinpoint test. GO to 10-3.

Symptom Chart 10

10-

Test Step		Result ►	Action to Take
10-3	PERFORM KOEO INJECTOR ELECTRICAL SELF TEST		
	• GO to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform KOEO Injector Electrical Self Test. • **Is a fault indicated?**	Yes ► No ►	GO to appropriate pinpoint test. GO to 10-4.
10-4	RETRIEVE / CLEAR CONTINUOUS DTCS		
	• GO to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Retrieve / Clear Continuous DTCs. • Record any codes retrieved. • Clear Continuous DTCs. • Check camshaft timing. — Rotate engine by hand until crankshaft timing mark for cylinder No. 1 is aligned with CMP sensor pointer. — Remove CMP sensor. — View spoked timing disk through hole for CMP sensor. If narrow spoke is not visible, rotate engine an additional 360 degrees. • **Is narrow sync spoke aligned with the middle of the hole?**	Yes ► No ►	GO to 10-5. Cam gear is misindexed with crank gear. REPAIR as required according to Workshop Manual direction.
10-5	CHECK COLD CMP CLEARANCE		
	• **Did engine fail to reach rated speed only when engine oil was cold?**	Yes ► No ►	GO to 10-6. GO to 10-7.
10-6	CHECK CMP CLEARANCE TO TIMING DISK		
	• Remove and inspect CMP for evidence of contact with the timing disk (scratches or unplugged holes on working surface). • **Is there evidence of contact?**	Yes ► No ►	REPLACE CMP according to Workshop Manual direction and add shim F6TZ-12J027-M to create approximately 0.5 mm (0.020 inch) clearance to timing disk. GO to 10-7.
10-7	CHECK FOR BIASED ICP SENSOR		
	• Warm up engine. • Turn off engine for one minute. • KOEO. • GO to Section 2, Diagnostic Methods, Parameter Identification (PID), selecting Parameter Identification (PID). • Select PIDs ICP and ICP V. • **Does ICP PID read greater than 0 kPa (0 psi) or ICP V PID read greater than 0.30 volt?**	Yes ► No ►	GO to Pinpoint Test DD. CONFIRM wiring is OK. If OK, REPLACE ICP sensor according to Workshop Manual direction. GO to 10-8.

Symptom Chart 10

10-

Test Step		Result ▶	Action to Take
10-8	CHECK FOR LOW IDM POWER		
	• Run engine at WOT, unloaded. • **Does engine reach 3300 rpm?**	Yes ▶ No ▶	GO to 10-12. GO to 10-9.
10-9	VERIFY GOVERNED IDLE		
	• **Does engine stay at governed idle (650 rpm)?**	Yes ▶ No ▶	GO to Symptom Chart 4. GO to 10-10.
10-10	CONFIRM INJECTION CONTROL PRESSURE		
	• Go to Section 2, Diagnostic Methods, Parameter Identification (PID), selecting Parameter Identification (PID). • Select PIDs ICP and ICP V. • **Does ICP PID read at least 6895 kPa (1000 psi [1.46 volts]) at maximum rpm reached?**	Yes ▶ No ▶	GO to 10-11. GO to 10-23.
10-11	CHECK FUEL PUMP PRESSURE		
	• Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform Fuel Pump Pressure Test. • Check both tanks. • **Is fuel pressure at least 172 kPa (25 psi) at maximum rpm?**	Yes ▶ No ▶	GO to Pinpoint Test NA Step NA29. CONFIRM injector wiring circuits are OK. If OK, REPLACE IDM according to Workshop Manual direction. GO to 10-15.
10-12	CHECK FOR AERATED OIL		
	CAUTION: Before running oil aeration tests, make sure the high-pressure oil passages are free of air from recent repairs by running vehicle hard for 32 kilometers (20 miles) after repair. **CAUTION: Engine must be warmed up to normal operating temperature.** • Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform Injection Control Pressure Test. • Run engine at WOT for 30 seconds. • **Does ICP read greater than 11032 kPa (1600 psi) or 2.15 volts in 30 seconds or less?**	Yes ▶ No ▶	GO to 10-13. GO to 10-14.
10-13	CHECK FOR OIL PUMP INTAKE LEAKS		
	• Confirm proper oil change interval. • Confirm proper oil level and type. • Overfill engine by 1.9 liters (2 quarts). • Raise and support rear of vehicle 254 mm (10 inches). • Run engine at WOT for 30 seconds. • **Does ICP read greater than 11032 kPa (1600 psi [2.15 volts])?**	Yes ▶ No ▶	LOWER vehicle. RETURN oil level to normal. GO to 10-14. Aeration is caused by O-ring leak or a hole in the oil pickup tube. REPAIR as required according to Workshop Manual direction.

Symptom Chart 10

10-

Test Step	Result ▶	Action to Take
10-14 INJECTION CONTROL PRESSURE TEST		
• Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform Injection Control Pressure Test. • Warm engine to normal operating temperature. • Run engine at WOT for 3 minutes. • **Does ICP read greater than 8756 kPa (1270 psi) or 1.75 volts?**	Yes ▶	Oil is aerating due to lack of defoaming agents. CHANGE to oil that meets CG4 / SH specifications and CONFIRM oil quantity is 13.2 liters (14 quarts). GO to 10-15.
	No ▶	GO to 10-15.
10-15 FUEL SYSTEM CHECK		
• Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform Fuel Pump Pressure Test. • **Is fuel pressure less than 206 kPa (30 psi) at 3300 rpm?**	Yes ▶	REMOVE filter cover and filter. DETACH pressure regulator from filter housing and CHECK for clogged return screen. CHANGE fuel filter, and RERUN pressure check. If fuel pressure is still less than 206 kPa (30 psi) at 3300 rpm, GO to 10-16.
	No ▶	GO to 10-16.
10-16 CHECK FUEL REGULATOR		
• Detach pressure regulator from filter housing, and check for clogged return screen or clogged orifices. • Check regulator valve for evidence of sticking or debris. • **Is regulator valve faulty?**	Yes ▶	REPLACE regulator valve according to Workshop Manual direction.
	No ▶	GO to 10-17.
10-17 CHECK PUMP INLET RESTRICTION		
• Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform Pump Inlet Pressure Test. • **Is vacuum greater than 20 kPa (6 in-Hg)?**	Yes ▶	CHECK inlet lines between tank(s) and fuel line fitting for blockage.
	No ▶	1998 models, GO to 10-18. 1998-1/2 Econoline with electric fuel pump and 1999 F-Series, GO to 10-20.
10-18 CHECK FOR AIR IN FUEL SYSTEM		
• Go to Section 4A, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform Air In Fuel System Test. • **Is there return fuel?**	Yes ▶	GO to 10-19.
	No ▶	GO to 10-20.

Symptom Chart 10

10-

Test Step	Result ▶	Action to Take
10-19 CHECK FOR BUBBLES IN FUEL RETURN		
• **Referring to Step 10-18, were there bubbles in the return fuel?**	Yes ▶	CHECK fuel regulator return passages for obstruction. LOCATE and REPAIR fuel supply line leak between tank(s) and fuel pump, or at high-pressure stage inlet.
	No ▶	Fuel system is OK. GO to 10-23.
10-20 CHECK FOR PLUGGED / KINKED RETURN LINE		
• Disconnect return line from clear line. • Catch return fuel in a container. • **Is there return fuel?**	Yes ▶	REPLACE return line according to Workshop Manual direction.
	No ▶	GO to 10-21.
10-21 CHECK FUEL REGULATOR FOR BLOCKAGE		
• Remove fuel regulator and check for blockage. • **If there blockage?**	Yes ▶	REPLACE fuel regulator according to Workshop Manual direction.
	No ▶	GO to 10-22.
10-22 CHECK FUEL INLET LINE FOR BLOCKAGE		
• Check fuel inlet line for blockage between quick connect fitting and fuel pump. • **Is there blockage?**	Yes ▶	REPLACE fuel inlet line according to Workshop Manual direction.
	No ▶	REPLACE fuel pump according to Workshop Manual direction.
10-23 CHECK HIGH-PRESSURE OIL SYSTEM		
• Confirm engine oil level in high-pressure pump reservoir is within 25.4 mm (1 inch) of inspection plug. • Attach 689 kPa (100 psi) oil pressure gauge on gauge bar (14-00761) to reservoir. • Warm engine to normal operating temperature. • **Is oil pressure 69 kPa (10 psig) or higher at idle (650 rpm)?**	Yes ▶	GO to 10-24.
	No ▶	GO to the Powertrain Group in the Workshop Manual to check for cause of low oil pressure.
10-24 KOER ON-DEMAND SELF TEST		
CAUTION: Before running KOER On-Demand Self Test, make sure the high-pressure oil passages are free of air from recent repairs by running vehicle hard for 32 kilometers (20 miles) after repair. • Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform KOER On-Demand Self Test. • **Was DTC P1211 received?**	Yes ▶	GO to 10-26.
	No ▶	GO to 10-25.

Symptom Chart 10

10-

Test Step		Result ►	Action to Take
10-25	CHECK FOR DTC P0476		
	• **Referring to Step 10-24, was DTC P0476 received?**	Yes ► No ►	GO to 10-29. GO to 10-33.
10-26	CHECK PRESSURE BALANCE		
	• Plug off high-pressure hose for right cylinder head using special tool. • Record IPR at 3300 rpm. • Plug off high-pressure hose for left cylinder head using special tool, and reattach high-pressure hose on right cylinder head. • Record IPR at 3000 rpm. • **Is IPR duty cycle difference greater than 2%?**	Yes ► No ►	GO to 10-27. REPLACE IPR according to Workshop Manual direction.
10-27	KOER CYLINDER CONTRIBUTION TEST		
	• Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform KOER Cylinder Contribution Test. • **Is a cylinder identified?**	Yes ► No ►	REPLACE identified injector according to Workshop Manual direction. GO to 10-28.
10-28	CHECK FOR LEAK SOURCE		
	• Remove valve cover on cylinder head with higher IPR reading. • With engine idling, look for bubbling around injector bores or oil gallery drain plugs. • Or, with engine off, attach approximately 689 kPa (100 psi) air pressure to high-pressure oil gallery. • Look / listen for leaks. • **Is a leak present?**	Yes ► No ►	REPLACE seals on injectors or RESEAL oil galleries as required according to Workshop Manual direction. REPLACE seals on all injectors on the indicated bank according to Workshop Manual direction.
10-29	EXHAUST RESTRICTION TEST		
	• Inspect exhaust system for damage. • Remove engine cover (lid). • Observe EBP valve operation while rerunning KOER On-Demand Self Test. • **Does EBP valve cycle and then open completely (tang against stop)?**	Yes ► No ►	GO to 10-31. GO to 10-30.
10-30	CHECK ELECTRICAL SYSTEM		
	• Go to Section 5, Pinpoint Test KB, and confirm that EPR and wiring are working. • **Is electrical system OK?**	Yes ► No ►	REPAIR EBP system. REPAIR electrical system.
10-31	CHECK FOR BIASED EBP SENSOR		
	• KOEO. • Use NGS tester to read EBP, MAP and BARO PIDs. • **Is the difference between EBP, MAP and BARO PIDs greater than 20 kPa (3 psi)?**	Yes ► No ►	GO to Pinpoint Test DF. CONFIRM wiring and PCM are OK. If OK, REPLACE EBP according to Workshop Manual direction. GO to 10-32.

Symptom Chart 10

10-

Test Step		Result ▶	Action to Take
10-32	CHECK FOR EXHAUST RESTRICTION		
	- Unplug EOT to cause EBP valve to stay open. - Run engine at WOT. - Read EBP on NGS or DVOM. - **Is EBP greater than 172 kPa [25 psia (2 volts)] ?**	Yes ▶ No ▶	LOCATE and REPAIR exhaust restriction according to Workshop Manual direction. GO to Pinpoint Test C.
10-33	CHECK FOR WEAK CYLINDER		
	- Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform KOER Cylinder Contribution Test. - **Is a cylinder identified?**	Yes ▶ No ▶	GO to 10-34. GO to 10-35.
10-34	CHECK FOR PISTON OR VALVE LEAKS		
	- Perform a compression pressure test. - **Is compression pressure lower than 2413 kPa (350 psig) and different from adjacent cylinders by 345 kPa (50 psig)?**	Yes ▶ No ▶	REPAIR as necessary according to Workshop Manual direction. REMOVE and REPAIR injector identified in Step 10-33 as required according to Workshop Manual direction.
10-35	CHECK FOR ENGINE WEAR		
	- Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform Crankcase Pressure Test. - **Is crankcase pressure higher than 4 inches of H_2O?**	Yes ▶ No ▶	REPAIR engine for rings or valves as required according to Workshop Manual direction. GO to 10-36.
10-36	BOOST PRESSURE TEST		
	- Go to Section 4A or Section 4B, Diagnostic Subroutines, Performance Diagnostic Procedures. Perform Boost Pressure Test. - Display PID MGP on NGS. - Road test to determine turbo boost. - Accelerate hard between 1500 and 3000 rpm. - **Is boost OK?**	Yes ▶ No ▶	GO to 10-38. GO to 10-37.
10-37	CHECK MAP SENSOR		
	- Go to Section 5. Perform Pinpoint Test DC or DJ. - **Does MAP system check OK?**	Yes ▶ No ▶	REPLACE MAP sensor according to Workshop Manual direction. INSPECT turbocharger. REPAIR as necessary according to Workshop Manual direction.

Symptom Chart 10	10-

Test Step		Result ▶	Action to Take
10-38	CHECK FOR BIASED EOT SENSOR		
	● Soak vehicle overnight. ● Do not start engine. ● Read EOT and IAT using NGS Tester with KOEO. ● **Do readings agree within 6°C (11°F)?**	Yes ▶	GO to 10-39.
		No ▶	GO to Pinpoint Test DB. CONFIRM wiring is OK. If OK, REPLACE EOT according to Workshop Manual direction.
10-39	CHECK EOT SENSOR		
	● Warm engine to between 15°C and 70°C (59°F and 158°F). ● Remove fill / check plug from high-pressure oil pump reservoir. ● Measure reservoir oil temperature with an A / C thermometer. ● Measure EOT using NGS Tester or DVOM. ● **Do readings between EOT and thermometer agree within ± 3°C (± 5.4°F)?**	Yes ▶	With transmission in fourth gear (M / T) or OD locked out (E4OD), RECORD time to accelerate hard between 48 and 97 km / h (30 and 60 mph). COMPARE time to another power stroke vehicle with same weight, transmission and axle.
		No ▶	GO to Pinpoint Test DB. CONFIRM wiring is OK. If OK, REPLACE EOT according Workshop Manual direction.

Symptom Chart 11

11-

Symptom	OASIS Number
Additional Driveability Concerns — CHECK ENGINE Light Concern	698298
Warning Indicators — CHECK ENGINE Light	206000

Test Step		Result ▶	Action to Take
11-1	OBSERVE CHECK ENGINE LIGHT		
	• **Is CHECK ENGINE light continuously illuminated?**	Yes ▶ No ▶	GO to 11-2. GO to 11-3.
11-2	PERFORM KOEO ON-DEMAND SELF TEST AND RETRIEVE / CLEAR CONTINUOUS DTCS		
	• Go to Section 2, Diagnostic Methods. Perform KOEO On-Demand Self Test, and Retrieve / Clear Continuous DTCs. • **Is fault indicated?**	Yes ▶ No ▶	GO to appropriate pinpoint test. GO to 11-3.
11-3	RUN BULB CHECK		
	• Cycle ignition switch. • **Does CHECK ENGINE light flash?**	Yes ▶ No ▶	CHECK ENGINE light is OK. GO to Pinpoint Test NB.

Symptom Chart 12

12-

Symptom	OASIS Number
Exhaust System Concerns	403000
— Visible Smoke	403400

Test Step		Result ▶	Action to Take
12-1	PRELIMINARY CHECKS		
	• Perform the following preliminary checks: — Check Filter Minder — Check MAP sensor hose for holes, blockage, or disconnection. Confirm correct MAP sensor. — Check intake manifold system for leaks with soapy water with engine running. Include orange seals, gaskets and fittings — Confirm acceptable SAE oil viscosity: • 15W-40: preferred -30°F to 120°F • 10W-30: preferred -10°F to -30°F • 5W-30: preferred below -20°F to 30°F — Check fuel quality by opening filter drain and cranking engine. • **Are all checks OK?**	Yes ▶	GO to 12-2.
		No ▶	REPAIR as required according to Workshop Manual direction. VERIFY a symptom no longer exists.
12-2	ATMOSPHERIC PRESSURE RATIONALITY CHECK		
	• Go to Section 2, Diagnostic Methods, Parameter Identification (PID), Selecting Parameter Identification (PID). • Select PIDs EBP, MAP and BARO. • Key on, engine off. • **Do all readings agree within 7 kPa (1.0 psi)?**	Yes ▶	GO to the appropriate pinpoint test for the sensor that disagrees with the other two sensors.
		No ▶	GO to 12-3.
12-3	CHECK TAILPIPE EXHAUST SMOKE		
	• **Is exhaust smoke coming from the tailpipe?**	Yes ▶	If exhaust smoke is white, GO to 12-4. If exhaust smoke is black, GO to 12-6.
		No ▶	VERIFY a symptom no longer exists.
12-4	CHECK WHITE TAILPIPE EXHAUST SMOKE		
	NOTE: White tailpipe exhaust smoke is a normal condition at start-up with temperatures below 10°C (50°F) or with an extended idle in a cool climate. • Go to Section 4A or Section 4B, Diagnostic Subroutines, Hard Start / No Start Diagnostic Procedures. Perform Glow Plug System Operation check. • Go to Section 4A or Section 4B, Diagnostic Subroutines. Perform Performance Diagnostic Procedures. • **Is a fault indicated?**	Yes ▶	FOLLOW Diagnostic Procedures direction.
		No ▶	GO to 12-5.

Symptom Chart 12

12-

Test Step		Result ▶	Action to Take
12-5	CHECK ENGINE COOLING		
	- Go to the Powertrain Group in the Workshop Manual to check thermostat operation. - **Is thermostat operating properly?**	Yes ▶	REPAIR as necessary according to Workshop Manual direction.
		No ▶	PERFORM cooling system leak tests. CHECK for internal engine leaks according to Workshop Manual direction.
12-6	MAP SENSOR VACUUM CHECK		
	- Apply vacuum to MAP sensor. - **Does MAP sensor hold vacuum?**	Yes ▶	Unable to verify concern at this time. RETURN to Symptom Index.
		No ▶	REPLACE MAP sensor according to Workshop Manual direction.

# Symptom Chart 13	13-

Symptom	OASIS Number
Additional Driveability Concerns — Speed Control	205200

Test Step		Result ▶	Action to Take
13-1	CHECK ABS LIGHT		
	● **Is ABS light on?**	Yes ▶ No ▶	REPAIR as necessary according to Workshop Manual direction. GO to 13-2.
13-2	CHECK BRAKE WARNING LIGHT		
	● **Is brake warning light on?**	Yes ▶ No ▶	GO to Pinpoint Test FF. GO to 13-3.
13-3	PERFORM KOEO ON-DEMAND SELF TEST AND RETRIEVE / CLEAR CONTINUOUS DTCS		
	● Go to Section 2, Diagnostic Methods. Perform KOEO On-Demand Self Test, and Retrieve / Clear Continuous DTCs. ● **Is a fault indicated?**	Yes ▶ No ▶	GO to appropriate pinpoint test. GO to 13-4.
13-4	PERFORM KOER SWITCH SELF TEST		
	● Go to Section 2, Diagnostic Methods. Perform KOER switch self test. ● **Is a fault indicated?**	Yes ▶ No ▶	GO to appropriate pinpoint test. GO to 13-5.
13-5	ROAD TEST		
	● Go to Section 2, Diagnostic Methods, Parameter Identification (PID), Selecting Parameter Identification (PID). ● Select PIDs PBA, BPA, CPP, BOO, SCCS__M, VSS, and VS SET. ● Drive vehicle and function speed control system. ● Compare VSS to Speedometer. ● **Does NGS display proper values for each PID selected?**	Yes ▶ No ▶	GO to 13-6. GO to appropriate pinpoint test.
13-6	CHECK SPEED CONTROL		
	● **Does speed control drop out when climbing hills?**	Yes ▶ No ▶	Engine power is not adequate to hold hill. GO to 13-7. GO to Symptom Chart 10.
13-7	CHECK VEHICLE LOAD		
	● Check vehicle for heavy loads. ● **Is vehicle load too heavy to hold hills?**	Yes ▶ No ▶	Vehicle speed dropped 10 mph below speed control set mph, causing speed control disengagement. CONFIRM condition with NGS PIDS VSS and VS SET. GO to Symptom Chart 10.

Symptom Chart 14

14-

Symptom	OASIS Number
Warning Indicators — TCIL	698298

Test Step		**Result** ▶	**Action to Take**
14-1	CHECK TCIL		
	● **Is TCIL flashing?**	Yes ▶ No ▶	GO to 14-3. GO to 14-2.
14-2	TOGGLE TCIL		
	● Toggle TCIL by pushing TCS switch several times. ● **Does TCIL toggle on and off?**	Yes ▶ No ▶	TCIL is OK. GO to Pinpoint Test HA.
14-3	OBSERVE CHECK ENGINE LIGHT		
	● **Is Check Engine Light on?**	Yes ▶ No ▶	GO to Symptom Chart 11. GO to 14-4.
14-4	RUN QUICK TEST		
	● Go to Section 2, Diagnostic Methods. Perform Quick Test Operation. ● **Is a fault indicated?**	Yes ▶ No ▶	GO to appropriate pinpoint test. GO to Pinpoint Test HA.

Symptom Chart 15

15-

Symptom	OASIS Number
Automatic Transmission Shift Concerns	
— A/T Upshift Concern	501000
— A/T Downshift Concern	502000
— Engagement Concern	503000

Test Step		Result ▶	Action to Take
15-1	CHECK AUTOMATIC TRANSMISSION FLUID		
	● Check automatic transmission fluid level and quality. ● **Are fluid level and quality OK?**	Yes ▶	GO to 15-2.
		No ▶	REPAIR as necessary according to Workshop Manual direction. VERIFY a symptom no longer exists.
15-2	CHECK PARAMETER IDENTIFICATIONS (PIDS)		
	NOTE: Refer to NGS Tester — Driver Operated Controls Check for PID values. ● Go to Section 2, Diagnostic Methods, Parameter Identification (PID), Selecting Parameter Identification (PID). ● Display PIDs TR, SCCS M, 4x4L and VSS. ● **Does the scan tool display proper values for each PID?**	Yes ▶	GO to 15-3.
		No ▶	GO to appropriate pinpoint test.
15-3	CHECK PERFORMANCE DIAGNOSTICS		
	● Go to Symptom Chart 10. ● **Is a fault indicated?**	Yes ▶	REPAIR engine faults first, then REPAIR automatic transmission faults.
		No ▶	GO to the Powertrain Group in the Workshop Manual to perform automatic transmission diagnosis.

Symptom Chart 16

16-

Symptom	OASIS Number
Oil System Concerns	401000
— High Oil Consumption	401100
— Leaks	401800

Test Step	Result ▶	Action to Take
16-1 PRELIMINARY CHECKS		
● Perform the following preliminary checks: — External leaks (rocker cover gasket, crankshaft seals, etc.) — Proper dipstick — Proper oil viscosity ● **Are all checks OK?**	Yes ▶	GO to 16-2.
	No ▶	REPAIR as required according to Workshop Manual direction. VERIFY a symptom no longer exists.
16-2 CHECK PERFORMANCE DIAGNOSTICS		
● Go to Symptom Chart 10. ● **Is a fault indicated?**	Yes ▶	FOLLOW Diagnostic Procedures direction.
	No ▶	GO to the Powertrain Group in the Workshop Manual to CHECK valves, valve guides, valve stem seals, intake manifold gaskets, cylinder head drain passages (blue smoke on startup), and piston rings. REPAIR as required according to Workshop Manual direction.

Symptom Chart 17

17-

Symptom	OASIS Number
Starting Concerns — Hard Start / No Start — Dry Reservoir	

Test Step		Result ▶	Action to Take
17-1	PERFORM OIL PUMP PRESSURE TEST		
	NOTE: Low oil pressure from the engine oil pump can also cause low oil levels in the reservoir. ● Go to the Powertrain Group in the Workshop Manual. Perform Oil Pump Pressure Test. ● **Is a fault indicated?**	Yes ▶	REPAIR as required according to Workshop Manual direction.
		No ▶	GO to 17-2.
17-2	CHECK OIL RESERVOIR		
	● Remove oil reservoir fill plug and refill reservoir. ● Start engine and test drive vehicle for 16 kilometers (10 miles). ● Remove oil reservoir fill plug and check reservoir oil level. ● **Is oil reservoir full?**	Yes ▶	GO to 17-3.
		No ▶	INSPECT oil reservoir and engine front cover for evidence of oil leakage. If leakage is detected, REPAIR or REPLACE as required according to Workshop Manual direction.
17-3	RECHECK OIL RESERVOIR		
	NOTE: Perform the following step before starting engine. ● Allow vehicle to sit overnight. ● Remove oil reservoir fill plug and check reservoir oil level. ● **Is oil reservoir full?**	Yes ▶	VERIFY a symptom no longer exists.
		No ▶	REMOVE high-pressure oil pump. INSPECT for internal leak pass across high-pressure oil pump gasket beads. REMOVE oil reservoir cover. INSPECT oil reservoir for casting porosity. If necessary, REPLACE high-pressure oil pump or oil reservoir according to Workshop Manual direction.

SECTION 4A

Diagnostic Subroutines — 1998

Contents

SECTION 4A

Diagnostic Subroutines — 1998

Contents (continued)

Hard Start/No Start Diagnostic Procedures

Hard Start/No Start Diagnostics

1 Visual Engine/Chassis Inspection

Fuel Oil Coolant Electrical Hoses Leaks	
Method	**Check**
Visual	

2. Check Engine Oil Level

- Check for contaminants (fuel, coolant)
- Correct Grade/Viscosity
- Miles/hours on oil, correct level
- Check level in reservoir

Method	Check
Visual	

3. Intake/Exhaust Restriction

- Inspect air filter and ducts - exhaust system
- Inspect exhaust back pressure device

Method	Check
Visual	

4 Sufficient Clean Fuel

- Check fuel tank(s), drain sample from fuel filter while cranking engine
- Note if operator has indicated that the Water in Fuel or Fuel Filter Restriction Lamp has been illuminated

Method	Check	
Visual	Front Tank	Rear Tank

5. Tandem Fuel Pump Pressure

- Measure at regulator block
- Minimum 100 RPM crank speed for 20 sec

Front Tank

Instrument	Spec.	Measurement
0-160 PSI Gauge	20 PSI min	

Rear Tank

Instrument	Spec.	Measurement
0-160 PSI Gauge	20 PSI min	

6. Perform KOEO On Demand Test

- Use NGS Tester
- Diagnostic Trouble Codes set during this test are current faults

Pass Code = P1111 or System Passed

Diagnostic Trouble Codes	

7. Retrieve Continuous Trouble Codes

- Diagnostic Trouble Codes retrieved during this test are historical faults

Pass Code = P1111 or System Passed

Diagnostic Trouble Codes	

8. KOEO Injector Electrical Self-Test

- Use NGS Tester
- All injectors will momentarily buzz, then individual injectors will buzz in sequence 1 through 8
- Diagnostic Trouble Codes will be transmitted after test is completed

Pass Code = P1111 or System Passed

Diagnostic Trouble Codes	

Refer to PC/ED manual Pinpoint tests if Diagnostic Trouble Codes are set.

9. NGS Tool-Data List Monitoring

- NGS Tester may reset below 9 5 volts
- Select the parameters indicated from the NGS parameter list and monitor while cranking engine

Parameter	Spec	Measurement
V PWR	7 volt minimum	
RPM	100 RPM minimum	
ICP	500 PSI or 3 4 mPa min	
FUEL PW	1 mS to 6 mS	

A- V PWR - If indicating a low voltage condition, check battery voltage, charging system or power and ground circuits to the PCM

GO TO PINPOINT TEST A

B- RPM - Low RPM could be an indication of starting/ charging system problems, No RPM indicated with the engine cranking-could be CMP circuit fault, check for Diagnostic Trouble Codes

GO TO PINPOINT TEST DG

C- ICP - A minimum of 500 PSI (3 4 mPa) is required before the injectors are enabled No or low oil in the reservoir, system leakage, faulty IPR or high pressure pump could cause pressure loss

Note: CMP signal is required before IPR is commanded above 14%

D- FUEL PW - Even though a 1 to 6 mS FUEL PW is shown on the NGS to be sent to the IDM, its possible that the IDM did not get the signal, due to a fault on either CID or FDCS circuits or even the IDM

Note: A hard start/no start concern with EOT temp. below 60 F perform this Test Step first.

10. Glow Plug System Operation

Relay Operation

- Glow Plug ON time is dependent on oil temperature and altitude The Glow Plug relay comes on between 1 to 120 sec and does not come on at all if oil Temp is above 86 F (49 State Econoline) or 131 F (all F-Series and California Econoline)
- Verify that B+ is being supplied on the large BK/W wire going to the Glow Plug relay
- Install a voltmeter to the glow plug feed terminal (terminal with two brown wires) or (center terminal on the shunt for California)
- Turn key to run position measure ON" time
- Using the NGS GPCTM and EOT pids, verify sufficient glow plug 'ON" time and voltage

(Dependent on oil temperature and altitude)

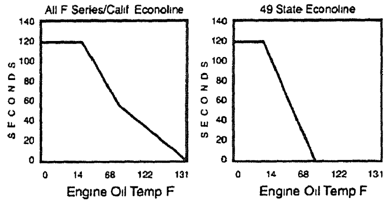
9-12 Volts	Spec	Measurement
Relay On time	1 to 120 seconds	

Note· Wait to Start Lamp "On" time (1-10 sec.) is independent from Glow Plug Relay "On" time

Glow Plug Operation

- Measure Glow Plug Resistance to Bat Ground
- Remove all glow plug/injector connectors
- Measure GP Harness Resistance to Relay

Glow Plug Number	Glow Plug to Ground .1 to 2 ohms	Connector to Relay 0 to 1 ohms
#1		
#3		
#5		
#7		
#2		
#4		
#6		
#8		



- Add 5 seconds to glow plug on time when above 7000 feet in altitude, but not to exceed 120 seconds

DA1454-A

Hard Start/No Start Diagnostic Procedures

1. Visual Engine/Chassis Inspection

Purpose:

This is a visual inspection to check the general condition of the engine and look for obvious causes of hard start or no start conditions.

1. Visual Engine/Chassis Inspection

Fuel Oil Coolant Electrical Hoses Leaks

Method	Check
Visual	

DA1455-A

Recommended Procedure:

Inspect fuel system including fuel tank and fuel lines for kinks, bends and/or leakage. Check oil lines and high pressure pump in engine V for major oil leaks. Inspect for coolant leaks at radiator and heater hoses and check coolant level. Inspect MAP sensor hose for pinched or open vacuum leaks. Inspect wiring for correct routing and make sure no rubbing or chafing has occurred. Inspect the in-line 42-way, injector driver module (IDM), powertrain control module (PCM) and sensor connectors to make sure they are completely seated and in good condition.

Possible Causes:

- Loose or leaking fuel supply lines could cause fuel system to lose prime.
- Kinked or blocked fuel supply lines will create fuel restriction.
- Massive fuel or oil leaks could contribute to no start conditions.
- Coolant leaks could indicate serious engine problems.
- Biased MAP sensor.
- Electronic connectors may be damaged or not installed properly causing a no start condition. The camshaft position (CMP) sensor and the injection pressure regulator (IPR) are the two most critical electronic sensors/actuators to inspect in no start situations.
- Pinched or open MAP sensor hose.

Tools Required:

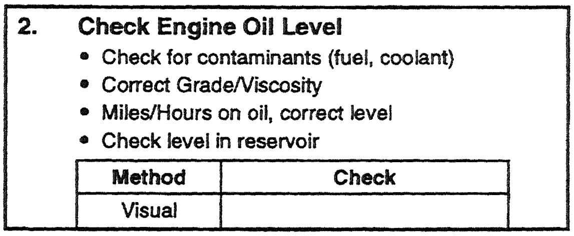
Inspection light

Hard Start/No Start Diagnostic Procedures

2. Check Engine Oil Level

Purpose:

To determine if there is enough oil or oil of sufficient quality to operate the injectors.



2. **Check Engine Oil Level**
   - Check for contaminants (fuel, coolant)
   - Correct Grade/Viscosity
   - Miles/Hours on oil, correct level
   - Check level in reservoir

Method	Check
Visual	

A22181-C

Recommended Procedure:

Check oil level with dipstick when vehicle is on level ground. If there is no oil or very little oil in the crankcase, the injectors will not operate.

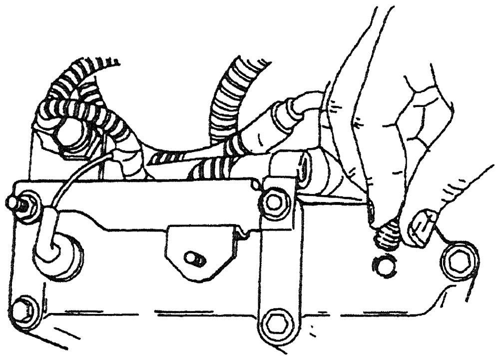
If the oil level on the dipstick is overfull it is possible the engine was incorrectly serviced or fuel is diluting the oil and filling the crankcase. Usually if a substantial amount of fuel is in the oil it will have a fuel odor.

Inspect oil for color. A milky white oil indicates possible coolant contamination and will have an ethylene glycol odor.

Check service records for correct oil type and viscosity for the vehicle operating temperature. Single weight or 15W-40 oil is not recommended for cold ambient temperatures. 10W-30 oil is recommended for cold ambient temperatures. Oil that has had extended drain intervals will have increased viscosity (become thicker) and will make engine cranking more difficult and starting less reliable at temperatures below freezing. Refer to the lube oil chart in the Workshop Manual or Owner's Guide for the correct oil selection for temperature conditions.

Hard Start/No Start Diagnostic Procedures

The level in the oil reservoir should also be checked. Remove the inspection plug in top of reservoir and check to see if the oil reservoir is full. (A reservoir that drains back after the engine has not been operated for a period of time can cause a hard start and die condition.) Filling the reservoir will allow the system to prime faster facilitating starting.



A23376-A

Possible Causes:

- Loss of lube oil pressure
- Oil level low — oil leak, oil consumption, incorrect servicing
- Oil level high — incorrect servicing, fuel dilution from tandem fuel pump, fuel dilution from injector O-rings
- Oil contamination with coolant — oil cooler, head gasket, porosity
- Low reservoir level — engine built dry (not pressure lubed), prolonged period of not running, excessive cranking without starting

Tools Required:

1 / 4-inch drive ratchet or breaker bar to remove inspection plug

Hard Start/No Start Diagnostic Procedures

3. Intake/Exhaust Restriction

Purpose:

This is a visual inspection to determine if an air intake or exhaust restriction is contributing to a no start or hard start condition. If the engine does start with a high air intake or exhaust restriction, a considerable amount of black / blue smoke is produced.

3. Intake/Exhaust Restriction

- Inspect air filter and ducts – exhaust system
- Inspect exhaust back pressure device

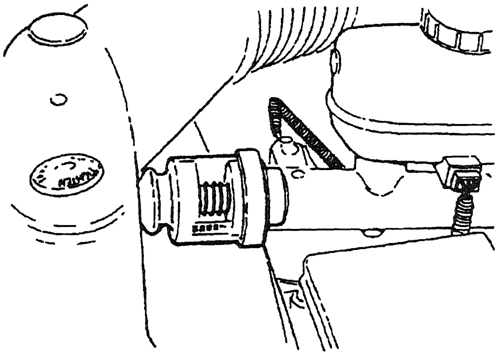
Method	Check
Visual	

A22182-C

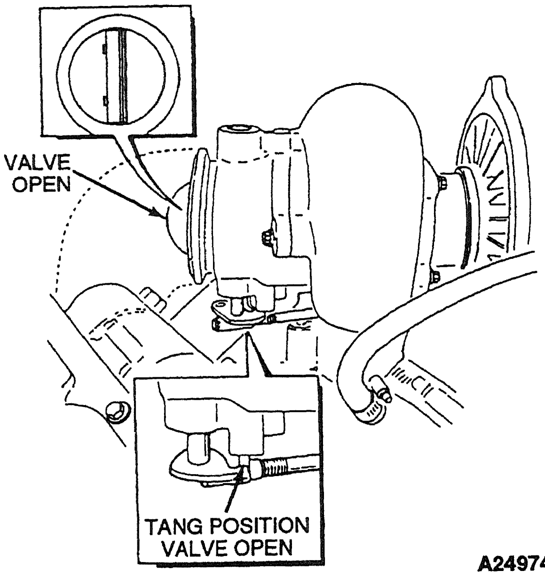
Recommended Procedure:

Inspect the air cleaner inlet and ducting to assure that it is not blocked or collapsed. Inspect the air cleaner housing and filter for proper installation. Inspect the filter minder to assure intake restriction is below the red marks.

Inspect the exhaust back pressure device bellcrank during cranking and assure that it is not closing. Inspect the exhaust system for damaged or blocked pipes. When the tang is against the stop, the valve is fully open.



A23378-A



A24974-A

Hard Start/No Start Diagnostic Procedures

Possible Causes:

- Snow, plastic bags or other foreign material may restrict airflow at the air inlet.
- Misrouted air cleaner ducting.
- On engines recently repaired, rags or cap plugs may have been inadvertently left in an air inlet pipe.
- Exhaust back pressure device may be closing during cranking or stuck closed.
- Tailpipe or muffler may have collapsed or been damaged or the catalytic converter is clogged.

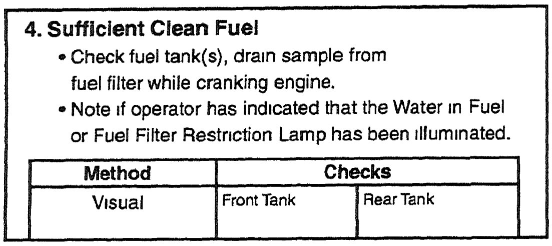
Tools Required:

None

4. Sufficient Clean Fuel

Purpose:

The purpose of this test is to see if the fuel system is getting sufficient clean fuel to start and run.



4. Sufficient Clean Fuel

- Check fuel tank(s), drain sample from fuel filter while cranking engine.
- Note if operator has indicated that the Water in Fuel or Fuel Filter Restriction Lamp has been illuminated.

Method	Checks	
Visual	Front Tank	Rear Tank

DA1456-A

Recommended Procedure:

Route a hose from the fuel drain line to a clear container and open the drain. Crank the engine and observe the fuel flowing into the container. Stop cranking the engine when the container is half full.

Observe the WATER IN FUEL lamp while cranking the engine. If the lamp is illuminated, the fuel is probably contaminated with water.

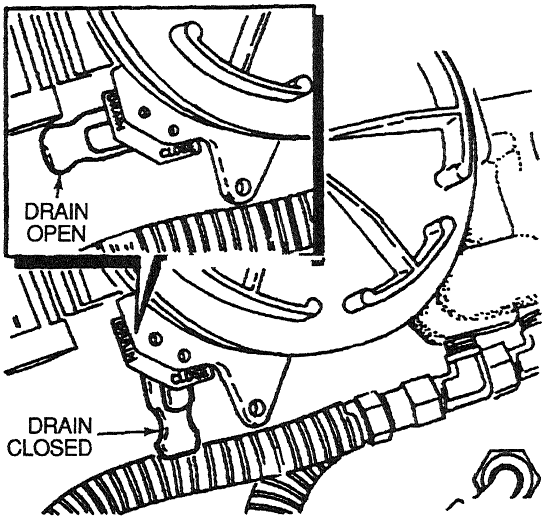
Flow out of the drain should be a steady stream. Insufficient flow could indicate fuel supply or fuel system problems.

Inspect fuel in the container. It should be straw colored, but not cloudy. It also should be free of water and contaminants. Dyed red or blue fuel indicates off-highway fuel.

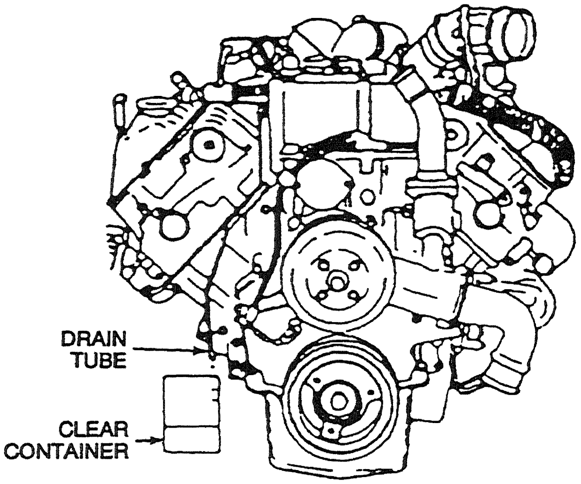
Hard Start/No Start Diagnostic Procedures

If engine oil is present in the fuel it may indicate an injector O-ring leak and subsequent loss of rail pressure. If that is suspected, check rail pressure during engine cranking (Hard Start / No Start Diagnostic Procedures Step 9C).

Some sediment and water may be present in the fuel sample if the fuel filter has not been serviced for a prolonged period of time and / or if the sediment and water have not been drained recently. If that is the case, a second sample may be required to determine fuel quality.



A23374-B



SUFFICIENT CLEAN FUEL

A23375-A

Possible Causes:

- No fuel in tank.
- If equipped with a fuel line valve, it could be shut off.
- If equipped with dual tanks, the switch valve could be faulty.
- Fuel supply line could be broken or crimped.
- Fuel could be jelled (most likely in cold weather with No. 2 fuel).
- Pickup tube screen in tank could be clogged.

Cloudy fuel indicates that the fuel may not be a suitable grade for cold temperatures; excessive water or contaminants may indicate that the tank and fuel system may need to be flushed and cleaned.

Tools Required:

Clear container — approximately 1-quart

Hard Start/No Start Diagnostic Procedures

5. Tandem Fuel Pump Pressure

Purpose:

To determine if there is sufficient fuel pressure for starting.

5. Tandem Fuel Pump Pressure

- Measure at regulator block
- Minimum 100 RPM crank speed for 20 sec.

Front Tank

Instrument	Spec.	Measurement
0-160 PSI Gauge	20 PSI min.	

Rear Tank

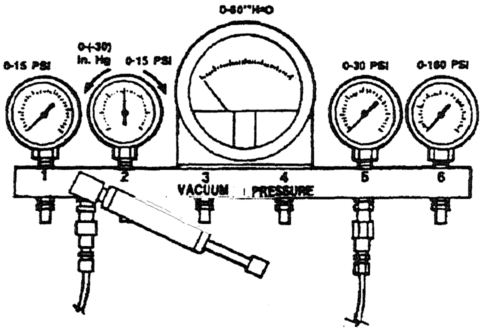
Instrument	Spec.	Measurement
0-160 PSI Gauge	20 PSI min.	

If failed test 5, change fuel filter, retest.

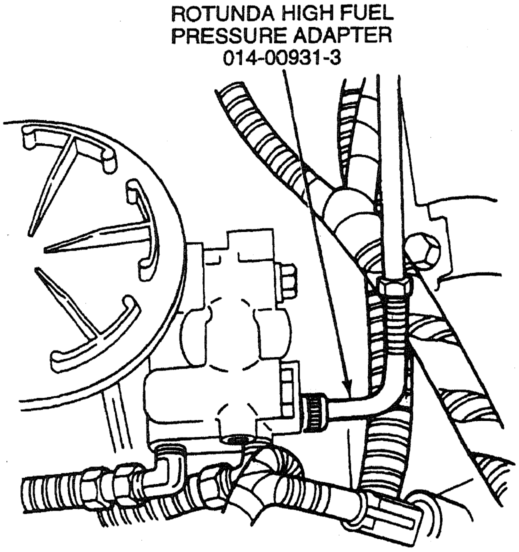
A22186-C

Recommended Procedure:

Connect High Fuel Pressure Adapter 014-00931-3 or equivalent to the Schrader valve mounted in the fuel regulator block. Connect a line for a 160-psi gauge to the adapter. Crank engine at 100 rpm minimum and measure maximum fuel pressure.

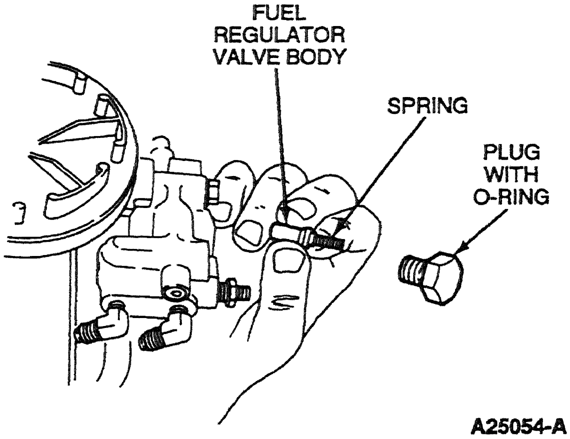


A23383-A



A23404-B

Hard Start/No Start Diagnostic Procedures



A25054-A

Possible Causes:

- A fuel filter could cause high restriction and low fuel pressure because of dirt or fuel jelling in cold ambient temperatures. Change filter and retest. (Note: It may take a couple of crank cycles to purge the air out of the fuel system.)
- Debris in the fuel regulator valve will cause low fuel pressure. Disassemble, inspect and clean.
- A kinked or severely bent fuel supply line or blockage at the pickup tube could cause restriction and therefore low fuel pressure.
- A loose fuel line on the suction side of the fuel system could cause air to be ingested into the system and cause low fuel pressure.
- The fuel pump could have internal damage, such as ruptured diaphragm, seized plunger or leaking check valves.

Tools Required:

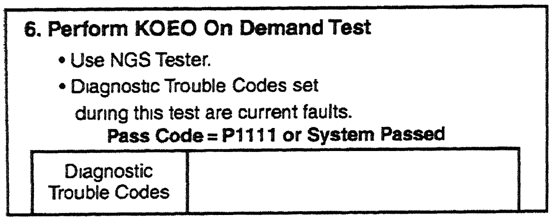
- 0-160 psi fuel pressure gauge
- High Fuel Pressure Adapter 014-00931-3 or equivalent line with 1/4-inch NPT fitting

Hard Start/No Start Diagnostic Procedures

6. Perform KOEO On-Demand Self Test

Purpose:

To determine if the PCM has detected any fault conditions that would cause a hard start or no start condition.



6. Perform KOEO On Demand Test

- Use NGS Tester.
- Diagnostic Trouble Codes set during this test are current faults.

Pass Code = P1111 or System Passed

Diagnostic Trouble Codes	

DA0836-B

NOTE: The IDM stores both historical and hard IDM fault codes. To retrieve IDM fault codes, you must run KOEO On-Demand Self Test or KOEO Injector Electrical Test. To ensure that the DTC is a hard fault, you must first clear Continuous DTCs (be sure to record all DTCs before clearing) even though IDM codes do not show up on the Continuous display. Rerun KOEO On-Demand Self Test if an IDM DTC is set. This is a hard fault.

Recommended Procedure:

Connect the NGS Tester to the data link connector (DLC) under the dash. Turn off accessories. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select KOEO ON-DEMAND SELF TEST.
- Turn key on.
- Follow operating instructions from the menu.
- Record DTCs and follow appropriate pinpoint test.
- After test, cycle key to off before running other tests or driving vehicle.

NOTE: If performing repeated self tests, it may be necessary to unplug glow plug relay to keep battery from going dead. Ignore glow plug codes while glow plug relay is unplugged.

Hard Start/No Start Diagnostic Procedures

Possible Causes:

The most likely PCM detectable faults that will cause a no start or hard start condition are:

- CMP sensor inactive faults.
- IPR output circuit check fault.
- FDCS, CID and IDM ENABLE circuit faults.

Tools Required:

New Generation Star (NGS) Tester 007-00500 or equivalent

7. Retrieve/Clear Continuous DTCs

Purpose:

To determine if the PCM has detected any historical or intermittent fault conditions that would cause a hard start/no start symptom. The condition that caused a continuous DTC may no longer exist.

7. Retrieve Continuous Trouble Codes

- Diagnostic Trouble Codes retrieved during this test are historical faults.

Pass Code = P1111 or System Passed

Diagnostic Trouble Codes	

DA0837-B

NOTE: The IDM stores both historical and hard IDM fault codes. To retrieve IDM fault codes, you must run KOEO On-Demand Self Test or KOEO Injector Electrical Test. To ensure that the DTC is a hard fault, you must first clear Continuous DTCs (be sure to record all DTCs before clearing) even though IDM codes do not show up on the Continuous display. Rerun KOEO On-Demand Self Test if an IDM DTC is set. This is a hard fault.

Recommended Procedure:

Connect the NGS Tester to the DLC under the dash. Turn off accessories. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.

Hard Start/No Start Diagnostic Procedures

- Select DIAGNOSTIC TEST MODE.
- Select RETRIEVE / CLEAR CONTINUOUS DTCs
- Turn key on.
- Follow operating instructions from the menu.
- Record DTCs and follow appropriate pinpoint test for continuous code diagnostics.
- After test, cycle key to off before running other tests or driving vehicle.
- Continuous DTCs must be cleared after repair is made.

If performing repeated self tests, it may be necessary to unplug glow plug relay to keep battery from going dead. Ignore any glow plug codes while glow plug relay is unplugged.

Tools Required:

New Generation Star (NGS) Tester 007-00500 or equivalent

8. KOEO Injector Electrical Self Test

NOTE: If unable to perform KOEO Injector Electrical Self Test, disconnect IDM connector and check injector high and low side for shorts or opens.

Purpose:

To determine if the injector solenoids and valves are operating by buzzing all injectors together and then each injector in numerical sequence (1 through 8).

8. KOEO Injector Electric Self-Test

- Use NGS Tester.
- All injectors will momentarily buzz , then individual injectors will buzz in sequence 1 through 8.
- Diagnostic Trouble Codes will be transmitted after test is completed

Pass Code = P1111 or System Passed

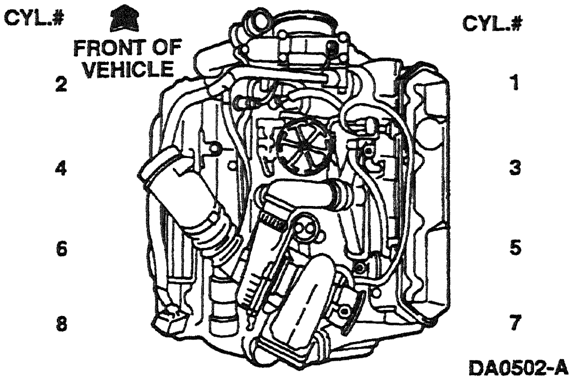
Injector Trouble Codes	

Refer to PC/ED manual Pinpoint tests if Diagnostic Trouble Codes are set.

DA0838-B

Hard Start/No Start Diagnostic Procedures

7.3L DI Engine, Cylinder and Fuel Injector Location



Recommended Procedure:

NOTE: If no DTCs are present and the KOEO Injector Electrical Self Test aborts while trying to perform, go to Pinpoint Test NA, Step NA29.

This test determines if the injector circuits and solenoids are electrically operating without fault. All injectors will first buzz together for approximately 2 seconds, then each injector will buzz for approximately 1 second in numerical order (1 through 8). The IDM stores all historical IDM fault codes; to ensure that the DTC is a hard fault, you must first clear continuous DTCs (be sure to record all IDM fault codes before clearing). After clearing, rerun self test; a fault must be present at the time of testing for the KOEO Injector Electrical Self Test to detect the fault. If a fault is detected, a DTC will be output on the data link at the end of the test when requested by a scan tool. Only a hard fault code (DTC) will be displayed.

Connect the NGS Tester to the DLC under the dash. Turn off accessories. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select KOEO INJECTOR ELECTRICAL SELF TEST.
- Follow operating instructions from the menu.
- Record DTCs and follow appropriate pinpoint test.
- After test, cycle key to off before running other tests or driving vehicle.

Hard Start/No Start Diagnostic Procedures

Possible Causes:

- Open or shorted injector circuits
- Bad injector connector
- Open or shorted CID or FDCS circuits
- Open injector solenoid
- IDM powering or ground circuit or IDM relay
- Defective IDM

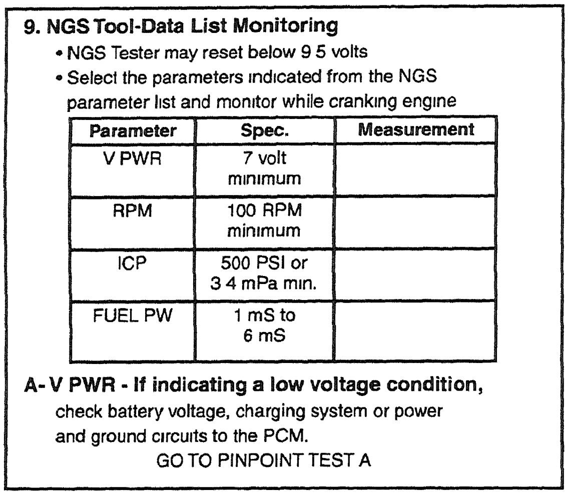
Tools Required:

New Generation Star (NGS) Tester 007-00500 or equivalent

9a. Check VPWR During Cranking

Purpose:

To verify PCM power-up during cranking. Lack of power to PCM can cause a no-start condition as well as fault code loss. The NGS Tester requires a minimum system voltage of 9.5 volts to avoid resetting.



9. NGS Tool-Data List Monitoring

- NGS Tester may reset below 9 5 volts
- Select the parameters indicated from the NGS parameter list and monitor while cranking engine

Parameter	Spec.	Measurement
V PWR	7 volt minimum	
RPM	100 RPM minimum	
ICP	500 PSI or 3 4 mPa min.	
FUEL PW	1 mS to 6 mS	

A- V PWR - If indicating a low voltage condition, check battery voltage, charging system or power and ground circuits to the PCM.

GO TO PINPOINT TEST A

DA1457-A

Recommended Procedure:

Install NGS Tester. Access VPWR PID on NGS Tester and monitor while cranking the engine.

Hard Start/No Start Diagnostic Procedures

Possible Causes:

- Low battery voltage
- Charging system problem
- Power circuit and ground faults to the PCM

Refer to Pinpoint Test A to diagnose a voltage concern.

NOTE: Battery voltage below 9.5 volts can cause the NGS Tester to reset. If the NGS Tester resets during a self test or while PID monitoring, it may be necessary to install a battery charger to maintain the correct voltage.

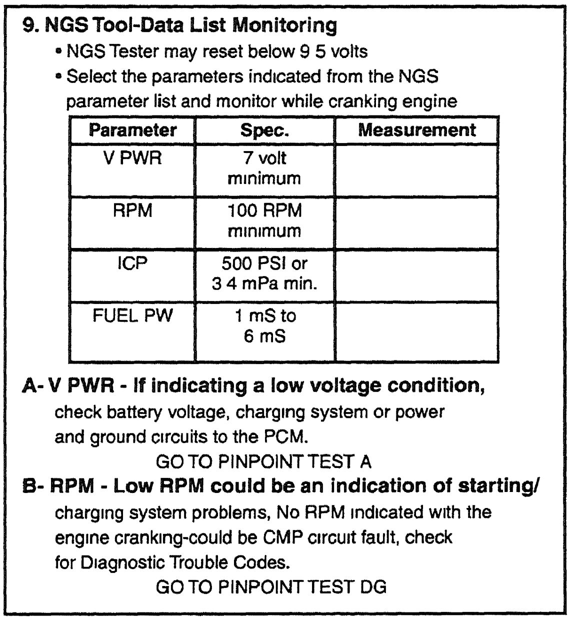
Tools Required:

New Generation Star (NGS) Tester 007-00500 or equivalent

9b. Check RPM Signal While Cranking

Purpose:

To determine if the CMP sensor and circuit are functioning.



9. NGS Tool-Data List Monitoring

- NGS Tester may reset below 9 5 volts
- Select the parameters indicated from the NGS parameter list and monitor while cranking engine

Parameter	Spec.	Measurement
V PWR	7 volt minimum	
RPM	100 RPM minimum	
ICP	500 PSI or 3 4 mPa min.	
FUEL PW	1 mS to 6 mS	

A- V PWR - If indicating a low voltage condition, check battery voltage, charging system or power and ground circuits to the PCM.

GO TO PINPOINT TEST A

B- RPM - Low RPM could be an indication of starting/ charging system problems, No RPM indicated with the engine cranking-could be CMP circuit fault, check for Diagnostic Trouble Codes.

GO TO PINPOINT TEST DG

DA1458-A

Hard Start/No Start Diagnostic Procedures

Recommended Procedure:

Access RPM PID with the NGS Tester, and monitor RPM reading while cranking the engine. If RPM stays at 0, the PCM is not receiving the CMP signal; refer to Pinpoint Test DG for CMP sensor diagnosis. If the PID reads above 0 but below 100 rpm, the engine is not turning over fast enough to start the engine; refer to the Powertrain Group in the Workshop Manual.

Install NGS Tester. Access RPM PID on NGS Tester and monitor rpm reading while cranking the engine. NGS Tester will read rpm if PCM is receiving a CMP signal.

Possible Causes:

- Weak battery or starter
- Faulty wire harness connection
- Poor CMP ground connection
- Incorrect CMP sensor to target wheel spacing
- Defective CMP sensor

Refer to Pinpoint Test DG for CMP sensor diagnosis.

Tools Required:

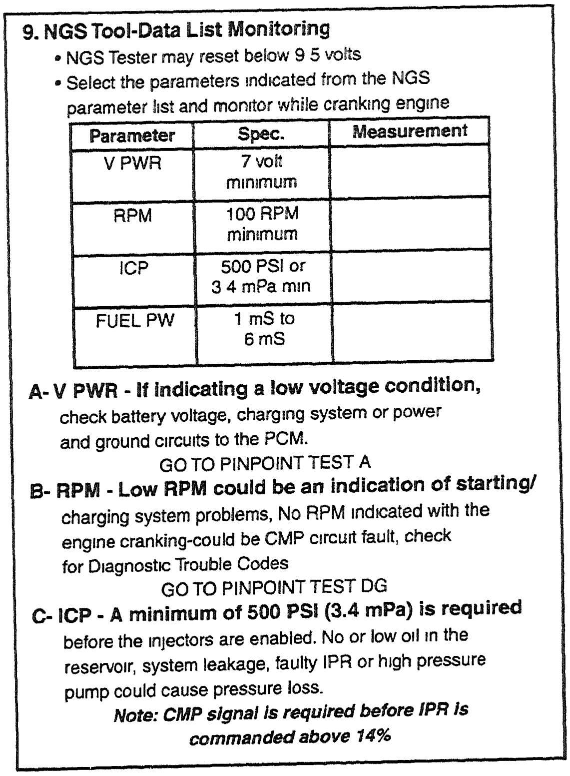
New Generation Star (NGS) Tester 007-00500 or equivalent

Hard Start/No Start Diagnostic Procedures

9c. Monitor ICP While Cranking

Purpose:

To determine if the injection control system can supply enough injection control pressure to sustain starting.



9. NGS Tool-Data List Monitoring

- NGS Tester may reset below 9 5 volts
- Select the parameters indicated from the NGS parameter list and monitor while cranking engine

Parameter	Spec.	Measurement
V PWR	7 volt minimum	
RPM	100 RPM minimum	
ICP	500 PSI or 3 4 mPa min	
FUEL PW	1 mS to 6 mS	

A- V PWR - If indicating a low voltage condition, check battery voltage, charging system or power and ground circuits to the PCM.

GO TO PINPOINT TEST A

B- RPM - Low RPM could be an indication of starting/ charging system problems, No RPM indicated with the engine cranking-could be CMP circuit fault, check for Diagnostic Trouble Codes

GO TO PINPOINT TEST DG

C- ICP - A minimum of 500 PSI (3.4 mPa) is required before the injectors are enabled. No or low oil in the reservoir, system leakage, faulty IPR or high pressure pump could cause pressure loss.

Note: CMP signal is required before IPR is commanded above 14%

DA1459-A

Recommended Procedure:

Install NGS Tester. Access ICP PID on NGS Tester, and monitor ICP reading while cranking the engine.

NOTE: CMP signal is required before IPR is commanded above 14%.

If the ICP does not meet the minimum specification (3.4 mPa [500 psi]), the injectors will not be enabled by the PCM because of insufficient rail pressure.

Access ICP and IPR PIDs with the NGS Tester, and monitor PID readings while cranking the engine. If IPR goes above 14%, ICP pressure should easily go above 3450 kPa (500 psi) provided that the oil reservoir is full, the IPR valve is not stuck open, the high pressure pump is building pressure and there is not an injection control pressure leak between the high pressure pump and all of the injectors.

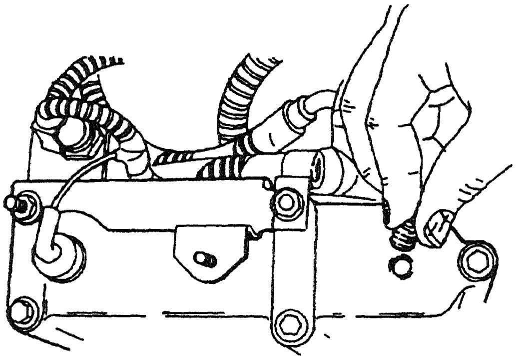
Hard Start/No Start Diagnostic Procedures

Possible Causes:

- Injection control pressure system leak
- Oil reservoir level low
- IPR failure
- Faulty high pressure pump
- Injector O-ring leaking

Injection Control Pressure Leak Test

Removing the ICP sensor and inspecting the level in the oil rail will determine if oil is being supplied to the rail. Removing the inspection plug in the top of the reservoir will help determine if the reservoir is full. A reservoir that drains back after the engine has not been operated for a long period of time can cause a hard start condition. If reservoir empties after filling, verify it is being supplied oil from the low pressure oiling system.



A23394-A

Purpose:

Isolate the cause of low injection control pressure.

Hard Start/No Start Diagnostic Procedures

Recommended Procedure:

Right Cylinder Head Check

Remove the high pressure hose from the right cylinder head and cover the fitting on the cylinder head with the appropriate cap from the Fuel / Oil / Turbo Protector Cap Set T94T-9395-AH. Install the plug from the Oil High Pressure Leakage Test Adapter Set D94T-6600-A into the high pressure hose to block it off. Connect the ICP / EBP Adapter Cable D94T-50-A to the ICP sensor. Connect a digital multimeter between signal return and ICP signal wires on the ICP / EBP Adapter Cable D94T-50-A. Crank the engine and monitor the signal. The digital multimeter should read 1 to 4 volts.

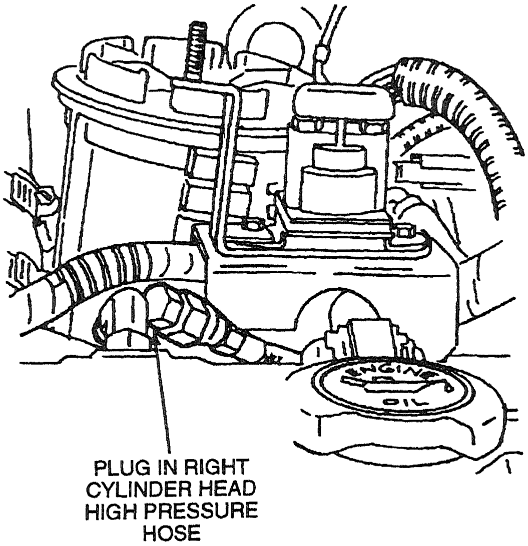
CAUTION

The engine may start!

If the engine starts or if injection control pressure is now within specification, the injection control pressure leak has been isolated to the right cylinder head. Inspect the fuel to see if oil is in the fuel. If no oil is present in the fuel, remove the valve cover, crank the engine and inspect the injector body and injector bore area for leakage.

CAUTION

Oil is under high pressure!



A23395-B

Hard Start/No Start Diagnostic Procedures

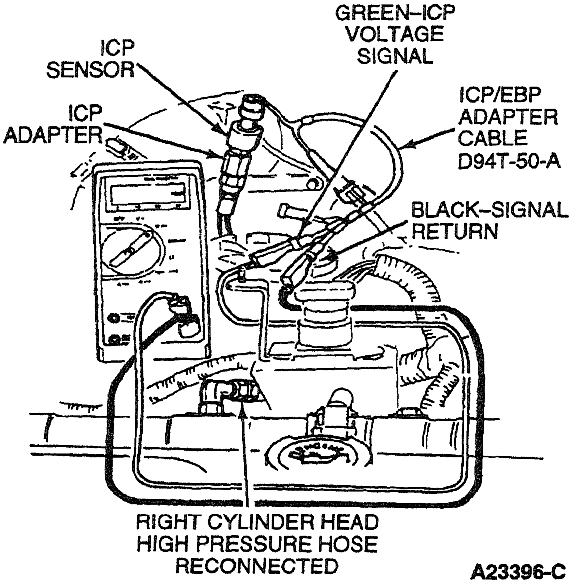
Left Cylinder Head Check

Remove the cap and plug, then reinstall the high pressure hose to the right cylinder head. Remove the high pressure hose from the left cylinder head and cover the fitting on the cylinder head with the appropriate cap from the Fuel / Oil / Turbo Protector Cap Set T94T-9395-AH. Install the ICP adapter from the Oil High Pressure Leakage Test Adapter Set D94T-6600-A into the high pressure hose. Remove the ICP sensor and install the sensor in the end of the ICP adapter. Connect the ICP / EBP Adapter Cable D94T-50-A to the ICP sensor. Connect a digital multimeter between the signal return and ICP signal wires of the ICP / EBP Adapter Cable D94T-50-A. Crank the engine and monitor the signal. The digital multimeter should read 1 to 4 volts.

CAUTION

The engine may start!

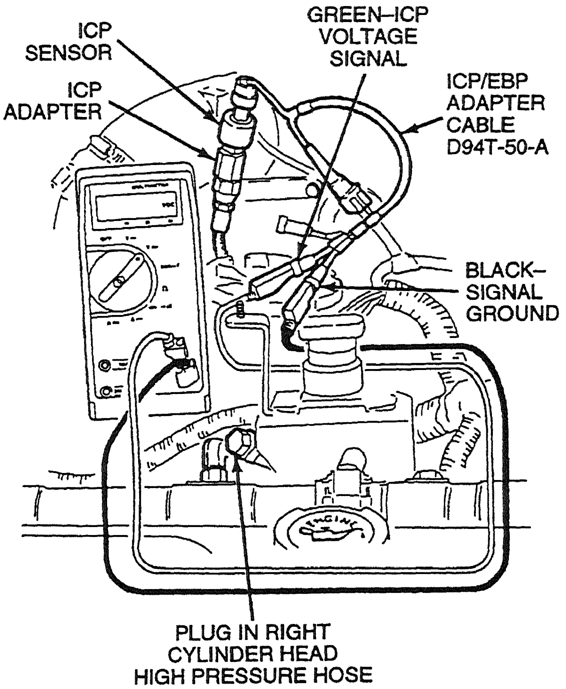
If the engine starts or if injection control pressure is now within specification, the injection control pressure leak has been isolated to the left cylinder head.



Hard Start/No Start Diagnostic Procedures

IPR and High-Pressure Pump Test

If injection control pressure is still low after ruling out both cylinder heads as the source of injection control pressure leakage, perform the following steps to isolate the cause. Leave the ICP sensor and ICP adapter connected to the left high-pressure hose. Remove the high-pressure hose from the right cylinder head and cover the fitting on the cylinder head with the appropriate cap from the Fuel / Oil / Turbo Protector Cap Set T94T-9395-AH. Install the plug from the Oil High Pressure Leakage Test Adapter Set D94T-6600-A into the high-pressure hose to block it off. With the high-pressure pump effectively deadheaded, crank the engine and monitor the signal. If injection control pressure is not within specification, replace the Injection Pressure Regulator (IPR) with a known good IPR and retest. If a low pressure condition still exists, the problem is most likely with the high-pressure pump or the high-pressure pump drive gear.



A25052-A

Tools Required:

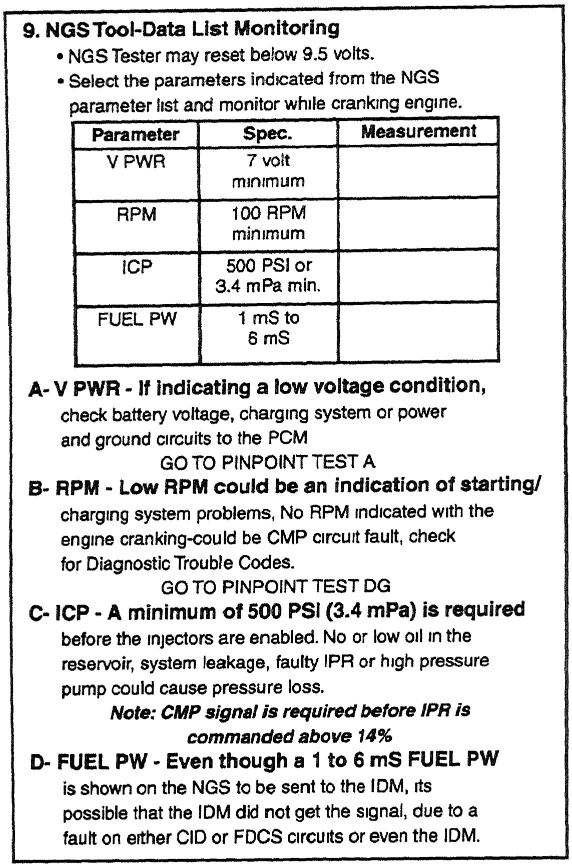
- Fuel / Oil / Turbo Protector Cap Set T94T-9395-AH
- ICP / EBP Adapter Cable D94T-50-A
- Oil High Pressure Leakage Test Adapter Set D94T-6600-A
- 23 Multimeter 105-00050 or equivalent
- 1 / 4-inch drive ratchet or breaker bar to remove inspection plug

Hard Start/No Start Diagnostic Procedures

9d. Check Fuel Pulse Width (FUEL PW) While Cranking

Purpose:

To verify that the Fuel Delivery Command Signal (FDCS) system is functioning correctly.



9. NGS Tool-Data List Monitoring

- NGS Tester may reset below 9.5 volts.
- Select the parameters indicated from the NGS parameter list and monitor while cranking engine.

Parameter	Spec.	Measurement
V PWR	7 volt minimum	
RPM	100 RPM minimum	
ICP	500 PSI or 3.4 mPa min.	
FUEL PW	1 mS to 6 mS	

A- V PWR - If indicating a low voltage condition, check battery voltage, charging system or power and ground circuits to the PCM

GO TO PINPOINT TEST A

B- RPM - Low RPM could be an indication of starting/ charging system problems, No RPM indicated with the engine cranking-could be CMP circuit fault, check for Diagnostic Trouble Codes.

GO TO PINPOINT TEST DG

C- ICP - A minimum of 500 PSI (3.4 mPa) is required before the injectors are enabled. No or low oil in the reservoir, system leakage, faulty IPR or high pressure pump could cause pressure loss.

Note: CMP signal is required before IPR is commanded above 14%

D- FUEL PW - Even though a 1 to 6 mS FUEL PW is shown on the NGS to be sent to the IDM, its possible that the IDM did not get the signal, due to a fault on either CID or FDCS circuits or even the IDM.

DA1460-A

Recommended Procedure:

Install NGS Tester. Access FUEL PW PID on NGS Tester and monitor while cranking engine.

No fuel command signal when ICP, RPM and VPWR signals are correct usually indicates a loss of CMP sync signal. Refer to Pinpoint Test DG for CMP sensor diagnosis.

Hard Start/No Start Diagnostic Procedures

A 1-6 mS fuel pulse width (FUEL PW) will be sent by the PCM to the IDM, if system voltage does not go below 7 volts during cranking, engine cranking speed is above 100 rpm and injection control pressure is above 3450 kPa (500 psi). Even though a 1-6 mS fuel pulse width is shown on the NGS to be sent to the IDM, it's possible the IDM did not get the signal, due to a fault on either the CID or FDCS circuits or even the IDM. Note that low fuel pressure or no glow plugs could still be the cause of the No Start or Hard Start condition. A 0.42-ms fuel pulse width (a no fueling pulse) will be sent by the PCM when a sync pulse has been received from the CMP sensor and if insufficient injection control pressure is present. This 0.42 ms fuel pulse width will not allow injectors to be enabled, but does keep the IDM and PCM synchronized until sufficient injection control pressure is realized.

Possible Causes:

- FDCS and CID circuitry
- PCM
- IDM

Tools Required:

New Generation Star (NGS) Tester 007-00500 or equivalent

Hard Start/No Start Diagnostic Procedures

10. Glow Plug System Operation

Purpose:

To determine if the glow plug system operation is sufficient to permit starting.

Hard Start/No Start Diagnostic Procedures

Note: A hard start/no start concern with EOT temp. below 60 F perform this Test Step first.

10. Glow Plug System Operation

Relay Operation

- Glow Plug ON time is dependent on oil temperature and altitude. The Glow Plug relay comes on between 1 to 120 sec and does not come on at all if oil Temp is above 86 F (49 State Econoline) or 131 F (all F-Series and California Econoline)
- Verify that B+ is being supplied on the large BK/W wire going to the Glow Plug relay.
- Install a voltmeter to the glow plug feed terminal (terminal with two brown wires) or (center terminal on the shunt for California)
- Turn key to run position, measure "ON" time
- Using the NGS GPCTM and EOT pids, verify sufficient glow plug "ON" time and voltage.

(Dependent on oil temperature and altitude)

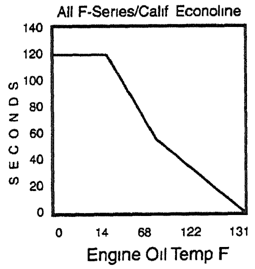
9-12 Volts	Spec.	Measurement
Relay On time	1 to 120 seconds	

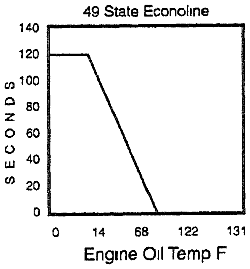
Note: Wait to Start Lamp "On" time (1-10 sec.) is independent from Glow Plug Relay "On" time

Glow Plug Operation

- Measure Glow Plug Resistance to Bat. Ground
- Remove all glow plug/injector connectors.
- Measure GP Harness Resistance to Relay

Glow Plug Number	Glow Plug to Ground .1 to 2 ohms	Connector to Relay 0 to 1 ohms
#1		
#3		
#5		
#7		
#2		
#4		
#6		
#8		





- Add 5 seconds to glow plug on time when above 7000 feet in altitude, but not to exceed 120 seconds.

DA1461-A

Hard Start/No Start Diagnostic Procedures

On California only, the glow plug system monitor will start when the glow plugs are commanded on for more than 35 seconds and the battery voltage is between 11.8-14 volts. A glow plug code will be stored in Continuous memory if one or more glow plugs are not being powered.

NOTE: Look very carefully for poor connections, burnt looking or loose fitting pins that will cause high resistance and set a code.

The Glow Plug Monitor Self Test is a functional test of the PCM performed on demand with the engine running and the A/C off. This test will activate the glow plug relay and detect any difference in the amount of current between both banks. Battery voltage must be 11.8-14 volts to complete the test. It may be necessary to raise engine rpm to maintain battery voltage. A fault must be present at the time of testing for the KOER Glow Plug Monitor Self Test to detect a fault. If a fault is detected, a DTC will be the output on the data link at the end of the test when requested by a scan tool. Only a hard fault code (DTC) will be displayed.

You can verify glow plug on time (and amps for California) by monitoring NGS PIDs EOT and GPCTM (California GPMR and GPML). The wait to start lamp ON time (1-10 seconds) is independent from glow plug relay ON time.

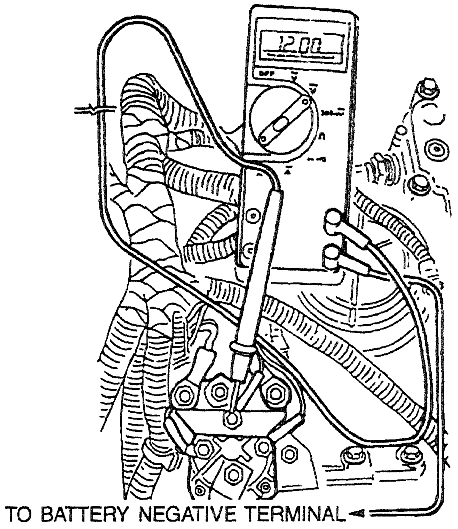
Recommended Procedure:

Install a digital multimeter on the glow plug feed side of the glow plug relay (large stud with two wires connected). Turn the ignition key to the ON position but do not attempt to start. Note the time in seconds from when the key is turned on and the glow plug relay energizes until the glow plug relay de-energizes. Glow plug on time is dependent on oil temperature and altitude. The glow plug relay comes on between 1-120 seconds and does not come on at all if EOT is above 30 °C (86°F) for 49-state or 55°C (131°F) for California. The wait to start light is independent from glow plug relay ON time. The glow plug relay makes a loud click noise which is easily heard when it energizes and de-energizes. The dome light will dim and the dash voltmeter will dip when the glow plugs are drawing current from the battery. Compare the times measured to the table (time will be affected by engine temperature, battery condition and vehicle altitude). The voltage at the glow plug feed terminal may vary from 9 to 12 volts depending upon battery condition.

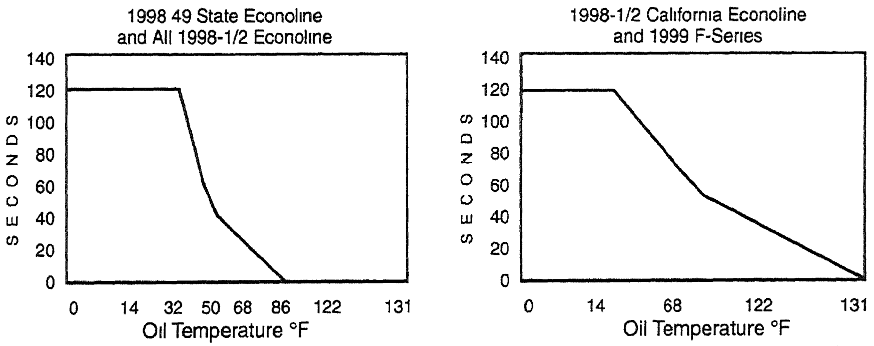
If battery voltage is not present, check for B+ at the power supply terminal (terminal with single large wire). Power for glow plug power supply is supplied from the starter relay through two fusible links at solenoid.

Hard Start/No Start Diagnostic Procedures

Disconnect all of the glow plug / injector harness connectors from the valve cover gaskets. With the Glow Plug Injector Adapter 014-00935 or equivalent installed, measure glow plug resistance to ground (preferably B-). A resistance measurement of 0.1-2 ohms indicates a good glow plug.

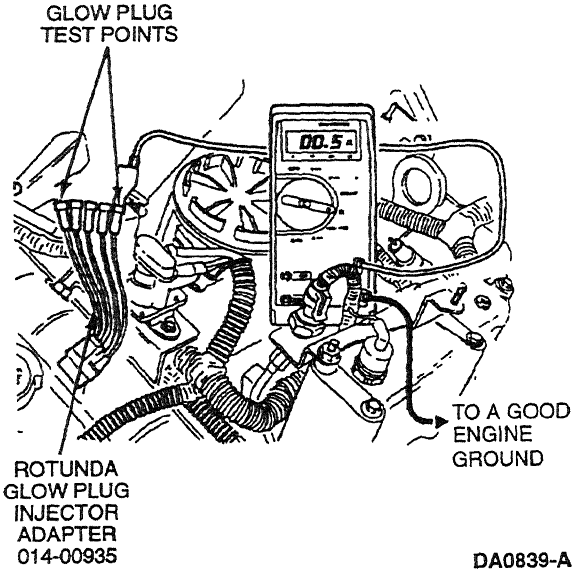


DA1499-A



Note: Add 5 seconds to glow plug on time when above 7000 feet in altitude, but not to exceed 120 seconds. **DA1462-A**

Hard Start/No Start Diagnostic Procedures

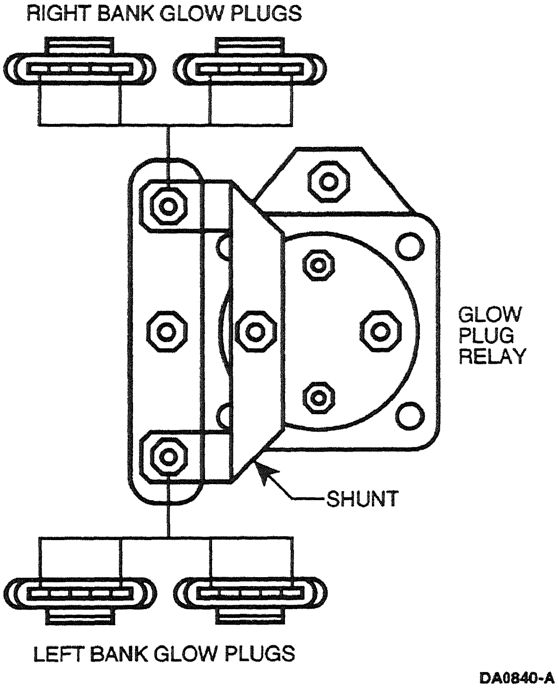


Glow Plug Harness Continuity

Measure for continuity from the connector harness to the glow plug feed terminal on the glow plug relay. Resistance should be less than 0.1-1 ohm.

Hard Start/No Start Diagnostic Procedures

Incorrect measurements will result if all glow plug/injector connectors to valve cover are not disconnected.



Possible Causes:

Insufficient glow plug ON time will not allow enough heat to accumulate in the combustion chamber to easily facilitate starting. If the glow plug system ON time does not meet any of the specifications in the accompanying chart the problem is most likely a faulty wire harness connection, ground connections or glow plug relay.

NOTE: Look very carefully for poor connections, burnt looking or loose fitting pins that will cause high resistance.

- Glow plug relay.
- Powering circuit to glow plug relay (fusible links from starter relay).
- Glow plug relay to valve cover connector circuits.
- Valve cover gasket.
- Under valve cover (UVC) harness.
- Glow plugs.

Hard Start/No Start Diagnostic Procedures

Tools Required:

- 23 Multimeter 105-00050 or equivalent
- Glow Plug Injection Adapter 014-00935 or equivalent
- Stopwatch or equivalent

Performance Diagnostic Procedures

Performance Diagnostics

1. Visual Engine/Chassis Inspection

Fuel Oil Coolant Electrical Hoses Leaks MAP hose open pinched or intake leaks	
Method	**Check**
Visual	

2. Sufficient Clean Fuel

- Check fuel tank(s), drain sample from fuel filter while cranking engine
- Note if operator has indicated that the Water in Fuel or Fuel Filter Restriction Lamp has been illuminated

Method	Check
Visual	

3. Check Engine Oil Level

- Check for contaminants (fuel, coolant)
- Correct Grade/Viscosity
- Miles/hours on oil, correct level

Method	Check
Visual	

4. Intake Restriction

- Check filter minder
- or Measure at WOT w/magnehelic gauge

Instrument	Check
Magnehelic/ Filter Minder	

5. Perform KOEO On Demand Test

- Use NGS Tester
- Diagnostic Trouble Codes set during this test are current faults

Pass Code = P1111 or System Passed

Diagnostic Trouble Codes	

6. Retrieve Continuous Trouble Codes

- Use NGS Tester
- Diagnostic Trouble Codes retrieved during this test are historical faults

Pass Code = P1111 or System Passed

Diagnostic Trouble Codes	

7. KOEO Injector Electrical Self-Test

- Use NGS Tester
- All Injectors will momentarily buzz, then individual injectors will buzz in sequence 1 through 8

Pass Code = P1111 or System Passed

Diagnostic Trouble Codes	

8a. Tandem Fuel Pump Pressure

- Measure at regulator block
- Road Test-select appropriate gear to obtain a full load on the engine

WOT - Front Tank

Instrument	Spec.	Measurement
0-160 PSI Gauge	30 80 PSI	

WOT -Rear Tank

Instrument	Spec	Measurement
0-160 PSI Gauge	30-80 PSI	

If fuel pressure falls low, inspect Fuel filter condition and regulator valve for debris

8b. Tandem Pump Inlet Restriction

- Measure at fuel inlet line
- Measure at WOT

Instrument	Spec.	Measurement
0-30" Hg Vacuum g	6" Hg	

» If fuel feed line is restricted above 6" Hg, check for blockage between pump and fuel tank

» If fuel feed is not restricted below 6" Hg, check regulator valve for sticking or internal debris

9. Air in Fuel System Test

- Remove fuel return line from fuel filter
- Install clear line from filter to return line
- View clear line during low idle for air

Method	Checks	
Visual	Front Tank	Rear Tank

10. Perform KOER On Demand Test

- Select KOER test from NGS test menu

Pass Code = P1111 or System Passed

KOER Diagnostic Trouble Codes	

11a. Injection Control Pressure Tests (Oil Aeration-Poor idle quality)

- Monitor ICP and RPM with the NGS Tester
- Turn A/C and all accessories off
- Hold engine speed at 3400 RPM for 3 minutes

High Idle

Parameter	Spec.	Measurement
ICP	750 to 1250 PSI @ 3400 RPM	

» If ICP signal increases above 1250 PSI after 3 minutes anti-foam oil additives may have become depleted from oil, change oil and re-test

11b. Low Idle Stability (ICP Pressure)

- Check at low idle
- Monitor ICP and RPM with the NGS Tester

Low Idle

Parameter	Spec @ 650 RPM	Measurement
ICP	400 to 600 PSI Calif and all Econoline	
ICP	550 to 700 PSI 49 State F-Series	

If engine RPM is unstable, disconnect the ICP sensor

» If idle speed still unstable, change IPR re-test

» If low idle smooths out, ICP signal faulty

(See ICP circuit diagnostics)

12. Crankcase Pressure Test

- Assure engine is at normal operating temp
- Measure at oil fill with adapter and orifice tool PN 5631 & 014-00743 installed
- Measure at WOT under no load

Parameter	Spec.	Measurement
Magnehelic 0 to 60" H^2o	less than 3" H^2o	

If more then 3" H^2o, Refer base engine in Shop Manual

13. Cylinder Contribution Test

- Ensure that the engine ia at operating temp 170°F (77°C) minimum before performing test
- Turn A/C and all accessories off
- Select Cylinder Contribution from the test menu

Note: Engine will smoke and run rough during test and you may not be able to hear a low contributing cylinder.

CCT Trouble Codes	

14. Exhaust Restriction

- Visually inspect exhaust system for damage
- Verify EBP device is open at WOT
- Monitor EBP with the NGS Tester with the engine temperature at 170°F minimum at 3400 RPM

Parameter	Spec	Measurement
EBP	28 PSI MAX @ 3400 RPM	

15. Boost Pressure Test

- Verify that MAP hose is not open, plugged or pinched
- Monitor MGP (manifold gauge pressure) and RPM with the NGS Tester
- Road Test-select appropriate gear to obtain desired engine speed at full load throttle position

Parameter	Spec.	Measurement
MGP	13 PSIG MIN	

Measure between 2500 to 3000 RPM

DA1463-A

1. Visual Engine/Chassis Inspection

1. Visual Engine/Chassis Inspection

Fuel Oil Coolant Electrical Hoses Leaks MAP hose open pinched or intake leaks	
Method	**Check**
Visual	

DA1464-A

Performance Diagnostic Procedures

Purpose:

This is a visual inspection to check the general condition of the engine and chassis. Look for obvious cause of a loss in performance.

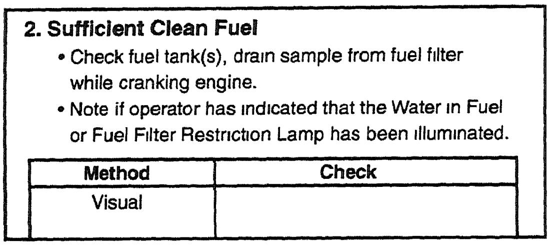
Recommended Procedure:

- Inspect for a hole in the MAP sensor hose or a pinched hose.
- Inspect fuel system, including fuel tank, fuel pump, fuel filter housing and fuel lines, for kinks, bends or leakage.
- Inspect oil lines and high-pressure pump in engine V for major oil leaks.
- Inspect for coolant leaks at radiator and heater hoses, and check coolant level.
- Inspect wiring for correct routing, and make sure no rubbing or chafing has occurred.
- Make sure all sensors and outputs from the PCM are plugged in.

2. Sufficient Clean Fuel

Purpose:

The purpose of this test is to see if the fuel system is getting sufficient clean fuel to operate correctly.



2. Sufficient Clean Fuel

- Check fuel tank(s), drain sample from fuel filter while cranking engine.
- Note if operator has indicated that the Water in Fuel or Fuel Filter Restriction Lamp has been illuminated.

Method	Check
Visual	

DA1465-A

Recommended Procedure:

Route a hose from the fuel drain line to a clear container and open the drain. Idle the engine and observe the fuel flowing into the container. Shut the engine off when the container is half full.

Observe WATER IN FUEL light while cranking. If the lamp is illuminated the fuel is probably contaminated with water.

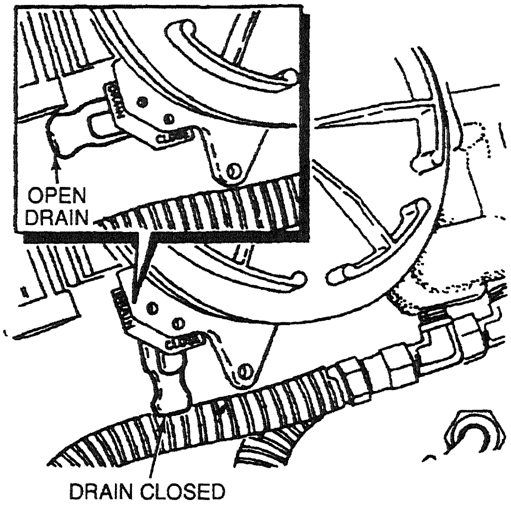
Flow out of the drain should be a steady stream. Insufficient flow could indicate fuel supply or fuel system problems.

Performance Diagnostic Procedures

Inspect fuel in the container, it should be straw colored but not cloudy. It also should be free of water and contaminants. Dyed red or blue fuel indicates off-highway fuel.

If engine oil is present in the fuel it may indicate an injector O-ring leak and subsequent loss of rail pressure. If that is suspected, check rail pressure during engine cranking (refer to Hard Start / No Start Diagnostic Procedures Step 9C).

Some sediment and water may be present in the fuel sample if the fuel filter has not been serviced for a prolonged period of time and / or if the sediment and water have not been drained recently. If that is the case a second sample may be required to determine fuel quality.



A23400-B

Possible Causes:

- No fuel in tank.
- If equipped with a fuel line valve, it could be shut off.
- If equipped with dual tanks, the switch valve could be faulty.
- Fuel supply line could be broken or crimped.
- Fuel could be jelled (most likely in cold weather with No. 2 fuel).
- Pickup tube screen in tank could be clogged.

Cloudy fuel indicates that the fuel may not be a suitable grade for cold temperatures. Excessive water or contaminants may indicate that the tank and fuel system may need to be flushed and cleaned.

Tools Required:

Clear container — approximately 1-quart

Performance Diagnostic Procedures

3. Check Engine Oil Level

Purpose:

To determine if there is enough oil or oil of sufficient quality to operate the injectors.

3. Check Engine Oil Level

- Check for contaminants (fuel, coolant).
- Correct Grade/Viscosity.
- Miles/hours on oil, correct level.

Method	Check
Visual	

DA1466-A

Recommended Procedure:

Check oil level with oil level dipstick. If there is no oil or very little oil in the crankcase, the injectors will not operate.

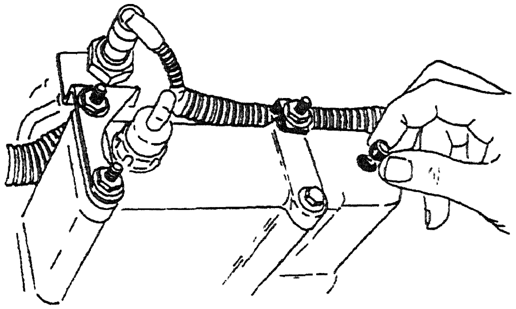
If the oil level is overfull, it is possible the engine was incorrectly serviced or fuel is diluting the oil and filling the crankcase. If a substantial amount of fuel is in the oil, it will have a fuel odor.

Inspect oil for color. A milky white oil indicates possible coolant contamination which will have an ethylene glycol odor.

Check service records for correct oil type and viscosity for the vehicle operating temperature. Single weight or 15W-40 oil is not recommended for cold ambient temperatures. 10W-30 oil is recommended for cold ambient temperatures. Oil that has had extended drain intervals will have increased viscosity (become thicker) and will make engine cranking more difficult and starting less reliable at temperatures below freezing. Refer to the lube oil chart in the Workshop Manual or Owner's Guide for the correct oil selection for temperature conditions.

Performance Diagnostic Procedures

The level in the oil reservoir should also be checked. Remove the inspection plug in top of reservoir and check to see if the oil reservoir is full (a reservoir that drains back after the engine has not been operated for a period of time can cause a hard start or a start and die condition). Filling the reservoir will allow the system to prime faster, facilitating starting.



A23401-A

Possible Causes:

- Oil level low — oil leak, oil consumption, incorrect servicing
- Oil level high — incorrect servicing, fuel dilution from tandem fuel pump, fuel dilution from injector O-rings
- Oil contamination with coolant — oil cooler, head gasket, porosity
- Low reservoir level — engine built dry (not pressure lubed), prolonged period of not running, leaking check valve in high pressure pump

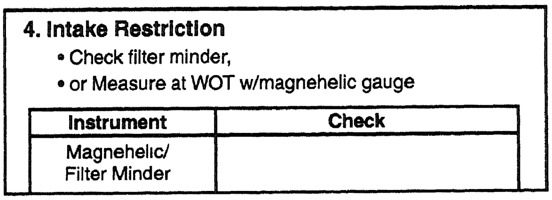
Tools Required:

1 / 4-inch drive ratchet or breaker bar to remove inspection plug

4. Intake Restriction

Purpose:

This is a visual inspection to determine if an air intake restriction is contributing to a low power condition. If the engine does have a high air intake restriction, a considerable amount of black or blue smoke may be produced.



4. Intake Restriction
- Check filter minder,
- or Measure at WOT w/magnehelic gauge

Instrument	Check
Magnehelic/ Filter Minder	

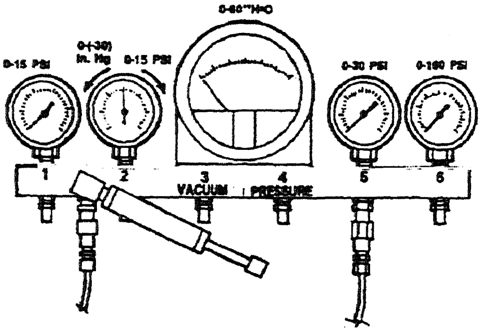
DA1467-A

Performance Diagnostic Procedures

Recommended Procedure:

Inspect the air cleaner inlet and ducting to assure that it is not blocked or collapsed. Inspect the air cleaner housing and filter for proper installation.

If necessary, use Pressure Adapter Kit 014-00761 or equivalent to install a Magnehelic® gauge on the port on the air cleaner and measure restriction at high idle.



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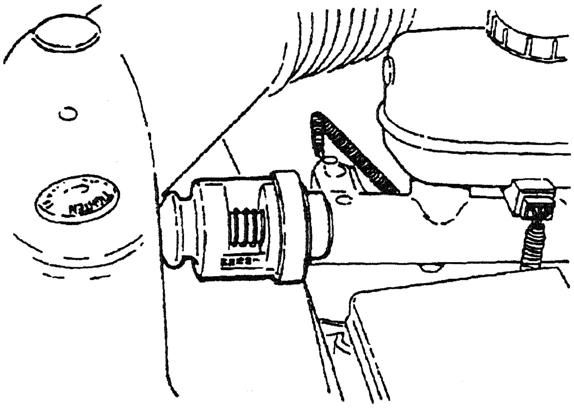


A23403-A

Possible Causes:

- Snow, plastic bags or other foreign material may restrict airflow at the air inlet.
- Misrouted air cleaner ducting.
- On engines recently repaired, rags or cap plugs may have been inadvertently left in an air inlet pipe.

Tools Required:

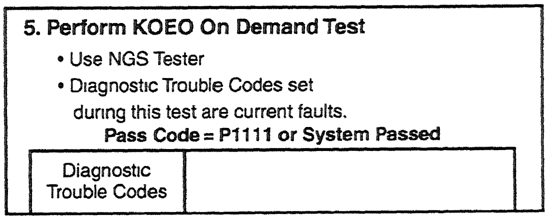
Magnehelic® gauge (part of Pressure Adapter Kit 014-00761 or equivalent)

Performance Diagnostic Procedures

5. Perform KOEO On-Demand Self Test

Purpose:

To determine if the PCM has detected any fault conditions that would cause a performance problem.



5. Perform KOEO On Demand Test

- Use NGS Tester
- Diagnostic Trouble Codes set during this test are current faults.

Pass Code = P1111 or System Passed

DA0841-B

NOTE: The IDM stores both historical and hard IDM fault codes. To retrieve IDM fault codes, you must run KOEO On-Demand Self Test or KOEO Injector Electrical Test. To ensure that the DTC is a hard fault, you must first clear Continuous DTCs (be sure to record all DTCs before clearing) even though IDM codes do no show up on the Continuous display.

Recommended Procedure:

Connect the NGS Tester to the DLC under the dash. Turn off accessories. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select KOEO ON DEMAND SELF TEST.
- Turn key on.
- Follow operating instructions from the menu.
- Record DTCs and follow appropriate pinpoint test.
- After test, cycle key to off before running other tests or driving vehicle.

If performing repeated self tests, it may be necessary to unplug glow plug relay to keep battery from going dead. Ignore any glow plug codes while glow plug relay is unplugged.

Performance Diagnostic Procedures

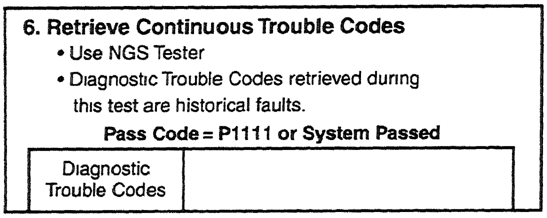
Tools Required:

New Generation Star (NGS) Tester 007-00500 or equivalent

6. Retrieve/Clear Continuous DTCs

Purpose:

To determine if the PCM has detected any historical or intermittent fault conditions that would cause a performance symptom. The condition that caused a continuous DTC may no longer exist.



6. Retrieve Continuous Trouble Codes

- Use NGS Tester
- Diagnostic Trouble Codes retrieved during this test are historical faults.

Pass Code = P1111 or System Passed

Diagnostic Trouble Codes	

DA0842-B

NOTE: The IDM stores both historical and hard IDM fault codes. To retrieve IDM fault codes, you must run KOEO On-Demand Self Test or KOEO Injector Electrical Test. To ensure that the DTC is a hard fault, you must first clear Continuous DTCs (be sure to record all DTCs before clearing) even though IDM codes do not show up on the Continuous display. Rerun KOEO On-Demand Self Test if an IDM DTC is set. This is a hard fault.

Recommended Procedure:

Connect the NGS Tester to the DLC under the dash. Turn off accessories. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select RETRIEVE/CLEAR CONTINUOUS DTCs.
- Turn key on.
- Follow operating instructions from the menu.

Performance Diagnostic Procedures

- Record DTCs and follow appropriate pinpoint test for continuous code diagnostics.
- After test, cycle key to off before running other tests or driving vehicle.
- Continuous DTCs must be cleared after repair is made.

If performing repeated self tests, it may be necessary to unplug glow plug relay to keep battery from going dead. Ignore any glow plug codes while glow plug relay is unplugged.

Tools Required:

New Generation Star (NGS) Tester 007-00500 or equivalent

7. KOEO Injector Electrical Self Test

NOTE: If unable to perform KOEO Injector Electrical Self Test, disconnect IDM connector and check injector high and low sides for shorts or opens.

Purpose:

To determine if the injector solenoids and valves are operating by buzzing all injectors together, then each injector in numerical sequence (1 through 8).

7. KOEO Injector Electrical Self-Test

- Use NGS Tester.
- All injectors will momentarily buzz, then individual injectors will buzz in sequence 1 through 8.

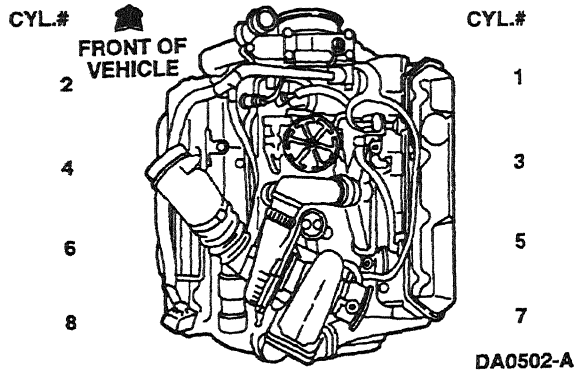
Pass Code = P1111 or System Passed

Injector Trouble Codes	

DA0843-B

Performance Diagnostic Procedures

7.3L DI Engine, Cylinder and Fuel Injector Location



This test determines if the injector circuits and solenoids are electrically operating without fault. All injectors will first buzz together for approximately 2 seconds, then each injector will buzz for approximately 1 second in numerical order (1 through 8). The IDM stores all historical IDM fault codes; to ensure that the DTC is a hard fault, you must first clear continuous DTCs (be sure to record all IDM fault codes before clearing). After clearing, rerun self test; a fault must be present at the time of testing for the KOEO Injector Electrical Self Test to detect the fault. If a fault is detected, a DTC will be output on the data link at the end of the test when requested by a scan tool. Only a hard fault code (DTC) will be displayed.

Recommended Procedure:

NOTE: If no DTCs are present and the KOEO Injector Electrical Self Test aborts while trying to perform, go to Pinpoint Test NA — Step NA29.

Connect the NGS Tester to the DLC under the dash. Turn off accessories. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select KOEO INJECTOR ELECTRICAL SELF TEST.
- Follow operating instructions from the menu.
- Record DTCs and follow appropriate pinpoint test.
- After test, cycle key to off before running other tests or driving vehicle.

Performance Diagnostic Procedures

If performing repeated self tests, it may be necessary to unplug glow plug relay to keep battery from going dead. Ignore any glow plug codes while glow plug relay is unplugged.

Possible Causes:

- Open injector wire
- Damaged injector connector
- Shorted wire or connector
- Open injector solenoid
- Defective IDM

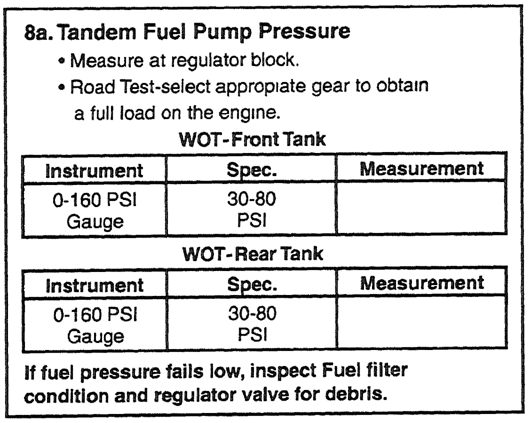
Tools Required:

New Generation Star (NGS) Tester 007-00500 or equivalent

8a. Tandem Fuel Pump Pressure

Purpose:

To determine if there is sufficient fuel pressure for correct engine operation.



8a. Tandem Fuel Pump Pressure

- Measure at regulator block.
- Road Test-select appropiate gear to obtain a full load on the engine.

WOT-Front Tank

Instrument	Spec.	Measurement
0-160 PSI Gauge	30-80 PSI	

WOT-Rear Tank

Instrument	Spec.	Measurement
0-160 PSI Gauge	30-80 PSI	

If fuel pressure fails low, inspect Fuel filter condition and regulator valve for debris.

DA1468-A

Recommended Procedure:

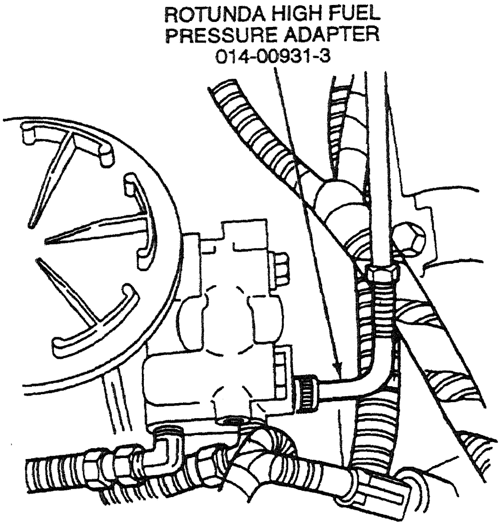
Note if operator has indicated if the high fuel restriction lamp has been illuminated. A restricted fuel filter may be causing low fuel pressure.

Performance Diagnostic Procedures

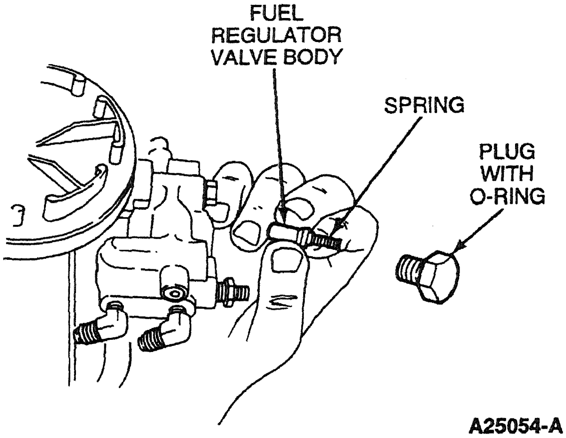
Connect High Fuel Pressure Adapter 014-00931-3 or equivalent to the Schrader valve mounted in the fuel regulator block on the side of the fuel filter housing. Connect a line for a 160-psi gauge to the adapter. Run the engine at low idle and check for leaks in the line to the gauge. Operate the engine at WOT (maximum engine speed out of gear with the brakes set and the wheels blocked). Measure maximum fuel pressure and compare to specification.

Repeat for front and rear tanks.

Change the fuel filter if the pressure is low and retest. If fuel pressure is still low, go to Performance Diagnostic Procedures Step 7b and check restriction from the fuel tank.



A23404-B



A25054-A

Possible Causes:

- A fuel filter could cause high restriction and low fuel pressure because of dirt or fuel jelling in cold ambient temperatures. Change filter and retest. It may take a couple of crank cycles to purge the air out of the fuel system.
- Debris in the fuel regulator valve will cause low fuel pressure. Disassemble, inspect and clean.
- A kinked or severely bent fuel supply line or blockage at the pickup tube could cause restriction and therefore low fuel pressure.
- A loose fuel line on the suction side of the fuel system could cause air to be ingested into the system and cause low fuel pressure.
- The fuel pump could have internal damage, e.g., ruptured diaphragm, seized plunger or leaking check valves.

Tools Required:

- 0-160 psi fuel pressure gauge
- High Fuel Pressure Adapter 014-00931-3 or equivalent line with 1/4-inch NPT fitting

Performance Diagnostic Procedures

8b. Tandem Fuel Pump Inlet Restriction

Purpose:

To determine if there is excessive restriction of fuel flow from the inlet fuel line to the fuel tank(s).

8b. Tandem Pump Inlet Restriction

- Measure at fuel inlet line.
- Measure at WOT.

Instrument	Spec.	Measurement
0-30" Hg vacuum g.	6" Hg	

» If fuel feed line is restricted above 6" Hg, check for blockage between pump and fuel tank.

» If fuel feed is not restricted below 6" Hg, check regulator valve for sticking or internal debris.

DA1469-A

Recommended Procedure:

Remove the short rubber hose at the fuel inlet line (left side of engine close to the frame rail). The larger of the two fuel lines is the fuel inlet. The smaller line is fuel return. Install Low Fuel Pressure Adapter 014-00931-2 or equivalent to the fuel inlet line and connect to a fuel restriction gauge (0-30 inch-Hg vacuum). Measure restriction at WOT (maximum engine speed out of gear with the brakes set and the wheels blocked). If restriction measures above specification, there is a blockage between the engine and the tank.

Possible Causes:

- A kinked or severely bent fuel supply line or blockage at the pickup tube could cause restriction and cause high restriction.
- The selector valve for fuel tanks could be damaged.
- In very cold ambient temperatures with No. 2 fuel, the fuel could be jelled in the lines and cause restriction.

Tools Required:

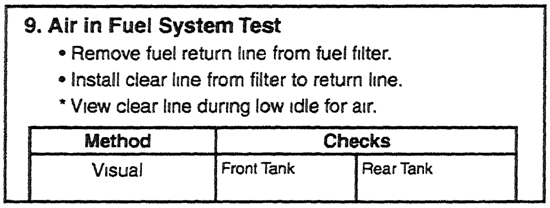
- Low Fuel Pressure Adapter 014-00931-2 or equivalent
- Pressure Test Adapter Kit 014-00761 or equivalent

Performance Diagnostic Procedures

9. Air in Fuel System Test

Purpose:

To determine if air is being drawn into the fuel system.



9. Air in Fuel System Test

- Remove fuel return line from fuel filter.
- Install clear line from filter to return line.

* View clear line during low idle for air.

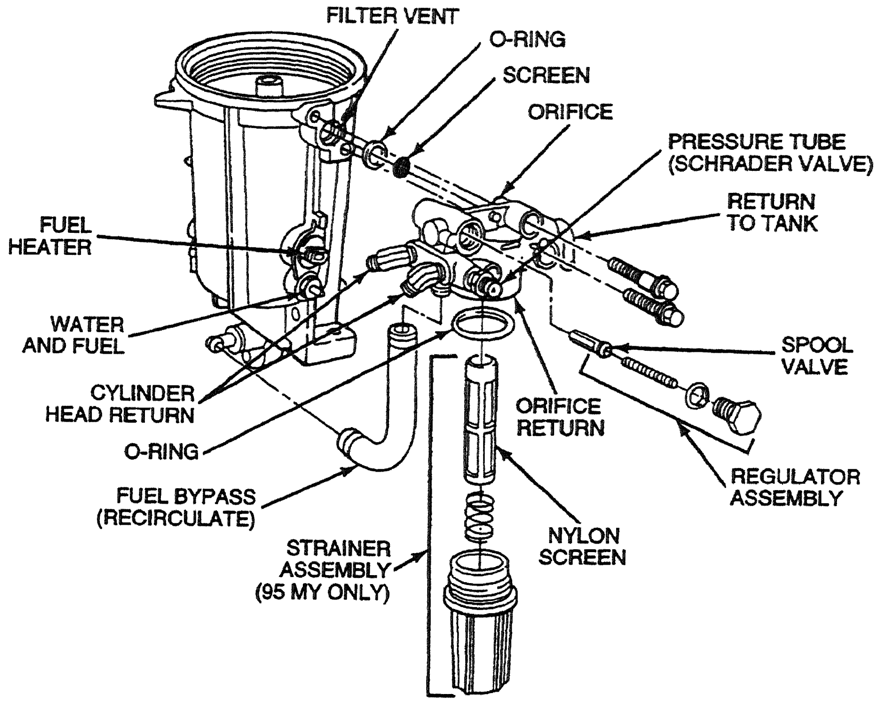
Method	Checks	
Visual	Front Tank	Rear Tank

DA1470-A

Recommended Procedure:

- Remove the rubber hose and clamps from the fuel return line at the fuel filter.
- Install a clear line from the return line to the fuel filter. Loop the excess line at a point higher than the filter.
- Observe the fuel in the line while the engine is running. The fuel should be flowing toward the return line to the tank. After approximately 5 minutes of running, fuel flow should be free of air.
- If the fuel is foamy, check the fuel supply lines from the tank to the fuel pump for an air leak.
- If there is no fuel return flow, remove fuel regulator block. Use care not to lose or damage O-ring as it must be used during fuel regulator block reinstallation. Inspect fuel return orifice screen for debris. Clean as necessary. Refer to the following illustration.

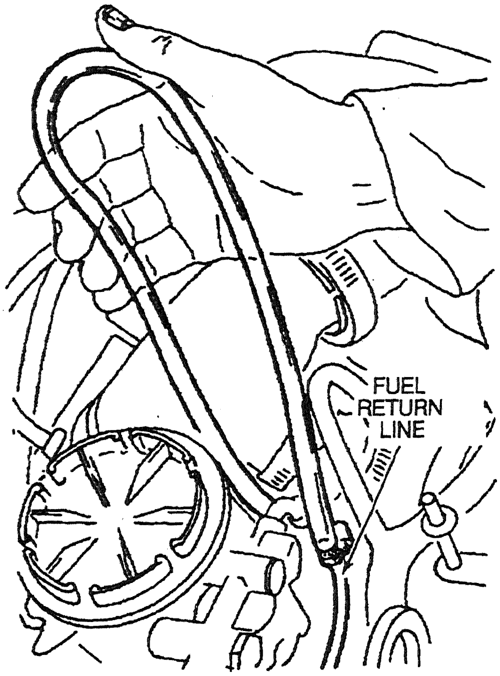
Performance Diagnostic Procedures



A25058-A

NOTE: If the filter has just been changed, air may be present in the clear line until purged from the system.

Performance Diagnostic Procedures



Possible Causes:

Loose and leaking fuel line fittings at:

- fuel tanks
- selector valve
- connection between the selector valve and engine
- O-ring connection from chassis line to engine fuel inlet tube
- hose clamps, rubber line on fuel pump

Tools Required:

Clear line and hose clamps

10. Perform KOER On-Demand Self Test

Purpose:

To determine if the PCM has detected any fault conditions that would cause a performance problem while the engine is running. This will perform step tests on the injection control pressure system and the exhaust back pressure system.

Performance Diagnostic Procedures

Step tests are PCM-controlled tests where the PCM commands a specific exhaust back pressure or injection control pressure and then measures the result. If a predetermined threshold is not reached, a fault code will be generated. This test can be performed at any engine temperature.

10. Perform KOER On Demand Test

- Select KOER test from NGS test menu.

Pass Code = P1111 or System Passed

KOER Diagnostic Trouble Codes	

DA0844-B

Recommended Procedure:

Connect the NGS Tester to the DLC under the dash. Turn off accessories. Turn A/C off. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

NOTE: Engine will run rough during this test.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select KOEO ON DEMAND SELF TEST.
- Start vehicle.
- Follow operating instructions from the menu.
- Record DTCs and follow appropriate pinpoint test.
- After test, cycle key to off before running other tests or driving vehicle.

Tools Required:

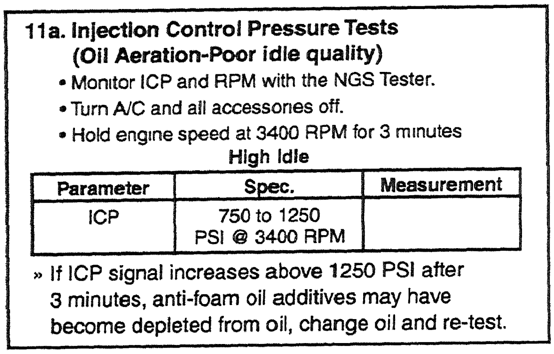
New Generation Star (NGS) Tester 007-00500 or equivalent

Performance Diagnostic Procedures

11a. Injection Control Pressure Tests (Oil Aeration — Poor Idle Quality)

Purpose:

To determine if the engine lube oil is aerated and causing poor idle quality.



11a. Injection Control Pressure Tests
(Oil Aeration-Poor idle quality)

- Monitor ICP and RPM with the NGS Tester.
- Turn A/C and all accessories off.
- Hold engine speed at 3400 RPM for 3 minutes

High Idle

Parameter	Spec.	Measurement
ICP	750 to 1250 PSI @ 3400 RPM	

» If ICP signal increases above 1250 PSI after 3 minutes, anti-foam oil additives may have become depleted from oil, change oil and re-test.

DA1471-A

Recommended Procedure:

Install NGS Tester. Turn A / C off. Access ICP PID on NGS Tester and monitor ICP pressure. Operate the engine at 3400 rpm for 3 minutes. This test should be performed with engine at normal operating temperature.

Possible Causes:

- Extended oil drain intervals — the anti-foam additives in the oil may be depleted either from severe use or extended intervals.
- Air present due to recent engine repair on injection control pressure system. It is necessary to run the vehicle aggressively for 24-32 kilometers (15-20 miles) to remove air.
- Wrong type or grade of oil.

Tools Required:

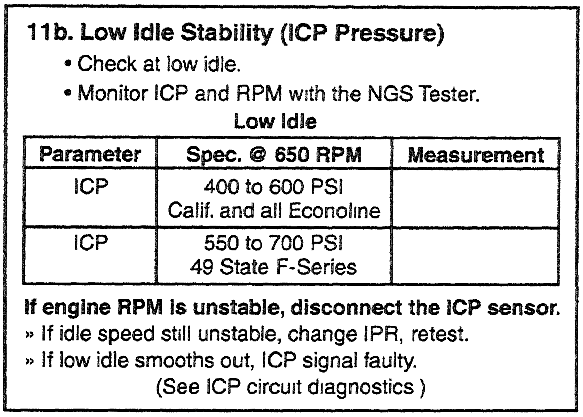
New Generation Star (NGS) Tester 007-00500 or equivalent

Performance Diagnostic Procedures

11b. Low Idle Stability (ICP Pressure)

Purpose:

To determine if idle stability and / or low power is caused by a stuck or dirty IPR or faulty ICP signal.



11b. Low Idle Stability (ICP Pressure)

- Check at low idle.
- Monitor ICP and RPM with the NGS Tester.

Low Idle

Parameter	Spec. @ 650 RPM	Measurement
ICP	400 to 600 PSI Calif. and all Econoline	
ICP	550 to 700 PSI 49 State F-Series	

If engine RPM is unstable, disconnect the ICP sensor.

» If idle speed still unstable, change IPR, retest.

» If low idle smooths out, ICP signal faulty.

(See ICP circuit diagnostics)

DA1472-A

Recommended Procedure:

Install NGS Tester. Turn A / C off. Access ICP PID on NGS Tester and monitor ICP pressure. Operate the engine at low idle. If engine does not stabilize, disconnect the ICP sensor. If low idle speed stabilizes with the ICP sensor disconnected, the problem is most likely in the ICP sensor circuit. Refer to Pinpoint Test DD. If rpm does not stabilize, change the IPR and retest. This test should be performed with engine at normal operating temperature.

Possible Causes:

- Debris stuck in the IPR
- In-range ICP sensor or circuit failure

Tools Required:

New Generation Star (NGS) Tester 007-00500 or equivalent

12. Crankcase Pressure Test

Purpose:

This test will measure crankcase pressure. Crankcase pressure is a measure of how well the cylinders are sealing.

Performance Diagnostic Procedures

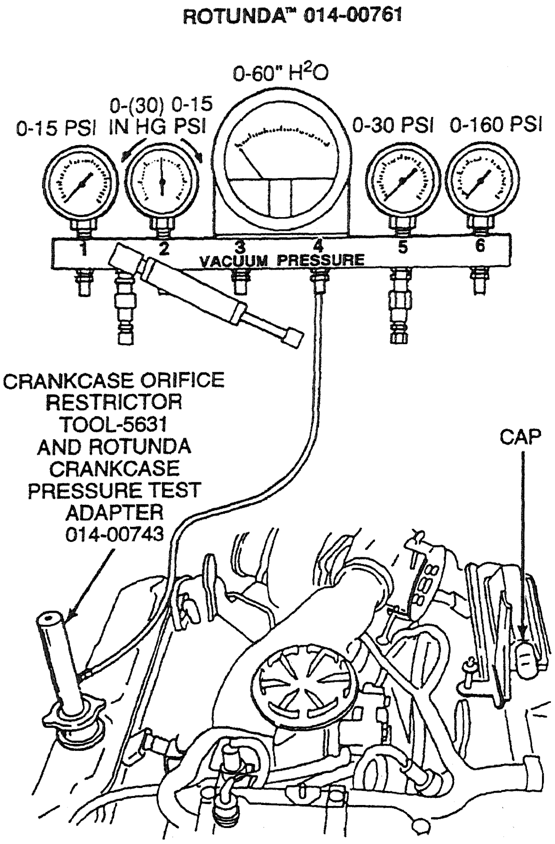
12. Crankcase Pressure Test

- Assure engine is at normal operating temp.
- Measure at oil fill with adapter and orifice tool P.N. 5631 & 014-00743 installed.
- Measure at WOT under no load.

Parameter	Spec.	Measurement
Magnehelic 0 to 60" H_20	less than 4" H_20	

If more then 4" H_20, Refer base engine in Shop Manual

DA1473-B



CRANKCASE PRESSURE A24026-B

Recommended Procedure:

NOTE: Do not plug hole on Crankcase Orifice Restrictor Tool PN 5631.

Make sure the engine is up to operating temperature. A cold engine will give higher readings. Remove the ducting to the turbocharger inlet pipe and remove the inlet pipe and elbow that connects to the breather box. Block the outlet at the breather box with the cap provided in Pressure Test Adapter Kit 014-00761 or equivalent. Install a protective screen over the turbocharger inlet.

Screw the Crankcase Orifice Restrictor Tool 014-00743 or equivalent and Crankcase Pressure Test Adapter 5631 or equivalent in the oil fill cap hole. Plumb to the Magnehelic® gauge in the gauge block. Make sure the Magnehelic® gauge has been zeroed.

Start the engine and operate at 3400 rpm. Hold for 30 seconds minimum and take a stabilized reading. Do not block the hole at the top of the restrictor tool.

Performance Diagnostic Procedures

Possible Causes:

- Broken or worn compression rings
- Polished cylinder bores
- Leaking or bent valves

Inspect air induction system. If the air induction system allows dirt to enter the cylinders, it will quickly "dust" the engine causing high crankcase pressure.

Tools Required:

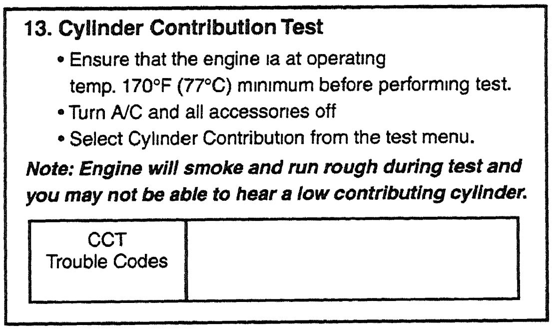
- Crankcase Orifice Restrictor Tool PN 5631 (part of Pressure Test Kit 014-00761)
- Magnehelic® gauge (part of Pressure Test Kit 014-00761)
- Protective screen
- Crankcase Pressure Test Adapter 014-00743 or equivalent

13. Cylinder Contribution Tests

Purpose:

To test individual cylinders and injectors to determine if all are contributing equally to engine performance.

This is a test performed after a standard KOER test is performed.



13. Cylinder Contribution Test

- Ensure that the engine ia at operating temp. 170°F (77°C) minimum before performing test.
- Turn A/C and all accessories off
- Select Cylinder Contribution from the test menu.

Note: Engine will smoke and run rough during test and you may not be able to hear a low contributing cylinder.

CCT Trouble Codes	

DA1474-A

Recommended Procedure:

If the base engine condition meets specifications, the injector may not be functioning correctly and will need replacement. The solenoid and wiring should have been checked in earlier tests. Verify KOEO Injector electrical Self Test passed.

NOTE: The A / C must be off and engine oil temperature above 76.6°C (170°F) to run this test.

Performance Diagnostic Procedures

This test will determine if all cylinders are contributing equally to engine performance. The PCM will test the cylinders in order (1 through 8). This test consists of two portions. First, the 8-cylinder test checks for a non-contributing cylinder; then, the 4-cylinder test detects a weak cylinder. The 4-cylinder portion of the test will never run if a fault is detected on the 8-cylinder portion of the test. The engine will give off smoke and rpm will vary for each test although you will not hear an rpm difference between good and bad cylinders during the test. A fault must be present at the time of testing for the KOER Cylinder Contribution Self Test to detect a fault. If a fault is detected, a DTC will be output on the data link at the end of the test when requested by a scan tool. Only a hard fault code (DTC) will be displayed.

Possible Causes:

Failing this test could indicate mechanical engine problems such as:

- broken compression rings
- leaking or bent valves
- bent push rods
- bent connecting rods
- damaged rocker arms
- faulty injector assembly

Go to the workshop manual for base engine diagnostic procedures.

Tools Required:

New Generation Star (NGS) Tester 007-00500 or equivalent

14. Exhaust Restriction

Purpose:

To determine if the exhaust system is sufficiently restricted to cause a performance problem.

14. Exhaust Restriction

- Visually inspect exhaust system for damage
- Verify EBP device is open at WOT.
- Monitor EBP with the NGS Tester with the engine temperature at 170°F minimum at 3400 RPM.

Parameter	Spec.	Measurement
EBP	28 PSI MAX @ 3400 RPM	

DA1475-A

Performance Diagnostic Procedures

Recommend Procedure:

Use NGS Tester PID EBPA. An EBPA reading above 193 kPa (28 psia) indicates a restricted exhaust condition.

Alternate Procedure:

A thorough visual inspection will find the problem quickly in most instances. If an NGS Tester is not available and a measurement is necessary, measure voltage at exhaust back pressure (EBP) sensor using a DVOM and ICP / EBP Adapter Cable D94T-50-A. Measure this pressure at WOT, wheels blocked and brake engaged.

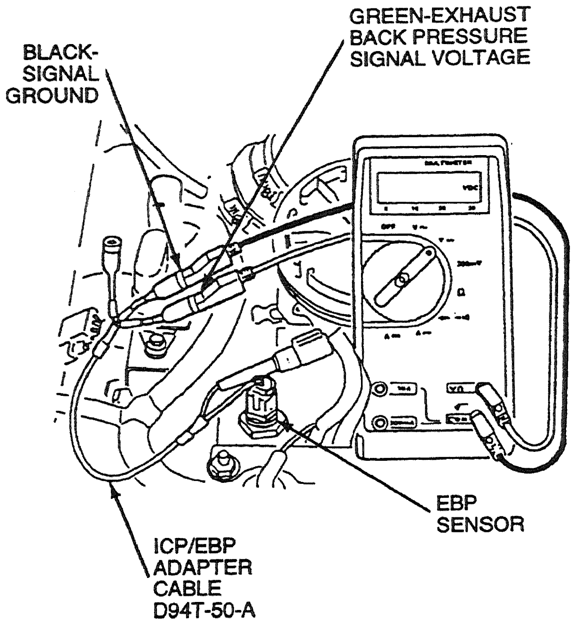
Possible Causes:

- Collapsed tail pipe
- Clogged tail pipe
- Closed exhaust back pressure device
- Clogged catalytic converter
- Damaged muffler

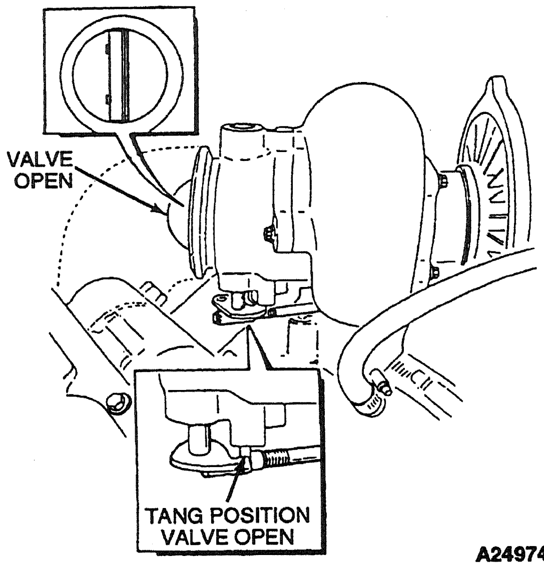
Tools Required:

- ICP / EBP Adapter Cable D94T-50-A or equivalent
- New Generation Star (NGS) Tester 007-00500 or equivalent
- 23 Multimeter 105-00050 or equivalent

Performance Diagnostic Procedures



EXHAUST BACK PRESSURE A24024-B



A24974-A

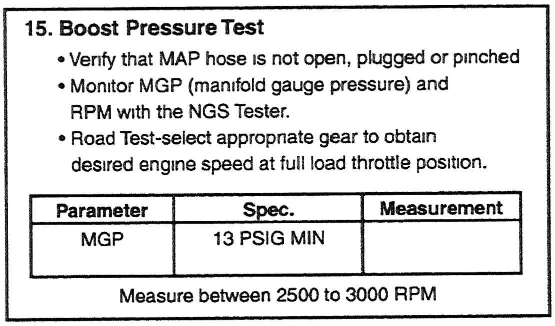
Performance Diagnostic Procedures

15. Boost Pressure Test

Purpose:

To determine if the engine can develop sufficient boost to obtain specific power.

If the engine can obtain specified boost there is no engine power problem. There may be chassis or applications concerns but the engine is performing as specified.



15. Boost Pressure Test

- Verify that MAP hose is not open, plugged or pinched
- Monitor MGP (manifold gauge pressure) and RPM with the NGS Tester.
- Road Test-select appropriate gear to obtain desired engine speed at full load throttle position.

Parameter	Spec.	Measurement
MGP	13 PSIG MIN	

Measure between 2500 to 3000 RPM

DA1476-A

Recommended Procedure:

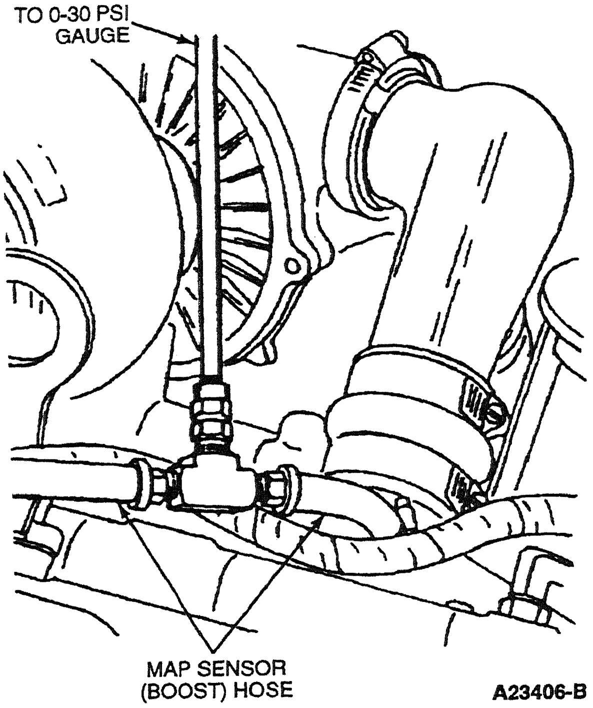
Monitor NGS PID "MGP." After the engine is up to operating temperature, find an open section of road and select the best gear to achieve a 2500-3000 rpm acceleration. With the accelerator at WOT, note the boost reading while accelerating through the 2500-3000 rpm range. Boost will level out after 3000 rpm. The highest boost reading will be noticed between 2500-3000 rpm. This test is best accomplished either climbing a hill or with the truck fully loaded.

Alternate Procedure:

Install a T (manufactured locally out of common fittings) into the manifold absolute pressure (MAP) sensor line that comes from the intake manifold. Make sure the MAP sensor is hooked up for this test.

Performance Diagnostic Procedures

Connect a T to a 0-30 psi gauge that is temporarily installed in the cab. Route the hose so that it is not crimped and does not come in contact with any hot surface.



Possible Causes:

- Restricted intake or exhaust
- Pinched or open MAP sensor hose
- Low fuel pressure
- Biased MAP sensor
- Low injection control pressure
- Control system faults
- IDM fault
- Defective injectors
- Defective turbocharger
- Base engine failure

Performance Diagnostic Procedures

Tools Required:

- A T manufactured locally out of common fittings
- 0-30 psi gauge
- New Generation Star (NGS) Tester 007-00500 or equivalent

Diagnostic Trouble Code Description

4 Digit	Description	Pinpoint Test Step Go to Direction		
		KOEO	KOER	Continuous
—	System Pass (No DTCs Available) — California and all Econoline	—	—	—
P0107	BARO Circuit Low Input	DH1	—	DH1
P0108	BARO Circuit High Input	DH8	—	DH8
P0112	IAT Sensor Circuit Low Input	DA5	—	DA8
P0113	IAT Sensor Circuit High Input	DA1	—	DA8
P0122*	Accelerator Pedal Sensor Circuit Low Input	DE5	—	DE5
P0123*	Accelerator Pedal Sensor Circuit High Input	DE1	—	DE1
P0196	EOT Sensor Circuit Performance	—	DB10	—
P0197*	EOT Sensor Circuit Low Input	DB4	—	DB6
P0198*	EOT Sensor Circuit High Input	DB1	—	DB6
P0220*	Throttle Switch B Circuit Malfunction	—	FE1	—
P0221*	Throttle Switch B Circuit Malfunction	—	—	FE1
P0236*	Turbo Boost Sensor A Circuit Performance	DC1	—	DC1
P0237*	Turbo Boost Sensor A Circuit Low Input	DC5	—	DC16
P0238*	Turbo Boost Sensor A Circuit High Input	DC15	—	DC24
P0261*	Injector Circuit Low — Cylinder 1	NA1	—	NA1
P0262	Injector Circuit High — Cylinder 1	NA6	—	NA6
P0263	Cylinder 1 Contribution/Balance Fault	—	NA25	—
P0264*	Injector Circuit Low — Cylinder 2	NA1	—	NA1
P0265	Injector Circuit High — Cylinder 2	NA6	—	NA6
P0266	Cylinder 2 Contribution/Balance Fault	—	NA25	—
P0267*	Injector Circuit Low — Cylinder 3	NA1	—	NA1
P0268	Injector Circuit High — Cylinder 3	NA6	—	NA6
P0269	Cylinder 3 Contribution/Balance Fault	—	NA25	—
P0270*	Injector Circuit Low — Cylinder 4	NA1	—	NA1
P0271	Injector Circuit High — Cylinder 4	NA6	—	NA6
P0272	Cylinder 4 Contribution/Balance Fault	—	NA25	—
P0273*	Injector Circuit Low — Cylinder 5	NA1	—	NA1
P0274	Injector Circuit High — Cylinder 5	NA6	—	NA6
P0275	Cylinder 5 Contribution/Balance Fault	—	NA25	—
P0276*	Injector Circuit Low — Cylinder 6	NA1	—	NA1
P0277	Injector Circuit High — Cylinder 6	NA6	—	NA6
P0278	Cylinder 6 Contribution/Balance Fault	—	NA25	—
P0279*	Injector Circuit Low — Cylinder 7	NA1	—	NA1
P0280	Injector Circuit High — Cylinder 7	NA6	—	NA6
P0281	Cylinder 7 Contribution/Balance Fault	—	NA25	—
P0282*	Injector Circuit Low — Cylinder 8	NA1	—	NA1
P0283	Injector Circuit High — Cylinder 8	NA6	—	NA6

(Continued)

Diagnostic Trouble Code Description

4 Digit	Description	Pinpoint Test Step Go to Direction		
		KOEO	KOER	Continuous
P0284	Cylinder 8 Contribution / Balance Fault	—	NA25	—
P0340	CMP Sensor Circuit Malfunction	DG1	—	DG1
P0341*	CMP Sensor Circuit Performance	—	DG1	DG1
P0344*	CMP Sensor Circuit Intermittent	DG1	—	DG1
P0380	Glow Plug Circuit Malfunction	KC3	—	KC3
P0381	Glow Plug Indicator Circuit Malfunction	KD1	—	KD3
P0470	Exhaust Back Pressure Sensor Circuit Malfunction	DF1	—	DF3
P0471	Exhaust Back Pressure Sensor Circuit Performance	—	—	DF5
P0472	Exhaust Back Pressure Sensor Circuit Low Input	DF9	—	DF9
P0473	Exhaust Back Pressure Sensor Circuit High Input	DF15	—	DF15
P0475	Exhaust Pressure Control Valve Malfunction	KB1	—	—
P0476	Exhaust Pressure Control Valve Performance	—	KB7	KB7
P0478	Exhaust Pressure Control Valve High Input	—	—	DF17
P0500	Vehicle Speed Sensor Malfunction — KOER Tests	—	—	HB1
P0560	System Voltage Malfunction	—	A1	—
P0562	System Voltage Low	A1	—	A1
P0563	System Voltage High	A1	—	A1
P0565	Cruise "On" Signal Malfunction	—	FG1	—
P0566	Cruise "Off" Signal Malfunction	—	FG1	—
P0567	Cruise "Resume" Signal Malfunction	—	FG1	—
P0568	Cruise "Set" Signal Malfunction	—	FG1	—
P0569	Cruise "Coast" Signal Malfunction	—	FG1	—
P0571	Brake Switch A Circuit Malfunction	—	FB1	—
P0603	Internal Control Module KAM Error	MA1	—	MA1
P0605	Internal Control Module ROM Error	MD1	—	MD1
P0606	PCM Processor Fault	MC1	—	—
P0703	Brake Switch B Circuit Malfunction	—	FD1	—
P0704	Clutch Pedal Position Switch Input Circuit Malfunction	—	FC1	—
P0705**	TR Sensor Circuit Malfunction	***	***	***
P0707**	TR Sensor Circuit Low Input	***	***	***
P0708**	TR Sensor Circuit High Input	***	***	***
P0712	Transmission Fluid Temp. Sensor CKT Low Input	***	***	***
P0713	Transmission Fluid Temp. Sensor CKT High Input	***	***	***
P0741	TCC Circuit Performance	***	***	***
P0743	Torque Converter Clutch System Electrical Failure	***	***	***
P0750	Shift Solenoid 1 Malfunction	***	***	***

(Continued)

Diagnostic Trouble Code Description

4 Digit	Description	Pinpoint Test Step Go to Direction		
		KOEO	KOER	Continuous
P0751	Shift Solenoid A Performance	***	***	***
P0755	Shift Solenoid 2 Malfunction	***	***	***
P0756	Shift Solenoid B Performance	***	***	***
P0760	Shift Solenoid C Malfunction	***	***	***
P0781	1-2 Shift Malfunction	***	***	***
P0781**	1-2 Shift Malfunction	***	***	***
P0782**	2-3 Shift Malfunction	***	***	***
P0783**	3-4 Shift Malfunction	***	***	***
P1000	OBD II Monitor Checks Not Complete, More Driving Required	—	—	AP
P1111	System Pass — 49-State except Econoline	Pass	Pass	Pass
P1184	Engine Oil Temp Sensor Circuit Performance	—	DB10	—
P1209	Injection Control System Pressure Peak Fault	—	—	KE15
P1210	Injection Control Pressure Above Expected Level	DD11	—	DD22
P1211*	ICP Not Controllable — Pressure Above/Below Desired	KE14	KE7	KE14
P1212*	ICP Voltage Not at Expected Level	DD11	—	DD14
P1218	CID Stuck High	KA10	—	KA10
P1219	CID Stuck Low	KA9	—	KA9
P1247	Turbo Boost Pressure Low	—	—	DC1
P1248	Turbo Boost Pressure Not Detected	—	—	DC1
P1261	High to Low Side Short — Cylinder 1	NA6	—	NA6
P1262	High to Low Side Short — Cylinder 2	NA6	—	NA6
P1263	High to Low Side Short — Cylinder 3	NA6	—	NA6
P1264	High to Low Side Short — Cylinder 4	NA6	—	NA6
P1265	High to Low Side Short — Cylinder 5	NA6	—	NA6
P1266	High to Low Side Short — Cylinder 6	NA6	—	NA6
P1267	High to Low Side Short — Cylinder 7	NA6	—	NA6
P1268	High to Low Side Short — Cylinder 8	NA6	—	NA6
P1271	High to Low Side Open — Cylinder 1	NA11	—	NA11
P1272	High to Low Side Open — Cylinder 2	NA11	—	NA11
P1273	High to Low Side Open — Cylinder 3	NA11	—	NA11
P1274	High to Low Side Open — Cylinder 4	NA11	—	NA11
P1275	High to Low Side Open — Cylinder 5	NA11	—	NA11
P1276	High to Low Side Open — Cylinder 6	NA11	—	NA11
P1277	High to Low Side Open — Cylinder 7	NA11	—	NA11
P1278	High to Low Side Open — Cylinder 8	NA11	—	NA11
P1280*	ICP Circuit Out of Range Low	DD1	—	DD1
P1281*	ICP Circuit Out of Range High	DD8	—	DD8
P1282	Excessive ICP	—	KE5	KE5

(Continued)

Diagnostic Trouble Code Description

4 Digit	Description	Pinpoint Test Step Go to Direction		
		KOEO	KOER	Continuous
P1283*	IPR Circuit Failure	KE1	—	—
P1284	ICP Failure — Aborts KOER or CCT Test	—	DD21	—
P1291	High Side No. 1 (Right) Short to GND or B+	NA16	—	NA16
P1292	High Side No. 2 (Left) Short to GND or B+	NA16	—	NA16
P1293	High Side Open Bank No. 1 (Right)	NA20	—	NA20
P1294	High Side Open Bank No. 2 (Left)	NA20	—	NA20
P1295*	Multiple Faults on Bank No. 1 (Right)	NA29	—	NA29
P1296*	Multiple Faults on Bank No. 2 (Left)	NA29	—	NA29
P1297	High Sides Shorted Together	NA27	—	NA27
P1298	IDM Failure	KA1	—	KA1
P1316	Injector Circuit / IDM Codes Detected	FJ10	—	FJ10
P1391	Glow Plug Circuit Low Input Bank No. 1 (Right)	—	KC1	KC1
P1392	Glow Plug Circuit High Input Bank No. 1 (Right)	—	KC1	KC1
P1393	Glow Plug Circuit Low Input Bank No. 2 (Left)	—	KC1	KC1
P1394	Glow Plug Circuit High Input Bank No. 2 (Left)	—	KC1	KC1
P1395	Glow Plug Monitor Fault Bank No. 1	—	KC1	KC1
P1396	Glow Plug Monitor Fault Bank No. 2	—	KC1	KC1
P1397	System Voltage out of Self Test Range	—	KC15	KC15
P1464	A / C On During KOER or CCT Test	—	FA1	—
P1501	Vehicle Moved During Testing	—	Repeat Test	—
P1502	Invalid Self Test — APCM Functioning	QA	QA	QA
P1531	Invalid Test — Accelerator Pedal Movement	—	Repeat Test	—
P1536	Parking Brake Applied Failure	—	Q1	—
P1660	Output Circuit Check Signal High	KH	—	KH
P1661	Output Circuit Check Signal Low	KJ	—	KJ
P1662	IDM EN Circuit Failure	NC1	—	—
P1663	FDCS Circuit Failure	KF1	—	—
P1667	CID Circuit Failure	KA1	—	—
P1668	PCM — IDM Diagnostic Communication Error	FJ1	—	FJ1
P1670	EF Feedback Signal Not Detected	—	—	FJ1
P1704	Digital TRS Failed to Transition State	—	—	—
P1705	TR Sensor out of Self Test Range	***	***	***
P1706**	High Vehicle Speed in Park	***	***	***
P1711	TFT Sensor Out of Self Test Range	***	***	***
P1714	Shift Solenoid A Inductive Signature Malfunction	***	***	***
P1715	Shift Solenoid B Inductive Signature Malfunction	***	***	***
P1727	Coast Clutch Solenoid Inductive Signature Malfunction	***	***	***
P1728**	Transmission Slip Error — Converter Clutch Failed	***	***	***

(Continued)

Diagnostic Trouble Code Description

4 Digit	Description	Pinpoint Test Step Go to Direction		
		KOEO	KOER	Continuous
P1729	4x4L Switch Error	***	***	***
P1740	Torque Converter Clutch Inductive Signature Malfunction	***	***	***
P1742	Torque Converter Clutch Failed On	***	***	***
P1744	Torque Converter Clutch System Performance	***	***	***
P1746	EPC Solenoid Open Circuit	***	***	***
P1747	EPC Solenoid Short Circuit	***	***	***
P1748**	EPC Malfunction	***	***	***
P1751	Shift Solenoid A Performance	***	***	***
P1754	CCS (Solenoid) Circuit Malfunction	***	***	***
P1756	Shift Solenoid B Performance	***	***	***
P1779	TCIL Circuit Malfunction	***	***	***
P1780	TCS Circuit out of Self Test Range	***	***	***
P1781	4x4L Circuit out of Self Test Range	***	***	***
P1783**	Transmission Overtemperature Condition	***	***	***
No Code	No Communication	QA1	QA1	QA1
No Code	Auxiliary Powertrain Control System	HA1	HA1	HA1
No Code	Tachometer	KG1	KG1	KG1

* Check Engine light illuminates when fault is present. On California and all Econoline, CHECK ENGINE light will turn off if no fault is detected for four consecutive drive cycles.

** Transmission Control Indicator Light (TCIL) flashes when fault is present.

*** Refer to the Powertrain Group in the Workshop Manual for diagnostic procedures.

NOTE: Speed control DTCs will be set during KOER Switch Test if the vehicle is not equipped with speed control. This is a normal condition. On these vehicles ignore the following DTCs P0565-P0566-P0567-P0568-P0569.

SECTION 4B

Diagnostic Subroutines — 1998-1/2 Econoline with Electric Fuel Pump and 1999 F-Series

Contents

Insert this manual behind the 7.3L Diesel tab in the 1998 Powertrain Control/ Emissions Diagnosis Service Manual.

7.3L Diesel

Powertrain Control/Emissions Diag

1998 Service Manual

Ford

Diagnostic Trouble Code Description

4 Digit	Description	Pinpoint Test Step Go to Direction		
		KOEO	KOER	Continuous
P1729	4x4L Switch Error	***	***	***
P1740	Torque Converter Clutch Inductive Signature Malfunction	***	***	***
P1742	Torque Converter Clutch Failed On	***	***	***
P1744	Torque Converter Clutch System Performance	***	***	***
P1746	EPC Solenoid Open Circuit	***	***	***
P1747	EPC Solenoid Short Circuit	***	***	***
P1748**	EPC Malfunction	***	***	***
P1751	Shift Solenoid A Performance	***	***	***
P1754	CCS (Solenoid) Circuit Malfunction	***	***	***
P1756	Shift Solenoid B Performance	***	***	***
P1779	TCIL Circuit Malfunction	***	***	***
P1780	TCS Circuit out of Self Test Range	***	***	***
P1781	4x4L Circuit out of Self Test Range	***	***	***
P1783**	Transmission Overtemperature Condition	***	***	***
No Code	No Communication	QA1	QA1	QA1
No Code	Auxiliary Powertrain Control System	HA1	HA1	HA1
No Code	Tachometer	KG1	KG1	KG1

* Check Engine light illuminates when fault is present. On California and all Econoline, CHECK ENGINE light will turn off if no fault is detected for four consecutive drive cycles.

** Transmission Control Indicator Light (TCIL) flashes when fault is present.

*** Refer to the Powertrain Group in the Workshop Manual for diagnostic procedures.

NOTE: Speed control DTCs will be set during KOER Switch Test if the vehicle is not equipped with speed control. This is a normal condition. On these vehicles ignore the following DTCs P0565-P0566-P0567-P0568-P0569.

SECTION 4B

Diagnostic Subroutines — 1998-1/2 Econoline with Electric Fuel Pump and 1999 F-Series

Contents

SECTION 4B

Diagnostic Subroutines — 1998-1/2 Econoline with Electric Fuel Pump and 1999 F-Series

Contents (continued)

SECTION 4B

Diagnostic Subroutines — 1998-1/2 Econoline with Electric Fuel Pump and 1999 F-Series

Contents (continued)

Hard Start/No Start Diagnostic Procedures

Econoline
Hard Start/No Start Diagnostics

1. Visual Engine/Chassis Inspection

Fuel Oil Coolant Electrical Hoses Leaks	
Method	**Check**
Visual	

2. Check Engine Oil Level
- Check for contaminants (fuel, coolant)
- Correct Grade/Viscosity
- Miles/Hours on oil, correct level
- Check level in reservoir

Method	**Check**
Visual	

3. Intake/Exhaust Restriction
- Inspect air filter and ducts - exhaust system
- Inspect exhaust back pressure device

Method	**Check**
Visual	

4. Sufficient Clean Fuel
- Check fuel tank, drain sample from fuel filter while cranking engine.
- Note if operator has indicated that the Water in Fuel has been illuminated

Method	**Checks**	
Visual		

5. Electric Fuel Pump Pressure
- After verifying that there is fuel in the tank and the pump is being powered
- Measure at the top of the left cylinder head with a (0-160 PSI) gauge
- Turn the Ign switch on

Instrument	**Spec.**	**Measurement**
0-160 PSI Gauge	30 PSI min	

If pressure falls low, Go to step 8a on the Performance side of this sheet.

6. Perform KOEO On Demand Test
- Use NGS Tester
- Diagnostic Trouble Codes set during this test are current faults

Pass Code = P1111 or System Passed

Diagnostic Trouble Codes	

7. Retrieve Continuous Trouble Codes
- Diagnostic Trouble Codes retrieved during this test are historical faults

Pass Code = P1111 or System Passed

Diagnostic Trouble Codes	

8. KOEO Injector Electrical Self-Test
- Use NGS Tester
- All injectors will momentarily buzz, then individual injectors will buzz in sequence 1 through 8
- Diagnostic Trouble Codes will be transmitted after test is completed

Pass Code = P1111 or System Passed

Injector Trouble Codes	

Refer to PC/ED manual Pinpoint tests if Diagnostic Trouble Codes are set.

9. NGS Tool - Data List Monitoring
- NGS Tester may reset below 9 5 volts
- Select the parameters indicated from the NGS parameter list and monitor while cranking engine

Parameter	**Spec.**	**Measurement**
V PWR	7 volt minimum	
RPM	100 RPM minimum	
ICP	500 PSI or 3 4 mPa min	
Fuel PW	1 mS to 6 mS	

A - **V PWR - If Indicating a low voltage condition,** check battery voltage, charging system or power and ground circuits to the PCM

GO TO PINPOINT TEST A

B - **RPM - Low RPM could be an indication of starting/** charging system problems, No RPM indicated with the engine cranking - could be CMP circuit fault, check for Diagnostic Trouble Codes

GO TO PINPOINT TEST DG

C - **ICP - A minimum of 500 PSI (3.4 mPa) is required** before the injectors are enabled No or low oil in the reservoir, system leakage, faulty IPR or high pressure pump could cause pressure loss.

Note. CMP signal is required before IPR is commanded above 14%

D - **FUEL PW - Even though a 1 to 6 mS Fuel PW** is shown on the NGS to be sent to the IDM, it's possible that the IDM did not get the signal, due to a fault on either CID or FDCS circuits or even the IDM

Note· A hard start/no start concern with EOT temp. below 60 F perform this Test Step first.

10. Glow Plug System Operation

Relay Operation

- Glow Plug ON time is dependent on oil temperature and altitude The Glow Plug relay comes on between 1 to 120 sec and does not come on at all if oil Temp is above 86 F
- Verify that B+ is being supplied on the large BK/W wire going to the Glow Plug relay
- Install a voltmeter to the glow plug feed terminal (terminal with two brown wires) or (center terminal on the shunt for California)
- Turn key to run position, measure "ON" time
- Using the NGS GPCTM and EOT pids, verify sufficient glow plug "ON" time and voltage

(Dependent on oil temperature and altitude)

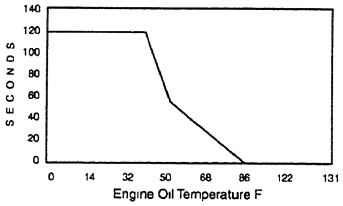
9 -12 volts	**Spec.**	**Measurement**
Relay On time	1 to 120 seconds	

Note: Wait to Start Lamp "On" time (1-10 sec.) is independent from Glow Plug Relay "On" time

Glow Plug Operation

- Measure Glow Plug Resistance to Bat Ground
- Remove all glow plug/injector connectors
- Measure GP Harness Resistance to Relay

Glow Plug Number	**Glow Plug to Ground .1 to 2 ohms**	**Connector to Relay 0 to 1 ohms**
#1		
#3		
#5		
#7		
#2		
#4		
#6		
#8		



- Add 5 seconds to glow plug on time when above 7000 feet in altitude, but not to exceed 120 seconds

DA1477-A

Hard Start/No Start Diagnostic Procedures

F-Series
Hard Start/No Start Diagnostics

1. Visual Engine/Chassis Inspection

Fuel Oil Coolant Electrical Hoses Leaks	
Method	**Check**
Visual	

2. Check Engine Oil Level

- Check for contaminants (fuel, coolant)
- Correct Grade/Viscosity
- Miles/Hours on oil, correct level
- Check level in reservoir.

Method	Check
Visual	

3. Intake/Exhaust Restriction

- Inspect air filter and ducts - exhaust system
- Inspect exhaust back pressure device

Method	Check
Visual	

4. Sufficient Clean Fuel

- Check fuel tank, drain sample from fuel filter while cranking engine
- Note if operator has indicated that the Water in Fuel has been illuminated.

Method	Checks	
Visual		

5. Electric Fuel Pump Pressure

- After verifying that there is fuel in the tank and the pump is being powered.
- Measure at the top of the left cylinder head with a (0-160 PSI) gauge.
- Turn the Ign switch on.

Instrument	Spec.	Measurement
0-160 PSI Gauge	30 PSI min	

If pressure falls low, Go to step 8a on the Performance side of this sheet.

6. Perform KOEO On Demand Test

- Use NGS Tester
- Diagnostic Trouble Codes set during this test are current faults

Pass Code = P1111 or System Passed

Diagnostic Trouble Codes	

7. Retrieve Continuous Trouble Codes

- Diagnostic Trouble Codes retrieved during this test are historical faults

Pass Code = P1111 or System Passed

Diagnostic Trouble Codes	

8. KOEO Injector Electrical Self-Test

- Use NGS Tester
- All injectors will momentarily buzz, then individual injectors will buzz in sequence 1 through 8
- Diagnostic Trouble Codes will be transmitted after test is completed

Pass Code = P1111 or System Passed

Injector Trouble Codes	

Refer to PC/ED manual Pinpoint tests if Diagnostic Trouble Codes are set.

9. NGS Tool - Data List Monitoring

- NGS Tester may reset below 9 5 volts
- Select the parameters indicated from the NGS parameter list and monitor while cranking engine

Parameter	Spec.	Measurement
V PWR	7 volt minimum	
RPM	100 RPM minimum	
ICP	500 PSI or 3 4 mPa min	
Fuel PW	1 mS to 6 mS	

A - V PWR - If indicating a low voltage condition, check battery voltage, charging system or power and ground circuits to the PCM

GO TO PINPOINT TEST A

B - RPM - Low RPM could be an indication of starting/ charging system problems, No RPM indicated with the engine cranking - could be CMP circuit fault, check for Diagnostic Trouble Codes

GO TO PINPOINT TEST DG

C - ICP - A minimum of 500 PSI (3.4 mPa) is required before the injectors are enabled No or low oil in the reservoir, system leakage, faulty IPR or high pressure pump could cause pressure loss

Note: CMP signal is required before IPR is commanded above 14%

D - FUEL PW - Even though a 1 to 6 mS Fuel PW is shown on the NGS to be sent to the IDM, it's possible that the IDM did not get the signal, due to a fault on either CID or FDCS circuits or even the IDM

Note: A hard start/no start concern with EOT temp. below 60 F perform this Test Step first.

10. Glow Plug System Operation

Relay Operation

- Glow Plug ON time is dependent on oil temperature and altitude The Glow Plug relay comes on between 1 to 120 sec and does not come on at all if oil Temp is above 131 F
- Verify that B+ is being supplied on the large BK/W wire going to the Glow Plug relay
- Install a voltmeter to the glow plug feed terminal (terminal with two brown wires) or (center terminal on the shunt for California)
- Turn key to run position, measure "ON" time
- Using the NGS GPCTM and EOT pids, verify sufficient glow plug "ON" time and voltage (Dependent on oil temperature and altitude)

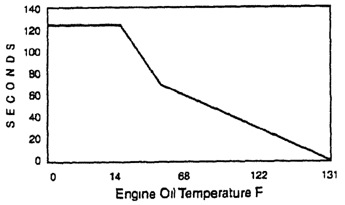
9 -12 volts	Spec	Measurement
Relay On time	1 to 120 seconds	

Note: Wait to Start Lamp "On" time (1-10 sec.) is independent from Glow Plug Relay "On" time

Glow Plug Operation

- Measure Glow Plug Resistance to Bat Ground
- Remove all glow plug/injector connectors
- Measure GP Harness Resistance to Relay

Glow Plug Number	Glow Plug to Ground .1 to 2 ohms	Connector to Relay 0 to 1 ohms
#1		
#3		
#5		
#7		
#2		
#4		
#6		
#8		



- Add 5 seconds to glow plug on time when above 7000 feet in altitude, but not to exceed 120 seconds

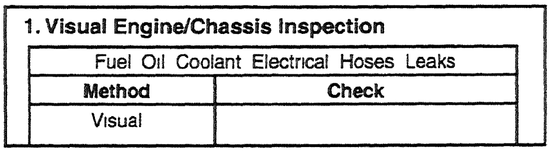
DA1478-A

Hard Start/No Start Diagnostic Procedures

1. Visual Engine/Chassis Inspection

Purpose:

This is a visual inspection to check the general condition of the engine and look for obvious causes of hard start or no start conditions.



1. Visual Engine/Chassis Inspection

Fuel Oil Coolant Electrical Hoses Leaks	
Method	**Check**
Visual	

DA1455-A

Recommended Procedure:

Inspect fuel system including fuel tank and fuel lines for kinks, bends and/or leakage. Check oil lines and high pressure pump in engine V for major oil leaks. Inspect for coolant leaks at radiator and heater hoses and check coolant level. Inspect MAP sensor and intercooler hoses for pinched or open vacuum leaks. Inspect wiring for correct routing and make sure no rubbing or chafing has occurred. Inspect the in-line 42-way, injector driver module (IDM), powertrain control module (PCM) and sensor connectors to make sure they are completely seated and in good condition.

Possible Causes:

- Loose or leaking fuel supply lines could cause fuel system to lose prime.
- Kinked or blocked fuel supply lines will create fuel restriction.
- Massive fuel or oil leaks could contribute to no start conditions.
- Coolant leaks could indicate serious engine problems.
- Electronic connectors may be damaged or not installed properly causing a no start condition. The camshaft position (CMP) sensor and the injection pressure regulator (IPR) are the two most critical electronic sensors/actuators to inspect in no start situations.
- Pinched or open MAP sensor hose.
- Pinched or open intercooler hose.

Tools Required:

Inspection light

Hard Start/No Start Diagnostic Procedures

2. Check Engine Oil Level

Purpose:

To determine if there is enough oil or oil of sufficient quality to operate the injectors.

2. Check Engine Oil Level

- Check for contaminants (fuel, coolant)
- Correct Grade/Viscosity
- Miles/Hours on oil, correct level
- Check level in reservoir

Method	Check
Visual	

A22181-C

Recommended Procedure:

Check oil level with dipstick when vehicle is on level ground. If there is no oil or very little oil in the crankcase, the injectors will not operate.

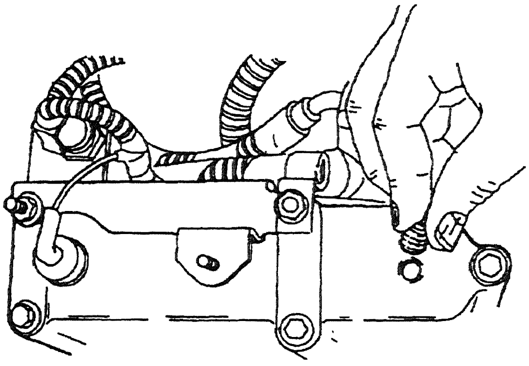
If the oil level on the dipstick is overfull it is possible the engine was incorrectly serviced or fuel is diluting the oil and filling the crankcase. Usually if a substantial amount of fuel is in the oil it will have a fuel odor.

Inspect oil for color. A milky white oil indicates possible coolant contamination and will have an ethylene glycol odor.

Check service records for correct oil type and viscosity for the vehicle operating temperature. Single weight or 15W-40 oil is not recommended for cold ambient temperatures. 10W-30 oil is recommended for cold ambient temperatures. Oil that has had extended drain intervals will have increased viscosity (become thicker) and will make engine cranking more difficult and starting less reliable at temperatures below freezing. Refer to the lube oil chart in the Workshop Manual or Owner's Guide for the correct oil selection for temperature conditions.

Hard Start/No Start Diagnostic Procedures

The level in the oil reservoir should also be checked. Remove the inspection plug in top of reservoir and check to see if the oil reservoir is full. (A reservoir that drains back after the engine has not been operated for a period of time can cause a hard start and die condition.) Filling the reservoir will allow the system to prime faster facilitating starting.



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Possible Causes:

- Loss of lube oil pressure
- Oil level low — oil leak, oil consumption, incorrect servicing
- Oil level high — incorrect servicing, fuel dilution from tandem fuel pump, fuel dilution from injector O-rings
- Oil contamination with coolant — oil cooler, head gasket, porosity
- Low reservoir level — engine built dry (not pressure lubed), prolonged period of not running, excessive cranking without starting

Tools Required:

1/4-inch drive ratchet or breaker bar to remove inspection plug

Hard Start/No Start Diagnostic Procedures

3. Intake/Exhaust Restriction

Purpose:

This is a visual inspection to determine if an air intake or exhaust restriction is contributing to a no start or hard start condition. If the engine does start with a high air intake or exhaust restriction, a considerable amount of black / blue smoke is produced.

3. Intake/Exhaust Restriction

- Inspect air filter and ducts – exhaust system
- Inspect exhaust back pressure device

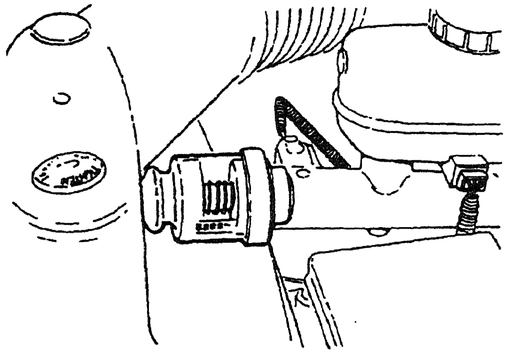
Method	Check
Visual	

A22182-C

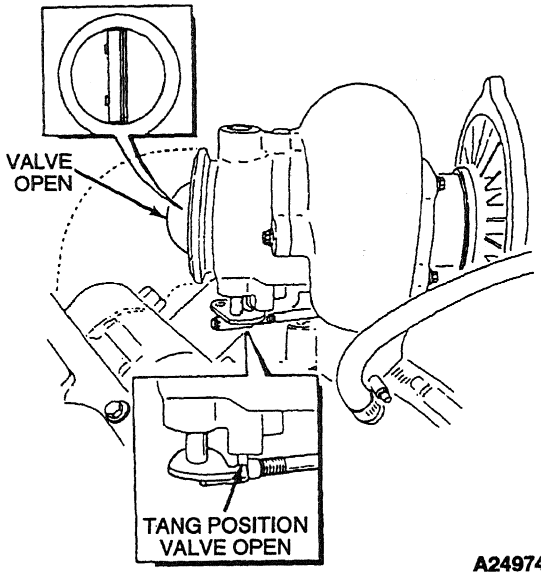
Recommended Procedure:

Inspect the air cleaner inlet and ducting to assure that it is not blocked or collapsed. Inspect the air cleaner housing and filter for proper installation. Inspect the filter minder to assure intake restriction is below the red marks.

Inspect the exhaust back pressure device bellcrank during cranking and assure that it is not closing. Inspect the exhaust system for damaged or blocked pipes. When the tang is against the stop, the valve is fully open.



A23378-A



A24974-A

Hard Start/No Start Diagnostic Procedures

Possible Causes:

- Snow, plastic bags or other foreign material may restrict airflow at the air inlet.
- Misrouted air cleaner ducting.
- On engines recently repaired, rags or cap plugs may have been inadvertently left in an air inlet pipe.
- Exhaust back pressure device may be closing during cranking or stuck closed.
- Tailpipe or muffler may have collapsed or been damaged or the catalytic converter is clogged.

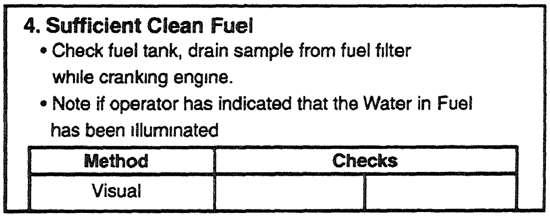
Tools Required:

None

4. Sufficient Clean Fuel

Purpose:

The purpose of this test is to see if the fuel system is getting sufficient clean fuel to start and run.



4. Sufficient Clean Fuel

- Check fuel tank, drain sample from fuel filter while cranking engine.
- Note if operator has indicated that the Water in Fuel has been illuminated

Method	Checks	
Visual		

DA1479-A

Recommended Procedure:

Route a hose from the fuel drain line to a clear container and open the drain. Crank the engine and observe the fuel flowing into the container. Stop cranking the engine when the container is half full.

Observe the WATER IN FUEL lamp while cranking the engine. If the lamp is illuminated, the fuel is probably contaminated with water.

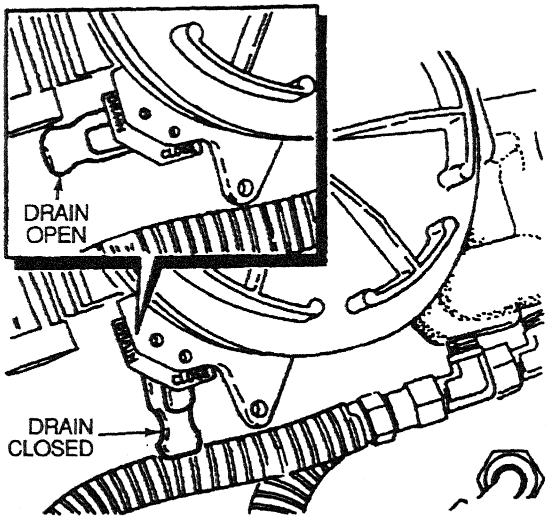
Flow out of the drain should be a steady stream. Insufficient flow could indicate fuel supply or fuel system problems.

Inspect fuel in the container. It should be straw colored, but not cloudy. It also should be free of water and contaminants. Dyed red or blue fuel indicates off-highway fuel.

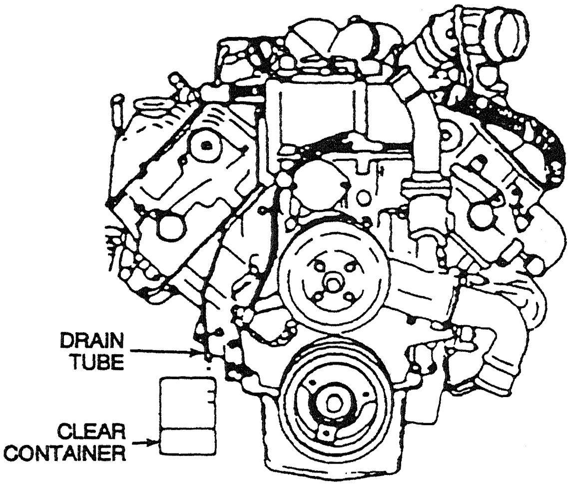
If engine oil is present in the fuel it may indicate an injector O-ring leak and subsequent loss of rail pressure. If that is suspected, check rail pressure during engine cranking (Hard Start / No Start Diagnostic Procedures Step 9C).

Hard Start/No Start Diagnostic Procedures

Some sediment and water may be present in the fuel sample if the fuel filter has not been serviced for a prolonged period of time and/or if the sediment and water have not been drained recently. If that is the case, a second sample may be required to determine fuel quality.



A23374-B



SUFFICIENT CLEAN FUEL

A23375-A

Possible Causes:

- No fuel in tank.
- If equipped with a fuel line valve, it could be shut off.
- If equipped with dual tanks, the switch valve could be faulty.
- Fuel supply line could be broken or crimped.
- Fuel could be jelled (most likely in cold weather with No. 2 fuel).
- Pickup tube screen in tank could be clogged.

Cloudy fuel indicates that the fuel may not be a suitable grade for cold temperatures; excessive water or contaminants may indicate that the tank and fuel system may need to be flushed and cleaned.

Tools Required:

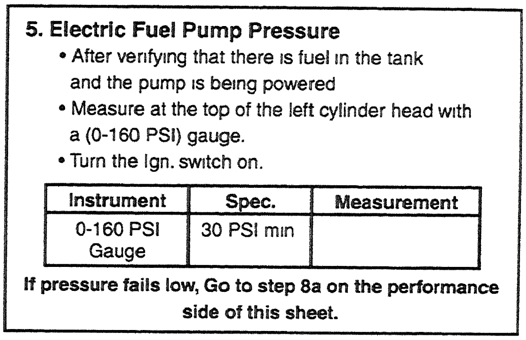
Clear container — approximately 1-quart

Hard Start/No Start Diagnostic Procedures

5. Electric Fuel Pump Pressure

Purpose:

To determine if there is sufficient fuel pressure for starting.



5. Electric Fuel Pump Pressure

- After verifying that there is fuel in the tank and the pump is being powered
- Measure at the top of the left cylinder head with a (0-160 PSI) gauge.
- Turn the Ign. switch on.

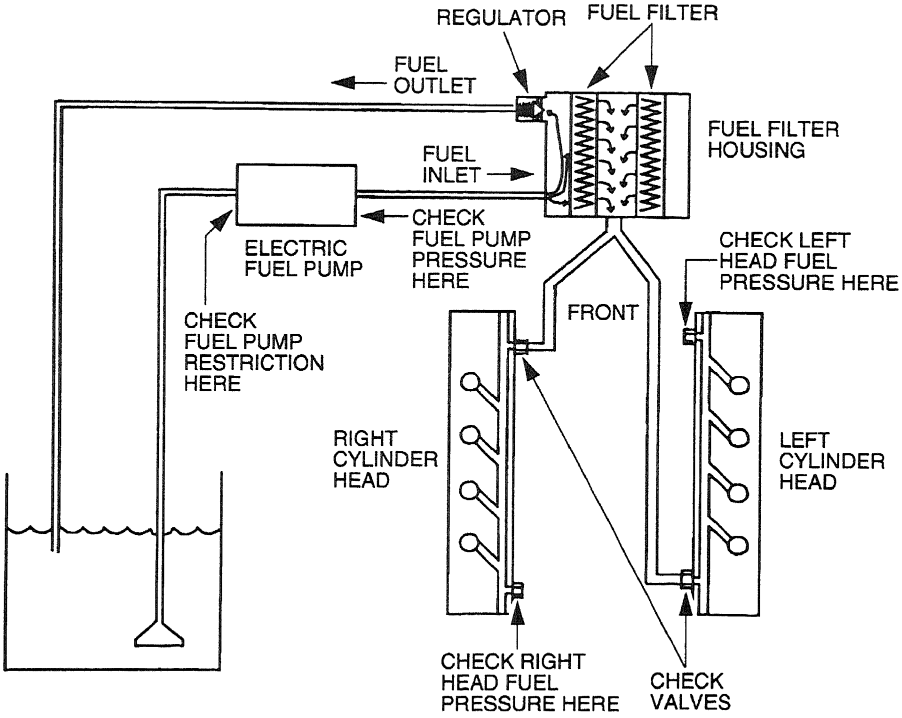
Instrument	Spec.	Measurement
0-160 PSI Gauge	30 PSI min	

If pressure fails low, Go to step 8a on the performance side of this sheet.

DA1480-A

Recommended Procedure:

First verify that there is fuel in the tank and battery voltage going to the fuel pump, using a digital multimeter connected between the two circuits going to the pump. Battery voltage will be present for approximately 20 seconds when the ignition key is turned on. If no voltage is present, go to Pinpoint Test FK.

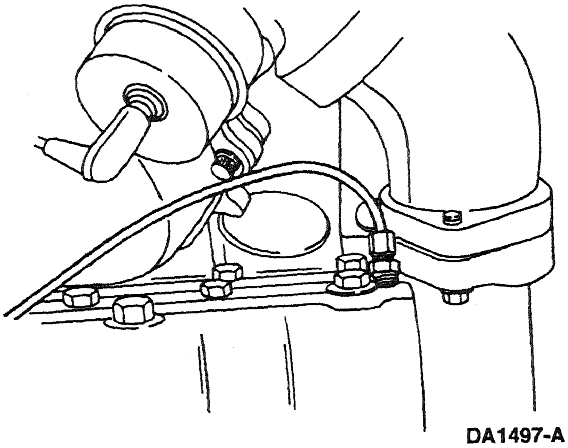


DA1521-A

Hard Start/No Start Diagnostic Procedures

Econoline

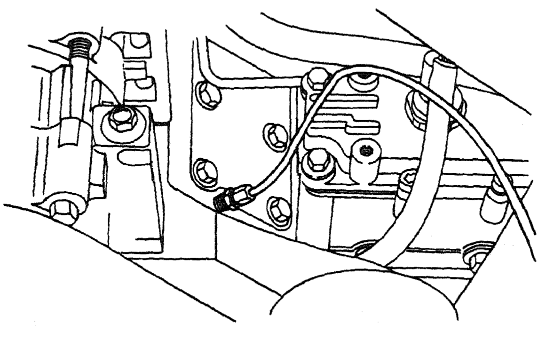
Remove the doghouse cover and remove the 1/8-inch pipe plug from the top rear of left head. Install Gauge (0-160 psi) Bar 014-00761 or equivalent. Measure pressure in crank or run. If pressure measures below specification (30-80 psi), perform test steps 8a-d in Performance Diagnostic Procedures in this section.



DA1497-A

F-Series

Remove the 1/8-inch pipe plug from the top front of the right head. Install Gauge (0-160 psi) Bar 014-00761 or equivalent. Measure pressure in crank or run. If pressure measures below specification (30-80 psi), perform test steps 8a-d in Performance Diagnostic Procedures in this section.



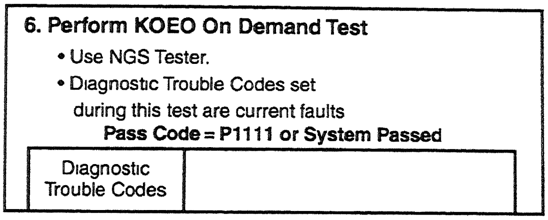
DA1498-A

Hard Start/No Start Diagnostic Procedures

6. Perform KOEO On-Demand Self Test

Purpose:

To determine if the PCM has detected any fault conditions that would cause a hard start or no start condition.



6. Perform KOEO On Demand Test

- Use NGS Tester.
- Diagnostic Trouble Codes set during this test are current faults

Pass Code = P1111 or System Passed

Diagnostic Trouble Codes	

DA0836-B

NOTE: The IDM stores both historical and hard IDM fault codes. To retrieve IDM fault codes, you must run KOEO On-Demand Self Test or KOEO Injector Electrical Test. To ensure that the DTC is a hard fault, you must first clear Continuous DTCs (be sure to record all DTCs before clearing) even though IDM codes do not show up on the Continuous display. Rerun KOEO On-Demand Self Test if an IDM DTC is set. This is a hard fault.

Recommended Procedure:

Connect the NGS Tester to the data link connector (DLC) under the dash. Turn off accessories. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select KOEO ON-DEMAND SELF TEST.
- Turn key on.
- Follow operating instructions from the menu.
- Record DTCs and follow appropriate pinpoint test.
- After test, cycle key to off before running other tests or driving vehicle.

NOTE: If performing repeated self tests, it may be necessary to unplug glow plug relay to keep battery from going dead. Ignore glow plug codes while glow plug relay is unplugged.

Hard Start/No Start Diagnostic Procedures

Possible Causes:

The most likely PCM detectable faults that will cause a no start or hard start condition are:

- CMP sensor inactive faults.
- IPR output circuit check fault.
- FDCS, CID and IDM ENABLE circuit faults.

Tools Required:

New Generation Star (NGS) Tester 007-00500 or equivalent

7. Retrieve/Clear Continuous DTCs

Purpose:

To determine if the PCM has detected any historical or intermittent fault conditions that would cause a hard start/no start symptom. The condition that caused a continuous DTC may no longer exist.

7. Retrieve Continuous Trouble Codes

- Diagnostic Trouble Codes retrieved during this test are historical faults.

Pass Code = P1111 or System Passed

Diagnostic Trouble Codes	

DA0837-B

NOTE: The IDM stores both historical and hard IDM fault codes. To retrieve IDM fault codes, you must run KOEO On-Demand Self Test or KOEO Injector Electrical Test. To ensure that the DTC is a hard fault, you must first clear Continuous DTCs (be sure to record all DTCs before clearing) even though IDM codes do not show up on the Continuous display. Rerun KOEO On-Demand Self Test if an IDM DTC is set. This is a hard fault.

Recommended Procedure:

Connect the NGS Tester to the DLC under the dash. Turn off accessories. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.

Hard Start/No Start Diagnostic Procedures

- Select DIAGNOSTIC TEST MODE.
- Select RETRIEVE / CLEAR CONTINUOUS DTCs
- Turn key on.
- Follow operating instructions from the menu.
- Record DTCs and follow appropriate pinpoint test for continuous code diagnostics.
- After test, cycle key to off before running other tests or driving vehicle.
- Continuous DTCs must be cleared after repair is made.

If performing repeated self tests, it may be necessary to unplug glow plug relay to keep battery from going dead. Ignore any glow plug codes while glow plug relay is unplugged.

Tools Required:

New Generation Star (NGS) Tester 007-00500 or equivalent

8. KOEO Injector Electrical Self Test

NOTE: If unable to perform KOEO Injector Electrical Self Test, disconnect IDM connector and check injector high and low side for shorts or opens.

Purpose:

To determine if the injector solenoids and valves are operating by buzzing all injectors together and then each injector in numerical sequence (1 through 8).

8. KOEO Injector Electric Self-Test

- Use NGS Tester.
- All injectors will momentarily buzz , then individual injectors will buzz in sequence 1 through 8.
- Diagnostic Trouble Codes will be transmitted after test is completed.

Pass Code = P1111 or System Passed

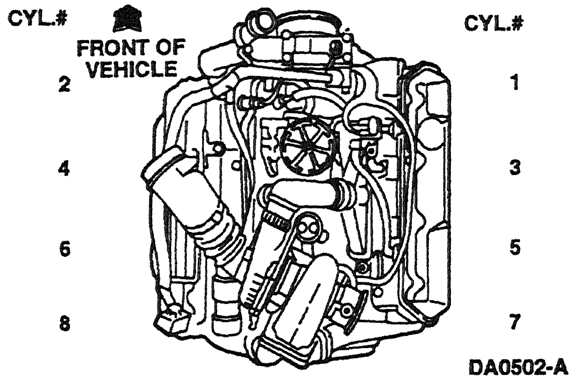
Injector Trouble Codes	

Refer to PC/ED manual Pinpoint tests if Diagnostic Trouble Codes are set.

DA0838-B

Hard Start/No Start Diagnostic Procedures

7.3L DI Engine, Cylinder and Fuel Injector Location



Recommended Procedure:

NOTE: If no DTCs are present and the KOEO Injector Electrical Self Test aborts while trying to perform, go to Pinpoint Test NA, Step NA29.

NOTE: This test determines if the injector circuits and solenoids are electrically operating without fault. All injectors will first buzz together for approximately 2 seconds, then each injector will buzz for approximately 1 second in numerical order (1 through 8). The IDM stores all historical IDM fault codes; to ensure that the DTC is a hard fault, you must first clear continuous DTCs (be sure to record all IDM fault codes before clearing). After clearing, rerun self test; a fault must be present at the time of testing for the KOEO Injector Electrical Self Test to detect the fault. If a fault is detected, a DTC will be output on the data link at the end of the test when requested by a scan tool. Only a hard fault code (DTC) will be displayed.

Connect the NGS Tester to the DLC under the dash. Turn off accessories. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select KOEO INJECTOR ELECTRICAL SELF TEST.
- Follow operating instructions from the menu.
- Record DTCs and follow appropriate pinpoint test.
- After test, cycle key to off before running other tests or driving vehicle.

Hard Start/No Start Diagnostic Procedures

Possible Causes:

- Open or shorted injector circuits
- Bad injector connector
- Open or shorted CID or FDCS circuits
- Open injector solenoid
- IDM powering or ground circuits
- Defective IDM

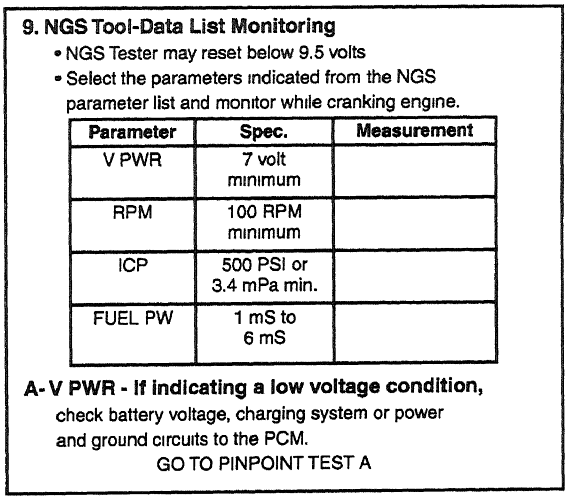
Tools Required:

New Generation Star (NGS) Tester 007-00500 or equivalent

9a. Check VPWR During Cranking

Purpose:

To verify PCM power-up during cranking. Lack of power to PCM can cause a no-start condition as well as fault code loss. The NGS Tester requires a minimum system voltage of 9.5 volts to avoid resetting.



9. NGS Tool-Data List Monitoring

- NGS Tester may reset below 9.5 volts
- Select the parameters indicated from the NGS parameter list and monitor while cranking engine.

Parameter	Spec.	Measurement
V PWR	7 volt minimum	
RPM	100 RPM minimum	
ICP	500 PSI or 3.4 mPa min.	
FUEL PW	1 mS to 6 mS	

A- V PWR - If indicating a low voltage condition, check battery voltage, charging system or power and ground circuits to the PCM.

GO TO PINPOINT TEST A

DA1457-A

Recommended Procedure:

Install NGS Tester. Access VPWR PID on NGS Tester and monitor while cranking the engine.

Hard Start/No Start Diagnostic Procedures

Possible Causes:

- Low battery voltage
- Charging system problem
- Power circuit and ground faults to the PCM

Refer to Pinpoint Test A to diagnose a voltage concern.

NOTE: Battery voltage below 9.5 volts can cause the NGS Tester to reset. If the NGS Tester resets during a self test or while PID monitoring, it may be necessary to install a battery charger to maintain the correct voltage.

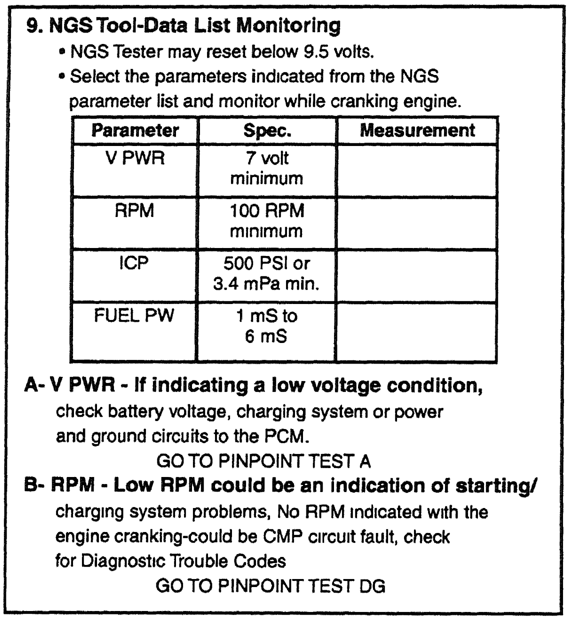
Tools Required:

New Generation Star (NGS) Tester 007-00500 or equivalent

9b. Check RPM Signal While Cranking

Purpose:

To determine if the CMP sensor and circuit are functioning.



9. NGS Tool-Data List Monitoring

- NGS Tester may reset below 9.5 volts.
- Select the parameters indicated from the NGS parameter list and monitor while cranking engine.

Parameter	Spec.	Measurement
V PWR	7 volt minimum	
RPM	100 RPM minimum	
ICP	500 PSI or 3.4 mPa min.	
FUEL PW	1 mS to 6 mS	

A- V PWR - If indicating a low voltage condition, check battery voltage, charging system or power and ground circuits to the PCM.

GO TO PINPOINT TEST A

B- RPM - Low RPM could be an indication of starting/ charging system problems, No RPM indicated with the engine cranking-could be CMP circuit fault, check for Diagnostic Trouble Codes

GO TO PINPOINT TEST DG

DA1458-A

Hard Start/No Start Diagnostic Procedures

Recommended Procedure:

Possible Causes:

- Weak battery or starter
- Faulty wire harness connection
- Poor CMP ground connection
- Incorrect CMP sensor to target wheel spacing
- Defective CMP sensor

Refer to Pinpoint Test DG for CMP sensor diagnosis.

Tools Required:

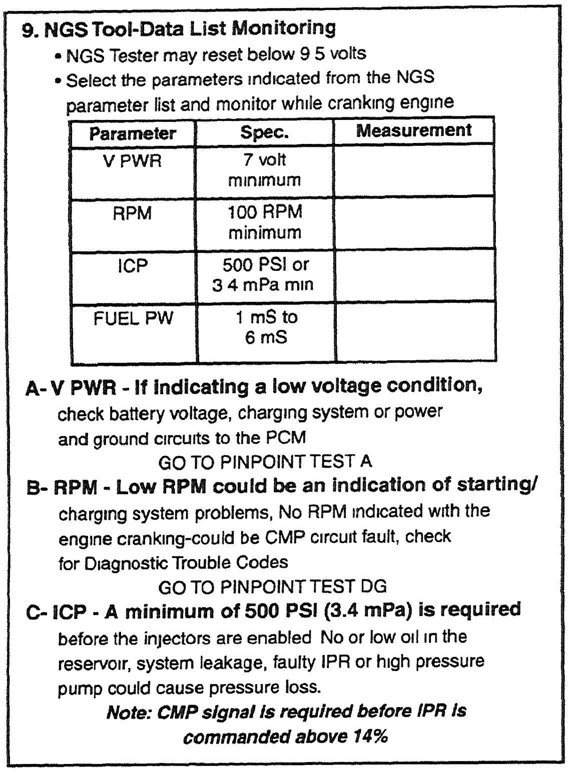
New Generation Star (NGS) Tester 007-00500 or equivalent

Hard Start/No Start Diagnostic Procedures

9c. Monitor ICP While Cranking

Purpose:

To determine if the injection control system can supply enough injection control pressure to sustain starting.



9. NGS Tool-Data List Monitoring

- NGS Tester may reset below 9 5 volts
- Select the parameters indicated from the NGS parameter list and monitor while cranking engine

Parameter	Spec.	Measurement
V PWR	7 volt minimum	
RPM	100 RPM minimum	
ICP	500 PSI or 3 4 mPa min	
FUEL PW	1 mS to 6 mS	

A- V PWR - If indicating a low voltage condition, check battery voltage, charging system or power and ground circuits to the PCM

GO TO PINPOINT TEST A

B- RPM - Low RPM could be an indication of starting/ charging system problems, No RPM indicated with the engine cranking-could be CMP circuit fault, check for Diagnostic Trouble Codes

GO TO PINPOINT TEST DG

C- ICP - A minimum of 500 PSI (3.4 mPa) is required before the injectors are enabled No or low oil in the reservoir, system leakage, faulty IPR or high pressure pump could cause pressure loss.

Note: CMP signal is required before IPR is commanded above 14%

DA1459-A

Recommended Procedure:

Install NGS Tester. Access ICP and IPR PIDs on NGS Tester, and monitor PID readings while cranking the engine.

NOTE: CMP signal is required before IPR is commanded above 14%.

If ICP does not meet the minimum specification of 3450 kPa (500 psi), the injectors will not be enabled by the PCM because of insufficient rail pressure.

If IPR goes above 14%, ICP pressure should easily go above 3450 kPa (500 psi) provided that the oil reservoir is full, the IPR valve is not stuck open, the high pressure pump is building pressure and there is not an injection control pressure leak between the high pressure pump and all of the injectors.

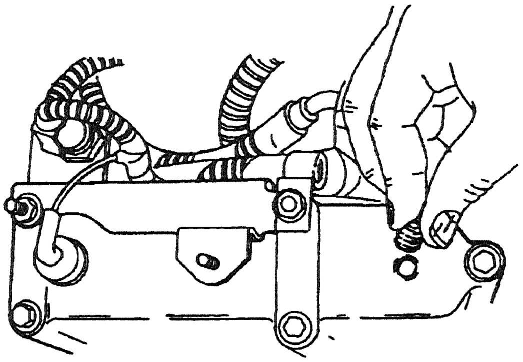
Hard Start/No Start Diagnostic Procedures

Possible Causes:

- Injection control pressure system leak
- Oil reservoir level low
- IPR failure
- Faulty high pressure pump
- Injector O-ring leaking

Injection Control Pressure Leak Test

Removing the ICP sensor and inspecting the level in the oil rail will determine if oil is being supplied to the rail. Removing the inspection plug in the top of the reservoir will help determine if the reservoir is full. A reservoir that drains back after the engine has not been operated for a long period of time can cause a hard start condition. If reservoir empties after filling, verify it is being supplied oil from the low pressure oiling system.



A23394-A

Purpose:

Isolate the cause of low injection control pressure.

Hard Start/No Start Diagnostic Procedures

Recommended Procedure:

Right Cylinder Head Check

Remove the high pressure hose from the right cylinder head and cover the fitting on the cylinder head with the appropriate cap from the Fuel/Oil/Turbo Protector Cap Set T94T-9395-AH. Install the plug from the Oil High Pressure Leakage Test Adapter Set D94T-6600-A into the high pressure hose to block it off. Connect the ICP/EBP Adapter Cable D94T-50-A to the ICP sensor. Connect a digital multimeter between signal return and ICP signal wires on the ICP/EBP Adapter Cable D94T-50-A. Crank the engine and monitor the signal. The digital multimeter should read 1 to 4 volts.

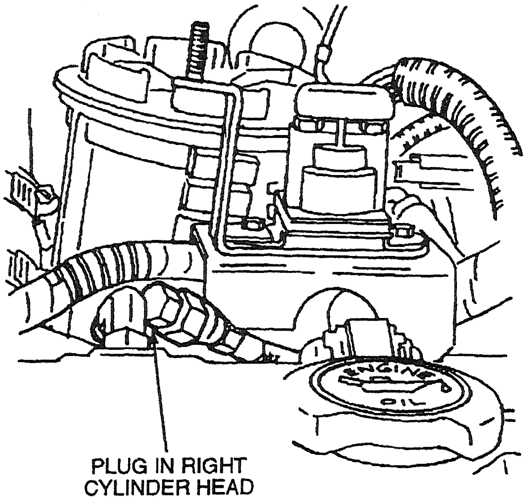
CAUTION

The engine may start!

If the engine starts or if injection control pressure is now within specification, the injection control pressure leak has been isolated to the right cylinder head. Inspect the fuel to see if oil is in the fuel. If no oil is present in the fuel, remove the valve cover, crank the engine and inspect the injector body and injector bore area for leakage.

CAUTION

Oil is under high pressure!



Hard Start/No Start Diagnostic Procedures

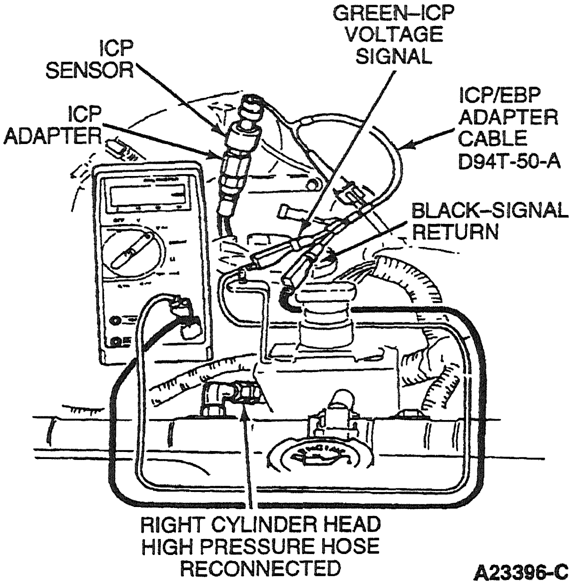
Left Cylinder Head Check

Remove the cap and plug, then reinstall the high pressure hose to the right cylinder head. Remove the high pressure hose from the left cylinder head and cover the fitting on the cylinder head with the appropriate cap from the Fuel / Oil / Turbo Protector Cap Set T94T-9395-AH. Install the ICP adapter from the Oil High Pressure Leakage Test Adapter Set D94T-6600-A into the high pressure hose. Remove the ICP sensor and install the sensor in the end of the ICP adapter. Connect the ICP / EBP Adapter Cable D94T-50-A to the ICP sensor. Connect a digital multimeter between the signal return and ICP signal wires of the ICP / EBP Adapter Cable D94T-50-A. Crank the engine and monitor the signal. The digital multimeter should read 1 to 4 volts.

CAUTION

The engine may start!

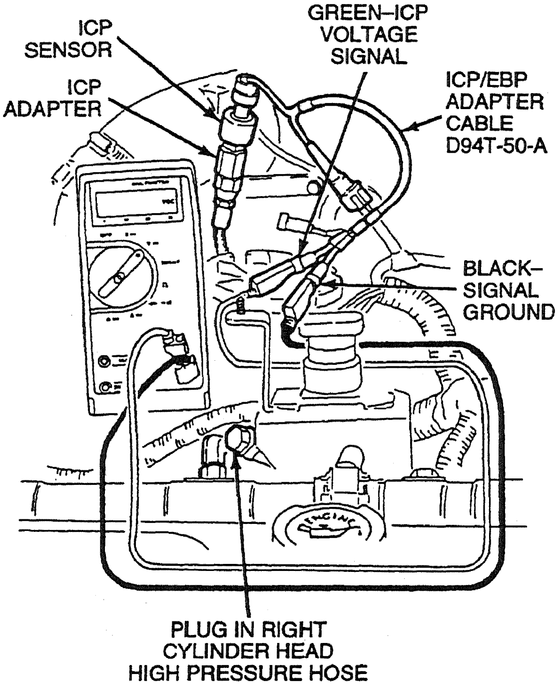
If the engine starts or if injection control pressure is now within specification, the injection control pressure leak has been isolated to the left cylinder head.



Hard Start/No Start Diagnostic Procedures

IPR and High-Pressure Pump Test

If injection control pressure is still low after ruling out both cylinder heads as the source of injection control pressure leakage, perform the following steps to isolate the cause. Leave the ICP sensor and ICP adapter connected to the left high-pressure hose. Remove the high-pressure hose from the right cylinder head and cover the fitting on the cylinder head with the appropriate cap from the Fuel / Oil / Turbo Protector Cap Set T94T-9395-AH. Install the plug from the Oil High Pressure Leakage Test Adapter Set D94T-6600-A into the high-pressure hose to block it off. With the high-pressure pump effectively deadheaded, crank the engine and monitor the signal. If injection control pressure is not within specification, replace the Injection Pressure Regulator (IPR) with a known good IPR and retest. If a low pressure condition still exists, the problem is most likely with the high-pressure pump or the high-pressure pump drive gear.



A25052-A

Tools Required:

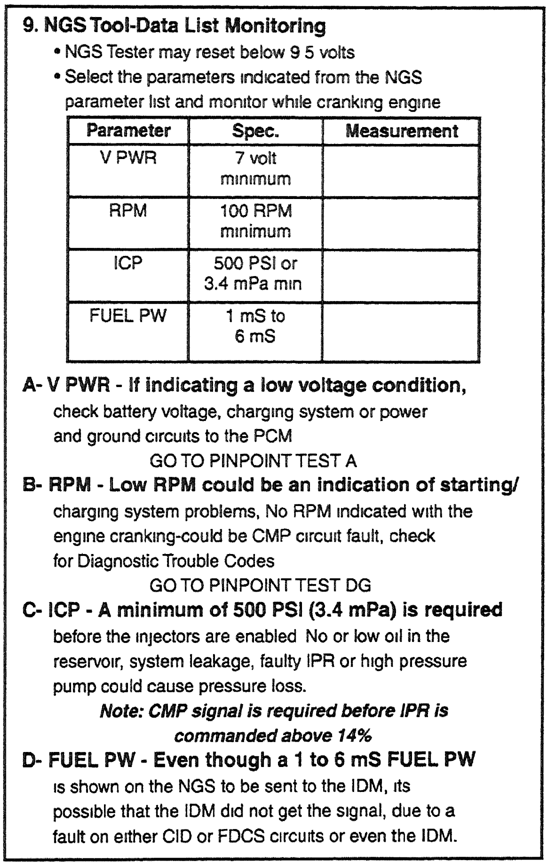
- Fuel / Oil / Turbo Protector Cap Set T94T-9395-AH
- ICP / EBP Adapter Cable D94T-50-A
- Oil High Pressure Leakage Test Adapter Set D94T-6600-A
- 23 Multimeter 105-00050 or equivalent
- 1/4-inch drive ratchet or breaker bar to remove inspection plug

Hard Start/No Start Diagnostic Procedures

9d. Check Fuel Pulse Width (FUEL PW) While Cranking

Purpose:

To verify that the Fuel Delivery Command Signal (FDCS) system is functioning correctly.



9. NGS Tool-Data List Monitoring

- NGS Tester may reset below 9 5 volts
- Select the parameters indicated from the NGS parameter list and monitor while cranking engine

Parameter	Spec.	Measurement
V PWR	7 volt minimum	
RPM	100 RPM minimum	
ICP	500 PSI or 3.4 mPa min	
FUEL PW	1 mS to 6 mS	

A- V PWR - If indicating a low voltage condition, check battery voltage, charging system or power and ground circuits to the PCM

GO TO PINPOINT TEST A

B- RPM - Low RPM could be an indication of starting/ charging system problems, No RPM indicated with the engine cranking-could be CMP circuit fault, check for Diagnostic Trouble Codes

GO TO PINPOINT TEST DG

C- ICP - A minimum of 500 PSI (3.4 mPa) is required before the injectors are enabled No or low oil in the reservoir, system leakage, faulty IPR or high pressure pump could cause pressure loss.

Note: CMP signal is required before IPR is commanded above 14%

D- FUEL PW - Even though a 1 to 6 mS FUEL PW is shown on the NGS to be sent to the IDM, its possible that the IDM did not get the signal, due to a fault on either CID or FDCS circuits or even the IDM.

DA1460-A

Recommended Procedure:

Install NGS Tester. Access FUEL PW PID on NGS Tester and monitor while cranking engine.

No fuel command signal when ICP, RPM and VPWR signals are correct usually indicates a loss of CMP sync signal. Refer to Pinpoint Test DG for CMP sensor diagnosis.

Hard Start/No Start Diagnostic Procedures

A 1-6 mS fuel pulse width (FUEL PW) will be sent by the PCM to the IDM if system voltage does not go below 7 volts during cranking, engine cranking speed is above 100 rpm and injection control pressure is above 3450 kPa (500 psi). Even though a 1-6 mS fuel pulse width is shown on the NGS to be sent to the IDM, it is possible the IDM did not get the signal, due to a fault on either the CID or FDCS circuits or even the IDM. Note that low fuel pressure or no glow plugs could still be the cause of the No Start or Hard Start condition. A 0.42-ms fuel pulse width (a no fueling pulse) will be sent by the PCM when a sync pulse has been received from the CMP sensor and if insufficient injection control pressure is present. This 0.42-ms fuel pulse width will not allow injectors to be enabled, but does keep the IDM and PCM synchronized until sufficient injection control pressure is realized.

Possible Causes:

- FDCS and CID circuitry
- PCM
- IDM

Tools Required:

New Generation Star (NGS) Tester 007-00500 or equivalent

Hard Start/No Start Diagnostic Procedures

10. Glow Plug System Operation

Purpose:

To determine if the glow plug system operation is sufficient to permit starting.

Hard Start/No Start Diagnostic Procedures

Econoline

Note: A hard start/no start concern with EOT temp. below 60 F perform this Test Step first.

10. Glow Plug System Operation

Relay Operation

- Glow Plug ON time is dependent on oil temperature and altitude. The Glow Plug relay comes on between 1 to 120 sec. and does not come on at all if oil Temp is above 86 F
- Verify that B+ is being supplied on the large BK/W wire going to the Glow Plug relay.
- Install a voltmeter to the glow plug feed terminal (terminal with two brown wires) or (center terminal on the shunt for California)
- Turn key to run position, measure "ON" time
- Using the NGS GPCTM and EOT pids, verify sufficient glow plug "ON" time and voltage.

(Dependent on oil temperature and altitude)

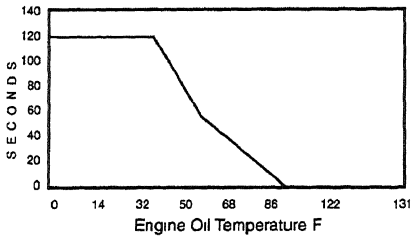
9 -12 volts	Spec.	Measurement
Relay On time	1 to 120 seconds	

Note: Wait to Start Lamp "On" time (1-10 sec.) is independent from Glow Plug Relay "On" time

Glow Plug Operation

- Measure Glow Plug Resistance to Bat Ground
- Remove all glow plug/injector connectors
- Measure GP Harness Resistance to Relay.

Glow Plug Number	Glow Plug to Ground .1 to 2 ohms	Connector to Relay 0 to 1 ohms
#1		
#3		
#5		
#7		
#2		
#4		
#6		
#8		



- Add 5 seconds to glow plug on time when above 7000 feet in altitude, but not to exceed 120 seconds

F-Series

Note: A hard start/no start concern with EOT temp. below 60 F perform this Test Step first.

10. Glow Plug System Operation

Relay Operation

- Glow Plug ON time is dependent on oil temperature and altitude The Glow Plug relay comes on between 1 to 120 sec. and does not come on at all if oil Temp is above 131 F
- Verify that B+ is being supplied on the large BK/W wire going to the Glow Plug relay.
- Install a voltmeter to the glow plug feed terminal (terminal with two brown wires) or (center terminal on the shunt for California).
- Turn key to run position, measure "ON" time
- Using the NGS GPCTM and EOT pids, verify sufficient glow plug "ON" time and voltage.

(Dependent on oil temperature and altitude)

9 -12 volts	Spec.	Measurement
Relay On time	1 to 120 seconds	

Note: Wait to Start Lamp "On" time (1-10 sec.) is independent from Glow Plug Relay "On" time

Glow Plug Operation

- Measure Glow Plug Resistance to Bat Ground
- Remove all glow plug/injector connectors
- Measure GP Harness Resistance to Relay.

Glow Plug Number	Glow Plug to Ground .1 to 2 ohms	Connector to Relay 0 to 1 ohms
#1		
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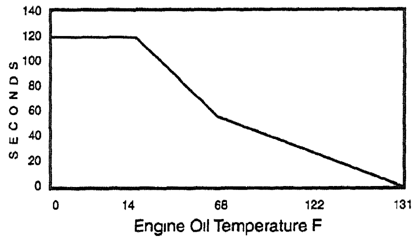


- Add 5 seconds to glow plug on time when above 7000 feet in altitude, but not to exceed 120 seconds.

DA1481-A

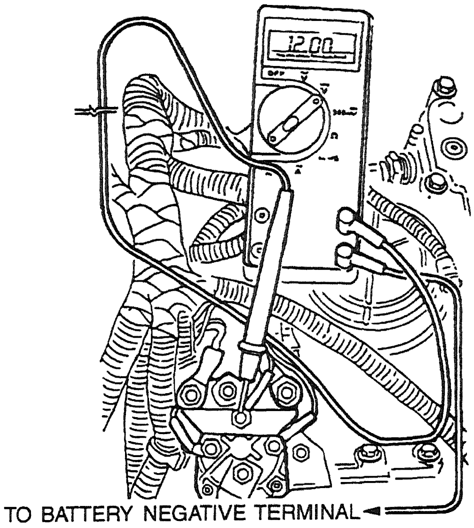
Hard Start/No Start Diagnostic Procedures

Recommended Procedure:

Relay Operation

Install a digital multimeter on the glow plug feed side of the glow plug relay (large stud with two wires connected). Turn the ignition key to the ON position but do not attempt to start. Note the time in seconds from when the key is turned on and the glow plug relay energizes until the glow plug relay de-energizes. The relay does not come on if EOT is above 55°C (131°F) for F-Series and 30°C (86 °F) for Econoline. The glow plug relay makes a loud click noise which is easily heard when it energizes and de-energizes. The dome light will dim and the dash voltmeter will dip when the glow plugs are drawing current from the battery. Compare the times measured to the table (time will be affected by engine temperature, battery condition and vehicle altitude). The voltage at the glow plug feed terminal may vary from 9 to 12 volts depending upon battery condition.

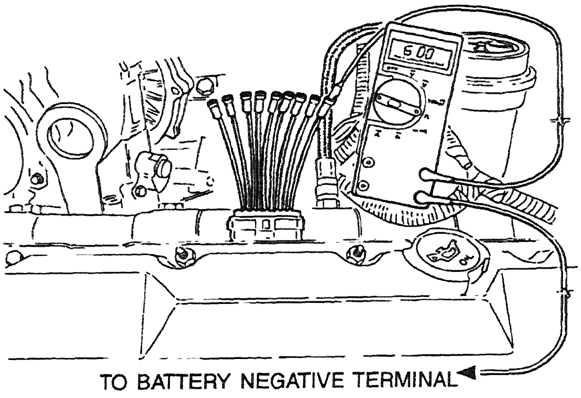
If battery voltage is not present, check for B+ at the power supply terminal (terminal with single large wire). Power for glow plug power supply is supplied from the starter relay through two fusible links at solenoid.



DA1499-A

Hard Start/No Start Diagnostic Procedures

Disconnect all of the glow plug/injector harness connectors from the valve cover gaskets. With the Rotunda Glow Plug Injector Adapter 014-00935 or equivalent installed, measure glow plug resistance to ground (preferably B-). A resistance measurement of 0.1-2 ohms indicates a good glow plug.



DA1500-A

Glow Plug Harness Continuity

Measure for continuity from the connector harness to the glow plug feed terminal on the glow plug relay. Resistance should be less than 0.1-1 ohm.

California Only

For California only, the glow plug system monitor will start when the glow plugs are commanded on for over 35 seconds and the battery voltage is between 11.5-14 volts. A glow plug code will be stored in continuous memory if one or more glow plugs are not being powered.

NOTE: Look very carefully for poor connections, burnt looking or loose fitting pins that will cause high resistance and set a code.

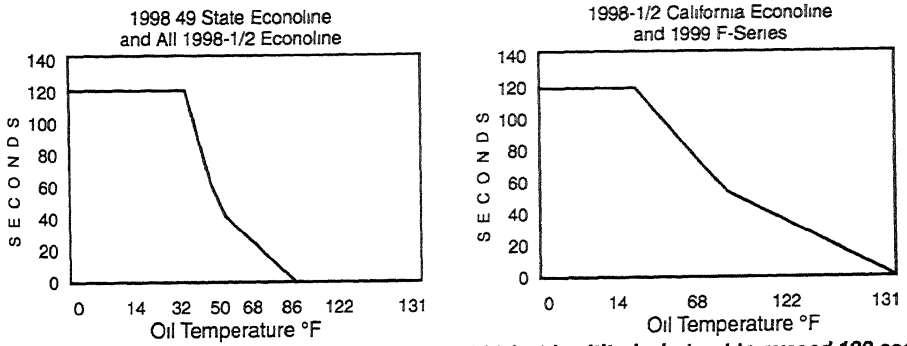
The Glow Plug Monitor Self Test (California only) is a functional test of the PCM performed on demand with the engine running and the A/C off. The test will raise engine speed to 1200 rpm to maintain a system voltage of 11.5-14 V. The PCM will activate the glow plug relay and monitor the glow plug circuits. A fault must be present at the time of testing for the test to detect a fault. If one bank is reading less than 32 amps or one bank is reading at least 8-1/2 amps lower than the other bank, a fault will be detected and a Diagnostic Trouble Code (DTC) will be output on the data link at the end of the test when requested by a scan tool. Only a hard fault code (DTC) will be displayed.

California or 49-State

The glow plug on time is dependent on oil temperature and altitude. The glow plug relay comes on between 1-120 seconds and does not come on at all if oil temperature is above 30°C (86°F) for Econoline or 55 °C (131 °F) for F-Series. By using the NGS you can run the Output State Self Test which will cycle the glow plug relay on for 5 seconds the first time only that the accelerator pedal is pressed. This self test does not set any codes.

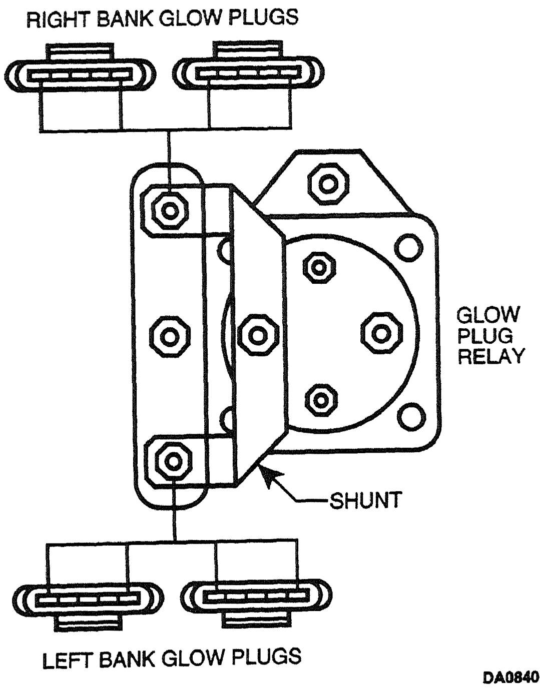
Hard Start/No Start Diagnostic Procedures

You can verify glow plug on time (and amps for California) by monitoring NGS PIDS: EOT, GPCTM (California GPMR and GPML). The wait to start lamp ON time (1-10 seconds) is independent from glow plug relay ON time.



Note: Add 5 seconds to glow plug on time when above 7000 feet in altitude, but not to exceed 120 seconds. DA1462-A

Incorrect measurements will result if all glow plug/injector connectors to valve cover are not disconnected.



DA0840-A

Hard Start/No Start Diagnostic Procedures

Possible Causes:

Insufficient glow plug ON time will not allow enough heat to accumulate in the combustion chamber to easily facilitate starting. If the glow plug system ON time does not meet any of the specifications in the accompanying chart the problem is most likely a faulty wire harness connection, ground connections or glow plug relay.

NOTE: Look very carefully for poor connections, burnt looking or loose fitting pins that will cause high resistance.

- Glow plug relay.
- Powering circuit to glow plug relay (fusible links from starter relay) .
- Glow plug relay to valve cover connector circuits.
- Valve cover gasket.
- Under valve cover (UVC) harness.
- Glow plugs.

Tools Required:

- 23 Multimeter 105-00050 or equivalent
- Glow Plug Injection Adapter 014-00935 or equivalent
- New Generation Star (NGS) Tester 007-00500 or equivalent

Performance Diagnostic Procedures

Econoline Performance Diagnostics

1. Visual Engine/Chassis Inspection

- Verify that there are no fluid, vacuum or pressure hose leaks
- Inspect all wire connection for damage

Fuel Oil Coolant Electrical Hoses Leaks MAP hose open, pinched or Intake leaks	
Method	**Check**
Visual	

2. Sufficient Clean Fuel

- Check fuel tank, drain sample from fuel filter while cranking engine

Method	Check
Visual	

3. Check Engine Oil Level

- Check for contaminants (fuel, coolant)
- Correct Grade/Viscosity
- Miles/hours on oil, correct level

Method	Check
Visual	

4. Intake Restriction

- Check filter minder
- or Measure at WOT w/magnehelic gauge

Instrument	Check
Magnehelic/ Filter Minder	

5. Perform KOEO On Demand Test

- Use NGS Tester
- Diagnostic Trouble Codes set during this test are current faults

Pass Code = P1111 or System Passed

Diagnostic Trouble Codes	

6. Retrieve Continuous Trouble Codes

- Use NGS Tester
- Diagnostic Trouble Codes retrieved during this test are historical faults.

Pass Code = P1111 or System Passed

Diagnostic Trouble Codes	

7. KOEO Injector Electrical Self-Test

- Use NGS Tester
- All injectors will momentarily buzz, then individual injectors will buzz in sequence 1 through 8

Pass Code = P1111 or System Passed

Injector Trouble Codes	

8a. Electric Fuel Pump Inlet Restriction

- Verify that fuel is in the tank and the pump is being powered
- Measure WOT at fuel inlet to Electric fuel pump for restriction

Instrument	Spec	Measurement
0-30" Hg vacuum g	6" Hg	

» If fuel feed line is restricted above 6" Hg, check for blockage between pump and fuel tank

8b. Electric Fuel Pump Pressure

- Measure at fuel outlet from Electric fuel Pump
- Road Test - select appropriate gear to obtain a full load on the engine

Instrument	Spec.	Measurement
0-160 PSI Gauge	30-80 PSI	

If fuel pressure fails low, inspect regulator valve condition and for debris, If OK replace pump.

8c. Fuel Pressure at the left head

- Measure fuel pressure at the rear of the left head
- Road Test - select appropriate gear to obtain a full load on the engine

Instrument	Spec.	Measurement
0-160 PSI Gauge	30-80 PSI	

If fuel pressure fails low, Replace fuel filter, Retest, If still fails, Replace left check valve.

8d. Fuel Pressure at the right head

- Measure fuel pressure at the front of right head
- Test under full load, but don't brake torque engine any longer than 10 sec

Instrument	Spec	Measurement
0-160 PSI Gauge	30-80 PSI	

If fuel pressure fails low, Replace right check valve.

9. Perform KOER On Demand Test

- Select KOER test from NGS test menu

Pass Code = P1111 or System Passed

KOER DTCs	

10a. Injection Control Pressure Tests (Oil Aeration - Poor Idle quality)

- All acc off, Monitor ICP and RPM with NGS Tester
- Hold engine speed at 3400 RPM for 3 minutes

Parameter	High RPM	Measurement
ICP	750 to 1250 PSI @ 3400 RPM	

» If ICP signal increases above 1250 PSI after 3 minutes anti-foam oil additives may have become depleted from oil, change oil and re-test

10b. Low Idle Stability (ICP Pressure)

- Check at low idle
- Monitor ICP and RPM with the NGS Tester

Low Idle

Parameter	Spec. @ 650 RPM	Measurement
ICP	400 to 600 PSI	

If engine RPM is unstable, disconnect the ICP sensor.

» If idle speed still unstable, change IPR retest

» if low idle smooths out, ICP signal faulty (See ICP circuit diagnostics)

11. Crankcase Pressure Test

- Assure engine is at normal operating temp
- Measure at oil fill with adapter and orifice tool P N 5631 & 014-00743 installed
- Measure at WOT under no load

Parameter	Spec.	Measurement
Magnehelic 0 to 60" H^20	less than 4" H^20	

If more then 3" H^20, Refer base engine in Shop Manual

12. Cylinder Contribution Test

- Ensure that EOT is at above 70 F min Automatic Vehicles Set parking brake and place Trans in drive
- Turn A/C and all accessories off
- Select Cylinder Contribution from the test menu

CCT Trouble Codes	

13. Exhaust Restriction

- Visually inspect exhaust system for damage
- Verify EBP device is open at WOT in park or neutral
- Monitor EBP with the NGS Tester with the engine temperature at 170°F minimum at 3400 RPM

Parameter	Spec.	Measurement
EBP	34 PSI MAX @ 3400 RPM	

14. Boost Pressure Test

- Verify that MAP hose is not open, plugged or pinched
- Monitor MGP (manifold gauge pressure) and RPM with the NGS Tester
- Road Test - select appropriate gear to obtain desired engine speed at full load throttle position Best accomplished climbing hill or truck fully loaded

Parameter	Spec.	Measurement
MGP	13 PSIG MIN	

Measure between 2500 to 3000 RPM

DA1482-A

Performance Diagnostic Procedures

F-Series Performance Diagnostics

1. Visual Engine/Chassis Inspection

- Verify that there are no fluid, vacuum or pressure hose leaks
- Inspect all wire connection for damage
- Inspect MAP, WGC, Inner cooler hoses and intake for leaks

Fuel Oil Coolant Electrical Hoses Leaks	
Method	**Check**
Visual	

2. Sufficient Clean Fuel

- Check fuel tank, drain sample from fuel filter while cranking engine

Method	Check
Visual	

3. Check Engine Oil Level

- Check for contaminants (fuel, coolant)
- Correct Grade/Viscosity
- Miles/hours on oil, correct level

Method	Check
Visual	

4. Intake Restriction

- Check filter minder
- or Measure at WOT w/magnehelic gauge

Instrument	Check
Magnehelic/ Filter Minder	

5. Perform KOEO On Demand Test

- Use NGS Tester
- Diagnostic Trouble Codes set during this test are current faults

Pass Code = P1111 or System Passed

Diagnostic Trouble Codes	

6. Retrieve Continuous Trouble Codes

- Use NGS Tester
- Diagnostic Trouble Codes retrieved during this test are historical faults

Pass Code = P1111 or System Passed

Diagnostic Trouble Codes	

7. KOEO Injector Electrical Self-Test

- Use NGS Tester
- All injectors will momentarily buzz, then individual injectors will buzz in sequence 1 through 8

Pass Code = P1111 or System Passed

Injector Trouble Codes	

8a. Electric Fuel Pump Inlet Restriction

- Verify that fuel is in the tank and the pump is being powered
- Measure WOT at fuel inlet to Electric fuel pump for restriction

Instrument	Spec.	Measurement
0-30" Hg vacuum g	6" Hg	

» If fuel feed line is restricted above 6" Hg, check for blockage between pump and fuel tank

8b. Electric Fuel Pump Pressure

- Measure at fuel outlet from Electric fuel pump
- Road Test - select appropriate gear to obtain a full load on the engine

Instrument	Spec	Measurement
0-160 PSI Gauge	30-80 PSI	

If fuel pressure falls low, Inspect regulator valve condition and for debris, if OK replace pump

8c. Fuel Pressure at the right head

- Measure fuel pressure at the front of right head
- Road Test - select appropriate gear to obtain a full load on the engine

Instrument	Spec	Measurement
0-160 PSI Gauge	30-80 PSI	

If fuel pressure falls low, Replace fuel filter, Retest, if still fails, Replace right check valve.

8d. Fuel Pressure at the left head

- Measure fuel pressure at the rear of left head
- Road Test - select appropriate gear to obtain a full load on the engine

Instrument	Spec	Measurement
0-160 PSI Gauge	30-80 PSI	

If fuel pressure falls low, replace left check valve.

9. Perform KOER On Demand Test

- Select KOER test from NGS test menu

Pass Code = P1111 or System Passed

KOER DTCs	

10a. Injection Control Pressure Tests (Oil Aeration - Poor idle quality)

- All acc off, Monitor ICP and RPM with NGS Tester
- Hold engine speed at 3400 RPM for 3 minutes

Parameter	High RPM	Measurement
ICP	750 to 1250 PSI @ 3400 RPM	

» If ICP signal increases above 1250 PSI after 3 minutes anti-foam oil additives may have become depleted from oil, change oil and re-test

10b. Low Idle Stability (ICP Pressure)

- Check at low idle
- Monitor ICP and RPM with the NGS Tester

Low Idle

Parameter	Spec. @ 650 RPM	Measurement
ICP	400 to 600 PSI	

If engine RPM is unstable, disconnect the ICP sensor.

» If idle speed still unstable, change IPR, retest

» If low idle smooths out, ICP signal faulty (See ICP circuit diagnostics)

11. Crankcase Pressure Test

- Assure engine is at normal operating temp
- Measure at oil fill with adapter and orifice tool PN 5631 & 014-00743 installed
- Measure at WOT under no load

Parameter	Spec.	Measurement
Magnehelic 0 to 60" H_2O	less than 4" H_2O	

If more then 3" H_2O, Refer base engine in Shop Manual

12. Cylinder Contribution Test

- Ensure that EOT is at above 70 F min
- Automatic Vehicles Set parking brake and place Trans in drive
- Turn A/C and all accessories off
- Select Cylinder Contribution from the test menu

CCT Trouble Codes	

13. Exhaust Restriction

- Visually inspect exhaust system for damage
- Verify EBP device is open at WOT in park or neutral
- Monitor EBP with the NGS Tester with the engine temperature at 170°F minimum at 3400 RPM

Parameter	Spec.	Measurement
EBP	34 PSI MAX @ 3400 RPM	

14. Boost Pressure Test

- Verify that MAP hose is not open, plugged or pinched
- Verify that inner cooler hoses or intake are not leaking
- Verify that the green Waste gate hose is not plugged
- Monitor MGP (manifold gauge pressure) and RPM with the NGS Tester
- Road Test - select appropriate gear to obtain desired engine speed at full load throttle position Best accomplished climbing hill or truck fully loaded

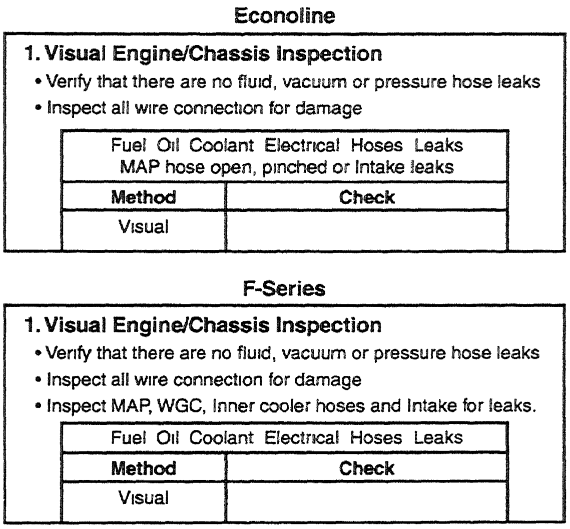
Parameter	Spec. PSIG	Measurement
MGP	16 PSIG	

Measure between 2500 to 3000 RPM

DA1483-A

Performance Diagnostic Procedures

1. Visual Engine/Chassis Inspection



Econoline

1. Visual Engine/Chassis Inspection

- Verify that there are no fluid, vacuum or pressure hose leaks
- Inspect all wire connection for damage

Fuel Oil Coolant Electrical Hoses Leaks MAP hose open, pinched or Intake leaks	
Method	**Check**
Visual	

F-Series

1. Visual Engine/Chassis Inspection

- Verify that there are no fluid, vacuum or pressure hose leaks
- Inspect all wire connection for damage
- Inspect MAP, WGC, Inner cooler hoses and Intake for leaks.

Fuel Oil Coolant Electrical Hoses Leaks	
Method	**Check**
Visual	

DA1484-A

Purpose:

This is a visual inspection to check the general condition of the engine and chassis. Look for obvious causes of a loss in performance.

Recommended Procedure:

- Inspect for a hole in the MAP sensor hose or a pinched hose.
- Inspect fuel system, including the fuel tank, fuel pump, fuel filter housing and fuel lines, for kinks, bends or leakage.
- Inspect oil lines and high pressure oil pump in engine V for major oil leaks.
- Inspect for coolant leaks at the radiator and coolant hoses. Also check coolant level.
- Inspect wiring for correct routing, and make sure no rubbing or chafing has occurred.
- Inspect all sensors, and make sure outputs from the PCM are properly connected.

Added Checks (F-Series):

- Inspect intercooler hoses for leaks.
- Inspect wastegate control solenoid and hoses.

Performance Diagnostic Procedures

2. Sufficient Clean Fuel

Purpose:

The purpose of this test is to see if the fuel system is getting sufficient clean fuel to operate correctly.

2. Sufficient Clean Fuel

- Check fuel tank, drain sample from fuel filter while cranking engine.

Method	Check
Visual	

DA1485-A

Recommended Procedure:

Route a hose from the fuel drain line to a clear container and open the drain. Idle the engine and observe the fuel flowing into the container. Shut the engine off when the container is half full.

Observe WATER IN FUEL light while cranking. If the lamp is illuminated the fuel is probably contaminated with water.

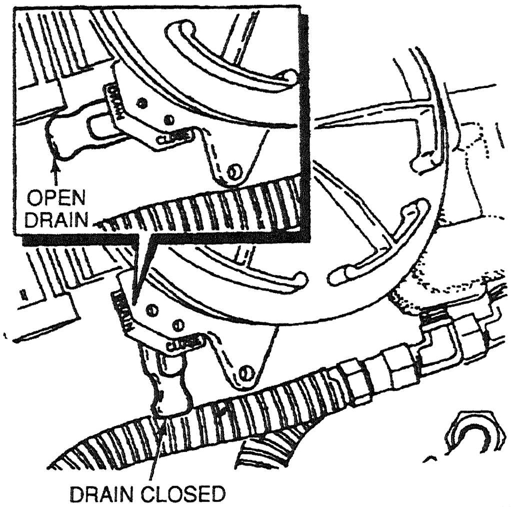
Flow out of the drain should be a steady stream. Insufficient flow could indicate fuel supply or fuel system problems.

Inspect fuel in the container, it should be straw colored but not cloudy. It also should be free of water and contaminants. Dyed red or blue fuel indicates off-highway fuel.

If engine oil is present in the fuel it may indicate an injector O-ring leak and subsequent loss of rail pressure. If that is suspected, check rail pressure during engine cranking (refer to Hard Start / No Start Diagnostic Procedures Step 9C).

Performance Diagnostic Procedures

Some sediment and water may be present in the fuel sample if the fuel filter has not been serviced for a prolonged period of time and/or if the sediment and water have not been drained recently. If that is the case a second sample may be required to determine fuel quality.



A23400-B

Possible Causes:

- No fuel in tank.
- If equipped with a fuel line valve, it could be shut off.
- If equipped with dual tanks, the switch valve could be faulty.
- Fuel supply line could be broken or crimped.
- Fuel could be jelled (most likely in cold weather with No. 2 fuel).
- Pickup tube screen in tank could be clogged.

Cloudy fuel indicates that the fuel may not be a suitable grade for cold temperatures. Excessive water or contaminants may indicate that the tank and fuel system may need to be flushed and cleaned.

Tools Required:

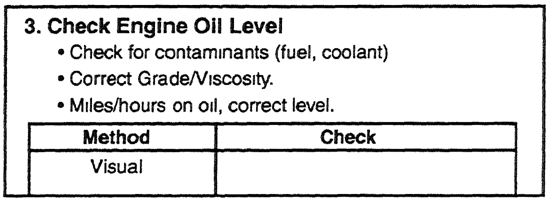
Clear container — approximately 1-quart

Performance Diagnostic Procedures

3. Check Engine Oil Level

Purpose:

To determine if there is enough oil or oil of sufficient quality to operate the injectors.



3. Check Engine Oil Level

- Check for contaminants (fuel, coolant)
- Correct Grade/Viscosity.
- Miles/hours on oil, correct level.

Method	Check
Visual	

DA1466-A

Recommended Procedure:

Check oil level with oil level dipstick. If there is no oil or very little oil in the crankcase, the injectors will not operate.

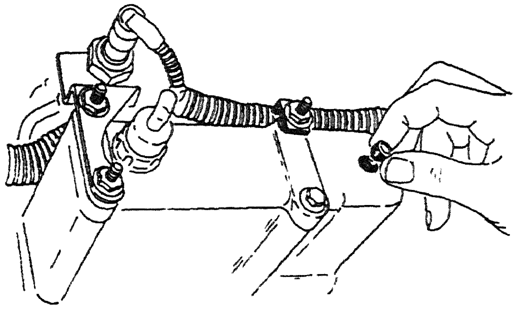
If the oil level is overfull, it is possible the engine was incorrectly serviced or fuel is diluting the oil and filling the crankcase. If a substantial amount of fuel is in the oil, it will have a fuel odor.

Inspect oil for color. A milky white oil indicates possible coolant contamination which will have an ethylene glycol odor.

Check service records for correct oil type and viscosity for the vehicle operating temperature. Single weight or 15W-40 oil is not recommended for cold ambient temperatures. 10W-30 oil is recommended for cold ambient temperatures. Oil that has had extended drain intervals will have increased viscosity (become thicker) and will make engine cranking more difficult and starting less reliable at temperatures below freezing. Refer to the lube oil chart in the service manual or operator's manual for the correct oil selection for temperature conditions.

Performance Diagnostic Procedures

The level in the oil reservoir should also be checked. Remove the inspection plug in top of reservoir and check to see if the oil reservoir is full (a reservoir that drains back after the engine has not been operated for a period of time can cause a hard start or a start and die condition). Filling the reservoir will allow the system to prime faster, facilitating starting.



A23401-A

Possible Causes:

- Oil level low — oil leak, oil consumption, incorrect servicing
- Oil level high — incorrect servicing, fuel dilution from tandem fuel pump, fuel dilution from injector O-rings
- Oil contamination with coolant — oil cooler, head gasket, porosity
- Low reservoir level — engine built dry (not pressure lubed), prolonged period of not running, leaking check valve in high pressure pump

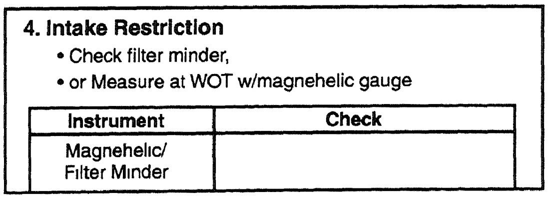
Tools Required:

1/4-inch drive ratchet or breaker bar to remove inspection plug

4. Intake Restriction

Purpose:

This is a visual inspection to determine if an air intake restriction is contributing to a low power condition. If the engine does have a high air intake restriction, a considerable amount of black or blue smoke may be produced.



4. Intake Restriction
- Check filter minder,
- or Measure at WOT w/magnehelic gauge

Instrument	Check
Magnehelic/ Filter Minder	

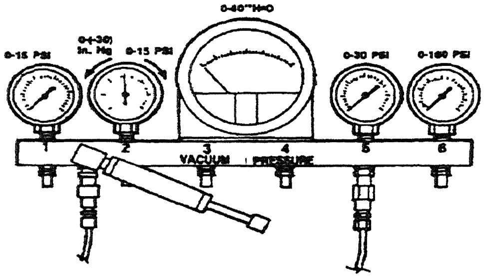
DA1467-A

Performance Diagnostic Procedures

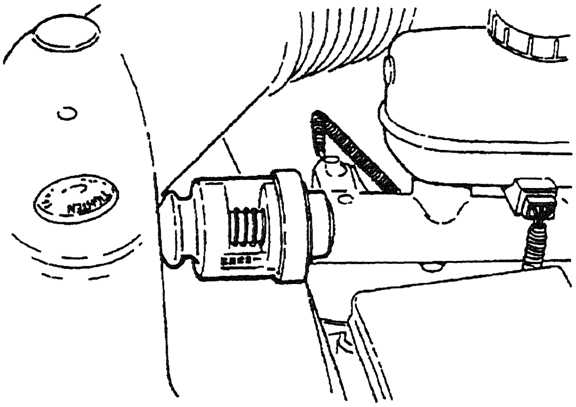
Recommended Procedure:

Inspect the air cleaner inlet and ducting to assure that it is not blocked or collapsed. Inspect the air cleaner housing and filter for proper installation.

If necessary, use Pressure Adapter Kit 014-00761 or equivalent to install a Magnehelic® gauge on the port on the air cleaner and measure restriction at high idle.



A23383-A



A23403-A

Possible Causes:

- Snow, plastic bags or other foreign material may restrict airflow at the air inlet.
- Misrouted air cleaner ducting.
- On engines recently repaired, rags or cap plugs may have been inadvertently left in an air inlet pipe.

Tools Required:

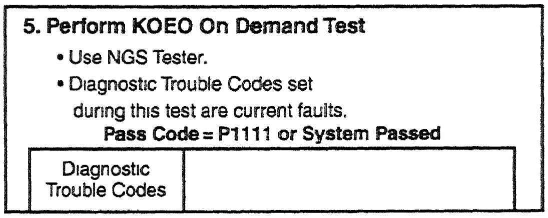
Magnehelic® gauge (part of Pressure Adapter Kit 014-00761 or equivalent)

Performance Diagnostic Procedures

5. Perform KOEO On-Demand Self Test

Purpose:

To determine if the PCM has detected any fault conditions that would cause a performance problem.



5. Perform KOEO On Demand Test

- Use NGS Tester.
- Diagnostic Trouble Codes set during this test are current faults.

Pass Code = P1111 or System Passed

Diagnostic Trouble Codes	

DA0841-B

NOTE: The IDM stores both historical and hard IDM fault codes. To retrieve IDM fault codes, you must run KOEO On-Demand Self Test or KOEO Injector Electrical Test. To ensure that the DTC is a hard fault, you must first clear Continuous DTCs (be sure to record all DTCs before clearing) even though IDM codes do not show up on the Continuous display.

Recommended Procedure:

Connect the NGS Tester to the DLC under the dash. Turn off accessories. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select KOEO ON DEMAND SELF TEST.
- Turn key on.
- Follow operating instructions from the menu.
- Record DTCs and follow appropriate pinpoint test.
- After test, cycle key to off before running other tests or driving vehicle.

If performing repeated self tests, it may be necessary to unplug glow plug relay to keep battery from going dead. Ignore any glow plug codes while glow plug relay is unplugged.

Performance Diagnostic Procedures

Tools Required:

Rotunda New Generation Star (NGS) Tester 007-00500 or equivalent

6. Retrieve Continuous DTCs

Purpose:

To determine if the PCM has detected any historical or intermittent fault conditions that would cause a performance symptom. The condition that caused a continuous DTC may no longer exist.

6. Retrieve Continuous Trouble Codes

- Use NGS Tester
- Diagnostic Trouble Codes retrieved during this test are historical faults.

Pass Code = P1111 or System Passed

Diagnostic Trouble Codes	

DA0842-B

NOTE: The IDM stores both historical and hard IDM fault codes. To retrieve IDM fault codes, you must run KOEO On-Demand Self Test or KOEO Injector Electrical Test. To ensure that the DTC is a hard fault, you must first clear Continuous DTCs (be sure to record all DTCs before clearing) even though IDM codes do not show up on the Continuous display.

Recommended Procedure:

Connect the NGS Tester to the DLC under the dash. Turn off accessories. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select RETRIEVE / CLEAR CONTINUOUS DTCs.
- Turn key on.
- Follow operating instructions from the menu.

Performance Diagnostic Procedures

- Record DTCs and follow appropriate pinpoint test for continuous code diagnostics.
- After test, cycle key to off before running other tests or driving vehicle.
- Continuous DTCs must be cleared after repair is made.

If performing repeated self tests, it may be necessary to unplug glow plug relay to keep battery from going dead. Ignore any glow plug codes while glow plug relay is unplugged.

Tools Required:

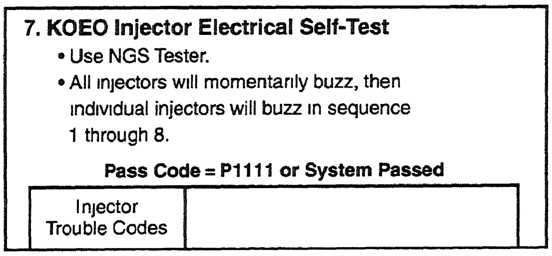
New Generation Star (NGS) Tester 007-00500 or equivalent

7. KOEO Injector Electrical Self Test

NOTE: If unable to perform KOEO Injector Electrical Self Test, disconnect IDM connector and check injector high and low sides for shorts or opens.

Purpose:

To determine if the injector solenoids and valves are operating by buzzing all injectors together, then each injector in numerical sequence (1 through 8).



7. KOEO Injector Electrical Self-Test

- Use NGS Tester.
- All injectors will momentarily buzz, then individual injectors will buzz in sequence 1 through 8.

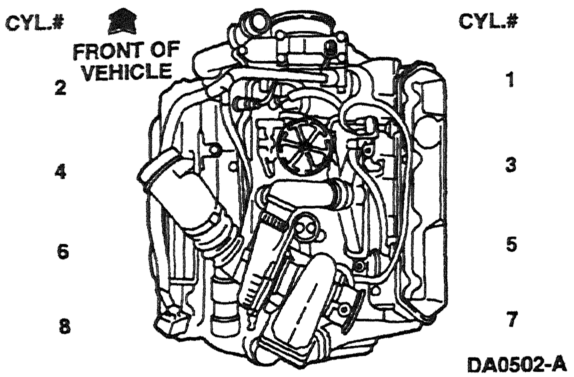
Pass Code = P1111 or System Passed

Injector Trouble Codes	

DA0843-B

Performance Diagnostic Procedures

7.3L DI Engine, Cylinder and Fuel Injector Location



This test determines if the injector circuits and solenoids are electrically operating without fault. All injectors will first buzz together for approximately 2 seconds, then each injector will buzz for approximately 1 second in numerical order (1 through 8). The IDM stores all historical IDM fault codes; to ensure that the DTC is a hard fault, you must first clear continuous DTCs (be sure to record all IDM fault codes before clearing). After clearing, rerun self test; a fault must be present at the time of testing for the KOEO Injector Electrical Self Test to detect the fault. If a fault is detected, a DTC will be output on the data link at the end of the test when requested by a scan tool. Only a hard fault code (DTC) will be displayed.

Recommended Procedure:

NOTE: If no DTCs are present and the KOEO Injector Electrical Self Test aborts while trying to perform, go to Pinpoint Test NA — Step NA29.

Connect the NGS Tester to the DLC under the dash. Turn off accessories. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select KOEO INJECTOR ELECTRICAL SELF TEST.
- Follow operating instructions from the menu.
- Record DTCs and follow appropriate pinpoint test.
- After test, cycle key to off before running other tests or driving vehicle.

Performance Diagnostic Procedures

If performing repeated self tests, it may be necessary to unplug glow plug relay to keep battery from going dead. Ignore any glow plug codes while glow plug relay is unplugged.

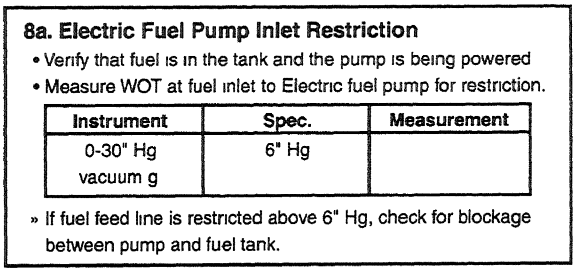
Possible Causes:

- Open injector wire
- Damaged injector connector
- Shorted wire or connector
- Open injector solenoid
- Defective IDM

Tools Required:

New Generation Star (NGS) Tester 007-00500 or equivalent

8a. Electric Fuel Pump Inlet Restriction



8a. Electric Fuel Pump Inlet Restriction

- Verify that fuel is in the tank and the pump is being powered
- Measure WOT at fuel inlet to Electric fuel pump for restriction.

Instrument	Spec.	Measurement
0-30" Hg vacuum g	6" Hg	

» If fuel feed line is restricted above 6" Hg, check for blockage between pump and fuel tank.

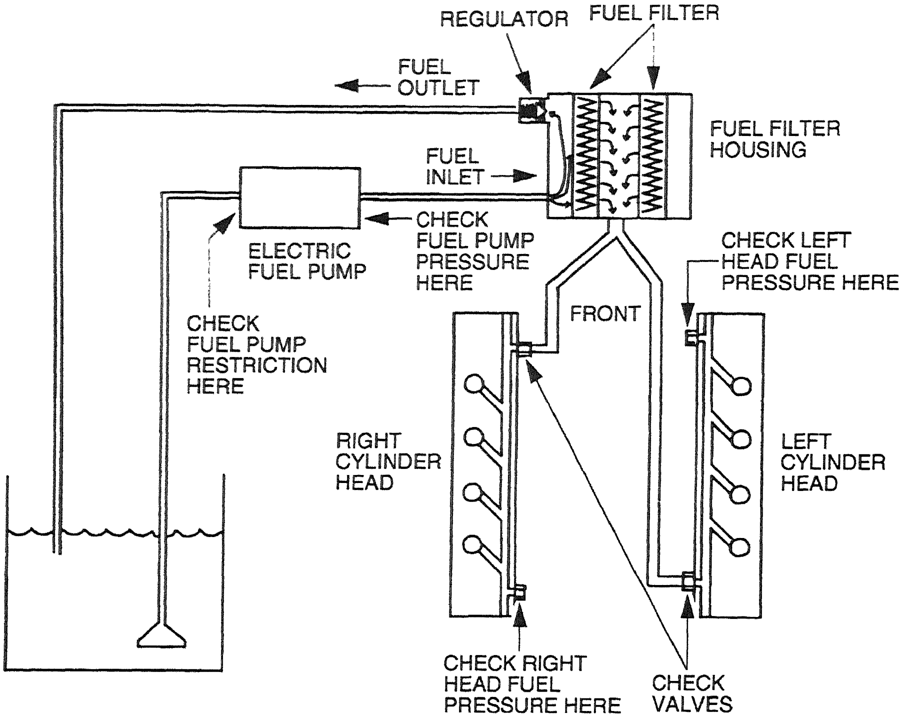
DA1486-A

Purpose:

To determine if there is excessive restriction of fuel flow between the fuel tank and the inlet line to the electric fuel pump.

Performance Diagnostic Procedures

Fuel is drawn from the fuel tank through the primary filter (the screen on the fuel tank sending unit) by the electric fuel pump. Pressurized fuel (approximately 30-80 psi) is supplied to the secondary filter (the fuel filter housing is located in the V on top of engine) by means of electric pump and regulator valve. The regulator relieves the pressure, sending fuel back to the fuel tank. Only the filtered fuel going through fuel filter will go to the heads. A check valve is located on both heads to prevent fuel pressure spikes in fuel rail.



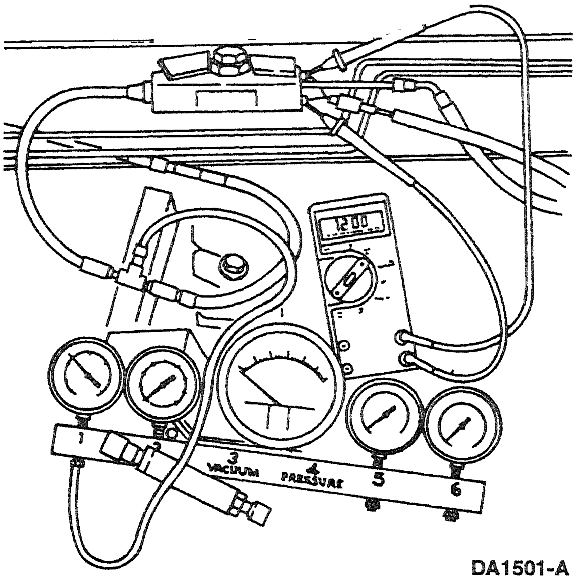
DA1521-A

Recommended Procedure:

First verify that there is fuel in the tank and battery voltage going to the fuel pump, using a digital multimeter connected between the two circuits going to the pump. Battery voltage will be present for approximately 20 seconds when the ignition key is turned on. If no voltage is present, go to Pinpoint Test FK.

Performance Diagnostic Procedures

Remove the fuel line to the inlet side of the fuel pump. Install Rotunda Low Fuel Pump Adapter 014-00931-2 or equivalent between the fuel inlet line and the electric fuel pump. Connect test adapter to gauge (0-30 in-Hg vacuum). Measure restriction at WOT (maximum engine speed out of gear with the brakes set and the wheels blocked). If restriction measures above specification (6 in-Hg), there is a blockage between the fuel pump and the fuel tank.

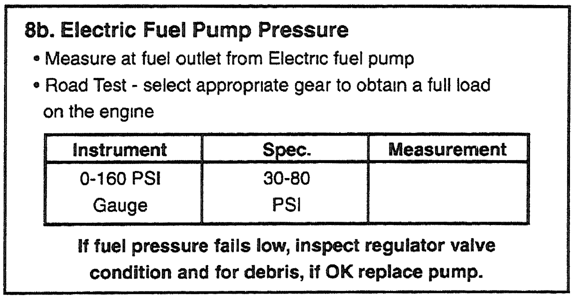


DA1501-A

Possible Causes:

- A plugged, kinked or severely bent fuel supply line.
- A plugged fuel sending unit screen.

8b. Electric Fuel Pump Pressure



8b. Electric Fuel Pump Pressure

- Measure at fuel outlet from Electric fuel pump
- Road Test - select appropriate gear to obtain a full load on the engine

Instrument	Spec.	Measurement
0-160 PSI Gauge	30-80 PSI	

If fuel pressure fails low, inspect regulator valve condition and for debris, if OK replace pump.

DA1487-A

Performance Diagnostic Procedures

Purpose:

To determine if there is sufficient fuel pressure for correct engine operation.

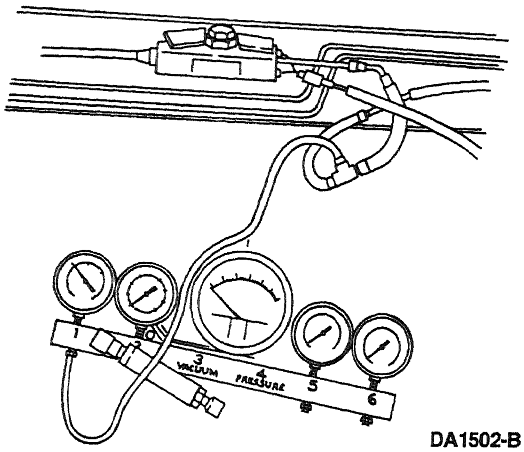
Recommended Procedure:

After verifying that there is fuel in the tank, the pump is being powered and there is not a restriction.

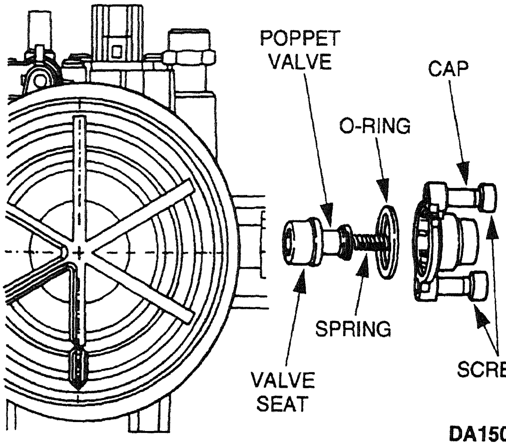
Remove the fuel line to the outlet side of the fuel pump. Install Low Fuel Pump Adapter 014-00931-2 or equivalent between the fuel outlet line and the electric fuel pump. Connect test adapter to gauge (160 psi). Run engine at idle and check for leaks from the line to the gauge. Measure pressure with a full load on the engine. If pressure measures below specification (30-80 psi), check fuel regulator valve for debris. If OK, replace the electric fuel pump. After replacing fuel pump, re-check fuel pressure to verify that there is not a restriction downstream of the pump causing high fuel pressure, which will cause the pump to fail again.

A stuck-open regulator valve will cause low fuel pressure.

A stuck-closed regulator valve (possibly caused by debris) will cause high fuel pressure for a short time until the pump fails.



DA1502-B



DA1503-A

Possible Causes:

- A stuck-open regulator valve will cause low fuel pressure.
- A stuck-closed regulator valve (possibly caused by debris) will cause high fuel pressure for a short time until the pump fails.
- A loose fuel line on the suction side of the fuel system can cause air to be ingested into the system and cause low fuel pressure.
- Electric fuel pump.
- Fuel pump fuse.

Performance Diagnostic Procedures

- Fuel pump relay.
- Inertia switch.
- Fuel pump circuit faults.

8c. Fuel Pressure Test at Left Head for Econoline or Right Head for F-Series

Econoline

8c. Fuel Pressure at the left head

- Measure fuel pressure at the rear of the left head
- Road Test - select appropriate gear to obtain a full load on the engine

Instrument	Spec.	Measurement
0-160 PSI Gauge	30-80 PSI	

If pressure fails low, Replace fuel filter, Retest, If still fails, Replace left check valve.

F-Series

8c. Fuel Pressure at the right head

- Measure fuel pressure at the Front of right head.
- Road Test - select appropriate gear to obtain a full load on the engine.

Instrument	Spec.	Measurement
0-160 PSI Gauge	30-80 PSI	

If pressure fails low, Replace fuel filter, Retest, if still fails, Replace right check valve.

DA1488-A

Purpose:

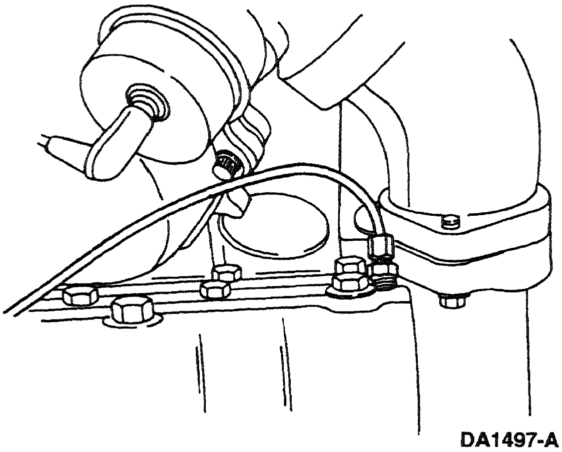
To determine if there is a restriction in the fuel filter or the head check valve.

Performance Diagnostic Procedures

Recommended Procedure:

Econoline

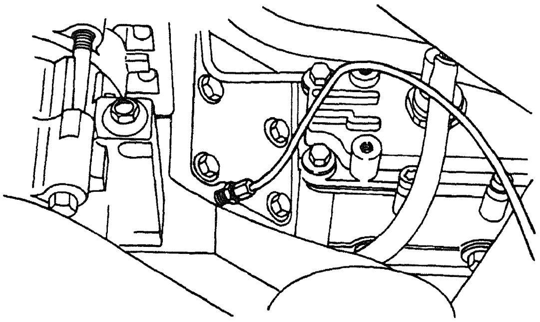
Remove the doghouse cover and remove the 1/8-inch pipe plug from the top rear of left head. Install Gauge (0-160 psi) Bar 014-00761 or equivalent. Run engine at idle and check for leaks from the line to the gauge. Measure pressure with a full load on the engine. If pressure measures below specification (30-80 psi), replace fuel filter. Retest and if still below specification, replace left head check valve, which is located on the front of the left head between the fuel inlet line and the head.



DA1497-A

F-Series

Remove the 1/8-inch pipe plug from the top front of the right head. Install Gauge (0-160 psi) Bar 014-00761 or equivalent. Run engine at idle and check for leaks from the line to the gauge. Measure pressure with a full load on the engine. If pressure measures below specification (30-80 psi), replace fuel filter. Retest and if still below specification, replace right head check valve, which is located on the rear of the right head between the fuel inlet line and the head.



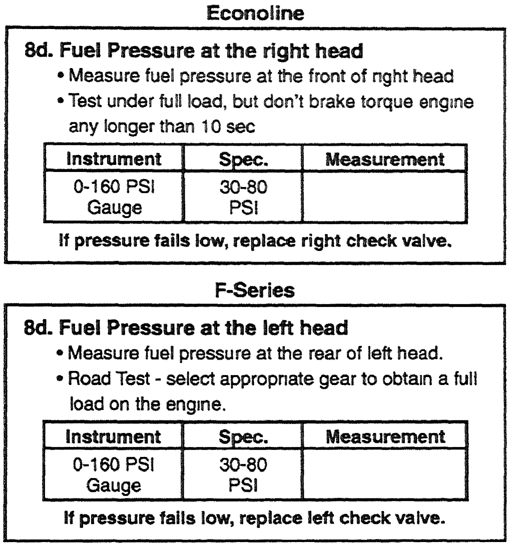
DA1498-A

Performance Diagnostic Procedures

Possible Causes:

- Fuel filter
- Head check valve

8d. Fuel Pressure Test at Right Head for Econoline or Left Head for F-Series



Econoline

8d. Fuel Pressure at the right head

- Measure fuel pressure at the front of right head
- Test under full load, but don't brake torque engine any longer than 10 sec

Instrument	Spec.	Measurement
0-160 PSI Gauge	30-80 PSI	

If pressure fails low, replace right check valve.

F-Series

8d. Fuel Pressure at the left head

- Measure fuel pressure at the rear of left head.
- Road Test - select appropriate gear to obtain a full load on the engine.

Instrument	Spec.	Measurement
0-160 PSI Gauge	30-80 PSI	

If pressure fails low, replace left check valve.

DA1489-A

Purpose:

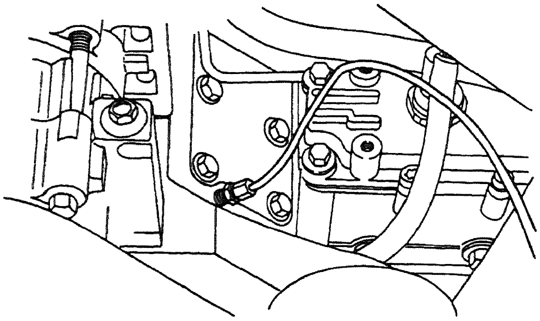
To determine if there is a restriction in the head check valve.

Performance Diagnostic Procedures

Recommended Procedure:

Econoline

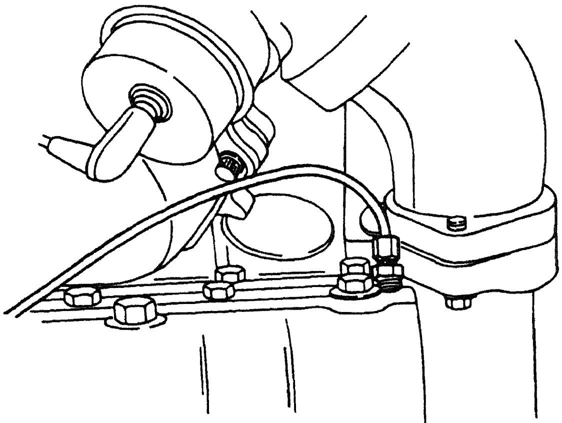
If necessary to remove the alternator and bracket from the right side of the engine to remove the 1/8-inch pipe plug from the top front of right head. Install Gauge (0-160 psi) Bar 014-00761 or equivalent. Run engine at idle and check for leaks from the line to the gauge. Measure pressure with a full load on the engine. **DO NOT** brake torque engine more than 10 seconds. After testing move the transmission range selector lever to N (NEUTRAL), and run the engine for about 15 seconds to allow the torque converter to cool. If pressure measures below specification (30-80 psi), replace right head check valve, which is located on the rear of the right head between the fuel inlet line and the head.



DA1498-A

F-Series

Remove the 1/8-inch pipe plug from the top rear of the left head. Install Gauge (0-160 psi) Bar 014-00761 or equivalent. Run engine at idle, and check for leaks from the line to the gauge. Measure pressure with a full load on the engine. If pressure measures below specification (30-80 psi), replace left head check valve, which is located on the front of the left head between the fuel inlet line and the head.



DA1497-A

Performance Diagnostic Procedures

Possible Causes:

- Head check valve

9. Perform KOER On-Demand Self Test

Purpose:

To determine if the PCM has detected any fault conditions that would cause a performance problem while the engine is running. This will perform step tests on the injection control pressure system and the exhaust back pressure system.

Step tests are PCM-controlled tests where the PCM commands a specific exhaust back pressure or injection control pressure and then measures the result. If a predetermined threshold is not reached, a fault code will be generated. This test can be performed at any engine temperature.

9. Perform KOER On Demand Test

- Select KOER test from NGS test menu.

Pass Code = P1111 or System Passed

KOER DTCs	

DA1490-A

Recommended Procedure:

Connect the NGS Tester to the DLC under the dash. Turn off accessories. Turn A/C off. If vehicle is equipped with an auxiliary powertrain control (rpm control), it must be turned off to perform self tests.

NOTE: Engine will run rough during this test.

- Perform the necessary vehicle preparation and visual inspection. Refer to Quick Test Operation.
- Select VEHICLE & ENGINE SELECTION menu.
- SELECT NEW VEHICLE, YEAR & MODEL.
- Select DIAGNOSTIC DATA LINK.
- Select PCM — POWERTRAIN CONTROL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select KOEO ON DEMAND SELF TEST.
- Start vehicle.

Performance Diagnostic Procedures

- Follow operating instructions from the menu.
- Record DTCs and follow appropriate pinpoint test.
- After test, cycle key to off before running other tests or driving vehicle.

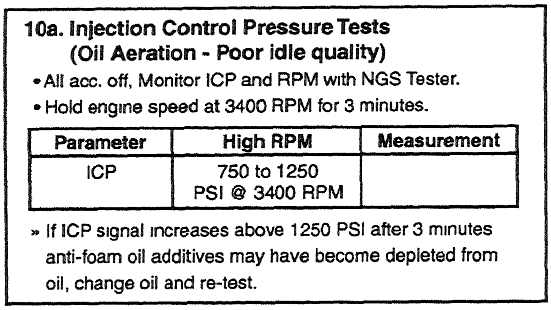
Tools Required:

New Generation Star (NGS) Tester 007-00500 or equivalent

10a. Injection Control Pressure Tests (Oil Aeration — Poor Idle Quality)

Purpose:

To determine if the engine lube oil is aerated and causing poor idle quality.



10a. Injection Control Pressure Tests
(Oil Aeration - Poor idle quality)

- All acc. off, Monitor ICP and RPM with NGS Tester.
- Hold engine speed at 3400 RPM for 3 minutes.

Parameter	High RPM	Measurement
ICP	750 to 1250 PSI @ 3400 RPM	

» If ICP signal increases above 1250 PSI after 3 minutes anti-foam oil additives may have become depleted from oil, change oil and re-test.

DA1491-A

Recommended Procedure:

Install NGS Tester. Turn A / C off. Access ICP PID on NGS Tester and monitor ICP pressure. Operate the engine at 3400 rpm for 3 minutes. This test should be performed with engine at normal operating temperature.

Possible Causes:

- Extended oil drain intervals — the anti-foam additives in the oil may be depleted either from severe use or extended intervals.
- Air present due to recent engine repair on injection control pressure system. It is necessary to run the vehicle aggressively for 24-32 kilometers (15-20 miles) to remove air.
- Wrong type or grade of oil.

Tools Required:

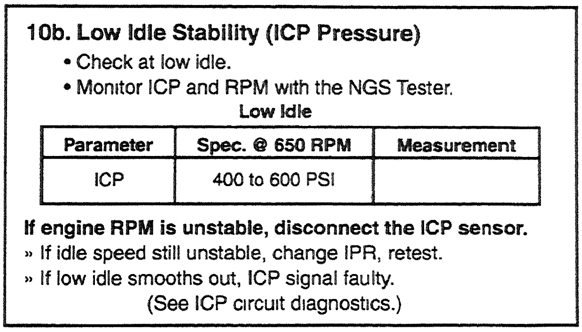
New Generation Star (NGS) Tester 007-00500 or equivalent

Performance Diagnostic Procedures

10b. Low Idle Stability (ICP Pressure)

Purpose:

To determine if idle stability or low power is caused by a stuck or dirty IPR or faulty ICP signal.



10b. Low Idle Stability (ICP Pressure)

- Check at low idle.
- Monitor ICP and RPM with the NGS Tester.

Low Idle

Parameter	Spec. @ 650 RPM	Measurement
ICP	400 to 600 PSI	

If engine RPM is unstable, disconnect the ICP sensor.

» If idle speed still unstable, change IPR, retest.

» If low idle smooths out, ICP signal faulty.
(See ICP circuit diagnostics.)

DA1492-A

Recommended Procedure:

Install NGS Tester. Turn A / C off. Access ICP PID on NGS Tester and monitor ICP pressure. Operate the engine at low idle. If engine does not stabilize, disconnect the ICP sensor. If low idle speed stabilizes with the ICP sensor disconnected, the problem is most likely in the ICP sensor circuit. Refer to Pinpoint Test DD. If rpm does not stabilize, change the IPR and retest. This test should be performed with engine at normal operating temperature.

Possible Causes:

- Debris stuck in the IPR
- In-range ICP sensor or circuit failure

Tools Required:

New Generation Star (NGS) Tester 007-00500 or equivalent

11. Crankcase Pressure Test

Purpose:

This test will measure crankcase pressure. Crankcase pressure is a measure of how well the cylinders are sealing.

Performance Diagnostic Procedures

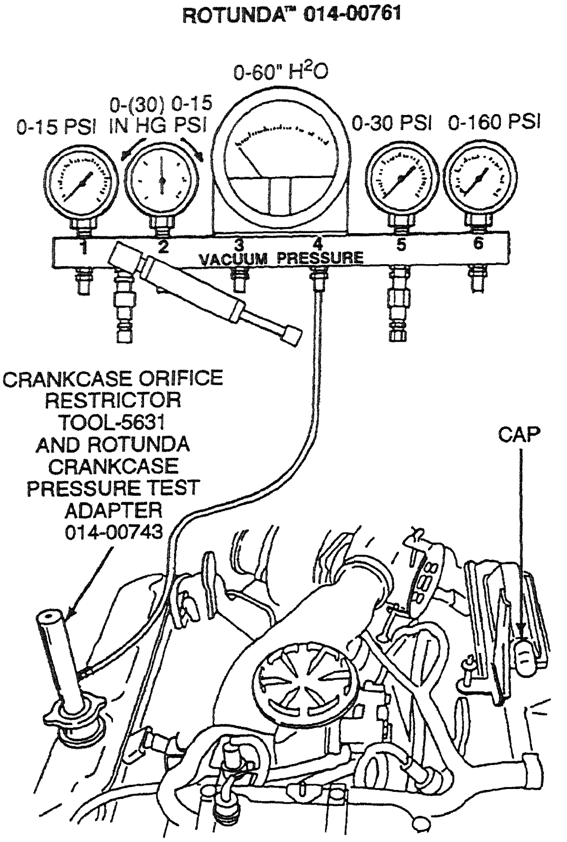
11. Crankcase Pressure Test

- Assure engine is at normal operating temp
- Measure at oil fill with adapter and orifice tool P.N. 5631 & 014-00743 installed.
- Measure at WOT under no load.

Instrument	Spec.	Measurement
Magnehelic 0 to 60" H^2O	less than 4" H^2O	

If more than 4" H^2O, Refer base engine in Shop Manual

DA1493-B



CRANKCASE PRESSURE A24026-B

Recommended Procedure:

NOTE: Do not plug hole on Crankcase Orifice Restrictor Tool 014-00743.

Make sure the engine is up to operating temperature. A cold engine will give higher readings. Remove the ducting to the turbocharger inlet pipe and remove the inlet pipe and elbow that connects to the breather box. Block the outlet at the breather box with the cap provided in Pressure Test Adapter Kit 014-00761 or equivalent. Install a protective screen over the turbocharger inlet.

Screw the Crankcase Orifice Restrictor Tool 014-00743 and Crankcase Pressure Test Adapter or equivalent in the oil fill cap hole. Plumb to the Magnehelic® gauge in the gauge block. Make sure the Magnehelic® gauge has been zeroed.

Start the engine and operate at 3400 rpm. Hold for 30 seconds minimum and take a stabilized reading. Do not block the hole at the top of the restrictor tool.

Performance Diagnostic Procedures

Possible Causes:

- Broken or worn compression rings
- Polished cylinder bores
- Leaking or bent valves

Inspect air induction system. If the air induction system allows dirt to enter the cylinders, it will quickly "dust" the engine causing high crankcase pressure.

Tools Required:

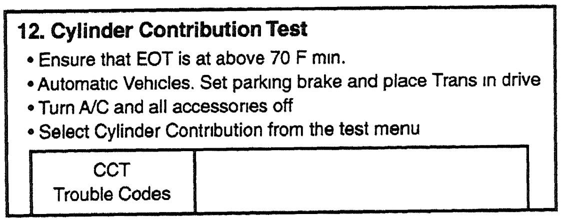
- Crankcase Orifice Restrictor Tool 014-00743 (part of Pressure Test Adapter Kit 014-00761)
- Magnehelic® gauge (part of Pressure Test Kit 014-00761)
- Protective screen
- Crankcase Pressure Test Adapter 014-00743 or equivalent

12. Cylinder Contribution Tests

Purpose:

To test individual cylinders and injectors to determine if all are contributing equally to engine performance.

NOTE: Only California vehicles will set a Continuous Misfire DTC. Both 49-state and California vehicles will set a KOER Cylinder Contribution Self Test code for a low or non-contributing cylinder. If any CCT or misfire DTCs are set, go to Pinpoint Test NA to diagnose the fault.



12. Cylinder Contribution Test

- Ensure that EOT is at above 70 F min.
- Automatic Vehicles. Set parking brake and place Trans in drive
- Turn A/C and all accessories off
- Select Cylinder Contribution from the test menu

CCT Trouble Codes	

DA1494-A

Performance Diagnostic Procedures

Recommended Procedure:

The A/C must be off and engine oil temperature above 21°C (70 °F) to run Cylinder Contribution Self Test. This test will determine if all cylinders are contributing equally to engine performance. The PCM will test all eight cylinders continuously during the test; there is no change in engine speed or operation that can be detected by the technician. The test checks for cylinder-to-cylinder decrease in speed and sets a code if the decrease is too high. The test consists of three portions. Each portion runs for 20 seconds. The first test checks for a badly missing injector or cylinder with no compression, and the second and third tests check for weak injectors or low compression cylinders. A fault must be present at the time of testing for the KOER Cylinder Contribution Self Test to detect a fault, so the engine operating condition at which the idle is worst will produce the best test results. For automatic transmission vehicles, the best results are reached with the parking brake set and the transmission in DRIVE. If a fault is detected, a Diagnostic Trouble Code (DTC) will be output on the data link at the end of the test when requested by a scan tool. Only a hard fault code (DTC) will be displayed.

Possible Causes:

Failing this test could indicate mechanical engine problems such as:

- broken compression rings
- leaking or bent valves
- bent push rods
- bent connecting rods
- damaged rocker arms
- faulty injector assembly

Go to the workshop manual for base engine diagnostic procedures.

If the base engine condition meets specifications, the injector may not be functioning correctly and will need replacement. The solenoid and wiring should have been checked in earlier tests. Verify KOEO Injector Electrical Self Test passed.

Tools Required:

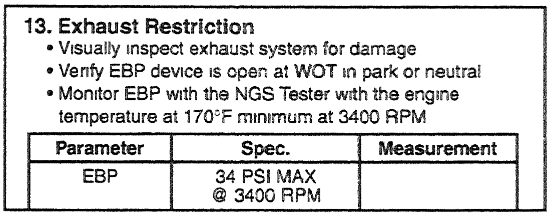
New Generation Star (NGS) Tester 007-00500 or equivalent

Performance Diagnostic Procedures

13. Exhaust Restriction

Purpose:

To determine if the exhaust system is sufficiently restricted to cause a performance problem.



13. Exhaust Restriction

- Visually inspect exhaust system for damage
- Verify EBP device is open at WOT in park or neutral
- Monitor EBP with the NGS Tester with the engine temperature at 170°F minimum at 3400 RPM

Parameter	Spec.	Measurement
EBP	34 PSI MAX @ 3400 RPM	

DA1495-A

Recommend Procedure:

Use NGS Tester PID EBP. An EBP reading above 193 kPa (28 psia) indicates a restricted exhaust condition.

Alternate Procedure:

A thorough visual inspection will find the problem quickly in most instances. If an NGS Tester is not available and a measurement is necessary, measure voltage at exhaust back pressure (EBP) sensor using a digital multimeter and ICP / EBP Adapter Cable D94T-50-A. Measure this pressure at WOT, wheels blocked and brake engaged.

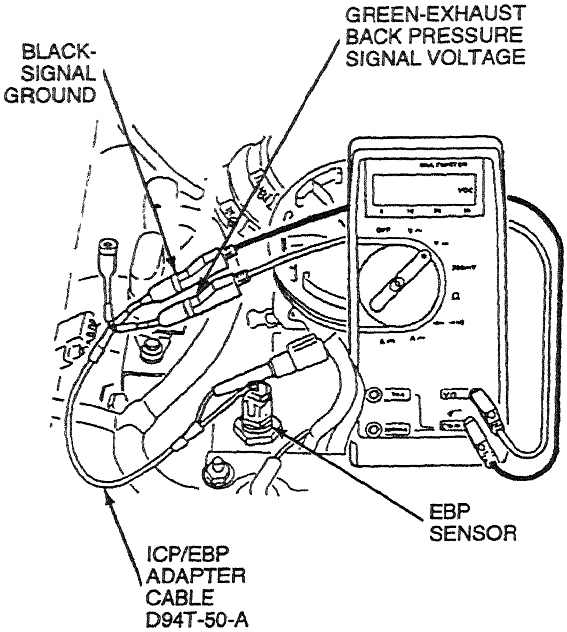
Possible Causes:

- Collapsed tail pipe
- Clogged tail pipe
- Closed exhaust back pressure device
- Clogged catalytic converter
- Damaged muffler

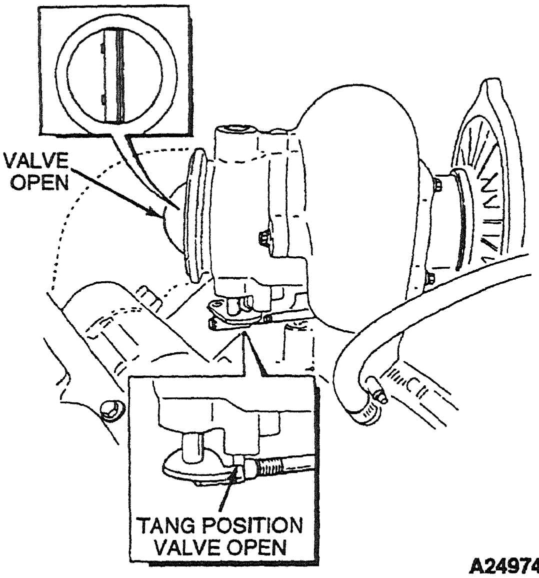
Tools Required:

- ICP / EBP Adapter Cable D94T-50-A or equivalent
- New Generation Star (NGS) Tester 007-00500 or equivalent
- 23 Multimeter 105-00050 or equivalent

Performance Diagnostic Procedures



EXHAUST BACK PRESSURE A24024-B



A24974-A

Performance Diagnostic Procedures

14. Boost Pressure Test

Purpose:

To determine if the engine can develop sufficient boost to obtain specific power.

Econoline

14. Boost Pressure Test

- Verify that MAP hose is not open, plugged or pinched.
- Monitor MGP (manifold gauge pressure) and RPM with the NGS Tester.
- Road Test - select appropriate gear to obtain desired engine speed at full load throttle position. Best accomplished climbing hill or truck fully loaded.

Parameter	Spec. PSIG	Measurement
MGP	13 PSIG MIN	

Measure between 2500 to 3000 RPM

F-Series

14. Boost Pressure Test

- Verify that MAP hose is not open, plugged or pinched.
- Verify that inner cooler hoses or intake are not leaking.
- Verify that the green Waste gate hose is not plugged.
- Monitor MGP (manifold gauge pressure) and RPM with the NGS Tester.
- Road Test - select appropriate gear to obtain desired engine speed at full load throttle position. Best accomplished climbing hill or truck fully loaded.

Parameter	Spec. PSIG	Measurement
MGP	16 PSIG	

Measure between 2500 to 3000 RPM

DA1496-A

Recommended Procedure:

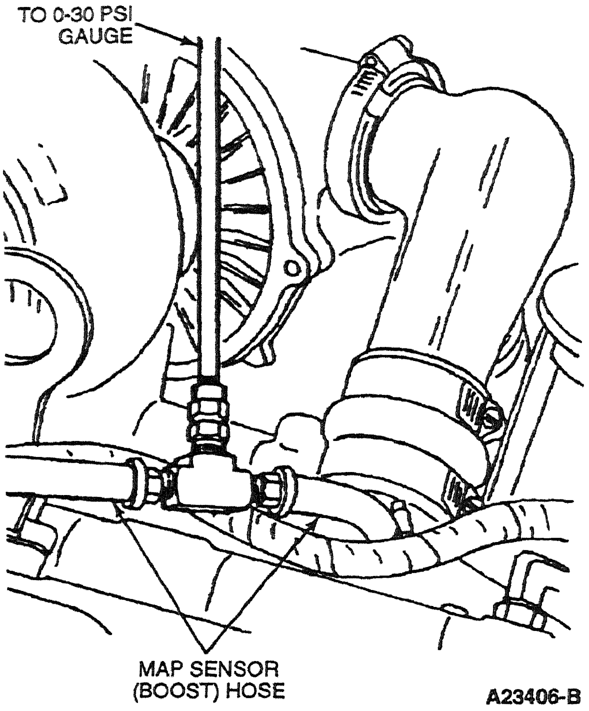
Monitor NGS Tester PID MGP and RPM. After the engine is up to operating temperature, find an open section of road and select the best gear to achieve a 2500-3000 rpm acceleration. With the accelerator at WOT, note the highest boost reading while accelerating through the 2500-3000 rpm range. Boost will level out after 3000 rpm. This is best accomplished either climbing a hill or with the vehicle fully loaded.

Alternate Procedure:

Install a T (manufactured locally out of common fittings) into the manifold absolute pressure (MAP) sensor line that comes from the intake manifold. Make sure the MAP sensor is hooked up for this test.

Performance Diagnostic Procedures

Connect a T to a 0-30 psi gauge that is temporarily installed in the cab. Route the hose so that it is not crimped and does not come in contact with any hot surface.



Possible Causes:

- MAP hose pinched or open
- Leaking intake, hoses or fittings
- Defective turbocharger
- Base engine failure

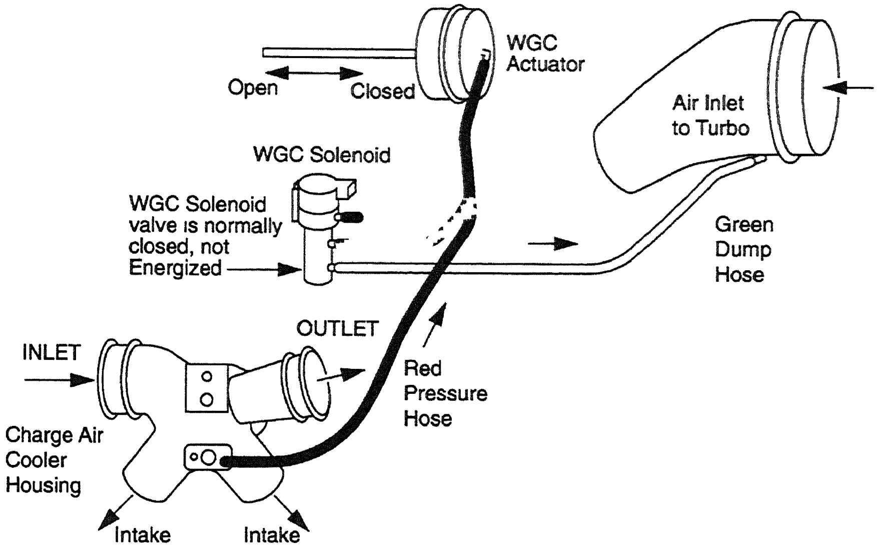
Added Causes for F-Series

- Plugged green wastegate hose or port in the charge air intake to the turbo
- Wastegate control solenoid not electrically but mechanically inoperative
- Wastegate actuator
- Wastegate valve
- Wastegate turbo
- Intercooler hoses leaking

Performance Diagnostic Procedures

A wastegated turbo is designed to reach maximum boost sooner then a conventional turbo, but overboosting will cause damage to the turbo. The PCM will control the boost pressure by duty cycle to the solenoid to maximize boosting performance. When pressure is supplied on the red hose going to the actuator (solenoid NOT energized) the valve will open, dumping boost. When low or no pressure is on the red hose going to the actuator (solenoid is being energized) the valve will stay closed.

Waste Gate Control Valve is Normally Closed



DA1504-A

Diagnostic Trouble Code Description

4 Digit	Description	Pinpoint Test Step Go To Direction		
		KOEO	KOER	Continuous
—	System Pass (No DTCs Available) — California and all Econoline	—	—	—
P0107	BARO Circuit Low Input	DH	—	DH
P0108	BARO Circuit High Input	DH	—	DH
P0112	IAT Sensor Circuit Low Input	DA	—	DA
P0113	IAT Sensor Circuit High Input	DA	—	DA
P0122[a]	Accelerator Pedal Sensor Circuit Low Input	DE5	—	DE5
P0123[a]	Accelerator Pedal Sensor Circuit High Input	DE1	—	DE1
P0196	EOT Sensor Circuit Performance	—	DB10	—
P0197[a]	EOT Sensor Circuit Low Input	DB4	—	DB6
P0198[a]	EOT Sensor Circuit High Input	DB1	—	DB6
P0220[a]	Throttle Switch B Circuit Malfunction	—	FE1	—
P0221[a]	Throttle Switch B Circuit Malfunction	—	—	FE1
P0230	Fuel Pump Relay Driver Fail	FK1	—	FK16
P0231	Fuel Pump Relay Driver Failed On	FK5	—	FK18
P0232	Fuel Pump Relay Driver Failed Off	FK11	—	FK11
P0236[a]	Turbo Boost Sensor A Circuit Performance	DJ1	—	DJ1
P0237[a]	Turbo Boost Sensor A Circuit Low Input	DJ5	—	DJ13
P0238[a]	Turbo Boost Sensor A Circuit High Input	DJ11	—	DJ15
P0261[a]	Injector Circuit Low — Cylinder 1	NA1	—	NA1
P0262	Injector Circuit High — Cylinder 1	NA6	—	NA6
P0263	Cylinder 1 Contribution/Balance Fault	—	NA25	—
P0264[a]	Injector Circuit Low — Cylinder 2	NA1	—	NA1
P0265	Injector Circuit High — Cylinder 2	NA6	—	NA6
P0266	Cylinder 2 Contribution/Balance Fault	—	NA25	—
P0267[a]	Injector Circuit Low — Cylinder 3	NA1	—	NA1
P0268	Injector Circuit High — Cylinder 3	NA6	—	NA6
P0269	Cylinder 3 Contribution/Balance Fault	—	NA25	—
P0270[a]	Injector Circuit Low — Cylinder 4	NA1	—	NA1
P0271	Injector Circuit High — Cylinder 4	NA6	—	NA6
P0272	Cylinder 4 Contribution/Balance Fault	—	NA25	—
P0273[a]	Injector Circuit Low — Cylinder 5	NA1	—	NA1
P0274	Injector Circuit High — Cylinder 5	NA6	—	NA6
P0275	Cylinder 5 Contribution/Balance Fault	—	NA25	—
P0276[a]	Injector Circuit Low — Cylinder 6	NA1	—	NA1
P0277	Injector Circuit High — Cylinder 6	NA6	—	NA6
P0278	Cylinder 6 Contribution/Balance Fault	—	NA25	—
P0279[a]	Injector Circuit Low — Cylinder 7	NA1	—	NA1
P0280	Injector Circuit High — Cylinder 7	NA6	—	NA6

(Continued)

Diagnostic Trouble Code Description

4 Digit	Description	Pinpoint Test Step Go To Direction		
		KOEO	KOER	Continuous
P0281	Cylinder 7 Contribution/Balance Fault	—	NA25	—
P0282[a]	Injector Circuit Low — Cylinder 8	NA1	—	NA1
P0283	Injector Circuit High — Cylinder 8	NA6	—	AB6
P0284	Cylinder 8 Contribution/Balance Fault	—	NA25	—
P0301	Fault Cylinder A-Misfire Detected (CYL 1)	—	—	NA25
P0302	Fault Cylinder B-Misfire Detected (CYL 2)	—	—	NA25
P0303	Fault Cylinder D-Misfire Detected (CYL 3)	—	—	NA25
P0304	Fault Cylinder E-Misfire Detected (CYL 4)	—	—	NA25
P0305	Fault Cylinder F-Misfire Detected (CYL 5)	—	—	NA25
P0306	Fault Cylinder G-Misfire Detected (CYL 6)	—	—	NA25
P0307	Fault Cylinder C-Misfire Detected (CYL 7)	—	—	NA25
P0308	Fault Cylinder H-Misfire Detected (CYL 8)	—	—	NA25
P0340	CMP Sensor Circuit Malfunction	DG1	—	DG1
P0341[a]	CMP Sensor Circuit Performance	—	DG1	DG1
P0344[a]	CMP Sensor Circuit Intermittent	DG1	—	DG1
P0380	Glow Plug Circuit Malfunction	KC3	—	KC3
P0381	Glow Plug Indicator Circuit Malfunction	KD1	—	KD3
P0460	Fuel Tank Level Indicator Circuit Malfunction	—	—	—
P0470	Exhaust Back Pressure Sensor Circuit Malfunction	DF1	—	DF3
P0471	Exhaust Back Pressure Sensor Circuit Performance	—	—	DF5
P0472	Exhaust Back Pressure Sensor Circuit Low Input	DF9	—	DF9
P0473	Exhaust Back Pressure Sensor Circuit High Input	DF15	—	DF15
P0475	Exhaust Pressure Control Valve Malfunction	KB1	—	—
P0476	Exhaust Pressure Control Valve Performance	—	KB7	KB7
P0478	Exhaust Pressure Control Valve High Input	—	—	DF17
P0500	Vehicle Speed Sensor Malfunction — KOER Tests	—	—	HB1
P0560	System Voltage Malfunction	—	A1	—
P0562	System Voltage Low	A1	—	A1
P0563	System Voltage High	A1	—	A1
P0565	Cruise "On" Signal Malfunction	—	FG1	—
P0566	Cruise "Off" Signal Malfunction	—	FG1	—
P0567	Cruise "Resume" Signal Malfunction	—	FG1	—
P0568	Cruise "Set" Signal Malfunction	—	FG1	—
P0569	Cruise "Coast" Signal Malfunction	—	FG1	—
P0571	Brake Switch A Circuit Malfunction	—	FB1	—
P0603	Internal Control Module KAM Error	MA1	—	MA1
P0605	Internal Control Module ROM Error	MD1	—	MD1

(Continued)

Diagnostic Trouble Code Description

4 Digit	Description	Pinpoint Test Step Go To Direction		
		KOEO	KOER	Continuous
P0606	PCM Processor Fault	MC1	—	—
P0703	Brake Switch B Circuit Malfunction	—	FD1	—
P0704	Clutch Pedal Position Switch Input Circuit Malfunction	—	FC1	—
P0705[b]	TR Sensor Circuit Malfunction	[c]	[c]	[c]
P0707	TR Sensor Circuit Low Input	[c]	[c]	[c]
P0708[b]	TR Sensor Circuit High Input	[c]	[c]	[c]
P0712	Transmission Fluid Temp. Sensor CKT Low Input	[c]	[c]	[c]
P0713	Transmission Fluid Temp. Sensor CKT High Input	[c]	[c]	[c]
P0731	Gear One Ratio Error	[c]	[c]	[c]
P0732	Gear Two Ratio Error	[c]	[c]	[c]
P0733	Gear Three Ratio Error	[c]	[c]	[c]
P0741	TCC Circuit Performance	[c]	[c]	[c]
P0743	Torque Converter Clutch System Electrical Failure	[c]	[c]	[c]
P0750	Shift Solenoid 1 Malfunction	[c]	[c]	[c]
P0751	Shift Solenoid A Performance	[c]	[c]	[c]
P0755	Shift Solenoid 2 Malfunction	[c]	[c]	[c]
P0756	Shift Solenoid B Performance	[c]	[c]	[c]
P0760	Shift Solenoid C Malfunction	[c]	[c]	[c]
P0781	1-2 Shift Malfunction	[c]	[c]	[c]
P0781[b]	1-2 Shift Malfunction	[c]	[c]	[c]
P0782[b]	2-3 Shift Malfunction	[c]	[c]	[c]
P0783[b]	3-4 Shift Malfunction	[c]	[c]	[c]
P1000	OBD II Monitor Checks Not Complete, More Driving Required	—	—	AP
P1118	Manifold Air Temperature Sensor Low Input	DK4	—	DK4
P1119	Manifold Air Temperature Sensor High Input	DK1	—	DK1
P1139	Water in Fuel Indicator Circuit Malfunction	DM1	—	DM1
P1140	Water in Fuel Condition	—	—	DL1
P1184	Engine Oil Temp Sensor Circuit Performance	—	DB10	—
P1209	Injection Control System Pressure Peak Fault	—	—	KE15
P1210	Injection Control Pressure Above Expected Level	DD11	—	DD22
P1211[a]	ICP Not Controllable — Pressure Above/Below Desired	KE14	KE7	KE14
P1212[a]	ICP Voltage Not at Expected Level	DD11	—	DD14
P1218	CID Stuck High	KA10	—	KA10
P1219	CID Stuck Low	KA9	—	KA9
P1247	Turbo Boost Pressure Low	—	—	DC1
P1248	Turbo Boost Pressure Not Detected	—	—	DC1

(Continued)

Diagnostic Trouble Code Description

4 Digit	Description	Pinpoint Test Step Go To Direction		
		KOEO	KOER	Continuous
P1249	Wastegate Fail Steady State Test	—	—	KL5
P1261	High to Low Side Short — Cylinder 1	NA6	—	NA6
P1262	High to Low Side Short — Cylinder 2	NA6	—	NA6
P1263	High to Low Side Short — Cylinder 3	NA6	—	NA6
P1264	High to Low Side Short — Cylinder 4	NA6	—	NA6
P1265	High to Low Side Short — Cylinder 5	NA6	—	NA6
P1266	High to Low Side Short — Cylinder 6	NA6	—	NA6
P1267	High to Low Side Short — Cylinder 7	NA6	—	NA6
P1268	High to Low Side Short — Cylinder 8	NA6	—	NA6
P1271	High to Low Side Open — Cylinder 1	NA11	—	NA11
P1272	High to Low Side Open — Cylinder 2	NA11	—	NA11
P1273	High to Low Side Open — Cylinder 3	NA11	—	NA11
P1274	High to Low Side Open — Cylinder 4	NA11	—	NA11
P1275	High to Low Side Open — Cylinder 5	NA11	—	NA11
P1276	High to Low Side Open — Cylinder 6	NA11	—	NA11
P1277	High to Low Side Open — Cylinder 7	NA11	—	NA11
P1278	High to Low Side Open — Cylinder 8	NA11	—	NA11
P1280[a]	ICP Circuit Out of Range Low	DD1	—	DD1
P1281[a]	ICP Circuit Out of Range High	DD8	—	DD8
P1282	Excessive ICP	—	KE5	KE5
P1283[a]	IPR Circuit Failure	KE1	—	—
P1284	ICP Failure — Aborts KOER or CCT Test	—	DD21	—
P1291	High Side No. 1 (Right) Short to GND or B+	NA16	—	NA16
P1292	High Side No. 2 (Left) Short to GND or B+	NA16	—	NA16
P1293	High Side Open Bank No. 1 (Right)	NA20	—	NA20
P1294	High Side Open Bank No. 2 (Left)	NA20	—	NA20
P1295[a]	Multiple Faults on Bank No. 1 (Right)	NA29	—	NA29
P1296[a]	Multiple Faults on Bank No. 2 (Left)	NA29	—	NA29
P1297	High Sides Shorted Together	NA27	—	NA27
P1298	IDM Failure	KA1	—	KA1
P1316	Injector Circuit / IDM Codes Detected	FJ10	—	FJ10
P1389	Glow Plug High Side Circuit Out of Range Low	—	KC1	KC1
P1391	Glow Plug Circuit Low Input Bank No. 1 (Right)	—	KC1	KC1
P1392	Glow Plug Circuit High Input Bank No. 1 (Right)	—	KC1	KC1
P1393	Glow Plug Circuit Low Input Bank No. 2 (Left)	—	KC1	KC1
P1394	Glow Plug Circuit High Input Bank No. 2 (Left)	—	KC1	KC1
P1395	Glow Plug Monitor Fault Bank No. 1	—	KC1	KC1
P1396	Glow Plug Monitor Fault Bank No. 2	—	KC1	KC1
P1397	System Voltage Out of Self Test Range	—	KC15	KC15

(Continued)

Diagnostic Trouble Code Description

4 Digit	Description	Pinpoint Test Step Go To Direction		
		KOEO	KOER	Continuous
P1464	A/C On During KOER or CCT Test	—	FA1	—
P1501	Vehicle Moved During Testing	—	Repeat Test	—
P1502	Invalid Self Test — APCM Functioning	QA	QA	QA
P1531	Invalid Test — Accelerator Pedal Movement	—	Repeat Test	—
P1536	Parking Brake Applied Failure	—	FF1	—
P1634	Data Output Link Failure	—	—	KM1
P1660	Output Circuit Check Signal High	KH	—	KH
P1661	Output Circuit Check Signal Low	KJ	—	KJ
P1662	IDM EN Circuit Failure	NC1	—	—
P1663	FDCS Circuit Failure	KF1	—	—
P1667	CID Circuit Failure	KA1	—	—
P1668	PCM — IDM Diagnostic Communication Error	FJ1	—	FJ1
P1670	EF Feedback Signal Not Detected	—	—	FJ1
P1690	Wastegate Control Valve Malfunction	KL1	—	KL1
P1704	Digital TRS Failed to Transition State	—	—	—
P1705	TR Sensor out of Self Test Range	[c]	[c]	[c]
P1706[b]	High Vehicle Speed in Park	[c]	[c]	[c]
P1711	TFT Sensor Out of Self Test Range	[c]	[c]	[c]
P1714	Shift Solenoid A Inductive Signature Malfunction	[c]	[c]	[c]
P1715	Shift Solenoid B Inductive Signature Malfunction	[c]	[c]	[c]
P1727	Coast Clutch Solenoid Inductive Signature Malfunction	[c]	[c]	[c]
P1728[b]	Transmission Slip Error — Converter Clutch Failed	[c]	[c]	[c]
P1729	4x4L Switch Error	[c]	[c]	[c]
P1740	Torque Converter Clutch Inductive Signature Malfunction	[c]	[c]	[c]
P1742	Torque Converter Clutch Failed On	[c]	[c]	[c]
P1744	Torque Converter Clutch System Performance	[c]	[c]	[c]
P1746	EPC Solenoid Open Circuit	[c]	[c]	[c]
P1747	EPC Solenoid Short Circuit	[c]	[c]	[c]
P1748[b]	EPC Malfunction	[c]	[c]	[c]
P1751	Shift Solenoid A Performance	[c]	[c]	[c]
P1754	CCS (Solenoid) Circuit Malfunction	[c]	[c]	[c]
P1756	Shift Solenoid B Performance	[c]	[c]	[c]
P1779	TCIL Circuit Malfunction	[c]	[c]	[c]
P1780	TCS Circuit Out of Self Test Range	[c]	[c]	[c]
P1781	4x4L Circuit Out of Self Test Range	[c]	[c]	[c]
P1783[b]	Transmission Overtemperature Condition	[c]	[c]	[c]
No Code	No Communication	[c]	[c]	[c]

(Continued)

Diagnostic Trouble Code Description

4 Digit	Description	Pinpoint Test Step Go To Direction		
		KOEO	KOER	Continuous
No Code	Auxiliary Powertrain Control System	c	c	c
No Code	Tachometer	c	c	c

a Check Engine light illuminates when fault is present. On California, CHECK ENGINE light will turn off if no fault is detected for three consecutive drive cycles.

b Transmission Control Indicator Light (TCIL) flashes when fault is present.

c Refer to the Powertrain Group in the Workshop Manual for diagnostic procedures.

NOTE: Speed control DTCs will be set during KOER Switch Test if the vehicle is not equipped with speed control. This is a normal condition. On these vehicles ignore the following DTCs: P0565-P0566-P0567-P0568-P0569-P0571.

SECTION 5

Pinpoint Tests

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SECTION 5

Pinpoint Tests

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SECTION 5

Pinpoint Tests

Contents (continued)

SECTION 5

Pinpoint Tests

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Pinpoint Test Index

(Continued)

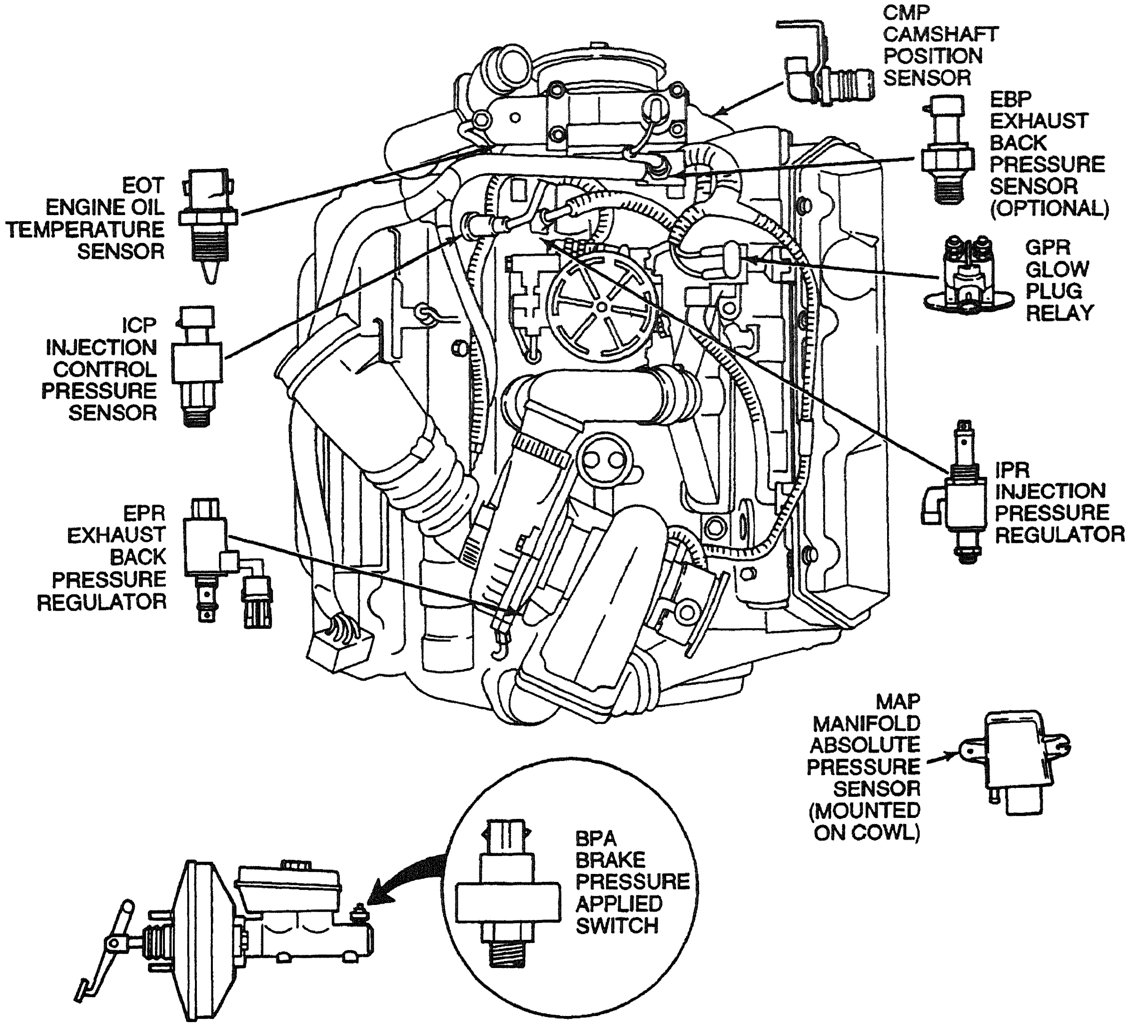
Sensor and Actuator Diagnostic Procedures

Operational Signal Checks

These checks are made with the breakout box installed and normally measure a signal voltage or frequency. They are useful for determining an in-range type concern, or an intermittent connection.

In the case of an intermittent concern, monitoring a suspected circuit and recreating the environmental or physical conditions that caused the complaint will help verify if a problem is in a particular circuit.

It is critical when measuring the signal level of a circuit to understand the function and whether it is an analog voltage, digital frequency, sine wave or digital communication signal. A standard digital multimeter has certain limitations in measuring any circuit that has a frequency.



A25061-A

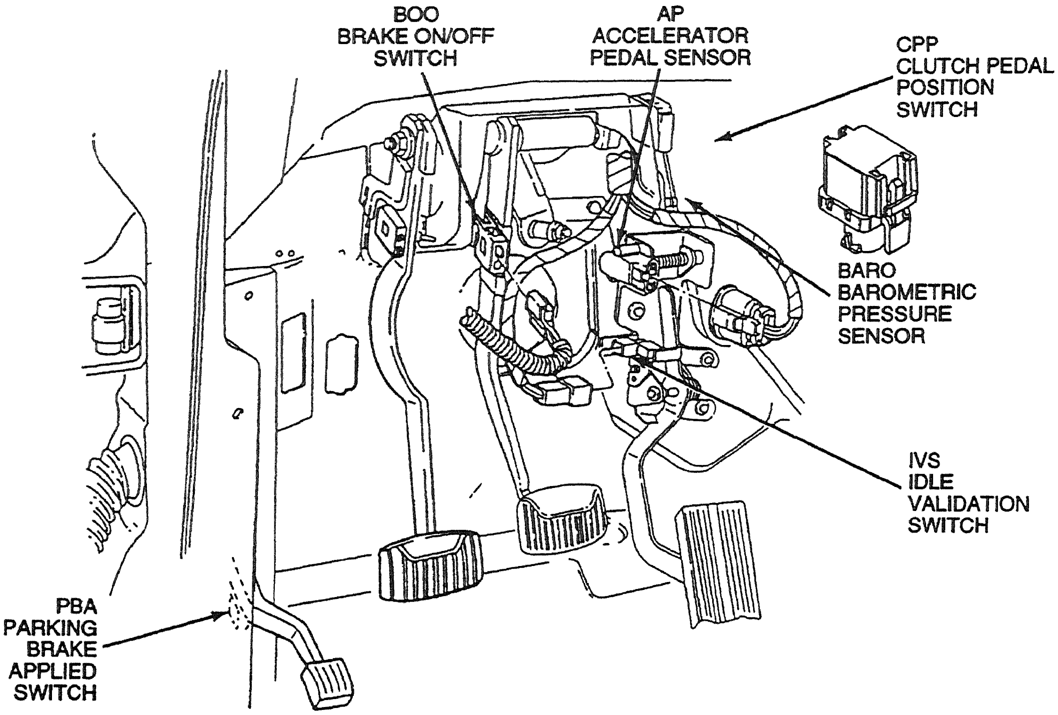
Sensor and Actuator Diagnostic Procedures

WARNING

RED-STRIPED WIRES CARRY 115 V DC. SEVERE ELECTRICAL SHOCK MAY BE RECEIVED. DO NOT PIERCE.

CAUTION

Do not pierce engine electrical wires or damage to the harness may occur.



A25062-A

General Procedures for Pinpoint Testing

Inspection

The basic diagnostic procedure recommended for most sensor and actuator circuits is to disconnect the harness at the connector and inspect for corrosion, bent pins, spread pins or any condition that could cause a loose or intermittent connection.

Connector Checks to Ground (B-)

Measure the resistance of all wiring harness connectors to ground (preferably the negative battery cable) to determine if a short to ground condition is present. **It is important that during this test all accessories, including the dome light, be turned off. Current flow in the system will affect resistance readings. If the reading is fluctuating greatly, disconnect the battery and measure to the negative battery cable.**

- Signal return (marked A on all sensor circuits except IAT) should measure less than 5 ohms.
- The VREF and signal lines, with the processor connected, will normally measure greater than 50 k ohms.
- Power ground on an actuator circuit should measure less than 5 ohms. The control side of an actuator circuit will also normally measure greater than 50 k ohms.

Connector Voltage Checks

The next step is to turn the ignition key to the ON position and measure if the expected voltages are present at the connector. On circuits with expected voltages this test will verify the integrity of that circuit. On circuits without an expected voltage this test will determine if that circuit is shorted or miswired to a voltage source.

- Signal return (marked A on all sensor circuits except IAT) should measure less than 2.5 volts.
- VREF should measure 4.5-5.5 volts. If this is higher or lower than expected, disconnect sensors one at a time to determine if a sensor is biasing the circuit and refer to VREF pinpoint procedures.
- Signal lines will measure either 0-.25v if the circuit is designed to pull down when disconnected or a higher voltage (normally 4.6-5, or 12v) if it is designed as a pull up circuit. A pull up signal circuit that measures the expected value normally indicates a good circuit.
- Actuator circuits may be either on / off type circuits (normally 12 volts) or pulse width modulated circuits (12 volts controlled by a % duty cycle).
- Communication circuits are similar to sensor circuits when disconnected in that they will be designed to either pull up or pull down when disconnected. Measuring the expected voltage of a communication circuit when disconnected will often discern its condition.

Harness Resistance Tests

Harness resistance tests are performed when a circuit is suspected of having high resistance or being open. These tests are performed with the breakout box connected and ignition off. Measure resistance from the sensor connector end to the processor connector. If an open circuit or high resistance is encountered, the problem is most easily isolated by separating the circuit at the interim connectors (normally the 42-way connector) and measuring resistance through both halves of the circuit.

Vehicle Battery

A

Note

Enter this pinpoint test only when directed here from the symptom flowcharts.

Remember

To prevent the replacement of good components, be aware that the following areas may be at fault:

- ignition switch
- battery cables
- generator
- voltage regulator
- ground straps

This pinpoint test is intended to diagnose only the following:

- powertrain control module (PCM)(12A650)
- harness circuits: SIG RTN, PWR GND, VPWR, KAPWR, IGNITION SWITCH, VREF
- battery positive voltage (B+)
- closed loop power relay

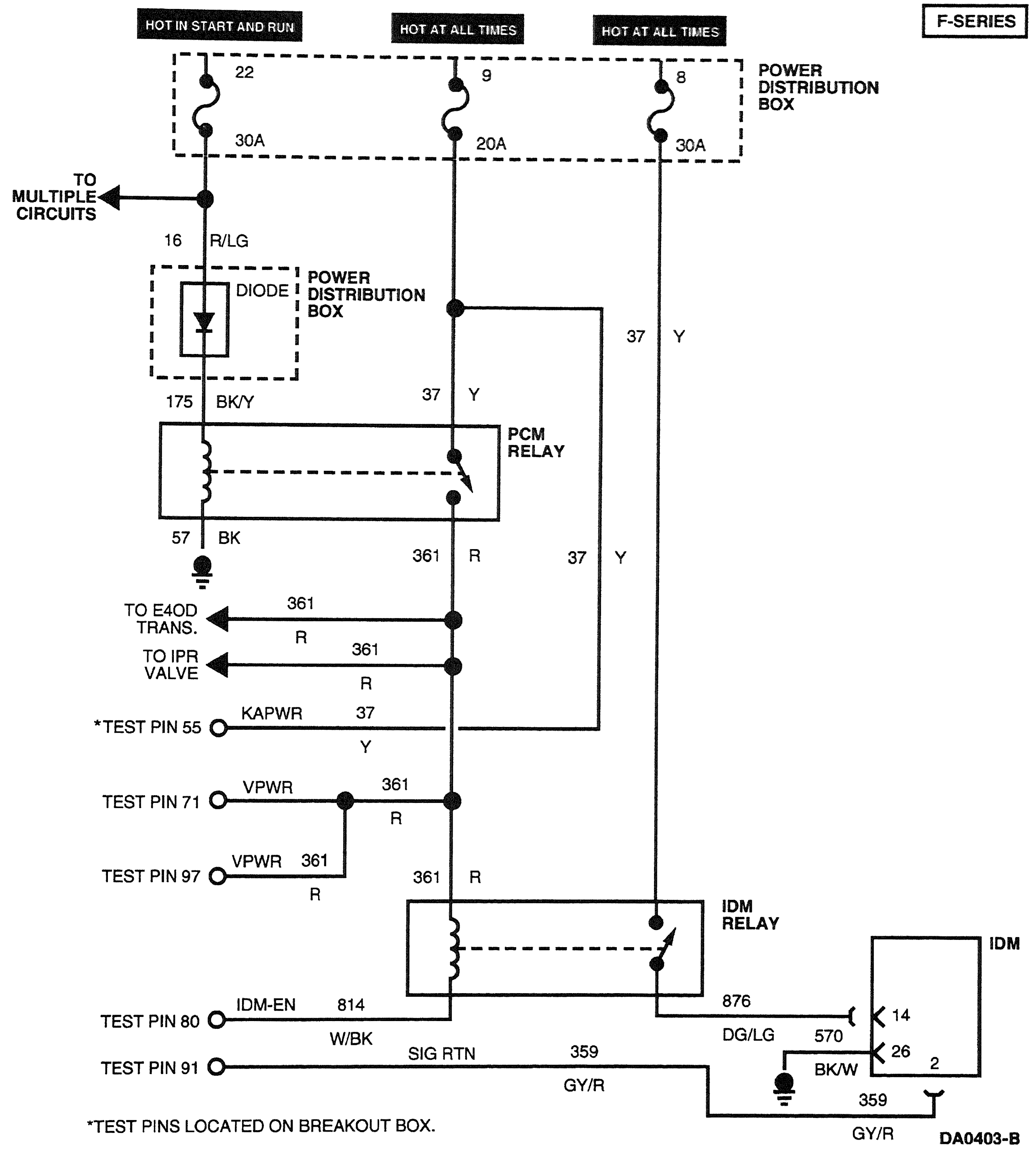
DTC Description

P0560 = System Voltage Malfunction

P0562 = System Voltage Low

Vehicle Battery	**A**

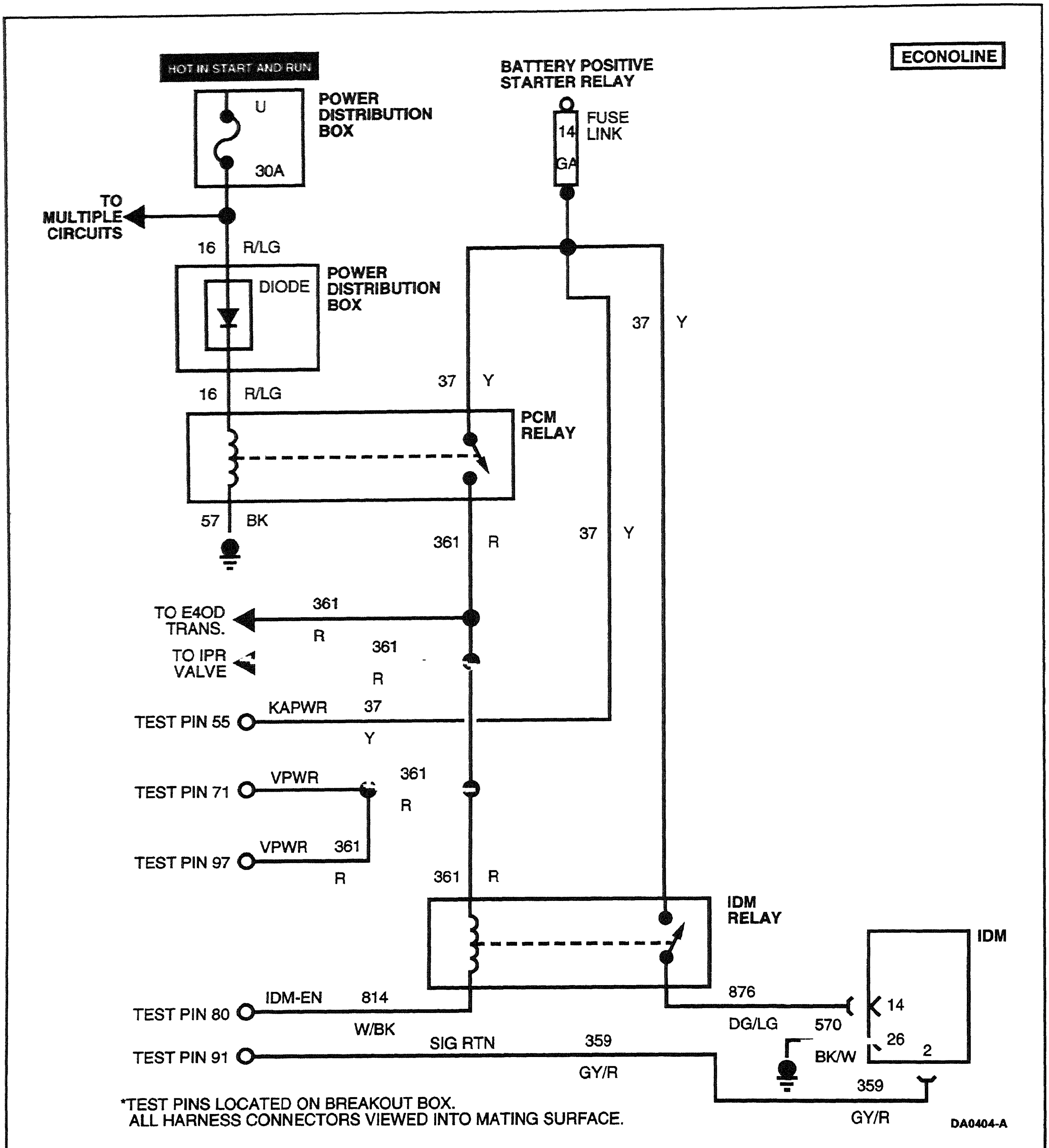
P0563 = System Voltage High



*TEST PINS LOCATED ON BREAKOUT BOX.

Vehicle Battery

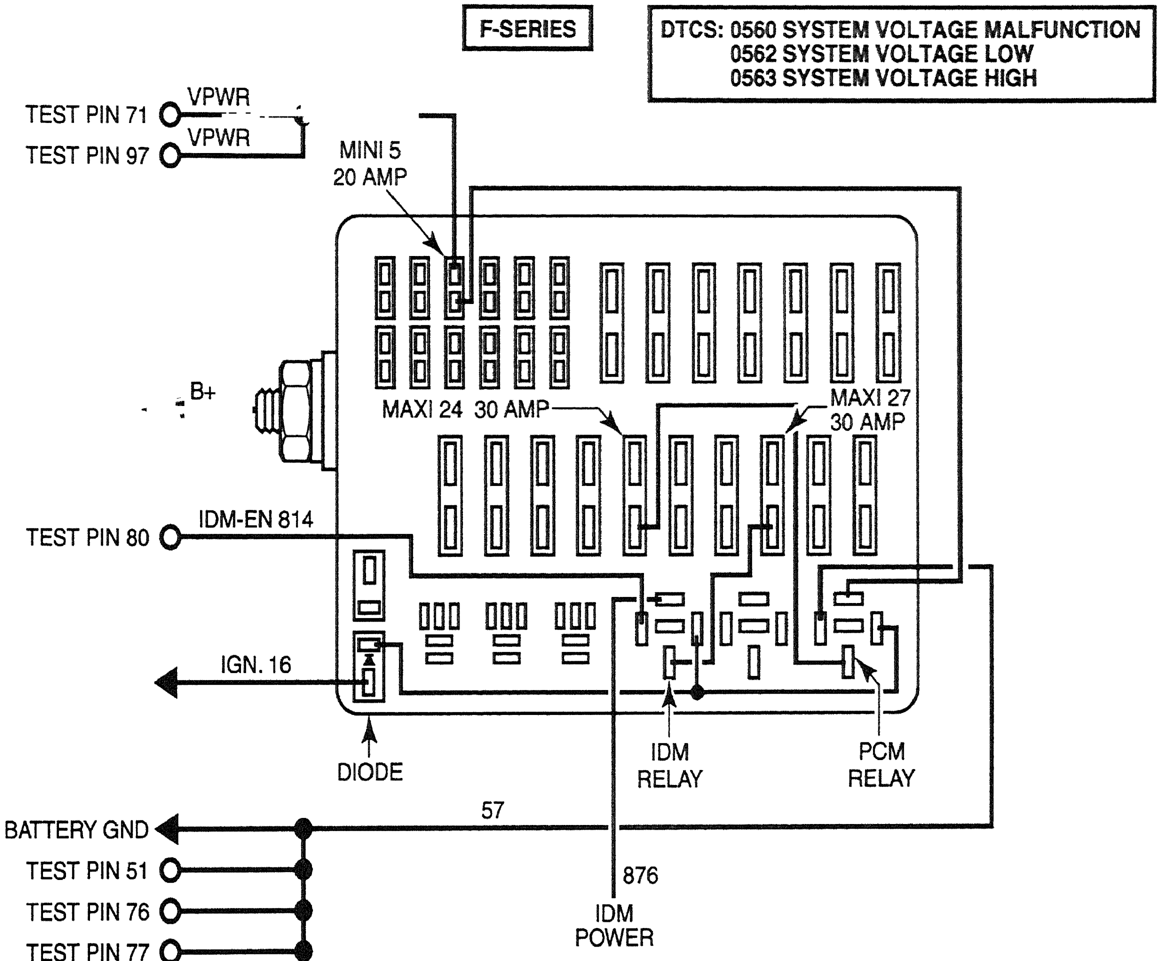
A



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

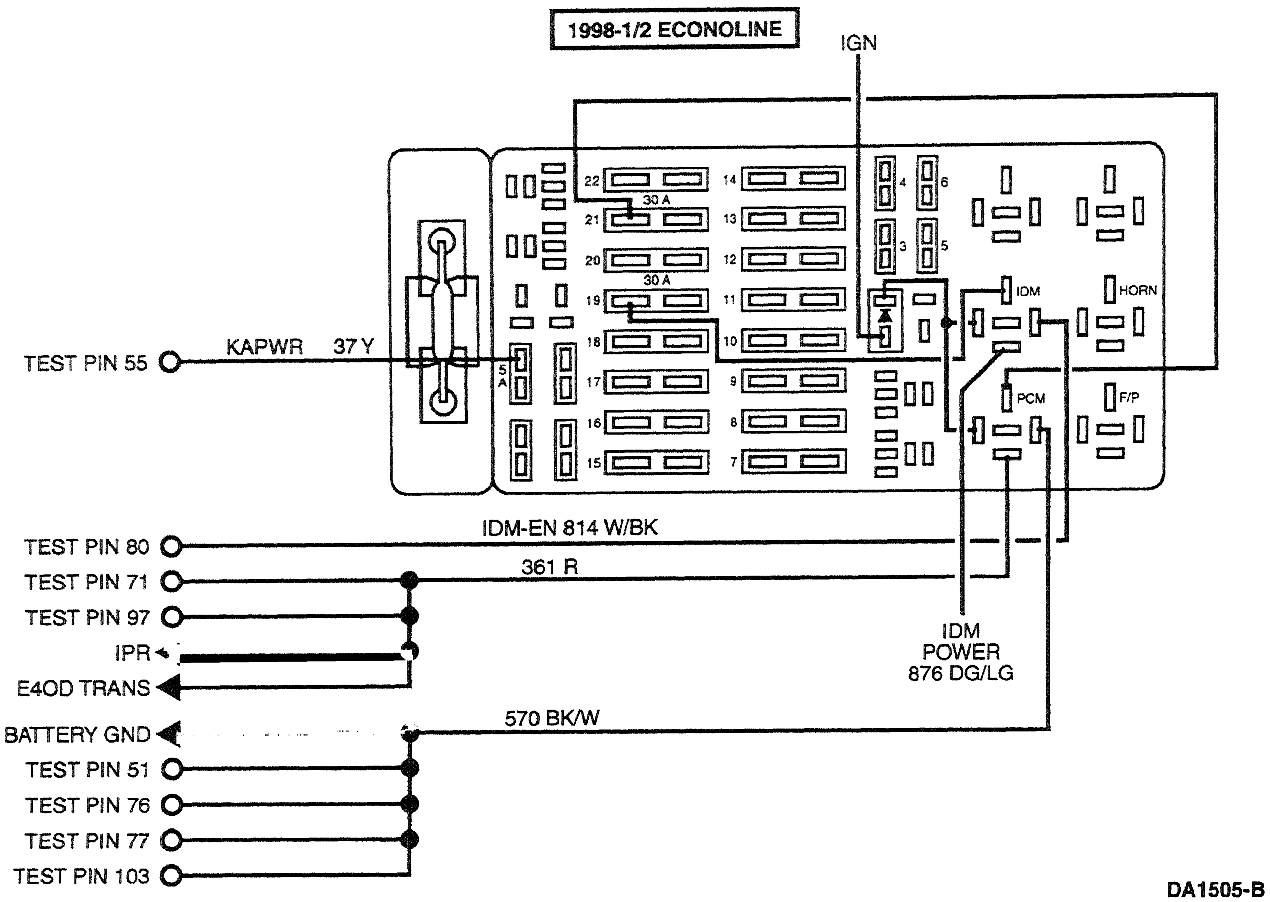
Vehicle Battery

A



DA0405-B

Vehicle Battery	**A**



DA1505-B

	Test Step	Result	▶	Action to Take
A1	DIAGNOSTIC TROUBLE CODES (DTCs) P0563 / P0562 / P0560			
	- Key on, engine off. - Measure voltage across battery terminals. - **Is voltage greater than 10.5 volts?** NOTE: DTC P0563 may be a temporary condition with a 24-volt jump start. DTC P0562 may be a temporary condition at crank only. P0563 — System voltage high P0562 — System voltage low P0560 — System voltage malfunction, below 11.5 volts during KOER tests	Yes No	▶ ▶	F-Series, GO to **A2**. Econoline, GO to **A12**. REPAIR discharged battery. REFER to the Electrical Group in the Workshop Manual.

Vehicle Battery

A

Test Step		Result ▶	Action to Take
A2	CHECK VOLTAGE AT MAXI FUSE 9		
	• Measure voltage between power distribution box Maxi Fuse 9 and battery negative post. • Key off. • **Is voltage greater than 10.5 volts?**	Yes ▶	GO to A3.
		No ▶	REPAIR open in Circuit 37 (Y) between the power distribution box and the starter relay. RESTORE vehicle.
A3	CHECK MAXI FUSE 9		
	• Check power distribution box Maxi Fuse 9. • **Is fuse blown?**	Yes ▶	REPAIR short to ground. REPLACE Maxi Fuse 9. RESTORE vehicle.
		No ▶	GO to A4.
A4	CHECK CIRCUIT 37 (Y) TO RELAY		
	• Remove PCM relay and Maxi Fuse 9. • Measure resistance of Circuit 37 (Y) between the nonpower side of Maxi Fuse 9 and the PCM relay connector. • **Is resistance less than 5 ohms?**	Yes ▶	GO to A5.
		No ▶	REPAIR open in Circuit 37 (Y). RESTORE vehicle.
A5	CHECK IGNITION FEED TO DIODE		
	• Key off. • Remove diode from power distribution box. • Key on, engine off. • Measure voltage between battery ground and ignition feed side of diode connector. • Key off. • **Was voltage greater than 10.5 volts?**	Yes ▶	GO to A6.
		No ▶	REPAIR open in ignition feed Circuit 16 (R/LG) or ignition switch. RESTORE vehicle.
A6	CHECK DIODE		
	• Disconnect diode and inspect. • **Does diode check OK?**	Yes ▶	F-Series, GO to A7. Econoline, GO to A13.
		No ▶	REPLACE diode. RESTORE vehicle.
A7	CHECK CIRCUIT 175 (BK/Y)		
	• Measure resistance of Circuit 175 (BK/Y) between the nonpower side of diode connector and the PCM relay connector. • **Is resistance less than 5 ohms?**	Yes ▶	GO to A8.
		No ▶	REPAIR open in Circuit 175. RESTORE vehicle.
A8	CHECK GROUND CIRCUIT 57 (BK) AT RELAY		
	• Measure resistance between battery ground and Circuit 57 (BK) at PCM relay connector. • **Is resistance less than 5 ohms?**	Yes ▶	GO to A9.
		No ▶	REPAIR open in Circuit 57 (BK). RESTORE vehicle.
A9	CHECK CIRCUIT 361 (R) FROM RELAY TO PCM		
	• Install breakout box, leave PCM disconnected. • Measure resistance of Circuit 361 (R) between the PCM relay connector and PCM Test Pins 71 and 97. • **Is resistance less than 5 ohms?**	Yes ▶	GO to A10.
		No ▶	REPAIR open in Circuit 361 (R). RESTORE vehicle.

Vehicle Battery

A

Test Step	Result ▶	Action to Take
A10 CHECK PWR GND CIRCUIT CONTINUITY ● Measure resistance between battery negative post and PCM Test Pins 25, 51, 76, 77 and 103. ● **Is each resistance less than 5.0 ohms?**	Yes ▶ No ▶	F-Series, GO to A11. Econoline, GO to A14. REPAIR open in PWR GND circuit. RESTORE vehicle. CLEAR DTCs and RETEST.
A11 CHECK PCM RELAY ● Remove Maxi Fuse 9. ● Install PCM relay. ● Key on, engine off. ● Measure resistance between the nonpower side of Maxi Fuse 9 and PCM Test Pins 71 and 97. ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	If fault is still present, REPLACE PCM. RESTORE vehicle. REPLACE PCM relay. RESTORE vehicle.
A12 CHECK VOLTAGE AT PCM RELAY ● Key off. ● Remove PCM relay. ● Key on, engine off. ● Measure voltage of Circuit 37 (Y) between the PCM relay connector and battery ground. ● **Is voltage greater than 10.5 volts?**	Yes ▶ No ▶	GO to A5. REPAIR open in Circuit 37 (Y) between PCM relay and starter relay. RESTORE vehicle.
A13 CHECK CIRCUIT 16 ● Measure resistance of Circuit 16 (R/LG) between the nonpower side of the diode connector and the PCM relay connector. ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to A8. REPAIR open in Circuit 16 (R/LG). RESTORE vehicle.
A14 PCM RELAY CHECK ● Install PCM relay. ● Key on, engine off. ● Measure voltage between battery negative post and PCM Test Pins 71 and 97. ● **Is voltage greater than 10.5 volts?**	Yes ▶ No ▶	If fault is still present, REPLACE PCM. RESTORE vehicle. REPLACE PCM relay. RESTORE vehicle.

Reference Voltage

C

Note

Enter this pinpoint test only when a check for VREF has failed in the sensor pinpoint tests for the AP, MAP, BARO, ICP, EBP or CMP 3-wire sensors.

Remember

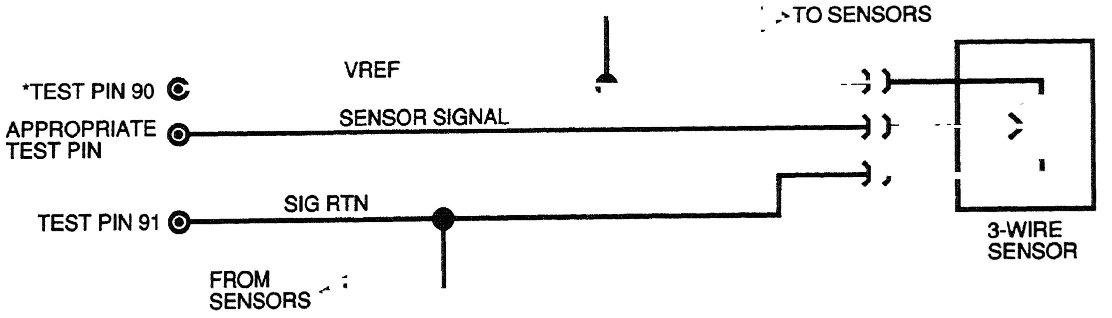
This pinpoint test is intended to diagnose only the following:

- sensor harness circuits: SIG RTN, VREF
- 3-wire sensors: AP, MAP, BARO, ICP, EBP, CMP
- powertrain control module (PCM)(12A650)

Description

Reference Voltage (VREF) is a positive voltage (approximately 5.0 volts ± 3%) that is output by the PCM. This consistent voltage is used by all 3-wire sensors.

Signal Return (SIG RTN) is a dedicated ground used by most sensors and some other inputs.



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

A22207-B

Reference Voltage

C

Test Step		Result ▶	Action to Take
C1	CHECK VEHICLE BATTERY POWER CIRCUIT		
	- Install breakout box; connect PCM to breakout box. - Key on, engine off. - Measure voltage between PCM Test Pins 55, 71 and 97 and PCM Test Pins 25, 51, 76, 77 and 103 Note voltage. - Measure voltage across battery terminals. Note voltage. - **Are both voltages greater than 10.5 volts, and are both voltages within 1.0 volt of each other?**	Yes ▶ No ▶	GO to C2. GO to A1.
C2	CHECK VREF VOLTAGE		
	- Measure voltage between PCM Test Pins 90 and 91. - Key off. - **Was voltage between 4.0 volts and 6.0 volts?**	Yes ▶ No ▶	GO to C3. Less than 4.0 volts, GO to C5. Greater than 6.0 volts, GO to C4.
C3	CHECK VREF AND SIG RTN CIRCUITS FOR CONTINUITY		
	- Sensor that sent you here disconnected. - Disconnect PCM from breakout box. - Measure resistance between PCM Test Pin 90 and VREF circuit at harness connector of the sensor that sent you here. - Measure resistance between PCM Test Pin 91 and SIG RTN circuit at harness connector of the sensor that sent you here. - **Is each resistance less than 5.0 ohms?**	Yes ▶ No ▶	RESTORE vehicle. CLEAR DTCs and RETEST. REPAIR open in VREF or SIG RTN circuits. RESTORE vehicle. CLEAR DTCs and RETEST.
C4	CHECK FOR EXCESS VOLTAGE ON VREF CIRCUIT		
	- Disconnect PCM from breakout box. - Key on, engine off. - Measure voltage between PCM Test Pin 90 and battery ground. - **Is voltage less than 0.5 volts?**	Yes ▶ No ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST. REPAIR short to power in harness. RESTORE vehicle. CLEAR DTCs and RETEST.
C5	SIG RTN CIRCUIT CHECK		
	- Measure resistance between PCM Test Pin 91 and PCM Test Pins 25, 51, 76, 77 and 103. - **Is each resistance less than 5 ohms?**	Yes ▶ No ▶	GO to C6. REPLACE PCM. RESTORE vehicle.

Reference Voltage

C

Test Step		Result ►	Action to Take
C6	CHECK FOR SHORTED ACCELERATOR PEDAL (AP) SENSOR		
	• Disconnect AP sensor harness connector. • Key on, engine off. • Measure voltage between PCM Test Pins 90 and 91. • Key off. • **Was voltage less than 4.0 volts?**	Yes	GO to C7.
		No	REPLACE AP sensor. RESTORE vehicle. CLEAR DTCs and RETEST.
C7	CHECK FOR SHORTED CAMSHAFT POSITION (CMP) SENSOR		
	• Disconnect CMP sensor harness connector. • Key on, engine off. • Measure voltage between PCM Test Pins 90 and 91. • Key off. • **Was voltage less than 4.0 volts?**	Yes	GO to C8.
		No	REPLACE CMP sensor. RESTORE vehicle.
C8	CHECK FOR SHORTED INJECTION CONTROL PRESSURE (ICP) SENSOR		
	• Disconnect ICP sensor harness connector. • Key on, engine off. • Measure voltage between PCM Test Pins 90 and 91. • Key off. • **Was voltage less than 4.0 volts?**	Yes	GO to C9.
		No	REPLACE ICP sensor. RESTORE vehicle.
C9	CHECK FOR SHORTED EXHAUST BACK PRESSURE (EBP) SENSOR		
	• Disconnect EBP sensor harness connector. • Key on, engine off. • Measure voltage between PCM Test Pins 90 and 91. • Key off. • **Was voltage less than 4.0 volts?**	Yes	GO to C10.
		No	REPLACE EBP sensor. RESTORE vehicle.
C10	CHECK FOR SHORTED MANIFOLD ABSOLUTE PRESSURE MAP SENSOR		
	• Disconnect MAP sensor harness connector. • Key on, engine off. • Measure voltage between PCM Test Pin 90 and 91. • Key off. • **Was voltage less than 4.0 volts?**	Yes	Leave MAP sensor disconnected. GO to C11.
		No	REPLACE MAP sensor. RESTORE vehicle.
C11	CHECK FOR SHORTED BAROMETRIC PRESSURE (BARO) SENSOR		
	• Disconnect BARO sensor harness connector. • Key on, engine off. • Measure voltage between PCM Test Pin 90 and 91. • Key off. • **Was voltage less than 4.0 volts?**	Yes	Leave BARO sensor disconnected. GO to C12.
		No	REPLACE BARO sensor. RESTORE vehicle.

Reference Voltage

C

Test Step	Result ▶	Action to Take
C12 CHECK VREF CIRCUIT FOR SHORT TO GROUND		
• Disconnect PCM from breakout box. • AP, CMP, ICP, EBP, MAP and BARO disconnected. • Measure resistance between PCM Test Pin 90 and PCM Test Pins 25, 51, 76, 77, 91 and 103. • **Are all resistances greater than 10,000 ohms?**	Yes ▶	REPLACE PCM. RESTORE vehicle. RERUN Scan Tool Diagnostic Test.
	No ▶	REPAIR short to ground. RESTORE vehicle. CLEAR DTCs and RETEST.

Intake Air Temperature (IAT) Sensor

DA

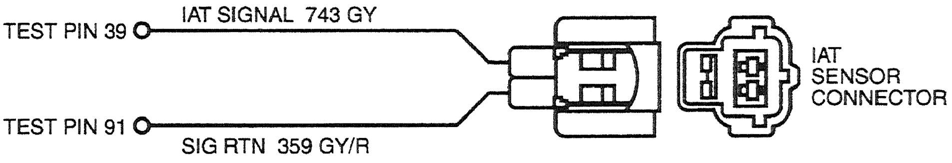
Signal Functions

The intake air temperature (IAT) sensor is a thermistor-type sensor with a variable resistance that changes when exposed to different temperatures. When interfaced with the powertrain control module (PCM), it produces a 0-5 volt analog signal that will measure temperature.

The IAT sensor's primary function is to measure ambient air temperature in order to determine when the exhaust back pressure device is needed.

Detection / Management

An IAT signal that is detected out of range high or low by the PCM will cause the engine to ignore the IAT signal, disable exhaust back pressure operation and assume an ambient temperature of 15°C (59°F).



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE

DA0407-B

Note

After removing connectors, always check for damaged pins, corrosion, loose terminals, etc.

kohms	IAT (Volts)	Degrees C	Degrees F
1.19	0.28	120	248
1.56	0.36	110	230
2.08	0.47	100	212
2.80	0.61	90	194
3.84	0.80	80	176
5.34	1.04	70	158
7.55	1.34	60	140
10.93	1.72	50	122
16.11	2.15	40	104
24.25	2.63	30	86
37.34	3.09	20	68
58.99	3.52	10	50

DTC Descriptions

P0113 = Intake Air Temperature Sensor Circuit High Input.

P0112 = Intake Air Temperature Sensor Circuit Low Input.

Intake Air Temperature (IAT) Sensor

DA

Test Step		Result ▶	Action to Take
DA1	DIAGNOSTIC TROUBLE CODE (DTC) P0113		
	● DTC P0113 indicates that the corresponding sensor signal circuit is out of range high. Possible causes: — open in harness — worn or damaged connection — worn or damaged sensor — damaged PCM ● Key on, engine off. ● Access IATV PID. ● **Is voltage reading 4.95 V or above?**	Yes ▶ No ▶	GO to DA2. GO to DA8.
DA2	INDUCE OPPOSITE FAILURE		
	● Disconnect IAT sensor harness connector. ● Jumper signal circuit Pin 2 on the IAT sensor connector to battery ground. ● Key off. ● **Did voltage reading on NGS Tester read 0 V?**	Yes ▶ No ▶	GO to DA3. GO to DA4.
DA3	CHECK SIGNAL RETURN		
	● Measure resistance between signal return Pin 1 on the IAT sensor connector and ground. ● **Is resistance less than 5 ohms?**	Yes ▶	REPLACE IAT sensor. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	REPAIR open in Signal Return Circuit 359 (GY/R). RESTORE vehicle. CLEAR DTCs and RETEST.
DA4	CHECK CONTINUITY OF SENSOR SIGNAL AND SIG RTN CIRCUITS		
	● Install breakout box; leave PCM disconnected. ● Measure resistance between sensor signal Pin 2 on the IAT sensor connector and PCM Test Pin 39. ● **Is resistance less than 5 ohms?**	Yes ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	REPAIR open in Circuit 743 (G/Y). RESTORE vehicle. CLEAR DTCs and RETEST.
DA5	DIAGNOSTIC TROUBLE CODE (DTC) P0112		
	● DTC P0112 indicates that the corresponding sensor signal circuit is out of range low. Possible causes: — grounded circuit in harness — worn or damaged sensor — damaged PCM — worn or damaged connection ● Key on, engine off. ● Access IATV PID. ● **Is voltage reading 0.13 V or below?**	Yes ▶ No ▶	GO to DA6. GO to DA8.

Intake Air Temperature (IAT) Sensor

DA

Test Step		Result ▶	Action to Take
DA6	INDUCE FAILURE		
	• Disconnect IAT sensor harness connector. • Key off. • **Did reading go to 4.59 V or above?**	Yes	▶ REPLACE IAT sensor. RESTORES vehicle. CLEAR DTCs and RETEST.
		No	▶ GO to DA7.
DA7	CHECK TEMPERATURE SENSOR SIGNAL CIRCUIT FOR SHORT TO GROUND		
	• Install breakout box; leave PCM disconnected. • Measure resistance between PCM Test Pin 39 and PCM Test Pins 51, 76, 77, 91 and 103. • **Is each resistance greater than 10,000 ohms?**	Yes	▶ REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
		No	▶ REPAIR short to ground Circuit 743 (G/Y). RESTORE vehicle. CLEAR DTCs and RETEST.
DA8	CONTINUOUS MEMORY DIAGNOSTIC TROUBLE CODE (DTC) P0113 OR P0112		
	• Continuous Memory DTC P0113 indicates that the sensor signal circuit was out of range high. The DTC was generated under normal driving conditions. Continuous Memory DTC P0112 indicates that the sensor signal circuit was out of range low. The DTC was generated under normal driving conditions. Possible causes: — worn or damaged sensor — open circuit in harness — grounded circuit in harness — damaged PCM • Access IATV PID. • Tap on sensor while observing scan tool reading. • **Does voltage reading fluctuate?**	Yes	▶ REPLACE IAT sensor. RESTORE vehicle. CLEAR DTCs and RETEST.
		No	▶ GO to DA9.
DA9	CHECK EEC VEHICLE HARNESS		
	• Observe IAT value on scan tool while performing the following: — Grasp the harness close to the sensor connector. — Wiggle and shake harness while working toward the PCM. • Key off. • **Did value fluctuate?**	Yes	▶ REPAIR circuits as required. RESTORE vehicle.
		No	▶ GO to C10.

Intake Air Temperature (IAT) Sensor

DA

Test Step		Result ▶	Action to Take
DA10	CHECK PCM AND VEHICLE HARNESS CONNECTORS		
	• Disconnect PCM. Disconnect sensor connector. Inspect for damage, loose or pushed-out pins, loose or poorly crimped wires. • **Are connectors and terminals OK?**	Yes ▶	Unable to duplicate or identify concern at this time. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	REPAIR as necessary. RESTORE vehicle. CLEAR DTCs and RETEST.

Engine Oil Temperature (EOT) Sensor

DB

Signal Functions

The engine oil temperature (EOT) sensor is a thermistor type sensor that has a variable resistance that changes when exposed to different temperatures. When interfaced with the powertrain control module (PCM), it produces a 0 to 5 volt analog signal that will deduce temperature.

Cranking Fuel Quantity/Timing Control — The EOT sensor signal is used to determine the timing and quantity of fuel required to optimize starting over all temperature conditions.

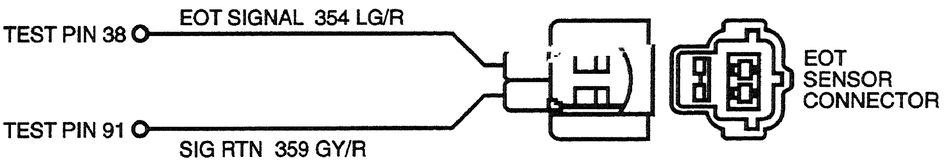
Idle Speed — At oil temperatures below 70°C (158°F) low idle is incrementally increased to a maximum of 950 rpm.

Temperature Compensation — Fuel quantity and timing is controlled throughout the total operating range to ensure adequate torque and power is available.

Glow Plug Control — The glow plug relay and lamp ON time are controlled by engine oil temperature.

Detection/Management

An EOT sensor signal that is detected out of range (high or low) by the PCM will cause the PCM to ignore the EOT sensor signal and assume an engine oil temperature of -34°C (-29°F) for starting and a temperature of 100°C (212°F) for engine-running conditions. The CHECK ENGINE light will also be illuminated as long as the condition exists.



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

DA0428-A

Note

After removing connectors, always check for damaged pins, corrosion, loose terminals, etc.

CONNECTOR CHECKS TO GROUND (B-)
(CHECK WITH SENSOR CONNECTOR DISCONNECTED AND IGNITION KEY OFF, ALL ACCESSORIES OFF)

Test Points	Spec.	Comments
A to Grd	<5 ohms	Resistance to ground. If greater than 5 ohms the harness is open
B to Grd	>5 ohms	Resistance less than 5 ohms indicates a short to ground

Engine Oil Temperature (EOT) Sensor — DB

CONNECTOR VOLTAGE CHECKS
(CHECK WITH SENSOR CONNECTOR DISCONNECTED AND IGNITION KEY ON)

Test Points	Spec.	Comments
A to Grd	0-.25 volts	If greater than.25 volts signal wire is shorted to VREF or battery
B to Grd	4.6-4.9 volts	Pull up voltage, if no or low voltage circuit has open or high resistance

DTC Descriptions

Circuit Faults:

P0197 = EOT sensor circuit low input

P0198 = EOT sensor circuit high input

System Faults

P0196 (49 State except Econoline) = Engine oil temperature less than 74°C (165°F) or above 116°C (240°F) during KOER Cylinder Contribution Self Test (self test access denied).

P1184 (California and all Econoline) = Engine oil temperature less than 74°C (165°F) or above 116°C (240°F) during KOER Cylinder Contribution Self Test (self test access denied).

kohms	EOT (Volts)	°C	°F
1.19	0.53	120	248
1.56	0.67	110	230
2.08	0.86	100	212
2.80	1.09	90	194
3.84	1.37	80	176
5.34	1.72	70	158

kohms	EOT (Volts)	°C	°F
7.55	2.11	60	140
10.93	2.56	50	122
16.11	3.01	40	104
24.25	3.44	30	86
37.34	3.82	20	68
58.99	4.13	10	50

Test Step		Result ▶	Action to Take
DB1	DIAGNOSTIC TROUBLE CODE (DTC) P0198		
	• DTC P0198 indicates EOT sensor circuit out of range high. Possible causes: — open in harness — damaged connection — damaged EOT sensor — damaged PCM • Disconnect EOT sensor harness connector. • Measure resistance between Pin 1 on the EOT connector and ground. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to DB2. REPAIR open in signal return circuit. RESTORE vehicle. CLEAR DTCs and RETEST.

Engine Oil Temperature (EOT) Sensor

DB

Test Step		Result ▶	Action to Take
DB2	INDUCE OPPOSITE FAILURE		
	● Key on, engine off. ● Jumper Pin 1 to Pin 2 on the EOT connector at harness connector. ● Key off. ● **Was DTC P0197 present?**	Yes ▶	REPLACE EOT sensor. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	GO to DB3.
DB3	CHECK CONTINUITY OF SENSOR SIGNAL AND SIG RTN CIRCUITS		
	● Install breakout box; leave PCM disconnected. ● Measure resistance between EOT connector Pin 2 and PCM Test Pin 38. ● **Is each resistance less than 5 ohms?**	Yes ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	REPAIR open in signal circuit. RESTORE vehicle. CLEAR DTCs and RETEST.
DB4	DIAGNOSTIC TROUBLE CODE (DTC) P0197		
	● DTC P0197 indicates EOT sensor circuit out of range low. Possible causes: — grounded circuit in harness — damaged EOT sensor — damaged PCM — damaged connection ● Disconnect EOT sensor harness connector. ● Run KOEO Self Test. ● **Is DTC P0198 present?**	Yes ▶	REPLACE EOT sensor. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	GO to DB5.
DB5	CHECK TEMPERATURE SENSOR SIGNAL CIRCUIT FOR SHORT TO GROUND		
	● Install breakout box; leave PCM disconnected. ● Measure resistance between PCM Test Pin 38 and PCM Test Pins 25, 51, 76, 77, 91 and 103. ● **Is each resistance greater than 10,000 ohms?**	Yes ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	REPAIR short to ground circuit. RESTORE vehicle. CLEAR DTCs and RETEST.

Engine Oil Temperature (EOT) Sensor

DB

Test Step		Result ▶	Action to Take
DB6	CONTINUOUS MEMORY DIAGNOSTIC TROUBLE CODE (DTC) P0198, OR P0197		
	• Continuous Memory DTC P0198 indicates EOT sensor circuit out of range high. The DTC was generated under normal driving conditions. Continuous Memory DTC P0197 indicates EOT sensor circuit out of range low. The DTC was generated under normal driving conditions. Possible causes: — worn or damaged EOT sensor — open circuit in harness — grounded circuit in harness — worn or damaged PCM • Key on, engine off. • Access EOT PID. • Tap on EOT sensor to simulate road shock, wiggle harness connector while observing NGS Tester value. • **Does EOT sensor value default to 100°C (212°F)?**	Yes ▶ No ▶	GO to DB9. GO to DB7.
DB7	CHECK VEHICLE HARNESS		
	• Access EOT PID. • Grasp the vehicle harness close to the EOT sensor connector. Wiggle and shake harness while working toward the PCM. • Key off. • **Did EOT sensor value default to 100°C (212°F)?**	Yes ▶ No ▶	REPAIR circuit as required. RESTORE vehicle. GO to DB8.
DB8	CHECK PCM AND VEHICLE HARNESS CONNECTORS		
	• Disconnect PCM. Inspect for damage, loose or pushed-out pins, loose or poorly crimped wires. • **Are connectors and terminals OK?**	Yes ▶ No ▶	Unable to duplicate or identify concern at this time. RESTORE vehicle. CLEAR DTCs and RETEST. REPAIR as necessary. RESTORE vehicle. CLEAR DTCs and RETEST.
DB9	INSPECT CONNECTOR PINS		
	• Disconnect EOT harness connector. • Inspect pins. • **Is a fault detected?**	Yes ▶ No ▶	REPAIR damaged pins as required. RESTORE vehicle. CLEAR DTCs and RETEST. REPLACE EOT sensor. RESTORE vehicle. CLEAR DTCs and RETEST.

Engine Oil Temperature (EOT) Sensor

DB

Test Step		Result ▶	Action to Take
DB10	DIAGNOSTIC TROUBLE CODE (DTC) P0196 OR P1184		
	• DTC P0196 or P1184 indicates that the engine oil temperature is not warm enough to perform a KOER Cylinder Contribution Self Test. The engine oil temperature must be greater than 74°C or 170°F (1.37 volts). Possible causes: — engine not fully warmed up — low oil level — cooling system failure — worn or damaged EOT sensor — faulty thermostat — EOT sensor circuit failure • Verify no KOEO DTCs are present. • Drive vehicle until thermostat opens. • Fully warm engine. • Check that upper radiator hose is hot and pressured. • Rerun KOER Cylinder Contribution Self Test • **Is DTC P0196 or P1184 present?**	Yes ▶ No ▶	GO to DB11. REPAIR other DTCs as necessary. RESTORE vehicle.
DB11	EOT SENSOR CHECK		
	• Key on, engine off. • Engine at normal operating temperature. • Access EOT PID. • Observe EOT PID while tapping on EOT sensor. • **Does EOT valve fluctuate or go below 74°C ([165°F) (1.37 volts)]?**	Yes ▶ No ▶	REPLACE EOT sensor. RESTORE vehicle. CLEAR DTCs and RETEST. GO to DB12.
DB12	VEHICLE HARNESS CHECK		
	• Observe EOT PID while performing the following: • Grasp the vehicle harness close to the EOT sensor connector. • Wiggle and shake vehicle harness while working toward PCM. • Key off. • **Did value fluctuate?**	Yes ▶ No ▶	REPAIR circuits as required. RESTORE vehicle. CLEAR DTCs and RETEST. GO to DB13.
DB13	CHECK PCM AND VEHICLE HARNESS CONNECTOR		
	• Disconnect EOT sensor and PCM harness connectors. • Inspect for damage, loose or pushed-out pins. • **Are connectors and terminals OK?**	Yes ▶ No ▶	Unable to duplicate or identify concern at this time. RESTORE vehicle. CLEAR DTCs and RETEST. REPAIR as required. RESTORE vehicle. CLEAR DTCs and RETEST.

Manifold Absolute Pressure (MAP) Sensor, Digital — 1998

DC

Signal Functions

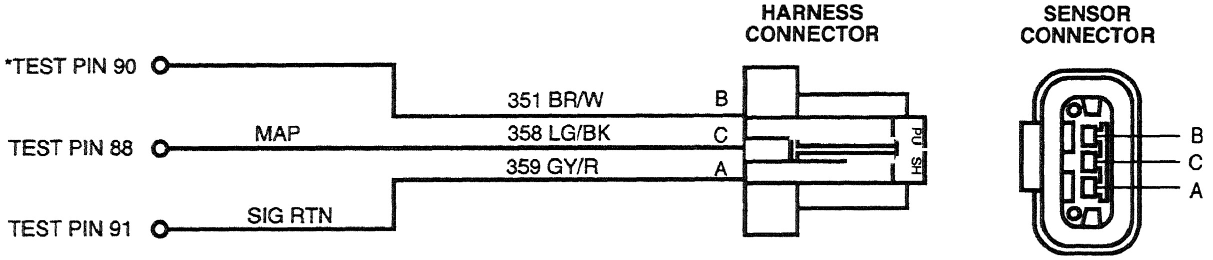
The manifold absolute pressure (MAP) sensor is a variable capacitance sensor that, when supplied with a 5-volt reference signal from the powertrain control module (PCM), produces a digital frequency signal that indicates pressure.

Smoke Control — The MAP signal is used to control smoke by limiting fuel quantity during acceleration until a specified boost pressure is obtained.

Dynamic Injection Timing — Optimizes injection timing for boost pressure measured.

Fault Detection/Management

A MAP signal that is detected by the PCM to be out of range or at an incorrect value for specific conditions will cause the PCM to ignore the MAP signal and operate the engine from an inferred boost pressure signal.



*TEST PINS LOCATED ON BREAKOUT BOX
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE

DA0408-B

Note

After removing connectors, always check for damaged pins, corrosion, loose terminals, etc.

DTC Descriptions

P0236 = Turbo Boost Sensor A Circuit Performance

P0237 = Turbo Boost Sensor A Circuit Low Input

P0238 = Turbo Boost Sensor A Circuit High Input

P1247 = Turbo Boost Pressure Low

P1248 = Turbo Boost Pressure Not Detected

Manifold Absolute Pressure (MAP) Sensor, Digital — 1998

DC

Hz	PSIA	KPA
94	10	70
102	12	83
109	14	97
111	14.7	101
116	16	110
123	18	124
130	20	138
138	22	152
145	24	166
152	26	179
159	28	193
167	30	207
174	32	221
181	34	234
188	36	248
195	38	262
203	40	276
210	42	290
217	44	303

Test Step		Result ▶	Action to Take
DC1	DIAGNOSTIC TROUBLE CODE (DTC) P0236, P1247 AND P1248		
	• DTC P0236 indicates a turbo boost sensor A circuit performance concern. DTCs P1247, P1248 indicate turbo boost pressure was low or not detected. Possible causes: — damaged MAP hose — low turbo boost — intake manifold or crossover tube hose leaks — damaged MAP sensor — damaged PCM • Inspect MAP sensor hose and manifolds for damage, leaks, restriction and misrouting. • **Are manifolds and MAP hose OK and free of damage?**	Yes ▶ No ▶	GO to DC2. REPAIR leak as necessary. RESTORE vehicle. CLEAR DTCs and RETEST.

Manifold Absolute Pressure (MAP) Sensor, Digital — 1998

DC

Test Step	Result ▶	Action to Take
DC2 MAP FREQUENCY CHECK		
• Disconnect MAP sensor harness connector. • Connect the MAP sensor tester between the harness connector and the MAP sensor. • Connect MAP sensor tester to a digital multimeter. Set digital multimeter to frequency scale. • Key on, engine off. • **Is frequency reading between 90 Hz and 115 Hz?**	Yes ▶ No ▶	GO to DC3. REPLACE MAP sensor. RESTORE vehicle. CLEAR DTCs and RETEST.
DC3 MAP SENSOR PRESSURE CHECK		
• Disconnect vacuum hose from MAP sensor. • Using Rotunda Pressure Adapter Kit 014-00761 or equivalent (gauge bar), apply 69 kPa (10 psi) of pressure to the MAP sensor. • Reconnect vacuum hose to MAP sensor. • **Was frequency reading 145 Hz ± 10 Hz?**	Yes ▶ No ▶	GO to DC4. REPLACE MAP sensor. RESTORE vehicle. CLEAR DTCs and RETEST.
DC4 MAP PERFORMANCE TEST		
• Disconnect MAP sensor vacuum hose from intake manifold and install a pressure (boost) gauge. • Road test vehicle and accelerate vehicle to achieve full boost. • **Is engine boost 82 kPa (12 psi) or greater?**	Yes ▶ No ▶	CLEAR DTCs and RETEST. If DTC returns, REPLACE ECM. RESTORE vehicle. INSPECT intake manifolds, crossover tubes for leaks. CHECK turbo condition. REFER to the Powertrain Group in the Workshop Manual.

Manifold Absolute Pressure (MAP) Sensor, Digital — 1998

DC

Test Step		Result ▶	Action to Take
DC5	KOEO DIAGNOSTIC TROUBLE CODE (DTC) P0237		
	● DTC P0237 indicates turbo boost sensor A circuit low input. Possible causes: — MAP signal circuit open, shorted to ground, shorted to B+, or shorted to VREF — open or shorted VREF circuit — open or shorted signal return circuit — damaged MAP sensor — damaged PCM ● Disconnect MAP sensor harness connector. ● Connect the MAP sensor tester between the vehicle harness connector and the MAP sensor. ● Insert the MAP sensor tester banana plugs into a digital multimeter. NOTE: Green light on tester indicates VREF is OK (4.5-5.5 volts) and signal return is OK. Red light indicates VREF is either too low or too high. No lights indicate VREF or signal return are open or shorted. ● Key on, engine off. ● Key off. ● **Was green light on?**	Yes ▶ No ▶	GO to DC6. Red light "less than 4V" on or no lights, GO to DC11. Red light "greater than 6V" on, GO to DC14.
DC6	MAP SIGNAL SHORT TO GROUND CHECK		
	● Install breakout box; leave PCM disconnected. ● Disconnect MAP sensor harness connector. ● Measure resistance between PCM Test Pin 34 (49 State except Econoline) or PCM Test Pin 88 (California and all Econoline) and PCM Test Pins 25, 51, 76, 77, 91, 103. ● **Is each resistance greater than 10,000 ohms?**	Yes ▶ No ▶	GO to DC7. REPAIR short to ground or signal return in MAP signal Circuit 358 (LG / BK). RESTORE vehicle. CLEAR DTCs and RETEST.
DC7	MAP SIGNAL SHORT TO VOLTAGE CHECK		
	● Key on, engine off. ● Measure voltage between PCM Test Pin 88 and PCM Test Pins 55, 71 and 97. ● Key off. ● **Was voltage present?**	Yes ▶ No ▶	REPAIR short to power in MAP signal Circuit 358 (LG / BK). RESTORE vehicles. CLEAR DTCs and RETEST. GO to DC8.
DC8	MAP SIGNAL SHORT TO VREF CHECK		
	● Measure resistance between PCM Test Pin 88 and PCM Test Pin 90. ● **Is resistance greater than 10,000 ohms?**	Yes ▶ No ▶	GO to DC9. REPAIR short to VREF in MAP signal Circuit 358 (LG / BK). RESTORE vehicle. CLEAR DTCs and RETEST.

Manifold Absolute Pressure (MAP) Sensor, Digital — 1998

DC

Test Step		Result ▶	Action to Take
DC9	MAP SIGNAL CONTINUITY CHECK		
	• Measure resistance between PCM Test Pin 88 and Circuit 358 (LG / BK) at the MAP harness connector. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to DC10. REPAIR open MAP signal Circuit 358 (LG / BK). RESTORE vehicle. CLEAR DTCs and RETEST.
DC10	PCM CHECK		
	• Connect PCM to breakout box. • Key on, engine off. • Measure voltage of Circuit 358 (LG / BK) at MAP harness connector. • **Is voltage reading 5 volts ± 0.5 V?**	Yes ▶ No ▶	REPLACE MAP sensor. RESTORE vehicle. CLEAR DTCs and RETEST. REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
DC11	VREF VOLTAGE CHECK		
	• Disconnect MAP sensor tester connector from MAP sensor, leaving it connected to harness. • Key on, engine off. • Key off. • **Was green light on tester on?**	Yes ▶ No ▶	REPLACE MAP sensor. RESTORE vehicle. CLEAR DTCs and RETEST. GO to DC12.
DC12	VREF CONTINUITY CHECK		
	• Install breakout box; leave PCM disconnected. • Disconnect MAP sensor tester from vehicle harness. • Measure resistance between PCM Test Pin 90 and Circuit 351 (BR / W) at MAP sensor connector. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to DC13. REPAIR open in VREF Circuit 351 (BR / W) between PCM and MAP sensor. RESTORE vehicle.
DC13	SIGNAL RETURN CONTINUITY CHECK		
	• Measure resistance between PCM Test Pin 88 and Circuit 359 (GY / R) at MAP sensor connector. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST. REPAIR open in signal return Circuit 359 (GY / R). RESTORE vehicle.
DC14	VREF SHORT TO B+ CHECK		
	• Install breakout box; leave PCM disconnected. • Key on, engine off. • Measure voltage between PCM Test Pin 90 and ground. • **Is voltage reading less than 0.25 V?**	Yes ▶ No ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST. REPAIR short to B+ in VREF circuit. RESTORE vehicle. CLEAR DTCs and RETEST.

Manifold Absolute Pressure (MAP) Sensor, Digital — 1998

DC

Test Step		Result ▶	Action to Take
DC15	KOEO DIAGNOSTIC TROUBLE CODE (DTC) P0238		
	● DTC P0238 indicates turbo boost sensor A circuit high input. Possible causes: — damaged MAP sensor — damaged PCM ● Disconnect MAP sensor harness connector. ● Connect the MAP sensor tester between the harness connector and the MAP sensor. ● Insert the MAP sensor tester banana plug into a digital multimeter. Set digital multimeter to frequency scale. ● Key on, engine off. ● **Is frequency reading above 125 Hz?**	Yes ▶ No ▶	REPLACE MAP sensor. RESTORE vehicle. CLEAR DTCs and RETEST. REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
DC16	CONTINUOUS DIAGNOSTIC TROUBLE CODE (DTC) P0237 OR P0235		
	NOTE: MAP connector has no letter identification. Refer to diagram at beginning of this pinpoint test for proper pin location. ● DTC P0237 indicates turbo boost sensor A circuit low input. The code was set during normal driving conditions. Possible causes: — MAP signal circuit open, shorted to ground, shorted to VREF — open in VREF circuit — open in signal return circuit — damaged MAP sensor — damaged PCM ● Disconnect MAP sensor harness connector. ● Connect MAP sensor tester between the vehicle harness connector and MAP sensor. ● Insert MAP sensor tester banana plug into a digital multimeter. ● Set digital multimeter to frequency scale. ● Key on, engine off. ● **Is frequency reading 110 Hz ± 5 Hz?**	Yes ▶ No ▶	GO to DC17. REPLACE MAP sensor. RESTORE vehicle.
DC17	MAP SENSOR CHECK		
	● Lightly tap on MAP sensor while monitoring frequency reading. ● **Does reading fluctuate?**	Yes ▶ No ▶	REPLACE MAP sensor. RESTORE vehicle. CLEAR DTCs and RETEST. GO to DC18.

Manifold Absolute Pressure (MAP) Sensor, Digital — 1998

DC

Test Step	Result ▶	Action to Take
DC18 MAP SENSOR PSI CHECK ● Apply 69 kPa (10 psi) of pressure with vacuum / pressure pump from Rotunda Pressure Adapter Kit 014-00761 or equivalent. ● Tap on sensor while monitoring frequency reading. ● Key off. ● **Does reading fluctuate?**	Yes ▶ No ▶	REPLACE MAP sensor. RESTORE vehicle. CLEAR DTCs and RETEST. GO to DC19.
DC19 SIGNAL RETURN HARNESS CHECK ● Measure resistance between Pin A on MAP sensor harness connector and ground. ● Observe the resistance value while performing the following: — Grasp the vehicle harness close to the sensor connector. Wiggle, shake vehicle harness while working towards the PCM. ● **Does resistance reading fluctuate?**	Yes ▶ No ▶	REPAIR intermittent open in Circuit 359 (GY / R) as required. RESTORE vehicle. CLEAR DTCs and RETEST. GO to DC20.
DC20 VREF CIRCUIT CHECK ● Key on, engine off. ● Measure voltage between Pin B on MAP sensor harness connector and ground. ● Observe VREF voltage (5 V ± 0.5) while performing the following: — Grasp the harness close to the sensor connector. — Wiggle and shake vehicle harness while working toward the PCM. ● Key off. ● **Did voltage value fluctuate?**	Yes ▶ No ▶	REPAIR intermittent open in Circuit 351 (BR / W) as required. RESTORE vehicle. CLEAR DTCs and RETEST. GO to DC21.
DC21 MAP SIGNAL WIRE CONTINUITY CHECK ● Install breakout box; leave PCM disconnected. ● Measure resistance between PCM Test Pin 88 and Circuit 358 (LG / BK) on MAP sensor harness connector. ● Observe resistance value while performing the following: — Grasp harness close to the sensor connector. — Wiggle and shake vehicle harness while working toward the PCM. ● **Does resistance stay below 5 ohms?**	Yes ▶ No ▶	GO to DC22. REPAIR intermittent open in Circuit 358 (LG / BK). RESTORE vehicle. CLEAR DTCs and RETEST.
DC22 MAP SIGNAL WIRE SHORT TO GND ● Measure resistance between PCM Test Pin 88 and PCM Test Pins 25, 51, 76, 77, 103. ● Perform harness shake test. ● **Does resistance value drop below 10,000 ohms?**	Yes ▶ No ▶	REPAIR intermittent short to ground in Circuit 358 (LG / BK). RESTORE vehicle. CLEAR DTCs and RETEST. GO to DC23.

Manifold Absolute Pressure (MAP) Sensor, Digital — 1998

DC

Test Step		Result ▶	Action to Take
DC23	MAP SIGNAL WIRE SHORT TO PWR		
	• Key on, engine off. • Measure voltage between PCM Test Pin 88 and ground. • Perform harness shake test. • **Does voltage reading go above 0 V?**	Yes ▶	REPAIR intermittent short to PWR in Circuit 358 (LG / BK). RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	Intermittent failure. Unable to VERIFY. RESTORE vehicle. CLEAR DTCs and RETEST.
DC24	CONTINUOUS DIAGNOSTIC TROUBLE CODE (DTC) P0238		
	• DTC P0238 indicates turbo boost sensor A circuit high input. This code was set under normal driving conditions. Possible causes: — damaged MAP sensor — damaged circuit • Disconnect MAP sensor harness connector. • Connect MAP sensor tester between the vehicle harness connector and MAP sensor. • Insert MAP sensor tester banana plug into a digital multimeter. • Set digital multimeter to frequency scale. • Key on, engine off. • Observe frequency reading while tapping on sensor. • **Does frequency reading go above 125 Hz?**	Yes ▶	REPLACE MAP sensor. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	GO to DC25.
DC25	CHECK MAP SENSOR		
	• Apply 69 kPa (10 psi) of pressure with vacuum / pressure pump from Rotunda Pressure Adapter Kit 014-00761 or equivalent. • Observe frequency reading while tapping on sensor. • **Does frequency reading go above 300 Hz?**	Yes ▶	REPLACE MAP sensor. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	GO to DC26.
DC26	MAP HARNESS CHECK		
	• Using a vacuum pump from Rotunda Pressure Adapter Kit 014-00761 or equivalent, apply 33 kPa (10 in-Hg) of vacuum. • Observe frequency reading while performing the following: — Grasp the vehicle harness close to the sensor connector. — Wiggle and shake the vehicle while working toward the PCM. • **Does frequency reading go above 300 Hz?**	Yes ▶	REPAIR intermittent circuit failure. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	Failure is intermittent. Unable to duplicate at this time. RESTORE vehicle. CLEAR DTCs and RETEST.

Injection Control Pressure (ICP) Sensor

DD

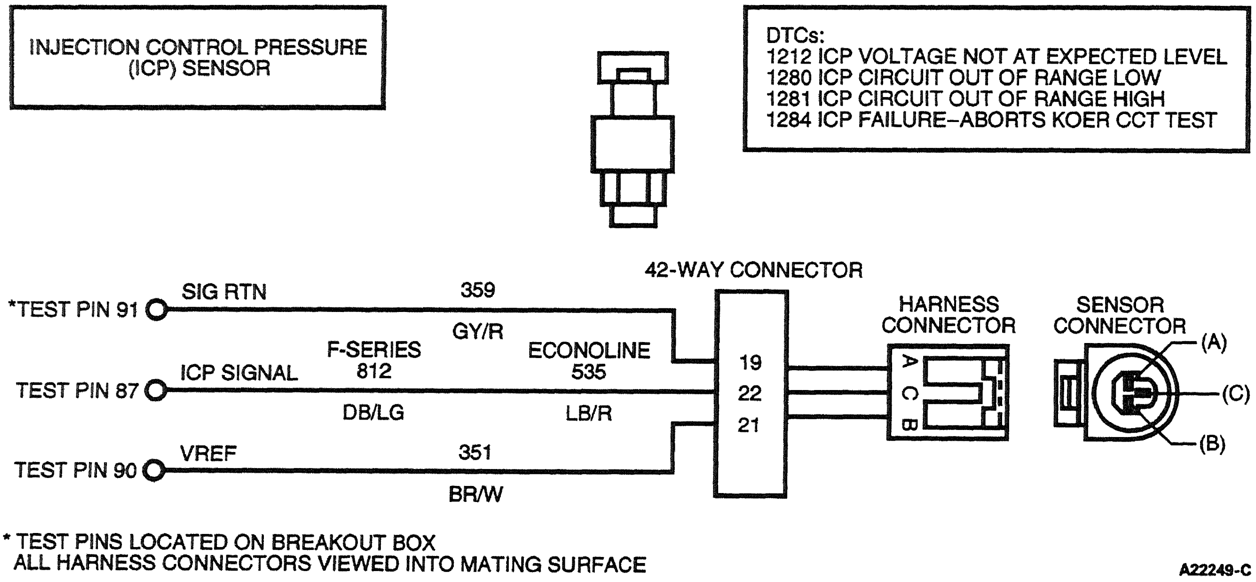
Signal Functions

The injection control pressure (ICP) sensor is a variable capacitance sensor that, when supplied with a 5-volt reference signal from the powertrain control module (PCM), produces a linear analog voltage signal that indicates pressure.

The ICP sensor's primary function is to provide a feedback signal to indicate rail pressure so that the PCM can command the correct injector timing and pulse width and the correct injection control pressure for proper fuel delivery at all speed and load conditions.

Detection/Management

If the PCM detects a malfunctioning ICP sensor the CHECK ENGINE light is illuminated and the PCM will go to open loop control of injection control pressure. (Operate from an estimated injection control pressure.)



* TEST PINS LOCATED ON BREAKOUT BOX
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE

Note

After removing connector, check for damaged pins, corrosion, loose terminals, etc.

DT Descriptions

P1212 = ICP voltage not at expected level

P1280 = ICP circuit out of range low

P1281 = ICP circuit out of range high

P1284 = ICP failure — aborts KOER Cylinder Contribution Self Test

Injection Control Pressure (ICP) Sensor

DD

Pressure (PSI)	Pressure (MPA)	Sensor Voltage
0	0	.02v
200	1.5	.4v
400	3	0.73v
600	4	.96v
800	5.5	1.2v
1000	7	1.4v
1200	8	1.6v
1400	9.7	1.9v
1600	11	2.1v
1800	12.4	2.3v
2000	13.8	2.6v
2200	15.2	2.8v
2400	16.5	3v
2600	18	3.3v
2800	19.3	3.5v
3000	20.6	3.8v

Test Step		Result ▶	Action to Take
DD1	DIAGNOSTIC TROUBLE CODE (DTC) P1280		
	● DTC P1280 indicates injector control signal circuit out of range low was detected during KOEO Self Test or during continuous diagnostic monitoring. Possible causes: — biased ICP sensor/PCM — open ICP sensor circuit — short to SIG RTN or PWR GND on ICP sensor circuit — open in VREF circuit ● Disconnect ICP sensor harness connector. ● Key on, engine off. ● Measure voltage between VREF Pin B and battery ground. ● **Is voltage between 4.5 and 5.5 volts?**	Yes ▶ No ▶	GO to DD2. REPAIR open in VREF Circuit 351 (BR/W). RESTORE vehicle. CLEAR DTCs and RETEST.
DD2	SIGNAL RETURN CIRCUIT CHECK		
	● Measure voltage between VREF Pin B and signal return Pin A. ● Key off. ● **Was voltage between 4.5 and 5.5 volts?**	Yes ▶ No ▶	GO to DD3. REPAIR open in signal return Circuit 359 (GY/R). RESTORE vehicle. CLEAR DTCs and RETEST.

Injection Control Pressure (ICP) Sensor

DD

Test Step		Result ▶	Action to Take
DD3	ICP SIGNAL CIRCUIT CHECK		
	• Install breakout box; leave PCM disconnected. • Measure resistance between PCM Test Pin 87 and Pin C at ICP sensor harness connector. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to DD4. REPAIR open in signal Circuit 812 (DB / LG) for F-Series or 535 (LB / R) for Econoline. RESTORE vehicle. CLEAR DTCs and RETEST.
DD4	VREF CIRCUIT CHECK		
	• Measure resistance between PCM Test Pin 90 and Pin B at ICP sensor harness connector. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to DD5. REPAIR open in VREF Circuit 351 (BR / W). RESTORE vehicle. CLEAR DTCs and RETEST.
DD5	SIGRTN CIRCUIT CHECK		
	• Measure resistance between PCM Test Pin 91 and Pin A at ICP sensor harness connector. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to DD6. REPAIR open in SIG RTN Circuit 359 (GY / R). RESTORE vehicle. CLEAR DTCs and RETEST.
DD6	SENSOR SIGNAL CIRCUIT SHORT TO GROUND		
	• Measure resistance between PCM Test Pin 87 and PCM Test Pins 25, 51, 76, 77, 91 and 103. • **Is resistance greater than 10,000 ohms?**	Yes ▶ No ▶	GO to DD7. REPAIR short to ground in signal wire Circuit 812 (DB / LG) for F-Series or 535 (LB / R) for Econoline. RESTORE vehicle. CLEAR DTCs and RETEST.
DD7	CHECK FOR SHORT ON PIN 87		
	• Connect breakout box to PCM. • Measure resistance between PCM Test Pin 87 and PCM Test Pins 25, 91, 51, 76, 77 and 103. • **Is resistance greater than 10,000 ohms?**	Yes ▶ No ▶	REPLACE ICP sensor. RESTORE vehicle. CLEAR DTCs and RETEST. REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
DD8	DIAGNOSTIC TROUBLE CODE (DTC) P1281		
	• DTC P1281 indicates injector control pressure circuit out of range high during KOEO Self Test or during continuous diagnostic monitoring. Possible causes: — biased ICP sensor / PCM — ICP circuit shorted to VREF • Key on, engine off. • Disconnect ICP harness connector. • Check DTCs. • Key off. • **Did DTC P1280 appear?**	Yes ▶ No ▶	REPLACE ICP sensor. RESTORE vehicle. CLEAR DTCs and RETEST. GO to DD9.

Injection Control Pressure (ICP) Sensor

DD

Test Step		Result ▶	Action to Take
DD9	CHECK FOR SHORT TO POWER ● Install breakout box; leave PCM disconnected. ● Measure resistance between PCM Test Pin 87 and PCM Test Pins 55, 71, 90 and 97. ● **Is resistance greater than 10,000 ohms?**	Yes ▶ No ▶	GO to DD10. REPAIR short to power in signal Circuit 812 (DB/LG) for F-Series or 535 (LB/R) for Econoline. RESTORE vehicle. CLEAR DTCs and RETEST.
DD10	CHECK FOR SHORT ON PIN 87 ● Connect PCM to breakout box. ● Measure resistance between PCM Test Pin 87 and PCM Test Pins 55, 71, 90 and 97. ● **Is resistance greater than 10,000 ohms?**	Yes ▶ No ▶	REPLACE ICP sensor. RESTORE vehicle. CLEAR DTCs and RETEST. REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
DD11	KOEO DIAGNOSTIC TROUBLE CODE (DTC) P1210 ● DTC P1210 indicates ICP signal voltage was greater than expected during KOEO On-Demand Self Test. Possible causes: — biased ICP sensor — open ICP signal return — signal circuit shorted to power — damaged PCM ● Disconnect ICP sensor harness connector. ● Measure resistance between signal return Circuit 359 (GY/R) Pin A and ground. ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to DD12. REPAIR open in signal return Circuit 359 (GY/R). RESTORE vehicle. CLEAR DTCs and RETEST.
DD12	CHECK SIGNAL CIRCUIT SHORT TO POWER ● Key on, engine off. ● Measure resistance between ICP signal circuit Pin C and ground. ● Key off. ● **Was voltage less than 0.25 volts?**	Yes ▶ No ▶	GO to DD13. REPAIR short to power in ICP signal circuit. RESTORE vehicle. CLEAR DTCs and RETEST.
DD13	ICP SENSOR CHECK ● Connect ICP sensor harness connector. ● Key on, engine off. ● Access ICP PID. ● **Is ICP reading 0 kPa (0 psi)?**	Yes ▶ No ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST. REPLACE ICP sensor. RESTORE vehicle. CLEAR DTCs and RETEST.

Injection Control Pressure (ICP) Sensor

DD

Test Step		Result ▶	Action to Take
DD14	CONTINUOUS DIAGNOSTIC TROUBLE CODE (DTC) P1212		
	NOTE: This code may set after a high-pressure oil system repair (i.e., injector change). Drive vehicle to clear air from system after repair, and clear code. ● Continuous DTC P1212 indicates that there was no ICP detected during crank (long crank time). Possible causes: — high-pressure oil system repair — empty / low oil reservoir at crank — low engine oil level or incorrect viscosity — IPR circuit fault — damaged low-pressure oil pump — damaged IPR valve — damaged ICP sensor — damaged high-pressure oil pump ● Check engine oil level. ● Perform KOEO On-Demand Self Test to verify ICP / IPR circuit faults are not present at this time. ● **Are KOEO DTCs present?**	Yes ▶	REPAIR KOEO DTCs before continuing. If DTC P1212 returns. GO to DD15.
		No ▶	GO to DD15.
DD15	CHECK OIL RESERVOIR LEVEL		
	NOTE: If vehicle stalls after start and reservoir empties, oil is not being supplied from low pressure oil system. ● Verify correct oil level, quality and viscosity. ● Check oil level in oil reservoir. ● Verify Steps 5 and 9 on the Hard Start / No Start Diagnostic Guide have been performed. ● Clear DTCs. ● Monitor ICP__V PID while cranking. ● **Is ICP__V reading at least 0.85 V within 5 seconds at crank?**	Yes ▶	DTC is intermittent. GO to DD19. If other DTCs are set, SERVICE them first.
		No ▶	GO to DD16.
DD16	CHECK ICP SENSOR		
	● Disconnect ICP sensor harness connector. ● **Does vehicle start?**	Yes ▶	REPLACE ICP sensor. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	GO to DD17.
DD17	HIGH-PRESSURE LEAKAGE TEST		
	● Connect ICP sensor harness connector. ● Clear ICP DTCs. ● Perform the Injection Control Pressure Leak Test per the procedures in Section 4C, Hard Start / No Start. ● **Is a leak fault indicated?**	Yes ▶	REPAIR condition causing the leak as necessary. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	GO to DD18.

Injection Control Pressure (ICP) Sensor

DD

Test Step		Result	▶	Action to Take
DD18	IPR VALVE CHECK			
	● Connect all hoses and ICP sensor harness connector. ● Replace IPR valve. ● Refill oil reservoir. ● **Does vehicle start?**	Yes	▶	IPR valve was faulty. RESTORE vehicle. CLEAR DTCs and RETEST.
		No	▶	REPLACE the high pressure pump. RESTORE vehicle. CLEAR DTCs and RETEST.
DD19	CHECK FOR INTERMITTENT CIRCUIT FAULTS			
	● Key on, engine off. ● Access ICP PID. ● Grasp the vehicle harness close to the sensor connector. Wiggle, shake vehicle harness while working towards the PCM. ● **Does ICP reading fluctuate?**	Yes	▶	REPAIR circuit as required. CLEAR DTCs and RETEST.
		No	▶	GO to **DD20**.
DD20	INSPECT IPR CIRCUIT			
	● Inspect IPR circuit from IPR valve through 42-way connector to the PCM. ● **Are any faults indicated?**	Yes	▶	REPAIR circuit as required. RESTORE vehicle. CLEAR DTCs and RETEST.
		No	▶	Unable to verify concern at this time. RESTORE vehicle. CLEAR DTCs and RETEST.
DD21	DIAGNOSTIC TROUBLE CODE (DTC) P1284			
	● DTC P1284 indicates that a ICP circuit failure was present while trying to perform KOER Cylinder Contribution Self Test. ● Perform KOEO On-Demand Self Test. ● **Is a ICP circuit fault indicated?**	Yes	▶	REFER to appropriate Pinpoint Test for ICP DTC retrieved.
		No	▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
DD22	CONTINUOUS DIAGNOSTIC TROUBLE CODE P1210			
	● Continuous DTC P1210 indicates ICP signal voltage was greater than expected with key on during normal driving conditions. Possible causes: — biased ICP sensor — open ICP signal return circuit — ICP signal circuit shorted to power ● Perform KOEO On-Demand Self Test. ● **Are KOEO ICP codes present?**	Yes	▶	REPAIR KOEO codes before continuing. If DTC P1210 is still present, GO to **DD23**.
		No	▶	DTC is intermittent. GO to **DD23**.

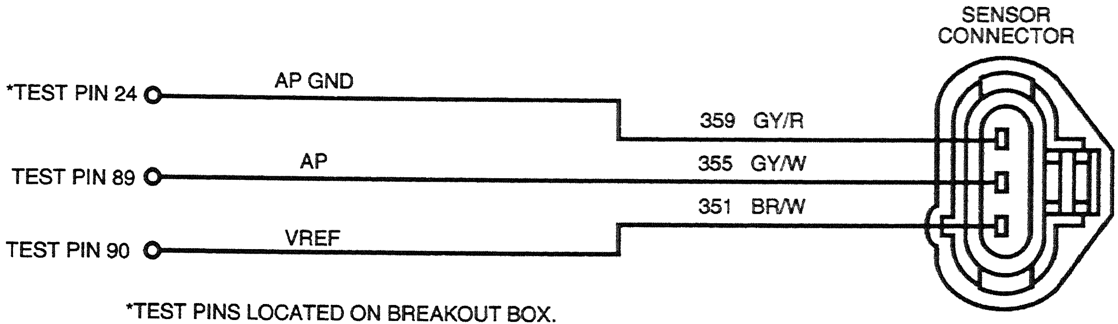
Injection Control Pressure (ICP) Sensor

DD

Test Step	Result ▶	Action to Take
DD23 ICP SIGNAL GROUND CIRCUIT CHECK		
• Key off. • Disconnect ICP sensor harness connector. • Install breakout box; leave PCM disconnected. • Measure resistance between signal return Circuit 359 (GY / R) Pin A and PCM Test Pin 91. • Observe resistance while performing the following. — Grasp the harness close to the sensor connector. Wiggle and shake vehicle harness while working toward the PCM. • Key off. • **Does resistance value stay below 5 ohms?**	Yes ▶ No ▶	GO to DD24. REPAIR intermittent open in Circuit 359 (GY / R). RESTORE vehicle. CLEAR DTCs and RETEST.
DD24 ICP CIRCUIT SHORT TO POWER CHECK		
• Key on, engine off. • Measure voltage between PCM Test Pin 87 and ground. • Observe voltage while performing the following: — Grasp the harness close to the sensor connector. Wiggle and shake harness while working toward PCM. • **Is voltage ever present?**	Yes ▶ No ▶	REPAIR intermittent short to power on SIG RETURN circuit. RESTORE vehicle. CLEAR DTCs and RETEST. GO to DD25.
DD25 ICP SENSOR CIRCUIT CHECK		
• Reconnect ICP sensor harness connector. • Remove breakout box; reconnect PCM. • Clear ICP DTC. • Key on, engine off. • Lightly tap ICP sensor. • **Does code P1210 reappear?**	Yes ▶ No ▶	REPLACE ICP sensor. RESTORE vehicle. CLEAR DTCs and RETEST. DTC is intermittent. Cannot duplicate failure at this time. RESTORE vehicle. CLEAR DTCs and RETEST.

Accelerator Pedal (AP) Sensor

DE



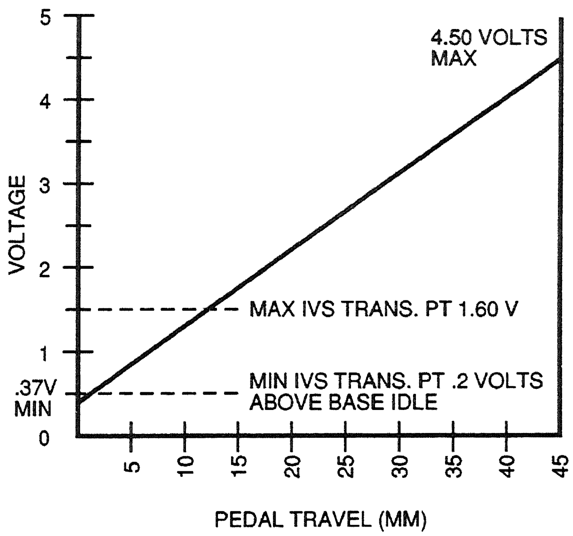
*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

DA0409-B

Signal Functions

The accelerator pedal (AP) sensor provides the powertrain control module (PCM) with the driver's demand for power.

The AP signal is used in calculating desired fuel quantity, injection timing and injection control pressure.



A23888-B

NOTE: Base idle should be no lower than 0.5 volts.

DTC Descriptions

P0122 = AP sensor circuit low input

P0123 = AP sensor circuit high input

P0220 = Throttle Switch B circuit malfunction

Accelerator Pedal (AP) Sensor

DE

P0221 = Throttle Switch B circuit performance

Fault Detection / Management

Any detected malfunction of the AP sensor will illuminate the CHECK ENGINE light.

An AP signal that is detected out of range high or low by the PCM will cause the engine to ignore the AP signal and will only allow the engine to operate at low idle.

If a disagreement in the state of idle validation switch (IVS) and AP sensor is detected by the PCM, the engine will only be allowed to operate at low idle.

Test Step		Result ▶	Action to Take
DE1	DIAGNOSTIC TROUBLE CODE (DTC) P0123		
	● DTC P0123 indicates AP sensor circuit high input. Possible causes are: — damaged accelerator pedal assembly — AP sensor may not be seated properly (tightened down) — damaged AP sensor — short to power in harness — damaged PCM ● Key on, engine off. ● Access AP PID. ● Slowly depress accelerator pedal while observing voltage reading on scan tool. ● **Does reading go above 4.5 V?**	Yes ▶ No ▶	GO to DE2. CLEAR DTCs and RETEST.
DE2	INDUCE OPPOSITE FAILURE		
	● Disconnect AP sensor harness connector. ● **Does AP voltage read 0 V?**	Yes ▶ No ▶	Circuit OK. REPLACE accelerator pedal assembly. RESTORE vehicle. CLEAR DTCs and RETEST. GO to DE3.
DE3	CHECK AP SENSOR SIGNAL WIRE		
	● AP sensor disconnected. ● Key on, engine off. ● Measure voltage between AP signal wire at harness connector and ground. ● Key off. ● **Was voltage above 4.5 V?**	Yes ▶ No ▶	GO to DE4. REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
DE4	CHECK AP CIRCUIT FOR SHORTS TO POWER		
	● Install breakout box; leave PCM disconnected. ● Key on, engine off. ● Measure voltage between PCM Test Pin 89 and ground. ● **Is voltage present?**	Yes ▶ No ▶	REPAIR short to power in Circuit 355 (GY/W). RESTORE vehicle. CLEAR DTCs and RETEST. REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.

Accelerator Pedal (AP) Sensor

DE

Test Step		Result ►	Action to Take
DE5	DIAGNOSTIC TROUBLE CODE (DTC) P0122		
	• DTC P0122 indicates the AP sensor circuit low input. Possible causes: — AP sensor may not be seated properly (tightened down) — damaged AP sensor — open harness — grounded harness — damaged PCM • Key on, engine off. • Access AP PID. • Depress accelerator pedal while observing voltage reading on scan tool. • Key off. • **Did voltage drop below 0.37 V?**	Yes ► No ►	GO to DE6. Unable to duplicate and / or identify concern at this time. RESTORE vehicle. CLEAR DTCs and RETEST.
DE6	INDUCE OPPOSITE FAILURE		
	• Disconnect AP sensor harness connector. • Jumper VREF pin to AP signal wire. • Key on, engine off. • **Does scan tool display stay on and read over 4.5 V?**	Yes ► No ►	REPLACE accelerator pedal assembly. RESTORE vehicle. CLEAR DTCs and RETEST. GO to DE7.
DE7	CHECK VREF CIRCUIT VOLTAGE		
	• Measure voltage between VREF circuit and ground. • Key off. • **Was voltage 5 V ± 0.5?**	Yes ► No ►	GO to DE8. REPAIR open in VREF Circuit 351 (BR / W). RESTORE vehicle. CLEAR DTCs and RETEST.
DE8	CHECK AP GROUND CIRCUIT		
	• Measure resistance between AP ground circuit and ground. • **Is resistance less than 5 ohms?**	Yes ► No ►	GO to DE9. REPAIR open in AP ground Circuit 837 (Y / BK). RESTORE vehicle. CLEAR DTCs and RETEST.
DE9	CHECK AP CIRCUIT CONTINUITY		
	• Install breakout box; leave PCM disconnected. • Measure resistance between AP circuit at the harness connector and PCM Test Pin 89. • **Is the resistance less than 5 ohms?**	Yes ► No ►	GO to DE10. REPAIR open in AP signal Circuit 355 (GY / W). RESTORE vehicle. CLEAR DTCs and RETEST.
DE10	CHECK AP CIRCUIT FOR SHORTS TO GROUND		
	• Measure resistance between PCM Test Pin 89 and PCM Test Pins 51, 76, 77, 91 and 103. • **Is each resistance greater than 10,000 ohms?**	Yes ► No ►	GO to DE11. REPAIR short to ground in AP sensor signal Circuit 355 (GY / W). RESTORE vehicle. CLEAR DTCs and RETEST.

Accelerator Pedal (AP) Sensor

DE

Test Step	Result ▶	Action to Take
DE11 VREF CIRCUIT CONTINUITY CHECK ● Measure resistance between VREF circuit at harness connector and PCM Test Pin 90. ● **Is resistance less than 5 ohms?**	Yes ▶	GO to E12.
	No ▶	REPAIR open in VREF Circuit 351 (BR / W). RESTORE vehicle. CLEAR DTCs and RETEST.
DE12 SIGNAL RETURN CIRCUIT CONTINUITY CHECK ● Measure resistance between AP ground circuit at harness connector and PCM Test Pin 24. ● **Is resistance less than 5 ohms?**	Yes ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
	No ▶	REPAIR open in AP ground Circuit 837 (Y / BK). CLEAR DTCs and RETEST.

Exhaust Back Pressure (EBP) Sensor

DF

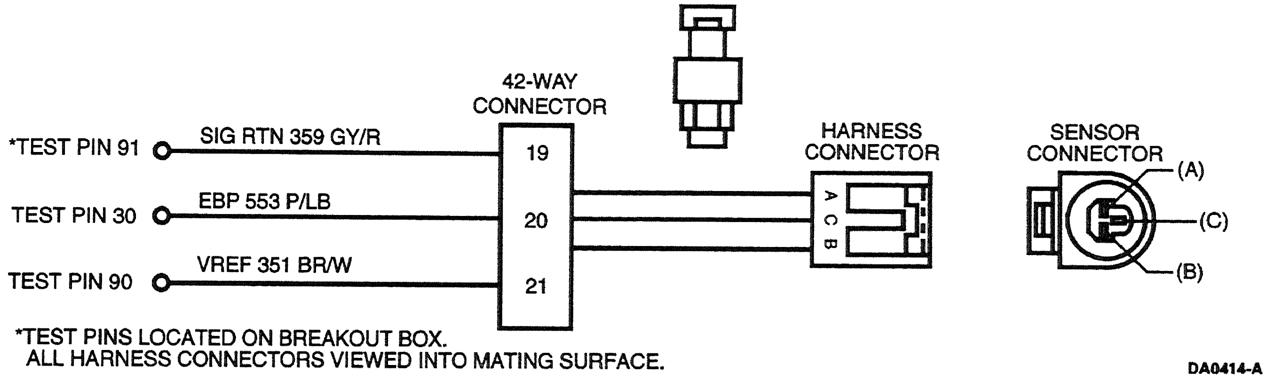
Signal Functions

The exhaust back pressure (EBP) sensor is a variable capacitance sensor that, when supplied with a 5-volt reference signal from the powertrain control module (PCM), produces a linear analog voltage signal that indicates pressure.

The EBP sensor's primary function is to measure exhaust back pressure so that the PCM can control the exhaust back pressure regulator (EPR) when needed.

Detection/Management

An EBP signal that is detected out of range (high or low) by the PCM will cause the engine to ignore the EBP signal and disable exhaust back pressure operation.



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

Note

After removing connectors always check for damaged pins, corrosion, loose terminals, etc.

DTC Descriptions

P0470 = EBP sensor circuit malfunction

P0471 = EBP sensor circuit performance

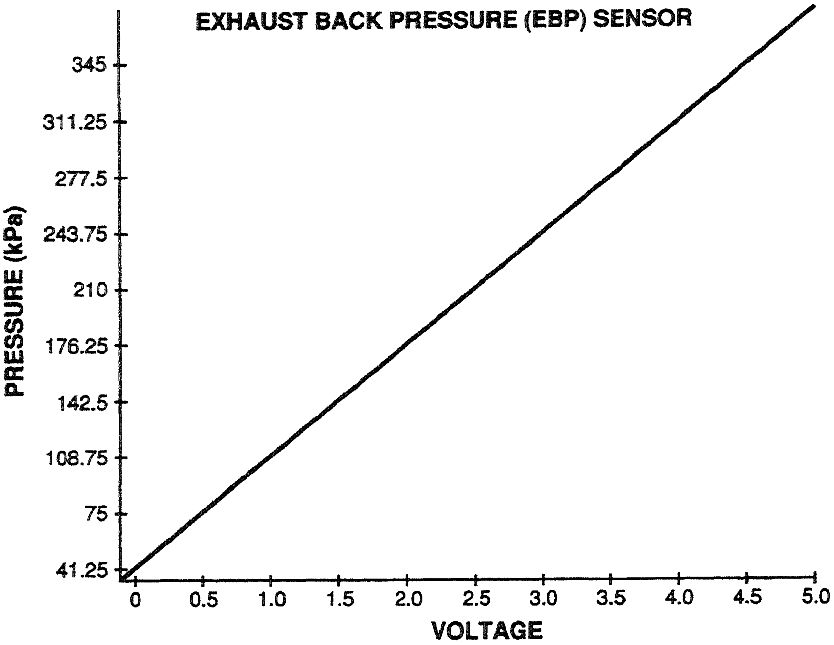
P0472 = EBP sensor circuit low input

P0473 = EBP sensor circuit high input

Exhaust Back Pressure (EBP) Sensor

DF

P0478 = Exhaust pressure control valve high input



A22224-A

kPa	EBP (Volts)
0	0
55.16	0.25
137.9	1.45
344.75	4.45
365.44	4.75
413.7	5.00

In Hg	PSI
0	0
16.38	8
40.94	20
102.36	50
108.50	53
122.83	60

Test Step	Result ▶	Action to Take
DF1 DIAGNOSTIC TROUBLE CODE (DTC) P0470		
● DTC P0470 indicates an EBP sensor malfunction was detected during KOEO On-Demand Self Test. Possible causes: — damaged EBP sensor — open signal ground — damaged PCM ● Key on, engine off. ● Select EBP PID. ● Key off. ● **Was EBP reading below 127 kPa (18.5 psi)?**	Yes ▶ No ▶	CLEAR DTC and RERUN KOEO On-Demand Self Test. If code is still present, REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST. GO to **DF2**.

Exhaust Back Pressure (EBP) Sensor

DF

Test Step		Result ▶	Action to Take
DF2	SIGNAL GROUND CIRCUIT CHECK		
	● Disconnect EBP sensor harness connector. ● Measure resistance from Pin A Circuit 359 (GY / R) to chassis ground. ● **Is resistance less than 5 ohms?**	Yes ▶	REPLACE EBP sensor. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	REPAIR open in signal return Circuit 359 (GY / R). RESTORE vehicle. CLEAR DTC and RETEST.
DF3	CONTINUOUS DIAGNOSTIC TROUBLE CODE (DTC) P0470		
	● Continuous DTC P0470 indicates an exhaust back pressure malfunction was detected during normal driving conditions. Possible causes: — damaged EBP sensor — damaged connection — damaged PCM ● Select EBP PID. ● Observe the PID while performing the following: — Grasp the vehicle harness close to the EBP sensor connector. — wiggle and shake the vehicle harness while working toward the PCM. ● Key off. ● **Does the EBP reading fluctuate?**	Yes ▶	ISOLATE intermittent connection problem. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	GO to DF4.
DF4	CONNECTOR INSPECTION		
	● Disconnect EBP sensor harness connector. ● Inspect connector terminals and sensor terminals for signs of poor connection or corrosion. ● Inspect connections at the 42-way and PCM connectors. ● **Are all connections good?**	Yes ▶	Unable to verify problem at this time. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	REPAIR connection concern as required. RESTORE vehicle. CLEAR DTCs and RETEST.

Exhaust Back Pressure (EBP) Sensor

DF

Test Step		Result ▶	Action to Take
DF5	DIAGNOSTIC TROUBLE CODE (DTC) P0471		
	• DTC P0471 indicates an EBP range / performance problem was detected during normal driving conditions when EBP is enabled. Possible causes: — damaged EBP sensor — plugged or restricted sensor supply tube — EPR linkage or butterfly damage — damaged PCM • Perform KOER On-Demand Self Test. If codes are present, repair them before continuing. • Select EBP PID. • Road test vehicle performing hard accelerations while monitoring the PID. • **Does EBP increase and go above 25 psi with EBP device on?**	Yes ▶ No ▶	Unable to duplicate failure. RESTORE vehicle. CLEAR DTC and RETEST. GO to DF6.
DF6	INSPECT FOR EXHAUST LEAKS		
	• Inspect turbo pipe, crossover pipes, and exhaust manifolds for leaks. • **Are exhaust leaks present?**	Yes ▶ No ▶	REPAIR exhaust leak. RESTORE vehicle. CLEAR DTCs and RETEST. GO to DF7.
DF7	SENSOR SUPPLY TUBE CHECK		
	• Inspect the EBP sensor supply tube from the exhaust manifold to the sensor bracket for damage. • Verify tube is not plugged or restricted. • **Is tube OK?**	Yes ▶ No ▶	GO to DF8. REPLACE tube. RESTORE vehicle. CLEAR DTC and RETEST.
DF8	EBP SENSOR CHECK		
	• Disconnect EBP sensor harness connector. • Install ICP / EBP Adapter Cable D94T-50-A or equivalent between EBP sensor and vehicle harness. • Engine running. • Measure voltage between signal circuit and signal ground on ICP / EBP Adapter Cable D94T-50-A or equivalent. • Accelerate engine to WOT several times. • **Is a minimum reading of 1.35 V present during acceleration?**	Yes ▶ No ▶	RESTORE vehicle. CLEAR DTC and RETEST. If code reappears REPLACE PCM. REPLACE EBP sensor. RESTORE vehicle. CLEAR DTC and RETEST.

Exhaust Back Pressure (EBP) Sensor

DF

Test Step		Result ▶	Action to Take
DF9	DIAGNOSTIC TROUBLE CODE (DTC) P0472 ● DTC P0472 indicates EBP sensor circuit low input was detected during KOEO Self Test or during continuous diagnostic monitoring. Possible causes: — open EBP sensor circuit — biased sensor / PCM — short to SIGN RTN or PWR GND on EBP sensor circuit — open in VREF circuit ● Disconnect EBP sensor harness connector. ● Key on, engine off. ● Measure voltage between Pin B Circuit 351 (BR / W) on harness connector and battery ground. ● Key off. ● **Was voltage reading 5 V ± 0.5?**	Yes ▶ No ▶	GO to DF10. REPAIR open in VREF Circuit 351 (BR / W). RESTORE vehicle. CLEAR DTCs and RETEST.
DF10	SIG RTN CIRCUIT CHECK ● Measure resistance between Pin A Circuit 359 (GY / R) and ground. ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to DF11. REPAIR open in SIG RTN Circuit 359 (GY / R). RESTORE vehicle. CLEAR DTCs and RETEST.
DF11	EBP SIGNAL CIRCUIT CHECK ● Install breakout box; leave PCM disconnected. ● Measure resistance between PCM Test Pin 30 and Pin C Circuit 553 (P / LB) at EBP sensor harness connector. ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to DF12. REPAIR open in EBP signal wire Circuit 553 (P / LB). RESTORE vehicle. CLEAR DTCs and RETEST.
DF12	VREF CIRCUIT CHECK ● Measure resistance between PCM Test Pin 90 and Pin B Circuit 351 (BR / W) at EBP sensor harness connector. ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to DF13. REPAIR open in EBP VREF (Circuit 351 [BR / W]). RESTORE vehicle. CLEAR codes and RETEST.
DF13	GROUNDED EBP SIGNAL CIRCUIT CHECK ● Measure resistance between PCM Test Pin 30 and PCM Test Pins 25, 91, 51, 76, 77 and 103. ● **Is resistance greater than 10,000 ohms?**	Yes ▶ No ▶	GO to DF14. REPAIR short to ground in EBP signal wire Circuit 533 (P / LB). RESTORE vehicle. CLEAR DTCs and RETEST.

Exhaust Back Pressure (EBP) Sensor

DF

Test Step	Result ▶	Action to Take
DF14 CHECK FOR INTERNAL PCM SHORT ON PIN 30		
• Connect PCM to breakout box. • Measure resistance between PCM Test Pin 30 and PCM Test Pins 25, 91, 51, 76, 77 and 103. • **Is resistance greater than 10,000 ohms?**	Yes ▶ No ▶	REPLACE EBP sensor. RESTORE vehicle. CLEAR DTCs and RETEST. REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
DF15 DIAGNOSTIC TROUBLE CODE (DTC) P0473		
• DTC P0473 indicates EBP sensor circuit high input detected during KOEO On-Demand Self Test or during continuous diagnostic monitoring. Possible causes: — biased sensor / PCM — EBP circuit shorted to VREF — induce opposite DTC • Disconnect EBP sensor harness connector. • Key on, engine off. • Perform KOEO On-Demand Self Test. • Key off. • **Did DTC P0472 appear?**	Yes ▶ No ▶	REPLACE EBP sensor. RESTORE vehicle. CLEAR DTCs and RETEST. GO to DF16.
DF16 CHECK SHORT TO POWER ON PIN 30		
• Install breakout box; leave PCM disconnected. • Measure resistance between PCM Test Pin 30 and PCM Test Pins 90, 97, 71 and 55. • **Is resistance greater than 10,000 ohms?**	Yes ▶ No ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST. REPAIR short to power in EBP signal Circuit 553 (P / LB). RESTORE vehicle. CLEAR DTCs and RETEST.
DF17 CONTINUOUS DIAGNOSTIC TROUBLE CODE P0478		
• DTC P0478 indicates an excessive back pressure condition existed during normal driving. • Possible causes: — stuck EBP butterfly valve — restricted exhaust — plugged EBP sensor line — misadjusted EPR linkage — F-Series wastegate turbo may be overboosting • Access PIDs MGP and RPM. • Road test vehicle selecting the best gear to achieve a 2500-3000 rpm acceleration. • Note the highest boost pressure. This is best accomplished either climbing a hill or with the truck fully loaded. • **Does MGP read 18 psi for over 5 seconds?**	Yes ▶ No ▶	GO to KL5. GO to DF18.

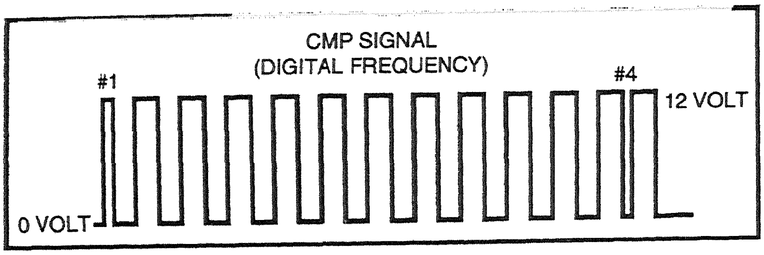
Exhaust Back Pressure (EBP) Sensor

DF

Test Step		Result ▶	Action to Take
DF18	INSPECT BUTTERFLY TANG		
	● Visually inspect butterfly tang. Refer to Section 4A or Section 4B, Diagnostic Routines, Performance Diagnostic Procedures, Exhaust Restriction for exhaust back pressure regulator tang position illustration. ● **Does tang reflect an open position?**	Yes ▶	GO to DF19.
		No ▶	REPAIR damaged linkage or butterfly valve as required. RESTORE vehicle. CLEAR DTCs and RETEST
DF19	EXHAUST RESTRICTION CHECK		
	● Select EBP PID. ● Engine running. ● Accelerate engine to WOT while observing scan tool reading. ● **Is EBP reading below 193 kPa (28 psi)?**	Yes ▶	GO to DF20.
		No ▶	REPAIR restricted exhaust. RESTORE vehicle. CLEAR DTCs and RETEST.
DF20	EBP SYSTEM CHECK		
	● Engine cold. EOT below 21°C (70°F) and IAT below 7°C (45°F). ● Road test vehicle while monitoring EBP reading on scan tool. ● Observe reading while back pressure device is on. ● **Does scan tool reading stay below 345 kPa (50 psi)?**	Yes ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	CHECK EPR linkage adjustment. REFER to Powertrain Group in the Workshop Manual. RESTORE vehicle.

Camshaft Position (CMP) Sensor

DG



DA0412-A

Signal Functions

The camshaft position (CMP) sensor is a Hall-effect type sensor that generates a digital frequency, as windows in a target wheel pass through its magnetic field. The frequency of the windows passing by the sensor as well as the width of selected windows allows the powertrain control module (PCM) to detect engine speed and position.

Engine Speed — Is determined by counting the 12 windows on the cam gear each camshaft revolution.

Fuel Timing Control — The position of cylinders No. 1 and No. 4 is determined by distinguishing a narrow or wide window on the camshaft gear.

Engine Mode Selection — Allows the PCM to discern when the engine is in the off, crank or run mode.

Injection Control Pressure — Engine speed is one of the controlling variables in the calculation of desired injection control pressure.

Exhaust Back Pressure — Exhaust back pressure control is a function of engine speed and load.

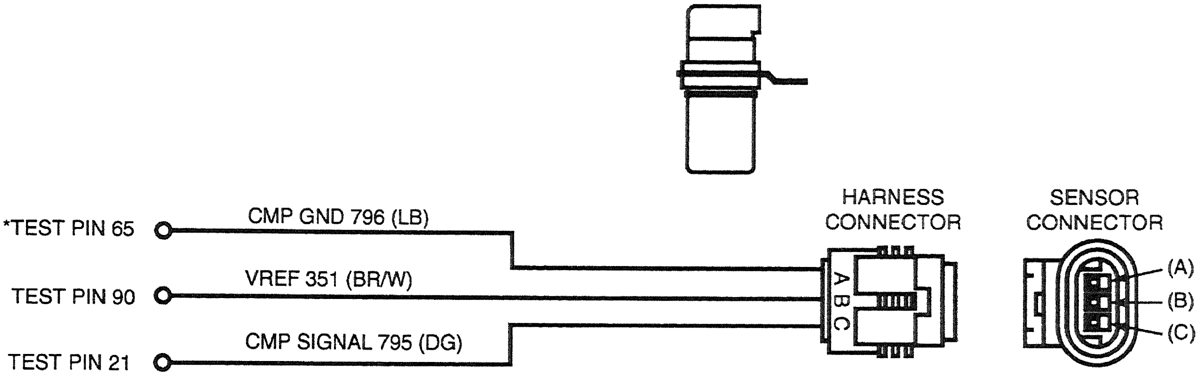
Camshaft Position (CMP) Sensor

DG

Fuel Quantity Control/Torque Limiting — Engine torque and fuel is controlled and is dependent on engine speed. Fuel quantity is determined by engine speed.

Detection/Management

An inactive CMP signal during cranking is detectable by the PCM. An inactive CMP signal will cause a no start condition. Electrical noise can also be detected by the PCM. If the level is sufficient to effect engine operation, a corresponding DTC will be set.



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

DA0413-B

Note

After removing connectors, always check for damaged pins, corrosion, loose terminals, etc.

DTC Descriptions

P0340 = CMP sensor circuit malfunction

P0341 = CMP sensor circuit performance

P0344 = CMP sensor circuit intermittent

Test Step		Result ▶	Action to Take
DG1	CLEAR AND ATTEMPT TO REGENERATE DTC P0344, P0341 OR P0340		
	● Clear Continuous Memory DTCs. ● Select RPM PID. ● Crank engine while monitoring RPM PID. ● **Does PID indicate crank RPM?**	Yes ▶ No ▶	GO to DG2. GO to DG3.

Camshaft Position (CMP) Sensor

DG

Test Step	Result ▶	Action to Take
DG2 RETRIEVE CLEAR CONTINUOUS DTCs ● Warm up engine to normal operating temperature. ● Increase rpm to 3300 rpm for 2 minutes. ● Key on, engine off. ● Retrieve / Clear Continuous DTCs. ● Key off. ● **Was DTC P0344 or P0341 present?**	Yes ▶ No ▶	GO to DG3. GO to DG12.
DG3 CHECK CMP SIGNAL RETURN CIRCUIT 796 (LB) ● Disconnect CMP sensor. ● Measure resistance between Pin A on CMP connector and chassis ground. ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to DG4. GO to DG9.
DG4 CHECK CMP CIRCUIT 351 (BR/W) FOR VREF ● Key on, engine off. ● Measure voltage between Pin B on CMP connector and chassis ground. ● **Is 5 volts ± 0.5 volts present?**	Yes ▶ No ▶	GO to DG5. REPAIR VREF circuitry. RESTORE vehicle. GO to C1.
DG5 CHECK CMP CIRCUIT 795 (DG) FOR B+ ● Measure voltage between Pin C on CMP connector and chassis ground. ● Key off. ● **Was B+ present?**	Yes ▶ No ▶	GO to DG6. GO to DG7.
DG6 CHECK CMP CIRCUIT 795 (DG) FOR SHORT TO B+ ● Disconnect PCM harness connector. ● Key on, engine off. ● Measure voltage between Pin C on CMP connector and chassis ground. ● **Is B+ present?**	Yes ▶ No ▶	REPAIR short to B+ in Circuit 795 (DG). RESTORE vehicle. CLEAR DTCs and RETEST. REPLACE CMP sensor. RESTORE vehicle. CLEAR DTCs and RETEST.
DG7 CHECK CIRCUIT 795 (DG) FOR SHORT TO GROUND ● Disconnect PCM harness connector. ● Measure resistance between Pin C on CMP connector and chassis ground. ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	REPAIR short to ground in Circuit 795 (DG). RESTORE system. CLEAR DTCs and RETEST. GO to DG8.
DG8 CHECK CIRCUIT 795 (DG) FOR OPEN ● Install breakout box; leave PCM disconnected. ● Measure resistance between Pin C on CMP connector and PCM Test Pin 21. ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	Open is at PCM Pin 49. SERVICE as necessary. RESTORE system. GO to DG11. REPAIR open in Circuit 795 (DG). RESTORE system. CLEAR DTCs and RETEST.

Camshaft Position (CMP) Sensor

DG

Test Step		Result ▶	Action to Take
DG9	CHECK FOR OPEN IN CMP GROUND CIRCUIT 796 (LB)		
	• Disconnect PCM harness connector. • Install breakout box; leave PCM disconnected. • Measure resistance between PCM Test Pin 65 and Pin A on CMP connector. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to DG10. REPAIR open in Circuit 796 (LB). RESTORE system. CLEAR DTCs and RETEST.
DG10	CHECK FOR CMP GROUND THROUGH PCM		
	• Connect PCM to breakout box. • Measure resistance between PCM Test Pins 25, 51, 76, 77 and 103 and ground. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	PCM internal ground not supplied to Pin 65. RESTORE system. GO to DG11. REPAIR open in Circuit 570 (BK / W) and Circuit 57 (BK) as required. RESTORE system. CLEAR DTCs and RETEST.
DG11	CONFIRM PCM FAULT		
	• Perform Steps DG1 and DG2. • **Are faults still present?**	Yes ▶ No ▶	REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST. System is OK. RESTORE system.
DG12	FIND INTERMITTENT		
	• Install breakout box; connect PCM to breakout box. • Remove IDM relay from engine compartment power distribution box. • Key on, engine off. • Connect digital multimeter between PCM Test Pin 21 and PCM Test Pin 65. • Rotate engine by hand until voltage toggles from B+ to between 0.3 and 2.7 volts. • **Did lower voltage toggle fall between 0.3 and 2.8 volts?**	Yes ▶ No ▶	GO to DG13. GO to DG3.
DG13	CHECK HARNESSES FOR INTERMITTENT		
	• Connect digital multimeter between PCM Test Pin 21 and PCM Test Pin 65. • Rotate engine by hand until voltage stays at lower toggle of between 0.3 and 2.7 volts. • Wiggle harnesses and watch for voltage jump to B+ or 0.0 volts. • **Did voltage jump to B+ or 0.0 volts?**	Yes ▶ No ▶	DETERMINE source of intermittent and REPAIR. RESTORE vehicle. CLEAR DTCs and RETEST. Intermittent not found. RESTORE vehicle. CLEAR DTCs and RETEST.

Barometric Pressure (BARO) Sensor

DH

Signal Functions

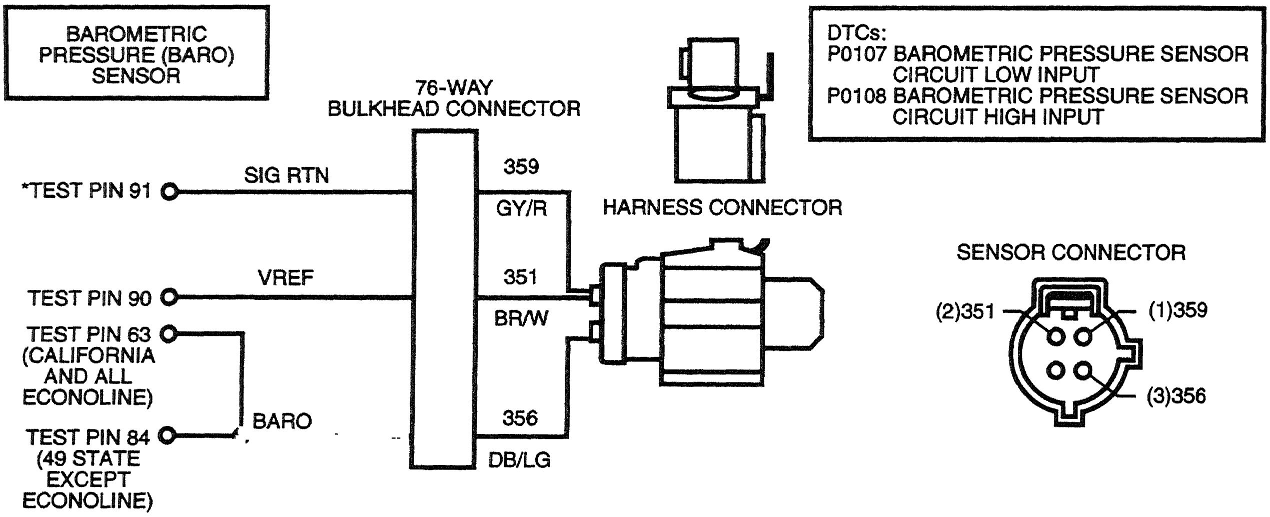
The barometric pressure (BARO) sensor is a variable capacitance sensor that, when supplied with a 5-volt reference signal from the powertrain control module (PCM), produces a linear analog voltage signal that indicates pressure.

Timing Control — The BARO signal is used to determine altitude to adjust timing and fuel quantity to optimize engine operation and control smoke throughout all altitude conditions.

Glow Plug Control — The BARO signal is one of the variables used to calculate glow plug ON time. At higher altitudes glow plug on time is increased to insure faster clean up of start-up smoke.

Detection / Management

A BARO signal that is detected out of range high or low by the PCM will cause the PCM to ignore the BARO signal and use the manifold absolute pressure (MAP) signal generated at low idle as an indication of barometric pressure.



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

Note

After removing connectors, always check for damaged pins, corrosion, loose terminals etc.

DTC Descriptions

Circuit Faults:

P0107 = BARO sensor circuit low input

Barometric Pressure (BARO) Sensor

DH

P0108 = BARO sensor circuit high input

Test Step		Result ▶	Action to Take
DH1	DIAGNOSTIC TROUBLE CODE (DTC) P0107		
	• DTC P0107 indicates barometric pressure out of range low was detected during KOEO Self Test or during continuous diagnostic monitoring. Possible causes: — open BARO sensor circuit — biased BARO sensor / PCM — short to SIG RTN or PWR GND on BARO sensor circuit — open VREF circuit • Disconnect BARO sensor harness connector. • Key on, engine off. • Measure voltage between Pin 2 at harness connector and ground. • **Is reading 5 V ± 0.5?**	Yes ▶ No ▶	GO to DH2. REPAIR open in Circuit 351 (BR / W). RESTORE vehicle. CLEAR DTCs and RETEST.
DH2	SIGNAL RETURN CIRCUIT CHECK		
	• Measure voltage between VREF Pin 2 and signal return Pin 1. • Key off. • **Was voltage reading 5 V ± 0.5?**	Yes ▶ No ▶	GO to DH3. REPAIR open in signal return Circuit 359 (GY / R). RESTORE vehicle. CLEAR DTCs and RETEST.
DH3	BARO SIGNAL WIRE CHECK		
	• Install breakout box; leave PCM disconnected. • Measure resistance between PCM Test Pin 84 (49 State except Econoline) or PCM Test Pin 63 (California and all Econoline) and signal wire Pin 3 at sensor harness connector. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to DH4. REPAIR open in Circuit 356 (DB / LG). RESTORE vehicle. CLEAR DTCs and RETEST.
DH4	VREF CIRCUIT CHECK		
	• Measure resistance between PCM Test Pin 90 and Pin 2 of BARO sensor harness connector. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to DH5. REPAIR open in VREF Circuit 351 (BR / W). RESTORE vehicle. CLEAR DTCs and RETEST.
DH5	SIG RTN CIRCUIT CHECK		
	• Measure resistance between PCM Test Pin 91 and Pin 1 and BARO harness connector. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to DH6. REPAIR open in SIG RTN Circuit 359 (GY / R). RESTORE vehicle. CLEAR DTCs and RETEST.

Barometric Pressure (BARO) Sensor

DH

Test Step	Result ▶	Action to Take
DH6 GROUNDED SIGNAL WIRE CHECK • Measure resistance between PCM Test Pin 84 (49 State except Econoline) or PCM Test Pin 63 (California and all Econoline) and PCM Test Pins 25, 51, 76, 77, 91 and 103. • **Is resistance greater than 10,000 ohms?**	Yes ▶	GO to DH7.
	No ▶	REPAIR short to ground in Circuit 356 (DB/LG). RESTORE vehicle. CLEAR DTCs and RETEST.
DH7 CHECK GROUNDED SIGNAL WIRE • Connect PCM to breakout box. • Measure resistance between PCM Test Pin 84 (49 State except Econoline) or PCM Test Pin 63 (California and all Econoline) and PCM Test Pins 25, 91, 51, 76, 77 and 103. • **Is resistance greater than 10,000 ohms?**	Yes ▶	REPLACE BARO sensor. RESTORE vehicle. CLEAR DTCs and RETEST.
	No ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
DH8 DIAGNOSTIC TROUBLE CODE (DTC) P0108 • DTC P0108 indicates barometric pressure out of range high during KOEO Self Test or during continuous diagnostic monitoring. Possible causes: — biased BARO sensor/PCM — BARO circuit shorted to VREF • Attempt to induce opposite DTC. • Disconnect BARO sensor. • Key on, engine off. • Retrieve DTCs. • Key off. • **Does DTC P0107 appear?**	Yes ▶	REPLACE BARO sensor. RESTORE vehicle. CLEAR DTCs and RETEST.
	No ▶	GO to DH9.
DH9 CHECK FOR SIGNAL WIRE POWER SHORT • Install breakout box; leave PCM disconnected. • Measure resistance between PCM Test Pin 84 and PCM Test Pins 55, 71, 90 and 97. • **Is resistance greater than 10,000 ohms?**	Yes ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
	No ▶	REPAIR short to power in signal wire Circuit 356 (DB/LG). RESTORE vehicle. CLEAR DTCs and RETEST.

Manifold Absolute Pressure (MAP) Sensor, Analog — 1998-1/2 Econoline and 1999 F-Series

DJ

Signal Functions

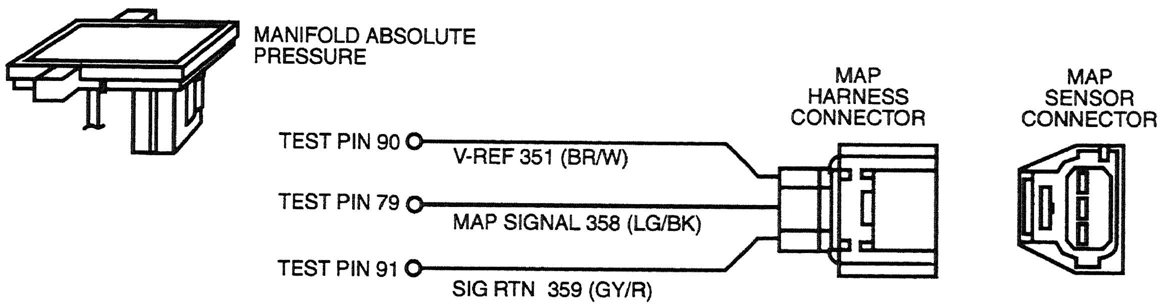
The manifold absolute pressure (MAP) sensor is a variable capacitance sensor that, when supplied with a 5-volt reference signal from the powertrain control module (PCM), produces an analog voltage signal that indicates pressure.

Smoke Control — The MAP signal is used to control smoke by limiting fuel quantity during acceleration until a specified boost pressure is obtained.

Dynamic Injection Timing — Optimizes injection timing for boost pressure measured.

Fault Detection/Management

A MAP signal that is detected by the PCM to be out of range or at an incorrect value for specific conditions will cause the PCM to ignore the MAP signal and operate the engine from an inferred boost pressure signal.



DA1520-B

Note

After removing connectors, always check for damaged pins, corrosion, loose terminals, etc.

DTC Descriptions

P0236 = Turbo Boost Sensor A Circuit Performance

P0237 = Turbo Boost Sensor A Circuit Low Input

P0238 = Turbo Boost Sensor A Circuit High Input

Volts	kPa	PSIA
1.1	80	11.5
1.5	101	14.7
2.2	138	20

(Continued)

Manifold Absolute Pressure (MAP) Sensor, Analog — 1998-1/2 Econoline and 1999 F-Series

DJ

Volts	kPa	PSIA
2.8	172	25
3.6	206	30
4.3	242	35

Note: ± 0.3 volt from expected voltage reading is allowed.

Test Step		Result ▶	Action to Take
DJ1	DIAGNOSTIC TROUBLE CODE (DTC) P0236, P1247 AND P1248		
	● DTC P0236 indicates a turbo boost sensor A circuit performance concern. DTCs P1247, P1248 indicate turbo boost pressure was low or not detected. Possible causes: — damaged MAP hose — low turbo boost — intake manifold or crossover tube hose leaks — damaged MAP sensor — damaged PCM ● Inspect MAP sensor hose and manifolds for damage, leaks, restriction and misrouting. ● **Are manifolds and MAP hose OK and free of damage?**	Yes ▶ No ▶	GO to DJ2. REPAIR leak as necessary. CLEAR DTCs and RETEST.
DJ2	CHECK MAP SENSOR		
	NOTE: Refer to MAP voltage table at beginning of pinpoint test. ● Install breakout box; reconnect PCM to breakout box. ● Key on, engine off. ● Measure voltage between MAP sensor harness connector signal Pin 79 and ground. ● **Is voltage ± 0.5 volt for given altitude?**	Yes ▶ No ▶	GO to DJ3. REPLACE MAP sensor. RESTORE vehicle. CLEAR DTCs and RETEST.
DJ3	MAP SENSOR VOLTAGE CHECK		
	● Disconnect MAP sensor harness connector. ● Connect the MAP sensor tester between the harness connector and the MAP sensor. ● Connect MAP sensor tester to a digital multimeter. Set digital multimeter to voltage scale. ● Disconnect vacuum hose from MAP sensor. ● Key on, engine off. ● Using Rotunda Pressure Adapter Kit 014-00761 or equivalent (gauge bar), apply 69 kPa (10 psi) of pressure to the MAP sensor. ● **Is voltage reading 2.8 volts ± 0.3 volt?**	Yes ▶ No ▶	GO to DJ4. REPLACE MAP sensor. RESTORE vehicle. CLEAR DTCs and RETEST.

Manifold Absolute Pressure (MAP) Sensor, Analog — 1998-1/2 Econoline and 1999 F-Series

DJ

Test Step		Result ▶	Action to Take
DJ4	MAP PERFORMANCE TEST		
	• Connect vacuum hose to MAP sensor. • Disconnect MAP sensor vacuum hose from intake manifold and install a pressure (boost) gauge. • Road test vehicle and accelerate vehicle to achieve full boost. • **Is engine boost 82 kPa (12 psi) or greater?**	Yes ▶	RESTORE vehicle. CLEAR DTCs and RETEST. If DTC returns, REPLACE ECM.
		No ▶	INSPECT intake manifolds, crossover tubes for leaks. CHECK turbo condition. REFER to the Powertrain Group in the Workshop Manual.
DJ5	KOEO DIAGNOSTIC TROUBLE CODE (DTC) P0237		
	• DTC P0237 indicates turbo boost sensor (MAP) A circuit low input. Possible causes: — MAP signal circuit open, shorted to ground or shorted to VREF — open or shorted VREF circuit — open or shorted signal return circuit — damaged MAP sensor — damaged PCM • Disconnect MAP sensor harness connector. • Key on, engine off • Measure voltage of VREF Circuit 351 (BR / W) between MAP sensor harness connector and ground. • **Are 5 volts present?**	Yes ▶	GO to DJ6.
		No ▶	REPAIR VREF Circuit 351 (BR / W). RESTORE vehicle. CLEAR DTCs and RETEST.
DJ6	CHECK SIGNAL RETURN		
	• Key off. • Measure resistance of signal return Circuit 359 (GY / R) between MAP sensor harness connector and ground. • **Is resistance less than 5 ohms?**	Yes ▶	GO to DJ7.
		No ▶	REPAIR open in signal return Circuit 359 (GY / R). RESTORE vehicle. CLEAR DTCs and RETEST.
DJ7	MAP SIGNAL CONTINUITY CHECK		
	• Install breakout box; leave PCM disconnected. • Measure resistance between PCM Test Pin 79 and Circuit 358 (LG / BK) at the MAP sensor harness connector. • **Is resistance less than 5 ohms?**	Yes ▶	GO to DJ8.
		No ▶	REPAIR open MAP signal Circuit 358 (LG / BK). RESTORE vehicle. CLEAR DTCs and RETEST.
DJ8	MAP SIGNAL SHORT TO GROUND CHECK		
	• Install breakout box; leave PCM disconnected. • Measure resistance between PCM Test Pin 79 and PCM Test Pins 25, 51, 76, 77, 91, 103. • **Is each resistance greater than 10,000 ohms?**	Yes ▶	GO to DJ9
		No ▶	REPAIR short to ground or signal return in MAP signal Circuit 358 (LG / BK). RESTORE vehicle. CLEAR DTCs and RETEST.

Manifold Absolute Pressure (MAP) Sensor, Analog — 1998-1/2 Econoline and 1999 F-Series

DJ

Test Step		Result ▶	Action to Take
DJ9	MAP SIGNAL SHORT TO VOLTAGE CHECK		
	• Measure resistance between PCM Test Pins 79 and 90. • **Is resistance greater than 10,000 ohms?**	Yes ▶ No ▶	GO to DJ10. REPAIR short to VREF in MAP signal Circuit 358 (LG/BK). RESTORE vehicle. CLEAR DTCs and RETEST.
DJ10	PCM CHECK		
	• Connect PCM to breakout box. • Key on, engine off. • Measure voltage between MAP signal Circuit 358 (LG/BK) on MAP sensor harness connector and ground. • **Is voltage reading 5 volts ± 0.5 volt?**	Yes ▶ No ▶	REPLACE MAP sensor. RESTORE vehicle. CLEAR DTCs and RETEST. REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
DJ11	KOEO DIAGNOSTIC TROUBLE CODE P0238		
	NOTE: Ignore P0237 set due to sensor being disconnected. • Refer to schematic for sensor identification. • DTC P0238 indicates a turbo boost sensor (MAP) circuit high input. Possible causes: — damaged MAP sensor — shorted MAP signal circuit — faulty PCM • Disconnect MAP sensor harness connector. • Key on, engine off. • Perform KOEO On-Demand Self Test. • **Is DTC P0238 set?**	Yes ▶ No ▶	GO to DJ12. REPLACE MAP sensor. RESTORE vehicle. CLEAR DTCs and RETEST.
DJ12	CHECK MAP SIGNAL CIRCUIT FOR SHORT TO POWER		
	• Key off. • Install breakout box; leave PCM disconnected. • Key on, engine off. • Measure resistance between PCM Test Pin 79 and PCM Test Pins 55, 71, 91 and 97. • **Is each resistance greater than 10,000 ohms?**	Yes ▶ No ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST. REPAIR MAP signal short to power. RESTORE vehicle. CLEAR DTCs and RETEST.

Manifold Absolute Pressure (MAP) Sensor, Analog — 1998-1/2 Econoline and 1999 F-Series

DJ

Test Step		Result ▶	Action to Take
DJ13	CONTINUOUS DIAGNOSTIC TROUBLE CODE P0237		
	● Refer to schematic for sensor identification. ● Continuous DTC P0237 indicates a turbo boost sensor (MAP) A circuit low input was detected. Possible causes: — MAP signal circuit open, shorted to ground or shorted to VREF — open VREF circuit — open signal return circuit — damaged MAP sensor ● Perform KOEO On-Demand Test. ● **Is DTC P0237 present?**	Yes ▶ No ▶	GO to DJ5. GO to DJ14.
DJ14	CHECK FOR INTERMITTENT CIRCUIT FAULT		
	● Clear Continuous DTCs. ● Grasp vehicle harness; wiggle and shake while working from PCM to MAP sensor. ● Retrieve Continuous DTCs. ● **Is DTC P0237 present?**	Yes ▶ No ▶	REPAIR intermittent circuit fault in MAP circuitry. RESTORE vehicle. CLEAR DTCs and RETEST. Unable to duplicate or identify failure at this time. RESTORE vehicle. CLEAR DTCs and RETEST.
DJ15	CONTINUOUS DIAGNOSTIC TROUBLE CODE P0238		
	● Continuous DTC P0238 indicates a turbo boost sensor (MAP) circuit high input was detected during normal driving conditions. ● Grasp vehicle harness; wiggle and shake while working from PCM to MAP sensor. ● Retrieve Continuous DTCs. ● **Is DTC P0237 present?**	Yes ▶ No ▶	REPAIR intermittent circuit fault in MAP circuitry. RESTORE vehicle. CLEAR DTCs and RETEST. Unable to duplicate or identify failure at this time. RESTORE vehicle. CLEAR DTCs and RETEST.

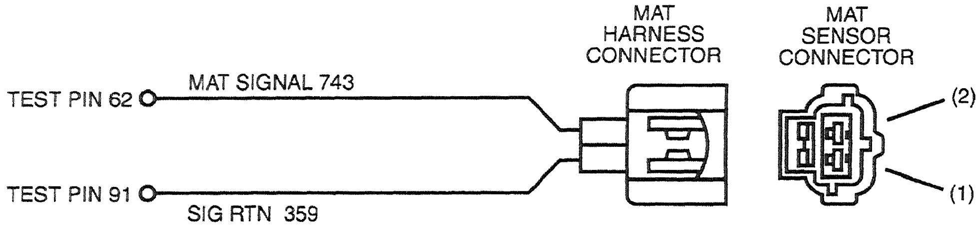
Manifold Air Temperature (MAT) Sensor — 1999 F-Series

DK

Signal Functions

The manifold air temperature (MAT) sensor is a thermistor-type sensor with a variable resistance that changes when exposed to different temperatures. When interfaced with the powertrain control module (PCM), it produces a 0-5 volt analog signal that will measure temperature.

A MAT sensor is used to measure intake air temperature after being cooled through the intercooler, used to determine injection timing.



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

DA1509-A

DTC Descriptions

P1118 = Manifold air temp. sensor low input

P1119 = Manifold air temp. sensor high input

Test Step	Result ▶	Action to Take
DK1 DIAGNOSTIC TROUBLE CODE (DTC) P1119		
• DTC P1119 indicates that the MAT sensor circuit was out of range high. Possible causes: — open in harness — damaged connection — damaged MAT sensor — damaged PCM • Disconnect MAT sensor harness connector. • Measure resistance between Pin 1 (SIG RTN) on the MAT sensor harness connector and ground. • **Is resistance less than 5 ohms?**	Yes ▶	GO to DK2.
	No ▶	REPAIR open in (SIG RTN) Circuit 359 (GY) between MAT sensor harness connector and the PCM.
DK2 INDUCE OPPOSITE FAILURE		
• Key on, engine off. • Jumper Pin 1 to Pin 2 on the MAT sensor harness connector. • Run KOEO Self Test. • Key off. • **Was DTC P1118 present?**	Yes ▶	REPLACE the MAT sensor. RESTORE vehicle. CLEAR DTCs and RETEST.
	No ▶	GO to DK3.

Manifold Air Temperature (MAT) Sensor — 1999 F-Series

DK

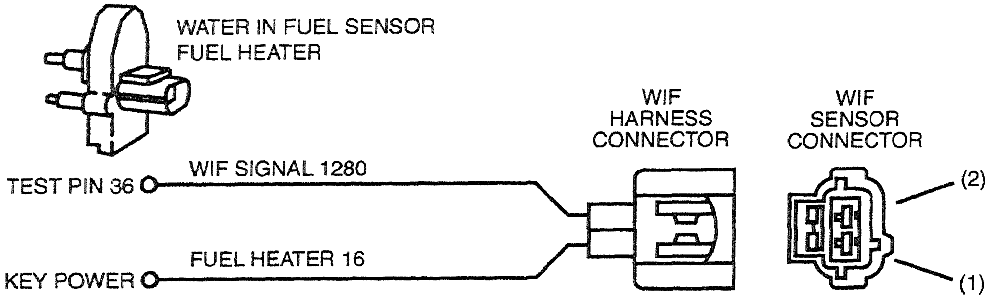
Test Step		Result ▶	Action to Take
DK3	CHECK CONTINUITY OF SIGNAL CIRCUIT		
	• Install breakout box; leave PCM disconnected • Measure resistance between MAT sensor harness connector Pin 2 and PCM Test Pin 62. • **Is resistance less than 5 ohms?**	Yes No	▶ GO to DK6. ▶ REPAIR open in MAT signal circuit. RESTORE vehicle. CLEAR DTCs and RETEST.
DK4	DIAGNOSTIC TROUBLE CODE (DTC) P1118 — INDUCE OPPOSITE DTC P1119		
	• DTC P1118 indicates that the MAT sensor circuit was out of range low. Possible causes: — grounded circuit in harness — damaged MAT sensor — damaged PCM — damaged connection. • Disconnect MAT sensor harness connector. • Run KOEO Self Test. • **Is DTC P1119 present?**	Yes No	▶ REPLACE the MAT sensor. RESTORE vehicle. CLEAR DTCs and RETEST. ▶ GO to DK5.
DK5	CHECK MAT SENSOR SIGNAL CIRCUIT FOR SHORT TO GROUND		
	• Install breakout box; leave PCM disconnected. • Measure resistance between PCM Test Pin 62 and PCM Test Pins 51, 76, 77, 91 and 103. • **Is each resistance reading greater than 10,000 ohms?**	Yes No	▶ REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST. ▶ REPAIR short to ground on MAT signal circuit. RESTORE vehicle. CLEAR DTCs and RETEST.
DK6	CHECK SIG RTN FOR OPEN		
	• Measure resistance between MAT sensor harness connector Pin 1 and PCM Test Pin 91. • **Is resistance less than 5 ohms?**	Yes No	▶ REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST. ▶ REPAIR open in SIG RTN circuit to MAT sensor. RESTORE vehicle. CLEAR DTCs and RETEST.

Water in Fuel (WIF) Sensor

DL

Input Function

The water in fuel (WIF) sensor is used to detect water in the fuel system and is located in the fuel filter housing. The WIF sensor is monitored by the PCM. If the PCM detects water for more than 5 seconds, it will set a Continuous DTC P1140 and turn on the WATER IN FUEL indicator lamp (WIFIL). Route a hose from the fuel drain line to a 1-qt clear container. Start engine and open the fuel filter housing drain valve. Close the valve when you have filled the container. Inspect fuel in the container. If no water or contaminants are in the container, you may have a circuit fault.



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

DA1510-A

DTC Descriptions

P1140 = Water in fuel condition

Test Step		Result ▶	Action to Take
DL1	DIAGNOSTIC TROUBLE CODE (DTC) P1140		
	● DTC P1140 indicates that the PCM has detected water in the fuel filter housing or a short to ground in the monitoring circuit. Possible causes: — water in the fuel filter housing — shorted circuit — damaged connection — damaged sensor — damaged PCM ● Route a hose from the fuel drain line, located on the engine right front lower side, to a 1-qt clear container. ● Start engine. ● Open the fuel filter housing drain valve, and close when you've filled the container. ● **Does the container have any water or contaminants?**	Yes ▶ No ▶	CLEAR DTCs and RETEST. If WIFIL comes back on and DTC P1140 returns, REPEAT Test Step DL1. If water is still found in fuel sample, FLUSH and CLEAN the fuel tank and fuel system. GO to DL2.

Water in Fuel (WIF) Sensor

DL

Test Step		Result	▶	Action to Take
DL2	CHECK WIF SENSOR CIRCUIT FOR SHORT TO GROUND			
	● Key on, engine off. ● Disconnect the WIF / FUEL HEATER harness connector. ● Clear Continuous DTCs. ● Cycle ignition key. ● Retrieve Continuous DTCs. ● Key off. ● **Did DTC P1140 reset?**	Yes No	▶ ▶	GO to DL3. GO to DL4.
DL3	CHECK FOR SHORT TO GROUND IN CIRCUIT 1280			
	● Disconnect PCM harness connector. ● Measure resistance between Pin 2 on WIF sensor harness connector and battery ground. ● **Is resistance greater than 10,000 ohms?**	Yes	▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
		No	▶	REPAIR short to ground in WIF sensor Circuit 1280 (GY / R). RESTORE vehicle. CLEAR DTCs and RETEST.
DL4	CHECK WIF SENSOR			
	● Remove the fuel filter, and inspect inside of filter housing for debris. ● **Was debris found inside the housing?**	Yes	▶	CLEAN out filter housing. REMOVE WIF sensor. CLEAN and REINSTALL. RESTORE vehicle. CLEAR DTCs and RETEST.
		No	▶	REPLACE WIF sensor. RESTORE vehicle. CLEAR DTCs and RETEST.

Water in Fuel Indicator Lamp (WIFIL)

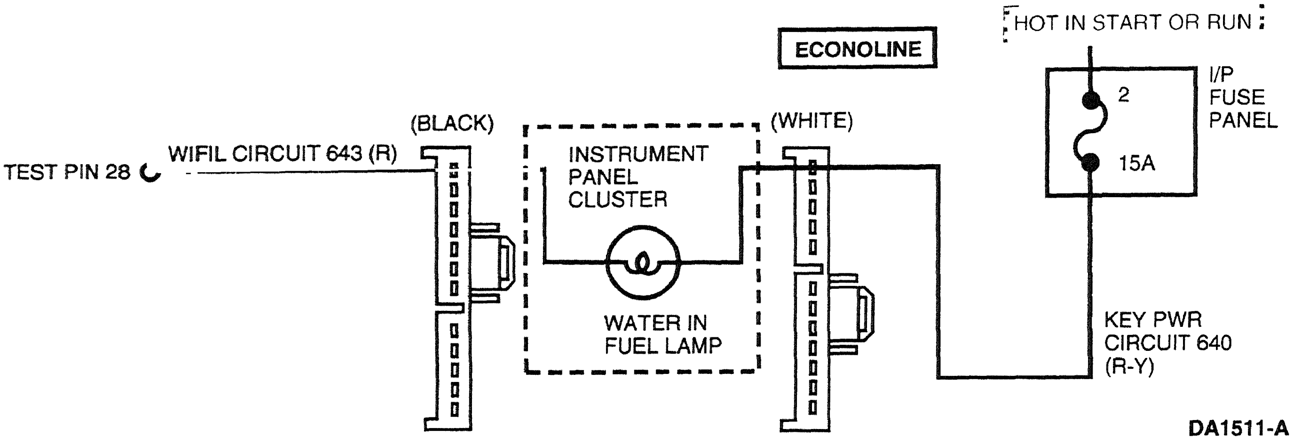
DM

Output Function

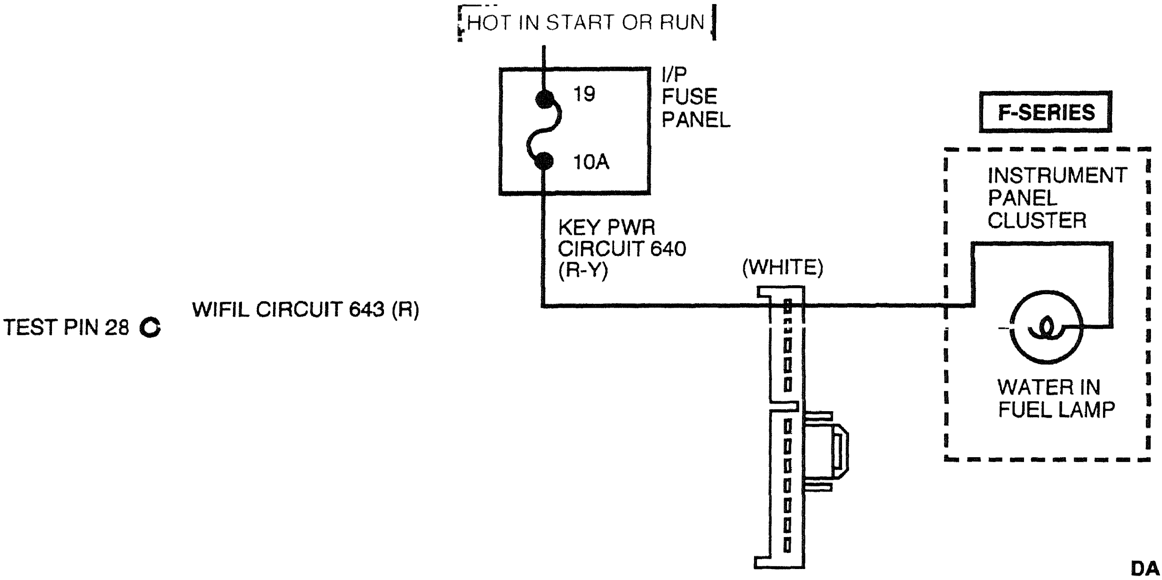
The water in fuel indicator lamp (WIFIL) is used to alert the operator when water is present in the fuel filter housing. Drain the water into a clear container. If excessive, water or contaminants may indicate that the tank and fuel system need to be flushed and cleaned.

Detection/Management

The WIFIL is controlled and monitored by the PCM. An open or short circuit will set a P1139 in KOEO On-Demand Self Test. If WIFIL comes on without a P1139, then the cause is most likely water in the fuel filter housing.



DA1511-A



DA1512-A

DTC Descriptions

P1139 = Water in fuel indicator circuit malfunction

Water in Fuel Indicator Lamp (WIFIL) | DM

Test Step		Result ▶	Action to Take
DM1	DIAGNOSTIC TROUBLE CODE (DTC) P1139		
	● DTC P1139 indicates that the PCM has detected a failure on the WIFIL circuit. NOTE: If only the light comes on with a DTC P1140, GO to Pinpoint Test (DL). Possible causes: — shorted circuit — open in harness — damaged connection — open in lamp — damaged PCM ● Key on, engine off. ● **Does the WIFIL come on for approximately 2 seconds, then turn off?**	Yes ▶	CLEAR DTC and RETEST. If DTC P1139 returns, CHECK for an intermittent open or short in Circuit 643 (R).
		No ▶	GO to DM2.
DM2	LAMP STATE		
	● Key off. ● **Did the WIFIL stay on in Step DM1?**	Yes ▶	GO to DM3.
		No ▶	GO to DM4.
DM3	CHECK FOR SHORT TO GROUND IN CIRCUIT 643		
	● Disconnect the PCM harness connector. ● Key on, engine off. ● **Does the WIFIL stay off?**	Yes ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	REPAIR short to ground in WIFIL control Circuit 643 (R). RESTORE vehicle. CLEAR DTCs and RETEST.
DM4	CHECK FOR BLOWN FUSE		
	● Check fuse for Circuit 640 (R/Y). ● **Is fuse blown?**	Yes ▶	REPLACE fuse. CHECK for short to ground. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	GO to DM5.
DM5	CHECK POWER TO CLUSTER		
	● Key off. ● Disconnect instrument cluster harness connector(s). ● Key on, engine off. ● Measure voltage between instrument cluster connector(s) Circuit 640 and ground. ● Key off. ● **Was voltage greater than 10.5 volts?**	Yes ▶	GO to DM6.
		No ▶	REPAIR open in PWR Circuit 640 (R/Y). RESTORE vehicle. CLEAR DTCs and RETEST.

Water in Fuel Indicator Lamp (WIFIL)

DM

Test Step		Result ▶	Action to Take
DM6	CHECK FOR OPEN IN WIFIL CIRCUIT 643		
	- Install breakout box; leave PCM disconnected. - Measure resistance between instrument cluster harness connector Circuit 643 (R / Y) and PCM Test Pin 28. - **Is resistance less than 5 ohms?**	Yes ▶	REPLACE the PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	REPAIR open in WIFIL control Circuit 643 (R). RESTORE vehicle. CLEAR DTCs and RETEST.

Air Conditioning

FA

Note

Enter this pinpoint test only when directed here.

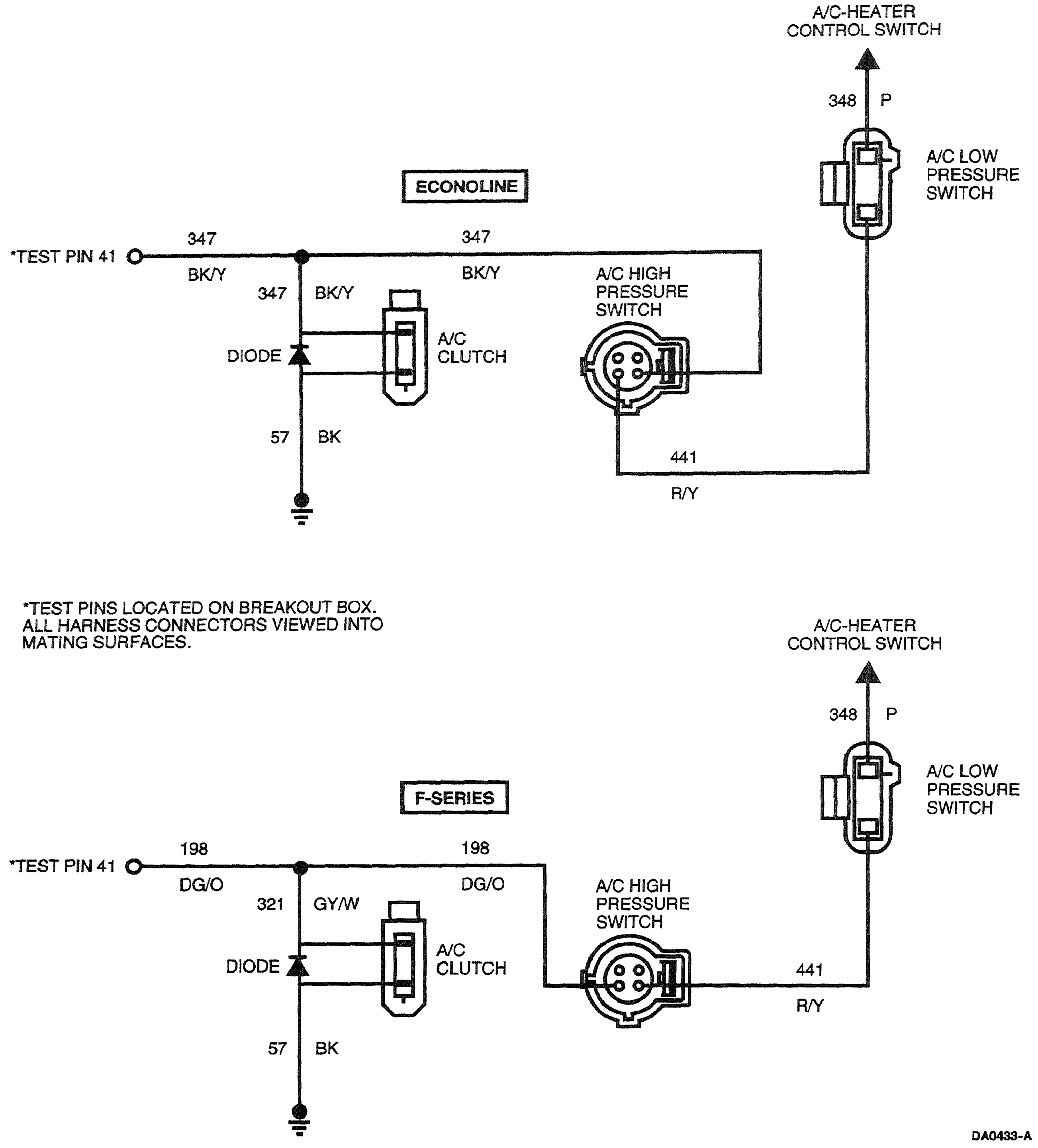
Remember

This pinpoint test is intended to diagnose the following:

- harness circuits for air conditioning
- powertrain control module (PCM)(12A650)
- A / C clutch

Air Conditioning

FA



DTC Description

P1464 = A / C on during KOER Cylinder Contribution Self Test

Air Conditioning

FA

Test Step		Result ▶	Action to Take
FA1	DIAGNOSTIC TROUBLE CODE (DTC) P1464		
	● Turn A/C-heater control switch to OFF position. ● Perform KOER Cylinder Contribution Self Test. ● Key off. ● **Did DTC P1464 set?**	Yes ▶	GO to FA2.
		No ▶	Problem may be intermittent. GO to FA4.
FA2	CHECK A/C POWER CIRCUIT FOR SHORT		
	● Key on, engine off. ● A/C-heater control switch off. ● Disconnect A/C clutch connector. ● Measure voltage between A/C clutch connector Circuit 321 [(GY/W) (F-Series)], or Circuit 347 [(BK/Y) (Econoline)] and battery ground. ● Key off. ● **Was B+ present?**	Yes ▶	REPAIR short to B+. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	GO to FA3.
FA3	CHECK TEST PIN 41 SHORTED TO POWER		
	● Install breakout box; leave PCM disconnected. ● Key on, engine off. ● A/C-heater control switch off. ● Measure voltage between PCM Test Pin 41 and ground. ● **Is B+ present?**	Yes ▶	REPAIR short to B+. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.
FA4	CHECK FOR INTERMITTENT SHORT TO POWER		
	● Install breakout box; leave PCM disconnected. ● Key on, engine off. ● A/C-heater control switch off. ● Measure voltage between PCM Test Pin 41 and ground. ● Grasp the harness. Wiggle and shake harness while working toward the PCM. ● **Is voltage ever present?**	Yes ▶	REPLACE short to B+. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	No problem found at this time. RESTORE system. CLEAR DTCs and RETEST.

Brake Pressure Applied (BPA) Switch

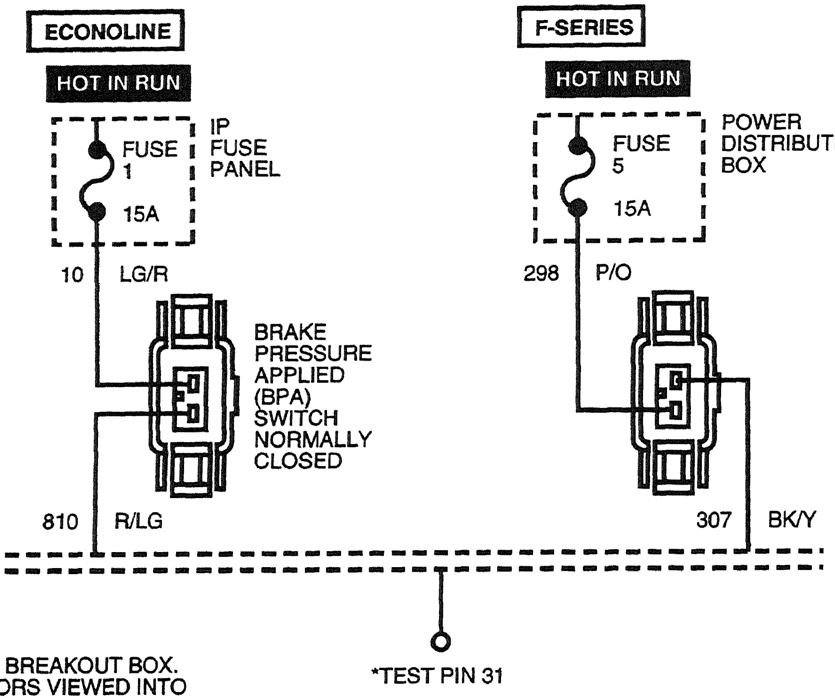
FB

Note

Enter this pinpoint test only when directed here from symptom flowcharts.

Description

The brake pressure applied (BPA) switch is a pressure switch that senses brake pressure and is redundant with the brake on / off (BOO) switch to provide a backup to deactivate speed control.



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACES.

DA0419-A

DTC Description

P0571 = Brake switch A circuit malfunction

Brake Pressure Applied (BPA) Switch

FB

Test Step		Result	▶	Action to Take
FB1	DIAGNOSTIC TROUBLE CODE (DTC) P0571			
	NOTE: When performing KOER switch test, wait five seconds after pressing the trigger to start the test before running through the driver operated controls. The test may also take up to five minutes to complete. NOTE: No PID transition indicates a BPA circuit failure. ● Key on, engine off. ● Access BPA PID. ● Cycle brake pedal firmly. ● **Does PID read ON only?**	Yes	▶	GO to FB2.
		No	▶	GO to FB5.
FB2	CHECK FOR BPA SWITCH FAILED CLOSED			
	● Disconnect BPA switch. ● Key off. ● **Did PID go to OFF?**	Yes	▶	REPLACE BPA switch. RESTORE system. CLEAR DTCs and RETEST.
		No	▶	F-Series, GO to FB3. Econoline, GO to FB4.
FB3	CHECK FOR SHORT TO B+ IN CIRCUIT 307 (BK/Y)			
	● Disconnect PCM. ● Key on, engine off. ● Measure voltage between Circuit 307 (BK/Y) on BPA harness connector and chassis ground. ● Key off. ● **Was B+ present?**	Yes	▶	REPAIR short to B+ in Circuit 307 (BK/Y). RESTORE system. CLEAR DTCs and RETEST.
		No	▶	Short to B+ is at Pin 31 in PCM. SERVICE as necessary. GO to FB11.
FB4	CHECK FOR SHORT TO B+ IN CIRCUIT 810 (R/LG)			
	● Disconnect PCM. ● Key on, engine off. ● Measure voltage between Circuit 810 (R/LG) on BPA harness connector and chassis ground. ● **Is B+ present?**	Yes	▶	REPAIR short to B+ in Circuit 810 (R/LG). RESTORE system. CLEAR DTCs and RETEST.
		No	▶	REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.
FB5	CHECK BPA PID			
	● Cycle brake pedal firmly. ● Key off. ● **Did PID read OFF only?**	Yes	▶	F-Series GO to FB6, Econoline GO to FB7.
		No	▶	Fault may be intermittent. GO to FB14.
FB6	CHECK FUSE 5 (15 AMP)			
	● Check Fuse 5 (15 amp) in power distribution box. ● **Is Fuse 5 blown?**	Yes	▶	REPLACE fuse. If fuse blows again, GO to FB8.
		No	▶	LOOK for open circuit. GO to FB10.

Brake Pressure Applied (BPA) Switch

FB

Test Step		Result ▶	Action to Take
FB7	CHECK FUSE 1 (15 AMP)		
	- Check Fuse 1 (15 amp) in power distribution box. - **Is Fuse 1 blown?**	Yes ▶	REPLACE fuse. If fuse blows again, GO to FB19.
		No ▶	GO to FB16.
FB8	CHECK CIRCUIT 298 (P / O) FOR SHORT TO GROUND		
	- Disconnect BPA switch. - Measure resistance between Circuit 298 (P / O) on BPA harness connector and chassis ground. - **Is resistance greater than 10,000 ohms?**	Yes ▶	GO to FB9.
		No ▶	REPAIR short to ground in Circuit 298 (P / O). REPLACE fuse. RESTORE system. CLEAR DTCs and RETEST.
FB9	CHECK CIRCUIT 307 (BK / Y) FOR SHORT TO GROUND		
	- Disconnect PCM. - Key on, engine off. - Measure resistance between Circuit 307 (BK / Y) on BPA harness connector and chassis ground. - **Is resistance greater than 10,000 ohms?**	Yes ▶	GO to FB21.
		No ▶	REPAIR short to ground in Circuit 307 (BK / Y). RESTORE system. CLEAR DTCs and RETEST.
FB10	CHECK BPA SWITCH FOR OPEN		
	- Disconnect BPA switch. - Key on, engine off. - Install jumper between BPA harness connector for Circuits 307 (BK / Y) and 298 (P / O) (two middle pins). - Key off. - **Did PID read ON?**	Yes ▶	REPLACE BPA switch. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	GO to FB11.
FB11	CHECK CIRCUIT 298 (P / O) FOR OPEN		
	- Measure resistance of Circuit 298 (P / O) between BPA harness connector and contact for Fuse 5. - Key off. - **Is the resistance less than 5 ohms?**	Yes ▶	Circuit 298 (P / O) is OK. GO to FB12.
		No ▶	REPAIR open in Circuit 298 (P / O). RESTORE system. CLEAR DTCs and RETEST.
FB12	CHECK CIRCUIT 307 (BK / Y) FOR OPEN		
	- Remove jumper. - Disconnect PCM. - Install breakout box; leave PCM disconnected. - Measure resistance between PCM Test Pin 31 and BPA harness connector Circuit 307 (BK / Y). - **Is resistance less than 5 ohms?**	Yes ▶	Circuit 307 (BK / Y) is OK. Open is at PCM Pin 31. REPAIR as required. GO to FB13.
		No ▶	REPAIR open in Circuit 307 (BK / Y). RESTORE system. CLEAR DTCs and RETEST.
FB13	CONFIRM PCM FAULT		
	- Key on, engine off. - **Does PID switch between ON and OFF?**	Yes ▶	System is OK.
		No ▶	REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.

Brake Pressure Applied (BPA) Switch — FB

Test Step		Result	▶	Action to Take
FB14	CHECKS FOR INTERMITTENT OPEN OR SHORT			
	● Disconnect BPA switch. ● Key on, engine off. ● Install Jumper between BPA connector Circuits 307 (BK/Y) and 298 (P/O) (two middle pins). ● Confirm BPA PID reads ON. ● Wiggle connectors and wires while observing BPA PID. ● **Does PID switch between ON and OFF?**	Yes No	▶ ▶	REPAIR circuitry at point of intermittent. RESTORE system. CLEAR DTCs and RETEST. GO to FB15.
FB15	CHECK FOR INTERMITTENT SHORT TO B+			
	● Remove Fuse 5 (15 amp). ● Confirm BPA PID reads OFF. ● Wiggle connector and wires while watching BPA PID. ● **Does PID switch between OFF and ON?**	Yes No	▶ ▶	REPAIR circuitry at point of intermittent contact with B+ source. INSTALL fuse. RESTORE system. CLEAR DTCs and RETEST. Intermittent not detected. RESTORE system. CLEAR DTCs and RETEST.
FB16	CHECK CIRCUIT 10 (LG/R) FOR OPEN			
	● Disconnect BPA switch. ● Measure resistance between Circuit 10 (LG/R) on BPA harness connector and non-power side of Fuse 1. ● **Is resistance less than 5 ohms?**	Yes No	▶ ▶	GO to FB17. REPAIR open in Circuit 10 (LG/R). RESTORE system. CLEAR DTCs and RETEST.
FB17	CHECK FOR OPEN IN BPA SWITCH			
	● Install Fuse 1. ● Key on, engine off. ● Install Jumper between BPA harness connector Circuits 10 (LG/R) and 810 (R/LG). ● Key off. ● **Did PID read ON?**	Yes No	▶ ▶	REPLACE faulty BPA switch. RESTORE system. CLEAR DTCs and RETEST. GO to FB18.
FB18	CHECK CIRCUIT 810 (R/LG) FOR OPEN			
	● Remove jumper. ● Install breakout box; leave PCM disconnected. ● Measure resistance between PCM Test Pin 31 and Circuit 810 (R/LG) on BPA harness connector. ● **Is resistance less than 5 ohms?**	Yes No	▶ ▶	REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST. REPAIR open in Circuit 810 (R/LG). RESTORE system. CLEAR DTCs and RETEST.
FB19	CHECK CIRCUIT 10 (LG/R) FOR SHORT TO GROUND			
	● Disconnect BPA switch ● Remove Fuse 1. ● Measure resistance between Circuit 10 (LG/R) on BPA harness connector and ground. ● **Is resistance greater than 10,000 ohms?**	Yes No	▶ ▶	GO to FB20. REPAIR short to ground in Circuit 10 (LG/R). REPLACE fuse. RESTORE system. CLEAR DTCs and RETEST.

Brake Pressure Applied (BPA) Switch

FB

Test Step		Result ▶	Action to Take
FB20	CHECK CIRCUIT 810 (R/LG) FOR SHORT TO GROUND		
	● Disconnect PCM. ● Measure resistance between Circuit 810 (R/LG) on BPA harness connector and ground. ● **Is resistance greater than 10,000 ohms?**	Yes ▶	GO to FB21.
		No ▶	REPAIR short to ground in Circuit 810 (R/LG). RESTORE system. CLEAR DTCs and RETEST.
FB21	PCM INTERNAL SHORT CHECK		
	● Install breakout box; connect PCM to breakout box. ● Measure resistance from PCM Test Pin 31 to PCM Test Pins 25, 76, 77 and 103. ● **Is resistance greater than 10,000 ohms?**	Yes ▶	Unable to identify short condition. REPLACE fuse. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	REPLACE shorted PCM. RESTORE system. CLEAR DTCs and RETEST.

Clutch Pedal Position (CPP) Switch

FC

Note

Enter this pinpoint test only when directed here from symptom flowcharts.

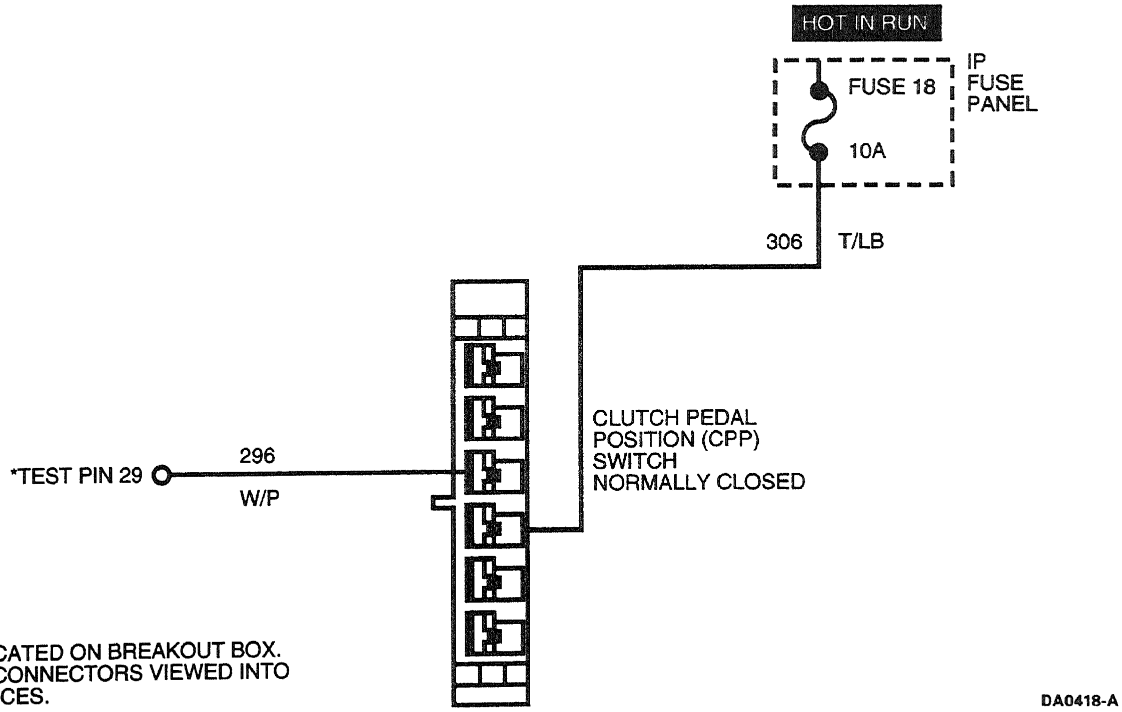
Remember

This pinpoint test is intended to diagnose only the following:

- clutch pedal position switch (CPP)(11A152)
- powertrain control module (PCM)(12A650)
- harness circuits: CPP and SIG RTN

Description

This switch detects when the clutch pedal is depressed (manual transmissions) to disable the speed control system and PTO / raised-idle mode. Switch actuation occurs as the clutch is initially depressed prior to disengaging the transmission at the top of travel.



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACES.

Clutch Pedal Position (CPP) Switch

FC

DTC Description

P0704 = Clutch switch input circuit malfunction

Test Step		Result ▶	Action to Take
FC1	DIAGNOSTIC TROUBLE CODE (DTC) P0704		
	NOTE: When performing KOER switch test, wait five seconds after pressing the trigger to start the test before running through the driver operated controls. The test may also take up to five minutes to complete. NOTE: No PID transition indicates a CPP circuit failure. ● Key on, engine off. ● Foot off clutch pedal. ● Access CPP PID. ● **Does PID read ON only?**	Yes ▶ No ▶	GO to FC2. GO to FC4.
FC2	CHECK FOR CPP SWITCH FAILED CLOSED		
	● Disconnect CPP switch. ● Key off. ● **Did PID go to OFF?**	Yes ▶ No ▶	REPLACE CPP switch. RESTORE system. CLEAR DTCs and RETEST. GO to FC3.
FC3	CHECK FOR SHORT TO B+ IN CIRCUIT 306 (T/LB)		
	● Disconnect PCM. ● Key on, engine off. ● Measure voltage between Circuit 306 (T/LB) on CPP harness connector and chassis ground. ● **Is B+ present?**	Yes ▶ No ▶	REPAIR short to B+ in Circuit 306 (T/LB). RESTORE system. CLEAR DTCs and RETEST. Short to B+ is at Pin 29 in PCM. SERVICE as necessary. GO to FC11.
FC4	CHECK PID CPP		
	● Hold clutch pedal to the floor. ● Key off. ● **Did PID read OFF only?**	Yes ▶ No ▶	GO to FC5. Fault may be intermittent. GO to FC12.
FC5	CHECK FUSE 18 (10 AMP)		
	● Check Fuse 18 (10 amp) in IP fuse panel. ● **Is Fuse 18 blown?**	Yes ▶ No ▶	THROW away fuse. LOOK for short to ground. GO to FC6. LOOK for open circuit. GO to FC8.
FC6	CHECK CIRCUIT 296 (W/P) FOR SHORT TO GROUND		
	● Disconnect CPP switch. ● Measure resistance between Circuit 296 (W/P) on CPP harness connector and chassis ground. ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	REPAIR short to ground in Circuit 296 (W/P). REPLACE fuse. RESTORE system. CLEAR DTCs and RETEST. GO to FC7.

Clutch Pedal Position (CPP) Switch

FC

Test Step		Result ▶	Action to Take
FC7	CHECK CIRCUIT 306 (T/LB) FOR SHORT TO GROUND		
	• Disconnect PCM. • Key on, engine off. • Measure resistance between Circuit 306 (T/LB) on CPP harness connector and chassis ground. • **Is resistance less than 10,000 ohms?**	Yes	▶ REPAIR short to ground in Circuit 306 (T/LB). RESTORE system. CLEAR DTCs and RETEST.
		No	▶ Short to ground is at PCM Pin 29. SERVICE as necessary GO to FC11.
FC8	CHECK CIRCUIT 296 (W/P) FOR OPEN		
	• Disconnect CPP switch. • Measure resistance between Circuit 296 (W/P) on CPP harness connector and contact for Fuse 18. • **Is resistance less than 5 ohms?**	Yes	▶ Circuit 296 (W/P) is OK. GO to FC9.
		No	▶ SERVICE open in Circuit 296 (W/P). RESTORE system. CLEAR DTCs and RETEST.
FC9	CHECK CPP SWITCH FOR OPEN		
	• Key on, engine off. • Install Jumper between CPP connector Circuits 306 (T/LB) and 296 (W/P) (two middle pins). • Key off. • **Did PID read ON?**	Yes	▶ REPLACE CPP switch. RESTORE system. CLEAR DTCs and RETEST.
		No	▶ GO to FC10.
FC10	CHECK CIRCUIT 306 (T/LB) FOR OPEN		
	• Remove jumper. • Disconnect PCM. • Install breakout box; leave PCM disconnected. • Measure resistance between PCM Test Pin 29 and Circuit 306 (T/LB) on CPP harness connector. • **Is resistance less than 5 ohms?**	Yes	▶ Circuit 306 (T/LB) is OK. Open is at PCM Pin 29. REPAIR as required. GO to FC11.
		No	▶ REPAIR open in Circuit 306 (T/LB). RESTORE system. CLEAR DTCs and RETEST
FC11	CONFIRM PCM FAULT		
	• Cycle clutch pedal. • **Does PID switch between ON and OFF?**	Yes	▶ System is OK. RESTORE system. CLEAR DTCs and RETEST.
		No	▶ REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.
FC12	CHECKS FOR INTERMITTENT OPEN OR SHORT		
	• CPP switch unplugged. • Key on. • Jumper between CPP connector contacts for Circuits 306 (T/LB) and 296 (W/P) (two middle pins). • Confirm that NGS Tester PID CPP shows ON. • Wiggle connectors and wires while watching CPP on NGS Tester. • **Does PID switch between ON and OFF?**	Yes	▶ REPAIR circuitry at point of intermittent. RESTORE system. CLEAR DTCs and RETEST.
		No	▶ GO to FC13.

Clutch Pedal Position (CPP) Switch

FC

Test Step	Result ▶	Action to Take
FC13 CHECK FOR INTERMITTENT SHORT TO B+		
● CPP switch unplugged. ● Remove fuse. ● Jumper between CPP connector contacts for Circuits 306 (T/LB) and 296 (W/P) (two middle pins). ● Confirm that NGS Tester PID CPP shows OFF. ● Wiggle connector and wires while watching CPP on NGS Tester. ● **Does PID switch between OFF and ON?**	Yes ▶	REPAIR circuitry at point of intermittent contact with B+ source. INSTALL fuse. RESTORE system. CLEAR DTCs and RETEST.
	No ▶	Intermittent not detected. RESTORE system. CLEAR DTCs and RETEST.

Brake Lamp Switch

FD

Note

Enter this pinpoint test only when directed here from symptom flowcharts.

Remember

This pinpoint test is intended to diagnose only the following:

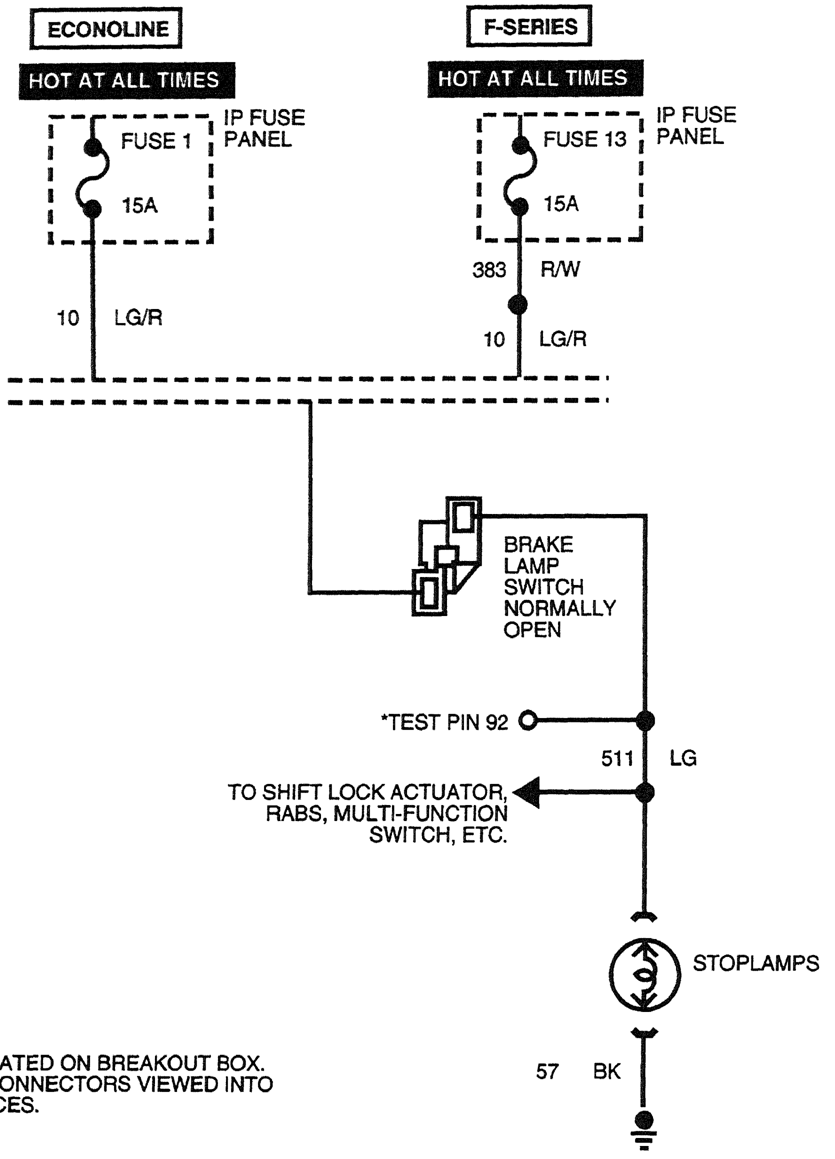
- brake on / off (BOO) circuit
- powertrain control module (PCM)(12A650)

Description

The BOO input is wired to the stoplamp circuit and informs the PCM when the brake is applied. The BOO input is used to disengage the speed control system.

Brake Lamp Switch

FD



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACES.

DA0416-B

DTC Description

P0703 = Brake Switch B circuit malfunction

Brake Lamp Switch

FD

Test Step		Result	▶	Action to Take
FD1	DIAGNOSTIC TROUBLE CODE (DTC) P0703 NOTE: When performing KOER switch test, wait five seconds after pressing the trigger to start the test before running through the driver operated controls. The test may also take up to five minutes to complete. NOTE: No PID transition indicates a BOO circuit failure. ● Key on, engine off. ● Firmly cycle brake pedal. ● Access BOO PID. ● **Does PID read ON only?**	Yes No	▶ ▶	GO to FD2. GO to FD4.
FD2	CHECK FOR BOO SWITCH FAILED CLOSED ● Disconnect brake lamp switch. ● Key off. ● **Did PID go to OFF?**	Yes No	▶ ▶	REPLACE brake lamp switch. GO to FD3.
FD3	CHECK FOR SHORT TO B+ IN CIRCUIT 511 (LG) ● Disconnect PCM. ● Key on, engine off. ● Check voltage between Circuit 511 (LG) on brake lamp switch harness connector and chassis ground. ● Key off. ● **Was B+ present?**	Yes No	▶ ▶	REPAIR short to B+ in Circuit 511 (LG). Short to B+ is at Pin 92 in PCM. SERVICE as necessary. GO to FD11.
FD4	CHECK PID BOO ● **Does PID read OFF only?**	Yes No	▶ ▶	F-Series, GO to FD5. Econoline, GO to FD6. Fault may be intermittent. GO to FD13.
FD5	CHECK FUSE 13 (15 AMP) ● Check Fuse 13 (15 amp) in IP fuse panel. ● **Is Fuse 13 OK?**	Yes No	▶ ▶	LOOK for open circuit. GO to FD9. THROW away fuse. LOOK for short to ground. GO to FD7.
FD6	CHECK FUSE 1 (15 AMP) ● Check Fuse 1 (15 amp) in IP fuse panel. ● **Is Fuse 1 OK?**	Yes No	▶ ▶	GO to FD9. THROW away fuse. LOOK for possible short to ground. GO to FD7.

Brake Lamp Switch

FD

Test Step		Result ▶	Action to Take
FD7	CHECK CIRCUIT 383 (R / W) AND 10 (LG / R) FOR SHORT TO GROUND ● Key off. ● Disconnect Brake lamp switch. ● Check resistance between circuit connector contact at brake lamp switch connector and chassis ground. ● **Is resistance less than 10,000 ohms?**	Yes ▶	REPAIR short to ground in Circuit 383 (R / W) or 10 (LG / R). REPLACE Fuse 13 (15A). RESTORE system. CLEAR DTCs and RETEST.
		No ▶	GO to FD8.
FD8	CHECK CIRCUIT 511 (LG) FOR SHORT TO GROUND ● Disconnect PCM. ● Key on, engine off. ● Check resistance between Circuit 511 (LG) on brake lamp switch harness connector and chassis ground. ● **Is resistance less than 10,000 ohms?**	Yes ▶	REPAIR short to ground in Circuit 511 (LG). RESTORE system. CLEAR DTCs and RETEST.
		No ▶	Short to ground is at PCM Pin 92. SERVICE as necessary. GO to FD12.
FD9	CHECK CIRCUITS 383 (R / W) AND 10 (LG / R) FOR OPEN ● Key off. ● Disconnect brake lamp switch. ● Check resistance between circuit connector contact at brake lamp switch connector and fuse contact for Circuit 383 (R / W). ● **Is resistance less than 5 ohms?**	Yes ▶	Circuits 383 (R / W) and 10 (LG / R) are OK. GO to FD10.
		No ▶	REPAIR open in Circuit 383 (R / W) or 10 (LG / R). RESTORE system. CLEAR DTCs and RETEST.
FD10	CHECK BOO SWITCH FOR OPEN ● Key on, engine off. ● Install jumper between brake lamp switch Circuits 511 (LG) and 10 (LG / R). ● Key off. ● **Did PID read ON?**	Yes ▶	REPLACE brake lamp switch. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	GO to FD11.
FD11	CHECK CIRCUIT 511 (LG) FOR OPEN ● Remove jumper. ● Disconnect PCM. ● Install breakout box; leave PCM disconnected. ● Key on, engine off. ● Check resistance between PCM Test Pin 92 and brake lamp switch harness connector Circuit 511 (LG). ● **Is resistance less than 5 ohms?**	Yes ▶	Circuit 511 (LG) is OK. Open is at PCM Pin 92. REPAIR as required. GO to FD12.
		No ▶	REPAIR open in Circuit 511 (LG). RESTORE system. CLEAR DTCs and RETEST.
FD12	CONFIRM PCM FAULT ● **Does PID switch between ON and OFF?**	Yes ▶	System is OK. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.

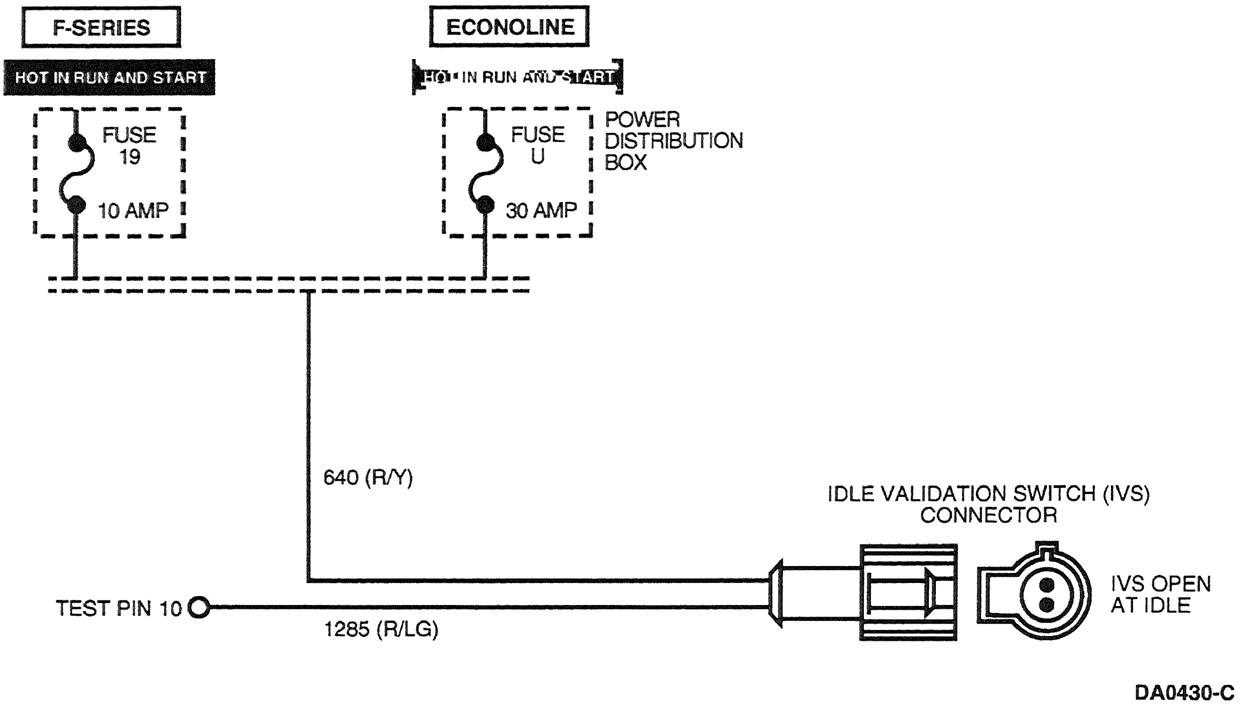
Brake Lamp Switch

FD

Test Step		Result ▶	Action to Take
FD13	CHECKS FOR INTERMITTENT OPEN OR SHORT		
	● Key off. ● Disconnect Brake lamp switch. ● Key on, engine off. ● Install jumper between brake lamp switch Circuits 511 (LG) and 10 (LG/R). ● Confirm BOO PID reads ON and that stoplamps are on. ● Wiggle connectors and wires while observing BOO PID and stoplamps. ● **Does PID switch between ON and OFF?**	Yes ▶ No ▶	REPAIR circuitry at point of intermittent. RESTORE system. CLEAR DTCs and RETEST. GO to FD14.
FD14	CHECK FOR INTERMITTENT SHORT TO B+		
	● Remove fuse. ● Confirm BOO PID reads OFF and that stoplamps are off. ● Wiggle connector and wires while watching BOO PID and stoplamps. ● **Does PID switch between OFF and ON?**	Yes ▶ No ▶	REPAIR circuitry at point of intermittent contact with B+ source. INSTALL fuse. RESTORE system. CLEAR DTCs and RETEST. Intermittent not detected. RESTORE system. CLEAR DTCs and RETEST.

Idle Validation Switch (IVS)

FE



Signal Functions

The idle validation switch (IVS) provides the powertrain control module (PCM) with a signal to verify when the accelerator pedal is in the idle position.

Detection/Management

Any detected malfunction of the IVS will illuminate the CHECK ENGINE light.

DTC Description

P0220 = Throttle Switch B circuit malfunction

P0221 = Throttle Switch B circuit performance

Idle Validation Switch (IVS)

FE

Test Step		Result ▶	Action to Take
FE1	DIAGNOSTIC TROUBLE CODE (DTC) P0221, P0220		
	NOTE: When performing KOER switch test, wait five seconds after pressing the trigger to start the test before running through the driver-operated controls. The test may take up to five minutes to complete. ● Possible Causes: — blown fuse — open in powering circuit to IVS switch — open in IVS circuit — IVS switch — IVS transition out of range ● Key on, engine off. ● Access AP and IVS PID. ● Foot off accelerator pedal. ● **Does the IVS PID read ON?**	Yes ▶ No ▶	GO to FE7. GO to FE2.
FE2	IVS TRANSITION VOLTAGE CHECK		
	● Depress accelerator pedal slowly while observing IVS state and AP voltage. ● **Does the IVS switch ON between 0.40 V and 1.6 V?**	Yes ▶ No ▶	CLEAR DTCs and RETEST. If code is still present, REPLACE PCM. GO to FE3.
FE3	IVS CHECK		
	● Fully depress accelerator pedal while observing IVS. ● **Does IVS PID go ON at any pedal travel?**	Yes ▶ No ▶	REPLACE accelerator pedal. CLEAR DTCs and RETEST. GO to FE4.
FE4	IVS RESISTANCE CHECK		
	● Key off. ● Disconnect IVS connector. ● Measure resistance across IVS on accelerator pedal with accelerator pedal depressed. ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to FE5. REPLACE accelerator pedal assembly. RESTORE system. CLEAR DTCs and RETEST.
FE5	CHECK IVS POWER CIRCUIT		
	● Key on, engine off. ● Measure voltage on powering circuit going to IVS between connector and ground. ● **Is B+ present?**	Yes ▶ No ▶	GO to FE6. REPLACE fuse or REPAIR open in powering circuit to IVS switch. RESTORE system. CLEAR DTCs and RETEST.
FE6	CHECK CIRCUIT 1285 (R/LG) FOR OPEN		
	● Install breakout box; leave PCM disconnected. ● Measure resistance between Circuit 1285 (R/LG) at IVS connector and PCM Test Pin 10. ● **Is resistance less then 5 ohms?**	Yes ▶ No ▶	REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST. REPAIR open in Circuit 1285 (R/LG). RESTORE system. CLEAR DTCs and RETEST.

Idle Validation Switch (IVS)

FE

Test Step		Result ▶	Action to Take
FE7	CHECK CIRCUIT 1285 (R/LG) SHORT TO POWER		
	- Disconnect IVS connector. - **Does IVS PID read OFF?**	Yes ▶	REPLACE accelerator pedal. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	REPAIR short to power in IVS Circuit 1285 (R/LG). RESTORE system. CLEAR DTCs and RETEST.

Parking Brake Applied (PBA) Switch

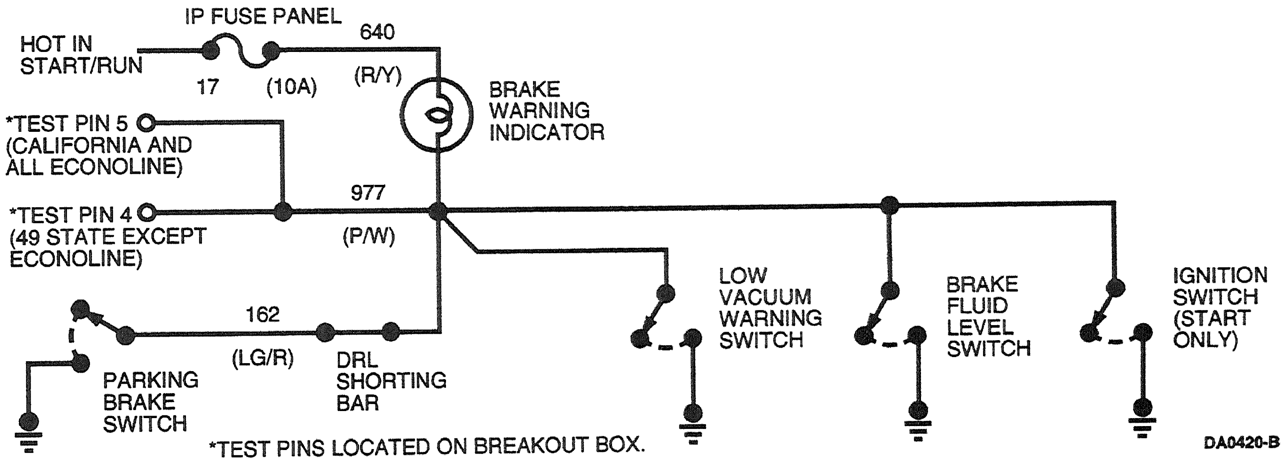
FF

Note

Enter this pinpoint test only when directed here from symptom flowcharts.

Description

The parking brake applied (PBA) switch detects when the parking brake is applied to enable the PTO / raised-Idle mode.



DTC Description

P1536 = Parking brake applied fail

Parking Brake Applied (PBA) Switch

FF

Test Step		Result ▶	Action to Take
FF1	DIAGNOSTIC TROUBLE CODE (DTC) P1536		
	NOTE: When performing KOER switch test, wait five seconds after pressing the trigger to start the test before running through the driver operated controls. The test may also take up to five minutes to complete. ● DTC P1536 is set when the PCM does not see a PBA state change during KOER. Possible causes: — low brake fluid — short to ground — short to B+ — open circuit ● Confirm BRAKE WARNING and RABS light are working during engine start mode (bulb check). ● **Are bulbs working?**	Yes ▶	GO to FF2.
		No ▶	REPAIR bulbs circuitry: Circuit 977 (P/W) (possible short to B+) and Circuit 640 (R/Y). CONFIRM fix with Bulb Check during start mode.
FF2	CHECK FOR BRAKE SYSTEM PROBLEM		
	● Key on, engine off. ● Parking brake fully off. ● **Are both BRAKE WARNING and RABS lights on?**	Yes ▶	REPAIR brake system. CLEAR DTCs and RETEST.
		No ▶	GO to FF3.
FF3	CHECK PID PBA		
	NOTE: No PID transition indicates a PBA circuit failure. ● Access PBA PID. ● Cycle parking brake. ● **Does PID read ON only?**	Yes ▶	GO to FF4.
		No ▶	GO to FF6.
FF4	CHECK FOR PBA SWITCH FAILED CLOSED		
	● Parking brake fully up. ● Disconnect PBA switch. ● **Does PID go to OFF?**	Yes ▶	REPLACE PBA switch. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	GO to FF5.
FF5	CHECK CIRCUIT 977 (P/W) FOR SHORT TO GROUND		
	● Key off. ● Disconnect PCM. ● Measure resistance between Circuit 977 (P/W) on PBA harness connector and chassis ground. ● **Is resistance less than 10,000 ohms?**	Yes ▶	REPAIR short to ground in Circuit 977 (P/W). RESTORE system. CLEAR DTCs and RETEST.
		No ▶	Short to ground is at PCM Pin 4 (49 State except Econoline) or Pin 5 (California and all Econoline). REPAIR as necessary. GO to FF9.

Parking Brake Applied (PBA) Switch

FF

Test Step		Result ▶	Action to Take
FF6	CHECK PID PBA		
	• Cycle parking brake. • **Does PID read OFF only?**	Yes ▶ No ▶	Open circuit. GO to FF7. Fault may be intermittent. GO to FF10.
FF7	CHECK PBA SWITCH AND CIRCUIT LEAD FOR OPEN		
	• Disconnect PBA switch. • Install jumper between PBA Circuit 977 (P / W) and ground. • **Does PID read ON?**	Yes ▶ No ▶	REPLACE PBA switch. RESTORE system. CLEAR DTCs and RETEST. GO to FF8.
FF8	CHECK CIRCUIT 977 (P / W) LEAD FOR OPEN		
	• Key off. • Install breakout box; leave PCM disconnected. • Key on, engine off. • Measure voltage between PCM Test Pin 4 (49 State except Econoline) or PCM Test Pin 5 (California and all Econoline) and chassis ground. • **Is B+ present?**	Yes ▶ No ▶	Circuit 977 (P / W) is OK. Open is at PCM Pin. RESTORE system. CLEAR DTCs and RETEST. REPAIR as required. GO to FF9. REPAIR open in Circuit 162 (LG / R), DRL jumper, or Circuit 977 (P / W) PBA switch lead. RESTORE system. CLEAR DTCs and RETEST.
FF9	CONFIRM PCM FAULT		
	• Cycle parking brake. • **Does PID switch between ON and OFF?**	Yes ▶ No ▶	System is OK. REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.
FF10	CHECK FOR INTERMITTENT SHORT TO GROUND		
	• Disconnect PBA switch. • Confirm PBA PID reads OFF. • Wiggle connectors and wires while watching PBA PID. • **Does PID switch between OFF and ON?**	Yes ▶ No ▶	REPAIR circuitry at point of intermittent. RESTORE system. CLEAR DTCs and RETEST. GO to FF11.
FF11	CHECK FOR INTERMITTENT OPEN		
	• Engage parking brake. • Confirm PBA PID reads ON. • Wiggle connector and wires while watching PBA PID. • **Does PID switch between ON and OFF?**	Yes ▶ No ▶	REPAIR circuitry at point of intermittent open. RESTORE system. CLEAR DTCs and RETEST. Intermittent not detected. RESTORE system. CLEAR DTCs and RETEST.

Speed Control Command Switch (SCCS)

FG

Note

Enter this pinpoint test only when directed here from the symptom flowcharts.

Remember

If the SCCS fails the switch test or vehicle speed is not being received by the PCM, the speed control will not operate.

This pinpoint test is intended to diagnose only the following:

- harness circuits: speed control command switch (SCCS)
- speed control switches
- powertrain control module (PCM)(12A650)

Description

The speed control function is integrated in the PCM. The speed control command switches are momentary switches which are located on the face of the steering wheel. They consist of one ON-OFF toggle switch and one three-position SET/ACCEL-COAST-RESUME switch. These switches, when depressed, select one of several resistance values to the PCM to select speed control functions. After pressing trigger, wait at least five seconds to depress accelerator pedal.

DTC Descriptions

P0565 = Speed control ON. Not pressed — KOER Switch Test.

P0566 = Speed control OFF. Not pressed — KOER Switch Test.

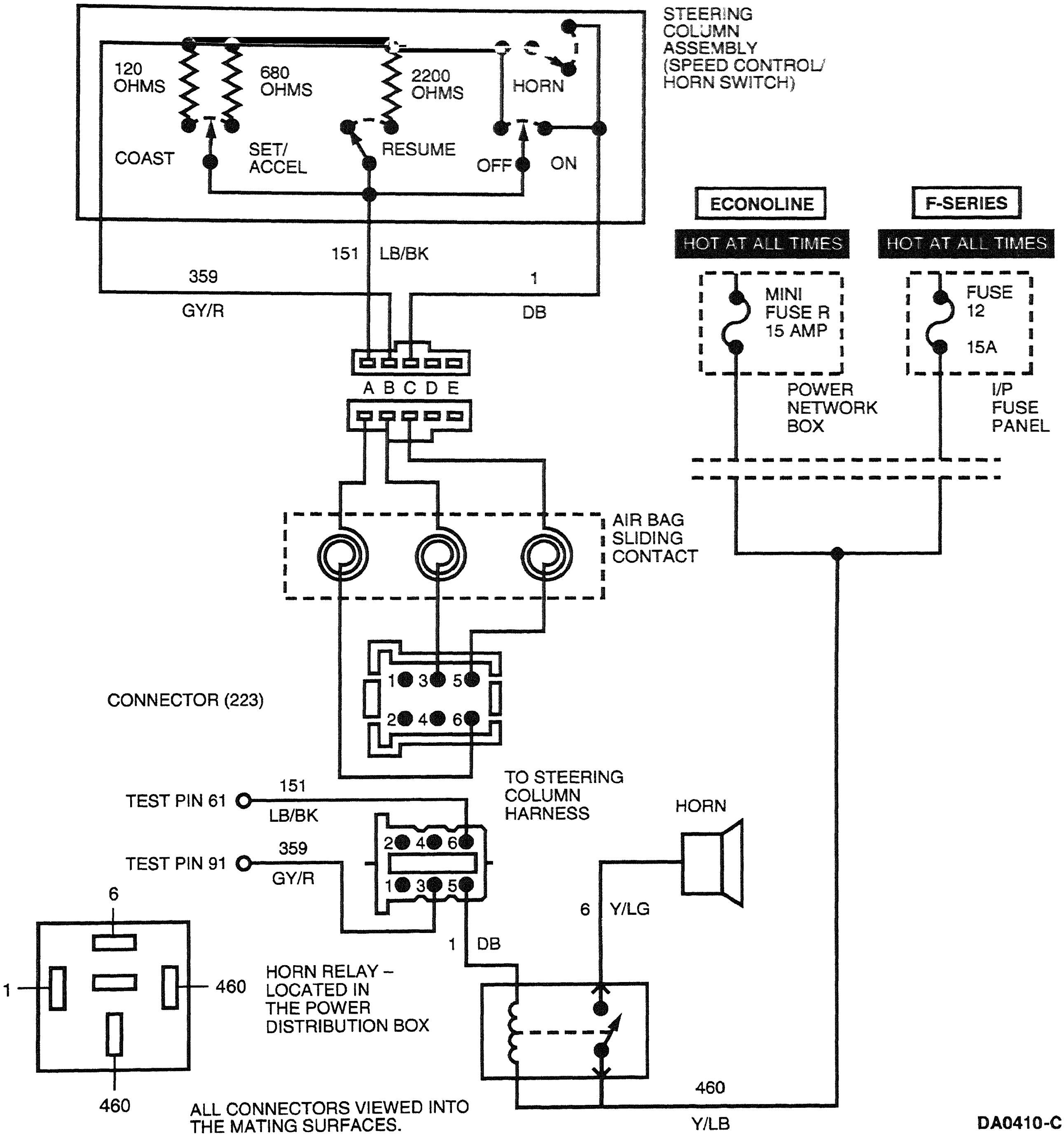
P0567 = Speed control RESUME. Not pressed — KOER Switch Test.

P0568 = Speed control SET. Not pressed — KOER Switch Test.

Speed Control Command Switch (SCCS)

FG

P0569 = Speed control COAST. Not pressed — KOER Switch Test.



DA0410-C

Speed Control Command Switch (SCCS)

FG

Test Step		Result ▶	Action to Take
FG1	DIAGNOSTIC TROUBLE CODES (DTCs) P0565/P0566/P0567/P0568/P0569		
	NOTE: When performing KOER switch test, wait five seconds after pressing the trigger to start the test before running through the driver operated controls. The test may also take up to five minutes to complete. ● DTCs P0565, P0566, P0567, P0568 and P0569 are set if the PCM does not detect when a switch has been pressed during the KOER switch test. Possible causes: — switch not depressed during test — worn or damaged speed control switch — open, grounded, or short to power in SCCS circuit — open or short in SC GND circuit — open in power supply circuit ● Access SCCS PID. ● Key on, engine off. ● No switches depressed. ● **Is voltage reading 6.68 V ± 0.1?**	Yes ▶	GO to FG2.
		No ▶	If voltage reading is 10 V, GO to FG5. If voltage reading is 0 V, GO to FG8.
FG2	SWITCH ON FUNCTION CHECK		
	● Press ON switch. ● **Does scan tool read 10 V?**	Yes ▶	GO to FG3.
		No ▶	GO to FG11.
FG3	SWITCH OFF FUNCTION CHECK		
	● Press OFF switch. ● **Does scan tool read 0 V?**	Yes ▶	GO to FG4.
		No ▶	GO to FG17.
FG4	COMMAND SWITCHES FUNCTION		
	● Press RESUME, COAST, SET/ACCEL switches. ● Observe voltage reading as each switch is depressed. ● Refer to Section 2, Diagnostic Methods, Parameter Identification (PID), Driver Operated Controls Check Chart for voltage specifications supplied for SCCS M PID. ● **Do voltage readings agree with voltage values in driver operated controls check chart ± 0.2 V?**	Yes ▶	RERUN KOER switch test. If code is still present, REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	REPLACE speed control switch assembly. RESTORE system. CLEAR DTCs and RETEST.
FG5	SHORTED COMMAND SWITCH CHECK		
	● Remove horn pad. ● Disconnect 3-way (F-Series) or 5-way (Econoline) speed control switch harness connector. ● **Is voltage reading 6.68 V ± 0.1?**	Yes ▶	REPLACE speed control switch assembly. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	GO to FG6.

Speed Control Command Switch (SCCS)

FG

Test Step		Result ▶	Action to Take
FG6	AIR BAG SLIDING CONTACT CHECK • Disconnect air bag sliding contact connector C219 (F-Series) or C223 (Econoline). • **Is voltage reading 6.68 V ± 0.1?**	Yes ▶	REPLACE air bag sliding contact. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	GO to FG7.
FG7	SIGNAL CIRCUIT CHECK • Key off. • Install breakout box; leave PCM disconnected. • Key on, engine off. • Measure voltage between PCM Test Pin 61 and ground. • **Is voltage reading 0 V?**	Yes ▶	REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	REPAIR short to power in Circuit 151 (LB/BK). RESTORE system. CLEAR DTCs and RETEST.
FG8	CHECK SHORTED COMMAND SWITCH • Remove horn pad. • Disconnect 3-way (F-Series) or 5-way (Econoline) speed control switch harness connector. • **Is voltage reading 6.68 V ± 0.1?**	Yes ▶	REPLACE speed control switch assembly. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	GO to FG9.
FG9	CHECK AIR BAG SLIDING CONTACT • Disconnect air bag sliding contact connector C219 (F-Series) or C223 (Econoline). • **Is voltage reading 6.68 V ± 0.1?**	Yes ▶	REPLACE air bag sliding contact. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	GO to FG10.
FG10	CHECK SIGNAL CIRCUIT • Key off. • Install breakout box; leave PCM disconnected. • Measure resistance between PCM Test Pin 61 and PCM Test Pins 25, 51, 76, 77 and 103. • **Is each resistance reading greater than 10,000 ohms?**	Yes ▶	REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	REPAIR short to ground in Circuit 151 (LB/BK). RESTORE system. CLEAR DTCs and RETEST.
FG11	FUSE R CHECK • Key off. • Remove Fuse R (15 amp) from power distribution box. • **Is Fuse R OK?**	Yes ▶	GO to FG12.
		No ▶	Replace Fuse R. RESTORE system. CLEAR DTCs and RETEST.

Speed Control Command Switch (SCCS)

FG

Test Step	Result ▶	Action to Take
FG12 CHECK CONTINUITY FROM FUSE R TO HORN PAD ● Remove horn pad. ● Disconnect 5-way speed control switch harness connector. ● Measure resistance between non-power side of Fuse R and Pin C of air bag sliding contact in column (refer to schematic at beginning of this pinpoint test for pin orientation). ● **Is resistance less than 75 ohms?**	Yes ▶ No ▶	GO to FG13. GO to FG16.
FG13 CHECK SPEED CONTROL SWITCH ● Measure resistance between Pin A and Pin C on horn assembly harness. ● Press ON switch. ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to FG14. REPLACE speed control switch assembly. RESTORE system. CLEAR DTCs and RETEST.
FG14 CHECK CIRCUIT 151 (LB/BK) FOR OPEN ● Disconnect air bag sliding contact connector C223. ● Measure resistance between Pin 61 and Circuit 151 (LB/BK) Pin 6 at vehicle harness side of connector C223. ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to FG15. REPAIR open in Circuit 151 (LB/BK). RESTORE system. CLEAR DTCs and RETEST.
FG15 CHECK AIR BAG SLIDING CONTACT CIRCUIT ● Measure resistance between Pin C and Pin 5 of air bag sliding contact side of connector C223 (refer to schematic at beginning of this pinpoint test for pin orientation). ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST. REPLACE air bag sliding contact. RESTORE system. CLEAR DTCs and RETEST.
FG16 RESISTANCE CHECK ACROSS AIR BAG SLIDING CONTACT ● Disconnect air bag sliding contact connector C223. ● Measure resistance between Pin B and Pin 5 on air bag sliding contact connector C223 column side. ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	REPAIR open in Circuit 1 (DB), 460 (Y/LB), or the horn relay. RESTORE system. CLEAR DTCs and RETEST. REPLACE air bag sliding contact. RESTORE system. CLEAR DTCs and RETEST.
FG17 GROUND CHECK AT SWITCH ● Remove horn pad. ● Disconnect 5-way speed control switch harness connector. ● Measure voltage between Pin B and Pin C of the air bag sliding contact connector C223 in column. ● **Does voltage reading indicate B+?**	Yes ▶ No ▶	REPLACE speed control switch assembly. RESTORE system. CLEAR DTCs and RETEST. GO to FG18.

Speed Control Command Switch (SCCS)

FG

Test Step		Result	▶ Action to Take
FG18	CHECK AIR BAG SLIDING CONTACT FOR OPEN		
	- Key off. - Disconnect air bag sliding contact connector C223. - Measure resistance between Pin B and Pin 3 on air bag sliding contact side of connector C223 (refer to schematic at beginning of this pinpoint test for pin orientation). - **Is resistance less than 5 ohms?**	Yes No	▶ GO to FG19. ▶ REPLACE air bag sliding contact. RESTORE system. CLEAR DTCs and RETEST.
FG19	CHECK FOR OPEN IN CIRCUIT 563 (O / Y)		
	- Install breakout box; leave PCM disconnected. - Measure resistance between Circuit 848 (G / O) Pin 3 at vehicle harness side of connector C223 and PCM Test Pin 40. - **Is resistance less than 5 ohms?**	Yes No	▶ REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST. ▶ REPAIR open in Circuit 848 (G / O) between PCM and connector C223. RESTORE system. CLEAR DTCs and RETEST.

4x4 Low

FH

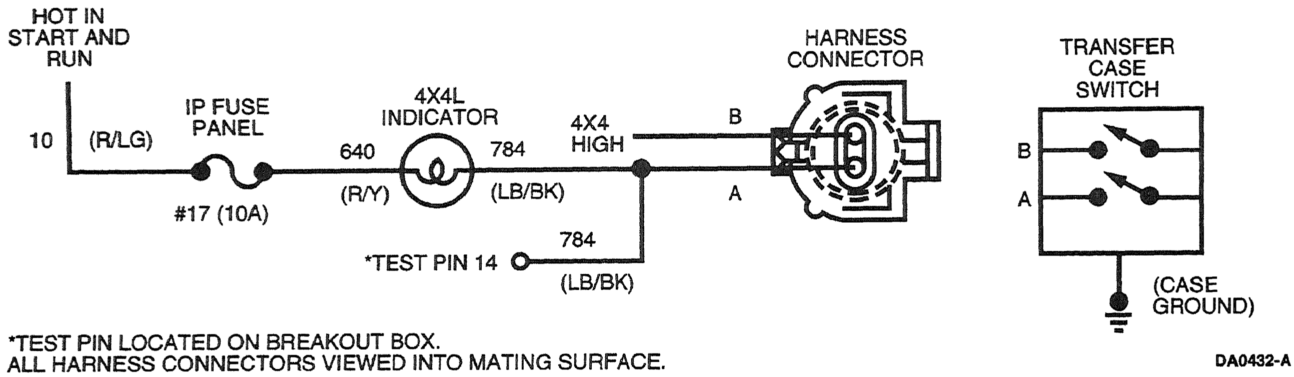
Note

Enter this pinpoint test only when directed here.

Remember

This pinpoint test is intended to diagnose the following:

- harness circuits and fuse for 4x4 low
- powertrain control module (PCM)(12A650)
- 4x4 low switch



DTC Description

P1729 = 4x4 low switch error

P1781 = 4x4L circuit out of self test range

Test Step		Result ▶	Action to Take
FH1	DIAGNOSTIC TROUBLE CODES (DTCs) P1729 AND P1781: PERFORM SWITCH FUNCTIONAL CHECK		
	• Key on, engine off. • Switch to and from 4x4L while monitoring the 4x4L indicator. • **Does the indicator agree with the lever position?**	Yes ▶ No ▶	GO to FH2. GO to FH4.

4x4 Low

FH

	Test Step	Result	Action to Take
FH2	CHECK 4X4 LOW		
	- Key on, engine off. - Access 4x4L PID. - Switch to and from 4x4L while monitoring the PID. - **Does PID agree with the lever position?**	Yes ▶	GO to FH3
		No ▶	GO to FH11.
FH3	INTERMITTENT PROBLEM		
	- Key on, engine off. - Wiggle all circuits for 4x4L while monitoring the PID. - **Does the PID change states during the wiggle test?**	Yes ▶	REPAIR failure in circuitry. CLEAR DTCs and RETEST.
		No ▶	Unable to duplicate error at this time. CLEAR DTCs and RETEST.
FH4	VOLTAGE CHECK AT SWITCH		
	- Key on, engine off. - Disconnect 2-way to 4x4L switch. - Measure voltage at 4x4L switch Pin A. - **Is voltage greater than 10.5 volts?**	Yes ▶	REPLACE 4x4L switch. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	GO to FH5.
FH5	LIGHT ALWAYS ON?		
	- Disconnect 4x4L harness. - Shift to and from 4x4L. - **Does the light remain ON regardless of lever position?**	Yes ▶	REPAIR short to ground between indicator light and switch connector. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	GO to FH6.
FH6	CHECK VOLTAGE AT FUSE		
	- Measure voltage to ground at both sides of the fuse. - **Is voltage greater than 10.5 volts?**	Yes ▶	GO to FH9.
		No ▶	GO to FH7.
FH7	MAIN POWER FEED TO FUSE		
	- Measure voltage to ground at the battery side of the fuse. - **Is voltage greater than 10.5 volts?**	Yes ▶	GO to FH8.
		No ▶	REPAIR voltage source. RESTORE system. CLEAR DTCs and RETEST.
FH8	CHECK SHORT TO GROUND		
	- 4x4 lever not in LOW position. - Key off. - Measure resistance to ground on Circuit 640 (R/Y). - **Is the resistance greater than 10,000 ohms?**	Yes ▶	REPLACE fuse. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	REPAIR short circuit to ground. REPLACE fuse. RESTORE system. CLEAR DTCs and RETEST.

4x4 Low

FH

Test Step		Result ▶	Action to Take
FH9	CHECK 4X4L BULB		
	- Key off. - Remove the 4x4L indicator light. - **Is the indicator bulb OK?**	Yes ▶ No ▶	GO to FH10. REPLACE bulb. RESTORE system. CLEAR DTCs and RETEST.
FH10	CHECK VOLTAGE AT INDICATOR LAMP		
	- Key on, engine off. - Shift out of 4x4 low. - Measure voltage between input Circuit 640 (R/Y) and indicator lamp - **Is voltage greater than 10.5 volts?**	Yes ▶ No ▶	REPAIR open in Circuit 784 (LB/BK) to switch connector. RESTORE system. CLEAR DTCs and RETEST. REPAIR open in Circuit 640 (R/Y) to lamp. RESTORE system. CLEAR DTCs and RETEST.
FH11	CHECK CIRCUIT 784 (LB/BK) FOR CONTINUITY		
	- Key off. - Install breakout box; leave PCM disconnected. - Measure resistance between PCM Test Pin 14 and Pin A. - **Is the resistance less than 5 ohms?**	Yes ▶ No ▶	GO to FH12. REPAIR open in Circuit 784 (LB/BK). RESTORE system. CLEAR DTCs and RETEST.
FH12	CHECK SHORT TO GROUND IN CIRCUIT 784 (LB/BK)		
	- Measure resistance to ground from Circuit 784 (LB/BK) at Pin A. - **Is resistance less than 10,000 ohms?**	Yes ▶ No ▶	REPAIR short to ground in circuit. RESTORE system. CLEAR DTCs and RETEST. REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.

Injector Driver Module Feedback

FJ

Note

Enter this pinpoint test only when directed here from the symptom flowcharts.

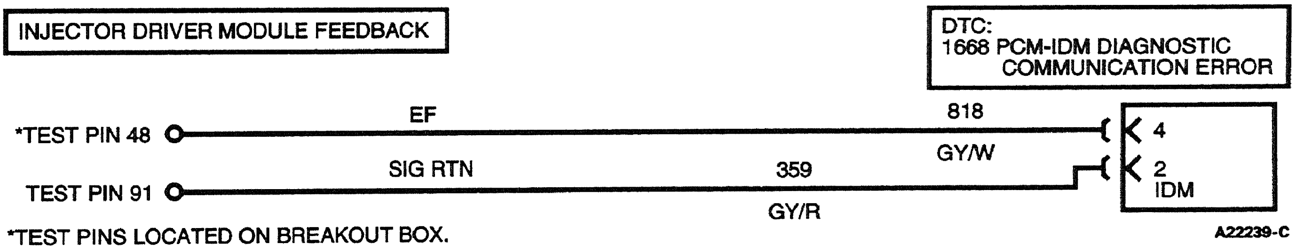
Remember

This pinpoint test is intended to diagnose only the following:

- powertrain control module (PCM)(12A650)
- injector driver module (IDM)
- harness circuits: EF

Description

The IDM provides the EF output signal to the PCM to confirm that proper timing / duration of fuel delivery command signal (FDCS) was received. Additionally, the EF signal is used to send diagnostics of the IDM and injectors (electrical) to the PCM.



DTC Description

P1668 = PCM-IDM diagnostic communication error

P1670 = EF signal feedback signal not detected

Injector Driver Module Feedback

FJ

Test Step		Result ▶	Action to Take
FJ1	DIAGNOSTIC TROUBLE CODE (DTC) P1668		
	● DTC P1668 indicates a PCM-IDM communication error on the EF line. Possible causes: — open / ground short in EF circuit — unpowered or damaged IDM — damaged PCM ● Open IDM ground signal. ● Perform KOEO Self Test again. ● Key off. ● **Was DTC P1668 present?**	Yes ▶	▶ If DTC P1668 or P1670 is present, GO to FJ3. ▶ If DTCs P1667 and P1663 are also present with DTC P1668, GO to FJ8. ▶ If DTC P1298 is also present with DTC P1668, GO to KA1. ▶ If DTC P1667 is also present with DTC P1668, GO to KA1. ▶ If DTC P1663 is also present with DTC P1668, GO to KF1. ▶ If DTC P1662 is also present with DTC P1668, GO to NC1.
		No ▶	GO to FJ2.
FJ2	MONITOR EF CIRCUIT UNDER SIMULATED ROAD SHOCK		
	WARNING: RED-STRIPED WIRES CARRY 115 V DC. SEVERE ELECTRICAL SHOCK CAN BE RECEIVED. DO NOT PIERCE. **CAUTION: Do not pierce engine electrical wires or damage to the harness can occur.** ● Key on, engine running. ● Wiggle Circuit 818 (GY / W). Refer to schematic at beginning of this pinpoint test. ● **Is DTC P1668 present?**	Yes ▶	REPAIR intermittent connection in Circuit 818 (GY / W). RESTORE system. CLEAR DTCs and RETEST.
		No ▶	Unable to repeat concern. RETURN to symptom flowchart.
FJ3	CHECK CIRCUIT 818 (GY / W) FOR OPEN		
	● Install breakout box; leave PCM disconnected. ● Disconnect the IDM harness connector. ● Measure resistance between PCM Test Pin 48 and Circuit 818 (GY / W) on IDM harness connector Pin 4. ● **Is resistance less than 5 ohms?**	Yes ▶	GO to FJ4.
		No ▶	REPAIR open in Circuit 818 (GY / W). RESTORE system. CLEAR DTCs and RETEST.
FJ4	CHECK CIRCUIT 818 (GY / W) FOR SHORT		
	● Measure resistance between PCM Test Pin 48 and PCM Test Pins 25, 51, 76, 77 and 103. ● **Is resistance greater than 10,000 ohms?**	Yes ▶	GO to FJ5.
		No ▶	REPAIR ground short in Circuit 818 (GY / W). RESTORE system. CLEAR DTCs and RETEST.
FJ5	CHECK CIRCUIT 818 (GY / W) FOR SHORT TO POWER		
	● Connect PCM to breakout box. ● Key on, engine off. ● Measure resistance between PCM Test Pin 48 and PCM Test Pins 55, 71, 97. ● **Is resistance greater than 10,000 ohms?**	Yes ▶	GO to FJ6.
		No ▶	REPAIR short to power. RESTORE system. CLEAR DTCs and RETEST.

Injector Driver Module Feedback

FJ

<table>
<tr><th colspan="2">Test Step</th><th>Result ▶</th><th>Action to Take</th></tr>
<tr><td>FJ6</td><td>SIGNAL GROUND TEST</td><td></td><td></td></tr>
<tr><td></td><td>● Measure resistance between PCM Test Pin 91 and IDM harness connector Pin 2.
● Is resistance less than 5 ohms?</td><td>Yes ▶
No ▶</td><td>GO to FJ7.
REPAIR the signal ground circuit. RESTORE system. CLEAR DTCs and RETEST.</td></tr>
<tr><td>FJ7</td><td>CHECK IDM POWER</td><td></td><td></td></tr>
<tr><td></td><td>● Measure voltage between PCM Test Pin 14 and battery ground post.
● Key off.
● Was voltage greater than 10.5 volts?</td><td>Yes ▶
No ▶</td><td>GO to FJ8.
GO to NC1.</td></tr>
<tr><td>FJ8</td><td>CHECK IDM GROUND</td><td></td><td></td></tr>
<tr><td></td><td>● Measure resistance between IDM harness connector Pin 26 and battery ground.
● Is resistance less than 5 ohms?</td><td>Yes ▶
No ▶</td><td>GO to FJ9.
REPAIR ground circuit. RESTORE system. CLEAR DTCs and RETEST.</td></tr>
<tr><td>FJ9</td><td>MEASURE FREQUENCY OF THE EF LINE</td><td></td><td></td></tr>
<tr><td></td><td>● Set up scan tool as follows:
— IDM connected.
— Use digital measurement system.
— Install IDM.
— Choose frequency meter.
— Choose "level" to change to a 4-volt scale.
— Connect scan tool common to Pin No. 77 (ground).
— Connect scan tool signal to Pin No. 48 (EF-LINE).
● Key on, engine running.
● Measure frequency at Pin No. 48.
● In turn, try each of the following rpms.
<table>
<tr><th>rpm</th><th>Frequency (Hz)</th></tr>
<tr><td>1000</td><td>66</td></tr>
<tr><td>2000</td><td>133</td></tr>
<tr><td>3000</td><td>200</td></tr>
</table>
● For each rpm value, does the corresponding frequency match closely to the table?</td><td>Yes ▶
No ▶</td><td>REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.
REPLACE IDM. RESTORE system. CLEAR DTCs and RETEST.</td></tr>
</table>

Injector Driver Module Feedback

FJ

Test Step		Result ▶	Action to Take
FJ10	DIAGNOSTIC TROUBLE CODE (DTC) P1316 NOTE: DTC P1316 indicates that IDM DTCs are stored in the IDM. NOTE: Injector faults are stored in the IDM and reported to the PCM during KOEO On-Demand Self Test and KOEO Injector Electrical Self Test. An intermittent fault will store a DTC in the IDM. IDM DTCs are cleared by using the CLEAR ALL command from the RETRIEVE/CLEAR CONTINUOUS DTCs menu on the NGS. ● Possible causes: — injector fault — IDM fault — PCM fault — EF circuit fault — FDCS circuit fault ● Perform KOEO On-Demand Self Test. ● **Are IDM DTCs stored?**	Yes ▶ No ▶	REPAIR KOEO DTCs. RESTORE system. CLEAR DTC P1316 and RETEST. GO to FJ11.
FJ11	VERIFY DTC P1316 RESETS ● Clear Continuous Memory DTCs. ● Road test vehicle. ● Retrieve/clear continuous DTCs. ● Perform KOEO On-Demand Self Test. ● **Is DTC P1316 set in continuous without IDM DTCs in KOEO?**	Yes ▶ No ▶	If any other Continuous Memory DTCs are set, GO to appropriate pinpoint test. If DTC P1316 is set only, GO to FJ12. SERVICE KOEO DTCs. RESTORE system. CLEAR DTCs and RETEST.
FJ12	DTC P1316 SET IN CONTINUOUS MEMORY WITH NO DTCS SET IN KOEO ON-DEMAND SELF TEST NOTE: DTC P1316 will set in Continuous Memory with no DTCs set in KOEO On-Demand Self Test if EF Circuit 818 (GY/W) or FDCS Circuit 821 (BR/O) are intermittently open or shorting high or low. ● Disconnect IDM harness connector. ● Install breakout box; leave PCM disconnected. ● Measure resistance between PCM Test Pin 48 and IDM harness connector Pin 4. ● Shake harness between IDM connector and PCM connector. ● **Does resistance ever go above 5 ohms?**	Yes ▶ No ▶	REPAIR open in EF Circuit 818 (GY/W). RESTORE system. CLEAR DTCs and RETEST. GO to FJ13.
FJ13	CHECK EF CIRCUIT FOR AN INTERMITTENT SHORT TO GROUND ● Measure resistance between PCM Test Pin 48 and ground. ● Shake harness between IDM connector and PCM connector. ● **Does resistance ever drop below 10,000 ohms?**	Yes ▶ No ▶	REPAIR short to ground in EF Circuit 818 (GY/W). RESTORE system. CLEAR DTCs and RETEST. GO to FJ14.

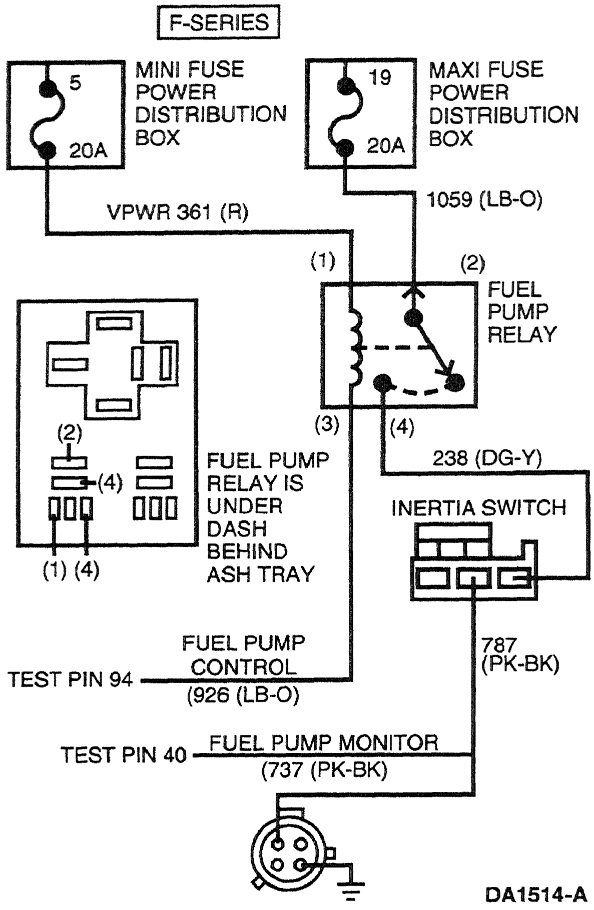
Injector Driver Module Feedback

FJ

Test Step		Result ►	Action to Take
FJ14	CHECK EF CIRCUIT FOR AN INTERMITTENT SHORT TO POWER		
	• Key on, engine off. • Measure voltage between PCM Test Pin 48 and ground. • Shake harness between IDM connector and PCM connector. • Key off. • **Did voltage ever appear?**	Yes ►	REPAIR short to power in EF Circuit 818 (GY / W). RESTORE system. CLEAR DTCs and RETEST.
		No ►	GO to FJ15.
FJ15	CHECK FDCS CIRCUIT 821 (BR / O) FOR AN INTERMITTENT OPEN		
	• Measure resistance between PCM Test Pin 95 and IDM harness connector Pin 17. • Shake harness between IDM connector and PCM connector. • **Does resistance ever go above 5 ohms?**	Yes ►	REPAIR open in FDCS Circuit 821 (BR / O). RESTORE system. CLEAR DTCs and RETEST.
		No ►	GO to FJ16.
FJ16	CHECK FDCS CIRCUIT FOR AN INTERMITTENT SHORT TO GROUND		
	• Measure resistance between PCM Test Pin 95 and ground. • Shake harness between IDM connector and PCM connector. • **Does resistance ever drop below 10,000 ohms?**	Yes ►	REPAIR short to ground in FDCS Circuit 821 (BR / O). RESTORE system. CLEAR DTCs and RETEST.
		No ►	GO to FJ17.
FJ17	CHECK FDCS CIRCUIT FOR AN INTERMITTENT SHORT TO POWER		
	• Key on, engine off. • Measure resistance between PCM Test Pin 95 and ground. • Shake harness between IDM connector and PCM connector. • **Does voltage ever appear?**	Yes ►	REPAIR short to power in FDCS Circuit 821 (BR / O). RESTORE system. CLEAR DTCs and RETEST.
		No ►	GO to FJ18.
FJ18	VERIFY DTC P1316		
	• Clear continuous DTCs. • Road test vehicle. • Retrieve / clear continuous DTCs. • Perform KOEO On-Demand Self Test. • Key off. • **Was DTC P1316 set in continuous without IDM DTCs in KOEO?**	Yes ►	GO to FJ19.
		No ►	REPAIR KOEO DTCs. RESTORE system. CLEAR DTCs and RETEST.
FJ19	ATTEMPT TO GENERATE IDM DTCS		
	• Disconnect one injector valve cover connector. • Start engine to generate IDM DTCs. • Perform KOEO Injector Electrical Self Test. • Perform KOEO On-Demand Self Test. • **Are IDM DTCs retrieved?**	Yes ►	REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.
		No ►	REPLACE IDM. RESTORE system. CLEAR DTCs and RETEST.

Fuel Pump Monitor/Control

FK



Signal Functions

The fuel pump control (FPC) is the control circuit from the PCM used to energize the fuel pump relay. At key on, the relay is energized for 20 seconds, and all the time when rpm is detected. The fuel pump monitor (FPM) circuit is downstream of the inertia switch and is used by the PCM to monitor voltage going to the fuel pump.

DTC Descriptions

P0230 = Fuel pump relay driver circuit fall

P0231 = Fuel pump relay driver failed on — was not detected on the FPM circuit when the fuel pump was commanded on

P0232 = Fuel pump relay driver failed off — voltage was detected on the FPM circuit when fuel pump was commanded off

Fuel Pump Monitor/Control

FK

Test Step		Result ▶	Action to Take
FK1	KOEO DIAGNOSTIC TROUBLE CODE P0230 ● DTC P0230 indicates that a fault was detected on the fuel pump relay control circuit. Possible causes: — blown fuse — failed F/P relay — open fuel pump control circuit — failed PCM ● Check fuel pump relay coil power fuse. ● **Is fuse OK?**	Yes ▶	GO to FK2.
		No ▶	REPLACE fuse. CLEAR DTCs and RETEST.
FK2	CHECK RELAY COIL POWER ● Remove fuel pump relay. ● Key on, engine off. ● For F-Series, measure voltage of Circuit 361 (R) between Pin 1 of the fuel pump relay harness connector and ground. ● For Econoline, measure voltage of Circuit 16 (R/LG) between Pin 1 of the fuel pump relay harness connector and ground. ● Key off. ● **Was voltage greater than 10.5 volts?**	Yes ▶	GO to FK3.
		No ▶	REPAIR open in fuel pump relay coil power supply circuit. RESTORE vehicle. CLEAR DTCs and RETEST.
FK3	CHECK RELAY TRIGGER CIRCUIT NOTE: At key on, the EEC only grounds Circuit 926 (LB/O) for 20 seconds with engine not running. ● Measure resistance of Circuit 926 (LB/O) between Pin 3 of the fuel pump relay harness connector and ground. ● Key on. ● Key off. ● **Was resistance less than 100 ohms when fuel pump was commanded on?**	Yes ▶	REPLACE fuel pump relay. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	GO to FK4.
FK4	CHECK FUEL PUMP CONTROL CIRCUIT FOR OPEN ● Install breakout box; leave PCM disconnected. ● Measure resistance between Pin 3 of the fuel pump relay harness connector and PCM Test Pin 94. ● **Is resistance less than 5 ohms?**	Yes ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	REPAIR open in relay control Circuit 926 (LB/O). RESTORE vehicle. CLEAR DTCs and RETEST.

Fuel Pump Monitor/Control

FK

Test Step		Result ▶	Action to Take
FK5	KOEO DIAGNOSTIC TROUBLE CODE P0231 NOTE: Voltage is present for 20 seconds after key on with engine not running. ● DTC P0231 indicates voltage was not present on fuel pump monitor circuit when the fuel pump was commanded on. Possible causes: — open inertia switch — blown F/P fuse — open fuel pump monitor circuit — open fuel pump control circuit — faulty fuel pump relay ● If DTC P0230 is also present, GO to FK1. ● Disconnect inertia switch harness connector. ● Key on, engine off. ● Measure voltage of Circuit 238 (DG/Y) between inertia switch harness connector and ground. ● **Is voltage greater than 10.5 volts?**	Yes ▶ No ▶	GO to FK6. GO to FK8.
FK6	CHECK INERTIA SWITCH ● Measure voltage of Circuit 787 (PK/BK) between inertia switch harness connector and ground. ● Key off. ● **Was voltage greater than 10.5 volts?**	Yes ▶ No ▶	GO to FK7. RESET or REPLACE inertia switch. RESTORE vehicle. CLEAR DTCs and RETEST.
FK7	CHECK FUEL PUMP MONITOR CIRCUIT ● Install breakout box; leave PCM disconnected. ● Disconnect inertia switch harness connector. ● Measure resistance of Circuit 737 (PK/BK) between inertia switch harness connector and PCM Test Pin 40. ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST. REPAIR open in fuel pump monitor Circuit 737 (PK/BK). RESTORE vehicle. CLEAR DTCs and RETEST.
FK8	CHECK FUEL PUMP FUSE ● Key off. ● Check fuel pump fuse. ● **Is fuse OK?**	Yes ▶ No ▶	GO to FK9. REPLACE fuse. RESTORE vehicle. CLEAR DTCs and RETEST.

Fuel Pump Monitor/Control

FK

Test Step		Result ▶	Action to Take
FK9	CHECK FOR POWER TO FUEL PUMP RELAY • Remove fuel pump relay. • Key on, engine off. • For F-Series, measure voltage of Circuit 1059 (LB/O) between Pin 2 of the fuel pump relay harness connector and ground. • For Econoline, measure voltage of Circuit 37 (Y) between Pin 2 of the fuel pump relay harness connector and ground. • Key off. • **Was voltage greater than 10.5 volts?**	Yes ▶ No ▶	GO to FK10. REPAIR open in Circuit 1059 (LB/O) for F-Series or Circuit 37 (Y) for Econoline. RESTORE vehicle. CLEAR DTCs and RETEST.
FK10	CHECK INERTIA SWITCH FEED CIRCUIT • Disconnect inertia switch harness connector. • Measure resistance of Circuit 238 (DG/Y) between fuel pump relay harness connector Pin 4 and inertia switch harness connector. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	REPLACE fuel pump relay. RESTORE vehicle. CLEAR DTCs and RETEST. REPAIR open in Circuit 238 (DG/Y). RESTORE vehicle. CLEAR DTCs and RETEST.
FK11	KOEO DIAGNOSTIC TROUBLE CODE P0232 NOTE: Ignore DTC P0230 at this time. • DTC P0232 indicates power was present on the fuel pump monitor circuit when the fuel pump was commanded off. Possible causes: — shorted fuel pump relay — short to power in fuel pump circuitry • Remove fuel pump relay coil power fuse. • Key on, engine off. • Perform KOEO On-Demand Self Test. • Key off. • **Was DTC P0232 present?**	Yes ▶ No ▶	GO to FK12. GO to FK15.
FK12	CHECK FUEL PUMP RELAY FOR SHORT • Reinstall fuse. • Remove fuel pump relay. • Perform KOEO On-Demand Self Test. • **Is DTC P0232 present?**	Yes ▶ No ▶	GO to FK13. REPLACE fuel pump relay. RESTORE vehicle. CLEAR DTCs and RETEST.
FK13	CHECK FOR SHORT TO INERTIA SWITCH • Disconnect inertia switch harness connector. • Perform KOEO On-Demand Self Test. • Key off. • **Was DTC P0232 present?**	Yes ▶ No ▶	GO to FK14. REPAIR short to power in Circuit 238 (DG/Y). RESTORE vehicle. CLEAR DTCs and RETEST.

Fuel Pump Monitor/Control

FK

	Test Step	Result ▶	Action to Take
FK14	CHECK FOR FUEL PUMP MONITOR OR FUEL PUMP FEED SHORT TO POWER		
	• Install breakout box; leave PCM disconnected. • Key on, engine off. • Measure voltage between PCM Test Pin 40 and ground. • **Is voltage greater than 10.5 volts?**	Yes ▶	REPAIR short to power in fuel pump or monitor circuit. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
FK15	CHECK FUEL PUMP CONTROL CIRCUIT FOR SHORT TO GROUND		
	• Install breakout box; leave PCM disconnected. • Measure resistance between PCM Test Pin 94 and ground. • **Is resistance less than 5 ohms?**	Yes ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	REPAIR short to ground in Circuit 926 (LB/O). RESTORE vehicle. CLEAR DTCs and RETEST.
FK16	CONTINUOUS DIAGNOSTIC TROUBLE CODE P0230		
	• Continuous DTC P0230 indicates that a fault was detected on the fuel pump relay control circuit. Possible causes: — blown fuse — failed F/P relay — open fuel pump control circuit — intermittent circuit fault • Perform KOEO On-Demand Self Test. • **Is DTC P0230 present?**	Yes ▶	GO to FK1.
		No ▶	GO to FK17.
FK17	CHECK FOR INTERMITTENT FAILURE		
	• Clear DTC. • Grasp vehicle harness; wiggle and shake while working from PCM to fuel pump relay. • Retrieve Continuous DTCs. • **Is DTC P0230 present?**	Yes ▶	REPAIR intermittent circuit fault. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	Unable to duplicate or identify problem at this time. RESTORE vehicle. CLEAR DTCs and RETEST.

Fuel Pump Monitor/Control

FK

Test Step		Result	▶	Action to Take
FK18	CONTINUOUS DIAGNOSTIC TROUBLE CODE P0231			
	NOTE: Voltage is present for 20 sec. (fuel pump commanded on) after key on with engine not running. ● Continuous DTC P0231 indicates voltage was not present on fuel pump monitor circuit when the fuel pump was commanded on. Possible causes: — open inertia switch — blown F/P fuse — open fuel pump monitor circuit — open fuel pump control circuit — faulty fuel pump relay ● Verify inertia was not reset without clearing codes. ● If DTC P0230 is also present, GO to FK16. ● Perform KOEO On-Demand Self Test. ● **Is DTC P0231 present?**	Yes No	▶ ▶	GO to FK5. GO to FK19.
FK19	CHECK FOR INTERMITTENT CIRCUIT FAULTS			
	● Clear DTCs. ● Grasp vehicle harness; wiggle and shake while working from PCM to inertia switch and from the inertia switch to the fuel pump relay. ● Retrieve Continuous DTCs. ● **Is P0231 present?**	Yes No	▶ ▶	REPAIR intermittent circuit fault in fuel pump circuitry. RESTORE vehicle. CLEAR DTCs and RETEST. Unable to duplicate or identify failure at this time. RESTORE vehicle. CLEAR DTCs and RETEST.
FK20	CONTINUOUS DIAGNOSTIC TROUBLE CODE P0232			
	● Continuous DTC P0232 indicates that power was present on the fuel pump monitor circuit when the fuel pump was commanded off during normal driving conditions. Possible causes: — shorted fuel pump relay — short to power in fuel pump circuitry ● Perform KOEO On Demand Self Test. ● **Is P0232 present?**	Yes No	▶ ▶	GO to FK11. GO to FK21.
FK21	CHECK FOR INTERMITTENT FAILURE			
	● Clear DTCs. ● Grasp vehicle harness, wiggle and shake while working from PCM to the fuel pump relay. ● Retrieve continuous DTCs. ● **Is P0232 present?**	Yes No	▶ ▶	REPAIR intermittent circuit fault. RESTORE vehicle. CLEAR DTCs and RETEST. Unable to duplicate or identify problem at this time. RESTORE vehicle. CLEAR DTCs and RETEST.

Auxiliary Powertrain Control System

HA

Note

Enter this pinpoint test only if there are no DTCs retrieved and auxiliary powertrain control module (APCM) does not control rpm.

Remember

This pinpoint test is intended to diagnose only the following:

- harness circuits: KEY PWR, GND, BUS+, BUS- and hi-mount stoplight circuit 569 (DG) for F-Series or 511 (LG) for Econoline
- APCM: F-Series F5TF-12B641, Econoline F5UF-12B641 (12B641)

Description

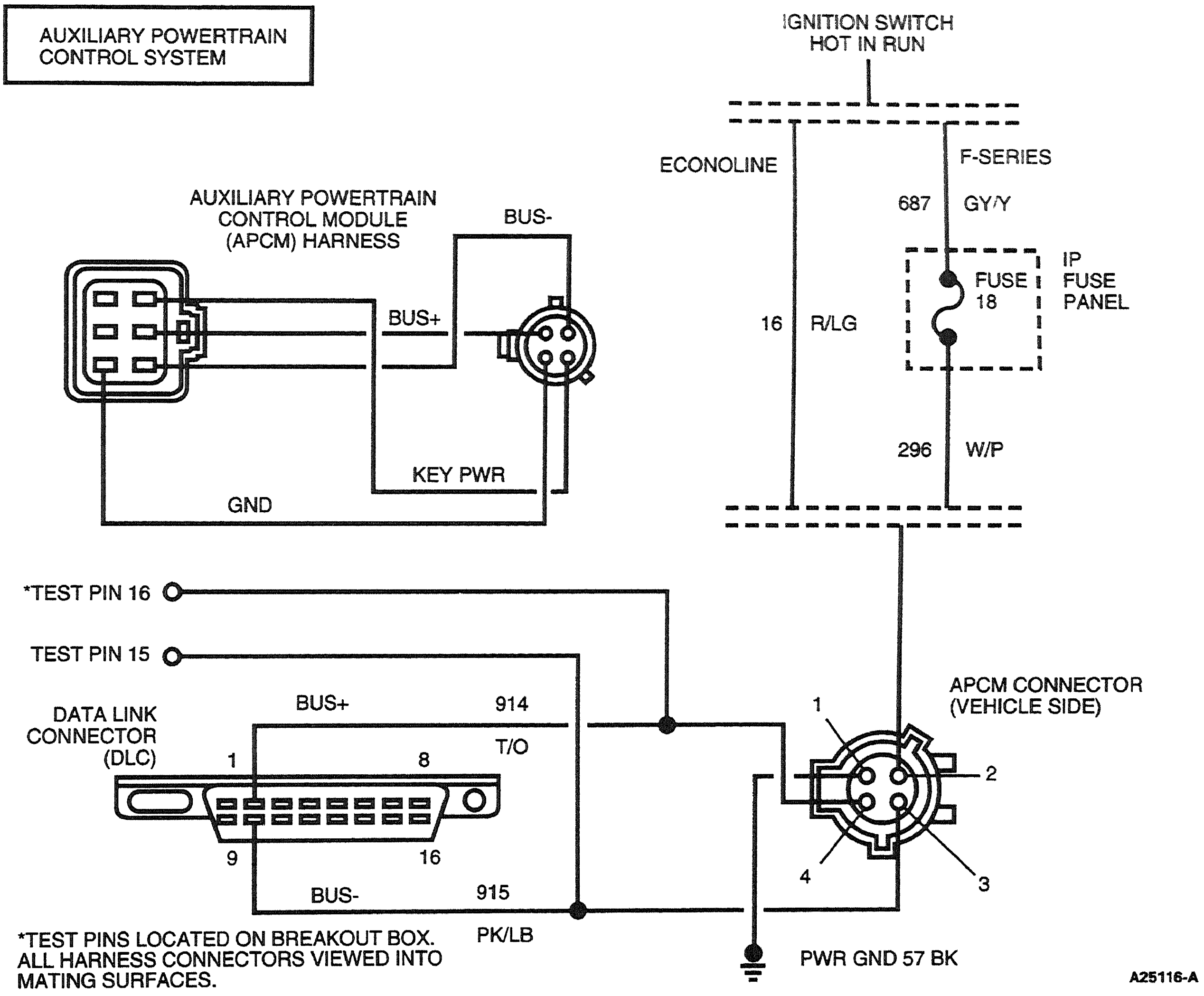
NOTE: Functions may not be available if the operator has deprogrammed them.

The auxiliary powertrain control system provides an operator interface to the drive-by-wire powertrain control system to effect Charge Protection, RPM Control, and manual throttle control between 1300 and 2500 rpm.

Auxiliary Powertrain Control System

HA

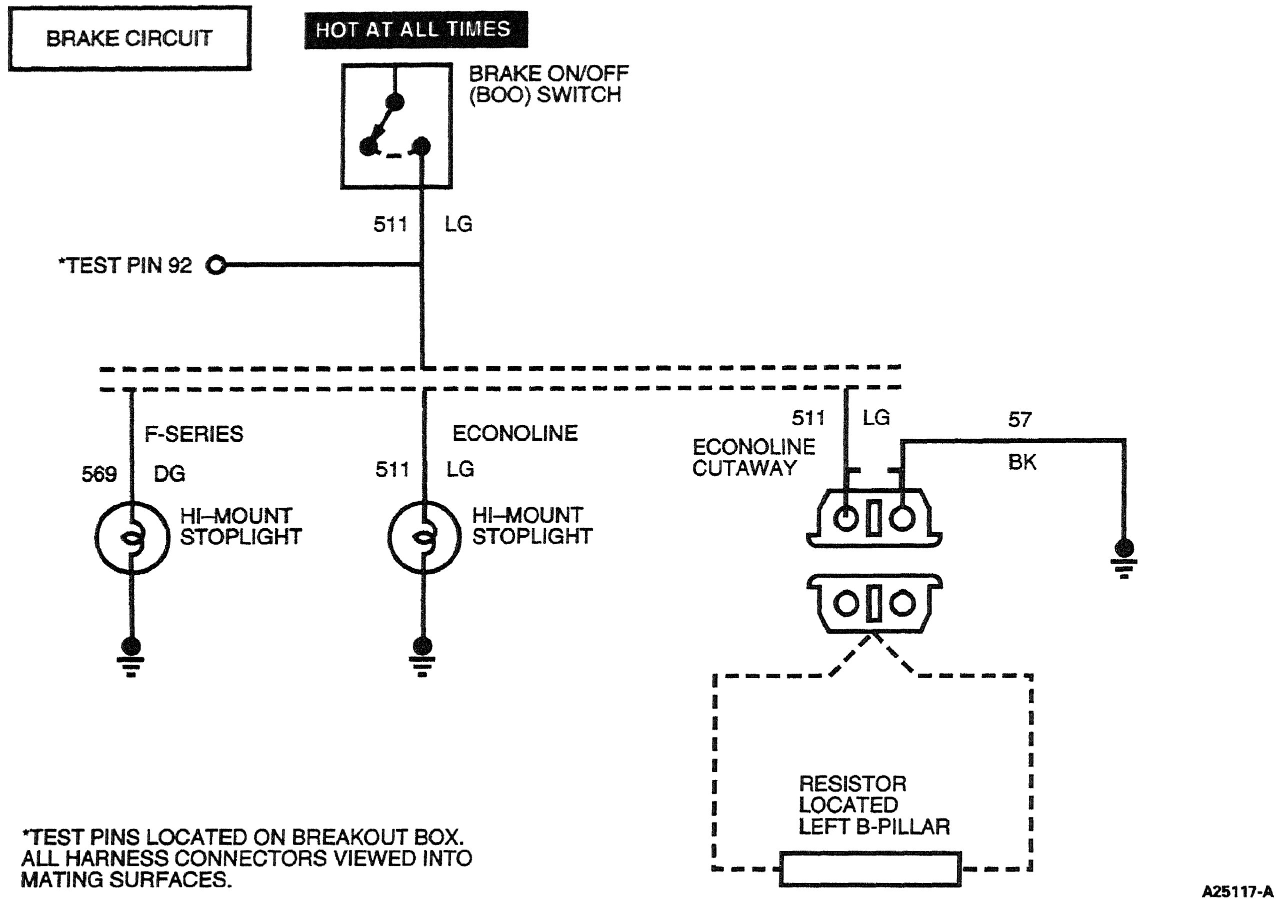
Enabling conditions: Parking brake set, automatic transmission in park, manual transmission in neutral, foot off clutch pedal, service brake and accelerator pedal, and brake lights connected and functional. To operate system with hazard flashers, the hi-mount stoplight circuit must be complete and operational: F-Series Circuit 569 (DG) and Econoline Circuit 511 (LG).



*TEST PINS LOCATED ON BREAKOUT BOX. ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACES.

Auxiliary Powertrain Control System

HA



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACES.

The following error codes are displayed from the APCM only:

- CErr indicates that one or both BUS circuits are open or shorted.
- CrSd indicates a fault on BUS circuits or internal APCM fault.
- EErr and AErr both indicate an internal APCM fault.

Follow the direction given below to aid in diagnosing the APCM fault condition:

- If APCM doesn't work at all, go to Pinpoint Test HA Step HA1.
- If APCM doesn't work with hazard flashers for all vehicles except Econoline Cutaway, go to Pinpoint Test HA Step HA7.
- If APCM doesn't work with hazard flashers on Econoline Cutaway only, go to Pinpoint Test HA Step HA11.
- If APCM error code CErr or CrSd are displayed, go to Pinpoint Test HA Step HA5.
- If APCM error code EErr or AErr are displayed, replace APCM.

Auxiliary Powertrain Control System | HA

Test Step		Result	► Action to Take
HA1	VERIFY OPERATION PROCEDURE		
	NOTE: For non-speed control vehicles (1995 only), powertrain control module (PCM) may be incorrect. For manual vehicles, processor catch-word must be SOD4 or later. For F-250, F-350, E-350 automatic vehicles, processor catch-word must be TEE5 or later. F-450 automatic must be PRY4 or later. The catch-word tag may be located on the vehicle A-pillar or on the PCM itself. ● Verify vehicle has 1995 or later calibration. ● Refer to the auxiliary powertrain control manual provided with the system to verify correct operating procedures and entry conditions. ● **Are entry conditions met and correct calibration installed?**	Yes No	► GO to HA2. ► CORRECT operating procedure or CORRECT calibration level as required. CLEAR DTCs and RETEST. If system still does not operate, GO to HA2.
HA2	CHECK FOR DTCs		
	NOTE: When performing KOER Switch Self Test, wait five seconds after pressing the trigger to start the test before running through the driver-operated controls. The test can also take up to five minutes to complete. NOTE: If vehicle is equipped with pre-1995 calibration, you will be unable to perform self test with NGS Tester. Update calibration and retest. If still unable to perform self test, go to AF1. ● Verify auxiliary powertrain control system is off before running any self tests. ● Run KOEO On-Demand Self Test, KOER Switch Self Test and Retrieve / Clear Continuous DTCs. ● **Were any DTCs retrieved?**	Yes No	► GO to appropriate pinpoint test. ► GO to HA3.
HA3	CHECK FOR KEY ON POWER		
	● Disconnect APCM harness connector. ● Key on, engine off. ● Measure voltage between Pin 2 of the APCM connector vehicle side and ground. Refer to circuit diagram for pin location. ● Key off. ● **Was battery voltage present?**	Yes No	► GO to HA4. ► F-Series: REPLACE Fuse 18 or REPAIR open in Circuit 296 (W/P). Econoline: REPAIR open in Circuit 16 (R/LG). RESTORE system. CLEAR DTCs and RETEST.
HA4	CHECK GROUND CIRCUIT		
	● Measure resistance between Circuit 57 (BK), Pin 1 of the APCM harness connector and ground. ● **Is resistance less than 5.0 ohms?**	Yes No	► GO to HA5. ► REPAIR open in ground Circuit 57 (BK). RESTORE system. CLEAR DTCs and RETEST.

Auxiliary Powertrain Control System

HA

Test Step	Result ▶	Action to Take
HA5 CHECK FOR OPEN IN (BUS-) CIRCUIT 915 (PK/LB)		
• Measure resistance of Circuit 915 (PK/LB) between the APCM harness connector Pin 3 and DLC Pin 10. • **Is resistance less than 5.0 ohms?**	Yes ▶ No ▶	GO to HA6. REPAIR open in Circuit 915 (PK/LB). RESTORE system. CLEAR DTCs and RETEST.
HA6 CHECK FOR OPEN IN (BUS+) CIRCUIT 914 (T/O)		
• Measure resistance of Circuit 914 (T/O) between the APCM harness connector Pin 4 and DLC Pin 2. • **Is resistance less than 5.0 ohms?**	Yes ▶ No ▶	REPLACE APCM. RESTORE system. CLEAR DTCs and RETEST. REPAIR open in Circuit 914 (T/O). RESTORE system. CLEAR DTCs and RETEST.
HA7 APCM DOESN'T WORK WITH HAZARD FLASHERS		
• Press service brake pedal. • **Does hi-mount stoplight come on?**	Yes ▶ No ▶	GO to FD1. GO to HA8.
HA8 CHECK HI-MOUNT STOPLIGHT		
• Bench test bulb by applying B+ to one side and B- to the other. • **Does the bulb illuminate?**	Yes ▶ No ▶	GO to HA9. REPLACE bulb. RESTORE system. CLEAR DTCs and RETEST.
HA9 GROUND CIRCUIT CHECK		
• Measure resistance on Circuit 57 (BK) between the bulb socket and ground. • **Is resistance less than 5.0 ohms?**	Yes ▶ No ▶	GO to HA10. REPAIR open in ground Circuit 57 (BK). RESTORE system. CLEAR DTCs and RETEST.
HA10 CHECK POWER TO LIGHT		
• Press service brake pedal. • Using a test light, probe between powering Circuit 569 (DG) for F-Series or 511 (LG) for Econoline and ground. • **Does the test light illuminate?**	Yes ▶ No ▶	REPAIR loose connection in the bulb socket. RESTORE system. CLEAR DTCs and RETEST. F-Series: REPAIR open in Circuit 569 (DG). Econoline: REPAIR open in Circuit 511 (LG). RESTORE system. CLEAR DTCs and RETEST.
HA11 ECONOLINE CUTAWAY ONLY: APCM DOESN'T WORK WITH HAZARD FLASHERS		
• Disconnect brake resistor, located on the left B-pillar. • Measure resistance of Circuit 57 (BK) between resistor connector and ground. • **Is resistance less than 5.0 ohms?**	Yes ▶ No ▶	GO to HA12. REPAIR open in Circuit 57 (BK). RESTORE system. CLEAR DTCs and RETEST.

Auxiliary Powertrain Control System

HA

Test Step		Result	▶	Action to Take
HA12	CHECK POWER CIRCUIT TO RESISTOR			
	● Press service brake pedal. ● Using a test light, probe between Circuit 511 (LG) of the resistor connector and ground. ● **Does the test light illuminate?**	Yes	▶	GO to HA13.
		No	▶	REPAIR open in Circuit 511 (LG). RESTORE system. CLEAR DTCs and RETEST.
HA13	CHECK RESISTOR			
	● Measure resistance across the resistor 13A427. ● **Is resistance 140 ± 10 ohms?**	Yes	▶	RECONNECT the resistor and GO to FD1.
		No	▶	REPLACE the resistor. RESTORE system. CLEAR DTCs and RETEST.

Programmable Speedometer/Odometer Module (PSOM)

HB

Note

Enter this pinpoint test only when directed here from symptom flowcharts.

Remember

To prevent the replacement of good components, the following areas may be of concern:

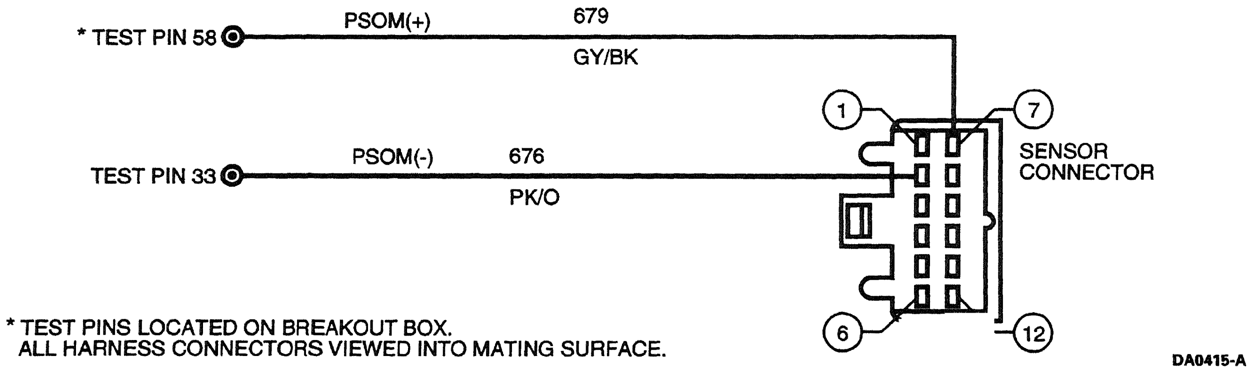
- vehicle speed control system
- rear anti-lock brake system
- ring gear inside differential
- instrumentation system

This pinpoint test is intended to diagnose the following:

- programmable speedometer / odometer module (PSOM) output to the powertrain control module (PCM)(12A650)
- harness circuits: PSOM(+) PSOM(-)
- powertrain control module

Description

The PSOM receives input from the rear anti-lock brake system (RABS) sensor, which is mounted on the rear axle differential. The PSOM takes this input signal information to the PCM.



Programmable Speedometer/Odometer Module (PSOM)

HB

DTC Description

P0500 = Vehicle speed sensor malfunction

Test Step		Result ▶	Action to Take
HB1	DIAGNOSTIC TROUBLE CODE (DTC) P0500		
	● Possible error in the PSOM output signal. Possible causes: — damaged rear anti-lock brake system (RABS) sensor — damaged PSOM — damaged harness circuits — damaged PCM ● Install breakout box; leave PCM disconnected. ● Measure resistance between PCM Test Pins 58 and 33. ● **Is resistance between 21,000 and 55,000 ohms?**	Yes ▶ No ▶	GO to HB4. GO to HB2.
HB2	CHECK CONTINUITY OF THE HARNESS CIRCUITS		
	● Disconnect PSOM harness connector. ● Measure resistance between PCM Test Pin 58 and PSOM harness connector Pin 7. ● Measure resistance between PCM Test Pin 33 and PSOM harness connector Pin 2. ● **Is each resistance less than 5 ohms?**	Yes ▶ No ▶	GO to HB3. REPAIR open circuit. RESTORE vehicle. CLEAR DTCs and RETEST.
HB3	CHECK HARNESS CIRCUITS FOR SHORTS TO POWER AND GROUND		
	● Measure resistance between PCM Test Pin 58 and PCM Test Pins 33, 71 and 51. ● **Is each resistance greater than 10,000 ohms?**	Yes ▶ No ▶	GO to HB4. REPAIR short circuit. RESTORE vehicle. CLEAR DTCs and RETEST.
HB4	CHECK RABS SENSOR RESISTANCE		
	● Disconnect RABS sensor harness connector. ● Measure the resistance of the RABS sensor. ● **Is resistance between 1300 and 1550 ohms?**	Yes ▶ No ▶	GO to HB5. REPLACE the RABS sensor. RESTORE vehicle. CLEAR DTCs and RETEST.

Programmable Speedometer/Odometer Module (PSOM)

HB

Test Step		Result ▶	Action to Take
HB5	CHECK PSOM OUTPUT VOLTAGE		
	WARNING: THIS TEST STEP REQUIRES ANOTHER PERSON TO ACCOMPANY THE DRIVER TO MAKE MEASUREMENTS AND RECORD DATA. ALL APPLICABLE SAFETY PROCEDURES AND TRAFFIC LAWS MUST BE FOLLOWED. ● Connect PCM to breakout box. ● Connect PSOM harness connector. ● Set scan tool for frequency measurement with a 4 volt DC scale. ● Attach scan tool probes across PCM Test Pins 33 and 58. ● Drive vehicle at 40 mph or 60 mph. ● **Does frequency read 90 Hz at 40 mph or 130 Hz at 60 mph (±2 Hz)?**	Yes ▶ No ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST. REPAIR PSOM. REFER to the Electrical Group, the Powertrain Group or the Chassis Group in the Workshop Manual.

Cylinder Identification (CID)

KA

Note

Enter this pinpoint test only when directed here from the symptom flowcharts.

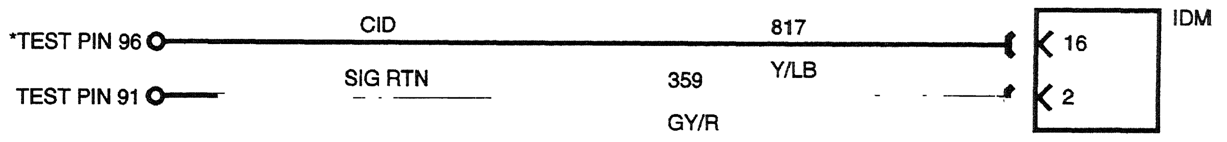
Remember

This pinpoint test is intended to diagnose only the following:

- powertrain control module (PCM)(12A650)
- injector driver module (IDM)
- harness circuits: cylinder identification (CID)

Description

The CID output provides information to the IDM so that the injector current can be applied to the correct injector.



*TEST PINS LOCATED ON BREAKOUT BOX.

DA0424-A

DTC Description

P1218 = CID stuck high

P1219 = CID stuck low

P1667 = CID circuit failure

Cylinder Identification (CID)

KA

Test Step		Result ▶	Action to Take
KA1	DIAGNOSTIC TROUBLE CODES (DTCs) P1667, P1218, P1219, P1668, P1298		
	● These DTCs indicate that the PCM has detected a concern on the CID line. Possible causes: — damaged PCM — damaged IDM — open or grounded circuit ● **Is DTC P1668 retrieved alone?**	Yes ▶	GO to FJ1.
		No ▶	If DTC P1667 retrieved with P1668, GO to KA2. If DTCs P1663, P1667 and P1668 are all retrieved, GO to FJ8. If DTC P1298 retrieved alone, REPLACE IDM. If DTC P1667 retrieved alone, GO to KA2. If DTC P1663 retrieved with DTC P1667, GO to FJ8.
KA2	CYLINDER IDENTIFICATION LINE TEST		
	NOTE: DTC P1667 or DTCs P1668 and P1667 retrieved together indicates there is a short high, short low or open on the CI line. ● Install breakout box; connect PCM to breakout box. ● Key on, engine off. ● Measure voltage between PCM Test Pin 96 and ground. ● **Is 0.6 ± 0.1 volt present?**	Yes ▶	GO to KA3.
		No ▶	Voltage less than 0.5 volt, GO to KA4.
		▶	Battery voltage is present. GO to KA5.
KA3	PERFORM AN OUTPUT STATE CHECK		
	● Perform KOEO Output State Test. ● Measure voltage between PCM Test Pin 96 and ground. ● **Does voltage toggle between 0.6 ± 0.1 volt and battery voltage?**	Yes ▶	Intermittent failure. GO to KA8.
		No ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
KA4	CIRCUIT 817 (Y/LB) RESISTANCE CHECK		
	● Key off. ● Disconnect PCM from breakout box. ● Disconnect IDM harness connector. ● Measure resistance between PCM Test Pin 96 and Pin 16 on IDM harness connector. ● **Is resistance less than 5 ohms?**	Yes ▶	GO to KA6.
		No ▶	REPAIR open in Circuit 817 (Y/LB). RESTORE vehicle. CLEAR DTCs and RETEST.
KA5	CHECK CID CIRCUIT FOR SHORT TO BATTERY VOLTAGE		
	● Disconnect IDM harness connector. ● Disconnect PCM from breakout box. ● Measure voltage between PCM Test Pin 96 and ground. ● **Is battery voltage present?**	Yes ▶	REPAIR short to battery voltage. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	GO to KA7.

Cylinder Identification (CID)

KA

	Test Step	Result	▶	Action to Take
KA6	CHECK CID CIRCUIT FOR SHORT TO GROUND			
	• Measure resistance between PCM Test Pin 96 and PCM Test Pins 25, 51, 76, 77 and 103. • **Is resistance greater than 10,000 ohms?**	Yes	▶	GO to KA7.
		No	▶	REPAIR ground short in Circuit 817 (Y/LB). RESTORE vehicle. CLEAR DTCs and RETEST.
KA7	CHECK PCM OUTPUT STATE FUNCTION			
	• Connect PCM to breakout box. • Perform KOEO Output State Test. • Measure voltage between PCM Test Pin 96 and ground. • **Does output toggle between 0.53 ± 0.1 and 0.0 V when cycling accelerator pedal?**	Yes	▶	REPLACE IDM. RESTORE vehicle. CLEAR DTCs and RETEST.
		No	▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
KA8	INTERMITTENT SHORT OR OPEN ON CID CIRCUIT			
	WARNING: THERE ARE 115 VOLTS PRESENT ON THE CID CIRCUIT AND PERSONAL INJURY MAY RESULT IF PROPER PROCEDURES ARE NOT FOLLOWED. • Clear all DTCs. • Key on, engine running at idle. • Grasp the harness with an insulated tool. • Shake the harness. • Key off. • Check for KOEO on-demand DTCs. • **Are DTCs present?**	Yes	▶	REPAIR intermittent short or open. RESTORE vehicle. CLEAR DTCs and RETEST.
		No	▶	Unable to duplicate failure at this time. RESTORE vehicle. CLEAR DTCs and RETEST
KA9	DTC P1219			
	NOTE: P1218 and P1219 are IDM continuous codes that only show up in KOEO On-Demand Self Test. P1219 is set when the CID circuit is intermittently shorted to ground. • Disconnect IDM harness connector. • Install breakout box; leave PCM disconnected. • Measure resistance between PCM Test Pin 96 and ground. • Shake harness between IDM connector and PCM connector. • **Does resistance ever drop below 10,000 ohms?**	Yes	▶	REPAIR Circuit 817 (Y/LB) shorting to ground. RESTORE vehicle. CLEAR DTCs and RETEST.
		No	▶	REINSTALL PCM and IDM. TEST DRIVE. If DTC reappears, REPLACE the IDM. RESTORE vehicle. CLEAR DTCs and RETEST.

Cylinder Identification (CID)

KA

Test Step		Result ▶	Action to Take
KA10	DTC P1218		
	NOTE: P1218 and P1219 are IDM continuous codes that only show up in KOEO On-Demand Self Test. P1218 is set when the CID circuit is intermittently shorted to power. ● Disconnect IDM harness connector. ● Install breakout box; leave PCM disconnected. ● Measure resistance between PCM Test Pin 96 and IDM Pin 16. ● Shake harness between IDM connector and PCM connector. ● **Does resistance ever go above 5 ohms?**	Yes ▶ No ▶	REPAIR open in Circuit 817 (Y/LB). RESTORE vehicle. CLEAR DTCs and RETEST. REINSTALL PCM and IDM. TEST DRIVE. If DTC reappears, REPLACE the IDM. RESTORE vehicle. CLEAR DTCs and RETEST.

Exhaust Back Pressure Regulator (EPR)

KB

Output Functions

Exhaust Back Pressure Regulator (EPR) — Is a variable position valve that controls exhaust back pressure during cold ambient temperatures to increase cab heat and decrease the amount of time needed to defrost the windshield. The powertrain control module (PCM) uses the measured exhaust back pressure, intake air temperature and engine load to determine the desired exhaust back pressure.

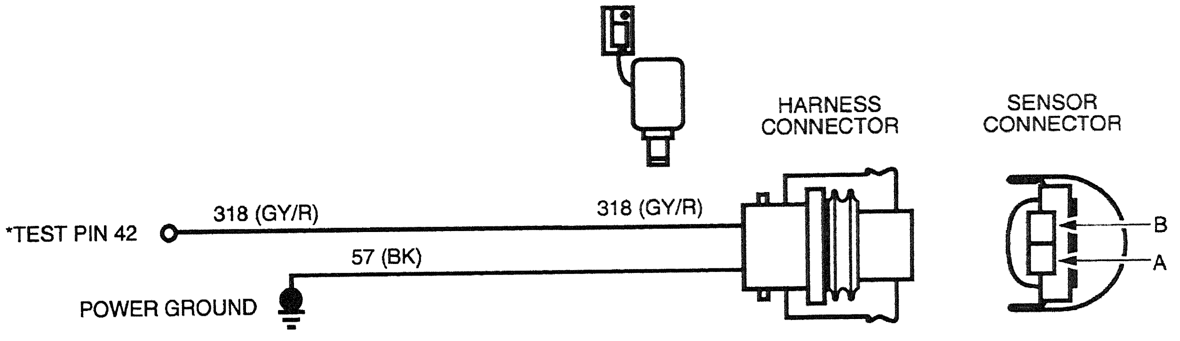
Valve position is controlled by switching the output signal circuit to 12 volts inside the PCM. On / off time is dependent upon the exhaust back pressure.

Detection / Management

An open or shorted to ground control circuit can be detected by an on-demand output circuit check performed during the KOEO test.

An exhaust back pressure step test, in which the PCM commands and then measures specific preprogrammed pressures, is performed during the KOER test.

If the PCM detects an exhaust back pressure (EBP) or intake air temperature (IAT) sensor fault it will disable the exhaust back pressure device.



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

DA0417-B

Note

After removing connectors, always check for damaged pins, corrosion, loose terminals, etc.

DTC Descriptions

P0475 = Exhaust pressure control valve malfunction

P0476 = Exhaust pressure control valve performance

Exhaust Back Pressure Regulator (EPR)

KB

Test Step		Result ▶	Action to Take
KB1	DIAGNOSTIC TROUBLE CODE (DTC) P0475		
	● possible causes: — shorted to power — open / grounded circuit — damaged solenoid — damaged PCM ● Disconnect EPR harness connector. ● Measure resistance between Pin A and ground. ● **Is the resistance less than 5 ohms?**	Yes ▶ No ▶	GO to KB2. REPAIR open in Circuit 574 (BK / PK). RESTORE system. CLEAR DTCs and RETEST.
KB2	CHECK EPR COIL		
	● Measure resistance across EPR coil contacts A and B. ● **Is the coil resistance between 2.5 ohms and 12 ohms?**	Yes ▶ No ▶	GO to KB3. REPLACE regulator. RESTORE system. CLEAR DTCs and RETEST.
KB3	CHECK FOR SHORT TO POWER IN CIRCUIT 318 (GY / R).		
	● Disconnect PCM harness connector. ● Measure voltage between Pin B and ground. ● Shake harness. ● **Is B+ ever present?**	Yes ▶ No ▶	REPAIR short to power in Circuit 318 (GY / R). RESTORE system. CLEAR DTCs and RETEST. GO to KB4.
KB4	CHECK CIRCUIT 318 (GY / R) FOR SHORT TO GROUND		
	● Measure resistance between Pin B and ground. ● Shake harness. ● **Does the resistance ever drop below 10,000 ohms?**	Yes ▶ No ▶	REPAIR short to ground in Circuit 318 (GY / R). RESTORE system. CLEAR DTCs and RETEST. GO to KB5.
KB5	CHECK FOR OPEN IN CIRCUIT 318 (GY / R)		
	● Install breakout box; leave PCM disconnected. ● Measure resistance between Pin B and Test Pin 42. ● Shake harness. ● **Does resistance ever go above 5 ohms?**	Yes ▶ No ▶	REPAIR open in Circuit 318 (GY / R). RESTORE system. CLEAR DTCs and RETEST. GO to KB6.
KB6	PERFORM OUTPUT STATE CHECK		
	● Key on, engine off. ● Measure voltage between EBP connector harness side Pin B and chassis ground. ● Run KOEO Output State Test on NGS Tester. ● **Does voltage toggle between 12 V and 0 V?**	Yes ▶ No ▶	Fault is intermittent; unable to duplicate failure. RESTORE system. CLEAR DTCs and RETEST. REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.

Exhaust Back Pressure Regulator (EPR)

KB

	Test Step	Result ▶	Action to Take
KB7	KOER DIAGNOSTIC TROUBLE CODE (DTC) P0476		
	● DTC P0476 indicates an exhaust back pressure control valve performance malfunction was detected during KOER On-Demand Self Test. Possible causes: — stuck or damaged butterfly — misadjusted or damaged linkage — restricted exhaust — exhaust leaks — damaged PCM — EPR valve — EBP sensor ● If KOEO EBP faults are present, repair them before continuing. ● Visually inspect butterfly tang (refer to Section 4A or Section 4B, Diagnostic Routines, Performance Diagnostic Procedures, Exhaust Restriction for exhaust back pressure regulator tang position illustration. ● **Is tang in the open position?**	Yes ▶ No ▶	GO to KB8. REPAIR condition causing valve to be stuck closed. RESTORE system. CLEAR DTCs and RETEST.
KB8	EXHAUST RESTRICTION CHECK		
	● Access EBP PID. ● Key on, engine running. ● Accelerate engine to WOT and hold for 30 seconds. ● **Is EBP below 28 psi?**	Yes ▶ No ▶	GO to KB9. REPAIR restricted exhaust condition. RESTORE system. CLEAR DTCs and RETEST.
KB9	EBP SENSOR CHECK		
	● Record EBP value. ● Accelerate engine several times. ● **Does EBP increase at least 4 psi with acceleration?**	Yes ▶ No ▶	GO to KB10. REPLACE EBP sensor. RESTORE system. CLEAR DTCs and RETEST.
KB10	INSPECT FOR EXHAUST LEAKS		
	● Inspect turbo pipe, crossover pipes and exhaust manifolds for leaks. ● **Are exhaust leaks present?**	Yes ▶ No ▶	REPAIR exhaust leak. RESTORE system. CLEAR DTCs and RETEST. GO to KB11.

Exhaust Back Pressure Regulator (EPR)

KB

Test Step		Result ▶	Action to Take
KB11	EBP CHECK DURING KOER		
	• Key off. • Disconnect EBP sensor harness connector. • Install ICP / EBP Adapter Cable D94T-50-A or equivalent between EBP sensor and harness connector. • Measure voltage between signal circuit and signal ground on ICP / EBP Adapter Cable D94T-50-A or equivalent. • Perform KOER On-Demand Self Test. • **Does voltage increase 2.0 V ± 0.5 and then decrease as the test ends?**	Yes ▶ No ▶	REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST. GO to KB12.
KB12	EPR VISUAL INSPECTION		
	• Observe EPR valve linkage while performing KOER On-Demand Self Test. • **Does the linkage move during the test?**	Yes ▶ No ▶	CHECK EPR linkage adjustment. REFER to the Powertrain Group in the Workshop Manual. RESTORE system. CLEAR DTCs and RETEST. REPLACE EPR valve. RESTORE system. CLEAR DTCs and RETEST.

Glow Plug System

KC

Output Functions

Glow Plug Relay — A relay that controls the current flow to the glow plugs. Glow plug relay ON time is controlled by the powertrain control module (PCM) and is a function of engine oil temperature, barometric pressure and battery voltage. Glow plug ON time normally varies between 10 to 120 seconds.

Note: WAIT TO START lamp ON time is independent from glow plug relay ON time (1 to 10 seconds).

Detection/Management

An open or shorted to ground glow plug relay or WAIT TO START lamp circuit can be detected by an on-demand output circuit check performed during the KOEO standard test.

On all 49 state non-OBD II vehicles, glow plug and glow plug harness concerns cannot be detected by the PCM.

Caution

Do not perform any voltage checks with the engine running; 115v DC at 10 amps present on injector circuits.

Note

Enter this pinpoint test only when directed here from the symptom flowcharts.

Remember

This pinpoint test is intended to diagnose only the following:

- powertrain control module (PCM)(12A650)
- harness circuit: GP/RELAY coil
- glow plug relay coil

Description

Glow Plug Monitoring System for California OBD II

The glow plug system is monitored when the glow plugs are commanded on for more than 35 seconds (EOT needs to be below 49°C [120 °F]) and battery voltage is between 11.8-14 volts for 1998 or 11.5-14 volts for 1998-1/2 Econoline and 1999 F-Series.

You can monitor glow plug amperage using NGS PIDs GPMR and GPML.

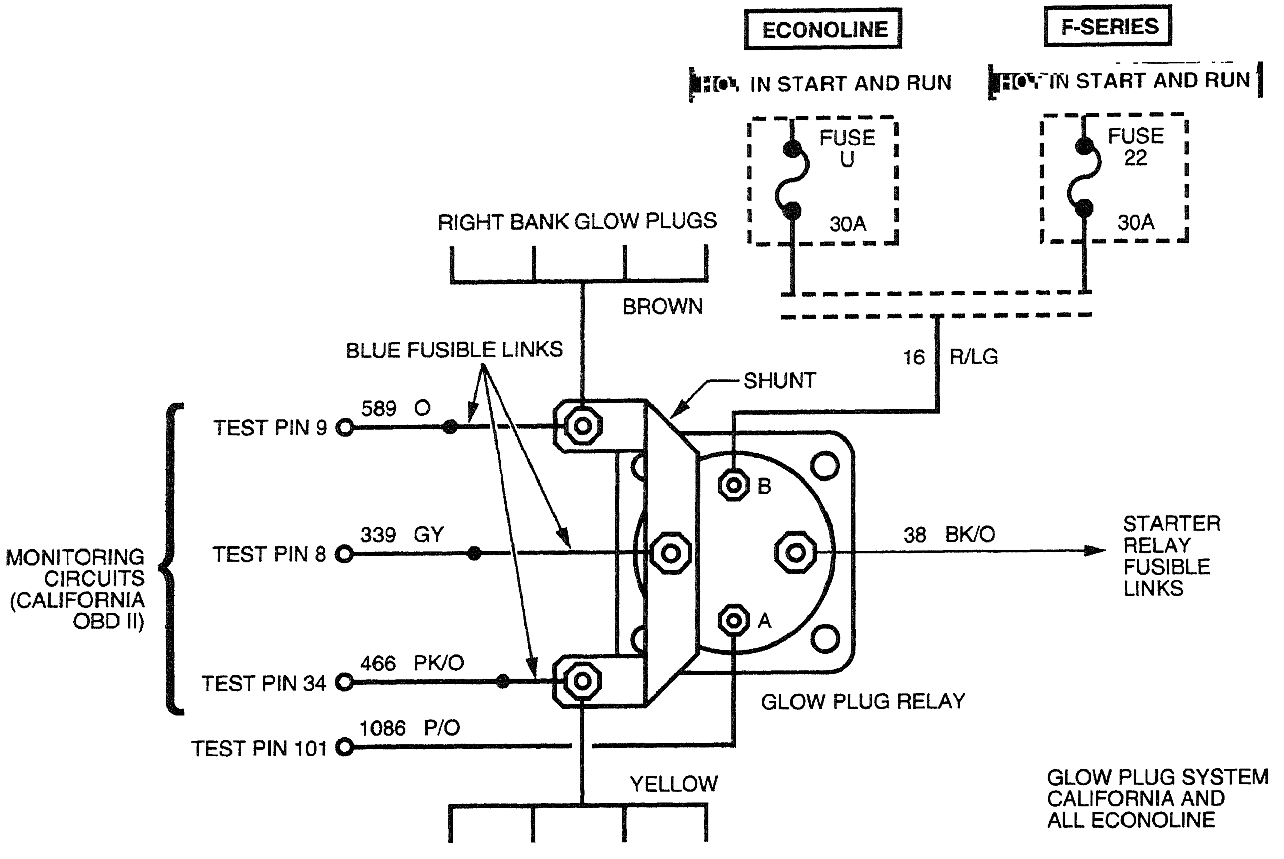
Glow Plug System

KC

DTC P1395 or P1396 will set on the bank that is reading less than 32 amps or the bank that is reading at least 8-1/2 amps lower than the other bank. Loose fitting pins in the circuit connectors causing high resistance or high resistance glow plug(s) on that bank could be the cause. A shorted circuit or low-resistance glow plug(s) on the opposite bank could also be the cause. Each bank needs to draw more than 32 amps but not more than 8-1/2 amps apart.

DTC P1391 or P1393 will set when the monitor indicates that all four glow plugs are not being powered on the bank. An open in the glow plug circuits, glow plug relay, glow plugs or monitoring circuit could be the possible causes.

Both DTCs P1391 and P1393 together will set when the monitor indicates that all eight glow plugs are not being powered. An open in all glow plug circuits, the glow plug relay, glow plugs, fusible links or all three monitoring circuits could be the possible causes. If KOEO On-Demand Self Test DTC P0380 is also set, a concern on the glow plug relay triggering circuit will cause all three DTCs to set.



DA0845-C

NOTE: Look very carefully for poor connections, burnt looking or loose fitting pins that will cause high resistance and set a code.

Glow Plug System

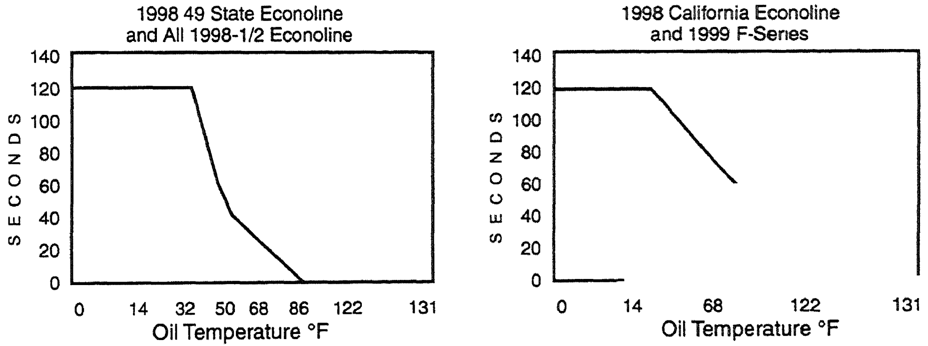
KC

The Glow Plug Monitor Self Test (California only) is a functional test of the Powertrain Control Module performed on demand with the engine running and the A / C off. For 1998 Econoline, battery voltage must be between 11.8-14 volts to complete the test. It may be necessary to raise engine rpm to maintain battery voltage. For 1998-1 / 2 Econoline and 1999 F-Series, the test will raise engine speed to 1200 rpm to maintain a system voltage of 11.5-14 V. The PCM will activate the glow plug relay and monitor the glow plug circuits. A fault must be present at the time of testing for the test to detect a fault. If one bank is reading less than 32 amps or one bank is reading at least 8-1 / 2 amps lower than the other bank, a fault will be detected and a Diagnostic Trouble Code (DTC) will be output on the data link at the end of the test when requested by a scan tool. Only a hard fault code (DTC) will be displayed.

Both California and 49 State

The glow plug on time is dependent on oil temperature and altitude. The glow plug relay comes on between 1-120 seconds and does not come on at all if oil temperature is above 86°F for Econoline or 131 °F for F-Series. Using the NGS, you can run the Output State Self Test, which will cycle the glow plug relay on for 5 seconds the first time only that the accelerator pedal is pressed. This Self Test does not set any codes.

You can verify glow plug on time (and amps for California) by monitoring NGS PIDs EOT and GPCTM (California: GPMR and GPML). The Wait to Start lamp ON time (1-10 seconds) is independent from glow plug relay ON time.



Note: Add 5 seconds to glow plug on time when above 7000 feet in altitude, but not to exceed 120 seconds. **DA1462-B**

DTC Description

P0380 = Glow plug circuit malfunction

P1391 = 4 glow plugs open right bank (California only)

P1392 = Glow plug circuit high input bank No. 1 (right) (California only)

P1393 = 4 glow plugs open left bank (California only)

P1394 = Glow plug circuit high input bank No. 2 (left) (California only)

P1395 = 1-3 glow plugs open right bank (California only)

P1396 = 1-3 glow plugs open left bank (California only)

P1397 = System voltage out of self-test range (California only)

Glow Plug System

KC

P1389 = Glow plug high side out of range low (center) (California only)

Test Step		Result ▶	Action to Take
KC1	DTC P1391 AND P1395 RIGHT BANK, P1393 AND P1396 LEFT BANK AND P1994 CENTER MONITORING CIRCUIT		
	NOTE: The glow plug system is monitored when the glow plugs are commanded on for more than 35 seconds and battery voltage is between 11.8-14 volts for 1998 or 11.5-14 volts for 1998-1/2 Econoline and 1999 F-Series. DTC P1395 or P1396 will set on the bank that is reading less than 32 amps or the bank that is reading at least 8-1/2 amps lower than the other bank. Loose fitting pins in the circuit connectors causing high resistance or high-resistance glow plug(s) on that bank could be the cause. A shorted circuit or low-resistance glow plug(s) on the opposite bank could also be the cause. Each bank needs to draw more than 32 amps but not more than 8-1/2 amps apart. DTC P1391 or P1393 will set when the monitor indicates that all four glow plugs are not being powered on that bank. An open in the glow plug circuits, glow plug relay, glow plugs or monitoring circuit could be the possible causes. Both DTCs P1391 and P1393 together will set when the monitor indicates that all eight glow plugs are not being powered. An open in all glow plug circuits, the glow plug relay, glow plugs, fusible links or all three monitoring circuits could be the possible causes. ● Possible causes: — glow plug relay — glow plug shunt — open in glow plug circuit(s) or monitoring circuit(s) — glow plugs — PCM ● Key on, engine off. ● Access PIDs VPWR, EOT, GPCT, GPMR and GPML. ● Verify that EOT is below 49°C (120°F) and GPCT is greater than 35 seconds. ● Compare GPMR to GPML, and record both readings. ● Measure voltage of Circuit 38 (BK/O) between glow plug relay and ground. ● **Is voltage greater than 10.5 volts?**	Yes ▶	GO to KC2.
		No ▶	REPAIR open Circuit 38 (BK/O) or fusible links. CLEAR DTCs and RETEST.

Glow Plug System

KC

Test Step		Result ▶	Action to Take
KC2	CHECK FOR DTC P0380		
	• Perform KOEO On-Demand Self Test and Retrieve / Clear Continuous DTCs. • **Is DTC P0380 present?**	Yes ▶ No ▶	GO to KC3. GO to KC8.
KC3	DTC P0380		
	• DTC P0380 is set when the PCM detects a malfunction in the glow plug relay control circuit. Possible causes: — shorted to power — open / grounded circuit — open fuse (F-Series — Fuse 22, Econoline — Fuse U) — worn or damaged glow plug relay • Key on, engine off. • Measure voltage at glow plug relay Point B, Circuit 16 (R / LG) and battery ground. Refer to the schematic for location of circuits. • **Is voltage greater than 10.5 volts?**	Yes ▶ No ▶	GO to KC4. REPAIR open in ignition power Circuit 16 (R / LG). If fuse is blown, CHECK for short to ground. RESTORE vehicle. CLEAR DTCs and RETEST.
KC4	RELAY COIL RESISTANCE TEST		
	• Key off. • Disconnect the wire going to the glow plug relay, Circuit 1086 (P / O) Point A. • Measure resistance through relay coil, between Point A and Point B. • **Is the resistance between 1 ohm and 8 ohms?**	Yes ▶ No ▶	GO to KC5. REPLACE glow plug relay. RESTORE vehicle. CLEAR DTCs and RETEST.
KC5	CHECK SHORT TO POWER		
	• Install breakout box; leave PCM disconnected. • Key on, engine off. • Measure voltage between PCM Test Pin 101 and battery ground. • Key off. • **Was voltage greater than 10.5 volts?**	Yes ▶ No ▶	REPAIR short to power. RESTORE vehicle. CLEAR DTCs and RETEST. GO to KC6.
KC6	CHECK SHORT TO GROUND		
	• Measure resistance between disconnected wire going to glow plug relay and battery ground. • **Is resistance greater than 10,000 ohms?**	Yes ▶ No ▶	GO to KC7. REPAIR short to ground. RESTORE vehicle. CLEAR DTCs and RETEST.
KC7	CHECK CIRCUIT FOR OPEN		
	• Measure resistance between PCM Test Pin 101 and Circuit 1086 (P / O) eyelet going to glow plug relay. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST. REPAIR open in Circuit 1086 (P / O). RESTORE vehicle. CLEAR DTCs and RETEST.

Glow Plug System — KC

Test Step		Result ▶	Action to Take
KC8	CHECK GLOW PLUG RELAY		
	NOTE: The glow plug ON time is dependent on oil temperature and altitude. The glow plugs come on between 1 to 120 seconds depending on oil temperature and do not come on at all if EOT is above 55°C (131°F). Verify glow plug control ON time using PID GPCTM. ● EOT temperature below 49°C (120°F). ● Key on, engine off. ● Measure voltage between center terminal of glow plug shunt and battery ground. ● **Is voltage present for at least 30 seconds?**	Yes ▶ No ▶	GO to KC9. REPLACE glow plug relay. RESTORE vehicle. CLEAR DTCs and RETEST.
KC9	CHECK GLOW PLUG		
	● Key off. ● On the bank with the code, disconnect both connectors on the valve cover gasket. ● Install Glow Plug Injector Adapter 014-00935 or equivalent to the valve cover gasket. ● Measure resistance between each of the four glow plug circuits on Adapter and engine ground (clean off a spot on the high-pressure oil reservoir to ensure a good ground). ● **Is resistance less than 2 ohms?**	Yes ▶ No ▶	For DTCs P1391 and P1395, GO to KC11. For DTCs P1393 and P1396, GO to KC12. GO to KC10.
KC10	CHECK UNDER VALVE COVER		
	● Remove valve cover and verify that the connections to the glow plugs are OK. ● If OK, disconnect the suspect glow plug connector. ● Measure resistance between the glow plug and engine ground. ● **Is resistance less than 2 ohms?**	Yes ▶ No ▶	REPLACE valve cover gasket or UVC harness. RESTORE vehicle. CLEAR DTCs and RETEST. REPLACE glow plug. RESTORE vehicle. CLEAR DTCs and RETEST.
KC11	CHECK GLOW PLUG MONITORING CIRCUIT — DTCS P1391, P1395		
	● Disconnect all four valve cover connectors on both right and left banks. ● Install breakout box; leave PCM disconnected. ● Measure resistance between all four glow plug circuits on the right bank and PCM Test Pin 9. ● **Are all readings within 2 ohms of each other?**	Yes ▶ No ▶	GO to KC13. REPAIR open between valve cover connector and PCM connector. VERIFY glow plug shunt nuts are clean and tight. RESTORE vehicle. CLEAR DTCs and RETEST.

Glow Plug System

KC

	Test Step	Result	▶	Action to Take
KC12	CHECK GLOW PLUG MONITORING CIRCUIT — DTCs P1393, P1396			
	• Measure resistance between all four glow plug circuits on the left bank and PCM Test Pin 34. • **Are all readings equal and less than 2 ohms?**	Yes	▶	GO to KC13.
		No	▶	REPAIR open between valve cover connector and PCM connector. VERIFY glow plug shunt nuts are clean and tight. RESTORE system. CLEAR DTCs and RETEST.
KC13	CHECK GLOW PLUG MONITORING CENTER CIRCUIT			
	• Measure resistance between center terminal on glow plug shunt and PCM Test Pin 8. • **Is resistance less than 2 ohms?**	Yes	▶	GO to KC14.
		No	▶	REPAIR open in Circuit 339 (GY). RESTORE system. CLEAR DTCs and RETEST.
KC14	COMPARE RIGHT BANK TO LEFT BANK			
	• Record all readings. The circuits must be within 2 ohms of each other. • Measure resistance between all four glow plug circuits on left bank and PCM Test Pins 8, 9 and 34, then all four glow plug circuits on right bank and PCM Test Pins 8, 9 and 34. • **Are all readings within 2 ohms of each other?**	Yes	▶	REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.
		No	▶	REPAIR open in the higher resistance circuit. VERIFY glow plug shunt nuts are clean and tight. RESTORE system. CLEAR DTCs and RETEST.
KC15	DTC P1397 — SYSTEM VOLTAGE OUT OF SELF-TEST RANGE DURING KOER GLOW PLUG MONITOR SELF TEST			
	NOTE: DTC P1397 will set if system voltage is above 14 volts or below 11.8 volts at any time during KOER Glow Plug Self Test. It may be necessary to raise rpm to maintain voltage. If unable to maintain system voltage, service as required according to service manual direction. • Perform KOER Glow Plug Monitor Self Test. With a digital multimeter connected to the battery. Maintain system voltage until test is complete. • **Does P1397 still set?**	Yes	▶	GO to Pinpoint Test A1.
		No	▶	No concern located at this time. RESTORE system. CLEAR DTCs and RETEST.

Glow Plug Lamp (GPL)

KD

Output Functions

Glow Plug WAIT TO START Lamp — A lamp to indicate to the operator when the glow plugs have been on long enough to crank the engine. It is controlled by the PCM. WAIT TO START lamp ON time is a function of engine oil temperature, barometric pressure and battery voltage. ON time normally varies between 1 to 10 seconds. Note: WAIT TO START light ON time is independent from glow plug relay ON time.

Detection/Management

An open or shorted to ground glow plug relay or WAIT TO START lamp circuit can be detected by an on-demand output circuit check performed during the KOEO standard test.

Glow plug and glow plug harness problems cannot be detected by the PCM.

Caution

Do not perform any voltage checks with the engine running; 115 V DC at 10 amps present on injector circuits.

Note

Enter this pinpoint test only when directed here from symptom flowcharts.

Remember

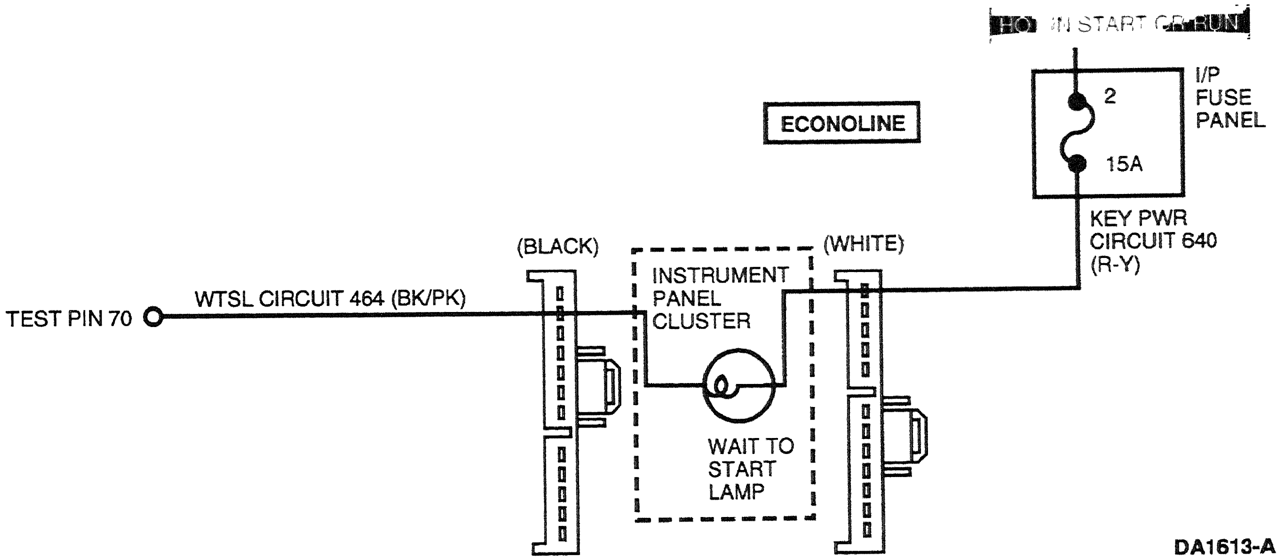
This pinpoint test is intended to diagnose only the following:

- powertrain control module (PCM)(12A650)
- harness circuits: WAIT TO START lamp
- warning lamp

Glow Plug Lamp (GPL) KD

Description

The glow plugs are energized during and after the WAIT TO START light is on. When the WAIT TO START light goes off, the engine is ready to be started.



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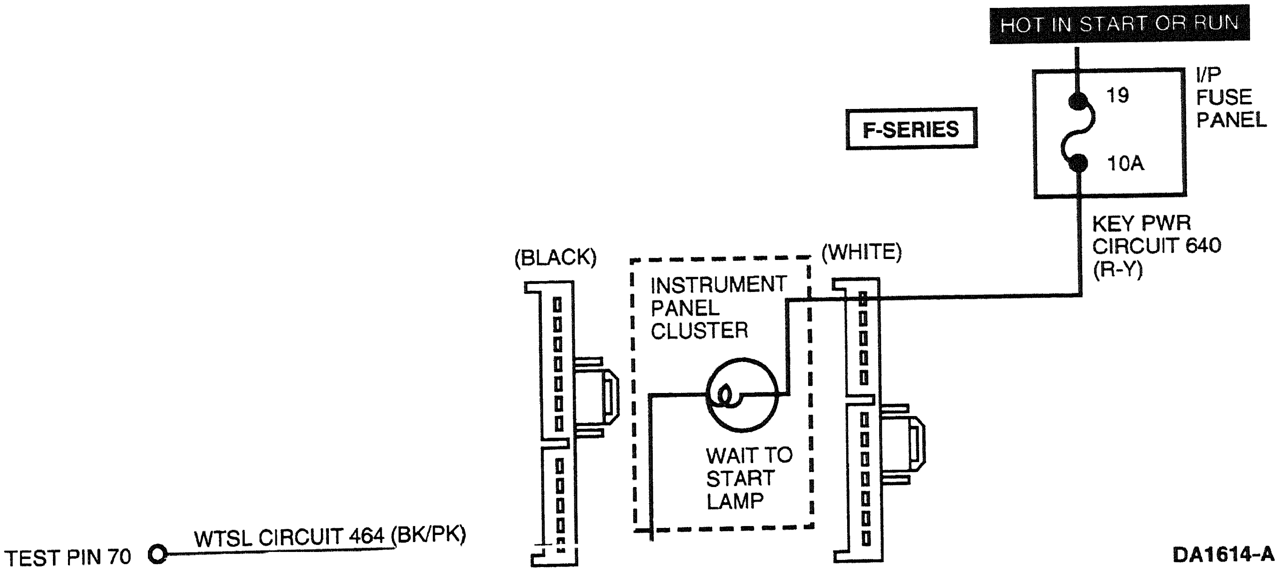


DA1614-A

Glow Plug Lamp (GPL)

KD

DTC Description

P0381 = Glow plug indicator circuit malfunction

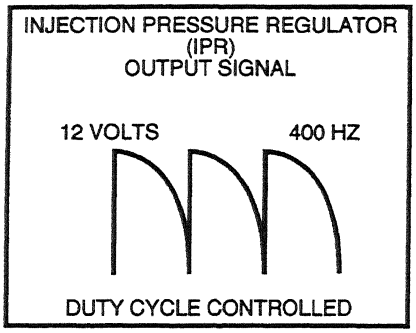
Test Step		Result ▶	Action to Take
KD1	DIAGNOSTIC TROUBLE CODE (DTC) P0381 ● DTC P0381 is set when the PCM detects a malfunction in the glow plug warning lamp circuit. Possible causes: — Open/grounded circuit — Open WAIT TO START light — Open fuse (F-Series — Fuse 17, Econoline — Fuse 18) ● Key on, engine running. ● **Does WAIT TO START light remain on?**	Yes ▶ No ▶	GO to KD2. GO to KD3.
KD2	CHECK CIRCUIT 464 (BK/PK) FOR SHORT ● Key off. ● Disconnect PCM harness connector. ● Key on, engine off. ● **Is WAIT TO START light on?**	Yes ▶ No ▶	REPAIR ground short in Circuit 464 (BK/PK) between WAIT TO START light and PCM. REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.
KD3	CHECK INTERMITTENT P0381 ● A Continuous DTC P0381 is set when the PCM detects a malfunction in the WAIT TO START light circuit. Possible causes: — intermittently open/grounded circuit or fuse. — intermittently open WAIT TO START light ● Key off. ● Key on. ● **Does WAIT TO START light come on for at least 1 second?**	Yes ▶ No ▶	Concern is intermittent. GO to KD9. GO to KD4.
KD4	CHECK FUSE FOR OPEN ● Key off. ● Check fuse for continuity. ● **Is fuse OK?**	Yes ▶ No ▶	GO to KD5. GO to KD6.
KD5	CHECK WARNING LIGHT BULB FOR OPEN ● Disconnect WAIT TO START light. ● Check bulb for continuity. ● **Is bulb OK?**	Yes ▶ No ▶	GO to KD7. REPLACE bulb. RESTORE system. CLEAR DTCs and RETEST.

Glow Plug Lamp (GPL) KD

Test Step		Result ►	Action to Take
KD6	CHECK CIRCUIT 640 (R/Y) FOR GROUND SHORT		
	• Disconnect WAIT TO START light. • Measure resistance between Circuit 640 (R/Y) and chassis ground. • **Is resistance greater than 10,000 ohms?**	Yes ►	REPLACE fuse. RESTORE system. CLEAR DTCs and RETEST.
		No ►	REPAIR ground short in Circuit 640 (R/Y). REPLACE fuse. RESTORE system. CLEAR DTCs and RETEST.
KD7	CHECK FOR OPEN CIRCUIT 640 (R/Y)		
	• Key off. • Disconnect WAIT TO START light. • Key on, engine off. • Measure voltage on Circuit 640 (R/Y) at warning light harness connector. • **Is B+ present?**	Yes ►	GO to KD8.
		No ►	REPAIR open in Circuit 640 (R/Y) between fuse and WAIT TO START light. RESTORE system. CLEAR DTCs and RETEST.
KD8	CHECK FOR OPEN IN CIRCUIT 464 (BK/PK)		
	• Install breakout box; leave PCM disconnected. • Measure resistance in Circuit 464 (BK/PK) between the WAIT TO START light and PCM Test Pin 70. • **Is resistance less than 5 ohms?**	Yes ►	REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.
		No ►	REPAIR open in Circuit 464 (BK/PK). RESTORE system. CLEAR DTCs and RETEST.
KD9	CONTINUOUS P0381 CODE		
	• Clear Continuous DTC P0381. • **Does P0381 return in Continuous after road test?**	Yes ►	GO to KD10.
		No ►	Code was not cleared after a previous repair. RESTORE system. CLEAR DTCs and RETEST.
KD10	CHECK FOR CODE P0381 AFTER ROAD TEST		
	• **Did the WAIT TO START light come on or flicker on and off during road test?**	Yes ►	REPAIR Circuit 464 (BK/PK) intermittently shorting to ground. RESTORE system. CLEAR DTCs and RETEST.
		No ►	GO to KD11.
KD11	CHECK FOR INTERMITTENTLY OPEN CIRCUIT		
	• Install breakout box; leave PCM disconnected. • Ground PCM Test Pin 70. • Tap on dashboard. Shake harness under dash and under hood between the 76-way connector and PCM connector. • **Does the WAIT TO START light flicker on and off?**	Yes ►	REPAIR an intermittently open light bulb or circuit between fuse and PCM connector. RESTORE system. CLEAR DTCs and RETEST.
		No ►	If unable to find an intermittent short or open, REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.

Injection Pressure Regulator (IPR)

KE



DA0426-A

Output Functions

Injection Pressure Regulator (IPR) — A variable position valve that controls injection control pressure. The powertrain control module (PCM) uses many input variables to determine the desired injection control pressure.

Battery voltage is supplied to the IPR when the ignition key is in the ON position. Valve position is controlled by switching the output signal circuit to ground inside the PCM. ON / OFF time is modulated from 0 to 50% dependent upon the desired injection control pressure.

Detection / Management

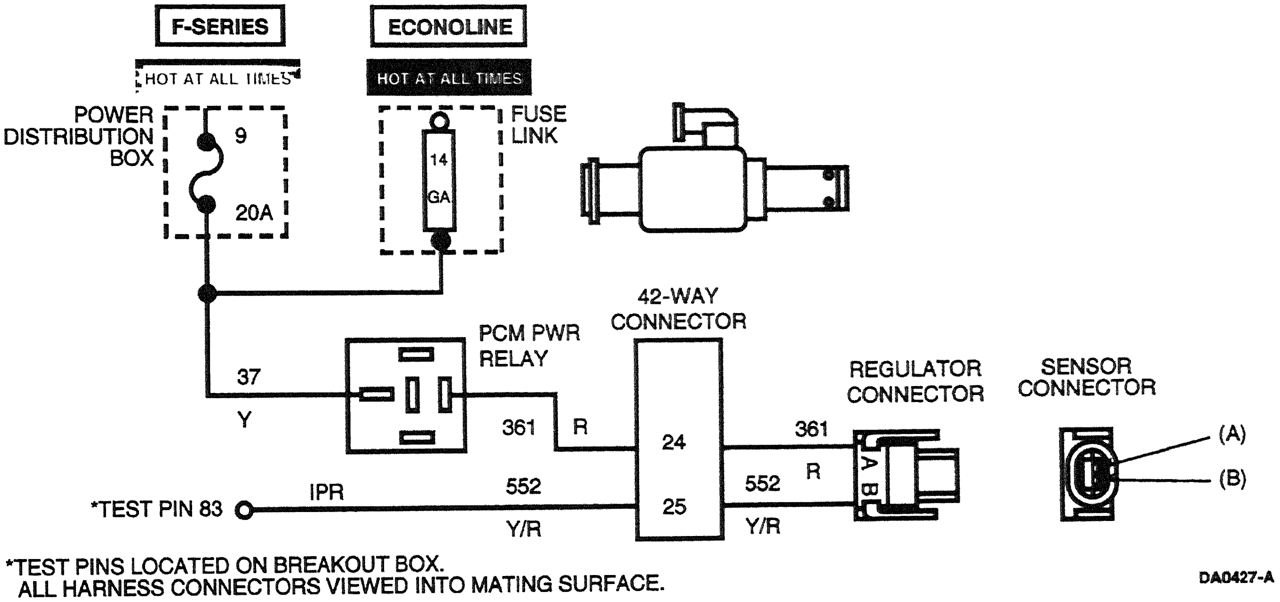
An open or shorted to ground control circuit can be detected by an on demand output circuit check performed during the KOEO test.

The PCM is capable of detecting whether desired injection control pressure is equal to measured injection control pressure while the engine is running. If the measured injection control pressure does not reasonably compare to the desired injection control pressure the PCM ignores the measured ICP sensor signal and attempts to control the engine with the desired value. (If the problem was in the sensor circuit this strategy causes little performance deterioration. If the problem is in the control circuit, engine performance will probably still be unsatisfactory).

An injection control pressure step test, in which the PCM commands and then measures specific preprogrammed pressures is performed during the KOER test.

Injection Pressure Regulator (IPR) | KE

The engine will not operate with an IPR circuit that is not functioning.



Note

After removing connectors, always check for damaged pins, corrosion, loose terminals, etc.

DTC Descriptions

P1211 = If set during normal engine operation, indicates engine is operating in open loop control and injection control pressure is above or below desired pressure. If set during KOER test, indicates ICP system failed step test and could not maintain commanded pressure.

P1282 = Injection control pressure was greater than 3675 psi for 1.5 seconds (possible grounded IPR control circuit). Refer to injection control pressure diagnostics if not electronic concern.

P1283 = Output circuit check detected during KOEO test; indicates high or low resistance in circuit.

	Test Step	Result ▶	Action to Take
KE1	DIAGNOSTIC TROUBLE CODE (DTC) P1283		
	NOTE: DTC P1283 indicates an IPR circuit failure was detected by the PCM. ● Disconnect IPR harness connector. ● Remove PCM relay. ● Measure resistance between IPR harness connector Pin A and PCM relay Terminal 361 (R). ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to **KE2**. REPAIR open Circuit 361 (R). RESTORE system. CLEAR DTCs and RETEST.

Injection Pressure Regulator (IPR) KE

Test Step		Result ▶	Action to Take
KE2	CHECK IPR COIL RESISTANCE ● Measure resistance of IPR coil. ● **Is resistance 5 to 20 ohms?**	Yes ▶ No ▶	GO to KE3. REPLACE IPR. RESTORE system. CLEAR DTCs and RETEST.
KE3	IPR CONTROL CIRCUIT SHORT TO POWER OR GROUND ● Install breakout box; leave PCM disconnected. ● Measure resistance between PCM Test Pin 83 and PCM Test Pins 71 and 97. ● Measure resistance between PCM Test Pin 83 and PCM Test Pins 25, 51, 76, 77 and 103. ● **Is resistance greater than 10,000 ohms?**	Yes ▶ No ▶	GO to KE4. REPAIR short in Circuit 552 (Y / R). RESTORE system. CLEAR DTCs and RETEST.
KE4	IPR HARNESS CONTROL CIRCUIT — RESISTANCE ● Measure resistance between PCM Test Pin 83 and Point B in the IPR regulator harness connector. ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST. REPAIR open Circuit 552 (Y / R). RESTORE system. CLEAR DTCs and RETEST.
KE5	DIAGNOSTIC TROUBLE CODE (DTC) P1282 ● DTC P1282 indicates excessive injection control pressure was detected during continuous diagnostic monitoring. Possible causes: — intermittent IPR control circuit short to ground — stuck IPR ● Disconnect IPR harness connector. ● **Will engine start?**	Yes ▶ No ▶	REPLACE IPR. RESTORE system. CLEAR DTCs and RETEST. GO to KE6.
KE6	CHECK FOR INTERMITTENT SHORT TO GROUND ● Install breakout box; leave the PCM disconnected. ● Measure resistance between PCM Test Pin 83 and ground. ● Wiggle IPR circuit connectors and wires to attempt to induce short to ground. ● **Is resistance greater than 10,000 ohms?**	Yes ▶ No ▶	CLEAR codes. RERUN KOER test. If codes return, REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST. REPAIR short to ground. RESTORE system. CLEAR DTCs and RETEST.

Injection Pressure Regulator (IPR)

KE

Test Step		Result ▶	Action to Take
KE7	KOER ON-DEMAND DIAGNOSTIC TROUBLE CODE (DTC) P1211		
	- DTC P1211 indicates that injection control pressure was above or below commanded desired pressure during self test mode. Possible causes: — incorrect oil or viscosity — poor oil quality — gel fuel / no fuel — low fuel pressure — damaged IPR valve — high-pressure oil system leak — damaged high-pressure oil pump — damaged PCM - Verify correct oil quality / viscosity and correct fuel grade are being used for the temperature conditions. - **Is oil and fuel quality OK?**	Yes ▶ No ▶	GO to KE8. REPAIR fuel or oil condition and VERIFY DTC does not return. RESTORE system. CLEAR DTCs and RETEST.
KE8	CHECK FUEL PRESSURE		
	- Measure fuel pressure at regulator block. - Measure fuel pressure at idle and on road at WOT at full load. Fuel pressure at idle should be 138 kPa (20 psi) minimum, and 206-482 kPa (30-70 psi) at WOT full load. - **Is fuel pressure OK?**	Yes ▶ No ▶	GO to KE9. REPAIR fuel system concern. RESTORE system. CLEAR DTCs and RETEST.
KE9	CHECK OIL RESERVOIR LEVEL		
	- Remove plug in top of oil reservoir and check level. - **Is oil level within 25.4 mm (1 inch) of the top of the reservoir?**	Yes ▶ No ▶	GO to KE10. REPAIR condition causing low oil supply to the reservoir. RESTORE system. CLEAR DTCs and RETEST.
KE10	ICP SENSOR CHECK		
	- Key on, engine off. - Access ICP PID. - **Is ICP reading 0 kPa (0 psi)?**	Yes ▶ No ▶	GO to KE11. REPLACE faulty ICP sensor. RESTORE system. CLEAR DTCs and RETEST.
KE11	OIL AERATION CHECK		
	- Accelerate engine to wide-open throttle and hold for three minutes. - **Does ICP reading increase above 8618 kPa (1250 psi)?**	Yes ▶ No ▶	CHANGE engine oil and REPEAT test. RESTORE system. CLEAR DTCs and RETEST. GO to KE12.

Injection Pressure Regulator (IPR) KE

Test Step	Result ▶	Action to Take
KE12 CHECK ICP WHILE PERFORMING SELF TEST		
NOTE: During KOER On-Demand Self Test, ICP will be commanded high (17 MPa), then low (5 MPa) and then EBP will be commanded high and low. ● Install ICP / EBP Adapter Cable D94T-50-A or equivalent between ICP sensor and engine harness. ● Measure the voltage between ICP signal circuit and ground. ● Perform KOER On-Demand Self Test. ● **Does voltage reading increase above 3 V and then decrease to approximately 1 V during the ICP portion of the KOER test?**	Yes ▶	If DTC 1211 was displayed, REPLACE the PCM. RESTORE system. CLEAR DTCs and RETEST.
	No ▶	GO to **KE13**.
KE13 INJECTOR LEAK TEST		
● Disconnect high pressure hose from right cylinder head. ● Using Oil High Pressure Leakage Adapter Set D94T-6600-A or equivalent, plug right high pressure hose. ● Access IPR PID. ● Start vehicle and record IPR reading. ● Key off. ● Reconnect right cylinder head high pressure hose. ● Disconnect left cylinder head high pressure hose. Install adapter and ICP into high pressure hose. ● Start vehicle and record IPR reading. ● **Are the two readings within 2% of each other?**	Yes ▶	REPLACE faulty IPR valve. If DTC 1211 is still present, GO to **KE14**.
	No ▶	REPAIR internal oil leak on the bank with the higher IPR reading. REFER to the Powertrain Group in the Workshop Manual. RESTORE system. CLEAR DTCs and RETEST.
KE14 OIL SYSTEM PRESSURE TEST		
● Go to the Powertrain Group in the Workshop Manual. Perform pressurized oil leak checks. ● **Is a leak condition indicated?**	Yes ▶	REPAIR leak as necessary. RESTORE system. CLEAR DTCs and RETEST.
	No ▶	REPLACE high pressure oil pump. RESTORE system. CLEAR DTCs and RETEST.

Injection Pressure Regulator (IPR) KE

	Test Step	Result ▶	Action to Take
KE15	CONTINUOUS DIAGNOSTIC TROUBLE CODE (DTC) P1211, P1209		
	● DTC P1209 and P1211 indicates that injection control pressure was above or below desired level under normal driving conditions. Possible causes: — incorrect oil or viscosity — poor oil quality — gel fuel / no fuel — low fuel pressure — damaged IPR valve — high-pressure oil system leak — damaged high-pressure oil pump — damaged PCM ● Verify correct oil quality / viscosity and correct fuel grade are being used for the temperature conditions. ● **Is oil and fuel quality OK?**	Yes ▶ No ▶	GO to KE16. REPAIR fuel or oil condition. RESTORE vehicle. CLEAR DTCs and RETEST.
KE16	RECHECK FUEL PRESSURE		
	● Measure fuel pressure at regulator block. ● Measure fuel pressure at idle and on road at WOT full load. Fuel pressure at idle should be 138 kPa (20 psi) minimum, and 206-482 kPa (30-70 psi) at WOT full load. ● **Is fuel pressure OK?**	Yes ▶ No ▶	GO to KE17. REPAIR fuel system concern. RESTORE vehicle. CLEAR DTCs and RETEST.
KE17	PERFORM KOER ON-DEMAND SELF TEST		
	● Perform KOER On-Demand Self Test. ● **Is DTC P1211 set?**	Yes ▶ No ▶	GO to KE9. GO to KE18.
KE18	CHECK OIL LEVEL IN RESERVOIR		
	NOTE: If may be necessary to soak vehicle if a leakdown concern is indicated. ● Remove plug from top of oil reservoir and check level. ● **Is oil level within 25.4 mm (1 inch) of the top of the reservoir?**	Yes ▶ No ▶	GO to KE19. REPAIR condition causing low oil supply to the reservoir. RESTORE system. CLEAR DTCs and RETEST.
KE19	CHECK ICP SENSOR		
	● Key on, engine off. ● Access ICP PID. ● **Is injection control pressure reading 0 kPa (0 psi)?**	Yes ▶ No ▶	GO to KE20. REPLACE ICP sensor. RESTORE system. CLEAR DTCs and RETEST.
KE20	CHECK OIL AERATION		
	● Accelerate engine and hold at 3300 rpm for three minutes. ● **Does injection control pressure reading increase above 8618 kPa (1250 psi)?**	Yes ▶ No ▶	CHANGE engine oil. RESTORE system. CLEAR DTCs and RETEST. GO to KE21.

Injection Pressure Regulator (IPR)

KE

Test Step		Result ▶	Action to Take
KE21	CHECK IPR DUTY CYCLE UNDER LOAD		
	● Run vehicle at WOT and full load condition. ● **Does IPR duty increase to 65%?**	Yes ▶	REPLACE IPR valve. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	Unable to duplicate failure. RESTORE vehicle. CLEAR DTCs and RETEST.

Fuel Delivery Command Signal (FDCS)

KF

Note

Enter this pinpoint test only when directed here from the symptom flowcharts.

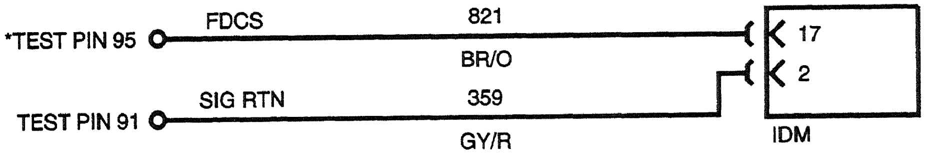
Remember

This pinpoint test is intended to diagnose only the following:

- powertrain control module (PCM)(12A650)
- injector driver module (IDM)
- harness circuits: fuel delivery command signal (FDCS)

Description

The FDCS is the output that controls the fuel injection timing and controls fuel quantity with the injection pressure regulator (IPR). This signal is sent with the cylinder identification (CID) signal to the IDM which provides power and distributes the proper signal to the appropriate injector.



*TEST PINS LOCATED ON BREAKOUT BOX.

DA0423-A

DTC Description

P1663 = FDCS circuit failure

Fuel Delivery Command Signal (FDCS)

KF

Test Step		Result ▶	Action to Take
KF1	DIAGNOSTIC TROUBLE CODE (DTC) P1663		
	● DTC P1663 indicates that the PCM has detected a failure on the FDCS line. Possible causes: — open / grounded circuit — damaged IDM — damaged PCM ● Install breakout box; connect PCM to breakout box. ● Key on, engine off. ● Measure voltage between PCM Test Pin 95 and ground. ● **Is voltage of 0.6 ± 0.1 volt present?**	Yes ▶ No ▶ ▶	GO to KF2. Voltage of less than 0.5 volt present. GO to KF3. Battery voltage is present. GO to KF4.
KF2	PERFORM KOEO OUTPUT STATE CHECK		
	● Perform KOEO Output State Test. Toggle output by pressing and releasing accelerator pedal. ● Measure voltage between PCM Test Pin 95 and ground. ● Key off. ● **Did the output toggle from 0.6 ± 0.1 volt to 12 volts?**	Yes ▶ No ▶	Intermittent failure. GO to KF7. REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.
KF3	CHECK CIRCUIT 821 (BR / O) FOR CONTINUITY		
	● Disconnect PCM from breakout box. ● Disconnect IDM harness connector. ● Measure resistance between PCM Test Pin 95 and Pin 17 on IDM harness connector. ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to KF5. REPAIR open in Circuit 821 (BR / O). RESTORE system. CLEAR DTCs and RETEST.
KF4	CHECK FDCS SIGNAL (CID) CIRCUIT FOR SHORT TO BATTERY VOLTAGE		
	● Key on, engine off. ● Measure voltage between PCM Test Pin 95 and ground. ● **Is voltage greater than 10.5 volts?**	Yes ▶ No ▶	REPAIR short to battery voltage. RESTORE system. CLEAR DTCs and RETEST. GO to KF6.
KF5	CHECK FDCS CIRCUIT TO GROUND		
	● Key off. ● Measure resistance between PCM Test Pin 95 and PCM Test Pins 25, 51, 76, 77, 91 and 103. ● **Is the resistance greater than 10,000 ohms?**	Yes ▶ No ▶	GO to KF6. REPAIR ground short in Circuit 821 (BR / O). RESTORE system. CLEAR DTCs and RETEST.

Fuel Delivery Command Signal (FDCS)

KF

Test Step		Result ▶	Action to Take
KF6	CHECK PCM OUTPUT STATE FUNCTION		
	● Connect PCM to breakout box. ● Perform KOEO Output State Test. ● Measure voltage between PCM Test Pin 95 and ground while pressing and releasing accelerator pedal. ● **Does output toggle between 0.53 V ± 0.1 V and 0 V?**	Yes ▶ No ▶	REPLACE IDM. RESTORE vehicle. CLEAR DTCs and RETEST. REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
KF7	INTERMITTENT		
	● Clear DTCs. ● Key on, engine running at idle. ● Wiggle wires from PCM to IDM. ● Key off. ● KOEO on-demand. ● Check DTCs. ● **Is DTC P1663 present?**	Yes ▶ No ▶	REPAIR intermittent in Circuit 821 (BR / O) or Circuit 359 (GY / R). RESTORE vehicle. CLEAR DTCs and RETEST. Unable to duplicate failure. System OK. RESTORE vehicle. CLEAR DTCs and RETEST.

Tachometer

KG

Note

Enter this pinpoint test only if there are no DTCs retrieved and the tachometer does not work.

Remember

This pinpoint test is intended to diagnose only the following:

- harness circuits: KEY PWR, GND and tach signal circuit from the powertrain control module (PCM)
- tachometer

Test Step		Result ▶	Action to Take
KG1	TACHOMETER INOPERATIVE: CHECK FUSE 17		
	• Check Fuse 17 in IP fuse panel for open. • **Is fuse blown?**	Yes ▶	REPAIR short to ground in Circuit 640 (R / Y). REPLACE fuse. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	GO to KG2.
KG2	CHECK GROUND TO TACHOMETER		
	• Measure resistance between ground Circuit 57 (BK), Pin 3 of the black instrument cluster connector and ground. • **Is resistance less than 5 ohms?**	Yes ▶	GO to KG3.
		No ▶	REPAIR open in ground Circuit 57 (BK). RESTORE vehicle. CLEAR DTCs and RETEST.
KG3	CHECK POWER TO TACHOMETER		
	• Key on, engine off. • Measure voltage between power Circuit 640 (R / LG), Pin 13 of the black instrument cluster connector and ground. • **Is voltage greater than 10.5 volts?**	Yes ▶	GO to KG4.
		No ▶	REPAIR open in Circuit 640 (R / LG). RESTORE vehicle. CLEAR DTCs and RETEST.

Tachometer

KG

Test Step	Result ►	Action to Take
KG4 CHECK SIGNAL CIRCUIT OUTPUT ● Use the scan tool plugged into the data link connector (DLC) and two jumpers, one plugged between the COM port of the scan tool to Pin 3 (ground) of the black instrument cluster connector and the other jumper plugged between the SIG port of the scan tool to Pin 9 (tach signal) of the black instrument cluster connector. ● Key on, engine running. — With scan tool, select VEHICLE and ENGINE. — Select DIGITAL MEASUREMENT SYSTEM. — Select FREQUENCY METER. — Change level to 4 VOLT DC. — Press the LINK button to choose a pid. — Select PID / DATA MONITOR. — Select the RPM PID. — Press start. ● Take three readings at 650 rpm, 1500 rpm and 3000 rpm. ● **Do readings match the table listed below?**	Yes ►	INSPECT printed circuit board for damaged or open circuits. If OK, REPLACE tachometer. RESTORE vehicle. CLEAR DTCs and RETEST.
	No ►	GO to KG5.
KG5 CHECK FOR OPEN IN TACH SIGNAL CIRCUIT ● Key off. ● Install breakout box; leave PCM disconnected. ● Measure resistance on Circuit 648 (W / PK) between Pin 9 of the black instrument cluster connector and PCM Test Pin 50 (49 State except Econoline) or PCM Test Pin 19 (California and all Econoline). ● **Is resistance less than 5 ohms?**	Yes ►	GO to KG6.
	No ►	REPAIR open in Circuit 648 (W / PK). RESTORE system. CLEAR DTCs and RETEST.
KG6 CHECK FOR SHORT TO GROUND IN TACH SIGNAL CIRCUIT ● Measure resistance between Circuit 648 (W / PK) PCM Test Pin 50 (49 State except Econoline) or PCM Test Pin 19 (California and all Econoline) and ground. ● **Is resistance greater than 10,000 ohms?**	Yes ►	GO to KG7.
	No ►	REPAIR short to ground in Circuit 648 (W / PK). RESTORE system. CLEAR DTCs and RETEST.

Step No.	Step 1	Step 2	Step 3
rpm	650 rpm	1500 rpm	3000 rpm
Frequency	129 ± 10 Hz	300 ± 10 Hz	600 ± 10 Hz

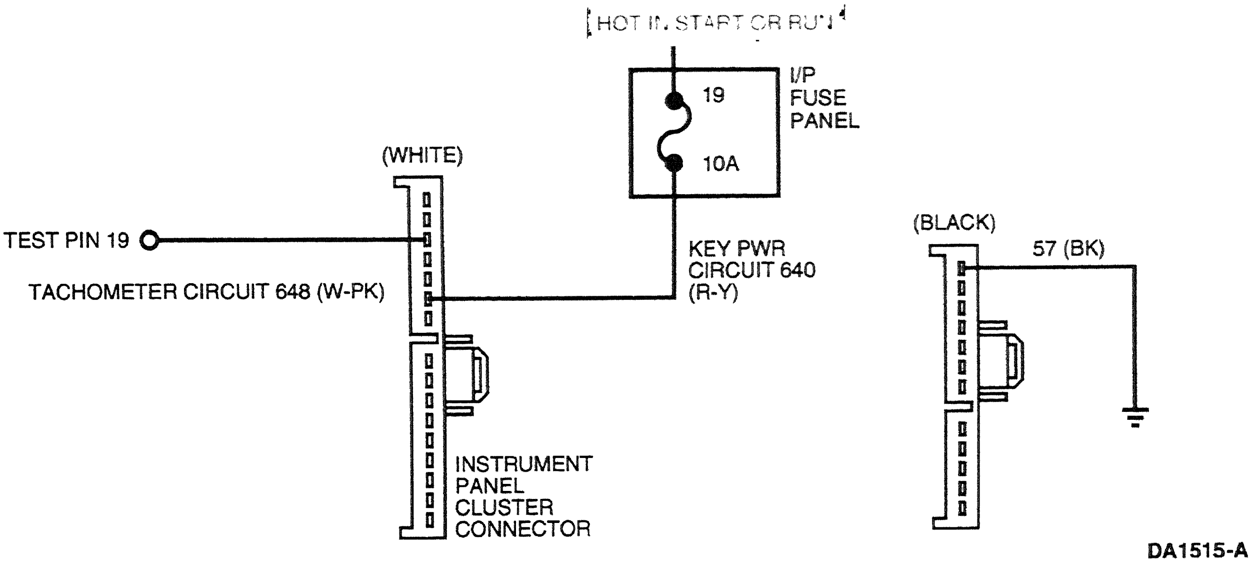
Tachometer

KG

Test Step		Result ▶	Action to Take
KG7	CHECK FOR SHORT TO POWER IN TACH SIGNAL CIRCUIT		
	● Key on, engine off. ● Measure voltage between Circuit 648 (W / PK) PCM Test Pin 50 and ground. ● **Is voltage present?**	Yes ▶	REPAIR short to power on Circuit 648 (W / PK). RESTORE system. CLEAR DTCs and RETEST.
		No ▶	REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.

Tachometer — 1999 F-Series

KH



Test Step		Result		Action to Take
KH1	TACHOMETER INOPERATIVE: CHECK FUSE			
	- Check I/P fuse panel Fuse 19. - **Is fuse blown?**	Yes	▶	REPAIR short to ground. REPLACE fuse. TEST system for normal operation.
		No	▶	GO to KH2.
KH2	CHECK GROUND TO TACHOMETER			
	- Disconnect small black instrument cluster harness connector. - Measure resistance of Circuit 57 (BK) between Pin 1 on the small black instrument cluster harness connector and ground. - **Is resistance less than 5 ohms?**	Yes	▶	GO to KH3.
		No	▶	REPAIR open in Circuit 57 (BK). RESTORE vehicle. TEST system for normal operation.
KH3	CHECK POWER TO TACHOMETER			
	- Disconnect large white instrument cluster harness connector. - Key on, engine off. - Measure voltage of Circuit 640 (R/Y) between Pin 6 on the large white instrument cluster harness connector and ground. - Key off. - **Was voltage greater than 10.5 volts?**	Yes	▶	GO to KH4.
		No	▶	REPAIR open in Circuit 640 (R/Y). RESTORE vehicle. TEST system for normal operation.

Tachometer — 1999 F-Series

KH

Test Step		Result ▶	Action to Take
KH4	CHECK SIGNAL CIRCUIT OUTPUT		
	● Use the NGS Tester plugged into the data link connector (DLC) and two jumpers, one plugged between the COM port of the NGS Tester to Pin 1 (ground) on the small black connector for the cluster, the other jumper plugged between the SIG port of the NGS Tester to Pin 4 (tach signal) on the large white connector for the cluster. ● Key to start, engine running. — With NGS Tester, select VEHICLE and ENGINE. — Select DIGITAL MEASUREMENT SYSTEM. — Change level to 4 VOLT DC. — Press the LINK button to choose a PID. — Select PID / DATA MONITOR. — Select the RPM PID. — Press START. ● Take three readings at 650 rpm, 1500 rpm and 3000 rpm. ● Key off. ● **Did the readings match the table listed below?**	Yes ▶	INSPECT printed circuit board for damaged or open circuits. If damaged or open circuits are present, REPLACE printed circuit board. If OK, REPLACE tachometer. RESTORE vehicle. TEST system for normal operation.
		No ▶	GO to KH5.

Step No.	Step 1	Step 2	Step 3
RPM	650	1500	3000
FREQUENCY	43 ± 10 Hz	100 ± 10 Hz	200 ± 10 Hz

KH5	CHECK FOR OPEN IN TACH SIGNAL CIRCUIT		
	● Install breakout box; leave PCM disconnected. ● Measure resistance of Circuit 648 (W / PK) between Pin 4 on the large white instrument cluster harness and PCM Test Pin 19. ● **Is resistance less than 5 ohms?**	Yes ▶	GO to KH6.
		No ▶	REPAIR open in Circuit 648 (W / PK). RESTORE vehicle. TEST system for normal operation.
KH6	CHECK FOR SHORT TO GROUND IN TACH SIGNAL		
	● Measure resistance of Circuit 648 (W / PK) between Pin 4 on the large white instrument cluster harness connector and ground. ● **Is resistance greater than 10,000 ohms?**	Yes ▶	GO to KH7.
		No ▶	REPAIR short to ground on Circuit 648 (W / PK). RESTORE vehicle. TEST system for normal operation.

Tachometer — 1999 F-Series

KH

Test Step		Result ▶	Action to Take
KH7	CHECK SHORT TO POWER IN TACH CIRCUIT		
	• Key on, engine off. • Measure voltage of Circuit 648 (W / PK) between Pin 4 on the large white instrument cluster harness connector and ground. • **Is voltage greater than 10.5 volts?**	Yes ▶	REPAIR short to power in Circuit 648 (W / PK). RESTORE vehicle. TEST system for normal operation.
		No ▶	REPLACE PCM. RESTORE vehicle. TEST system for normal operation.

Output Circuit Check (OCC) High

KJ

Test Step		Result ▶	Action to Take
KJ1	DIAGNOSTIC TROUBLE CODE (DTC) P1660		
	● DTC P1660 indicates that the output circuit check is high. Possible causes: — high system voltage — VREF circuit fault — damaged powertrain control module (PCM) ● Perform charging system and battery tests. ● **Is charging system OK?**	Yes ▶	GO to KJ2.
		No ▶	REPAIR charging system as required. RESTORE vehicle. CLEAR DTCs and RETEST.
KJ2	VREF CIRCUIT CHECK		
	● Install breakout box; leave PCM disconnected. ● Key on, engine off. ● Measure voltage between PCM Test Pin 90 and ground. ● **Is voltage less than 0.25 volt?**	Yes ▶	GO to KJ3.
		No ▶	REPAIR short to power in VREF Circuit 351 (BR/W). RESTORE vehicle. CLEAR DTCs and RETEST.
KJ3	PCM CHECK		
	● Connect PCM to breakout box. ● Perform KOEO Self Test. ● **Is DTC P1660 still present?**	Yes ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	System test OK. RESTORE vehicle. CLEAR DTCs and RETEST.

Output Circuit Check (OCC) Low

KK

Test Step		Result	▶	Action to Take
KK1	DIAGNOSTIC TROUBLE CODE (DTC) P1661			
	• DTC P1661 indicates that the output circuit check is low. Possible causes: — low battery voltage — circuit failure — damaged powertrain control module (PCM) • Perform charging system and battery tests. • **Is charging system OK?**	Yes	▶	GO to KK2.
		No	▶	REPAIR charging system as required. RESTORE system. CLEAR DTCs and RETEST.
KK2	VREF CIRCUIT CHECK			
	• Key on, engine off. • Disconnect manifold absolute pressure (MAP) sensor harness connector. • Measure voltage between SIG RETURN Circuit 359 (GY / R) and VREF Circuit 351 (BR / W) at the MAP sensor harness connector. • **Are 5.0 volts present?**	Yes	▶	GO to KK3.
		No	▶	IDENTIFY VREF circuit fault. GO to Pinpoint Test C1.
KK3	VPWR CIRCUIT CHECK			
	• Install breakout box; leave PCM disconnected. • Measure voltage between PCM Test Pins 71 and 97 and positive ground. • Key off. • **Is voltage present on both pins?**	Yes	▶	GO to KK4.
		No	▶	IDENTIFY VPWR circuit failure. GO to Pinpoint Test A1.
KK4	PCM GROUND CIRCUIT CHECK			
	• Measure resistance between PCM Test Pins 25, 51, 76, 77 and 103 and negative battery post. • **Is resistance less than 5 ohms?**	Yes	▶	REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.
		No	▶	REPAIR ground circuit fault. GO to Pinpoint Test A10.

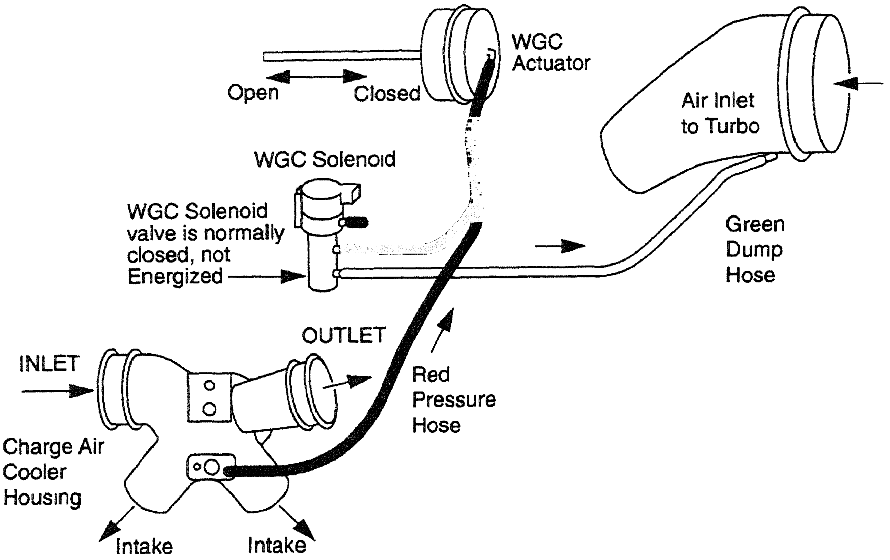
Wastegate Control (WGC) Solenoid — 1999 F-Series

KL

Control Functions

A wastegated turbo is designed to reach maximum boost sooner then a conventional turbo, but overboosting will cause damage to the turbo. The PCM will control the boost pressure by duty cycle to the solenoid to maximize boosting performance (no more than 16-1/2 psi). When pressure is supplied on the red hose going to the actuator (solenoid NOT energized) the valve will open, dumping boost. When low or no pressure is on the red hose going to the actuator (solenoid is being energized), the valve will stay closed.

Waste Gate Control Valve is Normally Closed



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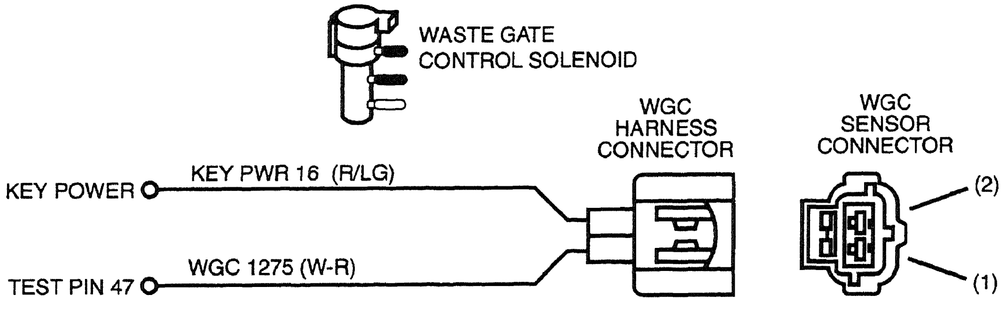


*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

DA1517-A

DTC Descriptions

P1690 = Wastegate control valve malfunction

P1249 = Wastegate fall steady state test

Wastegate Control (WGC) Solenoid — 1999 F-Series

KL

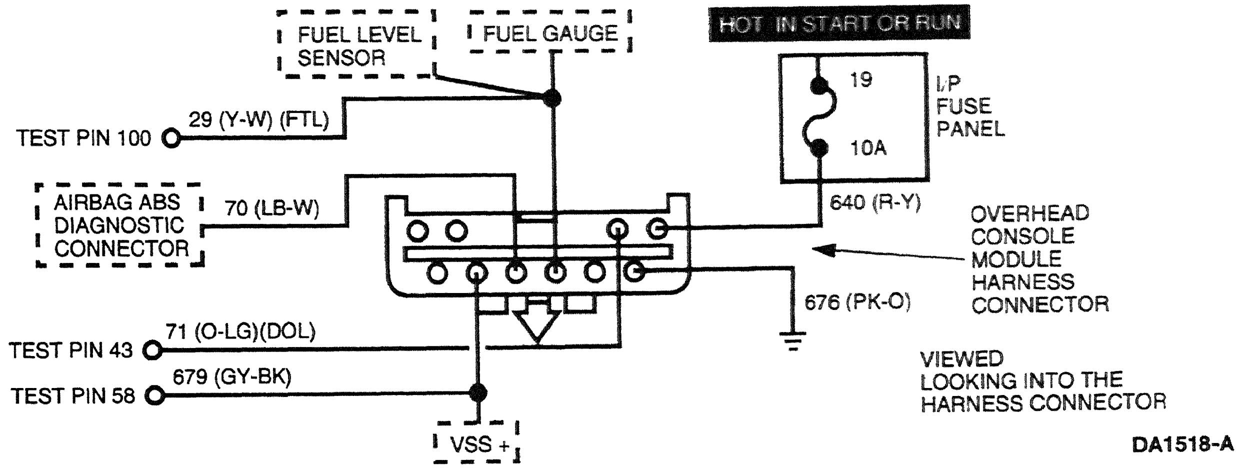
Test Step		Result ▶	Action to Take
KL1	DIAGNOSTIC TROUBLE CODE (DTC) P1690		
	● DTC P1690 indicates that the PCM has detected a failure on the WGC circuit. Possible causes: — short to ground — open in harness — damaged connection — damaged WGC solenoid — damaged PCM — blown fuse ● Disconnect the WGC solenoid harness connector. ● Key on, engine off. ● Measure voltage between Pin 2 (KEY PWR) on the WGC solenoid harness connector and ground. ● Key off. ● **Was voltage greater than 10.5 volts?**	Yes ▶ No ▶	GO to KL2. REPAIR open in (KEY PWR) Circuit 16, or REPLACE blown fuse. RESTORE vehicle. CLEAR DTCs and RETEST.
KL2	CHECK FOR OPEN IN CONTROL CIRCUIT		
	● Install breakout box; leave PCM disconnected. ● Measure resistance between Pin 1 on the WGC solenoid harness connector and PCM Test Pin 47. ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to KL3. REPAIR open in Circuit 1275 (W / R). RESTORE vehicle. CLEAR DTCs and RETEST.
KL3	CHECK FOR SHORT TO GROUND		
	● Measure resistance between WGC solenoid harness connector Pin 1 and ground. ● **Is resistance greater than 10,000 ohms?**	Yes ▶ No ▶	GO to KL4. REPAIR short to ground on Circuit 1275 (W / R). RESTORE vehicle. CLEAR DTCs and RETEST.
KL4	CHECK WGC SOLENOID		
	● Measure resistance between Pin 1 and Pin 2 of WGC solenoid harness connector. ● **Is resistance less than 50 ohms?**	Yes ▶ No ▶	REPLACE the PCM. RESTORE vehicle. CLEAR DTCs and RETEST. REPLACE the WGC solenoid. RESTORE vehicle. CLEAR DTCs and RETEST.

Wastegate Control (WGC) Solenoid — 1999 F-Series

KL

Test Step		Result ▶	Action to Take
KL5	DIAGNOSTIC TROUBLE CODE P1249 — CHECK KOEO FOR P1690		
	● DTC P1249 indicates that the PCM detected the turbo was overboosting. Possible causes: — short to ground — plugged WGC hose or port — WGC solenoid — WGC actuator — WGC valve — damaged PCM ● Perform KOEO On-Demand Self Test. ● **Is DTC P1690 present?**	Yes ▶ No ▶	GO to KL1. GO to KL6.
KL6	CHECK WGC HOSES		
	● Disconnect the RED hose from the WGC actuator. ● Install Gauge Bar 014-00760 vacuum pump or equivalent to the hose. ● **Does the hose hold vacuum?**	Yes ▶ No ▶	GO to KL7. GO to KL8.
KL7	CHECK INTAKE PORT		
	● Disconnect the RED hose from the charge air cooler housing. ● **Does hose still hold vacuum?**	Yes ▶ No ▶	REPLACE WGC hose. RESTORE vehicle. CLEAR DTCs and RETEST. CLEAN out plugged charge air cooler housing hose port. RESTORE vehicle. CLEAR DTCs and RETEST.
KL8	CHECK INTERCOOLER PORT		
	● Disconnect the RED hose from the charge air cooler housing. ● Install vacuum gauge to the port. ● **Does the port hold vacuum?**	Yes ▶ No ▶	CLEAN out the plugged port. RESTORE vehicle. CLEAR DTCs and RETEST. GO to KL9.
KL9	CHECK ACTUATOR		
	● Install vacuum gauge on the WGC actuator. ● **Does actuator hold vacuum?**	Yes ▶ No ▶	CHECK WGC linkage for sticking. REPLACE if necessary. RESTORE vehicle. CLEAR DTCs and RETEST. REPLACE WGC actuator. RESTORE vehicle. CLEAR DTCs and RETEST.

Data Output Link (DOL) — KM



Signal Function

The data output link is the circuit by which the PCM sends square-wave pulse signals to the trip minder module. This signal is one of the signals used to calculate fuel mileage. The signal sent by the PCM varies in frequency depending on the fuel demand of the engine (load, etc.). No signal will be sent if there is a circuit fault on the data output link circuit.

DTC Description

P1634 = Data output link failure

Test Step		Result ▶	Action to Take
KM1	DIAGNOSTIC TROUBLE CODE P1634		
	• DTC P1634 indicates a fault was indicated on the data output line. Possible causes: — open in DOL circuit — power circuit fault — ground circuit fault • Check power Fuse 19 in I/P fuse panel. • **Is fuse OK?**	Yes ▶ No ▶	GO to KM2. REPLACE Fuse 19. CLEAR DTCs and RETEST.
KM2	CHECK OVERHEAD CONSOLE POWER CIRCUIT		
	• Disconnect overhead console harness connector. • Key on, engine off. • Check voltage between Circuit 640 (R/Y) on the overhead console harness connector and ground. • Key off. • **Was voltage greater than 10.5 volts?**	Yes ▶ No ▶	GO to KM3. REPAIR open in Circuit 640 (R/Y). RESTORE vehicle. CLEAR DTCs and RETEST.

Data Output Link (DOL) KM

Test Step		Result ▶	Action to Take
KM3	CHECK OVERHEAD CONSOLE GROUND CIRCUIT		
	● Measure resistance between Circuit 676 (PK/O) on the overhead console harness connector and ground. ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to KM4. REPAIR open in Circuit 676 (PK/O). RESTORE vehicle. CLEAR DTCs and RETEST.
KM4	CHECK DATA OUTPUT LINK CIRCUIT		
	● Install breakout box; leave PCM disconnected. ● Measure resistance between PCM Test Pin 43 and Circuit 71 (O/LG) on the overhead console harness connector. ● **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to the Electrical Group in the Workshop Manual for trip minder module diagnosis. REPAIR open in data output link (DOL) Circuit 71 (O/LG). RESTORE vehicle. CLEAR DTCs and RETEST.

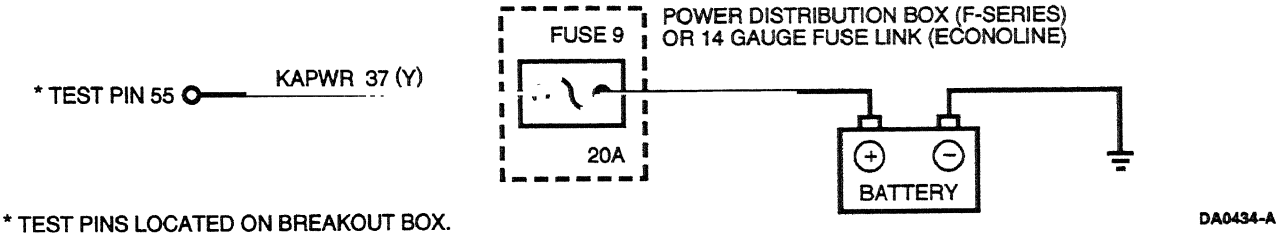
Continuous Memory Failure

MA

Remember

This pinpoint test is intended to diagnose only the following:

- powertrain control module (PCM)(12A650)
- harness circuit: keep alive power (KAPWR)



DTC Description

P0603 = Internal control module keep alive memory (KAM) error

Test Step		Result ▶	Action to Take
MA1	DIAGNOSTIC TROUBLE CODE (DTC) P0603		
	NOTE: Continuous Memory DTC P0603 indicates the PCM has experienced a power interrupt in its KAM circuit. NOTE: If KAPWR is interrupted to the PCM, for example when installing a breakout box, or when battery is disconnected, DTC P0603 can be stored in Continuous Memory. ● Possible causes: — battery cables loose or poor connection — battery discharged — open in KAPWR circuit — damaged PCM ● Install breakout box; leave PCM disconnected. ● Measure voltage between PCM Test Pin 55 and PCM Test Pins 25, 51, 76, 77 or 103. ● While observing digital multimeter, grasp the PCM harness and wiggle or shake a small section while working from the PCM to the instrument panel. ● **Does voltage drop below 10.5 volts?**	Yes ▶ No ▶	REPAIR open in KAPWR circuit. RESTORE system. CLEAR DTCs and RETEST. RECONNECT PCM. GO to MA2.

Continuous Memory Failure

MA

Test Step		Result ▶	Action to Take
MA2	CONFIRM DIAGNOSTIC TROUBLE CODE (DTC) P0603		
	• Clear Continuous Memory DTCs. • Wait 10 minutes to allow DTC P0603 to reset. • Rerun KOEO On-Demand Self Test. • **Is DTC P0603 still present on reset?**	Yes ▶	REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	Intermittent failure, unable to duplicate. REPAIR other DTCs as necessary. If none, testing is complete. RESTORE system. CLEAR DTCs and RETEST.

OBD II Readiness Code

MB

Test Step		Result ▶	Action to Take
MB1	DIAGNOSTIC TROUBLE CODE P1000		
	NOTE: If power to the PCM is disconnected, P1000 will be set until the OBD II monitors have run and cleared. ● Diagnostic code P1000 indicates that operating conditions have not been satisfied for all of the OBD II monitors to run. Possible causes: — drive conditions not satisfied — KAM cleared — damaged PCM ● Perform all self tests and check continuous codes. ● **Are DTCs other than P1000 set?**	Yes ▶	REPAIR other DTCs according to appropriate pinpoint test before continuing.
		No ▶	GO to MB2.
MB2	PERFORM MANUFACTURER-SPECIFIED DIESEL DRIVE CYCLE		
	● Perform diesel drive cycle. Refer to Section 2. ● **Is P1000 cleared?**	Yes ▶	No issue; DTC P1000 cleared.
		No ▶	GO to MB3.
MB3	VERIFY CERTAIN OPERATING CONDITIONS HAVE BEEN SATISFIED		
	● Using NGS Scan Tool, monitor EOT, IVPWR and GPC. If vehicle is started and EOT is below 49°C (120°F), IVPWR must be between 11.8v and 14v until the glow plug duty cycle is 0%. ● Using NGS Scan Tool, monitor MFDES and rpm at full load. MFDES must be above 37 MG/stroke for at least 12 seconds with rpm above 2300. ● Monitor MFDES at idle with vehicle warmed up. MFDES must be below 12 MG/stroke for at least 12 seconds. ● **With the above conditions met, is P1000 cleared?**	Yes ▶	No issue; DTC P1000 cleared.
		No ▶	COMPLETE all steps in Section 4A or Section 4B, Performance Diagnostic Procedures to determine DTC clearing issue.

PCM Inactive Background Fault

MC

Test Step		Result ▶	Action to Take
MC1	DIAGNOSTIC TROUBLE CODE (DTC) P0606		
	- DTC P0606 exists only when there has been an internal failure of the PCM. - Rerun Scan Tool Diagnostic Test. NOTE: If DTC P0606 is retrieved with other DTCs, service all other DTCs first. - **Is DTC P0606 still present after all other DTCs have been serviced?**	Yes ▶ No ▶	REPLACE PCM. CLEAR DTCs and RETEST. System OK. CLEAR DTCs and RETEST.

PCM-ROM Failure

MD

Test Step		Result ▶	Action to Take
MD1	DIAGNOSTIC TROUBLE CODE (DTC) P0605		
	- DTC P0605 exists only when there has been an internal failure of the powertrain control module (PCM). - Rerun Scan Tool Diagnostic Test. - **Is DTC P0605 retrieved?**	Yes ▶ No ▶	REPLACE PCM. CLEAR DTCs and RETEST. System OK. CLEAR DTCs and RETEST.

Injector Driver Circuit Operation

NA

Output Functions

High Side Drive Outputs (Right and Left Bank) — The high side driver output function is to distribute energy to the proper bank based on cylinder identification (CID) and provide regulated current to the unit injectors, based on fuel delivery command signal (FDCS) from the injector driver module (IDM) internal 115 V supply. The injection timing and duration is commanded by the powertrain control module (PCM) in the FDCS.

Low Side Drive Outputs — The low side drive outputs control the sequencing (firing order) of the engine based on the CID and FDCS inputs.

WARNING

RED-STRIPED WIRES CARRY 115 V DC. SEVERE ELECTRICAL SHOCK MAY BE RECEIVED. DO NOT PIERCE.

CAUTION

Do not pierce engine electrical wires or damage to the harness may occur.

Detection/Management

NOTE: Special instructions required to clear IDM trouble codes (1995/1996 model year).

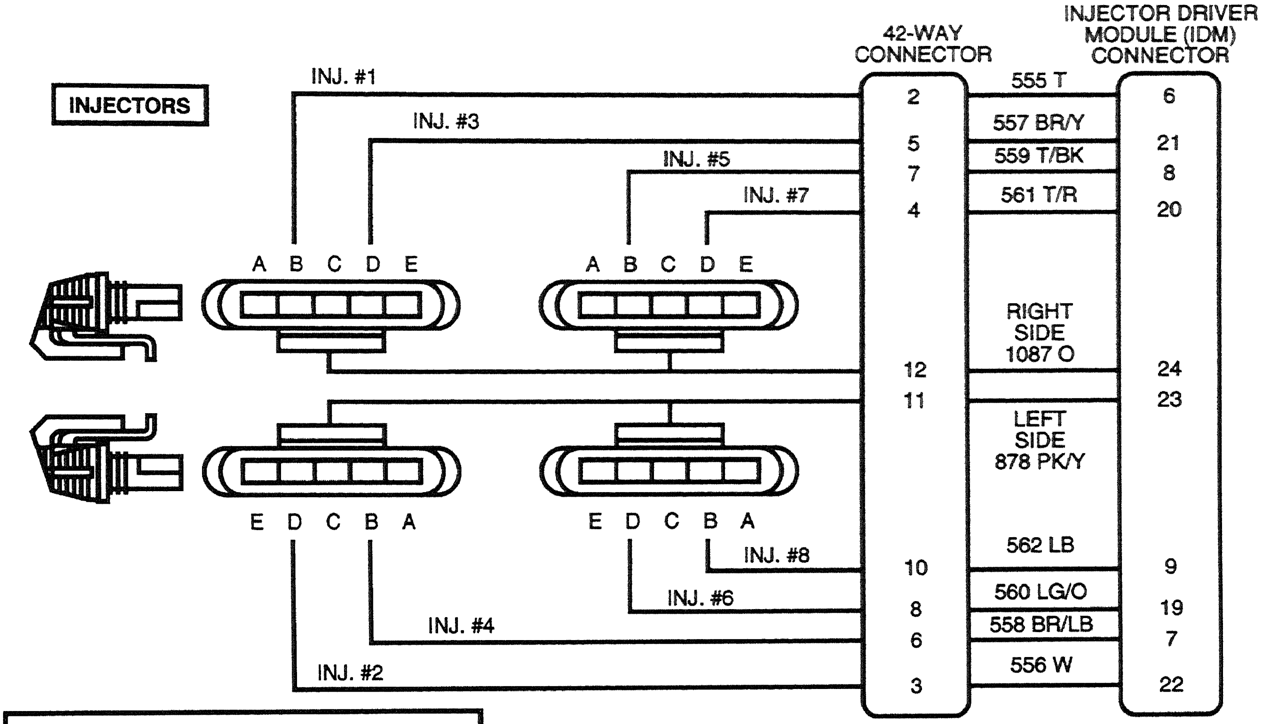
- Key on.
- Record IDM trouble codes stored in KOEO ON-DEMAND SELF TEST and KOEO INJECTOR ELECTRICAL SELF TEST modes.
- Access RETRIEVE/CLEAR CONTINUOUS DTCs from NGS Tester menu to clear IDM trouble codes from memory.
- Record any codes displayed. (P1111 may be the only code displayed.)
- Push CLEAR ALL button on NGS Tester.
- IDM trouble codes are now cleared from memory. Repeat the KOEO On-Demand Self Test and KOEO Injector Electrical Self Test. Any IDM codes that reappear are IDM hard faults. If no IDM codes reappear, then the fault is an intermittent IDM fault.

The IDM is capable of detecting individual injector open and shorts to either ground or battery while the engine is running. It is also capable of detecting right or left bank high side opens or shorts to ground. A special on-demand buzz electrical self test will also allow the operator to enable all injector solenoids while the engine is off to verify circuit operation. **IDM detected trouble codes will not be transmitted if the EF line is not functioning; however, the engine will not shut down due to a non-functional EF line.**

Injector Driver Circuit Operation

NA

If a low side short to ground condition is determined by the IDM, this condition will be transmitted to the PCM via the EF signal. The PCM will enable the CHECK ENGINE light and command minimum fuel to the affected bank.

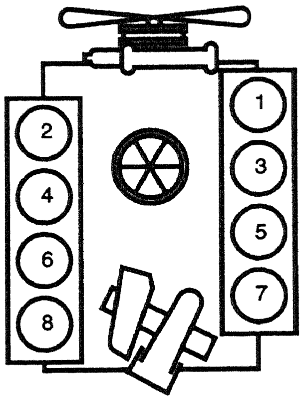


INJECTOR CONNECTORS VIEWED INTO MATING SURFACES.

INDIVIDUAL INJECTOR DIAGNOSTIC TROUBLE CODES					
	LOW SIDE SHORT TO GROUND	LOW SIDE SHORT TO BATTERY	CYLINDER CONTRIBUTION TEST	HIGH TO LOW SIDE SHORT	HIGH TO LOW SIDE OPEN
CYL. #1	0261	0262	0263	1261	1271
CYL. #2	0264	0265	0266	1262	1272
CYL. #3	0267	0268	0269	1263	1273
CYL. #4	0270	0271	0272	1264	1274
CYL. #5	0273	0274	0275	1265	1275
CYL. #6	0276	0277	0278	1266	1276
CYL. #7	0279	0280	0281	1267	1277
CYL. #8	0282	0283	0284	1268	1278

INJECTOR BANK DIAGNOSTIC TROUBLE CODES

1291	HIGH SIDE #1 (RIGHT) SHORT TO GRD. OR B+
1292	HIGH SIDE #2 (LEFT) SHORT TO GRD. OR B+
1293	HIGH SIDE OPEN, RIGHT GROUP
1294	HIGH SIDE OPEN, LEFT GROUP
1295	MULTIPLE FAULTS ON BANK #1 (RIGHT)
1296	MULTIPLE FAULTS ON BANK #2 (LEFT)
1297	HIGH SIDES SHORTED TOGETHER



FIRING ORDER
1-2-7-3-4-5-6-8
(CCT ORDER 1-2-3-4-5-6-7-8)

A25112-B

Injector Driver Circuit Operation

NA

<table>
<tr><th colspan="2">Test Step</th><th>Result ▶</th><th>Action to Take</th></tr>
<tr><td>NA1</td><td>DIAGNOSTIC TROUBLE CODES (DTCs) P0261, P0264, P0267, P0270, P0273, P0276, P0279, P0282</td><td rowspan="2">Yes ▶
No ▶</td><td rowspan="2">GO to NA2.
GO to NA4.</td></tr>
<tr><td colspan="2">

DTCs below indicate a low side ground short in the circuit between the IDM and the injector. The following table lists the circuit to inspect while performing these pinpoint tests, based on the DTC retrieved during the KOEO On-Demand or Injector Electrical Self Tests.

<table>
<tr><th>Cyl.</th><th>DTC</th><th>Circuit</th><th>Cyl.</th><th>DTC</th><th>Circuit</th></tr>
<tr><td>1</td><td>P0261</td><td>555 (T)</td><td>5</td><td>P0273</td><td>559 (T/BK)</td></tr>
<tr><td>2</td><td>P0264</td><td>556 (W)</td><td>6</td><td>P0276</td><td>560 (LG/O)</td></tr>
<tr><td>3</td><td>P0267</td><td>557 (BR/Y)</td><td>7</td><td>P0279</td><td>561 (T/R)</td></tr>
<tr><td>4</td><td>P0270</td><td>558 (BR/LB)</td><td>8</td><td>P0282</td><td>562 (LB)</td></tr>
</table>

Disconnect injector valve cover connector at the suspect injector.
Measure resistance between suspect circuit of the engine harness connector and battery negative post.
Is resistance greater than 10,000 ohms?

</td></tr>
<tr><td>NA2</td><td>CHECK SHORT IN CIRCUIT TO GROUND</td><td rowspan="2">Yes ▶
No ▶</td><td rowspan="2">Fault may be intermittent, GO to NA5.
GO to NA3.</td></tr>
<tr><td colspan="2">

Install Glow Plug Injector Adapter 014-00935 or equivalent to the valve cover gasket.
Measure resistance between suspect circuit and battery ground.
Is the resistance greater than 10,000 ohms?

</td></tr>
<tr><td>NA3</td><td>UNDER VALVE COVER SHORT</td><td rowspan="2">Yes ▶
No ▶</td><td rowspan="2">REPLACE UVC harness. RESTORE vehicle. CLEAR DTCs and RETEST.
REPLACE injector. RESTORE vehicle. CLEAR DTCs and RETEST.</td></tr>
<tr><td colspan="2">

Remove valve cover and disconnect injector connector.
Inspect under valve cover (UVC) harness for shorting to ground.
Is fault indicated?

</td></tr>
</table>

Injector Driver Circuit Operation

NA

Test Step		Result ▶	Action to Take
NA4	CHECK FOR SHORT BETWEEN INJECTOR VALVE COVER CONNECTOR AND IDM		
	● Disconnect IDM harness connector. ● Measure resistance between respective injector circuit and all other circuits in the IDM harness connector and to chassis ground. ● **Is the resistance greater than 10,000 ohms?**	Yes ▶ No ▶	REPLACE IDM. RESTORE vehicle. CLEAR DTCs and RETEST. REPAIR short to ground between injector valve cover connector and IDM connector. RESTORE vehicle. CLEAR DTCs and RETEST.
NA5	CHECK FOR INTERMITTENT SHORT TO GROUND		
	● Key off. ● Disconnect IDM. Inspect for damaged or pushed-out pins. ● All other connectors plugged in. ● Using a digital multimeter and the flex tips supplied with the NGS Tester, measure resistance between the suspect injector low side circuit on the IDM connector and battery ground post. Refer to injector illustration at beginning of this pinpoint test for pin location. ● Grasp the harness close to the suspect injector connector. Wiggle and shake harness while working toward the IDM. ● **Does resistance ever drop below 10,000 ohms?**	Yes ▶ No ▶	ISOLATE short to ground and REPAIR. RESTORE vehicle. CLEAR DTCs and RETEST. IDM internal failure, REPLACE IDM. RESTORE vehicle. CLEAR DTCs and RETEST.

Injector Driver Circuit Operation

NA

Test Step		Result ▶	Action to Take
NA6	DIAGNOSTIC TROUBLE CODES (DTCs) P0262, P0265, P0268, P0271, P0274, P0277, P0280, P0283 and P1261-P1268	Yes ▶ No ▶	GO to NA7. REPAIR short in circuits between IDM and injector valve cover connector. RESTORE system. CLEAR DTCs and RETEST.

- DTCs P1261-P1268 indicate that the low side circuit is shorted to B+ or the high side circuit between the IDM and the injector. The following table lists the circuits to inspect while performing these pinpoint tests, based o the DTC retrieved during the KOEO On-Demand or Injector Electrical Self Tests.

Cyl.	DTC	Low Side	High Side
1	P1261-P0262	555 (T)	1087 (O)
2	P1262-P0265	556 (W)	878 (PK/Y)
3	P1263-P0268	557 (BR/Y)	1087 (O)
4	P1264-P0271	558 (BR/LB)	878 (PK/Y)
5	P1265-P0274	559 (T/BK)	1087 (O)
6	P1266-P0277	560 (LG/O)	878 (PK/Y)
7	P1267-P0280	561 (T/R)	1087 (O)
8	P1268-P0283	562 (LB)	878 (PK/Y)

- Key on, engine off.
- Disconnect IDM harness connector.
- Disconnect both connectors on the bank with the code.
- Measure resistance between the low side and battery positive post, then to high side at the injector valve cover connector. Refer to injector illustration at beginning of this pinpoint test for pin location.
- Key off.
- **Are both resistance readings less than 10,000 ohms?**

Test Step		Result ▶	Action to Take
NA7	CHECK FOR SHORT INTERNAL TO VALVE COVER	Yes ▶ No ▶	GO to NA8. Fault may be intermittent. GO to NA10.

- Install Glow Plug Injector Adapter 014-00935 or equivalent to valve cover gasket.
- Measure resistance between high side and low side circuits.
- **Is resistance less than 2.0 ohms on a cold engine?**

Injector Driver Circuit Operation

NA

Test Step		Result ▶	Action to Take
NA8	CHECK FOR SHORT UNDER VALVE COVER		
	• Remove valve cover. • Disconnect injector connector. • Measure resistance between Glow Plug Injector Adapter 014-00935 or equivalent and injector connector on both high and low side circuits. • **Is resistance greater than 10,000 ohms?**	Yes ▶	REPLACE injector. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	GO to NA9.
NA9	GASKET HARNESS OR UVC SHORT LOW SIDE TO HIGH SIDE		
	• Remove UVC harness. • Measure resistance between gasket harness low side and high side circuitry. • **Is resistance less than 5 ohms?**	Yes ▶	REPLACE gasket harness. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	REPLACE UVC harness. RESTORE vehicle. CLEAR DTCs and RETEST.
NA10	CHECK FOR INTERMITTENT LOW SIDE SHORT TO B+ OR HIGH SIDE		
	• Key on, engine off. • All four valve cover connectors disconnected. • Measure resistance between the suspect injector low side circuit and battery positive post, then to high side circuit on the IDM connector. Refer to injector illustration at the beginning of this pinpoint test for pin location. • Grasp the harness close to the suspect injector connector. Wiggle and shake harness while working toward the IDM. • **Do either resistance readings ever drop below 10,000 ohms?**	Yes ▶	ISOLATE shorted circuit and REPAIR. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	IDM internal failure. REPLACE IDM. RESTORE vehicle. CLEAR DTCs and RETEST.

Injector Driver Circuit Operation

NA

Test Step | **Result ▶** | **Action to Take**

NA11 DIAGNOSTIC TROUBLE CODES (DTCs) P1271-P1278

- DTCs P1271-P1278 indicate a low side-to-high side open in the circuit between the IDM and the injector. The following table lists the circuits to inspect while performing these pinpoint tests, based on the DTC retrieved during the KOEO On-Demand or Injector Electrical Self Tests.

  NOTE: If all of the DTCs associated with an entire bank are retrieved, the high side circuit is most likely open.

Cyl.	DTC	Low Side	High Side	Bank
1	P1271	555 (T)	1087 (O)	Right
2	P1272	556 (W)	878 (PK/Y)	Left
3	P1273	557 (BR/Y)	1087 (O)	Right
4	P1274	558 (BR/LB)	878 (PK/Y)	Left
5	P1275	559 (T/BK)	1087 (O)	Right
6	P1276	560 (LG/O)	878 (PK/Y)	Left
7	P1277	561 (T/R)	1087 (O)	Right
8	P1278	562 (LB)	878 (PK/Y)	Left

- Disconnect injector valve cover connector.
- Install Glow Plug Injector Adapter 014-00935 or equivalent to valve cover gasket.
- Measure resistance between the high side and low side on the injector. Refer to injector illustration at beginning of this pinpoint test for proper pin location.
- **Is the resistance less than 5 ohms?**

Result ▶	Action to Take
Yes ▶	GO to NA13.
No ▶	GO to NA12.

NA12 CHECK INJECTOR FOR OPEN CIRCUIT

- Remove valve cover.
- Disconnect injector connector.
- Measure resistance between high side circuit from adapter tool and injector connector.
- Measure resistance between low side circuit from adapter tool and injector connector.
- **Is each resistance less than 5 ohms?**

Result ▶	Action to Take
Yes ▶	REPLACE injector. RESTORE vehicle. CLEAR DTCs and RETEST.
No ▶	GO to NA23.

Injector Driver Circuit Operation

NA

<table>
<tr><th colspan="2">Test Step</th><th>Result</th><th>▶ Action to Take</th></tr>
<tr><td rowspan="2">NA13</td><td rowspan="2">CHECK FOR OPEN IN LOW SIDE CIRCUIT
● Disconnect IDM harness connector.
● Measure resistance on injector low side circuit between valve cover connector and IDM.
● Is resistance less than 5 ohms?</td><td>Yes</td><td>▶ GO to NA14.</td></tr>
<tr><td>No</td><td>▶ REPAIR open in low side circuit. RESTORE vehicle. CLEAR DTCs and RETEST.</td></tr>
<tr><td rowspan="2">NA14</td><td rowspan="2">CHECK FOR OPEN IN HIGH SIDE CIRCUIT
● Measure resistance between suspect injector high side circuit on injector harness connector and IDM connector.
● Is resistance less than 5 ohms?</td><td>Yes</td><td>▶ Fault may be intermittent. GO to NA15.</td></tr>
<tr><td>No</td><td>▶ REPAIR open in high side circuit. RESTORE vehicle. CLEAR DTCs and RETEST.</td></tr>
<tr><td rowspan="2">NA15</td><td rowspan="2">CHECK FOR OPEN INJECTOR CIRCUIT
● Measure resistance between suspect low side and high side circuit at the IDM connector. Refer to injector illustration at beginning of this pinpoint test for pin location.
● Grasp the harness close to the suspect injector harness connector. Wiggle and shake harness while working your way back to the IDM.
● Do resistance readings ever go above 5 ohms?</td><td>Yes</td><td>▶ ISOLATE open in circuit and REPAIR. RESTORE vehicle. CLEAR DTCs and RETEST.</td></tr>
<tr><td>No</td><td>▶ REPLACE IDM. RESTORE vehicle. CLEAR DTCs and RETEST.</td></tr>
<tr><td rowspan="2">NA16</td><td rowspan="2">DIAGNOSTIC TROUBLE CODES (DTCs) P1291 AND P1292
● DTCs P1291 and P1292 indicate a ground short or short to battery positive exists on the high side circuit between the IDM and the injectors. The following table list the circuits to inspect while performing these pinpoint tests, based on the DTC retrieved during the KOEO test.
<table>
<tr><th>DTC</th><th>High Side</th><th>Bank</th></tr>
<tr><td>P1291</td><td>1087 (O)</td><td>Right</td></tr>
<tr><td>P1292</td><td>878 (PK/Y)</td><td>Left</td></tr>
</table>
● Disconnect IDM harness connector.
● Measure resistance between the suspect high side circuit at the IDM harness connector and battery negative post. Refer to injector illustration at beginning of this pinpoint test for proper pin location.
● Is resistance greater than 10,000 ohms?</td><td>Yes</td><td>▶ GO to NA18.</td></tr>
<tr><td>No</td><td>▶ GO to NA17.</td></tr>
</table>

Injector Driver Circuit Operation

NA

	Test Step	Result ▶	Action to Take
NA17	CHECK SHORT TO GROUND IN HIGH SIDE CIRCUIT		
	• Disconnect both valve cover connectors on the bank with the code. • Measure resistance between suspect high side circuit at IDM connector and battery negative post. • **Is resistance greater than 10,000 ohms?**	Yes ▶	GO to NA2.
		No ▶	REPAIR short to ground between IDM and injector valve cover connector. RESTORE vehicle. CLEAR DTCs and RETEST.
NA18	CHECK SHORT TO POWER IN HIGH SIDE CIRCUIT		
	• Key on, engine off. • Measure resistance between the suspect high side circuit at IDM connector and battery positive post, then to other high side circuit. • **Are both resistance readings greater than 10,000 ohms?**	Yes ▶	Fault may be intermittent. GO to NA19.
		No ▶	REPAIR short to power on high side circuit. RESTORE vehicle. CLEAR DTCs and RETEST.
NA19	CHECK FOR INTERMITTENT SHORT TO POWER IN HIGH SIDE CIRCUIT		
	• Measure resistance between suspect high side circuit on the IDM connector and battery positive post, then to other high side circuit. • Grasp the harness close to the suspect injector harness connector. Wiggle, shake harness while working towards the IDM. • **Do both resistance readings ever drop below 10,000 ohms?**	Yes ▶	ISOLATE short circuit and REPAIR. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	REPLACE IDM. RESTORE vehicle. CLEAR DTCs and RETEST.
NA20	DIAGNOSTIC TROUBLE CODES (DTCs) P1294 AND P1293: CHECK FOR VOLTAGE ON HIGH SIDE CIRCUIT		
	• DTCs P1294 and P1293 indicate an open circuit exists on the high side circuit between the IDM and the injectors. The following table lists the circuits to inspect while performing these pinpoint tests, based on the DTC retrieved during the KOEO On-Demand and Injector Electrical Self Tests.	Yes ▶	GO to NA21.
		No ▶	GO to NA24.

DTC	High Side	Injector Bank
P1294	878 (PK/Y)	Left
P1293	1087 (O)	Right

- Key off.
- Disconnect both connectors on the bank with the code.
- Key on, engine off.
- Measure voltage on the suspect high side circuit Pin C on the injector vehicle harness connectors and battery ground.
- **Is voltage greater than 10.5 volts?**

Injector Driver Circuit Operation NA

Test Step		Result ▶	Action to Take
NA21	CHECK INJECTOR RESISTANCE		
	• Key off. • Suspect injector valve cover connectors disconnected. • Install Glow Plug Injector Adapter 014-00935 or equivalent. • Measure resistance between high side and low side injector terminals on the adapter tool. • **Is resistance less than 5 ohms?**	Yes ▶	Fault may be intermittent. GO to **NA15**.
		No ▶	GO to **NA22**.
NA22	CHECK HARNESS FOR OPEN		
	• Remove valve cover. • Disconnect injector harness connector. • Measure resistance between injector connector and exterior gasket connector. • **Is resistance less than 5 ohms?**	Yes ▶	REPLACE injector. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	GO to **NA23**.
NA23	DETERMINE WHETHER GASKET OR UVC HARNESS HAS FAILED		
	• Disconnect UVC harness from gasket. • Measure resistance across each contact in the gasket. • **Is each resistance reading less than 5 ohms?**	Yes ▶	REPLACE UVC harness. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	REPLACE valve cover gasket. RESTORE system. CLEAR DTCs and RETEST.
NA24	CHECK FOR OPEN IN HIGH SIDE CIRCUIT		
	• Key off. • Disconnect IDM harness connector. • Both connectors on the bank with the code disconnected. • Measure resistance between suspect high side circuit at the IDM connector and Pin C and both suspect injector connectors. • **Are both resistance readings less than 5 ohms?**	Yes ▶	Fault may be intermittent. GO to **NA15**.
		No ▶	REPAIR open in high side circuit. RESTORE system. CLEAR DTCs and RETEST.

Injector Driver Circuit Operation

NA

<table>
<tr><th colspan="2">Test Step</th><th>Result ▶</th><th>Action to Take</th></tr>
<tr><td>NA25</td><td>DIAGNOSTIC TROUBLE CODES (DTCs) P0263, P0266, P0269, P0272, P0275, P0278, P0281, P0284, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308</td><td></td><td></td></tr>
<tr><td></td><td>NOTE: Only 1998-1/2 Econoline and 1999 F-Series will set a Continuous Misfire DTC. Both 49 state and California will set a KOER CCT DTC for a low or non-contributing cylinder. To run KOER Cylinder Contribution Test, refer to Quick Test description in Section 2, Diagnostic Routines.
● If any of the following DTCs set in either Continuous or KOER Cylinder Contribution Test, this pinpoint test must be used to diagnose the fault.
<table>
<tr><th>CCT DTCs</th><th>California Continuous DTCs</th><th>Cylinder</th></tr>
<tr><td>P0263</td><td>P0301</td><td>1</td></tr>
<tr><td>P0266</td><td>P0302</td><td>2</td></tr>
<tr><td>P0269</td><td>P0303</td><td>3</td></tr>
<tr><td>P0272</td><td>P0304</td><td>4</td></tr>
<tr><td>P0275</td><td>P0305</td><td>5</td></tr>
<tr><td>P0278</td><td>P0306</td><td>6</td></tr>
<tr><td>P0281</td><td>P0307</td><td>7</td></tr>
<tr><td>P0284</td><td>P0308</td><td>8</td></tr>
</table>
● Possible causes:
— broken compression rings
— inoperative injector assembly
— leaking or bent valves
— bent push rod
— broken rocker arm bolts
— bent connecting rod
● Perform KOEO On-Demand Self Test, KOER Cylinder Contribution Self Test, Retrieve/Clear Continuous DTCs.
● Were any DTCs retrieved?</td><td>Yes ▶
No ▶</td><td>REPAIR any concerns found. RESTORE system. CLEAR DTCs and RETEST.
GO to NA26.</td></tr>
<tr><td>NA26</td><td>CYLINDER NON-CONTRIBUTING</td><td></td><td></td></tr>
<tr><td></td><td>NOTE: A/C must be off when running KOER Cylinder Contribution Self Test.
● Go to Section 4A, Diagnostic Routines, Performance Diagnostic Procedures and perform Steps 8a, 8b, 9, 11a, 11b, and 12, or Section 4B, Diagnostic Routines, Performance Diagnostic Procedures and perform Steps 8a, 8b, 8c, 8d, 10a, 10b and 11.
● Were any problems found after running all of the above steps?</td><td>Yes ▶
No ▶</td><td>REPAIR any concerns found. RESTORE system. CLEAR DTCs and RETEST.
If base engine diagnostic checks pass, REPLACE injector assembly. If base engine does not pass, REPAIR concern. RESTORE system. CLEAR DTCs and RETEST.</td></tr>
</table>

Injector Driver Circuit Operation | NA

<table>
<tr><th colspan="2">Test Step</th><th>Result ▶</th><th>Action to Take</th></tr>
<tr><td>NA27</td><td>DIAGNOSTIC TROUBLE CODE (DTC) P1297</td><td></td><td></td></tr>
<tr><td></td><td>● Disconnect IDM harness connector.
● Measure resistance between both high side circuits at the IDM connector.
● Is resistance greater than 10,000 ohms?</td><td>Yes ▶
No ▶</td><td>GO to NA28.
REPAIR short between both high side circuits. RESTORE system. CLEAR DTCs and RETEST.</td></tr>
<tr><td>NA28</td><td>CHECK FOR INTERMITTENT SHORT BETWEEN BOTH HIGH SIDE CIRCUITS</td><td></td><td></td></tr>
<tr><td></td><td>● Measure resistance between both high side circuits at the IDM connector, Pins 22 and 23.
● Grasp the harness close to the IDM connector. Wiggle, shake harness while working towards the injectors.
● Does resistance ever drop below 10,000 ohms?</td><td>Yes ▶
No ▶</td><td>ISOLATE short circuit and REPAIR. RESTORE system. CLEAR DTCs and RETEST.
REPLACE IDM. RESTORE system. CLEAR DTCs and RETEST.</td></tr>
<tr><td>NA29</td><td>DIAGNOSTIC TROUBLE CODES (DTCs) P1295 AND P1296</td><td></td><td></td></tr>
<tr><td></td><td>● DTCs P1295 and P1296 indicate that more than one fault exists on the right or left bank. A short and open on both the low side and high side can exist on the bank with the DTC.
<table>
<tr><th>DTC</th><th>BANK</th></tr>
<tr><td>P1295</td><td>Right Bank</td></tr>
<tr><td>P1296</td><td>Left Bank</td></tr>
</table>
● Disconnect IDM harness connector.
● Measure resistance between each injector circuit one by one and battery ground from the IDM harness connector.
● Are all circuits greater than 10,000 ohms?</td><td>Yes ▶
No ▶</td><td>GO to NA30.
If low side short was found, GO to NA1 to find short, then RETURN to this step. If high side short was found, GO to NA16, then RETURN to this step.</td></tr>
<tr><td>NA30</td><td>CHECK FOR SHORT TO B+</td><td></td><td></td></tr>
<tr><td></td><td>● Key on, engine off.
● Measure voltage of each injector circuit one by one between IDM harness connector and battery ground.
● Key off.
● Was voltage present on any circuit?</td><td>Yes ▶
No ▶</td><td>GO to NA31.
If low side short was found, GO to NA6, then RETURN to this step. If high side short was found, GO to NA16, then RETURN to this step.</td></tr>
<tr><td>NA31</td><td>CHECK FOR HIGH SIDE CIRCUIT SHORTED TOGETHER</td><td></td><td></td></tr>
<tr><td></td><td>● Measure resistance between high side circuits from the IDM harness connector Pins 23 and 24.
● Is resistance greater than 10,000 ohms?</td><td>Yes ▶
No ▶</td><td>GO to NA32.
REPAIR short between both high side circuits. RESTORE system. CLEAR DTCs and RETEST.</td></tr>
</table>

Injector Driver Circuit Operation

NA

Test Step		Result ▶	Action to Take
NA32	CHECK FOR OPEN CIRCUIT		
	- Disconnect all four valve cover connectors on both banks. - Measure resistance between valve cover connector and IDM connector on all injector high side and low side circuits. - **Are any circuits greater than 10,000 ohms?**	Yes ▶	REPAIR open in suspect circuit. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	GO to NA33.
NA33	CHECK FOR OPEN UNDER VALVE COVER		
	- Using Glow Plug Injector Adapter 014-00935 or equivalent, measure resistance between high side and low side of every injector circuit through the valve cover. - **Are any injector circuits greater than 5 ohms?**	Yes ▶	GO to NA12.
		No ▶	RECONNECT everything, CLEAR continuous DTCs and RERUN KOEO Injector Electrical Self Test and KOEO On-Demand Self Test. If DTC P1295 or P1296 reappears, REPLACE IDM.

Check Engine Light

NB

Note

Enter this pinpoint test only when directed here from symptom flowcharts.

Remember

To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- fuse, bulb or socket

This pinpoint test is intended to diagnose only the following:

- STO / MIL circuit
- powertrain control module (PCM)(12A650)

Description

The CHECK ENGINE light is intended to alert the driver of certain concerns in the closed loop system. The CHECK ENGINE light output is turned on when the strategy detects a concern in certain input / output circuits. The light will remain on as long as the concern is present. Regulations governing this light also require that the Diagnostic Trouble Codes (DTCs) be displayed by the flashing of this light.

CHECK ENGINE Light Functionality

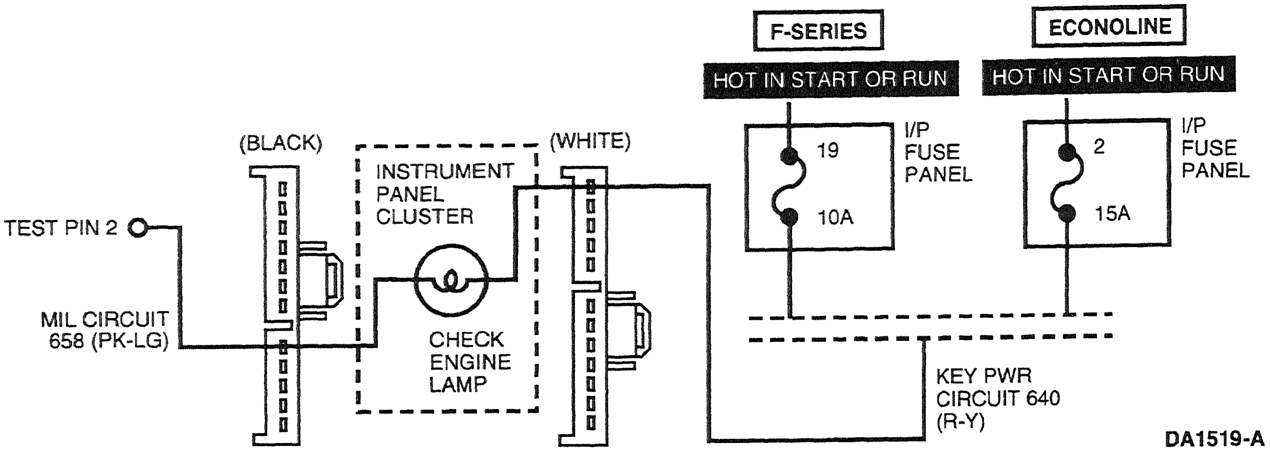
The CHECK ENGINE light is located in the instrument cluster and is amber colored. The CHECK ENGINE light functions in one of three modes.

1. Bulb check — at key-on the light is turned on for a short duration as a bulb check. If this does not occur, check the wiring, the bulb, and the associated fuse.
2. Detection of certain concerns — the CHECK ENGINE light is used to indicate that one of certain concerns has been detected by the PCM or IDM. Only those concerns which result in a change in power output available from the engine will cause the light to be turned on. Examples of such concerns are:
    a. Injector low side short to ground — the PCM will turn off four cylinders to prevent engine damage.

Check Engine Light

NB

b. Accelerator pedal sensor out of range — the PCM will allow the engine to idle only.



Test Step		Result ▶	Action to Take
NB1	CHECK ENGINE LIGHT FAULT		
	- If any KOEO On-Demand or Continuous Memory Diagnostic Trouble Codes are present, service before proceeding. - **Is CHECK ENGINE light always on?**	Yes ▶ No ▶	GO to NB2. GO to NB3.
NB2	CHECK ENGINE LIGHT ALWAYS ON: CHECK CIRCUIT 658 (PK/LG) FOR SHORTS TO GROUND		
	- Disconnect PCM harness connector. - Key on, engine off. - **Is CHECK ENGINE light on?**	Yes ▶ No ▶	REPAIR short to ground in Circuit 658 (PK/LG). RESTORE system. CLEAR DTCs and RETEST. REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.
NB3	CHECK ENGINE LIGHT NEVER ON		
	- Disconnect manifold absolute pressure (MAP) sensor. - Key on, engine running. - **Is CHECK ENGINE light on?**	Yes ▶ No ▶	System working OK. RESTORE system. CLEAR DTCs and RETEST. RECONNECT MAP sensor. GO to NB4.
NB4	CHECK IGNITION FEED CIRCUIT		
	- Key on, engine off. - Measure voltage between powering side of fuse in the IP fuse panel and known good ground. - **Is B+ present?**	Yes ▶ No ▶	GO to NB5. REPAIR open in ignition feed Circuit 640 (R/Y) or ignition switch. RESTORE system. CLEAR DTCs and RETEST.

Check Engine Light

NB

Test Step		Result	▶	Action to Take
NB5	CHECK FUSE			
	• Remove fuse, inspect. • **Is fuse OK?**	Yes	▶	REINSTALL fuse GO to **NB6**.
		No	▶	REPAIR short to ground to Circuit 640 (R/Y). REPLACE fuse. RESTORE system. CLEAR DTCs and RETEST.
NB6	CHECK CIRCUIT 640 (R/Y) FOR OPEN			
	• Remove fuse. • Remove check engine light bulb. • Measure resistance between nonpowering side of fuse Circuit 640 (R/Y) and powering side of check engine light bulb socket. • **Is resistance less than 5 ohms?**	Yes	▶	Circuit 640 (R/Y) OK. GO to **NB7**.
		No	▶	REPAIR open in Circuit 640 (R/Y). REINSTALL bulb. RESTORE system. CLEAR DTCs and RETEST.
NB7	TEST CHECK ENGINE LIGHT BULB			
	• Bench test bulb by applying B+ to one side and B- to the other. • **Does the bulb illuminate?**	Yes	▶	GO to **NB8**.
		No	▶	REPLACE bulb. RESTORE system. CLEAR DTCs and RETEST.
NB8	CHECK CIRCUIT 658 (PK/LG)			
	• Install breakout box; leave PCM disconnected. • Measure resistance between bulb socket Circuit 658 (PK/LG) and PCM Test Pin 2. • **Is resistance less than 5 ohms?**	Yes	▶	Circuit 658 (PK/LG) is OK. REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.
		No	▶	REPAIR open in Circuit 658 (PK/LG). RESTORE system. CLEAR DTCs and RETEST.

Injector Driver Module Enable (IDM-EN)

NC

Note

Enter this pinpoint test only when directed here from the symptom flowcharts.

Remember

This pinpoint test is intended to diagnose only the following:

- powertrain control module (PCM)(12A650)
- harness circuits: injector driver module enable (IDM-EN)
- injector driver module (IDM) relay

Injector Driver Module Enable (IDM-EN)

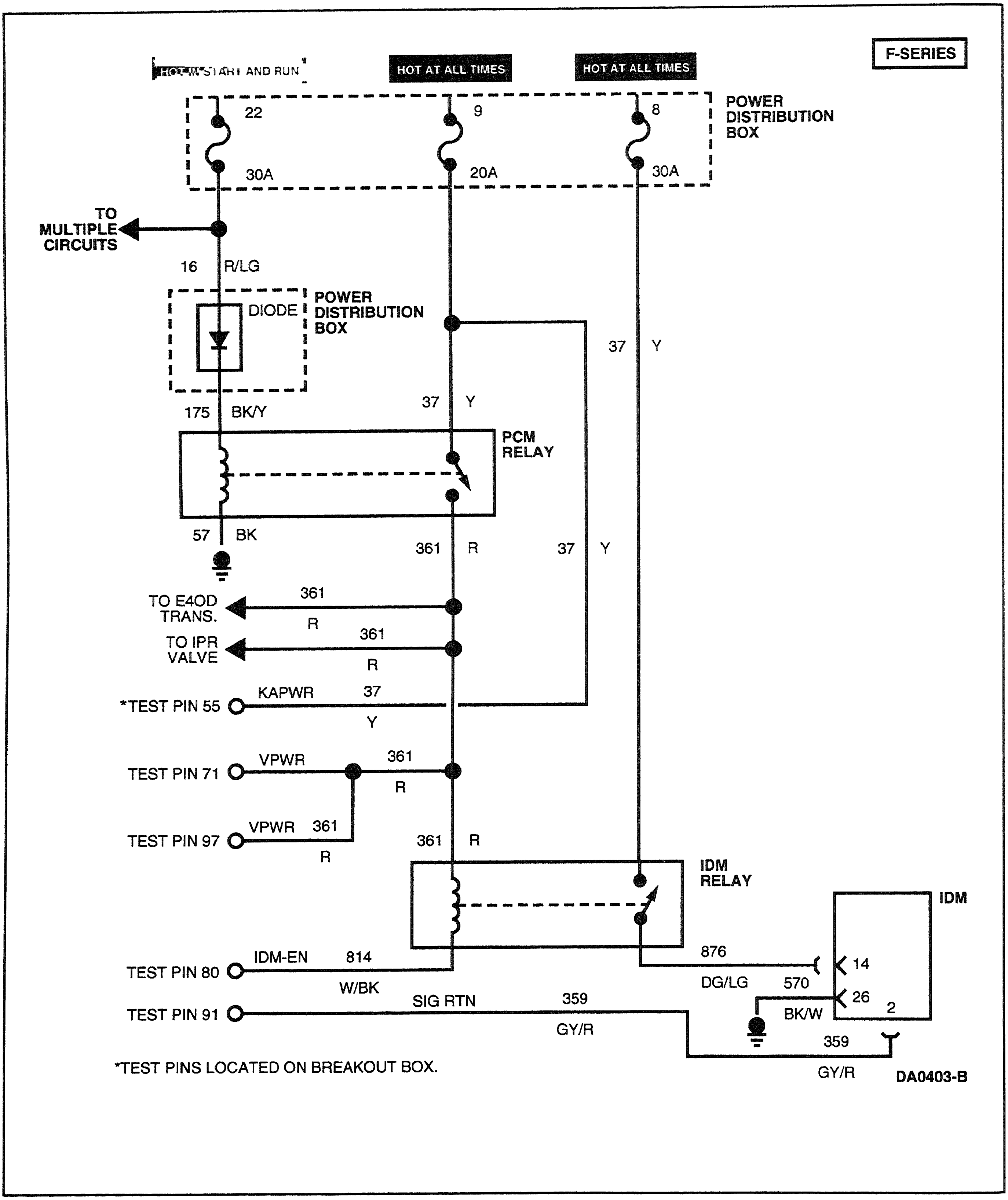
NC

Description

The IDM-EN output provides the shut-down control function for the fuel system by shutting off the IDM relay.

Injector Driver Module Enable (IDM-EN)

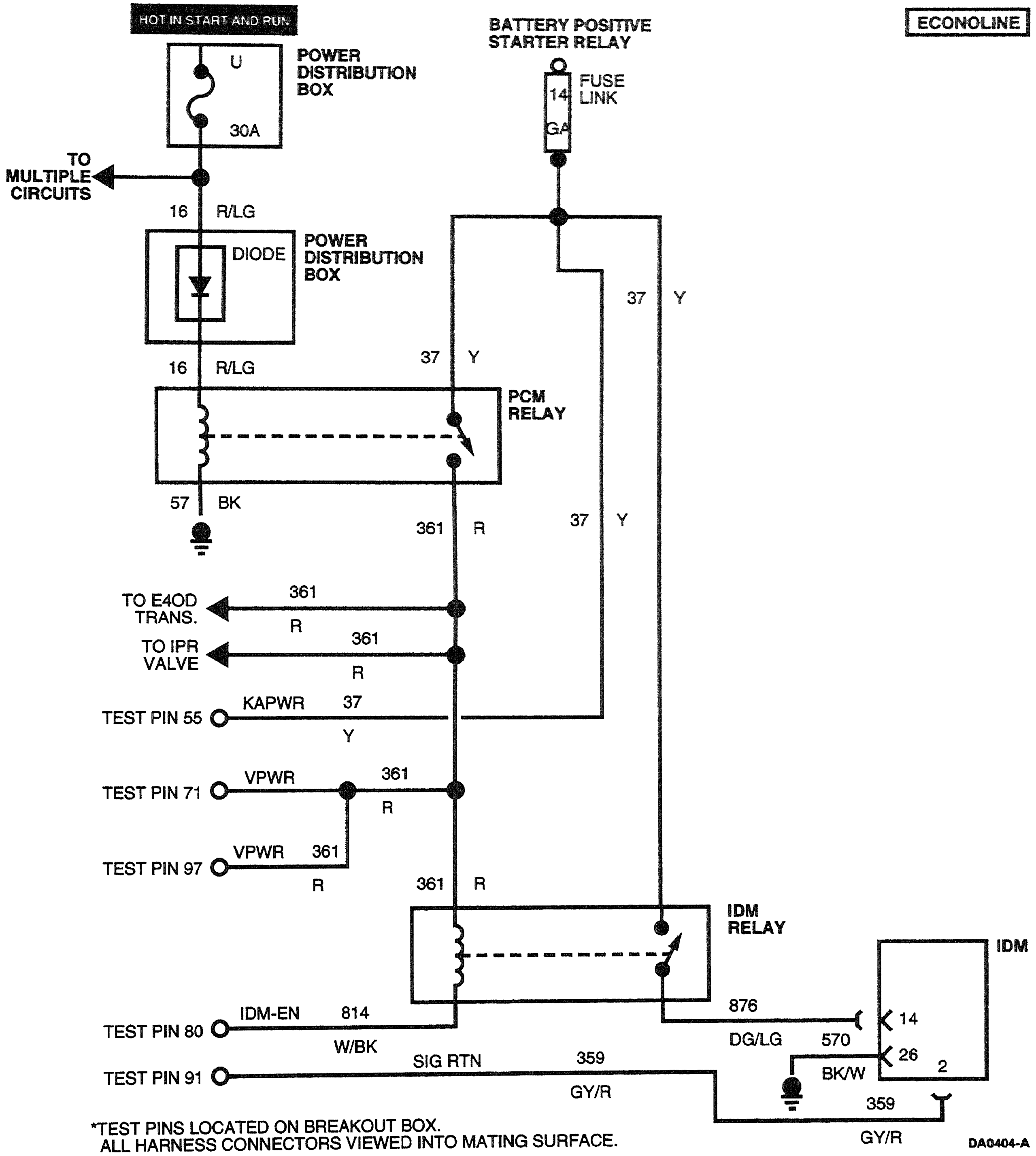
NC



*TEST PINS LOCATED ON BREAKOUT BOX.

Injector Driver Module Enable (IDM-EN)

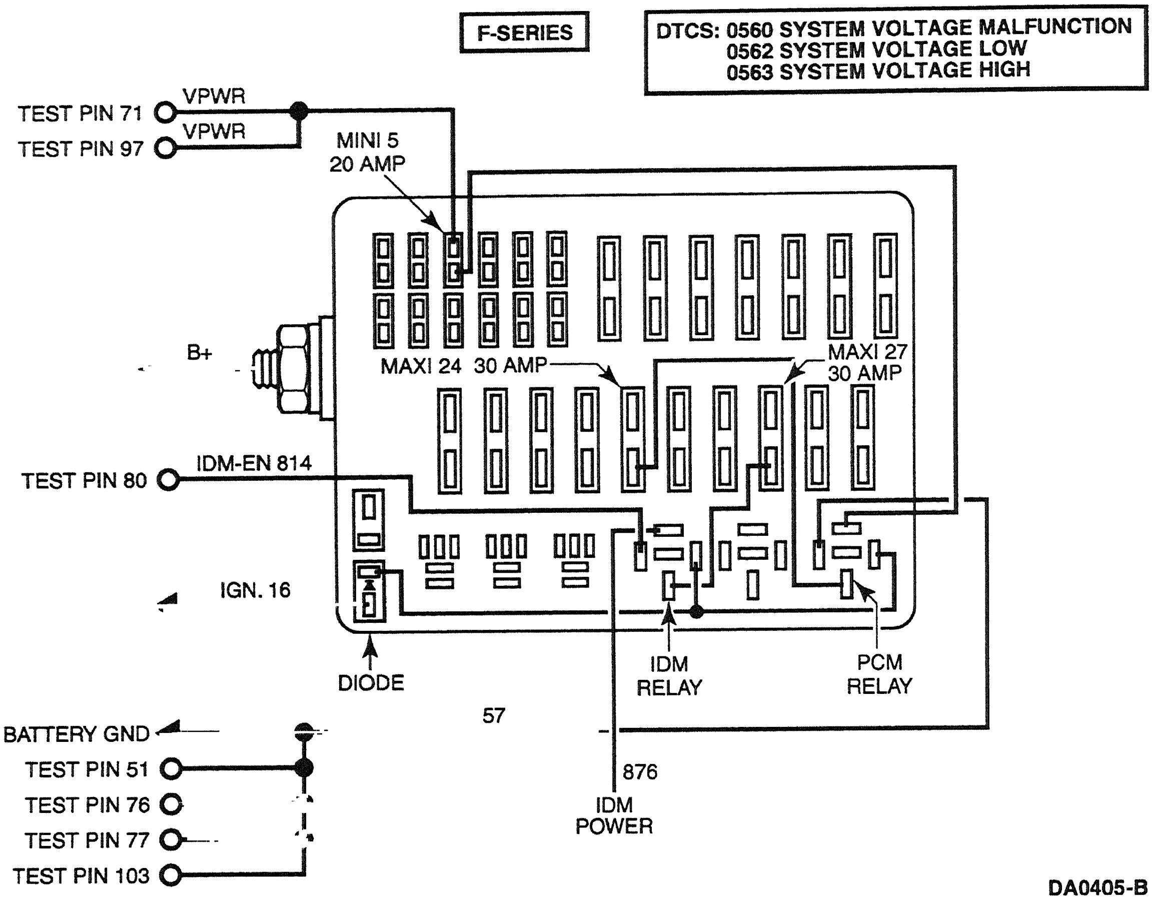
NC



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

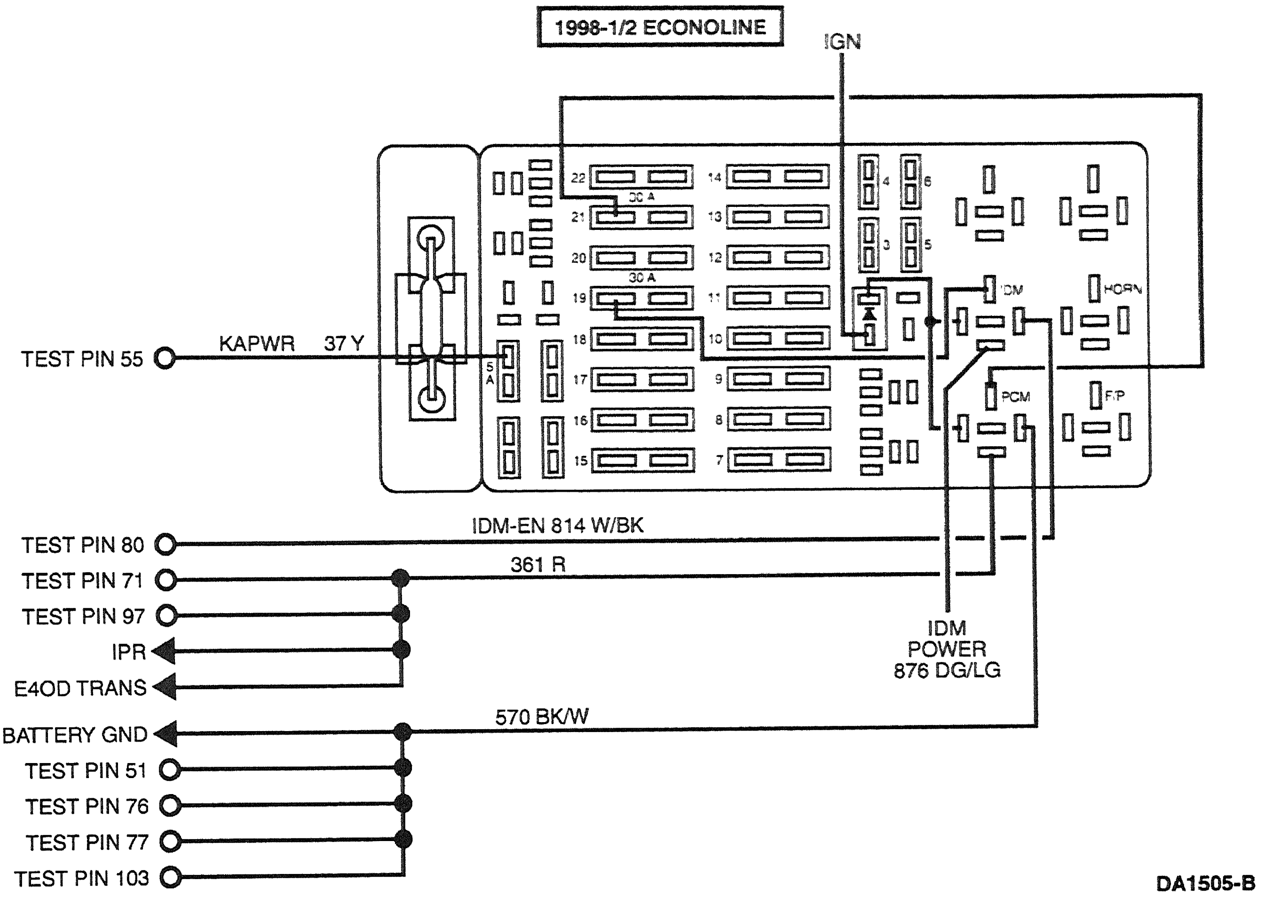
Injector Driver Module Enable (IDM-EN)

NC



Injector Driver Module Enable (IDM-EN)

NC



DTC Description

P1662 = IDM-EN circuit failure

Test Step	Result	Action to Take
NC1 DIAGNOSTIC TROUBLE CODE (DTC) P1662		
• DTC P1662 is set when a fault is detected on the IDM-EN circuit. Possible causes: — open IDM-EN circuit — blown fuse — worn or damaged relay • Disconnect IDM relay. • Key on, engine off. • Measure resistance between IDM relay Circuit 814 (W/BK) and chassis ground • Key off. • **Is resistance less than 100 ohms?**	Yes ▶ No ▶	GO to NC3. GO to NC2.

Injector Driver Module Enable (IDM-EN)

NC

Test Step	Result ▶	Action to Take
NC2 CHECK CIRCUIT 814 (W / BK) FOR OPEN ● Install breakout box; leave PCM disconnected. ● Measure resistance on Circuit 814 (W / BK) between PCM Test Pin 80 and IDM relay. ● **Is the resistance less than 5 ohms?**	Yes ▶	REPLACE PCM. RESTORE vehicle. CLEAR DTCs and RETEST.
	No ▶	REPAIR open in Circuit 814 (W / BK). RESTORE vehicle. CLEAR DTCs and RETEST.
NC3 CHECK FOR CONTINUITY ON CIRCUIT 361 (R) ● Disconnect PCM relay. ● Measure resistance on Circuit 361 (R) between PCM relay and IDM relay. ● **Is resistance less than 5 ohms?**	Yes ▶	RECONNECT PCM relay. F-Series, GO to NC4. Econoline, GO to NC9.
	No ▶	REPAIR open in Circuit 361 (R). RESTORE vehicle. CLEAR DTCs and RETEST.
NC4 CHECK MAXI FUSE 8 ● Check Maxi Fuse 8. ● **Is Fuse 8 blown?**	Yes ▶	REPAIR short to ground between fuse and IDM Pin 14. REPLACE fuse. RESTORE vehicle. CLEAR DTCs and RETEST.
	No ▶	GO to NC5.
NC5 CHECK MAXI FUSE 8 POWER SIDE ● Disconnect Maxi Fuse 8. ● Measure resistance between nonpower side of Maxi Fuse 8 and IDM relay Circuit 37 (Y). ● **Is resistance less than 5 ohms?**	Yes ▶	GO to NC6.
	No ▶	REPAIR open in Circuit 37 (Y). RESTORE vehicle. CLEAR DTCs and RETEST.
NC6 CHECK CONTINUITY IN CIRCUIT 876 (DG / LG) ● Disconnect IDM harness connector. ● Measure resistance on Circuit 876 (DG / LG) between IDM relay and Pin 14 at the IDM. ● **Is the resistance less than 5 ohms?**	Yes ▶	F-Series, GO to NC7. Econoline, GO to NC10.
	No ▶	REPAIR open in Circuit 876 (DG / LG). RESTORE vehicle. CLEAR DTCs and RETEST.
NC7 IDM RELAY CHECK ● Install IDM relay. ● Key on, engine off. ● Measure resistance between nonpower side of Maxi Fuse 8 connector and IDM connector Pin 14. ● **Is resistance less than 5 ohms?**	Yes ▶	GO to NC8.
	No ▶	REPLACE IDM relay. REINSTALL Maxi Fuse 8, IDM connector. RESTORE vehicle. CLEAR DTCs and RETEST.

Injector Driver Module Enable (IDM-EN)

NC

Test Step		Result ▶	Action to Take
NC8	IDM GROUND CHECK		
	● Measure resistance between battery ground post and IDM Pin 26. ● **Is resistance less than 5 ohms?**	Yes ▶	REPLACE IDM. RESTORE vehicle. CLEAR DTCs and RETEST.
		No ▶	REPAIR open in ground circuit. RESTORE vehicle. CLEAR DTCs and RETEST.
NC9	CHECK VOLTAGE AT IDM RELAY		
	● Measure voltage between IDM relay connector Circuit 37 (Y) and battery negative post. ● **Is battery voltage present?**	Yes ▶	GO to NC6.
		No ▶	REPAIR open in Circuit 37 (Y) between IDM relay and starter relay. RESTORE vehicle. CLEAR DTCs and RETEST.
NC10	CHECK IDM RELAY		
	● Install IDM relay. ● Key on, engine off. ● Measure voltage between IDM Pin 14 and battery negative post. ● **Is battery voltage present?**	Yes ▶	GO to NC8.
		No ▶	REPLACE IDM relay. RESTORE vehicle. CLEAR DTCs and RETEST.

Unable to Activate Self Test/SCP Communication Error/DTC Not Listed

QA

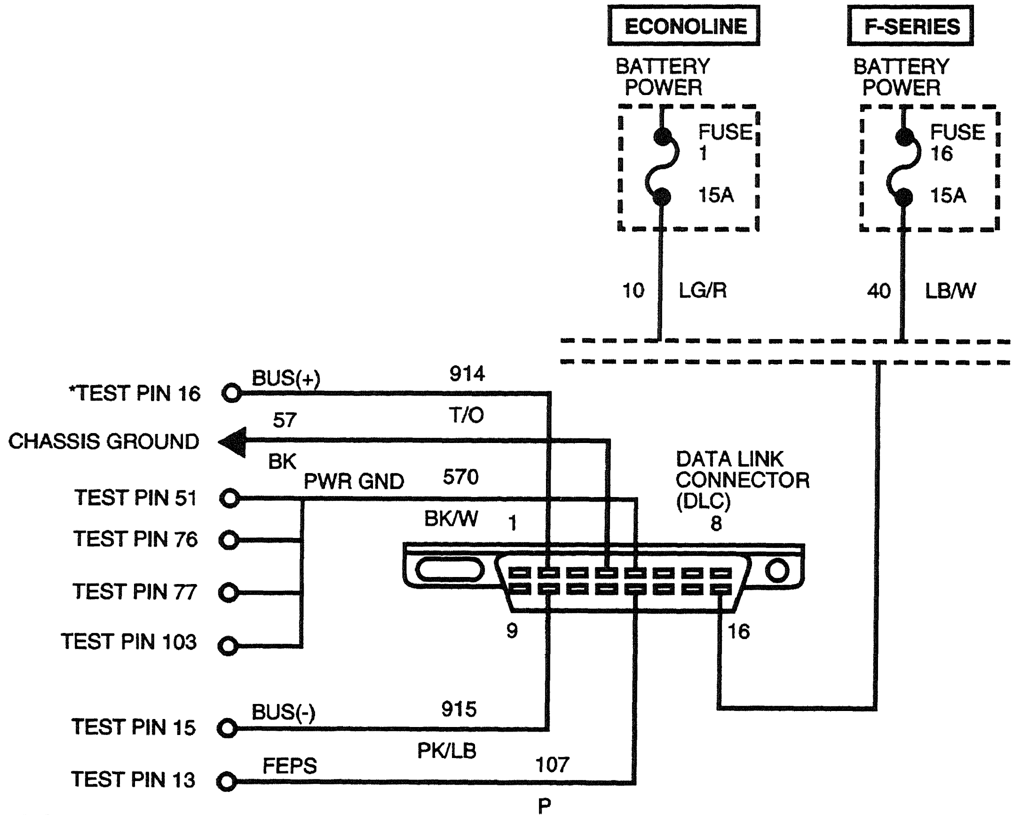
Note

Enter this pinpoint test only when directed here.

Remember

This pinpoint test is intended to diagnose only the following:

- standard corporate protocol (SCP) communication bus harness circuits: BUS (+), BUS(-)
- harness circuits: chassis ground, power ground (PWR GND), battery voltage (VBAT)
- powertrain control module (PCM)(12A650)



*TEST PINS LOCATED ON BREAKOUT BOX.
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACES.

A25114-A

Unable to Activate Self Test/SCP Communication Error/DTC Not Listed

QA

DTC Description

P1502 = APCM on during Self Test

Test Step		Result ▶	Action to Take
QA1	DIAGNOSTIC TROUBLE CODE (DTC) P1502		
	• Verify that the correct procedure was used to activate KOEO or KOER Self Test for the NGS Tester. NOTE: Verify scan tool operation on another vehicle before proceeding. • **Was the correct procedure used?**	Yes ▶ No ▶	Correct procedure for activating self test was used. GO to QA2. REFER to Section 2 for correct operating procedures.
QA2	CHECK PCM OUTPUT		
	NOTE: Scan tool will kick out if battery voltage drops below 9.5 volts. If performing repeated self testing, unplug glow plug relay to prevent the battery from going dead, and disregard glow plug codes while glow plug relay is unplugged. If equipped with auxiliary powertrain control system, it must be off or disconnected while trying to perform self test. • Verify that batteries are fully charged and are not the cause of the communication error. • **Does engine start?**	Yes ▶ No ▶	GO to QA3. GO to C1.
QA3	CHECK B+ AT DATA LINK CONNECTOR (DLC)		
	• Measure resistance between B+ circuit cavity at DLC Pin 16 and battery positive post. • Key off. • **Is resistance less than 5 ohms?**	Yes ▶ No ▶	GO to QA4. REPAIR open in DLC B+ circuit. RESTORE vehicle. CLEAR DTCs and RETEST.
QA4	CHECK DLC CHASSIS GROUND CONTINUITY		
	• Measure resistance between chassis ground circuit cavity at DLC Pin 4 and ground. • **Is resistance less than 5.0 ohms?**	Yes ▶ No ▶	GO to QA5. REPAIR open in DLC chassis ground circuit. RESTORE vehicle. CLEAR DTCs and RETEST.
QA5	CHECK DLC PWR GND CIRCUIT CONTINUITY		
	• Install breakout box; leave PCM disconnected. • Measure resistance between PCM Test Pins 51, 76, 77, 103 (PWR GND) and the PWR GND circuit cavity at the DLC Pin 5. • **Is resistance less than 5.0 ohms?**	Yes ▶ No ▶	GO to QA6. REPAIR open in DLC PWR GND circuit. RESTORE vehicle. CLEAR DTCs and RETEST.
QA6	CHECK DLC BUS(-) CIRCUIT CONTINUITY		
	• Measure resistance between PCM Test Pin 15 [BUS(-)] and the BUS(-) circuit at the DLC Pin 10. • **Is resistance less than 5.0 ohms?**	Yes ▶ No ▶	GO to QA7. REPAIR open in the DLC BUS (-) circuit. RESTORE system. CLEAR DTCs and RETEST.

Unable to Activate Self Test/SCP Communication Error/DTC Not Listed

QA

Test Step		Result ▶	Action to Take
QA7	CHECK BUS(-) CIRCUIT FOR SHORT TO GROUND		
	• Measure resistance between PCM Test Pin 15 [BUS(-)] and ground. • **Is resistance greater than 10,000 ohms?**	Yes ▶	GO to QA8.
		No ▶	REPAIR short to ground in the BUS(-) circuit. RESTORE system. CLEAR DTCs and RETEST.
QA8	CHECK BUS(-) CIRCUIT FOR SHORT TO POWER		
	• Key on, engine off. • Measure voltage between PCM Test Pin 15 [BUS(-)] and PCM Test Pins 51, 76, 77 or 103 (PWR GND). • **Was the voltage greater than 1.0 volt?**	Yes ▶	REPAIR short to power in the BUS(-) circuit. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	GO to QA9.
QA9	CHECK DLC BUS(+) CIRCUIT CONTINUITY		
	• Key off. • Measure resistance between PCM Test Pin 16 [BUS(+)] and BUS(+) circuit at the DLC Pin 2. • **Is resistance less than 5.0 ohms?**	Yes ▶	GO to QA10.
		No ▶	REPAIR open in DLC BUS(+) circuit. RESTORE system. CLEAR DTCs and RETEST.
QA10	CHECK BUS(+) CIRCUIT FOR SHORT TO POWER		
	• Key on, engine off. • Measure voltage between PCM Test Pin 16 [BUS(+)] and PCM Test Pins 51, 76, 77 or 103 (PWR GND). • **Was the voltage greater than 1.0 volt?**	Yes ▶	REPAIR short to power in the BUS(+) circuit. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	GO to QA11.
QA11	CHECK BUS (+) AND BUS (-) SHORTED TOGETHER		
	• Key off. • Measure resistance between PCM Test Pins 15 and 16. • **Is resistance greater than 10,000 ohms?**	Yes ▶	CLEAR DTCs and RETEST. If DTC P1502 is still present, or if still unable to perform Self Test, REPLACE PCM. RESTORE system. CLEAR DTCs and RETEST.
		No ▶	REPAIR short between BUS + and BUS - circuits. RESTORE system. CLEAR DTCs and RETEST.

SECTION 6

Reference Values

Contents

Control System Diagnostic Sheet Reference

PCM Pin Descriptions and Expected Values

49 State Except Econoline

Pin #	Name	Circuit #	Wire Color	Key Off	Key On	Low Idle	High Idle	Operating Range	Comments
1	SS2	315	P-O	0v	12v	12v	12v	0v/12v	Shift Solenoid #2 0v = "On," 12v = "Off"
2	Check Engine Light	658	PK-LG	0v	B+	B+	B+	B+	0v = Light On, 12v = Light Off
4	PBA	977D	P-W	0v	12v/0v	12v/0v	12v/0v	12v/0v	Parking Brake Applied Switch "Up/Down"
5	IVS	308	R-O	0v	0v/12v	0v	12v	0v/12v	Idle Validation Switch "Up/Down"
13	FEPS	107	P	N/A	N/A	N/A	N/A	N/A	Flash EPROM Power Supply
14	4X4L	784	LB-BK	0v	12v/0v	12v/0v	12v/0v	12v/0v	4x4 Low Switch 12v = "Off," 0v = "On"
15	BUS (-)	915	PK-LB	N/A	N/A	N/A	N/A	N/A	Data Link Connector
16	BUS (+)	914	T-O	N/A	N/A	N/A	N/A	N/A	Data Link Connector
24	APGND	837	Y/BK	0v	0v	0v	—	0v	Accelerator Pedal Sensor Ground
25	CASE GND	57Z	BK	0v	0v	0v	0v	0v	Case Ground
27	SS1	237	O-Y	0v	0v	0v	0v	0v/12v	Shift Solenoid #1 0v = "On," 12v = "Off"
28	TCC	480	P-Y	0v	12v	12v	12v	0v/12v	Converter Clutch Solenoid 0v = "On," 12v = "Off"
29	CPP TCS	306 224	T-LB T-W	0v	12v/0v	12v/0v	12v/0v	12v/0v	Clutch Pedal Position Switch (Manual) Transmission Control Switch (Automatic)
30	EBP	553	P-LB	0v	0.8v-0.95v	0.8v-0.95v	1.25v-1.75v	0.8v-0.3v	Exhaust Back Pressure Sensor
31	BPA	307	BK-Y	0v	12v/0v	12v/0v	12v/0v	12v/0v	Brake Pedal Applied "Up/Down"
33	VSS-	676	PK-O	0v	0v	0v	0v	0v	Vehicle Speed Sensor Ground
34	MAP	358	LG-BK	0.2v-0.5v	2.5v	2.5v	2.5v	110-186 Hz	Manifold Pressure 110/113 Hz = At. Press.
37	TFT	923	O-BK	0v	0.3v-4.5v	0.3v-4.5v	0.3v-4.5v	0.46v-212°F	Transmission Fluid Temp. 4.5v = 40°F/.3v = 230°F
38	EOT	354	LG-R	0v	0.35v-4.5v	0.35v-4.5v	0.35v-4.5v	0.75v = 212°F	Engine Oil Temp. 4.7v = -40°F/.68v = 230°F
39	IAT	743	GY	0v	0.35v-4.5v	0.35v-4.5v	0.35v-4.5v	3.07v = 68°F	Intake Air Temp. 4.53v = 40°F/.358v = 230°F
40	SC GND	848	DG-O	0v	0v	0v	0v	0v	Speed Control Ground

(Continued)

Control System Diagnostic Sheet Reference

Pin #	Name	Circuit #	Wire Color	Key Off	Key On	Low Idle	High Idle	Operating Range	Comments
41	ACC	198	DG-O	0v	12v/0v	12v/0v	12v/0v	12v/0v	Air Conditioning Clutch 12v = “On,” 0v = “Off”
42	EPR	318	GY-R	0v	6v-8v	6v-8v	0v	0v-10v	Exhaust Back Pressure Volt. only when enabled
48	EF	818	GY-W	0v	3.3v avg	0.4v-2.2v	1.9v-2.2v	0.4v-2.2v	Electronic Feedback line, digital 12v frequency
49	CMP	795	DG	0v	12v/2.5v	7v	7v	130-720 Hz	Camshaft Position Sensor 650-3600 rpm
50	TAC	648	W-PK	0v	12v	6.5v/130 Hz	6.5v/660 Hz	130-720 Hz	Tachometer Signal Reflected CMP signal
51	PWR GND	570A	BK-W	0v	0v	0v	0v	0v	Power Ground
53	CCS	924	BR-O	0v	0v	0v	0v	0v/12v	Coast Clutch Solenoid 0v = “On,” 12v = “Off”
55	KAPWR	37E	Y	B+	B+	B+	B+	B+	Keep Alive Power B+ = battery voltage
58	VVS (+)	679	GY-BK	Frequency Signal — Varies with Vehicle Speed					Vehicle Speed Signal
61	SCCS	151	LB-BK	0v	0 to 12v	0 to 12v	0 to 12v	0 to 12v	Cruise Cntl. voltage will vary w/switch position
64	TR	199	LB-Y	0v	4.5v	4.5v	4.5v	0v-4.5v	Transmission Range Sensor P = 4.5v, R = 3.7v, N = 2.9v, D = 2.2v, MAN2 = 1.4v, MAN1 =.7v
65	CMP GND	796	LB	0v	0v	0v	0v	0v	Camshaft position sensor ground
70	IDM__EN	814	W-BK	0v	12v->0v	0v	0v	12v/0v	IDM Relay 12v = IDM Off, 0v = IDM On
71	VPWR	361B	R	0v	B+	B+	B+	B+	Ignition source pwr.
76	PWR GND	570B	BK-W	0v	0v	0v	0v	0v	Power Ground
77	PWR GND	570C	Bk-W	0v	0v	0v	0v	0v	Power Ground
79	TCIL	911	W-LG	0v	12v/0v	12v/0v	12v/0v	12v/0v	Trans Control Indicator Light 12v = “Off,” 0v = “On”
80	GPL	464	BK-PK	0v	0v/12v	12v	12v	0v/12v	Glow Plug Lamp 0v = Light On, 12v = Light Off
81	EPC	925	W-Y	0v	4.5v	7.5v	12v	7.5v-12v	Electronic Pressure Control Solenoid
83	IPR	552	Y-R	0v	12v	12v	12v	12v	Injection Pressure Reg. Duty Cycle Controlled
84	BARO	356	DB-LG	0.75v-3v	0.75v-4.9v	0.75v-4.9v	0.75v-4.9v	0.75v-4.9v	4.64v at 100 kPa (sea level), 2.6v at 60 kPa (10,000 ft.)
87	ICP	812	DB-LG	0v	0.25v-0.4v	0.75-1v	1.1-1.5v	0.65-3.25v	Injection Control Pressure (Min.83v req. for starting)
89	AP	355	GY-W	0v	0.5-4.95v	0.5-1.6v	3.8-4.95v	0.5v-4.95v	Accelerator Pedal Sensor

(Continued)

Control System Diagnostic Sheet Reference

Pin #	Name	Circuit #	Wire Color	Key Off	Key On	Low Idle	High Idle	Operating Range	Comments
90	VREF	351	BR-W	.41v	5.0 ±.5v	5.0 ± 0.5v	5.0 ± 0.5v	5.0 ± 0.5v	Voltage Reference
91	Sig Grd.	GY-R	GY-R	0v	0v	0v	0v	0v	Ground for all sensor signals
92	BOO	511	LG	0v/12v	0v/12v	0v/12v	0v/12v	0v/12v	Brake On/Off Switch "Up/Down"
95	FDCS	821	BR-O	0v	0.5v	1v/49 Hz	2.7v/200 Hz	43/240 Hz	Fuel Demand Command Signal 650-3600 rpm
96	CID	817	Y-LB	0v	0.5v	6v/5 Hz	6v/720 Hz	5 Hz-720 Hz	Cylinder Identification
97	VPWR	361A	R	0v	B+	B+	B+	B+	Ignition source pwr.
101	GPC	1086	P-O	0v	0v/12v	0v/12v	12v	0v/12v	Glow Plug Cntrl. 0v = (GP relay On), 12v = (GP Relay Off)
103	Pwr. Grd.	570D	BK-W	0v	0v	0v	0v	0v	—

California and All Econoline

Pin #	Name	Circuit #	Wire Color	Key Off	Key On	Low Idle	High Idle	Operating Range	Comments
2	Check Engine Light	658	PK-LG	0v	0v/12v	0v/12v	0v/12v	0v/12v	0v = Light On, 12v = Light Off
5	PBA	162	LG-R	0v	0v/12v	0v/12v	0v/12v	0v-12v	Parking Brake Applied Switch; 12v = Brake Off, 0v = Brake On
6[a]	SS1	237	O-Y	0v	0v	0v	0v	0v/12v	Shift Solenoid #1 0v = "On," 12v = "Off"
8	GPMH	339	GY	0v	0v/12v	0v/12v	0v/12v	0v/12v	Glow Plug Monitor High Side; 0v = Plugs Off, 12v = Plugs On
9	GPMR	1087	O	0v	0v/12v	0v/12v	0v/12v	0v/12v	Glow Plug Monitor Right Bank; 0v = Plugs Off, 12v = Plugs On
10	IVS	308	R-O	0v	0v	0v	12v	0v/12v	Idle Validation Switch; 0v = At Idle, 12v = Off Idle
11[a]	SS2	315	P-O	0v	12v	12v	12v	0v/12v	Shift Solenoid #2 0v = "On," 12v = "Off"
12[a]	TCIL	911	W-LG	0v	0v/12v	0v/12v	0v/12v	0v/12v	Trans Control Indicator Light; 0v = Light "On," 12v = Light "Off"
13	FEPS	107	P	N/A	N/A	N/A	N/A	N/A	Flash EPROM Power Supply
14[ab]	4X4L	784	LB-BK	0v	0v/12v	0v/12v	0v/12v	0v/12v	4x4 Low Switch; 0v = "On," 12v = "Off"
15	BUS (-)	915	PK-LB	N/A	N/A	N/A	N/A	N/A	Data Link Connector

(Continued)

Control System Diagnostic Sheet Reference

Pin #	Name	Circuit #	Wire Color	Key Off	Key On	Low Idle	High Idle	Operating Range	Comments
16	BUS (+)	914	T-O	N/A	N/A	N/A	N/A	N/A	Data Link Connector
17[ac]	TR1	1012	O-BK	0v	Varies with gear			0v/10.7v	P = 0v, R = 0v, N = 0v, D = 10.7v, MAN2 = 10.7v, MAN1 = 10.7v
19	TAC	648	W-PK	0v	12v	6.5v/ 130 Hz	6.5v/ 660 Hz	130-720 Hz	Tachometer Signal Reflected CMP signal
20[a]	CCS	924	BR-O	0v	0v	0v	0v	0v/12v	Coast Clutch Solenoid; 0v = "On," 12v = "Off"
21	CMP	795	DG	0v	0.8v	7v	7v	130-720 Hz	Camshaft Position Sensor; 650-3600 rpm
24	APGND	837	Y-BK	0v	0v	0v	0v	0v	Accelerator Pedal Sensor Ground
25	CASE GND	875	BK-LB	0v	0v	0v	0v	0v	Case Ground
29	CPP (Manual) TCS (Auto)	306 224	T-LB T/W	0v 0v	0v/12v 0v/12v	0v/12v 0v/12v	0v/12v 0v/12v	0v/12v 0v/12v	Clutch Pedal Position Switch (Manual) Transmission Control Switch (Automatic)
30	EBP	553	R-LB	0v	0.9v	0.9v	1.2v	0.9v-3v	Exhaust Back Pressure Sensor
31	BPA	810	R-LG	0v/12v	0v/12v	0v/12v	0v/12v	0v/12v	Brake Pedal Applied Switch; 0v = Brake On, 12v = Brake Off
33	VSS (-)	676	PK-O	0v	0v	0v	0v	0v	Vehicle Speed Sensor Ground
34	GPML	466	PK-O	0v	0v/12v	0v/12v	0v/12v	0v/12v	Glow Plug Monitor Left Bank; 0v = Plugs Off, 12v = Plugs On
37[a]	TFT	923	O-BK	0.2v-0.5v	0.3v-4.5v	0.3v-4.5v	0.3v-4.5v	0.3v-4.5v	Transmission Fluid Temperature; 4.5v = -40°C, 0.3v = 130°C
38	EOT	354	LG-R	0.2v-0.5v	0.3v-4.7v	0.3v-4.7v	0.3v-4.7v	0.3v-4.7v	Engine Oil Temperature; 4.7v = -40°C, 0.3v = 150°C
39	IAT	743	GY	0.2v-0.5v	0.2v-4.5v	0.2v-4.5v	0.2v-4.5v	0.2v-4.5v	Intake Air Temperature; 4.5v =.40°C, 0.2v = 130°C
40	SC GND	563	O-Y	0v	0v	0v	0v	0v	Speed Control Ground
41[a]	ACC	347	BK-Y	0v	0v/12v	0v/12v	0v/12v	0v/12v	Air Conditioning Clutch; 0v = A/C Off, 12v = A/C On
42	EPR	318	GY-R	0v	0v	0v-12v	0v-12v	0v-12v	Exhaust Back Pressure Regulator; Duty cycled, 0v = "Off"
48	EF	818	GY-W	0v	3v	1v	0.9v-3v	0.9v-3v	Electronic Feedback line; Digital 12v frequency

(Continued)

Control System Diagnostic Sheet Reference

Pin #	Name	Circuit #	Wire Color	Key Off	Key On	Low Idle	High Idle	Operating Range	Comments
49[ac]	TR2	146	W-PK	0v	Varies with gear			0v 10.7v	P = 0v, R = 0v, N = 10.7v, D = 10.7v, MAN2 = 0v, MAN1 = 10.7v
50[ac]	TR4	145	GY-BK	0v	Varies with gear			0v 10.7v	P = 0v, R = 10.7v, N = 0v, D = 10.7, MAN2 = 10.7v, MAN1 = 0v
51	PWR GND	570A	BK-O	0v	0v	0v	0v	0v	Power Ground
54[a]	TCC	480	P-Y	0v	12v	12v	12v	0v / 12v	Torque Converter Clutch Solenoid; 0v = "On," 12v = "Off"
55	KAPWR	37E	Y	B+	B+	B+	B+	B+	Keep Alive Power; B+ = Battery voltage
58	VSS (+)	679	GY-BK	Frequency Signal — Varies with Vehicle Speed					Vehicle Speed Sensor
61	SCCS	151	LB-BK	0v	6.6v	6.6v	6.6v	0v-12v	Cruise Control Command Switch; On = 12v, Off = 0v, Set = 2.8v, Resume = 4.7v, Coast = 0.8v, Hold = 6.6v
63	BARO	356	DB-LG	0v	2v-4.9v	2v-4.9v	2v-4.9v	2v-4.9v	Barometric Pressure Sensor; 4.6v @ 100 kPa (sea level), 2.6v@ 60 kPa (10,000 ft.)
64[a]	TR (F-Series) TR3A (E-Series)	199	LB-Y	0v	Varies with gear			0.7v-4.5v 0v / 1.6v	F-Series: P = 4.5v, R = 3.7v, N = 2.9v, D = 2.2v, MAN2 = 1.4v, MAN1 = 0.7v
65	CMP GND	796	LB	0v	0v	0v	0v	0v	Camshaft position sensor ground
70	GPL	464	BK-PK	0v	0v / 12v	12v	12v	0v / 12v	Glow Plug Lamp, 0v = Light On, 12v = Light Off
71	VPWR	361B	R	0v	B+	B+	B+	B+	Ignition source power
76	PWR GND	570B	BK-O	0v	0v	0v	0v	0v	Power Ground
77	PWR GND	570C	BK-O	0v	0v	0v	0v	0v	Power Ground
80	IDM_EN	814	W-BK	0v	12v->0v	0v	0v	0v-12v	IDM Relay; 0v = Relay on, 12v = Relay off
81[a]	EPC	925	W-O	0v	8v	10v	12v	8v-12v	Electronic Pressure Control Solenoid
83	IPR	552	Y-R	0v	12v	12v	12v	12v	Injection Pressure Regulator; Duty cycle controlled
87	ICP	535	LB-R	0v	0.2v-0.4v	0.7v-1v	1.1v-1.5v	0.6v-3.2v	Injection Control Pressure Sensor (Min 0.83v req. for starting)
88	MAP	358	LG-BK	0.2v-0.5v	2.5v	2.5v	2.5v	110-190 Hz	Manifold Absolute Pressure; 110 Hz = Atmospheric Press.

(Continued)

Control System Diagnostic Sheet Reference

Pin #	Name	Circuit #	Wire Color	Key Off	Key On	Low Idle	High Idle	Operating Range	Comments
89	AP	355	GY-W	0v	0.5v-4.95v	0.5v-1.6v	3.4v-4.95v	0.5v-4.95v	Accelerator Pedal Sensor
90	V REF	351	BR-W	0.2v-0.5v	5.0 ± 0.5v	5.0 ± 0.5v	5.0 ± 0.5v	5.0 ±0.5v	Voltage Reference
91	SIG GRD	359	GY-R	0v	0v	0v	0v	0v	Ground for all sensor signals
92	BOO	511	LG	0v/12v	0v/12v	0v/12v	0v/12v	0v/12v	Brake On/Off Switch; 0v = Brake Off, 12v = Brake On
95	FDCS	821	BR-O	0v	0v	1v/49 Hz	4v/200 Hz	40 Hz-240 Hz	Fuel Delivery Control Signal; 650-3600 rpm
96	CI	817	Y-LB	0v	0v	6v/5 Hz	7v/30 Hz	5 Hz-30 Hz	Cylinder Identification
97	VPWR	361A	R	0v	B+	B+	B+	B+	Ignition source power
101	GPC	1086	P-O	0v	0v/12v	0v/12v	0v/12v	0v/12v	Glow Plug Control, 0v = Relay on, 12v = Relay off
103	PWR GND	570D	BK-O	0v	0v	0v	0v	0v	Power Ground

a E40D transmission only.
b Not used on 1997 Econoline.
c Not used on 1997 F-series.

Fault Code	Circuit Index	Condition Description	Comments	Probable Causes
P0107	BARO	Barometric pres. sensor circuit low input	Defaults to 100 kPa	Open/grounded circuit, PCM
P0108	BARO	Barometric press. sensor circuit high input	Defaults to 100 kPa	Circuit shorted to 5v, biased sensor, PCM
P0112	IAT	Intake air temp. sensor circuit low input	Defaults to 15°C	Grounded circuit, biased sensor, PCM
P0113	IAT	Intake air temp. sensor circuit high input	Defaults to 15°C	Open circuit, biased sensor, PCM, short to 5v
P0122*	AP	Accelerator pedal sensor circuit low input	Engine will only idle if hard fault	Grounded circuit, biased sensor, PCM
P0123*	AP	Accelerator pedal sensor circuit high input	Engine will only idle if hard fault	Open circuit, biased sensor, PCM, short to 5v
P0195	EOT	EOT above/below KOER limits (1995 model year)	Aborts KOER test	Engine not up to operating temp. leaking thermostat
P0196	EOT	Engine oil temp. sensor circuit performance	Aborts KOER CCT test	Engine not warm enough, leaking thermostat, ckt. failure
P0197*	EOT	Engine oil temp. sensor circuit low input	No cold adv., fast low idle	Grounded circuit, biased sensor, PCM
P0918*	EOT	Engine oil temp. sensor circuit high input	No cold adv., fast low idle	Open circuit, biased sensor, PCM, short to 5v
P0220*	IVS	Throttle switch B circuit malfunction	Switch test — KOER	Short/open circuit, switch failure, operator, PCM
P0221*	AP/IVS	Throttle switch B circuit performance	AP/IVS disagree — Engine will only idle if hard fault	Failed pedal assembly

(Continued)

Control System Diagnostic Sheet Reference

Fault Code	Circuit Index	Condition Description	Comments	Probable Causes
P0235	MAP	MAP signal inactive (1995 model year)	Uses inferred MAP signal	Open, short to ground or 5v, faulty sensor
P0236˙	MAP	Turbo boost sensor A circuit performance	Uses inferred MAP signal	Restricted inlet / exhaust / supply hose, missing hose
P0237˙	MAP	MAP signal out of range high / low (1995 model year)	Uses inferred MAP signal	Noise, faulty sensor, intermittent open
P0237˙	MAP	Turbo boost sensor A circuit low input (1996 model year)	Uses inferred MAP signal	Open, short to ground or 5v, faulty sensor
P0238˙	MAP	Turbo boost sensor A circuit high input	Uses inferred MAP signal	Noise, faulty sensor
P0261˙	INJ	Injector circuit low — Cylinder 1	FMEM mode, engine will run on 4 cyl.	Harness short to ground
P0262	INJ	Injector circuit high — Cylinder 1	FMEM mode, engine will run on 4 cyl.	Miswired connector or harness
P0263	PCED	Cylinder 1 contribution / balance fault	Cylinder not contributing during CCT test	Power cylinder, valve train or injector problem, circuit
P0264˙	INJ	Injector circuit low — Cylinder 2	FMEM mode, engine will run on 4 cyl.	Harness short to ground
P0265	INJ	Injector circuit high — Cylinder 2	FMEM mode, engine will run on 4 cyl.	Miswired connector or harness
P0266	PCED	Cylinder 2 contribution / balance fault	Cylinder not contributing during CCT test	Power cylinder, valve train or injector problem, circuit
P0267˙	INJ	Injector circuit low — Cylinder 3	FMEM mode, engine will run on 4 cyl.	Harness short to ground
P0268	INJ	Injector circuit high — Cylinder 3	FMEM mode, engine will run on 4 cyl.	Miswired connector or harness
P0269	PCED	Cylinder 3 contribution / balance fault	Cylinder not contributing during CCT test	Power cylinder, valve train or injector problem, circuit
P0270˙	INJ	Injector circuit low — Cylinder 4	FMEM mode, engine will run on 4 cyl.	Harness short to ground
P0271	INJ	Injector circuit high — Cylinder 4	FMEM mode, engine will run on 4 cyl.	Miswired connector or harness
P0272	PCED	Cylinder 4 contribution / balance fault	Cylinder not contributing during CCT test	Power cylinder, valve train or injector problem, circuit
P0273˙	INJ	Injector circuit low — Cylinder 5	FMEM mode, engine will run on 4 cyl.	Harness short to ground
P0274	INJ	Injector circuit high — Cylinder 5	FMEM mode, engine will run on 4 cyl.	Miswired connector or harness
P0275	PCED	Cylinder 5 contribution / balance fault	Cylinder not contributing during CCT test	Power cylinder, valve train or injector problem, circuit
P0276˙	INJ	Injector circuit low — Cylinder 6	FMEM mode, engine will run on 4 cyl.	Harness short to ground
P0277	INJ	Injector circuit high — Cylinder 6	FMEM mode, engine will run on 4 cyl.	Miswired connector or harness

(Continued)

Control System Diagnostic Sheet Reference

Fault Code	Circuit Index	Condition Description	Comments	Probable Causes
P0278	PCED	Cylinder 6 contribution / balance fault	Cylinder not contributing during CCT test	Power cylinder, valve train or injector problem, circuit
P0279*	INJ	Injector circuit low — Cylinder 7	FMEM mode, engine will run on 4 cyl.	Harness short to ground
P0280	INJ	Injector circuit high — Cylinder 7	FMEM mode, engine will run on 4 cyl.	Miswired connector or harness
P0281	PCED	Cylinder 7 contribution / balance fault	Cylinder not contributing during CCT test	Power cylinder, valve train or injector problem, circuit
P0282*	INJ	Injector circuit low — Cylinder 8	FMEM mode, engine will run on 4 cyl.	Harness short to ground
P0283	INJ	Injector circuit high — Cylinder 8	FMEM mode, engine will run on 4 cyl.	Miswired connector or harness
P0284	PCED	Cylinder 8 contribution / balance fault	Cylinder not contributing during CCT test	Power cylinder, valve train or injector problem, circuit
P0340	CMP	Camshaft position sensor ckt. malfunction	No CMP sensor signal detected during crank	Open / grounded circuit, sensor fault, short to power
P0341*	CMP	Camshaft position sensor ckt. performance	Electrical noise detected	Harness routing, charging circuit, sensor
P0344	CMP	Camshaft position sensor ckt. intermittent	Incorrect number of CMP transition counts	Harness routing, charging ckt., sensor, int. ckt., improper gap
P0380	GP	Glow plug circuit malfunction	Glow Plug Relay — KOEO OCC test	Open / grounded ckt., solenoid open / shorted, failed PCM
P0381	GP	Glow plug indicator circuit malfunction	Glow Plug Lamp — KOEO OCC test	Open / grounded circuit, lamp open, failed PCM
P0470	EBP	Exhaust back pressure sensor circuit malfunction	No-start or crank mode	Biased sensor, open signal return
P0471	EBP	Exhaust back pressure sensor circuit performance	Run mode	Plugged, stuck or leaking hose
P0472	EBP	Exhaust back pressure sensor circuit low input	Disables back pressure device	Open / grounded circuit, biased sensor, PCM
P0473	EBP	Exhaust back pressure sensor circuit high input	Disables back pressure device	Circuit shorted to 5v, biased sensor, PCM
P0475	EPR	Exhaust press. control valve malfunction	Exhaust back pressure regulator — OCC — KOEO	Open / grounded ckt., solenoid open / shorted, failed PCM
P0476	EPR	Exhaust press. control valve performance	Run mode and KOER on-demand test	Failed / stuck EPR control, EBP fault, EPR circuit
P0478	EPR	Exhaust press. control valve high input	Excessive back pressure — run mode	Plugged sensor line, stuck butterfly, restricted exhaust
P0500	VSS	Vehicle speed sensor malfunction	—	Sensor, circuit, PCM, PSOM, TR failure, low trans. fluid
P0560	PCED	System voltage malfunction	B+ too low for CCT test — aborts test	Charging system problem / load, glow plugs still enabled
P0562	PCED	System voltage low	May be temporary condition at crank only	Low sys. voltage, charging sys., internal PCM failure

(Continued)

Control System Diagnostic Sheet Reference

Fault Code	Circuit Index	Condition Description	Comments	Probable Causes
P0563	PCED	System voltage high	May be temporary condition — 24v jump start	High sys., voltage, charging sys., internal PCM failure
P0565	PCED	Cruise "On" signal malfunction	Switch Test — KOER (Code set if cruise not present)	Open or short circuit, switch failure, PCM failure or failed to activate switch during KOER switch test
P0566	PCED	Cruise "Off" signal malfunction	Switch Test — KOER (Code set if cruise not present)	Open or short circuit, switch failure, PCM failure or failed to activate switch during KOER switch test
P0567	PCED	Cruise "Resume" signal malfunction	Switch Test — KOER (Code set if cruise not present)	Open or short circuit, switch failure, PCM failure or failed to activate switch during KOER switch test
P0568	PCED	Cruise "Set" signal malfunction	Switch Test — KOER (Code set if cruise not present)	Open or short circuit, switch failure, PCM failure or failed to activate switch during KOER switch test
P0569	PCED	Cruise "Coast" signal malfunction	Switch Test — KOER (Code set if cruise not present)	Open or short circuit, switch failure, PCM failure or failed to activate switch during KOER switch test
P0571	BPA	Brake switch A circuit malfunction	Switch Test — KOER (Code set if cruise not present)	Cruise control codes will be set on every switch test on vehicles not equipped with cruise control
P0603	PCED	Internal control module KAM error	No historical faults output during a KOEO test	Open PCM pin, disconnect B+, faulty PCM
P0605	PCED	Internal control module ROM error	Internal PCM failure	Internal PCM failure
P0606	PCED	PCM processor fault	PCM inactive background fault	Internal PCM failure
P0703	BOO	Brake switch B circuit malfunction	Switch Test — KOER	Open / short circuit, switch, PCM, failed to activate switch during KOER switch test
P0704	CPP	Clutch switch input circuit malfunction	Switch Test — KOER	Open / short circuit, switch, PCM, failed to activate switch during KOER switch test
P0705**	TR	TR sensor circuit malfunction	—	Resistance in circuit, faulty sensor, PCM
P0707**	TR	TR sensor circuit low input	—	Short to ground in circuit, biased sensor, PCM
P0708**	TR	TR sensor circuit high input	—	Open in circuit, biased sensor, PCM, short to power
P0712	TFT	Trans. fluid temp. sensor ckt. low input	—	Short to ground, biased sensor, PCM
P0713	TFT	Trans. fluid temp. sensor ckt. high input	—	Open in circuit, biased sensor, PCM, short to power

(Continued)

Control System Diagnostic Sheet Reference

Fault Code	Circuit Index	Condition Description	Comments	Probable Causes
P0741	TCC	Torque converter clutch ckt. performance	—	Circuit failure, faulty solenoid, PCM
P0750	SS1	Shift solenoid A malfunction	—	Circuit failure, faulty solenoid, PCM
P0755	SS2	Shift solenoid B malfunction	—	Circuit failure, faulty solenoid, PCM
P0781**	—	1-2 Shift malfunction	—	Circuit failure, faulty solenoid, faulty clutch, PCM
P0782**	—	2-3 Shift malfunction	—	Circuit failure, faulty solenoid, faulty clutch, PCM
P0783**	—	3-4 Shift malfunction	—	Circuit failure, faulty solenoid, faulty clutch, PCM
P1111	N/A	System Pass	No PCM system faults detected	N/A
P1211*	IPR	ICP pressure above/below desired	Continuous and KOER on-demand test	IPR valve failed, stuck, or shorted to ground
P1212*	ICP	ICP voltage not at expected level	Crank or KOEO	Biased sensor or ckt., open signal return, low oil in reservoir
P1218	PCM/ IDM	CID stuck high	Cylinder identification line stuck high (historical fault only)	CID circuit open, probably intermittent
P1219	PCM/ IDM	CID stuck low	Cyl. identification line stuck low (historical fault only)	CID circuit short to ground, probably intermittent
P1261- P1268	INJ	High to low side short cyl. # 1-8	Cylinder with fault will not operate	Short circuit, shorted injector, failed IDM
P1271- P1278	INJ	High to low side open cyl. # 1-8	Cylinder with fault will not operate	Open circuit, open injector, failed IDM
P1280*	ICP	ICP circuit out of range low	Uses inferred ICP strategy	Open/grounded circuit, biased sensor, PCM
P1281*	ICP	ICP circuit out of range high	Uses inferred ICP strategy	Circuit shorted to 5v, biased sensor, PCM
P1282	IPR	Excessive ICP pressure	System fault	Faulty IPR regulator (sticking), IPR short to ground
P1283*	IPR	IPR circuit failure	Run mode or KOEO OCC test	Open/grounded circuit, stuck IPR, loose connection
P1284	N/A	ICP failure — aborts KOER CCT test	Detected sensor circuit fault — aborts KOER CCT test	See codes P1280, P1281, P1282, P1283, P1211
P1291	INJ	High side # 1 (right) short to grd. or B+	Inj. power supply circuit short (operates on 4 cylinders)	Short circuit, faulty IDM
P1292	INJ	High side # 2 (left) short to grd. or B+	Inj. power supply circuit short (operates on 4 cylinders)	Short circuit, faulty IDM
P1293	INJ	High side open bank No. 1 (right)	Inj. power supply circuit open (operates on 4 cylinders)	Open circuit, faulty IDM
P1294	INJ	High side open bank No. 2 (left)	Inj. power supply circuit open (operates on 4 cylinders)	Open circuit, faulty IDM

(Continued)

Control System Diagnostic Sheet Reference

Fault Code	Circuit Index	Condition Description	Comments	Probable Causes
P1295*	INJ	Multiple faults on bank No. 1 (right)	Fix low side short and rerun diagnostics	Miswired connector or harness, short to ground
P1296	INJ	Multiple faults on bank No. 2 (left)	Fix low side short and rerun diagnostics	Miswired connector or harness, short to ground
P1297	INJ	High sides shorted together	Fix shorts and rerun diagnostics	Shorted wires, faulty IDM
P1298	PCED	IDM failure	Internal IDM failure	Internal IDM failure
P1464	N/A	A/C on during KOER CCT test	Aborts KOER CCT TEST	Operator error, A/C circuit shorted to power
P1501	N/A	Vehicle moved during testing	Aborts test — KOER on-demand, CCT, or switch test	Operator error
P1531	N/A	Invalid test — accelerator pedal movement	Aborts test — KOER on-demand or CCT test	Accelerator moved during KOER on-demand or CCT test
P1536	PBA	Parking brake applied fail	Switch test — KOER	Circuit, switch, PCM, failed to activate switch KOER
P1660	PCED	OCC signal high	Aborts KOEO OCC test	High system voltage, internal PCM fault
P1661	PCED	OCC signal low	Aborts KOEO OCC test	Low system voltage, internal PCM fault
P1662	PCED	IDM EN circuit failure	IDM enable relay — KOEO OCC test	Open relay, blown fuse, open/grounded circuit
P1663	PCM/IDM	FDCS circuit failure	Fuel demand command signal — KOEO OCC test	Open/grounded circuit, faulty IDM
P1667	PCM/IDM	CID circuit failure	Cyl. identification circuit — KOEO OCC test	Open/grounded circuit, faulty IDM
P1668	PCM/IDM	PCM/IDM diag. communication error	Communication on EF (Electronic Feedback line)	Open/shorted EF or FDCS wire, open IDM grd.
P1705	TR	TR sensor out of self-test range	Not in PARK during KOEO or KOER	Operator error, circuit failure, faulty sensor, PCM
P1706**	TR	High vehicle speed in PARK	Shift to PARK at greater than 20 mph	Operator error, faulty TR sensor, PCM
P1711	TFT	TFT sensor out of self-test range	Transmission fluid temp. too high or low	Circuit failure, faulty sensor, PCM
P1728**	TCC	Trans. slip error — converter clutch failed	—	Solenoid failure or mechanical failure
P1729	4x4L	4x4L low switch error	—	Circuit failure, faulty switch, PCM
P1746	EPC	EPC solenoid open circuit	—	Open circuit, faulty solenoid, PCM
P1747	EPC	EPC solenoid short circuit	—	Short circuit, faulty solenoid, PCM shorted to ground
P1748**	EPC	EPC malfunction	—	Circuit failure, PCM
P1754	CCS	Coast clutch solenoid ckt. malfunction	KOEO-OCC test	Circuit failure, faulty solenoid, PCM
P1779	TCIL	TCIL circuit malfunction	KOEO-OCC test	Short to ground, PCM

(Continued)

Control System Diagnostic Sheet Reference

Fault Code	Circuit Index	Condition Description	Comments	Probable Causes
P1780	TCS	TCS circuit of out self-test range	Switch test — KOER	Circuit, switch, PCM, failed to activate switch KOER
P1781	4x4L	4x4L circuit out of self-test range	In 4x4L during KOEO or KOER	Operator error, short to ground, PCM
P1783**	TFT	Transmission overtemperature condition	—	Internal trans. failure, circuit failure, sensor, PCM

* CHECK ENGINE LIGHT illuminates when fault present.

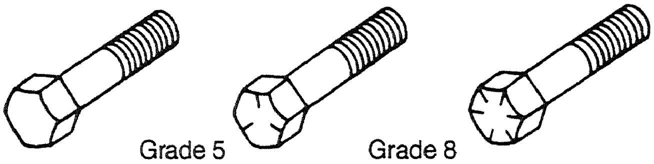
** Transmission Control Indicator Lamp (TCIL) flashes when fault is present.

PCED=Powertrain Control/Emissions Diagnosis Manual.

METRICS

BOLT STRENGTH IDENTIFICATION

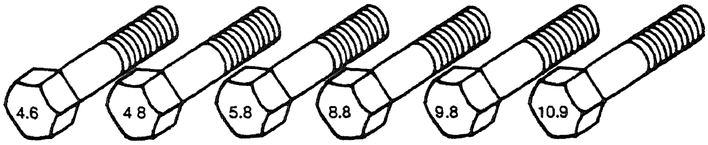
ENGLISH SYSTEM



Grade 1 or 2 Grade 5 Grade 8

English bolts: Identification marks on the bolt head represent Rockwell hardness. Generally, the bolt's grade is equal to the number of marks plus two. The higher the grade, the stronger the bolt.

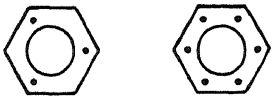
METRIC SYSTEM



Metric bolts: Identification class numbers on bolt heads represent tensile strength. Higher numbers indicate stronger bolts. Common metric fastener bolt strength properties are 9.8 and 10.9.

HEX NUT STRENGTH IDENTIFICATION

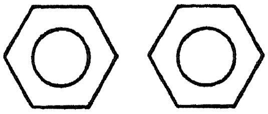
ENGLISH SYSTEM



Grade 5 Grade 8

Identification dots represent Rockwell hardness. The nut's grade is equal to the number of dots plus two. The higher the grade, the stronger the nut.

METRIC SYSTEM

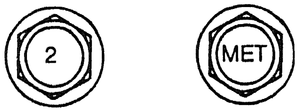


Identification class numbers on nuts represent tensile strength. Higher numbers indicate stronger nuts. Nuts may also have blue finish or paint daub on hex flat.

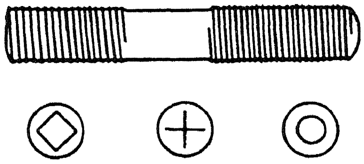
OTHER TYPES OF PARTS

Metric identification schemes vary by type of part, most often a variation of that used for bolts and nuts. Note that many types of English and Metric fasteners carry no special identification if they are otherwise unique.

–Stamped U-Nuts



–Tapping, thread forming and certain other case hardened screws.



CLASS 10.9 CLASS 9.8 CLASS 8.8

–Studs, Large studs may carry the property class number. Smaller studs use a geometric code on the end.

METRICS

ENGLISH/METRIC CONVERSION

DESCRIPTION	MULTIPLY	BY	FOR METRIC EQUIVALENT
Acceleration	ft/s^2	0.3048	m/s^2
	in/s^2	0.0254	m/s^2
Torque	lb-in	0.11298	N·m
	lb-ft	1.3558	N·m
Power	horsepower	0.746	kW
Pressure or Stress	inches of water	0.2491	kPa
	psi	6.895	kPa
	psi	0.069	bar
Energy or Work	BTU	1055.0	Joules(J)
	lb-ft	1.3558	Joules(J)
	kiloWatt-hour	3,600,000 or 3.6 x 10^6	Joules(J)
Light	foot candle	10.764	lumens/square meter (lm/m^2)
Fuel Performance	miles/gal	0.4251	kilometers/liter (km/L)
	gal/mile	2.3527	liters/kilometer (L/km)
Velocity	mph	1.6093	kilometers/hour (km/h)
Length	inch	25.4	mm
	foot	0.3048	m
	yard	0.9144	m
	mile	1.609	km
Area	square inch (in^2)	645.2	mm^2
		6.45	cm^2
	square ft (ft^2)	0.0929	m^2
	square yard	0.8361	m^2
Volume	cubic inch (in^3)	16387.0	mm^3
		16.387	cm^3
		0.0164	liters (L)
	quart	0.9464	liters (L)
	gallon	3.7854	liters(L)
	cubic yard	0.7646	m^3
Mass	pound	0.4536	kg
	ton	907.18	kg
	ton	0.9078	tonne (t)
Force	kilogram	9.807	N
	ounce	0.2780	N
	pound	4.448	N
Temperature	degree Farenheit (°F)	(°F-32) 0.556	degree Celsius (°C)

Customer Information Worksheet

Repair Order No. ________________

CUSTOMER NAME ____ DATE __________________________

PLEASE HELP US by checking all the spaces that describe the drive problem.

When did problem start to occur? ___ Suddenly ___ Gradually: approximate miles _________

Engine Starting Problems	Engine Quits Running Problems	Engine Idle Problems with the Vehicle Not Moving	Engine/Transmission Problems while the Vehicle is Moving
__ Will not start – will not even crank __ Cranks, but will not start __ Tries to start, but won't __ Starts, but takes a long time	__ Right after starting __ While idling __ When put into gear __ On acceleration __ During steady speed driving __ On deceleration __ Right after the vehicle is brought to a stop __ When parking	__ Engine speed is too slow all the time __ Engine speed is too slow when the A/C is on __ Engine speed is too fast __ Engine speed is rough or uneven	__ Runs rough __ Bucks and jerks __ Hesitates/stumbles on acceleration __ Misfires – cuts out __ Engine knocks or rattles __ Lack of power __ Backfires __ Poor fuel economy __ Transmission shifting concerns

About how often does the problem happen? ___ All the time ___ Most of the time ___ Occasionally

When does the problem usually occur? ___ Morning ___ Later in the day ___ Anytime

How long after starting the engine does the problem happen?
__ Within 2 minutes of starting the engine.
__ Between 2 and 10 minutes after the engine starts.
__ At least 10 minutes or longer after starting the engine.
__ It could happen any time after starting the engine.

How long does the engine have to be off before the problem will happen again?
__ 4 hours or more
__ More than 30 minutes, but less than 4 hours.
__ Less than 30 minutes after being turned off.
__ It does not matter how long the engine was off.

Do weather conditions affect the problem? __ No __ Yes
If yes, which ones? __ Hot __ Cold __ Rain __ Fog __ Snow __ Humid __ Dry
Does outside temperature affect the problem? __ No __ Yes
If yes, what temperature? ____ °F/°C

Please Check any of these driving conditions that cause the problem. __ Accelerating __ Decelerating __ Turning Right/Left
__ Steady Speed (approximate vehicle speed ______ MPH / Km/h)

Type of fuel used? __ Regular unleaded __ Midgrade unleaded __ Premium unleaded __ Gasohol __ Other

Was the Check Engine light on? __ Yes __ No __ Flashing
Were other warning lights on? __ Yes __ No __ Flashing Which Ones? ______________________________

Additional Comments:
____
____
____

Additional Customer Information Worksheet in the back of the manual.

AA0220-B

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Your suggestions will help us to improve future editions of this manual.

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☐ Passenger Car Workshop Manual
☐ Owner Guide
☐ Wiring Diagram
☐ Body Repair Manual
☐ Truck Workshop Manual
☐ PC/ED Manual
☐ EVTM

Vehicle Line:______________________________ **Model Year:**__________________

Please check the area in which the concern is located in the publication:

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☐ Body
☐ Frame and Mounting
☐ Engine
☐ Suspension
☐ Driveline
☐ Brakes
☐ Transmission/Transaxle
☐ Clutch
☐ Exhaust
☐ Fuel
☐ Climate Control
☐ Instrumental Warning
☐ Battery/Charging
☐ Audio
☐ Lighting
☐ Electrical
☐ Schematics
☐ Pinpoint Test

Section and Pages:__________________________

Explain your concern or suggestion below: ***(Please print)***

What do you think is the main cause of your concern?

☐ Missing Information ☐ Inaccurate Information ☐ Incomplete Information

Please tell us who you are: ***(Please print)***

Your Name:______________________________

Company Name:______________________________

Street:______________________________

City:__________________ **State:**____________ **Zip/Postal Code:**____________

Phone Number:__________________ **FAX Number:**__________________

Occupation: *(Please mark box)*

☐ Ford Dealership Technician
☐ Home Mechanic
☐ Technician - Other than Ford Dealership
☐ Ford Dealership Service Manager
☐ Engineer
☐ Other:__________________

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