SECTION 5

Pinpoint Tests

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Pinpoint Tests

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SECTION 5

Pinpoint Tests

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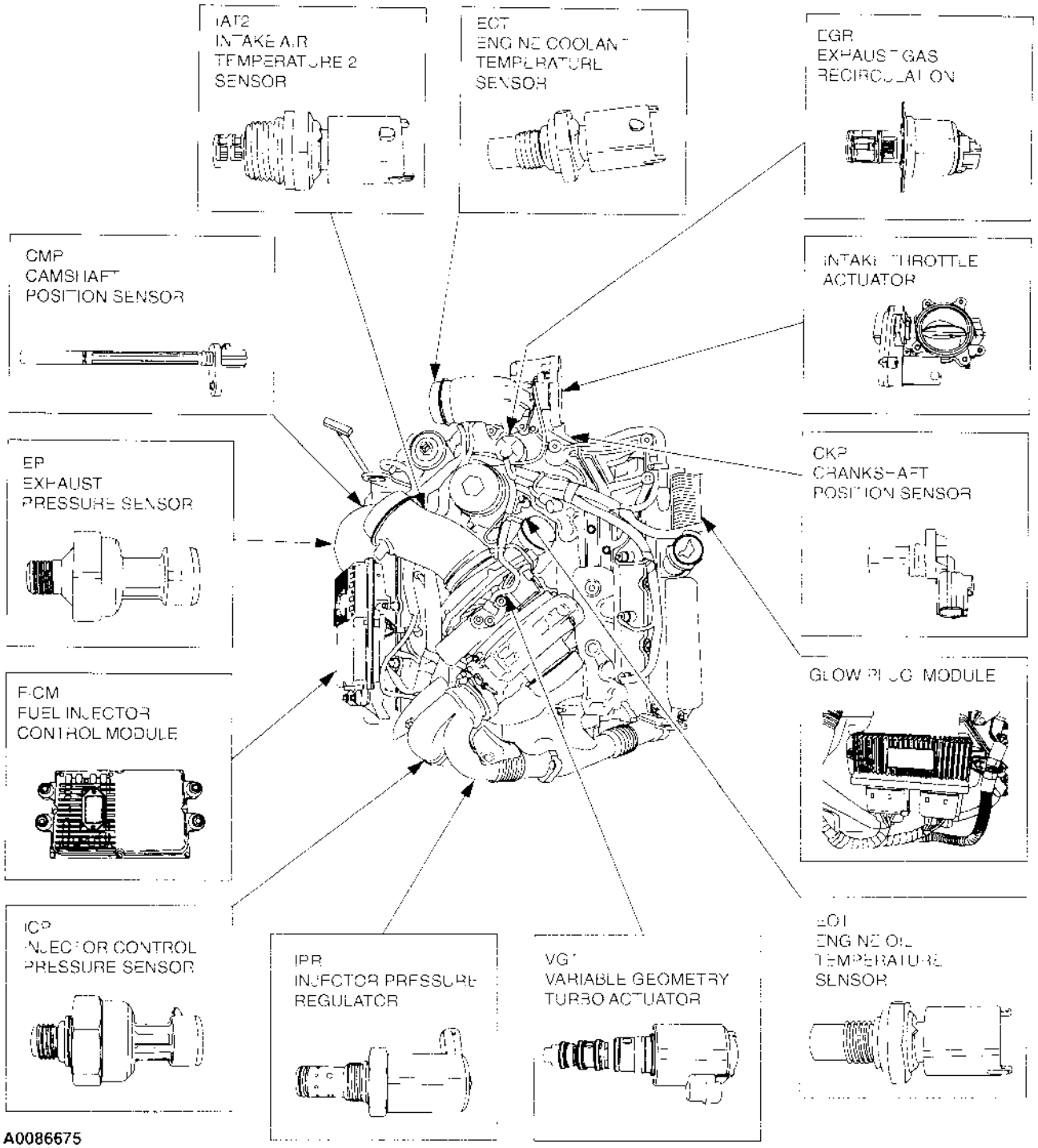
SECTION 5

Pinpoint Tests

Contents (Continued)

Component Location

F-SuperDuty/Excursion — Early Build



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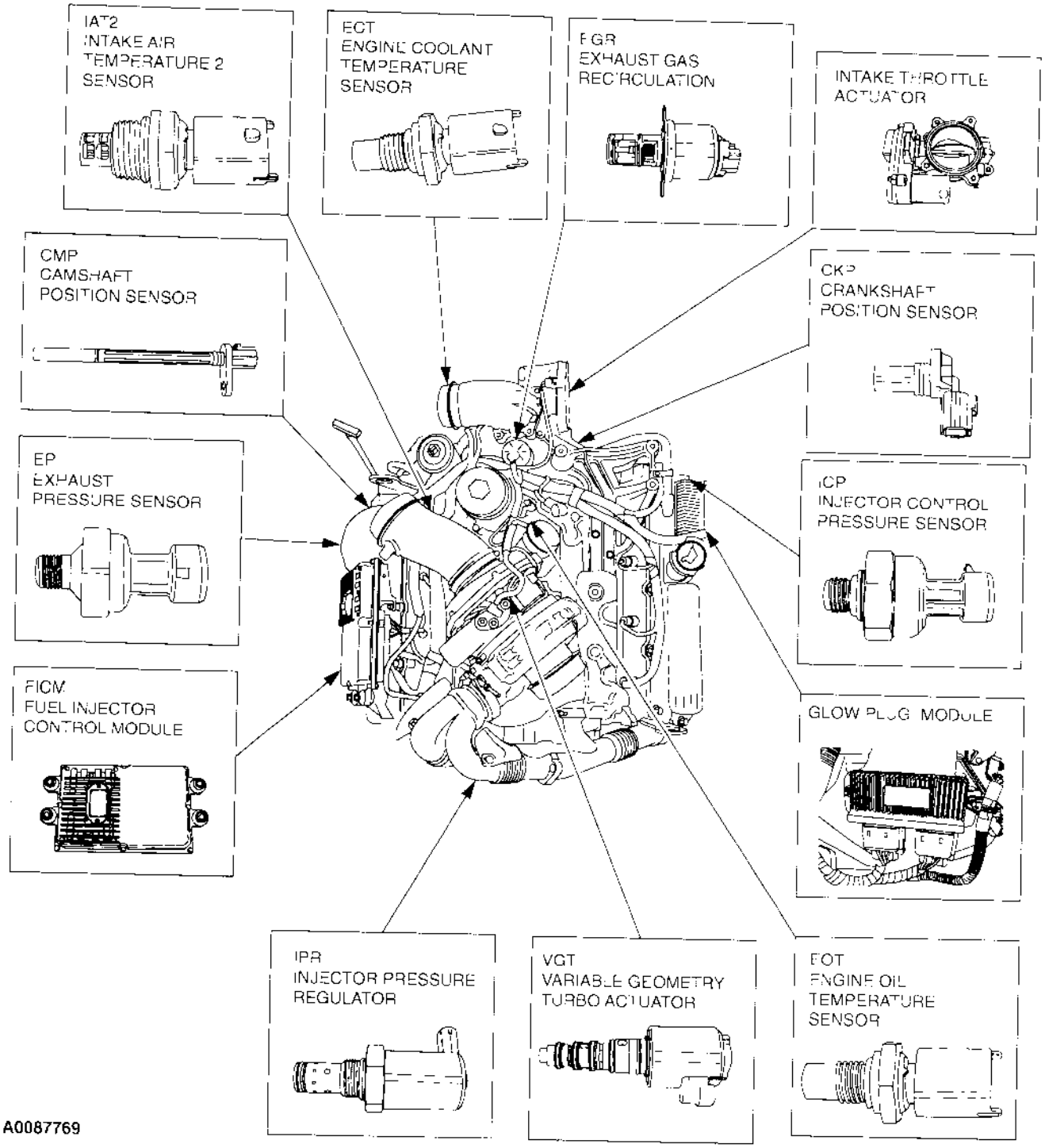
Component Location

E-Series or F-SuperDuty/Excursion — Late Build



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 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 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-.25 V if the circuit is designed to pull down when disconnected or a higher voltage (normally 4.6-5, or 12 V) 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.

General Procedures for Pinpoint Testing

Harness Resistance Tests

Harness resistance tests are carried out when a circuit is suspected of having high resistance or being open. These tests are carried out with the 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 and measuring resistance through both halves of the circuit.

Vehicle Battery

A

Circuit Function

With the ignition switch in the START or RUN position, voltage is applied to the coil of the powertrain control module (PCM) relay. The applied voltage energizes the relay and closes the internal relay contacts. With the relay contacts closed, vehicle power (VPWR) is supplied to the PCM.

Fault Detection

Vehicle power is monitored by the PCM. When the voltage is above or below a pre-calibrated value, an internal counter will increment until a DTC is set.

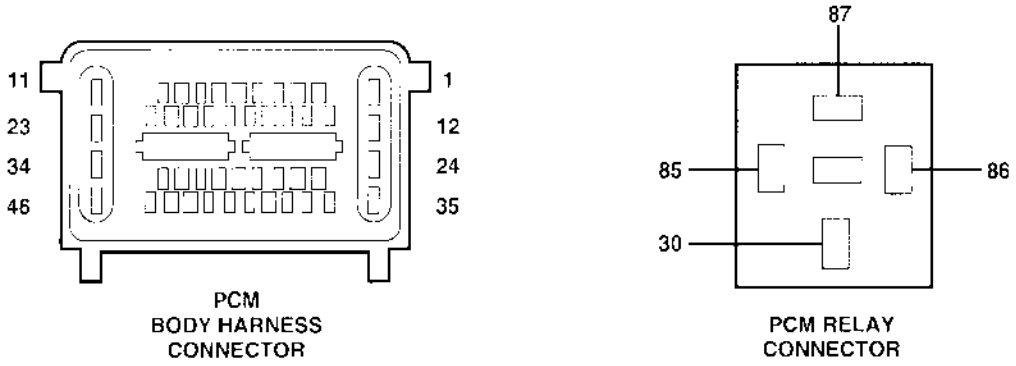
⚠ **CAUTION: The PCM harness connectors must be properly seated and the connector latch properly attached to eliminate possible driveability concerns or a no start condition. Installing the PCM connectors on an angle may cause an improper connection, misdiagnosis and damaged components. Install the connector until the lever pivots and seats itself. Apply light pressure to get the connector into position on the PCM and then fully seat the connector.**

Note: Visually inspect the harness connectors for corrosion, damage, proper mating and correct pin tension.

Note: When the PCM is disconnected additional DTCs will be set. Clear all DTCs after restoring the vehicle.

DTC Description

- P0560 = System Voltage
- P0562 = System Voltage Low
- P0563 = System Voltage High



PCM
BODY HARNESS
CONNECTOR

PCM RELAY
CONNECTOR

A0086708

Vehicle Battery

A

Test Steps	Results	Action to Take
A1 DIAGNOSTIC TROUBLE CODES (DTCS) P0560, P0562, OR P0563		
Note: DTC P0563 may set during a 24 volt jump start. DTC P0562 may set during crank with a low battery condition. • Check the battery and charging system voltages. REFER to Workshop Manual Section 414. • **Are the battery and charging system voltages within specifications?**	Yes No	→ GO to **A2**. → REPAIR as necessary. REFER to the Workshop Manual Section 414.
A2 CHECK THE PCM RELAY VOLTAGE CIRCUITS		
Note: For E-Series, the PCM diode is internal to the battery junction box (BJB). REFER to the Wiring Diagrams Manual for PCM relay coil pin locations. • Key off. • Disconnect the PCM relay. • Key on, engine off. • Measure the voltage between the PCM relay battery voltage circuit pin 30, harness side and ground; and measure the voltage between the PCM relay coil power circuit, harness side and ground. • **Are the voltages greater than 10.5 volts?**	Yes No	→ GO to **A3**. → REPAIR the circuit in question.
A3 CHECK THE PCM RELAY COIL GROUND CIRCUIT		
Note: For F-SuperDuty/Excursion, the PCM diode is internal to the central junction box (CJB). REFER to the Wiring Diagrams Manual for PCM relay coil pin locations. • Connect a test lamp between the PCM relay pin 30, harness side and the PCM relay coil ground circuit, harness side. • **Is the test lamp illuminated?**	Yes No	→ GO to **A4**. → REPAIR the open ground circuit.
A4 CHECK THE PCM RELAY		
• Perform the PCM relay component test. REFER to Wiring Diagrams Cell 149: Component Testing. • **Does the PCM relay pass the component test?**	Yes No	→ GO to **A5**. → INSTALL a new PCM relay.

Vehicle Battery

A

Test Steps		Results	→	Action to Take
A5	CHECK THE PCM POWER CIRCUITS FOR AN OPEN			
	• Key off. • Disconnect the PCM body harness connector. • Measure the resistance between the PCM relay pin 87, harness side and the PCM body harness connector pins 34 and 46, harness side. • **Are the resistances less than 5 ohms?**	Yes	→	GO to **A6.**
		No	→	REPAIR the circuit in question.
A6	CHECK THE PCM GROUND CIRCUITS FOR AN OPEN			
	• Measure the resistance between the PCM body harness connector pins 10, 11 and 23, harness side and ground. • **Are the resistances less than 5 ohms?**	Yes	→	CLEAR the DTCs. REPEAT the self-test. If DTC P0560, P0562, or P0563 is present again, INSTALL a new PCM.
		No	→	REPAIR the circuit in question.

Reference Voltage

B

Circuit Function

Reference voltage (VREF) is a positive voltage (approximately 5.0 volts ± 3%) that is an output by the powertrain control module (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.

Note: Enter this pinpoint test only when a check for VREF has failed in the sensor pinpoint tests for 3-wire sensors and actuators.

Note: A VREF circuit shorted to ground will cause a no-start condition. No DTCs will be present due to the inability of the PCM to communicate with the scan tool.

⚠ **CAUTION: The PCM harness connectors must be properly seated and the connector latch properly attached to eliminate possible driveability concerns or a no start condition. Installing the PCM connectors on an angle may cause an improper connection, misdiagnosis and damaged components. Install the connector until the lever pivots and seats itself. Apply light pressure to get the connector into position on the PCM and then fully seat the connector.**

Note: Visually inspect the harness connectors for corrosion, damage, proper mating and correct pin tension.

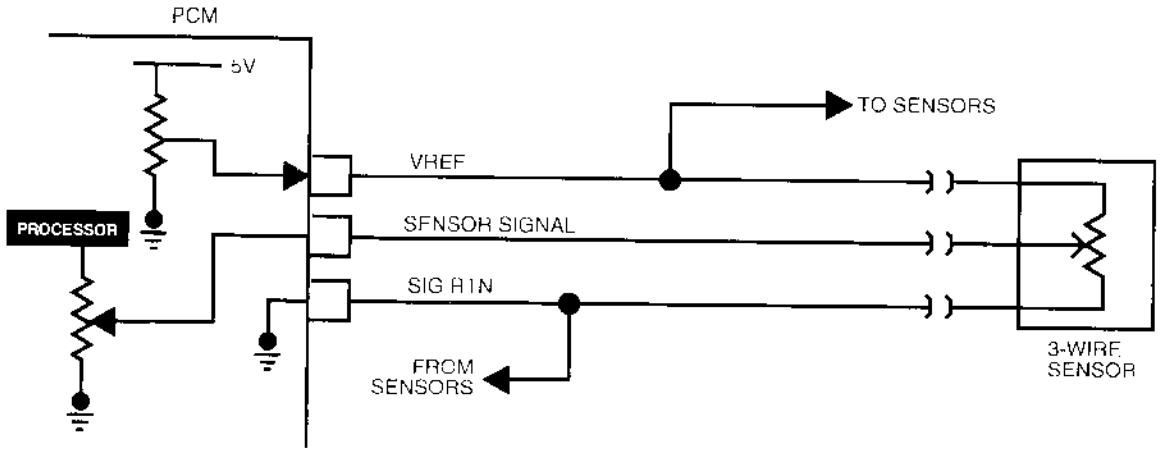
Note: When the PCM is disconnected additional DTCs will be set. Clear all DTCs after restoring the vehicle.

Remember

This pinpoint test is intended to diagnose only the following:

- sensor harness circuits: SIG RTN, VREF
- 3-wire sensors and actuators
- PCM

Reference Voltage — B



Test Steps	Results →	Action to Take
B1 CHECK VREF CIRCUIT		
Note: More than one VREF circuit may be present, all VREF circuits must be checked. • Key off. • Disconnect any 3-wire sensor. • Key on. • Measure the voltage between VREF signal circuit and ground. • **Is the voltage between 4.5 and 5.5 volts?**	Yes No	→ GO to **B4**. → GO to **B2**.
B2 CHECK VREF FOR A SHORT TO GROUND		
• Key off. • Disconnect the PCM harness connector. • Measure the resistance between suspect sensor VREF circuit and ground. • **Is the resistance greater than 10,000 ohms?**	Yes No	→ GO to **B3**. → REPAIR short in circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
B3 CHECK VREF CIRCUIT FOR AN OPEN		
• Measure the resistance between PCM harness connector and faulty sensor VREF circuit. • **Is the resistance less than 5 ohms?**	Yes No	→ INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system. → REPAIR open in VREF circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

Reference Voltage

B

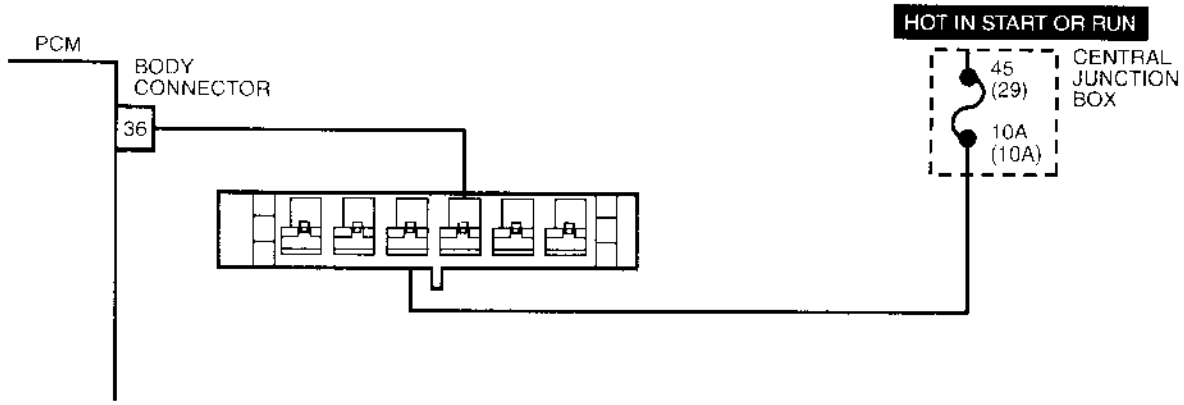
Test Steps		Results		Action to Take
B4	CHECK VREF AND SIG RTN CIRCUITS OF FAULTED SENSOR			
	• Disconnect suspect sensor. • Key on. • Measure the voltage between VREF circuit and SIG RTN circuit at the harness connector of the failed sensor. • **Is the voltage between 4.5 and 5.5 volts?**	Yes	→	WIGGLE the harness. CHECK for damaged or corroded pins. CHECK for loose connection. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
		No	→	GO to **B5**.
B5	CHECK SIG RTN CIRCUIT FOR AN OPEN			
	• Key off. • Measure the resistance between SIG RTN circuit and ground. • **Is the resistance less than 5 ohms?**	Yes	→	GO to **B6**.
		No	→	REPAIR open in SIG RTN circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
B6	CHECK VREF CIRCUIT FOR A SHORT TO GROUND			
	• Disconnect the PCM harness connector of faulty sensor. • Measure the resistance between VREF circuit and ground. • **Is the resistance greater than 10,000 ohms?**	Yes	→	GO to **B7**.
		No	→	REPAIR VREF circuit short to ground. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
B7	CHECK VREF CIRCUIT FOR AN OPEN			
	• Key off. • Measure the resistance between the PCM harness connector VREF signal circuit and fault sensor VREF circuit. • **Is the resistance less than 5 ohms?**	Yes	→	INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
		No	→	REPAIR open in VREF circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

Clutch Pedal Position (CPP)/Neutral Start Switch

C

Signal Functions

The normally closed clutch pedal position (CPP) switch detects when the clutch pedal is pressed (manual transmissions) to disable the speed control system and PTO and raised-idle mode. Switch actuation occurs as the clutch is initially pressed prior to disengaging the transmission at the top of travel.



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⚠ **CAUTION: The powertrain control module (PCM) harness connectors must be properly seated and the connector latch properly attached to eliminate possible driveability concerns or a no start condition. Installing PCM connectors on an angle may cause an improper connection, misdiagnosis and damaged components. Install the connector until the lever pivots and seats itself. Apply light pressure to get the connector into position on the PCM and then fully seat the connector.**

Note: Visually inspect the harness connectors for corrosion, damage. proper mating and correct pin tension.

Note: When the PCM is disconnected additional DTCs will be set. Clear all DTCs after restoring the vehicle.

DTC Description

- P0704 = Clutch Switch Input Circuit Malfunction

Clutch Pedal Position (CPP)/Neutral Start Switch

C

Test Steps	Results	Action to Take
C1 DIAGNOSTIC TROUBLE CODE (DTC) P0704 Note: Refer to the PCM and component connector pin numbers at the beginning of this pinpoint test. Note: No PID transition indicates a CPP circuit failure. • Connect the scan tool. • Key on. • Access CPP/PNP PID. • Apply and release the clutch pedal. • **Does the PID read ON only?**	Yes No	→ GO to **C2**. → GO to **C4**.
C2 CHECK CPP SWITCH • Disconnect the CPP switch. • **Does the PID go to OFF?**	Yes No	→ INSTALL a new CPP switch. RESTORE the vehicle. CLEAR DTCs and RETEST the system. → GO to **C3**.
C3 CHECK CPP CIRCUIT FOR A SHORT TO VOLTAGE • Key off. • Disconnect the PCM body harness connector. • Key on. • Measure the voltage between the PCM body harness connector pin 36 and ground. • **Is the voltage less than 0.2 volts?**	Yes No	→ INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system. → REPAIR short to voltage. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
C4 CHECK CPP SWITCH • Key off. • Remove CPP switch. • Measure the resistance across CPP switch terminals. • **Is the resistance less than 5 ohms?**	Yes No	→ GO to **C5**. → INSTALL a new CPP switch. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
C5 CHECK CPP CIRCUIT FOR AN OPEN • Reinstall CPP switch. • Measure the resistance between the PCM body harness connector pin 36 and the non-powered side of the fuse block. • **Is the resistance less than 5 ohms?**	Yes No	→ INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system. → REPAIR open in wiring. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

Crankshaft Position (CKP) Sensor | D

Signal Functions

The crankshaft position (CKP) signal source is a variable reluctance sensor mounted in the right front side of the engine block. The sensor reacts to a target wheel on the crankshaft. The target wheel is a 60 minus 2 tooth steel disk with 58 evenly spaced teeth and a SYNC gap (a minus 2 slot wide tooth). The sensor produces pulses for each tooth edge that passes it. Crankshaft speed is derived from the frequency of the CKP sensor signal. The crankshaft position is determined by synchronizing the SYNC tooth with the SYNC gap signals from the target wheel. Diagnostic information on the CKP input signal is obtained by carrying out accuracy checks on frequency, and duty cycle with software strategies.

The powertrain control module (PCM) uses the CKP and camshaft position (CMP) signal to calculate engine speed and piston position. The CKP creates a signal used by the PCM to indicate cylinder identification in a particular bank. The CKP contains a permanent magnet that creates a magnetic field. The signal is created when the target wheel rotates and breaks the magnetic field created by the sensor. The engine will not operate without a CKP signal.

Engine Speed — Is determined by counting the 15 windows on the crankshaft gear each crankshaft revolution.

Injection Control Pressure — Engine speed is one of the controlling variables in the calculation of desired injection control pressure.

Exhaust Pressure — Exhaust pressure control is a function of engine speed and load.

Fuel Quantity Control/Torque Limiting — Engine torque and fuel is controlled and is dependent on engine speed. Fuel quantity is determined by engine speed.

⚠ **CAUTION: The PCM harness connectors must be properly seated and the connector latch properly attached to eliminate possible driveability concerns or a no start condition. Installing the PCM connectors on an angle may cause an improper connection, misdiagnosis and damaged components. Install the connector until the lever pivots and seats itself. Apply light pressure to get the connector into position on the PCM and then fully seat the connector.**

Note: Visually inspect the harness connectors for corrosion, damage, proper mating and correct pin tension.

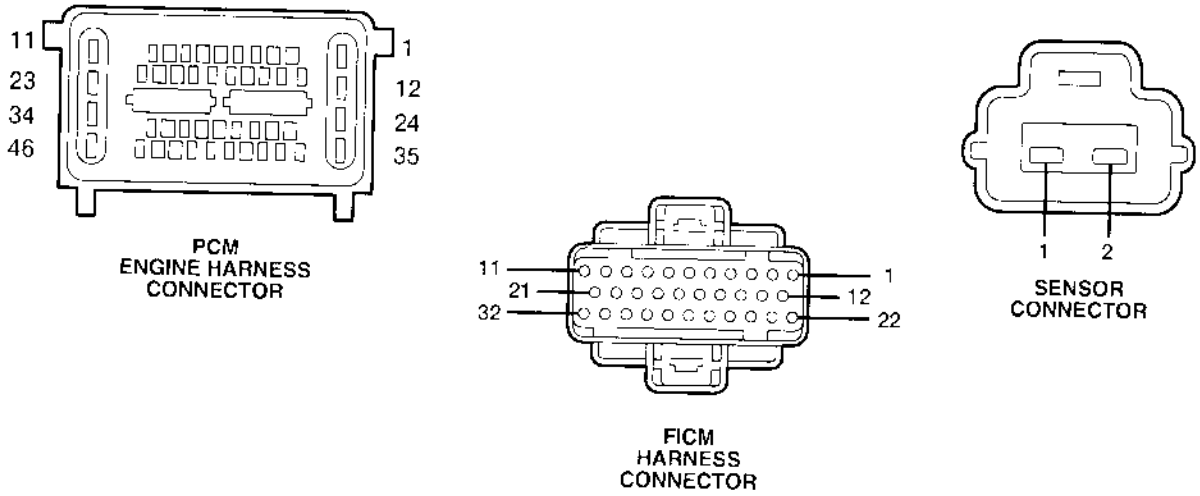
Note: When the PCM is disconnected additional DTCs will be set. Clear all DTCs after restoring the vehicle.

Crankshaft Position (CKP) Sensor | D

Note

This pinpoint test is intended to diagnose the following:

- CKP sensor
- harness circuits: CKP (+), CKP (-), CKP out and CKP shield
- PCM



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DTC Descriptions

- P0335 = Crankshaft Position Sensor Circuit A
- P0336 = Crankshaft Position Sensor Circuit A Range/Performance
- P2617 = Crankshaft Position Out Fault

Crankshaft Position (CKP) Sensor — D

Test Steps	Results	Action to Take
D1 PRELIMINARY DIAGNOSIS FOR DTCS P0335, P0336, P2617		
Note: Some DTCs require that the engine go through more than one key cycle to set. Note: DTCs P0336 and P2617 are calibrated to an increment counter. To set a DTC requires greater than 5 consecutive fault events in the crank mode or 10 fault events in the run mode. Perform the required number of key cycles from RUN to START to RUN (cycling to OFF will reset timer) and then perform the KOEO or KOER self-test. • Perform the visual inspection. • Connect the scan tool. • Retrieve and record all DTCs. • Clear all DTCs. • Perform the KOEO on-demand self-test. • Perform the KOER on-demand self-test. • **Is DTC P0335, P0336 or P2617 present?**	Yes No	→ For DTCs P0335 or P0336: GO to **D2**. For DTC P2617, GO to **D8**. → Unable to duplicate condition. CHECK for loose connection, damaged or corroded terminals or pins. WIGGLE harness attempting to recreate the fault. REPAIR as necessary. REFER to Section 3 if a driveability concern exists. REFER to Section 4 to diagnose a no-start condition.
D2 DIAGNOSTIC TROUBLE CODE (DTC) P0335, P0336		
Note: Refer to the PCM and component connector pin numbers at the beginning of this pinpoint test. • Possible causes: — one or both sensor outputs open — one of both sensor outputs shorted to ground — sensor outputs shorted together — one output open and the other output shorted to ground — sensor output shorted to voltage — CKP sensor — PCM • **Does the engine start?**	Yes No	→ GO to **D3**. → REFER to Section 4 to diagnose no-start condition.
D3 CHECK THE RESISTANCE OF THE CKP SENSOR		
• Key off. • Disconnect the PCM engine harness connector. • Measure the resistance between PCM engine harness connector pin 30 and pin 41. • **Is the resistance between 300 and 400 ohms?**	Yes No	→ GO to **D5**. → GO to **D6**.

Crankshaft Position (CKP) Sensor

D

Test Steps	Results	Action to Take
D5 CONFIRM PCM FAULT Note: Some DTCs require that the engine go through more than one key cycle to set. • Key on. • Reconnect all electrical connectors. • Key on. • Clear all DTCs. • Perform the KOEO on-demand self-test. • Perform the KOER on-demand self-test. • **Is DTC P0335, P0336 or P2617 present?**	Yes No	INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system. Unable to duplicate the condition. CHECK for loose connection, damaged or corroded terminals or pins. WIGGLE harness attempting to recreate the fault. REFER to Section 3 if a driveability concern exists.
D6 CHECK CKP CIRCUITS FOR A SHORT TO GROUND • Disconnect the CKP sensor. • Inspect the CKP sensor for damaged or corroded pins. • Measure the resistance between PCM engine harness connector as follows: — pin 30 and ground — pin 41 and ground — pin 30 and pin 42 — pin 41 and pin 42 • **Are the resistances greater than 10,000 ohms?**	Yes No	GO to **D7**. REPAIR short in CKP sensor circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
D7 CHECK CKP SENSOR CIRCUITS FOR AN OPEN • Measure the resistance between the PCM engine harness connector pin 30 and CKP sensor harness connector pin 1; and PCM engine harness pin 41 and CKP sensor harness connector pin 2. • **Are the resistances less than 5 ohms?**	Yes No	INSTALL a new CKP sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system. REPAIR open circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

Crankshaft Position (CKP) Sensor — D

Test Steps	Results	Action to Take
D8 DIAGNOSTIC TROUBLE CODE (DTC) P2617 Note: Refer to the PCM, FICM and component connector pin numbers at the beginning of this pinpoint test. Note: Some DTCs require that the engine go through more that one key cycle to set. Note: DTCs P2617 and P2614 may set simultaneously after an engine stalling event. Note: DTCs P0336 and P2617 are calibrated to an increment counter. To set a DTC requires greater than 5 consecutive fault events in the crank mode or 10 fault events in the run mode. Perform the required number of key cycles from RUN to START to RUN (cycling to OFF will reset timer) and then perform the KOEO or KOER self-test. • Possible causes: — signal shorted to voltage — signal shorted to ground — signal circuit open — PCM • Perform the KOEO on-demand self-test. • Perform the KOER on-demand self-test. • **Is DTC P2617 present?**	Yes No	→ GO to **D9**. → Unable to duplicate condition. CHECK for loose connections, damaged or corroded pins. WIGGLE harness attempting to recreate fault. REFER to Section 3 if a driveability concern exists.
D9 CHECK CRANKSHAFT POSITION SIGNAL CIRCUIT FOR A SHORT TO VOLTAGE • Key off. • Disconnect the PCM engine harness connector. • Disconnect the FICM harness connector C. • Key on. • Measure the voltage between FICM harness connector C pin 5 and ground. • **Is the voltage less than 0.2 volts?**	Yes No	→ GO to **D10**. → REPAIR short to voltage. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
D10 CHECK CRANKSHAFT POSITION SIGNAL FOR A SHORT TO GROUND • Key off. • Measure the resistance between FICM harness connector C pin 5 and ground. • **Is the resistance greater than 10,000 ohms?**	Yes No	→ GO to **D11**. → REPAIR short to ground in signal output circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

Crankshaft Position (CKP) Sensor

D

Test Steps		Results		Action to Take
D11	CHECK CRANKSHAFT POSITION SIGNAL CIRCUIT FOR AN OPEN			
	• Measure the resistance between FICM harness connector C pin 5 and PCM engine harness connector pin 19. • **Is the resistance less than 5 ohms?**	Yes	→	INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
		No	→	REPAIR open in output signal circuit.

Manifold Absolute Pressure (MAP) Sensor, Analog

E

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.

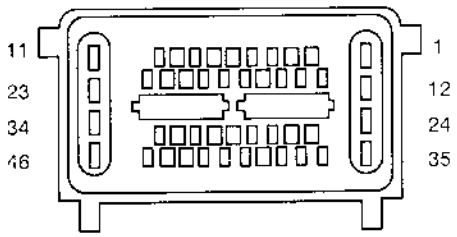
Fault Detection/Management

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.

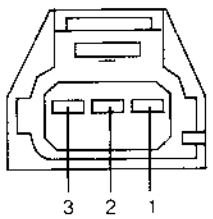
⚠ **CAUTION: The PCM harness connectors must be properly seated and the connector latch properly attached to eliminate possible driveability concerns or a no start condition. Installing the PCM connectors on an angle may cause an improper connection, misdiagnosis and damaged components. Install the connector until the lever pivots and seats itself. Apply light pressure to get the connector into position on the PCM and then fully seat the connector.**

Note: Visually inspect the harness connectors for corrosion, damage, proper mating and correct pin tension.

Note: When the PCM is disconnected additional DTCs will be set. Clear all DTCs after restoring the vehicle.



PCM
BODY HARNESS
CONNECTOR



SENSOR
CONNECTOR

A0063430

Manifold Absolute Pressure (MAP) Sensor, Analog

E

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
2.8	172	25
3.6	206	30
4.3	242	35

Note: ± 0.3 volt from expected voltage reading is allowed.

	Test Steps	Results	Action to Take
E1	PRELIMINARY DIAGNOSIS FOR DTCS P0236, P0237, P0238		
	• Perform the visual inspection. • Connect the scan tool. • Retrieve and record all DTCs. • Record freeze frame data. • Clear all DTCs. • Perform the KOEO On-Demand Self Test. • Perform the KOER On-Demand Self Test. • **Is DTC P0236, P0237 or P0238 present?**	Yes →	For DTC P0236, GO to **E2**. For DTC P0237, GO to **E6**. For DTC P0238, GO to **E10**.
		No →	Unable to duplicate condition. CHECK for loose connection, damaged or corroded pins. WIGGLE harness attempting to recreate the fault. REPAIR as necessary. REFER to Section 3 if a driveability concern exists.
E2	DIAGNOSTIC TROUBLE CODE (DTC) P0236		
	• Possible causes: — restricted MAP hose — low turbo boost — intake manifold — restricted MAP sensor — PCM • Perform visual inspection. • Inspect MAP sensor hose and manifolds for damage, leaks, restrictions and misrouting. • **Are manifolds and MAP hose OK and free from damage?**	Yes →	GO to **E3**.
		No →	REPAIR leaks as necessary. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

Manifold Absolute Pressure (MAP) Sensor, Analog — E

	Test Steps	Results →	Action to Take
E3	CHECK MAP SENSOR		
	Note: Refer to MAP voltage table at beginning of the pinpoint test. • Access MAP VOLT PID. • Key on. • **Is the voltage ± 0.5 volts for given altitude?**	Yes → No →	GO to **E4**. INSTALL a new MAP sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
E4	MAP SENSOR VOLTAGE CHECK		
	• Disconnect pressure hose from MAP sensor. • Key on, engine off. • Using Pressure Adapter Kit 014-00761 or equivalent (gauge bar), apply 69 kPa (10 psi) of pressure to the MAP sensor. • Measure voltage between MAP sensor harness connector signal pin 2 and ground. • **Is the voltage reading 2.8 volts + 0.3 volts?**	Yes → No →	GO to **E5**. INSTALL a new MAP sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
E5	MAP PERFORMANCE TEST		
	• Connect pressure hose to MAP sensor. • Disconnect MAP sensor pressure hose from intake manifold and install a pressure (boost) gauge. • Record the gauge pressure. • Road test the vehicle and accelerate vehicle to achieve full boost. • **Does the boost pressure exceed 82 kPa (12 psi) at full acceleration/boost and return to the recorded gauge pressure at idle?**	Yes → No →	RESTORE the vehicle. CLEAR DTCs and RETEST the system. If DTC returns, INSTALL a new PCM. INSPECT intake manifolds for leaks. CHECK turbo condition. REFER to the Workshop Manual Section 303.
E6	DIAGNOSTIC TROUBLE CODE (DTC) P0237		
	Note: Refer to the PCM and component connector pin numbers at the beginning of this pinpoint test. • Possible causes: — MAP signal circuit open or shorted to ground — open VREF circuit — MAP sensor — PCM • Key off. • Disconnect the MAP sensor. • Key on. • Measure the voltage between the VREF circuit pin 1 and signal return circuit pin 3. • **Is the voltage between 4.5 and 5.5 volts?**	Yes → No →	GO to **E7**. REPAIR open in VREF or signal return circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

Manifold Absolute Pressure (MAP) Sensor, Analog

E

Test Steps	Results	Action to Take
E7 CHECK SIGNAL CIRCUIT FOR A SHORT TO GROUND • Key off. • Disconnect the PCM body harness electrical connector. • Measure the resistance between the MAP sensor harness connector pin 2 and ground. • **Is the resistance greater than 10.000 ohms?**	Yes No	→ GO to **E8**. → REPAIR short to ground in the signal circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
E8 CHECK SIGNAL CIRCUIT FOR AN OPEN • Measure the resistance between MAP sensor electrical connector signal circuit pin 2 and PCM body harness electrical connector pin 41. • **Is the resistance less than 5 ohms?**	Yes No	→ GO to **E9**. → REPAIR open in signal circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
E9 CHECK MAP SENSOR CIRCUIT Note: This step may cause DTC P0238 to set. • Reconnect the PCM body harness connector. • Key on, engine off. • Access MAP VOLT PID. • Record the MAP VOLT PID reading. • Install a jumper wire between MAP sensor VREF circuit and signal circuit. • **Is the MAP PID voltage reading approximately 4.0 to 5.5 volts?**	Yes No	→ INSTALL a new MAP sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system. → INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
E10 DIAGNOSTIC TROUBLE CODE (DTC) P0238 Note: Visually inspect the vehicle for aftermarket accessories and performance modifications (exhaust system, turbocharger, performance chip, etc.). Refer to Section 1 Diesel Electronic Control (EC) System. Modifications to OBD Vehicles. Note. Refer to the PCM and component connector pin numbers at the beginning of this pinpoint test. • Possible causes: — signal circuit shorted to power — open ground circuit — MAP sensor — PCM • Induce opposite DTC. • Install the scan tool. • Clear all DTCs • Disconnect the MAP sensor electrical connector. • Perform the On-Demand Self Test. • **Is DTC P0237 set?**	Yes No	→ INSTALL a new MAP sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system. → GO to **E11**.

Manifold Absolute Pressure (MAP) Sensor, Analog

E

	Test Steps	Results	→	Action to Take
E11	CHECK MAP SENSOR SIGNAL CIRCUIT FOR A SHORT TO VOLTAGE			
	• Key off. • Disconnect the PCM body harness connector. • Key on. • Measure the voltage between the MAP sensor harness connector pin 2 and ground. • **Is the voltage less than 0.2 volts?**	Yes No	→ →	GO to **E12**. REPAIR short to voltage in signal circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
E12	CHECK MAP SENSOR SIGNAL RETURN FOR AN OPEN			
	• Key off. • Measure the resistance between MAP sensor harness connector pin 3 signal return and PCM body harness electrical connector pin 33. • **Is the resistance less than 5 ohms?**	Yes No	→ →	INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system. REPAIR open in signal return circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

Intake Air Temperature (IAT) Sensor | F

Circuit Function

The intake air temperature (IAT) sensor, located inside the mass air flow housing, is a thermistor-type sensor with a variable resistance that is inversely proportional to temperature changes. 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 intake air temperature to control timing and fuel rate when cold-starting. Continuous monitoring by the IAT sensor limits smoke emission.

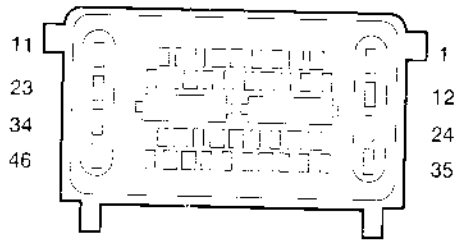
Fault Detection/Management

An IAT signal that is detected out of range high or low by the PCM will cause the engine to ignore the IAT signal and assume an ambient temperature of 25°C (77°F).

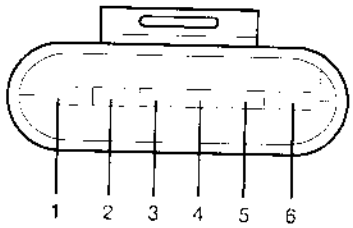
⚠ CAUTION: The PCM harness connectors must be properly seated and the connector latch properly attached to eliminate possible driveability concerns or a no start condition. Installing the PCM connectors on an angle may cause an improper connection, misdiagnosis and damaged components. Install the connector until the lever pivots and seats itself. Apply light pressure to get the connector into position on the PCM and then fully seat the connector.

Note: Visually inspect the harness connectors for corrosion, damage, proper mating and correct pin tension.

Note: When the PCM is disconnected additional DTCs will be set. Clear all DTCs after restoring the vehicle.



PCM
BODY HARNESS
CONNECTOR



MAF/IAT
SENSOR CONNECTOR

A0063431

DTC Descriptions

- P0113 = IAT Sensor Circuit High Input
- P0112 = IAT Sensor Circuit Low Input

Intake Air Temperature (IAT) Sensor — F

Test Steps		Results	Action to Take
F1	PRELIMINARY DIAGNOSIS FOR DTCs P0112, P0113		
	• Perform a visual inspection. • Connect scan tool. • Retrieve and record any continuous and on-demand DTCs. • Record freeze frame data. • Clear all DTCs. • Perform On-Demand Self-Test. • **Are DTCs P0112 or P0113 present?**	Yes No	→ For P0112. GO to **F2**. For P0113. GO to **F4**. → UNABLE to duplicate condition. CHECK for loose connections, damaged or corroded terminals or pins. WIGGLE harness attempting to recreate the fault. REPAIR as necessary. REFER to Section 3 if a driveability concern exists.
F2	DIAGNOSTIC TROUBLE CODE (DTC) P0112		
	Note: Refer to the PCM and component connector at the beginning of this pinpoint test. • Possible causes: — circuit shorted to ground — IAT sensor — PCM • Check for opposite failure. • Key off. • Disconnect the IAT sensor. • Perform On-Demand Self-Test. • **Is DTC P0113 present?**	Yes No	→ INSTALL a new IAT sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system. → GO to **F3**.
F3	CHECK SIGNAL CIRCUIT FOR A SHORT TO GROUND		
	• Disconnect the PCM body harness connector. • Measure the resistance between IAT sensor electrical connector pin 6, and ground. • **Is the resistance greater than 10,000 ohms?**	Yes No	→ INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system. → REPAIR short to ground in the IAT signal circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

Intake Air Temperature (IAT) Sensor

F

Test Steps	Results	Action to Take
F4 DIAGNOSTIC TROUBLE CODE P0113 Note: Refer to the PCM and component connector at the beginning of this pinpoint test. • Possible Causes: -- circuit shorted to voltage — open in signal return circuit — IAT sensor — PCM • Key off. • Disconnect the IAT sensor. • Install a jumper between pins 1 and 6, of the IAT sensor electrical connector. • Key on. • Perform On-Demand Self-Test. • **Is DTC P0112 present?**	Yes	→ INSTALL a new IAT sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
	No	→ GO to **F5**.
F5 CHECK SIGNAL RETURN CIRCUIT FOR AN OPEN • Key off. • Disconnect the PCM body harness electrical connector. • Measure the resistance between IAT sensor connector pin 1, and the PCM body harness electrical connector pin 33. • **Is the resistance less than 5 ohms?**	Yes	→ GO to **F6**.
	No	→ REPAIR open in the IAT sensor return circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
F6 CHECK SIGNAL CIRCUIT FOR A SHORT TO VOLTAGE • Key on. • Measure the voltage between IAT sensor connector pin 6 and ground. • **Is any voltage indicated?**	Yes	→ REPAIR short in the IAT signal circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
	No	→ GO to **F7**.
F7 CHECK SIGNAL CIRCUIT FOR AN OPEN • Key off. • Measure the resistance between the PCM body harness pin 43, and IAT sensor connector pin 6. • **Is the resistance less than 5 ohms?**	Yes	→ INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
	No	→ REPAIR open in the IAT signal circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

Intake Air Temperature 2 (IAT2) Sensor

G

Circuit Functions

The intake air temperature 2 (IAT2) sensor is a thermistor-type sensor with a variable resistance that is inversely proportional to temperature changes. When interfaced with the powertrain control module (PCM), it produces a 0-5 volt analog signal that will measure temperature.

The primary function of the IAT2 sensor is to provide a feedback signal to the PCM indicating manifold air temperature.

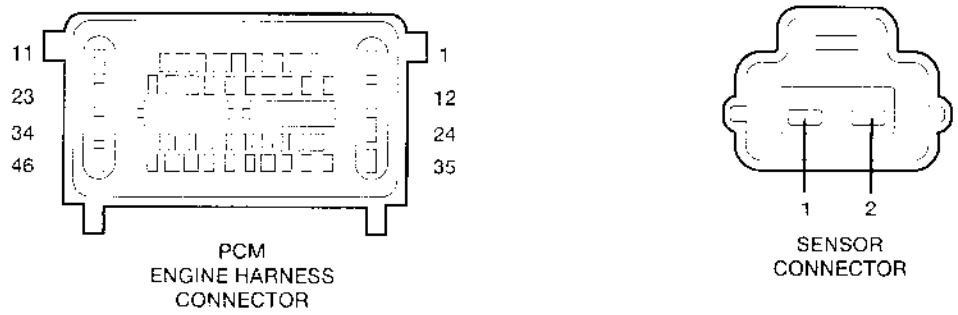
Fault Detection/Management

The PCM continuously monitors the IAT2 sensor. If the PCM detects the signal voltage is higher or lower than expected, a DTC will be set.

⚠ **CAUTION: The PCM harness connectors must be properly seated and the connector latch properly attached to eliminate possible driveability concerns or a no start condition. Installing the PCM connectors on an angle may cause an improper connection, misdiagnosis and damaged components. Install the connector until the lever pivots and seats itself. Apply light pressure to get the connector into position on the PCM and then fully seat the connector.**

Note: Visually inspect the harness connectors for corrosion, damage, proper mating and correct pin tension.

Note: When the PCM is disconnected additional DTCs will be set. Clear all DTCs after restoring the vehicle.



A0063432

DTC Descriptions

- P0096 = IAT2 Sensor 2 Circuit Range/Performance
- P0097 = IAT2 Sensor 2 Circuit Low Input
- P0098 = IAT2 Sensor 2 Circuit High Input

Intake Air Temperature 2 (IAT2) Sensor

G

Test Steps	Results	Action to Take
G1 PRELIMINARY DIAGNOSIS FOR DTCs P0096, P0097, P0098 • Perform the visual inspection. • Connect the scan tool. • Retrieve and record any continuous and on-demand DTCs. • Clear all DTCs. • Perform the On-Demand Self Test. • **Are DTCs P0096, P0097 or P0098 present?**	Yes	→ For P0096, GO to **G2**. For P0097, GO to **G6**. For P0098, GO to **G8**.
	No	→ Unable to duplicate condition. CHECK for loose connection, damaged or corroded terminals or pins. WIGGLE harness attempting to recreate the fault. REPAIR as necessary. REFER to Section 3 if a driveability concern exists.
G2 DIAGNOSTIC TROUBLE CODE P0096 Note: Refer to the PCM and component connector at the beginning of this pinpoint test. • Possible causes: — IAT2 sensor circuitry — IAT2 sensor — PCM • Inspect IAT 2 sensor circuitry at sensor and PCM. • **Are all connectors and terminals OK?**	Yes	→ GO to **G3**.
	No	→ REPAIR as necessary. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
G3 CHECK IAT2 SENSOR FAULT CODES • Perform On-Demand Self Test. • **Are other DTCs present?**	Yes	→ REPAIR other faults before proceeding. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
	No	→ Only P0096 present. GO to **G4**.
G4 CHECK IAT2 SENSOR OPERATION • Clear continuous DTCs. • Key on. • Using scan tool, monitor IAT2 and engine oil temperature PIDS. • Record IAT2 sensor temperature reading. • Drive vehicle while monitoring IAT2 sensor reading. • Operate vehicle until it reaches normal operating temperature. EOT above 176 F. • Idle engine for ten minutes. • **Did IAT2 readings change from value recorded at any time?**	Yes	→ Unable to duplicate the condition. CHECK for loose connections, damaged or corroded terminals. REPAIR as necessary. REFER to Section 3 if driveability concern exists.
	No	→ INSTALL a new IAT2 sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

Intake Air Temperature 2 (IAT2) Sensor

G

Test Steps	Results	Action to Take
G6 DIAGNOSTIC TROUBLE CODE P0097 Note: Refer to the PCM and component connector at the beginning of this pinpoint test. • Possible causes: — circuit shorted to ground — IAT2 sensor — PCM • Check for opposite failure. • Key off. • Disconnect the IAT2 sensor. • Perform the On-Demand Self Test. • **Is DTC P0098 present?**	Yes	→ INSTALL a new IAT2 sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
	No	→ GO to **G7**.
G7 CHECK SIGNAL CIRCUIT FOR A SHORT TO GROUND • Disconnect the PCM engine harness connector. • Measure the resistance between the IAT2 sensor electrical connector pin 2 and ground. • **Is the resistance greater than 10,000 ohms?**	Yes	→ INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
	No	→ REPAIR short to ground in the IAT2 sensor signal circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
G8 DIAGNOSTIC TROUBLE CODE P0098 Note: Refer to the PCM and component connector at the beginning of this pinpoint test. • Possible causes: — circuit shorted to voltage — open in signal return circuit — IAT2 sensor — PCM • Key off. • Disconnect the IAT2 sensor. • Measure the resistance between IAT2 sensor connector pin 1, and ground. • **Is the resistance less than 5 ohms?**	Yes	→ GO to **G9**.
	No	→ REPAIR open in the IAT2 sensor return circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
G9 CHECK SIGNAL CIRCUIT FOR A SHORT TO VOLTAGE • Key off. • Disconnect the PCM engine harness electrical connector. • Key on. • Measure the voltage between IAT2 sensor connector pin 2 and ground. • **Is the voltage greater than 0.2 volts?**	Yes	→ REPAIR short to voltage in the IAT2 sensor signal circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
	No	→ GO to **G10**.

Intake Air Temperature 2 (IAT2) Sensor

G

Test Steps	Results	Action to Take
G10 INDUCE OPPOSITE FAILURE • Install a jumper between pins 1 and 2, of the IAT2 sensor electrical connector. • Key on. • Perform the On-Demand Self Test. • **Is DTC P0097 present?**	Yes	→ INSTALL a new IAT2 sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
	No	→ GO to **G11**.
G11 CHECK SIGNAL CIRCUIT FOR AN OPEN • Key off. • Measure the resistance between the PCM engine harness pin 45, and IAT2 sensor connector pin 2. • **Is the resistance less than 5 ohms?**	Yes	→ INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
	No	→ REPAIR open in the IAT2 signal circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

Barometric Pressure (BARO) Sensor | H

Circuit Function

The barometric pressure (BARO) sensor is a cab-mounted variable capacitance sensor used to determine altitude. The BARO signal affects injection timing and fuel quantity to optimize engine operation and control smoke throughout all altitude conditions. 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 reduce start-up smoke.

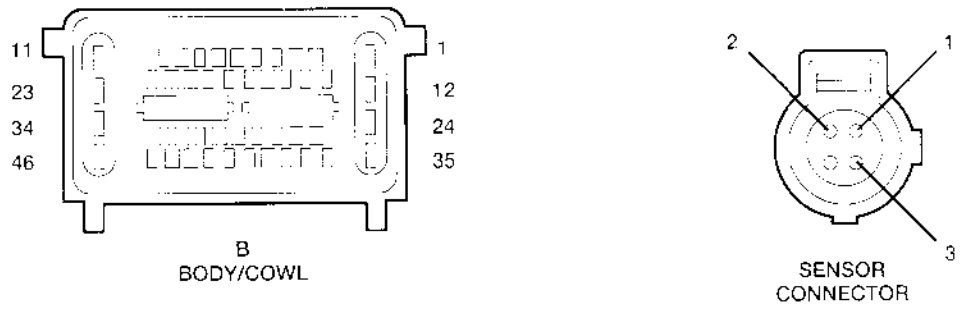
Fault Detection/Management

A BARO signal that is detected out of range high or low will cause the powertrain control module (PCM) to ignore the BARO signal and use the manifold absolute pressure (MAP) signal generated at low idle as an indication of barometric pressure.

CAUTION: The PCM harness connectors must be properly seated and the connector latch properly attached to eliminate possible driveability concerns or a no start condition. Installing the PCM connectors on an angle may cause an improper connection, misdiagnosis and damaged components. Install the connector until the lever pivots and seats itself. Apply light pressure to get the connector into position on the PCM and then fully seat the connector.

Note: Visually inspect the harness connectors for corrosion, damage, proper mating and correct pin tension.

Note: When the PCM is disconnected additional DTCs will be set. Clear all DTCs after restoring the vehicle.

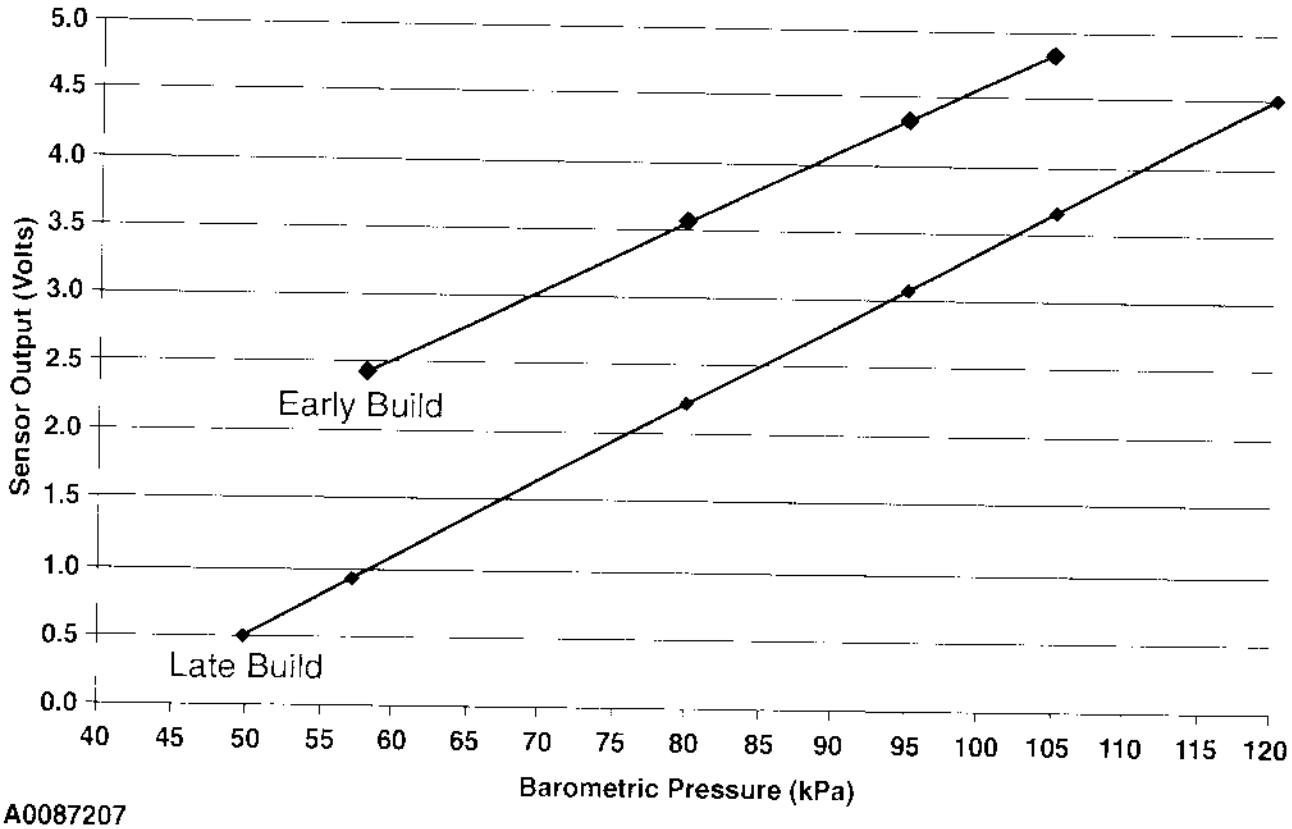


DTC Descriptions

- P0107 = BARO Sensor Low Input
- P0108 = BARO Sensor High Input

Note: Compare BARO sensor value with local barometric values.

Barometric Pressure (BARO) Sensor — H



A0087207

Early Build Applies To F-SuperDuty/Excursion — Early Build. Late Build Applies To E-Series Or F-SuperDuty/Excursion — Late Build.

	Test Steps	Results	→	Action to Take
H1	PRELIMINARY DIAGNOSIS FOR DTCs P0107, P0108 • Perform the visual inspection. • Connect the scan tool. • Retrieve and record all DTCs. • Record freeze frame data. • Clear all DTCs. • Perform the KOEO On-Demand Self Test. • **Are DTCs P0107 or P0108 present?**	Yes	→	For P0107, GO to **H2**. For P0108, GO to **H6**.
		No	→	UNABLE to duplicate condition. CHECK for loose connections, damaged or corroded pins. WIGGLE harness attempting to recreate fault. REFER to Section 3 if a driveability concern exists.

Barometric Pressure (BARO) Sensor — H

Test Steps	Results →	Action to Take
H2 DIAGNOSTIC TROUBLE CODE (DTC) P0107 Note: Refer to the PCM and component connector pin numbers at the beginning of this pinpoint test. • Possible causes: — signal circuit short to ground — VREF circuit open — BARO sensor — PCM • Key off. • Disconnect BARO sensor electrical connector. • Key on. • Measure voltage between VREF and SIG RTN circuits at the BARO connector pin 2 and pin 1. • **Is the VREF voltage between 4.5 and 5.5 volts?**	Yes No	→ GO to **H3**. → GO to Pinpoint Test B to diagnose VREF and SIG RETURN.
H3 INDUCE OPPOSITE DTC • Key off. • Install a jumper wire between BARO sensor electrical connector pin 2 and pin 3. • Key on. • Perform the KOEO On-Demand Self Test. • **Is DTC P0108 present?**	Yes No	→ INSTALL a new BARO sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system. → GO to **H4**.
H4 CHECK SIGNAL CIRCUIT FOR A SHORT TO GROUND • Key off. • Disconnect the PCM body harness electrical connector. • Measure the resistance between BARO sensor connector pin 3 and ground. • **Is the resistance greater than 10,000 ohms?**	Yes No	→ GO to **H5**. → REPAIR short to ground in signal circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
H5 CHECK SIGNAL CIRCUIT FOR AN OPEN • Measure resistance between BARO sensor electrical connector pin 3 and PCM body harness connector pin 38. • **Is the resistance less than 5 ohms?**	Yes No	→ INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system. → REPAIR open in signal circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

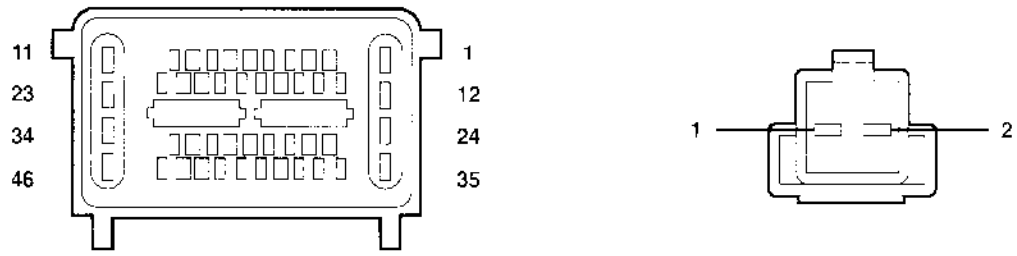
Barometric Pressure (BARO) Sensor | H

Test Steps	Results	Action to Take
H6 DIAGNOSTIC TROUBLE CODE (DTC) P0108		
Note: Refer to the PCM and component connector pin numbers at the beginning of this pinpoint test. • Possible causes: — circuit short to voltage — open in signal return circuit — BARO sensor — PCM • Key off. • Induce the opposite DTC. • Disconnect the BARO sensor. • Key on. • Perform On-Demand Self Test. • **Is DTC P0107 present?**	Yes	→ INSTALL a new BARO sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
	No	→ GO to **H7**.
H7 CHECK SIGNAL CIRCUIT FOR A SHORT TO VOLTAGE		
• Key off. • Disconnect the PCM body harness electrical connector. • Key on. • Measure the voltage between BARO sensor connector pin 3 and ground. • **Is the voltage greater than 0.2 volts?**	Yes	→ REPAIR short to voltage in the BARO sensor signal circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
	No	→ GO to **H8**.
H8 CHECK SIGNAL RETURN CIRCUIT FOR AN OPEN		
• Key off. • Measure the resistance between the BARO sensor connector pin 1 and PCM body harness connector pin 33. • **Is the resistance less than 5 ohms?**	Yes	→ INSTALL a new PCM sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
	No	→ REPAIR open in the signal return circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

Parking Brake Applied (PBA) Switch | I

Signal Function

The parking brake switch provides an input signal to the powertrain control module (PCM) indicating the current status of the parking brake (applied or released). The parking brake signal circuit is pulled to ground with the application of the parking brake.



PCM BODY HARNESS CONNECTOR

PARKING BRAKE SWITCH

A0091310

CAUTION: The PCM harness connectors must be properly seated and the connector latch properly attached to eliminate possible driveability concerns or a no start condition. Installing the PCM connectors on an angle may cause an improper connection, misdiagnosis and damaged components. Install the connector until the lever pivots and seats itself. Apply light pressure to get the connector into position on the PCM and then fully seat the connector.

Note: Visually inspect the harness connectors for corrosion, damage, proper mating and correct pin tension.

Note: When the PCM is disconnected additional DTCs will be set. Clear all DTCs after restoring the vehicle.

DTC Description

- P1536 = Parking Brake Switch Circuit

Parking Brake Applied (PBA) Switch | I

Test Steps	Results	→	Action to Take
I1 DIAGNOSTIC TROUBLE CODE (DTC) P1536 Note: When performing the key on engine running (KOER) self-test, wait five seconds after beginning the test before operating the parking brake. • Possible causes: — parking brake not applied and released during KOER self-test — parking brake switch — parking brake signal circuit short to ground — parking brake signal circuit open • Key on, engine off. • Access the PBA PID. • Apply and release the parking brake. • **Does the PBA PID indicate OFF with the parking brake released and does the PBA PID indicate ON with the parking brake applied?**	Yes	→	UNABLE to duplicate condition. CHECK for loose connections, damaged or corroded pins. REFER to Section 3 if a driveability concern exists.
	No	→	If the PBA PID indicates ON, GO to **I2**. If the PBA PID indicates OFF, GO to **I4**.
I2 CHECK THE PARKING BRAKE SWITCH • Key off. • Disconnect the parking brake switch. • Key on, engine off. • Access the PBA PID. • **Does PID indicate OFF?**	Yes	→	INSTALL a new parking brake switch.
	No	→	GO to **I3**.
I3 CHECK THE PARKING BRAKE SIGNAL CIRCUIT FOR A SHORT TO GROUND • Disconnect the PCM body harness connector. • Measure the resistance between the PCM body harness connector pin 17, harness side and ground. • **Is the resistance greater than 10,000 ohms?**	Yes	→	INSTALL a new PCM.
	No	→	REPAIR the circuit.
I4 CHECK THE PARKING BRAKE SIGNAL CIRCUIT VOLTAGE • Key off. • Disconnect the parking brake switch. • Key on, engine off. • Measure the voltage between the parking brake switch signal circuit pin 1, harness side and ground. • **Is the voltage greater than 10 volts?**	Yes	→	GO to **I6**.
	No	→	GO to **I5**.

Parking Brake Applied (PBA) Switch — I

	Test Steps	Results	→	Action to Take
I5	CHECK PARKING BRAKE CIRCUIT FOR AN OPEN			
	• Key off. • Disconnect the PCM body harness connector. • Measure the resistance between the parking brake switch signal circuit pin 1, harness side and the PCM body harness connector pin 17, harness side. • **Is the resistance less than 5 ohms?**	Yes No	→ →	INSTALL a new PCM. REPAIR the circuit.
I6	CHECK THE PARKING BRAKE GROUND CIRCUIT FOR AN OPEN			
	• Key off. • Measure the resistance between the parking brake switch ground circuit pin 2, harness side and ground. • **Is the resistance less than 5 ohms?**	Yes No	→ →	INSTALL a new parking brake switch. REPAIR the circuit.

Mass Air Flow (MAF) Sensor | J

Signal Function

The mass airflow (MAF) sensor measures the airflow rate into the engine and provides an analog signal to the powertrain control module (PCM) which is used to calculate air flow for the EGR monitor.

Current PCM implementation contains a mass airflow interface, which consists of a two pole, differential input, low pass filter. This filter is designed to pass an analog signal, originating from the mass air sensor, while rejecting unwanted ignition noise, high frequency electrical interference, and ground offsets.

The input to the interface is the analog voltage signal difference between MAF+ (mass airflow signal) and MAF- (mass airflow signal return). The MAF sensor outputs an analog voltage signal calibrated to 0.5 V at the lower limit of the flow range and 4.75 V at the upper limit of the flow range.

The intake air temperature (IAT) is also integrated into the MAF sensor. The PCM uses the IAT signal to control timing and fuel rate during cold starts.

⚠ **CAUTION: The PCM harness connectors must be properly seated and the connector latch properly attached to eliminate possible driveability concerns or a no start condition. Installing the PCM connectors on an angle may cause an improper connection, misdiagnosis and damaged components. Install the connector until the lever pivots and seats itself. Apply light pressure to get the connector into position on the PCM and then fully seat the connector.**

Note: Visually inspect the harness connectors for corrosion, damage, proper mating and correct pin tension.

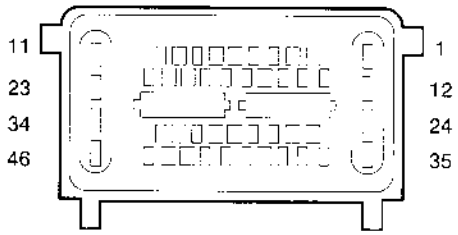
Note: When the PCM is disconnected additional DTCs will be set. Clear all DTCs after restoring the vehicle.

Note

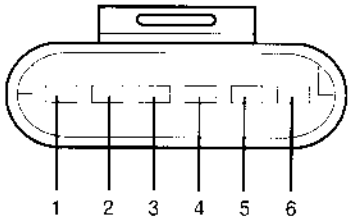
This pinpoint test is intended to diagnose the following:

- MAF sensor
- harness circuits: MAF SIG, MAF RTN, vehicle power (VPWR), and power ground (PWR GND)
- PCM

Mass Air Flow (MAF) Sensor — J



PCM
BODY HARNESS
CONNECTOR



MAF/IAT
SENSOR CONNECTOR

A0063431

DTC Descriptions

- P0101 = Mass or Volume Air Flow Circuit Range/Performance
- P0103 = Mass or Volume Air Flow Circuit High Input
- P1102 = Mass Air Flow Sensor In Range But Lower Than Expected

	Test Steps	Results		Action to Take
J1	PRELIMINARY DIAGNOSIS FOR DTCs P0101, P0103, P1102			
	• Perform the visual inspection. • Connect the scan tool. • Retrieve and record all DTCs. • Record freeze frame data. • Clear all DTCs. • Perform the KOEO On-Demand Self-Test. • Perform the KOER On-Demand Self-Test. • **Are DTCs P0101, P0103 or P1102 present?**	Yes	→	For P0101, GO to **J2**. For P1102, GO to **J4**. For P0103, GO to **J8**.
		No	→	Unable to duplicate condition. CHECK for restriction in air flow and water intrusion. CHECK for loose connection, damaged or corroded terminals or pins. WIGGLE harness attempting to recreate the fault. REFER to Section 3 if driveability concern exists.
J2	DIAGNOSTIC TROUBLE CODE (DTC) P0101			
	• Possible causes: — MAF sensor — contaminated sensor — unmetered air flow into engine — PCM • Check MAF sensor for contamination. • **Is any restriction or contamination present?**	Yes	→	REMOVE restriction and REPAIR system as necessary. CLEAR DTCs and RETEST the system.
		No	→	GO to **J3**.

Mass Air Flow (MAF) Sensor — J

Test Steps	Results →	Action to Take
J3 CHECK MAF OUTPUT SIGNAL TO PCM		
• Access MAF PIDs. • Engine running. • Monitor MAF PID volts at idle. • Increase idle to approximately 2,500 rpm while monitoring PID. • **Is MAF PID value 1.4 to 1.8 volts with engine idling and 1.9 to 2.1 volts at 2,500 rpm?**	Yes No	→ INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system. → INSTALL a new MAF sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
J4 DIAGNOSTIC TROUBLE CODE (DTC) P1102		
Note: Refer to the PCM connector pin numbers at the beginning of this pinpoint test. • Possible causes: — restricted air flow — MAF sensor disconnected — VPWR circuit open to MAF — PWR GND circuit open to MAF — MAF RTN signal open — MAF signal shorted to ground — mechanical failure — MAF sensor — PCM • Inspect air intake for restrictions • Key off. • Disconnect the MAF sensor harness connector. • Key on. • Measure the voltage between the MAF sensor VPWR circuit pin 2 and MAF PWR GND and signal return circuit pins 3 and 4. • **Is the voltage measurement greater than 10.5 volts at each circuit?**	Yes No	→ GO to **J5**. → REPAIR open in the vehicle power or vehicle ground circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
J5 CHECK MAF SENSOR SIGNAL CIRCUIT FOR A SHORT TO GROUND		
• Key off. • Disconnect the PCM body harness electrical connector. • Measure the resistance between MAF sensor harness connector signal circuit pin 5 and ground. • **Is the resistance greater than 10,000 ohms?**	Yes No	→ GO to **J6**. → REPAIR short to ground in signal circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
J6 CHECK MAF SENSOR SIGNAL CIRCUIT FOR AN OPEN		
• Measure the resistance between MAF sensor harness connector signal circuit pin 5 and PCM body harness connector pin 42. • **Is the resistance less than 5 ohms?**	Yes No	→ GO to **J7**. → REPAIR open in signal circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

Mass Air Flow (MAF) Sensor — J

	Test Steps	Results →	Action to Take
J7	CHECK MAF SENSOR CIRCUITS		
	Note: This step may cause DTC P0103 to set. • Reconnect the PCM body harness electrical connector. • Key on, engine off. • Access MAF VOLT PID. • Record MAF VOLT PID reading. • Install a jumper wire between the MAF signal circuit pin 5 and the MAF VPWR circuit pin 2. • **Does the MAF PID change from less than 0.04 volt to greater than 4.5 volts?**	Yes No	→ INSTALL a new MAF sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system. → INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
J8	DIAGNOSTIC TROUBLE CODE (DTC) P0103		
	Note: Refer to the PCM and component connector pin numbers at the beginning of this pinpoint test. • Possible causes: — restricted inlet air flow — water intrusion — MAF signal circuit shorted to power — open ground circuit — MAF sensor — PCM • Disconnect air inlet and check for restrictions and water intrusion. • **Is a concern present?**	Yes No	→ REPAIR as necessary. RESTORE the vehicle. CLEAR DTCs and RETEST the system. → GO to **J9**.
J9	INDUCE OPPOSITE FAILURE		
	• Disconnect the MAF sensor electrical connector. • Perform the KOER On-Demand Self-Test. • **Is DTC P0102 present?**	Yes No	→ RESTORE the vehicle. CLEAR DTCs. GO to **J12**. → GO to **J10**.
J10	CHECK MAF SENSOR SIGNAL CIRCUIT FOR A SHORT TO VOLTAGE		
	• Disconnect the PCM body harness electrical connector. • Measure the voltage between MAF sensor signal circuit pin 5 and ground. • **Is the voltage less than 0.2 volt?**	Yes No	→ GO to **J11**. → REPAIR short to voltage in signal circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
J11	CHECK MAF RETURN CIRCUITS FOR AN OPEN		
	• Key off. • Measure the resistance between MAF sensor harness connector signal return circuit pin 1 and PCM body harness connector pin 33; and between the MAF sensor harness connector pin 4 and PCM body harness connector pin 21. • **Is the resistance less than 5 ohms?**	Yes No	→ INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system. → REPAIR open in signal return circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

Mass Air Flow (MAF) Sensor

J

Test Steps		Results →	Action to Take
J12	CHECK THE MAF SIGNAL TO THE PCM		
	• Access the MAF PID. • Key on, engine running. • Monitor and record the MAF PID voltage at idle. • Increase the engine speed to 2,500 RPM. • Record the MAF PID voltage. • **Is the MAF PID voltage between 1.4 to 1.8 volts at idle and 1.9 to 2.1 volts at 2,500 RPM?**	Yes →	UNABLE to duplicate condition. Concern may have set due to water intrusion. REFER to Section 3 if a driveability concern exists.
		No →	INSTALL a new MAF sensor. RESTORE the vehicle. CLEAR the DTCs and RETEST the system.

Engine Coolant Temperature (ECT) Sensor

K

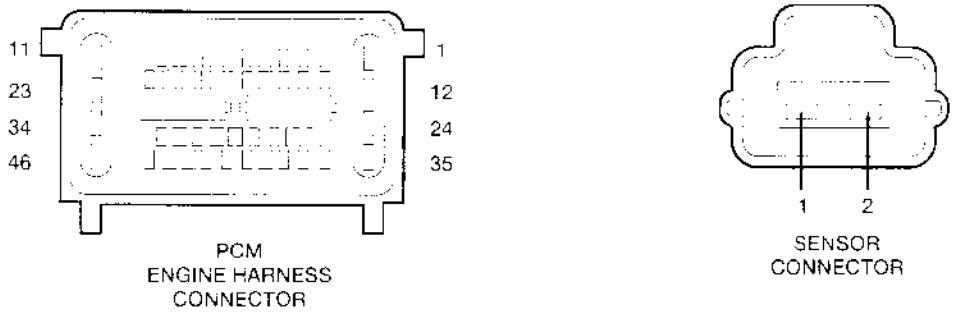
Circuit Functions

The engine coolant temperature (ECT) sensor is a thermistor device 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 powertrain control module (PCM) corresponding to temperature.

The engine coolant sensor is used as the primary input to the electronic control system to enable adaptive cooling. This provides a means of providing adequate cooling in severe engine temperature conditions. The PCM will limit the fueling rate of the engine to provide cooling protection and prevent engine damage due to overheating.

Fault Detection/Management

The ECT sensor is located on the left side of the front cover. The PCM supplies a five volt reference signal that the ECT sensor uses to produce an analog voltage, indicating temperature. The PCM continuously monitors the signal of the ECT sensor to determine if the signal is within an expected range. If the PCM detects an out of range high or low, the PCM will ignore the ECT signal and substitute the EOT signal. If both ECT and EOT signals are out of range, the PCM will assume an engine coolant temperature of -34°C (-29°F) for starting and 82°C (180°F) for engine running conditions.



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⚠ **CAUTION: The PCM harness connectors must be properly seated and the connector latch properly attached to eliminate possible driveability concerns or a no start condition. Installing the PCM connectors on an angle may cause an improper connection, misdiagnosis and damaged components. Install the connector until the lever pivots and seats itself. Apply light pressure to get the connector into position on the PCM and then fully seat the connector.**

Note: Visually inspect the harness connectors for corrosion, damage, proper mating and correct pin tension.

Engine Coolant Temperature (ECT) Sensor

K

Note: When the PCM is disconnected additional DTCs will be set. Clear all DTCs after restoring the vehicle.

TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)

°C	F	OHMS
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1,188
40	104	1 459
35	95	1,802
30	86	2,238
25	77	2,796
20	68	3,520
15	59	4,450
10	50	5,670
5	41	7,280
0	32	9,420
-5	23	12,300
-10	14	16,180
-15	5	21,450
-20	-4	28,680
-30	-22	52,700
-40	-40	100,700

DTC Descriptions

- P0117 = ECT Sensor Circuit Low Input
- P0118 = ECT Sensor Circuit High Input

Test Steps	Results	→	Action to Take
K1 PRELIMINARY DIAGNOSIS FOR DTCs P0117, P0118			
• Perform the visual inspection. • Connect the scan tool. • Retrieve and record all DTCs. • Clear all DTCs. • Perform On-Demand Self Test. • **Are DTCs P0117 or P0118 present?**	Yes	→	For DTC P0117, GO to **K2**. For DTC P0118, GO to **K4**.
	No	→	Unable to duplicate condition. CHECK for loose connection, damaged or corroded pins. WIGGLE harness attempting to recreate the fault. REFER to Section 3 if a driveability concern exists.

Engine Coolant Temperature (ECT) Sensor

K

Test Steps	Results	Action to Take
K2 DIAGNOSTIC TROUBLE CODE (DTC) P0117		
• Possible causes: — ECT signal circuit ground short — ECT sensor — PCM — induce opposite DTC • Disconnect ECT harness connector. • Perform KOEO On-Demand Self Test. • **Is DTC P0118 present?**	Yes No	→ INSTALL a new ECT sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system. → GO to **K3**.
K3 CHECK ECT SIGNAL CIRCUIT FOR A SHORT TO GROUND		
• Disconnect the PCM engine harness connector. • Measure the resistance between the ECT harness connector pin 2 and ground. • **Is the resistance greater than 10,000 ohms?**	Yes No	→ INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST system. → REPAIR short to ground in the ECT signal circuit. RESTORE the vehicle. CLEAR the DTCs and RETEST the system.
K4 DIAGNOSTIC TROUBLE CODE (DTC) P0118		
Note: Refer to the PCM and component connector pin numbers at the beginning of this pinpoint test. • Possible causes: — short to voltage in the ECT signal circuit — open in signal return circuit — ECT sensor — PCM • Key off. • Disconnect the ECT electrical connector. • Measure the resistance between ECT electrical connector pin 1 and ground. • **Is the resistance less than 5 ohms?**	Yes No	→ GO to **K5**. → REPAIR open in ECT return circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
K5 INDUCE OPPOSITE FAILURE		
• Key on, engine off. • Install a jumper between pins 1 and 2, of the ECT electrical connector. • Perform KOEO On-Demand Self Test. • **Is DTC P0117 present?**	Yes No	→ INSTALL a new ECT sensor. CLEAR DTCs and RETEST the system. → GO to **K6**.
K6 CHECK ECT SIGNAL CIRCUIT FOR A SHORT TO VOLTAGE		
• Disconnect the PCM engine harness electrical connector. • Measure the voltage on ECT electrical connector pin 2 and ground. • **Is the voltage less than 0.2 volts?**	Yes No	→ GO to **K7**. → REPAIR short to voltage in the ECT signal circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

Engine Coolant Temperature (ECT) Sensor

K

	Test Steps	Results	→	Action to Take
K7	CHECK ECT SIGNAL CIRCUIT FOR AN OPEN			
	• Key off. • Measure the resistance between the PCM engine harness connector pin 32 and ECT harness connector pin 2. • **Is the resistance less than 5 ohms?**	Yes	→	GO to **K8**.
		No	→	REPAIR open in the ECT signal circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
K8	CHECK ECT SIGNAL RETURN CIRCUIT FOR AN OPEN			
	• Measure the resistance between PCM engine harness connector pin 25 and ECT sensor harness connector pin 1. • **Is the resistance less than 5 ohms?**	Yes	→	INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
		No	→	REPAIR open in ECT signal return circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

Turbo Charger System Performance | KA

Signal Functions

The variable geometry turbocharger (VGT) is controlled by the powertrain control module (PCM). The PCM utilizes an exhaust pressure (EP) sensor to monitor the pressure and adjust the VGT solenoid duty cycle. The VGT solenoid receives a pulse width modulated (PWM) signal from the PCM that controls the solenoid on/off time. The VGT solenoid directs oil to a piston within the actuator housing. The direction of oil flow to the piston increases or decreases the exhaust pressure.

Sensor Bias

The VGT solenoid control is based on input sensors. The input sensors are used to calculate engine speed, desired fuel quantity, altitude, and exhaust pressure. The amount of voltage the sensor deviates from a calculated reference value (sensor bias) may cause a commanded versus actual pressure calculation error.

Detection/Management

The PCM monitors the exhaust pressure. A DTC is set when the difference between the commanded and the actual exhaust pressure is not within the calibrated limits.

⚠ CAUTION: The PCM harness connectors must be properly seated and the connector latch properly attached to eliminate possible driveability concerns or a no-start condition. Installing PCM connectors on an angle may cause an improper connection, misdiagnosis, and damaged components. Install the connector until the lever pivots and seats itself. Apply light pressure to get the connector into position on the PCM and then fully seat the connector.

Note: Visually inspect the harness connectors for corrosion, damage, proper mating and correct pin tension.

Note: When the PCM is disconnected additional DTCs will be set. Clear all DTCs after restoring the vehicle.

DTC Descriptions

- P0299 = Turbo/SuperCharger Underboost
- P0478 = Exhaust Pressure Control Valve High Input
- P2262 = Turbo/Super Charger Boost Pressure Not Detected
- P2263 = Turbo/Super Charger System Boost Performance

Turbo Charger System Performance — KA

Test Steps	Results	Action to Take
KA1 PRELIMINARY DIAGNOSIS • Key off. • Perform a visual inspection. • Connect the scan tool. • Key on, engine off (KOEO) • Perform the PCM self-test. • **Are any DTCs present?**	Yes	→ For DTC P0299, P0478, P2262 or P2263, GO to **KA2**. For all other DTCs, REFER to the Diagnostic Trouble Code (DTC) Charts, Section 4.
	No	→ GO to **KA2**.
KA2 CHECK THE ENGINE OPERATING TEMPERATURE • Key on, engine off. • Access the EOT PID. • **Is the EOT PID greater than 70°C (158°F)?**	Yes	→ GO to **KA4**.
	No	→ INCREASE the engine operating temperature. GO to **KA4**.
KA4 CHECK THE ICP SENSOR FOR BIAS • Key on, engine off. • Access the ICP PID. • **Is the ICP PID voltage between 0.18 and 0.24 volts?**	Yes	→ GO to **KA5**.
	No	→ INSTALL a new ICP sensor.
KA5 CHECK FOR INPUT SENSOR BIAS • Access the BARO, EGR, EP, MAF and MAP PIDs. • Refer to Section 6 for normal operating values. • **Are the BARO, EGR, EP, MAF and MAP PIDs within specifications?**	Yes	→ GO to **KA6**.
	No	→ REFER to the appropriate pinpoint test to continue sensor diagnostics.
KA6 CHECK THE TURBOCHARGER OPERATION • Key on, engine running. • Access Output Test Mode. • Access the EP PID. • Monitor the EP PID and the turbocharger. • Increase the engine speed to 1200 RPM. • Decrease the VGT duty cycle to 0%. • Record the EP PID. • Increase the VGT duty cycle to 45%. • Record the EP PID. • **Does the turbocharger pitch change and does the EP PID increase?**	Yes	→ The turbocharger system is operating correctly. REFER to Section 4, Engine Performance Diagnostic Procedures.
	No	→ If the turbocharger pitch did not change, REFER to the Workshop Manual Section 303-04D: Fuel Charging and Controls — Turbocharger. If the turbocharger pitch did change and the EP PID did not increase, GO to Pinpoint Test X.

Engine Oil Temperature (EOT) Sensor | L

⚠ **WARNING: BEWARE OF MOVING VEHICLE COMPONENTS AND HEAT.**

Circuit 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 Control Module (GPCM) and lamp ON times are controlled by engine oil temperature.

Detection/Management

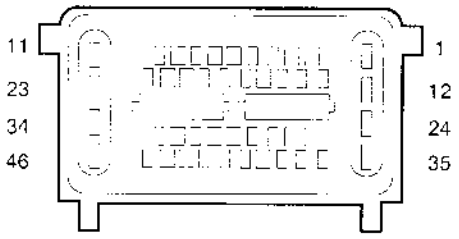
An EOT sensor signal that is detected out of range (high or low) by the PCM will cause the PCM to ignore the EOT sensor signal and assume an engine oil temperature of -20°C (-4°F) for starting and a temperature of 100°C (212°F) for engine-running conditions. The CHECK ENGINE light will also be illuminated as long as the condition exists.

⚠ **CAUTION: The PCM harness connectors must be properly seated and the connector latch properly attached to eliminate possible driveability concerns or a no-start condition. Installing PCM connectors on an angle may cause an improper connection, misdiagnosis, and damaged components. Install the connector until the lever pivots and seats itself. Apply light pressure to get the connector into position on the PCM and then fully seat the connector.**

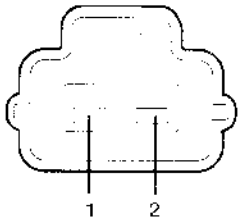
Note: Visually inspect the harness connectors for corrosion, damage, proper mating and correct pin tension.

Note: When the PCM is disconnected additional DTCs will be set. Clear all DTCs after restoring the vehicle.

Engine Oil Temperature (EOT) Sensor | L



PCM
ENGINE HARNESS
CONNECTOR



SENSOR
CONNECTOR

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DTC Descriptions

- **Circuit Faults:**
  - P0196 = EOT Sensor Circuit Range/Performance
  - P0197 = EOT Sensor Circuit Low Input
  - P0198 = EOT Sensor Circuit High Input
  - P1184 = EOT Sensor Out Of Self-Test Range
  - P0298 = Engine Oil Over Temperature Condition

K ohms	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

K ohms	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 Steps	Results	Action to Take
L1	PRELIMINARY DIAGNOSIS FOR DTCs P0196, P0197, P0198, P1184, P0298		
	• Perform visual inspection. • Connect the scan tool. • Retrieve and record any continuous and on-demand DTCs. • Clear all DTCs. • Perform the KOEO On-Demand Self-Test. • Perform the KOER On-Demand Self-Test for DTC P0196. • **Are DTCs P0196, P0197, P0198, P1184, P0298 present?**	Yes	→ For P0196, GO to **L2**. For P0197, GO to **L7**. For P0198, GO to **L9**. For P1184, GO to **L13**. For P0298, GO to **L19**.
		No	→ Fault correct. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

Engine Oil Temperature (EOT) Sensor | L

Test Steps	Results	→	Action to Take
L2 DIAGNOSTIC TROUBLE CODE (DTC) P0196			
• DTC P0196 indicates that an EOT sensor range/performance fault has been detected. P0196 is set when the vehicle has been driven above 1,250 rpm and 12 mg/stroke MFDES without EOT sensor signal increasing above 50°C (122 F). The time to set the fault is dependent on EOT and IAT temperatures, and can vary between approx. 15 to 45 minutes. Possible causes: — EOT sensor — EOT sensor circuitry — thermostat — PCM • Inspect EOT sensor circuitry at sensor and PCM. Inspect for damaged, loose or pushed-out pins, loose or poorly crimped wires. • **Are all connectors and terminals OK?**	Yes No	→	GO to **L3**. REPAIR as necessary. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
L3 CHECK FOR EOT SENSOR FAULT CODES			
• Perform KOEO On-Demand Self-Test. • **Are other DTCs present?**	Yes No	→ →	REPAIR other DTCs before proceeding. RESTORE vehicle and RETEST the system. Only P0196 present, GO to **L4**.
L4 CHECK EOT SENSOR OPERATION			
Note: Verify no accessories are in use (engine block or oil heaters) • Clear all DTCs. • Soak vehicle at ambient temperature for at least 10 hours. • Key on, engine off. • Using scan tool, monitor EOT, RPM and MFDES PIDs. • Record EOT sensor temperature reading. • Drive vehicle above 1,800 rpm and 15 mg/stroke MFDES for at least 15 minutes. Select appropriate gear to achieve operating conditions. • **Does EOT temperature reading change by at least 10 F of key on value recorded?**	Yes No	→ →	GO to **L5**. INSTALL a new EOT sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

Engine Oil Temperature (EOT) Sensor | L

Test Steps	Results	Action to Take
L5 COOLING SYSTEM CHECK		
• Drive vehicle an additional 15 minutes above 1,800 rpm and 15 mg/stroke. • **Does EOT temperature reading increase above 50 C (122 F)?**	Yes	→ GO to **L6**.
	No	→ CHECK thermostat for correct operation. If fault is indicated, INSTALL a new thermostat. If thermostat fault is not present, INSTALL a new EOT sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
L6 CONFIRM PCM FAULT		
• Check continuous memory DTCs. • **Is P0196 present?**	Yes	→ INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
	No	→ Unable to duplicate condition. CHECK for loose connections, damaged or corroded pins. WIGGLE harness attempting to recreate fault. REPAIR as necessary. REFER to Section 3.
L7 DIAGNOSTIC TROUBLE CODE (DTC) P0197		
Note: Refer to the PCM and component connector pin numbers at the beginning of this pinpoint test. • Possible causes: — EOT signal circuit short to ground — EOT sensor — PCM — EOT electrical connections • Key off. • Disconnect EOT sensor. • Check for damaged, pushed-out or corroded pins. • Check for opposite failure with EOT disconnected • Perform the KOEO On-Demand Self-Test. • **Is DTC P0198 present?**	Yes	→ INSTALL a new EOT sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
	No	→ GO to **L8**.

Engine Oil Temperature (EOT) Sensor — L

Test Steps	Results →	Action to Take
L8 CHECK EOT SENSOR SIGNAL CIRCUIT FOR A SHORT TO GROUND		
• Key off. • Disconnect the PCM engine harness connector. • Measure the resistance between the EOT sensor harness connector pin 2 and ground. • **Is the resistance greater than 10,000 ohms?**	Yes No	→ INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system. → REPAIR short to ground in EOT signal circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
L9 DIAGNOSTIC TROUBLE CODE (DTC) P0198		
Note: Refer to the PCM and component connector pin numbers at the beginning of this pinpoint test. • Possible causes: — open or short to voltage in EOT signal circuit — open in signal return circuit poor connections — EOT sensor — PCM — Key off. • Disconnect EOT sensor harness connector. • Disconnect the PCM engine harness connector. • Measure the resistance between pin 1 on the EOT connector and the PCM engine harness connector pin 25. • **Is the resistance less than 5 ohms?**	Yes No	→ GO to **L10**. → REPAIR open in signal return circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
L10 INDUCE OPPOSITE FAILURE		
• Connect the PCM engine harness connector • Key on, engine off. • Install a jumper between pins 1 and 2 of the EOT sensor electrical connector. • Perform the On-Demand Self-Test. • **Is DTC P0197 present?**	Yes No	→ INSTALL a new EOT sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system. → GO to **L11**.
L11 CHECK SIGNAL CIRCUIT FOR A SHORT TO VOLTAGE		
• Key off. • Disconnect the PCM engine harness electrical connector. • Key on, engine off. • Measure the voltage on the EOT sensor electrical connector pin 2 and ground. • **Is the voltage less than 0.2 volt?**	Yes No	→ GO to **L12**. → REPAIR short to voltage in signal circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

Engine Oil Temperature (EOT) Sensor | L

Test Steps	Results	Action to Take
L12 CHECK SIGNAL CIRCUIT FOR AN OPEN		
• Key off. • Measure the resistance between the PCM engine harness connector pin 44 and the EOT sensor harness connector pin 2. • **Is the resistance less than 5 ohms?**	Yes	→ INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
	No	→ REPAIR open signal circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
L13 DIAGNOSTIC TROUBLE CODE (DTC) P1184		
• DTC P1184 indicates that the engine oil temperature is not within the required range to perform the KOER Cylinder Contribution Self-Test. The engine oil temperature must be between 20°C (68°F) and 117°C (242°F). Possible causes: — engine not fully warmed up — low oil level — cooling system failure — EOT sensor — thermostat — EOT sensor circuit • Verify no KOEO DTCs are present. • Drive vehicle until thermostat opens. • Fully warm engine. • Check that upper radiator hose is hot and pressurized. • Rerun the KOER Cylinder Contribution Self-Test. • **Is DTC P1184 present?**	Yes	→ GO to **L14**.
	No	→ REPAIR other DTCs as necessary. RESTORE the vehicle.
L14 EOT SENSOR CHECK		
• Key on, engine off. • Engine at normal operating temperature. • Access EOT PID. • Observe EOT PID while tapping on EOT sensor. • **Does the EOT value fluctuate or go below 20°C (68°F) (3.82 volts)?**	Yes	→ INSTALL a new EOT sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
	No	→ GO to **L15**.
L15 VEHICLE HARNESS CHECK		
• Observe EOT PID while carrying out the following: • Grasp the vehicle harness close to the EOT sensor connector. • Wiggle and shake vehicle harness while working toward PCM. • Key off. • **Does value fluctuate?**	Yes	→ REPAIR circuits as required. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
	No	→ GO to **L16**.

Engine Oil Temperature (EOT) Sensor | L

Test Steps	Results	Action to Take
L16 CHECK PCM AND VEHICLE HARNESS CONNECTOR		
• Disconnect EOT sensor and PCM harness connectors. • Inspect for damaged, loose or pushed-out pins. • **Are connectors and terminals OK?**	Yes No	→ GO to **L17.** → REPAIR as required. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
L17 CHECK FOR BIASED EOT SENSOR		
Note: Verify no accessories are in use (engine block or oil heaters) • Allow vehicle to sit overnight. • Do not start engine. • Read EOT and IAT using scan tool with KOEO. • **Do the readings agree within 6 C (11 F)?**	Yes No	→ CONFIRM performance concern. REFER to Section 3 or Diagnostic Subroutines, Performance Diagnostic Procedures. → CONFIRM wiring is OK. If OK, INSTALL a new EOT.
L19 DIAGNOSTIC TROUBLE CODE (DTC) P0298		
• DTC P0298 indicates that an EOT sensor range/performance fault has been detected. P0298 is set when the vehicle has been running below 1,000 rpm and less than 20 mg/stroke MFDES with EOT sensor signal reading above 110°C (230 F). The time to set the fault is dependent on EOT and IAT temperatures, and can vary between approx. 15 to 45 minutes. Possible causes: — EOT sensor — EOT sensor circuitry — cooling system — thermostat — PCM • Inspect EOT sensor circuitry at sensor and PCM. Inspect for damaged, loose or pushed-out pins, loose or poorly crimped wires. • **Are all connectors and terminals OK?**	Yes No	→ GO to **L20.** → REPAIR as necessary. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
L20 COOLING SYSTEM CHECKS		
• Check coolant system for correct level. • Check radiator for correct performance. Verify there are no obstructions to airflow across radiator core, and that the radiator core is not plugged. • Verify correct cooling fan/clutch operation. • Verify correct thermostat operation. • **Is coolant system OK?**	Yes No	→ GO to **L21.** → REPAIR as necessary. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

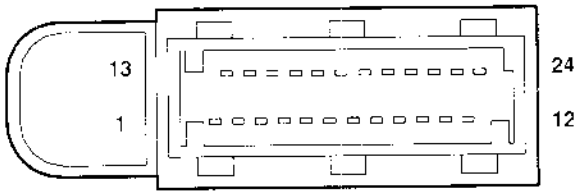
Engine Oil Temperature (EOT) Sensor | L

Test Steps	Results	Action to Take
L21 CHECK EOT SENSOR FAULT CODES		
• Perform KOEO On-Demand Self-Test. • **Are other DTCs present?**	Yes	→ REPAIR other DTCs before proceeding. RESTORE vehicle and RETEST the system.
	No	→ Only P0298 present. GO to **L22**.
L22 CHECK EOT SENSOR OPERATION		
Note: Verify no accesories are in use (engine block or oil heaters) • Clear continuous DTCs. • Soak vehicle at ambient temperature for at least 8 hours. • Key on, engine off. • Using scan tool, monitor EOT PID. • **Is EOT sensor equal to ambient temperature?**	Yes	→ GO to **L23**.
	No	→ INSTALL a new EOT sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
L23 CONFIRM PCM FAULT		
• Run engine for approximately 15 to 20 minutes. • Check continuous memory DTCs. • **Is DTC P0298 present?**	Yes	→ INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
	No	→ OPERATE vehicle to VERIFY EOT does not increase above 110°C (230°F) while running below 1,000 rpm. REFER to Section 3.

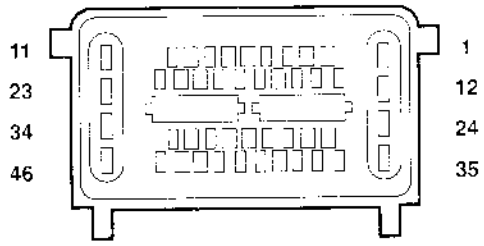
Fuel Pump Monitor/Control | M

Circuit Function

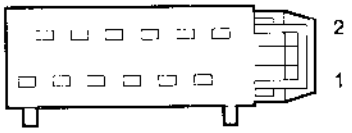
The fuel pump relay coil ground is controlled by the powertrain control module (PCM) with vehicle power (VPWR) supplied to the relay coil by the PCM power relay. Energizing the fuel pump relay closes the internal switch contacts and supplies B+ voltage through the inertia switch to the electric fuel pump. Fuel pump voltage is monitored by the PCM through the fuel pump monitor (FPM) circuit which is downstream of the inertia switch. When the ignition switch is turned on, the electric fuel pump will operate for approximately 20 seconds and will then be commanded off by the PCM if an RPM signal is not detected.



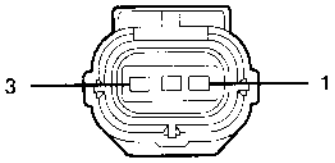
CENTRAL JUNCTION BOX (CJB) C270a



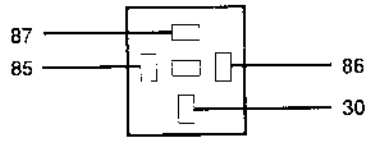
PCM BODY HARNESS CONNECTOR



CENTRAL JUNCTION BOX (CJB) C270F



INERTIA SWITCH F - SUPERDUTY/EXCURSION



FUEL PUMP RELAY

INERTIA SWITCH E - SERIES

A0090659

DTC Descriptions

- P0230 = Fuel Pump Primary Circuit
- P0231 = Fuel Pump Secondary Circuit Low
- P0232 = Fuel Pump Secondary Circuit High

Fuel Pump Monitor/Control — M

⚠ CAUTION: The PCM harness connectors must be properly seated and the connector latch properly attached to eliminate possible driveability concerns or a no-start condition. Installing PCM connectors on an angle may cause an improper connection, misdiagnosis, and damaged components. Install the connector until the lever pivots and seats itself. Apply light pressure to get the connector into position on the PCM and then fully seat the connector.

Note: Visually inspect the harness connectors for corrosion, damage, proper mating and correct pin tension.

Note: When the PCM is disconnected additional DTCs will be set. Clear all DTCs after restoring the vehicle.

	Test Steps	Results	Action to Take
M1	PRELIMINARY DIAGNOSIS FOR DTCS P0230, P0231, AND P0232		
	Note: For F-SuperDuty/Excursion, the fuel pump relay is internal to the central junction box (CJB). • Retrieve and record all DTCs. • Record freeze frame data. • Clear the DTCs. • Perform the On-Demand Self-Test. • **Are any DTCs retrieved?**	Yes	→ For DTC P0230 (F-SuperDuty/Excursion), GO to **M2**. For DTC P0230 (E-Series), GO to **M3**. For P0231, GO to **M8**. For P0232, GO to **M14**.
		No	→ UNABLE to duplicate condition. CHECK for loose connections, damaged or corroded terminals or pins. REPAIR as necessary. REFER to Section 3 if a driveability concern exists.
M2	DIAGNOSTIC TROUBLE CODE (DTC) P0230		
	• Possible causes: — fuel pump relay (internal to CJB) — circuitry — PCM • Key off. • Disconnect CJB C270f. • Key on, engine off. • Measure the voltage between CJB C270f pin 10, component side and ground. • **Is the voltage greater than 10.5 volts?**	Yes	→ GO to **M5**.
		No	→ INSTALL a new CJB.

Fuel Pump Monitor/Control — M

	Test Steps	Results →	Action to Take
M3	CHECK THE FUEL PUMP RELAY VOLTAGE CIRCUIT		
	Note: Refer to the Wiring Diagrams Manual for fuel pump relay coil pin locations. • Possible causes: — fuel pump relay — circuitry — PCM • Key off. • Disconnect the fuel pump relay. • Key on, engine off. • Measure the voltage between the fuel pump relay coil power circuit, harness side and ground. • **Is the voltage greater than 10.5 volts?**	Yes → No →	GO to **M4**. REPAIR the circuit.
M4	CHECK THE FUEL PUMP RELAY		
	• Perform the fuel pump relay component test. Refer to Wiring Diagrams Cell 149; Component Testing. • **Does the fuel pump relay pass the component test?**	Yes → No →	GO to **M5**. INSTALL a new fuel pump relay.
M5	CHECK THE FUEL PUMP RELAY CONTROL CIRCUIT FOR AN OPEN		
	Note: Refer to the Wiring Diagrams Manual for fuel pump relay coil pin locations. • Key off. • Disconnect the PCM body harness connector. • Measure the resistance between the CJB C270f pin 10 (F-SuperDuty/Excursion) or the fuel pump relay coil control circuit (E-Series), harness side and the PCM body harness connector pin 5, harness side. • **Is the resistance less than 5 ohms?**	Yes → No →	GO to **M6**. REPAIR the circuit.
M6	CHECK THE FUEL PUMP RELAY CONTROL CIRCUIT FOR A SHORT TO GROUND		
	• Measure the resistance between the PCM body harness connector pin 5, harness side and ground. • **Is the resistance greater than 10,000 ohms?**	Yes → No →	GO to **M7**. REPAIR the circuit.
M7	CHECK THE FUEL PUMP RELAY CONTROL CIRCUIT FOR A SHORT TO VOLTAGE		
	• Key on, engine off. • Measure the voltage between the PCM body harness connector pin 5, harness side and ground. • **Is any voltage indicated?**	Yes → No →	REPAIR the circuit. INSTALL a new PCM.

Fuel Pump Monitor/Control — M

Test Steps	Results	Action to Take
M8 DIAGNOSTIC TROUBLE CODE (DTC) P0231 Note: Diagnose and repair DTC P0230 before addressing DTC P0231. • Possible causes: — inertia switch — fuel pump monitor circuit open — fuel pump relay • Key off. • Disconnect the inertia switch. • Measure the resistance between the inertia switch pin 1, component side and the inertia switch pin 3 (F-SuperDuty/Excursion) or pin 2 (E-Series), component side. • **Is the resistance less than 5 ohms?**	Yes No	→ GO to **M9**. → INSTALL a new inertia switch.
M9 CHECK THE FUEL PUMP VOLTAGE • Connect a test lamp between the inertia switch pin 1 (F-SuperDuty/Excursion) or pin 2 (E-Series), harness side and ground. • Key on, engine off. • **Is the test lamp illuminated for approximately 20 seconds?**	Yes No	→ GO to **M13**. → For F-SuperDuty/Excursion, GO to **M10**. For E-Series, GO to **M11**.
M10 CHECK THE FUEL PUMP VOLTAGE CIRCUIT FOR AN OPEN • Key off. • Disconnect CJB C270a. • Measure the resistance between CJB C270a pin 22, harness side and the inertia switch pin 1, harness side. • **Is the resistance less than 5 ohms?**	Yes No	→ INSTALL a new CJB. → REPAIR the circuit.
M11 CHECK THE FUEL PUMP RELAY POWER CIRCUIT FOR VOLTAGE • Key off. • Disconnect the fuel pump relay. • Key on, engine off. • Measure the voltage between the fuel pump relay power circuit pin 30, harness side and ground. • **Is the voltage greater than 10.5 volts?**	Yes No	→ GO to **M12**. → REPAIR the circuit.
M12 CHECK THE FUEL PUMP RELAY • Perform the fuel pump relay component test. Refer to Wiring Diagrams Cell 149; Component Testing. • **Does the fuel pump relay pass the component test?**	Yes No	→ REPAIR the circuit. → INSTALL a new fuel pump relay.

Fuel Pump Monitor/Control — M

	Test Steps	Results	→	Action to Take
M13	CHECK THE FUEL PUMP MONITOR CIRCUIT FOR AN OPEN			
	• Key off. • Disconnect the PCM. • Measure the resistance between the inertia switch pin 3 (F-SuperDuty/Excursion) or pin 1 (E-Series), harness side and the PCM body harness connector pin 19, harness side. • **Is the resistance less than 5 ohms?**	Yes No	→ →	INSTALL a new PCM. REPAIR the circuit.
M14	DIAGNOSTIC TROUBLE CODE (DTC) P0232			
	Note: Diagnose and repair DTC P0230 before addressing DTC P0232. • Possible causes: — fuel pump relay — fuel pump monitor circuit short to voltage — fuel ground circuit open • Key off. • Disconnect CJB C270a (F-SuperDuty/Excursion). • Disconnect the fuel pump relay (E-Series). • Key on, engine off. • **Is the fuel pump ON?**	Yes No	→ →	GO to **M15**. INSTALL a new CJB (F-SuperDuty/Excursion) or fuel pump relay (E-Series).
M15	CHECK THE FUEL PUMP MONITOR CIRCUIT A SHORT TO VOLTAGE			
	• Key off. • Disconnect the PCM body harness connector. • Disconnect the fuel pump. • Key on, engine off. • Measure the voltage between the PCM body harness connector pin 19, harness side and ground. • **Is any voltage indicated?**	Yes No	→ →	REPAIR the circuit. GO to **M16**.
M16	CHECK THE FUEL PUMP GROUND CIRCUIT FOR AN OPEN			
	• Key off. • Measure the resistance between the fuel pump ground circuit, harness side and ground. • **Is the resistance less than 5 ohms?**	Yes No	→ →	INSTALL a new PCM. REPAIR the circuit.

Water in Fuel (WIF) Sensor | O

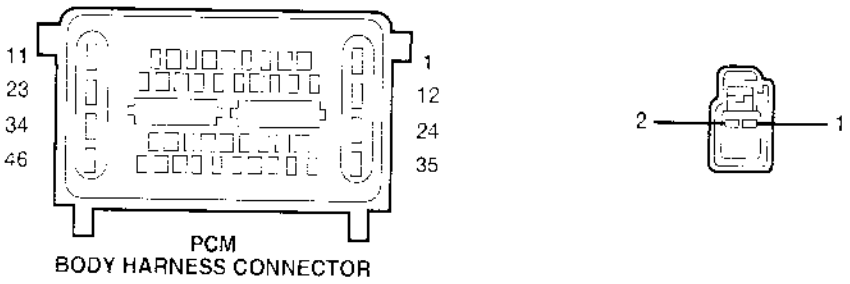
Circuit Function

The water in fuel (WIF) sensor is used to detect water in the fuel system and is located in the fuel control module. The WIF sensor is monitored by the powertrain control module (PCM). If the PCM detects water for more than 5 seconds, it will set continuous DTC P2269 and turn on the WATER IN FUEL indicator lamp (WIFIL). Route a hose from the fuel drain line to a 1-qt clear container. Open the fuel control module 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.

CAUTION: The PCM harness connectors must be properly seated and the connector latch properly attached to eliminate possible driveability concerns or a no-start condition. Installing PCM connectors on an angle may cause an improper connection, misdiagnosis, and damaged components. Install the connector until the lever pivots and seats itself. Apply light pressure to get the connector into position on the PCM and then fully seat the connector.

Note: Visually inspect the harness connectors for corrosion, damage, proper mating and correct pin tension.

Note: When the PCM is disconnected additional DTCs will be set. Clear all DTCs after restoring the vehicle.



PCM
BODY HARNESS CONNECTOR

A0080216

DTC Descriptions

- P2269 = Water In Fuel Condition

Water in Fuel (WIF) Sensor — O

	Test Steps	Results →	Action to Take
O1	PRELIMINARY DIAGNOSIS FOR DTC P2269 • Perform visual inspection. • Connect the scan tool. • Retrieve and record all DTCs. • Clear all DTCs. • Perform On-Demand Self Test. • **Is DTC P2269 present?**	Yes No	→ GO to **O2**. → UNABLE to duplicate condition. CHECK for loose connections, damaged or corroded terminals or pins. WIGGLE harness attempting to recreate fault. REPAIR as necessary. REFER to Section 3 if a driveability concern exists.
O2	DIAGNOSTIC TROUBLE CODE (DTC) P2269 Note: Refer to the PCM and component connector pin numbers at the beginning of this pinpoint test. • Possible causes: — water in the fuel filter housing — shorted circuit — damaged connection — WIF sensor — PCM • Route a hose from the fuel drain line, located on the fuel control module, to a 1-qt clear container. • Open the fuel control module drain valve and close the drain valve when you have filled the container. • **Does the container have any water or contaminants?**	Yes No	→ CLEAR DTCs and RETEST the system. If WIFIL comes back on and DTC P2269 returns, REPEAT Test Step **O2**. If water is still found in fuel sample, FLUSH and CLEAN the fuel tank and fuel system. → GO to **O3**.
O3	CHECK WIF SENSOR CIRCUIT FOR SHORT TO GROUND • Key on, engine off. • Disconnect the WIF sensor harness connector. • Clear Continuous DTCs. • Cycle ignition key. • Retrieve Continuous DTCs. • Key off. • **Did DTC P2269 reset?**	Yes No	→ GO to **O4**. → GO to **O5**.
O4	CHECK FOR SHORT TO GROUND IN THE SIGNAL CIRCUIT • Disconnect PCM body harness connector. • Measure resistance between pin 2 on WIF sensor harness connector and ground. • **Is the resistance greater than 10,000 ohms?**	Yes No	→ INSTALL a new PCM. RESTORE the vehicle. CLEAR DTCs and RETEST the system. → REPAIR short to ground in WIF sensor circuit. RESTORE the vehicle. CLEAR DTCs and RETEST the system.

Water in Fuel (WIF) Sensor

O

Test Steps	Results	Action to Take
O5 CHECK WIF SENSOR • Remove the fuel filter, and inspect inside of the filter housing for foreign material. • **Is debris found inside the housing?**	Yes →	CLEAN out filter housing. REMOVE WIF sensor. CLEAN and REINSTALL. RESTORE the vehicle. CLEAR DTCs and RETEST the system.
	No →	INSTALL a new WIF sensor. RESTORE the vehicle. CLEAR DTCs and RETEST the system.