CATERPILLAR®

RENR5042-02
February 2005

Troubleshooting

C11, C13, C15 and C18 Industrial Engines

JRE1-Up (Engine)
WJH1-Up (Engine)
LGK1-Up (Engine)
GLS1-Up (Engine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

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Electronic Troubleshooting

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System Overview

SMCS Code: 1900

System Operation

This engine is electronically controlled. Each cylinder has an electronic unit injector. The Electronic Control Module (ECM) sends a signal to each injector solenoid in order to control the operation of the fuel injection system.

Electronic Controls

The electronic system consists of the following components: the ECM, the Mechanically Actuated Electronically Controlled Unit Injectors (MEUI), the wiring harness, the switches, and the sensors. The ECM is the computer. The flash file is the software for the computer. The flash file contains the operating maps. The operating maps define the following characteristics of the engine:

- Horsepower
- Torque curves

The ECM determines the timing and the amount of fuel that is delivered to the cylinders. These decisions are based on the actual conditions and/or on the desired conditions at any given time.

The ECM compares the desired engine speed to the actual engine speed. The actual engine speed is determined through the engine speed/timing sensor. The desired engine speed is determined with the following factors:

- Throttle signal
- Other input signals from sensors
- Certain diagnostic codes

If the desired engine speed is greater than the actual engine speed, the ECM injects more fuel in order to increase the actual engine speed.

Fuel Injection

The ECM controls the amount of fuel that is injected by varying the signals to the injectors. The injector will pump fuel only if the injector solenoid is energized. The ECM sends a high voltage signal to the solenoid. This high voltage signal energizes the solenoid. By controlling the timing and the duration of the high voltage signal, the ECM can control injection timing and the ECM can control the amount of fuel that is injected.

The ECM limits engine power during cold mode operation and the ECM modifies injection timing during cold mode operation. Cold mode operation provides the following benefits:

- Increased cold weather starting capability
- Reduced warm-up time
- Reduced white smoke

Cold mode is activated whenever the engine temperature falls below a predetermined value. Cold mode remains active until the engine temperature rises above a predetermined value or until a time limit is exceeded.

The flash file inside the ECM sets certain limits on the amount of fuel that can be injected. The “FRC Fuel Limit” is used to control the air/fuel ratio for control of emissions. The “FRC Fuel Limit” is a limit that is based on the turbocharger outlet pressure. A higher turbocharger outlet pressure indicates that there is more air in the cylinder. When the ECM senses a higher turbocharger outlet pressure, the ECM increases the “FRC Fuel Limit”. When the ECM increases the “FRC Fuel Limit”, the ECM allows more fuel into the cylinder. The “FRC Fuel Limit” is programmed into the ECM at the factory. The “FRC Fuel Limit” cannot be changed.

The “Rated Fuel Limit” is a limit that is based on the power rating of the engine and on engine rpm. The “Rated Fuel Limit” is similar to the rack stops and to the torque spring on a mechanically governed engine. The “Rated Fuel Limit” provides the power curves and the torque curves for a specific engine family and for a specific engine rating. The “Rated Fuel Limit” is programmed into the ECM at the factory. The “Rated Fuel Limit” cannot be changed.

Once the ECM determines the amount of fuel that is required, the ECM must determine the timing of the fuel injection. The ECM calculates the top center position of each cylinder from the engine speed/timing sensor’s signal. The ECM decides when fuel injection should occur relative to the top center position and the ECM provides the signal to the injector at the desired time. The ECM adjusts timing for optimum engine performance, for optimum fuel economy, and for optimum control of white smoke.

Programmable Parameters

Certain parameters that affect the engine operation may be changed with Caterpillar Electronic Technician (ET). The parameters are stored in the ECM, and some parameters are protected from unauthorized changes by passwords. These passwords are called factory passwords.

Passwords

Several system configuration parameters and most logged events are protected by factory passwords. Factory passwords are available only to Caterpillar dealers. Refer to Troubleshooting, “Factory Passwords” for additional information.

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Electronic Service Tools

SMCS Code: 0785

Caterpillar Electronic Service Tools are designed to help the service technician:

- Obtain data.
- Diagnose problems.
- Read parameters.
- Program parameters.
- Calibrate sensors.

Required Service Tools

The tools that are listed in Table 1 are required in order to enable a service technician to perform the procedures.

Table 1

Required Service Tools	
Part Number	**Description**
N/A	4 mm Allen Wrench
6V-2197	Transducer
7X-1171	Transducer Adapter
7X-1695	Cable As
146-4080	Digital Multimeter Gp (RS232)
7X-1710	Multimeter Probes
208-0059	Adapter Cable As (70-PIN BREAKOUT)
7X-6370	Adapter Cable As (3-PIN BREAKOUT)
167-9225	Harness (SERVICE TOOL ADAPTER)
1U-5804	Crimp Tool (12−AWG TO 18−AWG)
175-3700	Connector Repair Kit (DEUTSCH DT)

Two short jumper wires are needed to check the continuity of some wiring harness circuits by shorting two adjacent terminals together in a connector. A long extension wire may also be needed to check the continuity of some wiring harness circuits.

Optional Service Tools

Table 2 lists the optional service tools that may help you service the engine.

Table 2

Optional Service Tools	
Part Number	**Description**
198-4240 or 1U-5470	Digital Pressure Indicator Engine Pressure Group
4C-4075	Crimp Tool (4−AWG TO 10−AWG)
4C-4911(1)	Battery Load Tester
5P-7277	Voltage Tester
6V-9130(2)	Temperature Adapter (MULTIMETER)
8T-5319	Connector Tool Group
155-5176	AC/DC Current Probe

(1) Refer to Special Instructions, SEHS9249, “Use of 4C-4911 Battery Load Tester for 6, 8, and 12 Volt Lead Acid Batteries” and Special Instructions, SEHS7633, “Battery Test Procedure”.
(2) Refer to Special Instructions, SEHS8382, “Use of the 6V-9130 Temperature Adapter Group”.

Caterpillar Electronic Technician (ET)

Cat ET can display the following information:

- Parameters
- Event codes
- Diagnostic codes
- Engine configuration

Cat ET can be used by the technician to perform the following functions:

- Diagnostic tests
- Sensor calibration
- Flash programming
- Set parameters

Table 3 lists the service tools that are required in order to use Cat ET.

Table 3

Service Tools for the Use of Cat ET	
Part Number	**Description**
N/A	Personal Computer (PC)
JERD2124	Single user license for Cat ET
JERD2129	Data Subscription for All Engines and Machines
171-4400(1)	Communication Adapter Gp (CAT ET TO ECM INTERFACE) ()
237-7547(2)	Adapter Cable As

(1) The 7X-1700 Communication Adapter Gp may also be used.
(2) The 237-7547 Adapter Cable As is required to connect to the USB port on computers that are not equipped with a RS232 serial port.

Note: For more information regarding the use of Cat ET and the PC requirements for Cat ET, refer to the documentation that accompanies your Cat ET software.

Connecting Cat ET and the Communication Adapter II

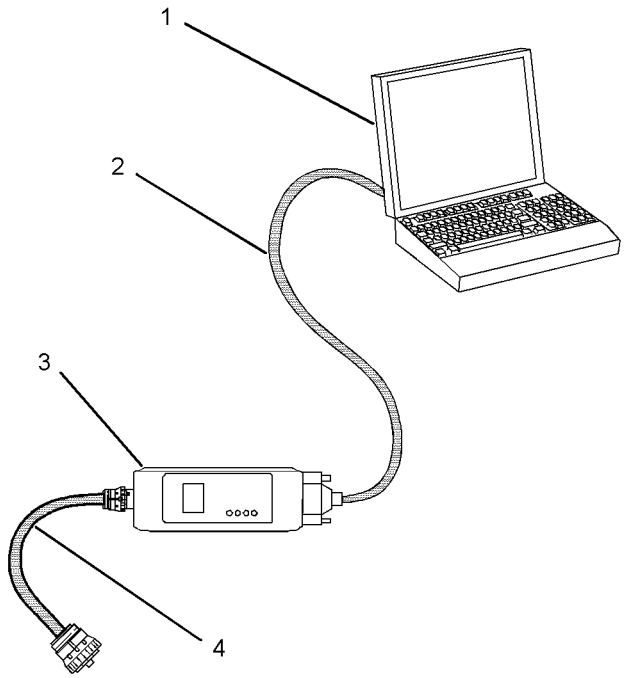

Illustration 1 g01115382

(1) Personal computer (PC)
(2) 196-0055 Adapter Cable As
(3) 171-4401 Communication Adapter As
(4) 207-6845 Adapter Cable As

Note: Items (2), (3), and (4) are part of the 171-4400 Communication Adapter Gp.

Use the following procedure in order to connect Cat ET and the Communication Adapter II.

1. Turn the keyswitch to the OFF position. If the keyswitch is not in the OFF position, the engine may start.
2. Connect cable (2) between the “COMPUTER” end of communication adapter (3) and the RS232 serial port of PC (1).

Note: The 237-7547 Adapter Cable As is required to connect to the USB port on computers that are not equipped with a RS232 serial port.

3. Connect cable (4) between the “DATA LINK” end of communication adapter (3) and the service tool connector.

4. Place the keyswitch in the ON position. If Cat ET and the communication adapter do not communicate with the Electronic Control Module (ECM), refer to the diagnostic procedure Troubleshooting, “Electronic Service Tool Will Not Communicate With ECM”.

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Electronic Display Module (If Equipped)

SMCS Code: 7490

An electronic display module may be used to display CID-FMI information from the electronic control system. Refer to the service manual for your electronic display module for more information.

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Replacing the ECM

SMCS Code: 1901-510

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Tools and Shop Products Guide” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

The Electronic Control Module (ECM) contains no moving parts. Replacement of the ECM can be costly. Replacement can also be a time consuming task. Follow the troubleshooting procedures in this manual in order to ensure that replacing the ECM will correct the problem. Verify that the suspect ECM is the cause of the problem.

Note: Ensure that the ECM is receiving power and that the ECM is properly wired to the negative battery circuit before a replacement of the ECM is attempted. Refer to Troubleshooting, “Electrical Power Supply Circuit - Test”.

A test ECM can be used to determine if the ECM is faulty. Install a test ECM in place of the suspect ECM. Flash program the correct flash file into the test ECM. Program the parameters for normal operation of the engine. The parameters must match the parameters in the suspect ECM. Refer to the following test steps for details. If the test ECM resolves the problem, connect the suspect ECM. Verify that the problem returns. If the problem returns, replace the suspect ECM.

Note: When a new ECM is not available, you may need to remove an ECM from an engine that is not in service. The interlock code for the replacement ECM must match the interlock code for the suspect ECM. Be sure to record the parameters from the replacement ECM on the “Parameters Worksheet”. Use the “Copy Configuration/ECM Replacement” feature that is found under the “Service” menu on the Caterpillar Electronic Technician (ET).

NOTICE
If the flash file and engine application are not matched, engine damage may result.

Perform the following procedure in order to replace the ECM:

1. Record the configuration data:

   a. Connect Cat ET to the service tool connector. Refer to Troubleshooting, “Electronic Service Tools”.

   b. Print the parameters from the “Configuration” screen on Cat ET. If a printer is unavailable, record all of the parameters. Record any logged diagnostic codes and logged event codes for your records. Record the injector codes from the “Calibrations” screen in the “Service” menu on Cat ET.

   c. Use the “Copy Configuration/ECM Replacement” feature that is found under the “Service” menu on Cat ET. Select “Load from ECM” in order to copy the configuration data from the suspect ECM.

Note: If the “Copy Configuration” process fails and the parameters were not obtained in Step 1.b, the parameters must be obtained elsewhere. Some of the parameters are stamped on the engine information plate. Most of the parameters must be obtained from the factory.

2. Remove the ECM:

   a. Turn the keyswitch to the OFF position.

   b. Disconnect the P1 and P2 connectors from the ECM.

NOTICE
Use a suitable container to catch any fuel that might spill. Clean up any spilled fuel immediately.

NOTICE
Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

   c. Remove the fuel lines (if equipped) from the ECM.

   d. Disconnect the ECM ground strap.

   e. Remove the mounting bolts from the ECM.

3. Install the replacement ECM:

   a. Use the old mounting hardware to install the replacement ECM.

   b. Connect the fuel lines (if equipped).

Note: Verify that the fuel lines are installed correctly. The fuel lines must not put tension on the ECM. Rubber grommets are used to protect the ECM from excessive vibration. The ECM should move slightly in the rubber grommets. If the ECM cannot be moved slightly, check that the fuel lines are not pulling the ECM against one side of the grommets.

   c. Connect the ECM ground strap.

   d. Connect the P1 and P2 connectors. Tighten the ECM connector (allen head screw) to the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque value.

4. Configure the replacement ECM:

   a. Flash program the flash file into the ECM. Refer to Troubleshooting, “Flash Programming” for the correct procedure.

   b. Use Cat ET to match the engine application and the interlock code if the replacement ECM was used for a different application.

   c. If the “Copy Configuration” process from Step 1.b was successful, return to the “Copy Configuration/ECM Replacement” screen on Cat ET and select “Program ECM”. Proceed to Step 4.e when programming is complete.

   d. If the “Copy Configuration” process from Step 1.b was unsuccessful, manually program the ECM parameters. The parameters must match the parameters from Step 1.b.

   e. Program the engine monitoring system, if necessary.

   f. Load the injector trim files for the injectors. Refer to Troubleshooting, “Injector Trim File”.

   g. Calibrate the engine speed/timing. Refer to Troubleshooting, “Engine Speed/Timing Sensor - Calibrate”.

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Self-Diagnostics

SMCS Code: 1901

The Electronic Control Module (ECM) has the ability to detect problems with the electronic system and with engine operation. When a problem is detected, a code is generated. An alarm may also be generated. There are two types of codes:

- Diagnostic
- Event

Diagnostic Code – When a problem with the electronic system is detected, the ECM generates a diagnostic code. This indicates the specific problem with the circuitry.

Diagnostic codes can have two different states:

- Active
- Logged

Active Code – An active diagnostic code indicates that an active problem has been detected. Active codes require immediate attention. Always service active codes prior to servicing logged codes.

Logged Code – Every generated code is stored in the permanent memory of the ECM. The codes are logged.

Event Code – An event code is generated by the detection of an abnormal engine operating condition. For example, an event code will be generated if the oil pressure is too low. In this case, the event code indicates the symptom of a problem.

Logged codes may not indicate that a repair is needed. The problem may have been temporary. The problem may have been resolved since the logging of the code. If the system is powered, it is possible to generate an active diagnostic code whenever a component is disconnected. When the component is reconnected, the code is no longer active. Logged codes may be useful to help troubleshoot intermittent problems. Logged codes can also be used to review the performance of the engine and of the electronic system.

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Sensors and Electrical Connectors

SMCS Code: 1900-NS; 7553-WW

Table 4

Connector	Function
J1/P1	ECM Connector (70-Pin Engine Harness)
J2/P2	ECM Connector (“120-Pin Engine Harness”)
J61/P61	Customer Connector (Optional) (40-Pin Connector)
J63/P63	Service Tool Connector (9-Pin Connector)
J66/P66	Customer Supplied Service Tool Connector (9-Pin Connector)
J100/P100	Coolant Temperature Sensor (2-Pin Connector)
J103/P103	Intake Manifold Air Temperature Sensor (2-Pin Connector)
J105/P105	Fuel Temperature Sensor (2-Pin Connector)
J142/P142	Auxiliary Temperature Sensor
J200/P200	Boost Pressure Sensor (3-Pin Connector)
J201/P201	Engine Oil Pressure Sensor (3-Pin Connector)
J203/P203	Atmospheric Pressure Sensor (3-Pin Connector)
J209/P209	Fuel Pressure Sensor
J220/P220	Auxiliary Pressure Sensor
J300/P300	Injector Solenoid Harness (12-Pin Connector)
J400/P400	Engine Timing Calibration Probe (2-Pin Connector)
J401/P401	Primary Engine Speed/Timing Sensor (Crankshaft) (2-Pin Connector)
J402/P402	Secondary Engine Speed/Timing Sensor (Camshaft) (2-Pin Connector)
J403/P403	Throttle Position Sensor (3-Pin Connector)
J800/P800	Engine Coolant Level Sensor

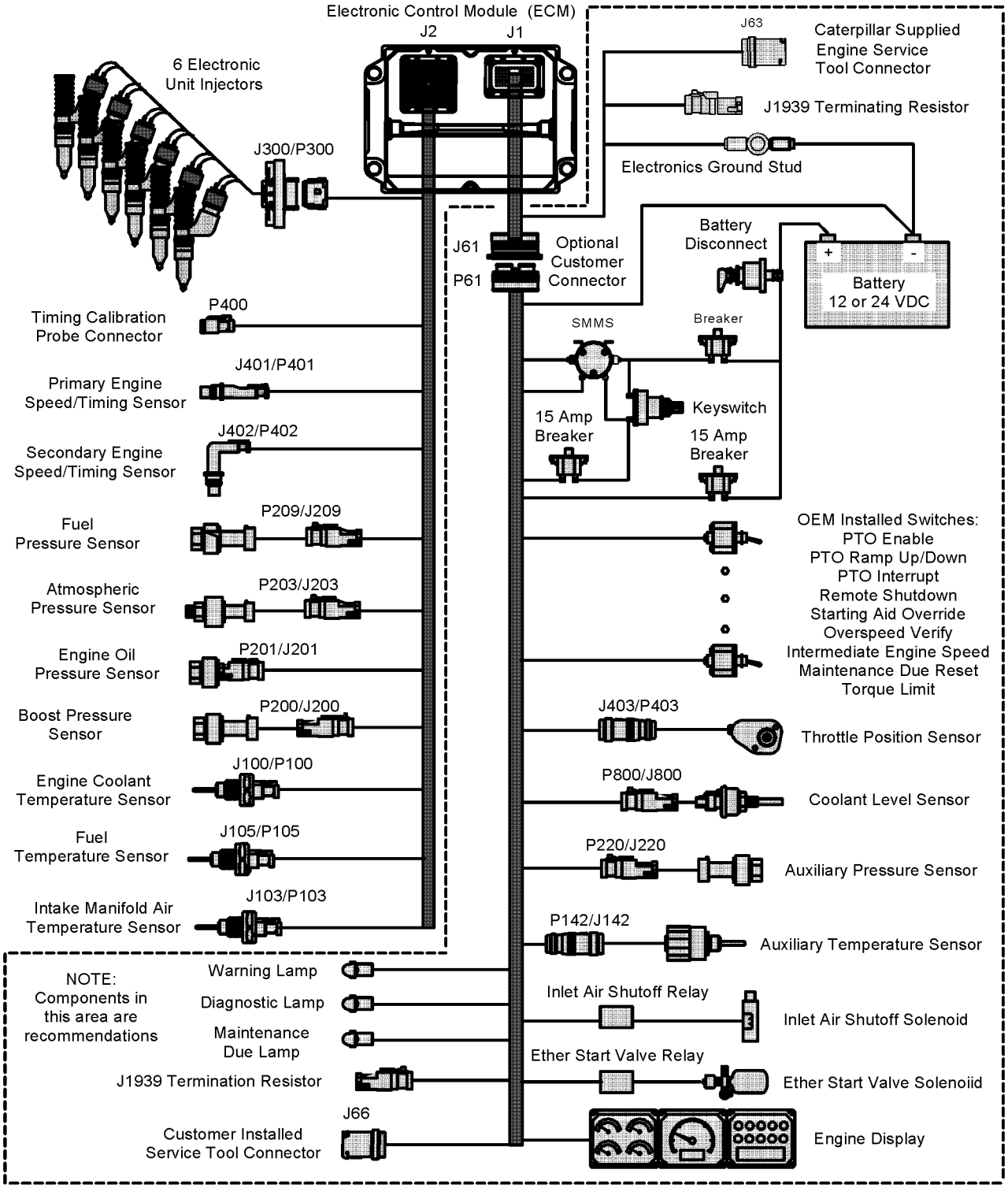

Illustration 2 g01104142

Components for the engine's control system

C11 and C13 Engines

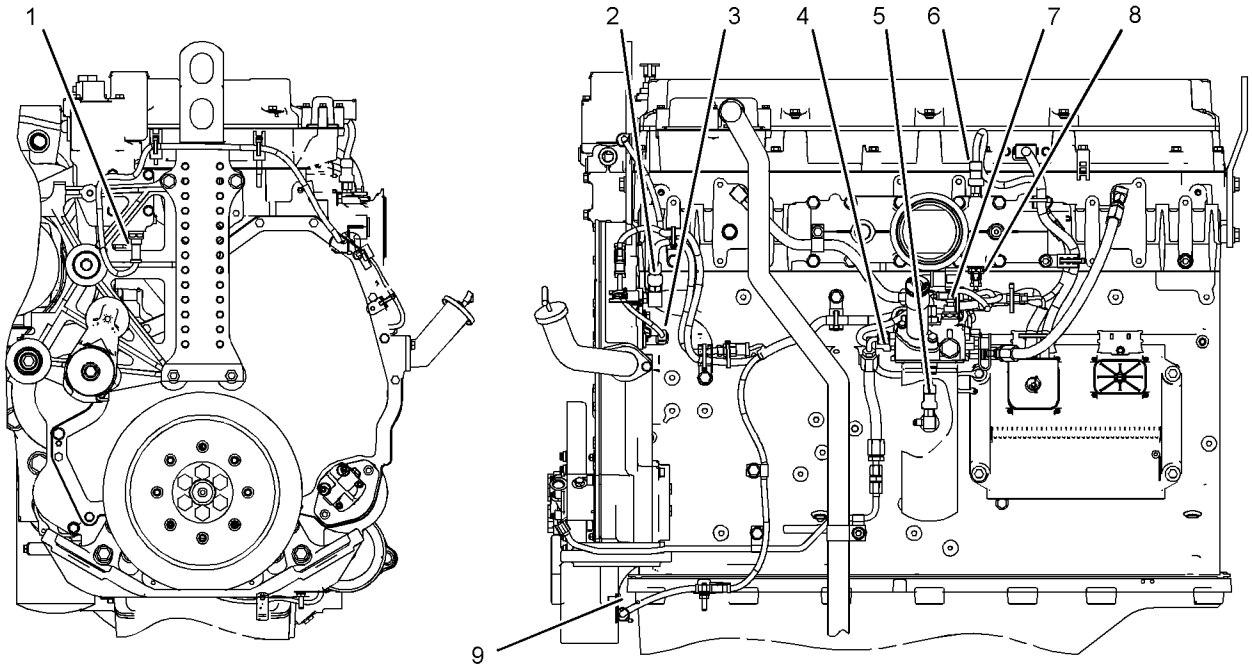

Illustration 3 g01099946

Locations of the sensors on C11 and C13 engines

(1) Coolant temperature sensor
(2) Atmospheric pressure sensor
(3) Secondary engine speed/timing sensor
(4) Fuel pressure sensor
(5) Engine oil pressure sensor
(6) Boost pressure sensor
(7) Fuel temperature sensor
(8) Intake manifold air temperature sensor
(9) Primary engine speed/timing sensor

C15 and C18 Engines

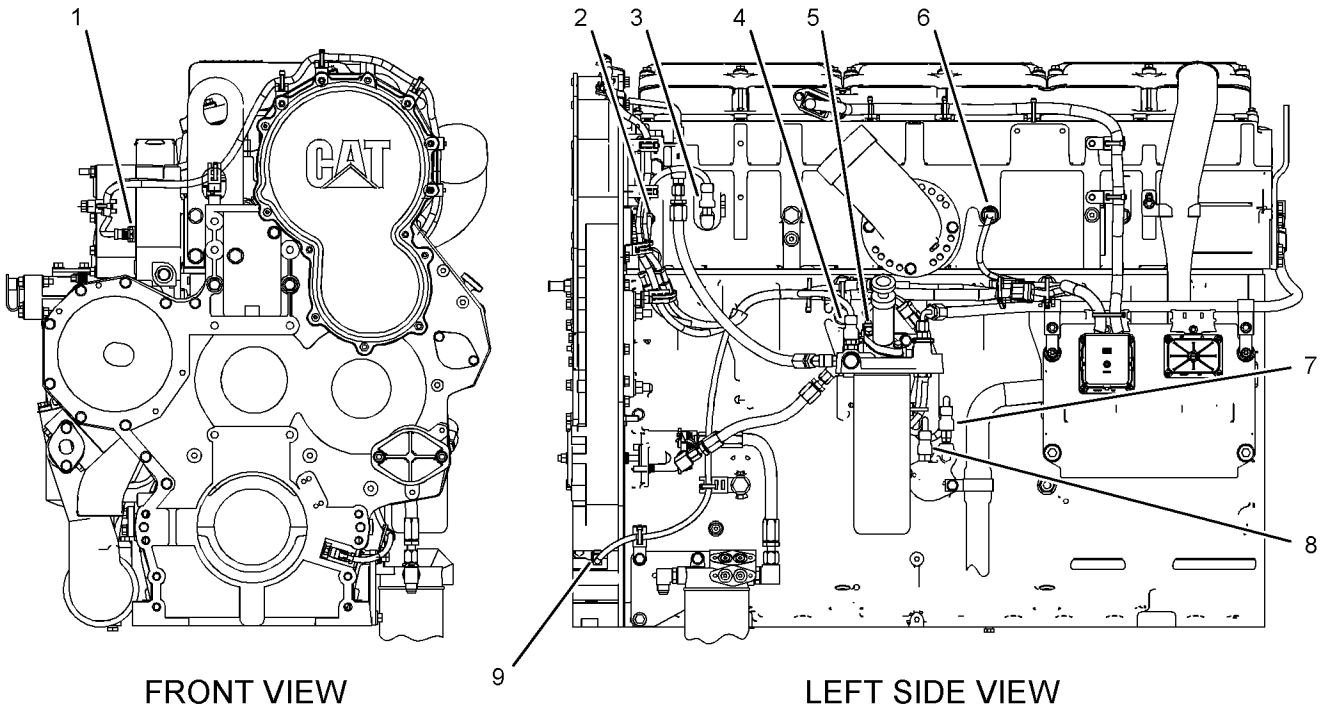

Illustration 4 g01099949

Locations of the sensors on C15 and C18 engines

(1) Coolant temperature sensor
(2) Secondary engine speed/timing sensor
(3) Boost pressure sensor
(4) Fuel pressure sensor
(5) Fuel temperature sensor
(6) Intake manifold air temperature sensor
(7) Engine oil pressure sensor
(8) Atmospheric pressure sensor
(9) Primary engine speed/timing sensor

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Engine Wiring Information

SMCS Code: 1408

The wiring schematics are revised periodically. The wiring schematics will change as updates are made to the machine harness. For the most current information, always check the revision number of the schematic. Use the schematic with the latest revision number.

Harness Wire Identification

Caterpillar identifies all wires with eleven solid colors. The circuit number is stamped on the wire at a 25 mm (1 inch) spacing. Table 5 lists the wire colors and the color codes.

Table 5

Color Codes for the Harness Wire			
Color Code	**Color**	**Color Code**	**Color**
BK	Black	GN	Green
BR	Brown	BU	Blue
RD	Red	PU	Purple
OR	Orange	GY	Gray
YL	Yellow	WH	White
		PK	Pink

For example, a wire identification of A701-GY on the schematic would signify a gray wire with the circuit number A701. A701-GY identifies the power circuit for the No. 1 Injector solenoid.

Another wire identification on the schematic is the size of the wire. The size of the wire will follow the wire color. Wire size or gauge is referred to as AWG (Americal Wire Gauge). AWG is a description of the diameter of the wire.

For example, a code of 150-OR-14 on the schematic would indicate that the orange wire in circuit 150 is a 14 AWG wire.

If the gauge of the wire is not listed, the wire is 16 AWG.

Conversion of AWG Numbers to Metric Measurements

Table 6 shows the various AWG numbers that are used for the wires. The metric equivalent for the diameter of each AWG number are also shown.

Table 6

Metric Equivalents for AWG Numbers			
AWG Number	**Diameter (mm)**	**AWG Number**	**Diameter (mm)**
20	0.8	14	1.6
18	1.0	12	2.0
16	1.3	4	3.2

Welding on a Machine that is Equipped with an Electronic Control System (ECM)

Proper welding procedures are necessary in order to avoid damage to the engine's electronic control module, sensors, and associated components. The component that requires welding should be removed. When welding on a machine that is equipped with an ECM and removal of the component is not possible, the following procedure must be followed. This procedure provides the minimum amount of risk to the electronic components.

NOTICE

Do not ground the welder to electrical components such as the ECM or sensors. Improper grounding can cause damage to the drive train bearings, hydraulic components, electrical components, and other components.

Clamp the ground cable from the welder to the component that will be welded. Place the clamp as close as possible to the weld. This will help reduce the possibility of damage.

1. Stop the engine. Turn the keyswitch to the OFF position.

2. Disconnect the negative battery cable from the battery. If a battery disconnect switch is installed, open the switch.

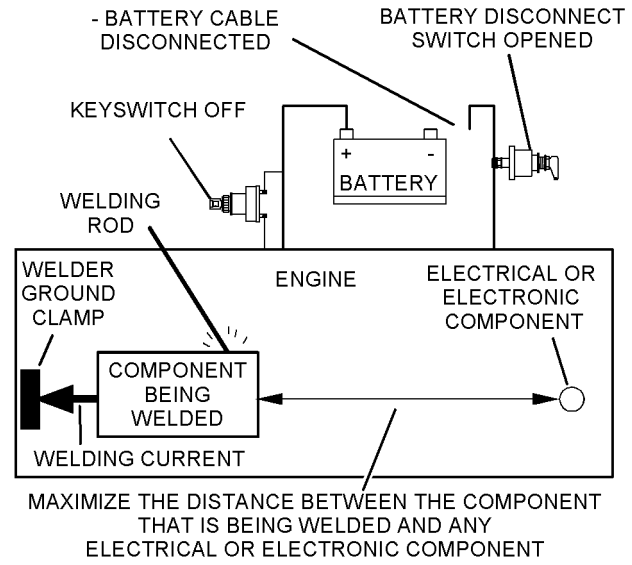

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Illustration 5

Service welding guide (typical diagram)

3. Connect the welding ground cable as close as possible to the area that will be welded. Components which may be damaged by welding include bearings, hydraulic components, and electrical/electronic components.

4. Protect the wiring harness from welding debris and from spatter.

5. Weld the materials by using standard welding methods.

Programming Parameters

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Programming Parameters

SMCS Code: 1901

The Caterpillar Electronic Technician (ET) can be used to view certain parameters that can affect the operation of the engine. Cat ET can also be used to change certain parameters. The parameters are stored in the Electronic Control Module (ECM). Some of the parameters are protected from unauthorized changes by passwords. Parameters that can be changed have a tattletale number. The tattletale number shows if a parameter has been changed.

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Customer Passwords

SMCS Code: 0785

Customer passwords must meet the following criteria:

- Alphanumeric
- Eight characters in length
- “Customer Password #1” can be programmed.

OR

- “Customer Password #1” can be programmed and “Customer Password #2” can be programmed.

OR

- No customer passwords are programmed.

If customer passwords have been entered, then the customer passwords are required to change any parameter that is customer programmable. Parameters that are customer programmable are those parameters that affect the engine speed limits, the power rating within an engine family and the PTO operation. Refer to Troubleshooting, “System Configuration Parameters” for more detail on parameters that are customer programmable.

Use the Caterpillar Electronic Technician (ET) to change parameters that are customer programmable. To obtain customer passwords, contact the owner of the engine. If the owner has lost the owner’s passwords, customer passwords may be read by using Cat ET.

Note: Factory passwords are required in order to read customer passwords.

Use the following procedure in order to read customer passwords with Cat ET:

1. Access the “Utilities menu”. Then access “View Passwords” under the “Utilities menu”.
2. When the “Factory Password” screen appears, record the information that is listed on the “Factory Passwords Worksheet”. Refer to Troubleshooting, “Factory Passwords Worksheet” for additional information.
3. Obtain the factory passwords. The information that is recorded on the “Factory Passwords Worksheet” must be provided. When you obtain the factory passwords, a permanent record of your access is generated at Caterpillar.
4. From the “Factory Password” screen, enter the factory passwords.
5. When the “Read Customer Passwords” screen appears, record the customer passwords. The customer passwords may then be used to change parameters that are customer programmable.

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Factory Passwords

SMCS Code: 0785

NOTICE
Operating the engine with a flash file not designed for that engine will damage the engine. Be sure the flash file is correct for your engine.

Note: Factory passwords are provided only to Caterpillar dealers.

Factory passwords are required to perform each of the following functions:

- Program a new Electronic Control Module (ECM).

  When an ECM is replaced, the system configuration parameters must be programmed into the new ECM. A new ECM will allow these parameters to be programmed once without factory passwords. After the initial programming, some parameters are protected by factory passwords.

- Clear event codes.

  Most event codes require the use of factory passwords to clear the code once the code has been logged. Clear these codes only when you are certain that the problem has been corrected.

- Unlock parameters.

  Factory passwords are required in order to unlock certain system configuration parameters. Refer to Troubleshooting, “System Configuration Parameters” for additional information.

Since factory passwords contain alphabetic characters, the Caterpillar Electronic Technician (ET) must be used to perform these functions. In order to obtain factory passwords, proceed as if you already have the password. If factory passwords are needed, Cat ET will request the factory passwords and Cat ET will display the information that is required to obtain the passwords. For the worksheet that is used for acquiring factory passwords, refer to Troubleshooting, “Factory Passwords Worksheet”.

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Factory Passwords Worksheet

SMCS Code: 0785

Note: A mistake in recording these parameters will result in incorrect passwords.

Table 7

Factory Passwords Worksheet	
Dealer Code	
Customer’s Name	
Address	
Telephone Number	
Information From the Engine Information Plate	
Engine Serial Number	
Full Load Setting	
Full Torque Setting	
Information From the Vehicle Odometer	
Engine’s Miles (km)	
Information From the “Factory Password Entry Screen” on the Caterpillar Electronic Technician (ET)	
Electronic Service Tool Serial Number	
Engine Serial Number	
ECM Serial Number	
Total Tattletale	
Reason Code	
From Interlock(1)	
To Interlock(1)	
Factory Passwords	
Factory Password (No. 1)	
Factory Password (No. 2)	

(1) This parameter is required when the engine is being rerated. This parameter is displayed only when the engine is being rerated.

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Flash Programming

SMCS Code: 1901-591

Flash Programming – This is a method of programming or updating the flash file in an Electronic Control Module (ECM).

The Caterpillar Electronic Technician (ET) can be utilized to flash a new flash file into the ECM. The flash is accomplished by transferring the data from a PC to the ECM.

Programming a Flash File

1. Obtain the part number for the new flash file.

Note: If you do not have the flash file's part number, use the "Flash File Search" tool on the Service Technician Workbench (STW). Alternatively, use the "Flash Software Files" feature on SIS Web.

Note: You must have the engine serial number in order to search for the flash file's part number.

2. Connect Cat ET to the service tool connector.

3. Turn the keyswitch to the ON position. Do not start the engine.

4. Select "WinFlash" from the "Utilities" menu on Cat ET.

Note: If "WinFlash" will not communicate with the ECM, refer to Troubleshooting, "Electronic Service Tool Will Not Communicate with ECM".

5. Program the flash file into the ECM.

   a. Select the engine ECM under the "Detected ECMs".

   b. Press the "Browse" button in order to select the part number of the flash file that will be programmed into the ECM.

   c. When the correct flash file is selected, press the "Open" button.

   d. Verify that the "File Values" match the application. If the "File Values" do not match the application, search for the correct flash file.

   e. When the correct flash file is selected, press the "Begin Flash" button.

   f. Cat ET will indicate when flash programming has been successfully completed.

6. Start the engine and check for proper operation.

   a. If a diagnostic code of 268-02 Check Programmable Parameters is generated, program any parameters that were not in the old flash file.

   b. Access the "Configuration" screen under the "Service" menu in order to determine the parameters that require programming. Look under the "Tattletale" column. All of the parameters should have a tattletale of 1 or more. If a parameter has a tattletale of 0, program that parameter.

"WinFlash" Error Messages

If you receive any error messages during flash programming, click on the "Cancel" button in order to stop the process. Access the information about the "ECM Summary" under the "Information" menu. Make sure that you are flashing the correct file for your engine.

i02289388

Injector Trim File

SMCS Code: 1290

The Caterpillar Electronic Technician (ET) is used to load the injector trim files into the Electronic Control Module (ECM).

The injector trim files must be loaded into the ECM if any of the following conditions occur:

- An injector is replaced.
- The ECM is replaced.
- A 268-02 diagnostic code is active.
- Injectors are exchanged between cylinders.

Exchanging Injectors

Exchanging injectors can help determine if a combustion problem is in the injector or in the cylinder. If two injectors that are currently installed in the engine are exchanged between cylinders, the injector trim files can also be exchanged. Press the "Exchange" button at the bottom of the "Injector Trim Calibration" screen on Cat ET. Select the two injectors that will be exchanged and press the "OK" button. The tattletale for the injectors that were exchanged will increase by one.

Note: The injector serial number and the injector confirmation code are located on the injector.

1. Refer to Table 8. Record the injector serial number and the injector confirmation code for each injector.

Table 8

Information for the Injectors		
Cylinder	**Serial Number**	**Confirmation Code**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

2. Click on “Injector Trim Files” in SIS Web.

3. Enter the serial number for the injector in the search field.

4. Download the injector trim file to the PC. Repeat this procedure for each injector, as required.

5. Connect Cat ET to the service tool connector. Refer to Troubleshooting, “Electronic Service Tools”.

6. Turn the keyswitch to the ON position.

7. Select the following menu options on Cat ET:

- Service
- Calibrations
- Injector Trim Calibration

8. Select the appropriate cylinder.

9. Click on the “Change” button.

10. Select the appropriate injector trim file from the PC.

11. Click on the “Open” button.

12. Enter the confirmation code if required by Cat ET.

13. Click on the “OK” button.

The injector trim file is loaded into the ECM.

14. Repeat the procedure for each cylinder, as required.

i02278907

Service Information Report

SMCS Code: 0336

After verifying the correct repair has been performed on the engine, it is critical to provide brief, detailed information. This information helps Caterpillar better serve you and the customer.

Recommendations

Customer’s Complaint

Obtain as much information from the customer as possible. Investigate any written information that is available and document any information that is gathered from the customer. The following information is of particular importance:

- Indicate if the diagnostic lamp was flashing.
- Indicate if the warning lamp was flashing, or if the lamp was on continuously.
- Indicate the symptoms of engine operation that are present.

Be as specific as possible.

Cause of Failure

Comments on the cause of failure should include the number of diagnostic codes that were logged. Comments should also indicate if the code was an active code. Indicate the source of the problem. Also indicate the method that was used to discover the problem. Examples of the methods that were used to discover the problem could be one of the following methods:

- A specific procedure in the manual was followed.
- A visual inspection indicated that wire abrasion on the engine harness existed.

- An engine dynamometer test indicated that the power was below the specification at 1700 rpm due to the loss of the no. 4 injector and an engine dynamometer test indicated that the power was below the specification at all engine speeds above 1700 rpm due to the loss of the no. 4 injector.

Be as specific as possible.

Repair Procedure

Comments on the repair procedure should include the following types of information:

- The wiring harness was repaired.
- The Full Load Setting (FLS) was changed per the factory's instructions.

Be as specific as possible.

System Configuration Parameters

i02290263

System Configuration Parameters

SMCS Code: 1901

System configuration parameters are parameters that affect the emissions and the power of the engine. Default values for the parameters are programmed at the factory. Some parameters may be changed by the customer in order to suit the needs of the specific application.

Parameter Descriptions

“Equipment ID”

“Equipment ID” allows the customer to enter a description into the Electronic Control Module (ECM) in order to identify the machine. A maximum of 17 characters may be entered in the field. This parameter is only for reference by the customer. This parameter is not required.

“Engine Serial Number”

Program the “Engine Serial Number” to match the engine serial number that is stamped on the engine information plate. If the ECM is replaced, the engine serial number from the engine information plate must be programmed into the new ECM.

Note: When you are requesting factory passwords, always use the engine serial number that is programmed in the ECM.

“Rating Number”

The “Rating Number” corresponds to the selected set of performance maps for the application. This selected set of performance maps comes out of several unique sets of maps that are resident in the flash file. The dealer and/or the OEM will need to select the appropriate rating tier, if more than one rating tier is present. The rating tiers are A through E.

Note: Factory passwords are required in order to change the “Rating Number”.

“Top Engine Limit” (TEL)

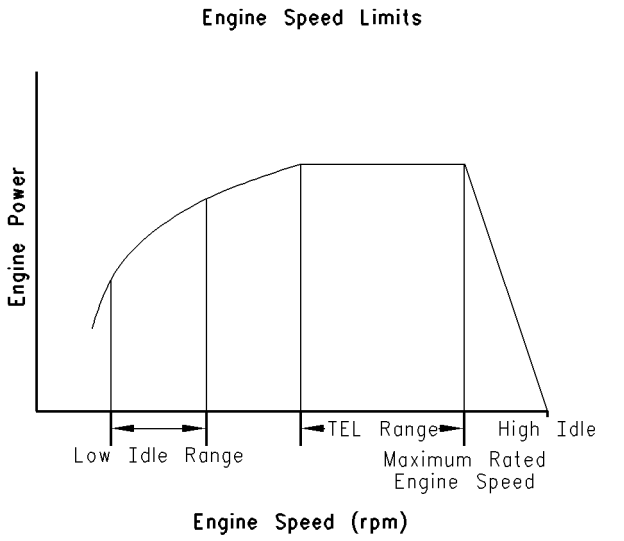

Illustration 6 g00763900

“TEL” is a customer programmable parameter that defines the maximum allowable engine speed for maximum power. “TEL” can be programmed up to the maximum rated engine speed. “TEL” is defined along the engine’s lug curve.

“Engine Accel. Rate”

“Engine Accel. Rate” determines the rate of change of the engine speed (acceleration or deceleration) during PTO operation. This rate of change is also used to achieve intermediate engine speed.

“Low Idle Speed”

“Low Idle Speed” is the minimum allowable operating speed for the engine. This parameter can be programmed between 600 and 1400 rpm.

“PTO Mode”

“PTO Mode” allows the ECM to be programmed to either one of the two PTO configurations that are available.

“Ramp Up/Ramp Down” – When “PTO Mode” is programmed to “Ramp Up/Ramp Down”, the ECM allows PTO operation with traditional features.

“Set/Resume” – When “PTO Mode” is programmed to “Set/Resume”, the ECM allows PTO operation with enhanced features.

“High Idle Speed”

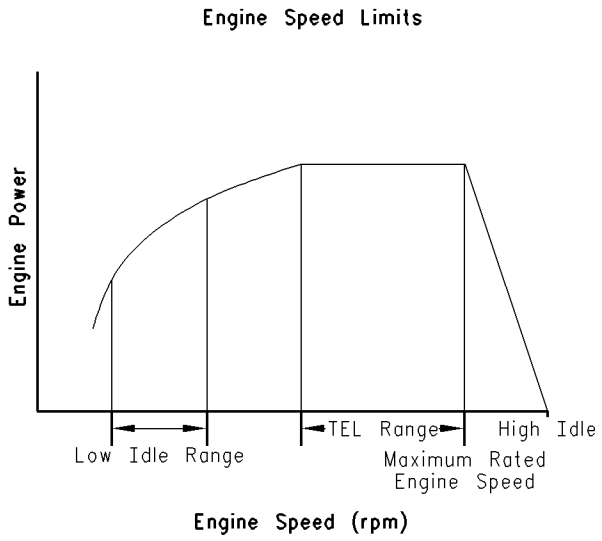

Illustration 7 g00763900

“High Idle Speed” is the maximum no-load engine speed when the throttle or the PTO switch is in the maximum position.

Note: “High Idle Speed” cannot be programmed lower than “TEL”.

“Intermediate Engine Speed”

“Intermediate Engine Speed” defines the speed for the engine when the intermediate engine speed switch is activated. This parameter can be programmed to any engine speed between “Low Idle Speed” and “TEL”. Engine speed will increase or engine speed will decrease at the rate that is defined by the programmed value for “Engine Accel. Rate”.

“Engine Power Trim”

This parameter cannot be changed.

“Maximum Engine Torque Limit”

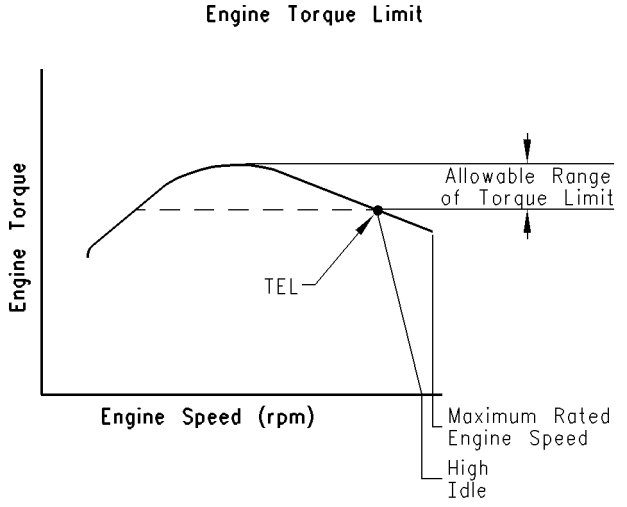

Illustration 8 g00817759

“Engine Torque Limit” can be used to limit torque output to the programmed value when the torque limit switch is activated.

“FLS” (Full Load Setting)

“FLS” is a number that represents the adjustment to the fuel system that was made at the factory in order to fine tune the fuel system. The correct value for this parameter is stamped on the engine information plate. Factory passwords are required in order to change this parameter.

“FTS” (Full Torque Setting)

“FTS” is similar to “FLS”. Factory passwords are required in order to change this parameter.

“Ether Control”

Program the “Ether Control” to “Enabled” if an ether injection system is installed on the engine. This allows the ECM to control ether injection. If the engine is not equipped with ether, program this parameter to “Disabled”.

“Air Shutoff”

“Air Shutoff” allows the ECM to be programmed for operation of an air shutoff system. If this parameter is programmed to “Installed”, the ECM will activate the air shutoff solenoid in the event of an engine overspeed condition.

Note: If an engine overspeed condition occurs and “Air Shutoff” is programmed to “Enabled”, the switched power to the ECM must be cycled and the air shutoff solenoid must be manually reset before the engine will restart.

“Maintenance Indicator Mode”

The ECM records data that is related to equipment maintenance. The ECM will activate the maintenance indicator lamp when scheduled maintenance is due. The maintenance indicator lamp can be reset by actuating the maintenance clear switch. The maintenance interval may be based on operating hours or on fuel consumption. The ECM provides information that pertains to maintenance intervals and the last maintenance that was performed.

“PM1 Interval”

“PM1 Interval” allows the customer to define the maintenance interval if “Maintenance Indicator Mode” is programmed to one of the manual options. Refer to the engine’s Operation and Maintenance Manual for more information.

“Throttle Position Sensor”

Program the “Throttle Position Sensor” to “Installed” if a throttle position sensor is used for desired speed control. Otherwise program this parameter to “Not Installed”.

“Coolant Level Sensor”

Program the “Coolant Level Sensor” to “Installed” if a coolant level sensor is installed on the engine. Otherwise program this parameter to “Not Installed”.

“Direct Fuel Control Mode”

Program the “Direct Fuel Control Mode” to “Enabled” if an external governor is used. Once this parameter is enabled, the governing system in the ECM is disabled. Otherwise program this parameter to “Disabled”.

“Aux Press Sensor Installation Status”

Program “Aux Press Enable” to “Installed” if an auxiliary pressure sensor is installed. This will allow the display for the Engine Monitoring System (EMS) to monitor the pressure of another system. Program this parameter to “Not Installed” if an auxiliary pressure sensor is not installed.

“Aux Temp Sensor Installation Status”

Program “Aux Temp Enable” to “Installed” if an auxiliary temperature sensor is installed. This will allow the display for the Engine Monitoring System (EMS) to monitor the temperature of another system. Program this parameter to “Not Installed” if an auxiliary temperature sensor is not installed.

System Configuration Parameters

Table 9

System Configuration Parameters			
Parameter	**Available Range or Options**	**Default**	**Required Password**
ECM Identification Parameters			
“Equipment ID”	17 alphanumeric characters	“NOT PROGRAMMED”	None
“Engine Serial Number”	0XX00000 or XXX00000	0XX00000	None
“ECM Serial Number”	“Read Only” (1)		
“Software Gp Part Number”	Software Dependent		Read Only (1)
“Software Gp Release Date”	Software Dependent		Read Only (1)
Selected Engine Rating			
“Rating Number”	Software Dependent		Customer
“Rated Power”	Software Dependent		Read Only (1)
“Rated Peak Torque”	Software Dependent		Read Only (1)
“Top Engine Speed Range”	Software Dependent		Read Only (1)
“Test Spec”	Software Dependent		Read Only (1)
“Top Engine Limit”	Software Dependent		Customer
“Engine Accel. Rate”	50 to 1000	50	None
“Low Idle Speed”	600 to 1400	700	None
“PTO Mode”	“Ramp Up/Ramp Down” “Set/Resume”	“Ramp Up/Ramp Down”	None
“High Idle Speed”	1800 to 2310	2310	Customer
“Intermediate Engine Speed”	Programmed “Low Idle” to “TEL”	1100	None
“Engine Power Trim”	This parameter cannot be changed.		
“Maximum Engine Torque Limit”	Software Dependent		None
“Customer Password #1”	8 alphanumeric characters	Blank	Customer
“Customer Password #2”	8 alphanumeric characters	Blank	Customer
“FLS” (Full Load Setting)	- 128 to 127	0	Factory
“FTS” (Full Torque Setting)	-128 to 127	0	Factory
“Ether Control”	“No Ether” “Continuous Flow”	“No Ether”	None
“Air Shutoff”	“Enabled” “Disabled”	“Disabled”	None
“Maintenance Indicator Mode”	“OFF” “Auto Fuel” “Auto Hour” “Man Fuel” “Man Hour”	“OFF”	None
“PM1 Interval”	100 to 750 Hours or 3785 to 28390 L (1000 to 7500 US gal)	250 Hours or 9463 L (2500 US gal)	None
“Throttle Position Sensor”	“Installed” “Not Installed”	“Not Installed”	None
“Coolant Level On”	“Installed” “Not Installed”	“Not Installed”	None

(continued)

(Table 9, contd)

System Configuration Parameters			
Parameter	**Available Range or Options**	**Default**	**Required Password**
“Direct Fuel Control Mode”	“Installed” “Not Installed”	“Not Installed”	Factory
“Last Tool to change Customer Parameters”	Read Only (1)		
“Last Tool to change System Parameters”	Read Only (1)		
“Aux Temp Sensor Installation Status”	“On” “Off”	“Off”	None
“Aux Press Sensor Installation Status”	“On” “Off”	“Off”	None
“Total Tattletale”	Read Only (1)		

(1) The parameter can only be viewed. No changes are allowed.

Parameters Worksheet

Note: A mistake in recording this information will result in incorrect passwords.

Table 10

Engine Parameters	
ECM Identification Parameters	
“Equipment ID”	
“Engine Serial Number”	
“ECM Serial Number”	
“Software Gp Part Number”	
“Software Gp Release Date”	
Selected Engine Rating	
“Rating Number”	
“Rated Power”	
“Rated Peak Torque”	
“Top Engine Speed Range”	
“Test Spec”	
“Top Engine Limit”	
“Engine Accel Rate”	

(continued)

(Table 10, contd)

Engine Parameters	
“Low Idle Speed”	
“PTO Mode”	
“High Idle Speed”	
“Intermediate Engine Speed”	
“Engine Power Trim”	
“Maximum Engine Torque Limit”	
“Customer Password #1”	
“Customer Password #2”	
“FLS”	
“FTS”	
“Ether Control”	
“Air Shutoff”	
“Maintenance Indicator Mode”	
“PM1 Interval”	
“Throttle Position Sensor”	
“Coolant Level Sensor”	

(continued)

(Table 10, contd)

Engine Parameters	
“Direct Fuel Control Mode”	
“Last Tool to change Customer Parameters”	
“Last Tool to change System Parameters”	
“Aux Press Temp Installation Status”	
“Aux Press Sensor Installation Status”	
“Total Tattletale”	
Information from Engine Information Plate	
“Engine Serial Number”	
“FLS”	
“FTS”	
Injector Codes	
Injector Code (1)	
Injector Code (2)	
Injector Code (3)	
Injector Code (4)	
Injector Code (5)	
Injector Code (6)	

Note: Compare the FLS and the FTS from the ECM with the values that are listed on the engine information plate. Only change the FLS and the FTS because of a mechanical change in the engine. The use of the wrong parameters could cause damage to the engine. The use of the wrong parameters may also void the Caterpillar warranty.

Monitoring System

The monitoring system determines the level of action that is taken by the ECM in response to a condition that can damage the engine. The monitoring of the various sensors by the ECM can be turned “On” or “Off”. These conditions are identified by the ECM from the signals that are produced from the following sensors:

- Engine oil pressure sensor
- Engine coolant temperature sensor
- Engine speed/timing sensors
- Inlet air temperature sensor
- Boost pressure sensor
- Coolant level sensor
- Fuel temperature sensor
- Fuel pressure sensor
- Auxiliary temperature sensor
- Auxiliary pressure sensor

The monitoring system can be locked out. In order to change the settings, the monitoring system must be unlocked. Access the “Parameter Lockout” under the “Service” menu on Cat ET in order to unlock the monitoring system.

Warnings, derates, and shutdowns can be disabled for any parameter or for all of the parameters.

Table 11

Settings for the Monitoring System							
Parameter	**Event Code**	**Action**	**Default Value**	**Time Delay in Seconds**		**Set Points**	
				Range	**Default**	**Range**	**Default**
“Low Coolant Level”	E057	Derate	On	1 to 54	10	None	
	E058	Shutdown	Off	1 to 54	10		
	E059	Warning	On	1 to 54	10		
“High Fuel Pressure”	E096	Warning	On	None	8	Maps are not programmable. (1)	
“Low Engine Oil Pressure”	E360	Warning	On	None	8	Maps are not programmable.(1)	
		Derate					
		Shutdown	Off		4		
“High Engine Coolant Temperature”	E361	Warning	On	None	10	85 °C (185 °F) to 110 °C (230 °F)	110 °C (230 °F)
		Derate		1 to 54	10	86 °C (187 °F) to 111 °C (232 °F)	111 °C (232 °F)
		Shutdown	Off	1 to 54	10	87 °C (189 °F) to 111 °C (232 °F)	
“Engine Overspeed”	E362	Warning	On	None	1	C11/ C13	1800-2600	2600
						C15		
						C18	1800-2500	2500
		Shutdown				C11/ C13	1800-2800	2800
						C15		
						C18	1800-2700	2700
“High Fuel Temperature”	E363	Warning	On	1 to 54	30	70 °C (158 °F) to 90 °C (194 °F)		90 °C (194 °F)
		Derate		1 to 54	10	71 °C (160 °F) to 91 °C (196 °F)		91 °C (196 °F)
		Shutdown	Off	1 to 54	10			
“High Auxiliary Pressure”(2)	E443	Warning	On	1 to 54	4	0 kPa (0 psi) to 3150 kPa (457 psi)		1500 kPa (218 psi)
		Derate	Off	1 to 54	3			
		Shutdown		1 to 54	3			
“High Auxiliary Temperature”(2)	E445	Warning	On	1 to 54	4	0 °C (0 °F) to 140 °C (284 °F)		105 °C (221 °F)
		Derate	Off	1 to 54	4			106 °C (223 °F)
		Shutdown		1 to 54	4			107 °C (224 °F)

(continued)

(Table 11, contd)

Settings for the Monitoring System							
Parameter	**Event Code**	**Action**	**Default Value**	**Time Delay in Seconds**		**Set Points**	
				Range	**Default**	**Range**	**Default**
“High Engine Air Inlet Temperature”	E539	Warning	On	None	8	None	75 °C (167 °F)
		Derate		1 to 54	8		79 °C (174 °F)

(1) The maps may be different. The maps depend on the model of the engine.
(2) The engine must be equipped with the appropriate sensor.

Troubleshooting without a Diagnostic Code

i02119218

Alternator (Charging Problem)

SMCS Code: 1405-035

Probable Causes

- Alternator drive belts
- Charging circuit
- Regulator
- Alternator

Recommended Actions

Alternator Drive Belts

1. Inspect the condition of the alternator drive belts. If the alternator drive belts are worn or damaged, replace the belts.
2. Check the tension on the alternator drive belts. Adjust the tension, if necessary.

Charging Circuit

Inspect the battery cables, wiring, and connections in the charging circuit. Clean all connections and tighten all connections. Replace any faulty parts.

Alternator or Regulator

Verify that the alternator or the regulator is operating correctly. Refer to Special Instruction, REHS0354, “Charging System Troubleshooting” for the proper testing procedures. Repair the alternator or replace the alternator, as needed.

i02170483

Battery

SMCS Code: 1401-035

Note: This is not an electronic system problem.

Refer to Special Instruction, REHS0354, “Charging System Troubleshooting” for the proper testing procedures.

Probable Causes

- Battery
- An electrical device drains the battery.

Recommended Actions

Battery

1. Verify that the battery is no longer able to hold a charge.
2. Replace the battery.

Electrical Device

1. Verify that an electrical device drained the battery by being left in the ON position.
2. Charge the battery.
3. Verify that the battery is able to maintain a charge.

i02290338

Can Not Reach Top Engine RPM

SMCS Code: 1915-035

Note: If this problem occurs only under load, refer to Troubleshooting, “Low Power/Poor or No Response to Throttle”.

⚠ WARNING

The connection of any electrical equipment and the disconnection of any electrical equipment may cause an explosion hazard which may result in injury or death. Do not connect any electrical equipment or disconnect any electrical equipment in an explosive atmosphere.

Probable Causes

- Diagnostic codes
- Event codes
- Programmable parameters
- Cold mode
- Altitude derate
- Throttle signal

- Rated fuel position and/or FRC fuel position
- Boost pressure sensor
- Fuel supply
- Air inlet and exhaust system
- Accessory equipment

Recommended Actions

Diagnostic Codes and Event Codes

Certain diagnostic codes and/or event codes may cause poor performance. Connect the Caterpillar Electronic Technician (ET) and check for active codes and logged codes. Troubleshoot any codes that are present before continuing with this procedure.

Programmable Parameters

Check the following parameters on Cat ET:

- “Throttle Position Sensor”
- “Desired Speed Input Configuration”
- “Direct Fuel Control Mode”

Determine the type of throttle that is used in the application. Program the parameters to match the type of throttle that is used. Refer to Troubleshooting, “Throttle Position Sensor Circuit - Test” for more information.

Note: The engine will have poor performance if the parameters are not programmed correctly.

Cold Mode

Use the electronic service tool to verify that the engine has exited cold mode. A status flag will appear if the engine is operating in cold mode. This may limit engine speed.

Altitude Derate

The engine may be derated due to high elevation. Connect Cat ET to the service tool connector. Check for an active engine derate on the status screens.

Note: There are no event codes that are associated with the altitude derate.

Throttle Signal

Connect Cat ET to the service tool connector. View the status for the throttle position on the status screen. Operate the throttle from the Low Idle position to the High Idle position. The status should be 0 percent at low idle and the status should be 100 percent at high idle. If the status can not operate in the full range, refer to Troubleshooting, “Throttle Position Sensor - Calibrate”.

Diagnostic codes that are related to the J1939 data link will prevent correct operation of the throttle if the throttle position is transmitted over the data link. If there is a problem with the data link, the engine will remain at low idle until the data link is repaired.

Boost Pressure Sensor, Rated Fuel Position and/or FRC Fuel Position

1. With the engine at full load, monitor “Fuel Position” and “Rated Fuel Limit” on the status screen. If “Fuel Position” does not equal “Rated Fuel Limit” then check air inlet manifold pressure.
2. Verify that there are no active diagnostic codes that are associated with the boost pressure sensor or with the atmospheric pressure sensor.
3. Monitor boost pressure and atmospheric pressure on the status screen for normal operation.

Note: Atmospheric pressure is not a default parameter on a status screen. You must manually select the parameter for the atmospheric pressure in order to monitor the atmospheric pressure sensor.

Fuel Supply

1. Check the fuel lines for the following problems: restrictions, collapsed lines, and pinched lines. If problems are found with the fuel lines, repair the lines and/or replace the lines.
2. Check the fuel tank for foreign objects which may block the fuel supply.
3. Check for air in the low pressure fuel supply system if any of the following procedures have been performed:
   - Replacement of the fuel filters
   - Service on the low pressure fuel supply circuit
   - Replacement of unit injectors
4. Purge air from the low pressure fuel supply circuit. Refer to Operation and Maintenance Manual, “Fuel System - Prime” for the correct procedure.

Note: A sight glass in the low pressure supply line is helpful in diagnosing air in the fuel.

5. Cold weather adversely affects the characteristics of the fuel. Refer to the Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold weather operation.

6. Check the fuel pressure during engine cranking. Check the fuel pressure on the outlet side of the fuel filter. Refer to Specifications for correct pressure values. If the fuel pressure is low, replace the fuel filters. If the fuel pressure is still low, check the following items: fuel transfer pump, fuel transfer pump coupling, and fuel pressure regulating valve.

Air Inlet and Exhaust System

1. Clean plugged air filters or replace plugged air filters. Refer to the Operation and Maintenance Manual.

2. Check the air inlet and exhaust system for restrictions and/or leaks. Refer to Testing and Adjusting, “Air Inlet and Exhaust System”.

Accessory Equipment

Check all accessory equipment for problems that may create excessive load on the engine. Repair any damaged components or replace any damaged components.

i02119298

Coolant in Engine Oil

SMCS Code: 1348-035; 1395-035

Probable Causes

- Engine oil cooler core
- Cylinder head gasket
- Cylinder head
- Cylinder liner
- Cylinder block

Recommended Actions

Engine Oil Cooler Core

1. Check for leaks in the oil cooler core. If a leak is found, install a new oil cooler core. Refer to the Disassembly and Assembly manual.

2. Drain the crankcase and refill the crankcase with clean engine oil. Install new engine oil filters. Refer to the Operation and Maintenance Manual.

Cylinder Head Gasket

1. Remove the cylinder head. Refer to the Disassembly and Assembly manual.

2. Check the cylinder liner projection. Refer to the Testing and Adjusting manual.

3. Install a new cylinder head gasket and new water seals in the spacer plate. Refer to the Disassembly and Assembly manual.

Cylinder Head

Check for cracks in the cylinder head. If a crack is found, repair the cylinder head and/or replace the cylinder head. Refer to the Disassembly and Assembly manual.

Cylinder Liner

Check for cracked cylinder liners. Replace any cracked cylinder liners. Refer to the Disassembly and Assembly manual.

Cylinder Block

Inspect the cylinder block for cracks. If a crack is found, repair the cylinder block or replace the cylinder block.

i02194394

Coolant Temperature Is Too High

SMCS Code: 1395-035

Refer to Systems Operation/Testing and Adjusting, “Cooling System - Check” for information on determining the cause of this condition.

i02285862

ECM Will Not Accept Factory Passwords

SMCS Code: 1901-035

Probable Causes

One of the following items may not be recorded correctly on the Caterpillar Electronic Technician (ET):

- Passwords
- Serial numbers
- Total tattletale
- Reason code

Recommended Actions

1. Verify that the correct passwords were entered. Check every character in each password. Remove the electrical power from the engine for 30 seconds and then retry.
2. Verify that the Cat ET is on the “Factory Password” screen.
3. Use Cat ET to verify that the following information has been entered correctly:
   - Engine serial number
   - Serial number for the electronic control module
   - Serial number for Cat ET
   - Total tattletale
   - Reason code

i02279167

ECM Will Not Communicate with Other Systems or Display Modules

SMCS Code: 1901-035

Probable Causes

- Wiring and/or electrical connectors
- Cat Data Link
- CAN data link (if equipped)
- Electronic Control Module (ECM)

Recommended Actions

1. Connect the electronic service tool to the service tool connector. If the ECM does not communicate with the electronic service tool, refer to Troubleshooting, “Electronic Service Tool Will Not Communicate with ECM”.
2. Troubleshoot the Cat Data Link for possible problems. Refer to Troubleshooting, “Cat Data Link Circuit - Test”.
3. Troubleshoot the CAN data link (if equipped) for possible problems. Refer to Troubleshooting, “CAN Data Link Circuit - Test”.

i02254038

Electronic Service Tool Will Not Communicate with ECM

SMCS Code: 0785-035; 1901-035

Probable Causes

- Configuration for the communications adapter
- Electrical connectors
- Communication adapter and/or cables
- Electrical power supply to the service tool connector
- Caterpillar Electronic Technician (ET) and related hardware
- Electrical power supply to the Electronic Control Module (ECM)
- Flash file
- Cat Data Link

Recommended Actions

Start the engine. If the engine starts, but the ECM will not communicate with Cat ET, continue with this procedure. If the engine will not start, refer to Troubleshooting, “Engine Cranks but Will Not Start”. If the engine will not crank, refer to Troubleshooting, “Engine Will Not Crank”.

Configuration for the Communications Adapter

1. Access “Preferences” under the “Utilities” menu on Cat ET.

2. Verify that the correct “Communications Interface Device” is selected.

3. Verify that the correct port is selected for use by the communication adapter.

Note: The most commonly used port is “COM 1”.

4. Check for any hardware that is utilizing the same port as the communications adapter. If any devices are configured to use the same port, exit or close the software programs for that device.

Electrical Connectors

Check for correct installation of the J1/P1 and J2/P2 ECM connectors and of the service tool connector. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

Communication Adapter and/or Cables

1. If you are using a “Communication Adapter II”, ensure that the firmware and driver files for the communication adapter are the most current files that are available. If the firmware and driver files do not match, the communication adapter will not communicate with Cat ET.

2. Disconnect the communication adapter and the cables from the service tool connector. Reconnect the communication adapter to the service tool connector.

3. Verify that the correct cable is being used between the communication adapter and the service tool connector. Refer to Troubleshooting, “Electronic Service Tools”.

Electrical Power Supply to the Service Tool Connector

Verify that battery voltage is present between terminals A and B of the service tool connector. If the communication adapter is not receiving power, the display on the communication adapter will be blank.

Cat ET and Related Hardware

In order to eliminate Cat ET and the related hardware as the problem, connect Cat ET to a different engine. If the same problem occurs on a different engine, check Cat ET and the related hardware in order to determine the cause of the problem.

Electrical Power Supply to the Electronic Control Module (ECM)

Check power to the ECM. Refer to Troubleshooting, “Electrical Power Supply Circuit - Test”.

Note: If the ECM is not receiving battery voltage, the ECM will not communicate.

Flash File

Ensure that the correct flash file is properly installed in the ECM.

Note: The new ECM does not have a flash file. The engine will not start and the engine will not communicate with Cat ET until the flash file has been installed. Refer to Troubleshooting, “Flash Programming”.

Cat Data Link

Troubleshoot the Cat Data Link for possible problems. Refer to Troubleshooting, “Cat Data Link Circuit - Test”.

i02290294

Engine Cranks but Will Not Start

SMCS Code: 1000-035

Probable Causes

- Electrical power to the Electronic Control Module (ECM)
- Flash file
- Remote shutdown switch
- Air shutoff circuit
- Starting motor solenoid or starting circuit
- Engine speed/timing sensors
- Electrical connections to the electronic unit injector
- Fuel supply
- Combustion problem

Recommended Actions

Electrical Power to the ECM

1. Turn the keyswitch OFF.
2. Check the positive battery and negative battery connections to the ECM.
3. Perform a pull test on positive battery wires and negative battery wires.
4. Check the negative battery connection to the engine ground.
5. Turn the keyswitch ON.
6. The warning lamps should illuminate for five seconds.

If the warning lamp illuminates for five seconds, continue with this procedure.

If the warning lamp does not illuminate for five seconds, refer to Troubleshooting, “Electrical Power Supply Circuit - Test”.

Flash File

If a new ECM has been installed on the engine, the engine will not start. The ECM will not communicate with the Caterpillar Electronic Technician (ET) until the correct flash file has been loaded into the ECM.

Check for a 253-02 Personality Module mismatch diagnostic code. If the code is active, load the correct flash file into the ECM. Refer to Troubleshooting, “Flash Programming”.

Remote Shutdown Switch

Access the screen on Cat ET that displays the remote shutdown switch status. The remote shutdown switch status on Cat ET is called “User Shutdown”.

Table 12

“User Shutdown Status”	Switch Status	Measured Voltage at P1-44 or P6-27
ON	Negative battery	<0.9 VDC
OFF	Open circuit	>10 VDC

If the voltage is not in the proper range, refer to Troubleshooting, “Remote Shutdown Switch Circuit - Test”.

Air Shutoff Circuit

Refer to Troubleshooting, “Air Shutoff System - Test” for additional information.

Starting Motor Solenoid or Starting Circuit

1. Test the operation of the starting motor solenoid.
2. Check the engine wiring to the starting motor solenoid.
3. Test the operation of the starting motor.
4. Inspect the starter motor pinion and the flywheel ring gear for damage.

Engine Speed/Timing Sensors

Observe the engine speed on Cat ET while the engine is being cranked.

This situation may require a direct hookup to the batteries in order to power Cat ET while the engine is cranking. Refer to Illustration 9 for the wiring diagram.

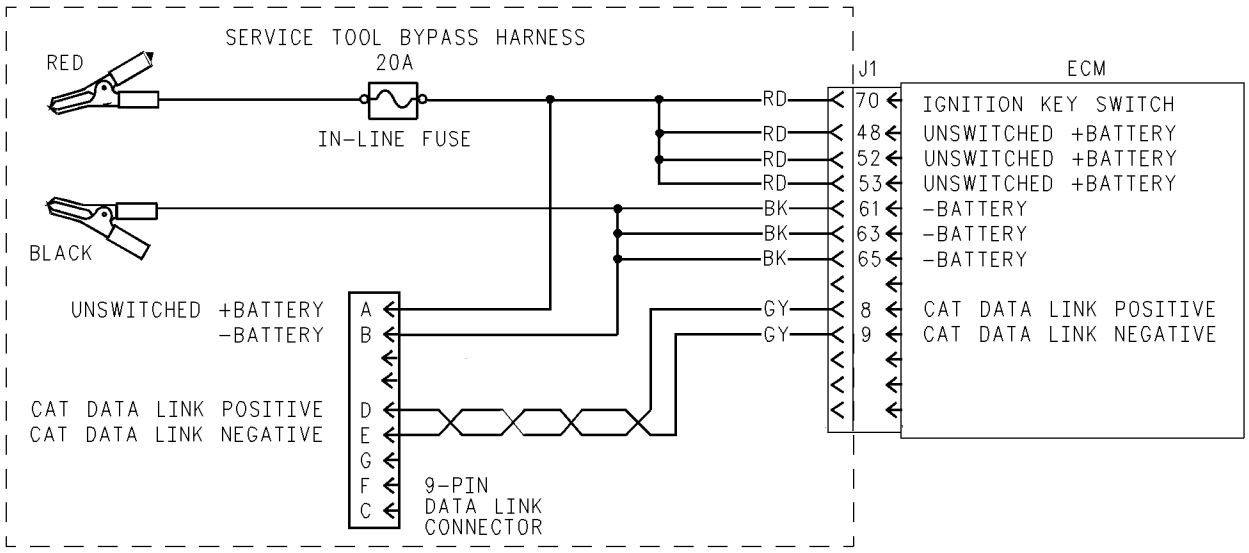

Illustration 9 g00781203

Direct connection of Cat ET to the P1 connector

If the engine is cranking and Cat ET displays zero rpm, a problem exists in the circuits for the engine speed/timing sensors. Refer to Troubleshooting, “Engine Speed/Timing Sensor Circuit - Test”.

If an engine speed is present, check the sensor installation. If the sensor is not properly installed, the ECM may read engine speed, but the ECM cannot determine the tooth pattern. The ability for the ECM to read the tooth pattern is necessary to determine the cylinder position. Engine speed is present when engine speed is greater than 50 rpm. Refer to Troubleshooting, “Engine Speed/Timing Sensor Circuit - Test”.

Electrical Connections to the Electronic Unit Injector

1. Ensure that the electronic unit injector connector (J300/P300) is fully connected and free of corrosion.

2. Check for logged diagnostic codes that are related to the cylinder. Refer to Troubleshooting, “Injector Solenoid Circuit - Test” if diagnostic codes that are related to the cylinder are present.

Check the Fuel Supply

1. Check the fuel level.

2. Monitor the exhaust for smoke while the engine is being cranked.

   If no smoke is present, there may be a problem with the fuel quality or there may be a problem with the fuel supply.

3. Check the fuel pressure. Refer to Systems Operation/Testing and Adjusting, “Fuel System Pressure - Test”.

4. Ensure that the fuel system has been primed. Refer to Systems Operation/Testing and Adjusting, “Fuel System - Prime”.

5. Check for fuel supply lines that are restricted.

6. Check the fuel filters.

7. Cold weather adversely affects the characteristics of the fuel. Refer to the Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold weather operation.

Check for Combustion Problems

Examples of conditions that may cause combustion problems are shown in the following list:

- Cold temperatures
- Injector misfiring
- Low compression
- Mechanical problem
- Valve lash settings

Refer to the engine's Systems Operation/Testing and Adjusting for more information on a particular problem.

i02170800

Engine Has Early Wear

SMCS Code: 1000-035

Probable Causes

- Incorrect engine oil
- Contaminated engine oil
- Contaminated air
- Contaminated fuel
- Low oil pressure

Recommended Actions

Incorrect Engine Oil

Use engine oil that is recommended and change the engine oil at the interval that is recommended by the engine's Operation and Maintenance Manual.

Contaminated Engine Oil

Drain the crankcase and refill the crankcase with clean engine oil. Install new engine oil filters. Refer to the engine's Operation and Maintenance Manual for more information.

If the oil filter bypass valve is open, the oil will not be filtered. Check the oil filter bypass valve for a weak spring or for a broken spring. If the spring is broken, replace the spring. Refer to the engine's Disassembly and Assembly manual. Make sure that the oil bypass valve is operating correctly.

Contaminated Air

Inspect the air inlet system for leaks. Inspect all of the gaskets and the connections. Repair any leaks.

Inspect the air filter. Replace the air filter, if necessary.

Contaminated Fuel

Inspect the fuel filter. Replace the fuel filter, if necessary.

Contaminants in the fuel such as hydrogen sulfide and sulfur can lead to the formation of acids in the crankcase. Obtain a fuel analysis.

Low Oil Pressure

When some components of the engine show bearing wear in a short time, the cause can be a restriction in a passage for engine oil.

An indicator for the engine oil pressure may indicate sufficient pressure, but a component is worn due to a lack of lubrication. In such a case, look at the passage for the engine oil supply to the component. Refer to Systems Operation/Testing and Adjusting, "Lubrication System" for additional information.

i02290324

Engine Misfires, Runs Rough or Is Unstable

SMCS Code: 1000-035

Note: If the symptom is intermittent and the symptom cannot be repeated, refer to Troubleshooting, "Intermittent Low Power or Power Cutout". If the symptom is consistent and the symptom can be repeated, continue with this procedure.

Probable Causes

- Diagnostic codes
- Programmable parameters
- Electrical connectors
- Cold mode
- Throttle signal
- Unit injectors
- Fuel supply
- Air inlet and exhaust system

Recommended Actions

Note: If the symptom only occurs under certain operating conditions (high idle, full load, engine operating temperature, etc), test the engine under those conditions. Troubleshooting the symptom under other conditions can give misleading results.

Diagnostic Codes

Check for active diagnostic codes on the Caterpillar Electronic Technician (ET). Troubleshoot any active codes before continuing with this procedure.

Programmable Parameters

Check the following parameters on Cat ET:

- Throttle Position Sensor
- Desired Speed Input Configuration
- Direct Fuel Control Mode

Determine the type of throttle that is used in the application. Program the parameters to match the type of throttle that is used. Refer to Troubleshooting, “Throttle Position Sensor Circuit - Test” for more information.

Note: The engine will have poor performance if the parameters are not programmed correctly.

Electrical Connectors

Check for correct installation of the Electronic Control Module (ECM) connectors and the unit injector connectors. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

Cold Mode

Use Cat ET to verify that the engine has exited cold mode. Cold mode operation may cause the engine to run rough and the engine power may be limited.

Throttle Signal

Monitor the throttle signal on Cat ET. Verify that the throttle signal is stable from the low idle position to the high idle position.

Unit Injectors

1. Use Cat ET to determine if there are any active diagnostic codes for the unit injectors.
2. Perform the injector solenoid test on Cat ET in order to determine if all of the injector solenoids are being energized by the ECM. Refer to Troubleshooting, “Injector Solenoid Circuit - Test” for the proper procedure.
3. Perform the cylinder cutout test on Cat ET in order to identify any injectors that might be misfiring. Refer to Troubleshooting, “Injector Solenoid Circuit - Test” for the proper procedure.

Fuel Supply

1. Check the fuel lines for the following problems: restrictions, collapsed lines, and pinched lines. If problems are found with the fuel lines, repair the lines and/or replace the lines.
2. Check the fuel tank for foreign objects which may block the fuel supply.
3. Check for air in the low pressure fuel supply system if any of the following procedures have been performed:
   - Replacement of the fuel filters
   - Service on the low pressure fuel supply circuit
   - Replacement of unit injectors
4. Purge air from the low pressure fuel supply circuit. Refer to Operation and Maintenance Manual, “Fuel System - Prime” for the complete procedure.

Note: A sight glass in the low pressure supply line is helpful in diagnosing air in the fuel.

5. Cold weather adversely affects the characteristics of the fuel. Refer to the Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold weather operation.
6. Check the fuel pressure during engine cranking. Check the fuel pressure after the fuel filter. Refer to Systems Operation/Testing and Adjusting, “Fuel System” for the correct pressure values. If the fuel pressure is low, replace the fuel filters. If the fuel pressure is still low, check the following items: fuel transfer pump, fuel transfer pump coupling, and fuel pressure regulating valve.

Air Inlet and Exhaust System

1. Check for an air filter restriction. Clean plugged air filters or replace plugged air filters. Refer to the Operation and Maintenance Manual for additional information.
2. Check the air inlet and exhaust system for restrictions and/or for leaks. Refer to Systems Operation/Testing and Adjusting, “Air Inlet and Exhaust System”.

i02173692

Engine Oil in Cooling System

SMCS Code: 1348-035; 1350-035

Probable Causes

- Engine oil cooler core
- Cylinder head gasket

Recommended Actions

Engine Oil Cooler Core

1. Inspect the engine oil cooler core for leaks. If a leak is found, replace the oil cooler core. Refer to Disassembly and Assembly, “Engine Oil Cooler - Remove”.

2. Drain the crankcase and refill the crankcase with clean engine oil. Install new engine oil filters. Refer to the Operation and Maintenance Manual for more information.

Cylinder Head Gasket

1. Remove the cylinder head. Refer to Disassembly and Assembly, “Cylinder Head - Remove” for the correct procedure.

2. Check the cylinder liner projection. Refer to Systems Operation/Testing and Adjusting for the correct procedure.

3. Install a new cylinder head gasket and new water seals in the spacer plate. Refer to Disassembly and Assembly, “Cylinder Head - Install” for the correct procedure.

i02214225

Engine Oil Temperature Is Too High

SMCS Code: 1348-035-TA

Probable Causes

- Engine oil level
- Engine oil temperature reading
- Coolant temperature
- Engine oil cooler bypass valve
- Engine oil cooler core

Recommended Actions

Engine Oil Level

Inspect the engine oil level. If necessary, add oil.

Engine Oil Temperature Reading

Compare the engine oil temperature reading from the Caterpillar Electronic Technician (ET) to the temperature from a 6V-9130 Temperature Adapter (MULTIMETER). Verify that the readings are reasonably close.

Coolant temperature

If a high coolant temperature condition is also occurring, refer to Troubleshooting, “Coolant Temperature is Too High”.

Engine Oil Cooler Bypass Valve

Clean the engine oil cooler bypass valve and inspect the engine oil cooler bypass valve. Clean the bore for the valve. Ensure that the bypass valve is not stuck in the open position. Replace the bypass valve, if necessary.

Engine Oil Cooler Core

Clean the engine oil cooler core or replace the engine oil cooler core.

i02253823

Engine Stalls at Low RPM

SMCS Code: 1915-035

Probable Causes

- Unit injectors
- Fuel supply
- Accessory equipment

Recommended Actions

Unit Injectors

1. Check for correct installation of the J1/P1 and J2/P2 connectors for the Electronic Control Module (ECM). Check for correct installation of the J300/P300 connectors for the unit injectors. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

2. Perform the “Injector Solenoid Test” with the Caterpillar Electronic Technician (ET) in order to determine if all of the injector solenoids are being energized by the ECM.

3. Perform the “Cylinder Cutout Test” with Cat ET in order to identify any injectors that might be misfiring. Refer to Troubleshooting, “Injector Solenoid Circuit - Test” for the proper procedure.

Fuel Supply

1. Check the fuel pressure. Refer to Systems Operation/Testing and Adjusting, “Fuel System” for the correct procedure.

2. Check the fuel lines for the following problems: restrictions, collapsed lines, and pinched lines. If problems are found with the fuel lines, repair the lines and/or replace the lines.

3. Check the fuel tank for foreign objects which may block the fuel supply.

4. Check for air in the low pressure fuel supply system if any of the following procedures have been performed:

   - Replacement of the fuel filters
   - Service on the low pressure fuel supply circuit
   - Replacement of unit injectors

Note: A sight glass in the low pressure supply line is helpful in diagnosing air in the fuel. Refer to Systems Operation/Testing and Adjusting, “Fuel System” for more information.

NOTICE
Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

5. Purge air from the low pressure fuel supply circuit. Refer to the Operation and Maintenance Manual, “Fuel System - Prime” for the correct procedure.

6. Cold weather adversely affects the characteristics of the fuel. Refer to the applicable Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold weather operation.

7. Check the fuel pressure after the fuel filter while the engine is being cranked. Refer to the Systems Operation/Testing and Adjusting manual for the correct pressure values. If the fuel pressure is low, replace the fuel filters. If the fuel pressure is still low, check the following items: fuel transfer pump, fuel transfer pump coupling, and fuel pressure regulating valve.

Accessory Equipment

Check all accessory equipment for problems that may create excessive load on the engine. Repair any damaged components or replace any damaged components.

i02214232

Engine Vibration

SMCS Code: 1000-035

Probable Causes

- Vibration damper
- Engine supports
- Driven equipment
- Engine misfiring or running rough

Recommended Actions

Vibration Damper

Check the vibration damper for damage. Install a new vibration damper, if necessary. Inspect the mounting bolts for damage and/or for wear. Replace any damaged bolts. Refer to the Disassembly and Assembly manual.

Engine Supports

Inspect the mounts and the brackets while you run the engine through the speed range. Look for mounts and brackets that are loose and/or broken. Tighten all of the mounting bolts. Install new components, if necessary.

Driven Equipment

Check the alignment and the balance of the driven equipment.

Engine Misfiring or Running Rough

Refer to Troubleshooting, “Engine Misfires, Runs Rough or Is Unstable”.

i02214238

Engine Will Not Crank

SMCS Code: 1000-035

Probable Causes

- Batteries
- Battery cables
- Starting circuit

- Starting motor solenoid
- Starting motor
- Flywheel ring gear
- Transmission
- Engine accessories
- Hydraulic cylinder lock
- Internal engine problem

Recommended Actions

Batteries and/or Battery Cables

1. Inspect the main power switch, battery posts, and battery cables for loose connections and for corrosion. If the battery cables are corroded, remove the battery cables and clean the battery cables. Tighten any loose connections.
2. Inspect the batteries.
   a. Charge the batteries. Refer to Special Instruction, SEHS7633, “Battery Test Procedure”.
   b. Load test the batteries. Refer to Special Instruction, SEHS9249, “Use of 4C-4911 Battery Load Tester for 6, 8 and 12 Volt Lead Acid Batteries”.

Starting Motor Solenoid or Starting Circuit

1. Test the operation of the starting motor solenoid.
2. Check the wiring to the starting motor solenoid.

Starting Motor or Flywheel Ring Gear

1. Test the operation of the starting motor.
2. Inspect the starter motor pinion and the flywheel ring gear for damage.

Transmission or Engine Accessories

1. Ensure free movement of the driveline.
2. Ensure that the timing pin was not left in the flywheel housing.
3. Remove any engine accessories that may lock up the engine and inspect any engine accessories that may lock up the engine.

   The following list illustrates examples of engine accessories that may lock up the engine:

   - Hydraulic pump that is driven from the rear gear group
   - Air compressor
   - Engine oil pump
   - Other components that are driven by the engine

Hydraulic Cylinder Lock

Check for fluid in the cylinders (hydraulic cylinder lock) by removing the individual unit injectors.

Note: Drain the fuel from the cylinder head. Fuel will flow from the cylinder head into the cylinders when the unit injector is removed.

Internal Engine Problem

Disassemble the engine. Refer to the Disassembly and Assembly manual. Inspect the internal components for the following conditions:

- Seizure
- Broken components
- Bent components

i02280902

Excessive Black Smoke

SMCS Code: 1088-035

Probable Causes

- Air inlet and exhaust system
- Engine speed/timing sensor
- Atmospheric pressure sensor
- Boost pressure sensor
- “Fuel Position” and/or “FRC Fuel Limit”
- Flash file
- Fuel quality
- Valve adjustment

Recommended Actions

Air Inlet and Exhaust System

1. Check the air inlet system for restrictions and/or for leaks.
   a. Check for an air filter restriction.
   b. Check for derates and for alarms.
   c. Perform a visual inspection of the system for restrictions and/or for leaks.
2. Ensure that the turbocharger has not failed.
3. Check the exhaust system for restrictions.
4. Repair any leaks that were found. Remove any restrictions that were found. Replace any damaged components that were found.

Engine Speed/Timing

1. Check the calibration of the engine speed/timing sensor. Refer to Troubleshooting, “Engine Speed/Timing Sensor - Calibrate”.
2. Verify that the crankshaft and the camshaft drive gears are set with the proper orientation. Refer to the Disassembly and Assembly manual.

Atmospheric Pressure Sensor

Check the atmospheric pressure sensor for dirt and/or for debris. Remove any dirt and/or debris that is present. The correct reading for the atmospheric pressure is between 50 kPa (7.25 psi) and 100 kPa (14.5 psi).

Boost Pressure Sensor, “Fuel Position”, and/or “FRC Fuel Limit”

1. Monitor the status of “Fuel Position” and “Rated Fuel Limit” while the engine is operating under full load. If “Fuel Position” equals “Rated Fuel Limit” and “Fuel Position” is less than “FRC Fuel Limit”, the electronics are operating correctly. Otherwise, proceed to the next Step.
2. Verify that there are no active diagnostic codes for the boost pressure sensor.
3. Monitor the status of “Boost Pressure” and “Atmospheric Pressure” for normal operation on the Caterpillar Electronic Technician (ET). When the engine is not running, “Boost Pressure” should be 0 kPa (0 psi).

Note: A problem with the FRC will only cause black smoke during acceleration. A problem with the FRC will not cause black smoke during steady state operation.

Flash File

Verify that the correct flash file is installed. Refer to Troubleshooting, “Flash Programming” for more information.

Fuel Quality

Cold weather adversely affects the characteristics of the fuel. Refer to Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold weather operation.

Valve Adjustment

Check the valve adjustment. Refer to Systems Operation/Testing and Adjusting, “Air Inlet and Exhaust System”.

i01405645

Excessive Engine Oil Consumption

SMCS Code: 1348-035

Probable Causes

- Oil leaks
- Oil level
- Engine oil temperature
- Turbocharger
- Valve guides
- Piston rings

Recommended Actions

Oil Leaks

Locate all oil leaks. Repair the oil leaks. Check for dirty crankcase breathers.

Oil Level

Remove excess oil. Locate the source of the excess fluid. Repair the leaks that are causing the problems. Recheck all fluid levels.

Engine Oil Temperature

Refer to Troubleshooting, “Engine Oil Temperature is Too High”.

Turbocharger

Check the air inlet manifold for oil. If necessary, repair the turbocharger or replace the turbocharger.

Valve Guides

If the valve guides are worn, reconditioning of the cylinder head is required.

Piston Rings

Inspect the internal engine components. Replace any worn components.

i02253900

Excessive Fuel Consumption

SMCS Code: 1250-035

Probable Causes

- Engine operation
- Fuel leaks
- Fuel quality
- Engine speed/timing
- Unit injectors
- Air inlet and exhaust system
- Accessory equipment

Recommended Actions

Engine Operation

Use the Caterpillar Electronic Technician (ET) to check the “Current Totals” for excessive idle time and/or for a high load factor which would be indicative of poor operating habits.

Note: Engine operation may also be affected by environmental conditions such as wind and snow.

Fuel Leaks

Check the fuel pressure during engine cranking. Check the fuel pressure after the fuel filter. Refer to Systems Operation/Testing and Adjusting, “Fuel System” for the correct pressure values. If the fuel pressure is low, replace the fuel filters. If the fuel pressure is still low, check the following items: fuel transfer pump, fuel transfer pump coupling, and fuel pressure regulating valve.

Fuel Quality

Cold weather adversely affects the characteristics of the fuel. Refer to the applicable Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold weather operation.

Engine Speed/Timing

Calibrate the engine speed/timing sensors. Refer to Troubleshooting, “Engine Speed/Timing Sensor - Calibrate”.

Unit Injectors

1. Check for correct installation of the J1/P1 and J2/P2 Electronic Control Module (ECM) connectors and the unit injector connectors. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

2. Perform the “Injector Solenoid Test” on Cat ET in order to determine if all of the injector solenoids are being energized by the ECM.

3. Perform the “Cylinder Cutout Test” on Cat ET in order to identify any injectors that might be misfiring. Refer to Troubleshooting, “Injector Solenoid Circuit - Test” for the proper procedure.

Air Inlet and Exhaust System

1. Inspect the air filter for a restriction. If the air filter shows signs of being plugged, clean the air filter or replace the air filter.

2. Check the air inlet and exhaust system for restrictions and/or for leaks. Refer to Systems Operation/Testing and Adjusting, “Air Inlet and Exhaust System”.

Accessory Equipment

Check all accessory equipment for problems that may create excessive load on the engine. Repair any damaged components or replace any damaged components.

i02280972

Excessive Valve Lash

SMCS Code: 1105-035

Probable Causes

- Lubrication
- Valve lash
- Valve train components

Recommended Actions

Lubrication

1. Remove the valve mechanism covers. Refer to the engine's Disassembly and Assembly manual for the correct procedure.
2. Check the lubrication in the valve compartment. Ensure that there is adequate engine oil flow in the valve compartment. The passages for the engine oil must be clean.

Valve Lash

Adjust the engine valve lash. Refer to the engine's Systems Operation/Testing and Adjusting manual for the correct procedure.

Valve Train Components

1. Inspect the following components of the valve train:
   - Rocker arms
   - Pushrods
   - Valve lifters
   - Camshaft
   - Valve stems
   - Rocker shafts
2. Check the components for the following conditions: abnormal wear, excessive wear, straightness, and cleanliness. Replace parts, if necessary.

Note: If you replace the camshaft, you must also replace the valve lifters.

3. Adjust the engine valve lash. Refer to the engine's Systems Operation/Testing and Adjusting manual for the correct procedure.

i02290300

Excessive White Smoke

SMCS Code: 1088-035

Note: Some white smoke may be present during cold start-up conditions when the engine is operating normally. If the white smoke persists, there may be a problem.

Probable Causes

- Diagnostic codes
- Starting aids
- Water temperature regulators
- Unit injectors
- Flash file
- Fuel supply
- Cooling system
- Component wear

Recommended Actions

Diagnostic Codes

Check for active diagnostic codes on the Caterpillar Electronic Technician (ET). Troubleshoot any active codes before continuing with this procedure.

Starting Aids

Air Inlet Heater (If Equipped)

Ensure that the air inlet heater is functioning properly. For additional information, refer to Troubleshooting, "Air Inlet Heater Circuit - Test".

Ether Injection System (If Equipped)

Ensure that the ether injection system is programmed to "On".

Ensure that the ether injection system is functioning properly. For additional information, refer to Troubleshooting, "Ether Injection System - Test".

Water Temperature Regulators

Check the water temperature regulators for correct operation. Refer to Systems Operation/Testing and Adjusting, “Cooling System” for the proper procedure.

Unit Injectors

Use Cat ET to perform the cylinder cutout test. Try to simulate the conditions for the test that were experienced during operation. Cut out each cylinder individually for approximately one minute in order to isolate any misfiring cylinders. If the misfire can be isolated to a specific cylinder, proceed to Troubleshooting, “Injector Solenoid Circuit - Test”.

Flash File

Verify that the correct flash file is installed. The flash file that is installed in the Electronic Control Module (ECM) will be displayed on the “Configuration” screen on Cat ET.

Fuel Supply

1. Monitor the exhaust for smoke while the engine is being cranked.

   If no smoke is present, there may be a problem with the fuel quality or there may be a problem with the fuel supply.

2. Check the fuel pressure. Refer to Systems Operation/Testing and Adjusting, “Fuel System Pressure - Test”.

3. Ensure that the fuel system has been primed. Refer to Systems Operation/Testing and Adjusting, “Fuel System - Prime”.

4. Check for fuel supply lines that are restricted.

5. Cold weather adversely affects the characteristics of the fuel. Refer to the Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold weather operation.

Cooling System

Check for an internal coolant leak. Check for coolant in the engine oil, coolant in the cylinders, and coolant in the exhaust system. Refer to Systems Operation/Testing and Adjusting, “Cooling System - Test”.

Component Wear

Check the following components for excessive wear:

- Valves
- Pistons
- Rings
- Cylinder liners

i02214294

Exhaust Temperature Is Too High

SMCS Code: 1088-035-TA

Probable Causes

- Diagnostic codes
- Electrical connectors
- Air inlet and exhaust system

Recommended Actions

Diagnostic Codes

Connect the Caterpillar Electronic Technician (ET) and check for active diagnostic codes. Troubleshoot any active diagnostic codes before continuing with this procedure.

Electrical Connectors

Check for correct installation of the J2/P2 Electronic Control Module (ECM) connector and of the J300/P300 unit injector connectors. Refer to Troubleshooting, “Electrical Connectors - Inspect” for more information.

Air Inlet and Exhaust System

1. Check the air inlet manifold pressure. Check for air inlet restrictions and/or leaks. Refer to Systems Operation/Testing and Adjusting, “Air Inlet and Exhaust System” for more information.

2. Check for leaks between the exhaust manifold and the turbocharger. Check for exhaust restrictions. Refer to Systems Operation/Testing and Adjusting, “Air Inlet and Exhaust System” for more information.

i01405833

Fuel in Cooling System

SMCS Code: 1350-035

Probable Causes

- Internal cylinder head

Recommended Actions

Internal Cylinder Head

1. Remove the valve mechanism covers.
2. Remove the fuel supply and the fuel return line from the cylinder head.
3. Cap the fuel return connector and apply 700 kPa (100 psi) maximum air pressure to the fuel supply connector. Check for fuel leakage around the unit injectors. If leakage is present, remove the unit injector and install a new O-ring seal.

i02119587

Fuel Dilution of Engine Oil

SMCS Code: 1348-035

Probable Causes

- Leaking seals on the case of the unit injector or on the barrel of the unit injector
- Leaking seals on the fuel line adapter for the cylinder head
- Excessive leakage from the unit injector tip or breakage of the unit injector tip
- Cracked fuel supply manifold
- Leaking seal on the fuel transfer pump

Recommended Actions

Leaking Seals on the Case of the Unit Injector or on the Barrel of the Unit Injector

Look for signs of damage to the seals for the unit injectors. Replace any seals that are leaking.

Leaking Seals on the Fuel Line Adapter for the Cylinder Head

Look for signs of damage to the seals on the fuel line adapter for the cylinder head. Repair any leaking fuel lines or components and/or replace any leaking fuel lines or components.

Excessive Leakage from the Unit Injector Tip or Breakage of the Unit Injector Tip

Look for signs of damage to the unit injectors. If necessary, repair the unit injectors or replace the unit injectors.

Cracked Fuel Supply Manifold

Look for signs of damage to the fuel supply manifold.

Leaking Fuel Transfer Pump Seal

Ensure that the weep hole is not plugged. If necessary, repair the fuel transfer pump or replace the fuel transfer pump.

i02290607

Intermittent Engine Shutdown

SMCS Code: 1000-035

Note: Use this procedure only if the engine shut down completely and it was necessary to restart the engine.

Probable Causes

- Diagnostic codes or event codes
- Selected engine rating parameters
- Electrical connections
- Faulty remote shutdown
- Circuit breakers
- Fuel supply
- Faulty overspeed verify switch

Note: If the problem only occurs under certain conditions such as high engine speed, full load or engine operating temperature, then perform the test under those operating conditions.

Recommended Actions

Diagnostic Codes or Event Codes

Certain diagnostic codes and/or event codes may cause the engine to shutdown. Connect the Caterpillar Electronic Technician (ET) and check for active codes and/or for logged codes. Troubleshoot any codes that are present before continuing with this procedure.

Selected Engine Rating Parameters

The engine may be shut down due to low pressure levels or other factors. Connect Cat ET and check for active shutdowns or diagnostic codes.

If a shutdown is active, “Injection Disabled” will appear in the third box of any status screen on Cat ET.

An engine shutdown event will appear on a J1939 device if the device is capable of displaying diagnostic codes.

Electrical Connections

1. Check the following connectors for proper installation:
   - J1/P1 and J2/P2 connectors for the Electronic Control Module (ECM)
   - J61/P61 Customer connectors
   - J300/P300 Connectors for the injector solenoid harness
   - J401/P401 and J402/P402 Engine speed/timing sensor connectors
2. Check the associated wiring for the following conditions: damage, abrasion, corrosion, and incorrect attachment.

   Refer to Troubleshooting, “Electrical Connectors - Inspect”.

Note: Aftermarket engine protection devices usually interrupt power to the ECM. Check for correct installation and for operation of aftermarket engine protection devices. It may be necessary to bypass the aftermarket devices in order to continue testing.

Faulty Remote Shutdown

1. Access the status screen that displays the remote shutdown switch status. The remote shutdown switch status on Cat ET is called “User Shutdown”.
2. Refer to Table 13. Measure the voltage between each terminal that is listed and the engine ground.

Table 13

“User Shutdown” Status	Measured Voltage at J1-44 or P61-27
ON	<0.9 VDC
OFF	>10 VDC

3. If the voltage is not in the proper range, refer to Troubleshooting, “Switch Circuits - Test”.

Circuit Breakers

Check the circuit breakers. The circuit breakers may exceed the trip point due to overheating. Reset the circuit breakers if the circuit breakers are tripped.

Fuel Supply

Check for a problem with the fuel supply. Verify that the fuel pressure is correct. Verify that the fuel pressure sensor is installed. Refer to Systems Operation/Testing and Adjusting, “Fuel System” for additional information.

Faulty Overspeed Verify Switch (If Equipped)

A problem with the circuit for the overspeed verify feature may be causing the engine to shut down. There are no diagnostic codes or event codes that are associated with the overspeed verify feature. Refer to Troubleshooting, “Switch Circuits - Test”.

i02290319

Intermittent Low Power or Power Cutout

SMCS Code: 1000-035

Note: Use this procedure only if the engine does not shut down completely.

Probable Causes

- Diagnostic codes
- Event codes
- Throttle signal
- Electrical connectors
- Fuel supply

Recommended Actions

Diagnostic Codes and Event Codes

Certain diagnostic codes and/or event codes may cause poor performance. Connect the Caterpillar Electronic Technician (ET) and check for active codes and logged codes. Troubleshoot any codes that are present before continuing with this procedure.

Throttle Signal

Connect Cat ET to the service tool connector. View the status for the throttle position on the status screen. Operate the throttle from the low idle position to the high idle position. The status should be 0 percent at low idle and the status should be 100 percent at high idle. Refer to Troubleshooting, “Throttle Position Sensor - Calibrate” if either value is incorrect.

Diagnostic codes that are related to the J1939 data link will prevent correct operation of the throttle if the throttle position is transmitted over the data link. If there is a problem with the data link, the engine will remain at low idle until the data link is repaired.

Electrical Connectors

1. Inspect the battery wires from the Electronic Control Module (ECM) back to the battery compartment. Refer to the Electrical System Schematic. Inspect the wires and the power relay. Check the power and ground connections to the ECM. Refer to the diagnostic functional test Troubleshooting, “Electrical Power Supply Circuit - Test” for more information.

Fuel Supply

1. Check the fuel lines for the following problems: restrictions, collapsed lines, and pinched lines. If problems are found with the fuel lines, repair the lines and/or replace the lines.

2. Check the fuel tank for foreign objects which may block the fuel supply.

3. Check for air in the low pressure fuel supply system if any of the following procedures have been performed:

   - Replacement of the fuel filters
   - Service on the low pressure fuel supply circuit
   - Replacement of unit injectors

Note: A sight glass in the low pressure supply line is helpful in diagnosing air in the fuel. Refer to Systems Operation/Testing and Adjusting, “Fuel System” for more information.

NOTICE
Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

4. Purge air from the low pressure fuel supply circuit. Refer to Operation and Maintenance Manual, “Fuel System - Prime” for the correct procedure.

5. Cold weather adversely affects the characteristics of the fuel. Refer to the Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold weather operation.

6. Check the fuel pressure after the fuel filter while the engine is being cranked. Refer to Systems Operation/Testing and Adjusting, “Fuel System Pressure - Test” for the correct pressure values. If the fuel pressure is low, replace the fuel filters. If the fuel pressure is still low, check the following items: fuel transfer pump, fuel transfer pump coupling, and fuel pressure regulating valve. Refer to Systems Operation/Testing and Adjusting, “Fuel System” for additional information.

i02171503

Low Engine Oil Pressure

SMCS Code: 1348-035-LP

NOTICE
Do not operate the engine with low oil pressure. Engine damage will result. If measured oil pressure is low, discontinue engine operation until the problem is corrected.

Refer to Systems Operation/Testing and Adjusting, “Lubrication System” for information on engine oil pressure.

i02290611

Low Power/Poor or No Response to Throttle

SMCS Code: 1000-035

Probable Causes

- Diagnostic codes

- Event codes
- Engine rating
- Programmable parameters
- Cold mode
- Altitude derate
- Electrical connectors
- PTO enable switch
- Intermediate speed switch
- Throttle signal
- Circuit for electronic unit injectors
- Fuel supply
- Boost pressure sensor (intake manifold air), rated fuel position and/or FRC fuel position
- Air inlet and exhaust system

Recommended Actions

Note: If the problem only occurs under certain conditions, test the engine under those conditions. Examples of certain conditions are high rpm, full load and engine operating temperature. Troubleshooting the symptoms under other conditions can give misleading results.

Diagnostic Codes and Event Codes

Certain diagnostic codes and/or event codes may cause poor performance. Connect the Caterpillar Electronic Technician (ET) and check for active codes and for logged codes. Troubleshoot any codes that are present before continuing with this procedure.

Engine Rating

Verify that the correct engine rating is being used for the application.

Programmable Parameters

Check the following parameters on Cat ET:

- Throttle Position Sensor
- Desired Speed Input Configuration
- Direct Fuel Control Mode

Verify that the injector trim files are programmed.

Determine the type of throttle that is used in the application. Program the parameters to match the type of throttle that is used. Refer to Troubleshooting, “Throttle Position Sensor Circuit - Test” for more information.

Note: The engine will have poor performance if the parameters are not programmed correctly.

Cold Mode

Monitor the status screen on Cat ET in order to verify that the engine has exited cold mode. Observe the reading for coolant temperature on Cat ET. The engine should exit cold mode whenever the coolant temperature is above 18 °C (64 °F).

Altitude Derate

The engine may be derated due to high elevation. Connect Cat ET to the service tool connector. Check for an active engine derate on the status screens.

Note: There are no event codes that are associated with the altitude derate.

Electrical Connections to the Electronic Control Module (ECM)

Check the associated wiring for damage, abrasion, corrosion or incorrect attachment on the following connectors. J1/P1 and J2/P2 ECM connectors, J61/P61 customer connector (optional), and J403/P403 throttle position sensor connector. Refer to Troubleshooting, “Electrical Connectors - Inspect” for additional information.

PTO Enable Switch

Connect Cat ET and verify that the “PTO Enable Switch” is “Not Engaged”. If the value of the parameter does not match the position of the switch, there is a problem with the circuit for the PTO enable switch. Refer to Troubleshooting, “Switch Circuits - Test”.

If the value of the “PTO Enable Switch” parameter matches the position of the switch, continue to next step.

Intermediate Speed Switch

Verify that the value of the “Intermediate Speed Switch” matches the position of the switch. If the value of the parameter does not match the position of the switch, there is a problem with the circuit for the switch for the intermediate speed. Refer to Troubleshooting, “Switch Circuits - Test”.

If the value of the “Intermediate Speed Switch” parameter matches the position of the switch, continue to next step.

Throttle Signal

View the status for the throttle position on the status screen. Operate the throttle from the low idle position to the high idle position. The status should be 0 percent at low idle and the status should be 100 percent at high idle. If the status cannot operate in the full range, refer to Troubleshooting, “Throttle Position Sensor - Calibrate”.

Diagnostic codes that are related to the J1939 data link will prevent correct operation of the throttle if the throttle position is transmitted over the data link. If there is a problem with the data link, the engine will remain at low idle until the data link is repaired.

Circuit for the Electronic Unit Injector

Inspect the J2/P2 ECM connector and the J300/P300 unit injector connector for proper connections. Refer to Troubleshooting, “ Electrical Connectors - Inspect”. Cut out each cylinder in order to isolate the misfiring cylinder or cylinders. If the results are inconclusive, shut off half of the cylinders and repeat the cylinder cutout test on the active cylinders that are remaining in order to locate those cylinders that are missing. Refer to Troubleshooting, “Injector Solenoid Circuit - Test”.

Fuel Supply

Check for a problem with the fuel supply and verify the fuel pressure. Verify that the fuel pressure sensor P209/J209 is installed. For further information, refer to Systems Operation/Testing and Adjusting, “Fuel System”.

Boost Pressure Sensor (Intake Manifold Air), Rated Fuel Position and/or FRC Fuel Position

1. With the engine at full load, monitor “Fuel Position” and “Rated Fuel Limit” on the status screen. If “Fuel Position” does not equal “Rated Fuel Limit”, then check air inlet manifold pressure.

2. Verify that there are no active diagnostic codes that are associated with the boost pressure sensor or with the atmospheric pressure sensor.

3. Monitor air inlet manifold pressure and atmospheric pressure for normal operation on the status screen.

Note: Atmospheric pressure is not a default parameter on the status screen.

Air Inlet and Exhaust System

Check the air inlet and exhaust systems for restrictions and for leaks. Refer to Systems Operation/Testing and Adjusting, “Air Inlet and Exhaust System”. Look for an indication of the warning lamp or restriction indicators that are tripped if the filters are equipped with these devices. These indicators are associated with plugged filters. Replace the plugged air filters or clean the plugged air filters according to the guidelines in the engine’s Operation and Maintenance Manual. Repair any leaks that are found in the system.

i02281043

Mechanical Noise (Knock) in Engine

SMCS Code: 1000-035

Probable Causes

- Driven equipment
- Cylinder head and related components
- Gear train
- Crankshaft and related components
- Piston

Recommended Repairs

Driven Equipment

Inspect the alignment and the balance of the driven equipment. Inspect the coupling. If necessary, disconnect the driven equipment and test the engine.

Cylinder Head and Related Components

Inspect the components of the valve train for good condition. Check for signs of damage and/or wear to the valves, cylinder head gasket, etc. Inspect the condition of the camshafts. If a camshaft is replaced, new valve lifters must be installed.

Gear Train

Inspect the condition of the gear train.

Inspect the engine oil filters for nonferrous material. Flaking of nonferrous material could indicate worn gear train bearings.

Crankshaft

Inspect the crankshaft and the related components. Inspect the connecting rod bearings and the bearing surfaces on the crankshaft. Make sure that the bearings are in the correct position.

Look for worn thrust plates and wear on the crankshaft.

Check the counterweight bolts.

Piston

Make sure that the piston pin is correctly installed.

Inspect the condition of the pistons according to Guidelines for Reusable Parts and Salvage Operations.

i02257027

Noise Coming from Cylinder

SMCS Code: 1000-035

Probable Causes

- Diagnostic codes
- Fuel quality
- Unit injectors
- Valve lash

Recommended Actions

Diagnostic Codes

Check for active diagnostic codes on the Caterpillar Electronic Technician (ET). Troubleshoot any active codes before continuing with this procedure.

Fuel Quality

Refer to Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold weather operation.

Unit Injectors

1. Check for correct installation of the J1/P1 and J2/P2 Electronic Control Module (ECM) connectors and the J300/P300 unit injector connectors. Refer to Troubleshooting, “Electrical Connectors - Inspect”.
2. Perform the “Injector Solenoid Test” on Cat ET in order to determine if all of the injector solenoids are being energized by the ECM.
3. Perform the “Cylinder Cutout Test” on Cat ET in order to identify any injectors that might be misfiring. Refer to Troubleshooting, “Injector Solenoid Circuit - Test” for additional information.

Valve Lash

Refer to Troubleshooting, “Excessive Valve Lash”.

i02290312

Poor Acceleration or Response

SMCS Code: 1000-035

Probable Causes

- Engine “Derated”
- Cold mode operation
- Flash file
- Throttle position sensor
- Electrical connectors
- Unit injectors
- Fuel Position, Rated Fuel Limit, and FRC Fuel Position
- Air inlet and exhaust system
- Fuel supply

Recommended Actions

Engine “Derated”

The engine may be derated due to dirty air filters or other factors. Use the Caterpillar Electronic Technician (ET) in order to check for engine derates.

Cold Mode Operation

Monitor the status screen on Cat ET in order to verify that the engine has exited cold mode. Observe the reading for coolant temperature on the Cat ET. Refer to Troubleshooting, “System Overview” for additional information.

Flash File

Verify that the correct flash file is installed.

Throttle Position Sensor

Monitor “Throttle Status” on Cat ET. Verify that the throttle position is stable and that the engine is able to reach high idle rpm. Refer to Troubleshooting, “Throttle Position Sensor Circuit - Test” for the proper troubleshooting procedure.

Electrical Connectors

Check for correct installation of the J1/P1 and J2/P2 connectors for the Electronic Control Module (ECM). Check for correct installation of the JH300/P300 unit injector connectors. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

Unit Injectors

1. Use Cat ET to determine if there are any active diagnostic codes for the unit injectors.

2. Perform the injector solenoid test on Cat ET in order to determine if all of the injector solenoids are being energized by the ECM. Refer to Troubleshooting, “Injector Solenoid Circuit - Test” for the proper procedure.

3. Perform the cylinder cutout test on Cat ET in order to identify any injectors that might be misfiring. Refer to Troubleshooting, “Injector Solenoid Circuit - Test” for the proper procedure.

Fuel Position, Rated Fuel Limit, and FRC Fuel Position

1. Monitor the status of “Fuel Position” and “Rated Fuel Limit” while the engine is operating under full load. If “Fuel Position” equals “Rated Fuel Limit” and “Fuel Position” is less than “FRC Fuel Limit”, the electronics are operating correctly. Otherwise, proceed to the next Step.

2. Verify that there are no active diagnostic codes for the boost pressure sensor.

3. Monitor the “Boost Pressure” and “Atmospheric Pressure” for normal operation. When the engine is not running, “Boost Pressure” should be 0 kPa (0 psi).

Air Inlet and Exhaust System

1. Check for an air filter restriction indicator. Clean plugged air filters or replace plugged air filters. Refer to the Operation and Maintenance Manual.

2. Check the air inlet and exhaust system for restrictions and/or leaks. Refer to Systems Operation/Testing and Adjusting, “Air Inlet and Exhaust System”.

Fuel Supply

1. Check the fuel lines for the following problems: restrictions, collapsed lines, and pinched lines. If problems are found with the fuel lines, repair the lines and/or replace the lines.

2. Check the fuel tank for foreign objects which may block the fuel supply.

3. Check for air in the low pressure fuel supply system if any of the following procedures have been performed:

   - Replacement of the fuel filters
   - Service on the low pressure fuel supply circuit
   - Replacement of unit injectors

Note: A sight glass in the low pressure supply line is helpful in diagnosing air in the fuel. Refer to Testing and Adjusting for more information.

NOTICE
Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

4. Purge air from the low pressure fuel supply circuit. Refer to Operation and Maintenance Manual, “Fuel System - Prime” for the correct procedure.

5. Cold weather adversely affects the characteristics of the fuel. Refer to the Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold weather operation.

6. Check the fuel pressure after the fuel filter while the engine is being cranked. Refer to Testing and Adjusting for the correct pressure values. If the fuel pressure is low, replace the fuel filters. If the fuel pressure is still low, check the following items: fuel transfer pump, fuel transfer pump coupling, and fuel pressure regulating valve. Refer to Systems Operation/Testing and Adjusting for more information.

i01405939

Valve Rotator or Spring Lock Is Free

SMCS Code: 1109-035

Probable Causes

- Cracked valve rotator
- Broken spring locks
- Broken valve spring(s)
- Broken valve

Recommended Actions

1. Determine the cause of an engine overspeed that would crack the valve rotator. Repair the condition.
2. Inspect the following components for damage:
   - Valve rotators
   - Spring locks
   - Valve springs
   - Valves

Note: Ensure that the valve has not contacted the piston. If the valve has contacted the piston, check the exhaust system for debris.

3. Replace any damaged components.

Troubleshooting with a Diagnostic Code

i02085761

Flash Codes

SMCS Code: 1900

Flash codes are a simple way to alert the operator that a problem exists with the engine's control system or with the engine's operation. Each flash code is a two digit number. The diagnostic lamp flashes in order to identify the flash code.

EXAMPLE

Note: Flash Code 27 would flash on the diagnostic lamp in the following manner:

- Two short flashes
- Hesitation
- Seven short flashes

For the descriptions of the flash codes, refer to Troubleshooting, "Diagnostic Code Cross Reference".

i02286316

Diagnostic Codes

SMCS Code: 1900

Diagnostic Codes

Diagnostic codes alert the operator that a problem in the electronic system has been detected. Diagnostic codes also indicate the nature of the problem to the service technician. The Caterpillar Electronic Technician (ET) is a software program that is designed to run on a personal computer. Diagnostic codes may be viewed on a personal computer that has Cat ET software. Diagnostic codes consist of the component identifier (CID) and the failure mode identifier (FMI).

Component Identifier (CID) – The CID is a number with three or four digits. The CID indicates the component that generated the code. For example, the CID number 0001 identifies the fuel injector for the number one cylinder.

Failure Mode Identifier (FMI) – The FMI is a two digit code that indicates the type of failure.

Refer to Troubleshooting, "Diagnostic Code Cross Reference" for the complete list of the diagnostic codes and a description of each code. There is a troubleshooting procedure for every diagnostic code. Refer to Troubleshooting, "Troubleshooting With A Diagnostic Code".

When a diagnostic code is activated, the Electronic Control Module (ECM) transmits information about the code over the J1939 data link. Some J1939 devices may display the code. However, the code will be displayed with a SPN-FMI code. Refer to Troubleshooting, "Diagnostic Code Cross Reference" for a cross-reference between SPN-FMI codes and diagnostic codes.

Do not confuse diagnostic codes with event codes. Event codes alert the operator that an abnormal operating condition such as low oil pressure or high coolant temperature has been detected. Refer to Troubleshooting, "Troubleshooting with an Event Code" for additional information on event codes.

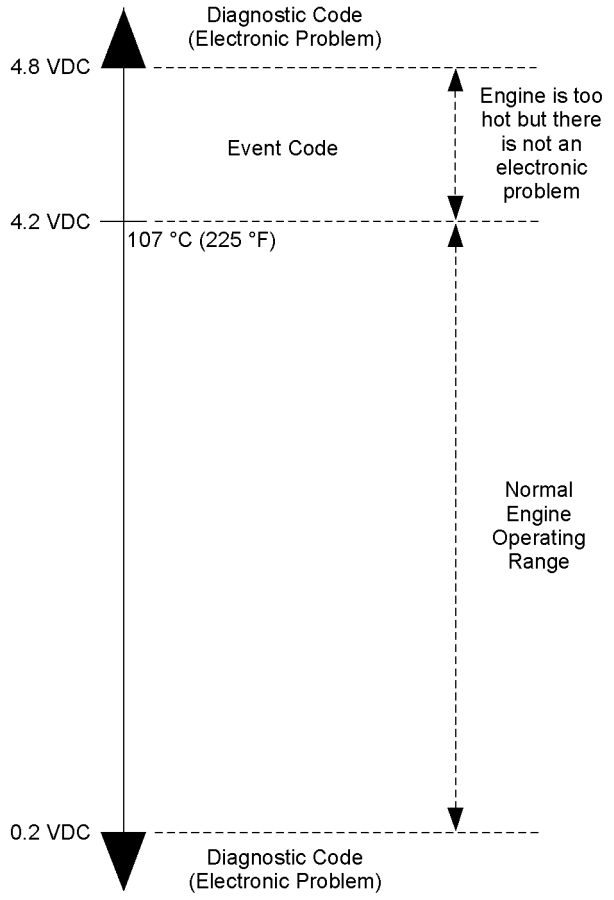

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Illustration 10

Output voltage from a typical analog temperature sensor

Illustration 10 indicates the signal range for a typical analog sensor. Diagnostic codes will be generated if the sensor's output signal is below 0.2 VDC or above 4.8 VDC.

Active Diagnostic Codes

An active diagnostic code represents a problem with the electronic control system. **Correct the problem as soon as possible.**

When the ECM generates an active diagnostic code, the "Active Alarm" indicator ("Engine Control Alarm Status" on Cat ET) is activated in order to alert the operator. If the condition that generated the code is momentary, the message disappears from the list of active diagnostic codes. The diagnostic code becomes logged.

Logged Diagnostic Codes

When the ECM generates a diagnostic code, the ECM logs the code in permanent memory. The ECM has an internal diagnostic clock. Each ECM will record the following information when a code is generated:

- The hour of the first occurrence of the code
- The hour of the last occurrence of the code
- The number of occurrences of the code

This information is a valuable indicator for troubleshooting intermittent problems.

A code is cleared from memory when one of the following conditions occur:

- The service technician manually clears the code.
- The code does not recur for 100 hours.
- A new code is logged and there are already ten codes in memory. In this case, the oldest code is cleared.

Some diagnostic codes may be easily triggered. Some diagnostic codes may log occurrences that did not result in complaints. The most likely cause of an intermittent problem is a faulty connection or damaged wiring. The next likely cause is a component failure. The least likely cause is the failure of an electronic module. Diagnostic codes that are logged repeatedly may indicate a problem that needs special investigation.

Note: Always clear logged diagnostic codes after investigating and correcting the problem which generated the code.

i02172201

Diagnostic Code Cross Reference

SMCS Code: 1900

Problems with the electronic control system are reported via these types of codes: flash codes, SPN/FMI codes, diagnostic codes, and event codes.

For information on flash codes, refer to Troubleshooting, "Flash Codes".

For information on SPN/FMI codes, refer to Troubleshooting, "Diagnostic Codes".

For information on diagnostic codes, refer to Troubleshooting, "Diagnostic Codes".

For information on event codes, refer to Troubleshooting, "Event Codes".

Use Table 14 as a cross reference between the various types of codes.

Table 14

Cross Reference for Diagnostic Codes			
Flash Code	**SPN[1]/FMI Code**	**Diagnostic Code or Event Code**	**Description of Code**
N/A	1835-15	E443[2]	High Auxiliary Pressure Warning
	1835-16		High Auxiliary Pressure Derate
	1835-00		High Auxiliary Pressure Shutdown
	1836-15	E445[2]	High Auxiliary Temperature Warning
	1836-16		High Auxiliary Temperature Derate
	1836-00		High Auxiliary Temperature Shutdown
	626-05	545-05	Ether Start Relay open/short to +batt
		2417-05	Ether Injection Control Solenoid open/short to +batt
	626-06	545-06	Ether Start Relay short to ground
		2417-06	Ether Injection Control Solenoid short to ground
	1835-03	1835-03	Auxiliary Pressure Sensor open/short to +batt
	1835-04	1835-04	Auxiliary Pressure Sensor short to ground
	1836-03	1836-03	Auxiliary Temperature Sensor open/short to +batt
	1836-04	1836-04	Auxiliary Temperature Sensor short to ground
	111-02	111-02	Engine Coolant Level Sensor Loss of Signal
13	174-03	174-03	Fuel Temperature open/short to +batt
	174-04	174-04	Fuel Temperature short to ground
21	678-03	41-03	8 Volt DC Supply short to +batt
	678-04	41-04	8 Volt DC Supply short to ground
	620-03	262-03	5 Volt Sensor DC Power Supply short to +batt
	1079-03		
	620-04	262-04	5 Volt Sensor DC Power Supply short to ground
	1079-04		
24	100-03	100-03	Engine Oil Pressure open/short to +batt
	100-04	100-04	Engine Oil Pressure short to ground
	100-10	100-10	Engine Oil Pressure abnormal rate of change
25	102-03	102-03	Boost Pressure Sensor short to +batt
	102-04	102-04	Boost Pressure Sensor short to ground
	102-10	102-10	Boost Pressure Sensor abnormal rate of change
26	108-03	274-03	Atmospheric Pressure open/short to +batt
	108-04	274-04	Atmospheric Pressure short to ground
27	110-03	110-03	Engine Coolant Temperature open/short to +batt
	110-04	110-04	Engine Coolant Temperature short to ground
28	91-13	91-13	Throttle Position calibration required
32	91-08	91-08	Throttle Position signal abnormal

(continued)

(Table 14, contd)

Cross Reference for Diagnostic Codes			
Flash Code	**SPN(1)/FMI Code**	**Diagnostic Code or Event Code**	**Description of Code**
34	190-08	190-08	Engine Speed signal abnormal
	723-08	342-08	Secondary Engine Speed signal abnormal
35	190-15	E362(2)	Engine Overspeed Warning
	190-00		Engine Overspeed Shutdown
37	94-03	94-03	Fuel Pressure open/short to +batt
	94-04	94-04	Fuel Pressure short to ground
38	105-03	172-03	Intake Manifold Air Temp open/short to +batt
	105-04	172-04	Intake Manifold Air Temp short to ground
42	637-13	261-13	Engine Timing calibration required
46	100-17	E360(2)	Low Engine Oil Pressure Warning
	100-18		Low Engine Oil Pressure Derate
	100-01		Low Engine Oil Pressure Shutdown
51	168-00	168-00	System Voltage high
	168-01	168-01	System Voltage low
	168-02	168-02	System Voltage intermittent/erratic
56	630-02	268-02	Check Programmable Parameters
58	639-09	247-09	J1939 Data Link communications
61	110-15	E361(2)	High Engine Coolant Temperature Warning
	110-16		High Engine Coolant Temperature Derate
	110-00		High Engine Coolant Temperature Shutdown
62	111-17	E059	Low Engine Coolant Level Warning
	111-18	E057	Low Engine Coolant Level Derate
	111-01	E058	Low Engine Coolant Level Shutdown
	111-17	E2143(2)	Low Engine Coolant Level Warning
	111-18		Low Engine Coolant Level Derate
	111-01		Low Engine Coolant Level Shutdown
63	94-15	E096	High Fuel Pressure Warning
64	1636-15	E539(2)	High Inlet Air Temperature Warning
	1636-00		High Inlet Air Temperature Shutdown
65	174-15	E363(2)	High Fuel Temperature Warning
	174-16		High Fuel Temperature Derate
	174-00		High Fuel Temperature Shutdown
71	651-05	001-05	Injector Cylinder 1 open circuit
	651-06	001-06	Injector Cylinder 1 short
	651-11	001-11	Injector Cylinder #1 fault

(continued)

(Table 14, contd)

Cross Reference for Diagnostic Codes			
Flash Code	**SPN(1)/FMI Code**	**Diagnostic Code or Event Code**	**Description of Code**
72	652-05	002-05	Injector Cylinder 2 open circuit
	652-06	002-06	Injector Cylinder 2 short
	652-11	002-11	Injector Cylinder #2 fault
73	653-05	003-05	Injector Cylinder 3 open circuit
	653-06	003-06	Injector Cylinder 3 short
	653-11	003-11	Injector Cylinder #3 fault
74	654-05	004-05	Injector Cylinder 4 open circuit
	654-06	004-06	Injector Cylinder 4 short
	654-11	004-11	Injector Cylinder #4 fault
75	655-05	005-05	Injector Cylinder 5 open circuit
	655-06	005-06	Injector Cylinder 5 short
	655-11	005-11	Injector Cylinder #5 fault
76	656-05	006-05	Injector Cylinder 6 open circuit
	656-06	006-06	Injector Cylinder 6 short
	656-11	006-11	Injector Cylinder #6 fault

(1) Suspect Parameter Number
(2) Caterpillar Electronic Technician (ET) will display the number 1, 2, or 3 after the event code in order to designate a warning, a derate, or a shutdown.

i02257686

CID 0001 FMI 05 Injector Cylinder 1 open circuit

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP.

i02257712

CID 0001 FMI 06 Injector Cylinder 1 short

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects a short circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP.

i02214566

CID 0001 FMI 11 Injector Cylinder #1 fault

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit or a short circuit in the circuit for the injector.

If the cause of the diagnostic code is a problem in the common wire, two cylinders will be affected because of the shared common wire for the injectors.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

The injector may not operate while the condition exists.

Possible Performance Effect:

- Engine misfires
- Low power

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP.

i02257733

CID 0002 FMI 05 Injector Cylinder 2 open circuit

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP.

i02257748

CID 0002 FMI 06 Injector Cylinder 2 short

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects a short circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP.

i02214575

CID 0002 FMI 11 Injector Cylinder #2 fault

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit or a short circuit in the circuit for the injector.

If the cause of the diagnostic code is a problem in the common wire, two cylinders will be affected because of the shared common wire for the injectors.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

The injector may not operate while the condition exists.

Possible Performance Effect:

- Engine misfires
- Low power

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP.

i02257759

CID 0003 FMI 05 Injector Cylinder 3 open circuit

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP.

i02257773

CID 0003 FMI 06 Injector Cylinder 3 short

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects a short circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP.

i02214584

CID 0003 FMI 11 Injector Cylinder #3 fault

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit or a short circuit in the circuit for the injector.

If the cause of the diagnostic code is a problem in the common wire, two cylinders will be affected because of the shared common wire for the injectors.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

The injector may not operate while the condition exists.

Possible Performance Effect:

- Engine misfires
- Low power

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP.

i02257781

CID 0004 FMI 05 Injector Cylinder 4 open circuit

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP.

i02257789

CID 0004 FMI 06 Injector Cylinder 4 short

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects a short circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP.

i02214587

CID 0004 FMI 11 Injector Cylinder #4 fault

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit or a short circuit in the circuit for the injector.

If the cause of the diagnostic code is a problem in the common wire, two cylinders will be affected because of the shared common wire for the injectors.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

The injector may not operate while the condition exists.

Possible Performance Effect:

- Engine misfires
- Low power

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP.

i02257799

CID 0005 FMI 05 Injector Cylinder 5 open circuit

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP.

i02257807

CID 0005 FMI 06 Injector Cylinder 5 short

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects a short circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP.

i02214590

CID 0005 FMI 11 Injector Cylinder #5 fault

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit or a short circuit in the circuit for the injector.

If the cause of the diagnostic code is a problem in the common wire, two cylinders will be affected because of the shared common wire for the injectors.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

The injector may not operate while the condition exists.

Possible Performance Effect:

- Engine misfires
- Low power

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP.

i02257822

CID 0006 FMI 05 Injector Cylinder 6 open circuit

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP.

i02257844

CID 0006 FMI 06 Injector Cylinder 6 short

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects a short circuit in the circuit for the injector.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

Possible Performance Effect:

- Engine misfires
- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP.

i02214594

CID 0006 FMI 11 Injector Cylinder #6 fault

SMCS Code: 1290-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to operate the injector. The ECM detects an open circuit or a short circuit in the circuit for the injector.

If the cause of the diagnostic code is a problem in the common wire, two cylinders will be affected because of the shared common wire for the injectors.

System Response:

The ECM will log the diagnostic code. The ECM will continue to attempt to operate the injector after the code has been logged.

The injector may not operate while the condition exists.

Possible Performance Effect:

- Engine misfires
- Low power

Perform the following diagnostic procedure: “Injector Solenoid Circuit - Test”

Results:

- OK – STOP.

i02257966

CID 0041 FMI 03 8 Volt DC Supply short to +batt

SMCS Code: 5574-038

Conditions Which Generate This Code:

The output voltage of the 8 volt supply exceeds 8.5 VDC for at least two seconds.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The diagnostic code may be viewed on a display module or on Caterpillar Electronic Technician (ET). The ECM flags all digital sensors as invalid data and all digital sensors are set to the respective default values.

Possible Performance Effect:

- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Digital Sensor Supply Circuit - Test”

Results:

- OK – STOP.

i02257985

CID 0041 FMI 04 8 Volt DC Supply short to ground

SMCS Code: 5574-038

Conditions Which Generate This Code:

The output voltage of the 8 volt supply falls below 7.5 VDC for at least two seconds.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The diagnostic code may be viewed on a display module or on Caterpillar Electronic Technician (ET). The ECM flags all digital sensors as invalid data and all digital sensors are set to the respective default values.

Possible Performance Effect:

- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Digital Sensor Supply Circuit - Test”

Results:

- OK – STOP.

i02258022

CID 0091 FMI 08 Throttle Position signal abnormal

SMCS Code: 1913-038

Conditions Which Generate This Code:

The frequency of the signal from the throttle that is connected to the primary throttle input is incorrect.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The ECM flags the throttle position as invalid data and a default value of zero percent is used.

Possible Performance Effect:

The engine speed is limited to low idle.

Troubleshooting:

Perform the following diagnostic procedure: “Throttle Position Sensor Circuit - Test”

Results:

- OK – STOP.

i02258069

CID 0091 FMI 13 Throttle Position calibration required

SMCS Code: 1913-038

Conditions Which Generate This Code:

The duty cycle of the signal from the throttle that is connected to the primary throttle input is incorrect.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The ECM flags the throttle position as invalid data and a default value of zero percent is used.

Possible Performance Effect:

The engine speed is limited to low idle.

Troubleshooting:

Perform the following diagnostic procedure: “Throttle Position Sensor - Calibrate”

Results:

- OK – STOP.

i02286369

CID 0094 FMI 03 Fuel Pressure open/short to +batt

SMCS Code: 1718-038

Conditions Which Generate This Code:

The signal voltage from the fuel pressure sensor is above 4.95 VDC for eight seconds.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The ECM flags fuel pressure as invalid data and a default value of 600 kPa (88 psi) is used.

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02286373

CID 0094 FMI 04 Fuel Pressure short to ground

SMCS Code: 1718-038

Conditions Which Generate This Code:

The signal voltage from the fuel pressure sensor is below 0.1 VDC for at least eight seconds.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The ECM flags fuel pressure as invalid data and a default value of 600 kPa (88 psi) is used.

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02281072

CID 0100 FMI 03 Engine Oil Pressure open/short to +batt

SMCS Code: 1924-038

Conditions Which Generate This Code:

The signal voltage from the engine oil pressure sensor is above 4.95 VDC for at least eight seconds.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The ECM flags oil pressure as invalid data and a default value of 600 kPa (88 psi) is used.

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02226250

CID 0100 FMI 04 Engine Oil Pressure short to ground

SMCS Code: 1924-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects all of the following conditions:

- The signal voltage from the engine oil pressure sensor is below 0.1 VDC for eight seconds.
- Engine speed equals 0 rpm or barometric pressure is greater than 47 kPa (6.8 psi).

Note: The trip point may be affected by the type of sensor that is used for barometric pressure.

System Response:

The ECM will log the diagnostic code. The ECM flags oil pressure as invalid data and a default value of 600 kPa (87 psi) is used.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02214839

CID 0100 FMI 10 Engine Oil Pressure Sensor abnormal rate of change

SMCS Code: 1924-038

Conditions Which Generate This Code:

This diagnostic code is designed to detect the loss of the 5 volt supply at the sensor connector.

The Electronic Control Module (ECM) detects the following conditions:

- The engine speed is greater than 600 rpm.
- The engine oil pressure signal is within the acceptable range.
- The engine oil pressure signal remains abnormally constant.
- All of the above conditions occur simultaneously for at least thirty seconds.

System Response:

The ECM will log the diagnostic code. The diagnostic code may be viewed on the electronic service tool. The ECM will flag the engine oil pressure as invalid data. The value of the engine oil pressure is set to a default value.

Possible Performance Effect:

None

Troubleshooting:

Perform the following diagnostic procedure: “5 Volt Engine Pressure Sensor Supply Circuit - Test”

Results:

- OK – STOP.

i02281074

CID 0102 FMI 03 Boost Pressure Sensor short to +batt

SMCS Code: 1917-038

Conditions Which Generate This Code:

The signal voltage from the boost pressure sensor is above 4.8 VDC for one second.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The ECM will flag the boost pressure as invalid data and a default value is used for the boost pressure.

Possible Performance Effect:

Low power

Troubleshooting:

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02281075

CID 0102 FMI 04 Boost Pressure Sensor short to ground

SMCS Code: 1917-038

Conditions Which Generate This Code:

The signal voltage from the boost pressure sensor is below 0.2 VDC for at least two seconds.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The ECM will flag the boost pressure as invalid data and a default value is used for the boost pressure.

Possible Performance Effect:

Low power

Troubleshooting:

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02214842

CID 0102 FMI 10 Boost Pressure Sensor abnormal rate of change

SMCS Code: 1917-038

Conditions Which Generate This Code:

This diagnostic code is designed to detect the loss of the 5 volt supply at the sensor connector.

The Electronic Control Module (ECM) detects all of the following conditions:

- The engine speed is greater than 1000 rpm.
- The signal from the boost pressure sensor is within the acceptable range.
- The signal from the boost pressure sensor remains abnormally constant.
- All of the above conditions occur simultaneously for at least 30 seconds.

System Response:

The ECM will log the diagnostic code. The diagnostic code may be viewed on the electronic service tool. The ECM will flag the boost pressure as invalid data. The value of the boost pressure is set to a default value.

Possible Performance Effect:

Engine performance is adversely affected.

Troubleshooting:

Perform the following diagnostic procedure: “5 Volt Engine Pressure Sensor Supply Circuit - Test”

Results:

- OK – STOP.

i02214851

CID 0110 FMI 03 Engine Coolant Temperature open/short to +batt

SMCS Code: 1906-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects the following conditions:

- The engine has been running for more than seven minutes.
- The signal voltage from the engine coolant temperature sensor is greater than 4.95 VDC for more than eight seconds.

System Response:

The ECM will log the diagnostic code if the engine has been running for more than seven minutes. The check engine lamp will illuminate after a delay.

The ECM will set the value of the coolant temperature to a default value.

The engine will not go into cold mode while this diagnostic code is active.

The ECM will activate the cooling fan after this code has been active for more than eight seconds.

Possible Performance Effect:

None

Troubleshooting:

Perform the following diagnostic procedure: “Engine Temperature Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02214871

CID 0110 FMI 04 Engine Coolant Temperature short to ground

SMCS Code: 1906-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects the following conditions:

The engine has been running for more than seven minutes.

The signal voltage from the engine coolant temperature sensor is less than 0.2 VDC for more than eight seconds.

System Response:

The ECM will log the diagnostic code. The check engine lamp will illuminate after a delay.

The ECM will set the value of the coolant temperature to a default value.

The engine will not go into cold mode while the diagnostic code is active.

The ECM will activate the cooling fan after this code has been active for more than eight seconds.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Temperature Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02290633

CID 0111 FMI 02 Engine Coolant Level Sensor Loss of Signal

SMCS Code: 5574-038-CLT

Conditions Which Generate This Code:

The signal from the coolant level sensor is missing.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The diagnostic code may be viewed on a display module or on the electronic service tool.

Troubleshooting:

Perform the following diagnostic procedure: “Coolant Level Sensor Circuit - Test”

Results:

- OK – STOP.

i02281079

CID 0168 FMI 00 System Voltage High

SMCS Code: 1401-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) has been powered for at least three seconds. The ECM detects the following condition:

- For 12 volt systems, the ECM reads battery voltage that is above 16 VDC.
- For 24 Volt systems, the ECM reads battery voltage that is above 32 VDC.

Note: Excessive voltage to the ECM may damage the ECM.

System Response:

The ECM will log the diagnostic code.

Possible Performance Effect:

None

Troubleshooting:

Perform the following diagnostic procedure:
“Electrical Power Supply Circuit - Test”

Results:

- OK – STOP.

i02281080

CID 0168 FMI 01 System Voltage Low

SMCS Code: 1401-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) has been powered for at least three seconds. The ECM detects the following condition:

- For 12 volt systems, the ECM reads battery voltage that is below 9 VDC.
- For 24 volt systems, the ECM reads battery voltage that is below 18 VDC.

System Response:

The ECM will log the diagnostic code.

Possible Performance Effect:

- Engine misfires
- Engine shutdown

Troubleshooting:

Perform the following diagnostic procedure:
“Electrical Power Supply Circuit - Test”

Results:

- OK – STOP.

i01942656

CID 0168 FMI 02 System Voltage intermittent/erratic

SMCS Code: 1401-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects one of the following conditions:

- The engine is running and battery voltage drops below 9 VDC for at least 0.06 seconds before the battery voltage recovers.
- The engine is running and the battery voltage drops below 9 VDC three times in the last seven seconds.

System Response:

The ECM will log the diagnostic code.

Possible Performance Effect:

- Engine misfires
- Engine shutdown

Troubleshooting:

Perform the following diagnostic procedure:
“Electrical Power Supply Circuit - Test”

Results:

- OK – STOP.

i02258949

CID 0172 FMI 03 Intake Manifold Air Temp open/short to +batt

SMCS Code: 1921-038

Conditions Which Generate This Code:

The engine coolant temperature is above −10 °C (14 °F). The signal voltage from the intake manifold air temperature sensor is greater than 4.95 VDC for more than eight seconds.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The ECM flags engine coolant temperature as invalid data and a default value of 40 °C (104 °F) is used.

Possible Performance Effect:

None

Troubleshooting:

Perform the following diagnostic procedure: “Engine Temperature Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02259267

CID 0172 FMI 04 Intake Manifold Air Temp short to ground

SMCS Code: 1921-038

Conditions Which Generate This Code:

The signal voltage from the intake manifold air temperature sensor is less than 0.2 VDC for more than eight seconds.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The ECM will flag the intake manifold air temperature as invalid data and a default value of 40 °C (104 °F) is used.

Possible Performance Effect:

None

Troubleshooting:

Perform the following diagnostic procedure: “Engine Temperature Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02259280

CID 0174 FMI 03 Fuel Temperature open/short to +batt

SMCS Code: 1922-038

Conditions Which Generate This Code:

The engine coolant temperature is above −10 °C (14 °F). The signal voltage from the fuel temperature sensor is above 4.95 VDC for eight seconds.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The ECM flags engine coolant temperature as invalid data and a default value of 50 °C (122 °F) is used.

Possible Performance Effect:

- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Engine Temperature Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02259293

CID 0174 FMI 04 Fuel Temperature short to ground

SMCS Code: 1922-038

Conditions Which Generate This Code:

The signal voltage from the fuel temperature sensor is below 0.2 VDC for eight seconds.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The ECM flags engine coolant temperature as invalid data and a default value of 50 °C (122 °F) is used.

Possible Performance Effect:

- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Engine Temperature Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02259324

CID 0190 FMI 08 Engine Speed abnormal

SMCS Code: 1907-038

Conditions Which Generate This Code:

The engine speed is greater than 120 rpm. The pattern for the timing ring is incorrect for five seconds.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. If a valid signal is not received from the primary engine speed/timing sensor, the ECM will default to the secondary engine speed/timing sensor.

Possible Performance Effect:

- Engine misfires
- Engine shutdown

Note: The engine will shut down only if the signals from the primary engine speed/timing sensor and the secondary engine speed/timing sensor are abnormal.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Speed/Timing Sensor Circuit - Test”

Results:

- OK – STOP.

i02048968

CID 0247 FMI 09 J1939 Data Link communications

SMCS Code: 1901-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) has detected a loss of communications with the J1939 data link.

System Response:

The ECM will log the diagnostic code.

Possible Performance Effect:

The engine may not operate properly. The equipment may not have engine speed control.

Perform the following diagnostic procedure: “CAN Data Link Circuit - Test”

Results:

- OK – STOP.

i02265592

CID 0253 FMI 02 Personality Module mismatch

SMCS Code: 1902-038

Conditions Which Generate This Code:

The flash file that is used for replacement is for a different engine family or for a different engine application.

System Response:

The Electronic Control Module (ECM) will not log this code. The Caterpillar Electronic Technician (ET) will not be able to clear the code.

Possible Performance Effect:

Fuel injection is disabled. The engine will not start.

Troubleshooting:

Check the Part Number of the Flash File

A. Turn the keyswitch to the ON position.

B. Verify that the part number for the flash file agrees with the latest update that is available on Service Technician Workbench (STW), or on SIS Web.

Expected Result:

The correct flash file is installed in the ECM.

Results:

- OK – The correct flash file is installed in the ECM.

  Repair: The engine will not start until the 253-02 diagnostic code is cleared. Clearing this code requires factory passwords.

  Acquire factory passwords. Clear the 253-02 diagnostic code. Return the engine to service.

  STOP.

- Not OK – The correct flash file is not installed in the ECM.

  Repair: Flash program the ECM with the correct flash file. Refer to Troubleshooting, “Flash Programming”. Verify that the problem is resolved.

  STOP.

i02214901

CID 0261 FMI 13 Engine Timing Calibration required

SMCS Code: 1912-038

Conditions Which Generate This Code:

The timing has not been calibrated since the Electronic Control Module (ECM) was installed or the calibration is incorrect.

System Response:

The ECM will log the diagnostic code.

The ECM uses default timing.

Possible Performance Effect:

- Engine misfires
- Low power
- Reduced engine speed
- White exhaust smoke

Troubleshooting:

Perform the following diagnostic procedure: “Engine Speed/Timing Sensor - Calibrate”

Results:

- OK – STOP.

i02259562

CID 0262 FMI 03 5 Volt Sensor DC Power Supply short to +batt

SMCS Code: 5574-038

Conditions Which Generate This Code:

The voltage level of the 5 volt supply is greater than 5.16 VDC for more than one second.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The ECM sets all of the pressure sensors to the respective default values.

Troubleshooting:

Perform the following diagnostic procedure: “Analog Sensor Supply Circuit - Test”

Results:

- OK – STOP.

i02259643

CID 0262 FMI 04 5 Volt Sensor DC Power Supply short to ground

SMCS Code: 5574-038

Conditions Which Generate This Code:

The voltage level of the 5 volt supply is less than 4.84 VDC for more than one second.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The ECM sets all of the pressure sensors to the respective default values.

Troubleshooting:

Perform the following diagnostic procedure: “Analog Sensor Supply Circuit - Test”

Results:

- OK – STOP.

i02261912

CID 0268 FMI 02 Check Programmable Parameters

SMCS Code: 1901-038

Conditions Which Generate This Code:

One or more of the programmable parameters have not been programmed.

System Response:

The Electronic Control Module (ECM) will activate the diagnostic code.

Possible Performance Effect:

Engine performance may be affected by the unprogrammed parameters. The ECM may use a default torque map or the ECM may limit the engine to low idle.

Troubleshooting:

Program the system configuration parameters. Refer to Troubleshooting, “System Configuration Parameters” for additional information.

Results:

- OK – STOP.

i02071664

CID 0273 FMI 00 Turbo Outlet Pressure above normal

SMCS Code: 1917-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects all of the following conditions:

- The outlet pressure of the turbocharger is greater than 200 kPa (29 psi).
- The engine speed is within 50 rpm of low idle for five seconds.
- The ECM has been powered for at least three seconds.

System Response:

The ECM will log the diagnostic code.

The ECM flags turbocharger compressor outlet pressure as invalid data and a default value of 0 kPa (0 psi) is used.

Possible Performance Effect:

- Low power

Troubleshooting:

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02281091

CID 0274 FMI 03 Atmospheric Pressure open/short to +batt

SMCS Code: 1923-038

Conditions Which Generate This Code:

The signal voltage from the atmospheric pressure sensor is above 4.8 VDC for at least eight seconds.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The ECM flags atmospheric pressure as invalid data and a default value of 100 kPa (15 psi) is used.

Possible Performance Effect:

Low power

Troubleshooting:

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02281092

CID 0274 FMI 04 Atmospheric Pressure short to ground

SMCS Code: 1923-038

Conditions Which Generate This Code:

The signal voltage from the atmospheric pressure sensor is below 0.2 VDC for at least eight seconds.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The ECM flags atmospheric pressure as invalid data and a default value of 100 kPa (15 psi) is used.

Possible Performance Effect:

Low power

Troubleshooting:

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02286859

CID 0342 FMI 08 Secondary Engine Speed signal abnormal

SMCS Code: 1907-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects the following conditions:

- The engine speed is greater than 120 rpm.
- The pattern for the timing ring is incorrect for five seconds.

System Response:

The ECM will log the diagnostic code. The ECM flags the secondary engine speed signal as invalid data and a default value of zero rpm is used.

Possible Performance Effect:

- Engine misfires
- Engine shutdown

Note: The engine will shut down only if the primary engine speed/timing sensor and the secondary engine speed/timing sensor are abnormal.

Troubleshooting:

Perform the following diagnostic procedure: “Engine Speed/Timing Sensor Circuit - Test”

Results:

- OK – STOP.

i02179461

CID 0545 FMI 05 Ether Start Relay open/short to +batt

SMCS Code: 4493-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to energize the ether relay. The ECM detects an open circuit in the circuit for the ether relay.

System Response:

The ECM will log the diagnostic code.

Possible Performance Effect:

The engine may be difficult to start.

Troubleshooting:

Perform the following diagnostic procedure: “Ether Injection System - Test”

Results:

- OK – STOP.

i02179467

CID 0545 FMI 06 Ether Start Relay short to ground

SMCS Code: 4493-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to energize the ether relay. The ECM detects a short circuit in the circuit for the ether relay.

System Response:

The ECM will log the diagnostic code.

Possible Performance Effect:

The engine may be difficult to start.

Troubleshooting:

Perform the following diagnostic procedure: “Ether Injection System - Test”

Results:

- OK – STOP.

i02290640

CID 1835 FMI 03 Auxiliary Pressure Sensor open/short to +batt

SMCS Code: 5574-038-PX

Conditions Which Generate This Code:

The signal voltage from the auxiliary pressure sensor is greater than 4.8 VDC.

System Response:

The Electronic Control Module (ECM) logs the diagnostic code. The value of the auxiliary pressure is set to a default value.

Possible Performance Effect:

None

Troubleshooting:

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02290644

CID 1835 FMI 04 Auxiliary Pressure Sensor short to ground

SMCS Code: 5574-038-PX

Conditions Which Generate This Code:

The signal voltage from the auxiliary pressure sensor is less than 0.2 VDC.

System Response:

The Electronic Control Module (ECM) logs the diagnostic code. The value of the auxiliary pressure is set to a default value.

Possible Performance Effect:

None

Troubleshooting:

Perform the following diagnostic procedure: “Engine Pressure Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02290965

CID 1836 FMI 03 Auxiliary Temperature Sensor open/short to +batt

SMCS Code: 5574-038-TA

Conditions Which Generate This Code:

The output from the auxiliary temperature sensor is greater than 4.8 VDC.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The auxiliary temperature is set to the default value.

Possible Performance Effect:

None

Troubleshooting:

Perform the following diagnostic procedure: “Engine Temperature Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02290973

CID 1836 FMI 04 Auxiliary Temperature Sensor short to ground

SMCS Code: 5574-038-TA

Conditions Which Generate This Code:

The signal voltage from the auxiliary temperature sensor is less than 0.5 VDC.

System Response:

The Electronic Control Module (ECM) logs the diagnostic code. The value of the auxiliary temperature is set to a default value.

Possible Performance Effect:

- None

Troubleshooting:

Perform the following diagnostic procedure: “Engine Temperature Sensor Open or Short Circuit - Test”

Results:

- OK – STOP.

i02178158

CID 2417 FMI 05 Ether Injection Control Solenoid current low

SMCS Code: 5479-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to energize the ether relay. The ECM detects an open circuit in the circuit for the ether relay.

System Response:

The ECM will log the diagnostic code.

Possible Performance Effect:

The engine may be difficult to start.

Troubleshooting:

Perform the following diagnostic procedure: “Ether Injection System - Test”

Results:

- OK – STOP.

i02214983

CID 2417 FMI 06 Ether Injection Control Solenoid current high

SMCS Code: 5479-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) is attempting to energize the ether relay. The ECM detects excessive current flow in the circuit for the ether relay.

System Response:

The ECM will log the diagnostic code.

Possible Performance Effect:

The engine may be difficult to start.

Troubleshooting:

Perform the following diagnostic procedure: “Ether Injection System - Test”

Results:

- OK – STOP.

Troubleshooting with an Event Code

i02290980

Event Codes

SMCS Code: 1901

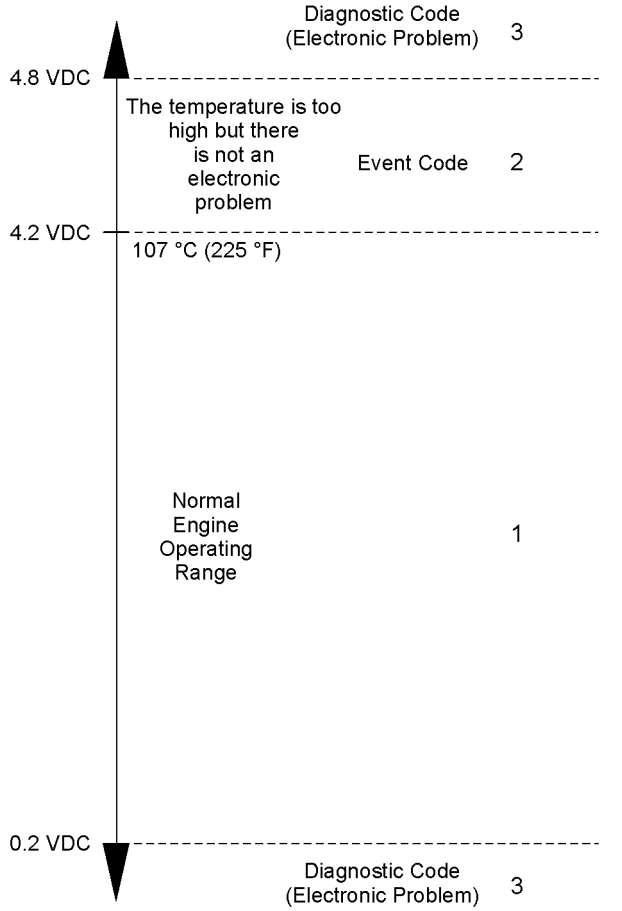
Event codes alert the operator that an abnormal engine operating condition such as low oil pressure or high coolant temperature has been detected. When the event code is generated, the event is active.

Active Event Codes

An active event code represents a problem with engine operation. **Correct the problem as soon as possible.**

Active event codes are listed in ascending numerical order. The code with the lowest number is listed first.

Illustration 11 is an example of the operating range of a temperature sensor. Do not use the Illustration to troubleshoot temperature sensors.



g01138880

Illustration 11

Example of the typical operating range of a temperature sensor

(1) This area represents the normal operating range of the parameter. The normal output voltage of the sensor is between 0.2 VDC and 4.2 VDC.
(2) In this area, the temperature above 107 °C (225 °F) is higher than normal. The output voltage of the sensor will generate an event code. The sensor does not have an electronic problem.
(3) In these areas, the output voltage of the sensor is too high or too low. The voltage is outside of the normal range. The electronic problem will generate a diagnostic code. Refer to Troubleshooting, “Troubleshooting with a Diagnostic Code” for additional information on diagnostic codes.

Events are represented in two formats. In the first format, the “E” means that the code is an event code. The “XXX” represents a numeric identifier for the event code. This is followed by a description of the code. If a warning, a derate, or a shutdown is applicable, the numeric identifiers are different. Refer to the following example:

- E004 Engine Overspeed Shutdown

In the second format, the “E” means that the code is an event code. The “XXX-X” represents a numeric identifier for the event code. The fourth “X” identifies the event as a warning, a derate, or a shutdown. This is followed by a description of the code. Refer to the following example:

- E360-1 Low Oil Pressure Warning
- E360-2 Low Oil Pressure Derate
- E360-3 Low Oil Pressure Shutdown

The definition for a warning, a derate, and a shutdown are defined below:

Warning – This condition represents a serious problem with engine operation. However, this condition does not require a derate or a shutdown.

Derate – For this condition, the ECM reduces the engine's power in order to help prevent possible engine damage.

Shutdown – For this condition, the ECM shuts down the engine in order to help prevent possible engine damage.

Logged Event Codes

When the ECM generates an event code the ECM logs the code in permanent memory. The ECM has an internal diagnostic clock. The ECM will record the following information when an event code is generated:

- The hour of the first occurrence of the code
- The hour of the last occurrence of the code
- The number of occurrences of the code

Logged events are listed in chronological order. The most recent event code is listed first.

This information can be helpful for troubleshooting intermittent problems. Logged codes can also be used to review the performance of the engine.

Clearing Event Codes

A code is cleared from memory when one of the following conditions occur:

- The code does not recur for 100 hours.
- A new code is logged and there are already ten codes in memory. In this case, the oldest code is cleared.
- The service technician manually clears the code.

Always clear logged event codes after investigating and correcting the problem which generated the code.

Troubleshooting

For basic troubleshooting of the engine, perform the following steps in order to diagnose a malfunction:

1. Obtain the following information about the complaint:
   - The event and the time of the event
   - Determine the conditions for the event. The conditions will include the engine rpm and the load.
   - Determine if there are any systems that were installed by the dealer or by the customer that could cause the event.
   - Determine whether any additional events occurred.
2. Verify that the complaint is not due to normal engine operation. Verify that the complaint is not due to error of the operator.
3. Narrow the probable cause. Consider the operator information, the conditions of operation, and the history of the engine.
4. Perform a visual inspection. Inspect the following items:
   - Fuel supply
   - Oil level
   - Oil supply
   - Wiring
   - Connectors

Be sure to check the connectors. This is very important for problems that are intermittent. Refer to Troubleshooting, "Electrical Connectors - Inspect".

If these steps do not resolve the problem, identify the procedures in this manual that best describe the event. Check each probable cause according to the tests that are recommended.

Trip Points for the Monitoring System

The monitoring system determines the level of action that is taken by the Electronic Control Module (ECM) in response to a condition that can damage the engine. When any of these conditions occur, the appropriate event code will trip.

Table 15 contains the conditions that are monitored and the default trip points for each condition. Each condition has an associated parameter. The settings for each parameter can be viewed with the Caterpillar Electronic Technician (ET). The trip points for some of the parameters may be adjustable with Cat ET.

Table 15

Trip Points for the Monitoring System							
Parameter	**Event Code**	**Action**	**Default Value**	**Time Delay in Seconds**		**Set Points**	
				Range	**Default**	**Range**	**Default**
Low Coolant Level	E057	Derate	On	1 to 54	10	None	
	E058	Shutdown	Off	1 to 54	10		
	E059	Warning	On	1 to 54	10		
High Fuel Pressure	E096	Warning	On	None	8	Maps are not programmable. (1)	
Low Engine Oil Pressure	E360	Warning	On	None	8	Maps are not programmable. (1)	
		Derate					
		Shutdown	Off		4		
High Engine Coolant Temperature	E361	Warning	On	None	10	85 °C (185 °F) to 110 °C (230 °F)	110 °C (230 °F)
		Derate		1 to 54	10	86 °C (187 °F) to 111 °C (232 °F)	111 °C (232 °F)
		Shutdown	Off	1 to 54	10	87 °C (189 °F) to 111 °C (232 °F)	
Engine Overspeed	E362	Warning	On	None	1	C11/ C13	1800-2600	2600
						C15		
						C18	1800-2500	2500
		Shutdown				C11/ C13	1800-2800	2800
						C15		
						C18	1800-2700	2700
High Fuel Temperature	E363	Warning	On	1 to 54	30	70 °C (158 °F) to 90 °C (194 °F)	90 °C (194 °F)
		Derate		1 to 54	10	71 °C (160 °F) to 91 °C (196 °F)	91 °C (196 °F)
		Shutdown	Off	1 to 54	10		
High Auxiliary Pressure (2)	E443	Warning	On	1 to 54	4	0 kPa (0 psi) to 3150 kPa (457 psi)	1500 kPa (218 psi)
		Derate	Off	1 to 54	3		
		Shutdown		1 to 54	3		
High Auxiliary Temperature (2)	E445	Warning	On	1 to 54	4	0 °C (0 °F) to 140 °C (284 °F)	105 °C (221 °F)
		Derate	Off	1 to 54	4		106 °C (223 °F)
		Shutdown		1 to 54	4		107 °C (224 °F)

(continued)

(Table 15, contd)

Trip Points for the Monitoring System							
Parameter	Event Code	Action	Default Value	Time Delay in Seconds		Set Points	
				Range	Default	Range	Default
High Engine Air Inlet Temperature	E539	Warning	On	None	8	None	75 °C (167 °F)
		Derate		1 to 54	8		79 °C (174 °F)

(1) The maps may be different. The maps depend on the model of the engine.
(2) The engine must be equipped with the appropriate sensor.

i02264589

E057 Low Engine Coolant Level Derate

SMCS Code: 1395-038-LO

Conditions Which Generate This Code:

The coolant level is below the coolant level sensor.

System Response:

The ECM will log the event.

Possible Performance Effect:

Engine power is reduced.

Troubleshooting:

- The coolant level is most likely low.
- There may be a problem with the coolant level sensor.

Check the Coolant Level

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

A. Stop the engine.

B. After allowing the engine to cool, check the coolant level. Refer to the Operation and Maintenance Manual for the proper procedure.

Expected Result:

The coolant level is low.

Results:

- OK – The coolant level is low.

  Repair: Check the cooling system for leaks. Repair any problems that are found. Refill the cooling system to the proper level.

  STOP.

- Not OK – The coolant level is not low.

  Repair: There may be a problem with the coolant level sensor. Refer to the diagnostic functional test Troubleshooting, “Coolant Level Sensor Circuit - Test” in order to verify that the coolant level sensor is operating correctly.

  Ensure that any repairs eliminate the problem.

  STOP.

i02274242

E058 Low Engine Coolant Level Shutdown

SMCS Code: 1395-038-LO

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a problem with the engine’s cooling system. Information on default settings and ranges for this event code can be found in Troubleshooting, “Event Codes”.

System Response:

The event code will be logged.

Possible Performance Effect:

E058 (Shutdown)

The engine will shut down.

Troubleshooting:

- The coolant level is most likely low.

- There may be a problem with the coolant level sensor.

Check the Coolant Level

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

A. Stop the engine.

B. After allowing the engine to cool, check the coolant level. Refer to the Operation and Maintenance Manual for the proper procedure.

Expected Result:

The coolant level is low.

Results:

- OK – The coolant level is low.

  Repair: Check the cooling system for leaks. Repair any problems that are found. Refill the cooling system to the proper level.

  STOP.

- Not OK – The coolant level is not low.

  Repair: There may be a problem with the coolant level sensor. Refer to the diagnostic functional test Troubleshooting, “Coolant Level Sensor Circuit - Test” in order to verify that the coolant level sensor is operating correctly.

  Ensure that any repairs eliminate the problem.

  STOP.

i02274243

E059 Low Engine Coolant Level Warning

SMCS Code: 1395-038-LO

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a problem with the engine’s cooling system. Information on default settings and ranges for this event code can be found in Troubleshooting, “Event Codes”.

System Response:

The event code will be logged.

Possible Performance Effect:

E057 (Warning)

None

Troubleshooting:

- The coolant level is most likely low.
- There may be a problem with the coolant level sensor.

Check the Coolant Level

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

A. Stop the engine.

B. After allowing the engine to cool, check the coolant level. Refer to the Operation and Maintenance Manual for the proper procedure.

Expected Result:

The coolant level is low.

Results:

- OK – The coolant level is low.

  Repair: Check the cooling system for leaks. Repair any problems that are found. Refill the cooling system to the proper level.

  STOP.

- Not OK – The coolant level is not low.

  Repair: There may be a problem with the coolant level sensor. Refer to the diagnostic functional test Troubleshooting, “Coolant Level Sensor Circuit - Test” in order to verify that the coolant level sensor is operating correctly.

  Ensure that any repairs eliminate the problem.

  STOP.

i02277367

E096 High Fuel Pressure

SMCS Code: 1250-038-HQ

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a problem with the engine's fuel pressure. Information on default settings and ranges for this event code can be found in Troubleshooting, "Event Codes".

System Response:

The event code will be logged.

Possible Performance Effect:

E096 (Warning)

None

Check the Fuel System

A. Verify that the check valve in the fuel manifold is operating correctly. Check for damage or for dirt in the check valve.

B. Check the return line from the check valve to the fuel tank for damage or collapse.

Results:

- OK – A problem was found in either the check valve or in the return line to the fuel tank.

  Repair: Replace all suspect parts.

  STOP.

i02274316

E360 Low Engine Oil Pressure

SMCS Code: 1348-038-LP

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a problem with the engine's oil pressure. Information on default settings and ranges for this event can be found in Troubleshooting, "Event Codes".

System Response:

The event code will be logged.

Possible Performance Effect:

E360-1 (Warning)

None

E360-2 (Derate)

The engine power will be derated.

E360-3 (Shutdown)

The engine will shut down.

Troubleshooting:

There may be a problem with the engine's lubrication system.

Check the Engine's Lubrication System

A. Check the engine oil level. If the oil level is below the oil pump's supply tube, the oil pump will not have the ability to supply enough lubrication to the engine components. If the engine oil level is low, add engine oil in order to obtain the correct engine oil level.

B. Check the following problems that may occur to the engine oil pump:

a. Air leakage in the supply side of the oil pump will also cause cavitation and loss of oil pressure. Check the supply side of the oil pump and make necessary repairs.

b. Oil pump gears that have too much wear will cause a reduction in oil pressure. Repair the engine oil pump.

c. If the engine is equipped with a scavenge pump, the scavenge pump may not be supplying oil to the main engine oil pump.

C. The inlet screen of the oil suction tube for the engine oil pump can have a restriction. This restriction will cause cavitation and a loss of engine oil pressure. Check the inlet screen on the oil pickup tube and remove any material that may be restricting engine oil flow. Low engine oil pressure may also be the result of the oil pickup tube that is drawing in air. Check the joints of the oil pickup tube for cracks or a damaged O-ring seal.

D. If the engine oil bypass valves are held in the open position, a reduction in the oil pressure can be the result. This may be due to debris in the engine oil. If the engine oil bypass valves are stuck in the open position, remove each engine oil bypass valve and clean each bypass valve in order to correct this problem. You must also clean each bypass valve bore.

E. Engine oil that is contaminated with fuel or coolant will cause low engine oil pressure. High engine oil level in the crankcase can be an indication of contamination.

F. Excessive clearance at engine bearings will cause low engine oil pressure. Check the engine components for excessive bearing clearance.

G. An oil line that is open, broken, or disconnected will cause low engine oil pressure.

Expected Result:

An inspection of the engine's lubrication system indicated a problem.

Results:

- OK – There is a problem in the engine's lubrication system.

  Repair: Repair the problem. Ensure that the repair eliminates the problem.

  STOP.

i02274479

E361 High Engine Coolant Temperature

SMCS Code: 1395-038-TA

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a problem with the engine's cooling system. Information on default settings and ranges for this event can be found in Troubleshooting, "Event Codes".

System Response:

The event code will be logged.

Possible Performance Effect:

E361-1 (Warning)

None

E361-2 (Derate)

The engine power will be derated.

E361-3 (Shutdown)

The engine will shut down.

Troubleshooting:

There may be a problem with the engine's cooling system.

Check the Engine's Cooling System

A. Verify that the cooling system is filled to the proper level. If the coolant level is too low, air will get into the cooling system. Air in the cooling system will cause a reduction in coolant flow.

B. Check the radiator or the heat exchanger for a restriction to coolant flow.

a. Check for debris or damage between the fins of the radiator core. Debris between the fins of the radiator core restricts air flow through the radiator core.

b. Check internally for debris, dirt, or deposits on the radiator core. Debris, dirt, or deposits will restrict the flow of coolant through the radiator.

C. Check the mixture of antifreeze and water. Make sure that the recommendations in the Operation and Maintenance Manual are followed.

D. Check the water temperature regulator. A water temperature regulator that does not open, or a water temperature regulator that only opens part of the way can cause overheating.

E. Check the water pump. A water pump with a damaged impeller does not pump enough coolant. Remove the water pump and check for damage to the impeller.

F. If the cooling system for this application is equipped with a fan, check the operation of the fan. A fan that is not turning at the correct speed can cause improper air speed across the radiator core. The lack of proper air flow across the radiator core can cause the coolant not to cool to the proper temperature differential.

G. Check for air in the cooling system. Air can enter the cooling system in different ways. The most common causes of air in the cooling system are the incorrect filling of the cooling system and combustion gas leakage into the cooling system. Combustion gas can get into the system through inside cracks, a damaged cylinder head, or a damaged cylinder head gasket.

H. Check the cooling system hoses and clamps. Damaged hoses with leaks can normally be seen. Hoses that have no visual leaks can soften during operation. The soft areas of the hose can become kinked or crushed during operation. These areas of the hose can restrict the coolant flow. Hoses become soft and/or get cracks after a period of time. The inside of a hose can deteriorate, and the loose particles of the hose can restrict the coolant flow.

I. If the cooling system for this application is equipped with an expansion tank, check the shunt line for the expansion tank. The shunt line must be submerged in the expansion tank. A restriction of the shunt line from the expansion tank to the inlet of the jacket water pump will cause a reduction in water pump efficiency. A reduction in water pump efficiency will result in low coolant flow.

J. If the cooling system for this application is equipped with an aftercooler, check the aftercooler. A restriction of air flow through the air to air aftercooler can cause overheating. Check for debris or deposits which would prevent the free flow of air through the aftercooler.

K. Check for a restriction in the air inlet system. A restriction of the air that is coming into the engine can cause high cylinder temperatures. High cylinder temperatures cause higher than normal temperatures in the cooling system.

L. Check for a restriction in the exhaust system. A restriction of the air that is coming out of the engine can cause high cylinder temperatures.

M. Consider high ambient temperatures. When ambient temperatures are too high for the rating of the cooling system, there is not enough of a temperature difference between the ambient air and coolant temperatures.

N. Consider high altitude operation. The cooling capability of the cooling system is reduced at higher altitudes. A pressurized cooling system that is large enough to keep the coolant from boiling must be used.

O. The engine may be running in the lug condition. When the load that is applied to the engine is too large, the engine will run in the lug condition. When the engine is running in the lug condition, engine rpm does not increase with an increase of fuel. This lower engine rpm causes a reduction in coolant flow through the system.

Expected Result:

A thorough inspection of the cooling system revealed a problem.

Results:

- OK – There is a problem with the cooling system.

  Repair: Repair the problem. Ensure that the repair eliminates the problem.

  STOP.

i02291001

E362 Engine Overspeed

SMCS Code: 7410-038; 7427-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an overspeed condition. Information on default settings and ranges for this event can be found in Troubleshooting, “Event Codes”.

System Response:

The event code will be logged.

Possible Performance Effect:

E362-1 (Warning)

None

E362-2 (Derate)

None

E362-3 (Shutdown)

The engine will be shut down.

Troubleshooting:

The operator may be operating the machine incorrectly.

Talk to the Operator

Determine the events that caused the overspeed of the engine.

Results:

- OK – STOP.

i02291100

E363 High Fuel Temperature

SMCS Code: 1250-038-TA

Conditions Which Generate This Code:

The temperature of the fuel has exceeded the trip point. Information on default settings and ranges for this event code can be found in Troubleshooting, “Event Codes”.

System Response:

The event code is logged.

Possible Performance Effect:

E363-1 (Warning)

None

E363-2 (Derate)

The engine power is derated.

E363-3 (Shutdown)

The engine is shut down.

Troubleshooting:

Check the Fuel System

Check the fuel system.

Expected Result:

A thorough inspection of the fuel system revealed a problem.

Results:

- OK – There is a problem with the fuel system.

  Repair: Make the necessary repairs. Verify that the repair eliminates the problem.

  STOP.

i02291109

E443 High Auxiliary Pressure

SMCS Code: 5095-038-AX

Conditions Which Generate This Code:

The pressure that is sensed by the auxiliary pressure sensor has exceeded the trip point. Information on default settings and ranges for this event can be found in Troubleshooting, “Event Codes”.

System Response:

The event code will be logged.

Possible Performance Effect:

443-1 (Warning)

None

443-2 (Derate)

The Electronic Control Module (ECM) will derate engine power.

443-3 (Shutdown)

The engine will shut down.

Troubleshooting:

Use the Caterpillar Electronic Technician (ET) to view the parameter setting for auxiliary pressure. Verify that the set points are valid for the application.

Determine the cause of the high pressure condition. Make corrections in order to prevent the high pressure from recurring.

Results:

- OK – STOP.

i02291151

E445 High Auxiliary Temperature

SMCS Code: 5095-038-AX

Conditions Which Generate This Code:

The pressure that is sensed by the auxiliary temperature sensor has exceeded the trip point. Information on default settings and ranges for this event can be found in Troubleshooting, “Event Codes”.

System Response:

The event code will be logged.

Possible Performance Effect:

443-1 (Warning)

None

443-2 (Derate)

The Electronic Control Module (ECM) will derate engine power.

443-3 (Shutdown)

The engine will shut down.

Troubleshooting:

Use the Caterpillar Electronic Technician (ET) to view the parameter setting for auxiliary temperature. Verify that the set points are valid for the application.

Determine the cause of the high temperature condition. Make corrections in order to prevent the high temperature from recurring.

Results:

- OK – STOP.

i02286870

E539 High Intake Manifold Air Temperature

SMCS Code: 1050-038-TA

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a problem with the engine's intake manifold air temperature. Information on default settings and ranges for this event can be found in Troubleshooting, "Event Codes".

System Response:

The event code will be logged.

Possible Performance Effect:

E539-1 (Warning)

None

E539-2 (Derate)

The engine power will be derated.

Troubleshooting:

Intake manifold air temperature can be high for the following reasons:

- Engine's cooling system
- High ambient air temperature
- High inlet air restriction and/or high altitude
- Restriction in the exhaust system
- Faulty inlet air temperature sensor and/or circuit

Perform the following Inspections

A. Check the Engine's Cooling System.

a. Verify that the cooling system is filled to the proper level. If the coolant level is too low, air will get into the cooling system. Air in the cooling system will cause a reduction in coolant flow.

b. Check the quality of the coolant. Follow the recommendations in the Operation and Maintenance Manual.

c. Check the radiator for blockage. Check the inlet temperature of the coolant for the radiator. Compare the reading to the regulated temperature. If the temperature is OK, check the outlet temperature of the coolant. A high temperature differential indicates an insufficient flow rate.

d. Check for air in the cooling system. Air can enter the cooling system in different ways. The most common causes of air in the cooling system are the incorrect filling of the cooling system and combustion gas leakage into the cooling system. Combustion gas can get into the system through inside cracks, a damaged cylinder head, or a damaged cylinder head gasket.

e. Check the cooling system hoses and clamps. Damaged hoses with leaks can normally be seen. Hoses that have no visual leaks can soften during operation. The soft areas of the hose can become kinked or crushed during operation. These areas of the hose can restrict the coolant flow. Hoses become soft and/or get cracks after a period of time. The inside of a hose can deteriorate, and the loose particles of the hose can restrict the coolant flow.

f. If a sea water strainer is used in the application, verify that the sea water strainer is not plugged.

g. Check the heat exchanger for a restriction to the flow of water.

h. Check the water pump. A water pump with a damaged impeller does not pump enough coolant. Remove the water pump and check for damage to the impeller.

i. Check the water temperature regulator. A water temperature regulator that does not open, or a water temperature regulator that only opens part of the way can cause overheating.

j. If the cooling system for this application is equipped with an expansion tank, check the shunt line for the expansion tank. The shunt line must be submerged in the expansion tank. A restriction of the shunt line from the expansion tank to the inlet of the jacket water pump will cause a reduction in water pump efficiency. A reduction in water pump efficiency will result in low coolant flow.

k. If the cooling system for this application is equipped with an aftercooler, check the aftercooler. A restriction of air flow through the air to air aftercooler can cause overheating. Check for debris or deposits which would prevent the free flow of air through the aftercooler.

l.

m. The engine may be running in the lug condition. When the load that is applied to the engine is too large, the engine will run in the lug condition. When the engine is running in the lug condition, engine rpm does not increase with an increase of fuel. This lower engine rpm causes a reduction in coolant flow through the system.

B. Check for High Ambient Air Temperature

a. Determine if the ambient air temperature is within the design specifications for the cooling system. When ambient temperatures are too high for the rating of the cooling system, there is not enough of a temperature difference between the ambient air and coolant temperatures.

b. Determine the cause of the high air temperature. Make corrections, when possible.

C. Check for High Inlet Air Restriction and/or High Altitude

a. When inlet air pressure is low, the turbocharger works harder in order to achieve the desired inlet manifold pressure. This increases inlet air temperature.

b. Measure the inlet air pressure while the engine is operating under load. For specific data, refer to the Technical Marketing Information for the engine.

c. Check for plugged air filters. Check for obstructions to the air inlet. A restriction of the air that is coming into the engine can cause high cylinder temperatures. High cylinder temperatures cause higher than normal temperatures in the cooling system.

d. Replace the air filters and/or remove the obstruction from the air inlet.

e. Consider high altitude operation. The cooling capability of the cooling system is reduced at higher altitudes. A pressurized cooling system that is large enough to keep the coolant from boiling must be used. Make sure that the settings for the engine are correct for the altitude.

D. Check the Engine's Exhaust System.

Check for a restriction in the exhaust system. A restriction of the air that is coming out of the engine can cause high cylinder temperatures.

Expected Result:

A thorough inspection revealed a problem.

Results:

- Yes – A thorough inspection revealed a problem.

  Repair: Repair the problem. Ensure that the repair eliminates the problem.

  STOP.

Diagnostic Functional Tests

i02289813

5 Volt Engine Pressure Sensor Supply Circuit - Test

SMCS Code: 5574-038

System Operation Description:

The Electronic Control Module (ECM) creates a regulated voltage of 5.0 ± 0.2 VDC that is supplied to terminal A of the harness connectors for these sensors:

- Injection actuation pressure sensor
- Boost pressure sensor
- Atmospheric pressure sensor
- Fuel pressure sensor
- Engine oil pressure sensor
- Auxiliary pressure sensor (if equipped)

This procedure covers the following diagnostic codes:

- 262-03 5 Volt Sensor DC Power Supply short to +batt
- 262-04 5 Volt Sensor DC Power Supply short to ground
- 100-10 Engine Oil Pressure Sensor abnormal rate of change
- 102-10 Boost Pressure Sensor abnormal rate of change

A +5 V diagnostic code is probably caused by a short circuit to ground or a short circuit to another voltage source in the harness. The next likely cause is a problem with a sensor. The least likely cause is a problem with the ECM.

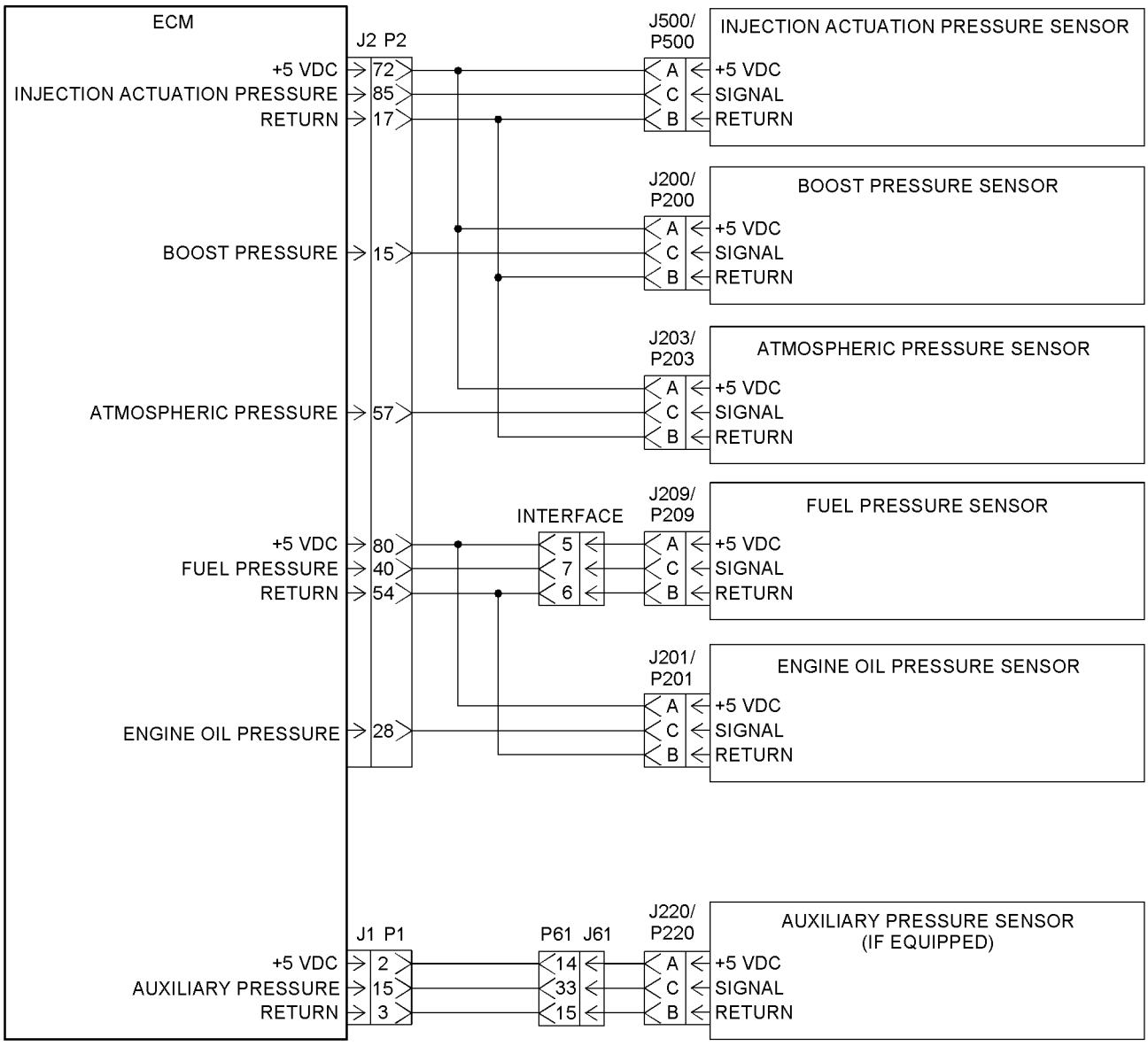
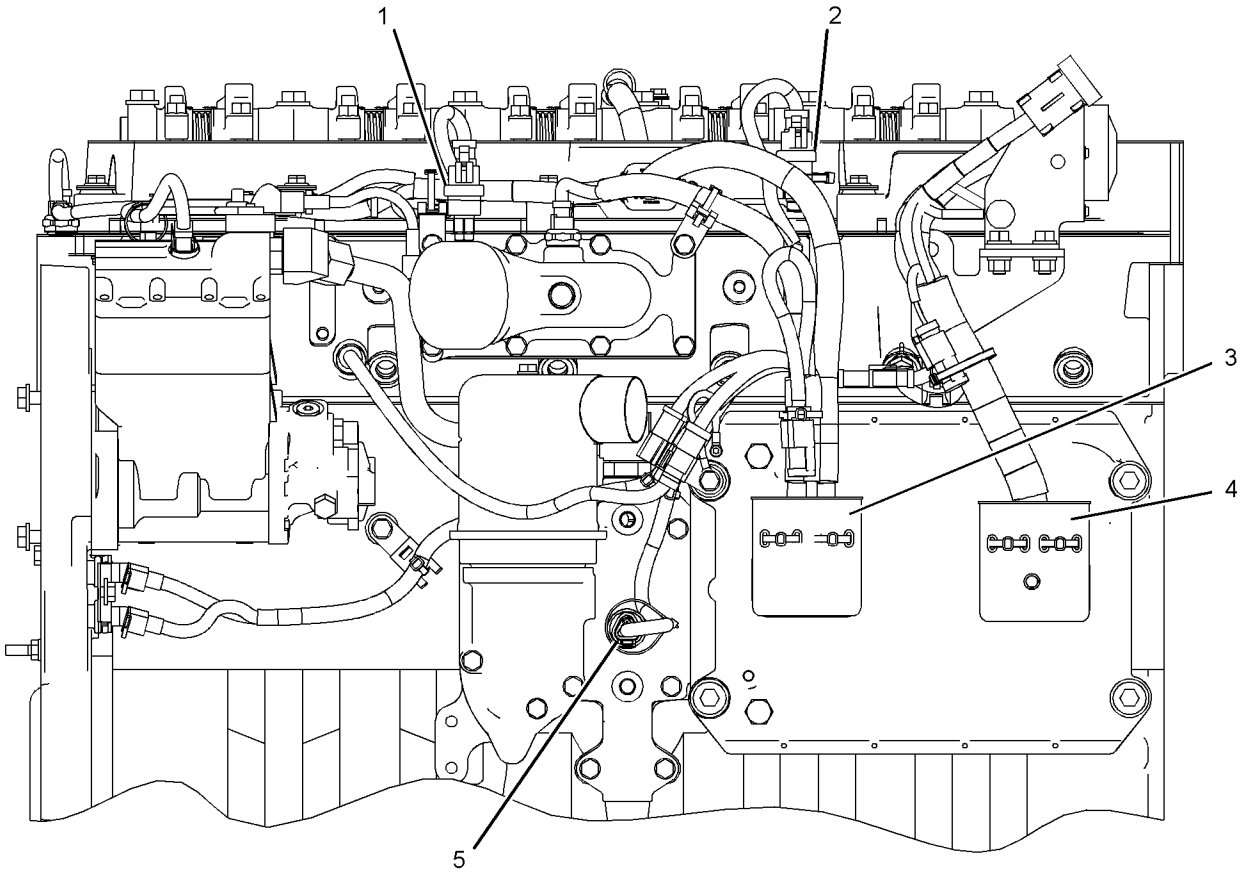


Illustration 12 g01119880

Schematic for the 5 volt supply

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Turn the keyswitch to the OFF position.

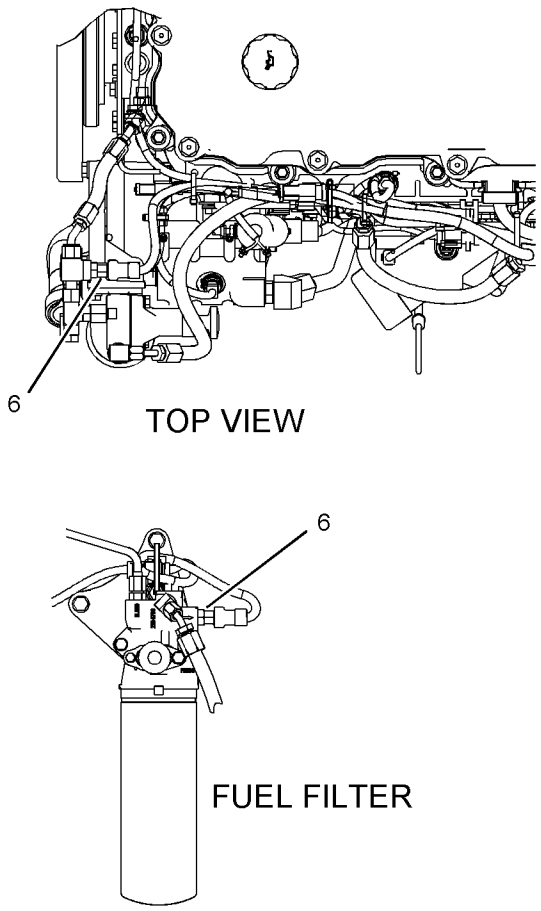


g01121143

Illustration 13

Left side view

(1) Boost pressure sensor
(2) Atmospheric pressure sensor
(3) J2/P2 connectors
(4) J1/P1 connectors
(5) Engine oil pressure sensor



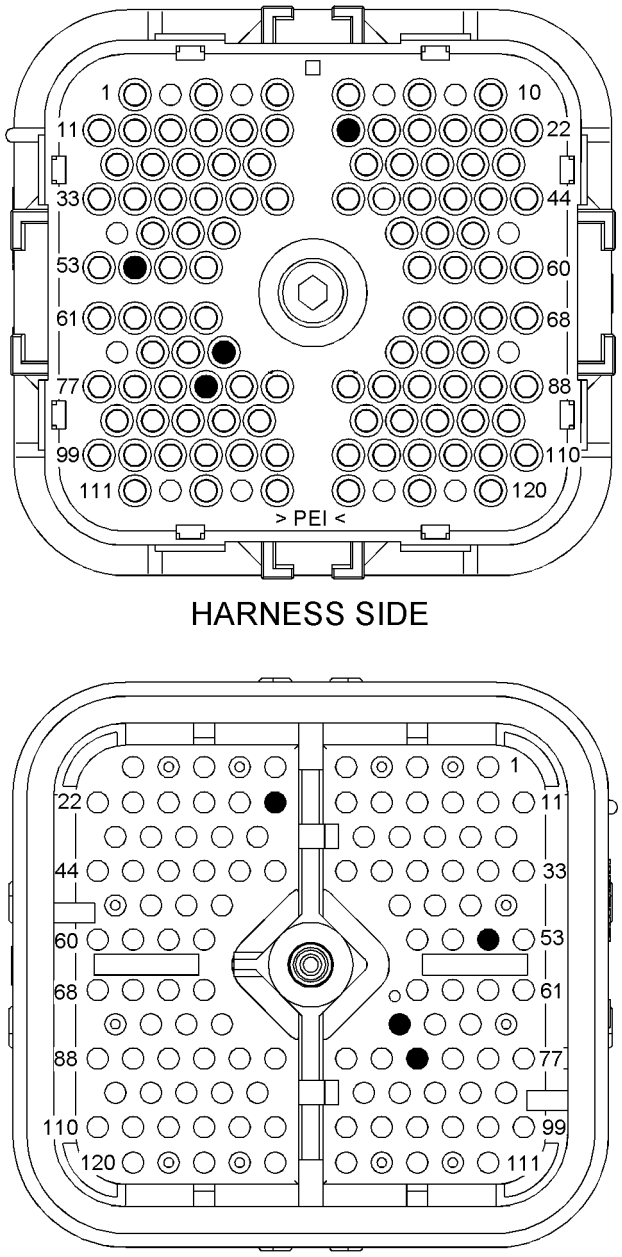
g01121144

Illustration 14

The location of the fuel pressure sensor depends on the engine's configuration.

(6) Fuel pressure sensor

B. Thoroughly inspect connectors (3) and (4). Thoroughly inspect the connectors for each pressure sensor. Refer to Troubleshooting, "Electrical Connectors - Inspect".



g01123205

Illustration 15

P2 terminals that are associated with the 5 volt supply for the pressure sensors

(P2-17) Return
(P2-54) Return
(P2-72) +5 VDC
(P2-80) +5 VDC

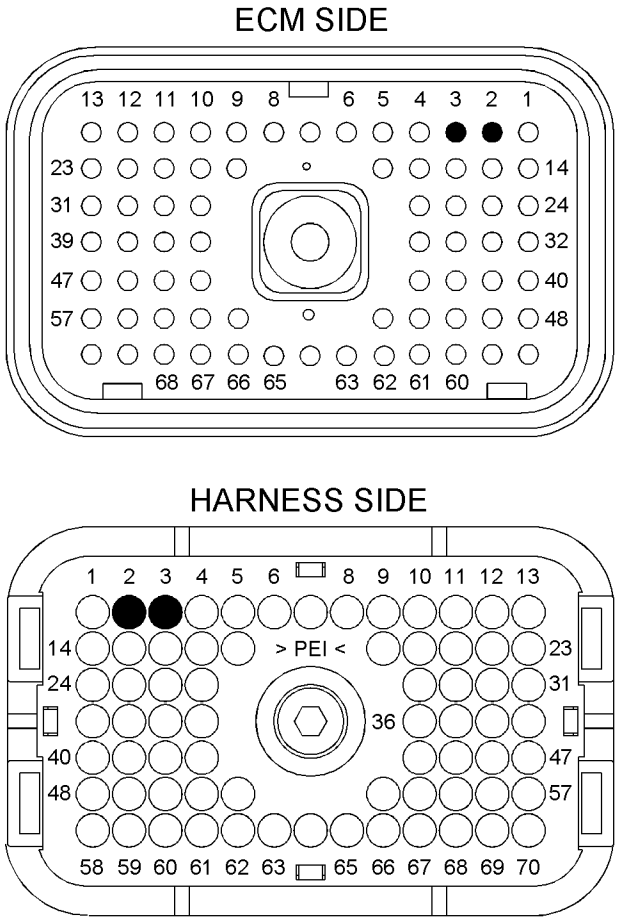


Illustration 16 g01123207

P1 terminals that are associated with the 5 volt supply for the pressure sensors

(P1-2) +5 VDC
(P1-3) Return

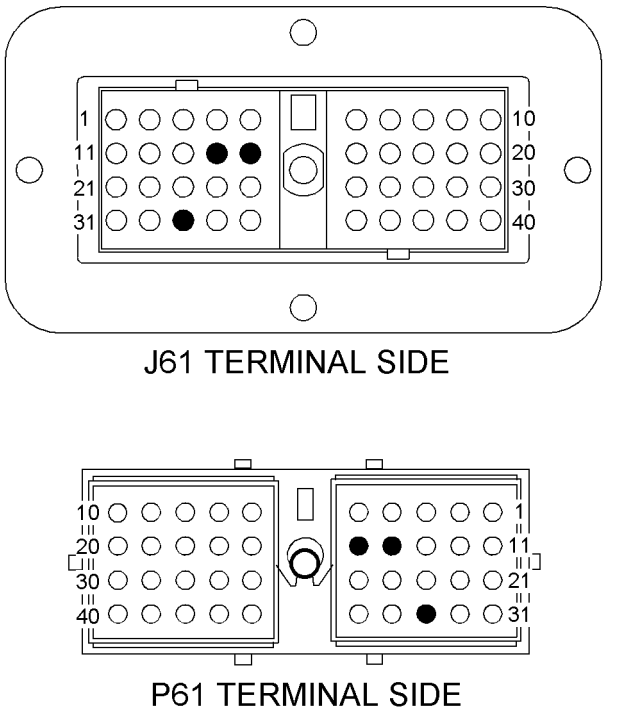


Illustration 17 g01123208

J61/P61 terminals that are associated with the 5 volt supply for the pressure sensors

(14) +5 VDC
(15) Return

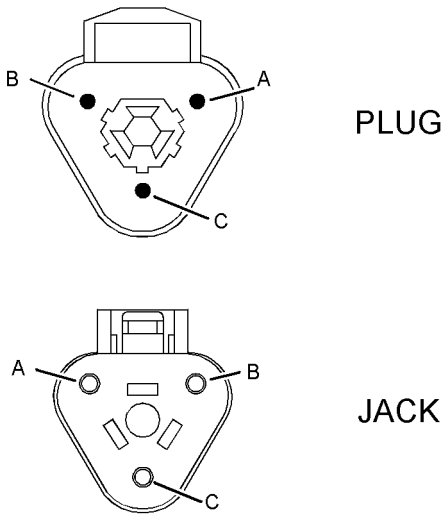


Illustration 18 g01123211

Connectors for the sensors

(A) Supply
(B) Return
(C) Signal

C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the pressure sensor supply.

D. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the allen head screw on the customer connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque value.

F. Check the harness and the wiring for abrasion and for pinch points from each sensor back to the ECM.

Expected Result:

All of the connectors, pins and sockets are completely coupled and/or inserted and the harness and wiring are free of corrosion, of abrasion and of pinch points.

Results:

- OK – The harness and connectors appear to be OK. Proceed to Test Step 2.
- Not OK – The connectors and/or wiring are not OK.

  Repair: Repair the wiring and/or the connectors. Replace parts, if necessary. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled. Verify that the repair eliminates the problem.

  STOP.

Test Step 2. Check for Active Diagnostic Codes

A. Connect the Caterpillar Electronic Technician (ET) to the service tool connector. Refer to Troubleshooting, “Electronic Service Tools”.

B. Turn the keyswitch to the ON position.

C. Observe the “Active Diagnostic” screen on Cat ET. Wait at least 15 seconds so that any codes may become active. Look for these codes:

- 262-03
- 262-04
- 100-10
- 102-10

Expected Result:

One of the above codes is active.

Results:

- Active 03 code – An 03 diagnostic code is active. Proceed to Test Step 3.
- Active 04 code – An 04 diagnostic code is active. Proceed to Test Step 5.
- Active 10 code – A 10 diagnostic code is active. Proceed to Test Step 4.
- No active codes – None of the above codes are active.

  Repair: If any of the above codes are logged and the engine is not running properly, refer to Troubleshooting, “Troubleshooting Without a Diagnostic Code”.

  If the engine is running properly at this time, there may be an intermittent problem in a harness that is causing the codes to be logged. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

Test Step 3. Check the Voltage on the +5 V Supply Wire

A. Turn the keyswitch to the OFF position.

B. Disconnect the harness connectors for the following sensors:

- Injection actuation pressure sensor J500/P500
- Boost pressure sensor J200/P200
- Atmospheric pressure sensor J203/P203
- Fuel pressure sensor J209/P209
- Engine oil pressure sensor J201/P201
- Auxiliary pressure sensor J220/P220 (if equipped)

C. Turn the keyswitch to the ON position.

Note: Be sure to wiggle the harness during the following measurements in order to reveal an intermittent condition.

D. Measure the voltage between terminals A and B at each sensor connector on the engine harness.

Expected Result:

Each voltage measurement is 5.0 ± 0.2 VDC.

Results:

- OK – Each voltage measurement is 5.0 ± 0.2 VDC.

  Repair: Connect all of the sensor connectors. Clear all diagnostic codes. Check for active diagnostic codes. If the problem is intermittent, refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

- Not OK – At least one voltage measurement is not 5.0 ± 0.2 VDC. There is a problem with the wiring or with the ECM. Proceed to Test Step 6.

Test Step 4. Check the Voltage on the +5 V Supply Wire for the Suspect Sensor

A. Turn the keyswitch to the OFF position.

B. Disconnect the harness connectors for the suspect sensor.

C. Turn the keyswitch to the ON position.

Note: Be sure to wiggle the harness during the following measurement in order to reveal an intermittent condition.

D. Measure the voltage between terminals A and B on the harness connector for the suspect sensor.

Expected Result:

The voltage measurement is 5.0 ± 0.2 VDC.

Results:

- Yes – The voltage measurement is 5.0 ± 0.2 VDC. The 5 volt supply is present at the harness connector for the suspect sensor. However, there is an active 10 diagnostic code.

  Repair: Replace the suspect sensor.

  Verify that the problem is resolved.

  STOP.

- No – The voltage measurement is not 5.0 ± 0.2 VDC. The 5 volt supply is not present at the harness connector. There is a problem with the wiring or with the ECM. Proceed to Test Step 6.

Test Step 5. Disconnect the +5 V Pressure Sensors and Check for Active Diagnostic Codes

A. Disconnect the following sensors one at a time:

- Injection actuation pressure sensor J500/P500
- Boost pressure sensor J200/P200
- Atmospheric pressure sensor J203/P203
- Fuel pressure sensor J209/P209
- Engine oil pressure sensor J201/P201
- Auxiliary pressure sensor J220/P220 (if equipped)

B. Wait for 15 seconds after you disconnect each sensor. Look for the active 262-04 code to deactivate.

Expected Result:

The 262-04 diagnostic code deactivates when a particular sensor is disconnected.

Results:

- OK – The 262-04 diagnostic code deactivates when a particular sensor is disconnected.

  Repair: Connect the suspect sensor. If the code returns, replace the sensor.

  Connect all of the connectors. Verify that the problem is resolved.

  STOP.

- Not OK – The 262-04 diagnostic code remains after all of the sensors are disconnected. Leave the sensors disconnected. Proceed to Test Step 6.

Test Step 6. Check the +5 V Supply Wire for a Short to Engine Ground or a Short Circuit

A. Turn the keyswitch to the OFF position.

B. Disconnect the J2/P2 ECM connector. Disconnect the J1/P1 ECM connector.

C. Verify that all of the pressure sensors are disconnected.

Note: Wiggle the harness during the following measurements in order to reveal an intermittent condition.

D. Measure the resistance between terminal P2-72 (+5 V Supply) and all of the other terminals on the P2 connector.

E. Measure the resistance between terminal P2-72 and the engine ground.

F. Measure the resistance between terminal P2-80 (+5 V Supply) and all of the other terminals on the P2 connector.

G. Measure the resistance between terminal P2-80 and the engine ground.

H. Measure the resistance between terminal P1-2 (+5 V Supply) and all of the remaining terminals on the P1 connector.

a. Measure the resistance between terminal P1-2 and the engine ground.

Expected Result:

Each resistance measurement indicates an open circuit.

Results:

- OK – Each resistance measurement indicates an open circuit. Proceed to Test Step 7.
- Not OK – At least one of the resistance measurements does not indicate an open circuit. A +5 V supply wire has a problem. There may be a problem with a connector.

  Repair: Repair the wire and/or the connector, when possible. Replace parts, if necessary. Verify that the problem is resolved.

  STOP.

Test Step 7. Check the +5 V Supply and the Sensor Common for an Open Circuit

A. Install a wire jumper between terminals P2-72 (+5 V Supply) and P2-3 (Sensor Common).

B. Install a wire jumper between terminals P1-2 (+5 V Supply) and P1-3 (Sensor Common).

Note: Wiggle the harness during the following measurements in order to reveal any intermittent short condition.

C. Measure the resistance between terminals A and B at the harness connector for each pressure sensor.

Expected Result:

Each resistance measurement is less than ten Ohms.

Results:

- OK – Each measurement is less than ten Ohms. Proceed to Test Step 8.
- Not OK – At least one resistance measurement is greater than ten Ohms. The +5 V supply wire or the return wire has excessive resistance. There may be a problem in a connector.

  Repair: Repair the wire and/or the connector, when possible. Replace parts, if necessary. Verify that the problem is resolved.

  STOP.

Test Step 8. Check the +5 V Supply at the ECM

A. Remove terminal 72 (+5 V Supply) from the P2 connector. Install a wire jumper with socket terminals on both ends into P2-72.

B. Connect ECM connectors J2/P2.

C. Remove terminal 2 (+5 V Supply) from the P1 connector. Install a wire jumper with socket terminals on both ends into P1-2.

D. Connect ECM connectors J1/P1.

E. Turn the keyswitch to the ON position.

F. Measure the voltage between the wire jumper in P1-2 and the engine ground.

G. Measure the voltage between the wire jumper in P2-2 and the engine ground.

H. Turn the keyswitch to the OFF position.

I. Restore both wires to the original configuration.

Expected Result:

Both voltage measurements are 5.0 ± 0.2 VDC.

Results:

- OK – Both voltage measurements are 5.0 ± 0.2 VDC.

  Repair: Clear all diagnostic codes. Check for active diagnostic codes. If the problem is intermittent, refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

- Not OK – At least one voltage measurement is not 5.0 ± 0.2 VDC.

  Repair: Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”.

  STOP.

i02289818

Air Shutoff System - Test

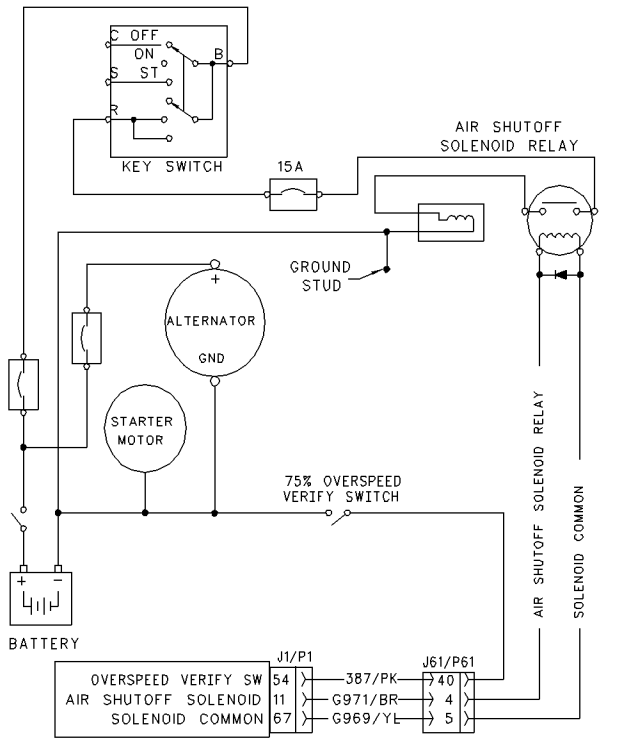
SMCS Code: 1078-038

System Operation Description:

The Electronic Control Module (ECM) has the ability to stop the engine by shutting off the inlet air supply in an emergency situation. The ECM activates a relay which energizes the air shutoff solenoid. The solenoid trips the air shutoff valve.

There are two conditions which can cause the ECM to activate the air shutoff relay. The first condition occurs when the ECM detects an engine overspeed. The relay will be energized until the ECM detects an engine speed of 0 rpm. The second condition occurs when a test of the air shutoff relay is made. The overspeed verify switch is activated. When the engine speed reaches 75 percent of the programmed overspeed setpoint, the ECM will activate the air shutoff relay. Again, this is used for testing purposes.

The air shutoff valve must be manually reset to the OPEN position.



g00743757

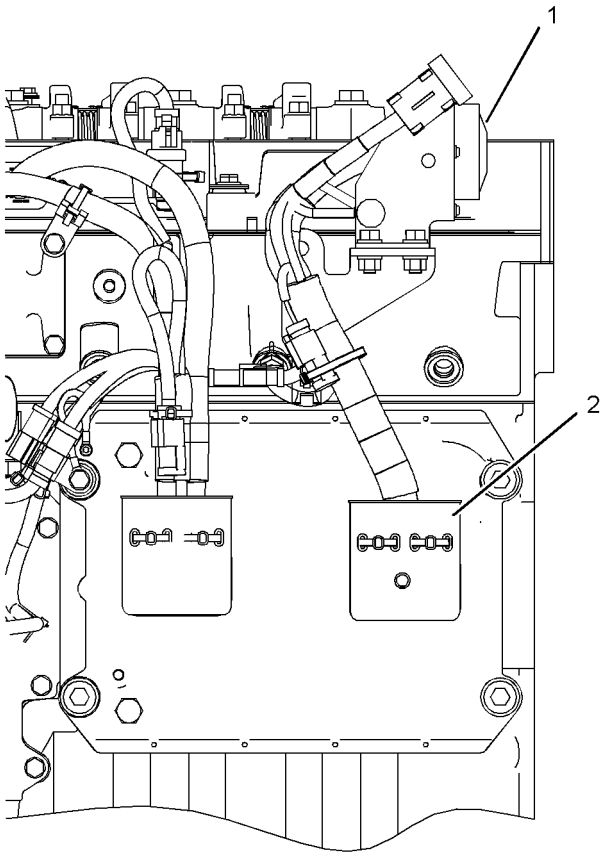
Illustration 19

Schematic for the air shutoff system

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Turn the keyswitch to the OFF position.

B. Verify that the air shutoff valves are set to the Open position.



g01121151

Illustration 20

Left side view

(1) P61 customer connector
(2) J1/P1 ECM connectors

C. Thoroughly inspect connectors (1) and (2). Refer to Troubleshooting, “Electrical Connectors - Inspect”.

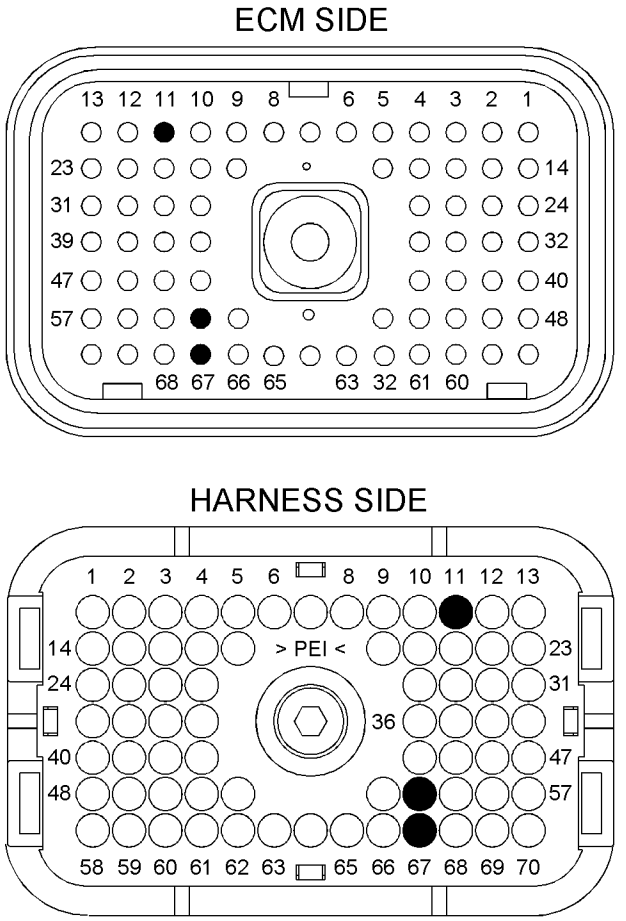


Illustration 21 g01102047

P1 terminals that are associated with the air shutoff system

(P1-11) Air shutoff solenoid
(P1-54) Overspeed verify switch
(P1-67) Solenoid common

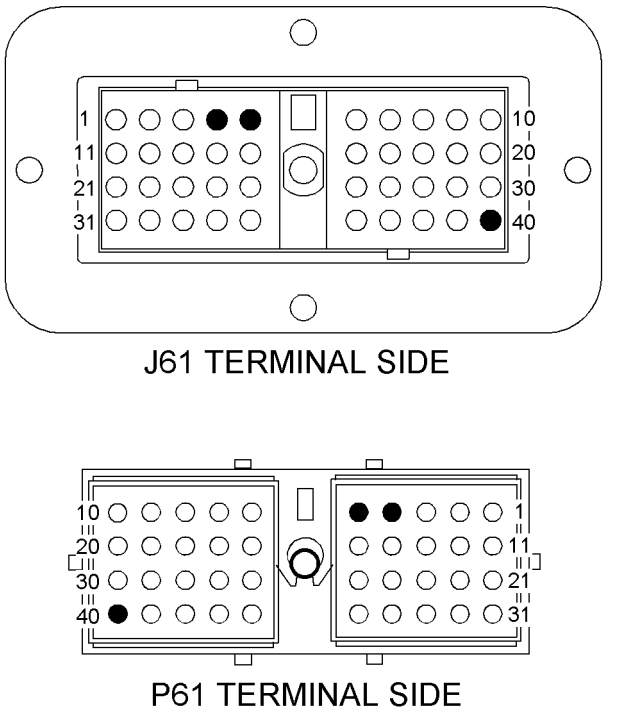


Illustration 22 g01123348

J61/P61 terminals that are associated with the air shutoff system

(4) Air shutoff solenoid
(5) Solenoid common
(40) Overspeed verify switch

D. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit for the air shutoff system.

E. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

F. Check the allen head screw on the customer connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque value.

G. Check the harness and the wiring for abrasion and for pinch points from the air shutoff solenoid to the ECM.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted, and the harness and wiring are free of corrosion, of abrasion and of pinch points.

Results:

- OK – The connectors and wiring are OK. Proceed to Test Step 2.
- Not OK – The connectors and/or wiring are not OK.

  Repair: Repair the wiring and/or the connectors. Replace parts, if necessary. Ensure that all of the seals are properly connected. Verify that the problem is resolved.

  STOP.

Test Step 2. Test for Voltage from the Normally Open Contacts of the Air Shutoff Relay

A. Turn the keyswitch to the OFF position.

B. Remove the wire from the normally open contacts of the air shutoff relay that goes to the air shutoff solenoid.

C. Connect a test lamp between the normally open contact of the air shutoff relay and engine ground.

D. Start the engine.

E. Activate the overspeed verify switch.

F. Monitor the test lamp while you increase the engine speed past 75 percent of the programmed overspeed setpoint.

G. Turn the keyswitch to the OFF position.

H. Disconnect the test lamp's leads. Connect the wire to the normally open contact.

Expected Result:

The test lamp illuminated when the engine speed increased past 75 percent of the programmed overspeed setpoint.

Results:

- OK – The test lamp illuminated. The air shutoff relay is operating correctly. Proceed to Test Step 3.
- Not OK – The test lamp did not illuminate. Proceed to Test Step 4.

Test Step 3. Test for Voltage at the Air Shutoff Solenoid

A. Turn the keyswitch to the OFF position.

B. Disconnect the wires that are connected to the coil of the air shutoff solenoid.

C. Connect a test lamp between the wire from the normally open contact of the air shutoff relay and engine ground.

D. Start the engine.

E. Activate the overspeed verify switch.

F. Monitor the test lamp while you increase the engine speed past 75 percent of the programmed overspeed setpoint.

Expected Result:

The test lamp illuminated when the engine speed increased past 75 percent of the programmed overspeed setpoint.

Results:

- OK – The test lamp illuminated. The voltage is present at the air shutoff solenoid.

  Repair: Verify the continuity of the wire from the air shutoff solenoid to the negative battery before proceeding. Replace the air shutoff solenoid. Verify that the problem is resolved.

  STOP.

- Not OK – The test lamp did not illuminate. System voltage was not present at the air shutoff solenoid. There is a problem in the wiring between the air shutoff solenoid and the air shutoff relay. There may be a problem with a connector.

  Repair: Repair the wiring and/or the connector. Replace parts, if necessary. Verify that the problem is resolved.

  STOP.

Test Step 4. Test for Voltage at the Coil of the Air Shutoff Relay

A. Turn the keyswitch to the OFF position.

B. Disconnect the wire that carries the drive signal from the ECM to the air shutoff relay. Disconnect the wire at the coil of the air shutoff relay.

C. Connect the test lamp between the end of the wire and engine ground.

D. Start the engine.

E. Activate the overspeed verify switch.

F. Monitor the test lamp while you increase the engine speed past 75 percent of the programmed overspeed setpoint.

Expected Result:

The test lamp illuminated when the engine speed increased past 75 percent of the programmed overspeed setpoint.

Results:

- OK – The test lamp illuminated. Verify the continuity of the wire from the coil of the air shutoff relay to the ECM connector P1-67 before proceeding. Proceed to Test Step 6.
- Not OK – The test lamp did not illuminate. The voltage from the ECM was not present at the coil of the air shutoff relay. Proceed to Test Step 5.

Test Step 5. Short the Overspeed Verify Switch at the ECM

A. Turn the keyswitch to the OFF position.

B. Disconnect ECM connector P1.

C. Remove terminal P1-54 (overspeed verify switch).

D. Insert one end of a wire jumper into the socket for P1-54 (overspeed verify swtich). Connect the other end of the wire jumper to engine ground.

E. Remove terminal P1-11 (air shutoff solenoid).

F. Insert one end of the wire jumper into the socket for P1-11 (air shutoff solenoid).

G. Connect one lead of the test lamp to the other end of the jumper wire in P1-11 (air shutoff solenoid).

H. Connect the other lead of the test lamp to negative battery.

I. Start the engine.

J. Activate the overspeed verify switch.

K. Monitor the test lamp while you increase the engine speed past 75 percent of the programmed overspeed setpoint.

Expected Result:

The test lamp illuminated when the engine speed increased past 75 percent of the programmed overspeed setpoint.

Results:

- OK – The test lamp illuminated.

  Repair: Verify the continuity of the wire for the overspeed verify switch to the negative battery. Close the overspeed verify switch and measure the continuity from P1-54 to the negative battery. If the wire does not have continuity to the negative battery, repair the wire and/or replace the overspeed verify switch.

  If the wire for the overspeed verify switch has continuity to the negative battery, there is a problem in the wiring between P1-11 and the air shutoff relay. Repair the circuit connectors or wiring and/or replace the circuit connectors or wiring. Verify that the problem is resolved.

  STOP.

- Not OK – The test lamp did not illuminate.

  Repair: Perform the following procedure:

  1. Remove all jumpers and reconnect all terminals.
  2. Temporarily install a new ECM. Refer to Troubleshooting, “Replacing the ECM”.
  3. Check the system for active diagnostic codes.
  4. Perform this Test Step again.
  5. If the problem is resolved with the test ECM, reconnect the suspect ECM. Verify that the problem returns. If the problem returns with the suspect ECM, replace the ECM.
  6. Verify that the problem is resolved.

  STOP.

Test Step 6. Test the Diode for Current Flow in One Direction

Illustration 23 g00761537
Diode

A. Disconnect the wires from the air shutoff relay.

B. Remove the diode from the air shutoff relay.

C. Put the digital voltmeter (DVM) in “Diode Check”.

D. Refer to Illustration 23. Place the red lead of the DVM on the diode at location (A). Place the black lead of the DVM on the diode at location (B).

E. Measure the voltage drop across the diode.

Expected Result:

The voltage drop across the diode is less than one volt.

Results:

- OK – The voltage drop across the diode is less than one volt. Proceed to Test Step 7.
- Not OK – The voltage drop across the diode is greater than one volt.

  Repair: Replace the diode. Verify that the problem is resolved.

  STOP.

Test Step 7. Test the Diode for Current Flow in the Opposite Direction

A. Reverse the locations of the leads for the DVM.

B. Measure the voltage drop across the diode.

Expected Result:

The voltage drop across the diode is an OL.

Results:

- OK – The voltage drop across the diode is an OL. Proceed to Test Step 8.
- Not OK – The voltage drop across the diode is less than one volt.

  Repair: Replace the diode. Verify that the problem is resolved.

  STOP.

Test Step 8. Check the Voltage from the Keyswitch to the Normally Open Contacts of the Air Shutoff Relay

A. Turn the keyswitch to the OFF position.

B. Disconnect the wire to the normally open contacts of the air shutoff relay from the keyswitch.

C. Connect the test lamp between the wire and engine ground.

D. Turn the keyswitch to the ON position.

Expected Result:

The test lamp illuminates.

Results:

- OK – The test lamp illuminated.

  Repair: Replace the air shutoff relay. Verify that the problem is resolved.

  STOP.

- Not OK – The test lamp did not illuminate. Proceed to Test Step 9.

Test Step 9. Check the Voltage from the Keyswitch to the Air Shutoff Relay

A. Turn the keyswitch to the OFF position.

B. Remove the wire from terminal R of the keyswitch.

C. Turn the keyswitch to the ON position.

D. Measure the voltage between terminal B of the keyswitch and engine ground.

E. Measure the voltage between terminal R of the keyswitch and engine ground.

F. Turn the keyswitch to the OFF position.

Expected Result:

Voltage is present on terminal B and terminal R at the keyswitch.

Results:

- OK – Voltage is present on terminal B and terminal R at the keyswitch.

  Repair: If voltage is present on terminal R, repair the wire between the keyswitch and the air shutoff relay. Verify that the breaker is not tripped. Return all wiring to the original configuration. Verify that the problem is eliminated.

  STOP.

- Not OK – Voltage is not present on terminal B at the keyswitch.

  Repair: If voltage is not present on terminal B, repair the wire between the +Battery and the keyswitch. Verify that the breaker is not tripped. Verify that the battery disconnect switch is operating correctly. Check the battery's no-load voltage. Return all wiring to the original configuration. Verify that the problem is eliminated.

  STOP.

- Not OK – Voltage is not present on terminal R at the keyswitch.

  Repair: If voltage is present on terminal B of the keyswitch but not present on terminal R, replace the keyswitch. Return all wiring to the original configuration. Verify that the problem is eliminated.

  STOP.

i02289824

CAN Data Link Circuit - Test

SMCS Code: 1901-038

System Operation Description:

The CAN data link is used to communicate information between the Electronic Control Module (ECM) and other modules. Use this procedure to troubleshoot any suspect problems with the CAN data link.

This procedure covers the 247-09 diagnostic code. This procedure identifies the following problems:

- Faulty connectors
- Missing termination resistors
- Short circuits
- Open circuits
- Faulty J1939 display

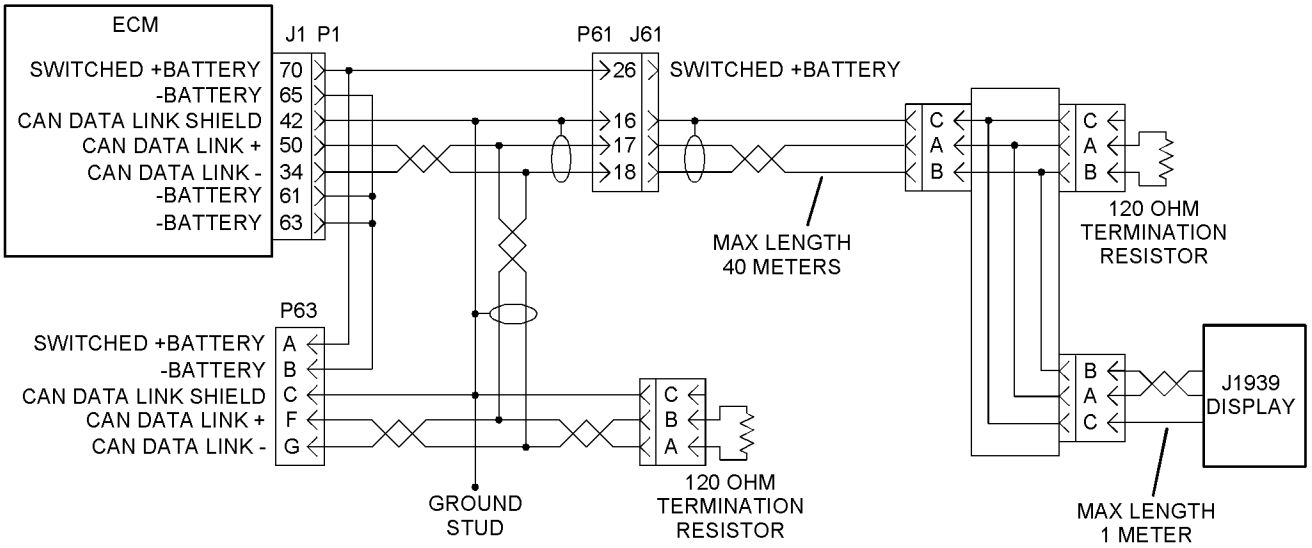


Illustration 24
g01119843

Schematic for the CAN data link

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Turn the keyswitch to the OFF position.

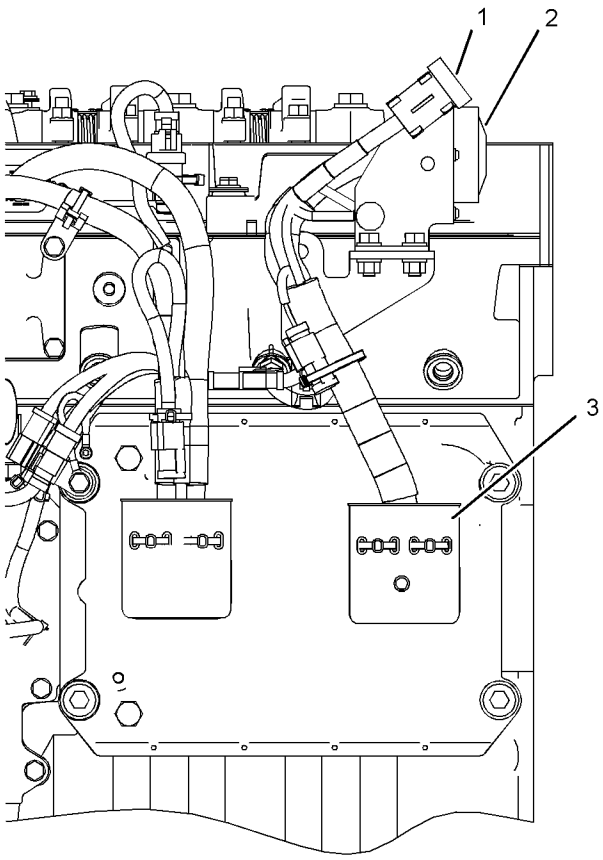


Illustration 25 g01121169

Engine components for the CAN data link

(1) P63 connector for the electronic service tool
(2) P61 customer connector
(3) J1/P1 connectors

B. Thoroughly inspect connectors (1), (2), and (3). Thoroughly inspect the connectors for each module that is connected to the CAN data link. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

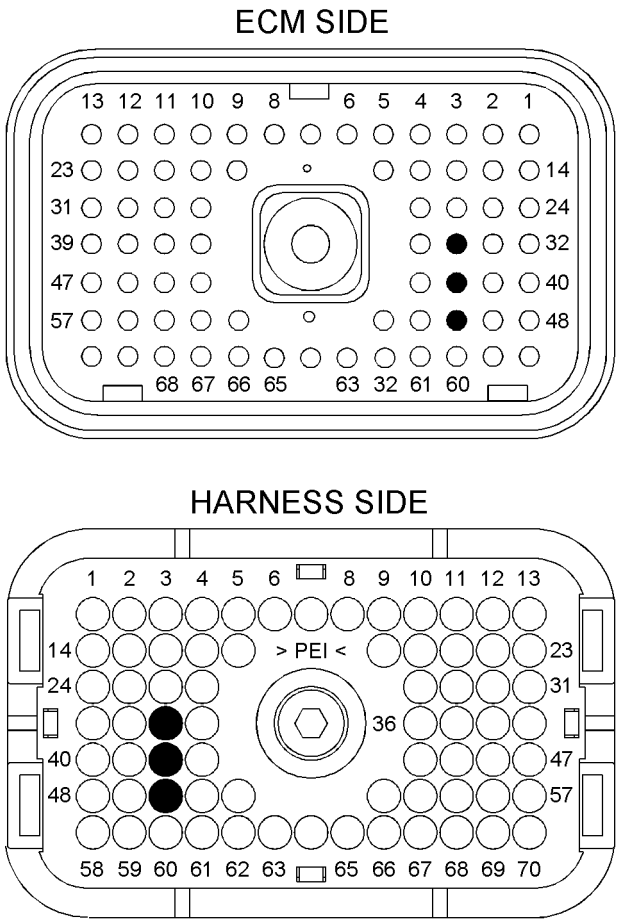
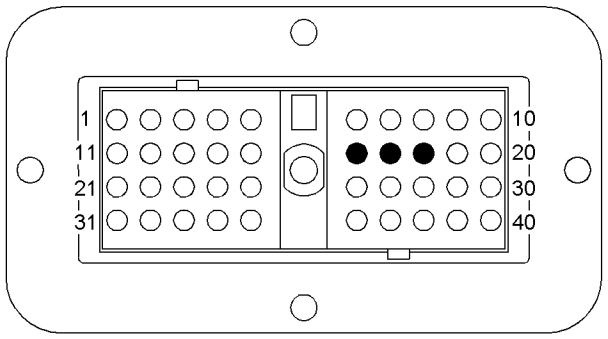


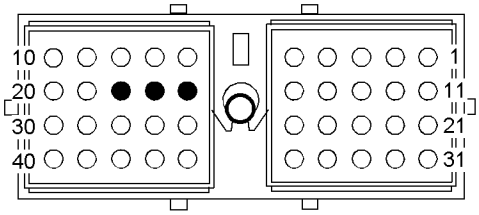
Illustration 26 g01102141

P1 terminals that are associated with the CAN data link

(P1-34) CAN data link −
(P1-42) CAN shield
(P1-50) CAN data link +



J61 TERMINAL SIDE



P61 TERMINAL SIDE

Illustration 27 g01123351

J61/P61 terminals that are associated with the CAN data link

(16) CAN shield
(17) CAN data link +
(18) CAN data link −

C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the CAN data link.

D. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the allen head screw on the customer connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque value.

F. Check the wiring harnesses for abrasion, for corrosion and for pinch points.

Expected Result:

All connectors, pins and sockets are completely coupled and/or inserted. The harness and wiring are free of corrosion, of abrasion and of pinch points.

Results:

- OK – The harness and the wiring appear to be OK. Proceed to Test Step 2.
- Not OK – There is a problem in the wiring harness.

  Repair: Repair the connectors and/or the wiring. Replace parts, if necessary. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled. Verify that the problem is resolved.

  STOP.

Test Step 2. Check for Active Diagnostic Codes

A. Connect the Caterpillar Electronic Technician (ET) to the service tool connector. Refer to Troubleshooting, “Electronic Service Tools”.

B. Turn the keyswitch to the ON position.

C. Observe the active diagnostic code screen on Cat ET. Wait at least 15 seconds so that any diagnostic codes may become active. Look for a 247-09 diagnostic code.

Expected Result:

No diagnostic codes are active.

Results:

- OK – No codes are active.

  Repair: The problem may be intermittent. If the problem is intermittent, refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

- Not OK **–** A 247-09 diagnostic code is active. Proceed to Test Step 3.

Test Step 3. Verify the Proper Installation of the CAN Data Link

A. Disconnect the J1939 display.

B. Disconnect the P1 connector and measure the resistance between terminals P1-50 (CAN data link +) and P1-34 (CAN data link -).

Expected Result:

The resistance is between 57 and 63 Ohms.

Results:

- OK – The resistance is between 57 and 63 Ohms. Proceed to Test Step 6.
- Not OK – The resistance is between 114 Ohms and 126 Ohms. A terminating resistor is missing.

Repair: Verify that two terminating resistors exist on the data link. One resistor must be located on each end of the data link. The engine is shipped with one terminating resistor that is installed between the ECM and the customer connector.

Refer to the appropriate electrical schematic in order to determine the missing resistor. Replace the missing resistor. Verify that the problem is resolved.

STOP.

- Not OK – The resistance is less than 57 Ohms. Proceed to Test Step 4.
- Not OK – The resistance is greater than 126 Ohms. Proceed to Test Step 5.

Test Step 4. Check for a Short Circuit

A. Disconnect the J1/P1 ECM connector.

B. Remove the terminating resistors from the CAN data link.

C. If a J1939 display is installed, disconnect the display.

D. Measure the resistance between the points that are listed in Table 16. Be sure to wiggle the wires in the harnesses as you make each resistance measurement.

Table 16

Resistance Measurements for the CAN Data Link	
Connector and Terminal	**Terminal**
P1-50 (CAN data link +)	All of the other terminals on the P1 connector
	Engine ground
P1-34 (CAN data link -)	All of the other terminals on the P1 connector
	Engine ground

Expected Result:

Each check of the resistance indicates an open circuit.

Results:

- OK – Each check of the resistance indicates an open circuit. Proceed to Test Step 5.
- Not OK – At least one check of the resistance does not indicate an open circuit. There is a short circuit in a harness. There may be a problem with a connector.

Repair: Repair the wiring and/or the connector. Replace part, if necessary. Verify that the problem is resolved.

STOP.

Test Step 5. Check for an Open Circuit

A. Verify that all of the connections are disconnected.

B. Fabricate a jumper wire. Use the jumper wire in order to create a short circuit between terminals G and F on the service tool connector.

C. Measure the resistance between terminals P1-50 (CAN data link +) and P1-34 (CAN data link -).

D. Remove the jumper wire from the service tool connector.

Expected Result:

The resistance is less than ten Ohms.

Results:

- OK – The resistance is less than ten Ohms. There is not an open circuit. Proceed to Test Step 6.
- Not OK – The resistance is more than ten Ohms. There is an open circuit or excessive resistance in the circuit. There may be a problem in a connector.

  Repair: Repair the wiring and/or the connector. Replace part, if necessary. Verify that the problem is resolved.

  STOP.

Test Step 6. Check the J1939 Display

A. Connect the J1939 display to another engine.

B. Operate the engine and monitor the J1939 display.

Expected Result:

The J1939 display operates properly.

Results:

- OK – The J1939 display operates properly on another engine.

  Repair: Connect the display to the original engine. If the display operates correctly, there may be a problem with an electrical connector. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

  If the display does not operate correctly on the original engine, there may be a problem with the ECM.

It is unlikely that the ECM has failed. Perform this entire procedure again. Replace the ECM if the display does not operate correctly. Refer to Troubleshooting, “Replacing the ECM”.

STOP.

- Not OK – The J1939 display does not operate properly on another engine.

  Repair: Replace the J1939 display. Verify that the problem is resolved.

  STOP.

i02289831

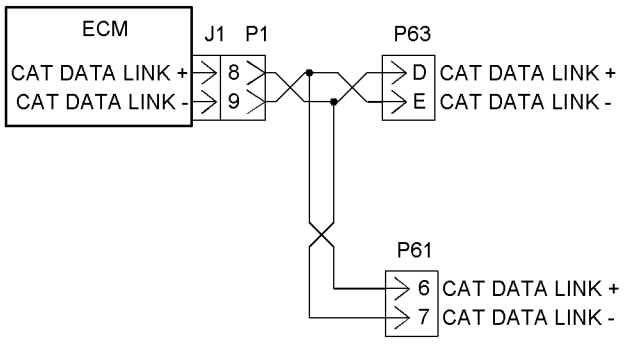
Cat Data Link Circuit - Test

SMCS Code: 1901-038

System Operation Description:

Note: This procedure checks for an open circuit or a short circuit in the Cat Data Link. If you are experiencing problems with communications between the Caterpillar Electronic Technician (ET) and the Electronic Control Module (ECM), refer to Troubleshooting, “Electronic Service Tool Will Not Communicate with ECM” before you use this procedure.

The Cat Data Link is the standard data link that is used by the ECM to communicate with Cat ET. The ECM communicates with Cat ET in order to share status information and diagnostic information. Cat ET can also be used to configure the ECM parameters. This information will not be available if communication fails between the ECM and Cat ET.



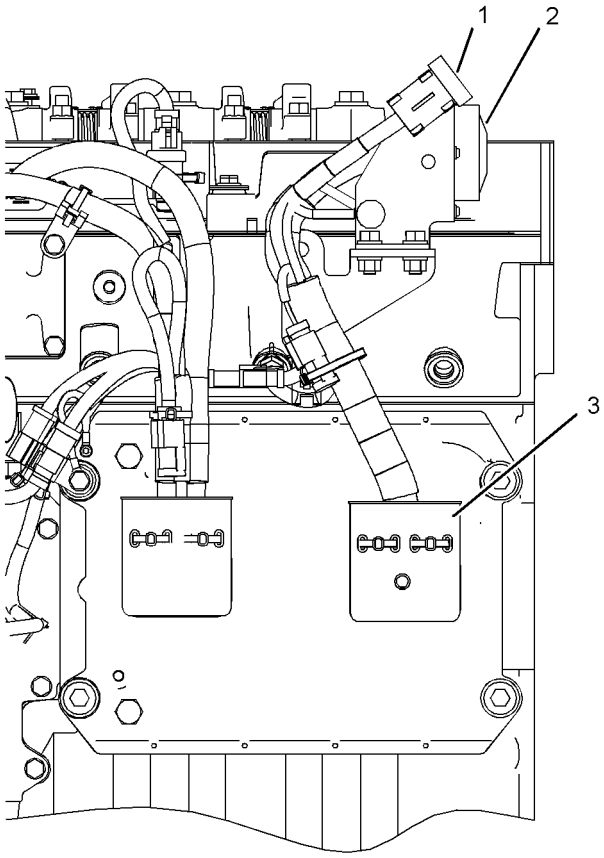
g01119836

Illustration 28

Schematic diagram of the Cat Data Link

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Turn the keyswitch to the OFF position.



g01121169

Illustration 29

Engine components for the Cat Data Link

(1) P63 connector for the electronic service tool
(2) P61 customer connector
(3) J1/P1 connectors

B. Thoroughly inspect connectors (1), (2), and (3). Refer to Troubleshooting, “Electrical Connectors - Inspect”.

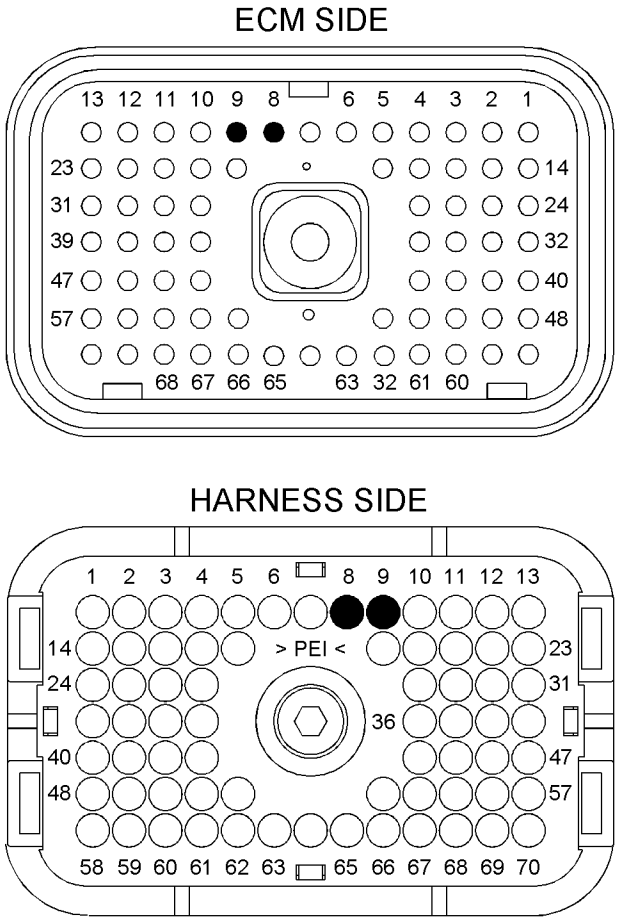


Illustration 30 g01104274

P1 terminals that are associated with the Cat Data Link

(P1-8) Cat Data Link +
(P1-9) Cat Data Link −

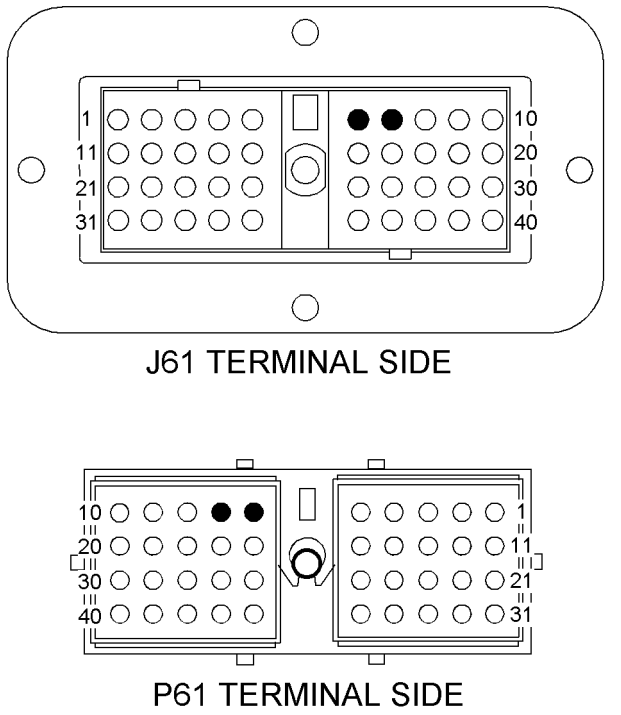


Illustration 31 g01119122

J61 and P61 terminals that are associated with the Cat Data Link

(6) Cat Data Link −
(7) Cat Data Link +

C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the Cat Data Link.

D. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the allen head screw on the customer connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque value.

Expected Result:

All connectors, pins, and sockets are completely inserted and coupled. The harness and wiring are free of corrosion, of abrasion, and of pinch points.

Results:

- OK **–** The harness and the connectors appear to be OK. Proceed to Test Step 2.
- Not OK – The connectors and/or the wiring are not OK.

Repair: Repair the connectors and/or the wiring. Replace parts, if necessary. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled. Verify that the original problem is resolved.

STOP.

Test Step 2. Check for a Short Circuit

A. Disconnect the J1 connector.

B. Disconnect Cat ET from the service tool connector.

C. Measure the resistance between the points that are listed in Table 17. Be sure to wiggle the wires in the harnesses as you make each resistance measurement.

Table 17

Resistance Measurements for the Cat Data Link	
Connector and Terminal	**Terminal**
P1-8 (Cat Data Link +)	All of the other terminals on the P1 connector
	Ground stud
P1-9 (Cat Data Link -)	All of the other terminals on the P1 connector
	Ground stud

Expected Result:

Each check of the resistance indicates an open circuit.

Results:

- OK **–** Each check of the resistance indicates an open circuit. Proceed to Test Step 3.
- Not OK – At least one check of the resistance does not indicate an open circuit. There is a short circuit in the harness or in a connector.

  Repair: Repair the connectors and/or the wiring. Replace parts, if necessary. Verify that the original problem is resolved.

  STOP.

Test Step 3. Check for an Open Circuit

A. Fabricate a jumper wire. Use the jumper wire in order to create a short circuit between terminals J63-D (Cat Data Link +) and J63-E (Cat Data Link −).

B. Measure the resistance between P1-8 (Cat Data Link +) and P1-9 (Cat Data Link −).

Expected Result:

Each check of the resistance is less than ten Ohms.

Results:

- OK – Each check of the resistance is less than ten Ohms.

  Repair: Perform the following procedure:

  1. Connect the J1/P1 connectors. Connect Cat ET to the service tool connector.
  2. Check the Cat Data Link for proper operation. If the Data Link does not operate correctly, there may be a problem with the ECM.

     Temporarily install a new ECM. Check the Cat Data Link again. If the new ECM solves the problem, install the original ECM and verify that the original problem returns. If the new ECM operates correctly and the original ECM does not operate correctly, replace the original ECM. Verify that the problem is resolved.

  STOP.

- Not OK – At least one check of the resistance is greater than ten Ohms. There is an open circuit or excessive resistance in the harness. There may be a problem with a connector.

  Repair: Repair the wiring and/or the connectors. Replace parts, if necessary. Verify that the original problem is resolved.

  STOP.

i02289833

Coolant Level Sensor Circuit - Test

SMCS Code: 5574-038-CLT

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the engine coolant level sensor.

The engine coolant level sensor provides a means of monitoring the engine coolant level in order to warn the operator in the event that the coolant level is low. The engine coolant level sensor is usually located in the top tank of the radiator. The sensor should be immersed in coolant at all times.

When the sensor is immersed in coolant, an internal switch is closed. When the internal switch closes, the signal for the engine coolant level is grounded through the sensor return. The Electronic Control Module (ECM) detects the ground on the input for the engine coolant level. If the signal is not present, an event code is generated.

Verify that the coolant level has been programmed to “Enabled” on the configuration screen on the Caterpillar Electronic Technician (ET). If the coolant level is not programmed, Cat ET will display “Unavailable” for the parameter.

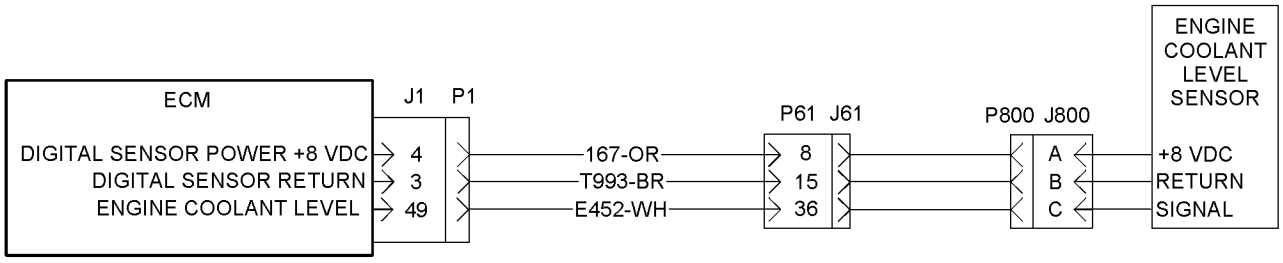


Illustration 32 g01119821

Schematic of the engine coolant level sensor

Test Step 1. Check the Coolant Level

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

A. Stop the engine. Allow the engine to cool.

B. Check the coolant level. Refer to the engine’s Operation and Maintenance Manual for the proper procedure.

Expected Result:

The coolant level is low.

Results:

- OK – The coolant level is low.

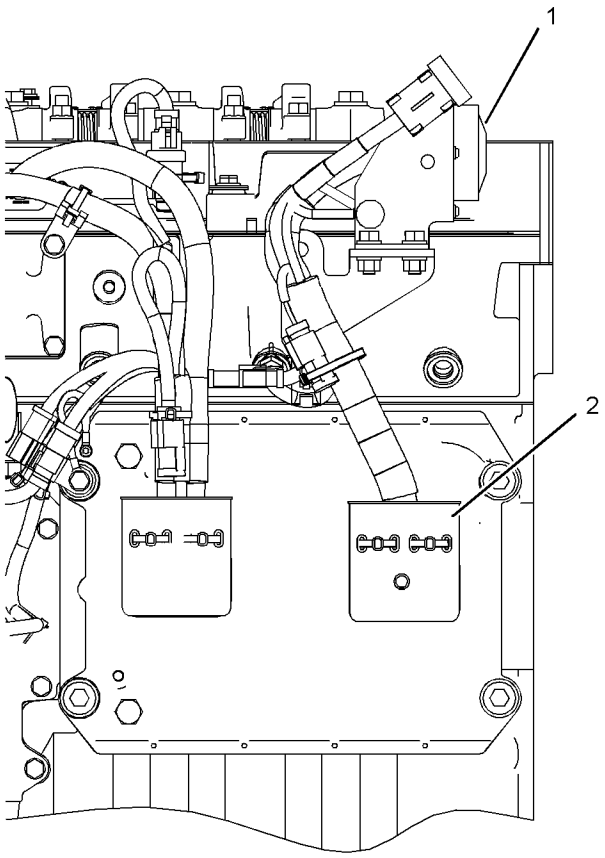
  Repair: Add coolant according to the procedure in the Operation and Maintenance Manual. Identify the source of the coolant leak and fix the problem. Verify that the original problem is resolved.

  STOP.

- Not OK – The coolant is at the proper level. Proceed to Test Step 2.

Test Step 2. Inspect the Electrical Connectors and the Wiring

A. Turn the keyswitch to the OFF position.

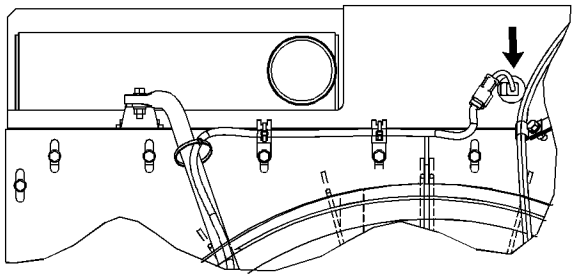


g01121173

Illustration 33

Engine components for the engine coolant level sensor

(1) P61 customer connector
(2) J1/P1 connectors

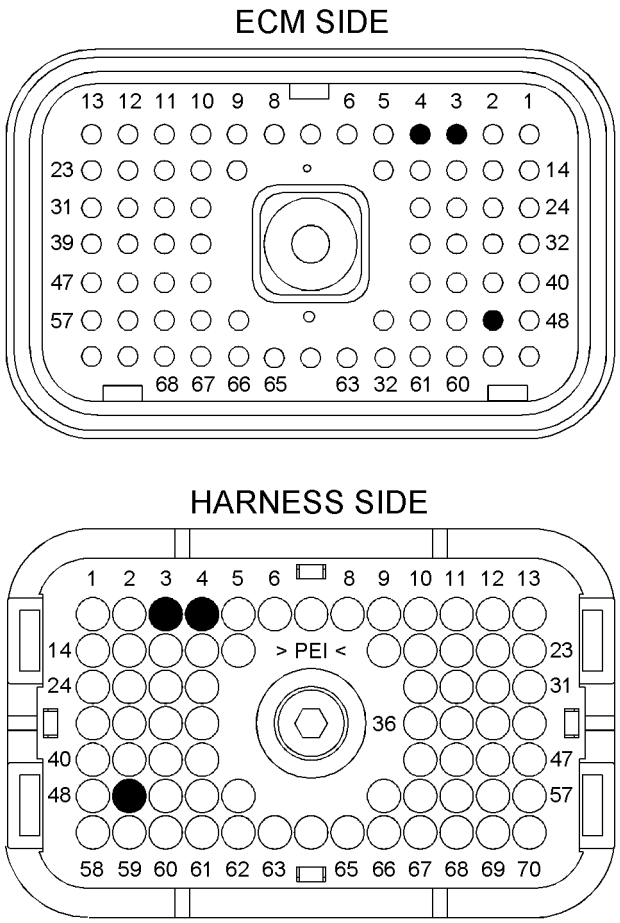


g01119186

Illustration 34

Rear view of a typical radiator with a engine coolant level sensor

B. Thoroughly inspect connectors (1) and (2). Inspect the J800/P800 connectors for the engine coolant level sensor. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

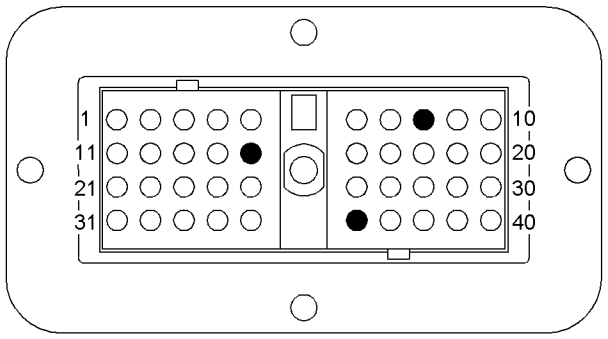


g01102181

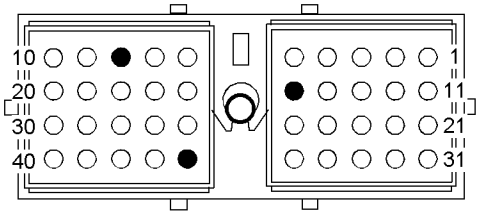
Illustration 35

P1 terminals that are associated with the engine coolant level sensor

(P1-3) Return
(P1-4) +8 VDC (digital sensor supply)
(P1-49) Engine coolant level



J61 TERMINAL SIDE



P61 TERMINAL SIDE

Illustration 36 g01119200

J61 and P61 terminals that are associated with the engine coolant level sensor

(8) +8 VDC (digital sensor supply)
(15) Return
(36) Engine coolant level

C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector, the customer connector, and the sensor connector that is associated with the circuit for the engine coolant level sensor.

D. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the allen head screw on the customer connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque value.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted, and the harness and wiring are free of corrosion, of abrasion, and of pinch points.

Results:

- OK – The connectors and wiring are OK. Proceed to Test Step 3.
- Not OK – There is a problem with the connectors and/or the wiring.

Repair: Repair the wiring and/or the connectors. Replace parts, if necessary. Ensure that all of the seals are properly connected. Verify that the original problem is resolved.

STOP.

Test Step 3. Short the Harness and Monitor the Status of the “Coolant Level”

A. Connect Cat ET to the service tool connector. Refer to Troubleshooting, “Electronic Service Tools”.

B. Disconnect the J800/P800 connectors for the engine coolant level sensor.

C. Install a jumper wire between P800-B (Digital Sensor Return) and P800-C (Coolant Level Sensor).

D. Turn the keyswitch to the ON position.

E. Monitor the status of “Coolant Level” on Cat ET while the jumper wire is installed.

F. Turn the keyswitch to the OFF position.

G. Remove the jumper wire.

H. Connect the J800/P800 connectors.

Expected Result:

The status of the “Coolant Level” is “OK” when the jumper wire is installed.

Results:

- OK – The status of the “Coolant Level” is “OK” when the jumper wire is installed. The ECM, the signal wire, and the return wire are OK. Proceed to Test Step 4.
- Not OK – The status of the “Coolant Level” is not “OK” when the jumper wire is installed. Proceed to Test Step 5.

Test Step 4. Check the Supply Voltage at the Sensor Connector

A. Disconnect the J800/P800 connectors.

B. Turn the keyswitch to the ON position.

C. Measure the voltage between terminals P800-A (+8 VDC digital sensor supply) and P800-B (Return) at the harness connector for the engine coolant level sensor.

D. Turn the keyswitch to the OFF position.

Expected Result:

The voltage between terminals A (+8 V digital supply) and B (sensor return) is 8.0 ± 0.4 VDC.

Results:

- OK – The supply voltage is reaching the sensor.

  Repair: Replace the engine coolant level sensor. Verify that the original problem is resolved.

  STOP.

- Not OK – The supply voltage is not reaching the sensor.

  Repair: Refer to Troubleshooting, “Digital Sensor Supply Circuit - Test” for the appropriate troubleshooting procedure.

  STOP.

Test Step 5. Create a Short Circuit at the ECM P1 Connector

A. Remove terminals P1-3 and P1-49. Install a jumper wire into open terminals P1-3 and P1-49.

B. Turn the keyswitch to the ON position and monitor the status of “Coolant Level” on Cat ET while the jumper wire is installed.

C. Remove the jumper wire. Monitor the status of “Coolant Level” on Cat ET.

D. Turn the keyswitch to the OFF position.

Expected Result:

The status of the switch is “OK” when the jumper wire is connected. The status of the switch is “Low” when the jumper wire is not connected.

Results:

- OK – The status of the switch is “OK” when the jumper wire is connected. The status of the switch is “Low” when the jumper wire is not connected. The ECM is properly reading the switch input. However, the ECM did not detect the jumper wire at the sensor connector. There is a problem with the wiring. There may be a problem with a connector.

  Repair: Repair the wiring and/or the connector. Replace parts, if necessary. Verify that the original problem is resolved.

  STOP.

- Not OK – The ECM is not reading the switch input.

  Repair: Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”. Verify that the original problem is resolved.

  STOP.

i02289836

Diagnostic Lamp Circuit - Test

SMCS Code: 7431-038-NQ

System Operation Description:

The diagnostic lamp is used to inform the operator of active diagnostic codes and active event codes.

The Electronic Control Module (ECM) provides a path to ground for the diagnostic lamp. When the ECM connects the diagnostic lamp to ground the diagnostic lamp will turn on.

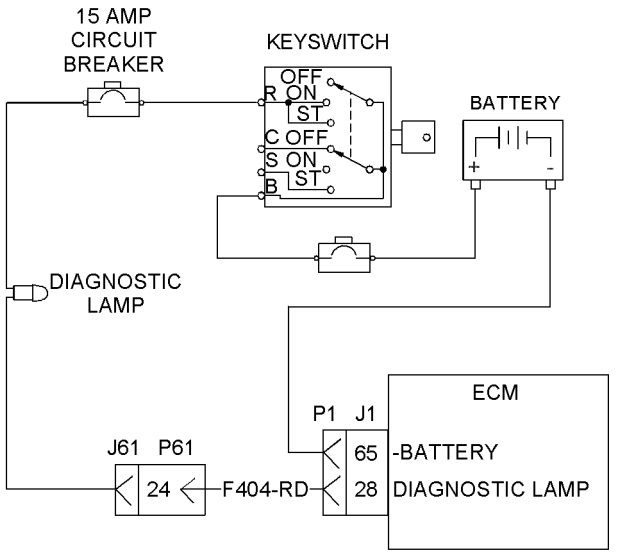


Illustration 37 g01123371

Schematic for the diagnostic lamp

Test Step 1. Check the Operation of the Diagnostic Lamp

A. Turn the keyswitch to the ON position.

B. Monitor the diagnostic lamp.

Expected Result:

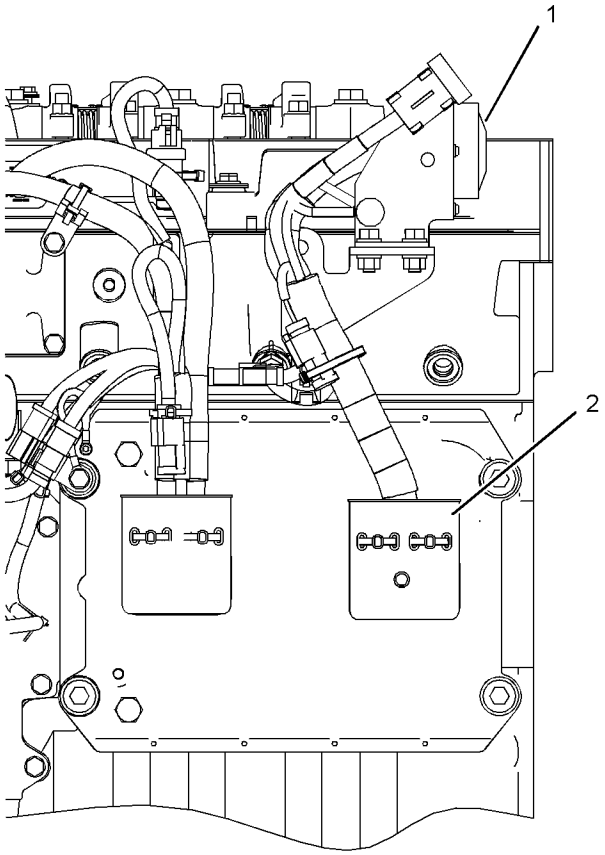
The diagnostic lamp turns on for five seconds. Then, the diagnostic lamp turns off. If a diagnostic code is active, the diagnostic lamp will flash.

Results:

- Yes – The diagnostic lamp turns on for five seconds. Then, the diagnostic lamp turns off. The diagnostic lamp appears to be operating correctly at this time. STOP.
- No – The diagnostic lamp did not turn on for five seconds. Proceed to Test Step 2.

Test Step 2. Inspect the Electrical Connectors and the Wiring

A. Turn the keyswitch to the OFF position.



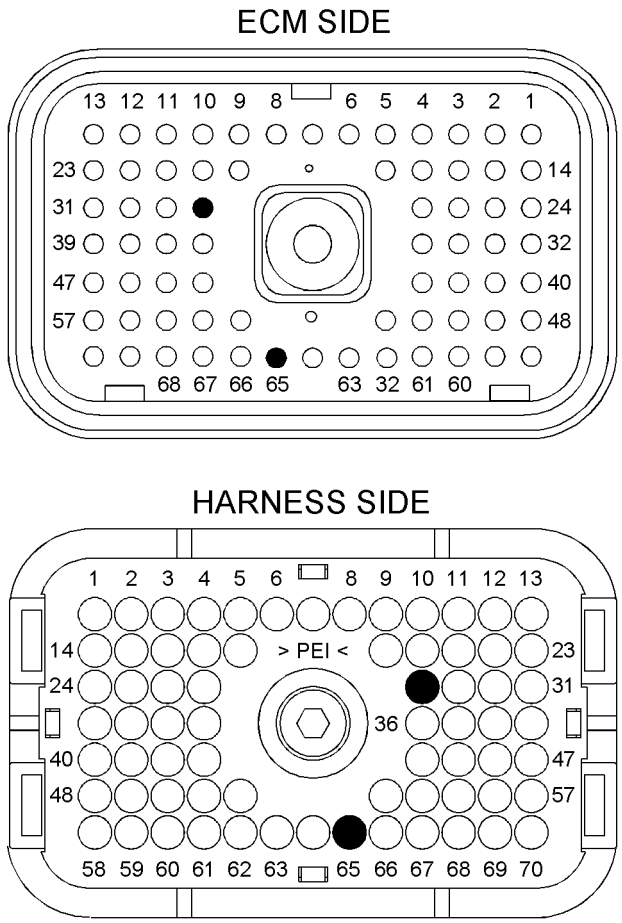
g01119456

Illustration 38

Left side view

(1) P61 customer connector
(2) J1/P1 ECM connectors

B. Thoroughly inspect connectors (1) and (2). Inspect the connections on the diagnostic lamp. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

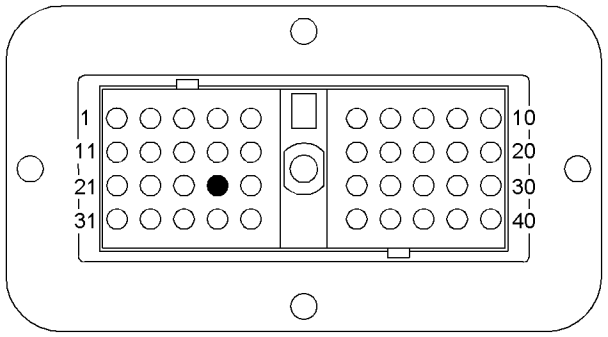


g01102224

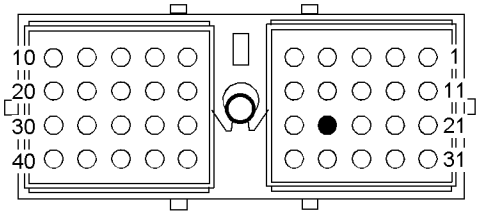
Illustration 39

P1 terminals that are associated with the diagnostic lamp

(P1-28) Diagnostic lamp
(P1-65) −Battery



J61 TERMINAL SIDE



P61 TERMINAL SIDE

Illustration 40 g01102219

J61 and P61 terminals that are associated with the diagnostic lamp

(24) Diagnostic lamp

C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the diagnostic lamp.

D. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the allen head screw on the customer connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque value.

F. Check the harness and wiring for abrasions and for pinch points from the diagnostic lamp to the ECM.

Expected Result:

All of the connectors, pins, and sockets are completely coupled and/or inserted, and the harness and wiring are free of corrosion, of abrasion or of pinch points.

Results:

- OK – The connectors and the wiring are OK. Proceed to Test Step 3.
- Not OK – There is a problem with a connector and/or the wiring.

  Repair: Repair the connector and/or the wiring. Replace parts, if necessary. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled. Verify that the problem is resolved.

  STOP.

Test Step 3. Test the Diagnostic Lamp Circuit at the ECM Connector

A. Disconnect the J1/P1 connectors.

B. Connect a jumper wire between terminal P1-28 and engine ground.

C. Turn the keyswitch to the ON position and observe the diagnostic lamp.

D. Remove the jumper wire and observe the diagnostic lamp.

Expected Result:

The diagnostic lamp turned on while the jumper wire was connected. The diagnostic lamp turned off when the jumper wire was removed.

Results:

- OK – The diagnostic lamp turned on while the jumper wire was connected. The diagnostic lamp turned off when the jumper wire was removed. The circuit for the diagnostic lamp is functioning properly. Proceed to Test Step 6.
- Not OK – The diagnostic lamp did not turn on. There is a problem with the circuit for the diagnostic lamp. Proceed to Test Step 4.

Test Step 4. Test the Diagnostic Lamp Circuit at the Diagnostic Lamp

A. Disconnect wire F404-RD from the diagnostic lamp.

B. Connect a jumper wire between the diagnostic lamp’s open terminal and engine ground.

C. Turn the keyswitch to the ON position and observe the diagnostic lamp.

D. Remove the jumper wire and observe the diagnostic lamp.

Expected Result:

The diagnostic lamp turned on while the jumper wire was connected. The diagnostic lamp turned off when the jumper wire was removed.

Results:

- OK – The diagnostic lamp turned on while the jumper wire was connected. The diagnostic lamp turned off when the jumper wire was removed. The +Battery side of the circuit for the diagnostic lamp is functioning properly. There is a problem with the return wire between the diagnostic lamp and the P1 connector.

  Repair: Repair wire F404-RD between the diagnostic lamp and P1-28. Verify that the problem is resolved.

  STOP.

- Not OK – The diagnostic lamp did not turn on when the jumper wire was connected. There is a problem with the +Battery side of the circuit for the diagnostic lamp. Proceed to Test Step 5.

Test Step 5. Check the Voltage from the Keyswitch to the Diagnostic Lamp

A. Turn the keyswitch to the OFF position.

B. Remove the wire from the terminal R of the keyswitch.

C. Turn the keyswitch to the ON position.

D. Measure the voltage on terminal B of the keyswitch to engine ground.

E. Measure the voltage on terminal R of the keyswitch to engine ground.

F. Turn the keyswitch to the OFF position.

Expected Result:

Voltage is present on terminal B and terminal R at the keyswitch.

Results:

- OK – Voltage is present on terminal B and terminal R at the keyswitch.

  Repair: If voltage is present on terminal R, repair the wire between the keyswitch and the diagnostic lamp. Verify that the breaker is not tripped. Return all wiring to the original configuration. Verify that the problem is resolved.

  STOP.

- Not OK – Voltage is not present on terminal B at the keyswitch.

  Repair: If voltage is not present on terminal B, repair the wire between the +Battery and the keyswitch. Check the battery's no-load voltage. Return all wiring to the original configuration. Verify that the problem is resolved.

  STOP.

- Not OK – Voltage is not present on terminal R at the keyswitch.

  Repair: If voltage is present on terminal B of the keyswitch but not present on terminal R, replace the keyswitch. Return all wiring to the original configuration. Verify that the problem is resolved.

  STOP.

Test Step 6. Check the Operation of the ECM

A. Remove terminal P1-28.

B. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.

C. Insert the jumper into P1-28.

D. Connect the J1/P1 connectors.

E. Connect one probe of a voltage test lamp to the jumper wire in P1-28.

F. Connect the other probe of the voltage test lamp to +Battery.

G. Turn the keyswitch to the ON position. Wait for ten seconds.

H. Turn the keyswitch to the OFF position.

Expected Result:

The test lamp turned ON for five seconds. Then, the test lamp turned OFF.

Results:

- OK – The test lamp turned ON for five seconds. Then, the test lamp turned OFF. The ECM is operating correctly. The problem appears to be resolved.

  Repair: The problem may be intermittent. If the problem is intermittent, refer to the diagnostic functional test Troubleshooting, "Electrical Connectors - Inspect".

  STOP.

- Not OK – The test lamp did not turn on for five seconds. There is a problem with the ECM.

  Repair: Temporarily connect a test ECM. Refer to Troubleshooting, “Replacing the ECM”. Check the operation of the diagnostic lamp when the test ECM is installed.

  If the problem is resolved with the test ECM, connect the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the problem is resolved.

  STOP.

i02289838

Digital Sensor Supply Circuit - Test

SMCS Code: 5574-038

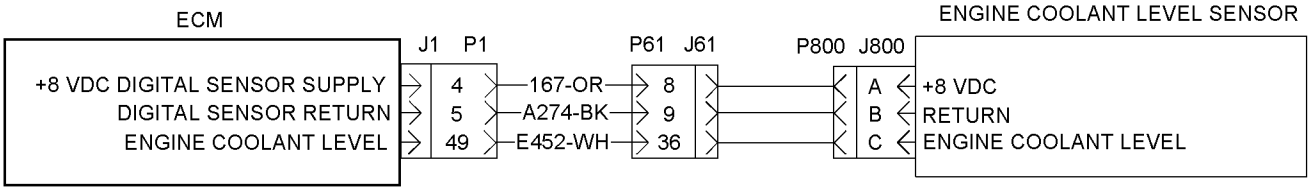
System Operation Description:

The Electronic Control Module (ECM) supplies a regulated voltage of 8.0 ± 0.4 VDC to terminal A of the engine coolant level sensor. This sensor is optional equipment.

This procedure covers the following diagnostic codes:

- 041-03
- 041-04

A +8 V diagnostic code is probably caused by a short circuit to ground or a short circuit to another voltage source in the harness. The next likely cause is a problem with a sensor. The least likely cause is a problem with the ECM.



g01146754

Illustration 41

Schematic for the digital sensor supply

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Turn the keyswitch to the OFF position.

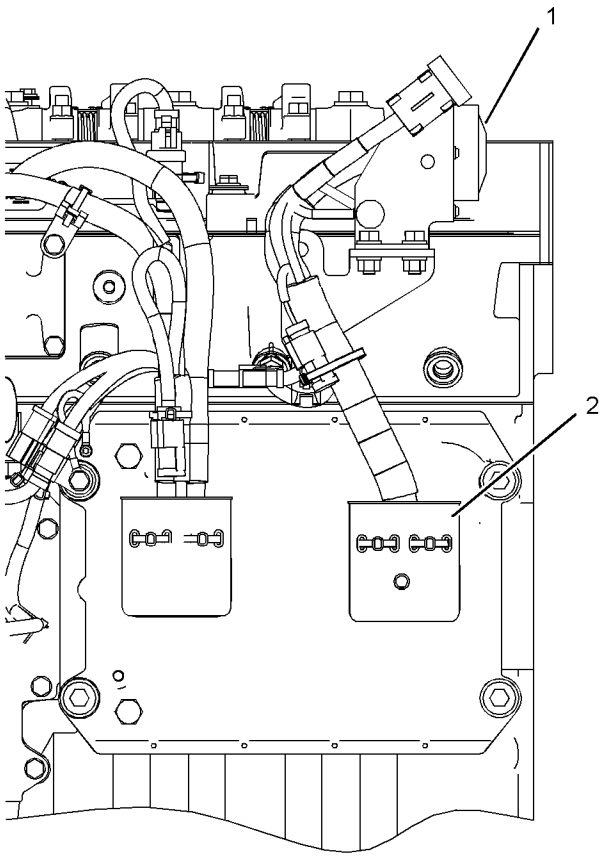


Illustration 42 g01121173

Left side view

(1) P61 customer connector
(2) J1/P1 ECM connectors

B. Thoroughly inspect connectors (1) and (2). Inspect the connectors for each digital sensor. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

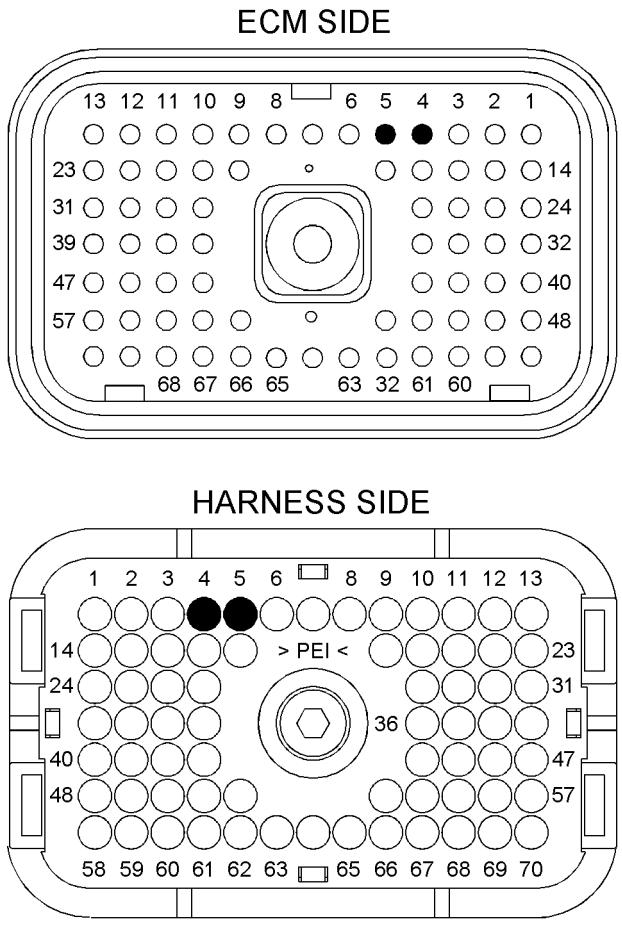
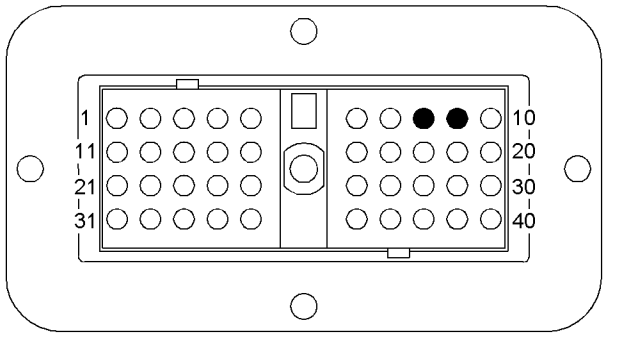


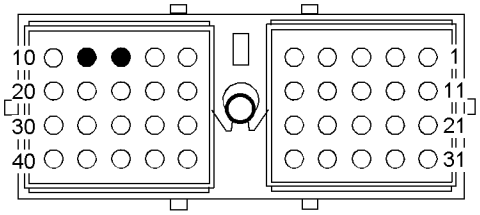
Illustration 43 g01119741

P1 ECM connector

(P1-4) +8 VDC (digital sensor supply)
(P1-5) Return



J61 TERMINAL SIDE



P61 TERMINAL SIDE

Illustration 44 g01119753

J61 and P61 customer connectors

(8) +8 VDC (digital sensor supply)
(9) Return

C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the digital sensor supply.

D. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the harness and wiring for abrasions and for pinch points from the battery to the ECM.

Expected Result:

All of the connectors, pins, and sockets are completely coupled and/or inserted, and the harness and wiring are free of corrosion, of abrasion or of pinch points.

Results:

- OK – The connectors and the wiring are OK. Proceed to Test Step 2.
- Not OK – There is a problem with a connector and/or the wiring.

  Repair: Repair the connector and/or the wiring. Replace parts, if necessary. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled. Verify that the problem is resolved.

  STOP.

Test Step 2. Check for Active Diagnostic Codes

A. Connect the Caterpillar Electronic Technician (ET) to the service tool connector. Refer to Troubleshooting, “Electronic Service Tools”.

B. Turn the keyswitch to the ON position.

C. Observe the active diagnostic code screen on Cat ET. Wait at least 15 seconds so that any codes may become active. Look for these codes:

- 041-03 8 Volt DC Supply short to +batt
- 041-04 8 Volt DC Supply short to ground

Expected Result:

One of the above diagnostic codes is active.

Results:

- Active 041-03 code – A 041-03 diagnostic code is active. Proceed to Test Step 3.
- Active 041-04 code – A 041-04 diagnostic code is active. Proceed to Test Step 4.
- No active codes – None of the above codes are active.

  Repair: If any of the above codes are logged and the engine is not running properly, refer to Troubleshooting, “Troubleshooting Without a Diagnostic Code”.

  If the engine is running properly at this time, there may be an intermittent problem in a harness that is causing the codes to be logged. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

Test Step 3. Check the Voltage on the +8 V Supply Wire

A. Turn the keyswitch to the OFF position.

B. Disconnect the harness connectors for the engine coolant level sensor J800/P800.

C. Turn the keyswitch to the ON position.

D. Measure the voltage between terminals A and B at the harness connector for the sensor.

Expected Result:

The voltage measurement is 8.0 ± 0.4 VDC.

Results:

- OK – The voltage measurement is 8.0 ± 0.4 VDC.

  Repair: Connect the sensor connectors. Clear all diagnostic codes. Check for active diagnostic codes. If the problem is intermittent, refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

- Not OK – The voltage measurement is not 8.0 ± 0.4 VDC. There is a problem with the wiring or with the ECM. Proceed to Test Step 5.

Test Step 4. Disconnect the +8 V Digital Sensor and Check for Active Diagnostic Codes

A. Disconnect the Engine coolant level sensor.

B. Wait for 15 seconds after you disconnect each sensor. Look for the active 041-04 diagnostic code to deactivate.

Expected Result:

The 041-04 diagnostic code deactivates when a particular sensor is disconnected.

Results:

- OK – The 041-04 diagnostic code deactivates when a particular sensor is disconnected.

  Repair: Connect the suspect sensor. If the diagnostic code returns, replace the sensor.

  Connect all of the connectors. Verify that the problem is resolved.

  STOP.

- Not OK – The 041-04 diagnostic code remains after all of the sensors are disconnected. Leave the sensors disconnected. Proceed to Test Step 5.

Test Step 5. Check the +8 V Supply Wire for a Short Circuit

A. Turn the keyswitch to the OFF position.

B. Disconnect the J1/P1 and J2/P2 connectors.

C. Verify that all of the digital sensors are disconnected.

Note: Wiggle the harness during the following measurements in order to reveal an intermittent condition.

D. Measure the resistance between P1-4 (+8 V supply) and the remaining terminals on the P1 and P2 connectors.

E. Measure the resistance between P1-4 (+8 VDC supply) and the engine ground.

Expected Result:

Each check of the resistance indicates an open circuit.

Results:

- OK – Each check of the resistance indicates an open circuit. Proceed to Test Step 6.

- Not OK – At least one check of the resistance does not indicate an open circuit. A +8 V supply wire has a problem. There may be a problem with a connector.

  Repair: Repair the wire and/or the connector, when possible. Replace parts, if necessary. Verify that the problem is resolved.

  STOP.

Test Step 6. Check the +8 V Supply and the Sensor Common for an Open Circuit

A. Install a jumper wire between terminals P1-4 (+8 V supply) and P1-5 (Return).

Note: Wiggle the harness during the following measurement in order to reveal any intermittent short condition.

B. Measure the resistance between terminals A and B at the harness connector for each digital sensor.

C. Remove the jumper wire.

Expected Result:

Each resistance measurement is less than ten Ohms.

Results:

- OK – Each resistance measurement is less than ten Ohms. Proceed to Test Step 7.

- Not OK – At least one resistance measurement is more than ten Ohms. A +8 V supply wire or a return wire has excessive resistance. There may be a problem with a connector.

Repair: Repair the wires and/or the connector, when possible. Replace parts, if necessary. Verify that the problem is resolved.

STOP.

Test Step 7. Check the +8 V Supply at the ECM

A. Remove terminal 4 from the P1 connector. Install a jumper wire with socket terminals on both ends into P1-4.

B. Remove terminal 5 from the P1 connector. Install a jumper wire with socket terminals on both ends into P1-5.

C. Connect the P1 connector.

D. Turn the keyswitch to the ON position.

E. Measure the voltage between the jumper wires in P1-4 and P1-5.

F. Turn the keyswitch to the OFF position.

G. Restore all wiring to the original configuration.

Expected Result:

The voltage measurement is 8.0 ± 0.4 VDC.

Results:

- OK – The voltage measurement is 8.0 ± 0.4 VDC.

  Repair: Clear all diagnostic codes. Check for active diagnostic codes. If the problem is intermittent, refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

- Not OK – The voltage measurement is not 8.0 ± 0.4 VDC.

  Repair: Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”.

  STOP.

i02289851

ECM/Personality Module - Test

SMCS Code: 1902-038

System Operation Description:

The Electronic Control Module (ECM) is the computer that controls the Caterpillar engine. The flash file contains the software that controls the operation of the ECM.

The flash file is the instructions that are used by the ECM to control the engine. For this reason, updating the flash file to a different version may affect some engine functions.

This procedure covers the following diagnostic codes:

- 253-02 Personality Module mismatch
- 268-02 Check Programmable Parameters

Also, use this procedure to troubleshoot the following conditions:

- The integrity of the customer parameters or the system parameters in the Electronic Control Module (ECM) is questionable.
- The data for the engine lifetime totals is questionable.

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Turn the keyswitch to the OFF position.

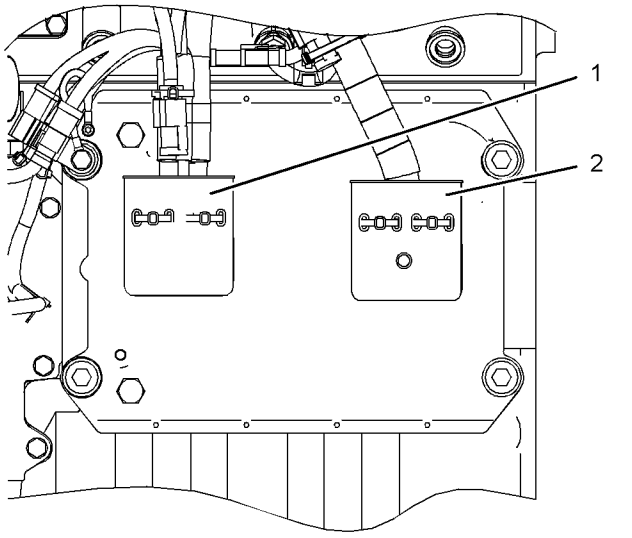


Illustration 45 g01120020

ECM

(1) J2/P2 connectors
(2) J1/P1 connectors

B. Thoroughly inspect connectors (1) and (2). Inspect the battery connections. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

C. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

D. Check the harnesses and the wiring for abrasion and for pinch points.

Expected Result:

All connectors, pins and sockets are completely coupled and/or inserted and the harnesses and wiring are free of corrosion, of abrasion or of pinch points.

Results:

- OK **–** The harnesses and the connectors appear to be OK. Proceed to Test Step 2.
- Not OK – The wiring and/or a connector are not OK.

  Repair: Repair the wiring and/or the connectors. Replace parts, if necessary. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled.

  Verify that the repair eliminates the problem.

  STOP.

Test Step 2. Check For Diagnostic Codes

A. Turn the keyswitch to the OFF position.

B. Connect the Caterpillar Electronic Technician (ET) to the service tool connector. Refer to Troubleshooting, “Electronic Service Tools”.

C. Turn the keyswitch to the ON position.

D. Observe the “Active Diagnostic” screen on Cat ET. Wait at least 15 seconds so that any codes may become active. Look for these codes:

- 253-02 Personality Module mismatch
- 268-02 Check Programmable Parameters

E. Verify that the engine’s configuration parameters are not scrambled.

Expected Result:

The 253-02 or 268-02 codes are not active. The configuration parameters are not scrambled.

Results:

- Active 253-02 code – A 253-02 diagnostic code is active. Proceed to Test Step 3.
- Active 268-02 code – A 268-02 diagnostic code is active. Proceed to Test Step 4.
- Scrambled parameters – The configuration parameters are scrambled. Proceed to Test Step 5.

Test Step 3. Check the Part Number of the Flash File

A. Turn the keyswitch to the ON position.

B. Verify that the flash file agrees with the original engine arrangement.

Expected Result:

The correct flash file is installed in the ECM.

Results:

- OK – The correct flash file is installed in the ECM.

  Repair: The engine will not start until the 253-02 diagnostic code is cleared. Clearing this code requires factory passwords.

  Acquire factory passwords. Clear the 253-02 diagnostic code. Return the engine to service.

  STOP.

- Not OK – The correct flash file is not installed in the ECM.

  Repair: Program the correct flash file into the ECM. Refer to Troubleshooting, “Flash Programming”. Verify that the problem is resolved.

  STOP.

Test Step 4. Determine the Parameters that Require Programming

A. Place the engine control in the ON mode.

B. Verify that the configuration parameters are correct for the engine’s application. Refer to Troubleshooting, “System Configuration Parameters”.

Expected Result:

The configuration parameters are correct.

Results:

- OK – The configuration parameters are correct.

  Repair: Clear the diagnostic code and return the engine to service.

  STOP.

- Not OK – The configuration parameters are not correct.

  Repair: The 268-02 diagnostic code cannot be cleared until all of the parameters are programmed with the correct values. The engine may use a default torque map or the ECM may limit the engine to low idle until this diagnostic code is cleared.

  Try to program the configuration parameters. Refer to Troubleshooting, “System Configuration Parameters”.

  If the programming is successful, clear the code and return the engine to service.

  If the parameters cannot be programmed, replace the ECM. Refer to Troubleshooting, “Replacing the ECM”. Clear the diagnostic code and return the engine to service.

  STOP.

Test Step 5. Review the Parameters and Data

A. Turn the keyswitch to the ON position.

B. Review the system configuration parameters and the engine lifetime totals.

Expected Result:

The parameters and totals are correct.

Results:

- OK – The parameters and totals are correct.

  Repair: Return the engine to service.

  STOP.

- Not OK – The parameters and/or the totals are incorrect.

  Repair: Try to program the suspect parameter or parameters. Refer to Troubleshooting, “System Configuration Parameters”.

  If the programming is successful, clear the code and return the engine to service.

  If the parameters cannot be programmed, replace the ECM. Refer to Troubleshooting, “Replacing the ECM”. Clear the diagnostic code and return the engine to service.

  STOP.

i02250507

Electrical Connectors - Inspect

SMCS Code: 7553-040-WW

System Operation Description:

Most electrical problems are caused by poor connections. The following procedure will assist in detecting problems with connectors and with wiring. If a problem is found correct the condition and verify that the problem is resolved.

Intermittent electrical problems are sometimes resolved by disconnecting and reconnecting connectors. It is very important to check for diagnostic codes immediately before disconnecting a connector. Also check for diagnostic codes after reconnecting the connector. If the status of a diagnostic code is changed due to disconnecting and reconnecting a connector, there are several possible reasons. The likely reasons are loose terminals, improperly crimped terminals, moisture, corrosion, and inadequate mating of a connection.

Follow these guidelines:

- Always use a 1U-5804 Crimp Tool to service Deutsch HD and DT connectors. Never solder the terminals onto the wires. Refer to “SEHS9615, Servicing Deutsch HD and DT Style Connectors”.
- Always use a 147-6456 Removal Tool to remove wedges from DT connectors. Never use a screwdriver to pry a wedge from a connector.
- Always use a breakout harness for a voltmeter probe or a test light. Never break the insulation of a wire in order to access to a circuit for measurements.
- If a wire is cut, always install a new terminal for the repair.

⚠ WARNING

The connection of any electrical equipment and the disconnection of any electrical equipment may cause an explosion hazard which may result in injury or death. Do not connect any electrical equipment or disconnect any electrical equipment in an explosive atmosphere.

Test Step 1. Check Connectors for Moisture and Corrosion

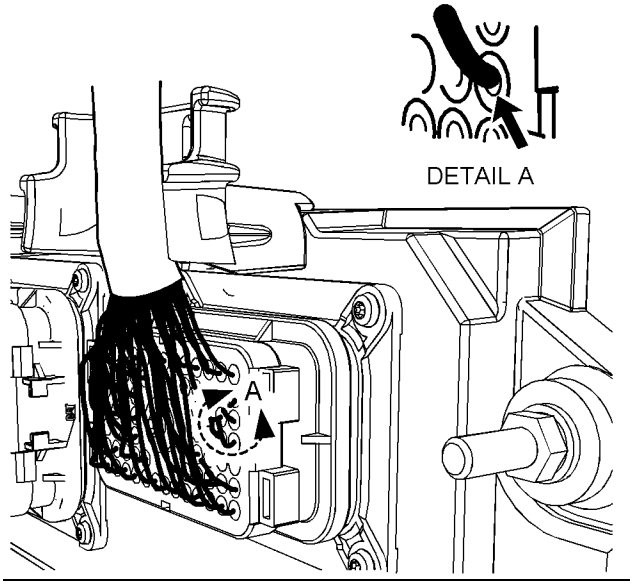


Illustration 46 g01131211

Leaky seal at the connector (typical example)

A. Inspect all wiring harnesses. Ensure that the routing of the wiring harness allows the wires to enter the face of each connector at a perpendicular angle. Otherwise, the wire will deform the seal bore. Refer to Illustration 46. This will create a path for the entrance of moisture. Verify that the seals for the wires are sealing correctly.

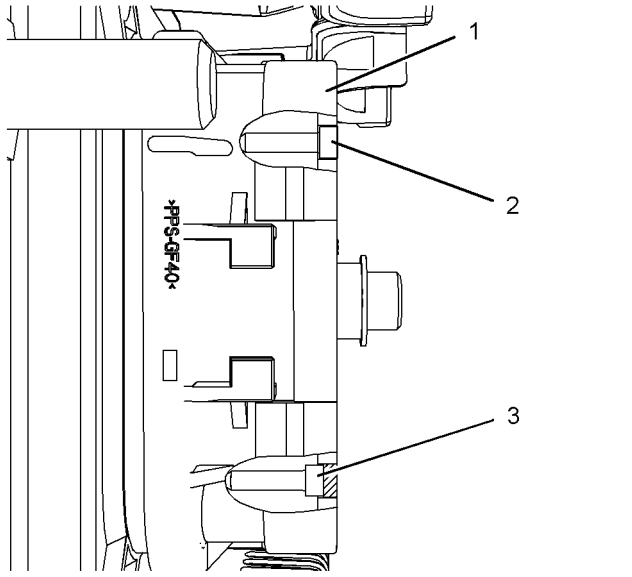


Illustration 47 g01131276

Diagram for the installation of a connector plug (typical example)

(1) Electronic Control Module (ECM) connector
(2) Correctly inserted plug
(3) Incorrectly inserted plug

B. Ensure that the sealing plugs are in place. If any of the plugs are missing, replace the plug. Ensure that the plugs are inserted correctly into the connector. Refer to Illustration 47.

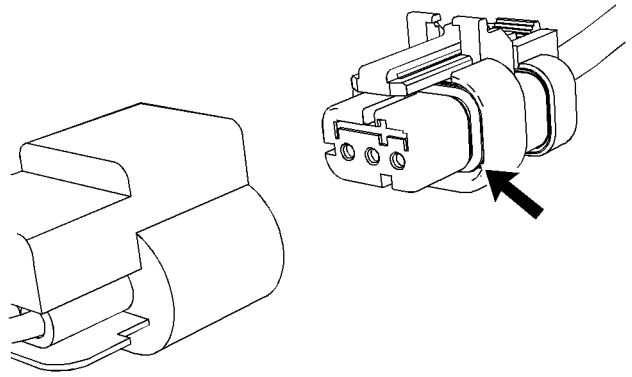


Illustration 48 g01131019

Seal for a three-pin connector (typical example)

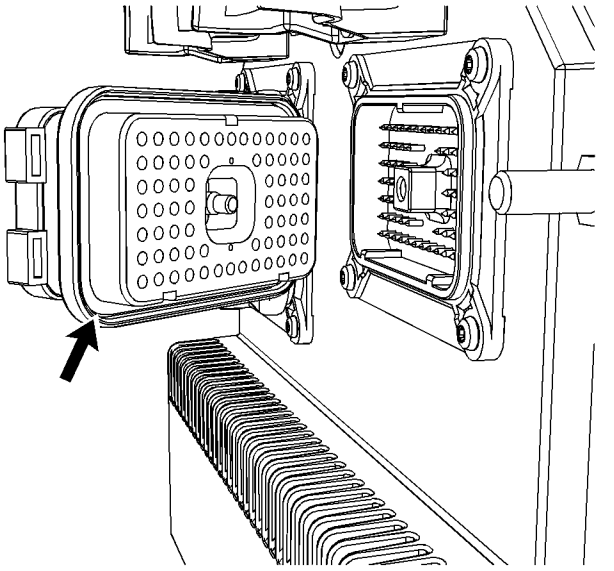


Illustration 49 g01131165

Seal for ECM connector (typical example)

C. Disconnect the suspect connector and inspect the connector seal. Ensure that the seals are in good condition. If necessary, replace the connector.

D. Thoroughly inspect the connectors for evidence of moisture entry.

Note: It is normal to see some minor seal abrasion on connector seals. Minor seal abrasion will not allow the entry of moisture.

If moisture or corrosion is evident in the connector, the source of the moisture entry must be found and the source of the moisture entry must be repaired. If the source of the moisture entry is not repaired, the problem will recur. Simply drying the connector will not fix the problem. Check the following items for the possible moisture entry path:

- Missing seals
- Improperly installed seals
- Nicks in exposed insulation
- Improperly mated connectors

Moisture can also travel to a connector through the inside of a wire. If moisture is found in a connector, thoroughly check the connector's harness for damage. Also check other connectors that share the harness for moisture.

Note: The ECM is a sealed unit. If moisture is found in an ECM connector, the ECM is not the source of the moisture. Do not replace the ECM.

Expected Result:

The harness wiring, connectors, and seals are in good condition. There is no evidence of moisture in the connectors.

Results:

- OK – The harness wiring, connectors, and seals are in good condition. Proceed to Test Step 2.
- Not OK – A problem has been found with the harness or the connectors.

  Repair: Repair the connectors or the wiring, as required. Ensure that all of the seals are properly in place. Ensure that the connectors have been reattached.

  If corrosion is evident on the pins, sockets or the connector, use only denatured alcohol to remove the corrosion. Use a cotton swab or a soft brush to remove the corrosion.

  If moisture was found in the connectors, run the engine for several minutes and check again for moisture. If moisture reappears, the moisture is wicking into the connector. Even if the moisture entry path is repaired, it may be necessary to replace the wires.

  Verify that the repair eliminates the problem.

  STOP.

Test Step 2. Check the Wires for Damage to the Insulation

A. Carefully inspect each wire for signs of abrasion, of nicks, and of cuts.

Inspect the wires for the following conditions:

- Exposed insulation
- Rubbing of a wire against the engine
- Rubbing of a wire against a sharp point

B. Check all of the wiring harness fasteners in order to verify that the harness is properly secured. Also check all of the fasteners in order to verify that the harness is not compressed. Pull back the harness sleeves in order to check for a flattened portion of wire. A fastener that has been overtightened flattens the harness. This damages the wires that are inside the harness.

Expected Result:

The wires are free of abrasion, of nicks, and of cuts and the harness is properly clamped.

Results:

- OK – The harness is OK. Proceed to Test Step 3.
- Not OK – There is damage to the harness.

  Repair: Repair the wires or replace the wires, as required. Verify that the repair eliminates the problem.

  STOP.

Test Step 3. Inspect the Connector Terminals

A. Visually inspect each terminal in the connector. Verify that the terminals are not damaged. Verify that the terminals are properly aligned in the connector and verify that the terminals are properly located in the connector.

Expected Result:

The terminals are properly aligned and the terminals appear undamaged.

Results:

- OK – The terminals are OK. Proceed to Test Step 4.
- Not OK – The terminals of the connector are damaged.

  Repair: Repair the terminals and/or replace the terminals, as required.

  Verify that the repair eliminates the problem.

  STOP.

Test Step 4. Perform a Pull Test on Each Wire Terminal Connection

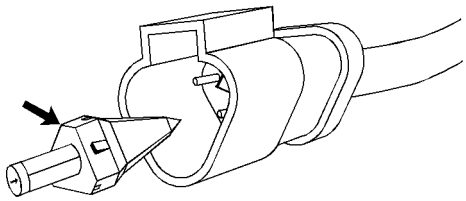


Illustration 50 g01131435

Receptacle lock wedge (typical example)

A. Ensure that the locking wedge for the connector is installed properly. Terminals cannot be retained inside the connector if the locking wedge is not installed properly.

B. Perform the 45 N (10 lb) pull test on each wire. Each terminal and each connector should easily withstand 45 N (10 lb) of tension and each wire should remain in the connector body. This test checks whether the wire was properly crimped in the terminal and whether the terminal was properly inserted into the connector.

Expected Result:

Each terminal and each connector easily withstands 45 N (10 lb) of pull and each wire remains in the connector body.

Results:

- OK – All terminals pass the pull test. Proceed to Test Step 5.
- Not OK – A wire has been pulled from a terminal or a terminal has been pulled from the connector.

  Repair: Use the 1U-5804 Crimp Tool to replace the terminal. Replace damaged connectors, as required. Verify that the repair eliminates the problem.

  STOP.

Test Step 5. Check Individual Pin Retention into the Socket

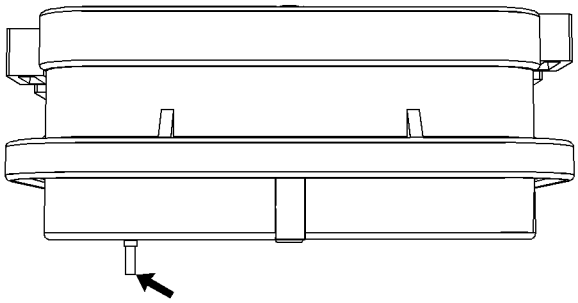


Illustration 51 g01131604

Diagram for testing pin retention (typical example)

A. Verify that the sockets provide good retention for the pins. Insert a new pin into each socket one at a time in order to check for a good grip on the pin by the socket.

Expected Result:

The sockets provide good retention for the new pin.

Results:

- OK – The terminals are OK. Proceed to Test Step 6.
- Not OK – Terminals are damaged.

  Repair: Use the 1U-5804 Crimp Tool to replace the damaged terminals. Verify that the repair eliminates the problem.

  STOP.

Test Step 6. Check the Locking Mechanism of the Connectors

A. Ensure that the connectors lock properly. After locking the connectors, ensure that the two halves cannot be pulled apart.

B. Verify that the latch tab of the connector is properly latched. Also verify that the latch tab of the connector returns to the locked position.

Expected Result:

The connector will securely lock. The connector and the locking mechanism are without cracks or breaks.

Results:

- OK – The connectors are in good repair. Proceed to Test Step 7.
- Not OK – The connector's locking mechanism is damaged or missing.

  Repair: Repair the connector or replace the connector, as required. Verify that the repair eliminates the problem.

  STOP.

Test Step 7. Check the Allen Head Screws on the Connectors

Visually inspect the allen head screws for the ECM connectors. Ensure that the threads on each allen head screw are not damaged.

A. Connect the ECM connectors.

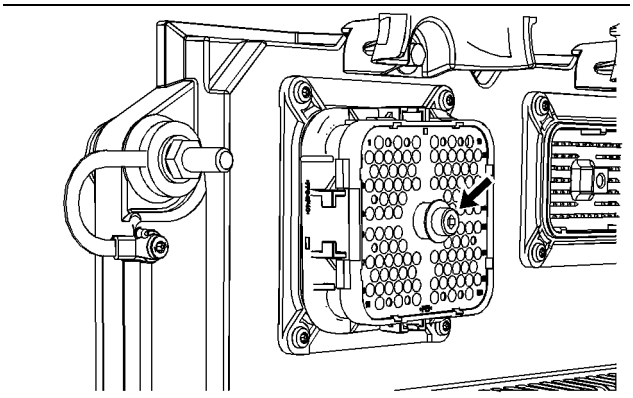


Illustration 52 g01132827

Allen head screw for the 120 pin ECM connector (typical example)

a. Torque the allen head bolt for the 120 pin ECM connector to 7.0 ± 0.5 N·m (60 ± 4 lb in).

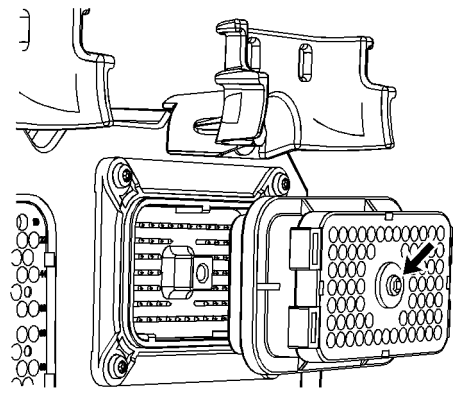


Illustration 53 g01132849

Allen head screw for the 70 pin ECM connector (typical example)

b. Torque the allen head screw for the 70 pin ECM connector to 6.0 + 1.5 - 0.5 N·m (55 + 13 - 4 lb in).

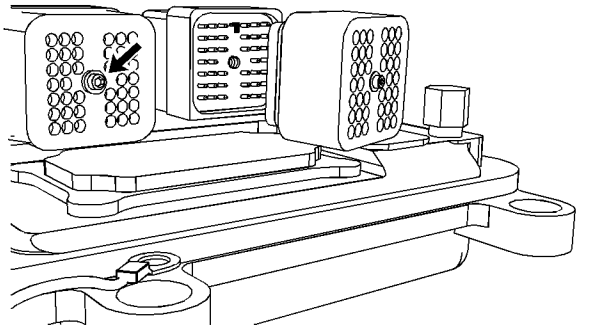


Illustration 54 g01132863

Allen head screw for the 40 pin ECM connector (typical example)

c. Torque the allen head screw for the 40 pin ECM connector to 2.25 ± 0.25 N·m (20 ± 2 lb in).

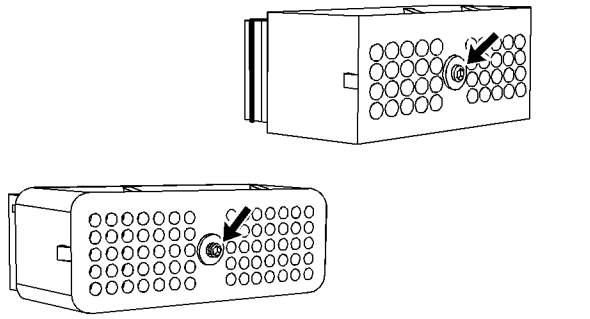


Illustration 55 g01133047

Allen head screw for the 40 pin customer connector and the 70 pin customer connector (typical example)

B. Connect the customer connector.

Torque the allen head screw for the 40 pin customer connector and the 70 pin customer connector to 2.25 ± 0.25 N·m (20 ± 2 lb in).

Expected Result:

The ECM connector is secure and the allen head screws are properly torqued.

Results:

- OK – The ECM connectors and the customer connector is properly connected. Proceed to Test Step 8.
- Not OK – The allen head screws for the ECM connector or the customer connector is damaged.

Repair: Repair the connector or replace the connector, as required. Verify that the repair eliminates the problem.

STOP.

Test Step 8. Perform the “Wiggle Test” on the Caterpillar Electronic Technician (ET)

A. Select the “Wiggle Test” from the diagnostic tests on Cat ET.

B. Choose the appropriate group of parameters to monitor.

C. Press the “Start” button. Wiggle the wiring harness in order to reproduce intermittent problems.

If an intermittent problem exists, the status will be highlighted and an audible beep will be heard.

Expected Result:

No intermittent problems were indicated during the “Wiggle Test”.

Results:

- OK – No intermittent problems were found. The harness and connectors appear to be OK. If you were sent from another procedure, return to the procedure and continue testing. If this test has resolved the problem, return the engine to service. STOP.
- Not OK – At least one intermittent problem was indicated.

Repair: Repair the harness or the connector. Verify that the repair eliminates the problem.

STOP.

i02289857

Electrical Power Supply Circuit - Test

SMCS Code: 1401-038

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the electrical power supply.

This procedure covers the following diagnostic codes:

- 168-00 System Voltage High
- 168-01 System Voltage Low
- 168-02 System Voltage intermittent/erratic

This procedure tests whether proper voltage is being supplied to the Electronic Control Module (ECM).

Unswitched battery voltage is supplied through the customer connector to the ECM at P1-48, P1-52, and P1-53. The negative battery is supplied to the ECM at P1-61, P1-63, and P1-65. The ECM receives the input from the keyswitch at P1-70 when the keyswitch is in the ON position or the START position. When the ECM detects battery voltage at this input, the ECM will power up. When battery voltage is removed from this input, the ECM will power down.

The cause of an intermittent power supply to the ECM can occur on either the positive side or the negative side of the battery circuit. Both sides are routed from the ECM to the battery. The three connections for the unswitched +Battery should be routed through a dedicated protective device (circuit breaker).

The engine ECM requires the keyswitch to be in the ON position in order to maintain communications with the electronic service tool.

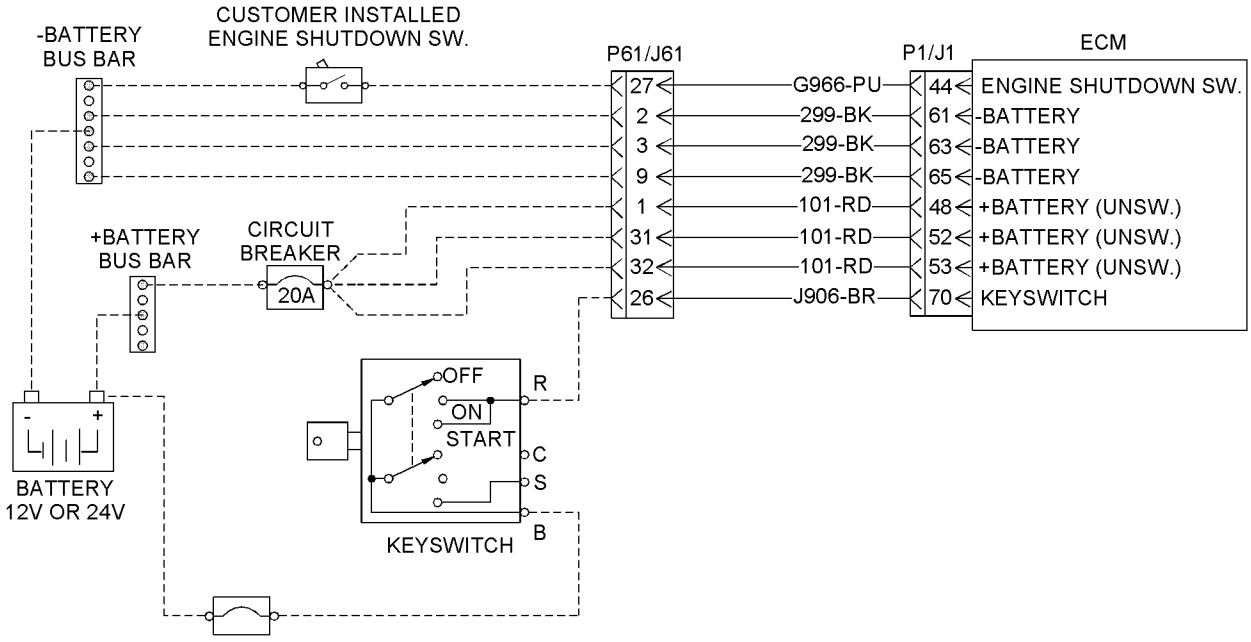
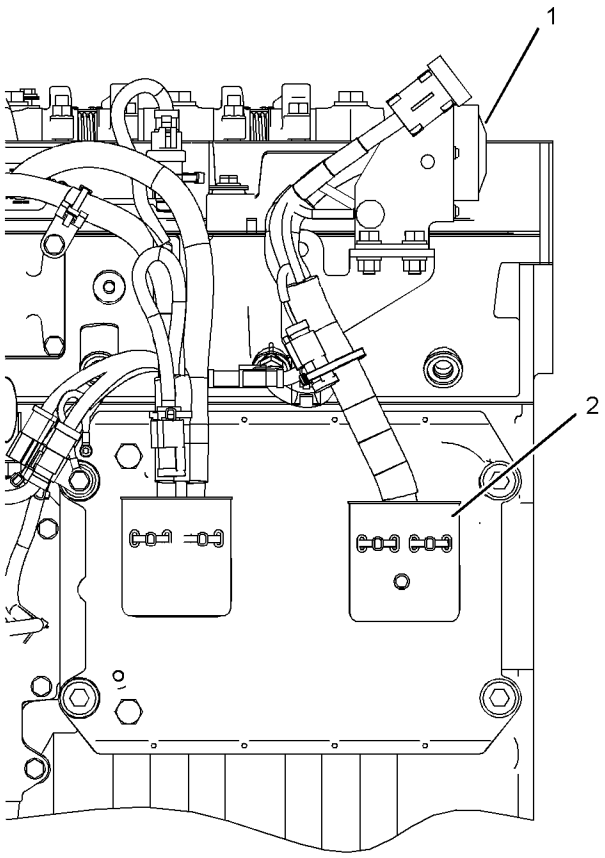


Illustration 56 g01102414

Schematic diagram for the electrical power supply

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Turn the keyswitch to the OFF position.



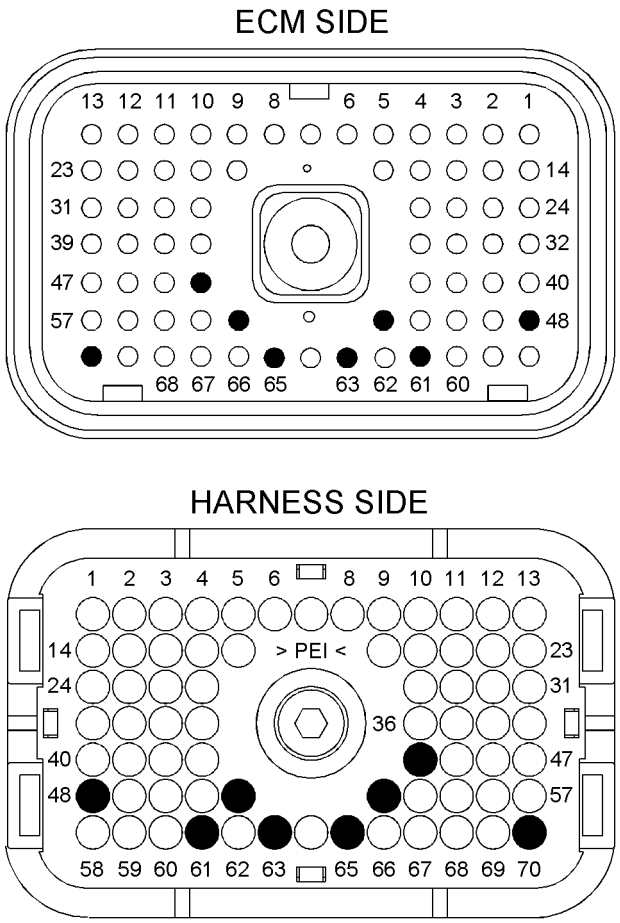
g01120079

Illustration 57

Left side view

(1) P61 customer connector
(2) J1/P1 ECM connectors

B. Thoroughly inspect connectors (1) and (2). Inspect the connections for the battery and the connections to the keyswitch. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

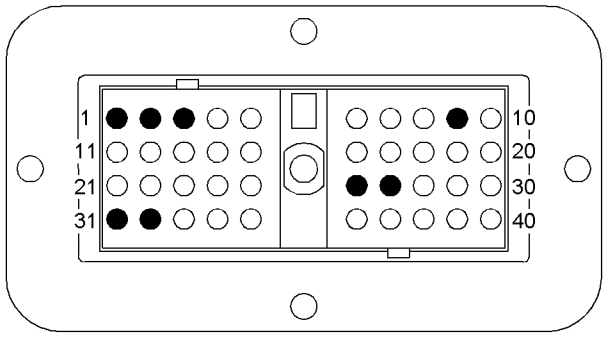


g01104383

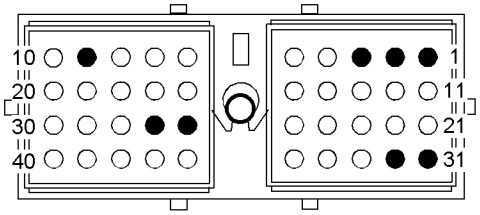
Illustration 58

P1 terminals that are associated with the electrical power supply

(P1-44) Shutdown
(P1-48) +Battery
(P1-52) +Battery
(P1-53) +Battery
(P1-61) −Battery
(P1-63) −Battery
(P1-65) −Battery
(P1-70) Keyswitch



J61 TERMINAL SIDE



P61 TERMINAL SIDE

Illustration 59 g01120091

J61 and P61 terminals that are associated with the electrical power supply

(1) +Battery
(2) -Battery
(3) -Battery
(9) -Battery
(26) Keyswitch
(27) Shutdown
(31) +Battery
(32) +Battery

C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the electrical power supply.

D. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the harness and wiring for abrasions and for pinch points from the battery to the ECM. Also, check the harness and wiring for abrasions and for pinch points from the keyswitch to the ECM.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted, and the harness and wiring are free of corrosion, of abrasion and of pinch points.

Results:

- OK – The connectors and wiring are okay. Proceed to Test Step 2.
- Not OK – There is a problem with the connectors or wiring.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled.

  STOP.

Test Step 2. Check the Battery Voltage at the ECM

A. Disconnect the J1/P1 ECM connector.

B. Turn the keyswitch to the ON position.

C. Measure the voltage between P1-52 (Unswitched Positive Battery) and P1-63 (Negative Battery).

D. Measure the voltage between P1-48 (Unswitched Positive Battery) and P1-61 (Negative Battery).

E. Measure the voltage between P1-53 (Unswitched Positive Battery) and P1-65 (Negative Battery).

F. Measure the voltage between P1-70 (Keyswitch) and P1-63 (Negative Battery).

Expected Result:

The measured voltage is between 11.0 VDC and 13.5 VDC for a 12 volt system and between 22.0 VDC and 27.0 VDC for a 24 volt system with no suspected intermittent problems at this time.

Results:

- OK – The ECM is receiving the correct voltage.

  Repair: If an intermittent condition is suspected, refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

- Battery voltage is out of range – Proceed to Test Step 3.
- Keyswitch voltage out of range

  Repair: Trace the wiring for the keyswitch from the ECM through the keyswitch circuit to the batteries. Find the problem and repair the problem. Check the circuit protection for the circuit and for the wiring.

Verify that the repairs eliminate the problem.

STOP.

Test Step 3. Check the Batteries

A. Measure the no-load battery voltage at the battery posts.

B. Load test the batteries. Use the 4C-4911 Battery Load Tester. Refer to Special Instruction, SEHS9249, “Use of 4C-4911 Battery Load Tester for 6, 8 and 12 Volt Lead Acid Batteries” and Special Instruction, SEHS7633, “Battery Test Procedure”.

Expected Result:

The batteries pass the load test. The measured voltage is the minimum specification for a 12V or 24V system.

Results:

- OK – The batteries are OK.

  Repair: Check the wiring between the batteries and the ECM for shorts.

  Check the connectors between the batteries and the ECM for moisture and/or corrosion.

  Repair the wiring and/or the connectors.

  Verify that the repair eliminates the problem.

  STOP.

- Not OK – The battery voltage is low or the battery did not pass the load test.

  Repair: Recharge or replace the faulty batteries. Verify that the repair eliminates the problem.

  STOP.

i02289985

Engine Pressure Sensor Open or Short Circuit - Test

SMCS Code: 5574-038-PX

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the following sensors:

- Engine oil pressure sensor
- Boost pressure sensor
- Atmospheric pressure sensor

This procedure covers the following diagnostic codes:

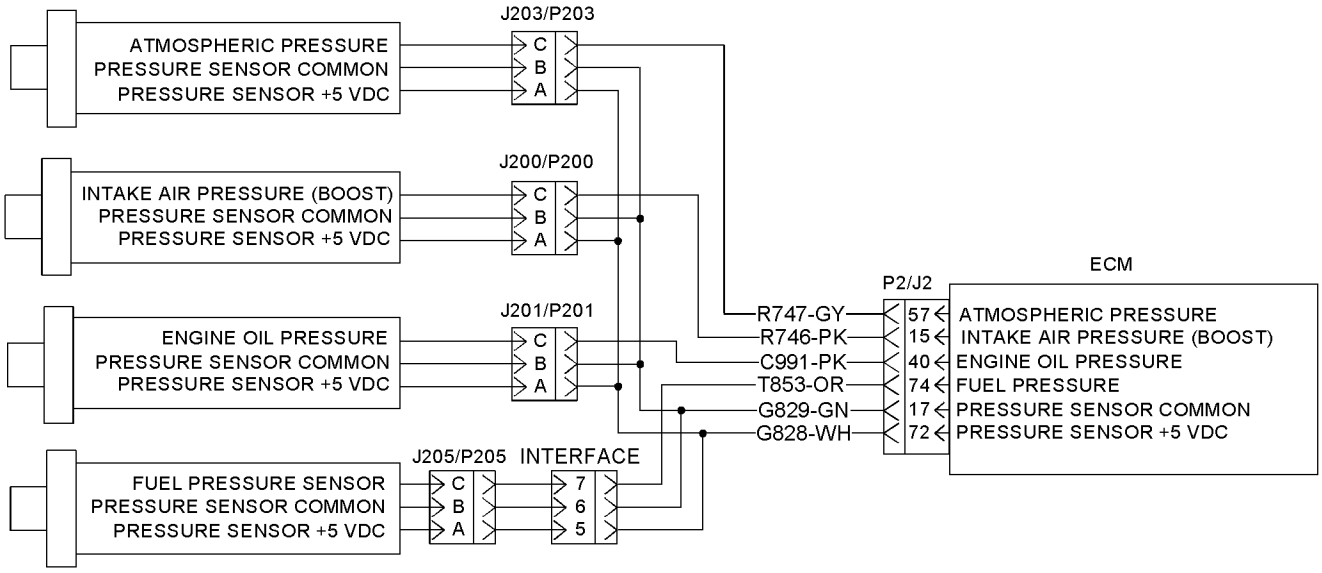
- 094-03Fuel Pressure open/short to +batt
- 094-04Fuel Pressure short to ground
- 100-03 Engine Oil Pressure open/short to +batt
- 100-04 Engine Oil Pressure short to ground
- 102-03 Boost Pressure Sensor short to +batt
- 102-04 Boost Pressure Sensor short to ground
- 274-03 Atmospheric Pressure open/short to +batt
- 274-04 Atmospheric Pressure short to ground

The troubleshooting procedures for the diagnostic codes of each pressure sensor are identical. The Engine Control Module (ECM) sends a 5 volt supply to terminal A of each sensor. The sensor common connection is connected to terminal B of each sensor. The signal voltage from terminal C of each sensor is sent to the appropriate terminal at the J2/P2 ECM connector.

Pull-up Voltage

The ECM continuously outputs a pull-up voltage on the circuit for the sensor signal wire. The ECM uses this pull-up voltage in order to detect an open in the signal circuit. When the ECM detects the presence of a voltage that is above a threshold on the signal circuit, the ECM will generate an open circuit diagnostic code (03) for the sensor.

If the sensor is disconnected at the sensor connector, the presence of pull-up voltage at the sensor connector indicates that the wires from the sensor connector to the ECM are not open or shorted to ground. If the sensor is disconnected at the sensor connector, the absence of pull-up voltage at the sensor connector indicates an open in the signal wire or a short to ground. If the sensor is disconnected at the sensor connector and the voltage at the sensor connector is different from pull-up voltage, the signal wire is shorted to another wire in the harness.



g01102442

Illustration 60

Schematic for the engine pressure sensors

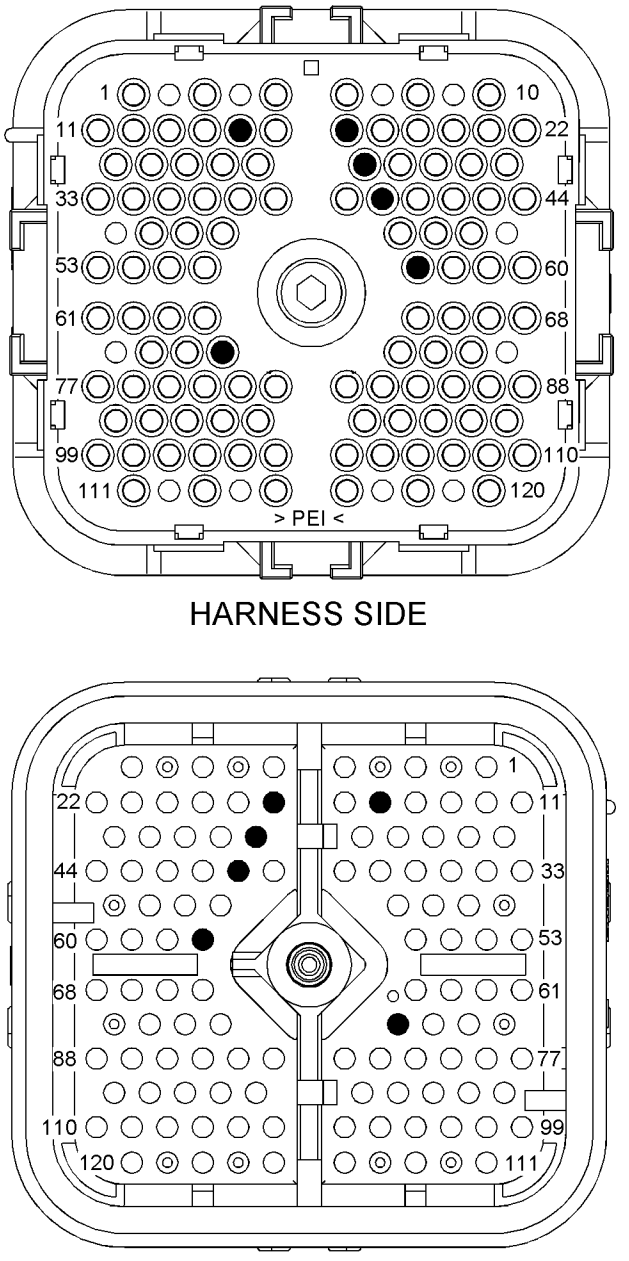


Illustration 61 g01102443

P2 ECM connector

(P2-15) Signal from the boost pressure sensor
(P2-17) Sensor common
(P2-28) Signal from the oil pressure sensor
(P2-40) Signal from the fuel pressure sensor
(P2-57) Atmospheric pressure sensor signal
(P2-72) +5 Volt sensor supply

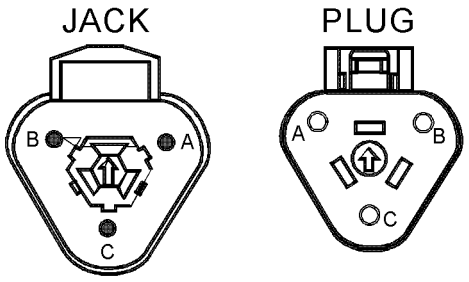


Illustration 62 g01094844

Sensor connector

(A) +5 VDC
(B) Common
(C) Signal

Test Step 1. Inspect the Electrical Connectors and Wiring

A. Turn the keyswitch to the OFF position.

B. Thoroughly inspect the J1/P1 ECM connector and the J2/P2 ECM connector. Thoroughly inspect the connectors for each analog sensor. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the active diagnostic code.

D. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the harness and wiring for abrasions and for pinch points from each sensor back to the ECM.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted. The harness and wiring are free of corrosion, of abrasion, and of pinch points.

Results:

- OK – The harness and wiring are OK. Proceed to Test Step 2.
- Not OK – There is a problem in the connectors and/or wiring.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled.

Verify that the repair eliminates the problem.

STOP.

Test Step 2. Check the Supply Voltage at the Sensor Connector

A. Turn the keyswitch to the OFF position.

B. Disconnect all of the following analog sensors at the sensor connector:

- Engine oil pressure sensor
- Boost pressure sensor
- Atmospheric pressure sensor
- Fuel pressure sensor

C. Turn the keyswitch to the ON position.

D. Measure the voltage between terminal A (5 V analog supply) and terminal B (sensor return) at the sensor connectors.

E. Turn the keyswitch to the OFF position.

F. Reconnect all of the sensors.

Expected Result:

The voltage is 5.0 ± 0.16 VDC.

Results:

- OK – The voltage is 5.0 ± 0.16 VDC. The voltage is correct. Proceed to Test Step 3.
- Not OK – The voltage is not 5.0 ± 0.16 VDC. The voltage is incorrect.

  Repair: Perform the diagnostic functional test Troubleshooting, “5 Volt Engine Pressure Sensor Supply Circuit - Test”.

  STOP.

Test Step 3. Check for Active Diagnostic Codes

A. Connect the electronic service tool to the service tool connector.

B. Turn the keyswitch to the ON position.

C. Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes.

Note: Wait at least 15 seconds in order for the diagnostic codes to become active.

D. Determine if the problem is related to an open circuit diagnostic code 03 or a short circuit diagnostic code 04.

Expected Result:

No diagnostic codes are active.

Results:

- OK – No diagnostic codes are active.

  Repair: The problem may have been related to a faulty connection in the harness. Carefully reinspect the connectors and wiring. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

- Not OK – A short circuit diagnostic code (04) is active at this time. Proceed to Test Step 4.
- Not OK – An open circuit diagnostic code (03) is active at this time. Proceed to Test Step 5.

Test Step 4. Disconnect the Suspect Sensor in Order to Create an Open Circuit

A. Turn the keyswitch to the OFF position.

B. Disconnect the sensor connector of the sensor with the short circuit diagnostic code (04).

C. Turn the keyswitch to the ON position. Wait at least 15 seconds for activation of the diagnostic codes.

D. Access the “Active Diagnostic Code” screen on the electronic service tool. Check for an active open circuit diagnostic code (03).

E. Turn the keyswitch to the OFF position.

Expected Result:

An open circuit diagnostic code 03 is now active for the disconnected sensor.

Results:

- OK – A short circuit diagnostic code (04) was active before disconnecting the sensor. An open circuit diagnostic code (03) became active after disconnecting the sensor.

Repair: Temporarily connect a new sensor to the harness, but do not install the new sensor in the engine. Verify that there are no active diagnostic codes for the sensor. If there are no active diagnostic codes for the sensor, permanently install the new sensor. Clear any logged diagnostic codes.

STOP.

- Not OK – There is a short circuit between the sensor harness connector and the ECM. Leave the sensor disconnected. Proceed to Test Step 8.

Test Step 5. Check the Pull-up Voltage at the Sensor Connector

A. Turn the keyswitch to the ON position.

B. Disconnect the suspect sensor.

C. Measure the voltage between terminal C (signal) and terminal B (sensor return) at the sensor connector.

D. Turn the keyswitch to the OFF position.

Expected Result:

The voltage is 11 ± 2 VDC.

Results:

- OK – The voltage is 11 ± 2 VDC. The signal wire to the ECM from the sensor connector is okay.

  Repair: The open circuit is in the sensor or the wire between the sensor and the sensor connector. Replace the sensor. Do not install the sensor in the engine. Verify that no diagnostic codes are active for the suspect sensor before permanently installing the sensor.

  STOP.

- Not OK – The voltage is not 11 ± 2 VDC. The voltage is incorrect. Proceed to Test Step 6.

Test Step 6. Check the Signal Wire for a Short Circuit

A. Turn the keyswitch to the OFF position.

B. Disconnect ECM connectors P1 and P2.

C. Disconnect the connector for the suspect sensor.

D. Measure the resistance between the terminal for the sensor signal wire at the ECM and every terminal on ECM connector P1 and ECM connector P2.

E. Measure the resistance between the terminal for the sensor signal wire at the ECM and engine ground.

F. Turn the keyswitch to the OFF position.

G. Reconnect P1 and P2.

Expected Result:

Each resistance measurement is greater than 20,000 Ohms.

Results:

- OK – Each of the resistance measurements is greater than 20,000 Ohms. Proceed to Test Step 7.

- Not OK – At least one resistance measurement is less than 20,000 Ohms.

  Repair: The low resistance measurement indicates a low resistance between two or more wires. Repair the connectors or wiring and/or replace the connectors or wiring.

  STOP.

Test Step 7. Create a Short at the Suspect Sensor Connector

A. Turn the keyswitch to the OFF position.

B. Install a jumper wire with Deutsch sockets on each end between terminal B (sensor return) and terminal C (signal) on the connector for the suspect sensor. Connect the jumper on the harness side of the connector.

C. Turn the keyswitch to the ON position.

D. Wait at least 15 seconds for activation of the short circuit diagnostic code 04.

Note: Monitor the “Active Diagnostic Codes” screen on the electronic service tool before installing the jumper wire and after installing the jumper wire.

E. Remove the jumper wire.

F. Turn the keyswitch to the OFF position.

Expected Result:

A short circuit diagnostic code 04 is active when the jumper wire is installed. An open circuit diagnostic code 03 is active when the jumper wire is removed.

Results:

- OK – The engine harness and the ECM are okay.

Repair: Temporarily connect a new sensor to the harness, but do not install the new sensor in the engine. Verify that there are no active diagnostic codes for the sensor. If there are no active diagnostic codes for the sensor, permanently install the new sensor. Clear any logged diagnostic codes.

STOP.

- Not OK – The open circuit diagnostic code 03 remains active with the jumper in place. The open circuit is between the ECM and the sensor connector. Proceed to Test Step 8.

Test Step 8. Check the Operation of the ECM

A. Turn the keyswitch to the OFF position.

B. Check the operation of the ECM by creating an open at the ECM.

a. Remove the signal wire for the suspect sensor from the P2 ECM connector.

b. Remove the sensor return for the suspect sensor from the P2 ECM connector.

Note: Disconnecting the sensor return from the ECM will generate an open circuit diagnostic code for all sensors that are connected to the sensor return. Troubleshoot the original diagnostic code. Delete the logged diagnostic codes when you are finished.

c. Reconnect the ECM connector.

d. Turn the keyswitch to the ON position. Monitor the “Active Diagnostic Code” screen on the electronic service tool. Wait at least 15 seconds for activation of the code.

An open circuit diagnostic code (03) should be active for the suspect sensor.

C. Check the operation of the ECM by creating a short at the ECM.

a. Install a wire jumper between the two terminals for the sensor signal and the sensor return.

b. Reconnect the ECM connector.

c. Monitor the “Active Diagnostic Code” screen on the electronic service tool. Wait at least 15 seconds for activation of the code.

A short circuit diagnostic code (04) should be active when the wire jumper is installed.

d. Remove the wire jumper and reconnect all wires.

Expected Result:

An open circuit diagnostic code 03 is active when the sensor signal wire is removed from the ECM connector. A short circuit diagnostic code 04 is active when the signal wire is connected to the sensor return.

Results:

- OK – The ECM is operating properly. The problem is in the wiring between the ECM and the sensor connector.

  Repair: If the code is active for more than one sensor, the problem is most likely in the return wire for the sensor. Repair the return wire for the sensor or replace the harness.

  If the code is only active for one sensor, the problem is most likely in the signal wire for the sensor. Repair the signal wire for the sensor.

  STOP.

- Not OK – One of the following conditions exists: The open circuit diagnostic code 03 is not active when the sensor signal wire is disconnected. The short circuit diagnostic code 04 is not active when the wire jumper is installed.

  Repair: Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”. Verify that the problem is resolved.

  STOP.

i02290001

Engine Speed/Timing Sensor Circuit - Test

SMCS Code: 1912-038

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the following sensors:

- Primary engine speed/timing sensor
- Secondary engine speed/timing sensor

This procedure covers the following open circuit diagnostic codes and short circuit diagnostic codes:

- 190-08 Engine Speed abnormal

- 342-08 Secondary Engine Speed signal abnormal

The engine uses two engine speed/timing sensors. The primary engine speed/timing sensor detects the unique pattern of crankshaft gear and the secondary engine speed/timing sensor picks up the unique pattern of the camshaft gear. Both of the engine speed/timing sensors detect the reference for engine speed and timing from a unique pattern on the gear. The Engine Control Module (ECM) measures the time between the pulses that are created by the sensors as the gears rotate in order to determine rpm.

Under normal operation, the secondary engine speed/timing sensor is used to determine timing for starting purposes. The secondary engine speed/timing sensor is used to determine when the piston in the No. 1 cylinder is at the top of the compression stroke. When the timing has been established, the primary engine speed/timing sensor is then used to determine engine speed.

After locating the No. 1 cylinder, the ECM triggers each injector in the correct firing order and at the correct unit injector timing. The actual timing and duration of each injection is based on engine rpm and load. If the engine is running and the signal from the primary engine speed/timing sensor is lost, a slight change in engine performance will be noticed when the ECM performs the changeover to the secondary engine speed/timing sensor. Loss of the signal from the secondary engine speed/timing sensor during engine operation will not result in any noticeable change in engine performance. However, if the signal from the secondary engine speed/timing sensor is not present during start-up the following conditions may exist:

- The engine may require a slightly longer period of time to start-up.
- The engine may run rough for a few seconds until the ECM determines the proper firing order with the primary engine speed/timing sensor.

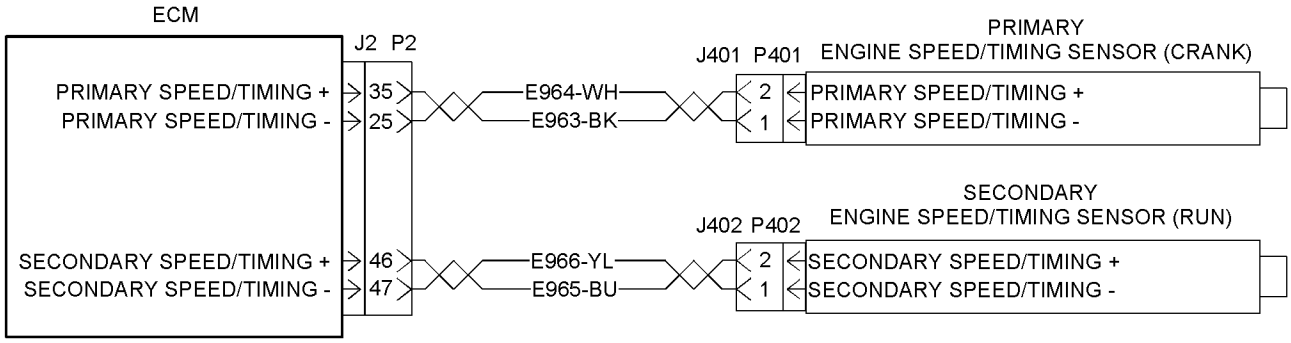
The engine will start and the engine will run when only one sensor signal is present. The loss of the signal from both of the sensors during engine operation will result in the termination of injection and the shutting down the engine by the ECM. The loss of the signal from both of the sensors during start-up will prevent the engine from starting.

Both sensors are magnetic sensors. The two sensors are not interchangeable. Do not switch the positions of the sensor. If the sensors are replaced, a timing calibration is not necessary.

If a replacement of the ECM is required, the ECM parameters and the timing calibration can be transferred from the suspect ECM to the replacement ECM. Timing calibration will not be necessary. This feature requires the Caterpillar Electronic Technician (ET) and this feature is only possible if the existing ECM can communicate with Cat ET. Use the “Copy Configuration - ECM Replacement” feature on Cat ET.

Complete all of the following tasks when you install a speed/timing sensor:

- Lubricate the O-ring with oil.
- Ensure that the sensor has a face seal inside the connector body. If a seal is damaged or missing, replace the seal.
- Ensure that the sensor is fully seated into the engine before tightening the bracket bolt.
- Ensure that the connector is latched on both sides.
- Ensure that the harness is properly secured, and ensure that the tie-wraps are placed in the correct location.



g01142626

Illustration 63

Schematic for engine speed/timing sensors

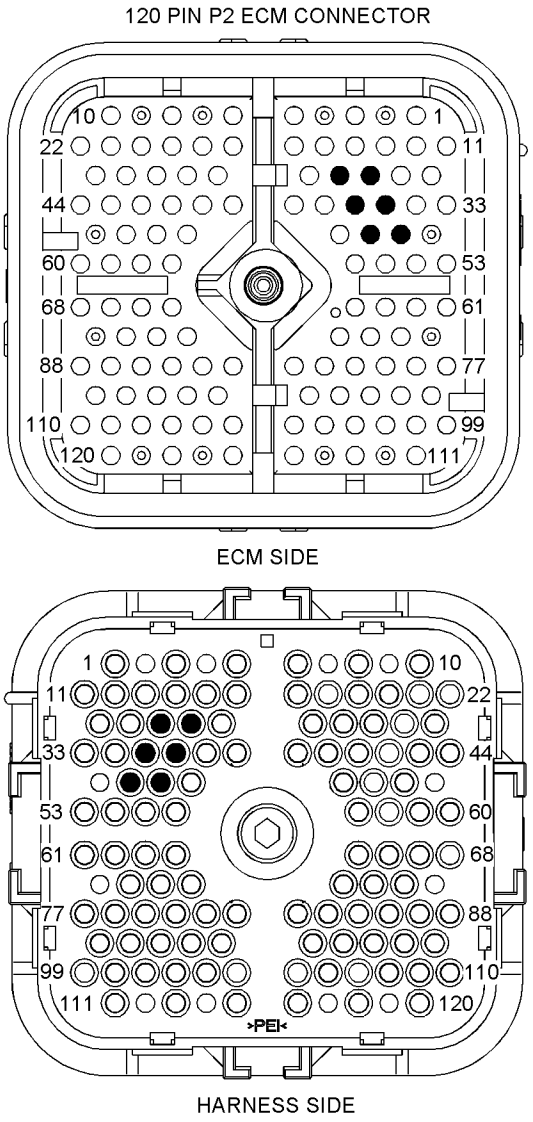


Illustration 64 g01099116

P2 ECM connector

(P2-25) Primary engine speed/timing −
(P2-26) TDC probe +
(P2-35) Primary engine speed/timing +
(P2-36) TDC probe −
(P2-46) Secondary engine speed/timing +
(P2-47) Secondary engine speed/timing −

Test Step 1. Check for Diagnostic Codes

A. Connect the Caterpillar Electronic Technician (ET) to the service tool connector.

B. Turn the key switch to the ON position.

C. Start the engine and run the engine until the engine is at normal operating temperature.

Note: If the engine will not start, monitor the engine rpm on Cat ET while the engine is being cranked. Cat ET may need to be powered from another battery while the engine is being cranked.

D. Check for one of the following logged diagnostic codes or active diagnostic codes:

- 190-08
- 342-08

Expected Result:

One or both of the diagnostic codes that are listed above are logged or active.

Note: If the engine will not start and Cat ET displayed 0 rpm during cranking, select “No Engine rpm”.

Results:

- 190-08 or 342-08 – There is an active diagnostic code or a logged diagnostic code. Proceed to Test Step 3.
- Not OK – If none of the codes that are listed are active or logged and the engine is not running properly, refer to the appropriate symptoms in Troubleshooting, “Troubleshooting Without a Diagnostic Code”. STOP.
- No Engine rpm – Engine rpm is not indicated on Cat ET. Proceed to Test Step 2.

Test Step 2. Check the Installation of the Sensors

A. Turn the key switch to the OFF position.

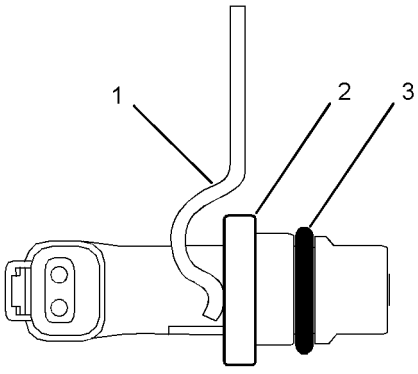


Illustration 65 g01146452

Typical speed sensor

(1) Bracket
(2) Flange
(1) O-ring

B. Visually inspect the sensor without removing the sensor from the engine. Flange (2) must be flush against the engine in order to ensure proper operation. Inspect bracket (1) in order to ensure that the installation allows the flange of the sensor to be flush against the engine. Verify that the bracket is not bent.

Note: The bracket cannot be replaced separately.

C. Remove the sensor. Ensure that one O-ring (3) is installed on the sensor. Check the O-ring for damage. Replace the O-ring, if necessary.

Expected Result:

The sensor's components are okay.

Results:

- OK – The sensor's components are okay.

  Repair: Perform the following procedure in order to properly install the sensor:

  1. Lubricate the O-ring with engine oil.

  2. Fully seat the sensor in the engine.

Note: If the sensor will not fully seat into the engine, replace the sensor.

  3. Tighten the bracket bolt.

  4. Connect the sensor's electrical connector. Verify that the connector is latched on both sides.

  5. Ensure that the harness is properly secured, and ensure that the tie-wraps are placed in the correct location.

  Proceed to Test Step 3.

- Not OK – At least one of the sensor's components is not okay.

  Repair: Obtain a new sensor. Perform the following procedure in order to properly install the new sensor:

  1. Lubricate the O-ring with engine oil.

  2. Fully seat the sensor in the engine.

Note: If the sensor will not fully seat into the engine, replace the sensor.

  3. Tighten the bracket bolt.

  4. Connect the sensor's electrical connector. Verify that the connector is latched on both sides.

  5. Ensure that the harness is properly secured, and ensure that the tie-wraps are placed in the correct location.

  Verify that the repair eliminates the problem.

  STOP.

Test Step 3. Measure the Sensor Resistance through the Engine Harness

A. Turn the key switch to the OFF position.

B. Thoroughly inspect the J2/P2 ECM connector. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.

C. Perform a 45 N (10 lb) pull test on the wires that are associated with the engine speed/timing sensors.

D. Ensure that the latch tab on each sensor connector is properly latched.

E. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, "Electrical Connectors - Inspect" for the correct torque values.

F. Repair the harness or repair the connector if a problem is found.

G. Ensure that the wiring harness is correctly routed and secured at the correct locations.

H. Ensure that the harness wiring is not pulled too tightly. When the harness wiring is pulled too tightly, vibrations or movement can cause intermittent connections.

I. Inspect the harness wiring for nicks and abrasions.

J. If the harness and the connector are OK, disconnect the J2/P2 ECM connector.

K. If you are troubleshooting a problem with the primary engine speed/timing sensor, perform the following procedure:

  a. Measure the sensor's resistance between P2-35 (Primary engine speed/timing positive) and P2-25 (Primary engine speed/timing negative).

  b. Check for an intermittent open circuit or for a short circuit by moving the harness while you take the resistance measurement. Pull the wires that are directly behind the sensor or shake the wires that are directly behind the sensor.

  Resistance ..... 75 to 230 Ohms

L. If you are troubleshooting a problem with the secondary engine speed/timing sensor, perform the following procedure:

a. Measure the sensor's resistance between P2-46 (Secondary engine speed/timing positive) and P2-47 (Secondary engine speed/timing negative).

b. Check for an intermittent open circuit or for a short circuit by moving the harness while you take the resistance measurement. Pull the wires that are directly behind the sensor or shake the wires that are directly behind the sensor.

Resistance ..... 600 to 1800 Ohms

Expected Result:

The readings are within the specifications.

Results:

- OK – The readings are within the specifications. Neither a short circuit nor an open circuit is indicated. Proceed to Test Step 5.
- Not OK – The readings are not within the specifications. The sensor resistance is not within the acceptable range when the sensor resistance is measured through the engine harness. Proceed to Test Step 4.

Test Step 4. Measure the Resistance of the Sensor

A. Disconnect the suspect sensor from the engine harness.

B. Thoroughly inspect the sensor's connectors. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.

C. If you are troubleshooting a problem with the primary engine speed/timing sensor, perform the following procedure:

a. Measure the sensor's resistance between J401-2 (Primary engine speed/timing positive) and J401-1 (Primary engine speed/timing negative).

Resistance ..... 75 to 230 Ohms

D. If you are troubleshooting a problem with the primary engine speed/timing sensor, perform the following procedure:

a. Measure the sensor's resistance between J402-2 (Secondary engine speed/timing positive) and J402-1 (Secondary engine speed/timing negative).

Resistance ..... 600 to 1800 Ohms

Expected Result:

The readings are within the specifications.

Results:

- OK – The readings are within the specifications. Proceed to Test Step 5.
- Not OK – The readings are not within the specifications.

Repair: Perform the following procedure in order to check and install the new sensor:

1. Before you install the new sensor, measure the resistance of the new sensor.

If the new sensor resistance is within the specification, install the new sensor in the engine according to the following procedure:

a. Loosen the bolt and remove the bolt that holds the sensor mounting bracket to the engine.

b. Ensure that one O-ring is installed on the new sensor. Verify that the O-ring is free of damage.

c. Seat the sensor and tighten the bolt.

If the sensor will not seat, repair the sensor or replace the sensor, as required.

Note: Do not remove the sensor from the bracket.

d. Ensure that the sensor is properly oriented and that the harness is secured in the proper location.

2. Verify that the repair eliminates the problem.

STOP.

Test Step 5. Install the Bypass Harness for the Engine Speed/Timing Sensors

A. Turn the key switch to the OFF position.

B. Disconnect the J2/P2 ECM connector.

C. Use the following procedure for the primary engine speed/timing sensor:

a. Fabricate a harness from two wires. The wires must reach between the primary engine speed/timing sensor and the P2 connector. Twisted pair wiring is required. Ensure that the wires have at least one twist per inch.

b. Connect one wire of the harness between P2-35 and P401-2.

c. Connect the other wire between P2-25 and P401-1.

D. Use the following procedure for the primary engine speed/timing sensor:

a. Fabricate a harness from two wires. The wires must reach between the secondary engine speed/timing sensor and the P2 connector. Twisted pair wiring is required. Ensure that the wires have at least one twist per inch.

b. Connect one wire of the harness between P2-46 and P402-2.

c. Connect one wire of the harness between P2-47 and P402-1.

E. Reconnect the P2 connector.

F. Attempt to start the engine. Verify that the original problem is resolved.

Expected Result:

The problem is corrected with the installation of the bypass harness.

Results:

- OK

  Repair: Permanently install a new section of harness.

  STOP.

- Not OK

  Repair: Verify that the correct terminals have been installed in the correct location on the P2 ECM connector. If the temporary harness was installed correctly, remove the temporary harness. Connect the original wiring.

  Proceed to Test Step 6.

Test Step 6. Check the ECM

A. Turn the key switch to the OFF position.

B. Temporarily connect a test ECM.

C. Start the engine. Run the engine in order to repeat the conditions when the problem occurs.

D. If the problem is resolved with the test ECM, reconnect the suspect ECM.

E. If the problem returns with the suspect ECM, replace the ECM.

Verify that the repair eliminates the problem.

Expected Result:

The problem remains with the suspect ECM.

Results:

- OK

  Repair: If the problem is resolved with the test ECM and the problem returns with the suspect ECM, replace the ECM.

  Verify that the repair eliminates the problem.

  STOP.

- Not OK

  Repair: Replace the sensor.

  Verify that the repair eliminates the problem.

  STOP.

i02289806

Engine Temperature Sensor Open or Short Circuit - Test

SMCS Code: 5574-038-TA

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the following sensors:

- Intake manifold air temperature sensor
- Coolant temperature sensor
- Fuel temperature sensor
- Auxiliary temperature sensor

This procedure covers the following diagnostic codes:

- 110-03 Engine Coolant Temperature open/short to +batt
- 110-04 Engine Coolant Temperature short to ground
- 172-03 Intake Manifold Air Temp open/short to +batt
- 172-04 Intake Manifold Air Temp short to ground
- 174-03 Fuel Temperature open/short to +batt

- 174-04 Fuel Temperature short to ground
- 1836-03 Auxiliary Temperature Sensor open/short to +batt
- 1836-04 Auxiliary Temperature Sensor short to ground

The troubleshooting procedures for the diagnostic codes of each temperature sensor are identical. The temperature sensors are passive sensors that have two terminals. The temperature sensors do not require supply voltage from the Electronic Control Module (ECM).

Pull-up Voltage

The ECM continuously outputs a pull-up voltage on the circuit for the sensor signal wire. The ECM uses this pull-up voltage in order to detect an open in the signal circuit. When the ECM detects the presence of a voltage that is above a threshold on the signal circuit, the ECM will generate an open circuit diagnostic code (03) for the sensor.

If the sensor is disconnected at the sensor connector, the presence of pull-up voltage at the sensor connector indicates that the wires from the sensor connector to the ECM are not open or shorted to ground. If the sensor is disconnected at the sensor connector, the absence of pull-up voltage at the sensor connector indicates an open in the signal wire or a short to ground. If the sensor is disconnected at the sensor connector and the voltage at the sensor connector is different from pull-up voltage, the signal wire is shorted to another wire in the harness.

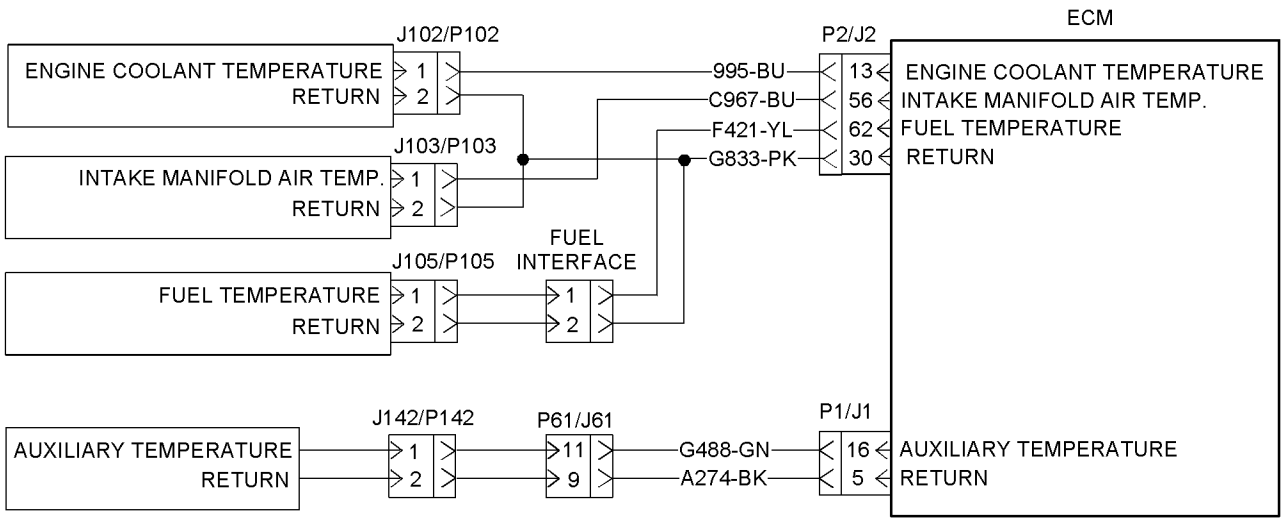
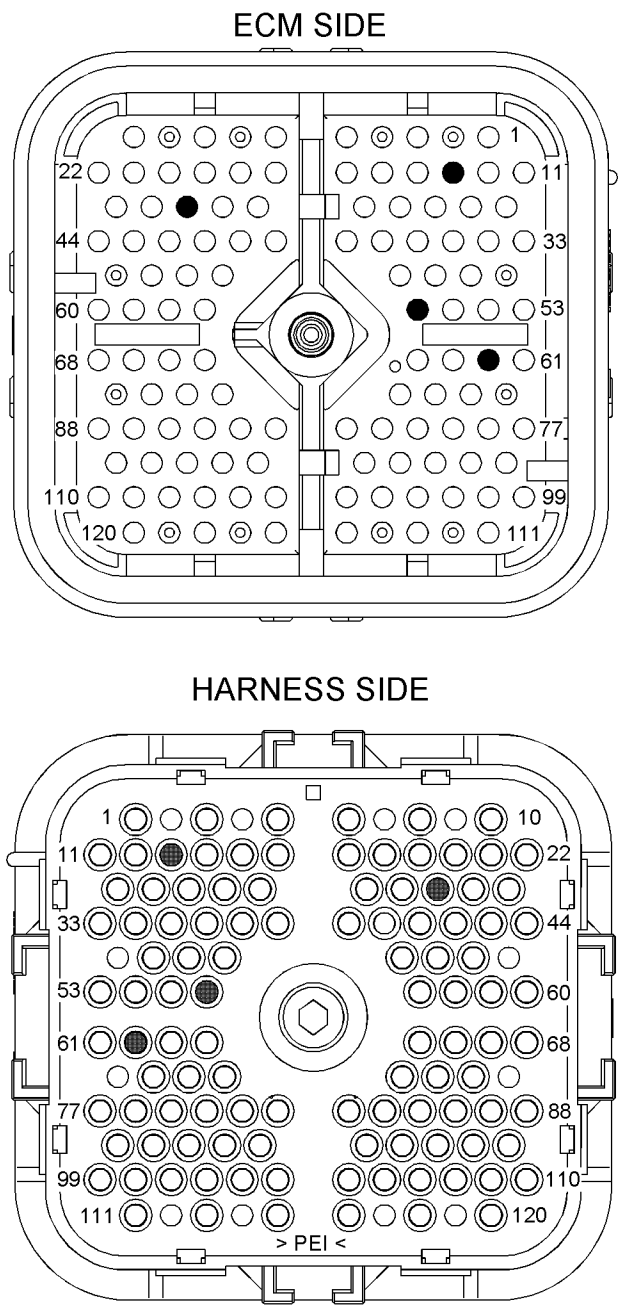


Illustration 66 g01146237

Schematic for the engine temperature sensors

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Turn the keyswitch to the OFF position.

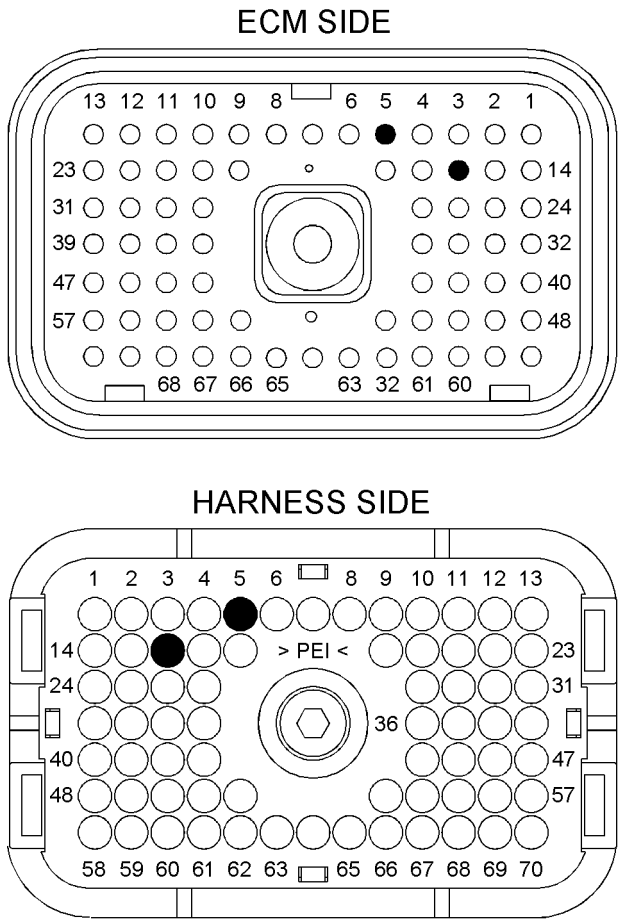


g01146245

Illustration 67

P2 ECM connector

(P2-13) Engine coolant temperature
(P2-30) Return
(P2-56) Intake manifold air temperature
(P2-62) Fuel temperature



g01146109

Illustration 68

P1 terminals that are associated with the auxiliary temperature sensor

(P1-5) Return
(P1-16) Auxiliary temperature

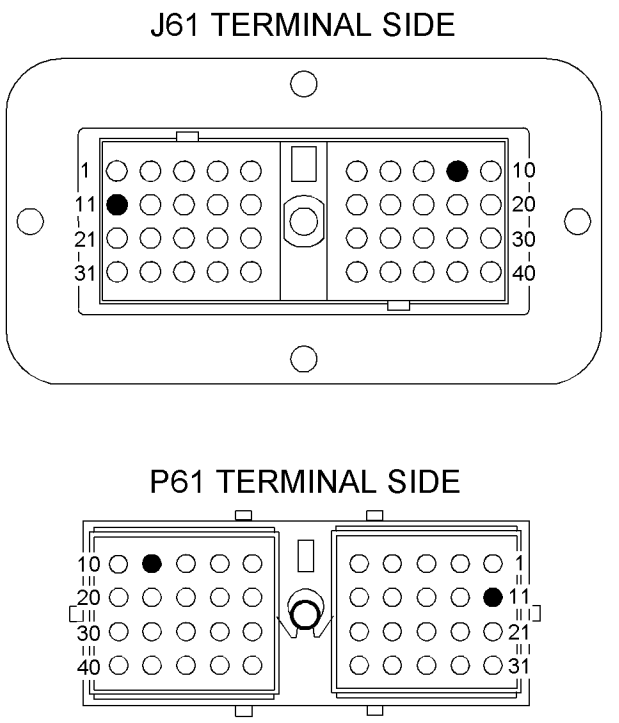


Illustration 69 g01146110

J61 and P61 terminals that are associated with the auxiliary temperature sensor

(9) Return
(11) Auxiliary temperature

B. Thoroughly inspect the ECM connectors and the connectors for the suspect sensor. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the temperature sensors.

D. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the allen head screw on the customer connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

F. Check the harness and wiring for abrasions and for pinch points from each sensor to the ECM.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted. The harness and wiring are free of corrosion, of abrasion, and of pinch points.

Results:

- OK – The connectors and wiring are OK. Proceed to Test Step 2.
- Not OK – There is a problem in the connectors and/or wiring.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled.

  Verify that the repair eliminates the problem.

  STOP.

Test Step 2. Check for Active Diagnostic Codes

A. Connect the electronic service tool to the service tool connector.

B. Turn the keyswitch to the ON position.

C. Monitor the active diagnostic code screen on the electronic service tool. Check and record any active diagnostic codes.

Note: Wait at least 15 seconds in order for the diagnostic codes to become active.

D. Look for an 03 diagnostic code or an 04 diagnostic code.

Expected Result:

No diagnostic codes are active.

Results:

- OK – No diagnostic codes are active.

  Repair: The problem may have been related to a faulty connection in the harness. Carefully reinspect the connectors and wiring. Refer to Troubleshooting, “Electrical Connectors - Inspect” for additional information.

  STOP.

- Not OK – An 03 diagnostic code is active at this time. Proceed to Test Step 3.
- Not OK – An 04 diagnostic code is active at this time. Proceed to Test Step 6.

Test Step 3. Check the Pull-up Voltage at the Sensor Connector

A. Disconnect the suspect sensor at the sensor connector.

B. Turn the keyswitch to the ON position.

C. Measure the voltage between terminal 1 (signal) and terminal 2 (sensor common) at the sensor connector.

D. Turn the keyswitch to the OFF position.

Expected Result:

The voltage is 5.5 ± 0.5 VDC.

Results:

- OK – The voltage is 5.5 ± 0.5 VDC. The correct pull-up voltage is present at the suspect sensor connector.

  Repair: The open circuit is in the sensor or the wire between the sensor and the sensor connector. Replace the sensor. Do not install the sensor in the engine. Verify that no diagnostic codes are active for the suspect sensor before permanently installing the sensor.

  STOP.

- Not OK – The voltage is not 5.5 ± 0.5 VDC. Proceed to Test Step 4.

Test Step 4. Check the Signal Wire for a Short Circuit

A. Turn the keyswitch to the OFF position.

B. Disconnect the P2 connector.

C. Measure the resistance between the terminal for the sensor signal wire at the ECM and the remaining terminals on the P2 connector.

D. Measure the resistance between the terminal for the sensor signal wire at the ECM and engine ground.

E. Turn the keyswitch to the OFF position.

F. Reconnect the P2 connector.

Expected Result:

Each check of the resistance is greater than 20,000 Ohms.

Results:

- OK – Each check of the resistance is greater than 20,000 Ohms. Proceed to Test Step 5.

- Not OK – At least one check of the resistance is less than 20,000 Ohms.

  Repair: The low resistance measurement indicates a short circuit between two or more wires. Repair the connectors or wiring and/or replace the connectors or wiring.

  STOP.

Test Step 5. Create a Short at the Suspect Sensor Connector

A. Turn the keyswitch to the OFF position.

B. Install a jumper wire between terminal 1 and terminal 2 on the connector for the suspect sensor. Connect the jumper on the harness side of the connector.

C. Turn the keyswitch to the ON position.

D. Wait at least 15 seconds for activation of the 04 diagnostic code.

Note: Monitor the “Active Diagnostic Codes” screen on the electronic service tool before installing the jumper wire and after installing the jumper wire.

E. Remove the jumper wire. Check for an 04 diagnostic code again.

F. Turn the keyswitch to the OFF position.

Expected Result:

An 04 diagnostic code is active when the jumper wire is installed. An 03 diagnostic code is active when the jumper wire is removed.

Results:

- OK – The engine harness and the ECM are okay.

  Repair: Temporarily connect a new sensor to the harness, but do not install the new sensor in the engine. Verify that there are no active diagnostic codes for the sensor. If there are no active diagnostic codes for the sensor, permanently install the new sensor. Clear any logged diagnostic codes.

  STOP.

- Not OK – The 03 diagnostic code remains active with the jumper in place. There is an open circuit between the ECM and the sensor connector. Proceed to Test Step 7.

Test Step 6. Disconnect the Suspect Sensor in Order to Create an Open Circuit

A. Turn the keyswitch to the OFF position.

B. Disconnect the suspect sensor from the harness at the sensor connector.

C. Turn the keyswitch to the ON position. Wait at least 15 seconds for activation of the diagnostic codes.

D. Access the “Active Diagnostic Codes” screen on the electronic service tool and check for an active 03 diagnostic code for the suspect sensor.

E. Turn the keyswitch to the OFF position.

Expected Result:

An 03 diagnostic code is now active for the suspect sensor.

Results:

- OK – An 04 diagnostic code was active before disconnecting the sensor. An 03 diagnostic code became active after the sensor was disconnected.

  Repair: Temporarily connect a new sensor to the harness, but do not install the new sensor in the engine. Verify that there are no active diagnostic codes for the sensor. If there are no active diagnostic codes for the sensor, permanently install the new sensor. Clear any logged diagnostic codes.

  Verify that the repair eliminates the problem.

  STOP.

- Not OK – The 04 diagnostic code is still present. Leave the sensor disconnected. Proceed to Test Step 7.

Test Step 7. Check the Operation of the ECM

A. Turn the keyswitch to the OFF position.

B. Check the operation of the ECM by creating an open at the ECM.

  a. Remove the signal wire for the suspect sensor from the P2connector.

  b. Remove the sensor return from terminal P2-30.

Note: Disconnecting the sensor return from the ECM will generate an 03 diagnostic code for all sensors that are connected to the sensor return. Troubleshoot the original diagnostic code. Delete the logged diagnostic codes when you are finished.

  c. Turn the keyswitch to the ON position. Monitor the “Active Diagnostic Code” screen on the electronic service tool. Wait at least 15 seconds for activation of the code.

  An 03 diagnostic code should be active for the suspect sensor.

C. Check the operation of the ECM by creating a short at the ECM.

  a. Install a wire jumper between the terminals for the sensor signal and the sensor return.

  b. Monitor the “Active Diagnostic Code” screen on the electronic service tool. Wait at least 15 seconds for activation of the code.

  An 04 diagnostic code should be active when the wire jumper is installed.

  c. Remove the wire jumper and reconnect all wires.

Expected Result:

An 03 diagnostic code is active when the sensor signal wire is removed from the ECM connector. An 04 diagnostic code is active when the signal wire is connected to the sensor return.

Results:

- OK – The ECM is working properly. The problem is in the wiring between the ECM and the sensor connector.

  Repair: If the code is active for more than one sensor, the problem is most likely in the return wire for the sensor. Repair the return wire for the sensor or replace the harness.

  If the code is only active for one sensor, the problem is most likely in the signal wire for the sensor. Repair the signal wire for the sensor.

  STOP.

- Not OK – One of the following conditions exists: The 03 diagnostic code is not active when the sensor signal wire is disconnected. The 04 diagnostic code is not active when the wire jumper is installed.

  Repair: Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”. Verify that the problem is resolved.

  STOP.

i02290014

Ether Injection System - Test

SMCS Code: 1456-038

System Operation Description:

Before you test the ether injection system, remove the ether canister from the system.

Use this procedure to troubleshoot any suspect problems with the ether injection system.

This procedure covers the following diagnostic codes:

- 2417-05 Ether Injection Control Solenoid open/short to +batt
- 2417-06 Ether Injection Control Solenoid short to ground

The ether injection system improves cold weather starting of the engine. The Electronic Control Module (ECM) controls the ether injection system. The ether injection system has two operating modes. The ether injection system can operate in automatic mode and in manual mode. The ether injection system is disabled if there is an active engine shutdown.

In the automatic mode, the ECM energizes the ether relay in cycles of six seconds. First, the ether is turned ON for three seconds. Then, the ether is then turned OFF for three seconds.

In the automatic mode, the ether injection system is enabled when all of the following conditions occur:

- “Ether” is programmed to the ON position in the configuration screen.
- The intake manifold air temperature is less than 0 °C (32 °F) or the engine coolant temperature is less than 0 °C (32 °F).
- The engine has not been within 50 rpm of low idle for more than ten seconds.
- Engine speed is between 35 rpm and at least 100 rpm below the low idle speed.
- No diagnostic codes are active for the engine coolant temperature sensor and the intake manifold air temperature sensor.

Manual mode is activated by pressing the ether starting aid switch. One 6 cc (0.36 in^3) shot of ether is injected when the ether starting aid switch is pressed. In the manual mode, the ether injection system is enabled when all of the following conditions are met:

- The ether starting aid switch is pressed.
- The intake manifold air temperature is less than 10 °C (50 °F).
- Engine speed is greater than 35 rpm and less than 1200 rpm.
- There are no active diagnostic codes for both the engine coolant temperature sensor and the intake manifold air temperature sensor.

A test on the Caterpillar Electronic Technician (ET) allows the technician to activate the ether system. The test is functional when the engine speed is 0 rpm. The test can be activated by selecting the “Override Parameters” screen on Cat ET.

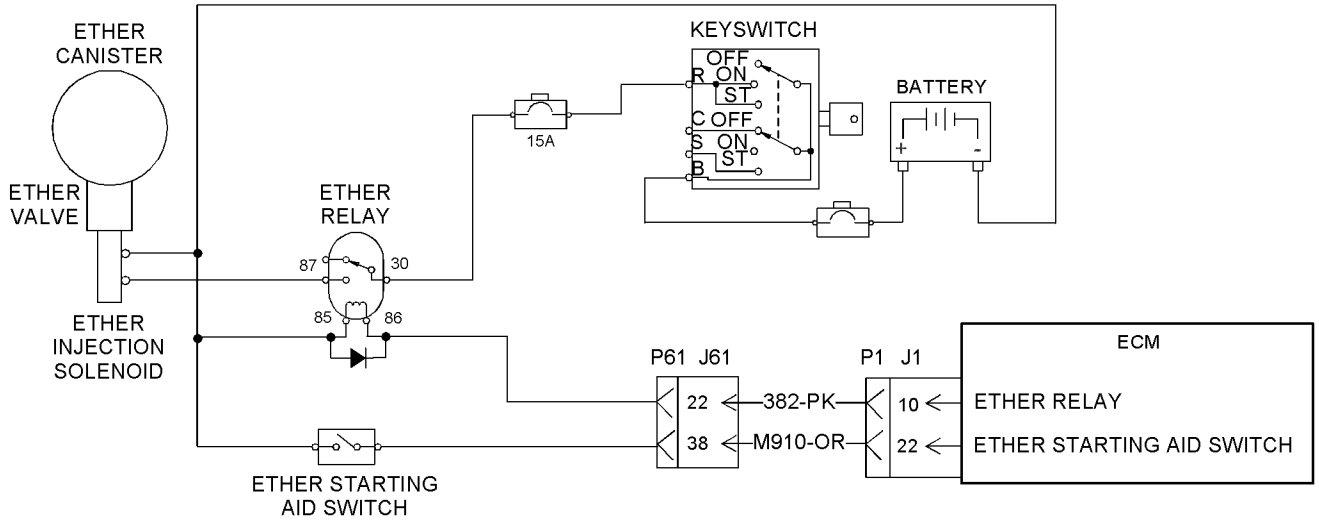


Illustration 70 g01121249

Schematic of the ether injection system

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Turn the keyswitch to the OFF position.

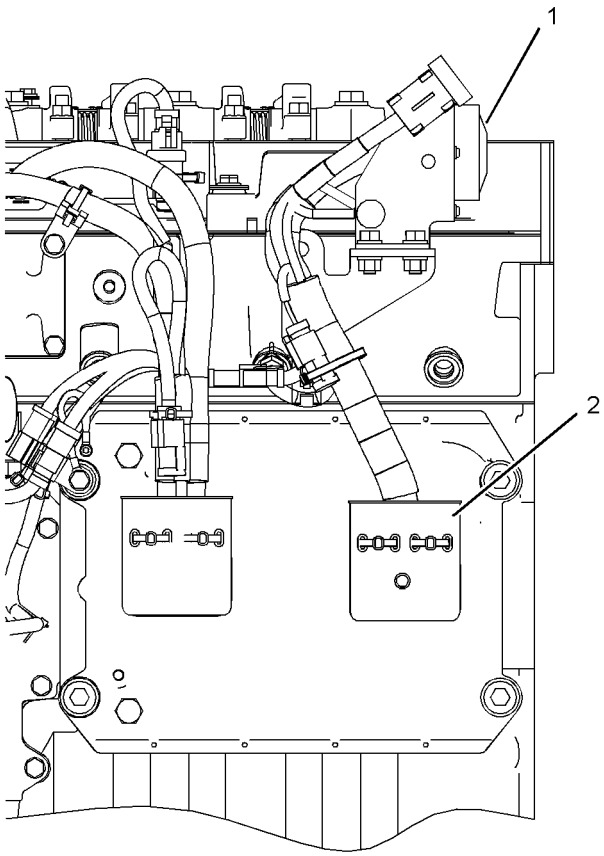


Illustration 71 g01120532

Engine components for the ether injection system

(1) P61 customer connector
(2) J1/P1 ECM connectors

B. Thoroughly inspect connectors (1) and (2). Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect”.

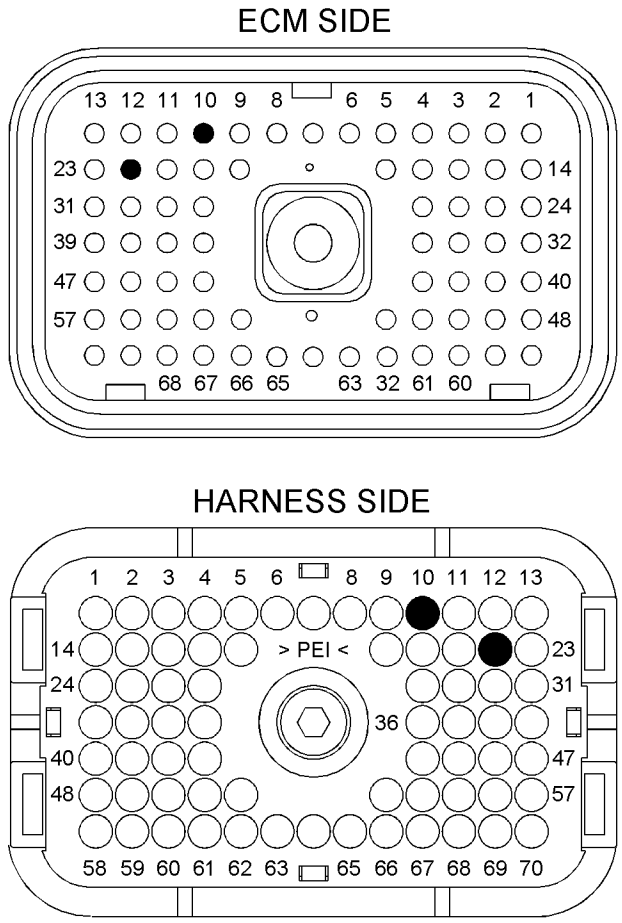


Illustration 72 g01121244

P1 terminals for the ether injection system

(P1-10) Ether relay
(P1-22) Ether starting aid switch

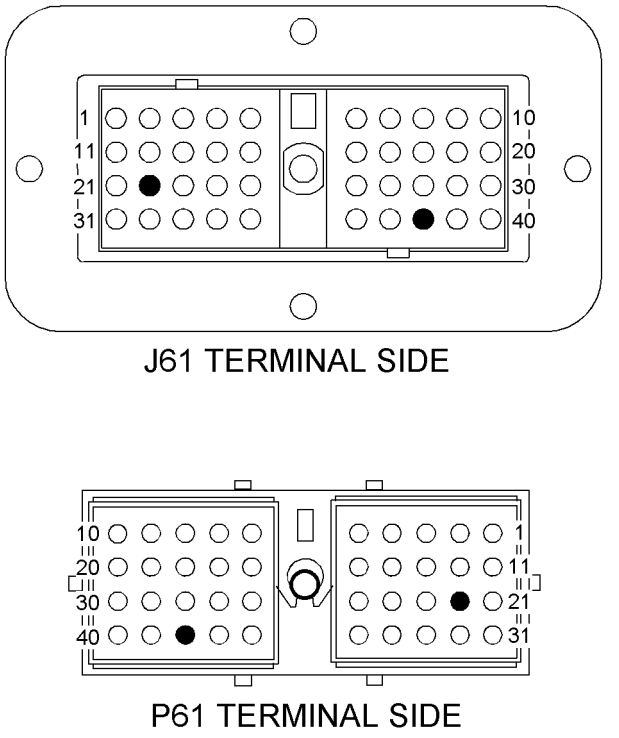


Illustration 73 g01120529

J61/P61 terminals for the ether injection system

(22) Ether relay
(38) Ether starting aid switch

C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the ether injection system.

D. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the allen head screw on the customer connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque value.

F. Check the harness and the wiring for abrasion and for pinch points from the ether injection solenoid to the ECM.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted, and the harness and wiring are free of corrosion, of abrasion or of pinch points.

Results:

- OK – The connectors and wiring are OK. Proceed to Test Step 2.

- Not OK – The connectors and/or wiring are not OK.

  Repair: Repair the wiring and/or the connectors. Replace parts, if necessary.

  Verify that the original problem is resolved.

  STOP.

Test Step 2. Check for Active Diagnostic Codes

A. Connect the Caterpillar Electronic Technician (ET) to the service tool connector. Refer to Troubleshooting, “Electronic Service Tools”.

B. Turn the keyswitch to the ON position.

C. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

Note: Wait at least 15 seconds in order for the diagnostic codes to become active.

D. Determine if the problem is related to an open circuit diagnostic code 05 or to a short circuit diagnostic code 06.

Expected Result:

No active codes are present.

Results:

- OK – No active codes are present. However, the ether injection system does not inject ether. Proceed to Test Step 3.
- Not OK – There is an active diagnostic code for the ether injection system. Proceed to Test Step 4.

Test Step 3. Check the Ether Canister

A. Turn the keyswitch to the OFF position.

B. Remove the ether canister from the ether valve. Determine if the canister is empty.

Expected Result:

The ether canister is not empty.

Results:

- OK – The ether canister is not empty. Do not install the ether canister. Proceed to Test Step 4.
- Not OK – The ether canister is empty.

  Repair: Replace the empty ether canister with a full ether canister. Verify that the original problem is resolved.

  STOP.

Test Step 4. Check the Voltage at the Ether Start Relay

A. Turn the keyswitch to the OFF position.

B. Connect Cat ET to the service tool connector.

C. Remove the ether canister from the ether valve.

D. Remove the wire from terminal 87 of the normally open contacts of the ether relay that goes to the ether injection solenoid.

E. Connect a voltmeter between terminal 87 of the ether relay and ground.

F. Turn the keyswitch to the ON position.

G. Select the “Diagnostic Tests” on Cat ET.

H. Select the “Override Parameters” screen on Cat ET.

I. Activate the ether override. The ECM will activate the ether injection system for ten seconds.

J. Measure the voltage at the ether relay while the ether injection system is activated.

K. Deactivate the ether override.

L. Turn the keyswitch to the OFF position.

M. Reconnect the wire to terminal 87 of the ether relay.

Expected Result:

The voltage at the ether relay is 24 ± 3 VDC.

Results:

- OK – The voltage at the ether relay is 24 ± 3 VDC. Proceed to Test Step 5.
- Not OK - 24 VDC – The voltage at the ether relay is not 24 ± 3 VDC. Proceed to Test Step 6.

Test Step 5. Check the Voltage at the Ether Injection Solenoid

A. Turn the keyswitch to the OFF position.

B. Disconnect the electrical connector for the ether injection solenoid.

C. At the harness connector for the ether injection solenoid, connect a voltmeter between terminal 1 and engine ground.

D. Turn the keyswitch to the ON position.

E. Select the “Diagnostic Tests” on Cat ET.

F. Select the “Override Parameters” screen on Cat ET.

G. Activate the ether override. The ECM will activate the override for ten seconds. Observe the voltmeter while the ether injection system is activated.

H. Deactivate the ether override.

I. Turn the keyswitch to the OFF position.

J. Connect all of the connectors.

Expected Result:

The voltage at the ether injection solenoid is 24 ± 3 VDC.

Results:

- OK – The voltage at the ether injection solenoid is 24 ± 3 VDC.

  Repair: Verify that the wire from the ether injection solenoid to the −Battery has continuity. If the wire is OK, replace the ether ether valve.

  STOP.

- Not OK – The voltage at the ether injection solenoid is not 24 ± 3 VDC.

  Repair: Inspect the wiring and connectors between the normally open contacts of the ether relay and the connector at the ether injection solenoid. Repair the connectors or wiring and/or replace the connectors or wiring.

  STOP.

Test Step 6. Check the Voltage at the Coil of the Ether Relay

A. Turn the keyswitch to the OFF position.

B. Disconnect the wire from terminal 86 of the ether relay.

C. Connect a voltmeter between the end of the wire and engine ground.

D. Turn the keyswitch to the ON position.

E. Select the “Diagnostic Tests” on Cat ET.

F. Select the “Override Parameters” screen on Cat ET.

G. Activate the ether override. The ECM will activate the override for ten seconds. Observe the voltmeter while the ether injection system is activated.

H. Deactivate the ether override.

I. Turn the keyswitch to the OFF position.

J. Connect the wire to terminal 86 of the ether start relay.

Expected Result:

The voltage measures 24 ± 3 VDC.

Results:

- OK – The voltage was 24 ± 3 VDC. Proceed to Test Step 7.
- Not OK – The voltage was not 24 ± 3 VDC. Proceed to Test Step 9.

Test Step 7. Check the Voltage to the Normally Open Contacts of the Ether Relay from the Keyswitch

A. Turn the keyswitch to the ON position.

B. Measure the voltage between terminal 30 of the ether relay and ground.

C. Turn the keyswitch to the OFF position.

Expected Result:

The voltage is 24 ± 3 VDC.

Results:

- OK – The voltage is 24 ± 3 VDC.

  Repair: Verify that the wire from terminal 85 of the ether relay has continuity to the −Battery. If the wire is OK, replace the ether relay. Verify that the original problem is resolved.

  If the wire from terminal 85 of the ether start relay does not have continuity to the −Battery, repair the wire. Replace the wire, if necessary. Verify that the original problem is resolved.

  STOP.

- Not OK – The voltage is not 24 ± 3 VDC. Proceed to Test Step 8.

Test Step 8. Check the Voltage from the Keyswitch to the Ether Relay

A. Turn the keyswitch to the OFF position.

B. Remove the wire from terminal R of the keyswitch.

C. Turn the keyswitch to the ON position.

D. Measure the voltage between terminal B of the keyswitch and engine ground.

E. Measure the voltage between terminal R of the keyswitch and engine ground.

F. Turn the keyswitch to the OFF position.

Expected Result:

Voltage is present on terminal B and terminal R at the keyswitch.

Results:

- OK – Voltage is present on terminal B and terminal R at the keyswitch.

  Repair: If voltage is present on terminal R, repair the wire between the keyswitch and the ether relay. Verify that the circuit breaker is not tripped. Return all wiring to the original configuration. Verify that the problem is resolved.

  STOP.

- Not OK – Voltage is not present on terminal B at the keyswitch.

  Repair: If voltage is not present on terminal B, repair the wire between the +Battery and the keyswitch. Check the battery's no-load voltage. Return all wiring to the original configuration. Verify that the problem is resolved.

  STOP.

- Not OK – Voltage is not present on terminal R at the keyswitch.

  Repair: If voltage is present on terminal B of the keyswitch but not present on terminal R, replace the keyswitch. Return all wiring to the original configuration. Verify that the problem is resolved.

  STOP.

Test Step 9. Check the Output Driver for the Ether Relay

A. Turn the keyswitch to the OFF position.

B. Remove wire 382-PK from terminal P1-10. Install a jumper wire into terminal P1-10.

C. Connect a voltmeter between the −Battery and the other end of the jumper wire.

D. Turn the keyswitch to the ON position.

E. Select the "Diagnostic Tests" on Cat ET.

F. Select the "Override Parameters" screen on Cat ET.

G. Activate the ether override. The ECM will activate the override for ten seconds. Observe the voltmeter while the ether injection system is activated.

H. Deactivate the ether override.

I. Turn the keyswitch to the OFF position.

J. Remove the wire jumper and install wire 382-PK into P1-10.

Expected Result:

The voltage measured 24 ± 3 VDC.

Results:

- OK – The voltage measured 24 ± 3 VDC. Proceed to Test Step 10.

- Not OK – The voltage at the ECM is not 24 ± 3 VDC.

  Repair: Temporarily connect a test ECM. Check the operation of the ether injection system when the test ECM is installed. If the problem is resolved with the test ECM, connect the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Refer to Troubleshooting, "Replacing the ECM".

  STOP.

Test Step 10. Check for an Open from the ECM to the Coil of the Ether Relay

A. Turn the keyswitch to the OFF position.

B. Disconnect the wire on terminal 86 of the ether relay.

C. Disconnect ECM connector J1/P1.

D. Measure the resistance of the wire between terminal P1-10 and wire 382-PK at the ether relay.

E. Connect all wires.

Expected Result:

The resistance is less than 5 Ohms.

Results:

- OK – The resistance is less than 5 Ohms. Proceed to Test Step 11.
- Not OK – The resistance is greater than 5 Ohms.

  Repair: Repair the wire between terminal 86 of the ether relay and terminal P1-10. Verify that the original problem is resolved.

  STOP.

Test Step 11. Check for a Short in the Wire between the ECM and the Ether Relay

A. Turn the keyswitch to the OFF position.

B. Disconnect the wire on terminal 86 of the ether relay.

C. Disconnect the J1/P1 and J2/P2 connectors.

D. Measure the resistance between terminal P1-10 and all of the other terminal in the P1 and P2 connectors. Measure the resistance between wire P1-10 and engine ground.

E. Return the wiring to the original configuration.

Expected Result:

Each check of the resistance indicates an open circuit.

Results:

- OK – Each check of resistance indicates an open circuit.

  Repair: The problem may be intermittent. If the problem is intermittent, refer to Troubleshooting, “Electrical Connectors - Inspect”.

  STOP.

- Not OK – At least one check of the resistance does not indicate an open circuit. There is a problem with the wiring. There may be a problem with a connector.

  Repair: Repair the wiring and/or the connector. Replace parts, if necessary. Verify that the original problem is resolved.

  STOP.

i02290022

Injector Solenoid Circuit - Test

SMCS Code: 1290-038

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the injector solenoids.

Use this procedure for the following diagnostic codes:

- 1-05 Injector Cylinder 1 open circuit
- 1-06 Injector Cylinder 1 short
- 1-11 Injector Cylinder #1 fault
- 2-05 Injector Cylinder 2 open circuit
- 2-06 Injector Cylinder 2 short
- 2-11 Injector Cylinder #2 fault
- 3-05 Injector Cylinder 3 open circuit
- 3-06 Injector Cylinder 3 short
- 3-11 Injector Cylinder #3 fault
- 4-05 Injector Cylinder 4 open circuit
- 4-06 Injector Cylinder 4 short
- 4-11 Injector Cylinder #4 fault
- 5-05 Injector Cylinder 5 open circuit
- 5-06 Injector Cylinder 5 short
- 5-11 Injector Cylinder #5 fault
- 6-05 Injector Cylinder 6 open circuit
- 6-06 Injector Cylinder 6 short
- 6-11 Injector Cylinder #6 fault
- You have been directed to this procedure from Troubleshooting, “Troubleshooting without a Diagnostic Code”.

Perform this procedure under conditions that are identical to the conditions that exist when the problem occurs. Typically, problems with an injector solenoid occur when the engine is warm and/or when the engine is under vibration (heavy loads).

These engines have Electronic Unit Injectors (EUI) that are mechanically actuated and electronically controlled. The Engine Control Module (ECM) sends a 105 volt pulse to each injector solenoid. The pulse is sent at the proper time and at the correct duration for a given engine load and speed. The solenoid is mounted on top of the fuel injector body. The 105 volt pulse can be individually cut out to aid in troubleshooting misfire problems.

If an open is detected in the solenoid circuit, a diagnostic code is generated. The ECM continues to try to fire the injector. If a short is detected, a diagnostic code is generated. The ECM will disable the solenoid circuit. The ECM will periodically try to fire the injector. If the short circuit remains this sequence of events will be repeated until the problem is corrected.

An injector trim file must be programmed into the ECM for each cylinder. Refer to troubleshooting, “Injector Trim File”.

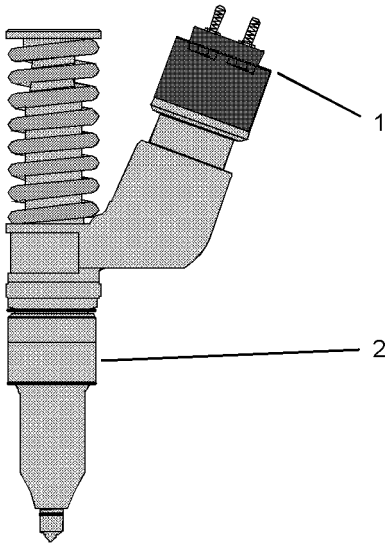


Illustration 74 g01102462

Electronic unit injector

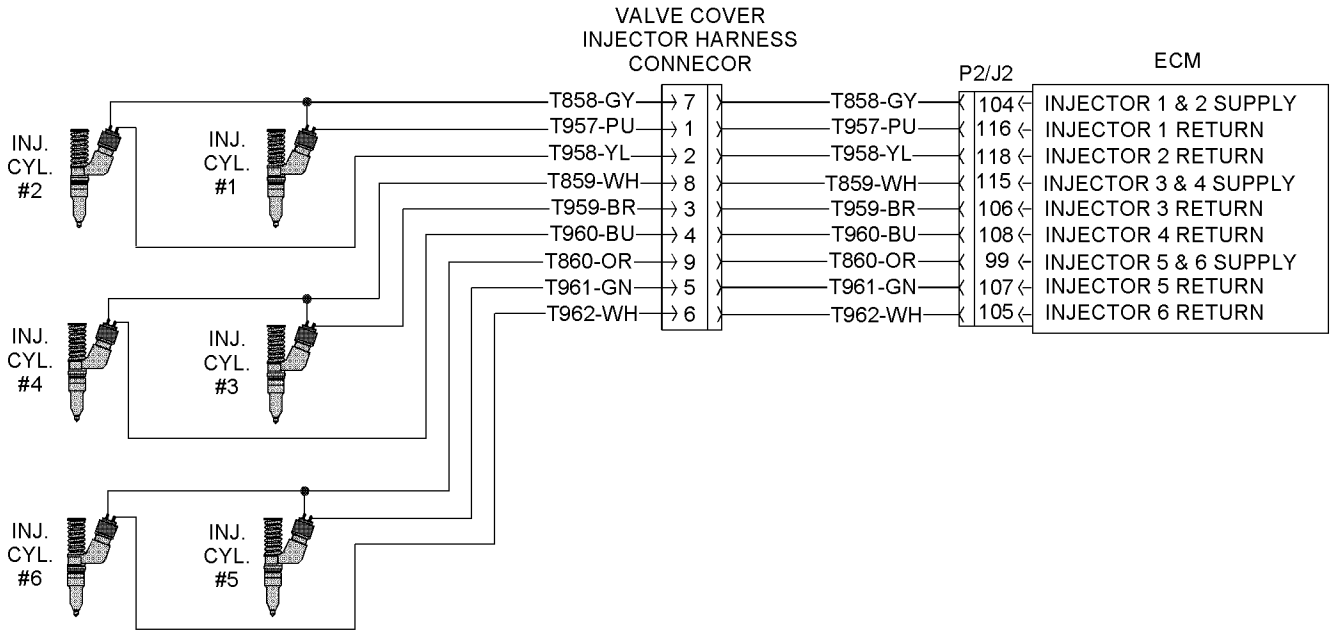
(1) Solenoid
(2) Injector

Cylinder Cutout Test

The “Cylinder Cutout Test” is used to isolate the malfunctioning injector in order to avoid replacement of good injectors. Use the “Cylinder Cutout Test” on the Caterpillar Electronic Technician (ET) to diagnose a malfunctioning injector while the engine is running. All active diagnostic codes must be repaired before running the “Cylinder Cutout Test”. When a good injector is cut out, the “Fuel Position” should change. The change in the fuel position is caused by the other injectors that are compensating for the cut out injector. If a malfunctioning injector is cut out, the “Fuel Position” will not change.

Injector Solenoid Test

The “Injector Solenoid Test” is used to isolate a malfunctioning injector in order to avoid replacement of good injectors. Use the “Injector Solenoid Test” on Cat ET to aid in diagnosing a diagnostic code while the engine is not running. The “Injector Solenoid Test” will send a signal to each solenoid. Cat ET will indicate the status of the solenoid as “OK”, “Open”, or “Short”. An open circuit or a short circuit in the common wire to two injector solenoids will cause two cylinders to have diagnostic codes.



g01102464

Illustration 75

Schematic diagram for the injector solenoids

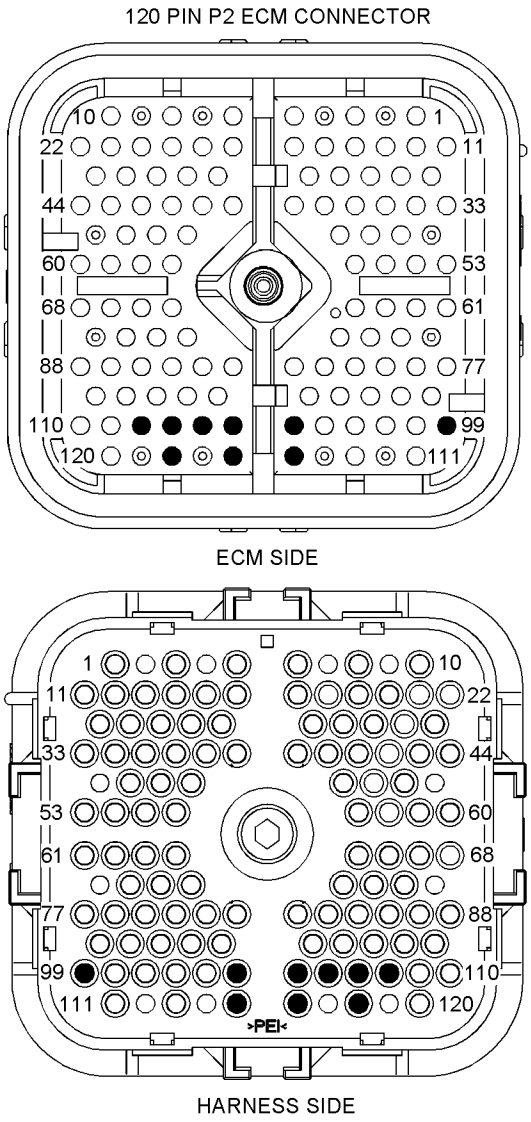


Illustration 76 g01099568

P2 ECM connector

(P2-99) “Injector 5 & 6 supply”
(P2-104) “Injector 1 & 2 supply”
(P2-105) “Injector 6 return”
(P2-106) “Injector 3 return”
(P2-107) “Injector 5 return”
(P2-108) “Injector 4 return”
(P2-115) “Injector 3 & 4 supply”
(P2-116) “Injector 1 return”
(P2-118) “Injector 2 return”

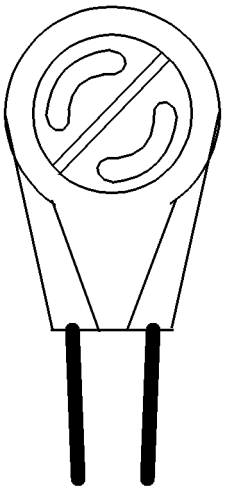


Illustration 77 g01001203

Harness connector for the injectors

Test Step 1. Inspect the Electrical Connectors and the Wiring

⚠ WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

A. Turn the key switch to the OFF position. A strong electrical shock hazard is present if the key switch is not turned off.

B. Thoroughly inspect the J2/P2 ECM connector. Thoroughly inspect the valve cover connector. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with injector solenoids.

D. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the harness and wiring for abrasion and for pinch points from the valve cover connector to the ECM.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted and the harness and wiring are free of corrosion, of abrasion, or of pinch points.

Results:

- OK – The harness and wiring are OK. Proceed to Test Step 2.
- Not OK – There is a problem in the connectors and/or wiring.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled.

  Verify that the repair eliminates the problem.

  STOP.

Test Step 2. Check for Logged Diagnostic Codes Regarding Injector Solenoids

A. Connect Cat ET to the service tool connector.

B. Turn the key switch to the ON position.

C. Check for logged diagnostic codes that are related to the injector solenoids on Cat ET.

Expected Result:

One or more diagnostic codes that are related to the injector solenoids have been logged.

Results:

- OK – One or more diagnostic codes are logged. Proceed to Test Step 4.
- Not OK – No diagnostic codes are logged. Proceed to Test Step 3.

Test Step 3. Check the Variation of the Injectors Between Cylinders

A. When possible, put the truck on a dynamometer.

B. Start the engine.

C. Allow the engine to warm up to the normal operating temperature.

D. After the engine is warmed up to the operating temperature, access the “Cylinder Cutout Test” by accessing the following display screens in order:

- “Diagnostics”
- “Diagnostic Tests”
- “Cylinder Cutout Test”

E. Enable the cooling fan, if the fan is not controlled by the ECM. If the ECM controls the cooling fan, the cooling fan will start automatically when the test begins.

F. Shut off all parasitic loads such as the air conditioning and the air compressors which could affect the results of the test.

G. Set the engine speed to 1000 ± 20 rpm.

H. Select the start button at the bottom of the screen for the cylinder cutout test on Cat ET.

I. Select the “4 Cylinder Cutout Test” which is the default test.

J. Follow the instructions that are provided in the cylinder cutout test. The cylinder cutout tests are interactive so you will be guided through the procedure.

Note: The “Manual Cylinder Cutout Test” is also available. Access the manual test by selecting the “Change” button on the screen for the cylinder cutout test. The “4 Cylinder Cutout Test” is the recommended starting procedure. The automated tests run twice collecting data. The two sets of data are analyzed and an “OK” or “Not OK” result is displayed.

K. Check for active diagnostic codes and for logged diagnostic codes that are related to the injector solenoids.

Expected Result:

All cylinders indicate “OK” on Cat ET.

Results:

- OK – All cylinders indicate “OK”.

  Repair: If the engine is misfiring or if the engine has low power, refer to Troubleshooting, “Engine Misfires, Runs Rough or Is Unstable” and Troubleshooting, “Low Power/Poor or No Response to Throttle”.

  If a diagnostic code results from running the Cylinder Cutout test, proceed to Test Step 4.

- Not OK – One or more cylinders displayed “Not OK” during the test. Proceed to Test Step 4.

Test Step 4. Use the “Injector Solenoid Test” to Test the Injector Solenoids

A. Start the engine.

B. Allow the engine to warm up to normal operating temperature.

C. Stop the engine.

D. Turn the key switch to the ON position.

E. Access the “Injector Solenoid Test” by accessing the following display screens in order:

- “Diagnostics”
- “Diagnostic Tests”
- “Injector Solenoid Test”

F. Activate the test.

Note: Do not confuse the “Injector Solenoid Test” with the “Cylinder Cutout Test”. The “Cylinder Cutout Test” is used to shut off fuel to a specific cylinder while the engine is running. The “Injector Solenoid Test” is used to actuate the injector solenoids. This allows the click of the injector solenoids to be heard when the engine is not running in order to determine that the circuit is functioning properly.

G. As each solenoid is energized by the ECM, an audible click can be heard at the valve cover.

H. Perform the “Injector Solenoid Test” at least two times.

Expected Result:

All cylinders indicate “OK”.

Results:

- OK – There is not an electronic problem with the injectors at this time.

  Repair: If the “Cylinder Cutout Test” returned a “Not OK” for any injector, refer to Troubleshooting, “Engine Misfires, Runs Rough or Is Unstable”.

  STOP.

- Open – Note the cylinders that indicate “Open”. Proceed to Test Step 5.

- Short – Note the cylinders that indicate “Short”. Proceed to Test Step 8.

Test Step 5. Check the Harness Between the ECM and the Valve Cover Base for an Open Circuit

⚠ WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

A. Turn the key switch to the OFF position. A strong electrical shock hazard is present if the key switch is not turned off.

B. Disconnect the connector from the valve cover base.

C. Turn the key switch to the ON position.

D. Fabricate a jumper wire 100 mm (4 inch) long with Deutsch pins on both ends of the wire.

E. Insert one end of the jumper wire into the common socket for the suspect injector on the harness connector. Insert the other end of the jumper wire into the socket for the suspect injector on the harness connector.

F. Perform the “Injector Solenoid Test” at least two times.

G. Repeat this test for each suspect injector. Stop the “Injector Solenoid Test” before handling the jumper wires.

Expected Result:

Cat ET displays “Short” for the cylinder with the jumper wire.

Results:

- OK – The harness between the ECM and the valve cover base is OK. Proceed to Test Step 6.
- Not OK – There is a problem between the ECM and the valve cover base. Proceed to Test Step 7.

Test Step 6. Check the Injector Harness under the Valve Cover

⚠ WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

A. Turn the key switch to the OFF position. A strong electrical shock hazard is present if the key switch is not turned off.

B. Remove the valve cover.

C. Disconnect the harness from the suspect injector. Disconnect the harness from the injector that shares the same injector common line.

Note: If both injectors that share a common wire indicate “Open”, inspect the common wire under the valve cover for problems. The open circuit is probably caused by an open in the common wire.

D. Thoroughly clean the terminals on both injectors and the harness connectors.

E. Exchange the harness between the two injectors that share the common line.

F. Turn the key switch to the ON position.

G. Perform the “Injector Solenoid Test” at least two times.

Expected Result:

Exchanging the harness between the two injectors caused the problem to move to the other injector on Cat ET.

Results:

- OK – The injector may be faulty.

  Repair: Replace the faulty injector.

  Restore the wiring to the proper injectors.

  Perform the “Injector Solenoid Test”.

  Verify that the repair eliminates the problem.

  STOP.

- Not OK – There is a problem with the injector harness under the valve cover.

  Repair: Repair the injector harness or replace the injector harness under the valve cover.

  Verify that the repair eliminates the problem.

  STOP.

Test Step 7. Check the ECM for an Open Circuit

⚠ WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

A. Turn the key switch to the OFF position. A strong electrical shock hazard is present if the key switch is not turned off.

B. Disconnect the P2 connector. Remove the two terminals for the suspect injector from the P2 connector.

C. Use a jumper wire to create a short circuit between the socket of the suspect injector and the common socket of the suspect injector. This will replace the engine wiring with a short circuit.

D. Turn the key switch to the ON position.

E. Perform the “Injector Solenoid Test” at least two times.

Expected Result:

Cat ET displays “Short” for the cylinder with the jumper wire.

Results:

- OK – Cat ET displays “Short” for the cylinder with the jumper wire. The ECM is OK.

  Repair: Repair the engine harness or replace the engine harness, as required.

  Verify that the repair eliminates the problem.

  STOP.

- Not OK – Cat ET does not display “Short” for the cylinder with the jumper wire. The ECM is not OK.

  Repair: Perform the following procedure:

  1. Remove the jumper wire and return the P2 wiring to the original configuration.
  2. Temporarily connect a test ECM.
  3. Perform the “Injector Solenoid Test”.

  If the test ECM fixes the problem, reconnect the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the repair eliminates the problem.

  STOP.

Test Step 8. Check the Harness between the ECM and the Valve Cover Base for a Short Circuit

⚠ WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

A. Turn the key switch to the OFF position. A strong electrical shock hazard is present if the key switch is not turned off.

B. Disconnect the connector from the valve cover base.

C. Turn the key switch to the ON position.

D. Perform the “Injector Solenoid Test” at least two times.

Expected Result:

All cylinders indicate “Open”.

Results:

- OK – All cylinders indicate “Open”. Proceed to Test Step 10.
- Not OK – One or more cylinders indicate “Short”. Note the cylinders that indicate “Short”. Proceed to Test Step 9.

Test Step 9. Check the ECM for a Short Circuit

⚠ WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

A. Turn the key switch to the OFF position. A strong electrical shock hazard is present if the key switch is not turned off.

B. Disconnect the P2 connector. Check the P2 and J2 connectors for evidence of moisture entry.

C. Turn the key switch to the ON position.

D. Perform the “Injector Solenoid Test” at least two times.

Expected Result:

All cylinders indicate “Open” when the P2 connector is disconnected.

Note: When the engine harness is disconnected, all of the diagnostic codes for supply voltage to the sensors will be active. This is normal. Clear all of these diagnostic codes after completing this test step.

Results:

- OK – All cylinders indicate “Open” when the P2 connector is disconnected. The short circuit is in the engine harness.

  Repair: The problem is most likely in the common wire to the injector. Inspect the connectors for moisture and for corrosion. Also, check the common wire for exposed wires.

  Repair the engine harness or replace the engine harness, as required. Clear all diagnostic codes after completing this test step.

  Verify that the repair eliminates the problem.

  STOP.

- Not OK – All cylinders do not indicate “Open” when the P2 connector is disconnected. There may be a problem with the ECM.

  Repair: Perform the following procedure:

  1. Reconnect the P2 ECM connector.

  2. Temporarily connect a test ECM.

  3. Perform the “Injector Solenoid Test”.

  If the test ECM fixes the problem, reconnect the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the repair eliminates the problem.

  STOP.

Test Step 10. Check the Engine Harness under the Valve Cover for a Short Circuit

⚠ WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

A. Turn the key switch to the OFF position. A strong electrical shock hazard is present if the key switch is not turned off.

B. Remove the valve cover.

C. Disconnect each of the injectors that indicate a “Short” from the wiring harness. Ensure that the disconnected connectors do not touch other components and create a short circuit.

D. Turn the key switch to the ON position.

E. Perform the “Injector Solenoid Test” at least two times.

Expected Result:

All of the injectors that were disconnected indicate “Open”.

Results:

- OK – All of the injectors that were disconnected indicate “Open”. The common wire is not shorted to the engine.

Repair: Leave the injector wires disconnected.

Proceed to Test Step 11.

- Not OK – One or more of the injectors that were disconnected indicate “Short”.

  Repair: The problem is most likely in the common wire to the injector. Inspect the connectors for moisture and for corrosion. Also, check the common wire for exposed wires.

  Repair the injector harness or replace the injector harness under the valve cover.

  Verify that the repair eliminates the problem.

  STOP.

Test Step 11. Check for a Short Circuit in the Return Wire

⚠ WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

A. Turn the key switch to the OFF position. A strong electrical shock hazard is present if the key switch is not turned off.

B. Disconnect the P2 connector.

C. Measure the resistance between the terminal for the common line for the problem injector in the P2 connector and engine ground.

Expected Result:

The resistance is greater than 10 Ohms.

Results:

- OK – The resistance is greater than 10 Ohms.

  Repair: Reconnect the J2/P2 connectors.

  Replace the faulty injector.

  Perform the “Injector Solenoid Test”.

  Verify that the repair eliminates the problem.

  STOP.

- Not OK – There is a short in the return line.

  Repair: Disconnect the connector from the valve cover base.

  Measure the resistance of the return wire between the P2 connector and engine ground.

  If the resistance is less than 10 Ohms, the problem is in the return wire between the ECM and the valve cover base.

  If the resistance is greater than 10 Ohms, the problem is in the return wire under the valve cover.

  Repair the injector harness or replace the injector harness.

  Perform the “Injector Solenoid Test”.

  Verify that the repair eliminates the problem.

  STOP.

i02290030

Maintenance Due Lamp Circuit - Test

SMCS Code: 7431-038

System Operation Description:

Use this procedure in order to troubleshoot any suspect problems with the circuit for the maintenance due lamp.

The maintenance due lamp is a maintenance indicator that is based on the PM levels that are programmed into the Electronic Control Module (ECM). The lamp will turn ON when the programmed interval is met.

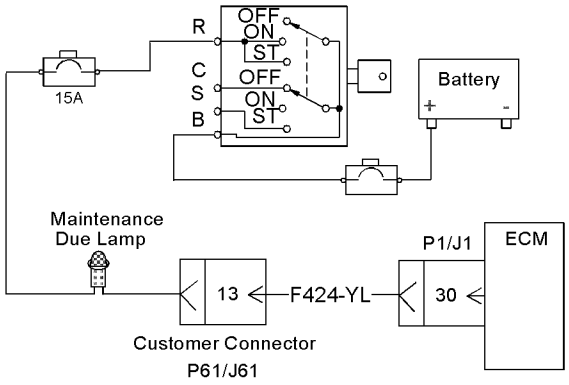


Illustration 78 g01102467

Schematic for the maintenance due lamp

The ECM provides a path to ground for the lamp. When the ECM connects the lamp to ground the lamp will turn on.

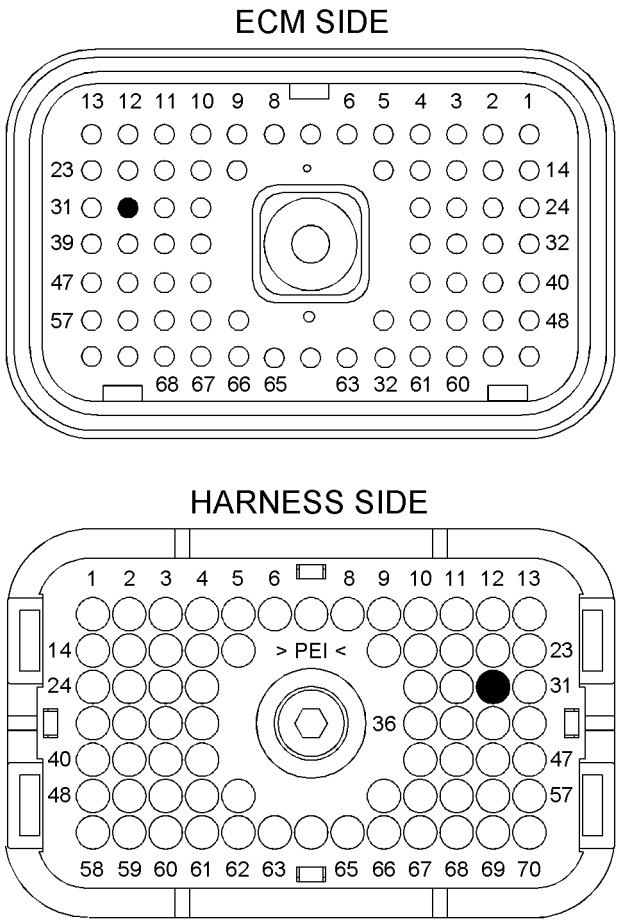


Illustration 79 g01102466

P1 connector

(P1-13) Maintenance due lamp

⚠ WARNING

The connection of any electrical equipment and the disconnection of any electrical equipment may cause an explosion hazard which may result in injury or death. Do not connect any electrical equipment or disconnect any electrical equipment in an explosive atmosphere.

Test Step 1. Check for Normal Operation of the Maintenance Due Lamp

A. Monitor the maintenance due lamp.

a. Turn the keyswitch to the ON position. The lamp should turn on for five seconds. Then, the lamp should turn off.

Note: The lamp will only turn off if a condition that requires maintenance does not exist.

Expected Result:

The maintenance due lamp turns on and the maintenance due lamp turns off per the above description.

Results:

- OK – The maintenance due lamp appears to operating correctly at this time. STOP.
- Not OK – The maintenance due lamp is not functioning correctly. Proceed to Test Step 2.

Test Step 2. Inspect Electrical Connectors and Wiring

A. Turn the keyswitch to the OFF position.

B. Thoroughly inspect the J61/P61 customer connector, and J1/P1 ECM connector. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the maintenance due lamp.

D. Check the allen head screw on the customer connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque value.

E. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

F. Check the harness and wiring for abrasions and for pinch points from the battery to the ECM.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted, and the harness and wiring are free of corrosion, of abrasion or of pinch points.

Results:

- OK – The connectors and wiring are OK. Proceed to Test Step 3.
- Not OK – There is a problem in the connectors and/or wiring.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled.

  Verify that the repair eliminates the problem.

  STOP.

Test Step 3. Test the Lamp Circuit

A. Disconnect the P1 connector.

B. Connect a jumper wire between wire F424-YL in terminal P1-30 and engine ground.

C. Turn the keyswitch to the ON position. Observe the lamp.

D. Remove the jumper wire and observe the lamp.

Expected Result:

The maintenance due lamp turns on while the jumper is connected. The maintenance due lamp turns off when the jumper is removed.

Results:

- OK – The maintenance due lamp circuit is functioning properly. Proceed to Test Step 6.
- Not OK – The lamp did not turn on. The lamp circuit is not functioning properly. Proceed to Test Step 4.

Test Step 4. Test the Circuit at the Maintenance Due Lamp

A. Disconnect wire F424-YL from the lamp.

B. Connect a jumper wire between the lamp’s empty terminal and engine ground.

C. Turn the keyswitch to the ON position. Observe the lamp.

D. Disconnect the jumper wire and observe the lamp.

Expected Result:

The lamp turns on while the jumper is connected. The lamp turns off when the jumper is disconnected.

Results:

- OK – The circuit for the lamp is functioning properly.

  Repair: Repair wire F424-YL between the lamp and terminal P1-30.

  STOP.

- Not OK – The lamp did not turn on. The lamp circuit is not functioning properly. Proceed to Test Step 5.

Test Step 5. Check the Voltage from the Keyswitch to the Maintenance Due Lamp

A. Turn the keyswitch to the OFF position.

B. Remove the wire from the terminal R of the keyswitch.

C. Turn the keyswitch to the ON position.

D. Measure the voltage on terminal B of the keyswitch to engine ground.

E. Measure the voltage on terminal R of the keyswitch to engine ground.

F. Turn the keyswitch to the OFF position.

Expected Result:

Voltage is present on terminal B and terminal R at the keyswitch.

Results:

- OK – Voltage is present on terminal B and terminal R at the keyswitch.

  Repair: If voltage is present on terminal R, repair the wire between the keyswitch and the maintenance due lamp. Verify that the breaker is not tripped. Return all wiring to the original configuration. Verify that the problem is eliminated.

  STOP.

- Not OK – Voltage is not present on terminal B at the keyswitch.

  Repair: If voltage is not present on terminal B, repair the wire between the +Battery and the keyswitch. Verify that the breaker is not tripped. Check the battery's no-load voltage. Return all wiring to the original configuration. Verify that the problem is eliminated.

  STOP.

- Not OK – Voltage is not present on terminal R at the keyswitch.

  Repair: If voltage is present on terminal B of the keyswitch but not present on terminal R, replace the keyswitch. Return all wiring to the original configuration. Verify that the problem is eliminated.

  STOP.

Test Step 6. Check the ECM

A. Remove wire F424-YL from terminal P1-30.

B. Fabricate a jumper wire 100 mm (4 inches) long. Crimp a Deutsch pin to both ends of the wire.

C. Insert one end of the jumper wire into terminal P1-30.

D. Connect one probe of a voltage test lamp to the wire jumper in terminal P1-30.

E. Connect the other probe of the voltage test lamp to +Battery.

F. Turn the keyswitch to the ON position.

Expected Result:

The test lamp turns ON for five seconds. Then, the test lamp turns OFF.

Results:

- OK – The ECM is operating correctly. The circuit appears to be operating correctly.

  Repair: The problem may be intermittent. If the problem is intermittent, refer to the diagnostic functional test Troubleshooting, "Electrical Connectors - Inspect".

  STOP.

- Not OK – The ECM is not sinking the current.

  Repair: Temporarily connect a test ECM. Check the operation of the maintenance due lamp when the test ECM is installed. If the problem is resolved with the test ECM, then reconnect the suspect ECM. If the problem returns with the suspect ECM, replace the ECM.

  STOP.

i02290038

PTO Switch Circuit - Test

SMCS Code: 7332-038

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the circuits for the power take-off controls (PTO). The PTO controls provide an alternative method of controlling the desired engine speed.

The Electronic Control Module (ECM) provides the PTO speed control function. The PTO speed control function requires the following inputs:

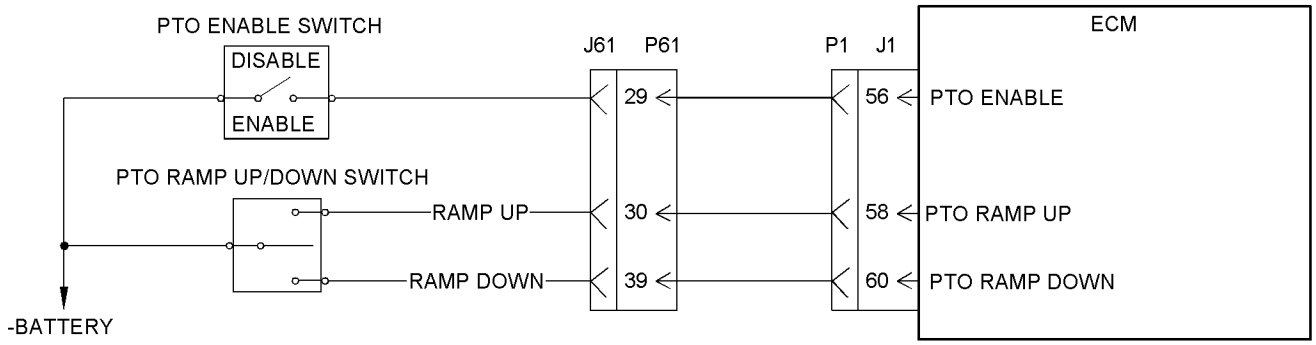
- PTO switches
- The “PTO Mode” parameter

The PTO switches enable the PTO speed control function and the PTO switches control the desired engine speed.

The “PTO Mode” parameter determines the mode of operation. There are two modes of operation: “Ramp Up/Ramp Down” and “Set/Resume”. Use the Caterpillar Electronic Technician (ET) in order to change the value of the parameter.

“Ramp Up/Ramp Down” Mode

This mode uses three inputs. The inputs are provided by two switches. Refer to Illustration 80.



g01121879

Illustration 80

Schematic for the PTO inputs for the “Ramp Up/Ramp Down” mode of operation

Placing the PTO Enable switch to the “Enable” position transfers the control of the desired engine speed from the throttle position sensor to the PTO speed control function. The PTO Ramp Up/Down switch controls the desired engine speed.

The PTO Ramp Up/Down switch is spring loaded to the normally open position. When the switch is held in the “Ramp Up” position, the desired engine speed increases according to the value of the “Engine Accel Rate” parameter. When the switch is released, the desired engine speed maintains the set speed. After the desired engine speed has been set, momentarily placing the switch in the “Ramp Up” position increases the desired engine speed by 20 rpm.

When the PTO Ramp Up/Down switch is held in the “Ramp Down” position, the desired engine speed decreases according to the value of the “Engine Accel Rate” parameter. When the switch is released, the desired engine speed maintains the set speed. After the desired engine speed has been set, momentarily placing the switch in the “Ramp Down” position decreases the desired engine speed by 20 rpm.

If the “PTO Ramp Up” and “PTO Ramp Down” inputs are connected to the −Battery at the same time, the ECM will ignore the inputs. The desired engine speed will not change.

“Set/Resume” Mode

This mode uses four inputs. The inputs are provided by three switches. Refer to Illustration 81.

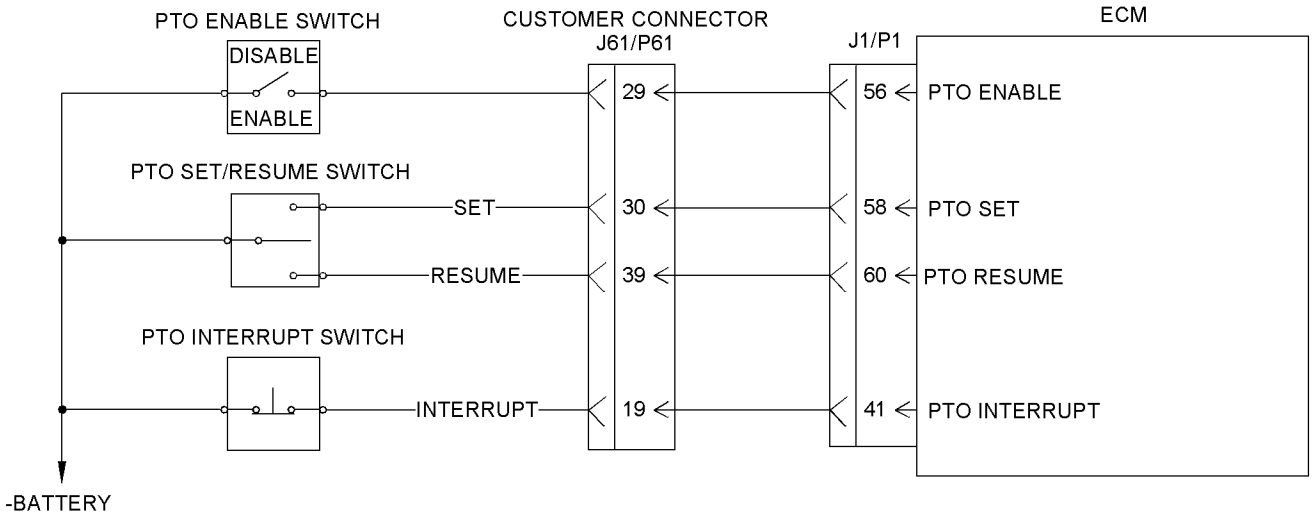


Illustration 81 g01105373

Schematic for the PTO inputs for the “Set/Resume” mode of operation

Placing the PTO Enable switch to the “Enable” position transfers the control of the desired engine speed from the throttle position sensor to the PTO speed control function. The PTO Interrupt switch momentarily transfers control back to the throttle position sensor. The PTO Set/Resume switch controls the desired engine speed.

The PTO Set/Resume switch is spring loaded to the normally open position. If the switch is momentarily placed in the “Set” position, the desired engine speed will be set to the current engine speed. If the switch is held in the “Set” position, the desired engine speed will increase according to the value of the “Engine Accel Rate” parameter. After the desired engine speed has been set, the desired engine speed will increase by 20 rpm when the PTO ramp up/down switch is momentarily placed in the “Set” position.

If the PTO Set/Resume switch is momentarily placed in the “Resume” position, the desired engine speed will be set to the current engine speed. If the switch is held in the “Resume” position, the desired engine speed will decrease according to the value of the “Engine Accel Rate” parameter. After the desired engine speed has been set, the desired engine speed will decrease by 20 rpm when the switch is momentarily placed in the “Resume” position.

If the “PTO Set” and “PTO Resume” inputs are connected to the −Battery at the same time, the ECM will ignore the inputs. The desired engine speed will not change.

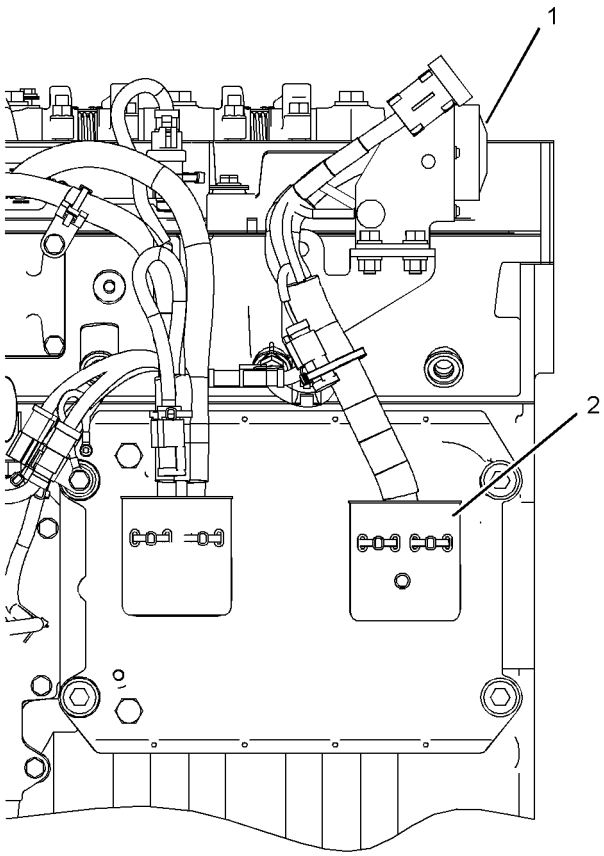


Illustration 82 g01120532

Left side view

(1) P61 customer connector
(1) J1/P1 ECM connectors

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Turn the keyswitch to the OFF position.

B. Thoroughly inspect connectors (1) and (2). Refer to Troubleshooting, “Electrical Connectors - Inspect”.

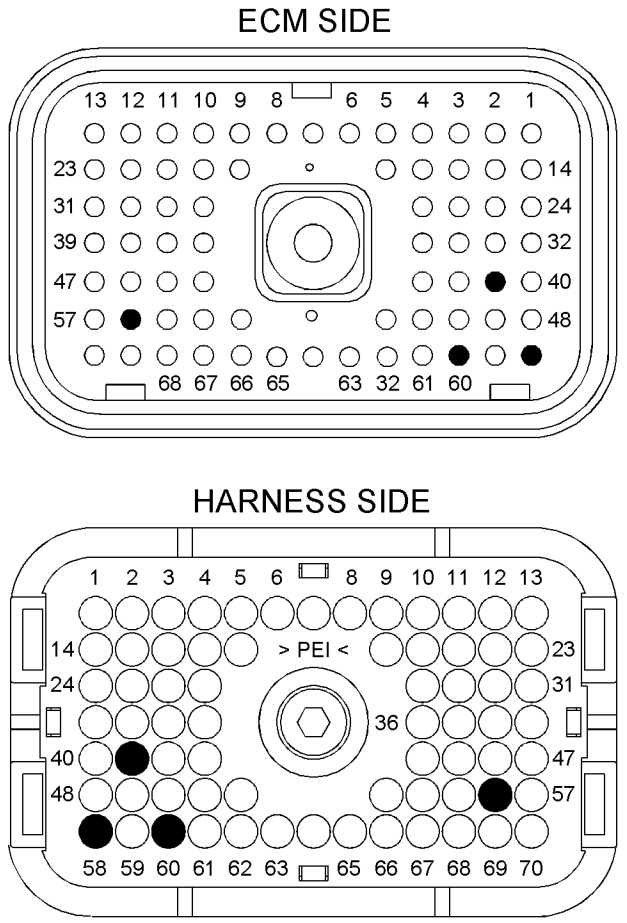


Illustration 83 g01102468

P1 terminals that are associated with the PTO

(P1-41) Input from the PTO interrupt switch
(P1-56) Input from the PTO enable switch
(P1-58) Input from the PTO ramp up switch (set)
(P1-60) Input for PTO ramp down switch (resume)

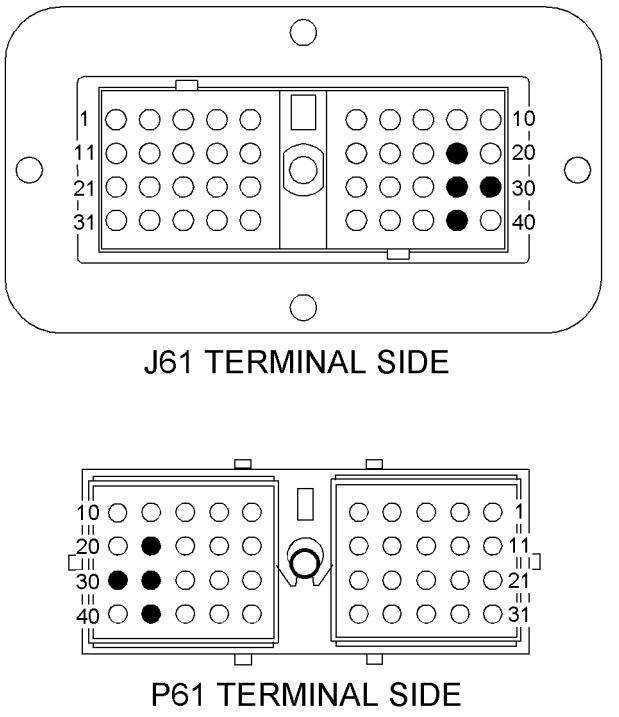


Illustration 84 g01123458

J61/P61 terminals that are associated with the PTO

(19) Input from the PTO interrupt switch
(29) Input from the PTO enable switch
(30) Input from the PTO ramp up switch (set)
(39) Input for PTO ramp down switch (resume)

C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuits for the PTO switches.

D. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the allen head screw on the customer connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque value.

F. Check the harness and wiring for abrasions and for pinch points from the battery to the ECM.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted, and the harness and wiring are free of corrosion, of abrasion or of pinch points.

Results:

- OK – The connectors and wiring are OK. If the engine is equipped with a customer connector, proceed to Test Step 2. Otherwise, proceed to Test Step 3.
- Not OK – There is a problem with the connectors and/or the wiring.

  Repair: Repair the wiring and/or the connectors. Replace parts, if necessary. Ensure that all of the seals are properly connected. Verify that the repair eliminates the problem.

  STOP.

Test Step 2. Check the Inputs from the Switches at the J61 Customer Connector

A. Disconnect the J61 connector.

B. Refer to Table 18. Connect a voltage test lamp between the input for the suspect switch circuit and terminal J61-31 (+Battery).

Table 18

J61 Terminals for the Inputs from the PTO Switches	
Switch	**J61 Terminals**
PTO Enable Switch	29
PTO Ramp Up Switch	58
PTO Ramp Down Switch	60
PTO Interrupt Switch	41

C. Observe the voltage test lamp as you operate the suspect switch.

Expected Result:

The voltage test lamp turns on when the switch is closed. The voltage test lamp turns off when the switch is opened.

Results:

- OK – The voltage test lamp turns on when the switch is closed. The voltage test lamp turns off when the switch is opened. The circuit is operating correctly. Connect the J61 connector. Proceed to Test Step 3.
- Not OK – The voltage test lamp does not turn on when the switch is closed. Alternatively, the voltage test lamp does not turn off when the switch is opened. There is a problem with the suspect switch and/or the wiring.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled.

  Verify that the repair eliminates the problem.

  STOP.

Test Step 3. Check the Inputs from the Switches at the J1 Connector

A. Disconnect the P1 connector.

B. Refer to Table 19. Connect a voltage test lamp between the input for the suspect switch circuit and terminal J1-48 (+Battery).

Table 19

J1 Terminals for the Inputs from the PTO Switches	
Switch	**J1 Terminals**
PTO Enable Switch	56
PTO Ramp Up Switch	58
PTO Ramp Down Switch	60
PTO Interrupt Switch	41

C. Observe the voltage test lamp as you operate the suspect switch.

Expected Result:

The voltage test lamp turns ON when the switch is closed. The voltage test lamp turns OFF when the switch is opened.

Results:

- OK – The voltage test lamp turns ON when the switch is closed. The voltage test lamp turns OFF when the switch is opened. The switch circuit is operating correctly. The problem may be in the ECM.

  Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the problem is not resolved, temporarily install a new ECM. Refer to Troubleshooting, “Replacing the ECM”.

  If the problem is resolved with the new ECM, install the original ECM and verify that the problem returns. IF the new ECM operates correctly and the original ECM does not operate correctly, replace the original ECM.

  STOP.

- Not OK – The voltage test lamp does not turn on when the switch is closed. Alternatively, the voltage test lamp does not turn off when the switch is opened. There is a problem in the wiring between the J1 connector and the switch. There may be a problem in a connector.

  Repair: Repair the wiring and/or the connector. Replace parts, if necessary. Verify that the repair eliminates the problem.

  STOP.

i02290046

Switch Circuits - Test

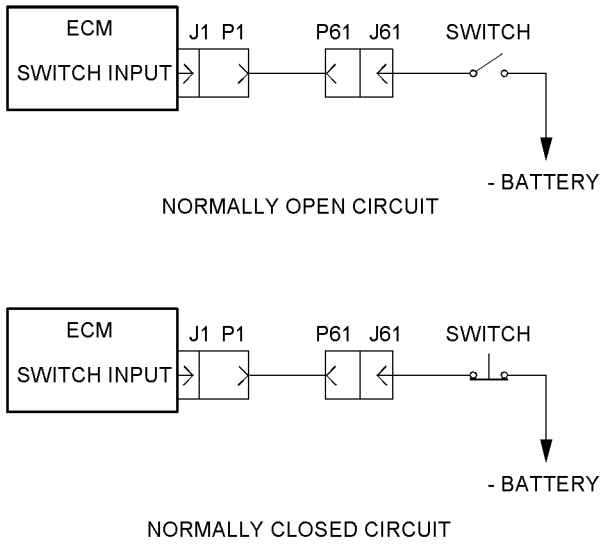
SMCS Code: 1435-038

System Operation Description:

Switch circuits may have problems such as faulty wiring, faulty switches, or faulty connectors. Use the following diagnostic procedures in order to diagnose problems with these switch circuits and repair these switch circuits:

- Maintenance clear switch
- Torque limit switch
- Ether starting aid switch
- PTO interrupt switch
- Remote shutdown switch
- Intermediate engine speed switch
- Overspeed verify switch
- PTO enable switch
- PTO ramp up switch
- PTO set switch
- PTO ramp down switch
- PTO resume switch

The switches are normally open or normally closed.



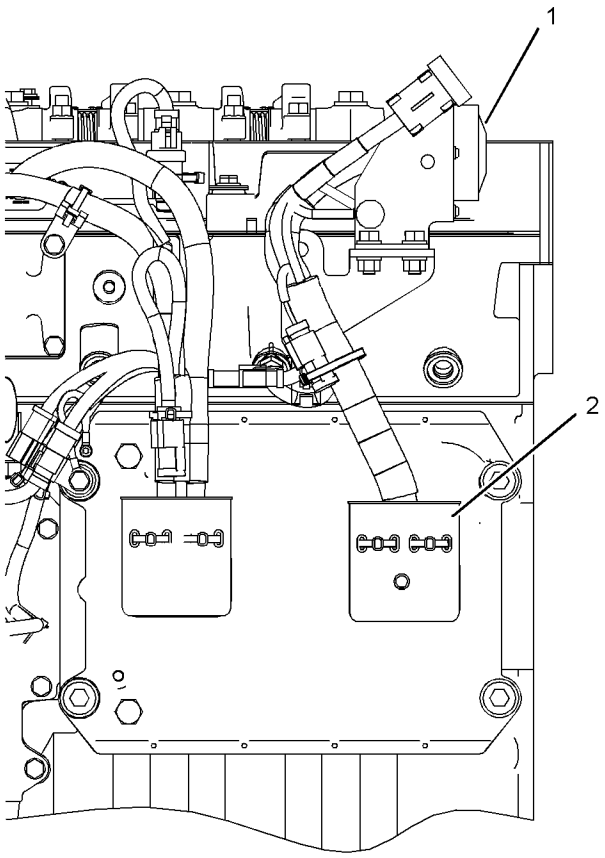
g01121934

Illustration 85

Typical switch inputs

Test Step 1. Check the Electrical Connectors and the Wiring

A. Place the keyswitch in the OFF position.



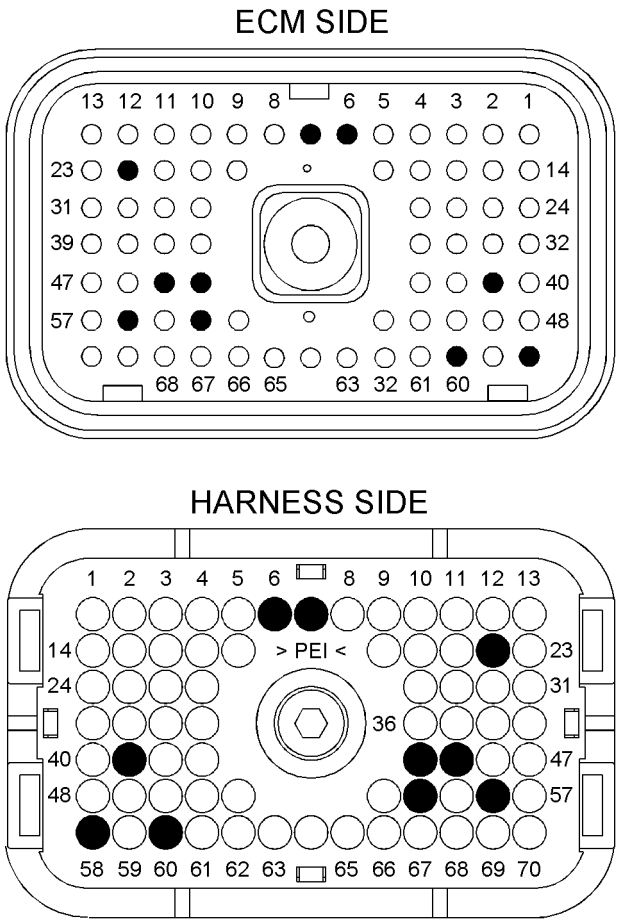
g01120532

Illustration 86

Left side view

(1) P61 customer connector
(2) J1/P1 Electronic Control Module (ECM) connectors

B. Thoroughly inspect connectors (1) and (2). Thoroughly inspect the connections for the suspect switch. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

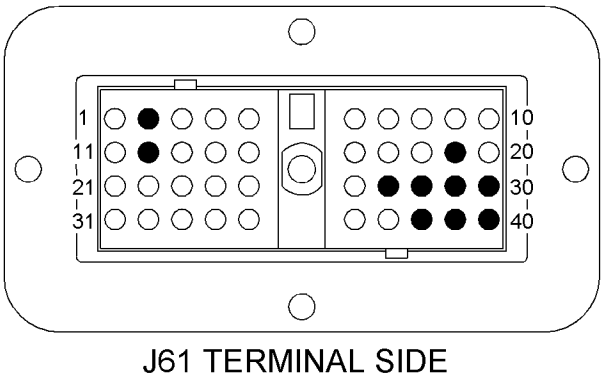


g01121943

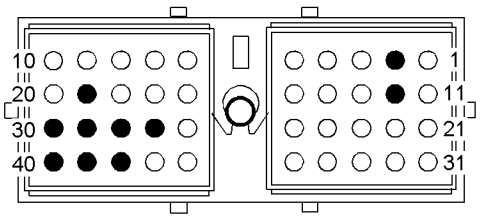
Illustration 87

P1 terminals for the various switches

(P1-6) Maintenance clear switch
(P1-7) Torque limit switch
(P1-22) Ether starting aid switch
(P1-41) PTO interrupt switch
(P1-44) Remote shutdown switch
(P1-45) Intermediate engine speed switch
(P1-54) Overspeed verify switch
(P1-56) PTO enable switch
(P1-58) PTO ramp up/set switch
(P1-60) PTO ramp down/resume switch



J61 TERMINAL SIDE



P61 TERMINAL SIDE

g01121946

Illustration 88

P61/J61 terminals for the various switches

(2) Torque limit switch
(12) Maintenance clear switch
(19) PTO interrupt switch
(27) Remote shutdown switch
(28) Intermediate engine speed switch
(29) PTO enable switch
(30) PTO ramp up/set switch
(38) Ether starting aid switch
(39) PTO ramp down/resume switch
(40) Overspeed verify switch

C. Perform a 45 N (10 lb) pull test on each of the wires in the circuit for the suspect switch.

D. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the allen head screw on the customer connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque value.

F. Check the harness and wiring for abrasions and for pinch points from the battery to the ECM.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted, and the harness and wiring are free of corrosion, of abrasion or of pinch points.

Results:

- OK – The wiring and connectors are OK. Proceed to Test Step 2.
- Not OK – There is a problem with the wiring and/or a connector.

  Repair: Repair the wiring and/or the connector. Replace parts, if necessary. Ensure that all of the seals are properly connected. Verify that the repair eliminates the problem.

  STOP.

Test Step 2. Test the Switch for Proper Operation

A. Disconnect the P1 connector.

B. Refer to Table 20. Determine the P1 terminal for the suspect switch.

Table 20

Terminals for the Switch Inputs		
Name of the Switch	**P1 Terminals**	**J61/P61 Terminals**
Maintenance clear switch	6	12
Torque limit switch	7	2
Ether starting aid switch	22	38
PTO interrupt switch	41	19
Remote shutdown switch	44	27
Intermediate engine speed switch	45	28
Overspeed verify switch	54	40
PTO enable switch	56	29
PTO ramp up/set switch	58	30
PTO ramp down/resume switch	60	39

C. Connect a meter lead to the P1 terminal for the suspect switch. Connect the other meter lead to engine ground.

Note: Wiggle the harnesses during the following measurements in order to reveal any intermittent short condition.

D. Measure the resistance between the P1 terminal for the suspect switch and engine ground.

E. Activate the switch and measure the resistance again.

Expected Result:

One resistance measurement indicates an open circuit. The other resistance measurement is less than ten Ohms.

Results:

- OK – One resistance measurement indicates an open circuit. The other resistance measurement is less than ten Ohms. The switch is operating correctly. The wiring does not have a short circuit or an open circuit.

  Repair: Operate the engine and check the switch for proper operation.

  If the switch does not operate correctly, there may be a short circuit between the circuit for the suspect switch and another circuit. Carefully reinspect the components. Refer to Troubleshooting, “Electrical Inspectors - Inspect”. Locate the short circuit and make repairs.

  STOP.

- Not OK – Both resistance measurements indicate an open circuit or both resistance measurements are less than ten Ohms. There is a problem with the circuit for the switch.

  Repair: The problem could be in the switch, in the wiring, or in a connector.

  Carefully reinspect the components. Refer to Troubleshooting, “Electrical Inspectors - Inspect”.

  If the inspection does not identify the faulty component, replace the switch and test the switch again.

  If the problem is not resolved, repair the wiring or the connector. Replace parts, if necessary. Verify that the problem is resolved.

  STOP.

i02290050

Throttle Position Sensor Circuit - Test

SMCS Code: 1913-038

System Operation Description:

The throttle position sensor eliminates the mechanical throttle and governor linkages. The sensor that is installed depends on the engine’s configuration.

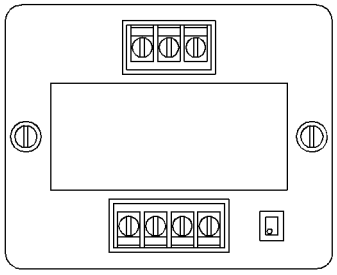


Illustration 89 g01123466

Electronic throttle position sensor

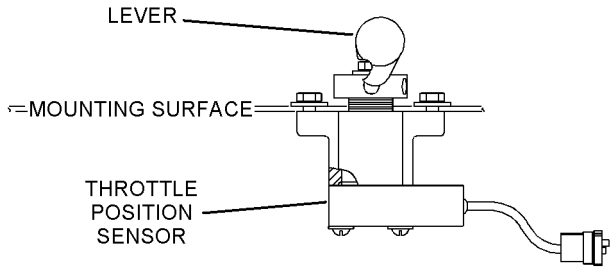


Illustration 90 g01122049

Throttle position sensor with a lever

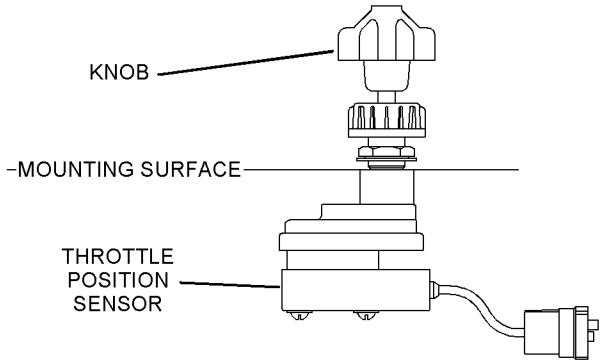


Illustration 91 g01122050

Throttle position sensor with a knob

Refer to Illustration 92. The sensor creates a Pulse Width Modulated (PWM) signal. The duty cycle varies with the throttle position. The signal has a low duty cycle when the throttle is at low idle. The signal has a high duty cycle when the throttle is at high idle. The Electronic Control Module (ECM) processes the signal in order to control the engine speed.

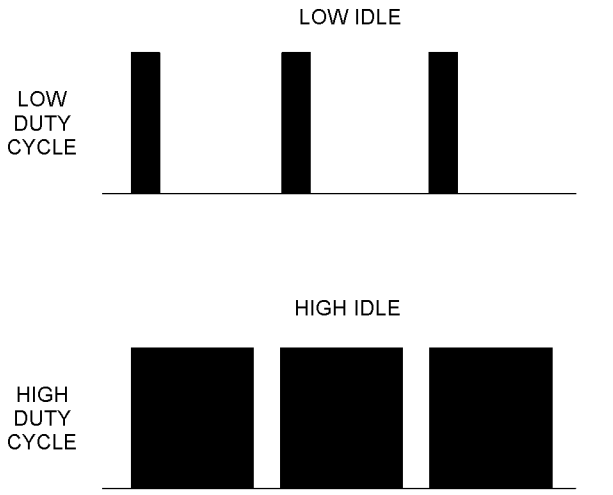


Illustration 92 g01122143

Duty cycle versus throttle position

The signal from the throttle position sensor has a specific frequency. The frequency of the signal must be between 150 Hz and 1050 Hz or the ECM will activate a 091-08 diagnostic code.

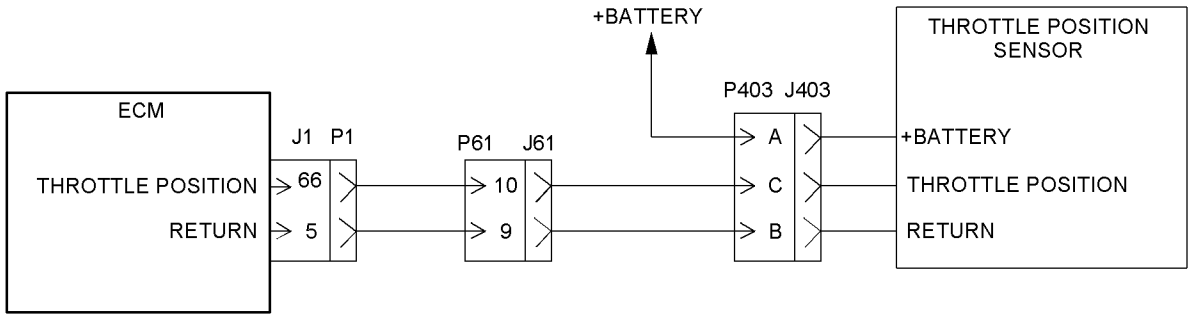


Illustration 93 g01122222

Schematic for the throttle position sensor

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Turn the keyswitch to the OFF position.

B. Thoroughly inspect connectors (1) and (2). Inspect the connections on the throttle position sensor. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

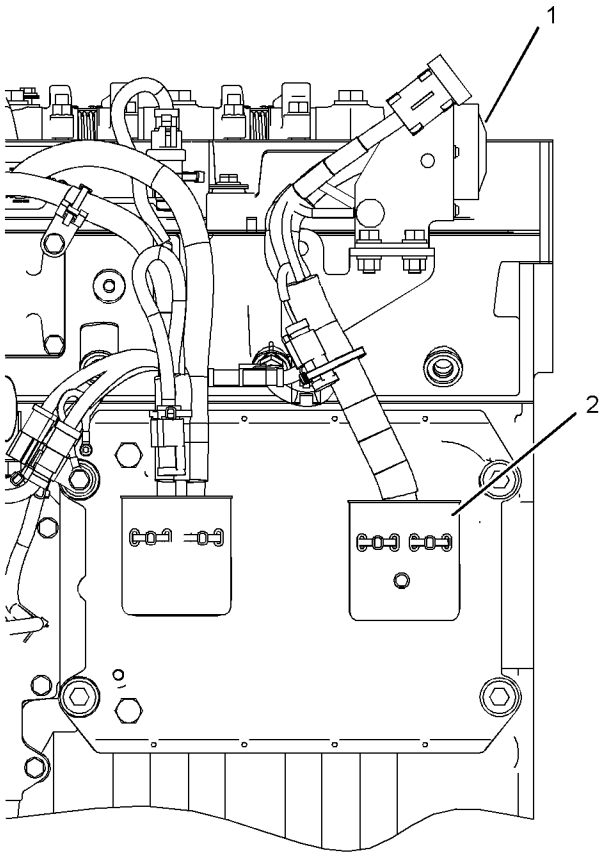


Illustration 94 g01120532

Left side view

(1) P61 customer connector
(2) J1/P1 ECM connectors

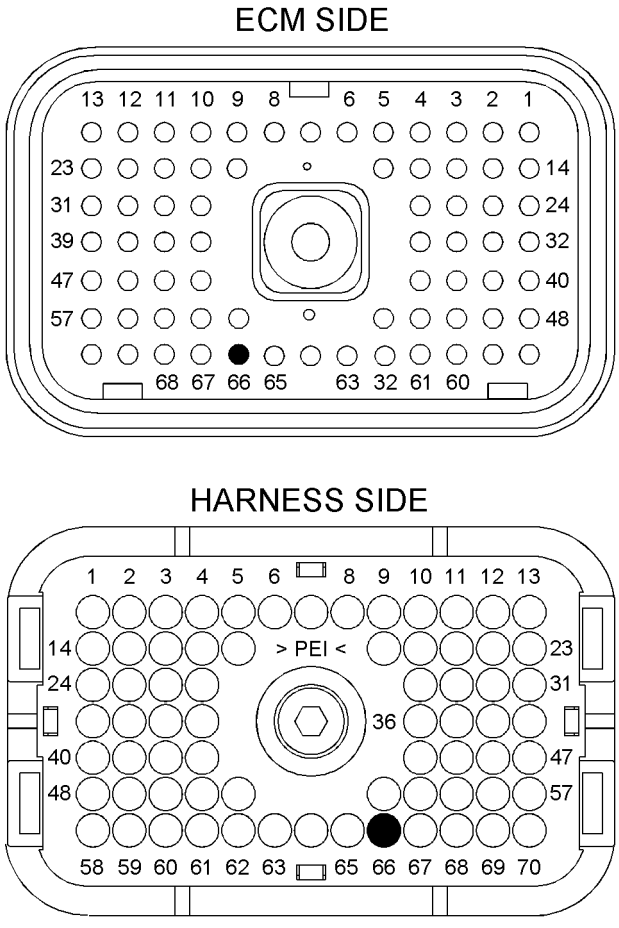
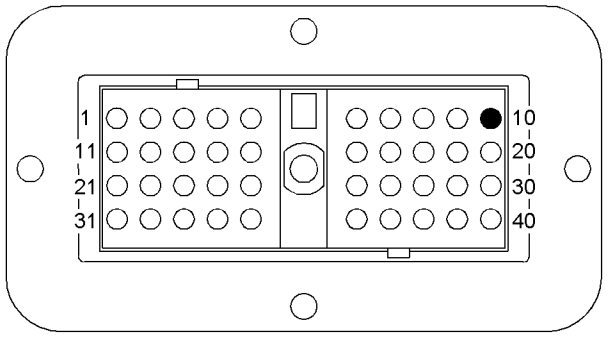


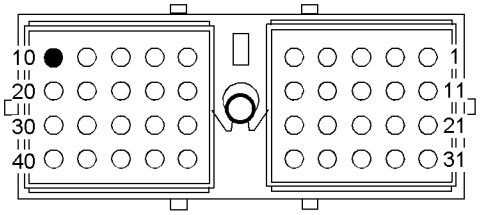
Illustration 95 g01122213

P1 terminal that is associated with the throttle position sensor

(P1-66) Throttle position



J61 TERMINAL SIDE



P61 TERMINAL SIDE

Illustration 96 g01122217

J61 and P61 terminal that is associated with the throttle position

(10) Throttle position

C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the throttle position sensor.

D. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the allen head screw on the customer connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque value.

F. Check the harness and wiring for abrasions and for pinch points from the throttle position sensor to the ECM and from the throttle position sensor to the battery.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted, and the harness and wiring are free of corrosion, of abrasion or of pinch points.

Results:

- OK – The wiring and the connectors are OK. Proceed to Test Step 2.
- Not OK – There is a problem with the wiring and/or the connectors.

  Repair: Repair the wiring and/or the connectors. Replace parts, if necessary. Ensure that all of the seals are properly connected. Verify that the repair eliminates the problem.

  STOP.

Test Step 2. Check for Supply Voltage at the Throttle Position Sensor

A. Disconnect the P403 connector.

B. Turn the keyswitch to the ON position. The engine should be OFF.

C. Measure the voltage between terminals P403-A and P403-B.

Expected Result:

The supply voltage is at least 11 VDC for a 12 volt system. The supply voltage is at least 22 VDC for a 24 volt system.

Results:

- OK – The supply voltage is at least 11 VDC for a 12 volt system. The supply voltage is at least 22 VDC for a 24 volt system. The supply voltage is reaching the sensor. Proceed to Test Step 3.
- Not OK – The supply voltage is incorrect.

  Repair: The configuration of the wiring between the +Battery and the throttle position sensor depends on the engine’s configuration. The problem could be in the wiring or in a connector. There may be a problem with the battery.

  Perform the necessary repairs. Verify that the problem is resolved.

  STOP.

Test Step 3. Check the Signal Wire for a Short Circuit

A. Turn the keyswitch to the OFF position.

B. Disconnect the P1 connector.

Note: Be sure to wiggle the harnesses during the following measurements. Be sure to wiggle each harness near each connector.

C. Measure the resistance between terminal P1-66 and all of the other terminals in the P1 connector.

Expected Result:

Each resistance measurement indicates an open circuit.

Results:

- OK – Each resistance measurement indicates an open circuit. Proceed to Test Step 5.
- Not OK – At least one resistance measurement does not indicate an open circuit. There is a problem with the signal wire for the throttle position sensor.

  Repair: The problem could be in the wiring or in a connector. Repair the wiring and/or the connector, when possible. Replace parts, if necessary. Verify that the problem is resolved.

  STOP.

Test Step 4. Check the Signal Wire for an Open Circuit

Note: Be sure to wiggle the harnesses during the following measurement. Be sure to wiggle each harness near each connector.

Measure the resistance between terminal P1-66 and terminal P403-C.

Expected Result:

The resistance measurement is less than ten Ohms.

Results:

- OK – The resistance measurement is less than ten Ohms. Connect the P403 connector. Proceed to Test Step 5.
- Not OK – The resistance measurement is greater than ten Ohms. There is a problem with the signal wire.

  Repair: The problem could be in the wiring or in a connector. Repair the wiring and/or the connector, when possible. Replace parts, if necessary. Verify that the problem is resolved.

  STOP.

Test Step 5. Check the Frequency of the Throttle Position Signal at the ECM

A. Connect the Caterpillar Electronic Technician (ET) to the service tool connector. Refer to Troubleshooting, “Electronic Service Tools”.

B. Connect a 208-0059 Adapter Cable As (70-PIN BREAKOUT) between the P1 connector and the J1 connector.

C. Connect a multimeter between terminals 66 and 5 on the breakout t.

D. Turn the keyswitch to the ON position.

E. Measure the frequency of the throttle position signal. Slowly move the throttle from low idle to high idle and back to low idle while you measure the frequency of the signal.

F. Observe the “Active Diagnostic” screen on Cat ET. Slowly move the throttle from the low idle position to the high idle position. Look for a 091-08 diagnostic code while you move the throttle.

Expected Result:

The frequency of the signal remains between 150 Hz and 1050 Hz as you move the throttle. A 091-08 diagnostic code is not activated.

Results:

- OK – The frequency of the signal remains between 150 Hz and 1050 Hz as you move the throttle. A 091-08 diagnostic code is not activated.

  Repair: Perform the following procedure:

  1. Turn the keyswitch to the off position.
  2. Remove the 208-0059 Adapter Cable As (70-PIN BREAKOUT).
  3. Connect the J1/P1 connectors.
  4. Turn the keyswitch to the ON position.
  5. Operate the throttle throughout the entire range.

     If the problem does not recur, the problem is resolved. The original problem was probably caused by a poor electrical connection. Return the engine to service.

  STOP.

- Not OK – The frequency of the signal is incorrect. A 091-08 diagnostic code is activated.

  Repair: Perform the following procedure:

  1. Turn the keyswitch to the off position.
  2. Replace the throttle position sensor. Check for a 091-08 diagnostic code again.

     If the diagnostic code does not recur, the problem is resolved. Return the engine to service.

If the diagnostic code recurs, replace the ECM. Refer to Troubleshooting, “Replacing the ECM”. Verify that the problem is resolved.

STOP.

i02290063

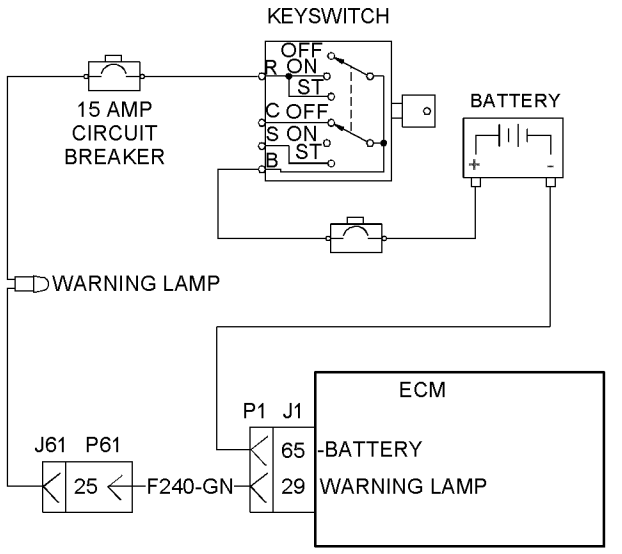
Warning Lamp Circuit - Test

SMCS Code: 7431-038

System Operation Description:

The warning lamp is a maintenance indicator that is based on the PM levels that are programmed into the Electronic Control Module (ECM). The warning lamp will turn on when a warning, a derate, or a shutdown condition exists.

Use this procedure to troubleshoot any suspect problems with the circuit for the warning lamp.



g01122447

Illustration 97

Schematic for the warning lamp

The ECM provides a path to ground for the warning lamp. When the ECM connects the warning lamp to ground the warning lamp will turn on.

Test Step 1. Check for Normal Operation of the Warning Lamp

A. Monitor the warning lamp.

a. Turn the keyswitch to the ON position. The warning lamp should turn on for five seconds. Then, the lamp should turn off.

Note: The lamp will only turn off only if a “Warning”, a “Derate”, or a “Shutdown” condition does not exist.

Expected Result:

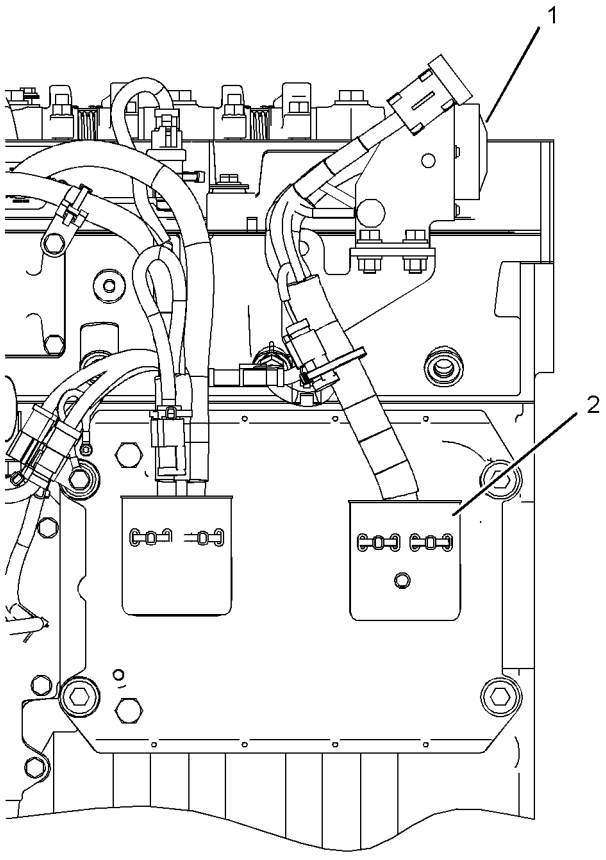
The warning lamp turns on and the warning lamp turns off per the above description.

Results:

- OK – The warning lamp appears to be operating correctly at this time. STOP.
- Not OK – The warning lamp is not functioning correctly. Proceed to Test Step 2.

Test Step 2. Inspect the Electrical Connectors and the Wiring

A. Turn the keyswitch to the OFF position.



g01119456

Illustration 98

Left side view

(1) P61 customer connector
(2) J1/P1 ECM connectors

B. Thoroughly inspect connectors (1) and (2). Inspect the connections on the warning lamp. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

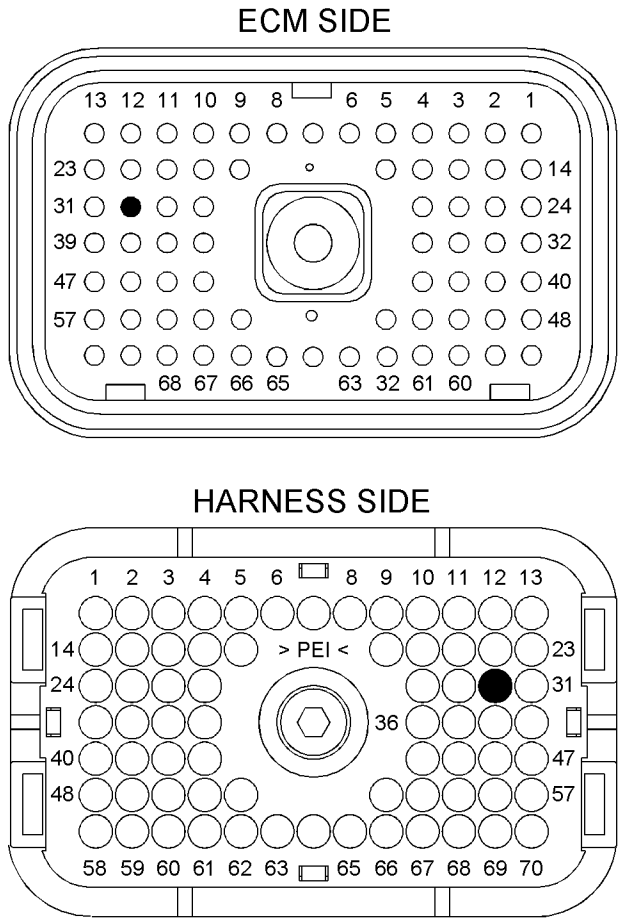


Illustration 99 g01122494

P1 terminals that are associated with the warning lamp

(P1-29) Warning lamp

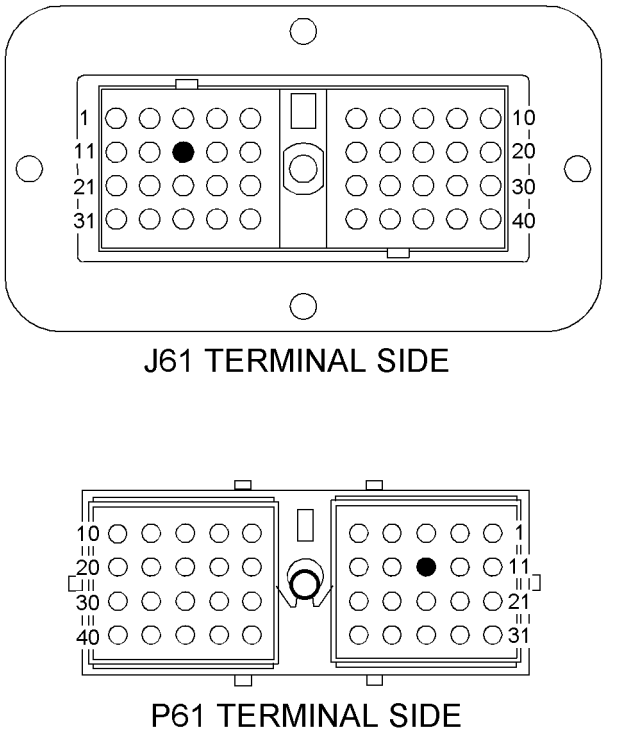


Illustration 100 g01121848

J61 and P61 terminals that are associated with the warning lamp

(13) Warning lamp

C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the warning lamp.

D. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the allen head screw on the customer connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque value.

F. Check the harness and wiring for abrasions and for pinch points from the warning lamp to the ECM.

Expected Result:

All of the connectors, pins, and sockets are completely coupled and/or inserted, and the harness and wiring are free of corrosion, of abrasion or of pinch points.

Results:

- OK – The connectors and the wiring are OK. Proceed to Test Step 3.
- Not OK – There is a problem with a connector and/or the wiring.

Repair: Repair the connector and/or the wiring. Replace parts, if necessary. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled. Verify that the problem is resolved.

STOP.

Test Step 3. Test the Warning Lamp Circuit at the ECM Connector

A. Disconnect the J1/P1 connectors.

B. Connect a jumper wire between terminal P1-30 and engine ground.

C. Turn the keyswitch to the ON position. Observe the warning lamp.

D. Remove the jumper wire and observe the warning lamp.

Expected Result:

The warning lamp turned on while the jumper was connected. The warning lamp turned off when the jumper was removed.

Results:

- OK – The warning lamp turned on while the jumper was connected. The warning lamp turned off when the jumper was removed. The warning lamp circuit is functioning properly. Proceed to Test Step 6.
- Not OK – The warning lamp did not turn on. There is a problem with the circuit for the warning lamp. Proceed to Test Step 4.

Test Step 4. Test the Circuit at the Warning Lamp

A. Disconnect wire F420-GN from the warning lamp.

B. Connect a jumper wire between the lamp's open terminal and engine ground.

C. Turn the keyswitch to the ON position. Observe the warning lamp.

D. Disconnect the jumper wire and observe the warning lamp.

Expected Result:

The warning lamp turns on while the jumper is connected. The warning lamp turns off when the jumper is disconnected.

Results:

- OK – The warning lamp turned on while the jumper wire was connected. The warning lamp turned off when the jumper wire was removed. The +Battery side of the circuit for the warning lamp is functioning properly. There is a problem with the return wire between the warning lamp and the P1 connector.

  Repair: Repair wire F420-GN between the warning lamp and terminal P1-29. Verify that the problem is resolved.

  STOP.

- Not OK – The warning lamp did not turn on when the jumper wire was connected. There is a problem with the +Battery side of the circuit for the warning lamp. Proceed to Test Step 5.

Test Step 5. Check the Voltage from the Keyswitch to the Warning Lamp

A. Turn the keyswitch to the OFF position.

B. Remove the wire from the terminal R of the keyswitch.

C. Turn the keyswitch to the ON position.

D. Measure the voltage on terminal B of the keyswitch to engine ground.

E. Measure the voltage on terminal R of the keyswitch to engine ground.

F. Turn the keyswitch to the OFF position.

Expected Result:

Voltage is present on terminal B and terminal R at the keyswitch.

Results:

- OK – Voltage is present on terminal B and terminal R at the keyswitch.

  Repair: If voltage is present on terminal R, repair the wire between the keyswitch and the warning lamp. Verify that the breaker is not tripped. Return all wiring to the original configuration. Verify that the problem is resolved.

  STOP.

- Not OK – Voltage is not present on terminal B at the keyswitch.

Repair: If voltage is not present on terminal B, repair the wire between the +Battery and the keyswitch. Check the battery's no-load voltage. Return all wiring to the original configuration. Verify that the problem is resolved.

STOP.

- Not OK – Voltage is not present on terminal R at the keyswitch.

  Repair: If voltage is present on terminal B of the keyswitch but not present on terminal R, replace the keyswitch. Return all wiring to the original configuration. Verify that the problem is resolved.

  STOP.

Test Step 6. Check the Operation of the ECM

A. Remove terminal P1-29.

B. Fabricate a jumper wire 100 mm (4 inch) long. Crimp a Deutsch pin to both ends of the wire.

C. Insert the jumper into P1-29.

D. Connect the J1/P1 connectors.

E. Connect one probe of a voltage test lamp to the jumper wire in P1-29.

F. Connect the other probe of the voltage test lamp to +Battery.

G. Turn the keyswitch to the ON position. Wait for ten seconds.

H. Turn the keyswitch to the OFF position.

Expected Result:

The test lamp turned ON for five seconds. Then, the test lamp turned OFF.

Results:

- OK – The test lamp turned ON for five seconds. Then, the test lamp turned OFF. The ECM is operating correctly. The problem appears to be resolved.

  Repair: The problem may be intermittent. If the problem is intermittent, refer to the diagnostic functional test Troubleshooting, "Electrical Connectors - Inspect".

  STOP.

- Not OK – The test lamp did not turn on for five seconds. There is a problem with the ECM.

  Repair: Temporarily connect a test ECM. Refer to Troubleshooting, "Replacing the ECM". Check the operation of the warning lamp when the test ECM is installed.

  If the problem is resolved with the test ECM, reconnect the original ECM. If the problem returns with the original ECM, replace the original ECM. Verify that the problem is resolved.

  STOP.

Calibration Procedures

i02286006

Engine Speed/Timing Sensor - Calibrate

SMCS Code: 1912-524

System Operation Description:

The Electronic Control Module (ECM) has the ability to calibrate the mechanical differences between the Top Center (TC) of the flywheel and the TC of the timing gear on the camshaft. A magnetic transducer signals the TC of the flywheel to the ECM when a notch on a counterweight passes by the transducer. The engine speed/timing sensor signals the TC of the timing gear to the ECM. Any offset between the TC of the flywheel and the TC of the timing gear is stored into the memory of the ECM.

Note: A timing calibration will not increase the available engine power.

Table 21 lists the special tools that are required in order to perform this procedure.

Table 21

Required Special Tools	
Part Number	**Description**
7X-1171	Transducer Adapter
6V-2197	Transducer
7X-1695	Cable As
170-3519	Harness (1)

(1) This item is not required if the engine harness has a connector for timing calibration.

Test Step 1. Install the Transducer Adapter

A. Turn the keyswitch to the OFF position.

B. Use the appropriate engine turning tool to put either the No. 1 piston or the No. 6 piston at top center. Refer to Systems Operation/Testing and Adjusting, “Finding the Top Center Position for the No. 1 Piston”.

C. Refer to Table 22. After the top center position has been located, rotate the crankshaft for the number of degrees that is applicable to your engine model. Be sure to rotate the crankshaft in the direction of rotation that is specified in the Table.

Table 22

Crankshaft Rotation		
Engine Model	**Number of Degrees**	**Direction of Rotation**
C7	100	Normal Rotation
C-9	85	Normal Rotation
C-10	60	**Opposite** Normal Rotation
C11	75	Normal Rotation
C-12	60	**Opposite** Normal Rotation
C13	75	Normal Rotation
C-15	60	**Opposite** Normal Rotation
C15	60	**Opposite** Normal Rotation
C-16	60	**Opposite** Normal Rotation
C18	30	**Opposite** Normal Rotation

D. Refer to Table 23. Locate the engine’s timing calibration port.

Table 23

Location of the Timing Calibration Port		
Engine Model	**Crankshaft Counterweight**	**Engine Location**
C7	3	Left Side
C-9	3	Left Side
C-10	8	Right Side
C11	8	Left Side
C-12	8	Right Side
C13	8	Left Side
C-15	2	Left Side
C15	2	Left Side
C-16	2	Left Side
C18	2	Left Side

E. Remove the plug from the timing calibration port.

F. Thread the transducer adapter into the port.

Continue to the next test step.

Test Step 2. Install the Transducer

NOTICE
If the crankshaft is not in the correct position when the transducer is installed, the transducer will be damaged when the engine is started.

A. Apply clean engine oil to a 2D-6392 O-Ring Seal. Install the O-ring seal on the end of the 6V-2197 Transducer.

B. Push the transducer through the transducer adapter until the transducer contacts the crankshaft counterweight.

C. Withdraw the transducer 1.0 mm (0.04 inch) and hand tighten the nut on the adapter sleeve in order to secure the transducer. Move the O-ring seal against the adapter.

Continue to the next test step.

Test Step 3. Connect the 7X-1695 Cable As

A. If the engine harness is equipped with a connector for timing calibration, connect the 7X-1695 Cable As to the connector for timing calibration and to the transducer.

B. If the engine harness is not equipped with a connector for timing calibration, perform the following procedure:

a. Disconnect the P2 connector from the ECM.

b. Remove the sealing plugs from P2-26 and P2-36. Do not discard the sealing plugs. The sealing plugs may be reinstalled when the timing calibration is complete.

Note: Ensure that each wire is installed into the correct location. The timing calibration will not be successful if the wires are installed incorrectly.

c. Install the white wire of the 170-3519 Harness into P2-26.

d. Install the yellow wire of the 170-3519 Harness into P2-36.

e. Connect the J2/P2 connectors. Tighten the allen head screw on the P2 connector to the appropriate torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque value.

f. Connect the 7X-1695 Cable As to the connector for timing calibration and to the transducer.

Continue to the next test step.

Test Step 4. Start the Engine and Check for Diagnostic Codes

A. Connect Caterpillar Electronic Technician (ET) to the service tool connector. Refer to Troubleshooting, “Electronic Service Tools”.

B. Start the engine and run the engine until the engine is at the normal operating temperature.

C. Check for active diagnostic codes.

The engine must not have any active diagnostic codes during the timing calibration except for a 261-13 Engine Timing Calibration required.

Expected Result:

There are no active diagnostic codes or there is only an active 261-13 diagnostic code.

Results:

- OK – There are no active diagnostic codes or there is only an active 261-13 diagnostic code. Proceed to Test Step 5.
- Not OK – There is at least one active code that is not 261-13.

Repair: Troubleshoot and repair any active diagnostic codes before you continue with this procedure.

STOP.

Test Step 5. Calibrate the Engine Speed/Timing Sensor

A. Set the engine speed to 1100 ± 50 rpm. The engine speed must be steady within this rpm range in order for the calibration to be successful.

B. After the engine has warmed up, access the "Timing Calibration" screen on the Cat ET. Access the following display screens in order:

- Service
- Calibrations
- Timing Calibration

C. To calibrate the timing, select "Continue" on Cat ET. Wait until Cat ET indicates that the timing is calibrated.

Expected Result:

Cat ET indicates that the timing is calibrated.

Results:

- OK – Cat ET indicates that the timing is calibrated.

  Repair: Perform the following procedure:

  1. Set the engine speed to low idle.

Note: Disconnect the 7X-1695 Cable As before you exit the "Timing Calibration" screen. Otherwise, diagnostic codes may be activated.

  2. Disconnect the 7X-1695 Cable As.
  3. Exit the "Timing Calibration" screen on Cat ET.
  4. Turn the keyswitch to the OFF position.
  5. Remove the transducer and remove the adapter.
  6. Install the plug into the timing calibration port.
  7. If you installed a 170-3519 Harness, you may remove the harness or you may permanently install the harness for future use. If you remove the harness, install the sealing plugs into the unused cavities of the P2 connector. Otherwise, moisture and debris will enter the connector. If you choose to permanently install the harness, fasten the harness to the existing engine wiring harness with cable ties. Also, install a 3E-3364 Receptacle and two 8T-8737 Seal Plugs on the P400 timing calibration probe connector in order to prevent moisture and debris from entering the connector.
  8. Return the engine to service.

  STOP.

- Not OK – The timing calibration was unsuccessful.

  Repair: The following conditions can cause the timing calibration to fail:

  - If the crankshaft and camshaft gears have been reassembled incorrectly, the timing will not calibrate.
  - Verify that the timing calibration probe is installed correctly.
  - Verify that the engine speed is correct and that the engine speed is stable. If the engine speed is unstable, refer to Troubleshooting, "Engine Misfires, Runs Rough or Is Unstable".
  - There may be a problem with the transducer or with the cables. Obtain a new transducer and/or a new cable and repeat the timing calibration.

  STOP.

i02225548

Throttle Position Sensor - Calibrate

SMCS Code: 1913-524

System Operation Description:

There are two options for calibrating the throttle position sensor:

Mechanical Calibration – During a manual calibration, two set screws on the throttle position sensor are adjusted. The set screws are for low idle stop and high idle stop.

Electronic Calibration – During an electronic calibration, the Caterpillar Electronic Technician (ET) is used to set the PWM that is equal to low idle and the PWM that is equal to high idle.

Test Step 1. Inspect the Throttle's Components

A. Turn the keyswitch to the OFF position.

B. Inspect the throttle linkage and related components for the following conditions:

- Loose
- Bent
- Broken
- Missing
- Worn

Expected Result:

The throttle linkage and related components are in good condition.

Results:

- OK – The throttle linkage and related components are in good condition. Proceed to Test Step 2.
- Not OK – The throttle linkage and related components are not in good condition.

  Repair: Repair the throttle linkage. Replace parts, if necessary. Continue with this procedure when the components for the throttle linkage are in good condition.

  STOP.

Test Step 2. Determine the Type of Calibration

Determine the type of calibration to be performed.

Results:

- Mechanical **–** Proceed to Test Step 3.
- Electronic **–** Proceed to Test Step 5.

Test Step 3. Adjust the Throttle at Low Idle

A. Connect Cat ET to the service tool connector. Refer to Troubleshooting, "Electronic Service Tools".

B. Turn the keyswitch to the ON position. Do not start the engine.

C. Observe the value of the "Throttle Position" on Cat ET.

D. Move the throttle to low idle. Adjust the throttle linkage and adjust the low idle set screw until the "Throttle Position" is zero percent.

E. Increase the throttle. Verify that the value of the "Throttle Position" increases.

Expected Result:

When the throttle is at low idle, the "Throttle Position" is zero percent. As you increase the throttle, the value of the "Throttle Position" increases.

Results:

- OK – When the throttle is at low idle, the "Throttle Position" is zero percent. As you increase the throttle, the value of the "Throttle Position" increases. The low idle adjustment is correct. Proceed to Test Step 4.
- Not OK – When the throttle is at low idle, the "Throttle Position" is zero percent. Alternatively, as you increase the throttle, the value of the "Throttle Position" does not increase. There is a problem with the throttle position sensor.

  Repair: Refer to Troubleshooting, "Throttle Postion Sensor Circuit - Test".

  STOP.

Test Step 4. Adjust the Throttle at High Idle

A. Move the throttle to high idle. Adjust the throttle linkage and/or adjust the high idle set screw until the "Throttle Position" is 100 percent.

Note: When you adjust the high idle on some types of linkage, the low idle adjustment may change.

B. Verify that low idle is correctly adjusted. Make adjustments, if necessary.

Expected Result:

When the throttle is at high idle, the "Throttle Position" is 100 percent. When the throttle is at low idle, the "Throttle Position" is zero percent.

Results:

- OK – When the throttle is at high idle, the "Throttle Position" is 100 percent. When the throttle is at low idle, the "Throttle Position" is 0 percent. Calibration of the throttle is complete. STOP.
- Not OK – The high idle position and/or the low idle position cannot be adjusted to the specification. An electronic calibration is required. Proceed to Test Step 5.

Test Step 5. Calibrate the Throttle at Low Idle

A. Connect Cat ET to the service tool connector. Refer to Troubleshooting, “Electronic Service Tools”.

B. Turn the keyswitch to the ON position. Do not start the engine.

C. Move the throttle to low idle.

D. Observe the “Throttle Position” on the status screen of Cat ET.

E. Verify that the “Throttle Position” is zero percent.

Expected Result:

The “Throttle Position” is zero percent when the throttle is at low idle.

Results:

- OK – The “Throttle Position” is zero percent when the throttle is at low idle. Proceed to Test Step 6.
- Not OK – The “Throttle Position” is not zero percent when the throttle is at low idle.

  Repair: Perform the following procedure:

  1. Adjust the value of the “Throttle Input Low Idle Duty Cycle Setpoint” on the “Configuration” screen of Cat ET.
  2. Verify that the “Throttle Position” is zero percent when the throttle is at low idle.

  Proceed to Test Step 6.

Test Step 6. Configure the Calibration for High Idle

A. Move the throttle to high idle.

B. Check the “Throttle Position” on the status screen of Cat ET.

C. Verify that the “Throttle Position” is 100 percent.

Expected Result:

The “Throttle Position” is 100 percent when the throttle is in high idle.

Results:

- OK – The “Throttle Position” is 100 percent when the throttle is at high idle. Calibration of the throttle is complete. STOP.
- Not OK – The “Throttle Position” is not 100 percent when the throttle is at high idle.

  Repair: Perform the following procedure:

  1. Adjust the “Throttle Input High Idle Duty Cycle Setpoint” on the “Configuration” screen on Cat ET.
  2. Verify that the “Throttle Position” is 100 percent when the throttle is at high idle.

  STOP.

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