CATERPILLAR®

RENR9348-01
January 2007

Troubleshooting

C27 and C32 Generator Set Engines

DWB1-Up (Generator Set)
SXC1-Up (Generator Set)
MED1-Up (Power Module)
MEG1-Up (Power Module)
WDR1-Up (Generator Set)

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.

Table of Contents

Troubleshooting Section

Index Section

Troubleshooting Section

Electronic Troubleshooting

i02436970

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 Electronic Unit Injectors (EUI), the wiring harness, the switches, and the sensors. The ECM is a computer that is used to control the engine. The software for the computer is loaded via the flash file. The flash file contains the operating maps and the performance maps for the engine. These maps define the following characteristics of the engine:

- Horsepower
- Torque curves

The ECM calculates the timing and the amount of fuel that is delivered to the cylinders. These calculations 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 ECM calculates actual engine speed from signals that are produced by the engine speed/timing sensor. The desired engine speed is calculated by the ECM with the following variables:

- Throttle signal
- Input signals from engine sensors
- Certain diagnostic codes

If the desired engine speed is greater than the actual engine speed, the ECM increases the duration of the fuel injection. This injects more fuel into the cylinders in order to increase the actual engine speed.

Cold Mode

The ECM limits engine power during cold mode operation. Injection timing is also modified 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.

Fuel Injection

The ECM controls the amount of fuel that is injected by varying the duration of the signals to the injectors. The injector will pump fuel only while 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 engine RPM.

The flash file that is programmed into 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 in order to control emissions. The “FRC Fuel Limit” is a limit that is based on the boost pressure of the engine. A higher boost pressure indicates that there is more air in the cylinder. As the boost pressure increases, the ECM calculates an increased “FRC Fuel Limit”. When the “FRC Fuel Limit” is increased, the ECM injects more fuel into the cylinder. The “FRC Fuel Limit” is programmed into the ECM at the factory. This fuel setting cannot be changed by the customer.

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 a fuel map that 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. This fuel setting cannot be changed by the customer.

Once the ECM calculates the amount of fuel that is required for the engine, the timing of the fuel injection cycle must be calculated. The ECM receives information about the top center position of each cylinder from the engine speed/timing sensor's signal. The ECM calculates the initiation of the fuel injection cycle relative to the top center position of the piston. The injection signal is then provided to the injector at the desired time. The ECM adjusts timing for optimum engine performance, for optimum fuel economy, and for optimum control of emissions.

Programmable Parameters

Certain parameters that affect the engine operation may be changed using Caterpillar Electronic Technician (ET). These parameters are stored in the ECM memory. 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.

i02647266

Electronic Service Tools

SMCS Code: 0785

Caterpillar electronic service tools are designed to help the service technician perform the following tasks:

- Information access
- System diagnostics
- System calibrations
- System configurations
- Data link communications

Required Service Tools

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

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
7X-6370	Adapter Cable As (3-PIN BREAKOUT)
208-0059	Adapter Cable As (70-PIN BREAKOUT)
257-8718	Adapter Cable As (120-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 be needed during testing or repair.

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
- Calibrations
- Flash programming
- Configuration of the Electronic Control Module (ECM)

Table 3 lists the software that is required in order to use Cat ET. Always use the latest version of Cat ET that is available.

Table 3

Software Requirements for Cat ET	
Part Number	**Description**
JERD2124	Single user license for Cat ET
JERD2129	Data subscription for all engines and machines

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

Connecting with the Communication Adapter II

Table 4 lists the standard hardware that is required in order to connect Cat ET.

Table 4

Standard Hardware for the Use of Cat ET	
Part Number	**Description**
N/A	Personal Computer (PC)
171-4400(1)	Communication Adapter Gp (CAT ET TO ECM INTERFACE)
237-7547(2)	Adapter Cable As
225-5985(3)	Parallel Port Cable (COMMUNICATION ADAPTER)

(1) The 7X-1700 Communication Adapter Gp may also be used.
(2) The 237-7547 Adapter Cable As is required to connect to the Universal Serial Bus (USB) on computers that are not equipped with a RS232 serial port.
(3) The 225-5985 Parallel Port Cable is required to connect to the parallel port.

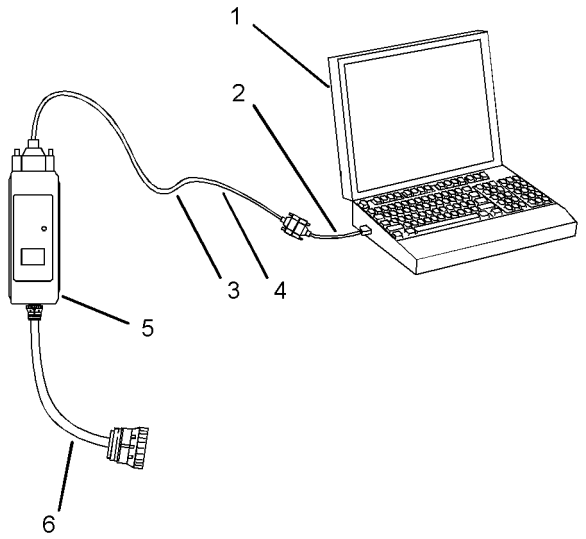


Illustration 1 g01255306

Connecting the Communication Adapter II

(1) Personal Computer (PC)
(2) 237-7547 Adapter Cable As
(3) 196-0055 Adapter Cable As
(4) 225-5985 Parallel Port Cable (COMMUNICATION ADAPTER)
(5) 171-4401 Communication Adapter As
(6) 207-6845 Adapter Cable As

Note: Items (3), (5), and (6) 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. Remove the electrical power from the ECM.
2. Connect communications adapter (5) to a communications port on the PC by using one of the following methods:

a. Connect cable (4) between the “COMPUTER” end of communications adapter (5) and the parallel port of PC (1). Be sure to configure Cat ET for the parallel port. This configuration provides the fastest connection.

b. Connect cable (3) between the “COMPUTER” end of communication adapter (5) and the RS232 serial port of PC (1).

c. Connect cables (2) and (3) between the “COMPUTER” end of communication adapter (5) and the USB port of PC (1).

3. Connect cable (6) to communication adapter (5).

4. Connect cable (6) to a service tool connector.

5. Verify that the “POWER” indicator on the communication adapter is illuminated.

6. Establish communication between Cat ET and the ECM.

7. If Cat ET and the communication adapter do not communicate with the Electronic Control Module (ECM), refer to troubleshooting without a diagnostic code Troubleshooting, “Electronic Service Tool Will Not Communicate with ECM”.

Communicating with the Wireless Communication Adapter

Table 5 lists the optional hardware that is needed in order to connect Cat ET by using a wireless connection.

Table 5

Optional Hardware for the Use of Cat ET	
Part Number	**Description**
N/A	Personal Computer (PC)
261-3363(1)	Wireless Communication Adapter Gp

(1) Refer to Tool Operating Manual, “Using the 261-3363 Wireless Communication Adapter Gp” for information that is related to the installation and the configuration.

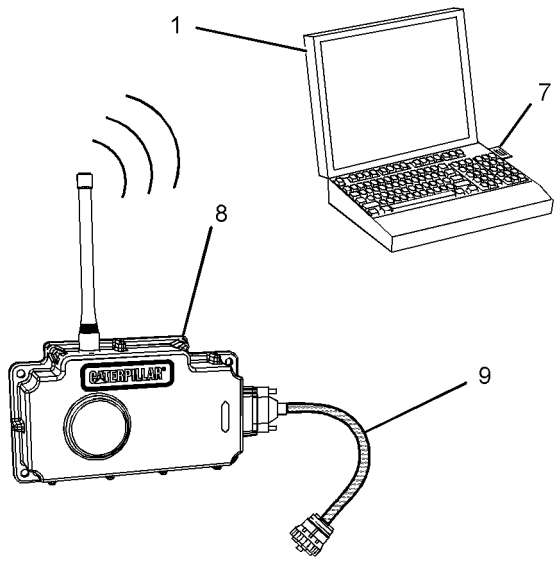


Illustration 2 g01297379

(1) Personal computer (PC)
(7) 261-4867 Card (PCMCIA)
(8) 239-9955 Communication Radio Gp
(9) 259-3183 Data Link Cable As

Note: Items (7), (8), and (9) are part of the 261-3363 Wireless Communication Adapter Gp.

Use the following procedure in order to connect the wireless communication adapter for use with Cat ET.

1. Remove the electrical power from the ECM.

2. Ensure that the computer has been correctly configured for the 261-4867 Card (PCMCIA). Verify that the PC card is installed in the computer’s PCI expansion slot.

3. Connect cable (9) between communication radio (8) and the service tool connector.

4. Restore the electrical power to the ECM. If Cat ET and the communication radio do not communicate with the ECM, refer to troubleshooting without a diagnostic code Troubleshooting, “Electronic Service Tool Will Not Communicate with ECM”.

i02518796

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 Dealer Service Tool Catalog” 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. Use these procedures to ensure that the 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 you attempt to replace the ECM. Refer to the diagnostic functional test Troubleshooting, “Electrical Power Supply Circuit - Test”.

Some application software supports the use of a new ECM as a test ECM. A new ECM can be temporarily placed into a “Test ECM Mode”. This ECM can then be used to replace a suspect ECM in order to determine if the suspect ECM is faulty. Refer to programming parameters Troubleshooting, “Test ECM Mode”.

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. Print the parameters from the “Configuration” screen on Caterpillar Electronic Technician (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 serial numbers from the “Calibrations” screen under the “Service” menu on Cat ET.

Note: The injector serial numbers are necessary for obtaining the correct injector trim files. The ECM uses the injector trim files in order to compensate for manufacturing variations between individual injectors. If you replace any of the unit injectors, you must reprogram the injector trim files for the new injectors. Also, if you replace the ECM, the injector trim files must be installed into the new ECM. A successful “Copy Configuration” process will accomplish this task. For more instruction, refer to programming parameters Troubleshooting, “Injector Trim File”.

2. 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 from the suspect ECM.

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

3. Remove the ECM from the engine.
   a. Remove the electrical power from the ECM.
   b. Disconnect the J1/P1 and J2/P2 ECM connectors.

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. Remove the mounting bolts from the ECM.
   e. Disconnect the ECM ground strap from the engine.

4. Install the replacement ECM.

a. If the old mounting hardware is in good repair, you can use the old mounting hardware to install the replacement ECM.

b. Reconnect the fuel lines (if equipped).

c. Ensure that the ECM mounting hardware is installed correctly. The fuel lines must not put tension on the ECM. The rubber grommets are used to protect the ECM from excessive vibration. The ECM must be able to drift in the rubber grommets. If the ECM cannot be moved slightly in the grommets, check that the fuel lines (if equipped) are not pulling the ECM against one side of the grommets.

d. Connect the ECM ground strap.

e. Connect the J1/P1 and J2/P2 ECM connectors. Tighten the allen head screw on each of the ECM connectors to the proper torque. Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect” for the correct torque value.

5. Program the flash file into the ECM. Refer to programming parameters Troubleshooting, “Flash Programming”.

6. If the replacement ECM was used previously for a different application, use Cat ET to match the engine application and the flash file.

7. Configure the ECM.

a. If the “Load from ECM” process from Step 2 was successful, return to the “Copy Configuration/ECM Replacement” screen on Cat ET and select “Program ECM”.

After using the “Program ECM” feature, be sure to cycle the power to the ECM. Wait at least 15 seconds after turning the keyswitch to the OFF position.

Note: Some control modules have a power off delay. The 15 seconds will be sufficient to cover this delay.

b. If the “Program ECM” process was successful, proceed to Step 9.

c. If the “Program ECM” process was unsuccessful, manually program the ECM parameters into the replacement ECM. The parameters must match the parameters from Step 1.

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

d. If necessary, program the engine monitoring system.

8. Program the injector trim files. Refer to programming parameters Troubleshooting, “Injector Trim File”.

9. Check for an active diagnostic code for timing calibration.

If the diagnostic code is active, calibrate the injection timing. Refer to calibration procedures Troubleshooting, “Engine Speed/Timing Sensor - Calibrate”.

10. Check for diagnostic codes and for event codes.

i02378227

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.

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.

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.

i02409268

Sensors and Electrical Connectors

SMCS Code: 1439; 7553-WW

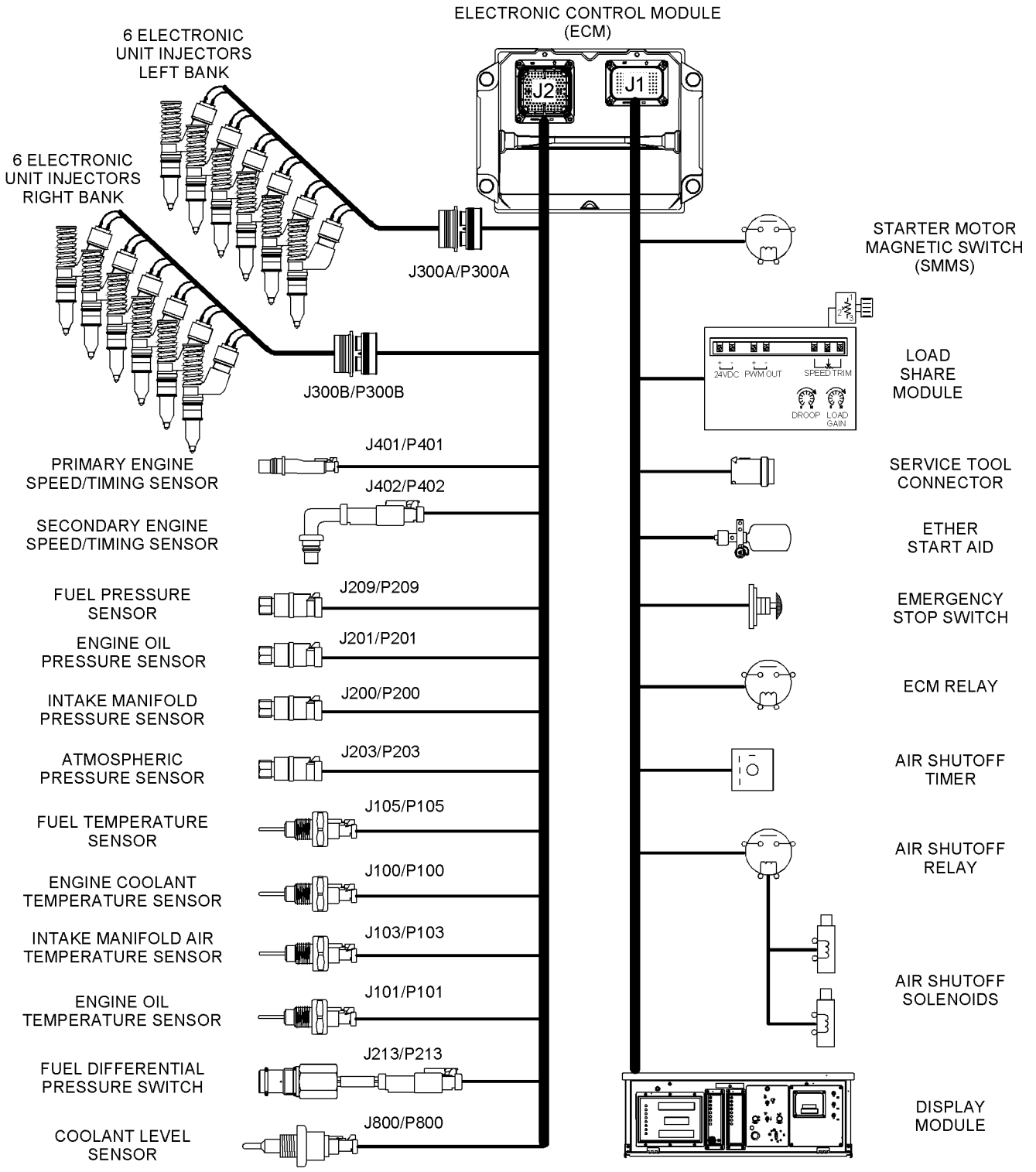


Illustration 3 g01203891

Block diagram

C27 and C32 Engines

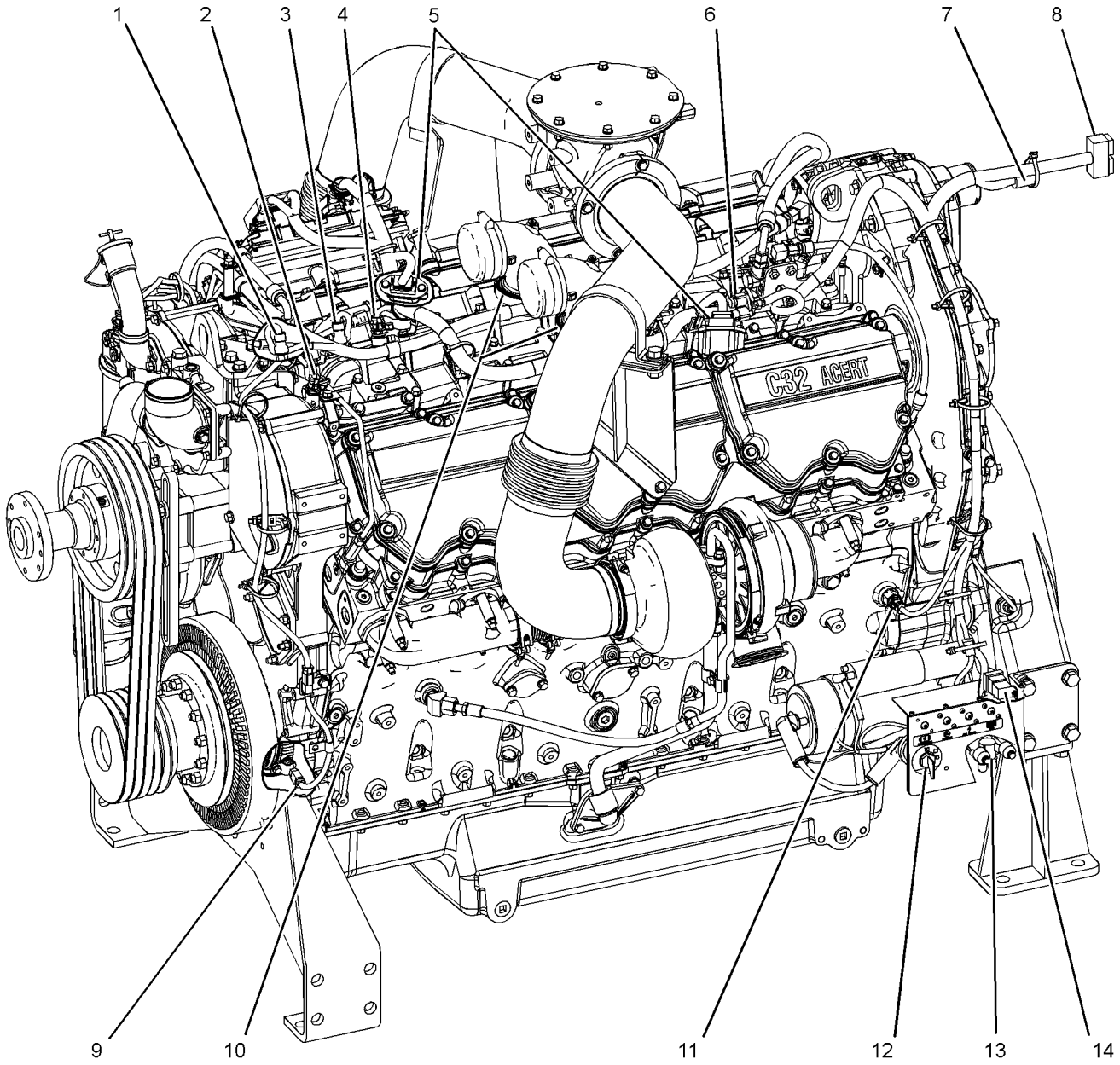


Illustration 4 g01204004

Component locations (typical left side engine view)

(1) Atmospheric pressure sensor
(2) Engine coolant temperature sensor
(3) Intake manifold pressure sensor
(4) Intake manifold air temperature sensor
(5) Injector valve cover entry connectors
(6) Termination resistor
(7) Service tool connector
(8) Interface connector
(9) Primary engine speed/timing sensor
(10) Air shutoff solenoids
(11) Engine oil temperature sensor
(12) Battery disconnect switch
(13) Starting Motor Magnetic Switch (SMMS)
(14) ECM relay

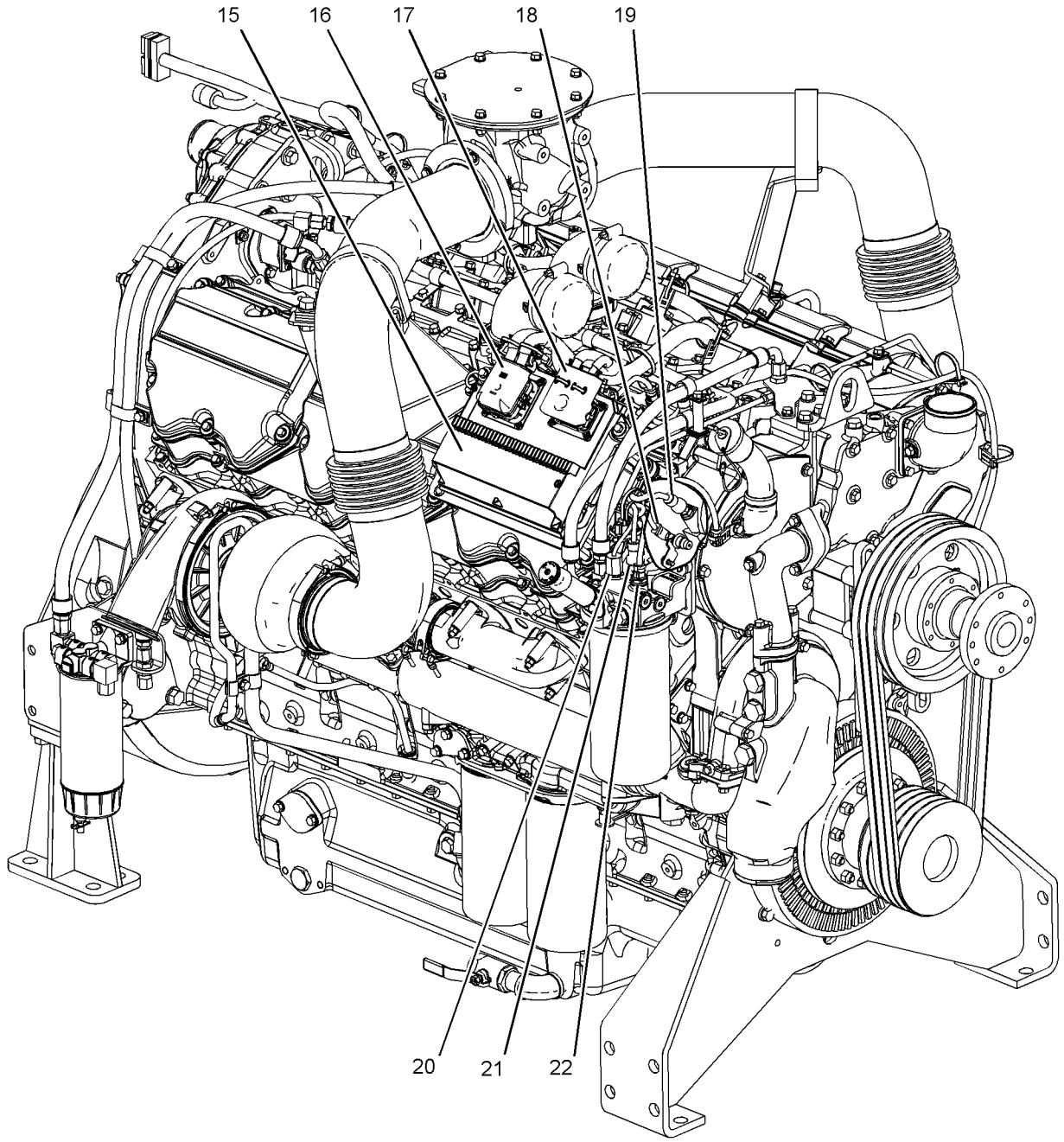


Illustration 5 g01203895

Component locations (typical right side engine view)

(15) Electronic Control Module (ECM)
(16) J2/P2 ECM connector
(17) J1/P1 ECM connector
(18) Secondary engine speed/timing sensor
(19) Engine oil pressure sensor
(20) Fuel filter differential pressure switch
(21) Fuel pressure sensor
(22) Fuel temperature sensor

i02433503

Engine Wiring Information

SMCS Code: 1408

The wiring schematics are revised periodically. The wiring schematics will change as updates are made to the engine's 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 6 lists the wire colors and the color codes.

Table 6

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 (American 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 7 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 7

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 Applications that are Equipped with an Electronic Control Module (ECM)

Proper welding procedures are necessary in order to avoid damage to the engine's electronic control module, sensors, and associated components. Remove the component that requires welding. When welding on an application 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. Remove the electrical power from the ECM.
2. Disconnect the negative battery cable from the battery. If a battery disconnect switch is installed, open the switch.

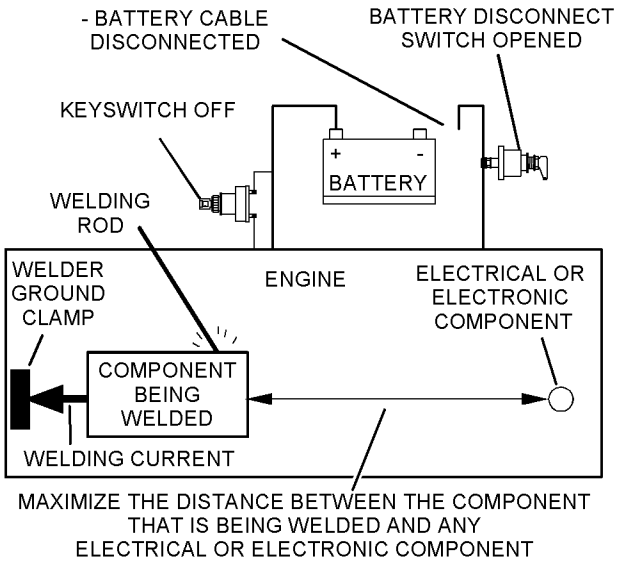


Illustration 6 g01143634

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 spatter.

5. Weld the materials by using standard welding methods.

Programming Parameters

i02253984

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.

i02419708

Test ECM Mode

SMCS Code: 1901

"Test ECM Mode" is a feature on Caterpillar Electronic Technician (ET) that is used to troubleshoot an engine that may have a problem with the Electronic Control Module (ECM). If an application supports this feature, Cat ET will allow a new ECM to be used temporarily as a test ECM.

When the "Test ECM Mode" is activated, an internal timer sets a 24 hour clock. This clock will count down only while the ECM is powered. If the new ECM fixes the problem, the engine can be released while the "Test ECM Mode" is still active. After the ECM has counted down the 24 hour period, the ECM will exit the "Test ECM Mode". The parameters, the accumulated hours, and the engine serial number will be permanently programmed into the new ECM. The new ECM can no longer be used for another engine or for a test ECM.

Note: When the"Test ECM Mode" is activated, the "Personality Module Code" is 0. After the ECM has counted down the 24 hour period, the "Personality Module Code" will be dependent on the application.

If the problem is not solved with the new ECM and the 24 hour period has not expired, the ECM can be removed from the engine and reused as a new ECM on another engine. Anytime prior to the 24 hour limit of the "Test ECM Mode", a new engine serial number and new parameters can be reprogrammed.

1. Search for the latest flash file for the engine.

Note: If a newer software version is available for the engine, install the newest software on the suspect ECM. If the new software does not fix the problem continue with this procedure.

2. Use the "Copy Configuration/ECM Replacement" feature on Cat ET to copy the configuration parameters from the suspect ECM to your personal computer (PC). If the "Copy Configuration/ECM Replacement" feature cannot be used, record the programmed values into the "Parameters Worksheet" in system configuration parameters Troubleshooting, "System Configuration Parameters". Record the injector serial numbers from the "Calibrations" screen under the "Service" menu on Cat ET.

Note: Some applications use injectors that have trim codes or injector trim files that are associated with the injectors. If injector trim codes are necessary, the injector trim codes are printed on the injector. If injector trim files are necessary, the injector serial numbers are necessary for obtaining the correct injector trim files from Cat ET. The injector trim file is a number that is specific to each unit injector. The ECM uses this number to compensate for manufacturing variations between individual injectors. If you replace any of the unit injectors, you must program the injector trim files for the new injectors. Also, if you replace the ECM, you must program all of the injector trim files into the new ECM.

3. Disconnect the suspect ECM. Temporarily connect the new ECM to the engine. Do not mount the new ECM on the engine.

Note: The "Test ECM Mode" must be activated before the engine serial number is programmed into the new ECM. "Test ECM Mode" can only be activated if the engine serial number has not already been programmed during normal operation of the ECM. If the engine serial number is programmed and the new ECM is not in "Test ECM Mode", the new ECM can never be used as a test ECM.

4. Start the "Test ECM Mode" on Cat ET. Access the feature through the "Service" menu. Cat ET will display the status of the "Test ECM Mode" and the hours that are remaining for the "Test ECM Mode".

5. Program the correct flash file into the new ECM.

Note: If the "Copy Configuration/ECM Replacement" feature cannot be used, program the values from the "Parameters Worksheet".

6. Use the "Copy Configuration/ECM Replacement" feature on Cat ET to program the correct parameters into the new ECM.

7. Program the engine serial number into the new ECM.

If the problem is resolved with the new ECM, remove the original ECM and permanently install the new ECM.

If the new ECM does not fix the problem, the original ECM is not the problem. Remove the new ECM before the 24 hour timer expires. Reconnect the original ECM.

i02433393

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”.

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 programming parameters Troubleshooting, “Factory Passwords Worksheet”.

i02193979

Factory Passwords Worksheet

SMCS Code: 0785

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

Table 8

Factory Passwords Worksheet
Dealer Code
Customer’s Name
Address
Telephone Number
Information from the “Enter Factory Passwords” Screen on the Caterpillar Electronic Technician (ET)
Serial Number for Cat ET
Engine Serial Number
ECM Serial Number
Total Tattletale
Reason Code
Factory Passwords
Factory Password (No. 1)
Factory Password (No. 2)

i02419726

Flash Programming

SMCS Code: 1901-591

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

Caterpillar Electronic Technician (ET) is used to flash program a file into the memory of the engine’s ECM.

If you do not have the flash file, use the “Flash File Search” tool on the Service Technician Workbench (STW) to obtain the flash file for your engine. Alternatively, use the “Service Software Files” feature on SIS Web to obtain the flash file for your engine. You must have the engine serial number in order to search for the flash file. After locating the correct flash file, download the flash file to your PC. Write down the name of the flash file for future reference.

Programming a Flash File

1. Establish communication between Cat ET and the engine's ECM.
2. Select "WinFlash" from the "Utilities" menu on Cat ET.

Note: If "WinFlash" will not communicate with the ECM, refer to troubleshooting without a diagnostic code Troubleshooting, "Electronic Service Tool Will Not Communicate with ECM".

3. 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 name 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, obtain 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.
4. Start the engine and check for proper operation. Repair any active diagnostic or event codes.

"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.

i02490769

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.
- "Injector Trim" is displayed below a 268-02 diagnostic code on Cat ET.
- 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. Cat ET may require the entry of injector confirmation code during this process. Cat ET will prompt you for the code, if necessary.

1. Record the injector serial number and the injector confirmation code for each injector.
2. Click on "Service Software 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 electronic troubleshooting Troubleshooting, "Electronic Service Tools".
6. Select the following menu options on Cat ET:
   - Service
   - Calibrations
   - Injector Trim Calibration
7. Select the appropriate cylinder.
8. Click on the "Change" button.
9. Select the appropriate injector trim file from the PC.
10. Click on the "Open" button.
11. If you are prompted by Cat ET enter the injector confirmation code into the field.
12. Click on the "OK" button.

The injector trim file is loaded into the ECM.

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

System Configuration Parameters

i02421358

System Configuration Parameters

SMCS Code: 1901

System configuration parameters are parameters that are configured to specify the engine's emissions levels, the power rating, and the specific application. Default values for the parameters are programmed at the factory. Some parameters may be changed in order to equip the engine for a specific application. The system configuration parameters must be reprogrammed if the Electronic Control Module (ECM) is replaced. It is not necessary to reprogram the system configuration parameters if you update the ECM flash file. Certain configuration parameters are stamped into the engine information plate.

Note: If the parameters that are protected with the factory passwords are changed, the Caterpillar warranty may be voided.

Parameter Descriptions

Rating Number

The rating number corresponds to the selected set of performance maps that has been selected for this application. There may be more than one set of performance maps that are available for this engine. All of the maps are resident in the flash file for the engine.

Rated Frequency

The line frequency of the generator set

Rated Engine Speed

The optimum speed of the engine

Rated Real Genset Power

The output power of the generator set in kilowatts

Rated Apparent Genset Power

The kVA rating of the generator set

Rating Configuration

The performance maps in the software

Test Spec

This is the engine's "Test Specifiction Number". Use this number to retrieve data that is related to the engine's specifications from the Technical Marketing Information System (TMI). The following information can be retrieved from TMI:

- "As shipped consists"
- "Engine test specifications"
- "Systems data"
- "Physical data"
- "Gasket kit data"
- "Reman parts"
- "Performance data"

A link to TMI Web can be found on the web site for the Service Information System (SIS).

Equipment ID

This parameter allows the customer to enter a description into the ECM in order to identify the engine's application. A maximum of 17 characters can be entered in the field.

Engine Serial Number

The engine serial number must be programmed to match the engine serial number that is stamped on the engine information plate. The engine serial number is not preprogrammed into a replacement ECM.

ECM Serial Number

The serial number of the ECM that is stored in the ECM memory

Software Group Part Number

The part number of the flash file that is currently installed in the ECM

Software Group Release Date

The release date of the flash file that is currently installed in the ECM

Software Group Description

The description of the application for the flash file that is currently installed in the ECM

Total Tattletale

The total tattletale counts the number of changes to system parameters.

Engine Accel. Rate

This parameter defines the maximum rate of engine acceleration.

Low Idle Speed

This parameter defines the low idle rpm of the engine.

Engine Speed Droop

This parameter enables the engine to be operated in a load sharing system.

Droop/Isochronous Switch Enable

This parameter defines the installation status of a switch that is used to select droop or isochronous mode.

Droop Mode Selection

This parameter allows the customer to select droop or isochronous mode.

Ether Control

This parameter defines the installation status of an ether starting aid for the engine.

Engine State Control Input Configuration

This parameter defines the input configuration for the engine state control.

Cooldown Duration

This parameter defines the cooldown period for the engine.

Prelube Duration

This parameter defines the duration of the prelube cycle for the engine.

Cranking Duration

This parameter defines the duration of the crank cycle for the engine.

Number of Crank Cycles

This parameter defines the number of crank cycles for the engine.

Engine Oil Temperature Sensor Installation Status

This parameter defines the installation status of an engine oil temperature sensor.

Desired Speed Input Configuration

This parameter defines the type of input for the primary throttle.

Secondary Desired Speed Input Configuration

This parameter defines the type of input for the secondary throttle.

Fuel Enable Input Configuration

This parameter allows the selection for the type of input that is used to enable the fuel for the engine.

Secondary Fuel Enable Input Configuration

This parameter sets the installation status of a secondary switch that can be used to enable the fuel for the engine.

Fuel Filter Differential Pressure Switch Configuration

This parameter sets the installation status and the normal state of the fuel filter differential pressure switch for the engine.

Emergency Shutdown Override Switch Installation Status

This parameter sets the installation status of an engine shutdown override switch.

Emergency Shutdown Override Switch Configuration

This parameter sets the configuration of an engine shutdown override switch.

Remote Emergency Stop Switch Input Type Configuration

This parameter sets the installation status and the configuration of the emergency stop switch.

Air Intake Shutoff Detection Installation Status

This parameter sets the installation status of an air shutoff system.

Coolant Level Sensor Installation Status

This parameter sets the installation status of the coolant level switch.

FLS

“FLS” is a parameter that represents the fuel system adjustment that was made at the factory in order to fine tune the fuel system to the engine. The correct value for this parameter is stamped on the engine information plate. Only change this value if the engine is rerated or if a new ECM has been installed. Factory passwords are required to change this parameter.

FTS

“FTS” is another parameter that represents a fuel system adjustment that was performed at the factory in order to fine tune the fuel system to this engine. Only change this value if the engine is rerated or if a new ECM has been installed. Factory passwords are required to change this parameter.

Governor Gain Factor

This parameter is used in determining the engine’s rate of response to an engine load.

Governor Minimum Stability Factor

This parameter is used by the ECM to offset the steady state speed error when the steady state speed error is less than 20 rpm.

Governor Maximum Stability Factor

This parameter is used by the ECM to offset the steady state speed error when the steady state speed error is greater than 20 rpm.

Crank Terminate Speed

This parameter is used to define the desired engine speed during engine cranking.

Digital Speed Control Min Speed

This parameter is used to configure the engine speed below the rated speed of the engine.

Digital Speed Control Max Speed

This parameter is used to configure the engine speed above the rated speed of the engine.

Parameter Table

Table 9

System Configuration Parameters			
Parameter	**Available Range or Options**	**Default**	**Required Password**
Selected Engine Ratings			
Rating Number	Software Dependent		None
Rated Frequency	Software Dependent		Read Only(1)
Rated Engine Speed	Software Dependent		Read Only(1)
Rated Real Genset Power	Kilowatts (if applicable)	Rated power	Read Only(1)
Rated Apparent Genset Power	Kilowatts (if applicable)	Rated power	Read Only(1)
Rating Configuration	Software Dependent		Read Only(1)
Test Spec	Software Dependent		Read Only(1)
ECM Identification Parameters			
Equipment ID	17 alphanumeric characters	Blank	Customer
Engine Serial Number	0XX00000 or XXX00000	Blank	Factory
ECM Serial Number	Hardware Dependent	Blank	Read Only(1)
Software Group Part Number	Software Dependent		Read Only(1)
Software Group Release Date	Software Dependent		Read Only(1)
Software Group Description	Software Dependent		Read Only(1)
Security Access Parameters			
Total Tattletale	0 to 65535	0	Read Only(1)
Engine/Gear Parameters			
Engine Accel. Rate	5 - 2000 rpm/sec	500	Customer
Low Idle Speed	600 to 1200 rpm	1200	Customer
Engine Speed Droop	0.0 - 8.0 %	3.0 %	Customer
Droop/Isochronous Switch Enable	Enabled or Disabled	Disabled	Customer
Droop mode selection	Droop or Isochronous	Isochronous	Customer
I/O Configuration Parameters			
Ether Control	Installed or Uninstalled	Uninstalled	Customer
Desired Speed Input Configuration	PWM CAN Input 0 - 5 VDC	CAN Input	Customer
Engine State Control Input Configuration	CAN Input or Uninstalled	CAN Input	Customer
Cooldown Duration	0 - 233 seconds	0 seconds	Customer
Prelube Duration	0 - 210 seconds	0 seconds	Customer
Cranking Duration	0 - 60 seconds	30 seconds	Customer
Maximum Number of Crank Cycles	0 - 10 cycles	5 cycles	Customer
Secondary Desired Speed Input Configuration	PWM CAN Input 0 - 5 VDC Unistalled	Unistalled	Customer

(continued)

(Table 9, contd)

System Configuration Parameters			
Parameter	**Available Range or Options**	**Default**	**Required Password**
Fuel Filter Differential Pressure Switch Configuration	Uninstalled Normally Open Normally Closed	Uninstalled	Customer
Emergency Shutdown Override Switch Installation Status	Installed or Uninstalled	Uninstalled	Customer
Emergency Shutdown Override Switch Configuration	Switch to Ground CAN Input	Switch to Ground	Customer
Remote Emergency Stop Switch Input Type Configuration	Uninstalled Normally Open Normally Closed	Normally Open	Customer
Air Intake Shutoff Detection Installation Status	Installed or Uninstalled	Uninstalled	Customer
Coolant Level Installation Status	Installed or Uninstalled	Uninstalled	Customer
System Parameters			
FLS	Programmed at the Factory		Factory
FTS	Programmed at the Factory		Factory
Governor Gain Factor	0 - 65,535	16,578	Customer
Governor Minumum Stability Factor	0 - 65,535	806	Customer
Governor Maximum Stability Factor	0 - 65,535	3225	Customer
Crank Terminate Speed	200 to 700 rpm	400	Customer
Digital Speed Control Min Speed	0 to 150 rpm	125	Customer
Digital Speed Control Max Speed	0 to 150 rpm	125	Customer

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

Parameter Worksheet

Table 10

Parameter Worksheet	
Engine Parameters	
Equipment ID	
Engine Serial Number	
ECM Serial Number	
Software Group Part Number	
Software Group Release Date	
Software Group Description	
FLS	
FTS	
Total Tattletale	
Engine Accel. Rate	
Low Idle Speed	
Engine Speed Droop	
Droop/Isochronous Switch Enable	

(continued)

(Table 10, contd)

Parameter Worksheet	
Droop mode selection	
Ether Control	
Prelube Duration	
Cranking Duration	
Maximum Number of Crank Cycles	
Desired Speed Input Configuration	
Engine State Control Configuration	
Cooldown Duration	
Secondary Desired Speed Input Configuration	
Fuel Filter Differential Pressure Switch Configuration	
Emergency Shutdown Override Switch Installation Status	
Emergency Shutdown Override Switch Configuration	
Remote Emergency Stop Switch Input Type Configuration	
Air Intake Shutoff Detection Installation Status	
Coolant Level Installation Status	
Emergency Shutdown Override Switch Configuration	
Emergency Shutdown Override Switch Configuration	
Governor Gain Factor	
Governor Minumum Stability Factor	
Governor Maximum Stability Factor	
Crank Terminate Speed	
Digital Speed Control Min Speed	
Digital Speed Control Max Speed	
Injector Serial Numbers	
Cylinder 1	
Cylinder 2	
Cylinder 3	
Cylinder 4	
Cylinder 5	
Cylinder 6	
Information from the Engine Information Plate	
Engine Serial Number	
FLS	
FTS	

Note: Compare the FLS and the FTS from the ECM with the values that are listed on the engine information plate. Use of incorrect parameters could cause damage to the engine. The use of the wrong parameters may also void the Caterpillar warranty or the emission certification for the engine.

Troubleshooting without a Diagnostic Code

i02121176

Alternator (Charging Problem)

SMCS Code: 1405-035

⚠ 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.

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

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.

i02422398

Can Not Reach Top Engine RPM

SMCS Code: 1915-035

Note: If the problem occurs during high engine loads then refer to Troubleshooting, “Low Power/Poor or No Response to Throttle”.

Probable Causes

- Diagnostic codes
- Event codes
- Throttle signal
- Intake manifold pressure
- Fuel supply
- Air inlet and exhaust system
- Accessory equipment
- Specific conditions

Recommended Actions

Diagnostic Codes and Event Codes

Certain diagnostic codes and/or event codes may cause poor performance. Connect the electronic service tool and check for active codes and/or logged codes. Troubleshoot any codes that are present before continuing with this procedure.

Throttle Signal

Monitor “Throttle Position” on Caterpillar Electronic Technician (ET). Verify that you can achieve full throttle. Refer to Troubleshooting, “Speed Control - Test” for the proper troubleshooting procedure.

Intake Manifold Pressure

1. Use Cat ET to monitor the “Fuel Position” and the “Rated Fuel Limit” during engine operation. If “Fuel Position” does not equal “Rated Fuel Limit” there may be a problem with the engine’s intake air system. Check for the proper operation of the following components:

   - Turbocharger

   Refer to Systems Operation/Testing and Adjusting for specific information.

2. Monitor the status of the intake manifold pressure sensor on Cat ET for normal operation. Ensure that the status for the “Boost Pressure” parameter is reasonable. Ensure that the intake manifold pressure fluctuates with the demand of the engine.

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. Prime the 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. Refer to the Operation and Maintenance Manual manual for the procedure.

Note: A sight glass in the fuel 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 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.

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.

2. If air shutoff valves are installed, verify that the air shutoff valves are fully opened.

3. Check the air inlet and exhaust system for restrictions and/or for leaks. Refer to the Systems Operation/Testing and Adjusting for information on the 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.

i02381103

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 Systems Operation/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.

i02419115

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 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

i02480112

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. Check for correct installation of the connectors for the Electronic Control Module (ECM) J1/P1, J2/P2 and J3/P3. Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect”.
2. Connect the electronic service tool to the service tool connector. If the ECM does not communicate with the electronic service tool, refer to troubleshooting without a diagnostic code Troubleshooting, “Electronic Service Tool Will Not Communicate with ECM”.
3. Troubleshoot the Cat Data Link for possible problems. Refer to the diagnostic functional test Troubleshooting, “Cat Data Link Circuit - Test”.
4. Troubleshoot the CAN data link (if equipped) for possible problems. Refer to the diagnostic functional test Troubleshooting, “CAN Data Link Circuit - Test”.

i02429900

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 the troubleshooting without a diagnostic code procedure Troubleshooting, “Engine Cranks but Will Not Start”. If the engine will not crank, refer to the troubleshooting without a diagnostic code procedure 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 the diagnostic functional test 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 electronic troubleshooting 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 the diagnostic functional test 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: A new ECM is not programmed to any specific engine until a flash file has been installed. The engine will not start and the engine will not communicate with Cat ET until the flash file has been downloaded. Refer to programming parameters Troubleshooting, “Flash Programming”.

Cat Data Link

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

i02475556

Engine Cranks but Will Not Start

SMCS Code: 1000-035

Probable Causes

- Diagnostic codes and event codes
- Electronic Control Module (ECM)
- Starting aids (if applicable)
- Engine shutdown switches
- Starting motor, solenoid, or starting circuit
- Engine speed/timing
- Unit injector
- Fuel supply
- Combustion

Recommended Actions

Diagnostic Codes and Event Codes

Certain diagnostic codes and/or event codes may prevent the engine from starting. 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.

Electronic Control Module (ECM)

If the ECM is not receiving battery voltage, the ECM will not operate. Refer to Troubleshooting, “Electrical Power Supply Circuit - Test”.

Starting Aids (If Applicable)

If cold ambient conditions exist, check operation of starting aids. Verify that the ether system is operating correctly. Refer to the appropriate diagnostic functional test for troubleshooting information.

Engine Shutdown Switches

The engine shutdown switches must be in the RUN position in order to start the engine. Use Cat ET to verify the status of the shutdown switches. When an engine shutdown switch is used to shut down the engine, electrical power must be removed from the ECM for at least 15 seconds before restarting the engine.

Starting Motor, Solenoid, or Starting Circuit

Remove the starter and visually inspect the pinion of the starter and the flywheel ring gear for damage.

Test the operation of the starting motor solenoid. Check the condition of the engine wiring for the starting motor solenoid. Test the operation of the starting motor.

If necessary, repair the starter or the starter circuit.

Engine Speed/Timing

1. Crank the engine and observe the engine speed on the Cat ET status screen. If Cat ET indicates zero rpm, refer to Troubleshooting, “Engine Speed/Timing Sensor Circuit - Test”.

Note: Upon initial cranking, the status for engine speed may indicate that the engine speed signal is abnormal. This message will be replaced with an engine speed once the ECM is able to calculate a speed from the signal.

2. 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”.

Unit Injector

1. Ensure that the valve cover connector for the injectors is fully connected and free of corrosion.

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 additional information.

Fuel Supply

1. Visually check the fuel level. Do not rely on the fuel gauge only. If necessary, add fuel. If the engine has been run out of fuel, it will be necessary to purge the air from the fuel system. Refer to Operation and Maintenance Manual, “Fuel System - Prime” 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. Prime the fuel 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.

5. Check the fuel filters.

6. 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.

7. Check the fuel pressure during engine cranking. Check the fuel pressure after the fuel filter. 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.

Combustion

Check the engine for combustion problems.

i02549485

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.

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 the Systems Operation/Testing and Adjusting manual.

i02513923

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 without a diagnostic code 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
- 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.

Electrical Connectors

Check for correct installation of the J1/P1 and J2/P2 Electronic Control Module (ECM) connectors and the unit injector connectors. Refer to the diagnostic functional test 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 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.
3. Perform the “Cylinder Cutout Test” on Cat ET in order to identify any misfiring cylinder(s). Refer to the diagnostic functional test Troubleshooting, “Injector Solenoid Circuit - Test”.

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. Prime the fuel 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. 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.
5. 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.

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”.

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.

i02455784

Engine Stalls at Low RPM

SMCS Code: 1915-035

Probable Causes

- Unit injectors
- Fuel supply
- Air supply
- Engine idle
- 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 the diagnostic functional test 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 the diagnostic functional test Troubleshooting, “Injector Solenoid Circuit - Test”.

Fuel Supply

1. Check the fuel pressure. Refer to Systems Operation/Testing and Adjusting.
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.

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. Prime the fuel 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.

5. Cold weather adversely affects the characteristics of the fuel. Refer to the Operation and Maintenance Manual.

6. Check the fuel pressure after the fuel filter while the engine is being cranked. For the correct pressure values, refer to the Systems Operation/Testing and Adjusting manual. 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 Supply

Check for restrictions in the air inlet system. Refer to Systems Operation/Testing and Adjusting.

Engine Idle

Check the parameter for the low engine idle (if applicable). Refer to Troubleshooting, “System Configuration Parameters”.

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.

i02419766

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 without a diagnostic code Troubleshooting, “Engine Misfires, Runs Rough or Is Unstable”.

i02422399

Engine Will Not Crank

SMCS Code: 1000-035

Probable Causes

- Emergency stop switch
- Batteries
- Battery cables
- Cranking circuit
- Starting circuit
- Starting motor solenoid
- Starting motor
- Flywheel ring gear
- Engine accessories
- Hydraulic cylinder lock
- Internal engine problem

Recommended Actions

Emergency Stop Switch

Verify that the emergency stop switch is in the RUN (out) position. If the switch is depressed, the engine will not be allowed to crank. Refer to Troubleshooting, “Emergency Stop Switch Circuit - Test”.

Batteries and/or Battery Cables

1. Inspect the 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”.

Cranking Circuit

The ECM controls the crank cycle for the engine. During a request for engine starting, the ECM provides power to the Starter Motor Magnetic Switch (SMMS) for the starter. Ensure that the cranking circuit is operating correctly. Perform the following Steps:

1. Check all of the circuit breakers for the application. If a breaker is tripped, investigate the cause.
2. Check the control input voltage for the SMMS at the ECM.
3. Ensure that the control input voltage is reaching the SMMS.
4. Check the input voltage for the secondary circuit of the SMMS.
5. Check the output voltage for the secondary circuit of the SMMS.

The correct voltages during engine cranking will be equal to the battery voltage.

If any of the voltages are incorrect, repair the circuit.

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 pinion for the starting motor and the flywheel ring gear for damage.

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.

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

1. Disassemble the engine. Refer to Disassembly and Assembly.
2. Inspect the internal components for the following conditions:
   - Seizure
   - Broken components
   - Bent components

i02407674

Excessive Black Smoke

SMCS Code: 1088-035

Probable Causes

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

- Valve adjustment

Recommended Actions

Air Inlet or Exhaust System

1. Check the air inlet system for restrictions and/or for leaks.

   a. Check for an air filter restriction.

   b. Perform a visual inspection of the system for restrictions and/or for leaks in the air inlet piping .

2. Ensure that the turbocharger is in good repair.

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).

Intake Manifold 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 Electronic Control Module (ECM) is providing the correct control. Otherwise, proceed to the next Step.

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

3. Monitor the status of “Intake Manifold Pressure” and “Atmospheric Pressure” on the Caterpillar Electronic Technician (ET). When the engine is not running, “Intake Manifold Pressure” should be 0 kPa (0 psi).

Note: A problem with the “FRC Fuel Limit” will only cause black smoke during acceleration. A problem with the “FRC Fuel Limit” 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 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 for information on valve adjustments.

i02410997

Excessive Engine Oil Consumption

SMCS Code: 1348-035

Probable Causes

- Oil leaks
- Oil level
- Turbocharger seal
- Internal engine wear

Recommended Actions

Oil Leaks

Check the engine compartment for oil leaks. Repair any oil leaks that are identified.

Oil Level

Check the engine oil level. Too much oil in the engine crankcase can cause the engine to consume oil. Remove excessive engine oil from the crankcase.

Ensure that the dipstick is properly calibrated and/or that the dipstick is correct for the application. Calibrate the dipstick and/or replace the dipstick.

Turbocharger

Check for turbocharger shaft seal leakage. Remove the air inlet piping and the exhaust outlet piping from the turbocharger. Check the compressor wheel and the turbine for evidence of an oil leak. If necessary, repair the turbocharger or replace the turbocharger. Refer to Systems Operation/Testing and Adjusting.

Internal Engine Wear

Internal engine wear can cause excessive oil leakage into the combustion area of the cylinders. Excessive wear on the following components may cause oil consumption:

- Piston rings
- Valve guides

Check for excessive crankcase blowby at the engine crankcase breather. Refer to Systems Operation/Testing and Adjusting.

i02430014

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

Engine Speed/Timing

Perform a speed/timing sensor calibration. Refer to the calibration procedure 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 the diagnostic functional test 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 the diagnostic functional test Troubleshooting, “Injector Solenoid Circuit - Test”.

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.

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.

i02285926

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
   - Roller followers (rocker arm)
   - Camshaft
   - Valve stems
   - Valve guides
   - 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 roller followers (rocker arm).

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

i02399564

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

- Starting aids (if applicable)
- Coolant temperature sensor
- Engine speed/timing
- Unit injectors
- Flash file
- Fuel supply
- Component wear
- Cooling system

Recommended Actions

Starting Aids

1. Check for proper operation of the jacket water heater. Repair the jacket water heater or replace the jacket water heater.
2. Ensure that the ether canister is not empty or low. Replace the ether canister if the ether canister is empty or low. Refer to Troubleshooting, "Ether Injection System - Test".

Coolant Temperature Sensor

1. Use the Caterpillar Electronic Technician (ET) to verify that the engine has exited cold mode.
2. Compare the coolant temperature from Cat ET to the coolant temperature that is obtained from the 6V-9130 Temperature Adapter (MULTIMETER). Ensure that the temperature readings are reasonable for the conditions that are present.

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 timing of the crankshaft and camshaft drive gears are set with the proper orientation. Refer to Disassembly and Assembly for information that is related to the correct gear installation.

Unit Injectors

1. Perform the “Cylinder Cutout Test” on Cat ET in order to try to isolate any cylinders that may be misfiring. A misfiring cylinder could be related to an injector that is worn or in poor repair. Refer to Troubleshooting, “Injector Solenoid Circuit - Test”.

2. Cut out each individual cylinder for 30 to 60 seconds. Verify that the smoke decreases.

Flash File

Verify that the correct flash file is installed. Refer to Troubleshooting, “System Configuration Parameters”.

Fuel Supply

1. Inspect the fuel system components.

2. Check the fuel pressure during engine cranking. Check the filtered fuel pressure. Refer to Systems Operation/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.

3. Check the fuel quality. Low cetane fuel can create white smoke. If necessary, replace the fuel with a higher cetane fuel.

4. 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.

Component Wear

Check the engine for the following problems: Excessive valve wear, piston wear, ring wear, liner wear, and reduced compression pressure.

Cooling System

Check for an internal coolant leak into the cylinder and/or the exhaust. Refer to Systems Operation/Testing and Adjusting for information on inspecting the cooling system.

i02281012

Fuel in Cooling System

SMCS Code: 1350-035

The probable root cause is a damaged O-ring seal for a fuel injector.

Perform the following procedure:

Remove the valve cover. Remove the fuel supply. Disconnect the fuel return line from the cylinder head. Cap the fuel return connector and apply 700 kPa (102 psi) maximum air pressure to the fuel supply connector. Check for fuel leakage around each fuel injector. If leakage is present, remove the leaking fuel injector. Install a new O-ring seal onto the injector. Install the injector. Connect the fuel return line. Install the valve cover. Verify that the problem is resolved.

i02360438

Fuel Dilution of Engine Oil

SMCS Code: 1348-035

Probable Causes

- Leaking seals on the body or the sleeve of the unit injector
- Excessive leakage from the unit injector tip or a broken unit injector tip
- Cracked cylinder head or leaking cylinder head gasket
- Leakage of the drive shaft seal on the fuel transfer pump

Recommended Actions

Leaking Seals on the Body or the Sleeve of the Unit Injector

Check the torque for the unit injector clamp retaining bolts. Ensure that the unit injectors are properly installed into the cylinder head.

If damage to the unit injector sleeves or to the O-ring seals is suspected, remove the unit injectors and/or the unit injector sleeves. Inspect the O-ring seals and the unit injector sleeves for damage. Replace any seals or sleeves that show evidence of leakage.

Excessive Leakage from the Unit Injector Tip or a Broken Unit Injector Tip

Look for signs of damage to the unit injectors. If necessary, replace the unit injectors that have damaged tips.

Cracked Cylinder Head or Leaking Cylinder Head Gasket

Check for symptoms of a damaged cylinder head or cylinder head gasket.

Inspect the cooling system for contamination of fuel. Inspect the crankcase for dilution of the engine oil. This may be a sign of a cracked cylinder head or of a leaking cylinder head gasket.

Leakage of the Drive Shaft Seal on the Fuel Transfer Pump

Ensure that the weep hole for the fuel transfer pump is not plugged. Inspect the front of the pump for signs of leakage. If necessary, repair the fuel transfer pump or replace the fuel transfer pump.

i02520529

Intermittent Engine Shutdown

SMCS Code: 1000-035

Note: Use this procedure only if the engine shuts down completely during operation.

Probable Causes

- Diagnostic codes
- Event codes
- Electrical connectors
- Circuit breakers
- Fuel supply

Recommended Actions

Diagnostic Codes and/or Event Codes

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

Electrical Connectors

1. Check for correct installation of the J1/P1 and J2/P2 connectors for the Electronic Control Module (ECM). Also, thoroughly inspect the connectors for the engine speed/timing sensors. Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect”.

2. Inspect the battery wires from the ECM to the battery compartment. Refer to the Schematic for specific wiring information. Check the unit injector connectors and associated wiring for damage, or for intermittent problems. Inspect the wires and connectors to all circuit protection for the engine. Check the power and ground connections to the ECM. Check any engine shutdown switches and associated wiring. Refer to the diagnostic functional test Troubleshooting, “Electrical Power Supply Circuit - Test”.

Circuit Breakers

Check the state of each of the circuit breakers. Reset the circuit breakers if the circuit breakers are tripped. Prior to returning the engine to service, determine the condition that caused the circuit breaker to trip. Make the necessary repairs.

Fuel Supply

1. Visually check the fuel level in the fuel tank. Do not rely on the fuel gauge only. If necessary, add fuel to the fuel tank. If the engine has been run out of fuel, it will be necessary to prime the fuel system. Refer to the Operation and Maintenance Manual.

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 debris or foreign objects which may block the fuel supply.

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. Prime the fuel 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: Check the fuel system for air. Refer to the Systems Operation/Testing and Adjusting manual.

5. Check fuel quality. Cold weather adversely affects the characteristics of the fuel. Refer to the Operation and Maintenance Manual.

6. Check the filtered fuel pressure while the engine is being cranked. Refer to Systems Operation/Testing and Adjusting.

   If the fuel pressure is low, replace the fuel filters. Clean the primary filter/water separator of debris. Refer to the Operation and Maintenance Manual.

   If the fuel pressure is still low, check the operation of the fuel pressure regulating valve. Also, check for the proper operation of the fuel transfer pump. Refer to Systems Operation/Testing and Adjusting.

i02487753

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
- Power supply for the Electronic Control Module (ECM)
- Fuel supply

Recommended Actions

Note: If the problem only occurs under certain conditions, test the engine under those conditions. Examples of certain conditions are high engine speed, 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/or for logged codes. Troubleshoot any codes that are present before continuing with this procedure.

Throttle Signal

Monitor the status for “Throttle Position” on Cat ET. Verify that the status for “Throttle Position” is stable and that the engine is able to reach high idle speed. Refer to Troubleshooting, “Speed Control - Test” for information that is related to troubleshooting the circuit for the throttle signal.

ECM Power Supply

1. Ensure that the ECM is receiving the correct voltage. Inspect the circuit between the ECM and the batteries. Refer to the Electrical System Schematic. Inspect the wires, the connectors, and the components in the circuit. Refer to 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. Prime the fuel system if any of the following components have been serviced recently:

   - Fuel filters
   - Low pressure fuel supply circuit
   - Unit injectors

Note: A sight glass in the low pressure supply line is helpful in diagnosing air in the fuel. For more information, refer to Systems Operation/Testing and Adjusting, “Air in Fuel - Test”.

4. 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.

5. Check the fuel pressure while the engine is being cranked. Refer to Systems Operation/Testing and Adjusting, “Fuel System” for the correct test procedure. If the fuel pressure is below the specification, replace the fuel filters. If the fuel pressure remains below the specification, check the following items: fuel transfer pump, fuel pressure relief valve, and fuel pressure regulator valve. Refer to Systems Operation/Testing and Adjusting for more information.

i02430113

Low Engine Oil Pressure

SMCS Code: 1348-035-LP

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

Probable Causes

- Engine oil level
- Engine oil filters and oil filter bypass valve
- Engine oil pump
- Engine oil cooler
- Fuel dilution
- Engine wear

Recommended Actions

Engine Oil Level

Inspect the engine oil level. If engine oil is low add engine oil. Refer to the Operation and Maintenance Manual.

Engine Oil Filters and Oil Filter Bypass Valve

Check the service records of the engine for information that is related to the last oil change. If necessary, perform an oil change on the engine and replace the engine oil filters.

Check the operation of oil filter bypass valve. Clean the bypass valve and the housing. If necessary, install new parts.

Engine Oil Pump

Check for blockage of the inlet screen for the engine oil pump. Check the components of the engine oil pump for excessive wear. If necessary, repair the oil pump or replace the oil pump.

Oil Cooler

Check the engine's oil cooler for plugging or blockage. Clean the engine oil cooler core(s) and/or install new engine oil cooler core(s).

Fuel Dilution

Check for presence of fuel in lubricating oil. Refer to the troubleshooting without a diagnostic code procedure Troubleshooting, "Fuel Dilution of Engine Oil".

Engine Wear

Inspect the camshaft and/or camshaft bearings for excessive wear. Inspect the crankshaft and/or crankshaft bearings. Excessive wear to discrete components may be an indication of a blocked oil passage. Use an oil pressure gauge to check the oil pressure at the main oil gallery. This will help determine if the excessive wear is from low system pressure or from passages that are blocked.

i02422402

Low Power/Poor or No Response to Throttle

SMCS Code: 1000-035

Probable Causes

- Engine derate or active codes
- Cold mode
- Throttle signal
- Electrical connectors
- Unit injectors
- Intake manifold pressure
- Air inlet and exhaust system
- Parameters
- Fuel supply

Recommended Actions

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

Engine Derate or Active Codes

Some engine monitoring parameters that are capable of triggering an engine derate do not produce an event code. Connect Caterpillar Electronic Technician (ET) in order to check for a derate of the engine.

Certain diagnostic codes and/or event codes may cause poor performance. Use Cat ET to check for active codes and for logged codes. Troubleshoot any codes that are present before continuing with this procedure.

Note: Although a sensor's signal may be in the operational range of the sensor, the signal may not represent the actual reading. Use Cat ET to check that the pressures and the temperatures are fluctuating. Also check that the values are reasonable for the conditions that are present.

Cold Mode

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

2. Observe the coolant temperature on the Cat ET status screen. Verify that the reading is valid.

Throttle Signal

Monitor the status for "Throttle Position" on Cat ET. Verify that the status for "Throttle Position" is stable and that the engine is able to reach high idle speed. Refer to Troubleshooting, "Speed Control - Test" for the correct procedure.

Electrical Connectors

Check for correct installation of the J1/P1 and J2/P2 connectors at the Electronic Control Module (ECM). Also, check for the correct installation of the valve cover connectors for the injector solenoids. Refer to Troubleshooting, "Electrical Connectors - Inspect".

Unit Injectors

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

2. Perform the "Cylinder Cutout Test" on Cat ET in order to identify any misfiring cylinder(s). Refer to Troubleshooting, "Injector Solenoids Circuit - Test" for more information.

Intake Manifold Pressure

1. Monitor the status of "Fuel Position", "Rated Fuel Limit", and "FRC Fuel Limit" on Cat ET while the engine is operating under full load. These parameters should reflect the information below.

Table 11

"Fuel Position" = "Rated Fuel Limit"
and
"Fuel Position" < "FRC Fuel Limit"

   If "Fuel Position" equals "Rated Fuel Limit" and "Fuel Position" is less than "FRC Fuel Limit", the electronics are operating correctly. Otherwise, proceed with the next Step.

2. Monitor the status of "Boost Pressure" and "Atmospheric Pressure" for normal operation on Cat ET. When the engine is not running, the correct value for the intake manifold pressure sensor is 0 kPa (0 psi).

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".

Parameters

If the ECM has been replaced, compare the values that are on the engine information plate to following parameters from Cat ET:

- FRC offset
- Full Load Setting (FLS)
- Full Torque Setting (FTS)

Fuel Supply

1. Visually check the fuel level in the fuel tank. Do not rely on the fuel gauge only. If necessary, add fuel to the fuel tank. If the engine has been run out of fuel, it will be necessary to purge the air from the fuel system. Refer to Operation and Maintenance Manual, "Fuel System - Prime" 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 debris or foreign objects which may block the fuel supply.

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. Prime the fuel 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: Check the fuel system for air. Refer to Systems Operation/Testing and Adjusting, “Air in Fuel - Test” for information that is related to checking the fuel system for air.

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

6. Check the filtered fuel pressure while the engine is being cranked. Refer to Systems Operation/Testing and Adjusting for the test procedure and for the correct pressure values.

   If the fuel pressure is low, replace the fuel filters. Clean the primary filter/water separator of debris. Refer to the Operation and Maintenance Manual for details.

   If the fuel pressure is still low, check the operation of the fuel pressure regulating valve. Also, check for the proper operation of the fuel transfer pump. Refer to Systems Operation/Testing and Adjusting for test information.

i02286073

Mechanical Noise (Knock) in Engine

SMCS Code: 1000-035

The probable root causes are listed below:

- Faulty accessory
- Damage to valve train components
- Failure of connecting rod bearing
- Crankshaft bearings

Perform the following checks:

1. Isolate the source of the noise. Remove the suspect engine accessories. Inspect the suspect engine accessories. Repair the engine accessories and/or replace the engine accessories.

2. Remove the valve cover from the suspect cylinder(s). Check the following items for damage: camshaft, valve rotocoil, valve springs, roller followers (rocker arm), rocker shaft, bridges, and injectors. Check for valves that do not move freely. Remove the cylinder head and inspect the valves. Replace any damaged parts. If damage has occurred, ensure that the following components are free of contamination: cylinder liner, piston, and exhaust system. Replace any damaged parts.

3. Inspect the connecting rod bearings and the bearing surfaces (journals) on the crankshaft. Check the piston pin for excessive wear. Replace any damaged parts.

4. Check main journals of the crankshaft and the main journal bearings for excessive wear. Replace any damaged parts.

i02477338

Noise Coming from Cylinder

SMCS Code: 1000-035

Probable Causes

- Diagnostic codes
- Fuel quality
- Unit injectors
- Valve lash
- Cylinder head and related components

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 the characteristics of the fuel.

Unit Injectors

1. Check the connectors at the Electronic Control Module (ECM). Check for correct installation of the J1/P1 and J2/P2 ECM connectors. Also, thoroughly inspect the unit injector wiring harness from the ECM to the J300/P300 valve cover entry connector. Refer to the diagnostic functional test 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 may be misfiring. Refer to the diagnostic functional test Troubleshooting, “Injector Solenoid Circuit - Test”.

Valve Lash

Check the engine valve lash settings. Inspect the valve train for sufficient lubrication. Check damage to valve train components which may cause excessive valve lash. Repair any problems that are found. Refer to troubleshooting without a diagnostic code Troubleshooting, “Excessive Valve Lash”.

Cylinder Head and Related Components

Check for signs of damage and/or wear to the valves, cylinder head gasket, etc. Inspect the condition of the camshafts.

i02422401

Poor Acceleration or Response

SMCS Code: 1000-035

Probable Causes

- Engine derate or active codes
- Cold mode
- Flash file
- Throttle signal
- Electrical connectors
- Unit injectors
- Intake manifold pressure
- Air inlet and exhaust system
- Fuel supply

Recommended Actions

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

Engine Derate or Active Codes

Some engine monitoring parameters that are capable of triggering an engine derate do not produce an event code. Connect Caterpillar Electronic Technician (ET) in order to check for a derate of the engine.

Certain diagnostic codes and/or event codes may cause poor performance. Use Cat ET to check for active codes and for logged codes. Troubleshoot any codes that are present before continuing with this procedure.

Note: Although a sensor’s signal may be in the operational range of the sensor, the signal may not represent the actual reading. Use Cat ET to check that the pressures and the temperatures are fluctuating. Also check that the values are reasonable for the conditions that are present.

Cold Mode

Use Cat ET to verify that the engine has exited cold mode. Cold mode operation may slow throttle response.

Flash File

Verify that the latest flash file is installed in the Electronic Control Module (ECM).

Throttle Signal

Monitor the status for “Throttle Position” on Cat ET. Verify that the status for “Throttle Position” is stable and that the engine is able to reach high idle speed. Refer to Troubleshooting, “Speed Control - Test” for information that is related to testing the system.

Electrical Connectors

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

Unit Injectors

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

2. Perform the “Cylinder Cutout Test” on Cat ET in order to determine the performance of each cylinder. Refer to Troubleshooting, “Injector Solenoid Circuit - Test” for the proper procedure.

Intake Manifold Pressure

1. Monitor the status of “Fuel Position”, “Rated Fuel Limit”, and “FRC Fuel Limit” on Cat ET while the engine is operating under full load. These parameters should reflect the information below.

Table 12

“Fuel Position” = “Rated Fuel Limit”
and
“Fuel Position” < “FRC Fuel Limit”

   If “Fuel Position” equals “Rated Fuel Limit” and “Fuel Position” is less than “FRC Fuel Limit”, the electronics are operating correctly. Otherwise, proceed with the next Step.

2. Monitor the status of the “Boost Pressure” parameter and the “Atmospheric Pressure” parameter on Cat ET. When the engine is not running, the correct value for the intake manifold pressure sensor is 0 kPa (0 psi).

Air Inlet and Exhaust System

1. Observe the check engine lamp. 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. Visually check the fuel level in the fuel tank. Do not rely on the fuel gauge only. If necessary, add fuel to the fuel tank. If the engine has been run out of fuel, it will be necessary to purge the air from the fuel system. Refer to Operation and Maintenance Manual, “Fuel System - Prime” 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 debris or foreign objects which may block the fuel supply.

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. Prime the fuel 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: Check the fuel system for air. Refer to Systems Operation/Testing and Adjusting, “Air in Fuel - Test” for information that is related to checking the fuel system for air.

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

6. Check the filtered fuel pressure while the engine is being cranked. Refer to Systems Operation/Testing and Adjusting for the test procedure and for the correct pressure values.

   If the fuel pressure is low, replace the fuel filters. Clean the primary filter/water separator of debris. Refer to the Operation and Maintenance Manual for details.

   If the fuel pressure is still low, check the operation of the fuel pressure regulating valve. Also, check for the proper operation of the fuel transfer pump. Refer to Systems Operation/Testing and Adjusting for test information.

i02643299

Valve Rotator or Spring Lock Is Free

SMCS Code: 1109-035

Use this procedure in order to troubleshoot a problem with the valve rotators or spring locks.

Probable Cause

- Valve Components

Recommended Actions

Valve components

1. A valve rotator that is cracked or a valve rotator that is broken is an indication of an engine overspeed. Determine the cause of the engine overspeed. 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

i02432846

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.

Suspect Parameter Number (SPN) – The SPN is a three digit code which is assigned to each component in order to identify data via the data link to the ECM. This is used on the diagnostics for the CAN data link.

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.

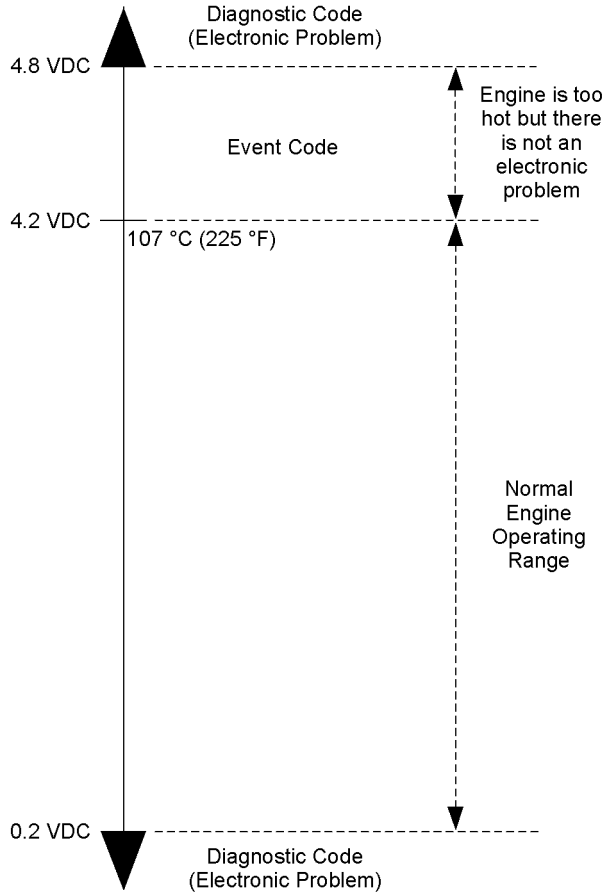


Illustration 7 g01117578

Output voltage from a typical analog temperature sensor

Illustration 7 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.

i02419262

Diagnostic Code Cross Reference

SMCS Code: 1900

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

Cross-Reference for SPN-FMI Code to CID-FMI

Table 13

Cross-Reference for SPN-FMI Code to CID-FMI		
SPN/FMI	**CID-FMI**	**Description of Code**
91-08	91-08	Throttle Position signal abnormal
94-03	94-03	Fuel Pressure open/short to +batt
94-04	94-04	Fuel Pressure short to ground
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 Sensor abnormal rate of change
108-03	274-03	Atmospheric Pressure open/short to +batt
108-04	274-04	Atmospheric Pressure short to ground
110-03	110-03	Engine Coolant Temperature open/short to +batt
110-04	110-04	Engine Coolant Temperature short to ground
168-00	168-00	System Voltage High
168-01	168-01	System Voltage Low
168-02	168-02	System Voltage intermittent/erratic
172-03	172-03	Intake Manifold Air Temp open/short to +batt
172-04	172-04	Intake Manifold Air Temp short to ground
174-03	174-03	Fuel Temperature open/short to +batt
174-04	174-04	Fuel Temperature short to ground
175-03	175-03	Engine Oil Temperature open/short to +batt
175-04	175-04	Engine Oil Temperature short to ground
190-08	190-08	Engine Speed abnormal
228-11	261-11	Engine Timing calibration invalid
228-13	261-13	Engine Timing calibration required
234-02	253-02	Personality Module mismatch
444-05	444-05	Start Relay open circuit
444-06	444-06	Start Relay short to ground
446-05	446-05	Air Shutoff Relay open
446-06	446-06	Air Shutoff Relay short
620-03	262-03	5 Volt Sensor DC Power Supply short to +batt
620-04	262-04	5 Volt Sensor DC Power Supply short to ground
651-05	1-05	Cylinder #1 Injector open circuit
651-06	1-06	Cylinder #1 short
652-05	2-05	Cylinder #2 Injector open circuit
652-06	2-06	Cylinder #2 Injector short
653-05	3-05	Cylinder #3 Injector open circuit
653-06	3-06	Cylinder #3 Injector short
654-05	4-05	Cylinder #4 Injector open circuit

(continued)

(Table 13, contd)

Cross-Reference for SPN-FMI Code to CID-FMI		
SPN/FMI	**CID-FMI**	**Description of Code**
654-06	4-06	Cylinder #4 Injector short
655-05	5-05	Cylinder #5 Injector open circuit
655-06	5-06	Cylinder #5 Injector short
656-05	6-05	Cylinder #6 Injector open circuit
656-06	6-06	Cylinder #6 Injector short
657-05	7-05	Cylinder #7 Injector open circuit
657-06	7-06	Cylinder #7 Injector short
658-05	8-05	Cylinder #8 Injector open circuit
658-06	8-06	Cylinder #8 Injector short
659-05	9-05	Cylinder #9 Injector open circuit
659-06	9-06	Cylinder #9 Injector short
660-05	10-05	Cylinder #10 Injector open circuit
660-06	10-06	Cylinder #10 Injector short
661-05	11-05	Cylinder #11 Injector open circuit
661-06	11-06	Cylinder #11 Injector short
662-05	12-05	Cylinder #12 Injector open circuit
662-06	12-06	Cylinder #12 Injector short
723-08	342-08	Secondary Engine Speed signal abnormal
1111-02	268-02	Check Programmable Parameters
1785-03	1785-03	Intake Manifold Pressure Sensor voltage high
1785-04	1785-04	Intake Manifold Pressure Sensor voltage low
1785-10	1785-10	Intake Manifold Pressure Signal abnormal rate of change

Cross-Reference for SPN-FMI Code to EID

Table 14

Cross-Reference for SPN-FMI Code to EID		
SPN/FMI	**EID**	**Description of Code**
16-17	E390-1	Fuel Filter Restriction Warning
16-19	E390-2	Fuel Filter Restriction Derate
16-01	E390-3	Fuel Filter Restriction Shutdown
94-15	E096-1	High Fuel Pressure Warning
94-16	E096-2	High Fuel Pressure Derate
94-00	E096-3	High Fuel Pressure Shutdown
94-17	E198-1	Low Fuel Pressure Warning
94-18	E198-2	Low Fuel Pressure Derate
94-01	E198-3	Low Fuel Pressure Shutdown
100-17	E360-1	Low Engine Oil Pressure Warning
100-01	E360-3	Low Engine Oil Pressure Shutdown
110-15	E361-1	High Engine Coolant Temperature Warning
110-16	E361-2	High Engine Coolant Temperature Derate
110-00	E361-3	High Engine Coolant Temperature Shutdown
111-17	E059-1	Low Engine Coolant Level Warning
111-18	E057-2	Low Engine Coolant Level Derate
174-15	E363-1	High Fuel Temperature Warning
174-16	E363-2	High Fuel Temperature Derate
174-00	E363-3	High Fuel Temperature Shutdown
175-0	E197-3	High Engine Oil Temperature Shutdown
175-15	E197-1	High Engine Oil Temperature Warning
175-16	E197-2	High Engine Oil Temperature Derate
190-15	E362-1	Engine Overspeed Warning
190-00	E362-3	Engine Overspeed Shutdown
1636-15	E539-1	High Intake Manifold Air Temperature Warning
1636-16	E539-2	High Intake Manifold Air Temperature Derate
N/A	E194-2	High Exhaust Temperature
N/A	E264-3	Emergency Stop Activated
N/A	E2087-3	Air Intake Shutoff Closed
N/A	E2088-1	Air Intake Shutoff Detection Circuit Detected but Not Installed

i02430358

CID 0001 FMI 05 Cylinder #1 Injector 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:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

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

Results:

- OK – STOP.

i02430360

CID 0001 FMI 06 Cylinder #1 Injector 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:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

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

Results:

- OK – STOP.

i02430362

CID 0002 FMI 05 Cylinder #2 Injector 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:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

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

Results:

- OK – STOP.

i02430363

CID 0002 FMI 06 Cylinder #2 Injector 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:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

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

Results:

- OK – STOP.

i02430365

CID 0003 FMI 05 Cylinder #3 Injector 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:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

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

Results:

- OK – STOP.

i02430366

CID 0003 FMI 06 Cylinder #3 Injector 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:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

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

Results:

- OK – STOP.

i02430368

CID 0004 FMI 05 Cylinder #4 Injector 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:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

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

Results:

- OK – STOP.

i02430370

CID 0004 FMI 06 Cylinder #4 Injector 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:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

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

Results:

- OK – STOP.

i02430371

CID 0005 FMI 05 Cylinder #5 Injector 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:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

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

Results:

- OK – STOP.

i02430373

CID 0005 FMI 06 Cylinder #5 Injector 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:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

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

Results:

- OK – STOP.

i02430375

CID 0006 FMI 05 Cylinder #6 Injector 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:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

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

Results:

- OK – STOP.

i02430376

CID 0006 FMI 06 Cylinder #6 Injector 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:

- The engine may misfire.
- The engine may experience low power.

Troubleshooting:

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

Results:

- OK – STOP.

i02420716

CID 0007 FMI 05 Cylinder #7 Injector 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.

i02420867

CID 0007 FMI 06 Cylinder #7 Injector 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.

i02420728

CID 0008 FMI 05 Cylinder #8 Injector 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.

i02420872

CID 0008 FMI 06 Cylinder #8 Injector 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.

i02420746

CID 0009 FMI 05 Cylinder #9 Injector 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.

i02420876

CID 0009 FMI 06 Cylinder #9 Injector 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.

i02420750

CID 0010 FMI 05 Cylinder #10 Injector 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.

i02420920

CID 0010 FMI 06 Cylinder #10 Injector 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.

i02420757

CID 0011 FMI 05 Cylinder #11 Injector 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.

i02420922

CID 0011 FMI 06 Cylinder #11 Injector 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.

i02420764

CID 0012 FMI 05 Cylinder #12 Injector 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.

i02420927

CID 0012 FMI 06 Cylinder #12 Injector 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.

i02401132

CID 0091 FMI 08 Throttle Position signal abnormal

SMCS Code: 1439-038; 1913-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal frequency for the speed control that is not in the operating range of the control.

System Response:

The ECM will log the diagnostic code. The throttle position is flagged as invalid data. The ECM sets engine speed to the programmed low idle.

Note: The Caterpillar Electronic Technician (ET) indicates a throttle position of “0 %” while this diagnostic code is active.

Possible Performance Effect:

The engine will remain in low idle while this diagnostic code is active.

Troubleshooting:

Perform the following diagnostic procedure: “Speed Control - Test”

Results:

- OK – STOP.

i02520759

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

SMCS Code: 1439-038; 1718-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage from the sensor that is above normal.

System Response:

The code is logged. The ECM flags fuel pressure as invalid data and a default value is used.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

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

Results:

- OK – STOP.

i02520760

CID 0094 FMI 04 Fuel Pressure short to ground

SMCS Code: 1439-038; 1718-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage that is below normal.

System Response:

The code is logged. The ECM flags fuel pressure as invalid data and a default value is used.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

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

Results:

- OK – STOP.

i02520773

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

SMCS Code: 1439-038-OC; 1924-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage that is above normal.

System Response:

The code is logged. The ECM flags oil pressure as invalid data and a default value is used.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

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

Results:

- OK – STOP.

i02520774

CID 0100 FMI 04 Engine Oil Pressure short to ground

SMCS Code: 1439-038-OC; 1924-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage that is below normal.

System Response:

The code is logged. The ECM flags oil pressure as invalid data and a default value is used.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

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

Results:

- OK – STOP.

i02581776

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

SMCS Code: 1439-038-OC; 1924-038

Conditions Which Generate This Code:

This code indicates that the 5 volt supply is missing from the sensor connector.

During normal engine operation, the oil pressure fluctuates slightly. When the 5 volt supply is missing from the oil pressure sensor, the signal from the oil pressure sensor goes to a midrange value. The signal does not fluctuate. If the signal from the oil pressure sensor remains abnormally steady for more than 30 seconds, the Engine Control Module (ECM) activates this code.

System Response:

A snapshot is triggered. The ECM uses a default value for the oil pressure.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

Repair the Open Circuit

A. Repair the supply wire or replace the supply wire between the ECM and the sensor.

Expected Result:

The problem is resolved.

Results:

- OK – The problem is resolved. STOP.
- Not OK – The problem is not resolved.

  Repair: Refer to the diagnostic functional test Troubleshooting, “5 Volt Engine Pressure Sensor Supply Circuit - Test”.

  STOP.

i02427669

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

SMCS Code: 1439-038-CLT; 1906-038

Conditions Which Generate This Code:

The signal voltage from the engine coolant temperature sensor is above normal.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The ECM flags coolant temperature as invalid data and a default value is used. The engine will not go into cold mode.

Possible Performance Effect:

- The engine may misfire.
- The engine may experience reduced speed (rpm) and/or low power.

Troubleshooting:

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

Results:

- OK – STOP.

i02427678

CID 0110 FMI 04 Engine Coolant Temperature short to ground

SMCS Code: 1439-038-CLT; 1906-038

Conditions Which Generate This Code:

The signal voltage from the engine coolant temperature sensor is below normal.

System Response:

The Electronic Control Module (ECM) will log the diagnostic code. The ECM flags coolant temperature as invalid data and a default value is used. The engine will not go into cold mode.

Possible Performance Effect:

- The engine may misfire.
- The engine may experience reduced speed (rpm) and/or low power.

Troubleshooting:

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

Results:

- OK – STOP.

i02424772

CID 0168 FMI 00 System Voltage High

SMCS Code: 1401-038

Conditions Which Generate This Code:

The Electronic Control Module (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:

- There are no performance effects.

Troubleshooting:

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

Results:

- OK – STOP.

i02480880

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:

- The engine may shut down.
- The engine may have hard starting and/or misfire.
- The contacts for the starting motor solenoid may be chatter during cranking. This can damage the contacts.

Troubleshooting:

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

Results:

- OK – STOP.

i02508878

CID 0168 FMI 02 System Voltage intermittent/erratic

SMCS Code: 1401-038

Conditions Which Generate This Code:

While the engine is running the Electronic Control Module (ECM) detects battery voltage that drops below 6 VDC and returns above 9 VDC.

System Response:

The ECM will log the diagnostic code.

Possible Performance Effect:

- An engine misfire may occur.
- An engine shutdown condition may occur.

Troubleshooting:

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

Results:

- OK – STOP.

i02440612

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

SMCS Code: 1439-038-AI; 1921-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage that is above normal or the intake manifold air temperature is below −35 °C (−31 °F) .

System Response:

The code is logged. The ECM will flag the intake manifold air temperature as invalid data and the intake manifold air temperature is set to a default value.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

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

Results:

- OK – STOP.

i02424787

CID 0172 FMI 04 Intake Manifold Air Temp short to ground

SMCS Code: 1439-038-AI; 1921-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage that is below normal.

System Response:

The code is logged. The ECM will flag the intake manifold air temperature as invalid data and the intake manifold air temperature is set to a default value.

Possible Performance Effect:

- The engine may experience hard starting and/or rough running.
- The engine may smoke.

Troubleshooting:

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

Results:

- OK – STOP.

i02424795

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

SMCS Code: 1439-038; 1922-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage from the sensor that is above normal.

System Response:

The ECM will log the diagnostic code. The ECM flags fuel temperature as invalid data and fuel temperature is set to a default value.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

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

Results:

- OK – STOP.

i02424798

CID 0174 FMI 04 Fuel Temperature short to ground

SMCS Code: 1439-038; 1922-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects signal voltage that is below normal.

System Response:

The ECM will log the diagnostic code. The ECM flags fuel temperature as invalid data and a default value is used.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

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

Results:

- OK – STOP.

i02427744

CID 0175 FMI 03 Engine Oil Temperature open/short to +batt

SMCS Code: 1439-038-OC; 1929-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage from the engine oil temperature sensor that is above the operating range of the sensor.

System Response:

The ECM will log the diagnostic code. The ECM flags engine oil temperature as invalid data. The value from the engine coolant temperature sensor is used for engine oil temperature while the diagnostic code is active.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

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

Results:

- OK – STOP.

i02427748

CID 0175 FMI 04 Engine Oil Temperature short to ground

SMCS Code: 1439-038-OC; 1929-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage from the engine oil temperature sensor that is below the operating range of the sensor.

System Response:

The ECM will log the diagnostic code. The ECM flags engine oil temperature as invalid data. The value from the engine coolant temperature sensor is used for engine oil temperature while the diagnostic code is active.

Possible Performance Effect:

- There are no performance effects.

Troubleshooting:

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

Results:

- OK – STOP.

i02421359

CID 0190 FMI 08 Engine Speed signal abnormal

SMCS Code: 1439-038-VF; 1907-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) receives erratic data from the engine speed/timing sensor.

System Response:

The code is logged.

Possible Performance Effect:

- The engine may not start.
- The engine will run rough.

Troubleshooting:

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

Results:

- OK – STOP.

i02490447

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.

Ensure that all flash files in the control system are current.

System Response:

The ECM will log the diagnostic code.

Possible Performance Effect:

- The engine may not operate properly and/or the equipment may not have engine speed control.

Troubleshooting:

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

Results:

- OK – STOP.

i02428636

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:

Caterpillar Electronic Technician (ET) will not be able to clear the code.

Possible Performance Effect:

- The fuel injection system is disabled and the engine will not start.

Troubleshooting:

Check the Part Number of the Flash File

A. Restore the electrical power to the Electronic Control Module (ECM).

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 programming parameters Troubleshooting, “Flash Programming”. Verify that the problem is resolved.

  STOP.

i02437198

CID 0261 FMI 11 Engine Timing Offset fault

SMCS Code: 1439-038; 1912-038

Conditions Which Generate This Code:

The signals from the engine speed/timing sensors indicate that the expected position of the camshaft is incorrect with respect to the crankshaft, or the polarity of the wiring to one of the speed/timing sensors is reversed.

System Response:

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

The ECM sets engine timing calibration to zero degrees.

Possible Performance Effect:

- The engine may misfire.
- The engine may experience low power and/or reduced speed.
- The engine may experience increased exhaust emissions and/or white exhaust smoke.

Troubleshooting:

Test Step 1. Check the Installation of the Speed/Timing Sensors

A. Visually inspect the sensors for correct installation:

  a. Ensure that the sensor’s mounting flanges are fully seated onto the surface of the engine.

  b. Ensure that the locating notch on the flange of each sensor is oriented correctly.

  c. Ensure that the sensor’s brackets are not bent or broken. Ensure that the brackets are securely holding the sensor in place.

  d. Ensure that the sensors are tight in the housing bore. If a sensor is loose in the bore, check the condition of the sensor’s O-ring seals. Ensure that the seals are not missing. Also, inspect the seals for damage.

B. Check for the correct installation of the sensor’s connectors. Ensure that the electrical connector is securely latched. Check for the correct polarity in the wiring at each sensor connector and at the ECM connector.

C. Ensure that the harness is properly secured, and ensure that each tie-wrap is placed in the correct location.

Expected Result:

The sensors, the connectors, and the wiring are correctly installed.

Results:

- OK – The sensors and the harness are OK. The problem is not with the sensor or the harness. There may be a mechanical problem with the engine's front gear train. Proceed to Test Step 2.
- Not OK – A problem has been identified with the installation of the sensors and/or the harness.

  Repair: Correct the problem that has been identified. Replace parts, if necessary. Ensure that the diagnostic code is no longer active.

  A timing calibration is necessary after this diagnostic code has become active. Refer to the diagnostic functional test Troubleshooting, "Engine Speed/Timing Sensor - Calibrate".

  STOP.

Test Step 2. Check the Condition of the Engine's Front Gear Train

The problem may be due to the incorrect orientation of the camshaft gear with respect to the orientation of the crankshaft gear during engine operation. Check the front gear train for damage and excessive wear:

Refer to Disassembly and Assembly.

A. Remove the cover from the front gear housing.

B. Check for correct timing between the crankshaft gear and the camshaft gear.

C. Check the gear train for gear tooth failure.

D. Check the gear train for excessive gear tooth wear and gear tooth failure. Perform a timing gear backlash check.

E. Check each idler gear assembly for excessive wear to the bearing and/or the idler stub shaft. Check for correct bearing clearance.

Expected Result:

The mechanical condition of the gear train is within specifications.

Results:

- OK – The condition of the gear train is OK.

  Repair: The problem is not in the gear train. Clear the diagnostic code. There may be a problem with the circuit for the speed/timing sensors. Refer to the diagnostic functional test Troubleshooting, "Engine Speed/Timing Sensor Circuit - Test".

  STOP.

- Not OK – The mechanical condition of the gear train is not within specifications.

  Repair: A problem with the gear train has been identified. Make the necessary repairs to the gear train. Clear the diagnostic code. A timing calibration is necessary after this diagnostic code has become active. Refer to the calibration procedure Troubleshooting, "Engine Speed/Timing Sensor - Calibrate".

  Verify that the original problem has been resolved.

  STOP.

i02445663

CID 0261 FMI 13 Engine Timing Calibration required

SMCS Code: 1439-038; 1912-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an incorrect engine timing.

Note: A timing calibration is required for a new engine, replacing an ECM that fails to communicate or following work on the front gear train, the camshaft, or the crankshaft.

System Response:

The check engine lamp will illuminate while this diagnostic code is active. The ECM uses default timing. Timing may be off as much as three degrees.

Possible Performance Effect:

- The engine may run rough and/or the engine may emit white smoke in the exhaust.

Troubleshooting:

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

Results:

- OK – STOP.

i02416460

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

SMCS Code: 1439-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an above normal voltage on the 5 volt supply.

System Response:

The code is logged. The check engine lamp will illuminate while this diagnostic code is active. The ECM sets all of the pressure sensors to the default values.

Possible Performance Effect:

- The engine power is derated.

Troubleshooting:

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

Results:

- OK – STOP.

i02416463

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

SMCS Code: 1439-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a below normal voltage on the 5 volt supply.

System Response:

The code is logged. The check engine lamp will illuminate while this diagnostic code is active. The ECM sets all of the pressure sensors to the default value.

Possible Performance Effect:

- The engine power is derated.

Troubleshooting:

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

Results:

- OK – STOP.

i02445689

CID 0268 FMI 02 Check Programmable Parameters

SMCS Code: 1901-038

Conditions Which Generate This Code:

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

- At least one system configuration parameter is not programmed.
- At least one injector trim file is not programmed.

System Response:

The diagnostic code will only be active. The check engine lamp will illuminate while this diagnostic code is active. Any unprogrammed parameters are set to the default value.

Possible Performance Effect:

- The unprogrammed parameters determine the action that is taken by the ECM.

Troubleshooting:

Program the missing parameter.

If a system configuration parameter has not been programmed, refer to Troubleshooting, “System Configuration Parameters”.

If an injector trim file has not been programmed, refer to programming parameters Troubleshooting, “Injector Trim File”.

Results:

- OK – STOP.

i02417898

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

SMCS Code: 1439-038-AI; 1923-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage that is above normal.

System Response:

The code is logged. The ECM will use the default value for atmospheric pressure.

Possible Performance Effect:

- The engine power is derated.

Troubleshooting:

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

Results:

- OK – STOP.

i02416783

CID 0274 FMI 04 Atmospheric Pressure short to ground

SMCS Code: 1439-038-AI; 1923-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal that is below normal.

System Response:

The code is logged. The ECM will use the default value for atmospheric pressure.

Possible Performance Effect:

- The engine power is derated.

Troubleshooting:

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

Results:

- OK – STOP.

i02407807

CID 0342 FMI 08 Secondary Engine Speed signal abnormal

SMCS Code: 1439-038-VF; 1907-038

Conditions Which Generate This Code:

The signal from the secondary engine speed/timing sensor is intermittent or the signal has been lost.

System Response:

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

Possible Performance Effect:

- None

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.

i02418613

CID 0444 FMI 05 Start Relay open circuit

SMCS Code: 1426-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an open circuit in the circuit.

System Response:

The code is logged.

Possible Performance Effect:

- The engine will not crank.

Troubleshooting:

Perform the following diagnostic procedure: “Start Relay Circuit - Test”

Results:

- OK – STOP.

i02418715

CID 0444 FMI 06 Start Relay short to ground

SMCS Code: 1426-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a short to ground in the circuit.

System Response:

The code is logged.

Possible Performance Effect:

- The engine will not crank.

Troubleshooting:

Perform the following diagnostic procedure: “Start Relay Circuit - Test”

Results:

- OK – STOP.

i02418751

CID 0446 FMI 05 Air Shutoff Relay open

SMCS Code: 4493-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a low current in the circuit.

System Response:

The ECM logs the code.

Possible Performance Effect:

The engine may not shut down.

Troubleshooting:

Perform the following diagnostic procedure: “Air Shutoff System- Test”

Results:

- OK – STOP.

i02418765

CID 0446 FMI 06 Air Shutoff Relay short

SMCS Code: 4493-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an excessive current in the circuit.

System Response:

The ECM logs the code.

Possible Performance Effect:

The engine may not shut down.

Troubleshooting:

Perform the following diagnostic procedure: “Air Shutoff System - Test”

Results:

- OK – STOP.

i02407892

CID 1785 FMI 03 Intake Manifold Pressure Sensor voltage high

SMCS Code: 1439-038-IL

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage above normal.

System Response:

The code is logged. The ECM flags intake manifold pressure as invalid data and a default value is used.

Possible Performance Effect:

- The engine power will be derated.

Troubleshooting:

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

Results:

- OK – STOP.

i02407894

CID 1785 FMI 04 Intake Manifold Pressure Sensor voltage low

SMCS Code: 1439-038-IL

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a signal voltage below the normal.

System Response:

The code is logged. The ECM flags intake manifold pressure as invalid data and a default value is used.

Possible Performance Effect:

- The engine power will be derated.

Troubleshooting:

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

Results:

- OK – STOP.

i02487751

CID 1785 FMI 10 Intake Manifold Pressure Signal abnormal rate of change

SMCS Code: 1439-038-IL

Conditions Which Generate This Code:

This code indicates that the 5 volt supply is missing from the sensor connector.

During normal engine operation, the intake manifold pressure fluctuates slightly. When the 5 volt supply is missing from the intake manifold pressure sensor, the signal from the pressure sensor floats to a midrange value. The signal does not fluctuate. If the signal from the intake manifold pressure sensor remains abnormally steady for more than 30 seconds, the Engine Control Module (ECM) activates this code.

System Response:

The ECM uses a default value for the intake manifold pressure.

Possible Performance Effect:

- Low power

Troubleshooting:

Repair the Sensor Supply Circuit

A. Repair the circuit for the supply wire between the ECM and the sensor.

Expected Result:

The problem is resolved.

Results:

- OK – The problem is resolved. STOP.
- Not OK – The problem is not resolved.

  Repair: Replace the sensor.

  STOP.

Troubleshooting with an Event Code

i02422406

Event Codes

SMCS Code: 1901

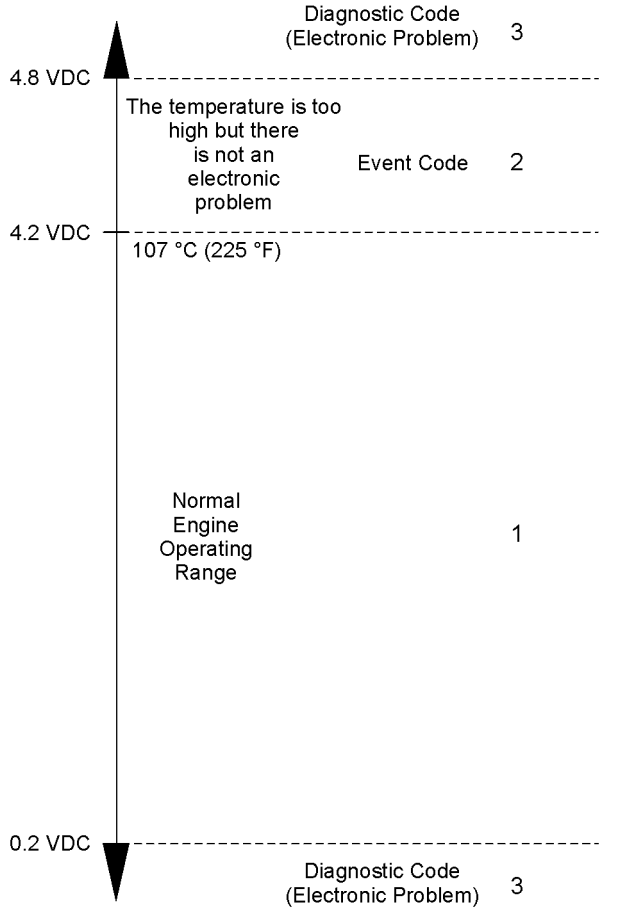
Event codes alert the operator that an abnormal engine operating condition such as low oil pressure or high coolant temperature has been detected. When the event code is generated, this indicates that an event has taken place.

Active of Event Codes

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

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

Illustration 8 is an example of the operating range of a temperature sensor. Do not use the Illustration to troubleshoot temperature sensors.



g01138880

Illustration 8

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 Electronic Control Module (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 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	**Action**	**Default Value**	**Time Delay in Seconds**		**Set Points**	
			Range	**Default**	**Range**	**Default**
E057 Low Engine Coolant Level	Derate	Off	N/A	N/A	N/A	N/A
E059 Low Engine Coolant Level	Warning	Off	4 to 65	30	N/A	N/A
E096 High Fuel Pressure	Warning	On	N/A	8	N/A	758 kPa (110 psi)
	Derate	Off		10		760 kPa (110 psi)
	Shutdown			12		762 kPa (111 psi)
E197 High Engine Oil Temperature	Warning	On	4 to 30	15	100 to 110 °C (212 to 230 °F)	115 °C (239 °F)
	Derate	Off			105 to 115 °C (221 to 235 °F)	
	Shutdown				N/A	
E198 Low Fuel Pressure	Warning	On	5 to 10	10	550 to 600 kPa (80 to 88 psi)	550 kPa (80 psi)
	Derate	Off			540 to 600 kPa (78 to 88 psi)	540 kPa (78 psi)
	Shutdown				530 to 600 kPa (76 to 88 psi)	530 kPa (76 psi)
E264 Emergency Stop Activated	Shutdown	On	N/A	0	N/A	Closed
E360 Low Engine Oil Pressure	Warning	On	N/A	8	Maps are not programmable. (1)	
	Shutdown			4	Maps are not programmable. (2)	
E361 High Engine Coolant Temperature	Warning	On	N/A	10	N/A	110 °C (230 °F)
	Derate	Off				111 °C (232 °F)
	Shutdown				87 to 111 °C (188 to 232 °F)	
E362 Engine Overspeed	Warning	On	N/A	0.6	N/A	2200
	Shutdown		0 to 5	0	1200 to 2400	2300
E363 High Fuel Temperature	Warning	On	1 to 120	30	65 to 90 °C (149 to 194 °F)	90 °C (194 °F)
	Derate	Off		10	65 to 91 °C (149 to 196 °F)	91 °C (196 °F)
	Shutdown				65 to 92 °C (149 to 198 °F)	92 °C (198 °F)
E390 Fuel Filter Restriction	Warning	On	N/A	30	None	75 °C (167 °F)
	Derate	Off		28800	N/A	
	Shutdown			28800		

(continued)

(Table 15, contd)

Trip Points for the Monitoring System						
Parameter	Action	Default Value	Time Delay in Seconds		Set Points	
			Range	Default	Range	Default
E539 High Intake Manifold Air Temperature	Warning	On	N/A	8	75 °C (167 °F)	N/A
	Derate	Off			79 °C (174 °F)	

(1) Refer to Table 16 for trigger points.
(2) Refer to Table 17 for trigger points.

Table 16

Trip Points for Low Oil Pressure Warning	
0 rpm	0 kPa (0 psi)
500 rpm	0 kPa (0 psi)
1600 rpm	154 kPa (22 psi)
2400 rpm	154 kPa (22 psi)

Table 17

Trip Points for Low Oil Pressure Shutdown	
0 rpm	0 kPa (0 psi)
500 rpm	0 kPa (0 psi)
1600 rpm	104 kPa (15 psi)
2400 rpm	104 kPa (15 psi)

i02515083

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. Information on default settings and ranges for this event code can be found in Troubleshooting, “Event Codes”.

System Response:

The Electronic Control Module (ECM) will log the event.

Possible Performance Effect:

E057(2)

- Engine power is derated.

Troubleshooting:

- The coolant level is most likely low.
- Air may be trapped in the cooling system.
- 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.

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 air in the cooling system. For information on checking the cooling system, refer to the engine’s Systems Operation/Testing and Adjusting manual.

  Ensure that any repairs eliminate the problem.

  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”.

Ensure that any repairs eliminate the problem.

STOP.

i02450212

E059 Low Engine Coolant Level Warning

SMCS Code: 1395-038-LO

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a low coolant level. Information on default settings and ranges for this event can be found in Troubleshooting, “Event Codes”.

System Response:

The ECM will log the event.

Possible Performance Effect:

- There are no performance effects.

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. Allow the engine to cool. Check the coolant level. Refer to the Operation and Maintenance Manual for the proper procedure.

Note: The coolant level sensor should be completely immersed in coolant.

Note: If the coolant has been changed recently, ensure that the air has been purged from the cooling system. Refer to Systems Operation/Testing and Adjusting, “Cooling System” for additional information.

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.

  There may be an intermittent problem. Monitor the operation of the engine and repair any problems.

  Ensure that the repair eliminates the original problem.

  STOP.

i02486626

E096 High Fuel Pressure

SMCS Code: 1250-038-HQ

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a high fuel pressure. Information on default settings and ranges for this event can be found in Troubleshooting, “Event Codes”.

System Response:

The ECM will log the event.

Possible Performance Effect:

E096(1)

- There are no performance effects.

E096(2)

- The engine power is derated.

E096(3)

- The engine is shut down.

Troubleshooting:

Check the Fuel System's Components

A. Inspect the pressure relief valve that is in the body of fuel transfer pump. Check for damage to the spring or to the valve assembly.

B. Verify that the pressure regulating valve in the fuel manifold is operating correctly. Check for damage or for dirt in the valve assembly.

C. Check the return line from the fuel filter base to the fuel tank for damage or collapse.

Expected Result:

There is a problem in the pressure relief valve, in the pressure regulating valve, or in the return line to the fuel tank.

Results:

- OK – A problem was found in the pressure relief valve, in the pressure regulating valve, or in the return line to the fuel tank.

  Repair: Make the necessary repairs. Verify that the repair eliminates the problem.

  Refer to Systems Operation/Testing and Adjusting.

  STOP.

- Not OK – A mechanical problem has not been found with the fuel system.

  Repair: If an electrical problem with the sensor circuit is suspected, refer to the diagnostic functional test Troubleshooting, "Engine Pressure Sensor Open or Short Circuit - Test".

  STOP.

i02477888

E194 High Exhaust Temperature

SMCS Code: 1088-038-TA

Conditions Which Generate This Code:

The Electronic Control Module (ECM) monitors the following parameters in order to calculate the exhaust temperature:

- Intake manifold air temperature
- Barometric pressure
- Engine speed

High intake manifold air temperature, high altitude operation, and high engine loads can cause the exhaust temperature to increase to a level that may damage the components of the exhaust system. When this occurs, the ECM derates the engine in order to reduce the exhaust temperature. This protects the components of the exhaust system from damage.

System Response:

The code is logged. Passwords are not required in order to clear the logged code.

Possible Performance Effect:

Engine power is reduced.

Test Step 1. Determine the Operating Conditions

Interview the operator, when possible. Determine if the engine was under heavy load or the engine is operating at a high altitude.

Expected Result:

The event occurred because of normal engine operation.

Results:

- OK – The event occurred because of normal engine operation. Clear the logged event and return the engine to service. STOP.
- Not OK – The event should not have occurred. Proceed to Test Step 2.

Test Step 2. Check the Air-to-Air Aftercooler (ATAAC)

The intake manifold air temperature can increase if the ATAAC is obstructed. Check the fins of the ATAAC for obstructions.

Expected Result:

The fins of the ATAAC are obstructed.

Results:

- OK – The fins of the ATAAC are obstructed.

Repair: Clean the fins of the ATAAC. Clear the event. Return the engine to service.

STOP.

- Not OK – The fins of the ATAAC are clear of obstructions. Proceed to Test Step 3.

Test Step 3. Check the 5 Volt Supply to the Atmospheric Pressure Sensor

If the atmospheric pressure sensor is not being powered by the 5 volt supply, the output of the sensor will float to a value that indicates a high barometric pressure. This is interpreted by the ECM as a high altitude condition. The ECM receives the erroneous value of altitude and the ECM derates the engine.

A. Verify that the keyswitch is in the ON position.

B. Measure the value of the 5 volt supply at the harness connector for the atmospheric pressure sensor.

Expected Result:

The voltage is approximately five volts.

Results:

- OK – The supply voltage at the atmospheric pressure sensor is approximately five volts. There are no further troubleshooting procedures for this event. Clear the event and return the engine to service. STOP.
- Not OK – The supply voltage at the atmospheric pressure sensor is not approximately five volts. There is a problem with the wiring for the 5 volt supply between the atmospheric pressure sensor and the ECM.

  Repair: Identify the wiring problem and make the necessary repairs.

  When the 5 volt supply is present at the atmospheric pressure sensor, clear the event and return the engine to service.

  STOP.

i02478132

E197 High Engine Oil Temperature

SMCS Code: 1348-038-TA

Conditions Which Generate This Code:

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

E197-1

- The engine has been running for at least three minutes.
- The ECM detects a high engine oil temperature for ten seconds.
- The engine oil temperature is above the trip point.

E197-2

- The engine has been running for at least three minutes.
- The ECM detects a high engine oil temperature for ten seconds.
- The engine oil temperature is above the trip point.

E197-3

- The engine has been running for at least three minutes.
- The ECM detects a high engine oil temperature for ten seconds.
- The engine oil temperature is above the trip point.

System Response:

E197-1

The ECM will trigger a snapshot. The event code is logged.

E197-1

The ECM will trigger a snapshot. The event code is logged. An engine derate will occur.

E197-3

The ECM will trigger a snapshot. The event code is logged. The engine will shut down.

Possible Performance Effect:

E197-1

- Engine performance is not affected.

E197-2

- An engine derate will be initiated.

E197-3

- The engine will shut down.

Troubleshooting:

A high engine oil temperature may be caused by the following problems:

- Improper engine oil level
- Faulty engine oil cooler bypass valve
- Damaged engine oil cooler core
- Problems with other engine systems

Test Step 1. Check the Level of the Engine Oil

Use the engine oil dipstick to check for the correct oil level. If necessary, add engine oil to the crankcase.

Continue to the next test step.

Test Step 2. Inspect the Engine Oil Cooler Bypass Valve

Inspect the components of the engine oil cooler bypass valve for damage. Clean the engine oil cooler bypass valve and clean the bore for the valve. Ensure that the bypass valve is not stuck in the open position. Replace the components of the bypass valve, if necessary.

Continue to the next test step.

Test Step 3. Inspect the Engine Oil Cooler Core

Check the engine oil cooler core for damage and for plugging. Clean the engine oil cooler core or replace the engine oil cooler core, if necessary.

Continue to the next test step.

Test Step 4. Check for a Problem with Other Engine Systems

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 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.

D. 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.

E. 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.

F. 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.

G. 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.

H. 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.

I. 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.

J. 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.

K. 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.

L. 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.

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.

Expected Result:

A thorough inspection of the other engine systems revealed a problem.

Results:

- OK – There is a problem with one of the other engine systems.

  Repair: Repair the problem. Ensure that the repair eliminates the problem.

  STOP.

i02486942

E198 Low Fuel Pressure

SMCS Code: 1250-038-LP

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a low fuel pressure. Information on default settings and ranges for this event can be found in Troubleshooting, “Event Codes”.

System Response:

The ECM will log the event.

Possible Performance Effect:

198(1)

- There are no performance effects.

198(2)

- The engine power is derated.

198(3)

- The engine is shut down.

Check the Fuel System’s Components

A. Inspect the pressure relief valve that is in the body of fuel transfer pump. Check for damage to the spring or to the valve assembly.

B. Verify that the pressure regulating valve in the fuel manifold is operating correctly. Check for damage or for dirt in the valve assembly.

C. Check the return line from the fuel filter base to the fuel tank for damage or collapse.

Expected Result:

There is a problem in the pressure relief valve, in the pressure regulating valve, or in the return line to the fuel tank.

Results:

- OK – A problem was found in the pressure relief valve, in the pressure regulating valve, or in the return line to the fuel tank.

  Repair: Make the necessary repairs. Verify that the repair eliminates the problem.

  Refer to Systems Operation/Testing and Adjusting.

  STOP.

- Not OK – A mechanical problem has not been found with the fuel system.

  Repair: If an electrical problem with the sensor circuit is suspected, refer to the diagnostic functional test Troubleshooting, “Engine Pressure Sensor Open or Short Circuit - Test”.

  STOP.

i02342292

E264 Emergency Stop Activated

SMCS Code: 7418-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an open circuit on the emergency stop input to the ECM.

System Response:

The ECM disables the injection signals to the injector solenoids.

Possible Performance Effect:

The engine will shut down.

Verify the Cause of the Emergency Stop Shutdown

A. Talk to the operator and determine the reason for the emergency stop shutdown.

B. Verify that the condition for the emergency stop shutdown has been resolved.

Expected Result:

The reason for the emergency stop shutdown has been determined. The reason for the emergency stop shutdown has been resolved.

Results:

- OK – The reason for the emergency stop shutdown has been determined. The reason for the emergency stop shutdown has been resolved.

  Repair: The emergency stop condition can be reset by performing the following steps:

  1. Reset the emergency stop switch to the OFF position.
  2. Cycle power to the ECM. If a “Diagnostic Reset” switch is installed, toggle the “Diagnostic Reset” switch in order to clear the emergency stop condition without shutting off power to the ECM.

  STOP.

i02486798

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)

- There are no performance effects.

E360(3)

- The engine will be 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.

i02486746

E361 High Engine Coolant Temperature

SMCS Code: 1395-038-TA

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects a high engine coolant temperature. 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:

E361(1)

- There are no performance effects.

E361(2)

- The engine power is derated.

E361(3)

- The engine is shut down.

Note: Certain applications may only derate the engine.

Troubleshooting:

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

Check the Engine

A. Check the cooling system for problems.

a. Verify that the cooling system is filled with coolant to the proper level. If the coolant level is too low, air may be allowed to enter the cooling system. Air in the cooling system will cause cavitation and a reduction in coolant flow.

b. Check the quality of the coolant. Refer to the Operation and Maintenance Manual for coolant recommendations.

c. Check for air in the cooling system. Air can be introduced into the cooling system in different ways.

The most common cause of air in the cooling system is the improper filling of the cooling system. Refer to the Operation and Maintenance Manual for the proper filling procedure for your engine.

The next likely cause is combustion gas leakage into the cooling system. Combustion gas can be introduced into the cooling system through damaged liner seals, cracks in the liners, a damaged cylinder head, or a damaged cylinder head gasket.

d. Check the cooling system hoses and clamps for damage.

Clamps that are damaged and hoses that are leaking can usually be discovered during a visual inspection.

Hoses that have no visual leaks can soften during operation. The soft areas of the hose can kink or the soft areas of the hose may collapse during operation. This can restrict the coolant flow. This can cause the engine to overheat. Check the hoses for soft spots.

Internal cracks can also develop in cooling system hoses. This type of deterioration usually produces particles that can build up in the cooling system. This may cause a restriction in the coolant flow through components. Check the hoses for spots that are hard or brittle.

e. Check the water pump. Remove the water pump and check for damage to the impeller. A water pump with a damaged impeller will not pump an adequate amount of coolant through the system.

f. Check the operation of 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.

g. 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. If the shunt line is not submerged, air will be introduced into the cooling system.

Check the shunt line for a restriction. A restriction of the shunt line from the expansion tank to the inlet of the water pump will cause a reduction in water pump efficiency. A reduction in water pump efficiency will result in low coolant flow.

B. High air inlet temperatures can cause high cooling system temperatures. Check for a problem in the engine's air inlet and exhaust systems.

a. 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.

b. 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.

c. If the air inlet 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. If the engine is equipped with a liquid cooled aftercooler verify that the coolant flow is unobstructed.

C. The engine's operating conditions can also affect cooling system temperatures. Check the operating conditions of the engine.

a. 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.

b. 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.

c. 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 engine revealed the cause of the high cooling system temperature.

Results:

- OK – The cause of the high cooling system temperature has been identified.

  Repair: Repair the problem. Ensure that the repair eliminates the original problem.

  STOP.

i02486716

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)

- There are no performance effects.

E362(3)

- The engine will be shut down.

Troubleshooting:

The operator may be operating the engine incorrectly.

Talk to the Operator

Determine the events that caused the overspeed.

Results:

- OK – STOP.

i02486675

E363 High Fuel Supply Temperature

SMCS Code: 1250-038-TA

Conditions Which Generate This Code:

The temperature of the fuel from the fuel supply has exceeded the trip point. Information on default settings and ranges for this event code can be found in troubleshooting with an event code Troubleshooting, “Event Codes”.

System Response:

The event code is logged.

Possible Performance Effect:

E363(1)

- There are no performance effects.

E363(2)

- The engine power is derated.

E363(3)

- 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.

i02401943

E390 Fuel Filter Restriction

SMCS Code: 1261-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) detects an abnormal fuel filter differential pressure. Information on default settings and ranges for this event can be found in Troubleshooting, “Event Codes”.

System Response:

The ECM will log the event.

Possible Performance Effect:

390-1 (Warning)

None

390-2 (Derate)

The engine power is derated.

390-3 (Shutdown)

The engine is shut down.

Troubleshooting:

The fuel filter element may need to be replaced.

Replace the Fuel Filter Element

A. Replace the fuel filter element.

B. Restart the engine and check for an active event code.

Expected Result:

The event code is no longer active.

Results:

- OK – The event code is no longer active. STOP.
- Not OK – The event code is active.

  Repair: There may be an electrical problem with the circuit for the fuel filter differential pressure switch. Refer to Troubleshooting, “Fuel Filter Differential Pressure Switch Circuit - Test” for diagnostic information.

  STOP.

i02498485

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 with an event code Troubleshooting, “Event Codes”.

System Response:

The event code will be logged.

Possible Performance Effect:

E539(1)

- There are no performance effects.

E539(2)

- The engine power will be derated.

Troubleshooting:

Intake manifold air temperature can be high for the following reasons:

- 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 for High Ambient Air Temperature

a. Determine if the ambient air temperature is within the design specifications for the inlet air system. When ambient temperatures are too high for the rating of the inlet air system, there is not enough of a temperature difference between the ambient air and inlet air temperatures.

b. Determine the cause of the high inlet air temperature. Correct the situation, when possible.

B. Check for High Inlet Air Restriction and/or High Altitude Operation

When inlet air pressure is low, the turbocharger works harder in order to achieve the desired inlet manifold pressure. This increases inlet air temperature.

a. Measure the inlet air pressure while the engine is operating under load. For specific data, refer to the Technical Marketing Information for the engine.

b. Check for plugged air filters. Check for obstructions to the air inlet. A restriction of the air that enters the engine can cause high cylinder temperatures. High cylinder temperatures cause higher than normal temperatures in the cooling system.

c. Replace the air filters and/or remove the obstruction from the air inlet.

d. Consider high altitude operation. The cooling capability of the cooling system is reduced at higher altitudes. A pressurized cooling system that has been designed for the higher altitudes must be used. Ensure that the engine is configured for high altitude operation.

C. Check for Exhaust System Restriction

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 problem has been found in the inlet air system and/or the related engine systems.

Results:

- OK – A thorough inspection revealed a problem.

Repair: Repair the problem.

STOP.

- Not OK – A thorough inspection did not reveal a problem.

  Repair: Connect Caterpillar Electronic Technician (ET) to the service tool connector. Check Cat ET for active/logged diagnostic codes related for the inlet air system. If an active/logged code is found, refer to the appropriate troubleshooting procedure.

  STOP.

i02450767

E2087 Air Intake Shutoff Closed

SMCS Code: 1078-038

Conditions Which Generate This Code:

The Electronic Control Module (ECM) will trip the air intake shutoff if one of the following conditions is detected:

- Emergency stop
- Engine overspeed

System Response:

The event code will be logged.

Possible Performance Effect:

- The engine will be shutdown.

Troubleshooting:

The operator may be operating the engine incorrectly. An emergency shutdown has been initiated.

Interview the Operator

Determine the cause of the engine shutdown.

Expected Result:

The shutdown was initiated by the operator.

Results:

- OK – The shutdown was initiated by the operator.

  Repair: Cycle the power to the ECM. Reset the air shutoff mechanism. Restart the engine.

  STOP.

- Not OK - Engine Overspeed – An engine overspeed caused the shutdown.

  Repair: Determine the cause of the engine overspeed. Make the necessary repairs.

  Cycle the power to the ECM. Reset the air shutoff mechanism. Restart the engine.

  STOP.

- Not OK - Electrical Problem – An electrical problem caused the shutdown.

  Repair: If an electrical problem is suspected with the air shutoff system, perform the following diagnostic code procedure: Troubleshooting, “Air Shutoff System - Test”

  STOP.

i02320143

E2088 Air Intake Shutoff Detection Circuit Detected but Not Installed

SMCS Code: 1078-038

Conditions Which Generate This Code:

The engine’s Electronic Control Module (ECM) has detected a problem with the air intake shutoff. 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:

The engine will still be shutdown.

Troubleshooting:

The parameter for the air intake shutoff may be set to “Not Installed”.

Check the Programmable Parameters

Determine the setting of the parameter. The Air Intake Shutoff Detection Circuit Detected but Not Installed parameter may need to be set to “Installed”.

Results:

- OK – STOP.

Diagnostic Functional Tests

i02410077

5 Volt Engine Pressure Sensor Supply Circuit - Test

SMCS Code: 1439-038

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the +5 V sensor supply.

Use this procedure to troubleshoot the system when one of the following diagnostic codes is active or easily repeated:

- 262-03 5 Volt Sensor DC Power Supply short to +batt
- 262-04 5 Volt Sensor DC Power Supply short to ground

The Electronic Control Module (ECM) supplies a regulated voltage of 5.0 ± 0.2 VDC to the following sensors:

- Atmospheric pressure sensor
- Boost pressure sensor
- Engine oil pressure sensor
- Fuel pressure sensor

The supply for the +5 V engine pressure sensor is routed from the ECM to terminal A of each pressure sensor connector. The sensor return from the ECM connector goes to terminal B of each sensor connector. The 5 V sensor supply is output short circuit protected. A short circuit to the battery will not damage the circuit inside the ECM.

Note: The sensors are not protected from overvoltage. A short from the supply line to the +Battery may damage the sensors. If the CID-FMI 262-03 is logged, it is possible that all of the sensors have been damaged. Repair the 5 V sensor supply and check for any active diagnostic codes for the sensor in order to determine if a sensor has failed.

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.

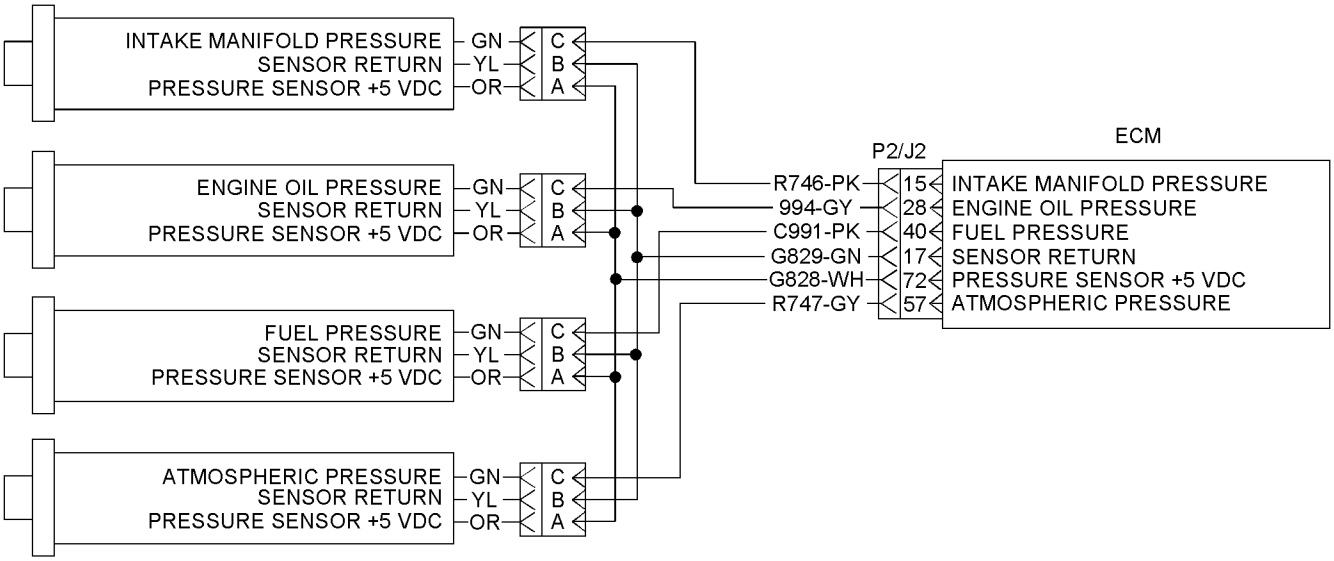


Illustration 9 g01204447

Schematic for the pressure sensor supply

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove electrical power from the ECM.

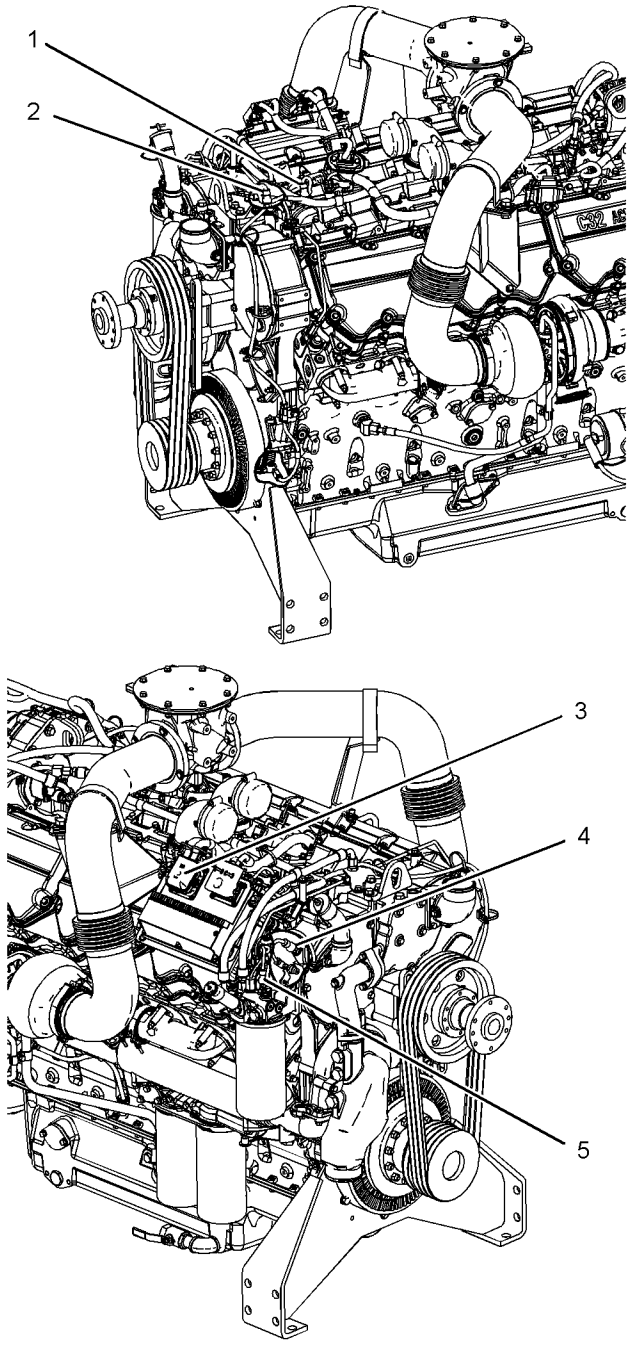


Illustration 10 g01204463

Sensor locations

(1) Intake manifold pressure sensor
(2) Atmospheric pressure sensor
(3) J2/P2 ECM connectors
(4) Engine oil pressure sensor
(5) Fuel pressure sensor

B. Thoroughly inspect connectors (3). Also, thoroughly inspect the connectors for sensors (1), (2), (4), and (5).

Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

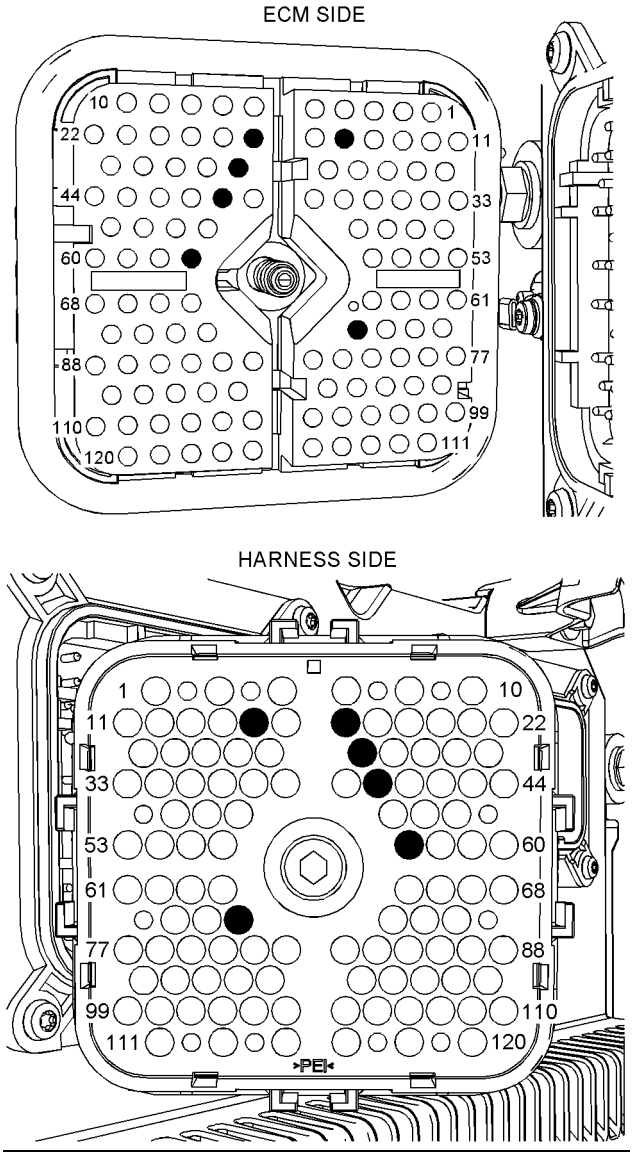


Illustration 11 g01204484

P2 ECM connector

(P2-15) Intake manifold pressure sensor
(P2-17) Sensor return
(P2-28) Engine oil pressure sensor
(P2-40) Fuel pressure sensor
(P2-57) Atmospheric pressure sensor
(P2-72) Sensor supply

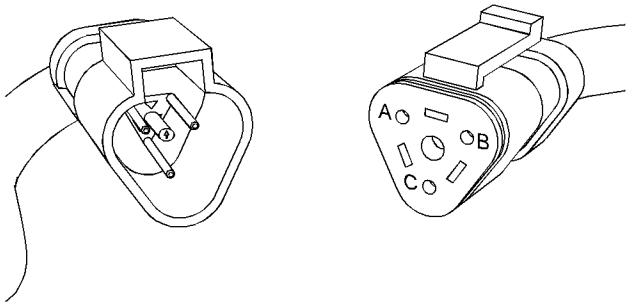


Illustration 12 g01159881

Sensor connector

(A) Sensor supply
(B) Sensor return
(C) Sensor signal

C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector and on each of the wires in the pressure sensor connectors.

D. Check the allen head screw for each of the ECM connectors and the machine connectors 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 of the pressure sensors back 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 connectors appear to be OK. Proceed to Test Step 2.
- Not OK – There is a problem with the connectors and/or wiring.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals for each of the connectors 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 Caterpillar Electronic Technician (ET) to the service tool connector.

B. Restore electrical power to the ECM.

C. Monitor the active diagnostic code screen on Cat ET. Check for an active 262-03 code and an active 262-04 code.

Note: Wait at least 30 seconds in order for the diagnostic codes to become active.

D. Remove electrical power from the ECM.

Expected Result:

No diagnostic codes are active.

Results:

- OK – No diagnostic 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.

- Not OK – Either the 262-03 or 262-04 diagnostic code is active at this time. Proceed to Test Step 3.

Test Step 3. Disconnect the Pressure Sensors and Check for Active Diagnostic Codes

A. Restore electrical power to the ECM.

B. Monitor the active diagnostic code screen on Cat ET while you disconnect each pressure sensor connector. Check for an active 262-03 code or an active 262-04 code.

Note: Wait at least 30 seconds in order for the diagnostic codes to become active.

a. Disconnect the following sensors one at a time:

- Engine oil pressure sensor
- Boost pressure sensor
- Fuel pressure sensor
- Atmospheric pressure sensor

Remove electrical power from the ECM.

Expected Result:

The diagnostic code deactivates when a particular sensor is disconnected.

Results:

- OK – The 262-03 or 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 262-03 or 262-04 diagnostic code remains active after all of the sensors are disconnected. The sensors are not the cause of the diagnostic code. Leave the sensors disconnected. Proceed to Test Step 4.

Test Step 4. Check the Supply Voltage at the ECM

A. Disconnect the J2/P2 ECM connectors.

B. Fabricate two jumper wires that are long enough to be used as test leads at the ECM connectors. Crimp connector sockets to one end of each jumper wire.

C. Remove the wires from terminal locations P2-72 (5 V sensor supply) and P2-17 (sensor return). Install a jumper wire into each of these terminal locations.

D. Connect the J2/P2 ECM connectors.

E. Restore electrical power to the ECM.

F. Measure the voltage between the jumper wire in P2-72 (5 V sensor supply) and the jumper wire in P2-17 (sensor return).

G. Remove electrical power from the ECM.

Expected Result:

The voltage measurement is 5.0 ± 0.2 VDC.

Results:

- OK – The voltage measurement is 5.0 ± 0.2 VDC. The ECM is operating correctly.

  Repair: There is a problem in the engine harness. The problem may be with a connector. Repair the harness and/or the connector. Replace parts, if necessary. Verify that the problem is resolved.

  STOP.

- Not OK – The voltage measurement is not 5.0 ± 0.2 VDC.

  Repair: There is a problem with the ECM. Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”.

  STOP.

i02419268

Air Shutoff System - Test

SMCS Code: 1078-038

System Operation Description:

Use this procedure to troubleshoot any problems with the air shutoff system.

The Electronic Control Module (ECM) has the ability to stop the engine in an emergency situation by shutting off the air supply to the engine. The ECM activates a relay which energizes two air shutoff solenoids. The solenoids trip the air shutoff valves.

There are three conditions which can cause the ECM to activate the air shutoff:

Engine Overspeed – The first condition occurs when the ECM detects an engine overspeed. During an engine overspeed, the ECM energizes the air shutoff relay. The ECM supplies voltage to the air shutoff relay for one second. The output of the relay will energize the air shutoff solenoids in order to shut down the engine. Once an event for the air shutoff system is activated, the event is latched until electrical power to the ECM system is cycled.

Overspeed Verify Feature – The second condition occurs when the overspeed verify feature is initiated with Caterpillar Electronic Technician (ET). This feature will energize the air shutoff relay when the engine speed is increased above 75 percent of the rated engine speed. The ECM supplies voltage to the air shutoff relay for one second during the shutdown. The overspeed verify feature can be initiated in order to test the operation of the air shutoff system.

Emergency Stop Sequence – The third condition occurs when the emergency stop switch is activated. When the emergency stop switch is placed in the STOP position, voltage is supplied to the relay control for the ECM relay. The ECM relay removes electrical power from the ECM. Voltage is also supplied to the air shutoff timer. The air shutoff timer supplies voltage to the air shutoff relay for 2.5 seconds. This latches the air shutoff valves in the closed position. The timer has been placed in the circuit in order to prevent the shutoff solenoids from being powered for extended periods.

After the air shutoff mechanism has been tripped, a manual reset of the mechanism is necessary.

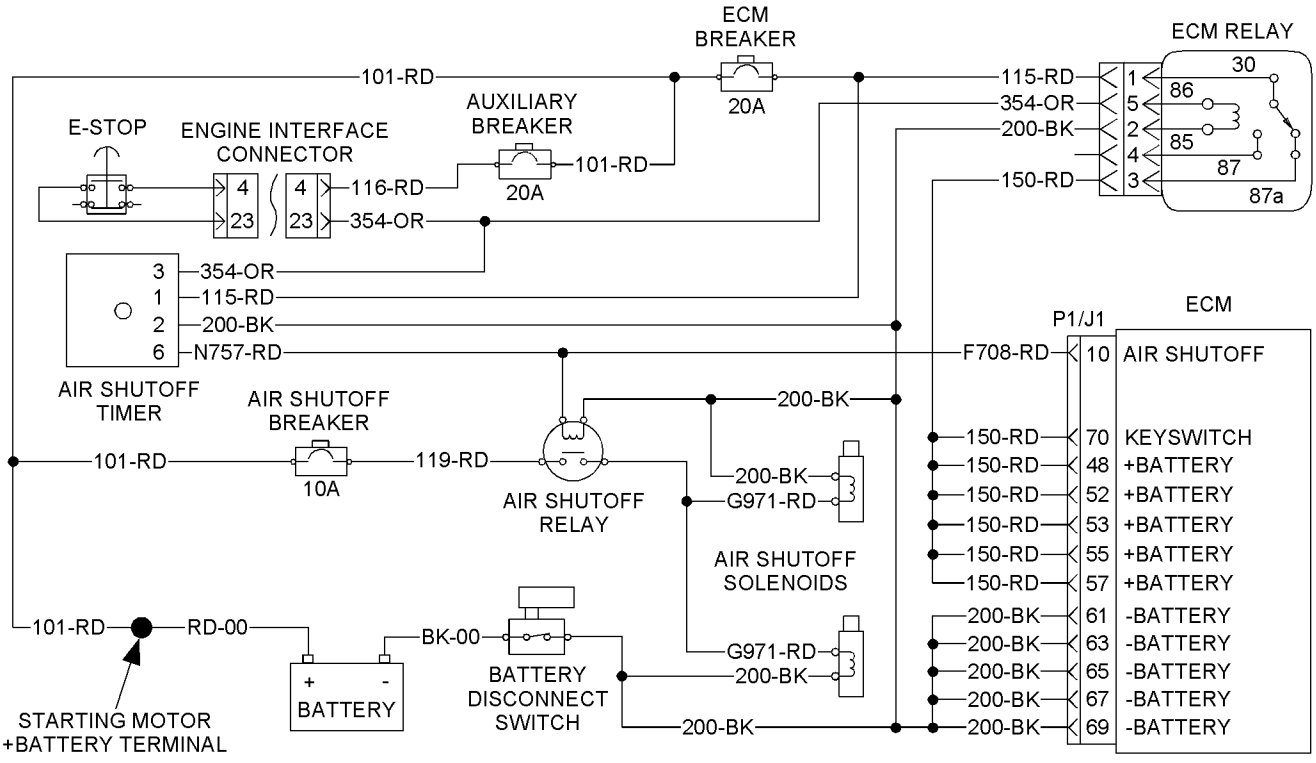


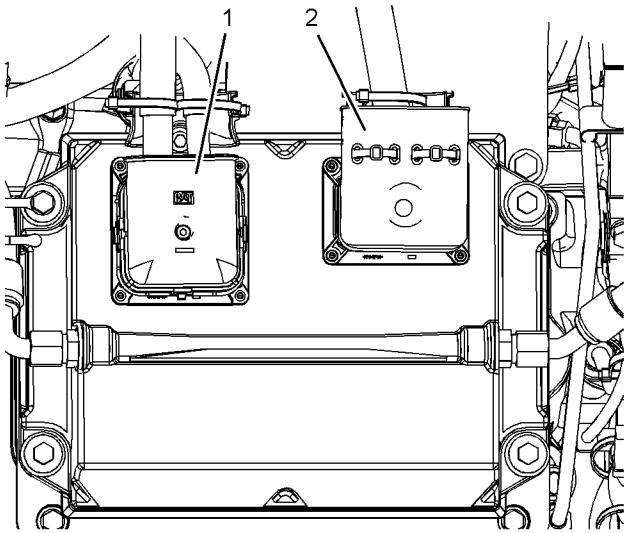
Illustration 13 g01209014

Schematic for the air shutoff system

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Turn the battery disconnect switch to the OFF position.

B. Verify that the air shutoff mechanisms are set to the OPEN position.

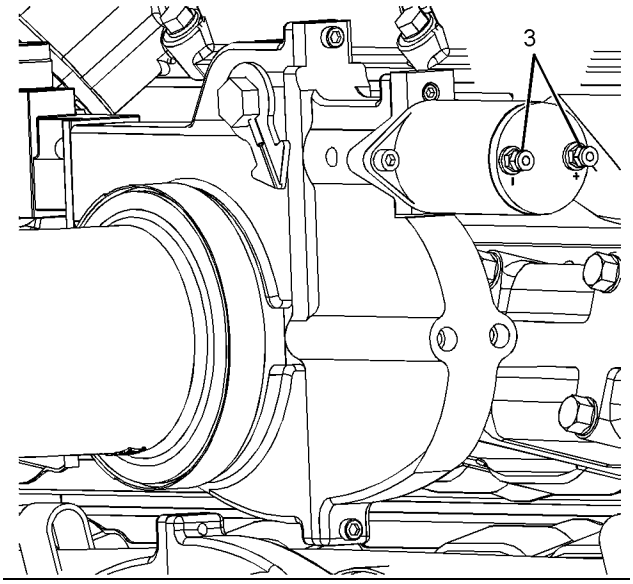


g01206567

Illustration 14

Location of the ECM connectors (typical engine view)

(1) J2/P2 ECM connectors
(2) J1/P1 ECM connectors



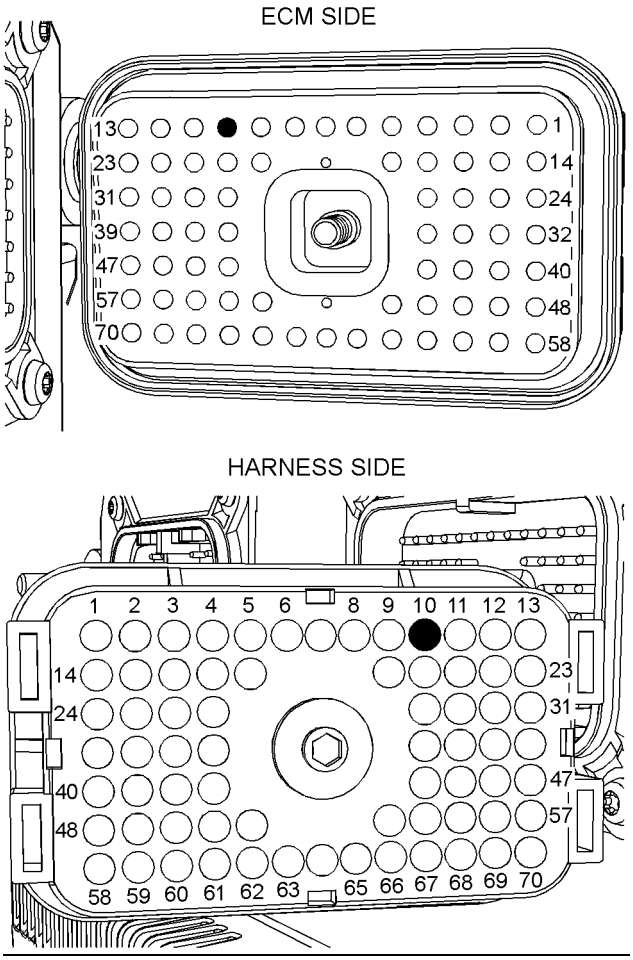
g01210157

Illustration 15

Air shutoff mechanism

(3) Terminals for the air shutoff solenoid

C. Thoroughly inspect connectors (1) and (2). Also, thoroughly inspect connections (3) at the air shutoff solenoid. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

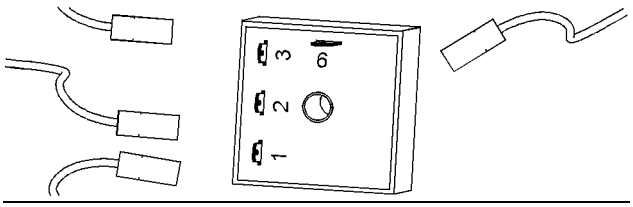


g01209725

Illustration 16

P1 terminals for the air shutoff system

(P1-10) Air shutoff



g01209281

Illustration 17

Terminal locations for the air shutoff timer

(1) +Battery
(2) −Battery
(3) Control
(6) Load

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 the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

F. 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 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 problem is resolved.

  STOP.

Test Step 2. Test the Operation of the Control Solenoid for the Air Shutoff Relay

A. Turn the battery disconnect switch to the ON position.

B. Test the air shutoff system with the emergency stop switch:

a. Place the emergency stop switch in the STOP position.

b. Check the position of the air shutoff valves. Activation of the emergency stop will activate the air shutoff system and the valve mechanisms will close.

Check that the solenoids have de-energized after the valves are closed. During an emergency stop, the air shutoff timer will activate the solenoids for 2.5 seconds.

c. Turn the battery disconnect switch to the OFF position.

Reset the valve mechanisms to the open position.

Place the emergency stop switch in the RUN position.

C. Test the air shutoff system with the “Overspeed Verify” feature in Cat ET:

a. Connect Cat ET to the service tool connector.

b. Turn the battery disconnect switch to the ON position.

c. Start the engine and allow the engine to run at low idle.

d. Use Cat ET to activate the “Overspeed Verify” feature. Wait at least 30 seconds for activation of the feature.

e. Increase engine speed to the rated speed of the engine.

f. Check the position of the air shutoff valves. An engine overspeed will activate the air shutoff system and the valve mechanisms will close at 75 percent of the rated engine speed.

g. Turn the battery disconnect switch to the OFF position.

Reset the valve mechanisms to the open position.

Expected Result:

The valve mechanisms operate correctly at this time.

Results:

- OK – The valve mechanisms are operating correctly.

  Repair: The air shutoff system appears to be operating correctly. The original problem seems to be resolved. There may be an intermittent problem in the harness or in a connector. If an intermittent problem is suspected, refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect” for information that is related to troubleshooting intermittent problems.

  STOP.

- Not OK - Emergency Stop Switch – The valve mechanisms do not close when the emergency stop switch is activated. There is a problem with the circuit for the emergency stop switch. There may be a problem with the air shutoff timer. Proceed to Test Step 3.
- Not OK - Overspeed Verify – The valve mechanisms do not close when the overspeed verify feature is activated. There is a problem in the harness from the ECM to the air shutoff relay. There may be a problem with the circuit from the relay to the air shutoff solenoids. Proceed to Test Step 6.

Test Step 3. Test for Control Input Voltage at the Timer

A. Remove the wire connection from terminal 3 (control) at the air shutoff timer.

B. Turn the battery disconnect switch to the ON position.

C. Place the emergency stop switch in the STOP position.

D. Measure the voltage between the wire that has been removed from terminal 3 (control) at the air shutoff timer and the engine ground stud.

The correct voltage is 24 ± 3 VDC.

E. Place the emergency stop switch in the RUN position.

F. Again, measure the voltage between the wire that has been removed from terminal 3 (control) at the air shutoff timer and the engine ground stud.

The correct voltage is zero volts.

Turn the battery disconnect switch to the OFF position.

Restore the wiring to the original configuration.

Expected Result:

The voltage is 24 ± 3 VDC with the emergency stop switch in the STOP position and the voltage is zero volts with the emergency stop switch in the RUN position.

Results:

- OK – The voltage is correct for the conditions that are stated above. The circuit for the emergency stop is supplying the correct voltage to the air shutoff timer. Proceed to Test Step 4.
- Not OK – The voltage is not 24 ± 3 VDC with the emergency stop switch in the STOP position and/or the voltage is not zero volts with the emergency stop switch in the RUN position.

  Repair: There is a problem in the circuit that is used to control the air shutoff timer. Ensure that the auxiliary circuit breaker for the emergency stop switch has not tripped. The problem may be in the harness or in a connector between the air shutoff timer and the ECM relay or the problem may be in the circuit for the emergency stop switch. Check for voltage at the ECM relay. Repair the harness and/or the connectors. Replace parts, if necessary.

  If a problem with the circuit for the emergency stop switch is suspected, refer to the diagnostic functional test Troubleshooting, “Emergency Stop Switch Circuit - Test” for information that is related to testing the circuit.

  STOP.

Test Step 4. Test the Operation of the Air Shutoff Timer

A. Remove the wire connection from terminal 6 (load) at the air shutoff timer.

B. Turn the battery disconnect switch to the ON position.

C. Connect a voltmeter between terminal 6 (load) of the air shutoff timer and the engine ground stud.

D. As the emergency stop switch is activated, measure the voltage between terminal 6 (load) of the air shutoff timer and the engine ground stud.

E. Check the voltage in the circuit as you place the emergency stop switch in the STOP position.

Note: The timer applies a voltage to terminal 6 for approximately 2.5 seconds. Run the test as many times as necessary in order to verify that a voltage is present at this output. The emergency stop switch must be reset before the test can be run again.

Place the emergency stop switch in the RUN position.

Turn the battery disconnect switch to the OFF position.

Restore the wiring to the original configuration.

Expected Result:

The voltage is 24 ± 3 VDC for 2.5 seconds after the emergency stop switch is activated.

Results:

- OK – The voltage is 24 ± 3 VDC for 2.5 seconds. The timer is operating correctly. Proceed to Test Step 5.
- Not OK – The voltage is not 24 ± 3 VDC for 2.5 seconds.

  Repair: There is a problem with the timer. There may be a problem in the circuit for the supply voltage to the timer. Perform the following procedure:

  1. Remove the wires from terminals 1 (+Battery) and 2 (−Battery) of the air shutoff relay.

2. Turn the battery disconnect switch to the ON position.

3. Measure the voltage between the wires for these terminals.

4. Turn the battery disconnect switch to the OFF position.

If voltage is 24 ± 3 VDC, the problem is in the air shutoff timer. Replace the air shutoff timer. Verify that the repair resolved the original problem.

If voltage is not 24 ± 3 VDC, the problem is in the supply circuit or the ground circuit for the air shutoff timer. Check that the circuit breaker for the ECM relay has not tripped. Repair the circuit. Replace parts, if necessary. Verify that the repair resolved the original problem.

STOP.

Test Step 5. Check the Harness Between the Timer and the Air Shutoff Relay

A. Remove the wire connection from the control input at the air shutoff relay.

B. Turn the battery disconnect switch to the ON position.

C. Connect a voltmeter between the loose end of the wire at the air shutoff relay and the engine ground stud.

D. As the emergency stop switch is activated, measure the voltage between loose wire at the air shutoff relay and the engine ground stud.

E. Check the voltage in the circuit as you place the emergency stop switch in the STOP position.

Note: The timer applies a voltage to the control input for approximately 2.5 seconds. Run the test as many times as necessary in order to verify that a voltage is present at this output. The emergency stop switch must be reset before the test can be run again.

Place the emergency stop switch in the RUN position.

Turn the battery disconnect switch to the OFF position.

Restore the wiring to the original configuration.

Expected Result:

The voltage is 24 ± 3 VDC for 2.5 seconds after the emergency stop switch is activated.

Results:

- OK – The voltage is 24 ± 3 VDC for 2.5 seconds. The harness between the timer and the relay is OK. The problem is with the air shutoff relay's secondary circuit or the relay. Proceed to Test Step 8.

- Not OK – The voltage is not 24 ± 3 VDC for 2.5 seconds.

  Repair: There is voltage at the output of the timer but not at the control input of the relay. The problem is in the harness between the air shutoff timer and the air shutoff relay. The problem may be in a connector. Repair the harness and/or the connector. Replace parts, if necessary. Verify that the original problem has been corrected.

  STOP.

Test Step 6. Check the Harness Between the Air Shutoff Relay and the ECM

A. Remove the wire connection from the control input at the air shutoff relay.

B. Turn the battery disconnect switch to the ON position.

C. Start the engine and allow the engine to run at low idle.

D. Use Cat ET to activate the "Overspeed Verify" feature. Wait at least 30 seconds for activation of the feature.

E. Increase engine speed to the rated speed of the engine.

F. As the engine speed increases above 75 percent of the rated engine speed, measure the voltage between the loose wire at the air shutoff relay and the engine ground stud.

G. Stop the engine.

Turn the battery disconnect switch to the OFF position.

Restore the wiring to the original configuration.

Expected Result:

As the engine speed increases above 75 percent of the rated engine speed, the voltage is 24 ± 3 VDC.

Results:

- OK – The voltage is 24 ± 3 VDC when the engine speed increases above 75 percent of the rated engine speed. The ECM and the wiring to the air shutoff relay are OK. The problem is with the air shutoff relay's secondary circuit or the relay. Proceed to Test Step 8.
- Not OK – The voltage is not 24 ± 3 VDC when the engine speed increases above 75 percent of the rated engine speed. There is a problem in the circuit between the ECM and the air shutoff relay. There may be a problem with the ECM. Proceed to Test Step 7.

Test Step 7. Check the ECM Output for the Air Shutoff Relay at the ECM

A. Disconnect J1/P1 ECM connector.

B. Fabricate a jumper wire that is long enough to use as a test lead at the ECM connector. Crimp a connector socket to one end of the jumper wire.

C. Remove the wire from terminal location P1-10 (air shutoff) at the ECM connector. Install the jumper wire into this terminal location.

D. Connect the J1/P1 ECM connectors.

E. Start the engine.

F. Use Cat ET to activate the "Overspeed Verify" feature. Wait at least 30 seconds for activation of the feature.

G. Increase engine speed to the rated speed of the engine.

H. As the engine speed increases above 75 percent of the rated engine speed, measure the voltage between the loose wire at the air shutoff relay and the engine ground stud.

Note: The ECM applies a voltage to the circuit for approximately one second. Run the test as many times as necessary in order to verify that a voltage is present at this output. The emergency stop switch must be reset before the test can be run again.

I. Stop the engine.

Turn the battery disconnect switch to the OFF position.

Restore the wiring to the original configuration.

Expected Result:

As the engine speed increases above 75 percent of the rated engine speed, the voltage is 24 ± 3 VDC.

Results:

- OK – The voltage is 24 ± 3 VDC when the engine speed increases above 75 percent of the rated engine speed.

  Repair: There is an electrical problem in the harness between the ECM and the air shutoff relay. The problem may be in a connector. Repair the harness and/or the connectors. Replace parts, if necessary. Verify that the original problem is resolved.

  STOP.

- Not OK – The voltage is 24 ± 3 VDC when the engine speed increases above 75 percent of the rated engine speed.

  Repair: The ECM is not responding to the overspeed condition. There is a problem with the ECM. Replace the ECM. Refer to the electronic troubleshooting procedure Troubleshooting, "Replacing the ECM" for information that is related to ECM replacement.

  STOP.

Test Step 8. Check the Relay Output at the Air Shutoff Solenoids

A. Remove the supply wires from the terminals of each air shutoff solenoid.

B. Start the engine.

C. Use Cat ET to activate the "Overspeed Verify" feature. Wait at least 30 seconds for activation of the feature.

D. Increase engine speed to the rated speed of the engine.

E. As the engine speed increases above 75 percent of the rated engine speed, measure the voltage between the supply wires for the air shutoff solenoids and the engine ground stud.

Note: The ECM applies a voltage to the circuit for approximately one second. Run the test as many times as necessary in order to verify that a voltage is present at this output. The emergency stop switch must be reset before the test can be run again.

F. Stop the engine.

Turn the battery disconnect switch to the OFF position.

Restore the wiring to the original configuration.

Expected Result:

As the engine speed increases above 75 percent of the rated engine speed, the voltage is 24 ± 3 VDC at the supply wire for each solenoid.

Results:

- OK – The voltage is 24 ± 3 VDC when the engine speed increases above 75 percent of the rated engine speed.

  Repair: The air shutoff solenoids are receiving the correct voltage. There may be a problem in the ground circuit to the air shutoff solenoids or the solenoids and/or the valve mechanisms may not be operating correctly. Perform the following procedure:

  1. Check the ground circuit to the air shutoff solenoid:

  a. Remove the ground wire from the air shutoff solenoid.

  b. Turn the battery disconnect switch to the ON position.

  c. Check continuity of the ground circuit from the solenoid to the battery.

  If continuity does not exist in the ground circuit to the air shutoff solenoid, repair the circuit.

  2. Check the mechanical condition of the valve mechanisms.

  a. Visually inspect the mechanical condition of the valve mechanisms.

  b. Manually operate the valve mechanisms. Check that the mechanisms are operating freely. Check the mechanisms for binding.

  If a mechanical problem with the valve mechanisms is suspected, repair the mechanisms. Replace parts, if necessary.

  3. Check the electrical condition of the solenoids:

  a. Use 24 ± 3 VDC to test the operation of the solenoids.

  If the solenoids are not operating correctly, replace the solenoids.

  STOP.

- Not OK – The voltage is not 24 ± 3 VDC when the engine speed increases above 75 percent of the rated engine speed. The air shutoff solenoids are not receiving the correct voltage. Proceed to Test Step 9.

Test Step 9. Test the Output Voltage at the Air Shutoff Relay

A. Remove the wire from the terminal of the air shutoff relay that is for the secondary output to the air shutoff solenoids.

B. Start the engine.

C. Use Cat ET to activate the “Overspeed Verify” feature. Wait at least 30 seconds for activation of the feature.

D. Increase engine speed to the rated speed of the engine.

E. As the engine speed increases above 75 percent of the rated engine speed, measure the voltage between the secondary output terminal of the air shutoff relay and the engine ground stud.

Note: The ECM applies a voltage to the circuit for approximately one second. Run the test as many times as necessary in order to verify that a voltage is present at this output. The emergency stop switch must be reset before the test can be run again.

F. Stop the engine.

Turn the battery disconnect switch to the OFF position.

Expected Result:

As the engine speed increases above 75 percent of the rated engine speed, the voltage is 24 ± 3 VDC at the secondary output terminal of the air shutoff relay.

Results:

- OK – The voltage is 24 ± 3 VDC when the engine speed increases above 75 percent of the rated engine speed.

  Repair: The voltage is present at the output of the relay, but not at the solenoid. There is an electrical problem in the harness between the air shutoff relay and the air shutoff solenoids. The problem may be in a connector. Repair the harness and/or the connectors. Replace parts, if necessary. Verify that the original problem is resolved.

  STOP.

- Not OK – The voltage is not 24 ± 3 VDC when the engine speed increases above 75 percent of the rated engine speed. The secondary output of the air shutoff relay is not supplying the correct voltage. There may be a problem with the relay. Proceed to Test Step 10.

Test Step 10. Check the Supply Voltage to the Air Shutoff Relay

A. Remove the wire from the supply to the secondary circuit of the air shutoff relay.

B. Turn the battery disconnect switch to the ON position.

C. Measure the voltage between the supply wire and the engine ground stud.

D. Turn the battery disconnect switch to the OFF position.

Expected Result:

The voltage is 24 ± 3 VDC.

Results:

- OK – The voltage is 24 ± 3 VDC.

  Repair: The air shutoff relay is not operating correctly.

  There may be a problem in the ground circuit for the control input of the air shutoff relay. The problem may be with the air shutoff relay. Perform the following procedure:

  1. Remove the ground wire from the air shutoff relay.
  2. Turn the battery disconnect switch to the ON position.
  3. Check the continuity of the ground circuit from the relay to the battery.

  If continuity exists in the ground circuit to the air shutoff relay, the problem is with the air shutoff relay. Replace the air shutoff relay.

  If continuity does not exist in the ground circuit to the air shutoff relay, the problem is in the ground circuit. Repair the circuit.

  STOP.

- Not OK – The voltage is not 24 ± 3 VDC .

  Repair: The problem is in the supply circuit to the air shutoff relay. Ensure that the circuit breaker for the air shutoff relay has not tripped. Repair the circuit. Replace parts, if necessary. Verify that the repair resolved the original problem.

  STOP.

i02421280

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 J1939 Data Link communications.

This procedure identifies the following problems:

- Faulty connectors
- Missing termination resistors
- Short circuits
- Open circuits
- Faulty J1939 display

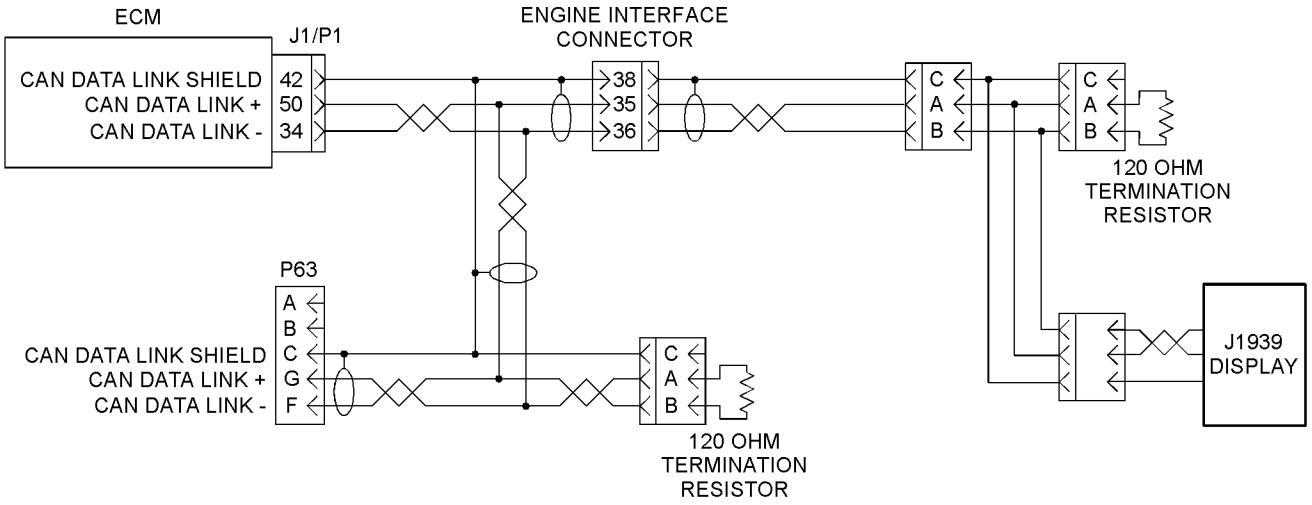


Illustration 18 g01209787

Schematic for the CAN data link

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Turn the keyswitch to the OFF position.

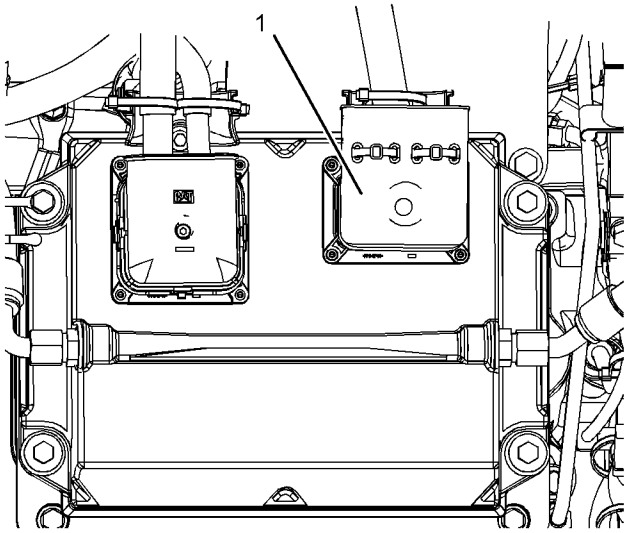


Illustration 19 g01167488

Location of the ECM (typical engine view)

(1) J1/P1 ECM conntctors

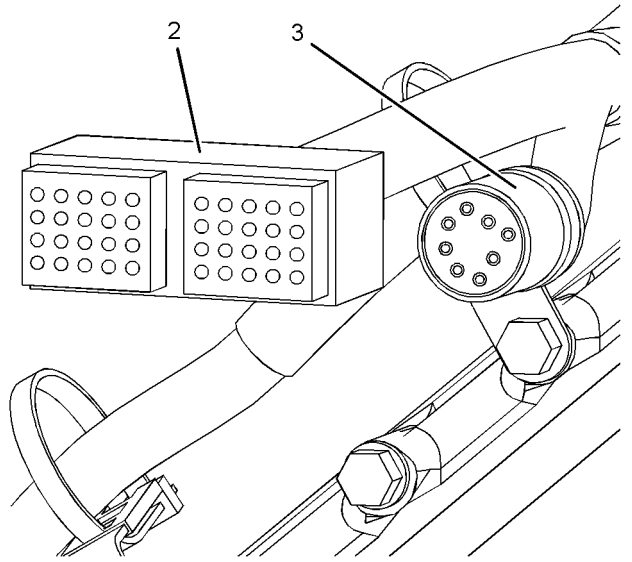


Illustration 20 g01207179

Location of the engine interface connector and the service tool connector (typical engine view)

(2) Engine interface connector
(3) Service tool connector

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”.

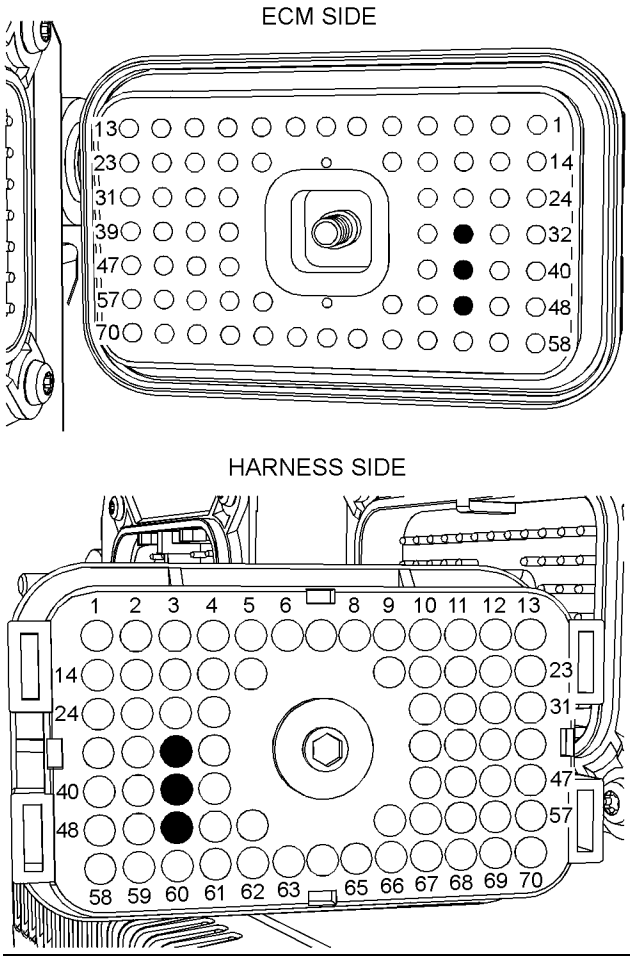


Illustration 21 g01209797

P1 terminals that are associated with the CAN data link

(P1-34) CAN data link −
(P1-42) CAN shield
(P1-50) CAN data link +

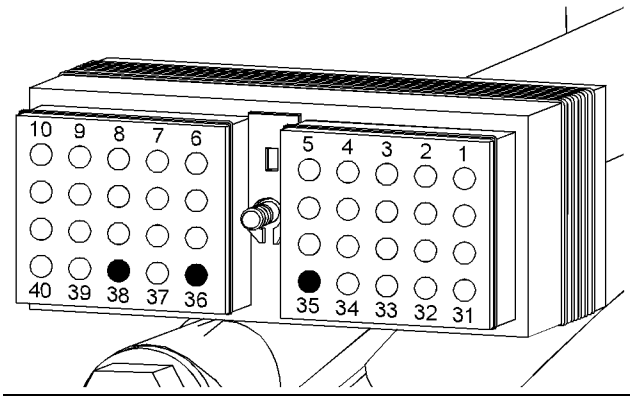


Illustration 22 g01209793

Terminals at the engine interface connector that are associated with the CAN data link

(35) CAN data link +
(36) CAN data link −
(38) CAN shield

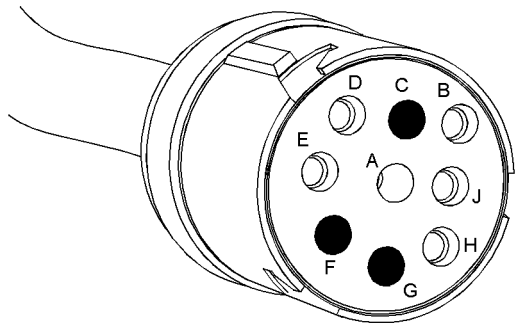


Illustration 23 g01209794

Terminals at the service tool connector that are associated with the CAN data link

(C) CAN shield
(G) CAN data link +
(F) 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. Also, check the allen head screw on the engine interface connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. 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. Check 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 18. Be sure to wiggle the wires in the harnesses as you make each resistance measurement.

Table 18

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.

i02415043

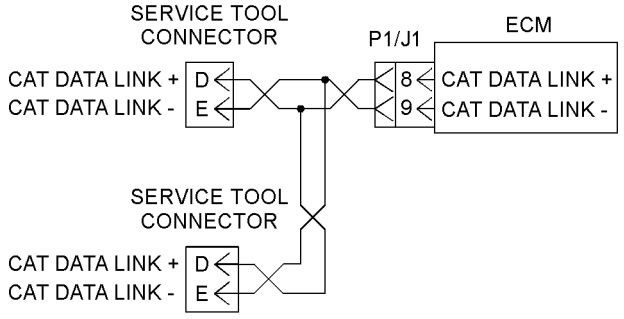
Cat Data Link Circuit - Test

SMCS Code: 1901-038

System Operation Description:

Note: This procedure checks for an open circuit or for 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.



g01207158

Illustration 24

Schematic for the Cat Data Link

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove the electrical power from the ECM.

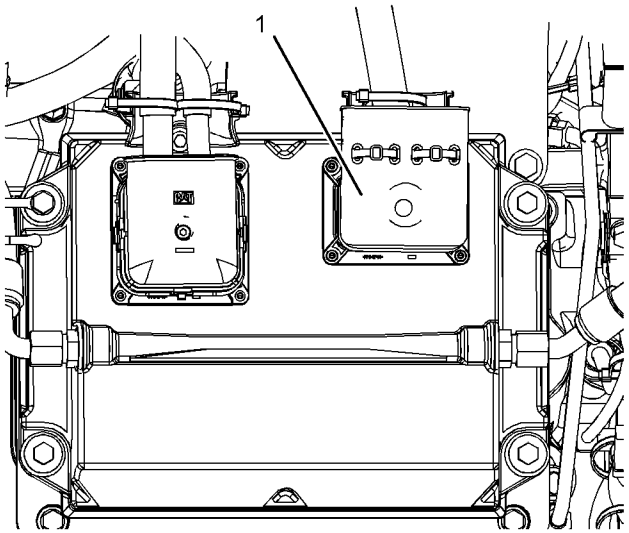


Illustration 25 g01167488

Location of the J1/P1 ECM connectors (typical engine view)

(1) J1/P1 ECM connectors

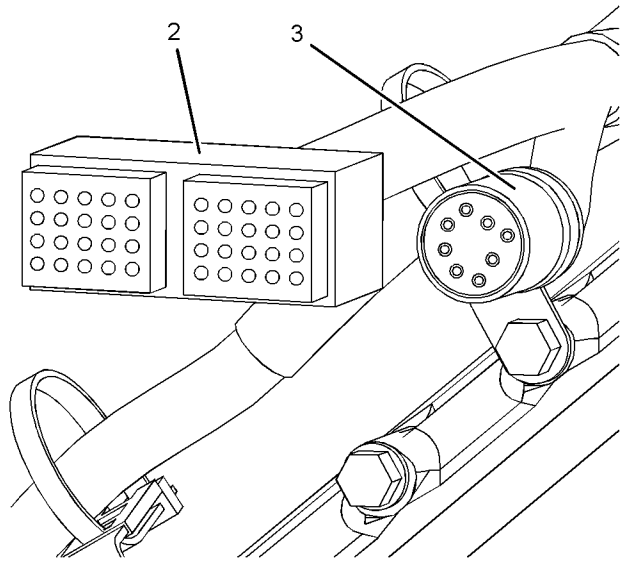


Illustration 26 g01207179

Location of the engine interface connector and the service tool connector (typical engine view)

(2) Engine interface connector
(3) Service tool connector

B. Thoroughly inspect connectors (1), (2), and (3). Refer to Troubleshooting, “Electrical Connectors - Inspect”.

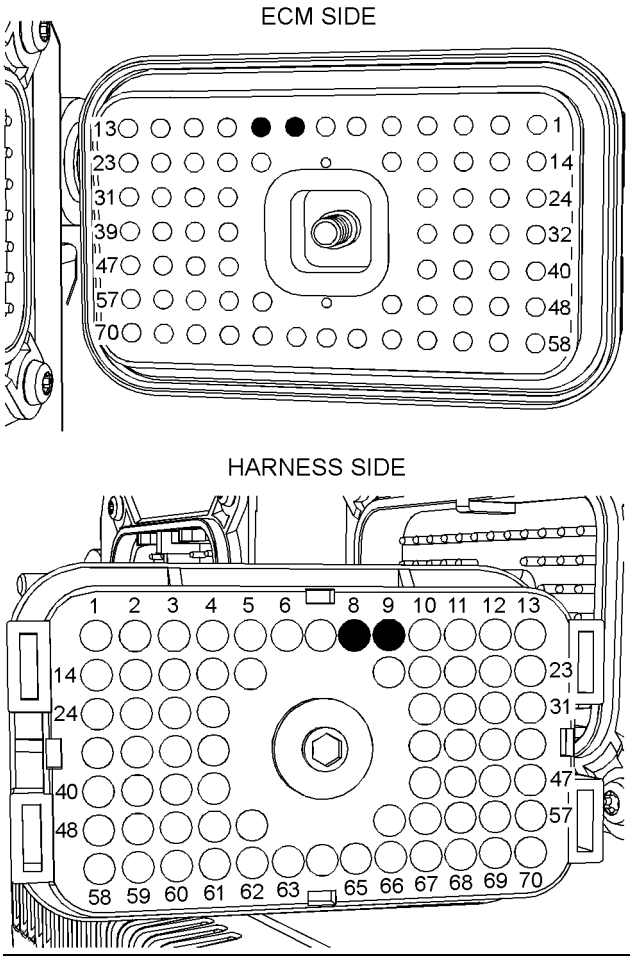


Illustration 27 g01207225

P1 terminals that are associated with the Cat Data Link

(P1-8) Cat Data Link +
(P1-9) Cat Data Link −

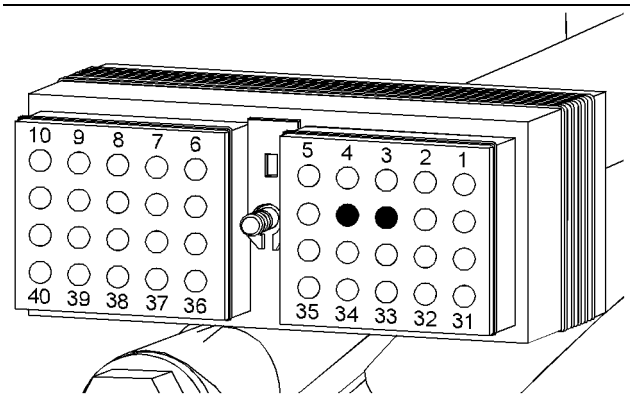


Illustration 28 g01207319

Terminals at the engine interface connector that are associated with the Cat Data Link

(13) Cat Data Link +
(14) Cat Data Link −

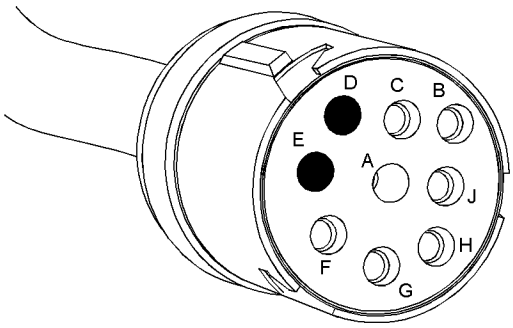


Illustration 29 g01207229

Terminals at the service tool connector that are associated with the Cat Data Link

(D) Cat Data Link +
(E) 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. Also, check the allen head screw on the engine interface connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

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 the Data Link 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 19. Be sure to wiggle the wires in the harnesses as you make each resistance measurement.

Table 19

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. The data link is not shorted to another wire in the harness. Proceed to Test Step 3.
- Not OK – At least one check of the resistance does not indicate an open circuit.

  Repair: There is a short circuit in the harness or in a connector. Repair the connectors and/or the wiring. Replace parts, if necessary.

  STOP.

Test Step 3. Check for an Open Circuit

A. Fabricate a jumper wire that is long enough to short circuit two terminals at the service tool connector. Crimp connector sockets to each end of the jumper wire.

B. Install the jumper wire between terminals D (Cat Data Link +) and E (Cat Data Link −) at the service tool connector.

C. At the J1 ECM connector, measure the resistance between P1-8 (Cat Data Link +) and P1-9 (Cat Data Link −).

Expected Result:

The resistance check indicates that continuity exists for the circuit.

Results:

- OK – The resistance check indicates that continuity exists.

  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.

     Replace the ECM. Refer to Troubleshooting, “Replacing the ECM” for information that is related to ECM replacement.

  STOP.

- Not OK – The resistance check did not indicate that continuity exists in the circuit. There is an open circuit or excessive resistance in the harness.

  Repair: There may be a problem with a connector. Repair the wiring and/or the connectors. Replace parts, if necessary.

  STOP.

i02410638

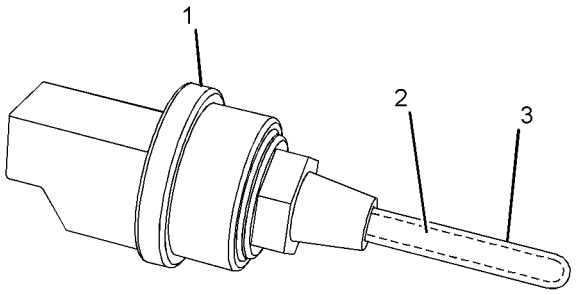
Coolant Level Sensor Circuit - Test

SMCS Code: 1439-038-CLT

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the circuit for the coolant level sensor.

The coolant level sensor monitors the engine coolant level in order to warn the operator in the event that the coolant level is low. The coolant level sensor is located on the expansion tank.



g01150024

Illustration 30

Coolant level sensor

(1) Sensor
(2) Sensor probe (brass dowel)
(3) Plastic cover

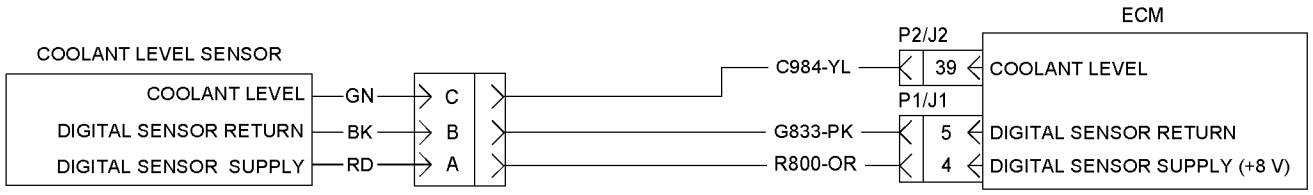
Coolant level sensor (1) contains no moving parts. The sensor provides the same function as a switch. The state of the switch is dependent on the capacitance value that is detected at the probe of the sensor. The sensor contains a probe (2) that is covered with plastic (3).

When the sensor’s probe is immersed in coolant, the sensor senses a particular capacitance. The sensor’s electronics react by sinking the signal to the digital return (ground).

When the probe is not immersed in coolant, approximately +5 VDC is sourced to the signal wire. When this condition is detected by the Electronic Control Module (ECM), an event code is activated.

Prior to troubleshooting any problems with the coolant level sensor, use Caterpillar Electronic Technician (ET) to check the installation status for the sensor. The coolant level sensor’s configuration parameter must be set to “Installed” in order for the ECM to monitor the signal from the sensor.

The activation of an event code and/or a warning lamp is probably caused by a low coolant level. The next likely cause is a problem with the wiring harness, a connector, or the sensor. The least likely cause is a problem with the ECM.



g01204880

Illustration 31

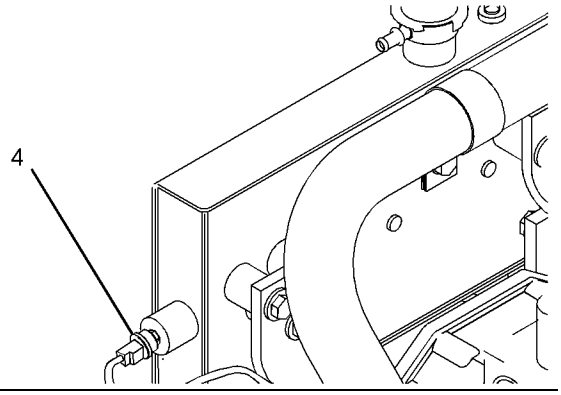
Schematic for coolant level sensor

⚠ 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.

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove electrical power from the ECM.

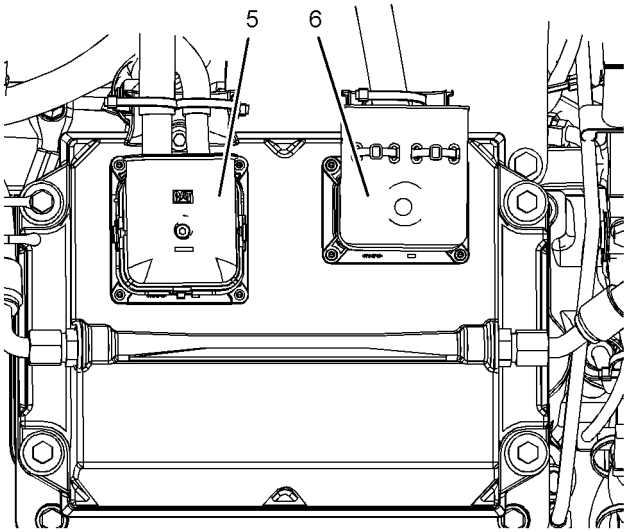


g01167362

Illustration 32

Typical location of the coolant level sensor

(4) Coolant level sensor



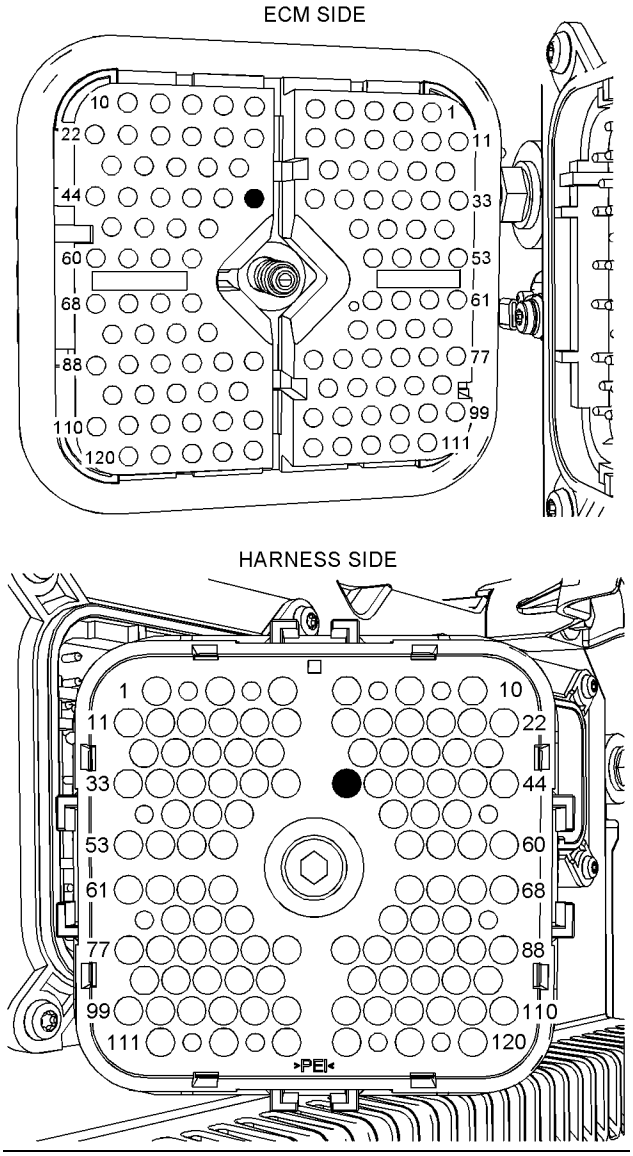
g01204997

Illustration 33

Location of the ECM connectors (typical engine view)

(5) J2/P2 connectors
(6) J1/P1 connectors

B. Thoroughly inspect the connectors for sensor (4). Also, thoroughly inspect connectors (5) and (6). Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

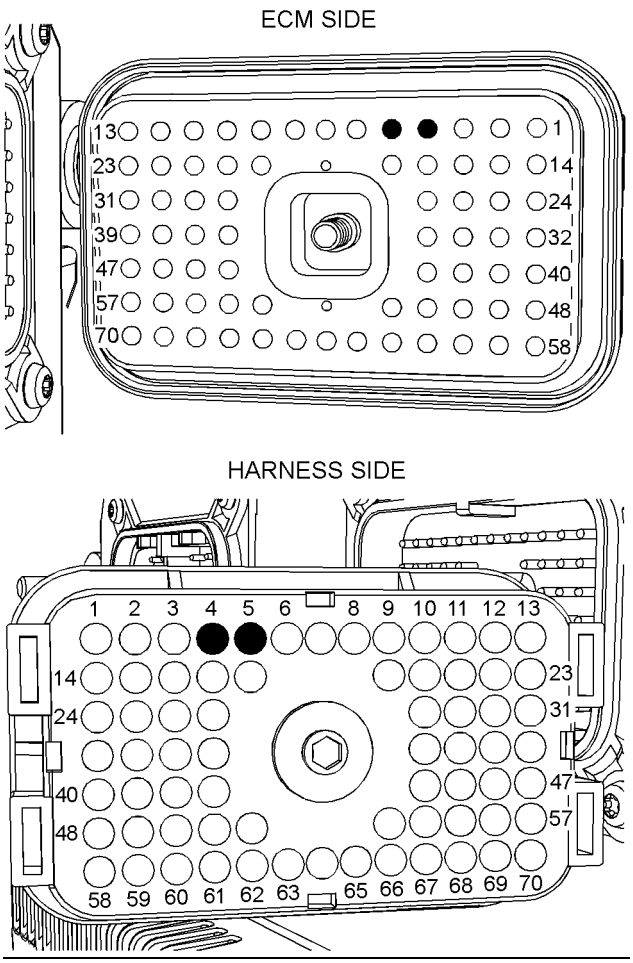


g01205002

Illustration 34

Terminal locations for the P2 ECM connector

(P2-39) Coolant level sensor

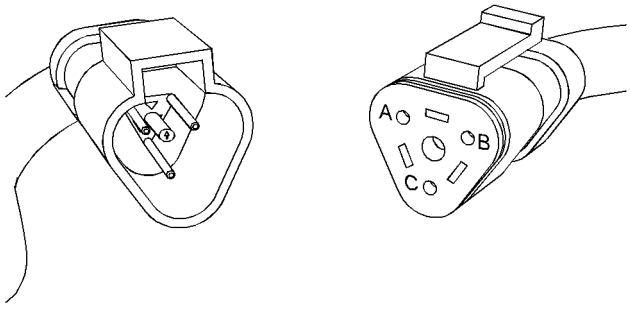


g01205323

Illustration 35

Terminal locations for the P1 ECM connector

(P2-4) Digital supply (+8 V)
(P2-5) Digital sensor return



g01159881

Illustration 36

Harness connector for the coolant level sensor

(A) Sensor supply
(B) Sensor return
(C) Sensor signal

C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit for the 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.

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 harnesses and the wiring appear to be OK. Proceed to Test Step 2.
- Not OK – There is a problem with the connectors and/or the wiring.

  Repair: Repair the wiring and connectors or replace the wiring or the connectors. Ensure that all of the seals are properly connected. Verify that the repair eliminates the problem.

  STOP.

Test Step 2. Check the Supply Voltage at the Sensor Connector

A. Disconnect the coolant level sensor at the sensor connector.

B. Restore electrical power to the ECM.

C. Measure the voltage between terminals A (sensor supply) and B (sensor return) at the harness connector for the coolant level sensor.

D. Remove electrical power from the ECM.

Expected Result:

The voltage measurement is 8.0 ± 0.4 VDC.

Results:

- OK – The voltage measurement is 8.0 ± 0.4 VDC. The supply voltage is reaching the sensor. Proceed to Test Step 3.
- Not OK – The voltage measurement is not 8.0 ± 0.4 VDC.

  Repair: The digital sensor supply voltage is not reaching the sensor. There is a problem in the circuit for the digital sensor supply. Refer to Troubleshooting, “Digital Sensor Supply Circuit - Test”.

  STOP.

Test Step 3. 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. Remove electrical power from the ECM.

Note: Allow the engine to cool prior to removal of the cooling system pressure cap.

B. Check the coolant level. Refer to the Operation and Maintenance Manual for the proper procedure to check the coolant level.

Expected Result:

The coolant is at the proper level.

Results:

- OK – The coolant is at the proper level. Proceed to Test Step 4.
- Not OK – The coolant level is low.

  Repair: Add coolant according to the procedure in the Operation and Maintenance Manual.

  There may be a leak in the cooling system. Identify the source of the coolant leak. Repair the leak.

  STOP.

Test Step 4. Disconnect the Coolant Level Sensor and Monitor the Status for “Coolant Level”

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

B. Disconnect the harness connector for the coolant level sensor.

C. Restore electrical power to the ECM.

D. Monitor the status of “Coolant Level” on Cat ET.

Note: Wait at least 30 seconds for activation of the status indicator.

E. Remove electrical power from the ECM.

Expected Result:

The status changes from “OK” to “LOW” when the sensor is disconnected.

Results:

- OK – The status is “LOW” when the sensor is disconnected. There may be a problem with the coolant level sensor. Proceed to Test Step 5.
- Not OK – The status is “OK” when the sensor is disconnected. The problem is between the ECM and the harness connector. There may be a problem with the ECM. Proceed to Test Step 6.

Test Step 5. Short the Signal Wire to Ground and Monitor the Status for “Coolant Level”

A. Remove electrical power from the ECM.

B. Fabricate a jumper wire that is long enough to create a short circuit between two terminals at the coolant level sensor’s harness connector. Crimp connector pins to each end of the jumper wire.

C. Install the jumper wire between terminals B (sensor return) and C (sensor signal) on the harness side of the connector for the coolant level sensor.

D. Restore electrical power to the ECM.

E. Monitor the status of “Coolant Level” on Cat ET while the jumper wire is installed.

Note: Wait at least 30 seconds for activation of the status indicator.

F. Remove electrical power from the ECM.

G. Remove the jumper wire. Connect the harness connector for the coolant level sensor.

Expected Result:

The status changes from “LOW” to “OK” when the jumper wire is installed.

Results:

- OK – The status changes from “LOW” to “OK” when the jumper wire is installed. The ECM and the wiring harness to the coolant level sensor are OK.

  Repair: Perform the following procedure:

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.

1. Drain the coolant below the level of the coolant level sensor.
2. Restore electrical power to the ECM.
3. Monitor the status of “Coolant Level” on Cat ET.

Note: Wait at least 30 seconds for activation of the status indicator.

4. Remove electrical power from the ECM.

   If the status of the “Coolant Level” is “OK”, replace the sensor.

   If the status for the coolant level is “LOW”, the circuit for the coolant level sensor is OK. There may be an intermittent problem in the harness or in a connector. Fill the cooling system according to the procedure in the Operation and Maintenance Manual. Return the engine to service. If an intermittent electrical problem is suspected, refer to Troubleshooting, “Electrical Connectors - Inspect” for troubleshooting information.

   STOP.

- Not OK – Shorting the harness does not affect the status on Cat ET. The problem is between the ECM and the harness connector. There may be a problem with the ECM. Proceed to Test Step 6.

Test Step 6. Check the Wiring Harness for an Open Circuit

A. Remove electrical power from the ECM.

B. Disconnect the J2/P2 ECM connector and the connector for the coolant level sensor.

C. Fabricate a jumper wire that is long enough to provide a test circuit between the ECM connector and the sensor connector. Crimp a connector pin to one end of the jumper wire.

D. Install the jumper wire’s connector pin into terminal C on the harness side of the connector for the coolant level sensor.

E. Measure the resistance between terminal P2-39 and the loose end of the jumper wire.

The correct resistance measurement is a short circuit.

Remove the jumper wire. Leave the sensor connector disconnected.

Expected Result:

The measurement indicates that a short circuit exists for the signal wire.

Results:

- OK – The measurement indicated a short circuit. There is not an open circuit in the harness wire for the sensor signal. Proceed to Test Step 7.
- Not OK – The measurement did not indicate a short circuit.

  Repair: There is an open circuit or excessive resistance in the harness or the connectors. Repair the wire and/or the connector, when possible. Replace damaged parts, if necessary.

  STOP.

Test Step 7. Check the Harness Wiring for a Short Circuit

A. Remove electrical power from the ECM.

B. Disconnect the J1/P1 and the J2/P2 ECM connectors. Also, disconnect the connector for the coolant level sensor.

C. Measure the resistance between the points that are listed in Table 20.

Note: Wiggle the harness during the following measurements in order to reveal an intermittent condition.

Table 20

Resistance Measurements for the Coolant Level Circuit	
Connector and Terminal	**Terminal**
P2-39 (Coolant level)	All of the terminals on the P1 connector
	All of the other terminals on the P2 connector
	Engine ground stud

Expected Result:

Each check of the resistance indicates an open circuit.

Results:

- OK – Each check of the resistance indicates an open circuit. There is not a short circuit to another wire in the harness. Proceed to Test Step 8.
- Not OK – At least one check of the resistance does not indicate an open circuit. There is a short to another wire in the harness. The problem may be with a connector.

  Repair: Repair the wire and/or the connector, when possible. Replace damaged parts, if necessary. Verify that the problem is resolved.

  STOP.

Test Step 8. Check the Operation of the ECM

A. Remove the wires from terminal locations P1-5 (sensor return) and P2-39 (coolant level).

B. Fabricate a jumper wire that is long enough to provide a test circuit between these two terminals at the P1 and the P2 ECM connectors. Crimp connector sockets to each end of the jumper wire.

C. Install one end of the jumper wire into terminal location P1-5. Install the other end of the jumper wire into terminal location P2-39. Connect the P1 and P2 ECM connectors to the ECM.

D. Restore electrical power to the ECM.

E. Use Cat ET to monitor the status for “Coolant Level”. Remove the jumper wire and check the status again.

Note: Wait at least 30 seconds for activation of the status indicator.

F. Remove electrical power from the ECM.

Restore all wiring to the original configuration.

Expected Result:

The status is “LOW” when the jumper wire is not connected. The status is “OK” when the jumper wire is connected.

Results:

- OK – The status is “LOW” when the jumper wire is not connected. The status is “OK” when the jumper wire is connected.

Repair: The ECM is properly reading the switch input. There may be an intermittent problem in the harness or in a connector. If an intermittent electrical problem is suspected, refer to Troubleshooting, “Electrical Connectors - Inspect” for troubleshooting information.

STOP.

- Not OK – The status is “LOW” when the jumper wire is connected.

  Repair: The ECM is not reading the switch input. Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”.

  STOP.

i02378207

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.

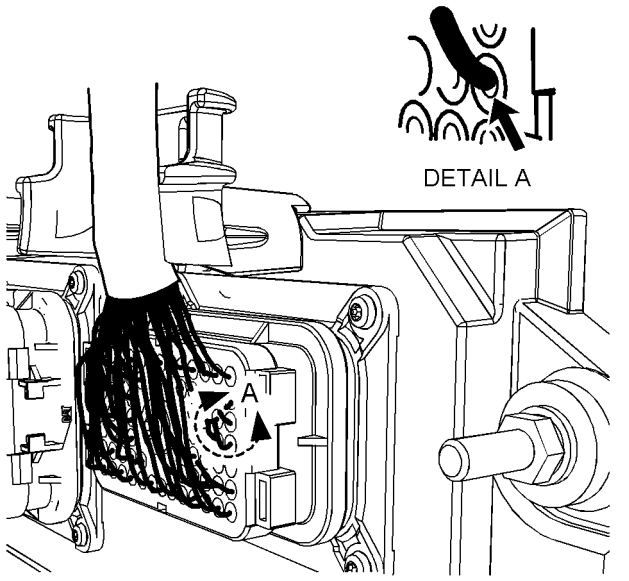
Follow these guidelines:

- 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 Wedge 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



g01131211

Illustration 37

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 37. This will create a path for the entrance of moisture. Verify that the seals for the wires are sealing correctly.

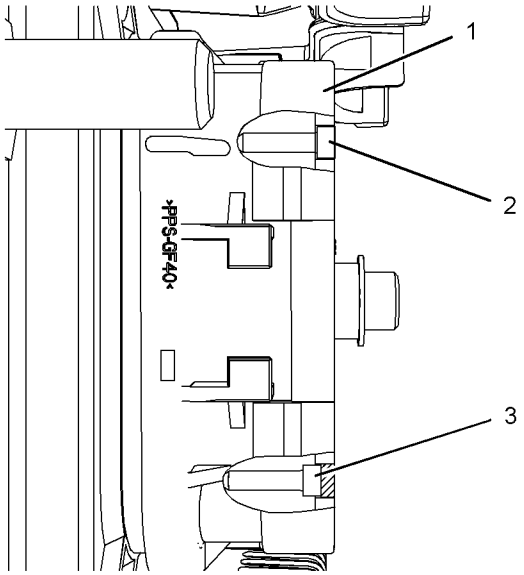


Illustration 38 g01131276

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 38.

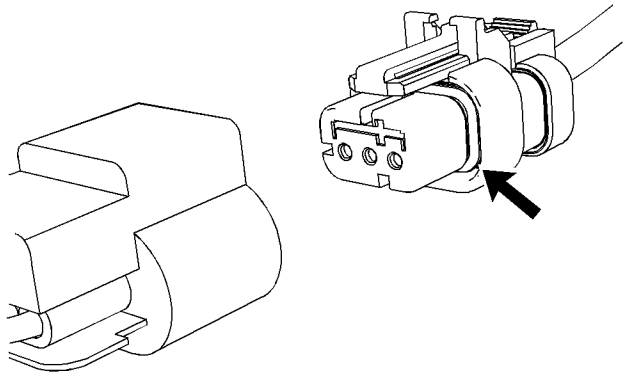


Illustration 39 g01131019

Seal for a three-pin connector (typical example)

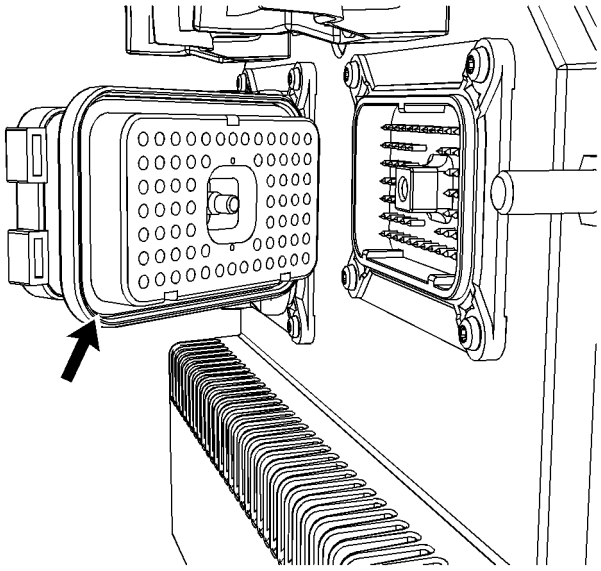


Illustration 40 g01131165

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:

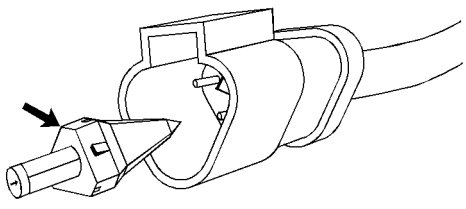
- OK – The terminals are OK. Proceed to Test Step 4.
- Not OK – The terminals of the connector are damaged.

  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



g01131435

Illustration 41

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

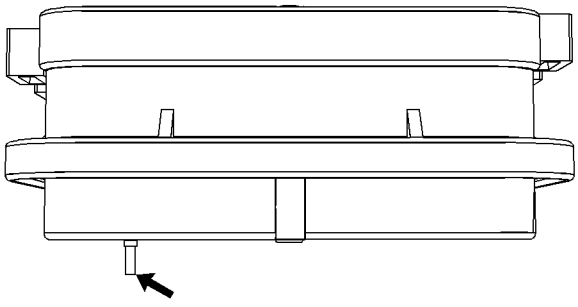


Illustration 42 g01131604

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.

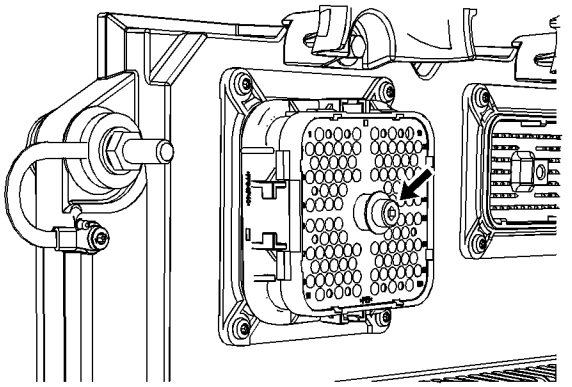


Illustration 43 g01132827

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).

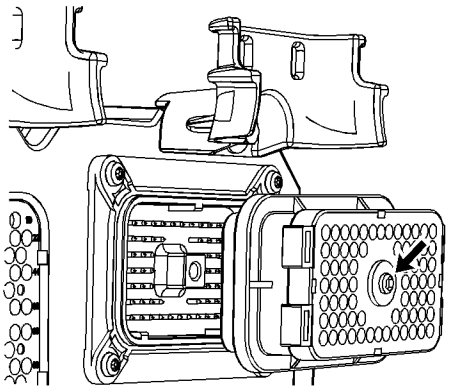


Illustration 44 g01132849

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).

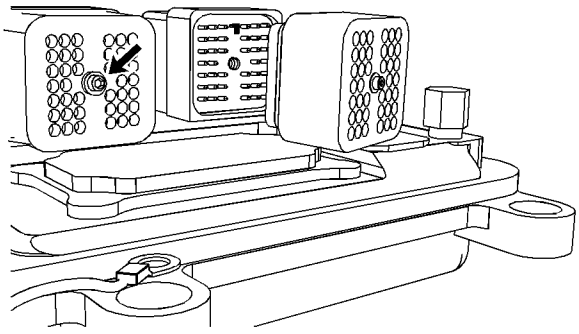


Illustration 45 g01132863

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).

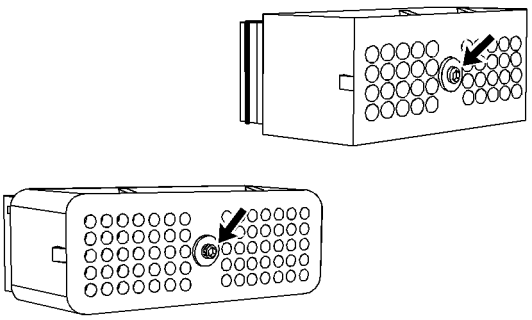


Illustration 46 g01133047

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.

i02412583

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).

The ECM is continuously powered with +Battery voltage that is supplied to inputs P1-48, P1-52, P1-53, P1-55, and P1-57 and P1-70 (keyswitch). If an emergency stop condition is initiated, the ECM relay will be energized and battery voltage will be removed from the ECM.

Power to the ECM is provided by a set of normally closed contacts that are in ECM relay. The ECM relay is controlled by a set of normally open contacts in the emergency stop switch. When the emergency stop switch is placed in the STOP position, the contacts in the emergency stop switch are closed and +24 VDC is supplied to the control circuit for the ECM relay. This opens the contacts in the relay and power is removed from the ECM.

Opening the battery disconnect switch will also remove power from the ECM. When the battery disconnect switch is placed in the OFF position, the ground connection to inputs P1-61, P1-63, P1-65, P1-67, and P1-69 of the ECM is removed.

During an engine start sequence, the Starting Motor Magnetic Switch (SMMS) is used by the ECM to engage the starting motor. Voltage for the control solenoid for the SMMS is supplied by the ECM. When the ECM supplies the signal, the SMMS is energized. This powers the starting solenoid and the starter is engaged. Refer to the diagnostic functional test Troubleshooting, “Start Relay Circuit - Test” for information that is related to troubleshooting the circuit for the SMMS.

Circuit protection is provided by circuit breakers for the ECM relay, the SMMS, and the emergency stop switch.

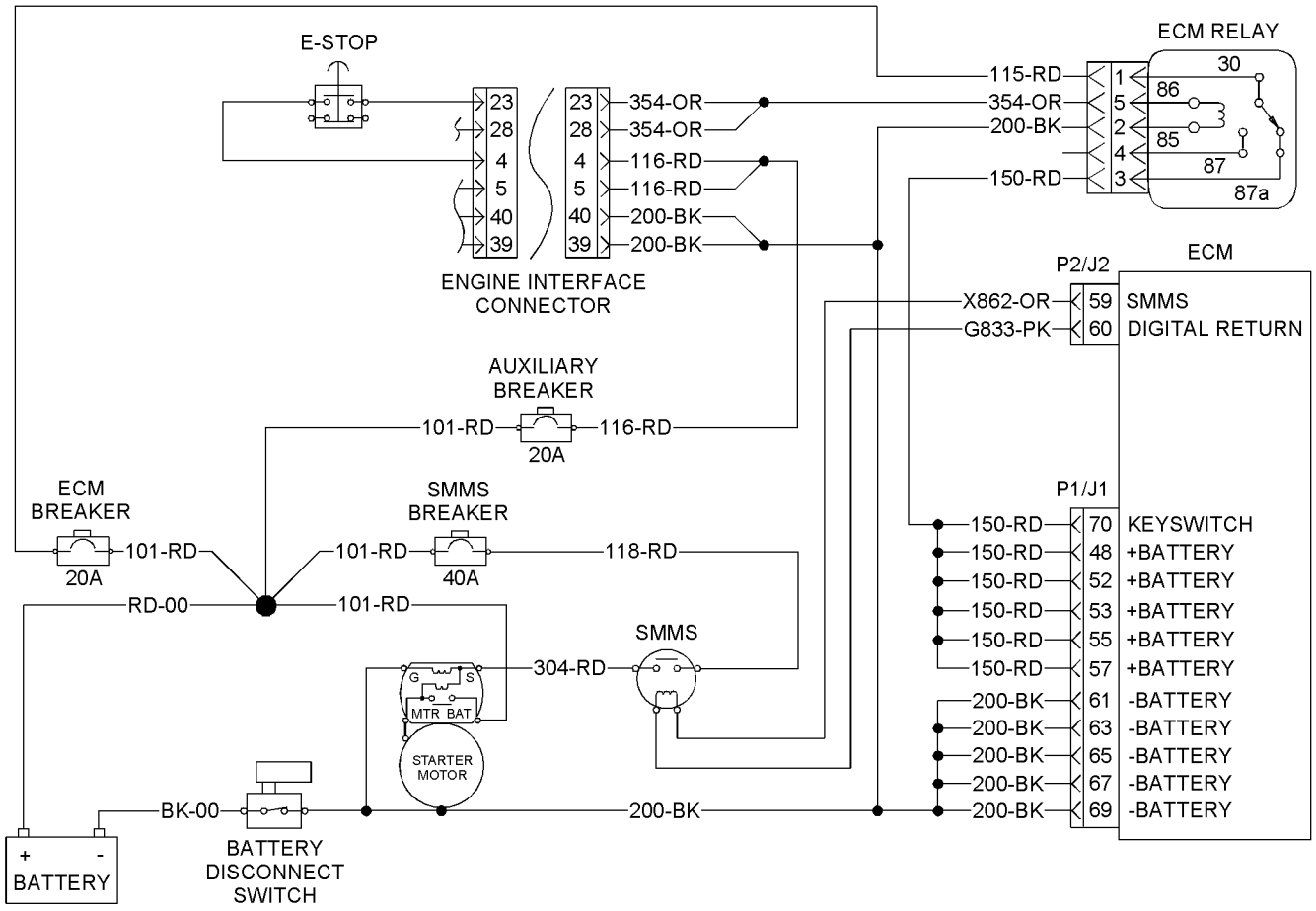


Illustration 47 g01205857

Schematic for the electrical power supply (typical example)

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Turn the battery disconnect switch to the OFF position.

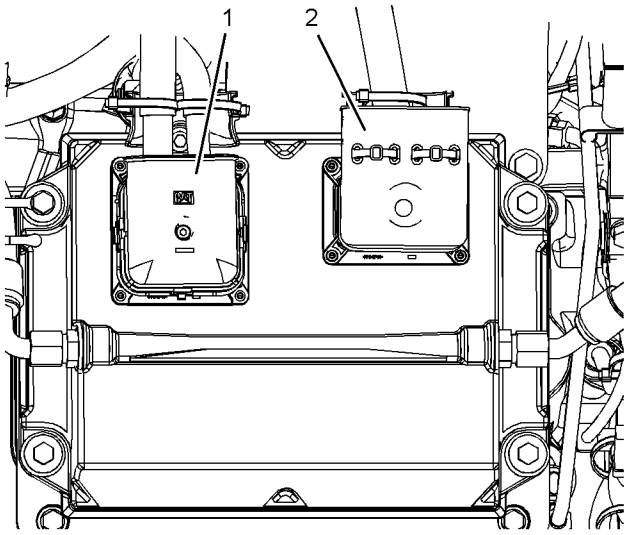


Illustration 48 g01206567

Location of the J1/P1 and the J2/P2 ECM connectors (typical engine view)

(1) J2/P2 ECM connector
(2) J1/P1 ECM connector

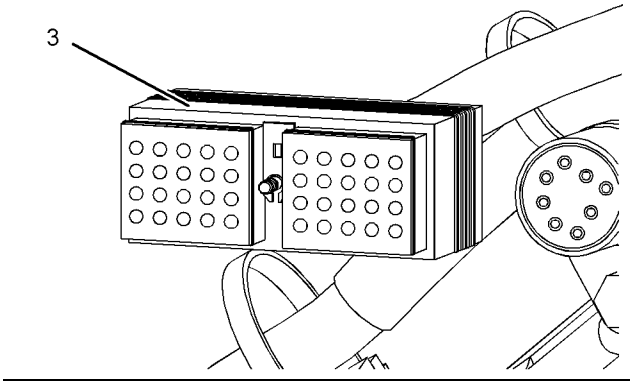


Illustration 49 g01207955

Location of the engine interface connector (typical engine view)

(3) Engine interface connector

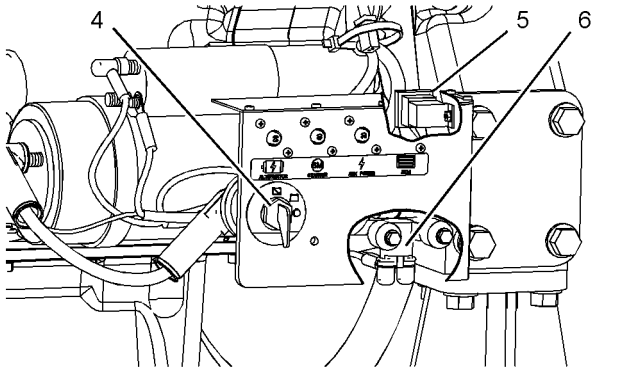
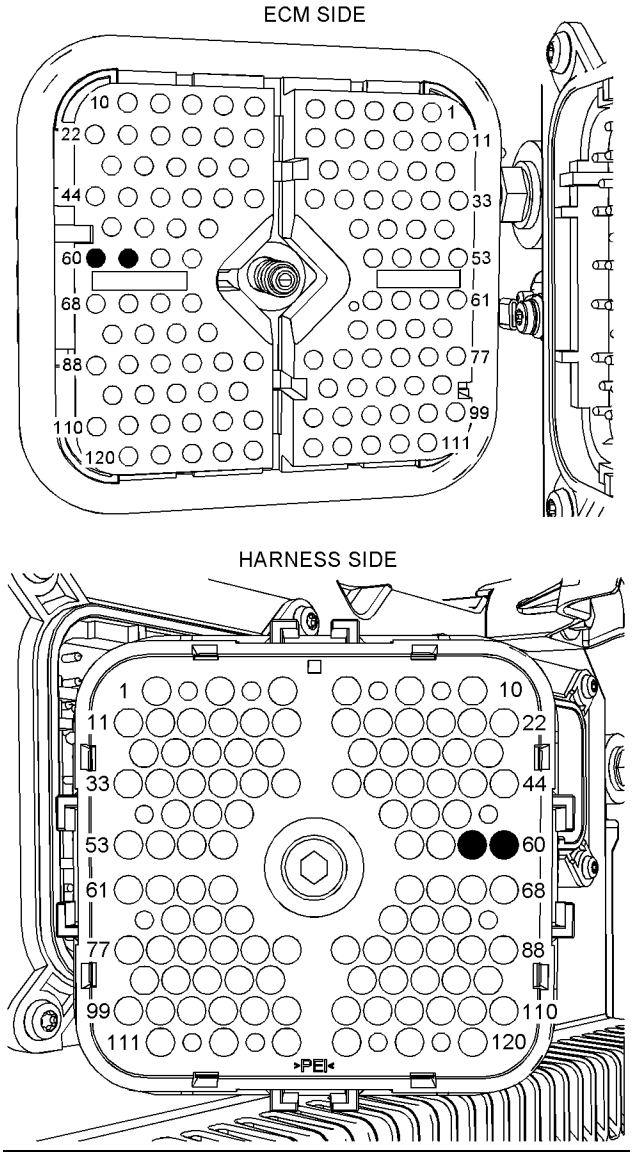


Illustration 50 g01206446

Location of the battery isolator switch, the ECM relay, and the starting motor magnetic switch (typical left side engine view)

(4) Battery disconnect switch
(5) ECM relay
(6) Starting motor magnetic switch

B. Thoroughly inspect connectors (1), (2), and (3). Also, thoroughly inspect the connectors for switches (4) and (6) and for relay (5). Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect” for details.

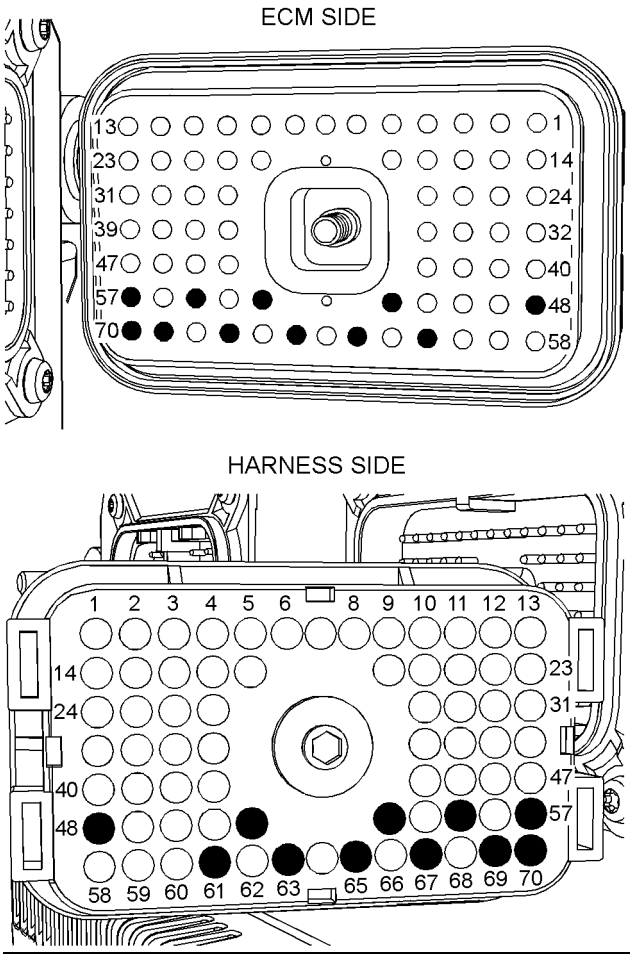


g01206553

Illustration 51

P2 ECM connector

(P2-59) SMMS
(P2-60) Digital return



g01206554

Illustration 52

P1 ECM connector

(P1-48) +Battery
(P1-52) +Battery
(P1-53) +Battery
(P1-55) +Battery
(P1-57) +Battery
(P1-61) −Battery
(P1-63) −Battery
(P1-65) −Battery
(P1-67) −Battery
(P1-69) −Battery
(P1-70) Keyswitch

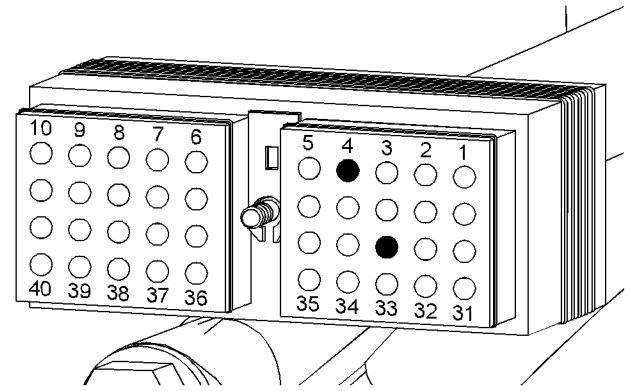


Illustration 53 g01207957

Terminal locations for the engine interface connector

(Terminal 4) +Battery
(Terminal 23) Relay control

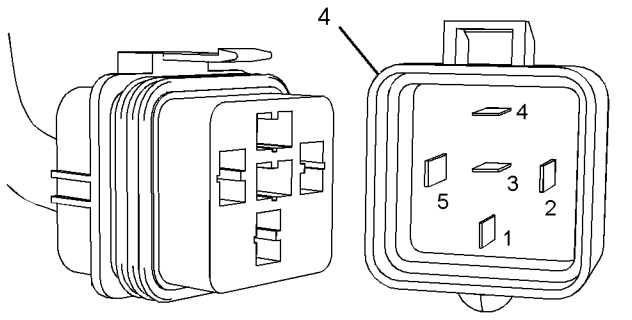


Illustration 54 g01207940

Terminal locations for the ECM relay and the connector (typical example)

(4) ECM relay
(Terminal 1) +Battery
(Terminal 2) Relay ground
(Terminal 3) Electrical power to the ECM
(Terminal 5) Relay control

C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connectors and the connector for the ECM relay.

D. Check the torque of the allen head screws for the ECM connectors. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the harness and the wiring for abrasion and for pinch points from the batteries 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 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. Verify that the original problem has been resolved.

  STOP.

Test Step 2. Check the Battery Voltage at the ECM

A. Disconnect the J1/P1 ECM connector.

B. Turn the battery disconnect switch to the ON position.

C. Measure the voltage between P1-48 (+Battery) and P1-61 (−Battery).

D. Measure the voltage between P1-52 (+Battery) and P1-63 (−Battery).

E. Measure the voltage between P1-53 (+Battery) and P1-65 (−Battery).

F. Measure the voltage between P1-55 (+Battery) and P1-67 (−Battery).

G. Measure the voltage between P1-57 (+Battery) and P1-69 (−Battery).

H. Measure the voltage between P1-70 (keyswitch) and P1-63 (−Battery).

I. Turn the battery disconnect switch to the OFF position.

Expected Result:

The measured voltage is between 22.0 VDC and 27.0 VDC.

Results:

- OK – The measured voltage is between 22.0 VDC and 27.0 VDC.

  Repair: The ECM is receiving the correct voltage. There may be an intermittent problem in the harness or in a connector. If an intermittent condition is suspected, refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect” for details.

  STOP.

- Not OK – The voltage is not correct at the ECM. There is a problem with the electrical power supply circuit. Leave the J1/P1 ECM connectors disconnected. Proceed to Test Step 3.

Test Step 3. Check the Batteries

A. Measure the no-load battery voltage at the battery posts.

The correct voltage is between 22.0 VDC and 27.0 VDC.

B. Load test the batteries. Use the 4C-4911 Battery Load Tester. Refer to the Operating Manual, SEHS9249. Refer to Special Instruction, SEHS7633 for details.

Expected Result:

The batteries pass the load test.

Results:

- OK – The batteries pass the load test. There is a problem in the harness between the batteries and the ECM. There may be a problem in the circuit for the ECM relay. Proceed to Test Step 6.
- Not OK – The batteries failed the load test.

  Repair: The batteries are the cause of the original problem. There may be a problem with the alternator. Recharge the batteries or replace the batteries. Restore the wiring to the original configuration.

  If a problem with the alternator is suspected, refer to Troubleshooting, “Alternator”.

  STOP.

Test Step 4. Check the Voltage from the ECM Relay to the ECM

A. Turn the battery disconnect switch to the OFF position.

B. Disconnect the connector from the ECM relay.

C. Remove the wire from the terminal location 3 of the connector for the ECM relay.

D. Fabricate a jumper wire that is long enough to provide a test circuit for a terminal location at the ECM relay. Crimp a spade terminal to one end of the jumper wire.

E. Install the jumper wire into terminal location 3 of the connector for the ECM relay. Connect the connector to the ECM relay.

F. Turn the battery disconnect switch to the ON position. Ensure that the emergency stop switch is in the RUN position.

G. Measure the voltage between the loose end of the jumper wire and engine ground.

H. Turn the battery disconnect switch to the OFF position.

Expected Result:

Voltage is present on terminal 3 at the ECM relay.

Results:

- OK – Voltage is present on terminal 3 at the ECM relay.

  Repair: If voltage is present on terminal 3, there is a problem in the harness between the ECM relay and the ECM. Repair the harness and/or the connectors. Replace parts, if necessary.

  STOP.

- Not OK – Voltage is not present on terminal 3 at the ECM relay. There is a problem in the harness between the ECM relay and the batteries. There may be a problem with the relay. Proceed to Test Step 6.

Test Step 5. Check for +Battery Voltage at the ECM Relay

A. Disconnect the connector from the ECM relay.

B. Turn the battery disconnect switch to the ON position.

C. Measure the voltage between terminal 1 at the connector for the ECM relay and the engine ground stud.

Expected Result:

The measured voltage is 24 ± 3 VDC.

Results:

- OK – The voltage is 24 ± 3 VDC. The proper voltage is reaching terminal 1 of the ECM relay. Check the circuit for the relay control for the proper operation. Leave the connector for the ECM relay disconnected. Proceed to Test Step 7.
- Not OK – The voltage is not 24 ± 3 VDC.

Repair: There is an open circuit in the harness or in a connector between the batteries and the ECM relay. Ensure that the circuit breaker for the ECM relay has not tripped. Repair the wiring and/or the connectors. Replace parts, if necessary. Verify that the original problem has been resolved.

STOP.

Test Step 6. Check the Voltage for the Relay Control at the ECM Relay

A. Check that the battery disconnect switch is in the ON position. Ensure that the emergency stop switch is in the RUN position.

B. Measure the voltage between terminals 2 (relay ground) and 5 (relay control) at the connector for the ECM relay.

A correct measurement will indicate that no voltage is present between the terminals.

C. Place the emergency stop switch in the STOP position.

D. Again, measure the voltage between terminals 2 (relay ground) and 5 (relay control) at the connector for the ECM relay.

A correct measurement will indicate that the voltage is 24 ± 3 VDC between the terminals.

Expected Result:

The voltage is correct between connector terminals for each position of the emergency stop switch.

Results:

- OK – The voltage is correct for each position of the emergency stop switch. The circuit for the relay control is operating correctly. The problem may be the ECM relay or the problem may be in the ground circuit from the batteries to the ECM. Leave the connector for the ECM relay disconnected. Proceed to Test Step 7.

- Not OK – One of the following conditions exists: Voltage is present at the terminals with the emergency stop switch in the RUN position. Voltage is not present at the terminals with the emergency stop switch in the STOP position.

  Repair: There is a problem in the circuit for the emergency stop switch. Repair the circuit and retest the electrical power supply circuit. Refer to the diagnostic functional test Troubleshooting, “Emergency Stop Circuit - Test”.

  STOP.

Test Step 7. Test the Ground Circuit

A. Ensure that the battery disconnect switch is in the ON position.

B. Measure the voltage between the battery’s +Battery terminal and the following test points. If voltage is not present at a test point, the problem is in the wire or in the connector that precedes the point in the circuit. Refer to Illustration 47 as a reference.

Table 21

Device	Test location
Battery disconnect switch	Input terminal
	Output terminal
Starting motor	−Battery terminal
P1 ECM connector	Terminal 61
	Terminal 63
	Terminal 65
	Terminal 67
	Terminal 69
Connector for the ECM relay	Terminal 2

Expected Result:

A voltage of 24 VDC is measured between the +Battery and each test location in Table 21.

Results:

- OK – A voltage of 24 VDC is measured for each test location.

  Repair: The wiring for the ground circuit is OK. The problem is an open circuit in the ECM relay. Replace the ECM relay. Verify that the original problem has been resolved.

  STOP.

- Not OK – A voltage of 24 VDC is not present at one of the test locations.

  Repair: There is an open circuit in the harness or in the connector that precedes this test location. Repair the wiring and/or the connectors. Replace parts, if necessary. Verify that the original problem has been resolved.

  STOP.

i02414122

Emergency Stop Switch Circuit - Test

SMCS Code: 7332-038

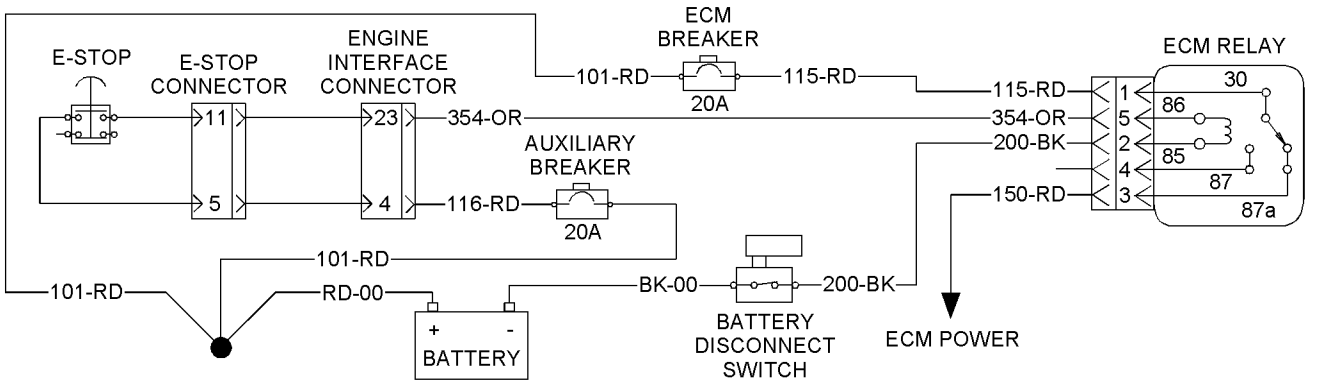
System Operation Description:

This application is equipped with an emergency stop switch. The switch is located on the control panel. The Electronic Control Module (ECM) is configured to record an event when the switch is activated.

The emergency stop switch provides a switch in the circuit from the +Battery to the control input for the ECM relay. The ECM relay provides the battery power for the ECM.

The emergency stop switch is a normally open switch in the RUN position. The secondary contacts for the ECM relay are normally closed contacts.

When the emergency stop switch is switched to the STOP position, the switch contacts for the emergency stop switch are closed. Control input voltage is supplied to the ECM relay and secondary contacts of the ECM relay are pulled open. This removes battery voltage from the ECM.



g01206694

Illustration 55

Schematic for the emergency stop switch

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Turn the battery disconnect switch to the OFF position.

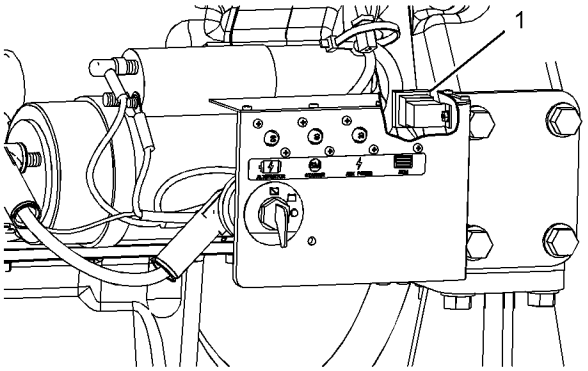


Illustration 56 g01207034

Location of the ECM relay (typical left side engine view)

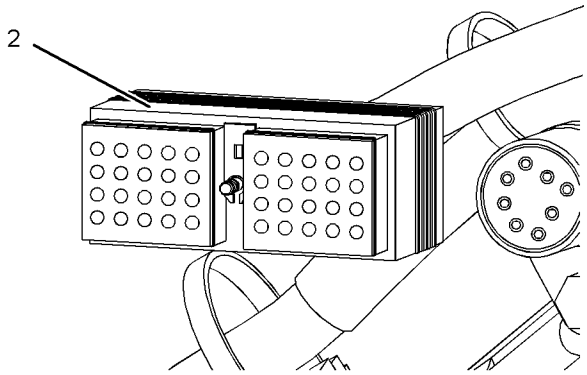


Illustration 57 g01210817

Location of the engine interface connector (typical engine view)

B. Thoroughly inspect the connector for relay (1) and connector (2). Also, thoroughly inspect any other connectors that are associated with the circuit. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

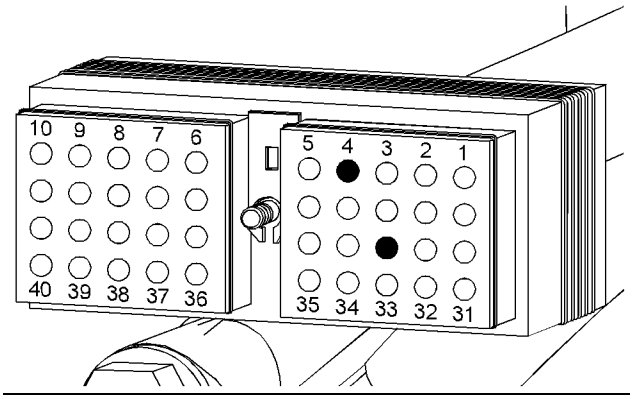


Illustration 58 g01206959

Terminal locations at the engine interface connector that are associated with the emergency stop switch

(4) +Battery
(23) Emergency stop

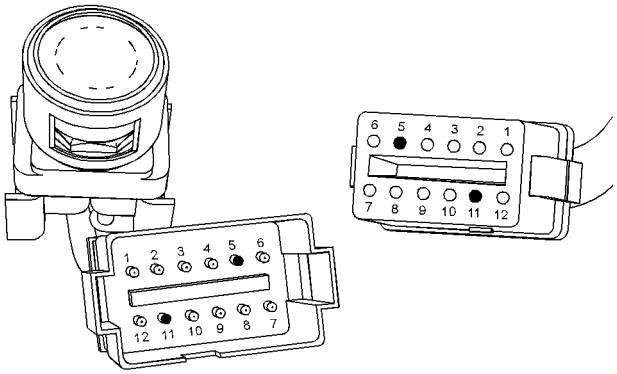


Illustration 59 g01206963

Terminal locations at the connector for the emergency stop switch

(5) +Battery
(11) Emergency stop

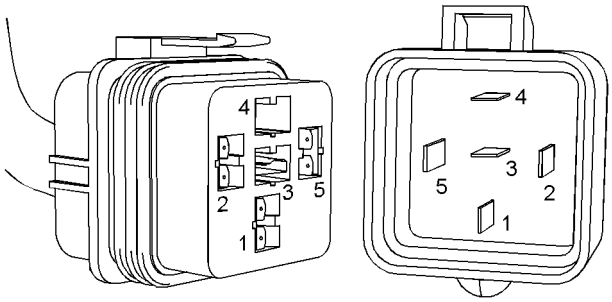


Illustration 60 g01210818

Terminal locations at the ECM relay that are associated with the emergency stop switch

(5) Emergency stop

C. Perform a 45 N (10 lb) pull test on each of the wires in the circuit for the emergency stop switch.

D. Check the torque of the allen head screws for the engine interface connector. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the harness and the wiring for abrasion and for pinch points from the battery to the ECM relay.

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 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.

  STOP.

Test Step 2. Check for Voltage at the Connector for the Emergency Stop Switch

A. Disconnect the connectors for the emergency stop switch.

B. Turn the battery disconnect switch to the ON position.

C. Measure the voltage between terminal 5 on the harness side of the connector for the emergency stop switch and the engine ground stud.

D. Turn the battery disconnect switch to the OFF position.

Expected Result:

The correct voltage is 24 ± 3 VDC.

Results:

- OK – The voltage is 24 ± 3 VDC. The supply voltage is reaching the connector for the emergency stop switch. There may be a problem with the emergency stop switch. Proceed to Test Step 4.
- Not OK – The voltage is not 24 ± 3 VDC. The supply voltage is not reaching the connector for the emergency stop switch. There is a problem in the circuit between the emergency stop switch and the battery. Proceed to Test Step 3.

Test Step 3. Check the Emergency Stop Switches

A. Disconnect the engine interface connectors.

B. Turn the battery disconnect switch to the ON position.

C. Measure the voltage between terminal 4 on the engine harness side of the engine interface connectors and the engine ground stud.

D. Turn the battery disconnect switch to the OFF position.

Expected Result:

The correct voltage is 24 ± 3 VDC.

Results:

- OK – The voltage is 24 ± 3 VDC.

  Repair: There is supply voltage at the engine interface connectors, but not at the connector for the emergency stop switch.

  There is a problem in the harness between the engine interface connectors and the connector for the emergency stop switch. The problem may be in a connector. Repair the harness and/or the connector. Replace parts, if necessary. Refer to Troubleshooting, “Inspecting Electrical Connectors”.

  STOP.

- Not OK – The voltage is not 24 ± 3 VDC.

  Repair: Supply voltage is not reaching the engine interface connector. There is a problem in the circuit from the battery to the engine interface connector. Ensure that the circuit breaker for the emergency stop switch is not tripped. Repair the harness and/or the connector. Replace parts, if necessary.

  Refer to Troubleshooting, “Inspecting Electrical Connectors”.

  STOP.

Test Step 4. Check the Emergency Stop Switch

A. Ensure that the emergency stop switch is in the RUN position.

B. Measure the resistance between terminals 5 and 11 on the switch side of the connector for the emergency stop switch.

An open circuit condition is the correct measurement with the emergency stop switch in the RUN position.

C. Place the emergency stop switch in the STOP position.

D. Again, measure the resistance between terminals 5 and 11 on the switch side of the connector for the emergency stop switch.

A short circuit condition is the correct measurement with the emergency stop switch in the STOP position.

Expected Result:

The measurements agree with the results that are stated above.

Results:

- OK – The measurements agree with the results that are stated above. The emergency stop switch is operating correctly. There may be a problem in the harness between the emergency stop switch and the engine interface connector. Connect the connectors for the emergency stop switch. Proceed to Test Step 5.
- Not OK – The measurements did not agree with the results that are stated above.

  Repair: There is a problem with the emergency stop switch. Replace the switch. Restore all wiring to the original configuration. Verify that the repair resolves the original problem.

  STOP.

Test Step 5. Check the Harness Between the Connector for the Emergency Stop Switch and the Engine Interface Connector

A. Ensure that the emergency stop switch is in the RUN position.

B. Measure the resistance between terminals 4 and 23 on the switch side of the engine interface connector.

An open circuit condition is the correct measurement with the emergency stop switch in the RUN position.

C. Place the emergency stop switch in the STOP position.

D. Again, measure the resistance between terminals 4 and 23 on the switch side of the engine interface connector.

A short circuit condition is the correct measurement with the emergency stop switch in the STOP position.

Expected Result:

The measurements agree with the results that are stated above.

Results:

- OK – The measurements agree with the results that are stated above. The harness between the emergency stop switch and the engine interface connector is OK. There may be a problem in the harness between the engine interface connector and the ECM relay. Connect the connectors for the engine interface connector. Proceed to Test Step 6.
- Not OK – The measurements did not agree with the results that are stated above.

  Repair: There is a problem in the circuit between the engine interface connector and the emergency stop switch. Repair the harness and/or the connectors. Replace parts, if necessary. Verify that the repair resolves the original problem.

  STOP.

Test Step 6. Check the Operation of the Emergency Stop Switch

A. Ensure that the battery disconnect switch is in the OFF position.

B. Disconnect the connector from the ECM relay.

C. Place the emergency stop switch in the RUN position.

D. Turn the battery disconnect switch to the ON position.

E. Measure the voltage between terminal 5 of the connector for the ECM relay and the engine ground stud.

The correct voltage is zero volts.

F. Place the emergency stop switch in the STOP position.

G. Again, measure the voltage between terminal 5 of the connector for the ECM relay and the engine ground stud.

The correct voltage is 24 ± 3 VDC.

H. Turn the battery disconnect switch to the OFF position.

I. Connect the connector for the ECM relay.

Expected Result:

The voltage at the ECM relay is zero volts with the emergency stop switch in the RUN position and the voltage at the ECM relay is 24 ± 3 VDC with the emergency stop switch in the STOP position.

Results:

- OK – The voltages are correct for the conditions that are stated above.

Repair: The correct supply voltage is reaching the ECM relay. The circuit for the emergency stop switch is operating correctly at this time. There may be an intermittent condition in the harness or in a connector.

If an intermittent electrical problem is suspected, refer to Troubleshooting, “Electrical Connectors - Inspect”.

If a problem is suspected in the circuit for the ECM relay, refer to Troubleshooting, “Electrical Power Supply Circuit - Test”.

STOP.

- Not OK – The voltages are correct for the conditions that are stated above.

  Repair: .The circuit is OK at the engine interface connector, but the ECM relay is not receiving the correct voltage. There is a problem in the circuit between the engine interface connector and the connector for the ECM relay. Repair the harness and/or the connectors. Replace parts, if necessary.

  STOP.

i02410299

Engine Pressure Sensor Open or Short Circuit - Test

SMCS Code: 1439-038-PX

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the circuits for the following sensors:

- Atmospheric pressure sensor
- Intake manifold pressure sensor
- Engine oil pressure sensor
- Fuel pressure sensor

This procedure covers the following open circuit diagnostic codes and short circuit diagnostic codes:

- 94-03 Fuel Pressure open/short to +batt
- 94-04 Fuel Pressure short to ground
- 100-03 Engine Oil Pressure open/short to +batt
- 100-04 Engine Oil Pressure short to ground
- 274-03 Atmospheric Pressure open/short to +batt
- 274-04 Atmospheric Pressure short to ground
- 1785-03 Intake Manifold Pressure Sensor voltage high
- 102-04 Intake Manifold Pressure Sensor voltage low

The 5 volt sensor supply provides power to all 5 volt sensors. The Electronic Control Module (ECM) supplies 5.0 ± 0.2 VDC to terminal A of each sensor connector. The sensor return from the ECM connector goes to terminal B of each sensor connector. The sensor supply is output short circuit protected. A short circuit to the battery will not damage the circuit inside the 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 a problem 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 a 03 diagnostic code 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 OK. If the sensor is disconnected at the sensor connector, the absence of pull-up voltage at the sensor connector indicates a problem in the signal wire. 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 may be shorted to another wire in the harness.

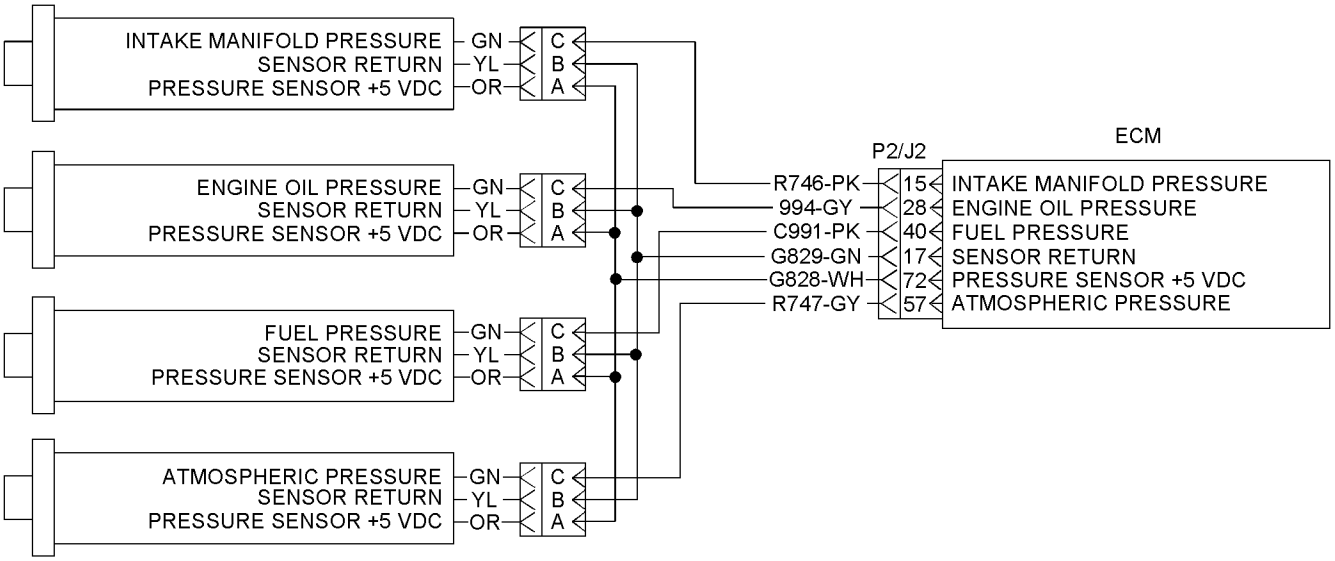


Illustration 61 g01204447

Schematic for the engine pressure sensors

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove electrical power from the ECM.

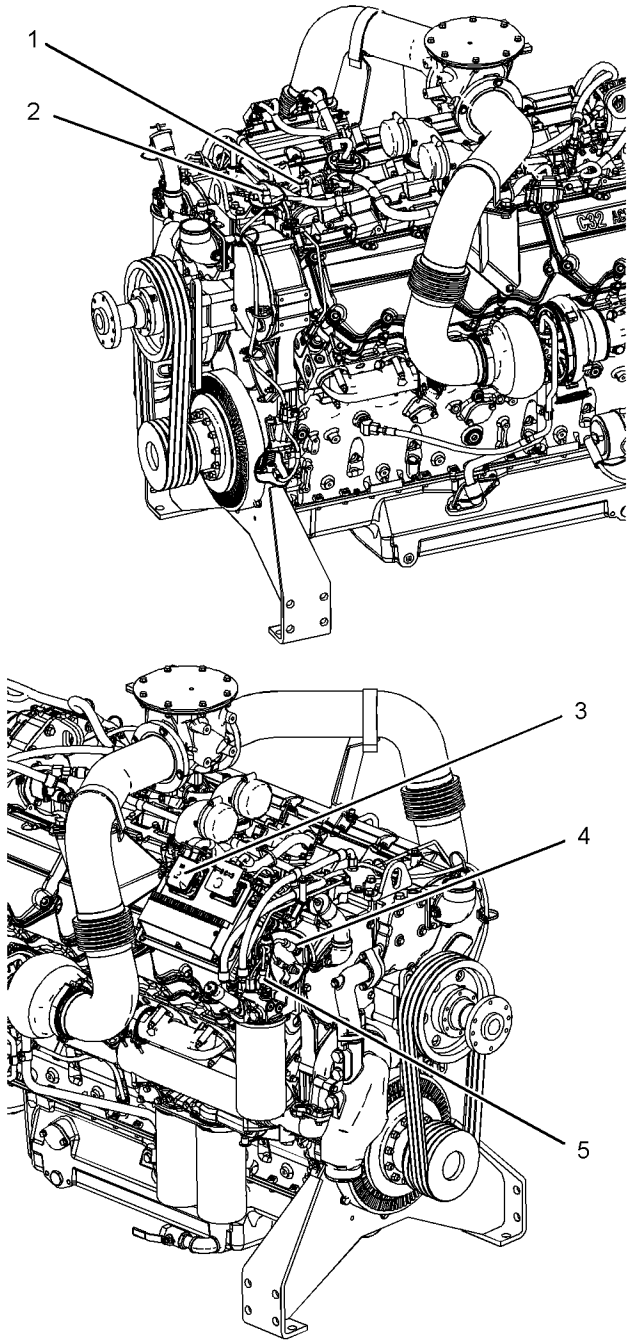


Illustration 62 g01204463

Sensor locations

(1) Intake manifold pressure sensor
(2) Atmospheric pressure sensor
(3) J2/P2 ECM connectors
(4) Engine oil pressure sensor
(5) Fuel pressure sensor

B. Thoroughly inspect connectors (3). Also, thoroughly inspect the connectors for sensors (1), (2), (4), and (5).

Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

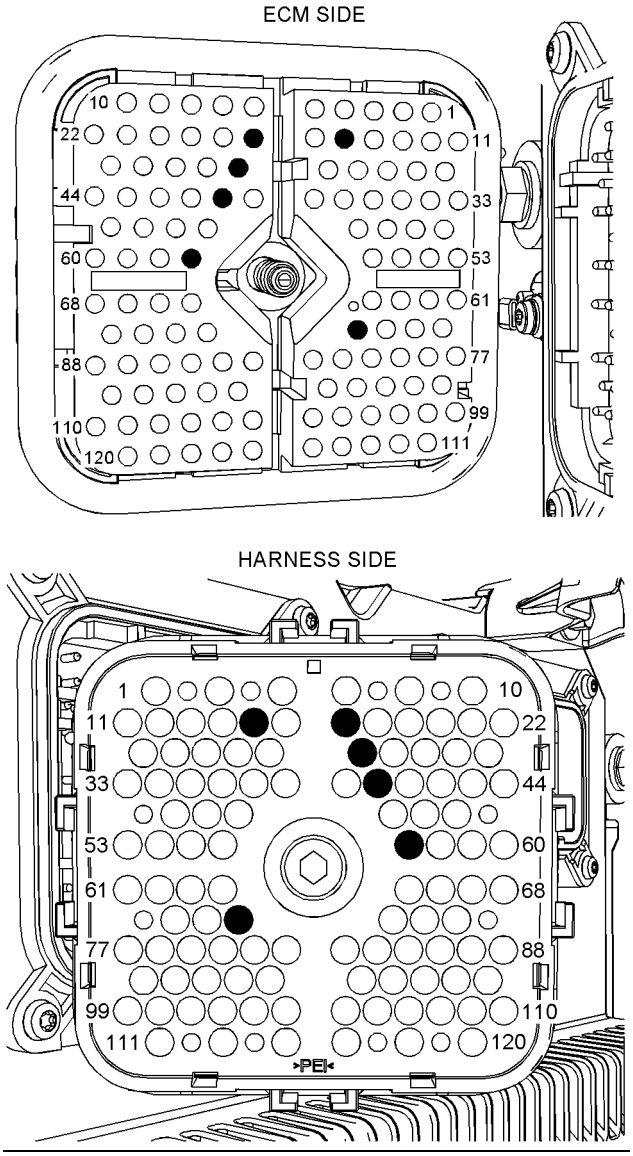


Illustration 63 g01204484

P2 ECM connector

(P2-15) Intake manifold pressure sensor
(P2-17) Sensor return
(P2-28) Engine oil pressure sensor
(P2-40) Fuel pressure sensor
(P2-57) Atmospheric pressure sensor
(P2-72) Sensor supply

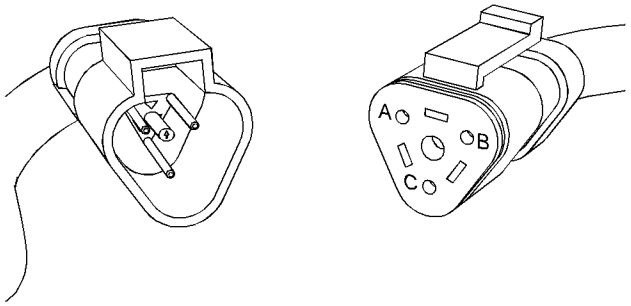


Illustration 64 g01159881

Sensor connector

(A) Sensor supply
(B) Sensor return
(C) Sensor signal

C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector and on each of the wires in the pressure sensor connectors.

D. Check the allen head screw for each of the ECM connectors and the customer 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 of the pressure sensors 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 appear to be 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 for each of the connectors 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. Remove electrical power from the ECM.

B. Disconnect the harness connectors for the following sensors:

- Atmospheric pressure sensor
- Intake manifold pressure sensor
- Engine oil pressure sensor
- Fuel pressure sensor

C. Restore electrical power to the ECM.

Note: The original diagnostic code may not stay active. An open circuit diagnostic code for the sensor supply may become active when all of the sensors are disconnected. Ignore the active codes at this time and continue with this test step.

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.

E. Remove electrical power from the ECM.

F. Connect all of the sensors.

Expected Result:

Each voltage measurement is 5.0 ± 0.2 VDC.

Results:

- OK – Each voltage measurement is 5.0 ± 0.2 VDC. The voltage is correct at the sensor connectors. Proceed to Test Step 3.
- Not OK – The voltage is not 5.0 ± 0.2 VDC.

  Repair: The voltage is incorrect. There may be a problem with the sensor supply circuit. Refer to Troubleshooting, “5 Volt Engine Pressure Sensor Supply Circuit - Test” for information that is related to troubleshooting the circuit.

  STOP.

Test Step 3. Check for Active Diagnostic Codes

A. Connect Caterpillar Electronic Technician (ET) to the service tool connector.

B. Restore electrical power to the ECM.

C. Monitor the active diagnostic code screen on Cat ET. Look for an active diagnostic code for an engine pressure sensor.

Note: Wait at least 30 seconds so that any codes may 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 for the engine pressure sensors.

  Repair: The problem seems to be resolved. 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 03 diagnostic code is active at this time. The ECM is detecting an open circuit condition. Proceed to Test Step 5.

- Not OK – A 04 diagnostic code is active at this time. The ECM is detecting a short circuit condition. Proceed to Test Step 4.

Test Step 4. Disconnect the Suspect Sensor in Order to Create an Open Circuit

A. Remove electrical power from the ECM.

B. Disconnect the sensor connector of the sensor with the short circuit diagnostic code (04).

C. Restore electrical power to the ECM.

D. Access the “Active Diagnostic Code” screen on Cat ET. Check for an active open circuit diagnostic code (03) while the sensor is disconnected.

Note: Wait at least 30 seconds for activation of the diagnostic codes.

E. Remove electrical power from the ECM.

Expected Result:

A 03 diagnostic code became active after the sensor was disconnected.

Results:

- OK – A 04 diagnostic code was active before the sensor was disconnected. A 03 diagnostic code became active after the sensor was disconnected.

  Repair: There may be a problem with a sensor. 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 – When the sensor is disconnected, a 04 diagnostic code remains active for the suspect sensor. There is a problem in the circuit between the sensor harness connector and the ECM. The problem may be in the ECM. Leave the sensor disconnected. Proceed to Test Step 6.

Test Step 5. Create a Short at the Suspect Sensor Connector

A. Remove electrical power from the ECM.

B. Fabricate a jumper wire that is long enough to short the terminals at the sensor connector. Crimp connector sockets to each end of the jumper wire.

C. Install the jumper wire between terminal B (sensor return) and terminal C (sensor signal) on the harness side of the suspect sensor’s connector.

D. Restore electrical power to the ECM.

E. Monitor the “Active Diagnostic Codes” screen on Cat ET. Check for an active short circuit diagnostic code (04) while the jumper wire is installed.

Note: Wait at least 30 seconds for activation of the diagnostic code.

F. Remove electrical power from the ECM.

G. Remove the jumper wire.

Expected Result:

A 04 diagnostic code was active when the jumper wire was installed.

Results:

- OK – A 04 diagnostic code was active when the jumper wire was installed.

Repair: There is a problem with the sensor. 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 a problem in the harness between the ECM and the sensor connector. There may be a problem with the ECM. Proceed to Test Step 6.

Test Step 6. Test the Operation of the ECM

A. Remove electrical power from the ECM.

B. Fabricate a jumper wire that is long enough to create a test circuit from the ECM connector to the engine ground stud. Crimp a connector socket to one end of the jumper wire.

C. Disconnect the P2 ECM connector.

D. Remove the suspect sensor's signal wire from the ECM connector. Install the jumper wire into this terminal location at the ECM connector.

E. Connect the ECM connectors.

F. Check the operation of the ECM by creating an open at the ECM:

a. Hold the loose end of the jumper wire away from any ground source in order to create an open circuit condition.

b. Restore electrical power to the ECM.

c. Monitor the "Active Diagnostic Code" screen on Cat ET. Check the suspect sensor for an active 03 diagnostic code.

Note: Wait at least 30 seconds so that any codes may become active.

d. Remove electrical power from the ECM.

G. Check the operation of the ECM by creating a short circuit at the ECM:

a. Connect the jumper wire to the engine ground stud.

b. Restore electrical power to the ECM.

c. Monitor the "Active Diagnostic Code" screen on Cat ET. Check the suspect sensor for an active 04 diagnostic code while the jumper wire is installed.

Note: Wait at least 30 seconds so that any codes may become active.

d. Remove electrical power from the ECM.

H. Remove the jumper wire. Return all wiring to the original configuration.

Expected Result:

A 03 diagnostic code is active when the sensor signal wire is removed from the ECM connector. A 04 diagnostic code is active when the signal wire is connected to the engine ground stud.

Results:

- OK – A 03 diagnostic code is active when the sensor signal wire is removed from the ECM connector. A 04 diagnostic code is active when the signal wire is connected to the engine ground stud.

  Repair: The ECM is operating properly. The problem is in the harness wiring between the ECM and the sensor connector.

  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.

  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: There is a problem with the ECM. Replace the ECM. Refer to Troubleshooting, "Replacing the ECM".

  STOP.

i02450722

Engine Speed/Timing Sensor Circuit - Test

SMCS Code: 1439-038-VF; 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 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 reference for engine speed and timing from a timing ring with a notched pattern that has been machined onto a portion of the crankshaft gear. The signal from the primary engine speed/timing sensor is also used by the ECM as a control reference during a timing calibration.

The secondary engine speed/timing sensor detects the reference for engine speed and timing from a timing ring with a notched pattern that has been machined onto a portion of the camshaft gear.

The Electronic Control Module (ECM) counts the time between pulses that is created by the sensor as each gear rotates in order to determine rpm. Timing is provided by the unique pattern of notches in the timing ring.

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.

When the timing has been established, the ECM triggers each injector in the correct firing order at the correct time. The actual timing and duration of each injection is based on engine rpm and on load.

If the engine is running and the signal from one sensor is lost, no noticeable change in engine performance will be noticed. If the engine is running and the signals from both sensors are lost, fuel injection will be terminated and the engine will be shut down by the ECM.

The engine will start when only one sensor signal is present. The engine will not start if the signals from both sensors are lost.

Both sensors are magnetic sensors. The two sensors are not interchangeable. If a sensor is 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.

A timing calibration is necessary after the ECM software has been updated. Refer to Troubleshooting, “Engine Speed/Timing Sensor - Calibrate” for information that is related to timing calibration.

Complete all of the following tasks when you install a speed/timing sensor:

- Ensure that an O-ring is installed on the sensor. If the O-ring is damaged or missing, replace the O-ring.
- Lubricate the O-ring with oil.
- Ensure that the sensor is fully seated into the engine before tightening the bracket bolt.
- Ensure that the electrical connector is latched.
- Ensure that the harness is properly secured, and ensure that each tie-wrap is placed in the correct location.

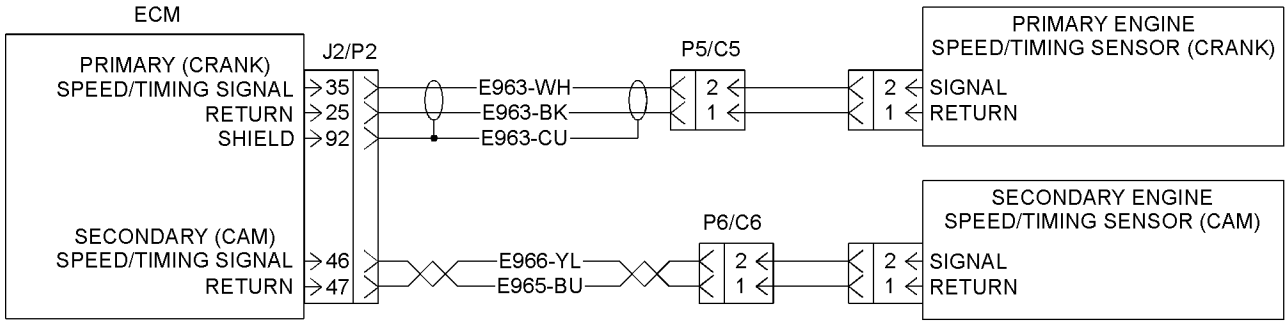


Illustration 65 g01223579

Schematic for the engine speed/timing sensors

Test Step 1. Check for Diagnostic Codes

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

B. Restore electrical power to the ECM.

C. Start the engine and run the engine until the engine is at the 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. Look for these codes on Cat ET:

- 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:

- No Engine rpm – Engine rpm is not indicated on Cat ET. Proceed to Test Step 2.
- 190-08 or 342-08 code – There is an active diagnostic code or a logged diagnostic code for an engine speed/timing sensor. Proceed to Test Step 4.
- No codes – Neither code is active or logged.

Repair: Refer to the appropriate symptoms in Troubleshooting, “Troubleshooting Without a Diagnostic Code”.

STOP.

Test Step 2. Check the Installation of the Sensor Assembly

A. Remove electrical power from the ECM.

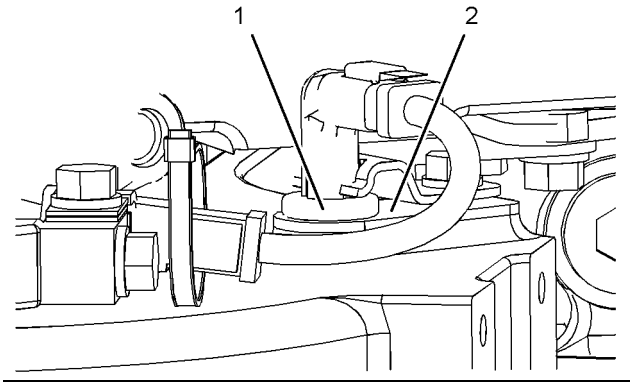


Illustration 66 g01167684

Typical engine speed/timing sensor

(1) Mounting flange
(2) Mounting surface

B. Visually inspect each sensor assembly without removing the sensor assembly from the engine. Ensure that flange (1) is installed squarely against surface (2).

C. Remove the suspect sensor assembly from the engine.

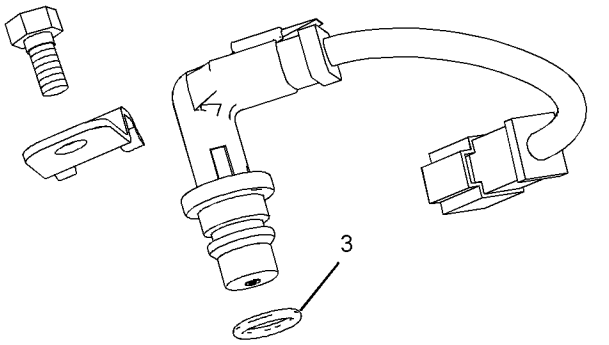


Illustration 67 g01167704

Typical engine speed/timing sensor

(3) O-ring

D. Ensure that one O-ring (3) is installed on the sensor. Check the O-ring for damage. Replace the O-ring, if necessary.

Results:

- OK – The sensor's components are OK.

  Repair: Perform the following procedure in order to properly install the sensor assembly:

  1. Lubricate the O-ring with engine oil.

  2. Fully seat the sensor assembly in the engine.

Note: If the sensor assembly will not fully seat into the engine, replace the sensor assembly.

  3. Tighten the bracket bolt.

  4. Connect the sensor's electrical connectors. Verify that the connectors are latched on both sides.

  5. Ensure that the harness is properly secured, and that the tie-wraps are placed in the correct location.

  Proceed to Test Step 3.

- Not OK – At least one of the sensor assembly's components is not OK.

  Repair: Obtain a new sensor assembly. Perform the following procedure in order to properly install the sensor assembly:

  1. Lubricate each O-ring with engine oil.

  2. Fully seat the sensor assembly in the engine.

Note: If the sensor assembly will not fully seat into the engine, replace the sensor assembly.

  3. Tighten the bracket bolt.

  4. Connect the sensor's electrical connectors. Verify that the connector is latched.

  5. Ensure that the harness is properly secured, and that the tie-wraps are placed in the correct location.

  Verify that the problem is resolved.

  STOP.

Test Step 3. Inspect the Electrical Connectors and the Wiring

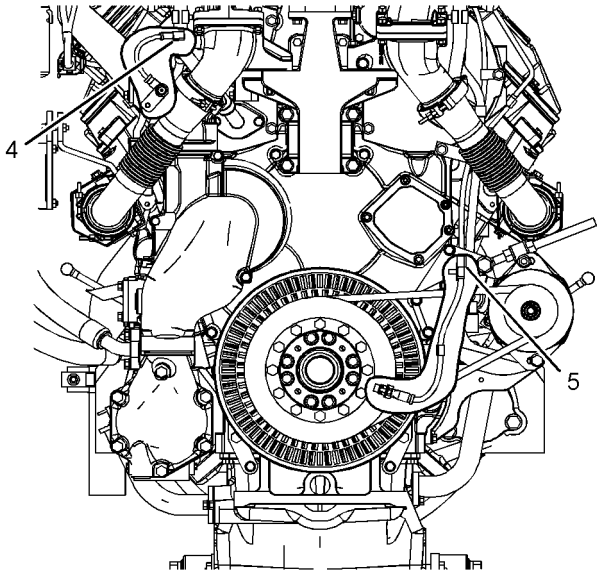


Illustration 68 g01167708

Location of the engine speed/timing sensors (typical front engine view)

(4) Harness connectors for the secondary engine speed/timing sensor

(5) Harness connectors for the primary engine speed/timing sensor

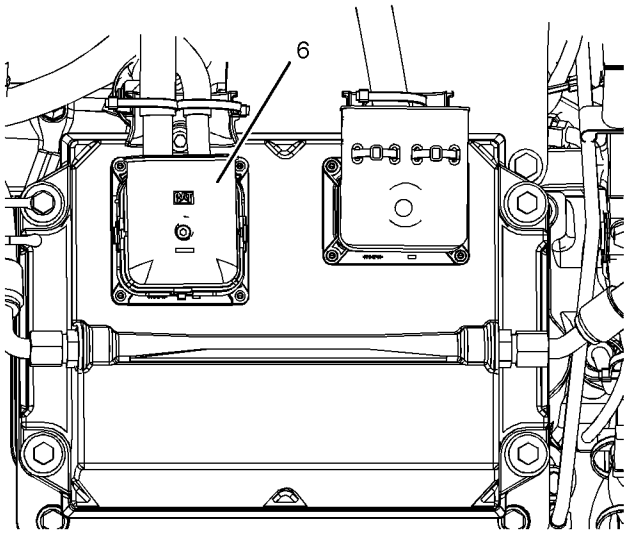


Illustration 69 g01167873

(6) J2/P2 ECM connector

A. Thoroughly inspect connectors (4), (5), and (6). Refer to Troubleshooting, “Electrical Connectors - Inspect”.

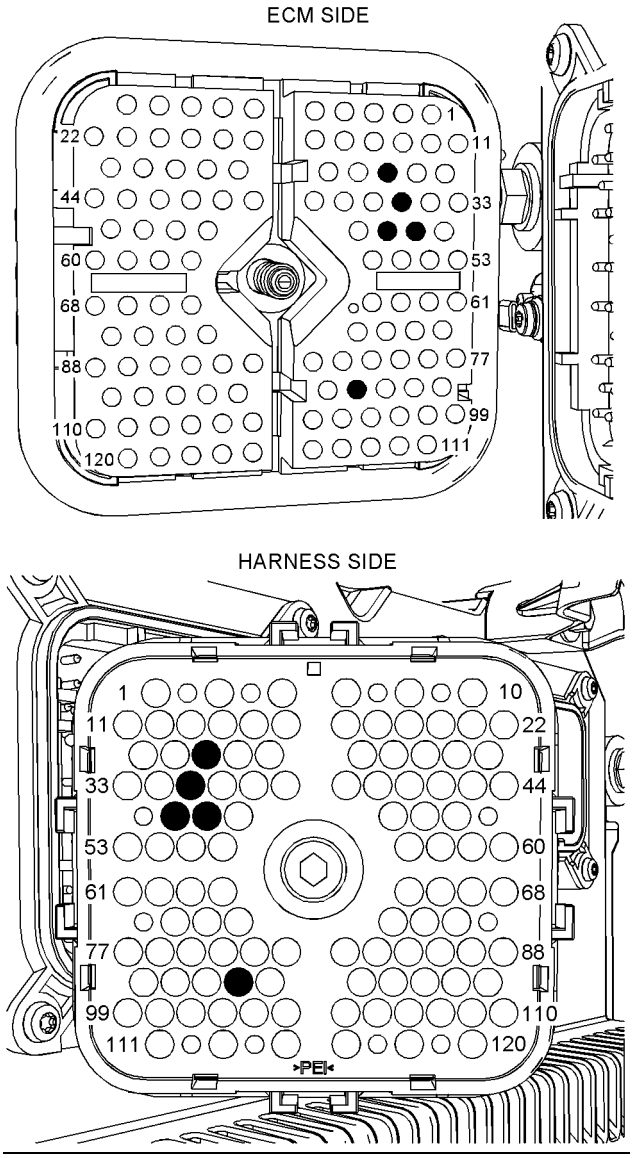


Illustration 70 g01212538

P2 terminals that are associated with the engine speed/timing sensors

(P2-25) Primary engine speed/timing −
(P2-35) Primary engine speed/timing +
(P2-46) Secondary engine speed/timing +
(P2-47) Secondary engine speed/timing −
(P2-92) Speed/timing shield

B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the engine speed/timing sensors.

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 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 4.
- 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 4. Measure the Sensor Resistance through the Engine Harness

A. Disconnect the J2/P2 ECM connectors.

B. If you are troubleshooting a problem with the primary engine speed/timing sensor, perform the following procedure:

a. Measure the sensor's resistance between P2-25 (primary engine speed/timing +) and P2-35 (primary engine speed/timing -).

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 at 25 °C (77 °F) ... 75 to 230 Ohms

C. If you are troubleshooting a problem with the secondary engine speed/timing sensor, perform the following procedure:

a. Measure the sensor's resistance between P2-47 (secondary engine speed/timing +) and P2-46 (secondary engine speed/timing -).

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 at 25 °C (77 °F) ..... 600 to 1800 Ohms

Expected Result:

The resistance measurement is within the specifications.

Results:

- OK – The resistance measurement is within the specifications.

  Repair: Neither a short circuit nor an open circuit is indicated in the circuit. Replace the ECM. Refer to Troubleshooting, "Replacing the ECM".

  STOP.

- 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 5.

Test Step 5. Measure the Resistance of the Sensor

A. Disconnect the harness connector for the suspect sensor.

B. Thoroughly inspect the sensor's connectors. Refer to Troubleshooting, "Electrical Connectors - Inspect".

C. Measure the sensor's resistance between terminals 1 and 2.

Resistance for primary engine speed/timing sensor at 25 °C (77 °F) ..... 75 to 230 Ohms

Resistance for secondary engine speed/timing sensor at 25 °C (77 °F) ..... 600 to 1800 Ohms

Expected Result:

The resistance measurement is within specifications.

Results:

- OK – The reading is within the specification. There is a problem with the wiring between the engine speed/timing sensor and the ECM. 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.

- Not OK – The reading is not within the specification. There is an electrical problem with the engine speed/timing sensor.

  Repair: Perform the following procedure in order to check and install the new sensor assembly:

  1. Before you install the new sensor assembly, measure the resistance of the new sensors.

     If the resistance measurements of the new sensors are within the specifications, install the new sensor assembly in the engine according to the following procedure:

     a. Loosen the bolt and remove the bolt that holds the sensor to the engine.

     b. Ensure that an O-ring is installed on the new sensor assembly. Verify that the O-ring is free of damage.

     c. Prior to installation, lubricate the O-ring with clean engine oil.

     d. Seat the sensor and tighten the bolt.

        If the sensor will not seat, replace the sensor.

     e. Ensure that the harness is secured in the proper location.

  2. Verify that the repair eliminates the problem.

  STOP.

i02410343

Engine Temperature Sensor Open or Short Circuit - Test

SMCS Code: 1439-038-TA; 1906-038

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the following sensors:

- Intake manifold air temperature sensor
- Engine coolant temperature sensor
- Fuel temperature sensor
- Engine oil 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
- 175-03 Engine Oil Temperature open/short to +batt
- 175-04 Engine Oil Temperature 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 a problem 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 OK. If the sensor is disconnected at the sensor connector, the absence of pull-up voltage at the sensor connector indicates a problem in the signal wire. 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.

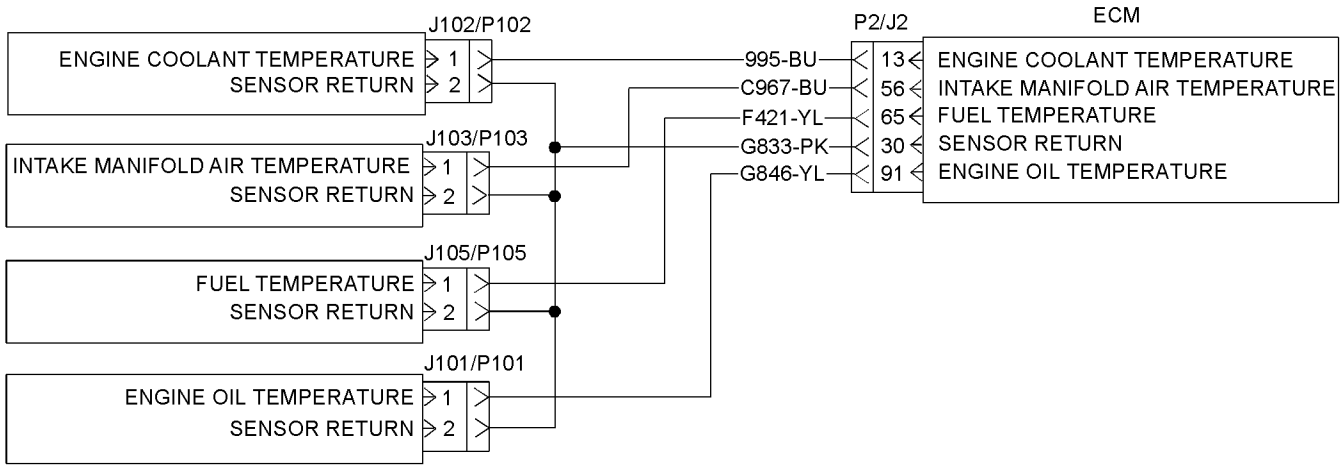


Illustration 71 g01204636

Schematic for the engine temperature sensors

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove electrical power from the ECM.

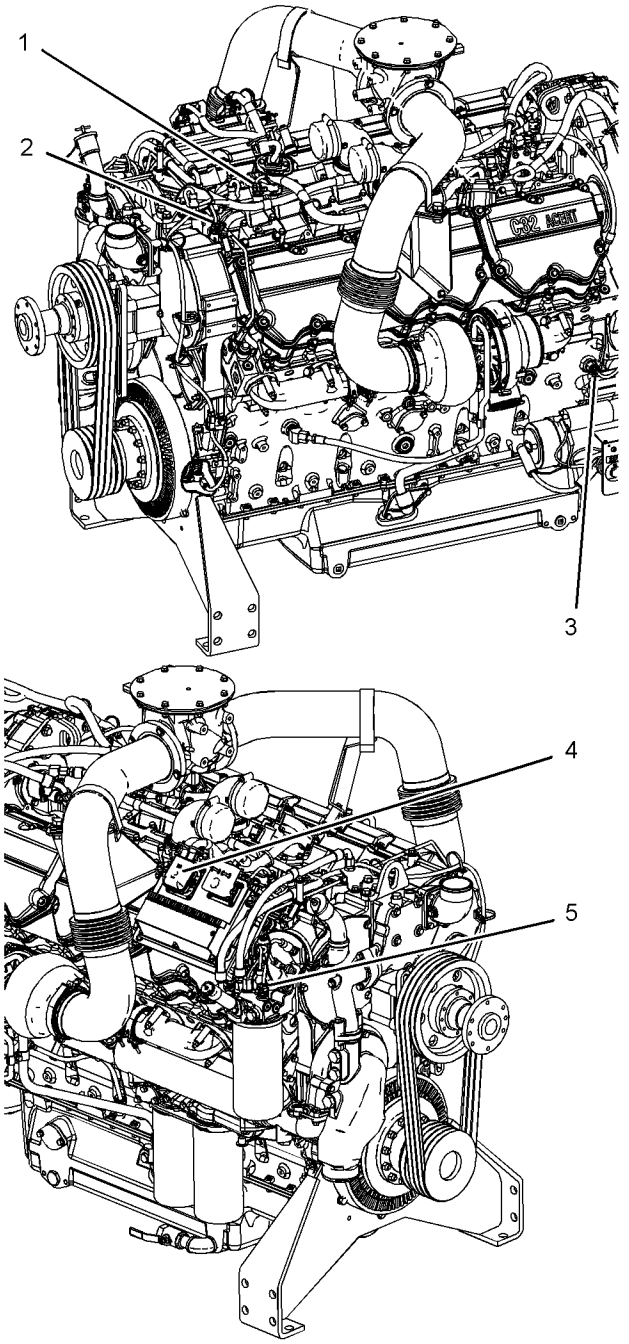


Illustration 72 g01204650

Left side engine view (typical example)

(1) Intake manifold air temperature sensor
(2) Engine coolant temperature sensor
(3) Engine oil temperature sensor
(4) J2/P2 ECM connectors
(5) Fuel temperature sensor

B. Thoroughly inspect the connectors for sensors (1), (2), (3) and (5). Also, thoroughly inspect ECM connectors (4). Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

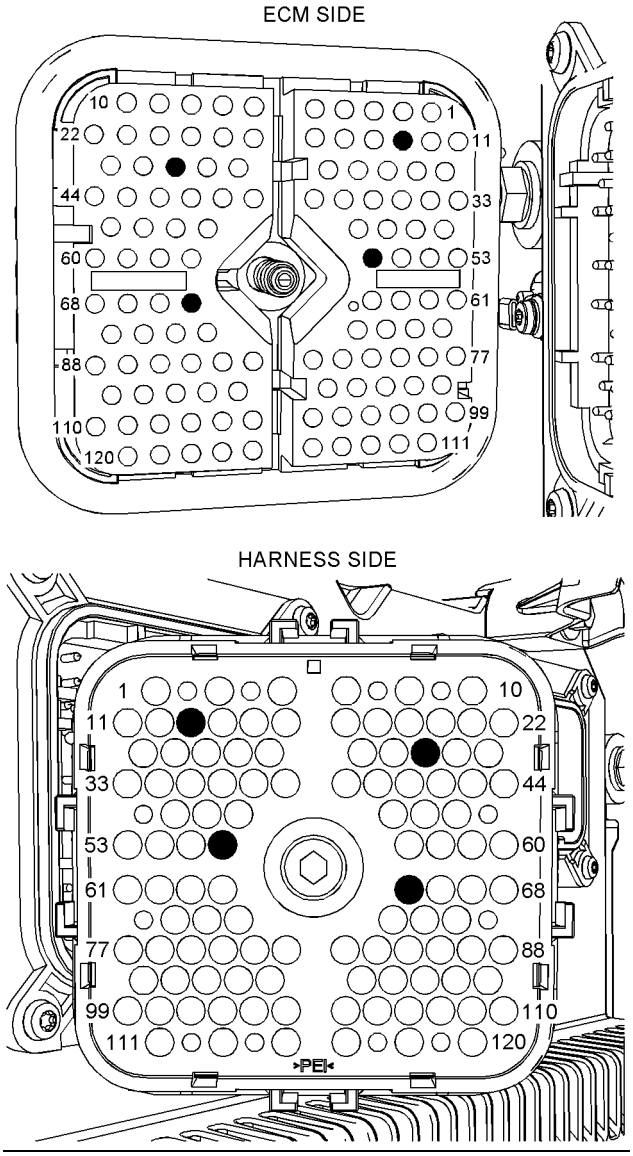


Illustration 73 g01223584

P2 ECM connector

(P2-13) Engine coolant temperature
(P2-30) Sensor return
(P2-56) Intake manifold air temperature
(P2-65) Fuel temperature

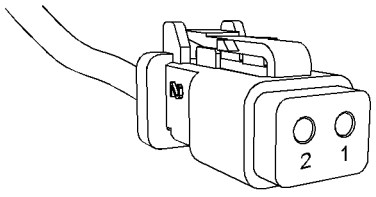


Illustration 74 g01155187

Connector for the temperature sensors

(1) Sensor signal
(2) Sensor return

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 for each of the ECM connectors for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for correct torque values.

E. 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 appear to be 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 Caterpillar Electronic Technician (ET) to the service tool connector.

B. Restore electrical power to the ECM.

C. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

Note: Wait at least 30 seconds in order for the diagnostic codes to become active.

D. Look for an active 03 or 04 diagnostic code.

Expected Result:

No diagnostic codes are active.

Results:

- OK – No diagnostic codes are active.

  Repair: The problem appears to be resolved. 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 – A 03 diagnostic code is active at this time. The ECM detects an open circuit condition. Proceed to Test Step 4.
- Not OK – A 04 diagnostic code is active at this time. The ECM detects a short circuit condition. Proceed to Test Step 3.

Test Step 3. Create an Open Circuit by Disconnecting the Sensor Connector

A. Remove electrical power from the ECM.

B. Disconnect the suspect sensor from the harness at the sensor connector.

C. Restore electrical power to the ECM.

D. Access the “Active Diagnostic Codes” screen on Cat ET. Check for an active 03 diagnostic code for the suspect sensor.

Note: Wait at least 30 seconds for activation of the diagnostic codes.

E. Remove electrical power from the ECM.

Expected Result:

A 03 diagnostic code is now active for the suspect sensor.

Results:

- OK – A 03 diagnostic code became active after the sensor was disconnected.

  Repair: There may be a problem with the sensor. 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 04 diagnostic code is still present while the sensor is disconnected from the harness. The sensor is OK. There is a problem in the harness between the ECM and the sensor connector. There may be a problem with the ECM. Leave the suspect sensor disconnected. Proceed to Test Step 5.

Test Step 4. Short at the Suspect Sensor at the Harness Connector

A. Remove electrical power from the ECM.

B. Disconnect the suspect sensor at the harness connector.

C. Fabricate a jumper wire that is long enough to short circuit the two terminals at the connector for the suspect sensor. Crimp connector pins to each end of the jumper wire.

D. Install the jumper wire between terminal 1 (sensor signal) and terminal 2 (sensor return) on the harness side of the suspect sensor's connector.

E. Restore electrical power to the ECM.

F. Monitor the "Active Diagnostic Codes" screen on Cat ET after installing the jumper wire. Check for an active 04 diagnostic code.

Note: Wait at least 30 seconds for activation of the 04 diagnostic code.

G. Remove electrical power from the ECM.

Expected Result:

A 04 diagnostic code is now active for the suspect sensor.

Results:

- OK – A 04 diagnostic code is active when the jumper wire is installed.

  Repair: There may be a problem with the sensor. 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. There may be a problem with the ECM. Proceed to Test Step 5.

Test Step 5. Check the Operation of the ECM

A. Remove electrical power from the ECM.

B. Check the operation of the ECM by creating an open at the ECM:

  a. Disconnect the J2/P2 ECM connector.

  b. Fabricate a jumper wire that is long enough to create a test circuit from the ECM connector to the engine ground stud. Crimp a connector socket to one end of the jumper wire.

  c. Remove the signal wire for the suspect sensor from the J2/P2 ECM connector. Install the jumper wire into this terminal location.

  d. Connect the ECM connectors.

  Hold the loose end of the jumper wire away from any ground source in order to create an open circuit condition.

  e. Restore electrical power to the ECM.

  f. Monitor the "Active Diagnostic Code" screen on Cat ET. A 03 diagnostic code will become active for the suspect sensor.

Note: Wait at least 30 seconds for activation of the code.

  g. Remove electrical power from the ECM.

C. Check the operation of the ECM by creating a short at the ECM.

  a. Connect the loose end of the jumper wire to the engine ground stud in order to create a short circuit condition.

  b. Restore electrical power to the ECM.

  c. Monitor the "Active Diagnostic Code" screen on Cat ET. A 04 diagnostic code will become active when the jumper wire is grounded.

Note: Wait at least 30 seconds for activation of the code.

  d. Remove electrical power from the ECM.

D. Restore all wiring to the original configuration.

Expected Result:

A 04 diagnostic code becomes active when the signal wire is shorted to the engine ground stud.

Results:

- OK – A 03 diagnostic code is active when the signal wire is open. A 04 diagnostic code is active when the signal wire is shorted to ground.

Repair: The ECM is working properly. The problem is in the wiring harness between the ECM and the sensor connector. Repair the harness and/or the connectors. Replace parts, if necessary.

STOP.

- Not OK – One of the following conditions exists: The 03 diagnostic code is not active when the sensor signal wire is open. The 04 diagnostic code is not active when the wire jumper is shorted to ground.

  Repair: There is a problem with the ECM. Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”.

  STOP.

i02414006

Ether Injection System - Test

SMCS Code: 1456-038

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the ether injection system.

The ether injection system is used as starting aid for the engine. The ether injection system can operate in auto mode, or manual mode. Auto mode is the normal setting for the system.

When the ether injection system is in auto mode, the Electronic Control Module (ECM) controls the ether injection system.

The ether injection system can also be operated in manual mode when the auto/manual switch is held in the ON position (momentary contact). The ether system is switched into manual mode whenever the auto/manual switch is depressed. Manual mode allows ether to be injected whenever the coolant temperature is less than 18 °C (64 °F) and engine rpm is greater than 50 rpm. The manual mode will inject ether for a duration that is dependent on the coolant temperature. The manual ether injection system is disabled whenever engine rpm exceeds 400 rpm or the engine coolant temperature exceeds 18 °C (64 °F).

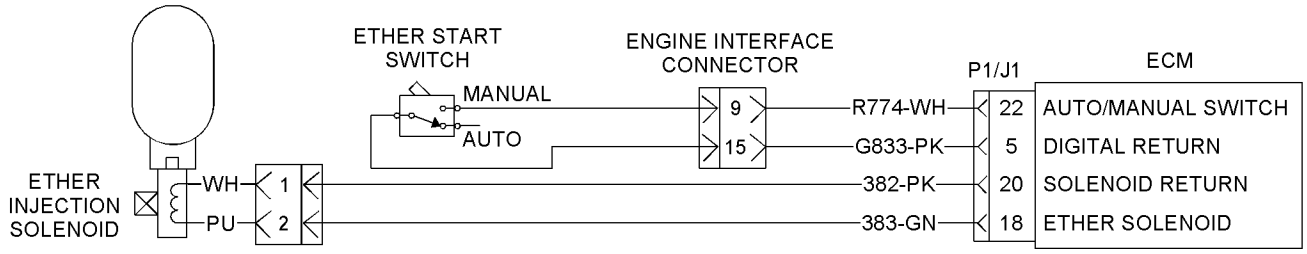


Illustration 75 g01206657

Schematic for the ether injection system

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove electrical power from the ECM.

⚠ WARNING

Breathing ether vapors or repeated contact of ether with skin can cause personal injury. Personal injury may occur from failure to adhere to the following procedures.

Use ether only in well ventilated areas.

Do not smoke while changing ether cylinders.

Use ether with care to avoid fires.

Do not store replacement ether cylinders in living areas or in the operator's compartment.

Do not store ether cylinders in direct sunlight or at temperatures above 49 °C (120 °F).

Discard cylinders in a safe place. Do not puncture or burn cylinders.

Keep ether cylinders out of the reach of unauthorized personnel.

To avoid possible injury, be sure the brakes are applied and all controls are in Hold or Neutral when starting the engine.

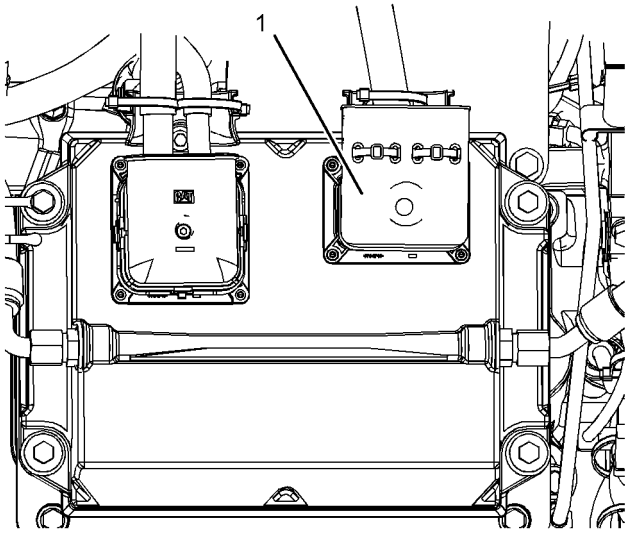


Illustration 76 g01167488

Location of the J1/P1 ECM connector (typical engine view)

(1) J1/P1 ECM connectors

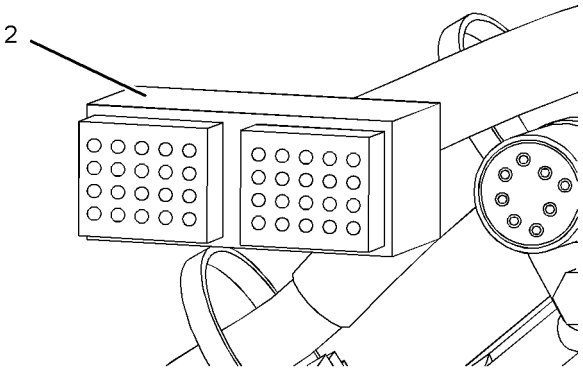


Illustration 77 g01210753

Location of the engine interface connector (typical engine view)

(2) Engine interface connector

B. Thoroughly inspect connectors (1) and (2). Also, thoroughly inspect all of the other connectors that are in the circuit. Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect” for details.

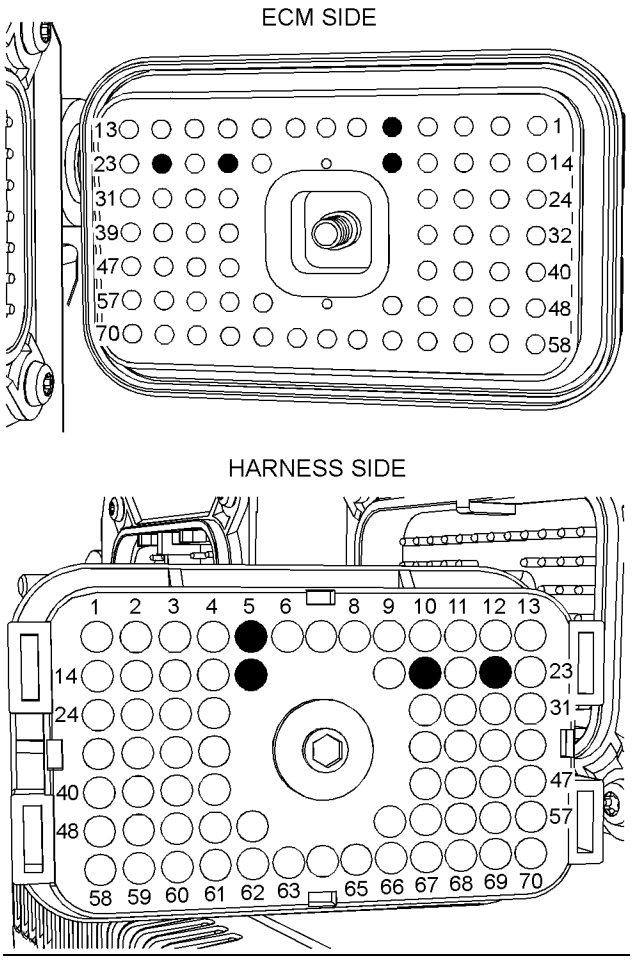


Illustration 78 g01210663

Terminal locations at the P1 ECM connector

(P1-5) Digital return
(P1-18) Ether solenoid
(P1-20) Solenoid return
(P1-22) Auto/manual switch

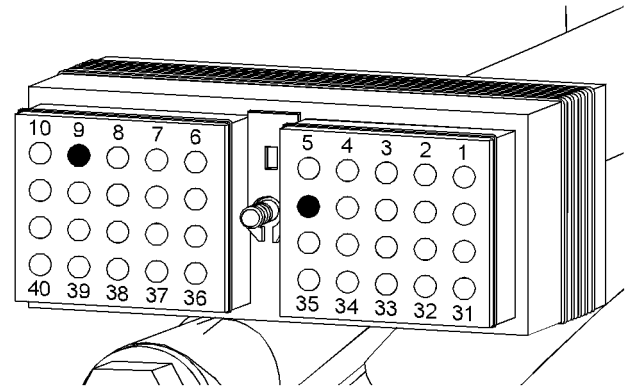


Illustration 79 g01210754

Terminal locations for the auto/manual switch at the engine interface connector

(9) Auto/manual switch
(15) Digital return

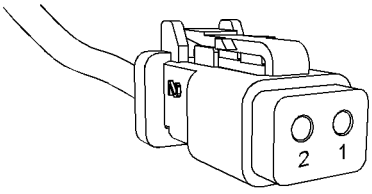


Illustration 80 g01155187

Terminal locations at the ether solenoid

(1) Solenoid return
(2) Ether solenoid

C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the circuit.

D. Check the allen head screw for each of the ECM connectors for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for correct torque values.

E. Check the harness and the wiring for abrasion and for pinch points.

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 appear to be OK. Proceed to Test Step 2.
- Not OK – There is a problem with the electrical 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.

STOP.

Test Step 2. Check the Ether Canisters for Fluid

A. Ensure that the electrical power is removed from the ECM.

B. Remove the ether canister from the ether valve.

C. Determine if the canister is empty.

Expected Result:

The ether canister is not empty.

Results:

- OK – The ether canister is not empty. Remove the ether canister from the ether valve for the remainder of this test. Proceed to Test Step 3.
- Not OK – The ether canister is empty.

  Repair: Replace the empty ether canister with a full ether canister. Retry the system.

  STOP.

Test Step 3. Use Cat ET to Check the Operation of the Auto/Manual Switch Circuit

A. Connect Caterpillar Electronic Technician (ET) to the service tool connector.

B. Select the “Status” screen on Cat ET.

C. Restore the electrical power to the ECM.

D. Toggle the auto/manual switch from the AUTO position to the MANUAL position.

E. Observe the status of the “Ether Switch” on Cat ET.

F. Remove electrical power from the ECM.

Expected Result:

The “Ether Switch” status changes from “Auto” to “Manual” as the switch is toggled.

Results:

- OK – The “Ether Switch” status changes correctly. The auto/manual switch circuit is OK. Proceed to Test Step 6.
- Not OK – The “Ether Switch” status does not change from “Auto” to “Manual” as the switch is toggled. There appears to be a problem with the switch or the switch circuit. Proceed to Test Step 4.

Test Step 4. Check the Operation of the Auto/Manual Switch

A. Fabricate a jumper wire that can be used to create a short circuit across the terminal locations of the connector for the auto/manual switch. Crimp connector sockets to each end of the jumper wire.

B. Install the jumper wire between the terminals of the connector for the auto/manual switch.

C. Restore the electrical power to the ECM.

D. Observe the status of the “Ether Switch” on Cat ET.

E. Remove the jumper wire from the connector for the auto/manual switch.

F. Observe the status of the “Ether Switch” on Cat ET.

G. Remove electrical power from the ECM.

Expected Result:

The status for the “Ether Switch” changes from “Manual” to “Auto” as the jumper wire is removed.

Results:

- OK – The status for the “Ether Switch” changes from “Manual” to “Auto”.

  Repair: There is a problem with the auto/manual switch. Replace the switch.

  STOP.

- Not OK – The status for the “Ether Switch” changes from “Manual” to “Auto” as the jumper wire is removed. There is a problem in the harness between the ECM and the auto/manual switch. There may be a problem with the ECM. Proceed to Test Step 5.

Test Step 5. Check the Operation of the ECM

A. Fabricate two jumper wires that are long enough to create a short circuit between terminal locations at the ECM connector. Crimp a connector socket to one end of each of the jumper wires.

B. Disconnect the J1/P1 ECM connectors.

C. Remove the wires from terminal locations P1-5 (digital return) and P1-22 (auto/manual switch) at the ECM connector. Install the jumper wires into these terminal locations.

D. Connect the J1/P1 ECM connector.

E. Restore the electrical power to the ECM.

Note: Ensure that the loose ends of the jumper wires are creating an open circuit at the ECM. Do not allow the jumper wires to contact a ground source or each other during the test.

F. Observe the status of the “Ether Switch” on Cat ET.

G. Connect the loose ends of the jumper wire in order to create a short in the circuit at the ECM connector.

H. Observe the status of the “Ether Switch” on Cat ET.

I. Restore the wiring to the original configuration.

Expected Result:

The status of the “Ether Switch” changes from “Auto” to “Manual” during the test.

Results:

- OK – The status of the “Ether Switch” changes from “Auto” to “Manual” during the test. The ECM is OK. The problem is in the harness between the ECM and the auto/manual switch. The problem may be in a connector. Repair the harness and/or the connector. Replace parts, if necessary. Verify that the original problem is resolved.

- Not OK – The status for the auto/manual switch does not change from “Auto” to “Manual” during the test.

  Repair: The ECM is not reading the switch input. Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”.

  STOP.

Test Step 6. Check the Voltage at the Starting Aid Solenoid

A. Disconnect the connector for the starting aid solenoid.

B. Connect a voltmeter between terminals 1 and 2 on the harness side of the connector.

C. Restore the electrical power to the ECM.

D. Select the “Override Parameters” option from the “Diagnostic Tests” on Cat ET.

E. Activate the override for “Ether Injection”.

F. Measure the voltage at the connector for the starting aid solenoid valve.

Note: The ether override will activate the solenoid for ten seconds. The measurement must be taken within this time period.

G. Remove electrical power from the ECM.

H. Restore the wiring to the original configuration.

Expected Result:

The voltage at the ether solenoid is 24 ± 3 VDC.

Results:

- OK – The voltage at the connector for the ether solenoid is 24 ± 3 VDC.

  Repair: Control input voltage is present at the connector for the starting aid solenoid. There is a problem with the ether solenoid. Replace the ether solenoid.

  STOP.

- Not OK – The voltage at the ether solenoid is not 24 ± 3 VDC. There is a problem in the harness between the ECM and the starting aid solenoid. There may be a problem with the ECM. Proceed to Test Step 7.

Test Step 7. Check the Operation of the ECM

A. Fabricate two jumper wires that are long enough to create a test circuit at the ECM connector. Crimp a connector socket to one end of each of the jumper wires.

B. Disconnect the J1/P1 ECM connectors.

C. Remove the wires from terminal locations P1-18 (ether solenoid) and P1-20 (solenoid return) at the ECM connector. Install a wire jumper into each of these terminal locations.

D. Connect the J1/P1 ECM connector.

E. Connect a voltmeter between the loose ends of the wire jumpers at the P1 ECM connector.

F. Restore the electrical power to the ECM.

G. Select the “Override Parameters” option from the “Diagnostic Tests” on Cat ET.

H. Activate the override for “Ether Injection”.

I. Measure the voltage at the connector for the starting aid solenoid valve.

Note: The ether override will activate the solenoid for ten seconds. The measurement must be taken within this time period.

J. Remove electrical power from the ECM.

K. Restore the wiring to the original configuration.

Expected Result:

The voltage measured 24 ± 3 VDC.

Results:

- OK – The voltage measured 24 ± 3 VDC. The output driver for the ether relay at the ECM is OK. The problem is in the harness from the ECM to the solenoid valve. The problem may be in a connector. Repair the harness and/or the connector. Replace parts, if necessary. Verify that the problem is resolved.
- Not OK – The voltage at the ECM is not 24 ± 3 VDC.

  Repair: The ECM is not providing voltage to the circuit for the ether solenoid. Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”.

  STOP.

i02450738

Fuel Filter Differential Pressure Switch Circuit - Test

SMCS Code: 1435-038-FI

System Operation Description:

Perform this procedure if you suspect that there is a problem in the circuit for the fuel filter differential pressure switch.

This procedure covers the following event codes:

- E390-1 Fuel Filter Restriction Warning
- E390-2 Fuel Filter Restriction Derate
- E390-3 Fuel Filter Restriction Shutdown

The fuel filter differential pressure switch is used to detect excessive restriction in the fuel filter. The switch is normally closed. When the fuel pressure at the switch reaches 103 ± 14 kPa (15 ± 2 psi) the switch will open. The switch is used in order to detect a plugged fuel filter element. The Electronic Control Module (ECM) will alert the operator of the condition. Use this test in order to verify that the fuel filter differential pressure switch is operating correctly.

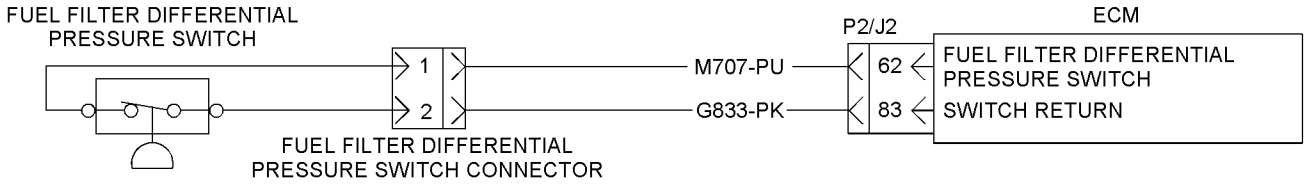


Illustration 81 g01223587

Schematic for fuel filter differential pressure switch

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove electrical power from the ECM.

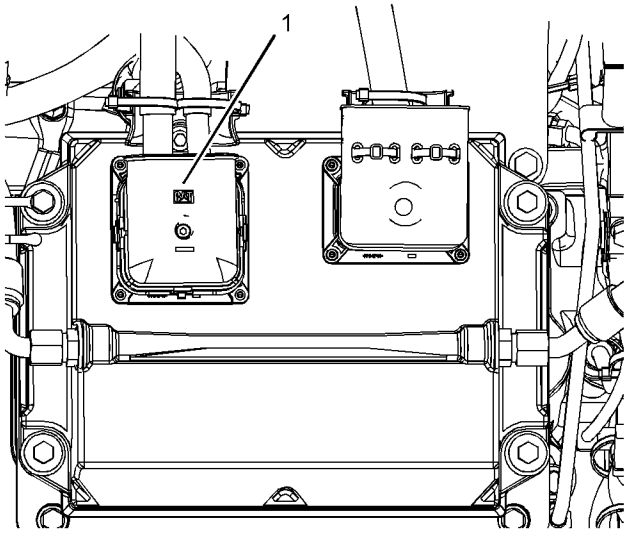


Illustration 82 g01214446

Left side engine view (typical example)

(1) J2/P2 ECM connectors

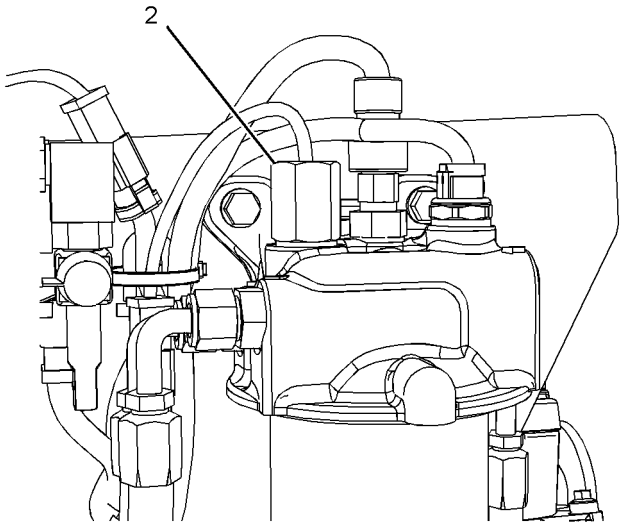


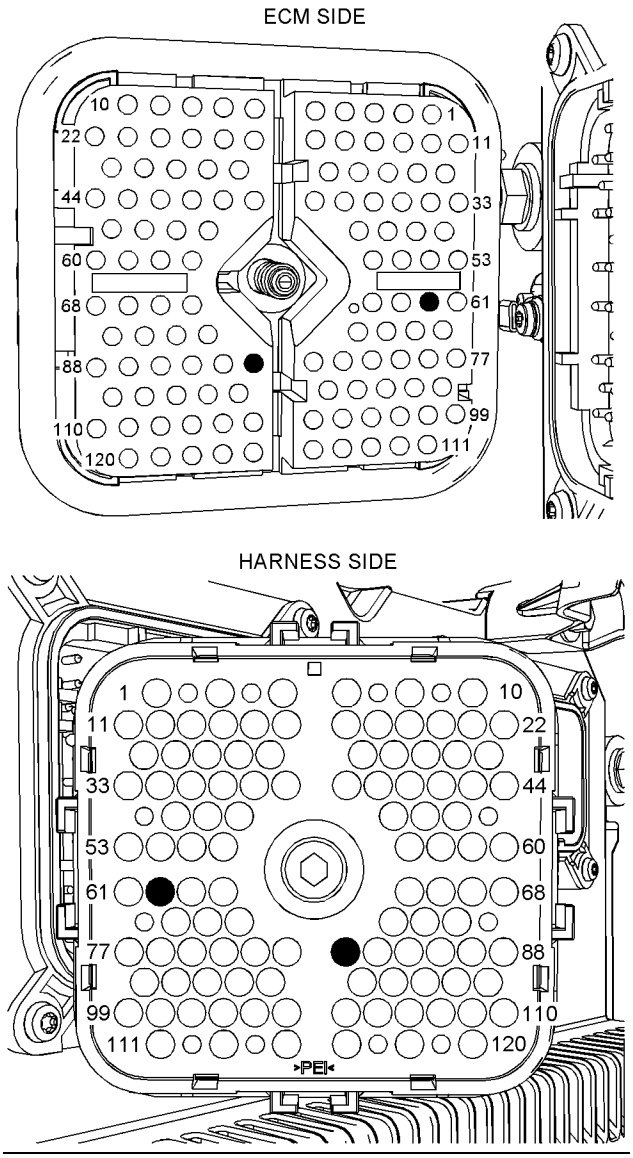
Illustration 83 g01161069

Fuel filter base (typical example)

(2) Fuel filter differential pressure switch

B. Thoroughly inspect connectors (1). Also, thoroughly inspect each connector for switch (2).

Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect” for details.

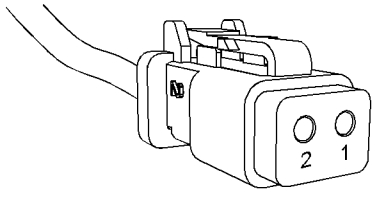


g01223593

Illustration 84

P2 ECM connector

(P2-62) Fuel filter differential pressure switch
(P2-83) Signal return



g01155187

Illustration 85

Connector for the fuel filter differential pressure switch

(Terminal 1) Fuel filter differential pressure switch
(Terminal 2) Signal return

C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector and the sensor connectors that are associated with the active diagnostic code.

D. Check the allen head screw of each ECM connector for the proper torque. Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect” for the correct torque value.

E. Check the harness and wiring for abrasions and for pinch points from the switch 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 appear to be 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 Switch Circuit at the Harness Connector

A. Fabricate a jumper wire that is long enough to short circuit the terminals at the harness connector for the fuel filter differential pressure switch. Crimp connector pins to each end of the jumper wire.

B. Disconnect the connector for the fuel filter differential pressure switch from the harness. Install the jumper wire across the terminals on the harness side of this connector.

C. Start the engine. Increase the engine speed to high idle.

D. Check for an event code for the engine fuel filter restriction.

E. Shut down the engine. Remove electrical power from the ECM.

Expected Result:

The event code is not active.

Results:

- OK – The event code is not active.

  Repair: The wiring between the connector and the ECM is OK. Replace the fuel filter element. Restart the engine and check for an event code. If the event code is still active, temporarily replace the fuel filter differential pressure switch. Verify that the problem is resolved before permanently replacing the fuel filter differential pressure switch.

  STOP.

- Not OK – The event code is still active. There is an open circuit in the wiring for the fuel filter differential pressure switch between the connector for the fuel filter differential pressure switch and the ECM. There may be a problem with the ECM. Connect the connector for the pressure switch. Proceed to Test Step 3.

Test Step 3. Check the ECM

A. Disconnect the J2/P2 ECM connector.

B. Fabricate a jumper wire that is long enough to create a short between the P2 ECM connector and the engine ground stud. Crimp a connector socket to one end of the jumper wire.

C. Remove the wire from terminal location P2-62 (fuel filter differential pressure switch) at the ECM connector. Install the jumper wire into the terminal location.

D. Secure the other end of the jumper wire to the engine ground stud.

E. Start the engine. Increase the engine speed to high idle.

F. Check for an event code for the engine fuel filter restriction.

G. Shut down the engine. Remove electrical power from the ECM.

Expected Result:

The event code is not active.

Results:

- OK – The event code is not active.

  Repair: The problem is in the harness wiring between the connector for the fuel filter differential pressure switch and the P2 ECM connector. Check the harness connector to the fuel filter differential pressure switch for a good connection. Repair the connectors or wiring and/or replace the connectors or wiring. Verify that the repair eliminates the problem.

  STOP.

- Not OK – The event code is still active.

  Repair: There is a problem with the ECM. Replace the ECM. Refer to electronic troubleshooting Troubleshooting, “Replacing the ECM”. Verify that the problem is resolved.

  STOP.

i02450744

Injector Solenoid Circuit - Test

SMCS Code: 1290-038

System Operation Description:

Use this procedure for the following conditions:

- A suspected problem with an injector solenoid
- You have been directed to this procedure from Troubleshooting, “Troubleshooting without a Diagnostic Code”.
- There is an active diagnostic code for an injector solenoid.

Use this procedure for the following diagnostic codes:

- 1-05 Cylinder #1 Injector open circuit
- 1-06 Cylinder #1 Injector short
- 2-05 Cylinder #2 Injector open circuit
- 2-06 Cylinder #2 Injector short
- 3-05 Cylinder #3 Injector open circuit
- 3-06 Cylinder #3 Injector short
- 4-05 Cylinder #4 Injector open circuit
- 4-06 Cylinder #4 Injector short
- 5-05 Cylinder #5 Injector open circuit
- 5-06 Cylinder #5 Injector short
- 6-05 Cylinder #6 Injector open circuit

- 6-06 Cylinder #6 Injector short
- 7-05 Cylinder #7 Injector open circuit
- 7-06 Cylinder #7 Injector short
- 8-05 Cylinder #8 Injector open circuit
- 8-06 Cylinder #8 Injector short
- 9-05 Cylinder #9 Injector open circuit
- 9-06 Cylinder #9 Injector short
- 10-05 Cylinder #10 Injector open circuit
- 10-06 Cylinder #10 Injector short
- 11-05 Cylinder #11 Injector open circuit
- 11-06 Cylinder #11 Injector short
- 12-05 Cylinder #12 Injector open circuit
- 12-06 Cylinder #12 Injector short

Perform this procedure under conditions that are identical to the conditions that exist when the problem occurs. Typically, problems with the injector solenoid occur when the engine is warmed up 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 high voltage signal to each injector solenoid. The signal is sent with the proper injection duration and injection timing for the current engine load and speed. The injector solenoid is mounted on top of the fuel injector body.

If an open circuit condition is detected in the solenoid circuit, a diagnostic code is generated. The ECM will continue to try to fire the injector. If a short circuit condition 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 condition remains, this sequence of events will be repeated until the problem is corrected.

Note: Refer to Illustration 86. Two injector solenoids share a supply wire. For this reason, an open circuit or a short circuit in a supply wire could cause diagnostic codes for two injector solenoids.

When an injector is replaced, new injector trim files must be programmed into the ECM. If the ECM is replaced, all injector trim files must be programmed into the new ECM. Refer to Troubleshooting, “Injector Trim File” for more information.

The Caterpillar Electronic Technician (ET) includes the following tests that aid in troubleshooting the injector solenoids:

“Cylinder Cutout Test”

The “Cylinder Cutout Test” is used on an engine in order to determine the individual cylinder performance while the engine is running. As one or more cylinders are cut out during the test, the “Cylinder Cutout Test” uses “Fuel Position” in order to evaluate the performance of the cylinders that are cut out. As the different cylinders are cut out, a comparison of the change in “Fuel Position” is used to identify cylinders that are weak or misfiring. One reason for a cylinder that is weak or misfiring is an injector that is malfunctioning.

The “Cylinder Cutout Test” can be used to isolate a malfunctioning injector in order to avoid replacement of injectors that are in good condition.

During the test, when a cylinder is cut out, an increase in “Fuel Position” will be noticed for the remaining cylinders. This increase in “Fuel Position” represents an increase in the amount of fuel that must be delivered by the remaining cylinders in order to maintain the desired engine speed.

When a weak cylinder (malfunctioning injector) is cut out, the increase in “Fuel Position” will not be as large as the increase for a cylinder that has an acceptable level of performance.

Note: Prior to running the “Cylinder Cutout Test”, all active diagnostic codes must be repaired.

“Injector Solenoid Test”

Use the “Injector Solenoid Test” to diagnose an open circuit or a short circuit in the wiring for the injector solenoids. With the engine stopped, the “Injector Solenoid Test” will briefly activate each injector solenoid. An audible click can be heard as each solenoid is activated. After performing the test, Cat ET will indicate the status of the solenoid as “OK”, “Open”, or “Short”.

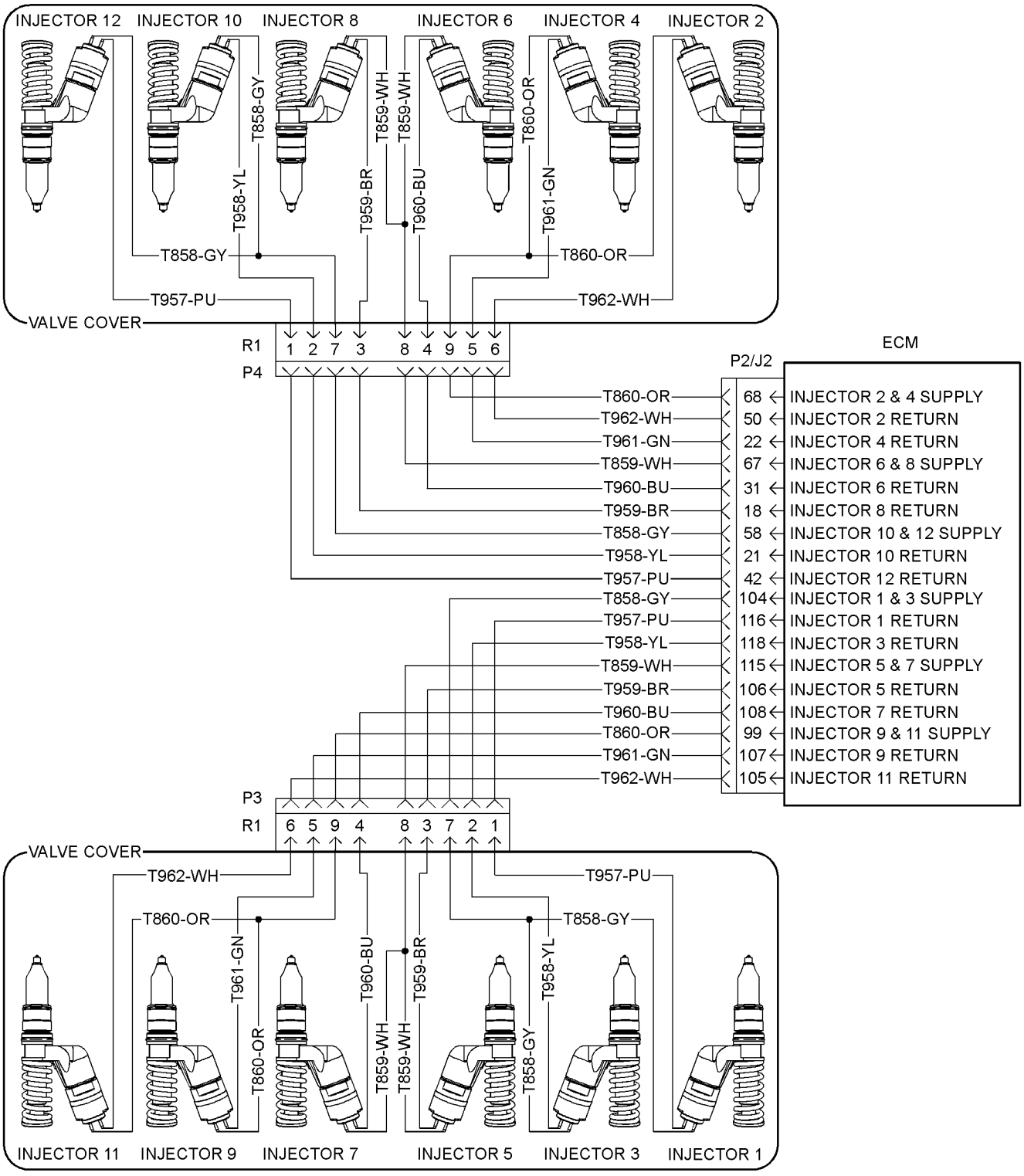


Illustration 86 g01223595

Schematic for the injector solenoids

Test Step 1. Inspect the Electrical Connectors and the Wiring

⚠ WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

A. Remove the electrical power from the ECM.

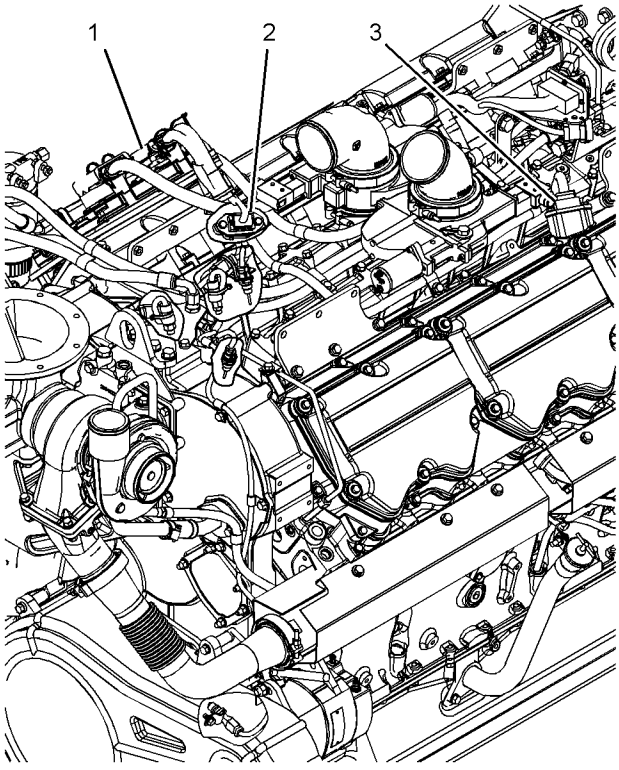


Illustration 87 g01166729

Left side engine view (typical example)

(1) J2/P2 ECM connectors
(2) R1/P3 Injector valve cover entry connectors (right bank)
(3) R1/P4 Injector valve cover entry connectors (left bank)

B. Thoroughly inspect connectors (1), (2), and (3). Refer to Troubleshooting, “Electrical Connectors - Inspect”.

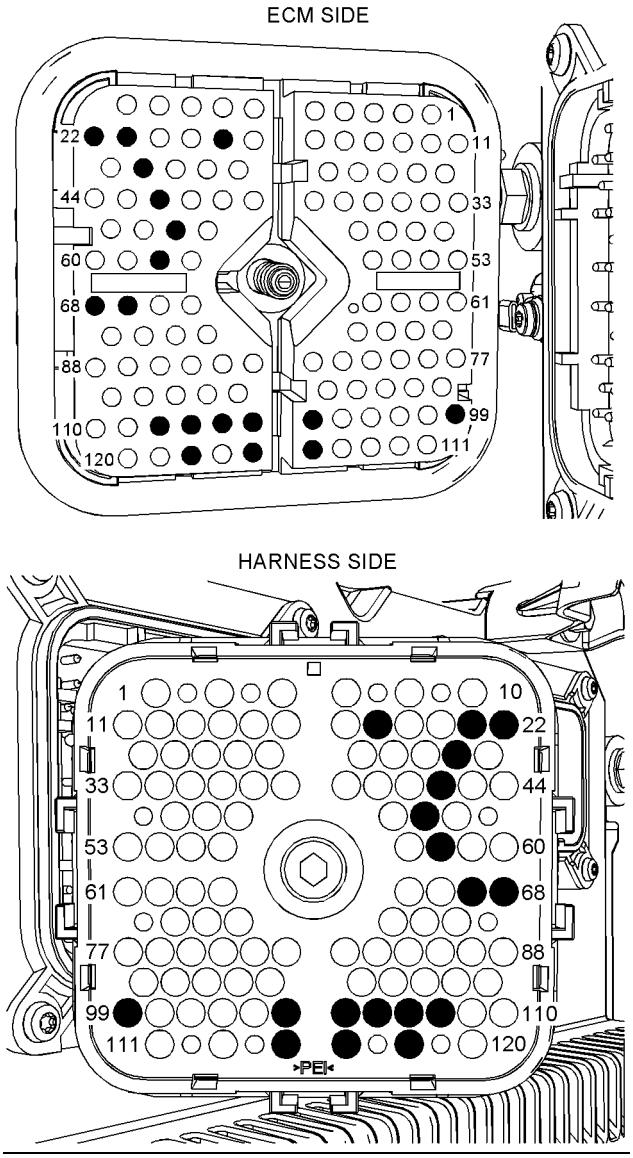


Illustration 88 g01202827

P2 terminals that are associated with the injector solenoids

(P2-18) Injector 8 return
(P2-21) Injector 10 return
(P2-22) Injector 4 return
(P2-31) Injector 6 return
(P2-42) Injector 12 return
(P2-50) Injector 2 return
(P2-58) Injectors 10 & 12 supply
(P2-67) Injectors 6 & 8 supply
(P2-68) Injectors 2 & 4 supply
(P2-99) Injectors 9 & 11 supply
(P2-104) Injectors 1 & 3 supply
(P2-105) Injector 11 return
(P2-106) Injector 5 return
(P2-107) Injector 9 return
(P2-108) Injector 7 return
(P2-115) Injectors 5 & 7 supply
(P2-116) Injector 1 return
(P2-118) Injector 3 return

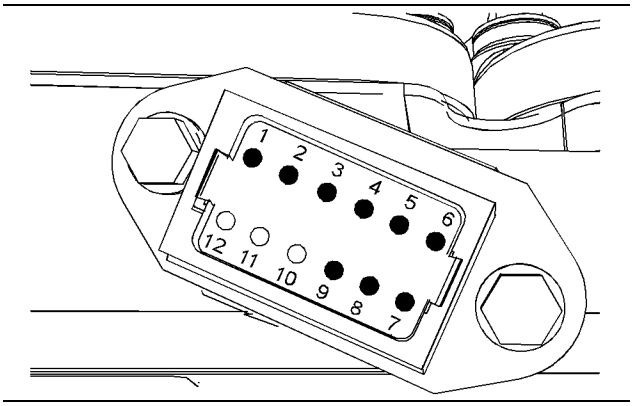


Illustration 89 g01161232

P4 terminals that are associated with the injector solenoids

(P4-1) Injector 12 return
(P4-2) Injector 10 return
(P4-3) Injector 8 return
(P4-4) Injector 6 return
(P4-5) Injector 4 return
(P4-6) Injector 2 return
(P4-7) Injectors 10 & 12 supply
(P4-8) Injectors 6 & 8 supply
(P4-9) Injectors 2 & 4 supply

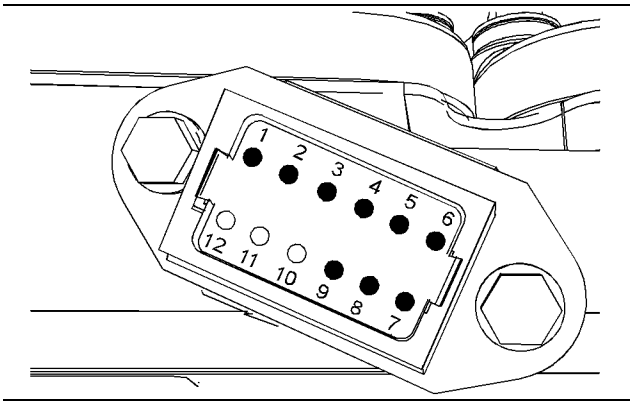


Illustration 90 g01161232

P3 terminals that are associated with the injector solenoids

(P3-1) Injector 1 return
(P3-2) Injector 3 return
(P3-3) Injector 5 return
(P3-4) Injector 7 return
(P3-5) Injector 9 return
(P3-6) Injector 11 return
(P3-7) Injectors 1 & 3 supply
(P3-8) Injectors 5 & 7 supply
(P3-9) Injectors 9 & 11 supply

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 the wiring for abrasion and for pinch points from each P300 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 harnesses and the wiring appear to be 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 for the Injector Solenoids

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

B. Restore the electrical power to the ECM.

C. Check Cat ET for logged diagnostic codes related to the injector solenoids.

Expected Result:

There are no logged diagnostic codes for the injector solenoids .

Results:

- OK – No diagnostic codes for the injector solenoids are logged. The injector solenoids are operating correctly. There may be a mechanical problem with the injector’s fuel delivery. Proceed to Test Step 3.
- Not OK – A diagnostic code is logged for one or more injector solenoid. There is an electrical problem with an injector solenoid or with the circuit. Proceed to Test Step 4.

Test Step 3. Perform the “Cylinder Cutout Test”

A. Start the engine.

B. Allow the engine to warm up to normal operating temperature 77 °C (171 °F).

C. Access the “Cylinder Cutout Test” by accessing the following display screens:

- “Diagnostics”
- “Diagnostic Tests”
- “Cylinder Cutout Test”

D. Shut off all parasitic loads such as air compressors which could affect the results of the test.

E. Follow the instructions that are given on the screen.

F. To start the test, select the start button at the bottom of the screen.

G. Use Cat ET to manually cut out the cylinders in order to identify injectors that may have a performance problem. Highlight a cylinder and select the “Change” button at the bottom of the screen. The injector for that cylinder will be disabled. Check for a difference in the sound, feel, or power of the engine. Also, look for a change to the operating parameters that are displayed on the “Cylinder Cutout Test” screen.

Expected Result:

The cylinder cutout test indicates that all of the injectors are operating correctly.

Results:

- OK – The cylinder cutout test indicates that all of the injectors are operating correctly.

  Repair: If a problem with the fuel system is suspected and diagnostic codes are not active or logged, refer to Systems Operation/Testing and Adjusting for information that is related to the low pressure fuel system.

  STOP.

- Not OK – The cylinder cutout test indicates that at least one of the injectors is not operating correctly. Proceed to Test Step 4.

Test Step 4. Perform the “Injector Solenoid Test”

A. Start the engine.

B. Allow the engine to warm up to normal operating temperature 77 °C (171 °F).

C. Stop the engine.

D. Restore the electrical power to the ECM.

E. Access the “Injector Solenoid Test” by accessing the following display screens:

- “Diagnostics”
- “Diagnostic Tests”
- “Injector Solenoid Test”

F. Activate the “Injector Solenoid Test”.

G. As each solenoid is energized by the ECM, an audible click can be heard at the valve cover. Allow the “Injector Solenoid Test” to continue until each cylinder is activated at least two times.

Expected Result:

All cylinders indicate “OK” on Cat ET.

Results:

- OK – There is not an electronic problem with the injectors at this time.

  Repair: The problem appears to be resolved. There may be an intermittent problem in the harness. The problem may have been caused by a poor electrical connection in a connector.

  If the codes continue to be logged, refer to Troubleshooting, “Electrical Connectors - Inspect”.

  If the engine is misfiring or if the engine has low power, refer to Troubleshooting, “Engine Misfires, Runs Rough or Is Unstable” or Troubleshooting, “Low Power/Poor or No Response to Throttle”.

  STOP.

- Not OK - “Open” – Note the cylinder that indicates “Open”. Proceed to Test Step 5.

- Not OK - “Short” – Note the cylinder that indicates “Short”. Proceed to Test Step 6.

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. Remove the electrical power from the ECM.

B. Disconnect the appropriate P300 connector at the valve cover base.

C. Restore the electrical power to the ECM.

D. Fabricate a jumper wire that will be long enough to short circuit two terminal locations at the P300 connector. Crimp connector pins to both ends of the jumper wire.

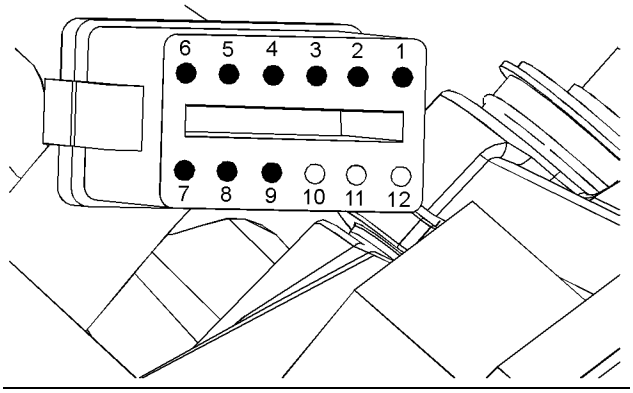


Illustration 91 g01203187

P4 terminals that are associated with the injector solenoids (harness side of connector)

(P4-1) Injector 12 return
(P4-2) Injector 10 return
(P4-3) Injector 8 return
(P4-4) Injector 6 return
(P4-5) Injector 4 return
(P4-6) Injector 2 return
(P4-7) Injectors 10 & 12 supply
(P4-8) Injectors 6 & 8 supply
(P4-9) Injectors 2 & 4 supply

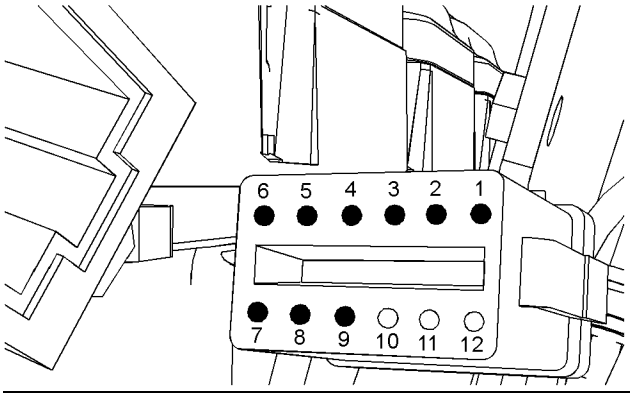


Illustration 92 g01161304

P3 terminals that are associated with the injector solenoids (harness side of connector)

(P3-1) Injector 1 return
(P3-2) Injector 3 return
(P3-3) Injector 5 return
(P3-4) Injector 7 return
(P3-5) Injector 9 return
(P3-6) Injector 11 return
(P3-7) Injectors 1 & 3 supply
(P3-8) Injectors 5 & 7 supply
(P3-9) Injectors 9 & 11 supply

E. Insert one end of the jumper wire into the P300 connector socket for the suspect injector's supply wire. Insert the other end of the jumper wire into the P300 connector socket for the suspect injector's return wire. This will replace the injector solenoid with a short circuit.

F. Perform the "Injector Solenoid Test" at least two times.

G. Repeat this test for each suspect circuit. Stop the "Injector Solenoid Test" before handling the jumper wire.

Restore the wiring to the original configuration.

Expected Result:

Cat ET displays "Short" for each circuits that was jumpered.

Results:

- OK – Cat ET displays "Short" for each circuit that was jumpered. The harness between the ECM and the P300 connector does not have an open circuit. Proceed to Test Step 7.
- Not OK – Cat ET displays "Open" for the cylinder with the jumper wire. There is a problem in the wiring between the ECM and the P300 connector. There may be a problem with the ECM. Proceed to Test Step 8.

Test Step 6. 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. Remove the electrical power from the ECM.

B. Disconnect the appropriate P300 connector.

C. Restore the electrical power to the ECM.

D. Perform the "Injector Solenoid Test" at least two times.

Expected Result:

All of the cylinders in the appropriate bank indicate "Open" on Cat ET.

Results:

- OK – All cylinders indicate "Open" on Cat ET. The ECM and the engine harness are OK. Proceed to Test Step 7.
- Not OK – One or more cylinders indicate "Short" on Cat ET. Note the cylinders that indicate "Short". Proceed to Test Step 8.

Test Step 7. Check the Injector Harness Under the Valve Cover for an Open Circuit or a Short Circuit

⚠ WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

A. Remove the electrical power from the ECM.

B. Remove the valve cover in order to gain access to the suspect injector.

C. Disconnect the harness connector from the suspect injector.

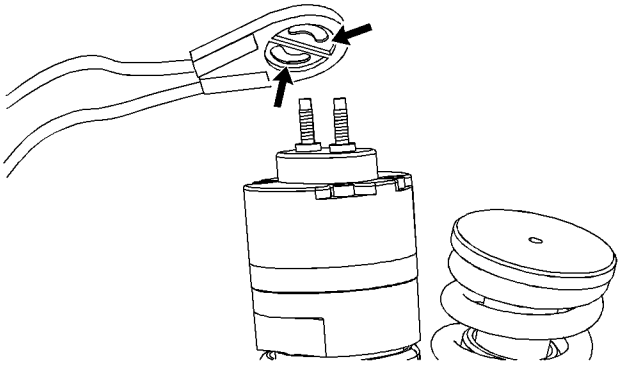


Illustration 93 g01147088

Connector terminals for the injector solenoid

D. Thoroughly clean the terminals on the injector solenoid and on the harness connector.

E. Use a jumper wire to short circuit the connector terminals for the suspect injector. This will effectively replace the injector solenoid with a short circuit.

F. Restore the electrical power to the ECM.

G. Perform the “Injector Solenoid Test” at least two times.

Note: The injector solenoid that shares the supply wire of the injector that is short circuited may indicate a false test result. Disregard this test result.

H. Remove the electrical power from the ECM.

I. Remove the jumper wire from the injector connector. This will effectively replace the injector solenoid with an open circuit.

J. Restore the electrical power to the ECM.

K. Perform the “Injector Solenoid Test” at least two times.

L. Remove the electrical power from the ECM.

Expected Result:

Cat ET displays “Short” for the cylinder with the jumper wire and “Open” when the jumper wire is removed.

Results:

- OK – Cat ET displays the correct status during the test.

  Repair: The harness wiring is OK. There may be a problem with the injector. Use a multimeter to check the resistance of the suspect injector solenoid.

  The correct resistance of each injector solenoid is 1.06 ± 0.05 Ohms at 25 °C (77 °F).

  If the resistance of the solenoid is not within specifications replace the faulty injector. Verify that the problem is resolved.

  If the resistance of the solenoid is within specifications the problem may be intermittent. If the problem is intermittent, refer to the diagnostic functional test Troubleshooting, “Inspecting Electrical Connectors”.

  STOP.

- Not OK – Cat ET did not display the correct status during the test.

  Repair: There is a problem with the injector harness under the valve cover. There may be a problem with a connector. Repair the wiring and/or the connector, when possible. Replace parts, if necessary.

  STOP.

Test Step 8. Check the ECM for Proper Operation

⚠ WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

A. Remove the electrical power from the ECM.

B. Fabricate a jumper that is long enough to reach from the P2 ECM connector to the engine ground stud. Crimp a connector socket to one end of the jumper wire.

C. Disconnect the P2 connector.

D. Remove the supply wire from the terminal location for the suspect injector at the ECM connector. Install the jumper wire into this socket.

E. Connect the J2/P2 ECM connectors.

F. Verify that the ECM will detect an open circuit for the suspect injector:

a. Ensure that the jumper wire is not in contact with a ground source or another circuit. Do not touch the jumper wire during the test. A strong electrical shock hazard is present at the jumper wire while the test is running.

b. Restore the electrical power to the ECM.

c. Perform the “Injector Solenoid Test” at least two times.

d. Remove the electrical power from the ECM.

Cat ET displays “Open” for the two injectors that share the supply wire.

G. Verify that the ECM detects a short circuit for the suspect injector:

a. Connect the jumper wire to the engine ground stud. Do not touch the jumper wire during the test. A strong electrical shock hazard is present at the jumper wire while the test is running.

b. Restore the electrical power to the ECM.

c. Perform the “Injector Solenoid Test” at least two times.

d. Remove the electrical power from the ECM.

Cat ET displays “Short” for the two injectors that share the supply wire.

Expected Result:

Cat ET displays the correct status for each test circuit.

Results:

- OK – The ECM detects the correct status of the circuit.

  Repair: The ECM is OK. The problem is in the engine harness or in a connector. Inspect the connectors for moisture and for corrosion. Repair the wiring and/or the connector, when possible. Replace parts, if necessary. Clear all diagnostic codes after you complete this test step.

  STOP.

- Not OK – The ECM does not detect the correct status of the circuit.

  Repair: There is a problem with the ECM. Replace the ECM. Refer to Troubleshooting, “Replacing the ECM”. Verify that the problem is resolved.

  STOP.

i02415737

Speed Control - Test

SMCS Code: 1439-038; 1913-038

System Operation Description:

The load sharing module provides a throttle signal to the engine’s Electronic Control Module (ECM). The output for rated speed is a pulse width modulated signal (PWM) at a constant frequency. The speed signal varies with the position of the speed adjust potentiometer. The output signal is referred to as a duty cycle or as a PWM signal. The output signal is expressed as a percentage between 0 and 100 percent for the speed adjust.

Note: Desired speed can be adjusted from 1141 to 1621 rpm over the range of the PWM signal for a 50 Hz application. For a 60 Hz application, the desired speed can be adjusted from 1369 to 1945 rpm over the range of the PWM signal.

The ECM calculates the desired engine rpm from the throttle signal and the droop signal. The throttle signal is valid when the duty cycle is in the range of 5 to 95 percent. If the ECM determines that the throttle signal is invalid, the engine rpm will be set to the programmed low idle.

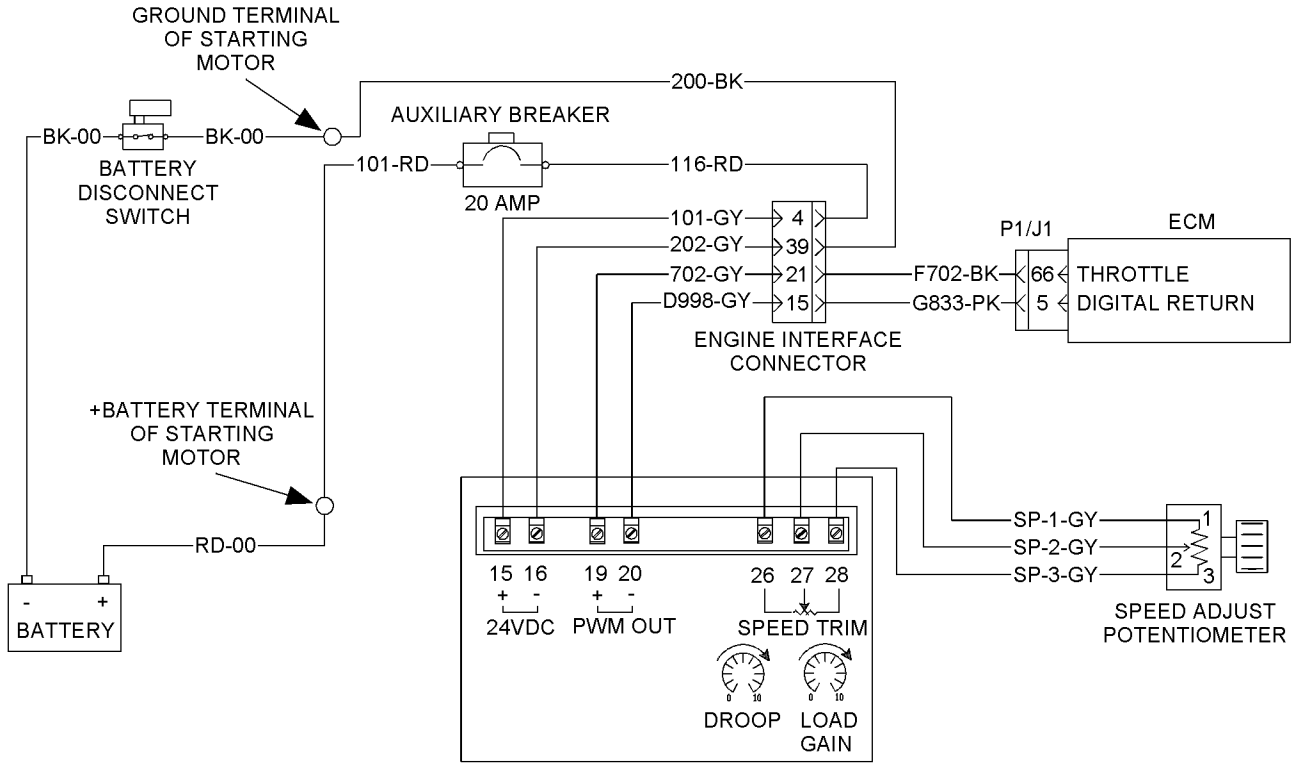


Illustration 94 g01207558

Schematic for the speed control circuit (typical example)

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove electrical power from the ECM.

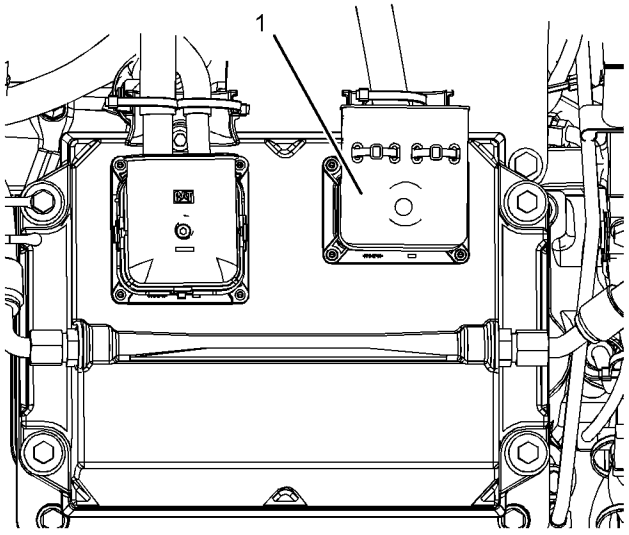


Illustration 95 g01167488

Location of the J1/P1 ECM connectors (typical engine view)

(1) J1/P1 ECM connectors

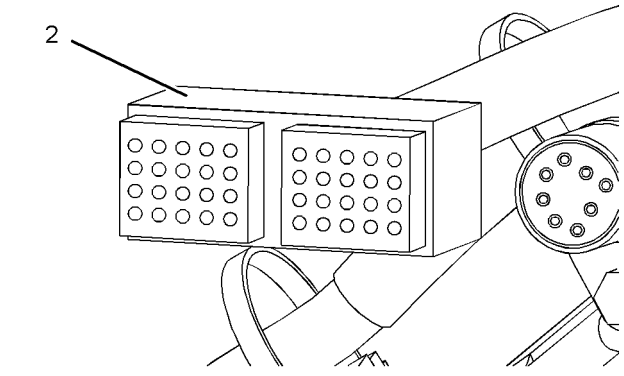


Illustration 96 g01207581

Location of the engine interface connector (typical engine view)

(2) Engine interface connector

B. Thoroughly inspect connectors (1) and (2). Also, thoroughly inspect all of the other connectors that are in the circuit. Refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect” for details.

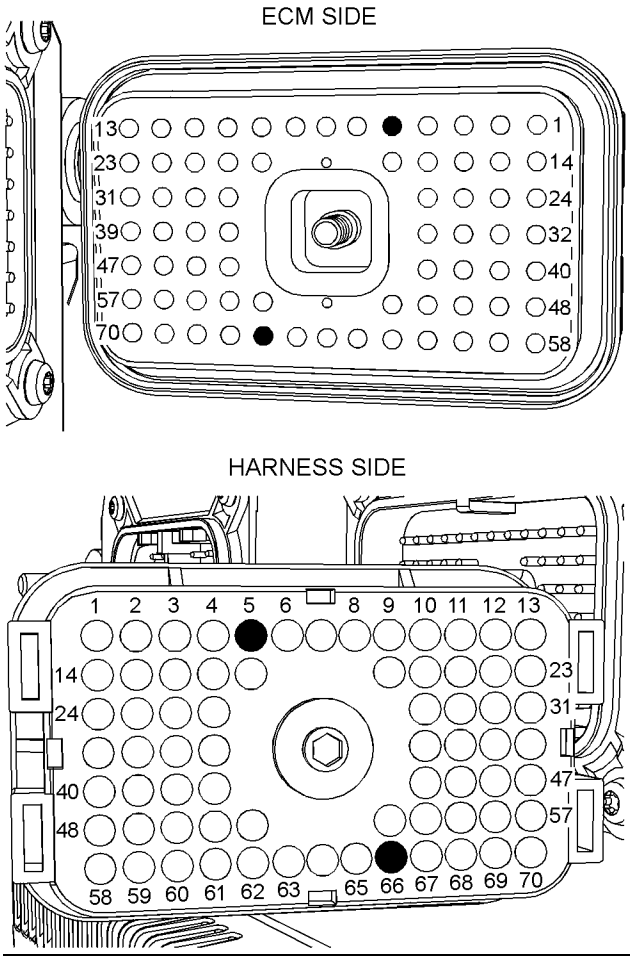


Illustration 97 g01207582

Terminal locations at the P1 ECM connector

(P1-5) Digital return
(P1-66) Throttle signal

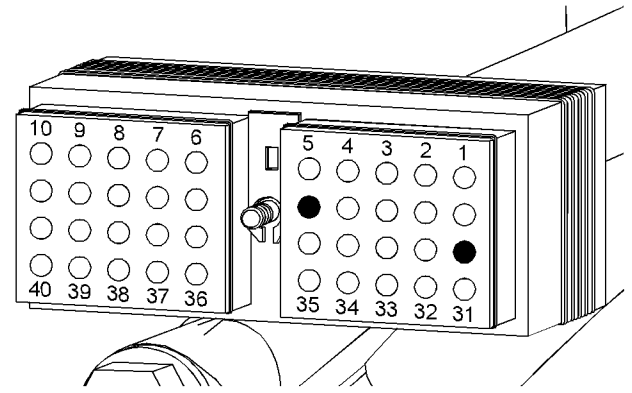


Illustration 98 g01207583

Terminal locations at the engine interface connector

(15) Digital return
(21) Throttle signal

C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector and the engine interface connector that are associated with the circuit.

D. Check the allen head screw on each ECM connector and the engine interface connector for the proper torque. refer to the diagnostic functional test Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the harness and the wiring for abrasion and for pinch points.

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 appear to be OK. Proceed to Test Step 2.
- Not OK – The connectors and/or wiring are not OK.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring.

  STOP.

Test Step 2. Check the Supply Voltage to the Speed Control

A. Restore electrical power to the ECM.

B. Measure the voltage between terminal 15 (+Battery) and terminal 16 (−Battery) on the speed control.

C. Remove electrical power from the ECM.

Expected Result:

The voltage is 24 ± 3 VDC.

Results:

- OK – The voltage is 24 ± 3 VDC. The voltage supply to the speed control is correct. Proceed to Test Step 3.
- Not OK – The voltage is not 24 ± 3 VDC.

  Repair: There is a problem in a harness or a connector between the batteries and the speed control. The problem may be in the circuit breaker or the batteries.

  Perform the following procedure:

1. Check the voltage between engine ground and the following test points. If voltage is not present at a test point, the problem is in the device, in the wire or in the connector that precedes the point in the circuit. Refer to Illustration 94 as a reference.

Table 22

Device	Test location
Battery	+Battery terminal
Starting motor	+Battery terminal
Auxiliary breaker	Input terminal
	Output terminal
Engine interface connector	Terminal 4

2. Measure the voltage between the battery's +Battery terminal and the following test points. If voltage is not present at a test point, the problem is in the device, in the wire or in the connector that precedes the point in the circuit. Refer to Illustration 94 as a reference.

Table 23

Device	Test location
Battery disconnect switch	Input terminal
	Output terminal
Starting motor	−Battery terminal
Engine interface connector	Terminal 39

Repair the circuit or replace the device that is causing the problem.

If a problem with the batteries is suspected, refer to the diagnostic functional test Operating Manual, SEHS9249 and Special Instruction, SEHS7633 for information that is related to testing the batteries.

STOP.

Test Step 3. Check the Status for the Throttle Position on Caterpillar Electronic Technician (ET)

A. Connect Cat ET to the service tool connector. Observe the status parameter for the throttle position on Cat ET.

B. Restore electrical power to the ECM.

C. Turn the speed adjust potentiometer to the lowest setting.

D. Adjust the speed adjust potentiometer from the lowest setting to the highest setting. Monitor the status for the throttle position on Cat ET while you perform the test.

E. Remove electrical power from the ECM.

Expected Result:

The throttle position on Cat ET changes proportionally as the speed adjust potentiometer is adjusted.

Results:

- OK – The speed control is operating correctly.

  Repair: There may be an intermittent problem in a harness or a connector. If an intermittent problem is suspected, refer to Troubleshooting, "Inspecting Electrical Connectors" for troubleshooting information.

  STOP.

- Not OK – The throttle position on Cat ET does not vary as the speed adjust potentiometer is adjusted. There is a problem in the circuit between the speed control and the ECM. Proceed to Test Step 4.

Test Step 4. Check the PWM Signal at the Speed Control

A. Remove the wires from terminal locations 19 (+PWM out) and 20 (−PWM out) at the speed control.

B. Use a multimeter that is capable of reading a percent duty cycle in order to measure the output at terminal locations 19 and 20 at the speed control.

C. Restore electrical power to the ECM.

D. Monitor the output of the percent duty cycle from the terminal locations at the speed control on the multimeter. Turn the speed adjust potentiometer from the low setting to the high setting.

E. Remove electrical power from the ECM.

Restore the wiring to the original configuration.

Expected Result:

The duty cycle changes as the speed adjust potentiometer is adjusted.

Results:

- OK – The throttle signal is present at the speed control. Proceed to Test Step 5.

- Not OK – The throttle signal is not present at the speed control.

  Repair: There is a problem with the speed control. Replace the speed control. Verify that the problem is no longer present.

  STOP.

Test Step 5. Check the PWM Signal at the Engine Interface Connector

A. Disconnect the engine interface connectors.

B. Remove the wires from terminal locations 15 (digital return) and 21 (rated speed) on the side of the engine interface connector that is from the speed control.

C. Connect the engine interface connectors.

D. Use a multimeter that is capable of reading a percent duty cycle in order to measure the output at the wires that have been removed from terminal locations 15 and 21 at the engine interface connectors.

E. Restore electrical power to the ECM.

F. Monitor the output of the percent duty cycle from these wires on the multimeter. Turn the speed adjust potentiometer from the low setting to the high setting.

G. Remove electrical power from the ECM.

Restore the wiring to the original configuration.

Expected Result:

The throttle signal is reaching the engine interface connectors.

Results:

- OK – The throttle signal is reaching the connector. Proceed to Test Step 6.

- Not OK – The throttle signal is not reaching the connector.

  Repair: Repair the connectors or wiring and/or replace the connectors or wiring between the speed control and the engine interface connector.

  STOP.

Test Step 6. Check the PWM Signal at the ECM

A. Disconnect the J1/P1 ECM connectors.

B. Remove the wires from terminals P1-5 (digital return) and P1-66 (throttle signal) at the ECM connector.

C. Connect the J1/P1 ECM connectors.

D. Use a multimeter that is capable of reading a percent duty cycle in order to measure the output at the wires from terminals P1-5 (digital return) and P1-66 (throttle signal) at the ECM connector.

E. Restore electrical power to the ECM.

F. Monitor the output of the percent duty cycle from the speed control on the multimeter. Turn the speed adjust potentiometer from the low setting to the high setting.

G. Remove electrical power from the ECM.

Expected Result:

The throttle signal is present at the connector.

Results:

- OK – The throttle signal is present at the connector.

  Repair: The ECM is not detecting the signal correctly. Replace the ECM. Refer to the diagnostic functional test Troubleshooting, “Replacing the ECM” for details.

  STOP.

- Not OK – The throttle signal is not present at the ECM connector.

  Repair: The problem is in the harness between ECM connector P1 and the engine interface connectors. There may be a problem with a connector. Repair the connectors or wiring and/or replace the connectors or wiring.

  STOP.

i02418874

Start Relay Circuit - Test

SMCS Code: 1426-038

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the circuit for the start relay.

This procedure covers the following diagnostic codes:

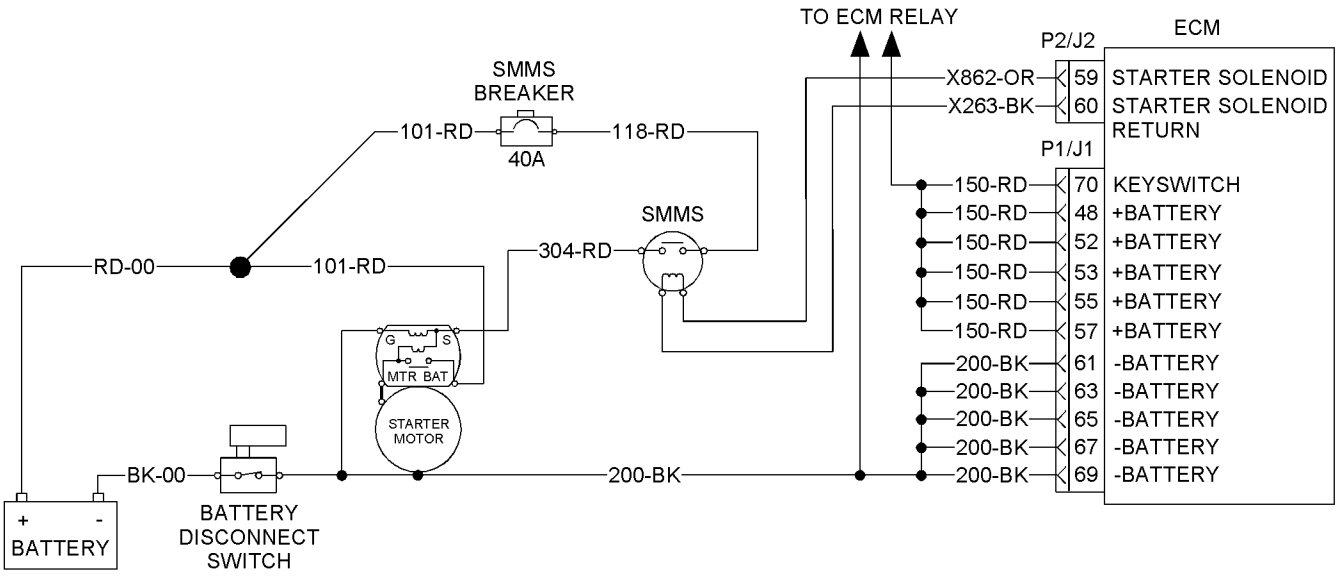
- 444-05 Start Relay open circuit

- 444-06 Start Relay short to ground

During an engine start sequence, the Starting Motor Magnetic Switch (SMMS) is used by the Electronic Control Module (ECM) to engage the starting motor. Control input voltage for the SMMS is supplied by the ECM. When the ECM supplies the signal to the circuit, the SMMS is energized. This powers the starting solenoid and the starting motor engages.

The SMMS is de-energized by the ECM when the engine speed reaches the crank terminate speed. The crank terminate speed is a system configuration parameter that is originally set at the factory. Refer to the parameter table that is found in Troubleshooting, “System Configuration Parameters” for the current setting of the parameter.

Circuit protection for the SMMS is provided by a circuit breaker that is located in the secondary circuit that is between the +Battery and the input terminal for the SMMS.



g01208810

Illustration 99

Circuit schematic for the SMMS

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Turn the battery disconnect switch to the OFF position.

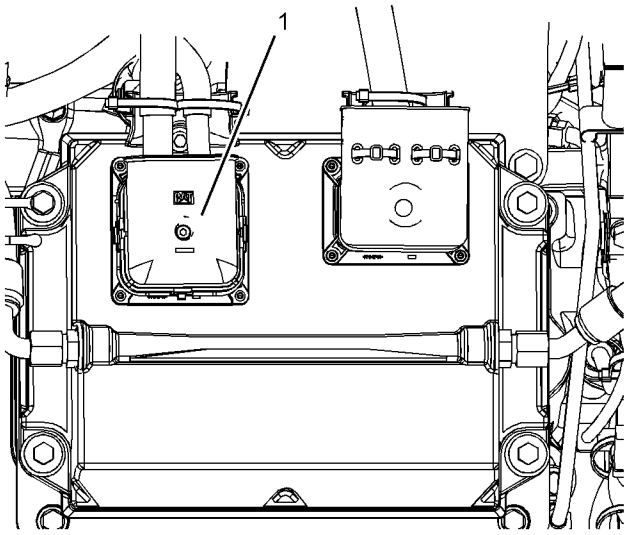


Illustration 100 g01210546

Location of the J2/P2 ECM connector (typical engine view)

(1) J2/P2 ECM connector

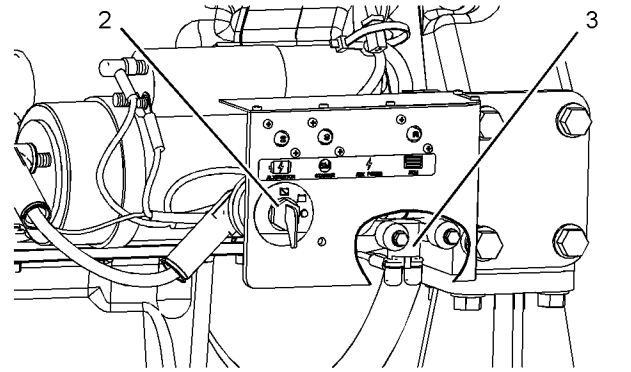


Illustration 101 g01210527

Location of the battery disconnect switch and the SMMS (typical left side engine view)

(2) Battery disconnect switch
(3) SMMS

B. Thoroughly inspect connector (1). Also, thoroughly inspect the connections at switches (2) and (3). Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

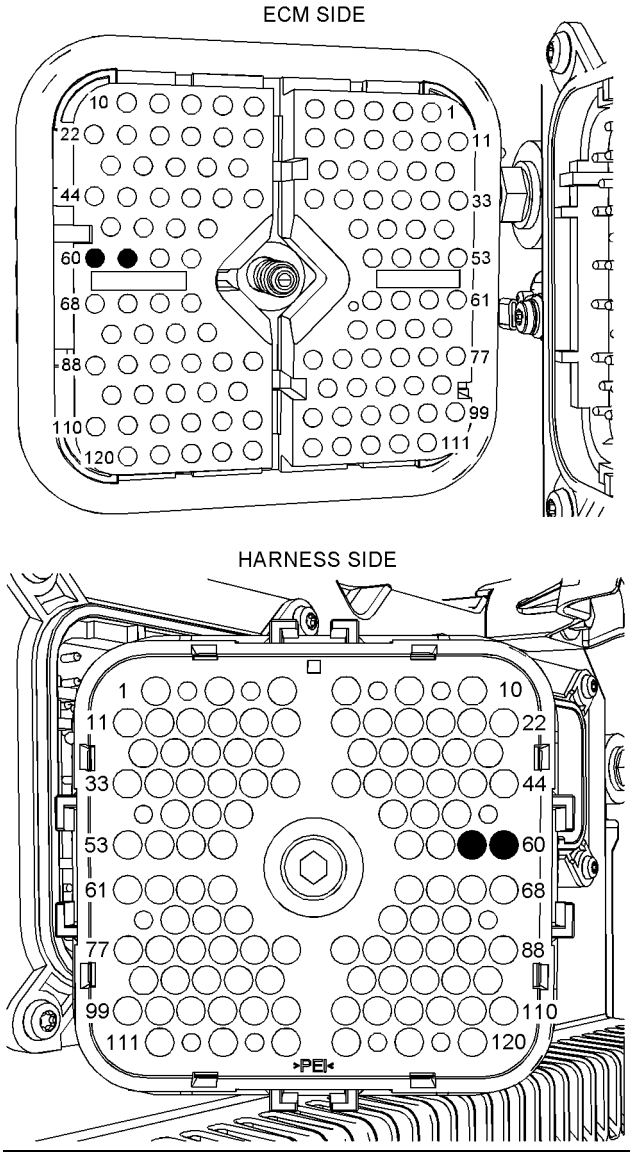


Illustration 102 g01210498

P2 terminal locations for the start relay

(P2-59) Starter solenoid
(P2-60) Starter solenoid return

C. Perform a 45 N (10 lb) pull test on each of the wires in the connectors that are associated with the circuit.

D. Check the torque of the allen head screws for each of the ECM connectors. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.

E. Check the harness and wiring for corrosion, for abrasion, and for pinch points back to the ECM.

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 wiring and the connectors appear to be OK. Proceed to Test Step 2.
- Not OK – There is a problem with the wiring and/or the connectors.

  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 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 battery disconnect switch to the ON position.

C. Observe the “Active Diagnostic” screen on Cat ET. Wait at least 30 seconds so that any codes may become active. Look for these codes:

- 444-05
- 444-06

D. Crank the engine.

E. Turn the battery disconnect switch to the ON position.

Expected Result:

There are no active diagnostic codes and the engine cranks.

Results:

- OK – No diagnostic codes are active and the starting motor cranks the engine.

  Repair: The problem appears to be resolved. The problem is probably related to a faulty connection in the harness or at a connector. Carefully inspect the connectors and the wiring that is related to the start circuit. Ensure that all connections are tight and ensure that all wires are crimped correctly. Refer to Troubleshooting, “Electrical Connectors - Inspect” for information that relates to the proper troubleshooting of intermittent electrical problems.

  STOP.

- 444-05 – There is an active 444-05 diagnostic code. An open circuit condition exists in the circuit for the SMMS. Proceed to Test Step 3.
- 444-06 – There is an active 444-06 diagnostic code. A short circuit condition exists in the circuit for the SMMS. Proceed to Test Step 4.
- Engine Will Not Crank – There are no active diagnostic codes and the engine will not crank. Proceed to Test Step 6.

Test Step 3. Check for an Open at the Control Input of the SMMS

A. Turn the battery disconnect switch to the OFF position.

B. Disconnect the wires that are for the control input at the terminals of the SMMS.

C. Fabricate a jumper wire that is long enough to short circuit the two wires that are for the control input. Use the jumper wire to short circuit the two wires.

D. Turn the battery disconnect switch to the ON position.

E. Observe the “Active Diagnostic” screen on Cat ET. Wait at least 30 seconds so that any codes may become active.

F. Crank the engine.

Turn the battery disconnect switch to the OFF position.

Remove the jumper wire. Restore the wiring to the original configuration.

Expected Result:

There is an active 444-06 diagnostic code.

Results:

- OK – A 444-06 code became active when the wires were short circuited at the control input for the SMMS.

  Repair: The open circuit is in the SMMS. Replace the SMMS. Clear any diagnostic codes. Verify that the problem is resolved.

  STOP.

- Not OK – A 444-05 code remained active when the wires were short circuited at the control input for the start relay. There is a open circuit in the harness between the connector and the SMMS. The problem may be in the ECM. Proceed to Test Step 5.

Test Step 4. Check for a Short at the Control Input of the SMMS

A. Disconnect the wires that are for the control input at the terminals of the SMMS.

B. Turn the battery disconnect switch to the ON position.

C. Observe the “Active Diagnostic” screen on Cat ET. Wait at least 30 seconds so that any codes may become active.

D. Crank the engine.

Turn the battery disconnect switch to the OFF position.

Remove the jumper wire. Restore the wiring to the original configuration.

Expected Result:

There is an active 444-05 diagnostic code.

Results:

- OK – A 444-05 became active when the control inputs for the SMMS were disconnected.

  Repair: The short circuit is in the SMMS. Replace the SMMS. Clear any diagnostic codes. Verify that the problem is resolved.

  STOP.

- Not OK – A 444-06 remained active when the control inputs for the SMMS were disconnected. The open is in the harness from the ECM to the SMMS. There may be a problem with the ECM. Proceed to Test Step 5.

Test Step 5. Check for Proper Operation of the ECM

A. Ensure that the battery disconnect switch is in the OFF position.

B. Disconnect the J2/P2 ECM connectors.

C. Fabricate two jumper wires that are long enough to create a short circuit across terminal locations at the ECM connector. Crimp a connector socket onto one end of each jumper wire.

D. Remove the wires from terminal locations P2-59 (starter solenoid) and P2-60 (starter solenoid return) from the ECM connector. Install a jumper wire into each of these terminal locations.

E. Connect the J2/P2 ECM connectors.

F. Create an open circuit condition at the ECM.

  a. Ensure that the jumper wires are not in contact with any ground source on the engine. Also, ensure that the ends of the jumper wires are not shorted to each other.

  b. Turn the battery disconnect switch to the ON position.

  c. Crank the engine.

  d. Observe the “Active Diagnostic” screen on Cat ET. Wait at least 30 seconds so that any codes may become active.

  The 444-05 diagnostic code will be active.

  e. Turn the battery disconnect switch to the OFF position.

G. Create a short circuit condition at the ECM.

  a. Connect the loose ends of the jumper wires together.

  b. Turn the battery disconnect switch to the ON position.

  c. Crank the engine.

  d. Observe the “Active Diagnostic” screen on Cat ET. Wait at least 30 seconds so that any codes may become active.

  The 444-06 diagnostic code will be active.

  e. Turn the battery disconnect switch to the OFF position.

Return the wiring to the original configuration.

Expected Result:

There is an active 444-05 diagnostic code when the open circuit condition is present. There is an active 444-06 diagnostic code when the short circuit condition is present.

Results:

- OK – The ECM is recognizing the circuit conditions successfully.

  Repair: The problem is in the harness between the ECM connector and SMMS.

If a 444-05 diagnostic code was originally present, there is an open circuit in the harness or in a connector.

If a 444-06 diagnostic code was originally present, there is an short circuit in the harness or in a connector.

Repair the harness and/or the connector. Replace parts, if necessary. Verify that the original problem is resolved.

STOP.

- Not OK – Either of the following conditions exist: The 444-05 diagnostic code is present when the jumper wires are shorted. The 444-06 diagnostic code is present when the jumper wires are open.

  Repair: There is a problem with the ECM. Replace the ECM. Refer to Troubleshooting, “Replacing the ECM” for the correct procedure. Verify that the problem is resolved.

  STOP.

Test Step 6. Check for Battery Voltage at the Input for the Secondary Circuit at the SMMS

A. Turn the battery disconnect switch to the ON position.

B. Connect a test lamp between the +Battery terminal of the SMMS and the engine ground stud.

C. Observe the test lamp.

D. Turn the battery disconnect switch to the OFF position.

Expected Result:

The test lamp turns on.

Results:

- OK – The test lamp turns on. Battery voltage is reaching the SMMS. Proceed to Test Step 7.

- Not OK – The test lamp does not turn on.

  Repair: Battery voltage is not reaching the secondary circuit of the SMMS. Ensure that the circuit breaker for the SMMS is not tripped. There may be an open circuit in the wiring between the battery and the SMMS. There may be a problem with a connection or the harness wiring. Repair the circuit. Replace parts, if necessary. Verify that the problem is resolved.

  STOP.

Test Step 7. Check for Voltage Output at the Start Relay

A. Remove the wire from the output terminal for the secondary circuit of the SMMS.

B. Turn the battery disconnect switch to the ON position.

C. Connect a test lamp between the output terminal for the secondary circuit of the SMMS and the engine ground stud.

D. Turn the battery disconnect switch to the ON position.

E. Crank the engine.

F. Observe the test lamp.

G. Turn the battery disconnect switch to the OFF position.

Expected Result:

The test lamp turned on when the engine was cranked.

Results:

- OK – The test lamp turned on when the engine was cranked.

  Repair: The SMMS and the circuit are OK. The problem is in the circuit for the starting motor solenoid. There may be a problem with the solenoid or the starting motor. Repair the circuit or the starting motor. Replace parts, if necessary. Verify that the original problem is resolved.

  STOP.

- Not OK – The test lamp did not turn on when the engine was cranked.

Repair: The control circuit and the SMMS are OK. The secondary circuit for the relay is not engaging. Replace the SMMS. Verify that the problem is resolved.

STOP.

Calibration Procedures

i02348860

Engine Speed/Timing Sensor - Calibrate

SMCS Code: 1439-524; 1912-524

System Operation Description:

Use this procedure if a 261-13 Engine Timing Calibration required is active.

Also use this procedure if any of the following conditions exist:

- The Electronic Control Module (ECM) has been replaced.
- The ECM software has been updated.
- The front gear group has been serviced.

The ECM has the ability to calibrate the mechanical differences between the Top Center (TC) of the No. 1 piston and the orientation of the camshaft. The ECM uses the signal from the primary engine speed/timing sensor as a control reference that identifies the exact orientation of the crankshaft. The ECM uses the signal that is detected from the secondary engine speed/timing sensor to identify the exact orientation of the camshaft.

The two signals are then used by the ECM to calculate a timing offset. The offset is used by the ECM to calibrate the signal from the secondary engine speed/timing sensor.

Note: A timing calibration will not increase the available engine power.

Test Step 1. Check for Active 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. Check for any active diagnostic codes.

Expected Result:

No active diagnostic codes are present.

Results:

- OK – No active diagnostic codes are present. If a timing calibration is necessary due to service to the ECM or to the front gear train, proceed to Test Step 2.
- Not OK – 261-13 Engine Timing Calibration required is the only active diagnostic code that is present. Proceed to Test Step 2.
- Not OK – There are active diagnostic codes. A 261-13 is not one of the active diagnostic codes.

  Repair: Troubleshoot the active diagnostic codes. Make the necessary repairs.

  STOP.
- Not OK – A 261-13 and other active diagnostic codes are present.

  Repair: Make the necessary repairs in order to resolve the active diagnostic codes. The 261-13 Engine Timing Calibration required may remain active while the repairs are made.

  Repeat Test Step 1.

Test Step 2. Calibrate the Engine Speed/Timing Sensor

A. Start the engine. Run the engine until the engine has exited cold mode operation.

B. After the engine has warmed up, access the “Timing Calibration” screen on Cat ET. Access the following display screens in order:

- “Service”
- “Calibrations”
- “Timing Calibration”

C. To calibrate the timing to the correct setting, set the engine speed to 1100 ± 50 rpm and select “Continue” on Cat ET. Wait until Cat ET indicates that the timing is calibrated.

D. Press the “Continue” button on Cat ET. Wait until Cat ET indicates that the ECM has calculated the timing reference.

Note: If Cat ET displays “Calibration Unsuccessful”, the electronic injection timing has not been calibrated.

Expected Result:

The timing calibration was successful.

Results:

- OK – The timing calibration was successful.

  Repair: 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 engine speed/timing sensors are 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”.

  If a problem with the engine speed/timing sensors is suspected, refer to Troubleshooting, “Engine Speed/Timing Sensor Circuit - Test”.

  STOP.

Index

D

E

F

I

L

M

N

P

R

S

T

V

Printed in U.S.A.