



Troubleshooting

C15 Engines for Caterpillar Built Machines

L4D1-Up (Machine)
L4E1-Up (Machine)
L4F1-Up (Machine)
ECM1-Up (Machine)
LTS1-Up (Machine)
L4L1-Up (Engine)
TXY1-Up (Engine)

Important Safety Information

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

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

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

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

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



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.

A non-exhaustive list of 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. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. 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 become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

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. Cat dealers have the most current information available.



When replacement parts are required for this product Caterpillar recommends using Cat 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.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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Troubleshooting Section

Introduction

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General Information

SMCS Code: 1000

Overview

These engines are equipped with an electronic control system. The system consists of a computer, sensors, and software. The system provides these capabilities:

- Control of the engine
- Applications control system interface
- Fault detection and reporting

Electronic Control System

The Electronic Control Module (ECM) is a computer that controls the operation of the engine.

The ECM contains a flash file. The flash file is the software for the ECM. The flash file contains the operating maps. The operating maps define the following characteristics of the engine:

- Horsepower
- Torque curves
- Engine speed (rpm)

Refer to Troubleshooting, "System Overview" for additional information on the electronic control system.

Application Interface

The ECM interfaces with the machine via software and an electrical connector on the ECM. The software can be configured.

The applications control system provides inputs to the electrical connector on the ECM in order to indicate the status of switches. Configure the ECM in order to interpret the inputs.

The ECM provides outputs for the applications control system via the electrical connector in order to control lamps, solenoids, and other devices. Configure the ECM to match the configuration of the applications control system.

Fault Detection and Reporting

The ECM monitors inputs from the sensors and inputs from the applications control system. Software in the ECM interprets the inputs. The software determines if the inputs are operating correctly. A diagnostic trouble code is activated when the software detects a problem with an input.

The ECM broadcasts the codes on two data links. The data links are the Cat Data Link (CDL) and J1939. Caterpillar Electronic Technician (ET) must communicate on both data links in order to service the engine. If a problem is suspected with one of the data links, refer to Troubleshooting, "Data Link - Test".

The codes can be displayed on Cat ET and optional operator interfaces. Refer to Troubleshooting, "Diagnostic Trouble Codes" for additional information on diagnostic trouble codes and a complete list of codes.

Troubleshooting

As a reference, simplified schematics for each of the engines subsystems are included with each of the circuit tests that are in this manual. For an accurate representation of the entire electrical schematic that is for your application, refer to the Electrical System Schematic.

During troubleshooting, inspect all harness connections before any component is replaced. If these connections are not clean and tight, continuous electrical problems or intermittent electrical problems can result. Check that the wires are pushed into the connectors completely. Make sure that the connections are tight before other tests are made.

Failure of an electrical component may cause the failure of other components. Always attempt to correct the cause of an electrical failure before you replace a component. If wire insulation is punctured, repair the damage. Seal the damaged wires with 8T-0065 Silicone Sealant. Cover the sealant with two layers of 1P-0810 Electrical Tape.

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Welding Precaution

SMCS Code: 1000

Proper welding procedures are necessary in order to avoid damage to the engine Electronic Control Module (ECM), to the Clean Emissions Module (CEM), if equipped, to sensors, and to associated components. Also consider components that are for the driven equipment. Remove the component that requires welding. When welding on an engine 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.

1. Stop the engine. Remove the electrical power from the ECM.
2. Ensure that the fuel supply to the engine is turned off.
3. Disconnect the negative battery cable from the battery. If a battery disconnect switch is installed, open the switch.
4. Disconnect all electronic components from the wiring harnesses. Electronic components include the following components:
 - Electronic components for the driven equipment
 - The engine ECM
 - Sensors

NOTICE

Do NOT use electrical components (ECM or sensors) or electronic component grounding points for grounding the welder.

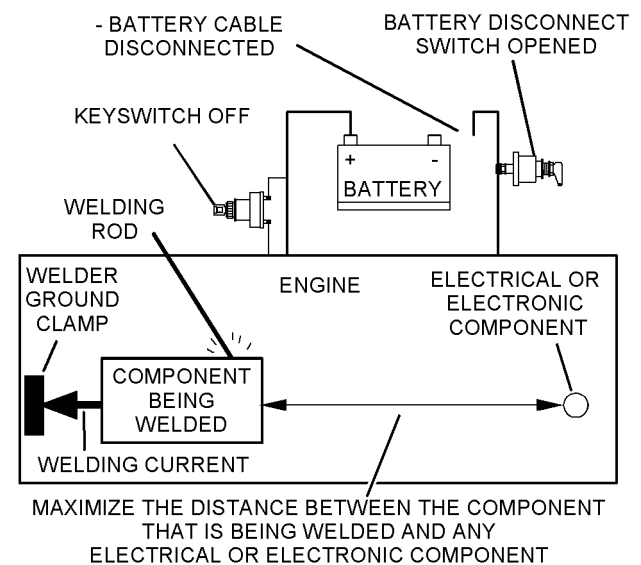


Illustration 1

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Service welding guide (typical diagram)

5. When possible, connect the welder ground clamp directly to the engine component that will be welded. Place the clamp as close as possible to the weld. A close connection will reduce the possibility of welding current damage to the engine bearings, to the electrical components, and to other components.
6. Protect the wiring harnesses from welding debris and/or from the welding spatter.
7. Use standard welding procedures to weld the materials together.

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Electronic Service Tools

SMCS Code: 0785

Service Tools

Most of the tools that are listed in Table 1 are required to enable a service technician to perform the test procedures in this manual. Some of the devices may be specific to the type of Electronic Control Module (ECM) that is being used.

Table 1

Service Tools	
Part Number	Description
N/A	4 mm Allen Wrench
151 - 6320	Wire Removal Tool (14-GA TO 18-GA, RED)
1U - 5804	Crimp Tool (12-AWG TO 18-AWG)
6V - 2197	Transducer
7X - 1171	Transducer Adapter
7X - 1695	Cable As
146 - 4080	Digital Multimeter Gp (RS232)
7X - 1710	Multimeter Probes
326 - 4904	Adapter Cable As (3-PIN BREAKOUT)
7X - 1715 134 - 5195	Adapter Cable As (40-PIN BREAKOUT) Harness (40-PIN) (For ADEM 2 ECM (two 40-pin connectors))
208 - 0059	Adapter Cable As (70-PIN BREAKOUT) (For ADEM 3 ECM (two 70-pin connectors) and for ADEM 4 ECM (one 70-pin connector and one 120-pin connector))
257 - 8718	Adapter Cable As (120-PIN BREAKOUT) (For ADEM 4 ECM (one 70-pin connector and one 120-pin connector))
N/A	Torque Wrench (capable of applying 1.5 N·m (13.3 lb in))
Repair Kits for Connectors	
362 - 3555	Connector Repair Kit (AMPSEAL)
175 - 3700	Connector Repair Kit (DEUTSCH DT)
Bypass Harnesses for the ECM	
129 - 2018	Power Cable (Stand alone cable for ADEM 2 ECM)
217 - 0113	Wiring Harness (ECM BYPASS) (The bypass harness connects to the battery. The bypass harness is used with the following harnesses for different types of electronic control modules.)
328 - 2292	Harness (ENGINE ECM BYPASS) (For ADEM 3 ECM and ADEM 4 ECM)
277 - 4734	Harness (ENGINE ECM BYPASS) (For A4:E2 ECM (Two 64-pin connectors))

Two short jumper wires may be 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 or 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
349 - 4199	AC/DC Current Probe
348 - 5430	Multi-Tool Gp

⁽¹⁾ Refer to Special Instructions, SEHS9249, "Use of 4C-4911 Battery Load Tester for 6, 8, and 12 v 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 be used by the technician to help perform the following procedures:

- Diagnostic testing
- Calibrations
- Flash programming
- Configuration of the ECM
- Print various reports

Cat ET can display the following information:

- Status parameters
- Event codes
- Diagnostic codes
- ECM settings
- Engine configuration

Always use the latest revision of Cat ET. The media is available on CD and the media can also be downloaded from various Caterpillar web sites.

Table 3

Software, JEBD3003, "CATERPILLAR ELECTRONIC TECHNICIAN"
--

Once you have downloaded Cat ET onto your PC, you will need a license from your Caterpillar dealer in order to use the software. Various licenses are available for different users with different requirements. Consult your Caterpillar dealer.

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

Connecting Cat ET

Connecting the Communication Adapter

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

Note: The 275-5120 Communication Adapter Gp was canceled and replaced by the 317-7484 Communication Adapter Gp. However, the 275-5120 Communication Adapter Gp can still be used.

Table 4

Standard Hardware for Connecting with Cat ET	
Part Number	Description
N/A	Personal Computer (PC)
317-7484	Communication Adapter Gp
Components of the 317-7484 Communication Adapter Gp	
317-7485	Communication Adapter (3)
370-4617	Cable As (USB)
327-8981	Cable As (DATA LINK)
Tool Operating Manual & Software CD ROM, NETG5057, "Communication Adapter 3"	

Follow the instructions for the communication adapter. Use the following procedure in order to connect Cat ET and the communication adapter to a PC.

1. Remove the electrical power from the ECM.

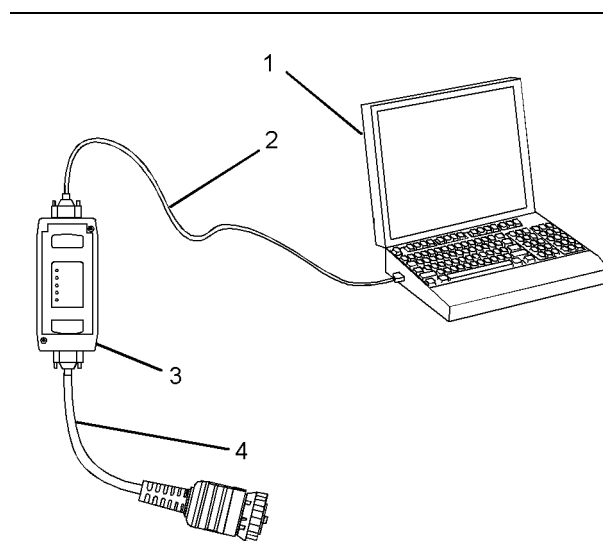


Illustration 2

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- (1) PC
- (2) 353-5083 Cable As (USB)
- (3) 317-7485 Communication Adapter (3)
- (4) 327-8981 Cable As (DATA LINK)

2. Connect cables (2) and (4) to communication adapter (3).

Note: The communication adapter will power up when the adapter is connected to a PC or to an ECM that is powered up.

3. Connect cable (2) to the USB port of the PC.
4. Connect cable (4) to a service tool connector.
5. Restore electrical power to the ECM. Verify that the "POWER" indicator on the communication adapter is illuminated. Make sure that the PC is powered up.
6. Establish communication between Cat ET and the ECM. If Cat ET indicates that there is more than one ECM, select the engine ECM.
7. If Cat ET and the communication adapter do not communicate with the ECM, refer to Troubleshooting, "Electronic Service Tool Will Not Communicate with ECM".

Refer to Troubleshooting, "Electronic Service Tool Does Not Communicate" if any of the following conditions exist:

- Cat ET displays a message that refers to a communication problem.
- Cat ET displays "Error #142 The interface hardware is not responding".

- Cat ET displays a message that indicates that the firmware in the communications adapter is old.

Dual Data Link Communications (If Equipped)

When the connection of the communication adapter is complete, observe the communication adapter and Cat ET. Certain applications require that dual data link communications be established in order to perform various test procedures. These tests will be listed in the "Diagnostic Tests" menu, some tests may not be available (grayed out). If there are diagnostic tests that are unavailable in Cat ET, ensure that your service tool is communicating in dual data link mode.

Use the following indicators to confirm that Cat ET is communicating on dual data links:

- "J1939" indicator is flashing
- "Cat Data Link" indicator is flashing
- Cat ET is not displaying "Service tool support is limited"

Refer to Troubleshooting, "Electronic Service Tool Does Not Communicate" if the "J1939" indicator and the "Cat Data Link" indicator are not flashing. Both indicators will be flashing during dual data link communications with the ECM.

Communicating with the Wireless Communication Adapter (If Equipped)

Table 6 lists the optional hardware that is needed in order to connect Cat ET by using a wireless connection.

Note: Some applications cannot use a wireless connection. Also, a dual data link cannot be used with a wireless connection.

Table 5

Optional Hardware for the Use of Cat ET	
Part Number	Description
N/A	Personal Computer (PC)

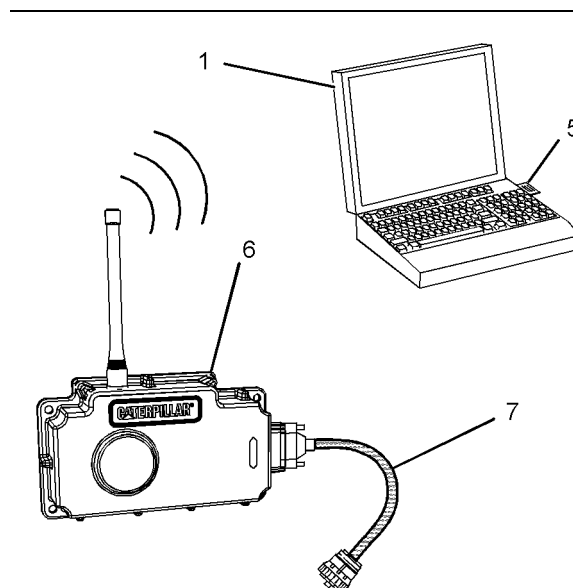


Illustration 3

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- (1) Personal computer (PC)
- (5) 261-4867 Card (PCMCIA)
- (6) 239-9955 Communication Radio Gp
- (7) 259-3183 Data Link Cable As

Note: Items (5), (6), and (7) are part of the 261-3363 Wireless Communication Adapter Gp.

Note: The 261-3363 Wireless Communication Adapter Gp was canceled and replaced by the 349-1206 Radio Kit. However, the 261-3363 Wireless Communication Adapter Gp can still be used.

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. Verify that the PC card is installed in the computer PCMCIA 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, "Electronic Service Tool Will Not Communicate with ECM".

Communicating with the 349-1206 Wireless Communication Adapter (If Equipped)

Table 6 lists the optional hardware that is needed in order to connect Cat ET by using a wireless connection.

Note: Some applications cannot use a wireless connection. Also, a dual data link cannot be used with a wireless connection.

Although changes can be made to the internal settings of the W-CA3 wirelessly. Caterpillar recommends that the radio is connected to a PC via 317-7496 Computer Cable As (USB) Cable Assembly (8) and 317-7510 Radio Cable Assembly (9).

Table 6

Optional Hardware for the Use of Cat ET	
Part Number	Description
N/A	Personal Computer (PC)

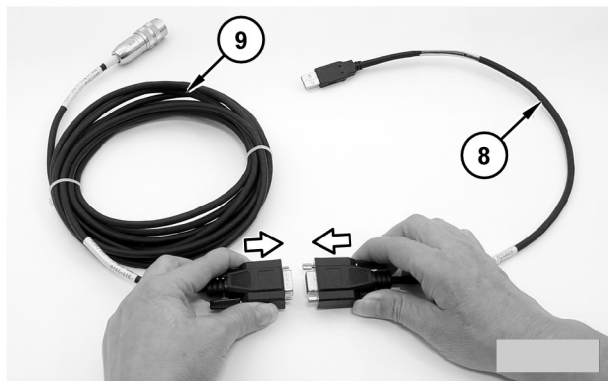


Illustration 4

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(8) 317-7496 Computer Cable As (USB)
(9) 317-7510 Radio Cable AssemblyC

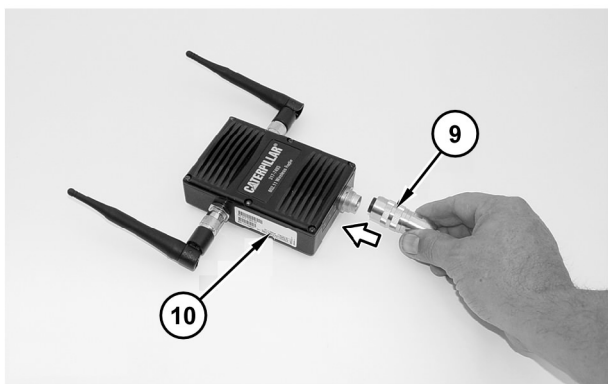


Illustration 5

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(9) 317-7510 Radio Cable Assembly
(10) W-CA3

Note: Items (8), (9), and (10) are part of the 349-1206 Radio Kit.

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 802.11a or 802.11b/g enabled wireless card. Verify that the PC wireless is installed and working correctly.
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, "Electronic Service Tool Will Not Communicate with ECM".

PL1000E Communication ECM (If Equipped)

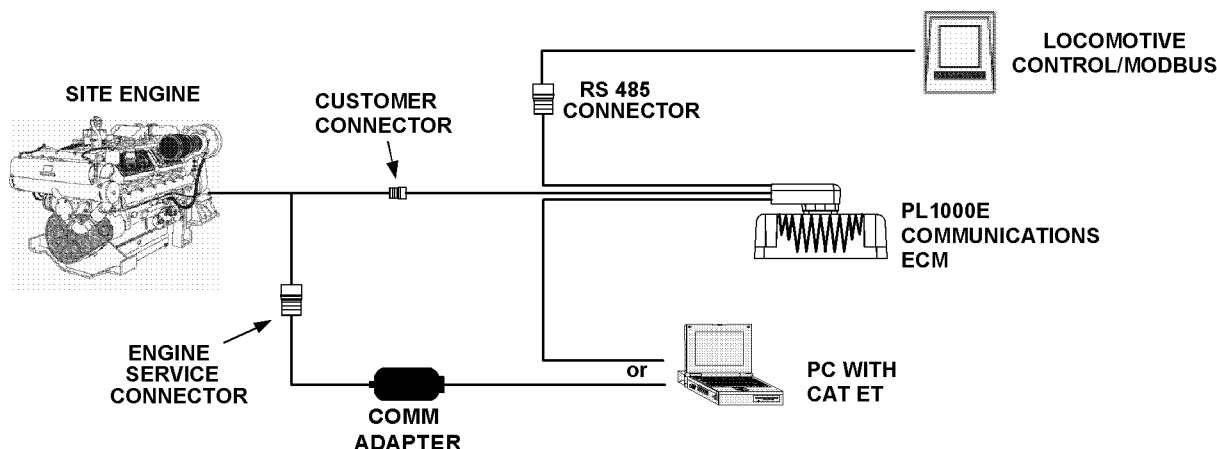


Illustration 6

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The PL1000E is an ECM that provides the customer with the ability to integrate Caterpillar engines into specific applications. The PL1000E enables communication from a J1939 data link to a device that utilizes a MODBUS communication protocol. A PC with Cat ET installed can be connected to the PL1000E through the RS232 serial port of the PC. The PL1000E contains an embedded communications adapter that will allow Cat ET to communicate with the engine over the J1939 data link.

Refer to System Operation/Troubleshooting/Test and Adjust, RENR8091, "PL1000E Communication ECM" for additional information.

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Service Information Report

SMCS Code: 0336

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

Recommendations

Customers Complaint

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

- Indicate if an event code was logged.
- Indicate if a diagnostic code was logged. Also, record the codes that are logged.
- Indicate the symptoms of engine operation that are present.
- Indicate the engine software part number.

Be as specific as possible.

Cause of Failure

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

- A specific procedure in the manual was followed.
- A visual inspection indicated wire abrasion on the engine harness.
- An engine dynamometer test indicated that the power was below the specification at 1700 rpm. The power loss was due to the loss of the no. 4 injector. The engine dynamometer test indicated that the power was below the specification at all engine speeds above 1700 rpm.

Be as specific as possible.

Repair Procedure

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

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

Be as specific as possible.

Electronic System Overview

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System Overview

SMCS Code: 1000; 1900

The engine is designed for electronic control of most engine operating functions. The electronic system consists of an Electronic Control Module (ECM), the wiring harness, switches, sensors, and fuel injectors. The engine ECM receives information from the sensors and the switches on the engine. The engine ECM processes the information that is collected in order to control the engine. By altering the fuel delivery with the fuel injectors, the engine ECM controls the speed and the power that is produced by the engine.

The following information provides a general description of the control system. Refer to the Systems Operation manual for detailed information about the control system.

System Operation

Engine Governor

The ECM governs the engine. The ECM determines the timing, the injection pressure, and the amount of fuel that is delivered to each cylinder. These factors are based on the actual conditions and on the desired conditions at any given time during starting and operation.

The ECM uses the throttle position sensor to determine the desired engine speed. The ECM compares the desired engine speed to the actual engine speed. The actual engine speed is determined through interpretation of the signals that are received by the ECM from the engine speed/timing sensors. If the desired engine speed is greater than the actual engine speed, the ECM requests that more fuel is injected in order to increase engine speed.

Timing Considerations

Once the ECM has determined the amount of fuel that is required, the ECM must determine the timing of the fuel injection. Fuel injection timing is determined by the ECM after processing input from the following components:

- Coolant temperature sensor
- Intake manifold temperature sensor
- Intake manifold pressure sensor

- Atmospheric pressure sensor

The ECM adjusts timing for optimum engine performance and for the fuel economy. Actual timing and desired timing cannot be viewed with Caterpillar Electronic Technician (ET). The ECM determines the location of top center of the number one cylinder from the signals that are provided by the engine speed/timing sensors. The ECM determines when injection should occur relative to the top center. The ECM then provides the signal to the injector at the desired time.

Fuel Injection

The ECM sends high voltage signals to the injector solenoids in order to energize the solenoids. By controlling the timing and the duration of the high voltage signals, the ECM can control the following aspects of injection:

- Injection timing
- Fuel delivery

The flash file inside the ECM establishes certain limits on the amount of fuel that can be injected. The "FRC Fuel Limit" is a limit that is based on the intake manifold pressure. The "FRC Fuel Limit" is used to control the air/fuel ratio for control of emissions. When the ECM senses a higher intake manifold pressure, the ECM increases the "FRC Fuel Limit". A higher intake manifold pressure indicates that there is more air in the cylinder. When the ECM increases the "FRC Fuel Limit", the ECM changes the control signal to the injector. The signal will allow more fuel into the cylinder.

The "Rated Fuel Limit" is a limit that is based on the power rating of the engine and on the engine rpm. The "Rated Fuel Limit" is like the rack stops and the torque spring on a mechanically governed engine. The "Rated Fuel Limit" provides the power curves and the torque curves for a specific engine family and a specific engine rating. All of these limits are determined at the factory. These limits cannot be changed.

Other ECM Functions for Performance

The ECM may also provide enhanced control of the engine for functions such as retarding the engine and controlling the cooling fan. Refer to Troubleshooting, "Configuration Parameters" for supplemental information about the systems that can be monitored by the ECM.

Programmable Parameters

Certain parameters that affect engine operation may be changed with Cat ET. The parameters are stored in the ECM, and the parameters are protected from unauthorized changes by passwords. These parameters are either system configuration parameters or customer parameters.

System configuration parameters are set at the factory. System configuration parameters affect emissions or power ratings within an engine family. Factory passwords must be obtained and factory passwords must be used to change the system configuration parameters.

Some of the parameters may affect engine operation in an unusual way. An operator might not expect this type of effect. Without adequate training, these parameters may lead to power complaints or performance complaints even though the engines performance is to the specification.

Customer parameters are variable. Customer parameters can be used to affect the characteristics of the engine. Limits are set by the factory and by the monitoring system.

Customer passwords may be required to change customer specified parameters.

Refer to Troubleshooting, "Configuration Parameters" for additional information on this subject.

Passwords

System configuration parameters are protected by factory passwords. Factory passwords are calculated on a computer system that is available only to Caterpillar dealers. Since factory passwords contain alphabetic characters, only Cat ET may change system configuration parameters.

Customer parameters can be protected by customer passwords. The customer passwords are programmed by the customer. Factory passwords can be used to change customer passwords if customer passwords are lost.

Refer to Troubleshooting, "Customer Passwords" and Troubleshooting, "Factory Passwords" for additional information on this subject.

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Component Location

SMCS Code: 1000; 1900

Electronic Control Circuit Diagram

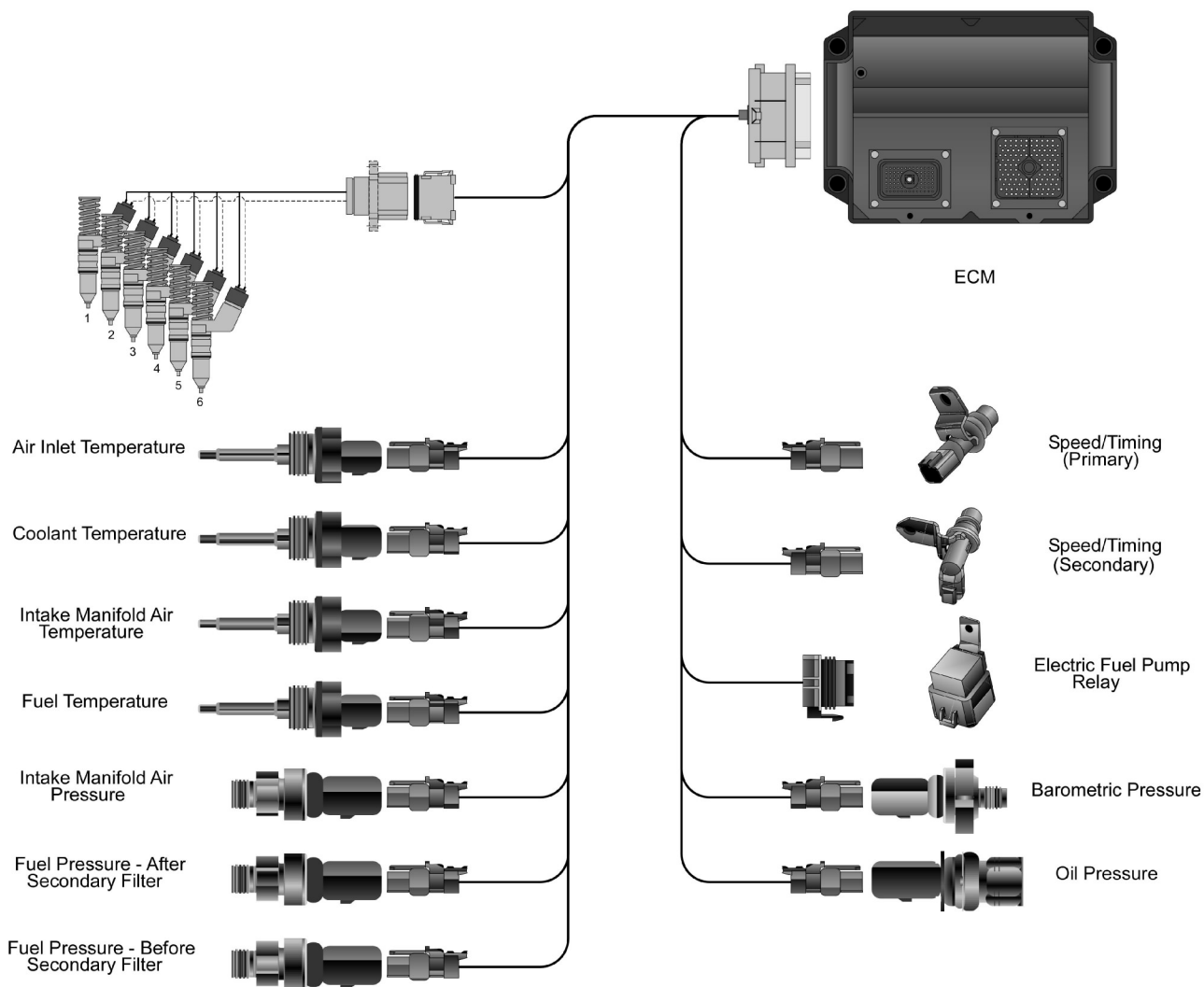


Illustration 7
Electronic system overview

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Sensor Locations

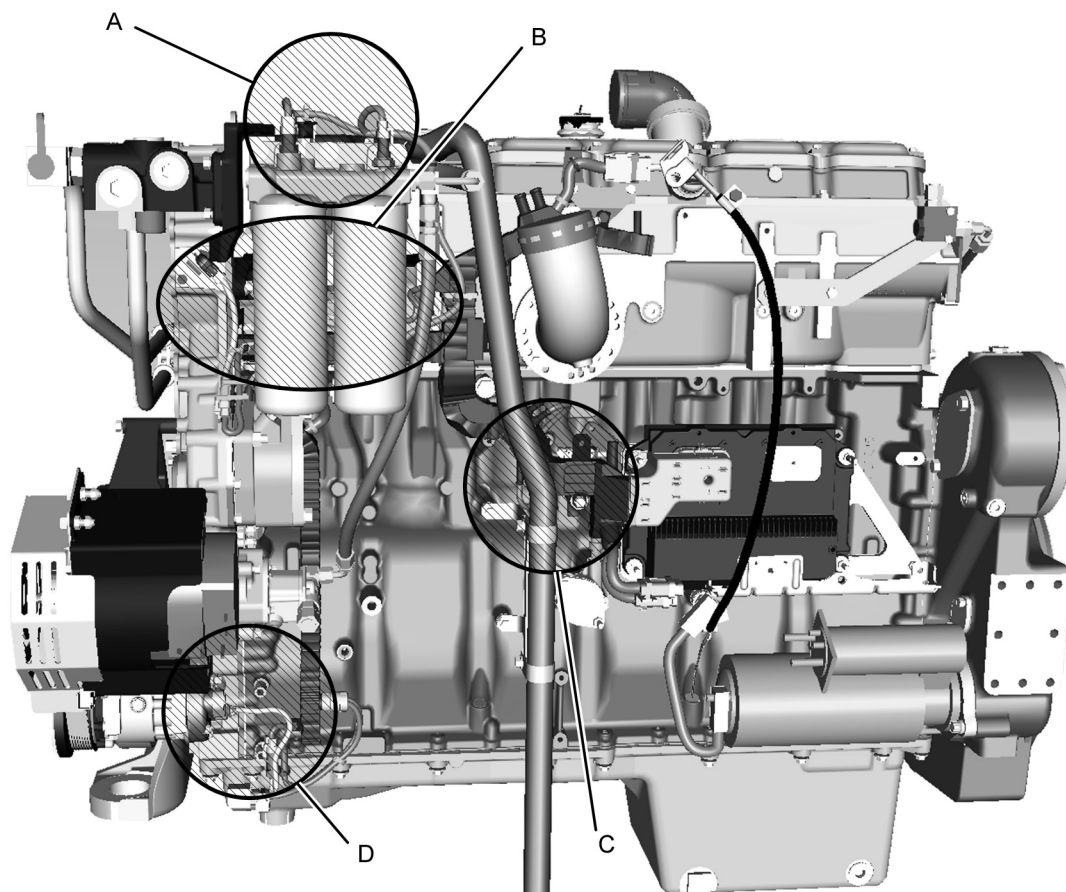


Illustration 8

g02176512

(A) Refer to "View A" for a detailed illustration.
(B) Refer to "View B" for a detailed illustration.

(C) Refer to "View C" for a detailed illustration.
(D) Refer to "View D" for a detailed illustration.

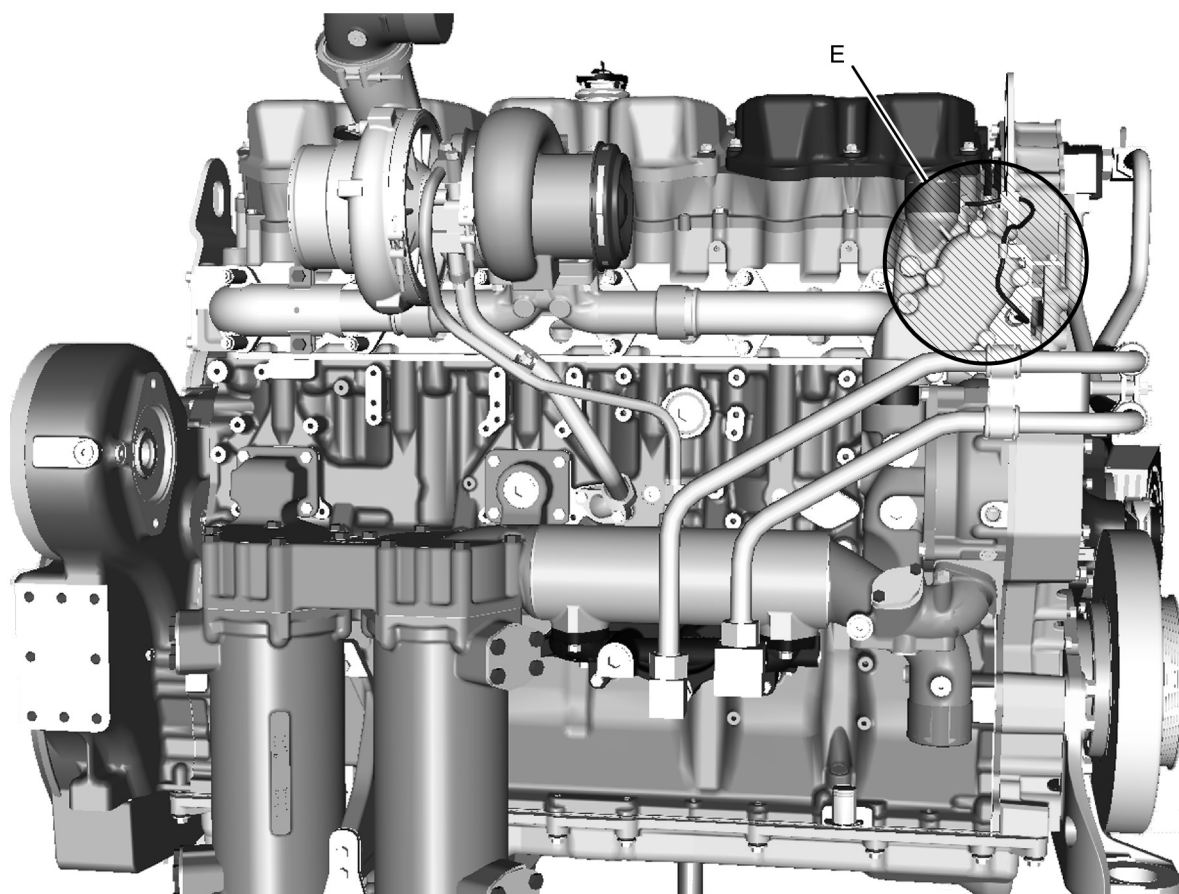


Illustration 9

(E) Refer to "View E" for a detailed illustration.

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View A

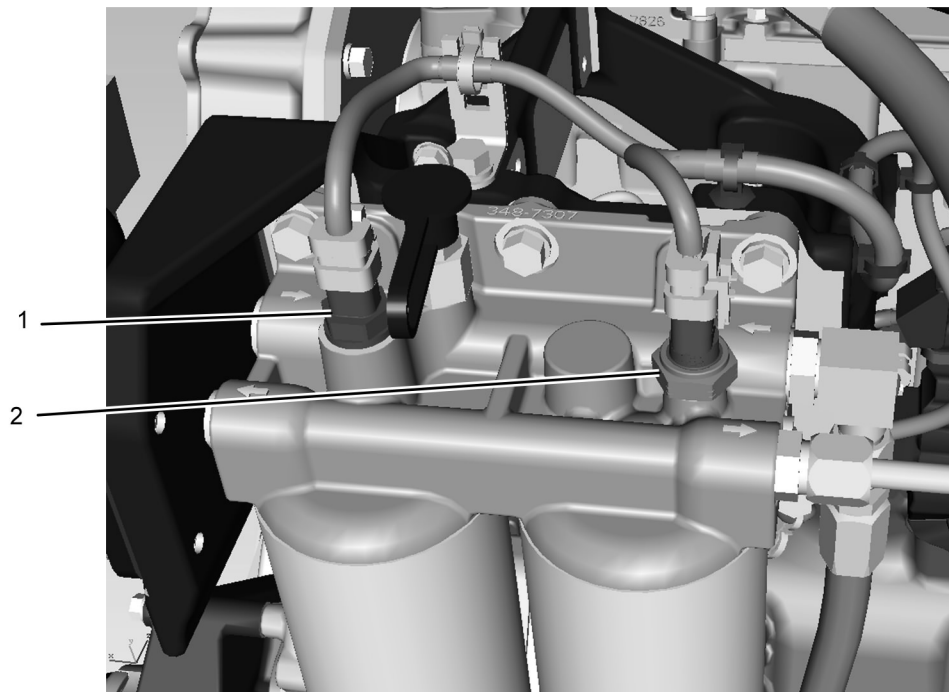


Illustration 10

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(1) Fuel temperature sensor

(2) Fuel pressure sensor

View B

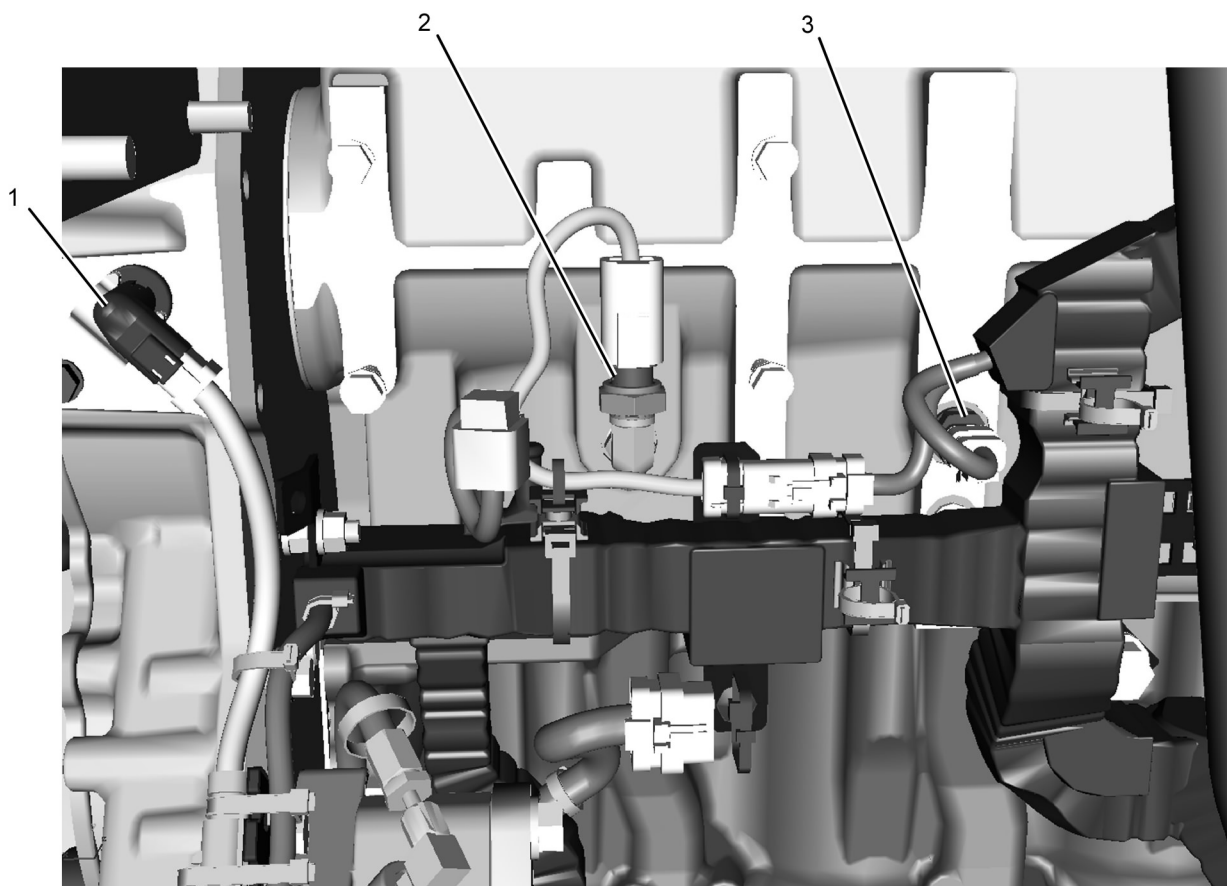


Illustration 11

g02176528

(1) Camshaft speed/timing sensor

(2) Intake main air pressure sensor

(3) Intake main air temperature sensor

View C

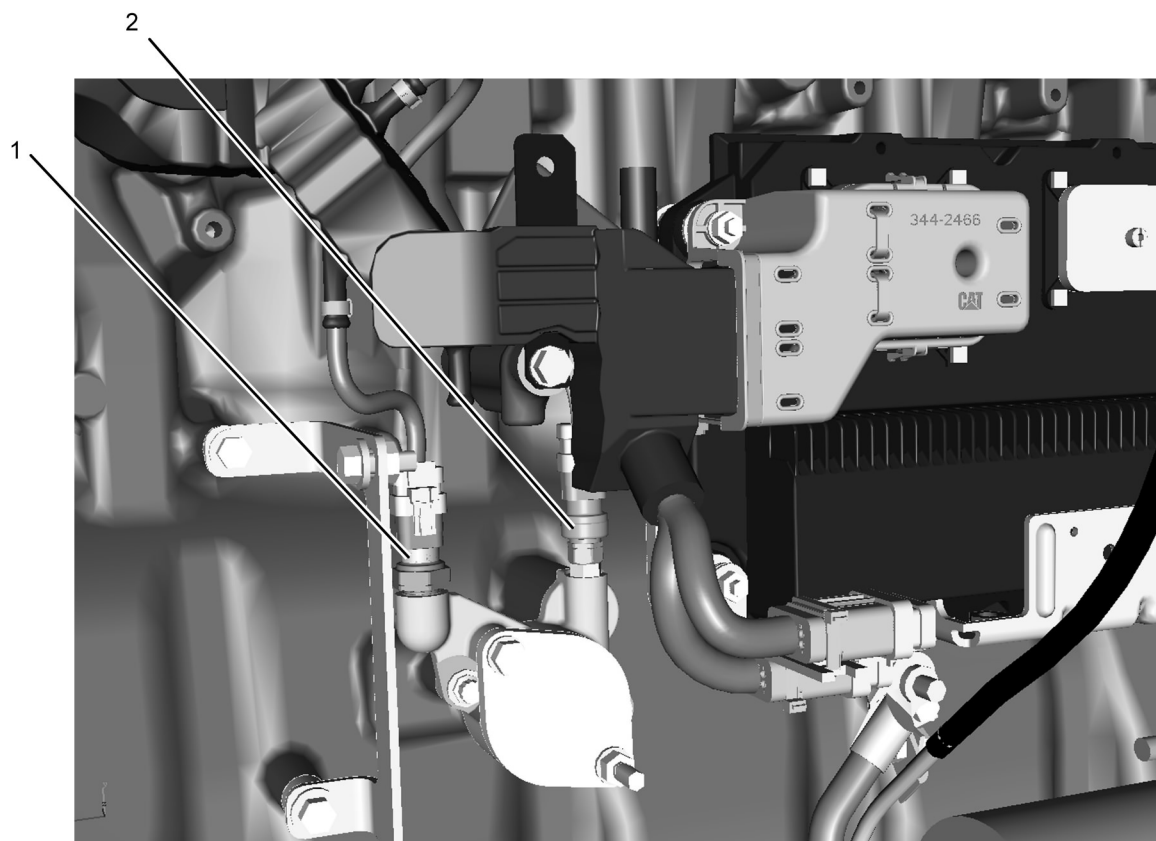


Illustration 12

g02176536

(1) Barometric pressure sensor

(2) Oil pressure sensor

View D

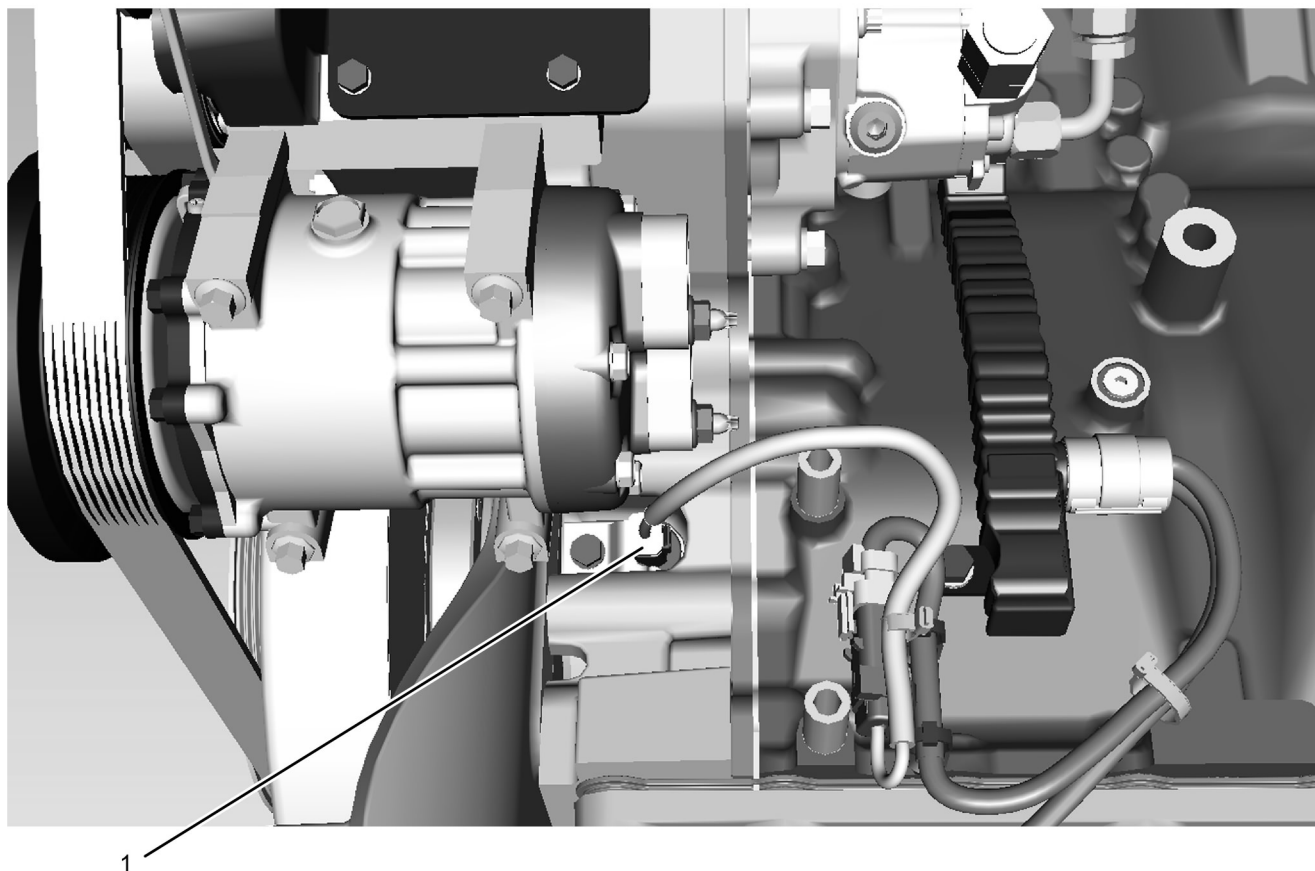


Illustration 13
(1) Crankshaft speed/timing sensor

g02176554

View E

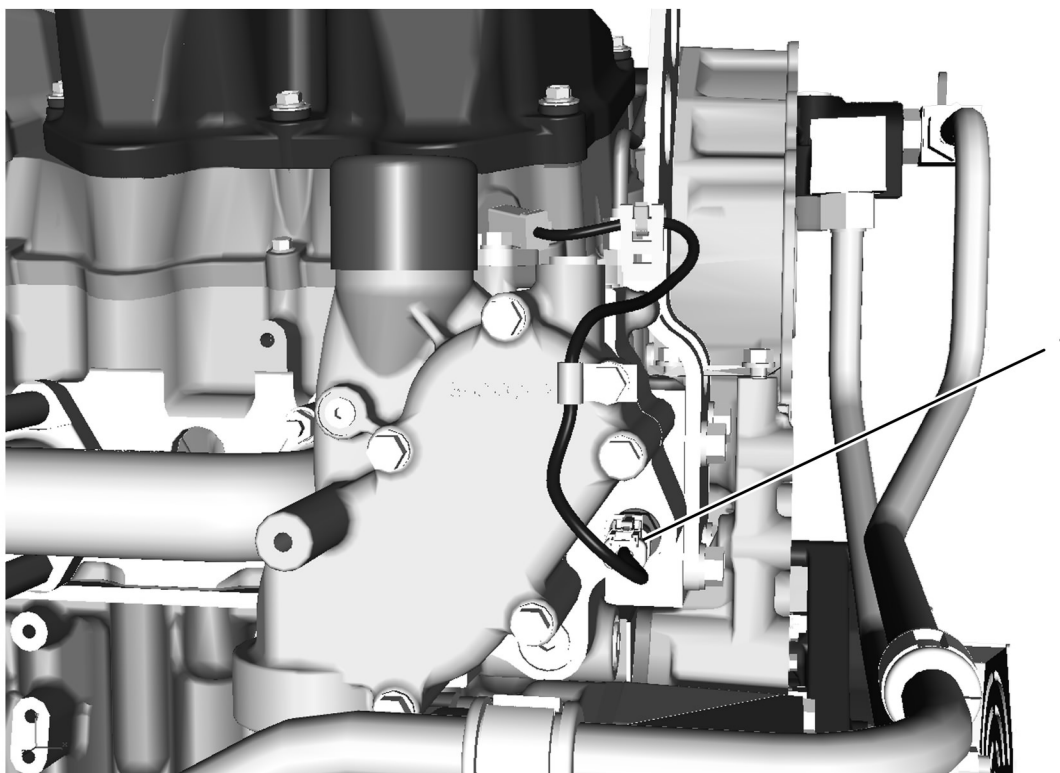


Illustration 14

g02176559

(1) Coolant temperature sensor

i03557540

Engine Monitoring System

SMCS Code: 1900

The Electronic Control Module (ECM) provides a comprehensive, programmable engine monitoring system for this engine. The ECM monitors specific engine operating parameters in order to detect abnormal conditions that may develop. The ECM will generate an event code if a specific engine parameter exceeds an acceptable range that is defined by the engine monitoring system. The ECM will react with an action that is dependent on the severity of the condition. For information on event codes, refer to Troubleshooting, "Event Codes".

The following actions may be initiated by the ECM. These actions are dependent on the severity of the condition.

- Illumination of a warning lamp or warning alarm

- Engine derate
- Engine shutdown

Three possible responses may be available for each parameter. Some of the responses are not available for some of the parameters. Refer to Table 7.

Table 7

Indicators (1), (2), and (3)	
Warning Category Indicator	Severity
(1)	Least Severe
(2)	Moderate Severity
(3)	Most Severe

Use Caterpillar Electronic Technician (ET) to perform the following activities for the monitoring system:

- Viewing parameters

- Parameter programming
- Set delay times

The default settings for the parameters are programmed at the factory. To accommodate unique applications and sites, some of the parameters may be reprogrammed with Cat ET. Use Cat ET to modify the monitoring system parameters.

Note: Some parameters do not require a password in order to be changed. Other parameters can be changed with customer passwords. Some of the parameters are protected by factory passwords. Some parameters cannot be changed. Some applications do not allow any changes to the programmable monitoring system. Parameters that are protected by factory passwords can only be changed by dealer personnel.

Viewing or Changing the Settings of the Monitoring System

Use the following procedure in order to view the parameter settings and/or change the parameter settings:

1. Select the "Service/Monitoring System" screen on Cat ET.

Note: Ensure that you select the correct ECM for the parameters that are being changed before continuing.

2. Highlight the desired parameter. Then click the "Change" button in the lower left corner of the screen.

The "Change Monitor System" screen will appear.

3. Change the "State" of the parameter.
4. Set the "Trip Point" and the "Delay Time" according to the "Allowed Values" that are displayed in the lower half of the screen.
5. Click the "OK" button.

If a password is required, the "Enter Passwords" screen will appear. Enter the correct passwords and then click the "OK" button.

Note: If a factory password is required, the "Enter Factory Passwords" screen will appear. Refer to Troubleshooting, "Factory Passwords" for information that is related to obtaining factory passwords.

The new settings will be effective immediately.

Note: Factory passwords are only available to service technicians from an authorized Caterpillar Dealership. Customers of Caterpillar do not have access to the Caterpillar Factory Password System (FPS).

i03559441

Diagnostic Capabilities

SMCS Code: 1900

Diagnostic Codes

The engines Electronic Control Module (ECM) can monitor the circuitry between the ECM and the engines components. The ECM can also monitor the engines operating conditions. If the ECM detects a problem, a code is generated.

There are two categories of codes:

- Diagnostic code
- Event code

Diagnostic Code – A diagnostic code indicates an electrical problem such as a short circuit or an open circuit in the engines wiring or in an electrical component.

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. Generally, event codes indicate abnormal operating conditions or mechanical problems rather than electrical problems.

Codes can have two different states:

- Active
- Logged

Active Codes

An active code indicates that a problem is present. Service the active code first. For the appropriate troubleshooting procedure for a particular code, refer to the following troubleshooting procedure:

- Troubleshooting, "Diagnostic Trouble Codes"
- Troubleshooting, "Event Codes"

Logged Codes

The codes are logged and stored in the ECM memory. The problem may have been repaired and/or the problem may no longer exist. If the system is powered, an active diagnostic code may be generated whenever a component is disconnected. If the component is reconnected, the code is no longer active but the code may become logged.

Logged codes may not indicate that a repair is needed. The problem may have been temporary. 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.

An additional status screen is available for the Enhanced Troubleshooting Indicator ETI. The screen is accessed through Caterpillar Electronic Technician (ET).

i03496620

Programmable Parameters

SMCS Code: 1900

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. There are some parameters that cannot be changed and there are some applications that do not allow any changes to the programmable monitoring system. 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.

i04233309

Electrical Connectors

SMCS Code: 7553-WW

Connectors for the Electronic Control Module (ECM)

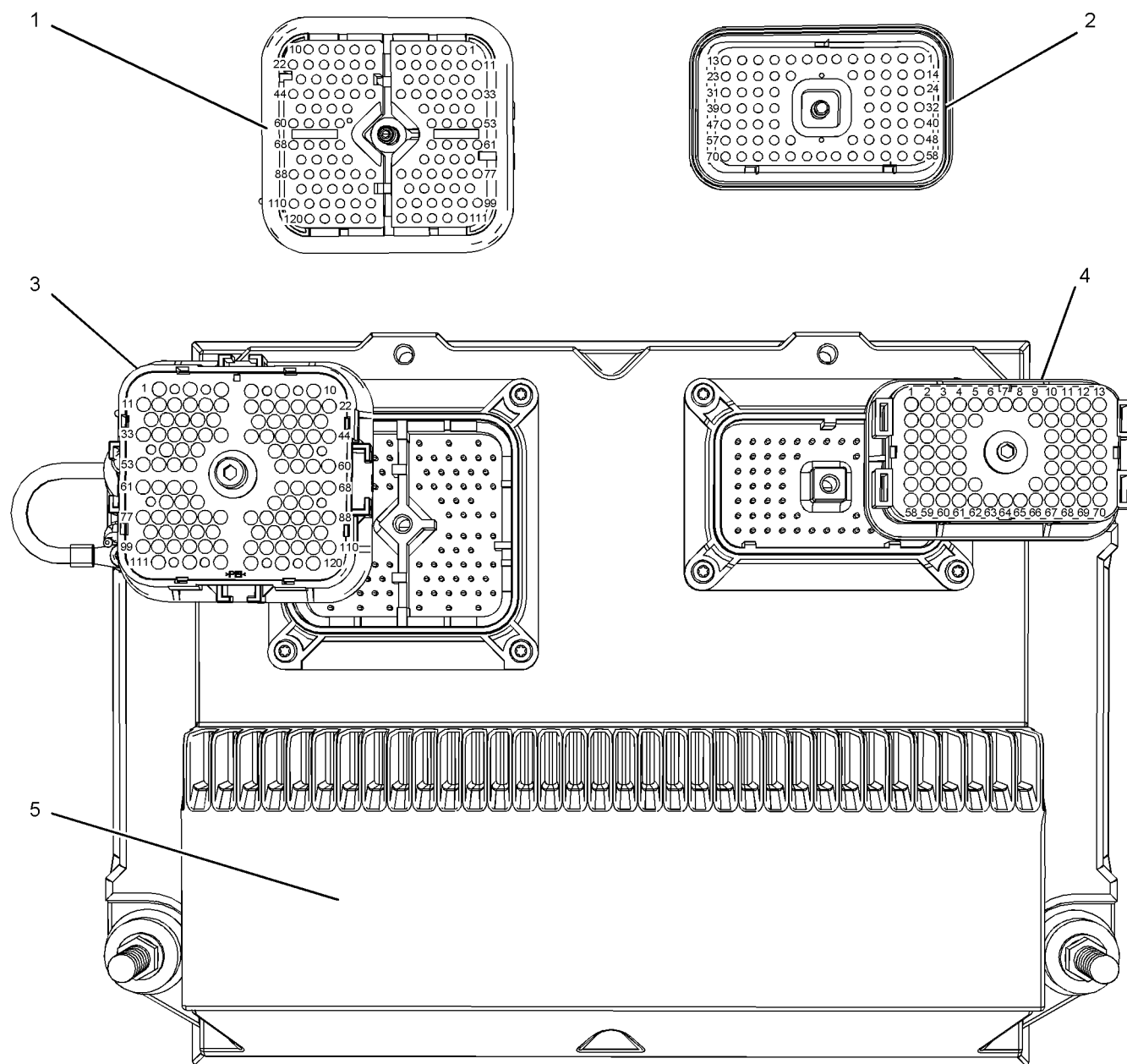


Illustration 15

g02141017

Locations of the components at the ECM

- (1) P2 ECM connector (ECM side)
- (2) P1 ECM connector (ECM side)

- (3) P2 ECM connector (harness side)
- (4) P1 ECM connector (harness side)

- (5) ECM

Injector Connectors

Connectors at the Valve Cover

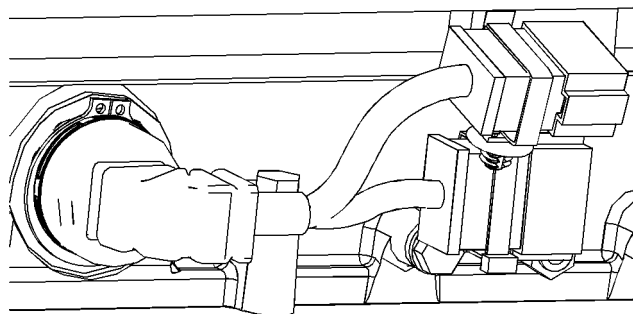
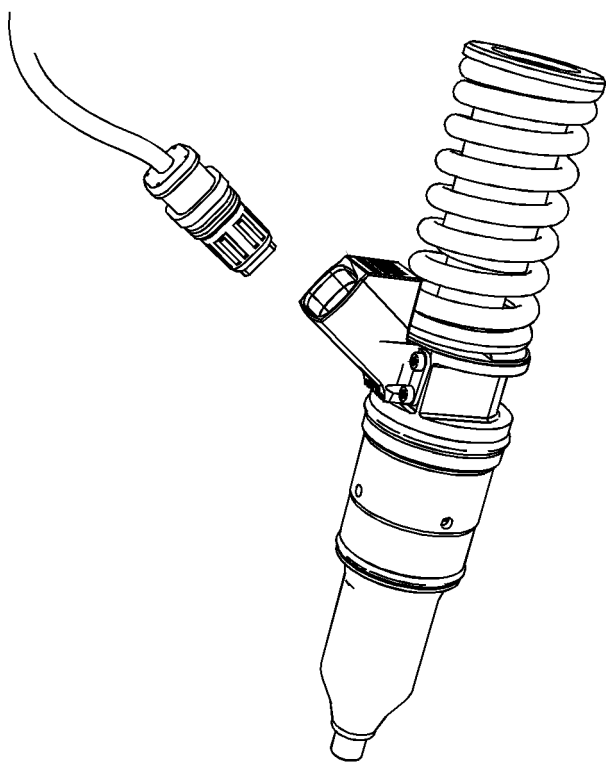


Illustration 16

g01746753

Connector at the Injector

Illustration 17
Typical injector

g01717773

Sensor Connectors

Analog Sensor Connector (active)

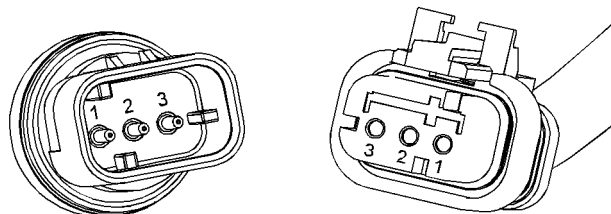


Illustration 18

g01240891

Analog Sensor Connector (passive)

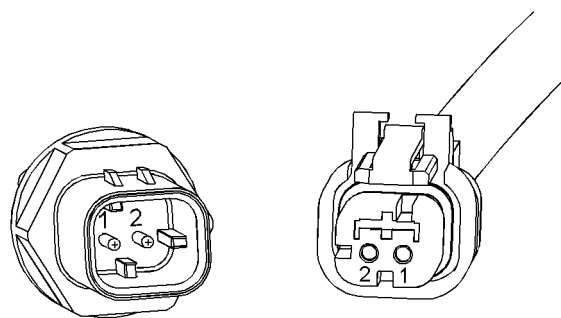


Illustration 19

g01241538

Connectors for the Termination Resistor

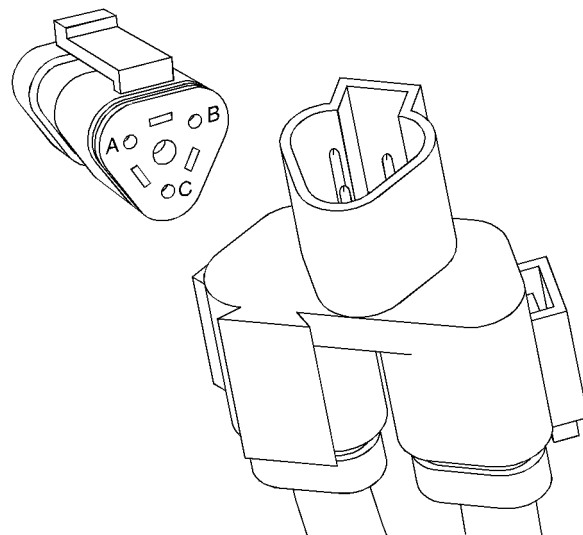


Illustration 20

g01355248

Engine Speed/Timing Connector

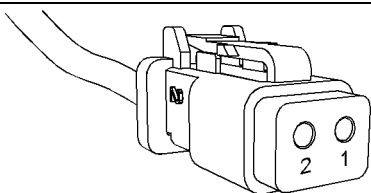


Illustration 21

g01155187

Ampseal Connector (typical)

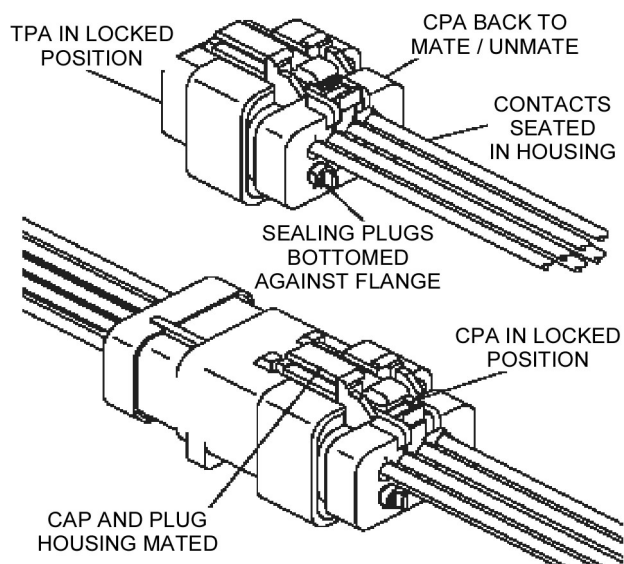


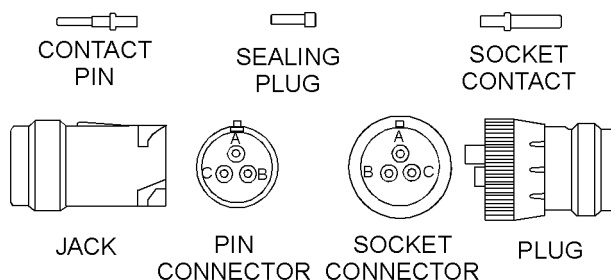
Illustration 22

g02219254

Refer to Special Instruction, REHS2556 for additional information

Deutsch Connectors (typical)

HD Connectors



DT Connectors

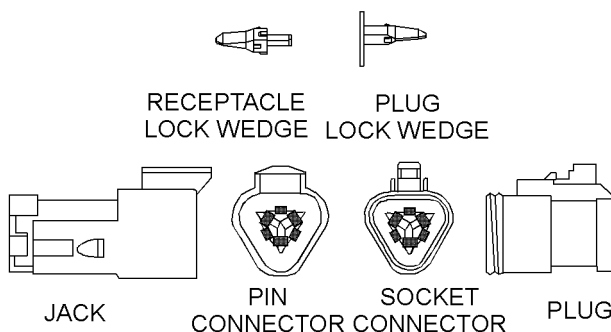


Illustration 23

g02220494

Refer to Tool Operating Manual, SEHS9615, "Servicing Deutsch HD and DT Style Connectors" for additional information

Configuration Parameters

i03979969

Configuration Parameters

SMCS Code: 1900

Use this procedure if the diagnostic code in Table 8 is active.

Table 8

Codes That Relate to Configuration Parameters		
Code	Code Description	Comments
268-2	Programmed Parameter Fault : Erratic, Intermittent, or Incorrect	The engines Electronic Control Module (ECM) detects that one or more of the programmable parameters have not been programmed. The ECM may use a default torque map or the ECM may limit the engine to low idle. The code is active only.
Follow the troubleshooting procedure in order to identify the root cause of the problem.		

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. Some parameters cannot be changed and some applications do not allow any changes to the programmable monitoring system. 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.

The parameters are divided into two different types:

Customer Specified Parameters – Customer passwords may be required to change the values of customer specified parameters.

System Configuration Parameters – System configuration parameters affect the emissions of the engine or the power of the engine. Factory passwords may be required to change the values of system configuration parameters.

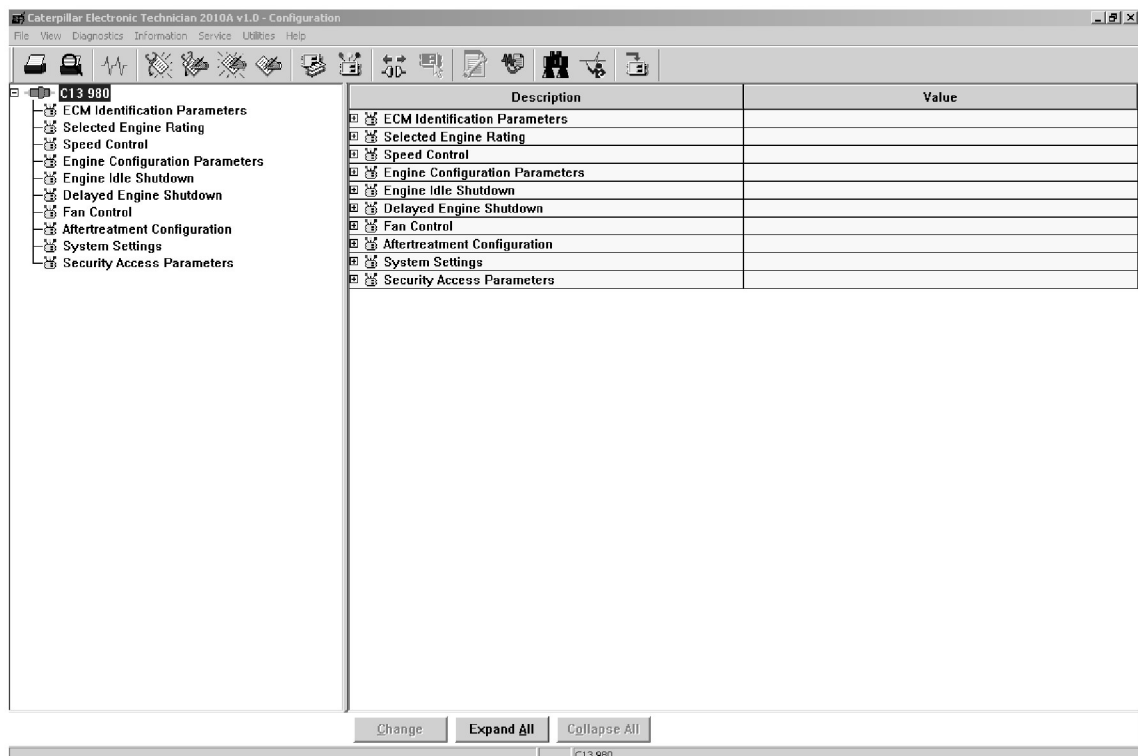


Illustration 24

g02161343

Typical configuration screen

1. Connect to Cat ET.
2. Select the Service tab.
3. Select the Configuration tab to view the configuration parameters.

If an ECM is replaced, the appropriate parameters must be copied from the old ECM. Copy the parameters with the "Copy Configuration" feature of the Cat ET. The "Copy Configuration" tab is below the "Configuration" tab. Alternatively, the settings can be recorded on paper and then programmed into the configuration screen that is for the new module.

NOTICE

Changing the parameters during engine operation can cause the engine to operate erratically. Changing the parameters during engine operation can cause engine damage.

Only change the settings of the parameters when the engine is STOPPED.

Check Programmable Parameters (268-2)

If a programmable parameter has not been programmed, the ECM will generate a 268-2 diagnostic code. The programmable parameter that is not programmed will be listed under the code. The unprogrammed parameters will be set to default. Certain aspects of the engines performance and engine monitoring may be affected.

If "Injector Trim" is displayed below a 268-2 diagnostic code on Caterpillar Electronic Technician (ET), refer to Troubleshooting, "Injector Trim File - Install".

Diagnostic Trouble Codes

i04513818

Diagnostic Trouble Codes

SMCS Code: 1900

Cross-Reference Information for Diagnostic Codes

Table 9 is a list of the diagnostic codes for the engine. The diagnostic codes are cross-referenced with the appropriate procedure that can be used to troubleshoot the code.

For information on flash codes, refer to Troubleshooting, "Diagnostic Code Cross Reference".

Further explanations of diagnostic codes are explained after Table 9.

Table 9

Cross-Reference from CID-FMI Code on Cat Data Link to Troubleshooting Procedure	
Code and Description	Procedure
1-5 Cylinder #1 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
1-6 Cylinder #1 Injector current above normal	
2-5 Cylinder #2 Injector current below normal	
2-6 Cylinder #2 Injector current above normal	
3-5 Cylinder #3 Injector current below normal	
3-6 Cylinder #3 Injector current above normal	
4-5 Cylinder #4 Injector current below normal	
4-6 Cylinder #4 Injector current above normal	
5-5 Cylinder #5 Injector current below normal	
5-6 Cylinder #5 Injector current above normal	
6-5 Cylinder #6 Injector current below normal	
6-6 Cylinder #6 Injector current above normal	
41-3 8 Volt DC Supply : Voltage Above Normal	Troubleshooting, "Sensor Supply - Test"
41-4 8 Volt DC Supply : Voltage Below Normal	Troubleshooting, "Sensor Supply - Test"
91-3 Throttle Position Sensor : Voltage Above Normal	Troubleshooting, "Speed Control - Test"
91-4 Throttle Position Sensor : Voltage Below Normal	Troubleshooting, "Speed Control - Test"

(continued)

(Table 9, contd)

Cross-Reference from CID-FMI Code on Cat Data Link to Troubleshooting Procedure	
Code and Description	Procedure
91-8 Throttle Position Sensor abnormal frequency, pulse width, or period	Troubleshooting, "Speed Control - Test"
100-3 Engine Oil Pressure Sensor voltage above normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
100-4 Engine Oil Pressure Sensor voltage below normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
100-13 Engine Oil Pressure Sensor : Calibration Required	Troubleshooting, "Sensor Calibration Required - Test"
110-3 Engine Coolant Temperature Sensor voltage above normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
110-4 Engine Coolant Temperature Sensor voltage below normal	
168-2 Electrical System Voltage : Erratic, Intermittent, or Incorrect	Troubleshooting, "Electrical Power Supply - Test"
168-3 Electrical System Voltage : Voltage Above Normal	
168-4 Electrical System Voltage : Voltage Below Normal	
172-3 Intake Manifold Air Temperature Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
172-4 Intake Manifold Air Temperature Sensor : Voltage Below Normal	
174-3 Fuel Temperature Sensor : Voltage Above Normal	
174-4 Fuel Temperature Sensor : Voltage Below Normal	
190-8 Engine Speed Sensor abnormal frequency, pulse width, or period	Troubleshooting, " Engine Speed- Test"
246-9 Proprietary CAN Data Link : Abnormal Update Rate	Troubleshooting, "Data Link - Test"
246-14 Proprietary CAN Data Link : Special Instruction	Troubleshooting, "Data Link Configuration Status - Test"
247-9 SAE J1939 Data Link : Abnormal Update Rate	Troubleshooting, "Data Link - Test"
247-14 SAE J1939 Data Link : Special Instruction	Troubleshooting, "Data Link Configuration Status - Test"
253-2 Personality Module : Erratic, Intermittent, or Incorrect	Troubleshooting, "ECM Software - Install"
261-11 Engine Timing Offset fault	Troubleshooting, "Engine Speed - Test"
261-13 Engine Timing Calibration : Calibration Required	Troubleshooting, "Timing - Calibrate"
262-3 5 Volt Sensor DC Power Supply : Voltage Above Normal	Troubleshooting, "Sensor Supply - Test"
262-4 5 Volt Sensor DC Power Supply : Voltage Below Normal	
267-3 Remote Shutdown Input : Voltage Above Normal	Troubleshooting, "Shutdown (Ground Level) - Test"
267-4 Remote Shutdown Input : Voltage Below Normal	Troubleshooting, "Shutdown (Ground Level) - Test"
268-2 Programmed Parameter Fault : Erratic, Intermittent, or Incorrect	Troubleshooting, "Configuration Parameters"
274-3 Atmospheric Pressure Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
274-4 Atmospheric Pressure Sensor : Voltage Below Normal	
274-13 Atmospheric Pressure Sensor : Calibration Required	Troubleshooting, "Sensor Calibration Required - Test"
274-21 Atmospheric Pressure Sensor : Data Drifted Low	Troubleshooting, "Sensor Supply - Test"

(continued)

(Table 9, contd)

Cross-Reference from CID-FMI Code on Cat Data Link to Troubleshooting Procedure	
Code and Description	Procedure
291-5 Engine Cooling Fan Solenoid : Current Below Normal	Troubleshooting, "Cooling Fan Control - Test"
291-6 Engine Cooling Fan Solenoid : Current Above Normal	Troubleshooting, "Cooling Fan Control - Test"
296-9 Transmission Control : Abnormal Update Rate	Troubleshooting, "Data Link - Test"
296-14 Transmission Control : Special Instruction	Troubleshooting, "Data Link Configuration Status - Test"
342-8 Secondary Engine Speed Sensor : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, "Engine Speed - Test"
460-3 Fuel Pressure Sensor - After Fuel Filter : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
460-4 Fuel Pressure Sensor - After Fuel Filter : Voltage Below Normal	
460-21 Fuel Pressure Sensor - After Fuel Filter : Data Drifted Low	Troubleshooting, "Sensor Supply - Test"
533-9 Brake Control : Abnormal Update Rate	Troubleshooting, "Data Link - Test"
533-14 Brake Control : Special Instruction	Troubleshooting, "Data Link Configuration Status - Test"
544-2 Engine Cooling Fan Speed Sensor : Erratic, Intermittent, or Incorrect	Troubleshooting, "Cooling Fan Speed - Test"
544-8 Engine Cooling Fan Speed Sensor : Abnormal Frequency, Pulse Width, or Period	Troubleshooting, "Cooling Fan Speed - Test"
1273-9 Chassis Control Module : Abnormal Update Rate	Troubleshooting, "Data Link - Test"
1273-14 Chassis Control Module : Special Instruction	Troubleshooting, "Data Link Configuration Status - Test"
1627-5 Fuel Pump Relay : Current Below Normal	, ⁴⁴³⁹
1627-6 Fuel Pump Relay : Current Above Normal	, ⁴⁴³⁹
1639-2 Machine Security System Module : Erratic, Intermittent, or Incorrect	Troubleshooting, "Data Link - Test"
1639-9 Machine Security System Module : Abnormal Update Rate	Troubleshooting, "Data Link - Test"
1785-3 Intake Manifold Pressure Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
1785-4 Intake Manifold Pressure Sensor : Voltage Below Normal	
1785-13 Intake Manifold Pressure Sensor : Calibration Required	Troubleshooting, "Sensor Calibration Required - Test"
1785-21 Intake Manifold Pressure Sensor : Data Drifted Low	Troubleshooting, "Sensor Supply - Test"
1834-2 Ignition Key Switch loss of signal	Troubleshooting, "Electrical Power Supply - Test"
2131-3 5 Volt Sensor DC Power Supply #2 : Voltage Above Normal	Troubleshooting, "Sensor Supply - Test"
2131-4 5 Volt Sensor DC Power Supply #2 : Voltage Below Normal	Troubleshooting, "Sensor Supply - Test"
2417-5 Ether Injection Control Solenoid : Current Below Normal	Troubleshooting, "Either Starting Aid - Test"
2417-6 Ether Injection Control Solenoid : Current Above Normal	Troubleshooting, "Either Starting Aid - Test"
2526-3 Air Inlet Temperature Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
2526-4 Air Inlet Temperature Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"

(continued)

(Table 9, contd)

Cross-Reference from CID-FMI Code on Cat Data Link to Troubleshooting Procedure	
Code and Description	Procedure
2533-5 Compression Brake Low/High yeaSolenoid #1 : Current Below Normal	Troubleshooting, "Retarder - Test"
2533-6 Compression Brake Low/High Solenoid #1 : Current Above Normal	Troubleshooting, "Retarder - Test"
2535-5 Compression Brake Medium/High Solenoid #1 : Current Below Normal	Troubleshooting, "Retarder - Test"
2535-6 Compression Brake Medium/High Solenoid #1 : Current Above Normal	Troubleshooting, "Retarder - Test"
2738-3 Turbocharger #1 Compressor Inlet Pressure Sensor : Voltage Above Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
2738-4 Turbocharger #1 Compressor Inlet Pressure Sensor : Voltage Below Normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"

Diagnostic Codes

Diagnostic codes alert the operator that a problem in the electronic system has been detected. Diagnostic codes are also used by the service technician to identify the nature of the problem. Caterpillar Electronic Technician (ET) is a software program that is designed to run on a personal computer. The software can be used by the service technician in order to view the diagnostic code information for an ECM. Diagnostic codes may consist of the component identifier (CID), and the failure mode identifier (FMI).

Component Identifier (CID) – The CID indicates the component that generated the code. For example, the CID number 1 identifies the fuel injector for the number one cylinder.

Failure Mode Identifier (FMI) – The FMI indicates the type of failure.

Refer to Table 9 for a complete list of the diagnostic codes and the appropriate troubleshooting procedure.

Note: 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. If an event code is active, refer to Troubleshooting, "Event Code List".

Illustration 25 is an example of the operating range of a sensor.

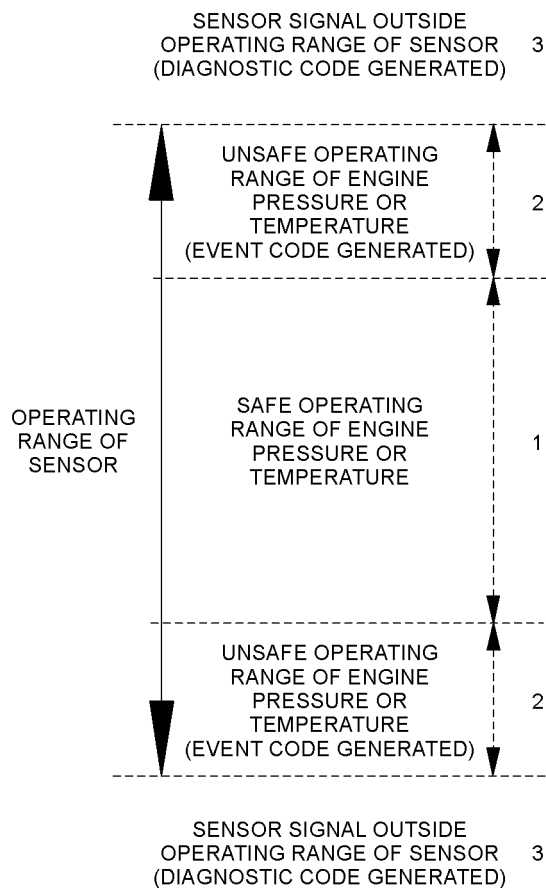


Illustration 25

g01365757

Example of the typical operating range of a sensor

- (1) This area represents the normal operating range of the engine parameter.
- (2) In these areas, the engine is operating in an unsafe operating range of the monitored parameter. An event code will be generated for the monitored parameter. The sensor circuit does not have an electronic problem. Refer to Troubleshooting, "Event Code List" for additional information on event codes.
- (3) In these areas, the signal from the sensor is outside of the operating range of the sensor. The sensor circuit has an electronic problem. A diagnostic code will be generated for the sensor circuit.

Active Diagnostic Codes

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

When the engine 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.

Event Codes

i03982150

Event Codes

SMCS Code: 1900

Cross-Reference Information for Event Codes

Table 10 is a list of the event codes for the engine. The event codes are cross-referenced with the appropriate procedure that can be used to troubleshoot the code.

Event codes are generated when abnormal operating conditions exist. A further explanation of event codes and the engine monitoring system are described after Table 10.

Table 10

Cross-Reference from Event Codes on Cat Data Link to Troubleshooting Procedure	
Code and Description	Troubleshooting Procedure
E096(2) High Fuel Pressure	Troubleshooting, "Fuel Pressure Is High"
E198(2) Low Fuel Pressure	Troubleshooting, "Fuel Pressure Is Low"
E232(1) High Fuel/Water Separator Water Level	Troubleshooting, "Fuel System Water Separator Has Water"
E232(2) High Fuel/Water Separator Water Level	
E265(2) User Defined Shutdown	Troubleshooting, "Engine Shutdown Occurrence"
E360(1) Low Engine Oil Pressure	Troubleshooting, "Oil Pressure Is Low"
E360(2) Low Engine Oil Pressure	
E360(3) Low Engine Oil Pressure	
E361(1) High Engine Coolant Temperature	Troubleshooting, "Coolant Temperature Is High"
E361(2) High Engine Coolant Temperature	
E361(3) High Engine Coolant Temperature	
E362(1) Engine Overspeed	Troubleshooting, "Engine Overspeeds"
E362(3) Engine Overspeed	
E363(1) High Fuel Supply Temperature	Troubleshooting, "Fuel Temperature Is High"
E363(2) High Fuel Supply Temperature	
E363(3) High Fuel Supply Temperature	
E441(1) Idle Elevated to Increase Battery Voltage	Troubleshooting, "Idle Speed Is High"
E539(1) High Intake Manifold Air Temperature	Troubleshooting, "Intake Manifold Air Temperature Is High"
E539(2) High Intake Manifold Air Temperature	
E539(3) High Intake Manifold Air Temperature	
E583(1) High Air Inlet #1 Differential Pressure	Troubleshooting, "Inlet Air Is Restricted"
E583(2) High Air Inlet #1 Differential Pressure	
E678(2) Ground Level Shutdown	Troubleshooting, "Shutdown (Ground Level) - Test"
E1045(2) Low Intake Manifold Pressure	Troubleshooting, "Intake Manifold Air Pressure Is Low"
E1171(1) Engine Idle Shutdown Occurred	Troubleshooting, "Engine Shutdown While Idling"
E1172(3) Engine Idle Shutdown Pending	Troubleshooting, "Engine Shutdown While Idling"
E1217(3) Delayed Engine Shutdown Override	The code will be logged. The "Delayed Engine Shutdown" has been overridden. The engine will be shut down. No troubleshooting is required.
E1363(1) Low Engine Cooling Fan Speed	Troubleshooting, "Cooling Fan Speed - Test"

Parts of the Event Code

Event Code – The "E" identifies the code as an event code. The "XXX(X)" represents a numeric identifier for the event code. The fourth "(X)" assigns one of three levels to the active event code according to the severity of the abnormal system condition. The code is followed by a description of the code. Refer to the following example:

- E360(1) Low Oil Pressure

- E360(2) Low Oil Pressure
- E360(3) Low Oil Pressure

The definition for the levels of severity for an event are defined below:

Level 1 – Level 1 alerts the operator that an engine system requires attention. The operator should check that the involved system condition or the operator should perform maintenance on the involved system at the earliest possible time.

Level 2 – Level 2 requires a change in the operation of the engine or the performance of a maintenance procedure. Failure to correct the problem may result in damage to the engine components.

Level 3 – Level 3 requires an immediate safe shutdown of the engine in order to avoid damage to the engine or injury to personnel around the engine. The problem that caused the event must be corrected before engine operation can resume.

Active Event Codes

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

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

Illustration 26 is an example of the operating range of a sensor.

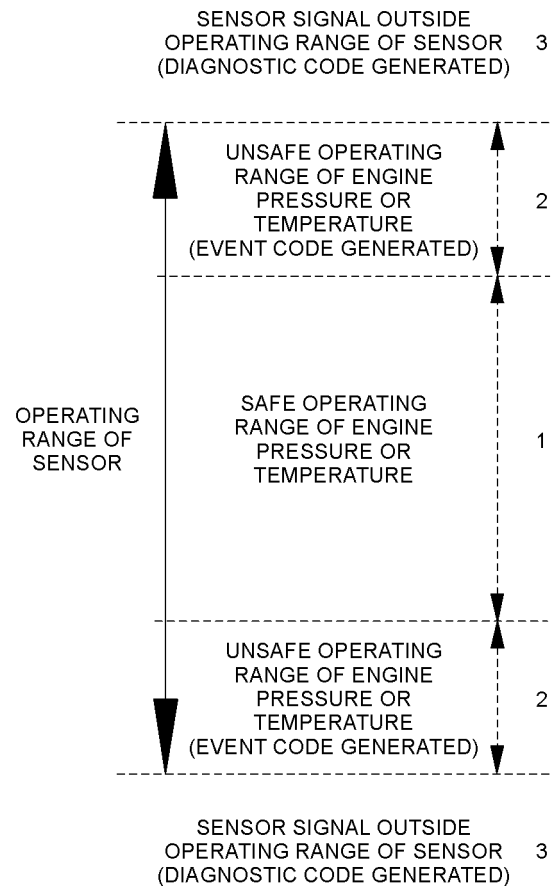


Illustration 26

g01365757

Example of the typical operating range of a sensor

- (1) This area represents the normal operating range of the engine parameter.
- (2) In these areas, the engine is operating in an unsafe operating range of the monitored parameter. An event code will be generated for the monitored parameter. The sensor circuit does not have an electronic problem.
- (3) In these areas, the signal from the sensor is outside of the operating range of the sensor. The sensor circuit has an electronic problem. A diagnostic code will be generated for the sensor circuit. Refer to Troubleshooting, "Diagnostic Trouble Code List" for additional information on diagnostic codes.

Logged Event Codes

When the Electronic Control Module (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. The connectors may cause intermittent problems. Refer to Troubleshooting, "Inspecting Electrical Connectors".

If these steps do not resolve the problem, refer to Table 10 for the procedure to troubleshoot the event code.

Symptom Troubleshooting

i04032299

Symptom Troubleshooting

SMCS Code: 7569

Use the following guidelines as you troubleshoot an engine symptom:

Gather Information

Interview the operator about the problem before you begin troubleshooting, when possible.

Verify the Problem

Attempt to duplicate the problem. Try to duplicate the operating conditions, when possible. Verify that the complaint is not due to normal engine operation.

Diagnostic Codes

Check for any logged diagnostic codes.

- Determine if the logged diagnostic codes correlate to probable causes.
- Determine if the logged diagnostic codes occur at the same time as the symptoms.
- Determine if the logged diagnostic codes are logged repeatedly.

Repair all active diagnostic codes. Refer to Troubleshooting, "Diagnostic Trouble Codes" for the correct troubleshooting procedure.

Connectors and Wiring

Check the wiring and the connectors for the following problems:

- Damage
- Abrasion
- Corrosion
- Incorrect attachment

Follow the Procedures

If these inspections do not reveal any problems, use the procedure that best describes the symptoms. The procedures in this manual provide the most efficient way to determine the root cause of the problem.

Provide Feedback to Caterpillar

After the correct repair has been performed on the engine, provide brief, detailed information to Caterpillar about the repair. This information helps Caterpillar better serve the dealer and the customer.

If a customer performed the repair, provide the information for the repair to the local Caterpillar dealership. The dealership will ensure that the information is recorded in the engine history file.

i03978169

Acceleration Is Poor or Throttle Response Is Poor

SMCS Code: 1000-035

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

Codes

- Active codes

Cold Starting

- Cold mode operation (if applicable)
- Starting aids (if applicable)

Flash File

- Noncurrent flash file

Coolant System

- Cooling system

Fuel Supply

- Unstable fuel supply
- Unstable fuel injection

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Active Codes

Certain diagnostic codes may cause poor performance. Connect Caterpillar Electronic Technician (ET) and check for active codes. Download the "Product Summary Report" from the engine Electronic Control Module (ECM) before performing any troubleshooting or clearing diagnostic trouble codes. Troubleshoot any codes that are present before continuing with this procedure.

Cold Mode Operation (if applicable)

Cold mode is activated whenever the engine coolant temperature falls below a predetermined value. Monitor the status screen on Cat ET in order to verify that the engine has exited cold mode. Observe the reading for coolant temperature on the Cat ET.

Starting Aids (If Applicable)

If cold ambient conditions exist, check operation of starting aids. Verify that the starting aid is operating correctly. Refer to the appropriate circuit test for information that is related to troubleshooting the starting aid.

Note: If ether bottles are not installed, monitor the configuration screen on Cat ET in order to verify that ether is not enabled.

Noncurrent Flash File

Verify that the latest flash file is installed in the ECM. Refer to Troubleshooting, "ECM Software - Install" for the proper procedure.

Cooling System

Check for an internal coolant leak into the cylinder and/or the exhaust. Refer to Systems Operation/Testing and Adjusting, "Cooling System".

Unstable Fuel Supply

WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

1. Inspect the fuel system. Refer to Systems Operation/Testing and Adjusting, "Fuel System" for additional information.

2. Cold weather adversely affects the characteristics of the fuel. Refer to the engine Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold-weather operation.
3. Check fuel quality. Refer to Systems Operation/Testing and Adjusting, "Fuel System" for the proper procedure. Check the fuel tank for debris or foreign objects which may block the fuel supply.
4. Check the filtered fuel pressure while the engine is being cranked. Refer to Systems Operation/Testing and Adjusting, "Fuel System" 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.

Also, check for the proper operation of the fuel transfer pump. Refer to Systems Operation/Testing and Adjusting, "Fuel System" for test information.

Unstable Fuel Injection

1. Perform the "Injector Solenoid Test" on Cat ET. The test will determine if all of the injector solenoids are being energized by the ECM.
2. Access the "Cylinder Cutout Test" in the "Diagnostic Tests" under the "Diagnostics" menu. Perform the "Automatic Cylinder Cutout Test".

Diagnose the problem and then repair the problem. Clear all logged diagnostic codes. Verify that the repair eliminated the problem.

i03975394

Alternator Problem (Charging Problem and/or Noisy Operation)

SMCS Code: 1405-035

Probable Causes

Alternator

- Condition of the alternator drive belts
- Electrical operation of the alternator
- Condition of the alternator bearings
- Condition of the alternator drive pulley

Charging Circuit

- Inspection of the charging circuit
- Condition of the batteries

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the following procedures in the order that is provided.

Condition of the Alternator Drive Belts

1. Inspect the condition of the alternator drive belts. If the alternator drive belts are worn or damaged, replace the belts. Refer to Disassembly and Assembly for the correct procedure.
2. Check the belt tension. If the engine is equipped with an automatic belt tensioner, check the automatic belt tensioner. If necessary, replace the automatic belt tensioner. Refer to Disassembly and Assembly for the correct procedure.

Note: Excessive belt tension may result in damage to the alternator.

Electrical Operation of the Alternator

Verify the electrical operation of the alternator.

1. Use a battery tester to verify that the batteries are fully charged. If the condition of the batteries is suspect, perform a load test in order to ensure that the batteries are ok. If necessary, replace the batteries.
2. Install a 225-8266 Ammeter Tool Gp to the engine battery cable.
3. Measure the current draw while the engine is not running.
 - a. While the engine is not running, apply a load to the electrical system. If equipped, use engine accessories such as headlights or a blower motor to load the electrical system.
 - b. Record the meter reading. Record the orientation of the meter installation.

Note: Ensure that you record the orientation of the meter installation. Be sure to record a positive current draw or a negative current draw for the electrical system.

- c. Remove the load from the electrical system.
4. Confirm that the alternator is applying current to the engine electrical system.

- a. Start the engine.
- b. Apply a strong load to the electrical system. If equipped, use loads such as headlights, auxiliary lighting, and the heater blower motor.
- c. Again, record the meter reading. Record the orientation of the meter installation.

Note: Ensure that you record the orientation of the meter installation. Be sure to record a positive current draw or a negative current draw for the electrical system.

- d. Remove the load from the electrical system and shut down the engine.
5. Compare the current readings that are recorded. Determine if the current flow had changed from a state of discharge to a state of charge.

If the ammeter readings indicate that the electrical system changed from a state of discharge to a state of charge, the alternator is operating correctly.

If the ammeter readings indicate that the system remained in a state of discharge during the test, the alternator may need to be replaced.

For additional testing procedures, refer to Special Instruction, REHS0354, "Charging System Troubleshooting". Repair the alternator or replace the alternator, as needed.

Condition of the Alternator Bearings

Check the alternator bearings for signs of wear. Repair the alternator or replace the alternator, as needed. Refer to Disassembly and Assembly for the correct procedure.

Condition of the Alternator Drive Pulley

Check the condition of the alternator drive pulley. If there is excessive wear, replace the pulley. Check that the nut for the pulley has not become loose. If necessary, tighten the nut to the proper torque specification. Refer to Disassembly and Assembly for the correct procedure.

Check the alignment of the alternator drive pulley with the other pulleys that are in the drive system. Correct the alignment of the pulley, if necessary.

Inspection of the Charging Circuit

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

Condition of the Batteries

Check the charge on the engine batteries. Charge the batteries, if necessary. Refer to Special Instruction, SEHS7633, "Battery Test Procedure" for the proper testing procedure.

Load test the batteries. Refer to Special Instruction, SEHS9249, "Use of 4C-4911 Battery Load Tester for 6, 8 V and 12 V Lead Acid Batteries".

i03975426

Battery Problem

SMCS Code: 1401-035

Probable Causes

Battery

- Worn battery
- Switched battery circuit

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Worn Battery

1. Verify that the battery is no longer able to hold a charge. Refer to Systems Operation/Testing and Adjusting for the correct procedure.
2. Replace the battery. Refer to Disassembly and Assembly for the correct procedure.

Switched Battery Circuit

1. Verify that a switched battery circuit drained the battery by being left in the ON position.
2. Charge the battery. Verify that the battery is able to maintain a charge. Refer to Systems Operation/Testing and Adjusting for the correct procedure.

i03975499

Coolant Contains Fuel

SMCS Code: 1250-035; 1395-035

Probable Causes

Injector Sleeve or Injector Sleeve Seals

- Leaking injector sleeve and/or damaged seals

Recommended Actions

Leaking Injector Sleeve and/or Damaged Seals

1. Remove the valve mechanism covers.
2. Remove the fuel injectors from the cylinder head.

Refer to the Disassembly and Assembly manual for details.



Personal injury can result from hot coolant, steam and alkali.

At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove filler cap slowly to relieve pressure only when engine is stopped and radiator cap is cool enough to touch with your bare hand.

Cooling System Conditioner contains alkali. Avoid contact with skin and eyes.

3. Pressurize the cooling system in order to identify the injector sleeve that is leaking. Closely inspect the sealing joint around the top of the injector sleeve. Small amounts of coolant will be dripping from the injector sleeve that is leaking.

Note: Do not allow the pressure on the cooling system to exceed 103 kPa (15 psi) during the test. Damage to the cooling system may result from applying excessive pressure.

4. Remove the injector sleeve that is leaking. Carefully inspect the sleeve for damage. If there are visible signs of damage to the injector sleeve, replace the sleeve. Replace the O-ring seals for the injector sleeve and reinstall the sleeve. Replace any damaged components.

Note: Coolant may also be contaminating the fuel system. After the engine is shut down, the retention of pressure in the cooling system may cause the transfer of coolant into the fuel system. Visually inspect the fuel tank for coolant. The contamination of coolant in the fuel system may damage injectors and other fuel system components. Ensure that all of the fuel system components are in good repair prior to returning the engine to service.

5. Evacuate all cylinders of fluid before trying to start the engine.

Note: Do not crank the engine if a cylinder is full of fluid. Engine damage may occur.

i03975460

Coolant Contains Oil

SMCS Code: 1348-035; 1395-035

Probable Causes

Engine Oil Cooler

- Leak in the engine oil cooler

Power Train Oil Cooler (if equipped)

- Leak in the power train oil cooler

Cylinder Head Gasket

- Cylinder head gasket
- Cylinder head

Block

- Cylinder liner
- Cylinder block

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the following procedures in the order that is provided.

Verify the presence of oil in the coolant with a scheduled oil sample. Verification must be made before following the procedure.

Leak in the Engine Oil Cooler

1. Check for leaks in the engine oil cooler. Refer to Testing and Adjusting for the proper procedure. If a leak is found, install a new oil cooler core. Refer to the Disassembly and Assembly manual.
2. Flush the cooling system. Refer to the Operation and Maintenance Manual for the proper flushing procedure. Refill the cooling system with the proper coolant. Refer to the Operation and Maintenance Manual for the correct coolant and capacities.
3. Check the oil for coolant. If coolant is found in the oil, drain the crankcase. Refill the crankcase with the proper oil after the leak has been repaired. Refer to the Operation and Maintenance Manual for the correct oil capacities and viscosity.

Leak in the Power Train Oil Cooler

1. Check for leaks in the power train oil cooler. Refer to Testing and Adjusting for the proper procedure. If a leak is found, install a new oil cooler. Refer to the Disassembly and Assembly manual.
2. Flush the cooling system. Refer to the Operation and Maintenance Manual for the proper flushing procedure. Refill the cooling system with the proper coolant. Refer to the Operation and Maintenance Manual for the correct coolant and capacities.
3. Check the oil for coolant. If coolant is found in the oil, drain the oil. Refill the oil after the leak has been repaired. Refer to the Operation and Maintenance Manual for the correct oil capacities and viscosity.

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. Perform a leak test on the cylinder head. Refer to Systems Operation/Testing and Adjusting for the proper procedure for checking 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. Check the liner projections. Refer to Systems Operation/Testing and Adjusting for the proper liner projections.

Cylinder Block

Inspect the cylinder block for cracks. If a crack is found, repair the cylinder block or replace the cylinder block. Inspect the deck of the engine. Refer to the Reuse and Salvage Guidelines for the proper inspection procedure.

i03975553

i03975617

Coolant Level Is Low

SMCS Code: 1395-035

Use this procedure in order to troubleshoot low coolant level or use this procedure if one of the following event codes is active. Refer to Troubleshooting, "Event Codes" for information about event codes. Access the monitoring system on Caterpillar Electronic Technician (ET) in order to view the current trip points for these codes. For information on the engine monitoring system, refer to Troubleshooting, "Engine Monitoring System".

Probable Causes

Low Coolant Level and/or Coolant Leakage

- Coolant

Coolant Level Sensor

- Coolant level sensor

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Coolant

1. Inspect the coolant level. If necessary, add coolant.
2. Check for the correct mixture of antifreeze and water. Refer to Operation and Maintenance Manual.
3. Check the cooling system for leaks. Refer to Systems Operation/Testing and Adjusting, "Cooling System - Test" for the correct procedure. Repair any leaks immediately.
4. Check for air in the cooling system. Refer to Systems Operation/Testing and Adjusting, "Testing the Cooling System" for the correct procedure.

Coolant Level Sensor (if equipped)

If an electrical problem with the coolant level sensor is suspected, refer to Troubleshooting, "Coolant Level - Test" for information that is related to troubleshooting an electrical problem with the coolant level sensor.

Coolant Temperature Is High

SMCS Code: 1395-035

Use this procedure in order to troubleshoot high coolant temperature or use this procedure if one of the following event codes is active. Refer to Troubleshooting, "Event Codes" for information about event codes. Access the monitoring system on Caterpillar Electronic Technician (ET) in order to view the current trip points for these codes.

Table 11

Event Code		
CDL Code	Code Description	Comments
E361(1)	Engine Coolant Temperature High- Least Severe (1)	The engine coolant temperature has exceeded the trip point and the delay time has expired. The code is logged.
E361(2)	High Engine Coolant Temperature High - Moderate Severity (2)	The engine coolant temperature has exceeded the trip point and the delay time has expired. Engine power is derated. The code is logged.
E361(3)	Engine Coolant Temperature High - Most Severe (3)	

Probable Causes

Low Coolant Level and/or Coolant Leakage

- Coolant

Coolant Temperature Sensor

- Coolant temperature sensor and/or the circuit

Water Temperature Regulator and/or Pressure Relief Valve

- Water temperature regulator
- Pressure relief valve

Radiator or Heat Exchanger

- Radiator
- Heat exchanger

Engine Cooling Fan (if equipped)

- Faulty engine cooling fan (if equipped)

Coolant Pump

- Inspection of the coolant pump

Cylinder Head Gasket

- Cylinder head gasket

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Coolant

1. Inspect the coolant level. If necessary, add coolant.

2. Check for the correct mixture of antifreeze and water. Refer to Operation and Maintenance Manual.

3. Check the cooling system for leaks. Repair any leaks immediately.

4. Check for air in the cooling system. Refer to Systems Operation/Testing and Adjusting, "Cooling System" for the correct procedure.

Coolant Temperature Sensor and/or the Circuit

Check the reading of the coolant temperature on Cat ET. The temperature should rise steadily as the engine is warmed. Ensure that the temperature is reasonable.

If the reading on Cat ET for the coolant temperature is not reasonable, troubleshoot the circuit and the coolant temperature sensor. Refer to Troubleshooting, "Sensor Signal (Analog, Passive) - Test".

Water Temperature Regulator and/or Pressure Relief Valve

1. Pressure test the cooling system. Refer to Systems Operation/Testing and Adjusting for the correct procedure.
2. Check that the seating surfaces of the pressure relief valve and the radiator cap are clean and undamaged.
3. Check operation of the pressure relief valve and/or the water temperature regulator. If necessary, clean the components and/or replace the components.

Radiator

1. Check the radiator fins for dirt, debris, and/or damage. Remove any dirt and/or debris and straighten any bent fins. Check for collapsed hoses and/or other restrictions.

2. Check the radiator for internal blockage.

Ensure that the radiator size is according to the OEM specifications. An undersized radiator does not have enough area for the effective release of heat. An undersized radiator may cause the engine to run at a temperature that is higher than normal. The normal temperature is dependent on the ambient temperature.

Heat Exchanger

Check for sufficient flow and temperature of the cooling water through the heat exchanger. If the flow of cooling water through the heat exchanger is insufficient, determine the location of the obstruction. If the temperature of the cooling water is too high, determine the cause. Ensure that the size of the heat exchanger is according to the OEM specifications. Make the necessary repairs.

Faulty Engine Cooling Fan (if equipped)

1. If the fan is belt driven, check for loose drive belts. A loose fan drive belt will cause a reduction in the air flow across the radiator. Check the fan drive belt for proper belt tension. Adjust the tension of the fan drive belt, if necessary. Refer to Operation and Maintenance Manual.
2. Check the fan clutch, if equipped. A fan clutch or a hydraulic driven 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. Refer to Troubleshooting, "Cooling Fan Control - Test" for troubleshooting information.

Inspection of the Coolant Pump

1. Inspect the impeller of the coolant pump for damage and/or erosion.
2. Make sure that the drive gear is not loose on the drive shaft of the coolant pump.
3. If necessary, replace the coolant pump. Refer to Disassembly and Assembly for the correct procedure.

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. Pressure test the head for leaks. Refer to the XXXXXXXXXXXXX manual for testing procedures.

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

i03975651

Coolant Temperature Is Low**SMCS Code:** 1395-035

Use this procedure in order to troubleshoot a low coolant temperature.

Probable Causes**Ambient Temperature**

- Extreme ambient temperatures

Load factor

- Light loads

Engine Speed

- Low engine speed

Cooling Fan

- The cooling fan is always on.

Water Temperature Regulator

- Faulty water temperature regulator

Auxiliary Coolant Heater (if equipped)

- The auxiliary coolant heater is faulty.

Faulty Coolant Temperature Sensor and/or Circuit

- The temperature sensor is faulty.

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Ambient Temperature

Install winter covers, if the ambient temperatures are extreme.

Load factor

Light loads can cause overcooling. This overcooling is caused by the low heat input of the engine.

Engine Speed

Low engine speed can cause overcooling.

Cooling Fan

A cooling fan that is operating incorrectly can cause overcooling. Refer to Troubleshooting, "Cooling Fan Is Always ON", if necessary.

Water Temperature Regulator

A regulator that is stuck open can cause overcooling. Test the water temperature regulator according to Testing and Adjusting, "Water Temperature Regulator - Test".

Make sure that the proper water temperature regulator is installed. Refer to the Specifications manual for the correct water temperature regulator.

Auxiliary Coolant Heater (if equipped)

A malfunctioning auxiliary coolant heater can cause low coolant temperature.

Determine if the engine is equipped with an auxiliary coolant heater. Check the heater for proper operation. Repair any problems.

Faulty Coolant Temperature Sensor and/or Circuit

Check the reading of the coolant temperature on the Cat ET. The temperature should rise steadily as the engine is warmed. Ensure that the temperature is reasonable.

If the reading on Cat ET for the coolant temperature is not reasonable, troubleshoot the circuit and the coolant temperature sensor. Refer to Troubleshooting, "Sensor Signal (Analog, Passive) - Test".

i03975909

Cooling Fan Is Always ON

SMCS Code: 1356-035

Probable Causes

- Operation of the Cooling Fan

Recommended Actions

Check the Operation of the Cooling Fan

1. Establish communication between the Caterpillar Electronic Technician (ET) and the Engine Control Module (ECM). Refer to Troubleshooting, "Electronic Service Tools", if necessary.
2. If applicable, check the value of the fan control parameters.

If the parameter is not programmed to allow the fan to operate, the ECM is not controlling the cooling fan. Refer to the troubleshooting information for the chassis in order to troubleshoot the cooling fan.

If the parameter is programmed to allow the fan to operate, the ECM is controlling the cooling fan.

Refer to the appropriate procedure in order to troubleshoot the cooling fan.

i04191390

Crankcase Fumes Disposal Tube Has Oil Draining

SMCS Code: 1000-035-BBY; 1317-035

Probable Cause

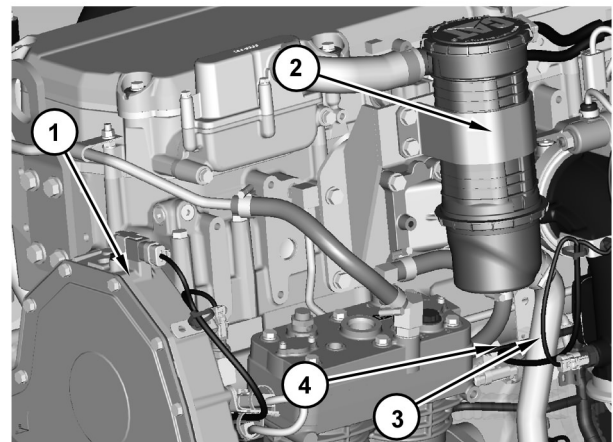


Illustration 27

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- (1) Crankcase pressure sensor
- (2) Crankcase filter housing
- (3) Fumes disposal tube
- (4) Oil drain tube

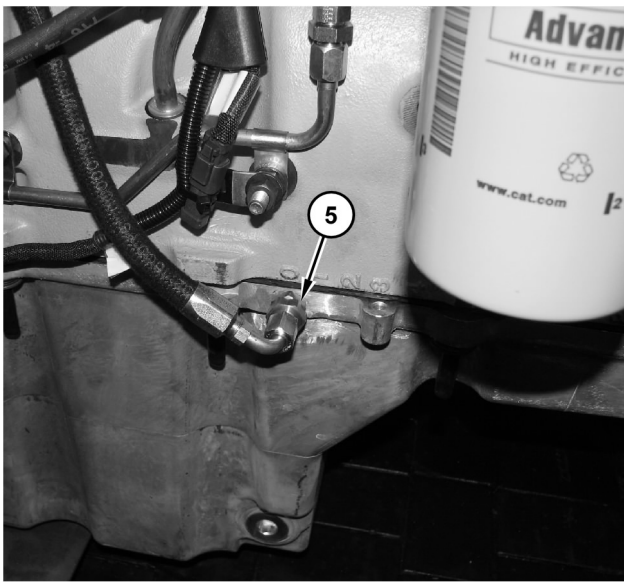


Illustration 28

g02013955

Left side of the engine

(5) Check valve

The check valve at the bottom of the oil drain tube has failed.

Recommended Actions

Replace check valve (5).

i04166015

Cylinder Is Noisy

SMCS Code: 1223-035

Probable Causes

Codes

- Active codes and logged codes

Fuel

- Low quality fuel

Fuel Injection

- Injectors

Lubrication

- Lack of lubrication

Engine Components

- Valve train components

- Gear train and components of the lower end

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Active Codes and Logged Codes

Establish communication between Caterpillar Electronic Technician (ET) and the Electronic Control Module (ECM).

Download the "Warranty Report" from the engine ECM before performing any troubleshooting or clearing diagnostic trouble codes.

Troubleshoot any active codes before continuing with this procedure.

Low Quality Fuel

Refer to Operation and Maintenance Manual for information on the proper characteristics of the fuel for the engine. If necessary, obtain a fuel analysis in order to confirm that the correct fuel is being used for the engine. Refer to Systems Operation/Testing and Adjusting, "Fuel System Quality Test" for the proper procedure.

Injectors

C13, C15, and C18 Applications

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. Access the "Cylinder Cutout Test" in the "Diagnostic Tests" under the "Diagnostics" menu.
3. Perform the "Automatic Cylinder Cutout Test" on Cat ET.

C9.3 Applications

1. Perform the "Fuel System Verification Test" in the "Diagnostic Tests" under the "Diagnostics" menu.

Diagnose the problem and then repair the problem. Reset all active codes and clear all logged codes. Verify that the repair eliminated the problem.

Lack of lubrication

1. Check for proper lubrication of the valve components. Check for sufficient lubrication between the injector tappets and the rocker arms.

2. Check for blocked oil passages. Oil passages must be clean. Clean any oil passages that are questionable. Refer to the Disassembly and Assembly for additional information.

Valve Train Components

1. Check the valve lash. Refer to Troubleshooting, "Valve Lash Is Excessive".
2. Check for damage to valve train components. Remove the valve cover from the suspect cylinders. Check the following items for damage: camshaft, valve rotocoil, valve springs, camshaft followers, rocker shaft, bridges, pushrods, and injectors.

Refer to the Disassembly and Assembly for additional information.

3. Check for valves that do not move freely. Remove the cylinder head and inspect the valves.

Refer to the Disassembly and Assembly for additional information.

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.

Gear Train and Components of the Lower End

Inspect the gear train and lower end components. Replace any damaged parts.

i03975989

Engine Cranks but Does Not Start

SMCS Code: 1000-035; 1450-035

Download the Product Status Report from the engine ECM before performing any troubleshooting or clearing diagnostic trouble codes. Troubleshoot any active codes before continuing with this procedure.

Probable Causes

Note: If the engine will not start and Cat ET will not communicate with the ECM, the problem is most likely with the electrical power supply to the ECM. Refer to Troubleshooting, "Electrical Power Supply - Test".

Fuel Supply

- Fuel level

Engine Shutdown Switches (if applicable)

- Engine shutdown switches

Starting Aids (if applicable)

- Starting aids

Restrictions in the Air Inlet and Exhaust System

- Restriction in the air inlet and exhaust system

Theft Deterrent System (if applicable)

Active theft deterrent system

Sensors

- Coolant temperature sensor
- Atmospheric pressure sensor

Engine Speed/Timing

- Engine timing sensor

Fuel System

- Low-pressure fuel system

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Fuel Supply

1. Visually check the fuel level in the fuel tank. Do not rely on the fuel gauge only.
2. Ensure that the fuel supply valve (if equipped) is in the full OPEN position.

Engine Shutdown Switches (if applicable)

The engine shutdown switches must be in the OFF position. Use Cat ET to verify the status of the engine shutdown switches. When a shutdown occurs, the keyswitch must be turned to the OFF position for at least 15 seconds before restarting the engine.

Starting Aids (if applicable)

If cold ambient conditions exist, check the operation of the starting aids. Verify that the starting aid is operating correctly. Refer to the appropriate circuit test in order to troubleshoot the starting aid.

Restriction in the Air Inlet and Exhaust System

1. Check for an air filter restriction indicator. Replace plugged air filters. Refer to the Operation and Maintenance Manual for the correct procedure.
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" for additional information.

Theft Deterrent System (if applicable)

Verify that the theft deterrent system is not active.

Check the Outputs of the Sensors

The coolant temperature sensor must provide a correct signal in order for cold mode operation to operate correctly. Verify that the coolant temperature on Cat ET is reasonable for the conditions that are present.

Engine Speed/Timing

Crank the engine and observe the engine speed on the Cat ET status screen. Refer to Troubleshooting, "Speed/Timing - Test" for additional information.

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.

Low Pressure Fuel System

1. Visually check the fuel level in the fuel tank. Do not rely on the fuel gauge only.
2. Ensure that the fuel supply valve (if equipped) is in the full OPEN position.
3. Inspect the fuel system. Refer to Systems Operation/Testing and Adjusting, "Fuel System" for additional information.
4. Cold weather adversely affects the characteristics of the fuel. Refer to the engines Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold weather operation.
5. Check fuel quality. Refer to Systems Operation/Testing and Adjusting, "Fuel System" for the proper procedure. Check the fuel tank for debris or foreign objects which may block the fuel supply.

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

Also, check for the proper operation of the fuel transfer pump. Refer to Systems Operation/Testing and Adjusting, "Fuel System" for test information.

i03976041

Engine Does Not Crank

SMCS Code: 1000-035; 1450-035

Probable Causes

Batteries

- Inspection of the batteries and battery cables

Switches

- Switches and/or circuit breakers (if applicable)

Starting Circuit

- Starting motor solenoid and starting circuit

Starting Motor or Flywheel Ring Gear

- Inspect the starter pinion and flywheel ring gear.

Engine Accessories

- Inspect engine accessories and the transmission (if applicable).

Internal Engine Problem

- Hydraulic cylinder lock

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the following procedures in the order that is provided.

Inspection of the Batteries and Battery Cables

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

Switches and/or Circuit Breakers (if applicable)

If equipped, check any switches and/or circuit breakers that may interfere with the engine cranking. Refer to the application electrical schematic for additional information.

Starting Motor Solenoid and Starting Circuit

Test the operation of the starting motor circuit. Refer to Systems Operation/Testing and Adjusting, "Electric Starting System" for additional information.

Inspect the Starter Pinion and Flywheel Ring Gear

1. Test the operation of the starting motor.
2. Check the pinion clearance. Inspect the pinion and the flywheel ring gear for damage. Refer to Systems Operation/Testing and Adjusting, "Electric Starting System" for additional information.

Inspect Engine Accessories and the Transmission (if applicable)

1. Ensure free movement of the driveline.
2. Remove any engine accessories that may lock up the engine and inspect any engine accessories that may lock up the engine.

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

- Hydraulic pump that is driven from the rear gear group

- Air compressor
- Engine oil pump
- Other components that are driven by the engine

Hydraulic Cylinder Lock

If an injector has been replaced, evacuate any fluids from the cylinder and attempt to start the engine. Fuel will flow from the cylinder head into the cylinders when a unit injector is removed.

If the engine will not start, check for fluid in the cylinders (hydraulic cylinder lock) by removing the individual unit injectors. Check for damaged seals. Determine the type of fluid that locked up the cylinder.

If there was a coolant leak, determine the cause of the leak.

If there was excessive fuel in the cylinder, replace the seals and reinstall the injector. Drain any excess fuel from the cylinder head.

If a mechanical problem is suspected, disassemble the engine. Refer to the Disassembly and Assembly manual. Inspect the internal components for the following conditions:

- Seizure
- Bent components
- Broken components

i03976304

Engine Has Early Wear

SMCS Code: 1000-035; 1200-035

Probable Causes

Engine Oil

- Incorrect maintenance intervals and/or incorrect oil
- Contaminated engine oil
- Low oil pressure

Contaminated Air

- Leaks in air system

Contaminated Fuel

- Inspect the fuel filters for contamination.

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Incorrect Maintenance Intervals and/or Incorrect Oil

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

Note: Use at least the minimum classification of engine oil that is recommended by Caterpillar..

Contaminated Engine Oil

Note: Obtain an S-O-S oil analysis. The analysis will contribute to a better understanding of the oil contamination.

Determine the reason for any contamination of the engine oil and perform the necessary repairs. Drain the crankcase and refill the crankcase with clean engine oil. Install new engine oil filters. Refer to the engine Operation and Maintenance Manual.

If the oil filter bypass valve remains 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. Verify that the oil bypass valve is operating correctly. Refer to the Disassembly and Assembly manual.

Note: Refer to the Caterpillar guidelines for "Reusability and Salvage/Repair" for determining if the replacement of parts is necessary in order to perform a quality repair.

Low Oil Pressure

Engine oil that is contaminated with another liquid can cause low engine oil pressure. High engine oil level can be an indication of contamination. Obtain an analysis of the engine oil.

The inlet screen of the 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 suction tube and remove any material that may be restricting engine oil flow.

When some components of the engine show wear in a short time, the cause can be a restriction in a passage for engine oil. An indicator for the engine oil pressure may indicate sufficient pressure, but a component is worn due to a lack of lubrication. In such a case, look at the passage for the engine oil supply to the component. Refer to Systems Operation/Testing and Adjusting, "Lubrication System" for additional information.

Leaks in Air System

A leak in the air intake system may allow unfiltered air into the engine. Inspect the air intake system for streaks which may indicate a leakage of unfiltered air. Inspect all of the gaskets and the connections. Repair any leaks.

Inspect the Fuel Filters for Contamination

WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

1. Remove the fuel filters. Inspect the fuel filters for contamination. Contaminants in the fuel such as hydrogen sulfide and sulfur can lead to the formation of acids in the crankcase. Obtain a fuel analysis. Determine the cause of any contamination and perform the necessary repairs.
2. Install new fuel filters. Refer to the Operation and Maintenance Manual.

i04166091

Engine Has Mechanical Noise (Knock)

SMCS Code: 1000-035

Probable Causes

Codes

- Active codes and logged codes

Electrical Connectors

- Electrical connections

Fuel

- Fuel injection
- Fuel quality

Lubrication

- Proper lubrication

Accessory Equipment

- Isolate the source of the noise.

Engine Components

- Valve train components
- Gear train and lower end components
- Crankshaft

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Active Codes and Logged Codes

Establish communication between Caterpillar Electronic Technician (ET) and the Electronic Control Module (ECM). Refer to Troubleshooting, “Electronic Service Tools”, if necessary.

Download the “Warranty Report” from the engine ECM before performing any troubleshooting or clearing diagnostic trouble codes.

Troubleshoot any active codes before continuing with this procedure.

Electrical Connections

Check for the correct installation of the ECM J1/P1 and the J2/P2 connectors. Check for correct installation of the fuel injector connectors. Repair connectors that are suspect or replace connectors that are suspect.

Perform the “Wiggle Test” on Cat ET.

Fuel Injection

1. For C13, C15, and C18 applications, perform the “Injector Solenoid Test” on Cat ET to determine if all of the injector solenoids are being energized by the ECM.
2. For C13, C15, and C18 applications, access the “Cylinder Cutout Test” in the “Diagnostic Tests” under the “Diagnostics” menu. Perform the “Automatic Cylinder Cutout Test” on Cat ET.

Note: For C9.3 engines, perform the “Fuel System Verification Test” on Cat ET.

Diagnose the problem and then repair the problem. Reset all active codes and clear all logged codes. Verify that the repair eliminated the problem.

Fuel Quality

Refer to Operation and Maintenance Manual for information on the proper characteristics of the fuel for the engine. If necessary, obtain a fuel analysis in order to confirm that the correct fuel is being used for the engine.

Proper Lubrication

Check for proper lubrication of the valve components. Check for sufficient lubrication between the injector tappets and the rocker arms.

Check for blocked oil passages. Oil passages must be clean. Clean any oil passages that are questionable. Refer to the Disassembly and Assembly for additional information.

Inspect the engine oil filters for ferrous material.

Note: Obtain an S-O-S oil analysis. The analysis will contribute to a better understanding of oil contamination and the origin of the contamination.

Isolate the Source of the Noise

If the source of the noise is the engine accessory, remove the suspect engine accessory. Inspect the suspect engine accessory. Repair the engine accessory and/or replace the engine accessory, if necessary.

Valve Train Components

Check the valve lash. Refer to Troubleshooting, “Valve Lash Is Excessive”.

Check for damage to valve train components. Remove the valve cover from the suspect cylinders. Check the following items for damage: camshaft, valve springs, camshaft followers, rocker shaft, bridges, pushrods, and injectors. Refer to the Disassembly and Assembly for additional information.

Replace any damaged parts. If damage has occurred, ensure that the following components are free of contamination: cylinder liner, piston, and exhaust system.

Gear Train and Lower End Components

Inspect the gear train and lower end components.

Replace any damaged parts. Refer to the Disassembly and Assembly for additional information.

Crankshaft

Inspect the crankshaft and the related components. Inspect the connecting rod bearings and the bearing surfaces on the crankshaft. Make sure that the bearings are in the correct position. Look for worn thrust plates and wear on the crankshaft. Check the counterweight bolts. Replace any damaged parts. Refer to the Disassembly and Assembly for additional information.

i03976429

Engine Misfires, Runs Rough or Is Unstable

SMCS Code: 1000-035

Probable Causes

Codes

- Active codes and logged codes

Fuel

- Low quality fuel

Fuel Injection

- Injectors

Lubrication

- Lack of lubrication

Engine Components

- Valve train components
- Gear train and components of the lower end

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Active Codes and Logged Codes

Establish communication between Caterpillar Electronic Technician (ET) and the Electronic Control Module (ECM). Refer to Troubleshooting, "Electronic Service Tools", if necessary.

Download the "Product Summary Report" from the engine ECM before performing any troubleshooting or clearing diagnostic trouble codes.

Troubleshoot any active codes before continuing with this procedure.

Low Quality Fuel

Refer to Operation and Maintenance Manual for information on the proper characteristics of the fuel for the engine. If necessary, obtain a fuel analysis in order to confirm that the correct fuel is being used for the engine. Refer to Systems Operation/Testing and Adjusting, "Fuel Quality - Test" for the proper procedure.

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. Access the "Cylinder Cutout Test" in the "Diagnostic Tests" under the "Diagnostics" menu.
3. Perform the "Automatic Cylinder Cutout Test" on Cat ET.

Lack of lubrication

1. Check for proper lubrication of the valve components. Check for sufficient lubrication between the injector tappets and the rocker arms.
2. Check for blocked oil passages. Oil passages must be clean. Clean any oil passages that are questionable. Refer to the Disassembly and Assembly for additional information.

Valve Train Components

1. Check the valve lash. Refer to Troubleshooting, "Valve Lash Is Excessive".
2. Check for damage to valve train components. Remove the valve cover from the suspect cylinders. Check the following items for damage: camshaft, valve rotocoin, valve springs, camshaft followers, rocker shaft, bridges, pushrods, and injectors.

Refer to the Disassembly and Assembly for additional information.

3. Check for valves that do not move freely. Remove the cylinder head and inspect the valves.

Refer to the Disassembly and Assembly for additional information.

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.

Gear Train and Components of the Lower End

Inspect the gear train and lower end components.
Replace any damaged parts.

i03976475

Engine Overspeeds

SMCS Code: 1915-035

Use this procedure in order to troubleshoot an engine overspeed or use this procedure if the following event code is active. Refer to Troubleshooting, “Event Codes” for information about event codes. For information on the engine monitoring system, refer to Troubleshooting, “Engine Monitoring System”.

Table 12

Event Codes		
CDL Code	Code Description	Comments
E362(1)	Engine Overspeed	The code is logged.
E362(3)		The code requires factory passwords to be cleared.

Probable Causes

Steep Grades

- Proceeding down steep grades (if applicable)

Air System

- Proper operation of the turbocharger
- Intake air

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in the following order:

Proceeding Down Steep Grades (If Applicable)

It may be necessary to engage the engine retarder on a steep grade.

Note: The operator must understand the proper operation of the machine during use of the engine retarder.

Note: Not all applications have engine retarders.

Proper Operation of the Turbocharger

Check for proper operation of the turbocharger.
Check for oil that may be leaking into the air inlet.

Intake Air

Check for combustible gases in the surrounding atmosphere. Do not operate the engine in an environment with combustible gases.

i04460870

Engine Shutdown Occurrence

SMCS Code: 1900-035

Use this procedure in order to troubleshoot the following event code.

Table 13

Diagnostic Trouble Codes			
CDL Code	J1939 Codes	Code Description (code descriptions may vary)	Comments
E265(2)		User Defined Shut down	The inputs from the ground level shutdown switch to the Electronic Control Module (ECM) have changed states. The engine will shut down. The code is logged.
E265(3)		User Defined Shut down	The inputs from the ground level shutdown switch to the Electronic Control Module (ECM) have changed states. The engine will shut down. The code is logged.
E268(3)		Unexpected Engine Shutdown	The code is logged. A warning lamp will be displayed.

The ignition is immediately terminated when an emergency stop button is pressed.

Probable Causes for a E265 Code

Shutdown switch

- Activated shutdown switch
- Circuit for the shutdown switch

Probable Causes for a E268 Code

- Operator
- Fuel
- Mechanical Failure

Recommended Actions for a E265 Code

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Activated Shut Down Switch

Talk to the operator and determine the reason for the emergency stop shutdown. Confirm that the condition for the emergency stop shutdown has been resolved. Cycle the keyswitch in order to reset the control system.

Circuit for the Shutdown Switch

Inspect the stop switches for evidence of damage that has been caused by vibration, moisture, or corrosion. Check the circuit for the shutdown switch. Refer to Troubleshooting, "Shutdown (Ground Level) - Test".

Recommended Actions for a E268 Code

Refer to Troubleshooting, "Troubleshooting without a Diagnostic Code" for additional information.

Operator

The operator may be operating the machine incorrectly and causing a stall. Interview the operator and determine the events that caused the engine to stall.

Fuel

The engine has ran out of fuel.

Mechanical Failure

A mechanical failure has occurred.

i04285665

Engine Shutdown Occurs Intermittently

SMCS Code: 1900-035

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

Probable Causes

Inlet Air

- Air shutoff

Codes

- Active codes and logged codes

Fuel

- Unstable fuel supply

Electrical

- Electrical connections
- Switches
- Circuit breakers

Engine Speed/Timing

- Engine speed/timing

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Air Shutoff

If equipped, verify that the air shutoffs are operating correctly.

Active Codes and Logged Codes

Certain diagnostic codes and/or event codes may cause an engine shutdown. Connect 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.

Unstable Fuel Supply

Note: If there is an immediate engine shutdown, troubleshoot the electrical connectors before proceeding with this procedure.

WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

1. Inspect the fuel system. Refer to Systems Operation/Testing and Adjusting, "Fuel System - Inspect" for additional information.

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

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

4. Check the filtered fuel pressure while the engine is being cranked.

Electrical Connections

1. Check the power and ground connections to the ECM. Refer to Troubleshooting, "Electrical Power Supply - Test".

Switches

Check the keyswitch input to the ECM.

Check any engine shutdown switches and associated wiring.

Circuit Breakers

Inspect the wires and connectors to all circuit protection for the engine. 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.

Engine Speed/Timing

Thoroughly inspect the connectors for the engine speed/timing sensors.

Crank the engine, if the engine starts and no speed timing codes are logged, the speed timing circuit is operating properly.

i03983086

Engine Shutdown While Idling

SMCS Code: 1900-035

Use this procedure if one of the following event codes is active. Refer to Troubleshooting, "Event Codes" for information about event codes.

Table 14

Event Code		
CDL Code	Description	Comments
E1171 (1)	Engine Idle Shutdown Occurred	The engine has been idling for an extended amount of time. This notification is for the operator. This notification is not a suspected engine problem. The code is logged.
E1172 (3)	Engine Idle Shutdown Pending	The engine is shutting down. An alarm will sound. The code is logged.

Probable Causes

Normal Operation

- Extended idle time

Recommended Actions

Engine At Idle Speed

This condition is normal operation. The engine has been idling for an extended amount of time and the Electronic Control Module (ECM) will shut down the engine.

The “Delay Engine Shutdown Status” parameter in Caterpillar Electronic Technician (ET) can be disabled. The amount of time before engine shutdown can then be configured.

i03976610

Engine Stalls at Low RPM

SMCS Code: 1000-035; 1900-035

Probable Causes

Codes

- Active codes and logged codes

Parameters

- Incorrect parameters

Air Inlet and Exhaust System

- Restriction in the air inlet and exhaust system

Fuel Supply

- Unstable fuel supply
- Unstable fuel injection

Accessory Equipment

- Engine accessories
- Parasitic loads

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Active Codes and Logged Codes

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

Incorrect Parameters

Use Cat ET to verify that the correct parameters are being used. Refer to Troubleshooting, “Configuration Parameters” for the proper information.

Restriction in the 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.

Unstable Fuel Supply

1. Visually check the fuel level in the fuel tank. Do not rely on the fuel gauge only.
2. Ensure that the fuel supply valve (if equipped) is in the full OPEN position.

WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

3. Inspect the fuel system. Refer to Systems Operation/Testing and Adjusting, "Fuel System" for additional information.
4. Cold weather adversely affects the characteristics of the fuel. Refer to the engines Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold-weather operation.
5. Check fuel quality. Check the fuel tank for debris or foreign objects which may block the fuel supply.
6. Check the filtered fuel pressure while the engine is being cranked.

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.

Also, check for the proper operation of the fuel transfer pump.

Fuel Injection

1. Perform the "Injector Solenoid Test" on Cat ET in order to determine if all of the injector solenoids are being energized by the Electronic Control Module (ECM).
2. Access the "Cylinder Cutout Test" in the "Diagnostic Tests" under the "Diagnostics" menu. Perform the "Automatic Cylinder Cutout Test".

Diagnose the problem and then repair the problem. Clear all logged diagnostic codes. Verify that the repair eliminated the problem.

Engine Accessories

Inspect any engine accessories and the transmission (if applicable). Repair any problems that may create excessive load on the engine.

i04460888

Engine Top Speed Is Not Obtained

SMCS Code: 1915-035

Note: If this fault occurs only under load, refer to Troubleshooting, "Acceleration Is Poor or Throttle Response Is Poor".

Note: Refer to Troubleshooting, "Cat ET Service Features" for information about service features.

Probable Causes

Codes

- Active codes and logged codes

Parameters

- Incorrect parameters

Engine Load

- Accessory and/or parasitic loads

Flash File

- Incorrect flash file

Air Inlet and Exhaust System

- Restriction in the air inlet and exhaust system
- Proper operation of the turbocharger

Fuel Supply

- Low-pressure fuel system
- Fuel injectors

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Active Codes and Logged Codes

Connect Caterpillar Electronic Technician (ET) and download the "Warranty Report" from the engine ECM before performing any troubleshooting or clearing diagnostic trouble codes. An active derate will be displayed on Cat ET. Troubleshoot any codes that are present before continuing with this procedure.

Table 15

Associated Diagnostic Trouble Codes
Suspect Parameter Number
E198
E398
5580-17
5580-18
157-17

Incorrect Parameters

Use Cat ET to verify that the correct engine parameters are being used. Refer to Troubleshooting, "Configuration Parameters" for additional information.

Verify that all of the parameters for parasitic loads are correct.

Accessory and/or Parasitic Loads

Check all accessory equipment for problems that may create excessive load on the engine.

Check for any excess parasitic load on the engine.

Note: Make the necessary repairs to damaged components. Replace parts, if necessary. Refer to the service literature for your application for additional information.

Incorrect Flash File

Verify that the latest flash file is installed in the Electronic Control Module (ECM). Refer to Troubleshooting, "ECM Software - Install" for the proper procedure.

Restriction in the Air Inlet and Exhaust System

1. Check the air filter restriction indicator, if equipped. 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.

Proper Operation of the Turbocharger

Check for proper operation of the turbocharger.

Low Pressure Fuel System

1. Visually check the fuel level in the fuel tank. Do not rely on the fuel gauge only.

2. Ensure that the fuel supply valve (if equipped) is in the full OPEN position.

WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

3. Inspect the fuel system. Inspect the fuel system. Refer to Systems Operation/Testing and Adjusting, "Fuel System - Inspect" for additional information.

Fuel Injectors

C13, C15, and C18 Applications

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 "Automatic Cylinder Cutout Test" on Cat ET.

C9.3 High Pressure Applications

1. If service has been performed on the engine fuel system recently, verify that the injector trim files are correct. Use Cat ET to check that the injector trim files are correct for the injectors that are installed on the engine.
2. Use Cat ET to ensure that there are not any active diagnostic codes for the injector solenoids. Perform the "Cylinder Cutout Test" in order to check for a misfiring cylinder. Refer to Troubleshooting, "Injector Solenoid - Test" for information that is related to the test.
3. Use Cat ET to perform the "Fuel System Verification Test" in order to check the mechanical condition of the fuel injectors. Refer to Troubleshooting, "Injector Solenoid - Test" for information that is related to the test.

i03585031

Engine Vibration Is Excessive

SMCS Code: 1000-035; 1152-035; 3252-035

Probable Causes

Vibration Damper

- Inspect the vibration damper.

Engine Mounts and Brackets

- Engine supports
- Driven equipment

Engine Misfiring or Running Rough

- Engine misfiring
- Running rough

Recommended Actions

Inspect the Vibration Damper

Clean any debris from around the 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. If necessary, replace any damaged components. Check the alignment of the following before operating the engine under load for any length of time:

- Mounts
- Coupling

Driven Equipment

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

Engine Misfiring or Running Rough

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

i04005071

Exhaust Has Excessive Black Smoke

SMCS Code: 1088-035; 1250-035

Probable Causes

- Air inlet or exhaust system
- Atmospheric pressure sensor

- 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.

Atmospheric Pressure Sensor

1. Remove the sensor.
2. Remove debris, moisture, or ice from the sensor.
3. Install the sensor.
4. Check the Caterpillar Electronic Technician (ET) for active diagnostic codes on the sensor. If no active diagnostic code exists, the sensor may be used. The correct reading for the atmospheric pressure is between 50 kPa (7.25 psi) and 100 kPa (14.5 psi).

Flash File

Verify that the latest flash file is installed. Refer to Troubleshooting, "ECM Software - Install" 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 that is related to valve adjustments.

i03978211

Exhaust Has Excessive White Smoke

SMCS Code: 1088-035; 1250-035

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

- Cold mode
- Diagnostic trouble codes
- Flash file
- Starting aids
- Fuel supply
- Cooling system
- Engine speed/timing
- Unit injectors
- Component wear

Recommended Actions

Cold Mode

Excessive white smoke emissions may occur during cold mode operation of the engine. During cold mode operation of the engine, the Electronic Control Module (ECM) may modify the injection timing and the ECM may cut out certain engine cylinders. This will increase startability and this will reduce warm-up time. Cold mode is activated whenever the engine coolant temperature falls below a predetermined value. Cold mode remains active until the engine has warmed or a time limit is exceeded.

Diagnostic Trouble Codes

Establish communication between Caterpillar Electronic Technician (ET) and the ECM. Verify that the communications adapter is communicating on both data links.

Check for active codes. Look for active codes that are related to the high-pressure fuel system and the low-pressure fuel system. Troubleshoot any active codes before continuing with this procedure.

Flash File

Verify that the correct flash file is installed. Refer to Troubleshooting, "ECM Software - Install".

Starting Aids (If Applicable)

1. If a jacket water heater is installed on your application, check for proper operation of the circuit. Repair the circuit for the jacket water heater, if necessary.
2. If the application has an ether injection system, ensure that the ether canister is not empty or low. Replace the ether canister if the ether canister is empty or low. If an electrical problem with the ether injection system is suspected, refer to the particular test procedure for your application.

Fuel Supply

WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

WARNING

Do not loosen any high pressure fuel lines when the engine is running. The high pressure in the fuel lines can cause personal injury or death. Wait 60 seconds after the engine has stopped to allow pressure to purge before any service or repair is performed on the engine fuel lines.

1. Check the fuel pressure during engine cranking. Check the filtered fuel pressure. If the fuel pressure is low, replace the fuel filters. Refer to Systems Operation/Testing and Adjusting, "Fuel System Pressure - Test".
2. Cold weather adversely affects the characteristics of the fuel. Refer to the Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold-weather operation.

Cooling System

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

Ensure that the temperature readings for the sensor are reasonable for the conditions that are present.

Engine Speed/Timing

Check the calibration of the engine speed/timing sensor. Refer to Troubleshooting, "Timing - Calibrate".

Unit Injectors

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 - Test".

Component Wear

1. Check the valve lash and reset the valve lash, if necessary. Refer to Systems Operation/Testing and Adjusting.
2. Possible causes of low compression are shown in the following list:
 - Faulty piston
 - Faulty piston rings
 - Worn cylinder bores
 - Worn valves
 - Faulty cylinder head gasket
 - Damaged cylinder head

i04285836

Exhaust System Contains Oil

SMCS Code: 1050-035; 1348-035

Probable Causes

- Failed turbocharger seals
- Worn valve guide seals or faulty valve guide seals
- Worn valve guides
- Worn piston rings
- Extended idle times

Recommended Actions

Note: After the repair has been made, the oil should be cleaned from the exhaust system. To clean the oil from the exhaust system, perform the following procedure:

- Remove excess oil from piping with a clean cloth.

- Operate the engine at idle for 10 minutes or until white smoke in the exhaust dissipates.

Failed Turbocharger Seals

Check the inlet manifold and the exhaust manifold for oil. If oil is present, replace the turbocharger.

Worn Valve Guide Seals or Faulty Valve Guide Seals

Inspect the valve guide seals for wear and for damage. Replace the valve guide seals, if necessary.

Worn Valve Guides

Inspect the valve guides for wear. Refer to the Specification manual for the maximum permissible wear of the valve guides. If necessary, recondition the cylinder head.

Worn Piston Rings

Piston rings that have excessive wear can cause too much pressure in the crankcase. The additional pressure in the crankcase will cause more than the normal amount of crankcase blowby from the crankcase breather. Use the following service tools, along with Software License, NETG5044:

- 285 -0900 Blowby Tool Gp (SMALL ENGINE)
- 348 -5430 Multi-Tool Gp

Inspect piston rings and install new parts, as required.

Extended Idle Times

Extended idle times will allow oil to pass into the exhaust system.

i03976849

Exhaust Temperature Is High

SMCS Code: 1088-035-TA; 7498-035

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

- Barometric pressure
- Intake manifold air temperature
- Engine speed

Certain operating conditions may cause the calculated exhaust temperature to increase to a level that may damage engine components. If high exhaust temperatures occur, the ECM derates the engine in order to reduce the calculated exhaust temperature. The engine is derated only to a level that allows the calculated exhaust temperature to return to an acceptable level.

Note: Refer to the High Exhaust Temperature Prevention Derate Time Histogram for derate information.

i03539643

Fuel Consumption Is Excessive

SMCS Code: 1250-035

Probable Causes

Engine Operation

- Look for excessive idle or high load

Diagnostic Codes

- Logged diagnostic codes or active diagnostic codes

Fuel Quality

- Fuel quality

Fuel Supply

- Unstable fuel supply

Engine Speed/Timing

- Calibration procedure of the engine speed/timing

Fuel Injection System

- Unstable injection system

Air Inlet and Exhaust System

- Restriction in the air inlet and exhaust

Accessory Equipment

- Check for damaged accessory equipment

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Look for Excessive Idle or High Load

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

Diagnostic Codes

Check for logged diagnostic codes or active diagnostic codes. If a diagnostic code is logged or active refer to Troubleshooting, "Diagnostic Trouble Codes" for more information.

Fuel Quality

The grade of the fuel affects the rate of fuel consumption. Refer to the engines Operation and Maintenance Manual for additional information.

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.

Calibration Procedure of the Engine Speed/Timing

Perform a speed/timing sensor calibration. Refer to the calibration procedure Troubleshooting, "Timing - Calibrate".

Unstable Injection Actuation System

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

Restriction in the Air Inlet and Exhaust

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.

Check for Damaged 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.

i03983135

Fuel Pressure Is High

SMCS Code: 1250-035

System Operation Description:

The probable causes of high fuel pressure

- Fuel pressure sensor
- Fuel lines
- Fuel transfer pump
- Fuel return pressure regulator

Note: High fuel pressure may cause high fuel temperatures. Troubleshoot a code for high fuel pressure before troubleshooting a code for high fuel temperature.

Use this procedure in order to troubleshoot high fuel pressure. Use this procedure if one of the following event codes is active. Refer to Troubleshooting, "Event Codes" for information about event codes. For information on the engine monitoring system, refer to Troubleshooting, "Engine Monitoring System".

Table 16

Event Code		
CDL Code	Code Description	Comments
E096 (2)	High Fuel Pressure	The code is logged. The fuel pressure is above the trip point pressure.

Test Step 1. Determine the Code

- A.** Connect Cat ET to the service tool connector. Refer to Troubleshooting, "Electronic Service Tools", if necessary.
- B.** Determine if a diagnostic trouble code is present.

Results:

- A E096 (2) code is present. – Proceed to Test Step 2.

- A code other than a E096 (2) code is present.

Repair: Troubleshoot the code. Refer to the proper troubleshooting procedure.

STOP.

Test Step 2. Check the Fuel Pressure Sensor

Table 17

Required Tooling
8t - 7860 Connector
110 - 6349 Fitting as
8t - 0855 Pressure Gauge
6v - 3990 Coupler

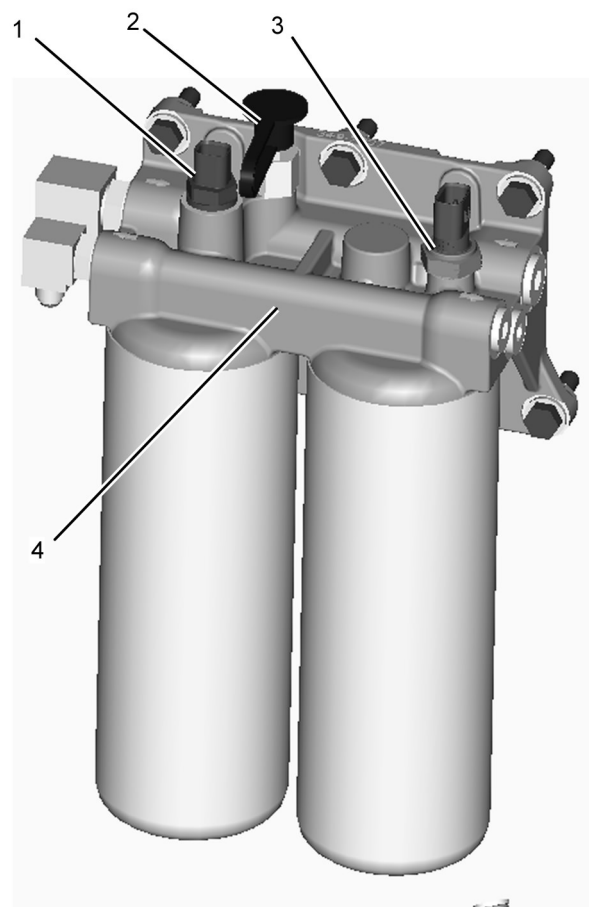


Illustration 29

g02023390

- (1) Fuel temperature sensor
(2) Fuel sampling port
(3) Fuel pressure sensor
(4) Secondary fuel filter base

Note: Do not use the fuel sampling port (2) for measuring the pressure. Follow the steps below.

- A. Record the fuel pressure from Cat ET. Record the data in Table 18.
 - B. Remove the fuel pressure sensor (3).
 - C. Install a 8T-7860 Connector into the port of the pressure sensor (3).
 - D. Install the 110-6349 Fitting as onto the 8T-7860 Connector.
 - E. Install a 8T-0855 Pressure Gauge onto a 6V-3990 Coupler.
 - F. Install the 6V-3990 Coupler onto the 110-6349 Fitting as.
- Note:** After the pressure sensor is removed, a code for low fuel pressure will become active. Clear the code after the sensor is reinstalled.
- G. Record the fuel pressure on the pressure gauge. Record the data in Table 18.

Table 18

Engine RPM	Fuel pressure from Cat ET	Fuel pressure from the mechanical gauge
800		
1800		

Results:

- The gauge value of the fuel pressure is within 137 kPa (20 psi) of the fuel pressure reading shown in ET. – Proceed to Test Step 3.
- The gauge value of the fuel pressure is not within 137 kPa (20 psi) of the fuel pressure reading shown in ET.

Repair: Replace the pressure sensor. Verify that the problem has been resolved.

If the problem is not resolved, proceed to Test Step 3.

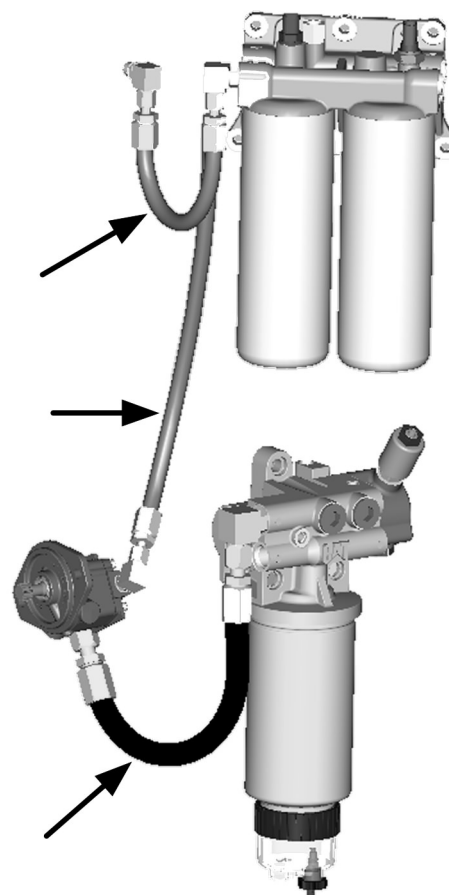
Test Step 3. Inspect the Fuel Supply Lines

Illustration 30
Fuel supply lines

g02023433

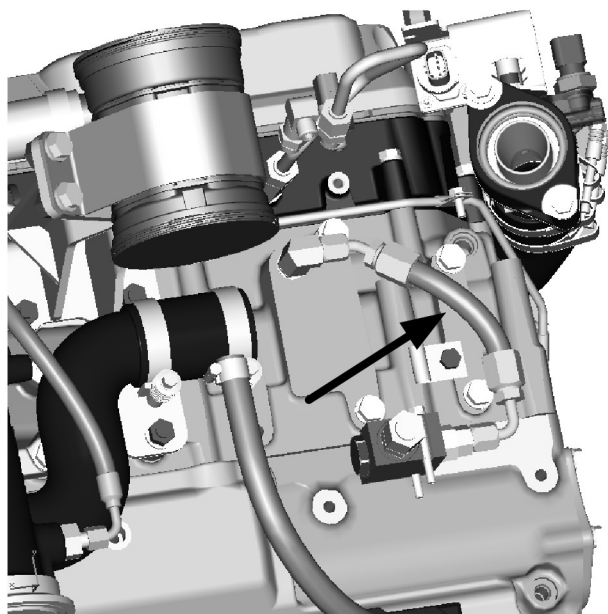


Illustration 31
Return fuel line

g02024502

- A.** Visually inspect the fuel lines between the primary filter base and the inlet to the cylinder head. Also, inspect the fuel cooler, if equipped. Inspect the fuel return line from the head to the fuel tank. Inspect the lines for restrictions, pinching, and swelling.

Results:

- The fuel lines and the cooler (if equipped) are OK. – Proceed to Test Step 4.
- The fuel lines and the cooler (if equipped) are not OK.

Repair: Make the necessary repairs. Verify that the problem has been resolved.

If the problem is not resolved, proceed to Test Step 4.

Test Step 4. Replace the Return Fuel Pressure Regulator

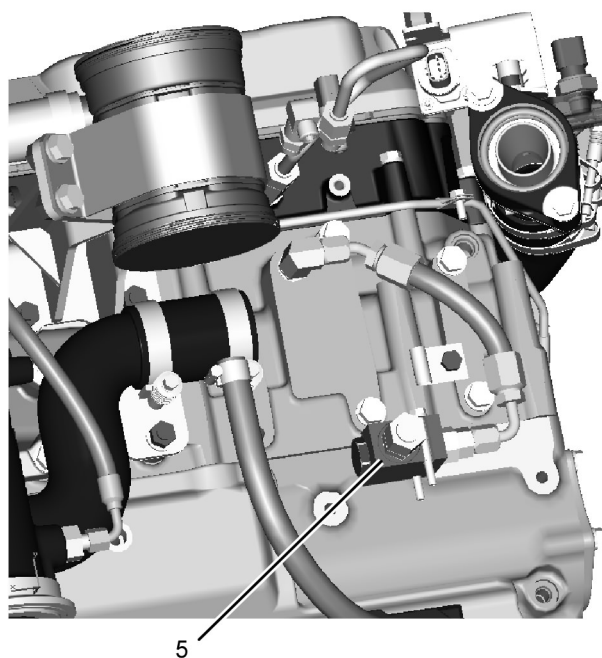


Illustration 32

g02024508

(5) Return fuel pressure regulator

Replace the fuel pressure regulator.

Results:

- The regulator was replaced. Verify that the problem is resolved. – If the problem is not resolved, proceed to Test Step 5.

Test Step 5. Inspect the Relief Valve for the Fuel Transfer Pump

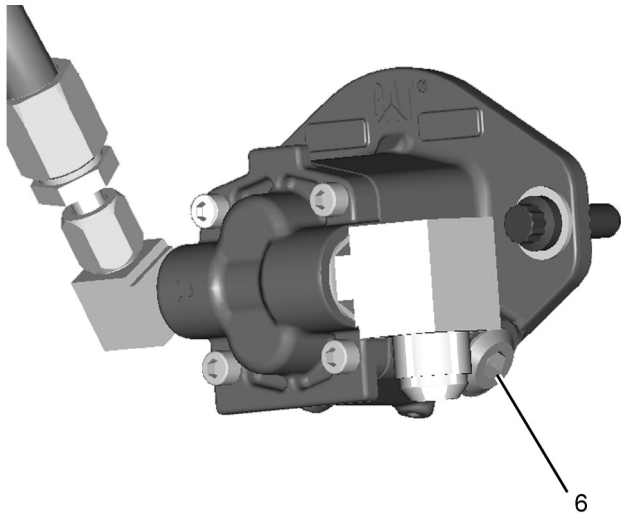


Illustration 33

g02031818

Typical fuel transfer pump

(6) Relief valve

A. Inspect the relief valve for the transfer pump. The spring must move freely.

Results:

- The relief valve is stuck closed.

Repair: Replace the fuel transfer pump. Verify that the problem has been resolved.

STOP.

- The relief valve is OK.

Repair: Clean the relief valve and reinstall the relief valve. Verify that the problem has been resolved.

STOP.

i03983192

Fuel Pressure Is Low

SMCS Code: 1250-035

System Operation Description:

The probable causes of low fuel pressure

- Fuel
- Fuel Tank
- Fuel Filters

- Fuel Transfer Pump
- Fuel Pressure Sensor
- Fuel Return Pressure Regulator
- Anti-Drain Check Valve
- Fuel Lines

Use this procedure in order to troubleshoot a low fuel pressure. Use this procedure if one of the following event codes is active. Refer to Troubleshooting, "Event Codes" for information about event codes. For information on the engine monitoring system, refer to Troubleshooting, "Engine Monitoring System".

Table 19

Event Code		
CDL Code	Code Description	Comments
E198 (1)	Low Fuel Pressure	The code is logged.
E198 (2)		The engine power is derated. The code is logged. The ECM will illuminate the action lamp.

Test Step 1. Determine the Code

A. Connect Cat ET to the service tool connector. Refer to Troubleshooting, "Electronic Service Tools", if necessary.

B. Determine if a diagnostic trouble code is present.

Results:

- A E198 code is present. – Proceed to Test Step 2.
- A code other than a E198 code is present.

Repair: Troubleshoot the code. Refer to the proper troubleshooting procedure. Low fuel pressures may cause high fuel temperatures. Troubleshoot a code for low fuel pressure before troubleshooting a code for high fuel temperature.

STOP.

Test Step 2. Check the Fuel Level in the Tank

A. Remove the fuel tank cap from the fuel tank. Check the vent port that is in the cap for debris. Clear any restrictions with compressed air.

B. Visually inspect the fuel level in the fuel tank. Ensure that the fuel tank contains enough fuel in order to operate the engine.

C. Ensure that the fuel supply valve (if equipped) is in the full OPEN position.

Results:

- The fuel level is OK. – Proceed to Test Step 3.
- The fuel level is not OK.

Repair: Fill the tank. Verify that the problem has been resolved.

If the problem is not resolved, proceed to Test Step 3.

Test Step 3. Inspect the Fuel System for Leaks

Perform a visual inspection of the fuel system. Verify that there are no fuel leaks. Inspect the fuel lines from the fuel transfer pump to the secondary fuel filter base for restrictions.

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

Results:

- No leaks were found. – Proceed to Test Step 4.
- Leaks were found in the fuel system.

Repair: Repair the leaks. Verify that the problem is resolved.

If the problem is not resolved, proceed to Test Step 4.

Test Step 4. Check the Fuel Pressure Sensor

Table 20

Required Tooling
8T-7860 Connector
110-6349 Fitting as
8T-0855 Pressure Gauge
6V-3990 Coupler

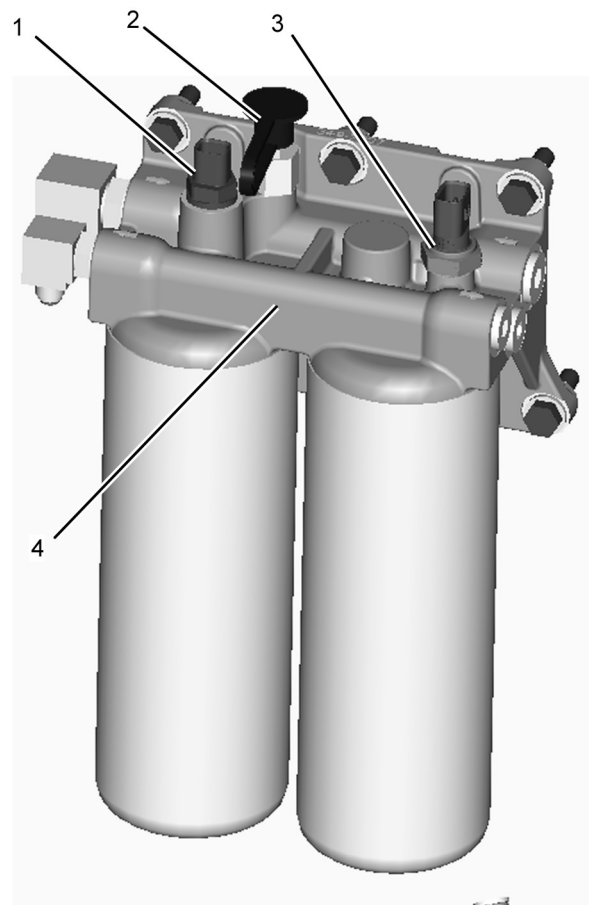


Illustration 34

g02023390

- (1) Fuel temperature sensor
- (2) Fuel sampling port
- (3) Fuel pressure sensor
- (4) Fuel filter base

Note: Do not use the fuel sampling port (2) for measuring the pressure. Follow the steps below.

- A.** Record the fuel pressure from Cat ET. Record the data in Table 21.
- B.** Remove the fuel pressure sensor (3).
- C.** Install a 8T-7860 Connector into the port of the pressure sensor (3).
- D.** Install the 110-6349 Fitting as onto the 8T-7860 Connector.
- E.** Install a 8T-0855 Pressure Gauge onto a 6V-3990 Coupler.
- F.** Install the 6V-3990 Coupler onto the 110-6349 Fitting as.
- G.** Record the fuel pressure on the pressure gauge. Record the data in Table 21.

Table 21

Engine RPM	Fuel pressure from Cat ET	Fuel pressure from the mechanical gauge
800		
1800		

Results:

- The gauge value of the fuel pressure is within 137 kPa (20 psi) of the fuel pressure reading shown in ET. – Proceed to Test Step 5.
- The gauge value of the fuel pressure is not within 137 kPa (20 psi) of the fuel pressure reading shown in ET.

Repair: Replace the pressure sensor. Verify that the problem has been resolved.

If the problem is not resolved, proceed to Test Step 5.

Test Step 5. Verify that the Fuel Pressure Is Within Specifications

Verify that the recorded fuel pressure is above the minimum acceptable fuel specifications. Refer to Table 22 for the minimum acceptable specifications.

Table 22

Engine RPM	Minimum acceptable fuel pressure
800	360 kPa (52 psi)
1800	450 kPa (65 psi)

Results:

- The fuel pressure is above the minimum acceptable fuel specifications. – Proceed to Test Step 7.
- The fuel pressure is not above the minimum acceptable fuel specifications. – Proceed to Test Step 6.

Test Step 6. Replace the Fuel Filters

A. Replace the primary filter, the secondary filter, and the tertiary fuel filters.

Note: The fuel system will need to be primed after the filters are replaced.

B. Verify that the fuel pressure is above the minimum acceptable pressure specifications. Refer to Table 22 for the proper specifications.

Results:

- The fuel pressure meets the minimum acceptable fuel pressure specifications.

Repair: Return the engine to service.

STOP.

- The fuel pressure does not meet the minimum acceptable fuel pressure specifications. – Proceed to Test Step 7.

Test Step 7. Check for Air in the Fuel System

Check for air in the fuel. Refer to Systems Operation/Testing and Adjusting, “Air in Fuel - Test” for the proper procedure.

Results:

- Air is in the system.

Repair: Refer to Systems Operation/Testing and Adjusting, “Air in Fuel - Test” for the proper repairs.

If the problem is not resolved, proceed to Test Step 8.

- Air is not in the system. – Proceed to Test Step 8.

Test Step 8. Replace the Fuel Return Pressure Regulator

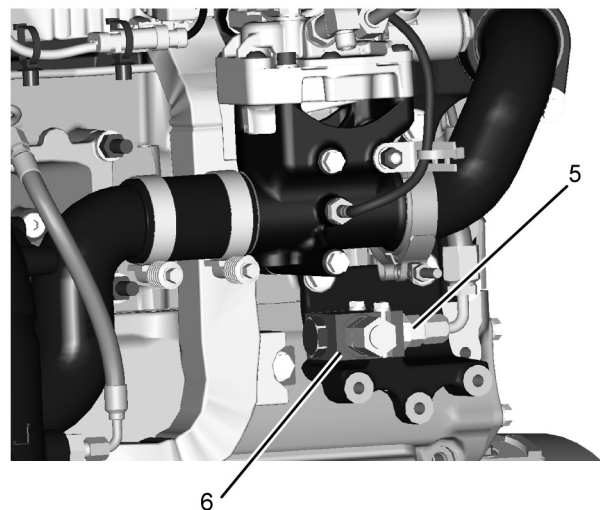


Illustration 35

g02025071

- (5) Anti-drain check valve
(6) Fuel return pressure regulator

 WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

- A.** Replace the fuel return pressure regulator.
- B.** Inspect the anti-drain check valve for proper operation.
- C.** Check the fuel pressure with Cat ET.

Note: Refer to Table 22 for the proper specifications.

Results:

- The fuel pressure meets the minimum acceptable fuel pressure specifications.

Repair: Return the engine to service.

STOP.

- The fuel pressure does not meet the minimum acceptable fuel pressure specifications. – Proceed to Test Step 9.

Test Step 9. Inspect the Relief Valve of the Transfer Pump

- A.** Inspect the relief valve for the transfer pump. The spring must move freely.

Results:

- The relief valve is stuck open.

Repair: Replace the fuel transfer pump. Verify that the problem has been resolved.

If the problem is not resolved, contact a member of the focus team.

- The relief valve is OK.

Repair: Clean the relief valve and reinstall the relief valve.

Proceed to Test Step 10.

Test Step 10. Perform a Pump Lift Test

Perform a pump lift test on the transfer pump.

Results:

- The pump failed the pump lift test

Repair: Replace the transfer pump. Verify that the problem has been resolved.

STOP.

i03982190

Fuel System Water Separator Has Water

SMCS Code: 1263-035

This procedure covers the following diagnostic codes:

Note: Some of the following codes may not be applicable for certain applications.

Table 23

Diagnostic Codes Table		
CDL Code	Code Description	Comments
E232 (1)	High Fuel/Water Separator Water Level	A high level of water is detected in the water separators. If equipped, the action lamp will illuminate.
E232 (2)	High Fuel/Water Separator Water Level	A high level of water is detected in the water separators. The level in the water separator has been high for at least an hour. The operator needs to empty the water separator. The engine will be derated. If equipped, the action lamp will illuminate.

Note: Visually identifying the presence of water in the bowl may be impossible. Water may turn dark yellow in color in the fuel system. Differentiating the water from the fuel would then be difficult.

i03978349

Fuel Temperature Is High

SMCS Code: 1250-035

Use this procedure in order to troubleshoot high fuel temperature. Use this procedure if one of the following event codes is active. Refer to Troubleshooting, "Event Code List" for information about event codes and the default trip points for these codes. Access the monitoring system on Caterpillar Electronic Technician (ET) in order to view the current trip points for these codes.

Troubleshooting Procedure

1. Turn the ignition key to the OFF position.
2. Drain the fuel/water separator bowl. Refer to the Operation and Maintenance Manual, "Fuel System Primary Filter (Water Separator) - Drain".
3. If necessary, prime the fuel system. Refer to the Operation and Maintenance Manual, "Fuel System - Prime".
4. Turn the ignition key to the ON position. Do not start the engine.
5. Wait for 1 minute. The "Water in Fuel" warning should disappear. If the "Water in Fuel" warning is still present, the switch circuit may be faulty.

Perform the following procedure.

- a. Turn the keyswitch to the OFF position.
 - b. Disconnect the harness.
 - c. Create a short in the harness.
 - d. Turn the keyswitch to the ON position.
 - e. If the "Water Separator Has Water" warning disappears, replace the switch.
 - f. If the "Water Separator Has Water" warning does not disappear, repair the wiring or replace the wiring.
6. If the "Water in Fuel" warning disappears within 1 minute after the bowl is drained, allow the engine to run for 5 minutes.
 7. If the "Water in Fuel" warning reappears, the fuel supply is contaminated with water. Drain the fuel tank and then fill the fuel tank with clean fuel. Repeat Steps 1 to 5 in order to reset the warning light.

Table 24

Event Code		
Code and Description	Conditions which Generate this Code	System Response
E363(1) High Fuel Supply Temperature	The fuel temperature is above the trip point temperature.	The code is logged. The diagnostic lamp is illuminated.
E363(2) High Fuel Supply Temperature		The engine power is derated. The derate is 12.5 percent for every degree over the trip point. The maximum derate is 25 percent. The code is logged. The diagnostic lamp is illuminated.
E363(3) High Fuel Supply Temperature		The engine is shut down. The code is logged. The diagnostic lamp is illuminated.

Probable Causes

- Fuel level in the tank
- Overheated engine
- Restriction in the fuel lines
- Fuel temperature sensor
- Fuel return pressure regulator
- Fuel injector

Recommended Actions

Check the Fuel Level in the Fuel Tank

Ensure that the fuel tank contains enough fuel. As the fuel tank level decreases, the fuel temperature generally increases.

Overheated Engine

The fuel is supplied to the injectors through a passage in the cylinder head. Abnormally high ambient air temperature could cause the fuel temperature to reach the trip level. An overheated engine could cause the fuel temperature to reach the trip level.

Inspect the Fuel Supply Lines

Visually inspect the fuel lines between the priming pump and the inlet to the cylinder head. Also, inspect the fuel cooler, if equipped. Inspect the fuel return line from the head to the fuel tank. Inspect the lines for restrictions, pinching, and swelling. Refer to Systems Operation/Testing and Adjusting, "Fuel System - Inspect" for additional information.

Replace the Temperature Sensor

Replace the fuel temperature sensor. Verify that the problem has been resolved.

Fuel Return Pressure Regulator

Replace the fuel return pressure regulator. Verify that the problem has been resolved.

The fuel is supplied to the injectors through a passage in the cylinder head. Abnormally high ambient air temperature could cause the fuel temperature to reach the trip level. An overheated engine could cause the fuel temperature to reach the trip level.

Perform a Fuel System Verification Test

Perform a "Fuel System Verification Test" in Cat ET. Replace the identified injectors. Verify that all trim files are installed into the ECM correctly. Refer to Troubleshooting, "Injector Trim File - Install". Repeat the "Fuel System Verification Test" after making the necessary repairs. Repeat the process until all the injectors are operating properly.

i04465335

Idle Speed Is High

SMCS Code: 1915-035

Note: The following code may not be applicable for certain applications.

Table 25

Diagnostic Trouble Codes			
CDL Code	J1939 Code	Description (Code descriptions may vary)	Comments
E441 (1)		Idle Elevated to Increase Battery Voltage	The battery voltage is below 24.5 VDC for 5 minutes. The engine speed is increased to 1000 rpm. The code is logged.

Probable Causes

i03977152

Charging Circuit

- Troubleshoot charging circuit

Normal Operation

- Low battery engine elevated idle

Recommended Actions

Troubleshoot Charging Circuit

Inspect the battery and charging circuit. Refer to Systems Operation/Testing and Adjusting, "Electrical System" for additional information.

Low Battery Engine Elevated Idle

This condition is normal operation. The engine idle speed will be elevated to 1000 rpm when all of the following conditions occur:

- Low Battery Engine Elevated Idle is enabled.
- A valid throttle position is present. The throttle position has not exceeded 25 percent of full throttle for 5 minutes.
- The transmission is in neutral.
- The parking brake is engaged.
- A valid engine speed is present.
- System battery voltage is below 24.5 VDC for 5 minutes.

Inlet Air Is Restricted

SMCS Code: 1087-035

Use this procedure in order to troubleshoot a high differential pressure for the air inlet system. Use this procedure if one of the following event codes are active. Refer to Troubleshooting, "Event Codes" for information about event codes. Access the engine monitoring system on Caterpillar Electronic Technician (ET) in order to view the current trip points for these codes. For information on the engine monitoring system, refer to Troubleshooting, "Engine Monitoring System".

Note: Some of the following codes may not be applicable for certain applications.

Table 26

Event Codes for a high differential pressure for the air inlet system		
Code	Description	System Response
E583(1)	High Air Inlet #1 Differential Pressure	The air filter differential pressure is above the trip point pressure for the delay time. The code is logged.
E583(2)	High Air Inlet #1 Differential Pressure	The air filter differential pressure is above the trip point pressure for the delay time. The code is logged. The engine power is derated.

Probable Causes

- Air filter element
- Air inlet piping

i03983030

- Atmospheric pressure sensor, turbocharger compressor inlet pressure sensors, and/or sensor circuits
- Enclosure

Recommended Actions

Air Filter Element

Check the air intake system for plugged air filters or for damaged air filters. If the engine is equipped with an air intake precleaner, verify the proper operation of the air intake precleaner.

Air Inlet Piping

Check the air inlet piping for damage or restrictions. Repair the piping or replace the piping.

Enclosure

Check that the engine has been installed in an enclosure that is sufficiently ventilated. Repair the ventilation for the enclosure.

Atmospheric Pressure Sensor, Turbocharger Compressor Inlet Pressure Sensors, and/or Sensor Circuits

Use Cat ET to compare the status of the following parameters while the engine is off:

- “Atmospheric Pressure”
- “Turbocharger #1 Compressor Inlet Pressure (absolute)”

Note: The status for air filter restriction is a calculated value. Before Cat ET reports the status parameters for air filter restriction, the engine must be running for 3 minutes. Cat ET will report “Conditions Not Met” for these parameters prior to this delay time.

Cat ET will report the status for “Atmospheric Pressure” as the barometric pressure that is for the surrounding area. While the engine is off, the readings for the turbocharger compressor inlet pressure sensor will be approximately the same value that is reported by the atmospheric pressure sensor. If the readings do not agree, troubleshoot the sensor circuits for the suspect sensor. Refer to Troubleshooting, “Sensor Signal (Analog, Active) - Test”.

Intake Manifold Air Pressure Is Low

SMCS Code: 1058-035-PX

System Operation Description:

Table 27 lists the diagnostic trouble code for low intake manifold air pressure.

Table 27

Related Diagnostic Trouble Codes		
Event Code	Description	Comments
E1045(2)	Low Intake Manifold Pressure	The code is logged. Engine power is derated.

Test Step 1. Check for Diagnostic Trouble Codes

- Connect Caterpillar Electronic Technician (ET) to the service tool connector.
- Download the “Product Summary Report” from the engine Electronic Control Module (ECM) before performing any troubleshooting or clearing diagnostic trouble codes.
- Check for an E583High Air Inlet #1 Differential Pressure that is active or logged.

Results:

- A E583 code is active or logged.

Repair: Refer to Troubleshooting, “Inlet Air Is Restricted” for troubleshooting information.

STOP.

- E1045 is active or logged – Proceed to Test Step 2.

Test Step 2. Check the Air Filter for Restrictions

- Visually inspect the air filter elements for plugging. Check that the air filter housing is in good repair. Ensure that any damage to the housing is not causing an air restriction at the air inlet.
- Visually inspect the inlet piping between the air filter housing and the turbocharger. Check the piping for dents and damage that may cause restriction.

Expected Result:

The air filter is clean and the air inlet is not restricted.

Results:

- OK – The air filters are OK and the inlet is not restricted. Proceed to Test Step 3.
- – A restricted filter element is found.

Repair: Clean the filter elements or replace the filter elements. Repair any inlet restriction that is found. Verify that the problem has been resolved.

STOP.

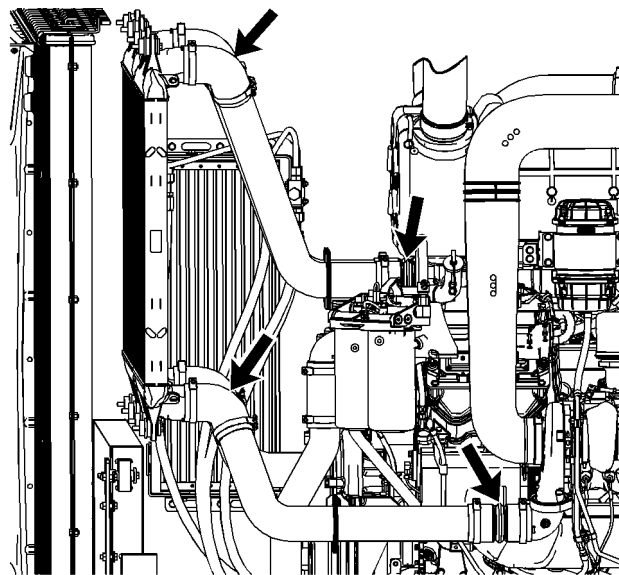
Test Step 3. Inspect the Air Piping and Connections

Illustration 36

g02068395

Rubber couplings for the air intake system piping (left side engine view)

- Visually inspect the air intake system piping from the turbocharger compressor outlet to the inlet of the air-to-air aftercooler core. Also, inspect the piping from the outlet of the air-to-air aftercooler to the intake of the engine. Check that the piping is in good repair and check that the piping is not leaking.
- Remove the rubber couplings for the piping that are on each side of the engine. Inspect the couplings for air leaks. If necessary, replace the couplings.

Expected Result:

The piping and rubber couplings are in good repair.

Results:

- OK – The piping and rubber couplings are OK. Replace the couplings. Ensure that the clamps are tight. Verify that there are no leaks in the system. Proceed to Test Step 4.
- Not OK – A problem with the piping has been identified.

Repair: Replace the damaged piping or hose connections. Verify that the problem has been resolved.

STOP.

Test Step 4. Inspect the Turbocharger

Remove the connection for the inlet air and the exhaust connection to the turbocharger. Verify that the compressor wheel and the turbine wheel are spinning freely. Verify that the compressor wheel and the turbine wheel are not damaged.

Expected Result:

The turbocharger is in good repair.

Results:

- Not OK

Repair: Replace the turbocharger. Return the engine to service.

STOP.

i03982886

Intake Manifold Air Temperature Is High

SMCS Code: 1058-035-TA

System Operation Description:

Table 28 lists the diagnostic trouble codes for high intake manifold air temperature.

Table 28

Diagnostic Trouble Codes for High Intake Manifold Air Temperature		
CDL Code	Code Description	Comments
E539 (1)	High Intake Manifold Air Temperature	The code indicates that the temperature of the intake air into the engine has risen above a predetermined threshold. The value is obtained from a virtual sensor. For information on virtual sensors, refer to System Operations and Testing and Adjusting. Engine power may be derated.
E539 (2)	High Intake Manifold Air Temperature	
E539 (3)	High Intake Manifold Air Temperature	
Follow the troubleshooting procedure in order to identify the root cause of the problem.		

Test Step 1. Check the ATAAC for Restrictions (if equipped)

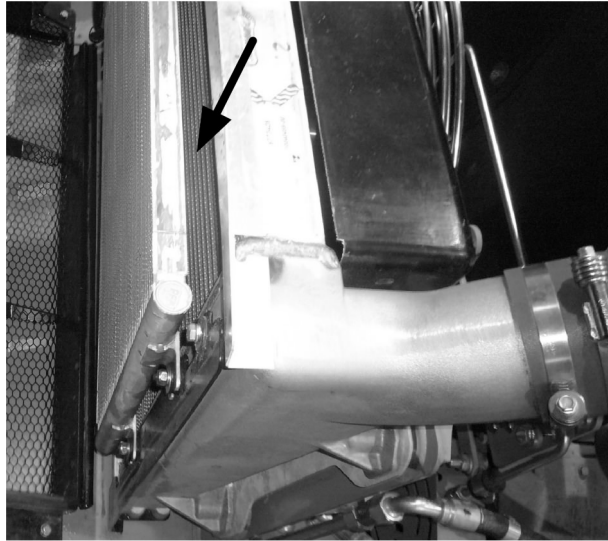


Illustration 37
Inspection point

g02023837

- A.** Inspect the exterior surface of the ATAAC for excessive buildup of dirt or debris. Also verify that the fins of the ATAAC are not damaged.

Results:

- The ATAAC has an excessive buildup of dirt or debris.

Repair: Clean the ATAAC. Verify that the problem has been resolved.

If the problem still exists, proceed to Test Step 2.

- The surface of the ATAAC is damaged.

Repair: Replace the ATAAC.

If the problem still exists, proceed to Test Step 2.

- The surface of the ATAAC is not damaged and the ATAAC does not have an excessive buildup of dirt or debris. – Proceed to Test Step 2.

Test Step 2. Check the Operation of the Cooling Fan

- A.** Verify that the cooling fan that is being used to transfer heat from the ATAAC is working properly. If the fan is belt driven, verify that the belt tension is adequate. Also, verify that the clutch is operating properly. If the fan is hydraulically driven, verify that there is no leakage around the motor and that the pressure for the fan is adequate.

Results:

- The fan drive system is not working properly.

Repair: Make the necessary adjustments to the clutch or the belt tension if the fan is mechanically driven. Refer to Testing and Adjusting for the proper procedure. Repair leaks or make the necessary adjustments to the motor or the hydraulic pump if the fan is hydraulically driven. Refer to Testing and Adjusting for the proper procedure.

If the problem still exists, proceed to Test Step 3.

- The fan drive system is working properly. – Proceed to Test Step 3.

Test Step 3. Check the Operation of the Intake Manifold Air Temperature Sensor

- A.** Remove the intake manifold air temperature sensor. Allow the intake manifold air temperature sensor to rest in ambient air for two minutes.
- B.** Connect to the engine ECM by using Cat ET.
- C.** Monitor the value of the intake manifold air temperature sensor on Cat ET.

Results:

- The value of the intake manifold air temperature sensor is within $\pm -9^{\circ}\text{C}$ ($\pm 15^{\circ}\text{F}$) of the ambient temperature.

Repair: Reinstall the sensor. Torque the sensor to the proper specifications.

Proceed to Test Step 4.

- The value of the intake manifold air temperature sensor is not within $\pm -9^{\circ}\text{C}$ ($\pm 15^{\circ}\text{F}$) of the ambient temperature.

Repair: Replace the intake manifold air temperature sensor. Return the unit to service.

STOP.

Test Step 4. Altitude of Operation

Consider high altitude operation. The cooling capability of the cooling system is reduced at higher altitudes. A pressurized cooling system that is large enough to keep the coolant from boiling must be used. Make sure that the settings for the engine are correct for the altitude.

Results:

- The altitude is normal. – Proceed to Test Step 5.

Test Step 5. Engine Overload

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.

Results:

- The engine is overloaded.

Repair: Reduce the load on the engine.

STOP.

i03977174

Oil Consumption Is Excessive

SMCS Code: 1348-035

Probable Causes

Oil Level

- Incorrect oil level in the crankcase

Oil Leaks

- Oil leaks on the outside of the engine
- Oil leaks in the combustion area of the cylinders

- Oil leakage at the injector

Oil Viscosity

- Incorrect oil viscosity

Turbocharger

- Condition of turbocharger

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Excessive Oil in the Crankcase

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

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. Refer to Systems Operation/Testing and Adjusting, "Lubrication System" for calibration of the dipstick gauge. Remove excessive engine oil from the crankcase.

Oil Leaks on the Outside of the Engine

Check for oil leaks on the outside of the engine. Refer to Systems Operation/Testing and Adjusting, "Lubrication System".

Oil Leaks in the Combustion Area of the Cylinder

Check for oil leaks in the combustion area of the cylinders.

Check for excessive engine blowby. Excessive engine blowby will cause unnecessary oil consumption. Excessive engine blowby can also cause unnecessary engine wear.

Oil leakage At the Injector

Check for the excessive transfer of oil from the high-pressure oil supply in the injector to the fuel return in the cylinder head.

Oil Viscosity

Excessive consumption of engine oil can also result if engine oil with the wrong viscosity is used. Engine oil with a thin viscosity can be caused by fuel leakage into the crankcase or by increased engine temperature. Refer to the Operation and Maintenance Manual for additional information.

Condition of Turbocharger

Check the turbocharger for leakage.

i03977249

Oil Contains Coolant

SMCS Code: 1348-035; 1395-035

Emulsion is a mixture of oil and water. The water occurs when condensation forms in the engine during certain operating and seasonal conditions. The emulsion may appear light in color. Emulsion may be found in the following areas:

- Engine oil filler
- Engine oil level gauge
- Valve cover
- Crankcase ventilation system

The emulsion should disappear with increased engine operating temperatures at higher load conditions.

Probable Causes

Engine Oil Cooler

- Leaks in the core of oil cooler

Cylinder Head Gasket

- Leaks in the cylinder head gasket
- Damaged water seals

Cylinder Head

- Cracks in the cylinder head

Cylinder Liner

- Cracks in a cylinder liner
- Liner seals

Cylinder Block

- Cracks in the cylinder block

Recommended Actions

Leaks in the Cooling System

Pressurize the cooling system. Refer to Systems Operation/Testing and Adjusting, "Cooling System - Test". If the test indicates a drop in pressure and no outside leaks are detected in the cooling system, there may be an internal leak. Make any repairs, as required.

Leaks in Core of Oil Cooler

Check for leaks in the oil cooler core.

Leaks in the Cylinder Head Gasket

Inspect the cylinder head gasket for leaks.

Damaged Water Seals

Inspect the water seal for damage.

Cracks in the Cylinder Head

Check for cracks in the cylinder head. If a crack is found, repair the cylinder head and/or replace the cylinder head.

Cracks in a Cylinder Liner

Check for cracked cylinder liners. Replace any cracked cylinder liners.

Check the liner seals for damage. Replace any damaged seals.

Cracks in the Cylinder Block

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

i03977230

Oil Contains Fuel

SMCS Code: 1250-035; 1348-035

Always verify fuel dilution. Ask the Caterpillar dealer to submit an oil sample to a Caterpillar regional SOS laboratory for analysis.

Note: For additional information, refer to , REHS3007, "Determining the Cause of Fuel Dilution of Engine Oil".

Probable Causes

Injector

- Leaking seals
- Fuel injector tip

Fuel Transfer Pump

- Fuel transfer pump seal

Cylinder Head

- Cracked cylinder head

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Leaking Seals

If leakage is found, remove the injector from the affected cylinder and visually inspect the injectors O-ring seals for damage. If damage is found, replace the damaged seals. Install the injector onto the engine and confirm that the repair has resolved the problem.

If leakage is found and the O-rings are in good repair, there may be a problem with the injector. Replace the injector. Ensure that the new trim files are installed. Refer to Troubleshooting, "Injector Trim File - Install" for details. Use Caterpillar Electronic Technician (ET) to perform a "Fuel System Verification Test". Refer to Troubleshooting, "Injector Solenoid - Test" for details.

If the leakage is not located, add the appropriate dye to the fuel tanks. Run the engine at high idle for several minutes. Shut down the engine and remove the valve covers. Use a black light to check for traces of dye around each injector.

If leakage is suspected for a specific injector, remove the injector from the affected cylinder and replace the damaged seals. Install the injector onto the engine and return the engine to service.

Fuel Injector Tip

Use Cat ET to perform the "Cylinder Cutout Test" in order to identify any cylinders that may be overfueled. A fuel injector tip that is broken or fractured is a possible cause of a cylinder that is being overfueled. If a cylinder is identified by the test, Remove the injector and check the injector tip for damage. Check the fuel injector tip for cracks or breakage. If necessary, replace the suspect unit injector.

Fuel Transfer Pump Seal

Check for fuel leakage around the shaft seal for the fuel transfer pump. Ensure that the weep hole is not plugged. If necessary, replace the fuel transfer pump.

Cracked Cylinder Head

Look for signs of damage to the internal passages in the cylinder head for the fuel supply to the injectors. Check for pin hole leaks. Refer to Disassembly and Assembly.

i04461893

Oil Pressure Is Low

SMCS Code: 1348-035-PX

Note: Severe slopes can cause low oil pressure. If the machine is operated on severe slopes, the oil level in the engine crankcase must be at the "FULL" mark on the dipstick. Refer to Operation and Maintenance Manual for details.

Use this procedure in order to troubleshoot low engine oil pressure. Use this procedure if one of the following event codes is active. Refer to Troubleshooting, "Event Codes" for information about event codes and the default trip points for these codes. For information on the engine monitoring system, refer to Troubleshooting, "Engine Monitoring System".

Table 29

Diagnostic Trouble Codes			
CDL Code	J1939 Code	Code Description (code descriptions may vary)	Comments
E360 (1)	100-17	Low Engine Oil Pressure	Oil pressure is below the specified pressure for at least 8 seconds. A snapshot is triggered. The code is logged. Engine performance is not affected.
E360 (2)	100-18	Low Engine Oil Pressure	Oil pressure is lower than the specified pressure for at least 4 seconds. Engine power is reduced. A snapshot is triggered. The code is logged. Factory passwords are required. After 30 seconds, the Engine Control Module (ECM) will shut down the engine if the "Engine Monitoring Mode" parameter is programmed to "Shut down".
E360 (3)	100-1	Low Engine Oil Pressure	Oil pressure is lower than the specified pressure for at least 4 seconds. Engine power is reduced. A snapshot is triggered. The code is logged. Factory passwords are required. After 30 seconds, the ECM will shut down the engine if the "Engine Monitoring Mode" parameter is programmed to "Shut down".

Probable Causes

Engine Oil Level

- Low engine oil level

Aerated Oil

- Aeration in the oil

Oil Viscosity

- Low oil viscosity

Oil Filter

- Plugged Oil Filter

Oil Pump

- Faulty oil pump

Engine Oil Pressure Sensor

- Faulty engine oil pressure sensor

Oil Filter Bypass

- Faulty bypass valve

Oil Pump Suction Tube

- Damaged suction tube or cracked suction tube

Worn Engine Components

- Excessive wear of engine components

Troubleshooting Sequence

Note: Complete the procedures in order.

WARNING

Work carefully around an engine that is running. Engine parts that are hot, or parts that are moving, can cause personal injury.

1. Engine Oil Level

- Check the engine oil level in the crankcase. Refer to the Operation and Maintenance Manual for calibration of the dipstick gauge. The oil level can possibly be too far below the oil pump supply tube. The oil pump cannot 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. Refer to Operation and Maintenance Manual, "Engine Oil" for the recommendations of engine oil.
- Start the engine. Inspect the exterior of the engine for oil leaks. Repair any oil leaks.
- If the problem has been corrected, return the unit to service.
- If the symptom remains, proceed to step 2. Aerated Oil.

2. Aerated Oil

- Sample the engine oil for aeration.

Note: Foamy oil on the dipstick is a good indication of aeration.

- b. If the oil is aerated, proceed to step 8. Oil Pump Suction Tube.
- c. If the oil is not aerated, proceed to step 3. Oil Viscosity.

3. Oil Viscosity

- a. Sample the engine oil viscosity. Obtain an S-O-S Oil Analysis to determine the characteristics of the oil.
- b. If the oil viscosity is not correct, replace the engine oil. Refer to Operation and Maintenance Manual, "Engine Oil" for the recommendations of engine oil. If the symptom is corrected, return the unit to service. If the symptom still exists, proceed to step 4. Oil Filter.
- c. If the oil viscosity is correct, proceed to step 4. Oil Filter. Refer to Operation and Maintenance Manual, "Engine Oil" for the recommendations of engine oil.

4. Oil Filter

- a. Replace the engine oil filter.
- b. If the symptom is corrected, return the unit to service.
- c. If the symptom still exists, proceed to step 5. Oil Pump.

5. Oil Pump

- a. Manually check the engine oil pressure. Refer to Systems Operation/Testing and Adjusting, "Engine Oil Pressure - Test" for the correct procedure.
- b. If the pressure at the test port is correct, proceed to step 6. Engine Oil Pressure Sensor.
- c. If the pressure does not meet the specifications, replace the pump.
- d. If the symptom is corrected, return the unit to service.
- e. If the symptom still exists, proceed to step 6. Engine Oil Pressure Sensor.

6. Engine Oil Pressure Sensor

- a. Remove the oil pressure sensor.
- b. Install a pipe "T" in the pressure sensor port.

- c. Install a manual gauge on one side of the pipe "T". Install the oil pressure sensor on the other side of the pipe "T".
- d. Start the engine and compare the two readings. The pressure reading must be within ± 13.8 kPa (± 2 psi).
- e. If the pressure is within ± 13.8 kPa (± 2 psi), proceed to step 7. Engine Oil Filter Bypass.
- f. If the pressure is not within ± 13.8 kPa (± 2 psi), replace the sensor.
- g. If the symptom is corrected, return the unit to service.
- h. If the symptom is corrected, proceed to step 7. Engine Oil Filter Bypass.

7. Engine Oil Filter Bypass

- a. Replace the oil filter base.
- b. If the symptom is corrected, return the unit to service.
- c. If the symptom is corrected, proceed to step 8. Oil Pump Suction Tube.

8. Oil Pump Suction Tube

- a. Remove the oil pan.
- b. Inspect the suction tube. Check the joints of the tube for cracks or for a damaged O-ring seal at the connection to the pump.
- c. Inspect the inlet screen of the suction tube for a restriction. This restriction will cause cavitation and a loss of engine oil pressure.
- d. Replace parts, if necessary.
- e. If the symptom is corrected, return the unit to service.
- f. If the symptom still exists, proceed to step 9. Worn Engine Components.

9. Worn Engine Components

- a. Remove the valve covers.
- b. Inspect the camshaft and bearings.
- c. Remove the oil pan.
- d. Excessive clearance at the crankshaft or camshaft bearings will cause low engine oil pressure. Check the engine components for excessive clearance. Also, inspect the piston cooling jets.

- e. Replace parts, if necessary. Check the Reuse and Salvage Guidelines for the reusability of existing engine components.

i03977291

Oil Temperature Is High

SMCS Code: 1348-035-TA

Probable Causes

Engine Oil

- Low engine oil level
- Incorrect engine oil
- Verify the engine oil temperature.

Engine Oil Cooler

- Restriction in the engine oil cooler core
- Engine oil cooler bypass valve

Engine Coolant Temperature

- High engine coolant temperature

Recommended Actions

Note: The procedures have been listed in order of probability. Complete the procedures in order.

Low Engine Oil Level

Check for the correct oil level. If necessary, add engine oil to the crankcase.

Incorrect Engine Oil

Make sure that the engine is supplied with the correct engine oil. For the correct engine oil to use, refer to the Operation and Maintenance Manual.

Verify Oil Temperature

Check the actual engine oil temperature with a calibrated test gauge. Compare the oil temperature reading from Caterpillar Electronic Technician (ET) to the reading on the test gauge.

Restriction in 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.

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.

High Engine Coolant Temperature

If a high coolant temperature condition is also occurring, refer to the symptom Troubleshooting, "Coolant Temperature Is High".

i03977370

Power Is Intermittently Low or Power Cutout Is Intermittent

SMCS Code: 1000-035-PWR

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

Probable Causes

Event Codes

- Check for active event codes that may derate engine power

Electrical Connections

- Electrical connections not properly connected.

Diagnostic Codes

- Check for intermittent diagnostic codes

Throttle Signal

- Intermittent throttle signal

Fuel System

- Fuel system components

Fuel Supply

- Fuel supply pressure

Air Inlet and Exhaust System

- Restriction in the air inlet and exhaust system
- Excessive temperature of the turbocharger that causes the engine derate

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.

Check for Active Event Codes that may Derate Engine Power

Certain event codes may derate engine power. Connect 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.

Electrical Connections

Verify that the following connectors are installed correctly:

- Electrical connectors for the ECM
- Connectors for the wiring harness under the valve cover
- Connectors for the engine speed/timing sensors

Refer to Troubleshooting, "Electrical Connectors - Inspect" for the proper troubleshooting procedure.

Check for Intermittent Diagnostic Codes

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

Intermittent 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".

Fuel System

Ensure that the fuel system is operating properly.

HD Fuel System

1. Start the engine.
2. Access the Cylinder Cutout Test in the Diagnostic Tests under the "Diagnostics" menu.
3. Select the "Automatic Cylinder Cutout Test" on Cat ET.

4. Start the test.

Diagnose the problem and then repair the cylinders that failed the "Cylinder Cutout Test" before continuing with this procedure. Clear all logged diagnostic codes. Verify that the repair has eliminated the problem in the cylinder.

Series MR Fuel System

- 1.

Fuel Supply Pressure

1. Check the fuel pressure. Ensure that the fuel is stable. Refer to Systems Operation/Testing and Adjusting for the procedure to check the fuel pressure manually.
2. 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, purge the air from the fuel system.
3. Ensure that the fuel supply valve (if equipped) is in the full OPEN position.
4. Check the fuel lines for the following problems: restrictions, collapsed lines, pinched lines, and loose connections. If problems are found with the fuel lines, repair the lines and/or replace the lines.
5. 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
6. Check the fuel tank for foreign objects which may block the fuel supply.
7. Check the fuel filters.
8. Check the fuel quality. Make sure that the fuel meets the requirements of Special Publication, SEBU6250, "Caterpillar Machine Fluids Recommendations".

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.

Restriction in the Air Inlet and Exhaust System

Ensure that the turbocharger is operating correctly. Periodic inspection and cleaning are recommended for the turbocharger compressor housing (inlet side).

Check the air filter restriction indicator. Clean plugged air filters or replace plugged air filters.

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

i03539985

Valve Lash Is Excessive

SMCS Code: 1105-035

Probable Causes

Valve Lash Setting

- Valve lash setting is not at factory specifications.

Rocker Arms

- Worn rocker arms

Valve Springs

- Worn valve springs or broken valve springs

Pushrods

- Bent pushrods

Camshaft

- Worn camshaft

Cylinder Head

- Valve seat wear

Troubleshooting Sequence

Note: Complete the procedures in order.

1. Valve Lash Setting

- Check the engine valve lash. If necessary, adjust the engine valve lash. Refer to Systems Operation/Testing and Adjusting for information on adjusting the engine valve lash.
- If the valve lash cannot be set to specifications, proceed to step 2. Rocker Arms`.

- If the valve lash can be set, return the unit to service.

2. Rocker Arms

- Inspect rocker arms for pitting or spalling on the roller.
- Check the rocker arm for a missing button.
- Replace parts, if necessary. If the symptom remains, proceed to step 3. Valve Springs.
- If the problem has been corrected, return the unit to service.

3. Valve Springs

- Check for cracked valve springs or broken valve springs.
- Replace parts, if necessary. If the symptom remains, proceed to step 4. Pushrods.
- If the problem has been corrected, return the unit to service.

4. Pushrods

- Check the pushrods for wear and straightness.

Note: Roll the pushrods on a flat surface in order to determine the straightness of the rod.

- Replace parts, if necessary. If the symptom remains, proceed to step 5. Camshaft.
- If the problem has been corrected, return the unit to service.

5. Camshaft

Note: Remove the camshaft in order to inspect the camshaft.

- Inspect the camshaft for large grooves.
- Measure the camshaft in order to determine if the camshaft is in specifications. Refer to Reuse and Salvage Guidelines for the correct measurements.
- Replace parts, if necessary. If the symptom remains, proceed to step 6. Cylinder Head.

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

- If the problem has been corrected, return the unit to service.

6. Cylinder Head

- a. Remove the cylinder head. Refer to the Reuse and Salvage Guidelines for the reusability specifications.
- b. Inspect the piston and valve for damage.
- c. Inspect the valve seat for wear.
- d. Replace parts, if necessary.

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.

Circuit Tests

i03855631

Coolant Level - Test

SMCS Code: 1395-038; 1439-038-CLT;
7422-038-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 when the coolant level is low.

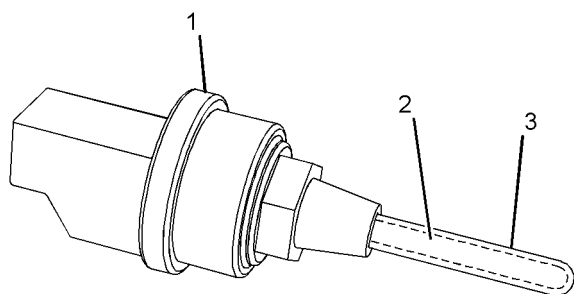


Illustration 38

g01150024

Components of the coolant level sensor

- (1) Sensor
- (2) Sensor probe (brass dowel)
- (3) Outer coating

When the probe is not immersed in coolant, approximately +5 VDC is sourced to the sensor 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 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.

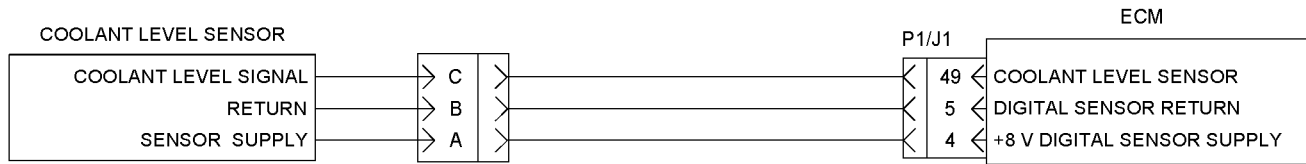


Illustration 39

g02199873

Test Step 1. Check the Coolant Level

WARNING

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

A. 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.

Results:

- OK – The coolant is at the proper level. Proceed to Test Step 2.
- 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 2. Verify that the “Coolant Level Sensor” Parameter is Programmed Correctly

- Connect Cat ET to the service tool connector.
- Establish communication with the ECM.
- Verify that the “Coolant Level Sensor” parameter is programmed to “Installed”.
- Remove electrical power from the ECM.

Results:

- The “Coolant Level Sensor” parameter is programmed correctly. – Proceed to Test Step 3.

- The “Coolant Level Sensor” parameter is not programmed correctly.

Repair: Program the “Coolant Level Sensor” parameter to “Installed”.

Verify that the repair eliminates the problem.

STOP.

Test Step 3. Check the Supply Voltage at the Sensor Connector

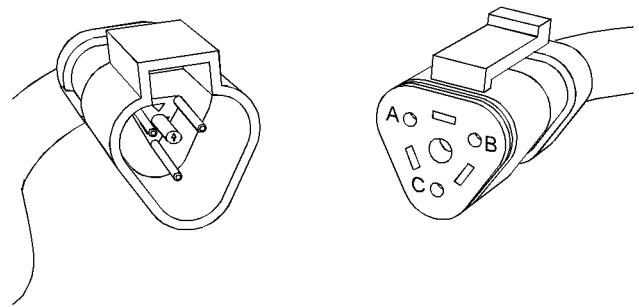


Illustration 40

g02090761

Terminal locations at the harness connector for the coolant level sensor

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

- Disconnect the coolant level sensor at the sensor connector.
- Restore electrical power to the ECM.
- Measure the voltage between terminals A (sensor supply) and B (sensor return) at the harness connector for the coolant level sensor.
- Remove electrical power from the ECM.

Results:

- The voltage measurement is 8.0 ± 0.5 VDC. – The supply voltage is reaching the sensor. Proceed to Test Step 4.
- The voltage measurement is not 8.0 ± 0.5 VDC.

Repair: The sensor supply voltage is not reaching the sensor. There is a problem in the circuit for the sensor supply. Repair the wiring between the sensor and the ECM.

STOP.

Test Step 4. Short the Signal Wire to Ground and Monitor the Status for “Coolant Level”

- A.** Fabricate a jumper wire that is long enough to create a short circuit between two terminals at the coolant level sensor harness connector. Crimp connector pins to each end of the jumper wire.
- B.** 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.
- C.** Restore electrical power to the ECM.
- D.** 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.

- E.** Remove the jumper wire. Connect the harness connector for the coolant level sensor.

Results:

- 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: Replace the coolant level sensor.

Verify that the repair eliminates the problem.

STOP.

- The status does not change from “LOW” to “OK” when the jumper wire is installed.

Repair: The problem is between the ECM and the sensor connector. Repair the wiring.

Verify that the repair eliminates the problem.

STOP.

i04001530

Cooling Fan Control - Test

SMCS Code: 1356-038-CLT; 1435-038; 5479-038

System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with the engine fan control solenoid. Also use this procedure if one of the diagnostic codes in Table 30 is active.

Table 30

Diagnostic Codes Table		
CDL Code	Code Description	Comments
291-5	Engine Cooling Fan Solenoid : Current Below Normal	The Electronic Control Module (ECM) detects an open circuit in the circuit for the engine fan control solenoid. The ECM sends minimum current to the fan control solenoid. The code is logged.
291-6	Engine Cooling Fan Solenoid : Current Above Normal	The ECM detects a short circuit to ground in the circuit for the engine fan control solenoid. The ECM sends minimum current to the fan control solenoid. The code is logged.

The ECM monitors engine coolant temperature, intake manifold air temperature, and hydraulic oil temperature. The correct speed for the engine cooling fan is then determined.

The ECM controls the speed of the fan by controlling the current to the engine fan control solenoid. The engine fan control solenoid controls the amount of pressure to the fan pump by allowing oil to bypass the fan pump. The fan pump drives the fan. The ECM outputs minimum current to the engine fan control solenoid in order to bypass less oil. The fan pump will then drive the fan at a higher rpm. The ECM outputs maximum current to the engine fan control solenoid in order to bypass more oil. The fan pump will then drive the fan at a lower rpm.

If the ECM detects a system fault, the ECM provides minimum current to the solenoid. The fan speed will be at maximum while the fault condition exists.

An override is available with Caterpillar Electronic Technician (ET). The fan can then be manually changed from the minimum to the maximum rpm.

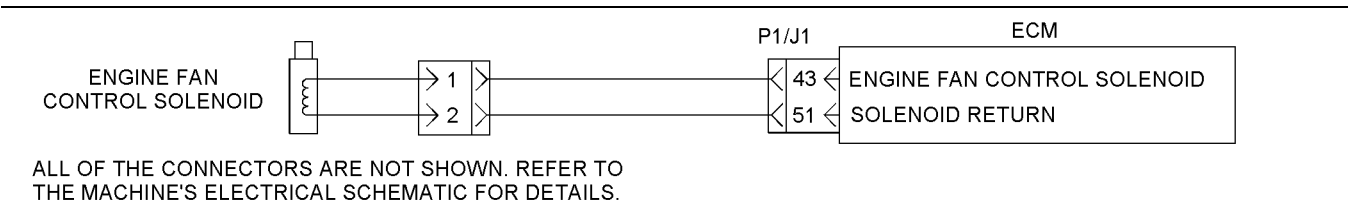


Illustration 41

g02061556

Schematic for the engine fan control solenoid

Test Step 1. Check for Active Diagnostic Codes

- A. Turn the keyswitch to the OFF position.
- B. Verify that the solenoid connector is free of debris and connected securely.
- C. Connect Cat ET to the service tool connector.
- D. Turn the keyswitch to the ON position.

- E. Select diagnostic tests from Cat ET.
- F. Select the “Override Parameters” screen on Cat ET.
- G. Activate the fan override.
- H. 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 code to become active.

I. Disable the fan override.

Results:

- No diagnostic codes are active.

Repair: The problem may have been related to a faulty connection in the harness. Carefully inspect the connectors and wiring. Refer to Troubleshooting, "Electrical Connectors - Inspect".

STOP.

- A short circuit diagnostic code -6 is active at this time. – Proceed to Test Step 2.
- An open circuit diagnostic code -5 is active at this time. – Proceed to Test Step 3.

Test Step 2. Disconnect the Connector for the Engine Fan Control Solenoid in Order to Create an Open Circuit

- Turn the keyswitch to the OFF position.
- Disconnect the connector for the engine fan control solenoid.
- Turn the keyswitch to the ON position.
- Activate the fan override.
- 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 code to become active.

- Disable the fan override.

Results:

- A short circuit diagnostic code -6 remains active. There is a short circuit between the harness connector for the engine fan control solenoid and the ECM.

Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Clear any logged diagnostic codes. Verify that the problem is resolved.

STOP.

- A short circuit diagnostic code -6 was active before disconnecting the connector. An open circuit diagnostic code -5 became active after disconnecting the connector.

Repair: Replace the engine fan control solenoid. Clear any logged diagnostic codes. Verify that the problem is resolved.

STOP.

Test Step 3. Create a Short at the Connector for the Engine Fan Control Solenoid

- Turn the keyswitch to the OFF position.
- Fabricate a jumper wire that is long enough to create a short between the terminals of the connector for the engine fan control solenoid. Crimp connector pins to each end of the jumper wire.
- Install the jumper wire between terminal 1 (engine fan control solenoid) and terminal 2 (solenoid return) on the harness side of the connector.
- Turn the keyswitch to the ON position.
- Activate the fan override.
- 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 code to become active.

- Disable the fan override. Remove the jumper wire.

Results:

- The open circuit diagnostic code -5 remains active with the jumper in place.

Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Clear any logged diagnostic codes. Verify that the problem is resolved.

STOP.

- A short circuit diagnostic code -6 is active when the jumper wire is installed. An open circuit diagnostic code -5 is active when the jumper wire is removed.

Repair: Replace the engine fan control solenoid. Clear any logged diagnostic codes. Verify that the problem is resolved.

STOP.

i04001412

Cooling Fan Speed - Test

SMCS Code: 1356-038-CLT; 1439-038-CLT**System Operation Description:**

Use this procedure to troubleshoot the electrical system if a problem is suspected with the cooling fan speed sensor. Also use this procedure if the diagnostic code in Table 31 is active or easily repeated.

Table 31

Diagnostic Codes Table		
Code	Code Description	Comments
E1363 (1)	Low Engine Cooling Fan Speed	The code is logged.
544-2	Engine Cooling Fan Speed Sensor : Erratic, Intermittent, or Incorrect	The code is logged.
544-8	Engine Cooling Fan Speed Sensor : Abnormal Frequency, Pulse Width, or Period	The code is logged.

The engine cooling fan speed sensor provides a signal to the Electronic Control Module (ECM). The ECM controls fan speed by varying the current to the fan control solenoid.

The engine cooling fan speed sensor receives a supply voltage of 8.0 ± 0.5 VDC from the ECM. The sensor outputs a frequency that is directly proportional to fan speed. The sensor generates a signal pulse for each revolution of the fan. The output frequency varies between 5 Hz to 180 Hz over the speed range between 50 rpm and 1800 rpm.

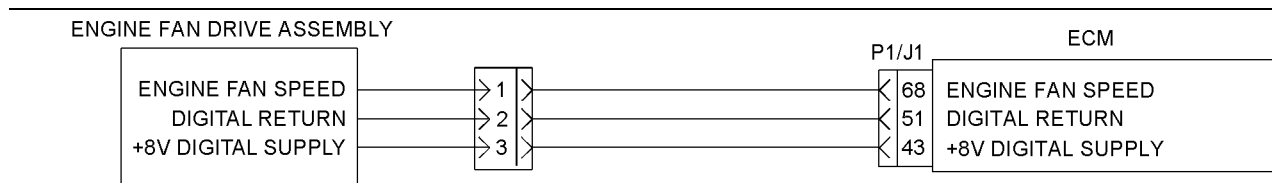


Illustration 42

g02176931

Schematic for the fan speed sensor

Test Step 1. Check the Status of the Engine Fan Speed

- Turn the keyswitch to the OFF position.
- Connect Caterpillar Electronic Technician (ET) to the service tool connector.
- Turn the keyswitch to the ON position.
- Access the "Fan Override Test" under the "Diagnostics" menu.
- Start the "Fan Override Test" on Cat ET. Set the fan speed to 500 rpm.
- Use a 351 - 8635 Tachometer Kit to determine the actual speed of the fan.
- Compare the engine fan speed that is reported by Cat ET to the actual engine fan speed that is reported by the photo-tachometer.
- Deactivate the "Fan Override Test".
- Turn the keyswitch to the OFF position.

Results:

- The engine fan speed is within ± 50 rpm.

Repair: The sensor is operating correctly. There may be an intermittent electrical problem in a connector or in the harness. If an intermittent problem is suspected, refer to Troubleshooting, "Electrical Connectors - Inspect".

STOP.

- The engine fan speed is not within ± 50 rpm. – Proceed to Test Step 2.

Test Step 2. Check the Sensor Supply Voltage at the Sensor Connector

- Turn the keyswitch to the OFF position.
- Disconnect the sensor connector from the wiring harness.
- Turn the keyswitch to the ON position.
- Measure the sensor supply voltage between terminal 2 and terminal 3.

Results:

- The supply voltage is reaching the sensor. – Proceed to Test Step 3.
- The supply voltage is not reaching the sensor. –

Repair: Refer to Troubleshooting, "Sensor Supply - Test".

STOP.

Test Step 3. Check the Signal Frequency at the Sensor Connector

- Turn the keyswitch to the OFF position.
- Remove the wire from terminal 1 on the sensor side of the connector. Connect the sensor connector.
- Turn the keyswitch to the ON position.
- Access the "Fan Override Test" under the "Diagnostics" menu on Cat ET.
- Start the "Fan Override Test" on Cat ET. Set the fan speed to 800 rpm.
- Use a multimeter to measure the frequency between the signal wire from the sensor and engine ground.
- Deactivate the "Fan Override Test".

- Turn the keyswitch to the OFF position.

- Restore all connectors and wiring to the original configuration.

Results:

- The frequency is approximately 80 Hz.

Repair: The engine cooling fan speed sensor is generating the correct signal.

Repair the harness or replace the harness.

Verify that the problem is resolved.

STOP.

- The frequency is not approximately 80 Hz.

Repair: Replace the fan drive assembly.

Verify that the problem is resolved.

STOP.

i04513931

Data Link - Test

SMCS Code: 1900-038

System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with the CAN data link or the Cat Data Link. Also use this procedure if a diagnostic code in Table 32 is active or easily repeated.

Table 32

Diagnostic Codes Table		
CDL Code	Code Description	Comments
246-9	Proprietary CAN Data Link : Abnormal Update Rate	The Electronic Control Module (ECM) has lost communications over the CAN data link. The code is logged. The check engine lamp is illuminated.
247-9	SAE J1939 Data Link : Abnormal Update Rate	The ECM has lost all communications over the global CAN data link. The code is logged. The check engine lamp is illuminated.
248-9	@CatDatalinkLong@ not communicating	The ECM has lost all communications with the transmission over the Cat Data Link. The code is logged. The check engine lamp is illuminated.
296-9	Transmission Control : Abnormal Update Rate	The ECM has lost all communications with the transmission. The code is logged. The check engine lamp is illuminated.
533-9	Brake Control : Abnormal Update Rate	The ECM has lost all communications with brake control. The code is logged. The check engine lamp is illuminated.
1273-9	Chassis Control Module : Abnormal Update Rate	The ECM has lost all communications with the chassis control module over the Cat Data Link. The code is logged. The check engine lamp is illuminated.
1639-2	Machine Security System Module : Erratic, Intermittent, or Incorrect	The ECM has lost communications with the Machine Security System Module (MSSM) over the Cat Data Link. The code is logged. The check engine lamp is illuminated.
1639-9	Machine Security System Module : Abnormal Update Rate	The ECM has lost all communications with the Cat Monitoring System over the Cat Data Link. The code is logged. The check engine lamp is illuminated.

Note: If a 1639-2 diagnostic code is active, verify that the following information is correct before proceeding with this procedure:

- The part number of the flash software for the Machine ECM
- The part number of the flash software for the Machine Security System ECM
- The part number of the Machine ECM
- The part number of the Machine Security System ECM

If the Caterpillar Electronic Technician (ET) will not communicate with the ECM, refer to Troubleshooting, "Electronic Service Tool Does Not Communicate" before you begin this procedure. The procedure verifies that electrical power is being supplied to the ECM and to the service tool connector.

The data links are used to communicate information between the engine ECM and other control modules that are a part of the application. Cat ET also communicates with the ECM via the data links.

The service tool connector contains connections for electrical power and for the data links.

When the keyswitch is in the OFF position, Cat ET may communicate with the ECM. However, the communications may be disrupted and the communications may require frequent reconnection. In order to avoid this problem, place the keyswitch in the ON position when Cat ET is being used.

Cat ET may display the following error message:

"The version of the ECM is not recognized and the integrity of the changed parameters and displayed data is not guaranteed."

This message indicates that one of the following conditions exist:

- The flash file in the ECM is newer than the version of Cat ET.
- The latest version of Cat ET has not been installed.

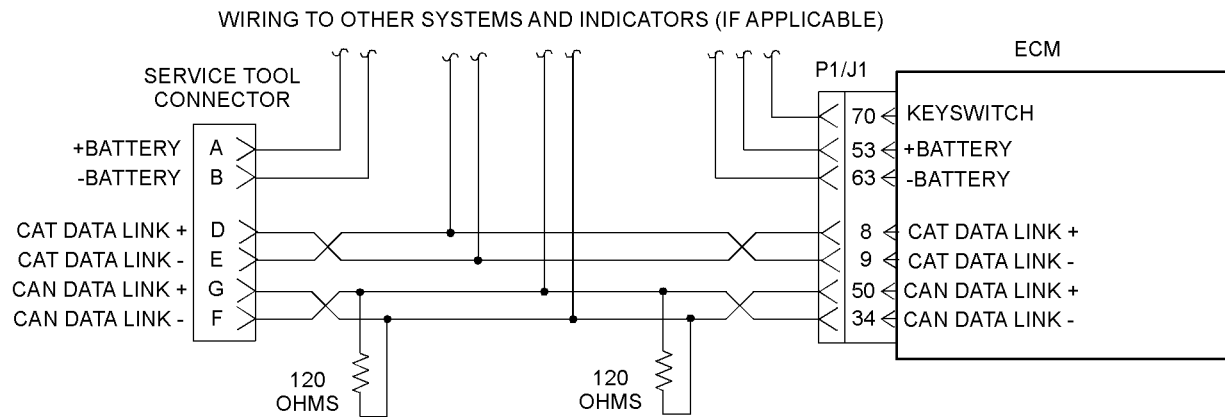


Illustration 43
Schematic for the Cat Data Link

g02177132

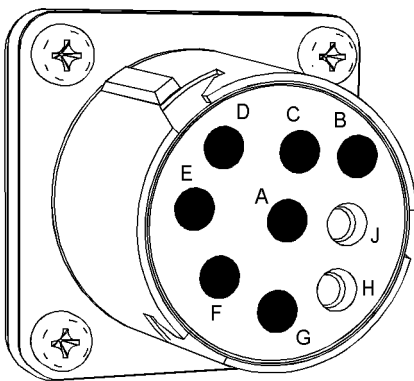


Illustration 44
Terminal locations at the service tool connector

g01672679

- (A) +Battery
- (B) -Battery
- (C) CAN shield
- (D) Cat Data Link +
- (E) Cat Data Link -
- (F) CAN data link -
- (G) CAN data link +

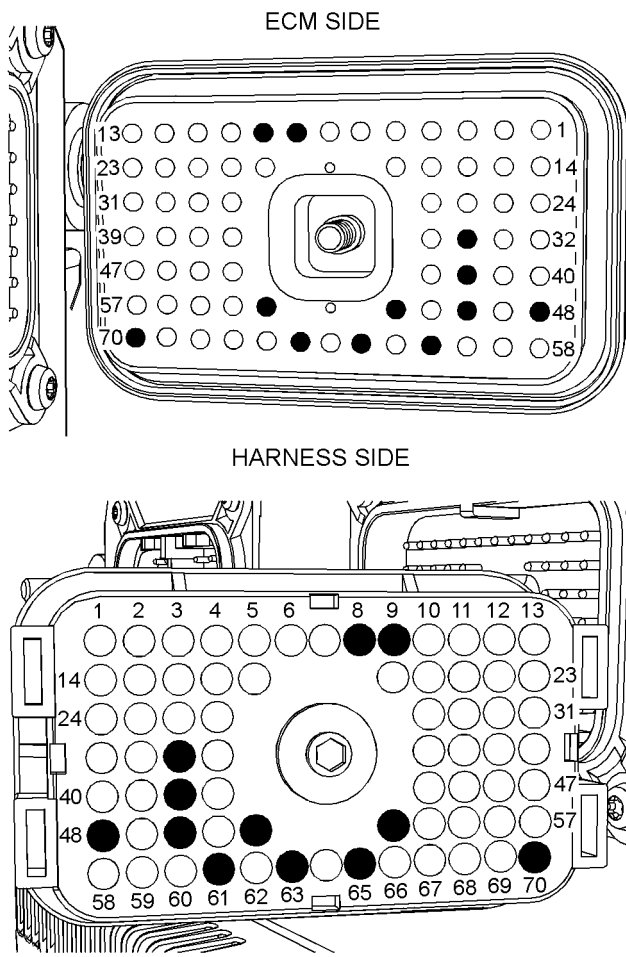


Illustration 45 g01672676

Terminal locations at the P1 ECM connector that are for the data link

(P1-8) Cat Data Link +
(P1-9) Cat Data Link -
(P1-34) CAN data link -
(P1-42) CAN shield
(P1-48) +Battery (if applicable)
(P1-50) CAN data link +
(P1-52) +Battery (if applicable)
(P1-53) +Battery (if applicable)
(P1-61) -Battery (if applicable)
(P1-63) -Battery (if applicable)
(P1-65) -Battery (if applicable)
(P1-70) Keyswitch

Test Step 1. Verify the Proper Installation of the Data Link Circuit

- A. Disconnect the P1 ECM connector.
- B. Measure the resistance between P1-50 and P1-34.

Results:

- The resistance is between 57 ohms and 63 ohms and a -9 code is logged.

Repair: Check the power supply and ground to the module and all ECMs on the Can Data Link and the Cat Data Link that pertain to the -9 code that is logged or active. Power loss to any control module will generate a -9 code. Refer to the electrical schematic for details.

STOP.

- 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 electrical schematic to determine the missing resistor. Replace the missing resistor and verify that the repair eliminates the problem.

STOP.

- The resistance is less than 57 ohms. – Proceed to Test Step 2.
- The resistance is greater than 126 ohms. – Proceed to Test Step 3.

Test Step 2. Check for a Short Circuit

- A. Turn the keyswitch to the OFF position.
- B. Thoroughly inspect the connectors that are associated with the data link circuits. Refer to Troubleshooting, "Electrical Connectors - Inspect".
- C. Disconnect the P1 ECM connector.
- D. Disconnect Cat ET from the service tool connector.
- E. Remove the terminating resistors from the CAN Data Link circuit.
- F. Disconnect the J1939 display if equipped.
- G. Measure the resistance between the points that are listed in Table 33. Be sure to wiggle the wires in the harnesses as you make each resistance measurement.

Table 33

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
	Negative ground
P1-9 (Cat Data Link -)	All of the other terminals on the P1 connector
	Negative ground
P1-50 (CAN data link +)	All of the other terminals on the P1 connector
	Negative ground
P1-34 (CAN data link -)	All of the other terminals on the P1 connector
	Negative ground

Results:

- The resistance is greater than 20,000 ohms. – Proceed to Test Step 3.
- The resistance is less than 20,000 ohms.

Repair: Repair the connectors and/or the wiring. Replace parts, if necessary. Verify that the original problem is resolved.

STOP.

Test Step 3. Check for an Open Circuit

- Fabricate a jumper wire that is long enough to create a test circuit across two terminals. Use the jumper wire in order to create a short circuit between terminals D (Cat Data Link +) and E (Cat Data Link -) on the service tool connector.
- Measure the resistance between P1-8 (Cat Data Link +) and P1-9 (Cat Data Link -).
- Fabricate a jumper wire that is long enough to create a test circuit across two terminals. Use the jumper wire in order to create a short circuit between terminals G (CAN data link +) and F (CAN data link -) on the service tool connector.
- Measure the resistance between P1-50 (Can Data Link +) and P1-34 (Can Data Link -).

Results:

- At least one of the resistance measurements indicates an open circuit.

Repair: Remove the jumper wire from the ECM connector. Determine the cause of the open circuit. Repair the problem, when possible. Replace parts, if necessary. Verify that the problem is resolved.

STOP.

i04513989

Data Link Configuration Status - Test

SMCS Code: 1900-038

System Operation Description:

The diagnostic code for the special instruction is logged in order to report the configuration status of the data link. The diagnostic code for the special instruction does not check the physical condition of the data link.

Use this procedure in order to troubleshoot a diagnostic code for a special instruction. Use this procedure if one of the following diagnostic codes are active.

Table 34

CDL Code	Code Description	Comments
246-14	Proprietary CAN Data Link: Special Instruction	The code is logged.
247-14	SAE J1939 Data Link: Special Instruction	The code is logged.
248-14	CAT Data Link : Special Instruction	The code is logged.
296-14	Transmission Control : Special Instruction	The code is logged.
533-14	Brake Control : Special Instruction	The code is logged.
1273-14	Chassis Control Module : Special Instruction	The code is logged.

Test Step 1. Check for an Associated -9 Code

- A. Establish communication between the Caterpillar Electronic Technician (ET) and the Electronic Control Module (ECM) for the engine.
- B. Download a "Product Summary Report" from the engine ECM before performing any troubleshooting or clearing diagnostic trouble codes.

Results:

- An associated -9 code is logged.

Repair: Repair all associated -9 codes before continuing with this procedure. Refer to Troubleshooting, "Data Link - Test".

If a -14 code is still present after resolving the -9 code, proceed to Test Step 2.

- An associated -9 code is not logged. – Proceed to Test Step 2.

Test Step 2. Check the Personality Module Code for Compatibility with the Application

- A. Connect to Cat ET.
- B. Select the ECM connection that is related to the logged code.
- C. Check if the personality module code is valid for the application.

Results:

- The code is valid for the application. – Proceed to Test Step 3.
- The code is not valid for the application.

Repair: Obtain the correct flash file and update the ECM. Clear all logged codes and return to service.

STOP.

Test Step 3. Check the Programmed Parameters

Check the programmed parameters in order to ensure that the parameters are programmed correctly. Refer to Troubleshooting, "Configuration Parameters" for the correct procedure.

Results:

- The parameters are programmed correctly. – Proceed to Test Step 4.
- The parameters are not programmed correctly.

Repair: Program the parameters to function with the other modules on the data link. Clear all logged codes and return to service.

STOP.

Test Step 4. Check for Compatibility with Any other ECM on the Data Link

- A. Use the as shipped information found in SIS web TMI to determine if any other ECM or display on the data link are compatible.

Results:

- The ECMs are not compatible.

Repair: Replace the incompatible ECM with the correct module. Clear all codes and return to service.

STOP.

i03984424

Electrical Power Supply - Test

SMCS Code: 1401-038

System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with the power to the engine Electronic Control Module (ECM) or if any one of the diagnostic codes in Table 35 is active or easily repeated.

Table 35

Diagnostic Codes Table		
CDL Code	Code Description	Comments
168-2	Electrical System Voltage : Erratic, Intermittent, or Incorrect	The engine is running. The battery voltage falls below 6 VDC and the voltage returns above 9 VDC for three voltage readings in the last 7 seconds.
168-3	Electrical System Voltage : Voltage Above Normal	The ECM detects voltage that is above the acceptable value.
168-4	Electrical System Voltage : Voltage Below Normal	The ECM detects voltage that is below the acceptable value.
1834-2	Ignition Key Switch loss of signal	The ECM detects an erratic signal from the keyswitch. The keyswitch was cycled at least three times in the last second.

The engine ECM requires the keyswitch to be in the ON position in order to maintain communications with Caterpillar Electronic Technician (ET).

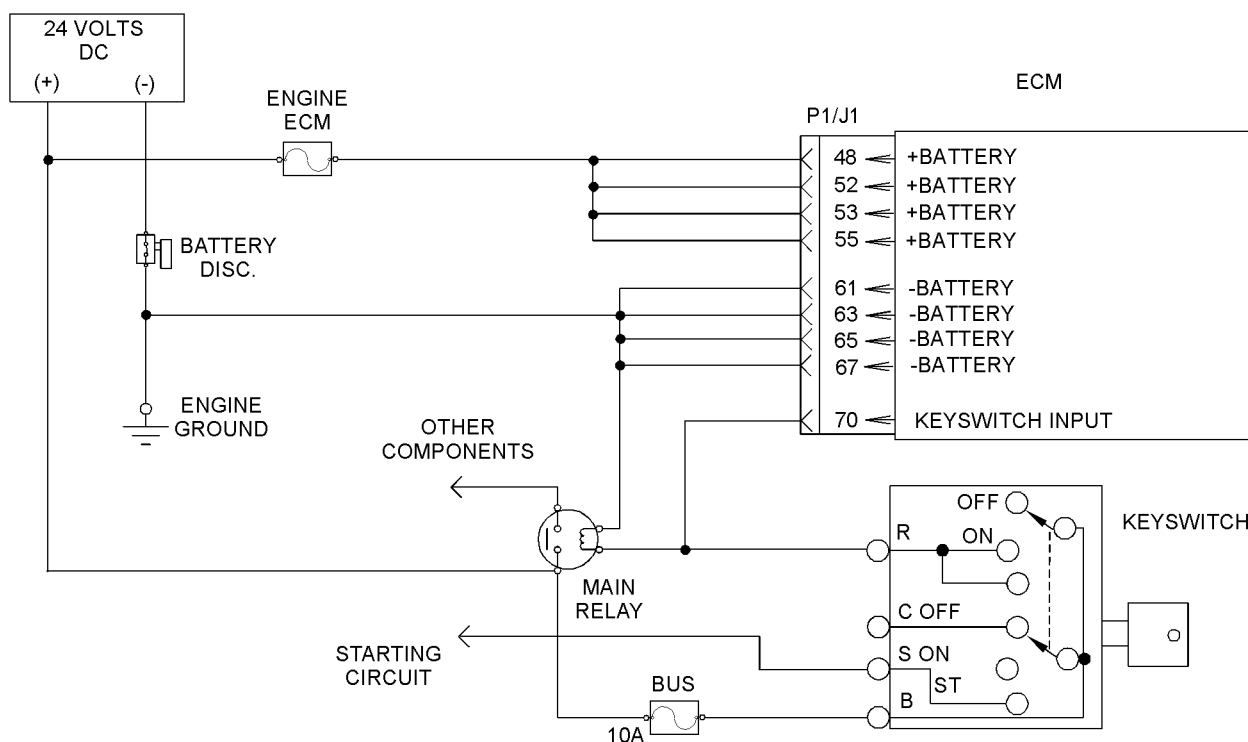


Illustration 46

Schematic for the electrical power supply circuit

g02100347

Test Step 1. Determine the Diagnostic Code

- Establish communication between the Cat ET and the ECM . Refer to Troubleshooting, “Electronic Service Tools”, if necessary.
- Start the engine. Run the engine until the engine is at normal operating temperature.
- Download the “Product Summary Report” from the engine ECM before performing any troubleshooting or clearing diagnostic trouble codes.

Look for these codes:

- 168-2
- 168-3
- 168-4
- 168-2

Results:

- A 168-2 or a 1834-2 diagnostic code is active. – Proceed to Test Step 2.
- A 168-3 diagnostic code is active. – Proceed to Test Step 3.

- A 168-4 diagnostic code is active. – Proceed to Test Step 4.

Test Step 2. Inspect the Electrical Connectors and the Wiring For the Charging Circuit

- Turn the keyswitch to the OFF position.
- Check the harness connections at the battery and at the alternator.
- Check the harness between the battery and the alternator.

Results:

- OK – The harness and connectors appear to be OK.

Repair: There is a problem with the charging system. Refer to Special Instruction, REHS0354, “Charging System Troubleshooting”.

STOP.

- 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 coupled. Verify that the repair eliminates the problem.

STOP.

Test Step 3. Check the Charging Circuit

A. Check the operation of the charging circuit.

Results:

- Not OK – The battery voltage is high.

Repair: There is a problem with the charging system. Refer to Special Instruction, REHS0354, "Charging System Troubleshooting".

STOP.

Test Step 4. Check the Battery

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

- a. Check the brightness of the lights.

B. Turn the keyswitch to the ON position. Start the engine.

- a. Check the brightness of the lights.

Results:

- OK – The lights are dim when the engine is not running. The lights are brighter when the engine is running. There is a problem with the battery. Proceed to Test Step 5.
- Not OK – The lights are dim when the engine is not running. The lights are still dim when the engine is running.

Repair: There is a problem with the charging system. Refer to Special Instruction, REHS0354, "Charging System Troubleshooting".

STOP.

Test Step 5. Check the Battery Charge

A. Measure the no-load battery voltage at the battery posts.

B. Test the batteries. Use the 4C-4911 Battery Load Tester. Refer to Special Instruction, SEHS9249, "Use of 4C-4911 Battery Load Tester for 6, 8 V and 12 V Lead Acid Batteries" and Special Instruction, SEHS7633, "Battery Test Procedure".

Results:

- OK – The batteries pass the load test. The measured voltage is between 11.0 VDC and 13.5 VDC for a 12 V system and between 22.0 VDC and 27.0 VDC for a 24 V system.

Repair: Check the wiring between the batteries and the ECM.

Check the connectors between the batteries and the ECM for moisture and/or corrosion.

Repair the wiring and/or the connectors.

Verify that the repair eliminates the problem.

STOP.

- Not OK – The battery voltage is low or the battery did not pass the load test.

Repair: Recharge or replace the faulty batteries. Verify that the repair eliminates the problem.

STOP.

i03978469

Engine Speed - Test

SMCS Code: 1907-038; 1915-038

System Operation Description:

Use this procedure to troubleshoot problems with the engine speed/timing sensors. This procedure covers the following diagnostic codes:

Table 36

Diagnostic Codes Table		
CDL Code	Code Description	Comments
190-8	Engine Speed Sensor : Abnormal Frequency, Pulse Width, or Period	The code is logged. , The Electronic Control Module (ECM) will default to the secondary engine speed/timing sensor, when a valid signal is not received from the primary engine speed/timing sensor. 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.
261-11	Engine Timing Offset fault	The code is latched in the active state until the power to the ECM is cycled. The offset for timing calibration is set to zero while the diagnostic code is active.
342-8	Secondary Engine Speed Sensor : Abnormal Frequency, Pulse Width, or Period	The code is logged. If a valid signal is not received from the secondary engine speed/timing sensor, the ECM will default to the primary engine speed/timing sensor. 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.

The engine uses two engine speed/timing sensors. Both sensors detect the reference for engine speed and timing from a unique pattern on the camshaft gear. The Engine Control Module (ECM) uses the pattern of the pulses in order to determine the position of the crankshaft. The ECM measures the time between the pulses that are created by the sensors as the gears rotate in order to determine rpm.

Under normal operation, the secondary engine speed/timing sensor is used to determine timing for starting purposes. The secondary engine speed/timing sensor is used to determine when the piston in the No. 1 cylinder is at the top of the compression stroke. When the timing has been established, the primary engine speed/timing sensor is then used to determine engine speed.

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 the 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. Also, 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. Do not switch the positions of the sensors. Replace the sensors as a set. If the sensors are replaced, a timing calibration is not necessary.

If a replacement of the ECM is required, the ECM parameters and the timing calibration can be transferred to the replacement ECM. Timing calibration will not be necessary. This feature requires the Caterpillar Electronic Technician (ET) and this feature is only possible if the existing ECM can communicate with Cat ET. Use the "Copy Configuration - ECM Replacement" feature on Cat ET.

Complete all of the following tasks when you install the speed/timing sensors:

- Ensure that an O-ring is installed on each sensor. If an O-ring is damaged or missing, replace the O-ring.
- Lubricate the O-rings with oil.
- Ensure that the sensor assembly is fully seated into the engine before tightening the bracket bolt.
- Ensure that each electrical connector is latched on both sides.
- Ensure that the harness is properly secured, and ensure that each tie-wrap is placed in the correct location.

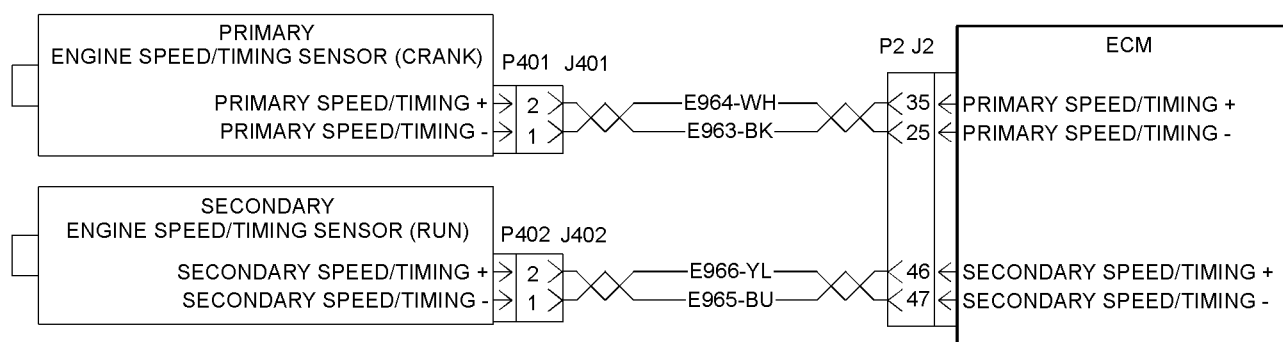


Illustration 47

g01182579

Schematic for the engine speed/timing sensors

Test Step 1. Check for Diagnostic Codes

A. Establish communication between the Caterpillar Electronic Technician (ET) and the ECM. Refer to Troubleshooting, "Electronic Service Tools", if necessary.

B. Start the engine and run the engine until the engine is at normal operating temperature.

Note: If the engine will not start, monitor the engine rpm on Cat ET while the engine is being cranked. Cat ET will need to be powered from another battery while the engine is being cranked, if battery voltage is low.

C. Look for these codes on Cat ET:

- 190-8
- 342-8
- 261-11

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 342-8 code – There is an active diagnostic code or a logged diagnostic code for the engine speed/timing sensor. Proceed to Test Step 4.
- 261-11 – There is more than 3 degrees of offset between the signals from the engine speed/timing sensors.

Repair: The wires from one of the engine speed/timing sensors are connected to the wrong terminals on the P2 connector. Refer to Illustration 47. Repair the wiring. Verify that the problem is resolved.

STOP.

- No codes – Neither code is active or logged.

Repair: Refer to the appropriate symptoms in Troubleshooting, "Symptom Troubleshooting".

STOP.

Test Step 2. Check the Installation of the Sensor Assembly

A. Turn the keyswitch to the OFF position.

B. Visually inspect the sensor assembly without removing the sensor assembly from the engine. The flange must be flush against engine in order to ensure proper operation.

Inspect the bracket. Verify that the bracket allows the flanges to be flush against the engine.

Verify that the bracket is not bent. If the bracket is bent or if an obstruction is preventing the sensor assembly from being installed correctly, the engine will not start.

Note: The bracket cannot be replaced separately.

C. Remove the sensor assembly from the engine.

D. Ensure that one O-ring is installed on each sensor. Check the O-rings for damage. Replace the O-rings, if necessary.

Results:

- OK – The sensor assembly components are OK.

Repair: Perform the following procedure in order to 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 sensors 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 components is not OK.

Repair: Obtain a new sensor assembly. Perform the following procedure in order to 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 sensors 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.

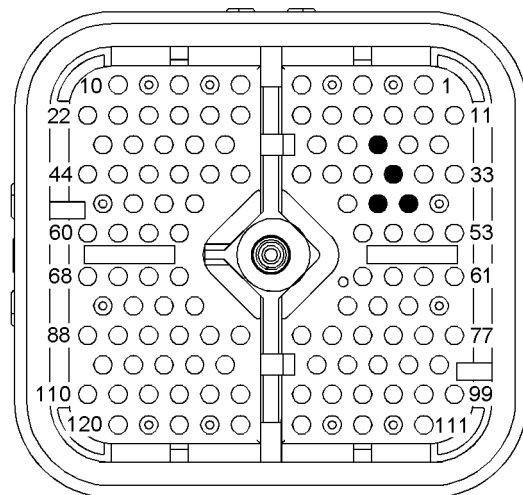
Verify that the problem is resolved.

STOP.

Test Step 3. Inspect the Electrical Connectors and the Wiring

- A. Thoroughly inspect the connectors for the ECM and sensors. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

ECM SIDE



HARNESS SIDE

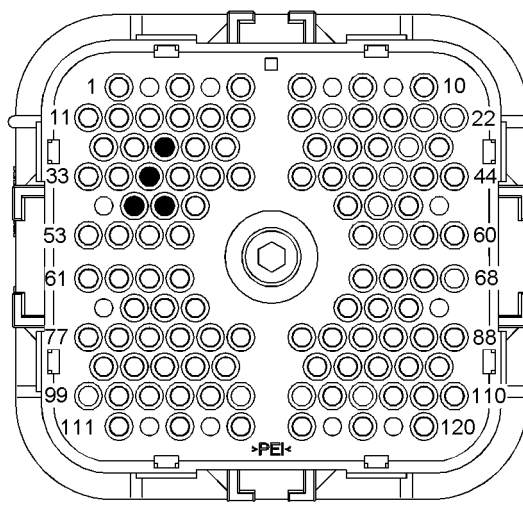


Illustration 48

g01144149

P2 terminations for the engine speed/timing sensors

- (P2-25) Primary engine speed/timing -
- (P2-26) TDC probe +
- (P2-35) Primary engine speed/timing +
- (P2-36) TDC probe -
- (P2-46) Secondary engine speed/timing +
- (P2-47) Secondary engine speed/timing -

- 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 torque of the allen head screws for the ECM connectors. 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 coupled and/or inserted and the harness. Also, the wiring is 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 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 connector.

B. If you are troubleshooting a problem with the primary engine speed/timing sensor, perform the following procedure:

- a. Measure the sensors 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 and shake the wires that are directly behind the sensor.

Resistance 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 sensors 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 and shake the wires that are directly behind the sensor.

Resistance 600 to 1800 ohms

Expected Result:

The resistance measurement is within the specifications.

Results:

- OK – The resistance measurement is within the specifications. A short circuit or an open circuit is not indicated.

Repair: Perform the following procedure:

1. Temporarily install a new ECM. Refer to Troubleshooting, “ECM - Replace”.
2. Start the engine. Run the engine until the engine is at normal operating temperature.
3. If the problem is resolved with the test ECM, connect the original ECM and verify that the problem recurs.
4. If the problem returns with the original ECM, replace the ECM.

Verify that the problem is resolved.

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 sensors connectors. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

C. Measure the sensors resistance between terminals A and B.

Expected Result:

For the primary engine speed/timing sensor, the resistance measurement is between 75 and 230 ohms. For the secondary engine speed/timing sensor, the resistance measurement is between 600 and 1800 ohms.

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 assembly to the engine.
- b. Ensure that O-rings are installed on the new sensor assembly. Verify that the O-rings are free of damage.
- c. Seat the sensor assembly and tighten the bolt.

If the sensor will not seat, replace the sensor.

- d. Ensure that the harness is secured in the proper location.
2. Verify that the repair eliminates the problem.

STOP.

i04003108

Ether Starting Aid - Test

SMCS Code: 1456-038

System Operation Description:

Before you test the ether injection system, remove the ether canister from the system.

Use this procedure in order to troubleshoot the ether system or use this procedure if a diagnostic code in Table 37 is active or logged.

Table 37

Diagnostic Codes Table		
Code	Conditions which Generate this Code	System Response
2417-5 Ether Injection Control Solenoid : Current Below Normal	The Electronic Control Module (ECM) detects low current in the circuit.	The code is latched. The code is logged. Ether injection is disabled.
2417-6 Ether Injection Control Solenoid : Current Above Normal	The ECM detects excessive current flow in the circuit.	

The ether injection system improves cold weather starting of the engine. The ECM controls the ether injection system. The ether injection system is enabled when all of the following conditions occur:

- The configuration parameter is enabled or the configuration parameter is set to continuous flow.
- The intake manifold air temperature is less than 0 °C (32 °F) or the engine coolant temperature is less than 0 °C (32 °F).
- Engine speed is greater than 0 rpm and less than 50 rpm below the low idle speed.
- No diagnostic codes are active for both the engine coolant temperature sensor and for the intake manifold air temperature sensor.

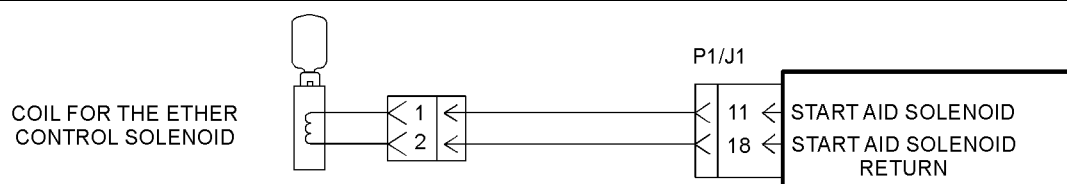


Illustration 49

Schematic of the ether injection system

g02099717

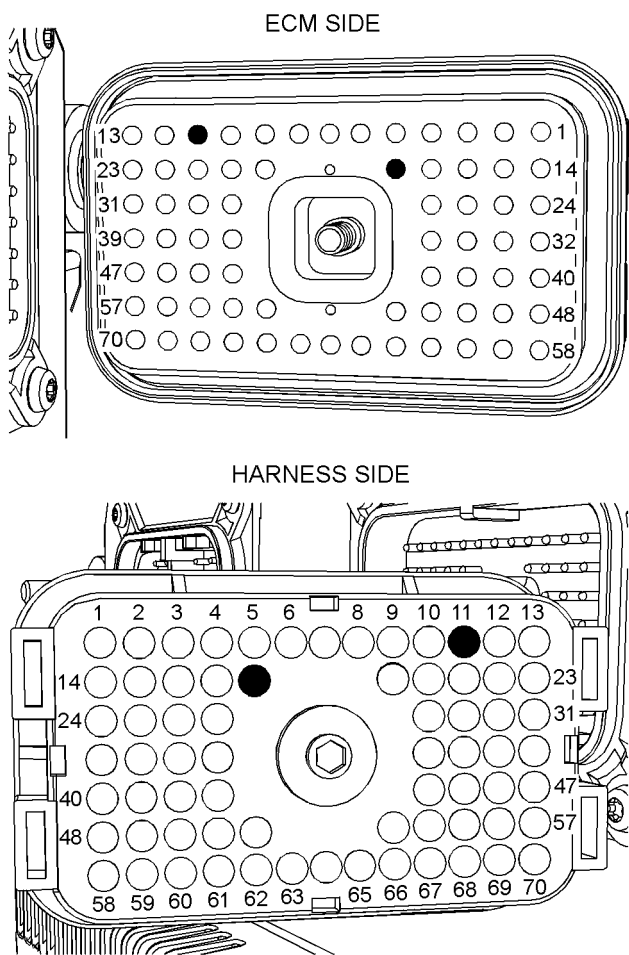


Illustration 50 g02099721

P1 terminals for the ether injection system
(P1-10) Starting aid solenoid
(P1-18) Return for the starting aid solenoid

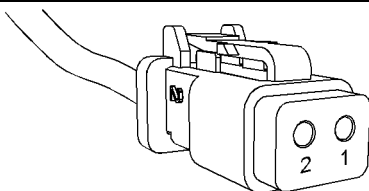


Illustration 51 g01155187

Terminal locations at the harness connector for the ether solenoid
(1) Starting aid solenoid
(2) Return for the starting aid solenoid

Test Step 1. Check the Harness Connectors

- A. Verify that the keyswitch is in the OFF position.
- B. Disconnect the harness connector for the ether solenoid.
- C. Check the harness connector for debris and for corrosion.

Results:

- The harness connector was not free of debris and/or not free of corrosion.

Repair: Perform the following procedure:

1. Clean the harness connector.
2. Reconnect the harness connector. Verify that the connection is secure.
3. Verify that the problem is resolved.

If the problem is not resolved, proceed to Test Step 2.

- The harness connector was free of debris and free of corrosion. – Proceed to Test Step 2.

Test Step 2. Create an Open at the Harness Connector for the Ether Injection Solenoid

Note: The ether canister must be removed prior to performing this procedure.

- A. If necessary, disconnect the harness connector from the ether solenoid.
- B. Turn the keyswitch to the ON position.
- C. A test on Caterpillar Electronic Technician (ET) allows the technician to activate the ether system. The test can be activated by selecting the "Diagnostic Overrides" screen on Cat ET.
- D. Activate the ether injection system. The system will activate for 10 seconds.
- E. Measure the voltage across terminal 1 and terminal 2 of the harness for the ether injection solenoid.
- F. Turn the keyswitch to the OFF position.

Results:

- The voltage measurement is 0 VDC after activating the ether injection system.

Repair: There is a problem in the harness. Repair the harness or replace the harness.

Verify that the problem is resolved.

STOP.

- The voltage measurement is equal to battery voltage after activating the ether injection system.

Repair: There is a problem in the solenoid. Replace the solenoid.

Verify that the problem is resolved.

STOP.

i03978529

Injector Solenoid - Test

SMCS Code: 1290-038-JV

System Operation Description:

This procedure covers the following diagnostic trouble codes:

Table 38

Diagnostic Codes Table		
CDL Code	Code Description	Comments
1-5	Cylinder #1 Injector : Current Below Normal	These codes relate to the electrical circuit that includes injector terminals 1 and 3.
1-6	Cylinder #1 Injector : Current Above Normal	
2-5	Cylinder #2 Injector : Current Below Normal	
2-6	Cylinder #2 Injector : Current Above Normal	
3-5	Cylinder #3 Injector : Current Below Normal	
3-6	Cylinder #3 Injector : Current Above Normal	
4-5	Cylinder #4 Injector : Current Below Normal	
4-6	Cylinder #4 Injector : Current Above Normal	
5-5	Cylinder #5 Injector : Current Below Normal	
5-6	Cylinder #5 Injector : Current Above Normal	
6-5	Cylinder #6 Injector : Current Below Normal	
6-6	Cylinder #6 Injector : Current Above Normal	

(continued)

(Table 38, contd)

Diagnostic Codes Table		
CDL Code	Code Description	Comments
2602-6	Cylinder #1 Injector Actuator #2 : Current Above Normal	These codes relate to the electrical circuit that includes injector terminals 2 and 4.
2602-5	Cylinder #1 Injector Actuator #2 : Current Below Normal	
2604-6	Cylinder #2 Injector Actuator #2 : Current Above Normal	
2604-5	Cylinder #2 Injector Actuator #2 : Current Below Normal	
2606-6	Cylinder #3 Injector Actuator #2 : Current Above Normal	
2606-5	Cylinder #3 Injector Actuator #2 : Current Below Normal	
2608-6	Cylinder #4 Injector Actuator #2 : Current Above Normal	
2608-5	Cylinder #4 Injector Actuator #2 : Current Below Normal	
2610-6	Cylinder #5 Injector Actuator #2 : Current Above Normal	
2610-5	Cylinder #5 Injector Actuator #2 : Current Below Normal	
2612-6	Cylinder #6 Injector Actuator #2 : Current Above Normal	
2612-5	Cylinder #6 Injector Actuator #2 : Current Below Normal	

Background Information

These engines have Electronic Unit Injectors (EUI) that are electronically controlled. Each injector contains two solenoids. The Engine Control Module (ECM) sends 105 v pulses to each injector solenoid. The pulses are sent at the proper time and at the correct duration for a given engine load and speed.

The ECM monitors the current flow through the circuit for each solenoid. If low current flow is detected, a diagnostic code is activated. The ECM continues to try to fire the injector.

If high current flow is detected, a diagnostic code is activated. The ECM will disable the solenoid circuit in order to prevent damage from the high current flow. However, the ECM will periodically try to fire the injector. If the short circuit remains, this sequence of events will be repeated until the problem is corrected.

Typically, problems with an injector solenoid occur when the engine is warmed up and/or when the engine is under vibration (heavy loads). Perform this procedure when the engine is at normal operating temperature. Pay careful attention to the condition of the wiring and the connectors as you perform this procedure. The wiring and/or the connectors may have problems that only occur during vibration.

Diagnostic Tests on the Caterpillar Electronic Technician (ET)

Cat ET includes the following test that aids in troubleshooting injector solenoids:

Injector Solenoid Test – The Injector Solenoid Test identifies an open circuit or a short circuit in the circuits for the injector solenoids. The test is performed while the engine is not running. The “Injector Solenoid Test” briefly activates each solenoid. A good solenoid will create an audible click when the solenoid is activated. Cat ET indicates the status of the solenoid as “OK”, “Open” or “Short”.

Note: Refer to the following schematic. Two injector solenoids share a common supply wire. For this reason, an open circuit or a short circuit in a supply wire could cause diagnostic codes for two cylinders.

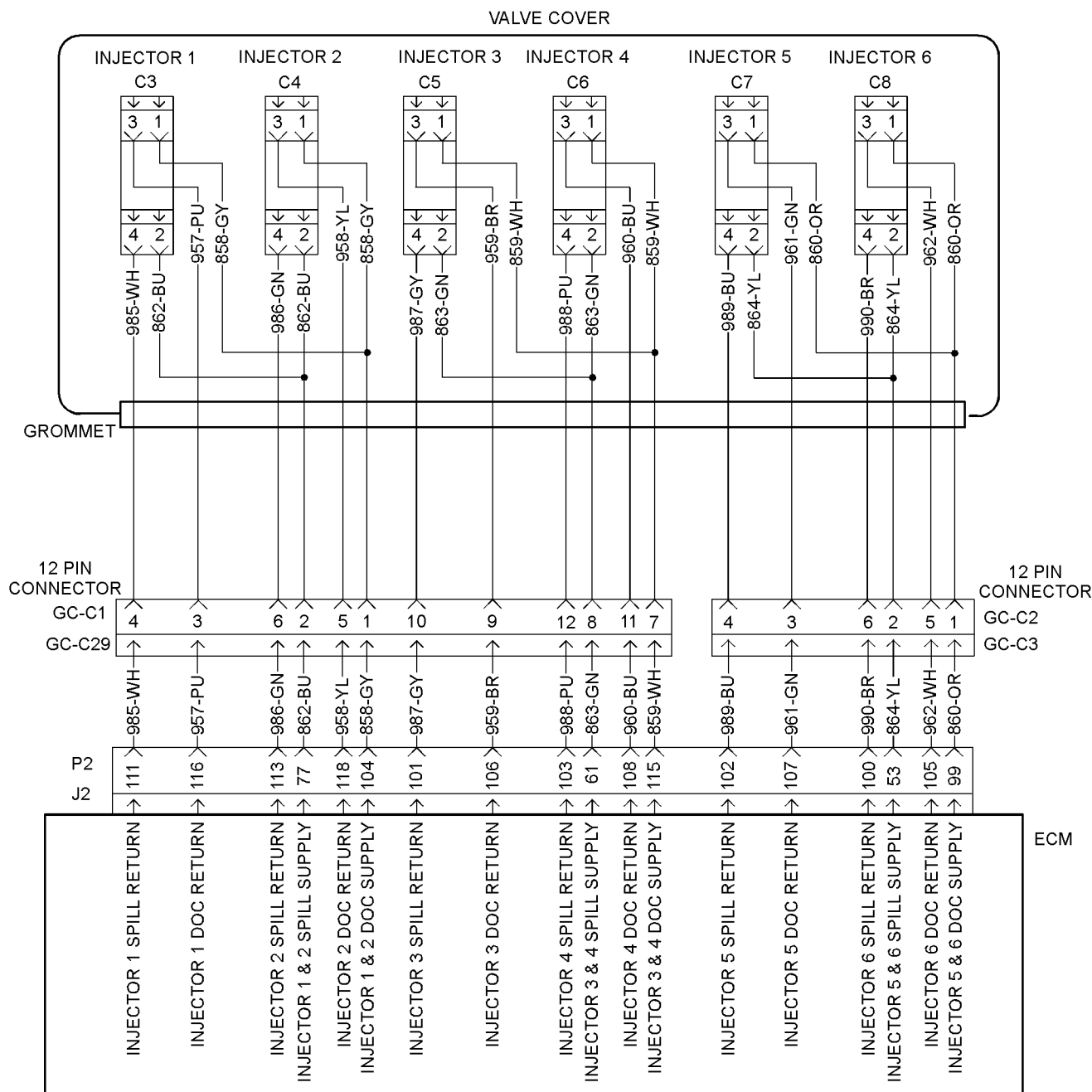


Illustration 52

Schematic for the injector solenoids

g01953821

Test Step 1. Check for Logged Codes or Active Codes

A. Establish communication between Cat ET and the ECM. Refer to Troubleshooting, "Electronic Service Tools", if necessary.

B. Determine if a code is active or logged.

Expected Result:

A code is logged or active.

Results:

- A code is not logged or active.

Repair: There is not an electronic problem with the injectors at this time.

STOP.

- A -5 code or a -6 code is logged or active. – Proceed to Test Step 2.

Test Step 2. Inspect the Wiring Harness Between the ECM and the Valve Cover Base

WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

- Turn the keyswitch to the OFF position.
- Thoroughly inspect the connectors. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.
- Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector. Perform a pull test on each of the wires that are associated with injector solenoids.
- Check the allen head screw on the ECM connector for the proper torque. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct torque values.
- Check the harness and wiring for abrasions and for pinch points from the valve cover base to the ECM.

Results:

- OK – The connectors and the wiring appear to be OK. Proceed to Test Step 3.
- 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 are properly in place and ensure that the connectors are coupled. Perform an injector solenoid test in order to verify that the problem has been resolved.

STOP.

Test Step 3. 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.

- Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the keyswitch is not turned off.
- Remove electrical power from the engine ECM.
- Disconnect the connectors of the injector harness at the valve cover base.
- Fabricate a jumper wire long enough to create a short circuit on the different terminal locations at the connector of the injector harness. Crimp connector pins on both ends of the jumper wire.
- Insert one end of the jumper wire into the connector socket for the suspect injectors supply wire. Insert the other end of the jumper wire into the connector socket for the suspect injectors return wire. The jumper wire will bypass the injector solenoid.
- Restore electrical power to the engine ECM.
- Turn the keyswitch to the ON position.
- Perform the “Injector Solenoid Test” in Cat ET.
- 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 a -6 code for each of the circuits that were jumpered.

Results:

- OK – Cat ET displays a -6 code for each circuit that was jumpered. The harness between the ECM and the connector does not have an open circuit. Proceed to Test Step 4.
- Not OK – Cat ET does not display a -6 code for the cylinder with the jumper wire.

Repair: Repair the harness or replace the harness between the ECM and the valve cover base. Perform an injector solenoid test in order to verify that the problem is resolved.

STOP.

Test Step 4. Check the Harness between the ECM and the Valve Cover Base for a Short Circuit

WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

- A. Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the keyswitch is not turned off.
- B. Remove electrical power from the engine ECM.
- C. Disconnect the connectors of the injector harness at the valve cover base.
- D. Restore electrical power to the engine ECM.
- E. Turn the keyswitch to the ON position.
- F. Perform the Injector Solenoid Test at least two times.

Expected Result:

All of the cylinders indicate a -5 code on Cat ET.

Results:

- OK – All cylinders indicate a -5 code on Cat ET. The harness between the ECM and the connector does not have a short circuit. Proceed to Test Step 5.
- Not OK – One or more cylinders indicate a -6 code on Cat ET. Note the cylinders that indicate “Short”.

Repair: The problem is in the wiring to the ECM or the ECM is not operating properly. Repair the wiring or replace the wiring to the ECM. Perform an injector solenoid test in order to verify that the problem is resolved.

If the problem still exists, proceed to Test Step 8.

Test Step 5. Inspect the Wiring Harness Between the Valve Cover Base and the Injectors

WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

- A. Turn the keyswitch to the OFF position.
- B. Thoroughly inspect the connectors. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

- C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with injector solenoids.

- D. Check the harness and wiring for abrasions and for pinch points from the valve cover base to the injectors.

Results:

- OK – The connectors and the wiring appear to be OK. Proceed to Test Step 6.
- 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 are properly in place and ensure that the connectors are coupled. Perform an injector solenoid test in order to verify that the problem is resolved.

STOP.

Test Step 6. Check the Injector Harness under the Valve Cover for a Short Circuit

WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

- A. Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the keyswitch is not turned off.
- B. Remove electrical power from the engine ECM.
- C. Remove the valve cover in order to gain access to the suspect injector.
- D. Disconnect the harness connector from the suspect injector.
 - a. Inspect the seal around each wire. Verify that the seal is sealing correctly.
 - b. Pull on each wire in order to verify that the wire and the terminal are correctly installed.
- E. Turn the keyswitch ON.
- F. Activate the “Injector Solenoid Test”. Allow the Injector Solenoid Test to continue until each solenoid is activated at least two times.

Expected Result:

Cat ET displays “Open” for the solenoid that is not connected.

Results:

- OK – Cat ET displays “Open” for the solenoid that is not connected. Proceed to Test Step 7.
- Not OK – Cat ET displays “Short” for the solenoid that is not connected. There is a problem with the injector harness under the valve cover. Replace the harness or repair the harness.

Repair: Repair the wiring and/or the connector, when possible. Replace parts, if necessary. Verify that the problem is resolved.

STOP.

Test Step 7. Check the Injector Harness under the Valve Cover for an Open Circuit

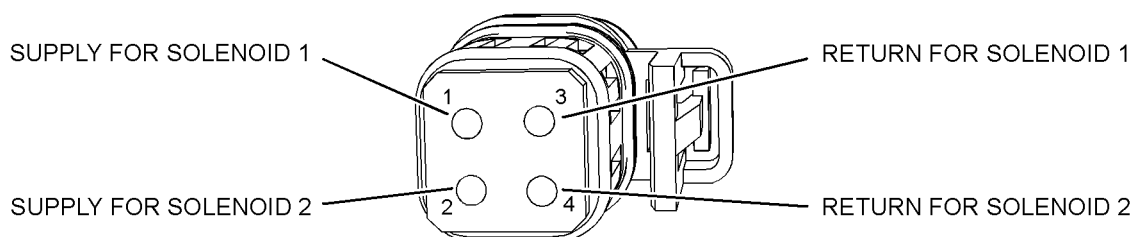


Illustration 53

Harness connector for an injector

g01322701

Table 39

Code	Connection for the Jumper
1-5 or -6 through 6- 5 or -6	Terminal 1 and Terminal 3
2602-5 or -6 through 2612-5 or -6	Terminal 2 and Terminal 4

WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

- Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the keyswitch is not turned off.
- Remove electrical power from the engine ECM.
- Determine the appropriate terminals for the solenoid with the code. Refer to Table 39 for the proper terminal connections. Connect a jumper wire between the terminal for the supply and the terminal for the return. The jumper wire will replace the injector solenoid with a short circuit.

D. Turn the keyswitch ON.

E. Activate the “Injector Solenoid Test”. Allow the Injector Solenoid Test to continue until each solenoid is activated at least two times.

Expected Result:

Cat ET displays “Short ” for the connector with the jumper wire.

Results:

- OK – Cat ET displays “Short ” for the connector that has the jumper wire. The wiring is OK. Proceed to Test Step 8.
- Not OK – Cat ET displays “Open ” for the connector that has the jumper wire.

Repair: The wiring has an open. Repair the harness or replace the harness under the valve cover. Perform an injector solenoid test in order to verify that the problem is resolved.

STOP.

Test Step 8. Check the ECM for Proper Operation **WARNING**

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

- A.** Turn the keyswitch OFF. A strong electrical shock hazard is present if the keyswitch is not turned off.

Note: When the P2 connector is disconnected, numerous diagnostic codes will be generated when the keyswitch is turned ON. The codes are normal. Ignore the codes and clear the codes after you complete this Test Step.

- B.** Disconnect the P2 connector.

- C.** Turn the keyswitch ON.

- D.** Activate the "Injector Solenoid Test". Allow the Injector Solenoid Test to continue until each solenoid is activated at least two times.

- E.** Turn the keyswitch OFF. A strong electrical shock hazard is present if the keyswitch is not turned off.

- F.** Use a jumper wire in order to create a short circuit on J2 between the terminals for the solenoids supply and the solenoids return.

- G.** Turn the keyswitch ON.

- H.** Activate the Injector Solenoid Test. Allow the Injector Solenoid Test to continue until each solenoid is activated at least two times.

Expected Result:

Cat ET displays "Short" for the solenoid with the jumper wire. Cat ET displays "open" when the P2 connector is disconnected.

Results:

- OK – Cat ET displays "Short" for the solenoid with the jumper wire. Cat ET will display "Open" when the P2 connector is not connected to the ECM.

Repair: The problem is in the injector. Replace the injector. Perform an injector solenoid test in order to verify that the problem is resolved.

STOP.

- Not OK – Cat ET does not display "Short" for the solenoid with the jumper wire. Cat ET does not display "Open" when P2 is not connected to the ECM.

Repair: Perform the following procedure:

1. Temporarily connect a test ECM. Refer to Troubleshooting, "Test ECM Mode".
2. Activate the "Injector Solenoid Test". Allow the Injector Solenoid Test to continue until each solenoid is activated at least two times.

If the test ECM fixes the problem, connect the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the problem is resolved.

STOP.

i04003104

Retarder - Test

SMCS Code: 1119-038

System Operation Description:

Use this procedure to troubleshoot any suspect problems with the compression brake solenoids.

Use this procedure for the following diagnostic codes:

Table 40

Diagnostic Codes		
CDL Code	Code Description	Comments
2533-5	Compression Brake Low/High Solenoid #1 : Current Below Normal	The code is logged.
2533-6	Compression Brake Low/High Solenoid #1 : Current Above Normal	The code is logged.
2535-5	Compression Brake Medium/High Solenoid #1 : Current Below Normal	The code is logged.
2535-6	Compression Brake Medium/High Solenoid #1 : Current Above Normal	The code is logged.

The operator can turn on the compression brake through a switch in the cab. If the engine retarder is installed on the engine, the configuration parameter for the engine retarder must be set to "Enabled" for this function to operate. The requested level of braking is sent over the Cat Data Link from the transmission ECM. The engine's ECM will activate the appropriate compression brake solenoids in order to meet the requested level of braking.

"Compression Brake Solenoid Override"

The Compression Brake Low/High Override and Compression Brake Med/High Override are diagnostic overrides that are available on Caterpillar Electronic Technician (ET). Use the overrides to assist in troubleshooting problems in the circuit for the compression brake. The ECM will only detect shorts in the circuit for the compression brake when the overrides are active. The overrides must be activated and then deactivated before the ECM will detect an open circuit. The ECM will only detect opens in the circuit for the compression brake when the overrides are not active.

Note: The engine speed must be zero before the overrides will function.

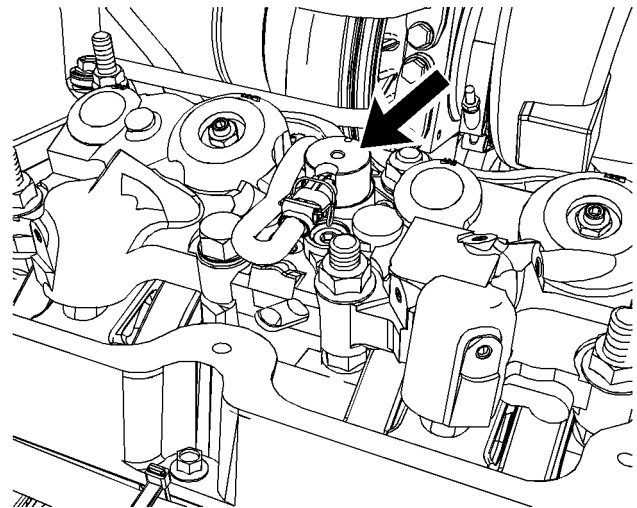


Illustration 54

g01199118

Location of the compression brake solenoid (typical example)

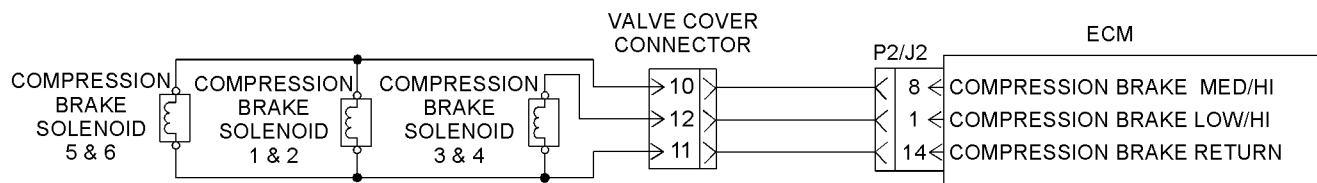


Illustration 55

g02101635

Schematic for the compression brake circuit

Test Step 1. Check for Active Diagnostic Codes and/or Logged Diagnostic Codes

- A. Connect Cat ET to the service tool connector.
- B. Turn the keyswitch to the ON position.
- C. Access the diagnostic overrides under the "Diagnostics" menu.
- D. Start the "Compression Brake Low/High Override" on Cat ET.
- E. Once Cat ET displays the status of the compression brake solenoid, stop the "Compression Brake Low/High Override".
- F. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.
- G. Start the "Compression Brake Med/High Override" on Cat ET.
- H. Once Cat ET displays the status of the compression brake solenoid, stop the "Compression Brake Med/High Override".
- I. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

Results:

- A 2533-5 diagnostic code or a 2535-5 diagnostic code is active at this time. If both diagnostic codes are active, the problem is most likely in the shared return wire. Inspect the wire and/or connectors for an open circuit. – Proceed to Test Step 2.
- A 2533-6 diagnostic code or a 2535-6 diagnostic code is active at this time. – Proceed to Test Step 4.

Test Step 2. Create a Short Between the Wires of the Suspect Compression Brake Solenoid at the Valve Cover Connector

Note: In order to troubleshoot a 2533-5 diagnostic code, use the "Compression Brake Low/High Override" on Cat ET. In order to troubleshoot a 2535-5 diagnostic code, use the "Compression Brake Med/High Override" on Cat ET.

- A. Turn the keyswitch to the OFF position.
- B. Disconnect the harness at the valve cover connector.
- C. Fabricate a jumper wire in order to create a short between the supply wire for the suspect compression brake solenoid and engine ground.
- D. Turn the keyswitch to the ON position.
- E. Access the diagnostic overrides under the "Diagnostics" menu.
- F. Start the override for the compression brake.
- G. Once Cat ET displays the status of the compression brake solenoid, stop the override.
- H. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.
- I. Turn the keyswitch to the OFF position. Remove the wire short.

Note: A -5 open circuit diagnostic code will be active for the other compression brake solenoid. Ignore the diagnostic codes for the other compression brake solenoid. Ignore any diagnostic codes for the injector solenoids.

Results:

- A 2533-6 diagnostic code or a 2535-6 diagnostic code is active at this time. The harness wiring between the valve cover connector and the ECM is OK. – Proceed to Test Step 3.
- A 2533-5 diagnostic code or a 2535-5 diagnostic code is active at this time. The ECM did not detect the short at the valve cover connector.

Repair: Repair the harness or replace the harness. Verify that the problem is resolved.

STOP.

Test Step 3. Create a Short Circuit at the Compression Brake Solenoid

Note: Two solenoids are activated in order to create a medium braking action. The open could be in either solenoid or in the harness. In order to isolate the problem for a medium braking action, run this test step for each of the solenoids. The short must be created separately at each solenoid.

Note: In order to troubleshoot a 2533-5 diagnostic code, use the “Compression Brake Low/High Override” on Cat ET. In order to troubleshoot a 2535-5 diagnostic code, use the “Compression Brake Med/High Override” on Cat ET.

- A. Turn the keyswitch to the OFF position.
 - B. Remove the valve cover.
 - C. Reconnect the valve cover connector.
 - D. Disconnect the connector on the suspect compression brake solenoid.
 - E. Inspect the terminals on the connector for the compression brake solenoid for damage.
 - F. Fabricate a jumper wire in order to short the two wires for the suspect solenoid on the solenoid connector. Crimp a pin to each end of the jumper wire.
 - G. Make sure that the solenoid connector securely holds the jumper wire.
- Note:** Worn terminals and/or damaged terminals on the solenoid connector could cause an intermittent “Open”.
- H. Turn the keyswitch to the ON position.
 - I. Access the diagnostic override under the “Diagnostics” menu.
 - J. Start the override for the compression brake.

- K. Once Cat ET displays the status of the compression brake solenoid, stop the override.

- L. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

- M. Turn the keyswitch to the OFF position. Remove the wire short.

Results:

- A 2533-6 diagnostic code or a 2535-6 diagnostic code is active at this time. The harness wiring between the connector for the compression brake solenoid and the ECM is OK.

Repair: Replace the suspect compression brake solenoid. Verify that the problem is resolved.

STOP.

- A 2533-5 diagnostic code or a 2535-5 diagnostic code is active at this time. The ECM did not detect the short at the connector for the compression brake. There is an open between the valve cover connector and the connector for the compression brake solenoid. –

Repair: Repair the harness or replace the harness between the connector for the compression brake solenoid and the valve cover connector.

STOP.

Test Step 4. Create an Open Between the Wires of the Suspect Compression Brake Solenoid at the Valve Cover Connector

Note: In order to troubleshoot a 2533-6 diagnostic code, use the “Compression Brake Low/High Override” on Cat ET. In order to troubleshoot a 2535-6 diagnostic code, use the “Compression Brake Med/High Override” on Cat ET.

- A. Turn the keyswitch to the OFF position.
- B. Disconnect the harness at the valve cover connector.
- C. Turn the keyswitch to the ON position.
- D. Access the diagnostic override under the “Diagnostics” menu.
- E. Start the override for the compression brake.
- F. Once Cat ET displays the status of the compression brake solenoid, stop the override.
- G. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.
- H. Turn the keyswitch to the OFF position.

I. Reconnect the valve cover connector.

Results:

- A 2533-5 diagnostic code or a 2535-5 diagnostic code is active at this time. The ECM detected the open at the valve cover connector for the compression brake solenoid. The harness wiring between the valve cover connector and the ECM is OK. – Proceed to Test Step 5.
- A 2533-6 diagnostic code or a 2535-6 diagnostic code is active at this time. The ECM did not detect the open at the valve cover connector for the compression brake solenoid.

Repair: Repair the harness or replace the harness between the connector for the compression brake solenoid and the valve cover connector.

Verify that the repair eliminates the problem.

STOP.

Test Step 5. Create an Open Circuit at the Compression Brake Solenoid

Note: Two solenoids are activated in order to create a medium braking action. The short could be in either solenoid or in the harness. In order to isolate the problem for a medium braking action, run this test step for each of the solenoids. The open must be created separately at each solenoid.

Note: In order to troubleshoot a 2533-6 diagnostic code, use the “Compression Brake Low/High Override” on Cat ET. In order to troubleshoot a 2535-6 diagnostic code, use the “Compression Brake Med/High Override” on Cat ET.

- Turn the keyswitch to the OFF position.
- Remove the valve cover.
- Reconnect the valve cover connector.
- Disconnect the connector on the suspect compression brake solenoid.
- Inspect the terminals on the connector for the compression brake solenoid for damage.
- Turn the keyswitch to the ON position.
- Access the diagnostic override under the “Diagnostics” menu.
- Start the override for the compression brake.
- Once Cat ET displays the status of the compression brake solenoid, stop the override.

J. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

K. Turn the keyswitch to the OFF position.

Results:

- A 2533-5 diagnostic code or a 2535-5 diagnostic code is active at this time. The ECM detected the open at the compression brake solenoid. The harness wiring between the connector for the suspect compression brake solenoid and the ECM is OK. –

Repair: Replace the suspect compression brake solenoid. Verify that the repair eliminates the problem.

STOP.

- A 2533-6 diagnostic code or a 2535-6 diagnostic code is active at this time. The ECM did not detect the open at the compression brake solenoid. There is a short circuit between the valve cover connector and the connector for the compression brake solenoid.

Repair: Repair the harness or replace the harness between the connector for the compression brake solenoid and the valve cover connector.

Verify that the repair eliminates the problem.

STOP.

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Sensor Calibration Required - Test

SMCS Code: 1439-038

System Operation Description:

Use this procedure to troubleshoot a problem with a pressure sensor calibration or use this procedure if any one of the diagnostic codes in Table 41 is active or easily repeated.

Table 41

Diagnostic Codes Table		
CDL Code	Code Description	Comments
100-13	Engine Oil Pressure Sensor : Calibration Required	The code is logged. During a manual calibration, the pressure offset value is set to 0 kPa (0 psi). During an automatic calibration, the pressure offset value is set to the previous calibration value.
274-13	Atmospheric Pressure Sensor : Calibration Required	The code is logged. During a manual calibration, the pressure offset value is set to 0 kPa (0 psi). During an automatic calibration, the pressure offset value is set to the previous calibration value.
460-13	Fuel Pressure Sensor - After Fuel Filter : Calibration Required	The code is logged. During a manual calibration, the pressure offset value is set to 0 kPa (0 psi). During an automatic calibration, the pressure offset value is set to the previous calibration value.
1785-13	Intake Manifold Pressure Sensor : Calibration Required	The code is logged. During a manual calibration, the pressure offset value is set to 0 kPa (0 psi). During an automatic calibration, the pressure offset value is set to the previous calibration value.

The Electronic Control Module (ECM) checks the signals from certain reference pressure sensors when the keyswitch is turned to the ON position. The key must remain in the ON position for 2 seconds in order for the ECM to check the signals from the sensors. During this time, the ECM compares the signal from the atmospheric pressure sensor with the signal from the following pressure sensors:

- Fuel pressure sensor
- Oil pressure
- Intake manifold air pressure

The sensor signal must be within the specified range of the signal from the reference pressure sensor. If a sensor signal is out of the range, the corresponding fault code becomes active.

Test Step 1. Check for Diagnostic Codes

Note: The engine coolant temperature must be greater than 0° C (32° F) before beginning this procedure.

- A.** Establish communication between Caterpillar Electronic Technician (ET) and the ECM . Refer to Troubleshooting, "Electronic Service Tools", if necessary.

- B.** Download the "Product Summary Report" from the engine ECM before performing any troubleshooting or clearing diagnostic trouble codes.

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

- C.** Look for an active -13 code or for a logged -13 code.

Results:

- There is an active or there is a logged -13 code for only one sensor. – Proceed to Test Step 2.
- There is an active or there is a logged -13 code for more than one sensor. – Proceed to Test Step 3.

Test Step 2. Inspect the Suspect Sensor Connector

- A.** Turn the keyswitch to the OFF position.
- B.** Inspect the connector of the suspect sensor. Verify that there is no moisture.
- C.** Turn the keyswitch to the ON position.

- D. Monitor the status parameter for the suspect sensor on Cat ET. Wiggle the wiring at the suspect sensor connector.

Results:

- The value of the status parameter does not remain steady.

Repair: Perform the following procedure.

1. Disconnect the suspect sensor connector.
2. Remove any moisture from the outside of the connector. Check for moisture and corrosion inside the connector. Verify that the seals for the wires are sealing correctly. Refer to Troubleshooting, "Electrical Connector - Inspect", if necessary.
3. If necessary, repair the connector or replace the connector.
4. Reconnect the connector. Verify that the connection is secure.
5. Monitor the status parameter for the suspect sensor on Cat ET. Wiggle the wiring at the suspect sensor connector. Verify that the signal is steady.
6. Turn the keyswitch to the OFF position. Clear the -13 diagnostic code.
7. Turn the keyswitch to the ON position.
8. Monitor the diagnostic codes on Cat ET. Check for an active -13 diagnostic code for the suspect sensor.

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

9. If the -13 code is active, replace the sensor. Verify that the problem is resolved.

STOP.

- The value of the status parameter remains steady.

Repair: Perform the following procedure.

1. Disconnect the suspect sensor connector.
2. Check for corrosion inside the connector. Verify that the seals for the wires are sealing correctly. Refer to Troubleshooting, "Electrical Connector - Inspect", if necessary.
3. If necessary, repair the connector or replace the connector.

4. Reconnect the connector. Verify that the connection is secure.

5. Monitor the status parameter for the suspect sensor on Cat ET. Wiggle the wiring at the suspect sensor connector. Verify that the signal is steady.

6. Turn the keyswitch to the OFF position. Clear the -13 diagnostic code.

7. Turn the keyswitch to the ON position.

8. Monitor the diagnostic codes on Cat ET. Check for an active -13 diagnostic code for the suspect sensor.

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

9. If the -13 code is active, replace the sensor. Verify that the problem is resolved.

STOP.

Test Step 3. Inspect the Connector for the Reference Sensor

- A. Turn the keyswitch to the OFF position.

- B. Inspect the connector of the suspect reference sensor. Verify that there is no moisture.

- C. Turn the keyswitch to the ON position.

- D. Monitor the status parameter for the suspect reference sensor on Cat ET. Wiggle the wiring at the suspect sensor connector.

Results:

- The value of the status parameter does not remain steady.

Repair: Perform the following procedure.

1. Disconnect the suspect sensor connector.
2. Remove any moisture from the outside of the connector. Check for moisture and corrosion inside the connector. Verify that the seals for the wires are sealing correctly. Refer to Troubleshooting, "Electrical Connector - Inspect", if necessary.
3. If necessary, repair the connector or replace the connector.
4. Reconnect the connector. Verify that the connection is secure.

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5. Monitor the status parameter for the suspect sensor on Cat ET. Wiggle the wiring at the suspect sensor connector. Verify that the signal is steady.
6. Turn the keyswitch to the OFF position. Clear the -13 diagnostic codes.
7. Turn the keyswitch to the ON position.
8. Monitor the diagnostic codes on Cat ET. Check for active -13 diagnostic codes.

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

9. If more than one -13 code is active, replace the reference sensor. Verify that the problem is resolved.

STOP.

- The value of the status parameter remains steady.

Repair: Perform the following procedure.

1. Disconnect the suspect reference sensor connector.
2. Check for corrosion inside the connector. Verify that the seals for the wires are sealing correctly. Refer to Troubleshooting, "Electrical Connector - Inspect", if necessary.
3. If necessary, repair the connector or replace the connector.
4. Reconnect the connector. Verify that the connection is secure.
5. Monitor the status parameter for the suspect reference sensor on Cat ET. Wiggle the wiring at the suspect sensor connector. Verify that the signal is steady.
6. Turn the keyswitch to the OFF position. Clear the -13 diagnostic codes.
7. Turn the keyswitch to the ON position.
8. Monitor the diagnostic codes on Cat ET. Check for active -13 diagnostic codes.

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

9. If more than one -13 code is active, replace the reference sensor. Verify that the problem is resolved.

STOP.

Sensor Signal (Analog, Active) - Test

SMCS Code: 1439-038

System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with the sensors or if any one of the diagnostic codes in Table 42 is active or easily repeated.

Table 42

Diagnostic Codes Table		
Code	Code Description	Comments
100-3	Engine Oil Pressure Sensor Voltage Above Normal	The ECM detects signal voltage that is above normal . The code is logged.
100-4	Engine Oil Pressure Sensor Voltage Below Normal	The ECM detects signal voltage that is below normal . The code is logged.
274-3	Atmospheric Pressure Sensor Voltage Above Normal	The ECM detects signal voltage that is above normal . The code is logged.
274-4	Atmospheric Pressure Sensor Voltage Below Normal	The ECM detects signal voltage that is below normal . The code is logged.
460-3	Fuel Pressure Sensor - After Fuel Filter : Voltage Above Normal	The ECM detects signal voltage that is above normal . The code is logged.
460-4	Fuel Pressure Sensor - After Fuel Filter : Voltage Below Normal	The ECM detects signal voltage that is below normal . The code is logged.
1785-3	Intake Manifold Pressure Sensor Voltage Above Normal	The ECM detects signal voltage that is above normal . The code is logged.
1785-4	Intake Manifold Pressure Sensor Voltage Below Normal	The ECM detects signal voltage that is below normal . The code is logged.
2738-3	Turbocharger #1 Compressor Inlet Pressure Sensor : Voltage Above Normal	The ECM detects signal voltage that is not in the acceptable range. The code is logged. The value of the parameter is set to a gauge pressure.
2738-4	Turbocharger #1 Compressor Inlet Pressure Sensor : Voltage Below Normal	The ECM detects signal voltage that is not in the acceptable range. The code is logged. The value of the parameter is set to a gauge pressure.

System Operation

Use this procedure to troubleshoot any suspect problems with the following sensors:

- Engine oil pressure sensor
- Barometric pressure sensor
- Fuel pressure sensor
- Intake manifold pressure sensor

The supply voltage is routed to terminal 1 of each sensor connector. The sensor return is routed to terminal 2 of each sensor connector. The sensor signal is routed to terminal 3 of each sensor connector. The ECM provides short circuit protection for the internal power supply. A short circuit to the battery will not damage the internal power supply.

The ECM performs an automatic calibration of these sensors whenever the ECM is powered and the engine is off for at least 5 seconds. During an automatic calibration, the ECM calibrates pressure sensors to the value of the atmospheric pressure at sea level. This calibration value is then checked against an acceptable offset pressure range.

The ECM continuously outputs a pull-up voltage on the input terminal from an analog sensor. The ECM uses this pull-up voltage in order to detect an open or a short in the signal circuit. When the ECM detects the presence of a voltage that is above the normal range of the sensor on the signal circuit, the ECM will generate an open circuit diagnostic code -3 for that sensor. When the ECM detects the absence of the pull-up voltage on the signal circuit, the ECM will generate a short circuit diagnostic code -4 for that sensor. The presence of pull-up voltage at the sensor connector indicates that the wires from the sensor connector to the ECM are not open or shorted to ground.

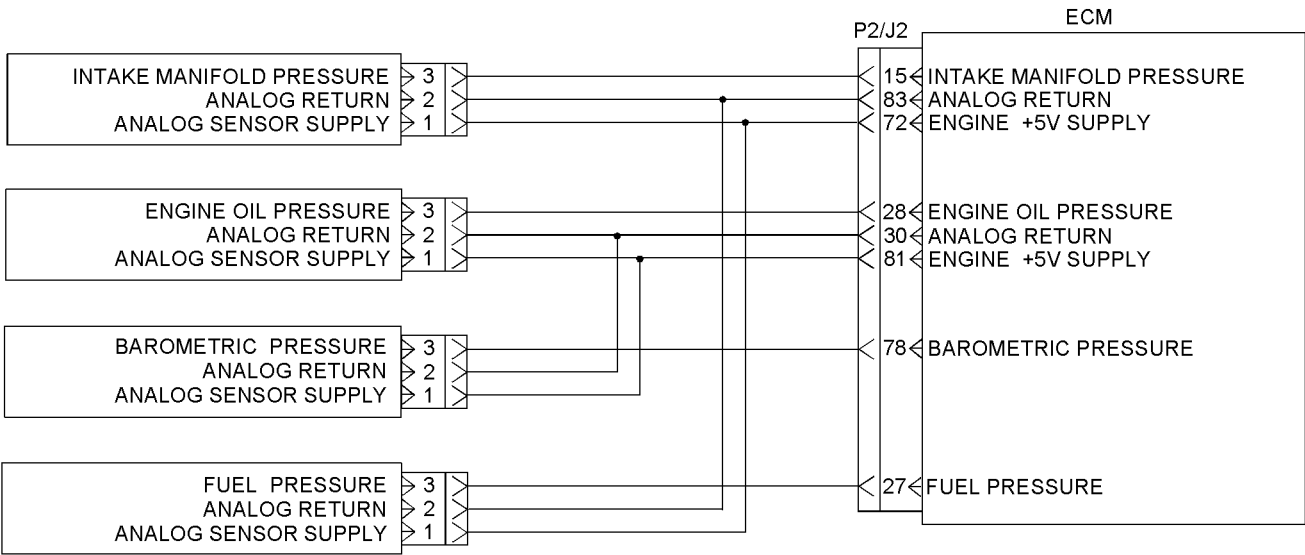


Illustration 56
Schematic for the analog sensors

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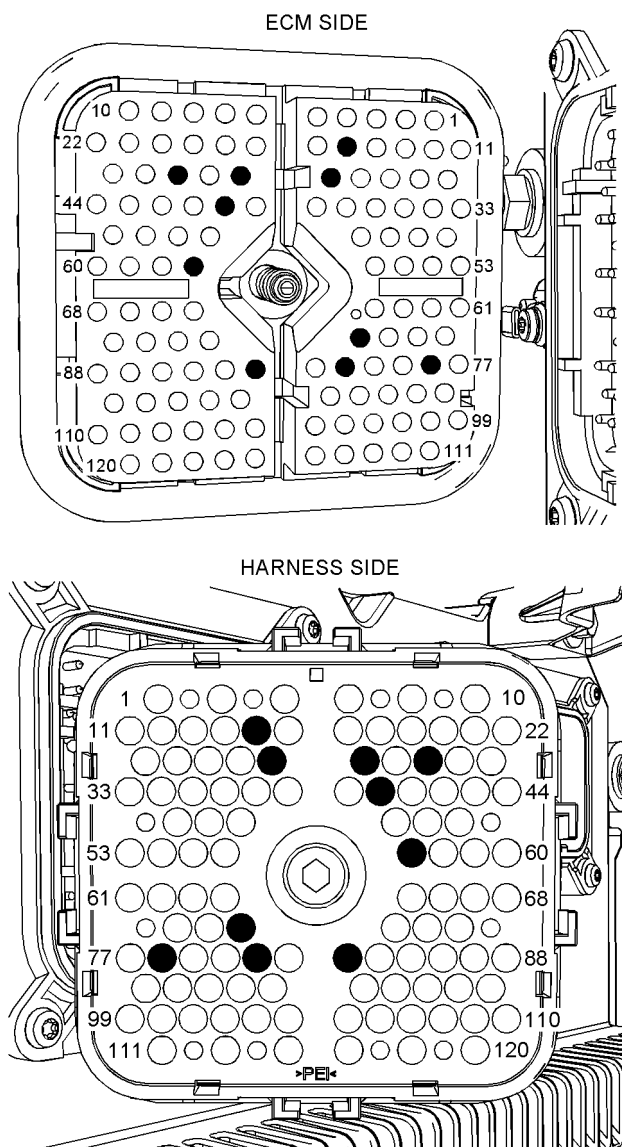


Illustration 57

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P2 ECM connector

(P2-15) Intake manifold pressure sensor
 (P2-27) Fuel pressure sensor
 (P2-28) Engine oil pressure sensor

(P2-30) Analog Return
 (P2-72) Engine +5V supply
 (P2-78) Barometric pressure sensor

(P2-81) Engine +5V supply
 (P2-83) Analog Return

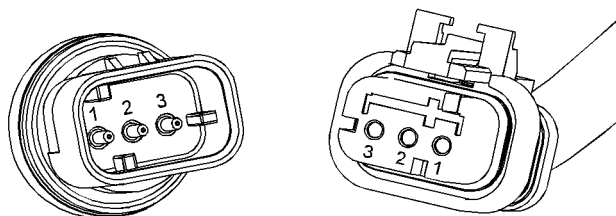


Illustration 58

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Sensor connector

- (1) Analog sensor supply
- (2) Analog sensor return
- (3) Sensor signal

Test Step 1. Check for “Active” and “Logged” Diagnostic Codes

A. Connect Caterpillar Electronic Technician (ET) to the service tool connector.

B. Turn the keyswitch to the ON position.

C. Monitor the diagnostic codes on Cat ET. Check and record any diagnostic codes.

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

D. Determine if a diagnostic code has occurred several times.

Note: A diagnostic code that is logged several times is an indication of an intermittent problem. Most intermittent problems are the result of a bad connection between a socket and a pin in a connector or a bad connection between a wire and a terminal. The problem may be caused by moisture, corrosion, or wear.

E. Determine if the problem is active and related to one of the following diagnostic codes:

- -3
- -4
- -10

Expected Result:

A diagnostic code is not active.

Results:

- OK – A diagnostic code is not active.

Repair: The problem may be intermittent. If the problem is intermittent, refer to Troubleshooting, “Electrical Connectors - Inspect”.

STOP.

- Not OK – A -10 diagnostic code is active.

Repair: A -10 diagnostic code indicates an open in the voltage supply to a sensor. If the code is only present for one sensor, the open will be between the sensor connector and a splice. If the open is for two or more sensors, the open will be before the splice for the voltage supply to those sensors. Repair the open in the wiring or connectors. Refer to the electrical schematic for the locations of splices in the harness. Refer to Troubleshooting, “Sensor Supply - Test” for information that is related to troubleshooting the sensor supply.

STOP.

- Not OK – A -3 code or a -4 code is active. Proceed to Test Step 2.

Test Step 2. Check the 5 V Supply Voltage at the Sensor Connector

A. Do not disconnect the suspect connector.

B. Connect a multimeter between pin 1 and pin 2 on the sensor side of the connector for the suspect sensor.

C. Measure the voltage between pin 1 and pin 2 for the suspect sensor.

D. Wiggle the harness while you monitor the voltage on the voltmeter. Perform the 45 N (10 lb) pull test on each wire in the circuit. 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:

The supply voltage is approximately 5.0 ± 0.5 VDC.

Results:

- OK – The supply voltage is approximately 5.0 ± 0.5 VDC. An active -3 diagnostic code is present. Proceed to Test Step 3.

- OK – The supply voltage is approximately 5.0 ± 0.5 VDC. An active -4 diagnostic code is present. Proceed to Test Step 5.

- Not OK – The supply voltage is not approximately 5.0 ± 0.5 VDC.

Repair: There is an open in the wiring or connectors between the suspect sensor and the ECM. Inspect the wiring and connectors.

STOP.

Test Step 3. Check for Battery Voltage on the Signal Wire

- A.** Measure the voltage on the harness side of the sensor connector between pin 2 and pin 3 for the suspect sensor.

Expected Result:

The signal voltage is less than battery voltage.

Results:

- OK – The signal voltage is less than battery voltage. Proceed to Test Step 4.
- Not OK – The signal voltage is equal to battery voltage.

Repair: There is a short in the harness to the battery. Repair the wiring.

STOP.

Test Step 4. Create a Short Circuit at the Sensor Connector

- A.** Turn the keyswitch to the OFF position.
- B.** Disconnect the suspect sensor.
- C.** Fabricate a wire jumper that is long enough to create a test circuit at the sensor connector. Use the jumper wire to create a short between terminal 3 (sensor signal) and terminal 2 (sensor return) at the sensor connector.
- D.** Turn the keyswitch to the ON position.
- E.** Monitor the diagnostic codes on Cat ET. Check for an active -4 diagnostic code for the suspect sensor.

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

- F.** Turn the keyswitch to the OFF position.

Expected Result:

A -4 diagnostic code is now active for the suspect sensor.

Results:

- OK – A -3 diagnostic code was active before installing the jumper wire at the sensor connector. A -4 diagnostic code became active after installing the jumper wire at the sensor connector.

Repair: The harness and the ECM are OK. 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 – A -3 diagnostic code is still active for the suspect sensor. The problem may be in the harness or with the ECM. Proceed to Test Step 6.

Test Step 5. Create an Open at the Suspect Sensor Connector

- A.** Turn the keyswitch to the OFF position.
- B.** Disconnect the sensor connector of the suspect sensor with the active -4 diagnostic code.
- C.** Turn the keyswitch to the ON position.
- D.** Monitor the diagnostic codes on Cat ET. Check for an active -3 diagnostic code for the suspect sensor.

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

- E.** Turn the keyswitch to the OFF position.

Expected Result:

A -3 diagnostic code is now active for the suspect sensor.

Results:

- OK – A -4 diagnostic code was active before disconnecting the sensor. A -3 diagnostic code became active after disconnecting the sensor.

Repair: The harness and the ECM are OK. 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 – A -4 diagnostic code is still active for the suspect sensor. Leave the sensor disconnected. The problem may be in the harness or with the ECM. Proceed to Test Step 6.

Test Step 6. Test the Operation of the ECM

- A. Fabricate a jumper wire that can be used to replace the signal wire in the ECM connector for the suspect sensor. Crimp a connector socket to one end of the jumper wire.
- B. Disconnect the appropriate ECM connector for the suspect sensor.
- C. Remove the signal wire for the suspect sensor from the ECM connector.
- D. Install the jumper wire into the terminal location for the suspect sensor signal wire at the ECM connector.
- E. Connect the ECM connector.
- 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 components in order to create an open circuit condition.
 - b. Turn the keyswitch to the ON position.
 - c. Monitor the active diagnostic code screen on Cat ET. Check for a -3 diagnostic code for the suspect sensor.

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

- G. **Check the operation of the ECM by creating a short circuit at the ECM:**
 - a. Short the jumper wire for the suspect sensor to the sensor return in order to create a short circuit condition.
 - b. Monitor the active diagnostic code screen on Cat ET. Check for a -4 diagnostic code for the suspect sensor.

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

- H. Turn the keyswitch to the OFF position.
- I. Remove all jumper wires. Return the wiring to the original configuration.

Expected Result:

A -3 diagnostic code is active when the sensor signal wire is removed from the ECM connector. A -4 diagnostic code is active when the signal wire is shorted to the analog return.

Results:

- OK – The ECM is operating properly. The problem is in the wiring between the ECM and the connector for the sensor.

Repair: If the code is active for more than one sensor, the problem is most likely in the return wire for the sensor. Repair the analog return wire for the sensor or replace the harness.

If the code is only active for one sensor, the problem is most likely in the signal wire for the sensor. Repair the signal wire for the sensor.

STOP.

- Not OK – One of the following conditions exists: The -3 diagnostic code is not active when the sensor signal wire is disconnected. The -4 diagnostic code is not active when the wire jumper is shorted to the analog return.

Repair: Replace the ECM. Refer to Troubleshooting, "ECM - Replace". Verify that the problem is resolved.

STOP.

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Sensor Signal (Analog, Passive) - Test

SMCS Code: 1439-038

System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with a sensor. Also, use this procedure if any one of the diagnostic codes in Table 43 is active or easily repeated.

Table 43

Diagnostic Codes Table		
Code and Description	Conditions which Generate this Code	System Response
110-3 Engine Coolant Temperature Sensor voltage above normal	The engine Electronic Control Module (ECM) detects signal voltage that is more than 4.95 VDC for 8 seconds. The ECM has been powered for at least 2 seconds.	The code is logged if the engine has been running for more than 7 minutes. The ECM uses the last valid engine coolant temperature. If the diagnostic code is active at start-up, the ECM will use intake manifold temperature. If intake manifold air temperature is not valid, the ECM will default to 90 °C (194 °F) for engine coolant temperature. The ECM will activate the cooling fan after this code has been active for more than 8 seconds.
110-4 Engine Coolant Temperature Sensor voltage below normal	The ECM detects signal voltage that is less than 0.2 VDC for 8 seconds. The ECM has been powered for at least 2 seconds.	
172-3 Intake Manifold Air Temperature Sensor voltage above normal	The engine ECM detects signal voltage that is more than 4.95 VDC for 8 seconds. The ECM has been powered for at least 2 seconds.	The ECM will log the diagnostic code. The ECM will flag the intake manifold air temperature as invalid data and the intake manifold air temperature is set to a default value of 40 °C (104 °F).
172-4 Intake Manifold Air Temperature Sensor voltage below normal	The ECM detects signal voltage that is less than 0.2 VDC for 8 seconds. The ECM has been powered for at least 2 seconds.	
174-3 Fuel Temperature Sensor voltage above normal	The engine Electronic Control Module (ECM) detects signal voltage that is more than 4.95 VDC for 8 seconds. The ECM has been powered for at least 2 seconds.	The code is logged. The ECM will flag the fuel temperature as invalid data and the fuel temperature is set to a default value of 40 °C (104 °F).
174-4 Fuel Temperature Sensor voltage below normal	The ECM detects signal voltage that is less than 0.2 VDC for 2 seconds. The ECM has been powered for at least 2 seconds.	
2526-3 Air Inlet Temperature Sensor : Voltage Above Normal	The engine Electronic Control Module (ECM) detects signal voltage that is more than 4.95 VDC for 8 seconds. The ECM has been powered for at least 2 seconds.	The code is logged. The ECM detects voltage that is not in the acceptable range.
2526-4 Air Inlet Temperature Sensor : Voltage Below Normal	The ECM detects signal voltage that is less than 0.2 VDC for 2 seconds. The ECM has been powered for at least 2 seconds.	The code is logged. The ECM detects voltage that is not in the acceptable range.

System Operation

Use this procedure to troubleshoot any suspect problems with the following sensors:

- Coolant temperature sensor
- Intake manifold air temperature sensor
- Fuel temperature sensor
- Air inlet temperature

The sensor signal for the passive sensor is routed from the ECM to terminal 1 of each sensor connector. The sensor return for the passive sensors is routed from the ECM to terminal 2 of each sensor connector.

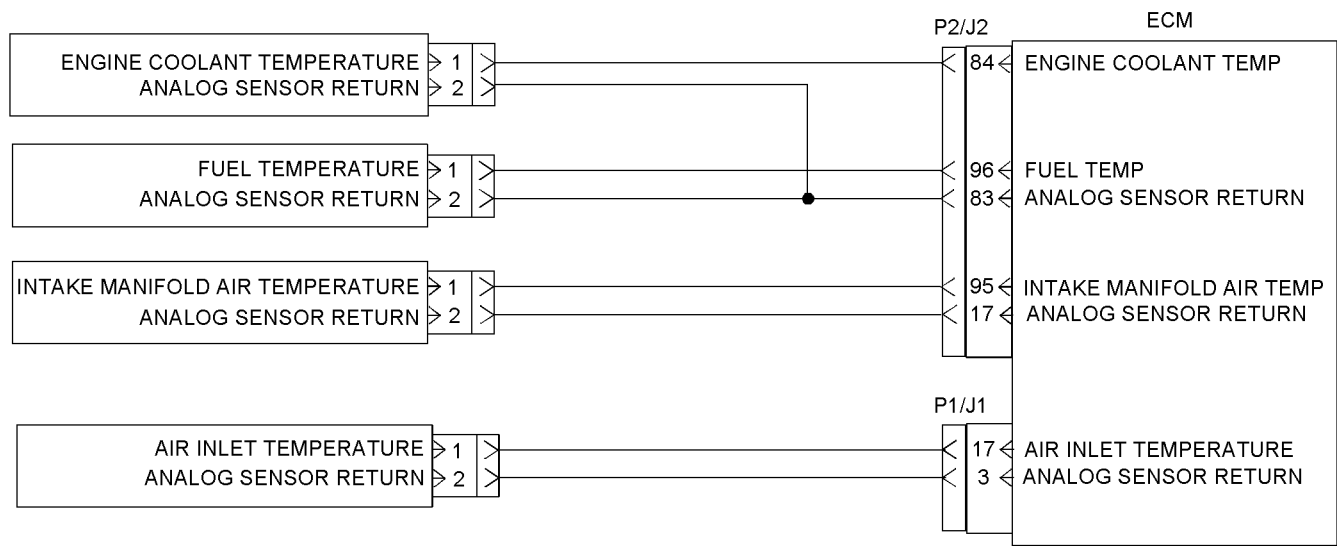


Illustration 59
Schematic for the passive analog sensors

g02165060

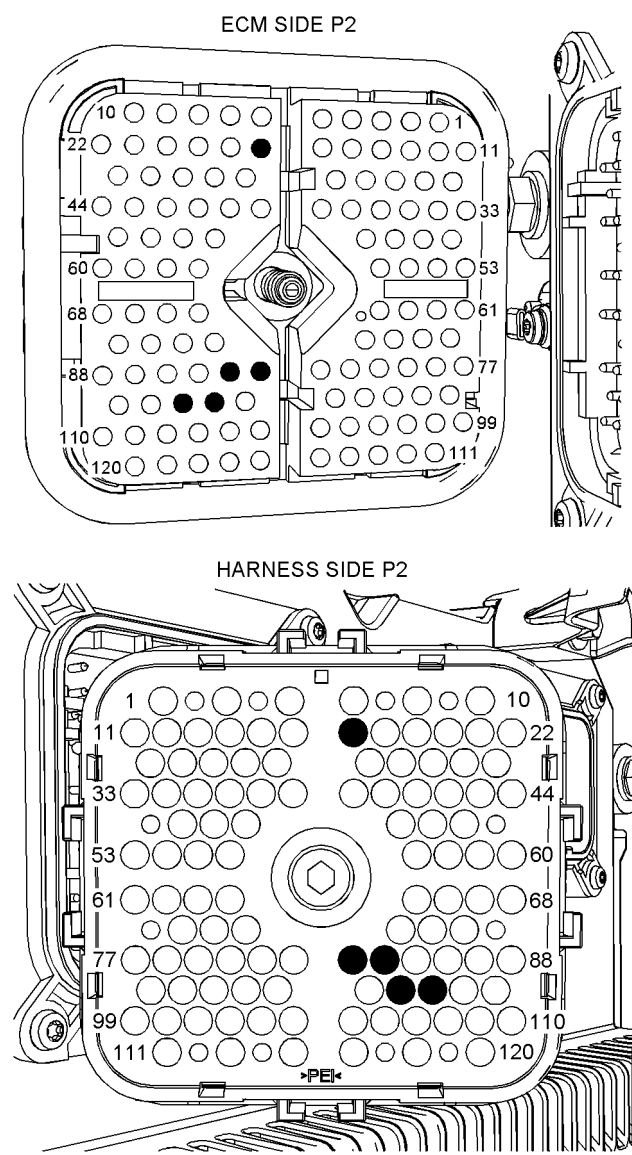


Illustration 60

g02165062

Terminal locations at the P2 ECM connector for the engine temperature sensors

(P2-17) Analog sensor return
 (P2-83) Analog sensor return
 (P2-84) Engine coolant temperature
 (P2-95) Intake manifold air temperature
 (P2-96) Fuel temperature

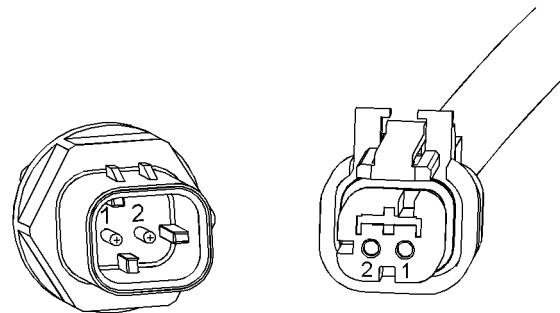


Illustration 61

g01423043

Terminal locations at the connector for the passive analog sensors

(Terminal 1) Sensor signal
 (Terminal 2) Analog sensor return

Test Step 1. Check for “Active” and “Logged” Diagnostic Codes

- A. Remove electrical power from the ECM.
- B. Connect Caterpillar Electronic Technician (ET) to the service tool connector.
- C. Restore electrical power to the ECM.
- D. Monitor the diagnostic codes on Cat ET. Check and record any diagnostic codes.

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

- E. Determine if a diagnostic code has occurred several times.

Note: A diagnostic code that is logged several times is an indication of an intermittent problem. Most intermittent problems are the result of a poor connection between a socket and a pin in a connector or of a poor connection between a wire and a terminal.

- F. Determine if the problem is active and related to one of the following diagnostic codes:

- -3
- -4

- G. Remove electrical power from the ECM.

Expected Result:

A diagnostic code is not active.

Results:

- OK – A diagnostic code is not active.

Repair: The problem may be intermittent. If the problem is intermittent, refer to Troubleshooting, “Electrical Connectors - Inspect”.

STOP.

- Not OK – An active -3 diagnostic code is present. Proceed to Test Step 2.
- Not OK – An active -4 diagnostic code is present. Proceed to Test Step 4.

Test Step 2. Check for Battery Voltage on the Signal Wire

- A. Restore electrical power to the ECM.
- B. Measure the voltage on the harness side of the sensor connector between pin 1 and engine ground for the suspect sensor.
- C. Remove electrical power from the ECM.

Expected Result:

The signal voltage is less than battery voltage.

Results:

- OK – The signal voltage is less than battery voltage. Proceed to Test Step 3.
- Not OK – The signal voltage is equal to battery voltage.

Repair: There is a short circuit to battery voltage in the harness. Repair the wiring harness or replace the wiring harness. Verify that the repair has resolved the original problem.

STOP.

Test Step 3. Create a Short Circuit at the Connector for the Suspect Sensor

- A. Disconnect the suspect sensor.
- B. Fabricate a jumper wire that is long enough to create a test circuit across the harness side of the sensor connector. Crimp connector pins to each end of the jumper wire.
- C. Install the jumper wire between terminal 1 (sensor signal) and terminal 2 (sensor return) at the sensor connector.
- D. Restore electrical power to the ECM.
- E. Access the “Active Diagnostic Code” screen on Cat ET. Check for an active -4 diagnostic code for the suspect sensor.

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

- F. Remove electrical power from the ECM.

Expected Result:

A -4 diagnostic code is now active for the suspect sensor.

Results:

- OK – A -3 diagnostic code was active before creating the short at the sensor connector. A -4 diagnostic code became active after creating the short at the sensor connector. The wiring between the ECM and the sensor connector is OK.

Repair: Temporarily connect a new sensor to the harness, but do not install the new sensor in the engine. Verify that there are no active diagnostic codes for the sensor. If there are no active diagnostic codes for the sensor, permanently install the new sensor. Clear any logged diagnostic codes.

STOP.

- Not OK – A -3 diagnostic code is still active for the suspect sensor. There is an open circuit between the sensor connector and the ECM. Leave the sensor disconnected. Proceed to Test Step 5.

Test Step 4. Create an Open Circuit at the Connector for the Suspect Sensor

- A. Remove electrical power from the ECM.
- B. Disconnect the sensor connector for the suspect sensor with the active -4 diagnostic code.
- C. Restore electrical power to the ECM.
- D. Access the “Active Diagnostic Code” screen on Cat ET. Check for an active -3 diagnostic code.

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

- E. Remove electrical power from the ECM.

Expected Result:

A -3 diagnostic code is now active for the suspect sensor.

Results:

- OK – A -4 diagnostic code was active before disconnecting the sensor. A -3 diagnostic code became active after disconnecting the sensor. The wiring between the ECM and the sensor connector is OK.

Repair: Temporarily connect a new sensor to the harness, but do not install the new sensor in the engine. Verify that there are no active diagnostic codes for the sensor. If there are no active diagnostic codes for the sensor, permanently install the new sensor. Clear any logged diagnostic codes.

STOP.

- Not OK – A -4 diagnostic code is still active for the suspect sensor. There is a short circuit between the sensor connector and the ECM. Proceed to Test Step 5.

Test Step 5. Check for Proper Operation of the ECM

- Ensure that electrical power has been removed from the ECM.
- Disconnect the appropriate ECM connectors for the sensor circuit.
- Check the operation of the ECM by creating an open at the ECM.**
 - Remove the signal wire for the suspect sensor from the appropriate ECM connector.
 - Fabricate a jumper wire that is long enough to create a test circuit between the ECM connector and the negative battery connection. Crimp a connector socket to one end of the jumper wire.
 - Install the socket end of the jumper wire into the J2 terminal location that is for the signal wire of the suspect sensor. Hold the loose end of the jumper wire away from any ground source in order to create an open circuit condition.
 - Reconnect the ECM connectors.
 - Restore electrical power to the ECM. Monitor the “Active Diagnostic Code” screen on Cat ET. Wait at least 30 seconds for activation of the code.

An open circuit diagnostic code -3 should be active for the suspect sensor.

- Check the operation of the ECM by creating a short at the ECM.**
 - Install the loose end of the jumper wire that is for the signal wire for the suspect sensor to negative battery.
 - Monitor the “Active Diagnostic Code” screen on Cat ET. Wait at least 30 seconds for activation of the code.

A -4 diagnostic code should be active when the wire jumper is installed.

- Remove the jumper wire. Restore the wiring to the original configuration.

Expected Result:

A -3 diagnostic code is active while an open circuit condition is present on the signal wire for the suspect sensor. A -4 diagnostic code is active while the signal wire for the suspect sensor is connected to the negative battery connection.

Results:

- OK – The ECM is operating properly. The problem is in the wiring between the ECM and the connector for the sensor.

Repair: If the code is active for more than one sensor, the problem is most likely in the return wire for the sensors. Repair the return wire for the sensor or replace the harness.

If the code is only active for one sensor, the problem is most likely in the signal wire for the sensor. Repair the signal wire for the sensor.

STOP.

- Not OK – One of the following conditions exists: The -3 diagnostic code is not active when the open circuit condition is present on the signal wire of the suspect sensor. The -4 diagnostic code is not active when the signal wire for the suspect sensor is connected to the negative battery connection.

Repair: The ECM is not operating properly. Replace the ECM. Refer to Troubleshooting, “ECM - Replace”. Verify that the problem is resolved.

STOP.

i03983410

Sensor Supply - Test

SMCS Code: 1439-038

System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with a sensor supply. Use this procedure if any one of the diagnostic codes in Table 44 is active or easily repeated.

Note: Some of the following codes may not be applicable for certain applications.

Table 44

Diagnostic Codes Table		
CDL Code	Code Description	Comments
41-3	8 VDC Supply : Voltage Above Normal	The code is logged.
41-4	8 VDC Supply : Voltage Below Normal	The code is logged.
262-3	5 Volt Sensor DC Power Supply : Voltage Above Normal	The code is logged. All sensors are set to default values.
262-4	5 Volt Sensor DC Power Supply : Voltage Below Normal	The code is logged. All sensors are set to default values.
274-21	Atmospheric Pressure Sensor : Data Drifted Low	The code is logged. The 5 VDC supply to the sensor has been lost.
460-21	Fuel Pressure Sensor - After Fuel Filter : Data Drifted Low	The code is logged. The 5 VDC supply to the sensor has been lost.
1785-21	Intake Manifold Pressure Sensor : Data Drifted Low	The code is logged. The 5 VDC supply to the sensor has been lost.
2131-3	5 v Sensor DC Power Supply #2 : Voltage Above Normal	The code is logged. Engine power may be derated.
2131-4	5 v Sensor DC Power Supply #2 : Voltage Below Normal	The code is logged. Engine power may be derated.

System Operation

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

- Engine oil pressure sensor
- Barometric pressure sensor
- Crankcase pressure sensor
- Intake manifold pressure sensor
- Fuel pressure sensor after the filter
- Air inlet pressure sensor

The supply voltage for the sensors is routed from the ECM to terminal 1 of each sensor connector. The sensor return for the sensors is routed from the ECM to terminal 2 of each sensor connector. The ECM provides short circuit protection for the internal power supply. A short circuit to the battery will not damage the internal power supply.

Note: The sensors are not protected from overvoltage. A short from the supply line to the +Battery may damage the sensors. If any of the diagnostic codes are active, a sensor may have been damaged. Repair the sensor supply and check for any active sensor diagnostic codes in order to determine if a sensor has been damaged.

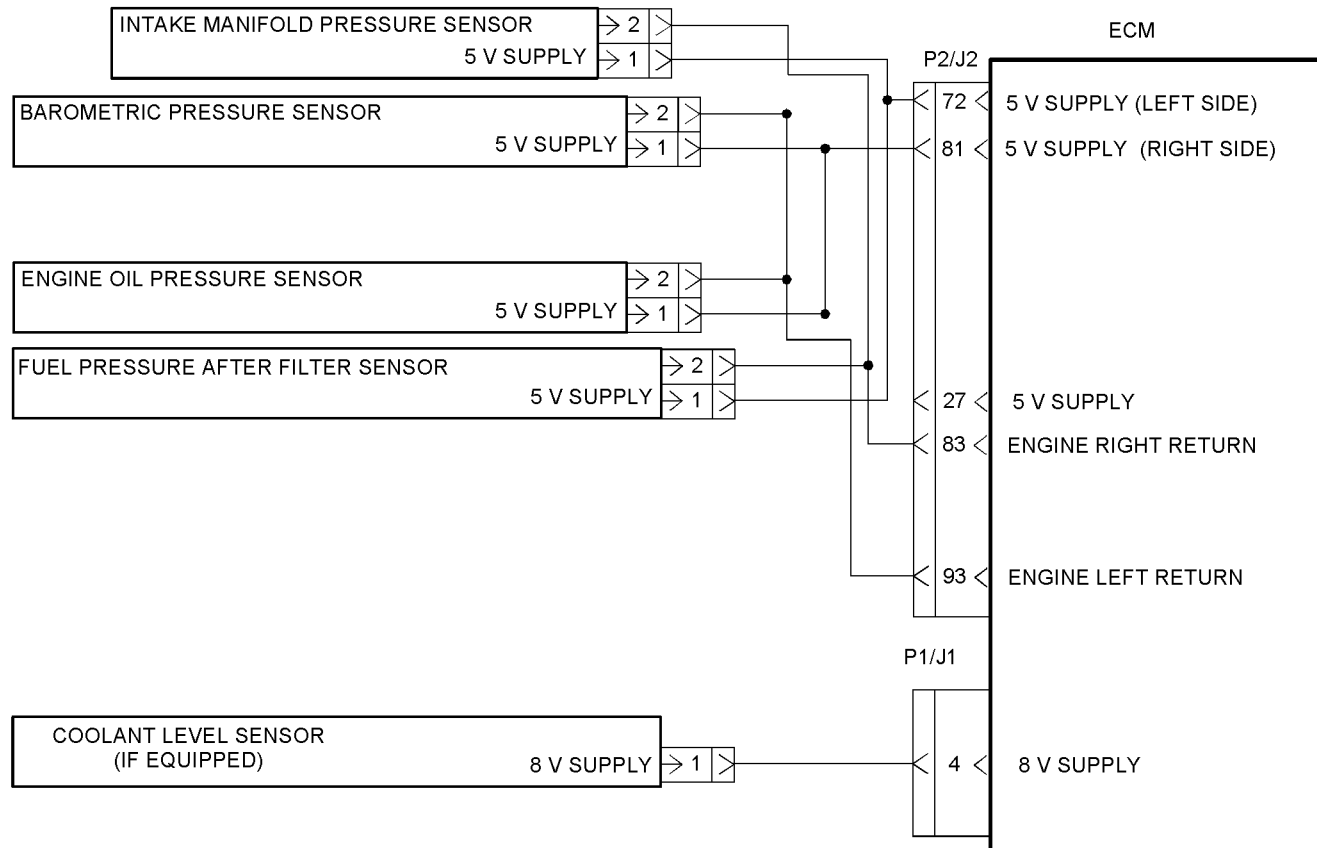


Illustration 62
Typical schematic

g02177069

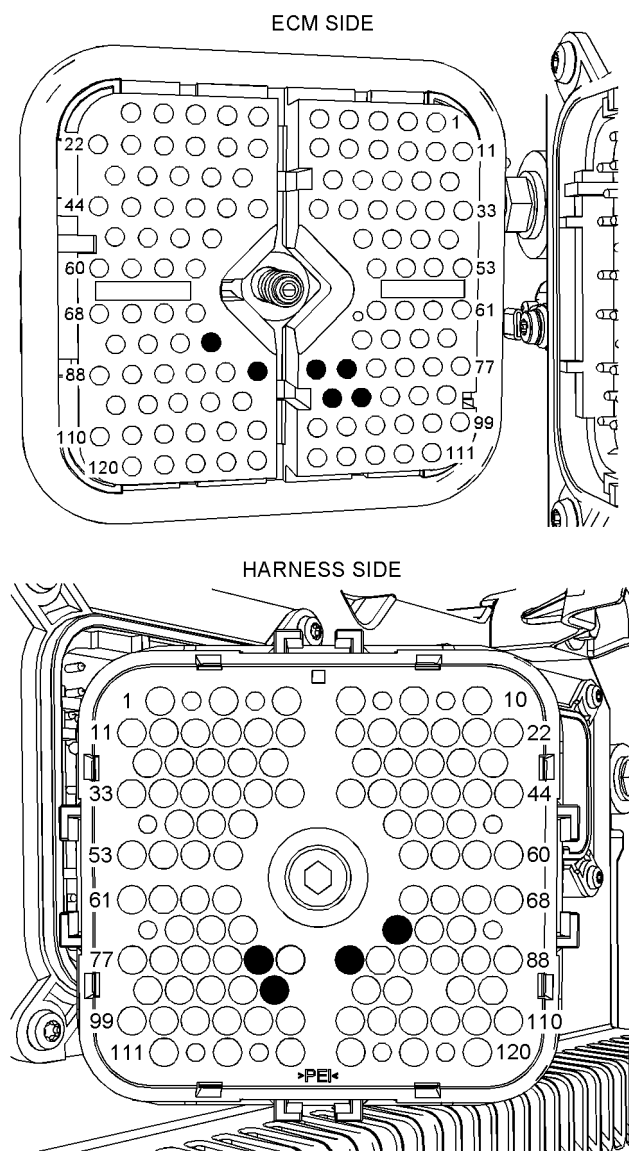


Illustration 63 g02452983

Terminal locations at the P2 ECM connector for the passive analog sensors

- (P2-72) +5 Sensor Power Supply (Left side of the engine)
- (P2-81) +5 Sensor Power Supply (Right side of the engine)
- (P2-83) Engine Return (right side)
- (P2-93) Engine Return (left side)

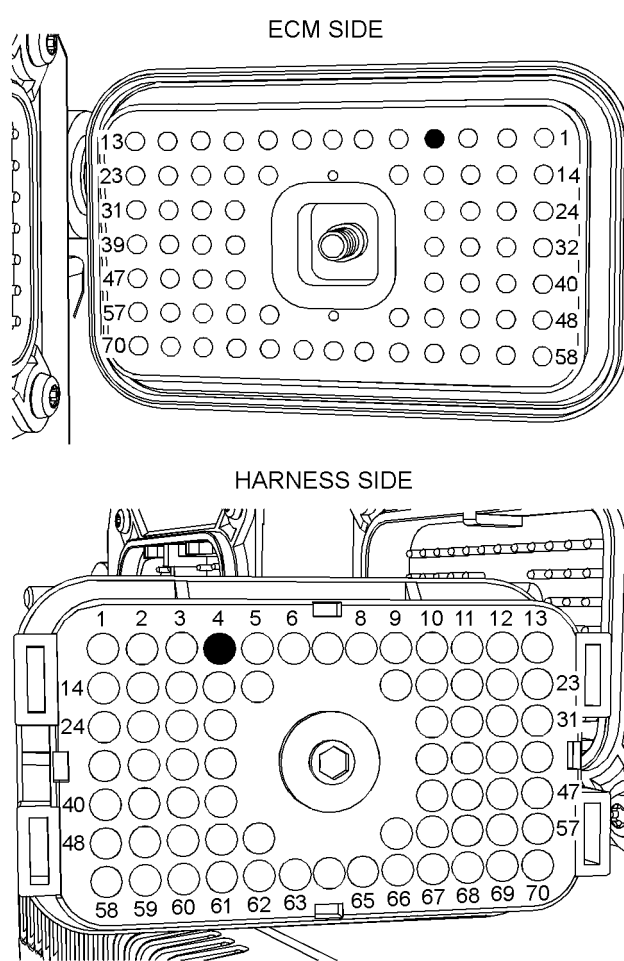


Illustration 64 g02101833

Terminal locations at the P1 ECM connector for the passive analog sensors

(P1-4) +8 Sensor Power Supply

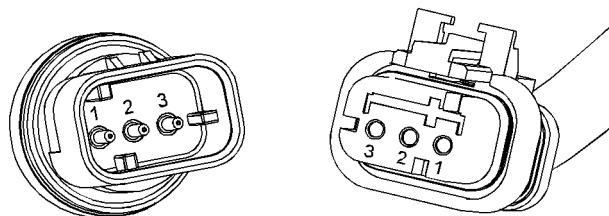


Illustration 65

g01240891

Sensor connector

- (A) 5 V or 8 V sensor supply
- (B) Sensor return
- (C) Signal

Test Step 1. Determine the Code

- A. Connect Cat ET to the service tool connector. Refer to Troubleshooting, "Electronic Service Tools", if necessary.
- B. Determine if a diagnostic trouble code is present.

Results:

- A -3 or -4 code is present.

Repair: Inspect the wiring at each sensor. Look for broken wiring or problems with a connector. Make the necessary repairs.

STOP.

- A -21 code is present. – There is an intermittent loss or solid loss of 5 v supply to the sensor. Proceed to Test Step 2.

Test Step 2. Check the Sensor Supply

- A. Turn the keyswitch to the ON position. Do not start the engine.
- B. Perform the "Wiggle Test" in Cat ET.
- C. Unplug the suspect sensor.
- D. Place a jumper wire across pin 1 to pin 2.

Results:

- A 41-4, a 2131-4 or a 262-4 code is activated.

Repair: There is a problem with the sensor. Replace the sensor. Verify the repair.

STOP.

- A 41-4, a 2131-4 or a 262-4 code is not activated.

Repair: The problem is in the wiring from the ECM to the sensor. Repair the wiring or replace the wiring. Verify the repair.

STOP.

i04001664

Shutdown (Ground Level) - Test

SMCS Code: 1900-038; 7332-038

System Operation Description:

This procedure covers the following diagnostic codes.

Table 45

Diagnostic Codes Table		
CDL Code	Code Description	Comments
267-3	Remote Shutdown Input : Voltage Above Normal	The code is logged.
267-4	Remote Shutdown Input : Voltage Below Normal	
E678 (2)	Ground Level Shutdown	The inputs from the ground level shutdown switch to the ECM have changed states. The engine will shut down. The code is logged.

The ground level shutdown switch allows the operator to shut down the engine from outside of the cab. When the switch is toggled to the STOP position, the engine shuts down. The Electronic Control Module (ECM) remains powered. Return the engine shutdown switch to the RUN position and cycle the electrical power to the ECM before attempting to restart the engine.

The status of the engine shutdown switch can be observed using Caterpillar Electronic Technician (ET).

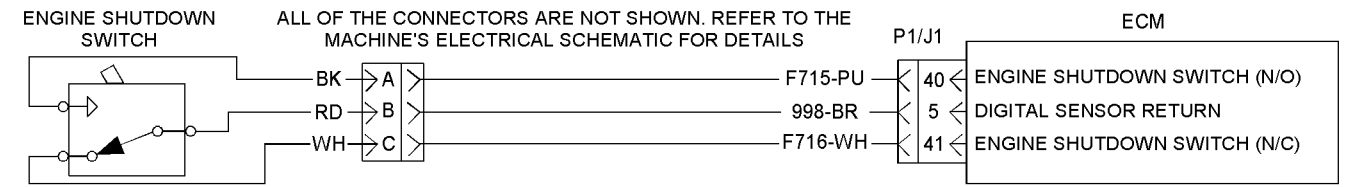


Illustration 66

g02133293

Schematic for the engine shutdown switch

Test Step 1. Inspect the Electrical Connectors and the Wiring

- A. Remove electrical power from the engine ECM.
- B. Thoroughly inspect ECM connectors (1). Also, thoroughly inspect the connectors for the machine interface connector and the engine shutdown switch. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.

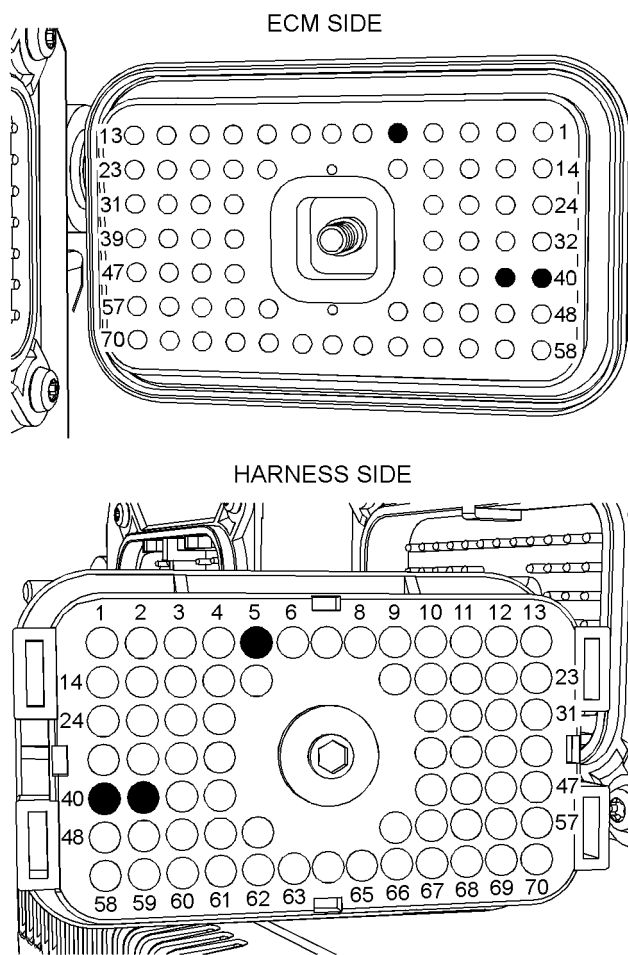


Illustration 67

g02133296

Terminal locations at the P1 ECM connector

(P1-5) Digital sensor return

(P1-40) Engine shutdown switch (N/O)

(P1-41) Engine shutdown switch (N/C)

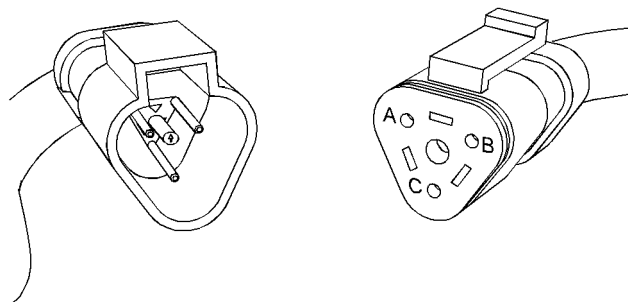


Illustration 68

g01159881

Harness connector for the engine shutdown switch

(Terminal A) Engine shutdown switch (N/O)

(Terminal B) Digital return

(Terminal C) Engine shutdown switch (N/C)

D. Check the torque of the allen head screw on 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 switch back to the ECM.

Expected Result:

All of the connectors, pins, and sockets are coupled and/or inserted and the harness and wiring are free of corrosion, abrasion, and pinch points.

Results:

- OK – The harness and the 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 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 coupled. Verify that the repair eliminates the problem.

STOP.

Test Step 2. Check the Status of the Shutdown Switch on Cat ET

A. Connect Cat ET to the service tool connector.

B. Turn the keyswitch to the ON position.

C. Monitor the status screen on Cat ET while you operate the shutdown switch. Observe the status for the shutdown switch.

Note: Wait at least 30 seconds for the status of the switch to change.

Expected Result:

The status of the shutdown switch reads "ON" with the shutdown switch in the STOP position. The status of the shutdown switch reads "OFF" when the shutdown switch is in the RUN position.

Results:

- OK – The status of the shutdown switch reads "ON" with the shutdown switch in the STOP position. The status of the shutdown switch reads "OFF" when the shutdown switch is in the RUN position. The shutdown switch is operating normally.

C. Perform a 45 N (10 lb) pull test on each of the wires for the engine shutdown switch.

Repair: The circuit for the shutdown switch appears to be operating correctly. There may be an intermittent problem in the harness or in a connector. If an intermittent problem is suspected, refer to Troubleshooting, "Electrical Connectors - Inspect".

STOP.

- Not OK – The status of the switch does not read "ON" with the shutdown switch in the STOP position. The status of the shutdown switch does not read "OFF" when the shutdown switch is in the RUN position. There is a problem with the circuit for the shutdown switch. There may be a problem with the ECM. Proceed to Test Step 3.

Test Step 3. Short the Terminals at the Harness Connector for the Shutdown Switch

- A. Turn the keyswitch to the OFF position.
- B. Fabricate a jumper wire that is long enough to short circuit two terminals at the harness connector for the shutdown switch. Crimp connector pins to each end of the jumper wire.
- C. Disconnect the harness connector for the shutdown switch.
- D. **Check the status of the shutdown switch while the circuit is shorted to the RUN position.**
 - a. Install the jumper wire between terminals B (digital return) and C (engine shutdown switch (N/C)) at the harness connector for the switch.
 - b. Turn the keyswitch to the ON position.
 - c. Observe the status of the shutdown switch using Cat ET.

Note: Wait at least 30 seconds for the status of the switch to change.

The correct status for the shutdown switch is "OFF".

- d. Turn the keyswitch to the OFF position.
- E. **Check the status of the shutdown switch while the circuit is shorted to the STOP position.**
 - a. Install the jumper wire between terminals A (engine shutdown switch (N/O)) and B (digital return) at the harness connector for the switch.
 - b. Turn the keyswitch to the ON position.
 - c. Observe the status of the shutdown switch using Cat ET.

Note: Wait at least 30 seconds for the status of the switch to change.

The correct status for the shutdown switch is "ON".

- F. Turn the keyswitch to the OFF position.

- G. Remove the jumper wire from the harness connector.

Expected Result:

The switch status on Cat ET agrees with the test results that are stated above.

Results:

- OK – The switch status on Cat ET agrees with the test results.

Repair: There is a problem with the shutdown switch. Replace the shutdown switch. Verify that the new shutdown switch solves the problem.

STOP.

- Not OK – The switch status on Cat ET does not agree with the test results that are stated above. The problem is in the harness between the ECM and the harness connector for the switch. There may be a problem with the ECM. Proceed to Test Step 4.

Test Step 4. Short the Terminals for the Shutdown Switch at the ECM

- A. Disconnect the J1/P1 ECM connectors.
- B. Fabricate three jumper wires that are long enough to short circuit the terminals at the P1 ECM connector. Crimp connector sockets to one end of each of the jumper wires.
- C. Remove the wires from terminal locations P1-5, P1-40, and P1-41 at the ECM connector. Install a jumper wire into each of these terminal locations.
- D. **Check the status of the shutdown switch while the circuit is shorted to the RUN position.**
 - a. Short circuit the ends of the jumper wires that are in terminal locations P1-5 and P1-41 at the ECM connector.

Note: Ensure that the jumper wire that is in terminal location P1-40 is not in contact with any ground source. The circuit for this terminal must be open.

- b. Turn the keyswitch to the ON position.
- c. Observe the status of the shutdown switch using Cat ET.

Note: Wait at least 30 seconds for the status of the switch to change.

The correct status for the shutdown switch is "OFF".

- d. Turn the keyswitch to the OFF position.

E. Check the status of the shutdown switch while the circuit is shorted to the STOP position.

- a. Short circuit the ends of the jumper wires that are in terminal locations P1-5 and P1-40 at the ECM connector.

Note: Ensure that the jumper wire that is in terminal location P1-41 is not in contact with any ground source. The circuit for this terminal must be open.

- b. Turn the keyswitch to the ON position.
- c. Observe the status of the shutdown switch using Cat ET.

Note: Wait at least 30 seconds for the status of the switch to change.

The correct status for the shutdown switch is "ON".

- F. Turn the keyswitch to the OFF position.

- G. Restore the wiring to the original configuration.

Expected Result:

The switch status on Cat ET agrees with the test results that are stated above.

Results:

- OK – The switch status on Cat ET agrees with the test results.

Repair: There is a problem in the harness between the ECM and the harness connector for the shutdown switch. There may be a problem with a connector. Repair the harness and/or the connector. Replace parts, if necessary. Verify that the repair resolves the original problem.

STOP.

- Not OK – The switch status on Cat ET does not agree with the test results that are stated above.

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

STOP.

Speed Control - Test

SMCS Code: 7332-038-VF

System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with the circuit that is for the throttle position sensor. Also use this procedure if one of the diagnostic codes in Table 46 is active or easily repeated.

Note: Some of the following codes may not be applicable for certain applications.

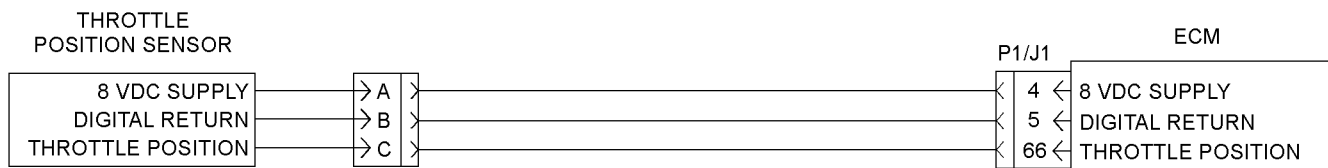
Table 46

Diagnostic Codes Table		
CDL Code	Code Description	Comments
91-3	Throttle Position Sensor : Voltage Above Normal	The Electronic Control Module (ECM) detects signal voltage that is not in the acceptable range. The code is logged. The ECM flags the throttle position as invalid data and a default value is used. The engine speed is limited to high idle.
91-4	Throttle Position Sensor : Voltage Below Normal	The ECM detects signal voltage that is not in the acceptable range. The code is logged. The ECM flags the throttle position as invalid data and a default value is used. The engine speed is limited to high idle.
91-8	Throttle Position Sensor abnormal frequency, pulse width, or period	The ECM detects an incorrect frequency on the throttle signal or an incorrect duty cycle on the throttle signal. The code is logged. The ECM flags the throttle position as invalid data and a default value is used. The engine speed is limited to high idle.

The throttle position sensor is mounted to a pedal assembly that allows the operator to control the speed of the engine. The geometry of the pedal assembly controls both the travel of the sensor and the range of the output signal. The throttle position sensor cannot be adjusted.

The output from the throttle position sensor is a PWM signal that varies with the position of the throttle pedal. The throttle position sensor produces a minimum duty cycle in the released position and a maximum duty cycle in the fully depressed position. When the pedal is released, the ECM translates the sensor output signal to a throttle position of 0 percent. When the pedal is fully depressed, the ECM translates the output signal to a throttle position of 100 percent.

ALL OF THE CONNECTORS ARE NOT SHOWN. REFER TO THE MACHINE'S ELECTRICAL SCHEMATIC FOR DETAILS



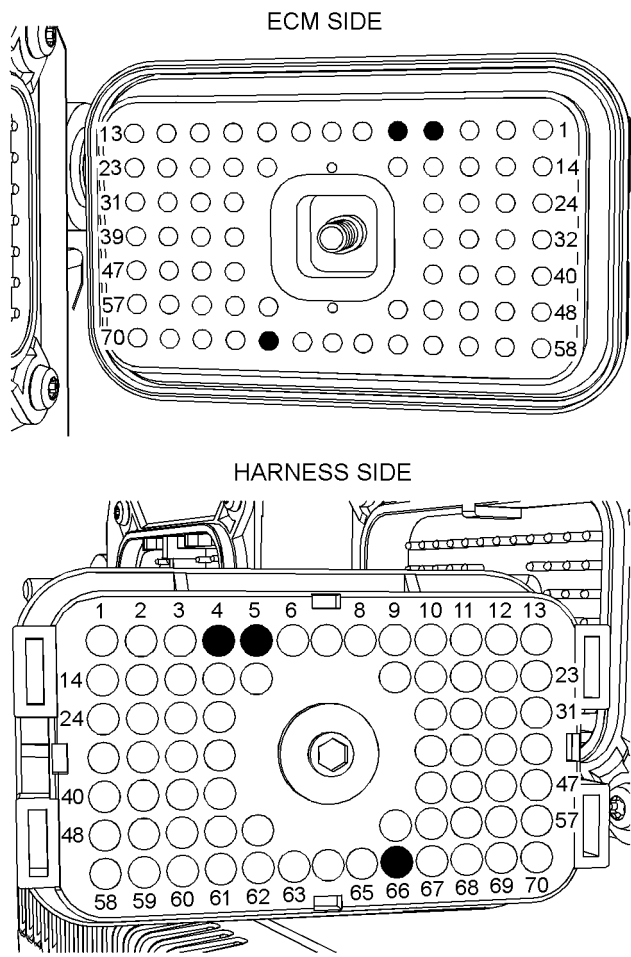


Illustration 70

g01214474

P1 ECM connector

(P1-4) 8 VDC supply

(P1-5) Digital return

(P1-66) Throttle position

Test Step 1. Check the Signal Frequency and the Duty Cycle at the Sensor

- A. Turn the keyswitch to the OFF position.
- B. Remove the wire from terminal location C (throttle position) on the harness side of the connector for the throttle position sensor.
- C. Install a 326-4904 Adapter Cable As (3-PIN BREAKOUT) at the connector for the throttle position sensor.
- D. Connect the connector for the throttle position sensor.
- E. Turn the keyswitch to the ON position.
- F. Measure the frequency and the duty cycle between terminal B (digital return) and terminal C (throttle position) at the 326-4904 Adapter Cable As (3-PIN BREAKOUT). Operate the throttle pedal while making the measurements.

G. Turn the keyswitch to the OFF position.

H. Remove the breakout harness. Restore the wiring for the harness connector to the original configuration.

Results:

- The frequency and the duty cycle are within specifications for the entire range of the pedal.

Repair: Repair the harness or replace the harness.

Verify that the problem is resolved.

STOP.

- The ECM detects an incorrect frequency on the throttle signal or an incorrect duty cycle on the throttle signal. The frequency is below 150 Hz or the frequency is above 1000 Hz. The duty cycle is less than 5 percent or the duty cycle is greater than 95 percent. – Proceed to Test Step 2.

Test Step 2. Check the Supply Voltage to the Sensor

A. Turn the keyswitch to the OFF position.

B. Disconnect the harness connector for the throttle position sensor.

C. Measure the voltage across terminal A (8 V supply) and terminal B (digital return) on the harness side of the connector.

Results:

- The supply voltage is above 7.5 VDC at the sensor connector.

Repair: The wiring is OK. Replace the sensor.

Verify that the problem is resolved.

STOP.

- The supply voltage is not above 7.5 VDC at the sensor connector.

Repair: The supply voltage is not reaching the speed control.

Repair the harness wiring or replace the harness.

Verify that the problem is resolved.

STOP.

Service

Customer Passwords

i03567615

SMCS Code: 0785; 1900

Customer passwords may be used to protect customer parameters from being changed. Caterpillar Electronic Technician (ET) can be used to change certain parameters. There are some parameters that cannot be changed and there are some applications that do not allow any changes to the programmable monitoring system. The passwords are programmed into the Electronic Control Module (ECM) with Cat ET. One password may be programmed or both passwords may be programmed. If customer passwords are not programmed, customer parameters may be changed by anyone.

To obtain customer passwords, contact the owner of the engine. If the owner has forgotten the customer passwords, factory passwords are used to create temporary customer passwords. Temporary customer passwords can be used to change the original customer passwords or any parameter that is protected by a customer password. When Cat ET is disconnected, you will be prompted to restore the original customer passwords. If the original passwords are not restored, the passwords will be changed to the temporary passwords.

i03592164

Factory Passwords

SMCS Code: 0785; 1900

Note: Factory passwords are only available to service technicians from an authorized Caterpillar Dealership. Customers of Caterpillar do not have access to the Caterpillar Factory Password System (FPS).

Factory passwords are necessary to authorize access to certain screens in Caterpillar Electronic Technician (ET). Factory passwords are also used to access specific configuration parameters in the Electronic Control Module (ECM). If changes are made that require factory passwords, the "Enter Factory Passwords" dialog box will automatically be displayed. A factory password must be obtained before the change can be made.

A hyperlink is available at the bottom of the dialog box that will simplify the entry of ECM information into the FPS. In order to use this hyperlink, the Personal Computer (PC) that is running Cat ET must be connected to the Internet. When the hyperlink is selected, the ECM information will automatically be transferred to the entry screen on the Caterpillar FPS.

If the PC that is running Cat ET is not connected to the Internet, you may save the ECM information to a file. This file can be opened when the PC is connected to the Internet and a hyperlink will be displayed. When you select the hyperlink, the ECM information will automatically be transferred to the entry screen that is on the Caterpillar FPS.

Factory passwords may be required to perform each of the following functions in Cat ET:

ECM Replacement – When an ECM is replaced, the system configuration parameters must be programmed into the new ECM. The new ECM will allow specific parameters to be programmed once without the use of factory passwords. There may be parameters that require factory passwords on the ECM that is being replaced. Factory passwords may be required in order to configure these parameters on the new ECM.

Rerate Engine Power – Changing the interlock code may be necessary. The interlock code is protected by factory passwords.

Software Enabled Attachments – Your application may have special features that can be enabled with Cat ET. This customized software is available to provide enhanced operation for your application. These features may also require the installation of additional hardware on the application. A cost may be associated with these software enabled attachments. Factory passwords are necessary to enable this software.

Customer passwords – Factory passwords are required in order to restore customer passwords and factory passwords are required in order to reset customer passwords.

Set Configuration parameters – Factory passwords are required in order to modify specific configuration parameters. Refer to Troubleshooting, "Configuration Parameters" for details that are related to the parameters for your application.

If factory passwords are needed in order to change a parameter, Cat ET will prompt you for the password when the change is attempted. Newer versions of Cat ET display an icon of a padlock that is used to indicate that a parameter requires a factory password for modification.

Clear engine events and certain diagnostic codes – Some engine events require factory passwords in order to clear the code from ECM memory. For example, factory passwords must be obtained in order to clear a code that is related to an engine overspeed condition. Clear these codes only when you are certain that the problem has been corrected.

i03592220

i04307470

ECM Will Not Accept Factory Passwords

SMCS Code: 0785; 1901

Probable Causes

- Incorrect information for the password request
- Incorrect passwords

Recommended Actions

Check the Information for the Password Request

The information for the password request must be obtained from the Engine Control Module (ECM) that is being programmed. Do not use information from an old ECM in order to program factory passwords on a replacement ECM.

Verify that the information used to request the password is identical to the information that is displayed on the Caterpillar Electronic Technician (ET).

Engine Serial Number – The engine serial number must be from the Cat ET screen rather than the engine information plate.

Reason Code – Use the reason code from the factory password screen. Reason codes are assigned for specific purposes and reason codes are not interchangeable.

Turn the key to the OFF position. Then, turn the keyswitch to the ON position. Try to enter the passwords again.

Incorrect Passwords

Verify that the correct passwords were entered. Check each character in each password.

If rechecking the passwords does not correct the problem, change a customer parameter. Change the parameter from the current value to another value and then change the customer parameter back to the original value. The sequence of events will change the total tattletale. The new total tattletale will require obtaining new factory passwords. Obtain new factory passwords and enter the passwords.

Electronic Service Tool Does Not Communicate

SMCS Code: 0785; 1900

System Operation Description:

Use this procedure to solve communication problems between the Caterpillar Electronic Technician (ET) and the engine control module (ECM). Cat ET must communicate with the ECM on the "Cat Data Link" and on the J1939 data link in order to service the engine.

Indicators on the communication adapter indicate that communication is occurring on a particular data link. The "J1939 / DeviceNet" indicator indicates that the communication adapter is communicating on the J1939 data link. The "J1708" indicator indicates that the communication adapter is communicating on the "Cat Data Link". Cat ET displays a message during the connection if Cat ET cannot communicate on both data links.

The following conditions can cause a communication problem:

- Incorrect communication adapter
- Use of a parallel cable between the communication adapter and the PC
- Incorrect version of Cat ET
- Incorrect firmware in the communication adapter
- Incorrect configuration of Cat ET
- A problem with electrical power to the communication adapter
- A problem with electrical power to the engine ECM
- A problem with the wiring for a data link
- A problem with the electrical cables between the PC and the vehicle

Test Step 1. Determine the Problem

Determine the communication problem.

Note: If an indicator other than the "POWER" indicator is illuminated when Cat ET is not communicating with an ECM, disconnect and reconnect the communication adapter.

Results:

- Both indicators on the communication adapter are not flashing. – Proceed to Test Step 2.

- Cat ET indicates that the engine is serviced on both links. – Proceed to Test Step 2.
- Cat ET displays a message that indicates the firmware in the communication adapter does not support communication on both data links. – Proceed to Test Step 3.
- Cat ET displays an Error“ #142 The interface hardware is not responding” message. – Proceed to Test Step 3.
- Cat ET displays a message that indicates that Cat ET cannot find an exact match for the software version in the ECM.

Repair: Update Cat ET to the latest available version.

STOP.

- The power indicator is not illuminated. – Proceed to Test Step 5.

Test Step 2. Verify that the Correct Communication Adapter is Being Used

A 317-7484 Communication Adapter Gp must be used to communicate. The following communication adapters cannot be used because the communication adapters do not communicate over both data links:

- Wireless communication adapter
- 7X-1701 Communication Adapter As

Determine the communication adapter that is being used.

Results:

- An incorrect communication adapter is being used.

Repair: Connect a correct communication adapter. Refer to Troubleshooting, “Electronic Service Tools”, if necessary.

Attempt to establish communication. Continue with this procedure if the communication adapter does not communicate on both data links.

- A correct communication adapter is being used. However, the “Power” indicator is not illuminated. – Proceed to Test Step 5.
- A correct communication adapter is being used. The “Power” indicator is illuminated. – Proceed to Test Step 4.

Test Step 3. Check the Version of the Firmware for the Communication Adapter

Note: The version of the firmware for the communication adapter must be “3.0.0” or higher.

- Electronically disconnect Cat ET. Verify that the “power” indicator on the communication adapter is illuminated.
- Click on the “Utilities” menu.
- Click on the “Comm Adapter II Toolkit” menu.
- Wait for the tool kit to open. Then, click the “Utilities” menu.
- Click “Application Firmware Flash”.
- Select the latest “.apf” file from the list.
- Click “OK”. Then, click “Begin Flash”.
- Wait for the “Flashes Completed Successfully” message to appear.
- Click “Toolkit”. Verify that the “Application Firmware Version (Serial IP)” is “3.0.0” or higher.
- Attempt to connect Cat ET.

Results:

- Yes – Cat ET communicates on both data links. STOP.
- No – Cat ET does not communicate on both data links. Proceed to Test Step 4.

Test Step 4. Verify That Cat ET is Configured Correctly

Cat ET must be configured correctly in order to communicate on both data links. Perform the following procedure:

- Click on the “Utilities” menu.
- Click on the “Preferences” menu.
- Select the “Communications” tab.
- Verify that “Caterpillar Communication Adapter II (Serial IP)” is selected.

If “Caterpillar Communication Adapter II (Serial IP)” is not an option for selection, the version of Cat ET is incorrect. Version “2007B” or higher must be used.

Update the version of Cat ET. Then, perform this Test Step again.

- E. Verify that the port is correct.
- F. Verify that the "Enable Dual Data Link Service" option is checked.
- G. Click "OK".

Note: Cat ET must reconnect in order for any changes to be used.

- H. Electronically disconnect Cat ET if changes are made to any of the settings for communications. Electronically connect Cat ET. Attempt to establish communication. Observe the indicators on the communication adapter.

A "limited support" warning should not be displayed. The "J1939 / DeviceNet" and "CDL" indicators should be flashing. The indicator indicates that Cat ET is communicating on both data links.

Results:

- Yes – Cat ET communicates on both data links. STOP.
- No – Cat ET does not communicate on both data links. The "POWER" indicator is not illuminated. Proceed to Test Step 5.
- No – Cat ET does not communicate on both data links. The "POWER" indicator is illuminated. Proceed to Test Step 6.

Test Step 5. Check the Electrical Power to the Communication Adapter

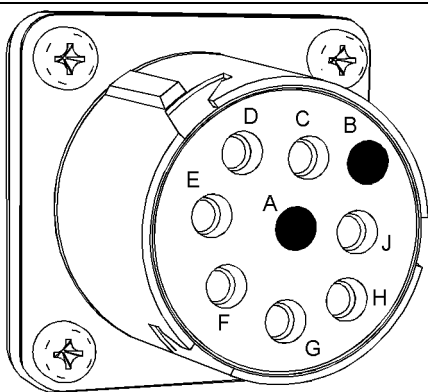


Illustration 71

g02061279

Power terminals at the service tool connector

(Terminal A) +Battery
(Terminal B) -Battery

- A. Check for battery voltage at the service tool connector.

Results:

- Battery voltage is not present at the service tool connector.

Repair: Inspect the vehicles wiring and fuses. Determine the cause of the missing voltage. Make the necessary repairs.

Attempt to establish communication after the electrical power is at the service tool connector. Proceed to Test Step 6 if the service tool does not communicate on both data links.

- Battery voltage is present at the service tool connector.

Repair: Verify that the cable between the service tool connector and the communication adapter is OK. Replace the cable, if necessary.

Replace the communication adapter if the following conditions are true:

- There is power at the cables "DATA LINK" connector.
- The communication adapters "POWER" indicator is not illuminated.

STOP.

Test Step 6. Check the Electrical Power to the ECM

- A. Verify that the keyswitch is ON.

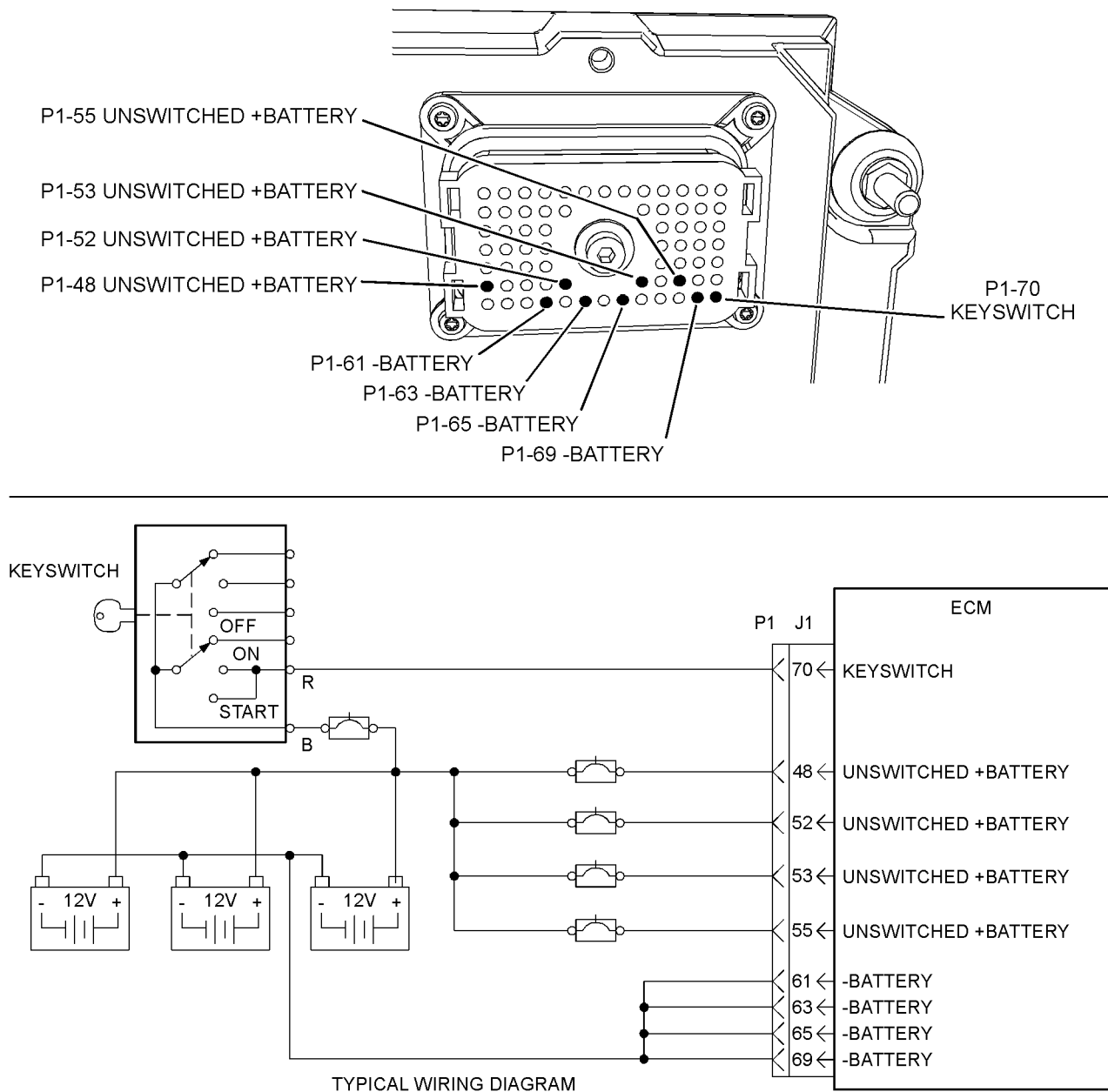


Illustration 72

g02061196

General information about the electrical power to the ECM

B. Refer to Illustration 72. Verify that battery voltage is present at the terminals that are indicated in the Illustration. Be sure to connect the voltmeter between the “UNSWITCHED +BATTERY” terminals and the “-BATTERY” terminals.

C. Verify that battery voltage is present at P1-70.

Results:

- Yes – Battery voltage is missing from a P1 terminal.

Repair: Inspect the vehicles wiring and fuses. Determine the cause of the missing voltage. Make the necessary repairs.

Attempt to establish communication after the electrical power is at all of the appropriate P1 terminals. Continue with this procedure, if necessary.

STOP.

- No – Battery voltage is present at all of the appropriate P1 terminals. Proceed to the Test Step 7.

Test Step 7. Try to Establish Communication With a Bypass Harness

A. Connect the communication adapter to the engine ECM with a 217-0113 Wiring Harness (ECM BYPASS) and a 328-2292 Harness (ELECTRONIC CONTROL MODULE). The harnesses support communication on both data links.

B. Attempt to establish communication.

Results:

- Yes – Cat ET communicates on both data links when the bypass harness is used. There is a problem with the wiring.

Repair: Repair the data link. Refer to Troubleshooting, “Data Link - Test”.

STOP.

i04315278

Test ECM Mode

SMCS Code: 1900

“Test ECM Mode” is a feature in the software that can be used to help troubleshoot an engine that may have a fault in the Electronic Control Module (ECM). This feature allows a standard ECM to be used as a test ECM. This feature eliminates the need to stock a test ECM.

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 eliminate the fault, continue with this procedure.

2. Use the “Copy Configuration” feature on the electronic service tool to copy the parameters from the suspect ECM.

Note: If the “ECM Replacement” feature cannot be used, record the programmed values into the “Parameters Worksheet”. Also record the system configuration parameters.

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

4. Flash program the test ECM with the newest software that is available.

5. Start the “Test ECM Mode” on the electronic service tool. Access the feature through the “Service” menu. The electronic service tool will display the status of the test ECM and the hours that are remaining for the “Test ECM Mode”.

Note: “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 ECM is not in “Test ECM Mode”, the ECM can never be used as a test ECM.

6. Use the “Copy Configuration” feature on the electronic service tool to program the test ECM.

Note: If the “ECM Replacement” feature cannot be used, program the test ECM with the values from the “Parameters Worksheet” and the values from the Configuration Parameters.

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

Note: The “Test ECM Mode” must be activated before the engine serial number is programmed into the ECM.

8. Verify that the test ECM eliminates the fault.

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 and the keyswitch is in the ON position. After the ECM has counted down the 24 hour period, the ECM will exit the “Test ECM Mode”. The parameters and the engine serial number will be set.

If the test ECM eliminates the fault, the engine can be released while the “Test ECM Mode” is still active.

Once an ECM has been activated in the “Test ECM Mode”, the ECM will stay in the “Test ECM Mode” until the timer times out. Anytime prior to the “Test ECM Mode” timing out, the “Test ECM Mode” can be reset to 24 hours.

If the ECM is used as a test ECM for more than one engine, reactivate the “Test ECM Mode” in order to reset the parameters to default values. Then use the “Copy Configuration” feature to program the parameters into the test ECM or manually program the parameters to the correct values.

i04465113

Injector Trim File - Install

SMCS Code: 1290-591; 7620-012

The Caterpillar Electronic Technician (ET) is used to load injector trim files into the Engine Control Module (ECM). Injector trim files are available from these sources:

- A CD-ROM that is packaged with each new injector and each remanufactured injector
- SIS Web

Replacing an Injector

An injector trim file must be loaded into the ECM if an injector is replaced.

Replacing the ECM

The "Copy Configuration" utility on Cat ET copies the injector trim files between two engine control modules. If the "Copy Configuration" fails, load all of the injector trim files manually into the new ECM.

"Injector Trim" is displayed below a 268-2 or 630-2 Programmed Parameter Fault : Erratic, Intermittent, or Incorrect. The diagnostic code is displayed on Cat ET.

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 have been exchanged and press the "OK" button. The tattletale for the injectors that were exchanged will increase by one.

1. Perform the following procedure to download an injector trim file from SIS Web. Otherwise, use the injector trim file from the CD-ROM that is packaged with the injector.

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

- a. Record the injector serial number and the injector confirmation code for each injector.
- b. Click on Service Software Files in SIS Web. Then select "Injector Trim Files".
- c. Enter the serial number for the injector in the search field.

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

2. Establish communication between Cat ET and the engine ECM. Refer to Troubleshooting, "Electronic Service Tools", if necessary.
3. Select the following menu options on Cat ET:
 - Service
 - Calibrations
 - Injector Trim Calibration
4. Select the appropriate cylinder.
5. Click on the "Change" button.
6. Select the appropriate injector trim file from the PC or the CD-ROM.
7. Click on the "Open" button.
8. Enter the injector confirmation code.
9. Click on the "OK" button.

The injector trim file is loaded into the ECM.
10. Repeat the procedure for each cylinder, as required.

i04465089

ECM Software - Install

SMCS Code: 1901-591; 7620-012

Use this procedure to troubleshoot the electrical system if the diagnostic code in Table 47 is active.

Table 47

Diagnostic Trouble Codes			
CDL Code	J1939 Code	Code Description (code descriptions may vary)	Comments
253-2	631-2	Personality Module : Erratic, Intermittent, or Incorrect	The flash file is for a different engine family or for a different engine application. The engine will not start. Clearing this diagnostic code requires factory passwords. The personality module code must be reset to zero.

Flash programming is a method of programming or updating the flash file in the engine Electronic Control Module (ECM). Caterpillar Electronic Technician (ET) is used to flash program a file into the memory of the engine ECM.

Note: Customer versions of CAT ET do not have the capability for flash programming. Consult your local Cat Dealer for assistance.

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 ECM.
2. Select “WinFlash” from the “Utilities” menu on Cat ET.

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

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.

Note: Record all error messages. The recorded error messages will be necessary if further assistance is needed.

i04285845

ECM - Replace

SMCS Code: 1901-510

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

A test ECM can be used to determine if the ECM is faulty. Refer to 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. Record the configuration data:
 - a. Try to establish communication between the Caterpillar Electronic Technician (ET) and the ECM. Proceed to Test Step 2 if Cat ET does not communicate with the ECM.

- b. Print the parameters from the "Configuration" screen on Cat ET. If a printer is unavailable, record all of the parameters.
- c. Obtain the customer passwords from the vehicle owner. Access the customer specified parameters with Cat ET. Record the value of each customer parameter.
 - Record ECM lifetime totals. _____
 - Record any logged diagnostic codes. _____

Note: If the customer passwords are not available proceed to Troubleshooting, "Customer Passwords" for details that are related to customer passwords.

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

Note: If the "Copy Configuration" process fails and the parameters are not obtained in Step 1.b, the parameters must be obtained elsewhere. Some of the system configuration parameters are stamped on the engine information plate. Most of the parameters must be obtained from the factory. Parameters that are related to customer specified parameters must be obtained from the customer or from the Original Equipment Manufacturer (OEM).

2. Remove the ECM:

- a. Turn the keyswitch OFF.
- b. Disconnect the P1 and P2 connectors.
- c. Disconnect the ECM ground strap.
- d. Remove the mounting hardware at each corner of the ECM.

3. Install the replacement ECM:

- a. Use the old mounting hardware to install the replacement ECM.
- b. Connect the ECM ground strap.
- c. Connect the P1 and P2 connectors. Refer to Troubleshooting, "Electrical Connectors - Inspect" for the correct torque values.

4. Configure the replacement ECM:

- a. Flash program the latest available flash file into the ECM. Refer to Troubleshooting, "ECM Software - Install" for the correct procedure.

- b. Use Cat ET to match the engine application and the interlock code if the replacement ECM was used for a different application.
- c. If the "Copy Configuration" process from Step 1.b was successful, return to the "Copy Configuration/ECM Replacement" screen on Cat ET and select "Program ECM". Proceed to Step 4.e when programming is complete.
- d. If the "Copy Configuration" process from Step 1.b was unsuccessful, manually program the ECM parameters. The parameters must match the parameters from Step 1.b.
- e. Program the engine monitoring system, if necessary.
- f. Calibrate the engine speed/timing if there is a diagnostic code for speed/timing sensor calibration. The procedure is in Troubleshooting, "Timing - Calibrate".

Note: If an engine is a Series C7 . 1 or Series C9 . 3, use Cat ET to perform the "fuel system functional test". This test established a baseline value of the fuel system rate of fuel return at high rail pressure. Other diagnostic codes may be activated if this test is not performed.

i04008890

Electrical Connectors - Inspect

SMCS Code: 7553-040-WW

Most electrical faults are caused by poor connections. The following procedure will assist in detecting faults with connectors and with wiring. If a fault is found, correct the condition and verify that the fault is resolved.

Intermittent electrical faults are sometimes resolved by disconnecting and reconnecting connectors. Check for diagnostic codes immediately before you disconnect a connector. Also check for diagnostic codes after you reconnect 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 in order 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.
- Determine if the problem is intermittent. If the problem is intermittent, attempt to test the circuit before you disconnect any electrical connectors. The test will help identify the root cause of intermittent problems. The "Wiggle Test" on Caterpillar Electronic Technician (ET) may be able to test the circuit. Refer to the documentation that accompanies Cat ET. Perform the wiggle test on the circuit, when possible. Otherwise, continue with this procedure.

Check Connectors for Moisture and Corrosion

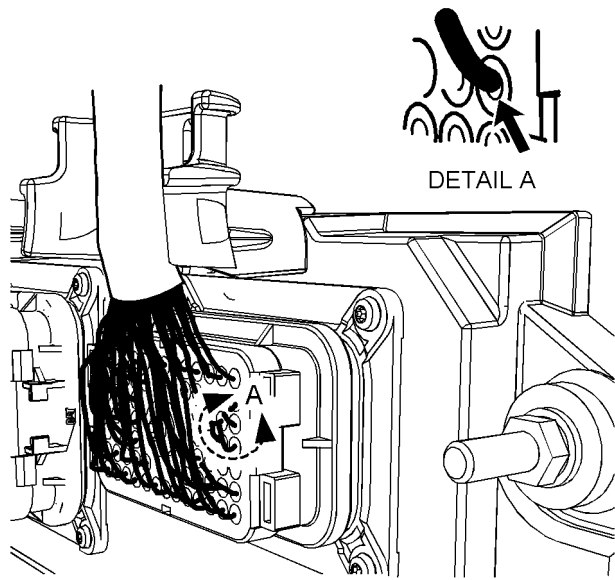


Illustration 73

g01131211

Detail A illustrates the **incorrect** angle of wire entry into the connector. The wire should enter the connector at a perpendicular angle. (typical example)

Inspect all the 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. The damaged seal will create a path for the entrance of moisture. Verify that the seals for the wires are sealing correctly.

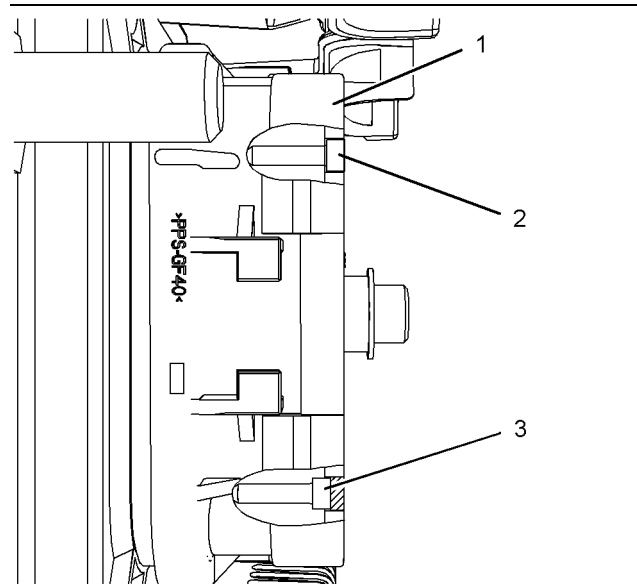


Illustration 74

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

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.

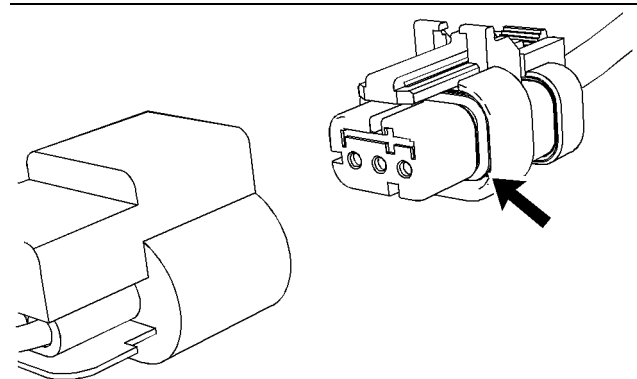


Illustration 75

g01131019

Seal for a three-pin connector (typical example)

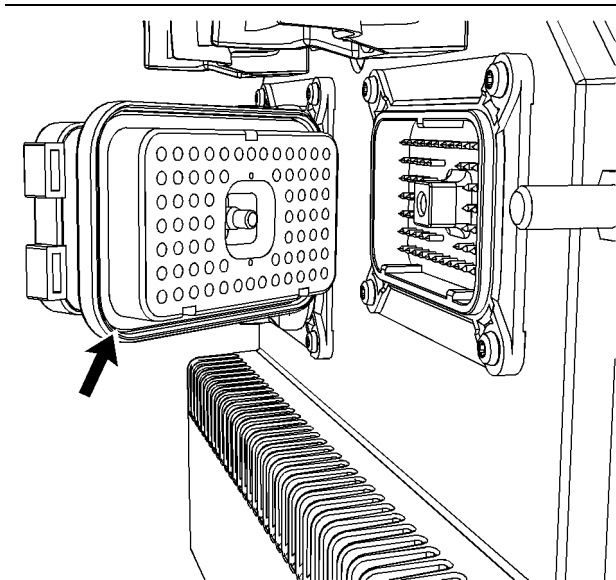


Illustration 76 g01131165

Seal for the ECM connector (typical example)

Disconnect the suspect connector and inspect the connector seal. Ensure that the seal is in good condition. If necessary, replace the connector.

Thoroughly inspect the connectors for evidence of moisture entry.

Note: Some minor seal abrasion on connector seals is normal. 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. The source of the moisture entry must be repaired. If the source of the moisture entry is not repaired, the fault will recur. Simply drying the connector will not fix the fault. Check the following items for the possible moisture entry path:

- Missing seals
- Incorrectly 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 harness for damage. Also check other connectors that share the harness for moisture.

Check the Wires for Damage to the Insulation

Carefully inspect each wire for signs of abrasion, nicks, and 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

Check all of the fasteners for the harness and the ECM in order to verify that the harness is correctly 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.

Inspect the Connector Terminals

Visually inspect each terminal in the connector. Verify that the terminals are not damaged. Verify that the terminals are correctly aligned in the connector and verify that the terminals are correctly located in the connector.

Perform a Pull Test on Each Wire Terminal Connection

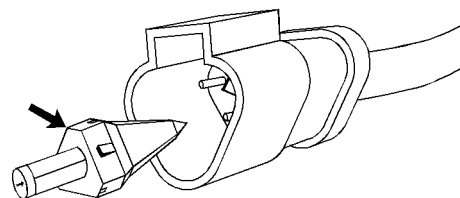


Illustration 77 g01131435

Receptacle lock wedge (typical example)

Ensure that the locking wedge for the connector is installed correctly. Terminals cannot be retained inside the connector if the locking wedge is not installed correctly.

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 correctly crimped in the terminal and whether the terminal was correctly inserted into the connector.

Check Individual Pin Retention into the Socket

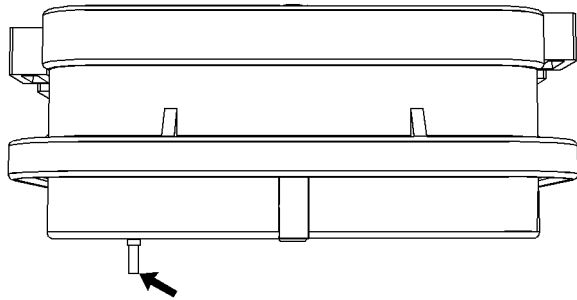


Illustration 78

g01131604

Diagram for testing pin retention (typical example)

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.

Check the Locking Mechanism of the Connectors

Ensure that the connectors lock correctly. After you lock the connectors, ensure that the two halves cannot be pulled apart.

Verify that the latch tab of the connector is correctly latched. Also verify that the latch tab of the connector returns to the locked position.

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.

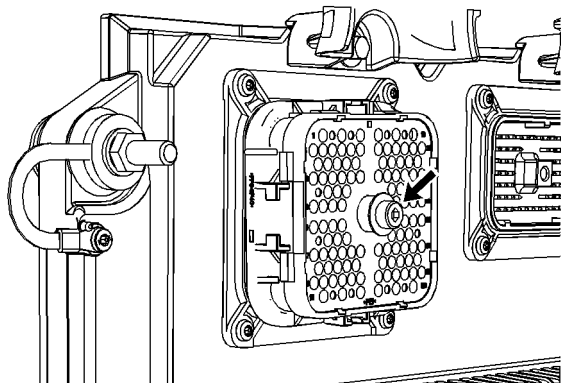


Illustration 79

g01132827

Allen head screw for the 120 pin ECM connector (typical example)

Torque the allen head bolt for the 120 pin ECM connector to $7.0 \pm 0.5 \text{ N}\cdot\text{m}$ ($60 \pm 4 \text{ lb in}$).

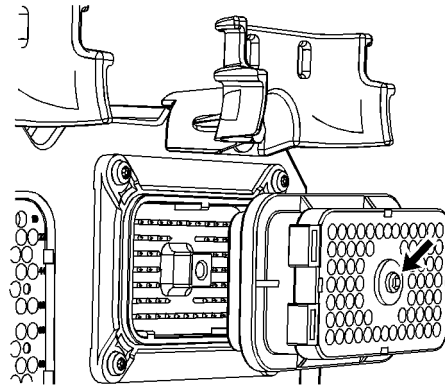


Illustration 80

g01132849

Allen head screw for the 70 pin ECM connector (typical example)

Torque the allen head screw for the 70 pin ECM connector to $6.0 + 1.5 - 1.0 \text{ N}\cdot\text{m}$ ($55 + 13 - 9 \text{ lb in}$).

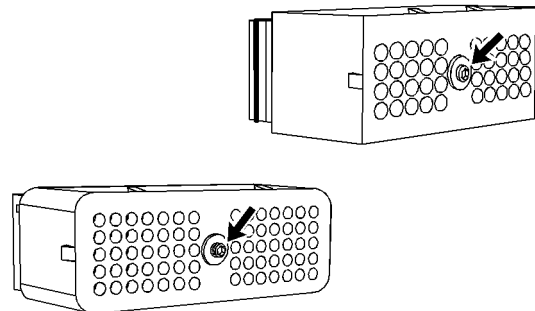


Illustration 81

g01133047

Allen head screw for the 40 pin customer connector and the 70 pin customer connector (typical example)

Torque the allen head screw for the 40 pin customer connector and the 70 pin customer connector to $2.25 \pm 0.25 \text{ N}\cdot\text{m}$ ($20 \pm 2 \text{ lb in}$).

Perform the Wiggle Test on the Caterpillar Electronic Technician (ET)

Select the "Wiggle Test" from the diagnostic tests on Cat ET.

Choose the appropriate group of parameters to monitor.

Press the "Start" button. Wiggle the wiring harness in order to reproduce intermittent faults.

If an intermittent fault exists, the status will be highlighted and an audible beep will be heard.

i04465049

Cooling Fan - Calibrate

SMCS Code: 1356-524

Use this procedure if the diagnostic code in Table 48 is active.

Table 48

Diagnostic Trouble Codes			
CDL Code	J1939 Code	Code Description (code descriptions may vary)	Comments
1551-13		Engine Demand Fan System : Calibration Required	The code is logged.

The Electronic Control Module (ECM) supplies current to the engine fan control solenoid. The engine fan control solenoid controls the pressure to the fan pump by allowing oil to bypass the fan pump. The fan pump drives the fan. For accuracy, the ECM must determine the relationship between the current to the engine fan control solenoid and the actual fan speed. Caterpillar Electronic Technician (ET) enables the user to calibrate the current to a known fan speed manually.

i04000530

Timing - Calibrate

SMCS Code: 1000-524; 1900-524; 1912-524

Use this procedure if the diagnostic code in Table 49 is active.

Note: The ECM will use a nominal current to drive the engine fan control solenoid on the initial calibration. The ECM uses the last calibrated value as the starting point on subsequent calibrations.

1. Select the "Service" tab and select "Calibrations". Start the "Fan Calibration".
2. Meet the required conditions in order to proceed with the calibration. Follow the directions that are provided on Cat ET. Proceed by pressing the "Next" button.
3. Measure actual fan speed with the following service tools and Software License, NETG5044:
 - 348-5430 Multi-Tool Gp
 - 308-7264 Multitach Tool Gp ()
 - a. If actual fan speed matches the fan speed on Cat ET, press the "Next" button.
 - b. Actual fan speed may not match the fan speed on Cat ET. The current must then be decremented or incremented in order to change fan speed.
4. When actual fan speed matches the fan speed on Cat ET, the calibration is complete. Follow the directions that are provided on Cat ET.

Table 49

Diagnostic Codes for the Timing Calibration		
CDL Code	Code Description	Comments
261-13	Engine Timing Calibration : Calibration Required	A timing calibration is required for a new engine, replacing an Electronic Control Module (ECM) that fails to communicate or following work on the front gear train, the camshaft, or the crankshaft.

If a 261-11 diagnostic code is active, verify that the wiring is installed correctly to the engine speed/timing sensors.

The ECM can calibrate the mechanical differences between the Top Center (TC) of the flywheel and the TC of the timing gear on the camshaft. A transducer signals the TC of the flywheel to the ECM when a notch on a counterweight passes by the transducer. The engine speed/timing sensor signals the TC of the timing gear to the ECM. Any offset between the TC of the flywheel and the TC of the timing gear is stored into the memory of the ECM.

Note: A timing calibration will not increase the available engine power.

Table 50 lists the special tools that are required in order to perform this procedure.

Table 50

Required Special Tools	
Part Number	Description
7X-1171	Transducer Adapter
6V-2197	Transducer
7X-1695	Cable as
170-3519	Harness ⁽¹⁾

⁽¹⁾ This item is not required if the engine harness has a connector for timing calibration.

1. Install the Transducer Adapter.

- a. Remove the electrical power from the ECM.
- b. Use the appropriate engine turning tool to put either the No. 1 piston or the No. 6 piston at the top center. Refer to the Systems Operation/Testing and Adjusting.
- c. Refer to Table 51. After the top center position has been located, rotate the crankshaft for the number of degrees that is applicable to your engine model. Be sure to rotate the crankshaft in the direction of rotation that is specified in the Table.

Table 51

Crankshaft Rotation		
Engine Model	Number of Degrees	Direction of Rotation
C7	100	Normal Rotation
C-9	85	Normal Rotation
C9	85	Normal Rotation
C9.3	85	Normal Rotation
C-10	60	Opposite Normal Rotation
C11	75	Normal Rotation
C-12	60	Opposite Normal Rotation
C13	75	Normal Rotation
C-15	60	Opposite Normal Rotation
C15	60	Opposite Normal Rotation
C-16	60	Opposite Normal Rotation
C18	30	Opposite Normal Rotation

- d. Refer to Table 52. Locate the engines timing calibration port.

Table 52

Location of the Timing Calibration Port		
Engine Model	Crankshaft Counterweight	Engine Location
C7	3	Left Side
C-9	3	Left Side
C9	3	Left Side
C9.3	3	Left Side
C-10	8	Right Side
C11	8	Left Side
C-12	8	Right Side
C13	8	Left Side
C-15	2	Left Side
C15	2	Left Side
C-16	2	Left Side
C18	2	Left Side

- e. Remove the plug from the timing calibration port.
- f. Thread the transducer adapter into the port.

Continue to the next test step.

2. Install the Transducer.

NOTICE

If the crankshaft is not in the correct position when the transducer is installed, the transducer will be damaged when the engine is started.

- a. Apply clean engine oil to a 2D-6392 O-Ring Seal. Install the O-ring seal on the end of the 6V-2197 Transducer.
- b. Push the transducer through the transducer adapter until the transducer contacts the crankshaft counterweight.
- c. Withdraw the transducer 1.0 mm (0.04 inch) and hand tighten the nut on the adapter sleeve in order to secure the transducer. Move the O-ring seal against the adapter.

Continue to the next test step.

3. Connect the 7X-1695 Cable as.

- a. If the engine harness is equipped with a connector for timing calibration, connect the 7X-1695 Cable as to the connector for timing calibration and to the transducer.
- b. If the engine harness is not equipped with a connector for timing calibration, perform the following procedure:

Disconnect the P2 connector from the ECM.

Determine the number of terminals on the P2 connector.

Refer to Table 53. Remove the sealing plugs from the appropriate terminals. Do not discard the sealing plugs. The sealing plugs may be reinstalled when the timing calibration is complete.

Table 53

P2 Locations for Connection of the 7X-1695 Cable as		
Wire Color	70 pin Connector	120 pin Connector
White	22	26
Yellow	23	36

Install the white wire of the 170-3519 Harness into the appropriate location.

Install the yellow wire of the 170-3519 Harness into the appropriate location. Disregard the pin-outs on the label of the harness.

Note: Ensure that each wire is installed into the correct location. The timing calibration will not be successful if the wires are installed incorrectly.

Connect the J2/P2 connectors. Tighten the allen head screw on the P2 connector to the appropriate torque. Refer to Troubleshooting, "Electrical Connectors - Inspect" for the correct torque value.

Connect the 7X-1695 Cable as to the connector for timing calibration and to the transducer.

Continue to the next test step.

4. Start the Engine and Check for Diagnostic Codes.

- a. Connect Caterpillar Electronic Technician (ET) to the service tool connector. Refer to Troubleshooting, "Electronic Service Tools".
- b. Start the engine and run the engine until the engine is at the normal operating temperature.
- c. Check for active diagnostic codes. Wait at least 30 seconds in order for the codes to become active.

The engine must not have any active diagnostic codes during the timing calibration except for a 261-13 Engine Timing Calibration required.

5. Calibrate the Timing.

- a. After the engine has warmed up, access the "Timing Calibration" screen on the Cat ET. Access the following display screens in order:
 - Service
 - Calibrations
 - Timing Calibration
- b. Set the engine speed to 1100 ± 50 rpm. The engine speed must be steady within this rpm range in order for the calibration to be successful.
- c. To calibrate the timing, select "Continue" on Cat ET. Wait until Cat ET indicates that the timing is calibrated.

Perform the following procedure if Cat ET indicates that the timing is calibrated:

Set the engine speed to low idle.

Note: Disconnect the 7X-1695 Cable as before you exit the "Timing Calibration" screen. Otherwise, diagnostic codes may be activated.

Disconnect the 7X-1695 Cable as.

Exit the "Timing Calibration" screen on Cat ET.

Remove the electrical power from the ECM.

Remove the transducer and remove the transducer adapter.

Install the plug into the timing calibration port.

If you installed a 170-3519 Harness, you may remove the harness or you may permanently install the harness for future use. If you remove the harness, install the sealing plugs into the unused cavities of the P2 connector. Otherwise, moisture and debris will enter the connector.

If you permanently install the harness, fasten the harness to the existing engine wiring harness with cable ties. Also, install a 3E-3364 Receptacle and two 8T-8737 Seal Plugs on the P400 timing calibration probe connector in order to prevent moisture and debris from entering the connector.

The following conditions can cause the timing calibration to fail:

- The crankshaft and camshaft gears have been reassembled incorrectly.
- The timing calibration probe is not installed correctly.
- The engine speed is not correct and the engine speed is unstable. If the engine speed is unstable, refer to Troubleshooting, "Engine Misfires, Runs Rough, or Is Unstable".
- There is a problem with the transducer or with the cables. Obtain a new transducer and/or a new cable and repeat the timing calibration.
- There is an active 190-8 code or an active 342-8 code. Troubleshoot the active codes before calibration.

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