



Troubleshooting

Preliminary Information

C175-16 and C175-20 Engines for Caterpillar Built Machines

LAJ1-Up (Machine)
SSP1-Up (Machine)
B7B1-Up (Engine)
LLM1-Up (Engine)

For use with 793F and 797F Off-Highway Truck/Tractors

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.

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

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

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



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

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

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Troubleshooting Section

Introduction

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General Information

SMCS Code: 1000

As a reference, simplified schematics for each of the engine's 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's electronic control module, to sensors, and to associated components. Remove the component that requires welding. When welding on a engine that is equipped with an Electronic Control Module (ECM) and removal of the component is not possible, the following procedure must be followed. This procedure provides the minimum amount of risk to the electronic components.

NOTICE

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

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

1. Stop the engine. Remove the electrical power from the ECM.
2. Disconnect the negative battery cable from the battery. If a battery disconnect switch is installed, open the switch.

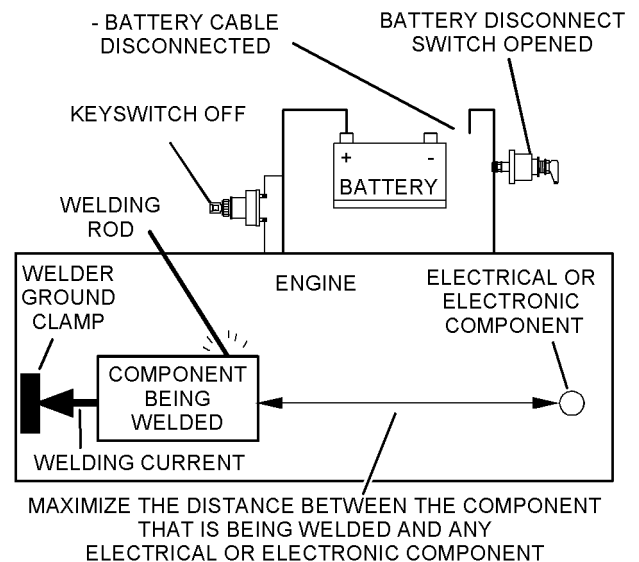


Illustration 1

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Service welding guide (typical diagram)

3. Connect the welding ground cable as close as possible to the area that will be welded. Components which may be damaged by welding include bearings, hydraulic components, and electrical/electronic components.
4. Protect the wiring harness from welding debris and from spatter.
5. Weld the materials by using standard welding methods.

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Electronic Service Tools

SMCS Code: 0785

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

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

Required Service Tools

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

Table 1

Required Service Tools	
Part Number	Description
N/A	4 mm Allen Wrench
6V-2197	Magnetic Transducer As
7X-1171	Transducer Adapter
7X-1695	Cable As
146-4080	Digital Multimeter Gp (RS232)
7X-1710	Multimeter Probes
7X-6370	Adapter Cable As (3-PIN BREAKOUT)
208-0059	Adapter Cable As (70-PIN BREAKOUT)
257-8718	Adapter Cable As (120-PIN BREAKOUT)
167-9225	Harness (SERVICE TOOL ADAPTER)
1U-5804	Crimp Tool (12-AWG TO 18-AWG)
175-3700	Connector Repair Kit (DEUTSCH DT)

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

Optional Service Tools

Table 2 lists the optional service tools that may be needed during testing or repair.

Table 2

Optional Service Tools	
Part Number	Description
198-4240 or 1U-5470	Digital Pressure Indicator Engine Pressure Group
4C-4075	Crimp Tool (4-AWG TO 10-AWG)
4C-4911 ⁽¹⁾	Battery Load Tester
5P-7277	Voltage Tester
6V-9130 ⁽²⁾	Temperature Adapter (MULTIMETER)
8T-5319	Connector Tool Group
155-5176	AC/DC Current Probe
285-0910	Multi-Tool Gp

⁽¹⁾ Refer to Special Instructions, SEHS9249, "Use of 4C-4911 Battery Load Tester for 6, 8, and 12 Volt Lead Acid Batteries" and Special Instructions, SEHS7633, "Battery Test Procedure".

⁽²⁾ Refer to Special Instructions, SEHS8382, "Use of the 6V-9130 Temperature Adapter Group".

Caterpillar Electronic Technician (ET)

Cat ET can display the following information:

- Parameters
- Event codes
- Diagnostic codes
- Engine configuration

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

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

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

Table 3

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

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

Connecting the Communication Adapter

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

Table 4

Standard Hardware for the Use of Cat ET	
Part Number	Description
N/A	Personal Computer (PC)
275-5120	Communication Adapter Gp (CAT ET TO ECM INTERFACE)
237-7547 ⁽³⁾	Adapter Cable As

⁽³⁾ The 237-7547 Adapter Cable As is required to connect to the Universal Serial Bus (USB) on computers that are not equipped with a RS232 serial port.

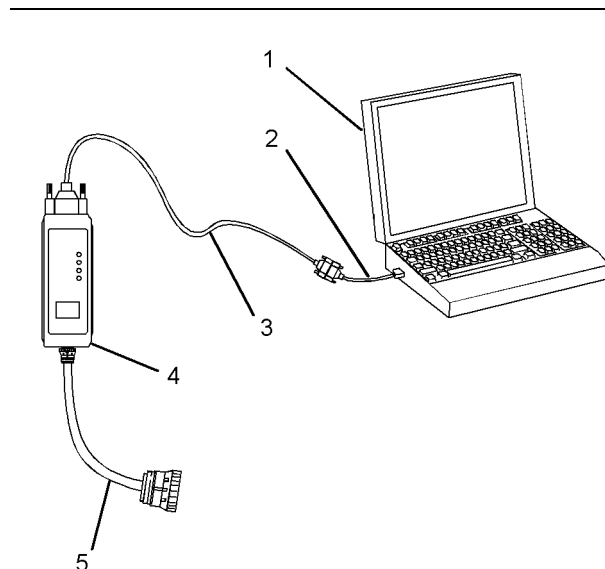


Illustration 2

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Connecting the Communication Adapter II

- (1) Personal Computer (PC)
- (2) 237-7547 Adapter Cable As
- (3) 196-0055 Adapter Cable As
- (4) 275-5121 Communication Adapter As
- (5) 207-6845 Adapter Cable As

Note: Items (3), (4), and (5) are part of the 275-5120 Communication Adapter Gp.

Use the following procedure in order to connect Cat ET and the communication adapter.

1. Remove the electrical power from the ECM.
2. Connect communication adapter (4) to a communications port on the PC by using one of the following methods:
 - a. Connect adapter cable (3) between the "COMPUTER" end of communication adapter (4) and the RS232 serial port of PC (1).
 - b. Connect adapter cables (2) and (3) between the "COMPUTER" end of communication adapter (4) and the USB port of PC (1).
3. Connect adapter cable (5) to communication adapter (4).
4. Connect adapter cable (5) to a service tool connector.
5. Restore electrical power to the ECM. Attempt to connect Cat ET to the ECM on the application.

If Cat ET indicates that there is more than one ECM on the vehicle, select the engine ECM.

Observe the communication adapter and Cat ET. If the "J1939 / DeviceNet" and the "Cat Data Link" indicators are flashing and Cat ET does not display a message that indicates "Service tool support is limited", Cat ET is communicating with the ECM on both data links.

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

- The "J1939 / DeviceNet" indicator and the "Cat Data Link" indicator are not flashing. Both indicators must be flashing.
- Cat ET displays a message that refers to a communication problem.
- Cat ET displays a "Error #142 The interface hardware is not responding" message.
- Cat ET displays a message that indicates that the firmware in the communications adapter is old.

Electronic System Overview

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Component Location

SMCS Code: 1000; 1900

Block Diagram

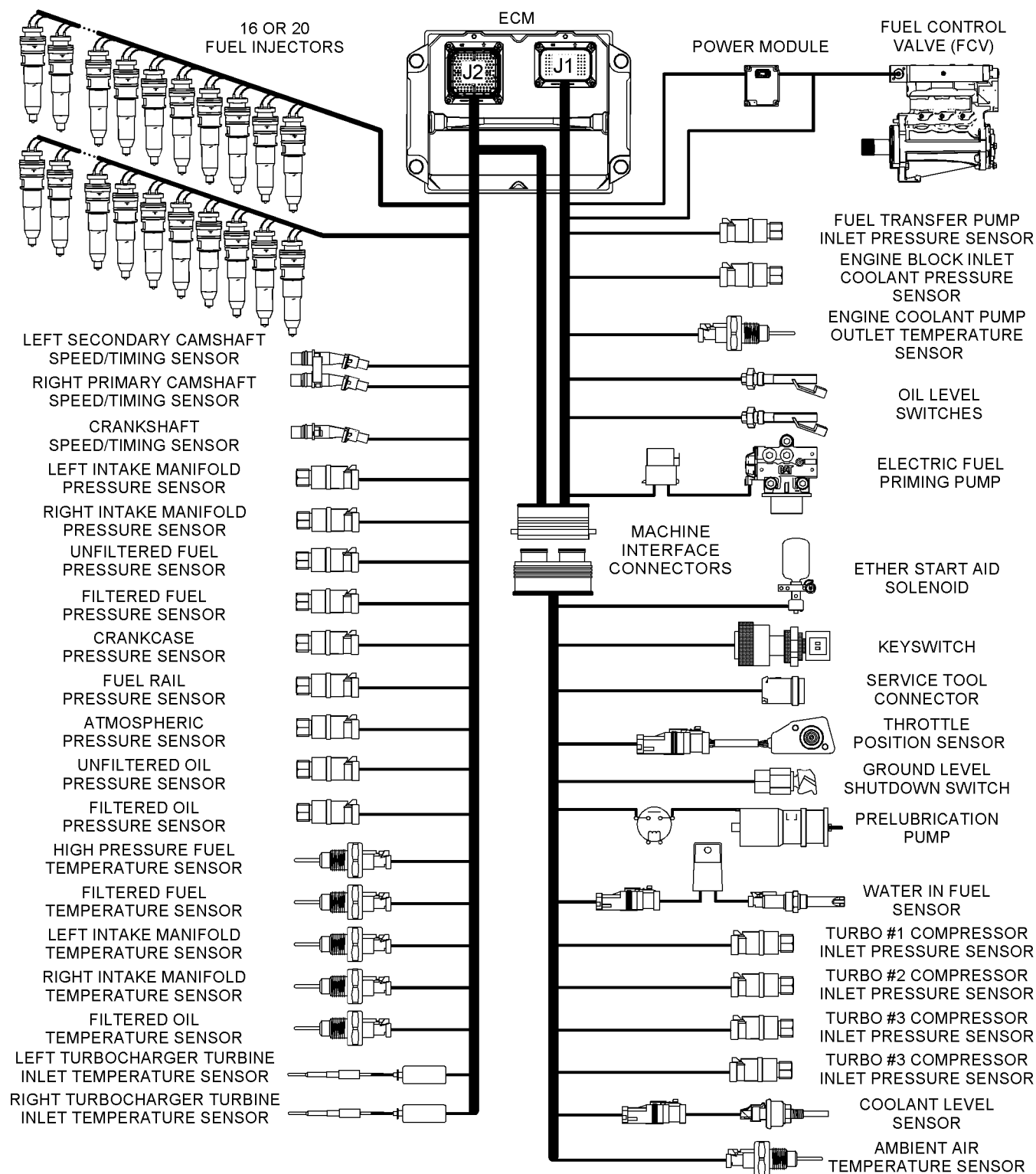


Illustration 3

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Locations of the Engine Sensors (16 and 20 Cylinder Engines)

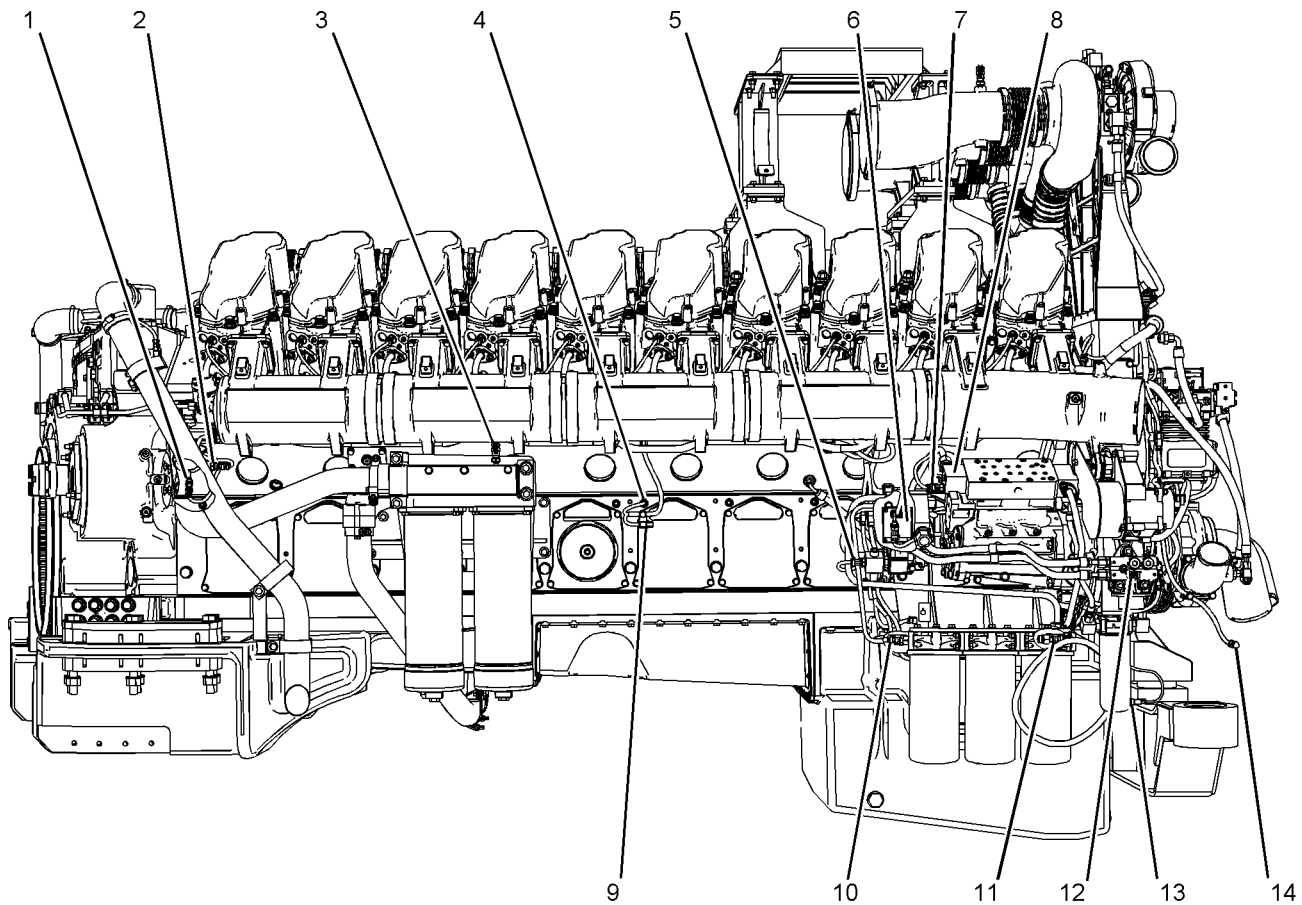


Illustration 4

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Locations of the engine sensors (typical right side engine view)

- | | | |
|--|--|-------------------------------------|
| (1) Filtered oil temperature sensor | (6) Power module | (11) Filtered fuel pressure sensor |
| (2) Filtered oil pressure sensor | (7) High pressure fuel temperature sensor | (12) Electric fuel priming pump |
| (3) Unfiltered oil pressure sensor | (8) Fuel control valve | (13) Water in fuel sensor |
| (4) Crankcase pressure sensor | (9) Connector for the oil renewal solenoid | (14) Connector for the prelube pump |
| (5) Fuel transfer pump inlet pressure sensor | (10) Unfiltered fuel pressure sensor | |

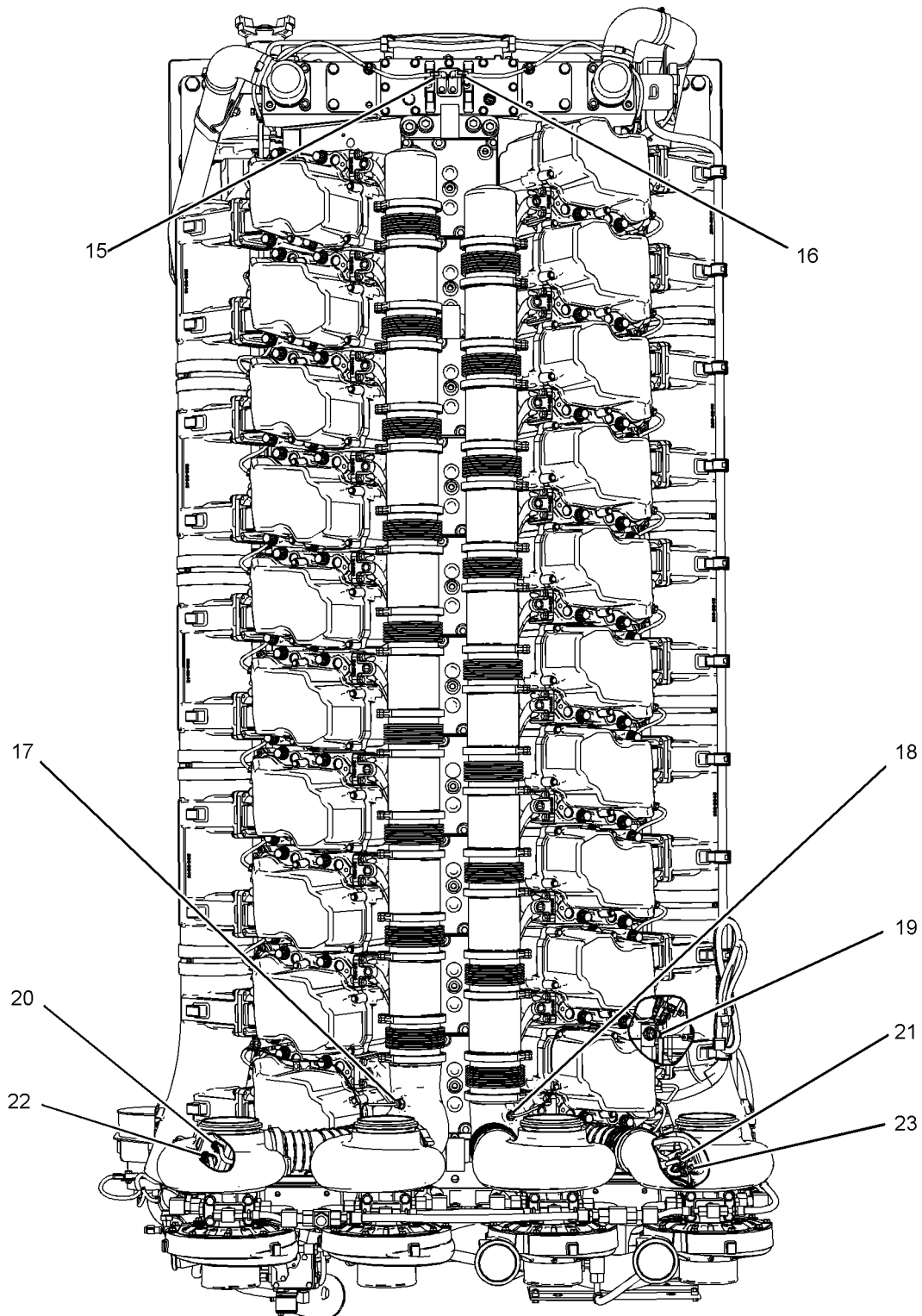


Illustration 5

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Locations of the engine sensors (typical top side engine view)

- | | | |
|--|---|--|
| (15) Right primary camshaft engine speed/timing sensor | (18) Sensor for the left turbocharger turbine inlet temperature | (22) Right intake manifold pressure sensor |
| (16) Left secondary camshaft engine speed/timing sensor | (19) Fuel rail pressure sensor | (23) Left intake manifold air temperature sensor |
| (17) Sensor for the right turbocharger turbine inlet temperature | (20) Right intake manifold air temperature sensor | |
| | (21) Left intake manifold pressure sensor | |

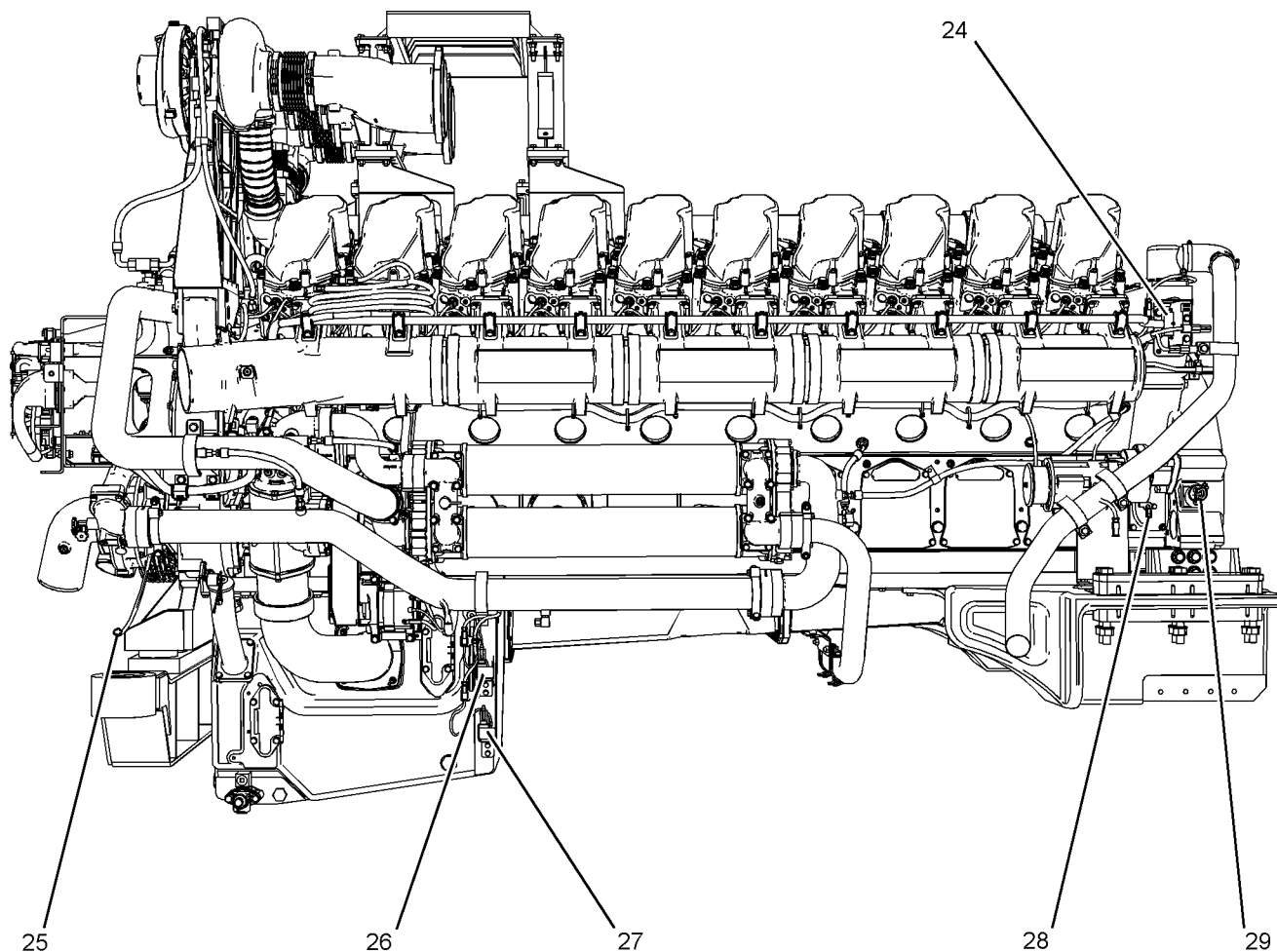


Illustration 6

g01446758

Locations of the engine sensors (typical left side engine view)

(24) Machine interface connector

(26) Upper oil level switch

(28) Location of the crankshaft speed/timing sensor

(25) Connector for the ground level shutdown switch

(27) Lower oil level switch

(29) Sensor for the machine tachometer

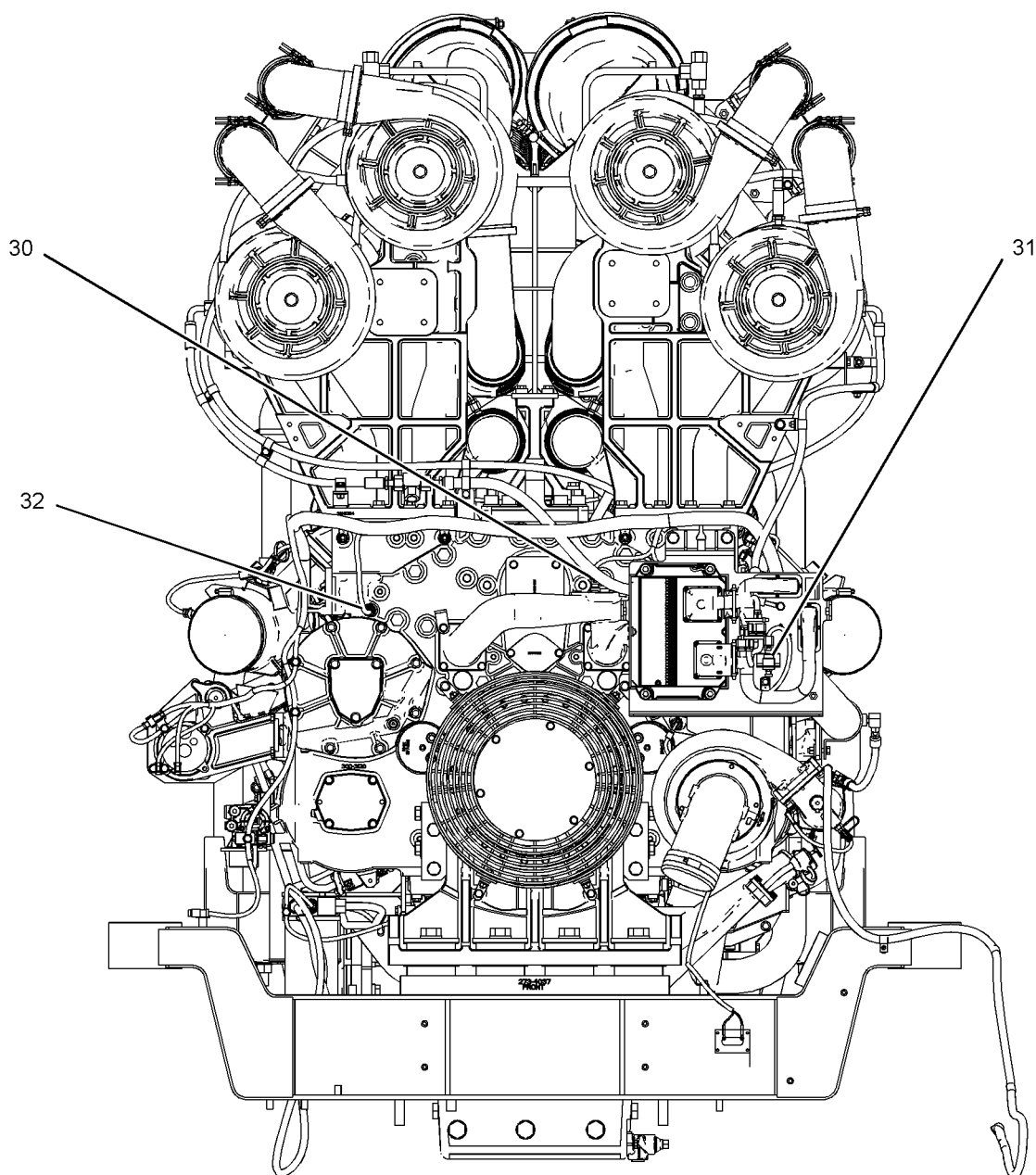


Illustration 7

g01446783

Locations of the engine sensors (front side engine view)

(30) Coolant pump outlet pressure sensor

(30) Engine block outlet coolant temperature sensor

(31) Atmospheric pressure sensor

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Engine Monitoring System

SMCS Code: 1900

The Electronic Control Module (ECM) monitors the operating parameters of the engine. The ECM will generate an event code if a specific engine parameter exceeds an acceptable range that is defined by the engine monitoring system. For information on event codes, refer to Troubleshooting, "Event Codes" for a list of the applicable event codes for this application.

Three possible responses may be available for each parameter. Some of the responses are not available for some of the parameters. Refer to Table 5.

Table 5

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
- Response configuration
- 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. The screens of Cat ET provide guidance for the changing of trip points.

Note: Some parameters require no password in order to be changed. Other parameters can be changed with customer passwords. Some of the parameters are protected by factory passwords. There are some parameters that cannot be changed. Some applications do not allow any changes to the programmable monitoring system.

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.
2. Highlight the desired parameter. Then click on 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.

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Diagnostic Capabilities

SMCS Code: 1900

Diagnostic Codes

The engine's Electronic Control Module (ECM) has the ability to monitor the circuitry between the ECM and the engine's components. The ECM also has the ability to monitor the engine's 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 engine's 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. Event codes indicate 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 Code List”
- Troubleshooting, “Event Code List”

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, it is possible to generate an active diagnostic code 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.

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Electrical Connectors

SMCS Code: 7553-WW

Connectors for the Electronic Control Module (ECM)

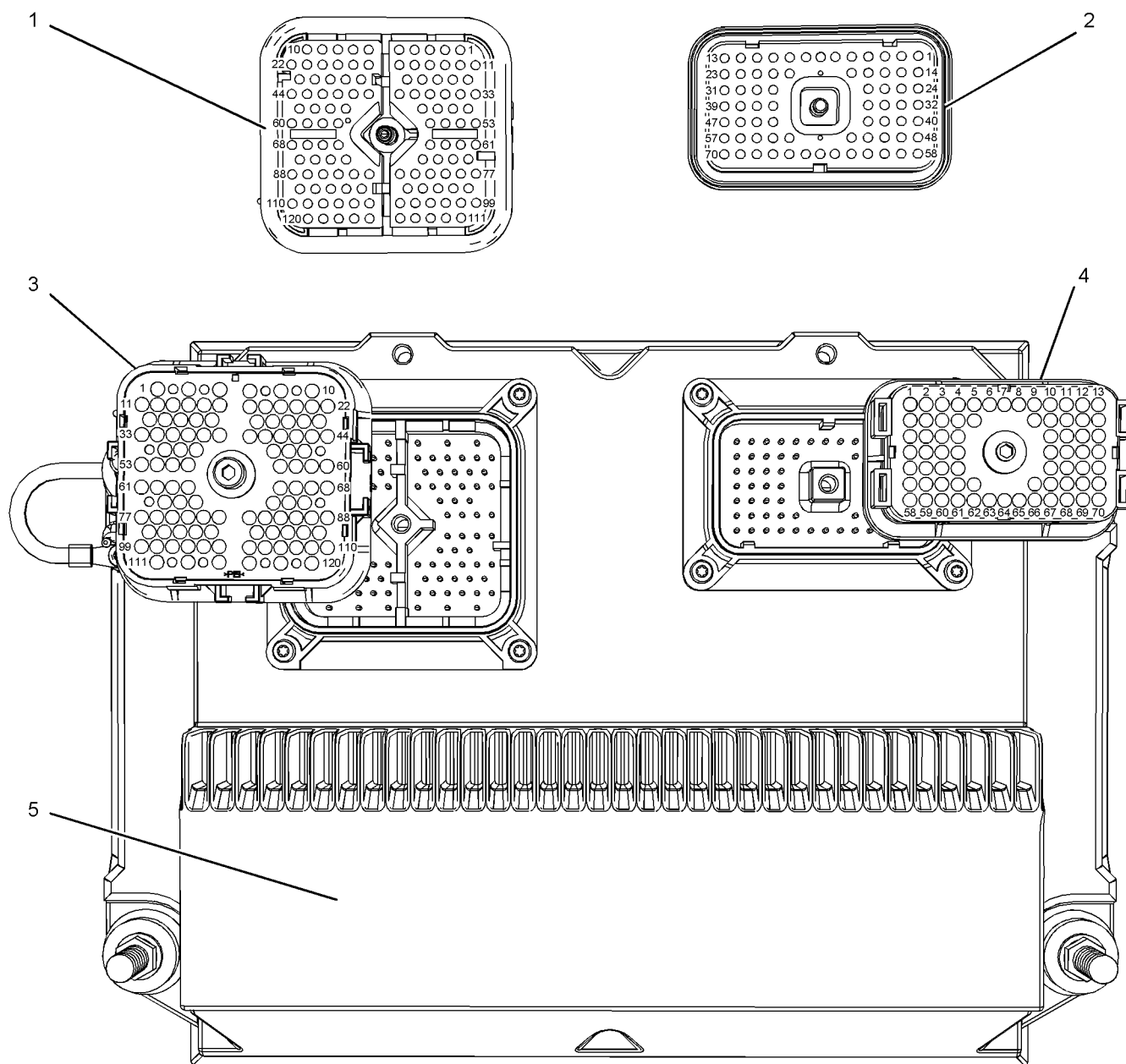


Illustration 8

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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) A4 ECM

Rail Connectors at the ECM Panel

16 Cylinder Engines

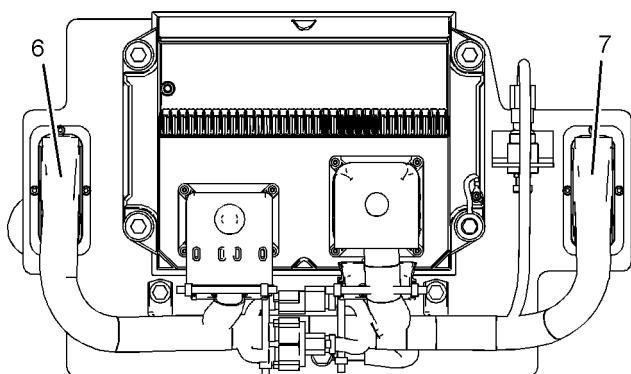


Illustration 9

g01333773

Locations of the rail connectors at the ECM panel

- (6) Right rail connector
(7) Left rail connector

20 Cylinder Engines

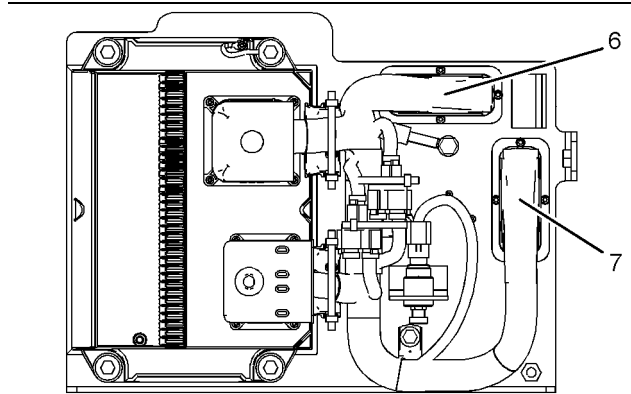


Illustration 10

g01431253

Locations of the rail connectors at the ECM panel

- (6) Right rail connector
(7) Left rail connector

Rail Connectors

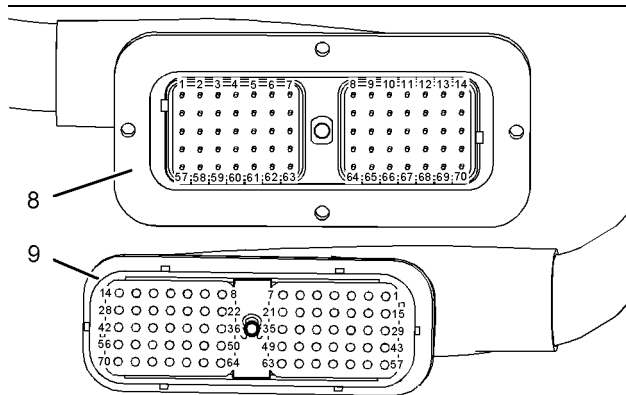


Illustration 11

g01431244

Terminal locations for the rail connectors (70-pin connector)

- (8) Connector for the engine harness
(9) Connector for the ECM harness

Machine Interface Connectors

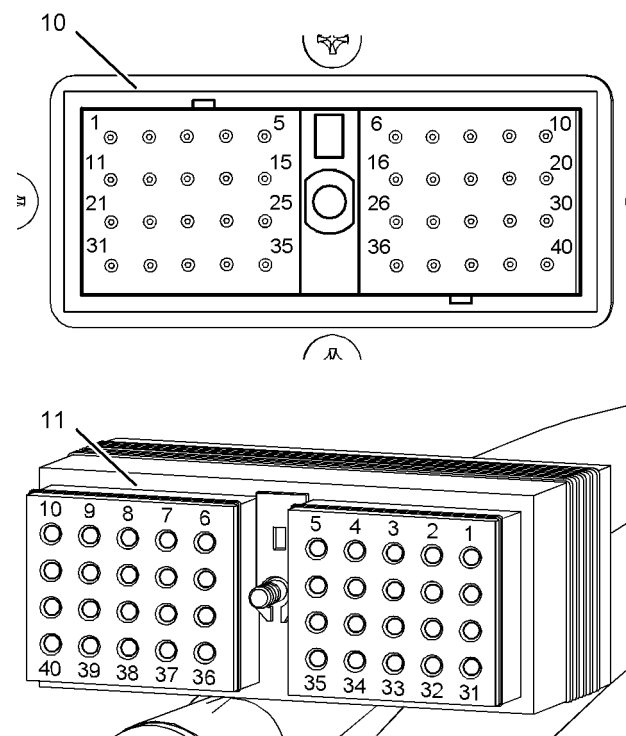


Illustration 12

g01431282

Terminal locations for the machine interface connectors (40-pin connector)

- (10) Connector for the engine harness
(11) Connector for the machine harness

Injector Connectors

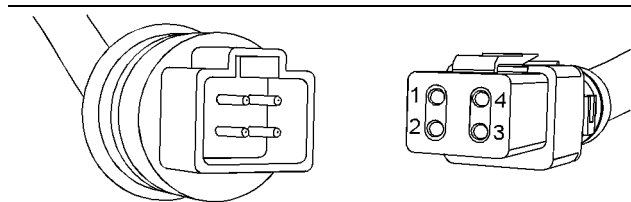


Illustration 13

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Sensor Connectors

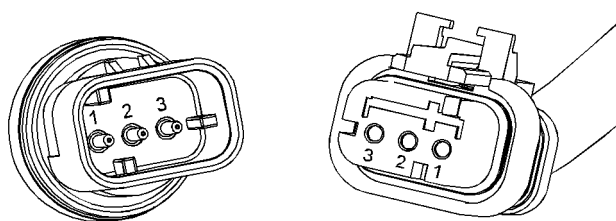


Illustration 14

g01240891

Analog sensor connector (active sensor)

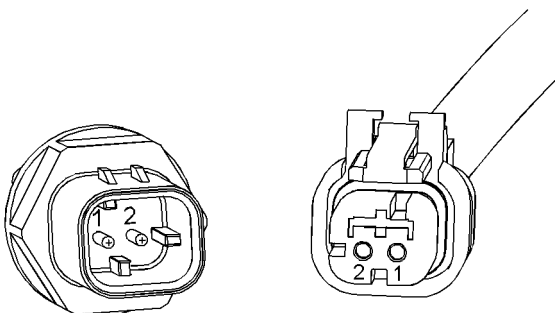


Illustration 15

g01241538

Analog sensor connector (passive sensor)

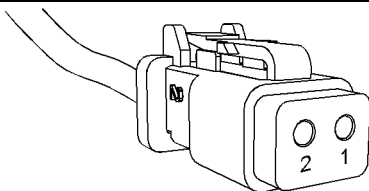


Illustration 16

g01155187

Engine speed/timing connector

Service Tool Connector for Caterpillar Electronic Technician

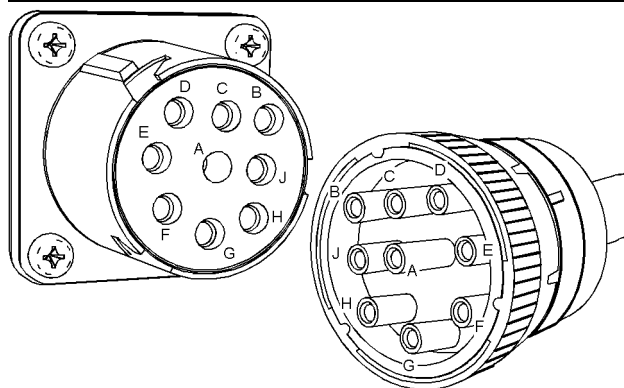


Illustration 17

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Termination Resistor for the CAN Data Link

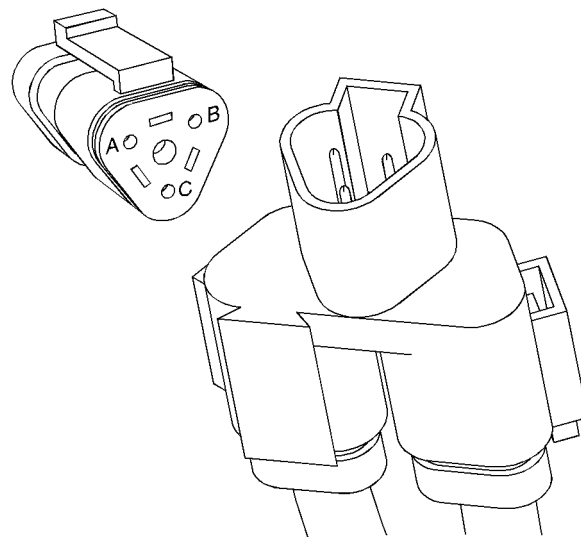


Illustration 18

g01355248

i02906509

Wiring Information

SMCS Code: 1408

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

Harness Wire Identification

Caterpillar identifies all wires with eleven solid colors. The circuit number is stamped on the wire at a 25 mm (1 inch) spacing. Table 6 lists the wire colors and the color codes.

Table 6

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

For example, a wire identification of A701-GY on the schematic would signify a gray wire with the circuit number A701.

Configuration Parameters

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Configuration Parameters

SMCS Code: 1900

System configuration parameters are parameters that affect emissions, power of the engine, and other features that define the characteristics of the engine subsystems. The parameters are preprogrammed at the factory. You may need to reprogram the system configuration parameters if the Electronic Control Module (ECM) is replaced and/or if you reprogram the engine rating. You do not need to reprogram the system configuration parameters if you replace the flash file. Caterpillar Electronic Technician (ET) can be used to view the values for these parameters at any time. Certain system configuration parameters are stamped on the engine information plate.

Note: The unauthorized tampering with the parameters that are protected by factory passwords may cause your Caterpillar warranty to be voided.

The system configuration parameters are listed in Table 7.

Table 7

System Configuration Parameters	
Parameter	Parameter Setting
ECM Identification Parameters	
Equipment ID ⁽¹⁾	17 alphanumeric characters
Engine Serial Number ⁽¹⁾	0XX00000 or XXX00000
ECM Part Number ⁽²⁾	Read Only
ECM Serial Number ⁽²⁾	Read Only
Software Group Part Number ⁽²⁾	Software Dependent
Software Group Release Date ⁽²⁾	Software Dependent
Software Group Description ⁽²⁾	Software Dependent
Engine Configuration Parameters	
Ether Solenoid Configuration ⁽¹⁾	Continuous Flow
Oil Renewal Rate	0
Engine Prelube	Enabled
Desired Engine Coolant Temperature Configuration	78 °C (172 °F)
System Settings	
FLS (Full Load Setting) ⁽¹⁾	Programmed at the factory
FTS (Full Torque Setting) ⁽¹⁾	Programmed at the factory
Security Access Parameters	
Total Tattletale	Read Only

⁽¹⁾ The parameter must be reprogrammed if the ECM is replaced.

⁽²⁾ This parameter can only be viewed. No changes are allowed.

Parameter Descriptions

ECM Identification Parameters

Equipment ID

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

Engine Serial Number

Program the “Engine Serial Number” to match the engine serial number that is stamped on the engine information plate.

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

ECM Part Number

This parameter identifies the part number of the ECM.

ECM Serial Number

The “ECM Serial Number” is stored in the memory of the ECM. The “ECM Serial Number” can be accessed by the use of Cat ET.

Software Group Part Number

This parameter identifies the part number of the flash file that is currently installed in the ECM.

Software Group Release Date

This parameter identifies the release date of the flash file that is currently installed in the ECM.

Software Group Description

This parameter identifies the description of the application for the flash file that is currently installed in the ECM.

Engine Configuration Parameters

Ether Solenoid Configuration

This parameter must be programmed to “Continuous Flow” if an ether injection system is installed on the engine.

Oil Renewal Rate

This parameter is used to configure the oil renewal system for the engine.

Engine Prelube

This parameter must be programmed to “Enabled” if an engine prelube system is installed on the engine.

Desired Engine Coolant Temperature Configuration

This parameter is used by the ECM in order to provide a desired setpoint for the temperature control module.

System Settings

Full Load Setting (FLS)

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

Full Torque Setting (FTS)

FTS is similar to FLS. Only change this value if the engine is rerated or if a new ECM has been installed. Factory passwords are required to change this parameter.

Parameter Worksheet

Table 8

System Configuration Parameters	
Parameter	Parameter Setting
ECM Identification Parameters	
Equipment ID	
Engine Serial Number	
ECM Part Number	
ECM Serial Number	
Software Group Part Number	
Software Group Release Date	
Software Group Description	
Engine Configuration Parameters	
Ether Solenoid Configuration	
Oil Renewal Rate	
Engine Prelube	
Desired Engine Coolant Temperature Configuration	
System Settings	
FLS (Full Load Setting)	
FTS (Full Torque Setting)	
Security Access Parameters	
Total Tattletale	

Diagnostic Trouble Codes

i02887659

Diagnostic Trouble Codes

SMCS Code: 1900

Cross-Reference Information for Diagnostic Codes

Table 9 lists the diagnostic codes that apply to the engines that are covered in this manual. Use Caterpillar Electronic Technician (ET) in order to determine the diagnostic codes that are active or logged. Then refer to the appropriate troubleshooting procedure for more information.

Table 9

Cross-Reference from CID-FMI Code to the Appropriate Test Procedure	
Diagnostic Code and Description	Troubleshooting Procedure
1-2 Cylinder #1 Injector erratic, intermittent, or incorrect	Troubleshooting, "Injector Solenoid - Test"
1-5 Cylinder #1 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
1-6 Cylinder #1 Injector current above normal	Troubleshooting, "Injector Solenoid - Test"
1-7 Cylinder #1 Injector not responding properly	Troubleshooting, "Injector Solenoid - Test"
2-2 Cylinder #2 Injector erratic, intermittent, or incorrect	Troubleshooting, "Injector Solenoid - Test"
2-5 Cylinder #2 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
2-6 Cylinder #2 Injector current above normal	Troubleshooting, "Injector Solenoid - Test"
2-7 Cylinder #2 Injector not responding properly	Troubleshooting, "Injector Solenoid - Test"
3-2 Cylinder #3 Injector erratic, intermittent, or incorrect	Troubleshooting, "Injector Solenoid - Test"
3-5 Cylinder #3 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
3-6 Cylinder #3 Injector current above normal	Troubleshooting, "Injector Solenoid - Test"
3-7 Cylinder #3 Injector not responding properly	Troubleshooting, "Injector Solenoid - Test"
4-2 Cylinder #4 Injector erratic, intermittent, or incorrect	Troubleshooting, "Injector Solenoid - Test"
4-5 Cylinder #4 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
4-6 Cylinder #4 Injector current above normal	Troubleshooting, "Injector Solenoid - Test"
4-7 Cylinder #4 Injector not responding properly	Troubleshooting, "Injector Solenoid - Test"
5-2 Cylinder #5 Injector erratic, intermittent, or incorrect	Troubleshooting, "Injector Solenoid - Test"
5-5 Cylinder #5 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
5-6 Cylinder #5 Injector current above normal	Troubleshooting, "Injector Solenoid - Test"
5-7 Cylinder #5 Injector not responding properly	Troubleshooting, "Injector Solenoid - Test"
6-2 Cylinder #6 Injector erratic, intermittent, or incorrect	Troubleshooting, "Injector Solenoid - Test"
6-5 Cylinder #6 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
6-6 Cylinder #6 Injector current above normal	Troubleshooting, "Injector Solenoid - Test"
6-7 Cylinder #6 Injector not responding properly	Troubleshooting, "Injector Solenoid - Test"

(continued)

(Table 9, contd)

Cross-Reference from CID-FMI Code to the Appropriate Test Procedure	
Diagnostic Code and Description	Troubleshooting Procedure
7-2 Cylinder #7 Injector erratic, intermittent, or incorrect	Troubleshooting, "Injector Solenoid - Test"
7-5 Cylinder #7 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
7-6 Cylinder #7 Injector current above normal	Troubleshooting, "Injector Solenoid - Test"
7-7 Cylinder #7 Injector not responding properly	Troubleshooting, "Injector Solenoid - Test"
8-2 Cylinder #8 Injector erratic, intermittent, or incorrect	Troubleshooting, "Injector Solenoid - Test"
8-5 Cylinder #8 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
8-6 Cylinder #8 Injector current above normal	Troubleshooting, "Injector Solenoid - Test"
8-7 Cylinder #8 Injector not responding properly	Troubleshooting, "Injector Solenoid - Test"
9-2 Cylinder #9 Injector erratic, intermittent, or incorrect	Troubleshooting, "Injector Solenoid - Test"
9-5 Cylinder #9 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
9-6 Cylinder #9 Injector current above normal	Troubleshooting, "Injector Solenoid - Test"
9-7 Cylinder #9 Injector not responding properly	Troubleshooting, "Injector Solenoid - Test"
10-2 Cylinder #10 Injector erratic, intermittent, or incorrect	Troubleshooting, "Injector Solenoid - Test"
10-5 Cylinder #10 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
10-6 Cylinder #10 Injector current above normal	Troubleshooting, "Injector Solenoid - Test"
10-7 Cylinder #10 Injector not responding properly	Troubleshooting, "Injector Solenoid - Test"
11-2 Cylinder #11 Injector erratic, intermittent, or incorrect	Troubleshooting, "Injector Solenoid - Test"
11-5 Cylinder #11 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
11-6 Cylinder #11 Injector current above normal	Troubleshooting, "Injector Solenoid - Test"
11-7 Cylinder #11 Injector not responding properly	Troubleshooting, "Injector Solenoid - Test"
12-2 Cylinder #12 Injector erratic, intermittent, or incorrect	Troubleshooting, "Injector Solenoid - Test"
12-5 Cylinder #12 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
12-6 Cylinder #12 Injector current above normal	Troubleshooting, "Injector Solenoid - Test"
12-7 Cylinder #12 Injector not responding properly	Troubleshooting, "Injector Solenoid - Test"
13-2 Cylinder #13 Injector erratic, intermittent, or incorrect	Troubleshooting, "Injector Solenoid - Test"
13-5 Cylinder #13 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
13-6 Cylinder #13 Injector current above normal	Troubleshooting, "Injector Solenoid - Test"
13-7 Cylinder #13 Injector not responding properly	Troubleshooting, "Injector Solenoid - Test"
14-2 Cylinder #14 Injector erratic, intermittent, or incorrect	Troubleshooting, "Injector Solenoid - Test"
14-5 Cylinder #14 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
14-6 Cylinder #14 Injector current above normal	Troubleshooting, "Injector Solenoid - Test"
14-7 Cylinder #14 Injector not responding properly	Troubleshooting, "Injector Solenoid - Test"
15-2 Cylinder #15 Injector erratic, intermittent, or incorrect	Troubleshooting, "Injector Solenoid - Test"
15-5 Cylinder #15 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
15-6 Cylinder #15 Injector current above normal	Troubleshooting, "Injector Solenoid - Test"
15-7 Cylinder #15 Injector not responding properly	Troubleshooting, "Injector Solenoid - Test"
16-2 Cylinder #16 Injector erratic, intermittent, or incorrect	Troubleshooting, "Injector Solenoid - Test"
16-5 Cylinder #16 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"

(continued)

(Table 9, contd)

Cross-Reference from CID-FMI Code to the Appropriate Test Procedure	
Diagnostic Code and Description	Troubleshooting Procedure
16-6 Cylinder #16 Injector current above normal	Troubleshooting, "Injector Solenoid - Test"
16-7 Cylinder #16 Injector not responding properly	Troubleshooting, "Injector Solenoid - Test"
18-7 Fuel Control Valve not responding properly	The actual position and the desired position of the fuel actuator is not within specifications. Replace the high pressure fuel pump.
18-8 Fuel Control Valve abnormal frequency, pulse width, or period	Troubleshooting, "Fuel Rail Pressure - Test"
18-9 Fuel Control Valve abnormal update rate	Troubleshooting, "Fuel Rail Pressure - Test"
18-11 Fuel Control Valve other failure mode	During a self test, the fuel control valve has detected an internal fault. Replace the high pressure fuel pump.
18-12 Fuel Control Valve failure	
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"
91-8 Throttle Position Sensor abnormal frequency, pulse width, or period	Troubleshooting, "Sensor Signal (PWM) - Test"
95-2 Fuel Filter Differential Pressure Sensor erratic, intermittent, or incorrect	The filtered fuel pressure is greater than the unfiltered fuel pressure. Ensure that the sensor connectors are connected to the correct sensors. If an electrical problem with a sensor is suspected, refer to Troubleshooting, "Sensor Signal (Analog, Active) - Test" for information that is related to troubleshooting an electrical problem with the fuel pressure sensors.
99-2 Engine Oil Filter Differential Pressure Sensor erratic, intermittent, or incorrect	The filtered oil pressure is greater than the unfiltered oil pressure. Ensure that the sensor connectors are connected to the correct sensors. If an electrical problem with a sensor is suspected, refer to Troubleshooting, "Sensor Signal (Analog, Active) - Test" for information that is related to troubleshooting an electrical problem with the oil pressure sensors.
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"
100-10 Engine Oil Pressure Sensor abnormal rate of change	Troubleshooting, "Sensor Supply - Test"
101-3 Crankcase Air Pressure Sensor voltage above normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
101-4 Crankcase Air Pressure Sensor voltage below normal	Troubleshooting, "Sensor Signal (Analog, Active) - 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	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
168-0 Electrical System Voltage high - most severe (3)	Troubleshooting, "Electrical Power Supply - Test"
168-1 Electrical System Voltage low - most severe (3)	Troubleshooting, "Electrical Power Supply - Test"
168-2 Electrical System Voltage erratic, intermittent, or incorrect	Troubleshooting, "Electrical Power Supply - Test"
171-3 Ambient Air Temperature Sensor voltage above normal	Troubleshooting, "Sensor Signal (PWM) - Test"
171-4 Ambient Air Temperature Sensor voltage below normal	Troubleshooting, "Sensor Signal (PWM) - Test"
171-8 Ambient Air Temperature Sensor abnormal frequency, pulse width, or period	Troubleshooting, "Sensor Signal (PWM) - Test"

(continued)

(Table 9, contd)

Cross-Reference from CID-FMI Code to the Appropriate Test Procedure	
Diagnostic Code and Description	Troubleshooting Procedure
172-3 Intake Manifold Air Temperature Sensor voltage above normal	Troubleshooting, "Sensor Signal (PWM) - Test"
172-4 Intake Manifold Air Temperature Sensor voltage below normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
174-3 Fuel Temperature Sensor voltage above normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
174-4 Fuel Temperature Sensor voltage below normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
175-3 Engine Oil Temperature Sensor voltage above normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
175-4 Engine Oil Temperature Sensor voltage below normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
190-8 Engine Speed Sensor abnormal frequency, pulse width, or period	Troubleshooting, "Speed/Timing - Test"
247-9 SAE J1939 Data Link abnormal update rate	Troubleshooting, "Data Link - Test"
253-2 Personality Module erratic, intermittent, or incorrect	Troubleshooting, "System Configuration Parameters"
262-3 5 Volt Sensor DC Power Supply voltage above normal	This power supply is not used for this application.
262-4 5 Volt Sensor DC Power Supply voltage below normal	This power supply is not used for this application.
267-2 Remote Shutdown Input erratic, intermittent, or incorrect	Troubleshooting, "Shutdown - 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	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
289-3 Fuel Pressure Sensor - Before Fuel Filter voltage above normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
289-4 Fuel Pressure Sensor - Before Fuel Filter voltage below normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
296-9 Transmission Control abnormal update rate	Troubleshooting, "Data Link - Test"
296-14 Transmission Control special instruction	Troubleshooting, "Data Link - Test"
338-5 Engine Pre-Lube Pump Relay current below normal	Troubleshooting, "Prelubrication - Test"
338-6 Engine Pre-Lube Pump Relay current above normal	Troubleshooting, "Prelubrication - Test"
342-8 Secondary Engine Speed Sensor abnormal frequency, pulse width, or period	Troubleshooting, "Speed/Timing - Test"
342-11 Secondary Engine Speed Sensor other failure mode	Troubleshooting, "Speed/Timing - 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	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
533-9 Brake Control abnormal update rate	Troubleshooting, "Data Link - Test"
533-14 Brake Control special instruction	Troubleshooting, "Data Link - Test"
542-3 Engine Oil Pressure Sensor - Before Oil Filter voltage above normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
542-4 Engine Oil Pressure Sensor - Before Oil Filter voltage below normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"

(continued)

(Table 9, contd)

Cross-Reference from CID-FMI Code to the Appropriate Test Procedure	
Diagnostic Code and Description	Troubleshooting Procedure
542-10 Engine Oil Pressure Sensor - Before Oil Filter abnormal rate of change	Troubleshooting, "Sensor Supply - Test"
569-5 Oil Injection Solenoid current below normal	Troubleshooting, "Oil Renewal - Test"
569-6 Oil Renewal Solenoid short to ground	Troubleshooting, "Oil Renewal - Test"
1273-9 Chassis Control Module abnormal update rate	Troubleshooting, "Data Link - Test"
1273-14 Chassis Control Module special instruction	Troubleshooting, "Data Link - Test"
1491-3 Right Turbo Turbine Inlet Temperature Sensor voltage above normal	Troubleshooting, "Sensor Signal (PWM) - Test"
1491-4 Right Turbo Turbine Inlet Temperature Sensor voltage below normal	Troubleshooting, "Sensor Signal (PWM) - Test"
1491-8 Right Turbo Turbine Inlet Temperature Sensor abnormal frequency, pulse width, or period	Troubleshooting, "Sensor Signal (PWM) - Test"
1492-3 Left Turbo Turbine Inlet Temperature Sensor voltage above normal	Troubleshooting, "Sensor Signal (PWM) - Test"
1492-4 Left Turbo Turbine Inlet Temperature Sensor voltage below normal	Troubleshooting, "Sensor Signal (PWM) - Test"
1492-8 Left Turbo Turbine Inlet Temperature Sensor abnormal frequency, pulse width, or period	Troubleshooting, "Sensor Signal (PWM) - Test"
1627-5 Fuel Pump Relay current below normal	Troubleshooting, "Fuel Transfer Pump - Test"
1627-6 Fuel Pump Relay current above normal	Troubleshooting, "Fuel Transfer Pump - 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	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
1785-10 Intake Manifold Pressure Sensor abnormal rate of change	Troubleshooting, "Sensor Supply - Test"
1796-3 Intake Manifold #2 Air Temperature Sensor voltage above normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
1796-4 Intake Manifold #2 Air Temperature Sensor voltage below normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
1797-3 Fuel Rail Pressure Sensor voltage above normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
1797-4 Fuel Rail Pressure Sensor voltage below normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
1797-7 Fuel Rail Pressure Sensor not responding properly	The pressure in the high pressure fuel system is fluctuating out of specifications. Use Cat ET to monitor the fuel pressure in the low pressure fuel system and in the high pressure fuel system. Refer to the appropriate troubleshooting procedure that is for the suspected problem. Verify that there is no problem with the pressure sensor for the high pressure fuel system. If a problem with the pressure sensor is suspected, refer to Troubleshooting, "Sensor Signal (Analog, Active) - Test". Check for diagnostic codes that are related to the high pressure fuel pump's fuel control valve. Repair any active codes. If the high pressure fuel pump is suspected of mechanical damage, replace the pump.

(continued)

(Table 9, contd)

Cross-Reference from CID-FMI Code to the Appropriate Test Procedure	
Diagnostic Code and Description	Troubleshooting Procedure
1797-10 Fuel Rail Pressure Sensor abnormal rate of change	During the engine's crank cycle, the ECM did not detect a deviation in the signal from the pressure sensor that is for the fuel rail. Refer to Troubleshooting, "Sensor Supply - Test" in order to troubleshoot the sensor.
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"
2247-3 Fuel Transfer Pump Inlet Pressure Sensor voltage above normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
2247-4 Fuel Transfer Pump Inlet Pressure Sensor voltage below normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
2302-3 Engine Coolant Pump Outlet Pressure Sensor voltage above normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
2302-4 Engine Coolant Pump Outlet Pressure Sensor voltage below normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
2323-3 Fuel Rail Temperature Sensor voltage above normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
2323-4 Fuel Rail Temperature Sensor voltage below normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
2348-9 SAE J1939 Data Link #2 abnormal update rate	Troubleshooting, "Data Link - Test"
2349-19 Engine Coolant Pump Outlet Temperature Sensor conditions not met	The temperature control module reported that there is a problem with the circuit for the coolant temperature sensor. Troubleshoot and repair the circuit.
2417-5 Ether Injection Control Solenoid current below normal	Troubleshooting, "Ether Starting Aid - Test"
2417-6 Ether Injection Control Solenoid current above normal	Troubleshooting, "Ether Starting Aid - Test"
2493-2 Cylinder #17 Injector erratic, intermittent, or incorrect	Troubleshooting, "Injector Solenoid - Test"
2493-5 Cylinder #17 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
2493-6 Cylinder #17 Injector current above normal	Troubleshooting, "Injector Solenoid - Test"
2493-7 Cylinder #17 Injector not responding properly	Troubleshooting, "Injector Solenoid - Test"
2494-2 Cylinder #18 Injector erratic, intermittent, or incorrect	Troubleshooting, "Injector Solenoid - Test"
2494-5 Cylinder #18 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
2494-6 Cylinder #18 Injector current above normal	Troubleshooting, "Injector Solenoid - Test"
2494-7 Cylinder #18 Injector not responding properly	Troubleshooting, "Injector Solenoid - Test"
2495-2 Cylinder #19 Injector erratic, intermittent, or incorrect	Troubleshooting, "Injector Solenoid - Test"
2495-5 Cylinder #19 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
2495-6 Cylinder #19 Injector current above normal	Troubleshooting, "Injector Solenoid - Test"
2495-7 Cylinder #19 Injector not responding properly	Troubleshooting, "Injector Solenoid - Test"
2496-2 Cylinder #20 Injector erratic, intermittent, or incorrect	Troubleshooting, "Injector Solenoid - Test"
2496-5 Cylinder #20 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
2496-6 Cylinder #20 Injector current above normal	Troubleshooting, "Injector Solenoid - Test"
2496-7 Cylinder #20 Injector not responding properly	Troubleshooting, "Injector Solenoid - Test"
2710-8 Engine Tertiary Speed Sensor abnormal frequency, pulse width, or period	Troubleshooting, "Speed/Timing - Test"

(continued)

(Table 9, contd)

Cross-Reference from CID-FMI Code to the Appropriate Test Procedure	
Diagnostic Code and Description	Troubleshooting Procedure
2710-11 Engine Tertiary Speed Sensor other failure mode	Troubleshooting, "Speed/Timing - 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"
2739-3 Turbocharger #2 Compressor Inlet Pressure Sensor voltage above normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
2739-4 Turbocharger #2 Compressor Inlet Pressure Sensor voltage below normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
2740-3 Turbocharger #3 Compressor Inlet Pressure Sensor voltage above normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
2740-4 Turbocharger #3 Compressor Inlet Pressure Sensor voltage below normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
2741-3 Turbocharger #4 Compressor Inlet Pressure Sensor voltage above normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
2741-4 Turbocharger #4 Compressor Inlet Pressure Sensor voltage below normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
2854-9 Coolant Temperature Control Module abnormal update rate	Troubleshooting, "Data Link - Test"
3031-3 Intake Manifold #2 Pressure Sensor voltage above normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
3031-4 Intake Manifold #2 Pressure Sensor voltage below normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
3031-10 Intake Manifold #2 Pressure Sensor abnormal rate of change	Troubleshooting, "Sensor Supply - 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 for 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 module identifier (MID), the component identifier (CID), and the failure mode identifier (FMI).

Component Identifier (MID) – The MID is a three digit code that identifies the ECM that generated the diagnostic code. For example, the MID 036 identifies the engine ECM.

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

Failure Mode Identifier (FMI) – The FMI is a number that 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 Codes".

Illustration 19 is an example of the operating range of a sensor.

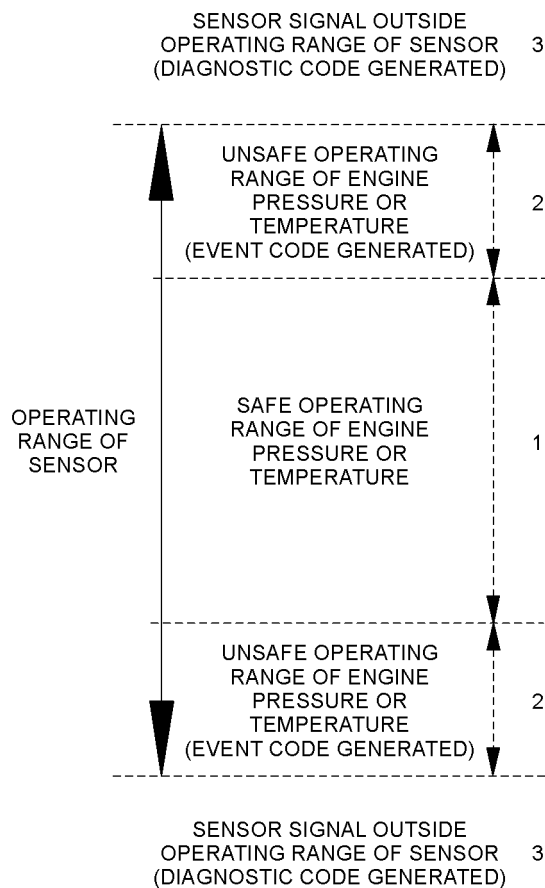


Illustration 19

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 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

i02881680

Event Codes

SMCS Code: 1900

Engine Monitoring

The Electronic Control Module (ECM) monitors the operating parameters of the engine. The ECM will generate an event code if a specific engine parameter exceeds an acceptable range that is defined by the engine monitoring system. For information on the engine monitoring system, refer to Troubleshooting, "Engine Monitoring System".

Cross-Reference Information for Event Codes

Event codes are generated when abnormal operating conditions exist. 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.

Table 10

Cross-Reference from Event Code to the Appropriate Test Procedure	
Event Code	Procedure
E072(2) Oil Level Low Mark	The engine oil level is below the specified level. Check the engine oil level. If necessary, add oil to the engine and return the engine to service. Refer to the Operation and Maintenance Manual for details. If a problem is suspected with the engine's lubrication system, refer to Troubleshooting, "Oil Consumption Is Excessive" for information that is related to troubleshooting this symptom.
E072(3) Oil Level Low Mark	
E096(1) High Fuel Pressure	Troubleshooting, "Fuel Pressure Is High"
E098(1) Engine Pre-lube Override	The keyswitch has been cycled from the START position, to the OFF position, and back to the START position in six seconds or less. The prelube cycle has been overridden by the operator.
E099(1) Engine Oil Filter Restriction Warning	Troubleshooting, "Oil Filter Differential Pressure Problem"
E101(1) High Crankcase Pressure Warning	Troubleshooting, "Crankcase Pressure Is High"
E103(0) Module Internal Over Temperature	Check the ECM for a buildup of debris and/or mud. Clean the ECM, as needed.
E197(1) High Engine Oil Temperature	Troubleshooting, "Oil Temperature Is High"
E197(2) High Engine Oil Temperature	
E197(3) High Engine Oil Temperature	
E198(1) Low Fuel Pressure	Troubleshooting, "Fuel Pressure Is Low"
E198(2) Low Fuel Pressure	

(continued)

(Table 10, contd)

Cross-Reference from Event Code to the Appropriate Test Procedure	
Event Code	Procedure
E232(1) High Fuel/Water Separator Water Level	The level of water that is in the fuel system's fuel/water separator is excessive. Remove the water from the water trap and return the engine to service. Refer to the Operation and Maintenance Manual for details.
E232(2) High Fuel/Water Separator Water Level	
E233(2) Low Engine Pre-lube Pressure	Troubleshooting, "Prelubrication Pump Problem"
E245(2) High Right Turbo Turbine Inlet Temperature	Troubleshooting, "Turbocharger Turbine Temperature Is High"
E245(3) High Right Turbo Turbine Inlet Temperature	
E246(2) High Left Turbo Turbine Inlet Temperature	
E246(3) High Left Turbo Turbine Inlet Temperature	
E265(2) User Defined Shutdown	This event is used to record a requested shutdown from an aftermarket shutdown device.
E360(1) Low Engine Oil Pressure	Troubleshooting, "Oil Pressure Is Low"
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(2) Engine Overspeed	
E362(3) Engine Overspeed	
E363(1) High Fuel Supply Temperature	Troubleshooting, "Fuel Temperature is High"
E363(2) High Fuel Supply Temperature	
E390(1) Fuel Filter Restriction	Troubleshooting, "Fuel Filter Is Restricted"
E390(2) Fuel Filter Restriction	
E396(1) High Fuel Rail Pressure	Troubleshooting, "Fuel Rail Pressure Is High"
E398(1) Low Fuel Rail Pressure	Troubleshooting, "Fuel Rail Pressure Is Low"
E398(2) Low Fuel Rail Pressure	
E539(1) High Intake Manifold Air Temperature	Troubleshooting, "Intake Manifold Air Temperature Is High"
E539(2) 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	
E584(1) High Air Inlet #2 Differential Pressure	Troubleshooting, "Inlet Air Is Restricted"
E584(2) High Air Inlet #2 Differential Pressure	
E585(1) High Air Inlet #3 Differential Pressure	Troubleshooting, "Inlet Air Is Restricted"
E585(2) High Air Inlet #3 Differential Pressure	
E586(1) High Air Inlet #4 Differential Pressure	Troubleshooting, "Inlet Air Is Restricted"
E586(2) High Air Inlet #4 Differential Pressure	
E678(2) Ground Level Shutdown	The ground level shutdown switch has been activated. Reset the switch to the RUN position. If an electrical problem with the switch or with the switch circuit is suspected, refer to Troubleshooting, "Shutdown - Test" for information that is related to troubleshooting the ground level shutdown switch.

(continued)

(Table 10, contd)

Cross-Reference from Event Code to the Appropriate Test Procedure	
Event Code	Procedure
E770(1) High Fuel Rail Temperature	Troubleshooting, "Fuel Temperature is High"
E770(2) High Fuel Rail Temperature	
E2089(1) Oil Renewal System Cannot Operate	Troubleshooting, "Oil Renewal - Test"
E2112(1) Low Engine Coolant Pressure	Troubleshooting, "Coolant Pressure Is Low"
E2143(2) Low Engine Coolant Level	The engine's coolant level is below the specified level. Check the level of the engine coolant. If necessary, add coolant to the cooling system and return the engine to service. Refer to the Operation and Maintenance Manual for details. If an electrical problem is suspected with the engine's cooling system, refer to Troubleshooting, "Coolant Level - Test" for information that is related to troubleshooting the coolant level switch.
E2143(3) Low Engine Coolant Level	
E2172(1) Low Fuel Transfer Pump Inlet Pressure	Troubleshooting, "Fuel Transfer Pump Inlet Pressure Is Low"

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. This 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:

Table 11

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

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 20 is an example of the operating range of a sensor.

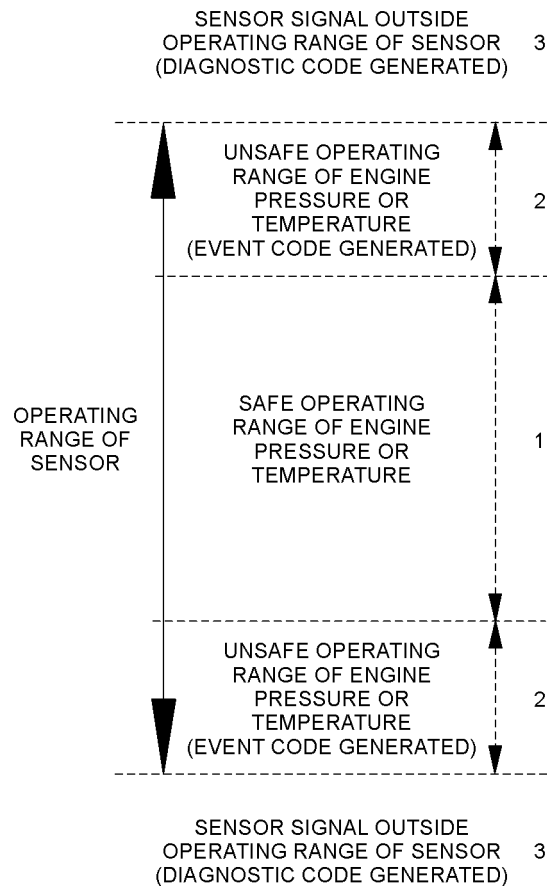


Illustration 20

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 Codes" for additional information on diagnostic codes.

Logged Event Codes

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

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

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

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

Clearing Event Codes

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

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

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

Troubleshooting

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

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

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

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

Machine Response to Active Event Codes

The Advisor panel is used to notify the operator of an immediate problem or of an impending problem that is detected by the engine monitoring system. An abnormal condition that is detected by the engine ECM is communicated over the Cat Data Link to the monitoring system. The following warning indicators are used by the monitoring system in order to communicate the levels of severity that are reported by the engine ECM:

- Check engine lamp
- Action lamp and Advisor message
- Action alarm

The following table summarizes the relationship between the levels of severity that are reported by the engine ECM and the actions that are taken by the monitoring system.

Table 12

VIMS Service Warning for the Engine System			
Warning Category Indicator	Check Engine Lamp	Action Lamp Advisor message	Action Alarm
(1)	The lamp is illuminated.	Off	Off
(2)	The lamp is illuminated.	The lamp will flash. Advisor displays a warning message.	Off
(3) ⁽¹⁾	The lamp is illuminated.	The lamp will flash. Advisor displays a warning message.	The alarm will sound.

⁽¹⁾ The VIMS may also perform an engine shutdown for some level 3 warnings that are reported by the engine ECM. This shutdown will only be performed if the vehicle speed is equal to zero rpm and the parking brake has been engaged.

Parameter Settings of the Engine Monitoring System

The default settings for the parameters are programmed at the factory. The parameter settings for the engine monitoring system can be viewed on Caterpillar Electronic Technician (ET). For information that is related to the engine monitoring system, refer to Troubleshooting, “Engine Monitoring System”.

Table 13

Trip Points for the Monitoring System				
Event Code	Level of Severity	Trip Point and Enabling Conditions	Delay Time in Seconds	Derate (%)
E072 Oil Level Low Mark	(2)	The circuit for the oil level switch is open. This event is enabled when the keyswitch is turned to the ON position.	10	N/A
	(3) ⁽¹⁾	The circuit for the oil level switch is open. This event is enabled 17 seconds after the engine has been started.	12	
E096 High Fuel Pressure	(1)	758 kPa (110 psi)	8	N/A
E099 Engine Oil Filter Restriction Warning (C175-16)	(1)	150 kPa (22 psi) This event is enabled 15 seconds after the engine oil temperature has exceeded 20 °C (68 °F).	10	N/A
E099 Engine Oil Filter Restriction Warning (C175-20)	(1)	180 kPa (26 psi) This event is enabled 15 seconds after the engine oil temperature has exceeded 20 °C (68 °F).	10	N/A
E101 High Crankcase Pressure Warning	(1)	4 kPa (0.6 psi) This event is enabled 15 seconds after the coolant temperature has exceeded 15 °C (59 °F).	5	N/A
E197 High Engine Oil Temperature	(1)	108 °C (226 °F)	15	N/A
	(2)	110 °C (230 °F)		Map Dependent Values
	(3)	115 °C (239 °F)		N/A
E198 Low Fuel Pressure	(1)	Refer to the control map for low fuel pressure in Illustration 21 for details.	10	N/A
	(2)			Map Dependent Values
E232 High Fuel/Water Separator Water Level	(1)	The switch has opened.	40	N/A
	(2)		3600	35
E233 Low Engine Pre-lube Pressure	(2)	48 kPa (7 psi)	45	N/A
E245 High Right Turbo Turbine Inlet Temperature	(2)	750 °C (1380 °F)	15	20
	(3)	845 °C (1550 °F)		N/A
E246 High Left Turbo Turbine Inlet Temperature	(2)	750 °C (1380 °F)	15	20
	(3)	845 °C (1550 °F)		N/A
E360 Low Engine Oil Pressure	(1)	Refer to the control map for low oil pressure in Illustration 22 for details.	8	N/A
	(3) ⁽¹⁾		4	35
E361 High Engine Coolant Temperature	(1)	100 °C (212 °F)	10	N/A
	(2)	101 °C (214 °F)		Map Dependent Values
	(3) ⁽¹⁾	110 °C (230 °F)		N/A
E362 Engine Overspeed	(1)	2250 rpm	0.6	The ECM disables injection above the trip point.
	(2)	2325 rpm		
	(3)	2400 rpm		

(continued)

(Table 13, contd)

Trip Points for the Monitoring System				
Event Code	Level of Severity	Trip Point and Enabling Conditions	Delay Time in Seconds	Derate (%)
E363 High Fuel Supply Temperature	(1)	65 °C (149 °F)	15	N/A
	(2)			Map Dependent Values
E390 Fuel Filter Restriction	(1)	105 kPa (15 psi)	120	N/A
	(2)	124 kPa (18 psi)	14400	35
E396 High Fuel Rail Pressure	(1)	(2)	N/A	N/A
E398 Low Fuel Rail Pressure	(1)	(2)	N/A	N/A
	(2)			100
E539 High Intake Manifold Air Temperature	(1)	65 °C (149 °F)	8	N/A
	(2)	75 °C (167 °F)		30
E583 High Air Inlet #1 Differential Pressure	(1)	(2)	N/A	Map Dependent Values
	(2)			
E584 High Air Inlet #2 Differential Pressure	(1)	(2)	N/A	Map Dependent Values
	(2)			
E585 High Air Inlet #3 Differential Pressure	(1)	(2)	N/A	Map Dependent Values
	(2)			
E586 High Air Inlet #4 Differential Pressure	(1)	(2)	N/A	Map Dependent Values
	(2)			
E678 Ground Level Shutdown	(3)	The ground level switch is on.	N/A	The engine ECM disables fuel injection to the engine.
E770 High Fuel Rail Temperature	(1)	100 °C (212 °F)	15	N/A
	(2)			Map Dependent Values
E2089 Oil Renewal System Cannot Operate	(1)	The ECM detects a fault in the circuit for the oil renewal solenoid. or The ECM detects a fault in the circuit for the coolant temperature sensor. or The ECM detects a fault in the circuit for the fuel level sensor. or The ECM detects a fault in the circuit for the oil pressure sensor.	N/A	N/A
E2112 Low Engine Coolant Pressure	(1)	Refer to the control map for low coolant pressure in Illustration 23 for details.	10	N/A

(continued)

(Table 13, contd)

Trip Points for the Monitoring System				
Event Code	Level of Severity	Trip Point and Enabling Conditions	Delay Time in Seconds	Derate (%)
E2143 Low Engine Coolant Level	(2)	The circuit for the engine coolant level switch is open. This event is enabled when the keyswitch is turned to the ON position.	10	N/A
	(3) ⁽¹⁾	The circuit for the engine coolant level switch is open. This event is enabled 17 seconds after the engine has been started.	12	
E2172 Low Fuel Transfer Pump Inlet Pressure	(1)	50 kPa (7 psi)	60	N/A

(1) The VIMS will perform an engine shutdown when the vehicle speed is equal to zero mph and the parking brake has been engaged.

(2) This code does not have a specific trip point. Several factors determine when the code is tripped.

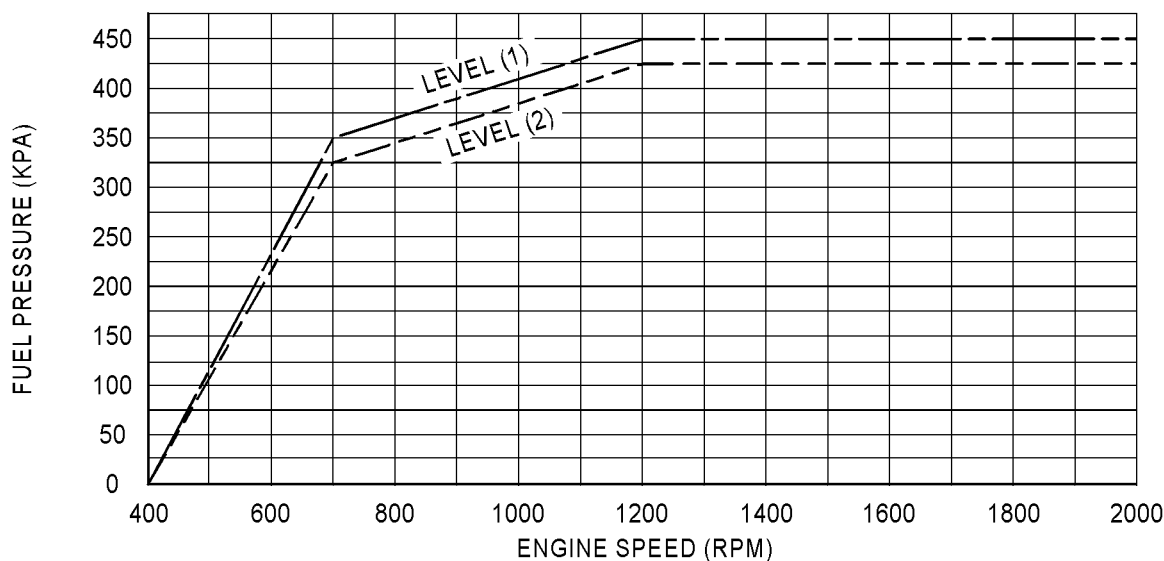


Illustration 21

g01442071

Control map for the engine monitoring system's low fuel pressure

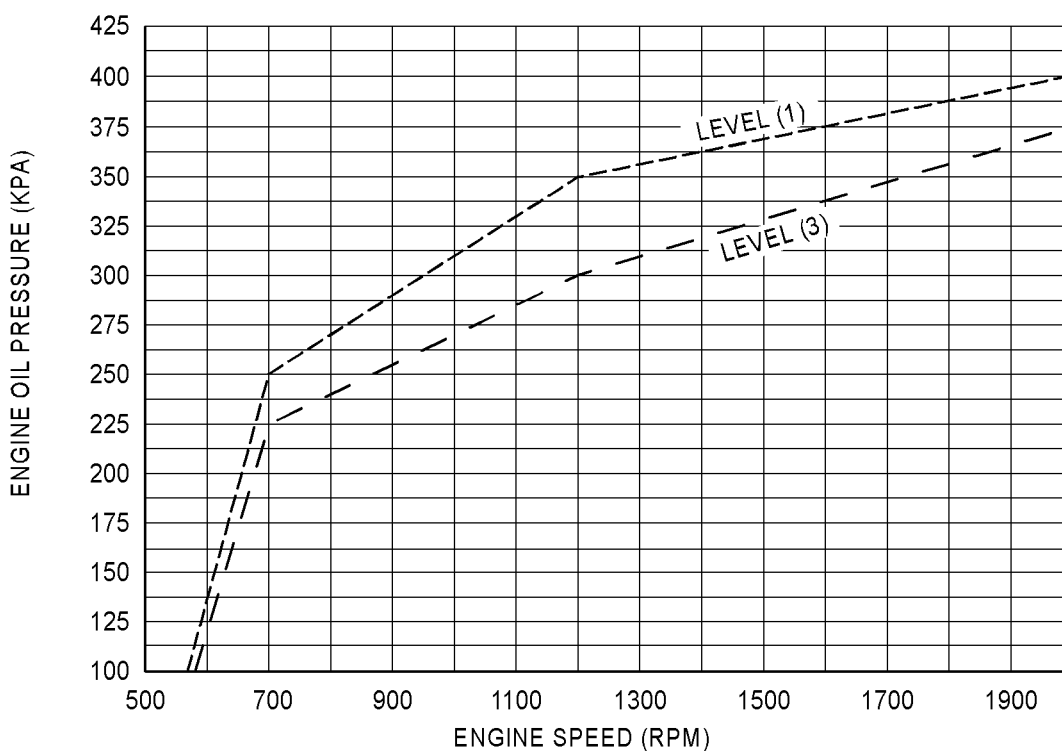


Illustration 22
Control map for the engine monitoring system's low oil pressure

g01442300

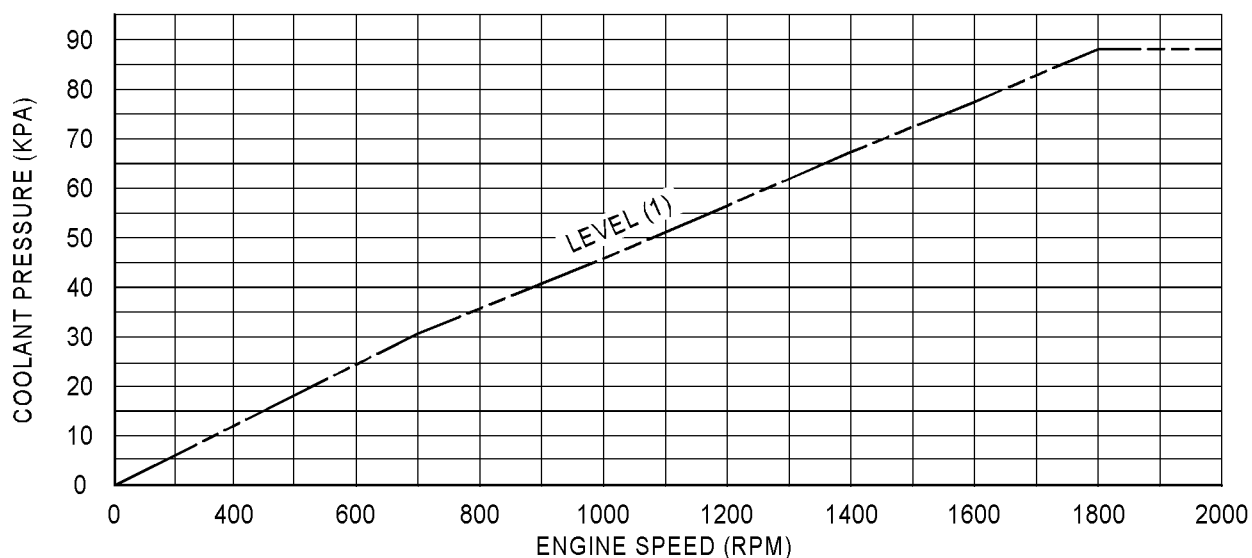


Illustration 23
Control map for the engine monitoring system's low coolant pressure

g01442097

Separate timers are used in the ECM for each response that is associated with a parameter. If a trip point is reached, the timer for that event is started.

Symptom Troubleshooting

i02581026

Symptom Troubleshooting

SMCS Code: 7569

Some engine symptoms can be unrelated to the electronic control system. Gather information about the complaint that describes the symptoms. Verify that the complaint is not due to normal engine operation.

Perform the following steps in order to determine the problem.

1. Repair all active diagnostic codes.
2. Gather operator information.
3. Verify that the complaint is not due to normal engine operation.
4. Perform a visual inspection of the engine. Inspect the following items:
 - Wiring
 - Connectors
 - Fuel level
 - Fuel supply
 - Engine oil level
 - Engine oil supply
 - Coolant level
 - Intake air system
 - Air exhaust system
5. Check the wiring and the connectors for the following problems:
 - Damage
 - Abrasion
 - Corrosion
 - Incorrect attachment
6. 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.

If these inspections do not reveal any problems, use the procedure that best describes the symptoms.

i02581127

Alternator Problem (Charging Problem and/or Noisy Operation)

SMCS Code: 1405-035

Probable Causes

- Alternator drive belts
- Alternator drive pulley
- Alternator bearings
- Charging circuit
- Regulator
- Alternator

Recommended Actions

Alternator Drive Belts

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

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

Alternator Drive Pulley

Check the condition of the alternator drive pulley. Look for deep grooves that have been worn into the pulley by the belt. If there is excessive wear, replace the pulley. Check that the nut for the pulley has not become loose. If necessary, tighten the nut.

Note: Make sure that the alignment is correct.

Alternator Bearings

Check the alternator bearings for signs of wear. Repair the alternator or replace the alternator, as needed.

Charging Circuit

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

Alternator or Regulator

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

i02726474

Coolant Contains Fuel

SMCS Code: 1250-035; 1395-035

Probable Causes

- Injector sleeve or injector sleeve seal

Recommended Actions

Injector Sleeve or Injector Sleeve 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.

Refer to the Systems Operation/Testing and Adjusting manual for details.

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 shutdown, 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 cause damage to 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.

i02883182

Coolant Contains Oil

SMCS Code: 1348-035; 1395-035

Probable Causes

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

Recommended Actions

i02897133

Water Pump

1. Check for leaks around the seal of the water pump. Look for damage to the seal, the impeller shaft, and the impeller shaft bearings. If a leak is identified, replace the damaged components. Refer to the Disassembly and Assembly manual.
2. Drain the crankcase and refill the crankcase with clean engine oil. Install new engine oil filters. Refer to the Operation and Maintenance Manual.

Engine Oil Cooler Core

1. Check for leaks in the oil cooler core. If a leak is found, install a new oil cooler core. Refer to the Disassembly and Assembly manual.
2. Drain the crankcase and refill the crankcase with clean engine oil. Install new engine oil filters. Refer to the Operation and Maintenance Manual.

Cylinder Head Gasket

1. Remove the cylinder head. Refer to the Disassembly and Assembly manual.
2. Check the cylinder liner projection. Refer to the Systems Operation/Testing and Adjusting manual.
3. Install a new cylinder head gasket and new water seals in the spacer plate. Refer to the Disassembly and Assembly manual.

Cylinder Head

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

Cylinder Liner

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

Cylinder Block

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

Coolant Pressure Is Low

SMCS Code: 1395-035

Use this procedure in order to troubleshoot low engine coolant pressure or use this procedure if the following event code is active. Refer to Troubleshooting, "Event Codes" for information about event codes. You must 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".

Table 14

Event Code		
Description	Conditions which Generate this Code	System Response
E2112(1) Low Engine Coolant Pressure	The engine coolant pressure is below the trip point pressure for the programmed delay time.	The code is logged.

Probable Causes

- Low coolant level
- Damaged coolant lines
- Radiator blockage
- Blockage of the oil cooler heat exchanger
- Engine coolant pump outlet pressure sensor
- Jacket water coolant pump

Recommended Actions

Low Coolant Level

Inspect the coolant level. If necessary, add coolant.

Damaged Cooling System's Piping

Perform a visual inspection of the cooling system's piping that is on the engine and on the machine. Look for piping that is damaged, crushed, or bent.

Check the condition of any rubber boots that are used in the circuit. Replace any of the boots that show signs of cracking or collapse.

Radiator Blockage

Check the radiator for internal blockage. Check the temperature difference between the inlet and the outlet of the radiator. Clean the radiator or perform the necessary repairs.

Blockage of the Oil Cooler Heat Exchanger

Internal blockage may be the cause of the low cooling system pressure. Inspect the inlet side of oil cooler heat exchanger for debris and blockage. Clean the oil cooler or perform the necessary repairs.

Engine Coolant Pump Outlet Pressure Sensor



WARNING

Steam or hot coolant can cause severe burns.

Do not loosen the filler cap or the pressure cap on a hot engine.

Allow the engine to cool before removing the filler cap or the pressure cap.

While the engine is off and the cooling system is cool, remove any pressure from the system by carefully removing the pressure cap. While there is no pressure in the cooling system, use Cat ET to check the status of the "Engine Coolant Pump Outlet Pressure (Absolute)" parameter. Compare the status to the status of the "Atmospheric Pressure" parameter. For sensors that are working correctly, the pressures will be comparable.

Install a pressure gauge near the pressure sensor at the outlet of the coolant pump. Start the engine. Use Cat ET to check the status of the "Engine Coolant Pump Outlet Pressure (Absolute)" parameter while the engine is at low engine idle. Compare the gauge reading with the reading from Cat ET. Also, compare the readings during engine operation.

If the readings from the comparative gauge do not agree approximately with Cat ET, troubleshoot the circuit for the pressure sensor. Refer to Troubleshooting, "Sensor Signal (Analog, Active) - Test" for details.

Perform the necessary repairs.

Jacket Water Coolant Pump

Inspect the impeller vanes of the water pump for damage and/or for erosion. Repair impeller vanes. Replace parts, if necessary. Refer to the engine's Disassembly and Assembly manual for details.

i02883183

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. You must 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".

Table 15

Event Code		
Description	Conditions which Generate this Code	System Response
E361(1) High Engine Coolant Temperature	The engine coolant temperature is above the trip point temperature for the programmed delay time.	The code is logged.
E361(2) High Engine Coolant Temperature		The code is logged. Engine power is derated.
E361(3) High Engine Coolant Temperature		The code is logged. If the vehicle's ground speed is zero and the parking brake is set, the engine will be shut down.

Probable Causes

- Low coolant level
- Radiator
- Coolant leak
- Engine cooling fan
- Pressure relief valve
- Electronic fluid temperature control system

- Jacket water coolant pump
- Excessive load on the engine

Recommended Actions

Low Coolant Level

Inspect the coolant level. If necessary, add coolant.

Radiator

Check the cooling fins on the radiator for dirt and/or for debris. Remove the dirt and/or debris.

1. Check the cooling fins on the radiator for damage. Refer to the Systems Operation/Testing and Adjusting manual for instructions for testing and inspecting the cooling system.
2. Check the radiator for internal blockage. Check the temperature difference between the inlet and the outlet of the radiator. Clean the radiator or perform the necessary repairs.

Coolant Leak

Check the cooling system for leaks.

1. Inspect the coolant for presence of bubbles. Cavitation will reduce the efficiency of the cooling system.
2. Check the cooling system for combustion gases. Inspect the cylinder liners for cracks.

Engine Cooling Fan

Check for proper operation of the cooling fan.

Pressure Relief Valve

Check operation of the pressure relief valve and the radiator cap. If necessary, clean the pressure relief valve and/or the radiator cap. Check that the seating surface of the valve is clean and undamaged. If necessary, install new parts.

Electronic Fluid Temperature Control System

Perform the following procedure:

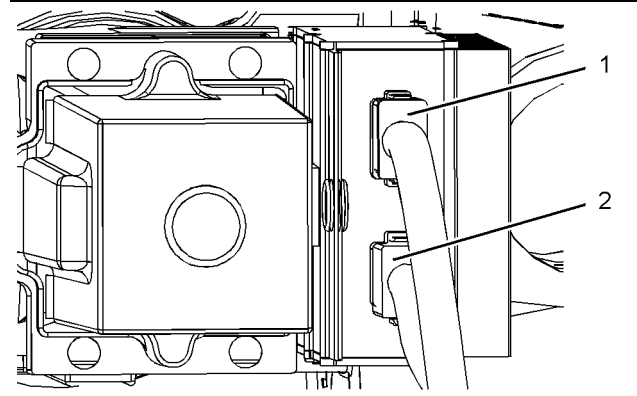


Illustration 24

g01320751

Connector locations for the temperature control module

- (1) 8-pin connector for the motor assembly and the communications device
- (2) 12-pin connector for the engine harness

1. Visually inspect the wiring from the temperature control module to the coolant temperature sensor and from the temperature control module to the power supply. Visually inspect the 12-pin connector and the 8-pin connector at the temperature control module. Check for a tight connection at the connectors.

All wiring and connections must be in good repair.

2. Check for proper operation of the electronic fluid temperature control:
 - a. Ensure that the keyswitch is in the OFF position. Turn the electrical disconnect to the OFF position.

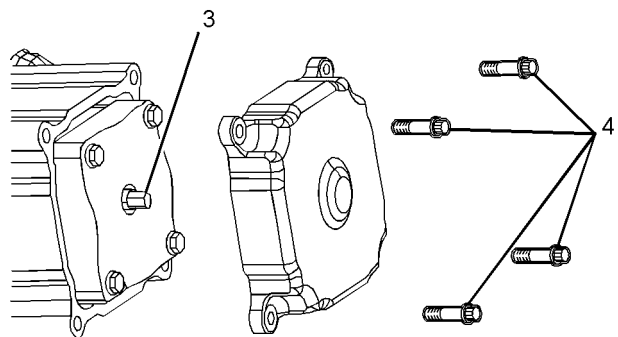


Illustration 25

g01320857

Removing the inspection cover from the motor assembly

- (3) Main shaft extension
- (4) Cover bolts

- b. Remove cover bolts (4) from the motor assembly. Remove the inspection cover from the motor.

- c. Check main shaft extension (3) for rotation while you turn the keyswitch to the ON position. The shaft will rotate several times during the powerup sequence.
- d. During the powerup sequence, listen for the valve to hammer the end stop. The valve will hammer the end stop in order to establish the valve position.
- e. With the keyswitch and the electrical disconnect in the ON position, disconnect the engine harness connector (12 pin) at the controller.
- f. Connect the connector and observe the motor assembly. The valve will repeat the power up sequence when the engine harness (power) is connected. While you connect the connector, check the main shaft extension for rotation. The valve will hammer the end stop.

Turn the keyswitch and the electrical disconnect to the OFF position. Replace the inspection cover and connect all connectors.

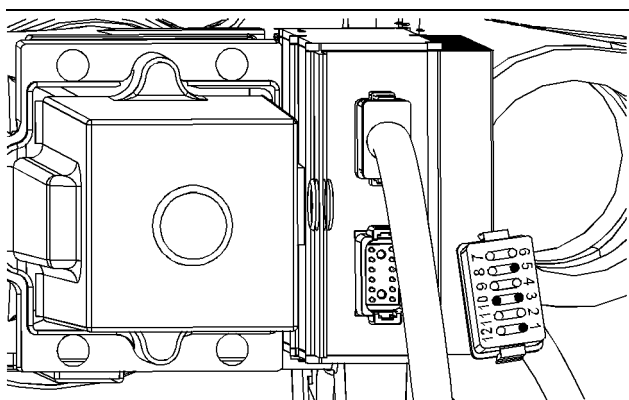


Illustration 26

g01321224

3. Disconnect the engine harness connector (12 pin) at the temperature control module.

Measure the battery voltage between terminal 1 (+Battery) and terminal 5 (return) on the harness side of the engine harness connector (12 pin) at the temperature control module. The supply voltage for the control module must be between 18 VDC and 32 VDC.

Restore the wiring to the original configuration.

If the problem has not been resolved, contact the Service Engineer for further instructions.

Jacket Water Coolant Pump

Inspect the impeller vanes of the water pump for damage and/or for erosion. Repair impeller vanes. Replace parts, if necessary.

Excessive Load on the Engine

Check that the engine is not loaded beyond design.

i02883184

Coolant Temperature Is Low

SMCS Code: 1395-035

Use this procedure in order to troubleshoot a complaint of low coolant temperature for the engine.

Probable Causes

- Very light loads
- Electronic fluid temperature control system

Recommended Actions

Very Light Loads

Very light loads or a very slow engine speed can cause overcooling. This overcooling is caused by the reduced amount of heat that is produced by the engine during light loads.

Electronic Fluid Temperature Control System

Perform the following procedure:

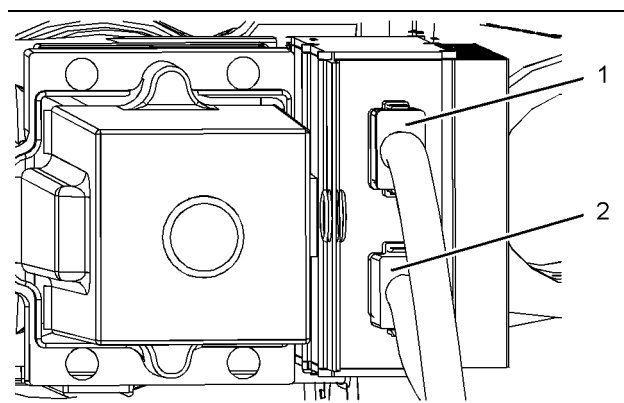


Illustration 27

g01320751

Connector locations for the temperature control module

- (1) 8-pin connector for the motor assembly and the communications device
- (2) 12-pin connector for the engine harness

1. Visually inspect the wiring from the temperature control module to the coolant temperature sensor and from the temperature control module to the power supply. Visually inspect the 12-pin connector and the 8-pin connector at the temperature control module. Check for a tight connection at the connectors.

All wiring and connections must be in good repair.

2. Check for proper operation of the electronic fluid temperature control:
 - a. Ensure that the keyswitch is in the OFF position. Turn the electrical disconnect to the OFF position.

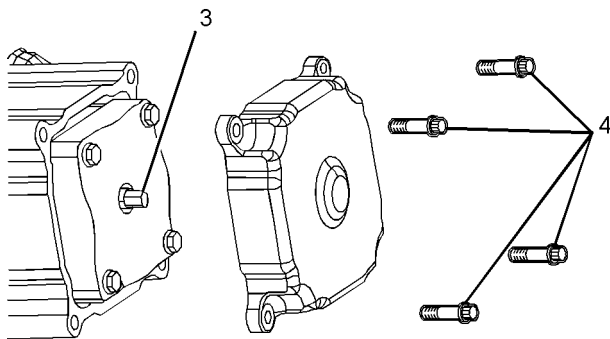


Illustration 28

g01320857

Removing the inspection cover from the motor assembly

- (3) Main shaft extension
(4) Cover bolts

- b. Remove cover bolts (4) from the motor assembly. Remove the inspection cover from the motor.
- c. Check main shaft extension (3) for rotation while you turn the keyswitch to the ON position. The shaft will rotate several times during the powerup sequence.
- d. During the powerup sequence, listen for the valve to hammer the end stop. The valve will hammer the end stop in order to establish the valve position.
- e. With the keyswitch and the electrical disconnect in the ON position, disconnect the engine harness connector (12 pin) at the controller.
- f. Connect the connector and observe the motor assembly. The valve will repeat the power up sequence when the engine harness (power) is connected. While you connect the connector, check the main shaft extension for rotation. The valve will hammer the end stop.

Turn the keyswitch and the electrical disconnect to the OFF position. Replace the inspection cover and connect all connectors.

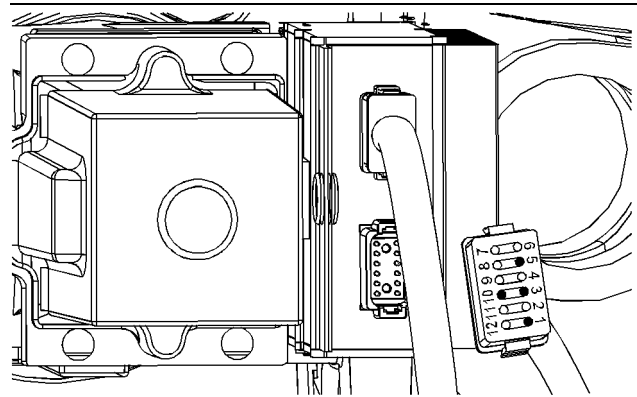


Illustration 29

g01321224

3. Disconnect the engine harness connector (12 pin) at the temperature control module.

Measure the battery voltage between terminal 1 (+Battery) and terminal 5 (return) on the harness side of the engine harness connector (12 pin) at the temperature control module. The supply voltage for the control module must be between 18 VDC and 32 VDC.

Restore the wiring to the original configuration.

i02893388

Crankcase Pressure Is High

SMCS Code: 1201-035-PX

Use this procedure in order to troubleshoot high crankcase pressure or use this procedure if the following event code is active. Refer to Troubleshooting, "Event Codes" for information about event codes. You must 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".

Table 16

Event Code		
Code and Description	Conditions which Generate this Code	System Response
E101(1) High Crankcase Pressure Warning	The engine's crankcase pressure is greater than the trip point pressure for the programmed delay time.	The code is logged.

Probable Causes

- Worn engine components
- Plugged crankcase breather

Recommended Actions

Engine Components

Damaged pistons or rings can cause excessive pressure in the crankcase. This condition may cause the engine to run rough. The engine will begin to emit an excessive volume of fumes (blowby) through the crankcase breather. The breather can then become restricted in a very short time, causing oil leakage at gaskets and seals that would not normally have leakage. Blowby can also be caused by worn valve guides or by a failed turbocharger seal.

Crankcase Breather

A plugged crankcase breather will cause excessive crankcase pressure. This can be the cause of leakage of the crankshaft seal. Sealing of the piston rings can be lost. This will enable crankcase blowby to further increase the crankcase pressure.

i02883186

ECM Does Not Communicate with Other Modules

SMCS Code: 1901-038

Probable Causes

- Electronic Control Module (ECM)
- Electrical connectors
- Data link communications

- Keyswitch power

Recommended Actions

ECM

Connect Caterpillar Electronic Technician (ET). If the ECM does not communicate with Cat ET, refer to service Troubleshooting, "Electronic Service Tool Does Not Communicate".

Note: This application utilizes dual data link communications for communicating with Cat ET. Some functionality will not be available if a single data link is being used for communications with the ECM.

Electrical Connectors

Check for correct installation of the J1/P1 and J2/P2 ECM connectors. Check for correct installation of all other applicable connectors. Refer to service Troubleshooting, "Electrical Connectors - Inspect".

Data Link Communications

Verify communications over the Cat Data Link and the CAN data link. Refer to Troubleshooting, "Data Link - Test" if a problem with communications via the data links is suspected.

Keyswitch Power

Ensure that keyswitch power is being provided to all of the modules that are on the application. Refer to Troubleshooting, "Electrical Power Supply - Test" for information that is related to troubleshooting the engine's keyswitch circuit.

i02883187

Engine Cranks but Does Not Start

SMCS Code: 1000-035; 1450-035

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

Probable Causes

- Diagnostic Codes and Event Codes
- Slow cranking speed
- Battery condition

- Keyswitch power to the Electronic Control Module (ECM)
- ECM supply voltage
- Engine speed/timing signal
- Low pressure fuel system
- High pressure fuel system
- Fuel quality
- Starting aids
- Gear train problem

Recommended Actions

Diagnostic Codes and Event Codes

Connect Caterpillar Electronic Technician to the service tool connector. Check for active diagnostic codes and event codes.

Look for active diagnostic codes or active event codes that are related to the low pressure fuel system, the high pressure fuel system, the engine speed/timing sensors, and the shutdown devices. Check for event codes that are logged repeatedly. This may be evidence of an impending problem. Check for logged events that have a severity of level 3. If a problem has been discovered, perform the necessary repairs. If necessary, use the appropriate circuit test to troubleshoot any active diagnostic codes.

Use Cat ET to confirm the status of any shutdown devices that are installed on the application. If the application has any shutoff devices that are latched mechanically, ensure that the devices have been reset. Also, check the status of any aftermarket shutdown devices that may be installed on the application. If engine starting is being prevented by one of these devices, refer to the OEM information for details.

Slow Cranking Speed

Use Cat to check the engine speed while you crank the engine. If the engine cranks too slowly, the engine will not start. Typically, an engine must crank at an engine speed that is greater than 100 rpm for a duration of four revolutions of the crankshaft in order for the engine to start.

If the engine has a low cranking speed, check for the following problems:

- Low voltage to the electric starting system
- Low air pressure to the air start system

- Excess parasitic load
- Engagement of a single starting motor on a dual starting motor system

Battery Condition

Check the charge on the engine's batteries. Charge the batteries, if necessary. Refer to Special Instruction, SEHS7633, "Battery Test Procedure".

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

Keyswitch Power to the ECM

1. Use a 7X-1708 Multimeter Probe (RED) to check the voltage at terminal location P1-70 of the ECM connector. Use a good source of the chassis ground as the ground circuit.
2. Crank the engine. Use a multimeter to measure the keyswitch power at the ECM while the engine is cranked.
3. Remove the multimeter probes from the engine.

The keyswitch power must be greater than 18 VDC in order for the engine to start. If the keyswitch power is below 18 VDC, troubleshoot the problem. Refer to Troubleshooting, "Electrical Power Supply - Test" for details that are related to troubleshooting a low voltage at the keyswitch circuit.

ECM Supply Voltage

1. Install a 7X-1708 Multimeter Probe (RED) and a 7X-1709 Multimeter Probe (BLACK) onto the test leads of a multimeter.
2. Check the battery supply voltage at the ECM during engine cranking.
 - a. Check the voltage between terminal locations P1-48 (+Battery) and P1-61 (-Battery) while you crank the engine.
 - b. Check the voltage between terminal locations P1-52 (+Battery) and P1-61 (-Battery) while you crank the engine.
 - c. Check the voltage between terminal locations P1-53 (+Battery) and P1-61 (-Battery) while you crank the engine.
 - d. Check the voltage between terminal locations P1-55 (+Battery) and P1-61 (-Battery) while you crank the engine.

- e. Check the voltage between terminal locations P1-57 (+Battery) and P1-61 (-Battery) while you crank the engine.

3. Remove the multimeter probes from the engine.

The supply voltage must be greater than 18 VDC at the ECM in order for the engine to start. If the supply voltage is below 18 VDC, troubleshoot the problem. Refer to Troubleshooting, "Electrical Power Supply - Test" for details that are related to troubleshooting a low voltage at the keyswitch circuit.

Engine Speed/Timing Signal

Use Cat ET to monitor the following status parameters while you crank the engine:

- "Engine Speed Primary Sensor"
- "Engine Speed Secondary Sensor"
- "Engine RPM from Tertiary Speed Sensor"
- "Primary Engine Speed Sensor Timing Pattern Status"
- "Secondary Engine Speed Sensor Timing Pattern Status"
- "Engine Tertiary Speed Sensor Timing Pattern Status"

Ensure that all three of the engine speed sensors are indicating an engine rpm during cranking. Also, ensure that the status of signal patterns for each of the engine speed/timing sensors is "Detected".

Note: The engine will not start if the signal from more than one sensor is missing.

If the operation of any of the engine speed/timing sensors is suspect, refer to Troubleshooting, "Speed/Timing - Test" for information that is related to troubleshooting the engine speed/timing circuit.

Low Pressure Fuel System

1. Perform a visual inspection of the fuel system components.
2. Use Cat ET to verify that the status indicator for Cold Mode is active for cold weather starting.
3. Check the fuel pressure during engine cranking. Check the filtered fuel pressure. Refer to Systems Operation/Testing and Adjusting for the correct pressure values.

4. If the fuel pressure is OK, check for air in the fuel system. Refer to Systems Operation/Testing and Adjusting for details.
5. If the fuel pressure is low, replace the fuel filters. If the problem is not found, refer to Troubleshooting, "Fuel Pressure is Low" for detailed troubleshooting that is related to the low pressure fuel system.

High Pressure Fuel System

Use Cat ET to monitor the "Fuel Rail Pressure (absolute)" status parameter while you crank the engine.

Ensure that the status of the "Fuel Rail Pressure (absolute)" parameter is greater than approximately 40,000 kPa (5800 psi) while you crank the engine. If the fuel rail pressure is below this specification, refer to Troubleshooting, "Fuel Rail Pressure Is Low" in order to troubleshoot the symptom.

Fuel Quality

Check the fuel quality. For further information, refer to the engine's Operation and Maintenance Manual.

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.

Starting Aids

1. Ensure that the ether canister is not empty or low. Replace the ether canister if the ether canister is empty or low. Refer to Troubleshooting, "Ether Starting Aid - Test".
2. Use Cat ET in order to verify that the engine has exited cold mode. During cold mode, fuel injection timing is modified. When the engine is in cold mode, the cold cylinder cutout strategy may be active. Cold mode cylinder cutouts may cause variations in vibration and available power. This is normal operation.

Gear Train Problem

Verify that the crankshaft and the camshaft drive gears are set with the proper orientation for engine timing. Check the gear train for excessive wear. Refer to the Disassembly and Assembly manual.

i02883188

Engine Does Not Crank

SMCS Code: 1000-035; 1450-035

Probable Causes

- Engine shutdown switches
- Diagnostic codes and event codes
- Batteries
- Engine starting system
- Flywheel ring gear
- Transmission
- Power Take-Off (PTO)
- Engine accessories
- Hydraulic cylinder lock
- Internal engine problem

Recommended Actions

Engine Shutdown Switches

The engine shutdown switches should be in the RUN position. Ensure that the ground level shutdown switch and the cab switches are in the proper positions. Use Caterpillar Electronic Technician (ET) to verify the status of the "Shutdown Switch" and the "User Shutdown" parameters. When a shutdown occurs, the keyswitch must be turned to the OFF position for at least 15 seconds prior to attempting to start the engine.

Diagnostic Codes and Event Codes

Connect Cat ET to the service tool connector. Check for active diagnostic codes and event codes.

Look for active diagnostic codes and event codes that will prevent the engine from being started. Also, look for active diagnostic codes and event codes that will prevent the engine from running after being started.

Batteries

Check the charge on the engine's batteries. Charge the batteries, if necessary. Refer to Special Instruction, SEHS7633, "Battery Test Procedure".

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

Engine Starting System

1. **If the application is equipped with an electric starting system, perform the following procedure:**
 - a. Check the wiring to the starting motor solenoid. Refer to the vehicle's electrical schematic.
 - b. Check the engine start switch and the engine start relay for electrical power.
 - c. Check the starting motor cables. If the starting motor cables are corroded, remove the starting motor cables and clean the starting motor cables.
 - d. Test the operation of the starting motors.
2. **If the application is equipped with an air start system, perform the following procedure:**
 - a. Verify that the air start system has an adequate supply pressure for starting.
 - b. Check the wiring to the air start relay that is for the air starting motors. Refer to the application's electrical schematic.
 - c. Check the engine start switch for electrical power.
 - d. Check the air start supply lines. If the supply lines are leaking or damaged, repair the lines.
 - e. Test the operation of the air start motors.

Flywheel Ring Gear

Inspect the flywheel ring gear for damage.

Transmission

Verify that the driveline moves freely.

PTO

Ensure that the PTO system is operating correctly.

Engine Accessories

Remove engine accessories that may prevent the engine cranking and inspect the accessories.

The following accessories may prevent the engine cranking:

- Air compressor
- Air conditioning compressor
- Engine oil pump

- High pressure fuel pump

Hydraulic Cylinder Lock

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

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

Internal Engine Problem

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

- Seizure
- Broken components
- Bent components

i02581286

Engine Has Mechanical Noise (Knock)

SMCS Code: 1000-035

Probable Causes

- Accessory equipment
- Valve train components
- Pistons
- Crankshaft
- Gear train

Recommended Actions

Accessory Equipment

Isolate the source of the noise. 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

Remove the valve mechanism cover. Check the following items for damage: camshaft, valve springs, lifters, pushrods, and bridges. Thoroughly clean the valve train components. If the camshaft is being replaced, also replace the valve lifters. Ensure that all of the valves move freely. Replace any damaged parts.

Pistons

Inspect the pistons for damage and wear. Replace any damaged parts.

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.

Gear Train

Inspect the condition of the gear train. Replace any damaged parts.

Inspect the flywheel and the flywheel bolts.

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

i02902881

Engine Misfires, Runs Rough or Is Unstable

SMCS Code: 1000-035

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

Probable Causes

- Diagnostic codes and event codes
- Cold mode operation and cold cylinder cutout
- Throttle signal
- Fuel quality
- Low pressure fuel system

- High pressure fuel system
- Air inlet and exhaust system
- Electrical connectors
- Valve train components

Recommended Actions

Diagnostic Codes and Event Codes

Connect Caterpillar Electronic Technician (ET) to the service tool connector. Check for active diagnostic codes and event codes.

Look for diagnostic codes that are active or logged. Check for codes that are related to the high pressure fuel system, the low pressure fuel system, and the engine speed/timing circuit. Use the appropriate circuit test to troubleshoot any active codes before continuing.

Also, look for event codes that are active or logged. Check for codes that are related to the low pressure fuel system. If there is evidence of a problem with the fuel system, repair the low pressure fuel system before continuing.

Note: Diagnostic codes that are logged repeatedly could be a sign of intermittent electrical problem. Event codes that are logged repeatedly may be evidence of an impending problem with the engine.

Cold Mode Operation and Cold Cylinder Cutout

Use Cat ET in order to verify that the engine has exited cold mode. During cold mode, fuel injection timing is modified. When the engine is in cold mode, the cold cylinder cutout strategy may be active. Cold mode cylinder cutouts may cause variations in vibration and available power. This is normal operation.

Throttle Signal

Monitor the throttle signal on Cat ET while you actuate the throttle through the entire range of travel. Verify that the throttle signal is smooth from the low idle position to the high idle position.

Fuel Quality

Check the fuel quality. For further information, refer to the engine's Operation and Maintenance Manual.

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.

Low Pressure Fuel System

1. Perform a visual inspection of the fuel system components.
2. Check the fuel pressure during engine cranking. Check the filtered fuel pressure. Refer to Systems Operation/Testing and Adjusting for the correct pressure values.
3. If the fuel pressure is OK, check for air in the fuel system. Refer to Systems Operation/Testing and Adjusting for details.
4. If the fuel pressure is low, replace the fuel filters. If the fuel pressure is still low, refer to Troubleshooting, "Fuel Pressure is Low" for more information that is related to troubleshooting the low pressure fuel system.

High Pressure Fuel System

Fuel Injectors

1. If service has been performed on the engine's fuel system recently, use Cat ET to check that the injector's 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.

Leakage in the High Pressure Fuel System

This engine is equipped with flow limiters that are installed in the high pressure fuel rail. If the fuel flow for a particular cylinder becomes excessive, the flow limiter for that cylinder will trip. The following conditions will cause a flow limiter to trip:

- Excessive fueling by a fuel injector
- Leakage of a connection at the quill tube

Check the high pressure fuel system for leaks:

Test for excess fuel flow through the injectors. Refer to Systems Operation/Testing and Adjusting, "Injector Bypass Fuel Flow - Test" for detailed information.

Check for excess fuel leakage in the fuel rail. Refer to Systems Operation/Testing and Adjusting, "Fuel Rail Leakage - Check" for detailed information.

Air Inlet and Exhaust System

1. Check for an air filter restriction. Clean plugged air filters or replace plugged air filters. Refer to the Operation and Maintenance Manual.
2. If air shutoff valves are installed, verify that the air shutoff valves are fully opened.
3. Check the air inlet and exhaust system for restrictions and/or leaks. Refer to the Systems Operation/Testing and Adjusting for information on the air inlet and exhaust system.

Valve Train Components

Visually inspect the engine's valve train components for excessive wear and/or damage.

Perform valve lash adjustments on affected cylinders. Refer to Systems Operation/Testing and Adjusting, "Engine Valve Lash - Inspect/Adjust" for detailed information.

i02889777

Engine Overspeeds

SMCS Code: 1915-035

Use this procedure in order to troubleshoot engine overspeed or use this procedure if one of the following event codes is active. Refer to Troubleshooting, "Event Codes" for information about event codes. You must 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".

Table 17

Event Code		
Code and Description	Conditions which Generate this Code	System Response
E362(1) Engine Overspeed	The engine rpm has exceeded the trip point for engine overspeed for the delay time.	The code is logged.
E362(2) Engine Overspeed		The Electronic Control Module (ECM) will not power the injectors above the engine high idle speed. The code is logged.
E362(3) Engine Overspeed		

Probable Causes

- Turbocharger oil seal
- Ether starting aid
- Automatic Retarder Control (ARC)

Recommended Actions

Turbocharger Oil Seal

A turbocharger oil seal that is leaking can provide fuel to an engine that would otherwise not be fueled. The oil is passed into the inlet air supply and to the engine. The engine oil provides the engine with combustible fuel.

Remove the inlet air piping from each of the turbocharger compressor housings. Visually inspect the internal portion of each of the compressor housings for engine oil.

Ether Starting Aid

Check for the proper operation of the ether system. A solenoid valve that is sticking may provide the engine with enough combustible fuel for an engine overspeed.

Remove the ether canisters and start the engine. If a problem with the ether system is suspected, make the necessary repairs.

Automatic Retarder Control (ARC)

The ARC is controlled by the brake ECM for the machine. The ARC allows the machine to maintain constant machine speed and engine speed during long downgrades. The ARC also provides protection for the engine in overspeed conditions. Ensure that the ARC is working properly. Refer to the service information that is provided for the machine's brake ECM.

i02897533

Engine Top Speed Is Not Obtained

SMCS Code: 1915-035

Use this procedure in order to troubleshoot a complaint for the engine's inability to reach engine high idle speed.

Probable Causes

- Diagnostic codes, event codes, and engine derates
- Air inlet and exhaust system
- Mechanical engine problem

Recommended Actions

Diagnostic Codes, Event Codes and Engine Derates

Certain diagnostic codes, event codes and/or derates may cause poor performance. 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.

Use Cat ET to check for logged derates. Refer to Troubleshooting, "Event Codes" for the specific events that are applicable to this application. A status screen on Cat ET will display a derate if a derate is active. Also, use Cat ET to view the histograms for intake manifold air temperatures and turbocharger compressor inlet air pressures. Look for intake manifold air temperatures that are greater than 65 °C (149 °F) and look for turbocharger compressor inlet air pressures that are less than 75 kPa (11 psi). Check the portion of the histograms at the time of the low power complaint. If a problem is indicated by the histograms, locate the cause of the problem and perform the necessary repairs.

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. Refer to Systems Operation/Testing and Adjusting.

Mechanical Engine Problem

1. Check for the possibility of a mechanical engine problem that is related to valve train wear, damage to the valve train, or low cylinder compression. Possible causes of low compression are shown in the following list:
 - Faulty piston
 - Faulty piston rings
 - Worn cylinder liners
 - Worn valves
 - Faulty cylinder head gasket
 - Damaged cylinder head
2. Locate the problem and perform all necessary repairs. Ensure that the repairs have eliminated the problem.

i02906097

Engine Vibration Is Excessive

SMCS Code: 1000-035

Probable Causes

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

Recommended Actions

Vibration Damper

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

Engine Supports

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

Driven Equipment

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".

i02898061

Exhaust Has Excessive Black Smoke

SMCS Code: 1088-035; 1250-035

Use this procedure in order to troubleshoot a complaint of excessive black smoke in the engine exhaust.

Probable Causes

- Diagnostic codes and event codes
- Air inlet or exhaust system
- Atmospheric pressure sensor
- Intake manifold pressure sensor
- Fuel quality
- Low pressure fuel system
- Valve lash adjustment
- Gear train problem
- Flash file

Recommended Actions

Diagnostic Codes and Event Codes

Connect Caterpillar Electronic Technician (ET) to the service tool connector. Check for active diagnostic codes and event codes.

Look for diagnostic codes that are active or logged. Check for codes that are related to the high pressure fuel system, the low pressure fuel system, and the engine speed/timing circuit. Use the appropriate circuit test to troubleshoot any active codes before continuing.

Also, look for event codes that are active or logged. Check for codes that are related to the low pressure fuel system. If there is evidence of a problem with the fuel system, repair the low pressure fuel system before continuing.

Note: Diagnostic codes that are logged repeatedly could be a sign of intermittent electrical problem. Event codes that are logged repeatedly may be evidence of an impending problem with the engine.

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 damage or restrictions. Also, inspect the air inlet system for air leaks in the piping.
2. Ensure that the turbochargers are 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

Check the atmospheric pressure sensor for dirt and/or for debris. Remove any dirt and/or debris that is present. The correct reading for the atmospheric pressure is between 50 kPa (7 psi) and 100 kPa (14 psi).

Intake Manifold Pressure Sensor, "Fuel Position", and/or "FRC Fuel Limit"

1. Monitor the status of "Fuel Position" and "Rated Fuel Limit" while the engine is operating under full load. If "Fuel Position" equals "Rated Fuel Limit" and "Fuel Position" is less than "FRC Fuel Limit", the ECM is providing the correct control. Otherwise, proceed to the next Step.
2. Verify that there are no active diagnostic codes for the intake manifold pressure sensor.

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3. Monitor the status of "Intake Manifold Pressure" and "Intake Manifold #2 Pressure" on Cat ET. When the engine is not running, "Intake Manifold Pressure" and "Intake Manifold #2 Pressure" should be approximately 0 kPa (0 psi).

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

Fuel Quality

Check the fuel quality. For further information, refer to the engine's Operation and Maintenance Manual.

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.

Low Pressure Fuel System

1. Perform a visual inspection of the fuel system components.
2. Check the fuel pressure during engine cranking. Check the filtered fuel pressure. Refer to Systems Operation/Testing and Adjusting for the correct pressure values.
3. If the fuel pressure is OK, check for air in the fuel system. Refer to Systems Operation/Testing and Adjusting for details.
4. If the fuel pressure is low, replace the fuel filters. If the fuel pressure is still low, refer to Troubleshooting, "Fuel Pressure is Low" for more information that is related to troubleshooting the low pressure fuel system.

Valve Lash Adjustment

Incorrect valve lash adjustment can be the cause of excessive black smoke in the engine exhaust. Refer to Systems Operation/Testing and Adjusting for information related to valve adjustments.

Gear Train Problem

Verify that the crankshaft and the camshaft drive gears are set with the proper orientation for engine timing. Refer to the Disassembly and Assembly manual.

Flash File

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

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

- Diagnostic codes and event codes
- Starting aids
- Coolant temperature sensor
- Low pressure fuel system
- Cooling system
- Flash file

Recommended Actions

Diagnostic Codes and Event Codes

Connect Caterpillar Electronic Technician (ET) to the service tool connector. Check for active diagnostic codes and event codes.

Look for diagnostic codes that are active or logged. Check for codes that are related to the high pressure fuel system, the low pressure fuel system, and the engine speed/timing circuit. Use the appropriate circuit test to troubleshoot any active codes before continuing.

Also, look for event codes that are active or logged. Check for codes that are related to the low pressure fuel system. If there is evidence of a problem with the fuel system, repair the low pressure fuel system before continuing.

Note: Diagnostic codes that are logged repeatedly could be a sign of intermittent electrical problem. Event codes that are logged repeatedly may be evidence of an impending problem with the engine.

Starting Aids

1. Ensure that the ether canister is not empty or low. Replace the ether canister if the ether canister is empty or low. Refer to Troubleshooting, "Ether Starting Aid - Test".

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2. Use Cat ET in order to verify that the engine has exited cold mode. During cold mode, fuel injection timing is modified. When the engine is in cold mode, the cold cylinder cutout strategy may be active. Cold mode cylinder cutouts may cause variations in vibration and available power. This is normal operation.
3. Check for proper operation of the jacket water heater. Repair the jacket water heater or replace the jacket water heater.

Coolant Temperature Sensor

1. Use Cat ET to verify that the engine has exited cold mode.
2. Compare the coolant temperature from Cat ET to the coolant temperature that is obtained from the 6V-9130 Temperature Adapter (MULTIMETER). Ensure that the temperature readings are reasonable for the conditions that are present.
3. If a problem is suspected with the sensor, refer to Troubleshooting, "Sensor Signal (Analog, Passive) - Test" for details that are related to troubleshooting the sensor and the sensor circuit.

Low Pressure Fuel System

1. Perform a visual inspection of the fuel system components.
2. Check the fuel pressure during engine cranking. Check the filtered fuel pressure. Refer to Systems Operation/Testing and Adjusting for the correct pressure values.
3. If the fuel pressure is OK, check for air in the fuel system. Refer to Systems Operation/Testing and Adjusting for details.
4. If the fuel pressure is low, replace the fuel filters. If the fuel pressure is still low, refer to Troubleshooting, "Fuel Pressure is Low" for more information that is related to troubleshooting the low pressure fuel system.

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.

Flash File

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

Fuel Filter Is Restricted

SMCS Code: 1261-035

Use this procedure in order to troubleshoot a problem with the fuel filters or use this procedure if one of the following event codes is active. Refer to Troubleshooting, "Event Codes" for information about event codes. You must 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".

Table 18

Event Code		
Code and Description	Conditions which Generate this Code	System Response
E390(1) Fuel Filter Restriction	The difference between the filtered fuel pressure and the unfiltered fuel pressure is greater than the trip point pressure for the programmed delay time.	The code is logged.
E390(2) Fuel Filter Restriction		The engine power is derated. The code is logged.

Probable Causes

- Secondary fuel filter elements

Recommended Actions

Fuel Filter Elements

1. Replace the fuel filter elements.
2. Prime the fuel system. Refer to the Operation and Maintenance Manual for information.
3. Restart the engine and check for an active event code.
4. If one of the above event codes remains active, check for logged diagnostic codes that are related to the fuel pressure sensors. If logged codes are present, check for intermittent problems in the harness or in the wiring for the fuel pressure sensors. Refer to Troubleshooting, "Electrical Connectors - Inspect" for information that is related to intermittent electrical problems.

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Fuel Pressure Is High

SMCS Code: 1250-035

Use this procedure in order to troubleshoot a problem with the fuel system or use this procedure if the following event code is active. Refer to Troubleshooting, "Event Codes" for information about event codes. You must 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".

Table 19

Event Code		
Code and Description	Conditions which Generate this Code	System Response
E096(1) High Fuel Pressure	The fuel pressure is above the programmed trip point for the programmed delay time.	The code is logged.

Probable Causes

- Fuel pressure regulating valve
- Fuel lines

Recommended Actions

Fuel Pressure Regulating Valve

A improperly operating fuel pressure regulating valve may cause high fuel pressure. If a problem is suspected, inspect the return fuel pressure regulating valve. Clean any contamination or debris that may keep the regulating valve from operating properly. If debris is present, find the source of the contamination. Replace the return fuel pressure regulating valve if the valve is worn or damaged.

Fuel Lines

Inspect the fuel lines for damage. A restricted return fuel line can increase fuel pressure.

Fuel Pressure Is Low

SMCS Code: 1250-035

Use this procedure in order to troubleshoot a problem with the low pressure fuel system or use this procedure if one of the following event codes is active. Refer to Troubleshooting, "Event Codes" for information about event codes. You must 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".

Table 20

Event Code		
Description	Conditions which Generate this Code	System Response
E198(1) Low Fuel Pressure	The fuel pressure in the engine's low pressure system is below the trip point for the programmed delay time.	The code is logged.
E198(2) Low Fuel Pressure	The fuel pressure in the engine's low pressure system is below the trip point for the programmed delay time.	The code is logged. The engine power is derated.

Probable Causes

- Fuel level
- Vent port at the fuel tank
- Diagnostic codes and event codes
- Fuel filters
- Fuel pressure sensors
- Fuel pressure regulating valve
- Fuel priming pump
- Fuel transfer pump

Recommended Actions

Fuel Level

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

Vent Port at the Fuel Tank

Check the vent port that is at the fuel tank for debris. Clear any restrictions with compressed air.

Note: Do not allow debris to enter the fuel tank while you clean the cap. Damage to the fuel system will occur.

Diagnostic Codes and Event Codes

Connect Cat ET to the service tool connector. Check for active diagnostic codes and event codes.

Look for diagnostic codes that are active or logged. Check for codes that are related to the low pressure fuel system. Use the appropriate circuit test to troubleshoot any active codes before continuing.

Also, look for event codes that are active or logged. Check for codes that are related to the low pressure fuel system. If there is evidence of a problem with the fuel system, repair the low pressure fuel system before continuing.

Note: Diagnostic codes that are logged repeatedly could be a sign of intermittent electrical problem. Event codes that are logged repeatedly may be evidence of an impending problem with the engine.

Fuel Filters

Replace clogged fuel filters.

Fuel Pressure Sensors

Start the engine. Run the engine at low idle. Use Cat ET to monitor the following status parameters:

- “Fuel Transfer Pump Inlet Pressure (absolute)”
- “Unfiltered Fuel Pressure (absolute)”
- “Fuel Pressure (absolute)”

Check the value of each parameter while the engine is at low idle. Ensure that the value for each of the parameters is reasonable.

Increase the engine speed from low engine idle to high engine idle while you monitor the parameters. Ensure that the value of each of the parameters fluctuates with the change in the speed of the engine. Ensure that the value of each of the sensors remains reasonable as the fuel pressure increases. Refer to Systems Operation/Testing and Adjusting for the correct pressure values.

If a problem with one of the sensors is suspected, refer to Troubleshooting, “Sensor Signal (Analog, Active) - Test” for details that are related to troubleshooting a problem with the sensor.

Fuel Pressure Regulating Valve

A fuel pressure regulating valve that is stuck in the open position may cause low fuel pressure. If a problem with the valve is suspected, the problem is probably caused by contamination or debris lodged between the valve and the valve seat. Remove the valve assembly from the fuel filter base. Inspect the valve assembly for contamination or debris. Clean any contamination or debris that may keep the regulating valve open. If debris is present, find the source of the contamination.

If the fuel pressure regulating valve is the suspected cause of the low fuel pressure, replace the valve assembly.

Fuel Priming Pump

The electric fuel priming pump is used to prime the low pressure fuel system prior to engine starting. The low pressure fuel system must be pressurized to approximately 350 kPa (51 psi) (gauge) in order to open the check valves that are for the high pressure pump. Use Cat ET to monitor the “Fuel Pressure (absolute)” parameter during engine cranking. Ensure that the electric fuel priming pump is achieving the correct pressure. Refer to Systems Operation/Testing and Adjusting for additional information that is related to testing the low pressure fuel system.

If the electric fuel priming pump is not generating the correct pressure during engine cranking, replace the electric fuel priming pump.

Fuel Transfer Pump

The fuel transfer pump may not be pumping an adequate volume of fuel in order to maintain the correct pressure in the low pressure fuel system. If the correct pressure in the low pressure fuel system is not maintained during start-up the engine will start, but the engine will not continue running.

Use Cat ET to monitor the “Fuel Pressure (absolute)” status parameter during engine starting. Ensure that the fuel pressure is at least 350 kPa (51 psi) (gauge) during engine cranking. Also ensure that the fuel pressure remains above 350 kPa (51 psi) (gauge) after the engine has started.

If the other components in the fuel system are operating within specifications, and the fuel pressure decreases after starting the engine, replace the fuel transfer pump.

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Fuel Rail Pressure Is High

SMCS Code: 1252-035

Use this procedure in order to troubleshoot a high fuel rail pressure or use this procedure if the following event code is active. Refer to Troubleshooting, “Event Codes” for information about event codes. You must 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”.

Table 21

Event Code		
Description	Conditions which Generate this Code	System Response
E396(1) High Fuel Rail Pressure	The fuel rail pressure is above the trip point pressure for the programmed delay time.	The code is logged.

Probable Causes

- Diagnostic codes and event codes
- Fuel rail pressure sensor
- High pressure fuel pump

Recommended Actions

Diagnostic Codes and Event Codes

Connect Cat ET to the service tool connector. Check for active diagnostic codes and event codes.

Look for active diagnostic codes that are related to the high pressure fuel system and the low pressure fuel system. Use the appropriate circuit test to troubleshoot any active codes before continuing.

Fuel Rail Pressure Sensor

1. With the engine shutdown, use Cat ET to check the status of the “Fuel Rail Pressure (absolute)”. After the engine has been shutdown for ten minutes, the “Fuel Rail Pressure (absolute)” will be less than 5,000 kPa (725 psi) (gauge).

Note: If the pressure is not less than 5,000 kPa (725 psi) (gauge) after ten minutes, vent the pressure from the fuel system. Refer to Systems Operation/Testing and Adjusting, “Fuel Rail Pressure - Release” for information.

If the sensor reports that the pressure that is in the fuel rail is less than 5,000 kPa (725 psi) (gauge) after venting the fuel system, the fuel rail pressure sensor and the sensor’s electrical circuit is OK.

If the sensor reports that the pressure that is in the fuel rail does not fall to less than 5,000 kPa (725 psi) (gauge) after venting the fuel system, there may be a problem with the fuel rail pressure sensor or the electrical circuit for the sensor. Perform the necessary repairs. Refer to Troubleshooting, “Sensor Signal (Analog, Active) - Test” for information that is related to testing the circuit.

High Pressure Fuel Pump

Check for the proper operation of the fuel control valve. Perform the following procedure:

1. Use Cat ET to check the status of the “Percent Fuel Position” parameter.

With the engine shutdown, The “Percent Fuel Position” parameter will read 0 percent.

If the “Percent Fuel Position” does not read zero percent with the engine shutdown, there is a problem with the fuel control valve. Replace the high pressure fuel pump.

2. Start the engine. Run the engine at low engine idle.
3. Use Cat ET to monitor the operation of the parameters that are for fuel control valve:
 - a. Monitor the “Fuel Actuator Position Command” parameter and the “Percent Fuel Position” parameter.
 - b. Monitor the “Desired Fuel Rail Pressure” parameter and the “Fuel Rail Pressure” parameter.
4. Vary the engine speed and the engine load. Continue to monitor the parameters as the engine speed and the engine load is changed.

As you vary the engine speed and the engine load, the “Fuel Actuator Position Command” parameter and the “Percent Fuel Position” parameter will change as the engine speed and load changes. During the proper operation of the fuel control valve, the actual position will closely match the desired position.

If the actual position does not closely match the desired position during testing, replace the high pressure fuel pump. Refer to the Disassembly and Assembly manual for details.

If the actual position closely matches the desired position during testing, the fuel control valve is OK. The high pressure fuel pump is generating too much pressure for the high pressure fuel system. Replace the high pressure fuel pump. Refer to the Disassembly and Assembly manual for details.

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Fuel Rail Pressure Is Low

SMCS Code: 1252-035

Use this procedure in order to troubleshoot a low fuel rail pressure or use this procedure if the following event code is active. Refer to Troubleshooting, “Event Codes” for information about event codes. You must 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”.

Table 22

Event Code		
Description	Conditions which Generate this Code	System Response
E398(1) Low Fuel Rail Pressure	The fuel rail pressure is below the trip point pressure for the programmed delay time.	The code is logged.
E398(2) Low Fuel Rail Pressure		The code is logged. Engine power is derated.

Probable Causes

- Diagnostic codes and event codes
- Low pressure fuel system
- Leakage in the high pressure fuel rail
- Fuel rail pressure sensor

- High pressure fuel pump

Recommended Actions

Diagnostic Codes and Event Codes

Connect Cat ET to the service tool connector. Check for active diagnostic codes and event codes.

Look for active diagnostic codes that are related to the sensors for the low pressure fuel system. Use the appropriate circuit test to troubleshoot any active codes before continuing.

Also, look for active event codes that are related to the low pressure fuel system. Ensure that a low pressure event has not been logged repeatedly for the low pressure fuel system. If there is evidence of a problem with the fuel system, repair the low pressure fuel system before continuing.

Low Pressure Fuel System

Use Cat ET to monitor the “Fuel Pressure (absolute)” status parameter while you operate the engine. Monitor the parameter at all engine speeds.

Ensure that the “Fuel Pressure (absolute)” parameter is greater than 350 kPa (51 psi) (gauge) at low engine idle and that the pressure is at least 450 kPa (65 psi) (gauge) with the engine at high engine idle. If the fuel system has low pressure, refer to Troubleshooting, “Fuel Pressure Is Low” in order to troubleshoot the symptom.

Leakage in the High Pressure Fuel System

Check the high pressure fuel system for leaks:

Check for excess fuel leakage in the fuel rail. Refer to Systems Operation/Testing and Adjusting, “Fuel Rail Leakage - Check” for detailed information.

Test for excess fuel flow through the injectors. Refer to Systems Operation/Testing and Adjusting, “Injector Bypass Fuel Flow - Test” for detailed information.

Fuel Rail Pressure Sensor

1. With the engine shutdown, use Cat ET to check the status of the “Fuel Rail Pressure (absolute)”. After the engine has been shutdown for ten minutes, the “Fuel Rail Pressure (absolute)” will be less than 5,000 kPa (725 psi) (gauge).

Note: If the pressure is not less than 5,000 kPa (725 psi) (gauge) after ten minutes, vent the pressure from the fuel system. Refer to Systems Operation/Testing and Adjusting, “Fuel Rail Pressure - Release” for information.

If the sensor reports that the pressure that is in the fuel rail is less than 5,000 kPa (725 psi) (gauge) after venting the fuel system, the fuel rail pressure sensor and the sensor’s electrical circuit is OK.

If the sensor reports that the pressure that is in the fuel rail does not fall to less than 5,000 kPa (725 psi) (gauge) after venting the fuel system, there may be a problem with the fuel rail pressure sensor or the electrical circuit for the sensor. Perform the necessary repairs. Refer to Troubleshooting, “Sensor Signal (Analog, Active) - Test” for information that is related to testing the circuit.

High Pressure Fuel Pump

Check for the proper operation of the fuel control valve. Perform the following procedure:

1. Use Cat ET to check the status of the “Percent Fuel Position” parameter.

With the engine shutdown, The “Percent Fuel Position” parameter will read 0 percent.

If the “Percent Fuel Position” does not read zero percent with the engine shutdown, there is a problem with the fuel control valve. Replace the high pressure fuel pump.

2. Start the engine. Run the engine at low engine idle.
3. Use Cat ET to monitor the operation of the parameters for fuel control valve:
 - a. Monitor the “Fuel Actuator Position Command” parameter and the “Percent Fuel Position” parameter.
 - b. Monitor the “Desired Fuel Rail Pressure” parameter and the “Fuel Rail Pressure” parameter.
4. Vary the engine speed and the engine load. Continue to monitor the parameters as the engine speed and the engine load is changed.

As you vary the engine speed and the engine load, the “Fuel Actuator Position Command” parameter and the “Percent Fuel Position” parameter will change as the engine speed and load changes. During the proper operation of the fuel control valve, the actual position will closely match the desired position.

If the actual position does not closely match the desired position during testing, replace the high pressure fuel pump. Refer to the Disassembly and Assembly manual for details.

If the actual position closely matches the desired position during testing and the fuel rail pressure remains low, the fuel control valve is OK. The high pressure fuel pump is not generating the correct fuel pressure. Replace the high pressure fuel pump. Refer to the Disassembly and Assembly manual for details.

i02882715

Fuel Temperature Is High

SMCS Code: 1250-035

Use this procedure in order to troubleshoot high fuel temperature or use this procedure if one of the following event codes is active. Refer to Troubleshooting, “Event Codes” for information about event codes. You must 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”.

Table 23

Event Code		
Description	Conditions which Generate this Code	System Response
E363(1) High Fuel Temperature Warning	The fuel temperature of the low pressure fuel system is above the trip point for the programmed delay time.	The code is logged.
E363(2) High Fuel Temperature Derate		The code is logged. Engine power will be derated.
E770(1) High Fuel Rail Temperature Warning	The fuel temperature of the high pressure system is above the trip point for the programmed delay time.	The code is logged.
E770(2) High Fuel Rail Temperature Derate		The code is logged. Engine power will be derated.

Probable Causes

- Diagnostic codes and event codes
- Fuel pressure regulating valve
- Fuel level
- Fuel temperature sensors

Recommended Actions

Diagnostic Codes and Event Codes

Connect Cat (ET) to the service tool connector.
Check for active diagnostic codes and event codes.

Look for active diagnostic codes that are related to the high pressure fuel system and the low pressure fuel system. Use the appropriate circuit test to troubleshoot any active diagnostic codes before continuing.

Also, check for logged diagnostic codes. Use the time stamps that are for the logged events in order to determine when the events have been active. If the E770 was active and the E363 was not active, there may be a problem with the high pressure fuel pump. Perform the following procedure:

1. Start the engine. Run the engine until normal operating temperature is achieved.
2. Use Cat ET to monitor the following parameters:
 - "Fuel Temperature"
 - "Fuel Rail Temperature"
3. Compare the value of each parameter while the engine is at normal operating temperature. Check that temperature difference across the high pressure fuel pump does not exceed 40 °C (104 °F).

If the temperature difference across the pump exceeds this specification, the high pressure fuel pump is producing excessive heat. Replace the high pressure fuel pump.

Fuel Pressure Regulating Valve

An improperly operating fuel pressure regulating valve may cause high fuel temperature. If a problem is suspected, inspect the regulating valve for contamination or debris. Clean any contamination or debris that may keep the valve from operating properly. If debris is present, locate the source of the contamination. If the return fuel pressure regulating valve is suspect, replace the valve assembly.

Fuel Level

Check the fuel level in the fuel tanks. Typically, as the level of the fuel in the tank decreases, the fuel temperature will increase.

Fuel Temperature Sensors

Ensure that the value for each of the parameters is reasonable.

i02894341

Fuel Transfer Pump Inlet Pressure Is Low

SMCS Code: 1256-035

Use this procedure in order to troubleshoot a problem with the fuel system or use this procedure if the following event code is active. Refer to Troubleshooting, "Event Codes" for information about event codes. You must 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".

Table 24

Event Code		
Description	Conditions which Generate this Code	System Response
E2172(1) Low Fuel Transfer Pump Inlet Pressure	The gauge pressure (vacuum) of the fuel at the inlet of the fuel transfer pump drops below -50 kPa (-7 psi) for the programmed delay time.	The code is logged.

Probable Causes

- Fuel shutoff valve
- Fuel level
- Primary fuel filter/water separator
- Fuel lines

Recommended Actions

Fuel Shutoff Valve

Check that the fuel shutoff valve is in the ON position.

Fuel Level

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

Primary Fuel Filter/Water Separator

Inspect the fuel/water separator for water and debris. Drain the water from the water trap. If necessary, replace the primary fuel filter element. Refer to the Operation and Maintenance Manual for information.

Fuel Lines

Check the fuel system's suction lines from the tank to the electric fuel priming pump. Check the engine's fuel lines from the electric fuel priming pump to the fuel transfer pump.

Check fuel lines for the following problems: restrictions, collapse, and pinched line. Ensure that the lines are not routed through pinch points. If any of the lines are suspect, repair the lines and/or replace the lines.

Check all of the fuel lines for debris. If debris is found in the fuel lines, locate the source of the contamination. Correct the problem. Clean the fuel system before returning the engine to service.

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

Prime the fuel system after replacement of the fuel filters or fuel injectors. Prime the fuel system after work has been performed on the low pressure fuel supply circuit.

Note: 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.

i02881193

Inlet Air Is Restricted

SMCS Code: 1087-035

Use this procedure in order to troubleshoot a high differential pressure for the air inlet system or use this procedure if one of the following event codes are active. Refer to Troubleshooting, "Event Codes" for information about event codes. You must 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".

Table 25

Event Code		
Description	Default Conditions which Generate this Code	System Response
E583(1) High Air Inlet #1 Differential Pressure	The inlet air restriction is above the trip point pressure for the delay time.	The code is logged.
E583(2) High Air Inlet #1 Differential Pressure		Engine power will be derated. The code is logged.
E584(1) High Air Inlet #2 Differential Pressure	The inlet air restriction is above the trip point pressure for the delay time.	The code is logged.
E584(2) High Air Inlet #2 Differential Pressure		Engine power will be derated. The code is logged.
E585(1) High Air Inlet #3 Differential Pressure	The inlet air restriction is above the trip point pressure for the delay time.	The code is logged.
E585(2) High Air Inlet #3 Differential Pressure		Engine power will be derated. The code is logged.
E586(1) High Air Inlet #4 Differential Pressure	The inlet air restriction is above the trip point pressure for the delay time.	The code is logged.
E586(2) High Air Inlet #4 Differential Pressure		Engine power will be derated. The code is logged.

Probable Causes

- Air filter element
- Atmospheric pressure sensor, turbocharger compressor inlet pressure sensors, and/or sensor circuits

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.

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)”
- “Turbocharger #2 Compressor Inlet Pressure (absolute)”
- “Turbocharger #3 Compressor Inlet Pressure (absolute)”
- “Turbocharger #4 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 three minutes. Cat ET will report “Conditions Not Met” for these parameters prior to this delay time.

Check that the sensors are correctly wired.

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 all four of the turbocharger compressor inlet pressure sensors will be approximately the same value that is reported by the atmospheric pressure sensor. If the readings do not agree, troubleshoot the sensor circuit(s) for the suspect sensor. Refer to Troubleshooting, “Sensor Signal (Analog, Active) - Test”.

i02898196

Intake Manifold Air Temperature Is High

SMCS Code: 1058-035-TA

Use this procedure in order to troubleshoot high intake manifold air temperature or use this procedure if one of the following event codes is active. Refer to Troubleshooting, “Event Codes” for information about event codes. You must 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”.

Table 26

Event Code		
Code and Description	Conditions which Generate this Code	System Response
E539(1) High Intake Manifold Air Temperature	The intake manifold air temperature is above the trip point for the delay time.	The code is logged.
E539(2) High Intake Manifold Air Temperature		The code is logged. Engine power is derated.

Probable Causes

- High coolant temperature
- High ambient air temperature
- Air inlet restriction
- Exhaust restriction
- Altitude
- Engine Overload

Recommended Actions

High Coolant Temperature

A high coolant temperature will increase the intake manifold air temperature.

Verify that the cooling system is filled to the proper level. If the coolant level is too low, air will get into the cooling system. Air in the cooling system will cause a reduction in coolant flow.

Check the operation of the cooling fan. A fan that is not turning at the correct speed can cause improper air speed across the aftercooler core. The lack of proper air flow across the aftercooler core can cause the intake air not to cool to the proper temperature.

Check for air in the cooling system. Air can enter the cooling system in different ways. The most common causes of air in the cooling system are the incorrect filling of the cooling system and combustion gas leakage into the cooling system. Combustion gas can get into the system through inside cracks, a damaged cylinder head, or a damaged cylinder head gasket.

High Ambient Air Temperature

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

Inlet Air Restriction

Check for a restriction in the air inlet system. A restriction of the air that is coming into the engine can cause high cylinder temperatures. High cylinder temperatures cause higher than normal temperatures in the cooling system. The coolant temperature must be within the correct range in order to cool the intake air.

Exhaust Restriction

Check for a restriction in the exhaust system. A restriction of the air that is coming out of the engine can cause high cylinder temperatures.

Altitude

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.

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.

i02612438

Oil Consumption Is Excessive

SMCS Code: 1348-035

Probable Causes

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

Recommended Actions

Oil Leaks

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

Oil Level

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

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

Turbocharger Seal

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

Internal Engine Wear

Internal engine wear or damage can cause excessive oil leakage into the combustion area of the cylinders. Inspect the following components for excessive wear or damage:

- Faulty piston
- Worn piston rings
- Worn cylinder bores
- Worn valves
- Faulty cylinder head gasket
- Damaged cylinder head

i02612458

Oil Contains Coolant

SMCS Code: 1348-035; 1395-035

Probable Causes

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

- Cylinder block

Recommended Actions

Engine Oil Cooler Core

1. Check for leaks in the oil cooler core. If a leak is found, install a new oil cooler core. Refer to the Disassembly and Assembly manual.
2. Drain the crankcase and refill the crankcase with clean engine oil. Install new engine oil filters. Refer to the Operation and Maintenance Manual.

Cylinder Head Gasket

1. Remove the cylinder head. Refer to the Disassembly and Assembly manual.
2. Check the cylinder liner projection. Refer to the Systems Operation/Testing and Adjusting manual.
3. Install a new cylinder head gasket and new water seals in the spacer plate. Refer to the Disassembly and Assembly manual.

Cylinder Head

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

Cylinder Liner

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

Cylinder Block

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

i02643283

Oil Contains Fuel

SMCS Code: 1250-035; 1348-035

Probable Causes

- Fuel injector seals
- Fuel injector tip
- Fuel transfer pump seal

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

Recommended Actions

Fuel Injector Seals

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

Fuel Injector Tip

Look for signs of damage to the fuel injectors. Check the fuel injector tip for cracks or breakage. If necessary, replace the unit injectors.

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, repair the fuel transfer pump or replace the fuel transfer pump.

i02881056

Oil Filter Differential Pressure Problem

SMCS Code: 1308-035-PX

Use this procedure in order to troubleshoot abnormal oil filter differential pressure or use this procedure if the following event code is active. Refer to Troubleshooting, "Event Codes" for information about event codes. You must 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".

Table 27

Event Code		
Code and Description	Conditions which Generate this Code	System Response
E99(1) Engine Oil Filter Restriction Warning	The difference between the filtered oil pressure and the unfiltered oil pressure is greater than the trip point pressure.	The code is logged.

Probable Causes

- Oil filter
- Oil pressure sensors and/or circuits
- Oil filter bypass valve

Recommended Actions

Oil Filters

Check the oil filter differential pressure. If the oil filter differential pressure is too high, the problem is probably a plugged oil filter. Replace the oil filter elements.

Inspect the condition of the oil filters. Replace any suspect oil filter.

Oil Pressure Sensors and/or Circuits

Use the Cat ET to compare the readings of the "Unfiltered Oil Pressure (abs)" and the "Engine Oil Pressure (abs)" while the engine is off. Check that the sensors are correctly wired.

If a reading is significantly different from the atmospheric pressure, troubleshoot the sensor circuit(s). Refer to Troubleshooting, "Sensor Signal (Analog, Active) - Test".

Oil Filter Bypass Valve

An oil filter bypass valve that is stuck in the closed position can cause a high reading for differential pressure when the oil is cold. An oil filter bypass valve that is stuck in the open position can cause a low reading for differential pressure when the oil is hot. Check the operation of the oil filter bypass valve. For more information, refer to Systems Operation/Testing and Adjusting.

If the oil filter bypass valve is faulty, repair the valve, when possible. Replace the valve, if necessary.

i02880997

Oil Pressure Is Low

SMCS Code: 1348-035-PX

Use this procedure in order to troubleshoot low engine oil pressure or use this procedure if one of the following event codes is active. Refer to Troubleshooting, "Event Codes" for information about event codes. You must 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".

Table 28

Event Code		
Code and Description	Conditions which Generate this Code	System Response
E360(1) Low Engine Oil Pressure	The engine oil pressure is below the trip point and the delay time has expired.	The code is logged.
E360(3) Low Engine Oil Pressure		The code is logged. Engine power is derated. If the vehicle's ground speed is zero and the parking brake is set, the engine will be shut down.

Probable Causes

- Low engine oil level
- Incorrect viscosity
- Contaminated engine oil
- Faulty oil pressure sensors
- Poor circulation of the engine oil
- Worn components

Recommended Actions

Low Engine Oil Level

Check the oil level. Add oil, as needed.

Incorrect Viscosity

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.

Contaminated Engine Oil

Engine oil that is contaminated with another liquid will cause low engine oil pressure. High engine oil level can be an indication of contamination. Obtain an analysis of the engine oil. Determine the reason for contamination of the engine oil and make the necessary repairs. Change the engine oil and the engine oil filter. For the correct engine oil to use, refer to the Operation and Maintenance Manual.

Faulty Engine Oil Pressure Sensors

Use the Cat ET to compare the readings of the "Unfiltered Oil Pressure (abs)" and the "Engine Oil Pressure (abs)" while the engine is off. Check that the sensors are correctly wired.

If a reading is significantly different from the atmospheric pressure, troubleshoot the sensor circuit(s). Refer to Troubleshooting, "Sensor Signal (Analog, Active) - Test".

Poor Circulation of the Engine Oil

Several factors could cause poor circulation of the engine oil:

The engine oil filter may be clogged. Replace the engine oil filter.

An engine oil line or a passage for engine oil may be disconnected or broken.

The engine oil cooler may be clogged. Thoroughly clean the engine oil cooler.

There may be a problem with a piston cooling jet. Breakage, a restriction, or incorrect installation of a piston cooling jet will cause seizure of the piston.

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.

The suction tube may be drawing in air. Check the joints of the tube for cracks or for a damaged O-ring seal.

There may be a problem with the engine oil pump. Check the gears of the engine oil pump for excessive wear. Engine oil pressure is reduced by gears that have too much wear.

The engine oil pump's pressure regulating valve or a bypass valve is stuck in the open position. Clean the valve. Replace parts, if necessary.

Worn Components

Excessive clearance at the crankshaft or camshaft bearings will cause low engine oil pressure. Also, inspect the clearance between the rocker arm shafts and the rocker arms. Check the engine components for excessive clearance.

Obtain an analysis of the engine oil. Check the analysis for the level of wear metals in the engine oil.

i02880700

Oil Temperature Is High

SMCS Code: 1348-035-TA

Use this procedure in order to troubleshoot high oil temperature or use this procedure if one of the following event codes is active. Refer to Troubleshooting, "Event Codes" for information about event codes. You must 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".

Table 29

Event Code		
Code and Description	Conditions which Activate the Code	System Response
E197(1) High Engine Oil Temperature	The engine oil temperature has exceeded the trip point and the delay time has expired.	The code is logged.
E197(2) High Engine Oil Temperature		The code is logged. Engine power is derated.
E197(3) High Engine Oil Temperature		The code is logged.

Probable Causes

- Engine oil level
- Engine oil cooler bypass valve
- Engine oil cooler core
- Engine coolant temperature

Recommended Actions

Engine Oil Level

Check the oil level. Add oil, as needed.

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. Refer to Systems Operation/Testing and Adjusting.

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 Coolant Temperature

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

i02881069

Power Is Intermittently Low or Power Cutout Is Intermittent

SMCS Code: 1000-035-PWR

Probable Causes

- Engine derate
- Low pressure fuel system
- High pressure fuel system
- Cold mode operation and cold cylinder cutout
- Throttle signal
- Air inlet and exhaust system
- Flash file
- Air shutoff valve (if applicable)

Recommended Actions

Engine Derate

Connect Caterpillar Electronic Technician (ET) and check for logged derate events that derate engine power. An engine derate indicator will appear on Cat ET if an active engine derate is occurring.

Low Pressure Fuel System

1. Perform a visual inspection of the fuel system components.
2. Check the fuel pressure during engine cranking. Check the filtered fuel pressure. Refer to Systems Operation/Testing and Adjusting for the correct pressure values.
3. If the fuel pressure is OK, check for air in the fuel system. Refer to Systems Operation/Testing and Adjusting for details.
4. If the fuel pressure is low, replace the fuel filters. If the fuel pressure is still low, refer to Troubleshooting, "Fuel Pressure is Low" for more information that is related to troubleshooting the low pressure fuel system.

High Pressure Fuel System

Fuel Injectors

1. If service has been performed on the engine's fuel system recently, use Cat ET to check that the injector's 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.

Leakage in the High Pressure Fuel System

This engine is equipped with flow limiters that are installed in the high pressure fuel rail. If the fuel flow for a particular cylinder becomes excessive, the flow limiter for that cylinder will trip. The following conditions will cause a flow limiter to trip:

- Excessive fueling by a fuel injector
- Leakage of a connection at the quill tube

Check the high pressure fuel system for leaks:

Test for excess fuel flow through the injectors. Refer to Systems Operation/Testing and Adjusting, "Injector Bypass Fuel Flow - Test" for detailed information.

Check for excess fuel leakage in the fuel rail. Refer to Systems Operation/Testing and Adjusting, "Fuel Rail Leakage - Check" for detailed information.

Cold Mode Operation and Cold Cylinder Cutout

Use Cat ET in order to verify that the engine has exited cold mode. Check the status indicators for "Cold Mode" and "Cold Cylinder Cutout". During cold mode, fuel injection timing is modified. When the engine is in cold mode, the cold cylinder cutout strategy may be active. The cold cylinder cutout strategy may cause variations in vibration and available power after a cold engine has been started. This is normal operation.

Throttle Signal

Use Cat ET in order to monitor the status of the throttle. Observe the throttle position. Verify that the throttle position is smooth from low idle to high idle. The throttle position should reach at least 90 percent at high idle.

Air Inlet and Exhaust System

1. Check for an air filter restriction. Clean plugged air filters or replace plugged air filters. Refer to the Operation and Maintenance Manual.
2. If air shutoff valves are installed, verify that the air shutoff valves are fully opened.
3. Check the air inlet and exhaust system for restrictions and/or leaks. Refer to the Systems Operation/Testing and Adjusting for information on the air inlet and exhaust system.

Flash File

Verify that the latest flash file has been installed in the engine's Electronic Control Module (ECM).

Air Shutoff Valve (If Equipped)

Check that both of the air shutoffs are open.

i02881185

Prelubrication Pump Problem

SMCS Code: 1319-035

Use this procedure in order to troubleshoot low prelube oil pressure or use this procedure if the following event code is active. Refer to Troubleshooting, "Event Codes" for information about event codes. You must 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".

Table 30

Event Code		
Code and Description	Conditions which Generate this Code	System Response
E233(2) Low Engine Pre-lube Pressure	The minimum pressure for the engine prelube sequence was not achieved. This event is disabled while the oil temperature is above 50 °C (122 °F).	The code is logged. The engine is not allowed to start.

Probable Causes

- Engine oil level
- Electrical power to the prelube pump motor
- Inadequate prelubrication pressure

Recommended Actions

Engine Oil Level

Check the engine oil level. Refer to the Operation and Maintenance Manual for details. If necessary, add engine oil to the engine. Inspect the lubrication system for leaks.

Electrical Power to the Prelube Pump Motor

Ensure that the prelube pump motor is wired correctly.

Connect Cat ET to the service tool connector. Check for active diagnostic codes and logged diagnostic codes that are related to the engine's prelubrication pump. Troubleshoot any codes that are active or logged before continuing. Refer to Troubleshooting, "Prelubrication - Test" for information that is related to the pump circuit.

Inadequate Prelubrication Pressure

Use Cat ET to monitor the engine oil pressure during the engine's prelube cycle. The prelube pump must be able to achieve 48 kPa (7 psi) in order to complete the cycle. If the pump fails to build the correct pressure during the cycle, repair the pump or replace the pump.

Note: If you are starting an engine that is near operating temperature, expect an extended prelube cycle. The prelubrication of the engine may be 45 seconds in order to be completed. This is due to the decreased viscosity of the hot engine oil.

i02882864

Turbocharger Turbine Temperature Is High

SMCS Code: 1052-035-TA

Use this procedure in order to troubleshoot a high turbocharger turbine inlet temperature or use this procedure if one of the following event codes is active. Refer to Troubleshooting, "Event Codes" for information about event codes. You must 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".

Table 31

Event Code		
Code and Description	Conditions which Generate this Code	System Response
E245(1) High Right Turbo Turbine Inlet Temperature	The exhaust temperature is above the trip point temperature.	The code is logged.
E245(2) High Right Turbo Turbine Inlet Temperature		The engine is derated. The code is logged.
E245(3) High Right Turbo Turbine Inlet Temperature		The code is logged.
E246(1) High Left Turbo Turbine Inlet Temperature	The exhaust temperature is above the trip point temperature.	The code is logged.
E246(2) High Left Turbo Turbine Inlet Temperature		The engine is derated. The code is logged.
E246(3) High Left Turbo Turbine Inlet Temperature		The code is logged.

Probable Causes

- Diagnostic codes and event codes
- Air inlet and exhaust system
- Fuel injectors
- Aftercooler
- Accessory equipment

Recommended Actions

Diagnostic Codes and Event Codes

Connect Cat (ET) to the service tool connector. Check for active diagnostic codes and event codes.

Look for active diagnostic codes that are related to the high pressure fuel system and the low pressure fuel system. Use the appropriate circuit test to troubleshoot any active codes before continuing.

Also, look for active event codes that are related to a low fuel pressure for the high pressure fuel rail. Ensure that a low pressure event has not been logged repeatedly for the high pressure fuel system. If a problem with the high pressure fuel system is suspected, refer to Troubleshooting, "Fuel Rail Pressure is Low" for troubleshooting information.

Air Inlet and Exhaust System

Check for air inlet restrictions and/or leaks. A one degree increase in the inlet manifold temperature will increase the exhaust temperature by approximately three degrees. Check for leaks between the exhaust manifold and the turbochargers. Check for exhaust restrictions. Refer to the Systems Operation/Testing and Adjusting manual for more information that is related to inspecting the air inlet and exhaust system.

Fuel Injectors

Faulty injectors that deliver too much fuel will increase exhaust temperatures. Connect Cat ET in order to determine if any diagnostic codes for the injector solenoids are present.

Perform the "Injector Solenoid Test". Check that the injector solenoids are "OK" on Cat ET.

Perform the "Cylinder Cutout Test". Locate the misfiring cylinder and correct the problem.

Perform the "Fuel System Verification Test". Identify any problem injectors and perform the necessary repairs.

Refer to Troubleshooting, "Injector Solenoid - Test".

Aftercooler

Normal intake manifold pressure with high exhaust temperature can be caused by blockage of the fins of the aftercooler core.

If the application has an aftercooler, check the aftercooler for plugging. Check for blockage in the cores of the aftercooler.

Accessory Equipment

Check all flywheel and damper driven equipment for proper operation. Ensure that the accessory equipment is not lugging down the engine.

Valve Lash Is Excessive

SMCS Code: 1105-035

Probable Causes

- Lubrication
- Valve lash
- Valve train components

Recommended Actions

Lubrication

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

Valve Lash

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

Valve Train Components

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

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

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

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

i02899462

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 in the event that the coolant level is low. The coolant level sensor is located on the expansion tank of the radiator.

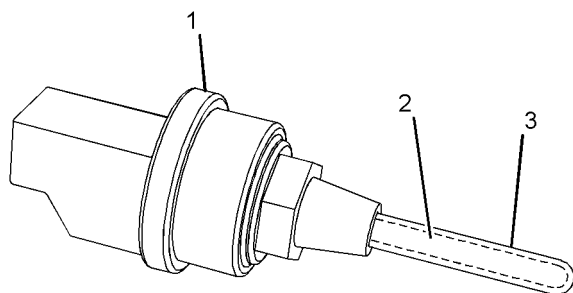


Illustration 30

g01150024

Components of the coolant level sensor

- (1) Sensor
- (2) Sensor probe (brass dowel)
- (3) Plastic cover

Coolant level sensor (1) contains no moving parts. The sensor provides the same function as a switch. The state of the switch is dependent on the capacitance value that is detected at the probe of the sensor. The sensor contains a probe (2) that is covered with plastic (3).

When the sensor's probe is immersed in coolant, the sensor senses a particular capacitance. The sensor's electronics react by sinking the signal to the sensor return (ground).

When the probe is not immersed in coolant, approximately +5 VDC is sourced to the signal wire. When this condition is detected by the Electronic Control Module (ECM), an event code is activated.

Prior to troubleshooting any problems with the coolant level sensor, use Caterpillar Electronic Technician (ET) to check the installation status for the sensor. The coolant level sensor's configuration parameter must be set to "Installed" in order for the ECM to monitor the signal from the sensor.

The activation of an event code and/or a warning lamp is probably caused by a low coolant level. The next likely cause is a problem with the wiring harness, a connector, or the sensor. The least likely cause is a problem with the ECM.

Before you perform this test procedure ensure that the coolant level is OK.

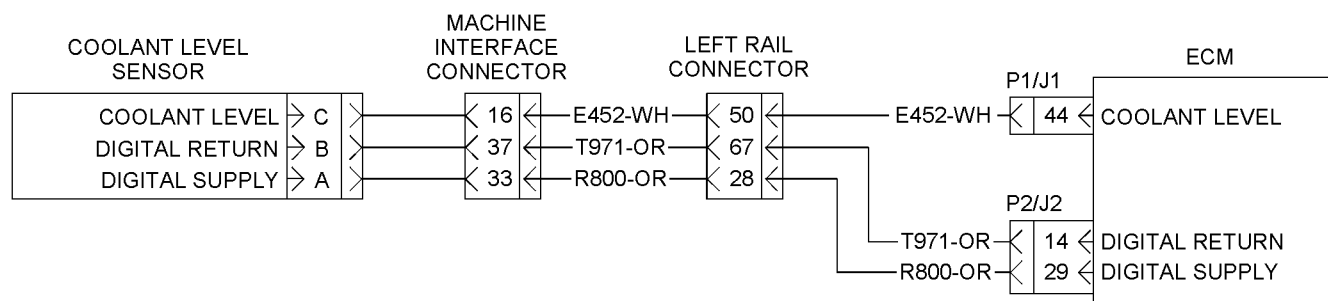


Illustration 31

g01443747

Typical schematic for the coolant level sensor

WARNING

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

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove electrical power from the ECM.

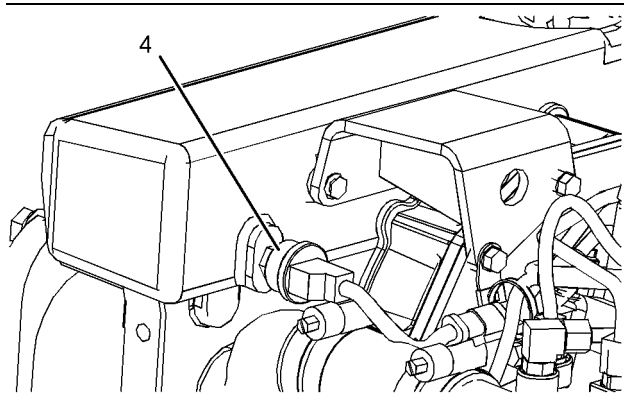


Illustration 32

g01365227

Location of the coolant level sensor (typical left front engine view)

(4) Coolant level sensor

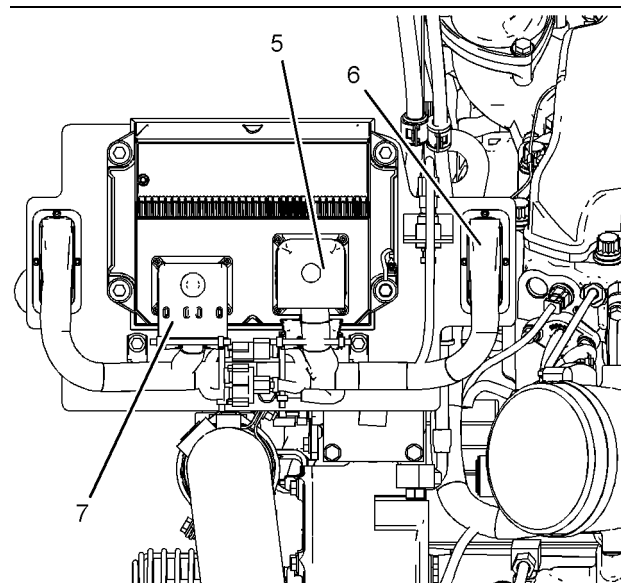


Illustration 33

g01443786

Location of the connectors at the ECM that are for the 16 cylinder engines (typical left front engine view)

- (5) J2/P2 ECM connector
- (6) Left rail connector
- (7) J1/P1 ECM connector

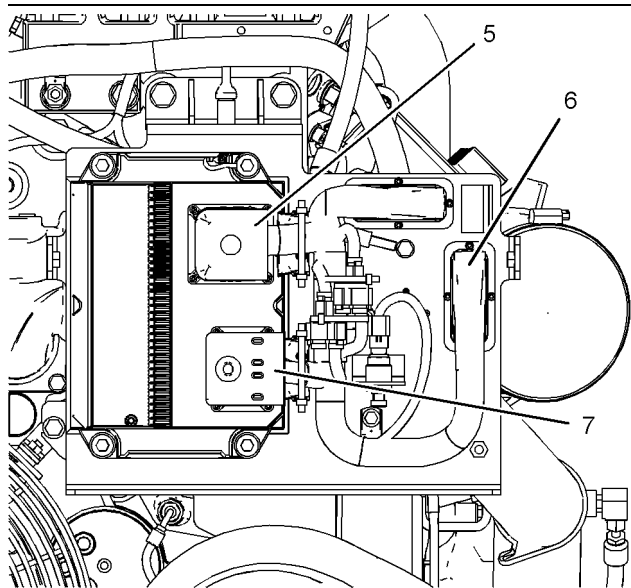


Illustration 34
g01443787
Location of the connectors at the ECM that are for the 20 cylinder engines (typical front side engine view)
(5) J2/P2 ECM connector
(6) Left rail connector
(7) J1/P1 ECM connector

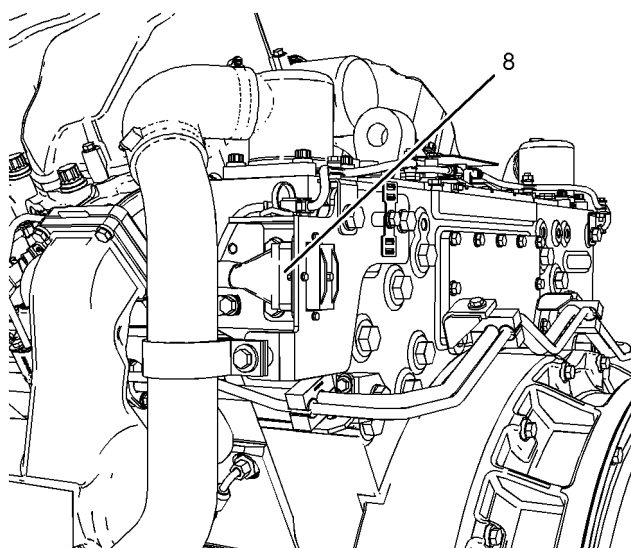


Illustration 35
g01443791
Location of the machine interface connector (left rear engine view)
(8) Machine interface connector

B. Thoroughly inspect the connector for sensor (1), ECM connectors (4), rail connector (5), and machine connector (6). Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.

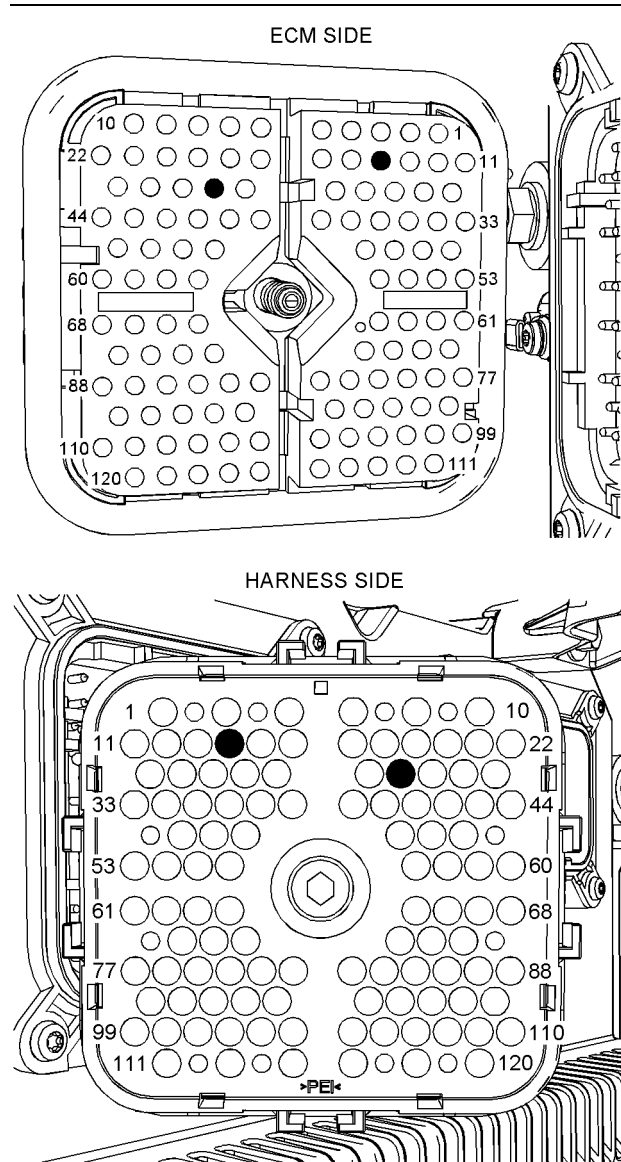


Illustration 36
g01443898
Terminal locations at the P2 ECM connector for the coolant level sensor
(P2-14) Digital return
(P2-29) Digital supply

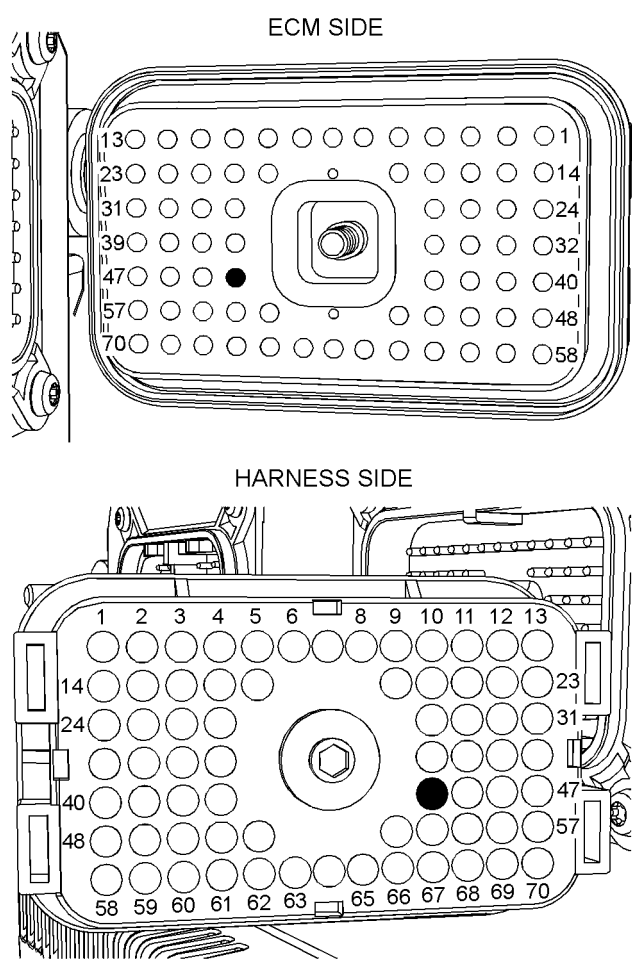


Illustration 37 g01443908

Terminal locations at the P1 ECM connector for the coolant level sensor

(P1-44) Coolant level

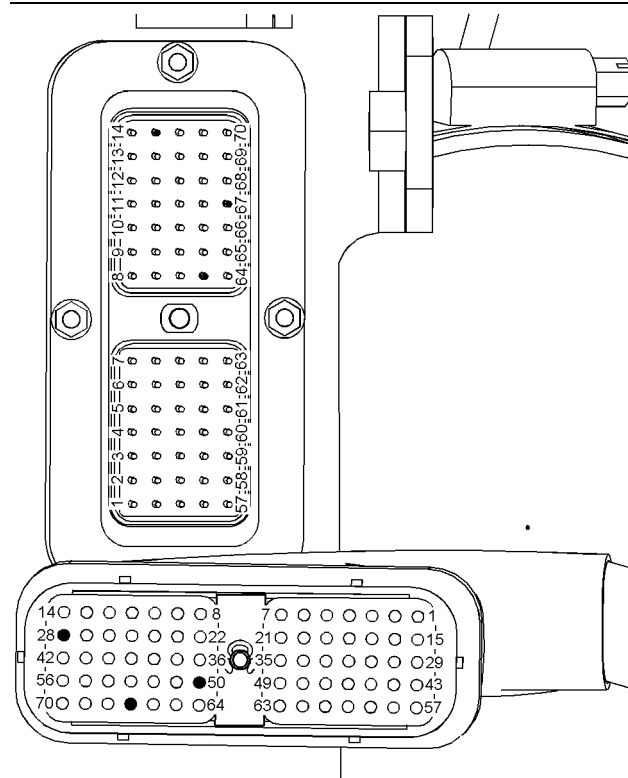


Illustration 38

g01443913

Terminal locations at the left rail connector for the coolant level sensor

(Terminal 28) Digital supply
(Terminal 50) Coolant level
(Terminal 67) Digital return

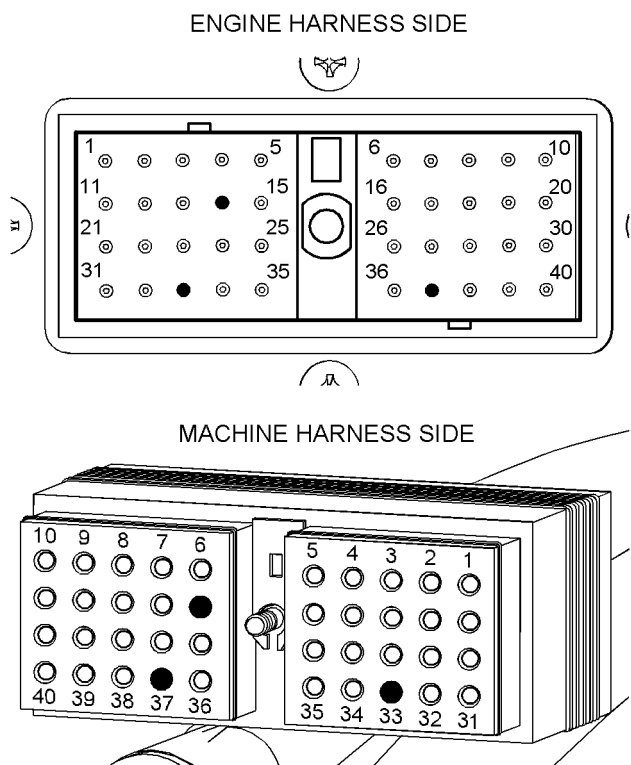


Illustration 39 g01443926

Terminal locations at the machine interface connector for the coolant level sensor

(Terminal 16) Coolant level
(Terminal 33) Digital supply
(Terminal 37) Digital return

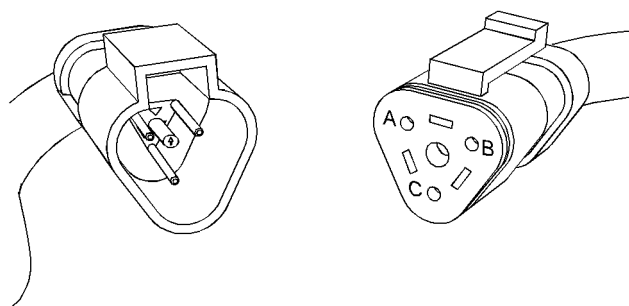


Illustration 40 g01159881

Terminal locations at the harness connector for the coolant level sensor

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

C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit for the coolant level sensor.

D. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, "Electrical Connectors - Inspect" for the correct torque values.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted, and the harness and wiring are free of corrosion, of abrasion or of pinch points.

Results:

- OK – The harnesses and the wiring appear to be OK. Proceed to Test Step 2.
- Not OK – There is a problem with the connectors and/or the wiring.

Repair: Repair the wiring and connectors or replace the wiring or the connectors. Ensure that all of the seals are properly connected. Verify that the repair eliminates the problem.

STOP.

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

A. Disconnect the coolant level sensor at the sensor connector.

B. Restore electrical power to the ECM.

C. Measure the voltage between terminals A (digital supply) and B (digital return) at the harness connector for the coolant level sensor.

D. Remove electrical power from the ECM.

Expected Result:

The voltage measurement is 8.0 ± 0.4 VDC.

Results:

- OK – The voltage measurement is 8.0 ± 0.4 VDC. The supply voltage is reaching the sensor. Proceed to Test Step 3.
- Not OK – The voltage measurement is not 8.0 ± 0.4 VDC.

Repair: The digital sensor supply voltage is not reaching the sensor. There is a problem in the circuit for the digital sensor supply. Refer to Troubleshooting, "Sensor Supply - Test".

STOP.

Test Step 3. Disconnect the Coolant Level Sensor and Monitor the Status for "Coolant Level"

- A. Disconnect the harness connector for the coolant level sensor.
- B. Restore electrical power to the ECM.
- C. Monitor the status of "Coolant Level" on Cat ET.

Note: Wait at least 30 seconds for activation of the status indicator.

- D. Remove electrical power from the ECM.

Expected Result:

The status changes from "OK" to "LOW" when the sensor is disconnected.

Results:

- OK – The status is "LOW" when the sensor is disconnected. There may be a problem with the coolant level sensor. Proceed to Test Step 4.
- Not OK – The status is "OK" when the sensor is disconnected. The problem is between the ECM and the harness connector. There may be a problem with the ECM. Proceed to Test Step 5.

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

- A. Remove electrical power from the ECM.
- B. Fabricate a jumper wire that is long enough to create a short circuit between two terminals at the coolant level sensor's harness connector. Crimp connector pins to each end of the jumper wire.
- C. Install the jumper wire between terminals B (digital return) and C (sensor signal) on the harness side of the connector for the coolant level sensor.
- D. Restore electrical power to the ECM.
- E. Monitor the status of "Coolant Level" on Cat ET while the jumper wire is installed.

Note: Wait at least 30 seconds for activation of the status indicator.

- F. Remove electrical power from the ECM.
- G. Remove the jumper wire. Connect the harness connector for the coolant level sensor.

Expected Result:

The status changes from "LOW" to "OK" when the jumper wire is installed.

Results:

- OK – The status changes from "LOW" to "OK" when the jumper wire is installed. The ECM and the wiring harness to the coolant level sensor are OK.

Repair: Perform the following procedure:

WARNING

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

1. Drain the coolant below the level of the coolant level sensor.
2. Restore electrical power to the ECM.
3. Monitor the status of "Coolant Level" on Cat ET.

Note: Wait at least 30 seconds for activation of the status indicator.

4. Remove electrical power from the ECM.

If the status of the "Coolant Level" is "OK", replace the sensor.

If the status for the coolant level is "LOW", the circuit for the coolant level sensor is OK. There may be an intermittent problem in the harness or in a connector. Fill the cooling system according to the procedure in the Operation and Maintenance Manual. Return the engine to service. If an intermittent electrical problem is suspected, refer to Troubleshooting, "Electrical Connectors - Inspect" for troubleshooting information.

STOP.

- Not OK – Shorting the harness does not affect the status on Cat ET. The problem is between the ECM and the harness connector. There may be a problem with the ECM. Proceed to Test Step 5.

Test Step 5. Check the Wiring Harness for an Open Circuit

- A. Remove electrical power from the ECM.
- B. Disconnect the J1/P1 ECM connector and the connector for the coolant level sensor.

- C. Fabricate a jumper wire that is long enough to provide a test circuit between the ECM connector and the sensor connector. Crimp a connector pin to one end of the jumper wire.
- D. Install the jumper wire's connector pin into terminal C on the harness side of the connector for the coolant level sensor.
- E. Measure the resistance between terminal P1-44 and the loose end of the jumper wire.

The correct resistance measurement is a short circuit.

Remove the jumper wire. Leave the sensor connector disconnected.

Expected Result:

The measurement indicates that a short circuit exists for the signal wire.

Results:

- OK – The measurement indicated a short circuit. There is not an open circuit in the harness wire for the sensor signal. Proceed to Test Step 6.
- Not OK – The measurement did not indicate a short circuit.

Repair: There is an open circuit or excessive resistance in the harness or the connectors. Repair the wire and/or the connector, when possible. Replace damaged parts, if necessary.

STOP.

Test Step 6. Check the Harness Wiring for a Short Circuit

- A. Remove electrical power from the ECM.
- B. Disconnect the J1/P1 and the J2/P2 ECM connectors. Also, disconnect the connector for the coolant level sensor.
- C. Measure the resistance between the points that are listed in Table 32.

Note: Wiggle the harness during the following measurements in order to reveal an intermittent condition.

Table 32

Resistance Measurements for the Coolant Level Circuit	
Connector and Terminal	Terminal
P1-44 (coolant level)	All of the terminals on the P1 connector
	All of the other terminals on the P2 connector
	Engine ground stud

Expected Result:

Each check of the resistance indicates an open circuit.

Results:

- OK – Each check of the resistance indicates an open circuit. There is not a short circuit to another wire in the harness. Proceed to Test Step 7.
- Not OK – At least one check of the resistance does not indicate an open circuit. There is a short to another wire in the harness. The problem may be with a connector.

Repair: Repair the wire and/or the connector, when possible. Replace damaged parts, if necessary. Verify that the problem is resolved.

STOP.

Test Step 7. Check the Operation of the ECM

- A. Fabricate a jumper wire that is long enough to provide a test circuit across the ECM connectors. Crimp connector sockets to each end of the jumper wire.
- B. Use a wire removal tool to remove the wires from terminal locations P2-14 (digital return) and P1-44 (coolant level). Install the jumper wire into these terminal locations.
- C. Restore electrical power to the ECM.
- D. Use Cat ET to monitor the status for "Coolant Level". Use a wire removal tool to remove the jumper wire and check the status again.

Note: Wait at least 30 seconds for activation of the status indicator.

- E. Remove electrical power from the ECM.

Restore all wiring to the original configuration.

Expected Result:

The status is "LOW" when the jumper wire is not connected. The status is "OK" when the jumper wire is connected.

Results:

- OK – The status is "LOW" when the jumper wire is not connected. The status is "OK" when the jumper wire is connected.

Repair: The ECM is properly reading the switch input. There may be an intermittent problem in the harness or in a connector. If an intermittent electrical problem is suspected, refer to Troubleshooting, "Electrical Connectors - Inspect" for troubleshooting information.

STOP.

- Not OK – The status is "LOW" when the jumper wire is connected.

Repair: The ECM is not reading the switch input. Replace the ECM. Refer to Troubleshooting, "ECM - Replace".

STOP.

If 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 engine ECM and to the service tool connector.

The data links provide a communication link between the various control modules on the application.

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."

If this message is displayed, the flash file in the ECM may be newer than the version of Cat ET, or the latest version of Cat ET has not been installed. You must correct this condition prior to continuing with this procedure.

i02900487

Data Link - Test

SMCS Code: 1900-038

System Operation Description:

This procedure verifies the integrity of the Cat Data Link between the following components:

- Brake electronic control module
- Chassis electronic control module
- Engine Control Module (ECM)
- Service tool connector
- Transmission electronic control module
- Vital Information Management System (VIMS)

This procedure verifies the integrity of the CAN data link between the following components:

- Temperature control module
- Engine Control Module (ECM)
- Fuel control valve
- Service tool connector

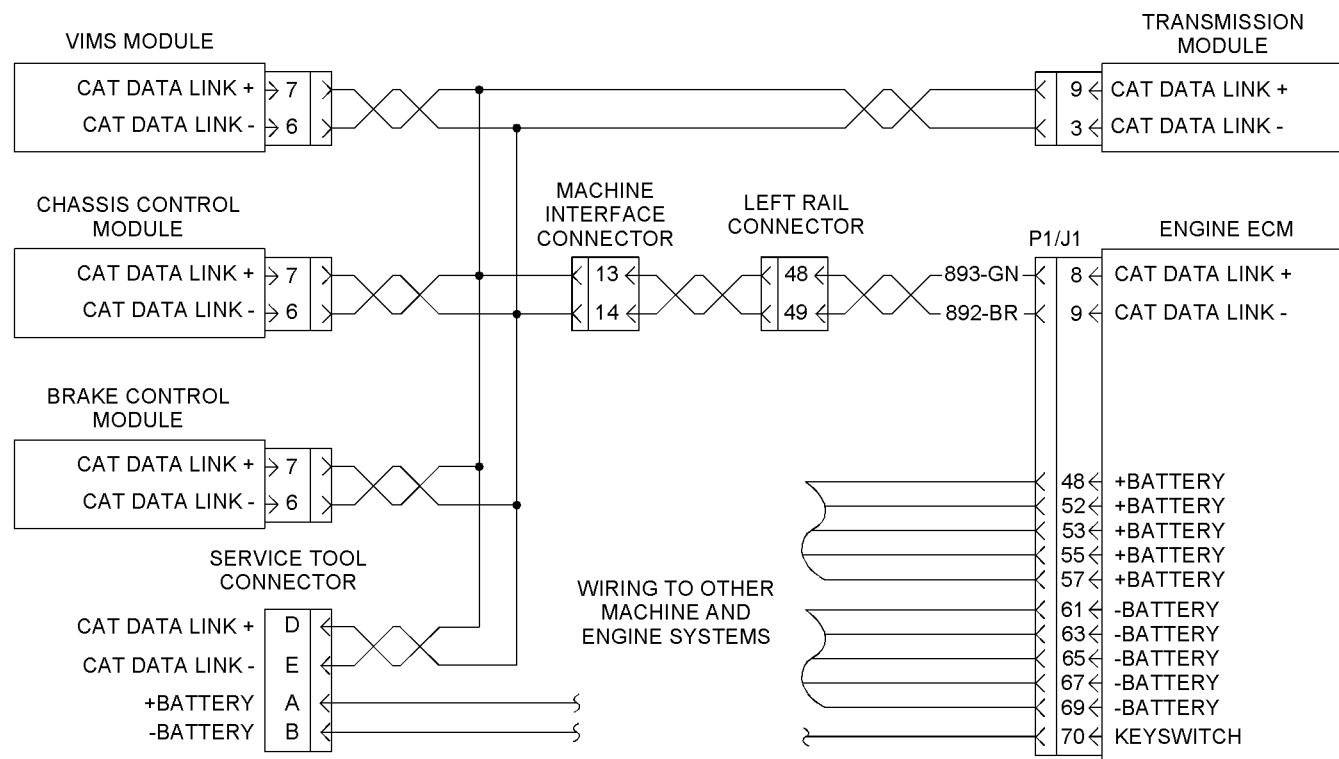


Illustration 41
Schematic for the Cat Data Link

g01444230

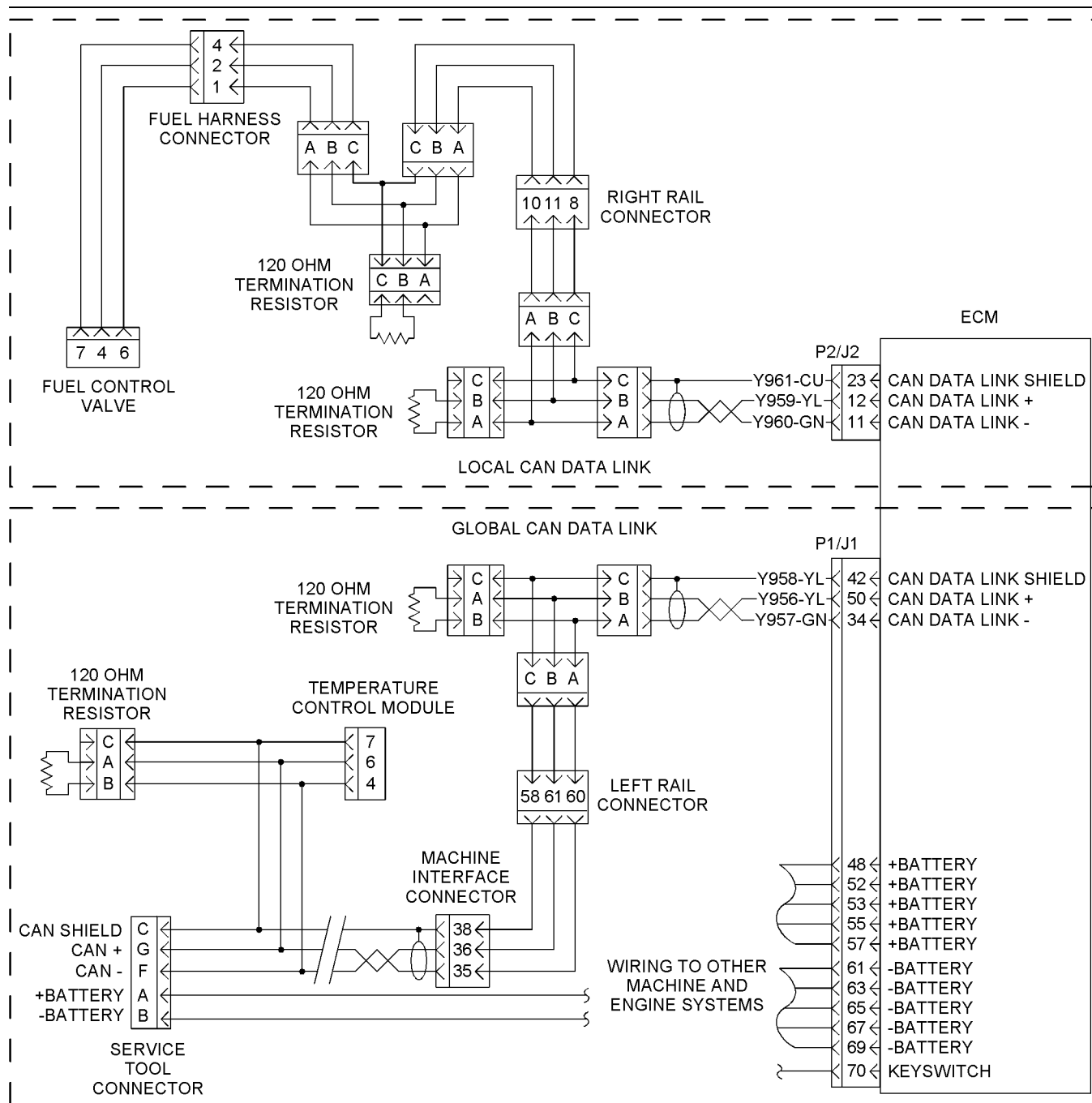


Illustration 42

Schematic for the CAN data link

g01444233

Test Step 1. Inspect the Electrical Connectors and the Wiring

Note: Carefully follow this procedure in order to identify an intermittent problem.

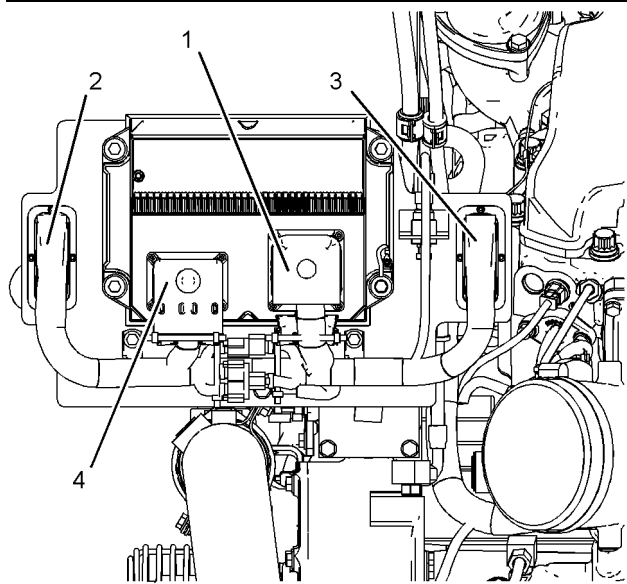


Illustration 43 g01444857

Location of the connectors at the ECM for the 16 cylinder engines (typical left side engine view)

- (1) Right rail connectors
- (2) J2/P2 ECM connector
- (3) Left rail connectors
- (4) J1/P1 ECM connector

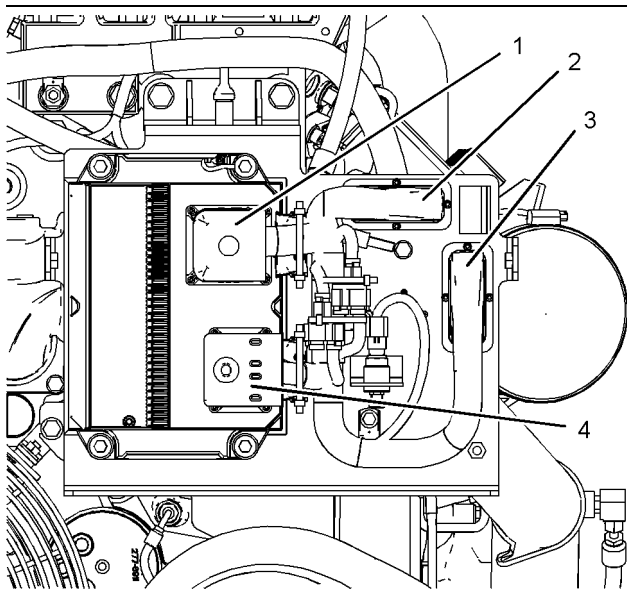


Illustration 44 g01444860

Location of the connectors at the ECM for the 20 cylinder engines (typical left side engine view)

- (1) Right rail connectors
- (2) J2/P2 ECM connector
- (3) Left rail connectors
- (4) J1/P1 ECM connector

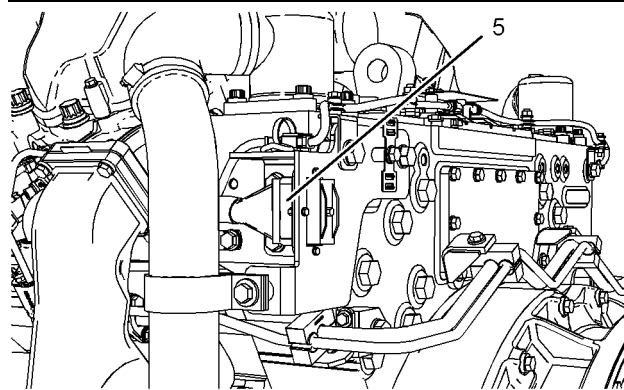


Illustration 45 g01444865

Location of the machine interface connectors (left rear engine view)

(5) Machine interface connectors

A. Perform a visual inspection of the wiring between the P1 and P2 ECM connectors and the service tool connector. Look for these problems:

- Harness damage that is caused by chafing
- Harness damage that is caused by excessive heat

B. Inspect the condition of the service tool connector:

- a.** Look for moisture on the wiring and on the connector.

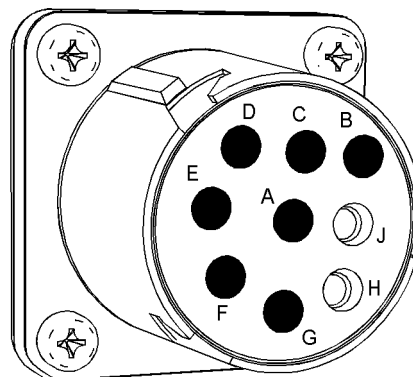


Illustration 46 g01444702

Terminal locations at the service tool connector

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

- b.** Pull on the wires that are associated with the data links. This verifies that the wire is properly attached to the terminal and that the terminal is properly inserted into the connector.

C. Inspect the P1 and P2 ECM connectors:

- a. Look for moisture on the wiring and on the connector.

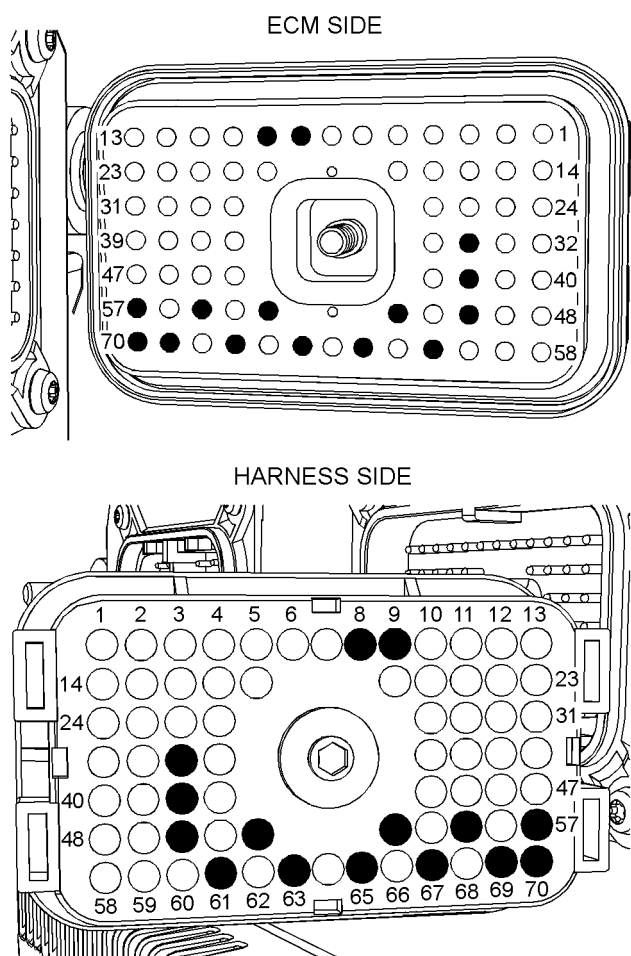


Illustration 47

g01444732

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
- (P1-50) CAN data link +
- (P1-52) +Battery
- (P1-53) +Battery
- (P1-55) +Battery
- (P1-57) +Battery
- (P1-61) -Battery
- (P1-63) -Battery
- (P1-65) -Battery
- (P1-67) -Battery
- (P1-69) -Battery
- (P1-70) Keyswitch

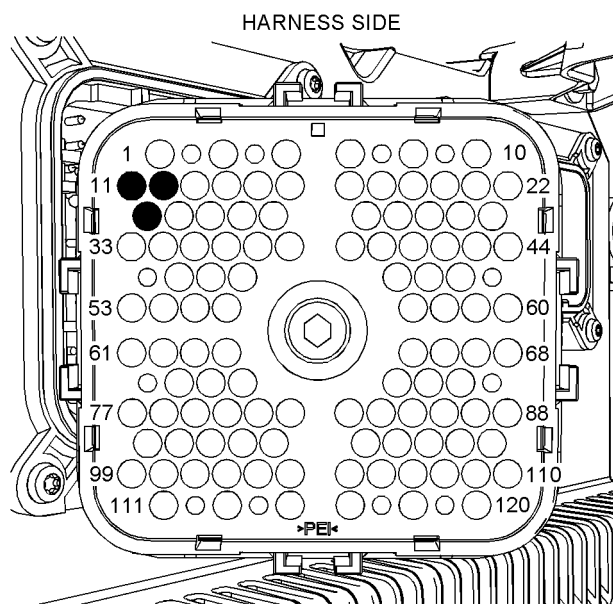
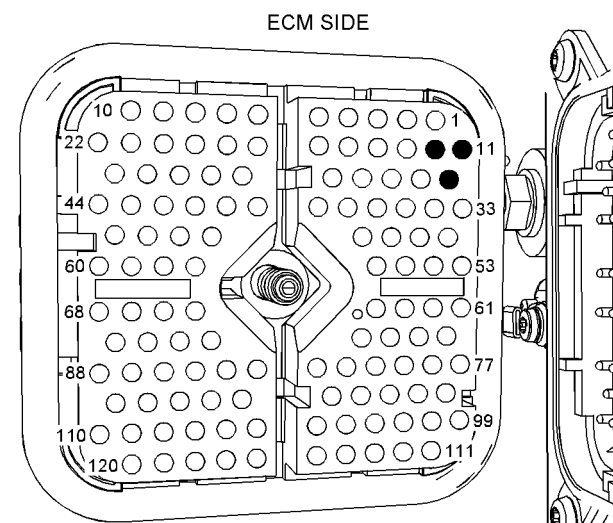


Illustration 48

g01326307

Terminal locations at the P2 ECM connector that are for the data link

- (P2-34) CAN data link -
- (P2-42) CAN shield
- (P2-50) CAN data link +

- b. Pull on the wires that are associated with the data links. This verifies that the wire is properly crimped to the terminal and that the terminal is properly inserted into the connector.

D. Inspect the left rail connectors and the right rail connectors:

- a. Look for moisture on the wiring and on the connector.

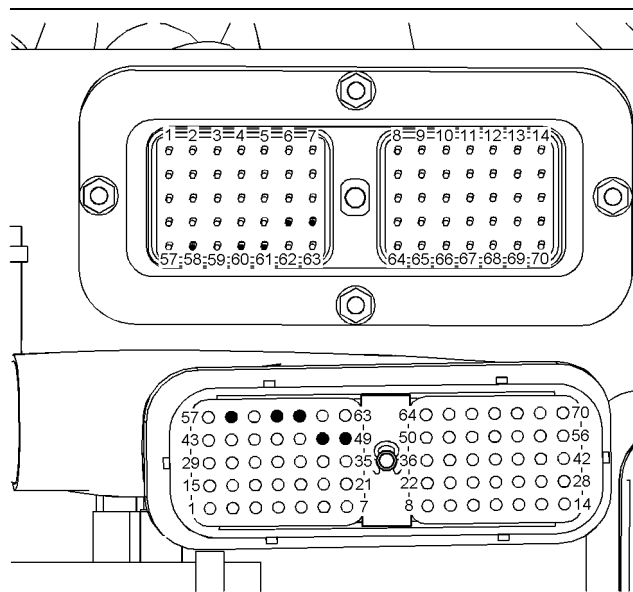


Illustration 49 g01444779

Terminal locations at the left rail connector that are for the data link

- (Terminal 48) Cat Data Link +
- (Terminal 49) Cat Data Link -
- (Terminal 58) CAN shield
- (Terminal 60) CAN data link -
- (Terminal 61) CAN data link +

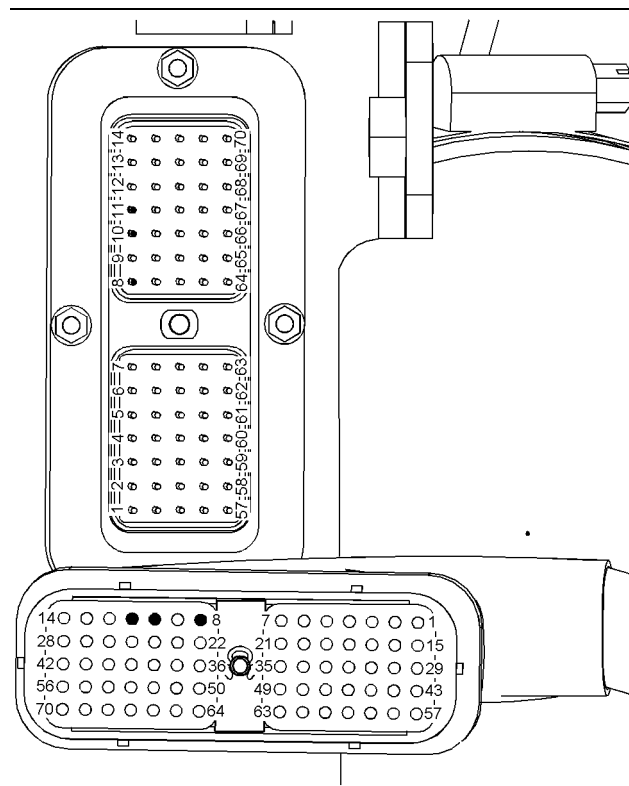


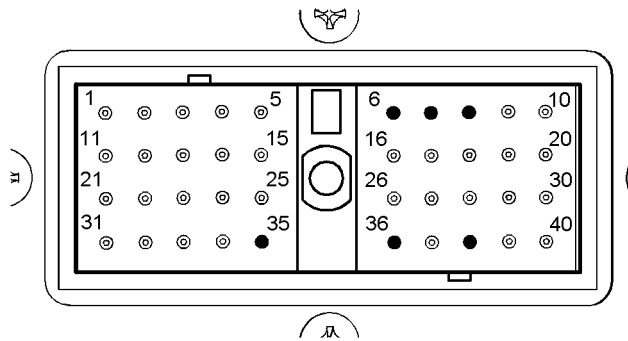
Illustration 50 g01444790

Terminal locations at the right rail connector that are for the data link

- (Terminal 8) CAN shield
- (Terminal 10) CAN data link -
- (Terminal 11) CAN data link +

- b.** Pull on the wires that are associated with the data links. This verifies that the wire is properly crimped to the terminal and that the terminal is properly inserted into the connector.
- E.** Inspect the machine interface connectors and the connectors at the various controllers:
- a.** Look for moisture on the wiring and on the connector.

CONNECTOR AT THE CONTROL BOX



HARNESS CONNECTOR

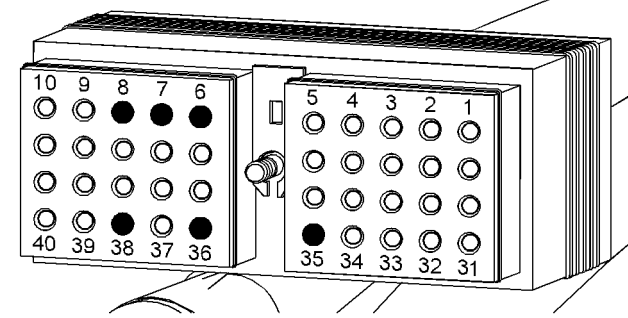


Illustration 51

g01444812

Terminal locations at the machine interface connector that are for the data link

- (Terminal 13) Cat Data Link +
- (Terminal 14) Cat Data Link -
- (Terminal 38) CAN shield
- (Terminal 35) CAN data link -
- (Terminal 36) CAN data link +

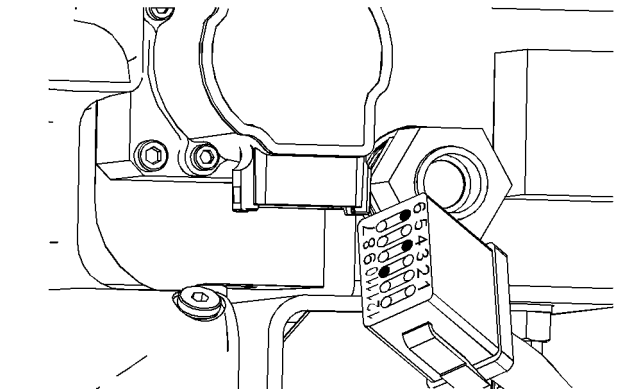


Illustration 52

g01326328

Terminal locations at the connector for the fuel control valve that are for the data link

- (Terminal 4) CAN data link +
- (Terminal 6) CAN data link -
- (Terminal 7) CAN shield

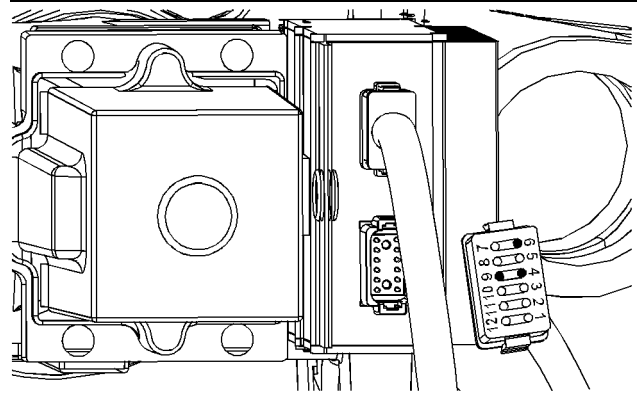


Illustration 53

g01444823

Terminal locations at the connector for the temperature control module that are for the data link

- (Terminal 4) CAN data link +
- (Terminal 6) CAN data link -
- (Terminal 9) CAN shield

- b. Pull on the wires that are associated with the data links. This verifies that the wire is properly crimped to the terminal and that the terminal is properly inserted into the connector.

Expected Result:

All connectors, pins and sockets are completely coupled and/or inserted and the harness and wiring are free of corrosion, of abrasion or of pinch points.

Results:

- OK – The wiring and the connectors appear to be OK. Proceed to Test Step 2.
- Not OK – There is a problem with the wiring or with a connector.

Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the connector seals are properly in place and ensure that the connectors are completely coupled. Verify that the problem is resolved.

STOP.

Test Step 2. Bypass the Wiring for the Data Link

- A. Connect the 167 - 9225 Harness (SERVICE TOOL ADAPTER) to the J1 connector, to the 207 - 6845 Adapter Cable As, and to the vehicle's battery.

- B. Try to establish communication between Cat ET and the ECM.

Expected Result:

Cat ET and the ECM communicate.

Results:

- OK – Cat ET and the ECM communicate.

Repair: Cat ET and the ECM communicate when the bypass harness is installed. However, communication cannot be established via the machine's wiring. Disconnect the electrical connector from each of the control modules that is on the specific data link one at a time in order to isolate the problem. Try to establish communication between Cat ET and the ECM after disconnecting each module.

The problem is in the control module if disconnecting the module allows Cat ET and the ECM to communicate. If a module is suspect, replace the module. Verify that the problem is resolved.

The control module is OK if the problem remains and when the module is disconnected.

STOP.

- Not OK – Cat ET and the ECM do not communicate.

Repair: Communication between Cat ET and the ECM is not established when the bypass harness is installed. Temporarily connect a test ECM. Refer to Troubleshooting, "Test ECM Mode". Verify that the problem is resolved.

Connect the original ECM and verify that the problem returns. Replace the original ECM.

STOP.

Test Step 3. Check the Wiring for the Data Links for a Short Circuit

- Turn the keyswitch OFF.
- Disconnect the negative cable from the vehicle's battery.
- Disconnect the P1 and P2 ECM connectors.
- Measure the resistance between the following terminals:
 - P1-8 (Cat Data Link +) and P1-61 (-Battery)
 - P1-9 (Cat Data Link -) and P1-61 (-Battery)
 - P1-50 (Global CAN data link +) and P1-61 (-Battery)
 - P1-34 (Global CAN data link -) and P1-61 (-Battery)

- P2-12 (Local CAN data link +) and P1-61 (-Battery)
- P2-11 (Local CAN data link -) and P1-61 (-Battery)

E. Measure the resistance between the following terminals:

- P1-8 (Cat Data Link +) and P1-52 (+Battery)
- P1-9 (Cat Data Link -) and P1-52 (+Battery)
- P1-50 (Global CAN data link +) and P1-52 (+Battery)
- P1-34 (Global CAN data link -) and P1-52 (+Battery)
- P2-12 (Local CAN data link +) and P1-52 (+Battery)
- P2-11 (Local CAN data link -) and P1-52 (+Battery)

Expected Result:

Each measurement indicates an open circuit.

Results:

- OK – Each measurement indicates an open circuit. The wiring for the data links does not have a short circuit. Proceed to Test Step 4.
- Not OK – Each measurement does not indicate an open circuit.

Repair: At least one measurement is less than five Ohms. The wiring for a data link has a short circuit. Determine the cause of the short circuit. Repair the problem, when possible. Replace parts, if necessary. Verify that the problem is resolved.

STOP.

Test Step 4. Check the Wiring for the Data Links for an Open Circuit

- Connect a jumper wire between terminals P1-8 and P1-9.
- At the service tool connector and the connector for each control module, measure the resistance between the terminals for the CAT Data Link.
- Connect a jumper wire between terminals P1-34 and P1-50.

- D. At the service tool connector and the connector for each control module that is on the global network, measure the resistance between the terminals for the CAN data link.
- E. Connect a jumper wire between terminals P2-11 and P2-12.
- F. At the service tool connector and the connector for each control module that is on the local network, measure the resistance between the terminals for the CAN data link.

Expected Result:

All of the resistance measurements indicates that continuity exists in the circuit.

Results:

- OK – All of the resistance measurements indicate a short circuit.

Repair: There does not appear to be an open circuit in the data link.

If you are troubleshooting the Cat Data Link, the data link appears to be OK. The problem is probably an intermittent problem in a connector or in the harness. If the problem persists, perform this test procedure again. If an intermittent problem is suspected, refer to Troubleshooting, "Electrical Connectors - Inspect" for information that is related to troubleshooting intermittent electrical problems.

If you are troubleshooting the CAN data link, remove the jumper wires. Leave the control modules disconnected from the data link. Proceed to Test Step 5.

- Not OK – One of the resistance measurements indicates an open circuit.

Repair: Determine the cause of the open circuit. Repair the problem, when possible. Replace parts, if necessary. Verify that the problem is resolved.

STOP.

Test Step 5. Check the Termination Resistors for the J1939 Data Link

Note: Perform this test step only if you are troubleshooting a problem with the CAN data link.

- A. Ensure that all of the control modules are disconnected from the data link. At the service tool connector, measure the resistance between the terminals for the CAN data link.

Expected Result:

The resistance is between 45 Ohms and 75 Ohms.

Results:

- OK – The resistance is between 45 Ohms and 75 Ohms.

Repair: The termination resistors are OK. The data link appears to be OK. The problem is probably an intermittent problem in a connector or in the harness. If the problem persists, perform this test procedure again. If an intermittent problem is suspected, refer to Troubleshooting, "Electrical Connectors - Inspect" for information that is related to troubleshooting intermittent electrical problems.

STOP.

- Not OK – The resistance is approximately 120 Ohms. There is a problem with a termination resistor.

Repair: Determine the cause of the missing termination resistor. Repair the problem, when possible. Replace parts, if necessary. Verify that the problem is resolved.

STOP.

- Not OK – The resistance is greater than 140 ohms. There is a problem with both termination resistors.

Repair: Determine the cause of the problem. Repair the problem, when possible. Replace parts, if necessary. Verify that the problem is resolved.

STOP.

i02906095

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's Electronic Control Module (ECM) or if any one of the diagnostic codes or the event code in Table 33 is active or easily repeated.

Table 33

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
168-0 Electrical System Voltage high - most severe (3)	The battery supply voltage is greater than 32 VDC for nine seconds. The engine's ECM has been powered for 30 seconds.	The code is logged.
168-1 Electrical System Voltage low - most severe (3)	The battery supply voltage is less than 18 VDC for 0.5 seconds. The engine's ECM has been powered for three seconds. The engine has started and the engine is running.	The code is logged. Engine parameters for most of the powered sensors will revert to default values.
168-2 Electrical System Voltage erratic, intermittent, or incorrect	The engine is running. Three voltage readings in the last seven seconds were below 6 VDC. The voltage then returned to above 9 VDC.	The code is logged.
1834-2 Ignition Key Switch loss of signal	Three voltage readings for the keyswitch for the last one second were below an acceptable voltage. The engine is not cranking.	The code is logged.

Use this test if there are intermittent engine shutdowns or if a difficulty in starting is not accompanied by loss of electrical accessories. Engine shutdowns that are accompanied by a loss of other electrical accessories indicate a problem in the keyswitch. This does not indicate a problem in the wiring at the ECM. Verify that there are no problems with the starting system or with the charging system before you use this test.

Unswitched battery voltage is supplied through the machine connector to the ECM. The voltage is supplied to terminals at P1-48, P1-52, P1-53, P1-55, and P1-57 of the ECM connector. The negative battery is supplied to the ECM at P1-61, P1-63, P1-65, P1-67, and P1-69. The ECM receives battery voltage from the keyswitch at P1-70 when the keyswitch is in the ON position or in the START position. When the ECM detects battery voltage at this input, the ECM will power up. When battery voltage is removed from this input, the ECM will power down.

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

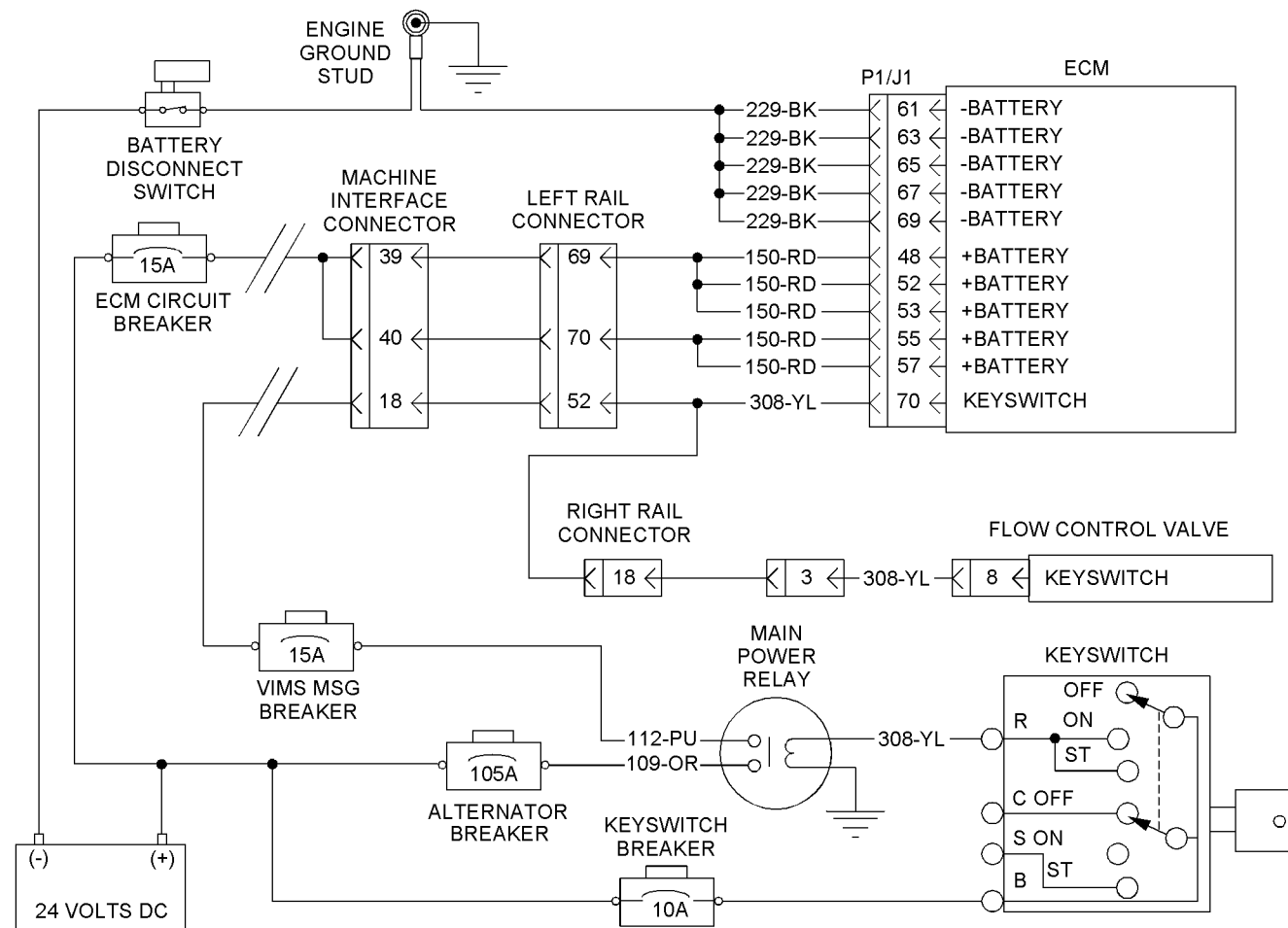


Illustration 54

g01446626

Typical schematic of the electrical power supply

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove electrical power from the ECM.

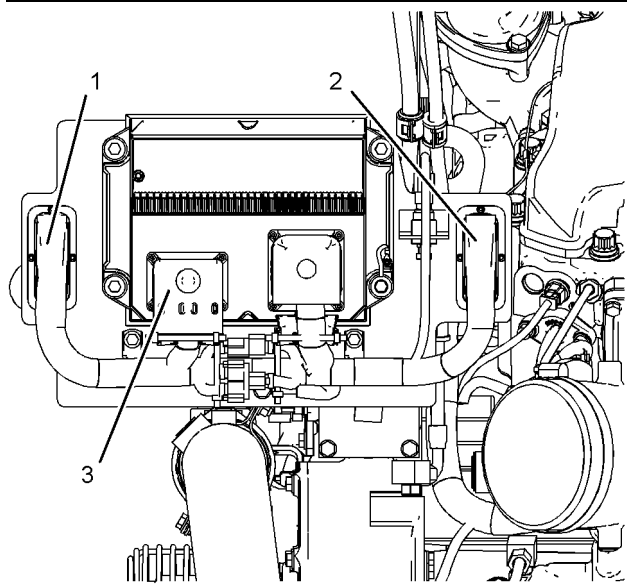


Illustration 55 g01446645
Locations of the connectors at the ECM that are for the 16 cylinder engines (typical left front engine view)
(1) Right rail connector
(2) Left rail connector
(3) J1/P1 ECM connectors

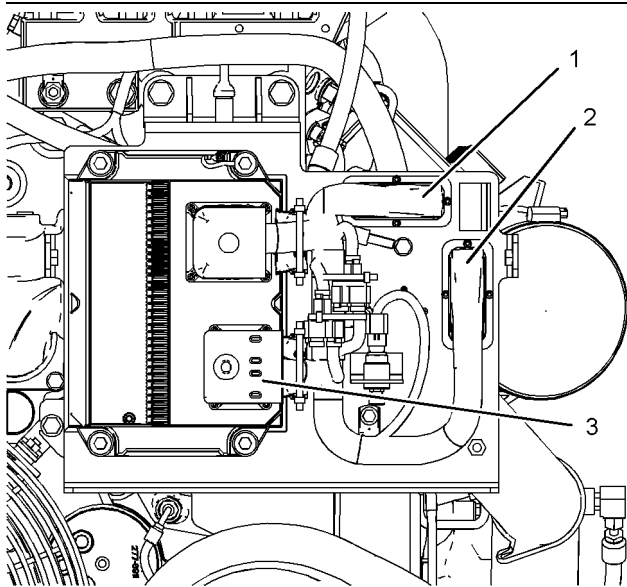


Illustration 56 g01446649
Locations of the connectors at the ECM that are for the 20 cylinder engines (typical left front engine view)
(1) Right rail connector
(2) Left rail connector
(3) J1/P1 ECM connectors

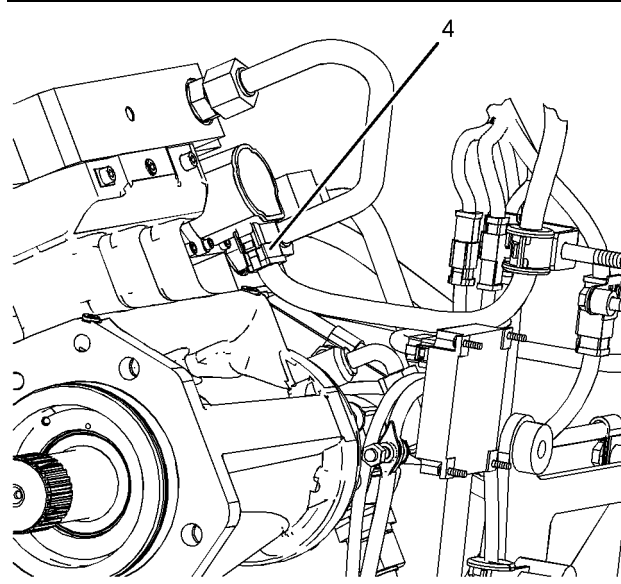


Illustration 57 g01324123
Location of the connectors at the fuel control valve
(4) Connectors for the fuel control valve

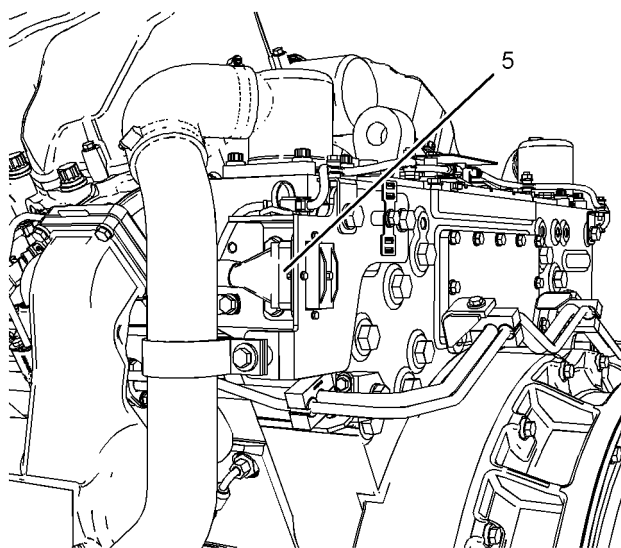


Illustration 58 g01430713
Location of the machine interface connectors (left rear engine view)
(5) Machine interface connectors

B. Thoroughly inspect connectors (1), (2), (3), (4), and (5). Inspect all of the other connectors that are in the circuit. Refer to Troubleshooting, “Electrical Connectors - Inspect” for the proper procedure for inspecting system wiring.

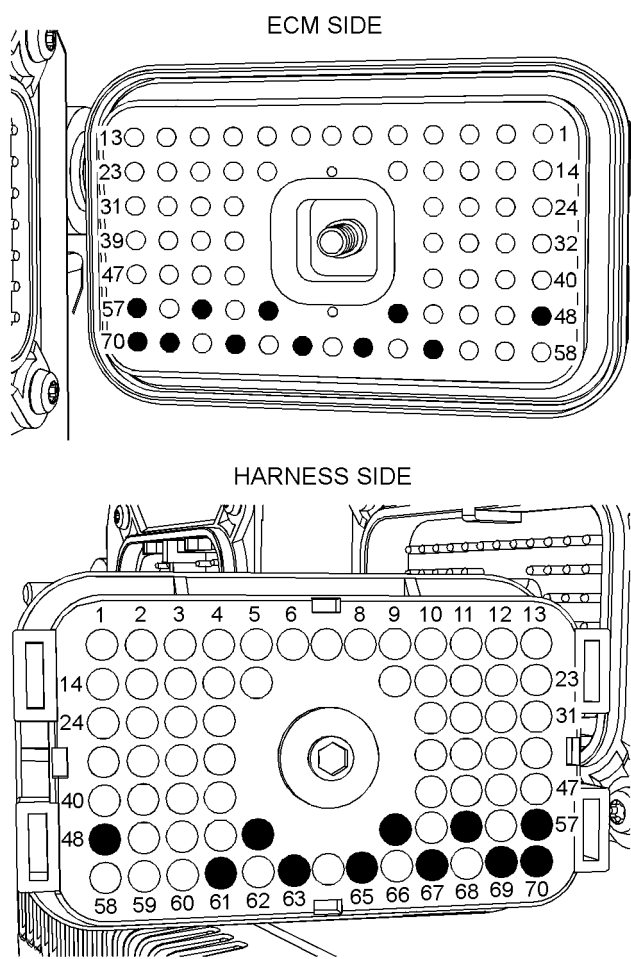


Illustration 59

g01323936

Terminal locations at the P1 ECM connector for the electrical power supply

- (P1-48) +Battery
- (P1-52) +Battery
- (P1-53) +Battery
- (P1-55) +Battery
- (P1-57) +Battery
- (P1-61) -Battery
- (P1-63) -Battery
- (P1-65) -Battery
- (P1-67) -Battery
- (P1-69) -Battery
- (P1-70) Keyswitch

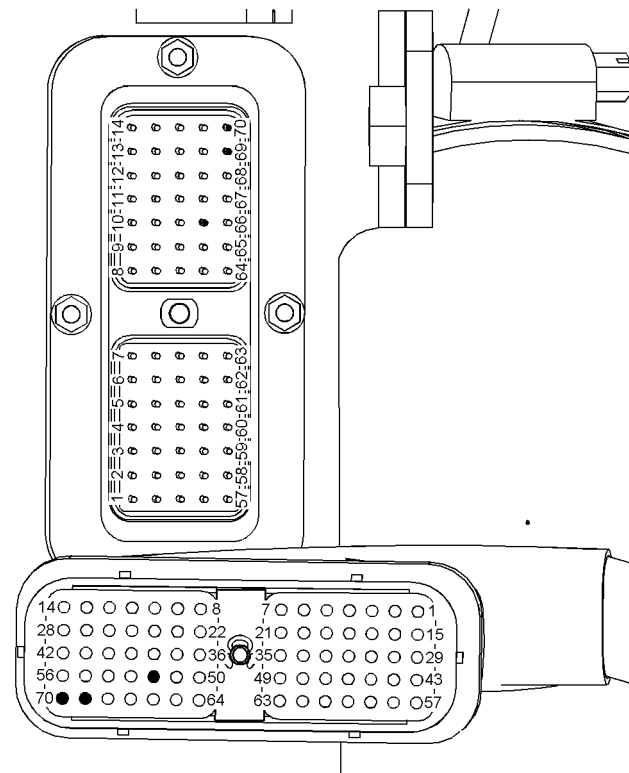


Illustration 60

g01446655

Terminal locations at the left rail connector that are for the electrical power supply

- (Terminal 52) Keyswitch
- (Terminal 69) +Battery
- (Terminal 70) +Battery

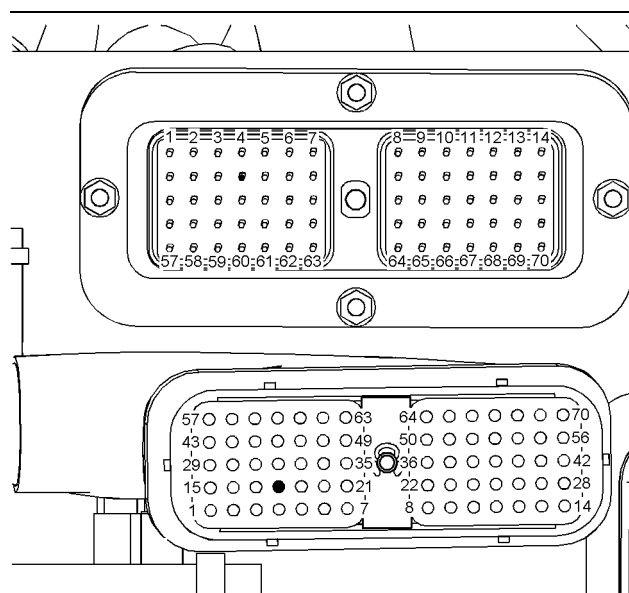


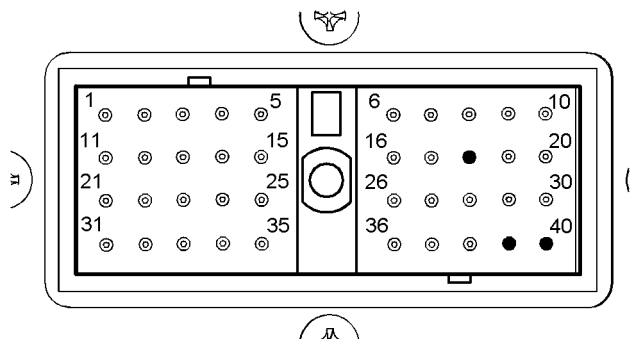
Illustration 61

g01446658

Terminal locations at the left rail connector that are for the electrical power supply

- (Terminal 18) Keyswitch

CONNECTOR AT THE CONTROL BOX



HARNESS CONNECTOR

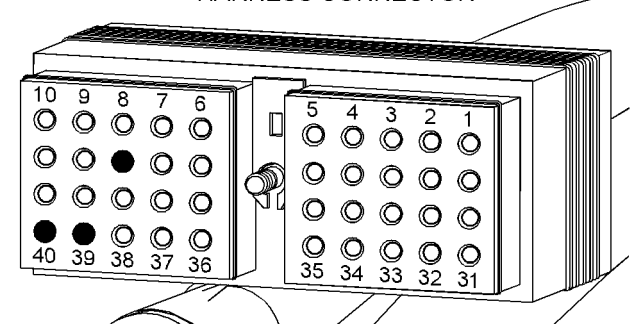


Illustration 62

g01324128

Terminal locations at the machine interface connector for the electrical power supply

(Terminal 18) Keyswitch
(Terminal 39) +Battery
(Terminal 40) +Battery

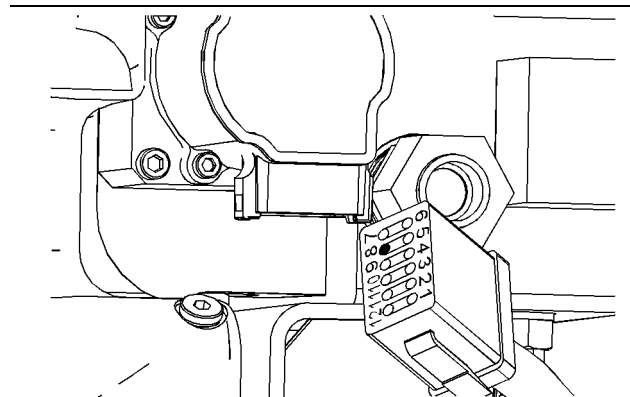


Illustration 63

g01324119

Terminal locations at the connector for the fuel control valve that are for the electrical power supply

(Terminal 8) Keyswitch

C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the circuit.

D. Check the allen head screws in each of the ECM connectors and the machine interface connector for the proper torque. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.

E. Check the harness and the wiring for abrasion and for pinch points.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted. The harness and wiring are free of corrosion, of abrasion, and of pinch points.

Results:

- OK – The harness and wiring are OK. Proceed to Test Step 2.
- Not OK – There is a problem in the connectors and/or wiring.

Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled.

Verify that the repair eliminates the problem.

STOP.

Test Step 2. Check the Voltage at the Battery Post

A. Measure the voltage across the battery posts.

Expected Result:

The voltage is 24 ± 3 VDC.

Results:

- OK – The voltage is 24 ± 3 VDC. Proceed to Test Step 3.
- Not OK – The voltage is not 24 ± 3 VDC.

Repair: There is a problem with the batteries or the charging system. Refer to Systems Operation/Testing and Adjusting for information that is related to troubleshooting the charging system.

STOP.

Test Step 3. Check the Voltage at the ECM Connector

A. Disconnect the J1/P1 ECM connectors.

- B. Measure the voltage between P1-48 (unswitched +Battery) and P1-61 (-Battery).
- C. Measure the voltage between P1-52 (unswitched +Battery) and P1-63 (-Battery).
- D. Measure the voltage between P1-53 (unswitched +Battery) and P1-65 (-Battery).
- E. Measure the voltage between P1-55 (unswitched +Battery) and P1-67 (-Battery).
- F. Measure the voltage between P1-57 (unswitched +Battery) and P1-69 (-Battery).
- G. Turn the keyswitch to the ON position.
- H. Measure the voltage between P1-70 (keyswitch) and P1-69 (-Battery).
- I. Turn the keyswitch to the OFF position.

Expected Result:

The voltage is with ± 1 VDC of the voltage that was measured at the battery terminals.

Results:

- OK – All of the voltage measurements are within the range that is specified.

Repair: The ECM is receiving the correct voltage. There may be an intermittent problem in a connector or in the harness wiring. If an intermittent condition is suspected, refer to Troubleshooting, “Electrical Connectors - Inspect” for information that is related to troubleshooting intermittent problems.

STOP.

- Not OK - Keyswitch voltage out of range – The voltage for the keyswitch is not within the range that is specified. Proceed to Test Step 4.
- Not OK - Voltage to the ECM is out of range – The voltage for the ECM is not within ± 1 VDC of the voltage that was measured at the battery terminals.

Repair: The voltage is not correct at the ECM. There is an open circuit or excessive resistance in the wiring or connections between the batteries and the ECM. Verify that the circuit breaker for the ECM is not tripped. Verify that the battery disconnect switch is in the ON position. Verify that the connection for the engine ground is clean and tight. Repair the connectors or wiring and/or replace the connectors or wiring.

STOP.

Test Step 4. Check the Voltage from the Keyswitch to the Main Power Relay

- A. Turn the keyswitch to the OFF position.
- B. Remove the wire from the terminal R of the keyswitch.
- C. Turn the keyswitch to the ON position.
- D. Measure the voltage on terminal B of the keyswitch to the engine ground stud.
- E. Measure the voltage on terminal R of the keyswitch to the engine ground stud.
- F. Turn the keyswitch to the OFF position.

Expected Result:

Voltage is present on terminal B and terminal R at the keyswitch.

Results:

- OK – Voltage is present on terminal B and terminal R at the keyswitch. Proceed to Test Step 5.
- Not OK – Voltage is not present on terminal B at the keyswitch.

Repair: If voltage is not present on terminal B, repair the wire between the +Battery and the keyswitch. Verify that the breaker for the keyswitch is not tripped. Verify that the original problem has been eliminated.

STOP.

- Not OK – Voltage is not present on terminal R at the keyswitch.

Repair: If voltage is present on terminal B of the keyswitch but not present on terminal R, replace the keyswitch. Return all wiring to the original configuration. Verify that the original problem has been eliminated.

STOP.

Test Step 5. Check the Voltage at the Main Power Relay

- A. Remove wire 112-PU from the main power relay.
- B. Turn the keyswitch to the ON position.
- C. Measure the voltage between the engine ground stud and the following test points at the main power relay.

Table 34

Test Point
Terminal for wire 112-PU
Wire 109-OR
Wire 308-YL

D. Turn the keyswitch to the OFF position.

Expected Result:

The voltage measures 24 ± 3 VDC between each of the test points and the engine ground stud.

Results:

- OK – The voltage measures 24 ± 3 VDC between each of the test points and the engine ground stud.

Repair: Verify that the “VIMS Breaker” is not tripped. Repair the wiring and/or connectors between the main power relay and the “VIMS Breaker”. Repair the wiring and/or connectors between the “VIMS Breaker” and the ECM.

STOP.

- Not OK – The voltage does not measure 24 ± 3 VDC between the terminal for wire 112-PU and the engine ground stud.

Repair: If voltage is present at the other two test points, check the wire 200-BK for continuity between the engine ground stud and the main power relay. If wire 200-BK is OK, replace the main power relay.

STOP.

- Not OK – The voltage does not measure 24 ± 3 VDC between wire 109-OR and the engine ground stud.

Repair: Verify that the “Alternator Breaker” is not tripped. Repair the wiring and/or connectors between the main power relay and the “Alternator Breaker”. Repair the wiring and/or connectors between the “Alternator Breaker” and the battery.

STOP.

- Not OK – The voltage does not measure 24 ± 3 VDC between wire 308-YL and the engine ground stud.

Repair: Repair the wiring and/or connectors between the main power relay and terminal R on the keyswitch.

STOP.

i02868020

Ether Starting Aid - Test

SMCS Code: 1456-038

System Operation Description:

Use this procedure in order to troubleshoot the ether system or use this procedure if any one of the diagnostic codes in Table 35 is active or easily repeated.

Table 35

Diagnostic Codes Table		
Code and Description	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 ECM can only detect this condition when the output driver is not activated.	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 ECM can only detect this condition when the output driver is activated.	

This starting aid output is used to connect to a relay and/or a solenoid in order to control a starting aid system. Typical starting aid systems will inject ether into the intake manifold in order to aid starting of the engine during cold weather operation. The output is automatically controlled by the ECM.

The reading of the coolant temperature sensor is used to determine if conditions require the use of the starting aid. If a fault condition exists with the circuit for the coolant temperature sensor, the reading for the intake manifold air temperature sensor will be used. The starting aid output will be enabled for a maximum of 30 seconds while the engine is cranking and the temperature reading is below 0 °C (32 °F). The starting aid output will be disabled if the engine starts. The starting aid output will also be disabled if a condition that prevents fuel injection occurs.

An override parameter on Caterpillar Electronic Technician (ET) allows the technician to activate the ether system. The test is only functional when the engine speed is zero rpm. Access the test via the "Override Parameters" screen on Cat ET.

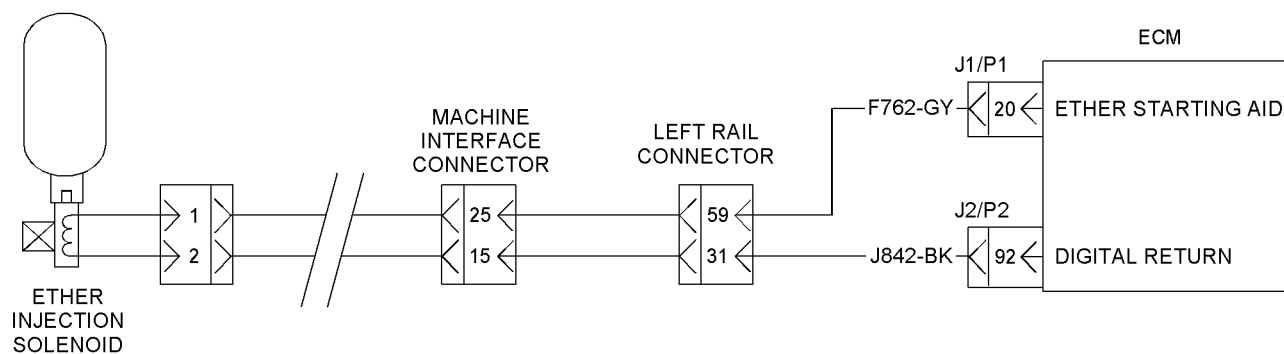


Illustration 64

g01446331

Schematic of the ether injection system

⚠ WARNING

Breathing ether vapors or repeated contact of ether with skin can cause personal injury. Personal injury may occur from failure to adhere to the following procedures.

Use ether only in well ventilated areas.

Do not smoke while changing ether cylinders.

Use ether with care to avoid fires.

Do not store replacement ether cylinders in living areas or in the operator's compartment.

Do not store ether cylinders in direct sunlight or at temperatures above 49 °C (120 °F).

Discard cylinders in a safe place. Do not puncture or burn cylinders.

Keep ether cylinders out of the reach of unauthorized personnel.

To avoid possible injury, be sure the brakes are applied and all controls are in Hold or Neutral when starting the engine.

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Turn the keyswitch to the OFF position.

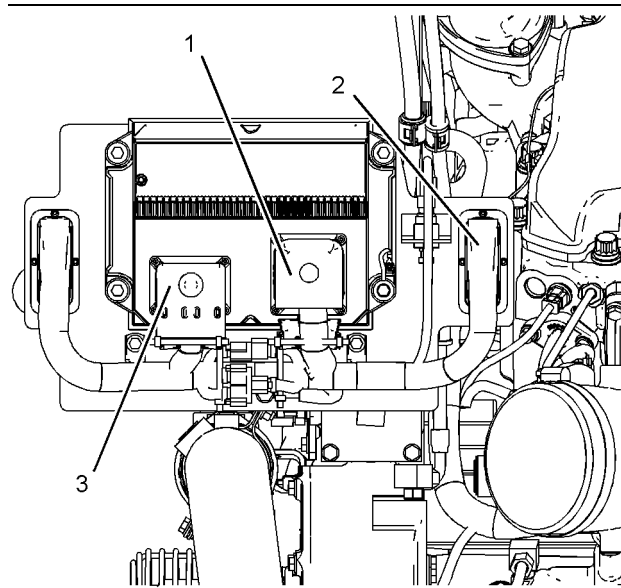


Illustration 65

g01446338

Location of the connectors at the ECM for the 16 cylinder engines (typical left side engine view)

- (1) J2/P2 ECM connector
- (2) Left rail connectors
- (3) J1/P1 ECM connector

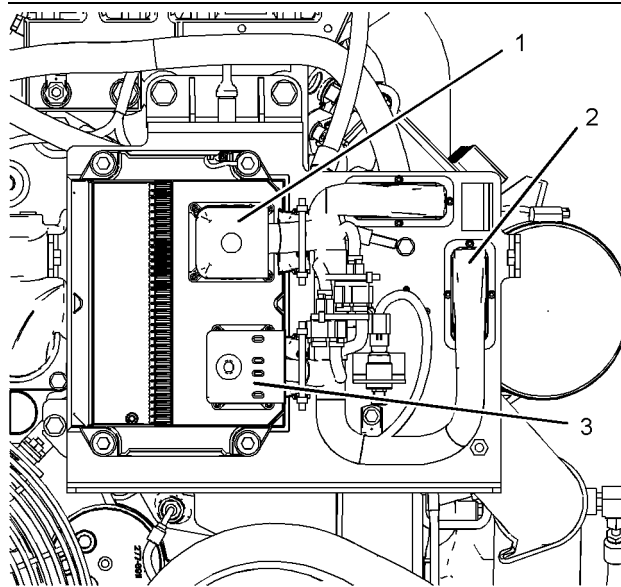


Illustration 66

g01446340

Location of the connectors at the ECM for the 20 cylinder engines (typical left side engine view)

- (1) J2/P2 ECM connector
- (2) Left rail connectors
- (3) J1/P1 ECM connector

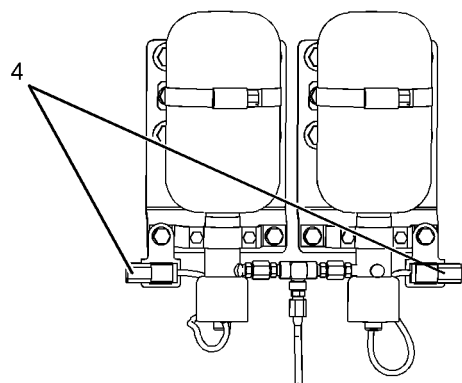


Illustration 67

g01324401

Location of the connectors for the ether injection solenoid (typical example)

(4) connectors for the ether injection solenoid

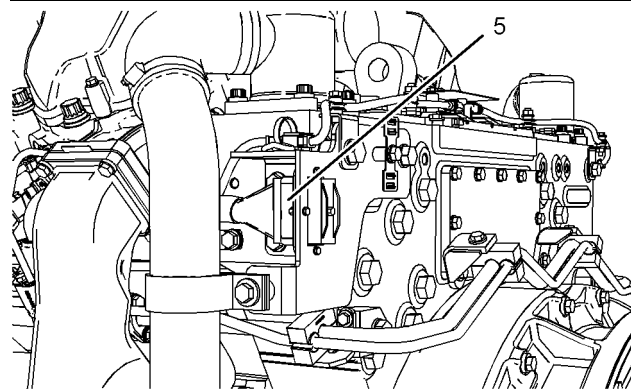


Illustration 68

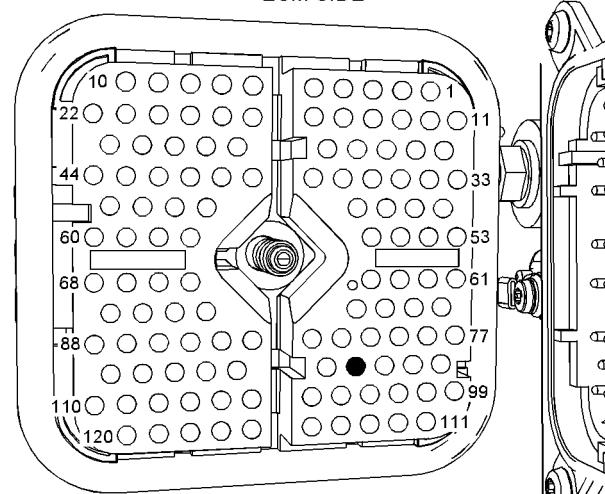
g01444865

Location of the machine interface connectors (left rear engine view)

(5) Machine interface connectors

B. Thoroughly inspect connectors (1), (2), (3), and (5). Also, inspect each connector (4) for the ether solenoids. Refer to Troubleshooting, "Electrical Connectors - Inspect".

ECM SIDE



HARNESS SIDE

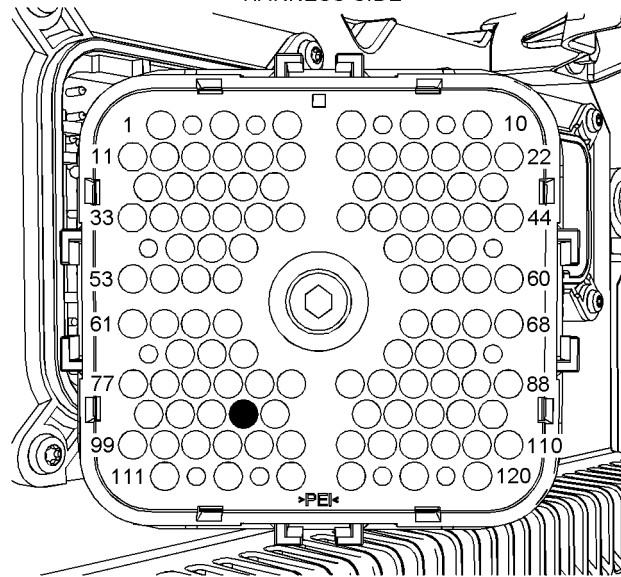


Illustration 69

g01324381

Terminal locations at the P2 ECM connector for the ether starting aid

(P2-92) Digital return

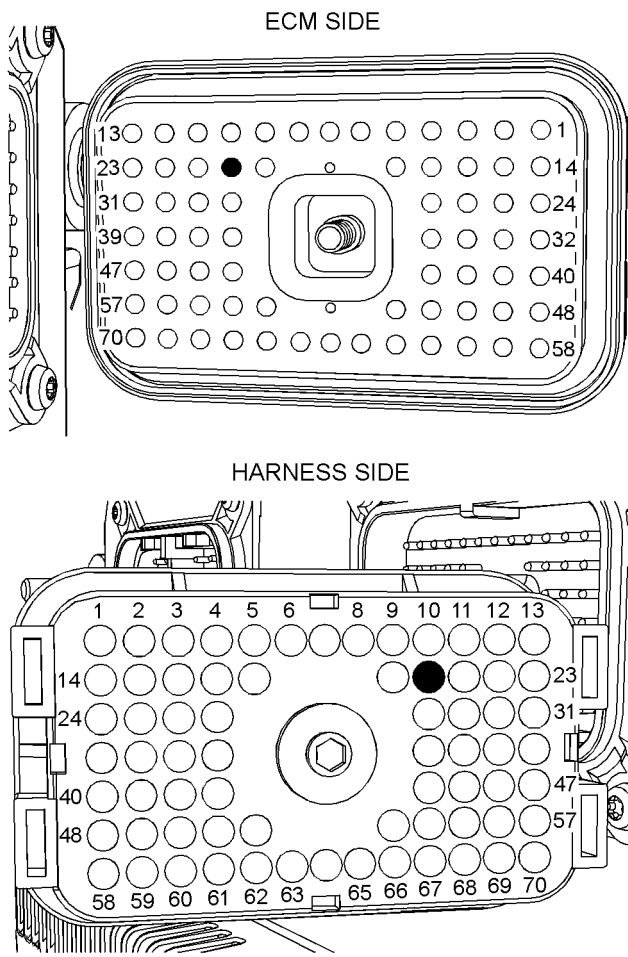


Illustration 70
Terminal locations at the P1 ECM connector for the ether starting aid
(P1-20) Ether starting aid

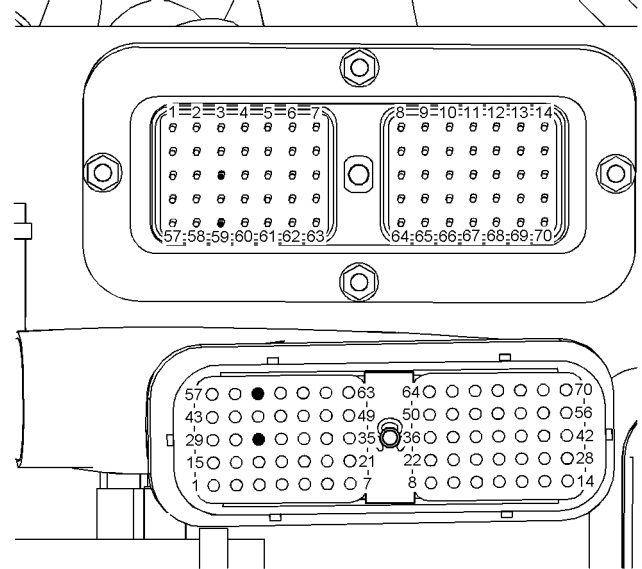
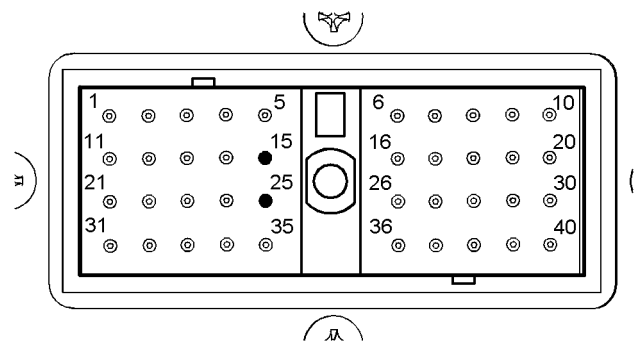


Illustration 71
Terminal locations at the left rail connector that are for the ether starting aid
(Terminal 31) Digital return
(Terminal 59) Ether starting aid

CONTROL BOX CONNECTOR



HARNESS CONNECTOR

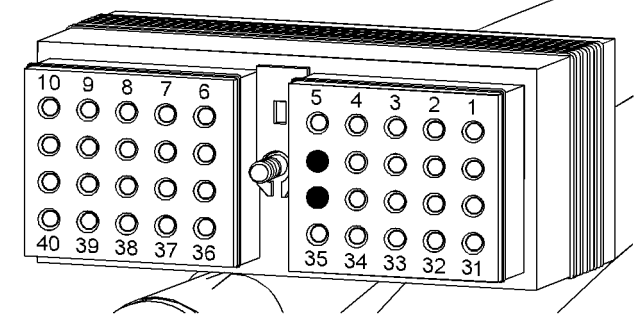


Illustration 72
Terminal locations at the machine interface connector for the ether starting aid
(Terminal 15) Digital return
(Terminal 25) Ether starting aid

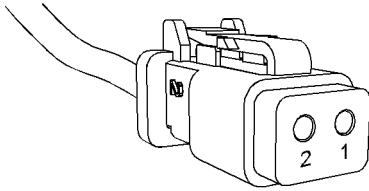


Illustration 73

g01155187

Connector for the Ether start valve
(Terminal 1) Ether injection solenoid
(Terminal 2) Digital return

- C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the ether injection system.
- D. Check the torque of the allen head screws for each of the ECM connectors. Refer to Troubleshooting, "Electrical Connectors - Inspect" for the correct torque values.
- E. Check the harness and the wiring for abrasion and for pinch points from the connectors for the ether injection solenoid to the ECM.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted, and the harness and wiring are free of corrosion, of abrasion and of pinch points.

Results:

- OK – The connectors and the wiring appear to be OK. Proceed to Test Step 2.
- Not OK – The connectors and/or the wiring are not OK.

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

STOP.

Test Step 2. Check for Active Diagnostic Codes

Note: Remove the ether canisters before you perform this procedure.

- A. Connect Cat ET to the service tool connector.
- B. Turn the keyswitch to the ON position.
- C. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

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

- D. Proceed to the "Diagnostic Overrides" screen on Cat ET.
- E. Activate the ether injection system. The system will activate for ten seconds.
- F. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

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

Expected Result:

No diagnostic codes are active.

Results:

- No active codes – No diagnostic codes are active.

Repair: The problem may have been caused by a poor electrical connection. Carefully reinspect the connectors and the wiring. Refer to Troubleshooting, "Electrical Connectors - Inspect".

STOP.

- Not OK – A 6 code is active at this time. Proceed to Test Step 3.
- Not OK – A 5 code is active at this time. Proceed to Test Step 4.

Test Step 3. Create an Open Circuit at the Harness Connectors for the Ether Injection Solenoids

- A. Turn the keyswitch to the OFF position.
- B. Disconnect the connector for the left ether injection solenoid and check for an open circuit diagnostic code:
 - a. Disconnect the connectors for the left ether injection solenoid.
 - b. Turn the keyswitch to the ON position.
 - c. Proceed to the "Diagnostic Overrides" screen on Cat ET.
 - d. Activate the ether injection system. The system will activate for ten seconds.
 - e. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

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

A -5 code will be active for the ether injection solenoid.

- f. Turn the keyswitch to the OFF position. Leave the connectors for the left ether injection solenoid disconnected.

C. Disconnect the connector for the right ether injection solenoid and check for an open circuit diagnostic code:

- a. Disconnect the connectors for the right ether injection solenoid.
- b. Turn the keyswitch to the ON position.
- c. Proceed to the "Diagnostic Overrides" screen on Cat ET.
- d. Activate the ether injection system. The system will activate for ten seconds.
- e. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

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

A -5 code will be active for the ether injection solenoid.

- f. Turn the keyswitch to the OFF position. Leave the connectors for the right ether injection solenoid disconnected.

Expected Result:

A -5 code became active for at least one of the ether injection solenoids during the test.

Results:

- OK – A -5 code became active for one or both of the ether injection solenoids.

Repair: The suspect solenoid will be the solenoid that had the disconnected connector during the change from a -6 code to a -5 code. Temporarily connect a new ether solenoid to the harness, but do not install the new ether solenoid. Verify that there are no active codes for the ether injection system.

If there are no active codes for the ether injection system, permanently install the new ether solenoid. Clear any logged diagnostic codes.

STOP.

- Not OK – The -6 code remained active after each of the connectors was disconnected. The short is in the harness between the connector for the ether solenoid and the ECM. There may be a problem with the ECM. Leave the connectors for both solenoids disconnected. Proceed to Test Step 5.

Test Step 4. Create a Short Circuit at the Machine Interface Connector

- A. Turn the keyswitch to the OFF position.
- B. Fabricate a jumper wire that can be used to create a short circuit at the machine interface connector. Crimp connector sockets to each end of the jumper wire.
- C. Disconnect the machine interface connectors.
- D. Install the jumper wire across terminal 15 (digital return) and terminal 30 (ether starting aid) of the machine interface connector.
- E. Turn the keyswitch to the ON position.
- F. Proceed to the "Diagnostic Overrides" screen on Cat ET.
- G. Activate the ether injection system. The system will activate for ten seconds.
- 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 codes to become active.

A -6 code will be active for the ether injection solenoid.

- I. Turn the keyswitch to the OFF position.

Expected Result:

A 6 code became active after the jumper wire was installed.

Results:

- OK – A -5 code was active before the jumper wire was installed. A -6 code became active after the jumper wire was installed.

Repair: The engine harness and the ECM are OK. The problem is in the harness between the machine interface connector and the ether injection solenoids. There may be a problem with the solenoids. Perform the following procedure:

Check the circuit resistance of the machine harness from the machine interface connector to the ether injector solenoids. Be sure to check both legs of the circuit for continuity.

If a problem with the wiring harness has been discovered, repair the harness or replace the harness. Verify that the original problem has been eliminated.

If an open circuit in the harness is not discovered then there is either an intermittent electrical problem in the harness or there is a problem with both of the ether injection solenoids. Make the necessary repairs to the ether system. Verify that the original problem has been eliminated.

STOP.

- Not OK – A -5 code was active before the jumper wire was installed. The -6 code did not become active after the jumper wire was installed. The open is in the harness wiring between the connector for the ether solenoid and the ECM. There may be a problem with the ECM. Proceed to Test Step 5.

Test Step 5. Check the Operation of the ECM

- A. Turn the keyswitch to the OFF position.
- B. Disconnect the J1/P1 ECM connectors.
- C. Fabricate a jumper wire that is long enough to reach from a terminal at the ECM connector to the engine ground stud. Crimp a connector socket to one end of the jumper wire.
- D. Remove the wire from terminal P1-20 at the ECM connector. Install the jumper wire into the terminal location for the solenoid.
- E. Connect the J1/P1 connectors.
- F. **Check the operation of the ECM by creating an open at the ECM:**
 - a. Ensure that the loose end of the jumper wire is isolated from any ground source during this portion of the test.
 - b. Turn the keyswitch to the ON position.
 - c. Proceed to the “Diagnostic Overrides” screen on Cat ET.
 - d. Activate the ether injection system. The system will activate for ten seconds.
 - e. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

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

A -5 code will become active for the ether injection solenoid.

- f. Turn the keyswitch to the OFF position.

G. Check the operation of the ECM by creating a short at the ECM:

- a. Connect the loose end of the jumper wire to engine ground stud.
- b. Turn the keyswitch to the ON position.
- c. Proceed to the “Diagnostic Overrides” screen on Cat ET.
- d. Activate the ether injection system. The system will activate for ten seconds.
- e. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

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

A -6 code will become active for the ether injection solenoid with the short circuit in place.

- H. Turn the keyswitch to the OFF position.
- I. Return all wiring to the original configuration.

Expected Result:

A -5 code is active when the solenoid wire is an open circuit. A -6 code is active when the jumper wire is short circuited to the engine ground stud.

Results:

- OK – A -5 code is active when the circuit is open. A -6 code is active when the jumper wire is shorted to engine ground.

Repair: The ECM is operating properly. The problem is in the wiring between the ECM and the machine interface connector. Repair the connectors or wiring and/or replace the connectors or wiring.

STOP.

- Not OK – One of the following conditions exists: A -5 code is not active when the wires are removed from the ECM connector. A -6 code is not active when the wire jumper is shorted to engine ground.

Repair: The ECM does not detect the open circuit or the short circuit at the ECM connector. There is a problem with the ECM. Perform the following procedure:

- 1. Temporarily connect a test ECM.

Refer to Troubleshooting, “ECM - Replace”.

- 2. Recheck the circuit in order to ensure that the original problem has been resolved.

If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the problem is resolved.

If the problem is not resolved with the test ECM, install the original ECM. There is a problem in the wiring.

STOP.

i02907031

Fuel Priming Pump - Test

SMCS Code: 1258-038

System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with the fuel pump relay or if one of the diagnostic codes in Table 36 is active or easily repeated.

Table 36

Diagnostic Codes Table		
Code and Description	Conditions which Generate this Code	System Response
1627-5 Fuel Pump Relay current below normal	The engine's Electronic Control Module (ECM) detects an open circuit at the fuel pump relay for 60 seconds. The ECM detects a short to battery voltage for the fuel pump relay for 60 seconds. The ECM can only detect this condition when the output driver is not activated.	The code is logged.
1627-6 Fuel Pump Relay current above normal	The engine's ECM detects a short circuit for the fuel pump relay. The ECM can only detect this condition when the output driver is activated.	

The ECM has the ability to energize the fuel pump relay. The fuel pump relay controls battery power to the fuel priming pump.

Manually Priming the Fuel System

A manual switch can be used to prime the fuel system. This is usually used after maintenance has been performed on the fuel system. This allows air to be purged from the system without opening up fuel lines.

When the switch is activated, the ECM powers the electric fuel priming pump. The ECM will command the throttle position to 25 percent. This provides a path for the air. To use this feature, the keyswitch must be in the ON position. Also, the engine speed must be 0 rpm.

The switch for the fuel priming pump is a normally open switch.

Automatically Priming the Fuel System

This strategy improves the capability of the fuel system at low engine speeds.

The ECM will automatically turn on the fuel priming pump during starting of the engine. The ECM turns on the fuel pump when the engine speed is greater than 50 rpm. The ECM turns off the fuel pump when the engine speed is 100 rpm below the low engine idle.

An override parameter on Caterpillar Electronic Technician (ET) allows the technician to activate the fuel priming pump. The test is only functional when the engine speed is zero rpm. Access the test via the "Override Parameters" screen on Cat ET.

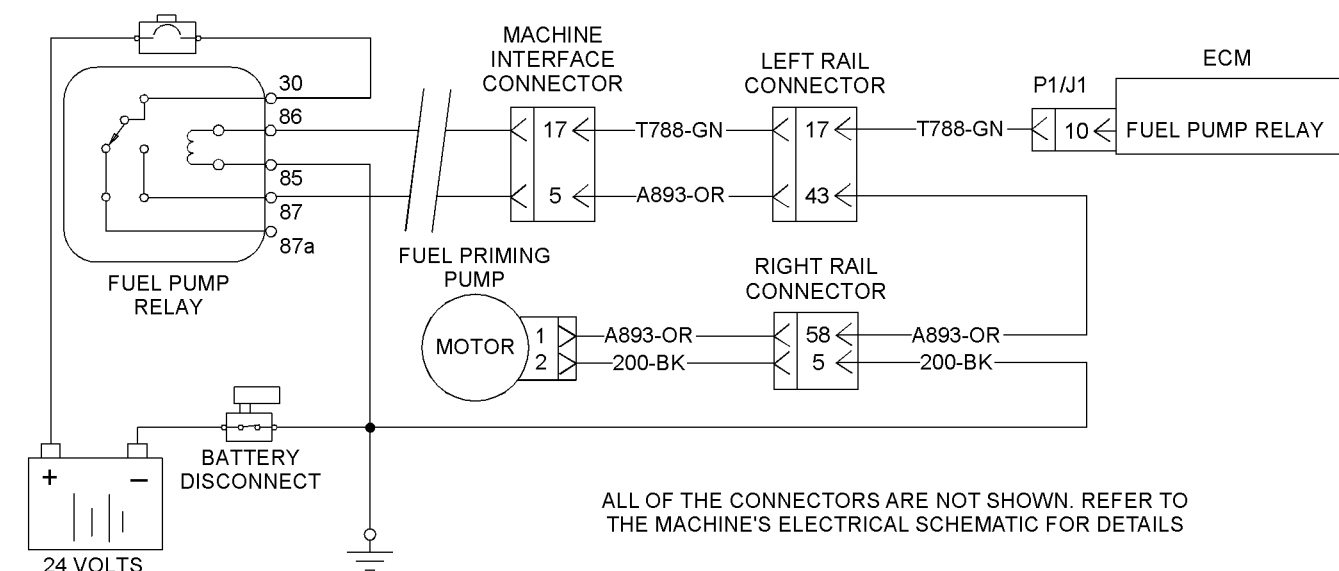


Illustration 74

Typical schematic

g01447069

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Turn the keyswitch to the OFF position.

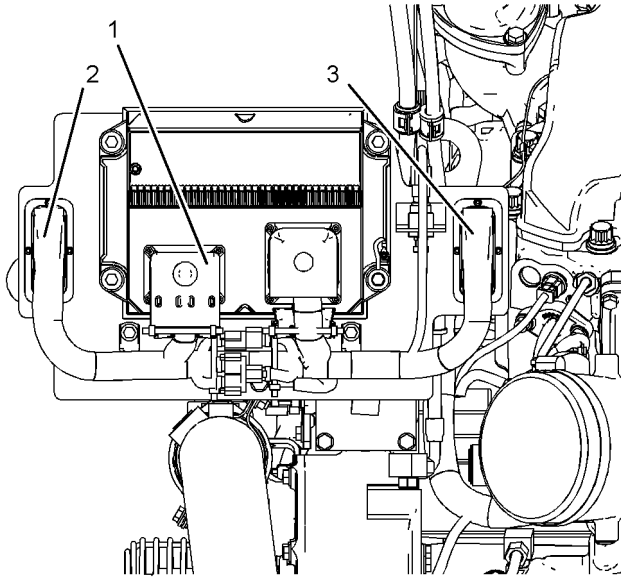


Illustration 75 g01428276

Location of the ECM connectors for the 16 cylinder engines (typical left front engine view)

- (1) J1/P1 ECM connector
- (2) Right rail connector
- (3) Left rail connector

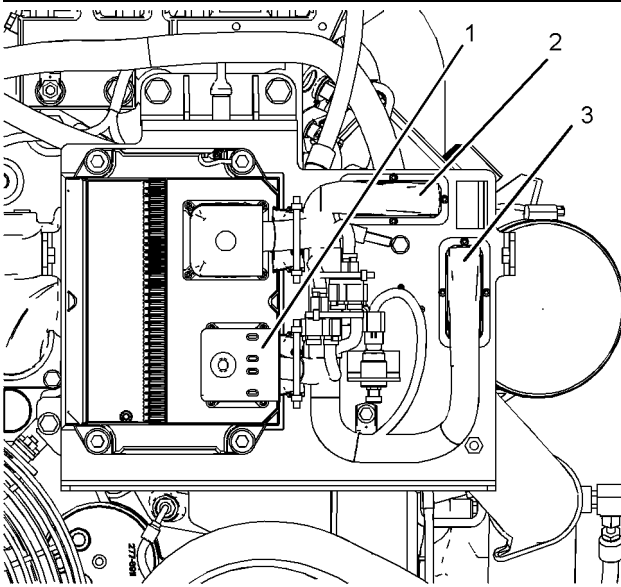


Illustration 76 g01428374

Location of the ECM connectors for the 20 cylinder engines (typical front side engine view)

- (1) J1/P1 ECM connector
- (2) Right rail connector
- (3) Left rail connector

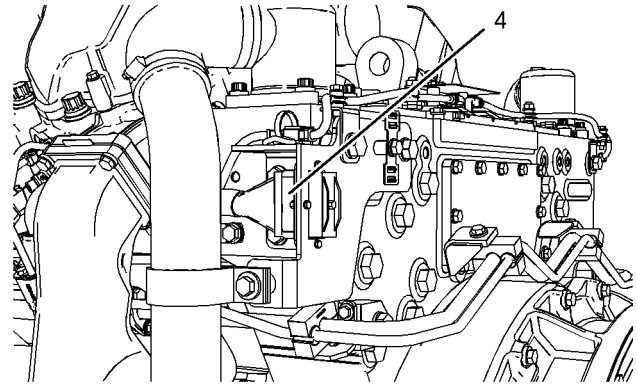


Illustration 77 g01428379

Location of the machine interface connectors (typical left rear engine view)

- (4) Machine interface connector

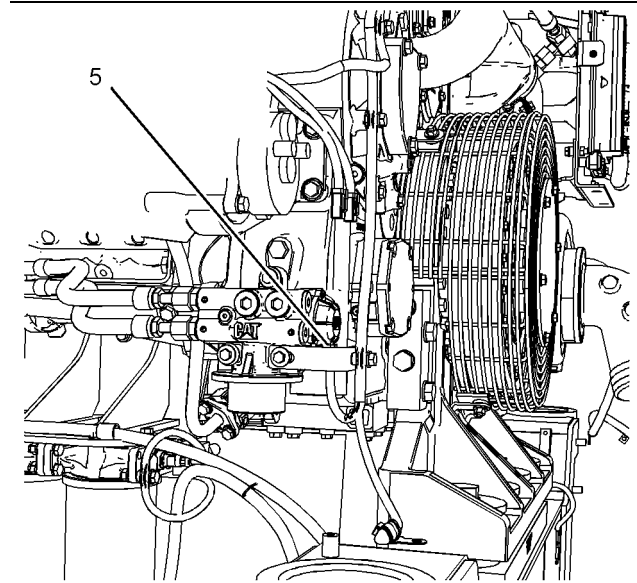


Illustration 78 g01447108

Location of the connectors for the fuel priming pump (typical front right engine view)

- B.** Thoroughly inspect connectors (1), (2), (3), (4), and (5). Refer to Troubleshooting, "Electrical Connectors - Inspect".

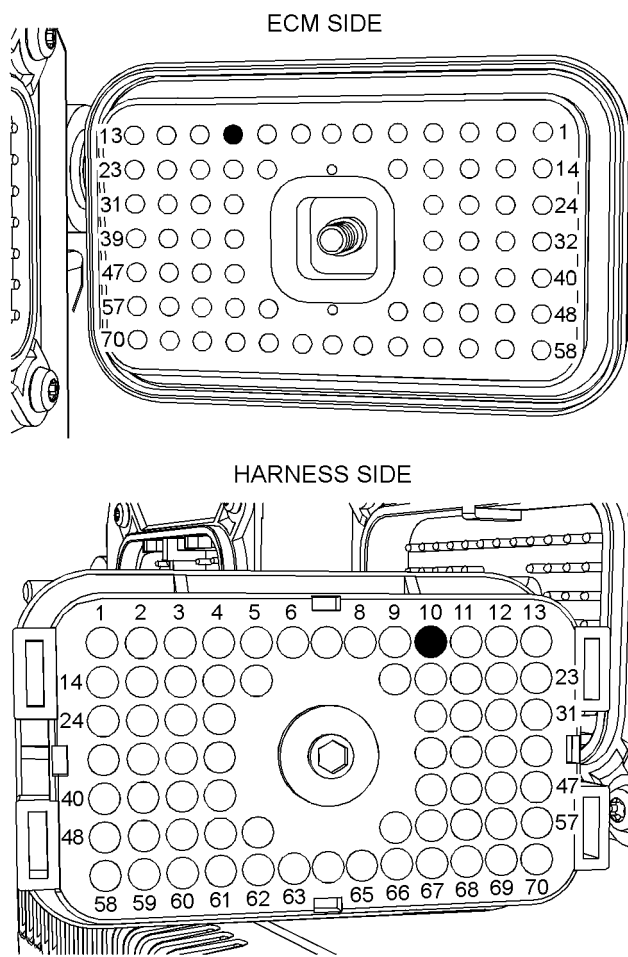


Illustration 79
Terminal locations for the high pressure fuel pump at the P1 ECM connectors
(P1-10) Fuel priming pump

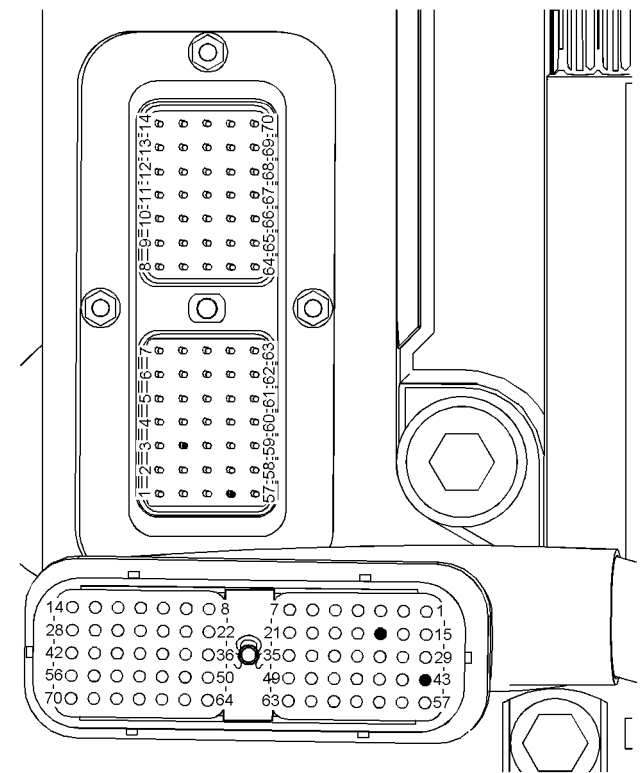


Illustration 80
Terminal locations for the fuel priming pump at the left rail connectors
(Terminal 17) Fuel priming pump
(Terminal 43) Relay signal circuit to the pump

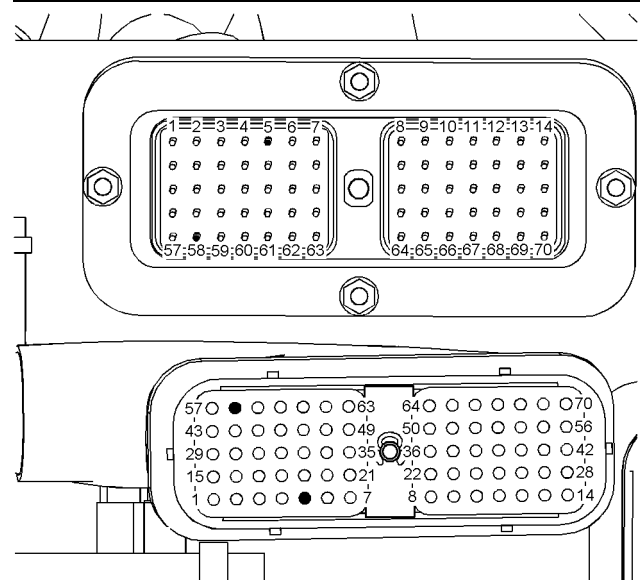


Illustration 81
Terminal locations for the fuel priming pump at the right rail connectors
(Terminal 58) Relay signal circuit to the pump
(Terminal 5) Return

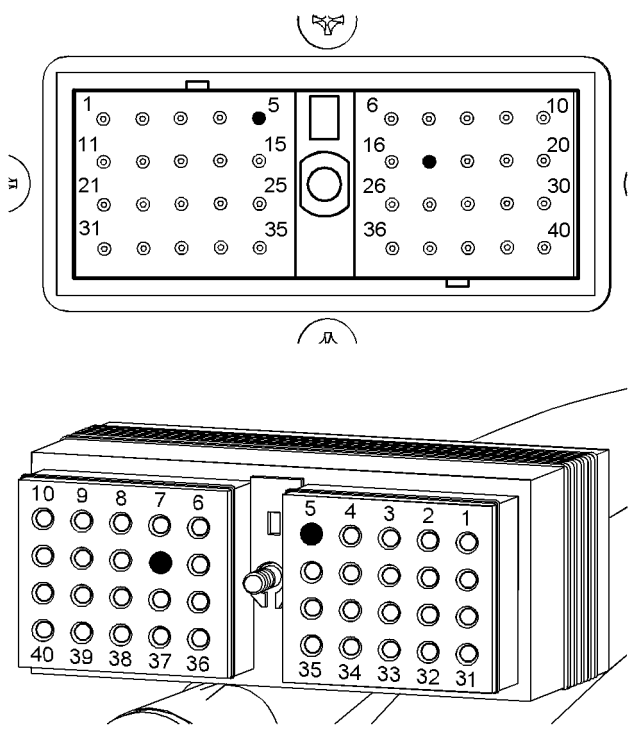


Illustration 82 g01447118

Terminal locations at the machine interface connector for the fuel priming pump

(Terminal 17) Fuel priming pump
(Terminal 5) Relay signal circuit to the pump

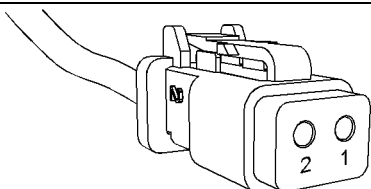


Illustration 83 g01155187

Terminal locations for the fuel priming pump at the right rail connectors

(Terminal 1) Relay signal circuit to the pump
(Terminal 2) Return

- C. Check the torque of the allen head screws for each of the ECM connectors. Refer to Troubleshooting, "Electrical Connectors - Inspect" for the correct torque values.
- D. Check the harness and the wiring for abrasion and for pinch points from the connectors for the ether injection solenoid to the ECM.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted, and the harness and wiring are free of corrosion, of abrasion and of pinch points.

Results:

- OK – The connectors and the wiring appear to be OK. Proceed to Test Step 2.
- Not OK – The connectors and/or the wiring are not OK.

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

STOP.

Test Step 2. Check for Active Diagnostic Codes

- A. Connect Cat ET to the service tool connector.
- B. Restore power to the ECM.
- C. Turn the keyswitch to the ON position.
- D. Select diagnostic tests from Cat ET.
- E. Select the "Override Parameters" screen on Cat ET.
- F. Activate the override for the fuel pump relay.
- G. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.
- H. Deactivate the override for the fuel pump relay.
- I. 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.

Note: Wait at least 70 seconds in order for the diagnostic codes to become active.

Expected Result:

No diagnostic codes are active.

Results:

- OK – No diagnostic codes are active, but a problem is suspected in the circuit for the fuel priming pump. Proceed to Test Step 6.
- Not OK – A -6 diagnostic code is active at this time. Proceed to Test Step 3.
- Not OK – A -5 diagnostic code is active at this time. Proceed to Test Step 4.

Test Step 3. Create an Open at the Connector for the Fuel Pump Relay

- A. Remove power from the ECM.
- B. Turn the keyswitch to the OFF position.
- C. Disconnect the connector from the fuel pump relay.
- D. Restore power to the ECM.
- E. Turn the keyswitch to the ON position.
- F. Select diagnostic tests from Cat ET.
- G. Select the "Override Parameters" screen on Cat ET.
- H. Activate the override for the fuel pump relay.
- I. 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.

- J. Deactivate the override for the fuel pump relay.
- K. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

Note: Wait at least 70 seconds in order for the diagnostic codes to become active.

Expected Result:

A -5 diagnostic code is now active for the fuel pump relay.

Results:

- OK – A -5 diagnostic code became active after disconnecting the connector for the fuel priming pump.

Repair: Temporarily install a new fuel pump relay. Verify that there are no active diagnostic codes for the fuel pump relay. Clear any logged diagnostic codes.

STOP.
- Not OK – A -6 diagnostic code remains active. There is a short between the connector for the fuel pump relay and the ECM. Proceed to Test Step 5.

Test Step 4. Create a Short at the Connector for the Fuel Pump Relay

- A. Remove power from the ECM.
- B. Turn the keyswitch to the OFF position.

- C. Disconnect the connector for the fuel pump relay. Install a jumper wire between the terminals at the connector for the fuel pump relay. Refer to Illustration 74 for the schematic of the circuit.
- D. Restore power to the ECM.
- E. Turn the keyswitch to the ON position.
- F. Select diagnostic tests from Cat ET.
- G. Select the "Override Parameters" screen on Cat ET.
- H. Activate the override for the fuel pump relay.
- I. 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.

- J. Deactivate the override for the fuel pump relay.
- K. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

Note: Wait at least 70 seconds in order for the diagnostic codes to become active.

Expected Result:

A -6 diagnostic code is active when the jumper wire is installed.

Results:

- OK – The engine harness and the ECM are OK.

Repair: Temporarily install a new fuel pump relay. Verify that there are no active diagnostic codes for the fuel pump relay. Clear any logged diagnostic codes.

STOP.
- Not OK – The -5 diagnostic code remains active with the jumper in place. Verify that wire at terminal 2 of the connector for the fuel pump relay has continuity to engine ground. If the ground circuit is OK, the open circuit is between the ECM and the connector for the fuel pump relay. Proceed to Test Step 5.

Test Step 5. Check the Operation of the ECM

- A. Remove power from the ECM.
- B. Turn the keyswitch to the OFF position.
- C. Check the operation of the ECM by creating an open at the ECM connector:

- a. Disconnect the J1/P1 ECM connector.
- b. Remove the wire for the fuel pump relay from P1-10.
- c. Install a wire jumper into the socket for P1-10. Ensure that the wire jumper is not in contact with any other wire in the harness or in contact with engine ground.
- d. Reconnect the ECM connector.
- e. Restore power to the ECM.
- f. Turn the keyswitch to the ON position.
- g. Select diagnostic tests from Cat ET.
- h. Select the "Override Parameters" screen on Cat ET.
- i. Activate the override for the fuel pump relay.
- j. 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.

- k. Deactivate the override for the fuel pump relay.
- l. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

Note: Wait at least 70 seconds in order for the diagnostic codes to become active.

D. Check the operation of the ECM by creating a short circuit at the ECM connector:

- a. Turn the keyswitch to the OFF position.
- b. Install a wire jumper between the wire jumper in P1-10 and engine ground.
- c. Restore power to the ECM.
- 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 override for the fuel pump relay.
- 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. Deactivate the override for the fuel pump relay.
- j. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

Note: Wait at least 70 seconds in order for the diagnostic codes to become active.

E. Remove power from the ECM. Reconnect all wires to the original configuration.

Expected Result:

A -5 diagnostic code is active when the wire for the fuel pump relay is open. A -6 diagnostic code is active when the wire jumper in P1-19 is connected to engine ground.

Results:

- OK – The ECM is operating properly. The problem is in the wiring between the ECM and the connector for the fuel pump relay.

Repair: Repair the connectors or wiring and/or replace the connectors or wiring.

STOP.

- Not OK – One of the following conditions exists:
The -5 diagnostic code is not active when the wire jumper is open. The -6 diagnostic code is not active when the wire jumper is grounded.

Repair: There is a problem with the ECM. Perform the following procedure:

1. Temporarily connect a test ECM.

Refer to Troubleshooting, "ECM - Replace".

2. Recheck the circuit in order to ensure that the original problem has been resolved.

If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the problem is resolved.

If the problem is not resolved with the test ECM, install the original ECM. There is a problem in the wiring.

STOP.

Test Step 6. Check the Voltage at the Connector for the Fuel Priming Pump

- A. Turn the keyswitch to the ON position.
- B. Select diagnostic tests from Cat ET.
- C. Select the "Override Parameters" screen on Cat ET.
- D. Activate the override for the fuel pump relay.
- E. Measure the voltage between terminal 1 and terminal 2 at the connector for the fuel priming pump. Refer to Illustration 74 for the schematic of the circuit.
- F. Deactivate the override for the fuel pump relay.

Expected Result:

The voltage is 24 ± 3 VDC.

Results:

- OK – The voltage is 24 ± 3 VDC.

Repair: The circuit for the fuel priming pump is operating correctly up to the connector for the fuel priming pump. Verify that the fuel priming pump is operating correctly by testing the fuel priming pump.

STOP.

- Not OK – The voltage is not 24 ± 3 VDC. Verify that the ground circuit at terminal 2 has continuity to engine ground. If the ground circuit is OK, proceed to Test Step 7.

Test Step 7. Check the Normally Open Contacts at the Fuel Pump Relay

- A. Remove power from the ECM.
- B. Turn the keyswitch to the OFF position.
- C. Disconnect the connector for the fuel pump relay.
- D. Remove the wire from terminal 85 of the connector at the relay.
- E. Reconnect the connector for the fuel pump relay.
- F. Restore power to the ECM.
- G. Turn the keyswitch to the ON position.
- H. Select diagnostic tests from Cat ET.
- I. Select the "Override Parameters" screen on Cat ET.

- J. Activate the override for the fuel pump relay.
- K. Measure the voltage between terminal 85 on the connector for the fuel pump relay and engine ground.
- L. Deactivate the override for the fuel pump relay.

Expected Result:

The voltage is 24 ± 3 VDC.

Results:

- OK – The voltage is 24 ± 3 VDC.

Repair: Repair the wire between the connector for the fuel pump relay and the fuel priming pump.

STOP.

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

Repair: Verify that battery voltage is present on terminal 30 at the connector for the fuel pump relay. Verify that the fuse for the engine control is not tripped. If voltage is present on terminal 30, replace the fuel pump relay.

STOP.

i02867033

Fuel Rail Pressure - Test

SMCS Code: 1251-038-PX; 1252-038-PX

System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with the fuel control valve or if a diagnostic code in Table 37 is active.

Table 37

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
18-8 Fuel Control Valve abnormal frequency, pulse width, or period	The controller for the fuel control valve has detected an error at the input for the Pulse Width Modulated signal (PWM). The problem is communicated to the ECM via the CAN data link.	Control for the fuel control valve reverts to the CAN data link.
18-9 Fuel Control Valve abnormal update rate	The engine's Electronic Control Module (ECM) did not receive the expected data link information from the controller for the fuel control valve.	Control for the fuel control valve reverts to the PWM signal.

This engine is equipped with a high pressure common rail fuel system. The fuel pressure for the high pressure common rail fuel system is generated by the high pressure fuel pump. Pressure regulation for the high pressure fuel pump is provided by the fuel control valve. The fuel control valve is a mechanical valve that is part of the high pressure fuel pump. The valve regulates the fuel pressure that is produced by the pump by controlling the volume of fuel that enters the pump. The valve is controlled by an electrical actuator. Control for the actuator is provided by an electronic controller that is an integral part of the actuator.

The engine ECM communicates a desired throttle position to the fuel control valve's controller in the form of a PWM signal. The PWM signal is generated from +5 VDC that is produced by the controller and applied to the signal line. The ECM converts the DC voltage to a PWM signal with a low side ECM driver.

Note: The desired throttle position is also communicated via the CAN data link as a throttle backup control.

The PWM signal that is used for the desired throttle position has a constant frequency of 500 hertz. At low engine idle, the signal will have a duty cycle of approximately 10 percent. At high engine idle with no load on the engine, the signal will have a duty cycle of approximately 20 to 25 percent. At high engine idle with a full load on the engine, the signal will have a duty cycle of approximately 50 to 60 percent.

The desired throttle position can be viewed on Caterpillar Electronic Technician (ET). View the status of the "Fuel Actuator Position Command" parameter in order to determine the desired throttle position of the engine. At low engine idle, the "Fuel Actuator Position Command" will be approximately 10 to 15 percent. At high engine idle with no load on the engine, the "Fuel Actuator Position Command" will be approximately 20 to 25 percent. At high engine idle with a full load on the engine, the "Fuel Actuator Position Command" will be approximately 40 to 50 percent.

A power module is used to supply electrical power to the controller for the fuel control valve. The power module is used to convert battery voltage (24 VDC) to 14.0 ± 1.5 VDC that is used by the controller.

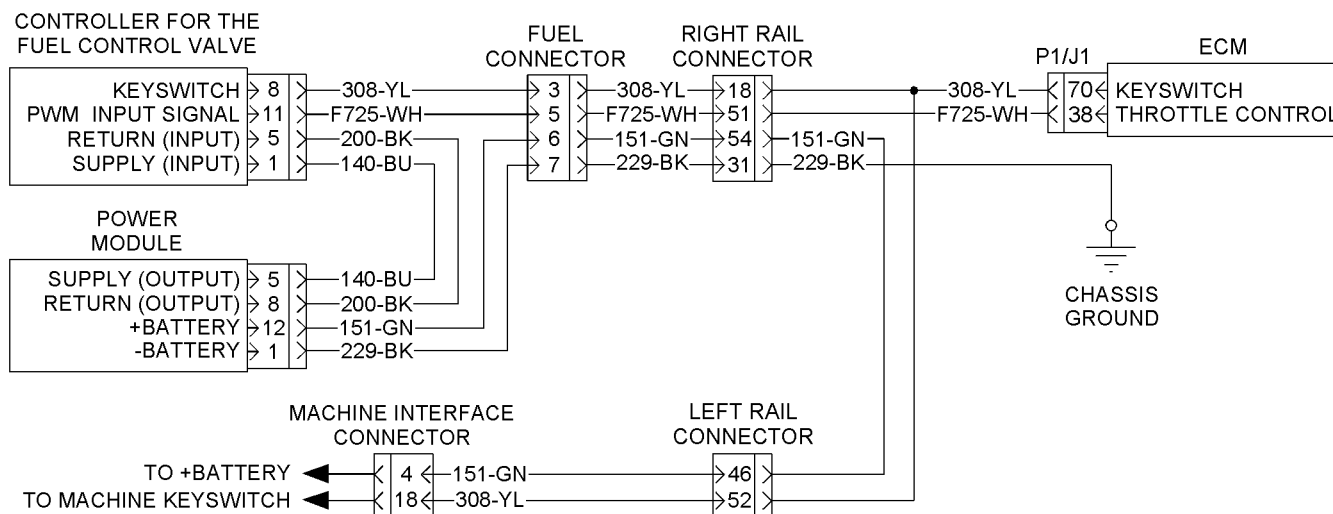


Illustration 84

g01428184

Schematic of the PWM signal for the high pressure fuel pump

Note: For a schematic and troubleshooting information that is related to the throttle backup control and the CAN data link, refer to Troubleshooting, "Data Link - Test".

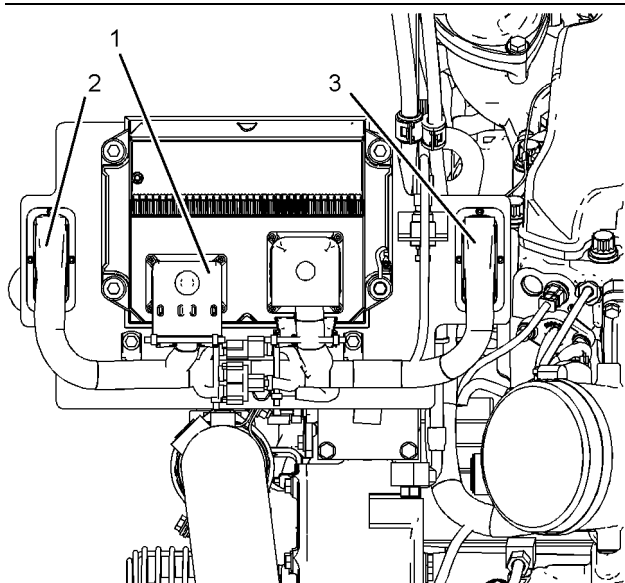


Illustration 85

g01428276

Location of the ECM connectors for the 16 cylinder engines (typical left front engine view)

- (1) J1/P1 ECM connector
- (2) Right rail connector
- (3) Left rail connector

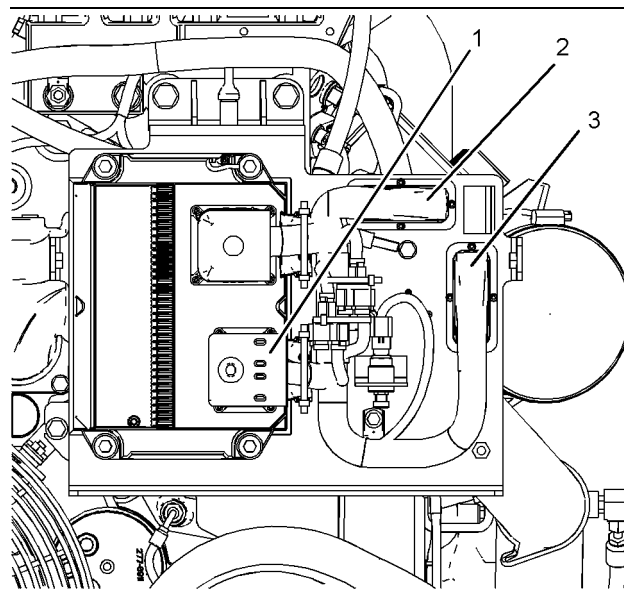


Illustration 86

g01428374

Location of the ECM connectors for the 20 cylinder engines (typical front side engine view)

- (1) J1/P1 ECM connector
- (2) Right rail connector
- (3) Left rail connector

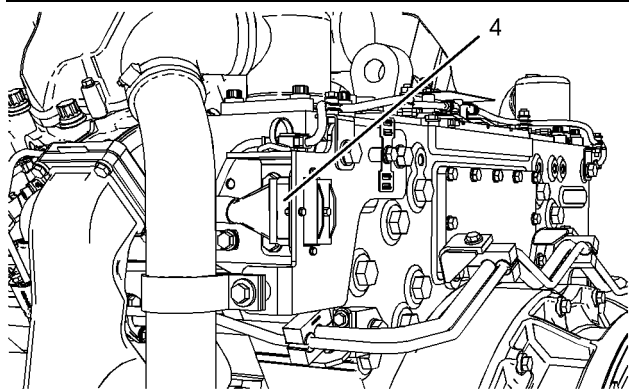


Illustration 87

g01428379

Location of the machine interface connectors (typical left rear engine view)

(4) Machine interface connector

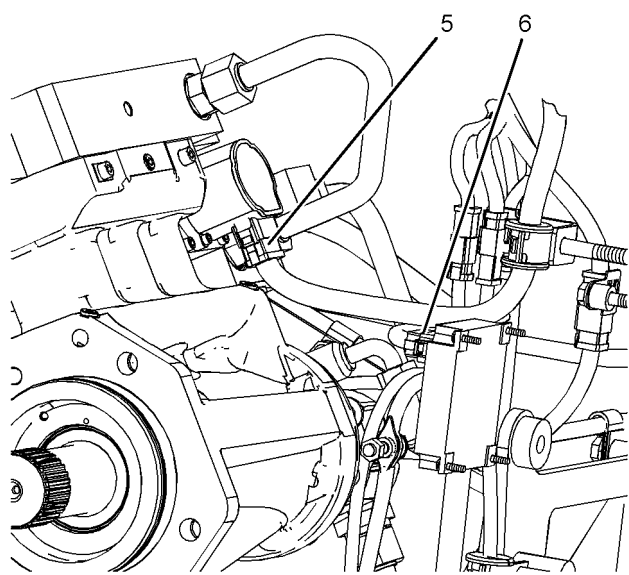


Illustration 88

g01317976

Location of the connectors at the high pressure fuel pump

(5) Connector for the fuel control valve's electronic controller

(6) Connectors at the power module

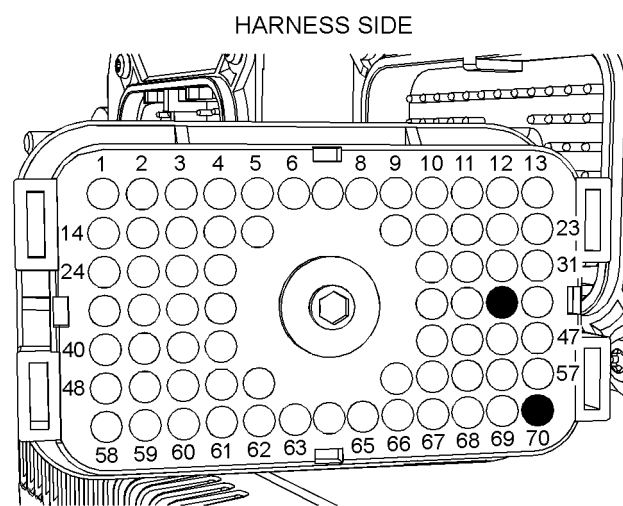
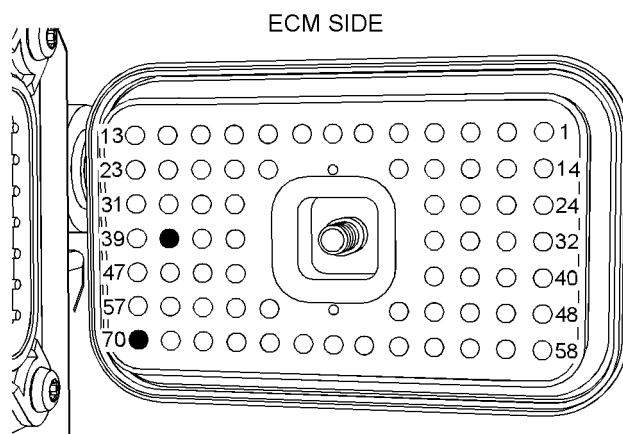


Illustration 89

g01318105

Terminal locations for the high pressure fuel pump at the P1 ECM connectors

(P1-38) PWM signal

(P1-70) Keyswitch

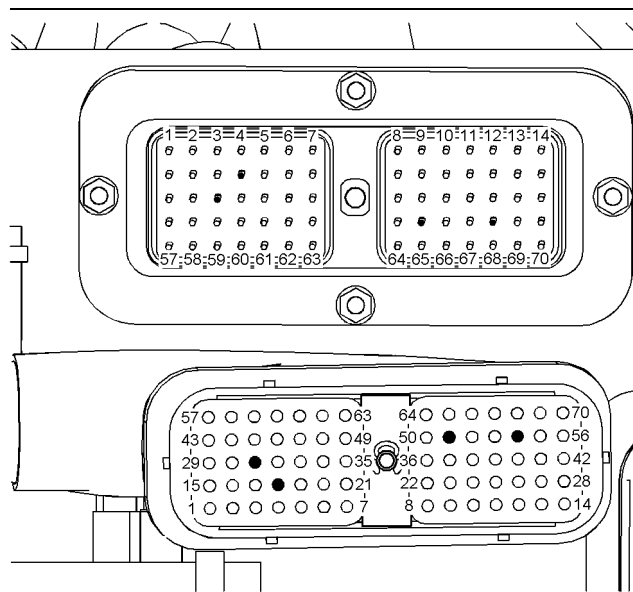


Illustration 90

g01428435

Terminal locations for the high pressure fuel pump at the right rail connectors

- (Terminal 18) Keyswitch
- (Terminal 31) -Battery
- (Terminal 51) PWM signal
- (Terminal 54) +Battery

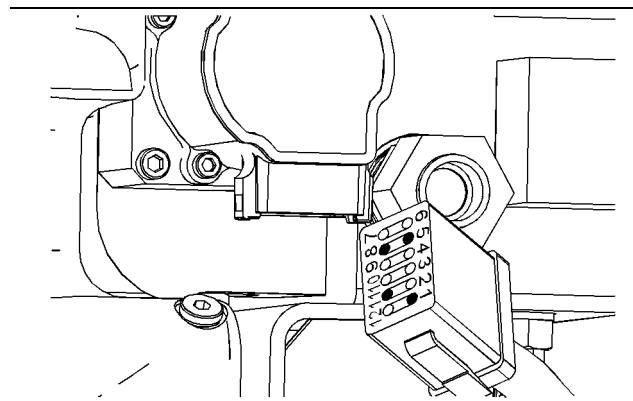


Illustration 91

g01318220

Terminal locations at the connector for the fuel control valve's controller

- (Terminal 1) Supply
- (Terminal 5) Return
- (Terminal 8) Keyswitch
- (Terminal 11) PWM signal

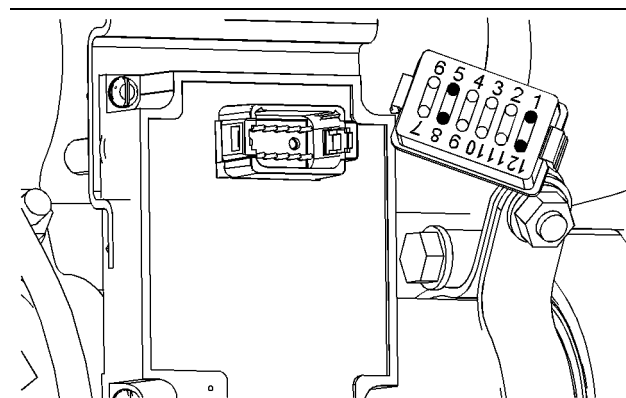


Illustration 92

g01318358

Terminal locations at the connector for the power module

- (Terminal 1) -Battery
- (Terminal 5) Supply voltage (output)
- (Terminal 8) Return (output)
- (Terminal 12) +Battery

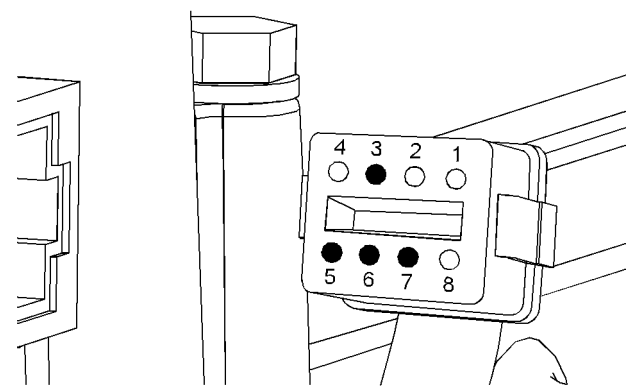


Illustration 93

g01428439

Terminal locations for the fuel system components at the harness connector

- (Terminal 3) Keyswitch
- (Terminal 5) PWM signal
- (Terminal 6) +Battery
- (Terminal 7) -Battery

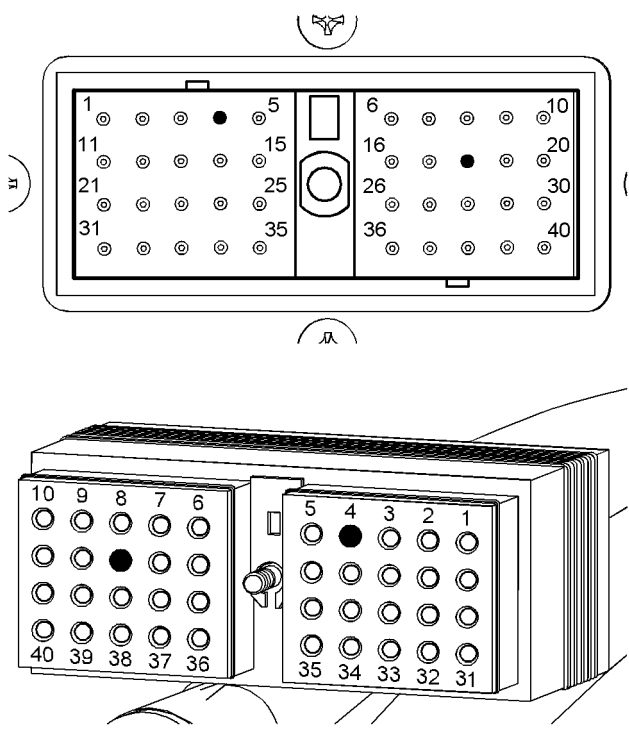


Illustration 94

g01428499

Terminal locations at the machine interface connector for the high pressure fuel pump

(Terminal 4) +Battery
(Terminal 18) Keyswitch

Test Step 1. Check for an Active Diagnostic Code

- A. Connect Cat ET to the service tool connector.
- B. Restore the electrical power to the ECM.
- 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.

- E. Look for one or more of the following diagnostic codes that are active or logged:

- 18-7

- 18-8
- 18-9
- 18-11
- 18-12

Expected Result:

No diagnostic codes are active for the fuel control valve's controller.

Results:

- OK – No diagnostic codes are active.

Repair: 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" for the correct procedures for inspecting electrical connectors.

STOP.

- 18-7 Code is Active – The 18-7 diagnostic code is active.

Repair: The actual position and the desired position of the fuel actuator is not within specifications. Replace the high pressure fuel pump.

STOP.

- 18-8 Code is Active – The 18-8 diagnostic code is active. The fuel control valve's controller detects a problem in the circuit for the PWM signal from the ECM. Proceed to Test Step 2.
- 18-9 Code is Active – The 18-9 diagnostic code is active. The ECM detects a problem with data link communications for the fuel control valve's controller. Proceed to Test Step 3.
- 18-11 Code or 18-12 Code is Active – The 18-11 diagnostic code or the 18-12 diagnostic code is active.

Repair: During a self test, the controller for the fuel control valve has detected an internal fault. Replace the high pressure fuel pump.

STOP.

Test Step 2. Check for +5 Volts at the Connector for the Fuel Control Valve's Controller

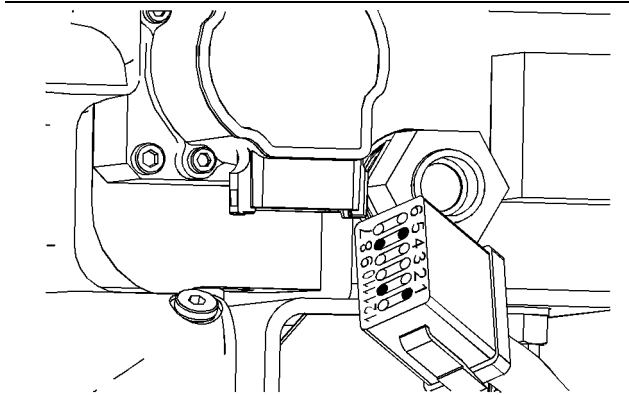


Illustration 95

g01318220

Terminal locations at the connector for the fuel control valve's controller

(Terminal 1) Supply
(Terminal 5) Return
(Terminal 8) Keyswitch
(Terminal 11) PWM signal

- A. Remove the electrical power from the ECM.
- B. Fabricate a jumper wire that is long enough to create a test circuit at the connector for the fuel control valve's controller. Crimp a connector socket to one end of the jumper wire.
- C. Disconnect the connector at the fuel control valve's controller.
- D. Use a wire removal tool to remove the wire from terminal location 11 (PWM signal) at the connector for the fuel control valve's controller. Install the jumper wire into this terminal location.

Note: Ensure that the loose end of the jumper wire does not come into contact with any ground source.

- E. Connect the connector at the controller.
- F. Install a 7X-1709 Multimeter Probe (BLACK) onto a multimeter negative lead (black).

Note: Ensure that the multimeter probe is in good repair. A bent probe may contact other terminals inside the connector.

- G. Carefully insert the spoon into terminal 5 (return) of the connector for the controller.
- H. Restore the electrical power to the ECM. Ensure that the keyswitch is in the ON position.
- I. Measure the voltage between the loose end of the jumper wire and the test lead for the spoon.

Note: Use the "DC Voltage" setting on the multimeter to check the voltage.

- J. Remove the electrical power from the ECM. Restore the wiring to the original configuration.

Expected Result:

The measurement indicates that there is +5 volts available at the controller.

Results:

- OK – There is +5 volts available at the controller. The controller is generating the correct voltage for the signal. There may be a problem in the harness wiring between the controller and the ECM. Proceed to Test Step 7.
- Not OK – The measurement indicates that there is not +5 volts available at the controller. Ensure that the wiring has been restored to the original configuration at the controller. Proceed to Test Step 3.

Test Step 3. Check the Supply Voltage at the Fuel Control Valve's Controller

- A. Disconnect the connector at the fuel control valve's controller.
- B. Restore the electrical power to the ECM. Ensure that the keyswitch is in the ON position.
- C. Use a multimeter to measure the supply voltage between terminal 1 (supply) and terminal 5 (return) on the harness side of the connector.
- D. Remove the electrical power from the ECM.

Expected Result:

The supply voltage measures 14.0 ± 1.5 VDC.

Results:

- OK – The supply voltage is 14.0 ± 1.5 VDC. The supply voltage is reaching the fuel control valve's controller. Proceed to Test Step 4.
- Not OK – The supply voltage is not 14.0 ± 1.5 VDC. The supply voltage is not reaching the fuel control valve's controller. Proceed to Test Step 5.

Test Step 4. Check for Keyswitch Power at the Fuel Control Valve's Controller

- A. Ensure that the connector for the fuel control valve's controller has been disconnected.
- B. Restore the electrical power to the ECM. Ensure that the keyswitch is in the ON position.
- C. Use a multimeter to measure the keyswitch power between terminal 8 (keyswitch) on the harness side of the connector and the chassis ground.

- D. Remove the electrical power from the ECM.
Restore the wiring to the original configuration.

Expected Result:

The voltage at the keyswitch input is 24.0 ± 1.5 VDC.

Results:

- OK – The voltage at the keyswitch input is 24.0 ± 1.5 VDC.

Repair: The voltage for the keyswitch and the supply are reaching the fuel control valve's controller. The controller is being powered, but the controller is not communicating with the ECM.

There may be a problem with the wiring for the CAN data link. Repair the CAN data link. Refer to Troubleshooting, "Data Link - Test" for information that is related to troubleshooting the circuit.

STOP.

- Not OK – The voltage at the keyswitch input is not 24.0 ± 1.5 VDC.

Repair: The keyswitch power is not reaching the fuel control valve's controller. There is a problem in the keyswitch circuit. Repair the circuit. Refer to Troubleshooting, "Electrical Power Supply - Test" for information that is related to troubleshooting the keyswitch circuit.

STOP.

Test Step 5. Check the Supply Voltage (Output) at the Power Module

- A. Disconnect the connectors for the power module.

- B. Fabricate two jumper wires that are long enough to create a test circuit at the connector for the power module. Crimp connector sockets to one end of each of the jumper wires.

- C. Remove the wires from terminal location 5 (supply voltage (output)) and terminal location 8 (return (output)) at the connector for the power module. Install a jumper wire into each of these terminal locations.

- D. Connect the connectors for the power module.

Note: Ensure that the loose ends of the jumper wires are not in contact with any ground source.

- E. Restore the electrical power to the ECM.

- F. Measure the supply voltage between the loose ends of the jumper wires at the power module.

- G. Remove the electrical power from the ECM.
Restore the wiring to the original configuration.

Expected Result:

The supply voltage (output) is 14.0 ± 1.5 VDC.

Results:

- OK – The supply voltage (output) is 14.0 ± 1.5 VDC.

Repair: The supply voltage for the controller is available at the power module, but the supply voltage is not reaching the controller. There is a problem in the harness that is between the power module and the fuel control valve's controller. Repair the harness or replace the harness. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.

STOP.

- Not OK – The supply voltage (output) is not 14.0 ± 1.5 VDC. The power module is not generating the correct voltage. There may be a problem with the battery circuit for the power module. Proceed to Test Step 6.

Test Step 6. Check for Battery Voltage to the Power Module

- A. Disconnect the connectors for the power module.

- B. Restore the electrical power to the ECM.

- C. Measure the battery voltage between terminal 12 (+Battery) and terminal 1 (–Battery) on the harness side of the connector for the power module.

- D. Remove the electrical power from the ECM.
Restore the wiring to the original configuration.

Expected Result:

The battery voltage to the power module is 24.0 ± 1.5 VDC.

Results:

- OK – The battery voltage to the power module is 24.0 ± 1.5 VDC.

Repair: The wiring for the power module is OK. The power module is not generating the correct supply voltage for the fuel control valve's controller. Replace the power module. Verify that the repair eliminates the original problem.

STOP.

- Not OK – The battery voltage to the power module is not 24.0 ± 1.5 VDC.

Repair: There is a problem in the circuit that supplies battery voltage to the power module. Repair the circuit. Refer to Troubleshooting, “Electrical Power Supply - Test” for information that is related to troubleshooting the battery circuit.

STOP.

Test Step 7. Check for +5 Volts on the PWM Signal Line at the ECM

- Disconnect the P1 ECM connector.
 - Use a wire removal tool to remove the wire from terminal location P1-38 (PWM signal) at the ECM connector.
- Note:** Ensure that the loose end of the wire does not come into contact with any ground source.
- Connect the P1 ECM connector.
 - Install a 7X-1709 Multimeter Probe (BLACK) onto a multimeter negative lead (black).
- Note:** Ensure that the multimeter probes are in good repair. A bent probe may contact other terminals inside the connector.
- Carefully insert the black spoon into terminal P1-18 (digital return) at the ECM.
 - Restore the electrical power to the ECM. Ensure that the keyswitch is in the ON position.
 - Measure the voltage between the loose end of the signal line and the test lead for the spoon.

Note: Use the “DC Voltage” setting on the multimeter to check the voltage.

- Remove the electrical power from the ECM. Restore the wiring to the original configuration.

Expected Result:

The measurement indicates that there is +5 volts available on the signal line at the ECM.

Results:

- OK – The measurement indicates that there is +5 volts available at the ECM. The ECM is receiving the correct signal voltage. The wiring harness is OK. There may be a problem with the ECM. Ensure that the wiring has been restored to the original configuration. Proceed to Test Step 8.

- Not OK – The measurement indicates that there is not +5 volts available in the circuit that is from the fuel control valve's controller.

Repair: The signal voltage is available at the controller, but the signal voltage is not reaching the ECM. There is a problem in the harness and/or in a connector that is between the fuel control valve's controller and the ECM. Repair the harness and/or the connector or replace the harness. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

STOP.

Test Step 8. Check the Integrity of the PWM Signal

- Carefully insert a red multimeter probe into terminal P1-38 (PWM signal) at the ECM connector.
 - Carefully insert a black multimeter probe into terminal P1-18 (digital return) at the ECM connector.
 - Connect Cat ET to the service tool connector.
 - Restore the electrical power to the ECM. Ensure that the keyswitch is in the ON position.
 - Use the multimeter to measure the duty cycle and the frequency of the PWM signal.
- The correct value is approximately 10 percent duty cycle while the keyswitch is in the ON position and the engine is not running. The correct frequency of the signal is 500 Hz.**
- Use Cat ET to override the “Fuel Actuator Position Command”. Enter a value of 50 percent for the override parameter.

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

- Use the multimeter to measure the duty cycle and the frequency of the PWM signal.

The correct value is approximately 50 percent duty cycle with the “Fuel Actuator Position Command” set to a value of 50 percent. The correct frequency of the signal is 500 Hz.

- Use Cat ET to override the “Fuel Actuator Position Command”. Enter a value of 100 percent for the override parameter.

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

- Use the multimeter to measure the duty cycle and the frequency of the PWM signal.

The correct value is approximately 90 percent duty cycle with the “Fuel Actuator Position Command” set to a value of 100 percent. The correct frequency of the signal is 500 Hz.

i02659488

J. Remove electrical power from the ECM.

Expected Result:

The duty cycle and the frequency of the PWM signal is consistent with the values that are given above.

Results:

- OK – The duty cycle and frequency is correct for all measurements.

Repair: The ECM is generating the correct PWM signal and the wiring is OK. There is a problem with the fuel control valve’s controller. Replace the high pressure fuel pump. Verify that the repair eliminates the original problem.

STOP.

- Not OK – The duty cycle is not consistent with the values that are given as the test results.

Repair: The ECM is not generating the correct PWM signal for the controller. The ECM does not appear to be operating properly. Perform the following procedure:

1. Temporarily connect a test ECM.

Refer to Troubleshooting, “ECM - Replace”.

2. Recheck the circuit in order to ensure that the original problem has been resolved.

If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the problem is resolved.

If the problem is not resolved with the test ECM, install the original ECM. There is a problem in the wiring.

STOP.

Injector Solenoid - Test

SMCS Code: 1290-038-JV

System Operation Description:

Use this procedure to troubleshoot the engine electrical system if a problem is suspected with the injectors, or if any of the diagnostic codes in Table 38 is active or easily repeated.

Table 38

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
1-2 Cylinder #1 Injector erratic, intermittent, or incorrect	The ECM receives a signal from the injector solenoid that is invalid or the ECM receives a signal from the injector solenoid that cannot be accurately interpreted.	The code is logged. The ECM continues to energize the injector solenoid.
2-2 Cylinder #2 Injector erratic, intermittent, or incorrect		
3-2 Cylinder #3 Injector erratic, intermittent, or incorrect		
4-2 Cylinder #4 Injector erratic, intermittent, or incorrect		
5-2 Cylinder #5 Injector erratic, intermittent, or incorrect		
6-2 Cylinder #6 Injector erratic, intermittent, or incorrect		
7-2 Cylinder #7 Injector erratic, intermittent, or incorrect		
8-2 Cylinder #8 Injector erratic, intermittent, or incorrect		
9-2 Cylinder #9 Injector erratic, intermittent, or incorrect		
10-2 Cylinder #10 Injector erratic, intermittent, or incorrect		
11-2 Cylinder #11 Injector erratic, intermittent, or incorrect		
12-2 Cylinder #12 Injector erratic, intermittent, or incorrect		
13-2 Cylinder #13 Injector erratic, intermittent, or incorrect		
14-2 Cylinder #14 Injector erratic, intermittent, or incorrect		
15-2 Cylinder #15 Injector erratic, intermittent, or incorrect		
16-2 Cylinder #16 Injector erratic, intermittent, or incorrect		
2493-2 Cylinder #17 Injector erratic, intermittent, or incorrect		
2494-2 Cylinder #18 Injector erratic, intermittent, or incorrect		
2495-2 Cylinder #19 Injector erratic, intermittent, or incorrect		
2496-2 Cylinder #20 Injector erratic, intermittent, or incorrect		

(continued)

(Table 38, contd)

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
1-5 Cylinder #1 Injector current below normal	The ECM detects a low current in the circuit for the injector solenoid.	The code is logged. The ECM continues the attempt to energize the solenoid circuit until the circuit is repaired.
2-5 Cylinder #2 Injector current below normal		
3-5 Cylinder #3 Injector current below normal		
4-5 Cylinder #4 Injector current below normal		
5-5 Cylinder #5 Injector current below normal		
6-5 Cylinder #6 Injector current below normal		
7-5 Cylinder #7 Injector current below normal		
8-5 Cylinder #8 Injector current below normal		
9-5 Cylinder #9 Injector current below normal		
10-5 Cylinder #10 Injector current below normal		
11-5 Cylinder #11 Injector current below normal		
12-5 Cylinder #12 Injector current below normal		
13-5 Cylinder #13 Injector current below normal		
14-5 Cylinder #14 Injector current below normal		
15-5 Cylinder #15 Injector current below normal		
16-5 Cylinder #16 Injector current below normal		
2493-5 Cylinder #17 Injector current below normal		
2494-5 Cylinder #18 Injector current below normal		
2495-5 Cylinder #19 Injector current below normal		
2496-5 Cylinder #20 Injector current below normal		

(continued)

(Table 38, contd)

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
1-6 Cylinder #1 Injector current above normal	The ECM detects a high current in the circuit for the injector solenoid.	The code is logged. The ECM disables this solenoid circuit. The ECM will periodically attempt to energize the solenoid circuit until the circuit is repaired.
2-6 Cylinder #2 Injector current above normal		
3-6 Cylinder #3 Injector current above normal		
4-6 Cylinder #4 Injector current above normal		
5-6 Cylinder #5 Injector current above normal		
6-6 Cylinder #6 Injector current above normal		
7-6 Cylinder #7 Injector current above normal		
8-6 Cylinder #8 Injector current above normal		
9-6 Cylinder #9 Injector current above normal		
10-6 Cylinder #10 Injector current above normal		
11-6 Cylinder #11 Injector current above normal		
12-6 Cylinder #12 Injector current above normal		
13-6 Cylinder #13 Injector current above normal		
14-6 Cylinder #14 Injector current above normal		
15-6 Cylinder #15 Injector current above normal		
16-6 Cylinder #16 Injector current above normal		
2493-6 Cylinder #17 Injector current above normal		
2494-6 Cylinder #18 Injector current above normal		
2495-6 Cylinder #19 Injector current above normal		
2496-6 Cylinder #20 Injector current above normal		

(continued)

(Table 38, contd)

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
1-7 Cylinder #1 Injector not responding properly	The engine's Electronic Control Module (ECM) has determined that the mechanical wear for the injector is out of specifications.	The code is logged. The ECM continues to energize the injector solenoid.
2-7 Cylinder #2 Injector not responding properly		
3-7 Cylinder #3 Injector not responding properly		
4-7 Cylinder #4 Injector not responding properly		
5-7 Cylinder #5 Injector not responding properly		
6-7 Cylinder #6 Injector not responding properly		
7-7 Cylinder #7 Injector not responding properly		
8-7 Cylinder #8 Injector not responding properly		
9-7 Cylinder #9 Injector not responding properly		
10-7 Cylinder #10 Injector not responding properly		
11-7 Cylinder #11 Injector not responding properly		
12-7 Cylinder #12 Injector not responding properly		
13-7 Cylinder #13 Injector not responding properly		
14-7 Cylinder #14 Injector not responding properly		
15-7 Cylinder #15 Injector not responding properly		
16-7 Cylinder #16 Injector not responding properly		
2493-7 Cylinder #17 Injector not responding properly		
2494-7 Cylinder #18 Injector not responding properly		
2495-7 Cylinder #19 Injector not responding properly		
2496-7 Cylinder #20 Injector not responding properly		

Background Information

Perform this procedure during operating conditions that are identical to the operating conditions that exist when the problem occurs. Typically, problems with the injector solenoid occur when the engine is warmed up and/or when the engine is under vibration (heavy loads). Be aware that the wiring and/or the connectors may have problems that only occur during vibration.

These engines have fuel injectors that are electronically controlled. A solenoid is used to actuate the injector. The solenoid is mounted on top of the fuel injector body. The ECM sends a 105 volt pulse to the injector solenoid. The pulse is sent at the proper time and for the correct duration for any given engine load and speed.

Trim Files

When an injector is replaced, program the new injector code into the ECM. Refer to Troubleshooting, "Injector Trim File - Install" for information that is related to trim files. If the ECM is replaced, all of the injector codes must be programmed into the new ECM. Refer to Troubleshooting, "ECM - Configure" for information that is related to the configuration of a new ECM.

Diagnostic Tests that are Available on Caterpillar Electronic Technician (ET)

Cat ET includes the following tests that will aid in troubleshooting injector solenoids:

Injector Solenoid Test – This 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".

Fuel System Verification Test – This test evaluates the health of each injector. The test determines if an injector needs to be replaced. When the test is performed, Cat ET indicates the status of each injector as "Success" or "Failed". Perform this test immediately after an injector has been replaced. Also, perform this test if a -2 code or -7 code is active.

Note: The "Fuel System Verification Test" test must be performed when the engine is running and the coolant temperature is above 65 °C (149 °F).

Refer to Illustration 96 for a schematic of the 16 cylinder engines and refer to Illustration 97 for a schematic of the 20 cylinder engines.

Note: Two injector solenoids may 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.

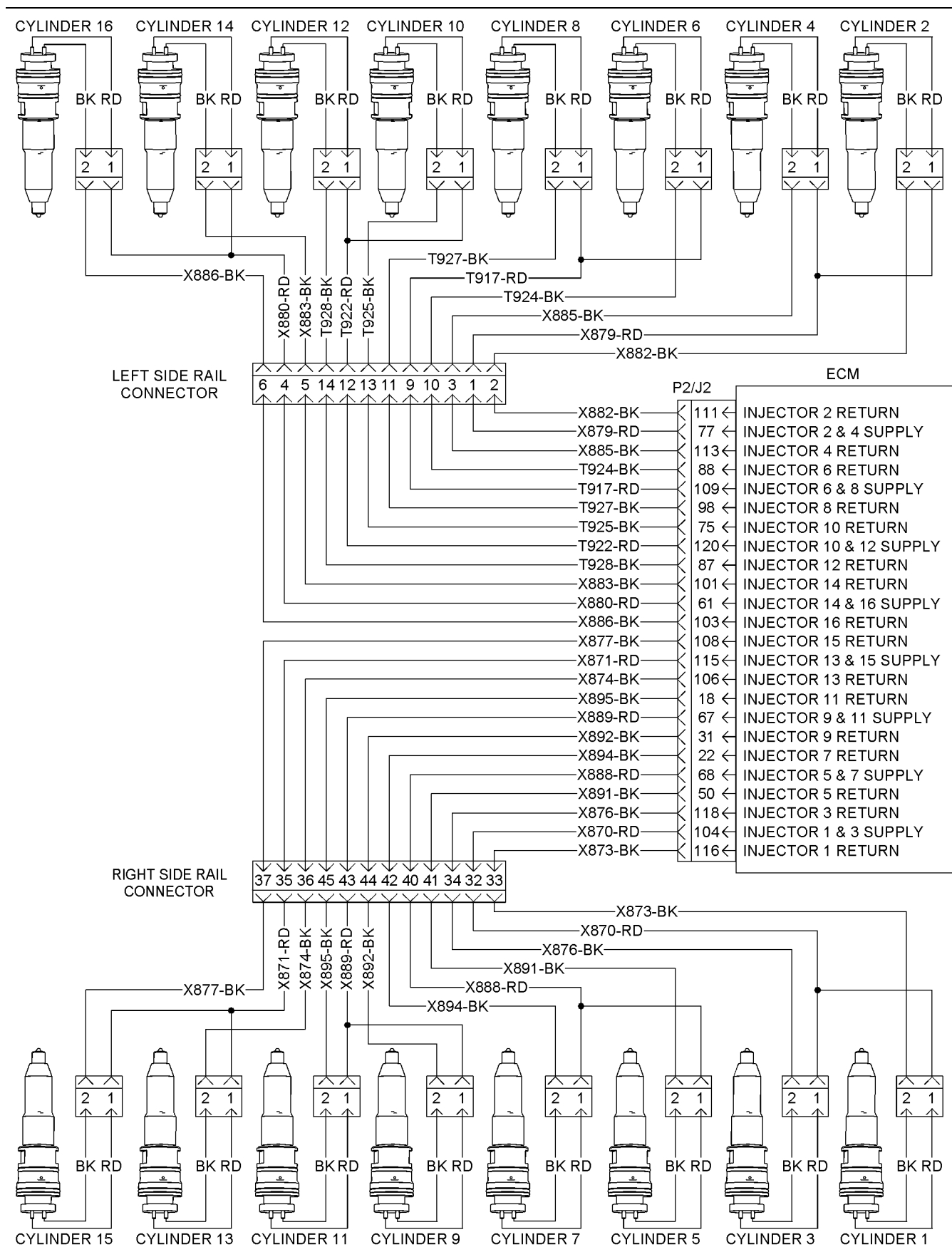


Illustration 96

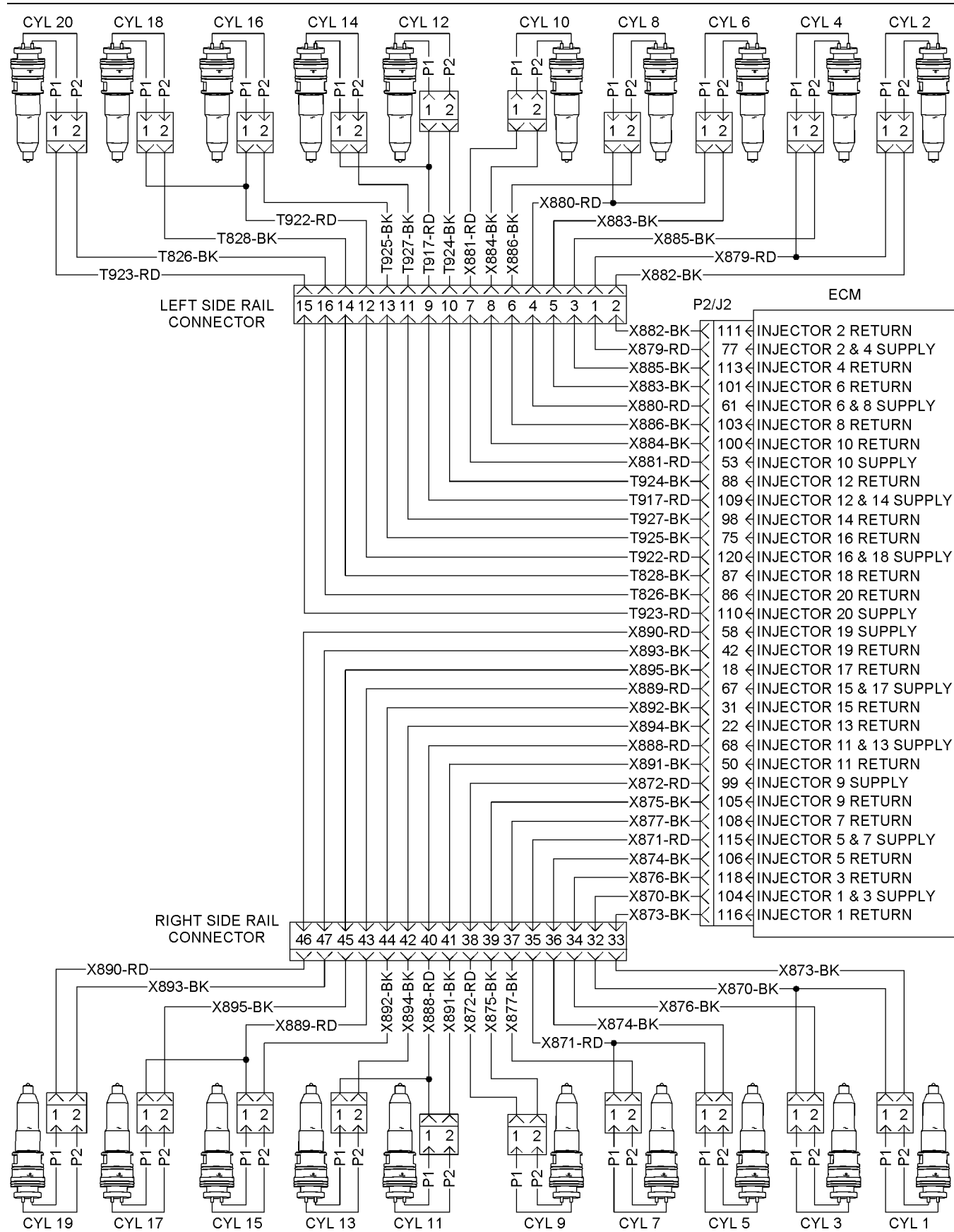


Illustration 97

g01336555

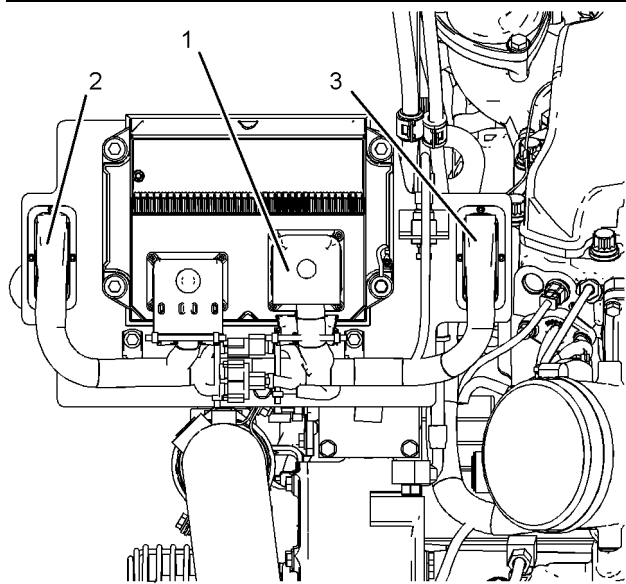


Illustration 98 g01336496

Location of the connectors at the ECM for the 16 cylinder engines (typical left front engine view)

- (1) J2/P2 ECM connector
- (2) Right rail connector
- (3) Left rail connector

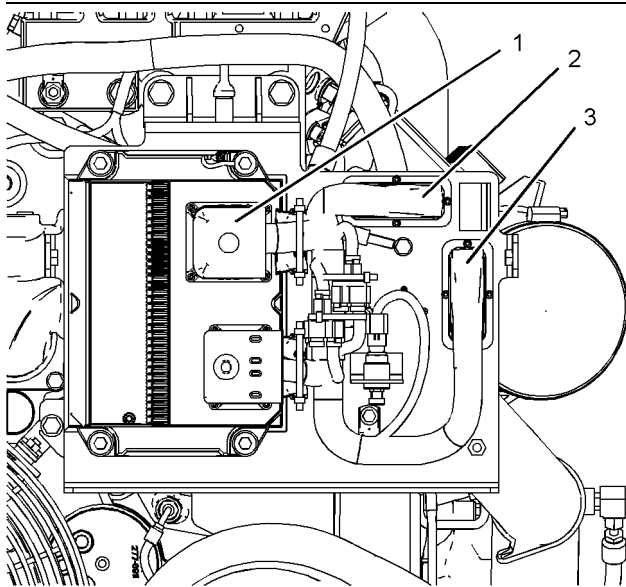


Illustration 99 g01427466

Location of the connectors at the ECM for the 20 cylinder engines (typical front side engine view)

- (1) J2/P2 ECM connector
- (2) Right rail connector
- (3) Left rail connector

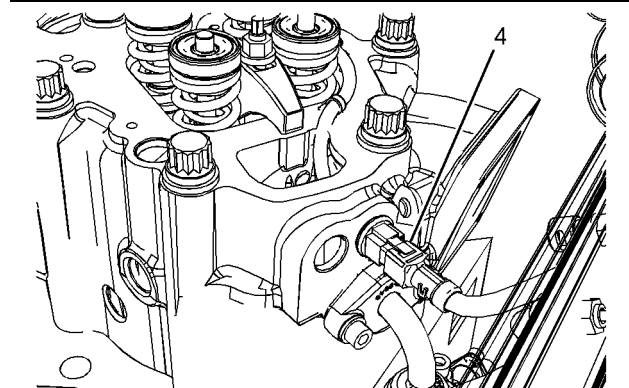


Illustration 100 g01336505

Location of the fuel injector connector at the cylinder head (typical example)

- (4) Fuel injector connector at the cylinder head

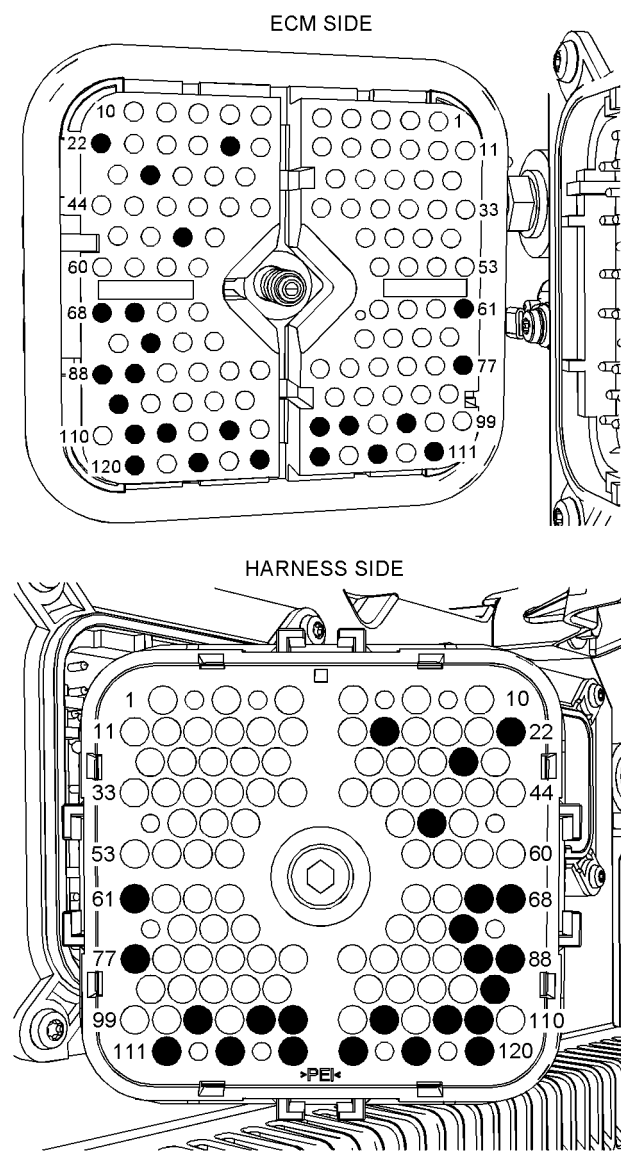


Illustration 101 g01270451

Terminal locations at the P2 ECM connector (16 cylinder engines)

(P2-18) Injector 11 return
 (P2-22) Injector 7 return
 (P2-31) Injector 9 return
 (P2-50) Injector 5 return
 (P2-61) Injector 14, 16 supply
 (P2-67) Injector 9, 11 supply
 (P2-68) Injector 5, 7 supply
 (P2-75) Injector 10 return
 (P2-77) Injector 2, 4 supply
 (P2-87) Injector 12 return
 (P2-88) Injector 6 return
 (P2-98) Injector 8 return
 (P2-101) Injector 14 return
 (P2-103) Injector 16 return
 (P2-104) Injector 1, 3 supply
 (P2-106) Injector 13 return
 (P2-108) Injector 15 return
 (P2-109) Injector 6, 8 supply
 (P2-111) Injector 2 return
 (P2-113) Injector 4 return
 (P2-115) Injector 13, 15 supply
 (P2-116) Injector 1 return
 (P2-118) Injector 3 return
 (P2-120) Injector 10, 12 supply

Terminal locations at the P2 ECM connector (20 cylinder engines)

(P2-18) Injector 17 return
 (P2-22) Injector 13 return
 (P2-31) Injector 15 return
 (P2-42) Injector 19 return
 (P2-50) Injector 11 return
 (P2-53) Injector 10 supply
 (P2-58) Injector 19 supply
 (P2-61) Injector 6, 8 supply
 (P2-67) Injector 15, 17 supply
 (P2-68) Injector 11, 13 supply
 (P2-75) Injector 16 return
 (P2-77) Injector 2, 4 supply
 (P2-86) Injector 20 return
 (P2-87) Injector 18 return
 (P2-88) Injector 12 return
 (P2-98) Injector 14 return
 (P2-99) Injector 9 supply
 (P2-100) Injector 10 return
 (P2-101) Injector 6 return
 (P2-103) Injector 8 return
 (P2-104) Injector 1, 3 supply
 (P2-105) Injector 9 return
 (P2-106) Injector 5 return
 (P2-108) Injector 7 return
 (P2-109) Injector 12, 14 supply
 (P2-110) Injector 20 supply
 (P2-111) Injector 2 return
 (P2-113) Injector 4 return
 (P2-115) Injector 5, 7 supply
 (P2-116) Injector 1 return
 (P2-118) Injector 3 return
 (P2-120) Injector 16, 18 supply

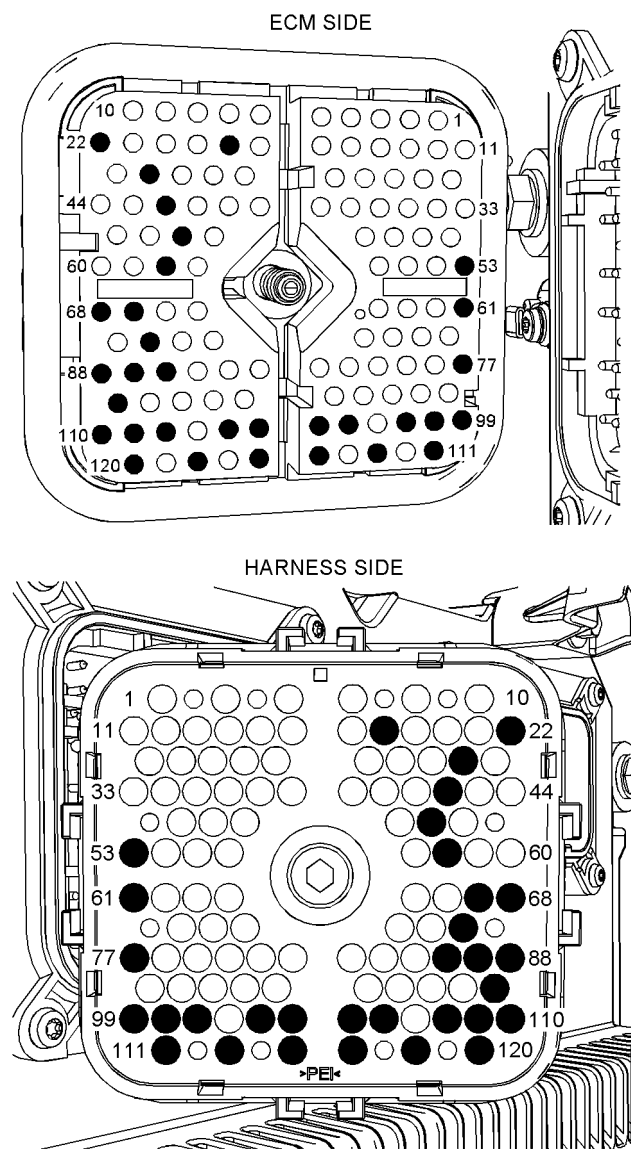


Illustration 102

g01306538

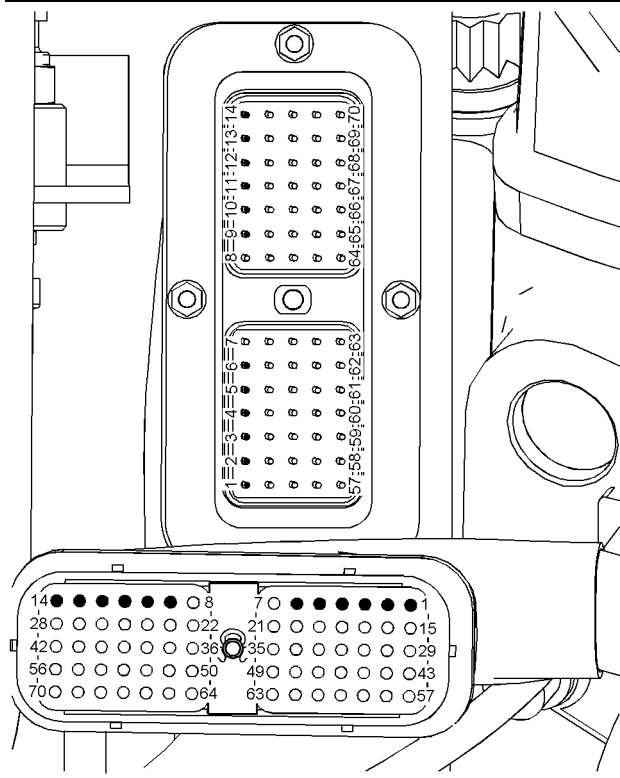


Illustration 103 g01347977

Terminal locations at the left side rail connector (16 cylinder engines)

- (Terminal 1) Injector 2, 4 supply
- (Terminal 2) Injector 2 return
- (Terminal 3) Injector 4 return
- (Terminal 4) Injector 14, 16 supply
- (Terminal 5) Injector 14 return
- (Terminal 6) Injector 16 return
- (Terminal 9) Injector 6, 8 supply
- (Terminal 10) Injector 6 return
- (Terminal 11) Injector 8 return
- (Terminal 12) Injector 10, 12 supply
- (Terminal 13) Injector 10 return
- (Terminal 14) Injector 12 return

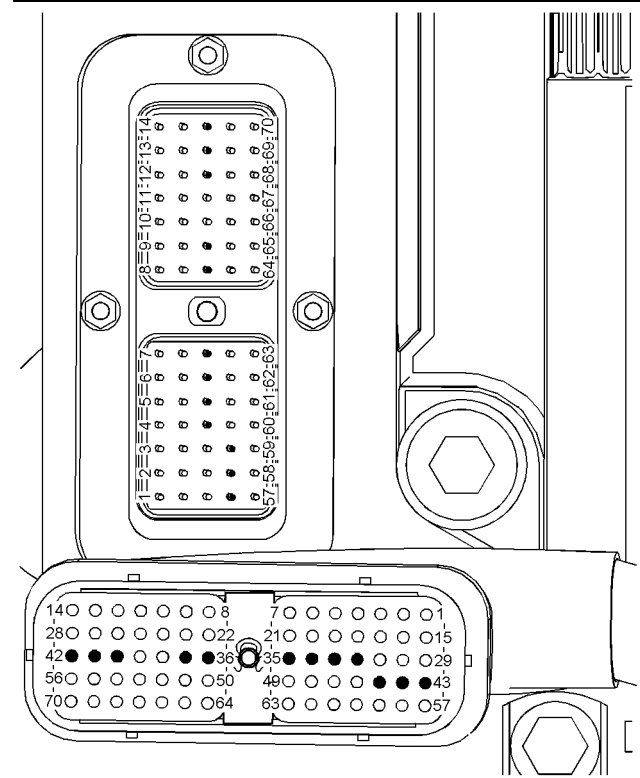


Illustration 104 g01348601

Terminal locations at the right side rail connector (16 cylinder engines)

- (Terminal 32) Injector 1, 3 supply
- (Terminal 33) Injector 1 return
- (Terminal 34) Injector 3 return
- (Terminal 35) Injector 13, 15 supply
- (Terminal 36) Injector 13 return
- (Terminal 37) Injector 15 return
- (Terminal 40) Injector 5, 7 supply
- (Terminal 41) Injector 5 return
- (Terminal 42) Injector 7 return
- (Terminal 43) Injector 9, 11 supply
- (Terminal 44) Injector 9 return
- (Terminal 45) Injector 11 return

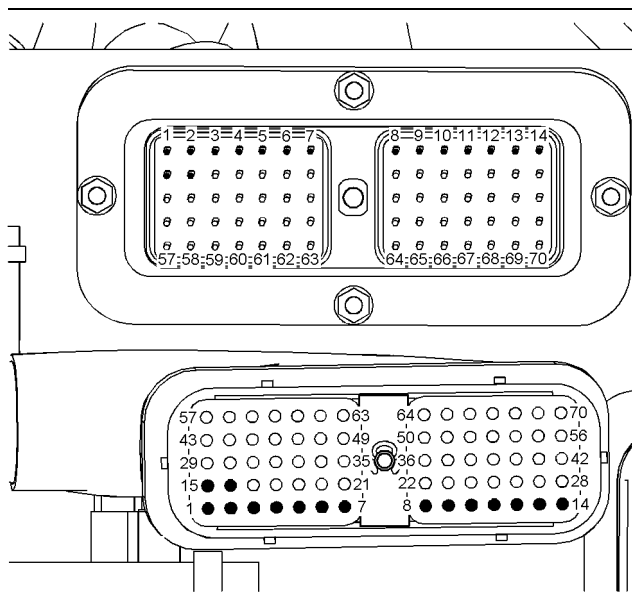


Illustration 105

g01348629

Terminal locations at the left side rail connector (20 cylinder engines)

- (Terminal 1) Injector 2, 4 supply
- (Terminal 2) Injector 2 return
- (Terminal 3) Injector 4 return
- (Terminal 4) Injector 6, 8 supply
- (Terminal 5) Injector 6 return
- (Terminal 6) Injector 8 return
- (Terminal 7) Injector 10 supply
- (Terminal 8) Injector 10 return
- (Terminal 9) Injector 12, 14 supply
- (Terminal 10) Injector 12 return
- (Terminal 11) Injector 14 return
- (Terminal 12) Injector 16, 18 supply
- (Terminal 13) Injector 16 return
- (Terminal 14) Injector 18 return
- (Terminal 15) Injector 20 supply
- (Terminal 16) Injector 20 return

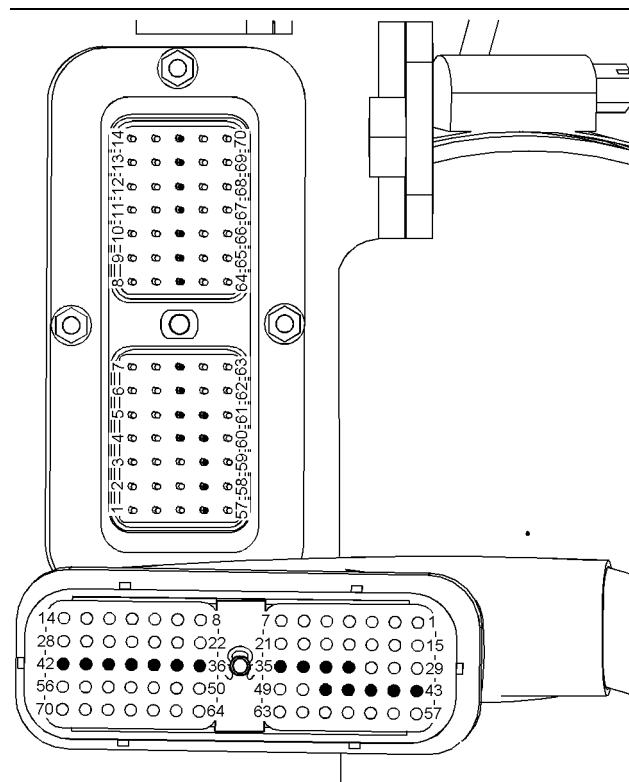


Illustration 106

g01348631

Terminal locations at the right side rail connector (20 cylinder engines)

- (Terminal 32) Injector 1, 3 supply
- (Terminal 33) Injector 1 return
- (Terminal 34) Injector 3 return
- (Terminal 35) Injector 5, 7 supply
- (Terminal 36) Injector 5 return
- (Terminal 37) Injector 7 return
- (Terminal 38) Injector 9 supply
- (Terminal 39) Injector 9 return
- (Terminal 40) Injector 11, 13 supply
- (Terminal 41) Injector 11 return
- (Terminal 42) Injector 13 return
- (Terminal 43) Injector 15, 17 supply
- (Terminal 44) Injector 15 return
- (Terminal 45) Injector 17 return
- (Terminal 46) Injector 19 supply
- (Terminal 47) Injector 19 return

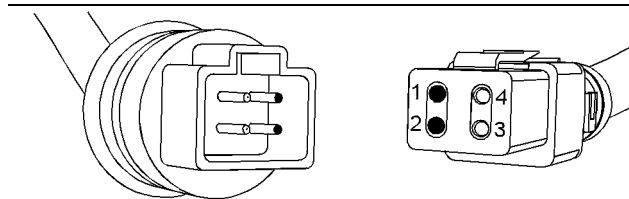


Illustration 107

g01348644

Terminal locations for the injector harness at the cylinder head

- (1) Supply
- (2) Return

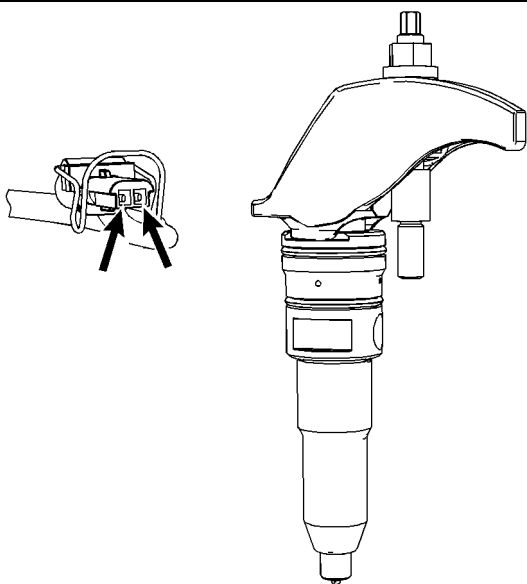


Illustration 108

g01271655

Terminal locations at the injector connector

- (1) Supply
(2) Return

Test Step 1. Check for Diagnostic Codes

WARNING

Electrical Shock Hazard. The unit injector system uses 90 - 120 volts. The ECM sends this signal to the unit injectors. Do not come in contact with the unit injector harness connector while the engine is operating. Failure to follow this instruction could result in personal injury or death.

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.

NOTICE

Ensure that all adjustments and repairs that are carried out to the fuel system are performed by authorised personnel that have the correct training.

Before beginning ANY work on the fuel system, refer to Operation and Maintenance Manual, "General Hazard Information and High Pressure Fuel Lines" for safety information.

Refer to Systems Operation, "Cleanliness of Fuel System Components" for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

- A. Establish communication between Cat ET and the engine ECM. Cat ET must be configured for Dual Data Link Communications in order to perform this procedure. Refer to Troubleshooting, "Electronic Service Tools", if necessary.
- B. Determine the diagnostic code that relates to an injector.

Expected Result:

A -2 code or a -7 code is present.

Results:

- A -2 code or a -7 code is present.

Repair: Perform the following procedure:

1. Do not clear the diagnostic code.
2. Access the Fuel System Verification Test by accessing the following display screens:
 - "Diagnostics"
 - "Diagnostic Tests"
 - "Fuel System Verification Test"
3. Perform the Fuel System Verification Test.

If the injector passes the test, the injector is OK. Cat ET will clear the code.

STOP

4. If the injector fails the test, perform the following procedure:
 - a. Replace the injector.

- b. Flash program the trim file for the new injector into the ECM. Refer to Troubleshooting, "Injector Trim File - Install", if necessary.
- c. Perform the Fuel System Verification Test again. This will clear the active diagnostic code for the new injector.

Verify that the original condition has been resolved.

STOP.

- -5 or -6 Diagnostic Code – Proceed to Test Step 2.

Test Step 2. Determine if the Diagnostic Code is Active or Logged

- A. Start the engine. Allow the engine to warm up to normal operating temperature 77 °C (171 °F).
- B. Determine if the -5 or -6 code is active or logged.

Expected Result:

The code is logged.

Results:

- Logged code – There is a logged diagnostic code. Do not turn off the engine. Proceed to Test Step 3.
- Active code – There is an active diagnostic code. Do not turn off the engine. Proceed to Test Step 5.

Test Step 3. Check the External Engine Harness

- A. Inspect the injector wiring harness between the ECM and the valve cover for the affected injector. Look for these problems:
 - Improper routing of the wire harness
 - Missing clamps or other hardware
 - Loose connectors or damaged connectors
 - Damage that is caused by excessive heat
 - Damage that is caused by chafing
- B. Slowly wiggle the wiring harness and the connectors between the P2 connector and the valve cover. Pay particular attention to the wiring near each connector. Look for activation of the diagnostic code as you wiggle the wiring.

Continue with this procedure if the code does not become active. If the code becomes active, note the location of the problem. Proceed to the appropriate result for this Test Step.

- C. Refer to the appropriate schematic diagram. Identify the wires at each connector that relate to the cylinder that has the code. Perform the following procedure for the wires at each connector:

- 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.

Expected Result:

The external engine harness is OK. A code does not become active.

Results:

- OK – The external engine harness is OK. Note the number of the cylinder that has the logged diagnostic code. Stop the engine. Proceed to Test Step 4.
- Not OK – A problem with the external engine harness has been identified.

Repair: Stop the engine. Repair the wiring problem. Replace parts, if necessary. Start the engine. Verify that the problem is resolved.

STOP.

Test Step 4. Check the Harness Under the Valve Cover for a Problem

- A. Remove the valve cover of the affected cylinder.
- B. Carefully perform a visual inspection of the wiring harness under the valve cover. Look for the following problems:
 - Improper routing of the wire harness
 - Missing clamps or other hardware
 - Loose connectors or damaged connectors
 - Damage that is caused by excessive heat
 - Damage that is caused by chafing
- C. Inspect the connectors on the harness under the valve cover. Perform the following procedure on each wire that relates to the cylinder that has the code:

- 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.

- c. Disconnect the harness connector from the suspect injector. Carefully inspect each terminal for debris, for moisture, and for corrosion. Verify that the seals and wedges are properly installed.
- d. Connect the harness connector to the injector. Verify that both clips work correctly.

Expected Result:

The wiring harness under the valve cover is OK.

Results:

- OK – The wiring harness under the valve cover appears to be OK.

Repair: Perform the following procedure:

1. Replace the injector that relates to the logged code. Install the valve cover.
2. Load the trim file for the new injector into the ECM.
3. Use Cat ET to perform a Fuel System Verification Test. This will clear the active diagnostic code for the new injector.

STOP.

- Not OK – There is a problem with the wiring harness under the valve cover.

Repair: Correct the problem. Replace parts, if necessary. Install the valve cover. Start the engine. Allow the engine to warm up to normal operating temperature. Verify that the code does not recur.

STOP.

Test Step 5. Check the Integrity of the External Engine Harness

- A.** Wiggle the injector wiring harness between the ECM and the valve cover. Look for these problems.
- Improper routing of the wire harness
 - Missing clamps or other hardware
 - Loose connectors or damaged connectors
 - Damage that is caused by excessive heat
 - Damage that is caused by chafing

- B.** Refer to the appropriate schematic diagram. Identify the wires at each connector that relate to the cylinder that has the code. Perform the following procedure for the wires at each connector:

- 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.

Expected Result:

The code becomes inactive when the wiring is moved.

Results:

- OK – The code becomes inactive when the wiring is checked.

Repair: Stop the engine. Repair the problem with the harness. Replace parts, if necessary. Start the engine. Verify that the problem is resolved.

STOP.

- Not OK - Active -5 Code – A -5 code remains active. Note the cylinder that has the active -5 code. Stop the engine. Proceed to Test Step 6.
- Not OK - Active -6 Code – A -6 code remains active. Note the cylinder that has the active -6 code. Stop the engine. Proceed to Test Step 8.

Test Step 6. Check the External Engine Harness for an Open Circuit



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.** Disconnect the harness connectors for the affected cylinder at the cylinder head.
- C.** Fabricate a jumper wire that is long enough to create a test circuit across the harness connector at the cylinder head. Crimp connector pins to each end of the jumper wire.
- D.** Connect the jumper wire between terminal locations 1 (supply) and 2 (return). This will effectively create a short circuit for the cylinder.

- E. Turn the keyswitch to the ON position.
- F. Perform the "Injector Solenoid Test" at least two times.

Expected Result:

Cat ET displays "Short" for the cylinder with the jumper wire.

Results:

- OK – Cat ET displays "Short" for the cylinder with the jumper wire. The harness between the ECM connector and the harness connector at the cylinder head is OK. Remove the jumper wire. Connect the harness connectors. Proceed to Test Step 7.
- Not OK – Cat ET displays "Open" for the cylinder with the jumper wire. The ECM did not detect the jumper wire. There is an open circuit in the wiring harness between the J2 ECM connector and the harness connector at the cylinder head.

Repair: Repair the problem with the harness. Replace parts, if necessary. Start the engine. Verify that the problem is resolved.

STOP.

Test Step 7. Check the Injector Harness under the Valve Cover for an Open 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 the valve cover.
- C. Carefully perform a visual inspection of the wiring harness under the valve cover. Look for the following problems:
 - Improper routing of the wire harness
 - Missing clamps or other hardware
 - Loose connectors or damaged connectors
 - Damage that is caused by excessive heat
 - Damage that is caused by chafing

- D. Inspect the connectors on the harness under the valve cover. Perform the following procedure on each wire that relates to the cylinder that has the code:

- 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.
- c. Disconnect the harness connector from the suspect injector. Carefully inspect each terminal for debris, for moisture, and for corrosion. Verify that the seals and wedges are properly installed.

- E. Connect a jumper wire across the terminals in the harness connector for the cylinder that has the code. This will effectively replace the injector solenoid with a short circuit.

- F. Turn the keyswitch to the ON position.

- G. Perform the "Injector Solenoid Test" at least two times.

Expected Result:

Cat ET displays "Short" for the cylinder with the jumper wire.

Results:

- OK – Cat ET displays "Short" for the cylinder with the jumper wire. The wiring is OK. There is a problem with the injector.

Repair: Perform the following procedure:

1. Replace the faulty injector. Install the valve cover.
2. Load the trim file for the new injector into the ECM.
3. Use Cat ET to perform a Fuel System Verification Test. This will clear the active diagnostic code for the new injector.

STOP.

- Not OK – Cat ET displays "Open" for the cylinder with the jumper wire. There is a problem with the injector harness under the valve cover. There may be a problem with a connector.

Repair: Repair the wiring and/or the connector, when possible. Replace parts, if necessary. Verify that the problem is resolved.

STOP.

Test Step 8. Check the External Engine Harness 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. Disconnect the harness connectors for the injector solenoid at the cylinder head. This will effectively create an open circuit at the harness connector.
- C. Turn the keyswitch to the ON position.
- D. Perform the "Injector Solenoid Test" at least two times.

Expected Result:

The suspect cylinder indicates "Open" on Cat ET.

Results:

- OK – The suspect cylinder indicates "Open" on Cat ET. The engine harness is OK. Connect the harness connectors. Proceed to Test Step 9.
- Not OK – A cylinder indicates "Short" on Cat ET. There is a problem with the engine harness between the J2 connector and the valve cover harness.

Repair: Repair the problem with the harness. Replace parts, if necessary. Start the engine. Verify that the problem is resolved.

STOP.

Test Step 9. Check the 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 the valve cover.

- C. Disconnect the harness connector for each injector solenoid that indicates a "Short" on Cat ET. Ensure that each disconnected connector does not touch other components and create a short circuit.

- D. Turn the keyswitch to the ON position.

- E. Perform the "Injector Solenoid Test" at least two times.

Expected Result:

All of the injector solenoids that were disconnected indicate "Open" on Cat ET.

Results:

- OK – All of the injector solenoids that were disconnected indicate "Open" on Cat ET.

Repair: Perform the following procedure:

1. Replace the injector that relates to the logged code. Install the valve cover.
2. Load the trim file for the new injector into the ECM.
3. Use Cat ET to perform a Fuel System Verification Test. This will clear the active diagnostic code for the new injector.

STOP.

- Not OK – At least one of the injector solenoids that were disconnected still indicate "Short" on Cat ET. There is a problem with the wiring harness inside the valve cover. There may be a problem with a connector.

Repair: Inspect the connectors for moisture and for corrosion. Repair the wiring and/or the connector, when possible. Replace parts, if necessary.

Verify that the problem is resolved.

STOP.

i02891272

Oil Renewal - Test

SMCS Code: 1348-038; 5479-038-OC

System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with the oil renewal solenoid or if one of the diagnostic codes in Table 39 is active.

Table 39

Diagnostic Codes Table		
Code and Description	Conditions which Generate this Code	System Response
569-5 Oil Injection Solenoid current below normal	The Electronic Control Module (ECM) detects an open circuit and/or a short to the +Battery in the circuit for the oil renewal solenoid.	The code is logged. The oil renewal system is disabled.
569-6 Oil Renewal Solenoid short to ground	The ECM detects a short circuit to ground in the circuit for the oil renewal solenoid.	
E2089(1) Oil Renewal System Cannot Operate	A 569-5 Oil Injection Solenoid current below normal is active. or A 569-6 Oil Renewal Solenoid short to ground is active. or The ECM detects a fault in the circuit for the coolant temperature sensor. or The ECM detects a fault in the circuit for the fuel level sensor. or The ECM detects a fault in the circuit for the oil pressure sensor.	

The ECM adds a controlled amount of engine oil to the fuel by energizing the oil renewal solenoid. The engine oil is added to the fuel and burned during combustion. The typical oil change interval may be extended.

For further information, refer to Service Manual, RENR2223, "Oil Renewal System".

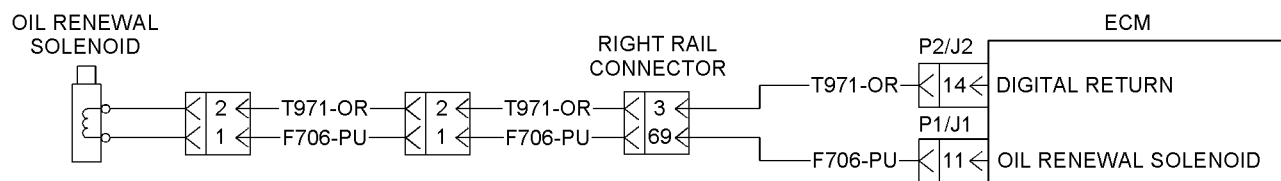


Illustration 109

Schematic for the oil renewal system

g01439943

Test Step 1. Inspect the Electrical Connectors and the Wiring

- A.** Remove the electrical power from the engine ECM.

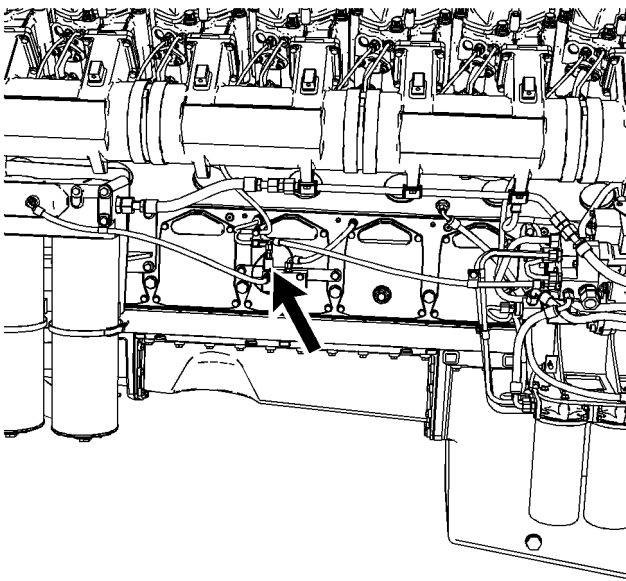


Illustration 110
Location of the oil renewal solenoid (typical right side engine view)

g01440000

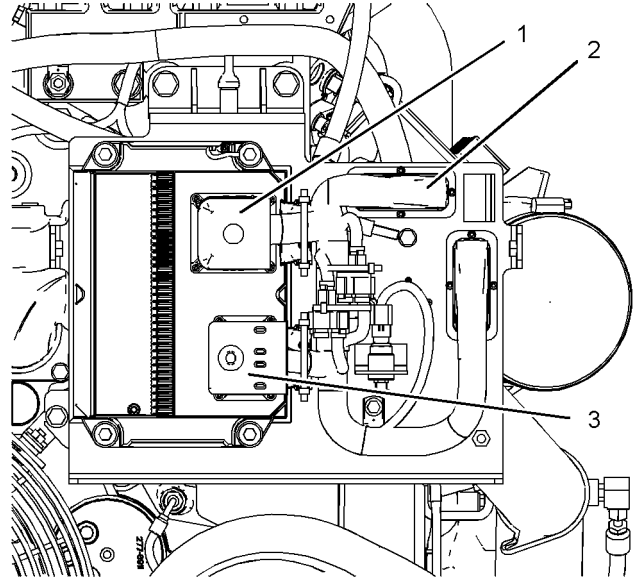


Illustration 112
Location of the connectors that are for the sensor signal circuit for the 20 cylinder engines (left side engine view)

g01440028

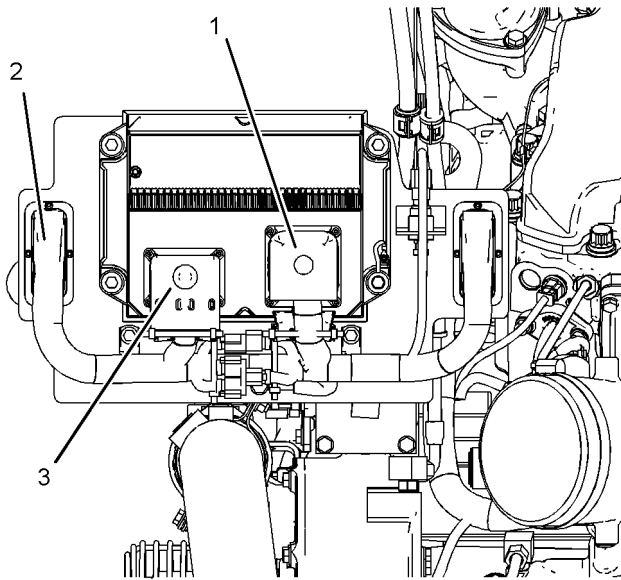


Illustration 111
Location of the connectors that are for the sensor signal circuit for the 16 cylinder engines (left side engine view)

g01440026

- (1) J2/P2 ECM connector
- (2) Right rail connector
- (3) J1/P1 ECM connector

- (1) J2/P2 ECM connector
- (2) Right rail connector
- (3) J1/P1 ECM connector

B. Thoroughly inspect the J1/P1 and J2/P2 ECM connectors. Inspect all of the other connectors that are in the circuit for the oil renewal solenoid. Refer to Troubleshooting, "Electrical Connectors - Inspect".

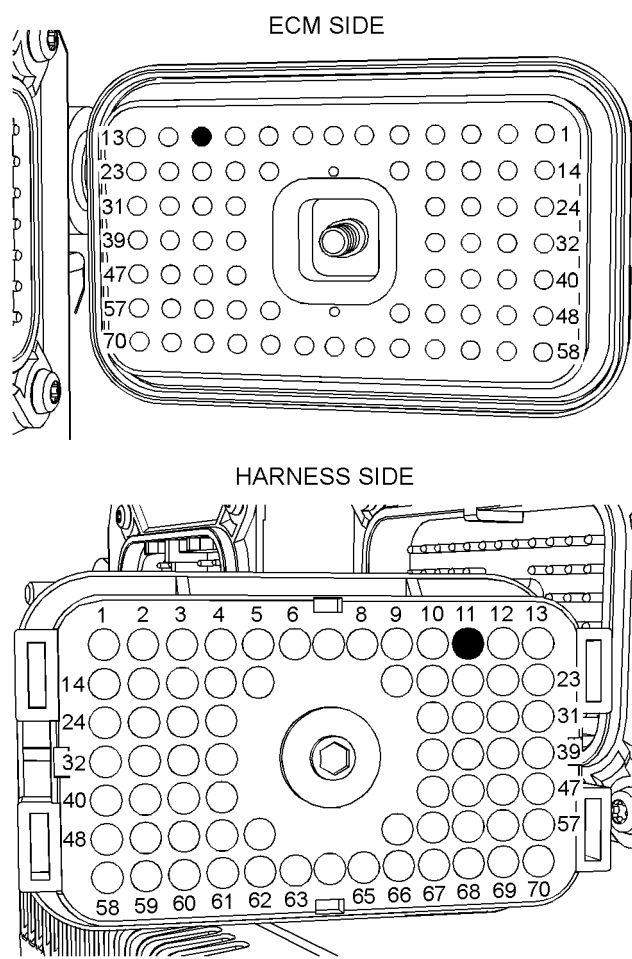


Illustration 113

g01440005

Terminal locations at the P1 ECM connector for the oil renewal solenoid

(P1-11) Oil renewal solenoid

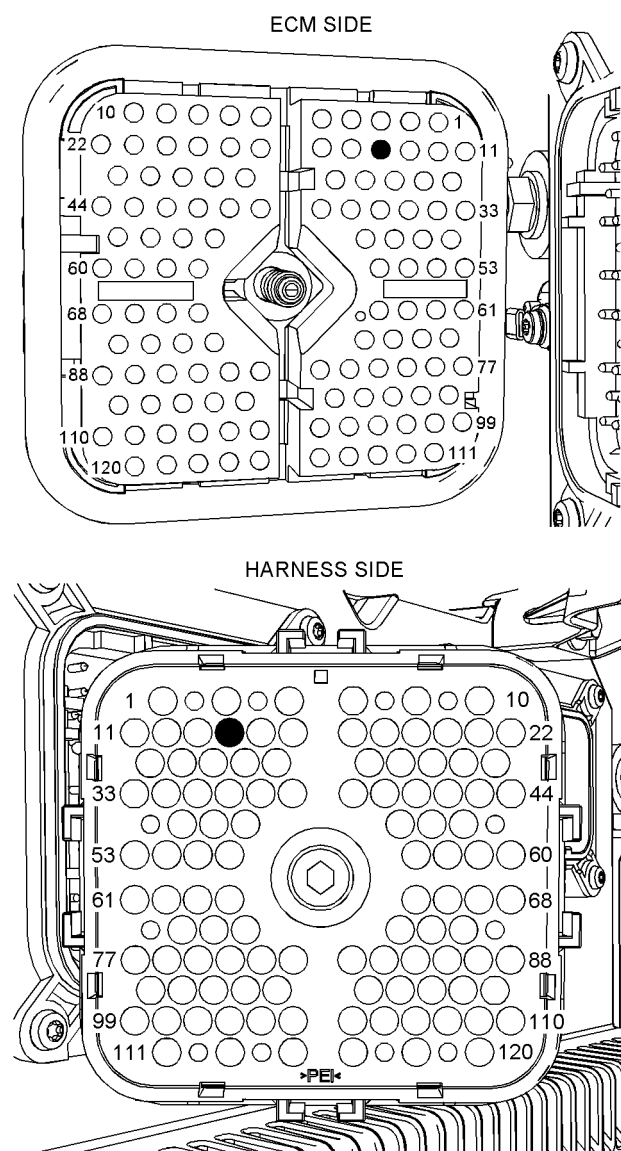


Illustration 114

g01440007

Terminal locations at the P2 ECM connector for the oil renewal solenoid

(P2-14) Digital return

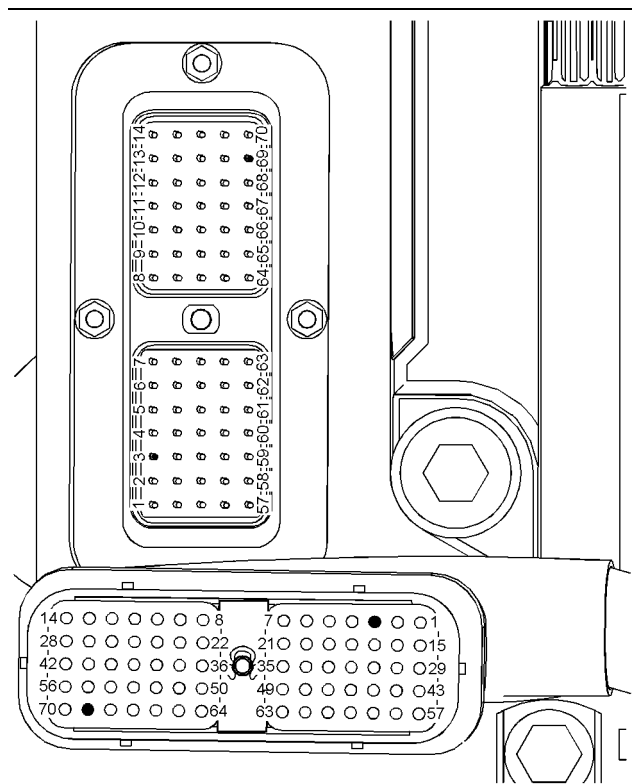


Illustration 115

g01440023

Terminal locations at the right rail connector for the oil renewal solenoid

(Terminal 3) Return
(Terminal 69) Oil renewal solenoid

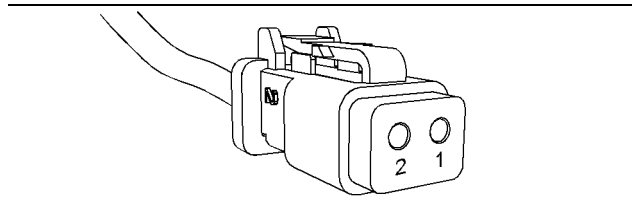


Illustration 116

g01155187

Terminal locations at the connector for the oil renewal solenoid

(1) Signal
(2) Return

- C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the circuit.
- D. Check the allen head screw on each of the ECM connectors for the proper torque. Refer to Troubleshooting, "Electrical Connectors - Inspect" for the correct torque values.
- E. Check the harness and the wiring for abrasion and for pinch points.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted. The harness and wiring are free of corrosion, of abrasion, and of pinch points.

Results:

- OK – The harness and wiring appear to be OK. Proceed to Test Step 2.
- Not OK – There is a problem in the connectors and/or wiring.

Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled.

Verify that the repair eliminates the problem.

STOP.

Test Step 2. Check for Active Diagnostic Codes

- A. Connect Caterpillar Electronic Technician (ET) to the service tool connector.
- B. Restore the electrical power to the engine ECM.
- C. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

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

- D. Select diagnostic tests from Cat ET.
- E. Select the "Override Parameters" screen on Cat ET.
- F. Activate the override for the oil renewal solenoid.
- G. 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.

- H. Disable the override for the oil renewal solenoid.
- I. Remove the electrical power from the engine ECM.
- J. Determine if the problem is related to an open circuit diagnostic code -5 or a short circuit diagnostic code -6.

Expected Result:

No diagnostic codes are active.

Results:

- OK – No diagnostic codes are active.

Repair: There does not appear to be a problem with the oil renewal solenoid at this time. The problem may have been related to an intermittent electrical problem in the harness or in a connector. If an intermittent electrical problem is suspected, carefully inspect the connectors and wiring. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

STOP.

- Not OK – A short circuit diagnostic code -6 is active at this time. Proceed to Test Step 3.
- Not OK – An open circuit diagnostic code -5 is active at this time. Proceed to Test Step 4.

Test Step 3. Disconnect the Connector for the Oil Renewal Solenoid in order to Create an Open Circuit

- Disconnect the connector for the oil renewal solenoid.
- Restore the electrical power to the engine ECM.
- Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

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

- Select diagnostic tests from Cat ET.
- Select the “Override Parameters” screen on Cat ET.
- Activate the override for the oil renewal solenoid.
- 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 override for the oil renewal solenoid.

Expected Result:

An open circuit diagnostic code -5 is now active for the oil renewal solenoid.

Results:

- OK – 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: Temporarily connect a new oil renewal solenoid to the harness, but do not install the newsolenoid. Verify that there are no active diagnostic codes for the oil renewal solenoid. If there are no active diagnostic codes for the solenoid, permanently install the new solenoid. Clear any logged diagnostic codes.

STOP.

- Not OK – A short circuit diagnostic code -6 remains active when the connector for the oil renewal solenoid is disconnected. There is a short circuit between the harness connector for the oil renewal solenoid and the ECM. Proceed to Test Step 5.

Test Step 4. Create a Short at the Connector for the Oil Renewal Solenoid

- Remove the electrical power from the engine ECM.
- Fabricate a jumper wire that is long enough to create a short between the terminals of the connector for the oil renewal solenoid. Crimp connector pins to each end of the jumper wire.
- Install the jumper wire between terminal 1 (oil renewal solenoid) and terminal 2 (return) on the harness side of the connector.
- Restore the electrical power to the engine ECM.
- Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

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

- Select diagnostic tests from Cat ET.
- Select the “Override Parameters” screen on Cat ET.
- Activate the override for the oil renewal solenoid.
- 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 override for the oil renewal solenoid. Remove the jumper wire.

Expected Result:

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.

Results:

- OK – 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: The engine harness and the ECM are OK. Temporarily connect a new oil renewal solenoid to the harness, but do not install the new solenoid. Verify that there are no active diagnostic codes for the oil renewal solenoid. If there are no active diagnostic codes for the solenoid, permanently install the new solenoid. Clear any logged diagnostic codes.

STOP.

- Not OK – The open circuit diagnostic code -5 remains active with the jumper in place. The open circuit is between the ECM and the connector for the oil renewal solenoid. There may be a problem with the ECM. Proceed to Test Step 5.

Test Step 5. Check for Proper Operation of the ECM

A. Disconnect the J1/P1 ECM connector.

B. Fabricate a jumper wire that is long enough to create a short between the ECM connector and engine ground. Crimp a connector socket to one end of the jumper wire.

C. Remove the wire from terminal location P1-11 (oil renewal solenoid) at the ECM connector. Install the jumper wire into this terminal location.

D. Connect the J1/P1 ECM connector.

E. Create an open at the ECM:

- a. Restore the electrical power to the engine ECM.

In order to ensure that an open circuit condition exists, do not allow the loose end of the jumper wire to connect to any other wires or to engine ground.

- b. Monitor the “Active Diagnostic Code” screen on Cat ET. Check and record any active diagnostic codes.

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

- c. Select diagnostic tests from Cat ET.
- d. Select the “Override Parameters” screen on Cat ET.
- e. Activate the override for the oil renewal solenoid.
- f. 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.

- g. Disable the override for the oil renewal solenoid.

F. Create a short at the ECM:

- a. Create a short between the jumper wire for the solenoid and engine ground.
- b. Monitor the “Active Diagnostic Code” screen on Cat ET. Wait at least 30 seconds for activation of the code.
- c. Select diagnostic tests from Cat ET.
- d. Select the “Override Parameters” screen on Cat ET.
- e. Activate the override for the oil renewal solenoid.
- f. 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.

- g. Disable the override for the oil renewal solenoid.
- h. Remove the electrical power from the engine ECM.

G. Restore all wiring to the original configuration.

Expected Result:

An open circuit diagnostic code -5 is active when the circuit is open. A short circuit diagnostic code -6 is active when the jumper wire for the solenoid is shorted to engine ground.

Results:

- OK – An open circuit diagnostic code -5 is active when the circuit is open. A short circuit diagnostic code -6 is active when the jumper wire for the solenoid is shorted to engine ground.

Repair: The ECM is operating properly. The problem is in the harness wiring between the ECM and the connector for the oil renewal solenoid. There may be a problem in one of the connectors. Repair the connectors or wiring and/or replace the connectors or wiring.

STOP.

- Not OK – One of the following conditions exists:
The open circuit diagnostic code -5 is not active when the circuit is open. The short circuit diagnostic code -6 is not active when the wire jumper is shorted to engine ground.

Repair: The solenoid and the harness are OK. The ECM does not appear to be operating properly. Perform the following procedure:

1. Temporarily connect a test ECM.

Refer to Troubleshooting, "ECM - Replace".

2. Recheck the circuit in order to ensure that the original problem has been resolved.

If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the problem is resolved.

If the problem is not resolved with the test ECM, install the original ECM. There is a problem in the wiring.

STOP.

i02906055

Prelubrication - Test

SMCS Code: 1319-038

System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with a prelubrication system or if one of the diagnostic codes in Table 40 is active or easily repeated.

Table 40

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
338-5 Engine Pre-Lube Pump Relay current below normal	The engine's Electronic Control Module (ECM) detects an open in the circuit for the engine prelubrication relay. The ECM detects a short to battery voltage in the circuit for the prelubrication relay.	The code is logged.
338-6 Engine Pre-Lube Pump Relay current above normal	The ECM detects a short in the circuit for the prelubrication relay.	

The ECM has the ability to automatically lubricate the engine before cranking. This may increase the life of certain engine parts by lubricating these parts before the starting motor is engaged.

The charge pressure status of the prelubrication system may be communicated to several different controllers that are on the application. Depending on the status that is communicated there could be an effect on the engine starting.

The prelubrication system is activated at ECM powerup. The ECM prevents the starting motor from engaging while the pump builds pressure in the engine's lubrication system. The ECM determines the charge pressure status via the engine oil pressure sensor.

An override for the prelubrication system is available in Caterpillar Electronic Technician (ET). The override allows the technician to activate the prelubrication system for service and testing. The test is functional only when the engine speed is zero rpm. The test is accessed by selecting the following menus on Cat ET:

- "Diagnostics"
- "Diagnostic Tests"
- "Override Parameters"

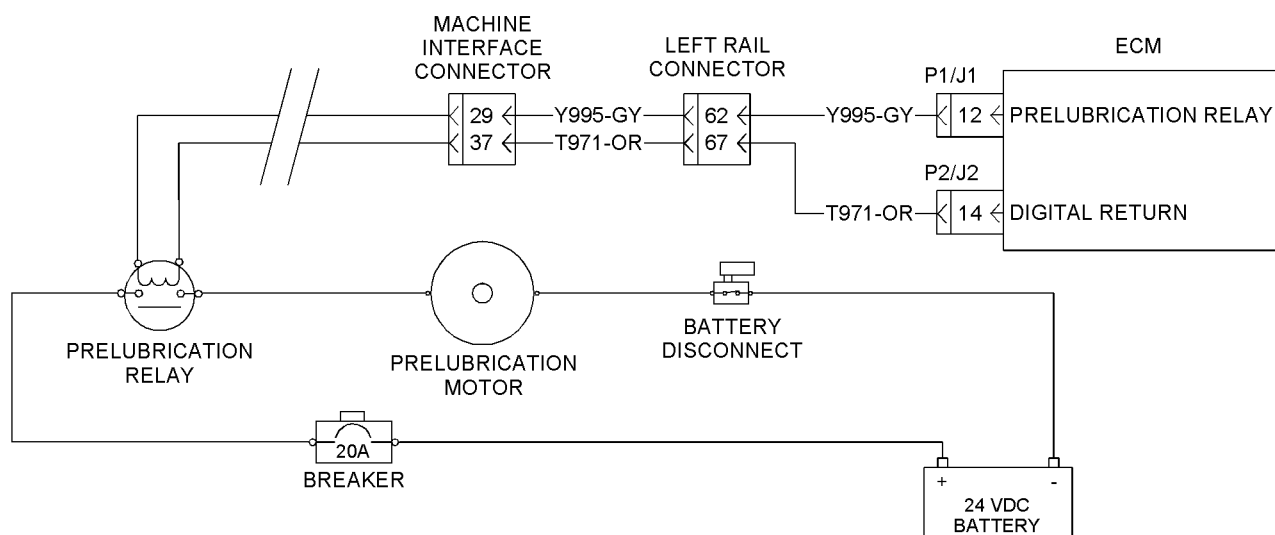


Illustration 117

Schematic for the prelubrication system

g01446607

Test Step 1. Inspect the Electrical Connectors and the Wiring

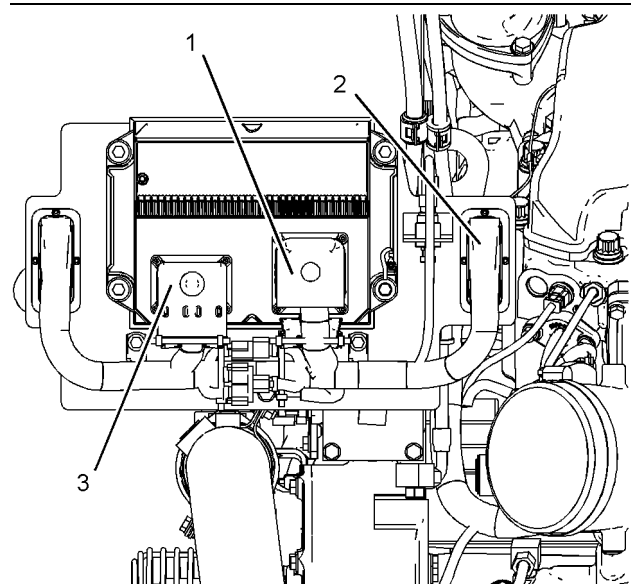


Illustration 118

g01446338

Location of the connectors at the ECM for the 16 cylinder engines (typical left side engine view)

- (1) J2/P2 ECM connector
- (2) Left rail connectors
- (3) J1/P1 ECM connector

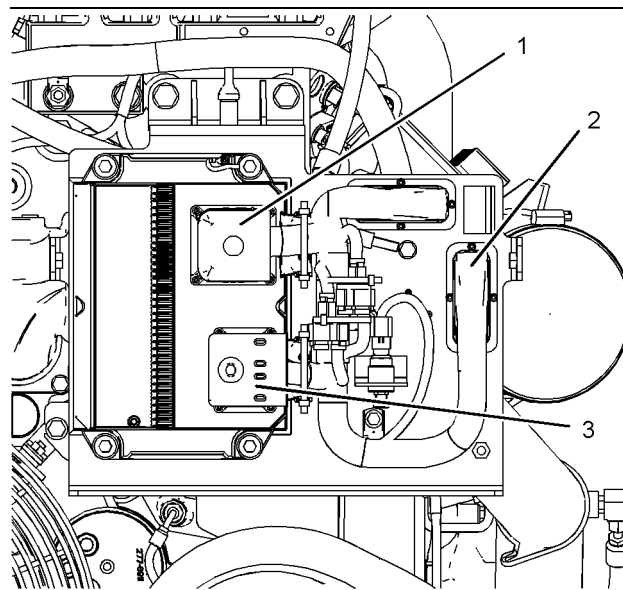


Illustration 119

g01446340

Location of the connectors at the ECM for the 20 cylinder engines (typical left side engine view)

- (1) J2/P2 ECM connector
- (2) Left rail connectors
- (3) J1/P1 ECM connector

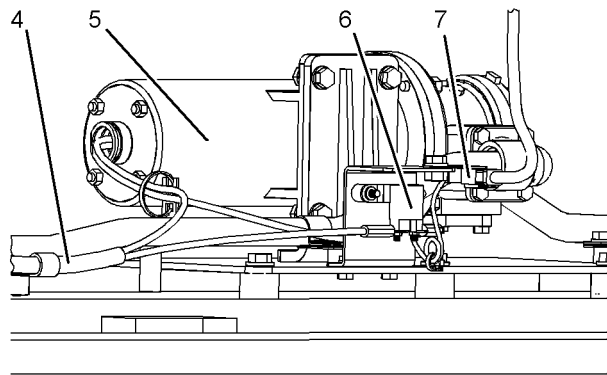


Illustration 120

g01324672

Location of the connectors for the prelubrication pump and the prelubrication relay

- (4) Battery wiring harness for the engine prelude pump
- (5) Prelubrication pump
- (6) Prelubrication relay
- (7) Harness connector for the engine prelubrication relay

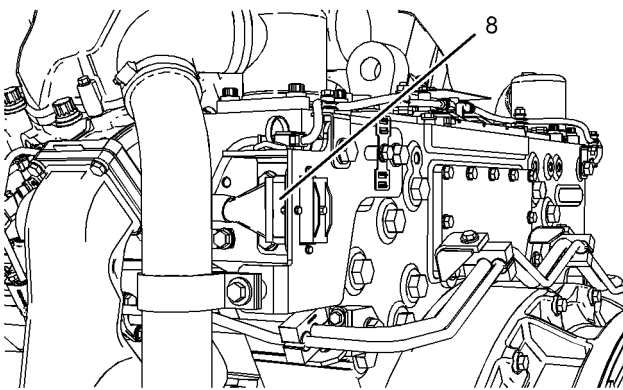


Illustration 121

g01446616

Location of the machine interface connectors (left rear engine view)

- (8) Machine interface connectors

A. Remove the electrical power from the ECM.

B. Thoroughly inspect connectors (1), (2), (3), (7), and (8). Also, thoroughly inspect the connections for harness (4) and relay (6). Refer to Troubleshooting, "Electrical Connectors - Inspect" for the proper procedure for inspecting the connectors and the wiring.

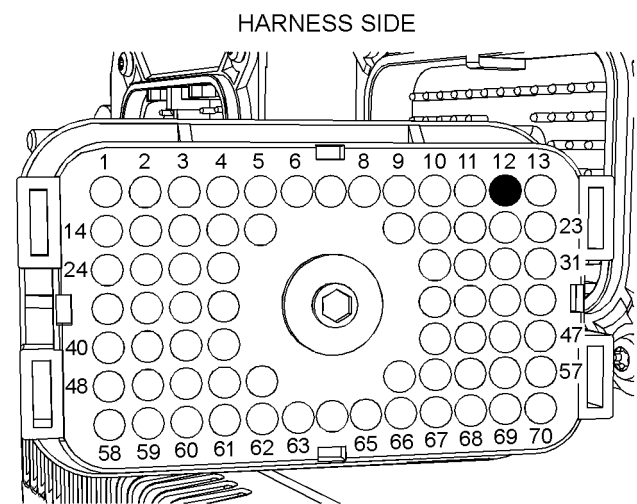
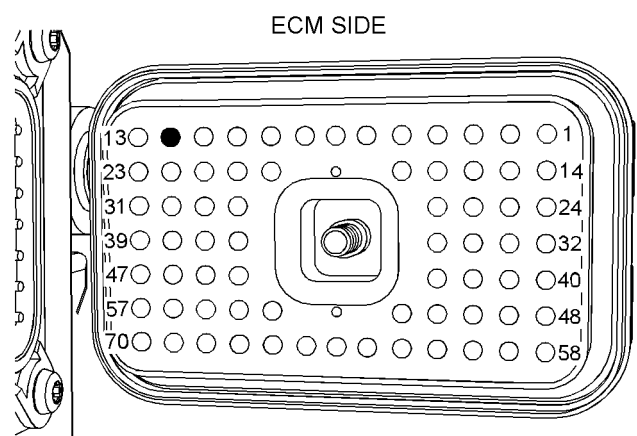


Illustration 122

g01284151

Terminal locations at the P1 ECM connector for the prelubrication system

(P1-12) Prelubrication relay

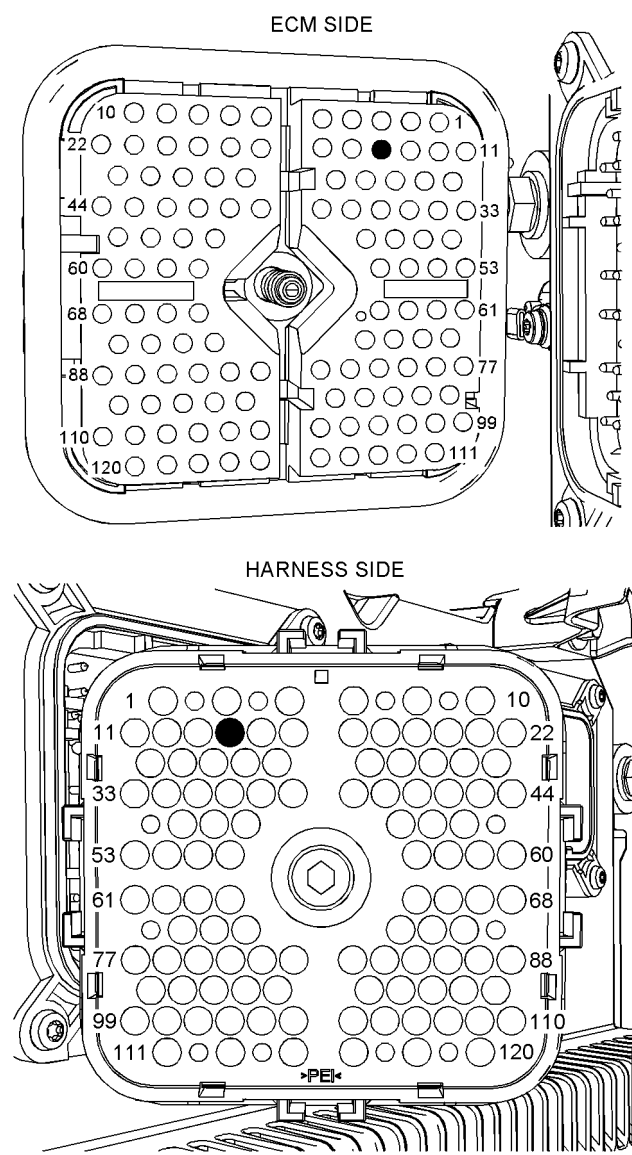


Illustration 123 g01284152

Terminal locations at the P2 ECM connector for the prelubrication system

(P2-14) Digital return

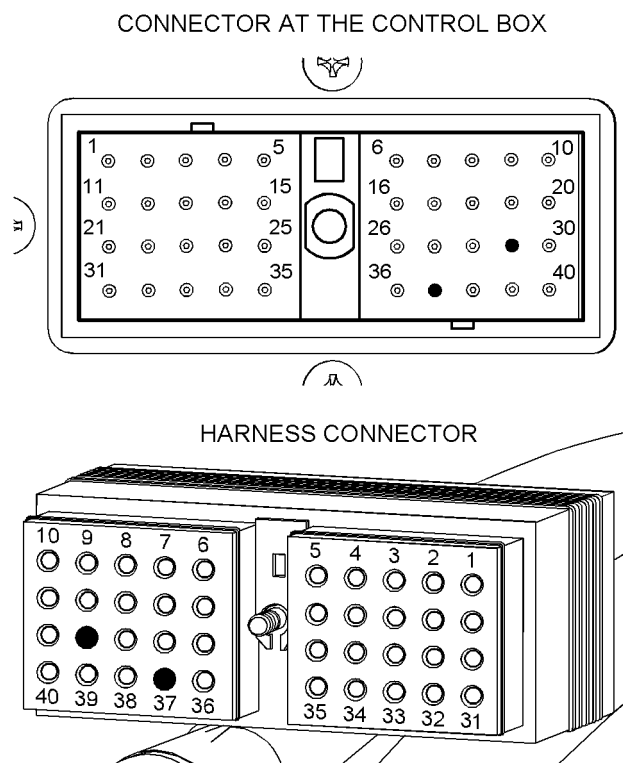


Illustration 124

g01324724

Terminal locations at the machine interface connector for the prelubrication system

(Terminal 29) Prelubrication relay

(Terminal 37) Digital Return

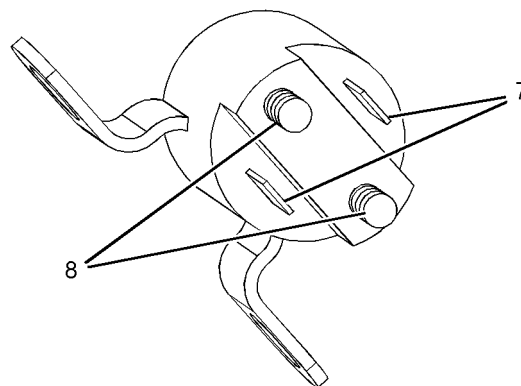


Illustration 125

g01284372

Terminal locations at the prelubrication relay

(7) Blade terminals for the control circuit at the prelubrication relay

(8) Terminal bolts for the secondary circuit at the prelubrication relay

- C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connectors and the other connections that are associated with the circuit.
- D. Check the allen head screw for each of the ECM connectors for the proper torque. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.

- E. Check the harness and the wiring for abrasion and for pinch points.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted. The harness and wiring are free of corrosion, of abrasion, and of pinch points.

Results:

- OK – The connectors and wiring appear to be OK. Proceed to Test Step 2.
- Not OK – There is a problem in the connectors and/or wiring.

Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled.

Verify that the repair eliminates the problem.

STOP.

Test Step 2. Check for Active Diagnostic Codes

- A. Connect Cat ET to the service tool connector.
- B. Restore the electrical power to the ECM.
- C. Select diagnostic tests from Cat ET.
- D. Select the “Override Parameters” screen on Cat ET.
- E. Activate the override for the prelubrication system.
- F. Monitor the active diagnostic code screen on Cat ET. Check the prelubrication system for an active diagnostic code.

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

- G. Disable the override for the prelubrication system.

Expected Result:

No diagnostic codes are active.

Results:

- OK – No diagnostic codes are active, but a problem is suspected in the prelubrication system. Proceed to Test Step 6.

- Active -6 Code – A -6 diagnostic code is active at this time. A short is detected in the circuit for the prelubrication relay. Proceed to Test Step 3.
- Active -5 Code – A -5 diagnostic code is active at this time. An open is detected in the circuit for the prelubrication relay. Proceed to Test Step 4.

Test Step 3. Create an Open Circuit at the Prelubrication Relay

- A. Remove the electrical power from the ECM.
- B. Disconnect the control inputs from the blade terminals at the prelubrication relay.
- C. Restore the electrical power to the ECM.
- D. Select diagnostic tests from Cat ET.
- E. Select the “Override Parameters” screen on Cat ET.
- F. Activate the override for the prelubrication system.
- G. Monitor the active diagnostic code screen on Cat ET. Check the prelubrication system for an active diagnostic code.

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

- H. Remove the electrical power from the ECM.

Expected Result:

A -6 diagnostic code was active for the prelubrication relay. After creating an open at the prelubrication relay, a -5 diagnostic code is now active.

Results:

- OK – A -6 diagnostic code was active before disconnecting the wire. A -5 diagnostic code became active after disconnecting the wire.

Repair: The harness and the ECM are OK. The short circuit is in the prelubrication relay. Perform the following repair:

1. Temporarily connect a new prelubrication relay.
2. Recheck the circuit in order to ensure that the original problem is resolved with the installation of the new relay.
3. If the problem is resolved with the new relay, reconnect the suspect relay. If the problem returns with the suspect relay, permanently install the new relay.

Clear any logged diagnostic codes.

STOP.

- Not OK – A -6 diagnostic code remains active. There is a short between the prelubrication relay and the ECM. There may be a problem with the ECM. Proceed to Test Step 5.

Test Step 4. Create a Short at the Connector for the Prelubrication Relay

- Remove the electrical power from the ECM.
- Fabricate a jumper wire that is long enough to create a short circuit between the terminals of the harness connector for the prelubrication relay. Crimp blade terminals to each end of the jumper wire.
- Install the jumper wire between the terminals of the harness connector at the prelubrication relay.
- Restore the electrical power to the ECM.
- Select diagnostic tests from Cat ET.
- Select the "Override Parameters" screen on Cat ET.
- Activate the override for the prelubrication system.
- Monitor the active diagnostic code screen on Cat ET. Check the prelubrication system for an active diagnostic code.

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

- Disable the override for the prelubrication system.
- Remove the electrical power from the ECM.
- Restore the wiring to the original configuration.

Expected Result:

A -6 diagnostic code is active when the jumper wire is installed. A -5 diagnostic code is active when the jumper wire is removed.

Results:

- OK – A -6 diagnostic code is active when the jumper wire is installed. A -5 diagnostic code is active when the jumper wire is removed.

Repair: The engine harness and the ECM are OK. The open circuit is in the coil of the prelubrication relay. Perform the following repair:

- Temporarily connect a new prelubrication relay.

- Recheck the circuit in order to ensure that the original problem is resolved with the installation of the new relay.

- If the problem is resolved with the new relay, reinstall the suspect relay. If the problem returns with the installation of the suspect relay, permanently install the new relay.

Clear any logged diagnostic codes.

STOP.

- Not OK – The -5 diagnostic code remains active with the jumper in place. The open circuit is between the ECM and the connector for the prelubrication relay. There may be a problem with the ECM. Proceed to Test Step 5.

Test Step 5. Test for the Proper Operation of the ECM

- Remove the electrical power from the ECM.
- Fabricate two jumper wires that are long enough to create a test circuit at the ECM connector. Crimp a connector socket to one end of each of the jumper wires.
- Disconnect the J1/P1 and J2/P2 ECM connectors.
- Remove the wires from terminal locations P1-12 and P2-14 at the ECM connectors. Install one of the jumper wires into each of these terminal locations.
- Connect the ECM connectors.
- Check the Operation of the ECM by Creating an Open Circuit at the ECM Connector:**
 - Hold the loose ends of each of the jumper wires away from any ground source in order to create an open circuit condition.
 - Restore the electrical power to the ECM.
 - Monitor the active diagnostic code screen on Cat ET. Check the prelubrication system for an active -5 diagnostic code.

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

- Select diagnostic tests from Cat ET.
- Select the "Override Parameters" screen on Cat ET.
- Activate the override for the prelubrication system.

- g. Disable the override for the prelubrication system.

G. Check the Operation of the ECM by Creating a Short Circuit at the ECM Connector:

- a. Short circuit the loose ends of the jumper wires that are for the prelubrication relay.
- b. Restore the electrical power to the ECM.
- c. Monitor the active diagnostic code screen on Cat ET. Check the prelubrication system for an active diagnostic code.

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

- d. Select diagnostic tests from Cat ET.
- e. Select the "Override Parameters" screen on Cat ET.
- f. Activate the override for the prelubrication system.
- g. Disable the override for the prelubrication system.

H. Remove the electrical power from the ECM.

I. Restore the wiring to the original configuration.

Expected Result:

A -5 diagnostic code is active when the loose ends of the wires for the prelubrication relay are open at the ECM connector. A -6 diagnostic code is active when the loose ends of the wires for the prelubrication relay are shorted at the ECM connector.

Results:

- OK – A -5 diagnostic code is active when the wires are open at the ECM connector. A -6 diagnostic code is active when the wires are shorted at the ECM connector.

Repair: The ECM is operating properly. The problem is in the wiring between the ECM and the prelubrication relay. Repair the connectors or wiring and/or replace the connectors or wiring. Verify that the original problem has been resolved.

STOP.

- Not OK – One of the following conditions exists: The -5 diagnostic code is not active when the loose ends of the wires for the prelubrication relay are open at the ECM connector. The -6 diagnostic code is not active when the loose ends of the wires for the prelubrication relay are shorted at the ECM connector.

Repair: The ECM is not operating properly. Perform the following repair:

1. Temporarily connect a test ECM.

Refer to Troubleshooting, "ECM - Replace".

2. Recheck the circuit in order to ensure that the original problem has been resolved.

If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the problem is resolved.

If the problem is not resolved with the test ECM, install the original ECM. There is a problem in the wiring. Retest the circuit.

STOP.

Test Step 6. Check the Voltage to the Secondary Circuit of the Prelubrication Relay

- A.** Disconnect the wire that is between the prelubrication relay and the prelubrication motor from the terminal bolt at the prelubrication relay.
- B.** Connect a voltmeter between the terminal bolt of the relay and the engine ground stud.
- C.** Restore the electrical power to the ECM.
- D.** Proceed to the "Diagnostic Overrides" screen on Cat ET.
- E.** Activate the override for the prelubrication system.
- F.** Measure the voltage at the terminal bolt.
- G.** Remove the electrical power from the ECM.
- H.** Restore the wiring to the original configuration.

Expected Result:

The voltage measures 24 ± 3 VDC.

Results:

- OK – The voltage is 24 ± 3 VDC. The prelubrication relay is operating properly. Proceed to Test Step 7.

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

Repair: Perform the following steps.

1. Remove the wire that is between the prelubrication relay and the circuit breaker from the terminal bolt at the prelubrication relay. Measure the voltage between the loose end of the wire and the engine ground stud.

If 24 ± 3 VDC is present on the loose end of the wire, there is a problem with the prelubrication relay. Replace the relay. Verify that the problem has been resolved.

If 24 ± 3 VDC is not present at the loose end of the wire, there is a problem with the circuit between the batteries and the relay. Check that the circuit breaker has not been tripped. Also, check that the batteries are fully charged. If the circuit breaker has not been tripped and if the circuit breaker and the batteries are in good repair, there is a problem in the harness wiring. Repair the wiring or replace the wiring that is between the batteries and the prelubrication relay.

STOP.

Test Step 7. Check the Voltage at the Prelubrication Motor

- A. Disconnect the wire that is between the prelubrication relay and the prelubrication motor from the terminal bolt at the prelubrication motor.
- B. Connect a voltmeter between the loose end of the wire and the engine ground stud.
- C. Restore the electrical power to the ECM.
- D. Proceed to the “Diagnostic Overrides” screen on Cat ET.
- E. Use Cat ET in order to activate the override for the prelubrication system.
- F. Measure the voltage between the loose end of the wire and the engine ground.
- G. Remove the electrical power from the ECM.

Expected Result:

The voltage is 24 ± 3 VDC.

Results:

- OK – The voltage is 24 ± 3 VDC. The circuit for the prelubrication system is OK. Proceed to Test Step 8.
- Not OK – The voltage is not 24 ± 3 VDC.

Repair: Voltage is present at the relay, but voltage is not present at the motor. There is a problem with the wiring that is between the prelubrication relay and the prelubrication motor. Repair the wiring or replace the wiring. Verify that the original problem has been resolved.

STOP.

Test Step 8. Check the Operation of the Prelubrication Motor

- A. Remove the electrical power from the ECM.
- B. Fabricate a jumper wire out of 10 AWG wire that can be used to provide a test circuit between the battery and the prelubrication motor. Connect one side of the jumper wire to the +Battery terminal.
- C. For one second, connect the other end of the wire to the positive terminal of the prelubrication motor.

Expected Result:

The prelubrication motor starts while the wire is connected to the positive terminal of the prelubrication motor.

Results:

- OK – The prelubrication motor starts. There is a problem in the wiring harness at the prelubrication motor.

Repair: Repair the connectors or wiring and/or replace the connectors or wiring.

STOP.

- Not OK – The prelubrication motor did not start.

Repair: Verify that the ground circuit at the prelubrication motor has continuity to engine ground. If the ground circuit is OK, the problem is in the prelubrication motor. Install a new prelubrication motor. Verify that the original problem has been resolved.

STOP.

i02867948

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 41 is active or easily repeated.

Table 41

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
100-3 Engine Oil Pressure Sensor voltage above normal	The Electronic Control Module (ECM) detects signal voltage that is above normal for eight seconds. The ECM has been powered for at least two seconds. Engine speed equals 0 rpm or the engine coolant temperature is less than 38 °C (100 °F).	The code is logged. If the signal is valid, the parameter will use the value from the sensor for the unfiltered oil pressure. If the signal is not valid, the value of the parameter will be set to 600 kPa (87 psi).
100-4 Engine Oil Pressure Sensor voltage below normal	The ECM detects signal voltage that is below normal for eight seconds. The ECM has been powered for two seconds. The sensor must detect a barometric pressure that is at least 55 kPa (8 psi) (absolute pressure) before the diagnostic code will be enabled.	
101-3 Crankcase Air Pressure Sensor voltage above normal	The ECM detects signal voltage that is above normal for thirty seconds. The ECM has been powered for two seconds.	The code is logged. The value of the parameter will be set to the value from the barometric pressure sensor.
101-4 Crankcase Air Pressure Sensor voltage below normal	The ECM detects signal voltage that is below normal for thirty seconds. The ECM has been powered for two seconds.	
274-3 Atmospheric Pressure Sensor voltage above normal	The ECM detects signal voltage that is above normal for thirty seconds. The ECM has been powered for four seconds.	The code is logged. The value of the parameter will be set to the value from a map dependent value that is stored in the ECM.
274-4 Atmospheric Pressure Sensor voltage below normal	The ECM detects signal voltage that is below normal for thirty seconds. The ECM has been powered for four seconds.	

(continued)

(Table 41, contd)

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
289-3 Fuel Pressure Sensor - Before Fuel Filter voltage above normal	The ECM detects signal voltage that is above normal for ten seconds. The ECM has been powered for two seconds.	The code is logged. If the signal is valid, the value of the parameter will be set to the value from the fuel pressure sensor after the fuel filter. If the signal is not valid, the value of the parameter will be set to 600 kPa (87 psi).
289-4 Fuel Pressure Sensor - Before Fuel Filter voltage below normal	The ECM detects signal voltage that is below normal for ten seconds. The ECM has been powered for two seconds. The sensor must detect a barometric pressure that is at least 55 kPa (8 psi) (absolute pressure) before the diagnostic code will be enabled.	
460-3 Fuel Pressure Sensor - After Fuel Filter voltage above normal	The ECM detects signal voltage that is above normal for eight seconds. The ECM has been powered for at least two seconds. The pressure for this sensor must be less than 1100 kPa (160 psi) in order for this diagnostic to be enabled.	The code is logged. The value of the parameter will be set to 15 kPa (2 psi) less than the value from the fuel pressure sensor before the fuel filter.
460-4 Fuel Pressure Sensor - After Fuel Filter voltage below normal	The ECM detects signal voltage that is below normal for eight seconds. The ECM has been powered for two seconds. The sensor must detect a barometric pressure that is at least 55 kPa (8 psi) (absolute pressure) before the diagnostic code will be enabled.	
542-3 Engine Oil Pressure Sensor - Before Oil Filter voltage above normal	The ECM detects signal voltage that is above normal for eight seconds. The ECM has been powered for at least two seconds. The pressure for this sensor must be less than 1100 kPa (160 psi) in order for this diagnostic to be enabled.	The code is logged. The value of the parameter will be set to 600 kPa (87 psi).
542-4 Engine Oil Pressure Sensor - Before Oil Filter voltage below normal	The ECM detects signal voltage that is below normal for eight seconds. The ECM has been powered for two seconds. The sensor must detect a barometric pressure that is at least 55 kPa (8 psi) (absolute pressure) before the diagnostic code will be enabled.	
1785-3 Intake Manifold Pressure Sensor voltage above normal	The ECM detects signal voltage that is above normal for two seconds.	The code is logged. The value of the parameter will be set to 320 kPa (46 psi) (absolute pressure).
1785-4 Intake Manifold Pressure Sensor voltage below normal	The ECM detects signal voltage that is below normal for two seconds. The sensor must detect a barometric pressure that is at least 55 kPa (8 psi) (absolute pressure) before the diagnostic code will be enabled.	
1797-3 Fuel Rail Pressure Sensor voltage above normal	The ECM detects signal voltage that is above normal.	The code is logged. The engine power is derated to a default torque map while the code is active.
1797-4 Fuel Rail Pressure Sensor voltage below normal	The ECM detects signal voltage that is below normal.	
2247-3 Fuel Transfer Pump Inlet Pressure Sensor voltage above normal	The ECM detects signal voltage that is above normal.	The code is logged.

(continued)

(Table 41, contd)

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
2247-4 Fuel Transfer Pump Inlet Pressure Sensor voltage below normal	The ECM detects signal voltage that is below normal.	The code is logged.
2302-3 Engine Coolant Pump Outlet Pressure Sensor voltage above normal	The ECM detects signal voltage that is above normal for ten seconds.	The code is logged. The value of the parameter will be set to 75 kPa (11 psi).
2302-4 Engine Coolant Pump Outlet Pressure Sensor voltage below normal	The ECM detects signal voltage that is below normal for ten seconds.	
2738-3 Turbocharger #1 Compressor Inlet Pressure Sensor voltage above normal	The ECM detects signal voltage that is above normal for 20 seconds.	The code is logged. An average pressure is calculated from the other turbocharger compressor inlet pressure sensors. The value of this parameter will be set to the calculated value.
2738-4 Turbocharger #1 Compressor Inlet Pressure Sensor voltage below normal	The ECM detects signal voltage that is below normal for 20 seconds.	
2739-3 Turbocharger #2 Compressor Inlet Pressure Sensor voltage above normal	The ECM detects signal voltage that is above normal for 20 seconds.	The code is logged. An average pressure is calculated from the other turbocharger compressor inlet pressure sensors. The value of this parameter will be set to the calculated value.
2739-4 Turbocharger #2 Compressor Inlet Pressure Sensor voltage below normal	The ECM detects signal voltage that is below normal for 20 seconds.	
2740-3 Turbocharger #3 Compressor Inlet Pressure Sensor voltage above normal	The ECM detects signal voltage that is above normal for 20 seconds.	The code is logged. An average pressure is calculated from the other turbocharger compressor inlet pressure sensors. The value of this parameter will be set to the calculated value.
2740-4 Turbocharger #3 Compressor Inlet Pressure Sensor voltage below normal	The ECM detects signal voltage that is below normal for 20 seconds.	
2741-3 Turbocharger #4 Compressor Inlet Pressure Sensor voltage above normal	The ECM detects signal voltage that is above normal for 20 seconds.	The code is logged. An average pressure is calculated from the other turbocharger compressor inlet pressure sensors. The value of this parameter will be set to the calculated value.
2741-4 Turbocharger #4 Compressor Inlet Pressure Sensor voltage below normal	The ECM detects signal voltage that is below normal for 20 seconds.	
3031-3 Intake Manifold #2 Pressure Sensor voltage above normal	The ECM detects signal voltage that is above normal for ten seconds.	The code is logged. The value of the parameter will be set to 320 kPa (46 psi) (absolute pressure).
3031-4 Intake Manifold #2 Pressure Sensor voltage below normal	The ECM detects signal voltage that is below normal for two seconds. The sensor must detect a barometric pressure that is at least 55 kPa (8 psi) (absolute pressure) before the diagnostic code will be enabled.	

System Operation

Use this procedure to troubleshoot any suspect problems with the following sensors:

- Atmospheric pressure sensor
- Crankcase pressure sensor
- Engine coolant pump outlet pressure sensor
- Filtered oil pressure sensor
- Filtered fuel pressure sensor
- Pressure sensor for the inlet of the fuel transfer pump
- Fuel rail pressure sensor
- Left intake manifold pressure sensor
- Right intake manifold pressure sensor
- Turbocharger 1 compressor inlet pressure sensor

- Turbocharger 2 compressor inlet pressure sensor
- Turbocharger 3 compressor inlet pressure sensor
- Turbocharger 4 compressor inlet pressure sensor
- Unfiltered fuel pressure sensor
- Unfiltered oil pressure sensor

Background Information

The ECM continuously creates a pull-up voltage on the signal wire for each sensor. The ECM uses this pull-up voltage in order to detect a problem in the signal circuit. When the ECM detects voltage that is above a threshold on the signal wire, the ECM activates a high voltage -3 diagnostic code. When the ECM detects voltage that is below a threshold on the signal wire, the ECM activates a low voltage -4 diagnostic code.

Note: There may be a delay of 30 seconds or more in order for Caterpillar Electronic Technician (ET) to display an active diagnostic code. When you check for a diagnostic code, be sure to wait at least 30 seconds.

The following components can cause these codes:

- Electrical connector or wiring
- Sensor
- ECM

The most likely cause of a code is a problem with an electrical connector or wiring. The least likely cause of a code is the ECM.

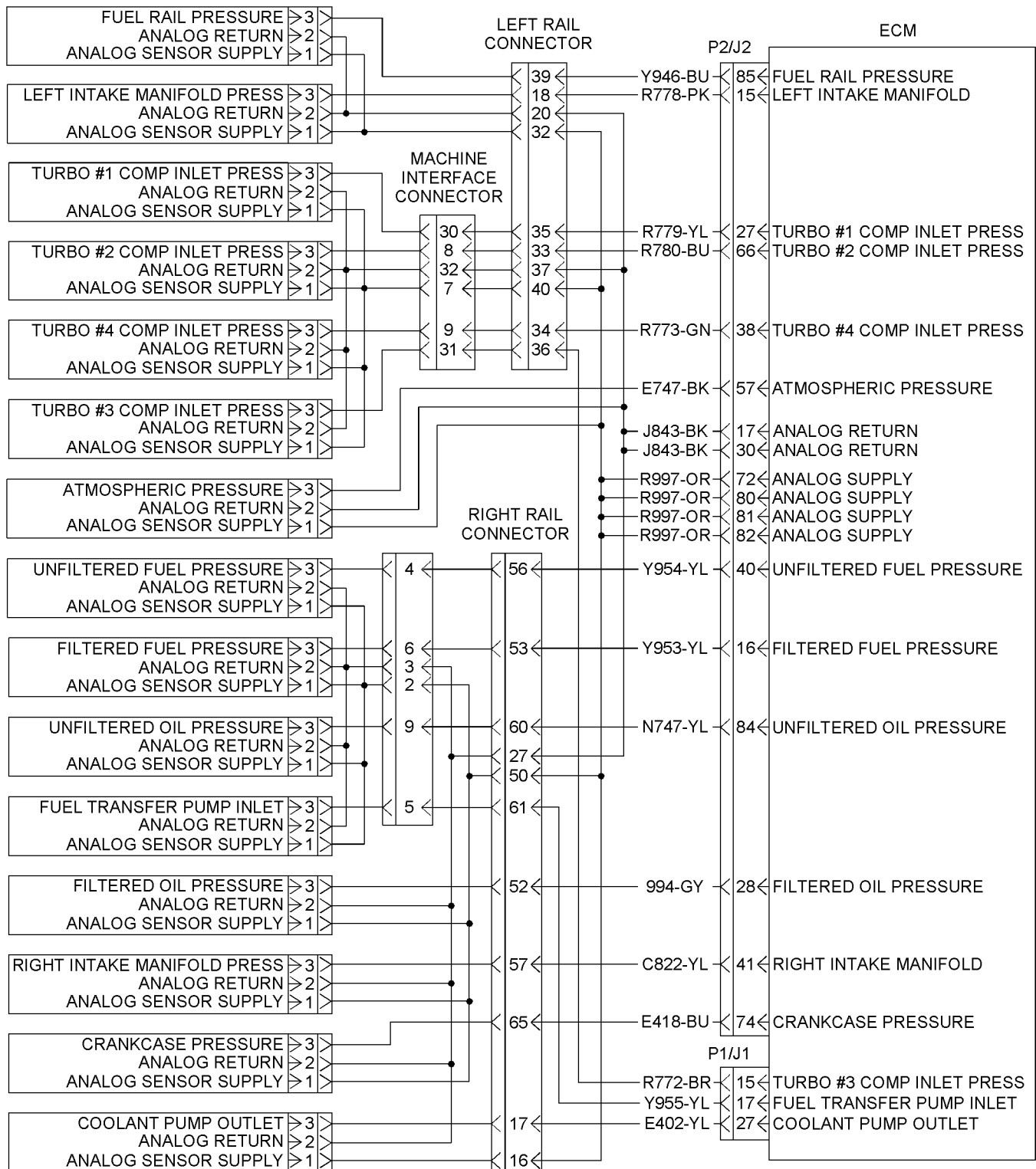


Illustration 126

Schematic for the analog sensors (16 cylinder and 20 cylinder engines)

g01428681

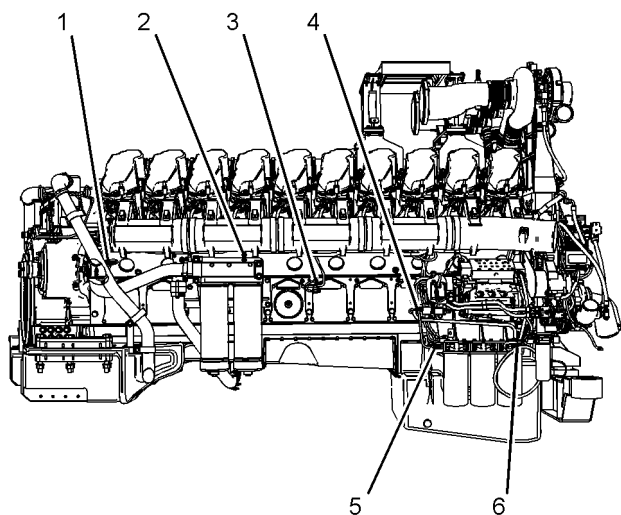


Illustration 127

g01320464

Locations of the analog sensors (right side engine view)

- (1) Filtered oil pressure sensor
- (2) Unfiltered oil pressure sensor
- (3) Crankcase pressure sensor
- (4) Fuel transfer inlet pressure sensor
- (5) Unfiltered fuel pressure sensor
- (6) Filtered fuel pressure sensor

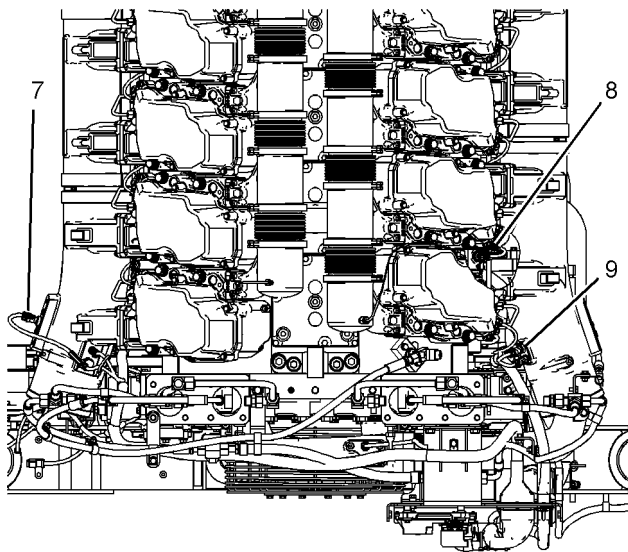


Illustration 128

g01429286

Locations of the engine sensors (typical top side engine view)

- (7) Right intake manifold pressure sensor
- (8) Pressure sensor for the high pressure fuel rail
- (9) Left intake manifold pressure sensor

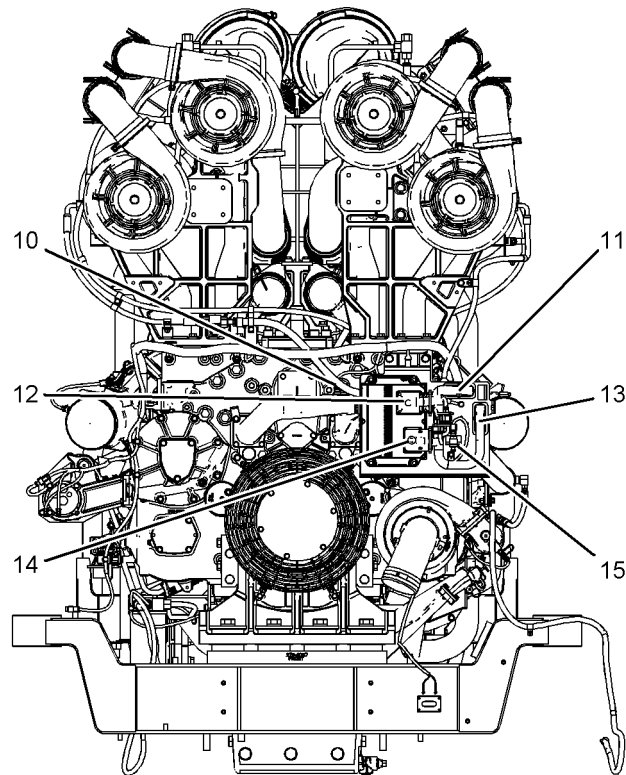


Illustration 129

g01429287

Locations of the components that are for the analog sensor signal for the 20 cylinder engines (front side engine view)

- (10) Coolant pump outlet pressure sensor
- (11) Right rail connector
- (12) J2/P2 ECM connectors
- (13) Left rail connector
- (14) J1/P1 ECM connectors
- (15) Atmospheric pressure sensor

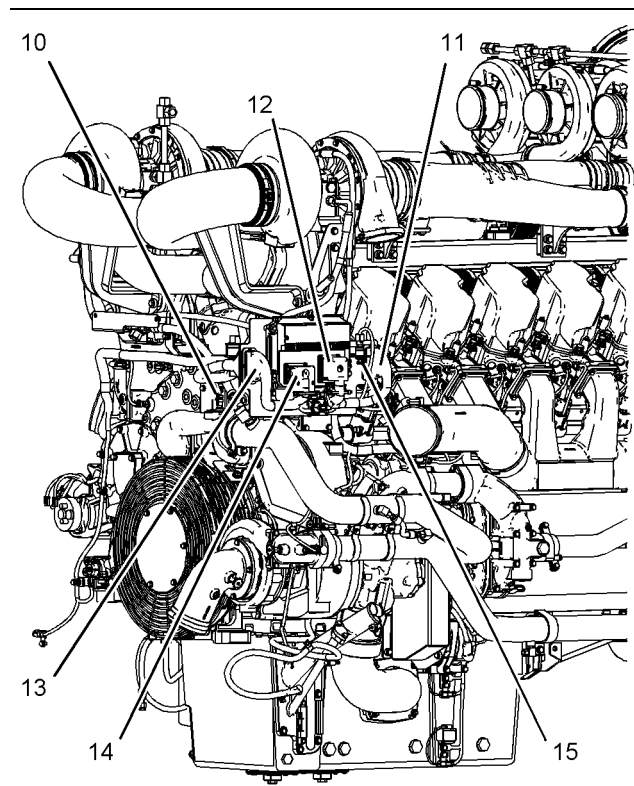


Illustration 130 g01429646

Locations of the components that are for the analog sensor signal for the 16 cylinder engines (front left side engine view)

- (10) Coolant pump outlet pressure sensor
- (11) Right rail connector
- (12) J2/P2 ECM connectors
- (13) Left rail connector
- (14) J1/P1 ECM connectors
- (15) Atmospheric pressure sensor

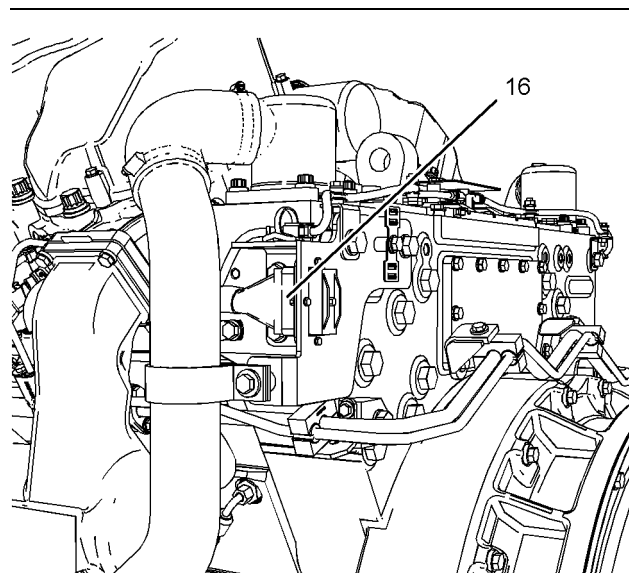


Illustration 131 g01429688

Locations of the machine interface connectors (left rear engine view)

- (16) Machine interface connector

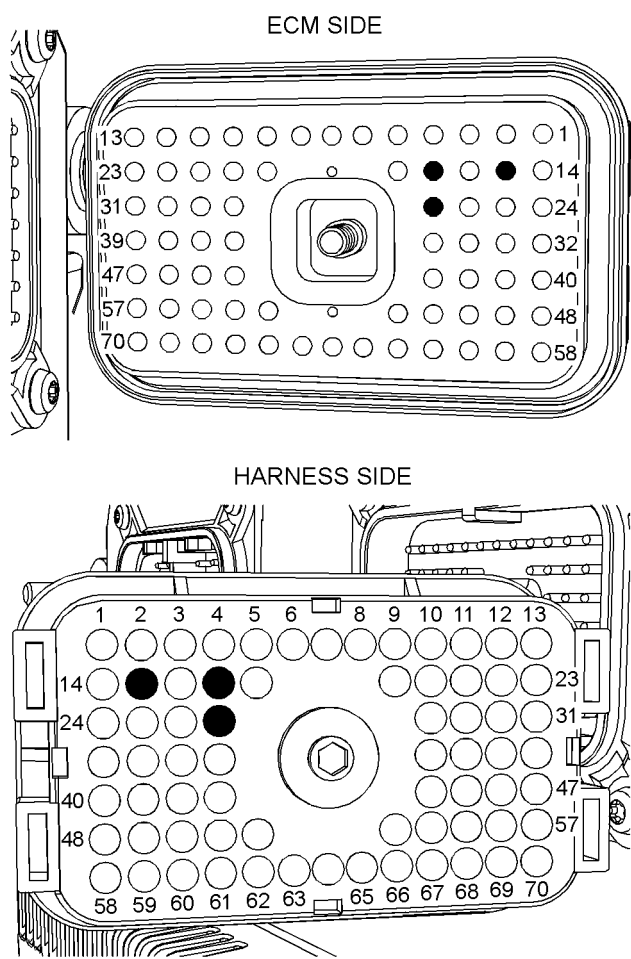


Illustration 132

g01322334

Terminal locations at the P1 ECM connector for the analog sensors

- (P1-15) Turbocharger 3 compressor inlet pressure
- (P1-17) Inlet pressure at the fuel transfer pump
- (P1-27) Coolant pump outlet pressure

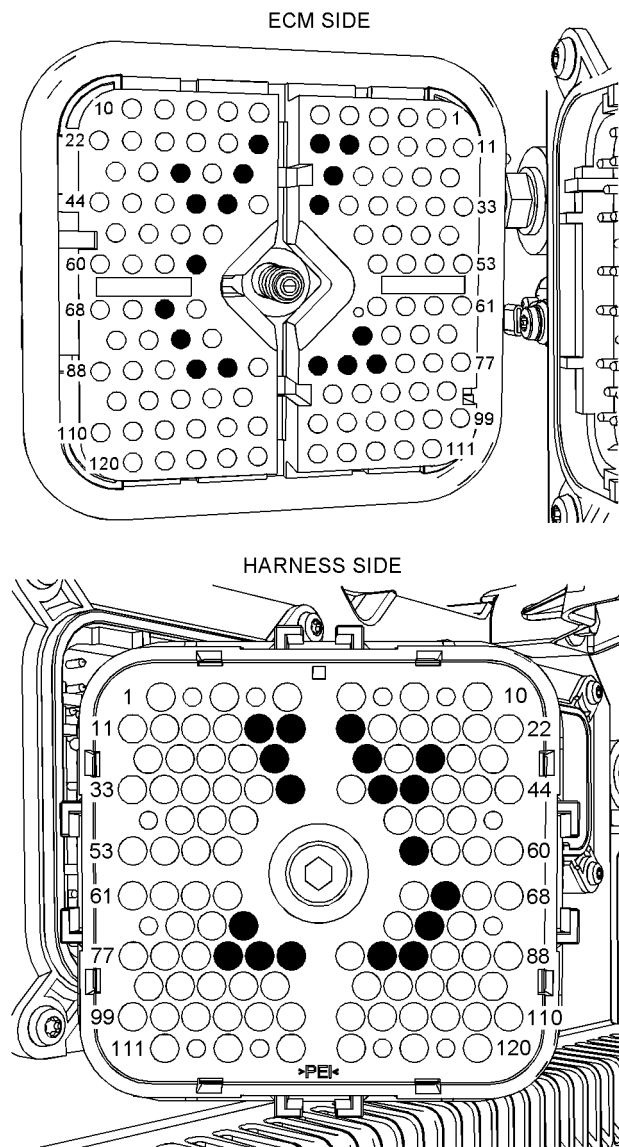


Illustration 133

g01429719

Terminal locations at the P2 ECM connector for the analog sensors

- (P2-15) Left intake manifold pressure
- (P2-16) Filtered fuel pressure
- (P2-17) Analog return
- (P2-27) Turbocharger 1 compressor inlet pressure
- (P2-28) Filtered oil pressure
- (P2-30) Analog return
- (P2-38) Turbocharger 4 compressor inlet pressure
- (P2-40) Unfiltered fuel pressure
- (P2-41) Left intake manifold pressure
- (P2-57) Atmospheric pressure
- (P2-66) Turbocharger 2 compressor inlet pressure
- (P2-72) Analog sensor supply
- (P2-74) Crankcase pressure
- (P2-80) Analog sensor supply
- (P2-81) Analog sensor supply
- (P2-82) Analog sensor supply
- (P2-84) Unfiltered oil pressure
- (P2-85) Fuel rail pressure

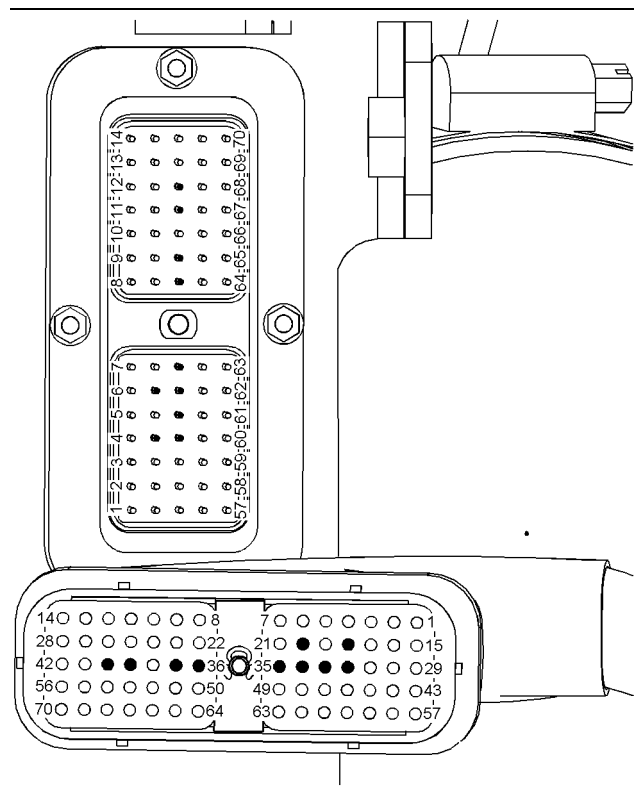


Illustration 134 g01429390

Terminal locations for the analog sensors at the left rail connector

- (Terminal 18) Left intake manifold pressure
- (Terminal 20) Analog return
- (Terminal 32) Analog sensor supply
- (Terminal 33) Turbocharger 2 compressor inlet pressure
- (Terminal 34) Turbocharger 4 compressor inlet pressure
- (Terminal 35) Turbocharger 1 compressor inlet pressure
- (Terminal 36) Turbocharger 3 compressor inlet pressure
- (Terminal 37) Analog return
- (Terminal 39) Fuel rail pressure
- (Terminal 40) Analog sensor supply

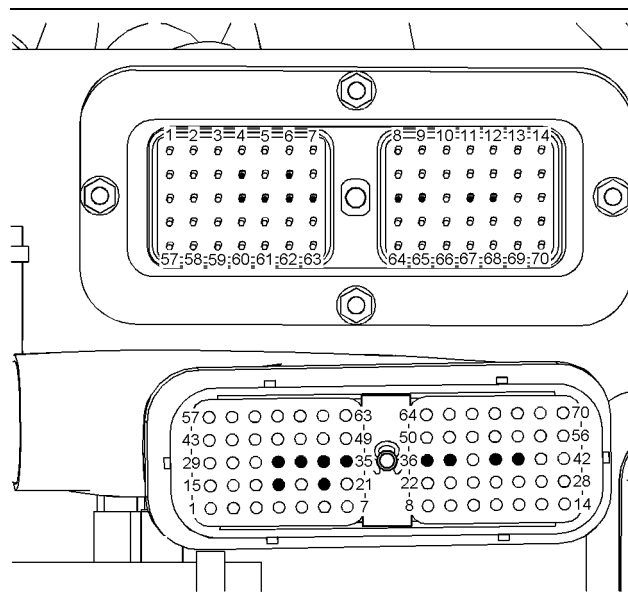


Illustration 135 g01429376

Terminal locations for the analog sensors at the right rail connector

- (Terminal 16) Analog sensor supply
- (Terminal 17) Coolant pump outlet pressure
- (Terminal 27) Analog return
- (Terminal 50) Analog sensor supply
- (Terminal 52) Filtered oil pressure
- (Terminal 53) Filtered fuel pressure
- (Terminal 56) Unfiltered fuel pressure
- (Terminal 57) Right intake manifold pressure
- (Terminal 65) Crankcase pressure

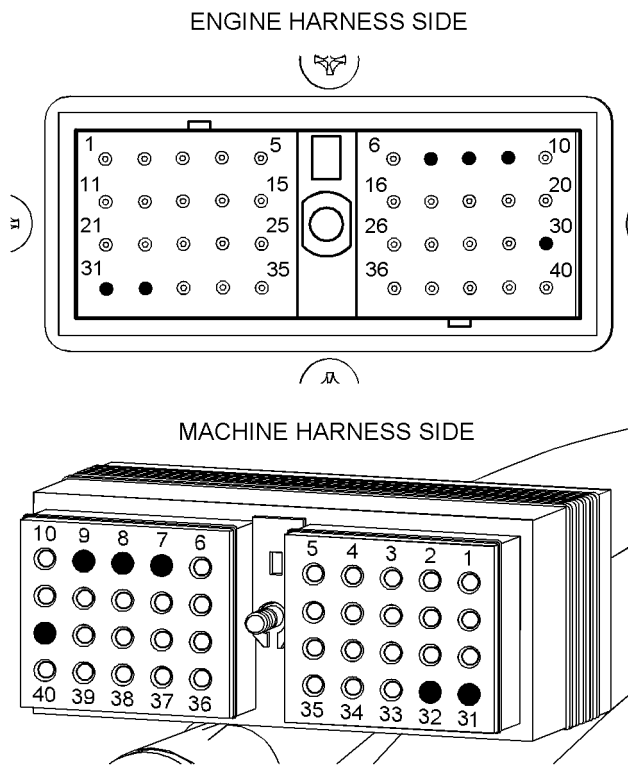


Illustration 136

g01429724

Terminal locations for the analog sensors at the machine interface connector (16 and 20 cylinder engines)

(Terminal 7) Analog sensor supply
 (Terminal 8) Turbocharger 2 compressor inlet pressure
 (Terminal 9) Turbocharger 4 compressor inlet pressure
 (Terminal 30) Turbocharger 1 compressor inlet pressure
 (Terminal 31) Turbocharger 3 compressor inlet pressure
 (Terminal 32) Analog return

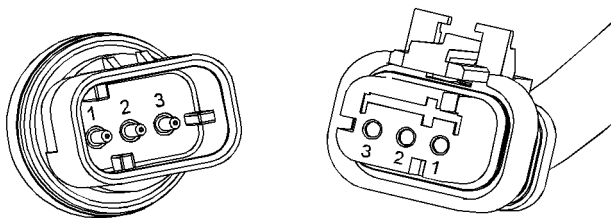


Illustration 137

g01240891

Sensor connector

(Terminal 1) Analog sensor supply
 (Terminal 2) Sensor return
 (Terminal 3) Signal

Test Step 1. Determine if the Code is Logged or Active

- Connect Cat ET to the service tool connector.
- Restore electrical power to the engine ECM.

- Monitor the active diagnostic code and the logged diagnostic codes on Cat ET.

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

Identify the diagnostic code.

Results:

- Logged code

Repair: Do not troubleshoot a logged code unless the code relates to an operator complaint. If the code is logged and the code does not relate to an operator complaint, clear the code.

If the code is logged and the code relates to an operator complaint, proceed to Test Step 2.

- Active code – Proceed to Test Step 3.

Test Step 2. Check the Integrity of the Connections at the Connectors

- Restore the electrical power to the ECM. Do not start the engine.
- Install a 7X-1708 Multimeter Probe (RED) and a 7X-1709 Multimeter Probe (BLACK) onto the test leads of a multimeter.

Note: Ensure that the multimeter probes are in good repair. Bent probes may contact other terminals inside the connector.

C. Check for an intermittent problem at the connector for the suspect sensor:

Note: Do not disconnect any harness connectors in order to perform this procedure.

- Carefully install the spoons (multimeter probes) into the terminal locations for the sensor supply and the sensor return at the appropriate ECM connector.
- While you observe the voltage reading on the multimeter, wiggle the wires and pull on the wires at the connector for the suspect sensor.

The voltage reading will not vary more than 0.5 volts for a solid electrical connection.

- Remove the spoons (multimeter probes) from the connector.

D. Check for an intermittent problem at the ECM connector:

Note: Do not disconnect any harness connectors in order to perform this procedure.

- a. Carefully install the spoons (multimeter probes) into the terminal locations for the sensor supply and the sensor return at the connector for the suspect sensor.
- b. While you observe the voltage reading on the multimeter, wiggle the wires and pull on the wires for the pressure sensor supply and the sensor return at the ECM connector.

The voltage reading will not vary more than 0.5 volts for a solid electrical connection.

- c. Remove the spoons (multimeter probes) from the connector.

E. Remove the electrical power from the ECM.

Expected Result:

The voltage reading did not vary more than 0.5 volts during either test.

Results:

- OK – The voltage reading did not vary more than 0.5 volts.

Repair: The connections are OK at the connectors. There does not appear to be an intermittent problem in the circuit at this time. Return the engine to service.

STOP.

- Not OK – The voltage reading varied more than 0.5 volts during the test.

Repair: Disconnect the suspect connector and inspect the connector and the terminals for moisture, damage, and corrosion. Repair the connectors and/or the terminals. Return the engine to service.

STOP.

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

Measure the voltage between terminal 1 (sensor supply) and terminal 2 (sensor return) at the harness connector for the sensor that relates to the code.

Expected Result:

The voltage is between 4.5 VDC and 5.5 VDC.

Results:

- OK – The voltage is between 4.5 VDC and 5.5 VDC. The supply voltage is available at the sensor connector. Record the voltage measurement. If you are troubleshooting a -3 diagnostic code, proceed to Test Step 4. If you are troubleshooting a -4 diagnostic code, proceed to Test Step 7.
- Not OK – The voltage is less than 4.5 VDC or the voltage is greater than 5.5 VDC.

Repair: The voltage of the sensor supply is incorrect. Refer to Troubleshooting, "Sensor Supply - Test".

STOP.

Test Step 4. Check for Battery Voltage on the Signal Wire

Measure the voltage between terminal 3 (signal) and terminal 2 (return) on the harness connector for the sensor that relates to the diagnostic code.

Expected Result:

The voltage measurement is less than the +Battery voltage.

Results:

- OK – The voltage measurement is less than the +Battery voltage. The signal wire is not shorted to the +Battery. Proceed to Test Step 5.
- Not OK – The voltage measurement is approximately equal to the +Battery voltage. The signal wire is shorted to the +Battery.

Repair: Repair the wiring, when possible. Replace parts, if necessary. Verify that the problem is resolved.

STOP.

Test Step 5. Check the Signal Wire for an Open Circuit

A. Disconnect the sensor that relates to the diagnostic code.

B. Connect a jumper wire between terminal 3 (signal) and the terminal 2 (return) on the harness connector for the sensor that relates to the diagnostic code. This will replace the sensor with a short circuit.

C. Look for a -4 diagnostic code.

Expected Result:

The -3 code does not change to a -4 code when the jumper wire is connected.

Results:

- OK – The -3 code does not change to a -4 code when the jumper wire is connected. Connect the sensor. There is a problem with the wiring harness or with the ECM. Proceed to Test Step 6.
- Not OK – The -3 code changes to a -4 code when the jumper wire is connected. The wiring harness and the ECM are OK.

Repair: Perform the following procedure:

1. Remove the jumper wire.
2. Connect a new sensor to the engine harness. Do not install the sensor into the engine.
3. Verify that the active -3 diagnostic code does not recur.
4. Install the sensor into the engine.
5. Clear all logged diagnostic codes and return the engine to service.

STOP.

Test Step 6. Check the ECM for Proper Operation

- A. Determine the terminal location at the appropriate ECM connector for the signal wire of the suspect sensor. Also, determine the terminal location at the appropriate ECM connector for the return wire of the suspect sensor.
- B. Remove the signal terminal and the return terminal from the ECM connector.
- C. Install a jumper wire between the terminal locations for the signal and the return at the ECM connector. This will replace the engine wiring with a short circuit.
- D. Look for a -4 diagnostic code.

Expected Result:

A -4 code is active when the jumper wire is installed.

Results:

- OK – A -4 code is active when the jumper wire is installed. The ECM detected the jumper wire at the ECM connector. However, the ECM did not detect the jumper wire at the harness connector for the sensor. There is an open circuit in the wiring.

Repair: Repair the wiring, when possible. Replace parts, if necessary. Verify that the problem is resolved.

STOP.

- Not OK – A -4 code is not active when the jumper wire is installed.

Repair: The ECM does not detect the short circuit at the ECM connector. There is a problem with the ECM. Perform the following procedure:

1. Temporarily connect a test ECM.

Refer to Troubleshooting, "ECM - Replace".

2. Recheck the circuit in order to ensure that the original problem has been resolved.

If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the problem is resolved.

If the problem is not resolved with the test ECM, install the original ECM. There is a problem in the wiring.

STOP.

Test Step 7. Check the Signal Wire for a Short Circuit

- A. Disconnect the sensor that applies to the -4 diagnostic code.
- B. Look for a -3 diagnostic code.
- C. Connect the sensor and look for a -4 diagnostic code.

Expected Result:

When the sensor is disconnected, the -4 code remains.

Results:

- OK – When the sensor is disconnected, the -4 code remains. There is a problem with the wiring harness or with the ECM. Proceed to Test Step 8.
- Not OK – When the sensor is disconnected, the -4 code changes to a -3 code. The harness and the ECM are OK. There is a problem with the sensor.

Repair: Perform the following procedure:

1. Connect a new sensor to the engine harness. Do not install the sensor into the engine.

2. Verify that the active -4 diagnostic code does not recur.
3. Install the sensor into the engine.
4. Clear all logged diagnostic codes and return the engine to service.

STOP.

Test Step 8. Check the ECM for Proper Operation

- A. Determine the terminal location at the appropriate ECM connector for the signal wire of the suspect sensor.
- B. Remove the signal wire from the ECM connector.
- C. Check if the -4 diagnostic code becomes an active -3 active code.

Expected Result:

A -3 code is active when the signal wire is disconnected from the ECM connector.

Results:

- OK – A -3 code is active when the signal wire is disconnected from the connector at the ECM. The ECM detected the open circuit at the ECM connector. However, the ECM did not detect the open circuit at the harness connector for the sensor. There is a problem with the wiring between the ECM connector and the harness connector for the sensor. There may be a problem with a connector.

Repair: Repair the wiring or the connector, when possible. Replace parts, if necessary. Verify that the problem is resolved.

STOP.

- Not OK – A -3 code is not active when the signal wire is disconnected from the ECM connector. The ECM did not detect the open circuit at the ECM connector. There is a problem with the ECM.

Repair: The ECM does not detect the open circuit at the ECM connector. There is a problem with the ECM. Perform the following procedure:

1. Temporarily connect a test ECM.

Refer to Troubleshooting, “ECM - Replace”.

2. Recheck the circuit in order to ensure that the original problem has been resolved.

If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the problem is resolved.

If the problem is not resolved with the test ECM, install the original ECM. There is a problem in the wiring.

STOP.

i02655569

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 the sensors or if any one of the diagnostic codes in Table 42 is active or easily repeated.

Table 42

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
110-3 Engine Coolant Temperature Sensor voltage above normal	The engine's Electronic Control Module (ECM) detects signal voltage that is greater than 4.95 VDC for eight seconds. The ECM has been powered for at least two seconds.	The code is logged after seven minutes. The value of the parameter is set to 90 °C (194 °F). The engine will not enter cold mode while the code is active.
110-4 Engine Coolant Temperature Sensor voltage below normal	The ECM detects signal voltage that is less than 0.2 VDC for eight seconds. The ECM has been powered for at least two seconds.	The code is logged. The value of the parameter is set to 90 °C (194 °F). The engine will not enter cold mode while the code is active.
172-3 Intake Manifold Air Temperature Sensor voltage above normal	The ECM detects signal voltage that is greater than 4.95 VDC for eight seconds. The ECM has been powered for at least two seconds.	Ambient temperature must be greater than -35 °C (-31 °F) in order to allow logging of this diagnostic. The value of the parameter is set to 85 °C (185 °F).
172-4 Intake Manifold Air Temperature Sensor voltage below normal	The ECM detects signal voltage that is less than 0.2 VDC for eight seconds. The ECM has been powered for at least two seconds.	Ambient temperature must be less than 140 °C (284 °F) in order to allow logging of this diagnostic. The value of the parameter is set to 85 °C (185 °F).
174-3 Fuel Temperature Sensor voltage above normal	The ECM detects signal voltage that is greater than 4.95 VDC for eight seconds. The ECM has been powered for at least two seconds.	Engine coolant temperature must be above -10 °C (14 °F) in order to allow logging of this diagnostic. The value of the parameter is set to the value of the engine coolant temperature.
174-4 Fuel Temperature Sensor voltage below normal	The ECM detects signal voltage that is less than 0.2 VDC for eight seconds. The ECM has been powered for at least two seconds.	The code is logged. The value of the parameter is set to the value of the engine coolant temperature.
175-3 Engine Oil Temperature Sensor voltage above normal	The ECM detects signal voltage that is greater than 4.95 VDC for eight seconds. The ECM has been powered for at least two seconds.	Ambient temperature must be greater than -35 °C (-31 °F) in order to allow logging of this diagnostic. The value of the parameter is set to the value of the engine coolant temperature.
175-4 Engine Oil Temperature Sensor voltage below normal	The ECM detects signal voltage that is less than 0.2 VDC for eight seconds. The ECM has been powered for at least two seconds.	The code is logged. The value of the parameter is set to the value of the engine coolant temperature.
1796-3 Intake Manifold #2 Air Temperature Sensor voltage above normal	The ECM detects signal voltage that is greater than 4.95 VDC for eight seconds. The ECM has been powered for at least two seconds.	The code will not be logged if the actual temperature is below -30 °C (-22 °F). The code may be active or the logged code may be pending until this temperature is reached. The value of the parameter is set to the value of the other intake manifold temperature sensor. If both sensor signals are lost, a value of 85 °C (185 °F) will be used.

(continued)

(Table 42, contd)

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
1796-4 Intake Manifold #2 Air Temperature Sensor voltage below normal	The ECM detects signal voltage that is less than 0.2 VDC for eight seconds. The ECM has been powered for at least two seconds.	Ambient temperature must be less than 140 °C (284 °F) in order to allow logging of this diagnostic. The code may be active or the logged code may be pending until this temperature is reached. The value of the parameter is set to the value of the other intake manifold temperature sensor. If both sensor signals are lost, a value of 85 °C (185 °F) will be used.
2323-3 Fuel Rail Temperature Sensor voltage above normal	The ECM detects signal voltage that is greater than 4.95 VDC for eight seconds. The ECM has been powered for at least two seconds.	Ambient temperature must be greater than -35 °C (-31 °F) in order to allow logging of this diagnostic. The value of the parameter is set to the value of the engine coolant temperature.
2323-4 Fuel Rail Temperature Sensor voltage below normal	The ECM detects signal voltage that is less than 0.2 VDC for eight seconds. The ECM has been powered for at least two seconds.	Ambient temperature must be less than 140 °C (284 °F) in order to allow logging of this diagnostic. The value of the parameter is set to the value of the engine coolant temperature.

System Operation

Use this procedure to troubleshoot any suspect problems with the following sensors:

- Engine coolant temperature sensor
- Engine oil temperature sensor
- Filtered fuel temperature sensor
- Left intake manifold air temperature sensor
- Right intake manifold air temperature sensor (No 2)
- High pressure fuel temperature sensor

The sensor signal for the passive sensors is routed to terminal 1 of each sensor connector. The analog return for the passive sensors is routed from the ECM to terminal 2 of each sensor connector.

The following components can cause these codes:

- Electrical connector or wiring
- Sensor
- ECM

The most likely cause of a code is a problem with an electrical connector or wiring. The least likely cause of a code is the ECM.

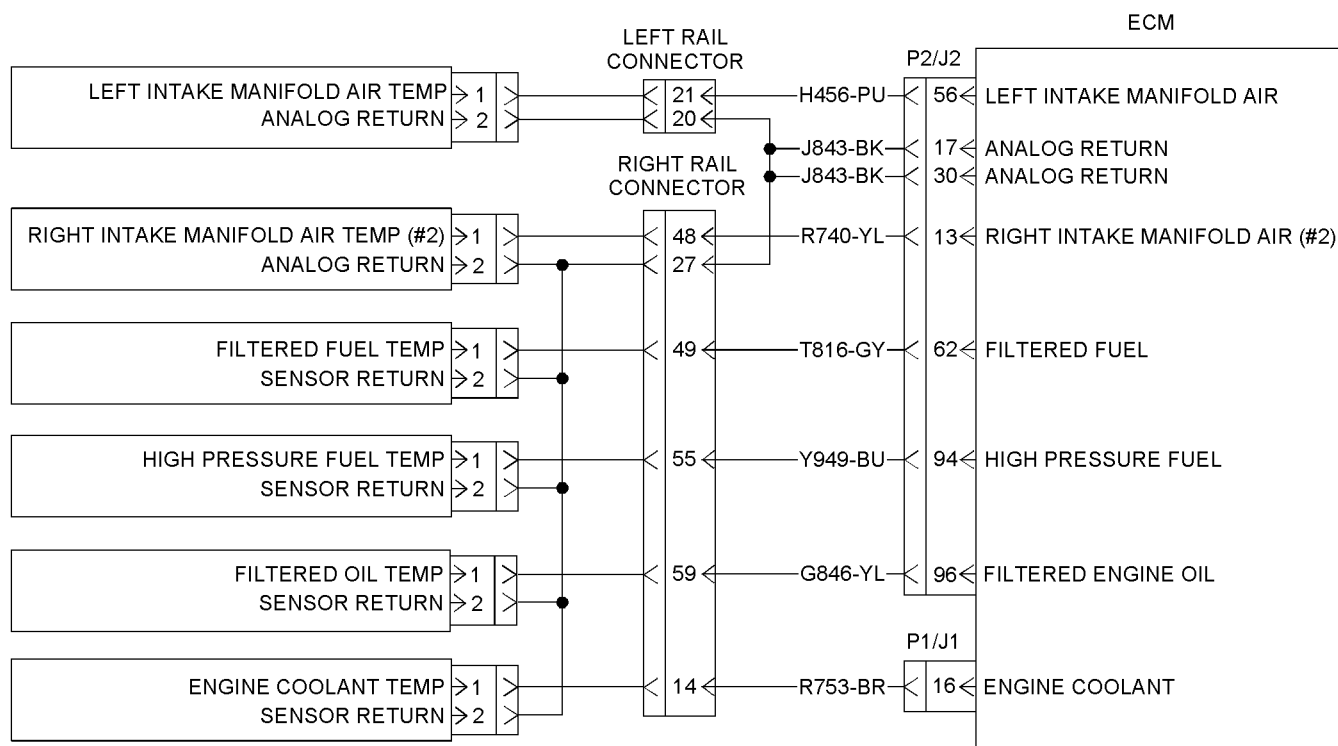


Illustration 138

g01430212

Schematic for the analog sensors

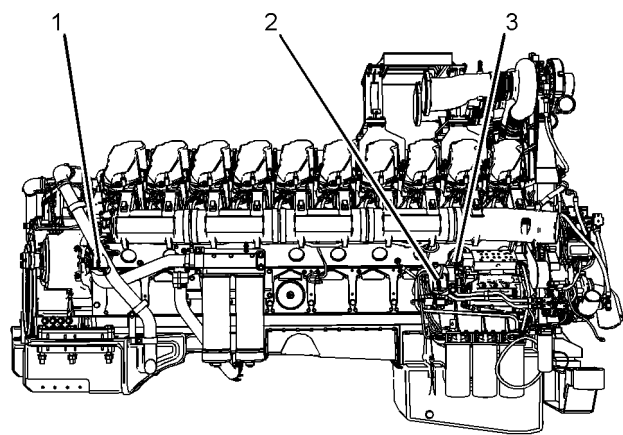


Illustration 139

g01323212

Locations of the analog sensors (right side engine view)

- (1) Filtered oil temperature sensor
- (2) Filtered fuel temperature sensor
- (3) High pressure fuel temperature sensor

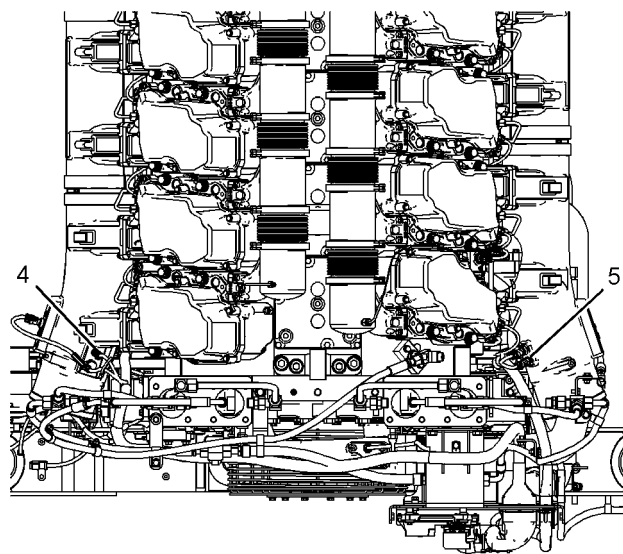


Illustration 140

g01430311

Locations of the analog sensors (top side engine view)

- (4) Right intake manifold air temperature sensor
- (5) Left intake manifold air temperature sensor (No 2)

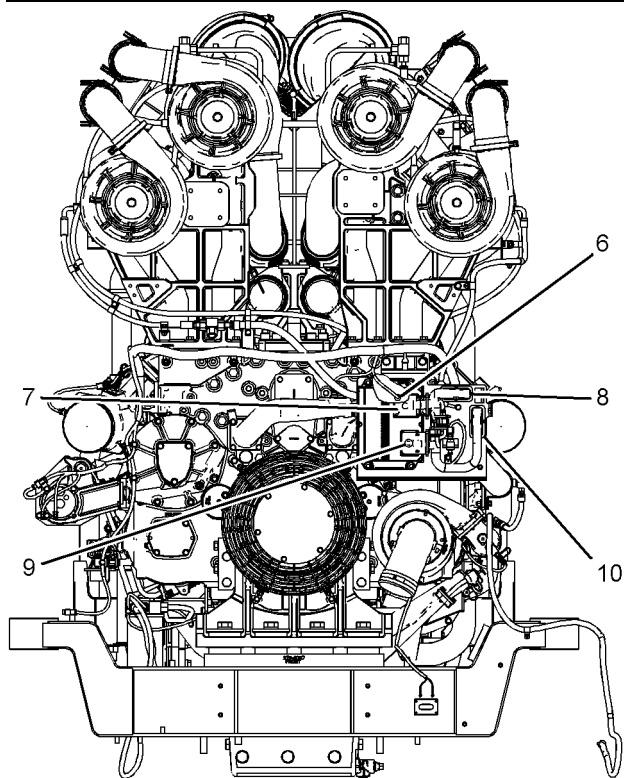


Illustration 141 g01430363

Locations of the components for the analog sensors for the 20 cylinder engines (front side engine view)

- (6) Engine block outlet coolant temperature sensor
- (7) J2/P2 ECM connectors
- (8) Right rail connector
- (9) J1/P1 ECM connectors
- (10) Left rail connector

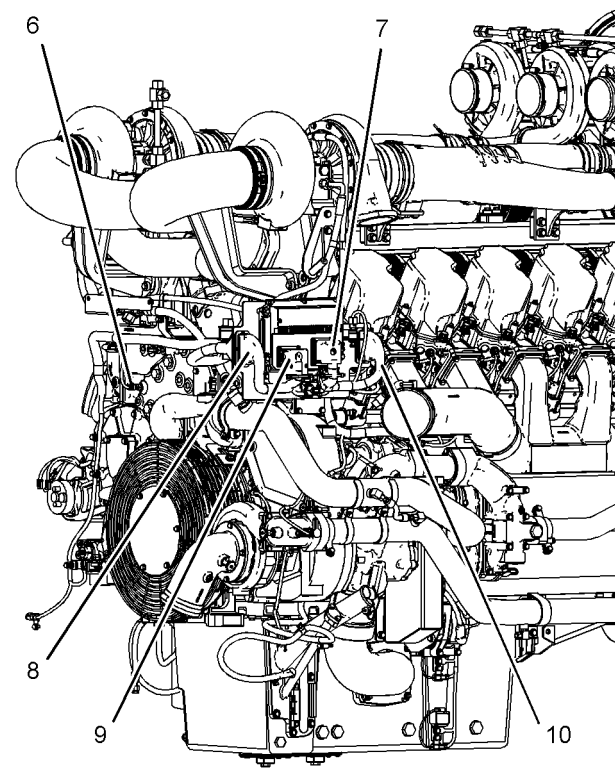


Illustration 142 g01430407

Locations of the components that are for the analog sensors for the 16 cylinder engines (front side engine view)

- (6) Engine block outlet coolant temperature sensor
- (7) J2/P2 ECM connectors
- (8) Right rail connector
- (9) J1/P1 ECM connectors
- (10) Left rail connector

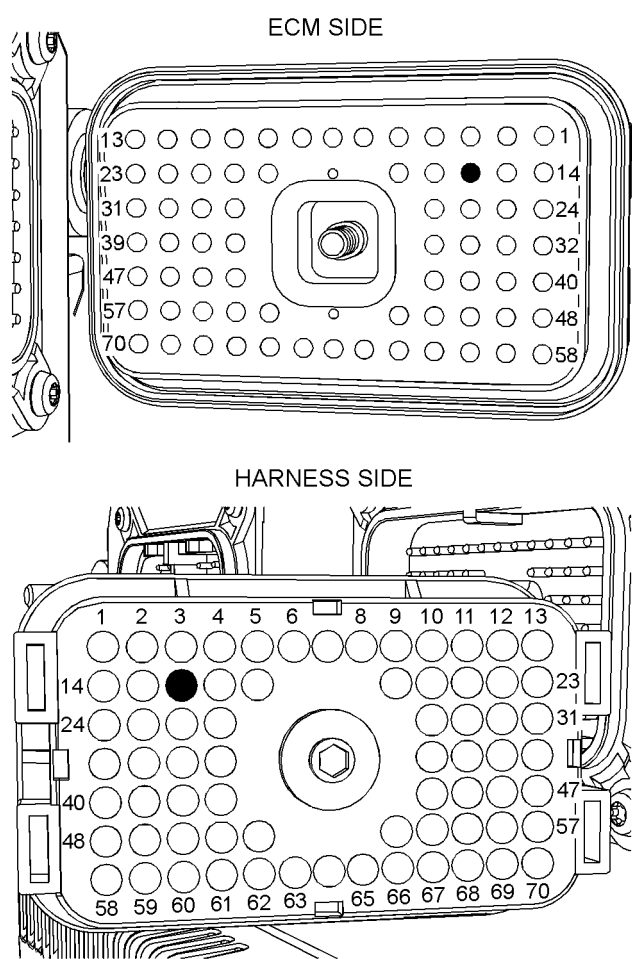


Illustration 143 g01282037

Terminal locations at the P1 ECM connector for the analog sensors
(P1-16) Engine coolant temperature

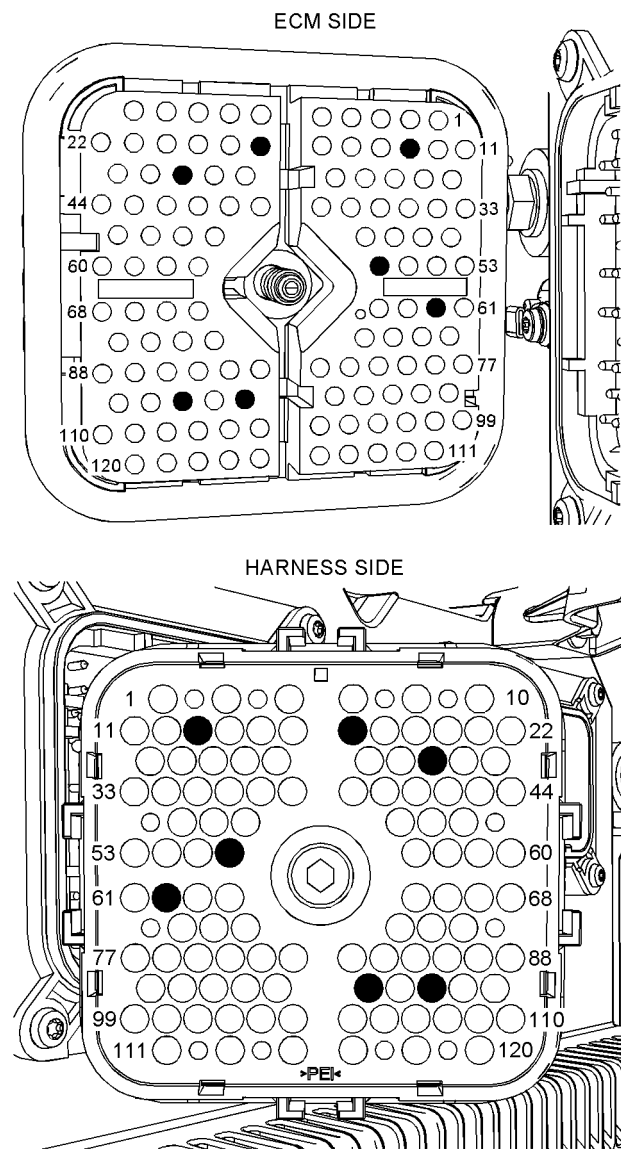


Illustration 144 g01323314

Terminal locations at the P2 ECM connector for the analog sensors

- (P2-13) Right intake manifold air temperature (No 2)
- (P2-17) Analog return
- (P2-30) Analog return
- (P2-56) Left intake manifold air temperature
- (P2-62) Filtered fuel temperature
- (P2-94) High pressure fuel rail temperature
- (P2-96) Filtered engine oil temperature

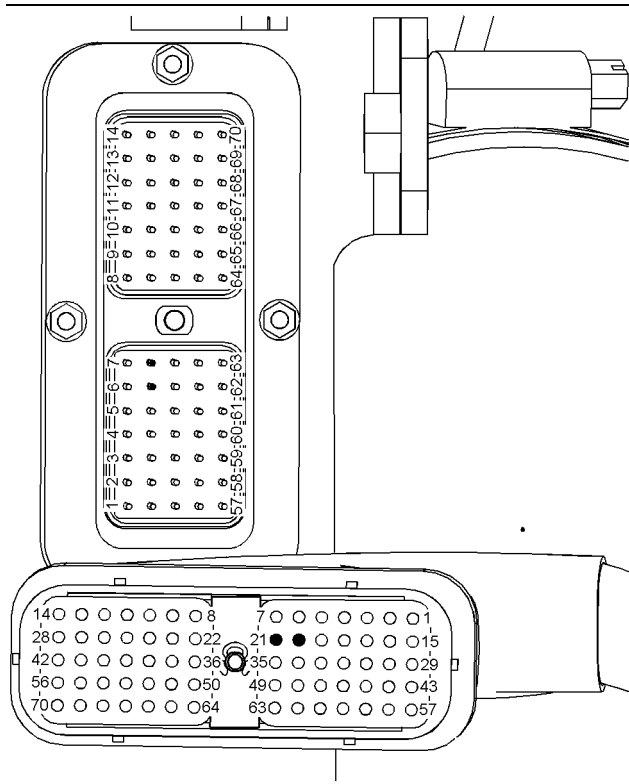


Illustration 145 g01430413

Terminal locations at the left rail connector that are for the analog sensors

- (Terminal 20) Analog return
- (Terminal 21) Left intake manifold air temperature

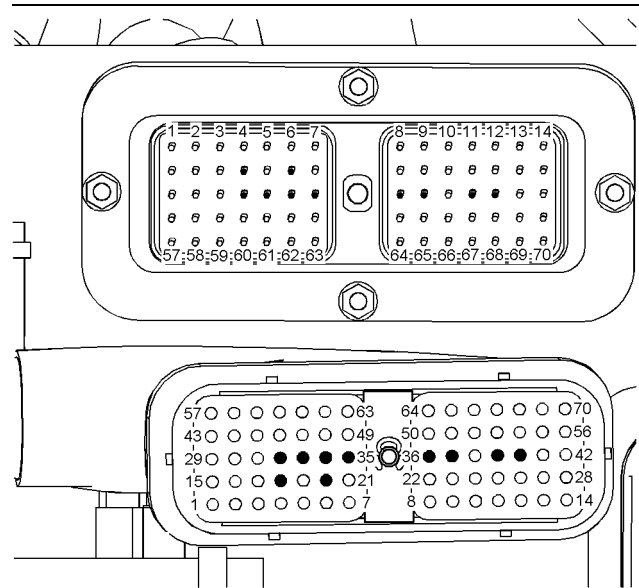


Illustration 146 g01430418

Terminal locations at the right rail connector that are for the analog sensors

- (Terminal 14) Engine coolant temperature
- (Terminal 27) Analog return
- (Terminal 48) Right intake manifold air temperature (No 2)
- (Terminal 49) Filtered fuel temperature
- (Terminal 55) High pressure fuel temperature
- (Terminal 59) Filtered engine oil temperature

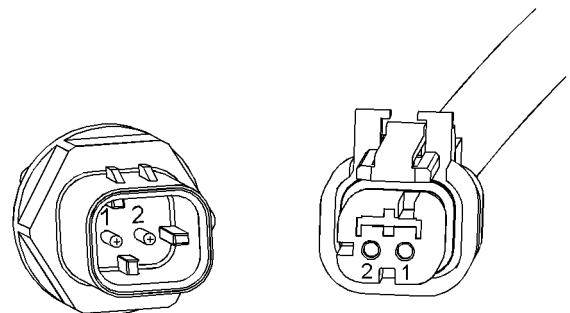


Illustration 147 g01241538

Terminal locations at the sensor connector for the analog sensors

- (Terminal 1) Sensor signal
- (Terminal 2) Analog return

Test Step 1. Check for “Active” or “Logged” Diagnostic Codes

- A. Connect Caterpillar Electronic Technician (ET) to the service tool connector.
- B. Restore power to the ECM.
- 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 the problem is active and related to one of the following diagnostic codes:

- -3 Voltage above normal
- -4 Voltage below normal

Expected Result:

No diagnostic codes are active at this time.

Results:

- OK – No diagnostic codes are active at this time.

Repair: The problem may be intermittent. If an intermittent problem is suspected, 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 a Short Circuit to the +Battery at the Sensor Connector

A. Measure the voltage on the harness side of the sensor connector between pin 1 and pin 2 for the suspect sensor(s).

Expected Result:

The voltage is less than battery voltage.

Results:

- OK – The voltage is less than battery voltage. Proceed to Test Step 3.
- Not OK – The voltage is equal to battery voltage.

Repair: There is a short in the harness to the +Battery. Repair the wiring.

STOP.

Test Step 3. Create a Short Circuit at the Sensor Connector

A. Disconnect the suspect sensor.

B. Fabricate a jumper wire that is long enough to create a short circuit at the sensor connector. Crimp connector pins to each end of the jumper wire.

C. Disconnect the connector from the suspect sensor.

D. Use the wire jumper in order to create a short between terminal 1 (sensor signal) and terminal 2 (analog return) on the harness side of the sensor connector.

E. Restore power to the ECM.

F. Access the “Active Diagnostic Code” screen 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.

G. Remove power from the ECM.

Expected Result:

A -4 diagnostic code is now active for the suspect sensor(s).

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.

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(s). Proceed to Test Step 5.

Test Step 4. Create an Open Circuit at the Connector for the Suspect Sensor

A. Remove power from the ECM.

B. Disconnect the sensor connector of the suspect sensor(s) with the active -4 diagnostic code.

C. Restore power to the ECM.

D. Access the “Active Diagnostic Code” screen on Cat ET. Check for an active -3 diagnostic code.

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

E. Remove power from the ECM.

Expected Result:

A -3 diagnostic code is now active for the suspect sensor(s).

Results:

- OK – A -4 diagnostic code was active before disconnecting the sensor. A -3 diagnostic code became active after disconnecting the sensor.

Repair: Temporarily connect a new sensor to the harness, but do not install the new sensor in the engine. Verify that there are no active diagnostic codes for the sensor. If there are no active diagnostic codes for the sensor, permanently install the new sensor. Clear any logged diagnostic codes.

STOP.

- Not OK – A -4 diagnostic code is still active for the suspect sensor. There is a short circuit between the sensor connector and the ECM. Leave the sensor disconnected. Proceed to Test Step 5.

Test Step 5. Check the Operation of the ECM

A. Remove power from the ECM.

B. Fabricate a jumper wire that is long enough to create a test circuit between the ECM connectors and the ECM ground strap. Crimp a connector socket to one end of the jumper wire.

C. Disconnect the appropriate ECM connector that is for the suspect sensor. Refer to Illustration 138 for the correct terminal locations.

D. Remove the signal wire for the suspect sensor from the terminal location at the ECM connector. Install the jumper wire into this terminal location.

E. Reconnect the ECM connectors.

F. Check the operation of the ECM by creating an open circuit at the ECM:

a. Ensure that the loose end of the jumper wire is not in contact with any ground source. Restore power to the ECM.

b. Monitor the “Active Diagnostic Code” screen on Cat ET.

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

An open circuit diagnostic code -3 will be active for the suspect sensor.

G. Check the operation of the ECM by creating a short circuit at the ECM:

a. Connect the loose end of the jumper wire to the ECM ground strap.

b. Monitor the “Active Diagnostic Code” screen on Cat ET.

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

A -4 diagnostic code will be active when the wire jumper is connected to the engine ground stud.

c. Remove power from the ECM. Restore 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 connected to engine ground.

Results:

- OK – The ECM is operating properly. The problem is in the wiring between the ECM and the sensor connector.

Repair: If the code is active for more than one sensor, the problem is most likely in the return wire for the sensor. Repair the return wire for the sensor or replace the harness.

If the code is only active for one sensor, the problem is most likely in the signal wire for the sensor. Repair the signal wire for the sensor.

STOP.

- Not OK – One of the following conditions exists: The -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 installed.

Repair: There is a problem with the ECM. Perform the following procedure:

1. Temporarily connect a test ECM.

Refer to Troubleshooting, “ECM - Replace”.

2. Recheck the circuit in order to ensure that the original problem has been resolved.

If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the problem is resolved.

If the problem is not resolved with the test ECM, install the original ECM. There is a problem in the wiring.

STOP.

i02872898

Sensor Signal (PWM) - Test

SMCS Code: 1439-038

System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with the sensor that is for the turbocharger turbine inlet temperature, the ambient air temperature sensor, or the throttle position 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		
Description	Conditions which Generate this Code	System Response
91-8 Throttle Position Sensor abnormal frequency, pulse width, or period	The Electronic Control Module (ECM) detects a duty cycle that is less than 7 percent, or the ECM detects a duty cycle that is greater than 95 percent.	The code is logged.
171-3 Ambient Air Temperature Sensor voltage above normal	The ECM detects a duty cycle that is greater than 96 percent for ten seconds.	The code is logged.
171-4 Ambient Air Temperature Sensor voltage below normal	The ECM detects a duty cycle that is less than 4 percent for ten seconds.	The code is logged.
171-8 Ambient Air Temperature Sensor abnormal frequency, pulse width, or period	The ECM detects a sensor frequency that is greater than 600 Hz or less than 400 Hz.	The code is logged.
1491-3 Right Turbo Turbine Inlet Temperature Sensor voltage above normal	The ECM detects a duty cycle that is greater than 96 percent for ten seconds.	The code is logged. If the signal from the other exhaust temperature sensor is OK, the signal from that sensor is used. If the signal from the other exhaust temperature sensor is not OK, a default value of 0 °C (32 °F) is used.
1491-4 Right Turbo Turbine Inlet Temperature Sensor voltage below normal	The ECM detects a duty cycle that is less than 4 percent for ten seconds.	
1491-8 Right Turbo Turbine Inlet Temperature Sensor abnormal frequency, pulse width, or period	The ECM detects a sensor frequency that is greater than 600 Hz or less than 400 Hz.	
1492-3 Left Turbo Turbine Inlet Temperature Sensor voltage above normal	The ECM detects a duty cycle that is greater than 96 percent for ten seconds.	The code is logged. If the signal from the other exhaust temperature sensor is OK, the signal from that sensor is used. If the signal from the other exhaust temperature sensor is not OK, a default value of 0 °C (32 °F) is used.
1492-4 Left Turbo Turbine Inlet Temperature Sensor voltage below normal	The ECM detects a duty cycle that is less than 4 percent for ten seconds.	
1492-8 Left Turbo Turbine Inlet Temperature Sensor abnormal frequency, pulse width, or period	The ECM detects a sensor frequency that is greater than 600 Hz or less than 400 Hz.	

System Operation

Use this procedure to troubleshoot any suspect problems with the following sensors:

- Throttle position sensor
- Sensor for the right turbocharger turbine inlet temperature
- Sensor for the left turbocharger turbine inlet temperature

The Pulse Width Modulated Sensor (PWM) provides a signal to the engine's ECM. The PWM signal can represent certain engine operating conditions or the signal can be used to detect the position of the engine's throttle control. The sensors receive 8.0 ± 0.4 VDC from a regulated power supply.

The ECM performs an automatic calibration of these sensors whenever the ECM is powered and the engine has been off for at least five seconds.

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 following components can cause problems with the power supply:

- Electrical connector or wiring
- Sensor
- ECM

The most likely cause of a problem is a problem with an electrical connector or wiring. The least likely cause is a problem with the ECM.

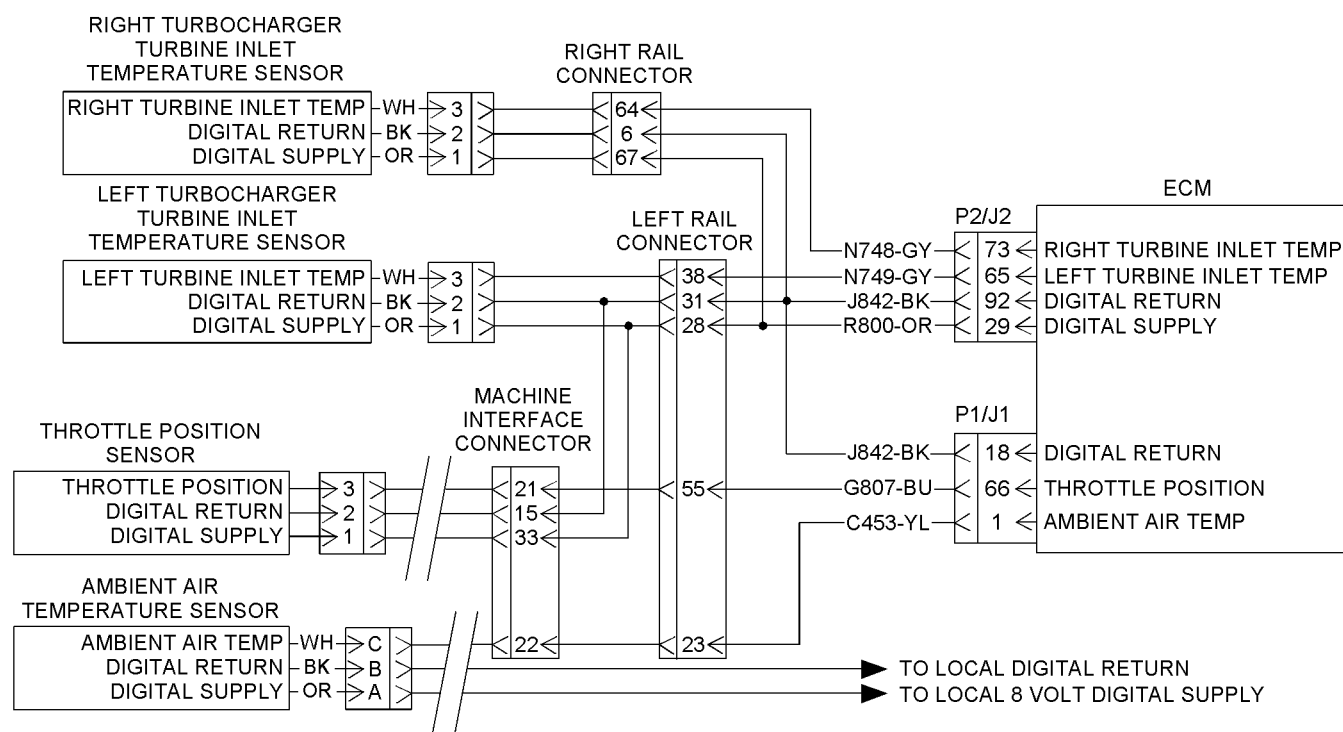


Illustration 148

g01430508

Schematic of the PWM sensors for the sensor signal circuit

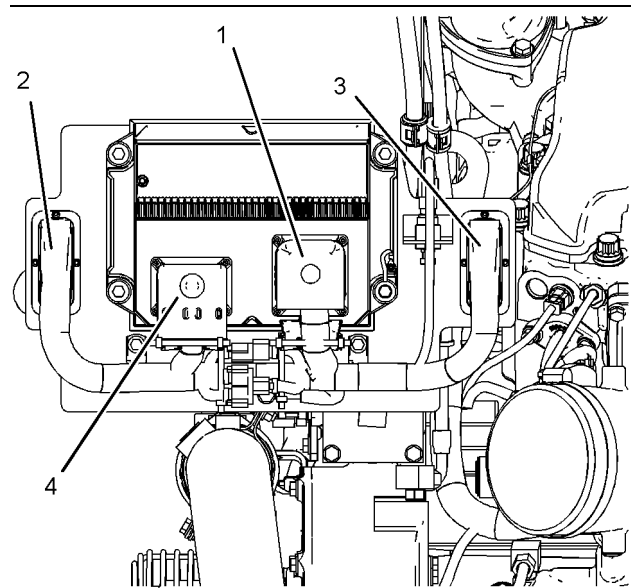


Illustration 149

g01430666

Location of the connectors that are for the sensor signal circuit for the 16 cylinder engines (left side engine view)

- (1) J2/P2 ECM connector
- (2) Right rail connector
- (3) Left rail connector
- (4) J1/P1 ECM connector

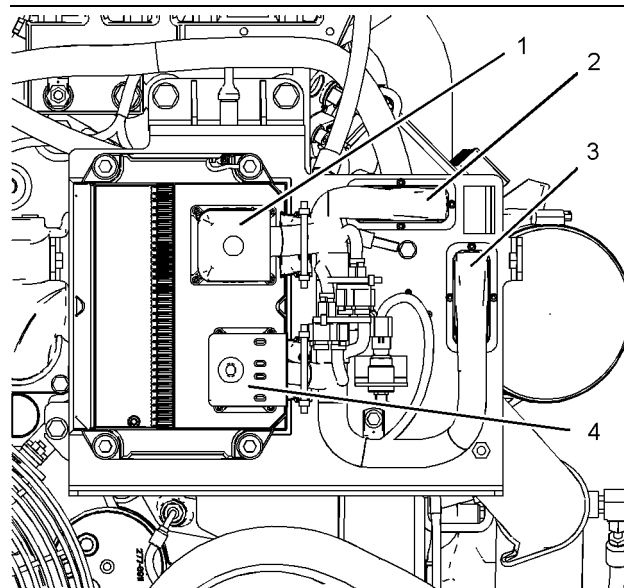


Illustration 150

g01430667

Location of the connectors that are for the sensor signal circuit for the 20 cylinder engines (left side engine view)

- (1) J2/P2 ECM connector
- (2) Right rail connector
- (3) Left rail connector
- (4) J1/P1 ECM connector

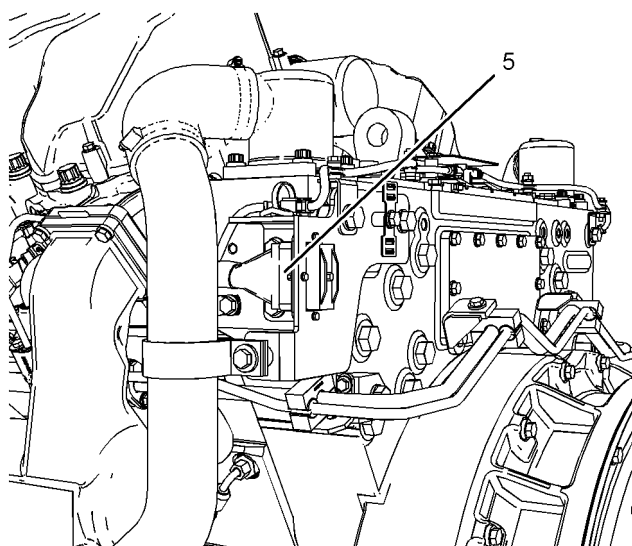


Illustration 151 g01430713
Location of the connectors that are for the sensor signal circuit (left rear engine view)
(5) Machine interface connector

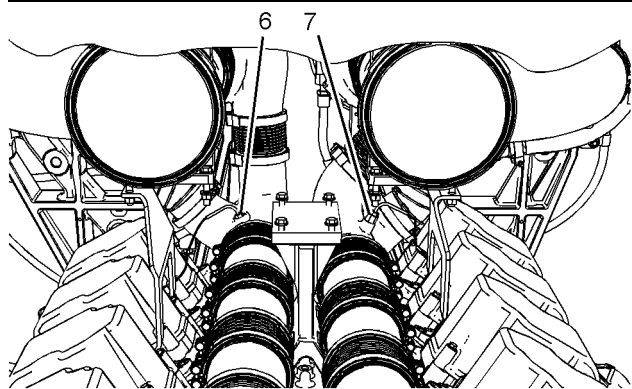


Illustration 152 g01312207
Location of the temperature sensors for the inlet of the turbocharger turbines (top front engine view)
(6) Exhaust sensor for the left turbocharger turbine inlet temperature
(7) Exhaust sensor for the right turbocharger turbine inlet temperature

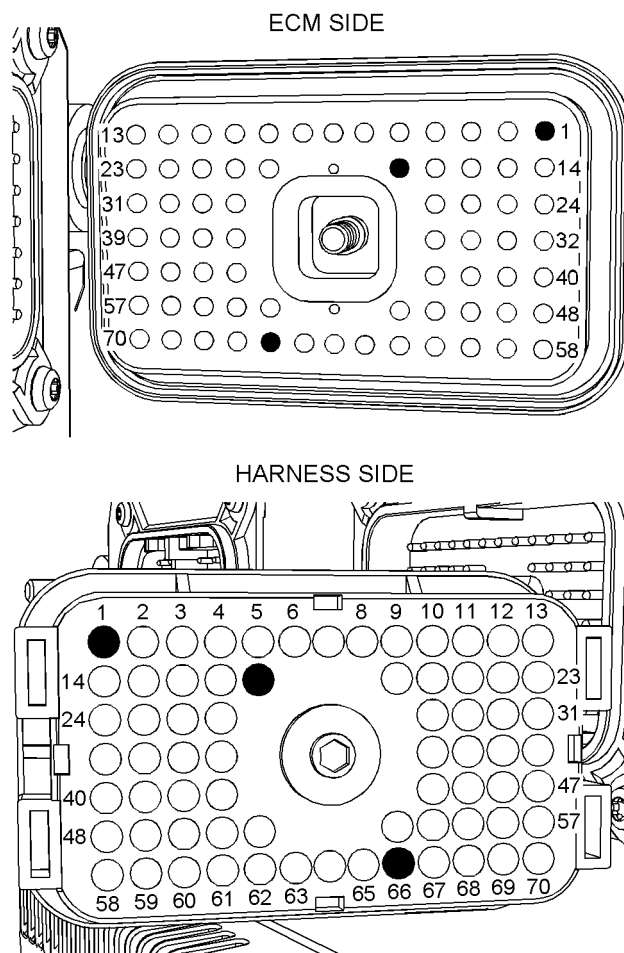


Illustration 153 g01430716
Terminal locations at the P1 ECM connector that are for the sensors for the turbocharger turbine inlet temperature
(P1-1) Ambient air temperature
(P1-18) Digital return
(P1-66) Throttle position

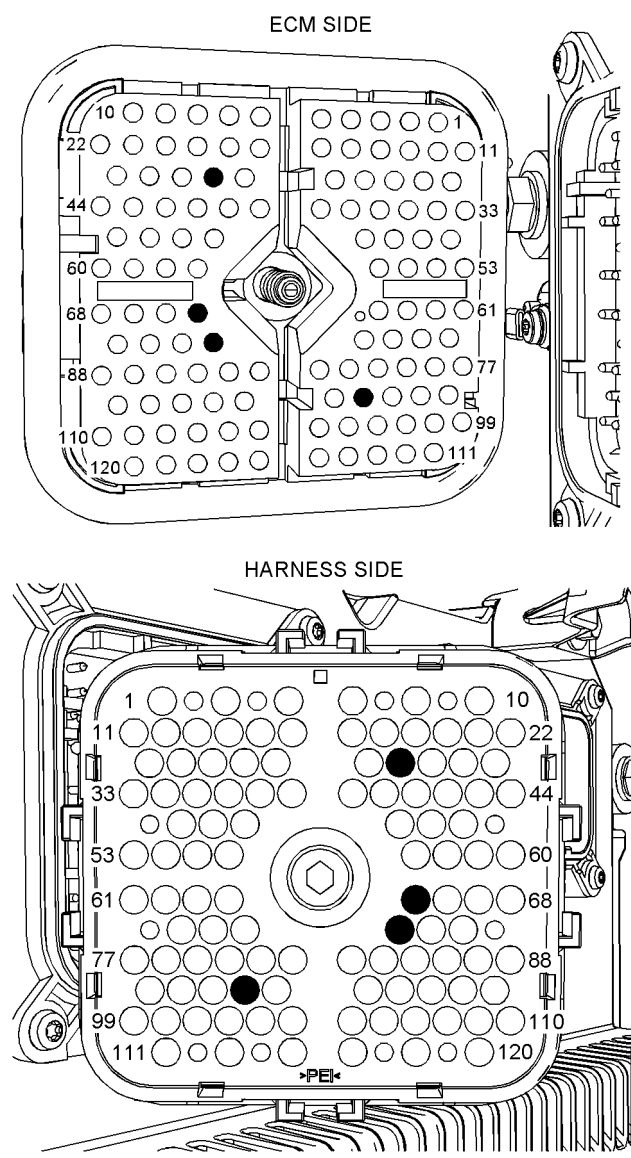


Illustration 154

g01279871

Terminal locations at the P2 ECM connector that are for the sensors for the turbocharger turbine inlet temperature

- (P2-29) Digital supply
- (P2-65) Left turbocharger turbine inlet temperature
- (P2-73) Right turbocharger turbine inlet temperature
- (P2-92) Digital return

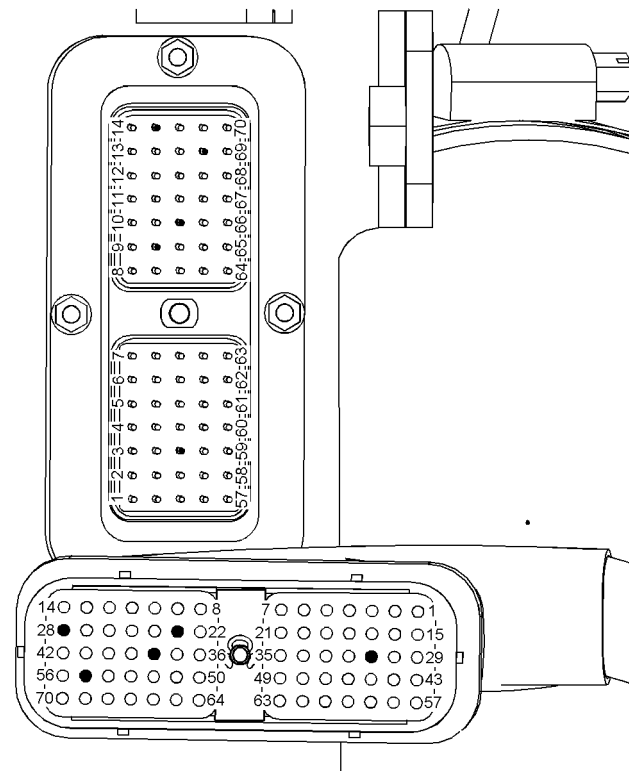


Illustration 155

g01430736

Terminal locations at the left rail connector that are for the sensor for the left turbocharger turbine inlet temperature

- (Terminal 23) Ambient air temperature
- (Terminal 28) Digital supply
- (Terminal 31) Digital return
- (Terminal 38) Left turbocharger turbine inlet temperature

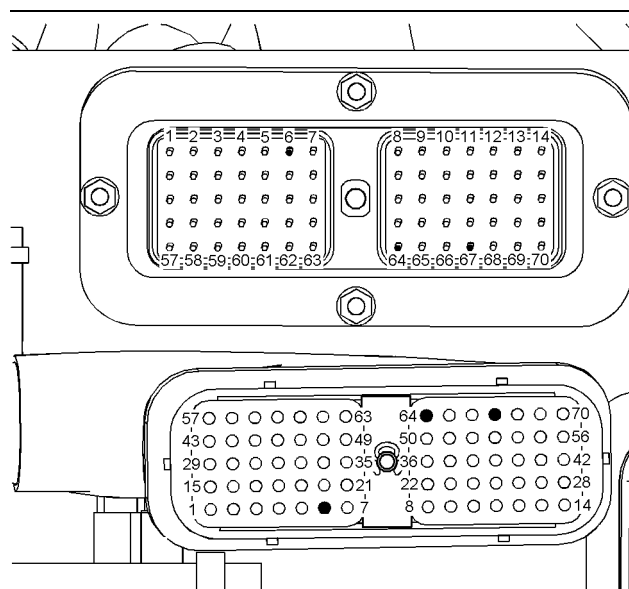


Illustration 156

g01430740

Terminal locations at the right rail connector that are for the sensor for the right turbocharger turbine inlet temperature

- (Terminal 6) Digital return
- (Terminal 64) Right turbocharger turbine inlet temperature
- (Terminal 67) Digital supply

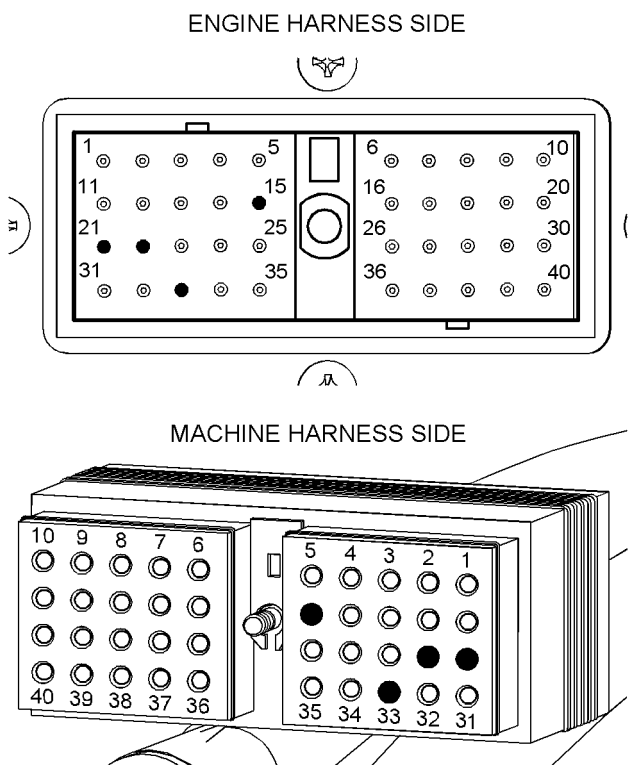


Illustration 157

g01430767

Terminal locations at the machine interface connector that are for the PWM sensors

(Terminal 15) Digital return
(Terminal 21) Throttle position
(Terminal 22) Ambient air temperature
(Terminal 33) Digital supply

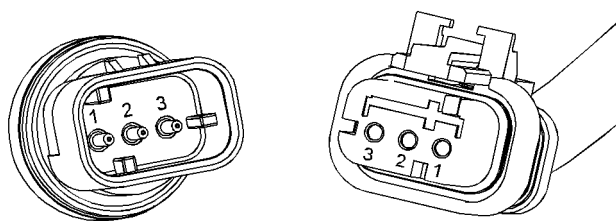


Illustration 158

g01240891

Sensor connector

(Terminal 1) Sensor supply
(Terminal 2) Sensor return
(Terminal 3) Signal

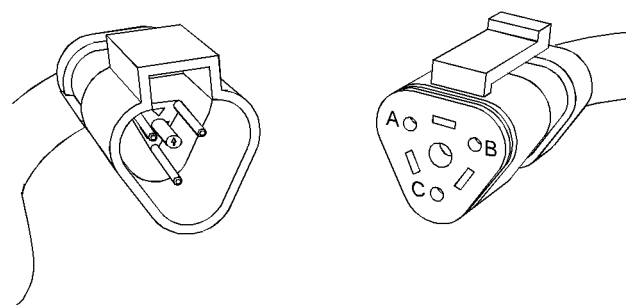


Illustration 159

g01159881

Connector for the ambient air temperature sensor

(Terminal 1) Sensor supply
(Terminal 2) Sensor return
(Terminal 3) Signal

Test Step 1. Check for an Active Diagnostic Code

A. Connect Caterpillar Electronic Technician (ET) to the service tool connector.

B. 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.

C. Determine if a diagnostic code has been logged 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 crimp connection.

D. Look for one or more of the following diagnostic codes that are active or logged:

- 91-8
- 171-3
- 171-4
- 171-8
- 1491-3
- 1491-4
- 1491-8
- 1492-3

- 1492-4
- 1492-8

Expected Result:

There are no active diagnostic codes for the PWM sensors.

Results:

- OK – No diagnostic codes are active.

Repair: If one of the codes that are listed above are logged, there may be an intermittent problem in the harness or in a connector. If an intermittent electrical problem is suspected, refer to Troubleshooting, “Electrical Connectors - Inspect” for the correct procedures for inspecting electrical connectors.

STOP.

- Not OK – One of the diagnostic codes that are listed above are active. The ECM detects a problem in one of the circuits for the PWM sensors. Proceed to Test Step 2.

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

- Remove the electrical power from the ECM.
- Disconnect the suspect sensor at the sensor connector:
- Restore the electrical power to the ECM.
- Measure the supply voltage on the harness side of the sensor connector. Measure the voltage between the terminal that is for the supply voltage and the terminal that is for the return.

Expected Result:

The supply voltage is 8.0 ± 0.4 VDC.

Results:

- OK – The supply voltage is 8.0 ± 0.4 VDC. The supply voltage is reaching the sensor connector. Proceed to Test Step 4.
- Not OK – The supply voltage is not 8.0 ± 0.4 VDC. The supply voltage is not reaching the sensor connector. Proceed to Test Step 3.

Test Step 3. Check the Digital Supply Voltage at the Supply

- Remove the electrical power from the ECM.
- Disconnect the J2/P2 ECM connectors.

C. Fabricate two jumper wires that are long enough to use as test leads at the ECM connector. Crimp connector sockets to one end of each of the jumper wires.

D. Remove the wires for the digital supply from terminal locations P2-29 and P2-92. Install a jumper wire into each of these terminal locations.

E. Connect the J2/P2 ECM connectors.

F. Restore the electrical power to the ECM.

G. Measure the voltage between the jumper wires that are in terminals P2-29 and P2-92.

H. Remove the electrical power from the ECM.

I. Restore the wiring to the original configuration.

Expected Result:

The supply voltage at the ECM measures 8.0 ± 0.4 VDC.

Results:

- OK – The supply voltage at the ECM is 8.0 ± 0.4 VDC.

Repair: The supply voltage at the ECM is correct. There is a problem in the wiring between the ECM and the sensor connector. Repair the connectors or wiring and/or replace the connectors or wiring.

STOP.

- Not OK – The supply voltage is not 8.0 ± 0.4 VDC.

Repair: The supply voltage at the ECM is not correct. The ECM does not appear to be operating properly. Perform the following procedure:

1. Temporarily connect a test ECM.

Refer to Troubleshooting, “ECM - Replace”.

2. Recheck the circuit in order to ensure that the original problem has been resolved.

If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the problem is resolved.

If the problem is not resolved with the test ECM, install the original ECM. There is a problem in the wiring.

STOP.

Test Step 4. Check the Suspect Sensor's Signal Frequency and the Duty Cycle at the Sensor Connector

- A. Remove the electrical power from the ECM.
- B. Remove the suspect sensor's signal wire from the appropriate terminal on the sensor side of the sensor connector.
- C. Reconnect the suspect sensor connector.
- D. Install a 7X-1709 Multimeter Probe (BLACK) onto the test lead (black) of a multimeter.

Note: Ensure that the multimeter probe is in good repair. A bent probe may contact other terminals inside the connector.

- E. Connect the red multimeter probe to the loose end of the signal wire that is from the sensor. Carefully insert the spoon into the digital return of the sensor connector.
- F. Restore the electrical power to the ECM.
- G. Measure the duty cycle and the frequency of the signal at the sensor connector.
- H. Remove electrical power from the ECM.
- I. Restore the wiring to the original configuration.

Expected Result:

For the throttle position sensor, the duty cycle is between 7 to 95 percent. For the temperature sensors, the duty cycle is between 4 to 96 percent.

The frequency off the signal is between 400 and 600 Hz.

Results:

- OK – For the throttle position sensor, the duty cycle is between 7 to 95 percent. For the temperature sensors, the duty cycle is between 4 to 96 percent. The frequency is between 400 and 600 Hz. The sensor is generating the correct signal. Proceed to Test Step 5.
- Not OK – The duty cycle and/or the signal frequency is incorrect.

Repair: The output from the sensor is not within specifications. Replace the sensor. Connect the new sensor to the sensor connector and use Cat ET to verify that no diagnostic codes are active for the new sensor before permanently installing the sensor.

STOP.

Test Step 5. Check the Suspect Sensor's Duty Cycle at the ECM

- A. Remove the electrical power from the ECM.
- B. Use a wire removal tool to remove the signal wire for the suspect sensor from the terminal location at the appropriate ECM connector. Refer to Illustration 148 for the terminal locations of the signal wires.
- C. Install a 7X-1709 Multimeter Probe (BLACK) onto the test lead (black) of a multimeter.

Note: Ensure that the multimeter probe (spoon) is in good repair. A bent probe may contact other terminals inside the connector.

- D. Connect the red multimeter probe to the loose end of the signal wire. Carefully insert the spoon onto terminal location 92 (digital return) of the J2/P2 ECM connector.
- E. Restore the electrical power to the ECM.
- F. Use the multimeter to measure the duty cycle and the signal frequency of the sensor.
- G. Remove electrical power from the ECM.

Restore all wiring to the original configuration.

Expected Result:

For the throttle position sensor, the duty cycle is between 7 to 95 percent. For the temperature sensors, the duty cycle is between 4 to 96 percent.

The frequency off the signal is between 400 and 600 Hz.

Results:

- OK – For the throttle position sensor, the duty cycle is between 7 to 95 percent. For the temperature sensors, the duty cycle is between 4 to 96 percent.

Repair: The duty cycle and the signal frequency is correct at the ECM. The sensor is producing the correct signal and the harness is OK. There is a problem with the ECM. Perform the following procedure:

1. Temporarily connect a test ECM.

Refer to Troubleshooting, "ECM - Replace".

2. Recheck the circuit in order to ensure that the original problem has been resolved.

If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the problem is resolved.

If the problem is not resolved with the test ECM, install the original ECM. There is a problem in the wiring.

STOP.

- Not OK – The duty cycle and/or the signal frequency is not correct.

Repair: The sensor signal is OK at the sensor connector, but the sensor signal is not reaching the ECM. There is a problem in the wiring between the sensor connector and the ECM. Repair the connectors and/or wiring between the sensor connector and the ECM.

Verify that the repair eliminates the original problem.

STOP.

i02872841

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 or if any one of the diagnostic codes in Table 44 is active or easily repeated.

Table 44

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
41-3 8 Volt DC Supply voltage above normal	The digital sensor supply voltage is above normal for two seconds.	The code is logged. All sensors are set to default values.
41-4 8 Volt DC Supply voltage below normal	The digital sensor supply voltage is below normal for two seconds.	The code is logged. All sensors are set to default values.
100-10 Engine Oil Pressure Sensor abnormal rate of change	The Electronic Control Module (ECM) detects a value for the oil pressure that is between 530 kPa (77 psi) and 662 kPa (96 psi). The pressure changes less than 2.2 kPa (0.3 psi) in 30 seconds.	The code is logged. The value of the parameter will be set to 600 kPa (87 psi).
542-10 Engine Oil Pressure Sensor - Before Oil Filter abnormal rate of change	The ECM detects a value for the unfiltered oil pressure that is between 530 kPa (77 psi) and 662 kPa (96 psi). The pressure changes less than 2.2 kPa (0.3 psi) in 30 seconds.	The code is logged. The value of the parameter will be set to 600 kPa (87 psi).
1785-10 Intake Manifold Pressure Sensor abnormal rate of change	The ECM detects a value for the intake manifold pressure that is between 410 kPa (59 psi) and 520 kPa (75 psi). The pressure changes less than 1.68 kPa (0.2 psi) in 30 seconds. The engine speed must be greater than 1000 rpm in order for this code to be set.	The code is logged. The value of the parameter will be set to 320 kPa (46 psi).
2131-3 5 Volt Sensor DC Power Supply #2 voltage above normal	The analog sensor supply voltage is above normal for one second.	The code is logged.
2131-4 5 Volt Sensor DC Power Supply #2 voltage below normal	The analog sensor supply voltage is below normal for one second.	The code is logged. If the circuit for the power supply is shorted to ground, the power supply will be turned off. The ECM will periodically attempt to power the circuit until the circuit is repaired.
3031-10 Intake Manifold #2 Pressure Sensor abnormal rate of change	The ECM detects a value for the intake manifold pressure that is between 410 kPa (59 psi) and 520 kPa (75 psi). The pressure changes less than 1.68 kPa (0.2 psi) in 30 seconds. The engine speed must be greater than 1000 rpm in order for this code to be set.	The code is logged. The value of the parameter will be set to 320 kPa (46 psi).

System Operation

The ECM supplies a regulated voltage of 5.0 ± 0.2 VDC to the following sensors:

- Atmospheric pressure sensor
- Crankcase pressure sensor
- Engine coolant pump outlet pressure sensor
- Filtered oil pressure sensor
- Filtered fuel pressure sensor
- Fuel transfer pump inlet pressure sensor
- Fuel rail pressure sensor
- Left intake manifold pressure sensor
- Right intake manifold pressure sensor
- Turbocharger 1 compressor inlet pressure sensor
- Turbocharger 2 compressor inlet pressure sensor
- Turbocharger 3 compressor inlet pressure sensor
- Turbocharger 4 compressor inlet pressure sensor
- Unfiltered fuel pressure sensor
- Unfiltered oil pressure sensor

The ECM supplies a regulated voltage of 8.0 ± 0.4 VDC to the following sensors:

- Right turbocharger turbine inlet temperature sensor
- Left turbocharger turbine inlet temperature 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.

-10 Codes – This code indicates that the 5 volt supply is missing from the harness connector for the suspect pressure sensor. The engine must be running in order for this code to become active. During normal engine operation, the actual system pressures will fluctuate slightly. When the 5 volt supply is missing from the suspect pressure sensor, the signal from the pressure sensor goes to a midrange value. This signal will not fluctuate. If the signal from the pressure sensor remains abnormally steady for more than 30 seconds, the ECM activates this code. A snapshot is triggered. The ECM sets the value of the suspect sensor to the sensor's default value. Refer to Table 44 for the default values that are for the particular sensor.

Note: The sensors are not protected from overvoltage. A short from the supply line to the +Battery may damage the sensors. If the diagnostic code 41-3 or the diagnostic code 2131-3 is logged, it is possible that all of the sensors on the circuit have been damaged. Repair the circuit for the sensor supply. As a precaution, replace the sensors that may have been damaged.

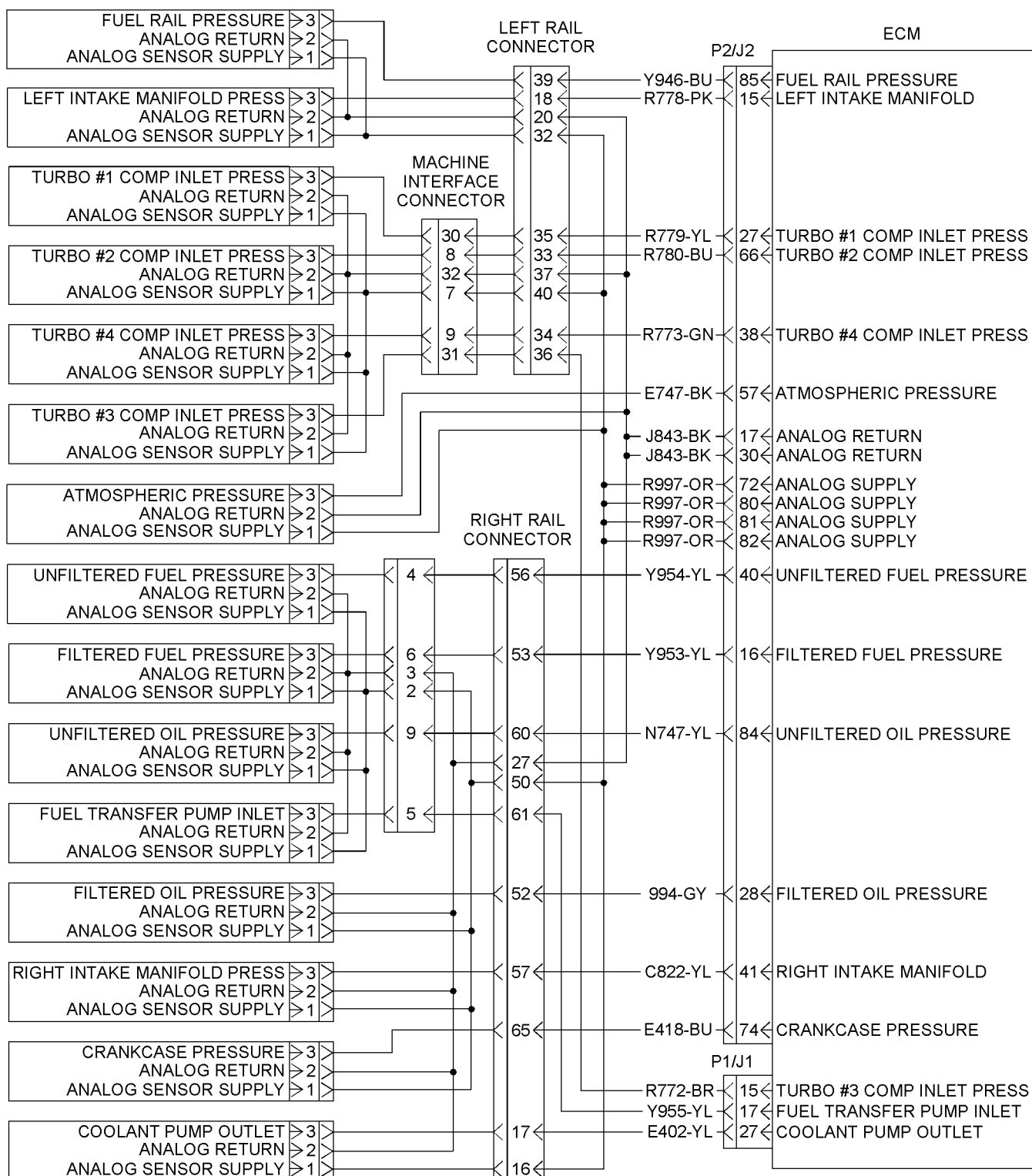


Illustration 160
Schematic for the analog sensors

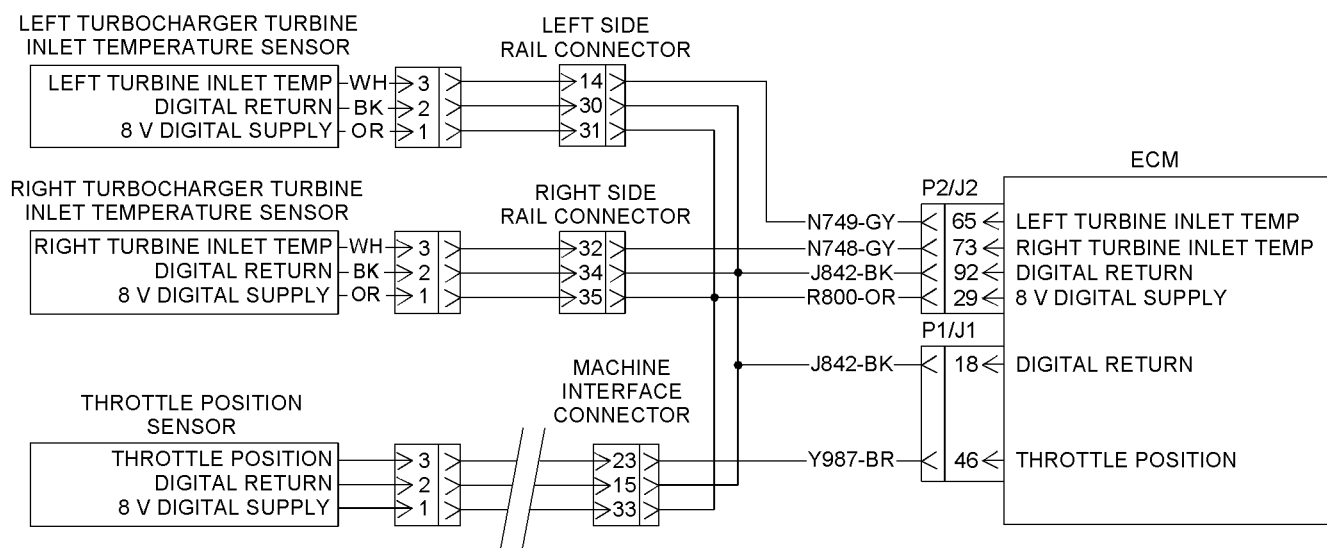


Illustration 161

g01312198

Schematic of the PWM sensors for the sensor signal circuit

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove the electrical power from the ECM.

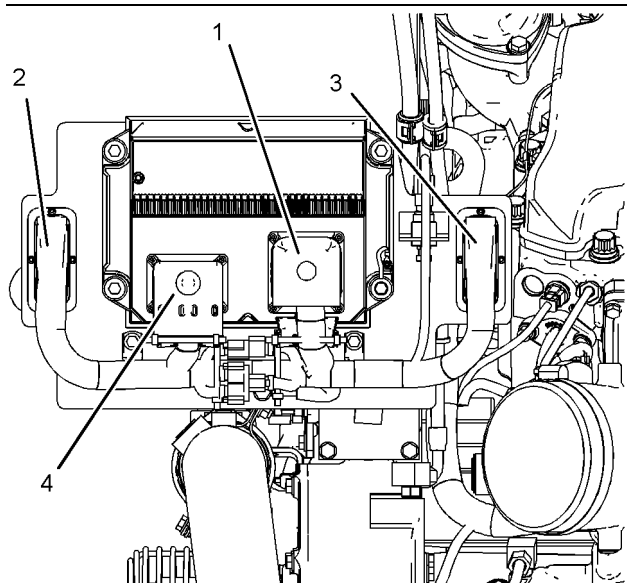


Illustration 162

g01430666

Location of the connectors that are for the sensor signal circuit for the 16 cylinder engines (left side engine view)

- (1) J2/P2 ECM connector
- (2) Right rail connector
- (3) Left rail connector
- (4) J1/P1 ECM connector

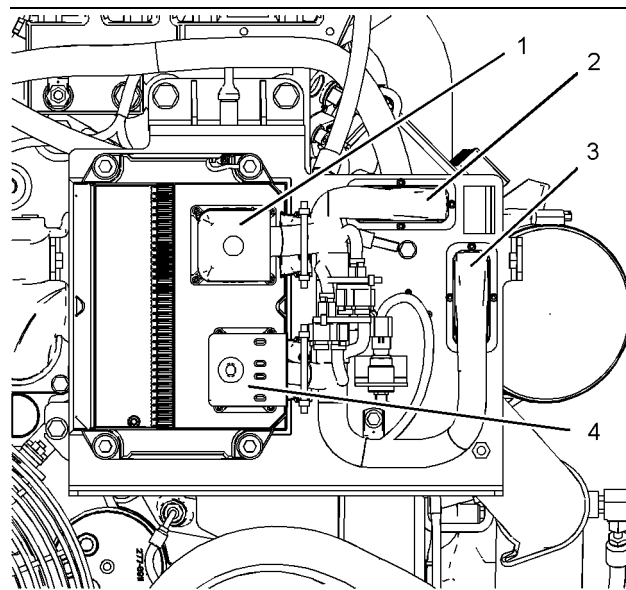


Illustration 163

g01430667

Location of the connectors that are for the sensor signal circuit for the 20 cylinder engines (left side engine view)

- (1) J2/P2 ECM connector
- (2) Right rail connector
- (3) Left rail connector
- (4) J1/P1 ECM connector

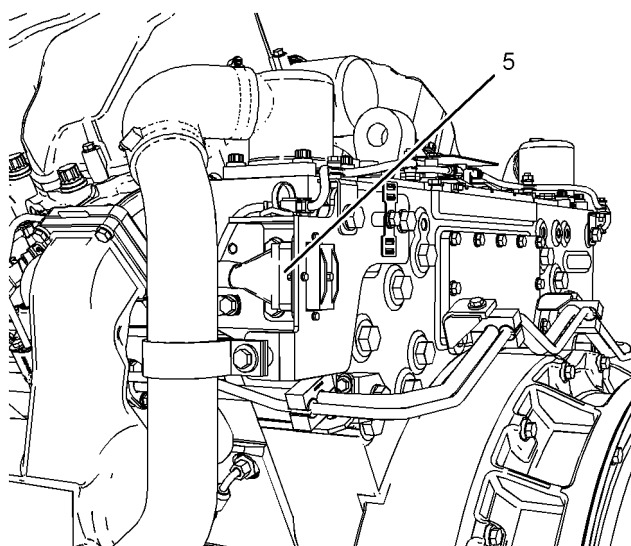


Illustration 164

g01430713

Location of the connectors that are for the sensor signal circuit (left rear engine view)

(5) Machine interface connector

- B.** Thoroughly inspect connectors (1), (2), (3), (4), and (5). Inspect all of the connectors that are associated with the circuit.

Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.

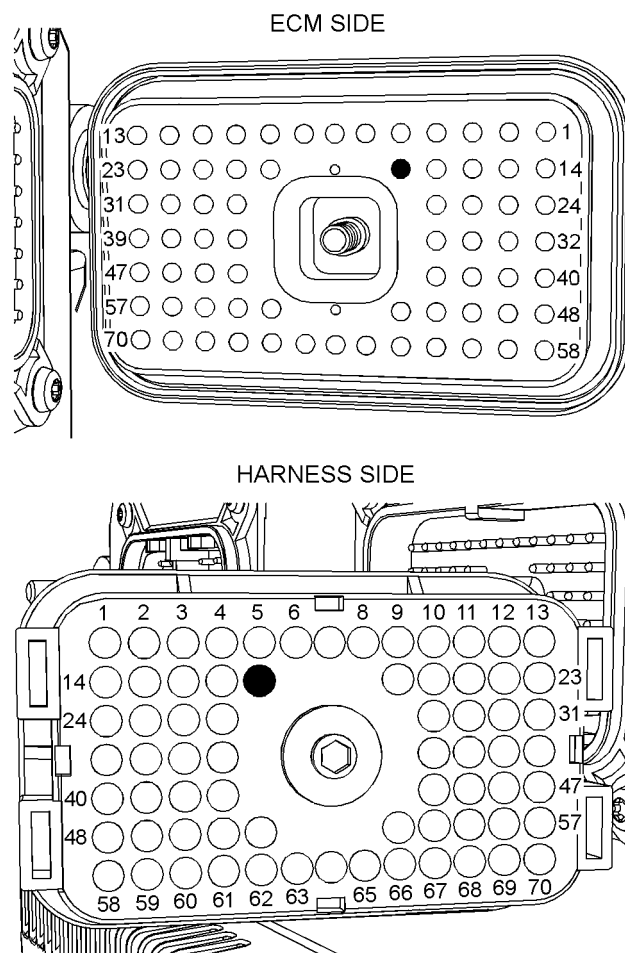


Illustration 165

g01446396

Terminal locations at the P1 ECM connector for the analog supply and the digital supply
(P1-18) Digital return

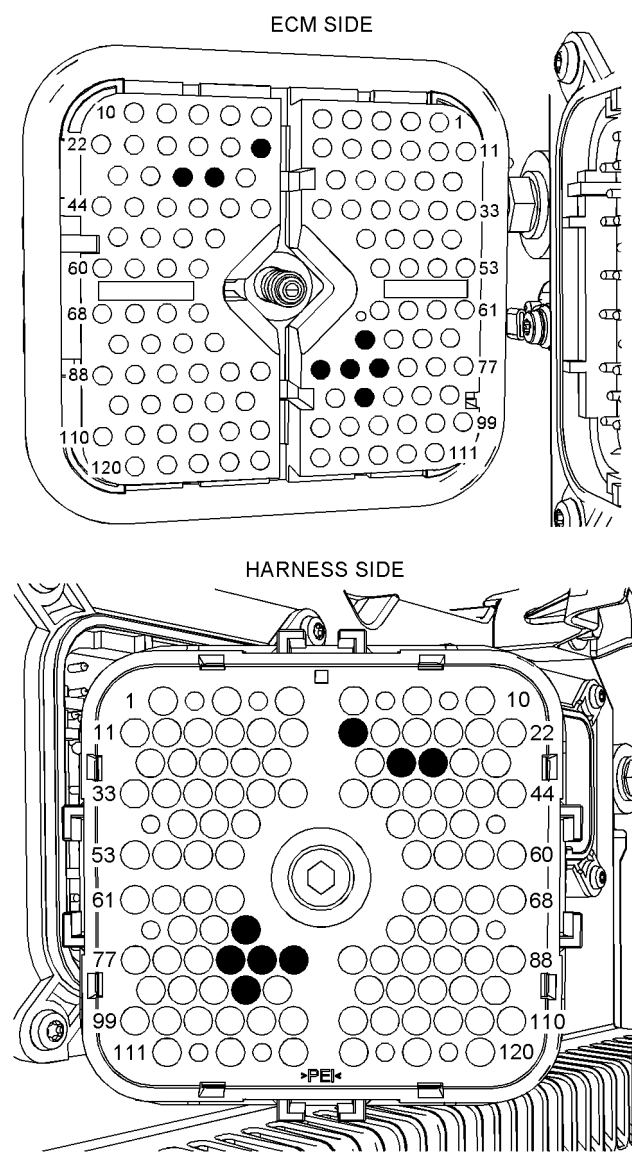


Illustration 166 g01446400

Terminal locations at the P2 ECM connector for the analog supply and the digital supply

- (P2-17) Analog return
(P2-29) 8 V digital supply
(P2-30) Analog return
(P2-72) Analog sensor supply
(P2-80) Analog sensor supply
(P2-81) Analog sensor supply
(P2-82) Analog sensor supply
(P2-92) Digital return

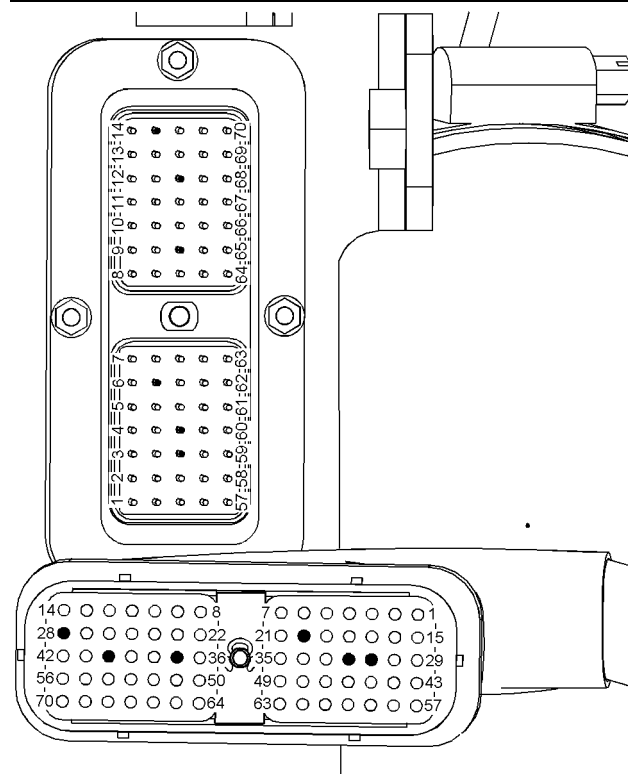


Illustration 167

g01446402

Terminal locations at the left rail connector for the analog supply and the digital supply

- (Terminal 20) Analog return
(Terminal 28) Digital supply
(Terminal 31) Digital supply
(Terminal 32) Analog sensor supply
(Terminal 37) Analog return
(Terminal 40) Analog sensor supply

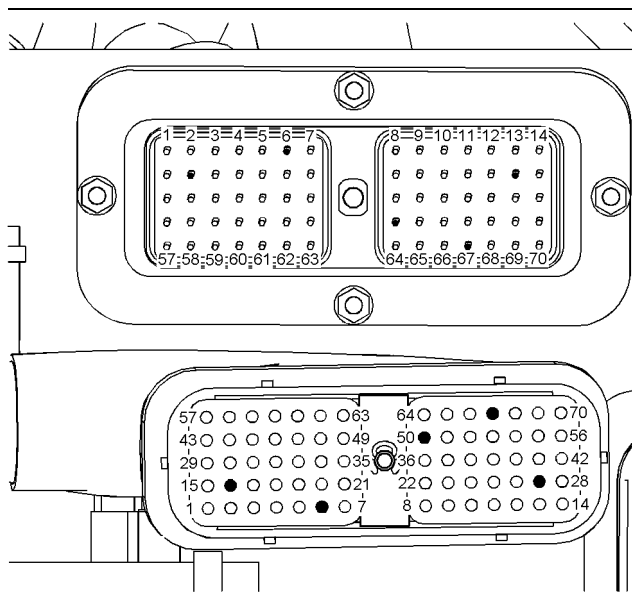


Illustration 168

g01446404

Terminal locations at the right rail connector for the analog supply and the digital supply

- (Terminal 6) Digital return
- (Terminal 16) Analog sensor supply
- (Terminal 27) Analog return
- (Terminal 50) Analog sensor supply
- (Terminal 67) Digital supply

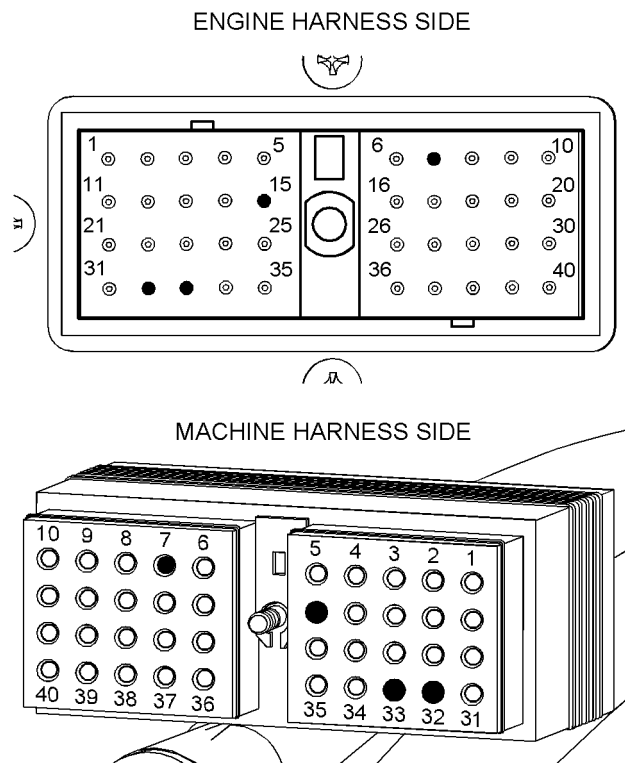


Illustration 169

g01446414

Terminal locations for the analog sensors at the machine interface connector (16 and 20 cylinder engines)

- (Terminal 7) Analog sensor supply
- (Terminal 15) Digital return
- (Terminal 32) Analog return
- (Terminal 33) Digital Supply

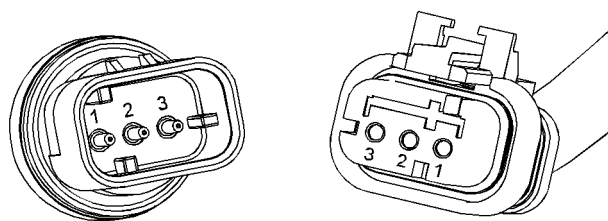


Illustration 170

g01240891

Sensor connector

- (Terminal 1) Sensor supply
- (Terminal 2) Sensor return
- (Terminal 3) Signal

C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connectors that are associated with the circuit.

- D. Check the allen head screw for each of the ECM connectors for the proper torque. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- E. Check the harness and wiring for abrasion and for pinch points from the sensors back to the ECM.

Expected Result:

All connectors, pins and sockets are completely coupled and/or inserted and the harness and wiring are free of corrosion, of abrasion and of pinch points.

Results:

- OK – The harness and connectors appear to be OK. Proceed to Test Step 2.
- Not OK – There is a problem with the connectors and/or wiring.

Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled.

Verify that the repair eliminates the problem.

STOP.

Test Step 2. Check for Diagnostic Codes that are Active or Logged

- A. Connect Caterpillar Electronic Technician (ET) to the service tool connector.
- B. Restore electrical power to the ECM.
- C. Monitor the active diagnostic code screen on Cat ET. Check and record any diagnostic codes that are active or logged. Look for the following diagnostic codes:
 - 41-3
 - 41-4
 - 100-10
 - 542-10
 - 1785-10
 - 2131-3
 - 2131-4
 - 3031-10

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

- D. Remove the electrical power from the ECM.

Expected Result:

No diagnostic codes are active or logged.

Results:

- OK – No diagnostic codes are active or logged.

Repair: There does not appear to be an electrical problem with the sensor supply at this time. If the problem is intermittent, refer to Troubleshooting, "Electrical Connectors - Inspect".

STOP.

- 41-3 or 41-4 Active or Logged – Either the 41-3 or 41-4 diagnostic code is active or logged at this time. There is an electrical problem with the digital sensor supply. Proceed to Test Step 6.
- 100-10, 542-10, 1785-10, or 3031-10 Logged – One of the -10 diagnostic codes is logged at this time. The analog supply is not reaching the sensor. Proceed to Test Step 3.
- 2131-3 or 2131-4 Active or Logged – Either the 2131-3 or 2131-4 diagnostic code is active or logged at this time. There is an electrical problem with the analog sensor supply. Proceed to Test Step 4.

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

- A. Disconnect the harness connectors for the following sensors:
 - Filtered oil pressure sensor
 - Unfiltered oil pressure sensor
 - Left intake manifold pressure sensor
 - Right intake manifold pressure sensor

- B. Restore the electrical power to the ECM.

Note: Be sure to wiggle the harness during the following measurements in order to reveal an intermittent condition.

- C. Measure the voltage between terminals 1 and 2 at the appropriate sensor connector.
- D. Remove the electrical power from the ECM.
- E. Connect all of the sensors.

Expected Result:

Each voltage measurement is 5.0 ± 0.2 VDC.

Results:

- OK – Each voltage measurement is 5.0 ± 0.2 VDC.

Repair: The analog supply is reaching the sensor connector. There may be a problem with the sensor. Perform the following procedure:

1. Clear all diagnostic codes.
2. Run the engine. Allow the engine to warm-up. Check if the code has been logged again.

If the code becomes active or logged, the sensor is faulty. Replace the sensor. Verify that the repair eliminates the original problem.

If the code does not become active or logged, 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” for the correct troubleshooting procedure.

STOP.

- Not OK – At least one voltage measurement is not 5.0 ± 0.2 VDC. There is a problem with the harness wiring or with the ECM. Proceed to Test Step 5.

Test Step 4. Disconnect the Analog Sensors While You Check for Active Diagnostic Codes

A. Restore the electrical power to the ECM.

B. Monitor the active diagnostic code screen on Cat ET while you disconnect each 5 Volt sensor at the sensor connector. Check for an active 2131-3 code or an active 2131-4 code.

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

a. Disconnect the following sensors one at a time:

- Atmospheric pressure sensor
- Crankcase pressure sensor
- Engine coolant pump outlet pressure sensor
- Filtered oil pressure sensor
- Filtered fuel pressure sensor
- Pressure sensor at the inlet of the fuel transfer pump
- Fuel rail pressure sensor
- Left intake manifold pressure sensor

- Right intake manifold pressure sensor
- Turbocharger 1 compressor inlet pressure sensor
- Turbocharger 2 compressor inlet pressure sensor
- Turbocharger 3 compressor inlet pressure sensor
- Turbocharger 4 compressor inlet pressure sensor
- Unfiltered fuel pressure sensor
- Unfiltered oil pressure sensor

C. Remove the electrical power from the ECM. Restore the wiring to the original configuration.

Expected Result:

The diagnostic code deactivates when a particular sensor is disconnected.

Results:

- OK – The 2131-3 or 2131-4 diagnostic code deactivates when a particular sensor is disconnected.

Repair: Connect the suspect sensor. If the code returns, replace the sensor. Connect all of the connectors. Verify that the problem is resolved.

STOP.

- Not OK – The 2131-3 or 2131-4 diagnostic code remains active after all of the sensors are disconnected. The sensors are not the cause of the diagnostic code. Leave the sensors disconnected. Proceed to Test Step 5.

Test Step 5. Check the 5 Volt Supply Voltages at the ECM

A. Disconnect the J2/P2 ECM connector.

B. Fabricate five jumper wires that are long enough to be used to measure the supply voltage at the ECM connector. Crimp connector sockets to one end of each jumper wire.

C. Remove the wires from the following terminal locations:

- P2-17 (analog return)
- P2-72 (analog sensor supply)

- P2-80 (analog sensor supply)
- P2-81 (analog sensor supply)
- P2-82 (analog sensor supply)

Install a jumper wire into each of these terminal locations.

D. Connect the J2/P2 ECM connector.

Note: Ensure that the loose ends of the jumper wires do not contact any ground source.

E. Restore electrical power to the engine ECM.

F. Measure the voltage between the jumper wire in the following terminal locations and the jumper wire that is in terminal location P2-17 (analog return):

- P2-72 (analog sensor supply)
- P2-80 (analog sensor supply)
- P2-81 (analog sensor supply)
- P2-82 (analog sensor supply)

G. Remove electrical power from the ECM. Restore the wiring to the original configuration.

Expected Result:

The voltage measurement is 5.0 ± 0.2 VDC.

Results:

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

Repair: The ECM is operating correctly. The supply wire that is in the harness is shorted to another wire in the harness or the supply wire is shorted to engine ground. Repair the harness.

STOP.

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

Repair: The ECM is not producing the correct supply voltage. There is a problem with the ECM. Perform the following procedure:

1. Temporarily connect a test ECM.

Refer to Troubleshooting, "ECM - Replace".

2. Recheck the circuit in order to ensure that the original problem has been resolved.

If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the problem is resolved.

If the problem is not resolved with the test ECM, install the original ECM. There is a problem in the wiring.

STOP.

Test Step 6. Disconnect the Digital Sensors while you Check for Active Diagnostic Codes

A. Restore the electrical power to the ECM.

B. Monitor the active diagnostic code screen on Cat ET while you disconnect each of the digital sensors at the sensor connector. Check for an active 41-3 code or an active 41-4 code.

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

a. Disconnect the following sensors one at a time:

- Right turbocharger turbine inlet temperature sensor
- Left turbocharger turbine inlet temperature sensor

C. Remove electrical power from the ECM. Restore the wiring to the original configuration.

Expected Result:

The diagnostic code deactivates when a particular sensor is disconnected.

Results:

- OK – The 41-3 or 41-4 diagnostic code deactivates when a particular sensor is disconnected.

Repair: Connect the suspect sensor. If the code returns, replace the sensor. Connect all of the connectors. Verify that the problem is resolved.

STOP.

- Not OK – The 41-3 or 41-4 diagnostic code remains active after the sensors are disconnected. Leave the sensors disconnected. The sensors are not the cause of the diagnostic code. Proceed to Test Step 7.

Test Step 7. Check the 8 Volt Supply Voltage at the ECM

A. Disconnect the J2/P2 ECM connector.

i02906031

- B. Fabricate two jumper wires that are long enough to be used to measure the supply voltage at the ECM connectors. Crimp connector sockets to one end of each jumper wire.
- C. Remove the wires from terminal locations P2-29 (digital sensor supply) and P2-92 (digital return). Install a jumper wire into each of these terminal locations.
- D. Connect the J2/P2 ECM connector.
- E. Restore electrical power to the engine ECM.
- F. Measure the voltage between the jumper wire in P2-29 (digital sensor supply) and P2-92 (sensor return).
- G. Remove electrical power from the ECM. Restore the wiring to the original configuration.

Expected Result:

The voltage measurement is 8.0 ± 0.4 VDC.

Results:

- OK – The voltage measurement is 8.0 ± 0.4 VDC. The ECM is operating correctly.

Repair: The supply wire is shorted to another wire in the harness or the supply wire is shorted to engine ground. Repair the supply wire.

STOP.

- Not OK – The voltage measurement is not 8.0 ± 0.4 VDC.

Repair: The ECM is not producing the correct supply voltage. There is a problem with the ECM. Perform the following procedure:

1. Temporarily connect a test ECM.

Refer to Troubleshooting, "ECM - Replace".

2. Recheck the circuit in order to ensure that the original problem has been resolved.

If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the problem is resolved.

If the problem is not resolved with the test ECM, install the original ECM. There is a problem in the wiring.

STOP.

Shutdown - Test

SMCS Code: 1900-038; 7332-038

System Operation Description:

Use this procedure in order to troubleshoot a problem with the circuit for the ground level shutdown switch or use this procedure if the following diagnostic code is active.

Table 45

Diagnostic Code		
Description	Conditions which Generate this Code	System Response
267-2 Remote Shutdown Input erratic, intermittent, or incorrect	The two inputs for the ground level shutdown switch are in the same state.	The code is active and the code is logged.

The ground level shutdown switch provides the ability to shut down the engine. The engine's Electronic Control Module (ECM) remains powered. Caterpillar Electronic Technician (ET) can be used to communicate with the ECM. The ground level shutdown switch must be returned to the RUN position and the keyswitch must be cycled to the OFF position before the ECM will allow the engine to start.

To shut down the engine, toggle the ground level shutdown switch to the SHUTDOWN position. The ECM reads the position of the ground level shutdown switch. If the engine is running, the ECM disables the fuel injection. If the engine is not running, the ECM will not allow the engine to start.

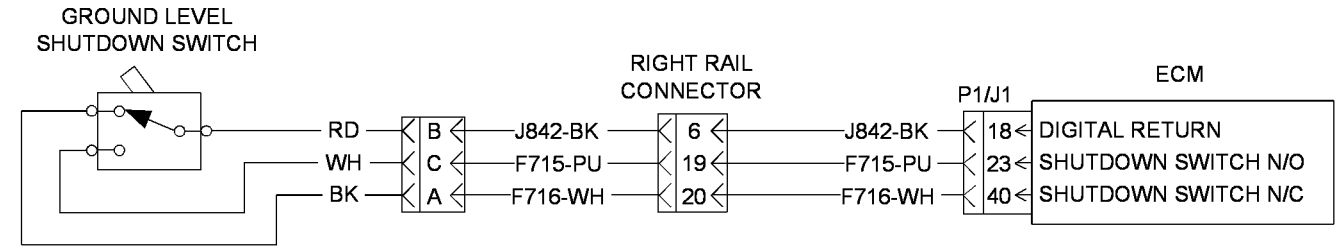


Illustration 171

g01446574

Schematic for the ground level shutdown switch

Test Step 1. Inspect Electrical Connectors and Wiring

A. Turn the keyswitch to the OFF position.

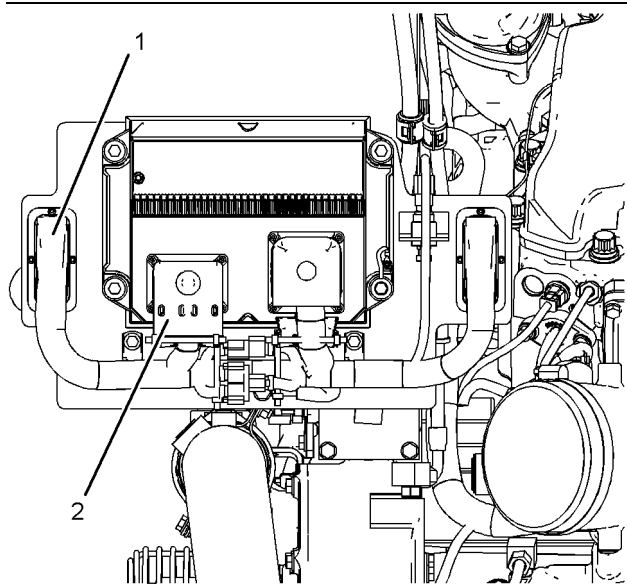


Illustration 172 g01446587

Location of the connectors at the ECM that are for the 16 cylinder engines (typical left front engine view)

- (1) Right rail connector
- (2) J1/P1 ECM connector

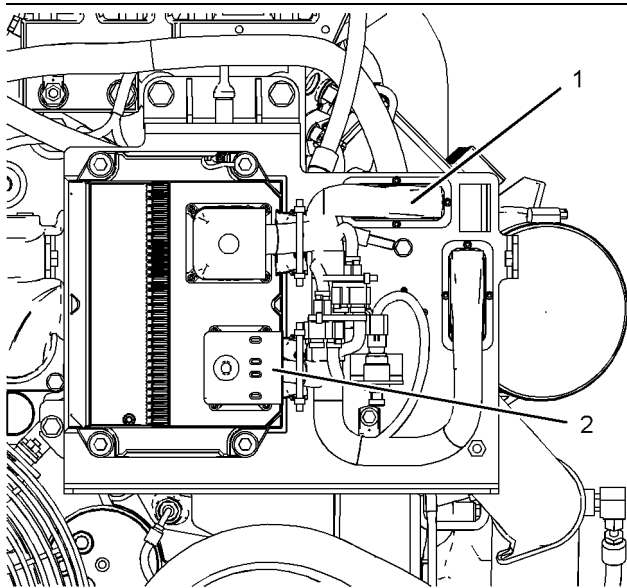


Illustration 173 g01446590

Location of the connectors at the ECM that are for the 20 cylinder engines (typical front side engine view)

- (1) Right rail connector
- (2) J1/P1 ECM connector

B. Thoroughly inspect connectors (1) and (2).
Thoroughly inspect the connectors for the ground level shutdown switch. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.

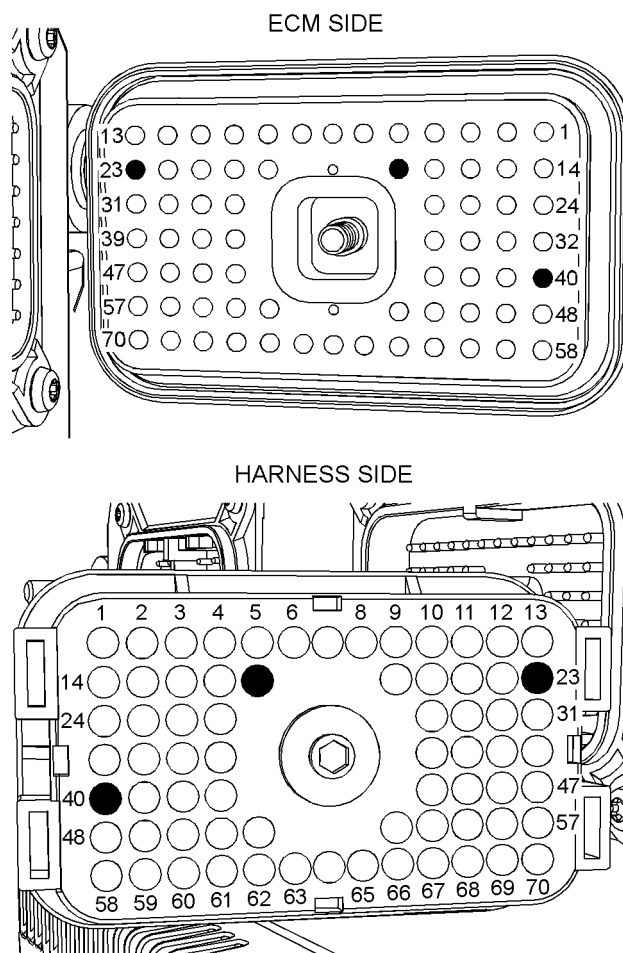


Illustration 174 g01447008

P1 ECM connector

- (P1-18) Digital return
- (P1-23) Ground level shutdown (NO)
- (P1-40) Ground level shutdown (NC)

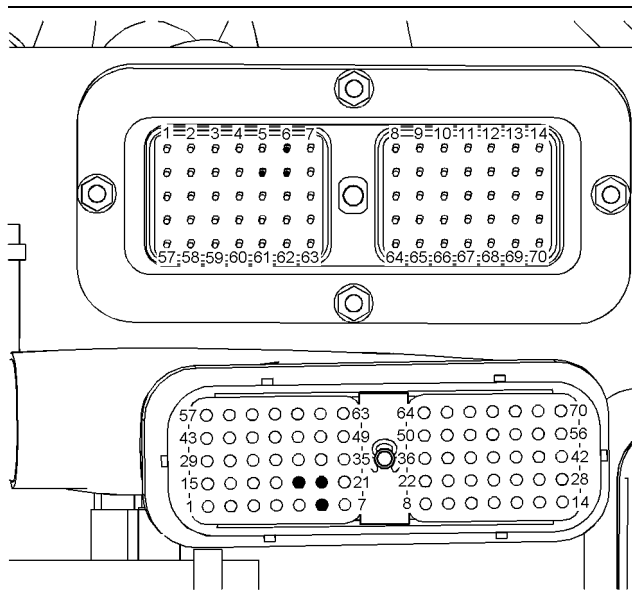


Illustration 175

g01446592

Terminal locations at the right rail connector for the ground level shutdown

(Terminal 6) Digital return
(Terminal 19) Ground level shutdown (NO)
(Terminal 20) Ground level shutdown (NC)

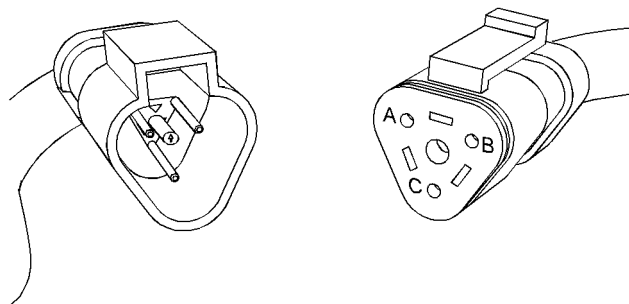


Illustration 176

g01159881

Terminal locations at the harness connector for the ground level shutdown

(Terminal A) Ground level shutdown (NC)
(Terminal B) Digital return
(Terminal C) Ground level shutdown (NO)

- C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the circuit.
- D. Check the ECM connector (allen head screw) for the proper torque. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- E. Check the harness and the wiring for abrasion and for pinch points.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted. The harness and wiring are free of corrosion, of abrasion, and of pinch points.

Results:

- OK – The harness and wiring are OK. Proceed to Test Step 2.
- Not OK – There is a problem in the connectors and/or wiring.

Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled.

Verify that the repair eliminates the problem.

STOP.

Test Step 2. Check the Status of the Ground Level Shutdown Switch on Cat ET

- A. Connect Cat ET to the service tool connector. Start Cat ET.
- B. Turn the keyswitch to the ON position.
- C. Operate the ground level shutdown switch. Observe the status for the "Shutdown Switch" on Cat ET.

Expected Result:

The status of the "Shutdown Switch" reads "ON" with the ground level shutdown switch in the SHUTDOWN position. The status of the "Shutdown Switch" reads "OFF" when the ground level shutdown switch is in the RUN position.

Results:

- OK – The status of the "Shutdown Switch" reads "ON" with the ground level shutdown switch in the SHUTDOWN position. The status of the "Shutdown Switch" reads "OFF" when the ground level shutdown switch is in the RUN position. The ground level shutdown switch is operating normally.

Repair: There may be an intermittent problem. If the problem is intermittent, refer to Troubleshooting, "Electrical Connectors - Inspect".

STOP.

- Not OK – The status of the “Shutdown Switch” does not read “ON” with the ground level shutdown switch in the SHUTDOWN position. The status of the “Shutdown Switch” does not read “OFF” when the ground level shutdown switch is in the RUN position. The ground level shutdown switch is not operating normally. Proceed to Test Step 3.

Test Step 3. Short the Wires together at the Ground Level Shutdown Switch

- Turn the keyswitch to the OFF position.
- Record the position of the wiring on the ground level shutdown switch before removing the wires.
- Disconnect the wires from the ground level shutdown switch.
- Create a short circuit at the connector for the ground level shutdown switch between terminal A (ground level shutdown (NC)) and the terminal B (digital return).
- Turn the keyswitch to the ON position.
- Observe the status of the “Shutdown Switch” on Cat ET.
- Remove the short circuit at the connector for the switch.
- Create a short circuit at the connector for the ground level shutdown switch between terminal C (ground level shutdown (NO)) and the terminal B (digital return).
- Observe the status of the “Shutdown Switch” on Cat ET.
- Turn the keyswitch to the OFF position.
- Remove the wire short.

Expected Result:

The status of the “Shutdown Switch” reads “OFF” when the short circuit is placed between terminals A and B. The status of “Shutdown Switch” reads “ON” when the short circuit is placed between terminals C and B.

Results:

- OK – The status of the switch is correct for both tests.

Repair: The problem is not with the harness or the ECM. Temporarily connect a new ground level shutdown switch. Verify that the new ground level shutdown switch solves the problem before you permanently install the new ground level shutdown switch.

STOP.

- Not OK – The status of the switch is not correct for at least one of the tests. There is a problem in the harness and/or the ECM. Proceed to Test Step 4.

Test Step 4. Short the Ground Level Shutdown Switch at the ECM

- Use a wire removal tool to remove the wires from terminal locations P1-18, P1-23, and P1-40 at the ECM connector.
 - Fabricate a jumper wire that is long enough to create a test circuit across the ECM connector. Crimp connector sockets to each end of the jumper wire.
 - Use the wire jumper to create a short circuit between terminal locations P1-18 and P1-40 at the ECM connector.
 - Turn the keyswitch to the ON position.
- Note:** The digital return will no longer be connected to the other sensors and switches. Additional diagnostic codes will be generated from the ECM. Clear the codes after you complete this test.
- Observe the status of the “Shutdown Switch” on Cat ET.
 - Turn the keyswitch to the OFF position.
 - Use a wire removal tool to remove the jumper wire.
 - Use the wire jumper to create a short circuit between terminal locations P1-18 and P1-23 at the ECM connector.

- Turn the keyswitch to the ON position.
- Observe the status of the ground level shutdown switch on Cat ET.
- Turn the keyswitch to the OFF position. Restore the wiring to the original configuration.

Expected Result:

The status reads “OFF” when the jumper wire is between terminal locations P1-18 and P1-40. The status reads “ON” when the jumper wire is between terminal locations P1-18 and P1-23.

Results:

- OK – The status is correct on Cat ET for each test.

Repair: There is a problem in the harness between the ECM connector and the ground level shutdown switch. Repair the harness or the connector.

STOP.

- Not OK – The status is incorrect on Cat ET for at least one of the tests.

Repair: There is a problem with the ECM. Perform the following procedure:

1. Temporarily connect a test ECM.

Refer to Troubleshooting, "ECM - Replace".

2. Recheck the circuit in order to ensure that the original problem has been resolved.

If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the problem is resolved.

If the problem is not resolved with the test ECM, install the original ECM. There is a problem in the wiring.

STOP.

i02891042

Speed/Timing - Test

SMCS Code: 1912-038

System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with the engine speed/timing sensor or if the diagnostic code in Table 46 is active.

Table 46

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
190-8 Engine Speed sensor abnormal frequency, pulse width, or period	The engine is running for more than three seconds. The pattern from the timing ring is lost for two seconds.	The engine speed from this sensor is ignored. The code is active. The code is logged if the pattern from the timing ring returns for five seconds.
342-8 Secondary Engine Speed sensor abnormal frequency, pulse width, or period	The engine is running for more than three seconds. The ECM detects an abnormal signal frequency.	The code is latched in the active state until the power to the Electronic Control Module (ECM) is cycled. The offset for the timing calibration is set to zero while the diagnostic code is active. The sensor is ignored. The engine speed is calculated by using only the signal from the primary speed/timing sensor.
342-11 Secondary Engine Speed sensor other failure mode	The engine is in run mode for more than five seconds. The condition is checked once after each start-up cycle. The position of the primary speed/timing sensor in relation to the position of the secondary speed/timing sensor may be out of specifications. The polarity of the sensor's wiring may be reversed.	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.
2710-8 Engine Tertiary Speed Sensor abnormal frequency, pulse width, or period	The engine is in run mode for more than three seconds. The ECM detects an abnormal signal frequency.	The sensor is ignored. The engine speed is calculated by using only the signal from the primary speed/timing sensor.
2710-11 Engine Tertiary Speed Sensor other failure mode	The engine is in run mode for more than five seconds. The condition is checked once after each start-up cycle. The position of the primary speed/timing sensor in relation to the position of the secondary speed/timing sensor may be out of specifications. The polarity of the sensor's wiring may be reversed.	The code is latched in the active state until the power to the ECM is cycled.

This engine is equipped with three engine speed/timing sensors. The primary engine speed/timing sensor for the crankshaft is mounted inside the engine crankcase and toward the left rear section of the engine. This sensor utilizes the teeth for the rear gear group's crankshaft gear in order to sense the engine speed and the crankshaft position. There are two camshaft speed/timing sensors that are located on the top rear portion of the engine. Both of these sensors utilize the teeth for the rear gear group's camshaft gear in order to sense the engine speed and the camshaft position. A single tooth for both of these gears has been partially removed in order to provide a timing reference for the ECM.

Under normal operation, the ECM utilizes the signal from the crankshaft's engine speed/timing sensor in order to determine the crankshaft position for an accurate fuel delivery and timing. This eliminates the need for a separate procedure for timing calibration. A timing offset is determined during each engine start-up. The value of the timing offset is stored in the electronic control module's non-volatile memory until the next engine start-up. If a failure mode for the crankshaft's engine speed/timing sensor is detected during engine start-up, the value of the timing offset that has been stored in memory will be used. This value will continue to be used for the engine's timing calibration until the diagnostic is resolved. A timing calibration cannot be performed manually on this engine.

The fuel delivery to the engine is synchronized by the signal from the camshaft speed/timing sensor (RH). If a failure mode for the crankshaft's engine speed/timing sensor is detected, the ECM will use the signal that is from the camshaft sensor (RH) for the fuel delivery and the engine timing.

In this application, the camshaft speed/timing sensor (LH) is provided as a backup for the camshaft speed/timing sensor (RH). If a failure mode for the camshaft speed/timing sensor (RH) is detected, the ECM will use the other camshaft sensor to provide the functionality of the failed sensor.

The engine will start when the signal from a single camshaft speed/timing sensor is present. If the engine is started and the ECM loses both of the signals that are from the camshaft speed/timing sensors, the ECM will use the signal from the crankshaft speed/timing sensor in order to keep the engine running. If the signal from both of the camshaft speed/timing sensors is lost, the engine will not start. The engine speed/timing sensors are not interchangeable. **Do not attempt to switch the positions of the sensors.**

Complete all of the following tasks when you are installing 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 prior to installation of the sensor.
- Ensure that the sensor assembly is fully seated into the engine before tightening the bracket bolt.
- Ensure that each electrical connector is securely latched.
- Ensure that the harness is properly secured, and ensure that each tie-wrap is placed in the correct location.

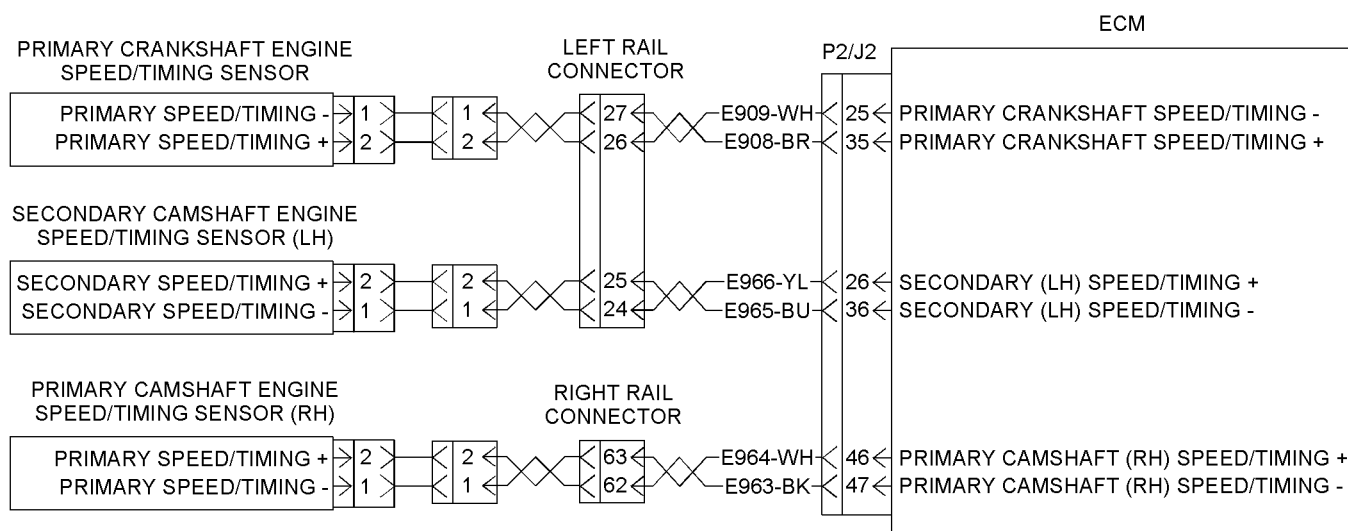


Illustration 177

g01439689

Schematic for the engine speed/timing circuit

Test Step 1. Check for Diagnostic Codes

- A. Remove electrical power from the ECM.
- B. Connect Caterpillar Electronic Technician (ET) to the service tool connector. Refer to Troubleshooting, "Electronic Service Tools", if necessary.
- C. Restore electrical power to the ECM.
- D. Start the engine and run the engine until the engine is at normal operating temperature.

Note: If the engine will not start, monitor the "No Start Parameters" parameter category on Cat ET while the engine is being cranked. Check each of the engine speed parameters for engine speed. Cat ET may need to be powered from another battery while the engine is being cranked.

- E. Look for these codes on Cat ET:

- 190-08
- 342-08
- 342-11
- 2710-08
- 2710-11

Note: These diagnostic codes will not become active until engine speed is above 600 rpm. If the engine will not start, check for logged diagnostic codes that are related to the engine speed/timing sensors.

Expected Result:

None of the diagnostic codes that are listed above are active or logged.

Results:

- OK – None of the diagnostic codes that are listed above are active or logged.

Repair: Use Cat ET in order to ensure that the engine speed is detected from all of the engine speed/timing sensors. If the diagnostic codes that are listed above are not active or logged, and the engine is not running properly, refer to the appropriate engine symptom in this Troubleshooting manual.

STOP.

- 190-08, 342-08, or 2710-08 active or logged – There is a 190-08, 342-08, or 2710-08 that is active or logged. Proceed to Test Step 2.
- 342-11 or 2710-11 active or logged – There is a 342-11 or 2710-11 diagnostic code that is active or logged.

Repair: The position of the crankshaft with respect to the camshaft is not within specifications.

This may be caused by a problem with the rear gear train. Check the gears that are in the rear gear train for damage and for excessive wear. Check that the gears that are in the gear train are properly timed. Repair any mechanical damage to the engine. Verify that the repair eliminates the original problem.

This may also be caused by the improper wiring of one or both of the engine speed timing sensors. Check that the wiring at the ECM and the wiring at each of the sensors is correct.

STOP.

- No engine rpm – Cat ET is not reporting engine rpm for at least one engine speed/timing sensor while the engine is cranked. Proceed to Test Step 3.

Test Step 2. Check the Installation of the Sensor Assembly

A. Remove electrical power from the ECM.

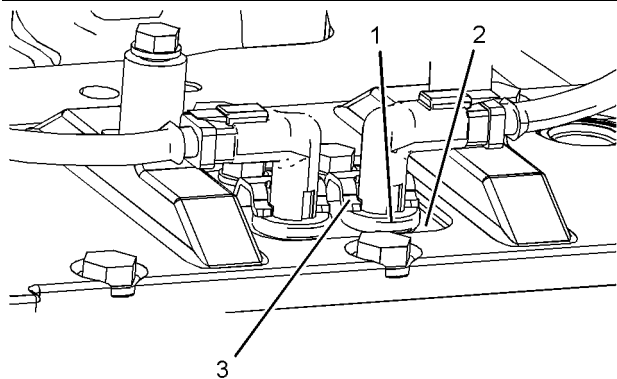


Illustration 178

g01279225

Sensor installation

- (1) Flange
- (2) Mounting surface
- (3) Bracket

- B.** Visually inspect the sensors without removing the sensor assembly from the engine. Flange (1) must be flush against mounting surface (2) in order to ensure proper operation.

Inspect bracket (3). Verify that the bracket securely holds the flange of the sensor flush against the mounting surface.

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.

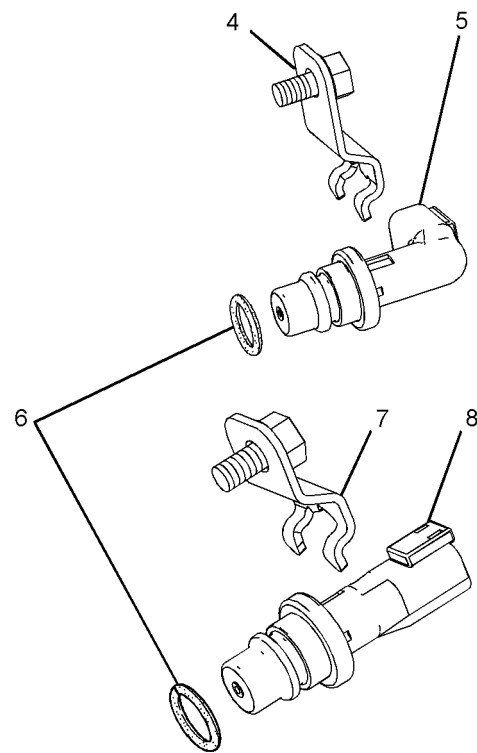


Illustration 179

g01279410

Engine speed/timing sensors

- (4) Bracket
- (5) Secondary speed/timing sensor
- (6) O-ring seals
- (7) Bracket
- (8) Primary speed/timing sensor

- C.** Remove the suspect engine speed/timing sensor from the engine.

- D.** Ensure that O-ring seals (6) are installed on sensors (5) and (8). Ensure that the O-ring seals are free of damage.

Expected Result:

All of the O-ring seals are properly installed and free of damage. The bracket is free of damage.

Results:

- OK – The O-ring seals are properly installed. The bracket and the seals are free of damage.

Repair: Perform the following procedure in order to properly install a sensor assembly:

1. Lubricate the O-ring seals with oil.
2. Fully seat each sensor into the housing.

Note: If the sensor assembly will not fully seat into the engine, replace the sensor assembly.

3. Tighten the bolt for brackets (4) and (7).
4. Connect the connector and verify that the locking tab of the connector is securely latched at the sensor.
5. Ensure that the harness is properly secured, and that the tie-wraps are placed in the correct location.

Proceed to Test Step 3.

- Not OK – At least one of the sensor assembly's components is not OK.

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

Note: Do not switch the positions of the sensors. The sensors are not interchangeable.

1. Lubricate each O-ring with oil.
2. Fully seat the sensor into the housing.
3. Tighten the bracket bolt.
4. Connect the connector and verify that the locking tab of the connector is securely latched.
5. Ensure that the harness is properly secured, and that the tie-wraps are placed in the correct location.

Verify that the problem is resolved.

STOP.

Test Step 3. Inspect the Electrical Connectors and the Wiring

- A. Remove the electrical power from the ECM.

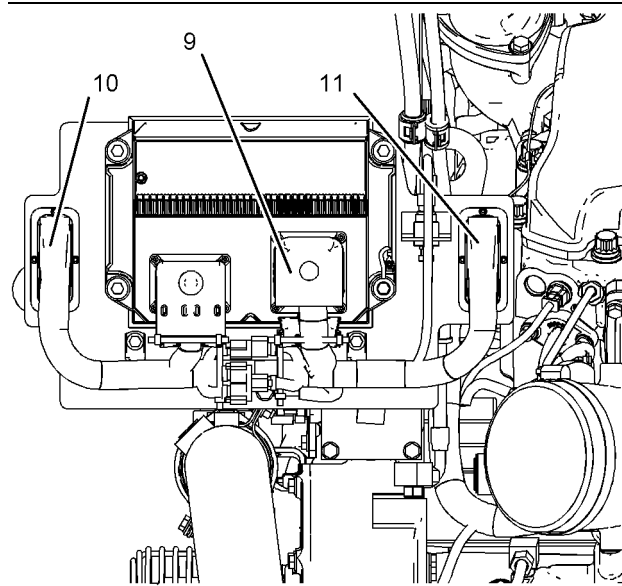


Illustration 180

g01439732

Location of the connectors at the ECM that are for the 16 cylinder engines (typical left front engine view)

- (9) J2/P2 ECM connector
- (10) Right rail connector
- (11) Left rail connector

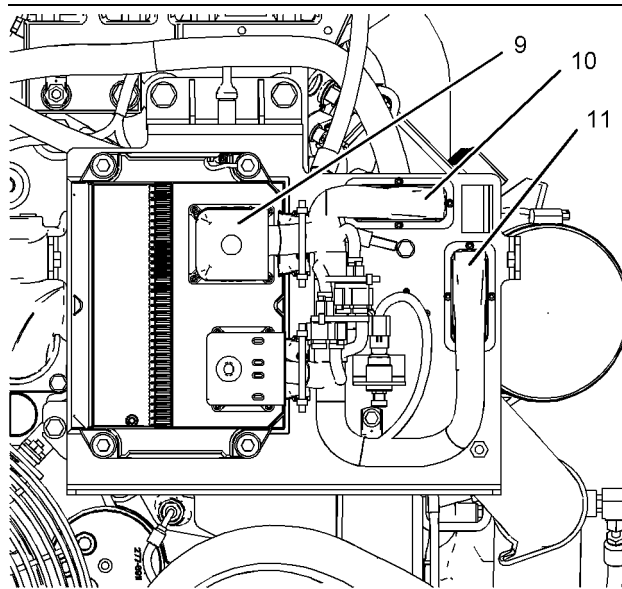


Illustration 181

g01439747

Location of the connectors at the ECM that are for the 20 cylinder engines (typical front side engine view)

- (9) J2/P2 ECM connector
- (10) Right rail connector
- (11) Left rail connector

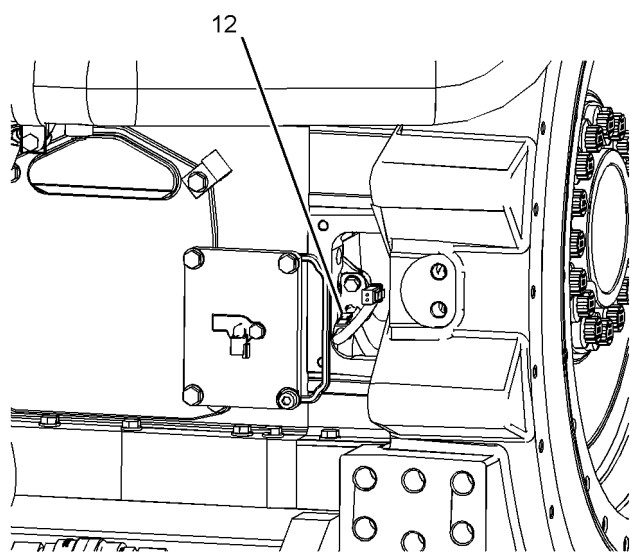


Illustration 182

g01308020

Location of the crankshaft speed/timing sensor (left side engine view)

(12) Primary crankshaft speed/timing sensor

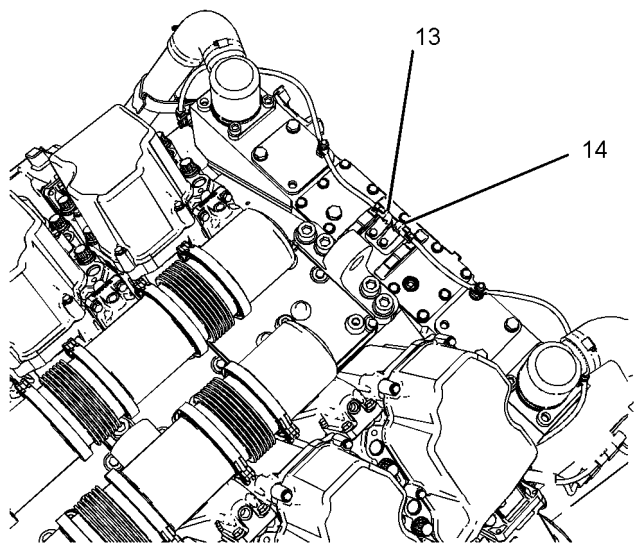


Illustration 183

g01304643

Location of the camshaft speed/timing sensors (top side engine view)

(13) Secondary camshaft speed/timing sensor (RH)

(14) Secondary camshaft speed/timing sensor (LH)

B. Thoroughly inspect connectors (9), (10), (11), (12), (13), and (14). Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.

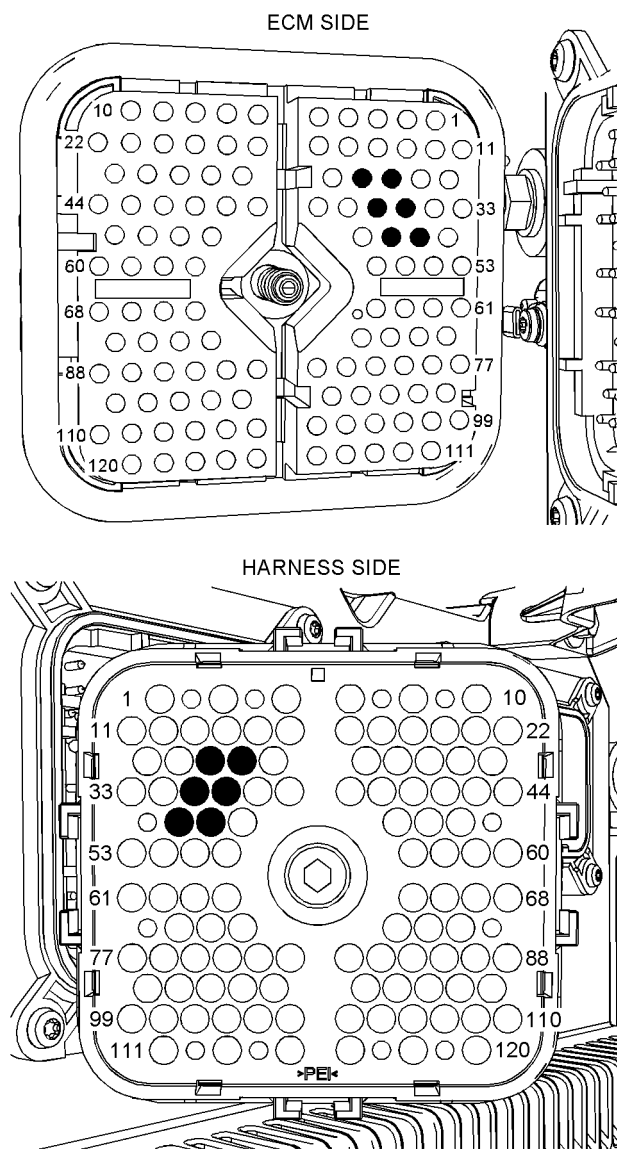


Illustration 184

g01279103

Terminal locations at the P2 ECM connector for the engine speed/timing sensors

(P2-25) Primary crankshaft engine speed/timing signal (+)

(P2-26) Secondary camshaft engine speed/timing signal (LH) (+)

(P2-35) Primary crankshaft engine speed/timing signal (-)

(P2-36) Secondary camshaft engine speed/timing signal (LH) (-)

(P2-46) Primary camshaft engine speed/timing signal (RH) (+)

(P2-47) Primary camshaft engine speed/timing signal (RH) (-)

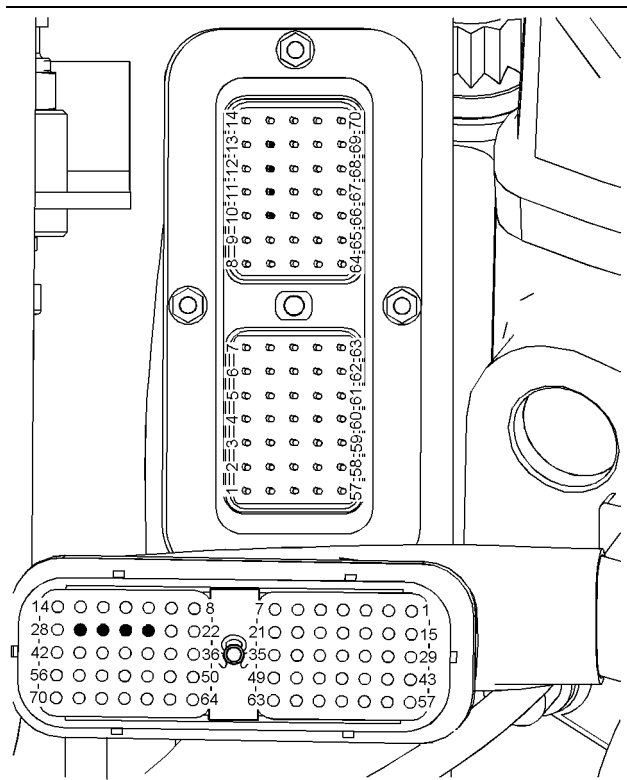


Illustration 185

g01439783

Terminal locations at the left rail connector for the engine speed/timing sensors

- (Terminal 24) Secondary camshaft engine speed/timing signal (LH) (-)
- (Terminal 25) Secondary camshaft engine speed/timing signal (LH) (+)
- (Terminal 26) Primary crankshaft engine speed/timing signal (+)
- (Terminal 27) Primary crankshaft engine speed/timing signal (-)

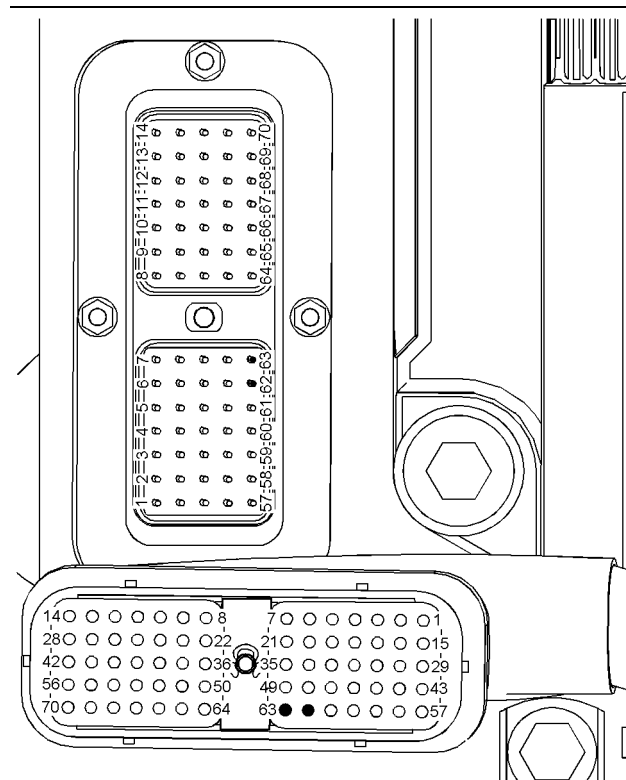


Illustration 186

g01439786

Terminal locations at the right rail connector for the engine speed/timing sensors

- (Terminal 62) Primary camshaft engine speed/timing signal (RH) (-)
- (Terminal 63) Primary camshaft engine speed/timing signal (RH) (+)

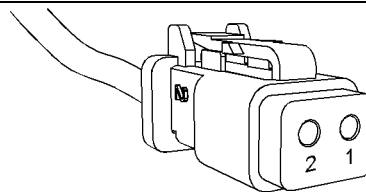


Illustration 187

g01155187

Harness connector for the engine speed/timing sensors

- (Terminal 1) Speed/timing sensor (-)
- (Terminal 2) Speed/timing sensor (+)

- C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit for the engine speed/timing sensors.
- D. Check the allen head screw for each ECM connector for the proper torque. Refer to Troubleshooting, "Electrical Connectors - Inspect" for the correct torque values.
- E. Check the harness and wiring for abrasion and for pinch points from the engine speed/timing sensors to the ECM.

Expected Result:

All connectors, pins, and sockets are completely coupled and/or inserted. The harness and wiring are free of corrosion, of abrasion, and of pinch points.

Results:

- OK – The harness and the wiring appear to be OK. Proceed to Test Step 4.
- Not OK – There is a problem in the connectors and/or wiring.

Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals for the connectors are properly in place and ensure that the connectors are completely coupled. Verify that the repair eliminates the problem.

STOP.

Test Step 4. Measure the Sensor Resistance through the Engine Harness

- A.** Turn the keyswitch to the OFF position.
- B.** Disconnect the P2 connector.
- C.** Perform the following procedure in order to measure the resistance of the primary engine speed/timing sensor:
- a.** Measure the resistance from P2-25 (primary (crankshaft) engine speed/timing +) to P2-35 (primary (crankshaft) engine speed/timing -).
- Resistance 110 to 200 Ohms
- D.** Perform the following procedure in order to measure the resistance of each of the secondary engine speed/timing sensors:
- a.** Measure the resistance from P2-46 (primary (camshaft (RH)) engine speed/timing +) to P2-47 (primary (camshaft (RH)) engine speed/timing -).
- Resistance 1000 to 1200 Ohms
- b.** Measure the resistance from P2-26 (secondary (camshaft (LH)) engine speed/timing +) to P2-36 (secondary (camshaft (LH)) engine speed/timing -).
- Resistance 1000 to 1200 Ohms

Expected Result:

The resistance measurements are within the specifications.

Results:

- OK – The resistance measurements are within the specifications.

Repair: The sensors and the harness are OK. The ECM does not appear to be operating properly. Perform the following procedure:

1. Temporarily connect a test ECM.

Refer to Troubleshooting, "ECM - Replace".

2. Recheck the circuit in order to ensure that the original problem has been resolved.

If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the problem is resolved.

If the problem is not resolved with the test ECM, install the original ECM. There is a problem in the wiring.

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 at the Sensor Connector

- A.** Disconnect the engine harness from the suspect sensor.
- B.** For the primary engine speed/timing sensor, measure the resistance between terminal 2 (primary (crankshaft) engine speed/timing +) and terminal 1 (primary (crankshaft) engine speed/timing -).
- Resistance 110 to 200 Ohms
- C.** For the secondary engine speed/timing sensor, measure the resistance between terminal 2 (primary (camshaft (RH)) engine speed/timing +) to terminal 1 (primary (camshaft (RH)) engine speed/timing -).
- Resistance 1000 to 1200 Ohms
- D.** For the secondary engine speed/timing sensor, measure the resistance between Terminal 2 (secondary (camshaft (LH)) engine speed/timing +) to Terminal 1 (secondary (camshaft (LH)) engine speed/timing -).
- Resistance 1000 to 1200 Ohms

Expected Result:

The resistance measurement for the suspect sensor is within the specification.

Results:

- OK – The resistance measurement for the suspect sensor is within the specification.

Repair: 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 the wiring and/or the connector. Replace parts, if necessary. Twisted pair wiring is required. Any new wiring must have at least one twist per inch. Verify that the problem is resolved.

STOP.

- Not OK – The resistance measurement for the suspect sensor is not within the specification.

Repair: There is a problem with the sensor. Replace the sensor assembly.

Do not switch the positions of the sensors. The sensors are not interchangeable. A timing calibration is not required when the sensors are replaced. Perform the following procedure in order to replace the sensor assembly:

1. Lubricate the O-ring seal of the new sensor with oil.
2. Fully seat the sensor into the housing.
3. Tighten the bracket bolt.
4. Connect the connector and verify that the latch tab of the connector is securely latched.
5. Ensure that the harness is secured in the proper location. Verify that the problem has been resolved.

STOP.

i02826488

Service

i02584369

Factory Passwords

SMCS Code: 0785; 1900

NOTICE

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

Note: Factory passwords are provided only to Caterpillar dealers.

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

- Program a new Electronic Control Module (ECM).

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

- Rerate the engine.

This may require changing the interlock code, which is protected by factory passwords.

- Unlock parameters.

Factory passwords are required in order to unlock certain system configuration parameters. Refer to Troubleshooting, "Configuration Parameters".

- Clear engine events and certain diagnostic codes.

Most engine events require factory passwords in order to clear the code from ECM memory. Clear these codes only when you are certain that the problem has been corrected. For example, the Engine Overspeed code requires the use of factory passwords in order to clear the code from ECM memory.

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

ECM Will Not Accept Factory Passwords

SMCS Code: 0785; 1901

Probable Causes

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

- Passwords
- Serial numbers
- Total tattletale
- Reason code

Recommended Actions

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

For additional information, refer to Troubleshooting, "Factory Passwords".

i02887774

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 Electronic Control Module (ECM). Cat ET must communicate with the ECM on the Cat Data Link and on the CAN data link in order to fully 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 CAN data link. The "Cat Data Link" indicator indicates that the communication adapter is communicating on the Cat Data Link. Cat ET displays a message during an attempt to connect if Cat ET can not communicate on both data links.

The following conditions can cause a communication problem:

- Incorrect communication adapter
- Use of a wireless communications 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

Identify the communication problem.

Note: If Cat ET is not communicating and the "POWER" indicator is not illuminated, cycle the power to the communications adapter.

Expected Result:

Both indicators on the communication adapter are not flashing.

Results:

- Both indicators on the communication adapter are not flashing. – Proceed to Test Step 2.
- Cat ET indicates the engine is intended to be serviced on two 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 a "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 171-4401 Communication Adapter As or a 275-5121 Communication Adapter As 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

Identify the communication adapter that is being used.

Expected Result:

An incorrect communication adapter is being used.

Results:

- An incorrect communication adapter is being used.

Repair: Obtain the correct communication adapter. Refer to Troubleshooting, “Electronic Service Tools”, if necessary.

Establish communication on both data links. 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.

- A. Electronically disconnect Cat ET. Verify that the “power” indicator on the communication adapter is illuminated.
- B. Select the “Utilities” drop-down menu.
- C. Select “Comm Adapter II Toolkit” from the menu.
- D. When the dialog box for the tool kit appears select the “Utilities” drop-down menu.
- E. Select “Application Firmware Flash” from the menu.
- F. Select the latest “.apf” file from the list.
- G. Click “OK”. Then, click “Begin Flash”.
- H. When the file is loaded, the “Flash Completed Successfully” message will appear.
- I. Click “Toolkit”. Verify that the “Application Firmware Version (Serial IP)” is “3.0.0” or higher.
- J. Attempt to connect Cat ET.

Expected Result:

Cat ET communicates on both data links.

Results:

- OK – Cat ET communicates on both data links. STOP.
- Not OK – Cat ET does not communicate using 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:

- A. Select the “Utilities” drop-down menu.
- B. Click on the “Preferences” menu.
- C. Select the “Communications” tab.
- D. 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. Ensure that version “2007B” has been installed.

If necessary, 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 recognized.

- H. Electronically disconnect Cat ET if changes were made to any of the settings for communications. Electronically connect Cat ET. Attempt to establish communication. Observe the indicators on the communication adapter.

At this point, a “limited support” warning should not be displayed. The “J1939 / DeviceNet” and “Cat Data Link” indicators should be flashing. This indicates that Cat ET is communicating on both data links.

Expected Result:

Cat ET is communicating on both data links.

Results:

- OK – Cat ET communicates on both data links. STOP.
- Not OK – 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

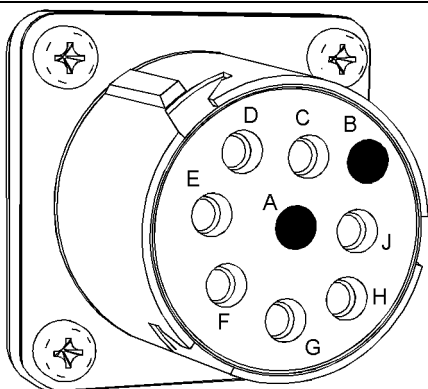


Illustration 188 g01430920

Power terminals at the service tool connector

(Terminal A) +Battery
(Terminal B) -Battery

Check for battery voltage at the service tool connector. Refer to Illustration 188.

Expected Result:

Battery voltage is present at the service tool connector.

Results:

- OK – 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 harness connector for the communication adapter.
- The communication adapter's "POWER" indicator is not illuminated.

STOP.

- Battery voltage is not present at the service tool connector.

Repair: Inspect the application's 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 will not communicate on both data links.

Test Step 6. Check the Electrical Power to the ECM

- A.** Verify that electrical power for the application is turned on.

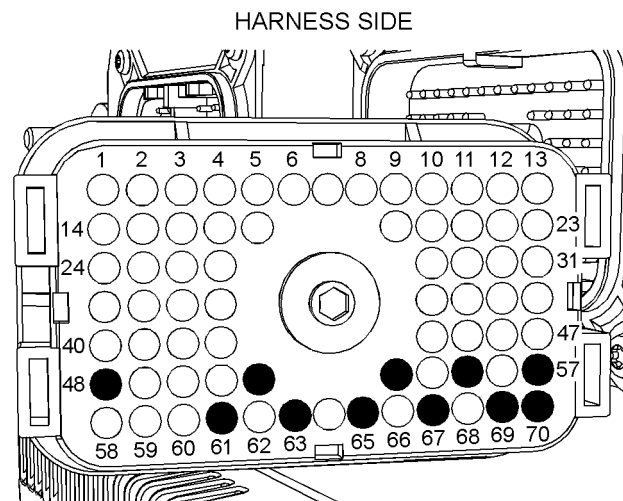
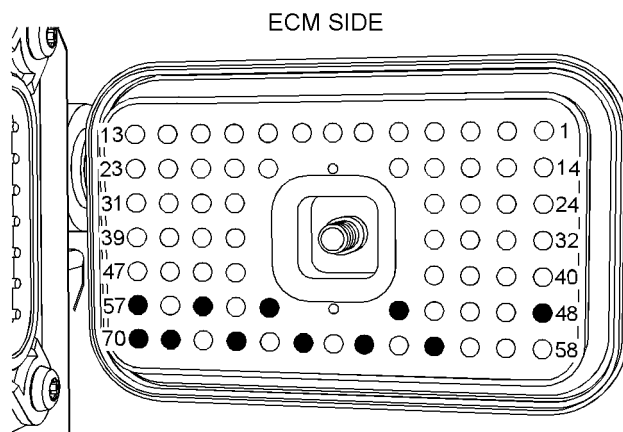


Illustration 189 g01431084

Terminal locations at the J1/P1 ECM connectors for the ECM power supply circuit (typical wiring)

(48) Unswitched +Battery
(52) Unswitched +Battery
(53) Unswitched +Battery
(55) Unswitched +Battery
(57) Unswitched +Battery
(61) -Battery
(63) -Battery
(65) -Battery
(67) -Battery
(69) -Battery
(70) Keyswitch

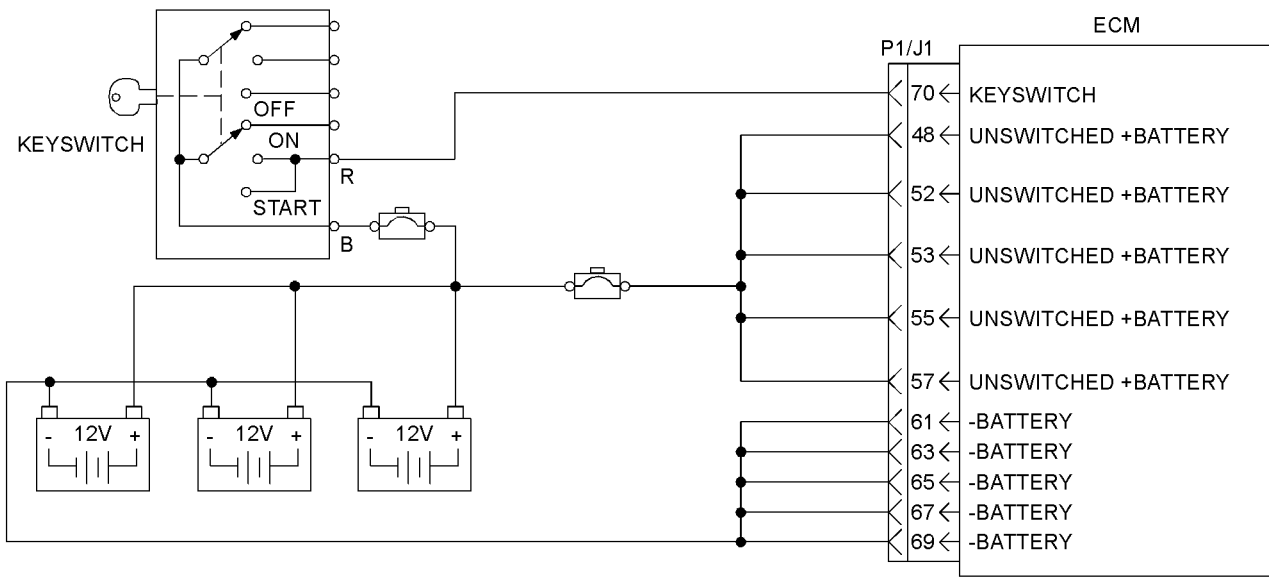


Illustration 190

g01430954

Schematic for the ECM power supply circuit (typical wiring diagram)

- B.** Refer to Illustrations 189 and 190. Verify that battery voltage is present at the terminals that are indicated in the Illustration. Be sure to connect the voltmeter between the +Battery terminals and the -Battery terminals at the ECM connector.
- C.** Verify that battery voltage is present at P1-70 when the keyswitch is turned on.

Expected Result:

Battery voltage is present at all of the P1 terminals that are associated with the ECM power supply circuit.

Results:

- OK – Battery voltage is present at all of the appropriate P1 terminals. The circuits for the battery power to the ECM are OK. Proceed to the Test Step 7.
- Not OK – Battery voltage is not present at an ECM battery connection.

Repair: Inspect the application's wiring, fuses, and/or circuit breakers. Determine the cause of the missing voltage. Make the necessary repairs.

Attempt to establish communication after the electrical problem at the ECM has been resolved. Continue with this procedure, if necessary.

STOP.

Test Step 7. Try to Establish Communication with a Bypass Harness

- A.** Connect the communication adapter to the engine ECM with a 167-9225 Harness (SERVICE TOOL ADAPTER). This harness supports communication on both data links.
- B.** Attempt to establish communication.

Expected Result:

Cat ET communicates on both data links when the bypass harness is used.

Results:

- OK – Cat ET communicates on both data links when the bypass harness is used. There is a problem with the application's wiring for one of the data links.

Repair: Repair the data link. Refer to Troubleshooting, "Data Link - Test".

STOP.

i02608713

Test ECM Mode

SMCS Code: 1900

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

i02857917

Injector Trim File - Install

SMCS Code: 1290-591; 7620-012

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

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

- An injector is replaced.
- The ECM is replaced.
- "Injector Trim" is displayed below a 268-2 diagnostic code on Cat ET.
- Injectors are exchanged between cylinders.

Exchanging Injectors

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

Note: The injector serial number and the injector confirmation code are located on the injector. Cat ET may require the entry of injector confirmation code during this process. Cat ET will prompt you for the code, if necessary.

1. Record the injector serial number and the injector confirmation code for each injector.
2. Click on "Service Software Files" in SIS Web.
3. Enter the serial number for the injector in the search field.
4. Download the injector trim file to the PC. Repeat this procedure for each injector, as required.
5. Connect Cat ET to the service tool connector. Refer to Troubleshooting, "Electronic Service Tools".
6. Select the following menu options on Cat ET:
 - Service
 - Calibrations
 - Injector Trim Calibration

7. Select the appropriate cylinder.
8. Click on the "Change" button.
9. Select the appropriate injector trim file from the PC.
10. Click on the "Open" button.
11. If you are prompted by Cat ET, enter the injector confirmation code into the field.
12. Click on the "OK" button.

The injector trim file is loaded into the ECM.

13. Repeat the procedure for each cylinder, as required. If the download of the injector trim file fails, confirm that the part number for the injector is correct. Repeat the previous test steps.

i02590353

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 Codes Table			
Code and Description	Conditions which Generate this Code	System Response	Procedure
253-2 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.	Program the correct flash file.

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

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

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

Programming a Flash File

1. Establish communication between Cat ET and the engine’s ECM.
2. Select “WinFlash” from the “Utilities” menu on Cat ET.

Note: If “WinFlash” will not communicate with the ECM, refer to troubleshooting without a diagnostic code Troubleshooting, “Electronic Service Tool 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.

i02612705

ECM - Configure

SMCS Code: 1901-025

Select “Configuration” from the “Service menu”. If the default function keys are set, push the F5 key. If the default is set, press the “Configuration Tool” icon on the toolbar. The display for the configuration has four columns:

Description – The “Description column” gives the name of the parameter.

Value – The “Value column” displays the status of the current parameter.

Unit – The “Unit column” displays the units of the configurable parameter.

TT – The “TT column” displays the list of total tattletales. The tattletale value represents the number of changes that have been made to the configurable parameter.

Note: The value of Total Tattletales is not supported for some products.

i02598671

ECM - Replace

SMCS Code: 1901-510

NOTICE

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

Refer to Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

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

Note: Ensure that the ECM is receiving power and that the ECM is properly wired to the negative battery circuit before you attempt to replace the ECM. Refer to Troubleshooting, "Electrical Power Supply - Test".

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

NOTICE

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

Perform the following procedure in order to replace the ECM:

1. Print the parameters from the "Configuration" screen on Caterpillar Electronic Technician (ET). If a printer is unavailable, record all of the parameters. Record any logged diagnostic codes and logged event codes for your records. Record the injector serial numbers from the "Calibrations" screen under the "Service" menu on Cat ET.

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

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

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

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

NOTICE

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

NOTICE

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

- c. Remove the fuel lines (if equipped) from the ECM.
 - d. Remove the mounting bolts from the ECM.
 - e. Disconnect the ECM ground strap from the engine.
4. Install the replacement ECM.

- a. If the old mounting hardware is in good repair, you can use the old mounting hardware to install the replacement ECM.
 - b. Reconnect the fuel lines (if equipped).
 - c. Ensure that the ECM mounting hardware is installed correctly. The rubber grommets are used to protect the ECM from excessive vibration. The ECM must be able to drift in the rubber grommets. If the installation is equipped with fuel lines, the fuel lines must not put tension on the ECM. If the ECM cannot be moved slightly in the grommets, check that the fuel lines are not pulling the ECM against one side of the grommets.
 - d. Connect the ECM ground strap.
 - e. Connect the J1/P1 and J2/P2 ECM connectors. Tighten the allen head screw on each of the ECM connectors to the proper torque. Refer to Troubleshooting, "Electrical Connectors - Inspect" for the correct torque value.
5. Install the ECM software. Refer to Troubleshooting, "ECM Software - Install".
 6. If the replacement ECM was used previously for a different application, obtain factory passwords in order to reset the interlock codes.
 7. Configure the ECM.
 - a. If the "Load from ECM" process from Step 2 was successful, return to the "Copy Configuration/ECM Replacement" screen on Cat ET and select "Program ECM".

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

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

- b. If the "Program ECM" process was successful, proceed to Step 9.
- c. If the "Program ECM" process was unsuccessful, manually program the ECM parameters into the replacement ECM. The parameters must match the parameters from Step 1.

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

- d. If necessary, program the engine monitoring system.
8. If necessary, install the injector trim files. Refer to Troubleshooting, "Injector Trim File - Install".
9. Check for an active diagnostic code for timing calibration.

If the diagnostic code is active, calibrate the injection timing. Refer to calibration procedures Troubleshooting, "Timing - Calibrate".
10. Check for diagnostic codes and for event codes.

i02614068

Electrical Connectors - Inspect

SMCS Code: 7553-040-WW

Most electrical problems are caused by poor connections. The following procedure will assist in detecting problems with connectors and with wiring. If a problem is found correct the condition and verify that the problem is resolved.

Intermittent electrical problems are sometimes resolved by disconnecting and reconnecting connectors. It is very important to check for diagnostic codes immediately before disconnecting a connector. Also check for diagnostic codes after reconnecting the connector. If the status of a diagnostic code is changed due to disconnecting and reconnecting a connector, there are several possible reasons. The likely reasons are loose terminals, improperly crimped terminals, moisture, corrosion, and inadequate mating of a connection.

Follow these guidelines:

- Always use a 1U-5804 Crimp Tool to service Deutsch HD and DT connectors. Never solder the terminals onto the wires. Refer to "SEHS9615, Servicing Deutsch HD and DT Style Connectors".
- Always use a 147-6456 Wedge Removal Tool 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.

WARNING

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

1. Determine If The Problem Is Intermittent.

If the problem is intermittent, attempt to test the circuit before you disconnect any electrical connectors. This helps identify the root cause of intermittent problems.

The "Wiggle Test" on the 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.

2. Check the Connectors for Moisture and For Corrosion.

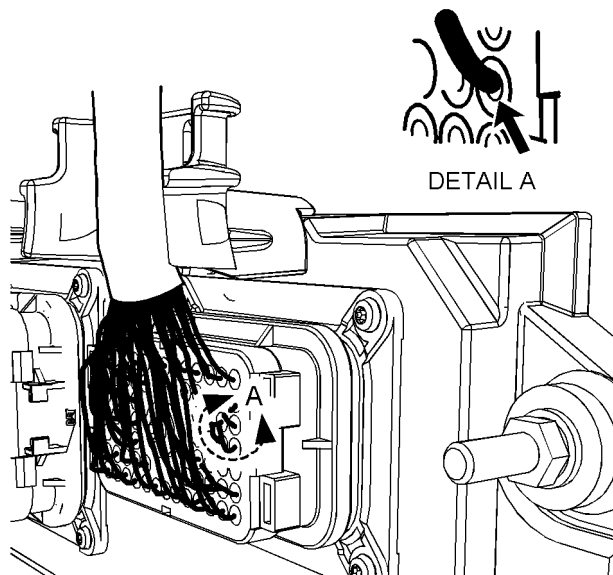


Illustration 191

g01131211

Leaky seal at the connector (typical example)

- Inspect all wiring harnesses. Ensure that the routing of the wiring harness allows the wires to enter the face of each connector at a perpendicular angle. Otherwise, the wire will deform the seal bore. Refer to Illustration 191. This will create a path for the entrance of moisture. Verify that the seals for the wires are sealing correctly.

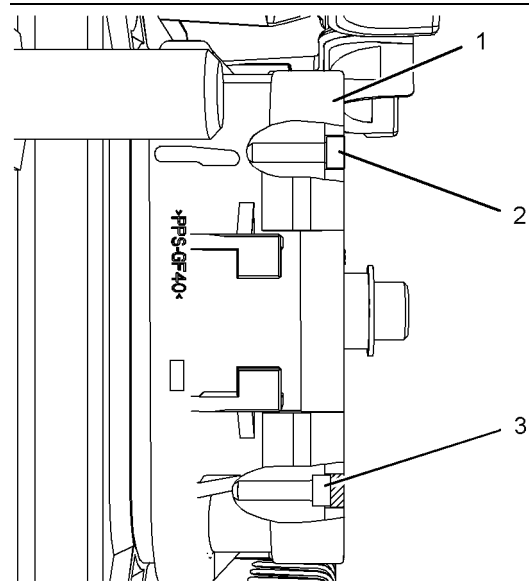


Illustration 192

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. Refer to Illustration 192.

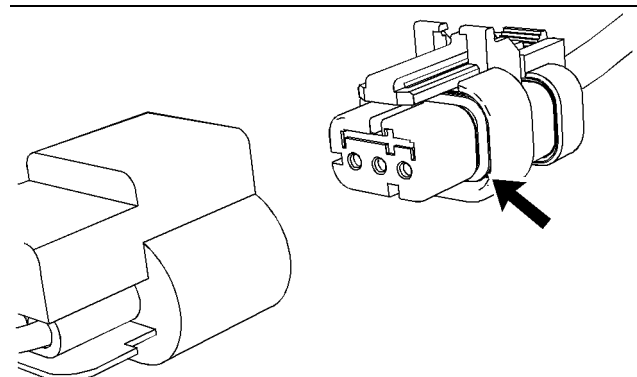


Illustration 193

g01131019

Seal for a three-pin connector (typical example)

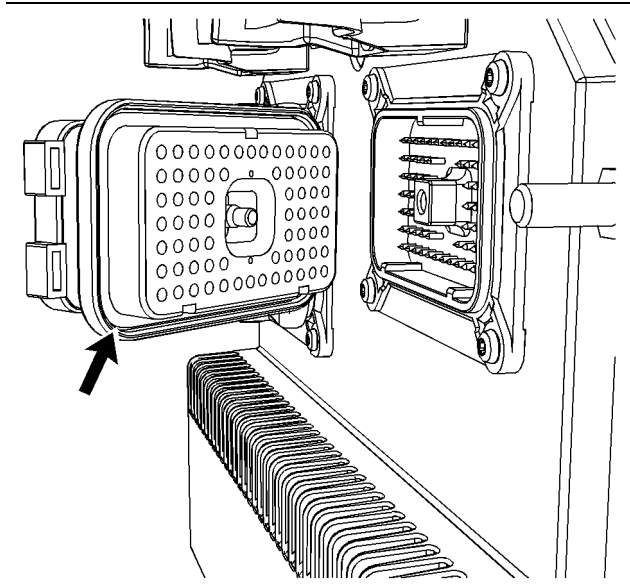


Illustration 194

g01131165

Seal for ECM connector (typical example)

- c. Disconnect the suspect connector and inspect the connector seal. Ensure that the seals are in good condition. If necessary, replace the connector.
- d. Thoroughly inspect the connectors for evidence of moisture entry.

Note: It is normal to see some minor seal abrasion on connector seals. Minor seal abrasion will not allow the entry of moisture.

If moisture or corrosion is evident in the connector, the source of the moisture entry must be found and the source of the moisture entry must be repaired. If the source of the moisture entry is not repaired, the problem will recur. Simply drying the connector will not fix the problem. Check the following items for the possible moisture entry path:

- Missing seals
- Improperly installed seals
- Nicks in exposed insulation
- Improperly mated connectors

Moisture can also travel to a connector through the inside of a wire. If moisture is found in a connector, thoroughly check the connector's harness for damage. Also check other connectors that share the harness for moisture.

Note: The ECM is a sealed unit. If moisture is found in an ECM connector, the ECM is not the source of the moisture. Do not replace the ECM.

3. Check the Wires for Damage to the Insulation.

- a. Carefully inspect each wire for signs of abrasion, of nicks, and of cuts.

Inspect the wires for the following conditions:

- Exposed insulation
- Rubbing of a wire against the engine
- Rubbing of a wire against a sharp point

- b. Check all of the wiring harness fasteners in order to verify that the harness is properly secured. Also check all of the fasteners in order to verify that the harness is not compressed. Pull back the harness sleeves in order to check for a flattened portion of wire. A fastener that has been overtightened flattens the harness. This damages the wires that are inside the harness.

4. Inspect the Connector Terminals.

Visually inspect each terminal in the connector. Verify that the terminals are not damaged. Verify that the terminals are properly aligned in the connector and verify that the terminals are properly located in the connector.

5. Perform a Pull Test on Each Wire Terminal Connection.

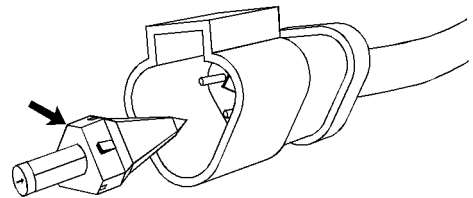


Illustration 195

g01131435

Receptacle lock wedge (typical example)

- a. Ensure that the locking wedge for the connector is installed properly. Terminals cannot be retained inside the connector if the locking wedge is not installed properly.

- b. Perform the 45 N (10 lb) pull test on each wire. Each terminal and each connector should easily withstand 45 N (10 lb) of tension and each wire should remain in the connector body. This test checks whether the wire was properly crimped in the terminal and whether the terminal was properly inserted into the connector.

6. Check Individual Pin Retention into the Socket.

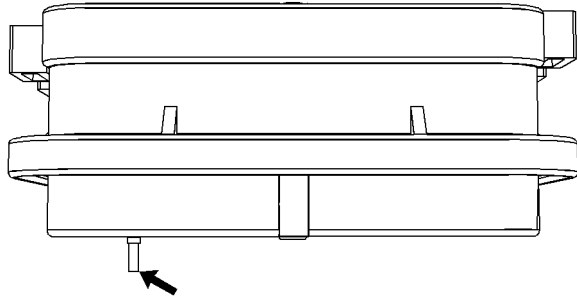


Illustration 196

g01131604

Diagram for testing pin retention (typical example)

- a. Verify that the sockets provide good retention for the pins. Insert a new pin into each socket one at a time in order to check for a good grip on the pin by the socket.

7. Check the Locking Mechanism of the Connectors.

- a. Ensure that the connectors lock properly. After locking the connectors, ensure that the two halves cannot be pulled apart.
- b. Verify that the latch tab of the connector is properly latched. Also verify that the latch tab of the connector returns to the locked position.

8. Check the Allen Head Screws on the Connectors.

Visually inspect the allen head screws for the ECM connectors. Ensure that the threads on each allen head screw are not damaged.

- a. Connect the ECM connectors.

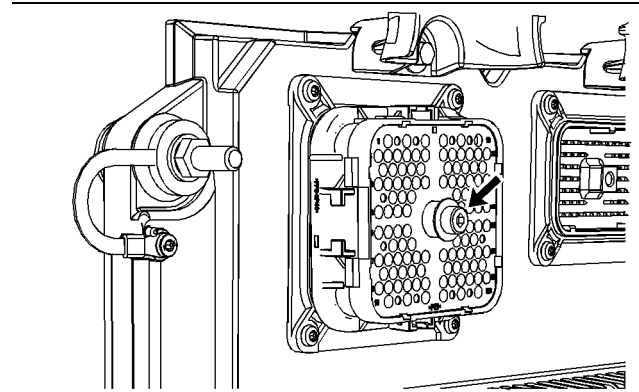


Illustration 197

g01132827

Allen head screw for the 120 pin ECM connector (typical example)

- b. Torque the allen head bolt for the 120 pin ECM connector to $7.0 \pm 0.5 \text{ N}\cdot\text{m}$ ($60 \pm 4 \text{ lb in}$).

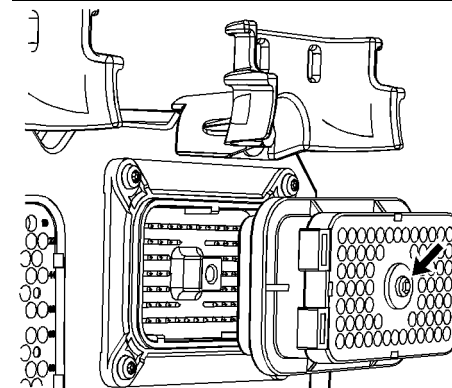


Illustration 198

g01132849

Allen head screw for the 70 pin ECM connector (typical example)

- c. Torque the allen head screw for the 70 pin ECM connector to $6.0 + 1.5 - 1.0 \text{ N}\cdot\text{m}$ ($55 + 13 - 9 \text{ lb in}$).

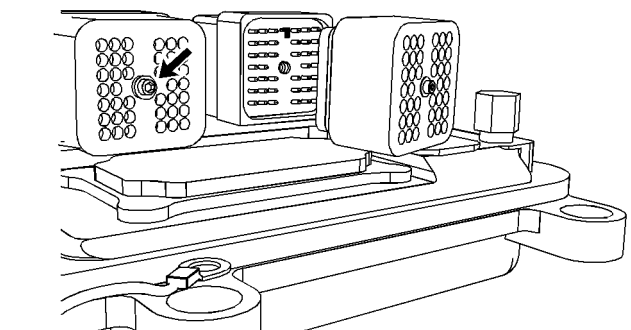


Illustration 199

g01132863

Allen head screw for the 40 pin ECM connector (typical example)

- d. Torque the allen head screw for the 40 pin ECM connector to $2.25 \pm 0.25 \text{ N}\cdot\text{m}$ ($20 \pm 2 \text{ lb in}$).
- e. Connect the customer connector.

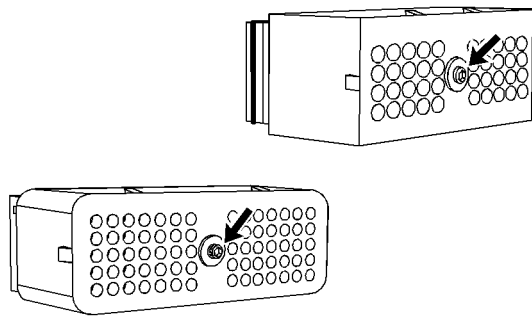


Illustration 200

g01133047

Allen head screw for the 40 pin customer connector and the 70 pin customer connector (typical example)

- f. Torque the allen head screw for the 40 pin customer connector and the 70 pin customer connector to $2.25 \pm 0.25 \text{ N}\cdot\text{m}$ ($20 \pm 2 \text{ lb in}$).

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