



Troubleshooting

C11, C13 Engines and for 14M and , 16M Motor Graders

B9H 1-UP (Machine)
MHX 1-UP (Engine)
R9H 1-UP (Machine)
B9J 1-UP (Machine)
R9J 1-UP (Machine)
RSX 1-UP (Engine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. 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 verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

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

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



The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

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

A non-exhaustive list of operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

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



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

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

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

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Troubleshooting Section

Introduction

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General Information

SMCS Code: 1000

Electronic Control System

The electronic system consists of an Electronic Control Module (ECM), the wiring harness, switches, sensors, and fuel injectors. The ECM consists of two main components, the control computer (hardware) and the flash file (software). The control computer consists of a microprocessor and electronic circuitry. The flash file contains the engine's operational characteristics. The operating maps define the following characteristics of the engine:

- Horsepower
- Torque curves
- Engine speed (rpm)

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

Interface

The ECM interfaces with the engine via software and electrical connectors on the ECM. The engine provides inputs to the electrical connector on the ECM in order to indicate the status of switches and sensors. The ECM must be correctly configured in order to interpret the inputs. The ECM provides outputs for the engine systems via the electrical connectors on the ECM in order to control lamps, solenoids, and other devices. Refer to Troubleshooting, "Configuration Parameters".

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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.

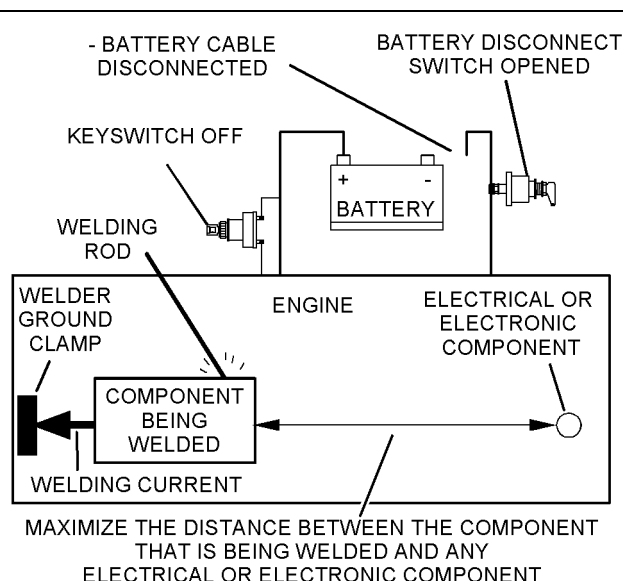


Illustration 1

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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

Service Tools

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

Table 1

Service Tools	
Part Number	Description
349 - 4200	Thermometer
360 - 0774	Refractometer

(Table 1, contd)

Service Tools	
Part Number	Description
431 - 7087	Tool Gp (REFRACTOMETER (DEF))
N/A	4 mm Allen Wrench
1U - 5805	Wire Removal Tool (14-GA, GREEN)
6V - 2197	Magnetic Transducer As (TIMING CALIBRATION)
121 - 9588	Wire Removal Tool (16-GA, BLUE)
147 - 6456	Wedge Removal Tool
151 - 6320	Wire Removal Tool (14-GA TO 18-GA, RED)
1U - 5804	Crimp Tool (12-AWG TO 18-AWG)
6V - 2197	Transducer
7X - 1171	Transducer Adapter
7X - 1695	Cable As
146 - 4080	Digital Multimeter Gp (RS232)
7X - 1710	Multimeter Probes
326 - 4904	Adapter Cable As (3-PIN BREAKOUT)
7X - 1715 134 - 5195	Adapter Cable As (40-PIN BREAKOUT) Harness (40-PIN) (For ADEM 2 ECM (two 40-pin connectors))
208 - 0059	Adapter Cable As (70-PIN BREAKOUT) (For ADEM 3 ECM (two 70-pin connectors) and for ADEM 4 ECM (one 70-pin connector and one 120-pin connector))
257 - 8718	The 257 - 8718 Adapter Cable As is not applicable with Tier IV Engines. Adapter Cable As (120-PIN BREAKOUT) (For ADEM 4 ECM (one 70-pin connector and one 120-pin connector))
N/A	Torque Wrench (capable of applying 1.5 N·m (13.3 lb in))
Repair Kits for Connectors	
362 - 3555	Connector Repair Kit (AMPSEAL)
175 - 3700	Connector Repair Kit (Deutsch connector)
Bypass Harnesses for the ECM	
129 - 2018	Power Cable (Stand alone cable for ADEM 2 ECM)
217 - 0113	Wiring Harness (ECM BYPASS) (The bypass harness connects to the battery. The bypass harness is used with the following harnesses for different types of electronic control modules.)

(continued)

(continued)

Introduction

(Table 1, contd)

Service Tools	
Part Number	Description
328 - 2292	Harness (ENGINE ECM BYPASS) (For ADEM 3 ECM and ADEM 4 ECM)
277 - 4734	Harness (ENGINE ECM BYPASS) (For A4:E2 ECM (Two 64-pin connectors))
276 - 7273	Sensor Test Box ⁽¹⁾

(1) Instrument used to test Cylinder Position sensors.

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

Except for harness tests, the use of certain test equipment is not recommended for use on modern Caterpillar electrical circuits. Such testers include the following examples: the 8T - 0500 Continuity Tester and 5P - 7277 Voltage Tester.

Note: A procedure has been developed to test "In Cylinder" Position Sensors. Reference Special Instruction REHS7338, "Procedure to Test the Position Sensor of a Hydraulic Cylinder".

Optional Service Tools

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

Table 2

Optional Service Tools	
Part Number	Description
198 - 4240 or 1U - 5470	Digital Pressure Indicator or Engine Pressure Group
4C - 4075	Crimp Tool (4-AWG TO 10-AWG)
4C - 4911 ⁽¹⁾	Battery Load Tester
5P - 7277	Voltage Tester
6V - 9130 ⁽²⁾	Temperature Adapter (MULTIMETER)
8T - 5319	Connector Tool Group
349 - 4199	AC/DC Current Probe
348 - 5430	Multi-Tool Gp
8T - 8726	Adapter Cable As
163 - 5443	Adapter Cable As (3-PIN BREAKOUT)
177 - 2330	Battery Analyzer (DIGITAL)
190 - 8900	Connector Repair Kit

(Table 2, contd)

Optional Service Tools	
Part Number	Description
225 - 5985	Parallel Port Cable (COMMUNICATION ADAPTER)
391 - 8170	EMISSIONS ANALYZER TOOL GP (Bluetooth Module)
393 - 0673	EMISSIONS ANALYZER TOOL GP

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

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

Cat[®] Electronic Technician (ET)

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

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

Cat ET can display the following information:

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

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

Table 3

Software, JEBD3003, "CATERPILLAR ELECTRONIC TECHNICIAN"
--

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

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

(continued)

Connecting Cat ET

Connecting the Communication Adapter

Note: The 466 - 6258 is the latest version of the Communication Adapter Group. Older service tool versions can still be used.

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

Table 4

Standard Hardware for Connecting with Cat ET	
Part Number	Description
N/A	Personal Computer (PC)
466 - 6258	Communication Adapter Gp
317-7492	Radio Kit (NACD only)
349 - 1206	Radio Kit (EAME only)
Components of the 466 - 6258 Communication Adapter Gp	
317 - 7485	Communication Adapter (3)
370 - 4617	Cable As (USB)
457 - 6114	Cable As (DATA LINK)
Components of the 317 - 7492 Radio Kit	
317 - 7493	Wireless Communication Radio
317 - 7496	Computer Cable As
317 - 7510	Radio Cable Assembly
326 - 9606	Antenna (2)
Components of the 349 - 1206 Radio Kit	
348 - 9250	Communication Radio Gp
317 - 7496	Computer Cable As
317 - 7510	Radio Cable Assembly
326 - 9606	Antenna (2)
Tool Operating Manual & Software CD ROM, NETG5057, "Communication Adapter 3"	

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

1. Remove the electrical power from the ECM.

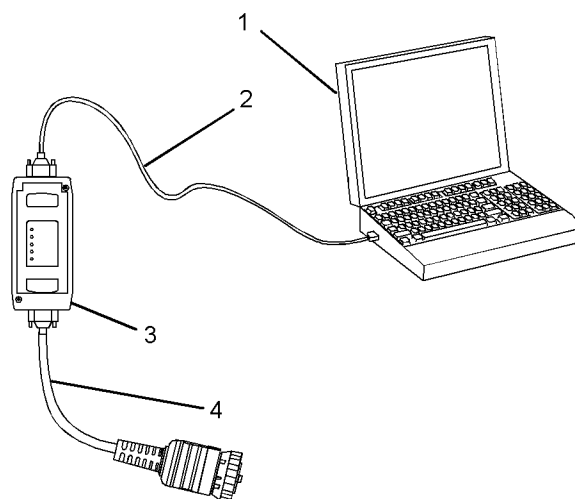


Illustration 2

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

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

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

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

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

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

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

Dual Data Link Communications (If so equipped)

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

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

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

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

Communicating with the Wireless Communication Adapter (If so equipped)

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

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

Table 5

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

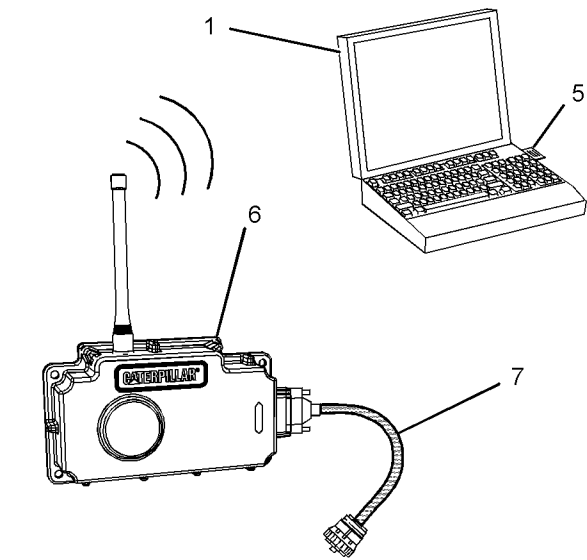


Illustration 3

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

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

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

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

1. Remove the electrical power from the ECM.
2. Ensure that the computer has been correctly configured for the 261 - 4867 Card. Verify that the PC card is installed in the computer PCMCIA expansion slot.
3. Connect cable (9) between communication radio (8) and the service tool connector.
4. Restore the electrical power to the ECM. If Cat ET and the communication radio do not communicate with the ECM, refer to Troubleshooting, "Electronic Service Tool Will Not Communicate with ECM".

Communicating with the Wireless Communication Adapter (If so equipped)

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

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

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

Table 6

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

2. Ensure that the computer has been correctly configured for the 802.11a or 802.11b/g enabled wireless card. Verify that the PC wireless is installed and working correctly.
3. Connect cable (9) between communication radio (8) and the service tool connector.
4. Restore the electrical power to the ECM. If Cat ET and the communication radio do not communicate with the ECM, refer to Troubleshooting, "Electronic Service Tool Will Not Communicate with ECM".

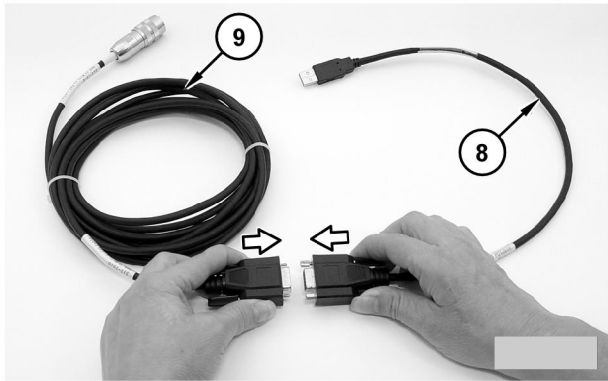


Illustration 4
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(8) 317-7496 Computer Cable As (USB)
(9) 317-7510 Radio Cable AssemblyC

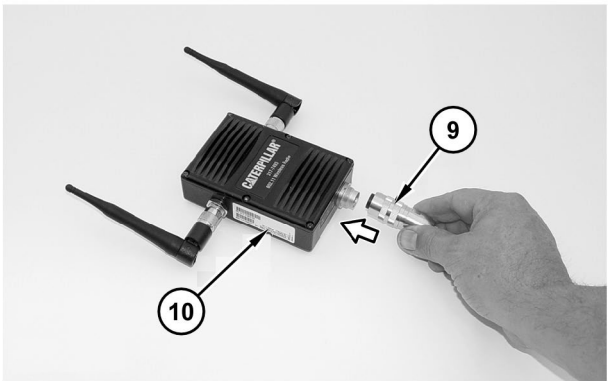


Illustration 5
g02596964
(9) 317-7510 Radio Cable Assembly
(10) W-CA3

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

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

1. Remove the electrical power from the ECM.

PL1000E Communication ECM (If so equipped)

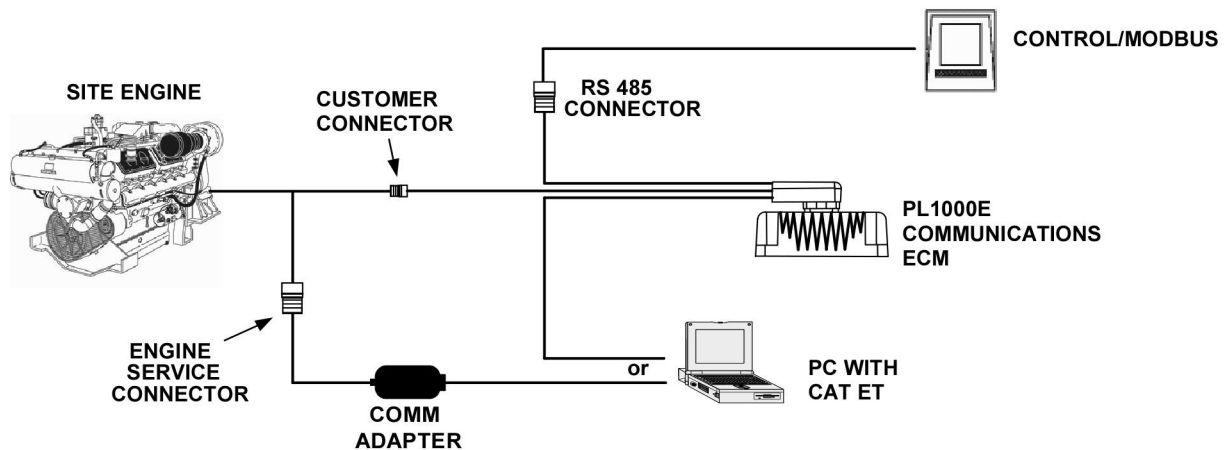


Illustration 6

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

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

Electronic System Overview

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System Overview

SMCS Code: 1000; 1900

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

Electronic Controls

Electronic Control Module

The ECM consists of two main components, the control computer (hardware) and the flash file (software). The control computer consists of a microprocessor and electronic circuitry. The flash file contains the engine's operational characteristics. The operating maps influence the engine's performance.

Engine Governor

The engine ECM governs engine speed. The engine ECM and the flash file work together by controlling the amount of fuel that is delivered by the injectors. Desired engine rpm is determined by the throttle position sensor signal and certain sensor readings. Diagnostic codes may derate the engine. Actual engine rpm is monitored by the engine speed/timing sensor.

Fuel Injection

The engine ECM controls the timing and the duration of the fuel that is injected. The engine ECM varies the signals to the fuel injectors. Fuel is injected only while an injector solenoid is energized by a 105 volt signal from the engine ECM. The timing of the injection signal determines the engine timing. The length of the injection signal determines engine speed. By controlling the timing and duration of the 105 volt signal, the ECM controls the engine speed.

Injection timing depends on the desired engine rpm and load. The ECM detects the top center of each cylinder. The ECM sends an injection signal at the desired time.

FRC Limit

The flash file inside the engine ECM sets certain limits on the amount of fuel that can be injected. The FRC limit is a limit that is based on the boost pressure. The boost pressure is calculated as the difference in pressure between atmospheric pressure and turbocharger outlet pressure. The FRC limit is used to control the air/fuel ratio for control of emissions. When the engine ECM senses a higher boost pressure, the engine ECM increases the FRC limit. A higher boost pressure indicates that there is more air in the cylinder. When the engine ECM increases the FRC limit, the engine ECM allows more fuel into the cylinder.

Rated Fuel Position

The rated fuel position is a limit that is based on the power rating of the engine. The rated fuel position is similar to the rack stops and the torque spring on a mechanically governed engine. The rated fuel position determines maximum power and torque values for a specific engine family and a specific rating. The rated fuel position is programmed into the flash file at the factory.

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Component Location

SMCS Code: 1000; 1900

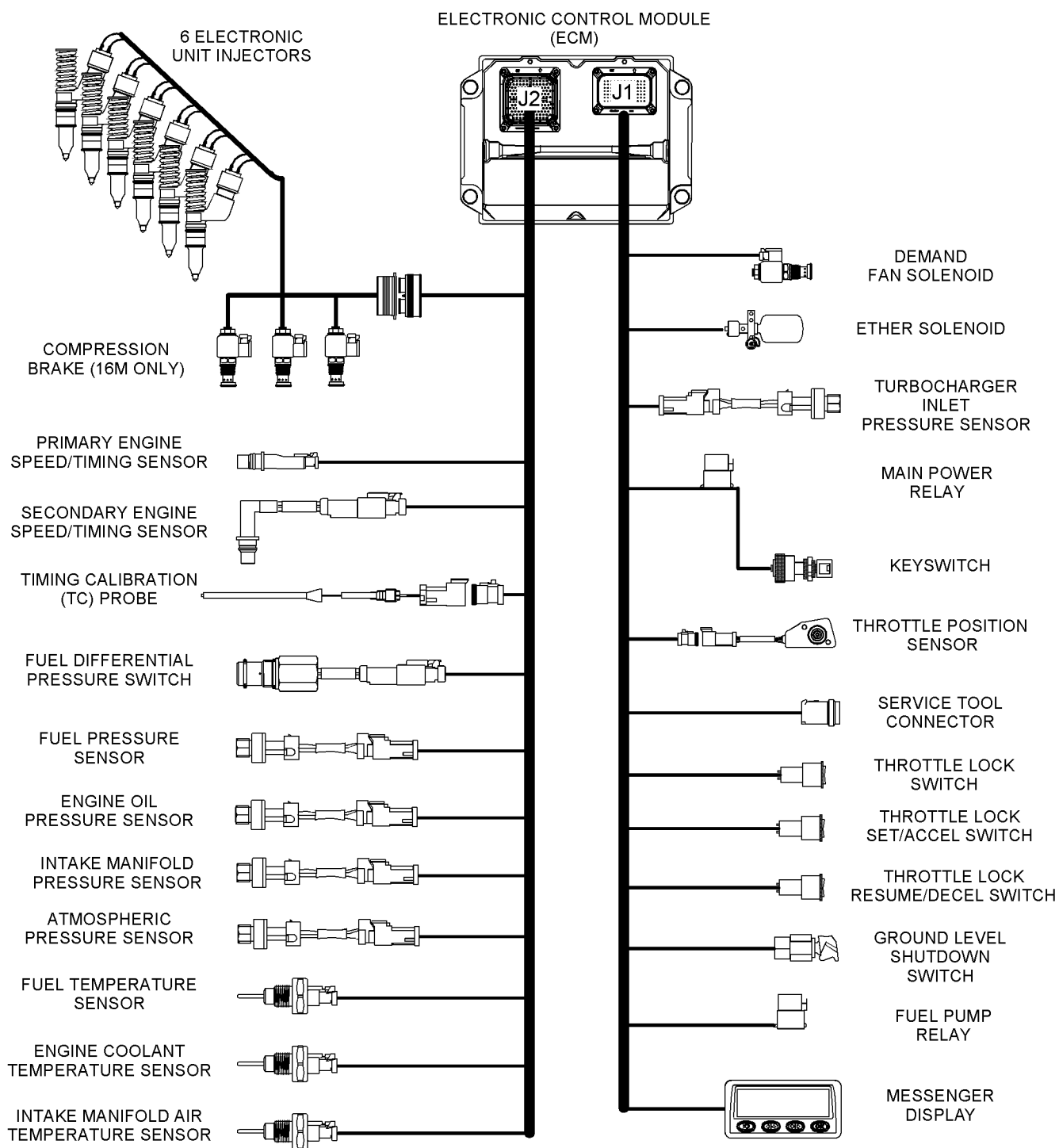


Illustration 7

Diagram of components

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C11 and C13 Engines

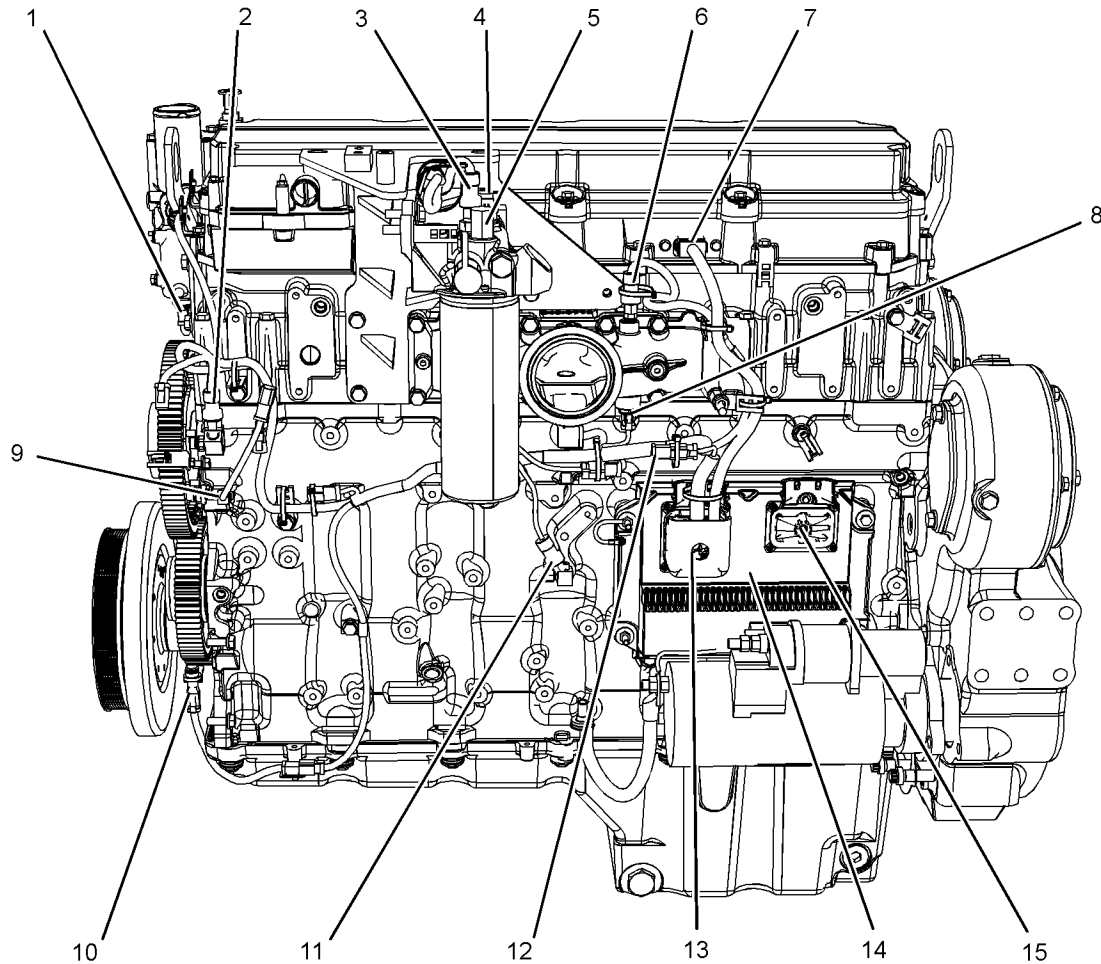


Illustration 8

g01200152

Left side engine view (typical example)

- | | | |
|---|--|---|
| (1) Engine coolant temperature sensor | (6) Intake manifold pressure sensor | (11) Engine oil pressure sensor |
| (2) Atmospheric pressure sensor | (7) Injector valve cover entry connector | (12) Timing calibration probe connector |
| (3) Fuel pressure sensor | (8) Intake manifold air temperature sensor | (13) J2/P2 ECM connector |
| (4) Fuel temperature sensor | (9) Secondary engine speed/timing sensor | (14) Engine Control Module (ECM) |
| (5) Differential pressure switch (fuel) | (10) Primary engine speed/timing sensor | (15) J1 ECM connector |

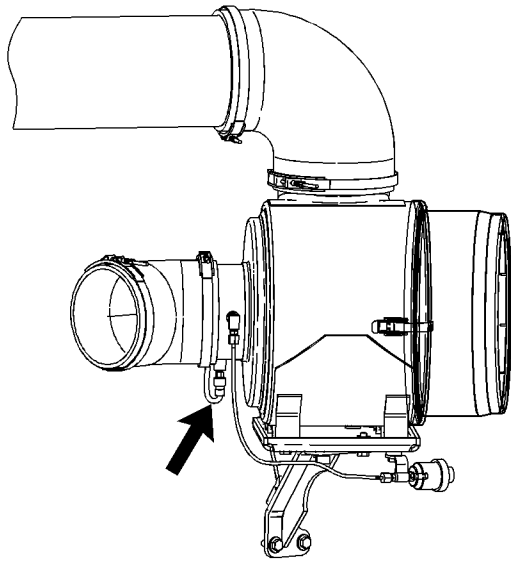


Illustration 9

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Location of the right turbocharger inlet pressure sensor (typical example)

i02987485

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

generally 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.

i06167277

Programmable Parameters

SMCS Code: 1900

The Cat[®] Electronic Technician (ET) can be used to view certain parameters that can affect the operation of the engine. Cat ET can also be used to change certain parameters. There are some parameters that cannot be changed and there are some applications that do not allow any changes to the programmable monitoring system. The parameters are stored in the Electronic Control Module (ECM). Some of the parameters are protected from unauthorized changes by passwords. Parameters that can be changed have a tattletale number. The tattletale number shows if a parameter has been changed.

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Electrical Connectors

SMCS Code: 7553-WW

Connectors for the Electronic Control Module (ECM)

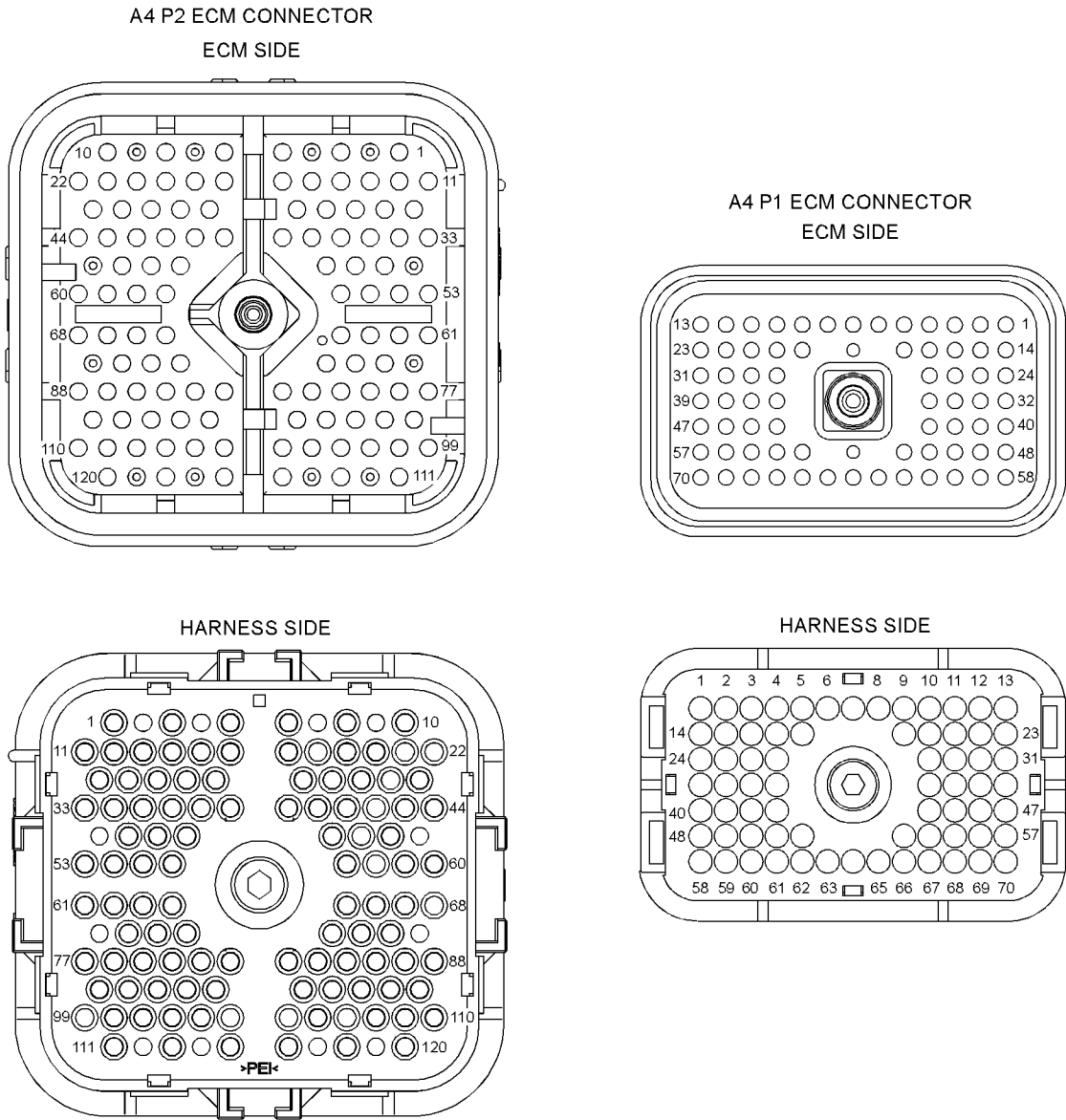


Illustration 10

Valve Cover Connector for the Injector Harness

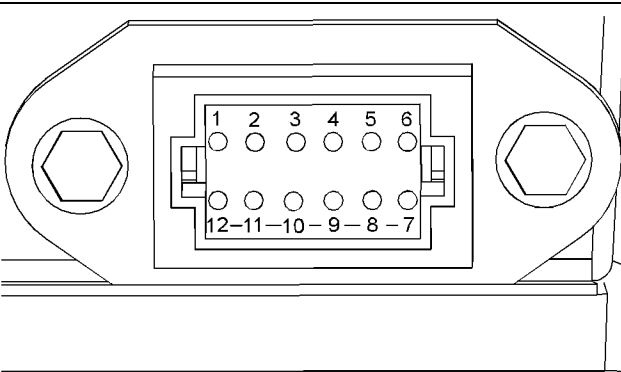


Illustration 11 g01310285

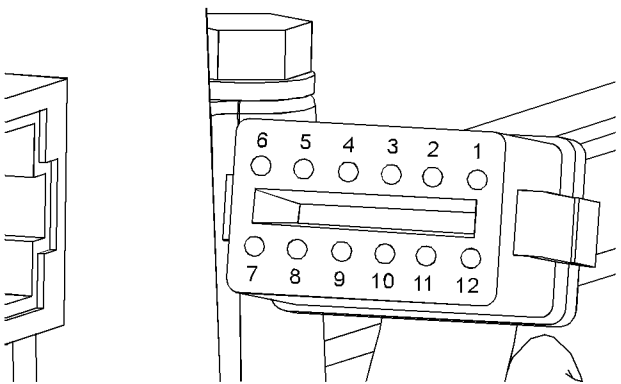


Illustration 12 g01310286

Sensor Connectors

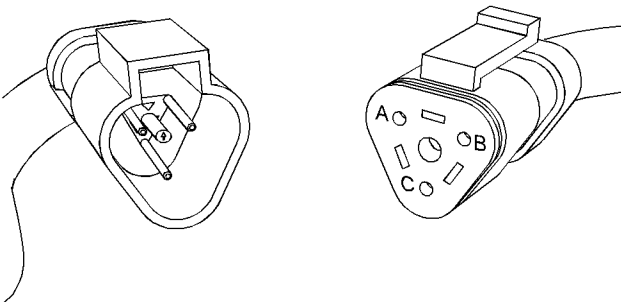


Illustration 13 g01159881

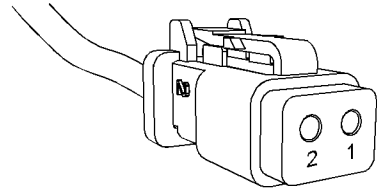


Illustration 14 g01155187

Service Tool Connector for Cat ET

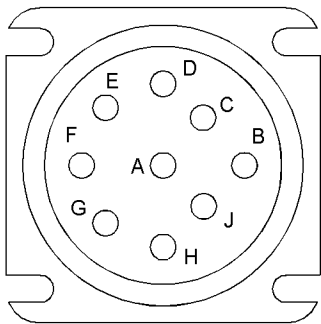


Illustration 15 g01158896

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 7 lists the wire colors and the color codes.

Table 7

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(Grey) on the schematic would signify a gray wire with the circuit number A701.

Configuration Parameters

i05374820

Configuration Parameters

SMCS Code: 1900

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

Table 8

Diagnostic Codes Table		
Code and Description	Conditions which Generate this Code	System Response
268-2 Programmed Parameter Fault : Erratic, Intermittent, or Incorrect	The engines Electronic Control Module (ECM) detects that one or more of the programmable parameters have not been programmed.	The ECM may use a default torque map or the ECM may limit the engine to low idle. The code is active only.

System configuration parameters are parameters that affect emissions, power of the engine, and machine applications. Default values for the parameters are programmed at the factory. Some parameters may be changed by the customer in order to suit the needs of the specific application. You must reprogram the system configuration parameters if the ECM is replaced and/or if you reprogram the engine rating. Values for these parameters are available on Caterpillar Electronic Technician (ET). Certain configuration parameters are also stamped on the engine information plate.

Check Programmable Parameters (268-2)

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

If "Injector Trim" is displayed below a 268-2 diagnostic code on Cat ET, refer to Troubleshooting, "Injector Trim File - Install".

Parameter Descriptions

"Product ID"

The "Product ID" parameter allows the customer to enter a description into the ECM in order to identify the machine. A maximum of 8 characters can be entered in the field.

"Equipment ID"

The "Equipment ID" parameter allows the customer to enter a description into the ECM in order to identify the machine. A maximum of 17 characters can be entered in the field.

"Engine Serial Number"

Program the "Engine Serial Number" to match the engine serial number that is stamped on the engine information plate. The engine serial number is not preprogrammed on a replacement ECM.

"FLS" (Full Load Setting)

"FLS" is a number that represents the adjustment to the fuel system that was made at the factory in order to fine-tune the fuel system. The correct value for this parameter is stamped on the engine information plate. Only change this value if the engine is rerated or if a new ECM is installed. The parameter allows one time of programming without a factory password. In order to change the "FLS" after the initial programming, factory passwords are required.

"FTS" (Full Torque Setting)

"FTS" is similar to "FLS". Only change this value if the engine is rerated or if a new ECM is installed. Factory passwords are required. A new ECM or a blank ECM allows one time of programming of the "FTS" without the use of factory passwords. In order to change the "FTS" after the initial programming, factory passwords are required.

"Engine Cooling Fan Map"

This parameter allows the selection of a standard cooling package or a high ambient cooling package.

“Engine Warmup Elevated Idle”

The “Engine Warmup Elevated Idle” parameter allows the operation of this feature to be enabled or disabled.

“Ether Solenoid Configuration”

The parameter for the “Ether Solenoid Configuration” allows the ether solenoid to be installed or not installed.

“Number of Available Engine Power Levels”

This parameter selects the engine power level. This parameter allows the selection of a different engine power level without reflashing the engine software. In order to change the engine power level after the initial programming, factory passwords are required.

“Security System Immobilizer Installation Status”

The “Security System Immobilizer Installation Status” allows the “security system immobilizer” to be installed or not installed.

“Injector Trim File”

This parameter is for the injector trim files that are associated with each injector. If an injector is replaced or if two injectors are exchanged between cylinders, the injector trim file for the injector must be programmed to the correct cylinder.

Parameter Table

Table 9

Customer Specified Parameters			
Parameter	Available Range or Options	Default	Required Password
"Product ID"	8 characters	blank	none
"Equipment ID"	17 characters	blank	none
"Engine Serial Number"	8 characters	blank	none
"FLS"	-128 to +127	0	Factory
"FTS"	-128 to +127	0	Factory
"Engine Cooling Fan Map"	"Standard" or "High Ambient"	"Standard"	none
"Engine Warmup Elevated Idle"	"Enabled" or "Disabled"	"Enabled"	none
"Ether Solenoid Configuration"	"Not Installed" or "Continuous Flow Solenoid"	"Continuous Flow Solenoid"	none
"Number of Available Engine Power Levels"	4 or 8 ⁽¹⁾	4	Factory
"Security System Immobilizer Installation Status"	"Installed" or "Not Installed"	"Not Installed"	none

(1) Option 4 is for Standard VHP, option 8 is for VHP Plus

Parameter Worksheet

Record the following information before you change any programmable parameter.

Table 10

Information from ECM	
"Product ID"	
"Equipment ID"	
"Engine Serial Number"	
"ECM Serial Number"	
"Personality Module Part Number"	
"Personality Module Release Date"	
"Personality Module Description"	
"FLS"	
"FTS"	
"Engine Cooling Fan Map"	
"Engine Warmup Elevated Idle"	

(Table 10, contd)

Information from ECM	
"Ether Solenoid Configuration"	
"Number of Available Engine Power Levels"	
"Security System Immobilizer Installation Status"	
"Total Tattletale"	
Information From Engine Information Plate	
Engine Serial Number	
Full Load Setting (for new ECM)	
Full Torque Setting (for new ECM)	
Injector Code (1)	
Injector Code (2)	
Injector Code (3)	
Injector Code (4)	
Injector Code (5)	
Injector Code (6)	

(continued)

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

Diagnostic Trouble Codes

i02592279

Diagnostic Trouble Code List

SMCS Code: 1900

Cross-Reference Information for Diagnostic Codes

Table 11 is a list of the diagnostic codes for the engine. The diagnostic codes are cross-referenced with the appropriate procedure that can be used to troubleshoot the code.

Further explanations of diagnostic codes are explained after Table 11 .

Table 11

Cross-Reference from CID-FMI Code on Cat Data Link to Troubleshooting Procedure	
Code and Description	Procedure
1-5 Cylinder #1 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
1-6 Cylinder #1 Injector current above normal	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"
3-5 Cylinder #3 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
3-6 Cylinder #3 Injector current above normal	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"
5-5 Cylinder #5 Injector current below normal	Troubleshooting, "Injector Solenoid - Test"
5-6 Cylinder #5 Injector current above normal	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"
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, "Speed Control - Test"
94-3 Fuel Delivery Pressure Sensor voltage above normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
94-4 Fuel Delivery Pressure Sensor voltage below normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
100-3 Engine Oil Pressure Sensor voltage above normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
100-4 Engine Oil Pressure Sensor voltage below normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
100-10 Engine Oil Pressure Sensor abnormal rate of change	Troubleshooting, "Sensor Signal (Analog, Active) - Test"

(continued)

(Table 11, contd)

Cross-Reference from CID-FMI Code on Cat Data Link to Troubleshooting Procedure	
Code and Description	Procedure
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"
172-3 Intake Manifold Air Temperature Sensor voltage above normal	Troubleshooting, "Sensor Signal (Analog, Passive) - Test"
172-4 Intake Manifold Air Temperature Sensor voltage below normal	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"
190-8 Engine Speed Sensor abnormal frequency, pulse width, or period	Troubleshooting, "Speed/Timing - Test"
253-2 Personality Module erratic, intermittent, or incorrect	Troubleshooting, "ECM Software - Install"
261-11 Engine Timing Offset fault	Troubleshooting, "Timing - Calibrate"
261-13 Engine Timing Calibration calibration required	Troubleshooting, "Timing - Calibrate"
262-3 5 Volt Sensor DC Power Supply voltage above normal	Troubleshooting, "Sensor Supply - Test"
262-4 5 Volt Sensor DC Power Supply voltage below normal	Troubleshooting, "Sensor Supply - Test"
267-3 Remote Shutdown Input voltage above normal	Troubleshooting, "Shutdown (Ground Level) - Test"
267-4 Remote Shutdown Input voltage below normal	Troubleshooting, "Shutdown (Ground Level) - Test"
268-2 Programmed Parameter Fault erratic, intermittent, or incorrect	Troubleshooting, "Configuration Parameters"
269-3 Sensor Power Supply voltage above normal	Troubleshooting, "Sensor Supply - Test"
269-4 Sensor Power Supply voltage below normal	Troubleshooting, "Sensor Supply - Test"
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"
291-5 Engine Cooling Fan Solenoid current below normal	Troubleshooting, "Cooling Fan Control - Test"
291-6 Engine Cooling Fan Solenoid current above normal	Troubleshooting, "Cooling Fan Control - Test"
296-9 Transmission Control abnormal update rate	Troubleshooting, "Cat Data Link - Test"
297-9 All Wheel Drive Control abnormal update rate	Troubleshooting, "Cat Data Link - Test"
342-8 Secondary Engine Speed Sensor abnormal frequency, pulse width, or period	Troubleshooting, "Speed/Timing - Test"
549-2 Throttle Lock Switch erratic, intermittent, or incorrect	Troubleshooting, "Throttle Lock - Test"
588-9 Monitoring System Display abnormal update rate	Troubleshooting, "Cat Data Link - Test"
596-9 Implement Control abnormal update rate	Troubleshooting, "Cat Data Link - Test"
791-5 Compression Brake Low/High Solenoid current below normal	Troubleshooting, "Retarder - Test"
791-6 Compression Brake Low/High Solenoid current above normal	Troubleshooting, "Retarder - Test"

(continued)

Diagnostic Trouble Codes

(Table 11, contd)

Cross-Reference from CID-FMI Code on Cat Data Link to Troubleshooting Procedure	
Code and Description	Procedure
792-5 Compression Brake Medium/High Solenoid current below normal	Troubleshooting, "Retarder - Test"
792-6 Compression Brake Medium/High Solenoid current above normal	Troubleshooting, "Retarder - Test"
1551-13 Engine Demand Fan System calibration required	Troubleshooting, "Cooling Fan - Calibrate"
1589-3 Turbocharger Inlet Air Pressure Sensor voltage above normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
1589-4 Turbocharger Inlet Air Pressure Sensor voltage below normal	Troubleshooting, "Sensor Signal (Analog, Active) - 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"
1639-2 Machine Security System Module erratic, intermittent, or incorrect	Troubleshooting, "Cat Data Link - Test"
1639-9 Machine Security System Module abnormal update rate	Troubleshooting, "Cat Data Link - Test"
1785-3 Intake Manifold Pressure Sensor voltage above normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
1785-4 Intake Manifold Pressure Sensor voltage below normal	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
1785-10 Intake Manifold Pressure Sensor abnormal rate of change	Troubleshooting, "Sensor Signal (Analog, Active) - Test"
2417-5 Ether Injection Control Solenoid current below normal	Troubleshooting, "Starting Aid - Test"
2417-6 Ether Injection Control Solenoid current above normal	Troubleshooting, "Starting Aid - Test"
2770-3 Throttle Lock Resume/Decel Switch voltage above normal	Troubleshooting, "Throttle Lock - Test"
2770-4 Throttle Lock Resume/Decel Switch voltage below normal	Troubleshooting, "Throttle Lock - Test"
2771-3 Throttle Lock Set/Accel Switch voltage above normal	Troubleshooting, "Throttle Lock - Test"
2771-4 Throttle Lock Set/Accel Switch voltage below normal	Troubleshooting, "Throttle Lock - Test"

Diagnostic Codes

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

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

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

Refer to Table 11 for a complete list of the diagnostic codes and the appropriate troubleshooting procedure.

Note: Do not confuse diagnostic codes with event codes. Event codes alert the operator that an abnormal operating condition such as low oil pressure or high coolant temperature has been detected. If an event code is active, refer to Troubleshooting, "Event Code List".

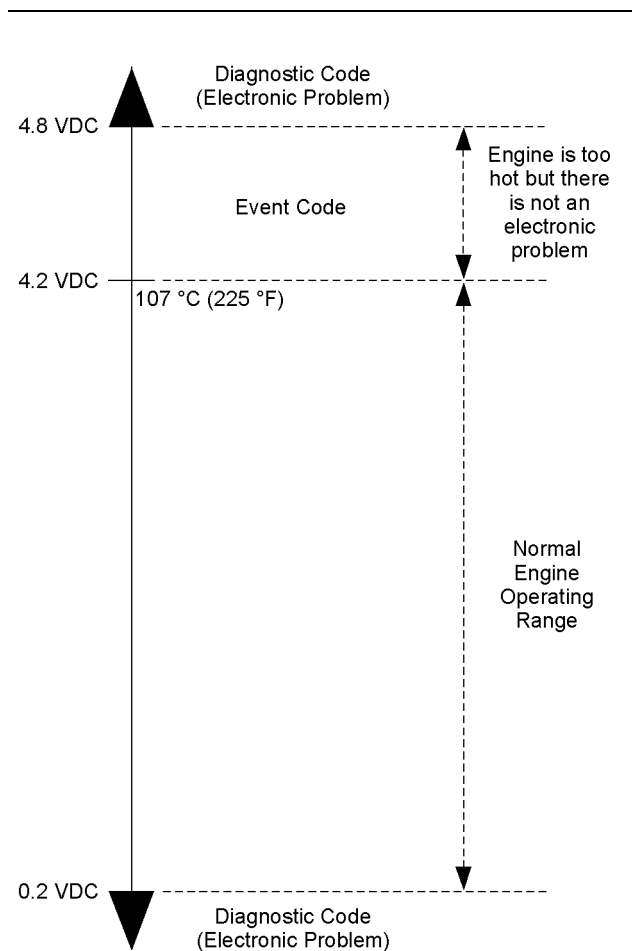


Illustration 16

g01117578

Output voltage from a typical analog temperature sensor

Illustration 16 indicates the signal range for a typical analog sensor. Diagnostic codes will be generated if the sensor's output signal is below 0.2 VDC or above 4.8 VDC.

Note: This graphic is an example. The signal ranges in this graphic are used only as examples.

Active Diagnostic Codes

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

When the engine's 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

i02592858

Event Code List

SMCS Code: 1900

Cross-Reference Information for Event Codes

Table 12 is a list of the event codes for the engine. The event codes are cross-referenced with the appropriate procedure that can be used to troubleshoot the code.

Event codes are generated when abnormal operating conditions exist. A further explanation of event codes and the engine's monitoring system are described after Table 12 .

Table 12

Cross-Reference from Event Codes on Cat Data Link to Troubleshooting Procedure	
Code and Description	Troubleshooting Procedure
E096(1) High Fuel Pressure	Troubleshooting, "Fuel Pressure Is High"
E172(1) High Air Filter Restriction	Troubleshooting, "Inlet Air Is Restricted"
E172(2) High Air Filter Restriction	
E194(2) High Exhaust Temperature	Troubleshooting, "Exhaust Temperature Is High"
E265(3) User Defined Shutdown	Troubleshooting, "Shutdown (Ground Level) - Test"
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	
E362(2) Engine Overspeed	Troubleshooting, "Engine Overspeeds"
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	
E441(1) Idle Elevated to Increase Battery Voltage	Troubleshooting, "Idle Speed Is High"
E539(1) High Intake Manifold Air Temperature	Troubleshooting, "Intake Manifold Air Temperature Is High"
E539(2) High Intake Manifold Air Temperature	

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:

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

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

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

Active Event Codes

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

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

Illustration 17 is an example of the operating range of a temperature sensor. Do not use the Illustration to troubleshoot temperature sensors.

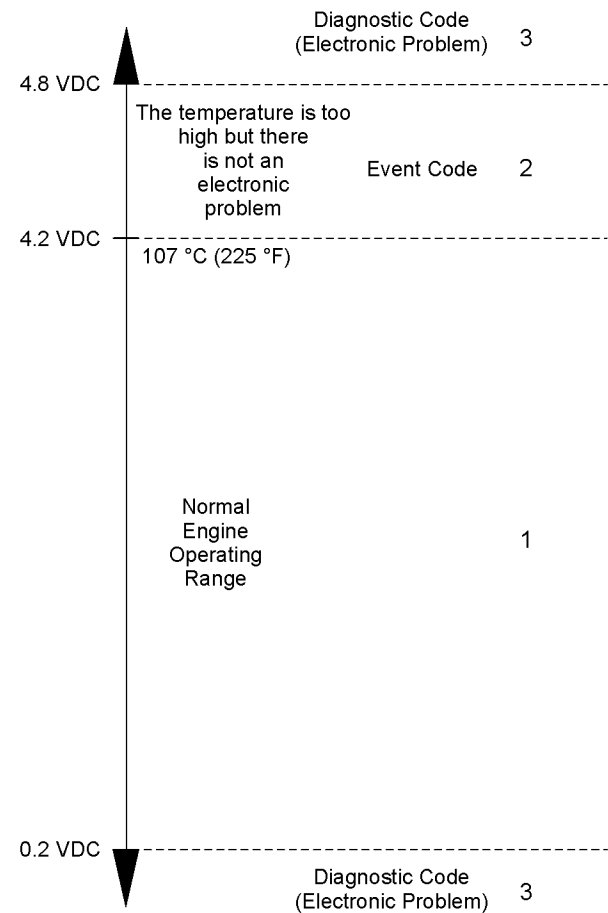


Illustration 17 g01138880

Example of the typical operating range of a temperature sensor

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

Logged Event Codes

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

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

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

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

Clearing Event Codes

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

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

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

Troubleshooting

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

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

- Connectors

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

If these steps do not resolve the problem, refer to Table 12 for the procedure to troubleshoot the event code.

Trip Points for the "Caterpillar Monitoring System"

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

Table 13 contains the parameters that are monitored and the appropriate event code(s) that can be generated for that parameter. Table 13 also contains the minimum and maximum ranges for the parameter and the default trip points for each parameter. The actual settings for each parameter can be viewed with Caterpillar Electronic Technician (ET). The trip points for some of the parameters may be adjustable with Cat ET.

Table 13

Monitoring System Parameters								
Parameter	Action	Delay Time in Seconds			Trip Point			Default State
		Min	Max	Default	Min	Max	Default	
E096(1) High Fuel Pressure	Warning	N/A	N/A	8	N/A	N/A	758 kPa (110 psi)	On
E172(1) High Air Filter Restriction	Warning	N/A	N/A	15	N/A	N/A	7.5 kPa (1 psi)	On
E172(2) High Air Filter Restriction	Derate ⁽¹⁾	N/A	N/A	30	N/A	N/A	7.5 kPa (1 psi)	On
E194(2) High Exhaust Temperature	Derate	N/A	N/A	N/A	N/A	N/A	Software dependent	On
E265(3) User Defined Shutdown	Shutdown	N/A	N/A	N/A	N/A	N/A	On/Off	
E360(1) Low Engine Oil Pressure	Warning	N/A	N/A	8	N/A	N/A	Map dependent value ⁽²⁾ .	On
E360(3) Low Engine Oil Pressure	Derate ⁽³⁾	N/A	N/A	4	N/A	N/A	Map dependent value ⁽⁴⁾ .	On
E361(1) High Engine Coolant Temperature	Warning	N/A	N/A	10	N/A	N/A	110 °C (230 °F)	On
E361(2) High Engine Coolant Temperature	Derate ⁽⁵⁾	N/A	N/A	10	N/A	N/A	111 °C (232 °F)	On
E362(2) Engine Overspeed	Warning	N/A	N/A	.6	N/A	N/A	2600 rpm for the initial action and 2800 rpm for the secondary action	On
E363(1) High Fuel Supply Temperature	Warning	N/A	N/A	30	N/A	N/A	90 °C (194 °F)	On
E363(2) High Fuel Supply Temperature	Derate ⁽⁶⁾	N/A	N/A	10	N/A	N/A	91 °C (196 °F)	On
E390(1) Fuel Filter Restriction	Warning	N/A	N/A	3600	N/A	N/A	open	On
E390(2) Fuel Filter Restriction	Derate ⁽⁷⁾	N/A	N/A	14400	N/A	N/A	open	On
E441(1) Idle Elevated to Increase Battery Voltage	Warning	N/A	N/A	N/A	N/A	N/A	Software dependent	On
E539(1) High Intake Manifold Air Temperature	Warning	N/A	N/A	8	N/A	N/A	82 °C (180 °F)	On
E539(2) High Intake Manifold Air Temperature	Derate ⁽⁸⁾	N/A	N/A	8	N/A	N/A	86 °C (187 °F)	On

(1) The derate is 2 percent for every kPa over the trip point. The maximum derate is 10 percent.

(2) Refer to Table 14 .

(3) The derate is 17.5 percent per second. The maximum derate is 35 percent.

(4) Refer to Table 15 .

(5) The derate is 25 percent for every degree over the trip point. The maximum derate is 100 percent.

(6) The derate is 12.5 percent for every degree over the trip point. The maximum derate is 25 percent.

(7) The derate is 35 percent.

(8) The derate is 3 percent for every degree over the trip point. The maximum derate is 20 percent.

Table 14

Warning Trip Points for Low Oil Pressure	
Engine RPM	Oil Pressure (kPag)
0	0
500	0
1600	154
2400	154

Table 15

Derate Trip Points for Low Oil Pressure	
Engine RPM	Oil Pressure (kPag)
0	0
500	0
1600	104
2400	104

Note: The hysteresis for the warning for low oil pressure and the derate for low oil pressure is 21kPag.

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.

i02702607

Acceleration Is Poor or Throttle Response Is Poor

SMCS Code: 1000-035

Probable Causes

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

Recommended Actions

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

Fuel Supply

1. Visually check the fuel level in the fuel tank. Do not rely on the fuel gauge only. If necessary, add fuel to the fuel tank. If the engine has been run out of fuel, it will be necessary to purge the air from the fuel system. Refer to Operation and Maintenance Manual for the correct procedure.
2. Check the fuel lines for the following problems: restrictions, collapsed lines and pinched lines. If problems are found with the fuel lines, repair the lines and/or replace the lines.
3. Check the fuel tank for debris or foreign objects which may block the fuel supply.

NOTICE

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

4. Prime the fuel system if any of the following procedures have been performed:
- Replacement of the fuel filters
 - Service on the low pressure fuel supply circuit
 - Replacement of unit injectors

Note: Check the fuel system for air. Refer to Systems Operation/Testing and Adjusting for information that is related to checking the fuel system for air.

5. Check fuel quality. Cold weather adversely affects the characteristics of the fuel. Refer to the engine's Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold weather operation.
6. Check the filtered fuel pressure while the engine is being cranked. Refer to Systems Operation/Testing and Adjusting for the test procedure and for the correct pressure values.

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

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

Engine Derate and Active Codes

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

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

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

Flash File

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

Throttle Signal

Monitor the status for "Throttle Position" on Cat ET. Verify that the status for "Throttle Position" is stable and that the engine is able to reach high idle speed. If a problem is suspected with the throttle, refer to the appropriate circuit test for information that is related to troubleshooting the throttle signal.

Electrical Connectors

Check for correct installation of the J1/P1 and J2/P2 ECM connectors and of the unit injector connectors at the valve cover. Refer to Troubleshooting, "Electrical Connectors - Inspect".

Unit Injectors

1. Perform the "Injector Solenoid Test" on Cat ET in order to determine if all of the injector solenoids are being energized by the ECM.
2. Perform the "Cylinder Cutout Test" on Cat ET in order to determine the performance of each cylinder. Refer to Troubleshooting, "Injector Solenoid - Test" for the proper procedure.

Intake Manifold Pressure Sensor

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

Table 16

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

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

2. Monitor the status of "Intake Manifold Pressure" on Cat ET. If the application is installed with an atmospheric pressure sensor, check the status of "Atmospheric Pressure" for normal operation. When the engine is not running, the correct value for "Intake Manifold Pressure" is 0 kPa (0 psi).

Air Inlet and Exhaust System

1. Observe the check engine lamp. Check for an air filter restriction indicator. Clean plugged air filters or replace plugged air filters. Refer to the Operation and Maintenance Manual.
2. Check the air inlet and exhaust system for restrictions and/or leaks. Refer to Systems Operation/Testing and Adjusting for information on inspecting the air inlet and exhaust system.

i03372684

Alternator Problem (Charging Problem and/or Noisy Operation)

SMCS Code: 1405-035

Probable Causes

Alternator

- Condition of the alternator drive belts
- Condition of the alternator drive pulley
- Condition of the alternator bearings
- Operation of the regulator

Charging Circuit

- Inspection of the charging circuit

Recommended Actions

Condition of the Alternator Drive Belts

1. Inspect the condition of the alternator drive belts. If the alternator drive belts are worn or damaged, replace the belts.
2. Check the belt tension. If the engine is equipped with an automatic belt tensioner, check the automatic belt tensioner. If necessary, replace the automatic belt tensioner.

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

Condition of the 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.

Wear of the Alternator Bearings

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

Operation of the 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.

Inspection of the Charging Circuit

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

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.

WARNING

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.

i02669797

Coolant Contains Oil

SMCS Code: 1348-035; 1395-035

Probable Causes

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

Recommended Actions

Engine Oil Cooler Core

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

Cylinder Head Gasket

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

Cylinder Head

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

Cylinder Liner

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

Cylinder Block

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

i02680957

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 Code List” for information about event codes and the default trip points for these codes. You must access the monitoring system on Caterpillar Electronic Technician (ET) in order to view the current trip points for these codes.

Table 17

Event Code		
Code and Description	Conditions which Generate this Code	System Response
E361(1) High Engine Coolant Temperature	The engine coolant temperature has exceeded the trip point and the delay time has expired.	The code is logged.

(continued)

(Table 17, contd)

E361(2) High Engine Coolant Temperature	The engine coolant temperature has exceeded the trip point and the delay time has expired.	Engine power is derated. The code is logged. The derate is 25 percent for every degree over the trip point. The maximum derate is 100 percent.
E361(3) High Engine Coolant Temperature	The engine coolant temperature has exceeded the trip point and the delay time has expired.	

Probable Causes

- Low coolant level and/or coolant leakage
- Water temperature regulator and/or pressure relief valve
- Radiator or heat exchanger
- Engine cooling fan (if equipped)
- Coolant pump
- Coolant temperature sensor

Recommended Actions

Coolant

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

Water Temperature Regulator and/or Pressure Relief Valve

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

Radiator or Heat Exchanger

Radiator

1. Check the radiator fins for dirt, debris, and/or damage. Remove any dirt and/or debris and straighten any bent fins. Check for collapsed hoses and/or other restrictions.
2. Check the radiator for internal blockage. Refer to Systems Operation/Testing and Adjusting for more information.

Heat Exchanger

Check for sufficient flow and temperature of the cooling water through the heat exchanger. If the flow of cooling water through the heat exchanger is insufficient, determine the location of the obstruction. If the temperature of the cooling water is too high, determine the cause. Make the necessary repairs.

Faulty Engine Cooling Fan (if equipped)

1. If the fan is belt driven, check for loose drive belts. A loose fan drive belt will cause a reduction in the air flow across the radiator. Check the fan drive belt for proper belt tension. Adjust the tension of the fan drive belt, if necessary. Refer to Operation and Maintenance Manual.
2. Check the fan clutch, if equipped. A fan clutch or a hydraulic driven fan that is not turning at the correct speed can cause improper air speed across the radiator core. The lack of proper air flow across the radiator core can cause the coolant not to cool to the proper temperature differential.

Coolant Pump

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

Check the Coolant Temperature Sensor and/or the Circuit

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

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

i02610496

Cylinder Is Noisy

SMCS Code: 1223-035

Probable Causes

- Low quality fuel
- Electrical connectors
- Injector
- Not enough lubrication
- Too much valve lash
- Damage to valve train components
- Failure of connecting rod bearing

Recommended Actions

Low Quality Fuel

Refer to Operation and Maintenance Manual for information on the proper characteristics of the fuel. Obtain a fuel analysis.

Electrical Connectors

Check for the correct installation of the connector(s) for the Electronic Control Module (ECM) J1/P1 and/or J2/P2. Check for correct installation of the applicable fuel injector connectors. Repair the connector and/or replace the connector. Refer to Troubleshooting, "Electrical Connectors - Inspect".

Injector

Use Caterpillar Electronic Technician (ET) to determine if any diagnostic codes for the injector solenoids are present. Perform the "Injector Solenoid Test". Observe that the injector solenoids are being energized on Cat ET. Perform the "Cylinder Cutout Test". Locate the misfiring cylinder. Refer to the diagnostic functional test Troubleshooting, "Injector Solenoid - Test".

Not Enough Lubrication

Check the lubrication in the valve compartment. Check for sufficient lubrication between the injector tappet and the rocker arm buttons. Check for blocked oil passages. Oil passages must be clean. Ensure that the oil passages that send oil to the cylinder heads are clean.

Valve Lash

Check the valve lash. Refer to the diagnostic procedure Troubleshooting, "Valve Lash Is Excessive".

Damage to Valve Train Components

Remove the valve cover from the suspect cylinder(s). Check the following items for damage: camshaft, valve rotocoil, valve springs, lifters, pushrods and bridges. Check for valves that do not move freely. Remove the cylinder head. Inspect the valves. Replace any damaged parts.

Failure of Connecting Rod Bearing

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

i03648660

ECM Does Not Communicate with Other Modules

SMCS Code: 1901-038

Probable Causes

Electronic Control Module (ECM)

- Power to the ECM

Data Link

- Problem in the circuit for the Cat Data Link or the CAN data link

Electrical connectors

- Installation of electrical connectors

Recommended Actions

Power to the ECM

Check for power to the ECM. Refer to Troubleshooting, "Electrical Power Supply - Test".

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

Problem in the Circuit for the Cat Data Link or the CAN Data Link

Verify that the data link does not have an open or short circuit. Refer to the circuit tests Troubleshooting, "Cat Data Link - Test" or refer to the circuit tests Troubleshooting, "CAN Data Link - Test".

Installation of 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".

i02610526

Engine Cranks but Does Not Start

SMCS Code: 1000-035; 1450-035

Probable Causes

- Diagnostic codes
- Event codes
- Fuel supply
- Electrical power supply to the Electronic Control Module (ECM)
- Starting aids (if applicable)
- Engine shutdown switches (if applicable)
- Engine speed/timing
- Unit injectors
- Combustion

Recommended Actions

Diagnostic Codes, Event Codes, and Electrical Power Supply to the ECM

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

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

Fuel Supply

1. Visually check the fuel level. Do not rely on the fuel gauge only. If necessary, add fuel. If the engine has been run out of fuel, it will be necessary to prime the fuel system. Refer to Operation and Maintenance Manual for the correct procedure.
2. Check the fuel lines for the following problems: restrictions, collapsed lines and pinched lines. If problems are found with the fuel lines, repair the lines and/or replace the lines.
3. Check the fuel tank for foreign objects which may block the fuel supply.

NOTICE

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

4. Prime the fuel supply system if any of the following procedures have been performed:
 - Replacement of the fuel filters
 - Service on the low pressure fuel supply circuit
 - Replacement of unit injectors

Note: A sight glass in the supply line is helpful in diagnosing air in the fuel. Refer to the Systems Operation/Testing and Adjusting manual for more information.

5. Cold weather adversely affects the characteristics of the fuel. Refer to the Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold weather operation.
6. Check fuel flow after the fuel filters. If the fuel flow is low, replace the fuel filters. If the fuel flow is still low, check the following items: fuel transfer pump, fuel transfer pump coupling and fuel pressure regulating valve.

Starting Aids (if applicable)

1. If cold ambient conditions exist, check operation of starting aids. Verify that the ether system is operating correctly. Refer to Troubleshooting, "Starting Aid - Test".

2. Ensure the proper operation of the jacket water heater. Repair the jacket water heater and/or replace the jacket water heater, if necessary.
3. Check for presence of solidified fuel (wax).

Engine Shutdown Switches (if applicable)

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

Engine Speed/Timing

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

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

2. Ensure that the timing reference gear is installed correctly. The engine will not start if the gear was installed backward. Check for proper orientation between the crankshaft and camshaft drive gears. Correct the orientation and/or replace the drive gear, if necessary. Refer to the Disassembly and Assembly manual.

Unit Injectors

Perform the "Injector Solenoid Test" on Cat ET in order to determine if all of the injector solenoids are being energized by the ECM. Refer to Troubleshooting, "Injector Solenoid - Test" for additional information.

Combustion

Check for mechanical problems in the combustion system.

i04385478

Engine Does Not Crank

SMCS Code: 1000-035; 1450-035

Probable Causes

- Batteries
- Battery cables

- Starting circuit
- Starting motor solenoid
- Shutdown switch
- Prelubrication system (if applicable)
- Faulty crank enable switch (if applicable)
- Starting motor
- Flywheel ring gear
- Transmission (if applicable)
- Engine accessories
- Hydraulic cylinder lock
- Internal engine problem

Recommended Actions

Batteries and/or Battery Cables

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

Starting Motor Solenoid or Starting Circuit

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

Shutdown Switch

Use Cat ET to monitor the status of the engine. Check the status of engine shutdowns that are "ACTIVE" due to shutdown switches. Determine the cause for the engine shutdown and take the necessary action in order to resolve the shutdown.

Prelubrication System (if applicable)

If equipped, inspect the prelubrication system for proper operation.

Crank Enable Switch (if applicable)

Ensure that the crank enable switch is not faulty.

Starting Motor or Flywheel Ring Gear

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

Transmission (if applicable) or Engine Accessories

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

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

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

Hydraulic Cylinder Lock

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

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

Internal Engine Problem

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

- Seizure
- Broken components

- Bent components

i05451574

Engine Has Early Wear

SMCS Code: 1000-035; 1200-035

Probable Causes

- Incorrect maintenance intervals and/or incorrect oil
- Contaminated engine oil
- Low oil pressure
- Leaks in the air system
- Inspect the fuel filters for contamination.

Recommended Actions

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

Table 18

Troubleshooting Test Steps	Values	Results
1. Incorrect Maintenance Intervals and/or Incorrect Oil A. Use engine oil that is recommended and change the engine oil at the interval that is recommended by the engines Operation and Maintenance Manual.	Maintenance intervals	Result: The engine oil was changed at the interval that is recommended by the engines Operation and Maintenance Manual. Proceed to Test Step 2. Result: The engine oil was not changed at the interval that is recommended by the engines Operation and Maintenance Manual. Use at least the minimum grade of Cat oil. Change the engine oil at the interval that is recommended. Repair or replace any damaged parts.
2. Contaminated Engine Oil A. Obtain an S-O-S oil analysis. The analysis will contribute to a better understanding of oil contamination. B. Check the oil filter bypass valve. If the oil filter bypass valve is open, the oil will not be filtered. Check the oil filter bypass valve for a weak spring or for a broken spring. If the spring is broken, replace the spring. Verify that the oil bypass valve is operating correctly. Refer to the Disassembly and Assembly manual. Refer to the Caterpillar guidelines for "Reusability and Salvage/Repair" for determining if the replacement of parts is necessary in order to perform a quality repair.	Contamination	Result: The oil is contaminated. Determine the reason for any contamination of the engine oil and make the necessary repairs. Drain the crankcase and refill the crankcase with clean engine oil. Install new engine oil filters. Refer to the engines Operation and Maintenance Manual. Result: The oil is not contaminated. Proceed to Test Step 3.
3. Low Oil Pressure A. Engine oil that is contaminated with another liquid can cause low engine oil pressure. High engine oil level can be an indication of contamination. Obtain an analysis of the engine oil. B. The inlet screen of the suction tube for the engine oil pump can have a restriction. This restriction will cause cavitation and a loss of engine oil pressure. Check the inlet screen on the suction tube and remove any material that may be restricting engine oil flow. When some components of the engine show wear in a short time, the cause can be a restriction in a passage for engine oil. An indicator for the engine oil pressure may indicate sufficient pressure, but a component is worn due to a lack of lubrication. In such a case, look at the passage for the engine oil supply to the component. Refer to Systems Operation/Testing and Adjusting, "Lubrication System" for additional information.	Restriction	Result: The inlet tube has a restriction. Clear the obstruction. Verify the repair. Result: The inlet tube does not have a restriction. Proceed to Test Step 4.

(continued)

(Table 18, contd)

Troubleshooting Test Steps	Values	Results
4. Leaks in Air System A. A leak in the air intake system may allow unfiltered air into the engine. Inspect the air intake system for streaks which may indicate a leakage of unfiltered air. Inspect all of the gaskets and the connections.	Air leak	Result: There are no air leaks. Proceed to Test Step 5. Result: There are air leaks. Repair any leaks.
5. Inspect the Fuel Filters for Contamination A. Remove the fuel filters. Inspect the fuel filters for contamination. Contaminants in the fuel such as hydrogen sulfide and sulfur can lead to the formation of acids in the crankcase. Obtain a fuel analysis.	Fuel filters	Result: The fuel has contamination. Determine the cause of any contamination and make the necessary repairs. Install new fuel filters. Refer to the Operation and Maintenance Manual.

Complete the procedure in the order in which the steps are listed.

The procedure corrected the issue. Return the engine to service.

The procedure did not correct the issue.

Contact your Cat dealer Technical Communicator (TC). For further assistance, your TC can confer with the Dealer Solutions Network (DSN).

i03385119

Engine Has Mechanical Noise (Knock)

SMCS Code: 1000-035

Probable Causes

Accessory Equipment

- Isolate the source of the noise.

Internal Engine Components

- Valve train components
- Pistons
- Crankshaft
- Gear train

Recommended Actions

Isolate the Source of the Noise

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 and the camshaft covers. Check the following items for damage: camshaft, valve springs, lifters, pushrods and bridges. Thoroughly clean the valve train components. Ensure that all of the valves move freely. Replace any damaged parts.

During engine operation at rated speed, the valve rotation can be observed and measured.

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. Inspect the engine oil filters for nonferrous material. Replace any damaged parts.

i02659867

Engine Misfires, Runs Rough or Is Unstable

SMCS Code: 1000-035

The probable root causes are listed in order below:

Note: If the problem is intermittent and the problem cannot be duplicated, refer to Troubleshooting, "Power Is Intermittently Low or Power Cutout Is Intermittent".

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

Probable Causes

- Diagnostic codes
- Fuel supply
- Throttle
- Air intake and exhaust system
- Cylinder performance
- Electrical connectors
- Electronic unit injectors

Recommended Actions

Diagnostic Codes

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

Fuel Supply

1. Visually check the fuel level. Do not rely on the fuel gauge only. If necessary, add fuel. If the engine has been run out of fuel, it will be necessary to purge the air from the fuel system. Refer to Operation and Maintenance Manual for more information.
2. Ensure that the fuel supply valve (if equipped) is in the full OPEN position.

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

4. Prime the fuel system if any of the following procedures have been performed:

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

Note: A sight glass in the low pressure supply line is helpful in diagnosing air in the fuel. Refer to Systems Operation/Testing and Adjusting.

5. Check the fuel tank for foreign objects which may block the fuel supply.
6. Check the fuel filters.
7. Check the diesel fuel for contamination. Refer to Systems Operation/Testing and Adjusting.
8. 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.

Throttle

There may be a problem with the throttle. Refer to Troubleshooting, "Speed Control - Test".

Air Intake 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.

Cylinder Performance

1. Check the valve lash and reset the valve lash, if necessary. Refer to Systems Operation/Testing and Adjusting.
2. Check for correct installation of the unit injector connectors. Check for correct installation of all other applicable connectors. Refer to Troubleshooting, "Electrical Connectors - Inspect".
3. Perform the "Cylinder Cutout Test" on Cat ET in order to identify any injectors that might be misfiring.

4. If Cat ET indicates a problem, remove the electronic unit injector from the suspect cylinder. Refer to Disassembly and Assembly.
5. Possible causes of low compression are shown in the following list:
 - Faulty piston
 - Faulty piston rings
 - Worn cylinder bores
 - Worn valves
 - Faulty cylinder head gasket
 - Damaged cylinder head
6. Perform all necessary repairs. Ensure that the repairs have eliminated the problem.
7. If the repair does not eliminate the problem, reinstall the electronic unit injectors that were removed and continue with this test procedure.

Electronic Unit Injectors

1. Perform the "Injector Solenoid Test" on Cat ET in order to determine if all of the injector solenoids are being energized by the ECM.
2. Perform the "Cylinder Cutout Test" on Cat ET in order to identify any injectors that might be misfiring.
3. If Cat ET indicates a problem, remove the electronic unit injector from the suspect cylinder and install a new electronic unit injector. Refer to Disassembly and Assembly.
4. Ensure that the repairs have eliminated the problem. If there is still a problem, refer to Troubleshooting, "Injector Solenoid - Test".

i02790962

Engine Overspeeds

SMCS Code: 1915-035

Use this procedure in order to troubleshoot an engine overspeed or use this procedure if one of the following event codes is active. Refer to Troubleshooting, "Event Code List" for information about event codes and the default trip points for these codes. You must access the monitoring system on Caterpillar Electronic Technician (ET) in order to view the current trip points for these codes.

Table 19

Event Code		
Code and Description	Conditions which Generate this Code	System Response
E362(2) Engine Overspeed	The engine rpm has exceeded the trip point for engine overspeed for the delay time.	The ECM will send information on the diagnostic code to the data link. A warning lamp will be activated for the initial overspeed. An audible alarm will be activated if the overspeed increases past the second trip point. The engine's ECM does not activate the warning lamp or the audible alarm. The code is logged.

Probable Causes

- Intake air is combustible.
- Sudden drop of load

Recommended Actions

Intake Air is Combustible

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

Sudden Drop of Load

Decrease the load on the engine gradually.

i02958578

Engine Stalls at Low RPM

SMCS Code: 1000-035; 1900-035

Probable Causes

- Diagnostic codes
- Fuel supply
- Air supply
- Engine idle
- Accessory equipment
- Electronic unit injectors

Recommended Actions

Diagnostic Codes

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

Fuel Supply

1. Visually check the fuel level. Do not rely on the fuel gauge only. If necessary, add fuel. If the engine has been run out of fuel, it will be necessary to purge the air from the fuel system. Refer to the Operation and Maintenance Manual.
2. Ensure that the fuel supply valve (if equipped) is in the full OPEN position.
3. Check the fuel lines for the following problems: restrictions, collapsed lines, pinched lines and loose connections. If problems are found with the fuel lines, repair the lines and/or replace the lines.
4. Prime the fuel system if any of the following procedures have been performed:
 - Replacement of the fuel filters
 - Service on the low pressure fuel supply circuit
 - Replacement of unit injectors

Note: A sight glass in the low pressure supply line is helpful in diagnosing air in the fuel. Refer to Systems Operation/Testing and Adjusting.

5. Check the fuel tank for foreign objects which may block the fuel supply.
6. Check the fuel filters.
7. Check the diesel fuel for contamination. Refer to Systems Operation/Testing and Adjusting.
8. 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.

Air Supply

Check for a restriction in the air inlet system. If equipped, verify that the air shutoff valves are completely open.

Engine Idle

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

Accessory Equipment

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

Electronic Unit Injectors

1. Perform the "Injector Solenoid Test" on Cat ET in order to determine if all of the injector solenoids are being energized by the ECM.
2. Perform the "Cylinder Cutout Test" on Cat ET in order to identify any injectors that might be misfiring.
3. If Cat ET indicates a problem, remove the electronic unit injector from the suspect cylinder and install a new electronic unit injector. Refer to Disassembly and Assembly.
4. Ensure that the repairs have eliminated the problem. If there is still a problem, refer to the circuit test Troubleshooting, "Injector Solenoid - Test".

i03082085

Engine Top Speed Is Not Obtained

SMCS Code: 1915-035

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

Probable Causes

- Diagnostic codes
- Event codes
- Derates
- Engine parameters
- Throttle signal
- Air inlet and exhaust system
- Fuel supply
- Cylinder performance

Recommended Actions

Diagnostic Codes, Event Codes and 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.

If this application supports engine derates, use Cat ET to check for logged derates. Refer to Troubleshooting, "Event Code List" 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.

Engine Parameters

Verify that the correct engine parameters are being used.

Throttle Signal

Monitor the status for "Throttle Position" on Cat ET. Verify that the status for "Throttle Position" is stable and that the engine is able to reach high idle speed.

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.

Fuel Supply

1. Visually check the fuel level. Do not rely on the fuel gauge only. If necessary, add fuel. If the engine has been run out of fuel, it will be necessary to purge the air from the fuel system. Refer to Operation and Maintenance Manual.
2. Ensure that the fuel supply valve (if equipped) is in the full OPEN position.
3. Check the fuel lines for the following problems: restrictions, collapsed lines, pinched lines and loose connections. If problems are found with the fuel lines, repair the lines and/or replace the lines.
4. Prime the fuel system if any of the following procedures have been performed:
 - Replacement of the fuel filters

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

Note: A sight glass in the low pressure supply line is helpful in diagnosing air in the fuel. Refer to Systems Operation/Testing and Adjusting.

5. Check the fuel tank for foreign objects which may block the fuel supply.
6. Check the fuel filters.
7. Check the diesel fuel for contamination. Refer to Systems Operation/Testing and Adjusting.
8. 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.

Cylinder Performance

1. Check the valve lash and reset the valve lash, if necessary. Refer to Systems Operation/Testing and Adjusting for the procedure.
2. Check for correct installation of the unit injector connectors. Check for correct installation of all other applicable connectors. Refer to Troubleshooting, "Electrical Connectors - Inspect".
3. Perform the "Injector Solenoid Test" on Cat ET in order to determine if all of the injector solenoids are being energized by the ECM.
4. Perform the "Cylinder Cutout Test" on Cat ET in order to identify any injectors that might be misfiring.
5. If Cat ET indicates a problem, remove the electronic unit injector from the suspect cylinder. Refer to Disassembly and Assembly.
6. Possible causes of low compression are shown in the following list:
 - Faulty piston
 - Faulty piston rings
 - Worn cylinder bores
 - Worn valves
 - Faulty cylinder head gasket
 - Damaged cylinder head

7. Perform all necessary repairs. Ensure that the repairs have eliminated the problem.

i03368844

Engine Vibration Is Excessive

SMCS Code: 1000-035

Probable Causes

Vibration Damper

- Inspect the vibration damper.

Engine Mounts and Brackets

- Engine supports
- Driven equipment

Engine Misfiring or Running Rough

- Engine misfiring
- Running rough

Recommended Actions

Inspect the Vibration Damper

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

Engine Supports

Inspect the mounts and the brackets while you run the engine through the speed range. Look for mounts and brackets that are loose and/or broken. Tighten all of the mounting bolts. If necessary, replace any damaged components. Check the alignment of the following before operating the engine under load for any length of time:

- Mounts
- Coupling
- Crankshaft deflection

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".

i02720249

Exhaust Has Excessive Black Smoke

SMCS Code: 1088-035; 1250-035

Probable Causes

- Air inlet or exhaust system
- Engine speed/timing sensors
- Atmospheric pressure sensor
- Intake manifold pressure sensor
- "Fuel Position" and/or "FRC Fuel Limit"
- Flash file
- Fuel quality
- Valve adjustment

Recommended Actions

Air Inlet or Exhaust System

1. Check the air inlet system for restrictions and for leaks.
 - a. Check for an air filter restriction.
 - b. Perform a visual inspection of the air inlet piping for restrictions and for leaks.
2. Ensure that the turbocharger is in good repair.
3. Check the exhaust system for restrictions.
4. Repair any leaks that were found. Remove any restrictions that were found. Replace any damaged components.

Engine Speed/Timing Sensors

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

Atmospheric Pressure Sensor

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

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

1. Monitor the status of “Fuel Position” and “Rated Fuel Limit” while the engine is operating under full load. If “Fuel Position” equals “Rated Fuel Limit” and “Fuel Position” is less than “FRC Fuel Limit” , the Electronic Control Module (ECM) is providing the correct control. Otherwise, proceed to the next Step.
2. Verify that there are no active diagnostic codes for the intake manifold pressure sensor.
3. Monitor the status of “Intake Manifold Pressure” and “Atmospheric Pressure” on Caterpillar Electronic Technician (ET). When the engine is not running, “Intake Manifold Pressure” should be 0 kPa (0 psi).

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

Flash File

Verify that the correct flash file is installed in the ECM. Refer to Troubleshooting, “ECM Software - Install” for information.

Fuel Quality

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

Valve Adjustment

Check for the correct valve adjustment. Refer to Systems Operation/Testing and Adjusting for information on adjustment of the valves.

i06850188

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

- Starting Aids
- Coolant
- Engine Speed/Timing
- Electronic Control Module (ECM)
- Injector
- Fuel
- Low Compression
- Turbocharger

Recommended Actions

Table 20

Troubleshooting Test Steps	Values	Results
1. Check the Jacket Water Heater A. If the application has a jacket water heater that is installed, check for proper operation of the circuit.	Jacket Water Heater	Result: The jacket water heater is NOT OK. Repair: Repair the circuit for the jacket water heater or replace the jacket water heater. Result: The jacket water heater is OK. Proceed to Test Step 2.
2. Check the Air Inlet Heater A. If the application has an air inlet heater that is installed, ensure that the heater is operating correctly. Refer to the particular test procedure for your application.	Air Inlet Heater	Result: The air inlet heater is NOT OK. Repair: Repair or replace the air inlet heater. Result: The air inlet heater is OK. Proceed to Test Step 3.
3. Check the Ether Injection System A. If the application has an ether injection system, ensure that the ether canister is not empty or low. Replace the ether canister if the ether canister is empty or low. If an electrical problem with the ether injection system is suspected, refer to the particular test procedure for your application.	Ether Injection System	Result: The ether injection system is NOT OK. Repair: Repair or replace the ether injection system. Result: The ether injection system is OK. Proceed to Test Step 4.
4. Check for a Coolant Leak A. Check for an internal coolant leak into the cylinder and/or the exhaust.	Coolant Leak	Result: There is a coolant leak. Repair: Replace or repair parts to repair the coolant leak. Result: There is no coolant leak. Proceed to Test Step 5.
5. Check the Engine Speed/Timing Sensors A. Check the calibration of the engine speed/timing sensor(s). Refer to Troubleshooting, "Timing - Calibrate". B. Verify that the timing of the crankshaft and camshaft drive gears are set with the proper orientation. Refer to Disassembly and Assembly for information that is related to the correct gear installation.	Engine Speed/Timing Sensors	Result: The engine speed/timing sensors are NOT OK. Repair: Replace the speed/timing sensors. Result: The engine speed/timing sensors are OK. Proceed to Test Step 6.

(continued)

(Table 20, contd)

6. Check the Flash File A. Verify that the correct flash file is installed in the ECM. Refer to Troubleshooting, "ECM Software - Install".	Flash File	Result: The correct flash file is not installed. Repair: Download and install the correct flash file. Result: The correct flash file is installed. Proceed to Test Step 7.
7. Check the Fuel Injector A. Perform the "Cylinder Cutout Test" on Cat ET in order to try to isolate any cylinders that may be misfiring. A misfiring cylinder could be related to an injector that is worn or in poor repair. Refer to Troubleshooting, "Injector Solenoid - Test". B. Cut out each individual cylinder for 30 to 60 seconds. Verify that the smoke decreases.	Fuel Injector	Result: The fuel injector is NOT OK. Repair: Replace the fuel injector. Result: The fuel injector is OK. Proceed to Test Step 8.
8. Check the Fuel Supply A. Check the fuel quality. Low cetane fuel can create white smoke.	Fuel	Result: The fuel is NOT OK. Repair: Replace the fuel with a higher cetane fuel. Result: The fuel is OK. Proceed to Test Step 9.

(continued)

(Table 20, contd)

9. Check for Component Wear A. Check the valve lash and reset the valve lash, if necessary. Refer to Systems Operation/Testing and Adjusting. B. Possible causes of low compression are shown in the following list: • Faulty piston • Faulty piston rings • Worn cylinder bores • Worn valves • Faulty cylinder head gasket • Damaged cylinder head	Components	Result: The components are worn. Repair: Replace any components that are worn. STOP
10. Inspect the Turbocharger for Oil Leak A. Inspect the turbocharger for failure of turbocharger oil seal. Remove the exhaust outlet piping from the turbocharger. Visually inspect the piping for the presence of oil. Refer to Operation and Maintenance Manual, "Turbocharger-Inspect".	Failure of turbocharger oil seal	Result: There is an oil leak. Repair: Make the necessary repairs. Result: There is no oil leak in turbocharger oil seal. Verify that the repair eliminated the problem.

i02766023

Exhaust Temperature Is High

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

Use this procedure in order to troubleshoot a high exhaust temperature or use this procedure if the following event code is active. Refer to Troubleshooting, "Event Code List" for information about event codes.

Table 21

Event Code		
Code and Description	Conditions which Generate this Code	System Response
E194(2) High Exhaust Temperature	The exhaust temperature that has been calculated by the Electronic Control Module (ECM) is above the trip point temperature.	The engine is derated. The code is logged.

The activation of this event indicates that a high virtual exhaust temperature has been calculated by the ECM. This temperature is calculated with maps that utilize intake manifold temperature, atmospheric pressure, and engine speed as factors.

High intake manifold air temperature, high altitude operation, and high engine loads can cause the exhaust temperature to increase to a level that may damage the exhaust valves and other components of the exhaust system.

When this event occurs, the ECM derates the engine in order to reduce the exhaust temperature. This helps to protect the components of the exhaust system from damage.

Probable Causes

- Engine operating conditions
- Aftercooler
- Power supply to the atmospheric pressure sensor

Recommended Actions

Engine Operating Conditions

Consider high altitude operation of the engine when you troubleshoot this diagnostic code. High altitude operation can cause the code to be generated. This is normal.

Interview the operator, when possible. Determine if the engine is being operated under heavy load. Ensure that the engine is being operated at the proper engine speed.

Aftercooler

The intake manifold air temperature can increase if the flow through the aftercooler is obstructed. Thoroughly check the aftercooler for obstructions. Ensure that the flow of air or coolant through the aftercooler is adequate.

Power Supply to the Atmospheric Pressure Sensor

If the atmospheric pressure sensor is not being powered by the 5 volt supply, the output of the sensor may float to a value that is interpreted by the ECM as a high altitude condition. The ECM receives the erroneous value of altitude and the ECM derates the engine. Ensure that the 5 volt supply is present at the harness connector for the atmospheric pressure sensor.

i03392822

Fuel Consumption Is Excessive

SMCS Code: 1250-035

Probable Causes

Engine Operation

- Look for excessive idle or high load

Fuel Supply

- Unstable fuel supply

Engine Speed/Timing

- Calibration procedure of the engine speed/timing

Fuel Injection System

- Unstable injection system

Air Inlet and Exhaust System

- Restriction in the air inlet and exhaust

Accessory Equipment

- Check for damaged accessory equipment

Recommended Actions

Look for Excessive Idle or High Load

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

Unstable Fuel Supply

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

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

Check fuel lines for the following problems: restrictions, collapse and pinched line. Repair the lines and/or replace the lines.

1. Check the fuel tank for foreign objects which may block the fuel supply. Check for air leaks in the suction line of the fuel pump. Purge the fuel system after you perform the following procedures:
 - Replacing the fuel filters
 - Working on the low pressure fuel supply circuit
 - Replacing fuel injectors
2. Cold weather adversely affects the characteristics of the fuel. Refer to the Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold weather operation.
3. Check the fuel pressure during engine operation. Check the fuel pressure after the fuel filter. Refer to the Systems Operation/Testing and Adjusting manual for the correct pressure values. If the fuel pressure is low, replace the fuel filters. If the fuel pressure is still low, check the following items: fuel pump, pump coupling and fuel pressure regulating valve.

Calibration Procedure of the Engine Speed/Timing

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

Unstable Injection Actuation System

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

Restriction in the Air Inlet and Exhaust

1. Inspect the air filter for a restriction. If the air filter shows signs of being plugged, clean the air filter or replace the air filter.
2. Check the air inlet and exhaust system for restrictions and/or for leaks. Refer to Systems Operation/Testing and Adjusting.

Check for Damaged Accessory Equipment

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

i02790972

Fuel Filter Is Restricted

SMCS Code: 1261-035

The Electronic Control Module (ECM) detects an abnormal fuel filter differential pressure.

Use this procedure if the following event code is active. Refer to Troubleshooting, "Event Code List" for information about event codes and the default trip points for this code. You must access the monitoring system on Caterpillar Electronic Technician (ET) in order to view the current trip point for this code.

Table 22

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. The delay time for this event code is one hour.	The code is logged.
E390(2) Fuel Filter Restriction	The difference between the filtered fuel pressure and the unfiltered fuel pressure is greater than the trip point pressure. The delay time for this event code is four hours.	The engine ECM will derate engine power. The code is logged.

Probable Causes

- Fuel filter element

Recommended Actions

Fuel Filter Element

1. Replace the fuel filter element.
2. Restart the engine.
3. The delay time for the E390(1) event code is one hour. If the event code becomes active after recently changing the fuel filter, the problem may be electrical. Refer to Troubleshooting, "Fuel Filter Differential Pressure - Test" for the procedure to troubleshoot the circuit.

i02766086

Fuel Pressure Is High

SMCS Code: 1250-035

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

Table 23

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 specified delay time.	The code is logged.

Probable Causes

- Fuel pressure regulating valve
- Pressure relief 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.

Pressure Relief Valve

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

Fuel Lines

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

i02763905

Fuel Temperature Is High

SMCS Code: 1250-035

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

Table 24

Event Code		
Code and Description	Conditions which Generate this Code	System Response
E363(1) High Fuel Supply Temperature	The fuel temperature is above the trip point temperature.	The code is logged.
E363(2) High Fuel Supply Temperature		The code is logged. The engine power is derated.

Probable Causes

- Fuel pressure regulating valve
- Fuel level
- Fuel lines
- Overheated engine

Recommended Actions

Fuel Pressure Regulating Valve

An improperly operating fuel pressure regulating valve may cause high fuel temperature. 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 Level

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

Fuel Lines

Restricted fuel return lines may produce very high fuel temperatures. Ensure that the fuel return flow to the fuel tank is not obstructed.

Overheated Engine

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

i02790978

Idle Speed Is High

SMCS Code: 1915-035

Use this procedure if the following event code is active. Refer to Troubleshooting, "Event Code List" for information about event codes.

Table 25

Event Code		
Code and Description	Conditions which Generate this Code	System Response
E441(1) Idle Elevated to Increase Battery Voltage	The battery voltage is below 24.5 VDC for five minutes.	The engine speed is increased to 1000 rpm. The code is logged.

Probable Causes

This condition is normal operation. One of the following features may be causing the elevated idle:

- "Low Battery Elevated Idle"
- "Cool Engine Elevated Idle"

Use Caterpillar Electronic Technician (ET) to verify that the engine is in elevated idle. Elevated idle is indicated in the upper part of any status screen.

Conditions

"Low Battery Elevated Idle"

The engine idle speed will be elevated to 1000 rpm when all of the following conditions occur:

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

"Cool Engine Elevated Idle"

The engine idle speed will be elevated to 1000 rpm when all of the following conditions occur:

- "Cool Engine Elevated Idle" is enabled.
- The coolant temperature is less than 70 °C (158 °F).
- The inlet manifold temperature is less than 5 °C (41 °F).
- A valid throttle position is present. The throttle position has not exceeded 25 percent of full throttle for five minutes.
- The transmission is in neutral.
- The parking brake is engaged.
- A valid engine speed is present.

i02791114

Inlet Air Is Restricted

SMCS Code: 1087-035

Use this procedure if any of the following event codes are active. Refer to Troubleshooting, "Event Code List" for information about event codes and the default trip points for these codes. You must access the monitoring system on Caterpillar Electronic Technician (ET) in order to view the current trip points for these codes.

Table 26

Event Code		
Code and Description	Conditions which Generate this Code	System Response
E172(1) High Air Filter Restriction	The inlet air restriction is above the trip point pressure for the delay time.	The code is logged.
E172(2) High Air Filter Restriction		The engine is derated. The code is logged.

Probable Causes

- Air filter element

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.

i02753655

Intake Manifold Air Temperature Is High

SMCS Code: 1058-035-TA

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

Table 27

Event Code		
Code and Description	Conditions which Generate this Code	System Response
E539(1) High Intake Manifold Air Temperature		The code is logged.
E539(2) High Intake Manifold Air Temperature	The intake manifold air temperature is above the trip point for the delay time.	The code is logged. The derate is three percent for every degree over the trip point. The maximum derate is 20 percent.

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.

i03361543

Oil Consumption Is Excessive

SMCS Code: 1348-035

Probable Causes

Oil Level

- Excessive oil in the crankcase

Oil Leaks

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

Oil Viscosity

- Incorrect oil viscosity

Turbocharger

- Turbocharger seal

Recommended Actions

Excessive Oil in the Crankcase

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.

Oil Leaks on the Outside of the Engine

Check for leakage at the seals at each end of the crankshaft. Look for leakage at the gasket for the engine oil pan and all lubrication system connections. Look for any engine oil that may be leaking from the crankcase breather. This can be caused by combustion gas leakage around the pistons. A dirty crankcase breather will cause high pressure in the crankcase. A dirty crankcase breather will cause the gaskets and the seals to leak.

Oil Leaks in the Combustion Area of the Cylinder

Engine oil that is leaking into the combustion area of the cylinders can be the cause of blue smoke. There are several possible ways for engine oil to leak into the combustion area of the cylinders:

- Leaks between worn valve guides and valve stems
- Worn components or damaged components (pistons, piston rings, or dirty return holes for the engine oil)
- Incorrect installation of the compression ring and/or the intermediate ring
- Leaks past the seal rings in the turbocharger shaft
- Overfilling of the crankcase
- Wrong oil level gauge or guide tube
- Sustained operation at light loads

Oil Viscosity

Excessive consumption of engine oil can also result if engine oil with the wrong viscosity is used. Engine oil with a thin viscosity can be caused by fuel leakage into the crankcase or by increased engine temperature.

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, "Turbocharger Inspect".

i02581426

Oil Contains Fuel

SMCS Code: 1250-035; 1348-035

Probable Causes

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

- Leaking seal on the fuel transfer pump

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

Recommended Actions



WARNING

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



WARNING

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

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

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

Leaking Seals on the Fuel Line Adapter for the Cylinder Head

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

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

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

Cracked Fuel Supply Manifold

Look for signs of damage to the fuel supply manifold.

Leaking Fuel Transfer Pump Seal

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

i05031891

Oil Pressure Is Low

SMCS Code: 1348-035-PX

Use this procedure in order to troubleshoot low engine oil pressure. Use this procedure if one of the following event codes is active. Refer to Troubleshooting, “Event Code List” for information about event codes and the default trip points for these codes.

Table 28

Event Code		
Code and Description	Conditions which Activate the Code	System Response
E360(1) Low Engine Oil Pressure	The engine oil pressure is less than the trip point and the delay time has expired.	The code is logged.
E360(3) Low Engine Oil Pressure		The derate is 17.5 percent per second. The maximum derate is 35 percent. The code is logged.

Probable Causes

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

Recommended Repairs

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 Caterpillar Electronic Technician (ET) to compare the readings of the filtered engine oil pressure and the unfiltered engine oil pressure while the engine is OFF. Both readings should be close to zero pressure.

If a reading is significantly different from zero, replace the suspect engine oil pressure sensor.

Poor Circulation of the Engine Oil

Several factors could cause poor circulation of the engine oil:

- The engine oil filter is clogged. Replace the engine oil filter.
- An engine oil line or a passage for engine oil is disconnected or broken.
- The engine oil cooler is clogged. Thoroughly clean the engine oil cooler.
- There is 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 is drawing in air. Check the joints of the tube for cracks or for a damaged O-ring seal.
- There is 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.

i03369620

Oil Temperature Is High

SMCS Code: 1348-035-TA

Probable Causes

Engine Oil Level

- Low engine oil level

Engine Oil Cooler

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

Engine Coolant Temperature

- High engine coolant temperature

Recommended Actions

Low Engine Oil Level

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

Restriction in the Engine Oil Cooler Core

Check the engine oil cooler core for damage and for plugging. Clean the engine oil cooler core or replace the engine oil cooler core, if necessary. Refer to Disassembly and assembly for the procedure to remove and install the oil cooler.

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 Disassembly and assembly for the procedure to remove and install the oil filter base.

High Engine Coolant Temperature

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

i02672319

Power Is Intermittently Low or Power Cutout Is Intermittent

SMCS Code: 1000-035-PWR

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

Probable Causes

- Diagnostic codes
- Event codes
- Air inlet and exhaust restrictions
- Throttle signal
- Power supply for the Electronic Control Module (ECM)
- Fuel supply

Recommended Actions

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

Diagnostic Codes and Event Codes

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

Air Inlet and Exhaust Restrictions

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

Check the air filter restriction indicator, if equipped. Clean plugged air filters or replace plugged air filters. Refer to the Operation and Maintenance Manual.

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

Throttle Signal

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

ECM Power Supply

1. Inspect the circuit between the ECM and the batteries. Refer to the Electrical System Schematic. Inspect the wires, the connectors, and the components in the circuit. Refer to Troubleshooting, "Electrical Power Supply - Test" for more information.
2. Inspect the circuit between the ECM and the keyswitch. Refer to the Electrical System Schematic. Inspect the wires, the connectors, and the components in the circuit. Refer to Troubleshooting, "Electrical Power Supply - Test" for more information.

Fuel Supply

1. Visually check the fuel level. Do not rely on the fuel gauge only. If necessary, add fuel. If the engine has been run out of fuel, it will be necessary to purge the air from the fuel system. Refer to the Operation and Maintenance Manual for more information.
2. Ensure that the fuel supply valve (if equipped) is in the full OPEN position.
3. Check the fuel lines for the following problems: restrictions, collapsed lines, pinched lines and loose connections. If problems are found with the fuel lines, repair the lines and/or replace the lines.
4. Prime the fuel system if any of the following procedures have been performed:
 - Replacement of the fuel filters
 - Service on the low pressure fuel supply circuit
 - Replacement of unit injectors

Note: A sight glass in the low pressure supply line is helpful in diagnosing air in the fuel. Refer to Systems Operation/Testing and Adjusting.

5. Check the fuel tank for foreign objects which may block the fuel supply.
6. Check the fuel filters.
7. Check the fuel quality. Make sure that the fuel meets the requirements of Special Publication, SEBU6250, "Caterpillar Machine Fluids Recommendations".

8. 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.

i03372246

Valve Lash Is Excessive

SMCS Code: 1105-035

Probable Causes

Lubrication

- Inadequate lubrication

Valve Train Components

- Worn valve train components

Valve Lash

- Incorrect valve lash

Recommended Actions

Inadequate Lubrication

Remove the valve mechanism covers. Refer to Disassembly and Assembly for removing the valve mechanism cover. 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.

Worn 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.

Incorrect Valve Lash

Check the engine valve lash. If necessary, adjust the engine valve lash. Refer to Systems Operation/ Testing and Adjusting for information on adjusting the engine valve lash.

i04563324

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

Table 29

Troubleshooting Test Steps	Values	Results
1. Valve Components A. Inspect the following components for damage: 1. Valve rotators 2. Spring locks 3. Valve springs 4. Valves B. Ensure that the valve has not contacted the piston. If the valve has contacted the piston, check the exhaust system for debris.	Damaged components	Result: The valve components are damaged. Replace the damaged components. 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.

Complete the procedure in the order in which the steps are listed.

If the procedure did not correct the issue, contact your Cat dealer Technical Communicator (TC). For further assistance, your TC can confer with the Dealer Solutions Network (DSN).

Circuit Tests

i02602055

CAN Data Link - Test

SMCS Code: 1900-038

System Operation Description:

Use this procedure in order to troubleshoot a problem with the CAN data link.

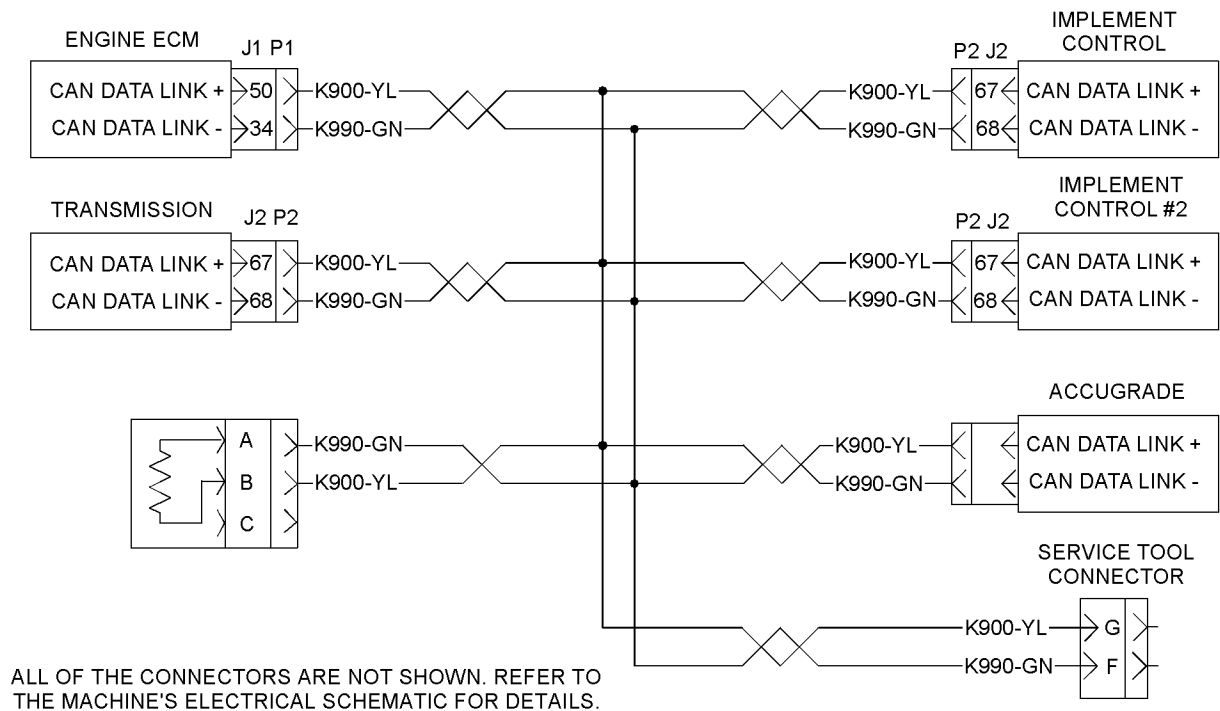
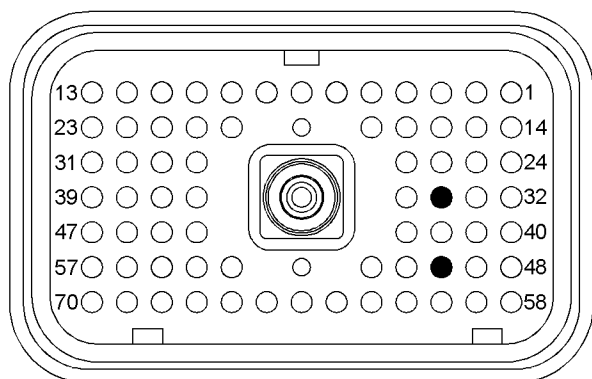
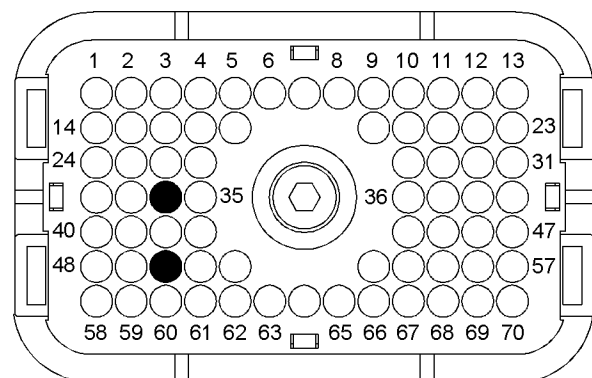


Illustration 18
Typical schematic

g01302376



P1 ECM SIDE



P1 HARNESS SIDE

Illustration 19

g01302383

P1 ECM connector

(P1-34) J1939 data link -
(P1-50) J1939 data link +

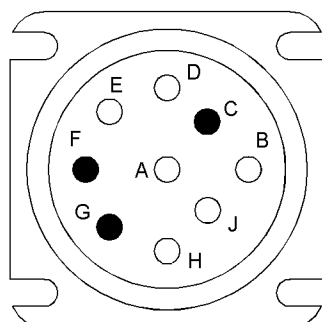


Illustration 20

g01302377

Service tool connector

(Terminal F) J1939 data link -
(Terminal G) J1939 data link +

Test Step 1. Inspect Electrical Connectors and Wiring

- A.** Remove power from the ECM.
- B.** Thoroughly inspect the J1/P1 ECM connector and the J2/P2 ECM connector. Inspect all of the connectors that are associated with the circuit.

Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- 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 on each ECM connector for the proper torque. Refer to Troubleshooting, "Electrical Connectors - Inspect" for the correct torque values.
- E.** Check the harness and wiring for abrasion and for pinch points.

Expected Result:

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

Repair: Perform the following 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. Refer to Troubleshooting, "Electrical Connectors - Inspect".

Verify that the repair eliminates the problem.

STOP.

Test Step 2. Verify the Proper Installation of the Data Link Circuit

- A.** Disconnect any module that is connected to the CAN data link.
- B.** Disconnect J1/P1 ECM connector and measure the resistance between P1-50 (CAN Data Link +) and P1-34 (CAN Data Link -).

Expected Result:

The resistance is between 57 and 63 Ohms.

Results:

- OK – The resistance is within the range. Proceed to Test Step 5.
- Not OK – The range of the resistance is 114 Ohms to 126 Ohms. A terminating resistor is missing.

Repair: Verify that two terminating resistors exist on the data link. One resistor must be located on each end of the data link.

STOP.

- Not OK – Resistance is less than 57 Ohms. Proceed to Test Step 3.
- Not OK – Resistance is greater than 126 Ohms. Proceed to Test Step 4.

Test Step 3. Check for a Short Circuit

- Disconnect the J1/P1 ECM connector.
- Remove the terminating resistors from the CAN data link.
- Measure the resistance from the following pins to every pin on ECM connector P1 and to engine ground.
 - P1-50 (CAN Data Link +)
 - P1-34 (CAN Data Link -)

Expected Result:

Each resistance measurement indicates an open circuit.

Results:

- OK – There are no shorts. Proceed to Test Step 4.
- Not OK – A short exists in the wiring harness.

Repair: Make the necessary repairs.

Verify that the repair eliminates the problem.

STOP.

Test Step 4. Check for an Open Circuit

- Make sure that all connections remain disconnected.
- Fabricate a jumper wire. Use the jumper wire in order to short pin F to pin G on the service tool connector.

- Measure the resistance between P1-50 (CAN Data Link +) and P1-34 (CAN Data Link -) at the ECM connector.

- Remove the wire short.

Expected Result:

The resistance measurement indicates a short circuit.

Results:

- OK – There is not an open circuit. Proceed to Test Step 5.
- Not OK – An open circuit exists in the wiring harness.

Repair: Make the necessary repairs.

Verify that the repair eliminates the problem.

STOP.

Test Step 5. Check the Module on the CAN Data Link

- Connect the module to another engine.
- If the module operates properly on a different engine, there may be a problem with the ECM.
- If the module does not function properly on the different engine, replace the module.

Expected Result:

The module operates properly.

Results:

- OK – The module operates properly on another engine.

Repair: The problem may be intermittent. If the problem is intermittent, refer to Troubleshooting, “Electrical Connectors - Inspect”.

STOP.

- Not OK – The module does not operate properly on another engine.

Repair: Replace the module. Verify that the repair corrects the problem.

STOP.

i02600481

Cat Data Link - Test

SMCS Code: 1900-038

System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with the Cat Data Link or if any one of the diagnostic codes in Table 30 is active or easily repeated.

Table 30

Diagnostic Codes Table		
Code and Description	Conditions which Generate this Code	System Response
296-9 Transmission Control abnormal update rate	Communication with the transmission control cannot be established within three seconds after the Electronic Control Module (ECM) is powered up. After communication with the transmission control has been established, communication stops for one second.	The ECM will log the diagnostic code. All features of the transmission control that rely on the data link are disabled. The ECM will disable the automatic control of engine speed through the throttle lock feature.
297-9 All Wheel Drive Control abnormal update rate	Communication with the all wheel drive control cannot be established within three seconds after ECM powerup. After communication with the all wheel drive control has been established, communication stops for one second.	The ECM will log the diagnostic code. All features of the all wheel drive control that rely on the data link are disabled.
588-9 Monitoring System Display abnormal update rate	Communication with the monitoring system cannot be established within three seconds after ECM powerup. After communication with the monitoring system has been established, communication stops for one second.	The ECM will log the diagnostic code. All features of the monitoring system that rely on the data link are disabled.
596-9 Implement Control abnormal update rate	Communication with the implement control cannot be established within three seconds after ECM powerup. After communication with the implement control has been established, communication stops for one second.	The ECM will log the diagnostic code. All features of the implement control that rely on the data link are disabled.
1639-2 Machine Security System Module erratic, intermittent, or incorrect	Communication with the machine security system cannot be established within three seconds after ECM powerup. After communication with the machine security system has been established, communication stops for one second.	The ECM will log the diagnostic code. All features of the machine security system that rely on the data link are disabled.
1639-9 Machine Security System Module abnormal update rate	Communication with the machine security system cannot be established within three seconds after ECM powerup. After communication with the machine security system has been established, communication stops for one second.	The ECM will log the diagnostic code. All features of the machine security system that rely on the data link are disabled.

Note: This procedure checks for an open circuit or for a short circuit in the Cat Data Link. If you are experiencing problems with communications between Caterpillar Electronic Technician (ET) and the ECM, refer to Troubleshooting, "Electronic Service Tool Does Not Communicate" before you use this procedure.

The Cat Data Link is the standard data link that is used by the ECM to communicate with Cat ET. The ECM communicates with Cat ET in order to share status information and diagnostic information. Cat ET can also be used to configure the ECM parameters.

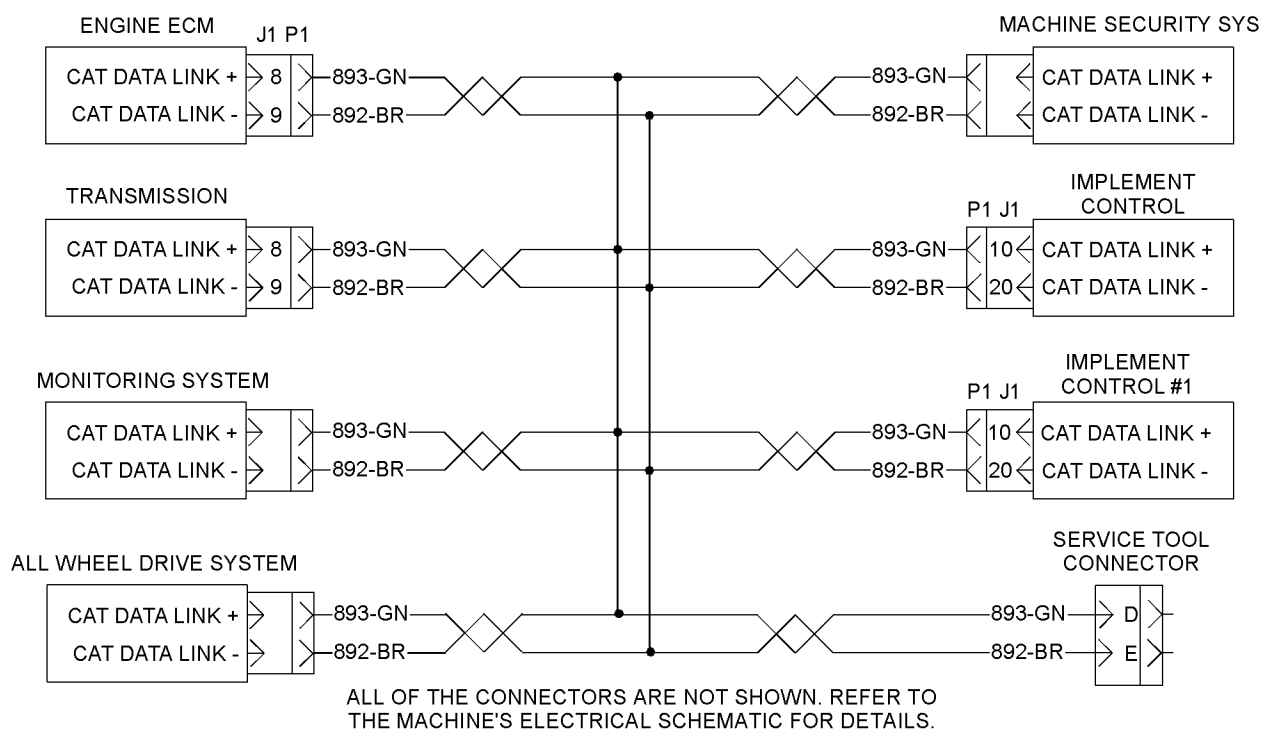


Illustration 21

g01301865

Typical schematic for the Cat Data Link

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove electrical power from the ECM.

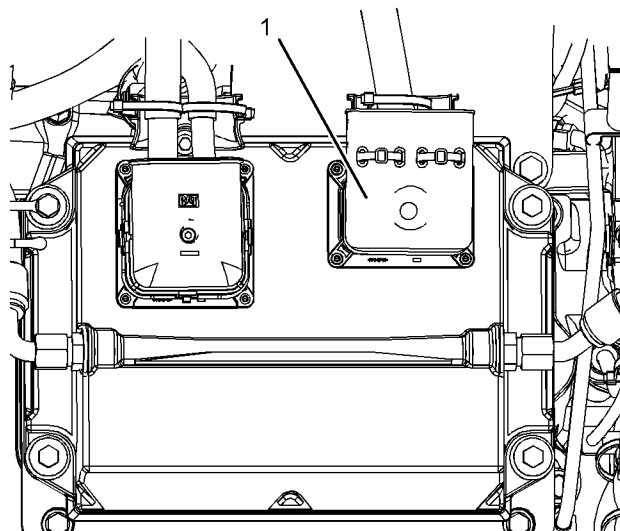


Illustration 22

g01167488

Engine view (typical example)

(1) J1/P1 ECM connectors

B. Thoroughly inspect connector (1). Refer to Troubleshooting, "Electrical Connectors - Inspect".

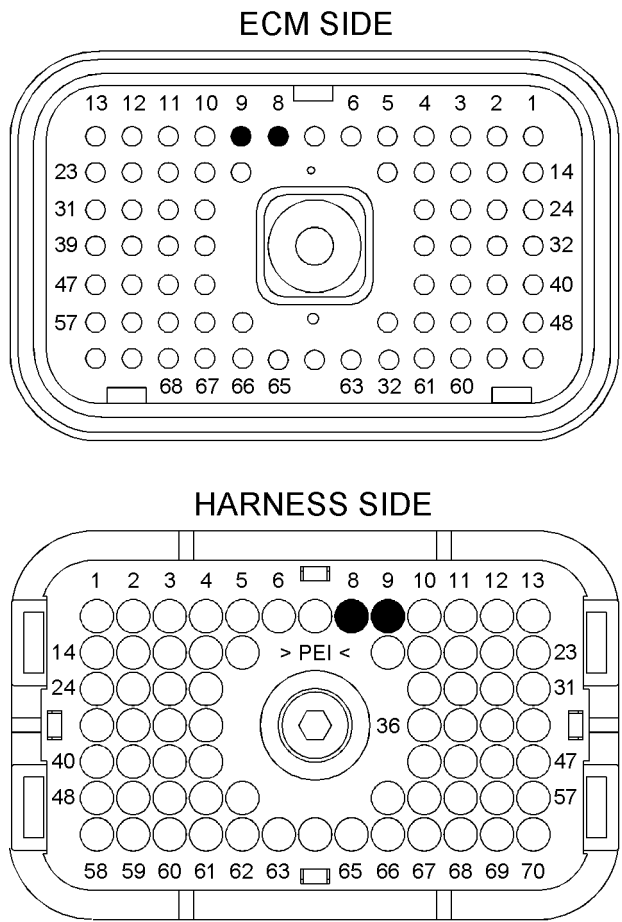


Illustration 23 g01104274

P1 terminals that are associated with the Cat Data Link

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

- C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the Cat Data Link.
- D. Check the allen head screw on each ECM connector for the proper torque. Also, check the allen head screw on the customer connector for the proper torque. Refer to Troubleshooting, "Electrical Connectors - Inspect" for the correct torque values.

Expected Result:

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

Results:

- OK The harness and the connectors appear to be OK. Proceed to Test Step 2.

- Not OK – The connectors and/or the wiring are not OK.

Repair: Repair the connectors and/or the wiring. Replace parts, if necessary. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled. Verify that the original problem is resolved.

STOP. STOP

Test Step 2. Check for a Short Circuit

- A. Disconnect the P1 ECM connector.
- B. Disconnect Cat ET from the service tool connector.
- C. Disconnect any other control modules from the Cat Data Link. Refer to the electrical schematic in order to identify other control modules on the Cat Data Link.
- D. Measure the resistance between the points that are listed in Table 31 . Be sure to wiggle the wires in the harnesses as you make each resistance measurement.

Table 31

Resistance Measurements for the Cat Data Link	
Connector and Terminal	Terminal
P1-8 (Cat Data Link +)	All of the other terminals on the P1 connector
	Ground stud
P1-9 (Cat Data Link -)	All of the other terminals on the P1 connector
	Ground stud

Expected Result:

Each check of the resistance indicates an open circuit.

Results:

- OK Each check of the resistance indicates an open circuit. Proceed to Test Step 3.
- Not OK – At least one check of the resistance does not indicate an open circuit. There is a short circuit in the harness or in a connector.

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

STOP. STOP

Test Step 3. Check for an Open Circuit

i02600103

- A.** Fabricate a jumper wire. Use the jumper wire in order to create a short circuit between terminals D (Cat Data Link +) and terminal E (Cat Data Link -) on the service tool connector.
- B.** Measure the resistance between P1-8 (Cat Data Link +) and P1-9 (Cat Data Link -).
- C.** Measure the resistance between the terminals at the connector for each control module that was connected to the Cat Data Link. Refer to Illustration 21 .
- D.** Remove the jumper wire from the service tool connector.

Expected Result:

Each check of the resistance indicates a short circuit.

Results:

- OK – Each check of the resistance indicates a short circuit.

Repair: Perform the following procedure:

- A.** Connect the J1/P1 connectors. Connect Cat ET to the service tool connector.
- B.** Check the Cat Data Link for proper operation. If the Data Link does not operate correctly, there may be a problem with the ECM.

Temporarily install a new ECM. Check the Cat Data Link again. If the new ECM solves the problem, install the original ECM and verify that the original problem returns. If the new ECM operates correctly and the original ECM does not operate correctly, replace the original ECM. Refer to Troubleshooting, "ECM - Replace".

STOP. STOP

- Not OK – At least one check of the resistance does not indicate a short circuit. There is an open circuit or excessive resistance in the harness. There may be a problem with a connector.

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

STOP. STOP

Cooling Fan Control - Test

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

System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with the engine fan control solenoid or if one of the diagnostic codes in Table 32 is active.

Table 32

Diagnostic Codes Table		
Code and Description	Conditions which Generate this Code	System Response
291-5 Engine Cooling Fan 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 engine fan control solenoid.	The ECM sends minimum current to the fan control solenoid. The code is logged.
291-6 Engine Cooling Fan Solenoid current above normal	The ECM detects a short circuit to ground in the circuit for the engine fan control solenoid.	

The ECM controls the speed of the engine cooling fan in order to provide the following benefits:

- Increased productivity
- Reduced noise
- Improved fuel economy
- Reduced overcooling of the engine

The ECM monitors engine coolant temperature, intake manifold air temperature, and hydraulic oil temperature in order to determine the correct speed for the engine cooling fan.

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

If the ECM detects a system fault, the ECM provides minimum current to the solenoid. This ensures a maximum fan speed while the fault condition exists.

An override is available with Caterpillar Electronic Technician (ET). This allows the fan to be manually changed from the minimum to the maximum possible rpm.

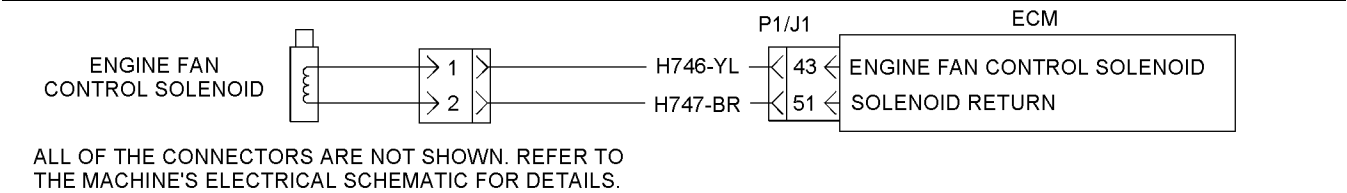


Illustration 24

g01194820

Schematic for the engine fan control solenoid

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove the electrical power from the ECM.

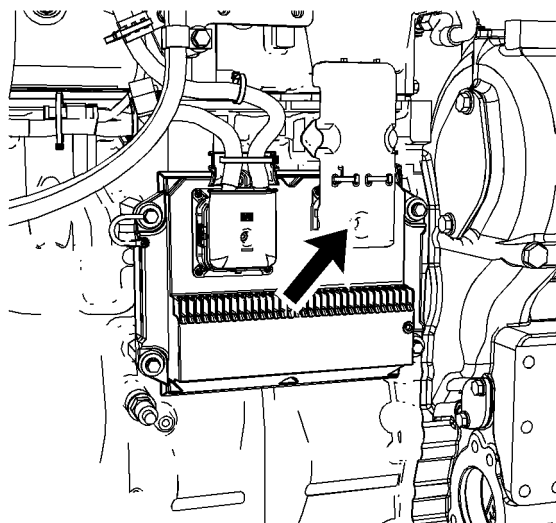


Illustration 25

g01141049

J1/P1 ECM connector (typical left side engine view)

- B.** Thoroughly inspect the J1/P1 ECM connectors. Inspect all of the other connectors that are in the circuit for the engine fan control solenoid. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

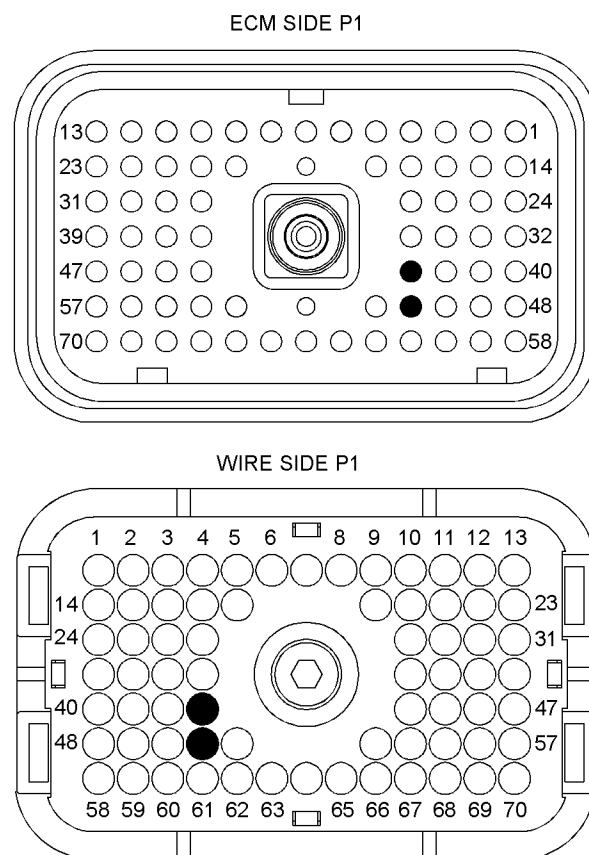


Illustration 26

g01113249

P1 ECM connector

(P1-43) Engine fan control solenoid

(P1-51) Solenoid 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

- Remove the electrical power from the ECM.
- Connect Cat ET to the service tool connector.
- Restore the electrical power to the 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 fan override.
- Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

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

- Disable the fan override.
- 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: The problem may have been related to a faulty connection in the harness. Carefully inspect the connectors and wiring. Refer to Troubleshooting, “Electrical Connectors - Inspect”.

STOP.

- 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 Engine Fan Control Solenoid in Order to Create an Open Circuit

- Remove the electrical power from the ECM.
- Disconnect the connector for the engine fan control solenoid.
- Restore the electrical power to the 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 fan override.
- Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

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

- Disable the fan override.

Expected Result:

An open circuit diagnostic code (5) is now active for the engine fan control 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 engine fan control solenoid to the harness, but do not install the new engine fan control solenoid. Verify that there are no active diagnostic codes for the engine fan control solenoid. If there are no active diagnostic codes for the engine fan control solenoid, permanently install the new engine fan control solenoid. Clear any logged diagnostic codes.

STOP.

- Not OK – A short circuit diagnostic code (6) remains active when the connector for the engine fan control solenoid is disconnected. There is a

short circuit between the harness connector for the engine fan control solenoid and the ECM. Proceed to Test Step 5.

Test Step 4. Create a Short at the Connector for the Engine Fan Control Solenoid

- A. Remove the electrical power from the ECM.
- B. Fabricate a jumper wire that is long enough to create a short between the terminals of the connector for the engine fan control solenoid. Crimp connector pins to each end of the jumper wire.
- C. Install the jumper wire between terminal 1 (engine fan control solenoid) and terminal 2 (solenoid return) on the harness side of the connector.
- D. Restore the electrical power to the ECM.
- 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.

- F. Select diagnostic tests from Cat ET.
- G. Select the "Override Parameters" screen on Cat ET.
- H. Activate the fan override.
- 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. Disable the fan override. 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 engine fan control solenoid to the harness, but do not install the new engine fan control solenoid. Verify that there are no active diagnostic codes for the engine fan control solenoid. If there are no active diagnostic codes for the engine fan

control solenoid, permanently install the new engine fan control 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 engine fan control solenoid. There may be a problem with the ECM. Proceed to Test Step 5.

Test Step 5. Check the Operation of the ECM

- A. Disconnect the J1/P1 ECM connector.
- B. Fabricate two jumper wires that are long enough to create a short between two terminals of the ECM connector. Crimp connector sockets to one end of each of the jumper wires.
- C. Remove the wire from terminal location P1-43 (engine fan control solenoid) at the ECM connector. Install one of the jumper wires into this terminal location.
- D. Remove the wire from terminal location P1-51 (solenoid return) at the ECM connector. Install the other jumper wire into this terminal location.
- E. Connect the J1/P1 ECM connector.

F. Create an open at the ECM:

- a. Restore the electrical power to the ECM.

In order to ensure that an open circuit condition exists, do not allow the loose ends of the jumper wires to connect to each other 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 fan override.
- 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 fan override.

G. Create a short at the ECM:

- a. Create a short between the jumper wires for the engine fan control solenoid at the ECM connector.
- 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 fan override.
- 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 fan override.

h. Remove the electrical power from the ECM.

H. Restore all wiring to the original configuration.

Expected Result:

An open circuit diagnostic code (5) is active when the jumper wires create an open circuit. A short circuit diagnostic code (6) is active when the jumper wires for the engine fan control solenoid are shorted together.

Results:

- OK – An open circuit diagnostic code (5) is active when the jumper wires create an open circuit. A short circuit diagnostic code 6 is active when the jumper wires are shorted together.

Repair: The ECM is operating properly. The problem is in the harness wiring between the ECM and the connector for the engine fan control 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 wires create an open circuit. The short circuit diagnostic code (6) is not active when the wire jumpers are shorted together.

Repair: Replace the ECM. Refer to Troubleshooting, "ECM - Replace". Verify that the problem is resolved.

STOP.

i02600189

Electrical Power Supply - Test

SMCS Code: 1401-038

System Operation Description:

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 engine's ECM. Verify that there are no problems with the starting system or the charging system before you use this test.

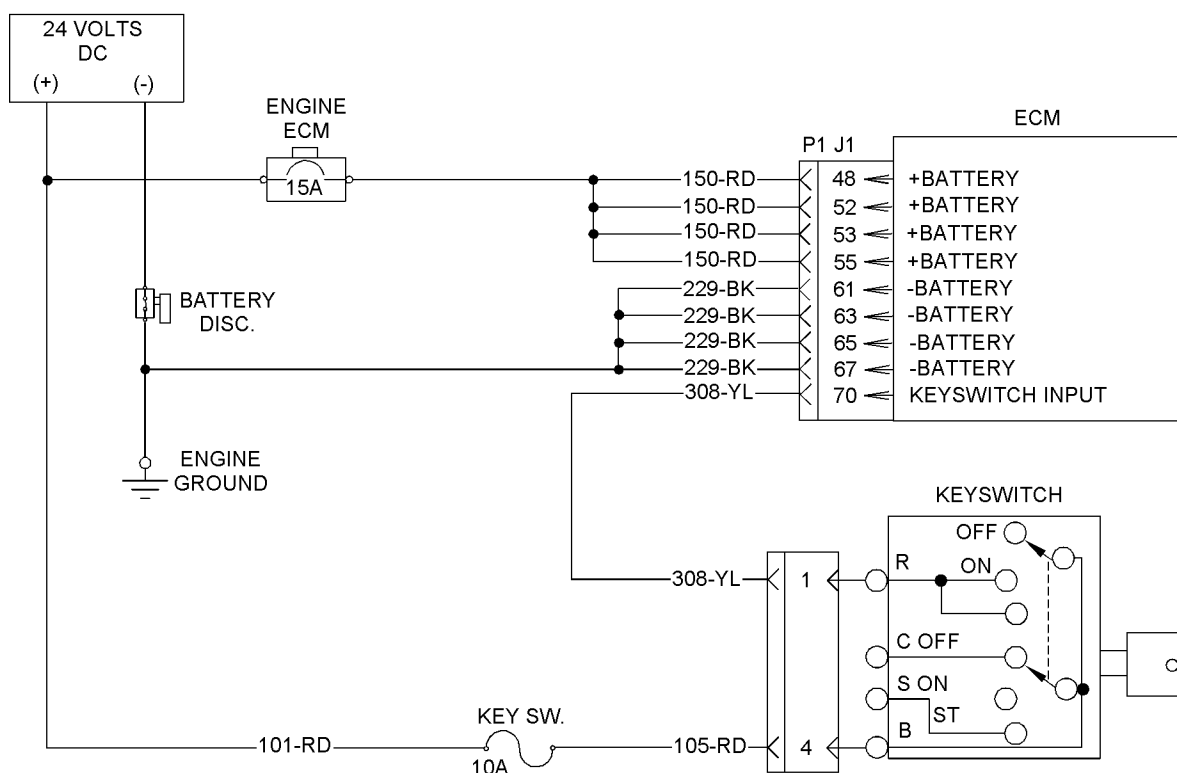
Use this procedure to troubleshoot the electrical system if a problem is suspected with the power to the engine's Electronic Control Module (ECM) or if any one of the diagnostic codes in Table 33 is active or easily repeated.

Table 33

Diagnostic Codes Table		
Code and 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 0.5 seconds. The engine's ECM has been powered for three seconds. The engine is not being cranked.	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 is not being cranked.	
168-2 Electrical System Voltage erratic, intermittent, or incorrect	The engine is running. The battery voltage falls below 6 VDC and the voltage returns above 9 VDC for three voltage readings in the last seven seconds.	

Unswitched battery voltage is supplied to the ECM at P1-48, P1-52, P1-53, and P1-55. The negative battery is supplied to the ECM at P1-61, P1-63, P1-65, and P1-67. The ECM receives the input 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 ECM continuously receives battery voltage through the circuit breaker for the engine ECM.

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



ALL OF THE CONNECTORS ARE NOT SHOWN. REFER TO THE MACHINE'S ELECTRICAL SCHEMATIC FOR DETAILS

Illustration 27

g01302247

Schematic for the electrical power supply circuit

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Remove electrical power from the engine ECM.

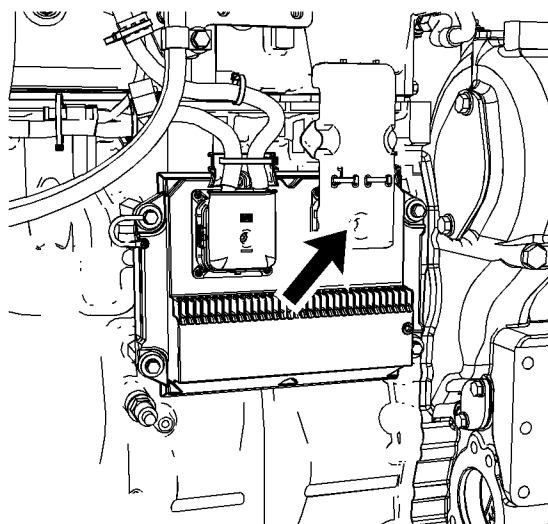


Illustration 28

g01141049

J1/P1 ECM connectors (typical left side engine view)

Circuit Tests

- B.** Thoroughly inspect the J1/P1 ECM connectors. Inspect all of the connectors that are in the circuit. Refer to the diagnostic functional test Troubleshooting, "Electrical Connectors - Inspect" for details.

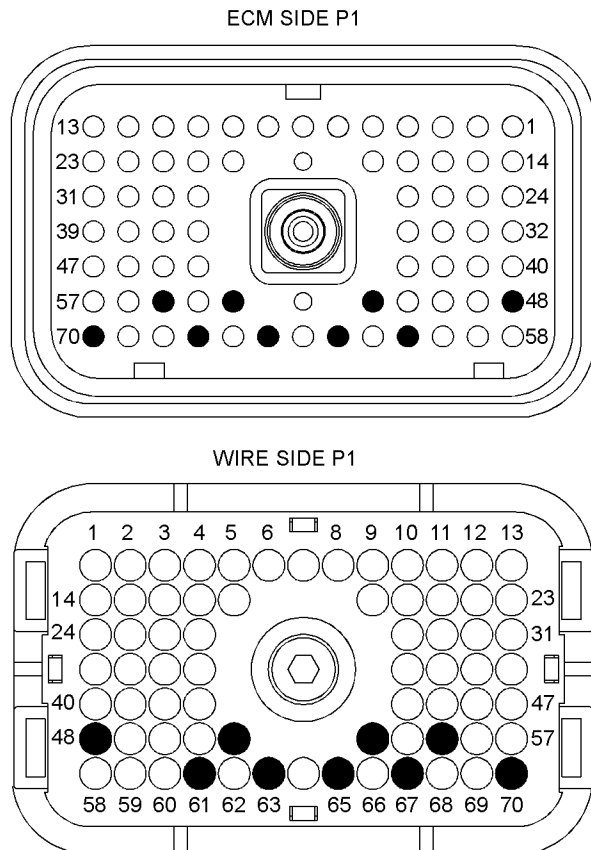


Illustration 29

g01302249

P1 connections for the electrical power supply circuit

(P1-48) +Battery
 (P1-52) +Battery
 (P1-53) +Battery
 (P1-55) +Battery
 (P1-61) -Battery
 (P1-63) -Battery
 (P1-65) -Battery
 (P1-67) -Battery
 (P1-70) 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 screw for 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 inserted and coupled. The harness and wiring are free of corrosion, of abrasion, and of pinch points. All connections and grounds are tight and free of corrosion.

Results:

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

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

STOP.

Test Step 2. Check the Battery Voltage at the ECM

- A.** Remove electrical power from the engine ECM.
- B.** Disconnect the J1/P1 ECM connector.
- C.** Restore electrical power to the engine ECM.
- D.** Turn the keyswitch to the ON position.
- E.** Wiggle the wires in the harness while performing the following test steps.
- Measure the voltage between P1-48 (Unswitched +Battery) and P1-61 (-Battery).
 - Measure the voltage between P1-52 (Unswitched +Battery) and P1-63 (-Battery).
 - Measure the voltage between P1-53 (Unswitched +Battery) and P1-65 (-Battery).
 - Measure the voltage between P1-55 (Unswitched +Battery) and P1-67 (-Battery).
 - Measure the voltage between P1-70 (Keyswitch) and P1-63 (-Battery).

Expected Result:

The measured voltage is between 22 VDC and 27 VDC.

Results:

- OK – The ECM is receiving the correct voltage.

Repair: There may be an intermittent electrical problem in a harness or in a connector. If an intermittent condition is suspected, refer to Troubleshooting, “Electrical Connectors - Inspect”.

STOP.

- Unswitched power out of range – The voltage is not correct for one of the unswitched battery circuits at the ECM. Proceed to Test Step 3.
- Keyswitch voltage out of range – The voltage is not correct for the keyswitch circuit at the ECM. Proceed to Test Step 4.

Test Step 3. Check the Batteries

- Measure the no-load battery voltage at the battery posts.
- Load test the batteries. Use the 4C-4911 Battery Load Tester. Refer to Special Instruction, SEHS9249, “Use of 4C-4911 Battery Load Tester for 6, 8 and 12 Volt Lead Acid Batteries” and Special Instruction, SEHS7633, “Battery Test Procedure”.

Expected Result:

The batteries pass the load test. The measured voltage is the minimum specification for a 24V system.

Results:

- OK – The batteries pass the load test.

Repair: The batteries are OK. There is an open circuit or excessive resistance in the wiring or connections between the batteries and the ECM. Verify that the 15 Amp circuit breaker for the engine ECM is not tripped. Verify that the connection at the engine ground stud is clean and tight and that the battery disconnect switch is functioning properly. Repair the connectors or wiring and/or replace the connectors or wiring between the battery and the ECM connector J1/P1.

STOP.

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

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

STOP.

Test Step 4. Check the Voltage from the Keyswitch to the ECM

- Remove electrical power from the engine ECM.
- Remove the wire from the terminal R of the keyswitch.
- Restore electrical power to the engine ECM.
- Turn the keyswitch to the ON position.
- Measure the voltage on terminal B of the keyswitch to engine ground.
- Measure the voltage on terminal R of the keyswitch to engine ground.
- Remove electrical power from the engine ECM.

Expected Result:

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

Results:

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

Repair: Check continuity of wire 308-YL (Yellow) between the keyswitch and the ECM. Verify that the wire does not have a short or an open.

STOP.

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

Repair: If voltage is not present on terminal B, repair the circuit between the +Battery and the keyswitch. Check the circuit protection for the circuit. Verify that the problem is eliminated.

STOP.

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

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

STOP.

i02602107

Fuel Filter Differential Pressure - Test

SMCS Code: 1261-038-ZS; 1435-038

System Operation Description:

Perform this procedure if you suspect that there is a problem in the circuit for the fuel filter differential pressure switch. The fuel filter differential pressure switch is used to monitor the differential pressure across the fuel filter element. The switch is normally closed. When the differential pressure at the switch reaches 103 ± 14 kPa (15 ± 2 psi) the switch will open. The Electronic Control Module (ECM) will alert the operator of fuel restriction. Use this test in order to verify that the fuel filter differential pressure switch is operating correctly.

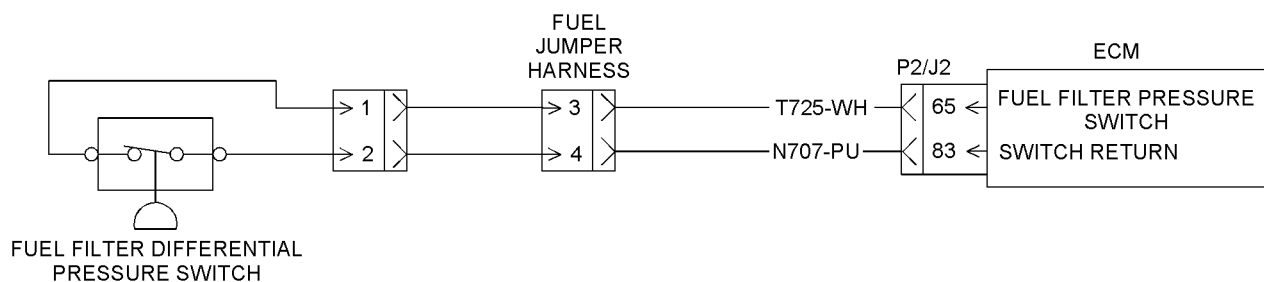


Illustration 30

g01027829

Schematic

Test Step 1. Inspect Electrical Connectors and Wiring

A. Remove electrical power from the engine ECM.

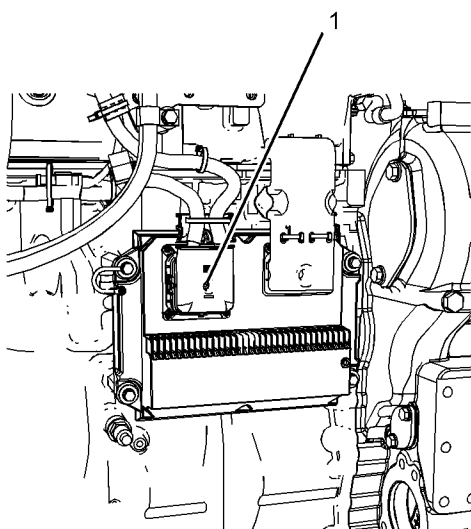


Illustration 31

g01310457

Left side engine view (typical example)

(1) J2/P2 ECM connectors

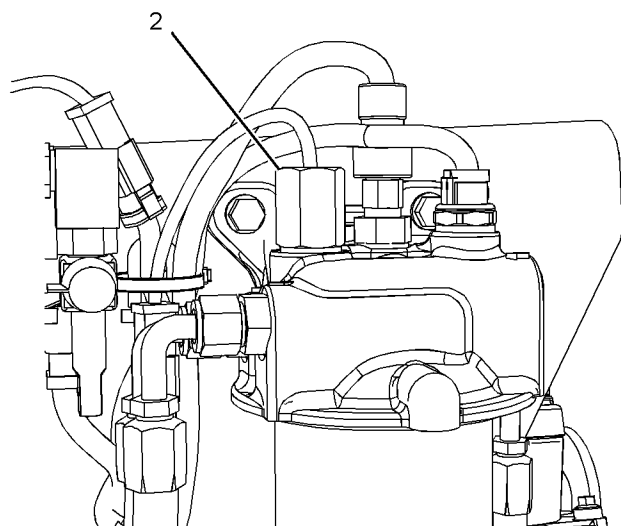


Illustration 32

g01161069

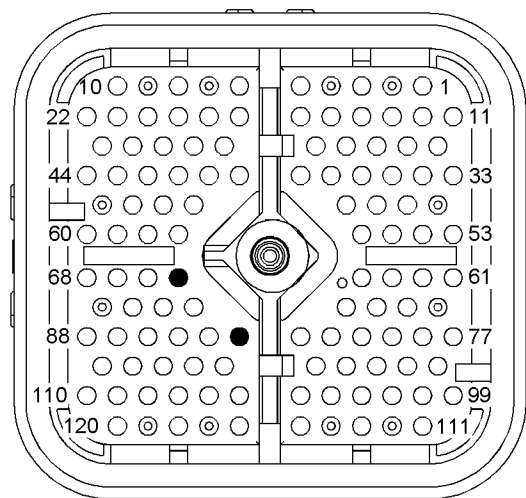
Typical location of the fuel filter differential pressure switch

(2) Fuel filter differential pressure switch

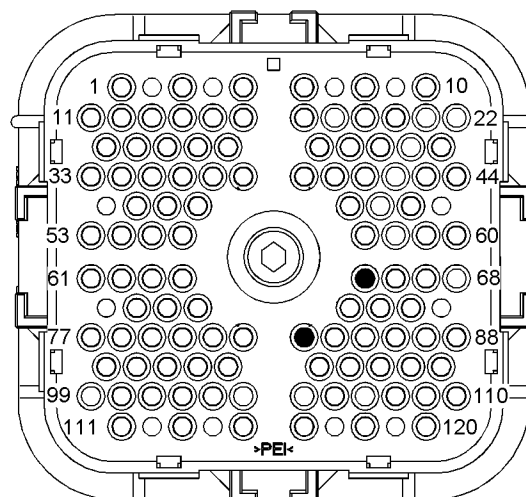
B. Thoroughly inspect connector (1). Also, thoroughly inspect the connector for switch (2).

Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.

120 PIN P2 ECM CONNECTOR



ECM SIDE



HARNESS SIDE

Illustration 33

g01027831

P2 ECM connector

(P2-65) Fuel filter differential pressure switch

(P2-83) Return for the switch

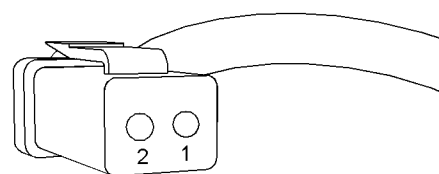


Illustration 34

g01160725

Connector for the fuel filter differential pressure switch

(Terminal 1) Fuel filter differential pressure switch

(Terminal 2) Return for the switch

- C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector and the sensor connectors that are associated with the active diagnostic code.
- D. Check the ECM connector (allen head screw) for the proper torque. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- E. Check the harness and wiring for abrasions and for pinch points from the sensors back to the ECM.

Expected Result:

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

Results:

- OK – The harness and wiring 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 Switch Circuit

- A. Disconnect the connector for the differential pressure switch.
- B. Check continuity between the terminals for the differential pressure switch at the connector.

Expected Result:

The resistance check indicates a short circuit.

Results:

- OK – The resistance check indicates a short circuit. The differential pressure switch is OK. Proceed to Test Step 3.
- Not OK – The resistance check indicates an open circuit. There is an open circuit in the wiring for the fuel filter differential pressure switch.

Repair: Replace the differential pressure switch.

STOP.

Test Step 3. Check the Wiring between the Connector for the Differential Pressure Switch and the ECM

- A. Disconnect the J2/P2 ECM connector.
- B. Create a short between the terminals of the connector for the differential pressure switch.
- C. Check continuity at the ECM connector between terminal P2-65 (fuel filter pressure switch) and terminal P2-83 (switch return).

Expected Result:

The resistance check indicates a short circuit.

Results:

- OK – The resistance check indicates a short circuit.

Repair: Check all connectors and wiring. Ensure that there are clean, solid connections at each connector. Return all wiring to the original configuration and retest the circuit. The most likely cause of the problem is a poor connection. The next most likely cause of the problem is the differential pressure switch. The least likely cause of the problem is the ECM. The ECM can be tested by creating a short between the ECM terminals for the differential pressure switch. Start and run the engine. After an hour, check for a E390 event code. If the event code is activated with the short in place at the ECM connector, replace the ECM. Refer to Troubleshooting, "ECM - Replace". Verify that the problem is resolved.

STOP.

- Not OK – The resistance check indicates an open circuit.

Repair: Repair the connectors or wiring and/or replace the connectors or wiring between the ECM and the connector for the differential pressure switch.

STOP.

i02602139

Fuel Transfer Pump - Test

SMCS Code: 1256-038

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 34 is active or easily repeated.

Table 34

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.

A test on Caterpillar Electronic Technician (ET) allows the technician to energize the fuel pump relay. The test is functional when engine speed is 0 rpm. The ECM will energize the output for the fuel pump relay for 120 seconds. The test is accessed by selecting the following menus on Cat ET:

- "Diagnostics"
- "Diagnostic Tests"
- "Override Parameters"

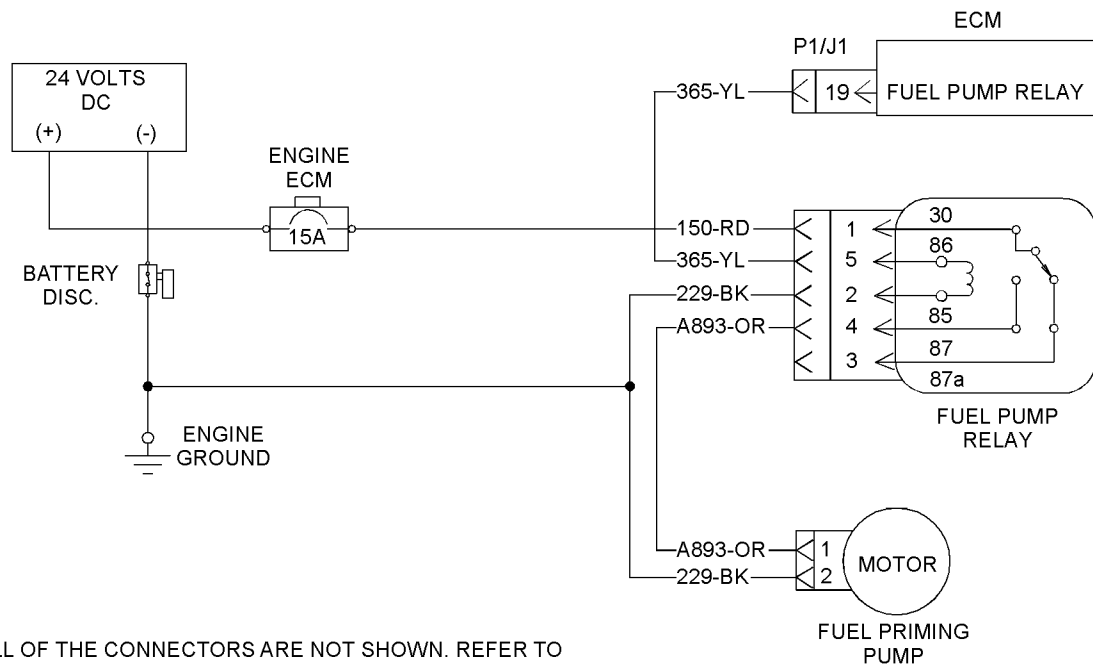


Illustration 35

g01302442

Typical schematic

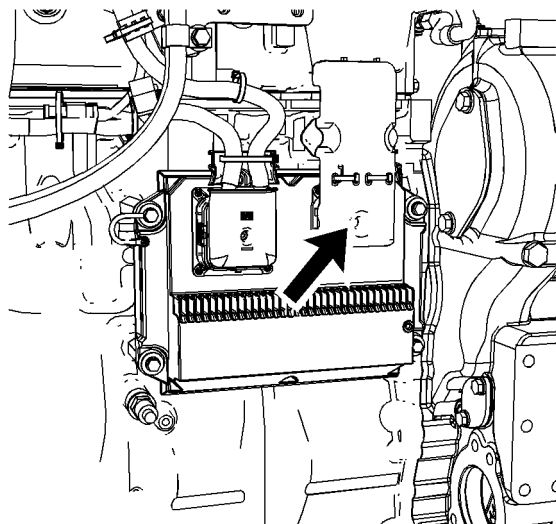


Illustration 36

g01141049

Typical location of the P1 ECM connectors

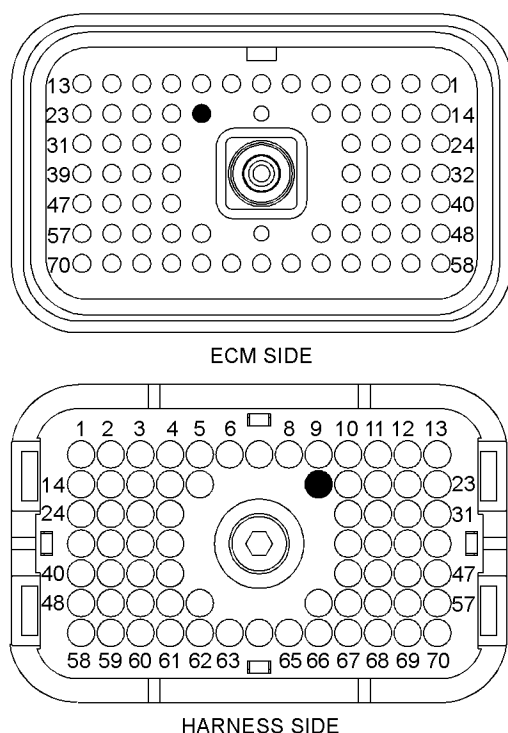


Illustration 37

g01302446

P1 ECM connector
(P1-19) Fuel pump relay

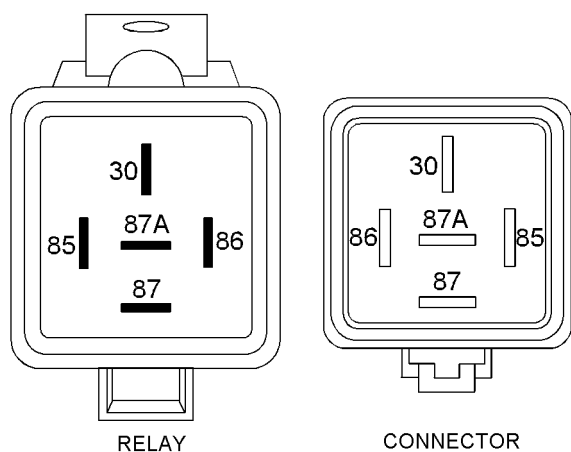


Illustration 38

g01149844

Terminal locations of the fuel pump relay

Test Step 1. 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.
- Note:** Wait at least 30 seconds in order for the diagnostic code to become active.
- 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 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 5.
- Not OK – A 6 diagnostic code is active at this time. Proceed to Test Step 2.
- Not OK – A 5 diagnostic code is active at this time. Proceed to Test Step 3.

Test Step 2. 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 for 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.

Repair: Temporarily connect a new fuel pump relay to the harness, but do not install the new fuel pump relay. Verify that there are no active diagnostic codes for the fuel pump relay. If there are no active diagnostic codes for the fuel pump relay, permanently install the new 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 4.

Test Step 3. 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 terminal 5 and terminal 2 at the connector for the fuel pump relay. Refer to Illustration 35 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 connect a new fuel pump relay to the harness, but do not install the new fuel pump relay. Verify that there are no active diagnostic codes for the fuel pump relay. If there are no active diagnostic codes for the fuel pump relay, permanently install the new 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 229-BK(Black) on terminal 2 of the connector for the fuel pump relay has continuity to engine ground. If wire 229-BK(Black) is OK, the open circuit is between the ECM and the connector for the fuel pump relay. Proceed to Test Step 4.

Test Step 4. 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 P1-19.

c. Install a wire jumper into the socket for P1-19. 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 P1-19 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: Replace the ECM. Refer to Troubleshooting, "ECM - Replace". Verify that the problem is resolved.

STOP.

Test Step 5. 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 35 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 wire 229-BK(Black) has continuity to engine ground. If wire 229-BK(Black) is OK, proceed to Test Step 6.

Test Step 6. 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 wire A893-OR(Orange) from terminal 4 of the connector.
- 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 4 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 wire A893-OR(Orange) 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 1 at the connector for the fuel pump relay. Verify that the 15 Amp circuit breaker for the engine ECM is not tripped. If voltage is present on terminal 1, replace the fuel pump relay.

STOP.

Injector Solenoid - Test

SMCS Code: 1290-038-JV

System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with the injectors or 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
1-5 Cylinder #1 Injector current below normal	The engine's Electronic Control Module (ECM) detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.
1-6 Cylinder #1 Injector current above normal	The ECM detects a short circuit.	The code is logged. The ECM will disable the solenoid circuit. The ECM will periodically try to fire the injector. If the short circuit remains, this sequence of events will be repeated until the problem is corrected.
2-5 Cylinder #2 Injector current below normal	The engine's ECM detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.
2-6 Cylinder #2 Injector current above normal	The ECM detects a short circuit.	The code is logged. The ECM will disable the solenoid circuit. The ECM will periodically try to fire the injector. If the short circuit remains, this sequence of events will be repeated until the problem is corrected.
3-5 Cylinder #3 Injector current below normal	The engine's ECM detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.
3-6 Cylinder #3 Injector current above normal	The ECM detects a short circuit.	The code is logged. The ECM will disable the solenoid circuit. The ECM will periodically try to fire the injector. If the short circuit remains, this sequence of events will be repeated until the problem is corrected.
4-5 Cylinder #4 Injector current below normal	The engine's ECM detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.
4-6 Cylinder #4 Injector current above normal	The ECM detects a short circuit.	The code is logged. The ECM will disable the solenoid circuit. The ECM will periodically try to fire the injector. If the short circuit remains, this sequence of events will be repeated until the problem is corrected.
5-5 Cylinder #5 Injector current below normal	The engine's ECM detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.
5-6 Cylinder #5 Injector current above normal	The ECM detects a short circuit.	The code is logged. The ECM will disable the solenoid circuit. The ECM will periodically try to fire the injector. If the short circuit remains, this sequence of events will be repeated until the problem is corrected.
6-5 Cylinder #6 Injector current below normal	The engine's ECM detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.
6-6 Cylinder #6 Injector current above normal	The ECM detects a short circuit.	The code is logged. The ECM will disable the solenoid circuit. The ECM will periodically try to fire the injector. If the short circuit remains, this sequence of events will be repeated until the problem is corrected.

Perform this procedure under conditions that are identical to the conditions that exist when the problem occurs. Typically, problems with the injector solenoid occur when the engine is warmed up and/or when the engine is under vibration (heavy loads).

These engines have Electronic Unit Injectors (EUI) that are mechanically actuated and electronically controlled. The ECM sends a 105 volt pulse to each injector solenoid. The pulse is sent at the proper time and at the correct duration for a given engine load and speed. The solenoid is mounted on top of the fuel injector body.

If an open is detected in the solenoid circuit, a diagnostic code is generated. The ECM continues to try to fire the injector. If a short is detected, a diagnostic code is generated. The ECM will disable the solenoid circuit. The ECM will periodically try to fire the injector. If the short circuit remains, this sequence of events will be repeated until the problem is corrected.

Note: Refer to Illustration 40 . Two injector solenoids share a supply wire. For this reason, an open circuit or a short circuit in a supply wire or a connector could cause diagnostic codes for two injector solenoids. Note that a diagnostic code for a single injector indicates that the problem is most likely in the return wire or a connector in the return circuit.

When an injector is replaced, you must program the new injector trim files into the ECM. If the ECM is replaced, all injector trim files must be programmed into the new ECM. Refer to Troubleshooting, "Injector Trim File - Install" for more information.

Caterpillar Electronic Technician (ET) includes the following tests that aid in troubleshooting the injector solenoids:

"Cylinder Cutout Test"

The "Cylinder Cutout Test" is used on an engine in order to determine the individual cylinder performance while the engine is running. As one or more cylinders are cut out during the test, the "Cylinder Cutout Test" uses the "Fuel Position" of each injector in order to evaluate the performance of the remaining cylinders that are firing. As the different cylinders are cut out, a comparison of the change in "Fuel Position" is used to identify cylinders that are weak or misfiring. One reason for a cylinder that is weak or misfiring is an injector that is malfunctioning mechanically.

During the test, when a good injector is cut out, the "Fuel Position" of the remaining injectors will show a consistent change. This consistent change in the "Fuel Position" is caused by the remaining injectors that are compensating for the cut out injector. If a malfunctioning injector is cut out, the "Fuel Position" will not show a proportional change. This unbalanced change is the result of the smaller quantity of fuel that is needed to compensate for the power loss from the malfunctioning injector. The "Cylinder Cutout Test" is used to isolate a malfunctioning injector in order to avoid replacement of injectors that are in good repair.

Note: Prior to running the "Cylinder Cutout Test" , all active diagnostic codes must be repaired.

"Injector Solenoid Test"

Use the "Injector Solenoid Test" to diagnose an open circuit or a short circuit in the wiring for the injector solenoids. While the engine is off, the "Injector Solenoid Test" briefly activates each injector solenoid. A good solenoid will create an audible click when the solenoid is activated. After performing the test, Cat ET will indicate the status of the solenoid as "OK" , "Open" , or "Short" .

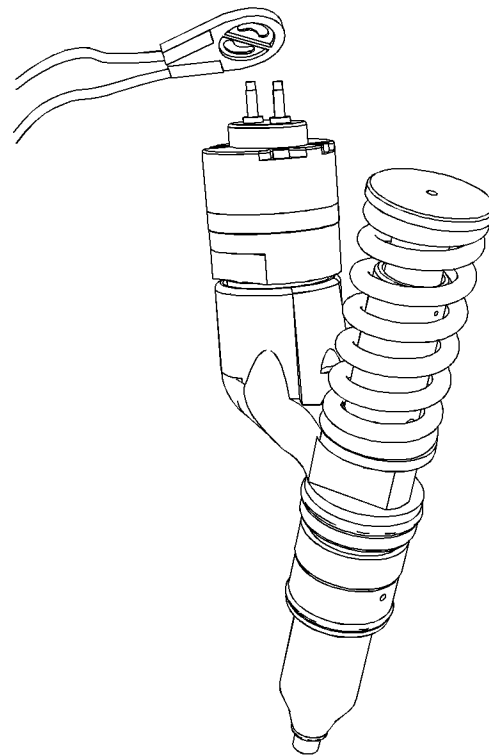


Illustration 39

g01147070

Electronic unit injector

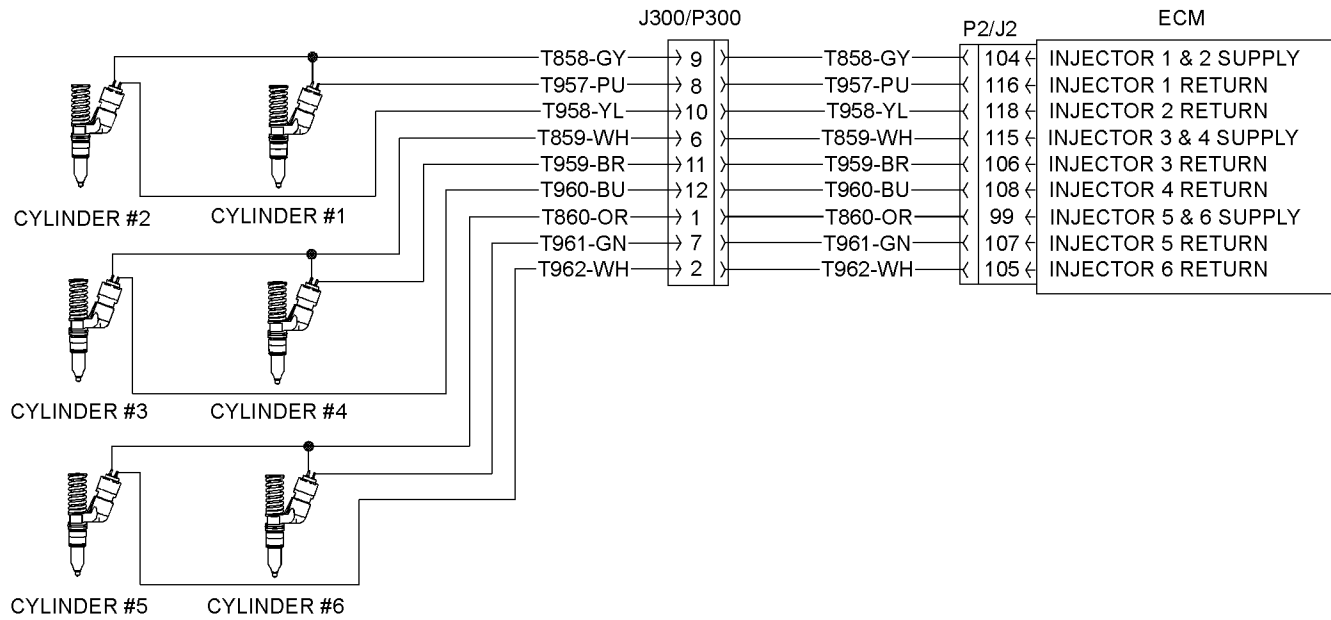


Illustration 40
Schematic for the injector solenoids

g01161139

Test Step 1. Inspect the Electrical Connectors and the Wiring

WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

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

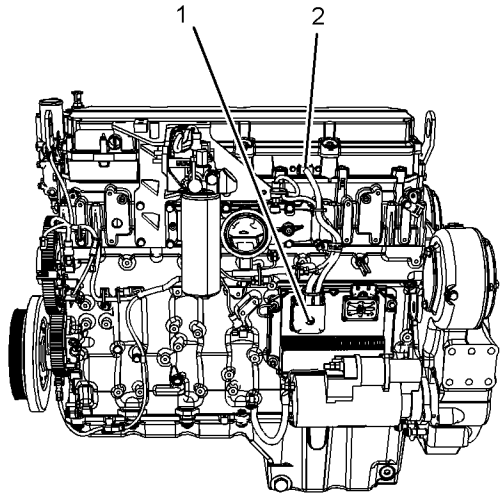


Illustration 41
Left side engine view (typical example)

g01200438

- (1) J2/P2 ECM connector
- (2) J300/P300 Injector valve cover entry connector

C. Thoroughly inspect connectors (1) and (2). Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.

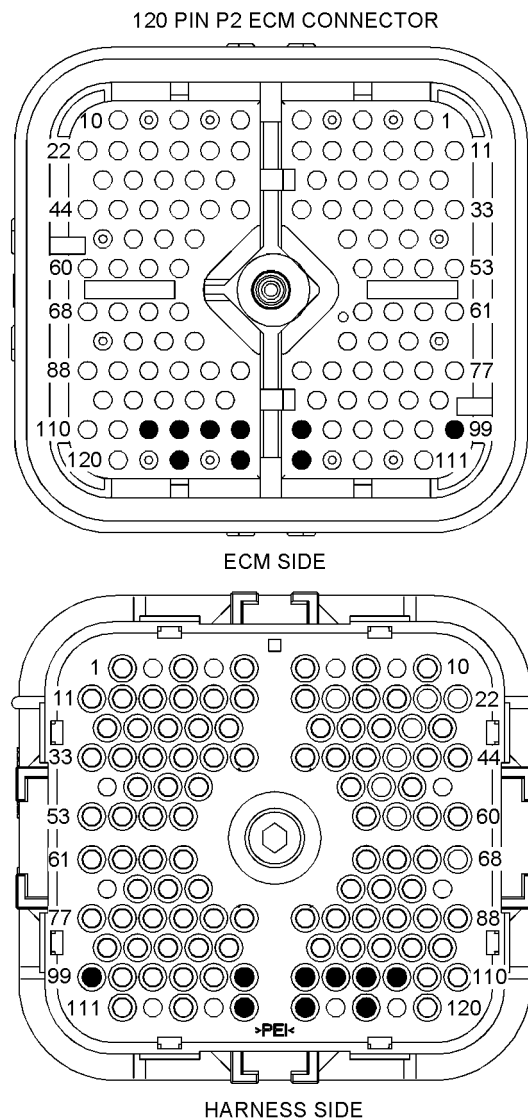


Illustration 42

g01099568

Terminal locations at the P2 ECM connector

(P2-99) Injector 5 & 6 supply
 (P2-104) Injector 1 & 2 supply
 (P2-105) Injector 6 return
 (P2-106) Injector 3 return
 (P2-107) Injector 5 return
 (P2-108) Injector 4 return
 (P2-115) Injector 3 & 4 supply
 (P2-116) Injector 1 return
 (P2-118) Injector 2 return

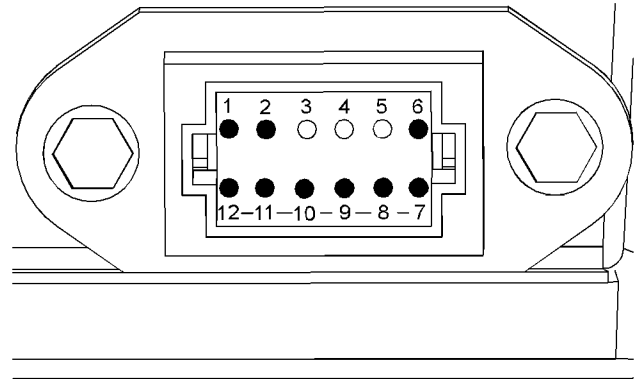


Illustration 43

g01161269

Terminal locations at the J300 injector valve cover entry connector

(J300-1) Injector 5 & 6 supply
 (J300-2) Injector 6 return
 (J300-6) Injector 3 & 4 supply
 (J300-7) Injector 5 return
 (J300-8) Injector 1 return
 (J300-9) Injector 1 & 2 supply
 (J300-10) Injector 2 return
 (J300-11) Injector 3 return
 (J300-12) Injector 4 return

- D. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector and each of the wires that are associated with injector solenoids.
- E. Check the allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, "Electrical Connectors - Inspect" for the correct torque values.
- F. Check the harness and wiring for abrasions and for pinch points from the injectors to the ECM.

Expected Result:

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

Results:

- OK – The connectors and the wiring 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 Logged Diagnostic Codes for the Injector Solenoids

- A. Connect Cat ET to the data link connector. Refer to Troubleshooting, "Electronic Service Tools".
- B. Restore electrical power to the engine ECM.
- C. Turn the keyswitch to the ON position.
- D. Check for logged diagnostic codes for the injector solenoids on Cat ET.

Expected Result:

There are no logged diagnostic codes for the injector solenoids.

Results:

- OK – No diagnostic codes have been logged. The injector solenoids are operating correctly. There may be a mechanical problem with the injector's fuel delivery. Proceed to Test Step 3.
- Not OK – One or more diagnostic codes have been logged. There may be an electrical problem in the circuit for the injector. Proceed to Test Step 4.

Test Step 3. Perform the "Cylinder Cutout Test"

- A. Turn the keyswitch to the ON position.
- B. Start the engine.
- C. Allow the engine to warm up to normal operating temperature (approximately 77 °C (171 °F)).
- D. After the engine is warmed to operating temperature, access the "Cylinder Cutout Test" by accessing the following display screens in order:
 - "Diagnostics"
 - "Diagnostic Tests"
 - "Cylinder Cutout Test"
- E. Shut off all parasitic loads such as the air conditioning and the air compressors which could affect the results of the test.
- F. Select the start button at the bottom of the screen for the cylinder cutout test on Cat ET.
- G. Follow the instructions that are provided in the cylinder cutout test. The cylinder cutout tests are interactive so the procedure is guided to the finish. The cylinder cutout test will set the correct engine speed for the application.

Expected Result:

The variation of the fuel rate for all cylinders is within specifications.

Results:

- OK – The cylinder cutout test indicates that all of the injectors are operating correctly.

Repair: If a problem with the fuel system is suspected and diagnostic codes are not active or logged, refer to Systems Operation/Testing and Adjusting for information that is related to the low pressure fuel system.

If a diagnostic code results from running the "Cylinder Cutout Test", proceed to Test Step 4.

- Not OK – The cylinder cutout test indicates that at least one of the injectors is not operating correctly.

Repair: Verify that the engine valve lash for that injector is set correctly. Rerun the "Cylinder Cutout Test". If the problem is still present, replace the injector. Change the injector trim file in the ECM. Refer to Troubleshooting, "Injector Trim File - Install".

STOP.

Test Step 4. Perform the "Injector Solenoid Test"

- A. Turn the keyswitch to the OFF position. Leave the keyswitch in the OFF position for a period of fifteen seconds.
- B. Turn the keyswitch to the ON position.
- C. Start the engine.
- D. Allow the engine to warm up to normal operating temperature (approximately 77 °C (171 °F)).
- E. Stop the engine.
- F. Restore electrical power to the engine ECM.
- G. Access the "Injector Solenoid Test" by accessing the following display screens in order:
 - "Diagnostics"
 - "Diagnostic Tests"
 - "Injector Solenoid Test"
- H. Activate the "Injector Solenoid Test".
- I. As each solenoid is energized by the ECM an audible click can be heard at the valve cover. Ensure the activation of each solenoid by comparing the location of the click with the progress that is displayed on Cat ET.

J. Perform the injector solenoid test at least two times.

Expected Result:

All cylinders indicate "OK" on Cat ET.

Results:

- OK – There is not an electronic problem with the injectors at this time.

Repair: The problem appears to be resolved. The problem was probably caused by a poor electrical connection in a connector.

If the codes continue to be logged, refer to Troubleshooting, "Electrical Connectors - Inspect".

If the engine is misfiring or if the engine has low power, refer to Troubleshooting, "Engine Misfires, Runs Rough or Is Unstable" or Troubleshooting, "Power Is Intermittently Low or Power Cutout Is Intermittent".

STOP. STOP

- Not OK - "Open" – Note the cylinder that indicates "Open". Proceed to Test Step 5.
- Not OK - "Short" – Note the cylinder that indicates "Short". Proceed to Test Step 6.

Test Step 5. Check the Harness between the ECM and the Valve Cover Base for an Open Circuit

WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

- Turn the keyswitch to the OFF position.
- Remove electrical power from the engine ECM.
- Disconnect the J300/P300 injector valve cover entry connector at the valve cover base.
- Fabricate a jumper wire that will be long enough to short circuit the different terminal locations at the P300 connector. Crimp connector pins on both ends of the jumper wire.

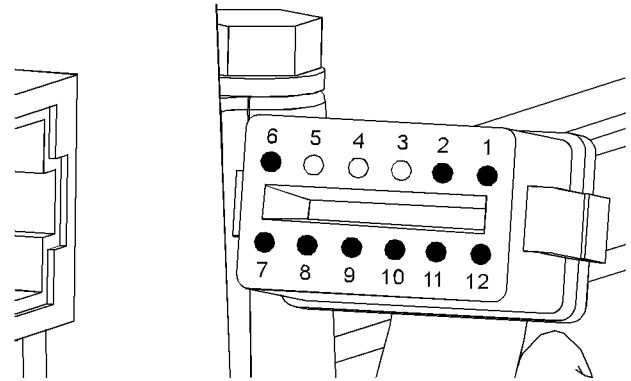


Illustration 44

g01161290

Terminal locations for P300 Injector valve cover entry connector (terminal side)

- (P300-1) Injector 5 & 6 supply
- (P300-2) Injector 6 return
- (P300-6) Injector 3 & 4 supply
- (P300-7) Injector 5 return
- (P300-8) Injector 1 return
- (P300-9) Injector 1 & 2 supply
- (P300-10) Injector 2 return
- (P300-11) Injector 3 return
- (P300-12) Injector 4 return

E. Insert one end of the jumper wire into the P300 connector socket for the suspect injector's supply wire. Insert the other end of the jumper wire into the P300 connector socket for the suspect injector's return wire. This will replace the injector solenoid with a short circuit.

F. Restore electrical power to the engine ECM.

G. Turn the keyswitch to the ON position.

H. Perform the "Injector Solenoid Test" at least two times.

I. Repeat this test for each suspect circuit. Stop the "Injector Solenoid Test" before handling the jumper wire. Restore the wiring to the original configuration.

Expected Result:

Cat ET displays "Short" for each of the circuits that were jumpered.

Results:

- OK – Cat ET displays "Short" for each circuit that was jumpered. The harness between the ECM and the P300 connector does not have an open circuit. Proceed to Test Step 7.
- Not OK – Cat ET displays "Open" for the cylinder with the jumper wire. There is a problem in the wiring between the ECM and the P300 connector. Proceed to Test Step 8.

Test Step 6. Check the Harness between the ECM and the Valve Cover Base for a Short Circuit

WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

- A. Turn the keyswitch to the OFF position.
- B. Remove electrical power from the engine ECM.
- C. Disconnect the P300 connector.
- D. Restore electrical power to the engine ECM.
- E. Turn the keyswitch to the ON position.
- F. Perform the "Injector Solenoid Test" at least two times.

Expected Result:

All of the cylinders indicate "Open" on Cat ET.

Results:

- OK – All cylinders indicate "Open" on Cat ET. The harness between the ECM and the P300 connector does not have a short circuit. Proceed to Test Step 7.
- Not OK – One or more cylinders indicate "Short" on Cat ET. Note the cylinders that indicate "Short". Proceed to Test Step 8.

Test Step 7. Check the Injector Harness Under the Valve Cover for an Open Circuit or 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.
- B. Remove electrical power from the engine ECM.
- C. Remove the valve cover in order to gain access to the suspect injector.
- D. Disconnect the harness connector from the suspect injector.

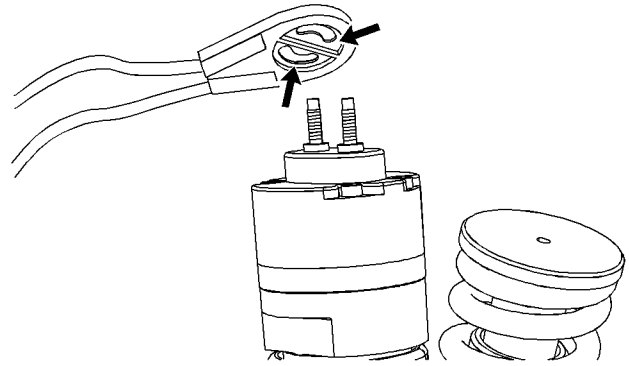


Illustration 45

g01147088

Connector terminals for the injector solenoid

- E. Thoroughly clean the terminals on the injector solenoid and on the harness connector.
 - F. Use a jumper wire to short circuit the connector terminals for the suspect injector. This will effectively replace the injector solenoid with a short circuit.
 - G. Restore electrical power to the engine ECM.
 - H. Turn the keyswitch to the ON position.
 - I. Perform the "Injector Solenoid Test" at least two times.
- Note:** The injector solenoid that shares the supply wire of the injector that is short circuited may indicate a false test result. Disregard this test result.
- J. Turn the keyswitch to the OFF position.
 - K. Remove electrical power from the engine ECM.
 - L. Remove the jumper wire from the injector connector. This will effectively replace the injector solenoid with an open circuit.
 - M. Restore electrical power to the engine ECM.
 - N. Turn the keyswitch to the ON position.
 - O. Perform the "Injector Solenoid Test" at least two times.
 - P. Turn the keyswitch to the OFF position.
 - Q. Remove electrical power from the engine ECM.

Expected Result:

Cat ET displays "Short" for the cylinder with the jumper wire and "Open" when the jumper wire is removed.

Results:

Circuit Tests

- OK – Cat ET correctly displays the correct status during the test. The harness wiring is OK.

Repair: Use a multimeter to check the resistance of the suspect injector solenoid.

The correct resistance of each injector solenoid is 1.06 ± 0.05 Ohms.

If the resistance of the solenoid is not within specifications replace the faulty injector. Verify that the problem is resolved.

If the resistance of the solenoid is within specifications the problem may be intermittent. If the problem is intermittent, refer to Troubleshooting, “Electrical Connectors - Inspect”. Verify that the repair eliminates the problem.

STOP. STOP

- Not OK – Cat ET did not correctly display the correct status during the test. 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. STOP

Test Step 8. Check the ECM for Proper Operation



WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

- Turn the keyswitch to the OFF position.
- Remove electrical power from the engine ECM.
- Fabricate a jumper that is long enough to reach from the P2 ECM connector to the engine ground stud. Crimp a socket terminal to one end of the jumper wire.
- Disconnect the P2 connector.
- Remove the supply wire for the suspect injector from the ECM connector. Install the jumper wire into the socket.
- Connect the J2/P2 ECM connector.
- Verify that the ECM will detect an open circuit for the suspect injector:
 - Ensure that the jumper wire is not in contact with a ground source or another circuit. Do not

touch the jumper wire during the test. A strong electrical shock hazard is present at the jumper wire while the test is running.

- Restore electrical power to the engine ECM.
- Turn the keyswitch to the ON position.
- Perform the “Injector Solenoid Test” at least two times.

Cat ET displays “Open” for the two injectors that share the supply wire.

- Turn the keyswitch to the OFF position.
 - Remove electrical power from the engine ECM.
- H. Verify that the ECM detects a short circuit for the suspect injector:

- Connect the jumper wire to the engine ground stud. Do not touch the jumper wire during the test. A strong electrical shock hazard is present at the jumper wire while the test is running.
- Restore electrical power to the engine ECM.
- Turn the keyswitch to the ON position.
- Perform the “Injector Solenoid Test” at least two times.

Cat ET displays “Short” for the two injectors that share the supply wire.

- Turn the keyswitch to the OFF position.
- Remove electrical power from the engine ECM.

Expected Result:

Cat ET displays the correct status for each test circuit.

Results:

- OK – The ECM detects the correct status of the circuit. There is an open circuit or a short circuit in the engine harness. 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. Clear all diagnostic codes after you complete this test step.

Verify that the problem is resolved.

STOP. STOP

- Not OK – The ECM does not detect the correct status of the circuit.

Repair: There is a problem with the ECM.
Replace the ECM. Refer to Troubleshooting,
"ECM - Replace". Verify that the problem is
resolved.

STOP. STOP

i02606054

Retarder - Test

SMCS Code: 1119-038

S/N: B9H1–Up

S/N: R9H1–Up

S/N: R9J1–Up

S/N: MHX1–Up

System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with the compression brake solenoids or if any 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
791-5 Compression Brake Low/High Solenoid current below normal	The Electronic Control Module (ECM) detects an open circuit or a short circuit to the +Battery for the "low/high solenoid" . The ECM can only detect this condition when the output driver is not activated.	The code is logged.
791-6 Compression Brake Low/High Solenoid current above normal	The ECM detects a short to ground condition for the "low/high solenoid" during an attempt to activate the compression brake. The ECM can only detect this condition when the output driver is activated.	
792-5 Compression Brake Medium/High Solenoid current below normal	The ECM detects an open circuit or a short circuit to the +Battery for the "medium/high solenoid" . The ECM can only detect this condition when the output driver is not activated.	The code is logged.
792-6 Compression Brake Medium/High Solenoid current above normal	The ECM detects a short to ground condition for the "medium/high solenoid" during an attempt to activate the compression brake. The ECM can only detect this condition when the output driver is activated.	

The operator has the ability to turn on the compression brake through a switch in the cab. If the engine retarder is installed on the engine, the configuration parameter for the engine retarder must be set to "Enabled" for this function to operate. The requested level of braking is sent over the Cat Data Link from the transmission ECM. The engine's ECM will activate the appropriate compression brake solenoids in order to meet the requested level of braking.

"Compression Brake Solenoid Override"

The “Compression Brake Low/High Override” and the “Compression Brake Med/High Override” are diagnostic overrides that are available on Caterpillar Electronic Technician (ET). Use the overrides to assist in troubleshooting problems in the circuit for the compression brake. The ECM will only detect shorts in the circuit for the compression brake when the overrides are active. The overrides must be activated and then deactivated before the ECM will detect an open circuit. The ECM will only detect opens in the circuit for the compression brake when the overrides are not active.

Note: The engine speed must be zero before the overrides will function.

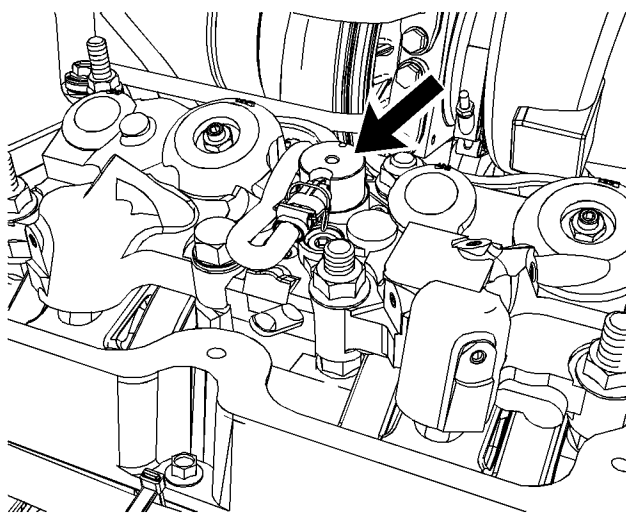


Illustration 46

g01199118

Location of the compression brake solenoid (typical example)

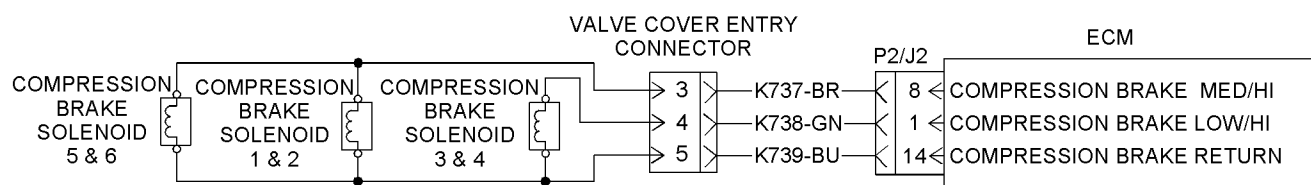


Illustration 47

g01304722

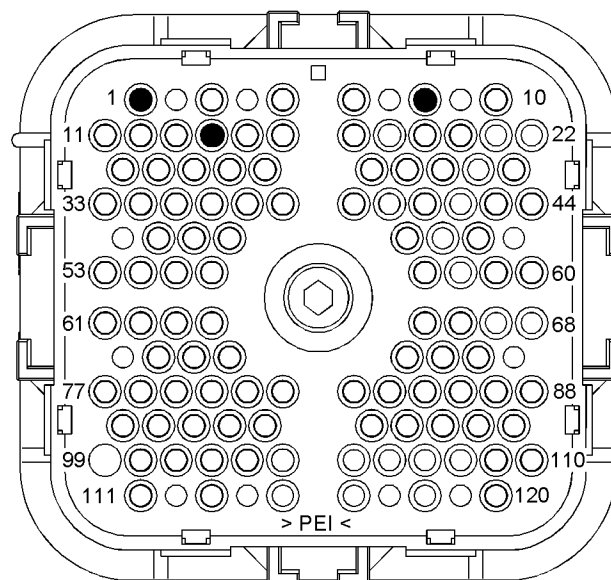
Schematic for the compression brake circuit

Test Step 1. Inspect the Electrical Connectors and the Wiring

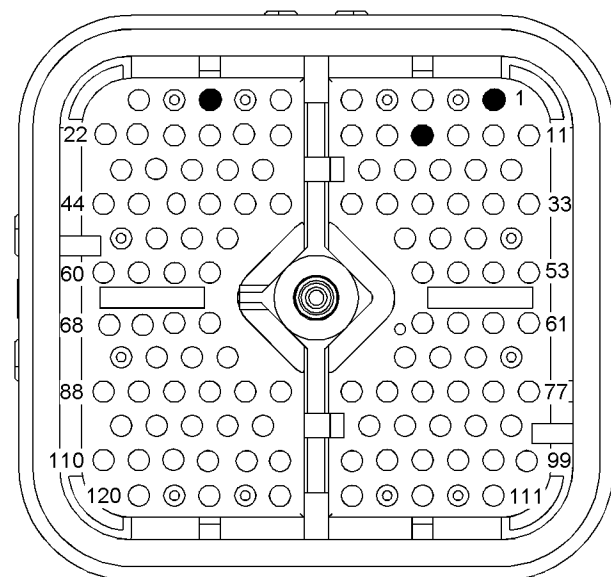
⚠ WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

- A.** Remove electrical power from the engine's ECM.
A strong electrical shock hazard is present if the electrical power is not removed from the engine ECM.
- B.** Thoroughly inspect ECM connector J2/P2 and the connector for the valve cover. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.



HARNESS SIDE



ECM SIDE

Illustration 48

g01141312

P2 ECM connector

- (P2-1) Compression brake solenoid low/high
- (P2-8) Compression brake solenoid med/high
- (P2-14) Digital return

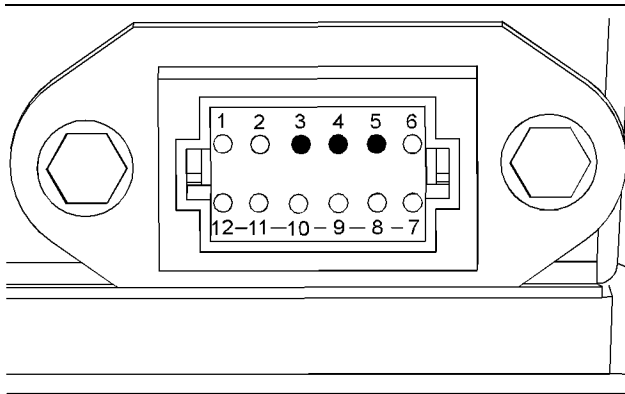


Illustration 49

g01304729

Valve cover entry connector

- (3) Compression brake solenoid med/high
- (4) Compression brake solenoid low/high
- (5) Digital return

- C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with the compression brake solenoids.
- D. Check the allen head screw for each of the ECM connectors and the machine connectors for the proper torque. Refer to Troubleshooting, "Electrical Connectors - Inspect" for the correct torque values.
- E. Check the harness and wiring for abrasion and for pinch points from the valve cover back to the ECM.

Expected Result:

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

Results:

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

Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals for each of the connectors are properly in place and ensure that the connectors are completely coupled. Verify that the repair eliminates the problem.

STOP.

Test Step 2. Check for Active Diagnostic Codes and/or Logged Diagnostic Codes

- A. Connect Cat ET to the service tool connector.
- B. Turn the keyswitch to the ON position.
- C. Access the diagnostic overrides under the "Diagnostics" menu.
- D. Start the "Compression Brake Low/High Override" on Cat ET.
- E. Once Cat ET displays the status of the compression brake solenoid, stop the "Compression Brake Low/High Override" .
- F. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.
- G. Start the "Compression Brake Med/High Override" on Cat ET.
- H. Once Cat ET displays the status of the compression brake solenoid, stop the "Compression Brake Med/High Override" .
- I. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

Expected Result:

No diagnostic codes are active or logged for the compression brake.

Results:

- OK – No diagnostic codes are active.

Repair: The problem may be intermittent. If the problem is intermittent, refer to Troubleshooting, "Electrical Connectors - Inspect".

STOP.

- Not OK – A 791-5 diagnostic code or a 792-5 diagnostic code is active at this time. If both diagnostic codes are active, the problem is most likely in the shared return wire. Inspect the wire and/or connectors for an open circuit. Proceed to Test Step 3.
- Not OK – A 791-6 diagnostic code or a 792-6 diagnostic code is active at this time. Proceed to Test Step 6.

Test Step 3. Create a Short Between the Wires of the Suspect Compression Brake Solenoid at the Valve Cover Connector

Note: In order to troubleshoot a 791-05 diagnostic code, you must use the "Compression Brake Low/High Override" on Cat ET. In order to troubleshoot a 792-05 diagnostic code, you must use the "Compression Brake Med/High Override" on Cat ET.

- A. Turn the keyswitch to the OFF position.
- B. Disconnect the harness at the valve cover connector.
- C. Fabricate a jumper wire in order to create a short between the supply wire for the suspect compression brake solenoid and engine ground.
- D. Turn the keyswitch to the ON position.
- E. Access the diagnostic overrides under the "Diagnostics" menu.
- F. Start the override for the compression brake.
- G. Once Cat ET displays the status of the compression brake solenoid, stop the override.
- H. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.
- I. Turn the keyswitch to the OFF position. Remove the wire short.

Expected Result:

A 791-6 diagnostic code or a 792-6 diagnostic code is active at this time.

Note: A 5 open circuit diagnostic code will be active for the other compression brake solenoid. Ignore the diagnostic codes for the other compression brake solenoid. Ignore any diagnostic codes for the injector solenoids.

Results:

- OK – A 791-6 diagnostic code or a 792-6 diagnostic code is active at this time. The harness wiring between the valve cover connector and the ECM is OK. Proceed to Test Step 4.
- Not OK – A 791-5 diagnostic code or a 792-5 diagnostic code is active at this time. The ECM did not detect the short at the valve cover connector. There is an open between the valve cover connector and the ECM. Proceed to Test Step 5.

Test Step 4. Create a Short Circuit at the Compression Brake Solenoid

Note: Two solenoids are activated in order to create a medium braking action. The open could be in either solenoid or in the harness. In order to isolate the problem for a medium braking action, run this test step for each of the solenoids. The short must be created separately at each solenoid.

Note: In order to troubleshoot a 791-05 diagnostic code, you must use the "Compression Brake Low/High Override" on Cat ET. In order to troubleshoot a 792-05 diagnostic code, you must use the "Compression Brake Med/High Override" on Cat ET.

- A. Turn the keyswitch to the OFF position.
- B. Remove the valve cover.
- C. Reconnect the valve cover connector.
- D. Disconnect the connector on the suspect compression brake solenoid.
- E. Inspect the terminals on the connector for the compression brake solenoid for damage.
- F. Fabricate a jumper wire in order to short the two wires for the suspect solenoid on the solenoid connector. Crimp a pin to each end of the jumper wire.
- G. Make sure that the solenoid connector securely holds the jumper wire.

Note: Worn terminals and/or damaged terminals on the solenoid connector could cause an intermittent "Open".

- H. Turn the keyswitch to the ON position.
- I. Access the diagnostic override under the "Diagnostics" menu.
- J. Start the override for the compression brake.
- K. Once Cat ET displays the status of the compression brake solenoid, stop the override.
- L. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.
- M. Turn the keyswitch to the OFF position. Remove the wire short.

Expected Result:

A 791-6 diagnostic code or a 792-6 diagnostic code is active at this time.

Results:

- OK – A 791-6 diagnostic code or a 792-6 diagnostic code is active at this time. The harness wiring between the connector for the compression brake solenoid and the ECM is OK.

Repair: Temporarily connect a new compression brake solenoid to the harness, but do not install the new compression brake solenoid in the engine. Retest the circuit for the compression brake solenoid. Verify that there are no active diagnostic codes for the compression brake solenoid. If there are no active diagnostic codes for the compression brake solenoid, permanently install the new compression brake solenoid.

STOP.

- Not OK – A 791-5 diagnostic code or a 792-5 diagnostic code is active at this time. The ECM did not detect the short at the connector for the compression brake. There is an open between the valve cover connector and the connector for the compression brake solenoid.

Repair: Repair the harness between the connector for the compression brake solenoid and the valve cover connector.

STOP.

Test Step 5. Create a Short Circuit at the ECM

Note: In order to troubleshoot a 791-05 diagnostic code, you must use the “Compression Brake Low/High Override” on Cat ET. In order to troubleshoot a 792-05 diagnostic code, you must use the “Compression Brake Med/High Override” on Cat ET.

- Turn the keyswitch to the OFF position.
 - Disconnect the J2/P2 ECM connector.
 - Inspect the terminals on the J2 and P2 ECM connectors for damage.
- Note:** Refer to Figure 48 for pin locations.
- Fabricate a jumper wire with a socket on one end.
 - Remove the supply wire for the suspect compression brake solenoid from the P2 ECM connector. Insert the jumper wire into the P2 ECM connector.
 - Reconnect the P2 ECM connector.
 - Create a short between the jumper wire and engine ground.
 - Turn the keyswitch to the ON position.
 - Start the override for the compression brake.
 - Once Cat ET displays the status of the compression brake solenoid, stop the override.

- Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.
- Turn the keyswitch to the OFF position. Remove the wire short.

Expected Result:

A 791-6 diagnostic code or a 792-6 diagnostic code is active at this time.

Results:

- OK – A 791-6 diagnostic code or a 792-6 diagnostic code is active at this time. The ECM detected the short.

Repair: Check continuity of the supply wire for the suspect compression brake solenoid between the valve cover connector and ECM connector P2. If the wire is open, replace the wire.

STOP.

- Not OK – A 791-5 diagnostic code or a 792-5 diagnostic code is active at this time. The ECM did not detect the short at the ECM connector.

Repair: Replace the ECM. Refer to Troubleshooting, “ECM - Replace”. Verify that the problem is resolved.

STOP.

Test Step 6. Create an Open Between the Wires of the Suspect Compression Brake Solenoid at the Valve Cover Connector

Note: In order to troubleshoot a 791-06 diagnostic code, you must use the “Compression Brake Low/High Override” on Cat ET. In order to troubleshoot a 792-06 diagnostic code, you must use the “Compression Brake Med/High Override” on Cat ET.

- Turn the keyswitch to the OFF position.
- Disconnect the harness at the valve cover connector.
- Turn the keyswitch to the ON position.
- Access the diagnostic override under the “Diagnostics” menu.
- Start the override for the compression brake.
- Once Cat ET displays the status of the compression brake solenoid, stop the override.
- Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

H. Turn the keyswitch to the OFF position.

I. Reconnect the valve cover connector.

Expected Result:

A 791-5 diagnostic code or a 792-5 diagnostic code is active at this time.

Note: A 5 open circuit diagnostic code will be active for the other compression brake solenoid. Ignore the diagnostic codes for the other compression brake solenoid. Ignore any diagnostic codes for the injector solenoids.

Results:

- OK – A 791-5 diagnostic code or a 792-5 diagnostic code is active at this time. The ECM detected the open at the valve cover connector for the compression brake solenoid. The harness wiring between the valve cover connector and the ECM is OK. Proceed to Test Step 7.
- Not OK – A 791-6 diagnostic code or a 792-6 diagnostic code is active at this time. The ECM did not detect the open at the valve cover connector for the compression brake solenoid. Proceed to Test Step 8.

Test Step 7. Create an Open Circuit at the Compression Brake Solenoid

Note: Two solenoids are activated in order to create a medium braking action. The short could be in either solenoid or in the harness. In order to isolate the problem for a medium braking action, run this test step for each of the solenoids. The open must be created separately at each solenoid.

Note: In order to troubleshoot a 791-06 diagnostic code, you must use the “Compression Brake Low/High Override” on Cat ET. In order to troubleshoot a 792-06 diagnostic code, you must use the “Compression Brake Med/High Override” on Cat ET.

A. Turn the keyswitch to the OFF position.

B. Remove the valve cover.

C. Reconnect the valve cover connector.

D. Disconnect the connector on the suspect compression brake solenoid.

E. Inspect the terminals on the connector for the compression brake solenoid for damage.

F. Turn the keyswitch to the ON position.

G. Access the diagnostic override under the “Diagnostics” menu.

H. Start the override for the compression brake.

I. Once Cat ET displays the status of the compression brake solenoid, stop the override.

J. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

K. Turn the keyswitch to the OFF position.

Expected Result:

A 791-5 diagnostic code or a 792-5 diagnostic code is active at this time.

Results:

- OK – A 791-5 diagnostic code or a 792-5 diagnostic code is active at this time. The ECM detected the open at the compression brake solenoid. The harness wiring between the connector for the suspect compression brake solenoid and the ECM is OK.

Repair: Temporarily connect a new compression brake solenoid to the harness, but do not install the new compression brake solenoid in the engine. Retest the circuit for the compression brake solenoid. Verify that there are no active diagnostic codes for the compression brake solenoid. If there are no active diagnostic codes for the compression brake solenoid, permanently install the new compression brake solenoid.

STOP.

- Not OK – A 791-6 diagnostic code or a 792-6 diagnostic code is active at this time. The ECM did not detect the open at the compression brake solenoid. There is a short circuit between the valve cover connector and the connector for the compression brake solenoid.

Repair: Repair the harness between the connector for the compression brake solenoid and the valve cover connector.

Verify that the repair eliminates the problem.

STOP.

Test Step 8. Create an Open at the ECM

Note: In order to troubleshoot a 791-06 diagnostic code, you must use the “Compression Brake Low/High Override” on Cat ET. In order to troubleshoot a 792-06 diagnostic code, you must use the “Compression Brake Med/High Override” on Cat ET.

A. Turn the keyswitch to the OFF position.

B. Disconnect the J2/P2 ECM connector.

i05432216

C. Inspect the terminals on the J2 and P2 ECM connectors for damage.

Note: Refer to Figure 48 for pin locations.

D. Remove the supply wire for the suspect compression brake solenoid from the P2 ECM connector.

E. Reconnect the P2 ECM connector.

F. Turn the keyswitch to the ON position.

G. Start the override for the compression brake.

H. Once Cat ET displays the status of the compression brake solenoid, stop the override.

I. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

J. Turn the keyswitch to the OFF position. Replace all wires to the original configuration.

Expected Result:

A 791-5 diagnostic code or a 792-5 diagnostic code is active at this time.

Results:

- OK – A 791-5 diagnostic code or a 792-5 diagnostic code is active at this time. The ECM detected the open at the ECM.

Repair: Disconnect the P2 ECM connector. Measure the resistance between the supply wire for the suspect compression brake solenoid and every terminal on ECM connector P1 and ECM connector P2. Measure the resistance between the supply wire for the suspect compression brake solenoid and engine ground. If the wire is shorted, replace the wire.

STOP.

- Not OK – A 791-6 diagnostic code or a 792-6 diagnostic code is active at this time. The ECM did not detect the open circuit at the ECM.

Repair: Replace the ECM. Refer to Troubleshooting, “ECM - Replace”. Verify that the problem is resolved.

STOP.

Sensor Signal (Analog, Active) - Test

SMCS Code: 1439-038

System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with the sensors or if any one of the diagnostic codes in Table 37 is active or easily repeated.

Table 37

Diagnostic Codes Table		
Code and Description	Conditions which Generate this Code	System Response
94-3 Fuel Delivery Pressure Sensor voltage above normal	The Electronic Control Module (ECM) detects signal voltage that is above normal for 8seconds. The ECM has been powered for at least 2 seconds.	The code is logged. The value of the parameter is set to a gauge pressure of 500 kPa (75 psi).
94-4 Fuel Delivery Pressure Sensor voltage below normal	The ECM detects signal voltage that is below normal for 8 seconds. The ECM has been powered for 2seconds.	
100-3 Engine Oil Pressure Sensor voltage above normal	The ECM detects signal voltage that is above normal for 8 seconds. The ECM has been powered for at least 2 seconds.	The code is logged. The value of the parameter is set to a gauge pressure of 500 kPa (75 psi).
100-4 Engine Oil Pressure Sensor voltage below normal	The ECM detects signal voltage that is below normal for eight second. The ECM has been powered for 2 seconds.	
100-10 Engine Oil Pressure Sensor abnormal rate of change	The ECM detects signal voltage that is not changing at a normal rate for 30 seconds. Engine speed must be above 600 rpm. The ECM has been powered for 2 seconds.	
274-3 Atmospheric Pressure Sensor voltage above normal	The ECM detects signal voltage that is above normal for 30 seconds. The ECM has been powered for at least 2 seconds.	The code is logged. The value of the parameter is set to 100 kPa (14.5 psi).
274-4 Atmospheric Pressure Sensor voltage below normal	The ECM detects signal voltage that is below normal for 30 seconds. The ECM has been powered for 2 seconds.	
1589-3 Turbocharger Inlet Air Pressure Sensor voltage above normal	The ECM detects signal voltage that is above normal for one second. The ECM has been powered for at least 3 seconds.	The code is logged. The value of the parameter is set to zero.
1589-4 Turbocharger Inlet Air Pressure Sensor voltage below normal	The ECM detects signal voltage that is below normal for one second. The ECM has been powered for 3 seconds.	
1785-3 Intake Manifold Pressure Sensor voltage above normal	The ECM detects signal voltage that is above normal for 2 seconds. The ECM has been powered for at least 2 seconds.	The code is logged. The value of the parameter is set to a gauge pressure of zero.
1785-4 Intake Manifold Pressure Sensor voltage below normal	The ECM detects signal voltage that is below normal for 2 seconds. The ECM has been powered for 2 seconds.	
1785-10 Intake Manifold Pressure Sensor abnormal rate of change	The ECM detects signal voltage that is not changing at a normal rate for 30 seconds. Engine speed must be above 1000 rpm. The ECM has been powered for 2 seconds.	

System Operation

Use this procedure to troubleshoot any suspect problems with the following sensors:

- Fuel pressure sensor
- Engine oil pressure sensor

- Atmospheric pressure sensor
- Turbocharger inlet pressure sensor
- Intake manifold pressure sensor

Circuit Tests

The supply voltage is routed to terminal A of each sensor connector. The sensor return is routed to terminal B of each sensor connector. The sensor signal is routed to terminal C of each sensor connector. The ECM provides short circuit protection for the internal power supply. A short circuit to the battery will not damage the internal power supply.

The ECM performs an automatic calibration of these sensors whenever the ECM is powered and the engine is off for at least 5 seconds. During an automatic calibration, the ECM calibrates pressure sensors to the value of the atmospheric pressure sensor and against an acceptable offset pressure range.

The ECM continuously outputs a pull-up voltage on the input terminal from an analog sensor. The ECM uses this pull-up voltage in order to detect an open or a short in the signal circuit. When the ECM detects the presence of a voltage that is above the normal range of the sensor on the signal circuit, the ECM will generate an open circuit diagnostic code 3 for that sensor. When the ECM detects the absence of the pull-up voltage on the signal circuit, the ECM will generate a short circuit diagnostic code 4 for that sensor. The presence of pull-up voltage at the sensor connector indicates that the wires from the sensor connector to the ECM are not open or shorted to ground.

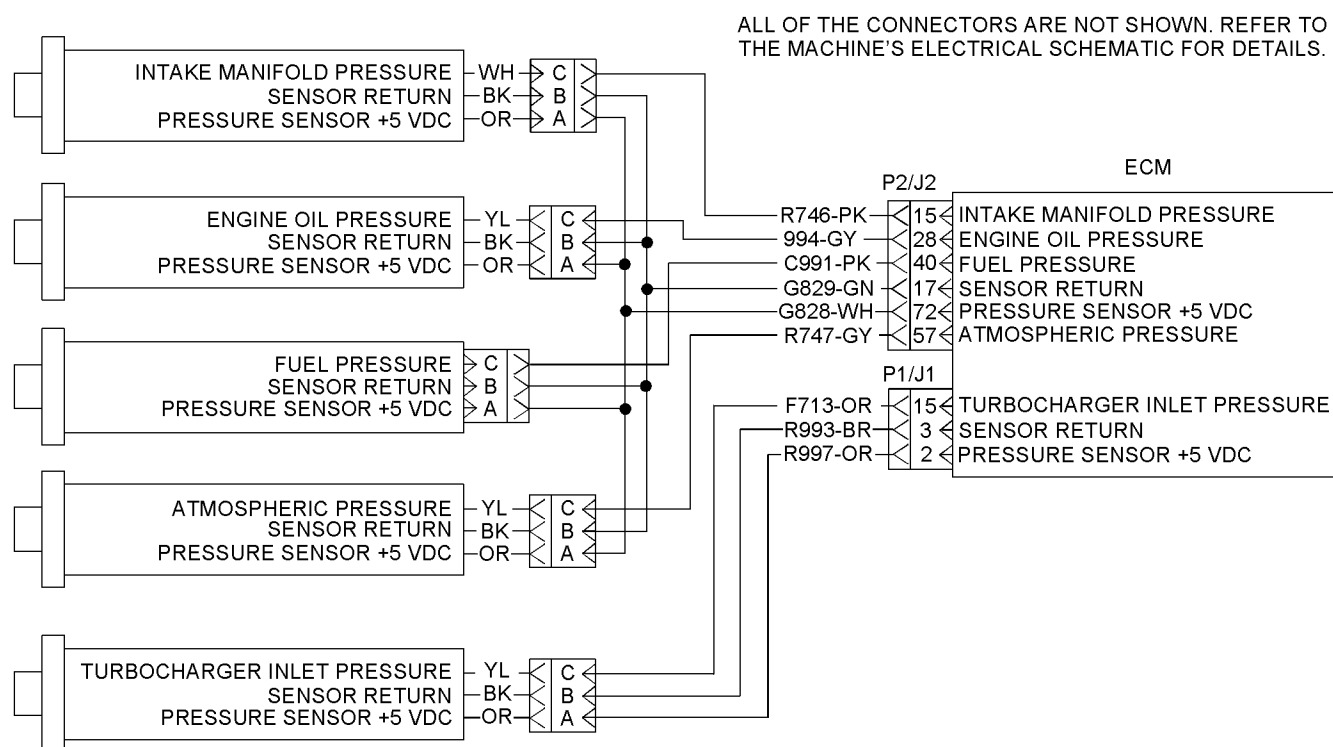
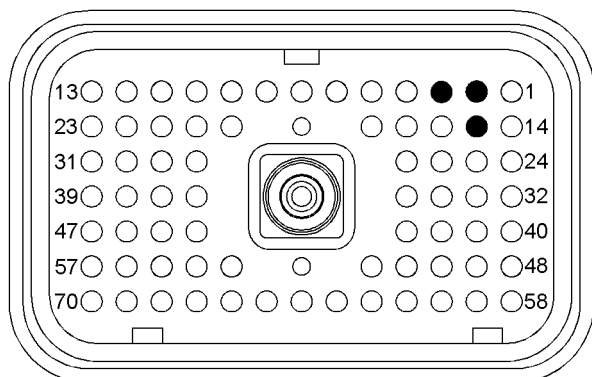


Illustration 50

Typical schematic

g03428500

ECM SIDE P1



WIRE SIDE P1

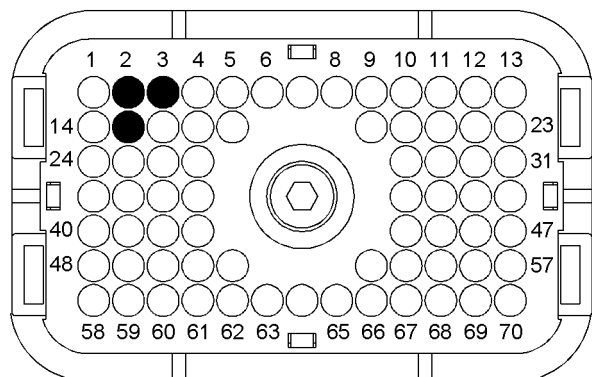


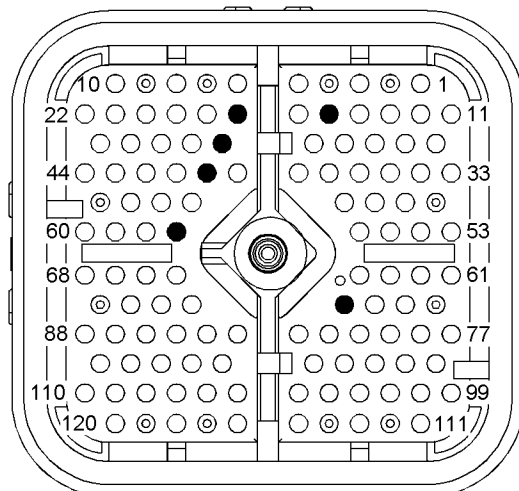
Illustration 51

g01145897

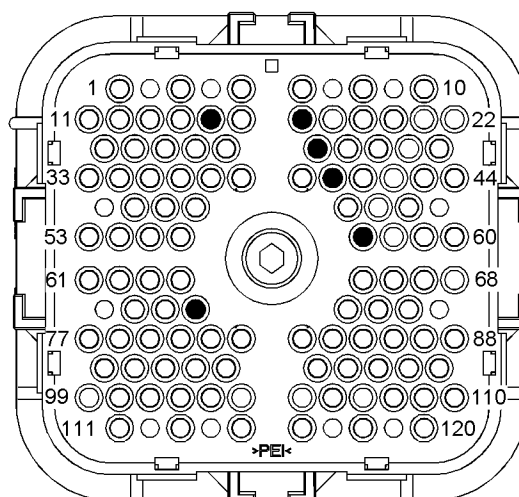
P1 ECM connector

- (P1-2) Sensor supply
- (P1-3) Sensor return
- (P1-15) Turbocharger inlet pressure sensor

120 PIN P2 ECM CONNECTOR



ECM SIDE



HARNESS SIDE

Illustration 52

g01024457

P2 ECM connector

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

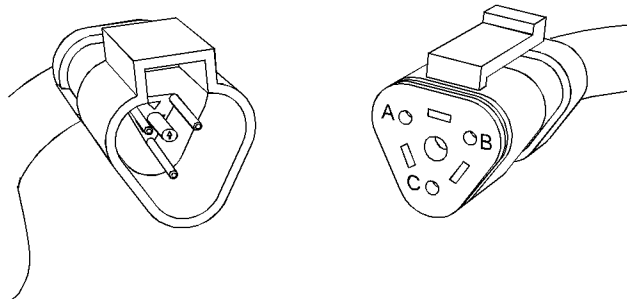


Illustration 53

g01159881

Sensor connector

- (A) 5 V sensor supply
(B) Sensor return
(C) Signal

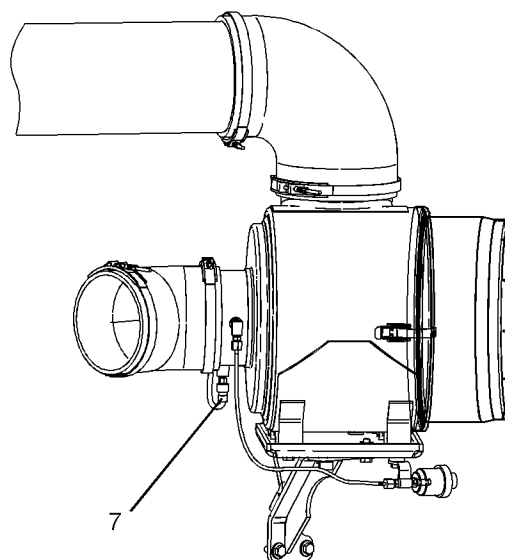


Illustration 55

g01142856

Air filter assembly

- (7) Turbocharger inlet pressure sensor

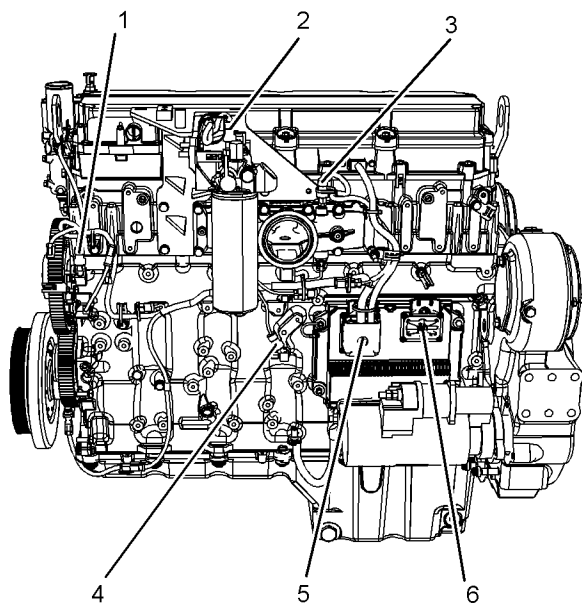


Illustration 54

g01200216

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

- (1) Atmospheric pressure sensor
(2) Fuel pressure sensor
(3) Intake manifold pressure sensor
(4) Engine oil pressure sensor
(5) J2/P2 ECM connectors
(6) J1/P1 ECM connectors

Test Step 1. Check for “Active” or “Logged” Diagnostic Codes

- A.** Connect Caterpillar Electronic Technician (ET) to the service tool connector.
- B.** Turn the keyswitch to the START position.
- C.** Monitor the diagnostic codes on Cat ET. Check and record any diagnostic codes.

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

- D.** Determine if a diagnostic code has occurred several times.

Note: A diagnostic code that is logged several times is an indication of an intermittent problem. Most intermittent problems are the result of a bad connection between a socket and a pin in a connector or a bad connection between a wire and a terminal. The problem may be caused by moisture, corrosion, or wear.

- E.** Determine if the problem is active and related to one of the following diagnostic codes:

- 3
- 4
- 10

Expected Result:

A diagnostic code is not active.

Results:

- OK – A diagnostic code is not active.

Repair: The problem may be intermittent. If the problem is intermittent, refer to Troubleshooting, “Electrical Connectors - Inspect”.

STOP. STOP

- Not OK – A 10 diagnostic code is active.

Repair: A 10 diagnostic code indicates an open in the voltage supply to a sensor. If the code is only present for one sensor, the open will be between the sensor connector and a splice. If the open is for two or more sensors, the open will be before the splice for the voltage supply to those sensors. Repair the open in the wiring or connectors. Refer to the electrical schematic for the locations of splices in the harness.

STOP. STOP

- Not OK – A 3 code or a 4 code is active. Proceed to Test Step 2.

Test Step 2. Check the 5 VDC Supply Voltage at the Sensor Connector

A. Do not disconnect the suspect connector.

B. Connect a voltmeter between pin A and pin B on the sensor side of the connector for the suspect sensor.

C. Measure the voltage between pin A and pin B for the suspect sensor or sensors.

D. Wiggle the harness while you monitor the voltage on the voltmeter. Perform the 45 N (10 lb) pull test on each wire in the circuit. Each terminal and each connector should easily withstand 45 N (10 lb) of tension and each wire should remain in the connector body. This test checks whether the wire was properly crimped in the terminal and whether the terminal was properly inserted into the connector.

Expected Result:

The supply voltage is approximately 5.0 ± 0.5 VDC.

Results:

- OK – The supply voltage is approximately 5.0 ± 0.5 VDC. An active 3 diagnostic code is present. Proceed to Test Step 3.

- OK – The supply voltage is approximately 5.0 ± 0.5 VDC. An active 4 diagnostic code is present. Proceed to Test Step 5.

- Not OK – The supply voltage is not approximately 5.0 ± 0.5 VDC.

Repair: There is an open in the wiring or connectors between the suspect sensor and the ECM. Inspect the wiring and connectors.

STOP. STOP

Test Step 3. Check for Battery on the Signal Wire

A. Measure the voltage on the harness side of the sensor connector between pin B and pin C for the suspect sensor or sensors.

Expected Result:

The signal voltage is less than battery voltage.

Results:

- OK – The signal voltage is less than battery voltage. Proceed to Test Step 4.
- Not OK – The signal voltage is equal to battery voltage.

Repair: There is a short in the harness to the Battery. Repair the wiring.

STOP. STOP

Test Step 4. Create a Short at the Sensor Connector

A. Turn the keyswitch to the OFF position.

B. Disconnect the suspect sensor.

C. Use a wire jumper in order to create a short between terminal C (signal) and terminal B (sensor return) at the sensor connector.

D. Turn the keyswitch to the START position.

E. Monitor the diagnostic codes on Cat ET. Check for an active 4 diagnostic code for the suspect sensor.

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

F. Turn the keyswitch to the OFF position.

Expected Result:

A 4 diagnostic code is now active for the suspect sensor or sensors.

Results:

- OK – A 3 diagnostic code was active before creating the short at the sensor connector. A 4 diagnostic code became active after creating the short at the sensor connector. The harness and the ECM are OK. There may be a problem with 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. STOP

- Not OK – A 3 diagnostic code is still active for the suspect sensor or sensors. The problem may be in the harness or with the ECM. Proceed to Test Step 6.

Test Step 5. Create an Open at the Suspect Sensor Connector

- Turn the keyswitch to the OFF position.
- Disconnect the sensor connector of the suspect sensor or sensors with the active 4 diagnostic code.
- Turn the keyswitch to the START position.
- Monitor the diagnostic codes on Cat ET. Check for an active 3 diagnostic code for the suspect sensor.

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

- Turn the keyswitch to the OFF position.

Expected Result:

A 3 diagnostic code is now active for the suspect sensor or sensors.

Results:

- OK – A 4 diagnostic code was active before disconnecting the sensor. A 3 diagnostic code became active after disconnecting the sensor. The harness and the ECM are OK. There may be a problem with 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. STOP

- Not OK – A 4 diagnostic code is still active for the suspect sensor. Leave the sensor disconnected. The problem may be in the harness or with the ECM. Proceed to Test Step 6.

Test Step 6. Test the Operation of the ECM

- Fabricate jumper wires that can be used to replace the signal wire in the ECM connector for the suspect sensor. Crimp a connector socket to one end of the jumper wire.
- Disconnect the appropriate ECM connector for the suspect sensor.
- Remove the signal wire for the suspect sensor from the ECM connector.
- Install the jumper wire into the terminal location for the suspect sensor at the ECM connector.

- Connect the ECM connector.

F. Check the operation of the ECM by creating an open at the ECM:

- Hold the loose end of the jumper wire away from any components in order to create an open circuit condition.
- Turn the keyswitch to the START position.
- Monitor the active diagnostic code screen on Cat ET. Check for a 3 diagnostic code for the suspect sensor.

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

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

- Short the jumper wire for the suspect sensor to the analog return in order to create a short circuit condition.
- Monitor the active diagnostic code screen on Cat ET. Check for a 4 diagnostic code for the suspect sensor.

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

- Turn the keyswitch to the OFF position.

- Remove all jumper wires. Return the wiring to the original configuration.

Expected Result:

A 3 diagnostic code is active when the sensor signal wire is removed from the ECM connector. A 4 diagnostic code is active when the signal wire is shorted to the analog return.

Results:

- OK – The ECM is operating properly. The problem is in the wiring between the ECM and the connector for the sensor.

Repair: If the code is active for more than one sensor, the problem is most likely in the return wire for the sensor. Repair the analog return wire for the sensor or replace the harness.

If the code is only active for one sensor, the problem is most likely in the signal wire for the sensor. Repair the signal wire for the sensor.

STOP. STOP

- Not OK – One of the following conditions exists:
The 3 diagnostic code is not active when the sensor signal wire is disconnected. The 4 diagnostic code is not active when the wire jumper is shorted to the analog return.

Repair: Replace the ECM. Refer to Troubleshooting, “ECM - Replace”. Verify that the problem is resolved.

STOP. STOP

i02796280

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 sensor or if any one of the diagnostic codes in Table 38 is active or easily repeated.

Table 38

Diagnostic Codes Table		
Code and 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 more than 4.95 VDC for eight seconds. The ECM has been powered for at least two seconds.	The code is logged if the engine has been running for more than seven minutes. The ECM uses the last valid engine coolant temperature. If the diagnostic code is active at start-up the ECM will use intake manifold temperature. If intake manifold air temperature is not valid, the ECM will default to 90 °C (194 °F) for engine coolant temperature. The ECM will activate the cooling fan after this code has been active for more than eight seconds.
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.	
172-3 Intake Manifold Air Temperature Sensor voltage above normal	The engine's ECM detects signal voltage that is more than 4.95 VDC for eight seconds. The ECM has been powered for at least two seconds.	The ECM will log the diagnostic code. The ECM will flag the intake manifold air temperature as invalid data and the intake manifold air temperature is set to a default value of 40 °C (104 °F).
172-4 Intake Manifold Air Temperature Sensor voltage below normal	The ECM detects signal voltage that is less than 0.2 VDC for eight seconds. The ECM has been powered for at least two seconds.	
174-3 Fuel Temperature Sensor voltage above normal	The engine's Electronic Control Module (ECM) detects signal voltage that is more than 4.95 VDC for eight seconds. The ECM has been powered for at least two seconds.	The code is logged. The ECM will flag the fuel temperature as invalid data and the fuel temperature is set to a default value of 40 °C (104 °F).
174-4 Fuel Temperature Sensor voltage below normal	The ECM detects signal voltage that is less than 0.2 VDC for two seconds. The ECM has been powered for at least two seconds.	

System Operation

Use this procedure to troubleshoot any suspect problems with the following sensors:

- Coolant temperature sensor
- Intake manifold air temperature sensor
- Fuel temperature sensor

The sensor signal for the passive sensor is routed from the ECM to terminal 1 of each sensor connector. The sensor return for the passive sensors is routed from the ECM to terminal 2 of each sensor connector.

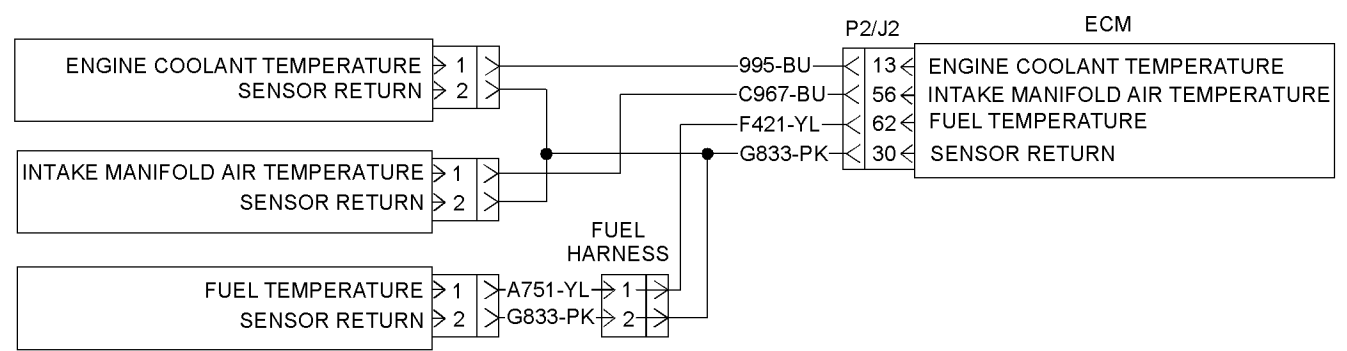
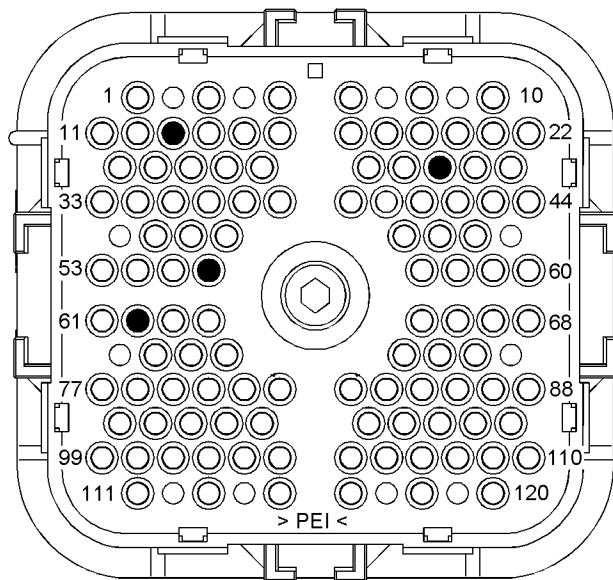
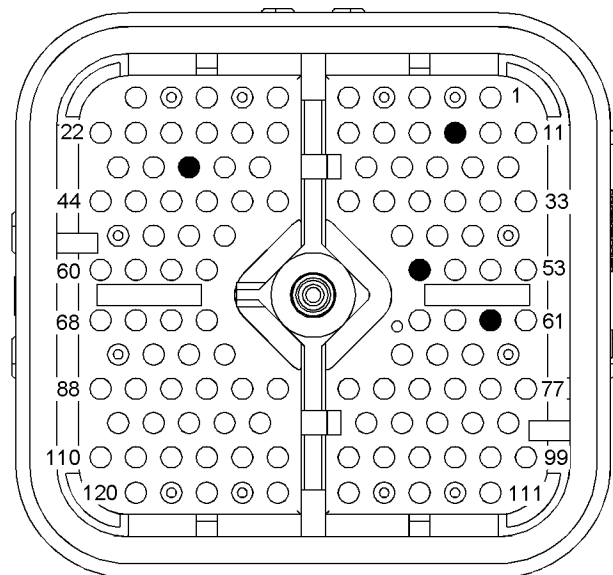


Illustration 56
Typical schematic

g01303228



HARNESS SIDE



ECM SIDE

Illustration 57

g01193814

P2 ECM connector

(P2-13) Engine coolant temperature
 (P2-30) Sensor return
 (P2-56) Intake manifold air temperature
 (P2-62) Fuel temperature

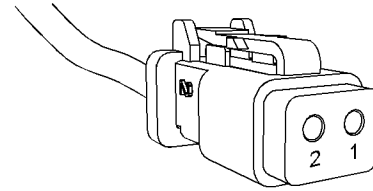


Illustration 58

g01155187

Connector for the temperature sensors

(1) Sensor signal
 (2) Sensor return

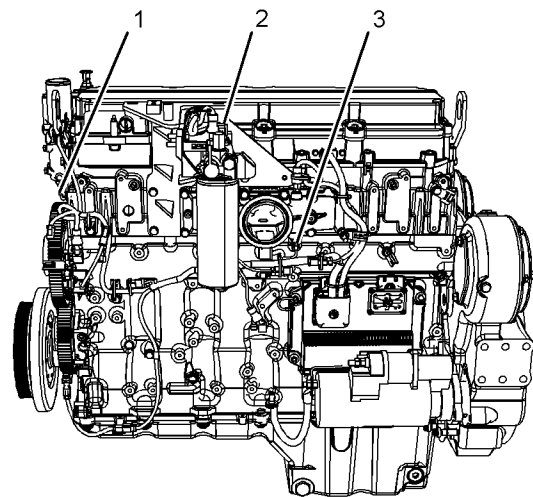


Illustration 59

g01200241

Sensor locations (typical left side engine view)

(1) Engine coolant temperature sensor
 (2) Intake manifold air temperature sensor
 (3) Fuel temperature sensor

Test Step 1. Check for “Active” or “Logged” Diagnostic Codes

- A.** Connect Caterpillar Electronic Technician (ET) to the service tool connector.
- B.** Restore 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 poor connection between a socket and a pin in a connector or of a poor connection between a wire and a terminal.

E. Determine if the problem is active and related to one of the following diagnostic codes:

- 3
- 4

Expected Result:

A diagnostic code is not active.

Results:

- OK – A diagnostic code is not active.

Repair: The problem may be intermittent. If the problem is intermittent, refer to Troubleshooting, “Electrical Connectors - Inspect”.

STOP.

- Not OK – An active 3 diagnostic code is present. Proceed to Test Step 2.
- Not OK – An active 4 diagnostic code is present. Proceed to Test Step 4.

Test Step 2. Check for Battery Voltage on the Signal Wire

A. Measure the voltage on the harness side of the sensor connector between pin 1 and engine ground for the suspect sensor(s).

Expected Result:

The signal voltage is less than battery voltage.

Results:

- OK – The signal voltage is less than battery voltage. Proceed to Test Step 3.
- Not OK – The signal voltage is equal to battery voltage.

Repair: There is a short in the harness to the Battery. Repair the wiring.

STOP.

Test Step 3. Create a Short at the Sensor Connector

A. Remove electrical power from the ECM.

B. Disconnect the suspect sensor.

C. Use a wire jumper in order to create a short between terminal 1 (signal) and terminal 2 (sensor return) at the sensor connector.

D. Restore electrical power to the ECM.

E. Access the “Active Diagnostic Code” screen on Cat ET. Check for an active 4 diagnostic code for the suspect sensor.

F. 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. The wiring between the ECM and the sensor connector is OK.

Repair: Temporarily connect a new sensor to the harness, but do not install the new sensor in the engine. Verify that there are no active diagnostic codes for the sensor. If there are no active diagnostic codes for the sensor, permanently install the new sensor. Clear any logged diagnostic codes.

STOP.

- Not OK – A 3 diagnostic code is still active for the suspect sensor(s). There is an open circuit between the sensor connector and the ECM. Leave the sensor disconnected. Proceed to Test Step 5.

Test Step 4. Create an Open at the Suspect Sensor Connector

A. Remove electrical power from the ECM.

B. Disconnect the sensor connector of the suspect sensor(s) with the active 4 diagnostic code.

C. Restore electrical power to the ECM. Wait at least 30 seconds for activation of the diagnostic codes.

D. Access the “Active Diagnostic Code” screen on Cat ET. Check for an active 3 diagnostic code.

E. Remove electrical 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. The wiring between the ECM and the sensor connector is OK.

Repair: Temporarily connect a new sensor to the harness, but do not install the new sensor in the engine. Verify that there are no active diagnostic codes for the sensor. If there are no active diagnostic codes for the sensor, permanently install the new sensor. Clear any logged diagnostic codes.

STOP.

- Not OK – A 4 diagnostic code is still active for the suspect sensor. There is a short circuit between the sensor connector and the ECM. Proceed to Test Step 5.

Test Step 5. Check the Operation of the ECM

A. Remove electrical power from the ECM.

B. Check the operation of the ECM by creating an open at the ECM.

- Remove the signal wire for the suspect sensor from the P2 ECM connector. Refer to Illustration 56 for terminal locations.
- Install a jumper wire with Deutsch sockets on each end into the socket for the signal wire of the suspect sensor. Hold the loose end of the jumper wire away from any components in order to create an open circuit condition.
- Reconnect the ECM connectors.
- Restore electrical power to the ECM. Monitor the “Active Diagnostic Code” screen on Cat ET. Wait at least 30 seconds for activation of the code.

An open circuit diagnostic code 3 should be active for the suspect sensor.

C. Check the operation of the ECM by creating a short at the ECM.

- Install a wire jumper between the wire jumper for the signal wire for the suspect sensor and engine ground.

- Monitor the “Active Diagnostic Code” screen on Cat ET. Wait at least 30 seconds for activation of the code.

A 4 diagnostic code should be active when the wire jumper is installed.

- Remove the wire jumper. Reconnect all wires and connectors.
- Remove the wire jumper. Reconnect all wires and connectors.

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 connector for the sensor.

Repair: If the code is active for more than one sensor, the problem is most likely in the return wire for the sensor. Repair the 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: Replace the ECM. Refer to Troubleshooting, “ECM - Replace”. Verify that the problem is resolved.

STOP.

i02603415

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 39 is active or easily repeated.

Table 39

Diagnostic Codes Table		
Code and 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 one second.	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 one second.	
262-3 5 Volt Sensor DC Power Supply voltage above normal	The analog sensor supply voltage is above normal for one second.	The code is logged. All sensors are set to default values.
262-4 5 Volt Sensor DC Power Supply voltage below normal	The analog sensor supply voltage is below normal for one second.	
269-3 Sensor Power Supply voltage above normal	The analog sensor supply voltage is above normal for one second.	The code is logged. All sensors are set to default values.
269-4 Sensor Power Supply voltage below normal	The analog sensor supply voltage is below normal for one second.	

Note: The 262 diagnostic codes indicate a problem with the 5 V power supply on the J2 ECM connector. The 269 diagnostic codes indicate a problem with the 5 V power supply on the J1 ECM connector.

System Operation

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

- Fuel pressure sensor
- Engine oil pressure sensor
- Atmospheric pressure sensor
- Turbocharger inlet pressure sensor
- Intake manifold pressure sensor

The ECM supplies a regulated voltage of 8.0 ± 0.4 VDC to the throttle position sensor.

The supply voltage for the sensors is routed from the ECM to terminal A of each sensor connector. The sensor return for the sensors is routed from the ECM to terminal B of each sensor connector. The ECM provides short circuit protection for the internal power supply. A short circuit to the battery will not damage the internal power supply.

Note: The sensors are not protected from overvoltage. A short from the supply line to the +Battery may damage the sensors. If any of the 3 diagnostic codes are active, it is possible that a sensor has been damaged. Repair the sensor supply and check for any active sensor diagnostic codes in order to determine if a sensor has failed.

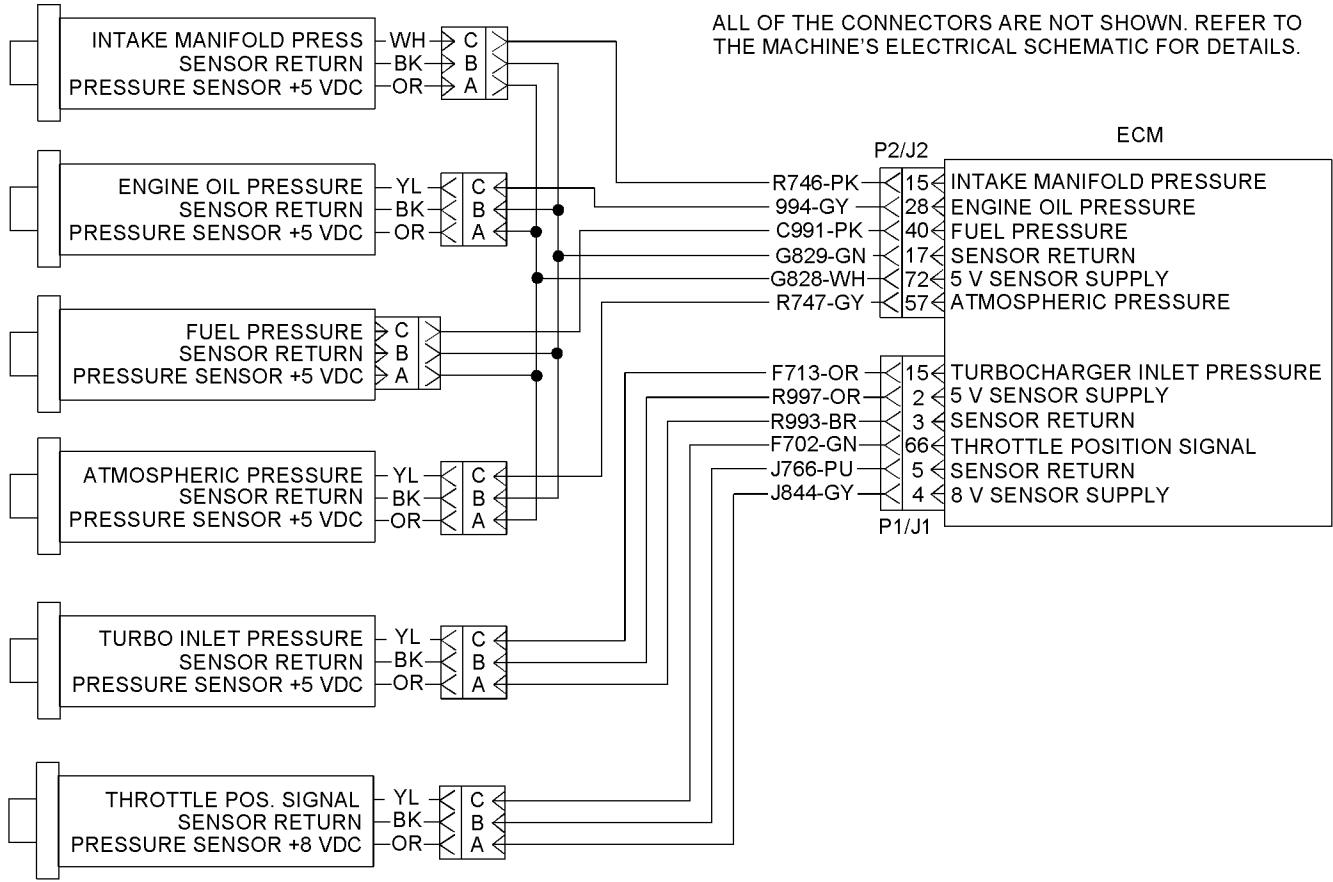


Illustration 60

g01303629

Typical schematic

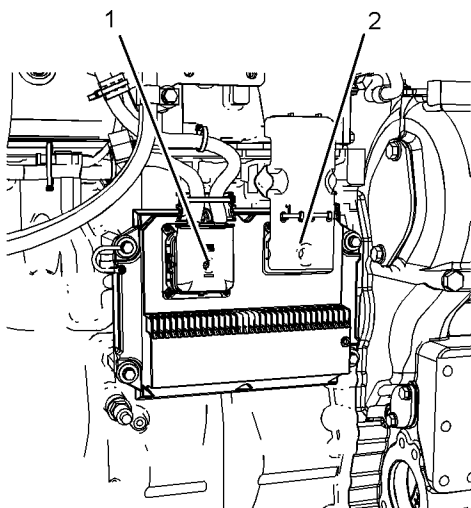


Illustration 61

g01310557

Location of ECM connectors

- (1) J2 ECM connector
- (2) J1 ECM connector

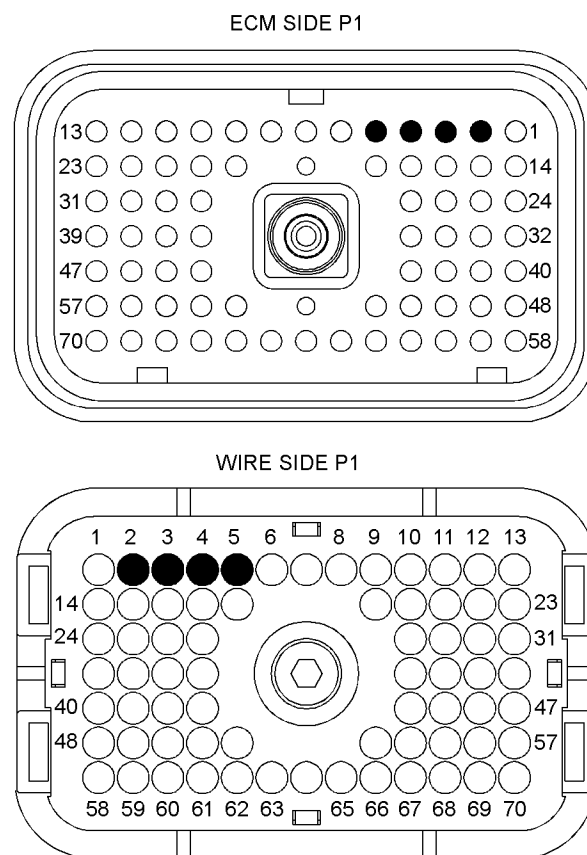


Illustration 62

g01303628

P1 ECM connector

- (P1-2) 5 V Sensor supply
- (P1-3) Analog sensor return
- (P1-4) 8 V Sensor supply
- (P1-5) Digital sensor return

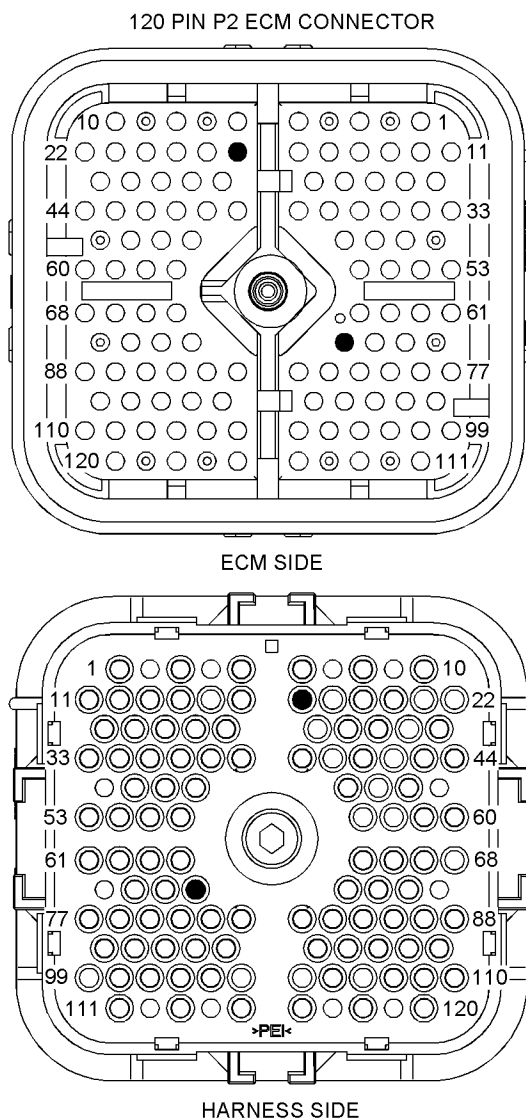


Illustration 63

g01303241

P2 ECM connector

(P2-17) Sensor return
(P2-72) 5 V Sensor supply

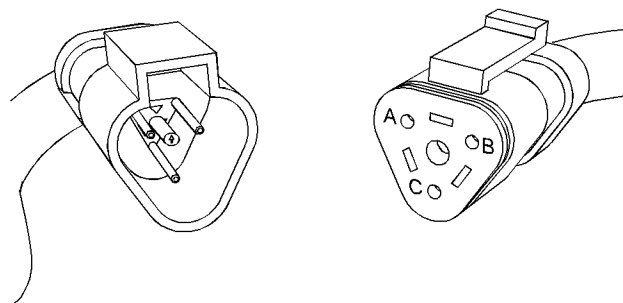


Illustration 64

g01159881

Sensor connector

(A) 5 V or 8 V sensor supply
(B) Sensor return
(C) Signal

Test Step 1. Inspect Electrical Connectors and Wiring

- A.** Remove electrical power from the ECM.
- B.** Thoroughly inspect the J1/P1 ECM connector and the J2/P2 ECM connector. Inspect all of the connectors that are associated with the circuit.

Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- 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 ECM connector (allen head screw) 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 Active Diagnostic Codes

- A. Connect Caterpillar Electronic Technician (ET) to the service tool connector.
- B. Restore electrical power to the ECM.
- C. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes. Look for the following diagnostic codes:

- 41-3
- 41-4
- 262-3
- 262-4
- 269-3
- 269-4

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

Expected Result:

No diagnostic codes are active.

Results:

- OK – No diagnostic code is active.

Repair: The problem is no longer present. If the problem is intermittent, refer to Troubleshooting, "Electrical Connectors - Inspect".

STOP. OK

- Not OK – A 262-3, 262-4, 269-3 or 269-4 diagnostic code is active at this time. Proceed to Test Step 3.
- Not OK – A 41-3 or 41-4 diagnostic code is active at this time. Proceed to Test Step 5.

Test Step 3. Disconnect the 5 Volt Sensor (s) while you Monitor the Active Diagnostic Codes

- A. Use this procedure for any 262 diagnostic codes.

- a. Monitor the active diagnostic code screen on Cat ET while you disconnect each 5 Volt sensor at the sensor connector. Check for an active 262-3 code or an active 262-4 code.

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

- b. Disconnect the following sensors one at a time:

- Fuel pressure sensor
- Engine oil pressure sensor
- Atmospheric pressure sensor
- Intake manifold pressure sensor

B. Use this procedure for any 269 diagnostic codes.

- a. Monitor the active diagnostic code screen on Cat ET while you disconnect each 5 Volt sensor at the sensor connector. Check for an active 269-3 code or an active 269-4 code.

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

- b. Disconnect the turbocharger inlet pressure sensor.

- C. Remove electrical power from the ECM.

Expected Result:

The diagnostic code deactivates when a particular sensor is disconnected.

Results:

- OK – The diagnostic code deactivates when a particular sensor is disconnected.

Repair: Connect the suspect sensor. If the code returns, replace the sensor. Connect the connector(s). Verify that the problem is resolved.

STOP.

- Not OK – The diagnostic code remains active after the sensor(s) is disconnected. Leave the sensor(s) disconnected. The sensor(s) is not the cause of the diagnostic code. Proceed to Test Step 4.

Test Step 4. Check the 5 Volt Supply Voltages at the ECM

- A. Use this procedure for any 262 diagnostic codes.

- a. Disconnect the J2/P2 ECM connector.
- b. Fabricate jumper wires that are long enough to be used to measure the supply voltages at the ECM connector. Crimp connector sockets to one end of each jumper wire.
- c. Remove the wires from terminal locations P2-72 (5 V sensor supply) and P2-17 (sensor return). Install a jumper wire into each of these terminal locations.
- d. Connect the J2/P2 ECM connector.
- e. Restore electrical power to the engine ECM.
- f. Measure the voltage between the jumper wire in P2-72 (5 V sensor supply) and the jumper wire in P1-17 (sensor return).
- g. Remove electrical power from the ECM.

B. Use this procedure for any 269 diagnostic codes.

- a. Disconnect the J1/P1 ECM connector.
- b. Fabricate jumper wires that are long enough to be used to measure the supply voltages at the ECM connector. Crimp connector sockets to one end of each jumper wire.
- c. Remove the wires from terminal locations P1-2 (5 V sensor supply) and P1-3 (sensor return). Install a jumper wire into each of these terminal locations.
- d. Connect the J1/P1 ECM connector.
- e. Restore electrical power to the engine ECM.
- f. Measure the voltage between the jumper wire in P1-2 (5 V sensor supply) and the jumper wire in P1-3 (sensor return).
- g. Remove electrical power from the ECM.

Expected Result:

Each voltage measurement is 5.0 ± 0.2 VDC.

Results:

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

Repair: 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 5.0 ± 0.2 VDC.

Repair: Replace the ECM. Refer to Troubleshooting, “ECM - Replace”.

STOP.

Test Step 5. Disconnect the 8 Volt Sensor while you Monitor the Active Diagnostic Codes

- A.** Monitor the active diagnostic code screen on Cat ET while you disconnect the throttle position sensor 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.

- B.** Remove electrical power from the ECM.

Expected Result:

The diagnostic code deactivates when the throttle position sensor is disconnected.

Results:

- OK – The 41-3 or 41-4 diagnostic code deactivates when the throttle position 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 throttle position sensor is disconnected. Leave the sensor disconnected. The sensor is not the cause of the diagnostic code. Proceed to Test Step 6.

Test Step 6. Check the 8 Volt Supply Voltage at the ECM

- A.** Disconnect the J1/P1 ECM connector.
- 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 P1-4 (8 V sensor supply) and P1-5 (sensor return). Install a jumper wire into each of these terminal locations.
- D.** Connect the J1/P1 ECM connector.

- E. Restore electrical power to the engine ECM.
- F. Measure the voltage between the jumper wire in P1-4 (8 V sensor supply) and P1-5 (sensor return).
- G. Remove electrical power from the ECM. Replace all wires and connectors 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: Replace the ECM. Refer to Troubleshooting, “ECM - Replace”.

STOP.

i02696828

Shutdown (Ground Level) - Test

SMCS Code: 1900-038; 7332-038

System Operation Description:

Use this procedure to troubleshoot a suspected problem with the ground level shutdown switch. Use this procedure if a diagnostic code in Table 40 is active or easily repeated.

Table 40

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
E265(3) User Defined Shutdown	The inputs from the ground level shutdown switch to the Electronic Control Module (ECM) have changed states.	The engine will shut down. The code is logged.
267-3 Remote Shutdown Input voltage above normal	Both of the switch contacts of the ground level shutdown switch are in the open state.	If both of the switch contacts from the ground level shutdown switch change to the same state and the engine is running, the engine will continue to run. The code is logged.
267-4 Remote Shutdown Input voltage below normal	Both of the switch contacts of the ground level shutdown switch are in the closed state.	

The ground level shutdown switch provides the ability to shut down the engine. The engine's ECM remains active. 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 engine rpm must be zero before the ECM will allow the engine to start.

To shut down the engine, lift the red cover guard and 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. The status screen will display "INJECTION DISABLED" and "REMOTE SHUTDOWN".

The ECM will not allow the engine to start if the status for the ground level shutdown switch is "REMOTE SHUTDOWN".

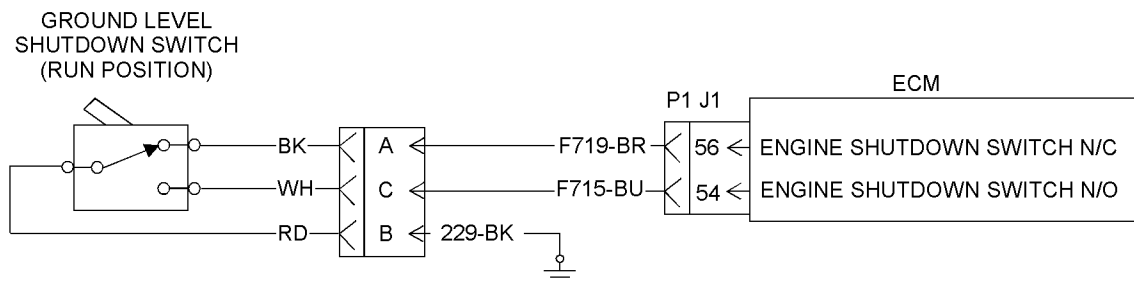
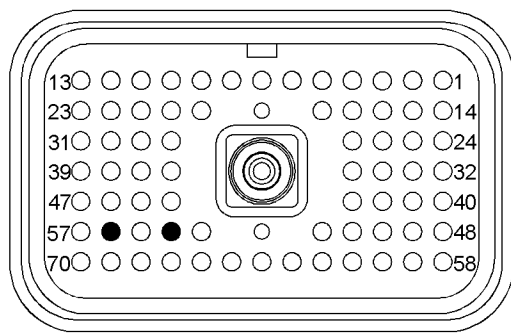


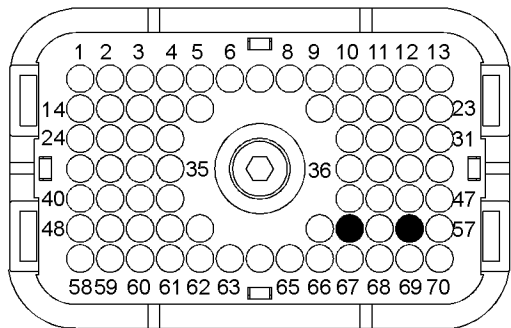
Illustration 65

g01303340

Schematic



ECM SIDE



HARNESS SIDE

Illustration 66

g01303342

P1 ECM connector

(P1-54) user defined shutdown (NO)
(P1-56) user defined shutdown (NC)

Test Step 1. Inspect Electrical Connectors and Wiring

- A. Turn the keyswitch to the OFF position.
- B. Thoroughly inspect the ECM connector J1/P1. Thoroughly inspect the connectors for the ground level shutdown switch. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- 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. Repair Complete

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. Observe the status of the ground level shutdown switch on Cat ET.
- D. Operate the ground level shutdown switch. Observe the status of the ground level shutdown switch on Cat ET.

Expected Result:

The status of the ground level shutdown switch on Cat ET is REMOTE SHUTDOWN when the ground level shutdown switch is in the SHUTDOWN position.

Results:

- OK – The status of the ground level shutdown switch on Cat ET is correct.

Repair: The ground level shutdown switch is operating normally. There may be an intermittent problem. If the problem is intermittent, refer to Troubleshooting, "Electrical Connectors - Inspect".

STOP. OK

- Not OK – The status of the ground level shutdown switch on Cat ET is incorrect. The ground level shutdown switch is not operating normally. Proceed to Test Step 3.

Test Step 3. Create a Short at the Connector for the Ground Level Shutdown Switch

- A. Turn the keyswitch to the OFF position.

- B.** Disconnect the connector for the ground level shutdown switch.
- C.** Create a short circuit at the connector for the ground level shutdown switch between terminal A and terminal B.
- D.** Turn the keyswitch to the ON position.
- E.** Observe the status of the ground level shutdown switch on Cat ET.
- F.** Create a short circuit at the connector for the ground level shutdown switch between terminal B and terminal C.
- G.** Observe the status of the ground level shutdown switch on Cat ET.
- H.** Turn the keyswitch to the OFF position.
- I.** Remove the wire short.

Expected Result:

The status of the ground level shutdown switch on Cat ET is REMOTE SHUTDOWN when a short circuit is created at the connector for the ground level shutdown switch between terminal B and terminal C.

Results:

- OK – The status of the ground level shutdown switch on Cat ET is correct.

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. Repair Complete

- Not OK – The status of the ground level shutdown switch on Cat ET is incorrect. There is a problem in the harness and/or the ECM. Proceed to Test Step 4.

Test Step 4. Create a Short at the ECM

- A.** Fabricate jumper wires that can be used to replace the wires in the ECM connector for the ground level shutdown switch. Crimp a connector socket to one end of the jumper wire.
- B.** Disconnect the ECM connector J1/P1.
- C.** Remove the wires from P1-56 and P1-54.
- D.** Install the jumper wires into the terminal locations for the ground level shutdown switch at the ECM connector.

- E.** Create a short circuit at the P1 ECM connector between the jumper wire in P1-56 and engine ground.
- F.** Turn the keyswitch to the ON position.
- G.** Observe the status of the ground level shutdown switch on Cat ET.
- H.** Create a short circuit at the P1 ECM connector between the jumper wire in P1-54 and engine ground.
- I.** Observe the status of the ground level shutdown switch on Cat ET.
- J.** Turn the keyswitch to the OFF position.
- K.** Return all wires to the original configuration.

Expected Result:

The status of the ground level shutdown switch on Cat ET is REMOTE SHUTDOWN when a short circuit is created between the jumper wire in P1-54 and engine ground.

Results:

- OK – The status of the ground level shutdown switch on Cat ET is correct.

Repair: The problem is in the harness between the ECM connector and the ground level shutdown switch. Repair the harness or the connector.

STOP. Repair Complete

- Not OK – The status of the ground level shutdown switch on Cat ET is incorrect.

Repair: Replace the ECM. Refer to Troubleshooting, "ECM - Replace".

STOP. Repair Complete

i02604532

Speed Control (Switch) - Test

SMCS Code: 1276-038; 1913-038; 1915-038; 7332-038-VF

System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with the throttle position sensor or if the diagnostic code in Table 41 is active or easily repeated.

Table 41

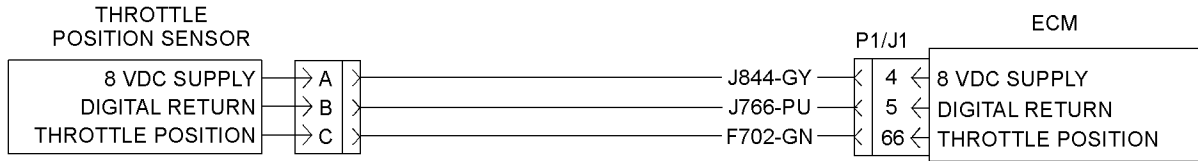
Diagnostic Codes Table		
Code and Description	Conditions which Generate this Code	System Response
91-8 Throttle Position Sensor abnormal frequency, pulse width, or period	The Electronic Control Module (ECM) detects an incorrect frequency on the throttle signal or an incorrect duty cycle on the throttle signal. The frequency is below 150 Hz or the frequency is above 1000 Hz. The duty cycle is less than 5 percent or the duty cycle is greater than 95 percent.	The code is logged. The ECM flags the throttle position as invalid data and a default value of zero percent is used. The engine speed is limited to low idle. The ECM will disable the automatic control of engine speed through the throttle lock feature.

The throttle position sensor provides the throttle signal to the ECM. The throttle position sensor is mounted to a pedal assembly that allows the operator to control the speed of the engine. The geometry of the pedal assembly controls both the travel of the sensor and the range of the output signal. The throttle position sensor cannot be adjusted.

The output from the throttle position sensor is a PWM signal that varies with the position of the throttle pedal. The throttle position sensor produces a minimum duty cycle in the released position and a maximum duty cycle in the fully depressed position. When the pedal is released, the ECM translates the sensor's output signal to a throttle position of 0 percent. When the pedal is fully depressed, the ECM translates the output signal to a throttle position of 100 percent.

The throttle position sensor is powered by 8.0 ± 0.4 VDC that is provided by the ECM. A digital return for the sensor is also provided by the ECM.

The ECM uses an automatic calibration function that allows the ECM to minimize the deadband of the sensor. The automatic calibration function assumes a range of PWM duty cycle at powerup. If the duty cycle of the sensor exceeds this initial range, the automatic calibration function adjusts the limits of the duty cycle in order to adjust for the new range.



ALL OF THE CONNECTORS ARE NOT SHOWN. REFER TO THE MACHINE'S ELECTRICAL SCHEMATIC FOR DETAILS.

Test Step 1. Inspect the Electrical Connectors and the Wiring

A. Turn the keyswitch to the OFF position.

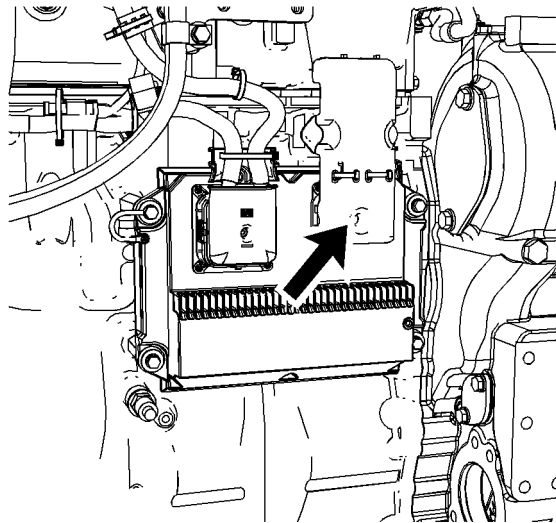
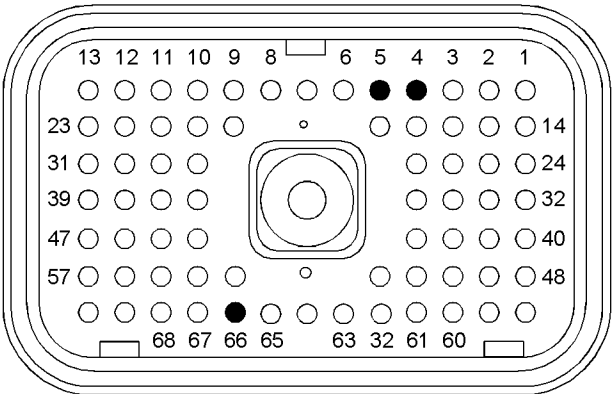


Illustration 68
J1/P1 ECM connector

B. Thoroughly inspect the J1/P1 ECM connector and the connector for the throttle position sensor. Refer to Troubleshooting, “Electrical Connectors - Inspect” for details.

ECM SIDE



HARNESS SIDE

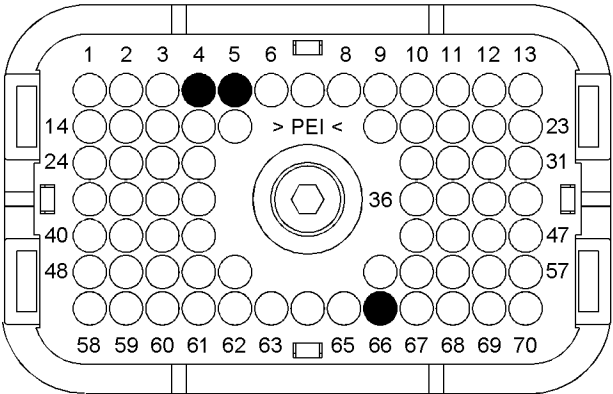


Illustration 69
P1 ECM connector
(P1-4) 8 VDC supply
(P1-5) Digital return
(P1-66) Throttle position

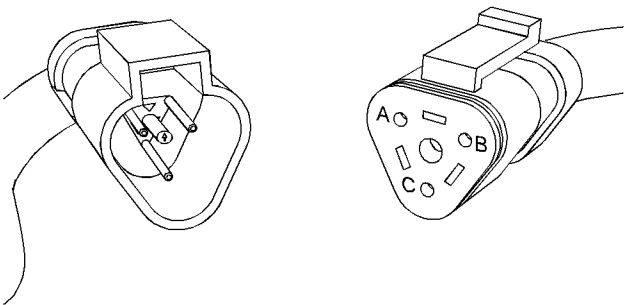


Illustration 70
Connector for the throttle position sensor
(A) 8 V supply
(B) Digital return
(C) Throttle position

- C. Perform a 45 N (10 lb) pull test on each of the wires in the circuit.
- D. Check the allen head screw from each ECM connector for the proper torque. Refer to Troubleshooting, "Electrical Connectors - Inspect" for the correct torque value.
- E. Check the harness and the wiring for abrasion and for pinch points.

Expected Result:

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

Results:

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

Repair: Repair the 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. STOP

Test Step 2. Inspect the Throttle Pedal Assembly

- A. Inspect the throttle pedal assembly for components that are loose, bent, missing, or worn.
- B. Slowly depress the pedal and release the pedal.

Expected Result:

The throttle pedal assembly operates smoothly without excessive drag. The pedal springs back smoothly to the LOW IDLE position without assistance.

Results:

- OK – The throttle pedal assembly functions properly. Proceed to Test Step 3.
- Not OK – The throttle pedal assembly is in poor repair.

Repair: Repair the throttle pedal assembly or replace the throttle pedal assembly, as required.

STOP.

Test Step 3. Check the Status for "Throttle Position"

- A. Connect Caterpillar Electronic Technician (ET) to the service tool connector.
- B. Turn the keyswitch to the ON position.
- C. Observe the status for "Throttle Position" on Cat ET while you operate the throttle pedal through the entire range of travel.

Expected Result:

The status is zero percent when the throttle pedal is released. The status progressively increases to 100 percent when the throttle pedal is fully depressed.

Results:

- OK – The throttle position sensor is working properly.

Repair: There may be an intermittent electrical problem with the harness or the connectors. Refer to Troubleshooting, "Electrical Connectors - Inspect" if the problem is intermittent.

STOP.

- Not OK – The throttle position that is displayed on Cat ET does not correspond to the movement of the throttle pedal. Proceed to Test Step 4.

Test Step 4. Check the Supply Voltage at the Sensor

- A. Disconnect the connector for the throttle position sensor.
- B. Turn the keyswitch to the ON position.
- C. Measure the voltage across terminal A (8 V supply) and terminal B (digital return) on the harness side of the connector.
- D. Turn the keyswitch to the OFF position.

Expected Result:

The supply voltage measures 8.0 ± 0.4 VDC at the sensor connector.

Results:

- OK – The correct voltage is measured at the sensor connector. The sensor is receiving the correct supply voltage. Proceed to Test Step 5.
- Not OK – The voltage is not correct at the sensor connector. The sensor is not receiving the correct supply voltage. Proceed to Test Step 7.

Test Step 5. Check the Signal Frequency and the Duty Cycle at the Sensor

- A. Install a 7X-6370 Adapter Cable As (3-PIN BREAKOUT) at the connector for the throttle position sensor.
- B. Remove the signal wire from terminal C of the connector for the throttle position sensor. Remove the wire from the harness side of the connector.
- C. Turn the keyswitch to the ON position.
- D. Measure the frequency and the duty cycle between terminal B (digital return) and terminal C (throttle position) at the 7X-6370 Adapter Cable As (3-PIN BREAKOUT) while you operate the throttle pedal.
- E. Turn the keyswitch to the OFF position.
- F. Remove the breakout harness. Restore the wires to the original configuration.

Expected Result:

The frequency is between 150 and 1000 Hz. The duty cycle is between 5 and 95 percent.

Results:

- OK – The frequency and the duty cycle are within specifications for the entire range of the pedal. The sensor is producing a valid signal. Proceed to Test Step 6.
- Not OK – The frequency and the duty cycle are not within specifications.

Repair: The sensor is not producing a valid signal. Replace the throttle position sensor. Verify that the repair eliminates the problem.

STOP.

Test Step 6. Check the Signal Frequency and the Duty Cycle at the ECM

- A. Remove the throttle signal wire F702-GN(Green) from ECM connector P1-66.
- B. Turn the keyswitch to the ON position.
- C. Measure the frequency between wire F702-GN(Green) and P1-5 (digital return) while you operate the throttle pedal.
- D. Measure the duty cycle of the sensor. Measure the duty cycle between wire F702-GN(Green) and P1-5 (digital return) while you operate the throttle pedal.
- E. Turn the keyswitch to the OFF position.

Expected Result:

The frequency is between 150 and 1000 Hz. The duty cycle is between 5 and 95 percent.

Results:

- OK – The frequency and the duty cycle are within specifications for the entire range of the pedal.

Repair: A valid signal appears at the ECM, but the ECM is not reading the signal properly. Replace the ECM. Refer to Troubleshooting, "ECM - Replace" for complete instructions. Verify that the repair eliminates the problem.

STOP.

- Not OK – The frequency and the duty cycle are not within specifications.

Repair: There is not a valid signal at the ECM connector. Repair the signal wire in the harness. Verify that the repair eliminates the problem.

STOP.

Test Step 7. Check the Supply Voltage at the ECM

- A. Disconnect the J1/P1 ECM connector.
- B. Remove the wires from terminals P1-4 (8 VDC supply) and P1-5 (digital return). Install jumper wires into the terminal locations for the digital return wire and the supply wire.
- C. Reconnect the J1/P1 ECM connector.
- D. Turn the keyswitch to the ON position.
- E. Measure the voltage between the wire jumpers in terminals P1-4 (8 VDC supply) and P1-5 (digital return).
- F. Turn the keyswitch to the OFF position.

Expected Result:

The supply voltage measures 8.0 ± 0.4 VDC at the ECM.

Results:

- OK – The correct voltage is measured at the ECM.

Repair: There is an open circuit or excessive resistance in the harness between the ECM and the sensor. Repair the circuit. Verify that the repair eliminates the problem.

STOP.

- Not OK – The voltage is not correct at the ECM.

Repair: The ECM does not appear to be producing the correct supply voltage. Replace the ECM. Refer to Troubleshooting, “ECM - Replace” for complete instructions. Verify that the repair eliminates the problem.

STOP.

i02604782

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 primary engine speed/timing sensor or with the secondary engine speed/timing sensor. Use this procedure to troubleshoot the electrical system if any of the diagnostic codes in Table 42 are active or easily repeated.

Table 42

Diagnostic Codes Table		
Code and Description	Conditions which Generate this Code	System Response
190-8 Engine Speed Sensor abnormal frequency, pulse width, or period	The signal from the primary engine speed/timing sensor is intermittent or the signal has been lost.	The code is logged. If a valid signal is not received from the primary engine speed/timing sensor, the Electronic Control Module (ECM) will default to the secondary engine speed/timing sensor. The engine will shut down only if the signals from the primary engine speed/timing sensor and the secondary engine speed/timing sensor are abnormal.
342-8 Secondary Engine Speed Sensor abnormal frequency, pulse width, or period	The signal from the secondary engine speed/timing sensor is intermittent or the signal has been lost.	The code is logged. If a valid signal is not received from the secondary engine speed/timing sensor, the ECM will default to the primary engine speed/timing sensor. The engine will shut down only if the signals from the primary engine speed/timing sensor and the secondary engine speed/timing sensor are abnormal.

The engine uses two engine speed/timing sensors. The secondary engine speed/timing sensor monitors the camshaft gear and the primary engine speed/timing sensor monitors the crankshaft gear. Both of the engine speed/timing sensors detect the reference for engine speed and timing from a unique pattern on the respective gear. The ECM counts the time between pulses that is created by the sensor as the gear rotates in order to determine rpm.

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

After locating the No. 1 cylinder, the ECM triggers each injector in the correct firing order and at the correct unit injector timing. The actual timing and duration of each injection is based on engine rpm and load. If the engine is running and the signal from the primary engine speed/timing sensor is lost, a slight change in engine performance will be noticed when the ECM performs the changeover to the secondary engine speed/timing sensor. Loss of the signal from the secondary engine speed/timing sensor during engine operation will not result in any noticeable change in engine performance. However, if the signal from the secondary engine speed/timing sensor is not present during start-up the following conditions may exist:

- The engine may require a slightly longer period of time to start-up.
- The engine may run rough for a few seconds until the ECM determines the proper firing order by using the primary engine speed/timing sensor only.

The engine will start and the engine will run when only one sensor signal is present from either of the sensors. The loss of the signal from both of the sensors during engine operation will result in the termination of injection and the shutting down of the engine by the ECM. The loss of the signal from both of the sensors during start-up will prevent the engine from starting.

Both sensors are magnetic sensors with an integral connector. The two sensors are not interchangeable. Do not switch the positions of the sensor. If the sensors are replaced, a timing calibration is not necessary for the engine.

Note: When the sensors are being installed, complete all of the following tasks:

- Lubricate the O-ring with oil.
- Ensure that the sensor is fully seated into the engine before tightening the bracket bolt.
- Ensure that the connector is properly latched.
- Ensure that the harness is properly secured, and ensure that the tie-wraps are placed in the correct location.

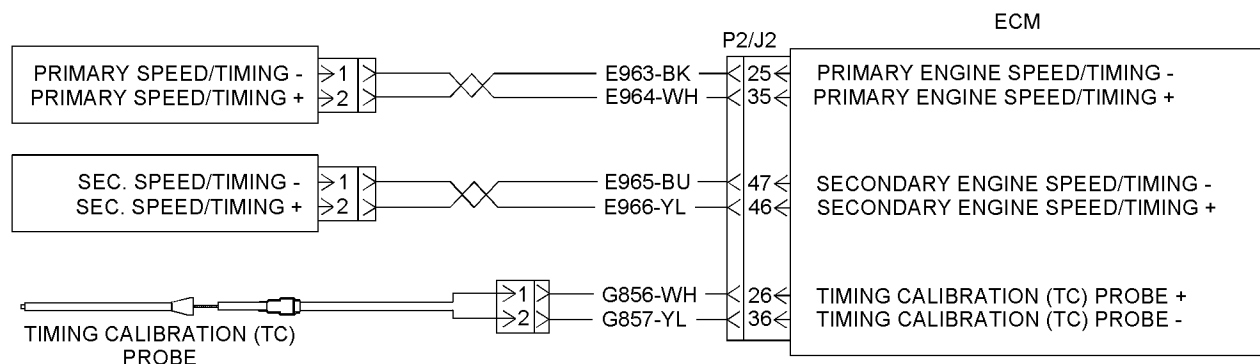


Illustration 71

g01199875

Schematic

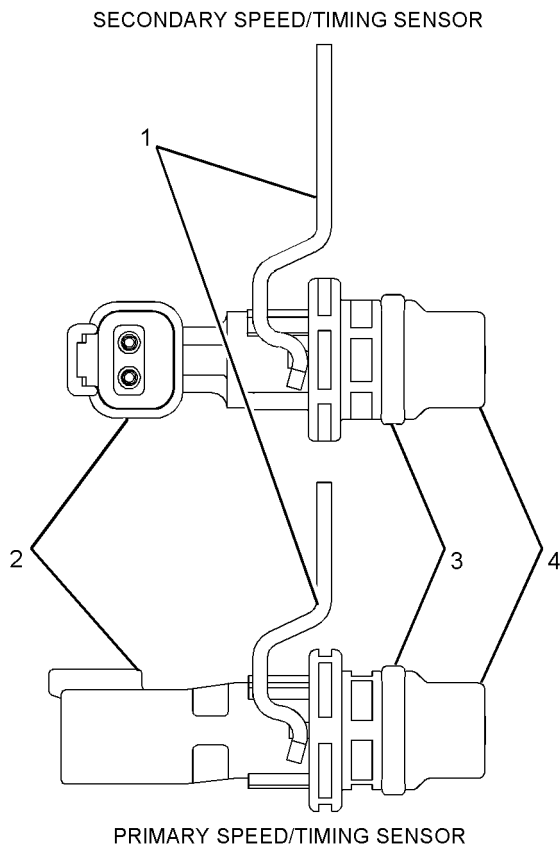


Illustration 72

g01113625

Engine speed/timing sensors

- (1) Brackets
- (2) Integral connectors
- (3) O-ring seals
- (4) Sensors

A. Connect Caterpillar Electronic Technician (ET) to the service tool connector.

B. Restore electrical power to the ECM.

C. Start the engine and run the engine. The problem may occur when the engine is at any operating temperature. However, the problem is more likely to occur when the engine is at the normal operating temperature.

D. If the engine will not start, monitor the engine speed on Cat ET while the engine is being cranked. Cat ET may need to be powered from another battery while the engine is being cranked. This is done so that Cat ET will not reset.

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

E. Wait at least 30 seconds for activation of the diagnostic codes. Look for these codes on Cat ET:

- 190-08
- 342-08

Expected Result:

One or both of the diagnostic codes that are listed above are logged or active.

Note: If the engine will not start and Cat ET displayed 0 rpm during cranking, select "No Engine rpm" .

Results:

- No Engine rpm – Engine rpm is not indicated on Cat ET. Proceed to Test Step 2.

Test Step 1. Check for Diagnostic Codes

- Active Code or logged code – There is an active diagnostic code or a logged diagnostic code for an engine speed/timing sensor. Proceed to Test Step 3.

Test Step 2. Inspect the Sensor Assembly

- Remove electrical power from the engine ECM.
- Remove the engine speed/timing sensors from the engine.
- Ensure that one O-ring seal is installed on each sensor, and ensure that the O-ring seals are free of damage.

Expected Result:

Two undamaged O-ring seals are properly installed. The brackets are not bent. The flange for each sensor can be flush against the housing.

Results:

- OK – Two undamaged O-ring seals are properly installed. The brackets are not bent. The flange for each sensor can be flush against the housing.

Repair: Perform the following procedure in order to properly install a sensor assembly:

- Lubricate the O-ring seal with oil.
- Fully seat the sensor into the housing.
- Tighten the bracket bolt.
- Connect the connector and verify that the latch tab of the connector is latched on both sides.
- Ensure that the harness is properly secured, and ensure that the harness is attached to the harness clip.

Proceed to Test Step 3.

- Not OK – The sensor assembly has a mechanical problem.

Repair: Replace the sensor assembly.

Note: Do not switch the positions of the sensors. The sensors are not interchangeable. A timing calibration is not required when the sensors are replaced.

- Lubricate the O-ring with oil.
- Fully seat the sensor into the housing.
- Tighten the bracket bolt.
- Connect the connector and verify that the latch tab of the connector is latched on both sides.

- Ensure that the harness is properly secured, and ensure that the harness is attached to the harness clip.

Verify that the problem is resolved.

STOP. STOP

Test Step 3. Inspect the Electrical Connectors and Wiring

- Remove electrical power from the ECM.

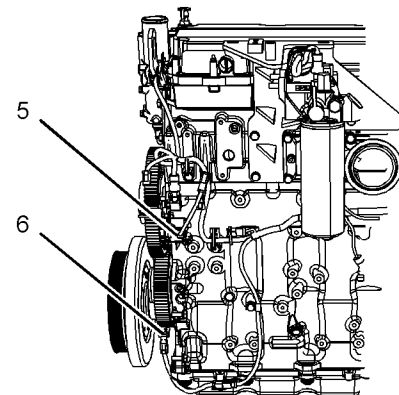


Illustration 73

g01200239

Typical location of sensors

- Secondary engine speed/timing sensor
- Primary engine speed/timing sensor

- Thoroughly inspect the connectors for the engine speed/timing sensors (5) and (6). Refer to Troubleshooting, “Electrical Connectors - Inspect”.

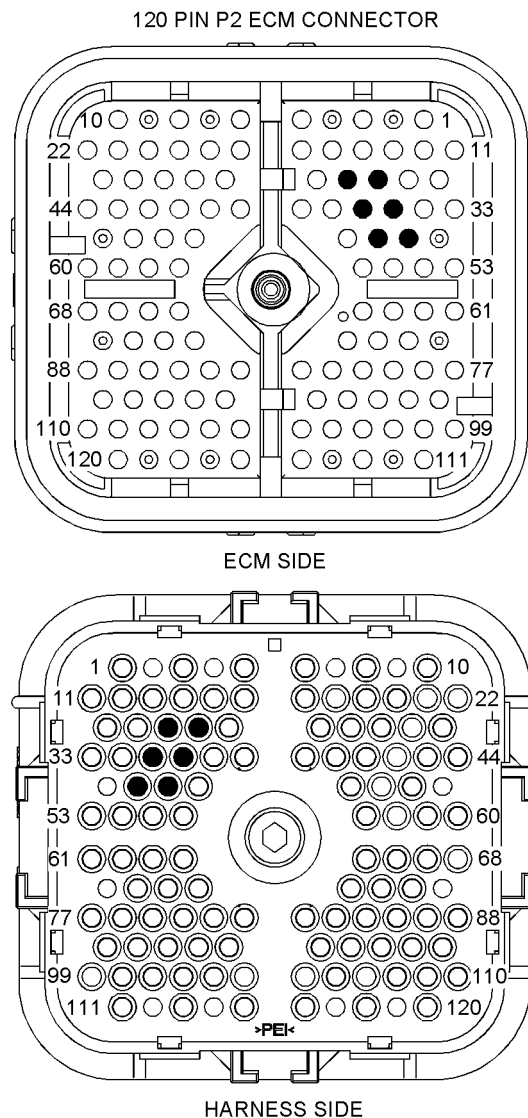


Illustration 74

g01113575

P2 connector

- (P2-25) Primary engine speed/timing signal (-)
 (P2-26) Timing calibration probe (+)
 (P2-35) Primary engine speed/timing signal (+)
 (P2-36) Timing calibration probe (-)
 (P2-46) Secondary engine speed/timing signal (+)
 (P2-47) Secondary engine speed/timing signal (-)

- 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 sensor.
- 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 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 wiring are 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 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. Remove electrical power from the ECM.

B. Disconnect the J2/P2 ECM connector.

C. If you are troubleshooting a problem with the primary engine speed/timing sensor, perform the following procedure:

- Measure the resistance from P2-35 (Primary engine speed/timing +) to P2-25 (Primary engine speed/timing -).
- Check for an intermittent open circuit or for a short circuit by moving the harness while you take the resistance measurement. Pull the wires that are directly behind the sensor or shake the wires that are directly behind the sensor.

Resistance 75 to 230 Ohms

D. If you are troubleshooting a problem with the secondary engine speed/timing sensor, perform the following procedure:

- Measure the resistance from P2-46 (secondary engine speed/timing +) to P2-47 (secondary engine speed/timing -).
- Check for an intermittent open circuit or for a short circuit by moving the harness while you take the resistance measurement. Pull the wires that are directly behind the sensor or shake the wires that are directly behind the sensor.

Resistance 600 to 1800 Ohms

Expected Result:

The resistance measurements are within the specifications.

Results:

- OK – The resistance measurements are within the specifications. The wiring appears to be OK.

Repair: The sensors and the harness are OK.

- A. Temporarily connect a test ECM.
- B. If the problem is resolved with the test ECM, reconnect the suspect ECM.
- C. If the problem returns with the suspect ECM, replace the ECM.

STOP. STOP

- Not OK – At least one of the resistance measurements is not within the specifications. Proceed to Test Step 5.

Test Step 5. Measure the Resistance of the Sensor

- A. Disconnect the engine harness from the suspect sensor.
- B. For the primary engine speed/timing sensor, measure the resistance between terminal 2 (Primary engine speed/timing +) to terminal 1 (Primary engine speed/timing –).

Resistance 75 to 230 Ohms

- C. For the secondary engine speed/timing sensor, measure the resistance between terminal 2 (secondary engine speed/timing +) to terminal 1 (secondary engine speed/timing –).

Resistance 600 to 1800 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. There is a problem with the wiring or there may be a problem with a connector.

Repair: Repair the connection and/or the wiring, when possible. Replace parts, if necessary. Twisted pair wiring is required. The wiring must have at least one twist per inch. Verify that the problem is resolved.

STOP. STOP

- Not OK – The resistance measurement for the suspect sensor is not within the specification. There is a problem with the sensor.

Repair: 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:

- A. Lubricate the O-ring seal with oil.
- B. Fully seat the sensor into the housing.
- C. Tighten the bracket bolt.
- D. Connect the connector and verify that the latch tab of the connector is latched on both sides.
- E. Ensure that the harness is properly secured, and ensure that the harness is attached to the harness clip.

Verify that the problem is resolved.

STOP. STOP

i02695195

Starting Aid - Test

SMCS Code: 1090-038; 1412-038; 1456-038

System Operation Description:

Use this procedure in order to troubleshoot the ether system or use this procedure if a diagnostic code in Table 43 is active or logged.

Table 43

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. In order for this diagnostic code to be enabled, the engine speed must be present.	The code is latched. The code is logged. Ether injection is disabled.
2417-6 Ether Injection Control Solenoid current above normal	The ECM detects excessive current flow in the circuit. The ECM can only detect this condition when the output driver is activated. In order for this diagnostic code to be enabled, the engine speed must be present.	

The ether injection system improves cold weather starting of the engine. The ECM controls the ether injection system.

The ether injection system is disabled if there is an active engine shutdown.

A test on Caterpillar Electronic Technician (ET) allows the technician to activate the ether system. The test is functional when the engine speed is zero rpm. Access the test via the “Override Parameters” screen on Cat ET. The test will not generate a diagnostic code.

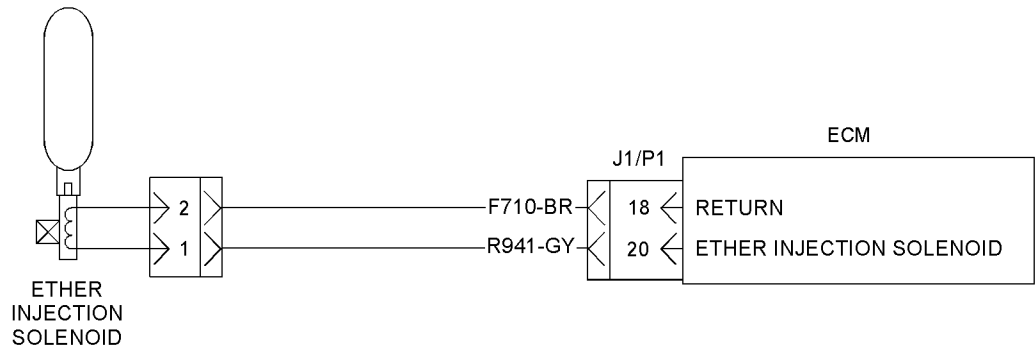


Illustration 75

g01303964

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.

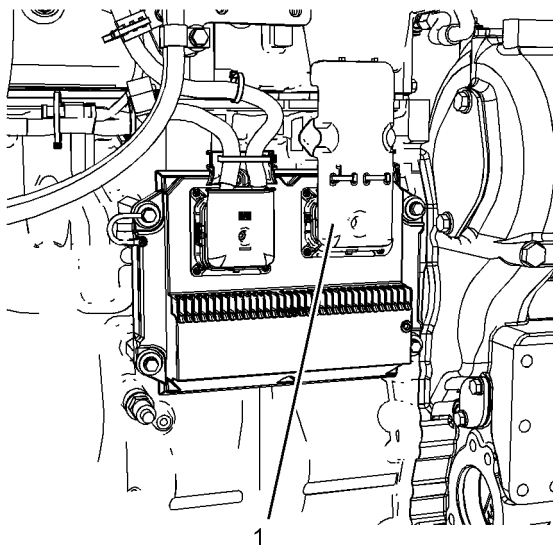


Illustration 76

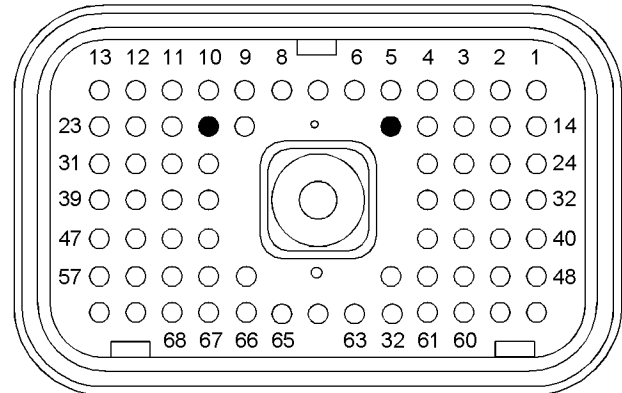
g01144470

Left side engine view (typical example)

(1) J1/P1 ECM connectors

B. Thoroughly inspect connectors (1). Inspect the connector for the ether solenoid. Refer to Troubleshooting, "Electrical Connectors - Inspect".

ECM SIDE



HARNESS SIDE

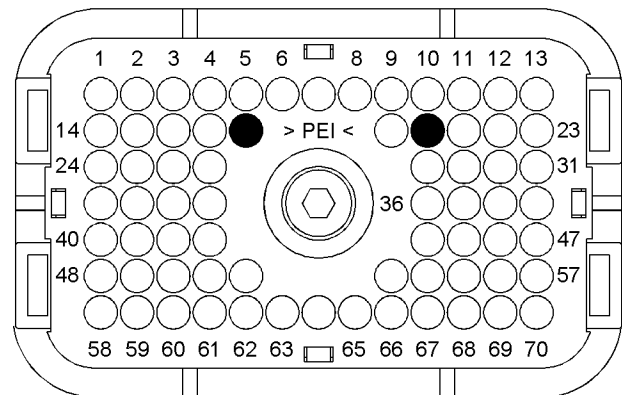


Illustration 77

g01142845

P1 terminals for the ether injection system

(P1-18) Solenoid return (ether start valve)

(P1-20) Ether injection solenoid

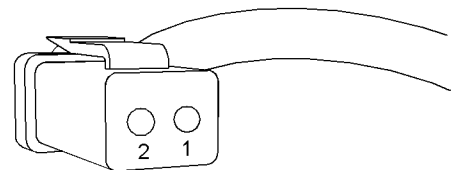


Illustration 78

g01160725

Connector for the Ether start valve

(Terminal 1) Ether injection solenoid

(Terminal 2) Solenoid return (ether start valve)

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 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 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. STOP

Test Step 2. Check for Voltage to the Ether Solenoid

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

- A.** Turn the keyswitch to the OFF position.
- B.** Disconnect the connector for the ether solenoid.
- C.** Turn the keyswitch to the ON position.
- D.** Measure the voltage between terminal 1 and terminal 2 on the harness side of the connector for the ether solenoid.
- E.** Proceed to the "Diagnostic Overrides" screen on Cat ET.
- F.** Activate the ether injection system. The system will activate for ten seconds.
- G.** Measure the voltage between terminal 1 and terminal 2 on the harness side of the connector for the ether solenoid.

Expected Result:

The voltage measures approximately 0 VDC when the override for the ether system is not activated. The voltage measures approximately 24 ± 3 VDC when the override for the ether system is activated.

Results:

- OK – The voltage measurements are correct.

Repair: Check the ether solenoid for an open or a short circuit. The resistance of the coil in the ether solenoid is approximately 20 Ohms.

STOP.

- Not OK – One of the voltage measurements was incorrect.

Repair: There is either a short or an open in the wiring between the connector for the ether solenoid and the ECM. Repair the wiring and/or connectors.

STOP.

i02696843

Throttle Lock - Test

SMCS Code: 1915-038; 1918-038

System Operation Description:

Use this procedure to troubleshoot the electrical system if any one of the diagnostic codes in Table 44 is active or easily repeated.

Table 44

Diagnostic Codes Table		
Code and Description	Conditions which Generate this Code	System Response
549-2 Throttle Lock Switch erratic, intermittent, or incorrect	The Electronic Control Module (ECM) detects an invalid signal from the throttle lock switch.	The code is logged. The ECM will disable the automatic control of engine speed through the throttle hold feature and the throttle lock feature.
2770-3 Throttle Lock Resume/Decel Switch voltage above normal	Both contacts of the "throttle lock resume/decel switch" are in the open state.	The code is logged. The ECM will disable the automatic control of engine speed through the throttle hold feature and the throttle lock feature.
2770-4 Throttle Lock Resume/Decel Switch voltage below normal	Both contacts of the "throttle lock resume/decel switch" are in the closed state.	
2771-3 Throttle Lock Set/Accel Switch voltage above normal	Both contacts of the "throttle lock set/accel switch" are in the open state.	The code is logged. The ECM will disable the automatic control of engine speed through the throttle hold feature and the throttle lock feature.
2771-4 Throttle Lock Set/Accel Switch voltage below normal	Both contacts of the "throttle lock set/accel switch" are in the closed state.	

The throttle lock feature is activated through the use of the throttle lock switch and the "throttle lock set/accel switch" in order to maintain a desired engine speed. The throttle lock switch is a three-position rocker switch that is used to select the mode of operation. The "throttle lock set/accel switch" is a two-position momentary rocker switch. This switch is for setting the engine speed and/or adjusting the engine speed. The throttle lock feature has the following three modes of operation:

- AUTOMATIC MODE
- MANUAL MODE
- OFF

Automatic Mode

Depress the throttle lock switch in the forward direction to the AUTO position in order to select the automatic mode. Use the throttle pedal to achieve the desired engine speed and then depress the "throttle lock set/accel switch" in the forward direction (SET/ACCEL) in order to set the desired engine speed.

Acceleration – Moving the "throttle lock set/accel switch" in the forward direction (SET/ACCEL) will increase the desired engine speed. Momentarily bumping the "throttle lock set/accel switch" will increase the desired engine speed by 100 rpm. Holding the "throttle lock set/accel switch" for more than 250 milliseconds will increase the desired engine speed at a rate of 700 rpm per second. Moving the throttle pedal past the engine speed setpoint will increase the engine speed. Releasing the throttle pedal will allow the engine speed to return to the locked engine speed.

Deceleration – Moving the "throttle lock resume/decel switch" (RESUME/DECEL) on the joystick will decrease the desired engine speed. Momentarily bumping the "throttle lock resume/decel switch" will decrease the desired engine speed by 100 rpm. Holding the "throttle lock resume/decel switch" for more than 250 milliseconds will decrease the desired engine speed at a rate of 700 rpm per second.

Note: Actual engine speed may ramp at a slower rate than desired engine speed. The "throttle lock set/accel switch" and the "throttle lock resume/decel switch" control desired engine speed. For example, if you bump the "throttle lock set/accel switch" five times, desired engine speed will immediately increase by 500 rpm. Actual engine speed may not react quickly if the engine is under load.

Automatic Mode ("Throttle Lock Kickout") – If the throttle lock feature is enabled and active, any of the following actions will cancel throttle lock.

- Applying the service brake will suspend the selected engine speed and the engine will decelerate at a rate of 700 rpm per second until the engine speed matches the desired engine speed for the throttle pedal position.
- After the throttle pedal has been released to less than 10 percent, depressing the throttle pedal to more than 25 percent will suspend the selected engine speed and the engine speed will change at a rate of 700 rpm per second until the engine speed matches the desired engine speed for the position of the throttle pedal.

- The operator moves the throttle lock switch to the OFF position.

The suspended engine speed may be resumed if none of the following actions has occurred:

- The throttle lock switch is moved to the OFF position.
- The keyswitch is turned to the OFF position.
- The engine stalls.

Manual Mode

Depress the throttle lock switch in the backward direction to the MAN position in order to select the manual mode. Use the throttle pedal to achieve the desired engine speed and then depress the “throttle lock set/accel switch” in the forward direction (SET/ACCEL) in order to set the desired engine speed.

Acceleration – Moving the “throttle lock set/accel switch” in the forward direction (SET/ACCEL) will increase the desired engine speed. Momentarily bumping the “throttle lock set/accel switch” will increase the desired engine speed by 100 rpm. Holding the “throttle lock set/accel switch” for more than 250 milliseconds will increase the desired engine speed at a rate of 700 rpm per second. Moving the throttle pedal past the engine speed setpoint will increase the engine speed. Releasing the throttle pedal will allow the engine speed to return to the locked engine speed.

Deceleration – Moving the “throttle lock resume/decel switch” (RESUME/DECEL) on the joystick will decrease the desired engine speed. Momentarily bumping the “throttle lock resume/decel switch” will decrease the desired engine speed by 100 rpm. Holding the “throttle lock resume/decel switch” for more than 250 milliseconds will decrease the desired engine speed at a rate of 700 rpm per second.

Note: Actual engine speed may ramp at a slower rate than desired engine speed. The “throttle lock set/accel switch” and the “throttle lock resume/decel switch” control desired engine speed. For example, if you bump the “throttle lock set/accel switch” five times, desired engine speed will immediately increase by 500 rpm. Actual engine speed may not react quickly if the engine is under load.

Manual Mode (“Throttle Lock Kickout”) – If the throttle lock feature is enabled and active, moving the throttle lock switch to the OFF position will cancel throttle lock.

OFF

When the throttle lock switch is in the OFF (center) position, the throttle lock feature is disabled and the throttle pedal is the only means of controlling engine speed.

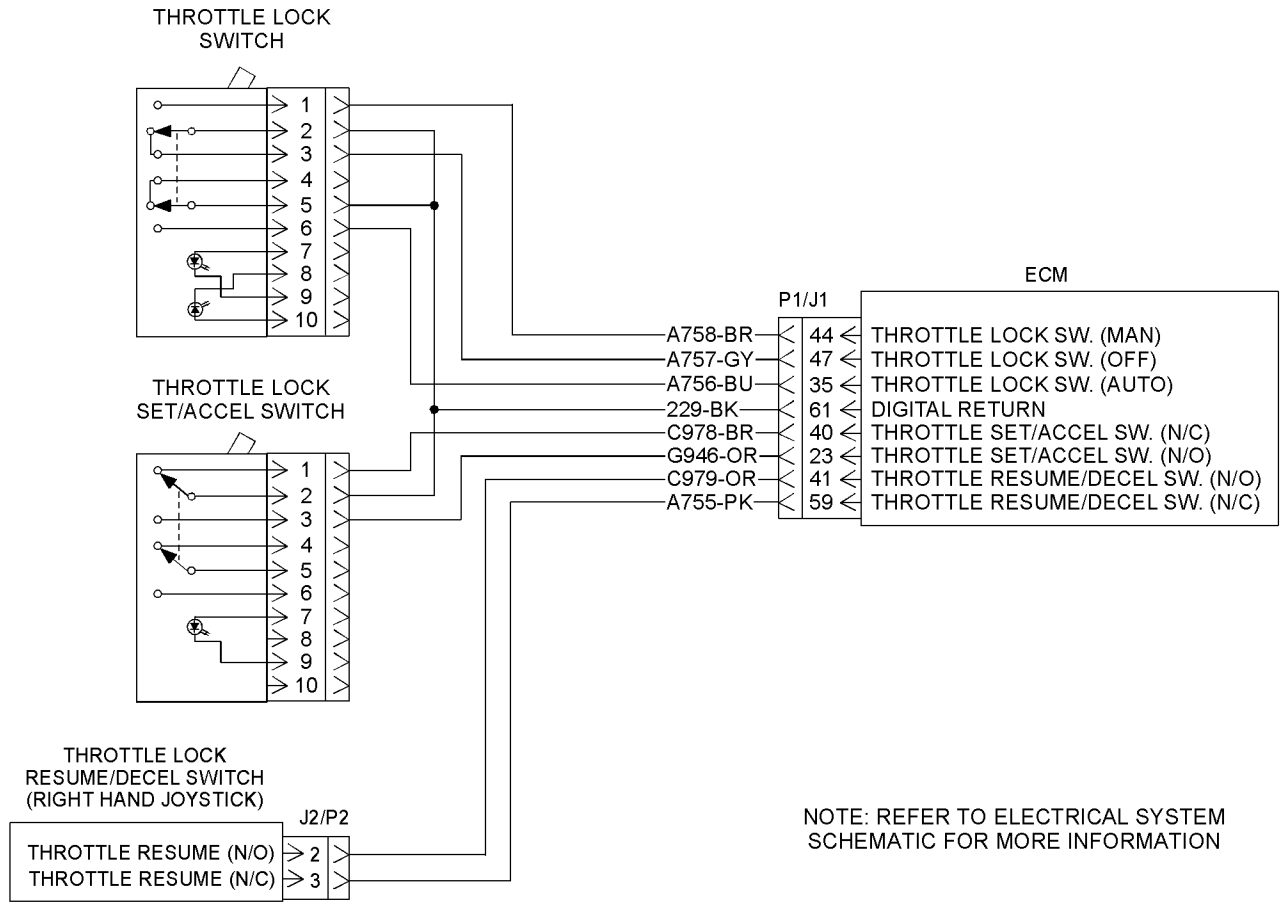


Illustration 79
Schematic

g01305672

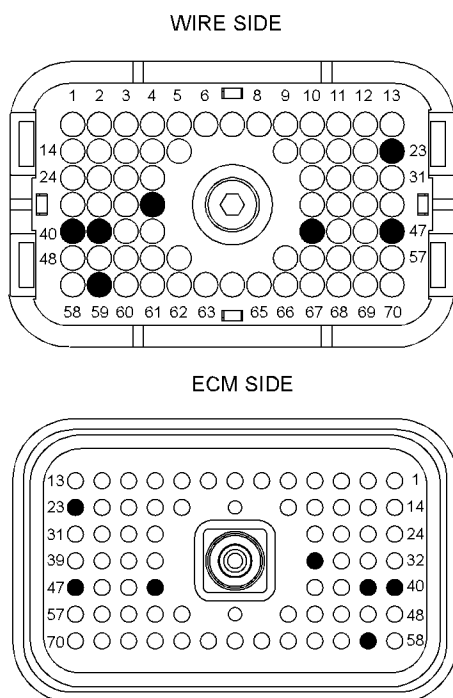


Illustration 80

g01305669

P1 ECM connector

- (P1-23) "Throttle lock set/accel switch (N/O)"
- (P1-35) "Throttle lock switch (AUTO)"
- (P1-40) "Throttle lock set/accel switch (N/C)"
- (P1-41) "Throttle lock resume/decel switch (N/O)"
- (P1-44) "Throttle lock switch (MAN)"
- (P1-47) "Throttle lock switch (OFF)"
- (P1-59) "Throttle lock resume/decel switch (N/C)"
- (P1-61) Digital return

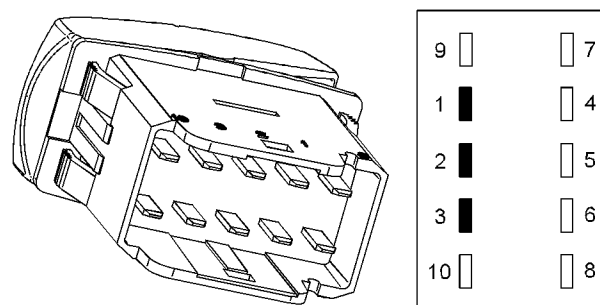


Illustration 82

g01305674

"Throttle lock set/accel switch"

- (Terminal 1) "Throttle lock set/accel switch (N/C)"
- (Terminal 2) Digital return
- (Terminal 3) "Throttle lock set/accel switch (N/O)"

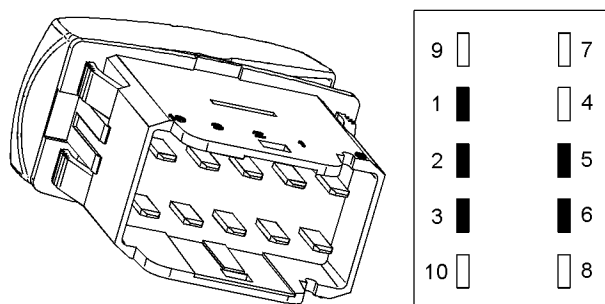


Illustration 81

g01305673

Throttle lock switch

- (Terminal 1) "Throttle lock switch (MAN)"
- (Terminal 2) Digital return
- (Terminal 3) "Throttle lock switch (OFF)"
- (Terminal 5) Digital return
- (Terminal 6) "Throttle lock switch (AUTO)"

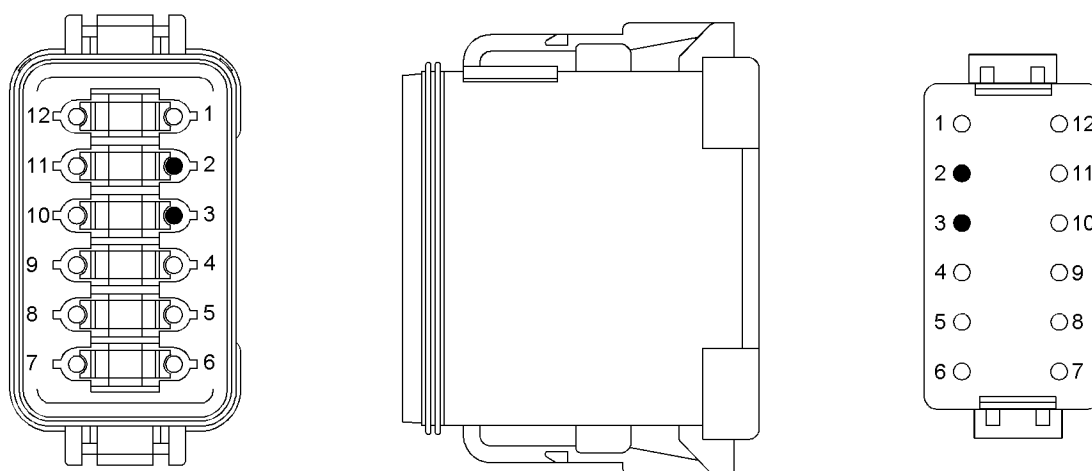


Illustration 83

g01305689

P2 connector for the proportional joystick

(Terminal 2) "Throttle lock resume/decel switch (N/O)"

(Terminal 3) "Throttle lock resume/decel switch (N/C)"

Test Step 1. Inspect Electrical Connectors and Wiring

- A. Turn the keyswitch to the OFF position.
- B. Thoroughly inspect the J1/P1 ECM connector, the throttle lock switch, the "throttle lock set/accel switch", any other connectors in the circuit, and the associated wiring. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- 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 ECM connector (allen head screw) for the proper torque. Refer to Troubleshooting, "Electrical Connectors - Inspect" for details.
- E. Check the harness and wiring for abrasion and for pinch points.

Expected Result:

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

Results:

- OK – The 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. Repair Complete

Test Step 2. Check for Active Diagnostic Codes

- A. Connect Caterpillar Electronic Technician (ET) to the service tool connector.
- B. Turn the keyswitch to the ON position. Start the engine.
- C. Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes. Look for the following diagnostic codes:

- 549-2
- 2770-3
- 2770-4
- 2771-3
- 2771-4

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

Expected Result:

No diagnostic codes are active.

Results:

- OK – No diagnostic code is active.

Repair: The problem is no longer present. If the problem is intermittent, refer to Troubleshooting, “Electrical Connectors - Inspect”.

STOP. OK

- Not OK – A 549-2 diagnostic code is active at this time. Proceed to Test Step 3.
- Not OK – A 2770-3 or 2770-4 diagnostic code is active at this time. Proceed to Test Step 6.
- Not OK – A 2771-3 or 2771-4 diagnostic code is active at this time. Proceed to Test Step 9.

Test Step 3. Check the Status of the Throttle Lock Switch on Cat ET

- Turn the keyswitch to the ON position.
- Move the throttle lock switch to the AUTO position and observe the status of the “Throttle Lock Switch” on Cat ET.

The status should be “On” .

- Move the throttle lock switch to the MAN position and observe the status of the “Throttle Lock Switch” on Cat ET.

The status should be “On” .

- Move the throttle lock switch to the OFF position and observe the status of the “Throttle Lock Switch” on Cat ET.

The status should be “Off” .

Expected Result:

The status should change accordingly as you change switch positions.

Results:

- OK – The throttle lock switch appears to be operating properly at this time.

Repair: The problem may be intermittent. If the problem is intermittent, refer to Troubleshooting, “Electrical Connectors - Inspect”.

STOP.

- Not OK – There is a problem in the circuit for the throttle lock switch. Proceed to Test Step 4.

Test Step 4. Short the Wires at the Throttle Lock Switch

- Turn the keyswitch to the OFF position.
- Disconnect the connector for the throttle lock switch.
- Install a jumper wire with male spade terminals on each end between terminal 5 (return) and terminal 6 (throttle lock switch (AUTO)) on the wiring harness connector for the throttle lock switch.
- Turn the keyswitch to the ON position.
- Observe the status of the “Throttle Lock Switch” on Cat ET.
The status should be “On” .
- Turn the keyswitch to the OFF position.
- Install a jumper wire with male spade terminals on each end between terminal 2 (return) and terminal 1 (throttle lock switch (MAN)) on the wiring harness connector for the throttle lock switch.
- Turn the keyswitch to the ON position.
- Observe the status of the “Throttle Lock Switch” on Cat ET.
The status should be “On” .
- Turn the keyswitch to the OFF position.
- Install a jumper wire with male spade terminals on each end between terminal 2 (return) and terminal 3 (throttle lock switch (OFF)) on the wiring harness connector for the throttle lock switch.
- Turn the keyswitch to the ON position.
- Observe the status of the “Throttle Lock Switch” on Cat ET.
The status should be “Off” .
- Turn the keyswitch to the OFF position.
- Remove the jumper wire and reconnect the switch.

Expected Result:

The status should change accordingly as you short the terminals in the wiring harness connector.

Results:

- OK – The ECM and the wiring harness are functioning properly.

Repair: Replace the throttle lock switch.

Verify that the repair eliminates the problem.

STOP. OK

- Not OK – There is a problem in the circuit between the ECM and the throttle lock switch. Proceed to Test Step 5.

Test Step 5. Short the Inputs at the ECM for the Throttle Lock Switch

- Remove wire 229-BK(Black) from ECM connector P1-61 (return). Install a jumper wire with Deutsch sockets on each end into P1-61. Connect the wire jumper in P1-61 to wire 229-BK(Black).
- Remove wire A758-BR(Brown) from ECM connector P1-44 (throttle lock switch (MAN)). Install a jumper wire with Deutsch sockets on each end into P1-44.
- Remove wire A756-BU(Blue) from ECM connector P1-35 (throttle lock switch (AUTO)). Install a jumper wire with Deutsch sockets on each end into P1-35.
- Remove wire A757-GY(Grey) from ECM connector P1-47 (throttle lock switch (OFF)). Install a jumper wire with Deutsch sockets on each end into P1-47.
- Short the wire jumper from P1-61 to the wire jumper from P1-44.
- Turn the keyswitch to the ON position.
- Observe the status of "Throttle Lock Switch" on Cat ET.
The status should be "On".
- Turn the keyswitch to the OFF position.
- Short the wire jumper from P1-61 to the wire jumper from P1-35.
- Turn the keyswitch to the ON position.
- Observe the status of "Throttle Lock Switch" on Cat ET.
The status should be "On".
- Turn the keyswitch to the OFF position.

- Short the wire jumper from P1-61 to the wire jumper from P1-47.

- Turn the keyswitch to the ON position.

- Observe the status of "Throttle Lock Switch" on Cat ET.

The status should be "Off".

- Turn the keyswitch to the OFF position.

- Remove the jumper wires and reconnect the wires to the P1 ECM connector.

Expected Result:

The status should change accordingly as you short the terminals in the P1 ECM connector.

Results:

- OK – There is either an open circuit or a short circuit in the wiring between the ECM and the switch.

Repair: Use continuity checks in order to determine the location of the open or short. Refer to the machine's electrical schematic for the complete electrical circuit.

STOP.

- Not OK – The ECM is not responding to the inputs from the switch.

Repair: Verify your results. Refer to Troubleshooting, "ECM - Replace" before replacing the ECM.

Verify that the new ECM eliminates the problem.

STOP.

Test Step 6. Check the Status of the "Throttle Lock Resume/Decel Switch" on Cat ET

- Observe the status of "Throttle Lock Resume/Decel Switch Position" on Cat ET.

Note: The status should be "Off".

- Hold the "throttle lock resume/decel switch" in the RESUME/DECEL position and observe the status of "Throttle Lock Resume/Decel Switch Position" on Cat ET.

Note: The status should be "On".

Expected Result:

The status should change accordingly as you change switch positions.

Results:

- OK – The “throttle lock resume/decel switch” appears to be operating properly at this time.

Repair: The problem may be intermittent. If the problem is intermittent, refer to Troubleshooting, “Electrical Connectors - Inspect”.

STOP.

- Not OK – There is a problem in the circuit for the “throttle lock resume/decel switch”. Proceed to Test Step 7.

Test Step 7. Short the Wire at the “Throttle Lock Resume/Decel Switch”

- Turn the keyswitch to the OFF position.
- Disconnect the P2 connector for the “throttle lock resume/decel switch”.
- Install a jumper wire between engine ground and terminal P2-3 (throttle lock resume/decel switch (N/C)) on the wiring harness connector for the “throttle lock resume/decel switch”.
- Turn the keyswitch to the ON position.
- Observe the status of the “Throttle Lock Resume/Decel Switch Position” on Cat ET.
The status should be “Off”.
- Turn the keyswitch to the OFF position.
- Install a jumper wire between engine ground and terminal P2-2 (throttle lock resume/decel switch (N/O)) on the wiring harness connector for the “throttle lock resume/decel switch”.
- Turn the keyswitch to the ON position.
- Observe the status of “Throttle Lock Resume/Decel Switch Position” on Cat ET.
The status should be “On”.
- Turn the keyswitch to the OFF position.
- Remove the jumper wire and reconnect the connector for the “throttle lock resume/decel switch”.

Expected Result:

The status should change accordingly as you short the terminals in the wiring harness connector.

Results:

- OK – The ECM and the wiring harness are functioning properly.

Repair: Verify that the ground connections on the P1 connector for the joystick have a good connection. The ground connections are on P1-3 and P1-8 of the P1 connector of the joystick. If the ground connections are OK, replace the “throttle lock resume/decel switch”.

Verify that the repair eliminates the problem.

STOP.

- Not OK – There is a problem in the circuit between the ECM and the “throttle lock resume/decel switch”. Proceed to Test Step 8.

Test Step 8. Short the Inputs at the ECM for the “Throttle Lock Resume/Decel Switch”

- Remove wire A755-PK(Pink) from ECM connector P1-59 (throttle lock resume/decel switch (N/C)). Install a jumper wire with Deutsch sockets on each end into P1-59.
- Remove wire C979-OR(Orange) from ECM connector P1-41 (throttle lock resume/decel switch (N/O)). Install a jumper wire with Deutsch sockets on each end into P1-41.
- Create a short between the wire jumper in P1-59 and engine ground. Ensure that the wire jumper in P1-41 is not touching any other wire in the harness or engine ground.
- Turn the keyswitch to the ON position.
- Observe the status of “Throttle Lock Resume/Decel Switch Position” on Cat ET.
The status should be “Off”.
- Turn the keyswitch to the OFF position.
- Create a short between the wire jumper in P1-41 and engine ground. Ensure that the wire jumper in P1-59 is not touching any other wire in the harness or engine ground.
- Turn the keyswitch to the ON position.
- Observe the status of “Throttle Lock Resume/Decel Switch Position” on Cat ET.
The status should be “On”.
- Turn the keyswitch to the OFF position.
- Remove the jumper wires and reconnect the wires to the P1 ECM connector.

Expected Result:

The status should change accordingly as you short the terminals in the P1 ECM connector.

Results:

- OK – There is either an open circuit or a short circuit in the wiring between the ECM and the “throttle lock resume/decel switch” .

Repair: Use continuity checks in order to determine the location of the open or short. Refer to the machine's electrical schematic for the complete electrical circuit.

STOP.

- Not OK – The ECM is not responding to the inputs from the “throttle lock resume/decel switch” .

Repair: Verify your results. Refer to Troubleshooting, “ECM - Replace” before replacing the ECM.

Verify that the new ECM eliminates the problem.

STOP.

Test Step 9. Check the Status of the “Throttle Lock Set/Accel Switch” on Cat ET

- A.** Observe the status of “Throttle Lock Set/Accel Switch Position” on Cat ET.

The status should be “Off” .

- B.** Hold the “throttle lock set/accel switch” in the SET/ ACCEL position and observe the status of “Throttle Lock Set/Accel Switch Position” on Cat ET.

The status should be “On” .

Expected Result:

The status should change accordingly as you change switch positions.

Results:

- OK – The “throttle lock set/accel switch” appears to be operating properly at this time.

Repair: The problem may be intermittent. If the problem is intermittent, refer to Troubleshooting, “Electrical Connectors - Inspect”.

STOP.

- Not OK – There is a problem in the circuit for the “throttle lock set/accel switch” .Proceed to Test Step 10.

Test Step 10. Short the Wires at the “Throttle Lock Set/Accel Switch”

- A.** Turn the keyswitch to the OFF position.

- B.** Disconnect the connector for the “throttle lock set/ accel switch” .

- C.** Install a jumper wire with male spade terminals on each end between terminal 2 (return) and terminal 3 (throttle lock set/accel switch (N/O)) on the wiring harness connector for the “throttle lock set/ accel switch” .

- D.** Turn the keyswitch to the ON position.

- E.** Observe the status of the “Throttle Lock Set/Accel Switch Position” on Cat ET.

The status should be “On” .

- F.** Turn the keyswitch to the OFF position.

- G.** Install a jumper wire with male spade terminals on each end between terminal 2 (return) and terminal 1 (throttle lock set/accel switch (N/C)) on the wiring harness connector for the “throttle lock set/accel switch” .

- H.** Turn the keyswitch to the ON position.

- I.** Observe the status of “Throttle Lock Set/Accel Switch Position” on Cat ET.

The status should be “Off” .

- J.** Turn the keyswitch to the OFF position.

- K.** Remove the jumper wire and reconnect the switch.

Expected Result:

The status should change accordingly as you short the terminals in the wiring harness connector.

Results:

- OK – The ECM and the wiring harness are functioning properly.

Repair: Replace the “throttle lock set/accel switch” .

Verify that the repair eliminates the problem.

STOP.

- Not OK – There is a problem in the circuit between the ECM and the “throttle lock set/accel switch” . Proceed to Test Step 11.

Test Step 11. Short the Inputs at the ECM for the “Throttle Lock Set/Accel Switch”

- A.** Remove wire 229-BK(Black) from ECM connector P1-61 (return). Install a jumper wire with Deutsch sockets on each end into P1-61. Connect the wire jumper in P1-61 to wire 229-BK(Black).
- B.** Remove wire C978-BR(Brown) from ECM connector P1-40 (throttle lock set/accel switch (N/C)). Install a jumper wire with Deutsch sockets on each end into P1-40.
- C.** Remove wire G946-OR(Orange) from ECM connector P1-23 (throttle lock set/accel switch (N/O)). Install a jumper wire with Deutsch sockets on each end into P1-23.
- D.** Short the wire jumper from P1-61 to the wire jumper from P1-40.
- E.** Turn the keyswitch to the ON position.
- F.** Observe the status of “Throttle Lock Set/Accel Switch Position” on Cat ET.
The status should be “Off” .
- G.** Turn the keyswitch to the OFF position.
- H.** Short the wire jumper from P1-61 to the wire jumper from P1-23.
- I.** Turn the keyswitch to the ON position.
- J.** Observe the status of “Throttle Lock Set/Accel Switch Position” on Cat ET.
The status should be “On” .
- K.** Turn the keyswitch to the OFF position.
- L.** Remove the jumper wires and reconnect the wires to the P1 ECM connector.

Expected Result:

The status should change accordingly as you short the terminals in the P1 ECM connector.

Results:

- OK – There is either an open circuit or a short circuit in the wiring between the ECM and the switch.

Repair: Use continuity checks in order to determine the location of the open or short. Refer to the machine's electrical schematic for the complete electrical circuit.

STOP.

- Not OK – The ECM is not responding to the inputs from the switch.

Repair: Verify your results. Refer to Troubleshooting, “ECM - Replace” before replacing the ECM.

Verify that the new ECM eliminates the problem.

STOP.

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".

i02305288

Factory Passwords Worksheet

SMCS Code: 0785; 1900

Factory passwords are required to perform the following functions:

- Clear certain logged events
- Full load setting
- Full torque setting

The following information is required to obtain Caterpillar Factory Passwords:

- Caterpillar Dealer Code
- Name
- Address
- Phone Number

The following information is required to obtain factory passwords.

- Engine hours

Note: Engine hours do not include service meter hours.

View the factory password screen on Caterpillar Electronic Technician (ET). Record the following information:

Table 45

Electronic Service Tool Serial Number	
Engine Serial Number	
ECM Serial Number	
Total Tattletale	

(continued)

(Table 45, contd)

Reason Code	
Other parameters	

i06910188

ECM Will Not Accept Factory Passwords

SMCS Code: 0785; 1901

Probable Causes

One of the following items may not be recorded correctly on the Cat[®] Electronic Technician (ET):

- Passwords
- Serial numbers
- Total tattletale
- Reason code

Recommended Actions

Table 46

Troubleshooting Test Steps	Values	Steps
1. Check the Factory Passwords A. Verify that the correct passwords were entered. B. Verify that Cat [®] Electronic Technician (ET) is displaying the "Enter Factory Passwords" dialog box.	Factory Passwords	Result: The factory passwords were not accepted in Cat ET. Repair: Check every character in each password and remove the electrical power from the engine for 30 seconds and then retry. Use Cat ET to verify that the following information has been entered correctly: Engine Serial Number, Serial Number for the Electrical Control Module, Serial Number for Cat ET, Total Tattletale, and Reason Code.

For additional information, refer to Troubleshooting, "Factory Passwords".

If the procedure did not correct the issues, contact your Cat dealer Technical Communicator (TC). For further assistance, your TC can confer with the Dealer Solutions Network (DSN).

i02598897

Electronic Service Tool Does Not Communicate

SMCS Code: 0785; 1900

Probable Causes

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

Recommended Actions

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

Configuration for the Communications Adapter

1. Access "Preferences" under the "Utilities" menu on Cat ET.
2. Verify that the correct "Communications Interface Device" is selected.
3. Verify that the correct port is selected for use by the communication adapter.

Note: The most commonly used port is "COM 1".

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

Electrical Connectors

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

Communication Adapter and/or Cables

1. If you are using a "Communication Adapter II", ensure that the firmware and driver files for the communication adapter are the most current files that are available. If the firmware and driver files do not match, the communication adapter will not communicate with Cat ET.
2. Disconnect the communication adapter and the cables from the service tool connector. Reconnect the communication adapter to the service tool connector.
3. Verify that the correct cable is being used between the communication adapter and the service tool connector. Refer to Troubleshooting, "Electronic Service Tools".

Electrical Power Supply to the Service Tool Connector

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

Cat ET and Related Hardware

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

Electrical Power Supply to the Electronic Control Module (ECM)

Check power to the ECM. Refer to Troubleshooting, "Electrical Power Supply - Test".

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

Cat Data Link

Troubleshoot the Cat Data Link for possible problems. Refer to Troubleshooting, "Cat Data Link - Test".

i04018732

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 new ECM does not resolve the problem, and 24 hours has not expired, the ECM can be used as a new ECM. 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.

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

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. A new ECM can never be used as a test ECM after the engine serial number is programmed.

5. 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".

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.

i05293125

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				
CDL Code	J1939 Code	Conditions which Generate this Code	System Response	Procedure
253-2 Personality Module : Erratic, Intermittent, or Incorrect	631-2 Calibration 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 engines Electronic Control Module (ECM).

Caterpillar Electronic Technician (ET) is used to flash program a file into the memory of the engines 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 engines 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.

i06732700

Electrical Connectors - Inspect

SMCS Code: 7553-040-WW

Most electrical problems are caused by poor connections. The following procedure will help 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. Check for diagnostic codes immediately before disconnecting a connector. Also check for diagnostic codes after reconnecting the connector. If the status of a diagnostic code is changed due to disconnecting and reconnecting a connector, there are several possible reasons. The likely reasons are loose terminals, improperly crimped terminals, moisture, corrosion, and inadequate mating of a connection.

Follow these guidelines:

- Always use a 1U-5804 Crimp Tool to service Deutsch HD and DT connectors. Never solder the terminals onto the wires. Refer to "SEHS9615, Servicing Deutsch HD and DT Style Connectors".
- Always use a 147-6456 Wedge Removal Tool to remove wedges from DT connectors. Never use a screwdriver to pry a wedge from a connector.
- Always use a breakout harness for a voltmeter probe or a test light. Never break the insulation of a wire 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. Testing the circuit helps identify the root cause of intermittent problems.

The “Wiggle Test” on the Cat® 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.

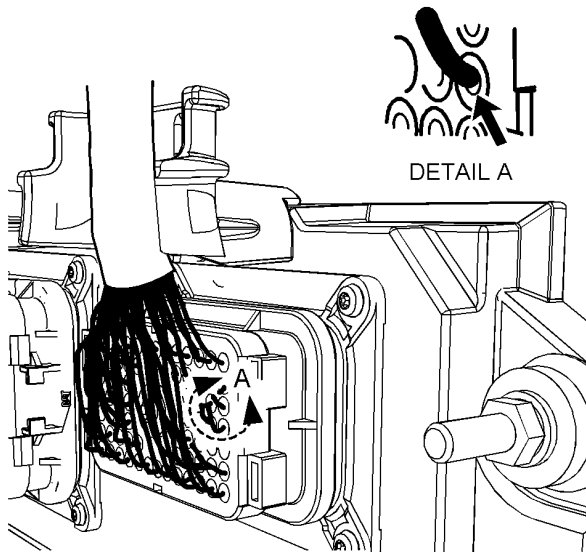


Illustration 84

g01131211

Detail A illustrates the **incorrect** angle of wire entry into the connector. The wire should enter the connector at a perpendicular angle. (typical example)

- a. Inspect all wiring harnesses. Ensure that the routing of the wiring harness allows the wires to enter the face of each connector at a perpendicular angle. Otherwise, the wire will deform the seal bore. Refer to Illustration 84 . deforming the seal bore will create a path for the entrance of moisture. Verify that the seals for

the wires are sealing correctly.

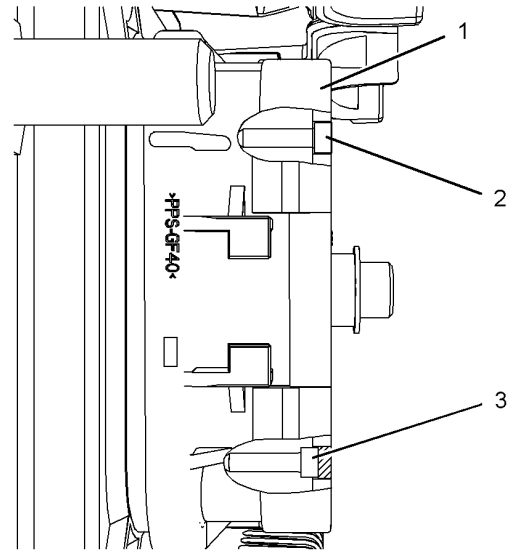


Illustration 85

g01131276

Diagram for the installation of a connector plug (typical example)

- (1) Electronic Control Module (ECM) connector
- (2) Correctly inserted plug
- (3) Incorrectly inserted plug

- b. Ensure that the sealing plugs are in place. If any of the plugs are missing, replace the plug. Ensure that the plugs are inserted correctly into the connector. Refer to Illustration 85 .

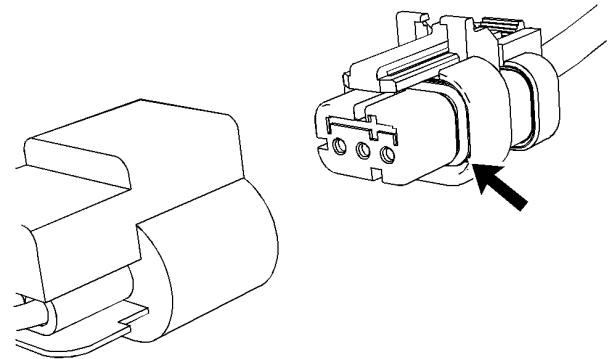


Illustration 86

g01131019

Seal for a three-pin connector (typical example)

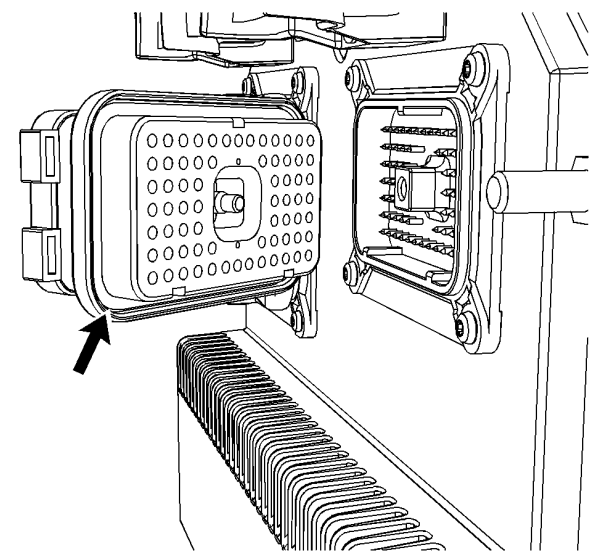


Illustration 87

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: Some minor seal abrasion on connector seals is normal. Minor seal abrasion will not allow the entry of moisture.

If moisture or corrosion is evident in the connector, the source of the moisture entry must be found. The source of the moisture entry must then 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 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 the wiring harness fasteners to verify that the harness is properly secured. Also check all the fasteners to verify that the harness is not compressed. Pull back the harness sleeves 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.

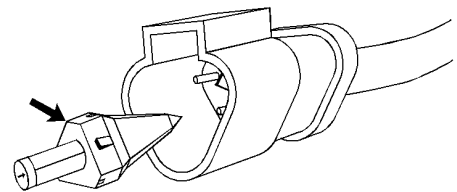


Illustration 88

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.

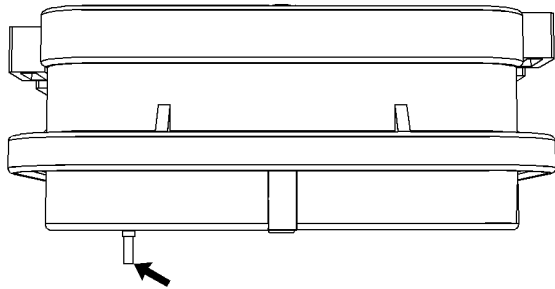


Illustration 89 g01131604

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 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.

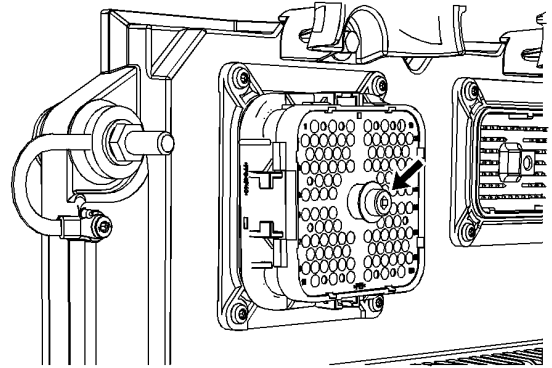


Illustration 90 g01132827

Allen head screw for the 120-pin ECM connector (typical example)

- b. Torque the allen head bolt for the 120-pin ECM connector to $7.0 \pm 0.5 \text{ N}\cdot\text{m}$ ($60 \pm 4 \text{ lb in}$).

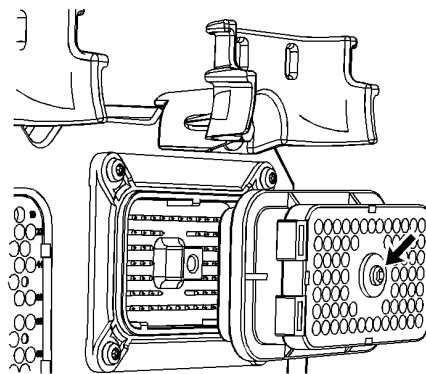


Illustration 91 g01132849

Allen head screw for the 70-pin ECM connector (typical example)

- c. Torque the allen head screw for the 70-pin ECM connector to $6.0 + 1.5 - 1.0 \text{ N}\cdot\text{m}$ ($55 + 13 - 9 \text{ lb in}$).

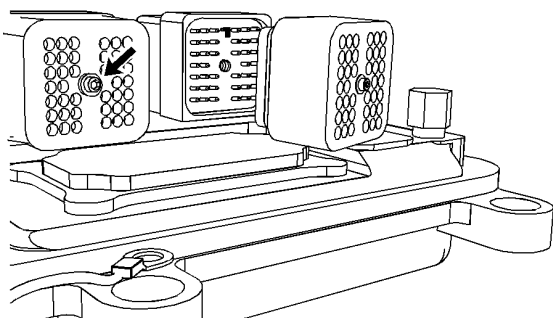


Illustration 92

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.

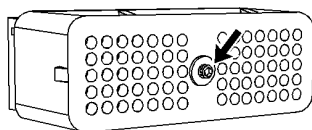
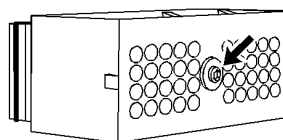


Illustration 93

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 $2.25 \pm 0.25 \text{ N}\cdot\text{m}$ ($20 \pm 2 \text{ lb in}$).

9. Perform the Wiggle Test on the Cat ET

- a. Select the "Wiggle Test" from the diagnostic tests on Cat ET.
- b. Choose the appropriate group of parameters to monitor.
- c. Press the "Start" button. Wiggle the wiring harness to reproduce intermittent faults.

- d. If an intermittent fault exists, the status will be highlighted and an audible beep will be heard.

i02609106

Cooling Fan - Calibrate

SMCS Code: 1356-524

Use this procedure if the diagnostic code in Table 48 is active.

Table 48

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
1551-13 Engine Demand Fan System calibration required	A calibration of the fan system is needed.	The code is logged.

The Electronic Control Module (ECM) supplies current to the engine fan control solenoid. The engine fan control solenoid controls the pressure to the fan pump by allowing oil to bypass the fan pump. The fan pump drives the fan. In order for the ECM to control the fan speed accurately, the ECM must determine the relationship between the current to the engine fan control solenoid and the actual fan speed. Caterpillar Electronic Technician (ET) enables the user to manually calibrate the current to a known fan speed.

Note: The ECM will use a nominal current to drive the engine fan control solenoid on the initial calibration. The ECM uses the last calibrated value as the starting point on subsequent calibrations.

1. Select the "Service" tab and select "Calibrations" .
Start the "Fan Calibration" .
2. Meet the required conditions in order to proceed with the calibration. Follow the directions that are provided on Cat ET. Proceed by pressing the "Next" button.
3. Measure actual fan speed with a 9U - 7400 Multitach Tool Gp.
 - a. If actual fan speed matches the fan speed on Cat ET, press the "Next" button.
 - b. If actual fan speed does not match the fan speed on Cat ET, the current must be decremented in order to increase fan speed or the current must be incremented in order to decrease fan speed.
4. When actual fan speed matches the fan speed on Cat ET, the calibration is complete. Follow the directions that are provided on Cat ET.

i06736793

Timing - Calibrate

SMCS Code: 1000-524; 1900-524; 1912-524

Use this procedure if the diagnostic code in Table 49 is active.

Note: Step 1 through 3 are required only if instructed by Cat® Electronic Technician (Cat ET) to install the transducer (timing probe).

Table 49

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
261-11 Engine Timing Offset fault	The wiring to the sensors has the wrong polarity.	The code is logged.
261-13 Engine Timing Calibration calibration required	A timing calibration is required for a new engine, replacing an Electronic Control Module (ECM) that fails to communicate or following work on the front gear train, the camshaft, or the crankshaft.	The code is logged.

If a 261-11 diagnostic code is active, verify that the wiring is installed correctly to the engine speed/timing sensors.

The ECM has the ability to calibrate the mechanical differences between the Top Center (TC) of the flywheel and the TC of the timing gear on the camshaft. A magnetic transducer signals the TC of the flywheel to the ECM when a notch on a counterweight passes by the transducer. The engine speed/timing sensor signals the TC of the timing gear to the ECM. Any offset between the TC of the flywheel and the TC of the timing gear is stored into the memory of the ECM.

Note: A timing calibration will not increase the available engine power.

Table 50 lists the special tools that are required to perform this procedure.

Table 50

Required Special Tools	
Part Number	Description
7X-1171	Transducer Adapter
6V-2197	Transducer
7X-1695	Cable As
170-3519	Harness ⁽¹⁾

⁽¹⁾ This item is not required if the engine harness has a connector for timing calibration.

1. Install the Transducer Adapter.

- Remove the electrical power from the ECM.
- Use the appropriate engine turning tool to put either the No. 1 piston or the No. 6 piston at top center. Refer to the Systems Operation/Testing and Adjusting.
- Refer to Table 51 . After the top center position has been located, rotate the crankshaft for the number of degrees that is applicable to your engine model. Be sure to rotate the crankshaft in the direction of rotation that is specified in the Table.

Table 51

Crankshaft Rotation		
Engine Model	Number of Degrees	Direction of Rotation
C7	100	Normal Rotation
C-9	85	Normal Rotation
C-10	60	Opposite Normal Rotation
C11	75	Normal Rotation
C-12	60	Opposite Normal Rotation
C13	75	Normal Rotation
C-15	60	Opposite Normal Rotation
C15	60	Opposite Normal Rotation
C-16	60	Opposite Normal Rotation
C18	30	Opposite Normal Rotation

- Refer to Table 52 . Locate the engine's timing calibration port.

Table 52

Location of the Timing Calibration Port		
Engine Model	Crankshaft Counterweight	Engine Location
C7	3	Left Side
C-9	3	Left Side
C-10	8	Right Side
C11	8	Left Side
C-12	8	Right Side
C13	8	Left Side
C-15	2	Left Side
C15	2	Left Side
C-16	2	Left Side
C18	2	Left Side

- Remove the plug from the timing calibration port.

- f. Thread the transducer adapter into the port.

Continue to the next test step.

2. Install the Transducer.

NOTICE

If the crankshaft is not in the correct position when the transducer is installed, the transducer will be damaged when the engine is started.

- Apply clean engine oil to a 2D - 6392 O-Ring Seal. Install the O-ring seal on the end of the 6V - 2197 Transducer.
- Push the transducer through the transducer adapter until the transducer contacts the crankshaft counterweight.
- Withdraw the transducer 1.0 mm (0.04 inch) and hand tighten the nut on the adapter sleeve to secure the transducer. Move the O-ring seal against the adapter.

Continue to the next test step.

3. Connect the 7X - 1695 Cable As.

- If the engine harness is equipped with a connector for timing calibration, connect the 7X - 1695 Cable As to the connector for timing calibration and to the transducer.
- If the engine harness is not equipped with a connector for timing calibration, perform the following procedure:

Disconnect the P2 connector from the ECM.

Determine the number of terminals on the P2 connector.

Refer to Table 53 . Remove the sealing plugs from the appropriate terminals. Do not discard the sealing plugs. The sealing plugs may be reinstalled when the timing calibration is complete.

Table 53

P2 Locations for Connection of the 7X - 1695 Cable As		
Wire Color	70-pin Connector	120-pin Connector
White	22	26
Yellow	23	36

Install the WH(White)wire of the 170 - 3519 Harness into the appropriate location.

Install the YL(Yellow)wire of the 170 - 3519 Harness into the appropriate location. Disregard the pin-outs on the label of the harness.

Note: Ensure that each wire is installed into the correct location. The timing calibration will not be successful if the wires are installed incorrectly.

Connect the J2/P2 connectors. Tighten the allen head screw on the P2 connector to the appropriate torque. Refer to Troubleshooting, "Electrical Connectors - Inspect" for the correct torque value.

Connect the 7X - 1695 Cable As to the connector for timing calibration and to the transducer.

Continue to the next test step.

4. Start the Engine and Check for Diagnostic Codes.

- Connect Caterpillar Electronic Technician (ET) to the service tool connector. Refer to Troubleshooting, "Electronic Service Tools".
- Start the engine and run the engine until the engine is at the normal operating temperature.
- Check for active diagnostic codes. Wait at least 30 seconds in order for the codes to become active.

The engine must not have any active diagnostic codes during the timing calibration except for a 261-13 Engine Timing Calibration required.

5. Calibrate the Timing.

- Set the engine speed to 1100 ± 50 rpm. The engine speed must be steady within this rpm range in order for the calibration to be successful.
- After the engine has warmed up, access the "Timing Calibration" screen on the Cat ET. Access the following display screens in order:
 - Service
 - Calibrations
 - Timing Calibration
- To calibrate the timing, select "Continue" on Cat ET. Wait until Cat ET indicates that the timing is calibrated.

Perform the following procedure if Cat ET indicates that the timing is calibrated:

Set the engine speed to low idle.

Note: Disconnect the 7X - 1695 Cable As before you exit the "Timing Calibration" screen. Otherwise, diagnostic codes may be activated.

Disconnect the 7X - 1695 Cable As.

Exit the "Timing Calibration" screen on Cat ET.

Remove the electrical power from the ECM.

Remove the transducer and remove the adapter.

Install the plug into the timing calibration port.

If you installed a 170 - 3519 Harness, you may remove the harness or you may permanently install the harness for future use. If you remove the harness, install the sealing plugs into the unused cavities of the P2 connector. Otherwise, moisture and debris will enter the connector.

If you choose to permanently install the harness, fasten the harness to the existing engine wiring harness with cable ties. Also, install a 3E - 3364 Receptacle and two 8T - 8737 Seal Plugs on the P400 timing calibration probe connector to prevent moisture and debris from entering the connector.

The following conditions can cause the timing calibration to fail:

- The crankshaft and camshaft gears have been reassembled incorrectly.
- The timing calibration probe is not installed correctly.
- The engine speed is not correct and the engine speed is unstable. If the engine speed is unstable, refer to Troubleshooting, "Engine Misfires, Runs Rough or Is Unstable".
- There is a problem with the transducer or with the cables. Obtain a new transducer and/or a new cable and repeat the timing calibration.

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