



# Troubleshooting

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## **3516B and 3516B High Displacement Engines for Caterpillar Built Machines**

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FDB1-Up (Machine)  
8WM1-Up (Engine)  
7TR1-Up (Engine)

**For use with 793D Off-Highway Trucks/Tractors**

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## Important Safety Information

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

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

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

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

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



The meaning of this safety alert symbol is as follows:

**Attention! Become Alert! Your Safety is Involved.**

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

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

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

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



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

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

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# Troubleshooting Section

## Electronic Troubleshooting

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### System Overview

**SMCS Code:** 1901-038; 1924

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 make decisions on control of 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 personality module 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 measured by the engine speed/timing signal.

#### 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 following conditions: desired engine rpm and load. The ECM detects the top center of each cylinder. The ECM sends an injection signal at the desired time.

#### Cold Cylinder Cutout

During a cold start or extended periods at low idle, the engine ECM will automatically turn off one unit injector at a time in order to determine if the cylinder is firing. If the ECM determines that the cylinder is not firing, the ECM turns off the unit injector. If the ECM determines that the cylinder is firing, the ECM turns on the unit injector. This strategy improves engine starting. This strategy reduces the following: white smoke, the use of ether injection, and warm-up time.

#### Cold Mode Operation

Cold mode controls fuel injection timing when the engine is cold. When the engine is cold, controlling the fuel injection timing reduces the possibility of engine damage. When the engine is cold, controlling the fuel injection timing helps minimize white smoke.

Cold mode is activated whenever the engine coolant temperature is below 70 °C (158 °F). Cold mode remains active until the engine coolant temperature is warmer than 73 °C (163 °F).

#### 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.

## “Multi-Torque” and “Dual Horsepower” Selection

This feature permits the use of different torque maps for different transmissions. The feature reduces the number of software part numbers that are required for operation. The feature protects the transmission from excessive torque.

The selection of “Multi-Torque” and “Dual Horsepower” is available through Caterpillar Electronic Technician (ET). If you select “Dual Horsepower”, the engine ECM will use the low power 1611 kW (2160 hp) torque map for all transmission gears. If you select “Multi-Torque”, the engine ECM will request the serial number of the transmission from the transmission ECM.

**Note: If the transmission ECM does not communicate with the engine ECM, the engine ECM will use the default 1611 kW (2160 hp) torque map. You may think that the low power is an engine problem. The problem is really the failure of communications between the transmission ECM and the engine ECM. Cat ET will continue to display “Multi-torque” on the Cat ET configuration screen in this circumstance. Power down the machine and then restart the machine. The ECM will then reset the display to the default “Dual Horsepower” configuration.**

If the transmission ECM responds with the 793C transmission, then the engine ECM will use the 1611 kW (2160 hp) torque map for the “CONVERTER DRIVE”. In the “DIRECT DRIVE” gears 1 through 5, the engine ECM will use a 1716 kW (2300 hp) torque map. In the “DIRECT DRIVE” gear 6, the engine ECM will use a second 1716 kW (2300 hp) torque map with a different torque shade.

## Block Diagram of Electronic Governor

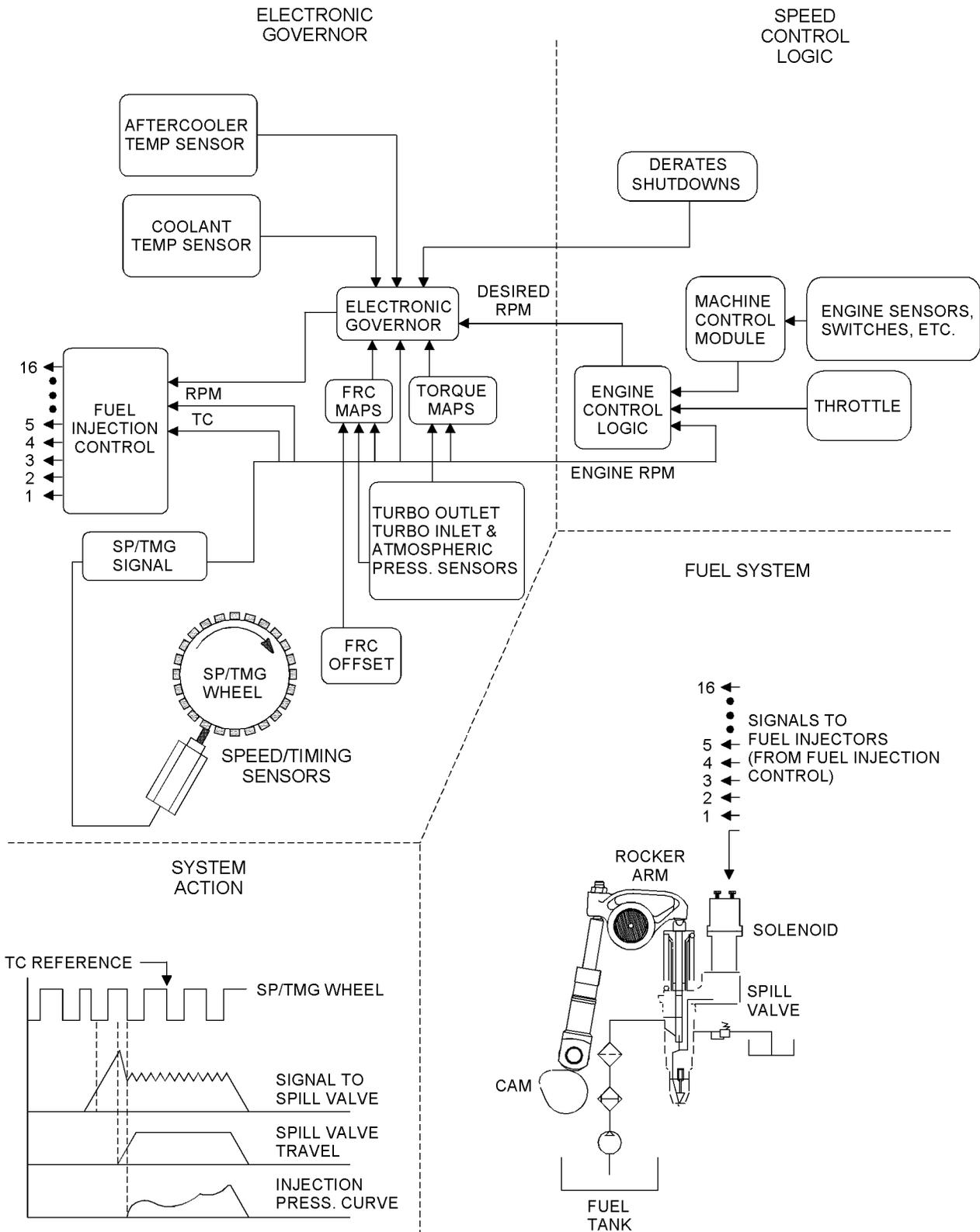


Illustration 1

Typical schematic

### Engine Wiring Diagram

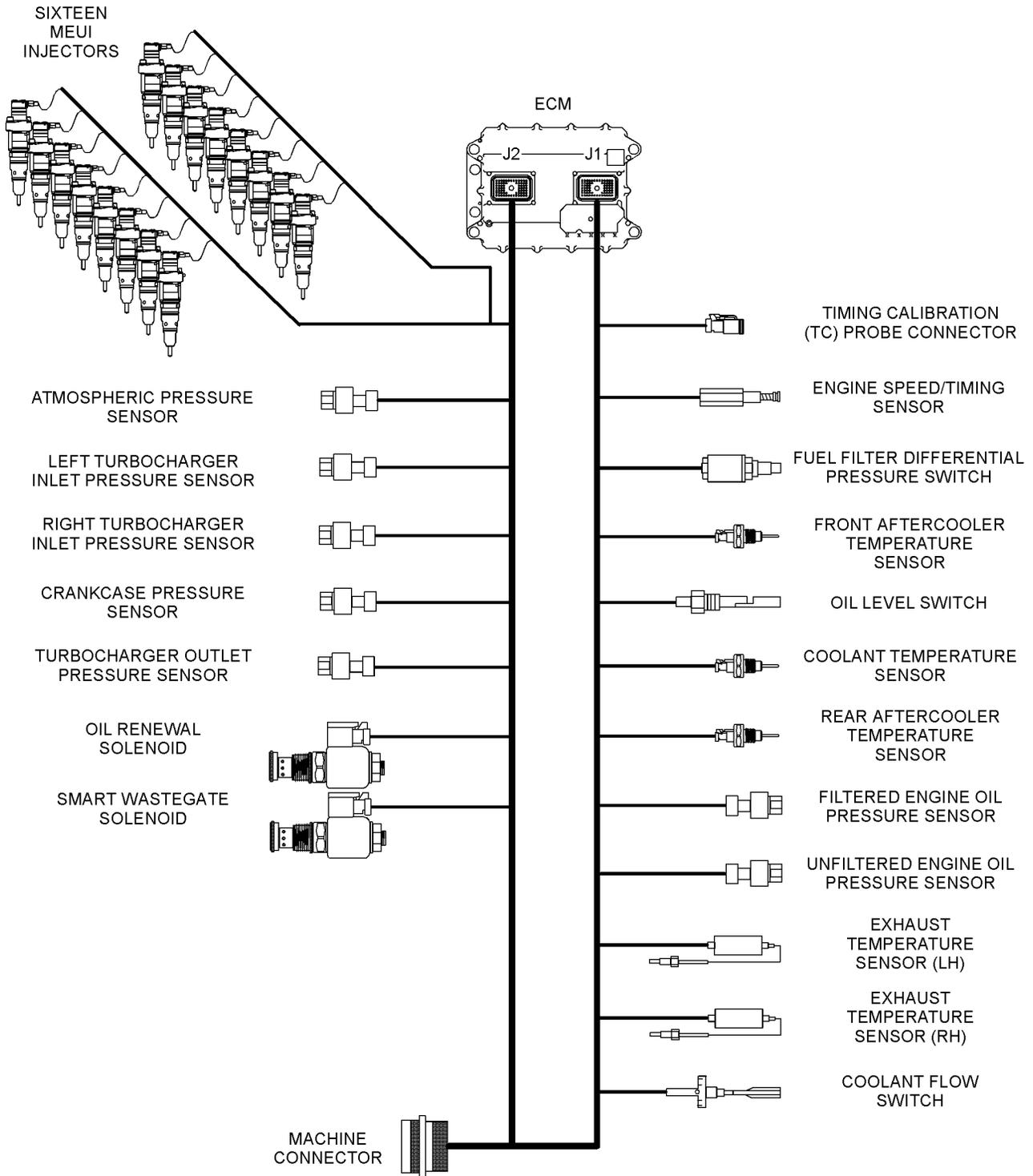


Illustration 2  
Typical schematic

### Engine Wiring Diagram

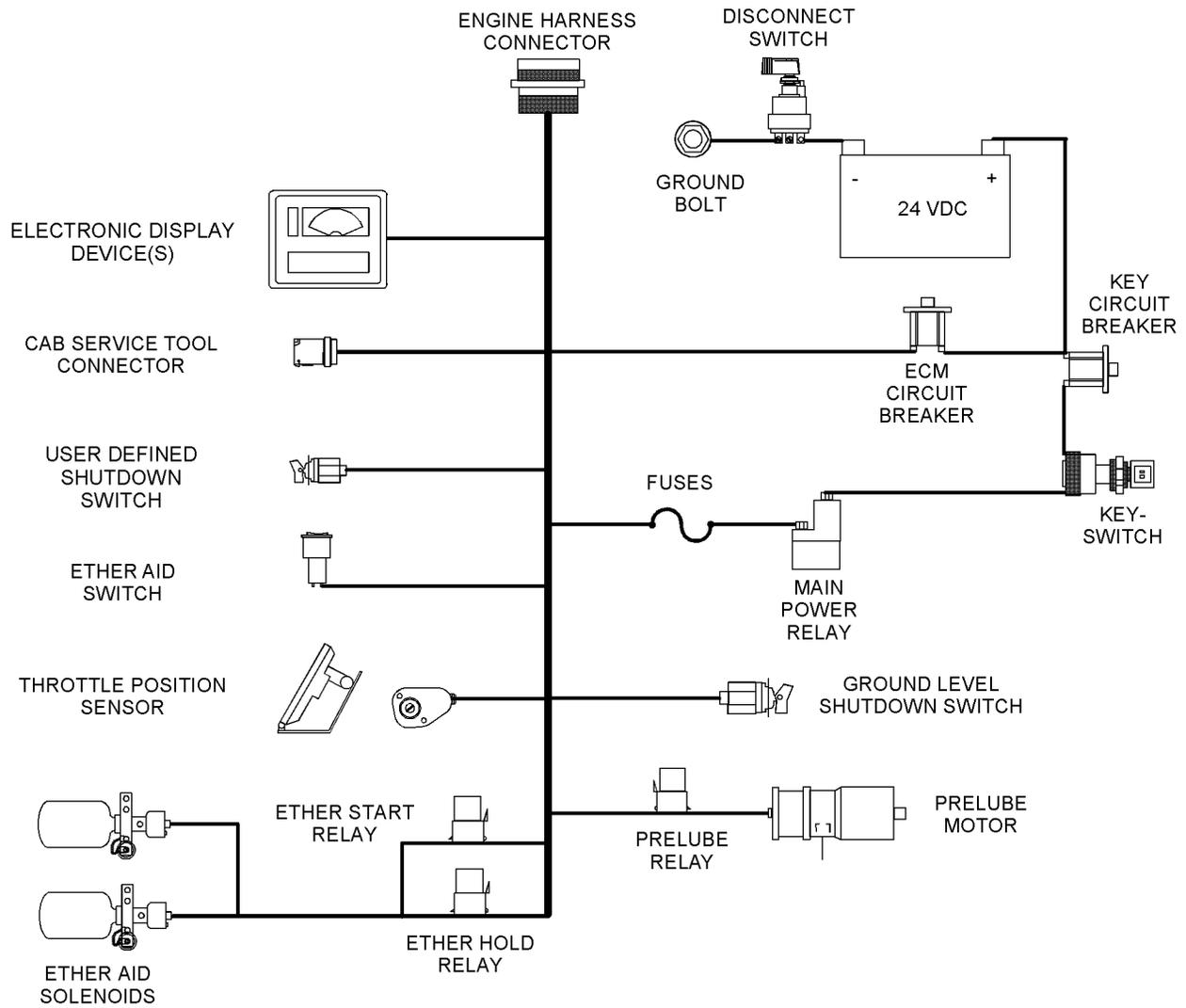


Illustration 3  
Typical schematic

## Location of the 3516B Engine Sensors

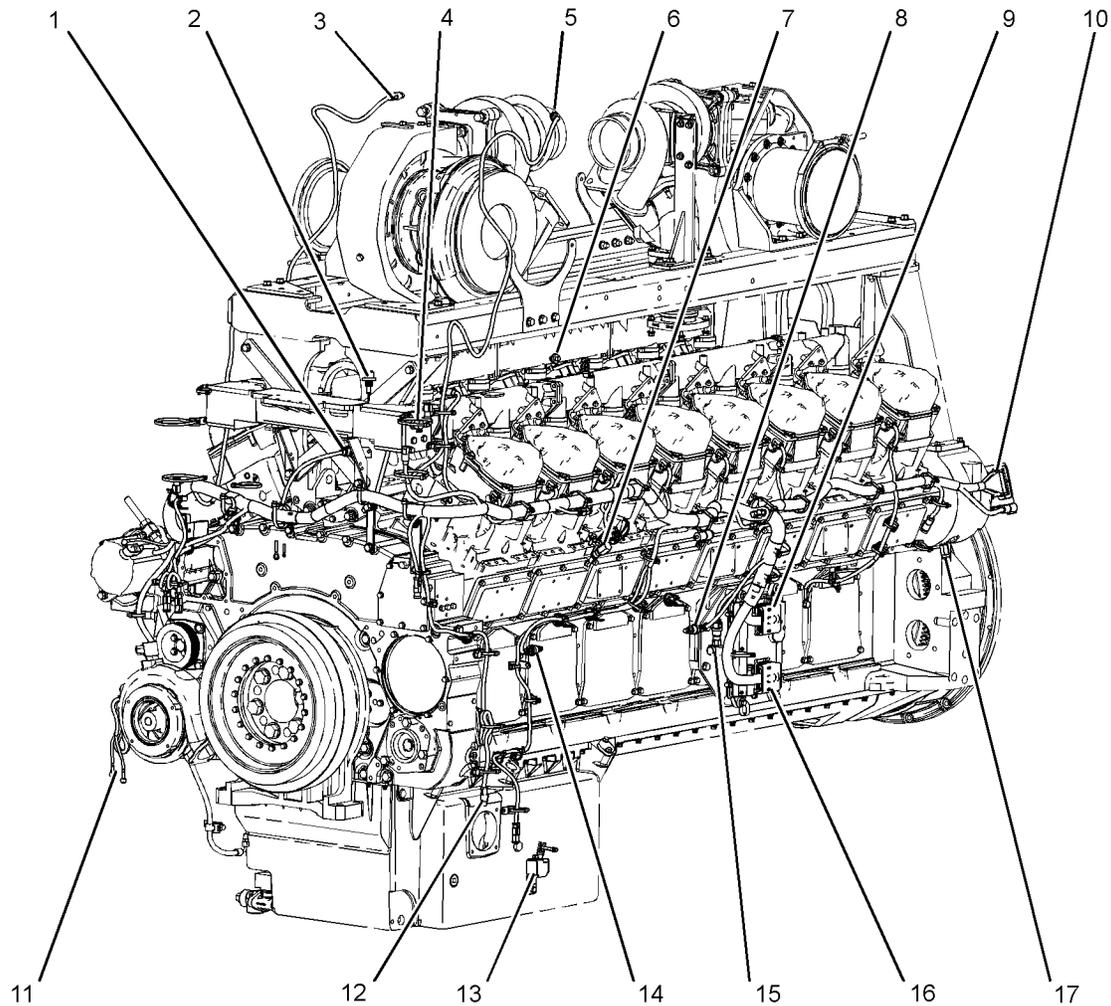


Illustration 4

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Front and Left view

- |  |  |  |
|--|--|--|
| (1) Turbocharger compressor outlet pressure sensor (boost) | (5) Left turbocharger compressor inlet pressure sensor | (12) Connector for the remote shutdown     |
| (2) Aftercooler temperature sensor (front)                 | (7) Fuel filter differential pressure switch           | (13) Low oil level switch                  |
| (3) Right turbocharger compressor inlet pressure sensor    | (8) Filtered engine oil pressure sensor                | (14) Unfiltered engine oil pressure sensor |
| (4) Coolant temperature sensor                             | (9) ECM connector J1/P1                                | (15) Atmospheric pressure sensor           |
| (6) Left exhaust temperature sensor                        | (10) Machine connector                                 | (16) ECM connector J2/P2                   |
|  | (11) Connection for the pre-lube                       | (17) Engine speed/timing sensor            |

## Location of the 3516B Engine Sensors

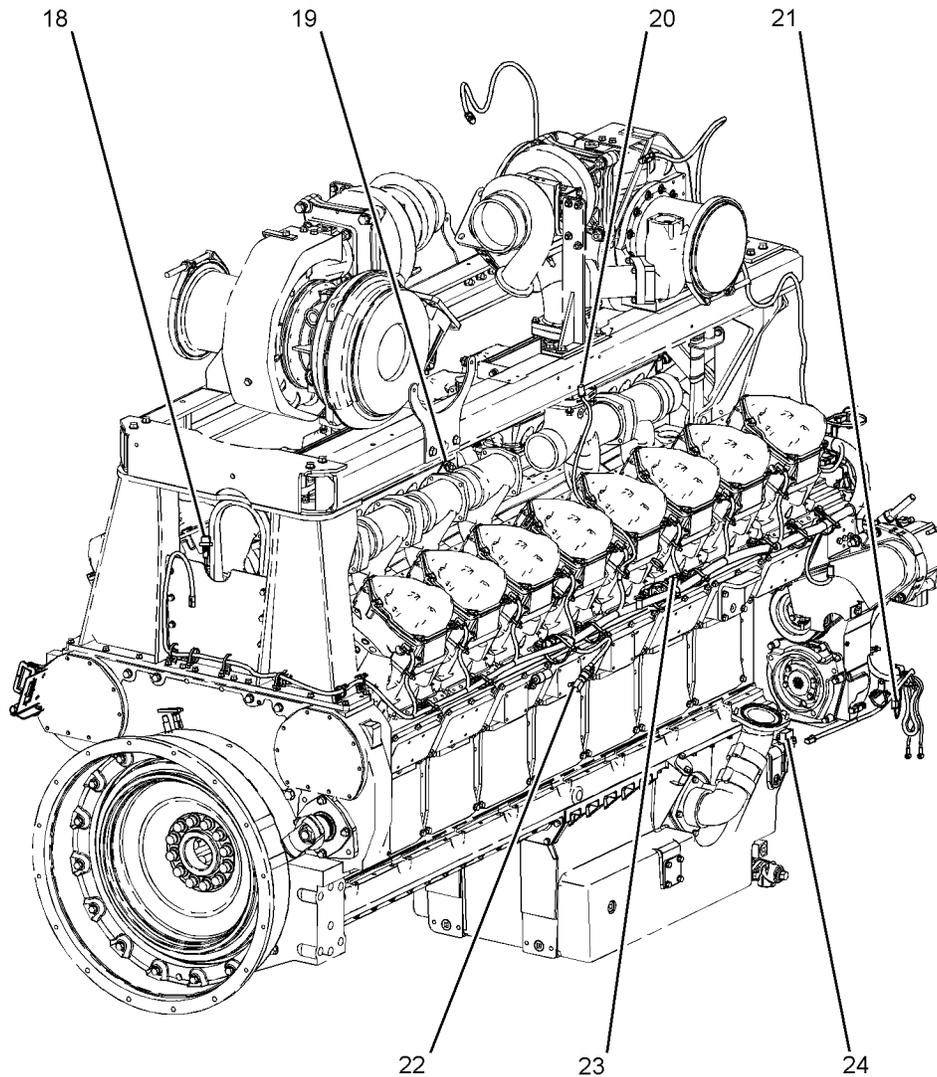


Illustration 5

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Rear and Right view

(18) Aftercooler temperature sensor (rear)  
(19) Right exhaust temperature sensor  
(20) Connector for the wastegate solenoid  
(21) Timing calibration plug

(22) Crankcase pressure sensor  
(23) Connector for the engine oil renewal  
solenoid  
(24) Coolant flow switch

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## Self-Diagnostics

**SMCS Code:** 1901-038

### Diagnostic Codes

The engine's Electronic Control Module (ECM) has the ability to monitor the circuitry to the ECM and the circuitry from the ECM to 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 or an open in the engine's wiring or in an electrical component of the engine.

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

Codes can have two different states:

- Active
- Logged

### Active Codes

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

- Troubleshooting, "Diagnostic Code List"
- Troubleshooting, "Event Code List"

### Logged Codes

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

Logged codes may not indicate that a repair is needed. The problem may have been temporary. Logged codes may be useful to help troubleshoot intermittent problems. Logged codes can also be used to review the performance of the engine and of the electronic system.

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# Electrical Connectors and Functions

SMCS Code: 1408-038

## Engine Electronic Control Module (ECM)

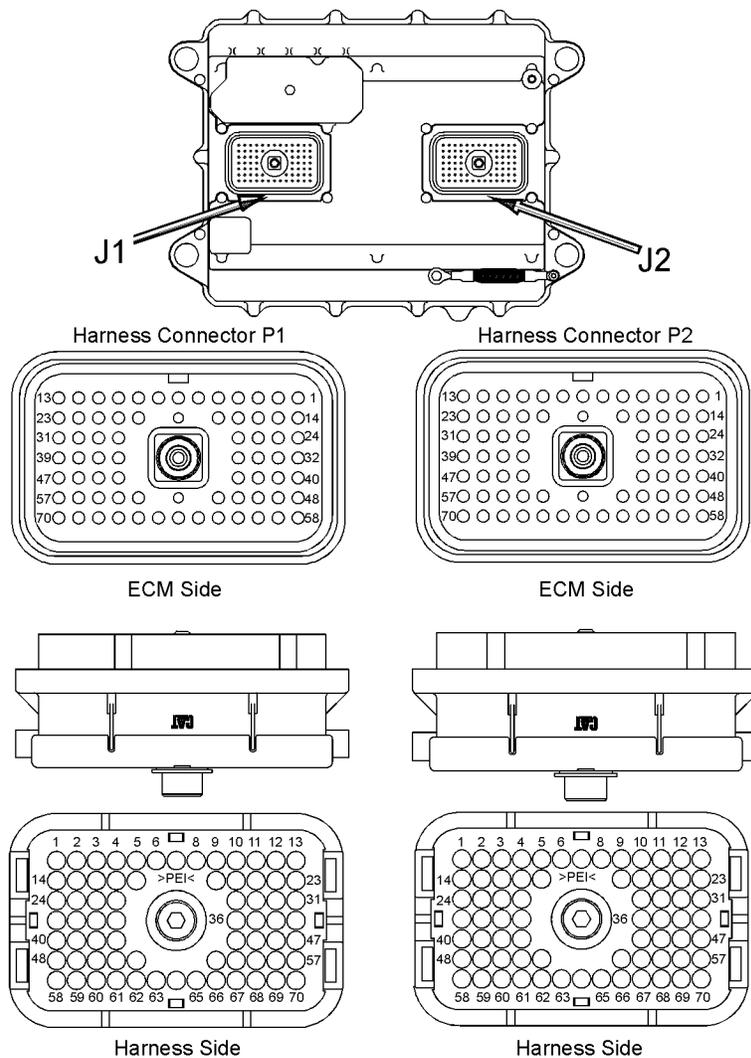
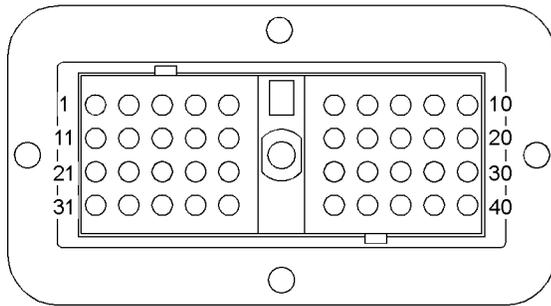


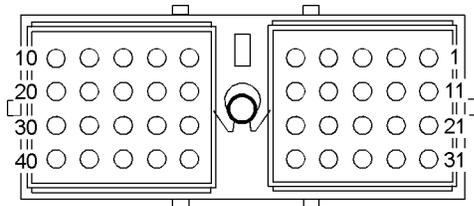
Illustration 6  
Connectors for the ECM

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## Machine Connector



SOCKET TERMINAL SIDE



PLUG TERMINAL SIDE

Illustration 7  
40 pin machine connector

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## Service Tool Connector for Cat ET

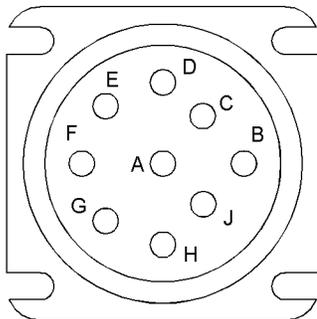


Illustration 8

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## Sensor Connectors

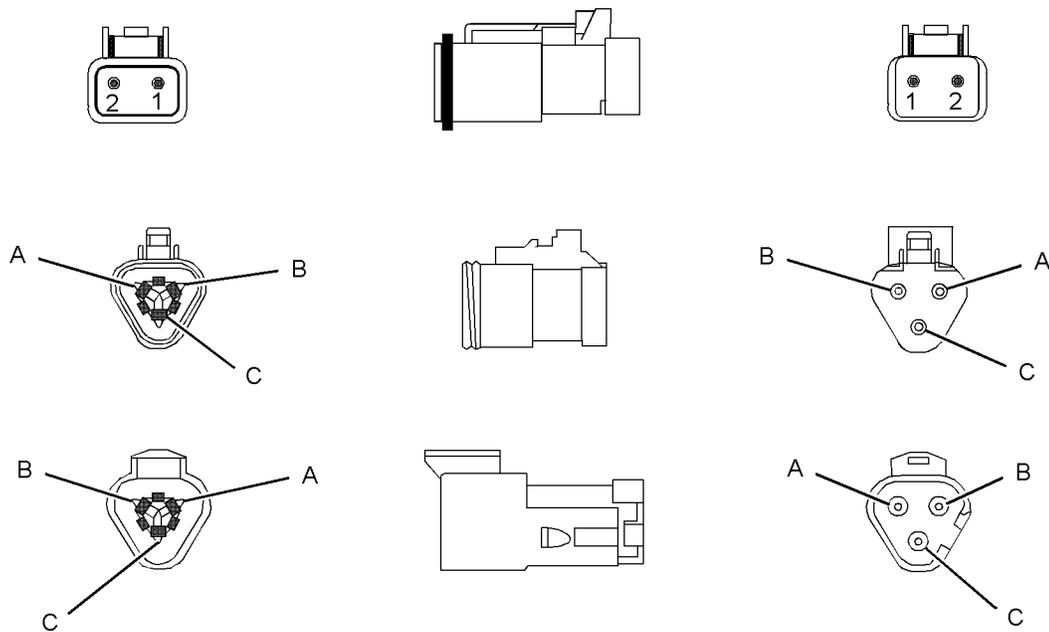


Illustration 9  
Typical engine connectors

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## Electronic Service Tools

**SMCS Code:** 1901-038

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

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

## Required Service Tools

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

Table 1

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

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

## Optional Service Tools

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

Table 2

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

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

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

## Caterpillar Electronic Technician (ET)

Cat ET can display the following information:

- Parameters

- Event codes
- Diagnostic codes
- Engine configuration

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

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

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

Table 3

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

<sup>(1)</sup> The 7X-1700 Communication Adapter Gp may also be used.

<sup>(2)</sup> The 237-7547 Adapter Cable As is required to connect to the USB port on computers that are not equipped with a RS232 serial port.

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

## Connecting Cat ET and the Communication Adapter II

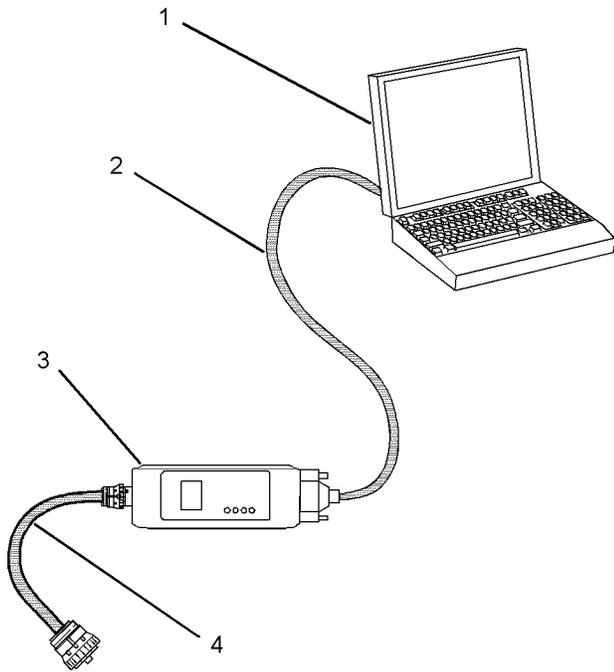


Illustration 10

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

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

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

1. Remove the electrical power to the ECM.
2. Connect cable (2) between the "COMPUTER" end of communication adapter (3) and the RS232 serial port of PC (1).

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

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

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

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## Diagnostic Code List

**SMCS Code:** 1901

### Cross-Reference Information for Diagnostic Codes

Table 4 is a list of the diagnostic codes for the engine. The diagnostic codes are cross-referenced with the appropriate functional test or the procedure that can be used to troubleshoot the code.

Further explanations of diagnostic codes are described after Table 4.

Table 4

<b>Cross-Reference from “MID-CID-FMI Code” to Functional Test or Procedure</b>	
<b>“MID-CID-FMI Code”</b>	<b>Functional Test or Procedure</b>
MID 0036 - CID 0001 - FMI 05 Cylinder #1 Injector open circuit	“Injector Solenoids”
MID 0036 - CID 0001 - FMI 06 Cylinder #1 Injector short	“Injector Solenoids”
MID 0036 - CID 0002 - FMI 05 Cylinder #2 Injector open circuit	“Injector Solenoids”
MID 0036 - CID 0002 - FMI 06 Cylinder #2 Injector short	“Injector Solenoids”
MID 0036 - CID 0003 - FMI 05 Cylinder #3 Injector open circuit	“Injector Solenoids”
MID 0036 - CID 0003 - FMI 06 Cylinder #3 Injector short	“Injector Solenoids”
MID 0036 - CID 0004 - FMI 05 Cylinder #4 Injector open circuit	“Injector Solenoids”
MID 0036 - CID 0004 - FMI 06 Cylinder #4 Injector short	“Injector Solenoids”
MID 0036 - CID 0005 - FMI 05 Cylinder #5 Injector open circuit	“Injector Solenoids”
MID 0036 - CID 0005 - FMI 06 Cylinder #5 Injector short	“Injector Solenoids”
MID 0036 - CID 0006 - FMI 05 Cylinder #6 Injector open circuit	“Injector Solenoids”
MID 0036 - CID 0006 - FMI 06 Cylinder #6 Injector short	“Injector Solenoids”
MID 0036 - CID 0007 - FMI 05 Cylinder #7 Injector open circuit	“Injector Solenoids”
MID 0036 - CID 0007 - FMI 06 Cylinder #7 Injector short	“Injector Solenoids”
MID 0036 - CID 0008 - FMI 05 Cylinder #8 Injector open circuit	“Injector Solenoids”
MID 0036 - CID 0008 - FMI 06 Cylinder #8 Injector short	“Injector Solenoids”
MID 0036 - CID 0009 - FMI 05 Cylinder #9 Injector open circuit	“Injector Solenoids”
MID 0036 - CID 0009 - FMI 06 Cylinder #9 Injector short	“Injector Solenoids”
MID 0036 - CID 0010 - FMI 05 Cylinder #10 Injector open circuit	“Injector Solenoids”
MID 0036 - CID 0010 - FMI 06 Cylinder #10 Injector short	“Injector Solenoids”
MID 0036 - CID 0011 - FMI 05 Cylinder #11 Injector open circuit	“Injector Solenoids”
MID 0036 - CID 0011 - FMI 06 Cylinder #11 Injector short	“Injector Solenoids”
MID 0036 - CID 0012 - FMI 05 Cylinder #12 Injector open circuit	“Injector Solenoids”
MID 0036 - CID 0012 - FMI 06 Cylinder #12 Injector short	“Injector Solenoids”
MID 0036 - CID 0013 - FMI 05 Cylinder #13 Injector open circuit	“Injector Solenoids”
MID 0036 - CID 0013 - FMI 06 Cylinder #13 Injector short	“Injector Solenoids”
MID 0036 - CID 0014 - FMI 05 Cylinder #14 Injector open circuit	“Injector Solenoids”
MID 0036 - CID 0014 - FMI 06 Cylinder #14 Injector short	“Injector Solenoids”
MID 0036 - CID 0015 - FMI 05 Cylinder #15 Injector open circuit	“Injector Solenoids”

(continued)

(Table 4, contd)

<b>Cross-Reference from "MID-CID-FMI Code" to Functional Test or Procedure</b>	
<b>"MID-CID-FMI Code"</b>	<b>Functional Test or Procedure</b>
MID 0036 - CID 0015 - FMI 06 Cylinder #15 Injector short	"Injector Solenoids"
MID 0036 - CID 0016 - FMI 05 Cylinder #16 Injector open circuit	"Injector Solenoids"
MID 0036 - CID 0016 - FMI 06 Cylinder #16 Injector short	"Injector Solenoids"
MID 0036 - CID 0091 - FMI 08 Throttle Position signal abnormal	"Throttle Position Sensor"
MID 0036 - CID 0101 - FMI 03 Crankcase Pressure open/short to +batt	"Analog Sensor (Active)"
MID 0036 - CID 0101 - FMI 04 Crankcase Pressure short to ground	"Analog Sensor (Active)"
MID 0036 - CID 0110 - FMI 03 Engine Coolant Temperature open/short to +batt	"Analog Sensor (Active)"
MID 0036 - CID 0110 - FMI 04 Engine Coolant Temperature short to ground	"Analog Sensor (Active)"
MID 0036 - CID 0168 - FMI 01 System Voltage Low	"Electrical Power Supply"
MID 0036 - CID 0168 - FMI 02 Battery Voltage intermittent/erratic	"Electrical Power Supply"
MID 0036 - CID 0190 - FMI 08 Engine Speed signal abnormal	"Engine Speed/Timing Sensor"
MID 0036 - CID 0253 - FMI 11 Personality Module mechanical failure	"Flash Programming"
MID 0036 - CID 0261 - FMI 13 Engine Timing calibration required	"Engine Speed/Timing Sensor - Calibrate"
MID 0036 - CID 0262 - FMI 03 5 Volt Sensor DC Power Supply short to +batt	"Sensor Supply"
MID 0036 - CID 0262 - FMI 04 5 Volt Sensor DC Power Supply short to ground	"Sensor Supply"
MID 0036 - CID 0263 - FMI 03 Digital Sensor Supply short to +batt	"Sensor Supply"
MID 0036 - CID 0263 - FMI 04 Digital Sensor Supply short to ground	"Sensor Supply"
MID 0036 - CID 0267 - FMI 02 Incorrect Engine Shutdown Switch inputs	"Ground Level Shutdown Switch"
MID 0036 - CID 0268 - FMI 02 Check Programmable Parameters	"System Configuration Parameters"
MID 0036 - CID 0273 - FMI 03 Turbo Outlet Pressure open/short to +batt	"Analog Sensor (Active)"
MID 0036 - CID 0273 - FMI 04 Turbo Outlet Pressure short to ground	"Analog Sensor (Active)"
MID 0036 - CID 0274 - FMI 03 Atmospheric Pressure open/short to +batt	"Analog Sensor (Active)"
MID 0036 - CID 0274 - FMI 04 Atmospheric Pressure short to ground	"Analog Sensor (Active)"
MID 0036 - CID 0275 - FMI 03 Right Turbo Inlet Pressure open/short to +batt	"Analog Sensor (Active)"

(continued)

(Table 4, contd)

<b>Cross-Reference from “MID-CID-FMI Code” to Functional Test or Procedure</b>	
<b>“MID-CID-FMI Code”</b>	<b>Functional Test or Procedure</b>
MID 0036 - CID 0275 - FMI 04 Right Turbo Inlet Pressure short to ground	“Analog Sensor (Active)”
MID 0036 - CID 0276 - FMI 03 Left Turbo Inlet Pressure open/short to +batt	“Analog Sensor (Active)”
MID 0036 - CID 0276 - FMI 04 Left Turbo Inlet Pressure short to ground	“Analog Sensor (Active)”
MID 0036 - CID 0279 - FMI 03 Aftercooler Temperature open/short to +batt	“Analog Sensor (Active)”
MID 0036 - CID 0279 - FMI 04 Aftercooler Temperature short to ground	“Analog Sensor (Active)”
MID 0036 - CID 0296 - FMI 09 Unable to communicate with Transmission ECM	“Cat Data Link”
MID 0036 - CID 0338 - FMI 05 Pre-lube Relay open circuit	“Prelubrication System”
MID 0036 - CID 0338 - FMI 06 Pre-lube Relay short to ground	“Prelubrication System”
MID 0036 - CID 0526 - FMI 05 Turbo Wastegate Drive current low	“Wastegate Solenoid”
MID 0036 - CID 0526 - FMI 06 Turbo Wastegate Drive current high	“Wastegate Solenoid”
MID 0036 - CID 0542 - FMI 03 Unfiltered Engine Oil Pressure open/short to +batt	“Analog Sensor (Active)”
MID 0036 - CID 0542 - FMI 04 Unfiltered Engine Oil Pressure short to ground	“Analog Sensor (Active)”
MID 0036 - CID 0543 - FMI 03 Filtered Engine Oil Pressure open/short to +batt	“Analog Sensor (Active)”
MID 0036 - CID 0543 - FMI 04 Filtered Engine Oil Pressure short to ground	“Analog Sensor (Active)”
MID 0036 - CID 0545 - FMI 05 Ether Start Relay open/short to +batt	“Ether Injection System”
MID 0036 - CID 0545 - FMI 06 Ether Start Relay short to ground	“Ether Injection System”
MID 0036 - CID 0546 - FMI 05 Ether Hold Relay open/short to ground	“Ether Injection System”
MID 0036 - CID 0546 - FMI 06 Ether Hold Relay short to +batt	“Ether Injection System”
MID 0036 - CID 0569 - FMI 05 Oil Renewal Solenoid open circuit	“Engine Oil Renewal Solenoid”
MID 0036 - CID 0569 - FMI 06 Oil Renewal Solenoid short to ground	“Engine Oil Renewal Solenoid”
MID 0036 - CID 0800 - FMI 09 Unable to communicate with VIMS	“Cat Data Link”
MID 0036 - CID 0827 - FMI 08 Left Exhaust Temperature signal abnormal	“Pulse Width Modulated Sensor”
MID 0036 - CID 0828 - FMI 08 Right Exhaust Temperature signal abnormal	“Pulse Width Modulated Sensor”
MID 0036 - CID 0829 - FMI 03 Rear Aftercool Temperature open/short to +batt	“Analog Sensor (Active)”

(continued)

(Table 4, contd)

Cross-Reference from "MID-CID-FMI Code" to Functional Test or Procedure	
"MID-CID-FMI Code"	Functional Test or Procedure
MID 0036 - CID 0829 - FMI 04 Rear Aftercool Temperature short to ground	"Analog Sensor (Active)"
MID 0036 - CID 1495 - FMI 02 Injector Trim Codes Not Programmed	"System Configuration Parameters"

## Diagnostic Codes

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

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

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

**Failure Mode Identifier (FMI)** – The FMI is a two digit code that indicates the type of failure. Refer to Table 5 for a complete list of the two digit codes. Refer to Table 5 for a description of the failure.

Table 5

FMI	Failure
00	Data is above the normal range.
01	Data is below the normal range.
02	Incorrect signal
03	Voltage is above the normal range.
04	Voltage is below the normal range.
05	Current is below the normal range.
06	Current is above the normal range.
08	Abnormal signal
09	Abnormal update
12	A device or a component failed.
13	A component is out of calibration.

Refer to Table 4 for a complete list of the diagnostic codes and the appropriate troubleshooting procedure.

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".

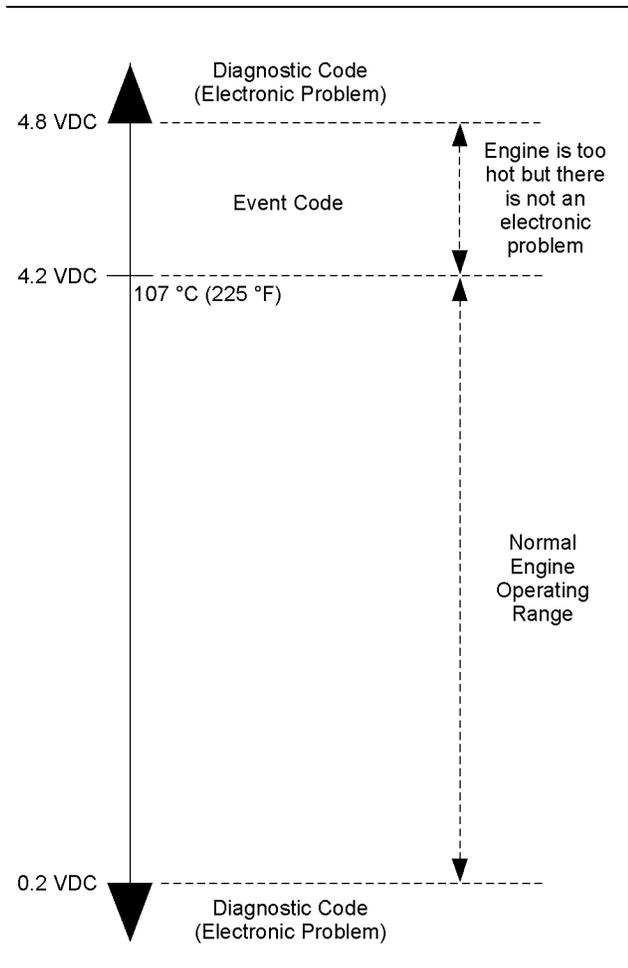


Illustration 11 g01117578  
Output voltage from a typical analog temperature sensor

Illustration 11 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 ranges in this graphic are 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.

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## Event Code List

**SMCS Code:** 1901

## Cross-Reference Information for Event Codes

Table 6 is a list of the event codes for the engine. The event codes are cross-referenced with the appropriate functional test or the 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 6.

Table 6

<b>Cross-Reference from Event Code to Troubleshooting Procedure</b>	
<b>Event Code</b>	<b>Troubleshooting Procedure</b>
E017 High Engine Coolant Temperature Warning	"Coolant Temperature Is Too High"
E021 High Exhaust Temperature Derate	"Exhaust Temperature Is Too High"
E035 Loss of Coolant Flow Warning	"Coolant Flow Switch"
E038 Low Engine Coolant Temperature Warning	"Coolant Temperature Is Too Low"
E072 Oil Level Low Mark	"Low Engine Oil Pressure"
E073 Oil Filter Differential Pressure High	"Low Engine Oil Pressure"
E074 Oil Filter Differential Pressure Very High	"Low Engine Oil Pressure"
E092 Boost Pressure Above Normal	"Boost Pressure Above Normal"
E093 Boost Pressure Below Normal	"Boost Pressure Below Normal"
E095 Fuel Filter Restriction Warning	"Fuel Filter Differential Pressure Switch"
E098 Engine Prelube Override	"Prelubrication System"
E100 Low Engine Oil Pressure Warning	"Low Engine Oil Pressure"
E101 High Crankcase Pressure Warning	"Crankcase Pressure (High)"
E190 Engine Overspeed Warning	"Engine Overspeed"
E265 User Defined Shutdown	"User Defined Shutdown Input"
E272 Inlet Air Restriction Warning	"Inlet Air Restriction"
E279 High Aftercooler Temperature Warning	"Coolant Temperature Is Too High"

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

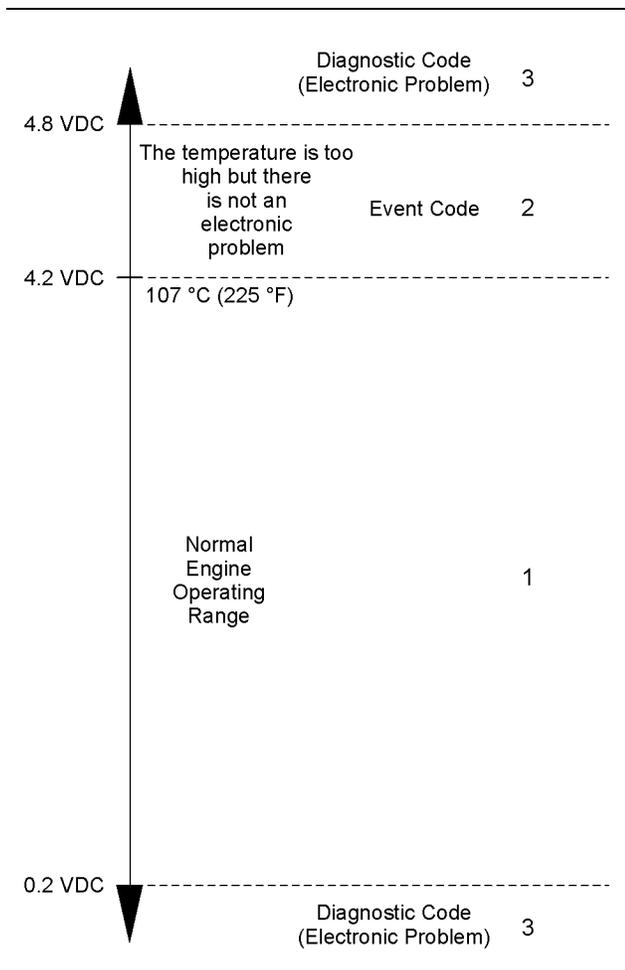


Illustration 12

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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 Code List" for additional information on diagnostic codes.

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

- E004 Engine Overspeed Shutdown

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

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

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

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

**Derate** – For this condition, the engine's Electronic Control Module (ECM) reduces the engine's power in order to help prevent possible engine damage.

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

## Logged Event Codes

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

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

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

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

## Clearing Event Codes

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

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

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

## Troubleshooting

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

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

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

If these steps do not resolve the problem, refer to Table 6 for the procedure to troubleshoot the event code.

## Trip Points for the Monitoring System

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

Table 7 contains the conditions that are monitored and the default trip points for each condition. Each condition has an associated parameter. The settings for each parameter can be viewed with Caterpillar Electronic Technician (ET). The trip points for some of the parameters may be adjustable with Cat ET.

Table 7

Trip Points for the Monitoring System								
Condition	Action	Delay Time in Seconds			Trip Point			Default State
		Min	Max	Default	Min	Max	Default	
E017 High Engine Coolant Temperature	Warning	N/A	N/A	5	N/A	N/A	102 °C (216 °F)	On
E021 High Exhaust Temperature	Derate <sup>(1)</sup>	1	60	5	500 °C (932 °F)	800 °C (1472 °F)	750 °C (1382 °F)	On
E035 Loss of Coolant Flow	Warning	N/A	N/A	8	N/A	N/A	Open	On
E038 Low Engine Coolant Temperature	Warning	N/A	N/A	120	N/A	N/A	70 °C (158 °F)	On
E072 Oil Level Low Mark	Warning	N/A	N/A	3	N/A	N/A	Open	On
E073 Oil Filter Differential Pressure High	Warning	N/A	N/A	240	N/A	N/A	69 kPa (10 psi)	On
E074 Oil Filter Differential Pressure Very High	Warning	N/A	N/A	240	N/A	N/A	200 kPa (29 psi)	On
E092 Boost Pressure Above Normal	Derate <sup>(2)</sup>	N/A	N/A	N/A	N/A	N/A	The actual boost pressure is 20 kPa (3 psi) above the desired boost pressure.	On
E093 Boost Pressure Below Normal	Warning	N/A	N/A	N/A	N/A	N/A	The actual boost pressure is 35 kPa (5 psi) below the desired boost pressure.	On
E095 Fuel Filter Restriction Warning	Warning	N/A	N/A	N/A	N/A	N/A	138 °C (280 °F)	On
E098 Engine Prelube Override	Warning	N/A	N/A	N/A	N/A	N/A	The engine has started without completing the engine prelubrication.	On
E100 Low Engine Oil Pressure	Warning	1	15	4	N/A	N/A	Map dependent value <sup>(3)</sup>	On
E101 High Crankcase Pressure	Warning	1	60	3	0.5 kPa (0.07 psi)	6 kPa (0.9 psi)	2 kPa (0.3 psi)	On
E190 Engine Overspeed	Warning	N/A	N/A	0	1200 rpm	2400 rpm	2200 rpm	On
E265 User Defined Shutdown	Warning	N/A	N/A	1	N/A	N/A	Closed	On
E272 Inlet Air Restriction	Warning	1	60	5	3 kPa (0.4 psi)	7 kPa (1 psi)	7 kPa (1 psi)	On
E279 High Aftercooler Temperature	Warning	1	60	5	40 °C (104 °F)	102 °C (216 °F)	102 °C (216 °F)	On

(1) The ECM derates the engine in 15 second intervals in 2 percent increments when the exhaust temperature is over the trip point. The maximum derate is 20 percent.

(2) The fuel is derated by 30 percent. The timing is retarded to four degrees before top dead center. The code is latched until power is cycled to the ECM.

(3) Refer to Illustration 13.

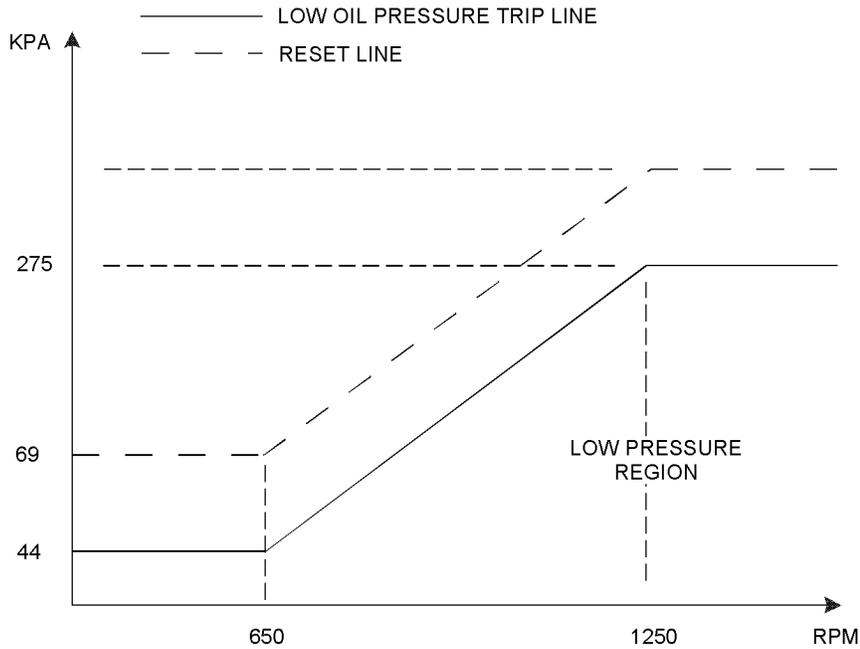


Illustration 13  
Low oil pressure map

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## Default Conditions for the Monitoring System

Table 8 contains the default conditions that cause an event code to be generated. Table 8 also contains a column that describes the system response when the conditions indicate that an abnormal operating condition exists.

Table 8

Default Conditions and System Response		
Event Code	Conditions which Generate this Code	System Response
E017 High Engine Coolant Temperature Warning	The engine coolant temperature is above the trip point temperature for five seconds.	The code is active and the code is logged.
E021 High Exhaust Temperature Derate	The exhaust temperature is above the trip point temperature for five seconds.	The code is active and the code is logged. The ramp rate of the derate is 2 percent per 15 seconds. The maximum derate is 20 percent.
E035 Loss of Coolant Flow Warning	The coolant flow switch opens.	The code is active and the code is logged.
E038 Low Engine Coolant Temperature Warning	The coolant temperature is below the trip point temperature for five seconds.	The code is active and the code is logged.

(continued)

(Table 8, contd)

<b>Default Conditions and System Response</b>		
<b>Event Code</b>	<b>Conditions which Generate this Code</b>	<b>System Response</b>
E072 Oil Level Low Mark	The oil level switch opens.	The code is active and the code is logged.
E073 Oil Filter Differential Pressure High	The oil filter differential pressure is above the trip point temperature. The warning for the oil filter differential pressure is determined by subtracting the filtered oil pressure from the unfiltered oil pressure.	The code is active and the code is logged.
E074 Oil Filter Differential Pressure Very High		
E092 Boost Pressure Above Normal	The actual boost pressure is above the desired boost pressure by the trip point pressure. Engine speed is between 1275 and 1800 rpm.	The code is active and the code is logged. The fuel is derated by 30 percent. The timing is retarded to four degrees before top dead center. The code is latched until power is cycled to the ECM.
E093 Boost Pressure Below Normal	The actual boost pressure is below the desired boost pressure by the trip point pressure. Engine speed is between 1275 and 1800 rpm.	The code is active and the code is logged. The fuel is derated by 30 percent. The timing is retarded to four degrees before top dead center. The code is latched until power is cycled to the ECM.
E095 Fuel Filter Restriction Warning	The restriction across the fuel filter is greater than the trip point pressure. The fuel filter differential pressure switch opens.	The code is active and the code is logged.
E098 Engine Prelube Override	The engine has started without completing the engine prelubrication.	The code is active and the code is logged.
E100 Low Engine Oil Pressure Warning	The engine oil pressure is below a map dependent value. The oil pressure is below this value for the delay time.	The code is active and the code is logged.
E101 High Crankcase Pressure Warning	Engine crankcase pressure is above trip point pressure for the delay time.	The code is active and the code is logged.
E190 Engine Overspeed Warning	The engine rpm has exceeded the trip point for engine overspeed for the delay time.	The code is active and the code is logged.
E265 User Defined Shutdown	The ECM detects ground on the input for the user defined shutdown.	The code is active and the code is logged.
E272 Inlet Air Restriction Warning	The inlet air restriction is above the trip point pressure for the delay time.	The code is active and the code is logged.
E279 High Aftercooler Temperature Warning	The aftercooler temperature is above the trip point temperature for the delay time.	The code is active and the code is logged.

# Programming Parameters

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## Programming Parameters

**SMCS Code:** 1901-038

The Caterpillar Electronic Technician (ET) can be used to view certain parameters that can affect the operation of the engine. The Cat ET can also be used to change certain parameters. 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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## Factory Passwords

**SMCS Code:** 1901-038

### Passwords

Passwords are part of a security system that helps to prevent unauthorized changing of certain parameters. Passwords prevent unauthorized erasing of logged events. Passwords allow the factory to control access to engine calibration parameters. Passwords allow the customer to control access to certain engine parameters.

### Factory Passwords

Factory passwords are required to clear any event code. Factory passwords are required to change certain parameters such as "Full Load Setting". Factory passwords restrict changes to authorized personnel. When the correct factory passwords have been entered, the changes can then be made.

**Note:** Factory passwords are calculated on a computer system that is only available to Caterpillar dealers.

In order to obtain the proper factory passwords, certain information must be given to an authorized Caterpillar dealer. Since the factory passwords contain alphabetic characters, the Caterpillar Electronic Technician (ET) can be used to perform this function. In order to obtain the factory passwords, proceed as if you already have the factory passwords. At some point, if the factory passwords are actually needed, Cat ET will request the factory passwords and Cat ET will display the information that is required to obtain the factory passwords.

**Note:** The old interlock code and the new interlock code are required to change the interlock code on a used Electronic Control Module (ECM).

The Cat ET screen for factory passwords will display the following parameters:

- Serial number of the ECM
- Engine serial number
- Serial number for Cat ET
- Reason code
- Interlock code
- Total tattletale

**Note:** Factory passwords are only valid for the current Cat ET screen. A different set of factory passwords will be required if you exit the current Cat ET screen. A different set of passwords will be required to change information on another Cat ET screen.

### Customer Passwords

Customer passwords allow the customer to restrict access to parameters that can be changed by the customer. The customer passwords cannot be longer than eight characters. The customer passwords may consist of alphanumeric characters. The customer has the option of entering one or two customer passwords.

If customer passwords have been entered, then the customer passwords are required to change any parameter that is customer programmable. Refer to the diagnostic procedure Troubleshooting, "System Configuration Parameters" for more detail on parameters that are customer programmable.

**Note:** If the customer passwords are lost, the parameters that are protected by customer passwords cannot be changed. You must use factory passwords in order to read the customer passwords. You may then use those customer passwords to change parameters that have been protected by customer passwords.

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## Factory Passwords Worksheet

**SMCS Code:** 1901-038

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 9

Electronic Service Tool Serial Number	
Engine Serial Number	
ECM Serial Number	
Total Tattletale	
Reason Code	
Other parameters	

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## Flash Programming

**SMCS Code:** 1901-038

Use this procedure if the code in Table 10 is active.

Table 10

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
MID 0036 - CID 0253 - FMI 11 Personality Module mechanical failure	The flash file in the engine's Electronic Control Module (ECM) is for a different application.	The code is active only. The engine will not run.

Program the correct flash file into the engine's ECM.

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

**Flash Programming** – This is a method of programming or updating the flash file in an engine's ECM.

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

## System Configuration Parameters

**SMCS Code:** 1901-038

Use this procedure if any one of the diagnostic codes in Table 11 is active.

### Programming a Flash File

1. Establish communication between Cat ET and the engine’s ECM.
2. Select “WinFlash” from the “Utilities” menu on Cat ET.

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

3. Program the flash file into the ECM.
  - a. Select the engine ECM under the “Detected ECMs”.
  - b. Press the “Browse” button in order to select the name of the flash file that will be programmed into the ECM.
  - c. When the correct flash file is selected, press the “Open” button.
  - d. Verify that the “File Values” match the application. If the “File Values” do not match the application, obtain the correct flash file.
  - e. When the correct flash file is selected, press the “Begin Flash” button.
  - f. Cat ET will indicate when flash programming has been successfully completed.
4. Start the engine and check for proper operation. Repair any active diagnostic or event codes.

### “WinFlash” Error Messages

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

Table 11

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
MID 0036 - CID 0268 - FMI 02 Check Programmable Parameters	The engine's Electronic Control Module (ECM) detects that one or more of the programmable parameters have not been programmed.	The code is active. The ECM may use a default torque map or the ECM may limit the engine to low idle.
MID 0036 - CID 1495 - FMI 02 Injector Trim Codes Not Programmed	The engine's ECM detects that one or more of the injector trim codes have not been programmed.	

System configuration parameters are parameters that affect emissions and power of the engine 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. Proper values for these parameters are available on the electronic service tool. Certain configuration parameters are also stamped on the engine information plate.

No password is required for programming a new Electronic Control Module (ECM) during the first 100 hours of service life. This 100 hour "free configuration" feature enables the customer to tailor the programmable setpoints to the requirements of the installation. Exceptions are "Fuel Limit" and "Personality Module Mismatch".

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

## Parameter Table

Table 12

System Configuration Parameters			
Parameter	Default	Range	Password
"Engine Serial Number"	00000000	8 alphanumeric characters	Yes
"Equipment ID"	000000000000000000	17 alphanumeric characters	No
"Full Load Setting (FLS)"	Not Programmed	-128 to +127	Yes
"Cold Cylinder Cutout"	Enabled	Enabled Disabled	No
"Fuel Ratio Control Offset"	0	-25 to 0	No
"Ether Injection"	Enabled	Enabled Disabled	No
"Oil Renewal"	Disabled	Enabled Disabled	Yes
"Personality Module interlock - Rating"	(1)	(1)	Yes
"Personality Module interlock - ECM"	(1)	(1)	Yes
"Prelube"	Disabled	Enabled Disabled	Yes
"Shutter Control"	Disabled	Enabled Disabled	No

(1) The "Personality Module" interlock is automatically programmed by the ECM after factory passwords have been entered.

## Injector Trim Code

**Note:** The injector trim code is not part of the "Configuration" screen on Caterpillar Electronic Technician (ET). "Injector Codes Calibration" can be found under "Calibrations" in the "Service" menu on Cat ET.

The injector trim code is a number that is found on each of the unit injectors. The ECM uses this number to compensate for manufacturing variations between individual injectors. If you replace any of the unit injectors, you must reprogram the injector trim codes for the new injectors. Also, if you replace the ECM, you must reprogram all of the injector trim codes.

Table 13

Injector Trim Code			
Injector	Default	Range	Password
"Inj #1 e-trim"	0000	4 numeric characters	No
"Inj #2 e-trim"	0000	4 numeric characters	No
"Inj #3 e-trim"	0000	4 numeric characters	No
"Inj #4 e-trim"	0000	4 numeric characters	No
"Inj #5 e-trim"	0000	4 numeric characters	No
"Inj #6 e-trim"	0000	4 numeric characters	No
"Inj #7 e-trim"	0000	4 numeric characters	No
"Inj #8 e-trim"	0000	4 numeric characters	No
"Inj #9 e-trim"	0000	4 numeric characters	No
"Inj #10 e-trim"	0000	4 numeric characters	No
"Inj #11 e-trim"	0000	4 numeric characters	No
"Inj #12 e-trim"	0000	4 numeric characters	No
"Inj #13 e-trim"	0000	4 numeric characters	No
"Inj #14 e-trim"	0000	4 numeric characters	No
"Inj #15 e-trim"	0000	4 numeric characters	No
"Inj #16 e-trim"	0000	4 numeric characters	No

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## Customer Parameters Worksheet

SMCS Code: 1901-038

Table 14

System Configuration Parameters	
Parameter Worksheet	
"Engine Serial Number"	
"Equipment ID"	
"Full Load Setting (FLS)"	
"Cold Cylinder Cutout"	
"Fuel Ratio Control Offset"	
"Ether Control"	
"Oil Renewal"	
"Personality Module interlock - Rating"	
"Personality Module interlock - ECM"	
"Pre-lube Control"	
"Shutter Control"	

Table 15

Injector Codes	
"Inj #1 e-trim"	
"Inj #2 e-trim"	
"Inj #3 e-trim"	
"Inj #4 e-trim"	
"Inj #5 e-trim"	
"Inj #6 e-trim"	
"Inj #7 e-trim"	
"Inj #8 e-trim"	
"Inj #9 e-trim"	
"Inj #10 e-trim"	
"Inj #11 e-trim"	
"Inj #12 e-trim"	
"Inj #13 e-trim"	
"Inj #14 e-trim"	
"Inj #15 e-trim"	
"Inj #16 e-trim"	

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## Replacing the ECM

**SMCS Code:** 1901-038

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### 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.

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### 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 be sure that replacing the ECM will correct the problem. Verify that the suspect ECM is the cause of the problem.

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

---

### NOTICE

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

---

Perform the following procedure in order to replace the ECM.

1. Record the configuration data:
  - a. Connect Caterpillar Electronic Technician (ET) to the service tool connector for the engine.

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

**Note:** The injector trim code is a number that is found on each of the unit injectors. The ECM uses this number to compensate for manufacturing variations between individual injectors. If you replace any of the unit injectors, you must reprogram the injector trim code for the new injectors. Also, if you replace the ECM, you must reprogram all of the injector trim codes.

- c. Copy the settings for the engine monitoring system. Refer to Troubleshooting, "Event Code List".
  - d. Use the "Copy Configuration/ECM Replacement" feature that is found under the "Service" menu on Cat ET. Select "Load from ECM" in order to copy the configuration data from the suspect ECM.

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

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

### 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.

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- c. Remove the fuel lines from the ECM (if equipped).
  - d. Remove the mounting bolts from the ECM.
  - e. Disconnect the ECM ground strap from the engine.

3. Install the replacement ECM.
  - a. Use the old mounting hardware to install the replacement ECM. The mounting hardware should be free of damage.
  - b. Reconnect the fuel lines (if equipped).
  - c. Ensure that the ECM mounting hardware is installed correctly. The fuel lines should not be putting tension on the ECM. The rubber grommets are used to protect the ECM from excessive vibration. The ECM should be able to drift in the rubber grommets. 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. Install the ECM ground strap on the engine.
  - e. Connect the P1 and P2 connectors. Tighten the allen head screws for each ECM connector to the proper torque. Refer to Troubleshooting, "Inspecting Electrical Connectors" for the correct torque values.
4. Restore electrical power to the ECM.
5. Configure the replacement ECM:
  - a. Flash program the flash file into the ECM. Refer to Troubleshooting, "Flash Programming" for the correct procedure.
  - b. Use Cat ET to match the engine application and the interlock code if the replacement ECM was used for a different application.
  - c. If the "Copy Configuration" process from Step 1.b was successful, return to the "Copy Configuration/ECM Replacement" screen on Cat ET and select "Program ECM".
  - d. Reprogram the injector trim codes. The injector trim codes are not part of the "Configuration" screen on Caterpillar Electronic Technician (ET). "Injector Codes Calibration" can be found under "Calibrations" in the "Service" menu on Cat ET. Proceed to Step 5.d.
  - e. If the "Copy Configuration" process from Step 1.b was unsuccessful, manually program the ECM parameters. The parameters must match the parameters from Step 1.b.
  - f. If necessary, program the engine monitoring system. Refer to Troubleshooting, "Event Code List".
  - g. Calibrate the engine speed/timing. Refer to Troubleshooting, "Engine Speed/Timing Sensor - Calibrate".

# Troubleshooting without a Diagnostic Code

i02319685

## Symptoms

**SMCS Code:** 1000-038; 1901-038

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.

i02398533

## Alternator (Noisy Operation)

**SMCS Code:** 1405-035

### Probable Causes

- Alternator drive belts
- Alternator drive pulley
- Alternator bearings

### Recommended Actions

#### Alternator Drive Belts

1. Inspect the condition of the alternator drive belts. If the belts are worn or damaged, replace the belts.
2. Check the tension on the belts. Adjust the tension, if necessary.
3. Ensure that the belts are in proper alignment. Inspect the alternator mounting bracket for cracks and wear. Repair the mounting bracket or replace the mounting bracket in order to ensure that the belts and the alternator drive pulley are aligned.

#### 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.

#### Alternator Bearings

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

i02418528

## Boost Pressure Above Normal

**SMCS Code:** 1000-035; 1901-038

Use this procedure in order to troubleshoot a high boost pressure or the following event code. Refer to Troubleshooting, “Event Code List” for information on specific trip points for the event codes.

Table 16

Event Code		
Description	Conditions which Generate this Code	System Response
E092 Boost Pressure Above Normal	The actual boost pressure is above the desired boost pressure.	The code is logged and the code is active.

### Probable Causes

- Leaking wastegate diaphragm
- Air supply
- Wrong Full Load Setting (FLS)

### Recommended Actions

#### Leaking Wastegate Diaphragm

Verify that the exhaust bypass valve for the wastegate can open. Use Caterpillar Electronic Technician (ET) to override the wastegate to 100 percent. Perform a torque converter stall test. After 30 seconds, a low boost pressure event should result. If a low boost pressure event occurs, the wastegate is opening properly.

#### Air Supply

Verify that the air supply to the wastegate control valve is at least 345 kPa (50 psi).

#### Wrong FLS

Check that the FLS is correct.

i02418529

## Boost Pressure Below Normal

**SMCS Code:** 1000-035; 1901-038

Use this procedure in order to troubleshoot a low boost pressure or the following event code. Refer to Troubleshooting, “Event Code List” for information on specific trip points for the event codes.

Table 17

Event Code		
Description	Conditions which Generate this Code	System Response
E093 Boost Pressure Below Normal	The actual boost pressure is below the desired boost pressure.	The code is logged and the code is active.

## Probable Causes

- Air inlet restrictions
- Fuel supply
- Injector solenoid
- Wastegate
- Engine speed/timing signal
- Active engine derate
- Intermittent sensor problem

### Air Inlet Restrictions

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

### Fuel Supply

1. Check fuel lines for the following problems: restrictions, collapse, and pinched line. Repair the lines and/or replace the lines.
  - a. Check the fuel tank for foreign objects which may block the fuel supply. Check for air in the low pressure fuel supply system after you have performed the following procedures:
    - Replace the filters.
    - Work on the low pressure fuel supply circuit
    - Replace the fuel injectors.
  - b. Purge air from the fuel system with the priming pump and by cranking the engine in 30 second cycles. After you crank the engine, stop for two minutes. This will allow the starting motor to cool. Loosen the vent plug at the fuel return. The plug is located on the rear upper left side of the engine block. Prime the engine again if air in fuel continues. A sight glass in the low pressure supply line is helpful in diagnosing air in the fuel.

- c. Check fuel quality. In temperatures below 0 °C (32 °F), check for solidified fuel (wax). Refer to the Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold weather operation. Check the fuel pressure while the engine is cranking. Check the fuel pressure at the filter. Refer to the Specifications manual for correct pressure values. If the pressure is low, check for plugged fuel filters. If the fuel pressure is still low, check the following items: fuel transfer pump, fuel transfer pump coupling, and fuel pressure regulating valve. Check for a problem with the combustion system.

### Injector Solenoid

Check for active diagnostic codes for the injector solenoids. Check for logged diagnostic codes for the injector solenoids. Perform the Injector Solenoid Test. Observe that the injector solenoids are being energized on Caterpillar Electronic Technician (ET). Perform the Cylinder Cutout Test. Locate the misfiring cylinder. Refer to the diagnostic functional test Troubleshooting, "Injector Solenoids".

### Wastegate

Verify that the exhaust bypass valve for the wastegate can close. Use Cat ET to override the wastegate to 0 percent. Perform a torque converter stall test. After 30 seconds, a high boost pressure event should result. If a high boost pressure event occurs, the wastegate is opening properly.

### Engine Speed/Timing Signal

Check Cat ET for the following logged Diagnostic Code 190-08. Refer to the diagnostic functional test Troubleshooting, "Engine Speed/Timing Sensor".

### Active Engine Derate

Connect Cat ET and check for "ACTIVE" engine derates. If the active engine derate is due to "Axle Protection", refer to the Service Manual for the transmission or implement control. Perform the torque converter stall test. Compare the achieved stall speed to specifications. If the output meets specifications, continue with diagnostic checks.

## Intermittent Sensor Problem

Check for any recently logged diagnostic codes. Check the connectors and wiring for any signs of damage. Refer to the diagnostic functional test Troubleshooting, “Inspecting Electrical Connectors”.

i02421020

## Can Not Reach Top Engine RPM

**SMCS Code:** 1000-038; 1901-038

**Note:** If this problem occurs under load, refer to the diagnostic procedure Troubleshooting, “Low Power/Poor Or No Response To Throttle”.

### Probable Causes

- Derated engine
- Cold mode
- Flash file
- Throttle signal
- Fuel supply
- Air inlet restriction
- Exhaust restriction
- Leaks in air system
- Valve adjustment
- Injectors
- Faulty accessory equipment

### Recommended Actions

#### Derate

Connect Caterpillar Electronic Technician (ET) and check for an active derate event. A derate status flag will appear on Cat ET if an active engine derate is occurring. In order to view active events, go to the “Events” menu under “Diagnostics”. Refer to Troubleshooting, “Troubleshooting with an Event Code” for the specific events for this application.

#### Cold Mode

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

## Flash File

Verify that the correct flash file has been installed.

## Throttle Signal

Use Cat ET in order to monitor the status of the throttle. Observe the throttle position. Verify that the throttle position is smooth from low idle to high idle. The throttle position should reach 100 percent at high idle.

## Fuel Supply

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

## Air Inlet Restriction

Replace plugged air filters and/or clean the filters. Leaks in the air inlet manifold system can lower Inlet manifold pressure.

## Exhaust Restriction

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

## Valve Adjustment

Check the valve lash setting.

## Injectors

Use Cat ET to determine if any active diagnostic codes are present for the injector solenoids. 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 Solenoids".

## Faulty Accessory Equipment

Check attached accessory equipment. Ensure that the accessory equipment is not lugging down the engine.

i02338332

## Coolant in Engine Oil

**SMCS Code:** 1300-038; 1901-038

### Probable Causes

- Failure of the oil cooler core
- Failure of cylinder head gasket
- Crack in cylinder head
- Cracked cylinder liner
- Cylinder liner seals
- Water pump

### Recommended Actions

#### Failure of Oil Cooler Cores

Inspect the oil cooler for leaks. Make repairs, as needed. Drain the crankcase. Refill the crankcase with clean lubricant. Change the oil filters.

#### Failure of Cylinder Head Gasket

Check the cylinder head gasket.

#### Crack in Cylinder Head

Check for cracks in the cylinder head. Repair the cylinder head and/or replace the cylinder head. Tighten the bolts that hold the cylinder head according to the Specifications Manual.

## Cracked Cylinder Liner

Check the cylinder liner for cracks. Use a borescope to check the cylinder liner.

## Cylinder Liner Seals

Check the liner water seals in the spacer plate. Check the bottom seals on the liner for damage.

## Water Pump

Check the weep hole in the water pump for blockage. Check the water pump seals for leakage.

i02423560

## Coolant Temperature Is Too Low

**SMCS Code:** 1350-038; 1901-038

Use this procedure in order to troubleshoot a low coolant temperature or use this procedure if the following event code is active. Refer to Troubleshooting, "Event Code List" for information on specific trip points for the event codes.

Table 18

Event Code		
Description	Conditions which Generate this Code	System Response
E038 Low Engine Coolant Temperature Warning	The coolant temperature is below the trip point.	The code is active and the code is logged.

## Probable Causes

- Faulty water temperature regulator
- Long idle periods
- Very light loads

## Recommended Actions

### Water Temperature Regulator

A regulator that is stuck open can cause overcooling. Overcooling also occurs when the water temperature regulator is stuck between the following positions: open position and closed position. Coolant leaks that are around the water temperature regulator can cause overcooling. An example would be a leak in the vent line.

### Very Light Loads

Very light loads or a very slow engine speed can cause overcooling. This overcooling is caused by the low heat input of the engine.

i02416900

## Coolant Temperature Is Too High

**SMCS Code:** 1350-038; 1901-038

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

Table 19

Event Code		
Description	Conditions which Generate this Code	System Response
E017 High Engine Coolant Temperature Warning	The engine coolant temperature is above the trip point temperature.	The code is active and the code is logged.
E279 High Aftercooler Temperature Warning	The aftercooler temperature is above the trip point temperature.	

## Probable Causes

- Low coolant level
- Radiator
- Coolant leak

- Faulty radiator cooling fan (if equipped)
- Faulty pressure relief valve
- Faulty temperature regulator
- Faulty jacket water coolant pump
- Load on the system

## Recommended Actions

### Low Coolant Level

Inspect the coolant level. If necessary, add coolant.

### Radiator

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

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

### Coolant Leak

Check the cooling system for leaks.

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

### Faulty Engine Cooling Fan (if equipped)

Check for proper operation of the cooling fan.

### Faulty Pressure Relief Valve

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

### Faulty Temperature Regulator

Check the water temperature regulators for correct operation.

### Faulty Jacket Water Coolant Pump

Inspect the impeller vanes at the jacket water pump for damage and/or for erosion. Repair impeller vanes and/or replace the impeller vanes.

### Load on the system

Check that the engine is not loaded beyond design.

i02418541

### Crankcase Pressure (High)

**SMCS Code:** 1901-038; 1916

Use this procedure in order to troubleshoot a high crankcase pressure or use this procedure if the following event code is active. Refer to Troubleshooting, "Event Code List" for information on specific trip points for the event codes.

Table 20

Event Code		
Description	Conditions which Generate this Code	System Response
E101 High Crankcase Pressure Warning	Engine crankcase pressure is above the trip point for high pressure.	The code is active and the code is logged.

## Probable Causes

- Worn engine components
- Plugged crankcase breather

## Recommended Actions

### Engine Components

Damaged pistons or rings can cause too much pressure in the crankcase. This condition will cause the engine to run rough. There will be more than the normal amount of fumes (blowby) rising from the crankcase breather. The breather can then become restricted in a very short time, causing oil leakage at gaskets and seals that would not normally have leakage. Blowby can also be caused by worn valve guides or by a failed turbocharger seal.

### Crankcase Breather

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

The 8T-2700 Blowby/Air Flow Indicator is used to check the amount of blowby. Refer to Special Instruction, SEHS8712, "Using the 8T-2700 Blowby/Air Flow Indicator" for the test procedure for checking the blowby.

i02419115

## ECM Will Not Accept Factory Passwords

**SMCS Code:** 1901-038

### Probable Causes

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

- Passwords
- Serial numbers
- Total tattletale

- Reason code

### Recommended Actions

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

i02385563

## ECM Will Not Communicate with Other Systems or Display Modules

**SMCS Code:** 1901-038

The probable root causes are listed below:

- Electronic Control Module (ECM)
- Connector or wiring problem
- Cat Data Link

Perform the following checks:

1. Connect the Caterpillar Electronic Technician (ET). If the ECM does not communicate with the Cat ET, perform the diagnostic functional test Troubleshooting, "Electronic Service Tool Will Not Communicate With ECM".
2. Check for correct installation of the ECM connectors J1/P1 and J2/P2. Refer to the diagnostic functional test Troubleshooting, "Inspecting Electrical Connectors".

3. Refer to the diagnostic functional test Troubleshooting, “Cat Data Link”.

i02304646

## Electronic Service Tool Will Not Communicate with ECM

**SMCS Code:** 1901-038

### Probable Causes

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

### Recommended Actions

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

### Configuration for the Communications Adapter

1. Access “Preferences” under the “Utilities” menu on Cat ET.
2. Verify that the correct “Communications Interface Device” is selected.
3. Verify that the correct port is selected for use by the communication adapter.

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

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

### Electrical Connectors

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

### 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”.

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

### Flash File

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

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

### Cat Data Link

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

i02385567

## Engine Cranks but Will Not Start

**SMCS Code:** 1000-038; 1901-038

### Probable Causes

- Diagnostic codes
- Event codes
- Electrical power supply to the Electronic Control Module (ECM)
- Starting aids (if applicable)
- Engine shutdown switches
- Engine speed/timing
- Unit injectors
- Fuel supply
- 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 the Caterpillar Electronic Technician (ET) and check for active codes and/or for logged codes. Troubleshoot any codes that are present before continuing with this procedure.

**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”.

### Starting Aids

1. If cold ambient conditions exist, check operation of starting aids. Verify that the ether system is operating correctly. Refer to Troubleshooting, “Ether Injection System”.
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 Equipped)

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, “Engine Speed/Timing Sensor”.

**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 Solenoids” for additional information.

### Fuel Supply

1. Visually check the fuel level. Do not rely on the fuel gauge only. If necessary, add fuel. If the engine has been run out of fuel, it will be necessary to 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 the fuel pressure during engine cranking. Check the fuel pressure after the fuel filter. Refer to the Systems Operation/Testing and Adjusting manual for the correct pressure values. If the fuel pressure is low, replace the fuel filters. If the fuel pressure is still low, check the following items: fuel transfer pump, fuel transfer pump coupling, and fuel pressure regulating valve.

## Combustion

Check for mechanical problems in the combustion system.

i02304590

## Engine Has Early Wear

**SMCS Code:** 1000-038; 1901-038

### Probable Causes

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

## Recommended Actions

### Incorrect Engine Oil

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

### Contaminated Engine Oil

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

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

### Contaminated Air

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

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

### Contaminated Fuel

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

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

### Low Oil Pressure

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

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

i02385587

## Engine Misfires, Runs Rough or Is Unstable

**SMCS Code:** 1000-038; 1901-038

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

### Probable Causes

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

### Recommended Actions

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

### Diagnostic Codes

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

### Electrical Connectors

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

### Cold Mode

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

### Throttle Signal

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

### Unit Injectors

1. Use Cat ET to determine if there are any active diagnostic codes for the unit injectors.
2. Perform the "Injector Solenoid Test" on Cat ET in order to determine if all of the injector solenoids are being energized by the ECM.
3. Perform the "Cylinder Cutout Test" on Cat ET in order to identify any misfiring cylinder(s). Refer to Troubleshooting, "Injector Solenoids" for more information.

### Fuel Supply

1. Check the fuel lines for the following problems: restrictions, collapsed lines, and pinched lines. If problems are found with the fuel lines, repair the lines and/or replace the lines.
2. Check the fuel tank for foreign objects which may block the fuel supply.
3. Prime the fuel 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 fuel supply line is helpful in diagnosing air in the fuel.

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

### Air Inlet and Exhaust System

1. Check for an air filter restriction. Clean plugged air filters or replace plugged air filters. Refer to the Operation and Maintenance Manual.
2. If air shutoff valves are installed, verify that the air shutoff valves are fully opened.

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

i02424547

## Engine Oil in Cooling System

**SMCS Code:** 1350-038; 1901-038

### Probable Causes

- Engine oil cooler core
- Cylinder head gasket
- Water pump

### Recommended Actions

#### Engine Oil Cooler Core

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

#### Cylinder Head Gasket

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

#### Water Pump

Check the weep hole in the water pump for blockage.  
Check the water pump seals.

i02418648

## Engine Overspeed

**SMCS Code:** 1000-038; 1901-038

Use this procedure in order to troubleshoot an engine overspeed or use this procedure if the following event code is active. Refer to Troubleshooting, "Event Code List" for information on specific trip points for the event codes.

Table 21

Event Code		
Description	Conditions which Generate this Code	System Response
E190 Engine Overspeed Warning	The engine rpm is above the trip point for overspeed.	The code is active and 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.

i02385598

## Engine Stalls at Low RPM

**SMCS Code:** 1000-038; 1901-038

## Probable Causes

- Unit injectors
- Fuel supply
- Air shutoff valves (if applicable) or blocked air supply
- Low engine idle
- Accessory equipment

## Recommended Actions

### Unit Injectors

1. Check for correct installation of the J1/P1 and J2/P2 connectors for the Electronic Control Module (ECM). Check for correct installation of the connectors for the unit injectors. Refer to Troubleshooting, "Inspecting Electrical Connectors".

2. Perform the "Injector Solenoid Test" with the Caterpillar Electronic Technician (ET) in order to determine if all of the injector solenoids are being energized by the ECM.
3. Perform the "Cylinder Cutout Test" with Cat ET in order to identify any injectors that might be misfiring. Refer to Troubleshooting, "Injector Solenoids" for the proper procedure.

## Fuel Supply

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

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### 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.

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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 fuel supply line is helpful in diagnosing air in the fuel.

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

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

### Air Shutoff Valves (if applicable)

1. Verify that the air shutoff valves are open.
2. Check for restrictions in the air inlet system. Refer to the Systems Operation/Testing and Adjusting manual for information on the air inlet system.

### Low Idle

Check the low idle setting.

### 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.

i02385621

## Engine Will Not Crank

**SMCS Code:** 1000-038; 1901-038

### Probable Causes

- Batteries
- Battery cables
- Starting circuit
- Starting motor solenoid
- Starting motor
- Shutdown switch
- Prelubrication system (if applicable)
- Faulty crank enable switch (if applicable)
- 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. Load test the batteries. Refer to Special Instruction, SEHS9249, "Use of 4C - 4911 Battery Load Tester for 6, 8 and 12 Volt Lead Acid Batteries".

### Starting Motor Solenoid or Starting Circuit

1. Check the operation of the engine start switch. Monitor the engine start switch on Cat ET.  
  
Refer to the appropriate troubleshooting test that is applicable to your engine if repairs are required.
2. Test the operation of the starting motor solenoid.
3. Check the wiring to the starting motor solenoid.

### Starting Motor or Flywheel Ring Gear

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

### Prelubrication System (if applicable)

If equipped, inspect the prelubrication system for proper operation.

### Shutdown Switch

Use Cat ET to monitor the status of the engine. Check for "ACTIVE" shutdowns due to shutdown switches. Determine the cause for the "ACTIVE" shutdown and make any repairs necessary.

### Crank Enable Switch (if applicable)

Ensure that the crank enable switch is not faulty.

## Transmission or Engine Accessories (if applicable)

1. If the engine's application has a transmission neutral switch, test the operation of the transmission neutral switch. Ensure that the machine is in neutral gear before attempting to start the engine.
2. Ensure free movement of the driveline.
3. Ensure that the timing pin was not left in the flywheel housing.
4. 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

i02304642

## Excessive Engine Oil Consumption

**SMCS Code:** 1300-038; 1901-038

### Probable Causes

- Oil leaks

- Oil level
- Engine oil cooler
- Turbocharger
- Valve guides
- Piston rings
- Incorrect installation of the compression ring and/or the intermediate ring

## Recommended Actions

### Oil Leaks

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

### Oil Level

Inspect the engine oil level. Remove any extra oil from the engine. Recheck all fluid levels.

### Engine Oil Cooler

Check for leaks in the engine oil cooler. Check for oil in the engine coolant. If necessary, repair the engine oil cooler.

### Turbocharger

Check the air inlet manifold for oil. Check for oil leakage past the seal rings in the impeller end of the turbocharger shaft. If necessary, repair the turbocharger.

### Valve Guides

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

### Piston Rings

Inspect the internal engine components. Replace any worn components.

i02304643

## Excessive Black Smoke

**SMCS Code:** 1000-038; 1901-038

### Probable Causes

- Air shutoff (if applicable)
- Air inlet and exhaust system

- Fuel injector
- Turbocharger
- Atmospheric pressure sensor
- “Fuel Position” and/or “FRC Fuel Limit”
- Flash file
- Fuel quality
- Valve adjustment

## Recommended Actions

### Air Shutoff (if applicable)

Check that both the air shutoffs are open.

### Air Inlet and Exhaust System

1. Check the air inlet system for restrictions and/or for leaks.
  - a. Check for an air filter restriction.
  - b. Check for derates and for alarms.
  - c. Perform a visual inspection of the system for restrictions and/or for leaks.
2. Check the exhaust system for restrictions.
3. Repair any leaks that were found. Remove any restrictions that were found. Replace any damaged components that were found.

### Fuel Injector

Check that the injector trim codes have been entered. Perform the “Cylinder Cutout Test”. Use similar conditions for the test that were experienced during operation. Refer to the diagnostic functional test Troubleshooting, “Injector Solenoids”.

### Turbocharger

Verify that the turbocharger has not failed. Periodic inspection and cleaning is recommended for the turbocharger compressor housing (inlet side).

### Atmospheric Pressure Sensor

1. Check the atmospheric pressure sensor for dirt and/or for debris. Remove the dirt and/or the debris. The atmospheric pressure should be between 50 kPa (7.2 psi) and 100 kPa (14.5 psi). The atmospheric pressure will vary depending on your altitude. If there is an active diagnostic code, perform the diagnostic functional test Troubleshooting, “Engine Sensor Open/Short Test”.
2. Verify that the crankshaft and the camshaft drive gears are set with the proper orientation. Refer to the Disassembly and Assembly manual.

### Turbocharger Compressor Outlet Pressure Sensor, “Fuel Position”, and/or “FRC Fuel Limit”

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

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

### Flash File

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

### Fuel Quality

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

## Valve Adjustment

Check the valve adjustment. Refer to the Systems Operation/Testing and Adjusting manual for more information.

i02421039

## Excessive White Smoke

**SMCS Code:** 1000-038; 1901-038

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

### Probable Causes

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

### Recommended Actions

#### Starting Aids (if applicable)

1. If equipped, check for proper operation of installed starting aids.
  - a. Ensure that the ether canister is not empty and/or low. Replace the ether canister if the ether canister is empty and/or low.
  - b. Actuate the system manually after start-up and observe results. The ether system will not operate if the coolant temperature is too high. Refer to the diagnostic functional test Troubleshooting, "Ether Injection System".

#### Coolant Temperature Sensor

1. Use the Caterpillar Electronic Technician (ET) to verify that the engine has exited cold mode.

2. Compare the coolant temperature from Cat ET to the coolant temperature that is obtained from the 6V-9130 Temperature Adapter (MULTIMETER).

### Water Temperature Regulators

Check the water temperature regulators for correct operation. Verify that the engine reaches full operating temperature. If the engine does not reach full operating temperature, a water temperature regulator may be stuck open. Remove the water temperature regulator and inspect the water temperature regulator. If necessary, repair the water temperature regulator and/or replace the coolant temperature regulator. Refer to the Systems Operation/Testing and Adjusting manual for the proper procedure.

### Engine Speed/Timing

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

### Unit Injectors

Perform the "Cylinder Cutout Test" on Cat ET in order to try to isolate any injectors that might be misfiring. Refer to Troubleshooting, "Injector Solenoids".

### Flash File

Verify that the correct flash file is installed.

### Fuel Supply

1. Inspect the fuel system components.
2. Check the fuel pressure during engine cranking. Check the filtered fuel pressure. Refer to the Systems Operation/Testing and Adjusting manual for the correct pressure values. If the fuel pressure is low, replace the fuel filters. If the fuel pressure is still low, check the following items: fuel transfer pump, fuel transfer pump coupling, and fuel pressure regulating valve.
3. Check the fuel quality. Low cetane fuel can create white smoke. If necessary, replace the fuel with a higher cetane fuel.
4. Cold weather adversely affects the characteristics of the fuel. Refer to the Operation and Maintenance Manual for information on improving the characteristics of the fuel during cold weather operation.

## Component Wear

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

## Cooling System

Check for proper operation of the jacket water heater. Repair the jacket water heater or replace the jacket water heater. Check for an internal coolant leak into the cylinder and/or the exhaust. Refer to the Systems Operation/Testing and Adjusting manual for more information.

i02416909

## Exhaust Temperature Is Too High

**SMCS Code:** 1050-038; 1901-038

Use this procedure in order to troubleshoot a high exhaust temperature or use this procedure if the following event code is active.

Table 22

Event Code		
Description	Conditions which Generate this Code	System Response
E021 High Exhaust Temperature Derate	The exhaust temperature is above the trip point.	The code is active and the code is logged.

## Probable Causes

- Air inlet and exhaust system
- Fuel injectors
- Aftercooler
- Accessory equipment

## Recommended Actions

### Air Inlet and Exhaust System

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

### Fuel Injectors

Faulty injectors that deliver too much fuel will increase exhaust temperatures. Connect Caterpillar Electronic Technician (ET) in order 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 Troubleshooting, "Injector Solenoids".

### Aftercooler

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

Check the aftercooler for correct operation. Check for blockage in the cores of the aftercooler.

### Accessory Equipment

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

i02119587

i01405833

## Fuel Dilution of Engine Oil

**SMCS Code:** 1300-038; 1901-038

### Probable Causes

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

### Recommended Actions

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

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

#### Leaking Seals on the Fuel Line Adapter for the Cylinder Head

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

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

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

#### Cracked Fuel Supply Manifold

Look for signs of damage to the fuel supply manifold.

#### Leaking Fuel Transfer Pump Seal

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

## Fuel in Cooling System

**SMCS Code:** 1350-038; 1901-038

### Probable Causes

- Internal cylinder head

### Recommended Actions

#### Internal Cylinder Head

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

i02423656

## Inlet Air Restriction

**SMCS Code:** 1087-038; 1901-038

Use this procedure if the following event code is active.

Table 23

Event Code		
Description	Default Conditions which Generate this Code	System Response
E272 Air Filter Restriction Warning	The inlet air restriction is above the trip point.	The code is active and 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.

i02421043

## Intermittent Engine Shutdown

**SMCS Code:** 1000-038; 1901-038

**Note:** Use this procedure only if the engine shuts down completely and the engine must be restarted.

## Probable Causes

- Crank without injection input (if applicable)
- Engine shutdown switch (if applicable)
- Engine start switch
- Engine speed/timing sensor(s)
- Electrical connections
- Fuel supply

## Recommended Actions

### Crank Without Injection Input (if applicable)

If equipped, verify that the plug is installed for the crank without injection input. Ensure that the plug for the crank without injection input is installed securely. Refer to the diagnostic functional test Troubleshooting, "Crank without Injection Input".

## Engine Shutdown Switch (if applicable)

Use Cat ET to monitor the status of the engine. Check for active shutdowns due to the engine shutdown switch. Determine the cause for the active shutdown and make any repairs necessary.

## Engine Start Switch

Check the engine start switch on Cat ET. Look for an intermittent problem in the wiring for the engine start switch.

## Engine Speed/Timing Sensor

If the following diagnostic codes are applicable, check Cat ET for any logged diagnostic codes for the primary engine speed/timing sensor: 190-02, 190-03, and 190-08. If the engine is equipped with a secondary engine speed/timing sensor, check for any of the following logged diagnostic codes: 342-02, 342-03, and 342-08. Refer to the diagnostic functional test Troubleshooting, "Engine Speed/Timing Sensor".

## Electrical Connectors

1. Check Cat ET for the following logged diagnostic codes: 168-01 and 168-02. Follow the battery wires from the ECM back to the battery compartment. Refer to the electrical system schematic. Inspect the wires and the power relay. Check the power to the ECM and to the ground connections. Refer to the diagnostic functional test Troubleshooting, "Electrical Power Supply".
2. Check for correct installation of the J1/P1 and J2/P2 Electronic Control Module (ECM) connectors. Refer to Troubleshooting, "Inspecting Electrical Connectors".
3. Inspect the battery wires from the ECM back to the battery compartment. Refer to the Electrical System Schematic. Inspect the wires and the power relay. Check the power and ground connections to the ECM. Refer to Troubleshooting, "Electrical Power Supply" for more information.

## Fuel Supply

1. Check the fuel lines for the following problems: restrictions, collapsed lines, and pinched lines. If problems are found with the fuel lines, repair the lines and/or replace the lines.
2. Check the fuel tank for foreign objects which may block the fuel supply.
3. Prime the fuel system if any of the following procedures have been performed:
  - Replacement of the fuel filters
  - Service on the low pressure fuel supply circuit
  - Replacement of unit injectors

Refer to the Operation and Maintenance Manual for the correct procedure.

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

4. 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.
5. Check the fuel pressure during engine cranking. Check the fuel pressure after the fuel filter. Refer to the Systems Operation/Testing and Adjusting manual for the correct pressure values. If the fuel pressure is low, replace the fuel filters. If the fuel pressure is still low, check the following items: fuel transfer pump, fuel transfer pump coupling, and fuel pressure regulating valve.

i02385735

## Intermittent Low Power or Power Cutout

**SMCS Code:** 1000-038; 1901-038

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

### Probable Causes

- Fuel position multiplier (if applicable)
- Engine speed/timing sensor(s)
- Turbocharger
- Rated fuel position
- Air inlet and exhaust restrictions

- Derates
- 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.

### Fuel Position Multiplier (if applicable)

If equipped, refer to the diagnostic procedure Troubleshooting, "Fuel Position Multiplier".

### Engine Speed/Timing Sensor(s)

If the following diagnostic codes are applicable, check Cat ET for any logged diagnostic codes for the primary engine speed/timing sensor: 190-02, 190-03, and 190-08. If the engine is equipped with a secondary engine speed/timing sensor, check for any of the following logged diagnostic codes: 342-02, 342-03, and 342-08. Refer to the diagnostic functional test Troubleshooting, "Engine Speed/Timing Sensor".

### Turbocharger

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

### Rated Fuel Position

Operate the engine under full load. Use Cat ET in order to monitor the following values: turbocharger compressor outlet pressure, fuel position, rated fuel position, and Fuel Ratio Control (FRC). The fuel position should equal the rated fuel position. The FRC fuel position should be greater than the rated fuel position.

If any of the above values are changing rapidly for no apparent reason, there may be an intermittent problem with the wiring. Refer to the diagnostic functional test Troubleshooting, "Inspecting Electrical Connectors".

### Air Inlet and Exhaust Restrictions

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

Check for an air filter restriction indicator. Replace plugged air filters and/or clean filters. Repair any leaks.

## Throttle Signal

Use Cat ET in order to monitor the status of the throttle. Observe the throttle position. Verify that the throttle position is smooth from low idle to high idle. The throttle position should reach 100 percent at high idle.

## 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" 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" for more information.

## Fuel Supply

1. Check the fuel lines for the following problems: restrictions, collapsed lines, and pinched lines. If problems are found with the fuel lines, repair the lines and/or replace the lines.
2. Check the fuel tank for foreign objects which may block the fuel supply.
3. Prime the fuel system if any of the following procedures have been performed:
  - Replacement of the fuel filters
  - Service on the low pressure fuel supply circuit
  - Replacement of unit injectors

Refer to the Operation and Maintenance Manual for the correct procedure.

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

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

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

i02417359

## Low Engine Oil Pressure

**SMCS Code:** 1300-038; 1901-038

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### NOTICE

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

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Use this procedure in order to troubleshoot low engine oil pressure or use this procedure if one of the following event codes is active. Refer to Troubleshooting, "Event Code List" for information on specific trip points for the event codes.

Table 24

Event Code		
Description	Conditions which Generate this Code	System Response
E072 Oil Level Low Mark	The oil level switch opens.	The code is active and the code is logged.
E073 Oil Filter Differential Pressure High	The oil filter differential pressure is greater than the trip point.	
E074 Oil Filter Differential Pressure Very High		
E100 Low Engine Oil Pressure Warning	The engine oil pressure is below a map dependent value.	

## Probable Causes

- Low engine oil level
- Dirty engine oil filters
- Restriction at engine oil pump
- Restriction in engine oil cooler(s)
- Fuel dilution of engine oil
- Camshaft and/or camshaft bearings
- Crankshaft bearings

## Recommended Actions

### Engine Oil Level

Inspect the engine oil level. If engine oil is low add engine oil.

### Oil Filter

Inspect the engine oil filter. If the engine oil filter is dirty, install a new engine oil filter. Check the operation of bypass valve for the filter. Clean the bypass valve and the housing. If necessary, install new parts.

### Engine Oil Pump

Check for blockage of the inlet screen in the engine oil pump. Examine the engine oil pump for excessive wear.

### Oil Cooler

Inspect the engine's oil cooler. Clean the engine oil cooler core(s) and/or install new engine oil cooler core(s).

## Fuel Dilution of Engine Oil

Check for presence of fuel in lubricating oil. Refer to the diagnostic procedure Troubleshooting, "Fuel Dilution of Engine Oil".

## Camshaft and/or Crankshaft

Inspect the camshaft and/or camshaft bearings. Check the components for excessive wear. Excessive wear is an indication of a blocked oil passage. Inspect the crankshaft and/or crankshaft bearings. Check the components for excessive wear.

i02304726

## Low Power/Poor or No Response to Throttle

**SMCS Code:** 1000-038; 1901-038

## Probable Causes

- Cold mode operation and cold cylinder cutout
- Derate mode
- Fuel position multiplier (if applicable)
- Throttle signal
- Electrical connectors
- Injector
- Fuel Ratio Control Limit (FRC)
- Air inlet restriction
- Exhaust restrictions
- Electronic Control Module (ECM)
- Fuel supply
- Air shutoff valve (if applicable)

## Recommended Actions

### Cold Mode Operation and Cold Cylinder Cutout

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

### Derate Mode

Connect Cat ET and check for logged derate events. A derate status flag will appear on Cat ET if an active engine derate is occurring. The engine speed might be limited due to one of the following possible causes: altitude, high exhaust temperatures, air filter restriction, high coolant temperature, aftercooler water temperature, and crankcase pressure.

### Fuel Position Multiplier (if applicable)

If equipped, refer to the diagnostic functional test Troubleshooting, "Fuel Position Multiplier".

### Throttle Signal

Use Cat ET in order to monitor the status of the throttle. Observe the throttle position. Verify that the throttle position is smooth from low idle to high idle. The throttle position should reach 100 percent at high idle.

### Electrical Connector

Check for the correct installation of the ECM connector(s) J1/P1 and/or J2/P2. Check for correct installation of the applicable fuel Injector connectors. Refer to the diagnostic functional test Troubleshooting, "Inspecting Electrical Connectors".

### Injector

Use Cat ET to determine if any active diagnostic codes are present. Check that the injector trim codes have been entered. Use Cat ET to determine if any logged diagnostic codes are present. Perform the "Injector Solenoid Test". Observe that the solenoids for the injectors are being energized on Cat ET. Perform the "Cylinder Cutout Test". Locate the misfiring cylinder. Refer to the diagnostic functional test Troubleshooting, "Injector Solenoids".

### Fuel Ratio Control Limit (FRC)

Operate the engine under full load. Use Cat ET in order to monitor the following values: turbocharger compressor outlet pressure, fuel position, rated fuel position, and Fuel Ratio Control (FRC). The fuel position should equal the rated fuel position. The FRC fuel position should be greater than the rated fuel position.

If any of the above values are changing rapidly for no apparent reason, there may be an intermittent problem with the wiring. Refer to the diagnostic functional test Troubleshooting, "Inspecting Electrical Connectors".

### Air Inlet Restriction

Check for an air filter restriction indicator. Replace plugged air filters and/or clean the filters. Repair any leaks.

Check the air inlet system for the following problems: restrictions, collapse, pinched line, and loose fittings. Repair the lines and/or replace the lines.

### Exhaust Restrictions

Check the exhaust system for the following problems: restrictions, collapse, pinched line, and loose fittings. Repair the lines and/or replace the lines.

### Electronic Control Module (ECM)

If you have replaced the ECM, check the read/change system configuration parameters. Verify that the parameters match the information on the engine information plate. Verify that the correct flash file has been installed.

### Fuel Supply

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

### Air Shutoff Valve (if applicable)

Check that both of the air shutoffs are open.

i02304760

## Mechanical Noise (Knock) in Engine

**SMCS Code:** 1000-038; 1901-038

### Probable Causes

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

### Recommended Actions

#### Faulty Accessory

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

#### 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, bridges, and injectors. Check for valves that do not move freely. Remove the cylinder head and inspect the valves. Replace any damaged parts. If damage has occurred, clean the following components: cylinder liner, piston, and exhaust system. 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.

#### Crankshaft Bearings

Check the crankshaft and/or crankshaft bearings. Check the components for excessive wear.

i02421025

## Noise Coming from Cylinder

**SMCS Code:** 1000-038; 1290-038

### Probable Causes

- Low quality fuel

- Engine speed/timing sensor
- 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.

#### Engine Speed/Timing Sensor

Calibrate the engine speed/timing sensor if a CID-FMI 261-13 Engine Timing calibration required diagnostic code is active. Refer to the calibration procedure Troubleshooting, "Engine Speed/Timing Sensor - Calibrate".

#### 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 the diagnostic functional test Troubleshooting, "Inspecting Electrical Connectors".

#### 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 Solenoids".

#### 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, “Too Much Valve Lash”.

## 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.

i02421030

## Poor Fuel Consumption

**SMCS Code:** 1000-038; 1901-038

### Probable Causes

- Engine speed/timing sensor(s)
- Electrical connectors
- Injector
- Fuel supply
- Air inlet restrictions
- Exhaust restrictions
- Accessory equipment

### Recommended Actions

#### Engine Speed/Timing Sensor(s)

Check the calibration of the engine speed/timing sensor if a CID-FMI 261-13 Engine Timing calibration required diagnostic code is active. Refer to the calibration procedure Troubleshooting, “Engine Speed/Timing Sensor - Calibrate”.

## Electrical Connectors

Check for the correct installation of the connectors for the Electronic Control Module (ECM) J1/P1 and/or J2/P2. Check for the correct installation of the applicable fuel injector connectors. Repair the connector and/or replace the connector. Refer to the diagnostic functional test Troubleshooting, “Inspecting Electrical Connectors”.

## Injector

Check for active diagnostic codes that are associated with the circuits for the fuel injector. Check that the injector trim codes have been entered. Perform the “Injector Solenoid Test”. Verify that the ECM is energizing all the injector solenoids. Refer to the diagnostic functional test Troubleshooting, “Injector Solenoids”.

## Fuel Supply

1. Check the fuel lines for the following problems: restrictions, collapsed lines, and pinched lines. If problems are found with the fuel lines, repair the lines and/or replace the lines.
2. Check the fuel tank for foreign objects which may block the fuel supply.
3. Prime the fuel system if any of the following procedures have been performed:
  - Replacement of the fuel filters
  - Service on the low pressure fuel supply circuit
  - Replacement of unit injectors

Refer to the Operation and Maintenance Manual for the correct procedure.

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

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

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

### Air inlet Restrictions

Inspect the engine air cleaner. Replace plugged air filters and/or clean the filters. Check the air inlet systems for restrictions and for leaks.

### Exhaust Restrictions

Check the exhaust systems for restrictions and for leaks.

### Accessory Equipment

Check attached accessory equipment. Ensure that the accessory equipment is not lugging down the engine.

i02304819

## Too Much Valve Lash

**SMCS Code:** 1000-038; 1901-038

### Probable Causes

- Rocker arm
- Not enough lubrication
- Worn rocker arm
- Worn bridges for valves
- Worn pushrods
- Worn valve lifters
- Worn camshaft
- Worn valve stem
- Incorrect valve lash
- Loose retaining bolt(s) for rocker shaft
- Worn valve springs
- Valve seats

## Recommended Actions

### Rocker Arm

Check for proper installation of the rocker arm adjustment screw locknut. If the rocker arm adjustment screw locknut is loose, adjust the valve lash.

Check the rocker arms for signs of wear. If there is too much wear, install new parts or rocker arms. Adjust the valve lash.

### Not Enough Lubrication

Check the lubrication in the valve compartment. Check for sufficient lubrication between the injector tappet and the rocker arm buttons.

### Worn Bridges for Valves

Check the bridges for signs of wear. Adjust the bridges and/or replace the bridges. If there is too much wear, install new parts. Adjust the valve lash.

### Worn Pushrods

Inspect the pushrods for signs of wear. If there is too much wear, install new pushrods. Adjust the valve lash.

### Worn Valve Lifters

Clean the valve train. Install new valve lifters.

### Worn Camshaft

Check the camshaft for wear.

### Worn Valve Stem

Check the valve stem for signs of wear. Check for free movement of valves. Check for a bent valve stem. Adjust the valve lash.

### Loose Retaining Bolt(s) for Rocker Shaft

Repair the retaining bolt for the rocker shaft and/or replace the retaining bolt.

### Worn Valve Springs

Check the valve springs for damage or for signs of wear. If there is too much wear, install new springs. Adjust the valve lash.

## Valve Seats

Check the valve seats for signs of wear. If there is too much wear, install new valve seats. Adjust the valve lash.

i02304892

## Too Much Vibration

i02304874

**SMCS Code:** 1000-038; 1901-038

### Probable Causes

- Vibration damper
- Loose engine supports
- Fan blade
- Misfiring cylinder
- Alignment and balance

### Recommended Actions

#### Vibration damper

Check the vibration damper for damage. Tighten the bolts. Check the vibration damper bolt holes for damage and/or wear.

#### Loose engine supports

Run the engine. Check the engine for the following problems: loose mounts, broken mounts, loose brackets, and broken brackets. Tighten all mounting bolts.

#### Fan blade

Check the fan blade for damage. Ensure that the fan blade is balanced.

#### Misfiring cylinder

Check for a misfiring cylinder. Perform the Cylinder Cutout Test. Refer to the diagnostic functional test Troubleshooting, "Injector Solenoids".

#### Alignment and balance

Check alignment and the balance. If the symptom remains refer to the diagnostic procedure Troubleshooting, "Engine Misfires, Runs Rough or Is Unstable".

## Valve Rotocoil or Spring Lock Is Free

**SMCS Code:** 1109-038

### Probable Causes

- Cracked inlet valve rotocoil
- Broken spring locks
- Broken valve spring(s)

### Recommended Actions

#### Valve Rotocoil

Determine the cause of the cracked rotocoil. Install new parts.

#### Spring Locks

Check the locks. A broken lock can cause the valve to fall into the cylinder.

#### Valve Spring(s)

Install the new valve spring(s). Replace the valve and/or other damaged parts.

# Diagnostic Functional Tests

i02408931

## Analog Sensor (Active)

**SMCS Code:** 5574-038

### 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 25 is active or easily repeated.

Table 25

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
MID 0036 - CID 0101 - FMI 03 Crankcase Pressure open/short to +batt	The Electronic Control Module (ECM) detects signal voltage that is above normal for one second. The ECM has been powered for at least three seconds.	The code is logged. The value of the parameter is set to zero.
MID 0036 - CID 0101 - FMI 04 Crankcase Pressure short to ground	The ECM detects signal voltage that is below normal for one second. The ECM has been powered for at least three seconds.	
MID 0036 - CID 0110 - FMI 03 Engine Coolant Temperature open/short to +batt	The ECM detects signal voltage that is above normal for one second. The ECM has been powered for at least three seconds.	The code is logged. The value of the parameter is set to -40 °C (-40 °F).
MID 0036 - CID 0110 - FMI 04 Engine Coolant Temperature short to ground	The ECM detects signal voltage that is below normal for one second. The ECM has been powered for three seconds.	
MID 0036 - CID 0273 - FMI 03 Turbo Outlet Pressure open/short to +batt	The ECM detects signal voltage that is above normal for one second. The ECM has been powered for at least three seconds.	The code is logged. The value of the parameter is set to zero.
MID 0036 - CID 0273 - FMI 04 Turbo Outlet Pressure short to ground	The ECM detects signal voltage that is below normal for one second. The ECM has been powered for three seconds.	
MID 0036 - CID 0274 - FMI 03 Atmospheric Pressure open/short to +batt	The ECM detects signal voltage that is above normal for one second. The ECM has been powered for at least three seconds.	The code is logged. The value of the parameter is set to 45 kPa (6.5 psi).
MID 0036 - CID 0274 - FMI 04 Atmospheric Pressure short to ground	The ECM detects signal voltage that is below normal for one second. The ECM has been powered for three seconds.	

(continued)

(Table 25, contd)

<b>Diagnostic Codes Table</b>		
<b>Description</b>	<b>Conditions which Generate this Code</b>	<b>System Response</b>
MID 0036 - CID 0275 - FMI 03 Right Turbo Inlet Pressure open/short to +batt	The ECM detects signal voltage that is above normal for one second. The ECM has been powered for at least three seconds.	The code is logged. The value of the parameter is set to 45 kPa (6.5 psi).
MID 0036 - CID 0275 - FMI 04 Right Turbo Inlet Pressure short to ground	The ECM detects signal voltage that is below normal for one second. The ECM has been powered for three seconds.	
MID 0036 - CID 0276 - FMI 03 Left Turbo Inlet Pressure open/short to +batt	The ECM detects signal voltage that is above normal for one second. The ECM has been powered for at least three seconds.	The code is logged. The value of the parameter is set to 45 kPa (6.5 psi).
MID 0036 - CID 0276 - FMI 04 Left Turbo Inlet Pressure short to ground	The ECM detects signal voltage that is below normal for one second. The ECM has been powered for three seconds.	
MID 0036 - CID 0279 - FMI 03 Aftercooler Temperature open/short to +batt	The ECM detects signal voltage that is above normal for one second. The ECM has been powered for at least three seconds.	The code is logged. The value of the parameter is set to -40 °C (-40 °F).
MID 0036 - CID 0279 - FMI 04 Aftercooler Temperature short to ground	The ECM detects signal voltage that is below normal for one second. The ECM has been powered for three seconds.	
MID 0036 - CID 0542 - FMI 03 Unfiltered Engine Oil Pressure open/short to +batt	The ECM detects signal voltage that is above normal for one second. The ECM has been powered for at least three seconds.	The code is logged. The value of the parameter is set to 500 kPa (75 psi).
MID 0036 - CID 0542 - FMI 04 Unfiltered Engine Oil Pressure short to ground	The ECM detects signal voltage that is below normal for one second. The ECM has been powered for three seconds.	
MID 0036 - CID 0543 - FMI 03 Filtered Engine Oil Pressure open/short to +batt	The ECM detects signal voltage that is above normal for one second. The ECM has been powered for at least three seconds.	The code is logged. The value of the parameter is set to 500 kPa (75 psi).
MID 0036 - CID 0543 - FMI 04 Filtered Engine Oil Pressure short to ground	The ECM detects signal voltage that is below normal for one second. The ECM has been powered for three seconds.	
MID 0036 - CID 0829 - FMI 03 Rear Aftercool Temperature open/short to +batt	The ECM detects signal voltage that is above normal for one second. The ECM has been powered for at least three seconds.	The code is logged. The value of the parameter is set to -40 °C (-40 °F).
MID 0036 - CID 0829 - FMI 04 Rear Aftercool Temperature short to ground	The ECM detects signal voltage that is below normal for one second. The ECM has been powered for three seconds.	

**System Operation**

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

- Aftercooler temperature sensor (rear)
- Aftercooler temperature sensor (front)
- Atmospheric pressure sensor

- Coolant temperature sensor
- Crankcase pressure sensor
- Filtered engine oil pressure sensor
- Left turbocharger inlet pressure sensor
- Right turbocharger inlet pressure sensor
- Turbocharger outlet pressure sensor
- Unfiltered engine oil pressure sensor

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 five 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 03 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 04 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.

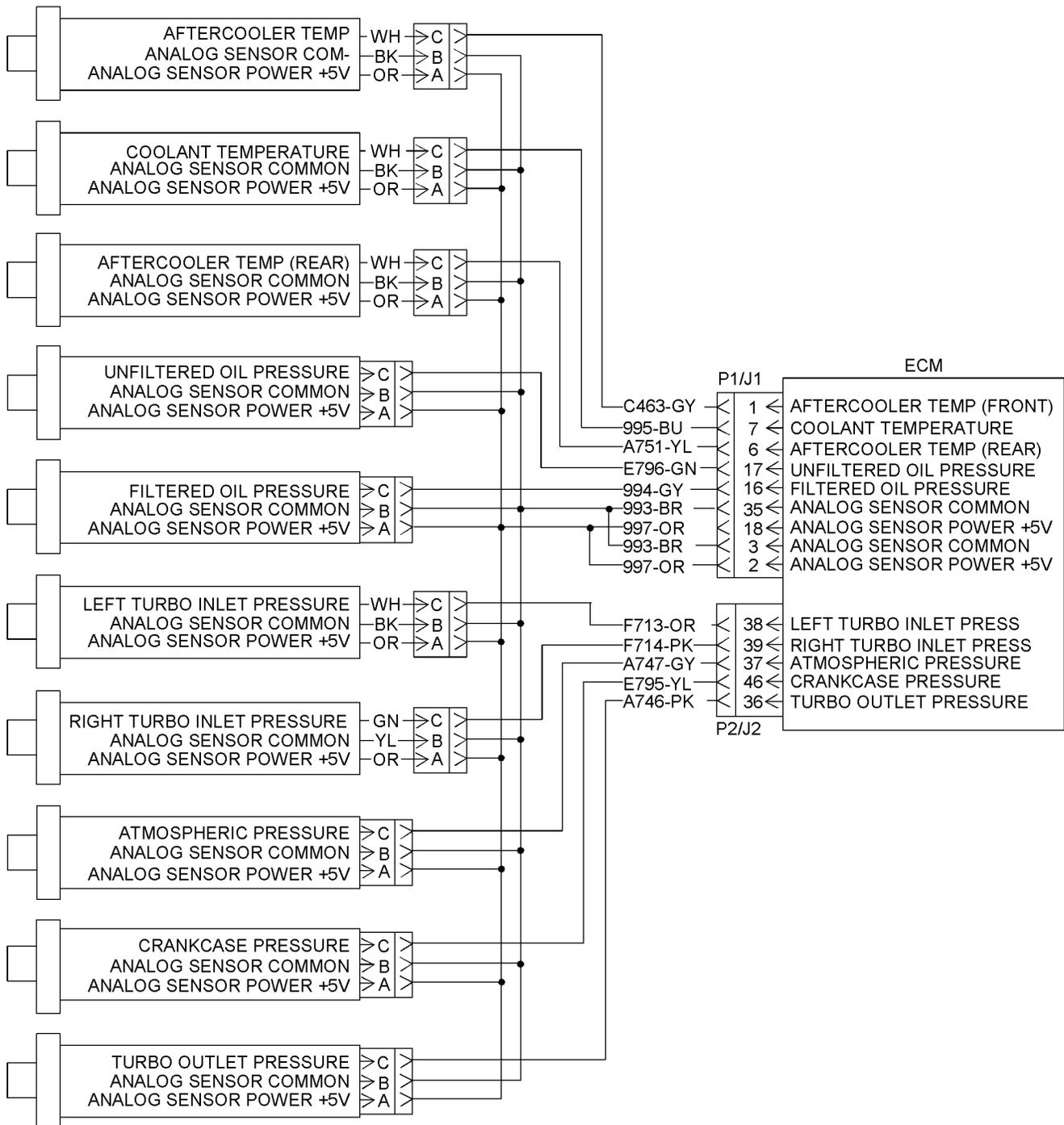


Illustration 14  
 Typical schematic

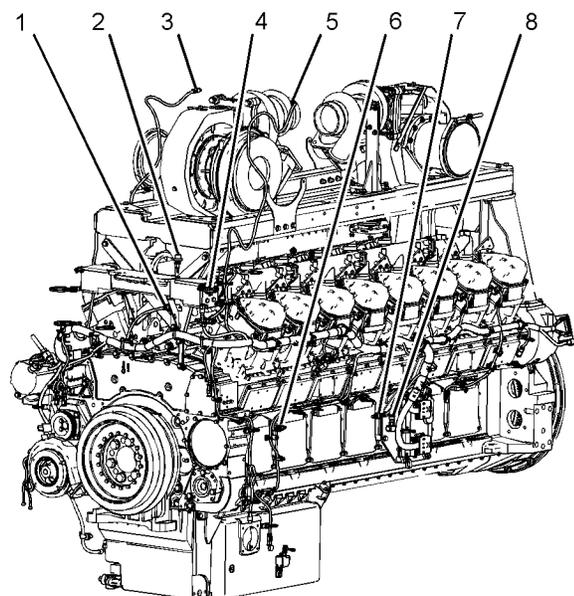


Illustration 15

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Front and Left view

- (1) Turbocharger compressor outlet pressure sensor (boost)
- (2) Aftercooler temperature sensor (front)
- (3) Right turbocharger compressor inlet pressure sensor
- (4) Coolant temperature sensor
- (5) Left turbocharger compressor inlet pressure sensor
- (6) Unfiltered engine oil pressure sensor
- (7) Filtered engine oil pressure sensor
- (8) Atmospheric pressure sensor

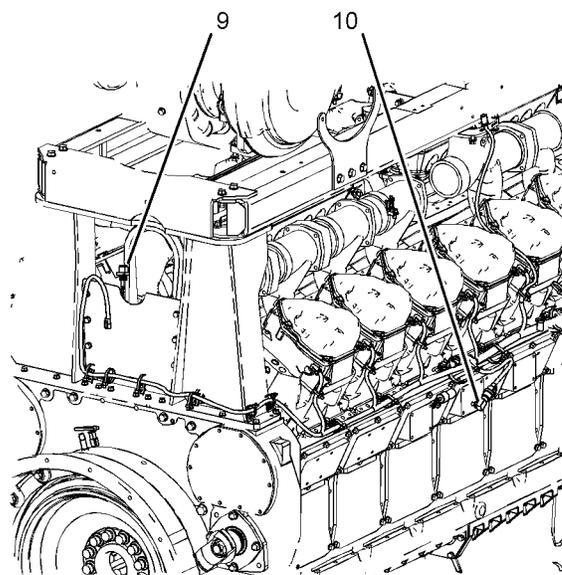
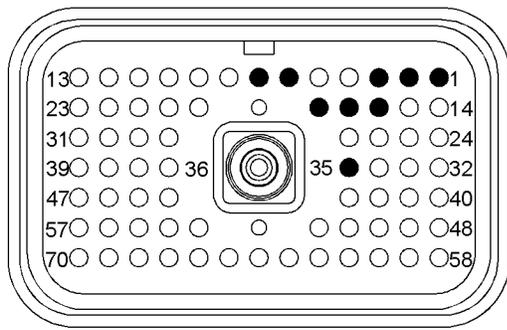


Illustration 16

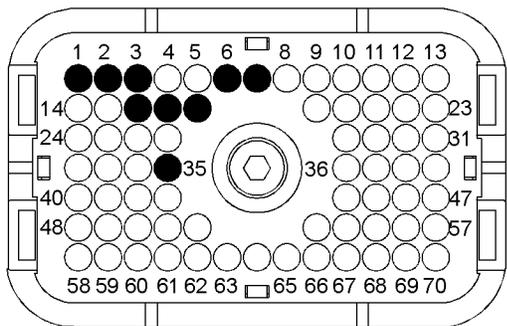
g01208831

Rear and Right view

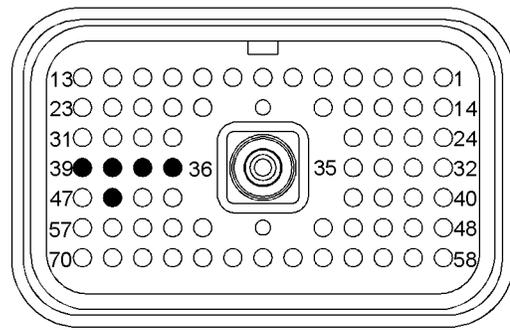
- (9) Aftercooler temperature sensor (rear)
- (10) Crankcase pressure sensor



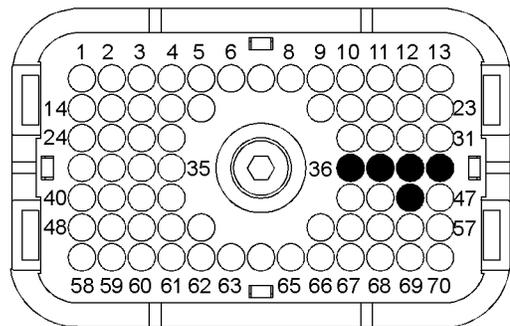
ECM SIDE



HARNESS SIDE



ECM SIDE



ENGINE SIDE

Illustration 17

g01203763

P1 ECM connector

- (P1-1) Aftercooler temperature sensor (front)
- (P1-2) 5 V sensor supply
- (P1-3) Sensor return
- (P1-6) Aftercooler temperature sensor (rear)
- (P1-7) Coolant temperature sensor
- (P1-16) Filtered engine oil pressure sensor
- (P1-17) Unfiltered engine oil pressure sensor
- (P1-18) 5 V sensor supply
- (P1-35) Sensor return

Illustration 18

g01203760

P2 ECM connector

- (P2-36) Turbocharger outlet pressure sensor
- (P2-37) Atmospheric sensor
- (P2-38) Left turbocharger inlet pressure sensor
- (P2-39) Right turbocharger inlet pressure sensor
- (P2-46) Crankcase pressure sensor

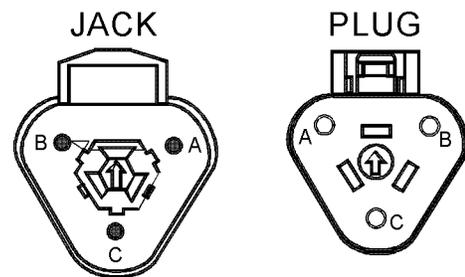


Illustration 19

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Sensor connector

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

**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 bad connection between a socket and a pin in a connector or a bad connection between a wire and a terminal.

- E. Determine if the problem is active and related to one of the following diagnostic codes:
  - 03
  - 04

**Expected Result:**

A diagnostic code has occurred several times.

**Results:**

- OK – A diagnostic code has occurred several times. Proceed to Test Step 2.
- Not OK - 03 – An active 03 diagnostic code is present. Proceed to Test Step 3.
- Not OK - 04 – An active 04 diagnostic code is present. Proceed to Test Step 5.

**Test Step 2. Perform the “Wiggle Test” on 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 for the suspect sensor in order to reproduce an intermittent problem.

If an intermittent problem is detected, the status will be highlighted and an audible beep will be heard.

**Expected Result:**

No intermittent problems were detected during the “Wiggle Test”.

**Results:**

- OK – No intermittent problems were found. The harness and connectors appear to be OK. If a diagnostic code is still active, proceed to Test Step 1 and continue to troubleshoot the active diagnostic code.
- Not OK – At least one intermittent problem was indicated.

**Repair:** Repair the harness or the connector. Refer to the diagnostic functional test Troubleshooting, “Inspecting Electrical Connectors”. Verify that the repair eliminates the problem.

STOP.

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

- A. Remove electrical power from the ECM.
- B. Disconnect the suspect sensor(s) at the sensor connector:
- C. Restore electrical power to the ECM.
- D. Measure the voltage on the ECM side of the sensor connector between pin A and pin B for the suspect sensor(s).

**Expected Result:**

The supply voltage is  $5.0 \pm 0.2$  VDC.

**Results:**

- OK – The voltage is  $5.0 \pm 0.2$  VDC. Proceed to Test Step 4.
- Not OK – The voltage is not  $5.0 \pm 0.2$  VDC. Proceed to Test Step 7.

**Test Step 4. 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 C (signal) and terminal B (sensor return) at the sensor connector.
- D. Restore electrical power to the ECM.
- E. Monitor the diagnostic codes on Cat ET. Check for an active 04 diagnostic code for the suspect sensor.

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

F. Remove electrical power from the ECM.

**Expected Result:**

A 04 diagnostic code is now active for the suspect sensor(s).

**Results:**

- OK – A 03 diagnostic code was active before creating the short at the sensor connector. A 04 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.

- Not OK – A 03 diagnostic code is still active for the suspect sensor(s). The problem may be in the harness or with the ECM. Proceed to Test Step 6.

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

- A. Remove electrical power from the ECM.
- B. Disconnect the sensor connector of the suspect sensor(s) with the active 04 diagnostic code.
- C. Restore electrical power to the ECM.
- D. Monitor the diagnostic codes on Cat ET. Check for an active 03 diagnostic code for the suspect sensor.

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

E. Remove electrical power from the ECM.

**Expected Result:**

A 03 diagnostic code is now active for the suspect sensor(s).

**Results:**

- OK – A 04 diagnostic code was active before disconnecting the sensor. A 03 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.

- Not OK – A 04 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. Check the Operation of the ECM**

- A. Remove electrical power from the ECM.
- B. Check the operation of the ECM by creating an open at the ECM.
  - a. Remove the signal wire for the suspect sensor from the P1 or P2 ECM connector. Refer to Illustration 14 for terminal locations.
  - b. Install a jumper wire with Deutsch sockets on each end into the socket for the signal wire of the suspect sensor.
  - c. Reconnect the ECM connectors.
  - d. Restore electrical power to the ECM.
  - e. Monitor the “Active Diagnostic Code” screen on Cat ET. Wait at least 30 seconds for activation of the code.

An open circuit diagnostic code 03 should be active for the suspect sensor.
- C. Check the operation of the ECM by creating a short at the ECM.
  - a. Install a wire jumper between the wire jumper for the signal wire for the suspect sensor and engine ground.
  - b. Monitor the “Active Diagnostic Code” screen on Cat ET. Wait at least 30 seconds for activation of the code.

A 04 diagnostic code should be active when the wire jumper is installed.
  - c. Remove the wire jumper. Reconnect all wires and connectors.

**Expected Result:**

A 03 diagnostic code is active when the sensor signal wire is removed from the ECM connector. A 04 diagnostic code is active when the signal wire is connected to engine ground.

**Results:**

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

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

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

STOP.

- Not OK – One of the following conditions exists: The 03 diagnostic code is not active when the sensor signal wire is disconnected. The 04 diagnostic code is not active when the wire jumper is shorted to ground.

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

STOP.

**Test Step 7. Check the Supply Voltage at the ECM**

- Remove electrical power from the ECM.
- Remove the supply wires from P1-2 and P1-18. Install wire jumpers into the sockets P1-2 and P1-18.
- Restore electrical power to the ECM.
- Measure the voltage between the wire jumper in terminal P1-2 and engine ground.
- Measure the voltage between the wire jumper in terminal P1-18 and engine ground.
- Remove electrical power from the ECM.
- Remove the wire jumpers and replace all wires.

**Expected Result:**

The supply voltage is  $5.0 \pm 0.2$  VDC.

**Results:**

- OK – The supply voltage is  $5.0 \pm 0.2$  VDC. The supply voltage at the ECM is correct. There is a problem in the wiring between the ECM and the sensor connector. Check the supply wires and the return wire for an open circuit.

**Repair:** Repair the connectors or wiring and/or replace the connectors or wiring.

STOP.

- Not OK – The supply voltage is not  $5.0 \pm 0.2$  VDC. The voltage at the ECM is not correct.

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

STOP.

i02409119

**Cat Data Link**

**SMCS Code:** 1901-038

**System Operation Description:**

Use this procedure to troubleshoot the Cat Data Link if a problem is suspected with the wiring. Use this procedure if any one of the diagnostic codes in Table 26 is active or easily repeated.

Table 26

<b>Diagnostic Codes Table</b>		
<b>Description</b>	<b>Conditions which Generate this Code</b>	<b>System Response</b>
MID 0036 - CID 0296 - FMI 09 Unable to communicate with Transmission ECM	The engine's Electronic Control Module (ECM) detects a failure in the Cat Data Link. The ECM detects a loss of communication with the transmission ECM.	The code is logged.
MID 0036 - CID 0800 - FMI 09 Unable to communicate with VIMS	The ECM detects a failure in the Cat Data Link. The VIMS main module has failed.	

The Cat Data Link is used for communication between electronic modules. The Cat Data Link is used to communicate information from the Electronic Control Module (ECM) to other electronic systems. The Cat Data Link is used for programming and troubleshooting the ECM.

The ECM communicates with Caterpillar Electronic Technician (ET) in order to share status information and diagnostic information. Cat ET can also be used to configure the ECM parameters. This information will not be available if communication fails between the ECM and Cat ET.

The ECM communicates with other controls in order to communicate the engine's operating status. The ECM communicates with the power train in order to perform machine functions. The following control modules may be used in your application: Engine ECM, VIMS Module, RAC Module, and Transmission Control.

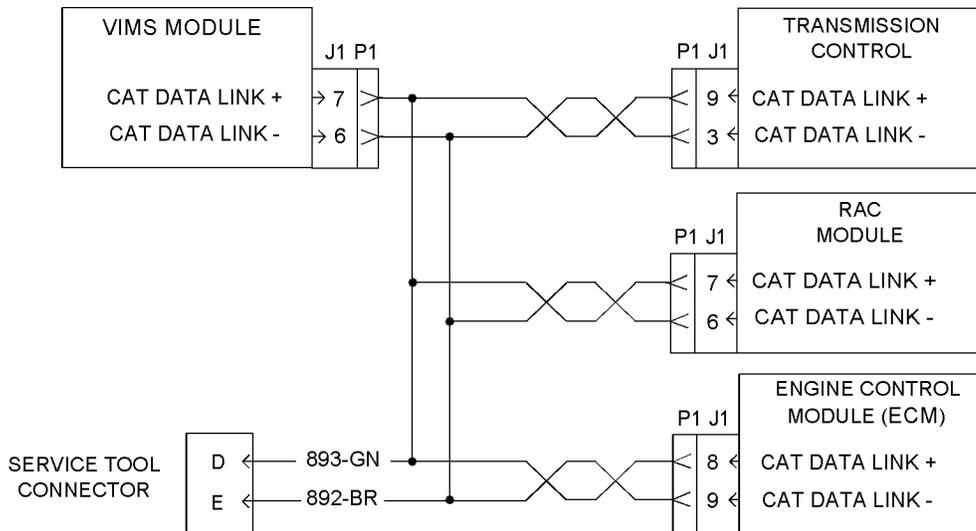


Illustration 20  
Schematic

g01203833

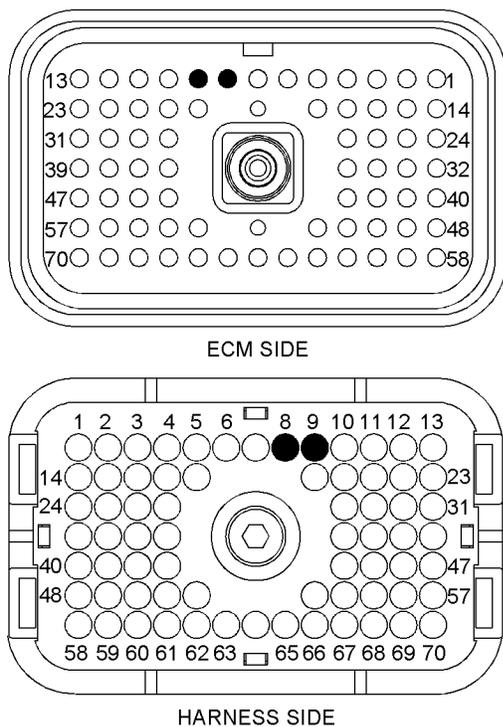


Illustration 21

g01156133

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

### Test Step 1. Inspect the Electrical Connectors and the Wiring

- A. Remove power from the ECM.
- B. Thoroughly inspect the ECM connectors J1/P1 and J2/P2. Inspect all of the connectors to other modules on the Cat Data Link. Refer to the diagnostic functional test Troubleshooting, "Inspecting Electrical Connectors" 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, "Inspecting Electrical Connectors" for details.
- 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.

### Test Step 2. Check for Shorts in the Harness

- A. Disconnect ECM connector J1/P1 at the engine ECM.
- B. Disconnect all control modules from the Cat Data Link.
- C. Disconnect Cat ET from the service tool connector.
- D. Measure the resistance from P1-8 to every terminal on ECM connectors P1 and P2.
- E. Measure the resistance from P1-8 to the chassis ground.
- F. Measure the resistance from P1-9 to every terminal on ECM connectors P1 and P2.
- G. Measure the resistance from P1-9 to the chassis ground.

#### Expected Result:

The resistance measurements indicate an open circuit.

#### Results:

- OK – The resistance measurements indicate an open circuit. Proceed to Test Step 3.
- Not OK – The resistance measurements do not indicate an open circuit.

**Repair:** Repair the connectors or wiring and/or replace the connectors or wiring.

STOP.

### Test Step 3. Check for an Open in the Harness

- A. Use a suitable piece of wire to create a short circuit at the cab service tool connector. Short terminal D and terminal E together.
- B. Measure the resistance between P1-8 and P1-9.

- C. Measure the resistance at the connectors of the other control modules.

#### Expected Result:

The resistance measurement indicates a short circuit.

#### Results:

- OK – The resistance measurement indicates a short circuit. The Cat Data Link is OK.

**Repair:** If the problem is intermittent, perform the diagnostic functional test Troubleshooting, “Inspecting Electrical Connectors”.

STOP.

- Not OK – The resistance measurement does not indicate a short circuit. There is an open circuit in the harness or connectors.

**Repair:** Repair the connectors or wiring and/or replace the connectors or wiring.

STOP.

i02409173

## Coolant Flow Switch

**SMCS Code:** 1438-038

#### System Operation Description:

Use this procedure in order to troubleshoot a problem with coolant flow or use this procedure if the following event code is active.

Table 27

Event Code		
Description	Default Conditions which Generate this Code	System Response
E035 Loss of Coolant Flow Warning	The coolant flow switch opens.	The code is active and the code is logged.

The coolant flow switch is used to determine if there is sufficient flow of coolant in the cooling system of the engine. The coolant flow switch is closed when coolant is flowing in the system. The Electronic Control Module (ECM) monitors the status of the coolant flow switch, and the ECM will alert the operator if there is a loss of coolant flow.

Check the operation of the jacket water coolant pump.

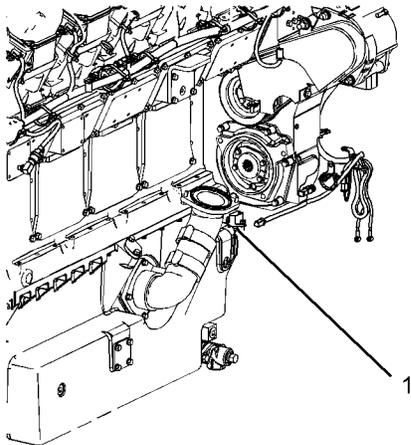


Illustration 22 g01208730  
Right side view  
(1) Coolant flow switch

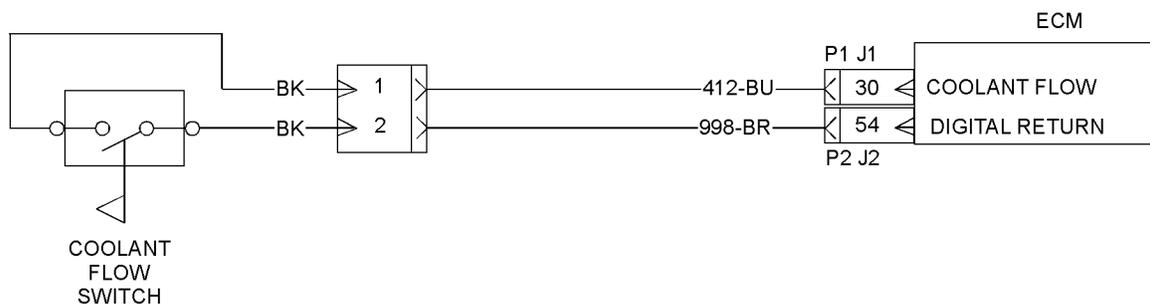
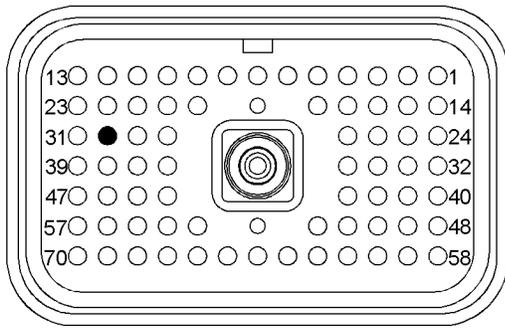
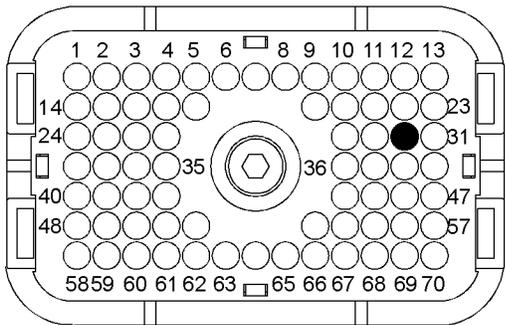


Illustration 23 g01203867  
Schematic

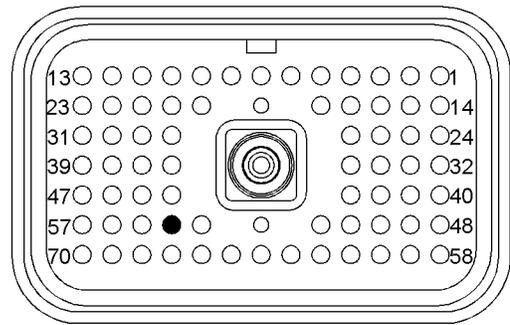


ECM SIDE

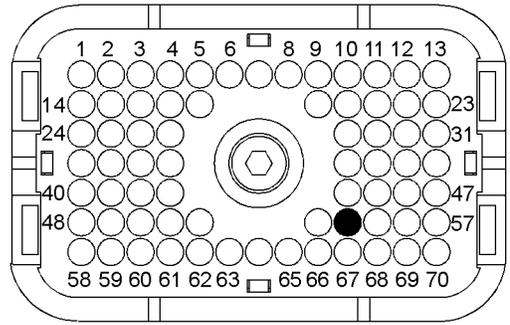


HARNESS SIDE

Illustration 24  
P1 ECM connector  
(P1-30) Coolant flow  
g01147985



ECM SIDE



HARNESS SIDE

Illustration 25  
P2 ECM connector  
(P2-54) Digital return  
g01147988

### Test Step 1. Check the Coolant Level

- A. Check the coolant level. Refer to the Operation and Maintenance Manual for information on checking the coolant level.

#### Expected Result:

The coolant level is OK.

#### Results:

- OK – The coolant is OK. Proceed to Test Step 2.
- Not OK – The coolant level is low.

**Repair:** Determine the reason for a low coolant level.

Refer to Systems Operation/Testing and Adjusting for information on testing the cooling system.

Verify that the repair eliminates the problem.

STOP.

## Test Step 2. Inspect Electrical Connectors and Wiring

- A. Remove electrical power from the engine ECM.
- B. Thoroughly inspect the J1/P1 and J2/P2 ECM connectors. Inspect the connector for the coolant flow switch. Refer to Troubleshooting, "Inspecting Electrical Connectors" for details.
- 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 connectors (allen head screw) for the proper torque. Refer to Troubleshooting, "Inspecting Electrical Connectors" 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 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 are OK. Proceed to Test Step 3.
- Not OK – There is a problem in the connectors and/or wiring.

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

Verify that the repair eliminates the problem.

STOP.

## Test Step 3. Check the Status of the Coolant Flow on Caterpillar Electronic Technician (ET)

- A. Restore electrical power to the engine ECM.
- B. Connect Cat ET to the service tool connector.
- C. Observe the reading for coolant flow on Cat ET.
- D. Turn the keyswitch to the START position. Start the engine.
- E. Observe the reading for coolant flow on Cat ET.
- F. Turn the keyswitch to the OFF position.

### Expected Result:

Cat ET indicates "NO FLOW" while the engine is not running. Cat ET indicates "FLOW" while the engine is running.

### Results:

- OK – Cat ET indicates "NO FLOW" while the engine is not running. Cat ET indicates "FLOW" while the engine is running. The coolant switch is OK.

**Repair:** If the problem is intermittent, perform the diagnostic functional test Troubleshooting, "Inspecting Electrical Connectors".

STOP.

- Not OK – Cat ET does not indicate "NO FLOW" while the engine is not running. Cat ET does not indicate "FLOW" while the engine is running. Cat ET does not indicate the correct status of the coolant flow switch. Proceed to Test Step 4.

## Test Step 4. Create a Short Circuit at the Connector of the Coolant Flow Switch

- A. Disconnect the connector for the coolant flow switch.
- B. Use a suitable piece of wire to short terminal 1 (coolant flow switch) to terminal 2 (engine ground).
- C. Turn the keyswitch to the ON position.
- D. Observe the status of "Engine Coolant Flow" on Cat ET.
- E. Turn the keyswitch to the OFF position.

### Expected Result:

The status indicates "Flow" with the jumper wire in place.

### Results:

- OK – The ECM and the wiring are operating correctly. Proceed to Test Step 5.
- Not OK – The status indicates "NO FLOW". Proceed to Test Step 6.

## Test Step 5. Check the Coolant Flow Switch

### WARNING

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

- A. Drain the engine coolant below the coolant flow switch.
- B. Remove the coolant flow switch from the engine.
- C. Manually close the coolant flow switch. Ensure that excessive force is not required to close the switch.
- D. Measure continuity between terminal 1 and terminal 2 with the switch in the closed position.

#### Expected Result:

The switch closes easily and there is continuity between terminal 1 and terminal 2 with the switch in the closed position.

#### Results:

- OK – There may be a mechanical problem with the engine's cooling system.

**Repair:** Refer to Systems Operation/Testing and Adjusting for information on testing the cooling system.

Verify that the repair eliminates the problem.

STOP.

- Not OK – There is a problem with the coolant flow switch.

**Repair:** Replace the coolant flow switch with a new switch.

Verify that the repair eliminates the problem.

STOP.

## Test Step 6. Check the ECM

- A. Disconnect the J1/P1 ECM connector.
- B. Remove wire 412-BU from ECM connector P1-30. Install a wire with Deutsch sockets on each end into P1-30.

- C. Reconnect the J1/P1 ECM connector.
- D. Use a suitable piece of wire to short the wire jumper in P1-30 to engine ground.
- E. Turn the keyswitch to the ON position.
- F. Observe the status of "Engine Coolant Flow" on Cat ET.
- G. Turn the keyswitch to the OFF position.

#### Expected Result:

The status indicates "Flow" with the jumper wire in place.

#### Results:

- OK – The status indicates "Flow" with the jumper wire in place.

**Repair:** There is an open in the wire between terminal 1 and the ECM and/or there is an open in the digital return wire between terminal 2 and P2-54. Repair the wire.

STOP.

- Not OK – The status indicates "NO FLOW". The ECM is not responding correctly.

**Repair:** Verify your results.

Refer to Troubleshooting, "Replacing the ECM" before replacing the ECM.

Verify that the repair eliminates the problem.

STOP.

i02409465

## Electrical Power Supply

**SMCS Code:** 1401-038

#### System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with the power to the engine's Electronic Control Module (ECM) or if any one of the diagnostic codes or the event code in Table 28 is active or easily repeated.

Table 28

<b>Diagnostic Codes Table</b>		
<b>Description</b>	<b>Conditions which Generate this Code</b>	<b>System Response</b>
MID 0036 - CID 0168 - FMI 01 System Voltage Low	The battery supply voltage is less than 9 VDC for two seconds. The engine's ECM has been powered for three seconds. The engine is not being cranked.	The code is logged if the engine is running.
MID 0036 - CID 0168 - FMI 02 Battery Voltage intermittent/erratic	The engine is running. The battery voltage falls below 9 VDC for at least .06 seconds. The voltage returns above 9 VDC. or Three voltage readings in the last seven seconds were below 9 VDC.	

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

There are two +Battery connections and two -Battery connections to the ECM. These multiple lines will reduce the resistance at the harness. The ECM continuously receives battery voltage through a 15 amp breaker. When the ECM senses the battery voltage at the keyswitch input, the ECM turns on. When the voltage is removed from the keyswitch input, the ECM turns off.

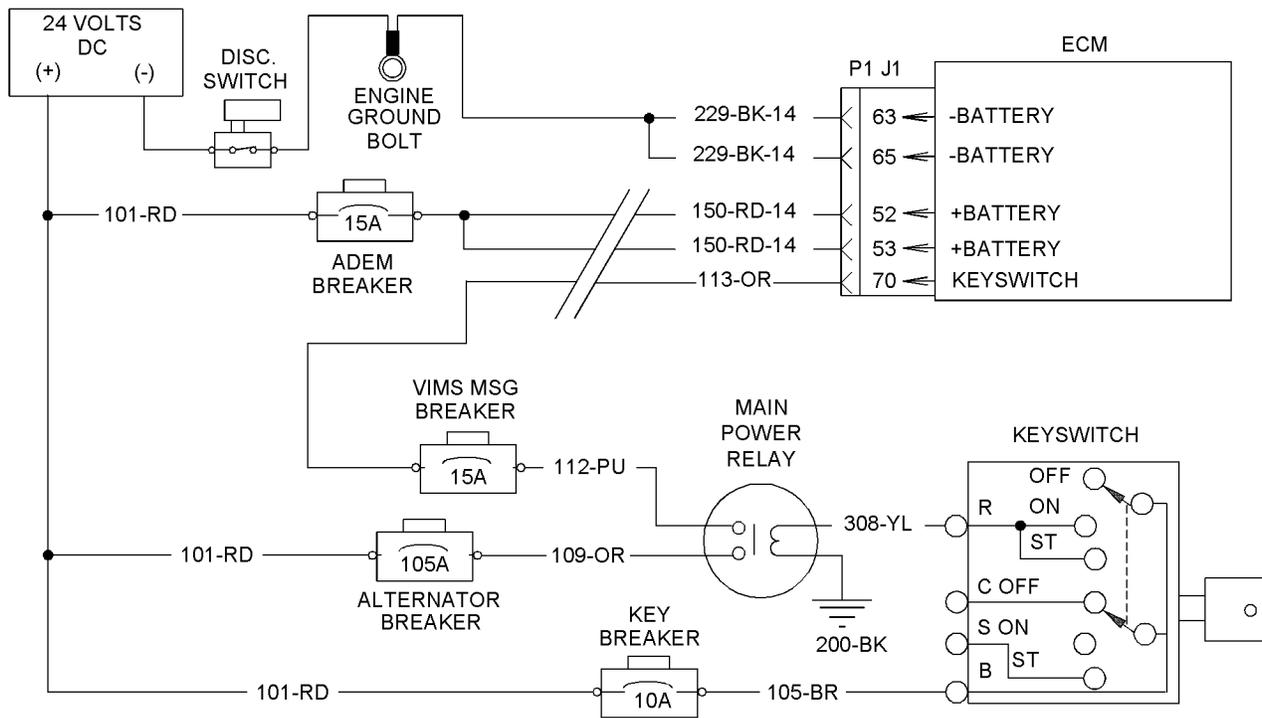


Illustration 26  
 Typical schematic

g01203933

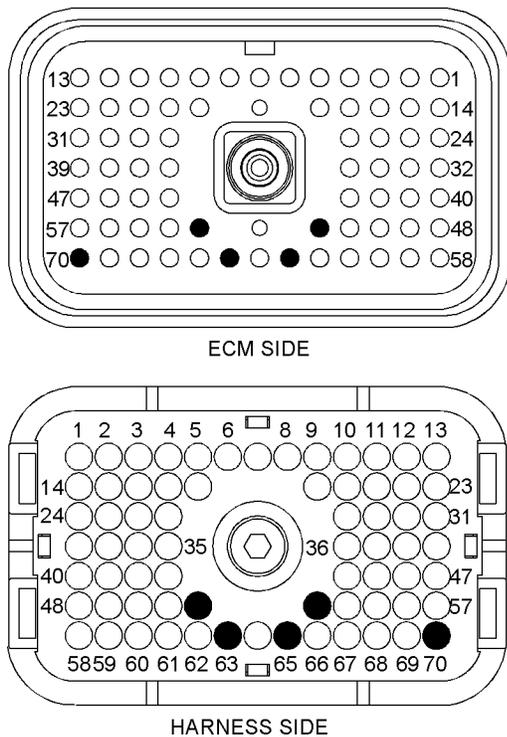


Illustration 27

g01203934

## P1 ECM connector

(P1-52) +Battery  
 (P1-53) +Battery  
 (P1-63) -Battery  
 (P1-65) -Battery  
 (P1-70) Keyswitch

### Test Step 1. Inspect Electrical Connectors and Wiring

- A. Remove electrical power from the ECM.
- B. Thoroughly inspect the ECM connectors J1/P1. Inspect all of the other connectors. Refer to Troubleshooting, "Inspecting Electrical Connectors" for the proper procedure for inspecting system wiring.
- 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, "Inspecting Electrical Connectors" for details.
- E. Check the harness and the wiring for abrasion and for pinch points.

#### Expected Result:

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

#### Results:

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

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

Verify that the repair eliminates the problem.

STOP.

### Test Step 2. Check the Voltage at the Battery Post

- A. Measure the voltage at the battery posts.

#### Expected Result:

The voltage is  $24 \pm 3$  VDC.

#### Results:

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

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

STOP.

### Test Step 3. Check the Voltage at the ECM Connector

- A. Disconnect the J1/P1 ECM connector.
- B. Measure the voltage between P1-52 (Unswitched Positive Battery) and P1-63 (Negative Battery).
- C. Measure the voltage between P1-53 (Unswitched Positive Battery) and P1-65 (Negative Battery).
- D. Measure the voltage between P1-70 (Keyswitch) and P1-63 (Negative Battery).

#### Expected Result:

The voltage is  $\pm 1$  VDC from the voltage at the battery terminals.

#### Results:

- OK – The ECM is receiving the correct voltage.

**Repair:** If an intermittent condition is suspected, refer to Troubleshooting, “Inspecting Electrical Connectors”.

STOP.

- Not OK - Keyswitch voltage out of range – Proceed to Test Step 4.
- Not OK – The voltage is not  $\pm 1$  VDC from the voltage at the battery terminals. The voltage is not correct at the ECM.

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

STOP.

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

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

**Expected Result:**

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

**Results:**

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

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

STOP.

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

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

STOP.

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

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

Table 29

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

- D. Turn the keyswitch to the OFF position.

**Expected Result:**

The voltage measures  $24 \pm 3$  VDC between each of the test points and engine ground.

**Results:**

- OK – The voltage measures  $24 \pm 3$  VDC between each of the test points and engine ground.

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

STOP.

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

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

STOP.

- Not OK – The voltage does not measure  $24 \pm 3$  VDC between wire 109-OR and engine ground.

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

STOP.

- Not OK – The voltage does not measure  $24 \pm 3$  VDC between wire 308-YL and engine ground.

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

STOP.

i02409475

## Engine Oil Level Switch

**SMCS Code:** 1408-038-ZS

### System Operation Description:

Use this procedure in order to troubleshoot a problem with the low oil level switch or use this procedure if the following event code is active. Refer to Troubleshooting, “Event Code List” for information on specific trip points for the event codes.

Table 30

Event Code		
Description	Conditions which Generate this Code	System Response
E072 Oil Level Low Mark	The oil level switch opens.	The code is active and the code is logged.

The low oil level switch signals the Electronic Control Module (ECM) if the oil level falls below a predetermined level in the oil pan. The ECM warns the operator of possible engine damage. The float closes a switch when the oil level is above a predetermined level.

The ECM may modify the operation of the engine in the event of low oil level. The ECM cannot determine if the low oil level switch or associated components have failed.

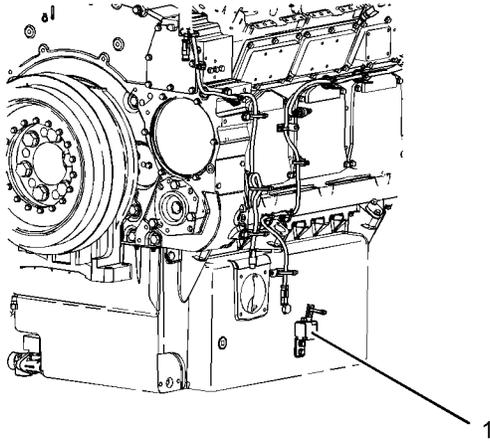


Illustration 28 g01208732  
Left side view  
(1) Low oil level switch

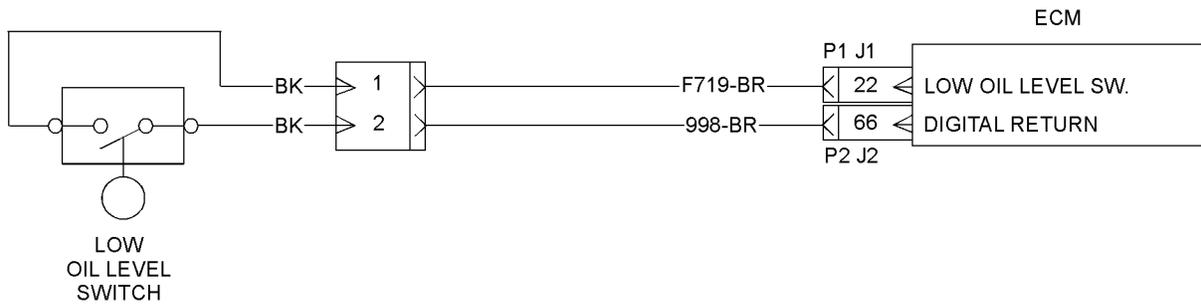


Illustration 29  
Schematic

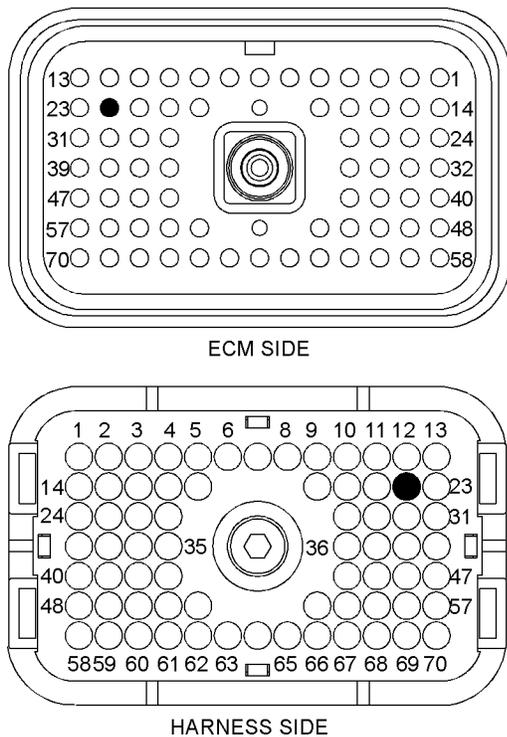


Illustration 30

g01203954

P1 ECM connector  
(P1-22) Low oil level

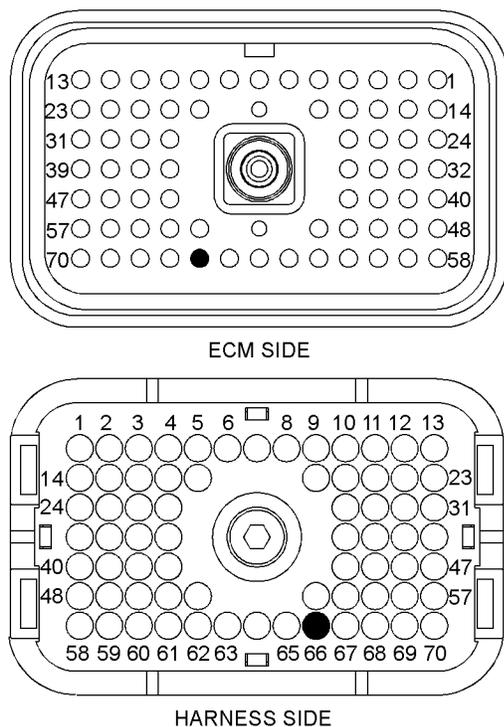


Illustration 31

g01203955

P2 ECM connector  
(P2-66) Digital return

## Test Step 1. Inspect Electrical Connectors and Wiring

- A. Turn the keyswitch to the OFF position.
- B. Thoroughly inspect the ECM connectors J1/P1 and J2/P2. Inspect the connector for the low oil level switch. Refer to Troubleshooting, "Inspecting Electrical Connectors" 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, "Inspecting Electrical Connectors" for details.
- E. Check the harness and the wiring for abrasion and for pinch points.

### Expected Result:

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

### Results:

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

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

Verify that the repair eliminates the problem.

STOP.

## Test Step 2. Check the Level of the Engine Oil

- A. Ensure that the correct engine oil dipstick is installed.
- B. Check the engine oil level.

### Expected Result:

The engine oil is at the correct level.

### Results:

- OK – The engine oil level is correct. Proceed to Test Step 3.
- Not OK – The engine oil level is low.

**Repair:** Add oil to the engine.

STOP.

### Test Step 3. Check the Engine Oil Level on Caterpillar Electronic Technician (ET)

- A. Connect Cat ET to the service tool connector.
- B. Turn the keyswitch to the ON position.
- C. Observe the “Engine Oil Level” reading on Cat ET.

#### Expected Result:

The “Engine Oil Level” reads “OK”.

#### Results:

- OK – The “Engine Oil Level” reads “OK”.

**Repair:** The switch signal is correct.

STOP.

- Not OK – The “Engine Oil Level” does not read “OK”. The switch signal is not correct. Proceed to Test Step 4.

### Test Step 4. Short the Wires at the Low Oil Level Switch

- A. Disconnect the connector for the low oil level switch.
- B. Use a wire to short terminal terminal 1 to terminal 2. Install the wire jumper on the harness side of the connector.
- C. Turn the keyswitch to the ON position.
- D. Observe the status of the “Engine Oil Level” on Cat ET.
- E. Remove the wire short.
- F. Observe the status of the “Engine Oil Level” on Cat ET.
- G. Turn the keyswitch to the OFF position.

#### Expected Result:

Cat ET indicates “OK” when the wire short is installed. Cat ET indicates “LOW” when the wire short is removed.

#### Results:

- OK – Cat ET indicates “OK”, when the wire short is in place. Cat ET indicates “LOW”, when the wire short is removed. Cat ET recognized the input from the switch.

**Repair:** Temporarily replace the switch. Verify that a new switch solves the problem before you permanently install the new switch.

STOP.

- Not OK – Cat ET does not indicate “OK”, when the wire short is in place. Cat ET does not indicate “LOW”, when the wire short is removed. Cat ET does not recognize the input from the switch. Proceed to Test Step 5.

### Test Step 5. Short the Input Wires of the Low Oil Level Switch at the ECM Connector

- A. Disconnect ECM connector P1.
- B. Remove the wire from P1-22 (low oil level). Install a wire jumper with a socket on one end into P1-29.
- C. Remove the wire from P2-66 (digital return). Install a wire jumper with a socket on one end into P2-20.
- D. Connect a wire jumper between the wire jumpers in P1-22 and P2-66.
- E. Reconnect all connectors.
- F. Turn the keyswitch to the ON position.

**Note:** Additional diagnostic codes will be generated because the digital return will no longer be connected to the other sensors and switches. Ignore the codes and clear the codes when you complete this test.

- G. Observe the status of the “Engine Oil Level” on Cat ET.
- H. Remove the wire short.
- I. Reconnect all connectors.
- J. Observe the status of the “Engine Oil Level” on Cat ET.
- K. Turn the keyswitch to the OFF position.
- L. Reconnect all connectors.

**Expected Result:**

Cat ET indicates that the “Engine Oil Level” is “OK” when the wire short is installed. Cat ET indicates that the “Engine Oil Level” is “LOW” when the wire short is removed.

**Results:**

- OK – Cat ET indicates that the “Engine Oil Level” is “OK” when the wire short is installed. Cat ET indicates that the “Engine Oil Level” is “LOW” when the wire short is removed. The problem is in the harness between the ECM and the low oil level switch.

**Repair:** Repair the connectors or wiring and/or replace the connectors or wiring.

STOP.

- Not OK – Cat ET does not indicate that the “Engine Oil Level” is “OK” when the wire short is installed. Cat ET does not indicate that the “Engine Oil Level” is “LOW” when the wire short is removed. The ECM is not reading the switch position.

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

STOP.

i02409564

## Engine Oil Renewal Solenoid

**SMCS Code:** 1348-038; 1901-038

**System Operation Description:**

Use this procedure to troubleshoot the circuit for the engine oil renewal solenoid or use this procedure if any one of the diagnostic codes in Table 31 is active or easily repeated.

Table 31

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
MID 0036 - CID 0569 - FMI 05 Oil Renewal Solenoid open circuit	The engine's Electronic Control Module (ECM) detects an open circuit or a short circuit to ground at the output to the oil renewal solenoid. The engine's ECM has been powered for two seconds.	The code is logged.
MID 0036 - CID 0569 - FMI 06 Oil Renewal Solenoid short to ground	The engine's ECM detects a short circuit to the +Battery at the output to the oil renewal solenoid. The engine's ECM has been powered for two seconds.	

Use this procedure to troubleshoot any suspect problems with the system for the engine oil renewal solenoid.

This procedure covers the following diagnostic codes:

- 2271-05 Engine Oil Renewal System Actuation Solenoid current low
- 2271-06 Engine Oil Renewal System Actuation Solenoid current high

The ECM adds a controlled amount of engine oil to the fuel by energizing the engine oil renewal solenoid. The engine oil is added to the fuel and burned during combustion. The typical oil change interval may be extended.

The ECM energizes the engine oil renewal solenoid which injects the engine oil into the return line for the fuel.

For further information, refer to Service Manual, RENR2223, "Oil Renewal System".

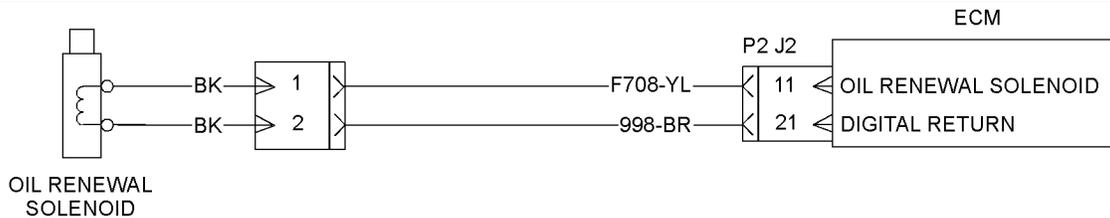


Illustration 32  
Schematic  
P2 ECM connector

g01152043

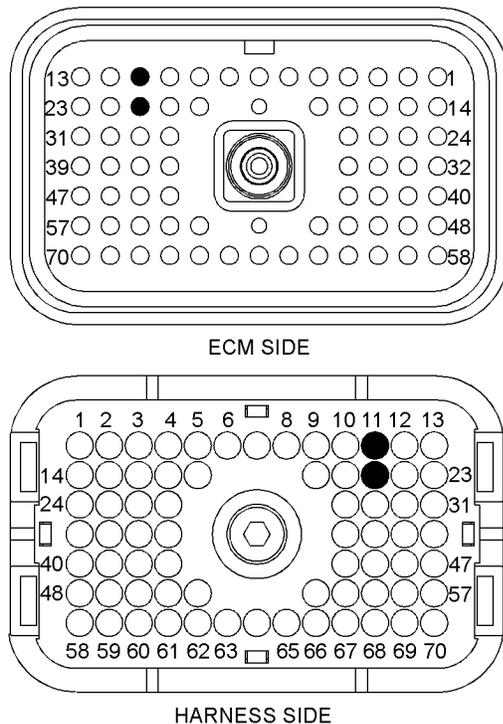


Illustration 33

g01156098

P2 ECM connector  
(P2-11) Engine oil renewal solenoid  
(P2-21) Digital return

### Test Step 1. Inspect Electrical Connectors and Wiring

- A. Turn the keyswitch to the OFF position.
- B. Thoroughly inspect the ECM connector J2/P2. Inspect all other connectors that are related to the circuit. Refer to Troubleshooting, "Inspecting Electrical Connectors" 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, "Inspecting Electrical Connectors" for details.
- E. Check the harness and the wiring for abrasion and for pinch points.

#### Expected Result:

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

#### Results:

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

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

Verify that the repair eliminates the problem.

STOP.

### Test Step 2. Check for an Internal Short or for an Open in the Engine Oil Renewal Solenoid's Coil

- A. Disconnect the connector of the engine oil renewal solenoid.
- B. Measure the resistance of the coil by measuring the resistance between terminal 1 and terminal 2 of the connector.

#### Expected Result:

The resistance is between 32 and 53 Ohms.

#### Results:

- OK – The resistance is between 32 and 53 Ohms. The resistance is correct. Proceed to Test Step 3.
- Not OK – The resistance is not between 32 and 53 Ohms. The resistance measurement indicates an open or a shorted coil. The resistance is incorrect.

**Repair:** The coil of the solenoid is internally shorted or open. Replace the solenoid.

STOP.

### Test Step 3. Check the Voltage at the Engine Oil Renewal Solenoid

- A. Connect Caterpillar Electronic Technician (ET) to the service tool connector.
- B. Turn the keyswitch to the ON position.
- C. Start Cat ET.
- D. Select the override for the engine oil renewal solenoid on Cat ET.
- E. Set the override for the engine oil renewal solenoid to 100 percent.

- F. Measure the voltage between terminal 1 and terminal 2 at the solenoid connector.

**Expected Result:**

The voltage is approximately 24 VDC.

**Results:**

- OK – The voltage is approximately 24 VDC. Voltage is present at the connector.

**Repair:** The voltage is reaching the solenoid. Check the mechanical operation of the solenoid.

STOP.

- Not OK – The voltage is not 24 VDC. The voltage is not present at the connector. Proceed to Test Step 4.

**Test Step 4. Check the Voltage at the ECM**

- A. Turn the keyswitch to the OFF position.
- B. Remove wire F708-YL from terminal P2-11 at ECM connector J2/P2. Install a wire jumper into the socket for P2-11.
- C. Turn the keyswitch to the ON position.
- D. Select the override for the engine oil renewal solenoid on Cat ET.
- E. Set the override for the engine oil renewal solenoid to 100 percent.
- F. Measure the voltage between the wire jumper in P2-11 and engine ground.
- G. Remove the jumper wires and reconnect all wires.

**Expected Result:**

The voltage is approximately 24 VDC.

**Results:**

- OK – The voltage is approximately 24 VDC. The voltage is correct. There is an open circuit or excessive resistance in the harness between the ECM and the solenoid.

**Repair:** Repair the connectors or wiring and/or replace the connectors or wiring.

STOP.

- Not OK – The voltage is not 24 VDC. The voltage is not present at the connector.

**Repair:** Replace the ECM. Refer to Troubleshooting, "Replacing the ECM".

STOP.

i02409685

## Engine Speed/Timing Sensor

**SMCS Code:** 1912-038

**System Operation Description:**

Use this procedure in order to troubleshoot a problem with the engine speed/timing sensor or use this procedure if the following diagnostic code is active.

Table 32

Event Code		
Description	Conditions which Generate this Code	System Response
MID 0036 - CID 0190 - FMI 08 Engine Speed signal abnormal	The engine speed is greater than zero rpm and the pattern from the timing ring is incorrect for five seconds.	The engine speed is set to zero rpm. The code is active. The code is logged if the pattern from the timing ring returns for five seconds.

The Electronic Control Module (ECM) provides the engine speed/timing sensor with  $12 \pm 1.0$  VDC. The engine speed/timing sensor provides a pulse signal to the ECM. The signal is created as the timing reference gear rotates past the pickup of the engine speed/timing sensor. The timing reference gear is mounted on the rear of the left camshaft. A unique tooth pattern on the timing reference gear allows the ECM to determine the crankshaft position, rotation, and rpm.

The engine speed/timing sensor generates a pulse signal to the ECM as each tooth passes the sensor. The ECM counts the pulses in order to determine the engine rpm. The ECM memorizes the pattern of the pulses. The ECM compares that pattern to a standard pattern in order to determine the crankshaft position. The ECM uses this information to determine the No. 1 cylinder. The ECM then triggers each fuel injector to fire in the correct firing order and at the correct time. The actual timing and duration of each injection is determined by the ECM. The ECM uses engine rpm and engine load to determine the timing and duration of injection. The loss of the signal from the engine speed/timing sensor generates a diagnostic code. The loss of the signal from the engine speed/timing sensor triggers the termination of the signals to the fuel injectors by the ECM.

**Note:** If the engine timing gear is installed backward, the ECM will generate a diagnostic code. The diagnostic code that is generated will be 190-08 Engine Speed signal abnormal. If this code is active, the ECM will not fire the injectors.

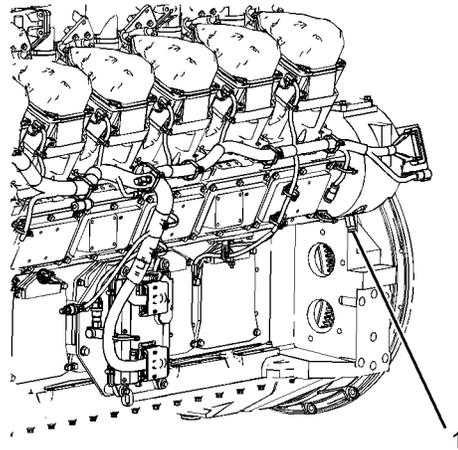


Illustration 34

g01208740

Left side view

(1) Engine speed/timing sensor

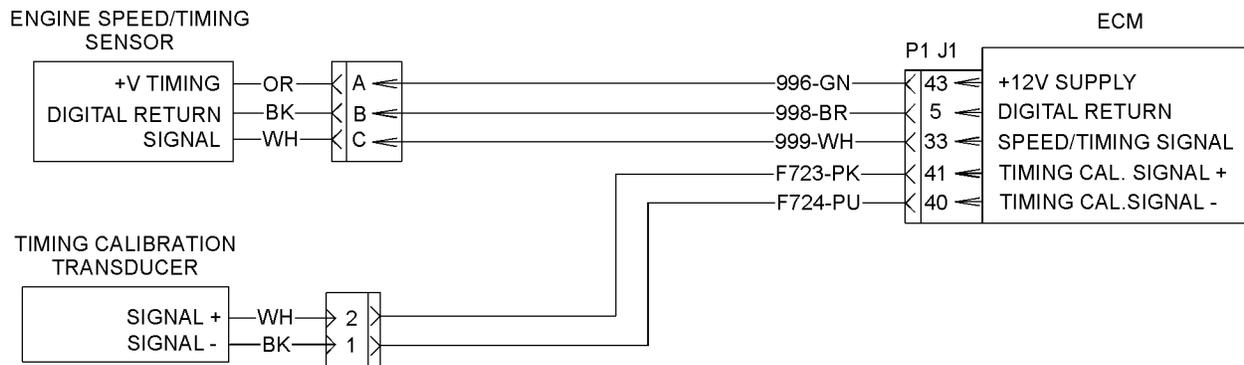


Illustration 35  
Schematic

g01204148

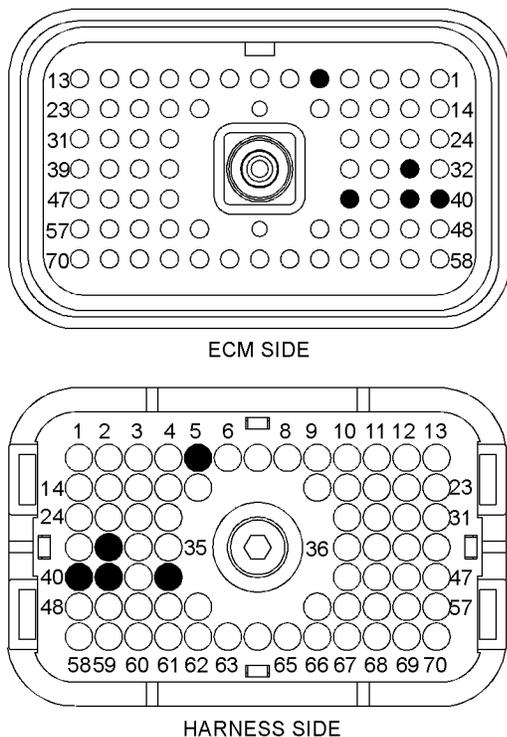


Illustration 36  
P1 ECM connector

g01156100

- (P1-5) Digital return
- (P1-33) Engine speed/timing signal
- (P1-40) Engine timing calibration -
- (P1-41) Engine timing calibration +
- (P1-43) +12 V supply

### Test Step 1. Inspect Electrical Connectors and Wiring

A. Turn the keyswitch to the OFF position.

- B. Thoroughly inspect the ECM connectors J1/P1 and J2/P2. Inspect all of the other connectors for the circuit. Refer to Troubleshooting, "Inspecting Electrical Connectors" 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, "Inspecting Electrical Connectors" 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 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 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 a “LOGGED” Diagnostic Code

- A. Connect Caterpillar Electronic Technician (ET) to the service tool connector.
- B. Turn the keyswitch to the ON position.
- C. Check the diagnostic codes on Cat ET.

#### Expected Result:

Cat ET indicates that a 190-08 diagnostic code has recently been logged.

#### Results:

- OK – The 190-08 diagnostic code is logged. Proceed to Test Step 3.
- Not OK – The 190-08 is not logged.

**Repair:** The problem is no longer present. If the problem is intermittent, refer to Troubleshooting, “Inspecting Electrical Connectors”.

STOP.

### Test Step 3. Check the Supply Voltage to the Sensor

- A. Disconnect the connector for the engine speed/timing sensor.
- B. Turn the keyswitch to the ON position.
- C. Measure the voltage between terminal A and terminal B at the sensor connector.

#### Expected Result:

The supply voltage is  $12 \pm 1.0$  VDC.

#### Results:

- OK – The supply voltage is  $12 \pm 1.0$  VDC. Proceed to Test Step 4.
- Not OK – The supply voltage is not  $12 \pm 1.0$  VDC. Proceed to Test Step 6.

### Test Step 4. Check the Signal Voltage at the Sensor

- A. Turn the keyswitch to the OFF position.
- B. Remove the wire from terminal C of the sensor connector.
- C. Turn the keyswitch to the ON position.

- D. Measure the voltage between the sensor signal wire and terminal B of the sensor connector. Crank the engine and measure the voltage between the sensor signal wire and terminal B.

- E. Turn the keyswitch to the OFF position.

- F. Reconnect the signal wire.

#### Expected Result:

The voltage measures less than 3 VDC or more than 9 VDC when the keyswitch is in the ON position and the engine is not cranking. While the engine is cranking, the voltage is between 2.0 VDC and 7.0 VDC.

**Note:** The voltage output is determined by the presence or the absence of a tooth on the timing gear.

#### Results:

- OK – The engine speed/timing sensor is producing the correct output signal. Proceed to Test Step 5.
- Not OK – The engine speed/timing sensor is not producing the correct output signal.

**Repair:** Replace the engine speed/timing sensor. Calibrate the sensor. Perform the calibration procedure Troubleshooting, “Engine Speed/Timing Sensor - Calibrate”.

STOP.

### Test Step 5. Check the Signal Voltage at the ECM

- A. Turn the keyswitch to the OFF position.
- B. Disconnect ECM connector J1/P1.
- C. Remove wire 999-WH from ECM connector P1-33.
- D. Reconnect ECM connector J1/P1.
- E. Turn the keyswitch to the ON position.
- F. Measure the signal voltage between the signal wire 999-WH and engine ground.
- G. Crank the engine and measure the signal voltage between the signal wire 999-WH and engine ground.
- H. Turn the keyswitch to the OFF position.
- I. Replace all wires. Reconnect ECM connector J1/P1.

**Expected Result:**

The voltage measures less than 3 VDC or more than 9 VDC when the keyswitch is in the ON position and the engine is not cranking. While the engine is cranking, the voltage is between 2.0 VDC and 7.0 VDC.

**Note:** The voltage signal is generated by the presence or the absence of a tooth on the timing gear.

**Results:**

- OK – A correct voltage appears at ECM connector P1 but the ECM is not reading the signal.

**Repair:** Replace the ECM. Refer to the diagnostic procedure Troubleshooting, “Replacing the ECM”.

STOP.

- Not OK – There is a problem in the engine speed/timing circuit.

**Repair:** The problem is between the ECM and the engine speed/timing sensor. Repair the connectors and/or wiring or replace the connectors and/or wiring.

STOP.

**Test Step 6. Check the Supply Voltage for the Engine Speed/Timing Sensor at the ECM**

- A. Turn the keyswitch to the OFF position.
- B. Disconnect ECM connector J1/P1.
- C. Remove wire 996-GN from ECM connector P1-43. Install a wire jumper into the socket for P1-43.
- D. Remove wire 998-BR from ECM connector P1-5. Install a wire jumper into the socket for P1-5.
- E. Reconnect ECM connector J1/P1.
- F. Turn the keyswitch to the ON position.
- G. Measure the supply voltage between the wire jumpers in P1-43 and P1-5.
- H. Turn the keyswitch to the OFF position.
- I. Remove the wire jumpers and replace all wires. Reconnect ECM connector J1/P1.

**Expected Result:**

The supply voltage is  $12 \pm 1.0$  VDC.

**Results:**

- OK – The supply voltage is  $12 \pm 1.0$  VDC. There is an open circuit or a short circuit between the ECM and the connector for the engine speed/timing sensor.

**Repair:** Repair the connectors and/or wiring or replace the connectors and/or wiring.

STOP.

- Not OK – The supply voltage is not  $12 \pm 1.0$  VDC. The supply voltage is incorrect.

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

STOP.

i02409847

## Ether Injection System

**SMCS Code:** 1456-038

**System Operation Description:**

Use this procedure if a problem is suspected with the ether system or if any one of the diagnostic codes in Table 33 is active or easily repeated.

Table 33

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
MID 0036 - CID 0545 - FMI 05 Ether Start Relay open/short to +batt	The engine's Electronic Control Module (ECM) detects an open circuit and/or a short circuit to the +Battery terminal at the output to the ether start relay. The ECM has been powered for at least two seconds.	The code is logged. Ether injection is disabled.
MID 0036 - CID 0545 - FMI 06 Ether Start Relay short to ground	The ECM detects a short circuit to ground at the output to the ether start relay. The ECM has been powered for at least two seconds.	
MID 0036 - CID 0546 - FMI 05 Ether Hold Relay open/short to ground	The ECM detects an open circuit and/or a short circuit to ground at the output to the ether hold relay. The ECM has been powered for at least two seconds.	The code is logged. Ether injection is disabled.
MID 0036 - CID 0546 - FMI 06 Ether Hold Relay short to +batt	The ECM detects a short circuit to the +Battery at the output to the ether hold relay. The ECM has been powered for at least two seconds.	

When the engine is in AUTO mode the engine uses an ether system to improve starting in cold temperatures. The duration of the ether cycle is based on the engine coolant temperature. The Electronic Control Module (ECM), which controls the ether system uses the engine coolant temperature sensor to detect the engine temperature. The ECM determines if ether should be injected by monitoring the actual engine rpm and the engine coolant temperature. The ECM will activate the ether solenoid if the engine coolant temperature is below a set temperature and engine rpm is below a certain level. The ether will activate for a minimum of 15 seconds at 30 °C (86 °F) up to a maximum of 130 seconds at -50 °C (-58 °F). The automatic ether injection system is disabled whenever the engine rpm exceeds 400 rpm or the engine coolant temperature exceeds 30 °C (86 °F).

The ether injection system can also be operated in manual mode. The ether system is switched into manual mode whenever the starting aid switch is depressed. Manual mode also allows ether to be injected whenever the coolant temperature is less than 30 °C (86 °F) and the engine rpm is greater than 50 rpm. Ether is injected in manual mode if the starting aid switch is depressed and the coolant temperature is below the maximum limit.

The ether start relay initially energizes the ether solenoid for approximately two seconds. After two seconds, the ether hold relay energizes and the ether start relay de-energizes. The voltage from the ether hold relay to the ether solenoid is less than battery voltage because of the voltage drop over the resistance that is in the resistor and diode assembly. The initial higher voltage is needed to actuate the ether solenoid. The lower voltage signal is then used to hold the ether solenoid valve open. The solenoid will be damaged if full battery voltage is applied continuously.

Two circuits from the ECM are used to control the ether cycle. The device drivers in the first circuit provide a +Battery voltage to the coil of the ether start relay and a return path to the ECM from the coil of the ether start relay. The ECM monitors current flow at two places in the circuit in order to determine if there is a problem in the circuit. The ECM monitors current flow on the device driver to the coil of the ether start relay and the ECM monitors current flow on the device driver from the coil of the ether start relay. If current is below a threshold on either device driver in the circuit, the ECM will generate a 545-05 diagnostic code. If current is above a threshold on either device driver in the circuit, the ECM will generate a 545-06 diagnostic code. If a 545-06 diagnostic code is generated, the ECM will latch both device drivers open for overcurrent protection.

The device driver in the second circuit provides a return path to the ECM from the coil of the ether hold relay. The other side of the coil is connected to the +Battery. The ECM monitors current flow in the circuit in order to determine if there is a problem in the circuit. The ECM monitors current flow on the device driver from the coil of the ether hold relay. If current is below a threshold on the device driver, the ECM will generate a 546-05 diagnostic code. If current is above a threshold on the device driver, the ECM will generate a 546-06 diagnostic code. If a 546-06 diagnostic code is generated, the ECM will latch the device driver open for overcurrent protection.

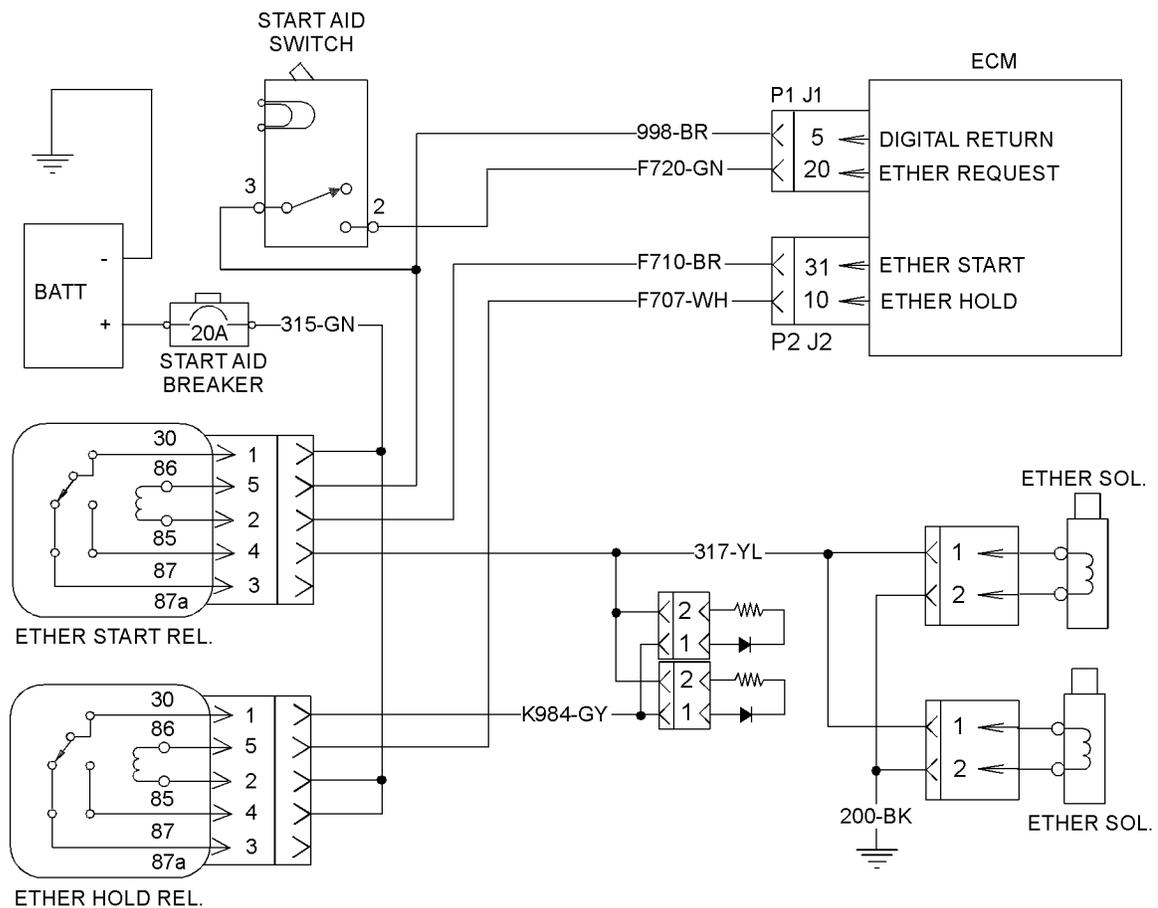


Illustration 37  
 Typical schematic

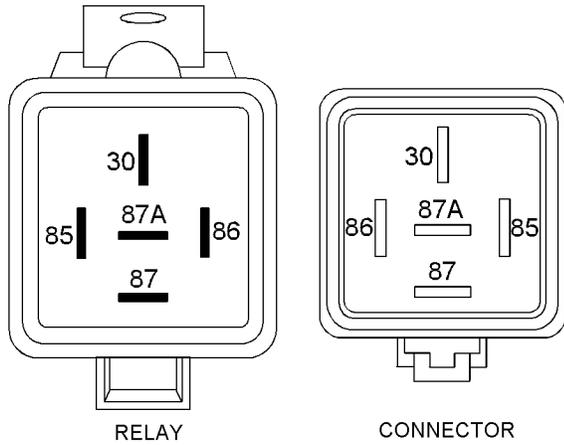


Illustration 38 g01149844  
Terminal locations for the ether start relay and for the ether hold relay

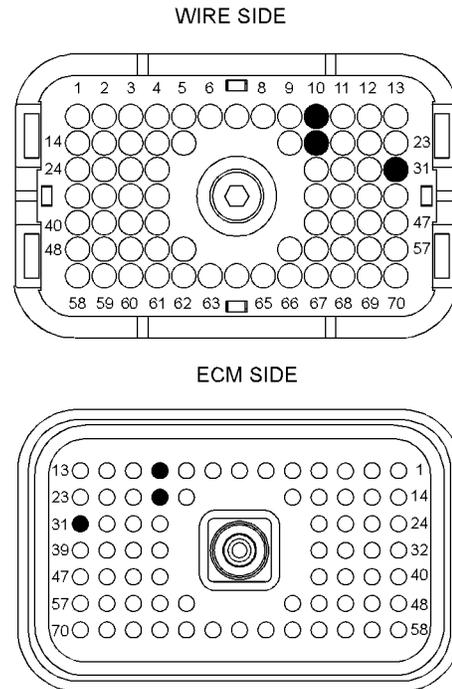


Illustration 40 g01204311  
P2 ECM connector  
(P2-10) Ether hold relay  
(P2-20) Ether request  
(P2-31) Ether start relay

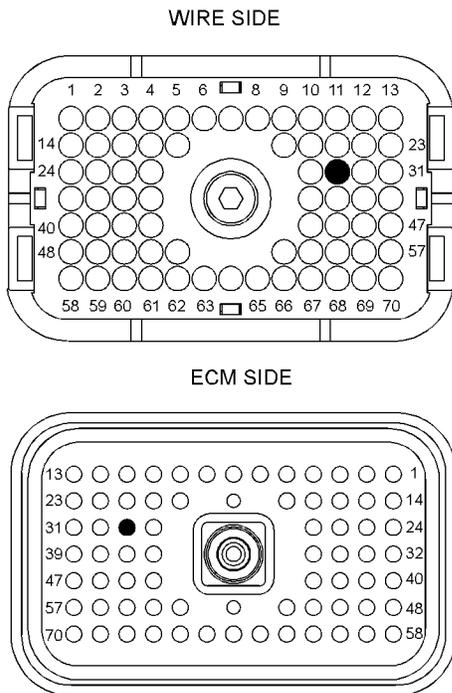


Illustration 39 g01204310  
P1 ECM connector  
(P1-5) Digital return

### Test Step 1. Inspect Electrical Connectors and Wiring

- A. Turn the keyswitch to the OFF position.
- B. Thoroughly inspect the ECM connectors J1/P1. Inspect all of the other connectors. Refer to Troubleshooting, "Inspecting Electrical Connectors" 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, "Inspecting Electrical Connectors" for details.
- E. Check the harness and the wiring for abrasion and for pinch points.

#### Expected Result:

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

**Results:**

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

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

Verify that the repair eliminates the problem.

STOP.

**Test Step 2. Check the Ether Canisters**

- A. Turn the keyswitch to the OFF position.
- B. Remove the ether canister(s) from the ether solenoid(s). Verify that the ether canister is full.

**Expected Result:**

The ether canister is full.

**Results:**

- OK – The ether canister is full. Proceed to Test Step 3.
- Not OK – An ether canister is empty.

**Repair:** Replace the empty ether canister with a full ether canister. Verify that the system is operating correctly.

STOP.

**Test Step 3. Check for Active Diagnostic Codes**

**Note:** Remove the ether canister(s) from the ether solenoid(s) before proceeding with the following test steps.

- A. Connect Caterpillar Electronic Technician (ET) to the cab service tool connector. Start Cat ET.
- B. Turn the keyswitch to the ON position.
- C. Toggle the starting aid switch. Observe the parameter for the starting aid switch on Cat ET.
- D. Determine if CID-FMI 545-05, 545-06, 546-05 or 546-06 is active or logged.

**Expected Result:**

The parameter for the starting aid switch displays “ON” while the starting aid switch is toggled. The parameter for the starting aid switch displays “OFF” when the starting aid switch is released. An active diagnostic code is present or a logged diagnostic code is present.

**Results:**

- OK - Active Code – The parameter for the starting aid switch displays “ON” while the starting aid switch is toggled. The parameter for the starting aid switch displays “OFF” when the starting aid switch is released. Active diagnostics are displayed. Make a note of the active diagnostic code. Proceed to Test Step 4.
- OK - Logged Code – The parameter for the starting aid switch displays “ON” while the starting aid switch is toggled. The parameter for the starting aid switch displays “OFF” when the starting aid switch is released. Logged diagnostics are displayed.

**Repair:** Check for an intermittent short or for an open in the wiring or in the connectors. Refer to Troubleshooting, “Inspecting Electrical Connectors”. Repair any suspect connectors or wiring and/or replace the connectors or wiring. Verify that the system is operating correctly. Replace the ether canister on the ether solenoid.

STOP.

- OK - No Codes – The parameter for the starting aid switch displays “ON” while the starting aid switch is toggled. The parameter for the starting aid switch displays “OFF” when the starting aid switch is released. No diagnostics are logged or active. The ether system is not injecting ether. Proceed to Test Step 8.
- Not OK – The parameter for the starting aid switch does not display “ON” while the starting aid switch is toggled. The parameter for the starting aid switch does not display “OFF” when the starting aid switch is released. The starting aid switch is not functioning correctly. Proceed to Test Step 12.

**Test Step 4. Switch the Relays in order to Isolate the Problem**

- A. Turn the keyswitch to the OFF position.
- B. Remove the ether start relay and the ether hold relay. Replace the ether start relay in the base for the ether hold relay. Replace the ether hold relay in the base for the ether start relay.
- C. Turn the keyswitch to the ON position.

D. Select the “Diagnostic Tests” on Cat ET.

---

**NOTICE**

Do not allow the ether injection system to be on for more than two minutes. Damage to the ether solenoid may occur.

---

E. Select the “Override Parameters” screen on Cat ET.

F. Activate the ether override.

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 codes to become active.

H. Disable the ether override.

**Expected Result:**

The 05 or 06 diagnostic code is now active for the other relay.

**Results:**

- OK – The active diagnostic code is now active for the other relay.

**Repair:** The problem is in the relay. Replace the relay that causes the diagnostic code to be generated .

STOP.

- Not OK - A 05 code is active – The diagnostic code does not change to the other relay when the relays are switched. Proceed to Test Step 5.
- Not OK - A 06 code is active – The diagnostic code does not change to the other relay when the relays are switched. Proceed to Test Step 6.

**Test Step 5. Create a Short at the Connector for the Suspect Relay**

- A. Turn the keyswitch to the OFF position.
- B. Disconnect the connector for the suspect relay. Install a wire jumper between terminal 2 and terminal 5 on the connector for the relay.
- C. Turn the keyswitch to the ON position.
- D. Select the “Diagnostic Tests” on Cat ET.

---

**NOTICE**

Do not allow the ether injection system to be on for more than two minutes. Damage to the ether solenoid may occur.

---

E. Select the “Override Parameters” screen on Cat ET.

F. Activate the ether override.

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 codes to become active.

H. Disable the ether override.

**Expected Result:**

The 05 diagnostic code changes to a 06 diagnostic code for the suspect relay.

**Results:**

- OK – The 05 diagnostic code changes to a 06 diagnostic code for the suspect relay.

**Repair:** The ECM detected the short circuit at the relay connector. The problem must be in the connector for the suspect relay or the problem must be in the relay assembly.

STOP.

- Not OK – The 05 diagnostic code is still active for the suspect relay. Proceed to Test Step 7.

**Test Step 6. Create an Open at the Connector for the Suspect Relay**

- A. Turn the keyswitch to the OFF position.
- B. Disconnect the connector for the suspect relay.
- C. Turn the keyswitch to the ON position.
- D. 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.

E. Disable the ether override.

**Expected Result:**

The 06 diagnostic code changes to a 05 diagnostic code for the suspect relay.

**Results:**

- OK – The 06 diagnostic code changes to a 05 diagnostic code for the suspect relay.

**Repair:** The ECM detected the open circuit at the relay connector. The problem must be in the connector for the suspect relay or the problem must be in the relay assembly.

STOP.

- Not OK – The 06 diagnostic code is still active for the suspect relay. Proceed to Test Step 7.

### Test Step 7. Test the Operation of the ECM

- A. Turn the keyswitch to the OFF position.
- B. Fabricate jumper wires that can be used to replace the wire(s) in the ECM connector for the suspect relay. Crimp a connector socket to one end of the jumper wires.
- C. Disconnect the appropriate ECM connector for the suspect relay.
- D. Remove the wire(s) for the suspect relay from the ECM connector.
- E. Install the jumper wire(s) into the terminal location(s) for the suspect relay at the ECM connector.
- F. Connect the ECM connectors.
- G. **Check the operation of the ECM by creating an open at the ECM:**
  - a. Hold the loose end of the jumper wire away from any components in order to create an open circuit condition.
  - b. Turn the keyswitch to the ON position.
  - c. Monitor the “Active Diagnostic Code” screen on Cat ET.

Check the suspect relay for an active 05 diagnostic code.

**Note:** Wait at least 30 seconds so that any codes may become active.

- d. Turn the keyswitch to the OFF position.

- H. **Check the operation of the ECM by creating a short circuit at the ECM:**

- a. If the suspect relay is the ether start relay, short the jumpers for the return wire and the output wire together.

If the suspect relay is the ether hold relay, short the jumper for the return wire to the +Battery.

- b. Turn the keyswitch to the ON position.
- c. Select the “Diagnostic Tests” on Cat ET.

---

#### NOTICE

Do not allow the ether injection system to be on for more than two minutes. Damage to the ether solenoid may occur.

---

- d. Select the “Override Parameters” screen on Cat ET.
- e. Activate the ether override.
- f. Monitor the “Active Diagnostic Code” screen on Cat ET.

Check the suspect relay for an active 06 diagnostic code.

**Note:** Wait at least 30 seconds so that any codes may become active.

- g. Disable the ether override.
- h. Turn the keyswitch to the OFF position.
- I. Remove the jumper wire. Return all wiring to the original configuration.

#### Expected Result:

A 05 diagnostic code is active when the wires or wire from the suspect relay are open at the ECM connector. A 06 diagnostic code is active if the wires or wire from the suspect relay are shorted at the ECM connector.

#### Results:

- OK – A 05 diagnostic code is active when the wires or wire from the suspect relay are open at the ECM connector. A 06 diagnostic code is active when the wires or wire from the suspect relay are shorted at the ECM connector.

**Repair:** The ECM is operating properly.

If the suspect relay is the ether start relay, the problem is in the harness wiring between the ECM and the connector for the relay. Repair the wires or wire.

If the suspect relay is the ether hold relay, the problem is in the harness wiring between the ECM and the connector for the relay or in the harness wiring between the battery and the ether hold relay. Repair the wire.

STOP.

- Not OK – One of the following conditions exists: The 05 diagnostic code is not active when the wires or wire from the suspect relay are open at the ECM connector. The 06 diagnostic code is not active when the wires or wire from the suspect relay are shorted at the ECM connector.

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

STOP.

### Test Step 8. Check the Voltage at the Ether Solenoid(s)

- Turn the keyswitch to the OFF position.
- Disconnect the ether solenoid connector at the solenoid(s).
- Connect a voltmeter to terminal 1 and terminal 2 of the ether solenoid connector(s).
- Turn the keyswitch to the ON position.

---

#### NOTICE

Do not allow the ether injection system to be on for more than two minutes. Damage to the ether solenoid may occur.

---

- Activate the ether override and observe the voltmeter while ether injection is activated.
- Disable the ether override.
- Reconnect all connectors.

#### Expected Result:

The voltage at the ether solenoid(s) is  $24 \pm 3$  VDC during the first two seconds of injection. The voltage at the ether solenoid(s) decreases to  $5 \pm 3$  VDC after the first two seconds of injection.

#### Results:

- OK – The voltage is approximately  $24 \pm 3$  VDC for the first two seconds of injection. The voltage then decreases to  $5 \pm 3$  VDC for the remainder of injection.

**Repair:** If ether is not being injected, replace the ether solenoid(s). Verify that the system is operating correctly.

STOP.

- Not OK - 24 VDC – The voltage did not measure  $24 \pm 3$  VDC for the first two seconds of injection. Verify that wire 200-BK has continuity to ground. If wire 200-BK has continuity to ground, proceed to test step 9.
- Not OK - 3 VDC – The voltage is approximately  $24 \pm 3$  VDC for the first two seconds of injection. The voltage did not decrease to  $5 \pm 3$  VDC for the remainder of the injection duration. Proceed to test step 9.

### Test Step 9. Check the Battery Voltage to the Ether Start Relay and to the Ether Hold Relay

- Disconnect the connector for the ether start relay and the connector for the ether hold relay.
- Measure the voltage between terminal 1 of the connector for the ether start relay and ground.
- Measure the voltage between terminal 4 of the connector for the ether hold relay and ground.

#### Expected Result:

The voltage measures  $24 \pm 3$  VDC.

#### Results:

- OK - Ether start relay – The voltage measures  $24 \pm 3$  VDC at the connector for the ether start relay.

**Repair:** Disconnect wire 317-YL from terminal 4 of the connector for the ether start relay. Reconnect the connector for the ether start relay.

If voltage is not present on terminal 4 of the connector for the ether start relay, replace the ether start relay. Verify that the problem is resolved.

Reactivate the ether override and check for voltage on terminal 4 of the connector for the ether start relay.

If voltage is present on terminal 4 of the connector for the ether start relay, repair the wire 317-YL between the connector for the ether start relay and the ether solenoid(s).

STOP.

- OK - Ether hold relay – The voltage measures  $24 \pm 3$  VDC at the connector for the ether hold relay. Reconnect the connector for the ether hold relay. Proceed to Test Step 10.
- Not OK – The voltage does not measure  $24 \pm 3$  VDC.

**Repair:** Verify that the breaker for the starting aid is not tripped. Check the wiring between the relay connectors and the battery for an open circuit or for a short circuit.

STOP.

### Test Step 10. Check the Voltage at the Resistor and the Diode Assembly

- A. Turn the keyswitch to the OFF position.
- B. Disconnect the connector at the resistor and the diode assembly.
- C. Connect a voltmeter between terminal 1 of the resistor and the diode assembly and ground.
- D. Turn the keyswitch to the ON position.

---

#### NOTICE

Do not allow the ether injection system to be on for more than two minutes. Damage to the ether solenoid may occur.

---

- E. Activate the ether override and observe the voltmeter while ether injection is activated. Disable the ether override.

#### Expected Result:

The voltage is  $24 \pm 3$  VDC.

#### Results:

- OK – The voltage is  $24 \pm 3$  VDC at the connector for the resistor and the diode assembly. Proceed to Test Step 11.
- Not OK – The voltage did not measure  $24 \pm 3$  VDC at the connector for the resistor and the diode assembly.

**Repair:** There is a problem in the harness between the ether hold relay and the resistor and diode assembly. Repair the connectors or wiring and/or replace the connectors or wiring. Verify that the system is operating correctly. Replace the ether canister on the ether solenoid.

STOP.

### Test Step 11. Check the Resistor and the Diode Assembly

- A. Disconnect the connector at the resistor and the diode assembly.
- B. Set the multimeter to the “Check Diode” setting.

- C. Connect the positive lead of the multimeter to terminal 2 and the negative lead to terminal 1 of the resistor and the diode assembly and observe the multimeter.

- D. Connect the positive lead of the multimeter to terminal 1 and the negative lead to terminal 2 of the resistor and the diode assembly and observe the multimeter.

- E. Repeat the measurements for all of the resistor and diode assemblies if more than one resistor and diode assembly is present.

#### Expected Result:

When the positive lead of the multimeter is connected to terminal 2 and the negative lead to terminal 1, the multimeter displays an overload “(OL)” condition.

When the positive lead of the multimeter is connected to terminal 1 and the negative lead to terminal 2, the multimeter displays a number less than one.

#### Results:

- OK – The resistor and the diode assembly is operating correctly.

**Repair:** There is a problem in the harness between the resistor and diode assembly and the ether solenoid(s). Repair the connectors or wiring and/or replace the connectors or wiring. Verify that the system is operating correctly. Replace the ether canister on the ether solenoid.

STOP.

- Not OK – The resistor and the diode assembly is not operating correctly.

**Repair:** The resistor and the diode assembly is causing the problem. Replace the resistor and the diode assembly. Verify that the system is operating correctly. Replace the ether canister on the ether solenoid.

STOP.

### Test Step 12. Check for an Open in the Harness of the Starting Aid Switch

- A. Turn the keyswitch to the OFF position.
- B. Disconnect the wires that are going to the starting aid switch at the starting aid switch.
- C. Turn the keyswitch to the ON position.
- D. Observe the parameter for the starting aid switch on Cat ET.

- E. Obtain a suitable piece of wire. Short the wires from the starting aid switch together at the starting aid switch.
- F. Observe the parameter for the starting aid switch on Cat ET.
- G. Remove the jumper. Leave the wires disconnected from the starting aid switch.

**Expected Result:**

The parameter for the starting aid switch displays "ON" while the wires from the starting aid switch are shorted together. The parameter for the starting aid switch displays "OFF" when the wires from the starting aid switch are not shorted together.

**Results:**

- OK – The ECM detects the open and the short from the starting aid switch.

**Repair:** The wiring between the ECM and the starting aid switch is OK. Replace the starting aid switch. Verify that the problem is no longer present.

STOP.

- OK – The ECM does not detect the open and the short at the starting aid switch. Proceed to Test Step 13.

**Test Step 13. Check the Inputs from the Starting Aid Switch to the ECM**

- A. Turn the keyswitch to the OFF position.
- B. Fabricate jumper wires that can be used to replace the wires in the ECM connector for the starting aid switch. Crimp a connector socket to the end of the jumper wires.
- C. Disconnect the appropriate ECM connector for the starting aid switch.
- D. Remove the wires for the starting aid switch from the ECM connector.
- E. Install the jumper wires into the terminal locations for the starting aid switch at the ECM connector.
- F. Connect the ECM connectors.
- G. **Check the operation of the ECM by creating an open at the ECM:**
  - a. Hold the loose ends of the jumper wires away from any components in order to create an open circuit condition.
  - b. Turn the keyswitch to the ON position.

- c. Observe the parameter for the starting aid switch on Cat ET.

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

- a. Short the jumper wires for the starting aid switch together.
- b. Observe the parameter for the starting aid switch on Cat ET.

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

**Expected Result:**

The parameter for the starting aid switch displays "ON" while the wires from the starting aid switch are shorted together. The parameter for the starting aid switch displays "OFF" when the wires from the starting aid switch are not shorted together.

**Results:**

- OK – The parameter for the starting aid switch displays "ON" while the wires from the starting aid switch are shorted together. The parameter for the starting aid switch displays "OFF" when the wires from the starting aid switch are not shorted together.

**Repair:** There is a short circuit or excessive resistance in the wiring between the starting aid switch and the ECM connector. Repair the wiring or replace the wiring. Verify that the system is operating correctly.

STOP.

- Not OK – Cat ET does not indicate "ON", when the wire short is in place. Cat ET does not indicate "OFF", when the wire short is removed. The ECM is not reading the switch position.

**Repair:** Replace the ECM. Refer to Troubleshooting, "Replacing the ECM".

STOP.

i02410957

## Fuel Filter Differential Pressure Switch

**SMCS Code:** 1261-038-ZS

### System Operation Description:

Use this procedure in order to troubleshoot a problem with the circuit for the fuel filter differential pressure switch or use this procedure if the following event code is active. Refer to Troubleshooting, "Event Code List" for information on specific trip points for the event codes.

Table 34

Event Code		
Description	Conditions which Generate this Code	System Response
E095 Fuel Filter Restriction Warning	The fuel filter differential pressure switch opens.	The code is active and the code is logged.

The fuel filter differential pressure switch is used to monitor the differential pressure across the filter element. The Electronic Control Module (ECM) will alert the operator of a restriction in the fuel filter. Use this test in order to verify that the fuel filter differential pressure switch is operating correctly.

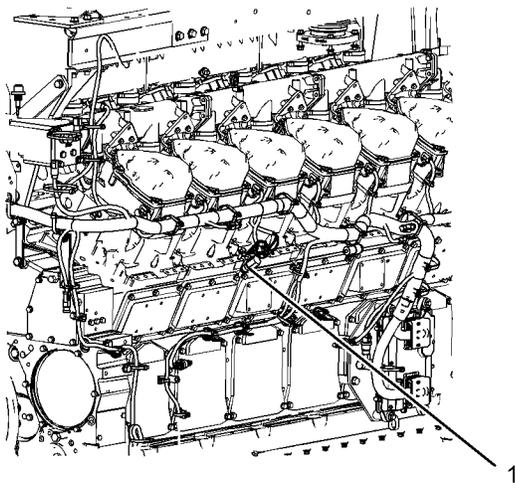


Illustration 41

g01208741

Left side view

(1) Fuel filter differential pressure switch

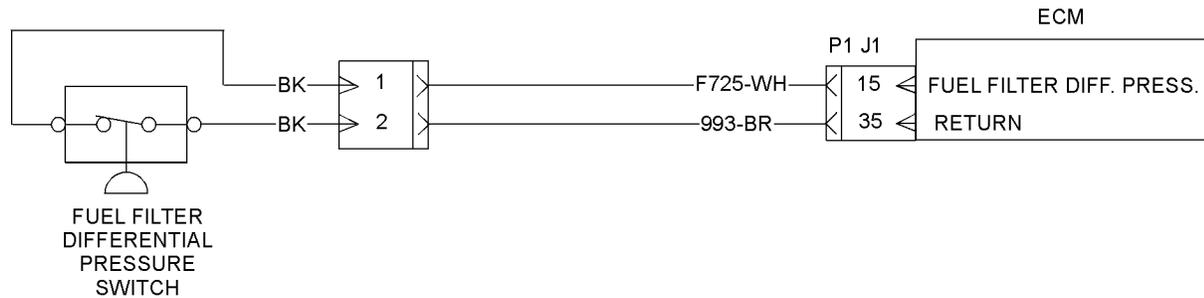


Illustration 42  
Schematic

g01204990

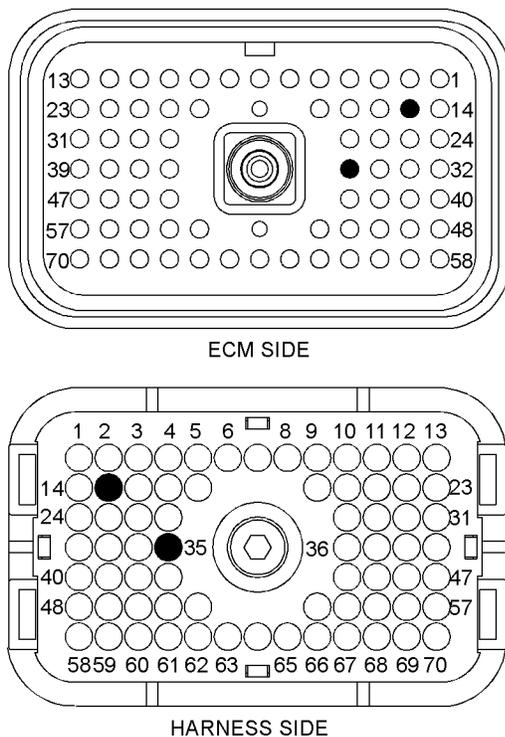


Illustration 43

g01148091

P1 ECM connector

(P1-15) Fuel filter differential pressure  
(P1-35) Return

### Test Step 1. Replace the Fuel Filter Element

A. Replace the fuel filter element.

#### Expected Result:

The E095 event code is no longer active.

#### Results:

- OK – The E095 event code is no longer active. STOP.
- Not OK – The fuel filter element was replaced. The E095 event code is still active. Proceed to Test Step 2.

### Test Step 2. Inspect Electrical Connectors and Wiring

- Turn the keyswitch to the OFF position.
- Thoroughly inspect the J1/P1 ECM connector. Thoroughly inspect the connectors for the fuel filter differential pressure switch.  
  
Refer to Troubleshooting, "Inspecting Electrical Connectors" for details.
- 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.
- Check the ECM connector (allen head screw) for the proper torque. Refer to Troubleshooting, "Inspecting Electrical Connectors" for details.

E. Check the harness and wiring for abrasions and for pinch points from the connectors 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 3.

- Not OK – There is a problem in the connectors and/or wiring.

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

Verify that the repair eliminates the problem.

STOP.

### Test Step 3. Check the Switch Circuit

- Turn the keyswitch to the OFF position.
- Disconnect the connector for the fuel filter differential pressure switch.
- Install a wire jumper between the terminals of the connector for the fuel filter differential pressure switch. Install the wire jumper on the harness side of the connector.
- Start the engine. Increase the engine speed to high idle.
- 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.

- Check for an event code for the engine fuel filter restriction.

#### Expected Result:

The event code is not active.

#### Results:

- OK – The event code is not active. The wiring between the connector and the ECM is OK.  
**Repair:** Check for a plugged fuel filter. If the fuel filter is OK, temporarily replace the fuel filter differential pressure switch. Verify that the problem is resolved before permanently replacing the fuel filter differential pressure switch.

STOP.

- Not OK – The event code is still active. There is an open circuit in the wiring for the fuel filter differential pressure switch between the connector and the ECM. Proceed to Test Step 4.

### Test Step 4. Check the ECM

- Turn the keyswitch to the OFF position.

- Disconnect the J1/P1 ECM connector.
- Install a jumper wire with Deutsch sockets on each end into the socket for the signal wire of the fuel filter differential pressure switch.
- Install a wire jumper between the wire jumper in the socket for the return wire of the fuel filter differential pressure switch.
- Short the jumper wires for the fuel filter differential pressure switch together.
- Reconnect the ECM connector.
- Start the engine. Increase the engine speed to high idle.
- 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.

- Remove the short between the jumper wires for the fuel filter differential pressure switch.
- Monitor the active diagnostic code screen on Cat ET. Check and record any active diagnostic codes.

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

#### Expected Result:

The event code is not active when the jumper wires are shorted together. The event code is active when the jumper wires are not shorted together.

#### Results:

- OK – The ECM detects the open and the short.  
**Repair:** There is an open or a short in the wiring between the connector for the fuel filter differential pressure switch and the ECM. Repair the connectors or wiring and/or replace the connectors or wiring. Check the harness connector to the fuel filter differential pressure switch for a good connection.

Verify that the repair eliminates the problem.

STOP.

- Not OK – The ECM does not detect the open or the short.

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

STOP.

i02411006

## Ground Level Shutdown Switch

**SMCS Code:** 1901-038

### System Operation Description:

Use this procedure in order to troubleshoot a problem with the circuit for the ground level shutdown switch or use this procedure if the following diagnostic code is active.

Table 35

Diagnostic Code		
Description	Conditions which Generate this Code	System Response
MID 0036 - CID 0267 - FMI 02 Incorrect Engine Shutdown Switch inputs	The two inputs from the ground level shutdown switch are in the same state.	The code is active and the code is logged.

The ground level shutdown switch provides the ability to shut down the engine. The engine's Electronic Control Module (ECM) remains active. The Caterpillar Electronic Technician (ET) can be used to communicate with the ECM. The ground level shutdown switch must be returned to the RUN position and the keyswitch must be cycled to the OFF position before the ECM will allow the engine to start.

To shut down the engine, 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 ECM will not allow the engine to start if the engine is not running.

The voltage at the ECM input P1-23 of the ground level shutdown switch should be  $11.5 \pm 0.5$  VDC with the ground level shutdown switch in the RUN position. The voltage at the ECM input P1-28 of the ground level shutdown switch should be less than 0.5 VDC with the ground level shutdown switch in the RUN position.

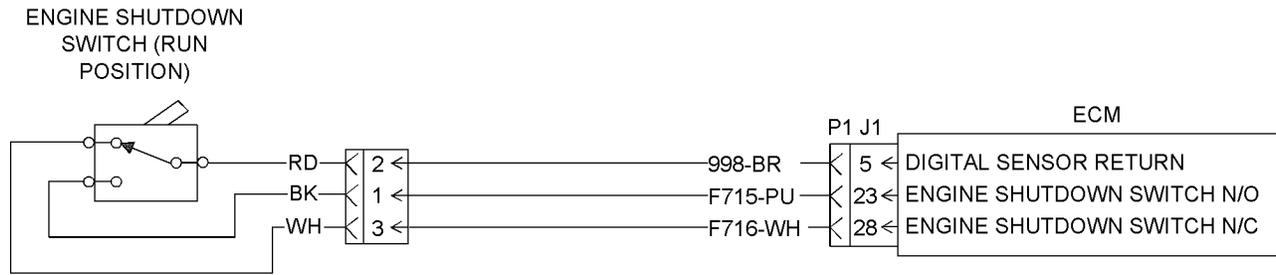


Illustration 44  
Schematic

g01205050

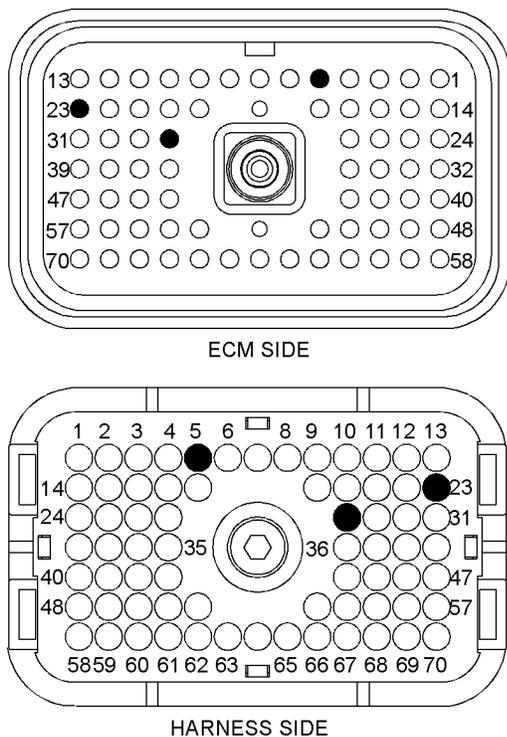


Illustration 45  
P1 ECM connector  
(P1-5) Digital return  
(P1-23) Ground level shutdown (NO)  
(P1-28) Ground level shutdown (NC)

g01148687

### 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, “Inspecting Electrical Connectors” 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, “Inspecting Electrical Connectors” for details.
- E. Check the harness and the wiring for abrasion and for pinch points.

#### Expected Result:

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

#### Results:

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

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

Verify that the repair eliminates the problem.

STOP.

### Test Step 2. Check the Status of the Ground Level Shutdown Switch on Cat ET

- A. Connect Cat ET to the service tool connector. Start Cat ET.
- B. Turn the keyswitch to the ON position.

- C. Operate the ground level shutdown switch.  
Observe the status for the ground level shutdown switch on Cat ET.

**Expected Result:**

The status of the ground level shutdown switch reads “ON” with the ground level shutdown switch in the SHUTDOWN position. The status of the ground level shutdown switch reads “OFF” when the ground level shutdown switch is in the RUN position.

**Results:**

- OK – The status of the ground level shutdown switch reads “ON” with the ground level shutdown switch in the SHUTDOWN position. The status of the ground level shutdown switch reads “OFF” when the ground level shutdown switch is in the RUN position. The ground level shutdown switch is operating normally.

**Repair:** There may be an intermittent problem. If the problem is intermittent, refer to Troubleshooting, “Inspecting Electrical Connectors”.

STOP.

- Not OK – The status of the ground level switch does not read “ON” with the ground level shutdown switch in the SHUTDOWN position. The status of the ground level shutdown switch does not read “OFF” when the ground level shutdown switch is in the RUN position. The ground level shutdown switch is not operating normally. Proceed to Test Step 3.

**Test Step 3. Short the Wires together at the Ground Level Shutdown Switch**

- A. Turn the keyswitch to the OFF position.
- B. Record the position of the wiring on the ground level shutdown switch before removing the wires.
- C. Disconnect the wires from the ground level shutdown switch.
- D. Create a short circuit at the ground level shutdown switch between the wire F716-WH and the digital return wire 998-BR. Leave the wire F715-PU open.
- E. Turn the keyswitch to the ON position.
- F. Observe the status of the ground level shutdown switch on Cat ET.
- G. Remove the short between the wire F716-WH and the wire 998-BR.
- H. Create a short circuit at the ground level shutdown switch between the wire F715-PU and the digital return wire 998-BR.

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

- J. Turn the keyswitch to the OFF position.

- K. Remove the wire short.

**Expected Result:**

The status of the ground level shutdown switch reads “OFF” when the wire F716-WH and the wire 998-BR are shorted together. The ground level shutdown switch status reads “ON” when the wire F715-PU and the wire 998-BR are shorted together.

**Results:**

- OK – The status of the ground level shutdown switch reads “OFF” when the wire F716-WH and the wire 998-BR are shorted together. The ground level shutdown switch status reads “ON” when the wire F715-PU and the wire 998-BR are shorted together. The problem is not with the harness or the ECM.

**Repair:** Temporarily connect a new ground level shutdown switch. Verify that the new ground level shutdown switch solves the problem before you permanently install the new ground level shutdown switch.

STOP.

- Not OK – The status of the ground level shutdown switch does not read “OFF” when the wire F716-WH and the wire 998-BR are shorted together. The ground level shutdown switch status does not read “ON” when the wire F715-PU and the wire 998-BR are shorted together. There is a problem in the harness and/or the ECM. Proceed to Test Step 4.

**Test Step 4. Short the Ground Level Shutdown Switch at the ECM**

- A. Disconnect the ECM connector J1/P1.
- B. Remove the wire F715-PU at the ECM connector P1-23. Remove the wire F716-WH at the ECM connector P1-28 and the digital return wire 998-BR from ECM connector P1-5.
- C. Insert a wire with socket terminals at each end into the ECM connector P1-28, P1-23 and P1-5. Short the wire jumpers in P1-28 and P1-5.
- D. Reconnect all the connectors.
- E. Turn the keyswitch to the ON position.

**Note:** The digital return will no longer be connected to the other sensors and switches. Additional diagnostic codes will be generated from the ECM. Clear the codes after you complete this test.

- F. Observe the status of the ground level shutdown switch on Cat ET.
- G. Turn the keyswitch to the OFF position.
- H. Remove the short between P1-28 and P1-5.
- I. Short the wire jumpers in P1-23 and P1-5.
- J. Turn the keyswitch to the ON position.
- K. Observe the status of the ground level shutdown switch on Cat ET.
- L. Turn the keyswitch to the OFF position.
- M. Remove the short between P1-23 and P1-5.

**Expected Result:**

The status reads "OFF" when the short is between P1-28 and P1-5. The status reads "ON" when the short is between P1-23 and P1-5.

**Results:**

- OK – The status reads "OFF" when the short is between P1-28 and P1-5. The status reads "ON" when the short is between P1-23 and P1-5. The status is correct on Cat ET.

**Repair:** The problem is in the harness between the ECM connector and the ground level shutdown switch. Repair the harness or the connector.

STOP.

- Not OK – The status does not read "OFF" when the short is between P1-28 and P1-5. The status does not read "ON" when the wire short is inserted between P1-23 and P1-5. The status is incorrect on Cat ET.

**Repair:** Replace the ECM. Refer to Troubleshooting, "Replacing the ECM".

STOP.

## Injector Solenoids

**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 36 is active or easily repeated.

Table 36

<b>Diagnostic Codes Table</b>		
<b>Description</b>	<b>Conditions which Generate this Code</b>	<b>System Response</b>
MID 0036 - CID 0001 - FMI 05 Cylinder #1 Injector open circuit	The engine's Electronic Control Module (ECM) detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.
MID 0036 - CID 0001 - FMI 06 Cylinder #1 Injector short	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.
MID 0036 - CID 0002 - FMI 05 Cylinder #2 Injector open circuit	The engine's ECM detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.
MID 0036 - CID 0002 - FMI 06 Cylinder #2 Injector short	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.
MID 0036 - CID 0003 - FMI 05 Cylinder #3 Injector open circuit	The engine's ECM detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.
MID 0036 - CID 0003 - FMI 06 Cylinder #3 Injector short	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.
MID 0036 - CID 0004 - FMI 05 Cylinder #4 Injector open circuit	The engine's ECM detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.
MID 0036 - CID 0004 - FMI 06 Cylinder #4 Injector short	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.
MID 0036 - CID 0005 - FMI 05 Cylinder #5 Injector open circuit	The engine's ECM detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.
MID 0036 - CID 0005 - FMI 06 Cylinder #5 Injector short	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.
MID 0036 - CID 0006 - FMI 05 Cylinder #6 Injector open circuit	The engine's ECM detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.
MID 0036 - CID 0006 - FMI 06 Cylinder #6 Injector short	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.

(continued)

(Table 36, contd)

<b>Diagnostic Codes Table</b>		
<b>Description</b>	<b>Conditions which Generate this Code</b>	<b>System Response</b>
MID 0036 - CID 0007 - FMI 05 Cylinder #7 Injector open circuit	The engine's ECM detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.
MID 0036 - CID 0007 - FMI 06 Cylinder #7 Injector short	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.
MID 0036 - CID 0008 - FMI 05 Cylinder #8 Injector open circuit	The engine's ECM detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.
MID 0036 - CID 0008 - FMI 06 Cylinder #8 Injector short	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.
MID 0036 - CID 0009 - FMI 05 Cylinder #9 Injector open circuit	The engine's ECM detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.
MID 0036 - CID 0009 - FMI 06 Cylinder #9 Injector short	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.
MID 0036 - CID 0010 - FMI 05 Cylinder #10 Injector open circuit	The engine's ECM detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.
MID 0036 - CID 0010 - FMI 06 Cylinder #10 Injector short	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.
MID 0036 - CID 0011 - FMI 05 Cylinder #11 Injector open circuit	The engine's ECM detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.
MID 0036 - CID 0011 - FMI 06 Cylinder #11 Injector short	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.
MID 0036 - CID 0012 - FMI 05 Cylinder #12 Injector open circuit	The engine's ECM detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.

(continued)

(Table 36, contd)

<b>Diagnostic Codes Table</b>		
<b>Description</b>	<b>Conditions which Generate this Code</b>	<b>System Response</b>
MID 0036 - CID 0012 - FMI 06 Cylinder #12 Injector short	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.
MID 0036 - CID 0013 - FMI 05 Cylinder #13 Injector open circuit	The engine's ECM detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.
MID 0036 - CID 0013 - FMI 06 Cylinder #13 Injector short	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.
MID 0036 - CID 0014 - FMI 05 Cylinder #14 Injector open circuit	The engine's ECM detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.
MID 0036 - CID 0014 - FMI 06 Cylinder #14 Injector short	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.
MID 0036 - CID 0015 - FMI 05 Cylinder #15 Injector open circuit	The engine's ECM detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.
MID 0036 - CID 0015 - FMI 06 Cylinder #15 Injector short	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.
MID 0036 - CID 0016 - FMI 05 Cylinder #16 Injector open circuit	The engine's ECM detects an open circuit.	The code is logged. The ECM continues to fire the injector solenoid.
MID 0036 - CID 0016 - FMI 06 Cylinder #16 Injector short	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 in the solenoid circuit, 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.

When an injector is replaced, program the new injector code into the ECM. If the ECM is replaced, all sixteen injector codes must be programmed into the new ECM. The injector codes are a four digit number. Refer to Troubleshooting, "System Configuration Parameters" for information on injector codes.

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

#### **"Cylinder Cutout Test"**

All active diagnostic codes must be repaired before running the "Cylinder Cutout Test". Use the "Cylinder Cutout Test" to diagnose a malfunctioning injector while the engine is running. When a good injector is cut out, the "Delivered Fuel Volume" of the remaining injectors should change. The change in "Delivered Fuel Volume" is due to the extra load on each of the remaining cylinders. If a malfunctioning injector is cut out, the "Delivered Fuel Volume" will not change for the remaining injectors. The "Cylinder Cutout Test" is used to isolate the malfunctioning injector in order to avoid replacement of good injectors.

#### **"Injector Solenoid Test"**

Use the "Injector Solenoid Test" to aid in diagnosing an open circuit or a short circuit while the engine is not running. The "Injector Solenoid Test" briefly activates each solenoid. A good solenoid will create an audible click when the solenoid is activated. Cat ET will indicate the status of the solenoid as "OK", "Open", or "Short".

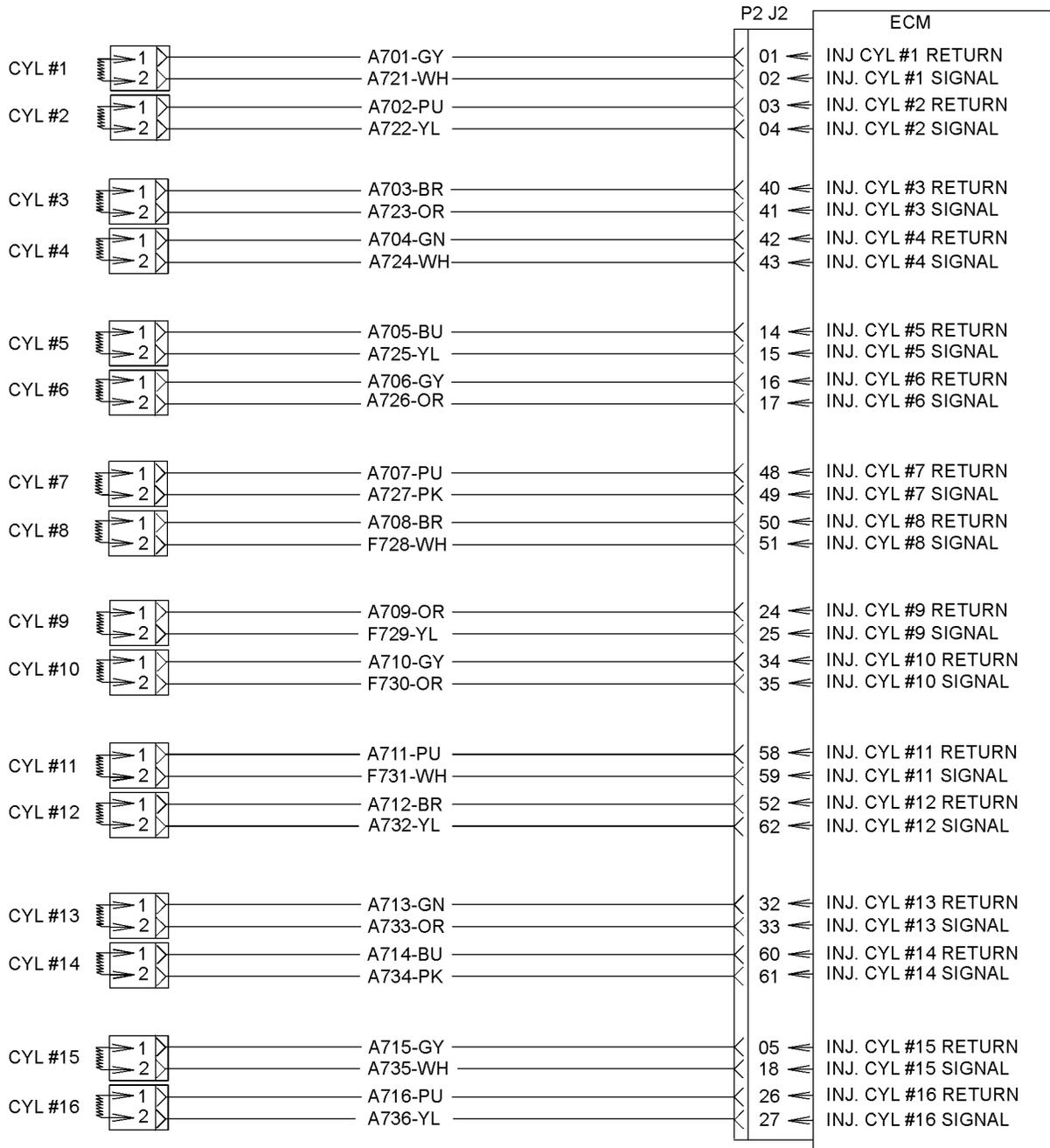


Illustration 46  
Typical schematic

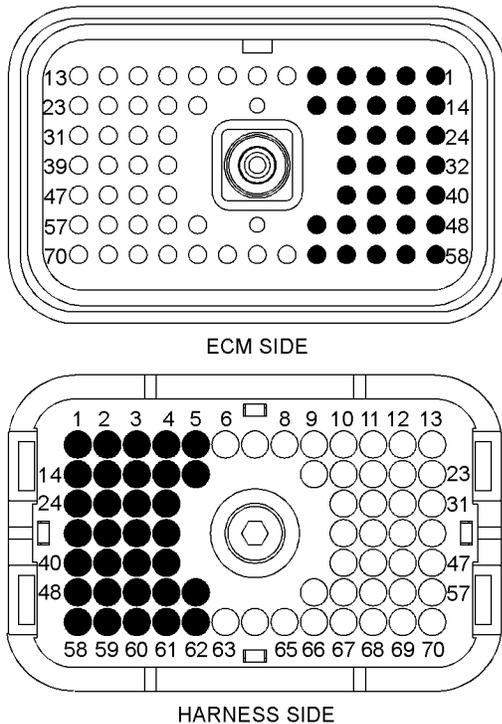


Illustration 47

g01152207

P2 terminals that are associated with the injector solenoids

- (P2-1) Injector cylinder #1 return
- (P2-2) Injector cylinder #1 signal
- (P2-3) Injector cylinder #2 return
- (P2-4) Injector cylinder #2 signal
- (P2-40) Injector cylinder #3 return
- (P2-41) Injector cylinder #3 signal
- (P2-42) Injector cylinder #4 return
- (P2-43) Injector cylinder #4 signal
- (P2-14) Injector cylinder #5 return
- (P2-15) Injector cylinder #5 signal
- (P2-16) Injector cylinder #6 return
- (P2-17) Injector cylinder #6 signal
- (P2-48) Injector cylinder #7 return
- (P2-49) Injector cylinder #7 signal
- (P2-50) Injector cylinder #8 return
- (P2-51) Injector cylinder #8 signal
- (P2-24) Injector cylinder #9 return
- (P2-25) Injector cylinder #9 signal
- (P2-34) Injector cylinder #10 return
- (P2-35) Injector cylinder #10 signal
- (P2-58) Injector cylinder #11 return
- (P2-59) Injector cylinder #11 signal
- (P2-52) Injector cylinder #12 return
- (P2-62) Injector cylinder #12 signal
- (P2-32) Injector cylinder #13 return
- (P2-33) Injector cylinder #13 signal
- (P2-1) Injector cylinder #14 return
- (P2-60) Injector cylinder #14 signal
- (P2-61) Injector cylinder #15 return
- (P2-18) Injector cylinder #15 signal
- (P2-26) Injector cylinder #16 return
- (P2-27) Injector cylinder #16 signal

### Test Step 1. Check for Connector Damage

A. Remove power from the ECM.

B. Thoroughly inspect the ECM connector J2/P2. Inspect the connectors for the right rail and for the left rail. Refer to the diagnostic functional test Troubleshooting, “Inspecting Electrical Connectors” 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 allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, “Inspecting Electrical Connectors” for the correct torque values.

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

#### Expected Result:

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

#### Results:

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

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

Verify that the repair eliminates the problem.

STOP.

### Test Step 2. Check for Logged Diagnostic Codes

A. Connect Cat ET to the service tool connector.

B. Restore power to the ECM.

C. Check for logged diagnostic codes for the injector solenoids on Cat ET.

#### Expected Result:

No 1-05 to 16-05 or 1-06 to 16-06 are logged.

#### Results:

- OK – No 1-05 to 16-05 or 1-06 to 16-06 are logged. Proceed to Test Step 3.

- Not OK – A 1-05 to 16-05 is logged. Proceed to Test Step 4.
- Not OK – A 1-06 to 16-06 is logged. Proceed to Test Step 5.

### Test Step 3. Perform the “Cylinder Cutout Test”

#### NOTICE

Engine power is reduced when a properly functioning cylinder is cut out. Make sure that you will not damage auxiliary or driven equipment if the engine power is suddenly reduced.

- Remove power from the ECM.
- Verify that the ECM connector J2/P2 and the injector connectors are properly connected.
- Restore power to the ECM.
- Start the engine.
- Apply a load to the engine.
- Perform the following steps on all suspect cylinders (solenoids).
- Use the diagnostic tests on Cat ET to initiate the “Cylinder Cutout Test”.
- Run the “Cylinder Cutout Test”. Run the “Cylinder Cutout Test”. Disable the suspect cylinder(s) during the test.

#### Expected Result:

The results indicated that the remaining injectors used more fuel when the “Cylinder Cutout Test” disabled the suspect injector(s).

#### Results:

- OK – There was a noticeable change in fuel usage.

**Repair:** The injectors are firing in all cylinders. Reset the system and check for diagnostic codes.

STOP.

- Not OK – There was no noticeable change in fuel usage.

**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. If the new injector has a trim code that is different from the old injector, change the trim code in the ECM.

STOP.

### Test Step 4. Check the Harness between the ECM and the Injector Connectors for an Open Circuit

#### WARNING

This engine uses high voltage to control the fuel injectors.

**Disconnect electronic fuel injector enable circuit connector to prevent personal injury.**

**Do not come in contact with the fuel injector terminals while the engine is running.**

- Remove power from the ECM.
  - Disconnect the connectors for the suspect injector(s).
  - Fabricate a jumper wire 100 mm (4 inch) long with Deutsch pins on both ends of the wire.
  - Insert one end of the jumper wire into the socket for the suspect injector’s supply wire. Insert the other end of the jumper wire into the socket for the suspect injector’s return wire. This will replace the injector solenoid with a short circuit.
  - Restore power to the ECM.
- Note:** This test will help the service technician verify that the ECM can fire the solenoids. Do not try to manually crank the engine during this test. The ECM will terminate the “Injector Solenoid Test”.
- Perform the “Injector Solenoid Test” at least two times.
  - Repeat this test for each suspect injector. Stop the “Injector Solenoid Test” before handling the jumper wire.

#### Expected Result:

Cat ET displays “Open” for the cylinder with the jumper wire.

#### Results:

- OK – Cat ET displays “Open” for the cylinder with the jumper wire. There is a problem in the wiring between the ECM and the injector connector. Proceed to Test Step 6.
- Not OK – Cat ET displays “Short” for the cylinder with the jumper wire. The harness between the ECM and the injector connector does not have an open circuit. Proceed to Test Step 7.

## Test Step 5. Check the Harness between the ECM and the Connectors for the Injector for a Short Circuit

### WARNING

This engine uses high voltage to control the fuel injectors.

Disconnect electronic fuel injector enable circuit connector to prevent personal injury.

Do not come in contact with the fuel injector terminals while the engine is running.

- A. Remove power from the ECM. A strong electrical shock hazard is present if power is not removed from the ECM.
- B. Disconnect the connectors for the suspect injector(s).
- C. Restore power to the ECM.

**Note:** This test will help the service technician verify that the ECM can fire the solenoids. Do not try to manually crank the engine during this test. The ECM will terminate the “Injector Solenoid Test”.

- D. Perform the “Injector Solenoid Test” at least two times.

### Expected Result:

All of the suspect cylinders indicate “Open” on Cat ET.

### Results:

- OK – All cylinders indicate “Open” on Cat ET. The harness between the ECM and the injector 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 6.

## Test Step 6. Check the ECM for Proper Operation

- A. Remove power from the ECM. A strong electrical shock hazard is present if power is not removed from the ECM.
- B. Check the operation of the ECM by creating an open at the ECM.

- a. Disconnect the appropriate suspect injector wire from the P2 ECM connector. Remove the signal wire for the suspect injector(s) from the ECM connector.
- b. Install a jumper wire with Deutsch sockets on each end into the socket for the signal wire of the suspect injector(s).
- c. Reconnect the ECM connector.
- d. Restore power to the ECM.

**Note:** This test will help the service technician verify that the ECM can fire the solenoids. Do not try to manually crank the engine during this test. The ECM will terminate the “Injector Solenoid Test”.

- e. Perform the “Injector Solenoid Test”.
- f. Monitor the “Active Diagnostic Code” screen on Cat ET. Wait at least 30 seconds for activation of the code.

A 05 diagnostic code should be active for the suspect injector(s).

- g. Remove power from the ECM.

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

- a. Create a short between the wire jumper for the suspect signal wire and engine ground.
- b. Restore power to the ECM.

**Note:** This test will help the service technician verify that the ECM can fire the solenoids. Do not try to manually crank the engine during this test. The ECM will terminate the “Injector Solenoid Test”.

- c. Perform the “Injector Solenoid Test”.
- d. Monitor the “Active Diagnostic Code” screen on Cat ET. Wait at least 30 seconds for activation of the code.

A 04 diagnostic code should be active when the wire jumper is installed.

- e. Remove power from the ECM.
- f. Remove the wire jumper. Reconnect all wires and connectors.

**Expected Result:**

Cat ET displays “Short” when the wire jumper is shorted to engine ground. Cat ET displays “Open” when the signal wire for the injector is removed from the ECM connector.

**Results:**

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

**Repair:** Repair the harness or the connector. Refer to the diagnostic functional test Troubleshooting, “Inspecting Electrical Connectors”. Verify that the repair eliminates the problem.

STOP.

- Not OK – The ECM did not detect the open or the short.

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

STOP.

**Test Step 7. Measure the Resistance of the Injector Solenoid****⚠ WARNING**

**Personal injury can result from high voltage.**

**The Electronic Control Module produces high voltage.**

**Make sure the Electronic Control Module is not powered and the fuel injector solenoids are disconnected before proceeding.**

- Measure the solenoid resistance between pin 1 and pin 2 at the injector connectors.
- Record the measured resistance for each solenoid.

**Expected Result:**

The resistance is  $1.07 \pm 0.1$  Ohms.

**Results:**

- OK – The resistance is  $1.07 \pm 0.1$  Ohms.

**Repair:** The problem may be intermittent. If the problem is intermittent, refer to the diagnostic functional test Troubleshooting, “Inspecting Electrical Connectors”. Verify that the repair eliminates the problem.

STOP.

- Not OK – The resistance is not  $1.07 \pm 0.1$  Ohms.

**Repair:** Replace the injector. If the new injector has a trim code that is different from the old injector, change the trim code in the ECM.

STOP.

i02301588

**Inspecting Electrical Connectors**

**SMCS Code:** 1901-038

**System Operation Description:**

Most electrical problems are caused by poor connections. The following procedure will assist in detecting problems with connectors and with wiring. If a problem is found, correct the condition and verify that the problem is resolved.

Intermittent electrical problems are sometimes resolved by disconnecting and reconnecting connectors. It is very important to check for diagnostic codes immediately before disconnecting a connector. Also check for diagnostic codes after reconnecting the connector. If the status of a diagnostic code is changed due to disconnecting and reconnecting a connector, there are several possible reasons. The likely reasons are loose terminals, improperly crimped terminals, moisture, corrosion, and inadequate mating of a connection.

Follow these guidelines:

- Always use a 1U-5804 Crimp Tool to service Deutsch HD and DT connectors. Never solder the terminals onto the wires. Refer to “SEHS9615, Servicing Deutsch HD and DT Style Connectors”.
- Always use a 147-6456 Wedge Removal Tool to remove wedges from DT connectors. Never use a screwdriver to pry a wedge from a connector.
- Always use a breakout harness for a voltmeter probe or a test light. Never break the insulation of a wire in order to access to a circuit for measurements.
- If a wire is cut, always install a new terminal for the repair.

**⚠ WARNING**

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

**Test Step 1. Check Connectors for Moisture and Corrosion**

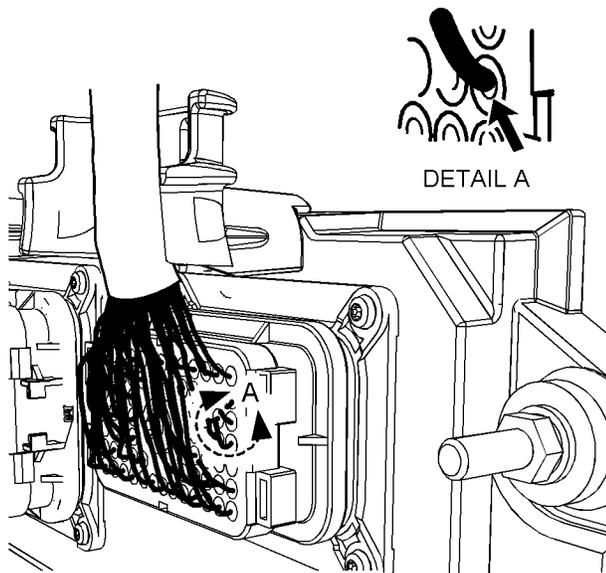


Illustration 48 g01131211  
Leaky seal at the connector (typical example)

**A.** Inspect all wiring harnesses. Ensure that the routing of the wiring harness allows the wires to enter the face of each connector at a perpendicular angle. Otherwise, the wire will deform the seal bore. Refer to Illustration 48. This will create a path for the entrance of moisture. Verify that the seals for the wires are sealing correctly.

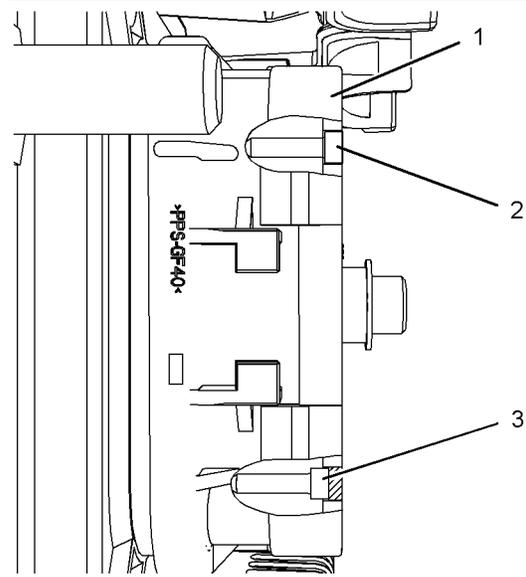


Illustration 49 g01131276  
Diagram for the installation of a connector plug (typical example)  
(1) Electronic Control Module (ECM) connector  
(2) Correctly inserted plug  
(3) Incorrectly inserted plug

**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 49.

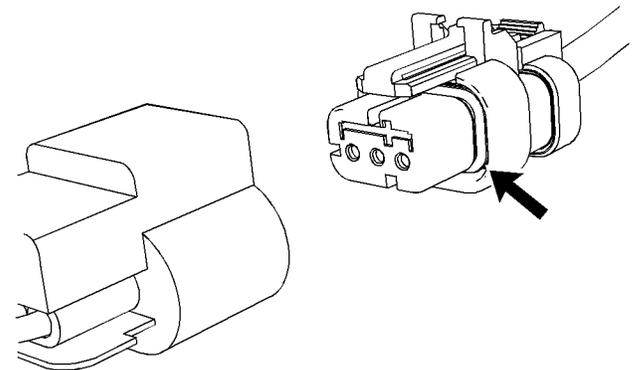


Illustration 50 g01131019  
Seal for a three-pin connector (typical example)

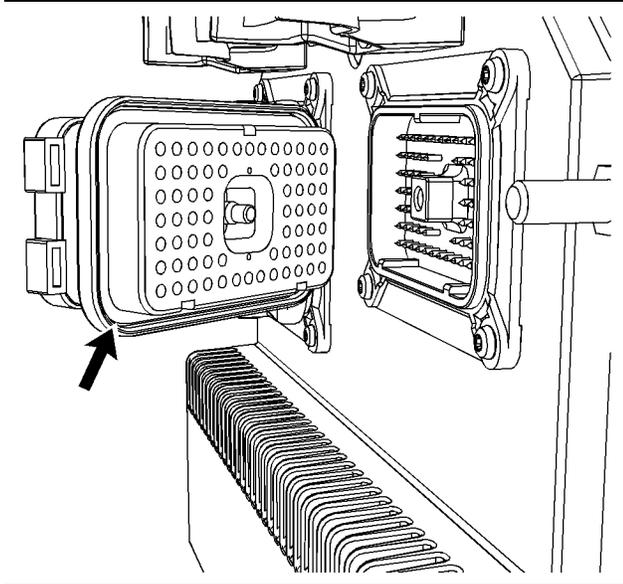


Illustration 51

g01131165

Seal for ECM connector (typical example)

**C.** Disconnect the suspect connector and inspect the connector seal. Ensure that the seals are in good condition. If necessary, replace the connector.

**D.** Thoroughly inspect the connectors for evidence of moisture entry.

**Note:** It is normal to see some minor seal abrasion on connector seals. Minor seal abrasion will not allow the entry of moisture.

If moisture or corrosion is evident in the connector, the source of the moisture entry must be found and the source of the moisture entry must be repaired. If the source of the moisture entry is not repaired, the problem will recur. Simply drying the connector will not fix the problem. Check the following items for the possible moisture entry path:

- Missing seals
- Improperly installed seals
- Nicks in exposed insulation
- Improperly mated connectors

Moisture can also travel to a connector through the inside of a wire. If moisture is found in a connector, thoroughly check the connector's harness for damage. Also check other connectors that share the harness for moisture.

**Note:** The ECM is a sealed unit. If moisture is found in an ECM connector, the ECM is not the source of the moisture. Do not replace the ECM.

### Expected Result:

The harness wiring, connectors, and seals are in good condition. There is no evidence of moisture in the connectors.

### Results:

- OK – The harness wiring, connectors, and seals are in good condition. Proceed to Test Step 2.
- Not OK – A problem has been found with the harness or the connectors.

**Repair:** Repair the connectors or the wiring, as required. Ensure that all of the seals are properly in place. Ensure that the connectors have been reattached.

If corrosion is evident on the pins, sockets or the connector, use only denatured alcohol to remove the corrosion. Use a cotton swab or a soft brush to remove the corrosion.

If moisture was found in the connectors, run the engine for several minutes and check again for moisture. If moisture reappears, the moisture is wicking into the connector. Even if the moisture entry path is repaired, it may be necessary to replace the wires.

Verify that the repair eliminates the problem.

STOP.

### Test Step 2. Check the Wires for Damage to the Insulation

**A.** Carefully inspect each wire for signs of abrasion, of nicks, and of cuts.

Inspect the wires for the following conditions:

- Exposed insulation
- Rubbing of a wire against the engine
- Rubbing of a wire against a sharp point

**B.** Check all of the wiring harness fasteners in order to verify that the harness is properly secured. Also check all of the fasteners in order to verify that the harness is not compressed. Pull back the harness sleeves in order to check for a flattened portion of wire. A fastener that has been overtightened flattens the harness. This damages the wires that are inside the harness.

### Expected Result:

The wires are free of abrasion, of nicks, and of cuts and the harness is properly clamped.

**Results:**

- OK – The harness is OK. Proceed to Test Step 3.
- Not OK – There is damage to the harness.

**Repair:** Repair the wires or replace the wires, as required. Verify that the repair eliminates the problem.

STOP.

**Test Step 3. Inspect the Connector Terminals**

- A.** Visually inspect each terminal in the connector. Verify that the terminals are not damaged. Verify that the terminals are properly aligned in the connector and verify that the terminals are properly located in the connector.

**Expected Result:**

The terminals are properly aligned and the terminals appear undamaged.

**Results:**

- OK – The terminals are OK. Proceed to Test Step 4.
- Not OK – The terminals of the connector are damaged.

**Repair:** Repair the terminals and/or replace the terminals, as required.

Verify that the repair eliminates the problem.

STOP.

**Test Step 4. Perform a Pull Test on Each Wire Terminal Connection**

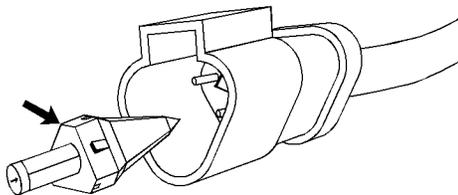


Illustration 52

g01131435

Receptacle lock wedge (typical example)

- A.** Ensure that the locking wedge for the connector is installed properly. Terminals cannot be retained inside the connector if the locking wedge is not installed properly.

- B.** Perform the 45 N (10 lb) pull test on each wire. Each terminal and each connector should easily withstand 45 N (10 lb) of tension and each wire should remain in the connector body. This test checks whether the wire was properly crimped in the terminal and whether the terminal was properly inserted into the connector.

**Expected Result:**

Each terminal and each connector easily withstands 45 N (10 lb) of pull and each wire remains in the connector body.

**Results:**

- OK – All terminals pass the pull test. Proceed to Test Step 5.
- Not OK – A wire has been pulled from a terminal or a terminal has been pulled from the connector.

**Repair:** Use the 1U-5804 Crimp Tool to replace the terminal. Replace damaged connectors, as required. Verify that the repair eliminates the problem.

STOP.

**Test Step 5. Check Individual Pin Retention into the Socket**

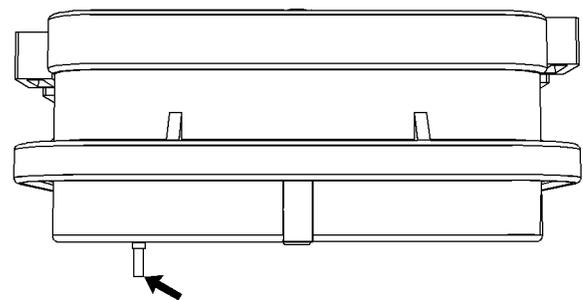


Illustration 53

g01131604

Diagram for testing pin retention (typical example)

- A.** Verify that the sockets provide good retention for the pins. Insert a new pin into each socket one at a time in order to check for a good grip on the pin by the socket.

**Expected Result:**

The sockets provide good retention for the new pin.

**Results:**

- OK – The terminals are OK. Proceed to Test Step 6.
- Not OK – Terminals are damaged.

**Repair:** Use the 1U-5804 Crimp Tool to replace the damaged terminals. Verify that the repair eliminates the problem.

STOP.

**Test Step 6. Check the Locking Mechanism of the Connectors**

- Ensure that the connectors lock properly. After locking the connectors, ensure that the two halves cannot be pulled apart.
- Verify that the latch tab of the connector is properly latched. Also verify that the latch tab of the connector returns to the locked position.

**Expected Result:**

The connector will securely lock. The connector and the locking mechanism are without cracks or breaks.

**Results:**

- OK – The connectors are in good repair. Proceed to Test Step 7.
- Not OK – The connector's locking mechanism is damaged or missing.

**Repair:** Repair the connector or replace the connector, as required. Verify that the repair eliminates the problem.

STOP.

**Test Step 7. Check the Allen Head Screws on the Connectors**

Visually inspect the allen head screws for the ECM connectors. Ensure that the threads on each allen head screw are not damaged.

- Connect the ECM connectors.

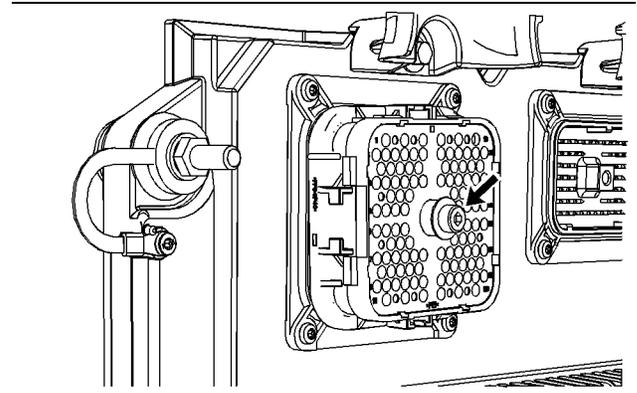


Illustration 54

g01132827

Allen head screw for the 120 pin ECM connector (typical example)

- Torque the allen head bolt for the 120 pin ECM connector to  $7.0 \pm 0.5$  N·m ( $60 \pm 4$  lb in).

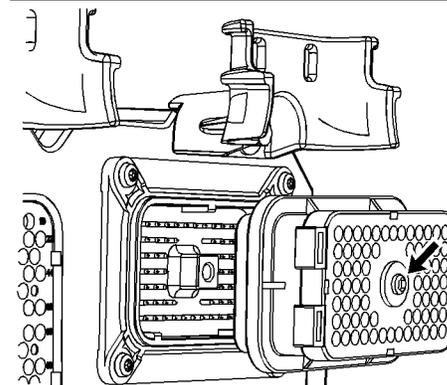


Illustration 55

g01132849

Allen head screw for the 70 pin ECM connector (typical example)

- Torque the allen head screw for the 70 pin ECM connector to  $6.0 + 1.5 - 0.5$  N·m ( $55 + 13 - 4$  lb in).

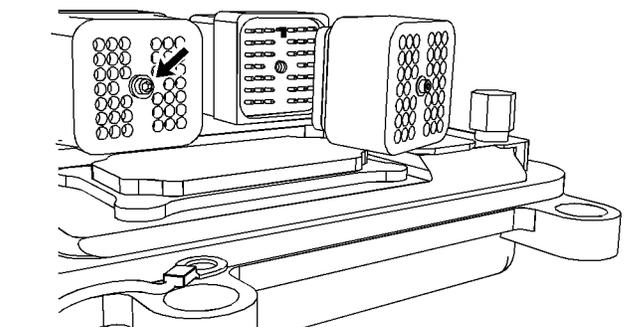


Illustration 56

g01132863

Allen head screw for the 40 pin ECM connector (typical example)

- Torque the allen head screw for the 40 pin ECM connector to  $2.25 \pm 0.25$  N·m ( $20 \pm 2$  lb in).

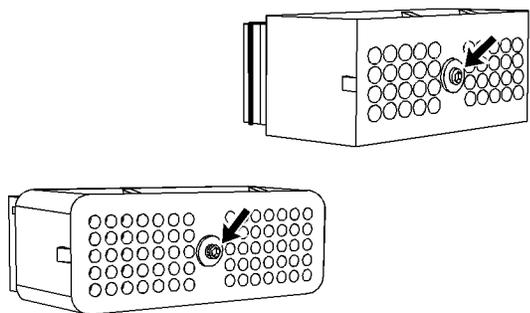


Illustration 57

g01133047

Allen head screw for the 40 pin customer connector and the 70 pin customer connector (typical example)

**B. Connect the customer connector.**

Torque the allen head screw for the 40 pin customer connector and the 70 pin customer connector to  $2.25 \pm 0.25$  N·m ( $20 \pm 2$  lb in).

**Expected Result:**

The ECM connector is secure and the allen head screws are properly torqued.

**Results:**

- OK – The ECM connectors and the customer connector is properly connected. Proceed to Test Step 8.
- Not OK – The allen head screws for the ECM connector or the customer connector is damaged.

**Repair:** Repair the connector or replace the connector, as required. Verify that the repair eliminates the problem.

STOP.

**Test Step 8. Perform the “Wiggle Test” on Caterpillar Electronic Technician (ET)**

- Select the “Wiggle Test” from the diagnostic tests on Cat ET.
- Choose the appropriate group of parameters to monitor.
- Press the “Start” button. Wiggle the wiring harness in order to reproduce intermittent problems.

If an intermittent problem exists, the status will be highlighted and an audible beep will be heard.

**Expected Result:**

No intermittent problems were indicated during the “Wiggle Test”.

**Results:**

- OK – No intermittent problems were found. The harness and connectors appear to be OK. If you were sent from another procedure, return to the procedure and continue testing. If this test has resolved the problem, return the engine to service. STOP.
- Not OK – At least one intermittent problem was indicated.

**Repair:** Repair the harness or the connector. Verify that the repair eliminates the problem.

STOP.

i02411560

## Prelubrication System

**SMCS Code:** 1319-038

**System Operation Description:**

Use this procedure to troubleshoot the electrical system if a problem is suspected with a prelubrication system or if one of the diagnostic codes or the event code in Table 37 is active or easily repeated. Refer to Troubleshooting, “Event Code List” for information on specific trip points for the event code.

Table 37

<b>Diagnostic Codes Table</b>		
<b>Description</b>	<b>Conditions which Generate this Code</b>	<b>System Response</b>
E098 Engine Prelube Override	The engine has started without completing the engine prelubrication.	The code is logged.
MID 0036 - CID 0338 - FMI 05 Pre-lube Relay open circuit	The engine's Electronic Control Module (ECM) detects an open circuit at the prelube relay. The ECM detects a short to battery voltage at the prelube relay.	
MID 0036 - CID 0338 - FMI 06 Pre-lube Relay short to ground	The engine's ECM detects a short circuit at the prelube relay.	

The ECM has the ability to automatically lubricate the engine before cranking. This may increase the life of certain engine parts by lubricating the parts before the starting motor is engaged.

The prelubrication system is activated when the keyswitch is turned to the START position. The system prevents the starting motor from engaging while the pump builds pressure in the engine oil system. After a short period of time, the starting motor is allowed to engage. The keyswitch must be left in the START position for the duration of the prelube cycle in order to ensure that the engine is properly lubricated before start-up.

The engine will start without proper lubrication. If the keyswitch is turned to the OFF position from the START position and then turned back to the START position the prelube cycle will be bypassed. In order to record the instances of improper lubrication, the event code E098 is generated whenever the prelubrication system is bypassed.

A test on Caterpillar Electronic Technician (ET) allows the technician to activate the prelube system. The test is functional when the engine speed is 0 rpm. The test is accessed by selecting the following menus on Cat ET:

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



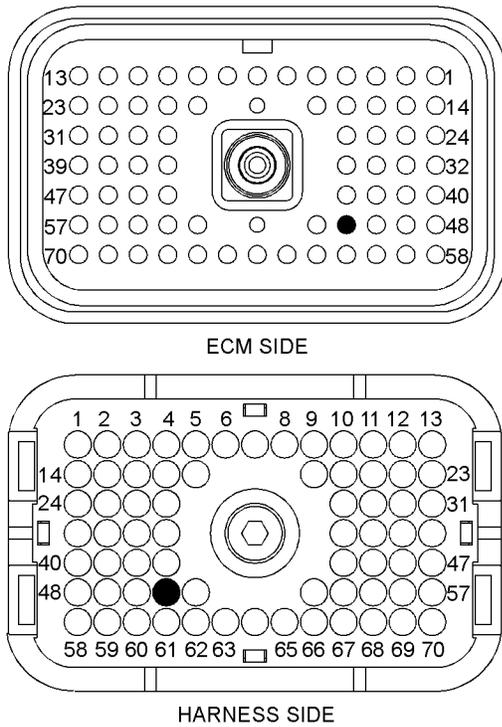


Illustration 59 g01205422  
P1 ECM connector  
(P1-51) Digital return

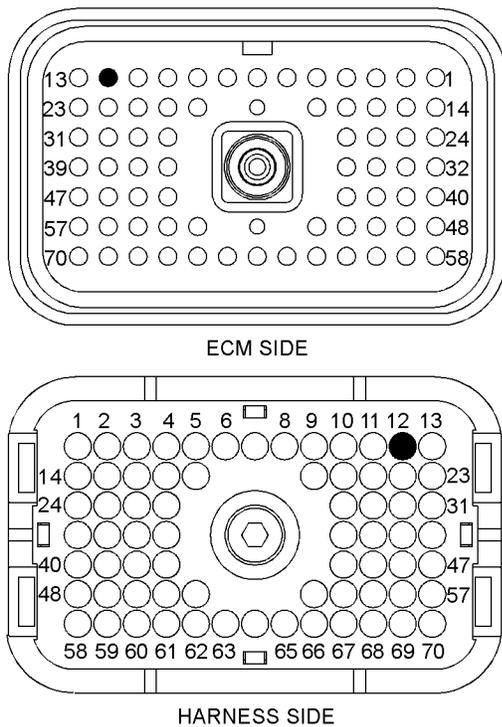


Illustration 60 g01205425  
P2 ECM connector  
(P2-12) Prelube relay

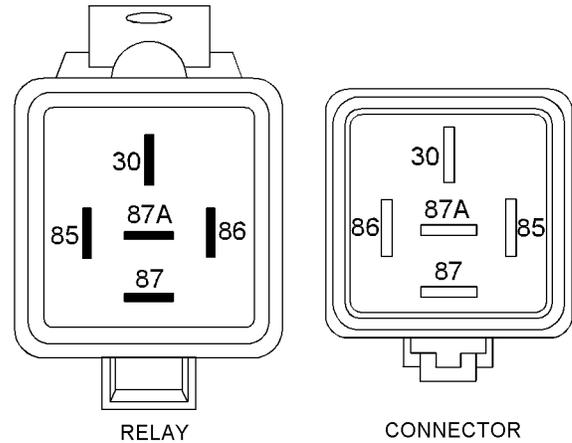


Illustration 61 g01149844  
Terminal locations of the pre-lube relay

### Test Step 1. Inspect Electrical Connectors and Wiring

- A. Turn the keyswitch to the OFF position.
- B. Thoroughly inspect the ECM connectors. Inspect all of the other connectors for the circuit. Refer to Troubleshooting, "Inspecting Electrical Connectors" 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, "Inspecting Electrical Connectors" for details.
- E. Check the harness and the wiring for abrasion and for pinch points.

#### Expected Result:

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

#### Results:

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

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

Verify that the repair eliminates the problem.

STOP.

### Test Step 2. Check for Active Diagnostic Codes

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

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

#### Expected Result:

No diagnostic codes are active.

#### Results:

- OK – No diagnostic codes are active, but a problem is suspected in the prelube system. Proceed to Test Step 6.
- Not OK – A 06 diagnostic code is active at this time. Proceed to Test Step 3.
- Not OK – A 05 diagnostic code is active at this time. Proceed to Test Step 4.

### Test Step 3. Create an Open at the Connector for the Prelube Relay

- A. Turn the keyswitch to the OFF position.
- B. Disconnect the connector for the prelube relay.
- C. Turn the keyswitch to the ON position.
- D. Proceed to the “Diagnostic Overrides” screen on Cat ET.
- E. Activate the prelube system.

**Note:** Monitor the “Active Diagnostic Codes” screen on Cat ET.

- F. Check for a 05 diagnostic code for the prelube relay.

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

- G. Turn the keyswitch to the OFF position.

#### Expected Result:

A 05 diagnostic code is now active for the prelube relay.

#### Results:

- OK – A 06 diagnostic code was active before disconnecting the connector. A 05 diagnostic code became active after disconnecting the connector. The harness and the ECM are OK. The problem may be in the prelube relay.

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

STOP.

- Not OK – A 06 diagnostic code remains active. There is a short between the connector for the prelube relay and the ECM. Leave the connector for the prelube relay disconnected. Proceed to Test Step 5.

### Test Step 4. Create a Short at the Connector for the Prelube Relay

- A. Turn the keyswitch to the OFF position.
- B. Install a jumper wire between terminal 85 and terminal 86 of the connector for the prelube relay.
- C. Turn the keyswitch to the ON position.

**Note:** Monitor the “Active Diagnostic Codes” screen on Cat ET after installing the jumper wire.

- D. Proceed to the “Diagnostic Overrides” screen on Cat ET.
- E. Activate the prelube system.

**Note:** Monitor the “Active Diagnostic Codes” screen on Cat ET.

- F. Wait at least 30 seconds for activation of the 06 diagnostic code.
- G. Turn the keyswitch to the OFF position. Remove the wire jumper.

#### Expected Result:

A 06 diagnostic code is active when the jumper wire is installed. A 05 diagnostic code is active when the jumper wire is removed.

**Results:**

- OK – A 06 diagnostic code is active when the jumper wire is installed. A 05 diagnostic code is active when the jumper wire is removed. The engine harness and the ECM are OK.

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

STOP.

- Not OK – The 05 diagnostic code remains active with the jumper in place. The open circuit is between the ECM and the connector for the prelube relay. Proceed to Test Step 5.

**Test Step 5. Test the Operation of the ECM**

- Turn the keyswitch to the OFF position.
- Fabricate jumper wires that can be used to replace the wire(s) in the ECM connector for the prelube relay. Crimp a connector socket to one end of the jumper wires.
- Disconnect the appropriate ECM connector(s) for the prelube relay.
- Remove the wire(s) for the prelube relay from the ECM connector.
- Install the jumper wire(s) into the terminal location(s) for the prelube relay at the ECM connector.
- Connect the ECM connectors.
- 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 ON position.
  - Proceed to the “Diagnostic Overrides” screen on Cat ET.
  - Activate the prelube system.
  - Monitor the “Active Diagnostic Code” screen on Cat ET.

Check the prelube relay for an active 05 diagnostic code.

**Note:** Wait at least 30 seconds so that any codes may become active.

- Turn the keyswitch to the OFF position.

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

- Short the jumpers for the return wire and the output wire together.
- Turn the keyswitch to the ON position.
- Proceed to the “Diagnostic Overrides” screen on Cat ET.
- Activate the prelube system.
- Monitor the “Active Diagnostic Code” screen on Cat ET.

Check the prelube relay for an active 06 diagnostic code.

**Note:** Wait at least 30 seconds so that any codes may become active.

- Turn the keyswitch to the OFF position. Reconnect all wires to the original configuration.

**Expected Result:**

A 05 diagnostic code is active when the wires from the prelube relay are open at the ECM connector. A 06 diagnostic code is active if the wires from the prelube relay are shorted at the ECM connector.

**Results:**

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

**Repair:** Repair the connectors or wiring and/or replace the connectors or wiring.

STOP.

- Not OK – One of the following conditions exists: The 05 diagnostic code is not active when the wire for the prelube relay is disconnected. The 06 diagnostic code is not active when the wire jumper is installed.

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

STOP.

### Test Step 6. Check the Voltage to the Coil of the Prelube Switch

- A. Disconnect wire 337-WH from the coil of the prelube switch.
- B. Connect a voltmeter between wire 337-WH and engine ground.
- C. Turn the keyswitch to the ON position.
- D. Proceed to the “Diagnostic Overrides” screen on Cat ET.
- E. Activate the prelube system.
- F. Measure the voltage between wire 337-WH and engine ground.
- G. Turn the keyswitch to the OFF position.
- H. Replace all wires to the original configuration.

#### Expected Result:

The voltage measures  $24 \pm 3$  VDC.

#### Results:

- OK – The voltage is  $24 \pm 3$  VDC. Proceed to Test Step 7.
- Not OK – The voltage is not  $24 \pm 3$  VDC.

#### Repair: Perform the following steps.

1. Remove wire 337-WH from terminal 85 on the prelube relay. Activate the prelube override and measure the voltage between terminal 85 on the prelube relay and engine ground. If voltage is present on terminal 85 on the prelube relay, repair the wire 337-WH.

If  $24 \pm 3$  VDC is not present on terminal 85 on the prelube relay, measure the voltage to terminal 30 on the prelube relay. If  $24 \pm 3$  VDC is not present on terminal 30 of the prelube relay, verify that the 20A start aid breaker is not tripped. Verify that the wiring between the battery and the prelube relay is OK.

2. If  $24 \pm 3$  VDC is present on terminal 30 on the prelube relay, replace the prelube relay and retest the prelube system.

STOP.

### Test Step 7. Check the Voltage at the Prelube Motor

- A. Disconnect the wire to the prelube motor from the prelube switch at the prelube motor.
- B. Connect a voltmeter between the wire and engine ground.
- C. Turn the keyswitch to the ON position.
- D. Proceed to the “Diagnostic Overrides” screen on Cat ET.
- E. Activate the prelube system.
- F. Measure the voltage between the wire and engine ground.
- G. Turn the keyswitch to the OFF position.
- H. Replace all wires to the original configuration.

#### Expected Result:

The voltage is  $24 \pm 3$  VDC.

#### Results:

- OK – The voltage is  $24 \pm 3$  VDC. Proceed to Test Step 8.
- Not OK – The voltage is not  $24 \pm 3$  VDC.

#### Repair: Perform the following steps.

1. Remove the wire to the prelube motor from the prelube switch at the prelube switch. Activate the prelube override and measure the voltage between the terminal on the prelube switch and engine ground. If voltage is present on the terminal, repair the wire to the prelube motor.
2. If voltage is not present on the terminal, verify that the wire 200-BK has continuity to engine ground. If wire 200-BK has continuity to engine ground, measure the voltage to the other side of the contacts of the prelube switch. If  $24 \pm 3$  VDC is present on the contacts of the prelube switch and the wire 200-BK is not open, replace the prelube switch and retest the prelube system.
3. If  $24 \pm 3$  VDC is not present on the other side of the contacts of the prelube switch, repair the wiring between the battery and the prelube switch.

STOP.

## Test Step 8. Check the Operation of the Prelubrication Motor

- A. Turn the keyswitch to the OFF position.
- B. Connect one side of a suitable piece of 10 AWG wire to the +Battery terminal.
- C. For one second, connect the other end of the wire to the positive terminal of the prelubrication motor.

### Expected Result:

The prelubrication motor starts while the wire is connected to the positive terminal of the prelubrication motor.

### Results:

- OK – The prelubrication motor starts. There is a problem in the wiring harness at the prelubrication motor.

**Repair:** Repair the connectors or wiring and/or replace the connectors or wiring.

STOP.

- Not OK – The prelubrication motor did not start.

**Repair:** Verify that the wire to ground at the prelubrication relay has continuity to engine ground. If the wire to ground is OK, the problem is in the prelubrication motor. Install a new prelubrication motor. Verify that the problem is no longer present.

STOP.

i02412085

## Pulse Width Modulated Sensor

**SMCS Code:** 5574-038

### System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with the exhaust temperature sensors or if any one of the diagnostic codes in Table 38 is active or easily repeated.

Table 38

<b>Diagnostic Codes Table</b>		
<b>Description</b>	<b>Conditions which Generate this Code</b>	<b>System Response</b>
MID 0036 - CID 0827 - FMI 08 Left Exhaust Temperature signal abnormal	The engine's Electronic Control Module (ECM) detects a sensor frequency that is greater than 1000 Hz or less than 150 Hz. The engine's ECM detects a duty cycle that is greater than 90 percent or a duty cycle that is less than 10 percent.	The code is logged. The value of the parameter is set to zero.
MID 0036 - CID 0828 - FMI 08 Right Exhaust Temperature signal abnormal		

### System Operation

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

- Left exhaust temperature sensor
- Right exhaust temperature sensor

The PWM sensors provide a signal to the engine's ECM for certain engine operating conditions. The sensors receive a  $8.0 \pm 0.4$  VDC regulated voltage from the ECM.

The sensor's wires are routed from the ECM to the sensor connectors. The following list gives the terminal locations for the sensor connector.

- Terminal A 8 V supply
- Terminal B sensor return
- Terminal C sensor signal

The ECM performs an automatic calibration of these sensors whenever the ECM is powered and the engine has been off for at least five seconds.

The ECM provides short circuit protection for the internal power supply. A short circuit to the battery will not damage the internal power supply.

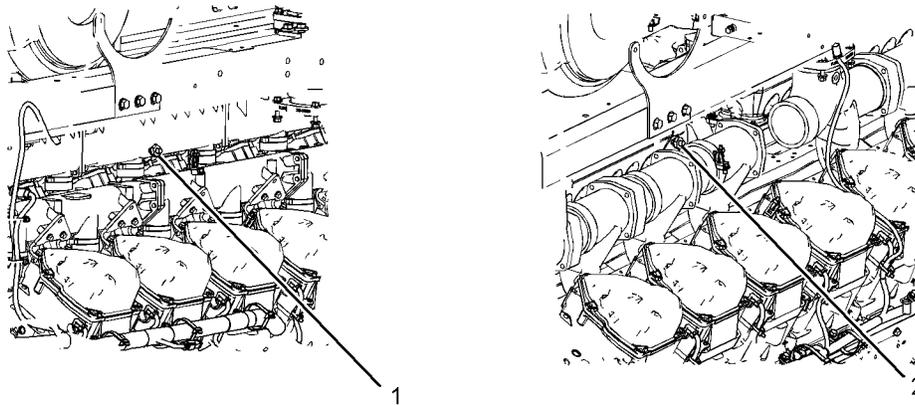


Illustration 62

g01208743

Sensor locations

(1) Left exhaust temperature sensor

(2) Right exhaust temperature sensor

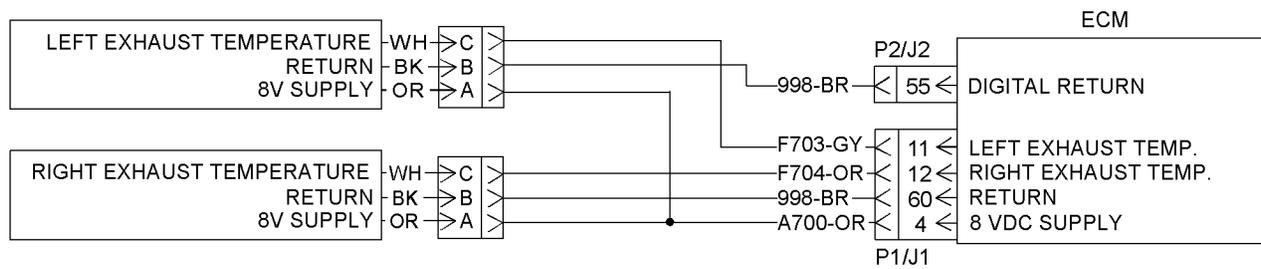
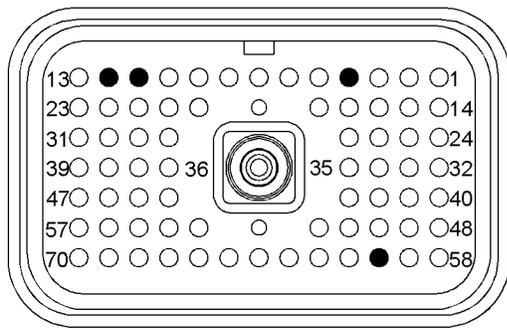


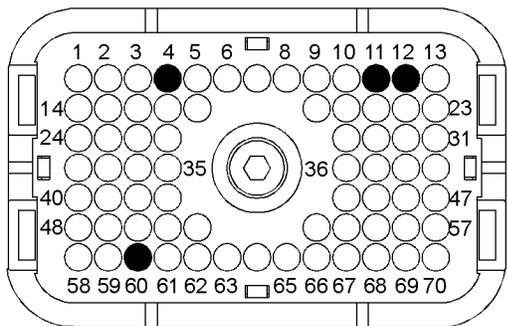
Illustration 63

g01205563

Typical schematic



ECM SIDE

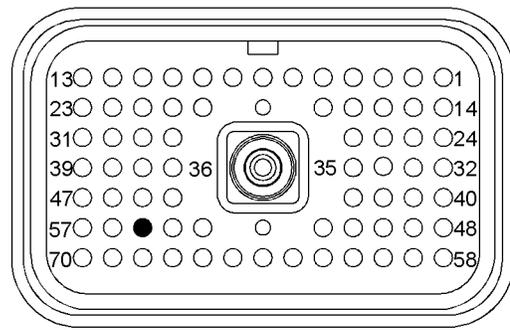


HARNESS SIDE

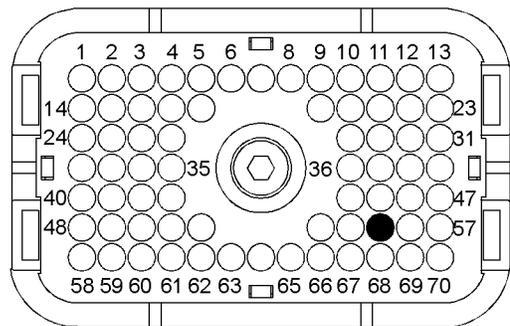
Illustration 64

g01205567

P1 ECM connector  
(P1-4) 8 V supply  
(P1-11) Left exhaust temperature  
(P1-12) Right exhaust temperature  
(P1-60) Digital return



ECM SIDE



HARNESS SIDE

Illustration 65

g01205569

P2 ECM connector  
(P2-55) Digital return

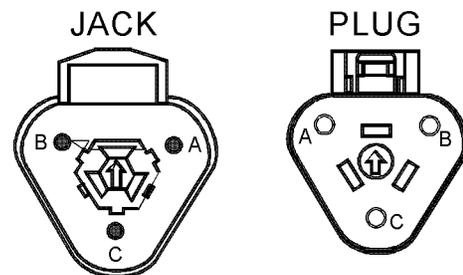


Illustration 66

g01094844

Sensor connector  
(Pin A) Sensor supply  
(Pin B) Sensor return  
(Pin C) Signal

### Test Step 1. Check for an “Active” or “Logged” Diagnostic Code

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

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

**C.** Determine if a diagnostic code has 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.

**D.** Determine if a 08 diagnostic code is active or if a 08 diagnostic code has been logged.

**Expected Result:**

No diagnostic code is active for the exhaust temperature sensors.

**Results:**

- OK – No diagnostic codes are active.

**Repair:** If the problem is intermittent, refer to Troubleshooting, “Inspecting Electrical Connectors” for the correct procedures for inspecting electrical connectors.

STOP.

- Not OK – A diagnostic code is active or the diagnostic code is logged several times. Proceed to Test Step 2.

**Test Step 2. Perform the “Wiggle Test” on 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 for the suspect sensor in order to reproduce an intermittent problem.

If an intermittent problem is detected, the status will be highlighted and an audible beep will be heard.

**Expected Result:**

No intermittent problems were detected during the “Wiggle Test”.

**Results:**

- OK – No intermittent problems were found. The harness and connectors appear to be OK. Proceed to Test Step 3 and continue to troubleshoot the active diagnostic code.

- Not OK – At least one intermittent problem was indicated.

**Repair:** Repair the harness or the connector. Refer to the diagnostic functional test Troubleshooting, “Inspecting Electrical Connectors”. Verify that the repair eliminates the problem.

STOP.

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

**A.** Disconnect the suspect sensor(s) at the sensor connector:

**B.** Measure the voltage on the ECM side of the sensor connector between pin A and pin B for the suspect sensor(s).

**Expected Result:**

The supply voltage is  $8.0 \pm 0.4$  VDC.

**Results:**

- OK – The supply voltage is  $8.0 \pm 0.4$  VDC. Proceed to Test Step 5.
- Not OK – The supply voltage is not  $8.0 \pm 0.4$  VDC. Proceed to Test Step 4.

**Test Step 4. Check the Digital Supply Voltage at the ECM**

**A.** Remove power from the ECM.

**B.** Remove the supply wire from P1-4. Install a wire jumper into the socket for P1-4.

**C.** Restore power to the ECM.

**D.** Measure the voltage between the wire jumper in terminal P1-4 and engine ground.

**E.** Remove power from the ECM.

**F.** Remove the wire jumper and reconnect all wires. Reconnect ECM connector J1/P1.

**Expected Result:**

The supply voltage is  $8.0 \pm 0.4$  VDC.

**Results:**

- OK – The supply voltage is  $8.0 \pm 0.4$  VDC. The supply voltage at the ECM is correct. There is a problem in the wiring between the ECM and the sensor connector. Repair the connectors or wiring and/or replace the connectors or wiring.

**Repair:** Repair the connectors or wiring and/or replace the connectors or wiring.

STOP.

- Not OK – The supply voltage is not  $8.0 \pm 0.4$  VDC. The voltage at the ECM is not correct.

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

STOP.

### Test Step 5. Check the Sensor’s Duty Cycle at the Sensor Connector

- A. Remove power from the ECM.
  - B. Remove the suspect sensor’s signal wire from pin C of the sensor connector.
  - C. Reconnect the suspect sensor connector.
  - D. Restore power to the ECM.
  - E. Measure the duty cycle between the sensor’s signal wire and pin B of the sensor connector.
- Note:** Set the multimeter to “VDC”. Press the “Hz” button twice so that the % symbol is displayed.
- F. Remove power from the ECM.
  - G. Replace the sensor’s signal wire and reconnect the sensor.

#### Expected Result:

The duty cycle is between 10 to 90 percent.

#### Results:

- OK – The duty cycle is correct. Proceed to Test Step 6.
- Not OK – The duty cycle is incorrect.

**Repair:** Replace the sensor. Verify that no diagnostic codes are active for the suspect sensor before permanently installing the sensor.

STOP.

### Test Step 6. Check the Sensor’s Duty Cycle at the ECM

- A. Remove power from the ECM.

- B. Remove the suspect signal wire for the sensor from ECM connector P1. Refer to Illustration 63 for the terminal locations for the ECM connector.

- C. Restore power to the ECM.

- D. Measure the duty cycle between the sensor’s signal wire and the sensor’s return wire.

**Note:** Set the multimeter to “VDC”. Press the “Hz” button twice so that the % symbol is displayed.

- E. Remove power from the ECM. Reconnect all wires.

#### Expected Result:

The duty cycle is between 10 to 90 percent.

#### Results:

- OK – The duty cycle is correct.

**Repair:** Replace the ECM. Refer to the diagnostic procedure Troubleshooting, “Replacing the ECM”.

STOP.

- Not OK – The duty cycle is not correct.

**Repair:** There is a problem in the wiring between the ECM and the connector for the left rail or the connector for the right rail. Repair the connectors and/or wiring between the ECM and the connector for the right rail or the connector for the left rail.

STOP.

i02413610

## Sensor Supply

**SMCS Code:** 5574-038

#### 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		
Description	Conditions which Generate this Code	System Response
MID 0036 - CID 0262 - FMI 03 5 Volt Sensor DC Power Supply short to +batt	The analog sensor supply voltage is above normal for two seconds.	The code is logged. All sensors are set to default values.
MID 0036 - CID 0262 - FMI 04 5 Volt Sensor DC Power Supply short to ground	The analog sensor supply voltage is below normal for two seconds.	
MID 0036 - CID 0263 - FMI 03 Digital Sensor Supply short to +batt	The digital sensor supply voltage is above normal for two seconds.	
MID 0036 - CID 0263 - FMI 04 Digital Sensor Supply short to ground	The digital sensor supply voltage is below normal for two seconds.	

### System Operation

The ECM supplies a regulated voltage of  $5.0 \pm 0.2$  VDC to the following sensors:

- Aftercooler temperature sensor (rear)
- Aftercooler temperature sensor (front)
- Atmospheric pressure sensor
- Coolant temperature sensor
- Crankcase pressure sensor
- Filtered engine oil pressure sensor
- Turbocharger outlet pressure sensor
- Left turbocharger inlet pressure sensor
- Right turbocharger inlet pressure sensor
- Unfiltered engine oil pressure sensor

The ECM supplies a regulated voltage of  $8.0 \pm 0.4$  VDC to the following sensors:

- Left exhaust temperature sensor
- Right exhaust temperature 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 the diagnostic code 262-03 or the diagnostic code 263-03 is logged, it is possible that all of the sensors have been damaged. Repair the sensor supply and check for any active sensor diagnostic codes in order to determine if a sensor has failed.

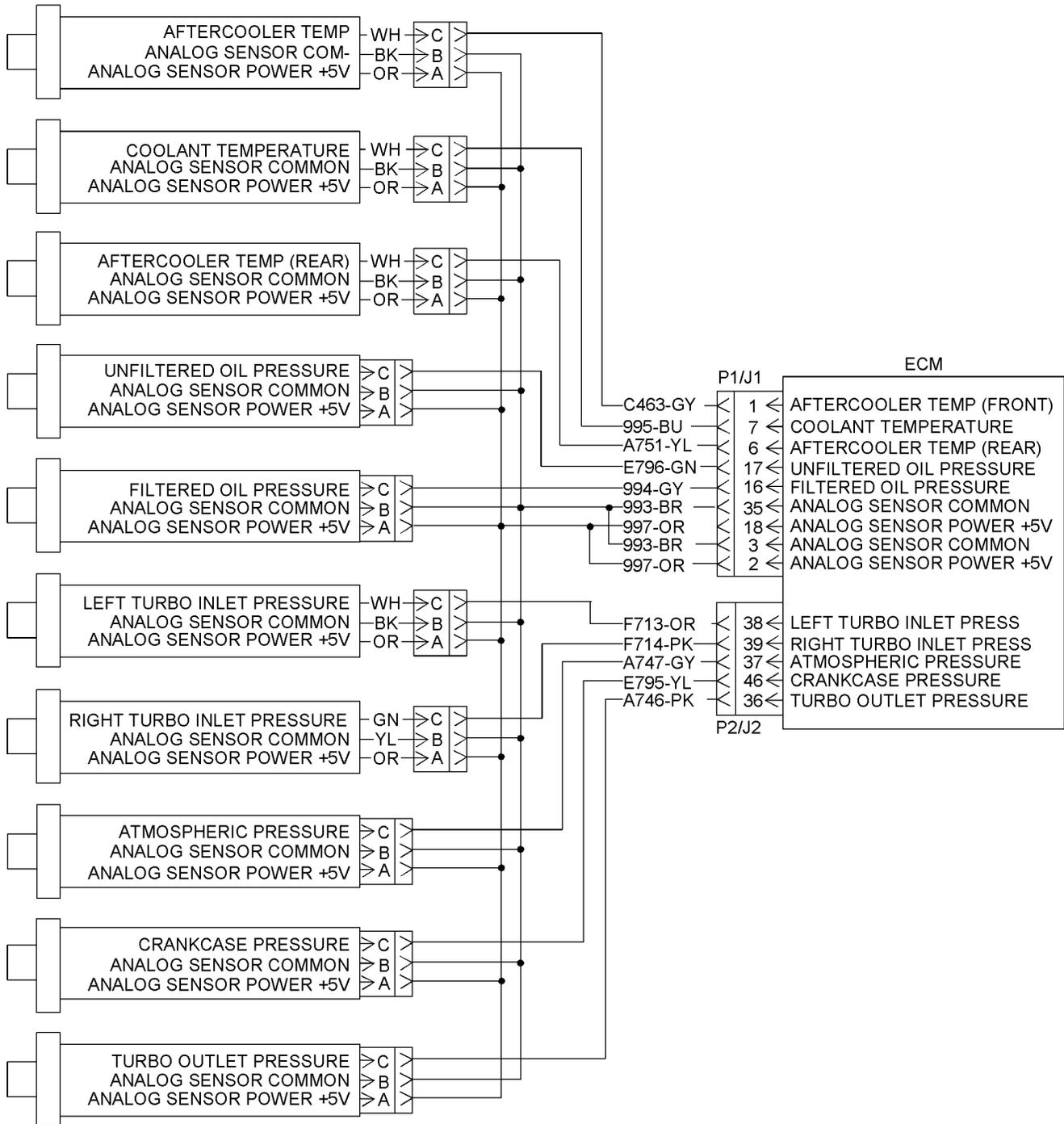


Illustration 67  
Typical 5 V supply

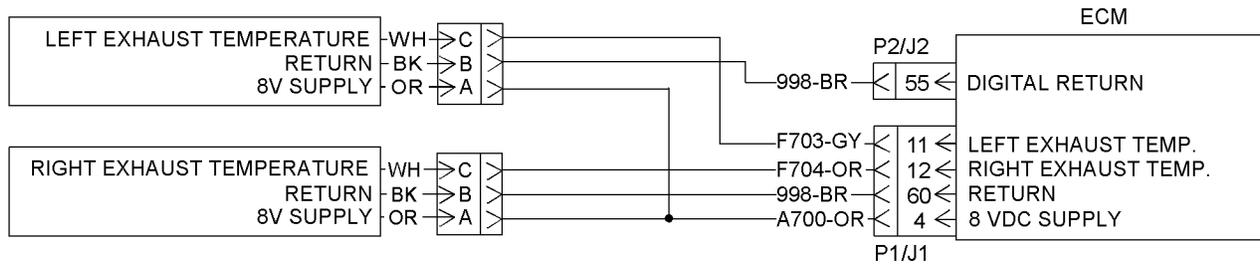
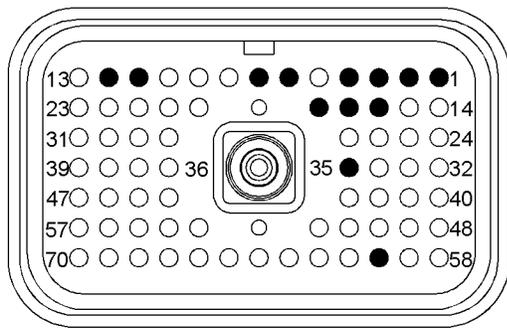


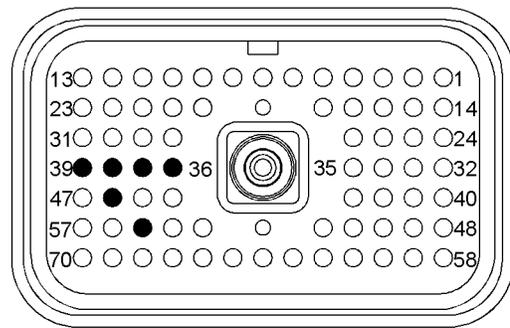
Illustration 68

g01205563

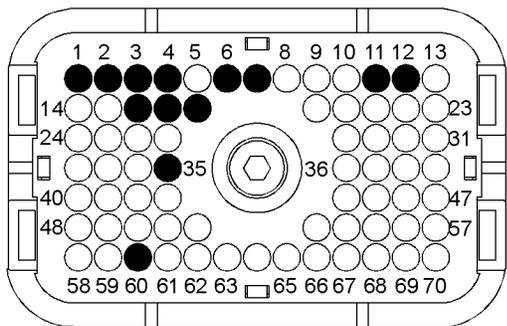
Typical 8 V supply



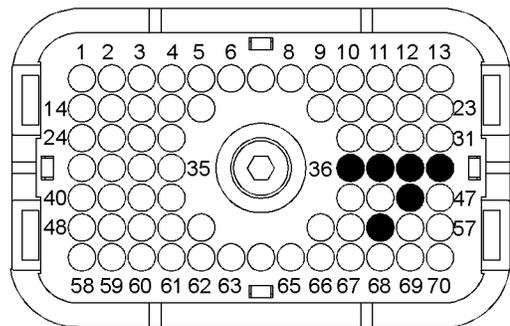
ECM SIDE



ECM SIDE



HARNES SIDE



ENGINE SIDE

Illustration 69

g01206359

P1 ECM connector

- (P1-1) Aftercooler temperature sensor (front)
- (P1-2) 5 V sensor supply
- (P1-3) Sensor return
- (P1-4) 8 V supply
- (P1-6) Aftercooler temperature sensor (rear)
- (P1-7) Coolant temperature sensor
- (P1-11) Left exhaust temperature
- (P1-12) Right exhaust temperature
- (P1-16) Filtered engine oil pressure sensor
- (P1-17) Unfiltered engine oil pressure sensor
- (P1-18) 5 V sensor supply
- (P1-35) Sensor return
- (P1-60) Digital return

Illustration 70

g01206347

P2 ECM connector

- (P2-36) Turbocharger outlet pressure sensor
- (P2-37) Atmospheric sensor
- (P2-38) Left turbocharger inlet pressure sensor
- (P2-39) Right turbocharger inlet pressure sensor
- (P2-46) Crankcase pressure sensor
- (P2-55) Digital return

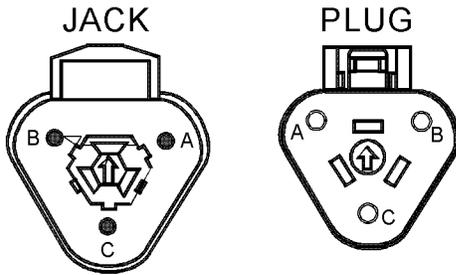


Illustration 71 g01094844

Sensor connector  
(Pin A) Sensor supply  
(Pin B) Sensor return  
(Pin C) Signal

### 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, “Inspecting Electrical Connectors” 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, “Inspecting Electrical Connectors” 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 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:
  - 262-03
  - 262-04
  - 263-03
  - 263-04

**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, “Inspecting Electrical Connectors”.

STOP.

- Not OK – Either the 262-03 or 262-04 diagnostic code is active at this time. Proceed to Test Step 3.
- Not OK – Either the 263-03 or 263-04 diagnostic code is active at this time. Proceed to Test Step 5.

### Test Step 3. Disconnect the 5 Volt Sensors while you Monitor the Active 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 262-03 code or an active 262-04 code.

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

a. Disconnect the following sensors one at a time:

- Aftercooler temperature sensor (rear)
- Aftercooler temperature sensor (front)
- Atmospheric pressure sensor
- Coolant temperature sensor
- Crankcase pressure sensor
- Filtered engine oil pressure sensor
- Turbocharger outlet pressure sensor
- Left turbocharger inlet pressure sensor
- Right turbocharger inlet pressure sensor
- Unfiltered engine oil pressure sensor

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

**Expected Result:**

The diagnostic code deactivates when a particular sensor is disconnected.

**Results:**

- OK – The 262-03 or 262-04 diagnostic code deactivates when a particular sensor is disconnected.

**Repair:** Connect the suspect sensor. If the code returns, replace the sensor. Connect all of the connectors. Verify that the problem is resolved.

STOP.

- Not OK – The 262-03 or 262-04 diagnostic code remains active after all of the sensors are disconnected. Leave the sensors disconnected. The sensors are 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.** Disconnect the J1/P1 ECM connector.

**B.** Fabricate four 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 P1-2 (5 V sensor supply) and P1-3 (sensor return). Install a jumper wire into each of these terminal locations.

**D.** Remove the wires from terminal locations P2-18 (5 V sensor supply) and P2-35 (sensor return). Install a jumper wire into each of these terminal locations.

**E.** Connect the J1/P1 ECM connector.

**F.** Restore electrical power to the engine ECM.

**G.** Measure the voltage between the jumper wire in P1-2 (5 V sensor supply) and the jumper wire in P1-3 (sensor return).

**H.** Measure the voltage between the jumper wire in P2-18 (5 V sensor supply) and the jumper wire in P2-35 (sensor return).

**I.** Remove electrical power from the ECM.

**Expected Result:**

Each voltage measurement is  $5.0 \pm 0.2$  VDC.

**Results:**

- OK – The voltage measurement is  $5.0 \pm 0.2$  VDC. The ECM is operating correctly.

**Repair:** One of the supply wires is shorted to another wire in the harness or one of the supply wires is shorted to engine ground. To isolate the problem to a specific harness, perform the following test steps:

**1.** One at a time, reinstall the wiring for each 5 V supply while you check Cat ET for an active 262-03 or 262-04 diagnostic code.

a. Disconnect the ECM connector.

b. Install the wires that were removed for the 5 V supply at the ECM connector. Refer to Illustration 67 for wiring information.

c. Connect the ECM connector.

d. Restore electrical power to the engine ECM.

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

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

**f. If a diagnostic code becomes active for this 5 V supply, there is a problem in this harness between the ECM and the sensor connector.**

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

STOP.

- Not OK – The voltage measurement is not  $5.0 \pm 0.2$  VDC.

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

STOP.

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

- A. Monitor the active diagnostic code screen on Cat ET while you disconnect each 8 Volt sensor at the sensor connector. Check for an active 263-03 code or an active 263-04 code.

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

- a. Disconnect the following sensors one at a time:
  - Exhaust temperature sensor (LH)
  - Exhaust temperature sensor (RH)

- B. Remove electrical power from the ECM.

#### Expected Result:

The diagnostic code deactivates when a particular sensor is disconnected.

#### Results:

- OK – The 263-03 or 263-04 diagnostic code deactivates when a particular sensor is disconnected.

**Repair:** Connect the suspect sensor. If the code returns, replace the sensor. Connect all of the connectors. Verify that the problem is resolved.

STOP.

- Not OK – The 263-03 or 263-04 diagnostic code remains active after the sensors are disconnected. Leave the sensors disconnected. The sensors are not the cause of the diagnostic code. Proceed to Test Step 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 P1-60 (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 P1-60 (sensor return).

- G. Remove electrical power from the ECM.

#### Expected Result:

The voltage measurement is  $8.0 \pm 0.4$  VDC.

#### Results:

- OK – The voltage measurement is  $8.0 \pm 0.4$  VDC. The ECM is operating correctly.

**Repair:** One of the supply wires is shorted to another wire in the harness or one of the supply wires is shorted to engine ground. To isolate the problem to a specific harness, perform the following test steps:

1. Reinstall the wiring for the 8 V supply while you check Cat ET for an active 263-03 or 263-04 diagnostic code.

- a. Disconnect the ECM connector.

- b. Install the wires that were removed for the 8 V supply at the ECM connector. Refer to Illustration 67 for wiring information.

- c. Connect the ECM connector.

- d. Restore electrical power to the engine ECM.

- e. Monitor the active diagnostic code screen on Cat ET. Check for an active 263-03 code or an active 263-04 code.

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

- f. **If a diagnostic code becomes active for this 8 V supply, there is a problem in this harness between the ECM and the sensor connector.**

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

STOP.

- Not OK – The voltage measurement is not  $8.0 \pm 0.4$  VDC.

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

STOP.

i02413879

## Throttle Position Sensor

**SMCS Code:** 1913-038

### System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with the throttle position signal or if the diagnostic code in Table 40 is active or easily repeated.

Table 40

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
MID 0036 - CID 0091 - FMI 08 Throttle Position signal abnormal	The Engine's Electronic Control Module (ECM) detects a sensor frequency that is less than 150 Hz or a sensor frequency that is greater than 1000 Hz for two seconds. or The engine's ECM detects a duty cycle that is less than 5 percent or a duty cycle that is greater than 95 percent for one second.	The code will be active. The throttle signal defaults to a zero percent duty cycle.

The throttle position sensor (TPS) provides a throttle position signal to the engine's ECM. The pedal mounted TPS is attached directly to the assembly. The pedal mounted TPS cannot be adjusted.

The engine ECM receives a PWM signal from the throttle position sensor. The ECM converts the duty cycle of the signal into a usable throttle position. The duty cycle must be between 5 percent and 95 percent for a valid signal. The frequency of the signal must be a fixed frequency between 150 Hz and 1000 Hz. The ECM displays the throttle position as a percentage between 0 and 100 percent.

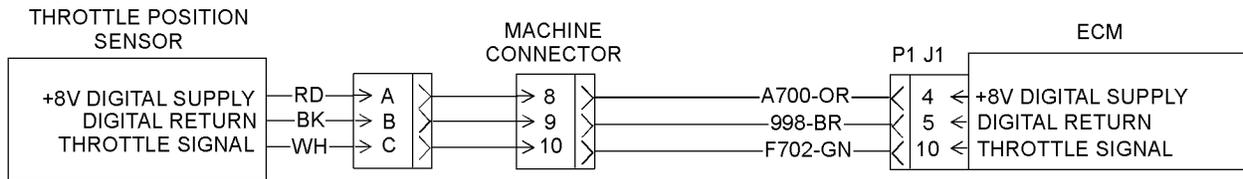


Illustration 72  
Typical schematic

g01206563

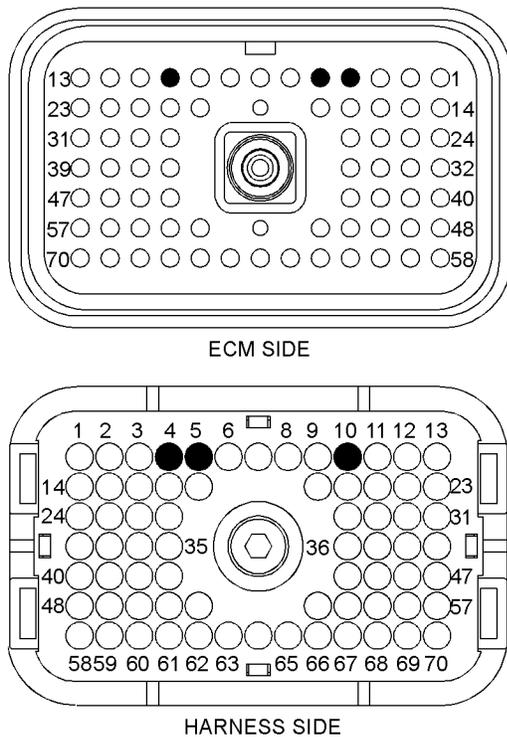


Illustration 73  
P1 ECM connector  
(P1-4) +8 V digital supply  
(P1-5) Digital return  
(P1-10) Throttle signal

g01151263

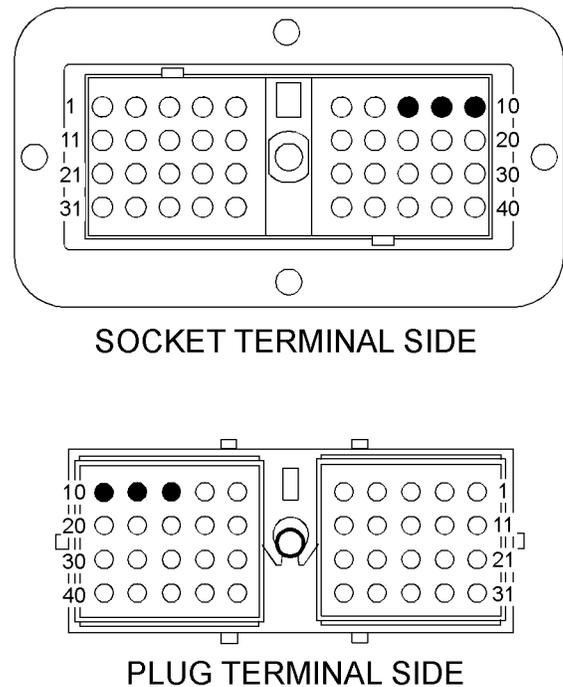


Illustration 74  
Machine connector  
(Terminal 8) +8 V digital supply  
(Terminal 9) Digital return  
(Terminal 10) Throttle signal

g01206568

### Test Step 1. Inspect the Throttle Assembly

- A. Inspect the throttle assembly for damaged components.
- B. Operate the throttle assembly through the full range of motion.

**Expected Result:**

The throttle assembly operates smoothly without excessive drag. The throttle assembly returns to the low idle position without assistance in less than one second.

**Results:**

- OK – The throttle assembly is operating correctly. Proceed to Test Step 2.
- Not OK – The throttle assembly is not operating correctly.

**Repair:** Repair the throttle assembly or replace the throttle assembly. The throttle assembly should operate smoothly without excessive drag. The throttle assembly should return to the low idle position without assistance in less than one second.

STOP.

**Test Step 2. Check the Throttle Position with Caterpillar Electronic Technician (ET)**

- Connect Cat ET to the service tool connector. Start Cat ET.
- Turn the keyswitch to the ON position.
- Observe the throttle position reading on Cat ET.
- Depress the throttle and release the throttle.

**Expected Result:**

The throttle position reads 0 percent when the throttle pedal is released. The throttle position increases to 100 percent when the throttle pedal is fully depressed.

**Results:**

- OK – The throttle position reads 0 percent when the throttle pedal is released. The throttle position increases to 100 percent when the throttle pedal is fully depressed. The throttle position sensor is OK.

**Repair:** There may be an intermittent problem. If the problem is intermittent, perform the diagnostic functional test Troubleshooting, “Inspecting Electrical Connectors”.

STOP.

- Not OK – The throttle position does not read 0 percent when the throttle pedal is released. The throttle position does not increase to 100 percent when the throttle pedal is fully depressed. The ECM is not receiving a correct signal from the sensor. There may be a problem in the harness. Proceed to Test Step 3.

**Test Step 3. Check the 8 Volt Sensor Supply at the Throttle Position Sensor Connector**

- Turn the keyswitch to the OFF position.
- Disconnect the connector for the throttle position sensor.
- Turn the keyswitch to the ON position.
- Measure the sensor supply voltage at the connector between Terminal A and Terminal B.

**Expected Result:**

The voltage is  $8.0 \pm 0.4$  VDC.

**Results:**

- OK – The voltage is  $8.0 \pm 0.4$  VDC. The supply voltage is reaching the sensor. Proceed to Test Step 4.
- Not OK – The voltage is not  $8.0 \pm 0.4$  VDC. The supply voltage is not reaching the sensor. Proceed to Test Step 7.

**Test Step 4. Check the Duty Cycle at the Throttle Position Sensor Connector**

- Turn the keyswitch to the OFF position.
- Remove wire F702-GN from Terminal C at the sensor connector.
- Turn the keyswitch to the ON position.
- Measure the duty cycle between wire F702-GN and Terminal B at the sensor connector.

**Note:** Set the multimeter to “VDC”. Press the “Hz” button twice so that the % symbol is displayed.

- Depress the throttle and release the throttle.
- Turn the keyswitch to the OFF position.
- Reconnect all connectors and wires.

**Expected Result:**

The duty cycle is between 6 and 10 percent when the throttle is released. The duty cycle is between 85 and 94 percent when the throttle is fully depressed.

**Results:**

- OK – A valid duty cycle is present at the sensor connector. Proceed to Test Step 5.
- Not OK – A valid duty cycle is not present at the sensor connector.

**Repair:** Replace the throttle position sensor. Verify that the new sensor is operating correctly.

STOP.

**Test Step 5. Check the Duty Cycle at the ECM**

- A. Remove wire F702-GN from P1-10 at the ECM connector P1.
- B. Turn the keyswitch to the ON position.
- C. Measure the duty cycle between wire F702-GN and P1-5 of ECM connector J1/P1.

**Note:** Set the multimeter to “VDC”. Press the “Hz” button twice so that the % symbol is displayed.

- D. Depress the throttle and release the throttle.
- E. Turn the keyswitch to the OFF position.
- F. Reconnect all connectors and wires.

**Expected Result:**

The duty cycle is between 6 and 10 percent when the throttle is released. The duty cycle is between 85 and 94 percent when the throttle is fully depressed.

**Results:**

- OK – A valid duty cycle is present at the ECM connector. Proceed to Test Step 6.
- Not OK – A valid duty cycle is not present at the ECM connector.

**Repair:** There is a problem in the wiring and/or connectors between the ECM and the throttle position sensor. Repair the connectors or wiring and/or replace the connectors or wiring.

STOP.

**Test Step 6. Check the Throttle Position with the Cat ET**

- A. Turn the keyswitch to the ON position.
- B. Observe the throttle position on Cat ET.

C. Depress the throttle and release the throttle.

D. Turn the keyswitch to the OFF position.

**Expected Result:**

The throttle position reads 0 percent when the throttle pedal is released. The throttle position increases to 100 percent when the throttle pedal is fully depressed.

**Note:** The throttle position on Cat ET will not match the percent duty cycle on the multimeter.

**Results:**

- OK – The throttle position reads 0 percent when the throttle pedal is released. The throttle position increases to 100 percent when the throttle pedal is fully depressed. The throttle position sensor is OK. There is an intermittent problem in the wiring and/or connectors between the ECM and the throttle position sensor.

**Repair:** If the problem is intermittent, perform the diagnostic functional test Troubleshooting, “Inspecting Electrical Connectors”.

STOP.

- Not OK – The throttle position does not read 0 percent when the throttle pedal is released. The throttle position does not increase to 100 percent when the throttle pedal is fully depressed.

**Repair:** The ECM is not reading the throttle position sensor signal correctly. Replace the ECM. Refer to the diagnostic procedure Troubleshooting, “Replacing the ECM.”.

STOP.

**Test Step 7. 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 P1-60 (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 P1-60 (sensor return).

**G.** Remove electrical power from the ECM.

**Expected Result:**

Each voltage measurement is  $8.0 \pm 0.4$  VDC.

**Results:**

- OK – The voltage measurement is  $8.0 \pm 0.4$  VDC. The ECM is operating correctly.

**Repair:** There is a open in one of the supply wires or there is a short in one of the supply wires. Repair the wire(s). Closely inspect the terminal at the machine connector. Refer to Illustration 74 for the correct terminals at the machine connector.

STOP.

- Not OK – The voltage measurement is not  $8.0 \pm 0.4$  VDC.

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

STOP.

i02414014

## User Defined Shutdown Input

**SMCS Code:** 1901-038

**System Operation Description:**

Use this procedure to troubleshoot any suspect problems with the user defined shutdown input. Use this procedure if the code in Table 41 is active or easily repeated.

Table 41

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
E265 User Defined Shutdown	The engine's Electronic Control Module (ECM) detects ground on the input for the user defined shutdown.	The code is logged.

The user defined shutdown can be connected to a device in the electrical system that would shut down the engine for any reason. When the signal is grounded, an event code is logged in memory and the injection signals from the ECM stop. Verify that the user has activated the user defined shutdown input.

The input must be pulled below 0.5 VDC for one second before the ECM will recognize the shutdown signal.

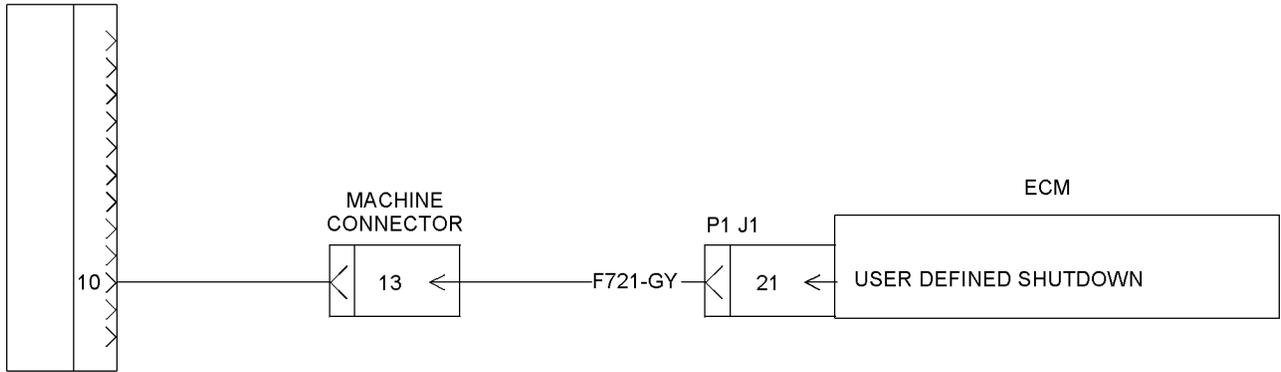


Illustration 75  
Typical schematic

g01206647

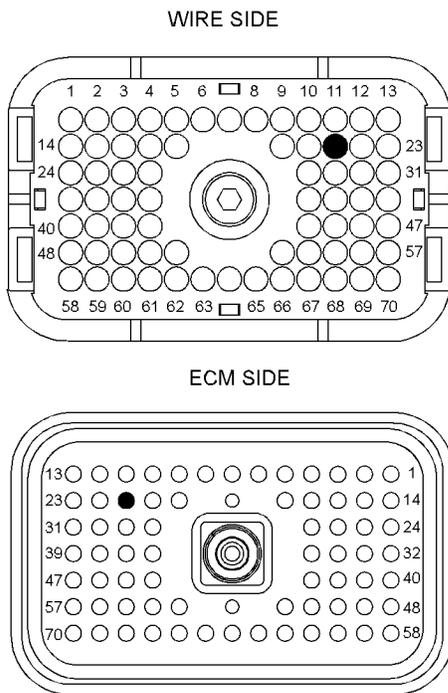


Illustration 76  
P1 ECM Connector  
(P1-21) User defined shutdown

g01206650

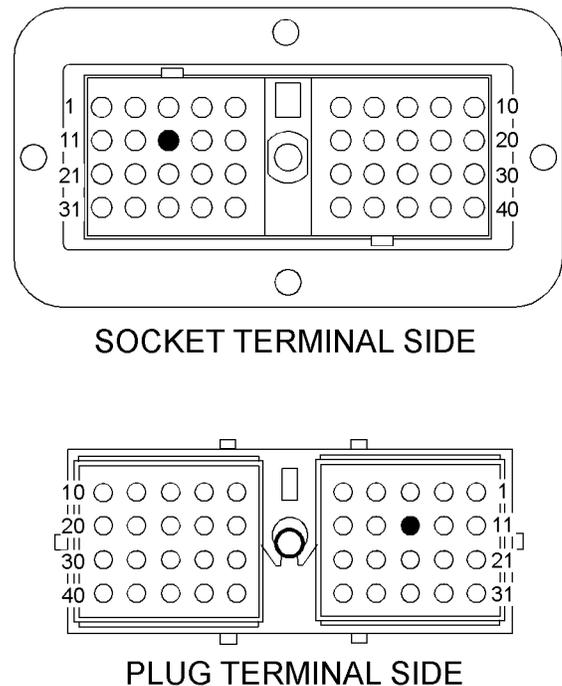


Illustration 77  
Machine Connector  
(Terminal 13) User defined shutdown

g01206655

### Test Step 1. Inspect Electrical Connectors and Wiring

- A. Turn the keyswitch to the OFF position.
- B. Thoroughly inspect the ECM connector J1/P1. Inspect all of the other connectors. Refer to Troubleshooting, "Inspecting Electrical Connectors" 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 allen head screw on each ECM connector for the proper torque. Refer to Troubleshooting, "Inspecting Electrical Connectors" for the correct torque values.
- E. Check the harness and the wiring for abrasion and for pinch points.

**Expected Result:**

The connectors and wiring are free of the following problems: damage, corrosion, abrasion, and incorrect attachment.

**Results:**

- OK – The connectors and wiring are OK. Proceed to Test Step 2.
- Not OK – The connectors and/or wiring need repair.

**Repair:** Repair the connectors and/or wiring or replace the connectors or wiring.

STOP.

**Test Step 2. Check the Status of the User Defined Shutdown on Caterpillar Electronic Technician (ET)**

- A. Ensure that the user defined shutdown switch is in the OFF position.
- B. Connect Cat ET to the service tool connector. Start Cat ET.
- C. Engage the parking brake.
- D. Turn the keyswitch to the ON position.
- E. Observe the status for the user defined shutdown on Cat ET.

**Expected Result:**

The status reads "OFF".

**Results:**

- OK – The status reads "OFF". The status is correct. Proceed to Test Step 3.
- Not OK – The status does not read "OFF". The status is incorrect. Proceed to Test Step 4.

**Test Step 3. Create a Short at the Connector for the User Defined Shutdown**

- A. Use a jumper wire with a socket terminal at one end to short wire F721-GY to the chassis ground. Create the short at the connector for the user defined shutdown.

**Expected Result:**

Cat ET indicates "User Shutdown ON" when the wire F721-GY is shorted to chassis ground.

**Results:**

- OK – Cat ET indicates "User Shutdown ON" when the wire F721-GY is shorted to chassis ground. Cat ET indicates the correct status. The shutdown feature is working properly.

**Repair:** There may be an intermittent problem. If the problem is intermittent, refer to Troubleshooting, "Inspecting Electrical Connectors".

STOP.

- Not OK – Cat ET does not indicate "User Shutdown ON" when the wire F721-GY is shorted to chassis ground. Cat ET does not show the correct status. Proceed to Test Step 5.

**Test Step 4. Check the Harness for a Short Circuit**

- A. Turn the keyswitch to the OFF position.
- B. Disconnect ECM connector J1/P1.
- C. Measure the resistance at the ECM connector between P1-21 and every pin in ECM connector P1.
- D. Measure the resistance at the ECM connector between P1-21 and the engine ground.

**Expected Result:**

The resistance measurement indicates an open circuit.

**Results:**

- OK – The resistance measurement indicates an open circuit. Proceed to Test Step 6.
- Not OK – The resistance measurement does not indicate an open circuit. There is a short circuit in the harness or a user defined device is activating the shutdown feature.

**Repair:** Repair the connectors and/or wiring or replace the connectors or wiring.

STOP.

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

**A.** Measure the resistance at the ECM connector between P1-21 and engine ground.

**B.** Remove the wire short.

#### Expected Result:

The resistance measurement indicates a short circuit.

#### Results:

- OK – The resistance measurement indicates a short circuit. The resistance is within acceptable limits. Proceed to Test Step 6.
- Not OK – The resistance measurement does not indicate a short circuit. There is an open circuit or excessive resistance in the harness.

**Repair:** Repair the connectors and/or wiring or replace the connectors or wiring.

STOP.

### Test Step 6. Short the Wire at the ECM

**A.** Remove the wire from the ECM connector at P1-21.

**B.** Insert a wire with a socket terminal at one end into the ECM connector at P1-21.

**C.** Reconnect ECM connector J1/P1.

**D.** Turn the keyswitch to the ON position.

**E.** Momentarily short the jumper wire at P1-21 to the chassis ground.

**F.** Turn the keyswitch to the OFF position.

**G.** Remove the wire short. Reconnect ECM connector J1/P1.

#### Expected Result:

Cat ET indicates “User Shutdown ON” with the wire short in place. Cat ET indicates “User Shutdown OFF” when the wire short is removed.

#### Results:

- OK – Cat ET indicates “User Shutdown ON” with the wire short in place. Cat ET indicates “User Shutdown OFF” when the wire short is removed. Cat ET indicates the correct status. The feature is working properly.

**Repair:** Repair the connectors and/or wiring or replace the connectors or wiring. There may be an intermittent problem. If the problem is intermittent, refer to Troubleshooting, “Inspecting Electrical Connectors”.

STOP.

- Not OK – Cat ET does not indicate “User Shutdown ON” with the wire short in place. Cat ET does not indicate “User Shutdown OFF” when the wire short is removed. Cat ET does not indicate the correct status.

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

STOP.

i02414188

## Wastegate Solenoid

**SMCS Code:** 1057-038

#### System Operation Description:

Use this procedure to troubleshoot any suspect problems with the wastegate solenoid.

Use this procedure if a problem is suspected with the wastegate solenoid or if any one of the diagnostic codes in Table 42 is active or easily repeated.

Table 42

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
MID 0036 - CID 0526 - FMI 05 Turbo Wastegate Drive current low	The engine's Electronic Control Module (ECM) detects an open circuit and/or a short circuit to the +Battery terminal at the output to the wastegate solenoid.	The code is logged.
MID 0036 - CID 0526 - FMI 06 Turbo Wastegate Drive current high	The ECM detects a short circuit to ground at the output to the wastegate solenoid.	

The wastegate control solenoid controls the air pressure to the wastegate. The wastegate contains a valve that controls the amount of exhaust gas that will bypass the turbocharger. This allows the ECM to control the turbocharger outlet pressure or boost pressure. The engine's ECM varies the current level to the wastegate control solenoid in order to maintain the desired boost pressure. For further information, refer to Service Manual, SENR5092, "Exhaust Bypass for 793, 793B, and 793C Off-Highway Trucks".

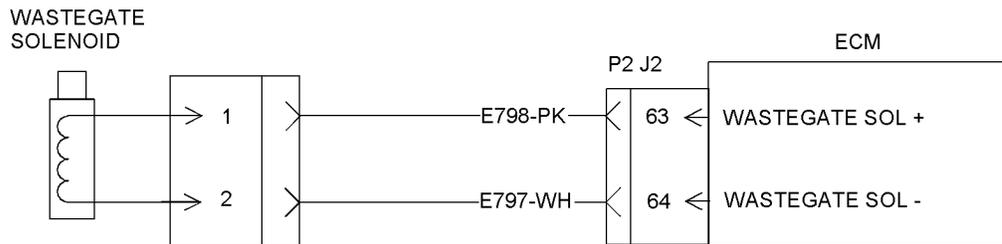


Illustration 78  
Typical schematic

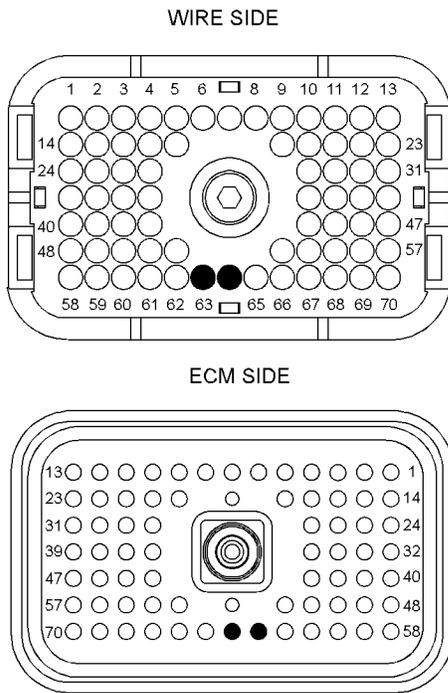


Illustration 79 g01206723  
P2 ECM connector  
(P2-63) "Wastegate solenoid (+)"  
(P2-64) "Wastegate solenoid (-)"

### Test Step 1. Check for Connector Damage

- A. Turn the keyswitch to the OFF position.
- B. Thoroughly inspect the ECM connector J2/P2. Inspect all of the other connectors. Refer to Troubleshooting, "Inspecting Electrical Connectors" 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, "Inspecting Electrical Connectors" for details.
- E. Check the harness and the wiring for abrasion and for pinch points.

#### Expected Result:

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

#### Results:

- OK – The connectors and wiring are OK. Proceed to Test Step 2.
- Not OK – The connectors and/or wiring need repair.

**Repair:** Repair the connectors or wiring and/or replace the connectors or wiring.

STOP.

### Test Step 2. Check for an "Active" Diagnostic Code

- A. Connect Caterpillar Electronic Technician (ET) to the service tool connector.
- B. Restore electrical power to the ECM.
- C. Select the override for the wastegate on Cat ET.
- D. Set the override for the wastegate to 100 percent.
- E. 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.

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

- 05
- 06

#### 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, "Inspecting Electrical Connectors".

STOP.

- Not OK – A 06 diagnostic code is active at this time. Proceed to Test Step 3.

- Not OK – A 05 diagnostic code is active at this time. Proceed to Test Step 4.

### Test Step 3. Create an Open at the Connector for the Wastegate Solenoid

- A. Turn the keyswitch to the OFF position.
- B. Disconnect the connector for the wastegate solenoid.
- C. Turn the keyswitch to the ON position.
- D. Proceed to the “Diagnostic Overrides” screen on Cat ET.
- E. Select the override for the wastegate solenoid on Cat ET.
- F. Set the override for the wastegate solenoid to 100 percent.
- G. Check for a 05 diagnostic code for the wastegate solenoid.

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

- H. Turn the keyswitch to the OFF position.

#### Expected Result:

A 05 diagnostic code is now active for the wastegate solenoid.

#### Results:

- OK – A 06 diagnostic code was active before disconnecting the connector. A 05 diagnostic code became active after disconnecting the connector. The engine harness and the ECM are OK.

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

STOP.

- Not OK – A 06 diagnostic code remains active. There is a short between the connector for the wastegate solenoid and the ECM. Leave the connector for the wastegate solenoid disconnected. Proceed to Test Step 5.

### Test Step 4. Create a Short at the Connector for the Wastegate Solenoid

- A. Turn the keyswitch to the OFF position.

- B. Install a jumper wire between terminal 1 and terminal 2 of the connector for the wastegate solenoid.
- C. Turn the keyswitch to the ON position.
- D. Proceed to the “Diagnostic Overrides” screen on Cat ET.
- E. Select the override for the wastegate on Cat ET.
- F. Set the override for the wastegate to 100 percent.
- G. Wait at least 30 seconds for activation of the 06 diagnostic code.
- H. Turn the keyswitch to the OFF position. Remove the wire jumper.

#### Expected Result:

A 06 diagnostic code is active when the jumper wire is installed. A 05 diagnostic code is active when the jumper wire is removed.

#### Results:

- OK – A 06 diagnostic code is active when the jumper wire is installed. A 05 diagnostic code is active when the jumper wire is removed. The engine harness and the ECM are OK.

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

STOP.

- Not OK – The 05 diagnostic code remains active with the jumper in place. There is an open circuit between the ECM and the connector for the wastegate solenoid. Proceed to Test Step 5.

### Test Step 5. Test the Operation of the ECM

- A. Turn the keyswitch to the OFF position.
- B. Fabricate jumper wires that can be used to replace the wire(s) in the ECM connector for the wastegate solenoid. Crimp a connector socket to one end of the jumper wires.
- C. Disconnect the appropriate ECM connector for the wastegate solenoid.
- D. Remove the wire(s) for the wastegate solenoid from the ECM connector.

E. Install the jumper wire(s) into the terminal location(s) for the wastegate solenoid at the ECM connector.

F. Connect the ECM connectors.

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

- a. Hold the loose end of the jumper wires away from any components in order to create an open circuit condition.
- b. Turn the keyswitch to the ON position.
- c. Proceed to the “Diagnostic Overrides” screen on Cat ET.
- d. Select the override for the wastegate solenoid on Cat ET.
- e. Set the override for the wastegate to 100 percent.
- f. Monitor the “Active Diagnostic Code” screen on Cat ET.

Check the wastegate solenoid for an active 05 diagnostic code.

**Note:** Wait at least 30 seconds so that any codes may become active.

- g. Turn the keyswitch to the OFF position.

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

- a. Short the jumpers for the return wire and the output wire together.
- b. Turn the keyswitch to the ON position.
- c. Proceed to the “Diagnostic Overrides” screen on Cat ET.
- d. Select the override for the wastegate solenoid on Cat ET.
- e. Set the override for the wastegate to 100 percent.
- f. Monitor the “Active Diagnostic Code” screen on Cat ET.

Check the wastegate solenoid for an active 06 diagnostic code.

**Note:** Wait at least 30 seconds so that any codes may become active.

I. Turn the keyswitch to the OFF position. Reconnect all wires to the original configuration.

**Expected Result:**

A 05 diagnostic code is active when the wires from the wastegate solenoid are open at the ECM connector. A 06 diagnostic code is active if the wires from the wastegate solenoid are shorted at the ECM connector.

**Results:**

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

**Repair:** Repair the connectors or wiring and/or replace the connectors or wiring.

STOP.

- Not OK – One of the following conditions exists: The 05 diagnostic code is not active when the wire for the wastegate solenoid is disconnected. The 06 diagnostic code is not active when the wire jumper is installed.

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

STOP.

# Calibration Procedures

i02415146

## Engine Speed/Timing Sensor - Calibrate

**SMCS Code:** 1912-524

### System Operation Description:

Use this procedure if the diagnostic code in Table 43 is active.

Table 43

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
MID 0036 - CID 0091 - FMI 08 Throttle Position signal abnormal	The engine's speed/timing sensor needs calibration.	The code is active only.

The engine speed/timing sensor is calibrated through a two-step process. A new timing reference is calculated first. The reference is based on the signals from the transducer and the engine speed/timing sensor. Next, the new timing reference is programmed into the permanent memory of the engine's Electronic Control Module (ECM).

The engine speed/timing sensor provides engine information to the ECM. The ECM powers the engine speed/timing sensor with  $12.5 \pm 1.0$  VDC. The sensor senses the tooth pattern on the timing reference gear that is attached to the left camshaft. As the timing gear rotates past the engine speed/timing sensor, a signal is generated in the sensor. This signal is sent to the ECM. The ECM uses this signal in order to calculate the engine position and the engine speed.

A loss of the engine speed/timing signal causes the ECM to stop sending power to the fuel injectors.

Calibration of the timing is required only after the following circumstances:

- The ECM has been replaced.
- The speed/timing sensor has been replaced.
- The timing gear and/or the rear gear train have been adjusted.
- The timing gear and/or the rear gear train have been replaced.

### Test Step 1. Check for an "ACTIVE" Diagnostic Code.

**A.** Turn the keyswitch to the OFF position.

**B.** Connect Caterpillar Electronic Technician (ET) to the service tool connector.

**C.** Remove the timing calibration plug from the flywheel housing.

**D.** Examine the flywheel through the timing calibration hole. Ensure that the probe is not inserted into the timing pin hole. If necessary, rotate the engine.

**E.** Install the 6V-3093 Transducer Adapter into the hole for the timing calibration at the flywheel.

**F.** Insert the 6V-2197 Transducer through the 6V-3093 Transducer Adapter. Insert the transducer until contact is made with the surface of the flywheel. Move the transducer 0.9 mm (0.04 inch) away from the flywheel.

---

#### NOTICE

Do not install the timing calibration probe over the timing pin hole in the flywheel or damage will result.

---

**G.** Tighten the nut on the 6V-3093 Transducer Adapter.

**H.** Connect the 7X-1695 Cable As between the transducer and the timing calibration connector P26.

**I.** Turn the keyswitch to the START position.

**J.** Start the engine. Allow the engine to exit cold mode operation.

**K.** Monitor the diagnostic codes on Cat ET. Check and record any diagnostic codes.

**Note:** Wait at least 15 seconds in order for the diagnostic codes to become active.

**Expected Result:**

Only the 261-13 diagnostic code is active.

**Results:**

- OK – The 261-13 is the only active code at this time. Proceed to Test Step 2.
- Not OK – The 261-13 is not the only active code at this time.

**Repair:** Repair any active diagnostic codes. Other active diagnostic codes will cause the calibration procedure to fail.

STOP.

## Test Step 2. Calibration

**Note:** The engine speed/timing sensor is calibrated through a two-step process. A new timing reference is calculated first. The reference is based on the signals from the transducer and the engine speed/timing sensor. Next, the new timing reference is programmed into the permanent memory of the engine's ECM.

- A. Select "Service" from the main menu on Cat ET. Select "Calibrations" from the drop-down menu. Select "Timing Calibration".
- B. Press the "Continue" button on Cat ET.

**Note:** Engine speed will be set to 800 rpm by the ECM during the calibration procedure.

Cat ET will indicate "Please wait...Calculating the new Timing Reference". After a few moments, Cat ET will display "The ECM has calculated the Timing Reference" and "Choose the Continue button to program the Timing Reference".

**Note:** If the Cat ET screen shows "CALIBRATION UNSUCCESSFUL", the electronic injection timing has not been set.

**Expected Result:**

The Cat ET screen shows "CALIBRATION SUCCESSFUL".

**Results:**

- OK – The timing calibration was successful.

**Repair:** Disconnect the timing calibration probe before you exit the "Timing Calibration" screen on Cat ET. Reset the system and check for any diagnostic codes.

STOP.

- Not OK – The timing did not calibrate.

**Repair:** Excessive backlash in the engine gear train will cause inconsistent timing. Refer to the Systems Operation/Testing and Adjusting manual for information on engine timing.

STOP.

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